MI POWER GRID

Making the Most of Michigan's Energy Future

New Technologies and Business Models

Stakeholder Meeting 7: Microgrids

The meeting will begin promptly at 1:00 pm.

April 21, 2021

1PM – 5 PM

MPSC

Michigan Public Service Commission

MI POWER GRID

Making the Most of Michigan's Energy Future

New Technologies and Business Models: Welcome and Overview

Joy Wang

WangJ3@Michigan.gov

Smart Grid Section

Michigan Public Service Commission

MPSC

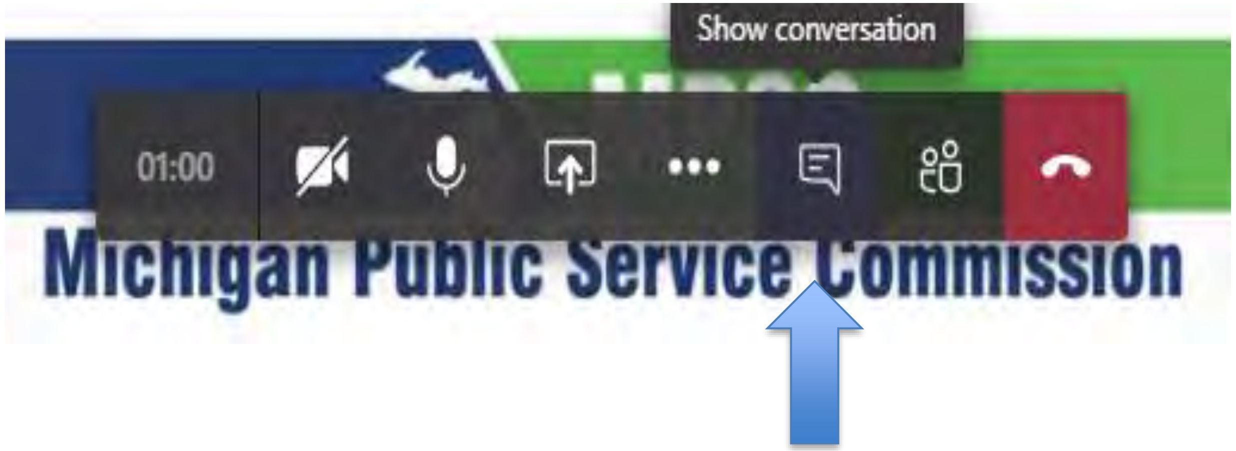
Michigan Public Service Commission

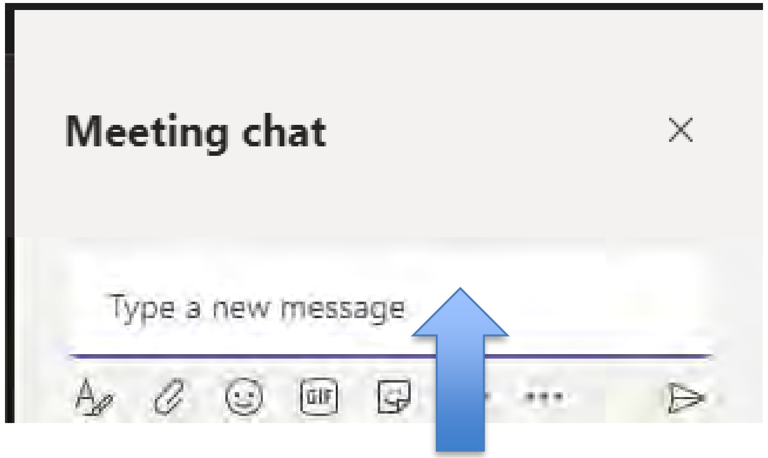
Agenda: Microgrids

1:00 pm	Welcome & Opening Statements	Joy Wang, MPSC Staff, and Katherine Peretick, Commissioner, MPSC
1:05 pm	Microgrid Resilience: Case Study of Energy Storage Applications & Planning Considerations	Jeremy Twitchell, Pacific Northwest National Laboratory
1:30 pm	Microgrid Applications and Business Cases	Douglas Gagne, National Renewable Energy Laboratory
1:55 pm	Veridian Living Community Microgrid: How a Neighborhood Can Emulate a Forest	Matt Grocoff, THRIVE Collaborative
2:07 pm	Smart Neighborhood Microgrid	Juan Shannon, Parker Village
2:19 pm	Break	
2:30 pm	*Panel: Business Perspectives on Microgrid Development* Sam Barnes, Commonwealth Mark Feasel, Schneider Electric Robert Rafson, Charthouse Energy	Moderator: Cory Connolly, Michigan Energy Innovation Business Council
3:25 pm	Break	
3:30 pm	Microgrid Applications and Benefits	Paul Connors, John Vernacchia, & Harold Ruckpaul, Eaton Corp
4:00 pm	UT Austin’s Microgrid	Juan Ontiveros, The University of Texas at Austin
4:15 pm	TBD	Steve Swinson, Thermal Energy Corporation
4:30 pm	*Panel: Utility Microgrid Perspectives* Carlos Casablanca, AEP Service Corporation Husaninder Singh, DTE Energy Nate Washburn, Consumers Energy	Moderator: Arindam Maitra, Electric Power Research Institute
5:00 pm	Closing Statements & Adjourn	Joy Wang, MPSC Staff

Housekeeping

- This meeting is being recorded
- Slides available and recording will be posted on workgroup website within a week
- All audience members will be muted
- Please type questions into the chat box
    - To access chat box:





- Staff will ask chat box questions during Q&A

Housekeeping, cont.

- During the meeting, if clarification of your question is needed, we will ask you to unmute.
  - To unmute:
    - Phone: Press *6
    - Teams: Click mic button
  - Please mute yourself again after your clarification.
- Chat box may note when audience members enter/exit.
  - These notices are automatic:

- If you are not a session speaker, please turn off your video.
- If Teams via web browser is not working, try a different web browser.
  - All work except Safari
- Please share your thoughts on the meeting with us by filling out the survey.

Making the Most of Michigan's Energy Future

Opening Remarks

Katherine Peretick
Commissioner
Michigan Public Service Commission

Stakeholder Meeting 7: Microgrids
April 21, 2021

MPSC
Michigan Public Service Commission

Microgrid Resilience: Case Study of Energy Storage Applications & Planning Considerations

Jeremy Twitchell

Energy Research Analyst

Pacific Northwest National Laboratory

Microgrid Resilience: Case Study of Energy Storage Applications & Planning Considerations

April 21, 2021

Jeremy Twitchell

MI Power Grid: New Technologies and Business Models Workgroup #7 – Microgrids

PNNL is operated by Battelle for the U.S. Department of Energy

Acknowledgment

The work described in this presentation is made possible through the funding provided by the U.S. Department of Energy's Office of Electricity, through the Energy Storage Program under the direction of Dr. Imre Gyuk.

Agenda

- Reliability and Resilience
- Proposed Resilience Planning Framework
- Resilience Case Studies
- Summary and Takeaways

Reliability and Resilience

Obstacles to Resilience

Problem Statement:

"Reliability" is an objective concept, defined by these standards:

- Mandatory Enforcement Standards (NERC has 98 of them),
- Additional Voluntary Standards (NERC has 484 of them), and
- Reporting Metrics (IEEE 1366-2012)

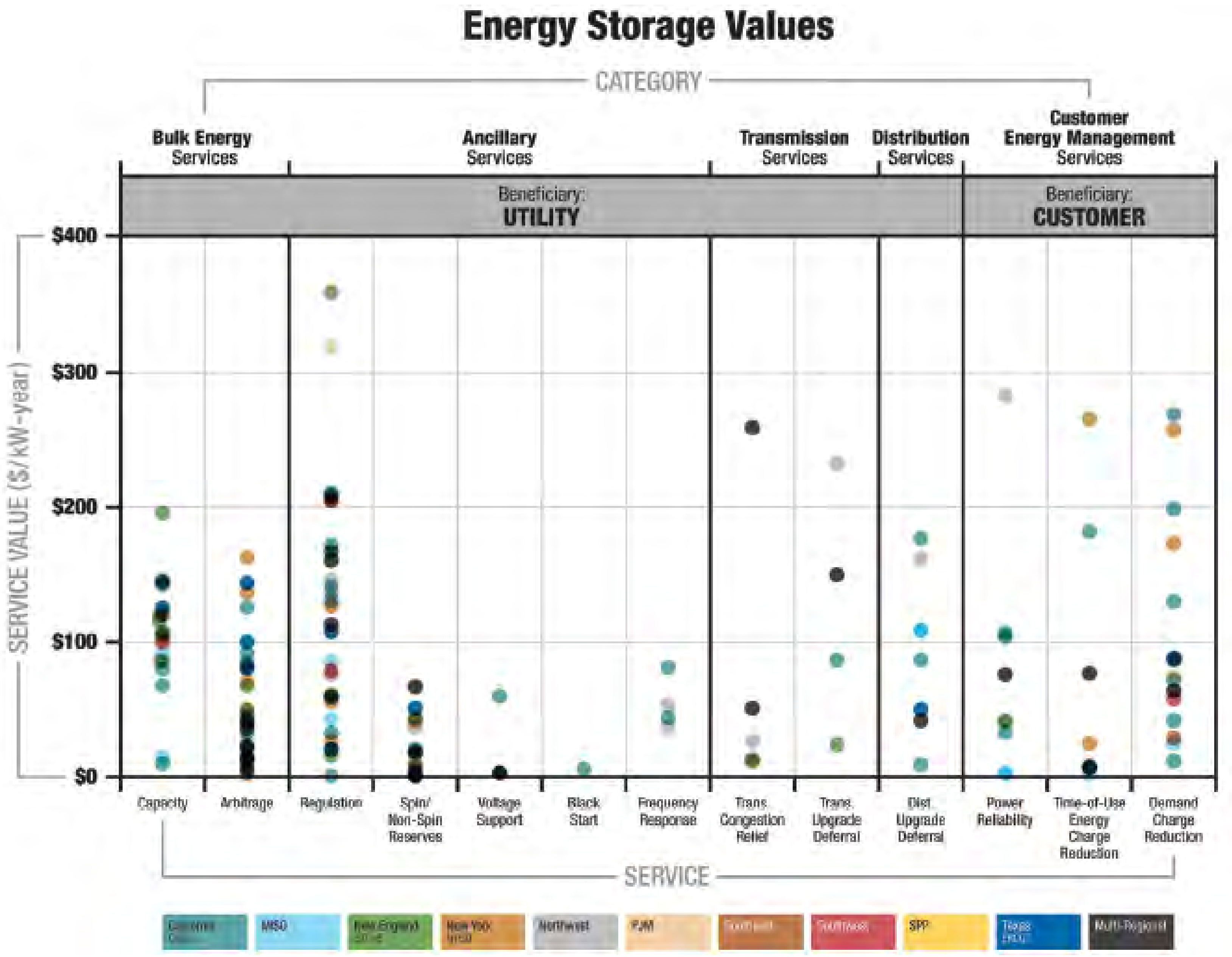
Standards facilitate the development of tangible planning objectives and make reliability a monetizable service. Reliability standards are firm requirements that a utility **must** meet at the least cost.

"Resilience" is more subjective, lacking specific metrics and standards, or even an agreed-upon definition. It is therefore difficult to develop planning objectives for resilience or to monetize it.

- Resilience, as a standalone application, is expensive and rarely needed
- Resilience investments must provide other value-add services to the grid (e.g., energy storage)
- Costs must be assigned based on benefits

Absent similar standards, resilience is a goal that is pursued subject to cost effectiveness, and it is rarely cost effective.

Reliability Standards Create Grid Values



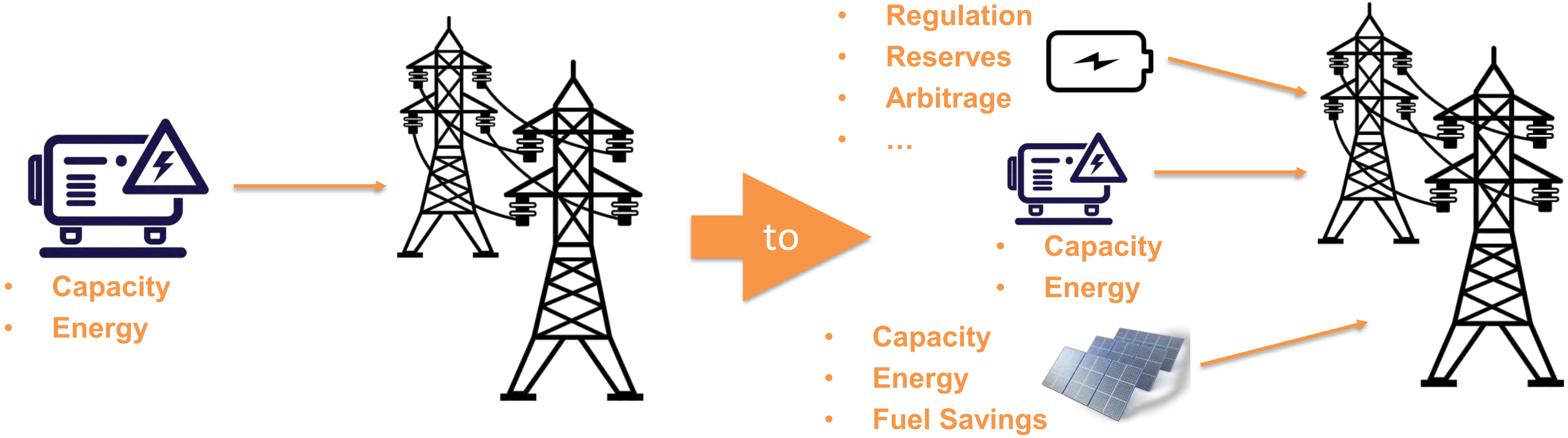
Due to its flexible nature, energy storage is uniquely capable of providing a broad range of those services, but the values of those services are dependent on many factors, and therefore vary by location.

Balducci et al, *Assigning Value to Energy Storage Systems at Multiple Points in an Electric Grid,* Energy Environ. Sci 2018, 11, 1926-1944.

Storage and Resilience: A New Paradigm

The advent of cost-competitive energy storage options has enabled us to go from:

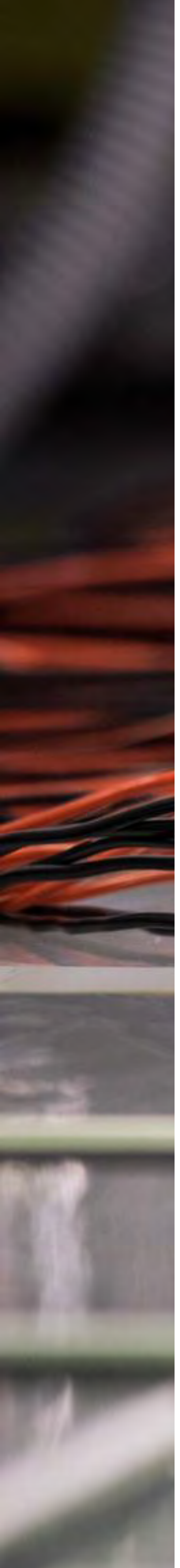
Mission-critical resilience | Economic Resilience



- Limited opportunities for grid participation
- High cost
- Limited to facilities in which resilience is mission critical

- Increased opportunities for grid participation
- Offsetting revenues reduce system costs
- Viable resilience for broader range of facilities

Full report: Planning Considerations for Energy Storage in Resilience Applications



Proposed Resilience Planning Framework

Where to Begin: Proposed Framework Overview

By rethinking resilience as a locational value, specific risks and optimal means of addressing them may be more easily identified:

1. Select site
2. Identify risks
3. Define critical loads
4. Engage in iterative planning between project and grid levels

Step One: Select Site

Questions for consideration:

- Thought exercise: If there is a complete blackout, what facilities need to be kept online?
- Some are obvious
  - Hospitals, emergency shelters, command centers
- Some are not
  - Pumping stations, prisons, ports, hotels

Key Takeaway
Resilience is a local value

Step Two: Identify Risks

Questions for consideration:

- What major events has the site experienced?
  - High winds, lightning, equipment failure
- What are the potential major events?
  - Earthquakes, tsunamis, wildfires
- Information sources
  - Utility reliability reports, local emergency management

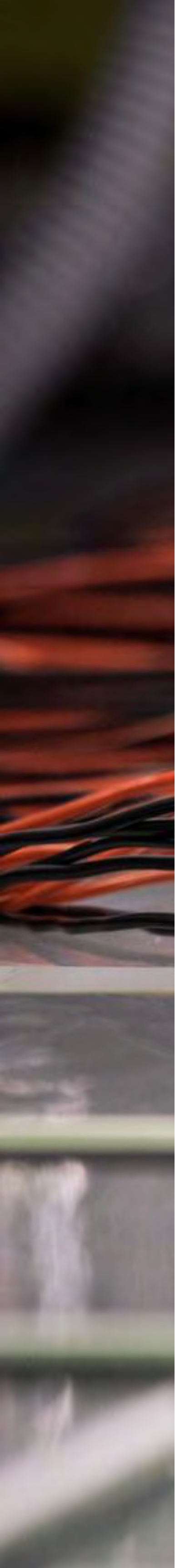
Key Takeaway
Resilience risks are site specific

Step Three: Define Critical Loads

Questions for consideration:

- What are the functions that must be maintained?
  - Entire facility, critical subset of functions?
- For how long must those loads be maintained?
  - Informed by the risk profile – what are the outage risks associated with the identified major events?
- What is an acceptable level of risk?
  - A system that has a 90% chance of meeting the desired resilience level will be much less expensive than one that is guaranteed to meet it. What are the acceptable tradeoffs?

Key Takeaway
Define success first. What are the resilient outcomes that planning should pursue?



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Step Four: Engage in Iterative, Bi-Level Planning

Questions for consideration:

- What are local grid conditions?
  - Are there specific grid services (transmission/distribution infrastructure deferral, regulation) that the grid operator needs in the area of the facility?
  - Does the local infrastructure have sufficient communications capability to support a microgrid?

Key Takeaway:
Optimal configuration will vary by location.

- What are the specific project needs?
  - What is the portfolio of resources that will meet the project's needs? Have stochastic models been used to consider a wide range of potential circumstances? Have utility tariffs (demand charges, net metering, etc.) been reflected in the planning?

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Resilience Case Studies

Emerging Models for Resilience: Military

- Marine Corps Air Station Yuma (AZ)
  - 25 MW diesel generators
  - MCAS Yuma hosts the project (in-kind donation of land)
  - Arizona Public Service built, operates the equipment
  - Under normal operating conditions, APS uses the generators to alleviate a transmission constraint
  - As project host, MCAS Yuma is guaranteed backup power in the even of a grid outage
  - 25 MW can support full facility functionality

U.S. Marine Corps/APS

Emerging Models for Resilience: Military

- Pacific Missile Range Facility (HI)
  - 19 MW PV array
  - 70 MWh battery
  - PMRF provides land
  - AES Distributed Energy builds, owns and operates the facility
    - Sells output to Kauai Island Utility Cooperative during normal operations (25-year power purchase agreement)
    - Supports PMRF during outages
  - Under development

U.S. Navy

Emerging Models for Resilience: Civilian

- **Green Mountain Power** (VT)
  - Distributed storage through cost sharing with customers
  - Customers pay $1,500 up front or $15/month
    - Receive a 7kW/13.5kWh Tesla Powerwall
  - Utility controls the devices; primarily uses them for peak shaving
    - Shaved ~3.5 MW off 2018 peak; saved $500k for all customers
  - Participating customers also receive backup power and time-of-use rate management
  - Fully subscribed (2,000 customers); has evolved into a bring-your-own device program

Green Mountain Power

Emerging Models for Resilience: Civilian

- **Sterling Municipal Light Department** (MA)
  - 2.4 MW Solar
  - 2 MW/3.9 MWh battery
  - Provides emergency backup power to police station and dispatch center
  - During normal operations, utility uses the microgrid to reduce monthly peaks (reduces transmission network charges) and annual peaks (ISO-NE capacity market revenue)
    - Projected annual benefits: $400,000
    - Year one benefits: $419,000
  - Supported by $250,0000 grant from U.S. DoE and analytical support from national labs
  - Projected 7-year payback

Clean Energy Group

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Summary and Takeaways

Emerging Models Summary

These projects represent a wide range of microgrid designs and uses. Despite those differences, there are several consistencies among successful projects:

- Resilience benefits are hyperlocal
  - Limited to a single facility, in some cases as small as a single residence
- Projects made economically feasible through grid services
  - Utility or knowledgeable third party operates projects to maximize value
- Key grid value drives each project
  - Peak shaving, reduced operating costs, grid constraint management
- Energy storage is a key enabling technology
  - Three projects included storage in initial project construction; fourth (AZ) studying its addition

Summary: Resilience in a Reliability-Constrained World

- Resilience as a standalone service is expensive
  - Unlike reliability, we have no standards for resilience
  - Projects must pay their own way through reliability-based services

- Energy storage represents a paradigm shift for resilience, microgrids
  - Flexible, scalable resource can provide a wide range of valuable grid services
  - Increased value reduces the net cost of resilience, broadens its availability

- Deliberate planning is needed
  - Grid level: Local grid communication and controls must be identified; local grid values must be considered
  - Project level: Stochastic analysis necessary to ensure portfolio robustness; consider values created by utility rate and tariff structures

- Resilience can be done – and it is happening with increasing frequency

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Additional Resources

- Department of Energy’s Energy Storage Grand Challenge: https://www.energy.gov/energy-storage-grand-challenge/
- PNNL Energy Storage (energystorage.pnnl.gov)
- Sandia National Laboratories (www.sandia.gov/ess/)
- DOE Global Energy Storage Database (www.energystorageexchange.org)
- Energy Storage Association (www.energystorage.org)

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Thank you

Jeremy Twitchell
jeremy.twitchell@pnnl.gov
971-940-7104

Microgrid Applications and Business Cases

Douglas Gagne

Researcher III, Economic/Financial Analysis

National Renewable Energy Laboratory

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Microgrid Applications and Business Cases

Douglas Gagne, National Renewable Energy Laboratory
April 21, 2021

Presentation Overview

Microgrid Deployments

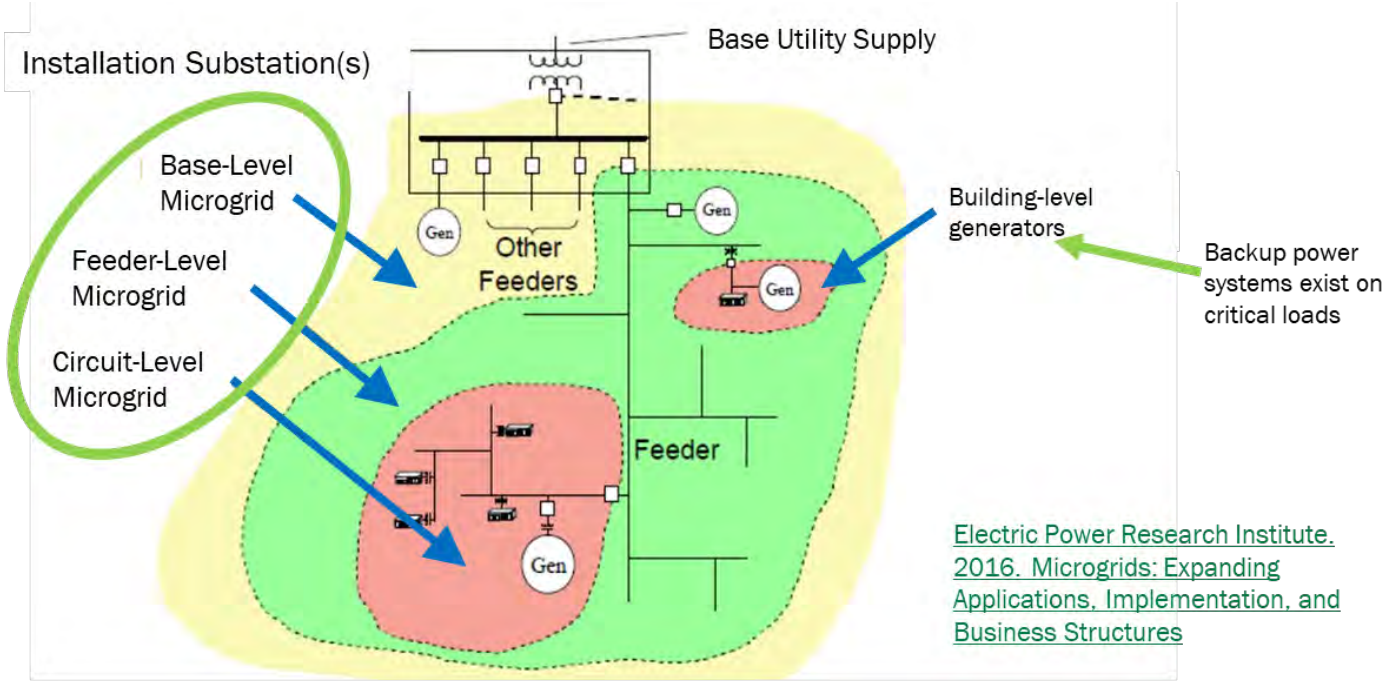
Microgrid Use Cases

Federal Microgrid Financing Approaches

Microgrid Deployments

What is a Microgrid?

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, and can operate in both grid-connected or island-mode (DOE 2011).



Electric Power Research Institute. 2016. Microgrids: Expanding Applications, Implementation, and Business Structures

Components of a Microgrid

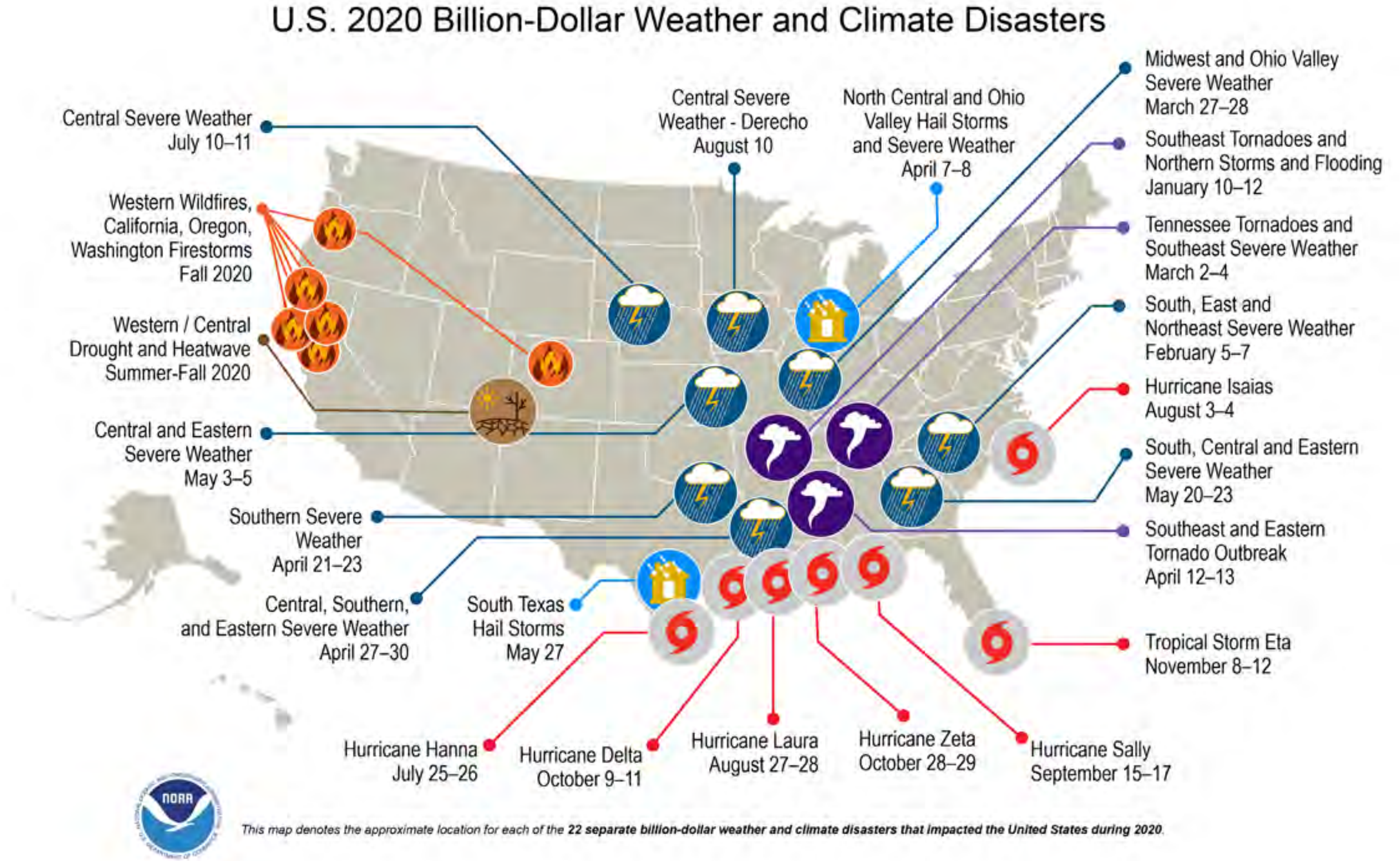
- Generation assets
- Energy storage (optional)

→ **DE project**

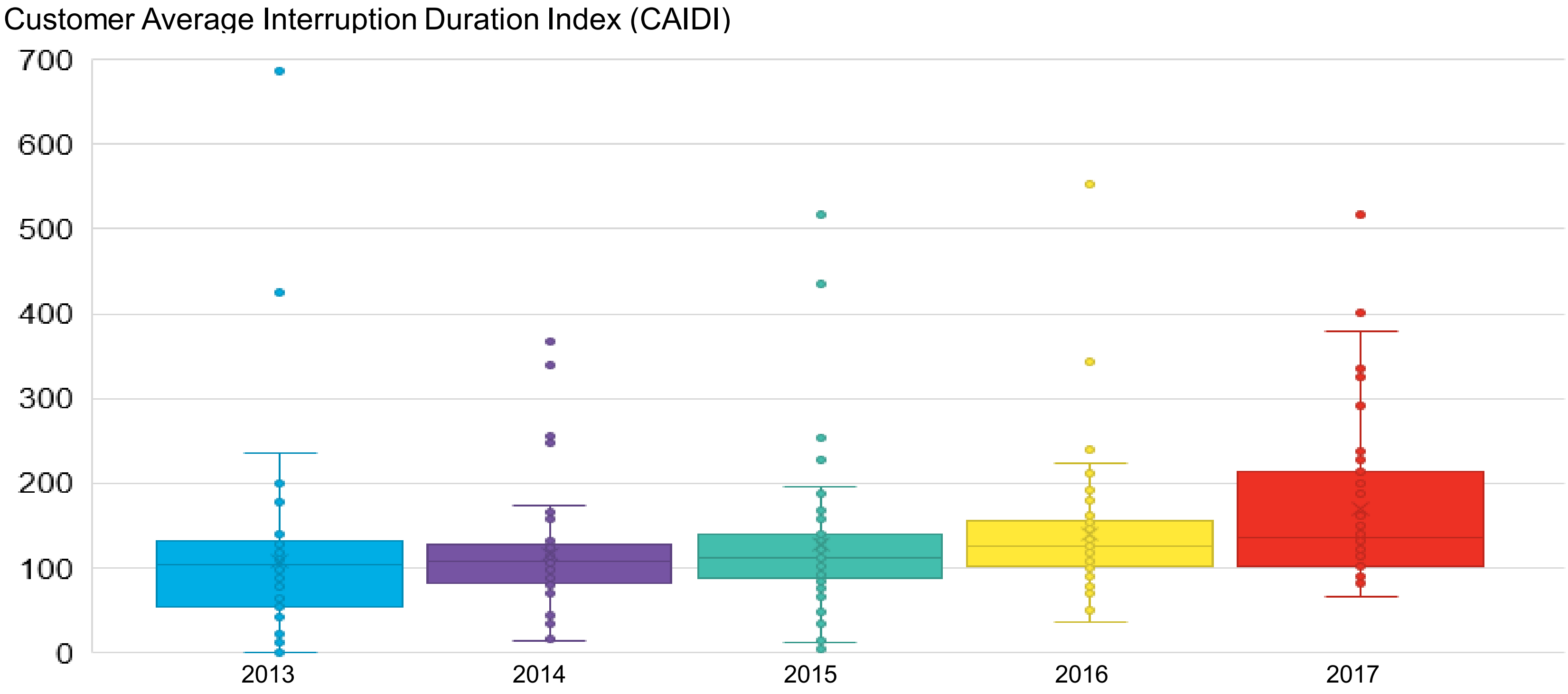
- Microgrid control hardware/software
  - Often-overlooked component
  - Can be significant portion of overall cost, especially for smaller microgrid systems
- Switching devices to island from the utility grid (can be automatic or manual)
- Conductors
- Protection devices
- Power factor correction (if needed or desired)

→ **Microgrid project**

Where are Microgrids Being Installed?

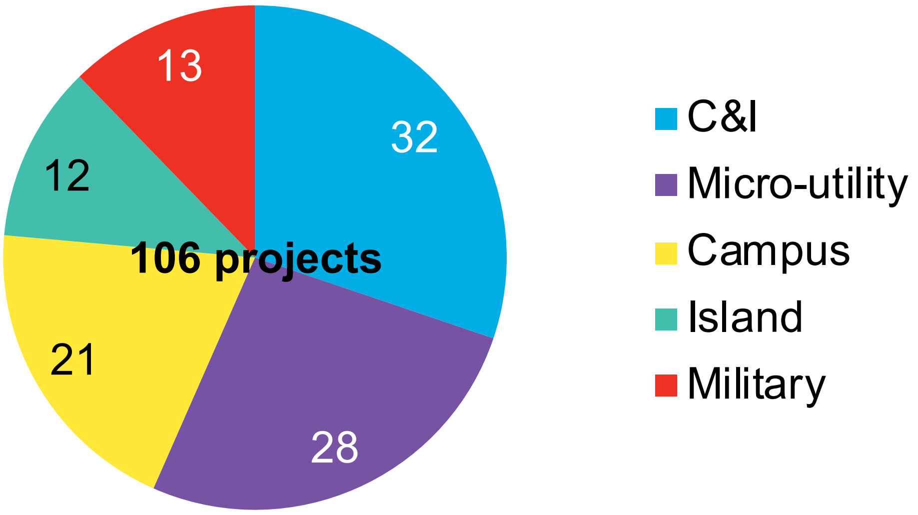


Customer Average Interruption Duration Index (CAIDI) in the US



Source: U.S. EIA, BloombergNEF.

Installed microgrids by customer segment in the US- H1-2019



Source: BloombergNEF.

Microgrid Use Cases

Do You Need a Microgrid?

A decision to pursue a microgrid is typically based on two factors:

1. **The site has a need for increased resilience:**
   - Are there critical site functions that could result in significant risk to loss of life or equipment if disrupted?
     - Examples: hospitals, flight operations, laboratory tests, emergency shelters
   - Is your utility power unreliable?

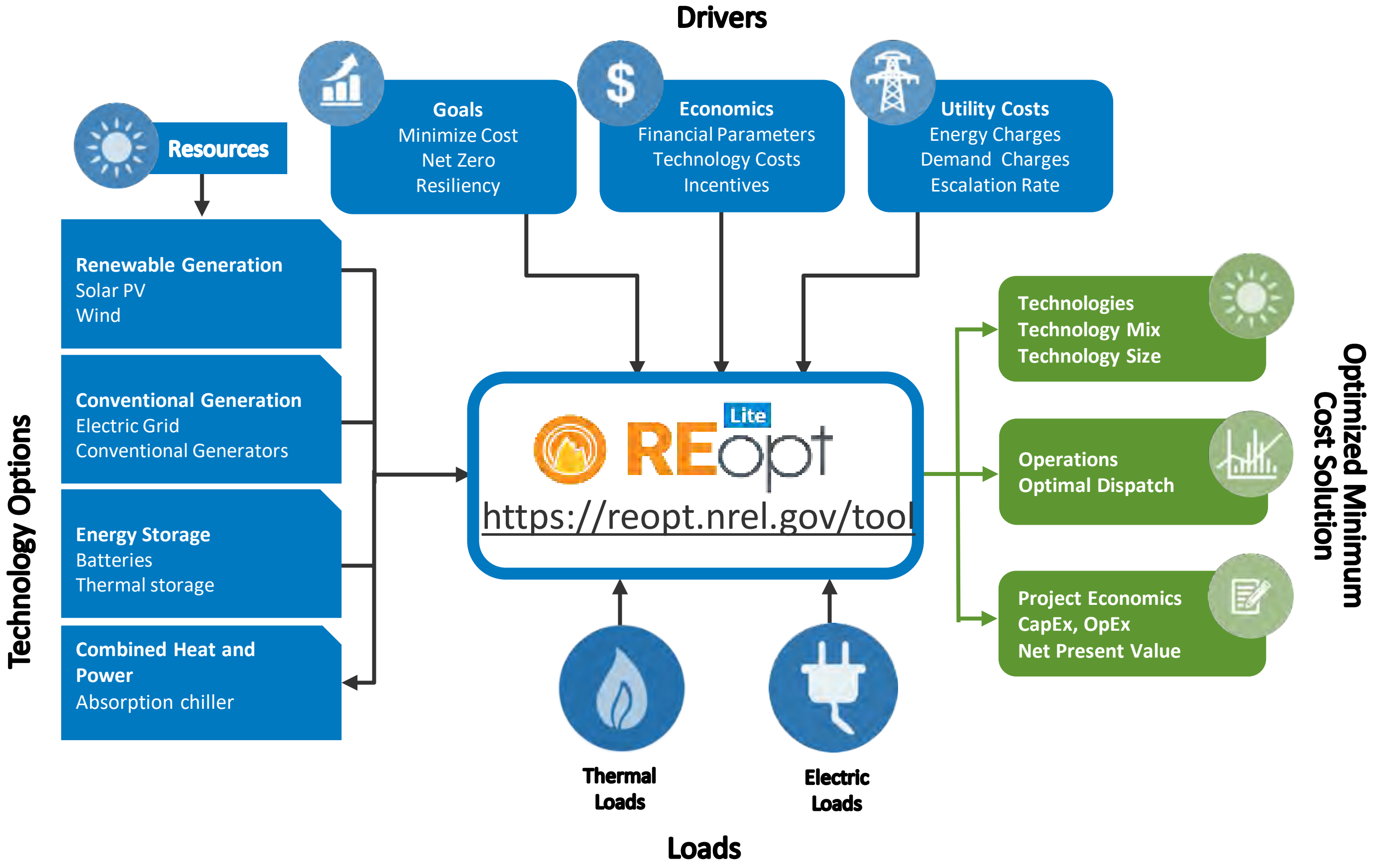
2. **The cost and economic benefits of the microgrid:**

- Is the improvement in resilience worth the added cost?
  - Microgrids are generally very expensive, because each site is different and requires tailored analysis, engineering, and equipment.
- Can the microgrid provide savings during normal operations?
  - Microgrids can provide a variety of financial benefits, including: Peak shaving, energy price arbitrage, demand response, RECs, capacity market payments, among others.

Potential Microgrid Value Streams

Value Stream	Description
Demand charge reduction	Reduce peak demand through on-site electricity generation and/or energy storage
Energy arbitrage	Energy time-of-use shift (from on-peak to off-peak hours) or charge during off-peak hours, use energy storage during on-peak hours
Demand response	Utility programs that pay customers to lower demand during system peaks
Power factor correction	Provide reactive power to increase power factor and reduce power factor penalty charges
Renewable energy certificate sales	Renewable energy certificates from certain technologies (especially solar) are very valuable and can be sold by the ESCO to reduce the ESA price
Ancillary services (frequency & voltage regulation, capacity markets, other)	Stabilize frequency on moment-to-moment basis Insert or absorb reactive power to maintain voltage ranges Supply spinning, non-spinning reserves (ISO/RTO)
Avoided site distribution system upgrade costs	Deferring the need for site distribution system upgrades

REopt Lite: Free Web Tool to Optimize Economic & Resilience Benefits of DERs



Federal Microgrid Financing Approaches

A Phased Approach to Microgrids

Basic

- **Grid-level generators that can island groups of loads from grid**
  - Connected generators can parallel
  - Manual operation of all switching and generation

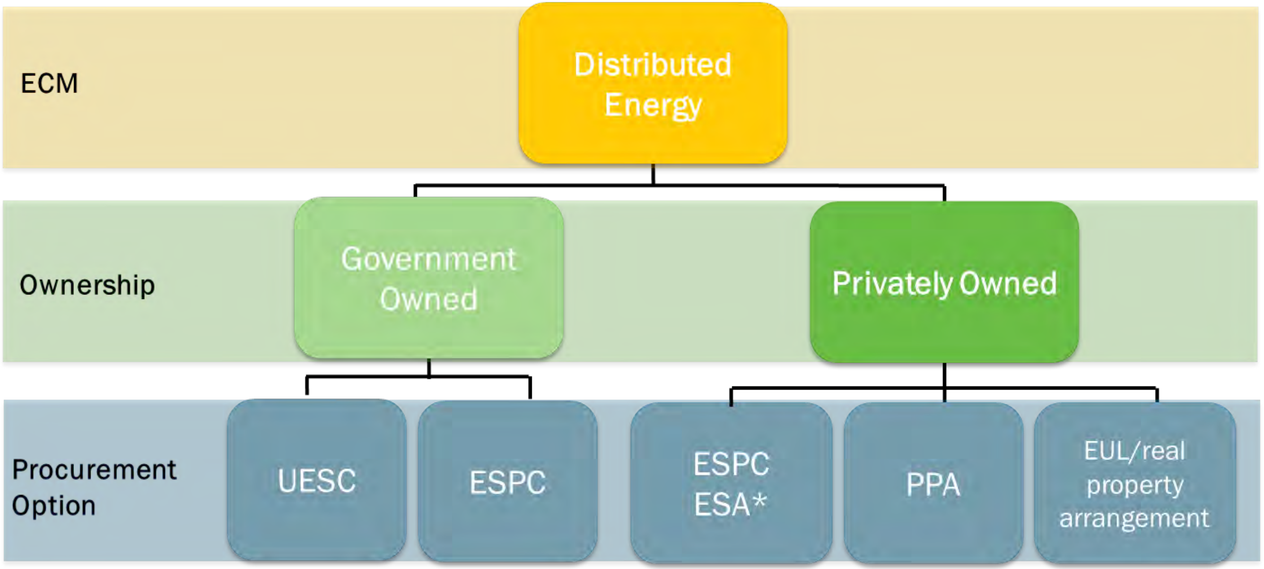
Intermediate

- **Grid-level generators that can remotely island loads from grid**
  - System is half-automated, but still requires manual load shedding
  - Generators can be remotely controlled once loads are shed

Advanced

- **Full Smart Microgrid capability**
  - Entire installation can be islanded
  - Central control of load shedding
  - Central control of generator output

Federal Microgrid Procurement Options



Legend & Abbreviations

ECM	Energy Conservation Measure	ESPC ESA	ESPC Energy Sales Agreement
UESC	Utility Energy Service Contract	PPA	Power Purchase Agreement
ESPC	Energy Savings Performance Contract	EUL	Enhanced Use Lease

*System is privately owned initially, government must retain title by end of the contract (OMB Memo requirement)

Questions?

www.nrel.gov

Douglas Gagne, NREL
Douglas.gagne@nrel.gov

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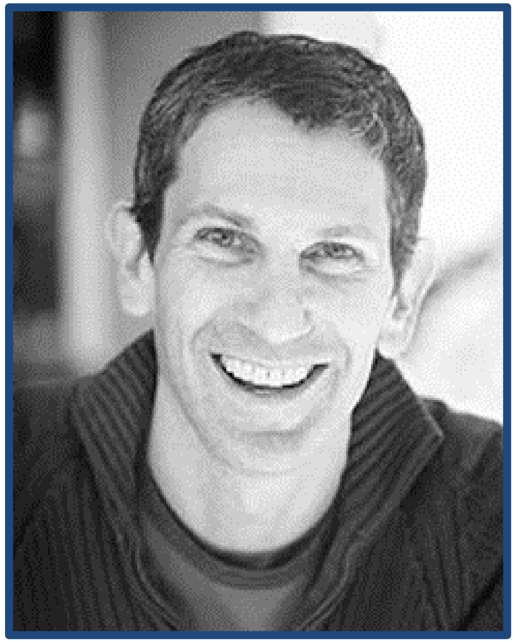
- The analysis results are not intended to be the sole basis of investment, policy, or regulatory decisions.

- The data, results, conclusions, and interpretations presented in this document have not been reviewed by technical experts outside NREL.

Veridian Living Community Microgrid: How a Neighborhood Can Emulate a Forest



Matt Grocoff

Founder

THRIVE Collaborative

Veridian at County Farm:
Living Community Microgrid

Matthew Grocoff, Esq., LEED-GA, LFA
Founder, THRIVE Collaborative

THRIVE COLLABORATIVE

@MattGrocoff

THRIVE-Collaborative.com

VERIDIAN
@ COUNTY FARM

LIVING
COMMUNITY
CHALLENGE℠


ZEROENERGY
CERTIFICATION


Google Earth


WASHTENAW COUNTY MICHIGAN
1826
Washtenaw County
Juvenile Center
2270 Platt

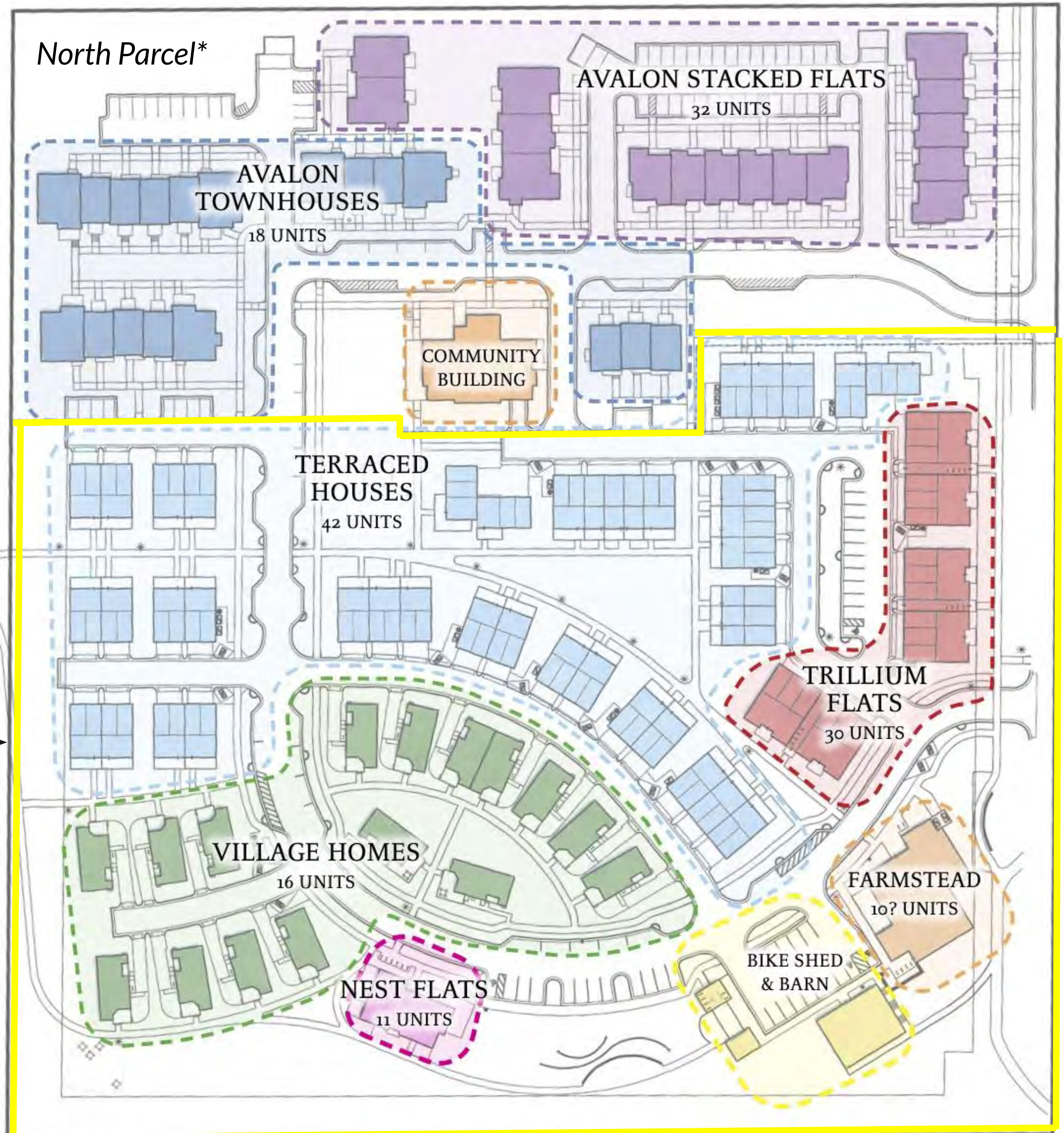
The Earth Institute at Columbia University selected Veridian at County Farm to be included in their **Local Projects Challenge for the United Nations Sustainable Development Program** to highlight exemplary projects from around the globe that demonstrate how to meet the UN Sustainable Development Goals.

SUSTAINABLE DEVELOPMENT GOALS


100% All-Electric
No Gas


100% Solar Powered
HONEY LOCUST
FARM STOP

Approved Site Plan and PUD Zoning



South Parcel Developed by THRIVE →

**North Parcel affordable supportive housing will be developed by Avalon Housing financed through LIHTC and is NOT part of this offering.*


HONEY LOCUST
FARM STOP

Strategically Diverse Product Offering

Meeting Market Demand and a Model for the Future

From Under $200k for Nest Units to $765+ for Village Homes

By targeting a diversity of unit types, we meet current demand and maintain ability to adapt to shifting markets. Veridian at County Farm offers a range of home styles at different price points. This mixed income approach creates a more dynamic and equitable neighborhood, while allowing for strategic flexibility if market trends change as homes become available for sale.

Village Homes
AT VERIDIAN

- 16 Single Family
- 3-4 BR
- 2350 SF
- Price Targets: $765,000
- Target Market: Families

Nest Flats
AT VERIDIAN

- 21 Micro-unit apartments
- 1 BR / Studio
- 300-400 sf
- Price Target: < $200k
- Target Market: Young Professionals & Seniors

Trillium flats
AT VERIDIAN

- 30 Walk-up Flats
- 1BR Apartments
- 792 SF
- Target Price: $280,000
- Target Market: Young Professionals & Seniors

Terraced Houses
AT VERIDIAN

- 42 units
- 3 - 4 BR
- 1200 - 1930 SF
- Target Price: $515k - $675k
- Target Market: Families, Seniors, Young Professionals

HONEY LOCUST
FARM STOP

The Farmstead

- Mixed-Use
- Retail Farm Stop Grocery
- Upper Floor Office, Daycare
- Residential
- (Up to 4 floors)

The Barn

- Restored structure planned as part of the Commons area creating a beautiful adaptive public space bound by the Farm Stop, Barn, and lawn and garden area.
- Potential to build out ground floor as office space or other adaptive use.

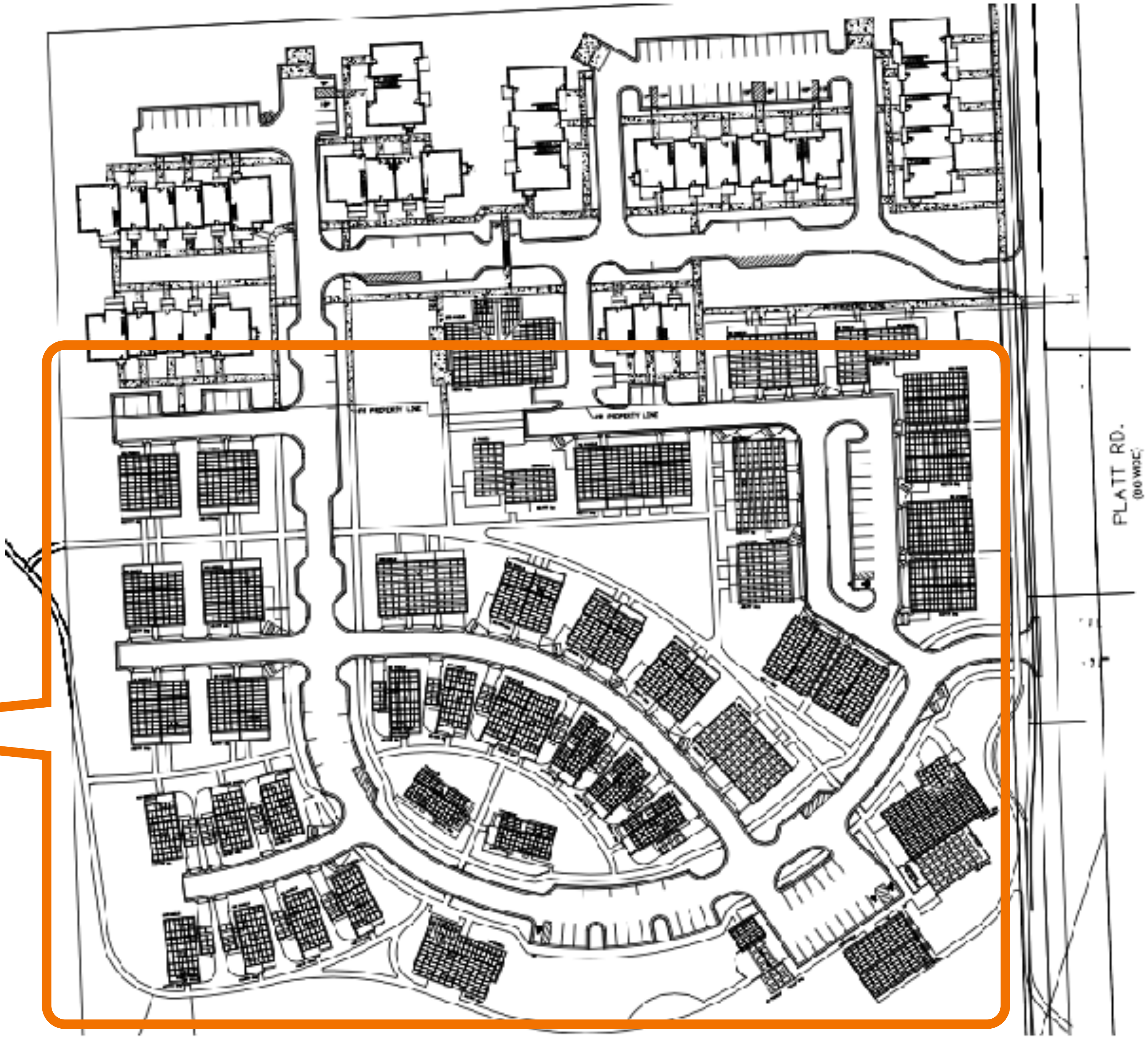

JuiceBox


TESLA

Solar Potential

1,409 kW Installed

1.6 MWh / yr Production



Barriers to Solar for Affordable Housing

Additional
44,356 sf roof


Equity / Resiliency


Poles 50+ Years Old
ARBOR HILLS


Need New Substation


250 ft
parking
EV & Carport potential
50k/sf
Rec
center
Barn
Washtenaw Ave
Huron Pkwy
maint.
bldg.
pavillion
parking
EV & Carport potential
Professional Dr
park
admin
bldg
Avalon community bldg
Platt Rd
mixed used
barn
fire dept
Redbud Nature Area
Old Hickory Pl
Canterbury Rd

Storage

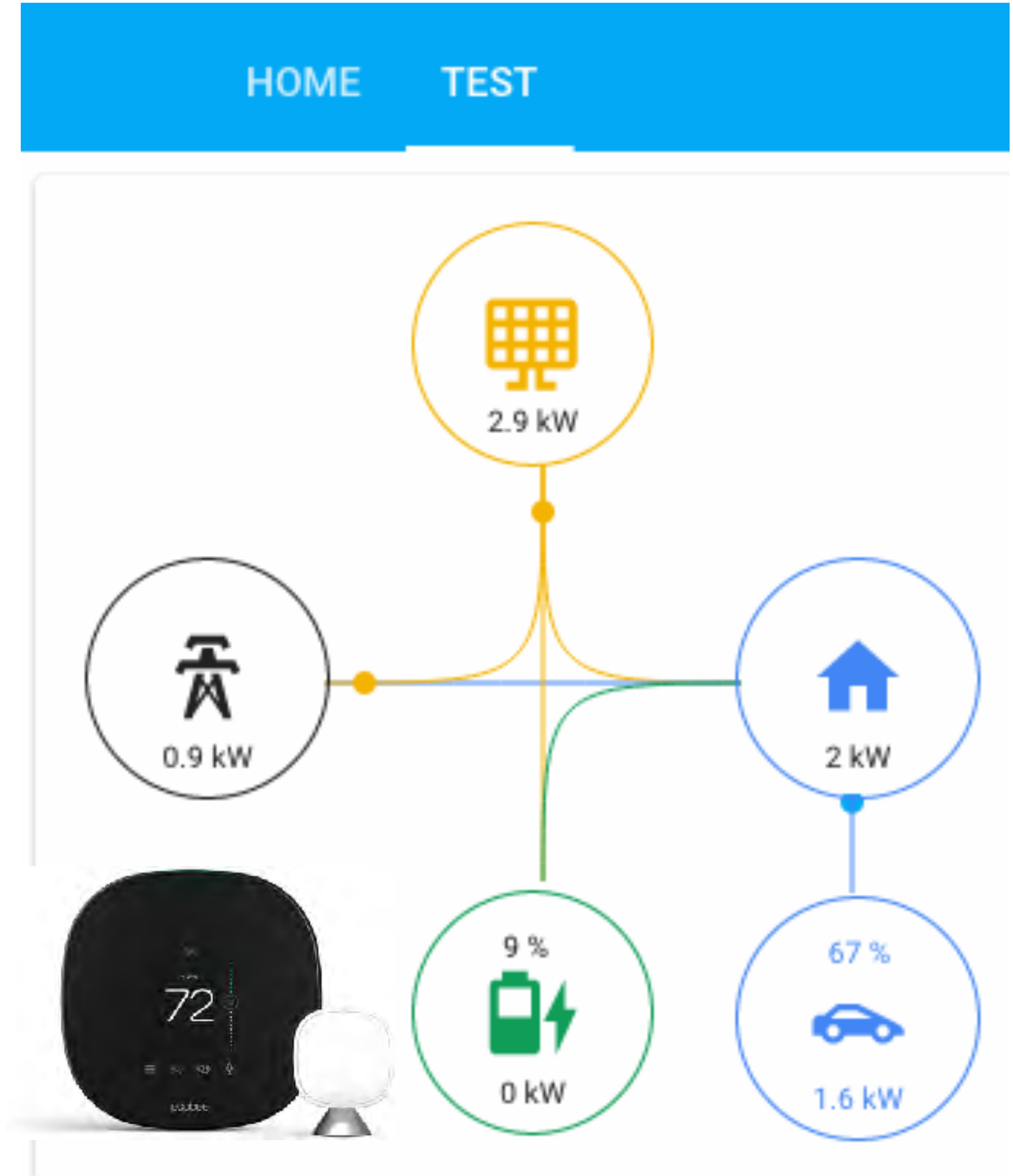
Demand Response

EV Charging

Solar

Efficiency

Resilience



Grid Interactive Connected Communities

THRIVE COLLABORATIVE

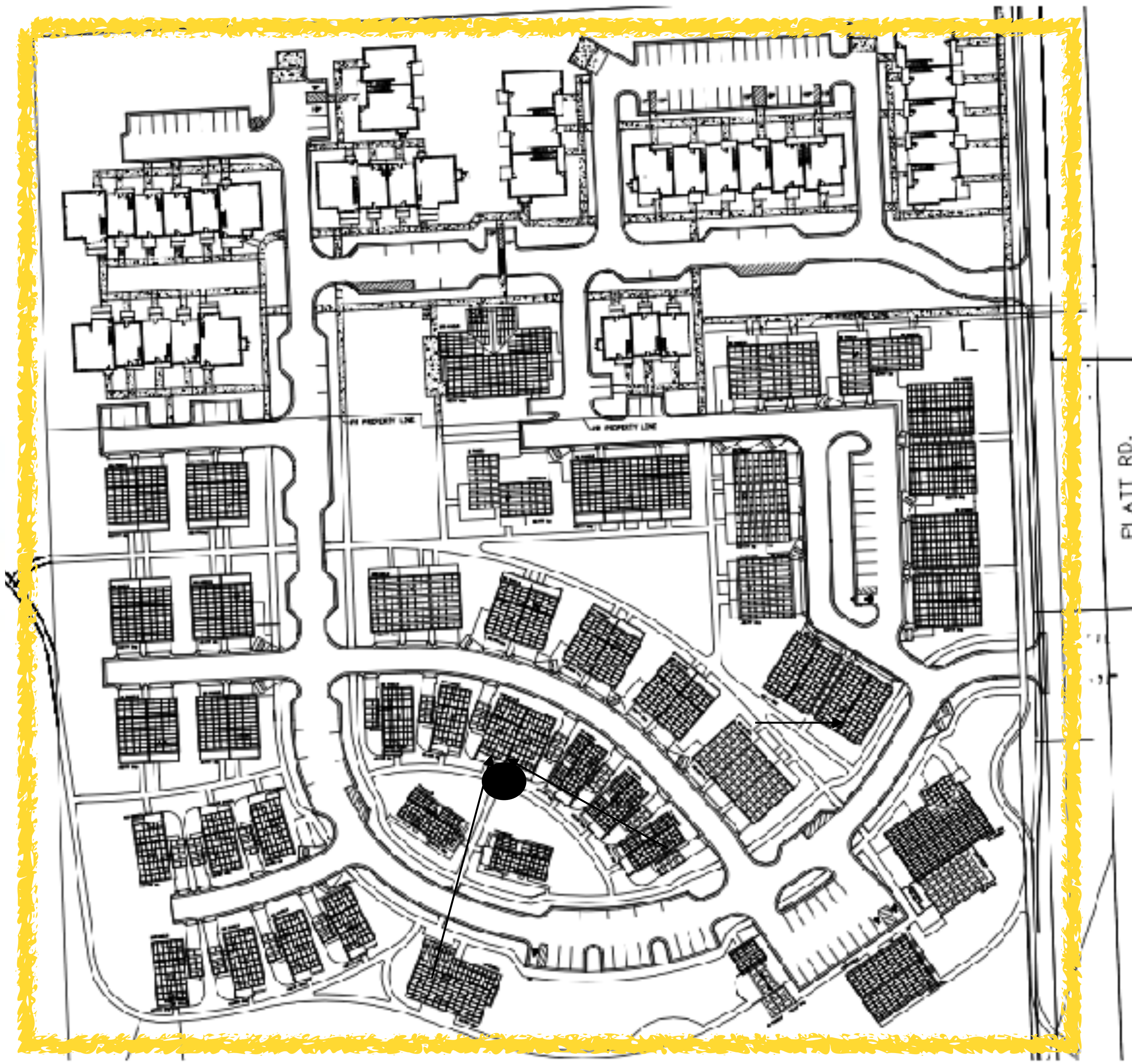
UNIVERSITY OF MICHIGAN

DTE Energy

ANN ARBOR 2030 DISTRICT

A2ZERO
EQUITABLE · SUSTAINABLE · TRANSFORMATIVE

NEXTENERGY




HONEY LOCUST
FARM STOP


WESTFIELD
Rescuing and Restoring Historic Barn

Humane Scale: Layered Social Spaces


BIKE
BARN

Human Powered Mobility

179 Bike Spaces
124 Enclosed

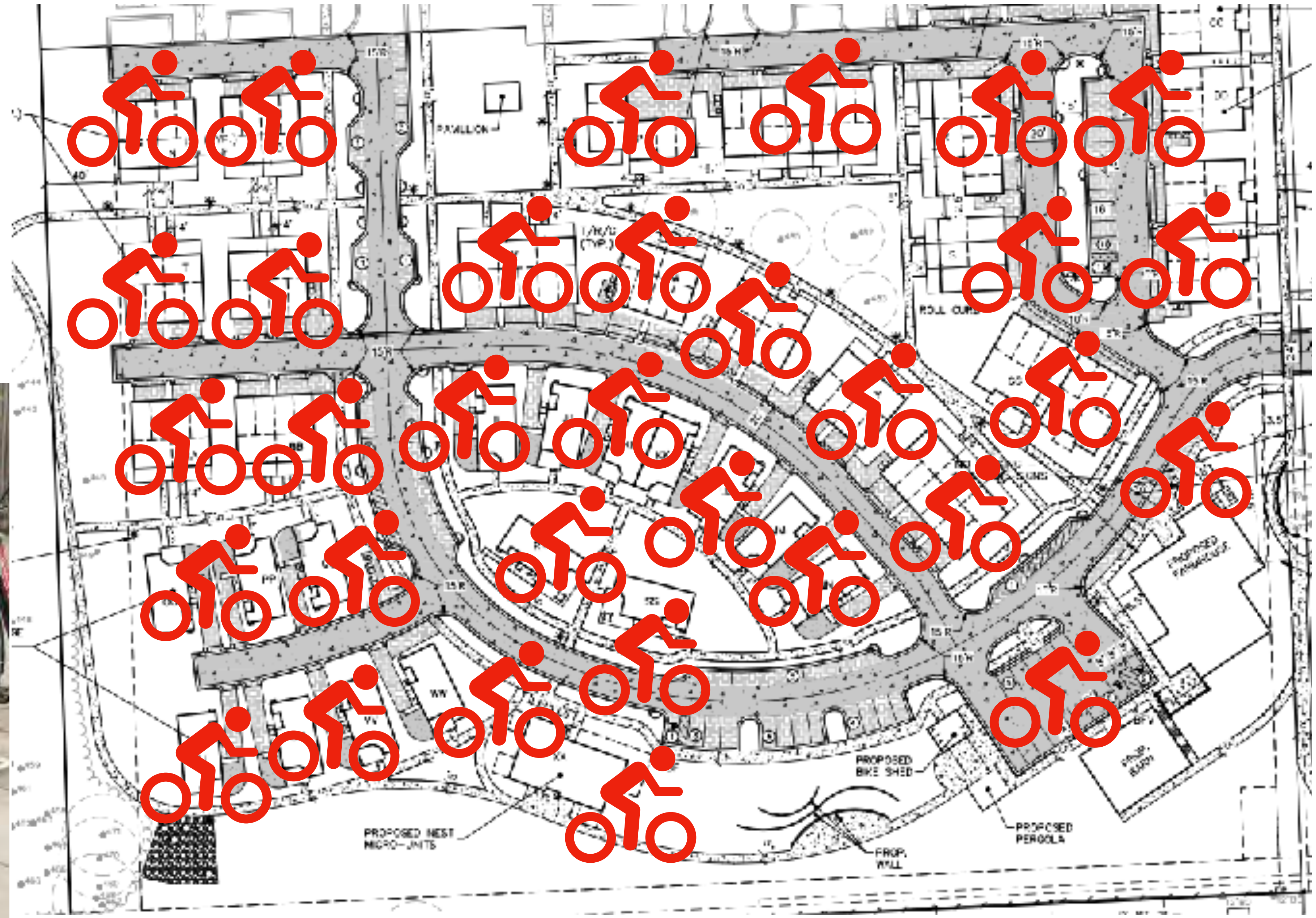


Illustration purposes only

Planned EV Car Charging & Car Sharing

sway

Illustration purposes only

$183

Monthly US Household Spending on Gas+Electric

$242

Monthly US Household Spending on Gasoline

$151/mo

Added Mortgage Cost to Include 16kW Solar

*Including incentives. 30yr Fixed!

$151/mo

Enough to power home and an EV

*Including incentives. 30yr Fixed!

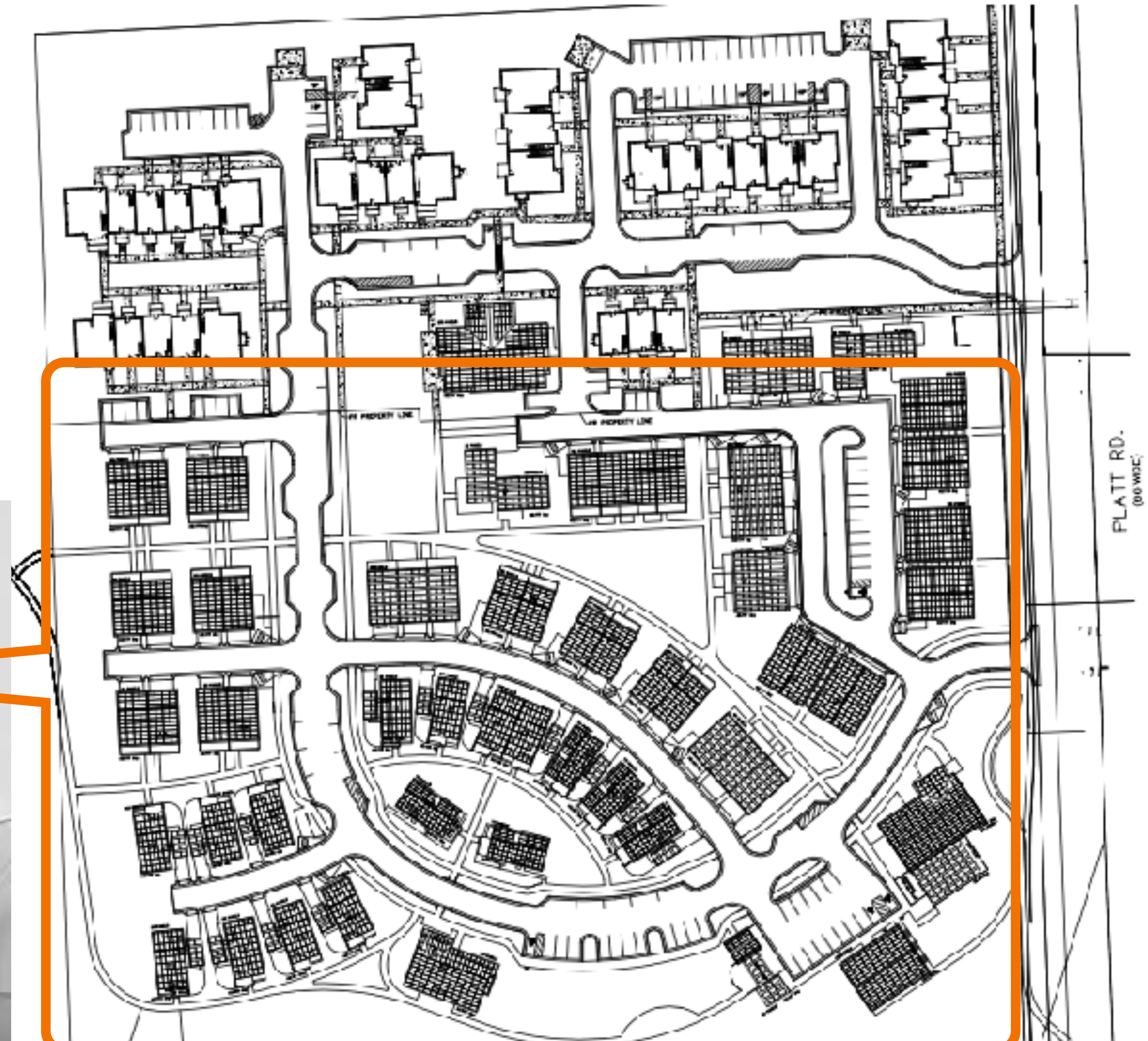
$151

NZE vs Norm

$425 /mo

BONUS: Developer Avoids Cost of Installing Gas

Planned Energy Storage & Resiliency

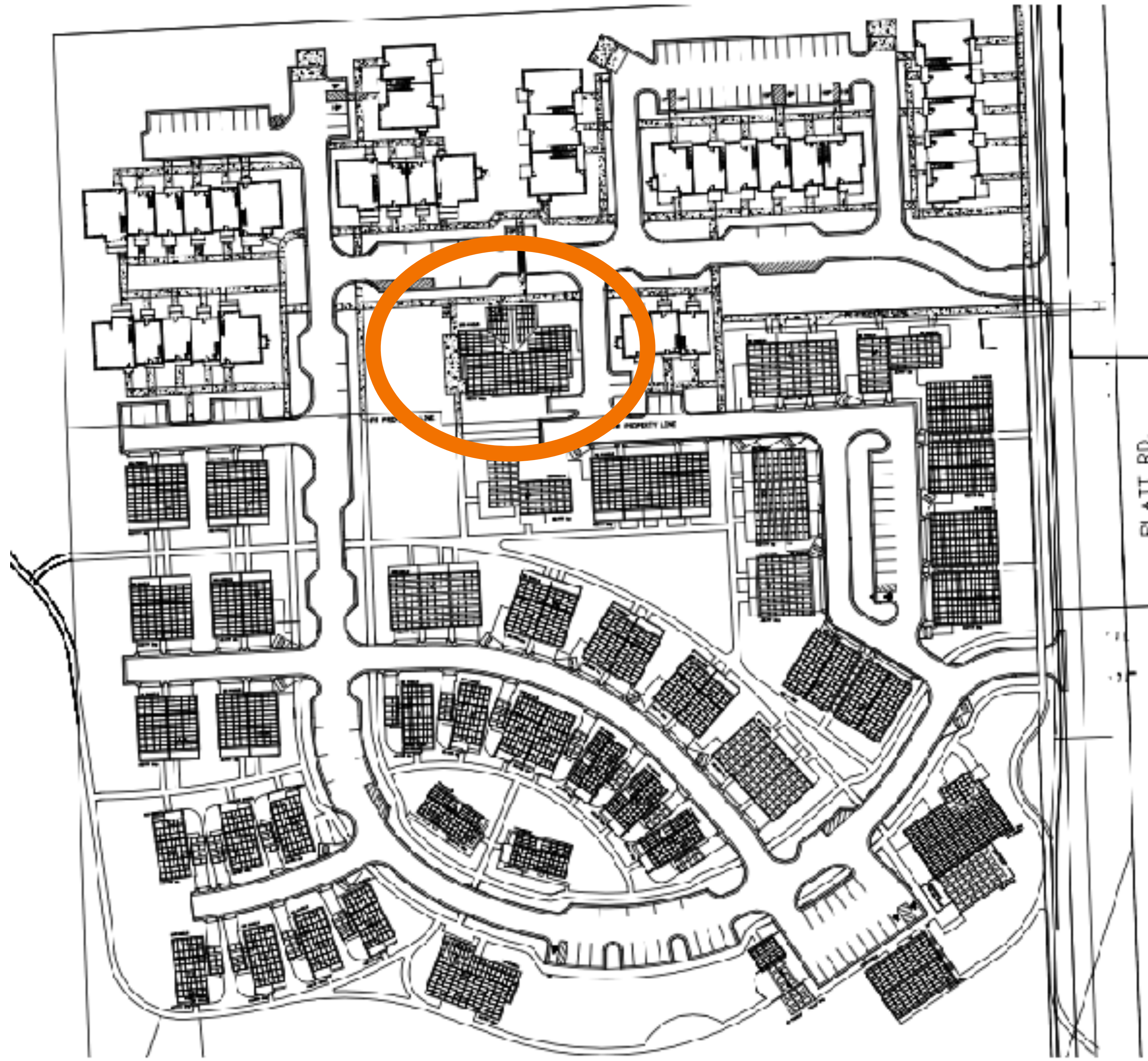


Avalon Community Building

LIVING BUILDING CHALLENGE

Affordable Housing Pilot Project

BUILDING E REAR (SOUTH) ELEVATION



Smart Neighborhood Microgrid

Juan Shannon

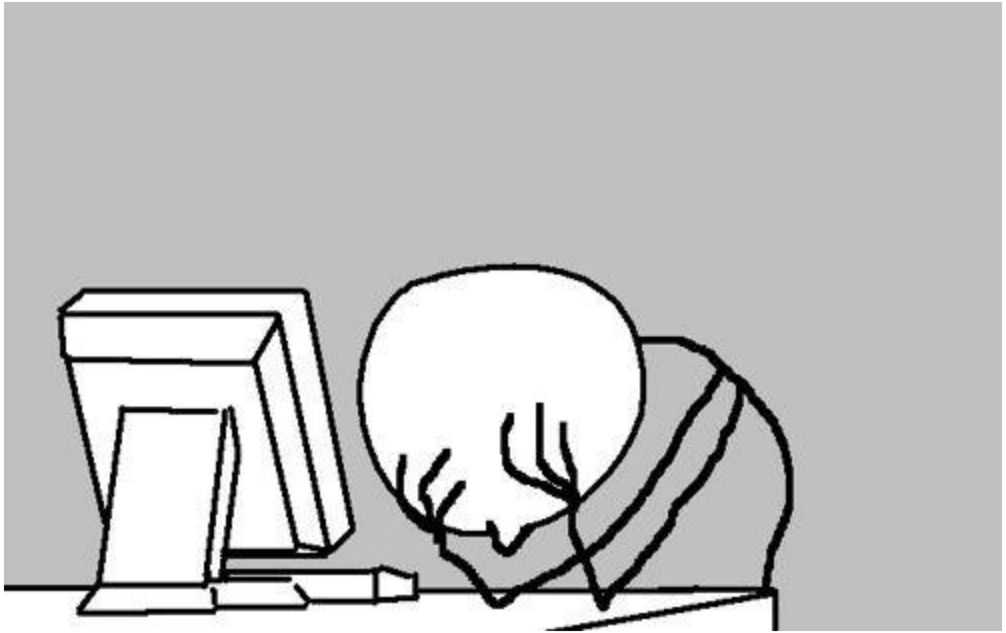
Developer

Parker Village

Smart Neighborhood Microgrid

Parker Village Highland Park


FOR JUNK



PARKER VILLAGE MASTER PLAN

SEAS Corporation


REVITALIZE

Making the Most of Michigan's Energy Future

New Technologies and Business Models

Break: 2:19 – 2:30 PM

Stakeholder Meeting 7: Microgrids

April 21, 2021

Panel: Business Perspectives on Microgrid Development

Moderator:

Cory Connolly
Vice President of Policy
Michigan Energy Innovation Business Council

Sam Barnes
Executive Vice President & Chief Operating Officer
Commonwealth

Mark Feasel
President of Smart Grid North America Business for Schneider Electric

Robert Rafson
President
Charthouse Energy

New Technologies and Business Models

Break: 3:25 – 3:30 PM

Stakeholder Meeting 7: Microgrids

April 21, 2021

Microgrid Applications and Benefits

Paul Connors
Director of Marketing
Electrical Engineering Services & Systems Division
Eaton Corporation

John Vernacchia
Energy Transition Segment Director
Electrical North America Sales
Eaton Corporation

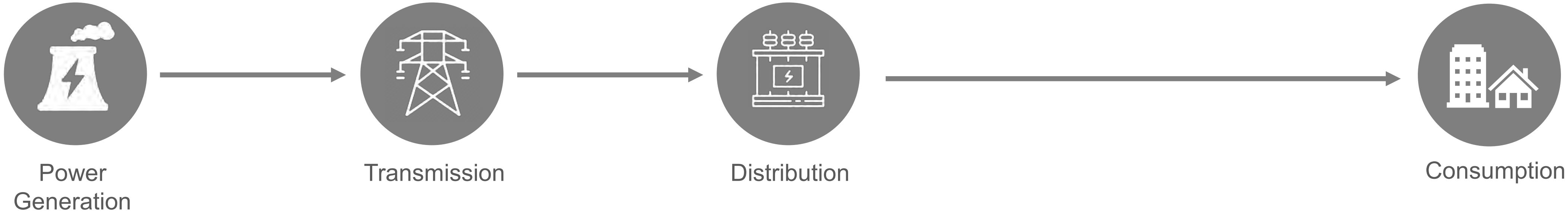
Harold Ruckpaul
Director of Strategic Alliances
Electrical Engineering Services & Systems Division
Eaton Corporation

Introduction to Microgrids

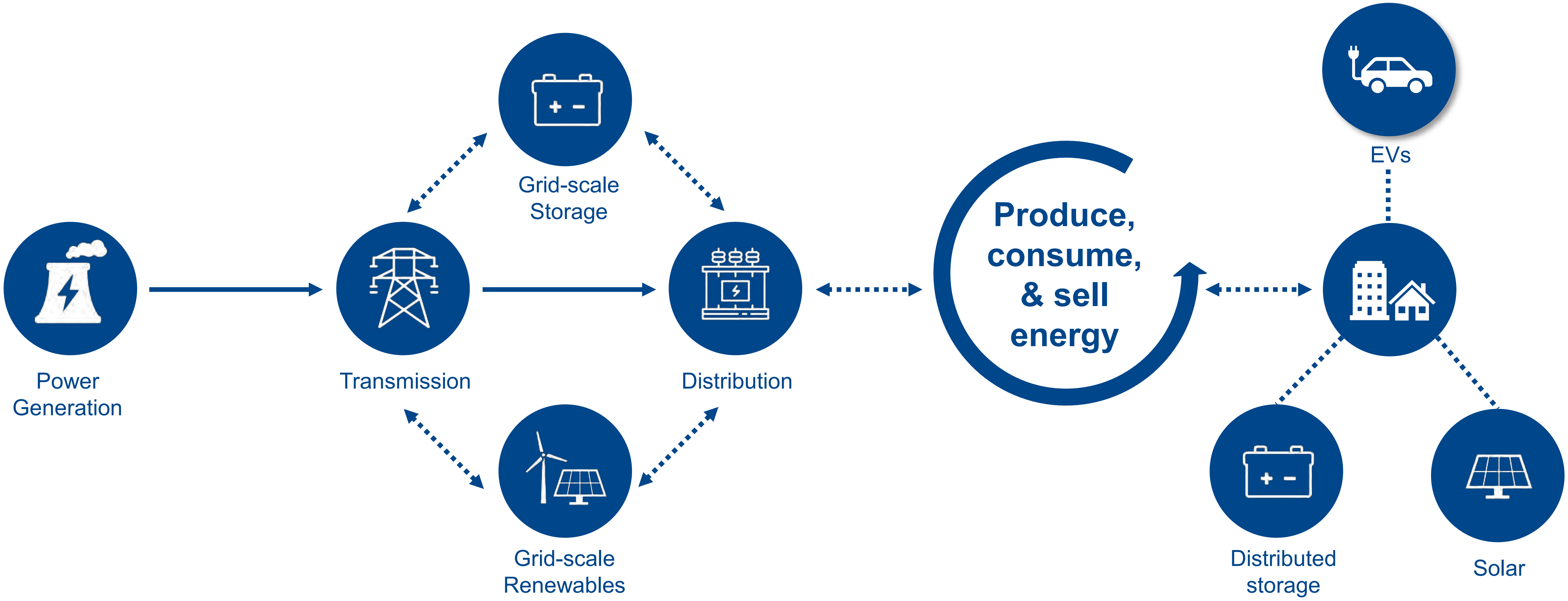
Powering Business Worldwide

► [Energy Transition Video]

Our Past: Centralized Power Generation



Our Future: Everything As A Grid



What is a Microgrid?

Distributed Energy Resources Management System (DERMS)

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

Microgrid is a DERMS than can (intentionally) operate autonomously or "islanded" from the grid for maximum system resiliency

Distributed Energy Resource (DER)

- Generators (petroleum or gas)
- Combined heat and power (CHP)
- Energy storage (battery or other)
- Solar
- Wind
- Fuel cells

Value Proposition of a Microgrid

Operational ● Environmental ● Economic

Resiliency

- Address grid instability; maintain uptime
- Provide backup power for operations
- Operate autonomously from the grid

Sustainability

- Achieve Net Zero with renewable power generation
- Reduce environmental pollutants (GHG, CO_2)

Efficiency

- Reduce grid energy spend with on-site generation, peak shaving, demand response, and more
- Participate in energy markets (monetize)
- Benefit from economic incentives; renewable energy credits (REC), tax credits (ITC), government funding

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Live Microgrid demonstration at Pittsburgh PSEC

PITTSBURGH, PA

PSEC showcases energy management, power quality, & safety

MICROGRID VIDEO

HOUSTON, TX

Expansive facility offering world-class training in various application environments

RALEIGH, NC

State-of-the-art facility with industry-leading power quality solutions (data center)

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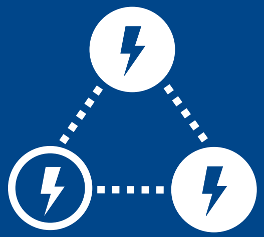
Powering Business Worldwide

A Grid Within The Grid

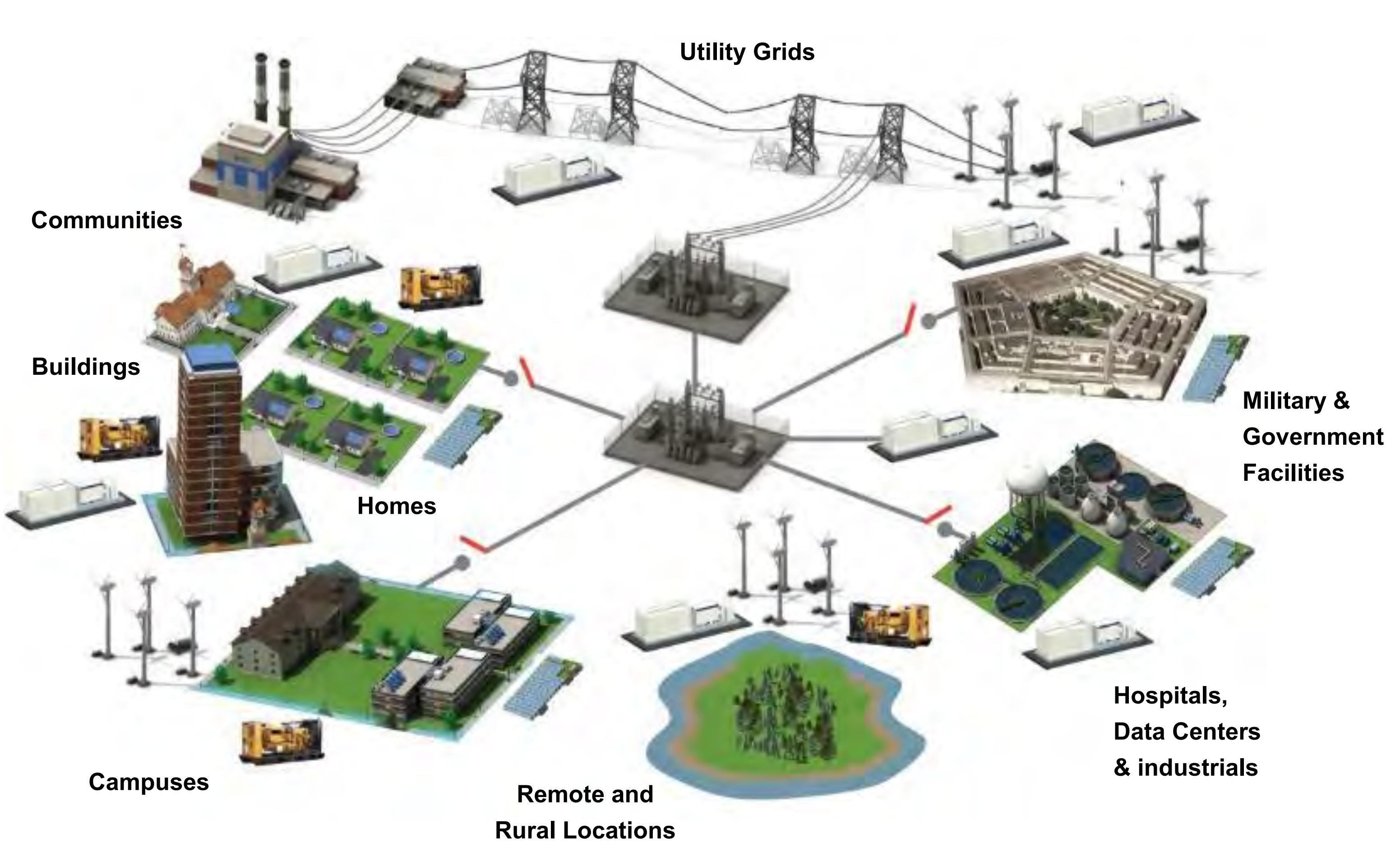


Microgrid can be:

- Community
- Campus
- Building
- Home

Common System Elements:

- **Controllable loads**
  Machinery, equipment, EVs, computing, lighting, HVAC, etc.
- **Distributed Energy Resources (DER)**
  Generators, solar, storage, etc.
- **Intelligent Controls***
  Hardware (DER controls) and software (control algorithms)



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Microgrid cost driven by size, complexity, & requirements

> 5 MW systems ~75% Complex
< 1 MW systems ~50% Basic

Resiliency | Efficiency | Sustainability

Complex

Government ▪ Municipal ▪ Utility Large Industrial ▪ University Hospital ▪ Data Center

- Mixed/many DER's
- Wide area (typically)
- Highly customized needs
- Seamless islanding required
- High redundancy required

Basic

Commercial Buildings ▪ Distribution Centers ▪ Small-scale Processing

- Compatible list of DER's
- Smaller footprint (typically)
- Constrained functionality
- Add-on expense for islanding
- Lower redundancy

Simple

Small office building ▪ Light Commercial ▪ Residential

- "Out-of-the-box" solution
- Remote configuration
- Highly constrained options
- PV + BESS + Genset only

Function	Intelligent microgrid controls (HW & SW)
Monetize	• Market bidding and scheduling • Aggregate and/or API to aggregators • Data analytics for monetization of data
Optimize	• Economic optimization based on owner needs • Peak shaving, time of use, demand response
Control	• Actuate controllable load and assets • High resiliency requires redundant controls
Forecast	• Forecasting of energy consumption and production for optimization
Monitor	• Facility level reporting, insights, KPI's, etc.
Data Acquisition	• Physical connection to assets • Cloud to cloud data acquisition • Additional metering of assets without cloud

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Multiple methods to fund Microgrid projects

Direct Purchase

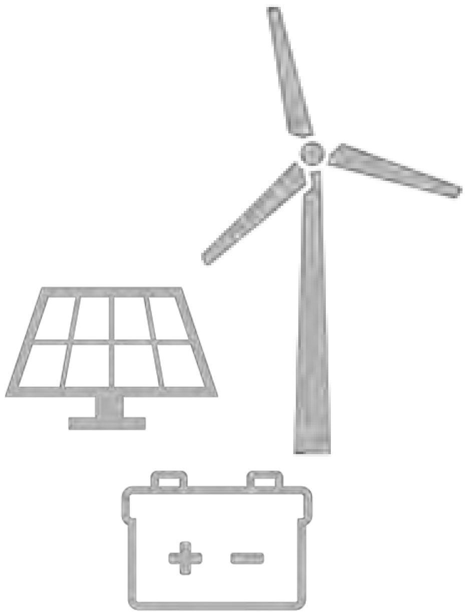
Site owner purchases a system from a solutions provider to design and build the microgrid, who is also often contracted for ongoing operations and maintenance support

Benefit Share

Primarily used for the deployment of Battery Energy Storage System (BESS) to create shared revenue streams between owner and provider

Power Purchase Agreement

Energy As A Service (EaaS) model where owner pays a single rate to provider (and/or financer) based on the output and performance of the microgrid system (no capital outlay)



Powering Business Worldwide

Key trends impacting Microgrid adoption

Electrical Demand

BUILDING ELECTRIFICATION:

50%

Increase in global building energy share by 2050

TRANSPORT ELECTRIFICATION:

27%

Increase in global electricity demand

DATA AND COMPUTE:

4X

Increase in share of electricity demand by 2030

Decentralized Supply

RENEWABLES:

50%

Of power generation by 2035

ENERGY STORAGE:

13X

Installed base growth by 2030

Infrastructure Needs

SYSTEM RESILIANCE:

5% - 12%

Increase in outage minutes

OPTIMIZATION:

13B

Connected power devices by 2025

CYBERSECURITY:

84%

Of companies have had an IoT breach

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Microgrid systems deployed by Eaton Services

Over 180 MW

Hundreds of microgrid systems deployed by EESS

Eaton has demonstrated experience

- Eaton is a market leader in electrical power management systems and services
- Eaton's Electrical Engineering Systems & Services (EESS) team manages large turnkey projects, including design engineering, procurement, prime contracting, installation, and support
- Eaton is experienced in designing and deploying microgrids and leading the way in Energy Transition:

  www.eaton.com/energytransition

EATON
Powering Business Worldwide

Company Overview

Powering Business Worldwide

Electrical	Filtration	**2019 FY**	
Aerospace	Vehicle	Total sales	**$21.4 B**
Hydraulics	eMobility	Net income	**$2.2 B**

We Make What Matters Work*

We're dedicated to improving people's lives and the environment with power management technologies that are more reliable, efficient and safe.

Our Business in:

Michigan

Employees Living MI:	1,918
Employees Working MI:	1,918
Wages Paid:	$220,405,227
Supplier Spend:	$59,329,429
Energy Spend:	$2,128,772
State Taxes Paid:	$8,975,954
Local Taxes Paid:	$424,203

UT Austin's Microgrid

Juan Ontiveros

Associate Vice President for

Utilities & Energy Management

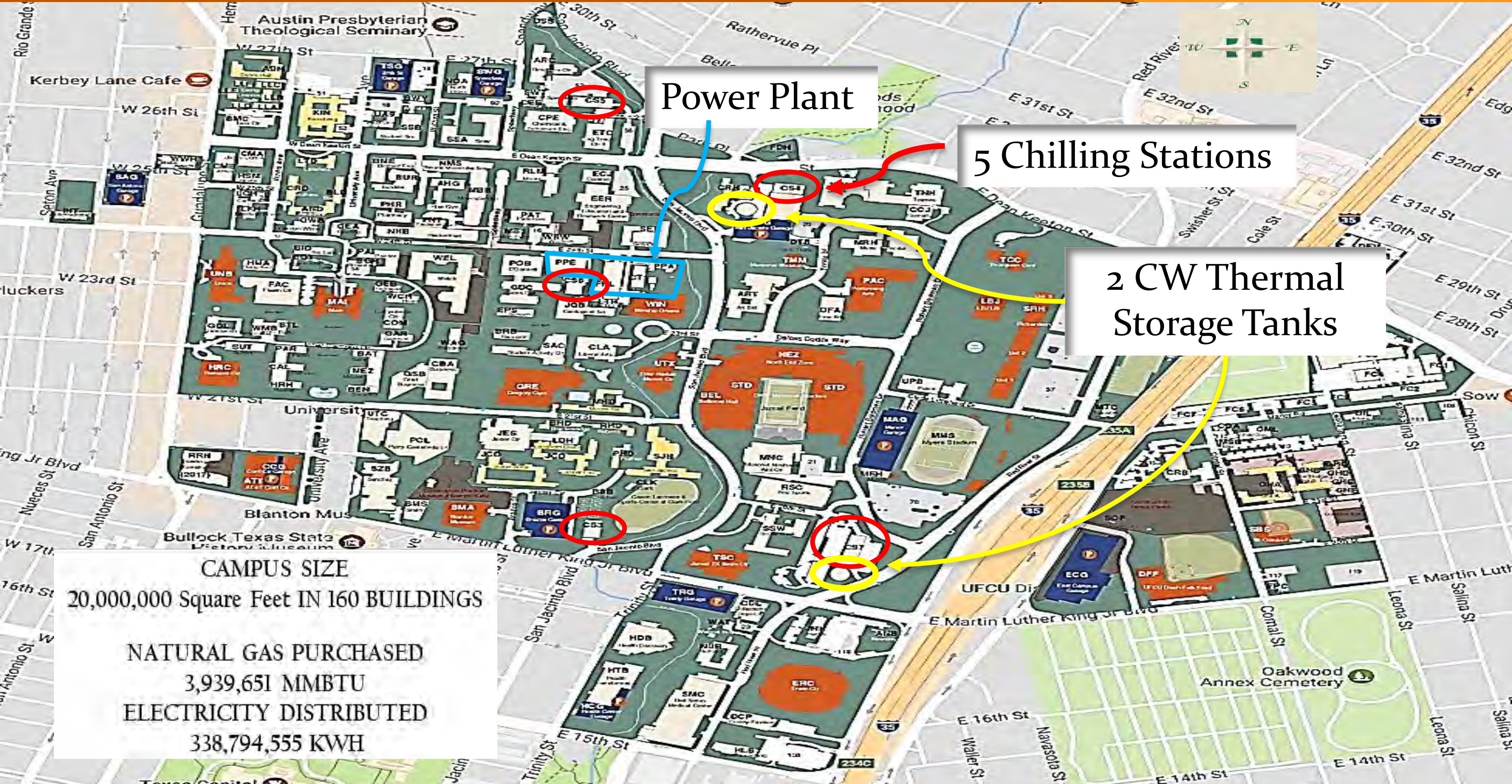
University of Texas at Austin

UT Austin’s Microgrid

Juan M. Ontiveros, P.E.
Associate Vice President
Utilities and Energy Management

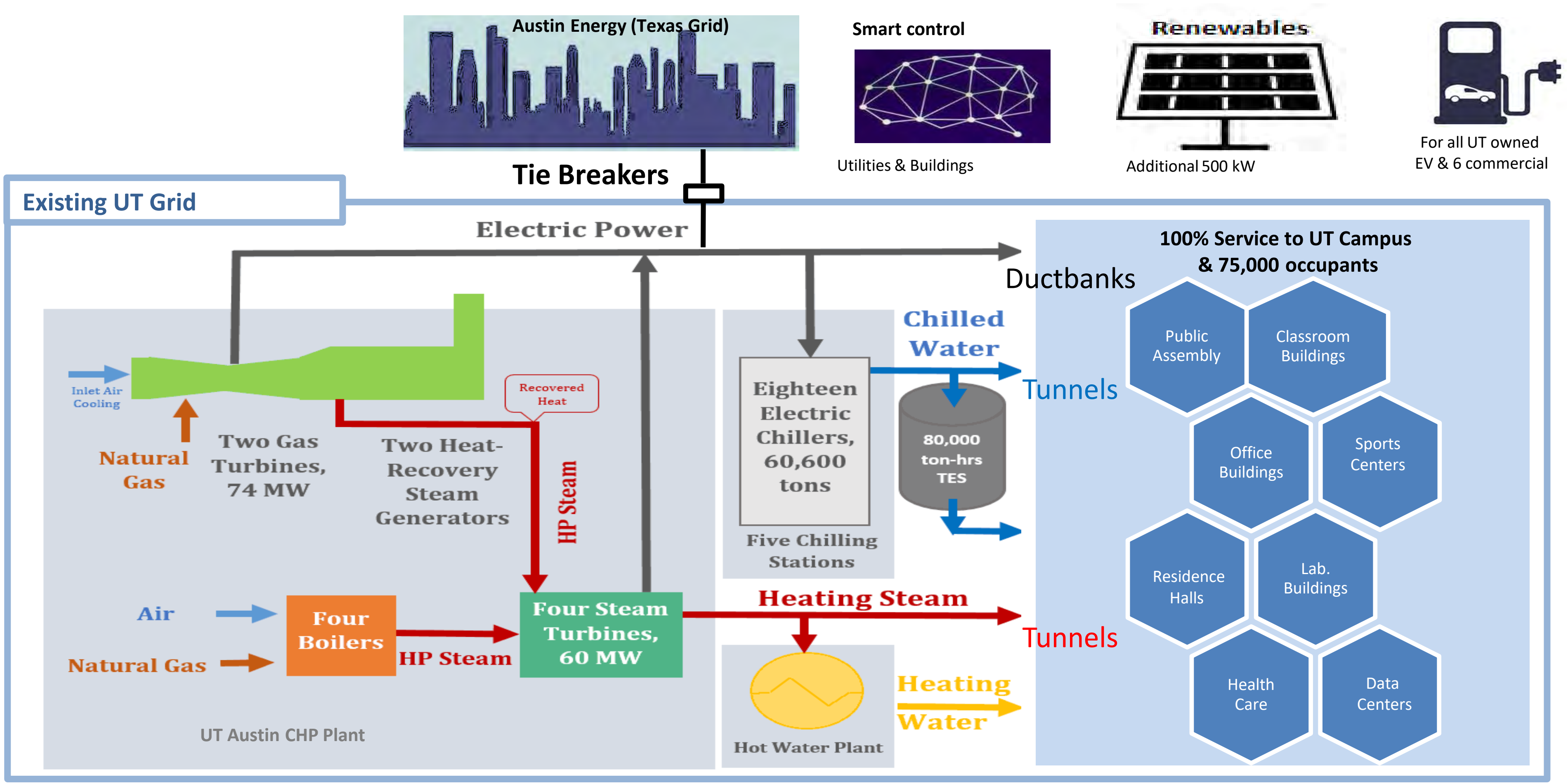
AGENDA

I. BACKGROUND
II. GENERAL CAPABILITIES
III. GRID DESIGN/PERFORMANCE
IV. Performance During Winter Storm Uri
V. Lessons Learned



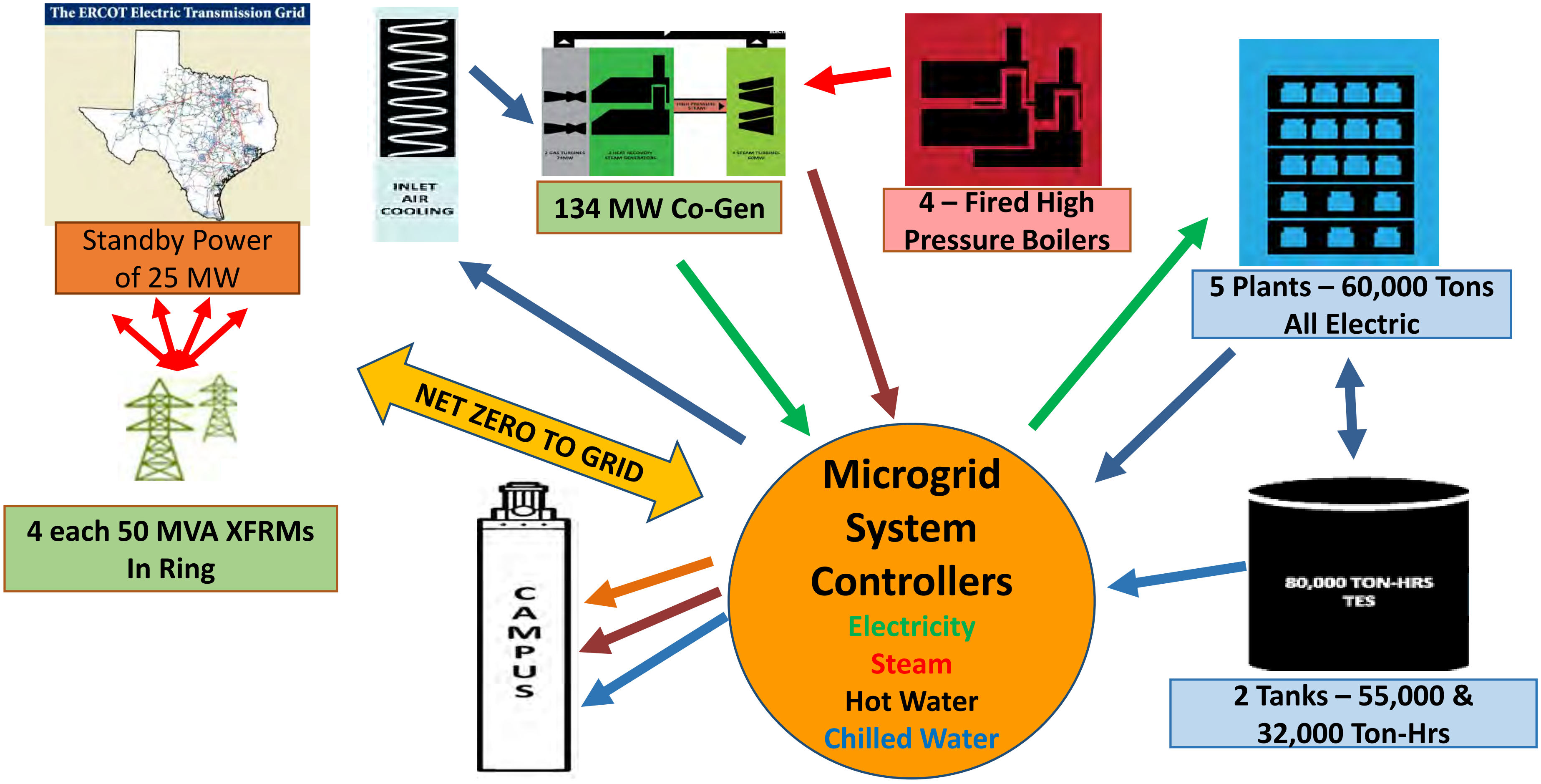
CAMPUS SIZE
20,000,000 Square Feet IN 160 BUILDINGS

NATURAL GAS PURCHASED
3,939,651 MMBTU
ELECTRICITY DISTRIBUTED
338,794,555 KWH

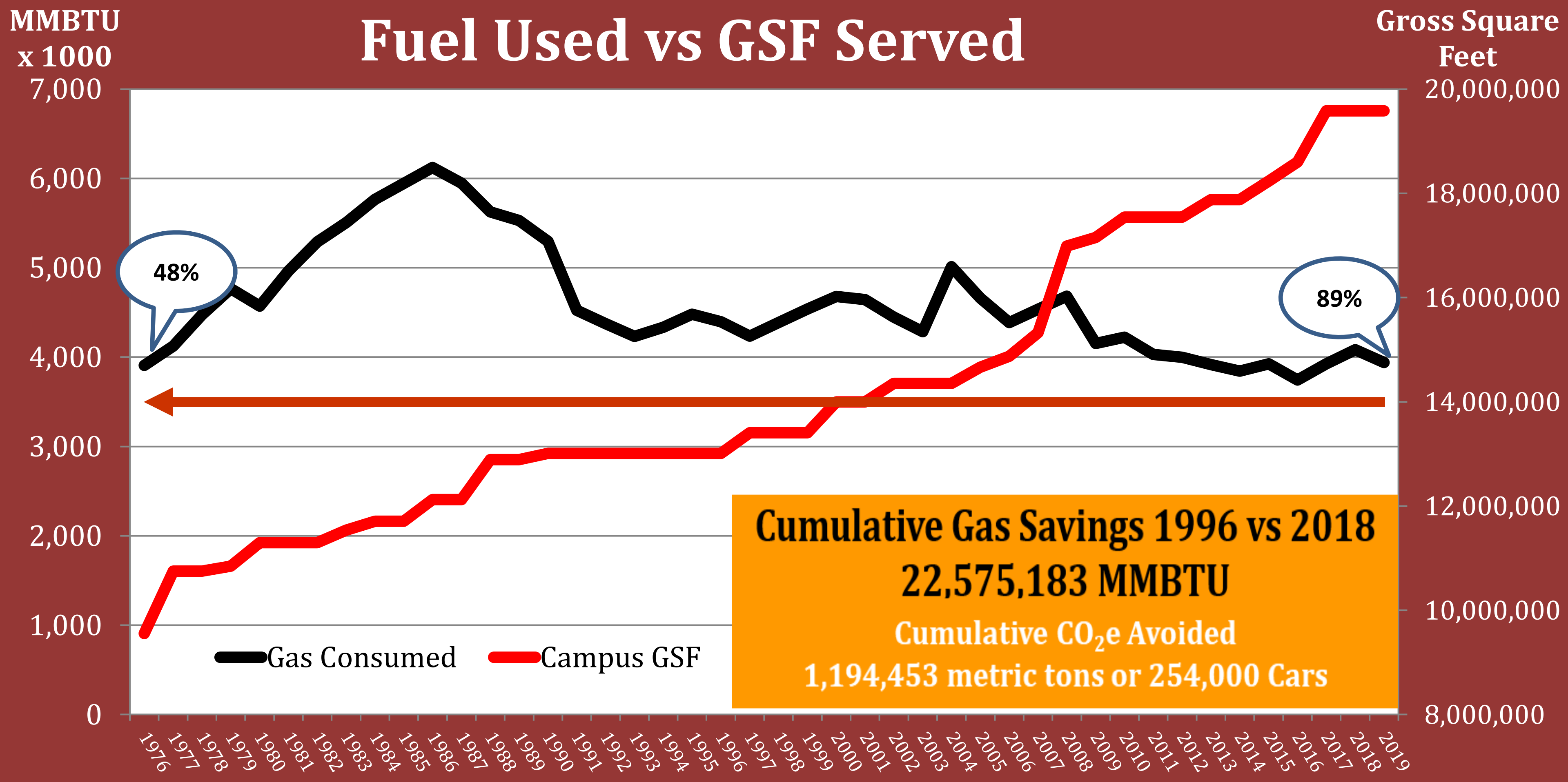

Austin Energy (Texas Grid)
Smart control
Utilities & Buildings
Renewables
Additional 500 kW
For all UT owned
EV & 6 commercial
Tie Breakers
Existing UT Grid
Electric Power
100% Service to UT Campus
& 75,000 occupants
Ductbanks
Public Assembly
Classroom Buildings
Office Buildings
Sports Centers
Residence Halls
Lab. Buildings
Health Care
Data Centers
Inlet Air Cooling
Natural Gas
Two Gas Turbines, 74 MW
Recovered Heat
Two Heat-Recovery Steam Generators
HP Steam
Eighteen Electric Chillers, 60,600 tons
Five Chilling Stations
Chilled Water
Tunnels
80,000 ton-hrs TES
Air
Natural Gas
Four Boilers
HP Steam
Four Steam Turbines, 60 MW
Heating Steam
Tunnels
Heating Water
Hot Water Plant
UT Austin CHP Plant

Performance Features

- Cost of produced electricity is $.07/kWh
- Purchased electricity about $.10/kWh
- Renewable energy is about twice our cost of generation
- 2019 total annual efficiency was 88.5%
- Reliability has been 99.999% for over 50 years
- Resiliency is built into our many options
- Fuel and carbon emissions is at 1976 levels


The ERCOT Electric Transmission Grid
Standby Power of 25 MW
4 each 50 MVA XFRMs In Ring
INLET AIR COOLING
134 MW Co-Gen
4 – Fired High Pressure Boilers
5 Plants – 60,000 Tons All Electric
NET ZERO TO GRID
CAMPUS
Microgrid System Controllers
Electricity
Steam
Hot Water
Chilled Water
80,000 TON-HRS TES
2 Tanks – 55,000 & 32,000 Ton-Hrs

Fuel Used vs GSF Served

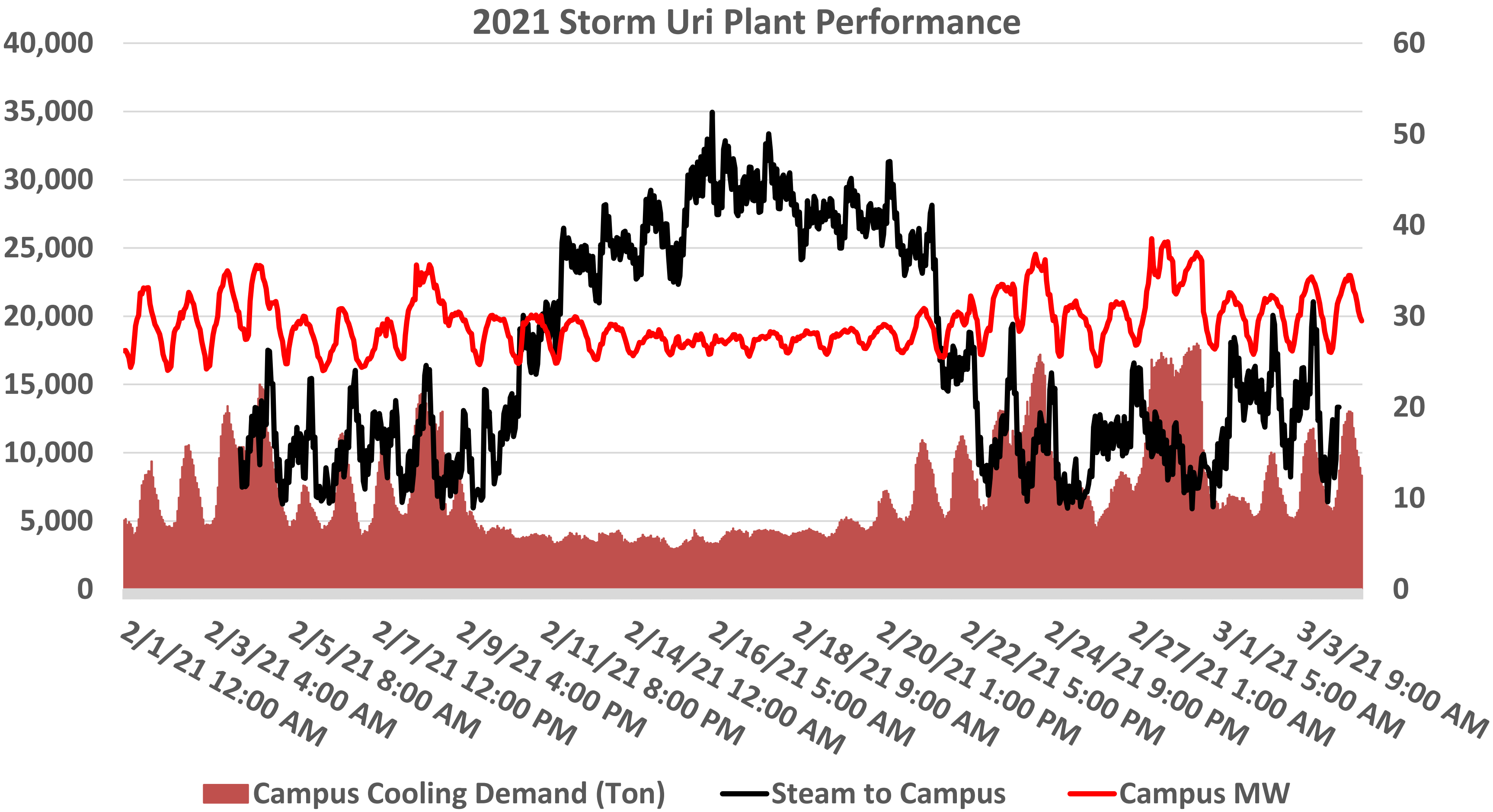


Cumulative Gas Savings 1996 vs 2018

22,575,183 MMBTU

Cumulative CO_2e Avoided

1,194,453 metric tons or 254,000 Cars


2021 Storm Uri Plant Performance
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
60
50
40
30
20
10
0
2/1/21 12:00 AM
2/3/21 4:00 AM
2/5/21 8:00 AM
2/7/21 12:00 PM
2/9/21 4:00 PM
2/11/21 8:00 PM
2/14/21 12:00 AM
2/16/21 5:00 AM
2/18/21 9:00 AM
2/20/21 1:00 PM
2/22/21 5:00 PM
2/24/21 9:00 PM
2/27/21 1:00 AM
3/1/21 5:00 AM
3/3/21 9:00 AM
Campus Cooling Demand (Ton)
Steam to Campus
Campus MW

Freeze 21 Impact

- $2.7 million additional cost for non-locked portion of natural gas for the plant
- For a $60 million annual budget will be absorbed this fiscal year.

Lessons Learned

- Build partners not adversaries with
  - Natural gas State Agency
  - Vendors/Engineers/contractors
- Use a data historian that is intuitive, allows for easy trending of data, and allows seamless access to optimization and operational tools
- Instrument and meter key equipment to measure performance but, “Think Holistically” of total system
- Build a link between linear and non-linear forecasting using AI to project energy loads

THANK YOU

QUESTIONS?

TECO – Real-life Benefits of Microgrids

Steve Swinson, P.E.

President & Chief Executive Officer

Therma Energy Corporation

Thermal Energy Corporation

MI Power Grid: New Technologies and Business Models
Workgroup Meeting #7: Microgrids

TECO – Real-Life Benefits of Microgrids

April 21, 2021

Thermal Energy Corporation

- TECO's is a not-for-profit district energy system serving the Texas Medical Center
- Largest CHP district chilled water system in the North America – 120,000 tons
- Over $575 million of assets with over $1.0 Billion in replacement value
- The district energy system commissioned in 1969
- Microgrid installed in 2010

Texas Medical Center

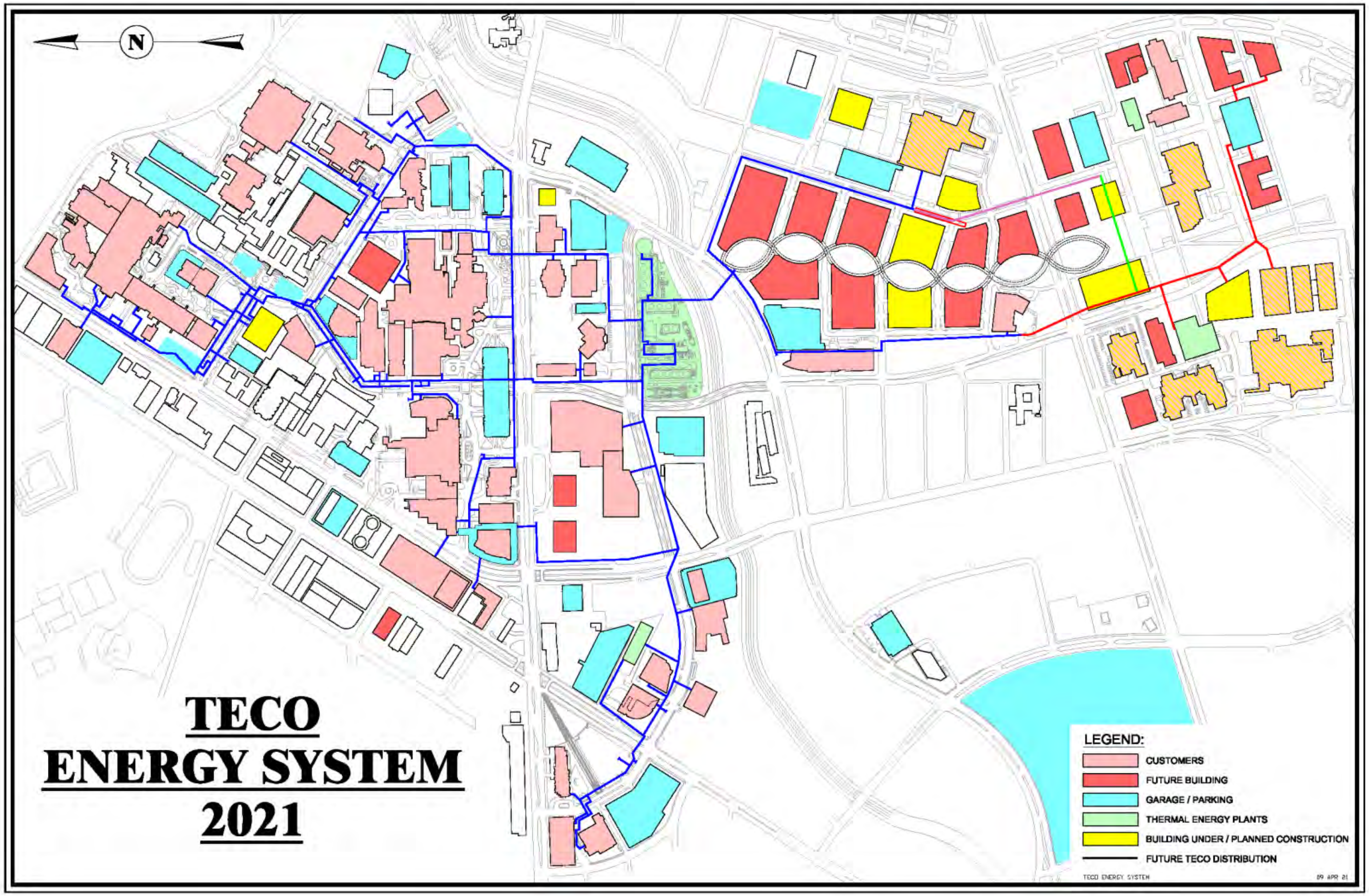
- Largest medical center (city) in the world
- 17 Institutions, $25 Billion in revenue
  - 8 hospitals
  - 2 medical schools
  - 2 nursing schools
  - 1 pharmacy school
- 110,000 total employees
- 23.7 million square feet, 50 buildings
- 9,200 hospital beds
- $2.5+ billon of annually funded medical research

Texas Medical Center Campus

TECO's
P. G. Bell, Jr. Energy Plant

TECO's South Main Plant

TECO's Distribution System



Microgrid

- Microgrid provides reliability and resiliency
- Flood walls surround TECO's energy plants
- Hurricane Harvey
  - August 2017
  - 60+ inches of rain
  - Largest recorded rainfall in US history

Flood Wall

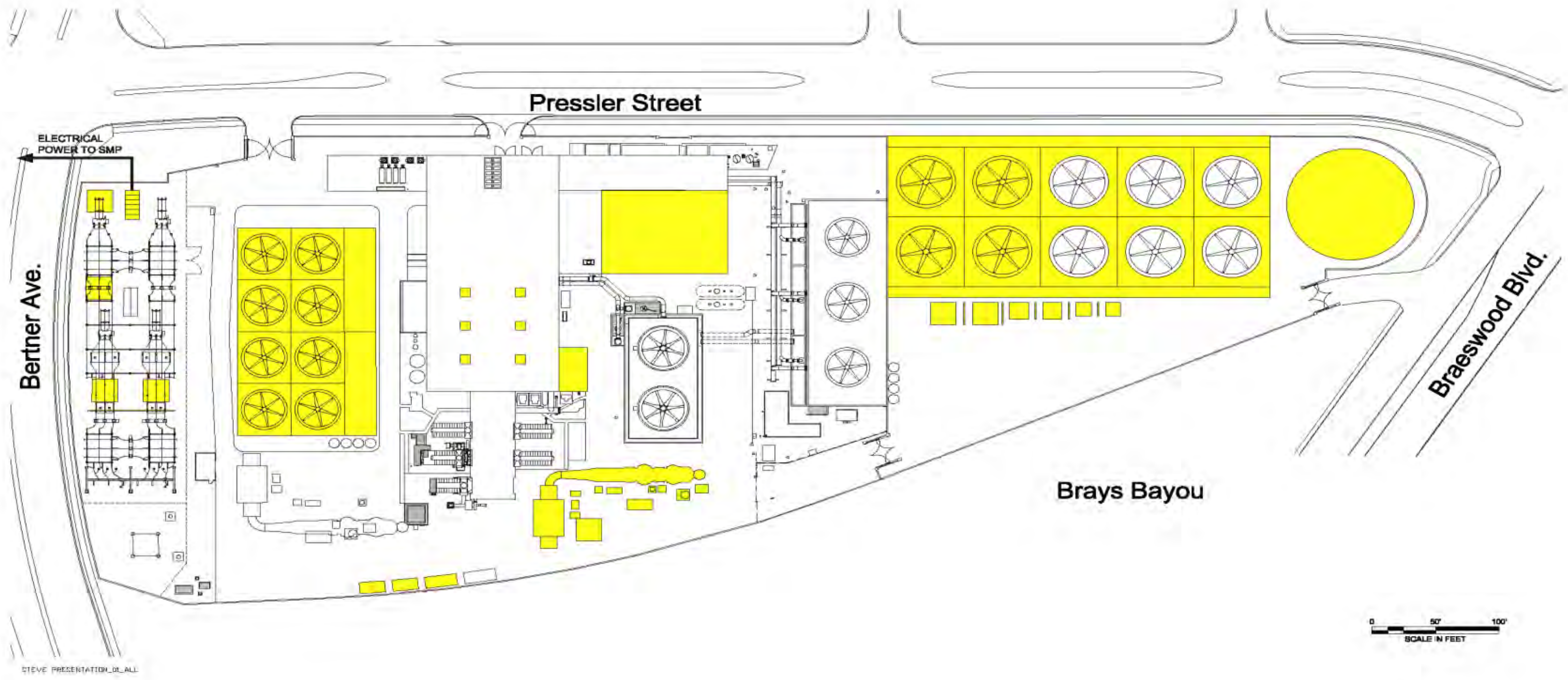
Hurricane Harvey

Microgrid Capacity

- 64 MW of power generation
  - 7 electric generators
    - 48 MW Gas Turbine, natural gas
    - 6 MW Cooper reciprocating engine, natural gas & oil
    - 4 – 2 MW Cummins reciprocating engines, oil
    - 1 – 2 MW Caterpillar reciprocating engine, oil
- Can provide 100% of TECO's peak power requirements

Master Plan Implementation Project

Microgrid Phase I



Combined Heat & Power

Real-Life Benefit

- Winter Strom Uri
  - Entire State of Texas experience record cold temperatures for 6 days
  - 107,514 MW installed capacity
  - 52,277 MW of outage
  - Frequency dropped to 59.302 Hz
  - At 59.300 Hz plants trip causing a total blackout

Real-Life Benefit

- TECO operated without interruption
- Provided 100%+ reliability
- How the plus
  - Exported 50 MW/hr for 6 days
    - Benefited 10,000 homes
    - Provided power grid support

Questions?

Thermal Energy Corporation

MI Power Grid: New Technologies and Business Models
Workgroup Meeting #7: Microgrids

TECO – Real-Life Benefits of Microgrids

April 21, 2021

Panel: Utility Microgrid Perspectives

Moderator

Arindam Maitra
Senior Technical Executive
Electric Power Research Institute

Carlos Casablanca
Managing Director
Distribution Planning & Analysis
AEP Service Corporation

Husaninder Singh
Manager
Grid Modernization
Distribution Operations
DTE Energy

Nate Washburn
Director
DER/I&C Design
Consumers Energy

Making the Most of Michigan's Energy Future

New Technologies and Business Models

Closing Comments

Stakeholder Meeting 7: Microgrids

April 21, 2021

MPSC

Michigan Public Service Commission

Thank You and Please Stay Engaged!

- Thank you for your participation
  - Share your thoughts through:
    - Meeting survey
    - Meeting chat
      - Remains open for comments or discussions after meeting.
      - Easier to access with the Teams App
    - Stakeholder comment section of workgroup website
      - Send a document to be posted to the comment section via email to Joy Wang at WangJ3@Michigan.gov
- Please stay engaged
  - Sign up for the listserv if you have not already
    - Go to MI Power Grid New Technologies and Business Models workgroup page
    - Scroll to bottom to add email
  - Attend future meetings
    - Next meeting on May 19 from 1 – 5 PM
    - Topic: Alternative Business & Ownership Models

Thank you!