Program Update:
Middletown Microgrid Feasibility Study

9/27/2018

Agenda

Topic	Presenter	Time
Introductions	Tony Mercantante	5 min
Middletown Feasibility Study Program Update	Joe Blackwell	10 min
Data Collection	Paul Heitmann	10 min
Technology Options	Paul Heitmann	15 min
Middletown Project Alternatives	Joe Blackwell	15 min
Adoption Challenges	Paul Heitmann	15 min
Community Dialog	Tony Mercantante	30 min

Tonight's Presentation Is a Project Update and Deep Dive
No Formal Recommendations Are Being Made

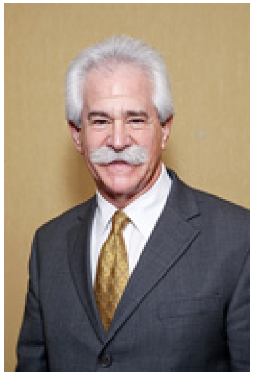
LEIDOS Program Team

Businovation, LLC

Paul Heitmann

- Strong background in DER technologies and standards (IEEE)
- Leading national initiatives in Transactive Energy

BBD, LLC



Fred Brody

- Leading multiple Monmouth community outreach coordination engagements
- Strong advocacy for NJ clean energy and transportation programs

Leidos Engineering

Joe Blackwell

- Deep experience in Microgrid design and planning
- Extensive knowledge of technology application and regulatory models

LEIDOS Program Team

Sridhar Chouhan
Ph.D., P.E.

- Microgrid design lead with extensive system planning and controls knowledge
- Distributed Energy Resource Interconnection Study Expert

Cory Schaeffer

- Expert in renewable energy generation with deep knowledge of energy storage
- Owners and independent engineer focused on performance and cost modeling

Middletown Microgrid Feasibility Study Program Update

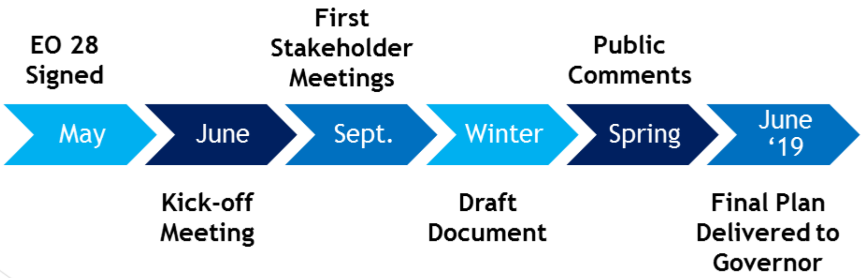
Project Purpose – Microgrid Study Grant

The **2015** New Jersey Energy Master Plan Update (EMP Update) established a new overarching goal: “Improve Energy Infrastructure Resiliency & Emergency Preparedness and Response.”

One of the EMP Update’s new Plan for Action’s policy recommendations included: “Increase the use of microgrid technologies and applications for Distributed Energy Resources (DER) to improve the grid’s resiliency and reliability in the event of a major storm.” This new policy recommends that:

> *“The State should continue its work with the USDOE, the utilities, local and state governments and other strategic partners to identify, design and implement Town Center DER microgrids to power critical facilities and services across the State.”*

The Town Center DER Microgrid – Feasibility Study Incentive Program is the first step in implementing this new policy goal.



2019 EMP Update

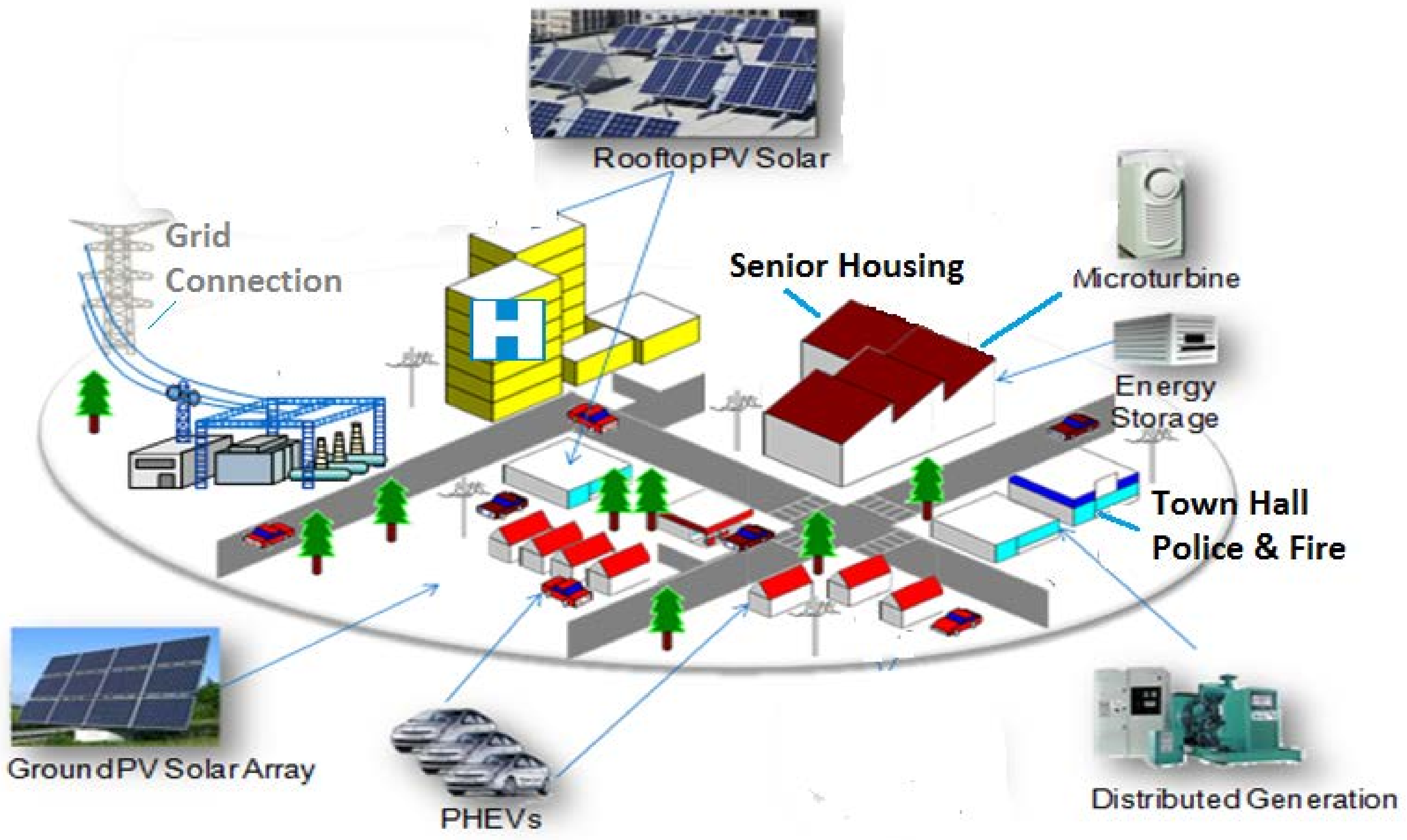
Next Meeting: “Sustainable and Resilient Infrastructure,” Friday, September 28, 10 a.m., the Conference Center at Mercer
Click here for directions

13 Microgrid Studies Underway in NJ

- **Paterson**
- **Montclair**
- **Hudson County (Secaucus)**
- **Hoboken**
- **Woodbridge**
- **Highland Park**
- **Middletown**
- **State of New Jersey (City of Trenton)**
- **Neptune**
- **Camden County (City of Camden)**
- **Galloway Township**
- **Atlantic City**
- **Cape May County (Middle Township)**

Average NJBPU grant: ~$175,000

Community Microgrid



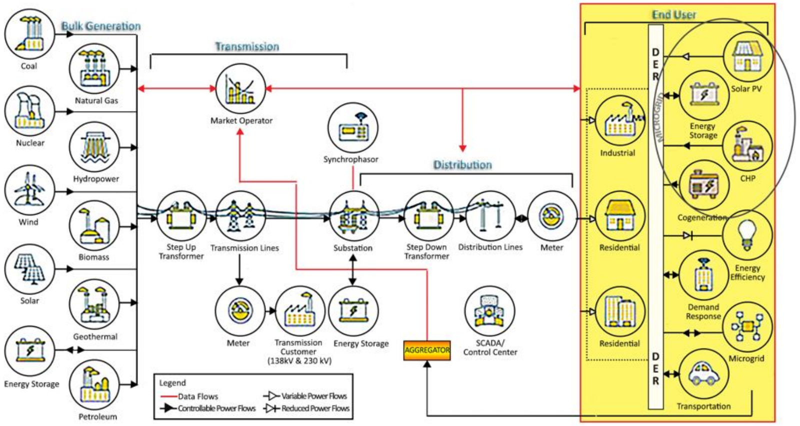
BPU’s Feasibility Study Report Requirements

- Details on the energy use
- MG boundaries and Rights of Way (ROW)
- Identification of emergency shelters
- Ownership/business model
- DER technologies/communication systems, interconnection & tariff issues
- Cost and financing options
- Optimization modeling with Rutgers University
- Community benefits

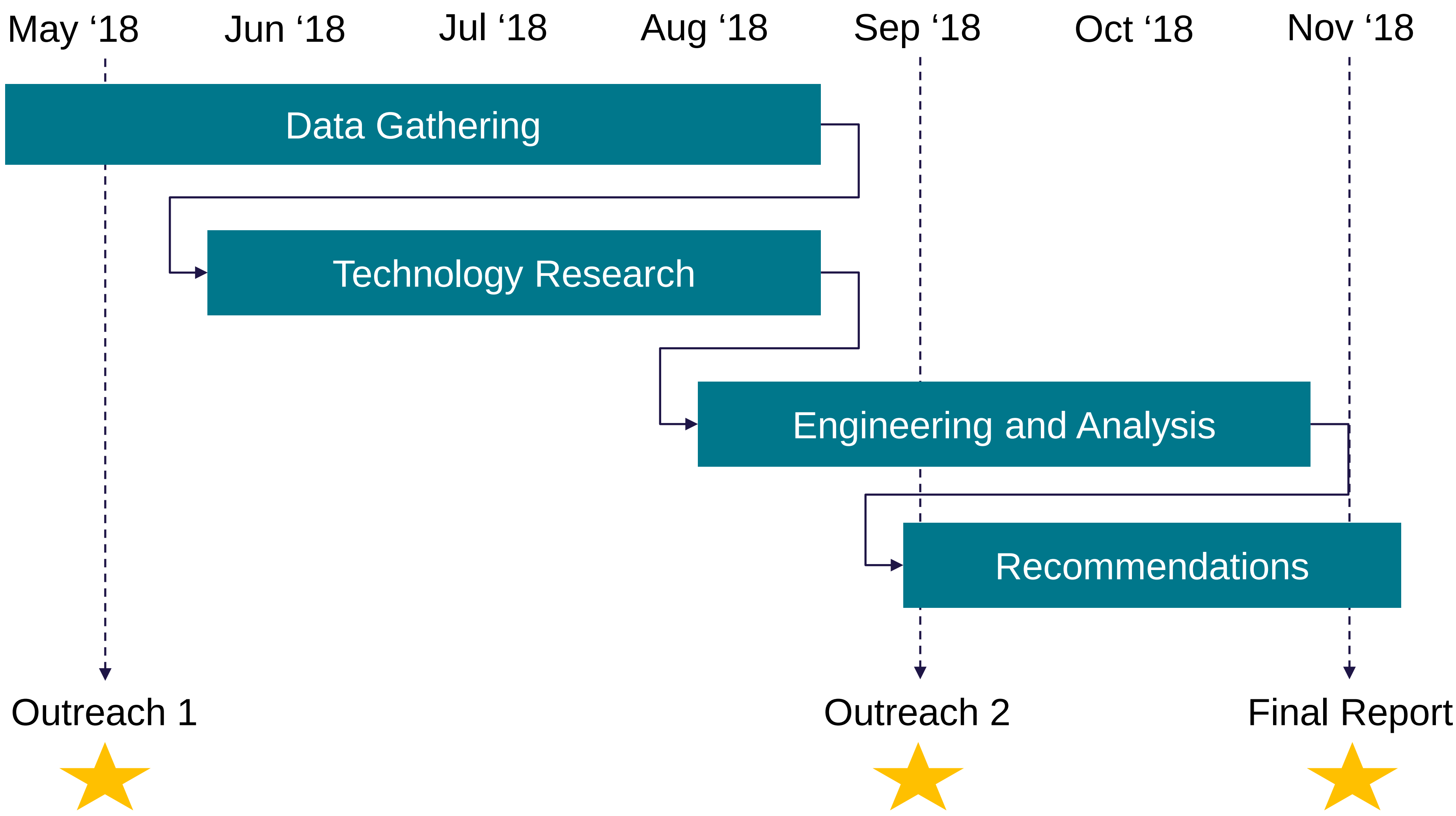
Next step: Competitive, limited funding for detailed design

Middletown Study: Critical Infrastructure

- NWS Earle Waterfront Administrative Area
- Township of Middletown Sewage Authority (TOMSA)
- NY Waterways Ferry Terminal
- Middletown Public Works and CNG Fueling Facilities
- Middletown Municipal Complex
- Public Schools
  - Bayshore Middle School
  - Leonardo Elementary School
  - Bayview Elementary School)
- Monmouth County Highway Department
- Middletown Fire Stations 3, 4 and 7
- Monmouth County Bayshore Outfall Authority
- State Route 35, 36 and Leonardville Road Traffic Signals

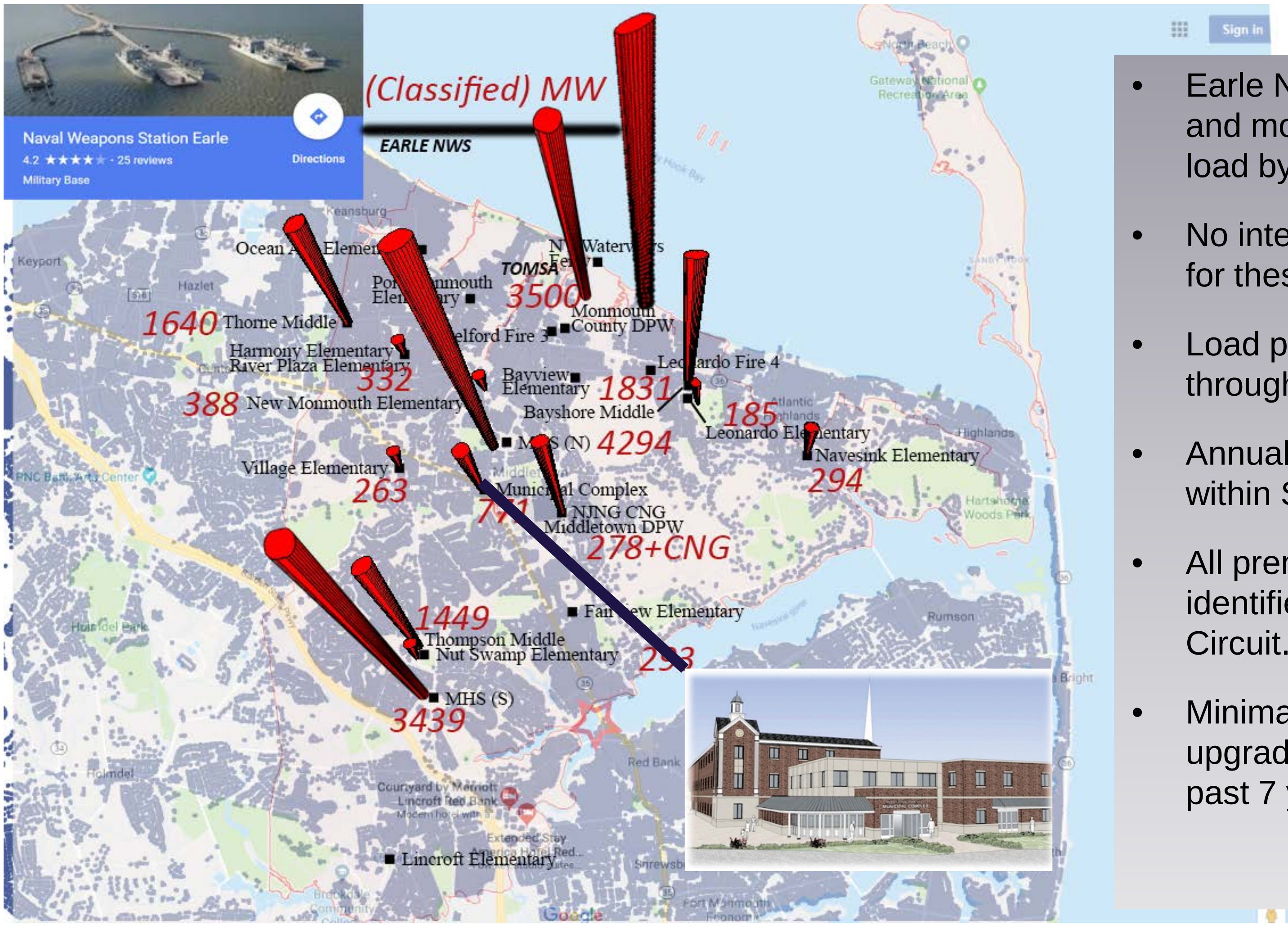


Project Activities Timeline



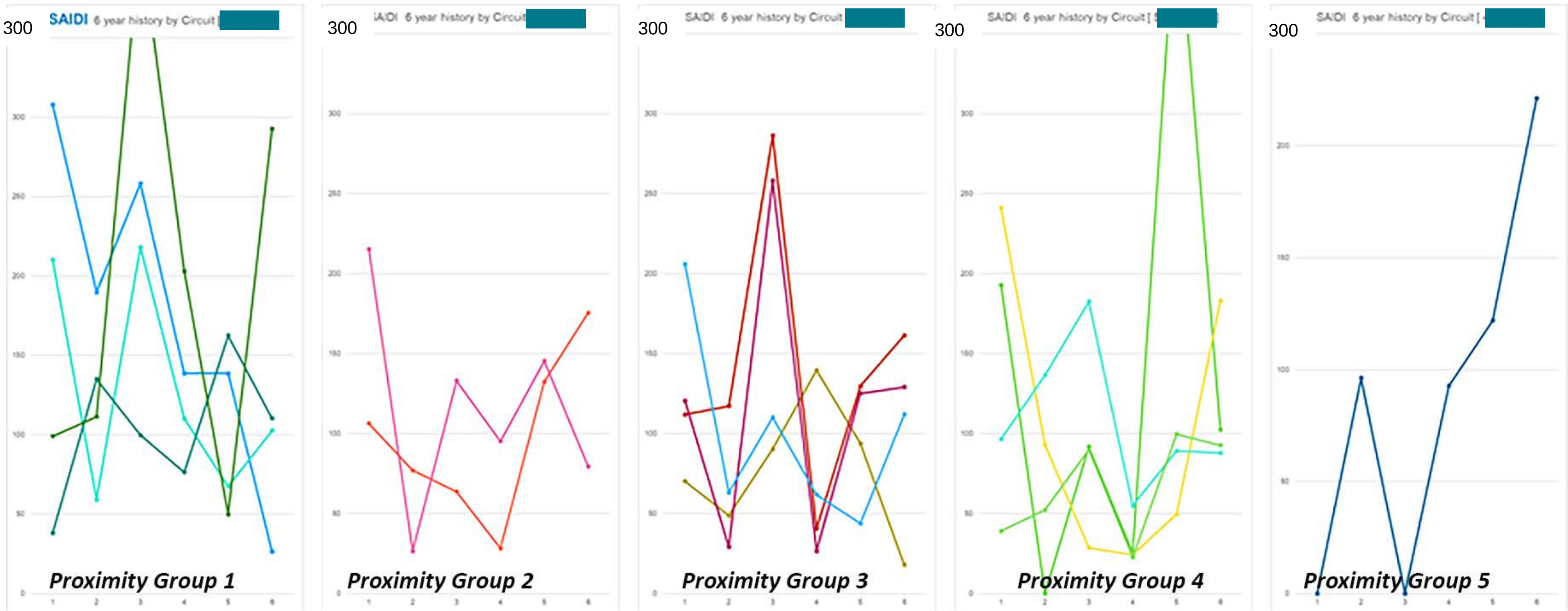
Data Collection

Data Collection Challenges and Opportunities



- Earle NWS represents largest and most variable industrial load by far.
- No interval data was available for these accounts
- Load predictability modeled through DERCAM type profiling
- Annual variability observed within SAIDI circuit reliability
- All premise connections are identified by Substation and Circuit.
- Minimal investment made in upgrade to any circuits over past 7 years

Data Viewpoints: 5 year circuit reliability variable

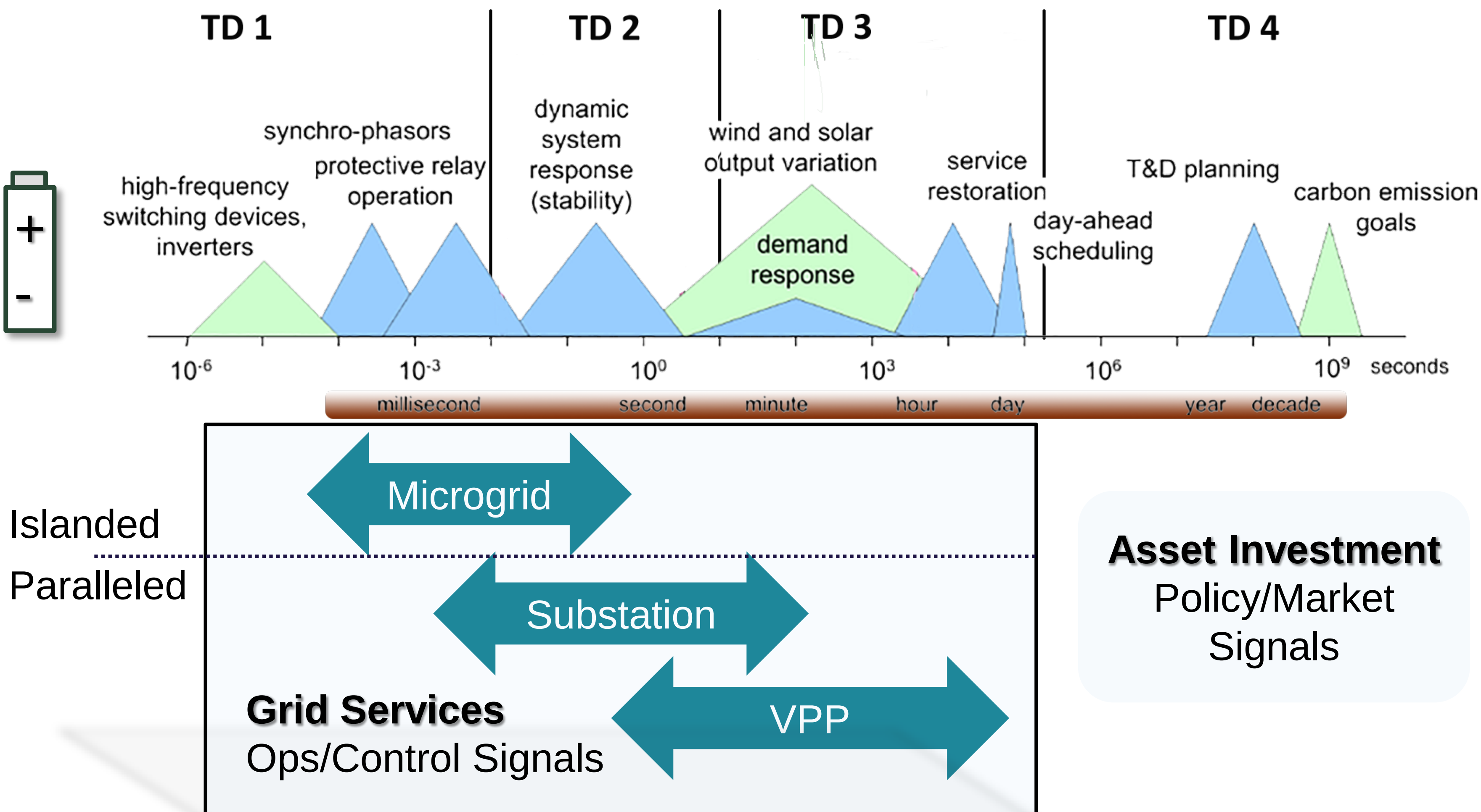


System Average Interruption Duration Index (**SAIDI**) measures the total duration of an interruption for the average customer given a defined time period.

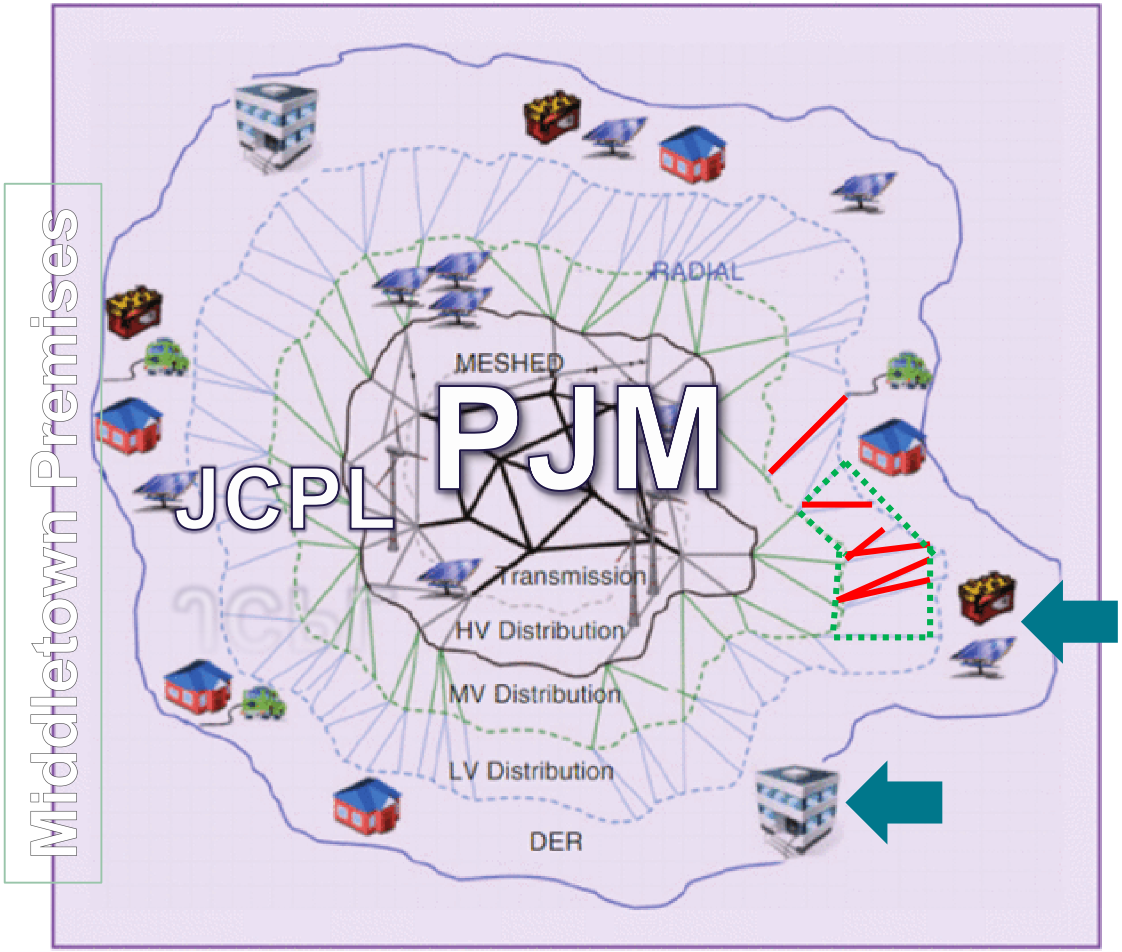
- Proximity groups organized by circuits to nearby premises served by common substations.
- High variability observed on most circuits year over year.
- Root cause needed for better understanding of failure mechanisms – but downed wires are typical.

Technology Options

How does Technology Support Grid Services?



The Radial Distribution Grid



> Diagram depicts the **Meshed** interconnection at the core wholesale and HV transmission level (PJM)

> Traditional **Radial** Grids have been built for the MV and LV distribution system

Grid Mod Opportunity **Conflict**:

+ Reinforce traditional radial last mile infrastructure to push central power or…

+ Enable virtualized grid edge that is driven by market signals, enabling flexible grid-edge DER transactions.

Now lets take a closer look at some of the relevant enabling DER technologies

Storage: The Rosetta Stone of Resilient DER

UTILITY DIVE Deep Dive Opinion Library Events Jobs Topics

DEEP DIVE

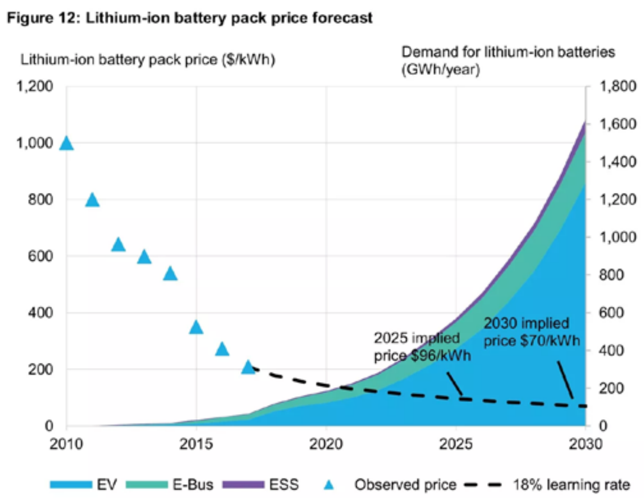
N.J. sets 'aggressive' 2 GW storage target by 2030

The latest energy storage goal could inspire more states to follow.

A-3723, raises the target of the state's renewable portfolio standard (RPS) to 50% by 2030**, establishes a 2,000 MW by 2030 target for energy storage** and updates the state’s policies for offshore wind, community solar, and energy efficiency.

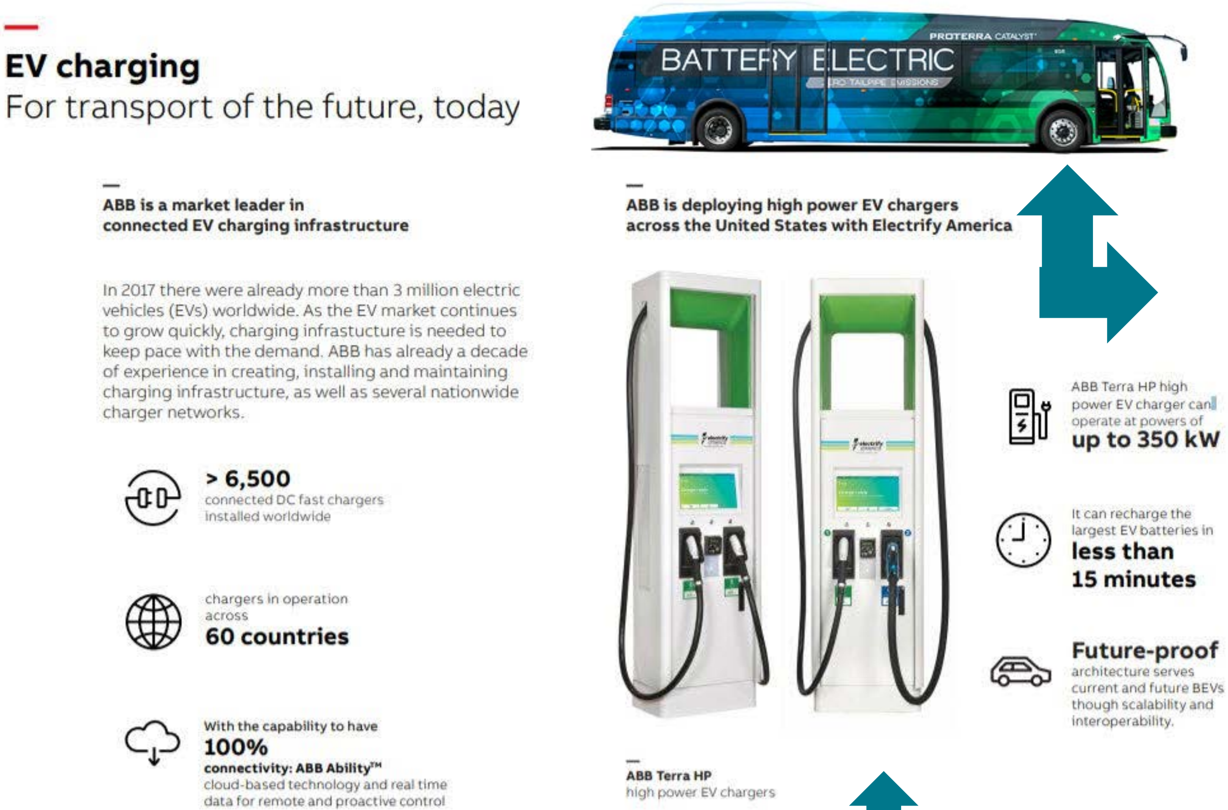
Storage: NJ Goals Lead the Nation

- Energy Storage
  - NJ has a significant program in place with *aggressive* energy storage goals. BPU must develop plan to have **600MW in place by 2021**
  - Grid storage has applications for distribution system management, community energy and offshore wind integration, *and* augmenting Ultra Fast EV charging
  - Costs for energy storage cells have dropped >80% over the past 10 years and continue to decrease with innovative process and achieving manufacturing scale



Typical <1MW Storage Unit

Storage: Enabling e-Mobility



Local storage can provide a seamless integration for microgrid and electric vehicles.

Solar: Vital to NJ Clean Power Goals

- Solar PV
  - NJ has a significant program in place with *aggressive* clean power goals. BPU mandate to aim for **50% clean energy by 2030**
  - Executive Order driving the newly launched 2019 Energy Master Plan to expand to 100% clean by 2050

  - Costs for wind energy and solar have dropped
    - **The average installed cost of wind projects in 2017 was $1,611 per kilowatt (kW), down 33 percent from the peak in 2009–2010.**
    - **Solar PV costs have fallen 73% since 2010 (IRENA), with additional 50% reduction expected by 2020**
  - Opt-In community solar programs are gaining support for shared virtual net-metering
- **As part of this new vision for a sustainable future, the new EMP will reflect new goals for the state**

Natural Gas Generation: A Right-Sized Example

Fuel	Power Output	Electrical Efficiency	Thermal Output	Thermal Efficiency	Total Efficiency
Natural Gas	59 kW	31.4%	105 kW	55.9%	87.2%
Natural Gas	120 kW	35.4%	192 kW	56.6%	92.0%
Natural Gas	150 kW	36.7%	224 kW	54.8%	91.4%
Natural Gas	190 kW	36.7%	264 kW	51.0%	87.6%
Natural Gas	235 kW	37.6%	312 kW	49.9%	87.5%
Natural Gas	285 kW	37.0%	424 kW	55.0%	92.0%
Natural Gas	375 kW	38.5%	465 kW	47.7%	86.2%
Natural Gas	550 kW	37.9%	764 kW	52.7%	90.6%
Natural Gas	840 kW	41.8%	909 kW	45.2%	87.0%
Natural Gas	1268 kW	42.3%	1344 kW	44.8%	87.1%
Natural Gas	1697 kW	42.2%	1819 kW	45.2%	87.4%
Natural Gas	2129 kW	42.4%	2263 kW	45.0%	87.4%
Bio/Waste	190 kW	36.7%	281 kW	54.2%	90.9%
Bio/Waste	250 kW	36.1%	368 kW	53.1%	89.2%
Bio/Waste	365 kW	36.0%	536 kW	52.9%	88.9%
Bio/Waste	550 kW	37.2%	800 kW	54.1%	91.3%
Bio/Waste	762 kW	41.8%	720 kW	39.2%	81.0%
Bio/Waste	1151 kW	42.0%	1076 kW	39.2%	81.2%
Bio/Waste	1542 kW	42.2%	1295 kW	35.4%	77.6%
Bio/Waste	1932 kW	42.6%	1622 kW	35.8%	78.4%

Pros:

- Modular, containerized generation
- Sized to fit the load requirement
- Fuel flexibility

Cons

- Challenges with emissions control compliance

Transactive Energy: Opening Participation Options

- Transactive Energy
  - SEPA and the US DOE have been advancing TE as one approach to grid mod/evolution
  - Blockchain technologies are advancing the possibility of a more automated, self-assembling and self-balancing microgrid using Smart Contracts
  - Continued advances in edge device compute and communication power will enable more refined *aggregation* and *virtualization* of DER
  - AI is driving levels of optimization and efficiency that reveal strong economic preference for more distributed but closely orchestrated energy resources.
  - Standards such as OpenADR and IEEE2030 are also enabling open system scalability and interoperability
  - Unlocking the *energy use data* and flowing it securely into market making platforms will capture the latent value of higher efficiency energy production and power distribution ops.

What about Blockchain?

- Blockchain is a fast emerging cryptographic structure that enables a distributed ledger recording immutable, consensus driven updates that are shared throughout a participant network.
- The use of blockchain technology is beginning to find its way into energy system applications – for both asset ownership and service transactions – and is revealing large gains in end-to-end efficiencies for generation, distribution and consumption. The technology is ideally suited to host Community Energy (solar and storage).
- Several industry organizations have been created to advance the industry awareness and standards for blockchain application to energy:

ENERGY BLOCKCHAIN CONSORTIUM

ENERGY WEB FOUNDATION

IEEE BLOCKCHAIN™

Middletown Project Alternatives

Community Microgrid Alternatives Identified

1. Central generation and reconductoring
2. Multiple independent microgrids – substation centric
3. Virtually managed microgrids

Community Microgrid Alternative Assessment

> A community microgrid connects multiple critical facilities with varied ownership and missions

> Substation-level focus enables architecture and implementation repeatability

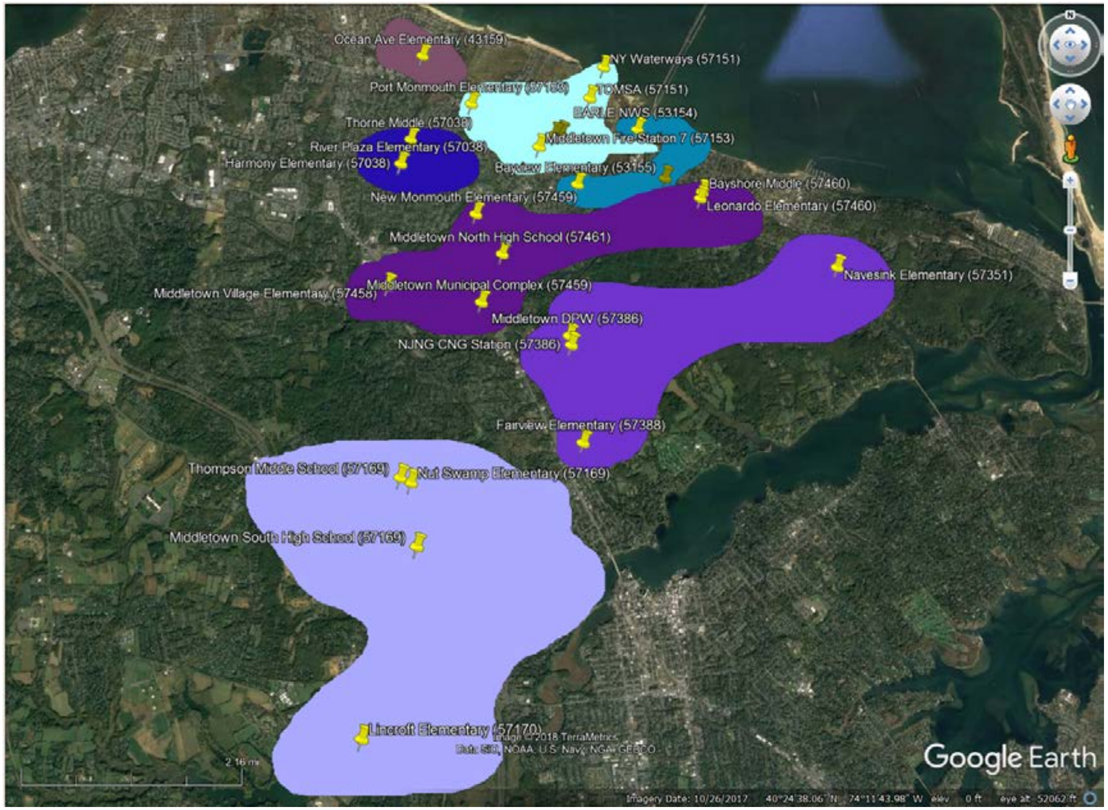
> Assessment starts with local generation and resiliency needs

> Grouping, control, and coordination opportunities are defined

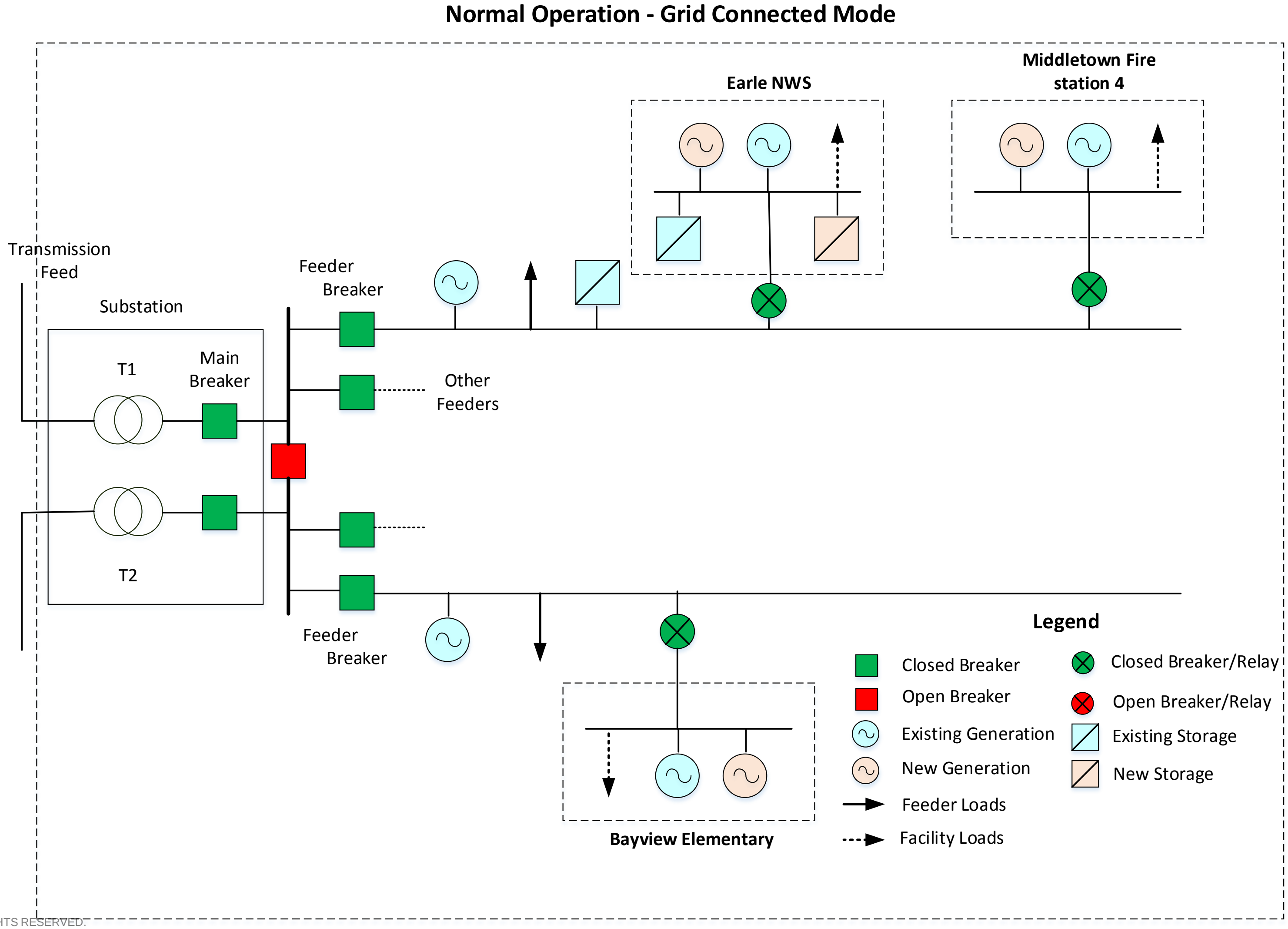
> DERCAM informs generation sizing analysis

> Benefit/Cost Analysis follows

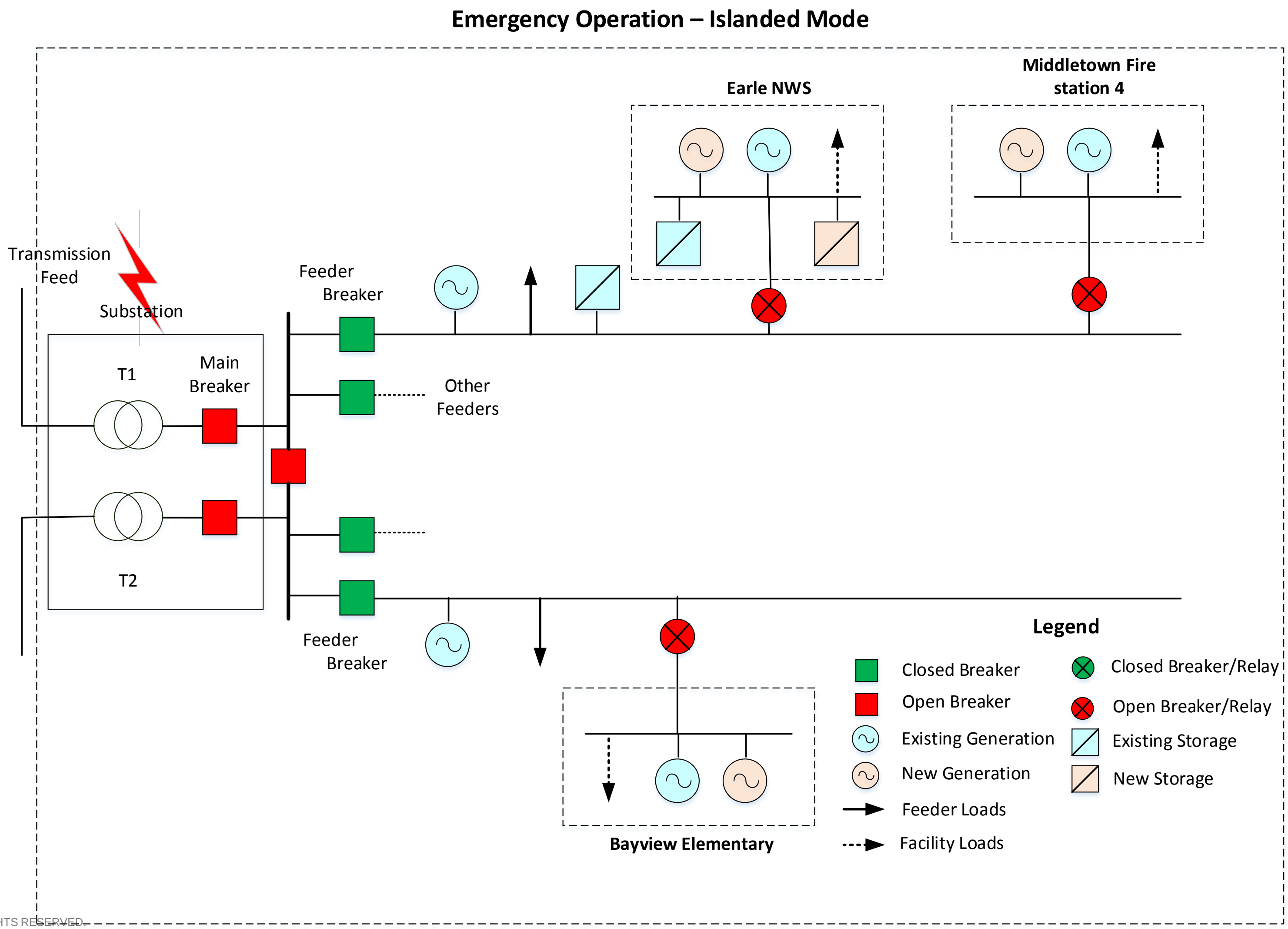
Example Alternative-1: Substation



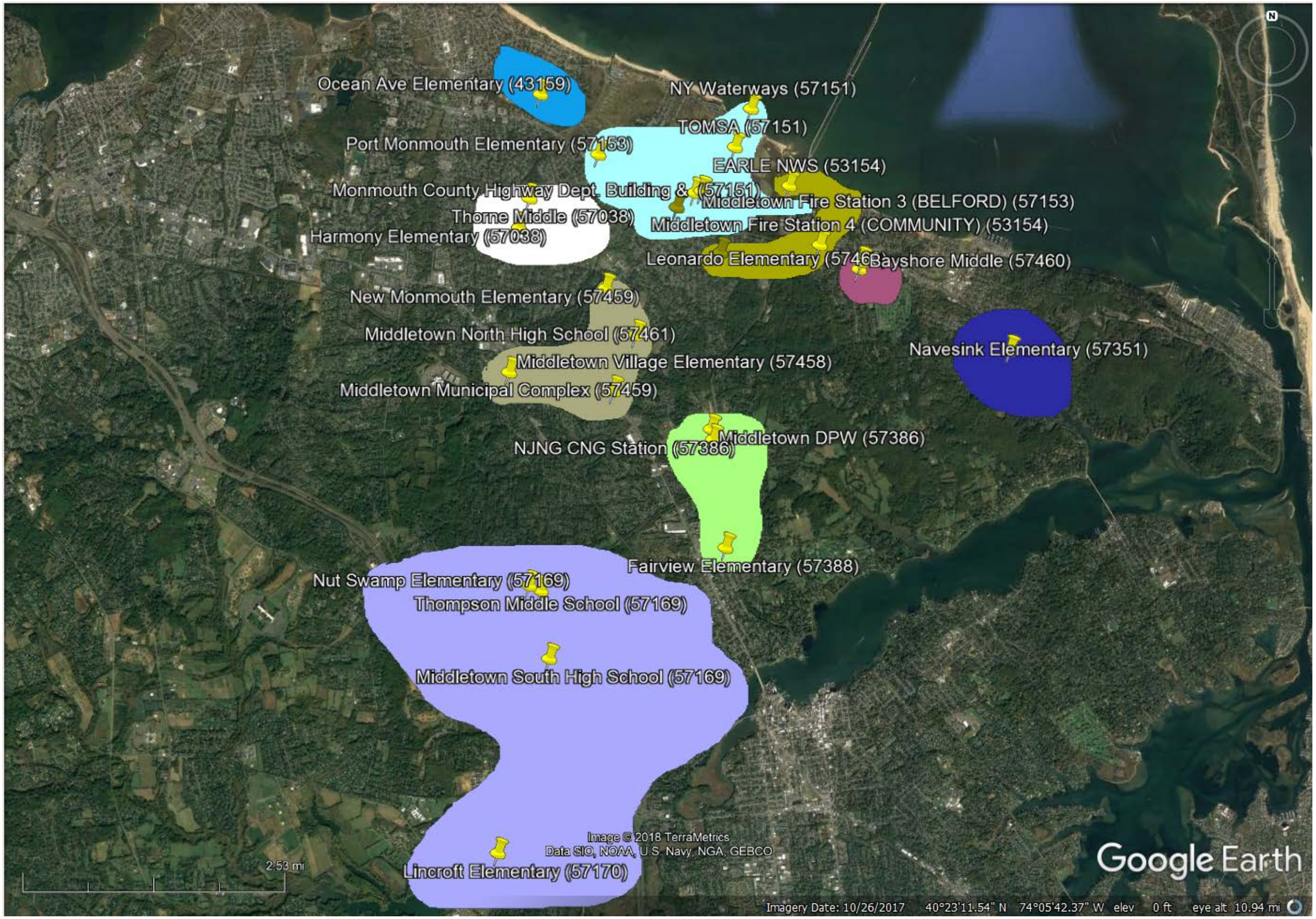
Example Alternative 1 – Grid Connected Mode



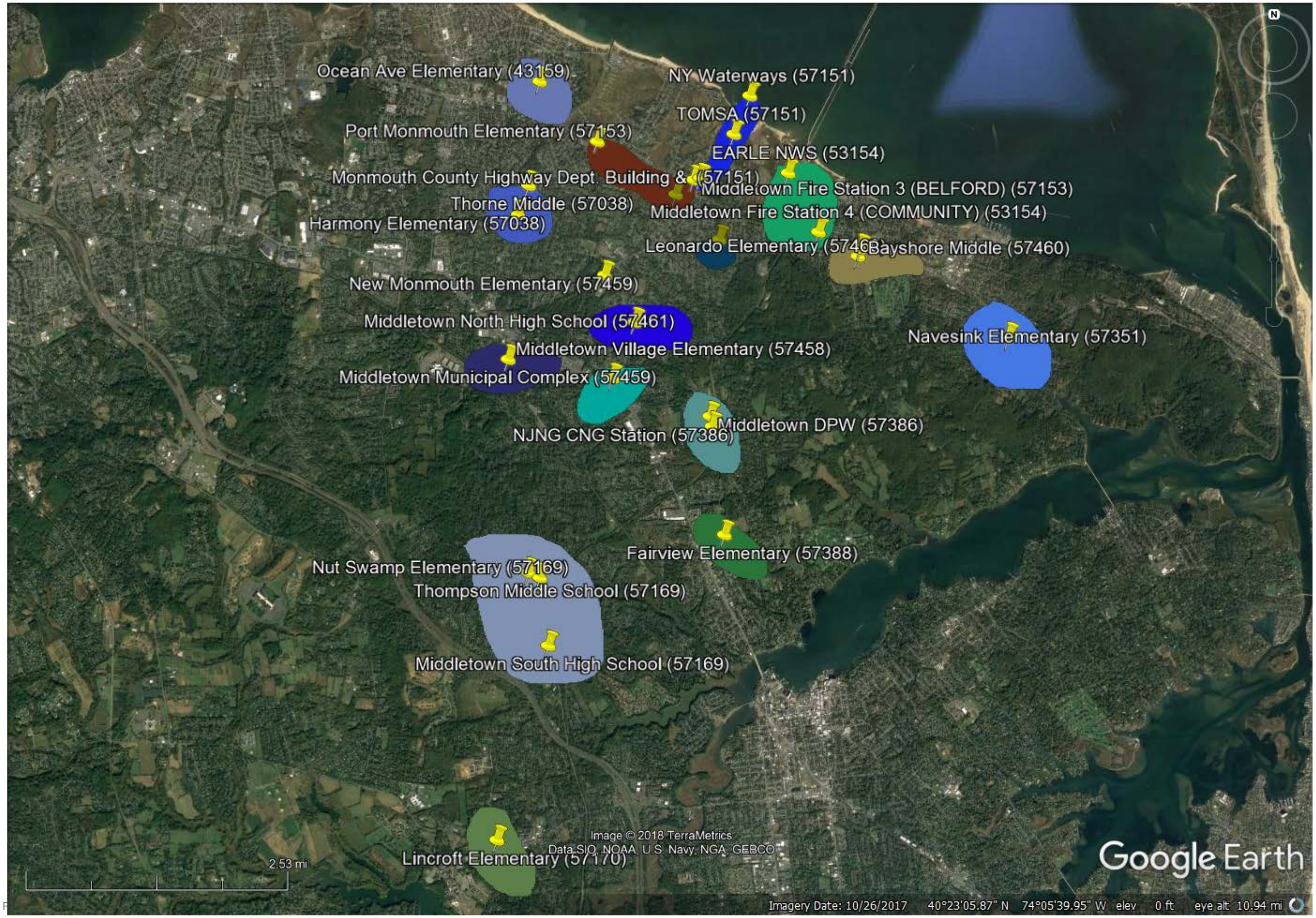
Example Alternative-1 – Islanded Mode



Example Alternative-2: Substation Bus



Example Alternative 3: Feeder



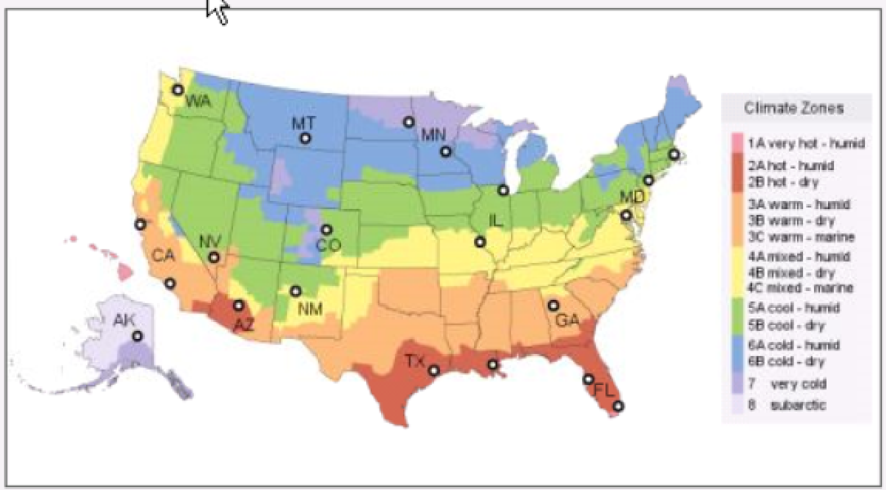
Pros & Cons for Substation Centric Alternative*

Community Microgrid Configuration	Pros	Cons
Substation	1. Less number of total community microgrids 2. Opportunity to optimize resources at larger scale 3. Better architecture which can be repeatable and re-usable	1. Difficulty in solving specific asset level use cases, such as peak reduction on station transformer or managing a specific load profile on the feeder.
Substation bus	1. Electrically makes better sense, and can optimize for specific use cases such as peak reduction on a substation transformer	1. More number of community microgrids 2. Miss opportunity for system level optimization
Feeder	1. Electrically makes more sense, and can optimize for specific use cases such as peak reduction on feeder	1. More number of community microgrids 2. Miss opportunity for system level optimization

*A virtual microgrid may substantially reveal a different balance of these pros and cons

DER-CAM Load Profiles

Information on load data

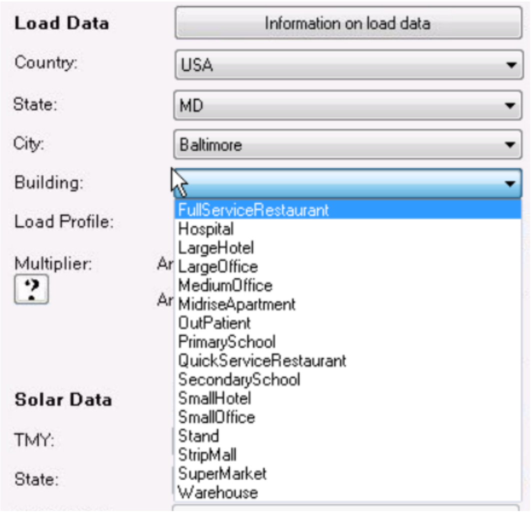


Please select a state and city as well as a vintage from the database. The database is based on ASHRAE climate zones (see picture). If you do not find a state and city in the database, select one from the same climate zone (e.g. use MD and Baltimore for NYC). Note that load profiles in this database are normalized to 1 GWh of electricity and 1 GWh of natural gas load per annum. In other words, all DER-CAM electricity loads together (electricity only, cooling and refrigeration) are noramilzed to 1 GWh. Also, all DER-CAM natural gas loads (heating, domestic hot water and natural gas only loads) are normalized to 1 GWh.To model your building, just check your annual electricity and natural gas bill and enter the annual electricity and natural gas demand in the boxes to scale the database load profiles to reflect your building.(1 GWh - gigawatt hour = 1 000 000 kWh and 1 kWh = 3412.14 BTU, 1 Therm (US) = 100,000 BTU = 29.3 kWh)

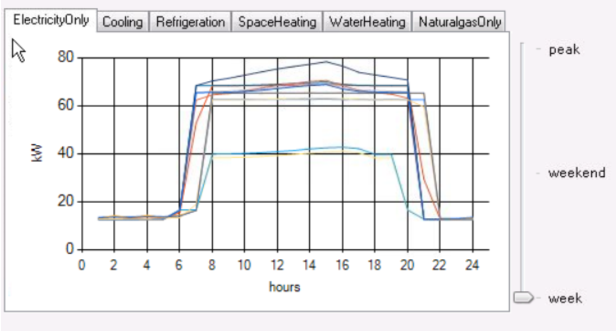
OK

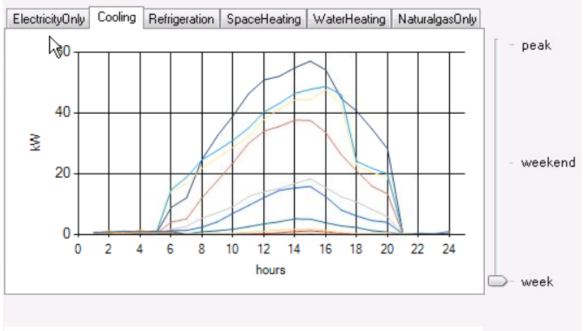
Customer Load Profiles

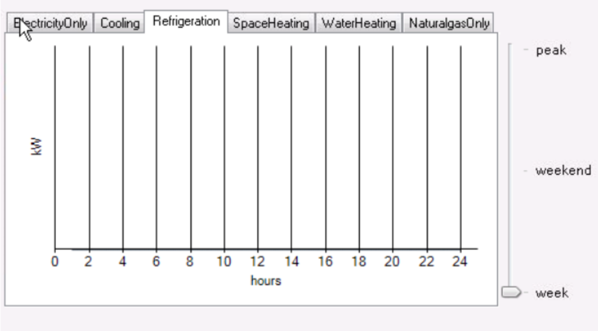
Participant	Load Type	Construction
Ocean Ave Elementary	Primary School	Post 1980/Pre 1980/New
EARLE NWS	?	Post 1980/Pre 1980/New
Middletown Fire Station 4 (COMMUNITY)	?	Post 1980/Pre 1980/New
Bayview Elementary	Primary School	Post 1980/Pre 1980/New
TOMSA	?	Post 1980/Pre 1980/New
NY Waterways	?	Post 1980/Pre 1980/New
Monmouth County Highway Dept. Building &	Medium Office	Post 1980/Pre 1980/New
Port Monmouth Elementary	Primary School	Post 1980/Pre 1980/New
Middletown Fire Station 3 (BELFORD)	?	Post 1980/Pre 1980/New
Middletown Fire Station 7	?	Post 1980/Pre 1980/New
Harmony Elementary	Primary School	Post 1980/Pre 1980/New
River Plaza Elementary	Primary School	Post 1980/Pre 1980/New
Thorne Middle	Secondary School	Post 1980/Pre 1980/New
Middletown South High School	Secondary School	Post 1980/Pre 1980/New
Nut Swamp Elementary	Primary School	Post 1980/Pre 1980/New
Thompson Middle School	Secondary School	Post 1980/Pre 1980/New
Lincroft Elementary	Primary School	Post 1980/Pre 1980/New
Navesink Elementary	Primary School	Post 1980/Pre 1980/New
Middletown DPW	Medium Office	Post 1980/Pre 1980/New
NJNG CNG Station	?	Post 1980/Pre 1980/New
Fairview Elementary	Primary School	Post 1980/Pre 1980/New
New Monmouth Elementary	Primary School	Post 1980/Pre 1980/New
Middletown Municipal Complex	Medium Office	Post 1980/Pre 1980/New
Bayshore Middle	Secondary School	Post 1980/Pre 1980/New
Leonardo Elementary	Primary School	Post 1980/Pre 1980/New
Middletown Village Elementary	Primary School	Post 1980/Pre 1980/New
Middletown North High School	Secondary School	Post 1980/Pre 1980/New

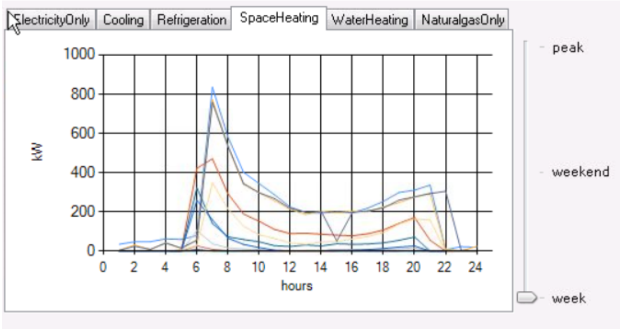


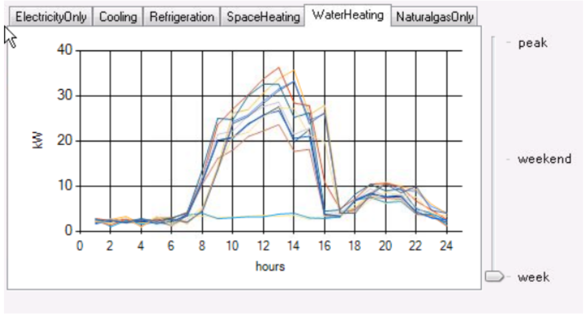
Bayview School: Weekday Load Profile

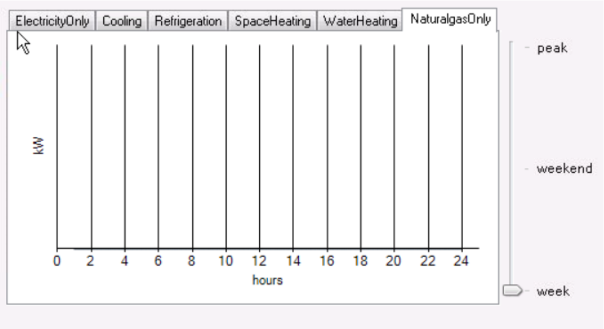




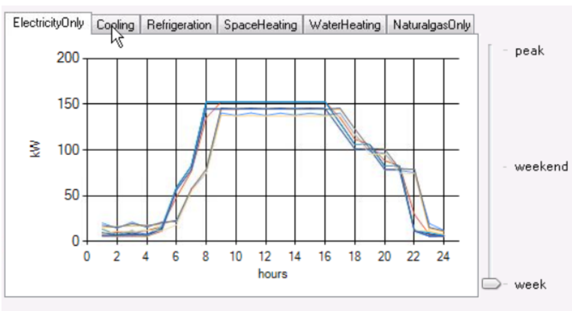


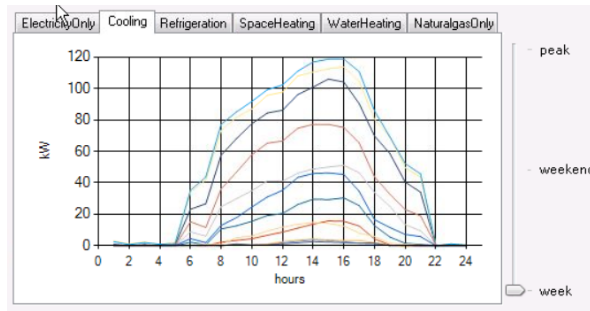


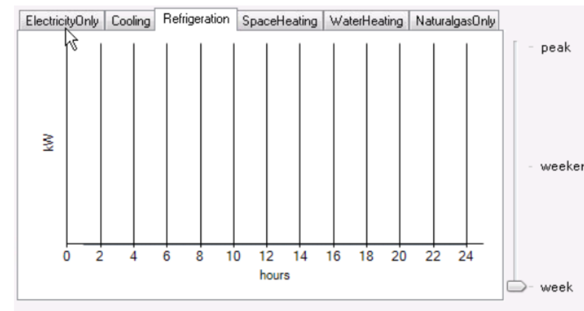


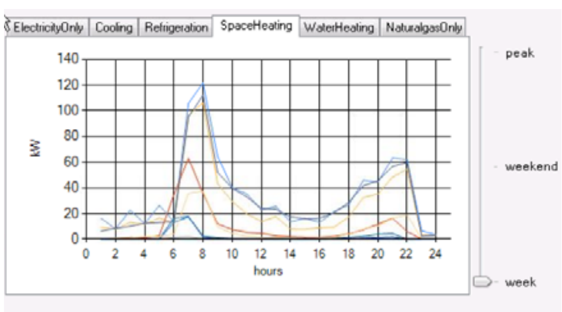


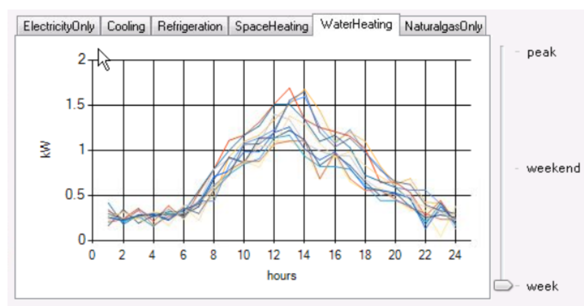
Existing Middletown Municipal Complex: Weekday Load Profile

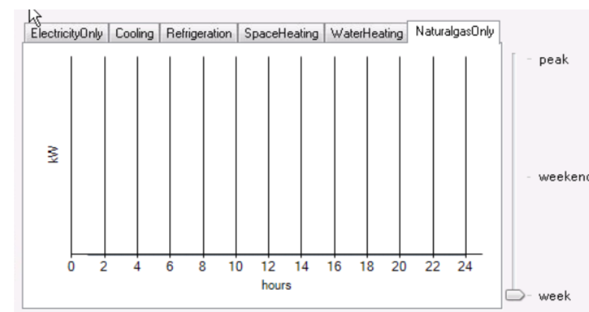












Barriers to Adoption

Microgrid Opportunities

- Microgrids are fast emerging as a viable decentralized alternative to traditional centrally sourced and controlled electric power delivery.
  - Costs for small renewable generation and storage dramatically dropping
  - Computing and communication power continues to advance, along with major advances in Artificial Intelligence and interoperability standards
  - Communities are recognizing that true resilience and fiduciary responsibility demand stronger local stake and participation in the process
  - Utilities themselves recognize the benefits of these flexible grid management resources that can help them meet and exceed reliability requirements and facilitate disaster recovery operations.

NJ Barriers Need Policy and Legislative Reform

- Microgrids in NJ face major barriers to adoption that require public policy reform and progressive legislation, because:
  - Existing utility franchise protection is threatened, leading to “preemptive friction”
  - Utility EDC business model is highly dependent on volumetric energy sales (kWhr)
  - Inadequate net benefit methodologies to properly value externalities
  - Legacy regulatory barriers prevent adoption of new business models and technologies which stifle innovation.

Sources of Preemptive Friction

- Limited transparency in the rate case process, and separation of "riders" that do not present holistic impact views
- Barriers to third party access of valuable customer and system performance data
- Emphasis on "compliance" with NERC reliability measures – forcing more capital investment rather than allowing alternatives.

Possible Approach to Mitigate:

Establish clear guidance and evaluation criteria within the 2019 Energy Master Plan for removing (or mitigating) these barriers.

Categorized Barriers

	PRIMARY	PRIMARY	SECONDARY	SOLVE
Current prohibitions	Energy resale prohibition	ROW Franchise boundaries	Environmental impact (emissions)	Regulatory Sandbox
Potential impact to utility franchise	Loss of revenue from volumetric energy sales	Stranded asset risk creates reluctance for CAPEX spend	Lack of customer/ratepayer transparency sows mistrust	Revenue Neutral , Decoupling
Customer awareness and requirements	Lack of customer alternatives for participation **choices**		Lack of customer/ratepayer transparency	
Alignment with cohesive state Energy Policy	Lack of clear policy signals allows for FUD, which benefits incumbents $$	Inability to capture inherent “cross-silo” system value and efficiency streams (ie Smart Cities)		

Wrap Up

Key Takeaways

> A community microgrid is technically feasible

> A community microgrid can provide benefits to Middletown citizens

> Distributed energy generation options are available and costs are falling

> Legislative and regulatory barriers must be overcome in order to succeed

> Ownership and financing innovations are required

Community Dialog

How To Provide Input

- Question and Comments?

- It is important for us to hear input going forward:

- Email: microgrid@middletownnj.org

Thank you!