pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Energy Programs Office

Improving Critical Facility Energy Resilience with Onsite Generation and Storage

March 9, 2022

Tom Wolf, Governor

Patrick McDonnell, Secretary

Today's goals and objectives

- Introduce energy resilience technology options for critical facilities
- Describe state/federal and other funding sources for these projects
- Make attendees stakeholders aware of no-cost feasibility studies
- Answer your questions about these topics

Speaker Introductions

Kerry Campbell
Environmental
Program Manager
PA Department of
Environmental Protection

Brian Moore
Director, Environmental
Emergency Response Program
PA Department of
Environmental Protection

Tom Hughes
Director, Emergency Mgmt.
Mitigation, Insurance and
Resilient Communities Office
PA Emergency Mgmt. Agency

Kevin Wright
President and co-founder
ProtoGen, Inc.

Agenda

1. Introduction & Purpose
2. Resilience Energy Technologies
3. Project Development Cycle
4. Funding and Financial Considerations
5. Regulatory and Legal Considerations
6. No-Cost Feasibility Studies
7. Q&A
8. Post-webinar survey: https://forms.office.com/r/W5b2QrCncZ

1. Introduction & Purpose

Adverse Events

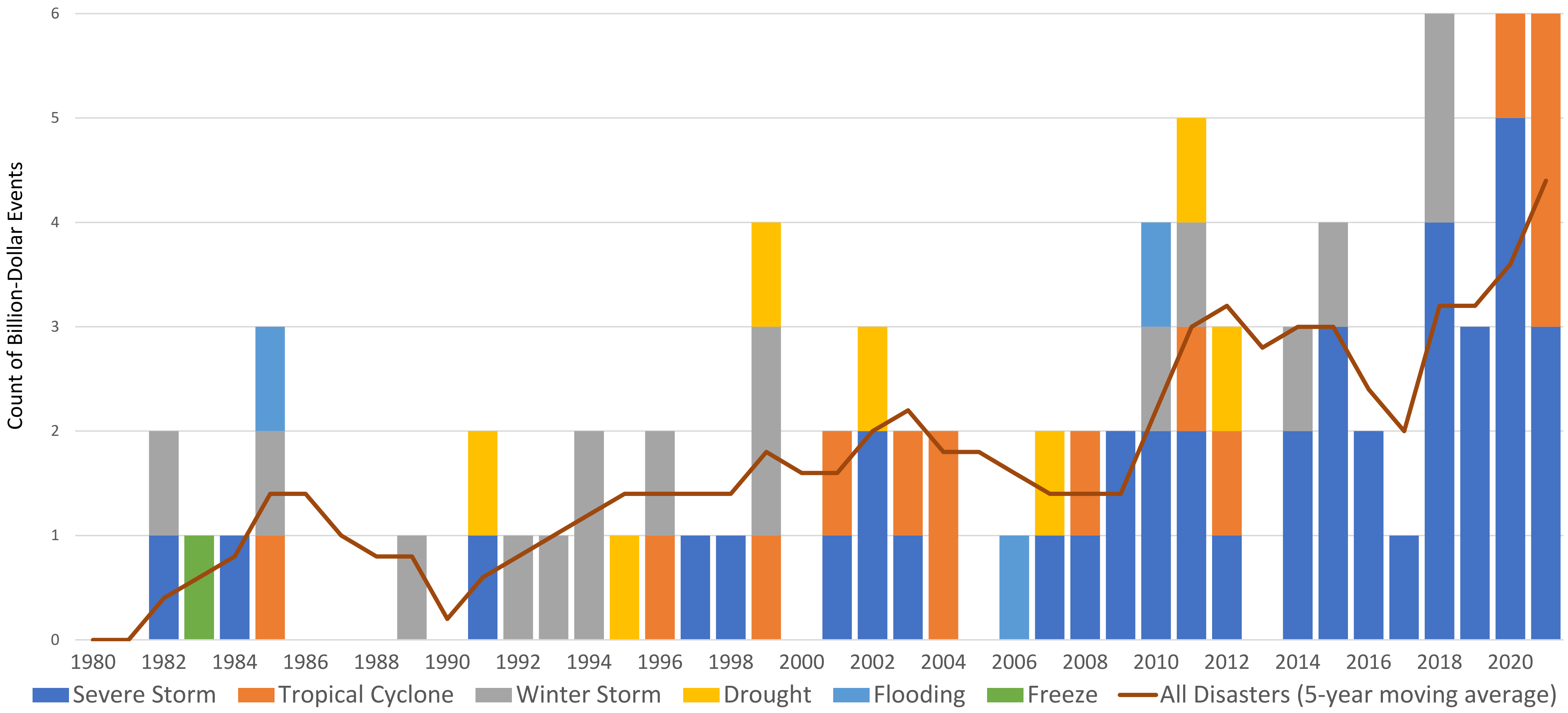
Adverse events are increasing in frequency and intensity

Such events can lead to cascading failures of critical infrastructure and systems

We need to adapt our critical infrastructure to withstand, ride through and recover faster from these events

Adverse Events

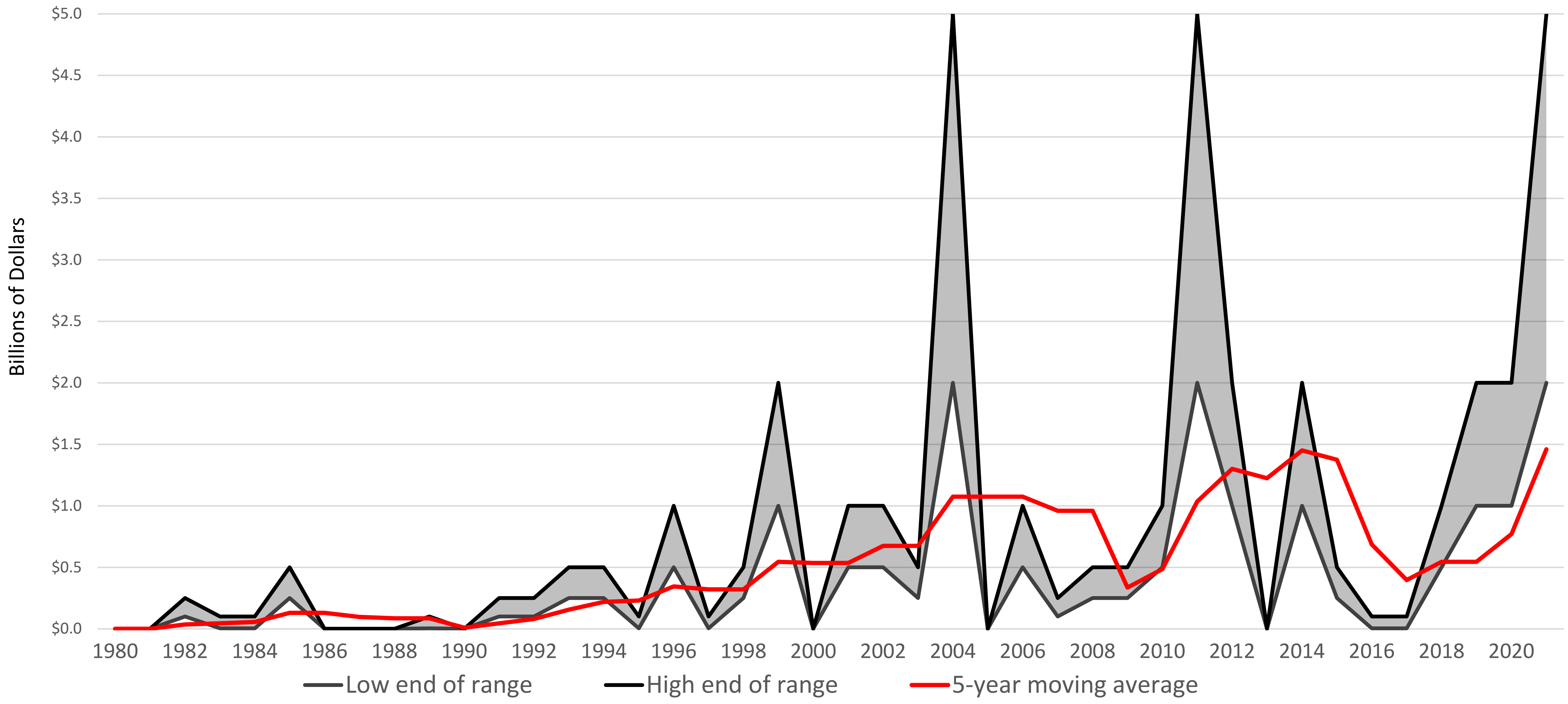
Pennsylvania Billion-Dollar Disaster Events 1980-2021 (CPI-Adjusted)



Source: https://www.ncei.noaa.gov/access/monitoring/billions/

Adverse Events

1980-2021 Pennsylvania Billion-Dollar Disaster Event Total Costs (CPI-Adjusted)



Source: https://www.ncei.noaa.gov/access/monitoring/billions/

DEP Energy Programs Office

The Energy Programs Office supports energy policies and programs that prevent pollution, protect our environment, improve public health, and ensure access to affordable energy options for all Pennsylvanians.

- Conservation and efficiency
- Advanced energy technologies
- Energy security and resiliency
- Education and outreach
- Climate

Responsibilities: State and Federal

Department of Environmental Protection: Emergency Support Functions 10 and 12 (Energy)

U.S. Department of Energy State Energy Program requires an Energy Assurance Plan that:

- Facilitates preparedness to prevent, mitigate and/or enable a rapid recovery response to the disruption or shortage of energy supplies;
- Assists in fulfilling the requirements of the Commonwealth Emergency Operations Plan, the Federal requirement for a Hazard Mitigation Plan, and the Pennsylvania Code.

Why Energy Resiliency is Important!

- Helps communities restart after natural or human made disasters.
- Helps keep critical, life sustaining facilities operational during emergencies.
- Enables a community or facility to become more independent and resilient.

Hazard Mitigation Planning

- Hazard Mitigation Planning is an essential tool for communities to better prepare for an uncertain future
- There are four core steps to complete or update an HMP

Source: https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/create-hazard-plan/process

FEMA HMA Grant Programs Discussed Today

Post-Disaster Grant Programs

Hazard Mitigation Grant Program (HMGP)
Implements long-term hazard mitigation measures after a major disaster declaration

HMGP Post-Fire
Helps communities implement hazard mitigation measures after wildfire disasters

Pre-Disaster Grant Programs

Flood Mitigation Assistance (FMA)
Reduces or eliminates the risk of repetitive flood damage to buildings and structures insured under the National Flood Insurance Program (NFIP)

Building Resilient Infrastructure and Communities (BRIC)
Supports the undertaking of new and innovative infrastructure projects reducing the risks faced from disasters and natural hazards

HMA Eligible Activities

Mitigation Projects	HMGP	BRIC	FMA
Property Acquisition	Yes	Yes	Yes
Structure Elevation	Yes	Yes	Yes
Mitigation Reconstruction	Yes	Yes	Yes
Flood Risk Reduction Measures	Yes	Yes	Yes
Dry Floodproofing non-Residential Buildings	Yes	Yes	Yes
Retrofitting	Yes	Yes	Yes
Generators	Yes	Yes	-
Advance Assistance	Yes	-	-
Project Scoping	-	Yes	Yes

Source: https://www.pema.pa.gov/Mitigation/Documents/FEMA-Hazard-Mitigation-Assistance.pdf

PEMA Generator Funding

- PEMA often receives county, municipal, and volunteer organization requests regarding generators
- FEMA Hazard Mitigation Grant Program is not the best programs for these requests

PEMA Generator Funding (cont.)

- Very low priority compared to other disaster and non-disaster mitigation projects vying for this same funding

- Potential applicants need to do some initial work to ensure they
  - have a clear scope of work
  - understand what their power generation requirements might be

More Resources to Explore Generator Funding

- Helpful questions to consider
- Alternative approaches
- Additional documents
  - Eligibility guidelines
  - Assessment tools
  - Tips, worksheets, application materials & more

PEMA HQ Parking Lot 2014, HMGP Funded Mobile 175kw Generators,
Photo - Courtesy of the PA Emergency Management Agency, MIRC Office

Visit:
pema.pa.gov/Mitigation/Grants-Projects/Generator-Funding/Pages/default.aspx

No-Cost Feasibility Studies

- Local, County and State bodies will be encouraged to apply for one of five (5) available no-cost project feasibility studies
- Feasibility studies shall address energy-related resilience projects and will be performed by ProtoGen, Inc.
- Studies conducted will be sufficient for adoption into a hazard mitigation plan (HMP)
- Studies can also be used to seek funding or issue a formal RFP

2. Resilience Energy Technologies

Overview of Distributed Energy Resources

COMBUSTION-BASED	NON-COMBUSTION

Gas-fired turbine

Reciprocating genset

Microturbine

Solar photo-voltaic (PV)

Battery Energy Storage System (BESS)

Gas-Fired Turbines

Size Range	1MW – 500+MW (1200+ MW in combined cycle)
Thermal Output	High-temperature exhaust can be used for steam, hot or chilled water, or industrial process
Part-load Operation	Efficiency declines significantly with load. Best economics at or near full load.
Fuel	Wide range of gas and liquid fuels. NG is most common for CHP.
Time to full load	< 10 minutes (aeroderivative) 20+ minutes (industrial) 50+ minutes (combined cycle)
Ramp rate	10% per minute (combined cycle) 20% per minute (industrial) 50% per minute (aeroderivative)
Reliability	Mature technology with high reliability.
Other	Relatively low emissions and require no cooling. Widely used in CHP applications; low installed costs.

Image source: https://cai3.com/spirit-10-12-mw

Reciprocating Genset

Size Range	10kW – 10+MW (can combine multiple engines)
Thermal Output	Waste heat from exhaust, cooling water and lubricating oil can be used for hot or chilled water or low-pressure steam.
Part-load Operation	Perform well at partial load; well suited for both baseload and load-following applications
Fuel	Wide range of gas and liquid fuels. NG is most common for CHP.
Time to full load	< 5 minutes
Ramp rate	> 100% per minute
Reliability	Mature technology with high reliability.
Other	Widely used for CHP with relatively low installed costs. Starts quickly; operates on typical NG delivery pressures.

Image source: https://www.generatorsource.com/14-MW-Wartsila-Natural-Gas-Power-Plant

Microturbines

Size Range	30kW– 200kW (1+MW in integrated modular packages)
Thermal Output	Microturbine exhaust temperatures are in the range of 500-600°F and can be used to make steam and hot or chilled water.
Part-load Operation	While efficiency declines significantly with load, this can be managed with modularity.
Fuel	Wide range of gas and liquid fuels. NG is most common for CHP.
Time to full load	5-6 minutes
Ramp rate	150-200% per minute
Reliability	Based on design principles used in larger turbines, with high reliability
Other	Low emissions with no cooling. Individual units are compact and can be easily shipped and sited in confined spaces.

Source: https://horizonpowersystems.com/c1000s

Solar Photovoltaic (PV)

- PV panels use silicon cells to create electricity from light (NO FUEL REQUIRED)
- Sunlight is intermittent, meaning PV alone can't provide firm power
- Can be integrated based on available site space (rooftops, canopy structures, ground-mount)
- Can be net-metered (3MW for non-residential, 5MW for micro-grid and emergency systems)*

*Source: https://programs.dsireusa.org/system/program/detail/65

Battery Energy Storage Systems (BESS)

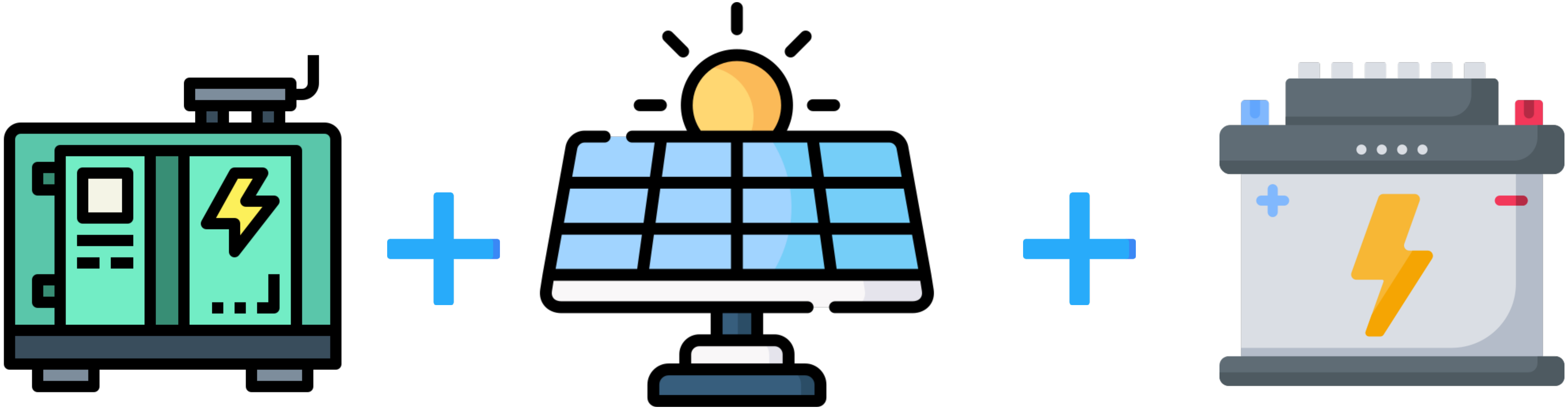
- Converts electrical energy to chemical energy and vice versa
- Most fundamental characteristics:
  - chemistry (lithium-ion, lead acid, etc.)
  - power (kW) and energy storage capacity (kWh)
  - duration in minutes/hours
- Need a charging source & a load
- Efficiency losses of 10-20%

More via PA Energy Storage Consortium:

dep.pa.gov/Business/Energy/OfficeofPollutionPrevention/Pages/Energy-Storage.aspx

Image courtesy of Scale Microgrids: BESS and switchgear inside enclosure

How can DER work with diesel backups?



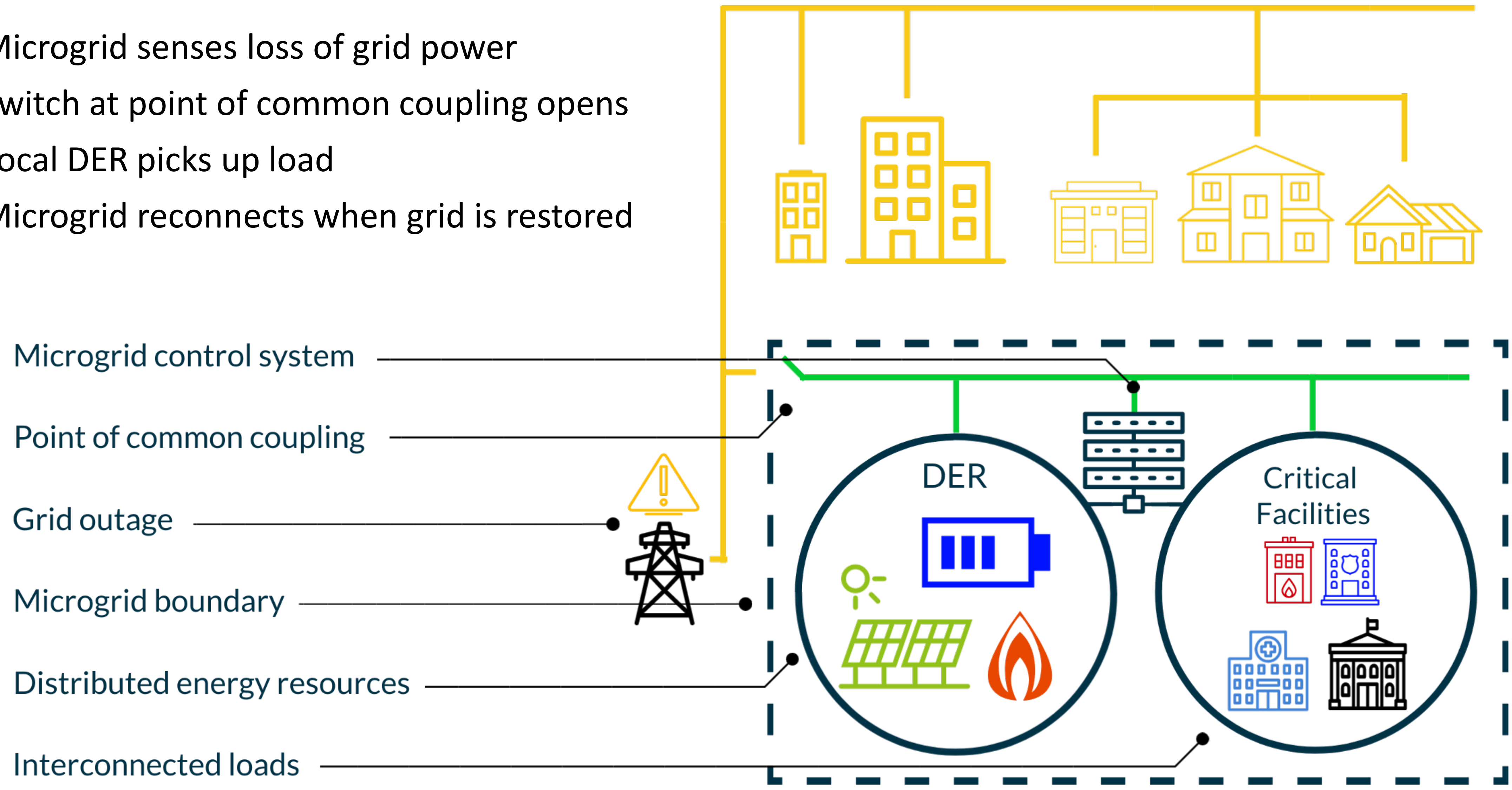
- Critical facilities typically have existing standby generators
- Adding PV and BESS can improve resilience, economics, and environmental impact

Ultimate Resilience: Microgrids

- Group of **interconnected loads** and **distributed energy resources (DER)**
- Has clearly defined **electrical boundaries**
- Acts as a **single controllable entity** with respect to the macrogrid
- Can **connect and disconnect** from the grid
- Can operate in **grid-connected** or **island-mode**

Islanded Microgrid Diagram

1. Microgrid senses loss of grid power
2. Switch at point of common coupling opens
3. Local DER picks up load
4. Microgrid reconnects when grid is restored

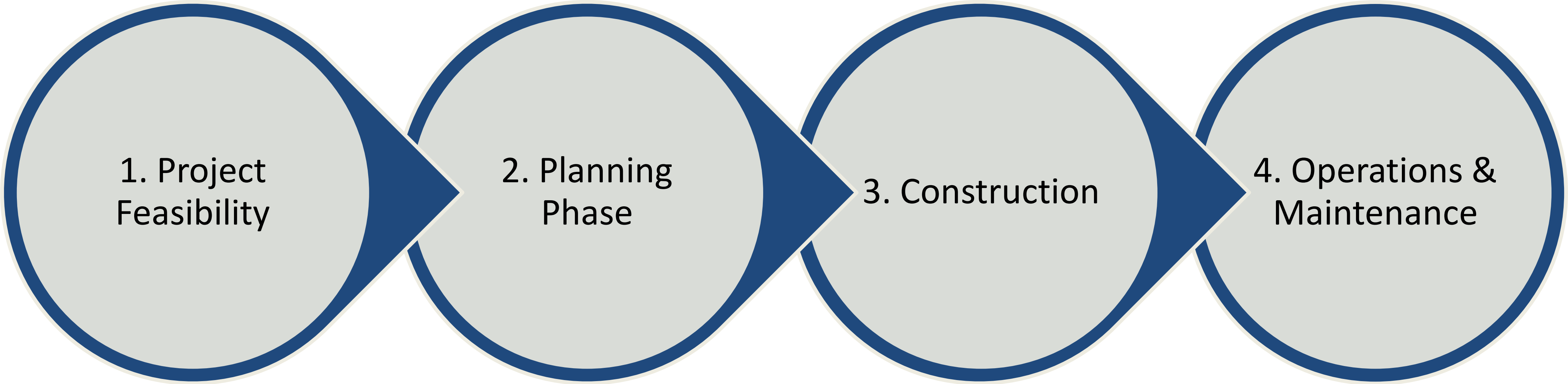


Standby Generators vs. Microgrids

Standby Generators	Microgrids
• Typically runs on diesel fuel (diesel emissions, heavily reliant on supply chain logistics) • Supplies power to local loads during an outage • A brief loss of power is typical • Rated to run ≈ 500 hours/year at 70% capacity • Cannot operate in parallel with or put energy onto the grid	• Can incorporate any DER (diesel, NG, RE, etc.) • Senses grid conditions; can react more nimbly • Reduce or eliminate experienced power loss • Can typically run indefinitely at or near capacity • Can be configured to interact with the grid and create revenue streams

3. Project development cycle

Project Development Cycle Overview



- Requirements gathering
- Modeling & simulation
- Business case and financing development
- Go/no-go decision

- Design and engineering
- Finalize approvals and contracts
- Procurement

- Planning
- Execution
- Monitoring
- Closeout

- Operations
- Maintenance
- Decommissioning

Feasibility Phase

Typical Feasibility Objectives

- ☐ Identify all project stakeholders
- ☐ Establish consensus on project concept
- ☐ Gather stakeholder input and project requirements
- ☐ Develop techno-economic modeling
- ☐ Refine model based on feedback
- ☐ Finalize study with recommendations
- ☐ Go/no-go decision

Image courtesy of ProtoGen, Inc: Screenshot of techno-economic modeling software

Feasibility Phase: Types of info needed

- Project goals
- Operational requirements including any planned changes to operations
- Site energy usage and utility bills
- Inventory of any existing or planned assets
- Spatial information about the site

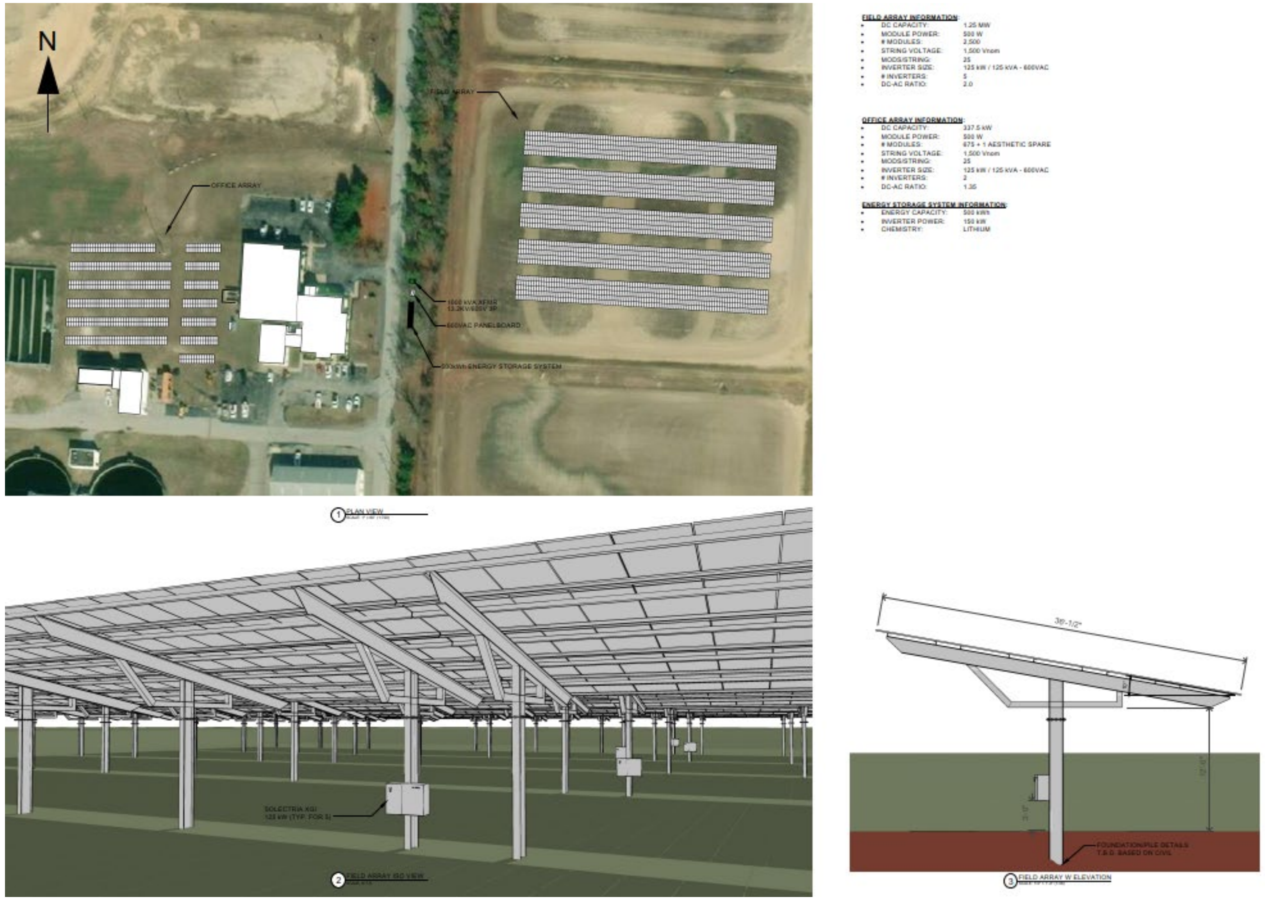


Image courtesy of ProtoGen, Inc: Solar microgrid rendering at a wastewater treatment facility

Feasibility Phase: Typical outcomes

- Develop project vision
- Conceptual basis of design
  - equipment types
  - capacities
  - modes of operation
  - renderings
- Proforma business case with supporting economic modeling
- Go/no-go decision

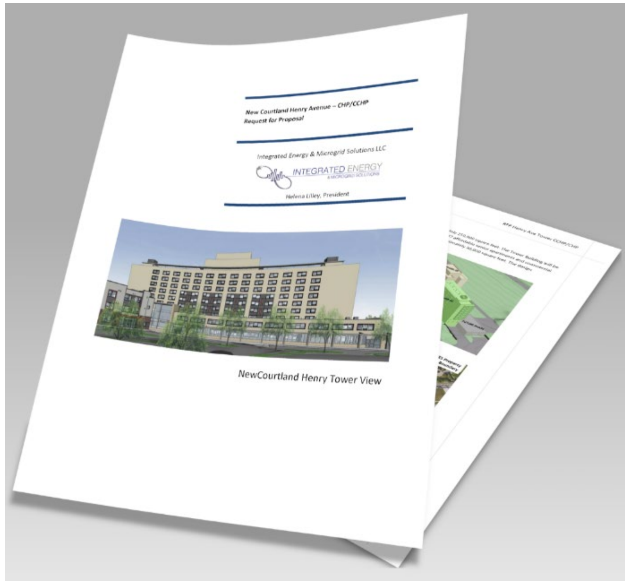


Image courtesy of ProtoGen, Inc: CCHP rendering with supporting feasibility report

Planning Phase

Typical Planning Objectives:

- ☐ Identify engineering disciplines required
- ☐ Identify relevant codes and standards
- ☐ Design and engineering kick-off
- ☐ Design coordination, review and approval
- ☐ Construction drawings and planning
- ☐ Procure equipment and subcontractors, as necessary

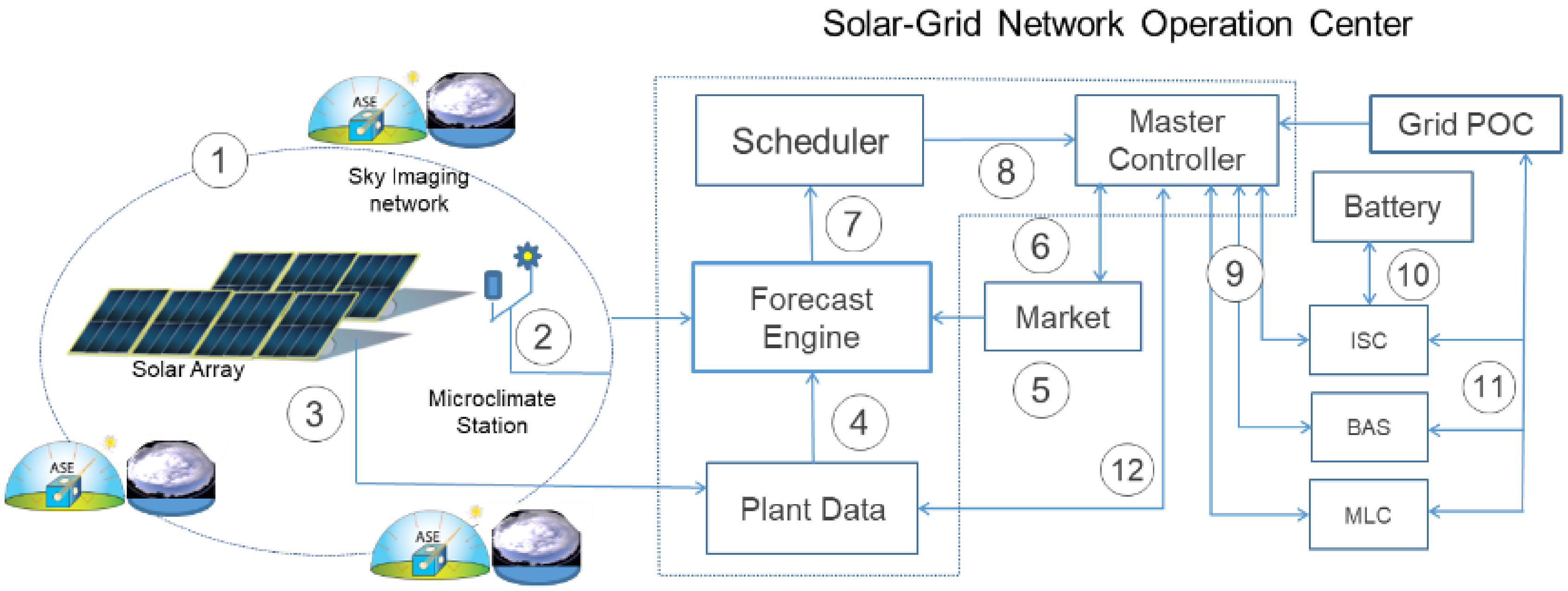


Image courtesy of ESAMTAC: Example of system control layers in a PV/BESS microgrid

Planning Phase: Typical outcomes

- Design & engineering
  - Preliminary design
  - 30-60-90% iterations
  - Construction drawings issued
- Procurement
  - Major equipment
  - Balance of plant

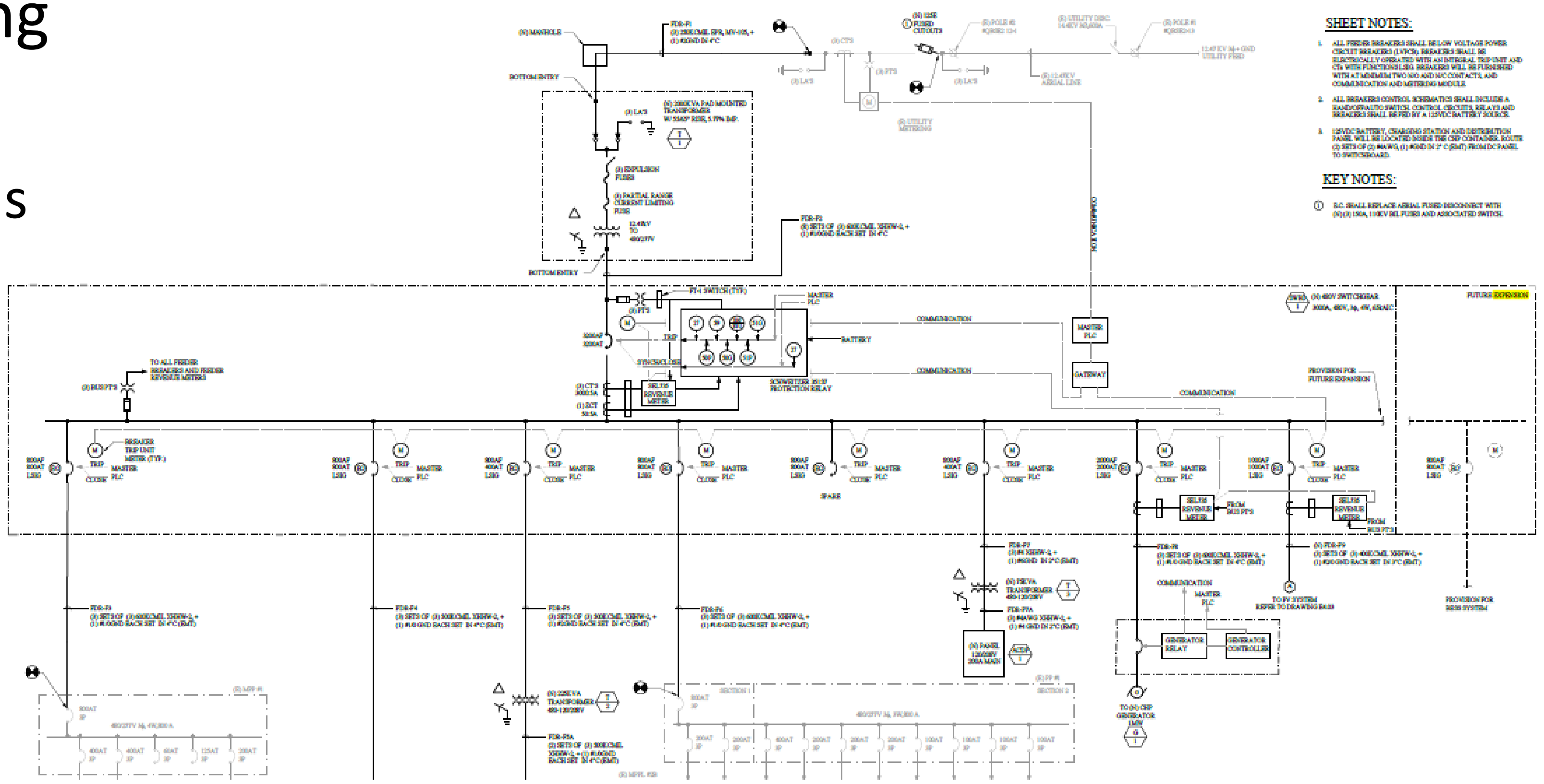


Image courtesy of ProtoGen, Inc: Single-line diagram of a solar/CHP microgrid with provision for BESS

Construction Phase

Typical Construction Objectives:

- ☐ Assemble the project team
- ☐ Implement a project charter
- ☐ Conduct project planning
- ☐ Execute the project
- ☐ Monitor and control the project
- ☐ Commission the project
- ☐ System is operational

Images courtesy of ProtoGen, Inc: Pad-mounted 65kW microturbine (left); BESS being hoisted into electrical room

Construction Phase: Typical outcomes

- Initiation
- Project planning
- Project execution
- Monitoring and control
- Project Commissioning

Image courtesy of ProtoGen, Inc: Electrical worker checks BESS connections

Operations and Maintenance Phase

O&M Objectives:

- ☐ Assemble project documentation
- ☐ Formalize an operational plan
- ☐ Operate the system per plan
- ☐ Meet reporting requirements
- ☐ Perform scheduled maintenance incl. equipment refreshes
- ☐ Troubleshoot pro-blems as they arise
- ☐ Decommission assets per plan

Images courtesy of ProtoGen, Inc: Worker inspects dc side of a PV inverter (left); replaces fuse holders in deenergized combiner box

O&M Phase: Considerations

- Operator training and/or outsourcing
- Scheduled and non-scheduled maintenance
- Operational modes
- Monitoring
- Decommissioning

Image courtesy of Core States Group: A 2MW natural gas reciprocating engine installed at a chemical plant

Microgrid Development Guidebook

- Deep resource for those interested in microgrids
- Divided Into 3 Parts
  - 1 Project Development Lifecycle
  - 2 Microgrid Framework
  - 3 Appendix

No-cost download:
electri.org/product/the-electrical-contractors-practical-guide-to-microgrid-development/

4. Funding and Financial Considerations

Microgrid and DER Business Drivers

ECONOMIC:

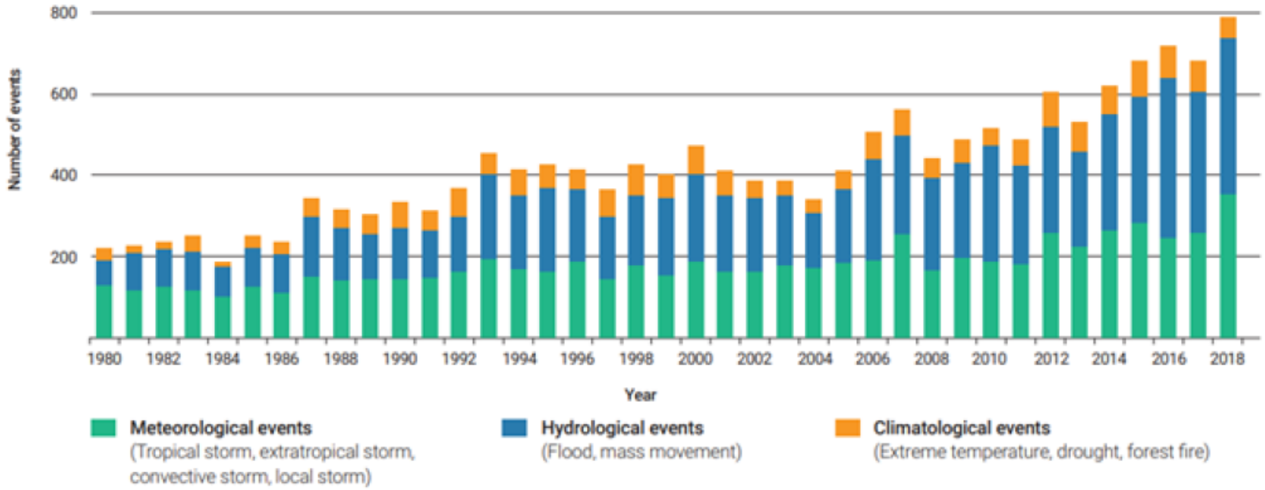
- reduced OPEX
- reduced or avoided CAPEX
- revenue generation

SUSTAINABILITY:

- Renewable energy goals
- Carbon reduction
- Climate change mandates

RESILIENCE: enhanced ability to ride-through adverse events such as extended grid outages, physical attack and cyber attack

World weather-related natural catastrophes by peril, 1980-2018



Note: Accounted events have caused at least one fatality and/or produced normalized losses ≥ US$100K, 300K, 1M, or 3M (depending on the assigned World Bank income group of the affected country).

Adapted from The United Nations World Water Development Report 2020

How are Energy Projects Funded?

GRANT FUNDS

- **hazard mitigation assistance**
- research grants
- infrastructure bill

SELF-FINANCED

- cash
- bonds
- loans
- property assessed clean energy

ENERGY-as-a-SERVICE (EaaS)

- provider designs, builds, finances, and operates the asset(s)
- end user offtakes the energy other attributes per the contract

3RD PARTY INVEST-MENT

- investor ownership flips and other tax equity schemes
- public-private partnership

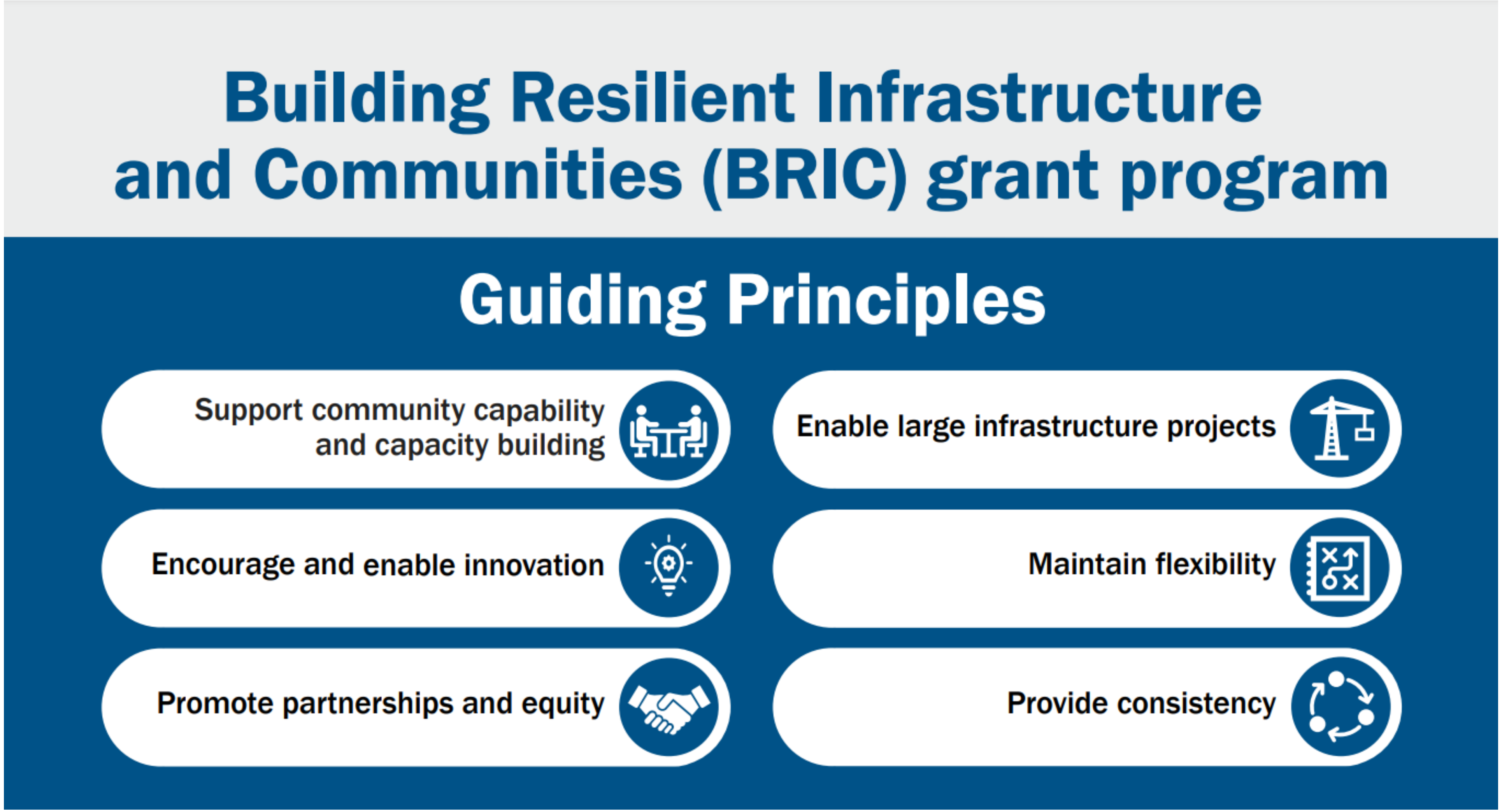
Typical Project Funding Participants

- Project owner
- Project developer or EaaS provider
- Debt (banks/lenders)
- Equity investor (individual or group)
- Granting agency or NGO

Key Questions to Consider

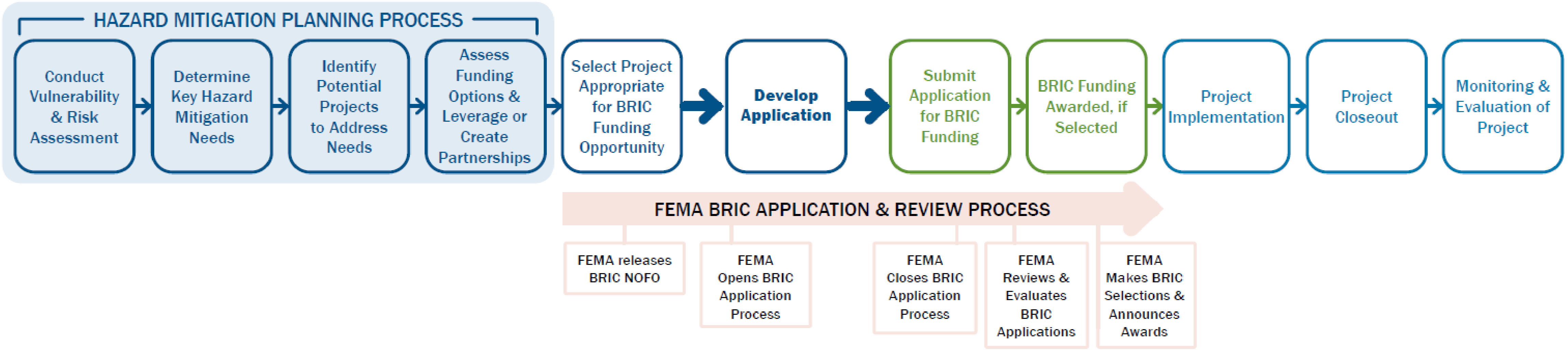
End Users	Third Parties	Utilities
Is it operationally and financially realistic to manage the implementation of an energy project? If a public entity, do relevant laws allow it to build and own energy projects?	Is there enough room in the deal to meet the investor's required economic return? Is there a compelling case for the project host or end user (e.g., savings, resilience, sustainability benefits)?	Do state regulations permit them to finance, own, and operate generation assets? Are they allowed to recover associated microgrid costs through the rate base?

HMP Funding Source



Source: https://www.fema.gov/sites/default/files/documents/fema_bric-infographic-fy21.PDF

HMP Funding Process



- Projects identified through the hazard mitigation planning process are eligible for BRIC funding
- BRIC is a competitive FEMA grant program to support states, local communities, tribes and territories

Source: https://www.fema.gov/sites/default/files/documents/feam_fy21-bric-mitigation-action-portfolio.pdf

HMP Funded Examples

HAZARD	PROJECT NAME	COMMUNITY LIFELINES						
		Safety & Security	Food, Water, Shelter	Health & Medical	Energy (Power & Fuel)	Communications	Transportation	Hazardous Material
All Hazards	Blue Lake Rancheria Tribe Microgrid	X	X		X			
	Bronzeville Microgrid Project	X	X		X	X	X	

- Microgrids and DER projects address all-hazard preparedness
- Energy is cross-cutting, can address multiple lifelines
- Ideal candidate projects:
  - **meet** BRIC goals
  - demonstrate a **convincing cost-benefit** analysis
  - create **social and environmental** and benefits
  - support **diversity, equity and inclusion**

Source: https://www.fema.gov/sites/default/files/documents/feam_fy21-bric-mitigation-action-portfolio.pdf

5. Regulatory and Legal Considerations

Permitting and Interconnection Procedures

- Microgrids not specifically defined under PA statutes
- Generally approached under net metering rules
- As with any energy project, you may need:
  - Air permitting for combustion (state and/or local)
  - Noise permit (local)
  - Environmental (NEPA)
  - Zoning and historic preservation approvals
  - Construction permitting and inspection
  - Utility interconnection

Net Metering

- Net metering available for commercial customers if
  - 3 MW or less and serves onsite load, or
  - 3-5 MW if system can operate in parallel to electric distribution system (EDS) and meets transmission operator requirements, or
  - meets IEEE Standard 1547.4 for Interconnecting Distributed Resources with Electric Power System, and
  - serves to maintain critical infrastructure
- Check local electric utility tariff for requirements

Contract Risk – Third-Party Ownership

Third-party owns/operates—sells power/resilience

- **Benefits:** no upfront costs; contracts are straightforward with set pricing
- **Drawbacks:** May be more costly at the end of life; less control and economic upside for the end-user

Contract Risk – Third-Party Design/Build

Self-own/operate project—pay third party to design/build

- **Benefits:** Allows end-user to capture economic upside including any subsidies
- **Drawbacks:** Inexperience in operating microgrids; can be complicated; exposure to market risk

Contract Risk – Third-Party Development

Self-own project—pay third party to design, build, operate

- **Benefits:** Simplicity; end-user captures economic upside
- **Drawbacks:** May be more costly than simply owning and operating; greater contract risk across construction and operations

6. No-Cost Feasibility Studies

Post-Webinar Survey

- Please take a few minutes to complete the post-webinar survey:
  - https://forms.office.com/r/W5b2QrCncZ
- Survey is anonymous UNLESS interested in a no-cost feasibility study
- Interested parties will be contacted to gather information about your project
- Up to five (5) feasibility studies will be awarded and performed by ProtoGen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Energy Programs Office

7. Questions

Contact Information

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Energy Assurance and Resiliency (pa.gov):
https://www.dep.pa.gov/Business/Energy/OfficeofPollutionPrevention/Pages/Energy-Assurance.aspx