Resilience Gaps & Clean Energy Solutions at State-Owned Medical & Residential Care Facilities

IDEA Pittsburgh – June 26th 2019

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Agenda

Resilience and Sustainability in MA

Study overview

Results

Example

Summary
Why do we need to be resilient?
The cost of extreme weather

Cost to US GDP
$3.9 trillion by 2025

Lost Business Sales
$7 trillion by 20205

Lost Jobs
2.5 million jobs in 2025

Cost to Families
$3,400 per year


http://www.asce.org/failuretoact/
Massachusetts Context

Resilience

$2.4 Billion in Proposed Governor and Legislative Resilience Initiatives

Sustainability

Robust clean energy and sustainability policies
# Overview: Resiliency Study Goals

<table>
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<th>Purpose of Study</th>
<th>“Identify opportunities to utilize clean energy technologies to increase the energy resiliency of each facility, thereby reducing the likelihood of prolonged outages during extreme weather events”</th>
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| **Resilience Goals** | • Increase length of time the site is able to maintain facility-wide or critical load operations during grid outage  
   • Increase number of ancillary services or facility square footage with backup generation in the event of grid outage  
   • Increase the redundancy of the existing backup generation |
| **Clean Energy Objectives** | • Replace or supplement fossil fuel back up power to increase facility operational capabilities during power outage  
   • Provide diversity of fuel sources to increase reliability by removing reliance on a single fuel and on fuel transport  
   • Reduce GHG emissions, reliance on fossil fuels |
**Primary Purpose** | **Size (SF)**  
--- | ---  
Community Mental Health Center | 61,000  
Community Mental Health Center | 12,000  
Community Mental Health Center | 67,000  
Community Mental Health Center | 86,000  
Hospital | 301,061  
Hospital | 1,036,982  
Hospital | 179,112  
Intermediate Care Facility | 314,385  
Long-term Care Facility | 233,000  
Long-term Care Facility | 609,427  
Youth Services Center | 70,000  
Youth Services Center | 23,390
What is resilience?

Resilience is the capacity to maintain services, increase flexibility, and continue to thrive despite shocks and stressors.

Key is to focus on the CRITICAL FUNCTIONALITY of systems, not simply restoring the system itself.

Why do we need to be resilient?

Enhanced resilience:

• Increases public and patient safety
• Avoids evacuations
• Protects vulnerable populations
• Reduces burden on emergency management personnel
• Reduces costs associated with crisis management
Study overview
3 Step Process

Step 1: Resilience Gap Assessment

Step 2: Preliminary Technology Screen

Step 3: Feasibility Studies / System Modeling
Step 1
Energy resilience gap assessment
Site investigation

Guided interview and site walk

• Are any sites particularly vulnerable to projected climate change impacts?
• Are any sites more susceptible to outages or operational failures?
• Are certain facility operations more vulnerable to outages than others?
• Are any of those operations critical?
• What types of resilience is needed for each site?
• How much would adding clean energy resiliency cost?
Shocks and stressors

Flooding & Sea Level Rise
Precipitation
Temperature (Extreme heat and extreme cold)
Wildfire

Manmade Hazards
Wind
Earthquakes
Winter Storms
Site score card

### Systems Resilience

**Electrical**
- Normal Power
  - System Resilience: 1.5
  - Equipment Age/Condition: 1
- Backup Power
  - On-site Generation Capacity: 1.5
  - Equipment Age/Condition: 1

**HVAC**
- System Resilience: 2
- System Capacity: 2
- HVAC Backup Power/Supply: 2
- Equipment Age/Condition: 2

**Heating**
- System Resilience: 2
- System Capacity: 2
- On-site Fuel Storage Capacity: 2
- Equipment Age/Condition: 2

**Cooling**
- System Resilience: 2
- System Capacity: 2
- HVAC Backup Power/Supply: 2
- Equipment Age/Condition: 1

**Miscellaneous Systems**
- Medical Records: 2
- Security/Access Control System: 2
- Elevators/Patient Transport: 3
- Domestic Water: 2
- Sanitary/Wastewater: 1
- Telecom: 2

**Operational Resilience**
- Emergency Mgmt. Plan: 0
- Staff Accessibility: 2
- Staff Accommodations: 1
- Operational Redundancy/Access to Nearby Facilities: 2
- Foodservice: 0
- Pharmacy/Drug Storage: 2
- Flooding Risk: 2
- Sensitivity to Extreme Heat or Cold: 2
- Sensitivity to Extreme Wind: 2
- Seismic Risk: 2

**Operational Resilience Average**: 1.4

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**Score System**

- 0: worst
- 1
- 2
- 3: best

- **Operational Resilience**
  - Insufficient for current needs
- **Redundancy**
  - Sufficient for current needs with significant redundancy
  - Sufficient for current needs with some redundancy
  - Sufficient for current needs, but lacks redundancy
  - Insufficient for current needs

---
Electrical
- Normal and emergency power system

HVAC
- Heating and cooling systems

Miscellaneous Systems
- Medical records
- Security/Access control
- Elevators/Patient Transport
- Domestic Water
- Sanitary/Wastewater
- Telecom/IT

## Energy resilience

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**Systems Resilience Average**: 1.4
Emergency Mgmt. Plan
Staff Accessibility
Staff Accommodations
Operational Redundancy/ Access to Nearby Facilities
Foodservice
Pharmacy/ Drug Storage
Flooding Risk
Sensitivity to Extreme Heat or Cold
Sensitivity to Extreme Wind
Seismic Risk

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Operational Resilience Average: 1.4
# Portfolio score card

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Key portfolio Resilience Gaps

- No backup power for cooling: 7 sites
- Generator failure during power outage: 4 sites
- No backup power for food service: 2 sites
- Insufficient emergency preparedness planning: 1 Site

Identified several “Quick hits” which could immediately improve energy resilience
Step 2
Clean energy technology screening
Solar photovoltaics  Battery energy storage  Solar thermal  Combined heat and power

High efficiency fuel cells  Thermal energy storage  Wind power  Microgrids
Step 3
Clean energy system modeling and feasibility study
Energy models

Resilience needs

Financial analysis (Business-as-usual)

Clean energy system model

GHG and energy impact

Did not include financial benefits from resilience

Iterative process
Results
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NPV, GHG reductions, and Resilience Benefit

30-Year NPV

-2,000,000 -1,500,000 -1,000,000 -500,000 0 500,000 1,000,000 1,500,000 2,000,000 2,500,000 3,000,000 3,500,000

Annual CO2 reduction (%)

-20% -10% 0% 10% 20% 30% 40% 50% 60%

- CHP
- CHP + TES
- CHP + Solar
- CHP + Solar + Storage
- Solar
- Solar + storage
- Fuel Cell
- Fuel Cell + TES
Cost Effectiveness of Clean Energy Technologies vs. Diesel Generation by Site

- **Clean Energy Technology 30-yr NPV**
- **Diesel Generator 30-yr NPV**
- **Sites Within MLP Territory**
Energy Trilemma

Need to balance:

- Resilience
- Sustainability
- Costs

Traditional metrics to evaluate solution effectiveness are insufficient
Solar + Storage example
Solar + storage basics

Maximize ROI (Business-as-usual):
Size solar to maximize ROI by minimizing export of PV energy
Size storage to reduce any remaining peak demand
Frequent charge/discharge cycles required to maximize revenue from energy storage

Maximize resilience:
Size solar to produce energy required for 24-hour operation of resilience loads
Size storage to power resilience loads once PV system is no longer generating energy
Solar + storage system sizing
Maximize ROI

Facility load

Hour

Load
Solar + storage system sizing
Maximize ROI

Facility electric load

PV system sized to ensure all energy is used on-site
Solar + storage system sizing
Maximize ROI

Facility electric load

Net energy import
Solar + storage system sizing
Maximize ROI

Utility demand charge window
Solar + storage system sizing
Maximize ROI

Utility demand charge window

Demand charge savings opportunity
Solar + storage system sizing
Maximize ROI

Utility demand charge window

Battery charges from solar or grid
Solar + storage system sizing
Maximize ROI

Utility demand charge window

Battery charges from solar or grid

Battery discharges to reduce demand charges
Solar + storage system sizing
Maximize ROI

Utility demand charge window

Battery charges from solar or grid

Battery discharges to reduce demand charges

Net energy purchased

Hour

Load
Solar + storage system sizing
Maximize ROI – Batteries allow larger PV system sizes

Graphs showing facility electric load over time.
Solar + storage system sizing
Maximize ROI

Utility demand charge window

Battery charges from solar and eliminates grid export

Battery discharges to reduce demand charges

Net energy purchased
Solar + storage system sizing
Resilience scenario - When utility power is not available

Hourly resilience load profile

Estimated hourly load provide for systems to be backed up
Solar + storage system sizing
Resilience scenario - When utility power is not available

PV output de-rated by 20% to accommodate for cloudy days
Solar + storage system sizing
Resilience scenario - When utility power is not available
Solar + storage system sizing
Resilience scenario - When utility power is not available

Battery charges from solar
Solar + storage system sizing

Resilience scenario - When utility power is not available

Battery charges from solar or grid

Load served from solar
Solar + storage system sizing
Resilience scenario - When utility power is not available

Battery charges from solar or grid
Load served from solar
Load served from batteries
Solar + storage system sizing
Challenge

If energy required for resilience is higher than that required to maximize ROI, system will not fully monetize installed battery capacity.
Solar + storage system sizing

Challenge

If energy required for resilience is higher than that required to maximize ROI, system will not fully monetize installed battery capacity.
Solar + storage system sizing

Challenge

If energy required for resilience is higher than that required to maximize ROI, system will not fully monetize installed battery capacity.
Summary
Process

Step 1: Resilience Gap Assessment

Step 2: Preliminary Technology Screen

Step 3: Feasibility Studies / System Modeling

Modify expectations for ROI and NPV for clean energy systems in order to value resilience benefits.

Align resilience expectations with realistic system capabilities.
Some resilience is better than none.

Resilience can address a range of challenges leading to multiple strategies.

Be flexible
Questions