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U.S. DEPARTMENT OF ENERGY

Distributed Energy Resources for Cost Savings & Resilience

June 9th, 2020

1:00 – 2:30 PM

Rachel Shepherd

U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY

Agenda

1. Welcome & Introductions
2. DER Overview and Context
3. Case Studies from Chesapeake College & Shands Hospital
4. Q&A Session

Logistics - Slido

Slido will be used as our platform for Q/A throughout the webinar.

Please go to www.slido.com

1. Using your mobile device or web browser **enter the event code - #BBSummit**
2. From the list of sessions provided, **select Distributed Energy Resources**

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Today's Presenters

Emma Elgqvist
National Renewable Energy Laboratory

Tina Jones
Chesapeake College

Isaac Panzarella
U.S. DOE Southeast CHP Technical Assistance Partnership

Poll #1

Which sector does your organization best represent?

Poll #2

In one or two words, what is your area of expertise?

Poll #3

What is the strangest energy-related issue you have encountered?

Poll #4

What are your biggest barriers to using distributed energy resources?

Poll #5

What kind of loads do you consider critical?

Emma Elgqvist

National Renewable Energy Laboratory

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NREL
NATIONAL RENEWABLE ENERGY LABORATORY

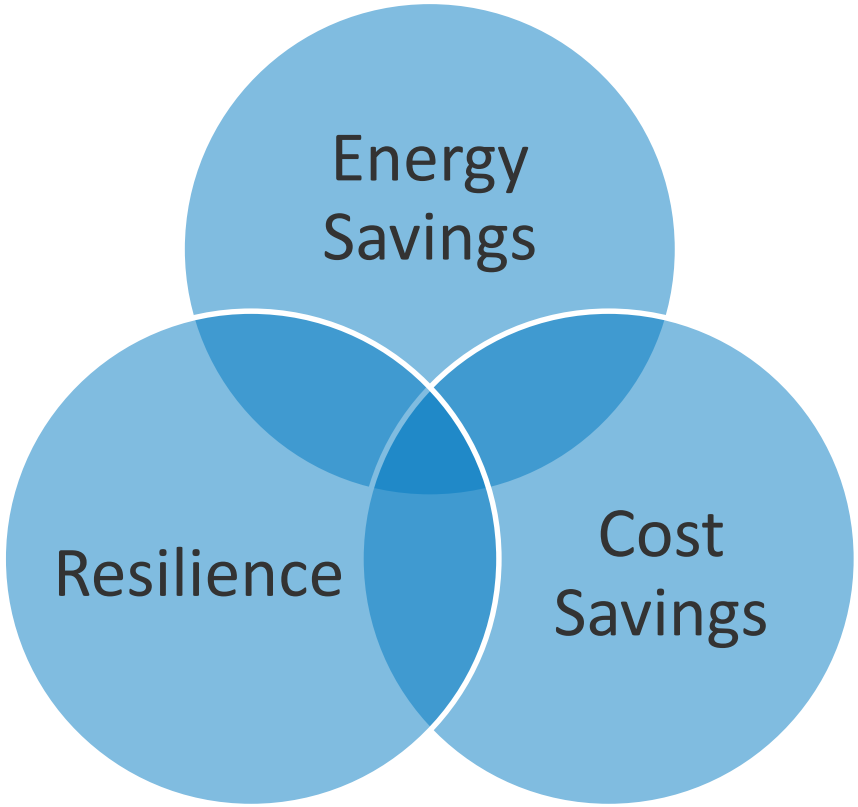
DERs for Cost Savings & Resilience Overview

Emma Elgqvist, Researcher, NREL
Better Buildings Summit -
DERs for Cost Savings & Resilience
Tuesday, June 9th from 1:00 – 2:30pm ET

REopt Integration and Optimization

Why Distributed Energy for Resilience

- Distributed energy resources (DERs) include renewable energy (RE) technologies, storage, and combined heat and power (CHP)
- DERs can provide revenue streams and savings while grid connected
  - Savings may allow for the incorporation of additional microgrid components
- When integrated into a microgrid, DERs can increase survival time during a grid outage when fuel supplies are limited



DER Economics

Will DERs Work for Your Site?

RE Resource

Technology Costs & Incentives

Resilience Goals

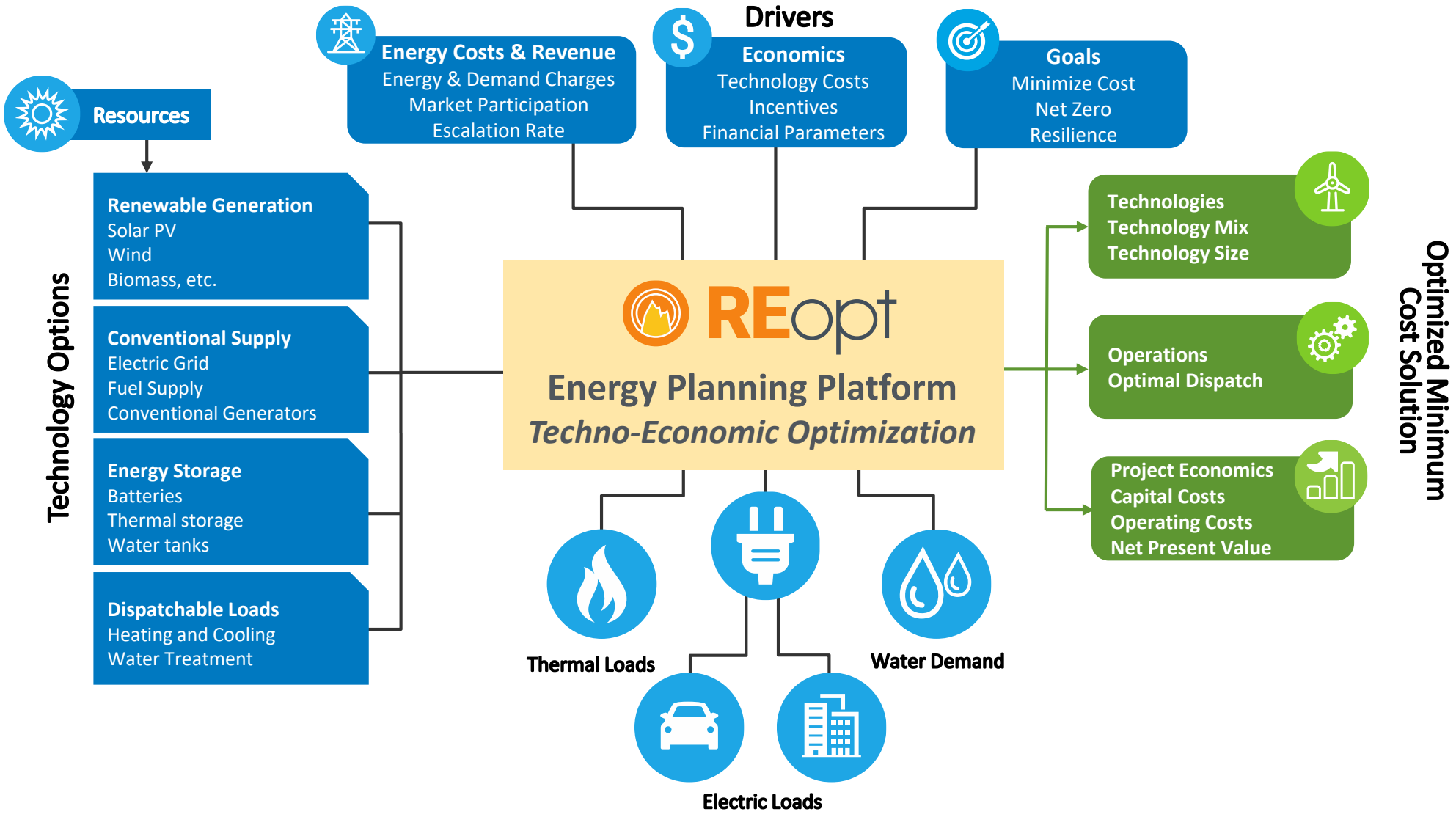
Utility Cost & Consumption

Financial Parameters

Many factors affect whether distributed energy technologies can provide cost savings and resilience to your site, and they must be evaluated concurrently.

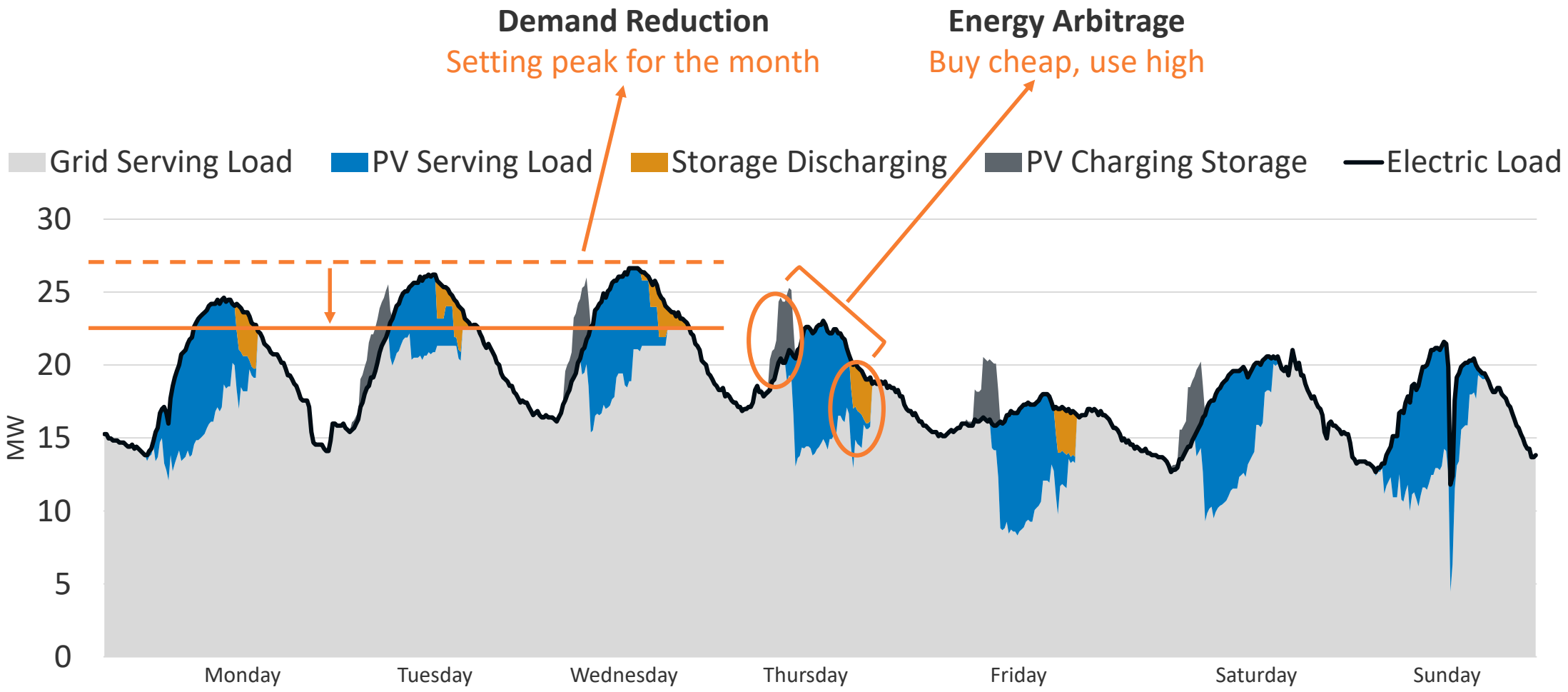
REopt Energy Planning Platform

Formulated as a mixed integer linear program, REopt provides an integrated, cost-optimal energy solution.



How Does REopt Work?

REopt considers the trade-off between ownership costs and savings across multiple value streams to recommend optimal size and dispatch.

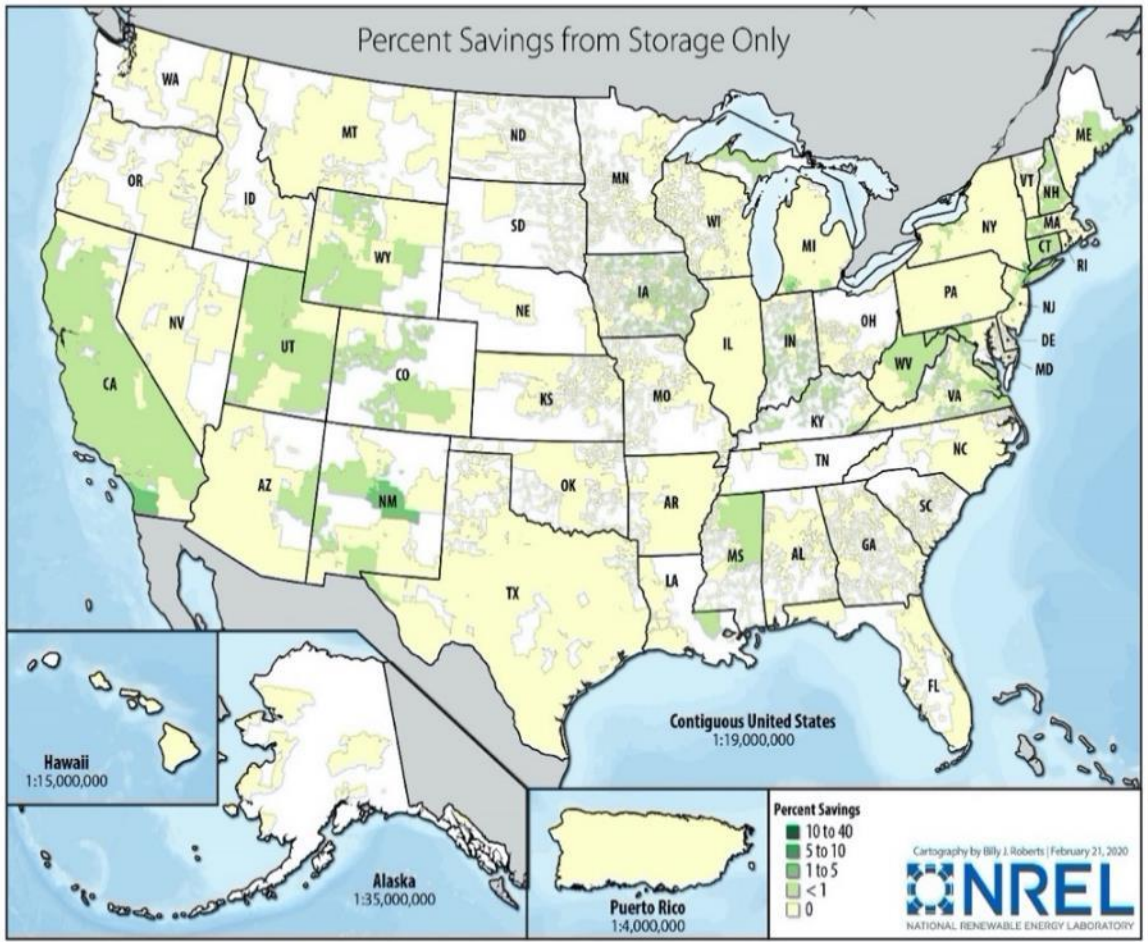


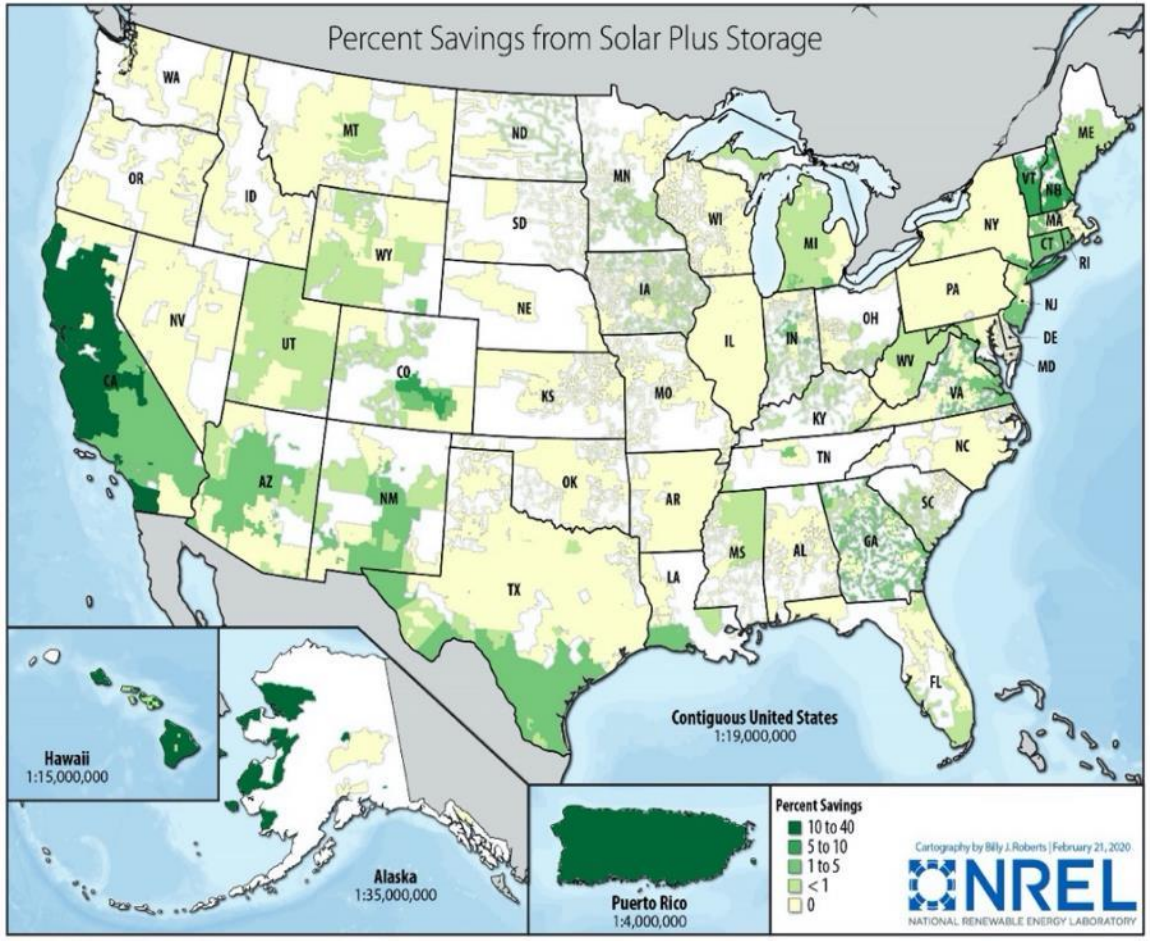
Example of optimal dispatch of PV and BESS

Value Streams for Storage

	Service	Description	Grid	Commercial	Residential
Driven by Utility Rate Structure	Demand charge reduction	Use stored energy to reduce demand charges on utility bills		✓	✓
	Energy Arbitrage	Behind the meter: energy time-of-use shift (from on-peak to off-peak hours)		✓	✓
		Wholesale: Buy during off-peak hours, sell during on-peak hours	✓	✓	
Utility/Regional Programs	Demand response	Utility programs that pay customers to lower demand during system peaks		✓	✓
	Frequency regulation and capacity markets	Stabilize frequency on moment-to-moment basis or supply spinning, non-spinning reserves (ISO/RTO)	✓	✓	
Transmission & Distribution	Voltage support	Insert or absorb reactive power to maintain voltage ranges on distribution or transmission system	✓		
	T&D Upgrade Deferral	Deferring the need for transmission or distribution system upgrades, e.g. via system peak shaving	✓		
Value varies	Resiliency / Back-up power	Using battery to sustain a critical load during grid outages	✓	✓	✓

PV and Storage Opportunities Across US





DERs for Resilience

PV + Storage Use Cases

	Off Grid PV + Storage	Grid Connected PV + Storage	Islandable PV + Storage	PV + storage for Large-scale Power Generation
Purpose	Providing continuous power in lieu of utility	Lowering cost of utility purchases	Lowering cost of utility purchases **and** Providing power during grid outage	Large-scale generation for off-site sale
Why/Where it works	• Remote sites with high fuel costs • Low grid reliability	• High demand charges • TOU rates • Ancillary service markets	• High demand charges • TOU rates • Ancillary service markets • Resilience requirements	• Deregulated market • Interested offtaker • large land-availability
Primary Power Supply	DERs (typically including generators)	Grid + DERs	Grid + DERs	Grid only
Back-up	None	None	DERs	Typically none but could be possible

Grid Connected vs. Islandable PV + Storage Components

- Distributed generation assets
- Energy storage
- Inverter

PV + storage project

- Interconnected loads
- Conductors
- Switching devices to island from the utility grid
  - Disconnect Switch
  - Transfer Switches (automatic or manual)
- Protection Devices
  - Protective Relays/Circuit Breakers
  - Recloser
  - Fuses
- Power Factor Correction
  - Voltage Regulator
  - Capacitor
- Microgrid Control Software and Hardware
  - This is an often-overlooked cost component of a microgrid
  - This can be a significant portion of the overall microgrid's cost
    - Especially for smaller microgrid systems

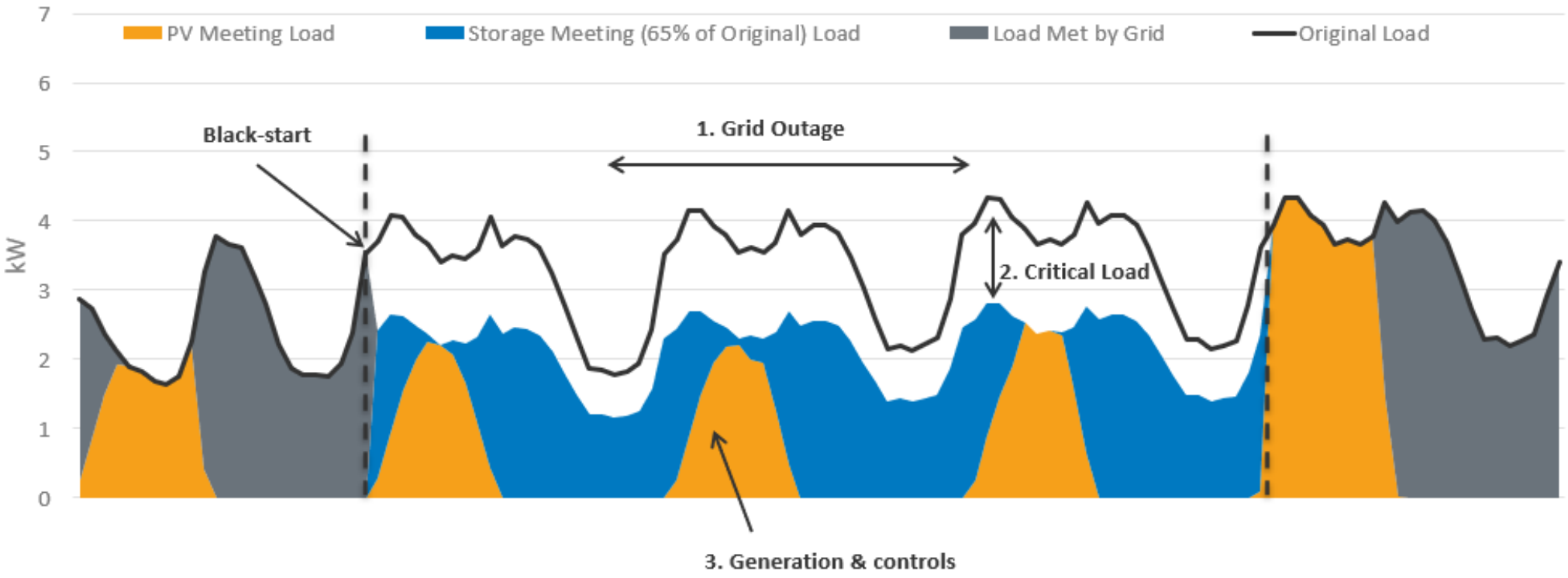
What you need to island (=$$)

Cost depends on:

- Complexity/size of system(s)
- Controller sophistication
- Interconnection Voltage

Islanding Considerations

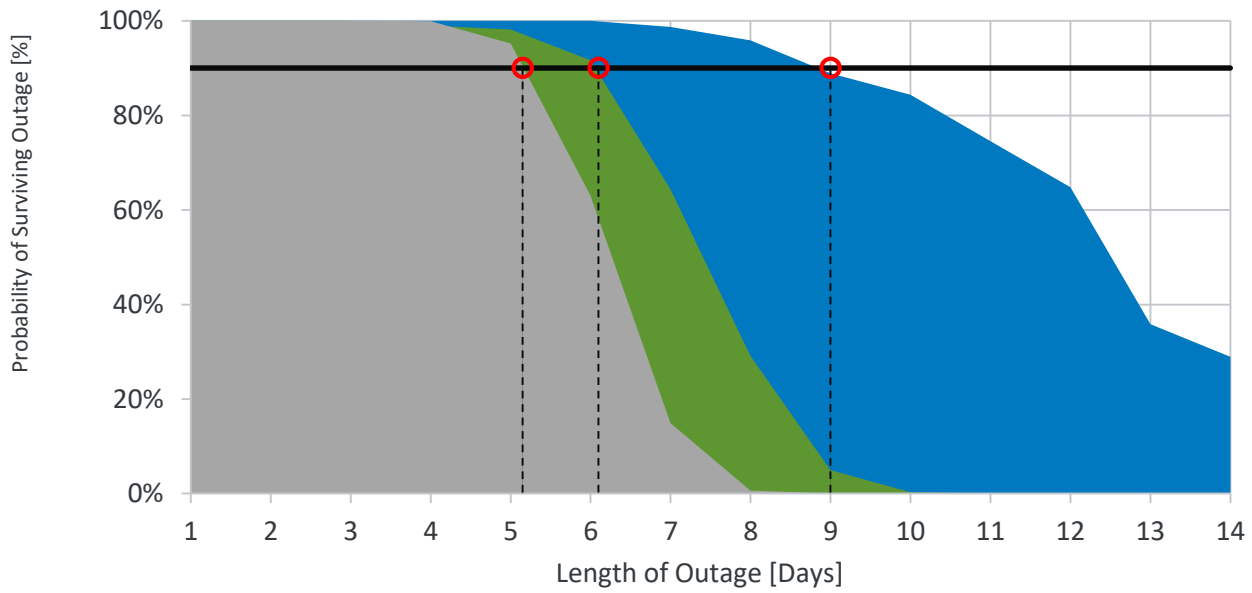
1. Duration and timing of grid outage
2. Critical load to be served during outage
3. On-site generation (and controls)



Increasing Resilience with Renewables

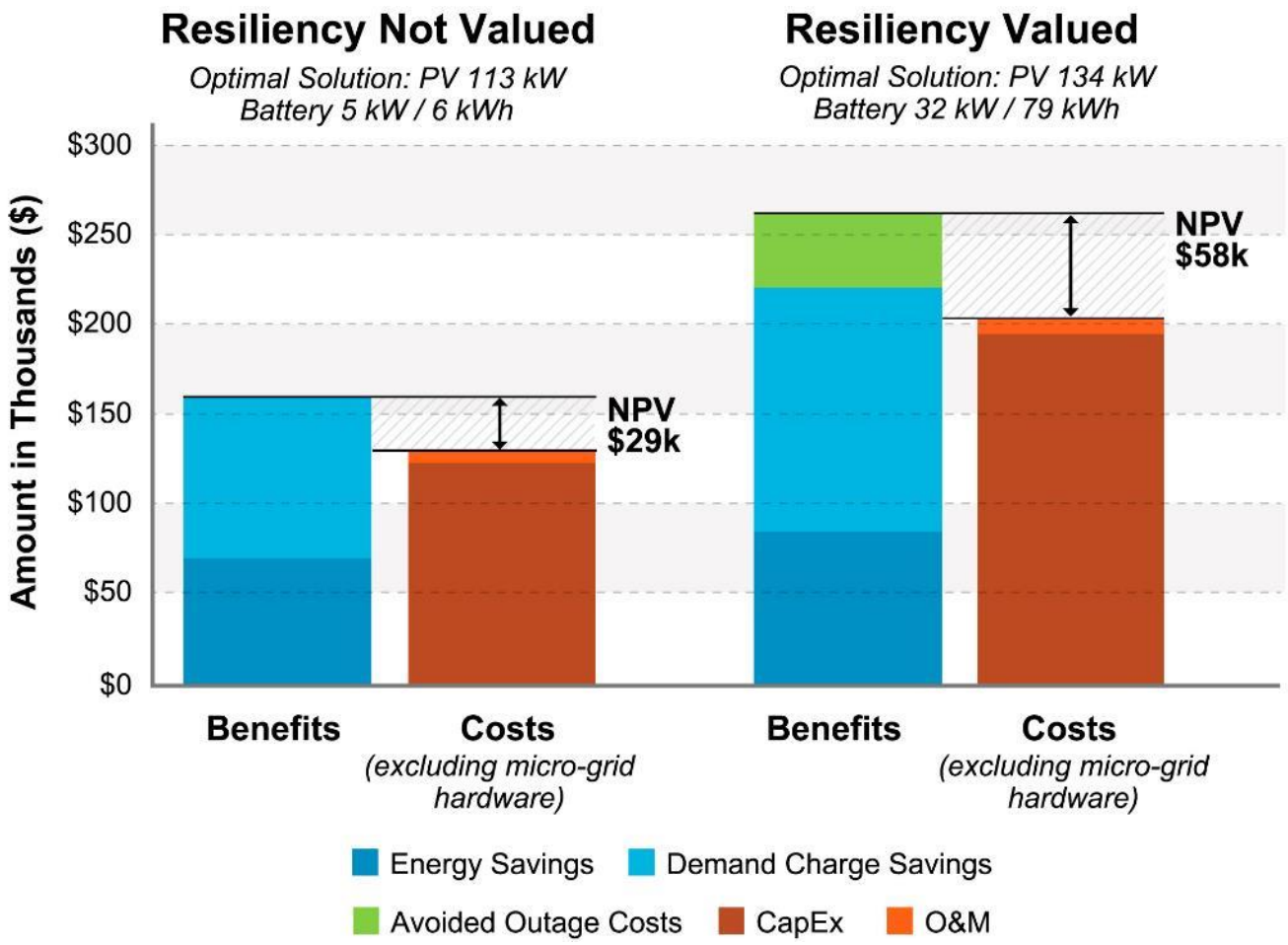
- Evaluated thousands of random grid outage occurrences and durations
- Compares hours survived with gensets vs. gensets augmented with PV and battery
- Found PV and battery gave site 90% probability of surviving an additional 1 day at no cost and an additional 4 days at minimal additional cost

	Generator	Solar PV	Storage	Lifecycle Cost	Outage
1. Base case	2.5 MW	-	-	$20 million	5 days
2. Lowest cost	2.5 MW	625 kW	175 kWh	$19.5 million	6 days
3. Proposed system	2.5 MW	2 MW	500 kWh	$20.1 million	9 days



K. Anderson et al., "Increasing Resiliency Through Renewable Energy Microgrids". SCTE Journal of Energy Management Vol.2 (2) August 2017 https://www.nrel.gov/docs/fy17osti/69034.pdf

Value of Resiliency

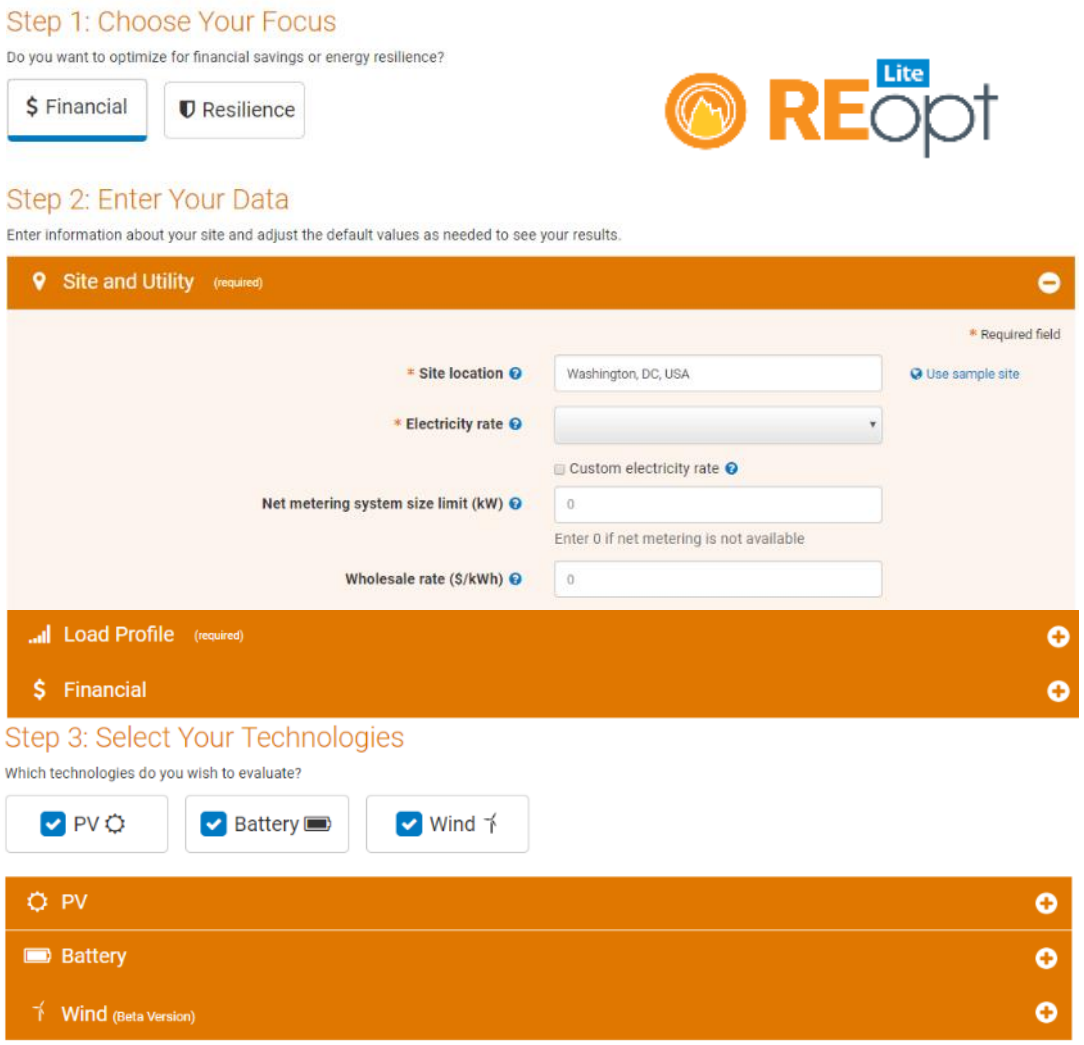


Implementing a value of resilience into a least-cost optimization can influence the "optimal" PV+storage system at a given site:

- Increases PV capacity
- Increases battery size and duration
- Increases the overall NPV

REopt Lite Web Tool

- **REopt Lite** is a web tool that offers a no-cost subset of NREL's more comprehensive REopt model
- **Financial mode** optimizes PV, wind, and battery system sizes and battery dispatch strategy to minimize life cycle cost of energy (CHP coming soon!)
- **Resilience mode** optimizes PV, wind, and storage systems along with back-up generators to sustain critical load during grid outages
- To access REopt Lite: https://reopt.nrel.gov/tool



Key Takeaways

- Many factors affect whether distributed energy technologies can provide cost savings and resilience to your site, and they should be evaluated concurrently
- It is important to consider a site's specific load profile, utility rate structure, and value streams available when assessing techno-economic potential
- There are many different use cases for on-site DERs, and no one fits all solution
- Enabling the use of DERs for back-up provide resilience benefits but is more costly. The value of resilience should be considered compared to this additional cost

Thank you!

Emma Elgqvist
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www.nrel.gov

reopt.nrel.gov

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Tina Jones

Chesapeake College

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Distributed Energy Resources for Cost Savings and Resilience

Tina Grace Jones, VP for Administrative Services

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College Demographics

- Small Community College
  - 2000 transfer students
  - 6000 continuing education students
- Located on rural Eastern Shore of Maryland
- Situated outside of any municipality
  - No utilities provided beyond grid power
  - Provide own water, waste water, gateway to internet backbone

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Distributed Energy Resources at Chesapeake College

- 1.8 MW Photovoltaic Solar Array
  - Over 50% of power demand 24/7
  - 100% of power during peak production hours
- Car Charging Stations
- Solar Water Heating
- Geothermal
- High Efficiency HVAC with heat recapture
- 2 MW Storage Battery
  - Important for both resilience and cost savings

Your time.Your place.
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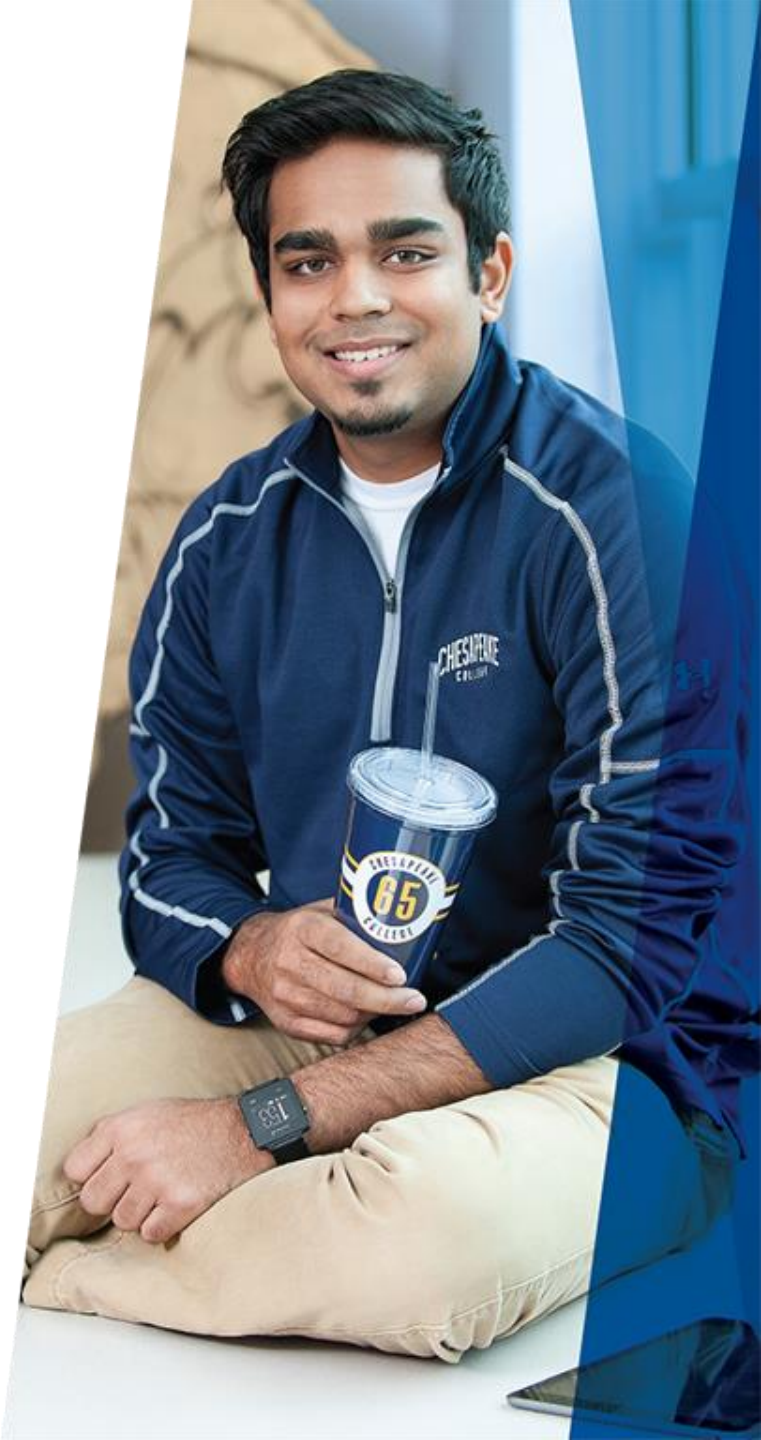

Energy Efficiency Initiatives

- Employee Education
- Modern Building Automation Systems coordinated with campus operations schedule
- Planned replacement of major facility resources with high efficiency systems
- Incremental replacement of large energy consumers
  - Lighting to LED
  - Computers to high efficiency

Your time.Your place.
Chesapeake College

Cost and Cashflow Considerations

- Since 2011, energy consumption has declined by 24%, while footprint has increased by 20%
- Energy Costs have declined by 40%, from $600,000 to $350,000 annually which is equivalent to:
  - 1% of total budget
  - 5% of non-staff costs
  - 50+ full time student tuitions

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Cost and Cashflow Considerations

- No additional capital or maintenance and repair costs
  - Budget has remained constant since 2015
  - Solar procured using Power Purchase Agreement with performance guarantees
  - Health Professions and Athletics Center planned for LEED Silver, achieved LEED platinum within budget
  - Storage Battery gifted to college
- Routine maintenance budgets are unchanged since 2015 and expected to decline in future due to longer life of many high efficiency components

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Resiliency Benefits

- All key information technology assets have redundant power sources
  - Maintains 24/7 availability for on-campus and remote education and back office operations
- 3 of 12 buildings as well as all fresh water and wastewater plants have multiple energy sources
- Future expansion of battery storage would permit micro-gridding of entire campus

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Why Resiliency Matters at Chesapeake

- Our students
  - Enhanced 24/7 operational reliability
  - Decreased costs
    - 2% total tuition increase over last 3 years
- Our Faculty and Staff
  - Decreased occurrence of down times during class times
  - Greater flexibility in work locations and times
  - Rapid shift from on-site instruction and work to online teaching and teleworking

Your time.Your place.
Chesapeake College

Why Resiliency Matters at Chesapeake

- Our students
  - Enhanced operational reliability
- Our Community
  - Serve as a cultural center with our theatre
  - Easily accessible and affordable meeting space
- In Times of Crisis
  - Emergency Shelter for hurricanes or other natural disasters
  - Regional Medication Point of Distribution Site
  - Food Distribution Center
  - Alternative Health Care Site for COVID-19

Your time.Your place.
Chesapeake College

Questions?

Tina Grace Jones

VP for Administrative Services
Chesapeake College
tjones@chesapeake.edu

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Chesapeake College

Poll #6

What is the primary reason you are interested in DERs?

Isaac Panzarella

U.S. DOE Southeast CHP Technical Assistance Partnership

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Resilient CHP at Shands Hospital

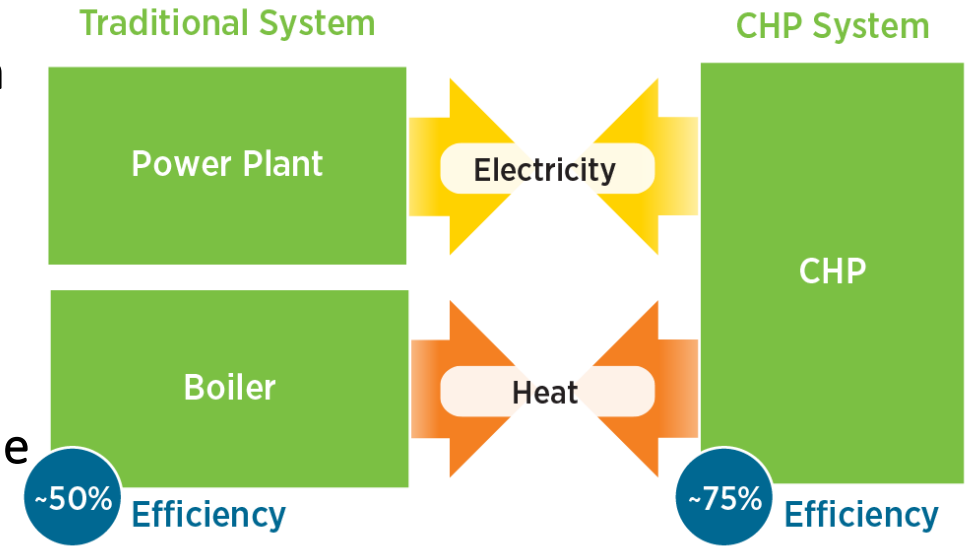
- DOE Better Buildings Summit – Distributed Energy Resources for Cost Savings and Resilience

09 June 2020

Isaac Panzarella, Director,
DOE Southeast CHP TAP;
NC Clean Energy Technology Center
NC State University

CHP: A Key Part of Our Energy Future

- Form of Distributed Generation (DG)
- An integrated system
- Located at or near a building / facility
- Provides at least a portion of the electrical load and
- Uses thermal energy for:
  - Space Heating / Cooling
  - Process Heating / Cooling
  - Dehumidification



CHP provides efficient, clean, reliable, affordable energy – today and for the future.

Source: www.energy.gov/chp

DOE CHP Technical Assistance Partnerships (CHP TAPs)

- **End User Engagement**
  Partner with strategic End Users to advance technical solutions using CHP as a cost effective and resilient way to ensure American competitiveness, utilize local fuels, and enhance energy security. CHP TAPs offer fact-based, non-biased engineering support to manufacturing, commercial, institutional and federal facilities and campuses.

- **Stakeholder Engagement**
  Engage with strategic Stakeholders, including regulators, utilities, and policy makers, to identify and reduce the barriers to using CHP to advance regional efficiency, promote energy independence, and enhance the nation's resilient grid. CHP TAPs provide fact-based, non-biased education to advance sound CHP programs and policies.

- **Technical Services**
  As leading experts in CHP (as well as microgrids, waste heat to power, and district energy) the CHP TAPs work with sites to screen for CHP opportunities as well as provide advanced services to maximize the economic impact and reduce the risk of CHP from initial CHP screening to installation.

National Manufacturing Day 2019 at the University of Illinois at Chicago

www.energy.gov/chp

DOE CHP Technical Assistance Partnerships (CHP TAPs)

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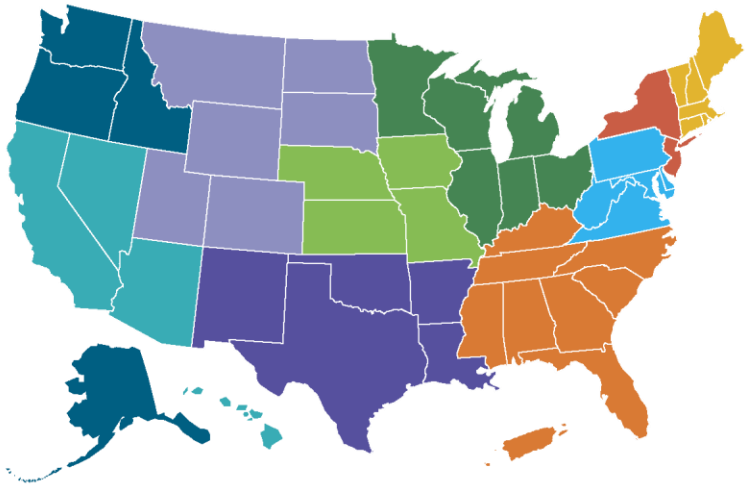

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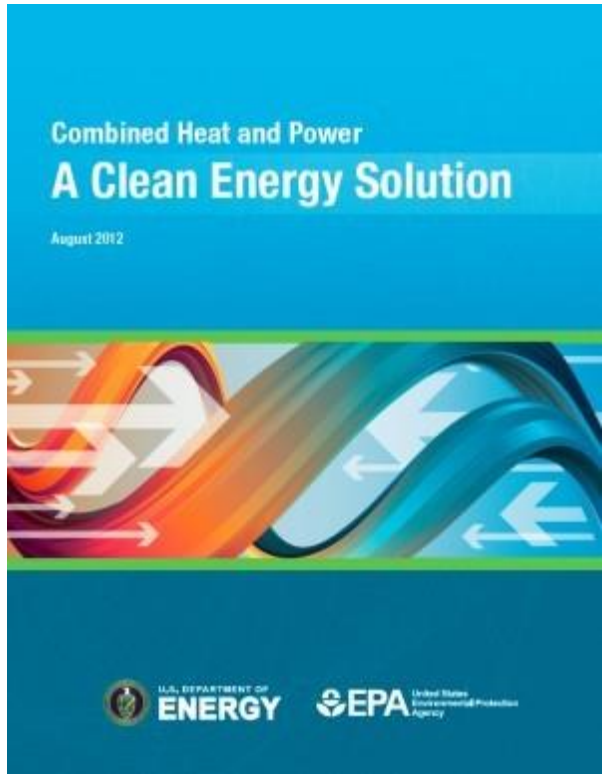
Emerging National Drivers for CHP

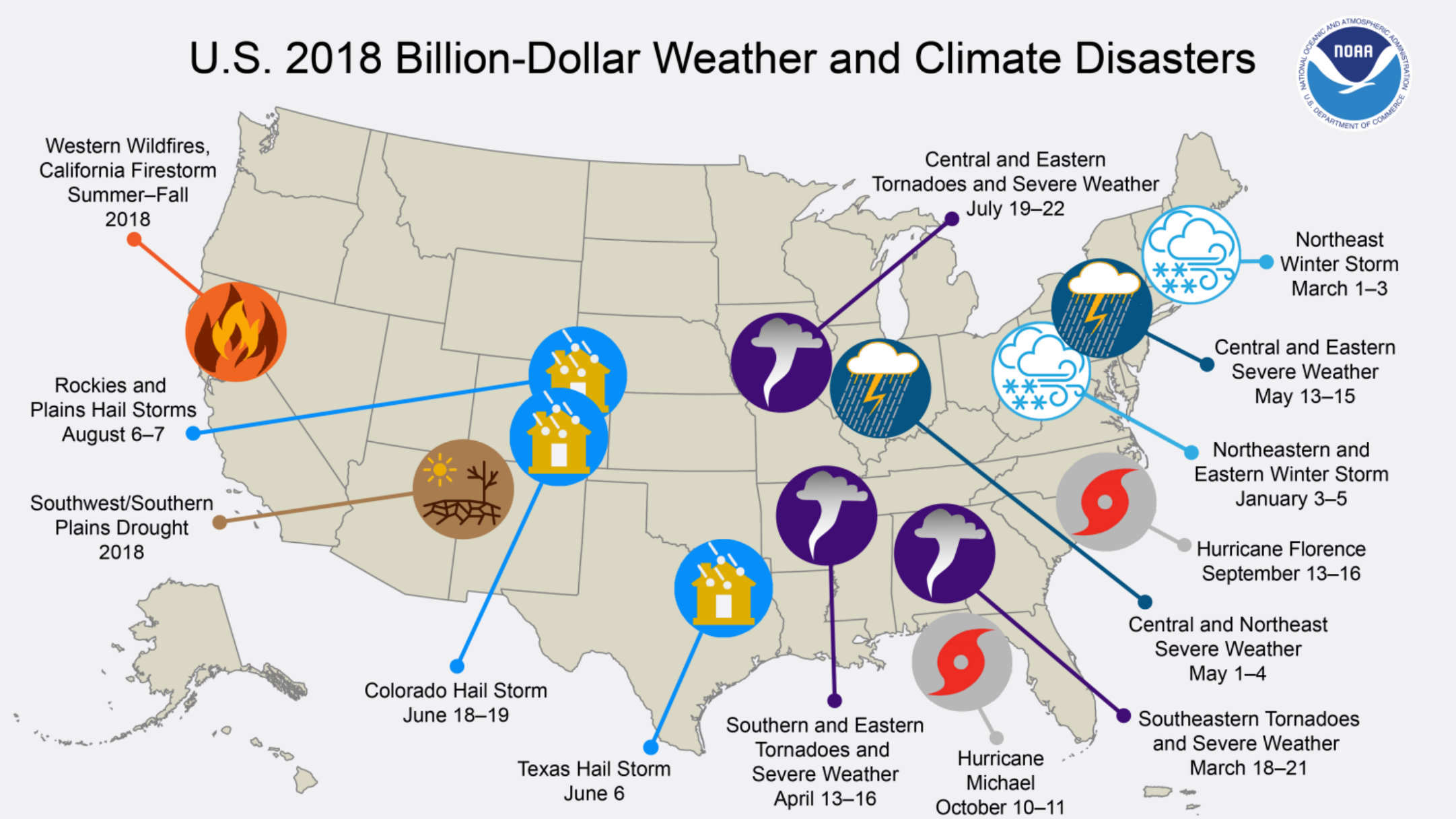
- Benefits of CHP recognized by policymakers
  - State Portfolio Standards (RPS, EEPS), Tax Incentives, Grants, standby rates, etc.
- Favorable outlook for natural gas supply and price in North America
- Opportunities created by environmental drivers
- Utilities finding economic value
- Energy resiliency and critical infrastructure
- Interest in hybrid CHP systems

DOE / EPA CHP Report (8/2012)



http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_clean_energy_solution.pdf

Power Outages are Costly



Critical Infrastructure and Resiliency Benefits of CHP

"Critical infrastructure" refers to those assets, systems, and networks that, if incapacitated, would have a substantial negative impact on national security, national economic security, or national public health and safety."

Patriot Act of 2001 Section 1016 (e)

Applications:

- Hospitals and healthcare centers
- Water / wastewater treatment plants
- Police, fire, and public safety
- Centers of refuge (often schools or universities)
- Military/National Security
- Food distribution facilities
- Telecom and data centers

CHP (if properly configured):

- Offers the opportunity to improve Critical Infrastructure (CI) resiliency
- Can continue to operate, providing uninterrupted supply of electricity and heating/cooling to the host facility

Project Snapshot: Shands Hospital at the University of Florida – Gainesville Regional Utilities

- **Location:** Gainesville, FL
- **Application/Industry:** Hospitals
- **Capacity:** 12 MW electric, **16.8 MW thermal**
- **Prime Mover:** 4.6 MW Gas turbine + 7.4 MW Recip. engine
- **Fuel Type:** Natural gas
- **Thermal Use:** Steam for heating and steam turbine chiller, hot water
- **Installation Year:** 2008, 2017
- **Resilience Benefits**
  - GRU South Energy Center incorporates hurricane-resistant design and meets the planned expansion of the Shands Cancer Center campus
  - Provides consistent power and thermal energy to critical hospital and research facilities
  - GRU continues to operate the system in island mode in the event of a broader grid outage

UFHealth UNIVERSITY OF FLORIDA HEALTH GRU More than Energy

Project Profile available at this link: https://chptap.lbl.gov/profile/200/ShandsHospital-Project_Profile.pdf

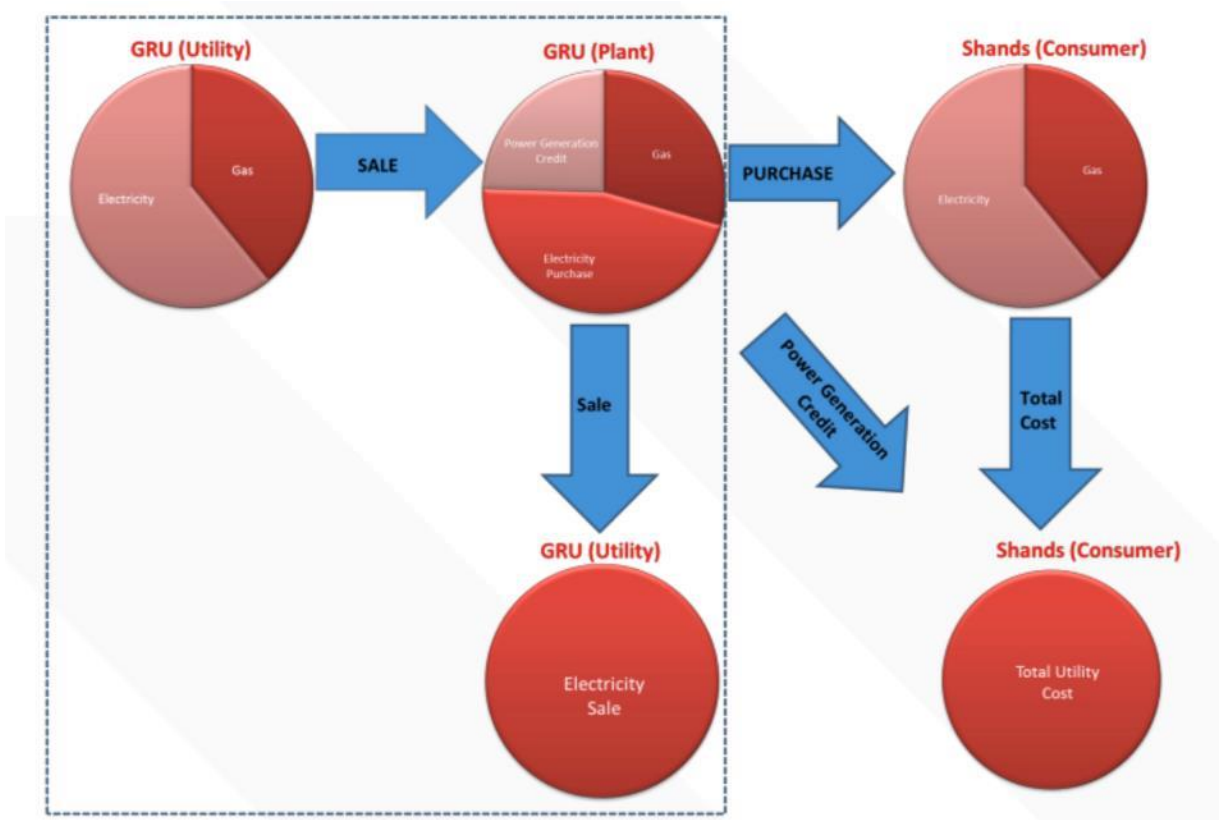
Shands Hospital – GRU CHP Partnership

Benefits for Shands

- Saved $45 million capital investment
- Resilience with islandable microgrid
- Capable of providing all critical loads
- Hospital achieved LEED Gold certification thanks to Energy Center
- Concentrate on core business

Benefits for GRU

- Invested in highly efficient CHP resource
- Low heat rate / low emission generation
- Adds diversity and redundancy



Partnership

Source: Heidt & Lee, 2020, "Gainesville Regional Utilities: The Importance of Revisiting a Utility Master Plan
https://www.districtenergy.org/viewdocument/gainesville-regional-utilities-the

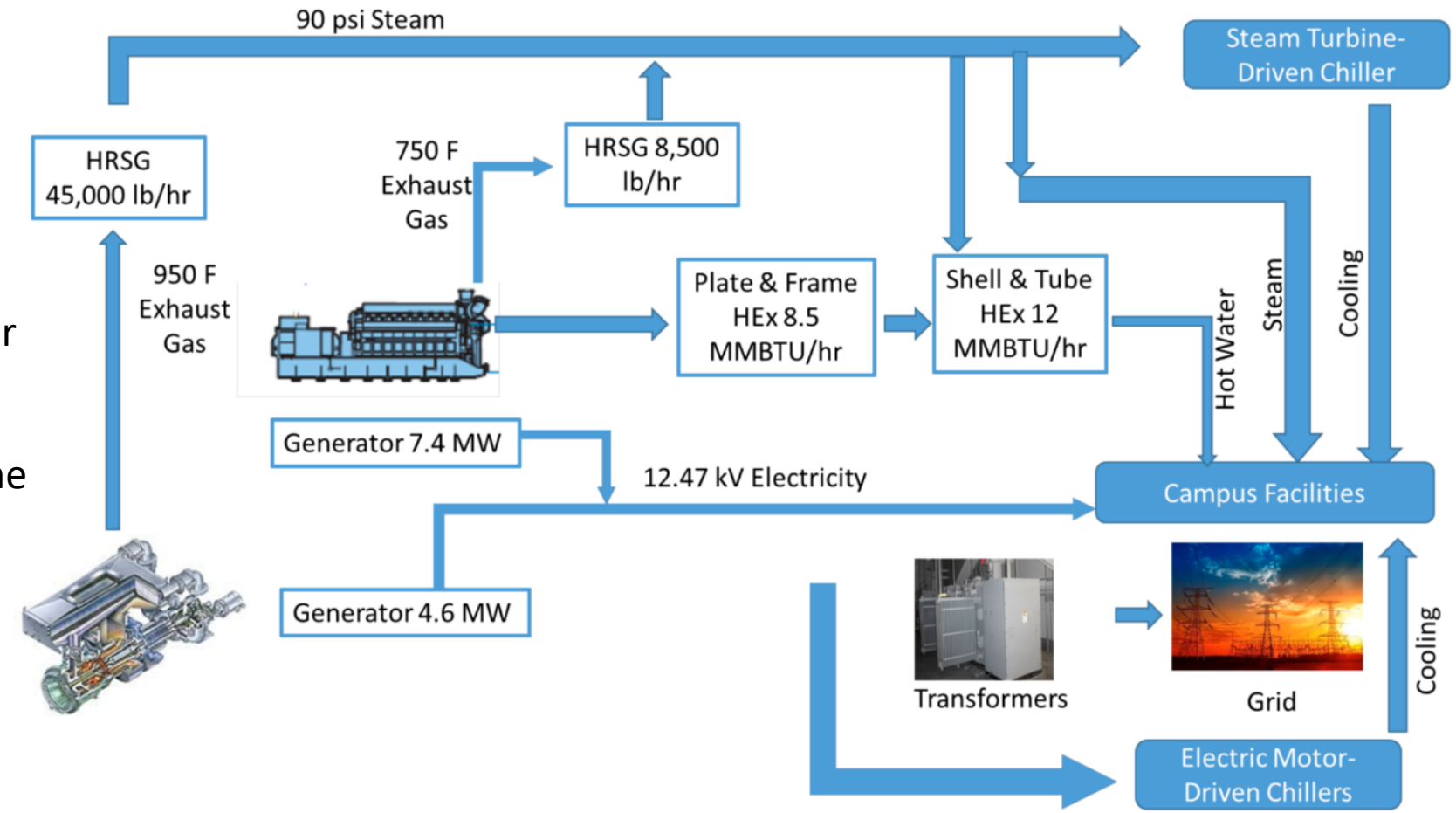
Shands – GRU CHP Development Process

Phase 1 - 2008

- 4.6 MW gas turbine
- 45,000 lb/hr steam
- 4,200 ton steam chiller
- 500 kW blackstart generator

Phase 2 - 2017

- 7.4 MW reciprocating engine generator
- 8,500 lb/hr steam
- 8.5 MMBtu/hr hot water
- 1,500 ton electric chiller



Source: Heidt, Lee & Verschage, 2017, "Gainesville Regional Utilities: Reciprocating Engine CHP"
https://www.districtenergy.org/viewdocument/gainesville-regional-utilities-rec

Critical Infrastructure Facilities in Florida that Maintained Operations with CHP during Hurricane Irma

Shands Hospital / GRU South Energy Center

Eight Flags Energy Center, Fernandina Beach

St. Josephs Hospital, Tampa

Miami-Dade South District WWTP

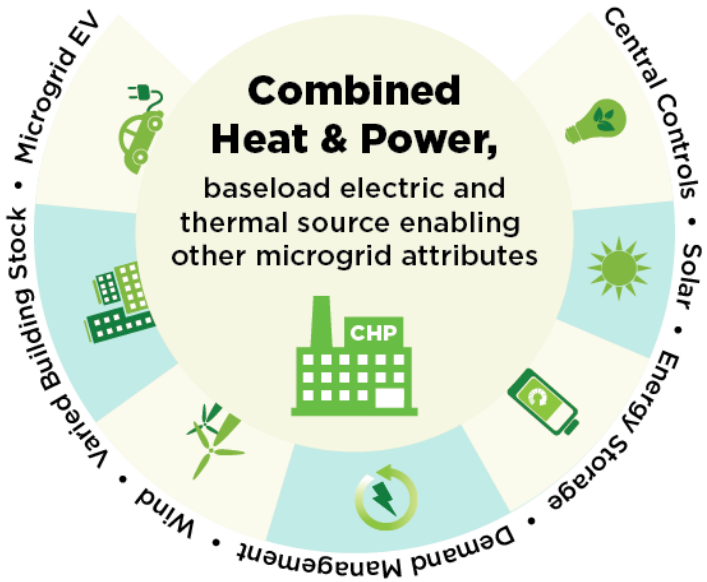
CHP and Microgrids

A microgrid is 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.

A microgrid can **connect and disconnect** from the larger utility grid to enable it to operate in both **grid-connected** or **island-mode**.

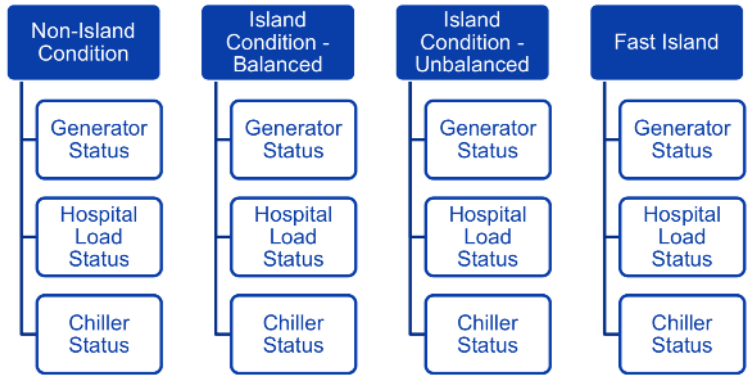
Source: U.S. Department of Energy Microgrid Exchange Group

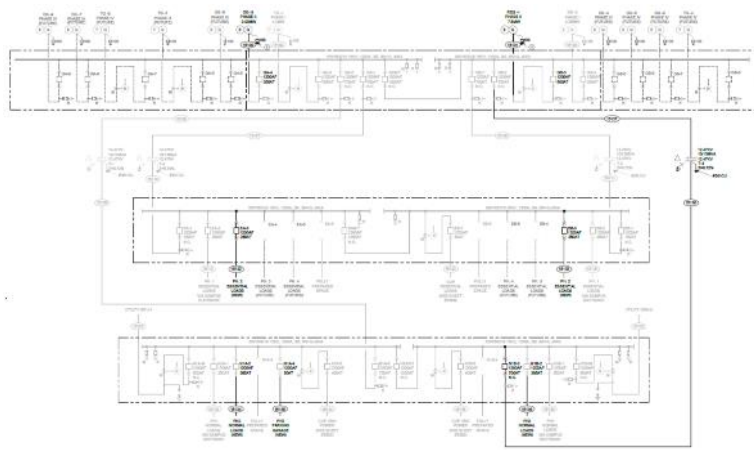
- With a CHP system providing reliable baseload electric and thermal energy, microgrids can add renewables and storage
- Increased focus on resilience for critical infrastructure
  - Universities, Hospitals, Military bases, Communities



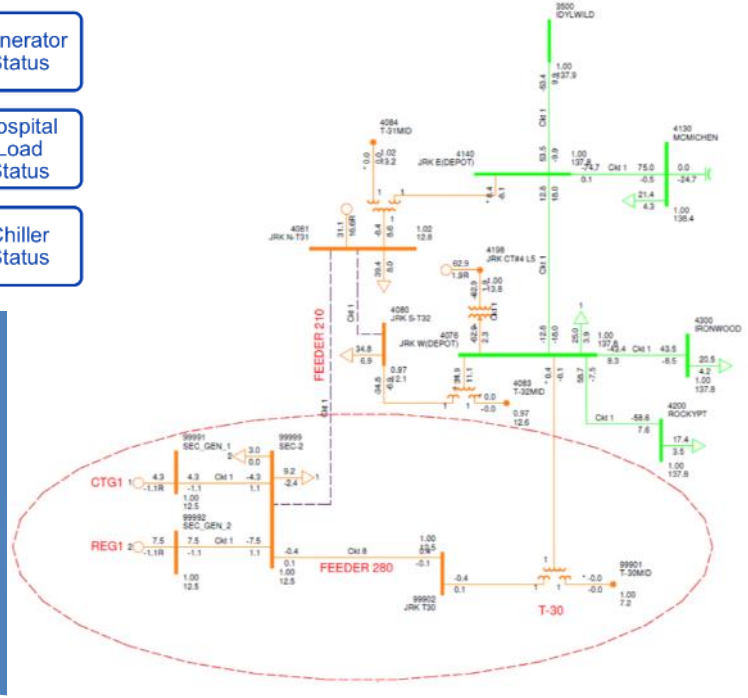
Microgrid Islanding Evaluation

Operating scenarios





Protection schemes

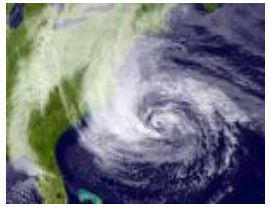


Utility interconnection

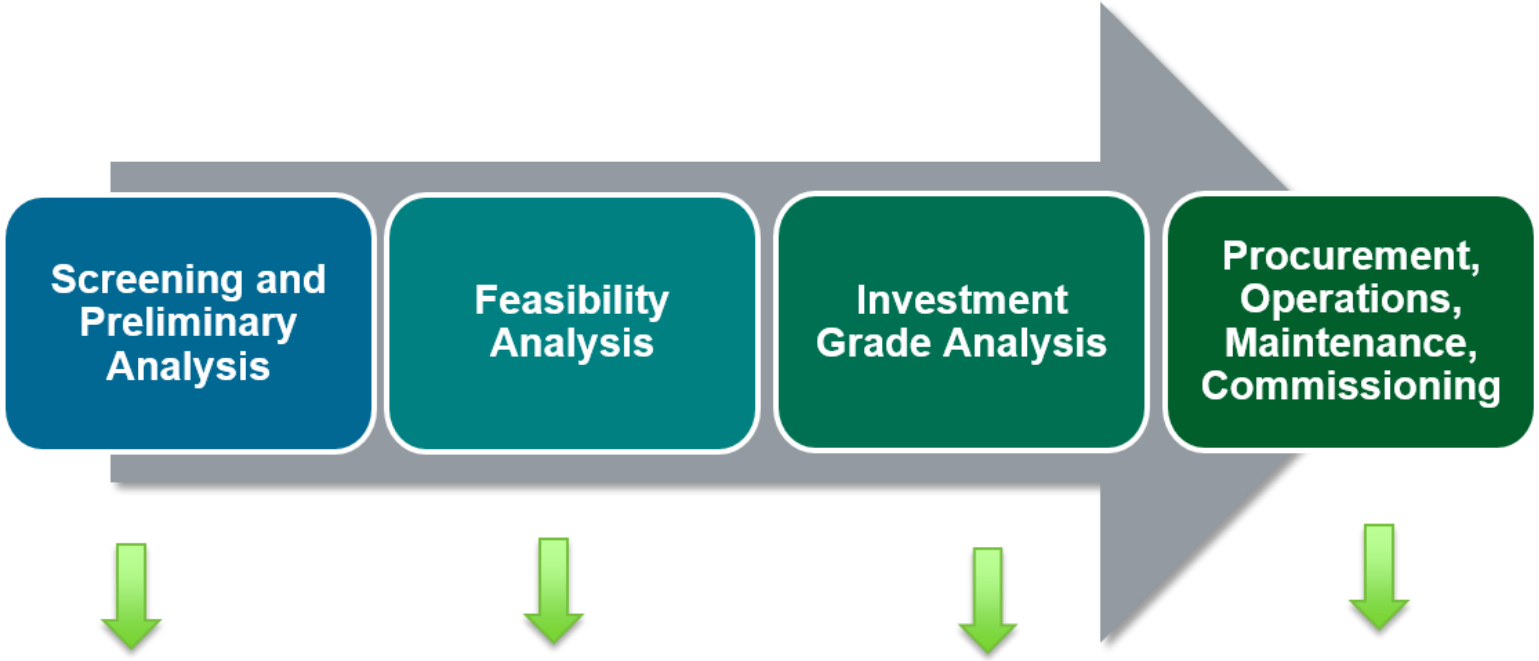
Source: Dempsey, 2017, "Microgrid Islanding with CHP – The Evolution of a Project
https://www.districtenergy.org/viewdocument/microgrid-islanding-with-chp-the-ev

CHP Increases Resilience

- For end users:
  - Provides continuous supply of electricity and thermal energy for critical loads
  - Can be configured to automatically switch to “island mode” during a utility outage, and to “black start” without grid power
  - Ability to withstand long, multiday outages
- For utilities:
  - Enhances grid stability and relieves grid congestion
  - Enables microgrid deployment for balancing renewable power and providing a diverse generation mix
- For communities:
  - Keeps critical facilities like hospitals and emergency services operating and responsive to community needs



CHP TAP Role: Technical Assistance



Quick screening questions with spreadsheet payback calculator; Advanced technical assistance to explore equipment or operational scenarios.

Perform 3rd Party reviews of site feasibility assessments: Estimates on savings, installation costs, simple paybacks, equipment sizing, and type.

Perform 3rd Party reviews of Engineering Analysis. Review equipment sizing and choices.

Review specifications and bids.

DOE TAP CHP Screening Analysis

- **High level assessment to determine if site shows potential for a CHP project**
  - **Quantitative Analysis**
    - Energy Consumption & Costs
    - Estimated Energy Savings & Payback
    - CHP System Sizing
  - **Qualitative Analysis**
    - Understanding project drivers
    - Understanding site peculiarities

Annual Energy Consumption	Base Case	CHP Case
Purchased Electricty, kWh	88,250,160	5,534,150
Generated Electricity, kWh	0	82,716,010
On-site Thermal, MMBtu	426,000	18,872
CHP Thermal, MMBtu	0	407,128
Boiler Fuel, MMBtu	532,500	23,590
CHP Fuel, MMBtu	0	969,845
Total Fuel, MMBtu	532,500	993,435
Annual Operating Costs		
Purchased Electricity, $	$7,060,013	$1,104,460
Standby Power, $	$0	$0
On-site Thermal Fuel, $	$3,195,000	$141,539
CHP Fuel, $	$0	$5,819,071
Incremental O&M, $	$0	$744,444
Total Operating Costs, $	$10,255,013	$7,809,514
Simple Payback		
Annual Operating Savings, $		$2,445,499
Total Installed Costs, $/kW		$1,400
Total Installed Costs, $/k		$12,990,000
Simple Payback, Years		**5.3**
Operating Costs to Generate		
Fuel Costs, $/kWh		$0.070
Thermal Credit, $/kWh		($0.037)
Incremental O&M, $/kWh		$0.009
Total Operating Costs to Generate, $/kWh		**$0.042**

Next Steps

Contact your regional CHP TAP for assistance if:

- Interested in having a screening performed to determine if there is an opportunity for CHP at your site
- If you already have an existing CHP plant and interested in expanding it
- Need an unbiased 3rd Party Review of a CHP proposal

CHP
TECHNICAL ASSISTANCE
PARTNERSHIPS

A program sponsored by

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

www.energy.gov/chp

Thank You!...

Questions?

Isaac Panzarella

NC Clean Energy Technology Center

NC State University

ipanzar@ncsu.edu

(919) 515-0354

Poll #7

To what extent have your questions been answered on DERs for cost savings and resilience?

Q & A

Submit Questions

www.slido.com event code **#BBSummit**

U.S. DEPARTMENT OF ENERGY

Additional Resources

Combined Heat & Power for Resilience Accelerator

- DER Disaster Matrix
- Distributed Generation for Resilience Planning Guide
- Resilience Risk Evaluation Tool
- Site Screening Tool

Better Buildings Renewable Integration Team

- On-Site Energy Storage Decision Guide
- On-Site Commercial Solar PV Decision Guide
- Solar PV RFP & Procurement Template

FEMP's Distributed Energy Program

- Distributed Energy Implementation Process
- Distributed Energy Technologies for Resilience
- REopt Lite Web Tool
- Microgrid-Ready Solar PV

Better Buildings: Summer Webinar Series

BEHIND THE METER DISTRIBUTED ENERGY RESOURCES:
BEST PRACTICES FOR INTEGRATING DERS INTO COMMERCIAL BUILDINGS

July 8

NEXT-GENERATION BUILDING PERFORMANCE POLICIES:
MAXIMIZING ENERGY SAVINGS AND ENVIRONMENTAL IMPACTS

July 16

EVERYONE HAS A DATA CENTER:
HOW TO BE AN ENERGY CHAMPION FOR YOURS

July 28

PROGRAM DESIGN WITH EVERYONE IN MIND:
LOW-INCOME SOLAR PROGRAM STRATEGIES

July 9

STRATEGIES TO COMBINE ENERGY + HEALTH UPGRADES IN MULTIFAMILY HOUSING

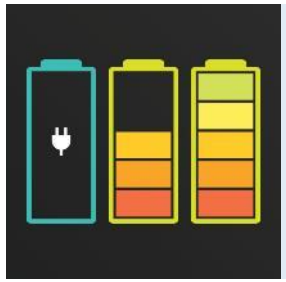
July 21

SUCCEED WITH SUBMETERING:
HOW TO MAKE THE BUSINESS CASE

August 4

THE DYNAMIC DUO:
UNLEASH PUBLIC SECTOR ENERGY SAVINGS WITH FINANCING AND TECHNICAL ASSISTANCE

July 14



CASE IN POINT:
OREGON'S RECENT EFFORTS TO REDUCE PLUG LOAD ENERGY CONSUMPTION

July 22

REGISTER NOW

Poll #8

What additional resources (e.g. tools, training, information) would help you and your organization implement a successful DER project?

Additional Questions?

Please Contact Us

Follow us on Twitter
@BetterBldgsDOE

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https://betterbuildingssolutioncenter.energy.gov/

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