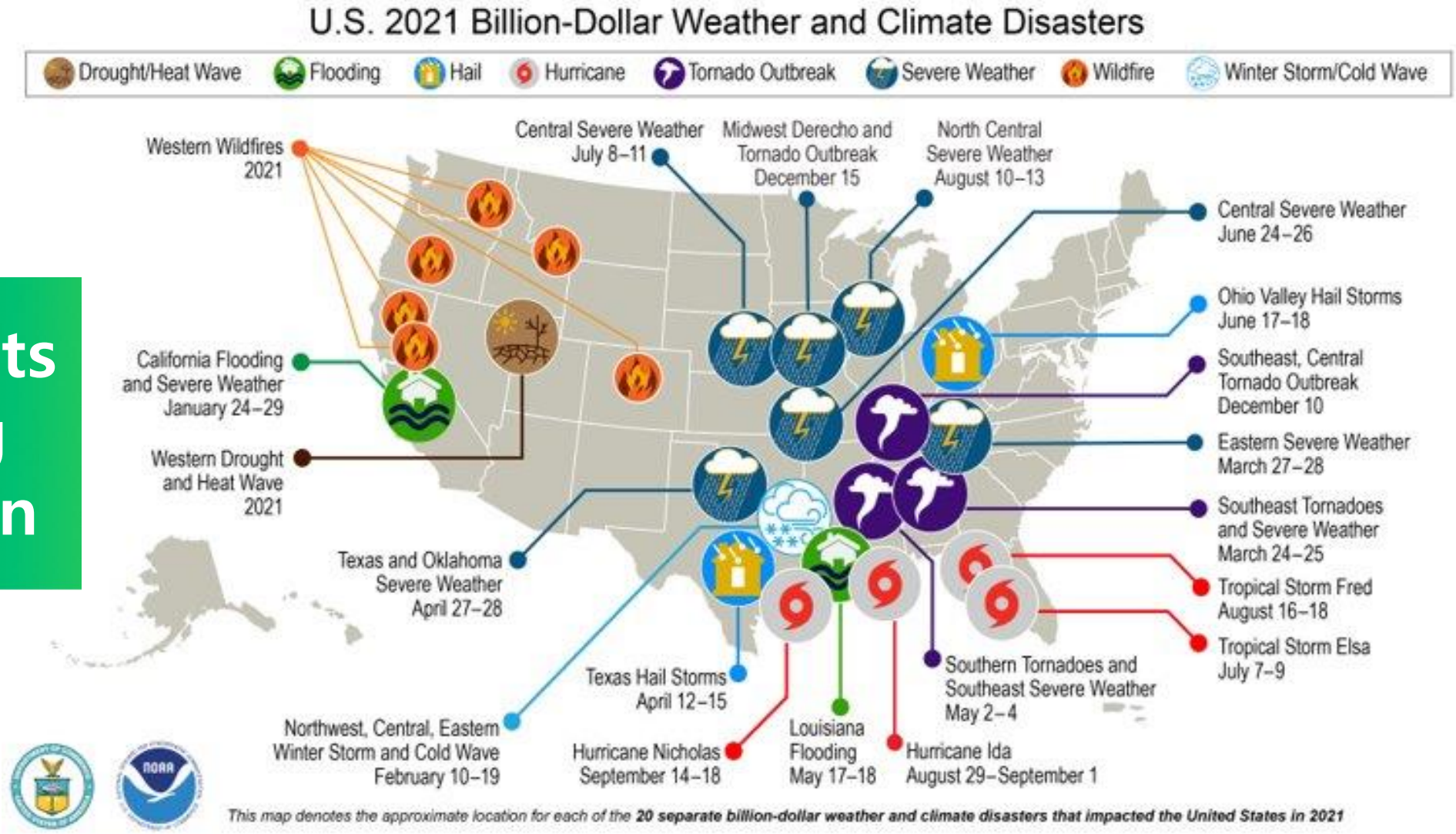
Energy Resilience in Your Community

Margaret Cook

July 27, 2023

HARC applies science to drive energy, air, water, and resilience solutions for a sustainable and equitable future.

Extreme events are becoming more common



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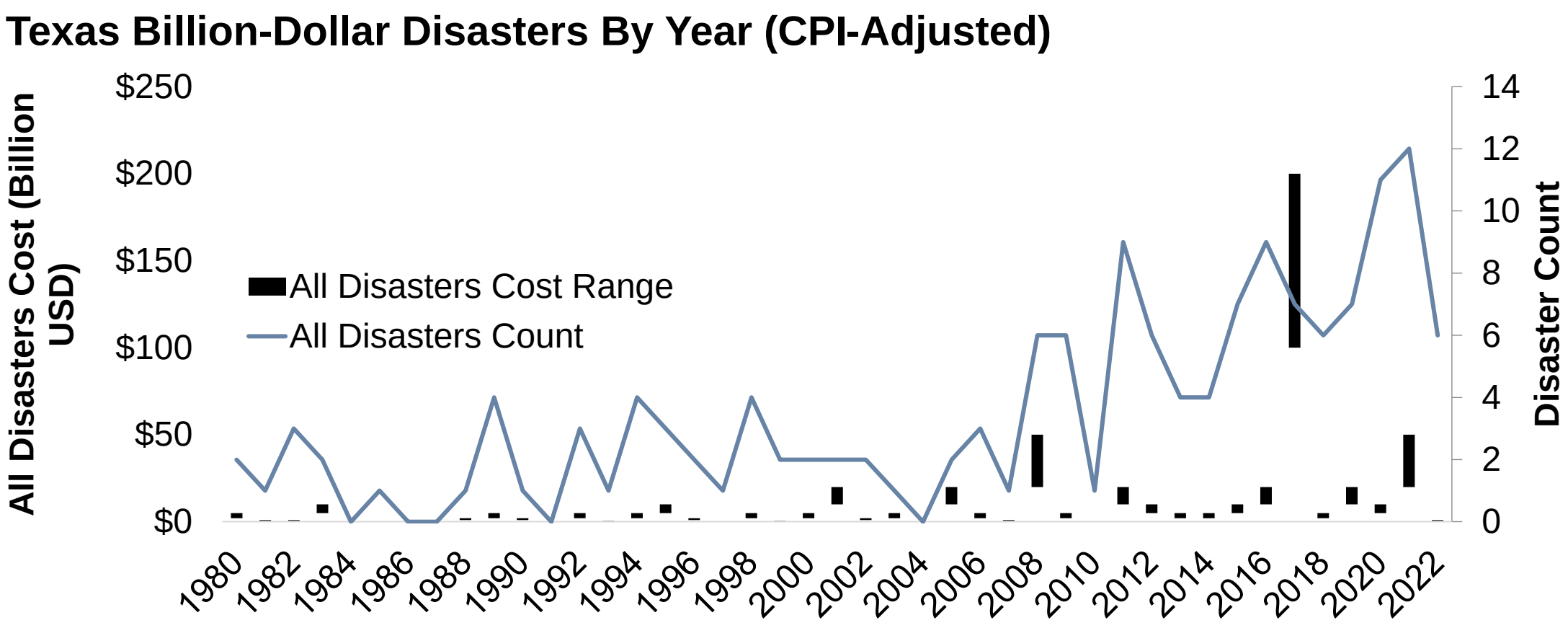
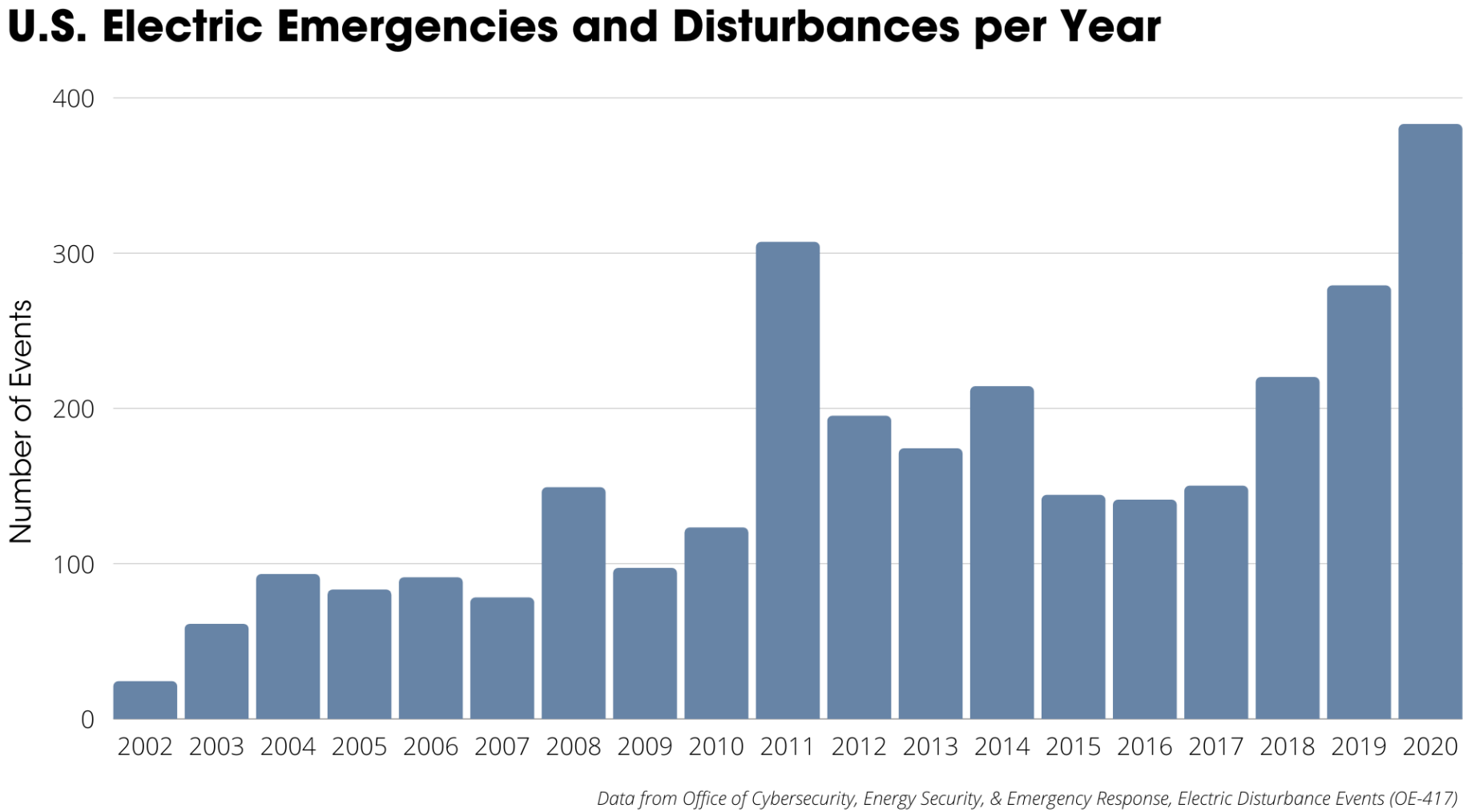


Data from NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Discussion Questions

- What kind of events have caused problems in the past?
  - Extreme heat
  - Extreme cold/freeze
  - Flooding
  - Drought
  - Others?
- What kind of problems were most common?

Power disturbances are increasing



Data from Office of Cybersecurity, Energy Security, & Emergency Response, Electric Disturbance Events (OE-417)

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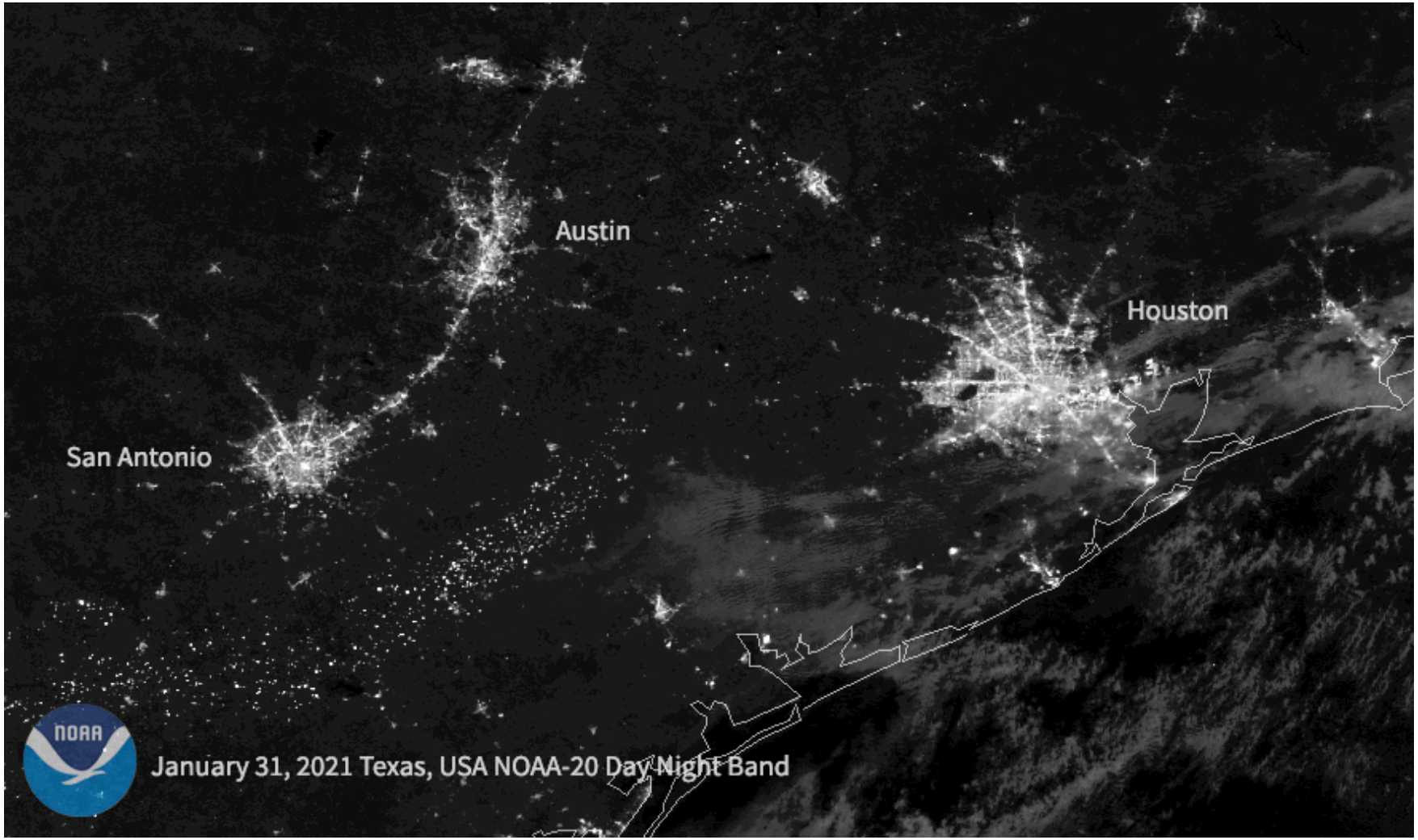
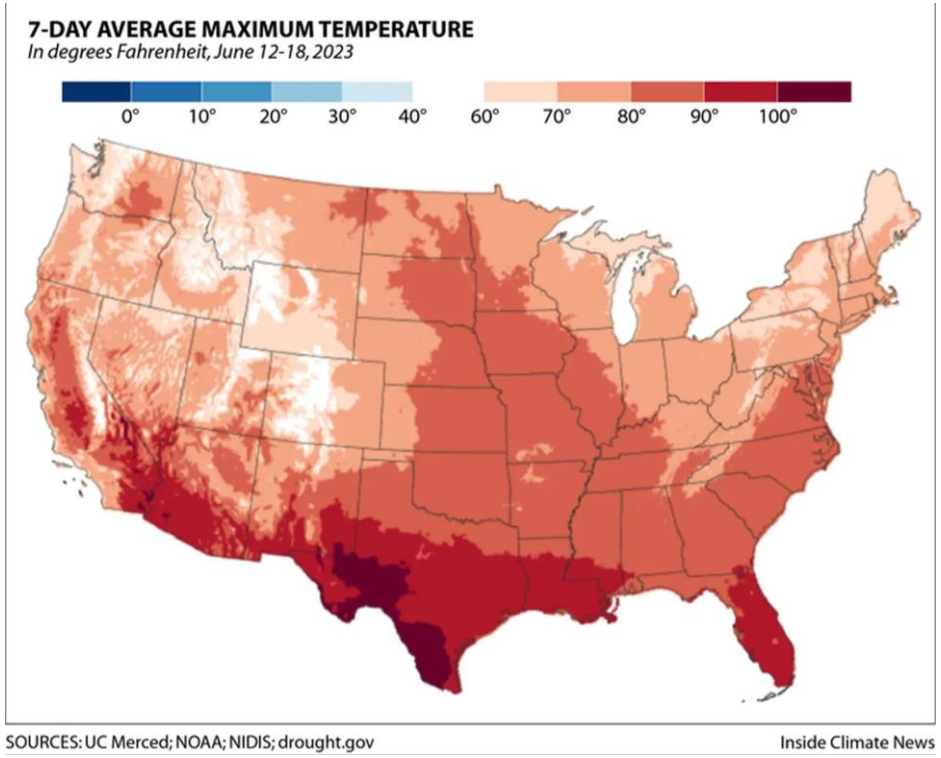
Some extreme events challenge the grid



Some extreme events challenge the grid

U.S. NEWS

A blistering heat wave is turning up the pressure on Texas' power grid



Energy Resilience

- Ability to operate during and in response to disruptions
  - Heating
  - Cooling
  - Plug-loads

09-02-21

In New Orleans, a solar microgrid is keeping lights on in this affordable apartment building

While the rest of the neighborhood is dark, the residents at the St. Peter Apartments still have power. Can it be a model for more resilient architecture?

[Photo: courtesy Eskew Dumez + Ripple]

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Energy Resilience

- Backup and/or distributed energy resources, e.g., battery storage
- Grid/infrastructure hardening, protecting transformers
- Energy efficiency, weatherization, passive survivability
- Energy management, e.g., training & protocols

Source: Power Systems West

Energy Resilience

- Strategically deployed
  - Critical facilities, e.g., hospitals, emergency services, water and wastewater treatment, grocery stores
  - Critical demands/processes within a building

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Project Snapshot:
Healthcare

Texas Medical Center
Houston, TX

- Application/Industry: Healthcare
- Capacity: 48 MW
- Prime Mover: Combustion turbine
- Fuel Type: Natural gas
- Thermal Use: Steam-driven chillers, space heating, hot water, dehumidification, and sterilization
- Installation Year: 2010
- Energy Savings: $6-12 million in energy savings each year

"The customers we serve, hospitals and medical research facilities, have critical loads. Reliability is extremely important to them, and CHP is an important factor in ensuring excellent reliability." - Steve Swinson, President, Thermal Energy Corporation

Source: Southwest CHP TAP

Discussion Questions

- Who has had experience thinking about energy resilience for your organization?
  - No experience – hand on the table
  - Some experience – half hand raise
  - Very experienced – raise your hand up high
- Who has had experience planning or managing energy resilience for your organization?

Discussion Questions

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- Who has had experience planning or managing energy resilience for your organization?
  - Why does (or doesn't) your organization prioritize energy resilience planning?
  - What kind of planning?

Discussion Questions

- Who has had experience thinking about energy resilience for your organization?
  - No experience – hand on the table
  - Some experience – half hand raise
  - Very experienced – raise your hand up high

- Who has had experience planning or managing energy resilience for your organization?
  - Why does (or doesn't) your organization prioritize energy resilience planning?
  - What kind of planning?
  - Does your organization consider climate?

Onsite power can help increase resilience

- For end users:
  - Provides continuous supply of electricity (sometimes 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

Ranking Criteria

Four basic criteria were used to estimate the vulnerability of a resource during each type of disaster event. They include the likelihood of experiencing:

1. *a fuel supply interruption,*
2. *damage to equipment,*
3. *performance limitations, or*
4. *a planned or forced shutdown*

indicates the resource is unlikely to experience any impacts

indicates the resource is likely to experience one, two, or three impacts

indicates the resource is likely to experience all four impacts

Natural Disaster or Storm Events	*Flooding*	*High Winds*	*Earthquakes*	*Wildfires*	*Snow/Ice*	*Extreme Temperature*
Battery Storage	◒	○	◒	●	○	◒
Biomass/Biogas CHP	◒	◒	◒	●	○	○
Distributed Solar	○	◒	◒	●	◒	◒
Distributed Wind	○	◒	◒	◒	◒	◒
Natural Gas CHP	○	○	◒	◒	○	○
Standby Generators	◒	○	◒	●	◒	○

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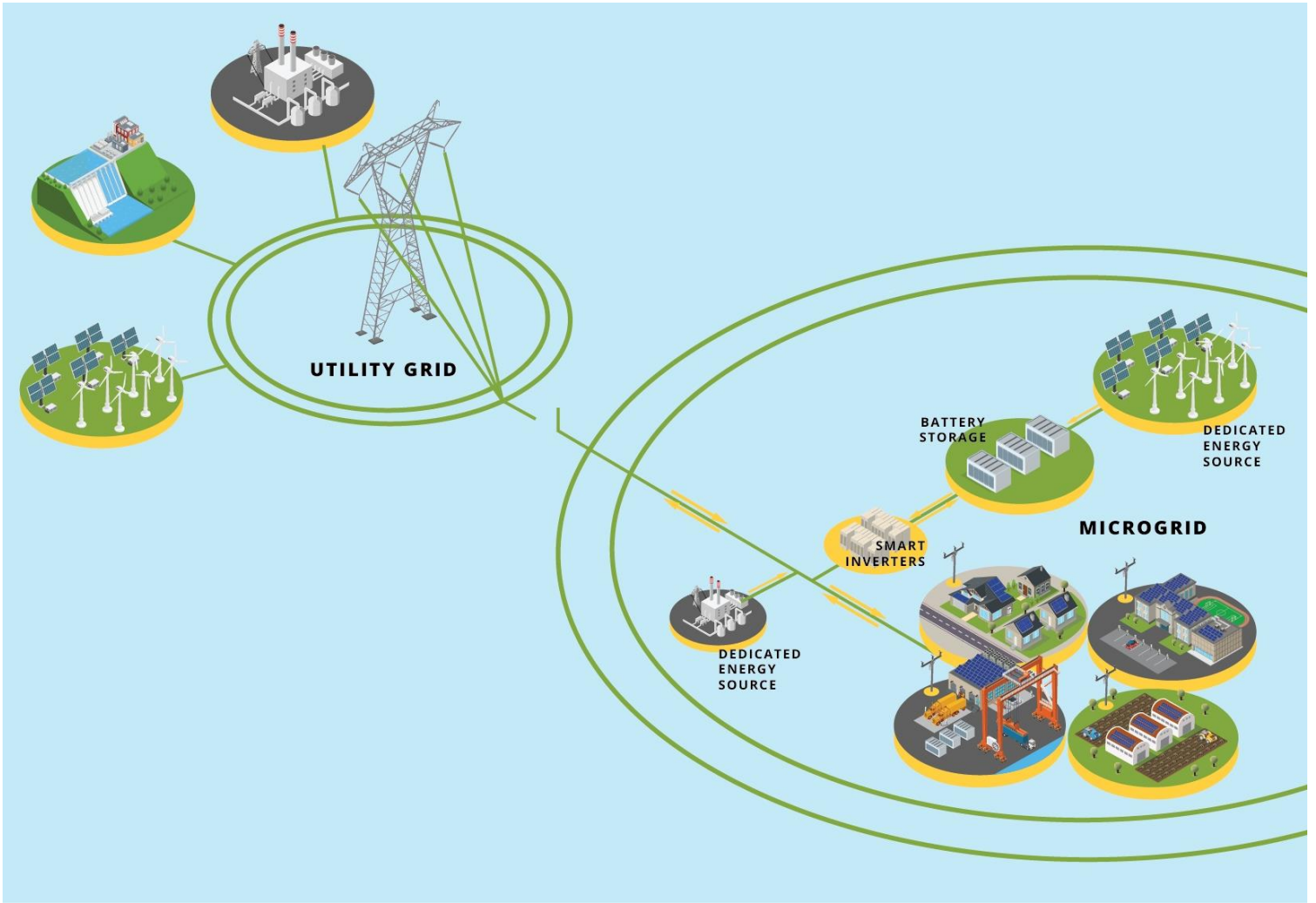
Microgrids can help increase resilience



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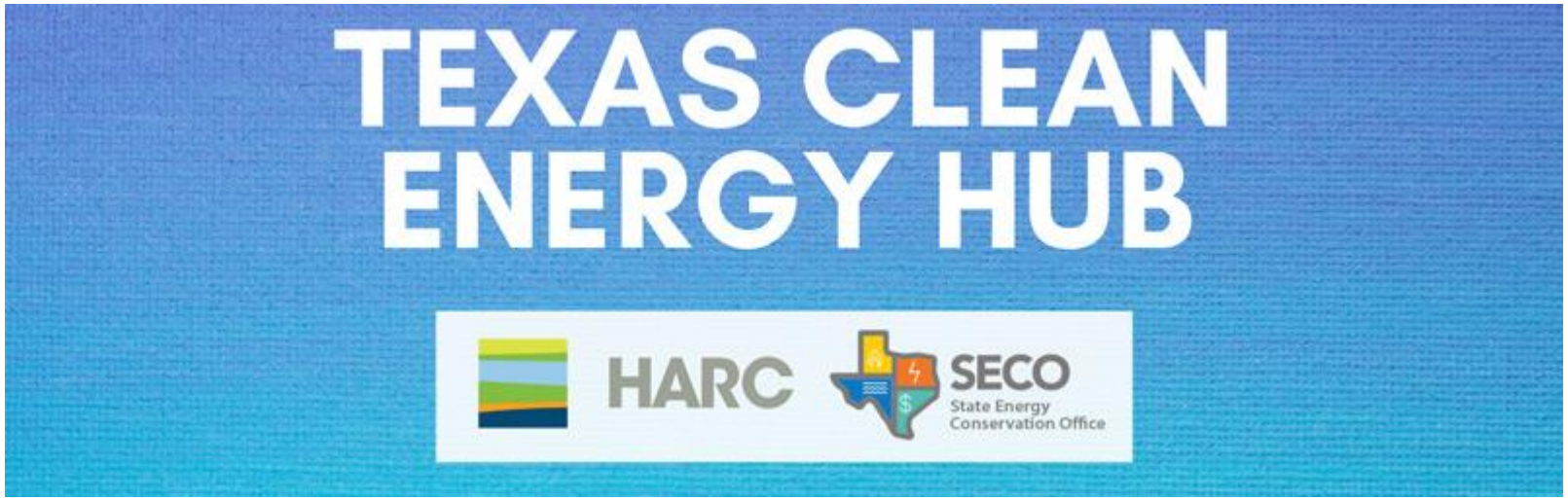
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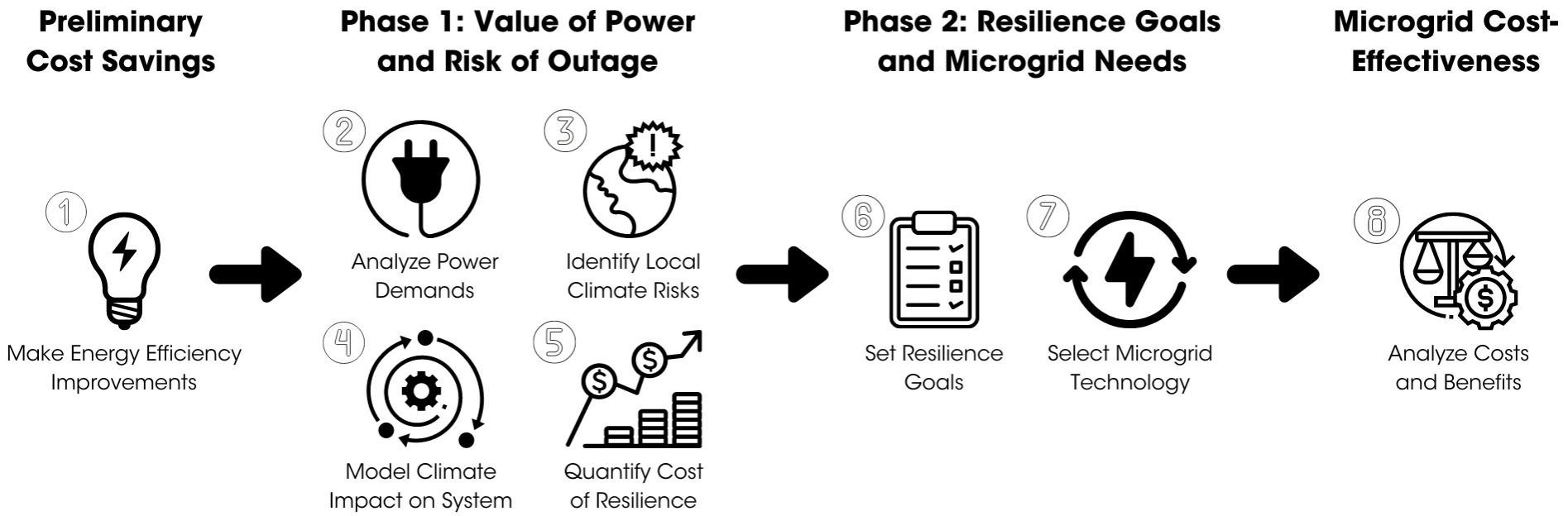
ENERGY HUB
HARC
SECO
State Energy
Conservation Office


Microgrid Resilience
Tool

Microgrids can help increase resilience

Microgrid Resilience Framework



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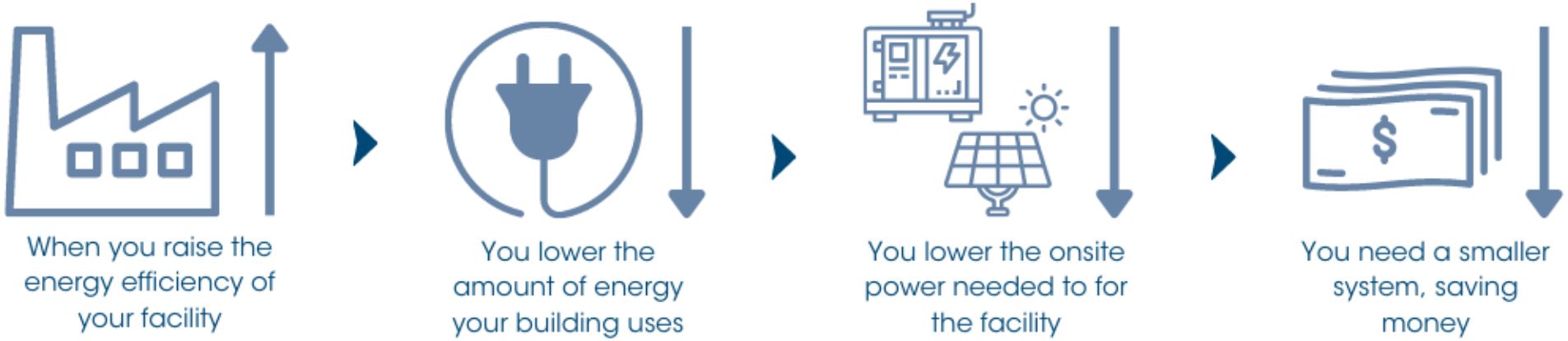
Step 1: Energy Efficiency

Energy Efficiency = System Savings



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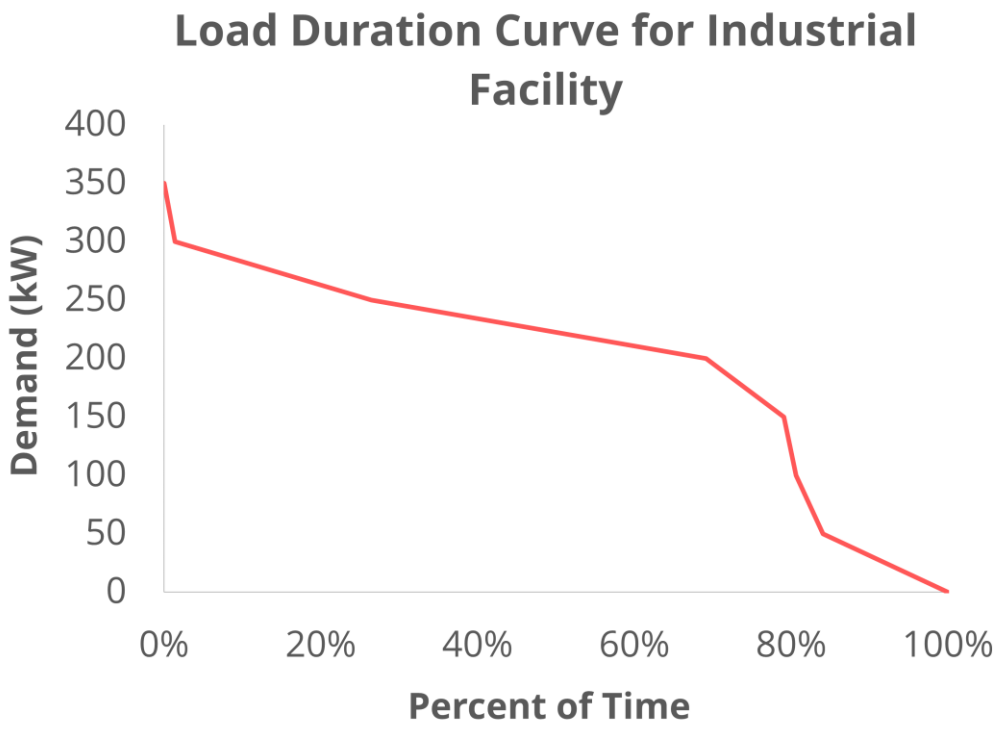
Step 1: Energy Efficiency

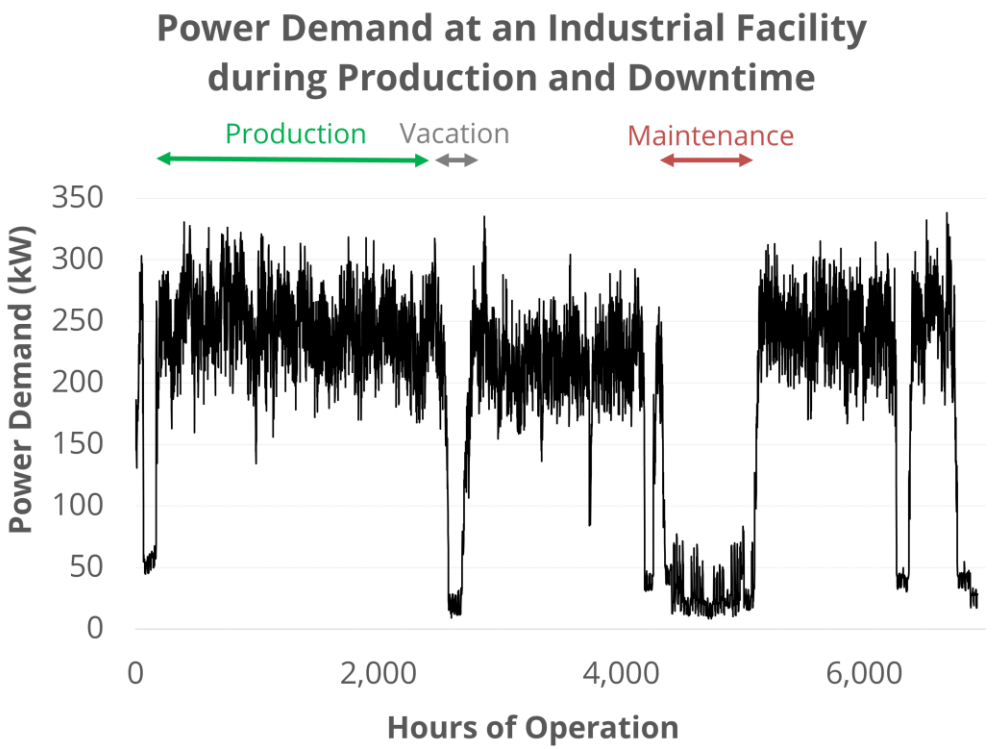
- Conduct energy efficiency audit (ASHRAE Level 1 or 2 should be sufficient to begin)
- Implement a strategic energy management plan

- Resources:
  - SECO Energy Assessments
  - EPA Energy Star
  - Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities
  - Industrial Energy Efficiency Assessments
  - A Guide to Energy Audits
  - ASHRAE Procedures for Commercial Building Energy Audits
  - ASHRAE Standard for Commercial Building Energy Audits
  - ISO 50001 Energy Management
  - PACE Energy Savings & Financing Tool

Step 2: Analyze Power Demands

- Use energy audit data to analyze power demands
- Identify frequent scenarios and critical loads





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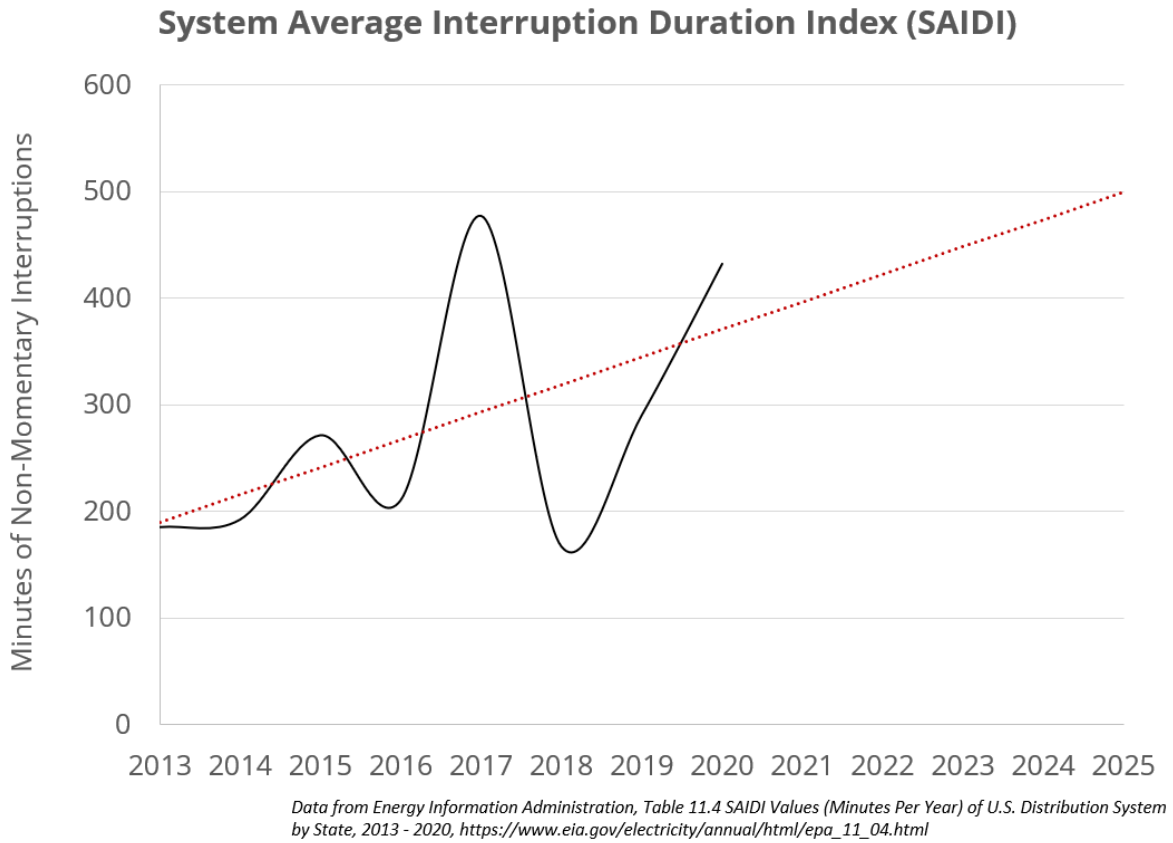
Step 3: Identify Local Climate Risks

- Site-specific risks
- Evaluate site history or experience of nearby facilities
- Estimate future climate conditions
- Resources:
  - SAIDI, SAIFI
  - Climate indicator
  - RESIN



Data from Energy Information Administration, Table 11.4 SAIDI Values (Minutes Per Year) of U.S. Distribution System by State, 2013 - 2020, https://www.eia.gov/electricity/annual/html/epa_11_04.html

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Resilience Science Information Network (RESIN)

Found at: https://harcresearch.org/research/resilience-science-information-network-resin/

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Step 4: Model Climate Impact on System

Consider impact to

- Critical processes onsite
- Product demand
- Grid conditions
- Size and configuration of system

Step 5: Quantify Cost of Resilience

- How frequently do you have power outages?
- How important or valuable is the load you want to power?

- Assess your Value of Lost Load (VOLL)
  - Assign costs to power consumption scenarios or plans
  - Willingness to pay
  - Cost per hour for loss of planned power
  - Interruption Cost Estimate (ICE) calculator

Step 6: Set Resilience Goals

- Set resilience goals using emergency and contingency plans and energy audit information

- Resources:
  - Department of Energy Better Buildings – Resilience
  - Benchmarking and Disclosing Resilience Performance
  - Creating a Resilience Risk Management Plan
  - Microgrids for Energy Resilience: A Guide to Conceptual Design and Lessons from Defense Projects

Step 7: Select Microgrid Technology

- Choose tech that matches your needs
  - Recognize tech vulnerabilities, e.g., supply chain concerns
- Use modeling to determine optimum size and schedule for operating your microgrid using your resilience goals

Ranking Criteria

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Distributed Solar	○	◒	◒	●	◒	◒
Distributed Wind	○	◒	◒	◒	◒	◒
Natural Gas CHP	○	○	◒	◒	○	○
Standby Generators	◒	○	◒	●	◒	○

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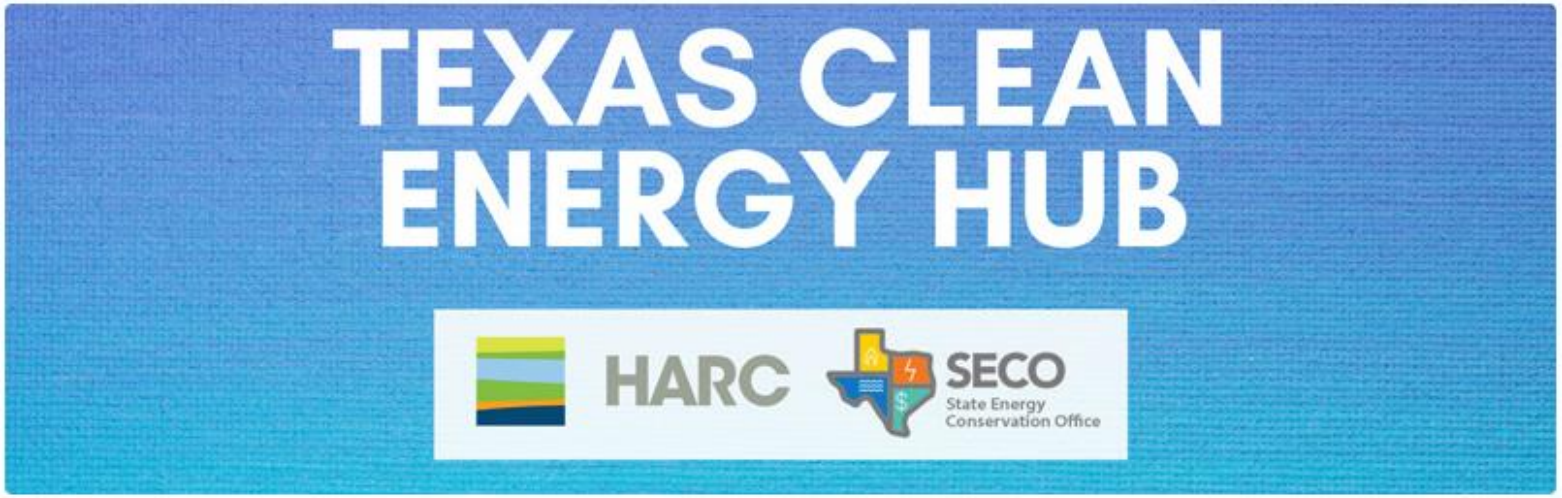
Step 8: Analyze Costs and Benefits

- Compare costs from step 5 to cost of the microgrid chosen in step 7
- Will your system meet your resilience needs and save you money?



Welcome to the Clean Energy Hub hosted by **HARC**, a Texas-based research non-profit organization with expertise in identifying and supporting cost-effective, practical solutions to speed the transition to a decarbonized and resilient energy system. The Clean Energy Hub, funded by the State Energy Conservation Office (**SECO**), houses a variety of interactive tools, podcasts, webinars, guides, and case studies to help accelerate the adoption of distributed generation and energy efficiency projects in Texas.

Interactive Tools

Funding

- Federal Emergency Management Agency
  Microgrids have been funded or are eligible for
  - Hazard Mitigation Grant Program (HMGP)
  - Building Resilient Infrastructure and Communities (BRIC)
- Department of Energy
  Microgrids, clean energy, storage, and other onsite energy options
  - Energy Efficiency and Conservation Block Grant Program (EECBG)
  - Upcoming BIL and IRA grant programs e.g., Energy Improvement in Rural or Remote Areas
- Environmental Protection Agency
  - Upcoming BIL and IRA grant programs e.g., Greenhouse Gas Reduction Fund – $20B in 3 programs aimed at increasing financial assistance for solar
- Also- state and federal rebates, equipment rebates, developer equity, net metering income, power purchase agreement income, philanthropic grants, SECO grants, Texas PACE loans

Questions

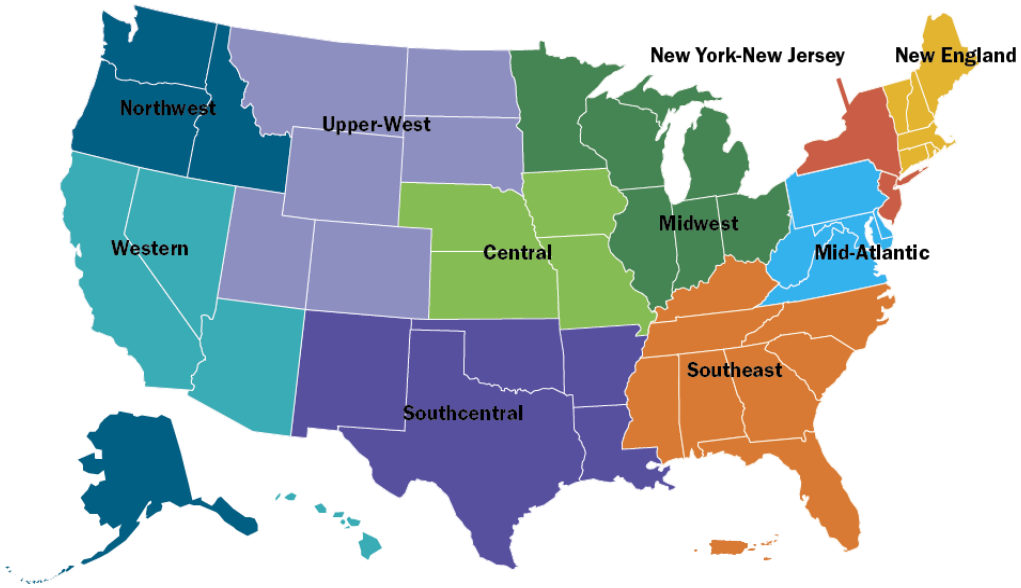
CHP Overview

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, 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.



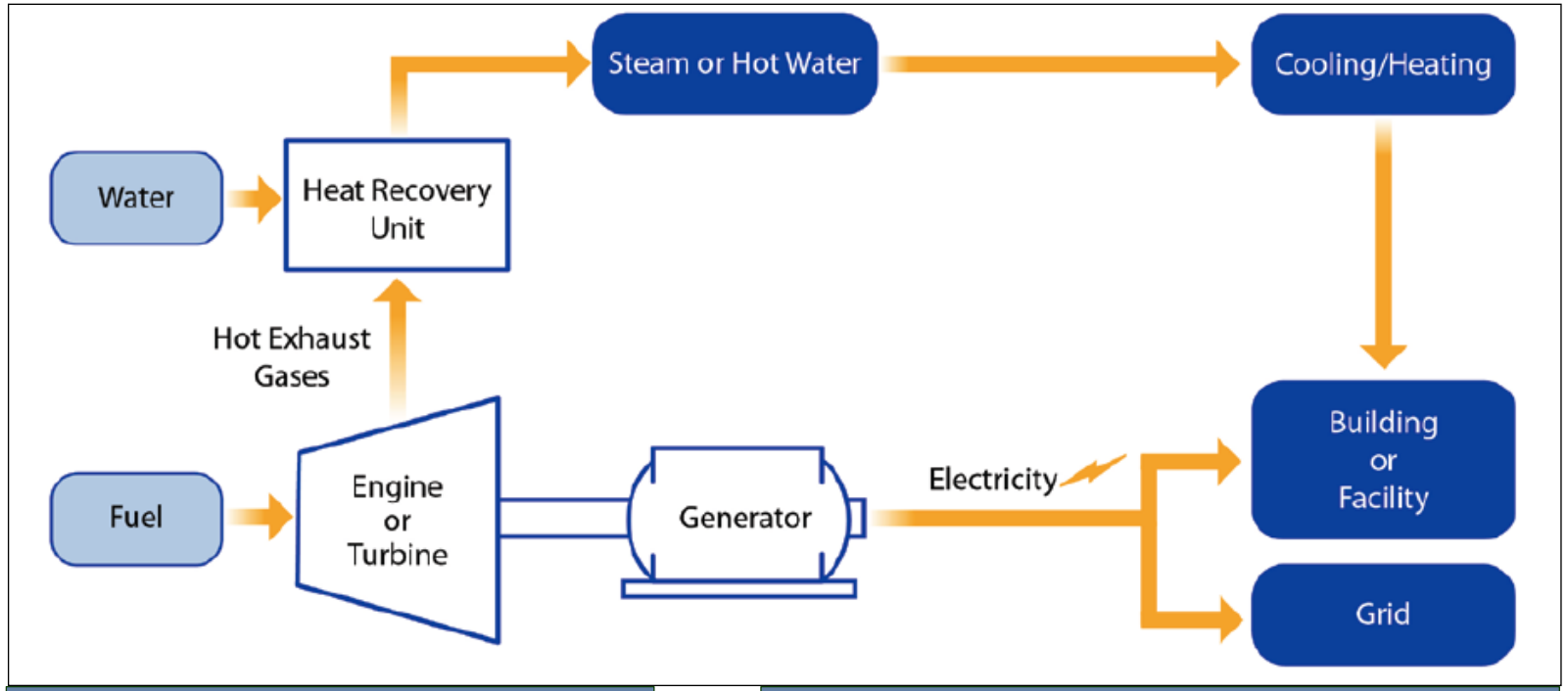
www.energy.gov/chp

Defining Combined Heat & Power (CHP)

The on-site simultaneous generation of two forms of energy (heat and electricity) from a single fuel/energy source

Conventional CHP

(also referred to as Topping Cycle CHP or Direct Fired CHP)



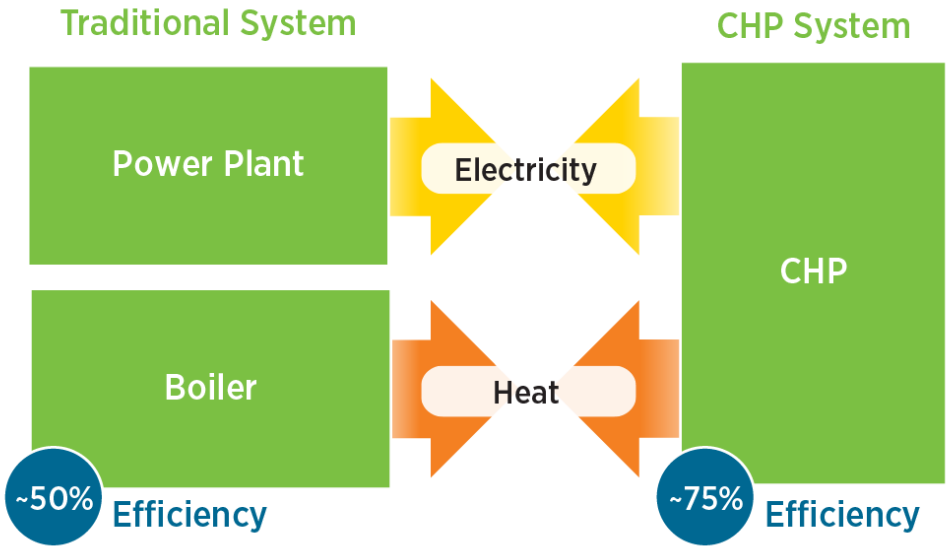
Separate Energy Delivery:

- Electric generation – 33%
- Thermal generation - 80%
- Combined efficiency – 45% to 55%

CHP Energy Efficiency (combined heat and power)
70% to 85%

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

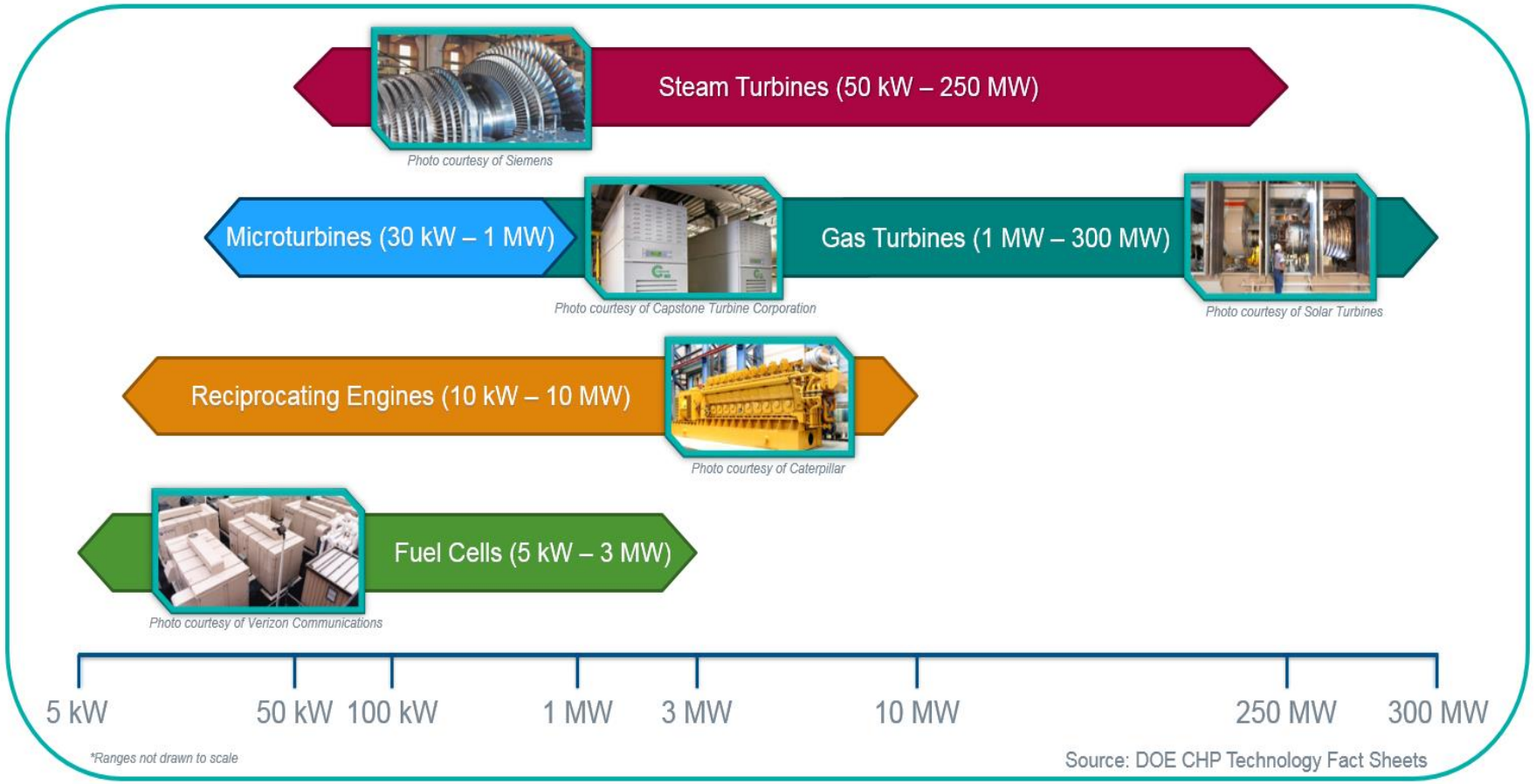
What Are the Benefits of CHP?

- CHP is **more efficient** than separate generation of electricity and heating/cooling
- Higher efficiency translates to **lower operating costs** (but requires capital investment)
- Higher efficiency **reduces emissions** of pollutants
- CHP can also increase **energy resilience, reliability** and enhance power quality
- On-site electric generation can **reduce grid congestion** and avoid distribution costs.

Common CHP Technologies and Capacity Ranges

Five Common Prime Movers

- Reciprocating engines
- Gas turbines
- Microturbines
- Fuel cells
- Steam turbines



CHP Today in the United States

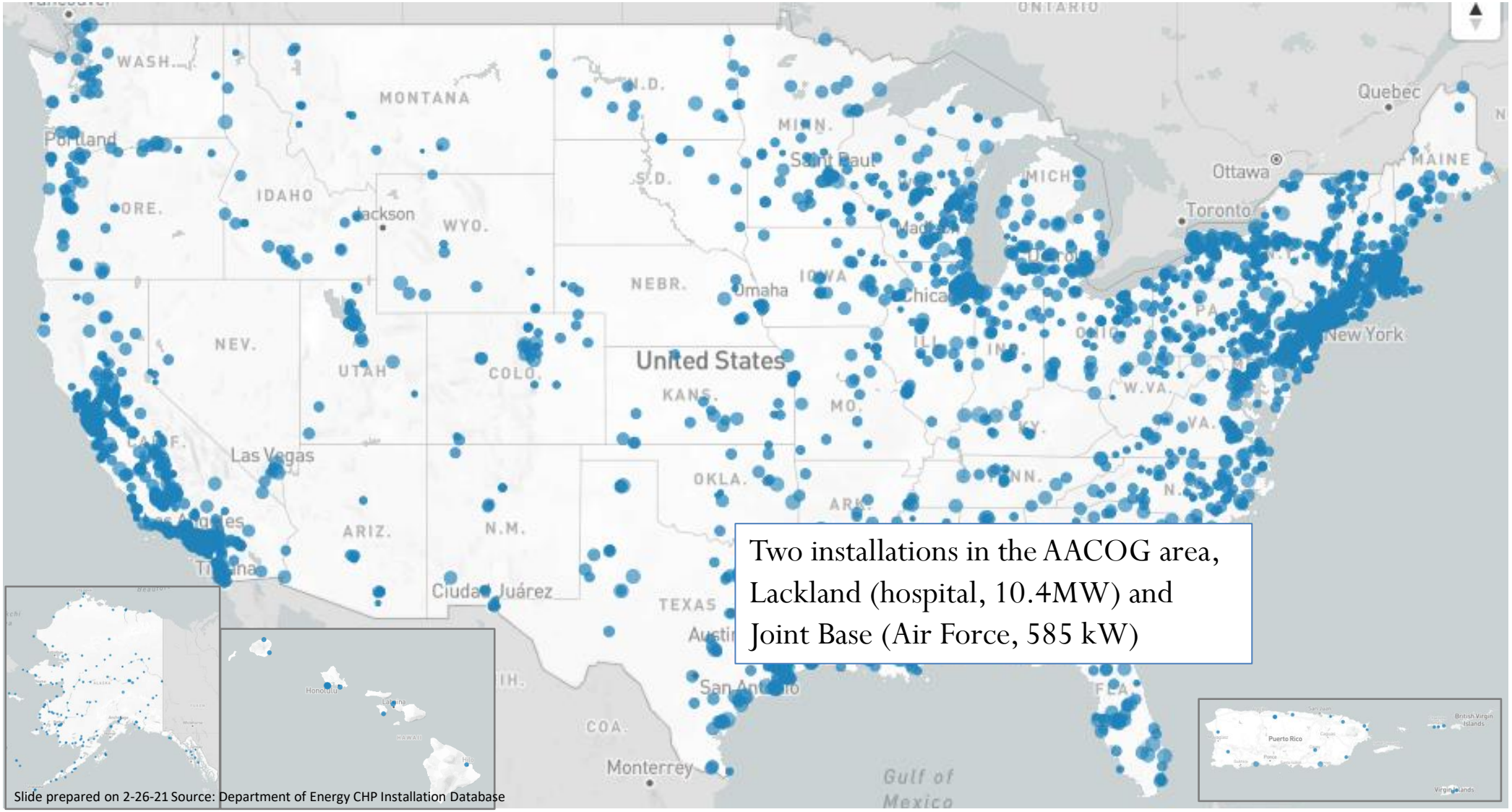
81.1GW installed capacity

+4,500 CHP sites

8% of U.S. electricity generation

Saves 1.8 quads of fuel each year

241MMT of CO2 avoided annually

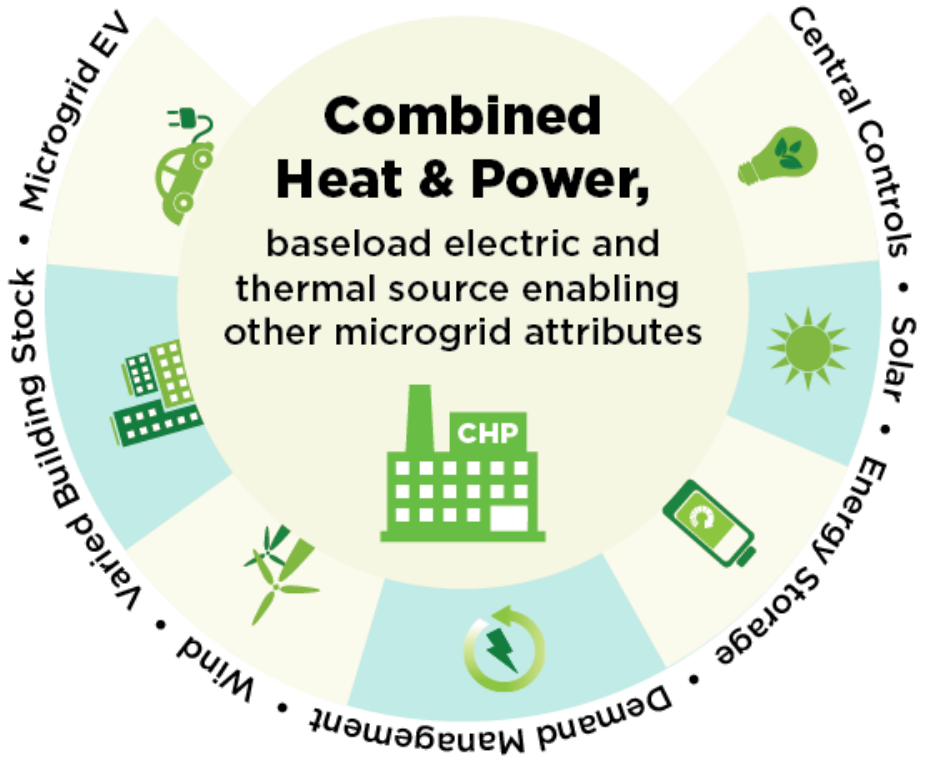


Slide prepared on 2-26-21 Source: Department of Energy CHP Installation Database

Ideal Candidates for CHP

- **Practical**
  - Buildings and facilities with installed CHP systems experience reduced operating costs and higher reliability of continued service.
- **Proven**
  - The DOE's CHP installation database presents most of the CHP systems currently operating in the US.
  - Packaged Combined Heat and Power e-catalog presents 308 different packaged CHP solutions.
- **Economical**
  - Efficient CHP systems can lead to attractive investments with electric and thermal energy savings, especially in areas with high electric rates and lower natural gas costs.
- **Reliable/Resilient**
  - CHP is able to maintain both power and heat supplies during storms and other climate events, providing a "dynamic asset" with an **economic return running every day**.
  - Emergency generators that may not be able operate as expected over the full duration of an outage.
- **Clean**
  - High efficiency, low emissions CHP systems have been recognized as the centerpiece of sustainability strategies at hotels and resorts.
  - High efficiency CHP can reduce greenhouse gas emissions with a single investment.

Microgrid Technologies



- CHP can be part of a microgrid supporting:
  - Solar and wind resources
  - Energy storage
  - Demand management
  - Central controls
  - Electric vehicle charging
- Flexible CHP systems can ramp up and down as needed to balance renewable loads and provide grid services

DOE's Evolving CHP Program

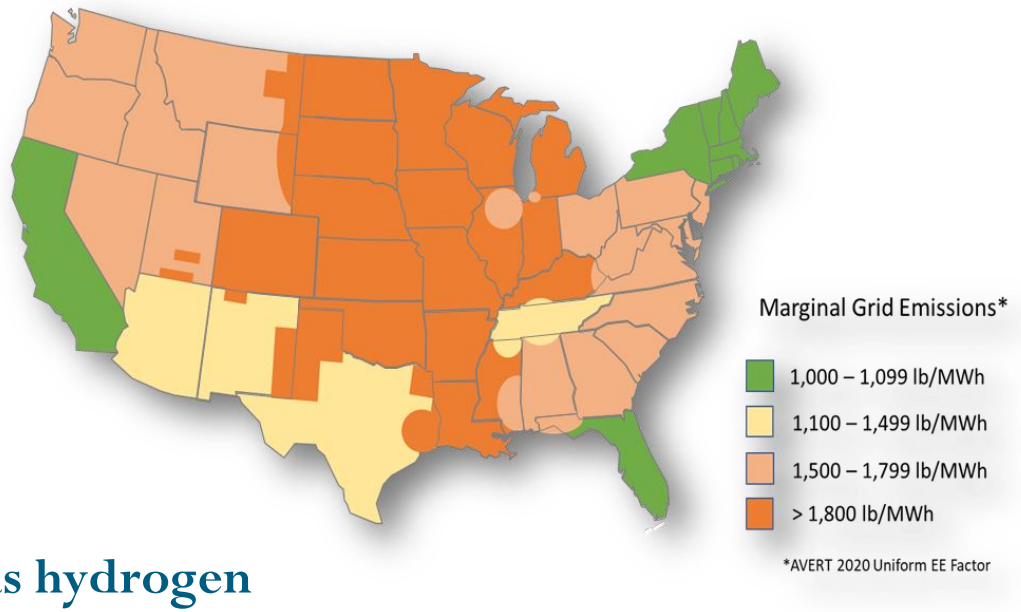
- Focus future program activities on renewably fueled CHP

  biofuels | waste heat | green hydrogen

- Natural gas-fired CHP for:
  - Heavily fossil geographies
  - Hard-to-decarbonize industries
  - Long-term resilience
  - Sites with fuel flexible outlooks

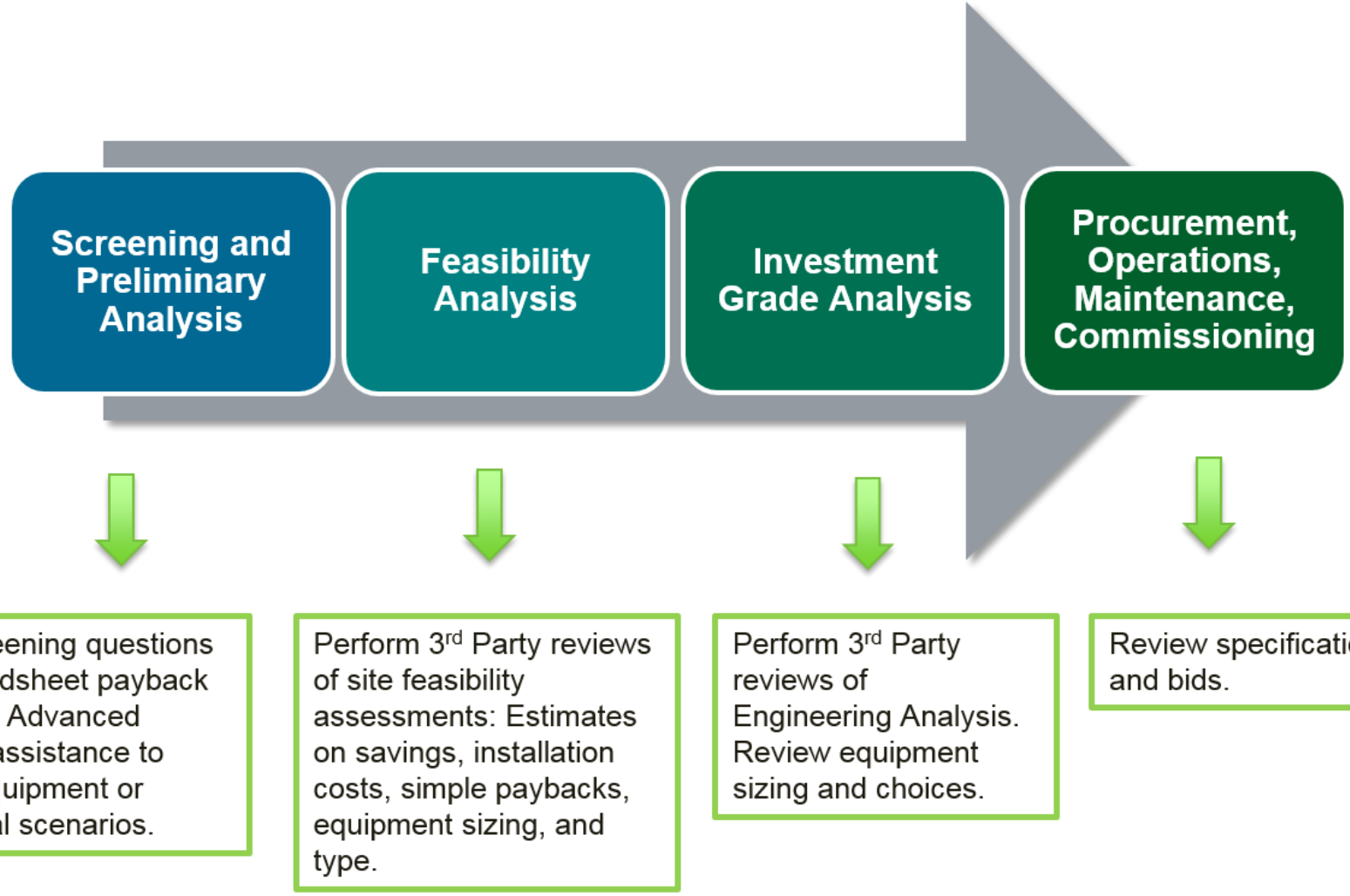
- R&D investments pair with deployment priorities to prepare for the future by:
  - Addressing challenges with renewable fuels, such as hydrogen
  - Developing technologies for flexible grid connections

Regional Marginal Grid Emissions Factors based on EPA AVERT 2021



CHP Tools and Resources

CHP TAP Role: Technical Assistance



US DOE CHP Program Resources

energy.gov/chp

[Packaged CHP eCatalog]

[DOE CHP Technologies Fact Sheet Series]

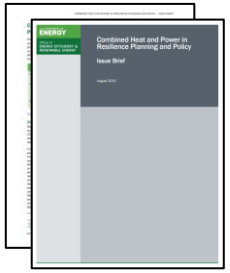
[State of CHP Pages]

[DOE Project Profile Database]

[DOE Policy/ Program Profiles]

[DG for Resilience Planning Guide]

[CHP Issue Brief Series]



[CHP and Microgrid Installation Databases]

DOE CHP Technical Assistance Partnerships (CHP TAPs)

Upper-West
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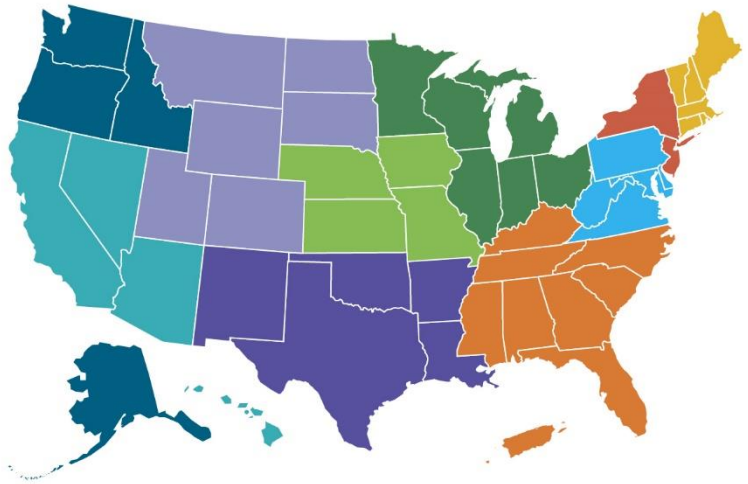

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DOE CHP Deployment Program Contacts
www.energy.gov/CHPTAP

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Summary

- CHP can provide lower operating costs, reduce emissions, increase energy reliability, enhance power quality, and reduce grid congestion and avoid distribution costs
- CHP can provide power system resilience given increasing extreme events and grid concerns
- A variety of CHP technologies and sizes are available
- CHP resources are available at www.energy.gov/chp

Questions

Thank You

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Appendix

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