



Hospital



University



Correctional facility



Nursing home

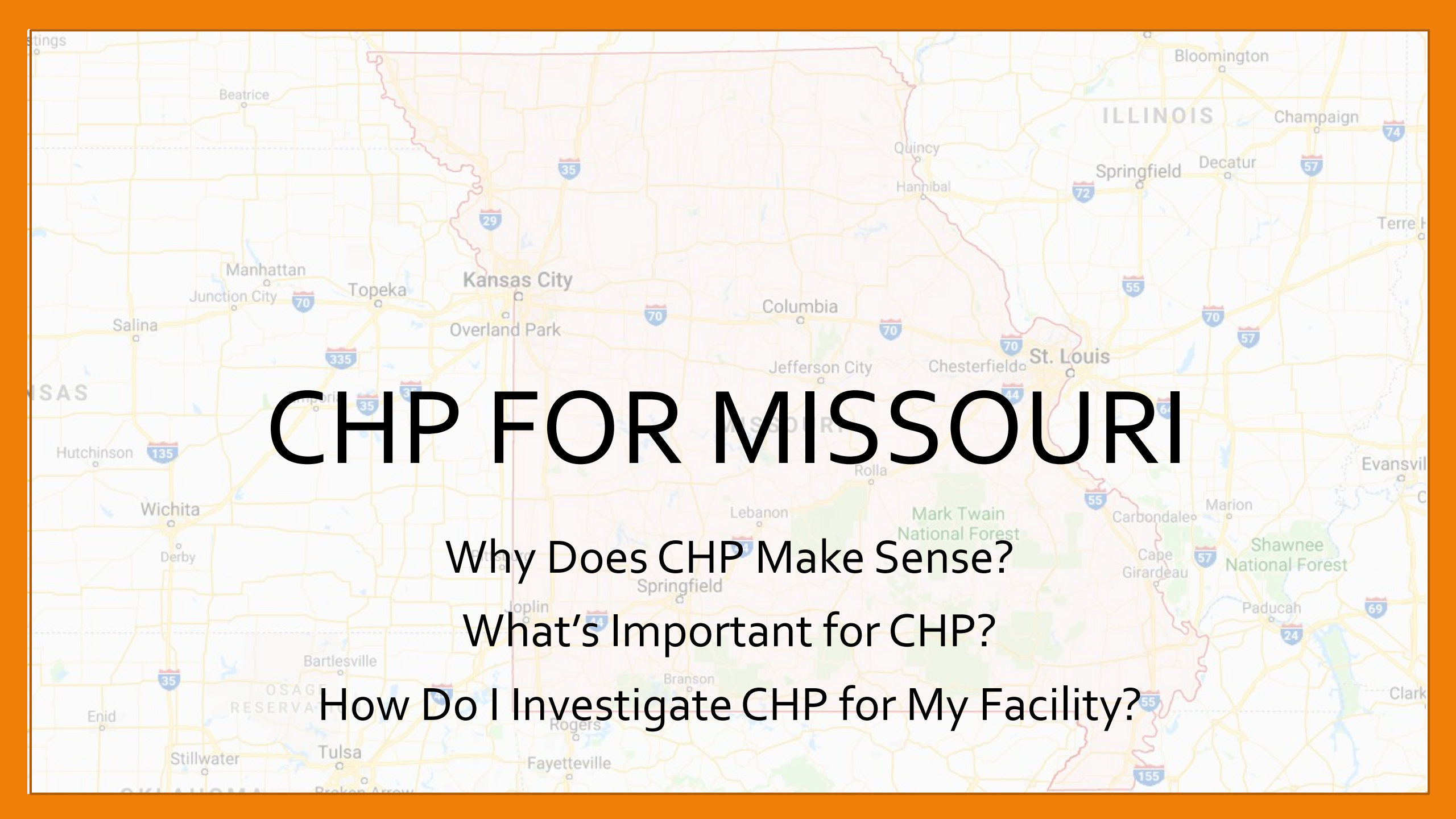
April 10, 2018

CHP

Combined Heat and Power

Summit

Eastern Missouri

A map of Missouri and surrounding states (Kansas, Illinois, Arkansas, Oklahoma, and Nebraska) is shown in the background. The map displays major cities, highways, and geographical features like the Mark Twain National Forest and Shawnee National Forest. The text is overlaid on this map.

CHP FOR MISSOURI

Why Does CHP Make Sense?

What's Important for CHP?

How Do I Investigate CHP for My Facility?

Introduction

Speaker

- Blake Ellis, PE, DBIA, LEED AP
- Principal with **BURNS**  **MCDONNELL**
- Director of *OnSite* Energy & Power Practice



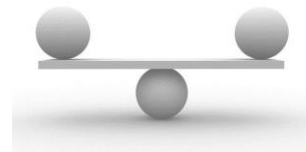
Agenda

- Why Does CHP Make Sense?
- Insight into CHP Project Development
- Case Studies
 - Hospital
 - Correctional Facility
 - Nursing Homes
 - Higher Education

Why Does CHP Make Sense?

- Energy Cost Stability
 - Longer term contracts
 - Fuel flexibility
- Environmental
 - Reduces carbon footprint
 - Provides a bridge to other technologies
- Efficiency
 - Higher efficiency than traditional systems
- Financial
 - Lost revenue due to power disruption
 - Reduce energy costs (*It makes cents*)
 - Funds other initiatives
- Resiliency (Energy Security)
 - Natural disasters
 - Point of refuge for the community

Why CHP?



What's Important for CHP?

- Near term capital expenses
 - Replacement of aged assets (ideally heating assets)
 - Facility expansion (need for new assets)
- Hours of operation
 - Closer to 24/7/365 the better
 - High utilization of high efficiency system
- Connection costs
 - Heating system
 - Fuel source
 - Electrical

BUSINESS HOURS:			
Mon.	12am	to	12am
Tues.	12am	to	12am
Wed.	12am	to	12am
Thur.	12am	to	12am
Fri.	12am	to	12am
Sat.	12am	to	12am
Sun.	12am	to	12am



What's Important for CHP?

- Implementation logistics
 - Access
 - Shutdowns
 - Timeline
- Year-round thermal needs
 - Ideally heating, but can be cooling
 - Includes laundries and domestic hot water
- Load profiles
 - Thermal
 - Electrical

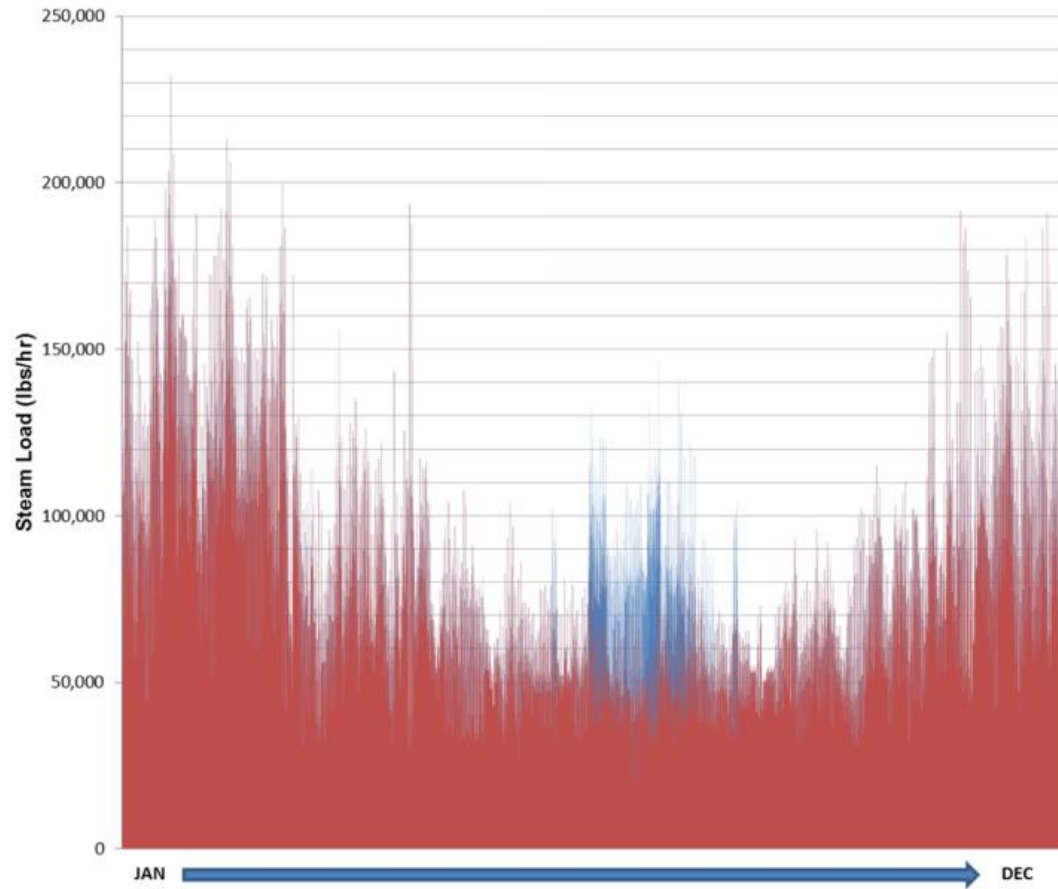


Domestic Hot Water

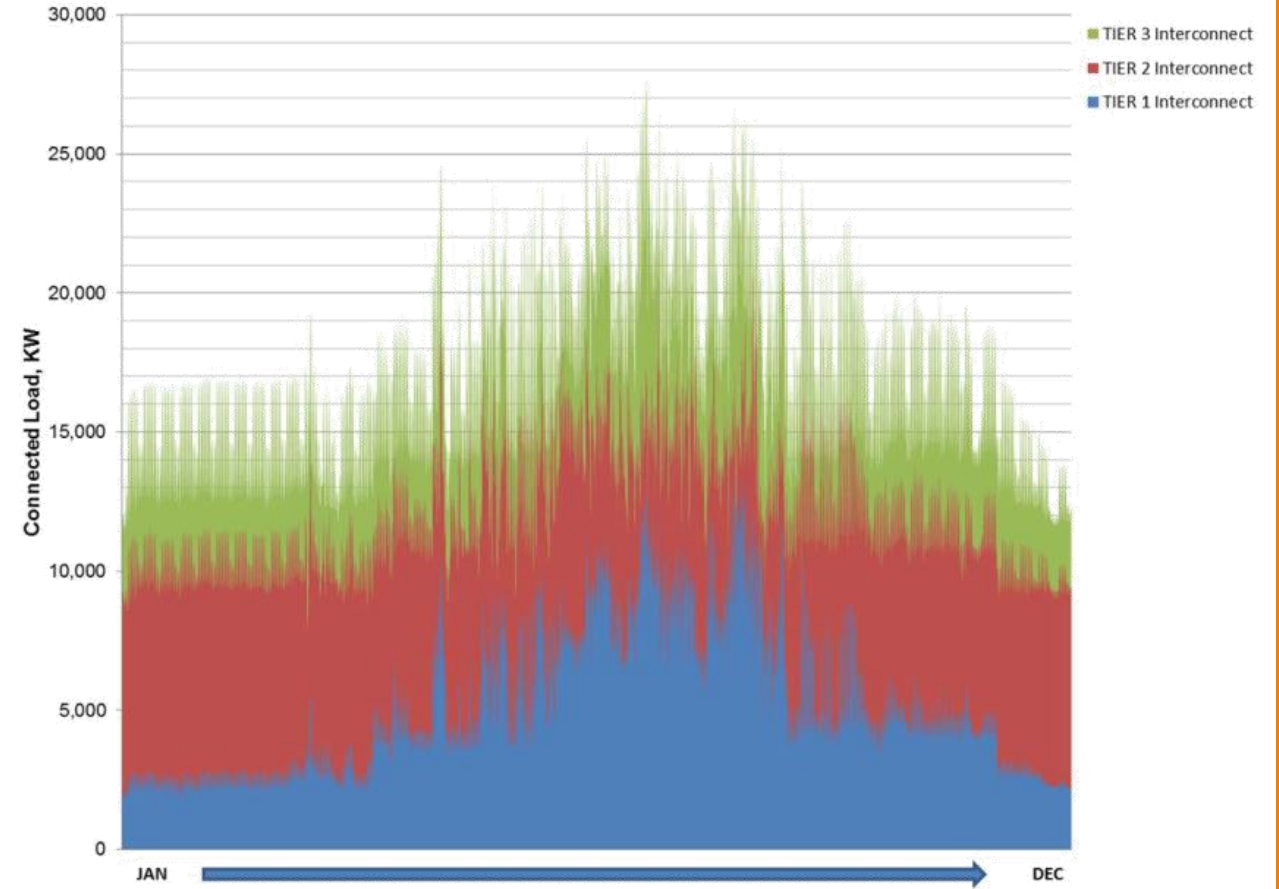


Commercial Laundry

What's Important for CHP?



Steam Load Profile



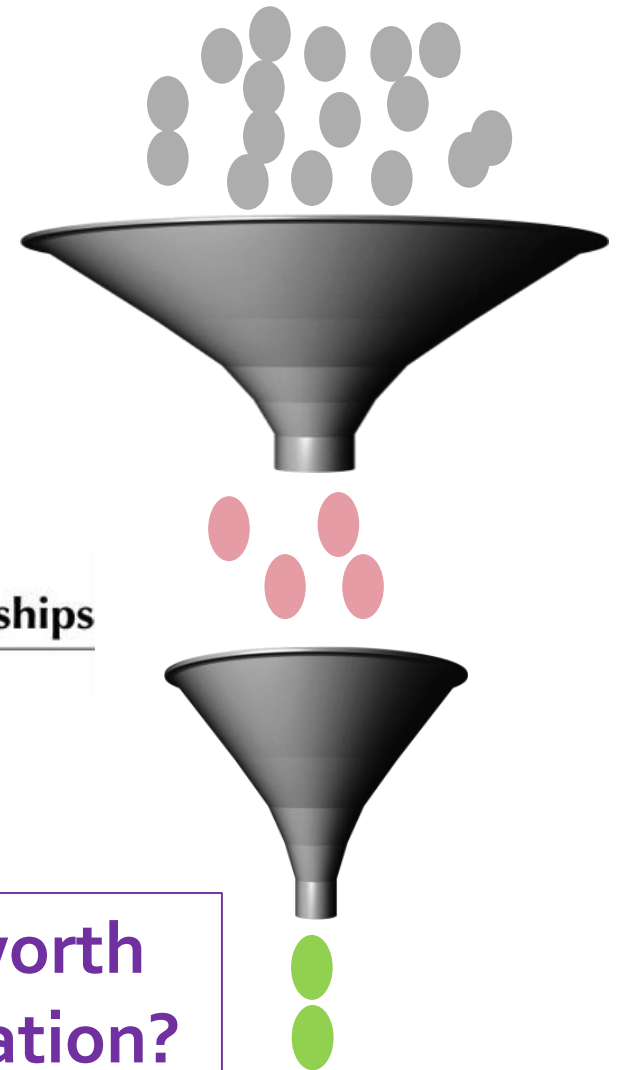
Electric Load Profile

Project Development Process

- Initial Step: CHP Evaluation (fitness test)
 - DOE TAP
 - Engineering firm
 - Small capital investment
 - Desktop evaluation
- Areas of focus
 - Current load profiles
 - Growth plans / asset replacement
 - Electric and gas rates
 - Fuel source availability
 - Implementation logistics



U.S. DEPARTMENT OF ENERGY
CHP Technical Assistance Partnerships
MIDWEST

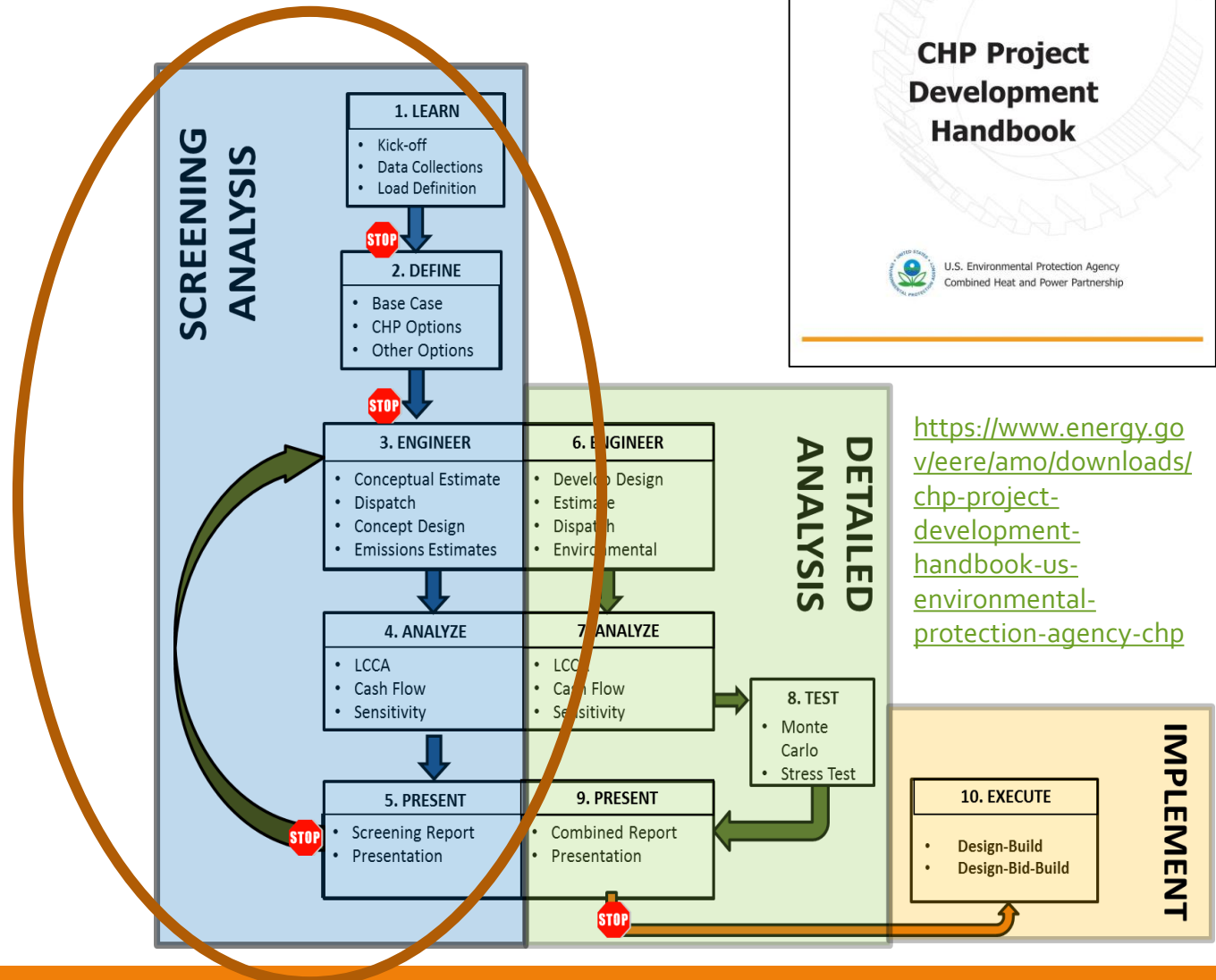


**Is CHP an idea worth
further investigation?**

Without spending much money

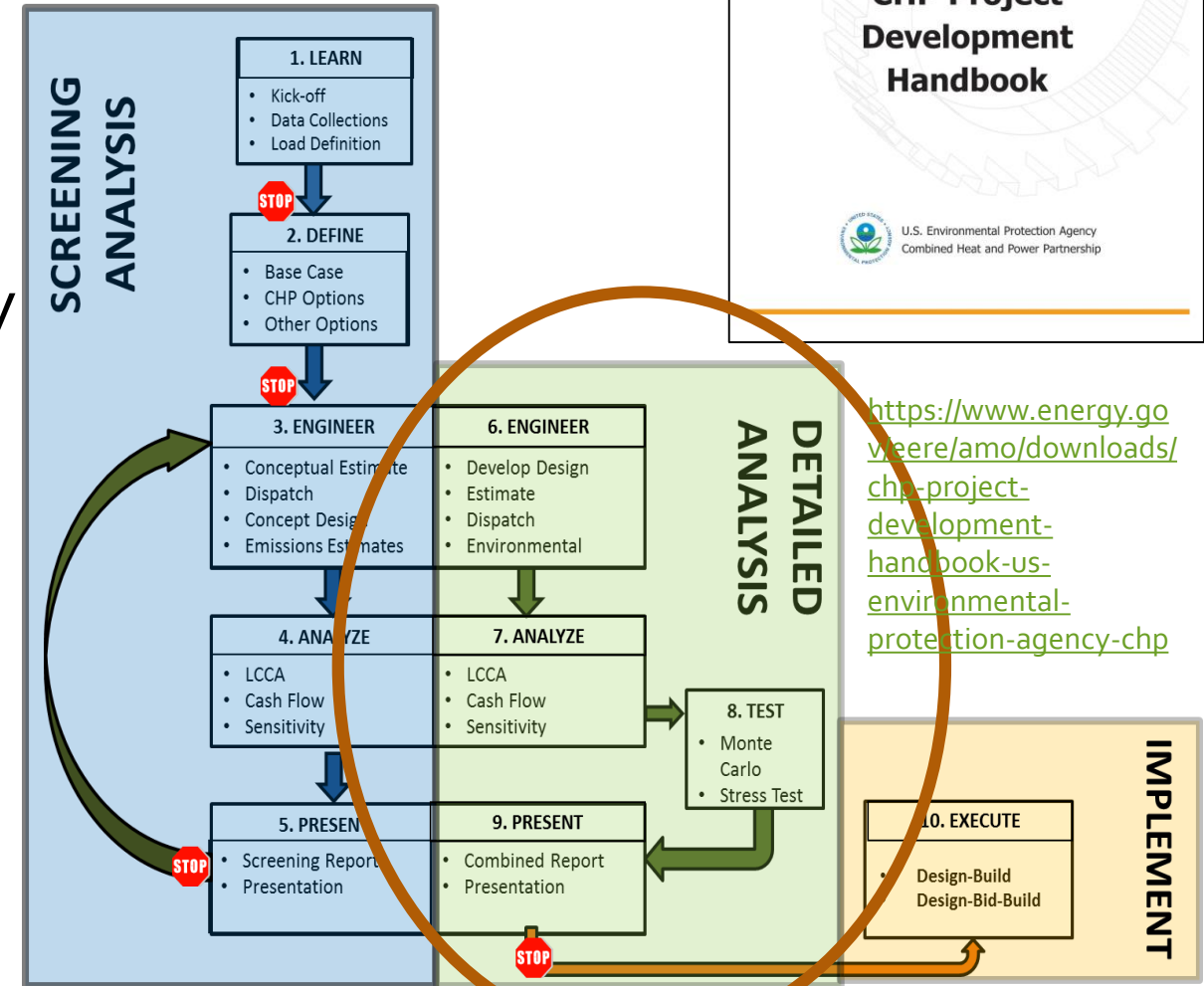
Project Development Process

- Next Step: Screening Analysis
 - **Level I** CHP analysis
 - Described in CHP Handbook
 - Narrows range of options
 - Requires a site visit
- Areas of focus
 - Detailed (hourly) load profiles
 - Detailed energy rate structures
 - Including standby charges
 - Develop a Base Case
 - General arrangements
 - Parametric cost estimates
 - Air permit review



Project Development Process

- Next Step: Detailed Analysis
 - **Level II** CHP analysis
 - Described in CHP Handbook
 - Determines the best option
 - Level of detail/effort can vary widely
- Areas of focus
 - Focus on just a few (1-3) options
 - More detailed design
 - Project execution developed
 - More detailed cost estimates
 - Detailed sensitivity
 - Air permit analysis



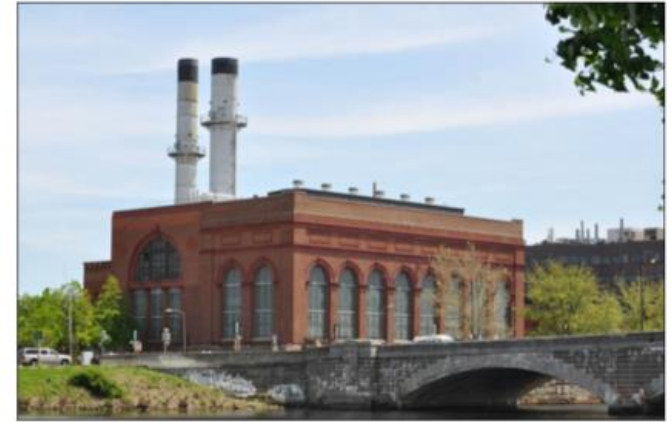
Project Development Process

- Final Steps: Design, Construction & Operation
 - Like a typical project
 - Many implementation methods
- Areas of focus
 - Funding
 - Self-Financed
 - Energy Investment Firms
 - Energy Performance Contracts (ESCO & UESC)
 - Design
 - Construction
 - Turnover
 - Operations



Case Studies

- Hospital
 - Shands Healthcare, Gainesville, FL
- Correctional Facility
 - Fresno County, California – Fresno, CA
- Nursing Homes
 - Summary of 148 installations nationwide
- Higher Education
 - Carleton College, Northfield, MN
 - Harvard University, Boston, MA



Shands Hospital

Gainesville, FL

- New Cancer Hospital Campus
- Phase 1:
 - 500,000 ft²
 - 200 beds
 - Level 1 trauma center
- 35 Year Plan:
 - 3,000,000 ft²
 - 1200 beds
 - 15 MW electrical demand
 - 16,000 tons of cooling



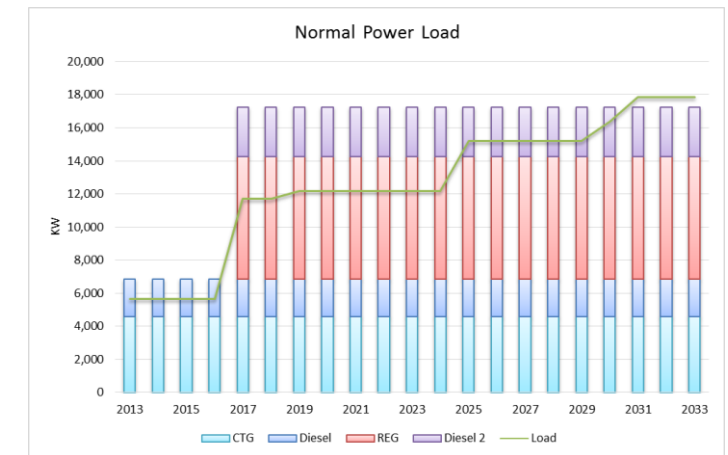
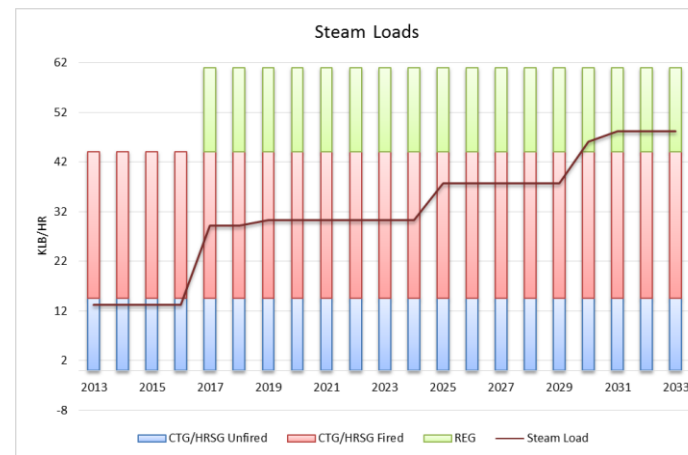
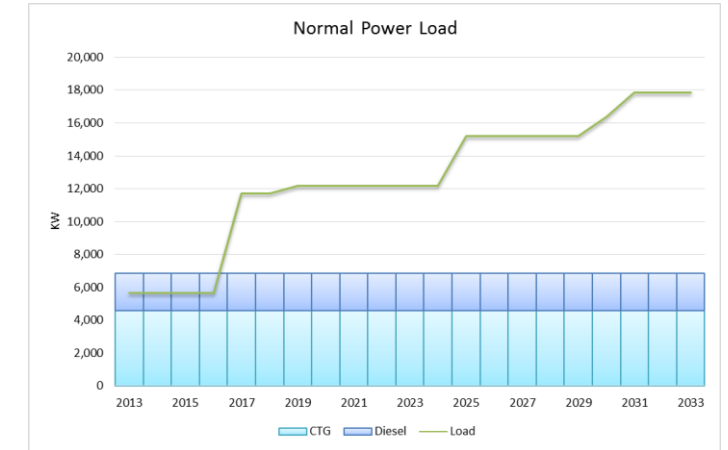
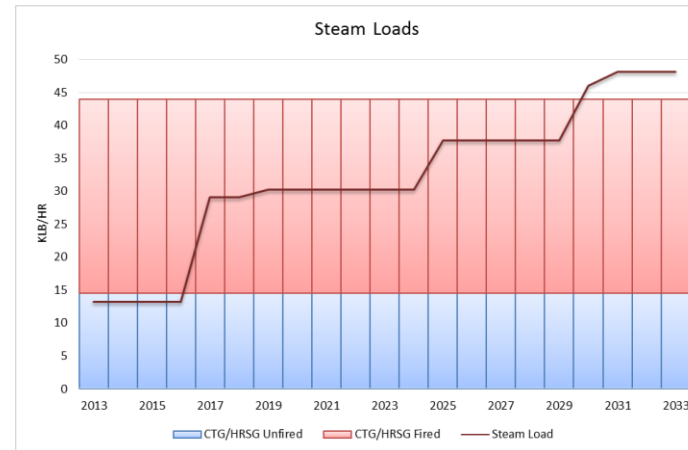
South Energy Center:

- Phase 1
 - 4.6 MW gas turbine
 - 45,000 lb/hr fired HRSG
 - 30,000 lb/hr back-up boiler
 - 4,200 Tons of chilled water
- Planned Phase 2
 - 4.6 MW CTG w/ HRSG
 - 1,500 ton chiller

Shands Hospital

Gainesville, FL

- Phase 1 CHP
 - Owned & Operated by Gainesville Regional Utilities
 - Serves 100% of electrical load
 - Disconnects from the grid during storms
 - Calculated thermal loads ~ 30% greater than actual loads
- Phase 2 CHP
 - Need only electrical & cooling
 - 7.4 MW reciprocating engine



Fresno County (CA) Facilities

Includes County Correctional Facility

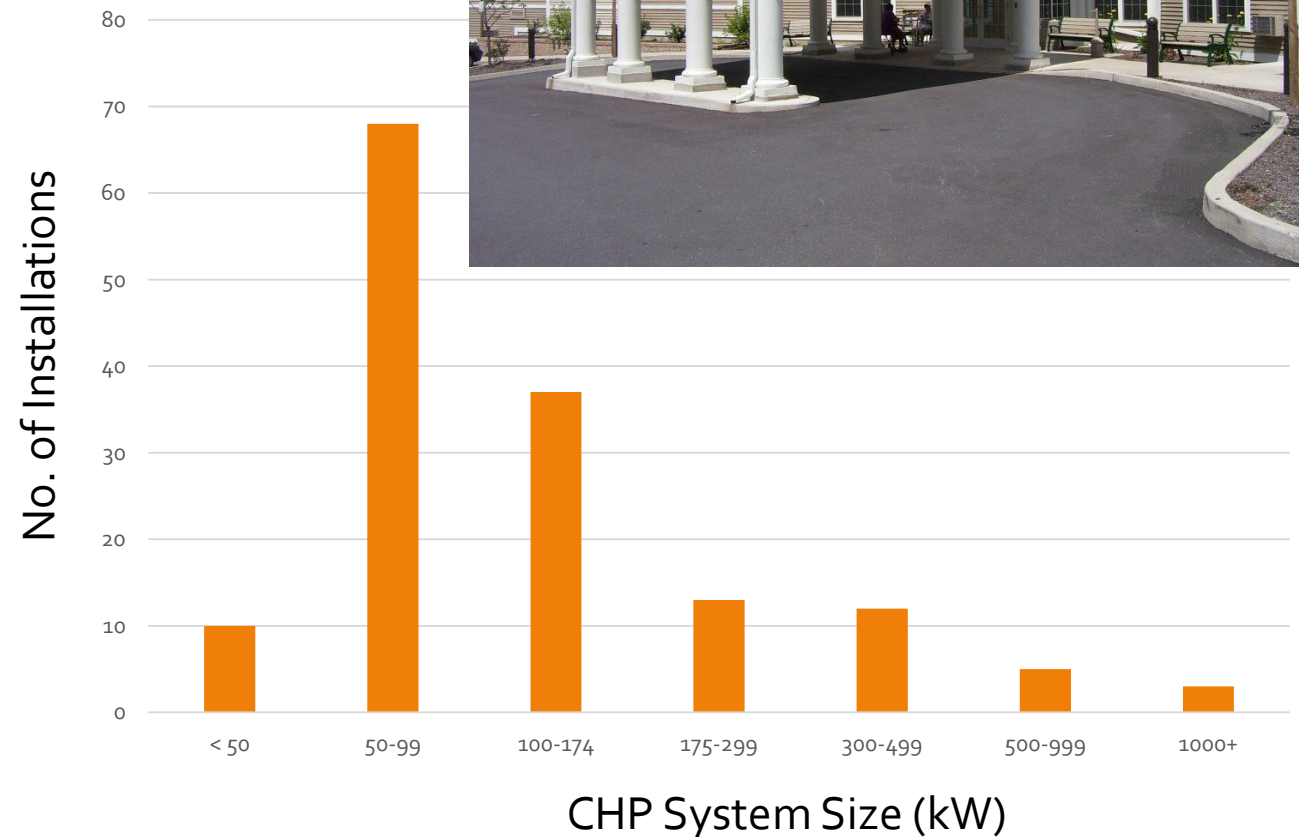
- 1.25 MW reciprocating engine prime mover
 - Exhaust recovery generates steam
 - Jacket water recovery generates DHW
- Upgraded boilers, chillers & HVAC Systems
- Conversion of electrical service from secondary to primary
- \$1 million in rebates for the CHP system
- 5,086 tons of CO₂ reduction
- 15 year energy savings project



Nursing Homes

Nationwide

- 148 installations nationwide
- Locations
 - 12 states
 - Top 5 (90% of total): NY, NJ, CT, MA, CA
- Type of prime mover
 - 92% reciprocating engines
 - 8% microturbine & other
- Summary
 - Generally smaller systems
 - Many ESCO financed examples



Nursing Home Examples

Nationwide

Wartburg Nursing Home

Brooklyn, NY

- 230 beds
- Old boiler room needed replacement
- Solution
 - 225kW CHP system (three modules)
 - Three small thermal storage tanks
 - Supplemental gas boiler
 - Self financed with savings
- Purchase 5% of electricity from utility

Meriden Nursing Home

Meriden, CT

- 104 beds
- Natural gas boilers, water heaters
- Looking to be more environmentally friendly
- Solution
 - 75kW CHP system
 - \$30,000 savings per year/four year payback
 - ESCO financed

Carleton College

Northfield, MN

- Liberal arts college in Minnesota
- Strong sustainability focus
- Timeline
 - 1910: Steam heating (via coal) from central plant
 - 1941-42: Convert central plant to natural gas
 - 1950's & 60's: New buildings use hot water for heating
 - 2004: 1.65 MW wind turbine
 - 2006: Convert to 15kV distribution add backup generators
 - 2011: Add second wind turbine
 - 2014: Campus master plan
 - 2016: Campus utility master plan

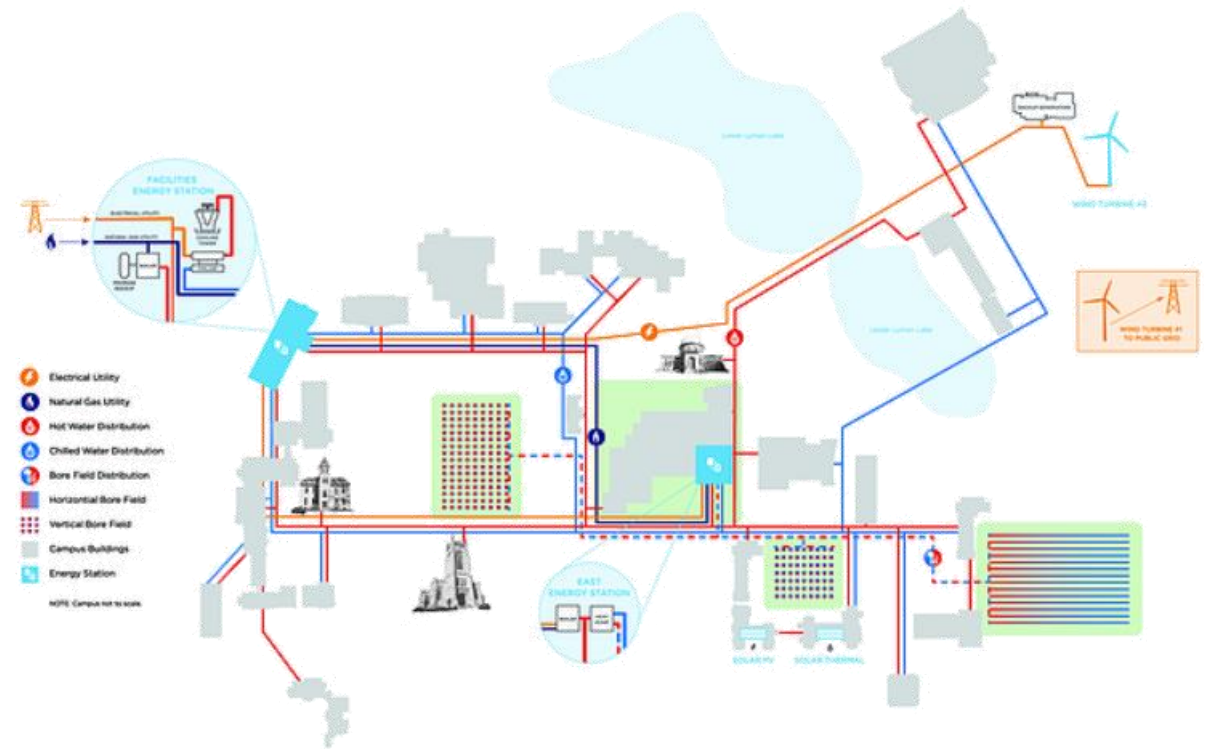


CARBON
FREE
BY
2050

Carleton College

Northfield, MN

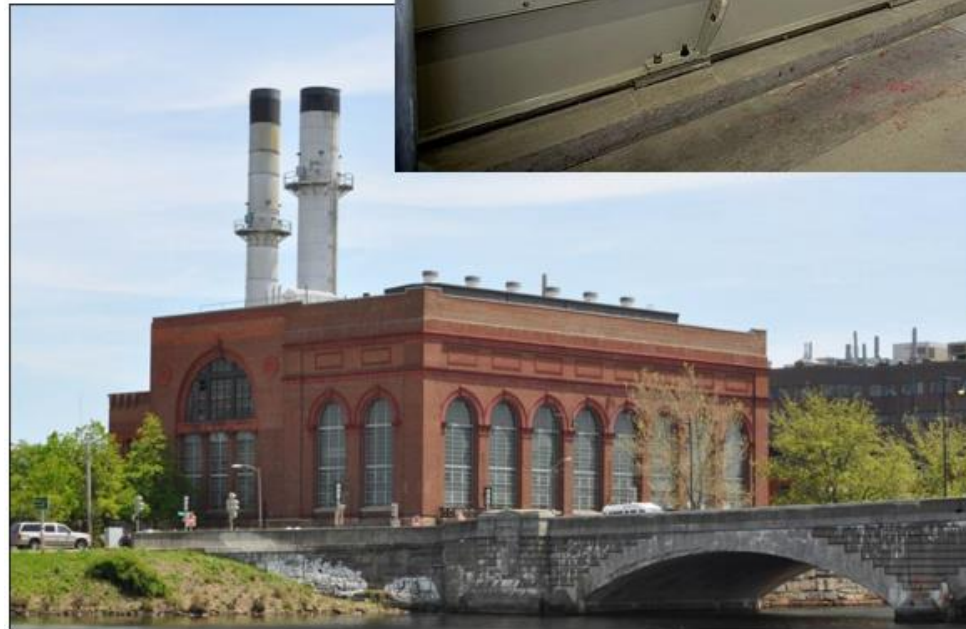
- Desire: Convert campus to geothermal
- Problem: Long (20+ year) payback
- Solution: Include CHP
 - Reciprocating engines
 - Investigated options from 1.1-1.7 MW
 - Reduces utility & operating by 36%
 - Reduces Scope 1 and Scope 2 emissions by 38%
 - Reduces payback to **17 years**
 - \$9.8M savings over 30 years
 - Natural Gas: \$3.90 / MMBtu (HHV)
 - Electricity: \$0.072 / kWh (blended)



Harvard University

Cambridge, MA

- Development Process
 - Level I CHP Study (5-15 MW)
 - Level II CHP Study (5-15 MW)
 - Design & Construction
- 7.5 MW combustion turbine prime mover
- Works with existing steam turbine
 - Existing 5 MW backpressure turbine
 - Combined cycle for 8 mo. per year
- Expanded electrical distribution (new microgrid)
 - New service to buildings
 - Connects with solar array



Summary

- CHP Makes Sense (& Cents)
 - Energy cost stability, environmental, efficiency, financial & resiliency
- What's Important for CHP
 - Near term capital expenses, hours of operation, connection costs, implementation logistics, year-round thermal needs & load profiles
- Project Development has Many Phases
 - Evaluation, screening analysis, detailed analysis, design, construction & operation
 - Allows for gradual investment
 - The devil is in the details (regarding analysis)
- Several examples of Successful Projects
 - All segments (hospital, correctional facility, nursing homes, college & university)
 - Large and small (kW to MW)