Combined Heat and Power Systems in the Midwest: Examining Current Efforts and Opportunities for Growth

MEEA and Energy Resources Center

December 12, 2023

Housekeeping

- This webinar is being recorded, and MEEA will be sending a link to view it
- If you have any questions for the presenters, please put them in the Question box, not the chat, to make sure we see them
- Feel free to provide input using the chat functionality

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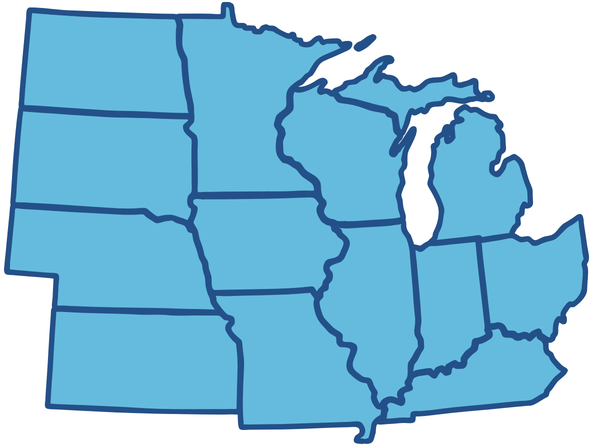
Midwest Energy Efficiency Alliance

The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network, promoting energy efficiency to optimize energy generation, reduce consumption, create jobs and decrease carbon emissions in all Midwest communities.

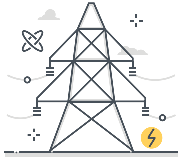


MEEA is a non-profit membership organization with 150+ members, including:

Energy service companies & contractors

State & local governments

Academic & Research institutions



Electric & gas utilities

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Assessment of Combined Heat and Power (CHP) Systems in the Midwest's Top Manufacturing Industries

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Originally presented at the 2023 ACEEE Summer Study on Energy Efficiency in Industry (July 2023)

December 12, 2023

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Background

- CHP systems offer numerous advantages, but their utilization in some Midwest states is low due to policy barriers and high upfront costs.
- Our analysis aimed to identify gaps in the distribution of CHP systems across major electric use industries in **Illinois**, **Indiana**, **Kentucky**, **Michigan**, **Missouri** and **Ohio**.
- We assessed the current deployment of CHP systems in specific industrial subsectors and identified subsectors that can more effectively utilize CHP based on economic indicators.
- Based on the current deployment of CHP, we extrapolated the region's potential generation, capacity and GHG savings.

Data Sources

There is no 'one stop shop' for data

EIA ***Manufacturing Energy Consumption Survey*** (MECS)

Census Bureau ***American Survey of Manufacturers*** (ASM)

DOE ***CHP & Microgrid Database***

Midwest States Studied

A Cross-section of MEEA's states

State	Total Industrial Consumption (Trillion Btu)	Nat'l Rank (of 51)	MW Rank (of 13)
Indiana	1,187	5	1
Illinois	1,131	6	2
Ohio	1,107	7	3
Michigan	620	12	5
Kentucky	565	14	7
Missouri	305	31	12

NAICS Levels

Identifying Relevant Industries

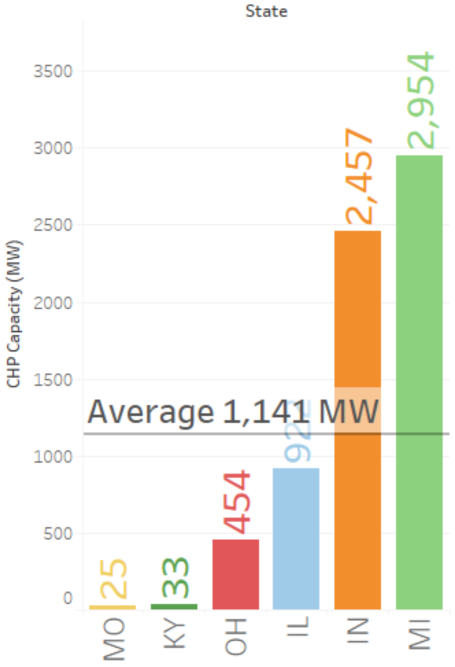
- 2 digit
  - 31-34 Manufacturing
- **3 digit**
  - **Broad subsectors**
- 4-6 digits
  - More precise segmentation

Top 10 Energy Use Subsectors in Midwest		
NAICS Code	Manufacturing Subsector	Total consumption (trillion Btu)
331	Primary Metals	922
325	Chemicals	804
324	Petroleum and Coal Products	518
311	Food	485
322	Paper	274
327	Nonmetallic Mineral Products	237
336	Transportation Equipment	182
332	Fabricated Metal Products	124
326	Plastics and Rubber Products	110
333	Machinery	73

State Results & Averages

MW

Total *CHP Capacity* across Top 10 sectors



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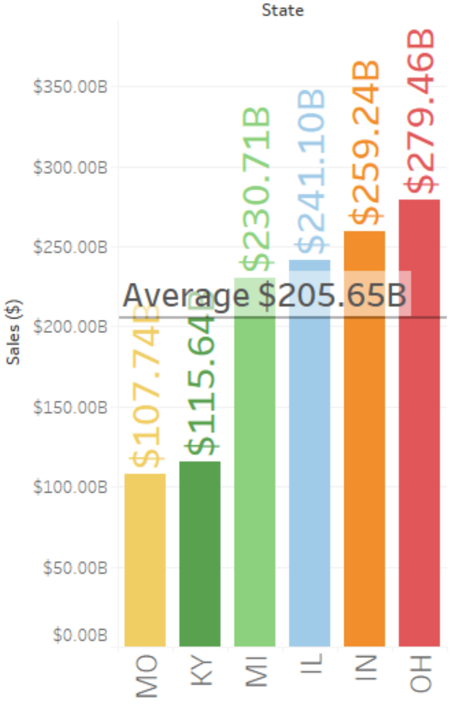
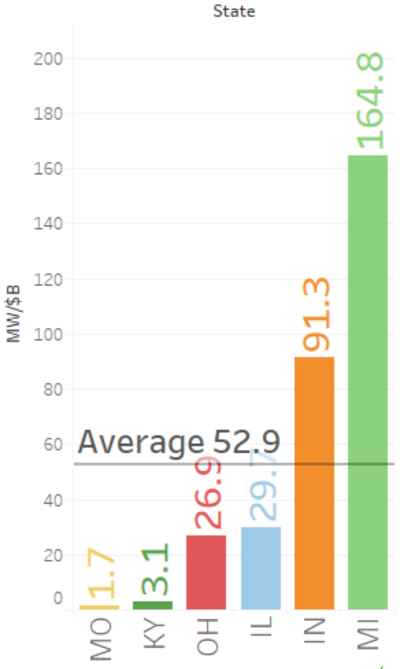
Total *Sales* across Top 10 sectors



MW/$

Total *Capacity/Sales* across Top 10 sectors



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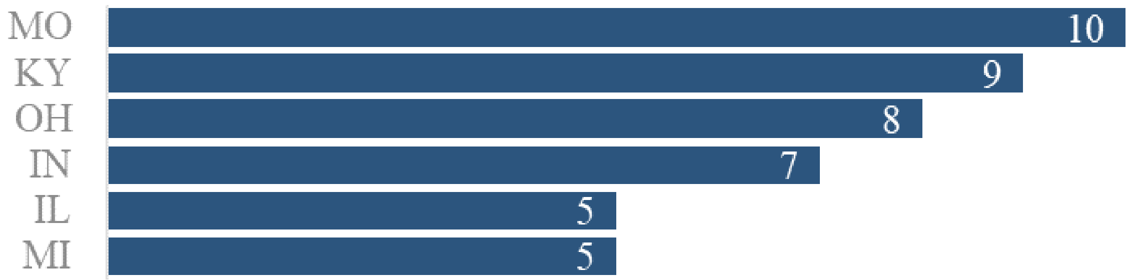
MW of *CHP Capacity* per $1B *Sales* by Subsector

NAICS code	Meaning of NAICS Code	IL	IN	KY	MI	MO	OH
311	Food manufacturing	9.50	3.31	0.07	1.46	0.00	0.02
322	Paper manufacturing	0.95	0.00	0.00	47.68	0.00	14.20
324	Petroleum and coal products manufacturing	6.71	36.97	0.00	0.00	0.00	4.81
325	Chemical manufacturing	0.75	0.53	2.29	100.70	1.72	2.26
326	Plastics and rubber products manufacturing	0.00	7.06	0.76	0.00	0.00	0.52
327	Nonmetallic mineral product manufacturing	2.82	0.00	0.00	7.68	0.00	0.00
331	Primary metal manufacturing	5.60	42.91	0.00	0.10	0.00	4.93
332	Fabricated metal product manufacturing	0.06	0.00	0.00	0.09	0.00	0.14
333	Machinery manufacturing	3.30	0.26	0.00	0.00	0.00	0.03
336	Transportation equipment manufacturing	0.00	0.29	0.00	7.05	0.00	0.00

Projections: Using Below-Average Deployment

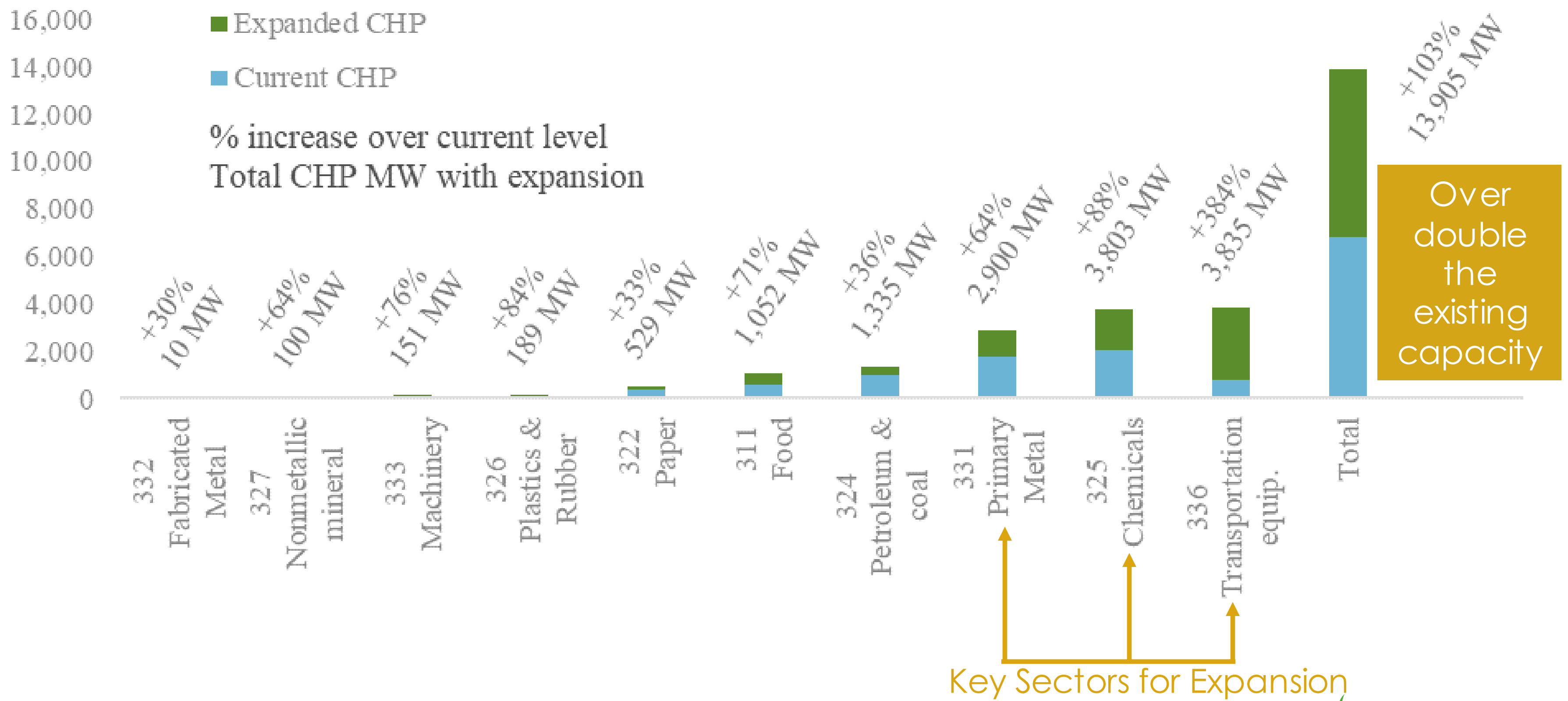
Number of manufacturing subsectors per state with below-average deployed CHP capacity for that subsector



Without trying to prescribe specific policy changes for each state, we assume in our expanded CHP scenario:

1. For each industry with CHP levels below the regional average in a given state, new CHP installations can close the gap
2. Policy drivers have been enhanced and barriers reduced

Projections



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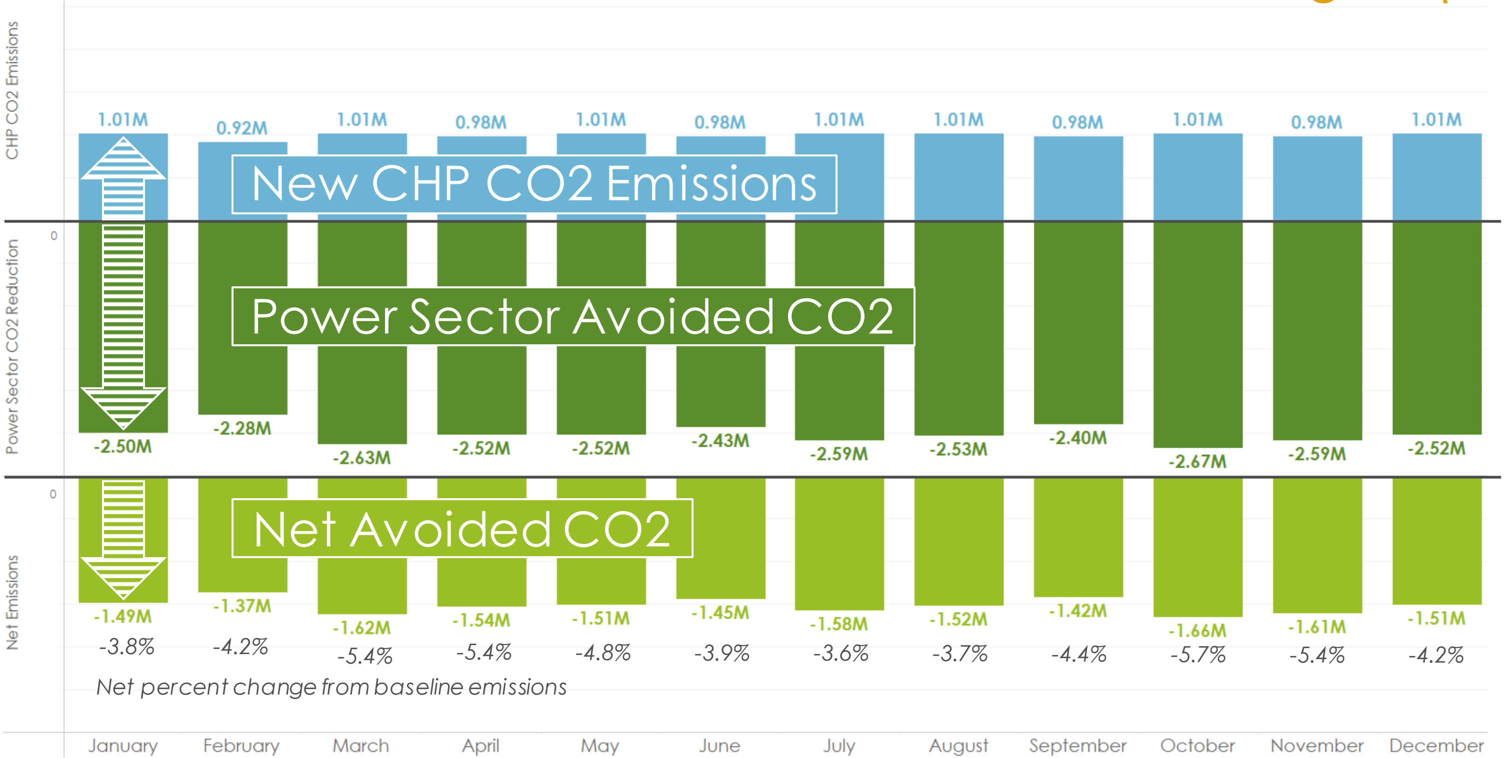
Potential GHG Savings Under Expanded CHP Scenario

Grid CO2 Emissions Reduction Across Midwest AVERT Region (tons)



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Policy Implications for CHP Adoption in the Midwest

Interconnection

- Interconnection Standards govern how CHP and other DERs can connect to the grid
- According to a DOE analysis, **Illinois**, **Indiana**, **Michigan** and **Ohio encourage CHP** through their interconnection standards, while **Kentucky** and **Missouri do not**.

Interconnection standards that **effectively promote CHP deployment** generally:

- Address larger systems
- Apply to both fossil and renewable fuels
- Include capacity tiers
- Include net metering policies
- Offer standardized application forms / contracts

Policy Implications for CHP Adoption in the Midwest

Net metering *in Studied Midwest States*

State	Net Metering Allowed for CHP?	Fuel / Size Restrictions
IL	**Yes**	Renewable Fuel / Max 5 MW
IN	No – But has feed-in tariff (FIT)	Renewable Fuel / 3 kW -1 MW
KY	**Yes**	Renewable Fuel / 30 kW
MI	**Yes**, for existing customers (Replaced with *Distributed Generation Program*)	Renewable Fuel / Customer restrictions by size
MO	**Yes**	Renewable Fuel / Max 100 kW
OH	**Yes**	Renewable Fuel / 2 MW for Microturbines

Policy Implications for CHP Adoption in the Midwest

Portfolio Standards

- Renewable Portfolio Standards (RPS) are policies implemented by states to promote the use of renewable sources of energy.

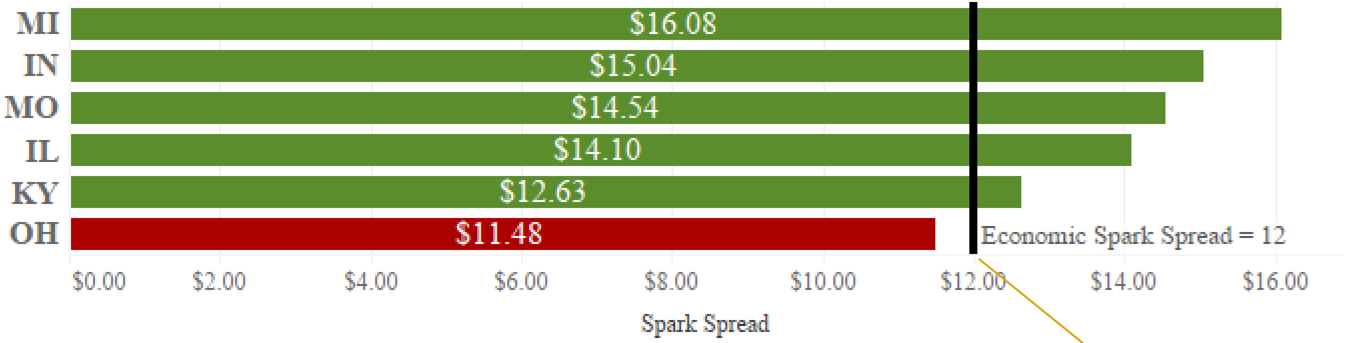
In **Illinois**, **Michigan**, **Missouri** and **Ohio**, CHP with renewable fuel can count toward RPS compliance

In **Indiana**, 30% of the voluntary renewable goal can be met with CHP that uses renewable fuel

Kentucky has not implemented an RPS or a voluntary goal

Economic Implications - Spark Spread

Difference between average annual electricity and natural gas prices ($/MMBTU) in states included in this study



A spread > $12 indicates CHP has more potential for favorable paybacks

Utility Implications for CHP Adoption in the Midwest

Rate Structures

- Utilities often implement **burdensome rate structures** for CHP customers.
  - These include **disproportionate standby rates** and **harsh penalties** for any system outages.
  - Tariffs that are poorly designed often feature **reservation fees and demand charges** that are fixed and billed based on contracted standby capacity, rather than actual usage.

Available Incentives and Funding

Federal *– Investment Tax Credit*

- Under the IRA, the Sec. 48 ITC is available for qualifying CHP systems.
- New CHP systems meeting the criteria can receive a tax credit of up to 50%.

To be eligible for the ITC, CHP projects must meet the following:
• Commence construction before January 1, 2025. • Have a maximum capacity of 50 MW or less. • Have an efficiency of 60% or more.

Available Incentives and Funding

State-level *tax incentives*

- Industrial users can secure state-level funding or tax credits to incentivize CHP implementation.

Ohio offers a tax exemption on certain CHP projects

Kentucky provides tax credits for CHP systems using renewable fuel sources

Kentucky also offers tax incentives for businesses investing in the renovation of industrial sites, which can include CHP system installation or rehabilitation

Available Incentives and Funding

***State-level** Funding: Property Assessed Clean Energy (**PACE**)*

- PACE enables industrial customers to finance energy efficiency projects, including CHP, without a significant upfront investment.
- **Illinois**, **Kentucky**, **Michigan**, **Missouri** and **Ohio** have existing legislation supporting PACE.
- **Indiana** previously provided funding for industrial CHP projects, but currently only limited state-level tax incentives or funding is available.

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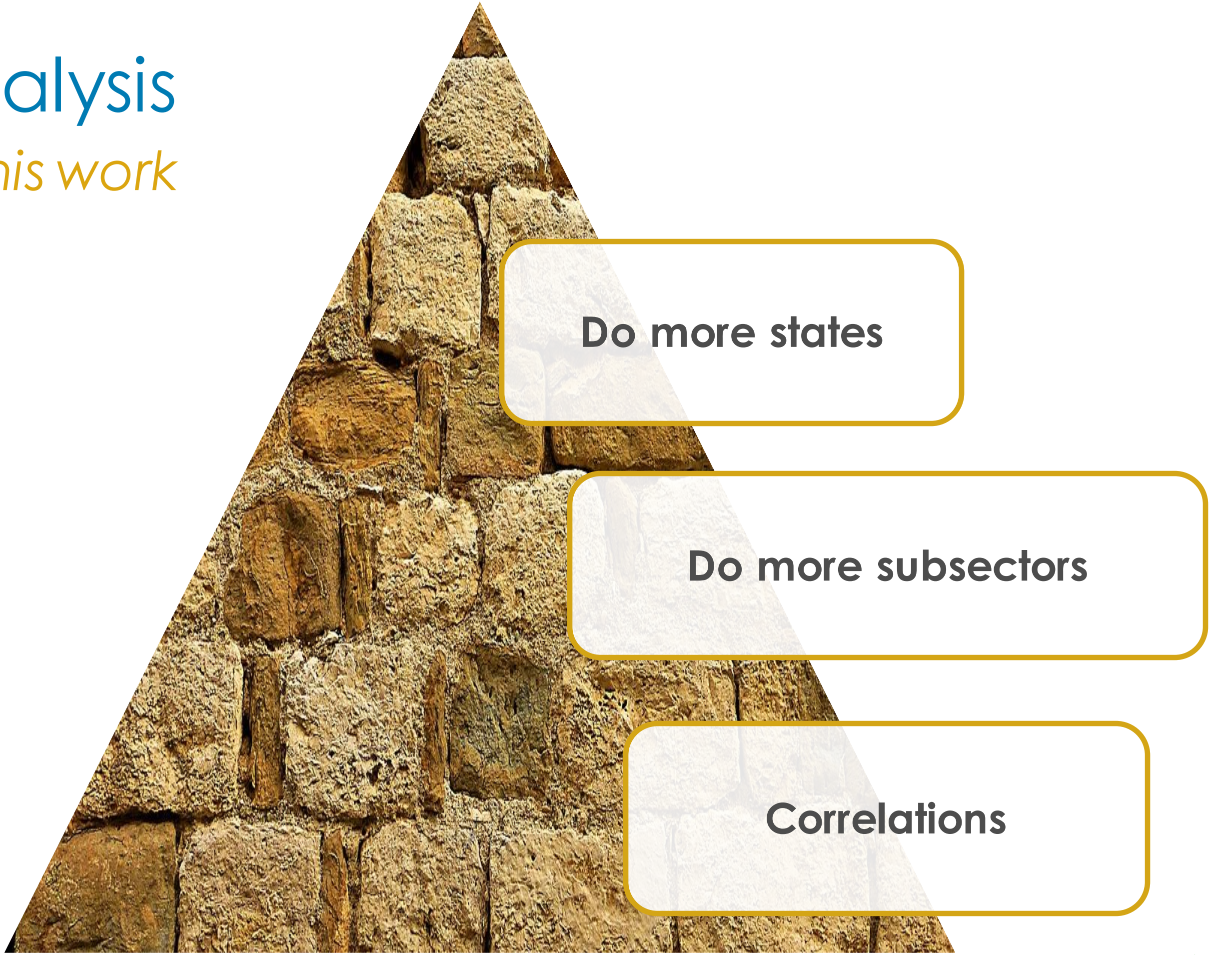
Available Incentives and Funding

Utility *Incentives*

- Utility-level incentives can also make CHP projects more appealing
- In several Midwest states, utilities offer custom incentive programs that can include compensation for CHP

Future Analysis

Building on this work



Main Takeaways

Overall, CHP capacity would **more than double** under our expansion scenario, with certain subsectors ripe for expansion.

Under the expansion scenario CHP could save the Midwest **18 million tons of CO2 annually, a 4.4% reduction** of grid-based CO2 emissions for the region.

Policy implications must be considered when undertaking a CHP project as they have the potential to impede or encourage CHP installations.

There are numerous opportunities available to **leverage utility, state, and federal incentives and funding** to enhance the economic feasibility of their projects.

Questions?

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Technical Resources Offered Through the DOE Combined Heat and Power Technical Assistance Partnership

Midwest Energy Efficiency Alliance

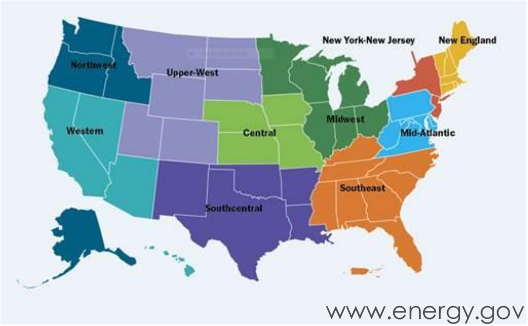
December 12 2023

Graeme Miller
Assistant Director
US DOE Midwest CHP Technical Assistance Partnership

CHP Technical Assistance Partnerships

U.S. 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

National Manufacturing Day 2019 at the University of Illinois at Chicago

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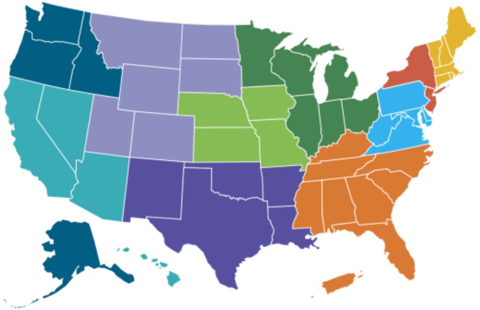

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DOE CHP TAP Technical Assistance Services and Resources

Ideal Conditions for a CHP System

1) Necessary conditions
   - ✓High electric usage
   - ✓Coincidental thermal load
   - ✓High hours of operation
2) Equipment replacement
   - ✓Older back-up generator
   - ✓ Replacing chillers
   - ✓ Replacing boilers
3) Customer motivation
   - ✓ Utility cost
   - ✓ Power reliability
   - ✓ Waste heat or biofuel untapped resource
   - ✓Sustainability & environmental
   - ✓Plans to expand facility
4) Other factors
   - ✓ EE measures already implemented
   - ✓ Centralized HVAC

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CHP TAP Role: Technical Assistance

Screening and Preliminary Analysis	Feasibility Analysis	Investment Grade Analysis	Procurement, Operations, Maintenance, Commissioning
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 Analy

- High level assessment to determine if site shows potential for CHP

- 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 Electricity, 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**

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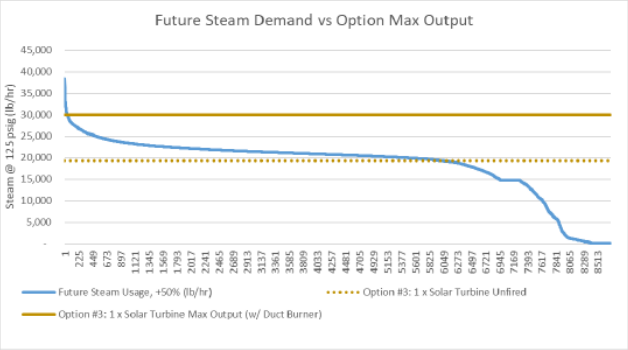
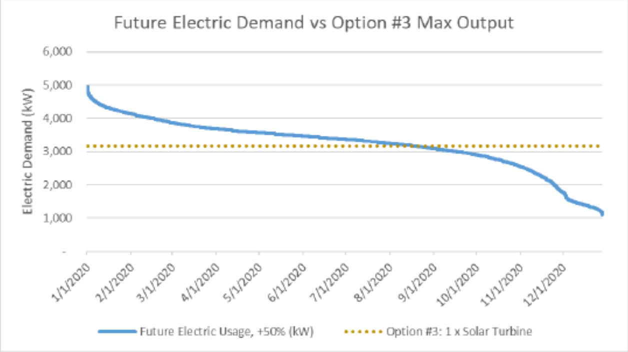
Advanced Technical Assistance Examples

- 15-Min Performance Model
- Financial Pro-Forma (NPV, ROI, etc.)
- GHG Analysis
- Utility Rate Analysis (Standby Rates)
- Thermal use determination (what to do with the heat)
- Installation cost estimation (Equipment Budgetary Pricing)
- Biogas Analysis (Cleanup Equipment Required)
- RFP/RFQ Assistance
- 3rd Party Review
- Other, as-needed analysis

Advanced Technical Assistance Examples





COST CATEGORIES:		
Equipment Costs:	Source	
Centaur 40 SoLoNOx Turbine Generator Set	Solar Turbines	$ 2,900,000
Heat Recovery Steam Generator with ductburners	Solar Turbines	$ 1,828,700
Electrical Equipment	Solar Turbines	$ 904,500
Fuel Gas Compressor	Solar Turbines	$ 654,500
Deaerator	Solar Turbines	N/A
Building Work	EPA Estimate	$ 438,500
Total Equipment Cost:		$ 6,726,200
Construction Costs	EPA Estimate	$ 2,204,000
Total Installed Costs		$ 8,930,200
Other Costs:		
Commissioning Parts and Site Tes	Solar Turbines	$ 205,200
Project Management	Solar Turbines	$ 250,000
Shipping	Solar Turbines	$ 143,800
Balance of Plant Contingency	Solar Turbines	$ 247,900
Development Fees	EPA Estimate	$ 652,800
TOTAL PROJECT COSTS		$ 10,429,900

1xSolar Centaur 40 Turbine Financial Pro-Forma	
Financial Results:	
Equity Contribution: 100%	$10,429,900.00
INSTALLED COST $/KW	$3,129
Return on Equity	1.26%
Discount Rate	7%
Net Present Value over 80,000 Hours	($2,168,308.56)
Simple Payback, Years (without incentives)	10.52

	Option #3 CHP Estimated Annual Emissions
3,159	CHP Net Capacity, kW
23,758	CHP Electricity, MWh
158,448	CHP Thermal used, MMBtu
369,005	CHP Fuel input, MMBtu
15.5	System Fuel Use, MMBtu/MWh
8.0	Displaced Boiler Fuel, MMBtu/MWh
1816	CHP Gross Emissions Factor - CO_2, lbs/MWh
876	**CHP Net Emissions Factor - CO_2, lbs/MWh**
20,820,390	CHP Net Emissions - CO_2, lbs
1566	**Ohio Grid Marginal Emissions Factor - CO_2, lbs/MWh**
(16,381,727.22)	CHP Net Emissions Reduction - CO_2, lbs
(8,190.86)	CHP Net Emissions Reduction - CO_2, tons

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Summary

- CHP can provide lower operating costs, reduced emissions, increased energy reliability, enhanced power quality, and reduced grid congestion
- The Midwest CHP TAP can provide technical assistance to help your facility explore CHP solutions
- The program is evolving in 2024 – stay tuned!

Questions

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CHP Technical Assistance Partnerships

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