Industrial Decarbonization Peer Exchange

April 17th, 2024

Better Buildings, Better Plants Summit

[Congratulations 2023 goal achievers]

[Congratulations Better Project and Better Practice Award Winners]

Better Plants Bootcamps

Energy Bootcamp

Crash course in industrial energy system fundamentals, energy management, and industrial decarbonization

The next Energy Bootcamp is **May 13 - 17** at Oak Ridge National Laboratory

Last day to register is **April 29th**

Register here!

If you are interested in participating please contact the following individuals:

- Jennifer Travis (travisjm@ornl.gov)
- Wei Guo (guow@ornl.gov)
- Thomas Wenning (wenningtj@ornl.gov)

In-Plant Trainings (INPLTs)

Host Plant Name / City, State	Energy System Type	Date
PepsiCo / Charlotte, NC	Treasure Hunt Exchange	April 23-25, 2024
Leggett & Platt / High Point, NC	Treasure Hunt Exchange	April 28-30, 2024
Legrand North & Central America / Kenosha, WI	Process Heating	May 7-9, 2024
Owens Corning / Newark, OH	Water Efficiency	May 7-9, 2024
Leggett & Platt / Tupelo, MS	Treasure Hunt Exchange	May 19-21, 2024
Lockheed Martin / Owego, NY	Compressed Air	May 21-23, 2024
PepsiCo / Lynchburg, VA	Treasure Hunt Exchange	June 11-13, 2024
Lear Corporation / Southfield, MI	50001 Ready	May 7-9, 2024
Quanex Custom Components / St. Cloud, MN	Treasure Hunt	Aug 12-15, 2024
Saint-Gobain Corporation / Shreveport, LA	Process Heating	June 4-6, 2024
Stryker / Mahwah, NJ	Treasure Hunt	TBD

Next Round In-Plant Training Application Due May 6th

Better Plants and Better Climate Challenge Data

Better Plants® U.S. DEPARTMENT OF ENERGY

Submit energy data to TAMs
Reporting deadline May 31st

Better Climate CHALLENGE™ U.S. DEPARTMENT OF ENERGY

Submit your GHG emissions data to TAMs by May 1st (if assistance needed)
Reporting deadline May 31st

Virtual In-Plant Training

Industrial Water Efficiency

May 21, 2024 to July 9, 2024

Participants will be trained on water system fundamentals and undertake a facility-level water assessment, including hands-on training on the Plant Water Profiler (PWP) tool

If you or your colleagues are interested in participating in the training, please register here.

Questions? Contact Wei Guo (guow@ornl.gov)

Tools and Resources for Electrification
ORNL and EPIXC

Speakers

Dr. Michael Baldea,

Professor at University of Texas Austin

EPIXC

mbaldea@che.utexas.edu

Kiran Thirumaran

R&D Assistant Staff

Oak Ridge National Lab

thirumarank@ornl.gov

Poll Question #1

Poll Question 2

Poll Question 3

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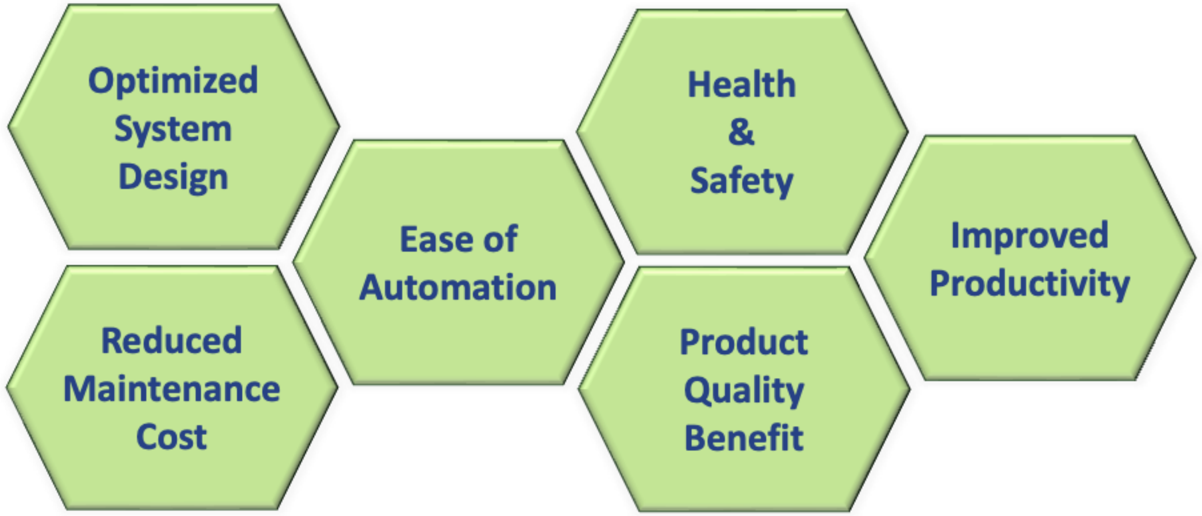
U.S. DEPARTMENT OF ENERGY

Why Electrification?

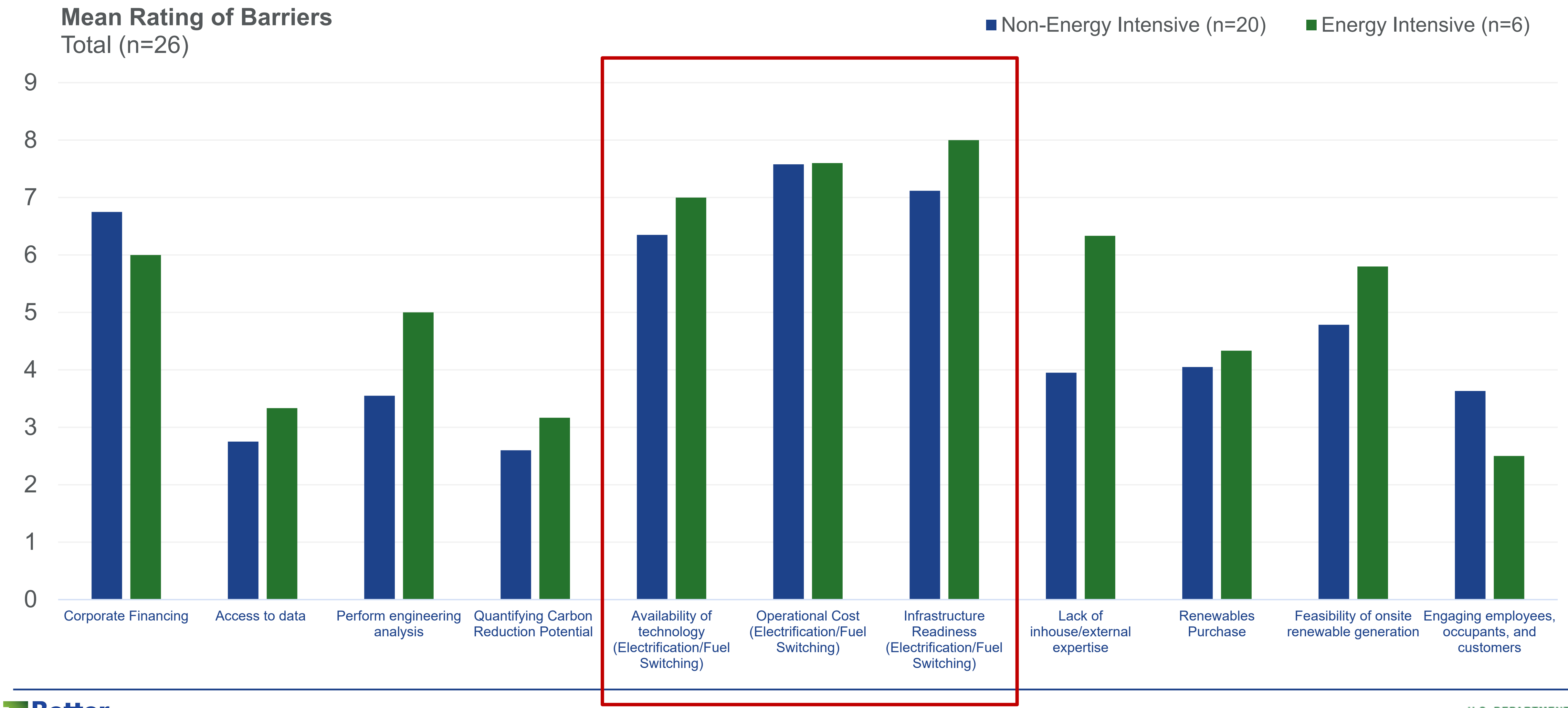
While decarbonization is a major driver for electrification, it is just one of the many benefits

- Productivity
- Product Quality (Scrap & Repair)
- Process Flexibility
- Up-time
- Labor Cost
- Capital (Equipment & Inventory)
- Product Features & New Products
- Health & Safety
- Environmental



Summary of electrified technologies. Data Source: AMO Process Heating Sourcebook. Improving Process Heating System Performance: A Sourcebook for Industry. U.S. Department of Energy 2015

Barriers to Electrification



Electrification Assessment Framework

Developed through collaborative discussions within Better Climate Challenge partners as part of the Industrial Electrification working group held from August 18, 2022, to June 1, 2023.

ESTABLISH INVENTORY AND ENERGY USE

Estimating baseline energy use and emissions breakdown for each existing fuel fired system

ASSESSING FACILITY'S ELECTRIFICATION READINESS

Involves evaluating a facility's electric distribution infrastructure to determine its suitability for electrification projects.

IDENTIFYING STRATEGIES FOR ELECTRIFICATION

Identifying appropriate Electrotechnology for each fuel fired application at the facility.

EVALUATING AND IMPLEMENTING PROJECTS

Evaluating the electrification projects in a holistic manner to determine its impact.

1.) Establish Inventory and Energy Use

Understanding the existing fuel-fired systems can help better plan for electric transition

1. Inventorying
   - Identifying existing system at the facility
   - Determining key design and operational parameters

2. Establishing Energy Use (Baseline)
   - Metering and Submetering
   - Engineering estimates based on burner size and load fact
   - Utility Bill Analysis
   - Understanding the load profile
   - Regression

3. Establishing Energy Use (Post Electrification)
   - Determining additional Electric Load
   - Determining impact on cost and emissions

Inventorying – Example

Equipment Name / ID	Install Date	Installed MMBTU/ hr	Typical operating hours	Operating Temperature	Load Factor	Fuel Used	Estimated yearly MMBTU (gas)	Baseline Systems Efficiency	Expected Electric System Efficiency	System Size/Added kW Demand	Additional Amps Required (at 480V and 0.8 pf)
Furnace 1	2021	1.2	8,760	1700	42.00%	Natural Gas	4,415	0.5	0.75	**185**	**279**
Heat Treat Furnace 2	2010	3.5	1,664	1200	44.04%	Natural Gas/ Propane	2,565	0.6	0.75	**648**	**975**
Gas Generator	2011	1.6	1,664	1900	44.10%	Propane	1,174	0.8	0.95	**395**	**594**
Drying Ovens	2010	1.5	3520	400	76.00%	Natural Gas	4,013	0.8	0.95	**370**	**557**
			Total				**12,167**			**1,598**	**2,405**

Note that this is first would be first order estimation and the actual increased demand with electrification will demand on multiple factors including the technology implemented, size and efficiency of the new system etc.

Can be used to evaluate facilities infrastructure requirement

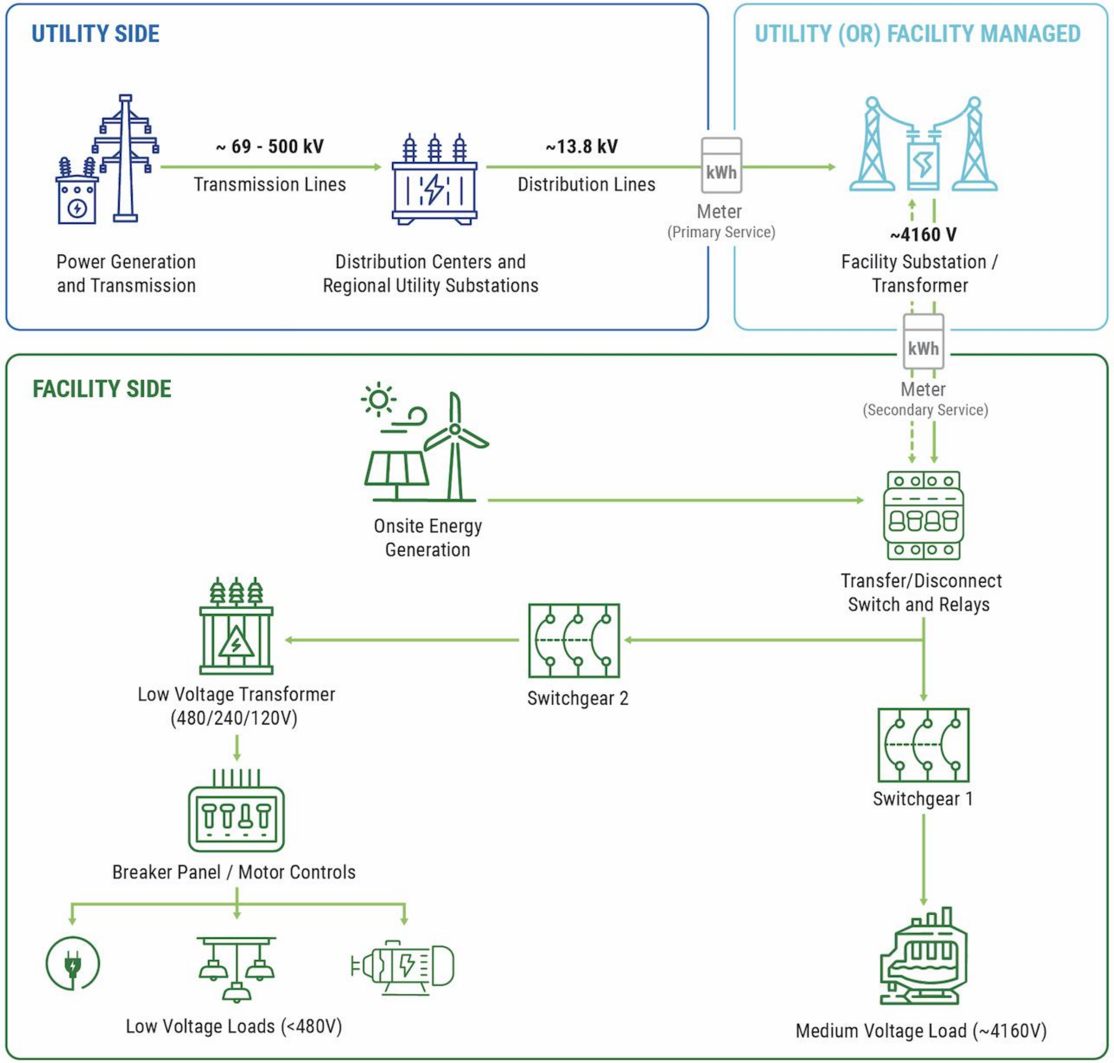
2.) Assessing Utility Side and Facility Side Infrastructure

Major Components

- Substations transformers used to step down transmission voltage and associated feeders
- Facility owned transformers to step down voltage at the plant
- Switchgear, motor control centers and control panel used to distribute power throughout the plant
- Electric load

Actionable Items

- Assessing distribution feed from one line diagram
- Discuss with the utility representative to understand the substation and feeder capacity to serve facility loads



3.) Identifying Strategies for Electrification

Studying existing process heating application and its operational demands can help identify the ideal technology pathways to investigation

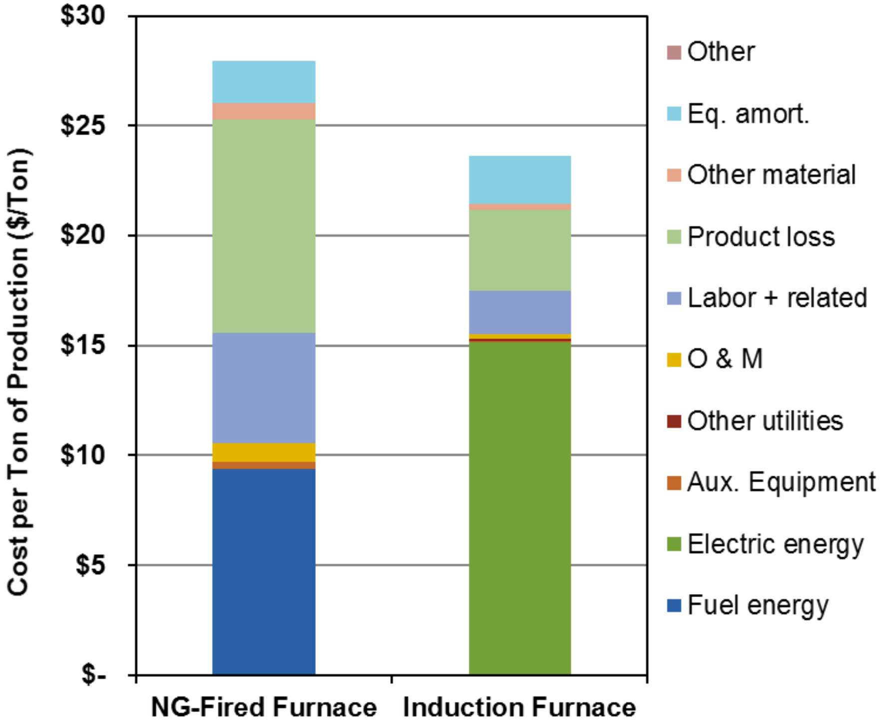
Thermal process	RH	IH	EAH	EIP	MWH	RFH
Fluid heating	■	■		■	■	
Steam generation	■					
Metal heating	■	■		■		
Metal melting		■	■			
Metal heat treating	■	■		■		
Smelting, agglomeration etc.	■					
Nonmetal heating, heat treating					■	■
Nonmetal melting	■	■				
Calcining	■				■	■
Drying	■			■		
Curing and thermal forming	■	■		■		■
Thermal reactors	■	■		■	■	
Other heating	■	■		■	■	■

RH: Resistance Heating, IH: Induction Heating, EAH: Electric Arc Heating, EIP: Electric Infrared Processing, MWH: Microwave Heating, RFH: Radio Frequency Heating

Technology	Considerations
Resistance Heating	• Requires a traditional mode of heat transfer (conductive or convective) • Not very efficient (comparatively) for large applications
Electric Infrared Heating	• Required "line of site" to operate – not suitable for complex shapes • Cannot be used if the atmosphere contains gases, hazardous vapors
Induction Heating	• Material must be conductive • Production size - small production runs are not ideal • Requires high voltage power
Microwave Heating	• Suitable material coupling with microwave • Material's sensitivity to rapid heating

4.) Evaluating and Implementing Projects

While decarbonization is a major driver for electrification, it is just one of the many benefits - Evaluation of an electrification project should involve consideration of all relevant co-benefits



From case study on NG-Fired Furnace vs Induction Furnace in a Forging Plant

Some Unique Considerations when implementing electrification projects

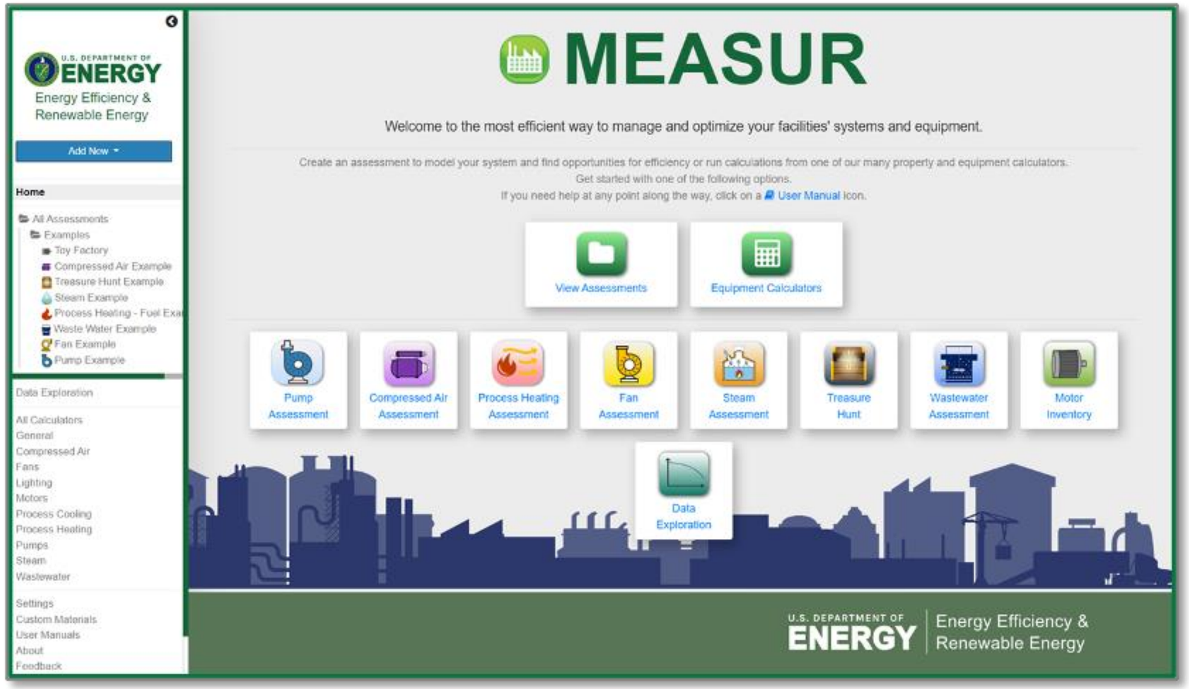
1. System design and testing
2. Auxiliary Infrastructure Upgrades
3. Optimized Operations
4. Energy Reliability
5. Workforce Education

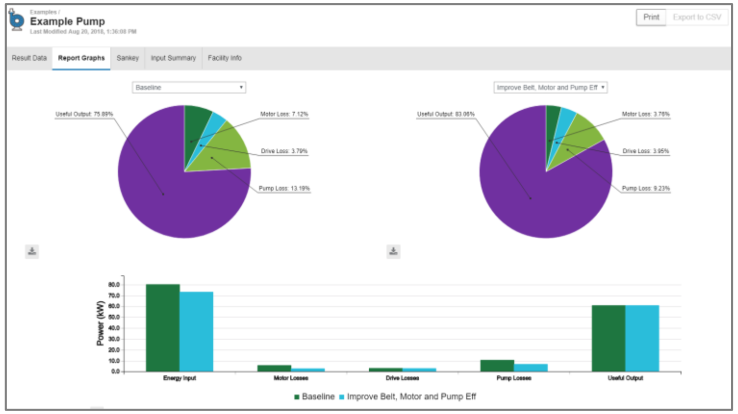
DOE Resources for Industrial Electrification

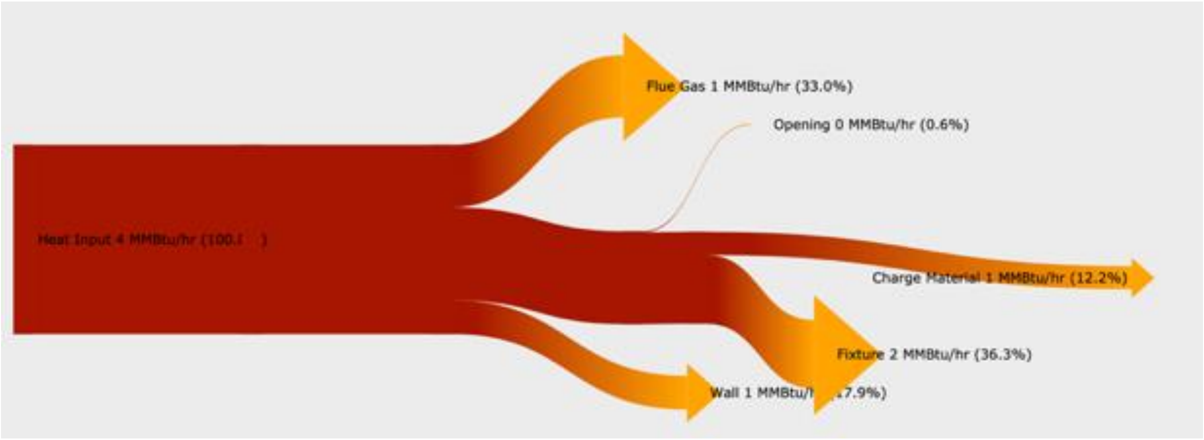
Available Tools: MEASUR

Model existing process heating systems

https://measur.ornl.gov/landing-screen

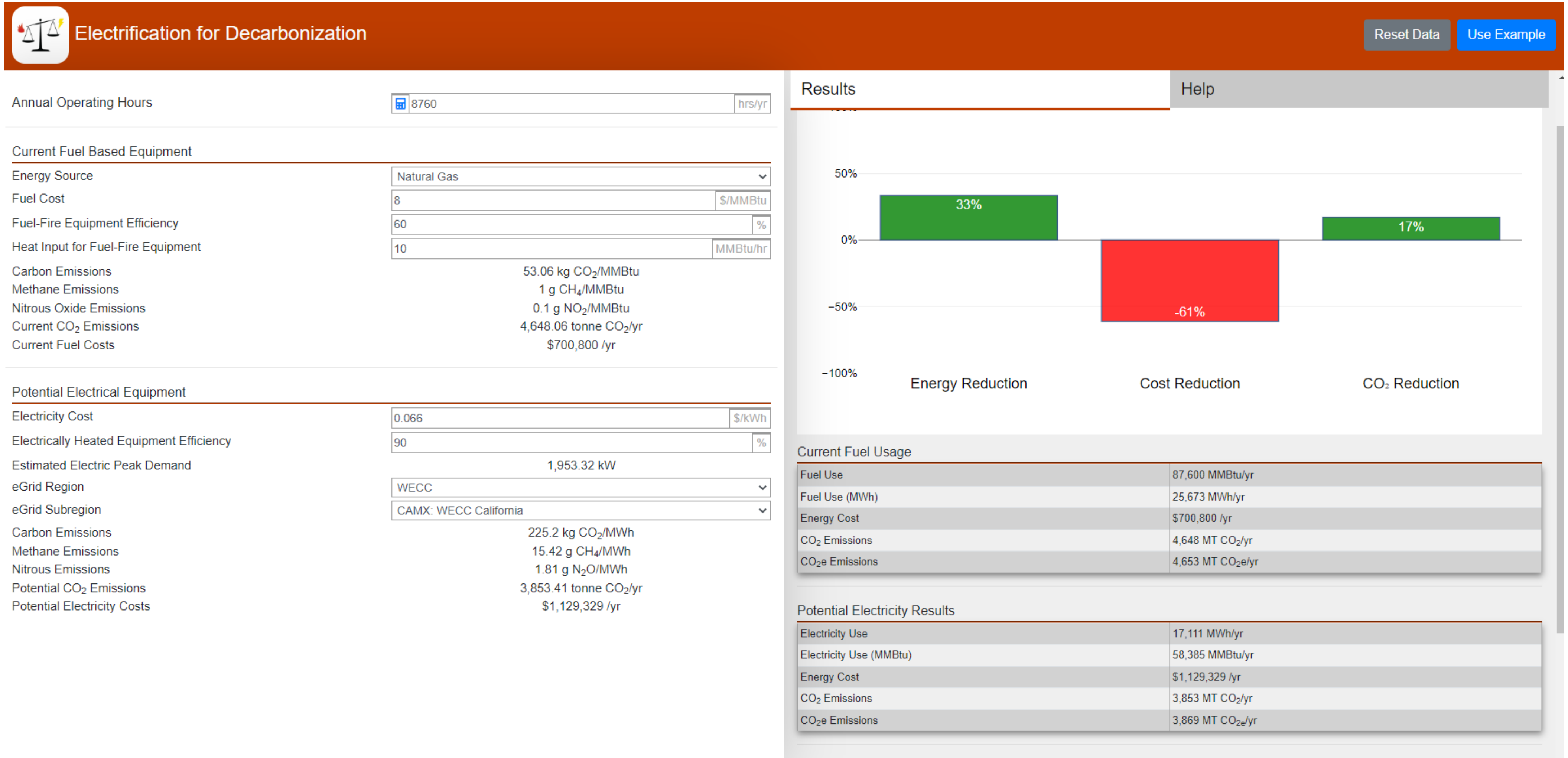






Available Tools: Electrification for Decarbonization Tool

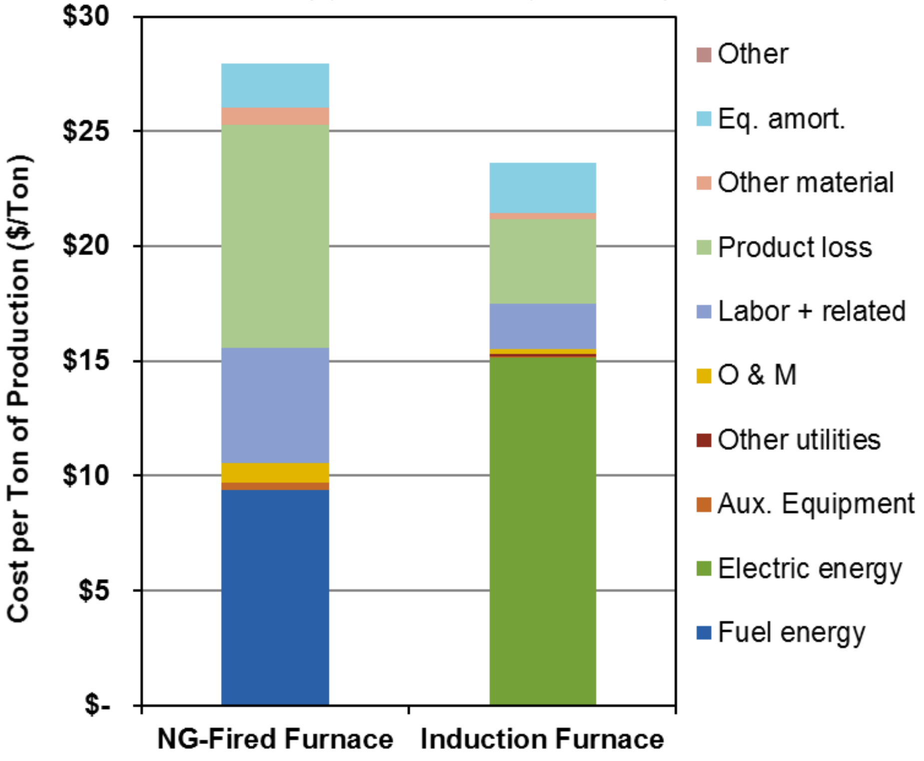
Determine location-based emissions reduction. Available at https://electrification.ornl.gov/



Available Tools: Cost Comparison Calculator

Calculate holistic cost of switching to electrotechnology

https://energyefficiency.ornl.gov/tools-training/



Cost Modelling comparing NG-Fired Furnace vs Induction Furnace in a Forging Plant

Electrotechnology vs Fuel Fired Thermal Processing Cost Comparison Model

Developed by E3M Inc. under contract with Oak Ridge National Laboratory

Overview of Process Heating Systems

Control Page

Items	Instruction
Guide - Instructions	Guidance on using the tool
Cost Comparison Calculator	Main input page for the tool
Other Impacts	Qualitative Analysis of impacts to the facility and product

Supporting Calculators

Energy Use	The "Supporting Calculators" are provided to help estimate the various components of the inputs, used in the analysis The user may choose to use these calculator as required The "Supporting Calculators" can also be accessed directly from the "Comparison Calculator" page
Maintenance Cost	
Auxiliary Equipment	
Other Utilities	
Other Materials Cost	
Labor Cost	
Water Use Module	

Cost Report

Resources being built

The Electrification Assessment Framework

A comprehensive guide to identifying, evaluating and implementing electrification opportunities in a manufacturing facility

System Specific Scoping tools

Helps users take the “first step” to understand the scope/opportunity for specific electric technologies (Heat Pumps) at your facility

Checklist for Facility Readiness

Helps users assess a facility’s preparedness to integrating electric technologies. Checklist format with questions related to power threshold, electric infrastructure, utility rates, workforce availability

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Facility Level Electrification Assessment Framework

Table of Contents

Guidance and templates to support a facility level electrification planning

Electrification Readiness Worksheet

Assessing Facility's Transformer Capacity		
Transformer ID		**Facility Transformers:** Industrial facilities typically have one or more dedicated transformers that step down the voltages from 12.47 kV to 4,160 V (medium) or 480 V (low). The number of feeder circuits available, its maximum capacity, and present load will determine the hosting constraints at these facility transformers. **[1] Primary and Secondary Service:** Depending on the contractual agreement with the utility, these transformers can be owned and maintained either by the utility or the facility. The type of service is also typically dictated based on this ownership of these assets. Depending on the size of the electrification opportunity at the site, understanding existing utility agreements and potentially re-negotiating them becomes critical. **[2] Transformer Lifespan:** The age of the transformer can help determine if is close to its end of life and if a replacement/upgrade is warranted. The typical lifespan of a transformer can vary depending on factors such as its type, usage conditions, and maintenance. General-purpose dry-type transformers typically last more than 25 years, Oil-filled transformers have a typical lifespan of around 20-30 years. **How to collect data?** The transformers and other electrical components on the facility's electric distribution side can be evaluated by reviewing the facility's one-line electrical diagram and as part of a scheduled arc flash study. It is to be noted that in the rated capacity can be represented in kVa (apparent power) in cases as opposed to kW (real power). kW can be calculated from kVa using the formula: kVa = kW × power factor. Power factor can be assumed to be 0.7-0.8 if not known.
What is the type of service from the utility[1]	Primary/Secondary	
Is the transformer nearing the end of its lifespan?[2]	Yes/No	
What is the primary and secondary voltage at the transformer?	V	
What is the total capacity of the facility transformer?	(a) kW	
What is the present peak load on the transformer?	(b) kW	
B1. Total Additional Capacity Available at the Facility Substation: [(a)- (b)]	kW	
Transformer ID		
What is the type of service from the utility[1]	Primary/Secondary	
Is the transformer nearing the end of its lifespan?[2]	Yes/No	
What is the primary and secondary voltage at the transformer?	V	
What is the total capacity of the facility transformer?	(a) kW	
What is the present peak load on the transformer?	(c) kW	
B2. Total Additional Capacity Available at the Facility Substation: [(a)- (b)]	kW	

Electrification Readiness Report

Expected Power Demand Increase from Electrification - Identified from Inventorying

Process Heating Equipment	Expected Demand Increase	Priority Rating	HVAC Equipment	Expected Demand Increase	Priority Rating	Warehouse Utility Vehicles (UTV)	Expected Demand Increase	Priority Rating
Equipment 1			Equipment 1			Equipment 1		
Equipment 2			Equipment 2			Equipment 2		
Equipment 3			Equipment 3			Equipment 3		
Equipment 4			Equipment 4			Equipment 4		

Capacity Availability - Identified from Electrification Readiness Evaluation

Capacity Available at the Site This is based on the capacity available at the Switchgears		*From result C1 in the Electrification Readiness Worksheet*
Potential Capacity with Facility Level Upgrades This is based on the capacity limitation at the facility transformers		*From result B1 and B2 in the Electrification Readiness Worksheet*
Potential Capacity with Utility Upgrades This is based on the capacity limitation at the utility		*From result A1 in the Electrification Readiness Worksheet*

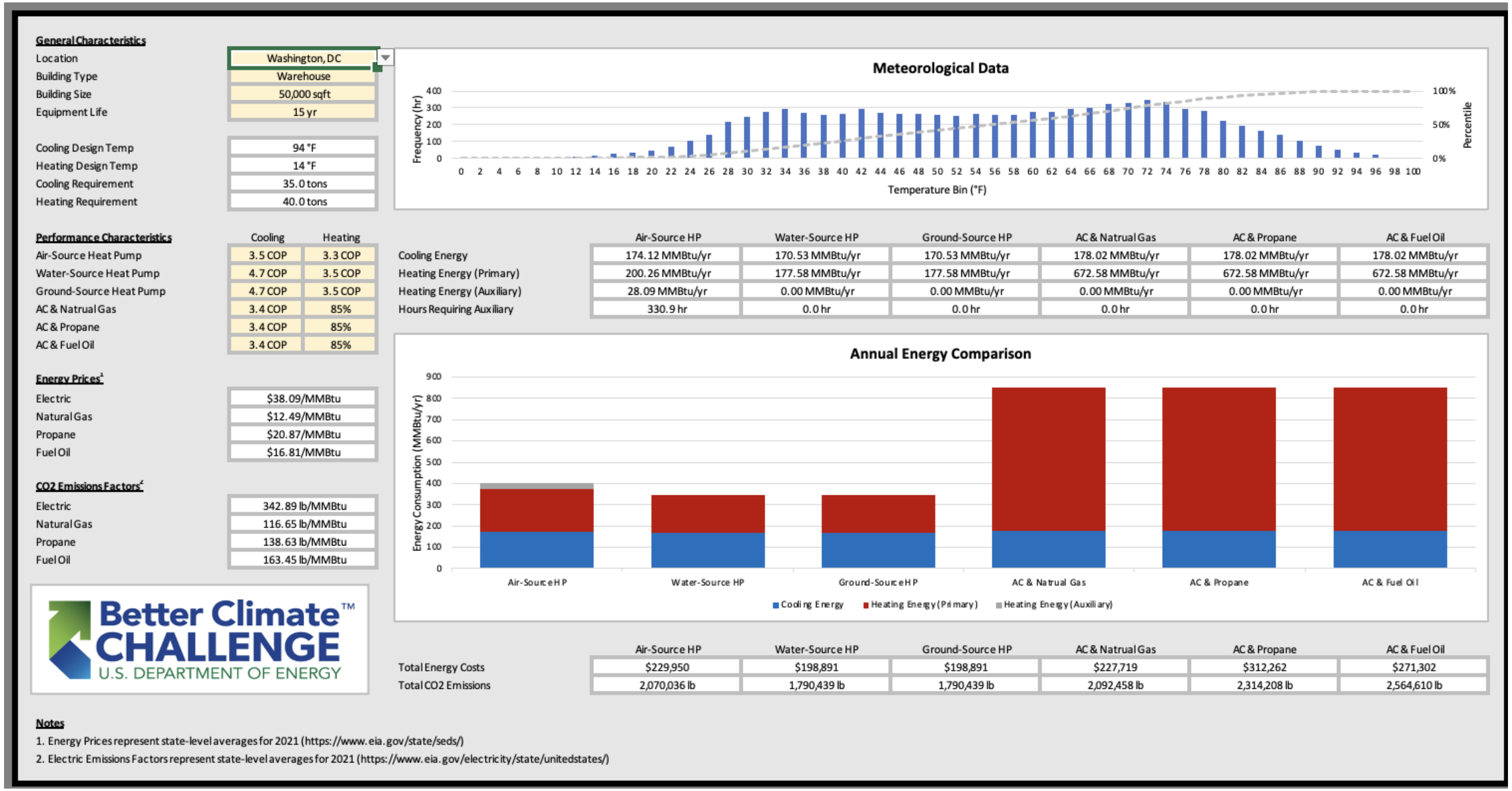
Electrification Plan

Projects/Activities (near term)	Projects/Activities (midterm)	Projects/Activities (long term)
•	•	•

Following consideration can help build an effective electrification plan.

- Projects are categorized into the appropriate timeframe by comparing the increase in electric demand with electrifying individual electric equipment with the capacity available. For competing projects, the system's priority rating can be considered.
- Near term projects can be implemented with the additional capacity available at the site while midterm and long-term projects have capacity demand higher than what is available at the facility transformers and/or utility substation.
- Re-evaluate the plan when significant changes occur within the facility, such as expansion, upgrades, or shifts in operational priorities.

Heat Pump for HVAC



Tool Inputs

- Location (decimal degrees)
- Building Type
- Building Area (sqft)
- Baseline Equipment and Fuel
- Efficiencies

This tool estimates energy and CO_2 emission savings for various electric, natural gas, and propane HVAC equipment.

Can ideally be used as a high-level screening tool to understand HP application for a region or a facility

Thank you!