Better Plants®
U.S. DEPARTMENT OF ENERGY

# DOE Energy Management Tools

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# DOE Industrial Software Tools

- Help energy and sustainability teams identify, understand, and identify opportunities for energy and emission savings in their operations.

## Energy Systems

MEASUR
Electrification for Decarbonization
Compressed Air Scoping Tool

## Energy Management

VERIFI
50001 Ready Navigator
Energy Footprint Tool
Plant Energy Profiler
Implementation Guidance Toolkit

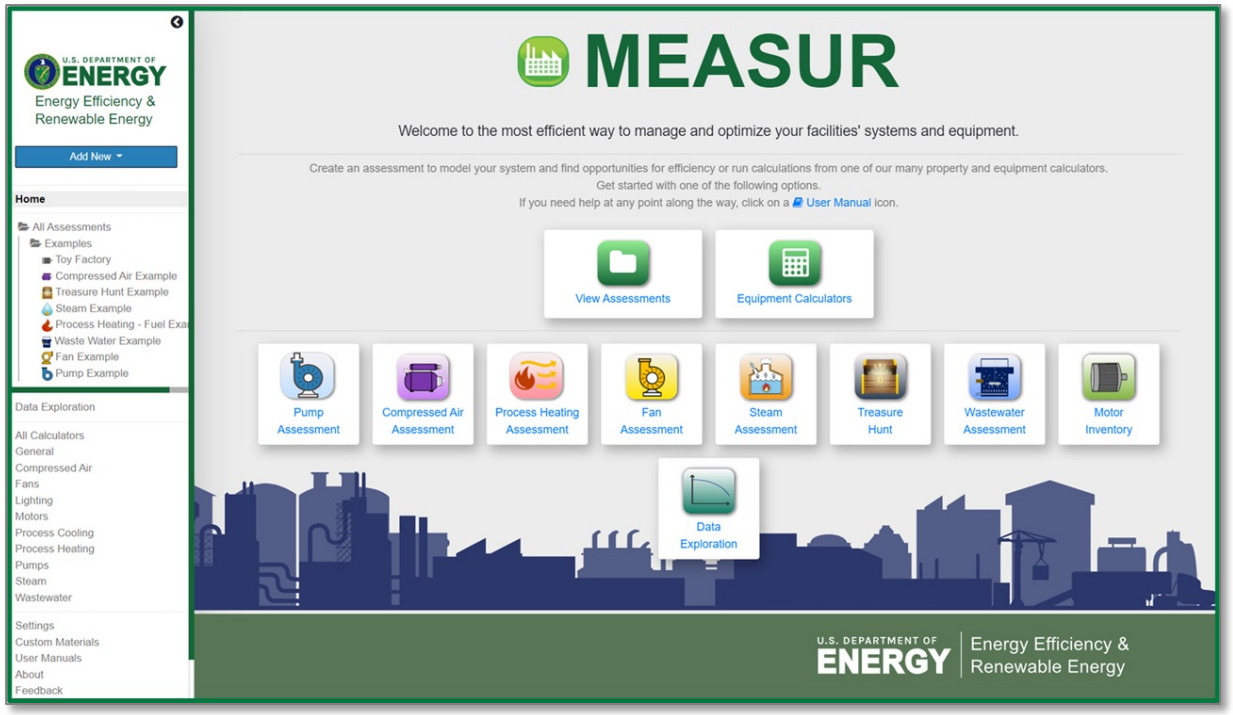
## Carbon, Water, & Waste

Plant Water Profiler
Plant Carbon Footprint &
Decarbonization Assessment Tool
Carbon Emissions Calculator
Waste Stream Energy Content

# MEASUR

## Helps identify, assess, and quantify energy savings and decarbonization opportunities in their manufacturing operations and energy support systems.

- Energy savings analysis
  - Open source
  - Cross-platform tool
  - Technology and vender agnostic
- Key User Features
  - Similar workflow for all assessment modules
  - Graphs & Figures!
  - Easy unit system switching and translation functionality
  - Accessible help text and examples

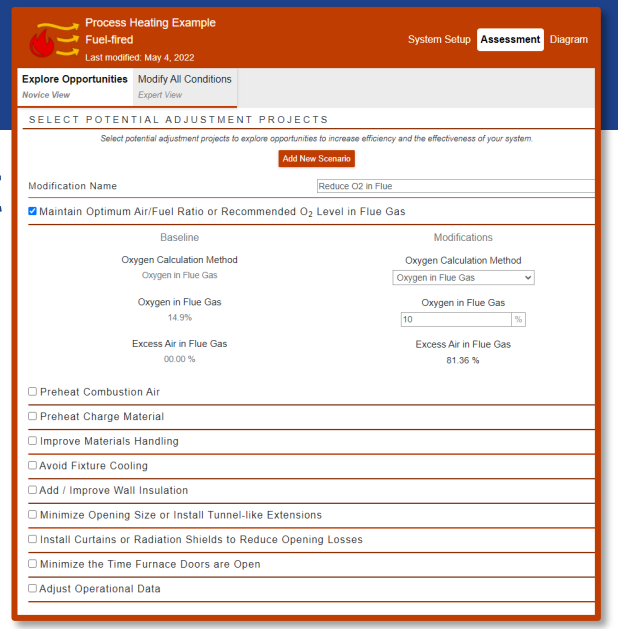


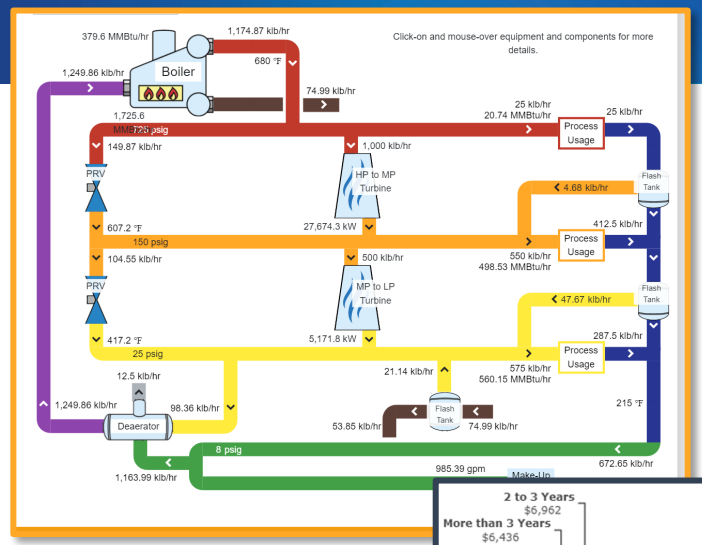

Find this tool at
https://measur.ornl.gov
https://www.energy.gov/eere/amo/measur

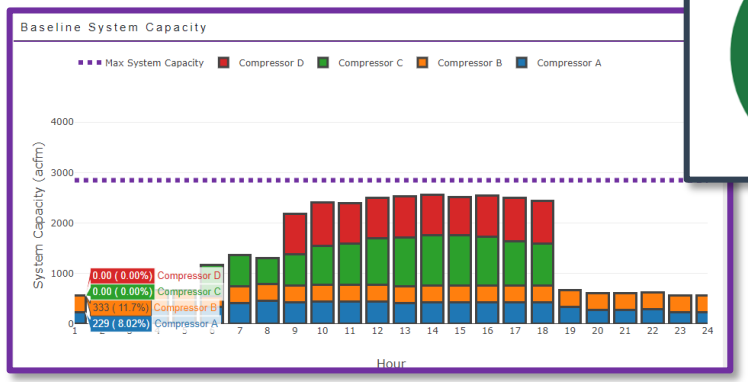
# MEASUR

Has 7 industrial system assessment modules, plus equipment inventory and data analysis modules, and over 70 standalone calculators!

- Assessment Modules
  - Pumps, Fans, Process Heating, **Compressed Air,** Steam, **Wastewater**, and Treasure Hunt
  - Baseline and What-if Analyses (Novice & Expert Views)
  - Explore energy, cost, and **carbon emissions** impact of projects
- Other Modules
  - **Motor Inventory** (others coming soon)
  - **Data Analysis** (day type & visual analyses)



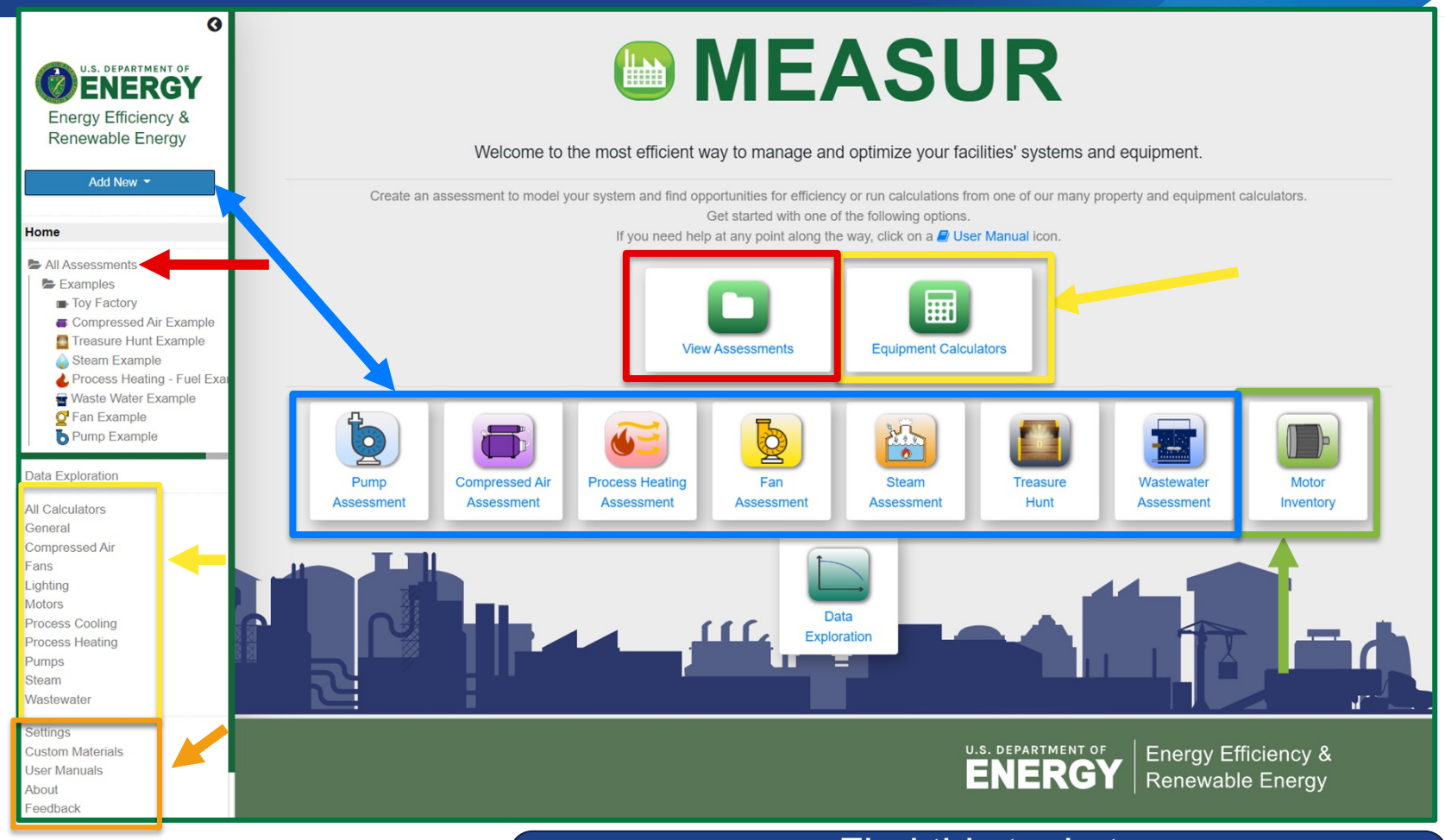






Find this tool at
https://measur.ornl.gov
https://www.energy.gov/eere/amo/measur

# MEASUR – Getting Started

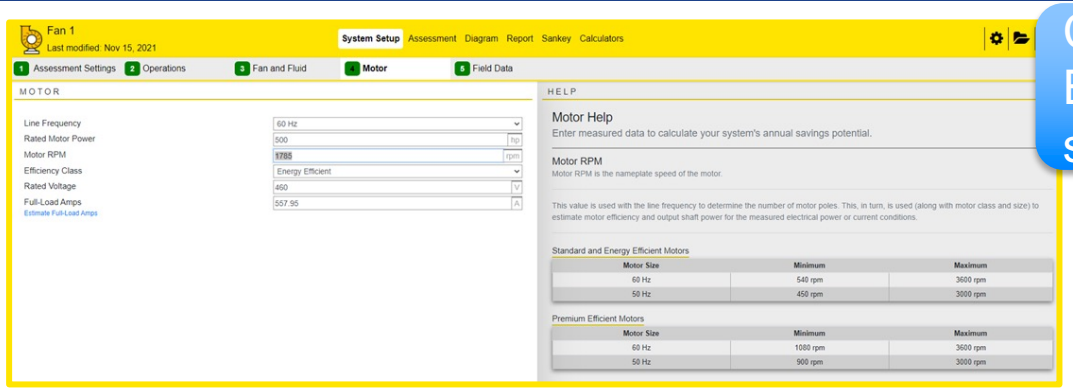
- Start an assessment
- Create an inventory
- View Assessment Dashboard
- Use Properties & Equipment Calculators
- Help and User Experience
  - Change Settings
  - View Tutorials
  - Manage Custom Materials
  - Provide Feedback
  - Translate




Clearing your browser cache DELETES online assessments

Find this tool at
https://measur.ornl.gov
https://www.energy.gov/eere/amo/measur

# MEASUR - Assessments

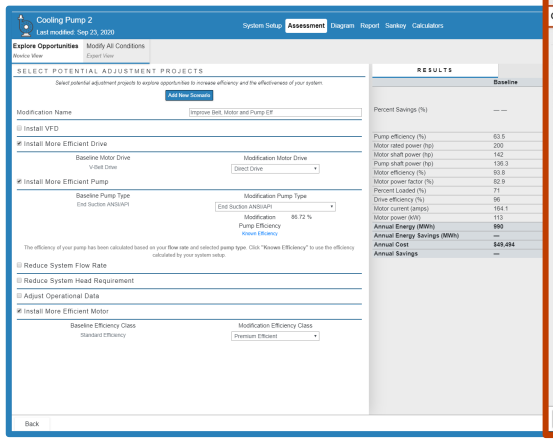


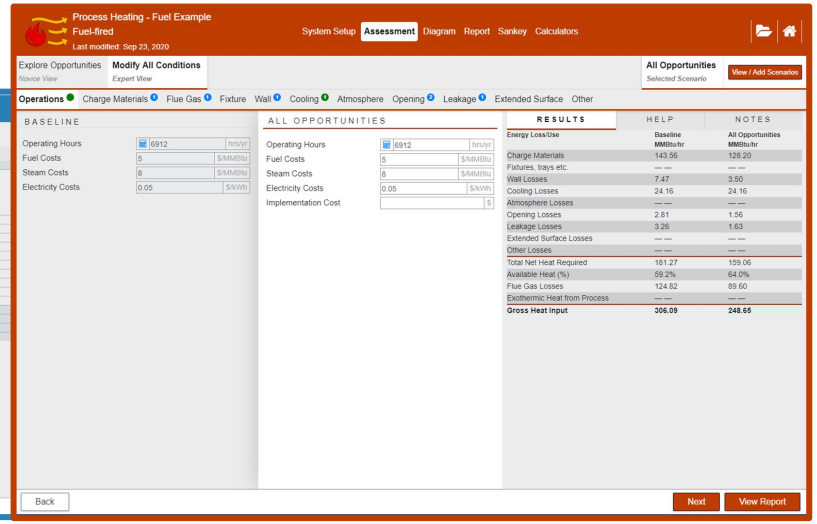

Create a baseline
Enter data about current system setup

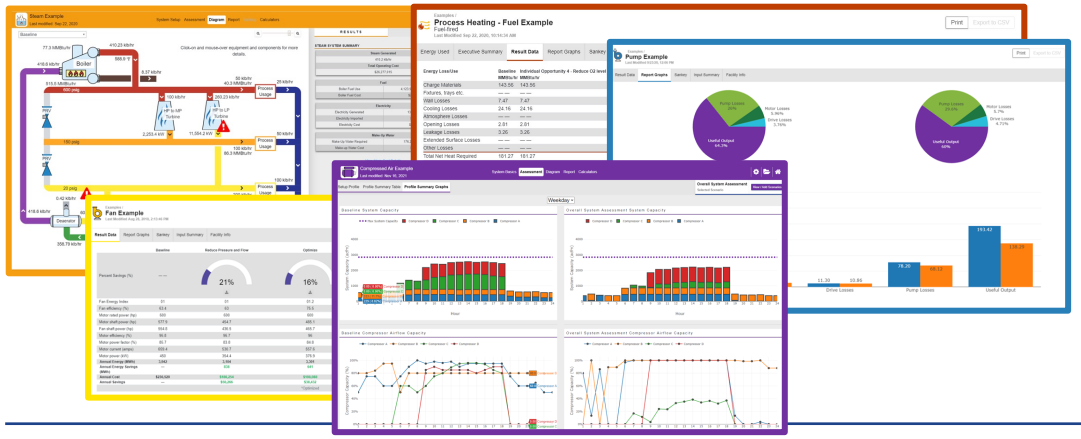
1

Create an assessment
Modify key variables to create
What-if scenarios and compare

2




Review Results

3

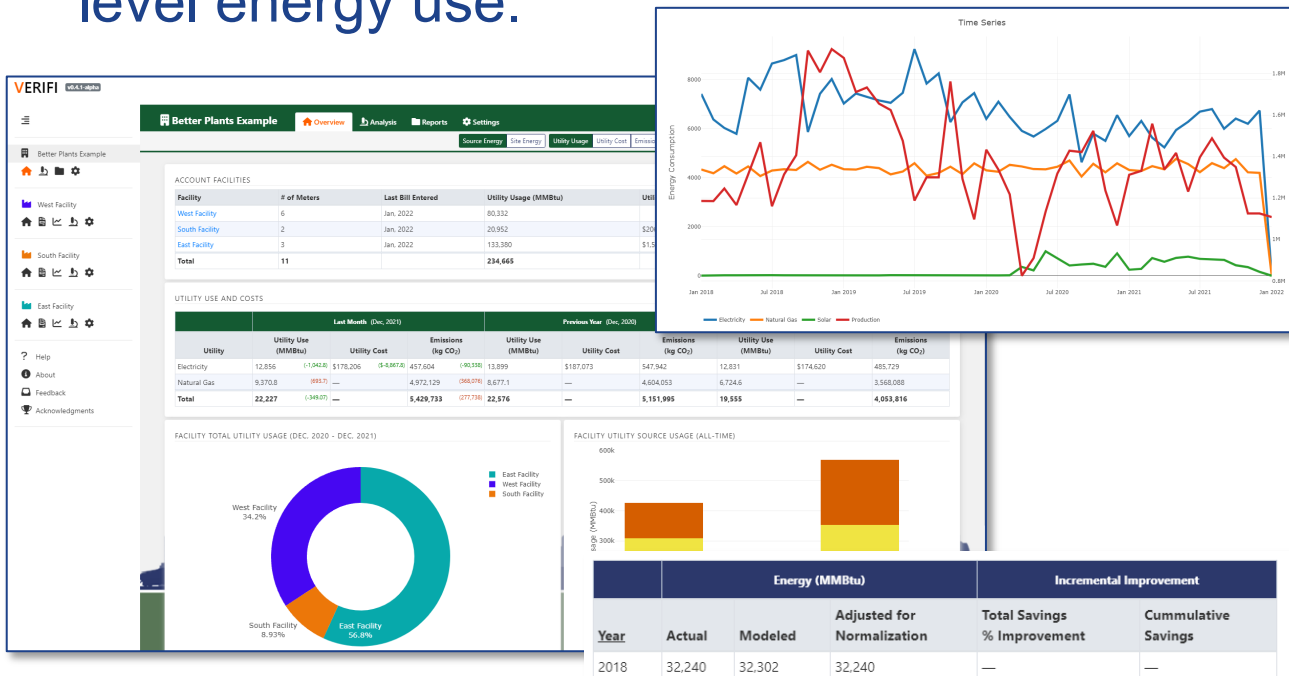
# MEASUR - Calculators

- 70+ Stand alone Calculators
  - Motors
  - Pumps
  - Fans
  - Process Heating
  - Process Cooling
  - Steam
  - Compressed Air
  - Lighting
  - General
- Most have graphical results

# VERIFI

- Corporate and facility-level views
- Enter utility bills and see total energy use in a new way
  - Calendarization of energy data
  - Annual cost, energy use, and limited carbon emissions overview
- Analyze your data and generate a Better Plants Annual Reporting Form or other custom reports
- Available for “Beta” testing
  - Will replace EnPI tool and other DOE facility-level utility analysis tools
  - Updates currently about every two weeks
  - Updates may impact functioning of existing data

Will help energy management and decarbonization teams track and understand their facility and corporate level energy use.




| | Energy (MMBtu) | | | Incremental Improvement | |
|---|---|---|---|---|---|
| Year | Actual | Modeled | Adjusted for Normalization | Total Savings % Improvement | Cummulative Savings |
| 2018 | 32,240 | 32,302 | 32,240 | — | — |
| 2019 | 30,917 | 31,892 | 31,831 | 2.87 % | 913.91 |
| 2020 | 19,407 | 21,232 | 21,171 | 8.33 % | 2,677.7 |
| 2021 | 20,952 | 23,176 | 23,115 | 9.35 % | 4,840 |

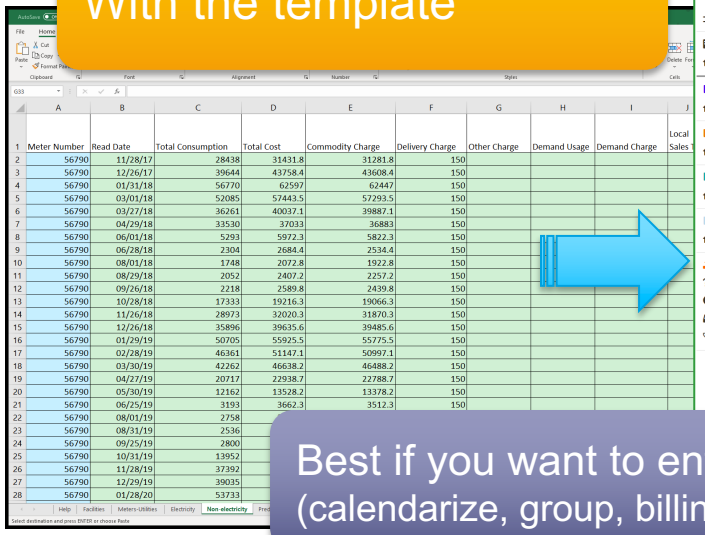
Find this tool at
https://verifi.ornl.gov/
https://github.com/ORNL-AMO/VERIFI/releases

Clearing your browser cache DELETES online data

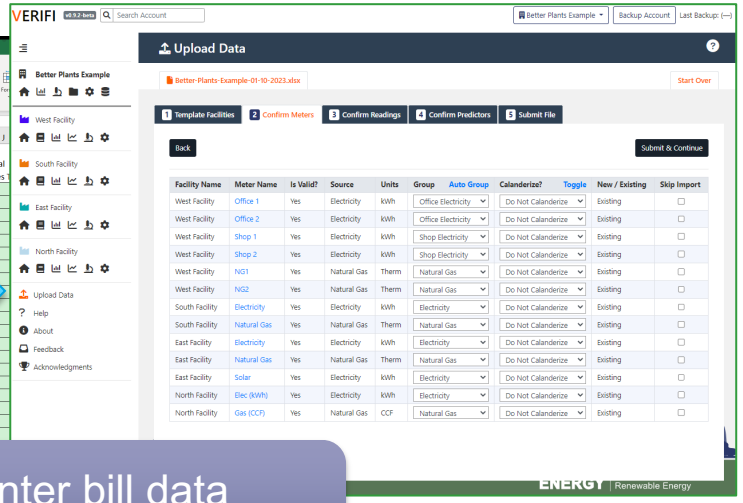
# VERIFI – Entering Data

There are several ways to enter data into VERIFI

## With the template

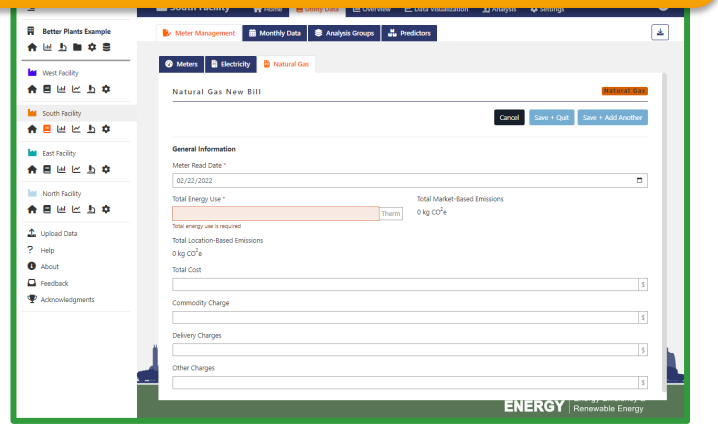


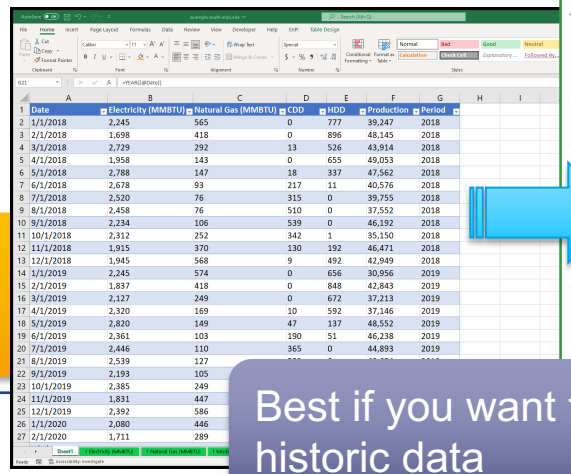
| Meter Number | Read Date | Total Consumption | Total Cost | Commodity Charge | Delivery Charge | Other Charge | Demand Usage | Demand Charge | Local Sales |
|---|---|---|---|---|---|---|---|---|---|
| 56790 | 11/28/17 | 28438 | 31431.8 | 31281.8 | 150 | | | | |
| 56790 | 12/26/17 | 39644 | 43758.4 | 43608.4 | 150 | | | | |
| 56790 | 01/31/18 | 56770 | 62597 | 62447 | 150 | | | | |
| 56790 | 03/01/18 | 52085 | 57443.5 | 57293.5 | 150 | | | | |
| 56790 | 03/27/18 | 36261 | 40037.1 | 39887.1 | 150 | | | | |
| 56790 | 04/29/18 | 33530 | 37033 | 36883 | 150 | | | | |
| 56790 | 06/01/18 | 5293 | 5972.3 | 5822.3 | 150 | | | | |
| 56790 | 06/28/18 | 2304 | 2684.4 | 2534.4 | 150 | | | | |
| 56790 | 08/01/18 | 1748 | 2072.8 | 1922.8 | 150 | | | | |
| 56790 | 08/29/18 | 2052 | 2407.2 | 2257.2 | 150 | | | | |
| 56790 | 09/26/18 | 2218 | 2589.8 | 2439.8 | 150 | | | | |
| 56790 | 10/28/18 | 17333 | 19216.3 | 19066.3 | 150 | | | | |
| 56790 | 11/26/18 | 28973 | 32020.3 | 31870.3 | 150 | | | | |
| 56790 | 12/26/18 | 35896 | 39635.6 | 39485.6 | 150 | | | | |
| 56790 | 01/29/19 | 50705 | 55925.5 | 55775.5 | 150 | | | | |
| 56790 | 02/28/19 | 46361 | 51147.1 | 50997.1 | 150 | | | | |
| 56790 | 03/30/19 | 42262 | 46638.2 | 46488.2 | 150 | | | | |
| 56790 | 04/27/19 | 20717 | 22938.7 | 22788.7 | 150 | | | | |
| 56790 | 05/30/19 | 12162 | 13528.2 | 13378.2 | 150 | | | | |
| 56790 | 06/25/19 | 3193 | 3662.3 | 3512.3 | 150 | | | | |
| 56790 | 08/01/19 | 2758 | | | | | | | |
| 56790 | 08/31/19 | 2536 | | | | | | | |
| 56790 | 09/25/19 | 2800 | | | | | | | |
| 56790 | 10/31/19 | 13952 | | | | | | | |
| 56790 | 11/28/19 | 37392 | | | | | | | |
| 56790 | 12/29/19 | 39035 | | | | | | | |
| 56790 | 01/28/20 | 53733 | | | | | | | |




Best if you want to enter bill data
(calendarize, group, billing analysis, etc.)

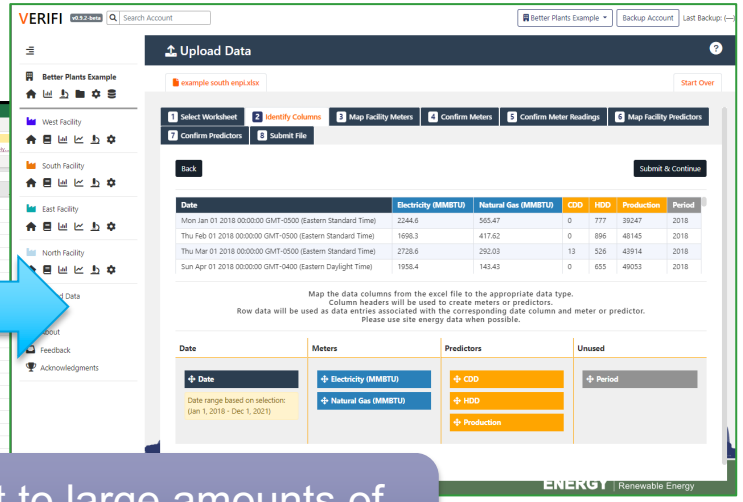
## Enter each bill individually
(best when maintaining)



| Date | Electricity (MMBTU) | Natural Gas (MMBTU) | CDD | HDD | Production | Period |
|---|---|---|---|---|---|---|
| 1/1/2018 | 2,245 | 565 | 0 | 777 | 39,247 | 2018 |
| 2/1/2018 | 1,698 | 418 | 0 | 896 | 48,145 | 2018 |
| 3/1/2018 | 2,729 | 292 | 13 | 526 | 43,914 | 2018 |
| 4/1/2018 | 1,958 | 143 | 0 | 655 | 49,053 | 2018 |
| 5/1/2018 | 2,788 | 147 | 18 | 337 | 47,562 | 2018 |
| 6/1/2018 | 2,678 | 93 | 217 | 11 | 40,576 | 2018 |
| 7/1/2018 | 2,520 | 76 | 315 | 0 | 39,755 | 2018 |
| 8/1/2018 | 2,458 | 76 | 510 | 0 | 37,552 | 2018 |
| 9/1/2018 | 2,234 | 106 | 539 | 0 | 46,192 | 2018 |
| 10/1/2018 | 2,312 | 252 | 342 | 1 | 35,150 | 2018 |
| 11/1/2018 | 1,915 | 370 | 130 | 192 | 46,471 | 2018 |
| 12/1/2018 | 1,945 | 568 | 9 | 492 | 42,949 | 2018 |
| 1/1/2019 | 2,245 | 574 | 0 | 656 | 30,956 | 2019 |
| 2/1/2019 | 1,837 | 418 | 0 | 848 | 42,843 | 2019 |
| 3/1/2019 | 2,127 | 249 | 0 | 672 | 37,213 | 2019 |
| 4/1/2019 | 2,320 | 169 | 10 | 592 | 37,146 | 2019 |
| 5/1/2019 | 2,820 | 149 | 47 | 137 | 48,552 | 2019 |
| 6/1/2019 | 2,361 | 103 | 190 | 51 | 46,238 | 2019 |
| 7/1/2019 | 2,446 | 110 | 365 | 0 | 44,893 | 2019 |
| 8/1/2019 | 2,539 | 127 | | | | 2019 |
| 9/1/2019 | 2,193 | 105 | | | | |
| 10/1/2019 | 2,385 | 249 | | | | |
| 11/1/2019 | 1,831 | 447 | | | | |
| 12/1/2019 | 2,392 | 586 | | | | |
| 1/1/2020 | 2,080 | 446 | | | | |
| 2/1/2020 | 1,711 | 289 | | | | |

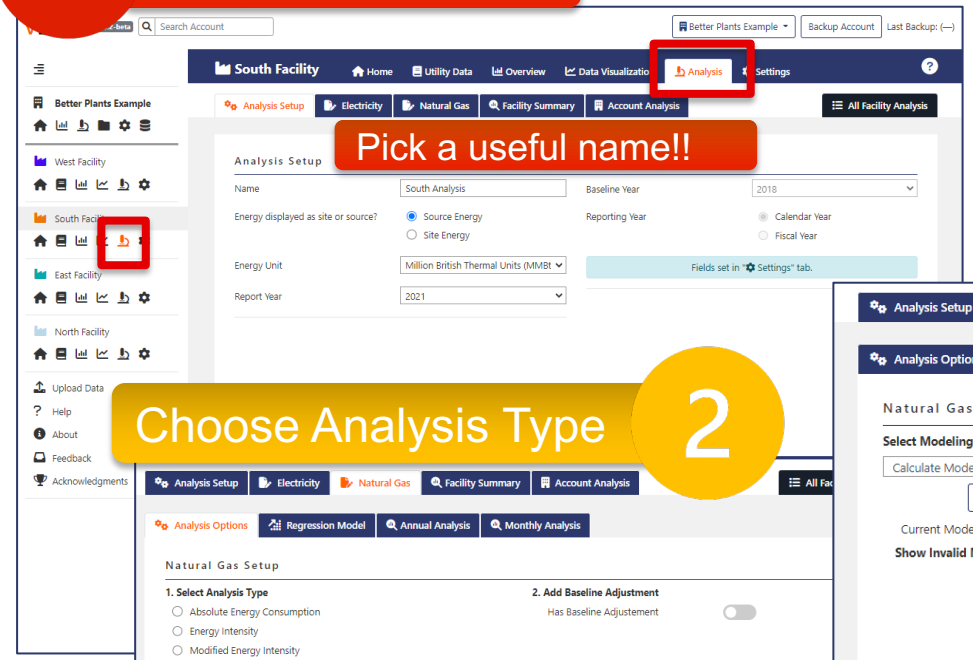
Directly enter old EnPI files




Best if you want to large amounts of historic data

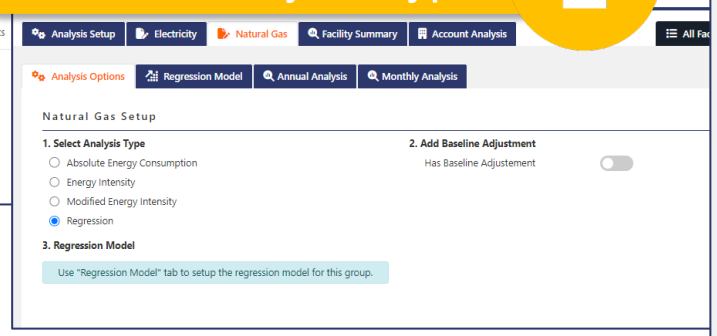
# VERIFI – Savings Analysis

## 1 Setup basic info

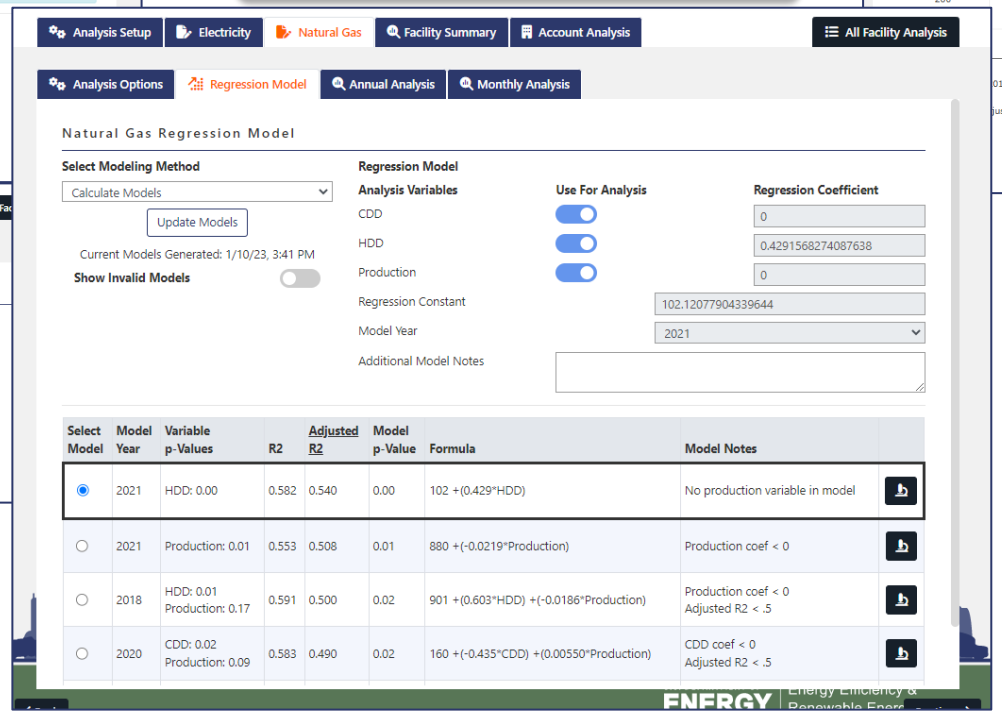



Pick a useful name!!

## 2 Choose Analysis Type

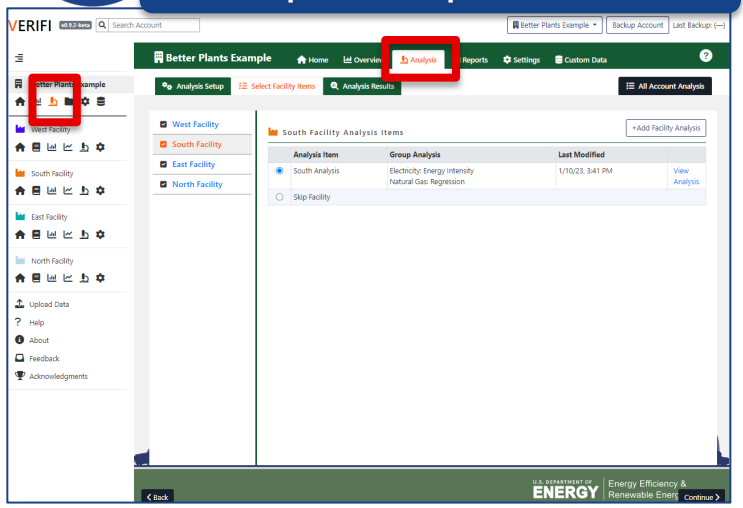



## 3 Regression made easy!



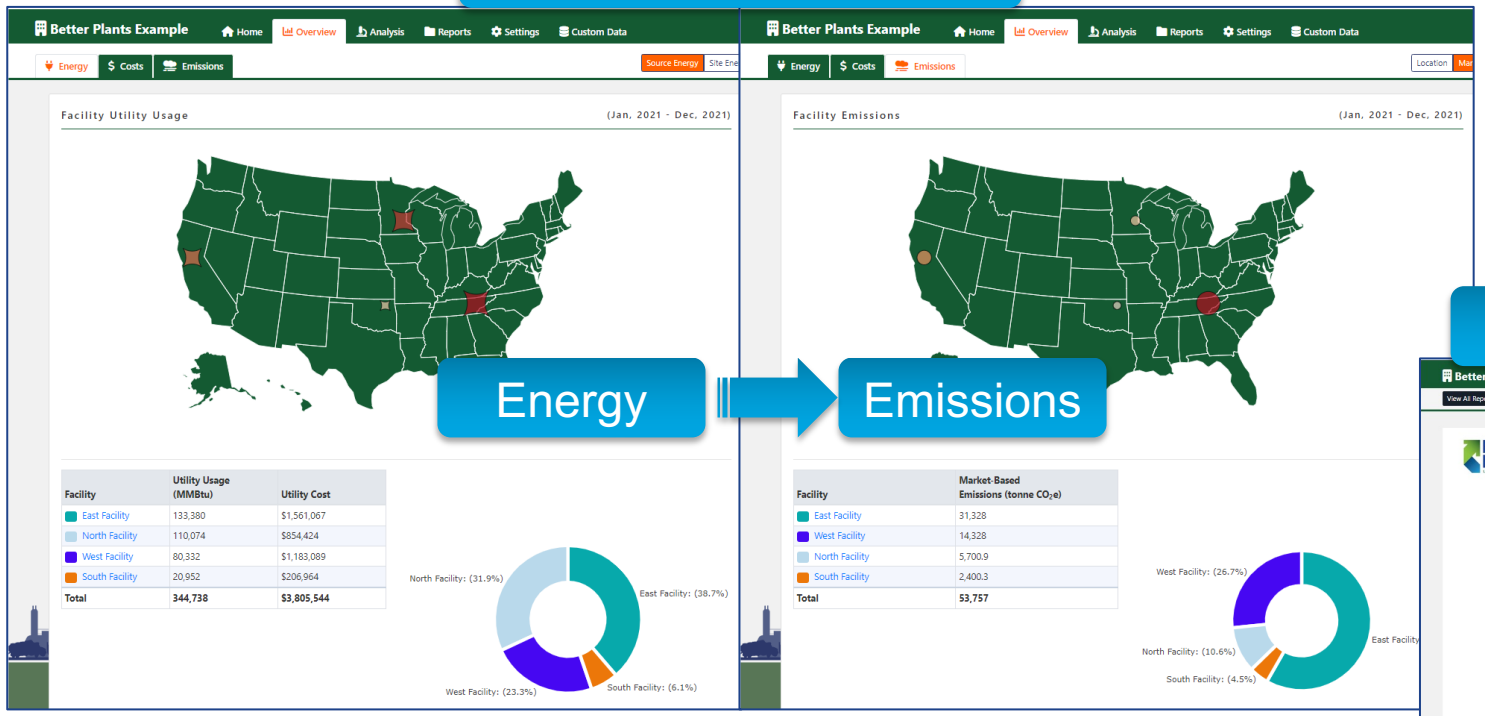

## 4 View results!

## 5 Roll up to corporate level!

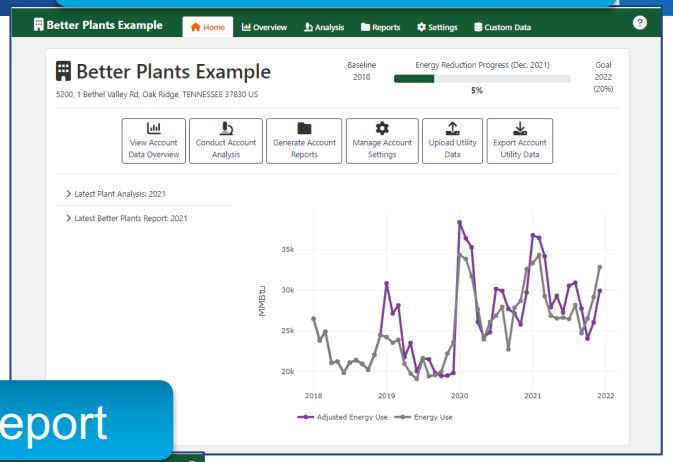


# VERIFI – Dashboards & Reports

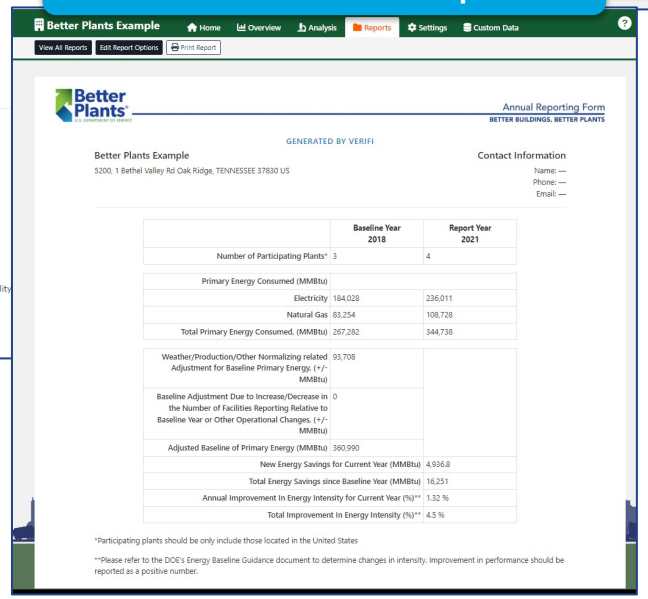
## Overview Dashboard




## Home Dashboard




## Better Plants Report

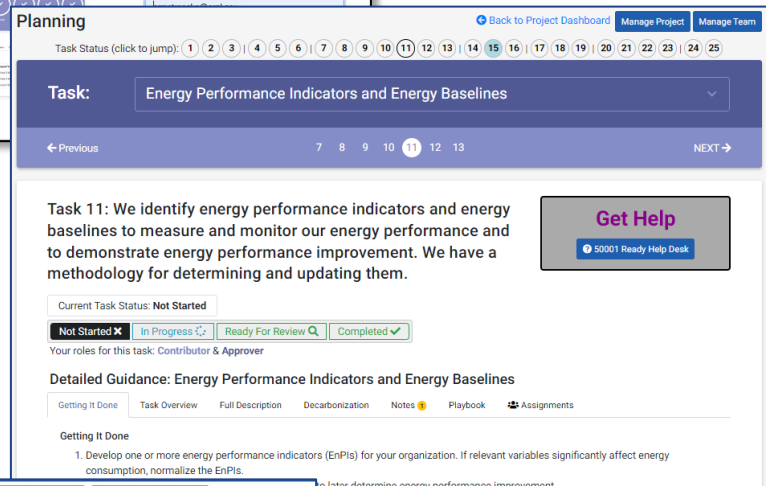


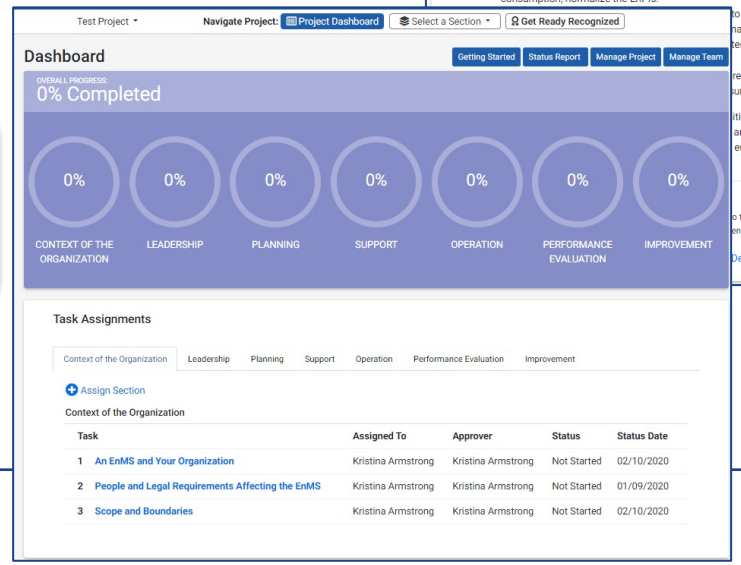

- Several Dashboards & Reports to help keep an eye on energy, costs, and decarbonization efforts

More Features & Reports to come!!!

# 50001 Ready Navigator

- Helps energy and sustainability teams create a near-ISO 50001 compliant energy management system.
  - ✓ Step-by-step "Turbo Tax" approach to 50001
  - ✓ 25 tasks divided into 4 sections
  - ✓ Extensive guidance available in each module
  - ✓ Self-attest to completion of 50001 Navigator




Cohorts available to help develop EnMS!

Find this tool at
https://navigator.lbl.gov/
https://betterbuildingssolutioncenter.energy.gov/iso-50001/50001Ready

# 50001 Ready Navigator for Decarbonization

- Helps incorporate GHG management into your EnMS
  - ✓ Shows possible tradeoffs between energy efficiency and decarbonization goals and helps guide discussion between

Planning

Back to Project Dashboard | Manage Project | Manage Team

Task Status (click to jump): 1 2 3 | 4 5 6 | 7 8 9 10 11 12 13 | 14 15 16 | 17 18 19 | 20 21 22 23 | 24 25

Task: Energy Performance Indicators and Energy Baselines

← Previous 7 8 9 10 11 12 13 NEXT →

Task 11: We identify energy performance indicators and energy baselines to measure and monitor our energy performance and to demonstrate energy performance improvement. We have a methodology for determining and updating them.

Get Help

50001 Ready Help Desk

Current Task Status: **Not Started**

Not Started ✕ | In Progress | Ready For Review | Completed ✓

Your roles for this task: Contributor & Approver

Detailed Guidance: Energy Performance Indicators and Energy Baselines

Getting It Done | Task Overview | Full Description | Decarbonization | Notes 1 | Playbook | Assignments

Getting It Done

1. Dev… …ce indicators (EnPIs) for your organization. If relevant variables significantly affect energy …r is.
… …eline (EnB) for EnPI in order to later determine energy performance improvement.
… proposed EnPIs and EnBs to top management so they can ensure the EnPIs and EnBs are appropriate for the organization.
… and regularly review the method used to determine and update EnPIs, and establish the conditions under which adjustments to the baseline(s) will be made.
5. Compare EnPI values to their respective EnBs on a regular basis.
6. Implement a process for ongoing monitoring, measurement, and analysis of your EnPIs, EnBs, and energy performance improvements.

- If you are planning on seeking 50001 Ready recognition for this project please refer to the, "Get Ready Recognized," page of the 50001 Ready Navigator to ensure you select an EnPI, EnB, and method for demonstrating energy performance improvement allowed by the recognition program. To achieve Ready recognition energy performance improvement is demonstrated for the same scope and boundaries as your 50001 Ready EnMS.

Task 11 Guidance Version: **v18.11.02.02**

The creative commons license is applicable only to the technical content found in the "Getting it Done", "Task Overview", "Full Description", and "Decarbonization" tabs. The creative commons license does not extend to the 50001 Ready Navigator software or other resources.

**Need assistance?** Contact the 50001 Ready Help Desk | Download as PDF

Detailed Guidance: Energy Performance Indicators and Energy Baselines

Getting It Done | Task Overview | Full Description | Decarbonization | Notes 1 | Playbook | Assignments

**Decarbonization** Not required for DOE recognition

Energy performance indicators are quantitative metrics used to monitor energy performance and demonstrate energy performance improvement. As quantitative measures, energy performance indicators (EnPIs) are measured values, ratios, or models your organization accepts as meaningful representations of energy performance.

When managing energy-related GHG emissions as part of your EnMS, include energy-related GHG performance indicators as quantitative ways to monitor your energy-related GHG emissions. Like other EnPIs, energy-related GHGperformance indicators can be:

- A single metric, such as total emissions
- A ratio or per unit basis, such as pounds of emissions per unit, or
- A numerical model that accounts for one or more relevant variables

When developing performance indicators for energy-related GHG emissions, your organization should consider:

- Using emissions intensity, either from a ratio or from a numerical model, as a meaningful internal metric to manage energy-related GHG emissions and changes in energy-related GHG emissions performance over time.
- Establishing an energy-related GHG performance indicator for each emission type (i.e. Scope 1, 2, and 3) included in your scope and boundaries.
- Establishing at least one energy-related GHG performance indicator for each SEU.
- Setting performance indicators based on stakeholder needs relative to GHG emissions reporting.

In addition to your energy baselines, an energy-related GHG emissions baseline should be developed. The energy-related GHG emissions baseline should provide a quantitative reference for determining if your energy-related GHG emissions have reduced and performance has improved. When developing your energy-related GHG emissions baseline, your organization should consider:

- How the energy-related GHG emissions performance indicators will be used for evaluating GHG emissions performance.
- Whether there is a logical baseline for each energy-related GHG emissions performance indicator.
- Whether there are stakeholder interests to account for when establishing energy-related GHG emissions performance indicators.
- Whether there are strategic initiatives that can drive the formation of energy-related GHG emission performance indicators and baselines.

▸ Establishing a new EnMS prioritizing decarbonization

▸ Adapting an existing EnMS to prioritize decarbonization

Find this tool at
https://navigator.lbl.gov/
https://betterbuildingssolutioncenter.energy.gov/iso-50001/50001Ready

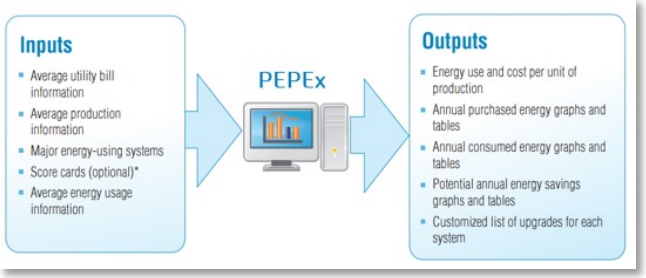
# Plant Energy Footprint Tool

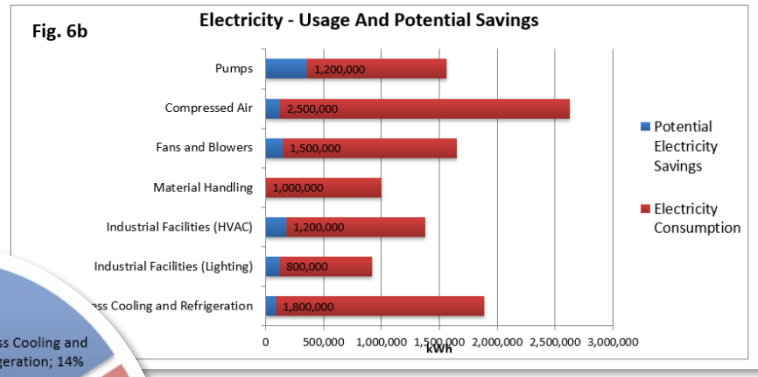
- Helps commercial and industrial facilities understand their energy consumption
  - Track energy consumption
  - Track relevant variables affecting energy consumption
  - Identify significant energy users
  - Discover trends and learn where to focus your efficiency efforts
  - Requires MS Excel and enabling macros

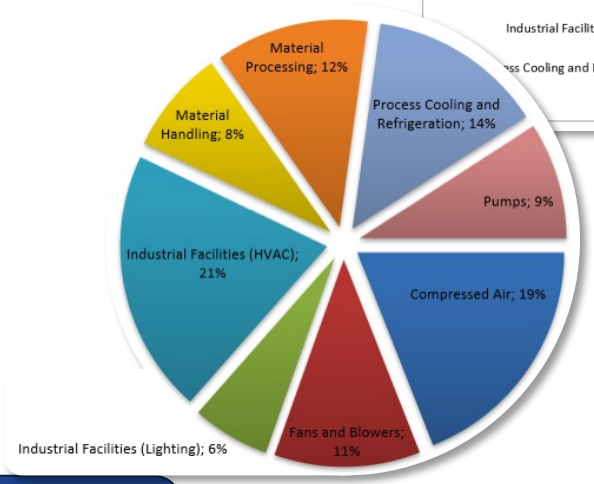
Find this tool at https://www.energy.gov/eere/amo/articles/energy-footprint-tool

# Plant Energy Profiler Tool (PEPEx)

- Identify how much energy is being purchased and consumed and identify and quantify potential energy and cost savings
  - Enter basic energy & production data
  - System scorecards
  - Energy use and costs by production and system
  - Energy & cost savings estimates
  - List of energy savings measures
  - MS Excel-based tool

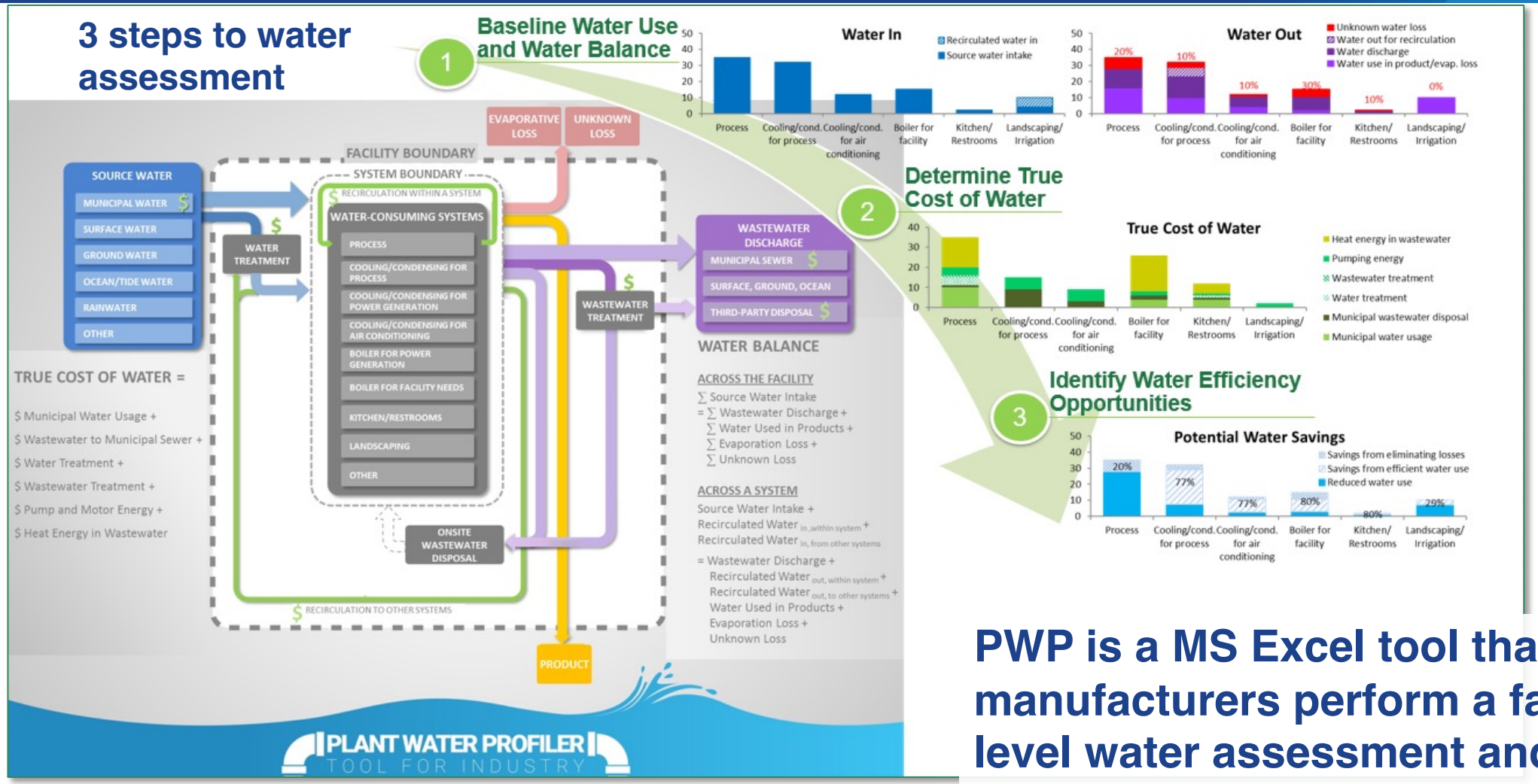



Find this tool at https://www.energy.gov/eere/amo/downloads/plant-energy-profiler-excel

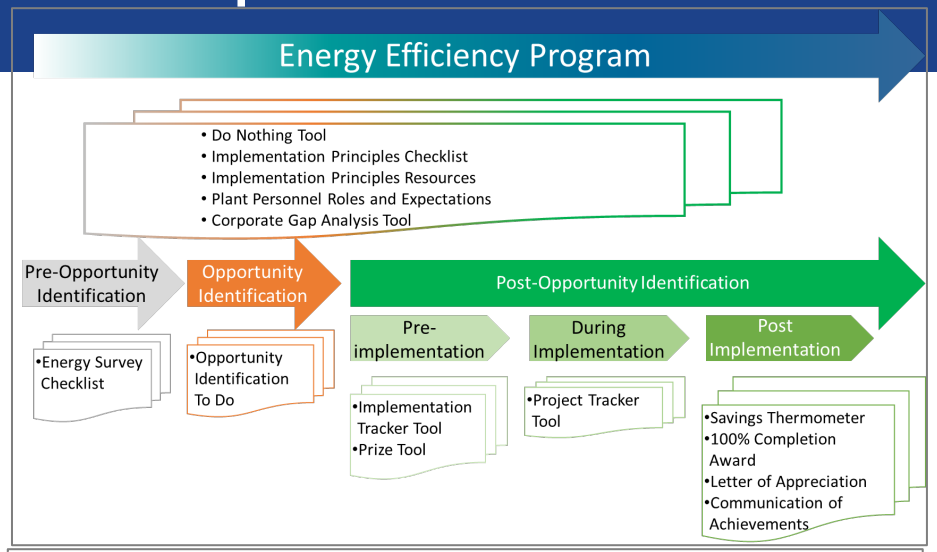
# Plant Water Profiler Tool (PWP)

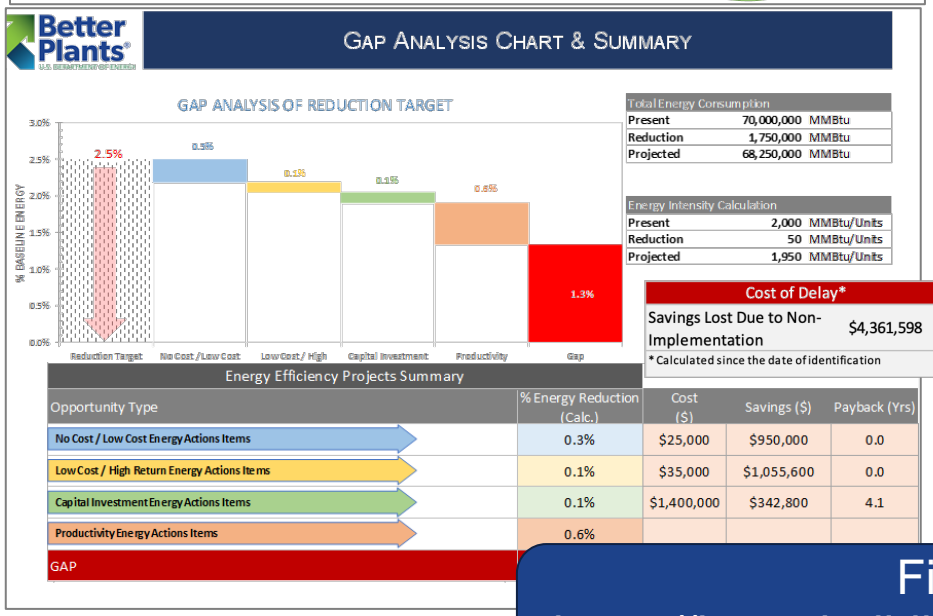


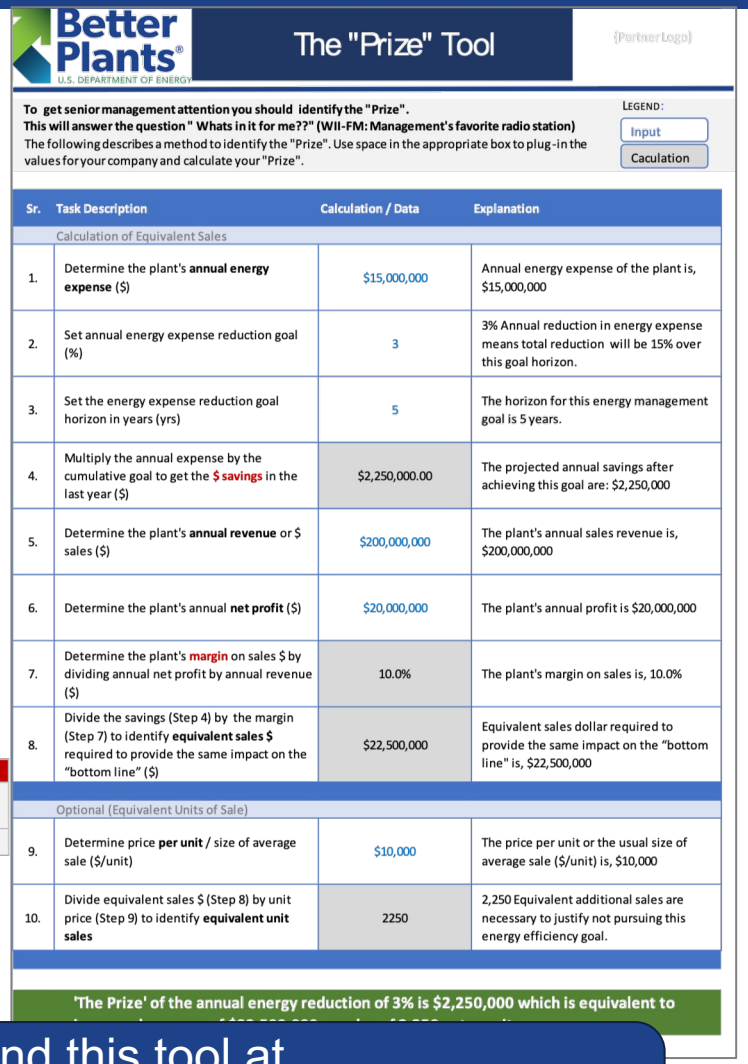

**PWP is a MS Excel tool that helps manufacturers perform a facility level water assessment and understand their true cost of water.**

Find this tool at https://www.energy.gov/eere/amo/plant-water-profiler-tool-excel-version-10-pwpex-v10

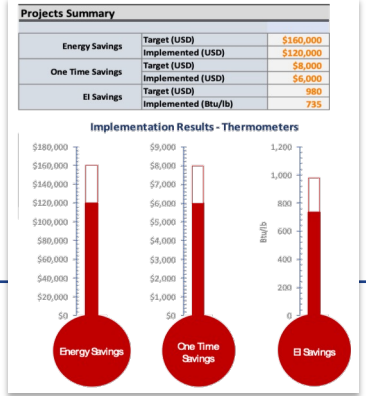
# Implementation Guidance Toolkit




- Collection of tools to help projects implementation and communicate success
- 15 different MS Excel tools focused on different stages of implementation
  - Program level
  - Pre-identification
  - During Identification
  - Post-identification
- Tools to justify projects, track implementation progress, conduct GAP analysis to focus implementation efforts




Find this tool at https://betterbuildingssolutioncenter.energy.gov/better-plants/implementation-guidance-toolkit

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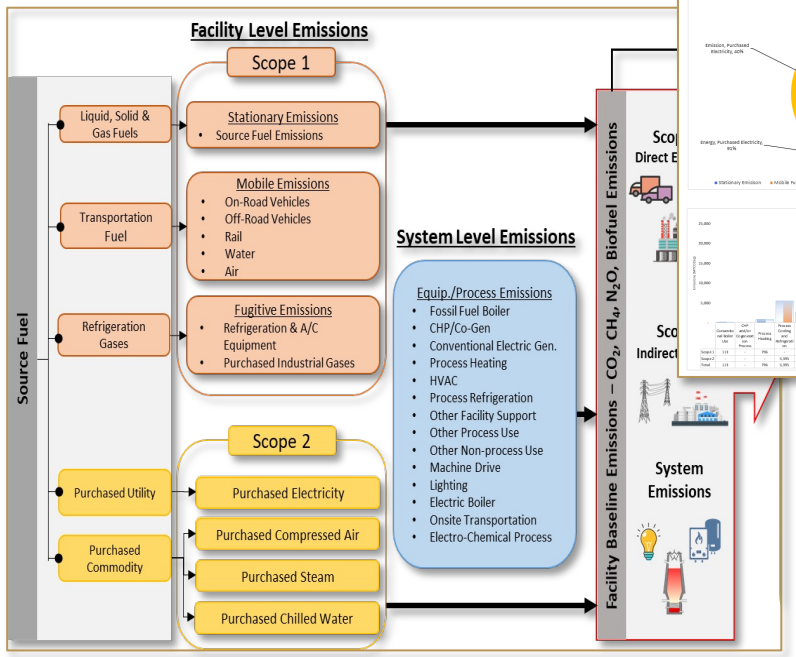
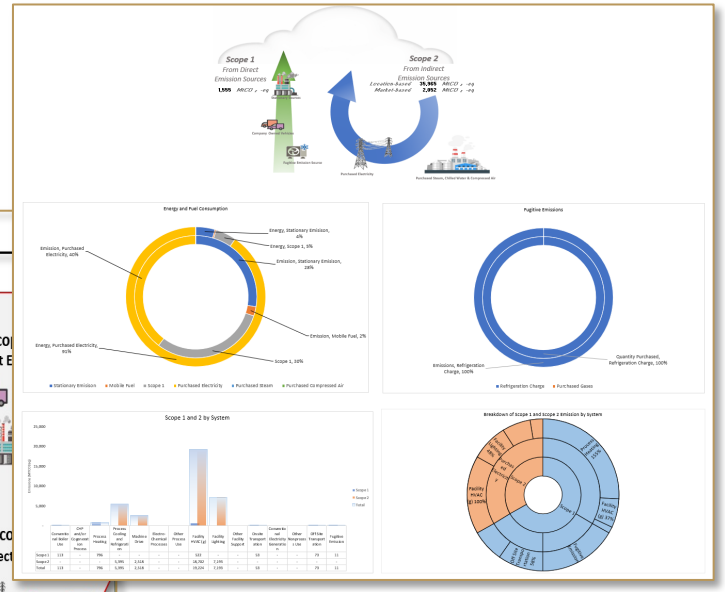
# Plant Carbon Footprint and Decarbonization Assessment Tool

- Enables users to create and analyze baseline emissions for facility and at system level
- Scope 1 –
  - Stationary, Mobile & Fugitive
- Scope 2 –
  - Purchased Electricity (Location & Market based),
  - Other Purchased Utilities (steam, chilled water, compressed air)
- Future Updates
  - Provide users the ability to evaluate decarbonization scenarios and perform techno-economic analyses
- MS Excel-based tool



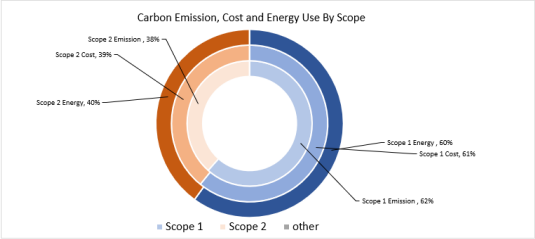



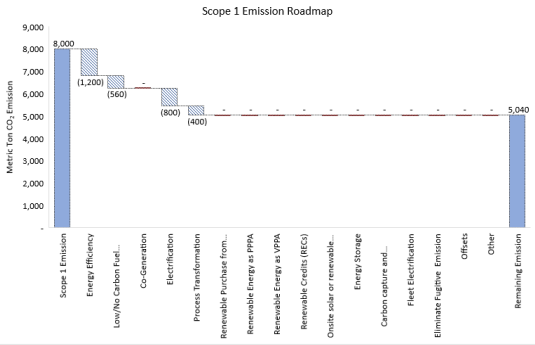
Find this tool at https://energyefficiency.ornl.gov/tools-training/

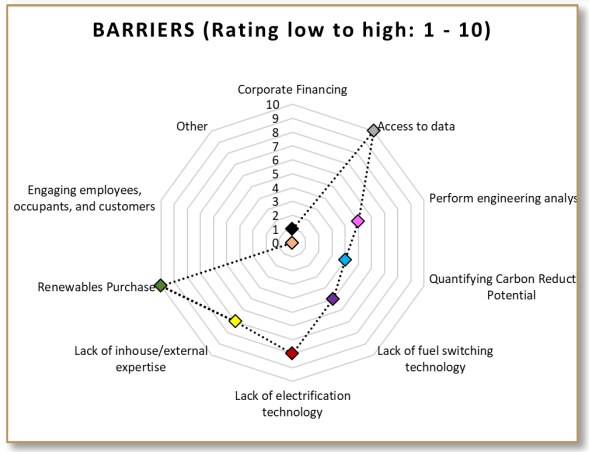
# Decarbonization Action Plan Tool

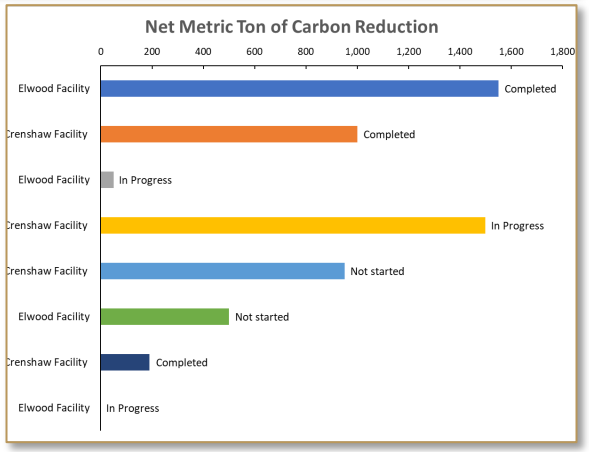
| Showcase Plant Name | Elwood Facility | | | |
|---|---|---|---|---|
| Scope of Emission | Description | Energy Source (MMBTU) | Energy Cost ($) | $CO_{2eq}$ Emission (Metric Ton) |
| Scope 1 Emission | | 15,000 | 7,000 | 8,000 |
| Stationary Emission | | 15,000 | 7,000 | 8,000 |
| Natural Gas | | 15,000 | 7,000 | 8,000 |
| | | | | |
| | | | | |
| Mobile Emission | | - | - | - |
| | | | | |
| | | | | |
| | | | | |
| Fugitive Emission | | | | |
| Scope 2 Emission | | 10,000 | 4,500 | 5,000 |
| Purchased Electricity | | 10,000 | 4,500 | 5,000 |
| | | | | |
| | | | | |
| Other | | | | |

| Pillars of Decarbonization | Opportunity | Barrier | Scope 1 % Carbon Reduction | Scope 2 % Carbon Reduction |
|---|---|---|---|---|
| Energy Efficiency | | | 15% | 30% |
| Low/No Carbon Fuel Switching | | | 7% | |
| Co-Generation | | | | |
| Electrification | | | 10% | -20% |
| Process Transformation | | | 5% | |
| Renewable Purchase from Utility | | | | 10% |
| Renewable Energy as PPPA | | | | 15% |
| Renewable Energy as VPPA | | | | |
| Renewable Credits (RECs) | | | | 30% |
| Onsite solar or renewable energy generation | | | | 20% |
| Energy Storage | | | | |
| Carbon capture and sequestration | | | | |
| Fleet Electrification | | | | |



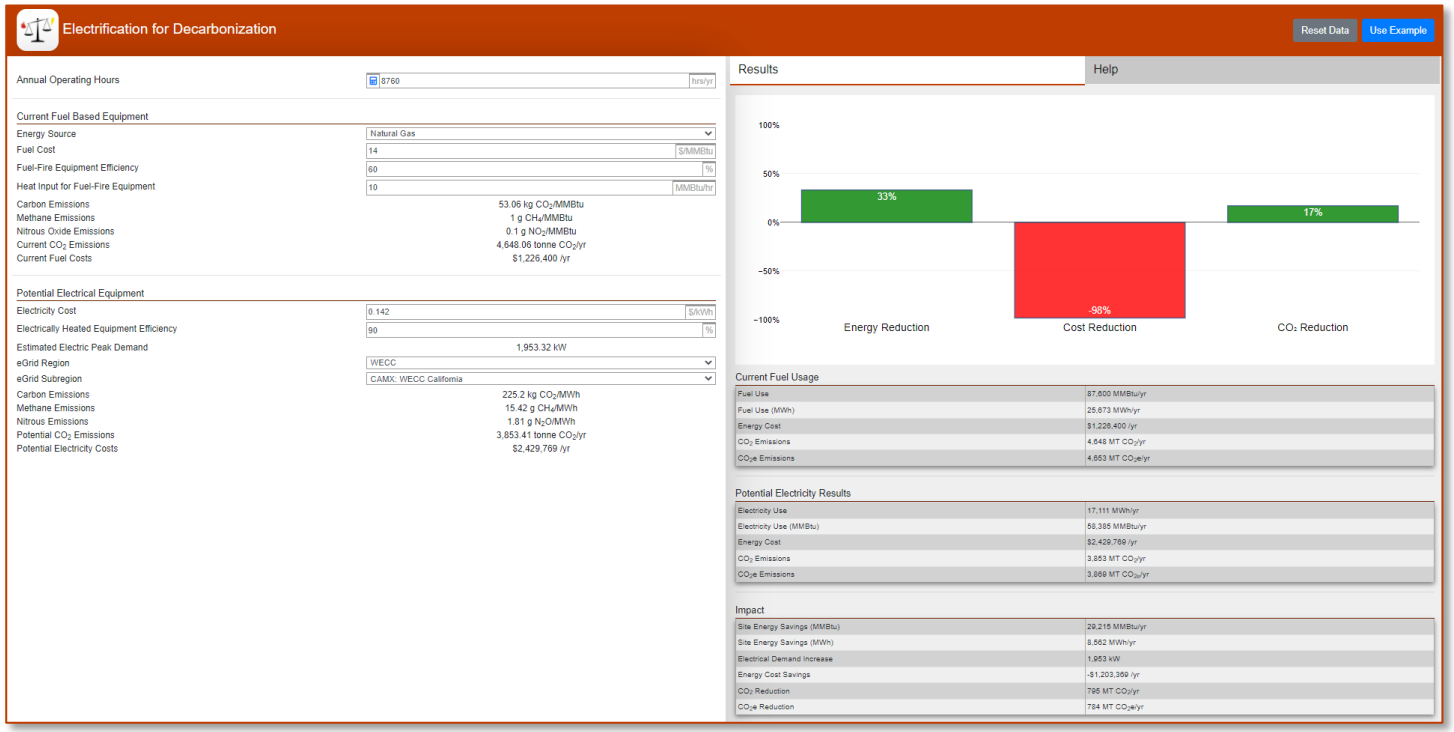

Aids industrial partners in visualization of Scope 1 and Scope 2 emissions at corporate and facility level.

- Outline corporate and facility level decarbonization roadmap
- Identify barriers faced on their journey to low carbon future
- MS Excel-based tool

Find this tool at https://energyefficiency.ornl.gov/tools-training/

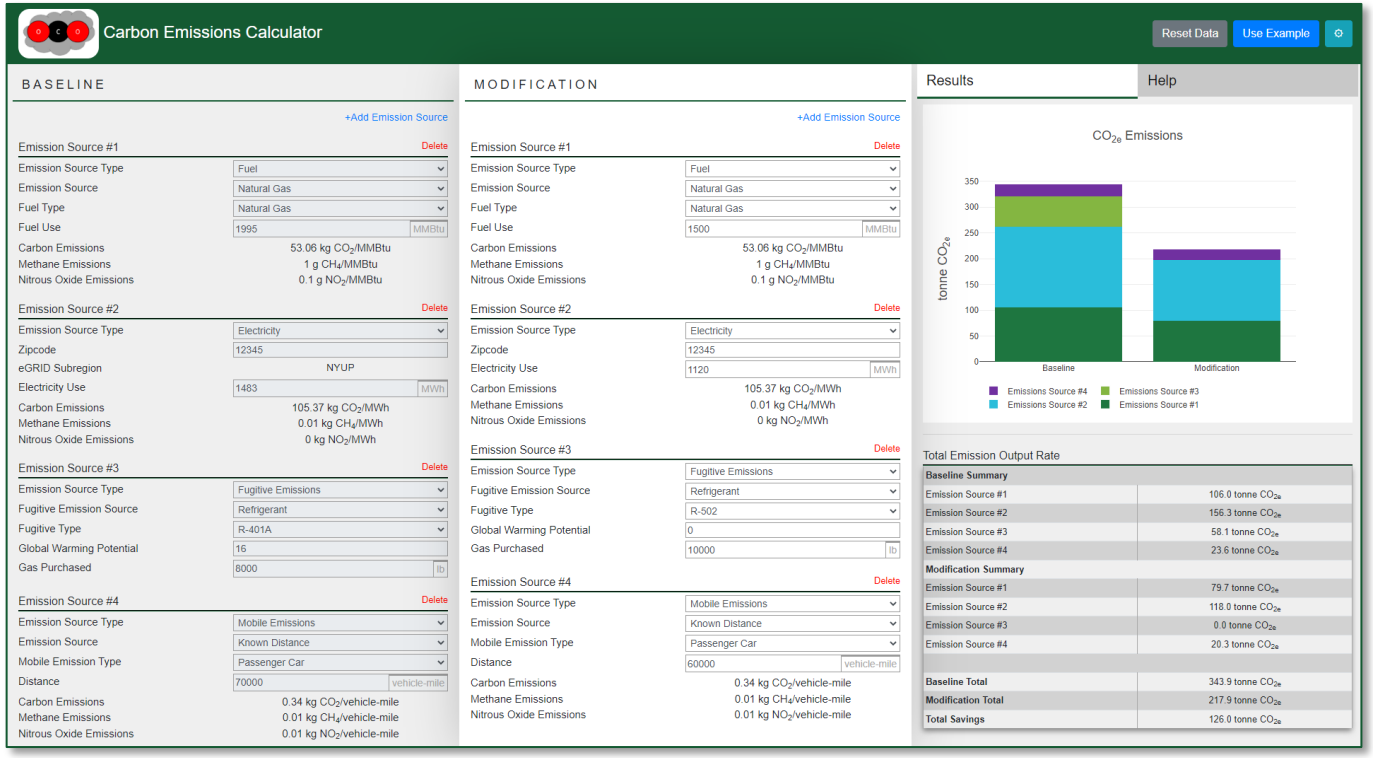
# Electrification for Decarbonization

- Quickly explore energy, cost, and carbon impact of electrification
  - Enter basic data about system and potential replacement system
  - Location-based electricity emissions




Find this tool at
https://electrification.ornl.gov

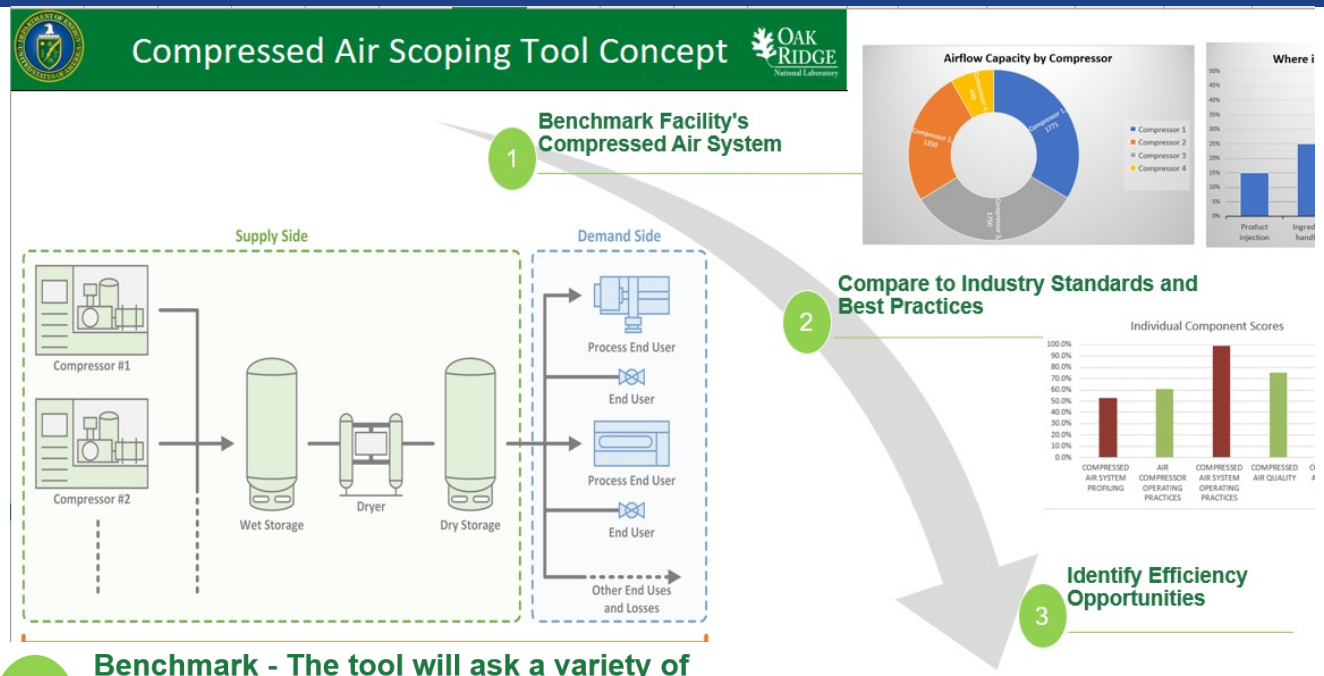
# Carbon Emissions Calculator




- Quickly estimate Scope 1 & 2 emissions and see where you need to reduce to hit your goals
  - Stationary Emissions
  - Scope 2 (Purchased Electricity, location-based) Emissions
  - Fugitive Emissions
  - Mobile Emissions
- Use emission factors in tool or enter custom factors
- Compare $CO_2$ emissions for two scenarios

Find this tool at
https://carboncalc.ornl.gov

# Compressed Air Scoping Tool




1 **Benchmark** - The tool will ask a variety of questions regarding each aspect of the compressed air system including the supply side, the demand side, and the system as a whole.

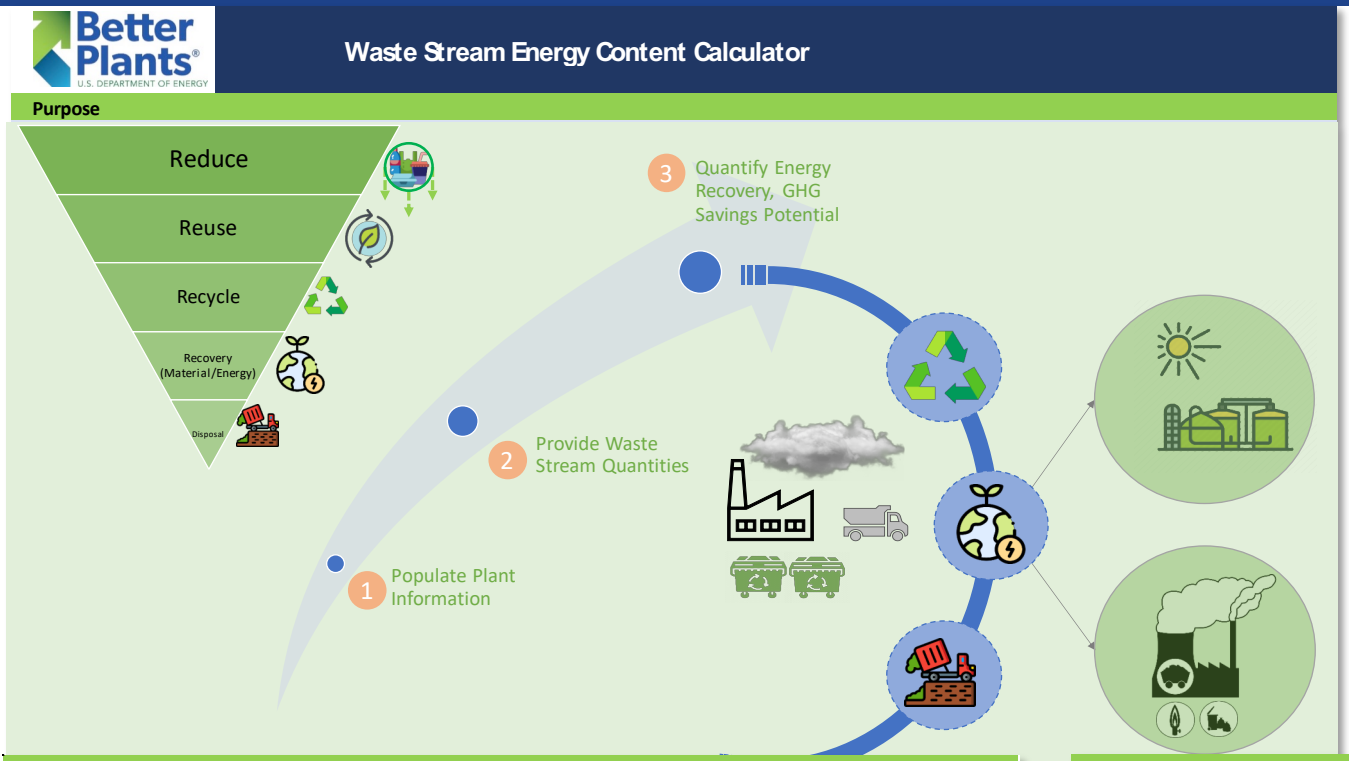
2 **Compare** - The information in the tool will then be compared to industry best practices and a "score card" will be produced to rate the compressed air system

3 **Identify** - The tool will then suggest adjustments for consideration that will increase the facility's score and that may improve the compressed air system's overall efficiency

- Understand your compressed air practices
  - Users answer a series of questions about various aspects of CA system
  - A "report card" is generated by comparing answers to current best practices
  - A list of recommendations to improve the score is provided
  - MS Excel-based tool

Find this tool at https://www.energy.gov/eere/amo/compressed-air-scoping-tool-excel-beta-version-ca-scoping-tool-beta-v10

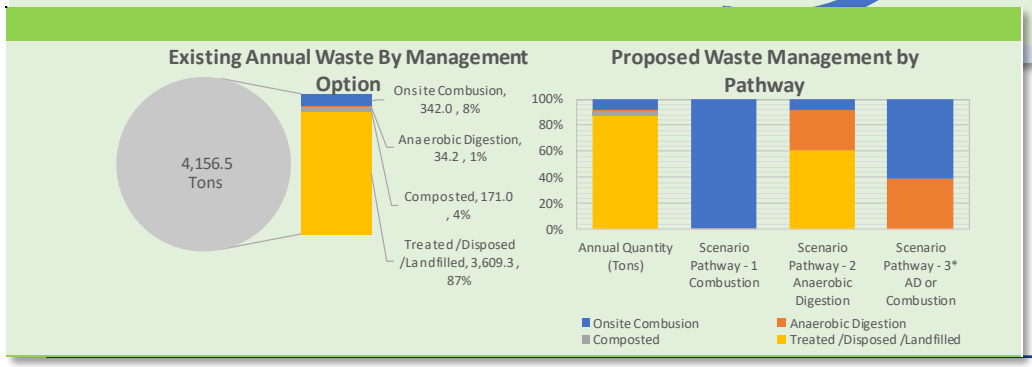
# Waste Stream Energy Content Calculator

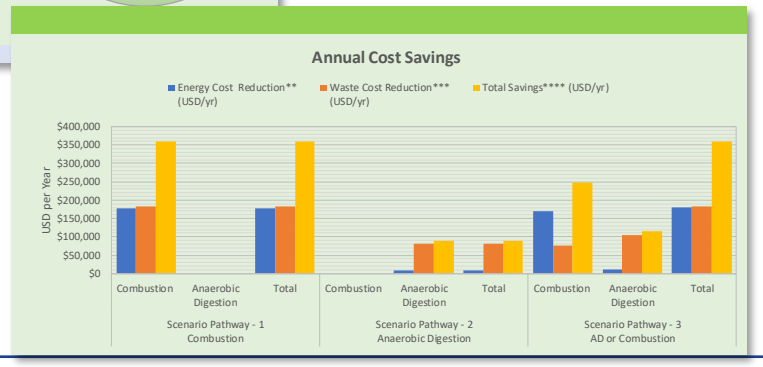


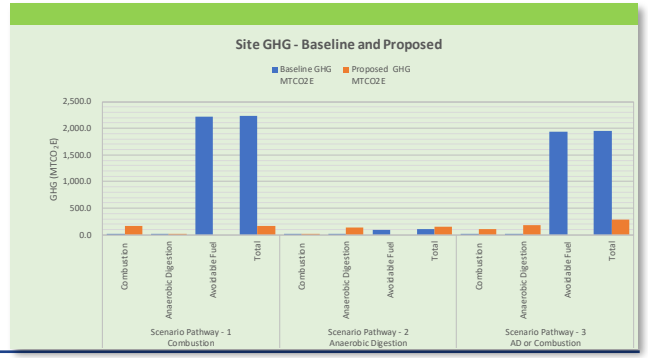

## Quick evaluation of energy recovery potential from most common waste streams

- Analyzes three scenario pathways for energy generation – Combustion, Anaerobic digestion, or Combination
- Evaluates Cost and GHG Impact ($CO_2$eq.)
- MS Excel-based tool

Find this tool at https://energyefficiency.ornl.gov/tools-training/



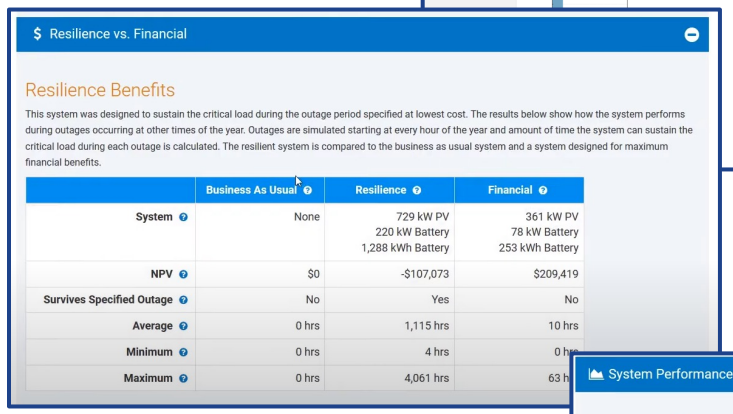



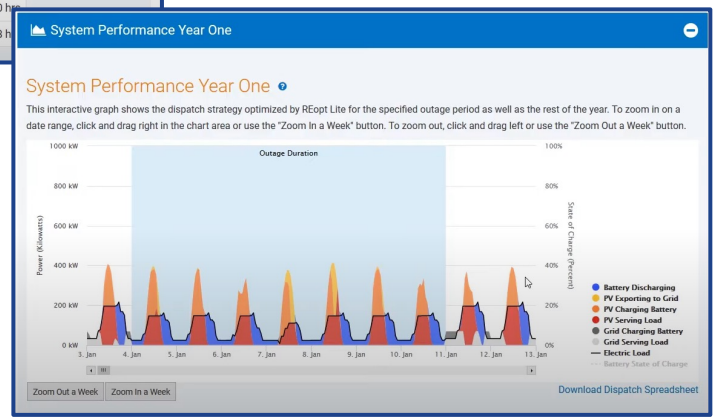
# Renewables Analysis

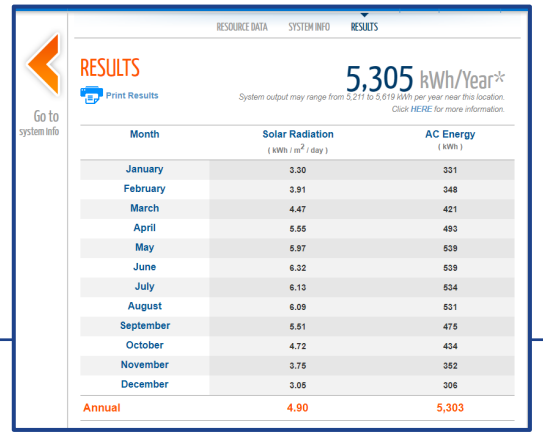
- System Advisor Model (SAM)
  - Facilitates decision-making for implementing renewable energy project
    - Hourly data to estimate long-term cost & performance of technologies
  - FREE! Open-source!
  - https://sam.nrel.gov/
- REopt/REopt Lite
  - Helps evaluating economic and technical aspects of grid-connected solar PV, wind, energy storage systems.
    - Optimized system size and dispatch
    - High-level economics based on location & rates
  - FREE! Web-based!
  - https://reopt.nrel.gov/
- PVWatts Calculator
  - Estimates PV energy generation (no economics)
    - Monthly & Annually
  - FREE! Simple!
  - https://pvwatts.nrel.gov/index.php

NREL
NATIONAL RENEWABLE ENERGY LABORATORY




| | Business As Usual | Resilience | Financial |
|---|---|---|---|
| System | None | 729 kW PV<br>220 kW Battery<br>1,288 kWh Battery | 361 kW PV<br>78 kW Battery<br>253 kWh Battery |
| NPV | $0 | -$107,073 | $209,419 |
| Survives Specified Outage | No | Yes | No |
| Average | 0 hrs | 1,115 hrs | 10 hrs |
| Minimum | 0 hrs | 4 hrs | 0 hr |
| Maximum | 0 hrs | 4,061 hrs | 63 h |




| Month | Solar Radiation ( kWh / m² / day ) | AC Energy ( kWh ) |
|---|---|---|
| January | 3.30 | 331 |
| February | 3.91 | 348 |
| March | 4.47 | 421 |
| April | 5.55 | 493 |
| May | 5.97 | 539 |
| June | 6.32 | 539 |
| July | 6.13 | 534 |
| August | 6.09 | 531 |
| September | 5.51 | 475 |
| October | 4.72 | 434 |
| November | 3.75 | 352 |
| December | 3.05 | 306 |
| Annual | 4.90 | 5,303 |

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# Energy Treasure Hunt

- A 3-day training focused on:
  - Low-cost/No-cost actions to reduce energy consumption
  - Learning ways to continuously improve
  - Cross-functional teams brainstorming
  - Teams identify, analyze, and evaluate energy savings opportunities
  - Identified opportunities quantified

**Observing the Idle Facility**

- Energy Treasure Hunts usually start on Sunday or periods of reduced production

**Employee Engagement**

- Cross-functional team of employees conduct the Treasure Hunts and have ownership of the ideas / opportunities

**Expert Facilitation**

- Outside experts / participants are there to facilitate the process, generate discussion, and help quantify opportunities

**Leverage Plant Personnel Knowledge**

- Plant personnel will have insights into opportunities in their facilities and will take ownership of energy savings measures

**Employees implement the Treasure Hunt process!**

# Treasure Hunt Toolkit – Anyone can do it!

**PHASE 1 — Preparation**
- Agenda - Template
- Pre-event Data Collection Form
- Plant Energy Profiler (PEPEx) Tool

**PHASE 2 — Event**
- Kick off Presentation
- Handouts
- Energy Efficiency Calculators
- Opportunity Sheet and Summary Report Generator

**PHASE 3 — Follow-up**
- Event Certificate - Template
- Evaluation Form - Template
- Project Implementation Tracker

## Key Aspects:

- Learn to utilize MEASUR software
- Empower and enable plant personnel
- Focus on low-cost/no-cost opportunities
- Observing the idle facility
- Facility employees conduct and have ownership of the ideas / opportunities

# Q & A