



Simple Tools for Saving Energy - DOE's New Energy Assessment Software

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Laboratory**

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Better Buildings, Better Plants

- **What is Better Plants?** A voluntary, public-private partnership program for **manufacturers** and industrial organizations
- Through Better Plants:
 - Partners set long-term efficiency goals
 - Receive **technical assistance, networking platforms** and **national recognition**
- Manufacturers have two opportunities to engage in Better Plants:
 1. Broader-based **Program** level
 2. Higher-level **Challenge**



Productivity + Cost Savings = Competitiveness

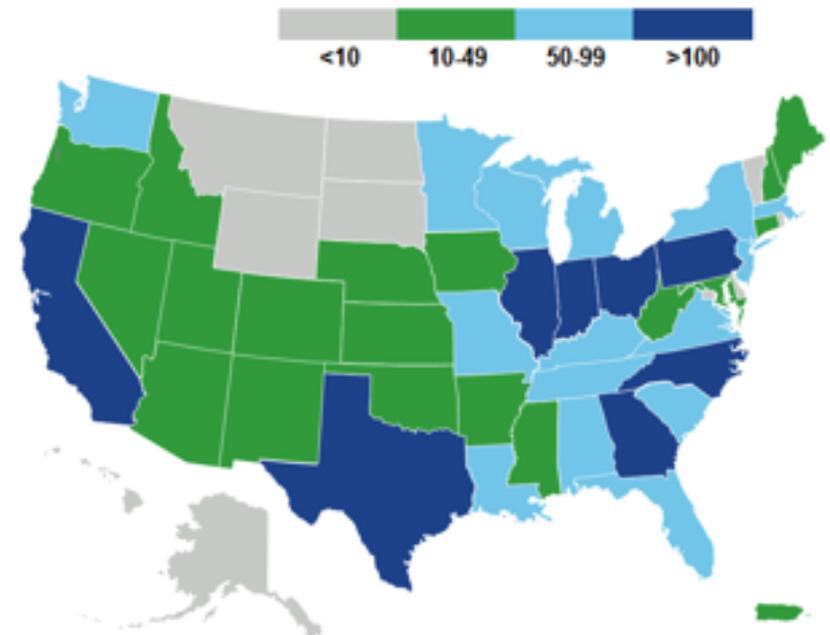
Better Plants Overview

Energy savings and program footprint continue to grow

Better Plants Snapshot

Accomplishments	Total
Number of Partners	202
Approximate Number of Plants	3,000
Percent of U.S. Manufacturing Energy Footprint	12%
Reported Savings	
Cumulative Energy Savings (TBtu)	1,056
Cumulative Cost Savings (Billions)	\$5.3
Cumulative Avoided CO ₂ Emissions (Million Metric Ton)	36
Average Annual Energy Intensity Improvement Rate	3.2%

Regional Distribution of Better Plants Facilities



52 goal achievers total, 9 this year!

Better Plants Challenge Partners



Why Partner with Better Plants?

Technical Assistance

- **Technical Account Manager:** navigate program and access resources
- **In-Plant Trainings:** expert instructors come to your plant
- **Resources:** Diagnostic & Software Tools/Industrial Assessment Centers/CHP TAPs/Water Savings Tools/Connection to National Labs
- **Supply Chain Engagement:** resources to advance supplier energy efficiency

National Recognition

- **Awards** for Goal Achievers
- **Better Project/Better Practice Awards**

Peer-to-Peer Networking Opportunities



Cummins' green initiative takes root
Nov 5, 2014, 12:26pm EST

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David Bertola
Buffalo Business First Reporter-
Buffalo Business First
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The U.S. Department of Energy is recognizing the Cummins Inc. Jamestown engine plant as a showcase project for its Better Buildings Better Plants Challenge.

[Enlarge Photo](#)

According to the Department of Energy's [A Cummins engine at the Jamestown plant. \(file photo\)](#)

Technical Assistance: Diagnostic Equipment Program

Field data is best for evaluating system performance



- Free of charge, including shipping
- Use equipment for one day, or up to four weeks
- Some technical assistance with selection and usage
- First come, first serve application

Advanced Technology Partnerships

Better Plants hosts events at National Laboratories to:

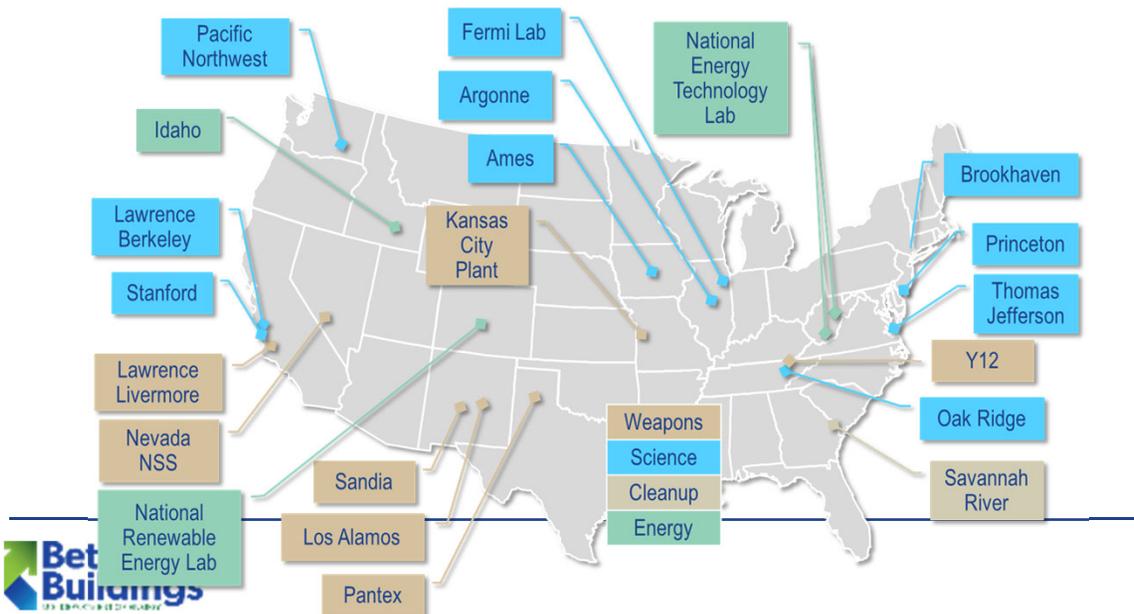
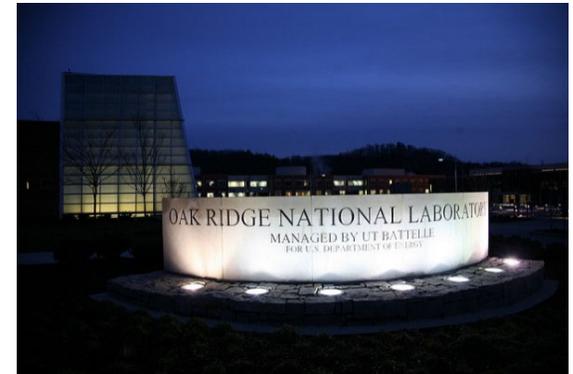
Tour World-Class Facilities

View Demonstrations of innovative technologies

Hear from experts and Industry peers

Learn about research partnerships

Network with BP partners and researchers



Treasure Hunt Toolkit

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

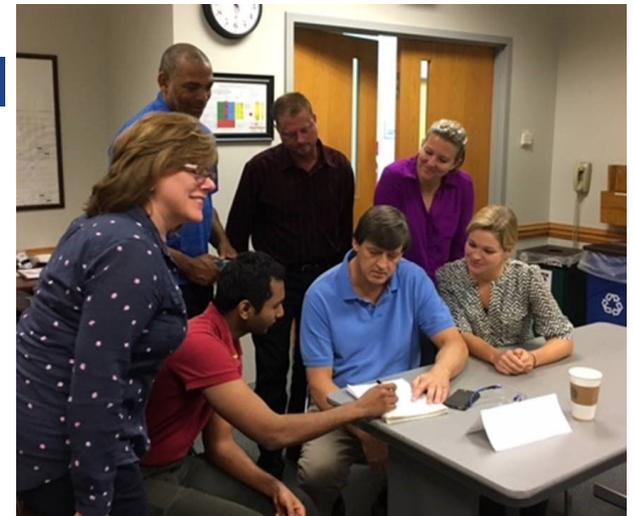
3

Follow-up

- Event Certificate - Template
- Evaluation Form - Template
- Project Implementation Tracker

Key Aspects:

- 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



DOE Software Tools

www.energy.gov/eere/amo/software-tools

Overview: Current DOE Software Tools

Energy Management & Performance Tracking

50001 Ready Navigator

Energy Footprint Tool

Automated Register of Implemented Actions

EnPI and EnPI Lite Tools

PEP (Plant Energy Profiler)

Corporate Energy Performance Tracking for Better Plants partnership

PWP (Plant Water Profiler)

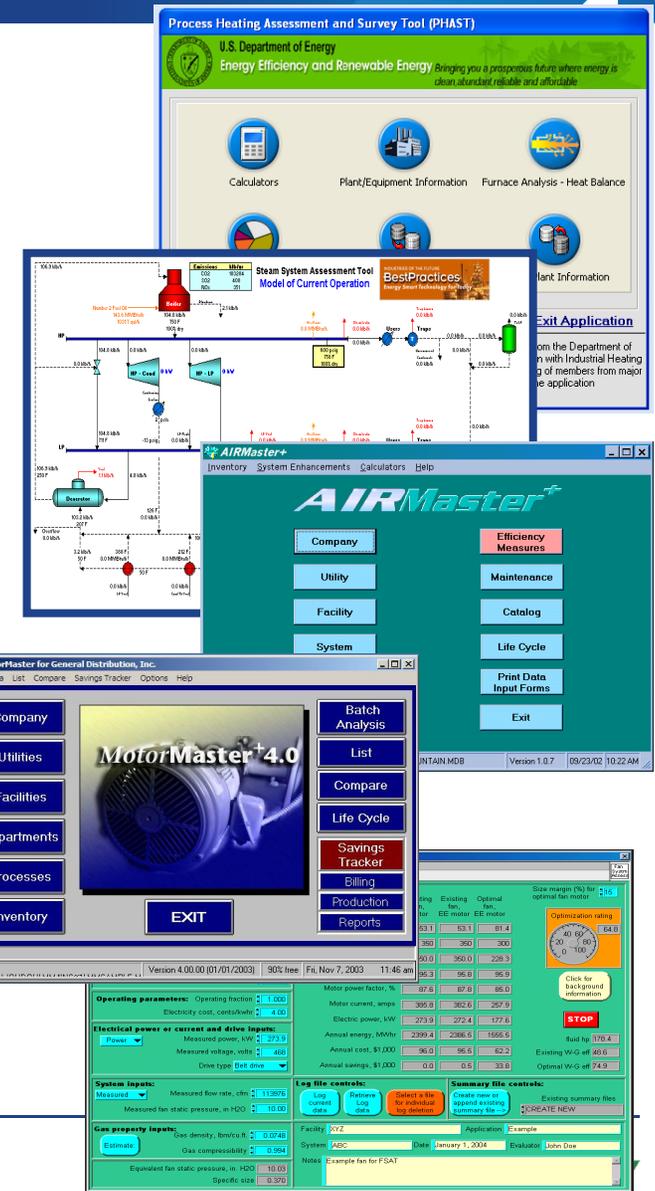
Facility Energy Performance Tracking for Superior Energy Performance

Energy Systems Analysis

- Motors
- Pumps
- Fans
- Compressed Air
- Steam
- Process Heating
- Data Centers
- Simple Calculators
- Treasure Hunt Toolkit

Overview – DOE Software Tool History

- **Technology and Vendor Agnostic** tools to identify, quantify and validate energy saving opportunities
- Most DOE software tools were **developed in the '90's**
 - Operating Systems updated...DOE did not!
 - Many **no longer work** with current operating systems
- Original tools were **developed with industry experts**
- **Highly valued by the manufacturing community** – including end-users, trade associations, utility programs, etc.
- Foundational tools to support other DOE activities
 - Energy Saving Assessments (ESAs)
 - Better Plants In-Plant Trainings
 - Industrial Assessment Centers
 - Case Studies & Fact Sheets



Software Changes, Systems Don't

High-level Plant Energy & Savings Profile

Process Heating/
Steam Systems
60 – 80%

← Typical Energy
Consumption Rates

Electric Motor
Systems
8-15%

Pumping
Systems
7-15%

Compressed
Air Systems
2-7%

Other*
< 2%



* Other ancillary energy
usages such as lighting
represent less than 2% of
energy consumption

10% to 30%

5% to 10%

10% to 20%

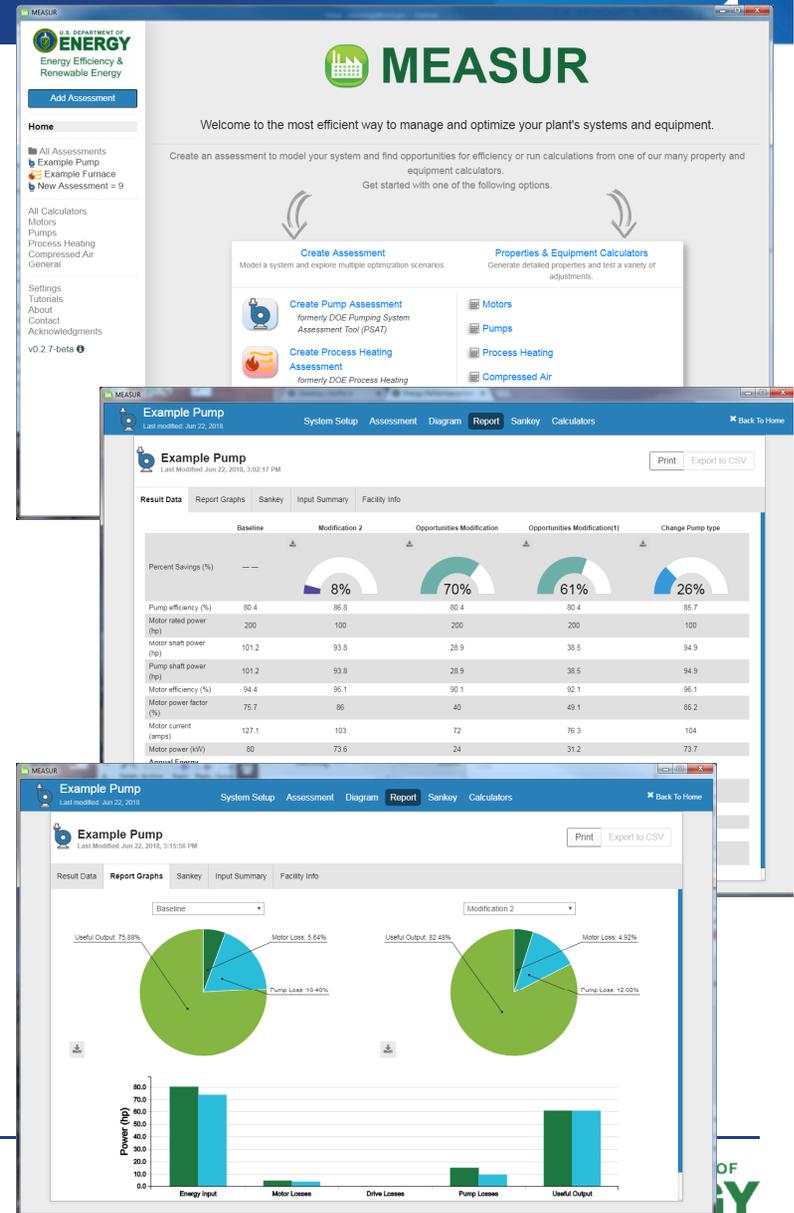
10% to 20%

5% to 10%

← Potential Energy Saving Opportunities →

MEASUR Software Tools

- Modernize to **Open-Source Software!**
 - DOE will own and control code
 - Upgrading tool capabilities where feasible
 - **Ex: Auto-Update** capability (silent updates)
 - Government-wide Open-Source Software - <https://github.com/ORNL-AMO>
 - UT-Battelle Permissive License – *“Do whatever, but please provide attribution”*
 - Desktop (Windows, Mac & Linux) & Web/Mobile
- Provide industry with **technology/vendor agnostic** analysis and evaluation tools



Integrated Energy Software - MEASUR



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Energy Efficiency & Renewable Energy

MEASUR

Welcome to the most efficient way to manage and optimize your plant's systems and equipment.

Create an assessment to model your system and find opportunities for efficiency or run calculations from one of our many property and equipment calculators.
Get started with one of the following options.

Create Assessment
Model a system and explore multiple optimization scenarios.

Properties & Equipment Calculators
Generate detailed properties and test a variety of adjustments.

Create Pump Assessment
formerly DOE Pumping System Assessment Tool (PSAT)

Create Process Heating Assessment
formerly DOE Process Heating Assessment and Survey Tool (PHAST)

Create Fan Assessment
formerly DOE Fan System Assessment Tool (FSAT)

Motors

Pumps

Fans

Process Heating

Steam

Compressed Air

General

[View All Your Assessments](#)

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- All system level software tools will be available to through **one platform**
- Includes system modelers and individual calculators for **field validation**
- Includes **built-in guides and tutorials**

Getting Started

The screenshot shows the MEASUR web application interface. At the top left is the U.S. Department of Energy logo and the text "Energy Efficiency & Renewable Energy". Below this is a blue button labeled "Add Assessment". A sidebar on the left contains a "Home" section with "All Assessments", "Examples", and "Extra case studies". Below that is "All Calculators" with sub-items: Motors, Pumps, Fans, Process Heating, Steam, Compressed Air, and General. Further down are "Settings", "Custom Materials", "Tutorials", "About", "Contact", and "Acknowledgments". At the bottom of the sidebar is "v0.3.0-beta". The main content area features the MEASUR logo and a welcome message: "Welcome to the most efficient way to manage and optimize your plant's systems and equipment. Create an assessment to model your system and find opportunities for efficiency or run calculations from one of our many property and equipment calculators. Get started with one of the following options." Below this are two main sections: "Create Assessment" (with sub-options: "Create Pump Assessment", "Create Process Heating Assessment", "Create Fan Assessment", and "View All Your Assessments") and "Properties & Equipment Calculators" (with sub-items: "Motors", "Pumps", "Fans", "Process Heating", "Steam", "Compressed Air", and "General"). A footer at the bottom right contains the U.S. Department of Energy logo and "Energy Efficiency & Renewable Energy".

- ➡ Start an assessment
- ➡ View Assessment Dashboard
- ➡ Use Properties & Equipment Calculators
- ➡ Change Settings, view tutorials, manage custom materials

Assessments Dashboard

View all your assessments in a folder-based organization

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Energy Efficiency & Renewable Energy

Home

- All Assessments
- Examples
- Extra case studies**

All Calculators

- Motors
- Pumps
- Fans
- Process Heating
- Steam
- Compressed Air
- General

Settings

- Custom Materials
- Tutorials
- About
- Contact
- Acknowledgments

v0.3.0-beta

Assessments Dashboard

Extra case studies

Buttons: Add Assessment, Add Pre-Assessment, Add Folder, Generate Report, Delete, Export, Import

EXTRA CASE STUDIES INFO

Company	ORNL	Facility	ORNL	Date	8/14/2018
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EXTRA CASE STUDIES SUMMARY

Type	Assessments	Annual Energy Used	Annual Energy Cost
Pumps	3	6,508.68 kWh	\$373,614.00
Process Heating	3	3,472,440 MMBtu	\$35,678,552.74
Fans	2	15,659.6 kWh	\$939,573.03
Total	8	3,472,510 MMBtu	\$36,991,739.76

EXTRA CASE STUDIES SETTINGS

Units of Measure	Imperial
Fuel Cost	\$3.99 /MMBtu
Steam Cost	\$4.69 /MMBtu
Electricity Cost	\$0.07 /kWh

FURNACES

Number of Furnaces	3
Annual Energy Used	548.54 MMBtu
Annual Energy Cost	\$4,336.47

FANS

Number of Fans	2
Annual Energy Used	6.31 MMBtu
Annual Energy Cost	\$122.10

PUMPS

Number of Pumps	3
Annual Energy Used	2.57 MMBtu
Annual Energy Cost	\$49.70

ELECTRIC ARC FURNACE

Furnace Type:	Electric Arc Furnace (EAF)
Baseline Data:	
Annual Energy Use:	375,802,931 kWh
Annual Energy Costs:	\$24,802,993
Modification Data:	
Number of Modifications:	3
Max. Energy Savings:	20,985,174 kWh
Max. Cost Savings:	\$1,385,022

PUSHER FURNACE

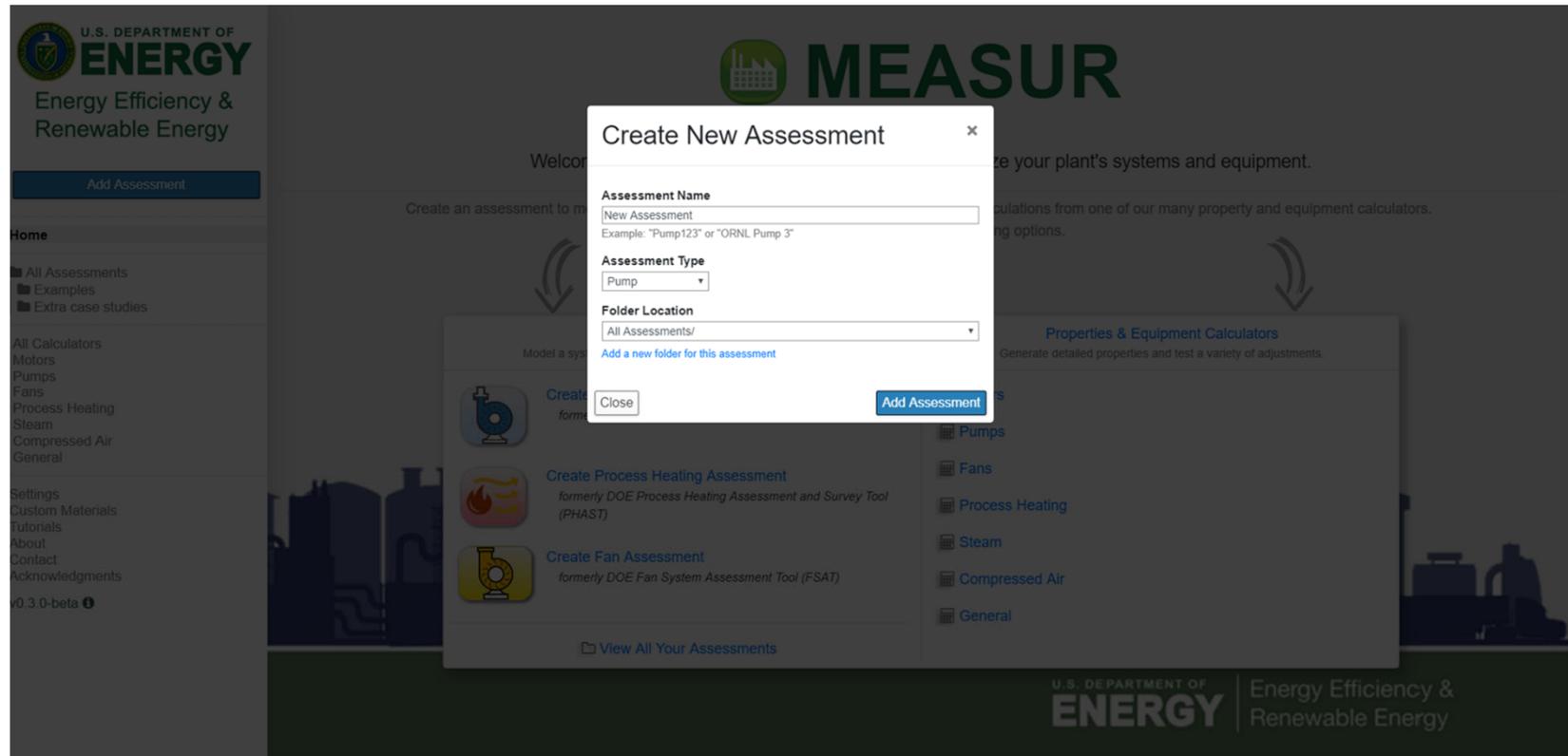
Furnace Type:	Pusher Furnace
Baseline Data:	
Annual Energy Use:	74,450 MMBtu
Annual Energy Costs:	\$297,056
Modification Data:	
Number of Modifications:	4
Max. Energy Savings:	31,415 MMBtu
Max. Cost Savings:	\$125,348

REHEAT FURNACE

Furnace Type:	Reheat Furnace
Baseline Data:	
Annual Energy Use:	2,115,701 MMBtu
Annual Energy Costs:	\$10,578,503
Modification Data:	
Number of Modifications:	5
Max. Energy Savings:	396,998 MMBtu
Max. Cost Savings:	\$1,984,992

- ➔ Move, copy, import and export assessments
- ➔ Add/view facility information and folder-wide settings
- ➔ Make pre-assessment screenings
- ➔ Generate rollup reports of several assessments

Starting an Assessment



- Choose a unique name for the folder
- Set Equipment type (Pump, Fan, Process Heater)
- Choose folder location
 - Or make a new folder

System Setup

Start with current equipment and operations - baseline

Reheat Furnace Case Study
Fuel-fired

System Setup Assessment Diagram

1 Assessment Settings 2 Heat Balance 3 Aux Equipment 4 Design Energy Use 5

REHEAT FURNACE CASE STUDY SETTINGS

Language: English
Currency: \$ - US Dollar
Units of Measure: Imperial Metric
Energy Result Unit: Millions British Thermal Units (MMBtu)
Select Energy Source Type: Fuel-fired Electrotechnology Steam-based
Common Result Unit: Millions British Thermal Units (MMBtu)
Common Fuel Unit: Millions British Thermal Units (MMBtu)
Common Electricity Unit: Kilowatt-hours (kWh)
Common Steam Unit: Millions British Thermal Units (MMBtu)

EQUIPMENT NOTES
Add additional information for your equipment

OPERATING CONDITIONS AT TIME OF ASSESSMENT
The furnace was running at the full load capacity during the PH assessment.

Fan Example
Last modified: Aug 28, 2018

System Setup Assessment Diagram Report Sankey Calculators

1 Assessment Settings 2 Fluid 3 Fan 4 Motor 5 Field Data

MOTOR

Line Frequency: 60 Hz
Rated Motor Power: 600 hp
Motor RPM: 1125 rpm
Efficiency Class: Energy Efficient
Rated Voltage: 460 V
Full-Load Amps: 683.25 A
Estimate Full-Load Amps

HELP

Motor Help
Enter measured data to calculate your system's annual savings potential.

Motor RPM
Motor RPM is the nameplate speed of the motor.

This value is used with the line frequency to determine the number of motor poles. This, in turn, is used (along with motor class and size) to estimate motor efficiency and output shaft power for the measured electrical power or current conditions.

Standard and Energy Efficient Motors

Motor Size	Minimum	Maximum
60 Hz	540 rpm	3600 rpm
50 Hz	450 rpm	3000 rpm

Premium Efficient Motors

Motor Size	Minimum	Maximum
60 Hz	1080 rpm	3600 rpm
50 Hz	900 rpm	3000 rpm

- Assessment Settings: Set units and basic assessment settings
- Assessment Specific Tabs
 - Data Entry for baseline assessment
 - Intermediate Results
 - Help text for each data entry field

Assessments

Explore energy savings opportunities

Basic Pump Example
Last modified: [Date]

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities **Optimize Pump & Motor Combo**

SELECT POTENTIAL ADJUSTMENT PROJECTS

Modify All Conditions

Optimize Pump & Motor Combo

Percent Savings (%) **9%**

	Baseline	Optimize Pump & Motor Combo
Pump efficiency (%)	81.8	87.5
Motor rated power (hp)	150	150
Motor shaft power (hp)	110.4	103.2
Pump shaft power (hp)	105.9	99
Motor efficiency (%)	93.4	96.4
Motor power factor (%)	85	83.4
Load factor (%)	74	69
Drive efficiency (%)	95.9	95.9
Motor current (amps)	130.3	120.2
Motor power (kW)	88.2	79.9
Annual Energy (MWh)	773	700
Annual Energy Savings (MWh)	—	73
Annual Cost	\$50,998	\$46,203
Annual Savings	—	\$4,795

Reheat Furnace Case Study
Fuel-fired

System Setup **Assessment** Diagram Report Sankey Calculators

Explore Opportunities **Modify All Conditions**

BASELINE

Cooling Medium	Water
Name of Cooling Medium	Water
Average Specific Heat	1 [Btu/(lb·°F)]
Density	8.338 [lb/gal]
Liquid Flow	3450 [gal/min]
Inlet Temperature	77 [°F]
Outlet Temperature	91 [°F]
Correction Factor	1

Loss #1 Total **24.1635 MMBtu/hr**

ALL OPPORTUNITIES

Cooling Medium	Water
Name of Cooling Medium	Water
Average Specific Heat	1 [Btu/(lb·°F)]
Density	8.338 [lb/gal]
Liquid Flow	3450 [gal/min]
Inlet Temperature	770 [°F]
Outlet Temperature	91 [°F]
Correction Factor	1

Loss #1 Total **-1,171.93 MMBtu/hr**

Cooling Total **-1,171.93 MMBtu/hr**

- Explore Opportunities: build scenarios from pre-established energy savings measures
- Modify All Conditions: build scenarios using same forms as baseline

- Badges and field highlighting for visual cues

Reports

View side-by-side comparison of all scenarios and graphs for data visualization

Examples / **Fan Example**
Last Modified Aug 28, 2018, 2:13:46 PM

Print Export to CSV

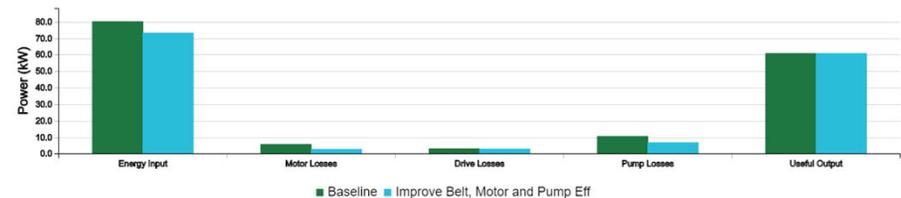
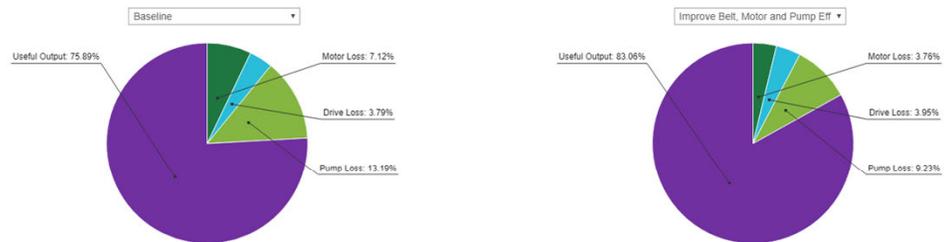
Result Data Report Graphs Sankey Input Summary Facility Info

	Baseline	Reduce Pressure and Flow	Optimize	Motor Belt Drive	Change Fan Type-Optimized
Percent Savings (%)	---	21%	16%	3%	23%
Fan Energy Index	01	01	01.2	01	01.3
Fan efficiency (%)	63.4	63	75.5	63	82.4
Motor rated power (hp)	600	600	600	600	600
Motor shaft power (hp)	577.9	454.7	485.1	558.2	444.6
Fan shaft power (hp)	554.8	436.5	465.7		
Motor efficiency (%)	95.8	95.7	96		
Motor power factor (%)	85.7	83.8	84.8		
Motor current (amps)	659.4	530.7	557.6		
Motor power (kW)	450	354.4	376.9		
Annual Energy (MWh)	3,942	3,104	3,301		
Annual Energy Savings (MWh)	---	838	641		
Annual Cost	\$236,520	\$186,254	\$198,088		
Annual Savings	---	\$50,266	\$38,432		

Examples / **Example Pump**
Last Modified Aug 20, 2018, 1:36:08 PM

Print Export to CSV

Result Data Report Graphs Sankey Input Summary Facility Info



Pumps

Basic Pump Example
Last modified: [System Setup] **Assessment** [Diagram] [Report] [Sankey] [Calculators]

Explore Opportunities Modify All Conditions
Novice View Expert View

Optimize Pump & Motor Combo
Last modified: Aug 20, 2018 [System Setup] [Assessment] [Diagram] **Report** [Sankey] [Calculators]

Example Pump
Last Modified Aug 20, 2018, 1:36:08 PM [Print] [Export to CSV]

Result Data [Report Graphs] [Sankey] [Input Summary] [Facility Info]

	Baseline	Improve Belt, Motor and Pump Eff	PSAT Optimization	Adjust Fluid Temperature	Opportunities Modification
Percent Savings (%)	--	9%	4%	1%	8%
Pump efficiency (%)	85.2	90	86.8	85.2	86.8
Motor rated power (hp)	200	200	100	200	100
Motor shaft power (hp)	99.6	94.3	97.8	98.5	93.8
Pump shaft power (hp)	95.5	90.4	93.8	94.5	93.8
Motor efficiency (%)	92.9	96.2	95.4	92.8	95.5
Motor power factor (%)	76.1	73.6	86.6	75.8	86.1
Motor current (amps)	126.5	119.5	106.2	125.5	102.4
Motor power (kW)	80	73.1	76.5	79.2	73.3
Annual Energy (MWh)	701	640	670	693	642
Annual Energy Savings (MWh)	--	60.5	31.1	7.41	59.0
Annual Cost (\$)	\$35,040	\$32,013	\$33,484	\$34,670	\$32,089
Annual Savings (\$)	--	\$3,027	\$1,556	\$370	\$2,951
Implementation Cost	--	--	--	--	--
Payback Period (months)	--	--	--	--	--

■ Compute motor full load amps, load current and power factor, fluid head, and fan and motor efficiency

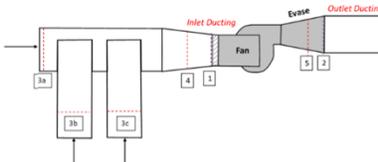
■ Explore the savings from changing pump and motor efficiency (which can be optimized automatically), flow and head, or even fluid temperature

Fans

CALCULATE FLOW AND PRESSURES

[Return to Setup](#)

2 INPUT PLANE DATA



INPUT PITOT TUBE DIFFERENTIAL PRESSURE READINGS

INSERTION POINTS	TRAVERSE HOLES									
	1	2	3	4	5	6	7	8	9	10
1	0.662	0.568	0.546	0.564	0.463	0.507	0.865	1.17	1.247	1.63
2	0.639	0.542	0.53	0.57	0.603	0.75	0.965	1.014	1.246	1.596
3	0.554	0.452	0.453	0.581	0.551	0.724	0.844	1.077	1.323	1.62

[Finish and Return to Plane Data](#)

RESULTS

Use Static Pressure Use Total Pressure

ASSESSMENT DATA

Plane #	Gas Density lb/scf	Volume Flow ft ³ /min	Gas Velocity ft/min	Status
1	0.0209268	379.792	5,834.67	Static
2	0.0220295	361.787	9,541.64	Static
3a	0.0208934	191.147	5,873.12	Static
3b	0.0209602	188.649	5,796.35	Static
4	0.0209268	379.792	5,834.67	Static
5	0.0135984	584.468	25,105.7	Static

FULL PLANAR RESULTS

BASELINE

Operating Fraction: 1

Cost: 0.06 \$/kWh

Inlet Pressure: -16.36 in H₂O

Outlet Pressure: 1.1 in H₂O

Flow Rate: 129691 ft³/min

Motor Power: 450 kW

Measured Voltage: 460 V

Specific Heat Ratio (γ): 1.4

Compressibility Factor: 0.988

REDUCE PRESSURE AND FLOW

Operating Fraction: 1

Cost: 0.06 \$/kWh

Inlet Pressure: -19.19 in H₂O

Outlet Pressure: 1.29 in H₂O

Flow Rate: 85461 ft³/min

Specific Heat Ratio (γ): 1.4

Compressibility Factor: 0.988

RESULTS

Percent Savings (%)

21%

Parameter	Baseline	Reduce Pressure and Flow
Fan Energy Index	01	01
Fan efficiency (%)	63.4	63
Motor rated power (hp)	600	600
Motor shaft power (hp)	577.9	454.7
Fan shaft power (hp)	554.8	436.5
Motor efficiency (%)	95.8	95.7
Motor power factor (%)	85.7	83.8
Motor current (amps)	659.4	530.7
Motor power (kW)	450	354.4
Annual Energy Savings (MWh)	3,942	3,104
Annual Cost	\$236,520	\$186,254
Annual Savings	—	\$50,266

- Compute motor full load amps, load current and power factor, pressure and flow from a traverse analysis, and fan and motor efficiency
- Explore the savings from changing fan and motor efficiency (which can be optimized automatically), flow and pressure, or even fluid characteristics

Process Heating

SELECT POTENTIAL ADJUSTMENT PROJECTS

Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

Add New Scenario

Modification Name Individual Opportunity 4 - Reduce O2 level in flue gases

Maintain Optimum Air/Fuel Ratio or Recommended O₂ Level in Flue Gas

Baseline Oxygen Calculation Method	Oxygen in Flue Gas	
Modified Oxygen Calculation Method	Oxygen in Flue Gas	
Baseline Oxygen in Flue Gas	6	%
Modified Oxygen in Flue Gas	2	%
Baseline Excess Air in Flue Gas		36.52 %
Modified Excess Air in Flue Gas		09.90 %

- Preheat Combustion Air
- Preheat Charge Material
- Control and Optimize Furnace Pressure
- Add / Improve Wall Insulation
- Minimize Opening Size or install tunnel-like extensions
- Install curtains or radiation shields to reduce opening losses
- Minimize the Time Furnace Doors are Open
- Optimize or Improve Furnace Cooling System
- Adjust Operational Data

Electric Arc Furnace (EAF) System Setup Assessment Diagram Report Sankey Calculators

Explore Opportunities Modify All Conditions
Novice View Expert View

Operations Charge Materials Energy Input Fixture Wall Cooling Atmosphere Opening Leakage Extended Surface Other Slag Exhaust

BASELINE		REDUCE SLAG	
Natural Gas Heat Input	6,976 MMBtu/hr	Natural Gas Heat Input	6,976 MMBtu/hr
Coal Carbon Injection	3632.9999 lbs/hr	Coal Carbon Injection	3632.9999 lbs/hr
Coal Heating Value	9000 Btu/lb	Coal Heating Value	9000 Btu/lb
Electrode Use	2065 lbs/hr	Electrode Use	2065 lbs/hr
Electrode Heating Value	12000 Btu/lb	Electrode Heating Value	12000 Btu/lb
Other Fuels	0 MMBtu/hr	Other Fuels	0 MMBtu/hr
Electricity Input	0 kW	Electricity Input	0 kW
Chemical Heat Delivered	18,889.4 kW	Chemical Heat Delivered	18,889.4 kW
Electrical Heat Delivered	24,128.4 kW	Electrical Heat Delivered	23,446.0 kW
Energy Input Total	43,017.7 kW	Energy Input Total	42,335.4 kW

- Calculate heat losses from several heater components
- Explore the savings from reducing flue gas oxygen or temperature, preheating air or charge materials, controlling furnace pressure, closing openings, etc.

Calculators

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

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Add Assessment

Home

All Assessments

- Examples
 - Reheat Furnace Case Study
 - Example Pump
 - Fan Example
- Case Studies
 - Electric Arc Furnace
 - Pusher Furnace
 - Reheat Furnace
 - Coal Dryer
 - HVAC Fan
 - Cooling Pump 1
 - Cooling Pump 2
 - Process Pump 1
 - IR furnace

All Calculators

- Motors
- Pumps
- Fans
- Process Heating
- Steam
- Compressed Air
- General

Settings

- Custom Materials
- Tutorials
- About
- Contact
- Acknowledgments

v0.3.0-beta

Motors Calculators

- NEMA Energy Efficiency**
The predicted efficiency of an induction motor from NEMA MG1, based on size, rotating speed and efficiency class.
- Motor Performance**
Plots current, efficiency, power factor vs motor shaft load for a given motor description.
- Percent Load Estimation**
Calculates Percent Load Estimation
- Motor Drive**
The Motor Drive Calculator compares the annual energy cost of three motor drives: V-belt drive, Notched V-Belt drive, and Synchronous Belt Drive. Synchronous belts are the most efficient, however cost analysis and application should be considered.
- Replace Existing Motor**
Calculate the energy savings, cost savings, and payback period for replacing an existing motor with a higher efficiency motor.
- Replace vs Rewind**
Compare the cost and energy expenditure of rewinding a failed motor versus replacing it with a new energy-efficient model.

Pump Calculators

- Head Tool**
Use head tool calculator to calculate pump head.
- System Curve**
Use system curve to graph your pumps flow.
- Specific Speed**
This calculator determines the optimal specific speed for a pump at the given conditions and calculates the amount of efficiency penalty to be deducted from the maximum value due to operation away from the optimal specific speed.
- Pump Efficiency Curves**
Determine the achievable pump efficiency for various pump styles which are based on the Hydraulic Institute (HI) standard ANSI/HI 1.3-2000
- Pump Curve**
Use pump curve calculator to develop a pump curve and explore the effects of changes in head, flow, pump speed and impeller diameter

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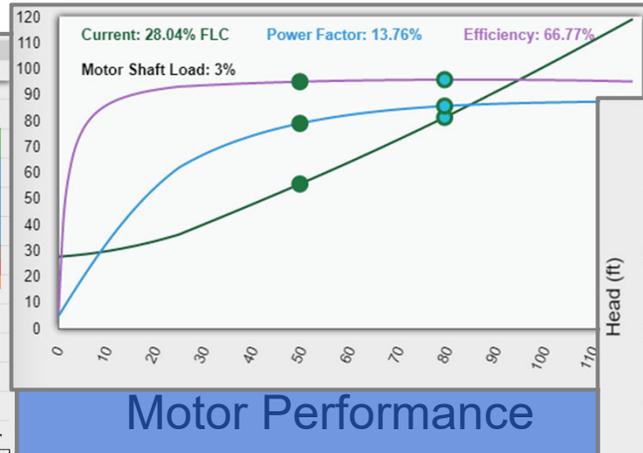
BETTER BUILDINGS

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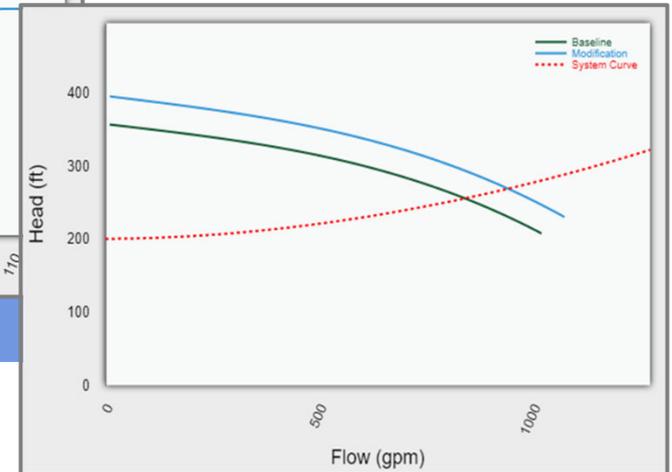
Example Calculators



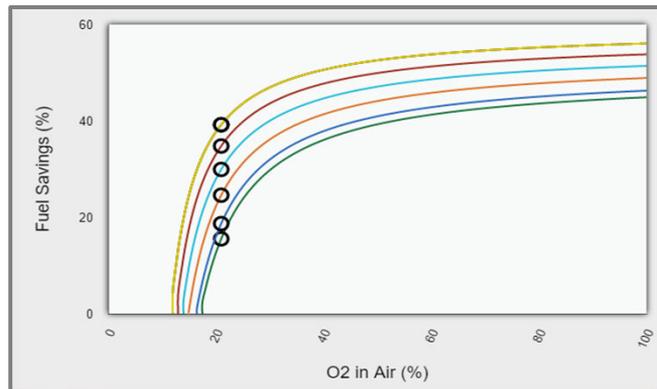
Cash Flow Diagram



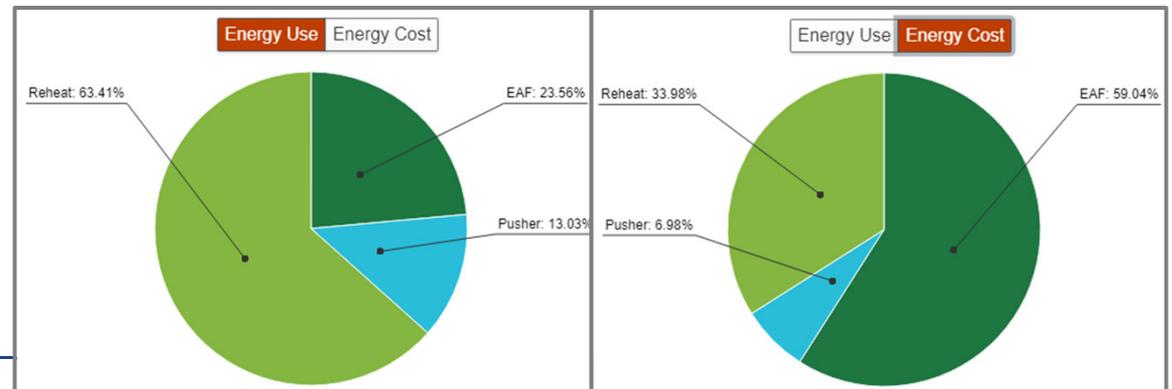
Motor Performance



Pump Curve



O₂ Enrichment

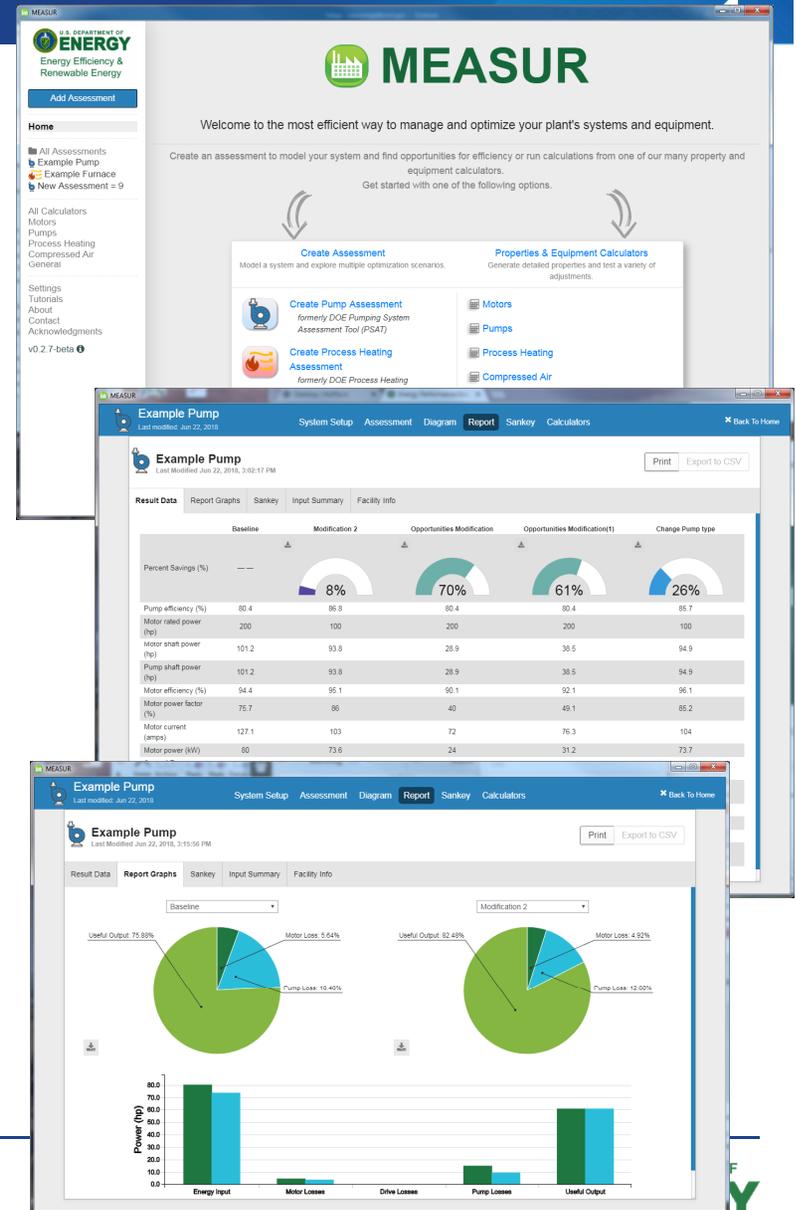


Pre-assessment

ENERGY

Results and Accomplishments

- **Community Engagement: Key Point** – want to engage end users!
- **Tool Development Schedule**
 - **Systems completed:**
 - Process Heat (PHAST)
 - Pumps (PSAT)
 - Fans (FSAT)
 - **Under Development:**
 - Steam (SSMT/SSAT) – Jan 2019
 - Compressed Air (AirMaster+) – May 2019
 - Motors (MotorMaster+) – May 2019
- www.energy.gov/eere/amo/measur
- Ongoing Feedback link - <https://www.surveymonkey.com/r/DOE-AMO-TOOLS>



Transition (beyond DOE)

What will this effort help enable going forward?

- **Open-Source** Library Suite - <https://github.com/ORNL-AMO>
 - Greater transparency
 - Future-proofing
 - New algorithms can be added to characterize other plant processes and equipment
 - Equipment providers can develop equipment specific databases that interface with the tool
- Library can be used to **effectively test** real-world equipment performance versus theoretic capabilities
- **Leverage sensors** for real-time data collection, monitoring and optimization
 - Leverage the Internet of Things devices coming online within manufacturing
- Enable **real-time system analysis and optimization**
 - Possibilities for exploring machine learning algorithms for system optimization

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 - Contributed algorithms for the new version of FSAT

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