Energy System Tools and Training Modernization

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DOE & Oak Ridge National Laboratory
FY16-FY18

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Overview

Timeline

- Project Started in March 2016
- Projected end date September 2020
- Project 65% complete

Budget

	FY 17 Budget	FY 18 Budget
DOE Funded	$750k	$760k

Barriers

- Lack of open-source resources to enable technology validation
- Lack of low-cost and unbiased means to:
  - Identify and analyze opportunities to improve and optimize current energy use
  - Identify opportunities for new or enhanced technology needs related to manufacturing energy use
  - Validate and verify new technology enhancements

Partners

- Oak Ridge National Laboratory
- Intertech Inc
- Subject Matter Experts
  - Diagnostic Solutions LLC
  - E3M LLC
  - FLOWCARE Engineering Inc
  - Productive Energy Solutions LLC
  - DOE Qualified Specialist
  - DOE Industrial Assessment Centers

Overview: Current AMO Software Tools

Today's Focus

Energy Management & Performance Tracking

50001 Ready Navigator

Automated Register of Implemented Actions

PEP (Plant Energy Profiler)

PWP (Plant Water Profiler)

Energy Footprint Tool

EnPI and EnPI Lite Tools

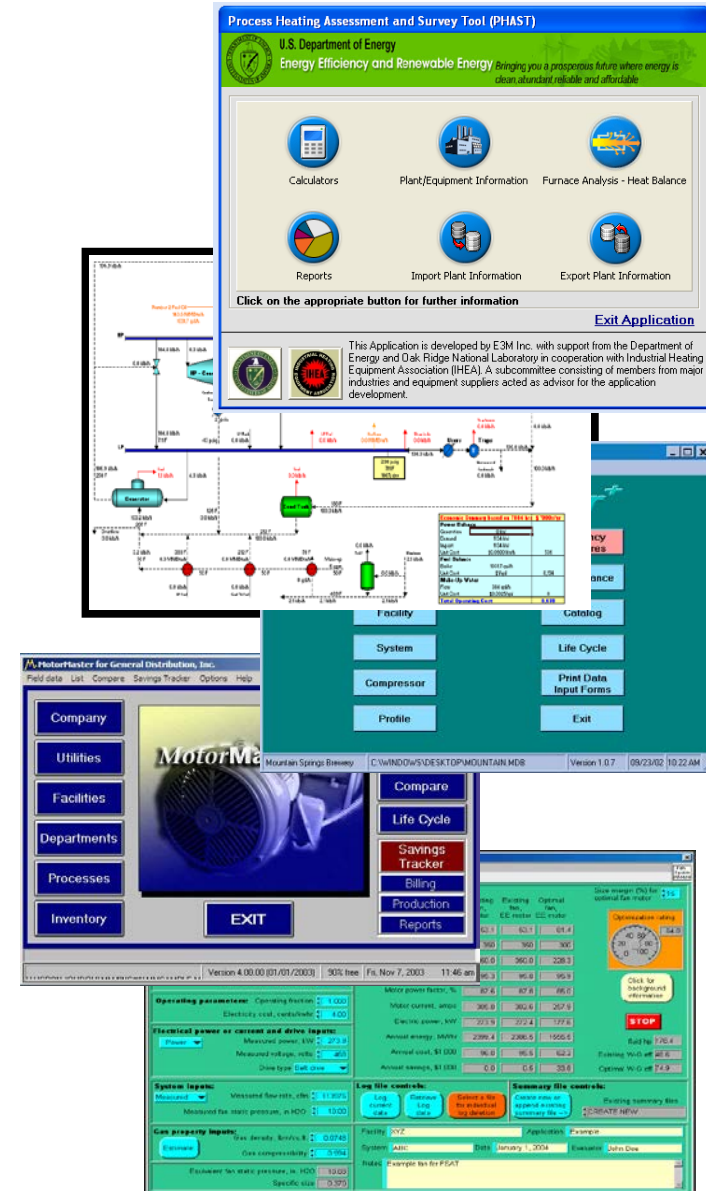Corporate Energy Performance Tracking for Better Plants partnership

Facility Energy Performance Tracking for Superior Energy Performance

Energy Systems Analysis

- **Motors**
- **Pumps**
- **Fans**
- **Compressed Air**
- **Steam**
- **Process Heating**
- Data Centers
- **Simple Calculators**

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

Overview – AMO 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

Overview – Need for DOE Energy Tool Suite

Major Industry Needs and Drivers include:

- Software tools which enable end-users to **identify, verify and validate** in-facility energy use in specific systems or plant-wide energy management

- Tools which allow users to model and **optimize energy** using equipment and systems in manufacturing environments

- **Open-source approach** enables greater transparency, community adoption, and integration into future technologies (i.e. – "Internet of Things" devices, machine learning optimization, etc)

- Low-cost and **unbiased means** to:
  - Identify and analyze opportunities to improve and optimize current energy use
  - Identify opportunities for new or enhanced technology needs related to manufacturing energy use
  - Validate and verify new technology enhancements
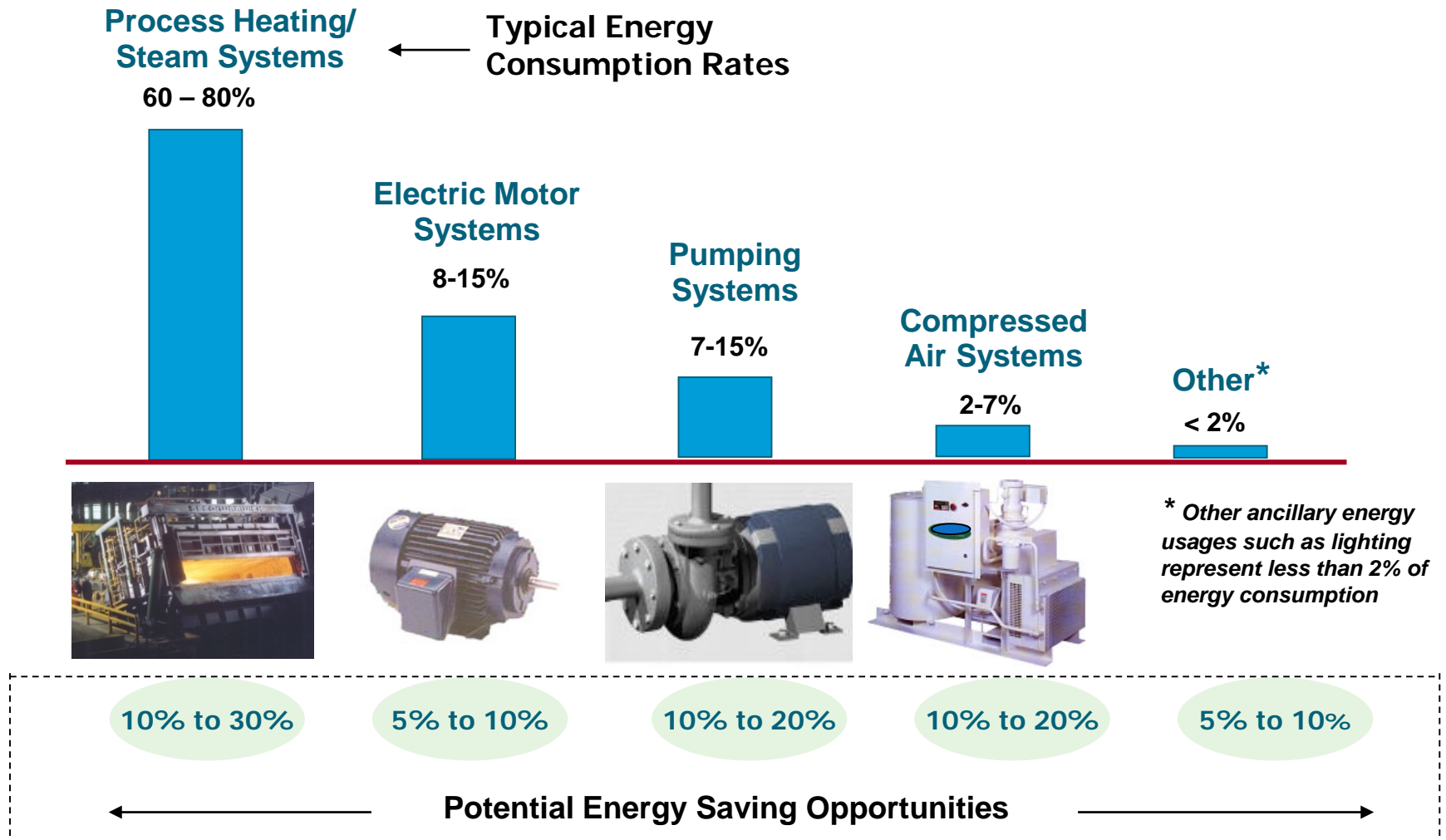
Project Objectives

AMO Multi-year Program Plan

Target 19.1 Develop or advance 15 workforce curricula focused on manufacturing energy systems and advanced technologies.

- Modernize the AMO energy system software tool suite to be compatible with current and emerging IT requirements

- Convert AMO energy system tools for pumps, fans, compressed air, steam, and process heating to open-source platform, and develop companion tool training.

- Expand AMO's In-Plant Trainings offered to Better Plants partners for energy systems and energy management.

- Support development of exam-based credentials for specific energy systems (e.g., compressed air, steam, process heating, pumping) in addition to existing Energy Management Systems certification (CP EnMS).
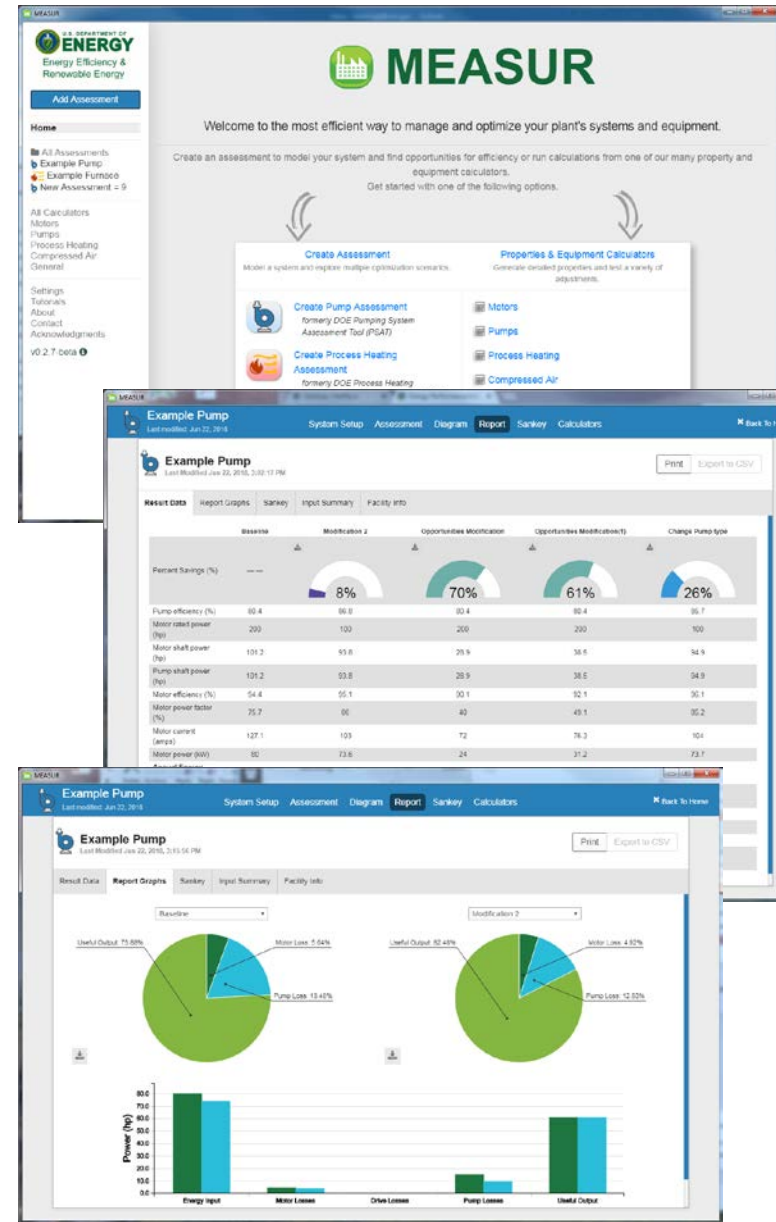
Project Objectives - Background

High-level Plant Energy & Savings Profile

**Process Heating/
Steam Systems**

**Typical Energy
Consumption Rates** ←

60 – 80%

**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

Project Objectives – Software Tools

- Modernize to **Open-Source Software**!
  - DOE will own and control code
  - Upgrading tool capabilities where feasible
  - Government-wide Open-Source Software
    - UT-Battelle Permissive License – *"Do whatever, but please provide attribution"*
  - Desktop / Web / Mobile
- Enable Technology **Field Validation**
- Provide industry with **technology/vendor agnostic** analysis and evaluation tools
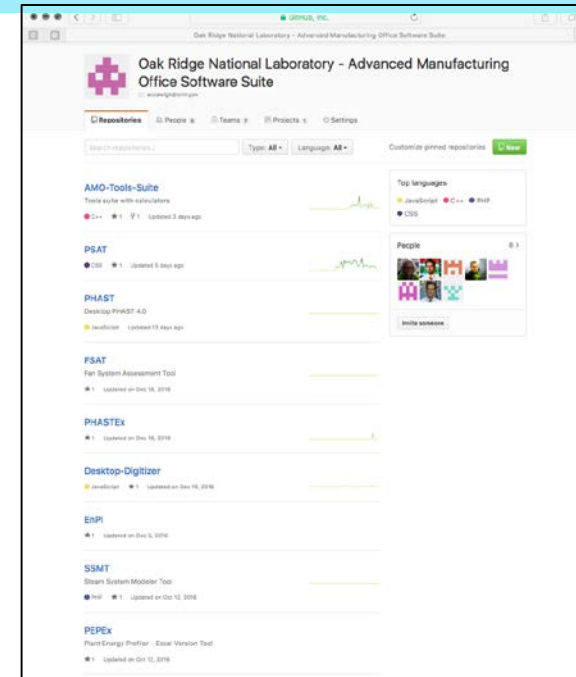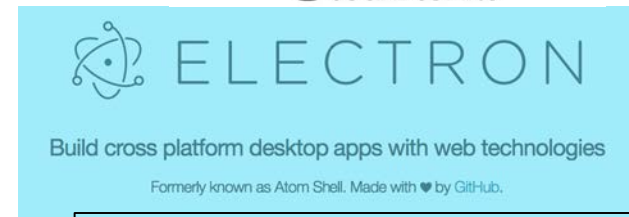
Project Objectives - Training

- Tool-use tutorials will be developed for each system tool (online, video)
- Expand deployment of In-Plant training curriculum (classroom/in-person)
  - System based with tool introduction
  - Updated curriculum combining online and classroom modules with hands-on and participant interaction focus
- Explore 3rd party development and implementation of professional certifications in key systems
  - Looking to external organizations to develop and deliver (ex: Compressed Air Challenge, CAGI, IHEA)
  - Hydraulic Institute is completing a Pump System certification w/ associated curriculum
  - *Compressed Air Challenge* has Compressed Air System curriculum

Technical Innovation and Approach

- Designed for **Multiple interfaces**
  - Desktop (Windows, Mac & Linux) & Web/Mobile
- Utilizing industry-recognized **open-source code** sharing platform
  - Provides versioning control
  - Allows individuals to follow progress and push suggested modifications
  - Repository Includes:
    - Source code, license info, configuration files, inline documentation utilizing doxygen
- **GitHub** repository for Open Access - https://github.com/ORNL-AMO
- Other Benefits:
  - Common software engine library
  - **Auto-Update** capability (silent updates)
  - Crash reporting to assist in debugging
  - Consistency in appearance across all platforms

Technical Innovation and Approach

Community Engagement: <u>Key Point</u> – want to engage end users!

- Core Development group
  - Review coding
  - Test Beta Tools
- General Stakeholders' group
  - End users of tools
  - General awareness
  - General Feedback on Tool Functionality
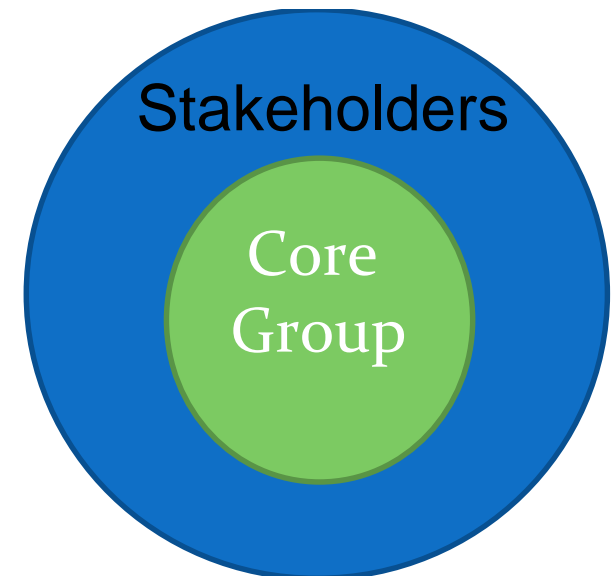 - Feature feedback – identifying additional features/calculators that could help companies
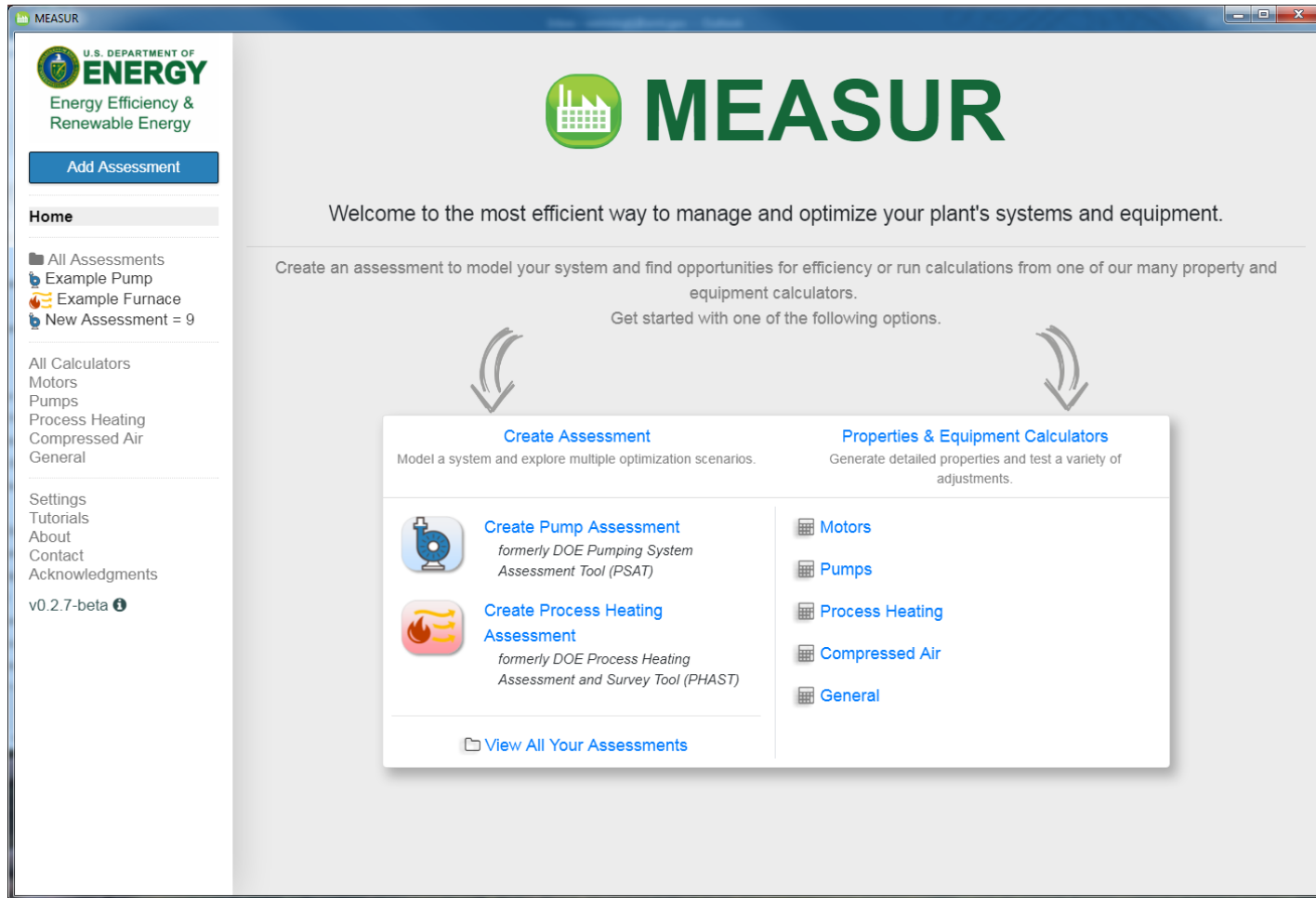
All under-development tools can be accessed:
- https://ornl-amo.github.io/

Ongoing Feedback link -
https://www.surveymonkey.com/r/DOE-AMO-TOOLS

Stakeholders

Core Group

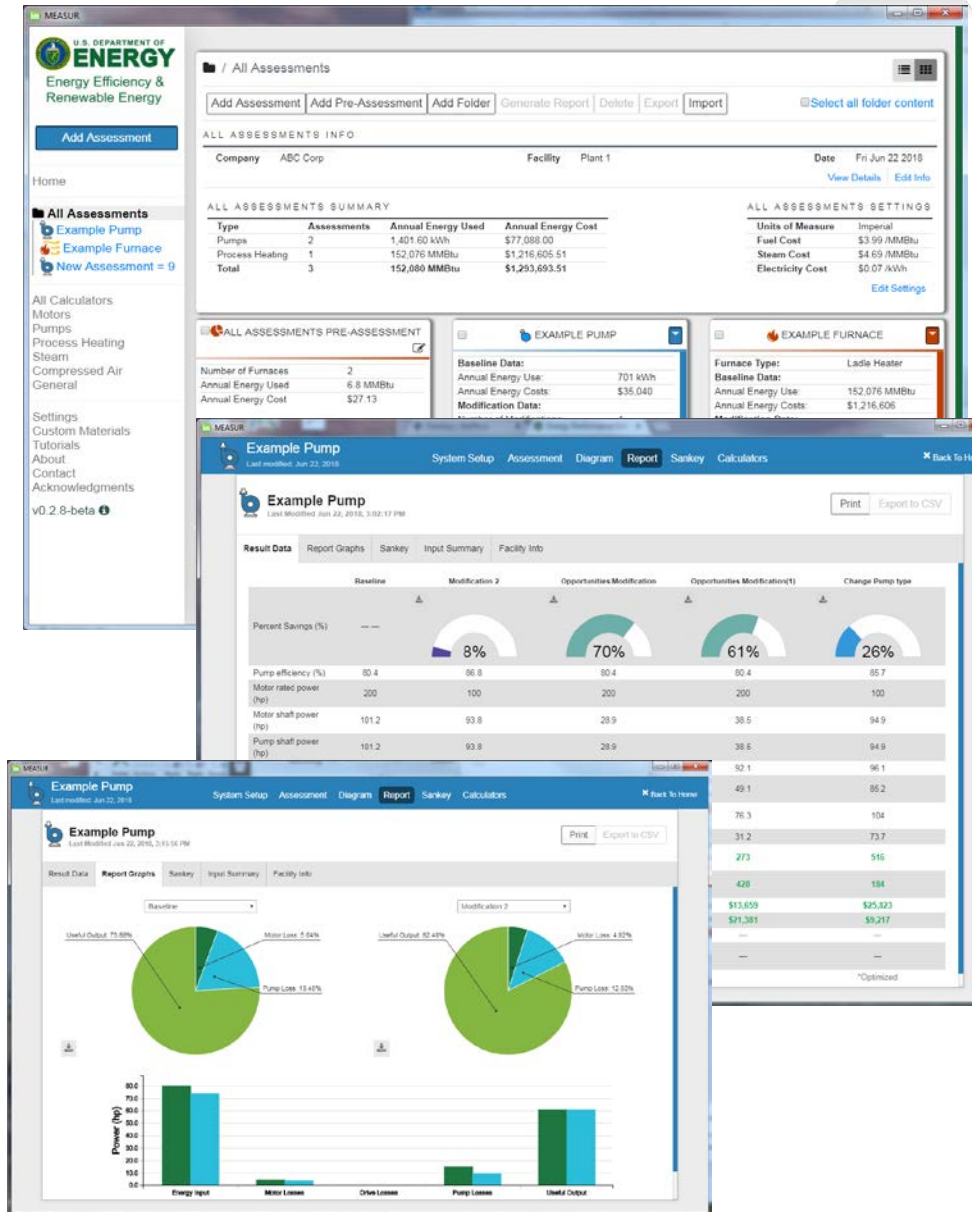# Integrated Energy Tool - MEASUR

- 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**
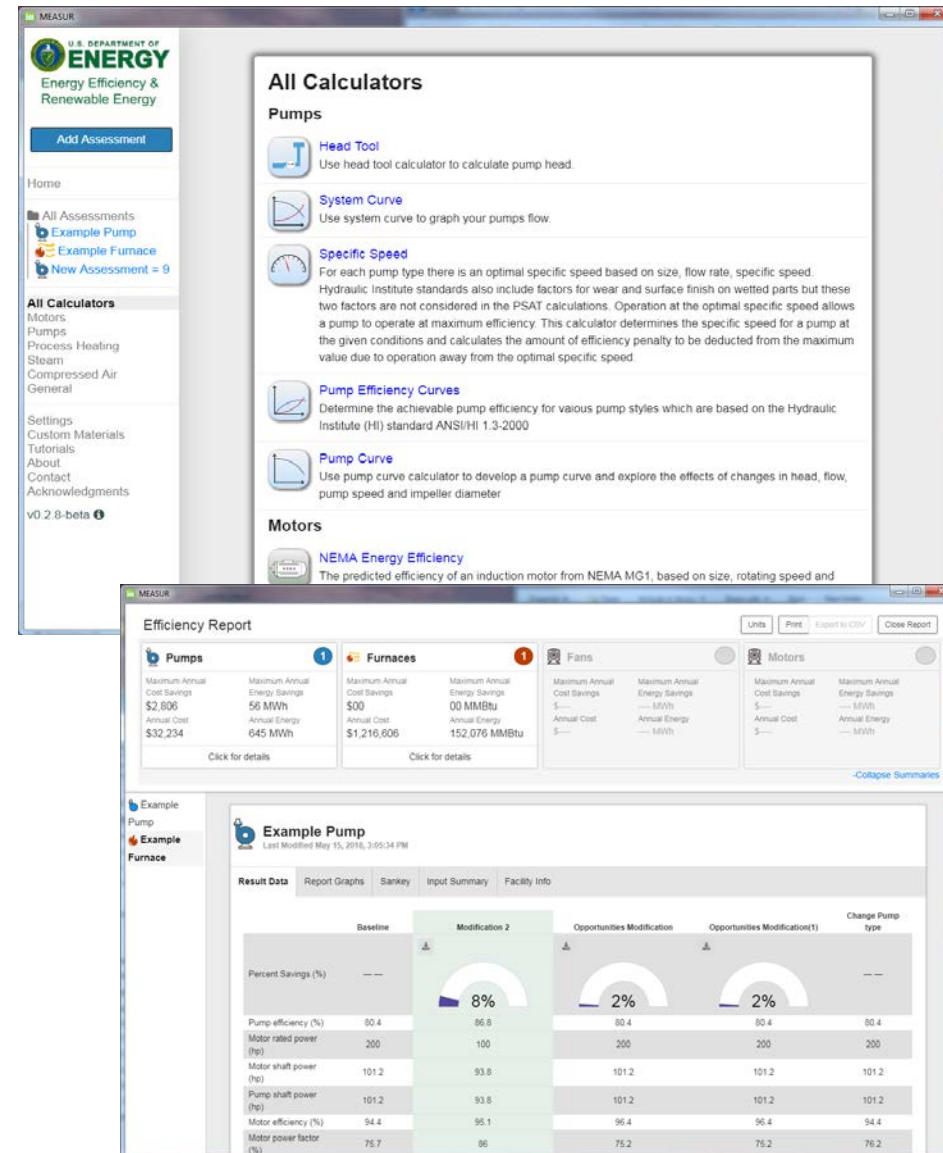
Integrated Energy Tool - MEASUR

- New functionalities
  - Built-in guided tutorials
  - Guided process to perform system assessment and field validation
    - Includes Novice and Expert Approaches
  - Dashboards for multi-system summary roll-ups
  - Dynamically generated summary reports
    - Creates PDF
    - Export to CSV & JSON files
  - Customizable system units (Standard, Metric, other)
  - Ability to evaluate numerous "alternate scenarios"
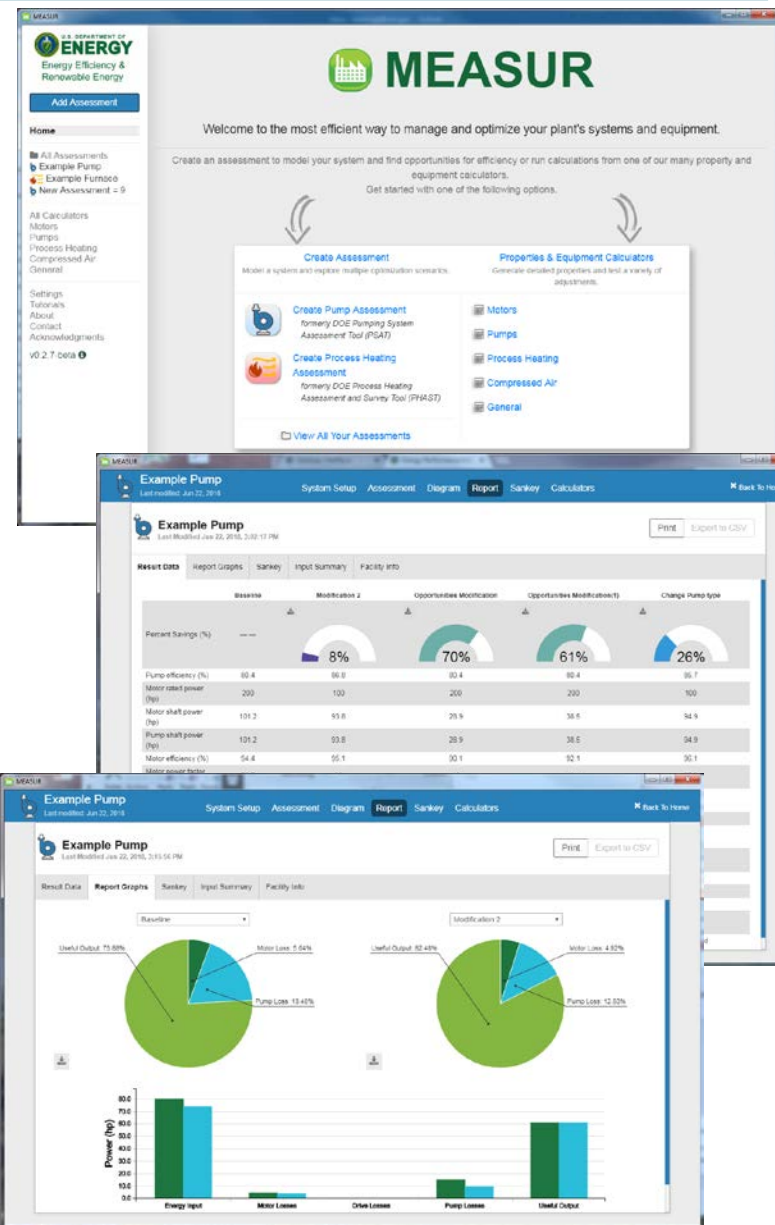
Integrated Energy Tool - MEASUR

- ## New functionalities (cont.)
  - ### Operating System flexibility
    - Windows, Mac and Linux Compatible
  - ### Downloadable and Online functionality with transferrable data structures
  - ### Auto-update capabilities (users can always have the latest version)
  - ### Provides system-level analysis modules (3 currently) or simple equipment calculators (28 currently)
  - ### Software API for 3rd party development

Results and Accomplishments

- Update and Schedule
  - Systems completed:
    - Process Heat (PHAST)
    - Pumps (PSAT)
    - Fans (FSAT)
  - Under Development:
    - Steam (SSMT/SSAT) - 9/2018
    - Compressed Air (AirMaster+) – 5/2019
    - Motors (MotorMaster+) - 5/2019
- https://www.energy.gov/eere/amo/integrated-tool-suite
- All Beta tools can be accessed:
  - https://ornl-amo.github.io/
- Ongoing Feedback link - https://www.surveymonkey.com/r/DOE-AMO-TOOLS

Transition (beyond DOE assistance)

What will this effort help enable going forward?

- **Open-Source** Library Suite
  - 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

Questions?