



**Gulf Coast Center
of Excellence**



Session 03: eLearning and Software Resources

Hannah Farias

Graduate Researcher, Gulf Coast Center of Excellence

Session Overview



Gulf Coast Center
of Excellence

This session will discuss the various technical resources and support programs available to manufacturers to enhance energy efficiency:

- Software Tools



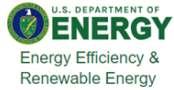
- eLearning



And More...



Software Tools for Energy Efficiency Projects



Add New ▾

Home

- ▢ All Assessments
- ▢ Examples
 - ▢ Fan Example
 - ▢ Pump Example
 - ▢ Compressed Air Example
 - ▢ Waste Water Example
 - ▢ Treasure Hunt Example
 - ▢ Steam Example
 - ▢ Process Heating - Fuel E...
 - ▢ Pump Inventory Example
 - ▢ Motor Inventory Example

Data Exploration

- All Calculators
- General
- Compressed Air
- Fans
- Lighting
- Motors
- Process Cooling
- Process Heating
- Pumps
- Steam
- Wastewater

- Download Backup Data
- Settings
- Custom Materials
- User Manuals



Welcome to the most efficient way to manage and optimize your facilities' 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.

If you need help at any point along the way, click on a [User Manual](#) icon.



[View Assessments](#)



[Equipment Calculators](#)



[Pump
Assessment](#)



[Compressed Air
Assessment](#)



[Process Heating
Assessment](#)



[Fan
Assessment](#)



[Steam
Assessment](#)



[Treasure
Hunt](#)



[Wastewater
Assessment](#)



[Motor
Inventory](#)



[Pump
Inventory](#)



[Data
Exploration](#)



Treasure Hunt Example

Last modified: Sep 19, 2024

Facility Basics

Find Treasure

Treasure Chest

Report



Find ways to save your hard earned treasure!

Use one of the following calculators to determine savings opportunities within your manufacturing facility.

Once an opportunity has been found, save the opportunity to your "Treasure Chest".

Add more details to each opportunity by clicking the  icon and filling out an opportunity sheet.

Click the "Treasure Chest" tab to view a summary of your found treasure.

Filter Calculators by Utility Type

All 



Electricity Reduction

This calculator is used to quantify the energy savings associated with reducing electricity usage.



Replace Existing Motor

This calculator calculates the energy savings, cost savings, and payback period for replacing an existing motor with a higher efficiency motor.



Upgrade 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.



Lighting Replacement

The calculator is designed to quantify the energy savings associated with lighting opportunities.



Waste Heat

Calculate energy savings from using exhaust gas (waste) heat to provide energy for an absorption chiller in place of a compressor.



Natural Gas Reduction

This calculator is used to quantify the energy savings associated with reducing natural gas usage.



Steam Reduction

This calculator is used to quantify the energy savings associated with reducing steam use.



Pipe Insulation

This calculator is used to quantify the energy savings associated with insulating hot pipes.



Tank Insulation

This calculator is used to quantify the energy savings associated with insulating hot tanks.



Flue Gas

Determine the amount of heat lost in the furnace flue gas.



Opening Loss

Estimates losses due to openings in the heating system.



Wall Loss

This calculator can be used to calculate fuel savings due to changes in wall insulation for a heating system.

Compressed Air Calculators



Compressed Air Flow
Quantify the energy



Compressed Air Pressure
Quantify the energy



Compressed Air Leak
Quantify the energy



Actual to Standard
Converts acfm (Actual) to standard conditions



Bleed Test
Estimate leak rate for



Leak Loss Estimation
Estimates the leakage

Motors Calculators



NEMA Energy
Shows the predicted



Motor Performance
Plots current, efficiency



Percent Load
Calculate percent



Motor Drive Comparison
Compares the actual



Replace vs Repair
Compares the cost



Full-Load Amps
Calculate the full

Process Cooling Calculators



Chiller Analysis
Analyze



Chiller Analysis
Analyze



Cooling Analysis
Analyze



Cooling Calculation
Calculate



Cooling Analysis
Analyze



Psychrometric Calculator
Calculate the properties of moist air based on formulas published in ASHRAE Fundamental Handbook.

Pump Calculators



Pump Head Tool
Calculate pump head using inlet and out pressures, elevation and pipe diameter



Specific Speed
Calculate the optimal specific speed for a pump and the penalty due to non-optimal operation



Pump Achievable Efficiency
Estimate the achievable pump efficiency for various pump styles based on ANSI/HI 13-2000



Pump Curve
Develop a pump curve and explore the effects of changes in head, flow, pump speed and impeller diameter


Pump Example
 Last modified: Sep 19, 2024

System Setup | Assessment | Diagram | Report | Sanke

1 Assessment Settings | **2** Operations | **3** Pump & Fluid | **4** Motor | **5** Field Data

PUMP

Pump Type End Suction ANSI/API
 Pump Speed 2000 rpm
 Drive V-Belt Drive

FLUID

Fluid Type Water
 Fluid Temperature 68 °F
 Specific Gravity 1.002
 Kinematic Viscosity 1.107 cSt
 Stages - + 1


Pump Example
 Last modified: Sep 19, 2024

System Setup | **Assessment** | Diagram | Report | Sanke

Explore Opportunities | Modify All Conditions

Novice View | Expert View

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 New Pump and Motor

Implementation Costs \$

☐ Install VFD

☐ Install More Efficient Drive

☒ Install More Efficient Pump

Baseline Pump Type End Suction ANSI/API

Modification Pump Type End Suction ANSI/API

Modification 87.52 %
 Pump Efficiency
[Known Efficiency](#)

The efficiency of your pump has been calculated based on your flow rate and selected pump type. Click "Known Efficiency" to use the efficiency calculated by your system setup.

☒ Reduce System Flow Rate

Baseline Flow Rate 2,500 gpm

Modification Flow Rate 2499.99 gpm

☒ Reduce System Head Requirement

Baseline Head 410 ft

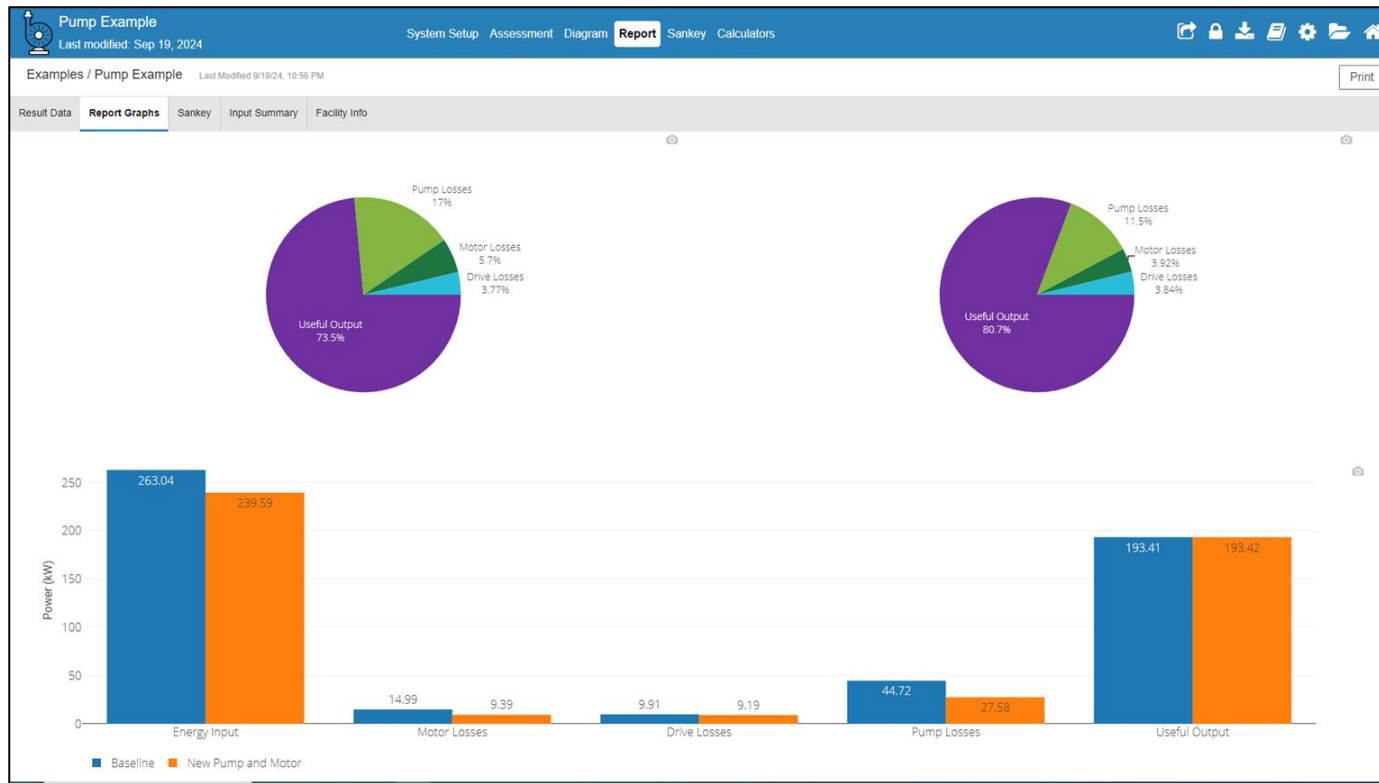
Modification Head 409.99 ft
[Calculate Head](#)

☐ Adjust Operational Data

☒ Install More Efficient Motor

Baseline Efficiency Class Standard Efficiency

Modification Efficiency Class Premium Efficient





Software Tools for Steam Systems

Major manufacturers of steam system components offer training resources and online calculators.

Caution:

- Flow calculations can vary significantly between sites
- Some sites provide equations behind calculations, others don't
- Read the "fine print" and compare answers to ensure that energy savings estimates are reasonable

TLV: Steam System Calculators



- Fundamentals of Steam Systems
- <http://www.tlv.com/global/US/steam-theory>
- Online Calculators
 - Flow through an orifice (steam, air, water)
 - Condensate Recovery
 - Flash Steam Generation
- <http://www.tlv.com/global/US/calculator/>

TLV A Steam Specialist Company

English (N.America) Search

Products Resources & Tools Training Corporate Profile Contact Us

Home > Steam Theory > Steam Trap Losses - what it costs you

Steam Theory

- 1. Basics of Steam
- 2. Basics of Steam Traps
- 3. Steam Trap Selection
- 4. Steam Trap Problems
- 5. Steam Trap Management
- Steam Trap Losses - what it costs you**
- A Guide to Steam Trap Testing
- Implement a Sustainable Steam Trap Management Program
- Why Bad Things Happen to Good Steam Equipment
- 6. Water Hammer
- 7. Steam Quality
- 8. Steam Distribution
- 9. Condensate Recovery
- 10. Energy Efficiency
- 11. Compressed Air / Gas
- 12. Other Valves

Steam Trap Losses - what it costs you

Have you had times when you can see the white cloud of your breath in the winter and the interior of the plant is white with thick clouds of vapor?

This is a time when the outside temperature is low and more vapor than usual is generated - a cause for concern for the persons doing trap maintenance. It is recommended that a failed trap be replaced as soon as it is found.

Even one failed trap can have steam leakage resulting in losses of hundreds of dollars/pounds/euros per year. Though it depends somewhat on the other conditions, traps on applications of 150 psi or less will typically have a service life of many years, making it possible to recover investment costs in approximately 1 year in most regions. Vapor is not only unsightly - let's calculate the monetary losses that shouldn't be overlooked if the vapor results from steam leakage.

Calculating the cost of losses from one trap

Please note, values are approximate.

Amount of steam leakage (lb / h)
Enter numbers here

Hours in operation (h / yr)
Enter numbers here

Unit cost of steam (\$ / 1000 lb)
Enter numbers here

Calculate

Cost of losses from 1 trap
\$ / yr

Contents:

1. Calculating the cost of losses from one trap
2. Calculating steam leakage amounts from holes in piping

Copyright TLV CO., LTD.

TLV: Steam System Calculators

Engineering Calculator

Steam

Piping Design

Pipe Sizing by Pressure Loss

Pipe Sizing by Velocity

Pipe Sizing for Steam Vent

Pressure Loss through Piping

Steam Velocity through Piping

Steam Flow Rate through Piping

Economical Insulation Thickness

Valves and Orifices

Condensate Load

Improved Steam Dryness

Effect of Air Mixed in

[Home](#) / [Engineering Calculator](#) / Calculator: Pipe Sizing by Pressure Loss for Steam

Calculator: Pipe Sizing by Pressure Loss for Steam



TLV ToolBox - For iOS and Android

Input Data

Units Imperial

Pipe Grade

ANSI Sch40

Steam Pressure

0

psig

Steam Flow Rate

0

lb/h

Maximum Allowable Pressure Loss

0

psi

Pipe Length [?]

0

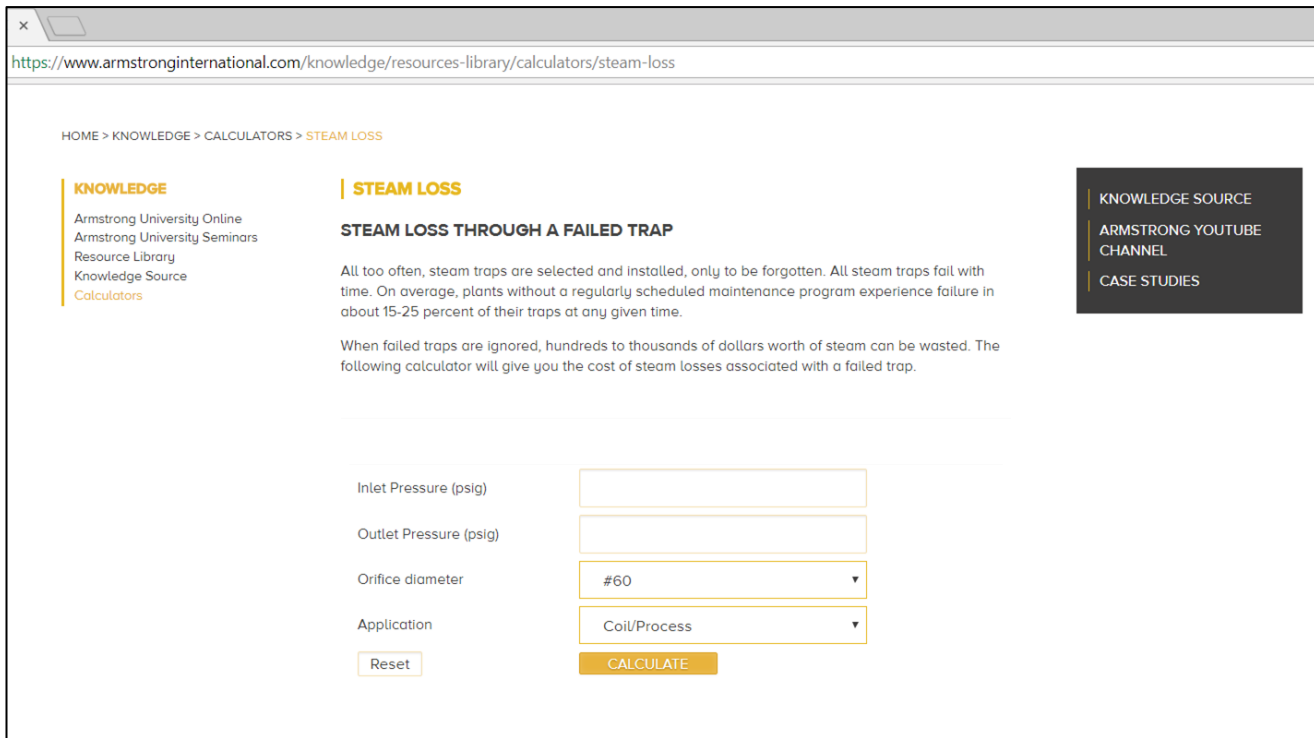
ft

[+ Show Advanced Options](#)

- Online Calculator

- **Example:** Steam Loss through a Failed Trap

- <https://www.armstronginternational.com/knowledge/resource-library/calculators/steam-loss>



The screenshot shows a web browser window with the URL <https://www.armstronginternational.com/knowledge/resource-library/calculators/steam-loss>. The page has a breadcrumb trail: HOME > KNOWLEDGE > CALCULATORS > STEAM LOSS. On the left, a 'KNOWLEDGE' sidebar lists: Armstrong University Online, Armstrong University Seminars, Resource Library, Knowledge Source, and Calculators (highlighted). The main content area is titled 'STEAM LOSS' and 'STEAM LOSS THROUGH A FAILED TRAP'. It contains two paragraphs of text explaining the importance of regular maintenance and the potential cost of failed traps. Below the text is a form with four input fields: 'Inlet Pressure (psig)', 'Outlet Pressure (psig)', 'Orifice diameter' (set to #60), and 'Application' (set to Coil/Process). There are 'Reset' and 'CALCULATE' buttons at the bottom of the form. On the right, a dark sidebar lists: KNOWLEDGE SOURCE, ARMSTRONG YOUTUBE CHANNEL, and CASE STUDIES.

HOME > KNOWLEDGE > CALCULATORS > STEAM LOSS

KNOWLEDGE

- Armstrong University Online
- Armstrong University Seminars
- Resource Library
- Knowledge Source
- Calculators

STEAM LOSS

STEAM LOSS THROUGH A FAILED TRAP

All too often, steam traps are selected and installed, only to be forgotten. All steam traps fail with time. On average, plants without a regularly scheduled maintenance program experience failure in about 15-25 percent of their traps at any given time.

When failed traps are ignored, hundreds to thousands of dollars worth of steam can be wasted. The following calculator will give you the cost of steam losses associated with a failed trap.

Inlet Pressure (psig)

Outlet Pressure (psig)

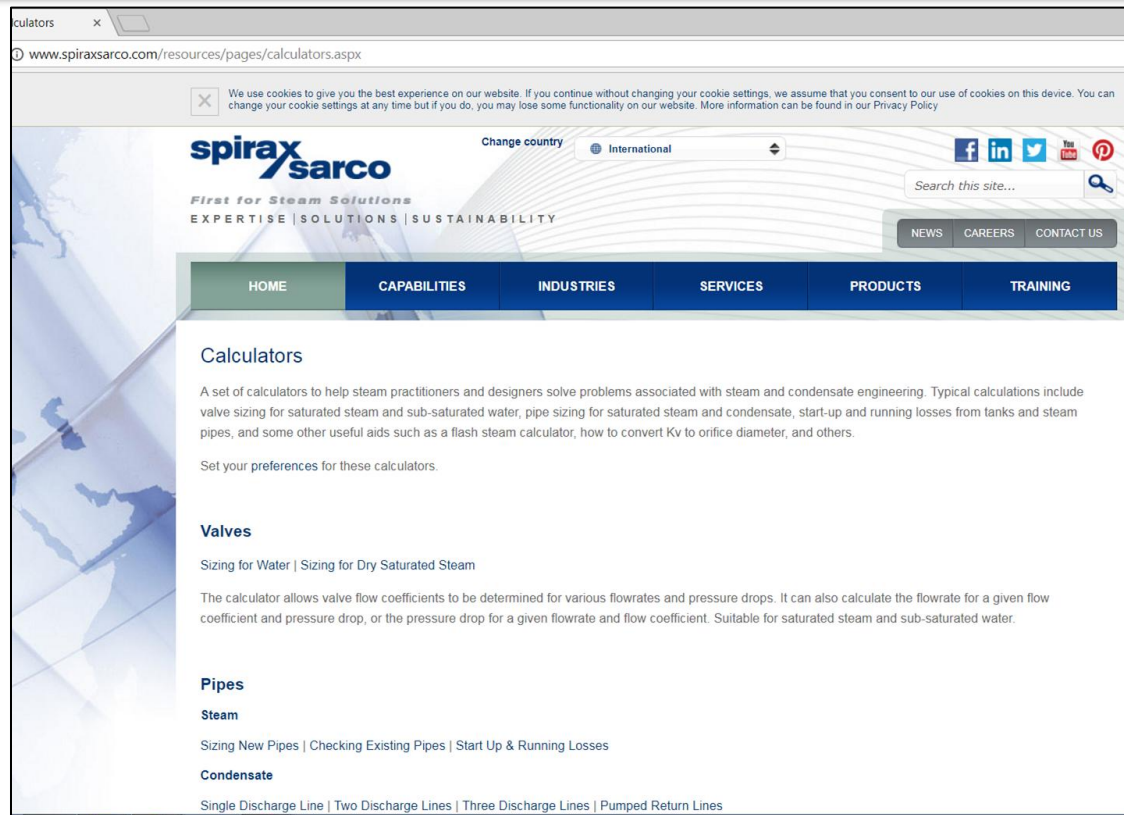
Orifice diameter

Application

KNOWLEDGE SOURCE

- ARMSTRONG YOUTUBE CHANNEL
- CASE STUDIES

- Online Calculator
- <http://www.spiraxsarco.com/resources/pages/calculators.aspx>





Software Tools for Waste Heat Recovery

3E Plus: Insulation Modeling Software



- A free online software for calculating the appropriate insulation thickness.
- The calculator also estimates energy savings, cost savings, and avoided carbon emissions.
- Includes a library of commercially available insulation materials and form factors.

Last saved: just now [CALCULATIONS](#) [MATERIALS](#) [TEAMS](#) IP  SI [BRYAN R](#) 

Favorites  

Test 

Example 1C 

SEE ALL PROJECTS

Insulation Details

System Application
Pipe - Horizontal 

Dimensional Construction
ASTM C 585 Rigid 

Pipe Size
15 mm 

[SHOW PREVIEW](#)

Insulation Layers

Filter Materials
All Materials 

Type	Name	Thickness
● Base Metal	Steel 	
● Insulation 1	850F MF BLANKET, Type IV, C553-... 	Varied  
● Jacket Material	0.3 – Stainless Steel, dull, in servi... 	

[+ ADD LAYER](#)

Calculations

[CALCULATE](#)

3E Plus: Insulation Modeling Software



Insulation Details

System Application: Pipe - Horizontal
Dimensional Construction: ASTM C 585 Rigid
Pipe Size: 15 mm

SHOW PREVIEW

Insulation Layers

Filter Materials
All Materials

Type	Name	Thickness
Base Metal	Steel	
Insulation 1	850F MF BLANKET, Type IV, C553-...	Varied
Jacket Material	0.3 - Stainless Steel, dull, in servi...	

+ ADD LAYER

Calculations

CALCULATE

Calculation Types

Personnel Protection

Personnel Protection

Thickness Table

Max Surface T...
140 °C

Process Temp
450 °C

Ambient Temp
80 °C

Wind Speed
0 m/s

Results

REPORT ALL ALL

Example 1C: NU01A

Calculation Results
Personnel Protection

REPORT CSV

Insulation Thickness (mm)	Surface Temp (°C)	Heat Flow (W/m)	Efficiency (%)
Bare	448.8	1047.53	—
15.0	214.5	258.13	75.36
25.0	158.6	188.17	82.04
40.0	132.9	154.32	85.27
50.0	120.7	137.19	86.9
65.0	109.5	120.17	88.53
80.0	105.1	113.07	89.21
90.0	101.9	107.47	89.74
100.0	99.3	102.93	90.17
115.0	97.1	98.68	90.58
125.0	95.5	95.52	90.88
140.0	94.1	92.79	91.14
150.0	92.8	89.84	91.42
165.0	91.8	87.77	91.62
175.0	91	85.92	91.8
190.0	90.3	84.25	91.96
200.0	89.7	82.74	92.1
215.0	89.1	81.35	92.23
225.0	88.6	80.07	92.36
240.0	88.2	78.9	92.47
250.0	87.8	77.81	92.57

Results include:

- Surface temperature
- Heat loss per length

Excel-based questionnaire designed to assist plants in assembling information needed to procure vendor quotes for an Industrial Heat Pump (IHP supplier list included)

Industrial Heat Pumps are best for applications:

- Process heating loads **require temperatures of 250°F/121°C or less**
- Process heating operations run for **more than 4,000 hours per year**
- There are **simultaneous, co-located heating and cooling needs**
- There are **waste heat recovery opportunities** that is 80°F/27°C or greater and, in aggregate, greater than 1 MMBTUs/hour or comparable to the size of the heating load

CHP eCatalog

- List of packaged CHP systems
- Filter by:
 - Geographic Availability
 - kW size
 - Prime Mover
 - Fuel
 - Thermal Output Type
 - etc.

<https://chp.ecatalog.ornl.gov/search>

TEDOM USA:
QUANTO 2000 C

Download PDF version 
(login required)

OVERVIEW 


Quanto 2000 C

PACKAGED CHP SYSTEM HIGHLIGHTS

CHP Packager	Tedom USA
Model	Quanto 2000 C
Thermal Outputs	Hot Water
Assurance Plan	Depends on location
Grid Connection Type	Grid Parallel and Stand-alone Transition: Automatic
Outdoor Placement	Standard Option

KEY PERFORMANCE DATA

Prime Mover	Reciprocating engines MWM TCG2020V20
Number of Prime Movers	1
Net Power Output (kW) ₂	1,960
Fuel	Natural Gas or Pipeline RNG

- List of packaged CHP systems
- Filter by:
 - Geographic Availability
 - kW size
 - Prime Mover
 - Fuel
 - Thermal Output Type
 - etc.

<https://chp.ecatalog.ornl.gov/search>

PERFORMANCE DATA									
Performance data presented below is based on capacity that is available at the respective prime mover load conditions. Fuel data is in Higher Heating Value (HHV). Note that when multiple thermal capacities are presented e.g. hot water, steam, chilled water and/or CRC kW, these capacities are based on using all the thermal heat available from the prime mover and should be viewed as independent and not concurrent with other thermal capacities. Exception, for reciprocating engines steam production is generally using only exhaust heat so that hot water or chilled water capacity is concurrent with the steam capacity. All performance ratings are at sea level and adjustments should be made for operation at altitude, particularly for microturbines and combustion turbines. In all cases, contact the Packager or Solution Provider for site specific details.									
	100% GROSS POWER			75% GROSS POWER			50% GROSS POWER		
Ambient Temperature	95°F	59°F	0°F	95°F	59°F	0°F	95°F	59°F	0°F
CHP Fuel Input (MMBtu per hour HHV)	17.3	17.3	17.3	13.4	13.4	13.4	9.5	9.5	9.5
Gross Electricity Output (kW)	2,000	2,000	2,000	1,500	1,500	1,500	1,000	1,000	1,000
Net Electricity Output (kW)	1,960	1,960	1,960	1,470	1,470	1,470	980	980	980
Net Electric Efficiency % (HHV)	38.7	38.7	38.7	37.4	37.4	37.4	35.2	35.2	35.2
Supply Temp to Site (°F)	180 °F			180 °F			180 °F		
HW flow (GPM)	631	618	618	500	493	493	368	364	364
Return Temp from Site (°F)	158	158	158	158	158	158	158	158	158
Hot Water Capacity (MMBtu/hr)	6.94	6.80	6.80	5.50	5.42	5.42	4.05	4.01	4.01
Thermal Efficiency % (HHV)	40.1	39.3	39.3	41.0	40.4	40.4	42.6	42.2	42.2

*Be sure that the site thermal load will handle return water temperatures to the CHP system as stated. (e.g. 5 to 10 F below) Otherwise, hot water capacity will be less than stated. Contact the Packager/Solution Provider for details.



Software Tools for Renewable Energy

SAM: System Advisor Model and PVWatts



Free software that enable detailed performance and financial analysis for renewable energy systems



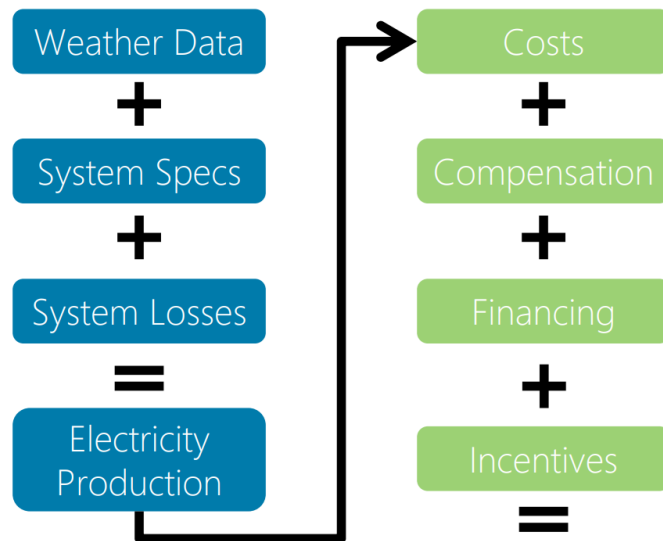
Figure Credit: NREL
<https://sam.nrel.gov/>

<http://sam.nrel.gov/download>
<https://pvwatts.nrel.gov>

SAM: System Advisor Model and PVWatts



Steps to Modeling Renewable Energy



Technologies

Photovoltaics
Detailed & PVWatts
Battery Storage
Concentrating solar power
Fuel cell-PV-battery
Wind
Marine Energy
Geothermal
Solar water heating
Biomass

Financial

Behind-the-meter
residential
commercial
third-party owned
Power purchase agreements
single owner
equity flips
sale-leaseback
Host/developer
Merchant plant
Simple LCOE calculator

Results

Annual, Monthly, and Hourly Output, Capacity Factor, LCOE, NPV, Payback, Revenue

Reopt: Renewable Energy Optimization



The REopt web tool allows users to evaluate the economic viability of distributed energy resources (DER)

- PV
- wind
- battery storage
- combined heat and power (CHP)
- geothermal heat pumps (GHP)
- thermal energy storage

The tool can also identify optimal system sizes and dispatch strategies to **minimize energy costs** or **maximize resilience**.

Step 1: Choose Your Focus

Do you want to optimize for financial savings or energy resilience?

\$ Financial

🛡️ Resilience



Step 2: Enter Your Data

Enter information about your site and adjust the default values as needed to see your results.

📍 Site and Utility (required)	⊕
📶 Load Profile (required)	⊕
\$ Financial	⊕

Step 3: Select Your Technologies

Which technologies do you wish to evaluate?

☒ PV ⚙️	☒ Battery 🔋	☒ Wind 🌪️
---	---	---

⚙️ PV	⊕
🔋 Battery	⊕
🌪️ Wind (Beta Version)	⊕

🔄 Reset to default values

Get Results ⊕

<https://reopt.nrel.gov/tool>

Reopt: Renewable Energy Optimization

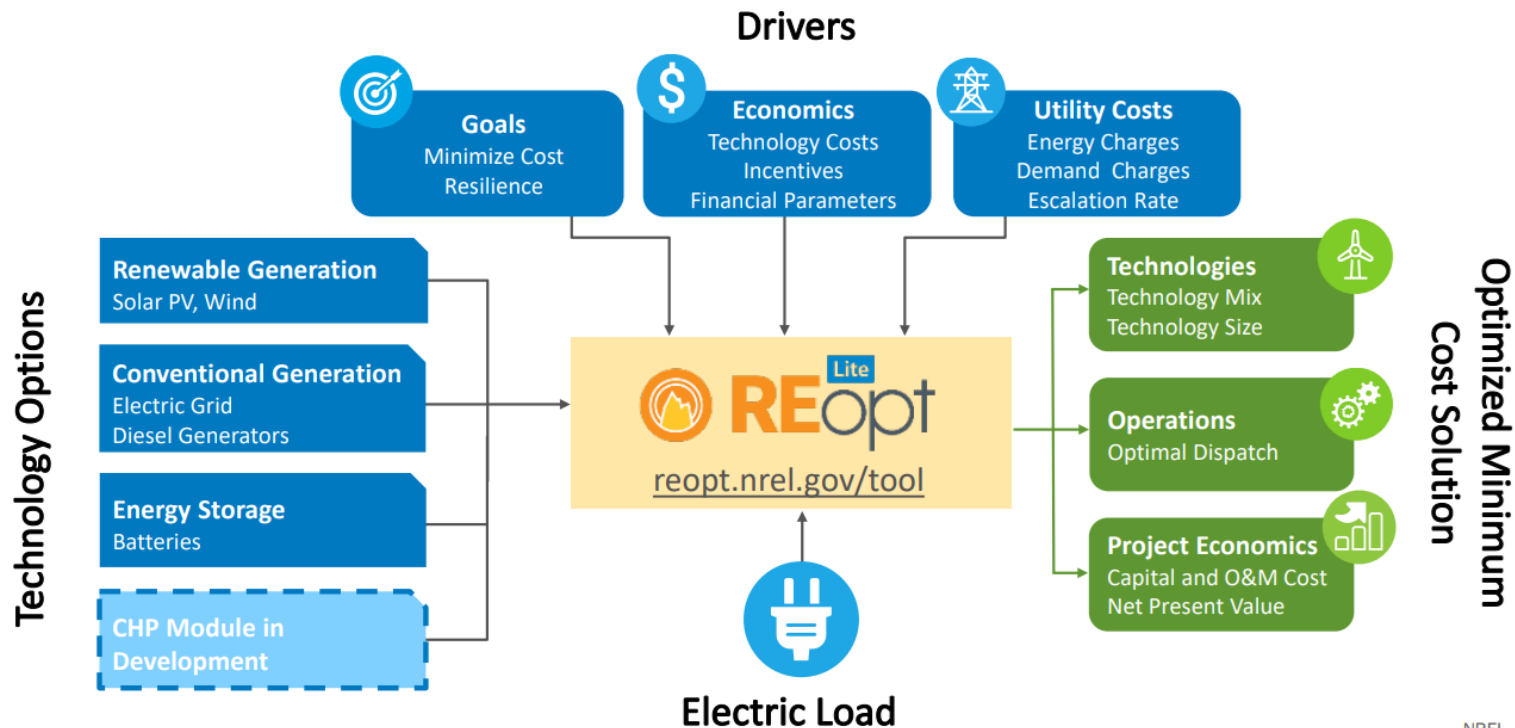
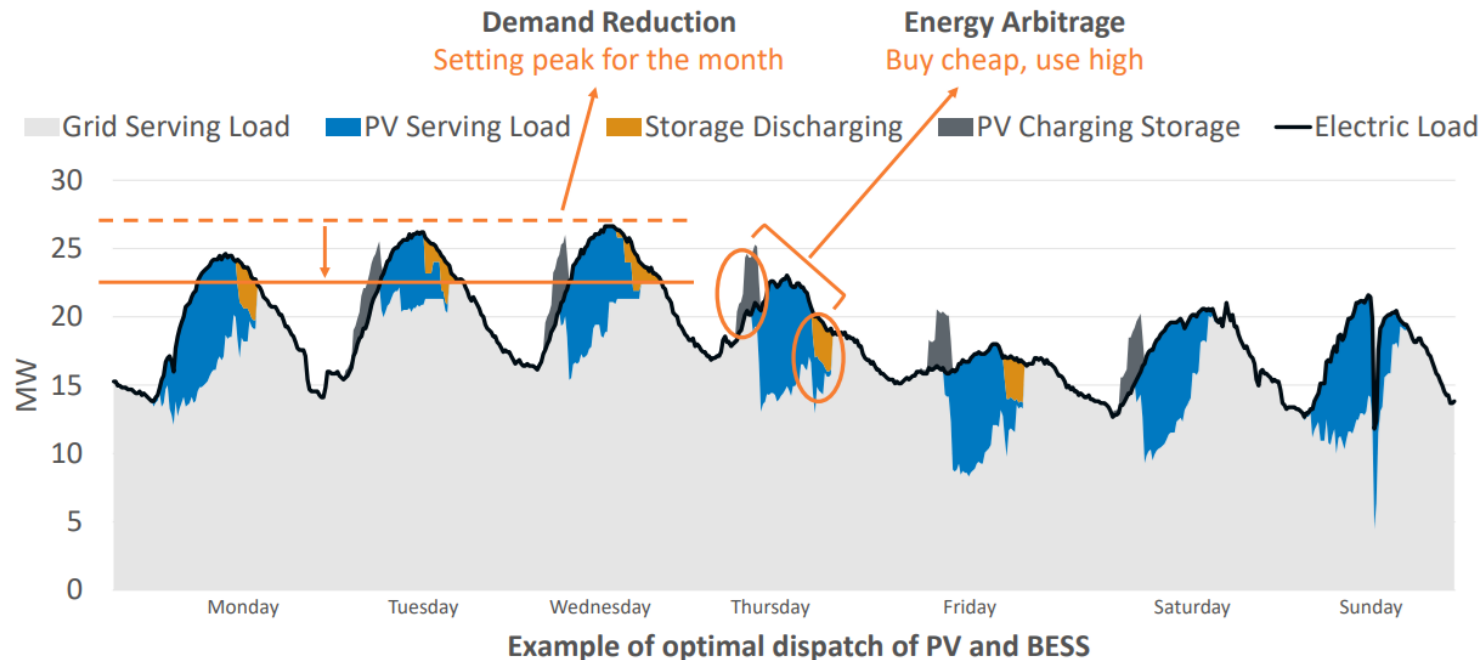


Figure Credit: NREL
<https://www.nrel.gov/reopt/curriculum/curriculum.html>

NREL |

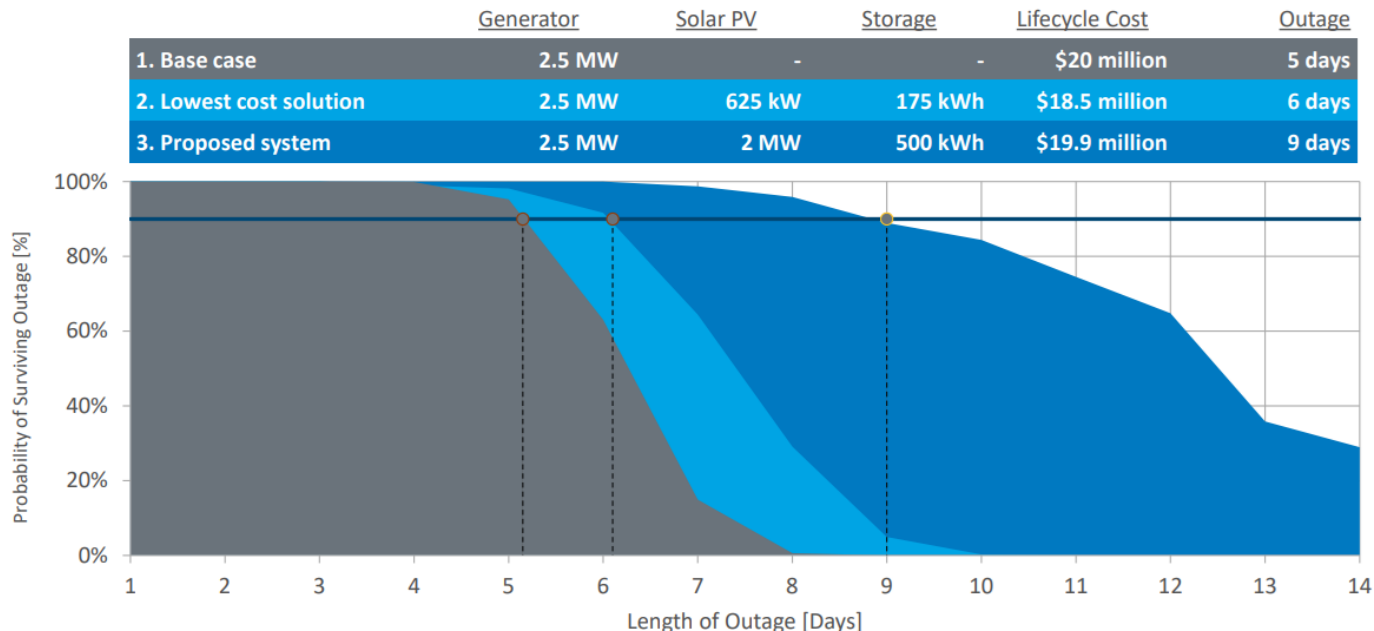
Reopt: Renewable Energy Optimization



NREL |

Figure Credit: NREL
<https://www.nrel.gov/reopt/curriculum/curriculum.html>

Reopt: Renewable Energy Optimization



NREL |

Figure Credit: NREL
<https://www.nrel.gov/reopt/curriculum/curriculum.html>



eLearning

IAC 101 Videos and Webinars



A set of training videos created by Dr. Michael Muller of Rutgers University.

The videos cover common industrial energy systems, including compressed air, steam, motors, industrial cooling, etc.

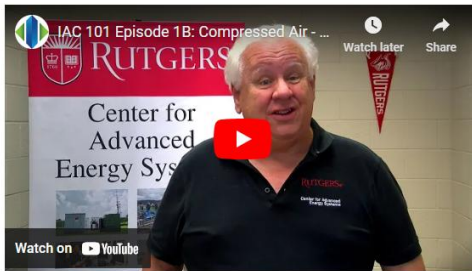
<https://iac.university/iac101>

 IAC 101 [back to top ↑](#)

Episode 1B: Air Compressors: Demand

Dr. Michael Muller of Rutgers University talks about the demand side of air compressors. Topics include how to find holes in a compressed air system, common oversights by plants when using compressed air, and how IIOT can be used for compressed air systems. This is the final part of the air compressor series.

[Take the Air Compressors Demand Online Quiz](#)



Watch on  YouTube

Episode 2A: Efficiency in Industrial Cooling

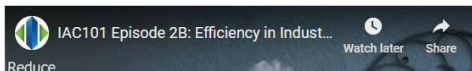
Dr. Michael Muller of Rutgers University talks about process cooling. Topics include the importance of industrial cooling and its related efficiencies, chiller basics, process temperature control, temperature reaction management, and ancillary processes such as refrigeration and cold storage. This is the first installment of a two-part series on industrial cooling.

[Take the Industrial Cooling Online Quiz](#)



Watch on  YouTube

Episode 2B: Efficiency in Industrial Cooling Towers

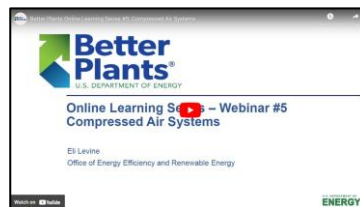
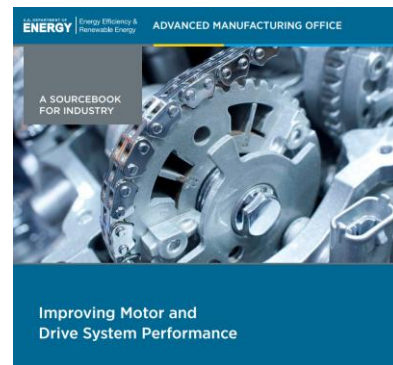


Reduce

Better Plants Resource Library



- **Better Plant Info Cards.** A set of concise information cards on key industrial systems, which include “Top 5 Energy Conservation Measures” and common rules-of-thumb for estimating energy savings.
- **Sourcebooks and Tip Sheets.** A set of reference manuals with a particular focus on opportunities for improving system performance. Each sourcebook includes “tip sheets” of common energy efficiency measures.
- **Webinars.**
- **Wastewater Treatment Plant (WWTP) Resources.**
- **Utility Bill Tutorials.**
- **Industrial Cybersecurity Screening Tool.**
- **... and more**



[https://betterbuildingssolutioncenter.energy.gov/better%20plants/better-plants-resource-](https://betterbuildingssolutioncenter.energy.gov/better%20plants/better-plants-resource-library)

Energy Efficiency (124) 



BY LANGUAGE / ENGLISH

Compressed Air Systems II:
Compressor Types



BY LANGUAGE / ENGLISH

Boiler Types and Opportunities for
Energy Efficiency



BY LANGUAGE / ENGLISH

Energy Audits
Instrumentation II

 energy audits



My courses

How to use
Schneider Electric
University

Course Catalog

College of Data Center

College of Energy Efficiency

Courses by Topic

Resources

Courses by Language

- auf Deutsch
- Brasileira



BY LANGUAGE / ENGLISH

Fan Systems III: Improving System Efficiency

Fan systems are vital to the operation of many industries and buildings. Fans often serve over a wide range of operating conditions because of changes in ambient conditions, occupancy, and production demands. The importance of fans often causes system designers to be...

ADD TO CART

View more

TOPIC : FAN SYSTEMS

Course content

 Course Overview

 Online Course

 Course Assessment

 Course Feedback

 Reference Materials

 Course Transcript

<https://schneider.efrontlearning.com/catalog/college/>



College of Water Treatment

BOILER WATER TREATMENT

Boiler Water Treatment

[View Course](#)

In this course, you will:

- Learn why boiler water needs to be treated
- Identify impurities found in water
- Discover water treatment methods
- Learn about feedwater and boiler drum water quality
- Discover the energy relationship between boiler blowdown and water treatment

Course Length: 30 minutes

Spirax Sarco: The Boiler House

Knowledge exchange

Perspectives on steam systems, their sustainable future, and the various sectors relying on its unparalleled thermal energy.

[Read the latest articles](#)



[Introduction](#)

[Why is steam so important to many industries today, its powerful capabilities, and how this sustainable, natural energy source is generated today.](#)

[Steam - the energy fluid](#)

Here we look at the many benefits that come from using steam as an energy source. Efficient, economic, flexible, and manageable, steam is widely used by many different industries.

[Steam and the organisation](#)

Depending upon your role in your organisation, how steam is relevant to you will vary. From CEOs and managers to technicians and engineers, here we answer common questions about steam systems.

[The steam and condensate loop](#)



Trane University (HVAC Courses)

OVERVIEW

Industry-leading training for high-level proficiency.

Explore our complete catalog of learning opportunities, featuring free and paid options like self-paced courses, instructor-led classes, and more.



Explore Training Catalog



Comprehensive Training, Direct from Trane

Our industry-leading training empowers customers to develop a high level of proficiency operating and optimizing HVAC equipment and systems using Trane building automation system and factory training for commercial systems service, maintenance and operation.



Extensive Knowledge Base

Experienced professional trainers have strong controls and HVAC service backgrounds and are familiar



An Effective Way to Learn

Trane University integrates innovative teaching technologies for instructor-led, distance learning and online courses and webinars. Interactive and hands-on experience uses proprietary Trane-developed tools for load, system, energy and economic analysis.

Hydraulic Institute



 LOGIN

 CART



MENU



More to know about pumps



Pumps are everywhere and the World Without Pumps series will highlight aspects of everyday life that would be completely different if pumps didn't exist.

[Learn More](#)

PUMP PROS KNOW



What do pump pros know and why do they know it? This series of articles highlight the brilliance of those who work with pumps.

[Learn More](#)

TRAINING

[Go to Pump Systems Matter](#)



TRAINING

[Go to Data Tool](#)



[PUMP INCENTIVES](#)

[FREE RESOURCES](#)

[PUMP FAQs](#)

[CASE STUDIES](#)

[PUMP INDUSTRY WORKFORCE
DEVELOPMENT](#)

Fan-pedia

» FANPEDIA

The Fan & Blower Encyclopedia

(click on thumbnails to view image galleries)



» FAN BASICS



Fan Types



Exploded Views



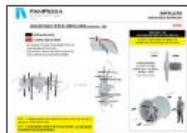
Fan Arrangements



Impeller Types, Impeller Orientation & Hub Types



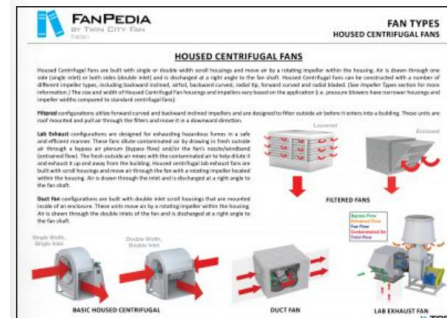
Discharges & Impeller Rotation



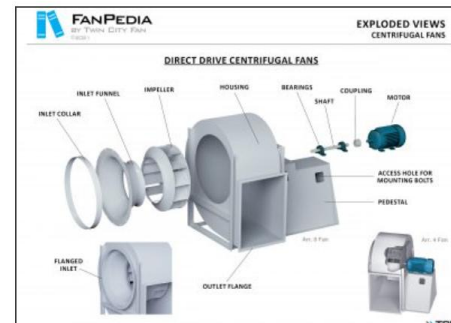
Impeller Airflow & Rotation (Axial Fans)



Motor Positions



Fan Types



Exploded Views



Questions?



Acknowledgement:

This material is based upon work supported by the U.S. Department of Energy's Office of Manufacturing and Energy Supply Chains (DE-MS0000022). The views expressed herein do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

Disclaimer:

Any mention, listing, or link to specific websites, software programs, or commercial products in this presentation is for informational and educational purposes only. Such references do not constitute or imply any endorsement, recommendation, or favoring by the Gulf Coast Center of Excellence, Texas A&M University, or the U.S. Department of Energy. Furthermore, we make no guarantees regarding the functionality, accuracy, or reliability of any third-party tools mentioned.