

Tools and Tips for Estimating Energy Savings – Workshop

Customer Energy Savings Calculations Reference Guide

Presented by:
San Diego Gas & Electric



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Customer Programs Reference Guide
Sempra Energy Utilities



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Preferred Calculation Tools

Customers submitting customized projects are asked to use the list of preferred tools when applicable. The tools listed have been reviewed by San Diego Gas & Electric's engineering groups for satisfactory use in calculating customized project savings.

While the tools listed have been reviewed, none of them are endorsed by any of the IOUs or its engineering groups. Use of these tools are NOT mandatory. However, they are strongly recommended to help improve accuracy, shorten review time, speed-up approval and incentive payment process. Project savings calculated by these tools are not pre-approved. Projects will need to be reviewed and approved by San Diego Gas & Electric to ensure inputs are appropriate and consistent with the project scope and statewide laws and codes, and that all necessary documentation is available.

The table below includes a list of preferred calculation tools.

Preferred Tool List		
Calculation Tool	Category	Notes/Applications
AirMaster	Preferred	Air Compressor Systems
DOE2.2R	Preferred	Refrigeration measures
EnergyPro	Preferred	Residential & Non-Residential Retrofits/New Construction
eQuest	Preferred	Residential & Non-Residential Retrofits/New Construction
IDSM Online Application Tool	Preferred	Non-Residential Retrofits & Industrial Processes
LPD Calculator	Preferred	Non-Residential Lighting Retrofits (Title 24 Covered Buildings)
Motor Master	Preferred	Motors Replacements
TRACE 700	Preferred	Non-Residential Retrofits

Note: This list will routinely be updated for new versions, software phase out (i.e. SDG&E moving to Online Application), and stakeholder recommendations on new methodologies.

Note 2: Newest Version should be used at all times, Inter-version (e.g. 1.2.1 vs. 1.2.3) are okay, only if changes do not impact calculation method in a significant way (i.e. savings significantly different from previous version).

Terms, Acronyms, and Websites

TERMS	DEFINITION
_programs	http://www.SDGE.com/rebates-finder/business/
“/kFP”	“ per 1000 square feet of building ” used with READI to define Impact units (See READI, UES)
“Cap-Tons”	Capacity in Tons (for Chillers, Cooling Towers, AHUs, ACs, HPs) used with READI to define Impact units (See READI, and UES).
3P, 3 rd Party	SDG&E has agreements with outside contractors (3 rd parties) to provide energy efficiency related programs.
AE	San Diego Gas & Electric “Account Executive”.
AHU	Air Handling Unit
Aircuity	A control system for demand control ventilation. See website: http://www.aircuity.com/technology/
Air-Master	AIRMaster+ is a free online software tool that helps users analyze energy use and savings opportunities in industrial compressed air systems. Download at: http://www1.eere.energy.gov/manufacturing/tech_assistance/software_airmaster.html
Baseline	Historic point of comparison used to track changes and improvements to your building or equipment or systems over time.
BHP	Brake Horsepower
Bin Analysis	Calculations are done using weather bins, which are created by accumulating all hourly occurrences of closely related weather data as if they had the same values. Hours that fall into a certain range of a defined parameter, most often dry bulb temperature, are collected and characterized by the mid-point of the range.
BOA Tool	Building Optimization Analysis (BOA) tool is an Excel® spreadsheet-based tool designed to streamline and standardize the energy savings calculation process for engineering service providers working under the Retrocommissioning (RCx) programs for five California utilities. The BOA tool targets commercial buildings and allows providers to calculate energy and peak demand savings for thirteen common controls- and schedule-based optimization measures. Download at: http://www.cacx.org/resources/rcxtools/spreadsheet_tools.html#energy_analysis_tools

Building Creation Wizard	A building modeling option used in the eQUEST (Quick Energy Simulation Tool)
California utilities	Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), Southern California Gas Company (SoCal Gas), San Diego Gas and Electric (SDG&E), and the Sacramento Municipal Utility District (SMUD).
CCT	Customized Calculation Tool (2013) used with the SDG&E Incentive Program. Download at: http://www.aesc-inc.com/download/spc/
CEC	California Energy Commission
CFL	Compact Fluorescent Light
CHW	Chilled Water
CW	Condenser Water
Climate Zone	California Climate Zone weather data set for weather related measures. The Climate Zone list is from the California Energy Commissions (CEC) website: http://www.energy.ca.gov/maps/renewable/building_climate_zones.html
Closed loop	A cooling water system with cooling water closed to the atmosphere. Closed loop systems generally do not require pumping against a fixed static head
CMPA	Custom Measure Project Archive
CPUC	California Public Utilities Commission. Governmental panel of 5 commissioners appointed by the Governor for 6 yr. terms.
CRAC /CRAH	Computer Room Air-Conditioner/ Computer Room Air Handler
CT	Current Transformer, or Cooling Tower
Data Center	Energy Efficiency Baselines for Data Centers available at: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hightech/data_center_baseline.pdf
Deemed	"Deemed" incentives have a predetermined agreed upon amount of savings (per energy unit). Rebate programs and DEER provided Deemed savings
DEER	Database for Energy Efficient Resources a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all within one data source.

DOE	U.S. Department of Energy. DOE sponsored building energy software tools for download: http://apps1.eere.energy.gov/buildings/tools_directory/doe_sponsored.cfm
DRP	Demand Response Program. Program to reward/influence customers to reduce their consumption during peak hours. This may or may not result in overall reduction in consumption – Objective is to use less during peak periods.
DSM	Demand Side Management
Dual Baselines	<p>The first baseline in a dual-baseline project uses the existing equipment parameters to determine the baseline energy usage. Savings calculated using this baseline are eligible throughout the RUL of the existing equipment.</p> <p>The second baseline uses industry standard practice (ISP) or building code standards to determine the baseline energy usage, because this baseline represents the period of time that is beyond the existing equipment's EUL. Savings calculated using this baseline are eligible for the time period beyond the RUL of the existing equipment, through the EUL of the proposed equipment.</p>
EAR	Ex Ante Review
ECM	Energy Conservation Measure
ED	Energy Division (a division of the California Public Utilities Commission)
EE	Energy Efficiency
EEBI	Energy Efficiency Business Incentive, The SDG&E version of the Statewide Customized Offering. The 2013 Statewide Customized Offering provides financial incentives for the installation of high-efficiency equipment or systems.
EEBR	Energy Efficiency Business Rebate, The SDG&E version of the Statewide Customized Offering. Provides rebates to eligible business customers for installing energy-efficient lighting, refrigeration, food service, natural gas, and other technologies.
EEGA	Energy Efficiency Groupware Application, Consolidated public repository of California Investor Owned Utility (IOU) submitted reports on energy efficiency (EE) programs and savings achievements. Website: http://eega.cpuc.ca.gov/
EMS	Energy Management System
EM&V	Evaluation, Measurement, and Verification
EE Measurement Wizard	A building modeling option used in the eQUEST, Quick Energy Simulation Tool.

eQuest	eQUEST-the <u>QU</u> ick <u>E</u> nergy <u>S</u> imulation <u>T</u> ool. Download at: http://www.doe2.com/equest/
EUL	Effective Useful Life is an estimate of the median number of years that a piece of equipment will function cost-effectively (without prohibitively expensive maintenance costs and frequent breakdowns). For estimating energy savings, the PUC has developed a list of EUL's in the DEER database, used by the READI tool.
Ex-Ante	Expected savings based upon calculations, before installation.
Ex-Post	Actual savings based upon measurements, following installation.
HHW	Heating Hot Water
HVAC	Heating, Ventilating, and Air Conditioning
Incremental Cost	The differential cost between full measure cost and Code or Industry Standard Practice cost.
IDSM	Integrated Demand Side Management
IOU	Investor Owned Utility
IR	Installation Report
ISP	Industry Standard Practice
kW	Kilowatt; rate of energy flow per unit time (1000 Joules per second, 3415 BTU's per hour)
kWh	Kilowatt hour; unit of energy (3600 kilojoules, 3412 BTU's)
LabPro	A laboratory airflow system modeling software provided by Phoenix Controls Corporation, see: http://www.newmatic.net/resources/pdf/energysavings/LabPro-User-Manual-and-Appendix.pdf
LED	Light Emitting Diode
Lighting Tool	2013 Calculated Lighting Equipment Survey Table is an interactive excel spreadsheet tool for calculating existing lighting LPD's, 1 st and 2 nd baselines, and estimated energy savings. Download at: http://www.SDGE.com/rebates-finder/save-energy-earn-incentives
LPD	Lighting Power Density, LPD values for various building applications can be found in current California Title 24 Code (watts per square foot).
Lumens	Amount of light produced by a lamp (bulb), the "brightness" level.

M&V	Measurement And Verification , The calculation approach for some EE projects requires baseline and/or post-retrofit measurement and verification (M&V) to confirm the energy savings. The M&V requirements vary widely depending on the size and type of a project. Projects with variable loads generally require more measurement and verification than constant-load projects.
M&V Option B	International Performance Measurement and Verification Protocol Option B –Savings are determined by measuring energy use of the systems to which the ECM was applied, separate from the energy use of the rest of the facility. Short-term or continuous measurements are taken through the post-retrofit period.
M&V Option C	International Performance Measurement and Verification Protocol Option C - Savings are determined by measuring energy use at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period.
MBCx	Monitoring Based Commissioning
Measure	A capital investment that reduces energy cost in an amount sufficient to recover the total cost of purchasing and installing such a measure. May also qualify for a rebate or incentive through SDG&E's customer programs.
Measure Life	See EUL and RUL
Motor-Master	MotorMaster+ is a free online software tool that helps users to analyze energy use and savings opportunities in systems. Download at: http://www1.eere.energy.gov/manufacturing/tech_assistance/software_motormaster.html
NTG	Net To Gross - The ratio or percentage of net program impacts divided by the gross or total impacts. NTG is used to estimate and describe the free- ridership that may be occurring within efficiency programs.
Open loop	A cooling water system with cooling water exposed to the atmosphere. Open loop systems generally require pumping against a fixed static head.
OBF	On Bill Financing - Program to finance “zero” interest loans to customers who install replacement energy efficient equipment. See website: http://www.SDGE.com/business/bill-financing
OR	Operating Report
PA	Program Assistant
PUC	California Public Utilities Commission (also CPUC)
RCx	Retrocommissioning. See program website: http://www.sandiegorcx.com/

READI	<p>Remote Ex-Ante Database Interface Download <u>READI (Version 2.0.1)</u> at: http://www.deeresources.com/index.php/deer2013-update-for-2014-codes</p> <p>All of the DEER2013 Unit Energy Savings (UES) values and measure data are stored on a remote database server. A database access tool has been developed that provides live access to the database. The tool, READI (Remote Ex-Ante Database Interface) connects to the database over the internet utilizing a secure and encrypted connection over port 22 or a standard remote database connection over port 5432. The program allows users to view and download all of the data associated with the DEER2013, DEER2013 Alternate and DEER2011 databases. The program allows users to view and download any of the data associated with the DEER2013 update, in a CSV file format.</p>
Rebuild	Equipment that has received major service or reconditioning.
ROB	Replace on Burnout - category includes retrofits where the existing equipment is either non-functional or has less than one year of RUL. The energy savings for ROB measures are calculated as the difference in energy use between the high-efficiency equipment and the standard-efficiency equipment that would have been purchased without program intervention.
RET	Retrofit , Replacing equipment that still has at least one year of remaining useful life (RUL)
Retrofit/ Add-ons	Retrofit/Add-on measures typically involve adding equipment or controls on to existing equipment in order to save energy. Typically, a building owner is not compelled to install new controls in order to comply with code. Therefore, REA energy savings are typically calculated as the difference between the proposed system's energy consumption and the existing system's consumption.
RUL	Remaining Useful Life of a piece of equipment is the estimated remaining time that a given piece of equipment will operate cost-effectively. If the exact equipment vintage is known, as in the example above, then the RUL is calculated as the difference between the EUL and the equipment's age. Otherwise, it is estimated to be 1/3 of the EUL.
Smart Controls	Smart controls provide comprehensive integrated control of electric or natural gas end uses to minimize overall system energy consumption. Smart controls employ algorithms and control sequences to optimize (minimize) energy consumption. In addition, smart controls may employ algorithms and control sequences to automatically regulate energy systems in response to demand response events.
SPC	Standard Performance Contract (expired program, rolled into EEBR/EEBI)
Space Types	Generally, building types listed in DEER
Title 20	2012 California Appliance Efficiency Regulations, Section 1601 et seq. Download at: http://www.energy.ca.gov/appliances/

Title 24	2013 California Building Energy Efficiency Standards, Part 6. Download at: http://www.energy.ca.gov/title24/2013standards/index.html
TMY3	Typical Meteorological Year Weather Data, (TMY3) data sets derived from the 1991-2005 National Solar Radiation Data Base (NSRDB) archives, Download at: http://doe2.com/Download/Weather/TMY3/
TOU	Time Of Use rate structure.
TRAV	Terminal Regulated Air Volume (TRAV) is an HVAC and lighting control strategy that has been made possible with the introduction of high- performance full-DDC systems, developed by Thomas Hartman. See: http://www.hartmanco.com/pdf/p02.pdf
UES	Unit Energy Savings - UES values are the annual savings associated with a specific measure. Savings include annual total electric savings in kWh, annual total gas savings in therms and peak period demand reduction in kW. Savings are expressed in terms of a “common unit” such as; tons of cooling capacity; a single appliance such as a clothes washer; a single dwelling unit such as a single family home or individual apartment; square foot of conditioned floor area; lighting fixture or lamp.
VFD/ VSD	Variable Frequency Drive/ Variable Speed Drive – used interchangeably.
Vintage	The age of a facility or equipment.
Whole Building Method	Energy saving analysis method that uses Whole Building Modeling calibrated to annual electric bills.
Work Paper	A Work Paper is a living engineering document that provides comprehensive information and calculations on energy efficiency measures commonly installed in the residential and /or nonresidential market segments. The document contains a description of the measure under consideration, as well as its delivery mechanism, and baseline data. It also gives an explanation and reasoning behind using a specific calculation method that differs from the Database of Energy Efficiency Resources (DEER). A work paper serves as a starting point in the planning and forecasting of the impacts and cost-benefit analysis of energy efficiency and demand response programs.
WSHP	Water Source Heat Pump
Qualified Lighting Products	Commercial Lighting Qualifying Products List. Available at: http://library.cee1.org/content/commercial-lighting-qualifying-products-lists

End Use	Measure Description	EUL	RUL	Sector
Agriculture	Greenhouse Heat Curtain	5	1.67	Ag
Agriculture	Infrared Film for Greenhouses	5	1.67	Ag
Agriculture	Low Pressure Sprinkler Nozzles (permanent)	5	1.67	Ag
Agriculture	Low Pressure Sprinkler Nozzles (portable)	3	1	Ag
Agriculture	Milk Pre-Cooler	15	5	Ag
Agriculture	Milk Transfer Pump Variable Speed Drive	15	5	Ag
Agriculture	Milking Vacuum Pump Variable Speed Drive	15	5	Ag
Agriculture	Sprinkler to Drip/Micro Irrigation	20	6.67	Ag
Agriculture	Well Pump Variable Speed Drive	10	3.33	Ag
Agriculture	Wine Tank Insulation	15	5	Ag
Appliance	80 PLUS Power Supply	4	1.33	Com
Appliance	High Efficiency Clothes Washer (CEE Tiers 1,2,3)	11	3.67	Com
Appliance	High Efficiency Copiers	6	2	Com
Appliance	Occupancy sensors	8	2.67	Com
Appliance	Vending Machine Controller	5	1.67	Com
Building Envelope	Cool Roof	15	5	Com
Building Envelope	Daylighting - controls	8	2.67	Com
Building Envelope	Floor Insulation	20	6.67	Com
Building Envelope	High Performance Windows for Daylighting	20	6.67	Com
Building Envelope	Low Solar Heat Gain Coefficient Windows	20	6.67	Com
Building Envelope	Reflective Window Films & Sunscreens	10	3.33	Com
Building Envelope	Roof/Ceiling Insulation	20	6.67	Com
Food Service	Combination Oven	12	4	Com
Food Service	Commercial Gas Rack Ovens	12	4	Com
Food Service	Commercial Insulated Holding Cabinet	12	4	Com
Food Service	Commercial Reach-In Refrigerator / Freezer	12	4	Com
Food Service	Convection Ovens	12	4	Com
Food Service	Electric Fryer	12	4	Com
Food Service	Gas Fryer	12	4	Com
Food Service	Griddle	12	4	Com
Food Service	Steam Cooker (electric)	12	4	Com
Food Service	Steam Cooker (gas)	12	4	Com
Food Service	Vat Fryer	12	4	Com
HVAC	Add Economizer	10	3.33	Com
HVAC	Air Conditioners (split and unitary)	15	5	Com
HVAC	Air To Air Heat Exchanger	14	4.67	Com
HVAC	Cooling Tower for Packaged System	15	5	Com
HVAC	Duct Insulation Material	20	6.67	Com
HVAC	Duct Sealing - Single Zone Package System	18	6	Com
HVAC	Energy Management System	15	5	Com
HVAC	Evap Cool Indirect	15	5	Com
HVAC	Fan Powered Mixing Boxes	10	3.33	Com
HVAC	Heat Pumps (split and unitary)	15	5	Com
HVAC	High Efficiency Boiler	20	6.67	Com

Measure Life – EUL/RUL Table – Cont. (2)

HVAC	High Efficiency Chillers	20	6.67	Com
HVAC	High Efficiency Furnace	20	6.67	Com
HVAC	High Efficiency Water Source Heat Pump	15	5	Com
HVAC	HVAC Fan Motors	15	5	Com
HVAC	Hydronic Heat Pump Var Flow Valve	10	3.33	Com
HVAC	Reducing Overventilation	10	3.33	Com
HVAC	Refrigerant Charge	10	3.33	Com
HVAC	Repair Economizer	5	1.67	Com
HVAC	Rotary Heat Recovery	14	4.67	Com
HVAC	Setback Programmable Thermostats	11	3.67	Com
HVAC	Steam Traps	6	2	Com
HVAC	Time Clocks (heating/cooling)	11	3.67	Com
HVAC	Two-Speed Fan	15	5	Com
HVAC	Variable Air Volume Box, VSD Fan	15	5	Com
HVAC	Variable Flow Water Loop, VSD Pump	15	5	Com
HVAC	VSD Supply Fan Motors	15	5	Com
HVAC	Water Loop Reset	10	3.33	Com
HVAC	Water Side Economizer	15	5	Com
HVAC-PTACCtrl	Package Terminal AC - Controller	15		Com
Lighting	Display Case Lighting LED Lighting	16	5.33	Com
Lighting	HID Lighting - High Pressure Sodium	15	5	Com
Lighting	HID Lighting - Metal Halide	15	5	Com
Lighting	Linear Fluorescent - Fixtures	16	5.33	Com
Lighting	Linear Fluorescent with Electronic Ballast	15	5	Com
Lighting	Linear Fluorescent with Electronic Ballast	14.26	4.75	Com
Lighting	Linear Fluorescent with Magnetic Ballast	15	5	Com
Lighting	Linear Fluorescent with Magnetic Ballast	9.16	3.05	Com
Lighting	Linear Fluorescent with Magnetic Ballast	8.56	2.85	Com
Lighting	Linear Fluorescent with Magnetic Ballast	12.75	4.25	Com
Lighting	Linear Fluorescent with Magnetic Ballast	13.98	4.66	Com
Lighting	Linear Fluorescent with Magnetic Ballast	10.82	3.61	Com
Lighting	Linear Fluorescent with Magnetic Ballast	9.32	3.11	Com
Lighting	Linear Fluorescent with Magnetic Ballast	13.31	4.44	Com
Lighting	Linear Fluorescent with Magnetic Ballast	13.16	4.39	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	7.66	2.55	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	8.26	2.75	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	9.35	3.12	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	8.06	2.69	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	4.07	1.36	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	3.8	1.27	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	10.26	3.42	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	5.67	1.89	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	6.21	2.07	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	12.9	4.3	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	4.81	1.6	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	7.58	2.53	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	5.92	1.97	Com
Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	4.68	1.56	Com

Measure Life – EUL/RUL Table – Cont. (3)

Lighting	Linear Fluorescent with T12 Lamp + Magnetic Ballast	4.19	1.4	Com
Lighting	Timeclock with or without photocell	8	2.67	Com
Lighting - Indoor	CFL Fixtures	12	4	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	4.13	1.38	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	4.46	1.49	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	3.85	1.28	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	4.29	1.43	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.57	0.86	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.38	0.79	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	5.99	2	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	3.24	1.08	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	7.3	2.43	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.8	0.93	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	3.36	1.12	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.08	0.69	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.7	0.9	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.3	0.77	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.49	0.83	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	3.62	1.21	Com
Lighting - Indoor	CFL Lamps - 10,000 Hour	2.11	0.7	Com
Lighting - Indoor	Exit Lighting	16	5.33	Com
Lighting - Indoor	HID Lighting - Metal Halide	15	5	Com
Lighting - Indoor	HID Lighting - Metal Halide	14.26	4.75	Com
Lighting - Indoor	HID Lighting - Metal Halide	13.31	4.44	Com
Lighting - Indoor	HID Lighting - Metal Halide	14.46	4.82	Com
Lighting - Indoor	HID Lighting - Metal Halide	14.68	4.89	Com
Lighting - Indoor	HID Lighting (T-5)	15	5	Com
Lighting - Indoor	HID Lighting (T-5)	14.26	4.75	Com
Lighting - Indoor	HID Lighting (T-5)	13.31	4.44	Com
Lighting - Indoor	HID Lighting (T-5)	14.46	4.82	Com
Lighting - Indoor	HID Lighting (T-5)	14.68	4.89	Com
Lighting - Indoor	Occupancy Sensors	8	2.67	Com
Lighting - Indoor	Timeclocks	8	2.67	Com
Lighting - Outdoor	HID Lighting - High Pressure Sodium	15	5	Com
Lighting - Outdoor	HID Lighting - High Pressure Sodium	14.26	4.75	Com
Lighting - Outdoor	HID Lighting - High Pressure Sodium	13.31	4.44	Com
Lighting - Outdoor	HID Lighting - High Pressure Sodium	14.46	4.82	Com
Lighting - Outdoor	HID Lighting - High Pressure Sodium	14.68	4.89	Com
Lighting - Outdoor	LED Lighting	12		CC
Lighting - Outdoor	Outdoor CFL Lamps - 10,000 Hour	2.44	0.81	Com
Lighting - Outdoor	Outdoor HID Lighting (T-5)	15	5	Com
Lighting - Outdoor	Outdoor Linear Fluorescent with Electronic Ballast	15	5	Com
Lighting - Outdoor	Outdoor Linear Fluorescent with Magnetic Ballast	10.98	3.66	Com
Lighting - Outdoor	Timeclock with or without photocell	2.44	0.81	Com
Lighting - Outdoor	Timeclock with or without photocell	8	2.67	Com
Motors	Premium-Efficiency Motors	15	5	Com
Motors	Water Loop Pumps	15	5	Com

Measure Life – EUL/RUL Table – Cont. (4)

Process	High Efficiency Boiler	20	6.67	Com
Process	Insulation for Bare Suction Lines	11	3.67	Com
Process	Refrigerator Upgrades (Condenser)	15	5	Com
Process	Refrigerator Upgrades (Head Pressure)	15	5	Com
Process	Refrigerator Upgrades (Subcooling)	15	5	Com
Process	Refrigerator Upgrades (Suction Pressure)	15	5	Com
Process	Refrigerator Upgrades (Variable Speed Compressors)	15	5	Com
Process	Scroll Compressors for Bulk Tanks	12	4	Com
Process	Steam Traps	6	2	Com
RCx	Retrocommissioning	10	3.33	Com
Recreation	Commercial Pool Heater	5	1.67	Com
Refrigeration	Anti-Sweat Heat (ASH) Controls	12	4	Com
Refrigeration	Auto-Closer for Walk-In Cooler/Freezer Doors	8	2.67	Com
Refrigeration	Commercial Reach-In Refrigerator / Freezer	12	4	Com
Refrigeration	Display Case Lighting Control	8	2.67	Com
Refrigeration	Door Gaskets on Cooler/Freezer Doors	4	1.33	Com
Refrigeration	Evaporator Fan Controller for Walk-In Coolers	16	5.33	Com
Refrigeration	Heat Recovery from Central Refrigeration System	10	3.33	Com
Refrigeration	High Efficiency Evaporator Fan Motors	15	5	Com
Refrigeration	Ice Machine	10	3.33	Com
Refrigeration	New case with Doors	12	4	Com
Refrigeration	Night Covers for vertical & horizontal refrigerated display cases	5	1.67	Com
Refrigeration	Strip Curtains for Walk-Ins	4	1.33	Com
Refrigeration	Zero Heat Reach-in Glass Doors	12	4	Com
Service	Clean Condenser Coils	3	1	Com
Water Heating	Circulation Pump Timeclock Retrofit	15	5	Com
Water Heating	Compressor Heat Recovery (w/electric water heating)	14	4.67	Com
Water Heating	Faucet Aerators	10	3.33	All
Water Heating	High Efficiency Central Water Heater	15	5	Com
Water Heating	High Efficiency Commercial Storage Water Heater	15	5	Com
Water Heating	Instantaneous Water Heater	20	6.67	Com
Water Heating	Pipe Insulation - Electric Water Heater	13	4.33	Com
Water Heating	Pipe Insulation - Gas Water Heater	11	3.67	Com
Water Heating	Water Heater Tank Wrap	7	2.33	Com

Tools and Tips for Estimating Energy Efficiency

Custom Energy Savings Calculations Workshop



"Enabling Customers in Energy Efficiency"

October 4, 2018

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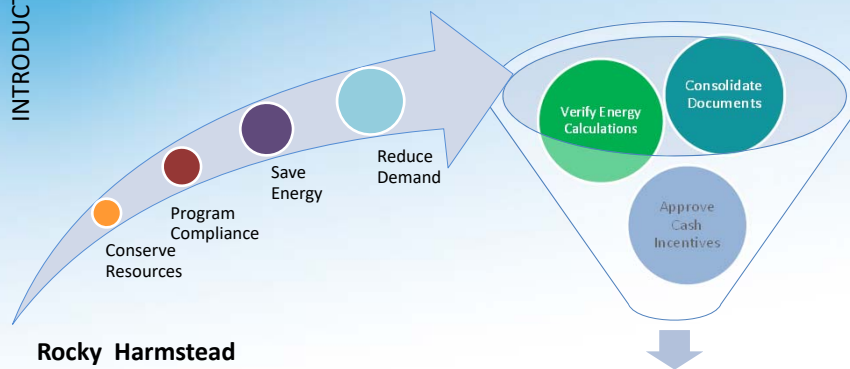
1

Tools for Estimating Energy Savings



INTRODUCTION

SDG&E's Team of Energy Efficiency Engineers



Rocky Harmstead
Rod Houdyshel
Jessie Wang
James Gibson
John Barbour

Save Money

2

Tools for Estimating Energy Savings



INTRODUCTION

Workshop Goals:

Understand the program

Define Terms and Abbreviations

Describe Tools and Calculators

Discuss CPUC requirements for custom projects (California Public Utilities Commission)

Provide instruction on how to meet these requirements (with typical examples)

Address Questions and Concerns

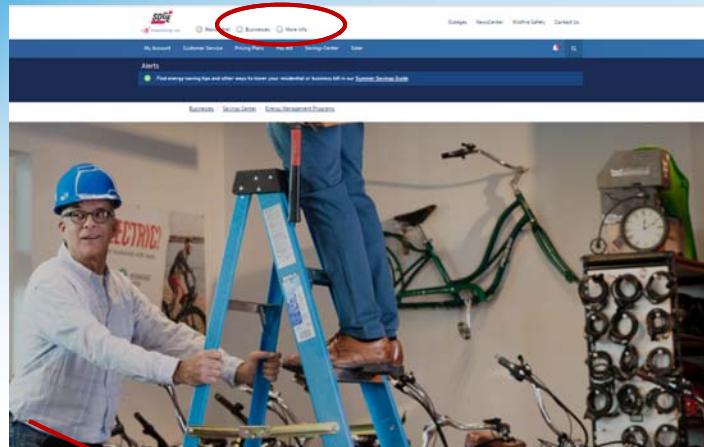
3

Tools for Estimating Energy Savings



INTRODUCTION

sdge.com/businesses/savings-center/energy-management-programs/energy-efficiency-programs



Energy Efficiency Programs for Our Business Customers

Businesses can save money on improvements with [Energy Efficiency Business Programs](#).
*Eligible customers can get 10% financing for qualifying energy efficiency improvements to their business with [SDGE Financing](#).

4

Differences between Rebate and Incentives



INTRODUCTION

Which one should I pick? Rebate first.

Rebate Program (EEBR)

- Check Rebate List
- Install first, application after
- Deemed Savings
- Post-inspections only for most measures

Incentives Program (EEBI)

- Pre-application and Application first
- Customized Annual Savings
- Pre-and Post-inspections for all measures, sometimes M&V
- Need notice to proceed before starting projects/ordering equipment

5

Tools for Estimating Energy Savings



INTRODUCTION



Flow of Review Progress For Your Incentive:

6

Tools for Estimating Energy Savings

INTRODUCTION

Energy Efficiency Business Incentives Program Checklist

1 STARTING POINT FOR ALL SUBMITTALS

- Submit Completed Application (forms 1, 2, 3)
- Submit Completed IRS Form W-9 (if you have not already submitted this form for our records)
- Submit Manufacturer Specification Sheets (Please submit data sheets, not product brochures)
- Submit Trade Professional Agreement
- Submit Detailed Project Description (As a separate attachment)

- Describe how proposed equipment is controlled (include set points, schedules, and any other relevant information)
- Calculate the total kW, kWh and/or therms that each piece of equipment will consume annually
- Provide calculation tools from the approved list (all spreadsheet tabs must be unlocked and unprotected)

- Define the efficiency, run hours, load factor, horsepower, tons, or any other relevant equipment information
- Describe how existing equipment is controlled (include set points, schedules, and any other relevant information)
- Calculate total kW, kWh and/or therms that each piece of equipment consumes annually
- Provide calculation tools from the approved list (all spreadsheet tabs must be unlocked and unprotected)

- Submit Proposed Measurement and Verification (M&V) if applicable
- If lighting is included the 2013 Calculated Lighting Equipment Survey Table is required

2 REPLACE ON BURN OUT AND NEW LOAD PROJECTS

- Projects Must Fulfill Items Listed Below and Section 1
- Define the annual energy usage using minimum code or industry standard practice (ISP)
- Provide Title 24 minimum code efficiencies or the industry standard efficiencies for the equipment in question
- Define the efficiency, run hours, load factor, horsepower, tons, or any other relevant equipment information

3 EARLY RETIREMENT PROJECTS

- Projects Must Fulfill Items Listed Below and Section 1 & 2
- Provide the following to support an early retirement claim
- Simple payback with and without incentives
- Documented equipment alternatives considered by customer

- Statement from the customer supporting remaining useful life - include maintenance records
- Existing equipment invoices (if available)
- Document any non-energy-efficiency drivers of the project

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Include a written:
"Scope of Work"
or
"Proposal"

Tools for Estimating Energy Savings

INTRODUCTION

Required Documentation:

Scope of Work

- Written Description of Proposed Efficiency Measures
- Equipment List (Existing and Proposed)
- Manufactures Spec Sheets (watts, eff., EER, IPLV)

Calculations for Energy Savings Estimates

- READI, CCT, BOA, C-BOA
- eQuest, ePro, Proprietary software (input & output)
- Excel Spreadsheets Only for Smaller projects (unprotected)
- Lighting Survey Table (for Lighting Measures)

Application

- <https://www.sdge.com/businesses/savings-center/rebates-incentives/incentives>

Completed W-9 Form

Proposal and/or Invoice

CPUC Requirements

Custom projects use Standard tools, Building Codes and Standards, and Industry Standard Practice

Concurrent review of projects by CPUC Staff (commission staff - CS) and more site data collection

Documentation to show Utility Influence

9

Order of Project Evaluation:

Resources

- **DEER** (Database for Energy Eff. Resources)
- **READI** (Remote Ex-Ante Database Interface)
- **Modified DEER** (Interpolation between points)

Standard Tools

- Customized Calculation Tool (CCT2013)
- Building Optimization Analysis Tool (BOA)
- Energy Modeling (eQUEST)
- Measurement and Verification (M&V)

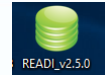
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Tools for Estimating Energy Savings

INTRODUCTION

Tools and Calculators:

- Remote Ex-Anti Database Interface (**READI**)
- <http://www.deeresources.com/>



- Customized Calculation Tool (**CCT2013**)
- <https://www.sdge.com/businesses/savings-center/rebates-incentives/incentives>
- <https://www.aesc-inc.com/download/spc/>



- Building Optimization Analysis Tool (**BOA /C-BOA**)
- http://cacx.org/resources/rcxtools/spreadsheet_tools.html

- Energy Modeling (**eQUEST** ver.3.65)
- <http://www.doe2.com/equest/>



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Tools for Estimating Energy Savings

INTRODUCTION

- Building Codes, Standards, and Industry Standard Practice (C&S, ISP):

existing equipment

If worn-out, New equipment installed require a minimum efficiency

Efficiency – Based on current code or industry standard

incentivize

Worn-out equipment is not incentivized on entire savings

Based on only savings above current minimum standards

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Tools for Estimating Energy Savings



INTRODUCTION

• Industry Standard Practice (ISP):

Industry Type	Machine Size – Tons of Clamping Force		
	200 or Less	200 – 500	500 or Greater
Automotive	All-electric	Hybrid 1	Hybrid 1
Medical	All-electric	All-electric	All-electric
Packaging	All-electric	Hybrid 1	Hybrid 1
Consumer products	All-electric	Hybrid 1	Hybrid 1

Load Factor Chiller CHW Pumps Cooling Tower CW Pumps Chilled Water Plant (Total kW/ton)

0.2	0.803	0.146	0.001	0.278	1.228
0.3	0.661	0.1	0.002	0.19	0.953
0.4	0.58	0.075	0.003	0.143	0.8
0.5	0.542	0.06	0.003	0.114	0.719
0.6	0.524	0.05	0.004	0.095	0.673
0.7	0.519	0.045	0.005	0.081	0.65
0.8	0.518	0.048	0.005	0.071	0.643
0.9	0.528	0.051	0.006	0.063	0.649
1	0.539	0.054	0.007	0.057	0.657

Fan Motor Horsepower	Baseline Fan Efficiency
0.5	0.42
1	0.5
1.5	0.5
2	0.5
3	0.5
5	0.5
7.5	0.533
10	0.556
15	0.587
20	0.608
25	0.624
30	0.638
40	0.658
50	0.675
60	0.686
75	0.698
100	0.715
125	0.727
150	0.736
200	0.75

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Tools for Estimating Energy Savings



INTRODUCTION

Concurrent Review by CPUC Staff (CS):

DEER Measures excluded

Custom Measure Project Archive (CMPA)

Projects may be selected at **Application** stage

Projects may be selected after **Installation**

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Tools for Estimating Energy Savings



INTRODUCTION

Project Data Collection

<ul style="list-style-type: none"> - Project Scope - Location - Building Type & Vintage - General description & savings premise - Estimated savings - Live spread sheets supporting the savings estimates - 3rd party audit reports - Inspection reports - Raw data, EMS, csv 	<ul style="list-style-type: none"> - M&V plan - Existing equipment age - New equipment cut sheets & Performance - Incremental costs - Documents to support baseline - Control Strategy - Existing system capacity & output - Schematics and Drawings - Interaction among multiple measures 	<ul style="list-style-type: none"> - Production output - Billing history (pre- & post-install) - Alternatives (repair/replace w/hi eff./replace w T24) - Proposals - Invoices - Measured savings <p>More is Better Less can cause Delay</p>
--	---	--

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Tools for Estimating Energy Savings



INTRODUCTION

Documenting Utility Influence:

Provide proof -incentive payment
“major factor driving project”

Audit report showing energy savings

ROI calculations for the proposed measure

Payback analysis with multiple ECM options

On-Bill Financing (OBF)

Emails and Correspondence

Program Manual, pgs. 1-13 and 1-14

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Tools for Estimating Energy Savings



INTRODUCTION

2013-14 FREERIDER SCREENING FORM

FREERIDER SCREENING SECTION (SDG&E USE ONLY)

Freerider Screening Questions

Yes	No	
<input type="checkbox"/>	<input type="checkbox"/>	A. Have products associated with this project been purchased? (If the product was purchased prior to receiving approval from SDG&E the project is a freerider)
<input type="checkbox"/>	<input type="checkbox"/>	B. Has installation occurred? If yes, please indicate date: ____/____/____ (If installation has occurred the project is highly likely a freerider and will be disqualified)
<input type="checkbox"/>	<input type="checkbox"/>	C. If the customer is part of a chain, are these measures being retrofitted in areas outside CA? (Examples: Vons, Bank of America, Arco, Hilton Hotels and McDonalds) (If measures are being installed outside of CA the project may be deemed a freerider, please provide additional documentation to support influence)
		D. When did the customer decide to implement this measure? ____/____/____ (If this date precedes item E then it is highly likely a freerider project and will be disqualified) All AE's must document influence using iAvenue to ensure this information can be provided to program evaluators. Influence emails shall include all of the following: Identification of measure, Discussion about payback periods, and Routing to third party implementers.
		E. When did the customer learn about the Utility incentive? ____/____/____
		F. What was the primary driver for this energy efficiency project?
		<input type="checkbox"/> Energy Efficiency <input type="checkbox"/> Repairs <input type="checkbox"/> Continuation of Operations <input type="checkbox"/> Productivity/Product Improvement <input type="checkbox"/> Payback Timeframe (Simple Payback # ____ Yrs) <input type="checkbox"/> Code/Regulatory Compliance <input type="checkbox"/> Safety <input type="checkbox"/> End of Life Replacement <input type="checkbox"/> Planned Renovation <input type="checkbox"/> Other: _____

If anything other than energy efficiency and payback influenced the installation this is likely a freerider)

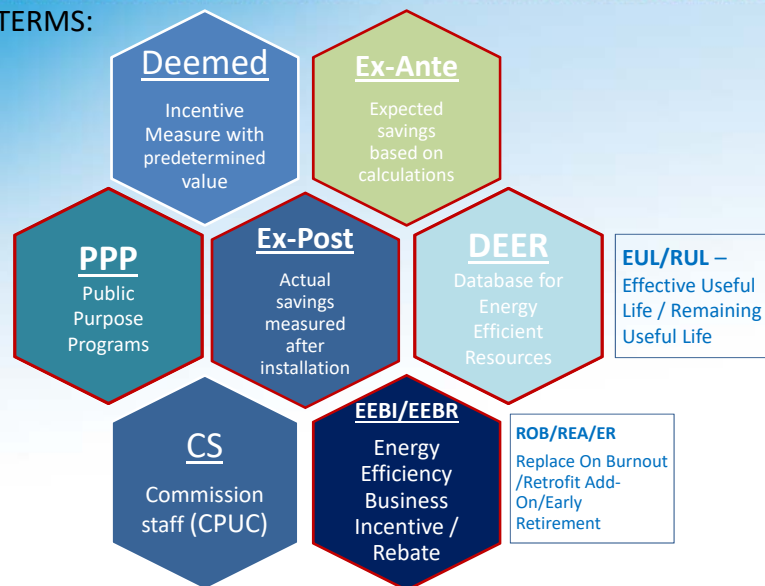
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Tools for Estimating Energy Savings



INTRODUCTION

KEY TERMS:

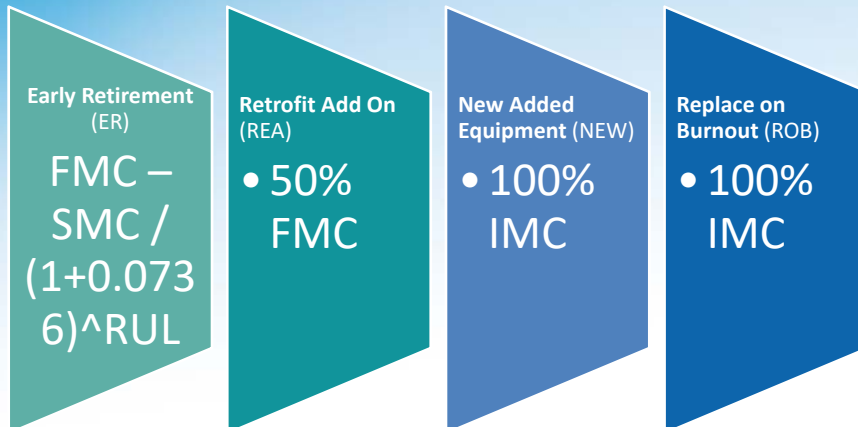


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Tools for Estimating Energy Savings

INTRODUCTION

PROGRAM INCENTIVE LIMITS:



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Tools for Estimating Energy Savings

INTRODUCTION

• Calculation Examples to follow:

- Energy Code Ace ➤ John
- Controls ➤ Rocky
- CAV to VAV ➤ Rocky
- Chillers ➤ Rocky
- (Break) ➤ (15 minutes)
- Data Centers ➤ Rod
- Economizers ➤ Rod
- Boilers ➤ Rod
- Pumps w/ VSDs ➤ Rod
- Measurement & Verification ➤ Rod



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Custom Energy Savings Calculations



ENERGY CODE ACE

- ENERGY CODE ACE:

John Barbour



www.EnergyCodeAce.com

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Energy Code Ace

Supporting Title 24, Part 6 and Title 20
Compliance Improvement



This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.



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Application Guides, Facts Sheets, Trigger Sheets and Checklists to help you understand how and when to comply with California's building and appliance energy efficiency standards.


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 **Ace Installation™** Step-by-step guide to the Title 24, Part 6 compliance process in easy-to-follow flowchart format

 **Ace Navigator™** A "field guide" to assist you in identifying proper installation techniques and visual aides for some components commonly installed incorrectly

 **Ace Reference™** Helps you navigate the Standards using key word search capabilities, hyperlinked tables and related sections
Now also including Title 20

 **Ace Forms™** Aids in determining which compliance forms are applicable to your specific project



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Nonresidential & residential "field guides" to assist you in identifying proper installation techniques and visual aides for some components commonly installed incorrectly

2016 Installation Ace

Nonresidential

Envelope FENESTRATION

Manufactured Products - Certification
 Manufactured fenestration products and exterior doors may be installed only if the manufacturer has certified to the Commission that the product complies with all of the applicable requirements. Look for the NFRC label on all fenestration products, unless they are site-built.
Code Reference: 2016 Title 24, Part 6 Sections 110.0-110.10

Manufactured Products - Labeling
 Manufactured fenestration products shall have a temporary label listing the certified U-factor, SHGC and VT. Labels shall not be removed before inspection by the enforcement agency. Compare the U-factor and SHGC on the labels to the maximum values shown on the CP-F-1000 label.
Code Reference: 2016 Title 24, Part 6 Sections 110.0-110.10

Field Fabricated Fenestration Products
 Field fabricated fenestration and field fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using actual U-factors from TABLE 110.0-B and SHGC values from TABLE 110.0-B.
 Field fabricated fenestration and field fabricated exterior doors shall be installed and weather-stripped.
Code Reference: 2016 Title 24, Part 6 Sections 110.0-110.10

ACO+ PLACEMAKER
 ACO+2 - 60mm Protection Agency
 ACO+2 - 60mm Fire Protection Agency



*Helps you navigate the Standards
using key word search capabilities,
hyperlinked tables and related
sections – now also including Title 20*

2016 Building and Appliance Efficiency Regulations - Reference Ace v26

2016 BUILDING ENERGY EFFICIENCY STANDARDS

- REFERENCE APPENDICES
- RESIDENTIAL COMPLIANCE MANUAL
- RESIDENTIAL ACM REFERENCE MANUAL
- NONRESIDENTIAL COMPLIANCE MANUAL
- NONRESIDENTIAL ACM REFERENCE MANUAL
- TITLE 20 APPLIANCE EFFICIENCY REGULATIONS
- TITLE 20 APPLIANCE EFFICIENCY REGULATIONS
- Appliance-Specific Backers Only

**2016 Building Energy Efficiency Standards and
Title 20 Appliance Efficiency Regulations
Reference Ace Tool**

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*Aids in determining which
compliance forms are
applicable to your specific
project*

Tools Ace Training Ace Resources Ace Search

2016 Nonresidential Forms Ace

Instructions: Complete all the questions on these screens based upon the project you are planning to permit. The project specific Title 24 Building Energy Forms required during Plan Check and Inspection will be summarized in the final screen. You will be able to print or email the summary.

Basic Info Additional Info Project Components

Lighting

Prescriptive PCL-1 What is the nature of the lighting alteration/ addition (select all that apply)?

- ☒ Interior Lighting
- ☐ Exterior Lighting
- ☐ Sign Lighting

Prescriptive PCL-2 Will the project install additional wattage in a videoconference room?

☐ Yes ☒ No

Prescriptive PCL-3 Will the project include adding or altering any of the following: (Select all that apply)

- ☒ Lighting Control System
- ☐ Energy Management Control System (EMCS)
- ☐ Self-contained lighting controls

Prescriptive PCL-15 Will more than 20 fixtures be controlled?

☐ Yes ☒ No

Prescriptive PCL-6 Will the project install track lighting?

☐ Yes ☒ No

- Identify compliance steps
- Understand which compliance path is least cumbersome
- Identify which forms will be required
- Generate a checklist
- Identify whether or not your project requires HERS

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Ace Training™

Role-Specific, Activity-Based Multiple Formats

- 
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- 
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- 
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- 
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 Online, on-demand training—take them whenever and wherever you like, at your own pace
- 
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Training Ace

Energy Code Ace free training courses target a wide range of "hot topic" measures and audience groups, and are provided in a variety of formats. Use the filters on this page to find the perfect class to help you "decode" the California building and appliance energy efficiency standards.

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[Click here](#) to see the complete list of courses and delivery options we offer.
[Click here](#) to request one of our traditional classroom courses.

Title 24, Part 6 2016 Standard

2016 Title 24 Part 6 Essentials - Nonresidential Standards for Plans Examiners and Building Inspectors

This interactive, "hands-on" course is designed to provide plans examiners and building inspectors with the knowledge and skills needed to more quickly and effectively enforce the 2016 energy code for nonresidential projects.

Show Available Training

2016 Title 24 Part 6 Essentials - Residential Standards for Plans Examiners and Building Inspectors

This interactive, "hands-on" course is designed to provide plans examiners and building inspectors with the knowledge and skills needed to more quickly and effectively enforce the energy code for residential projects.

Show Available Training

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LIST CALENDAR

Event Type
Traditional Classroom

Standards & Regs
2016 Standard







Topics

Building Types

Roles
Building De... & 4 more



Robust Library of Job Aides

-  **Trigger Sheets** Quick reference component-by-component summaries of code requirements "triggered" based on project scope
-  **Fact Sheets** Quick reference summaries of key requirements, forms, definitions and resources
-  **Checklists** Step-by-step guidance for plans checks and field inspections
-  **Application Guides** Short manuals including compliance requirements and recommendations
-  **Useful Links** A list of useful links, telephone numbers and handy documents
- NEW!**  **Note Blocks** Aids in determining which mandatory measures are applicable to a project and that they are being met
- NEW!** **Nonresidential Lighting Wheel** At-a-glance guidance for understanding and interpreting standards and controls for nonresidential lighting installations

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2016 ENERGY CODE



Nonresidential Outdoor Lighting

Application	Mandatory Requirements					Prescriptive Requirements	
	Outdoor Incandescent Lighting §130.2(a)F	Luminaire Cutoff Requirements §130.2(b)	Lighting Controls ^a §130.2(c)	Sign Lighting Controls §130.3(a)	Lighting Control Acceptance and Installation Certificate Requirements §130.4 ^M	Outdoor Lighting Power Trade-off §140.7(b)	Additional Lighting Power Allowance §140.7(d)2
Alterations That Increase Connected Lighting Load	YES	YES	YES	no	YES	YES	YES
Alterations That Replace ≥ 10%	YES ^b	YES	YES ^H	no	YES	no	no
Alterations That Replace ≥ 50%	YES ^b	YES	YES ^I	no	YES	YES	YES ^N
Outdoor Incandescent Lighting Rated > 100 Watts	YES ^b	no	YES ^J	no	YES	no	no
All Outdoor Lighting Rated > 150 Watts ^A	no	YES	YES ^J	no	YES	no	no
Lighting for Outdoor Sales Frontage ^a	no	no	YES	no	YES	no	YES
Lighting for Building Facades, Ornamental Hardscape and Outdoor Dining ^a	no	no	YES	no	YES	no	YES
General Hardscape Lighting ^a	no	no	YES	no	YES	YES	no
Outdoor Sign Lighting	no	no	YES ^K	YES ^L	YES	no	no
Electronic Message Centers	no	no	no	YES ^L	YES	no	no

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HVAC AND DOMESTIC HOT WATER: Mandatory Measures

Color background indicates code language: ☐ NO CHANGE ☐ REVISED ☐ NEW FOR 2016

Heating Equipment Efficiency	110.2(a)	Table 110.2(a) Heating loads Table 110.2(a) SHW and PWT Table 110.2(a) DHW and PWT Table 110.2(a) Boiler ratings
Cooling Equipment Efficiency	110.2(a)	Table 110.2(a) Air conditioning Table 110.2(a) Air and water Table 110.2(a) Cooling loads Table 110.2(a) Equipment
Space Conditioning Equipment	110.2(a)(1)	No Change
Service Water Heating Systems & Equipment	110.2(a)(2)	No Change. NATE. Temporal Standard. In volume 2015-6
Pool & Spa	110.2(a)(3)	No Change
Pool Lights	110.2(a)(4)	No Change
Ventilation	110.2(a)(5)	No Change

Section	Table	Notes
Systems & Equipment	110.2(a)	Table 110.2(a) Heating loads and equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Heating Equipment Efficiency	110.2(a)(1)	Table 110.2(a) Heating loads and equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Cooling Equipment Efficiency	110.2(a)(2)	Table 110.2(a) Cooling loads and equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Space Conditioning Equipment	110.2(a)(3)	Table 110.2(a) Space conditioning equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Service Water Heating Systems & Equipment	110.2(a)(4)	Table 110.2(a) Service water heating systems and equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Pool & Spa	110.2(a)(5)	Table 110.2(a) Pool and spa equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Pool Lights	110.2(a)(6)	Table 110.2(a) Pool lighting equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.
Ventilation	110.2(a)(7)	Table 110.2(a) Ventilation equipment efficiency requirements are updated to reflect changes in the Energy Code Commission's requirements for the equipment.

Skyline Daylight Zones

The skyline daylight zone is an area of the space equal to the area of the skylight plus a distance 0.7 times the average height of the skylight above the floor, extending out from the edges of the skylight. See Section 130.10(d)(1).



Parking Garages

Mandatory daylighting control requirements for parking garages are different than for other spaces. See Section 130.10(d)(2).

[Click here](#)

- New infographic approach
- Engaging, simple illustrations
- Hyperlinks to relevant code sections and forms



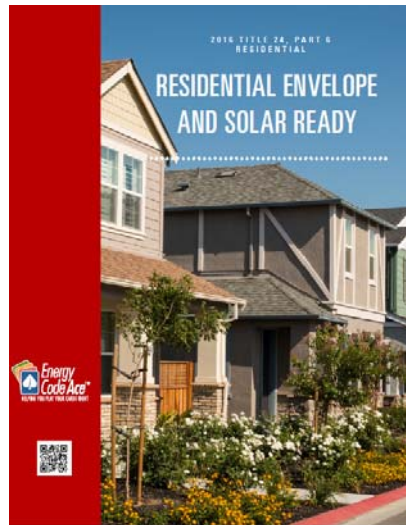
Parking Garages

Mandatory daylighting control requirements for parking garages are different than for other spaces. For instance, parking garage daylight controls are mandatory for secondary daylight zones, whereas this is not the case for interior areas of the building. Parking garages that have a combined glazing or opening area of 36 square feet or greater must also comply with the daylighting control requirements of the Energy Standards, except when the combined general lighting power in the primary daylight zones is less than 60 watts. Daylighting controls are not required in parking garage daylight transition zones, which is a vehicular path intended to provide a transition between exterior and interior illumination levels and does not include parking areas. Primary and secondary daylight zones can be controlled together. Daylighting controls for parking garages can be on/off, where other spaces require continuous or stepped dimming controls. Lighting in the primary and secondary daylight zones of parking garages must be completely turned off, when the space is fully daylight. For other space types multilevel dimming can be used with the dimmed lights consuming up to 35% of full power.



Ace Resources™

Application Guides (New)



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NEW! Nonresidential Lighting Wheel

Helps professionals who design, specify, install or inspect nonresidential lighting installations understand and interpret the lighting standards and controls.

Key Features Include:

- ▲ Provides guidance on what lighting controls are required for nonresidential new construction and lighting alterations (using both the Area Category approach and the Reduced Wattage approach)
- ▲ Supports the Area Category lighting power density (LPD) allowances per Table 140.6-C - including the footnote allowances
- ▲ Fun to use!

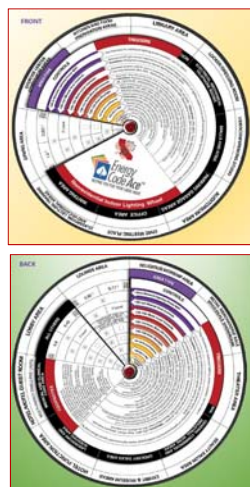
Order yours at


<http://fruitridge.co/energycode/main2.php>

and enter:

Username: EnergyCodeAce

Password: LightWheel






Ace Resources™
Appliance Guides, Heat
Shocks, Trigger Sheets and
Checklists to help you understand
how and when to comply with
California's building and
appliance energy efficiency
standards.

Ace 2

Filters guide you based on resource type or topic

Resources Ace

Energy Code Ace provides resources to help facilitate effective implementation of California's building and appliance energy efficiency standards. Use our filters to find the right aide to help you "decode" Title 24, Part 6 and Title 20.



Fact Sheet: Just the Basics: HERS for Residential and Nonresidential Projects 2016

Fact Sheet: Residential Opaque Envelopes 2016

Fact Sheet: Residential Penetration 2016

Fact Sheet: Nonresidential Penetration 2016

Filter Available Resources

Resource Type:

Standards & Regs:

Topics:

Envelope & 7 more

- ☒ Envelope
- ☒ Penetration
- ☒ Filtration and Air Sealing
- ☒ Floors and Slabs
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- ☒ Roof and Attic
- ☒ Windows

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SoCalGas
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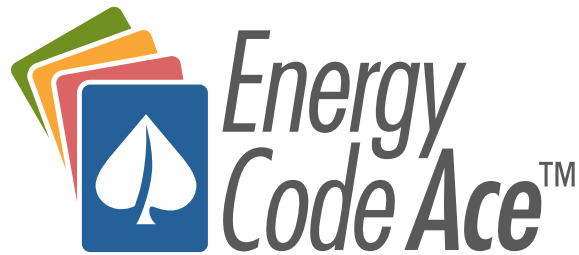
EDISON
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Pacific Gas and Electric Company

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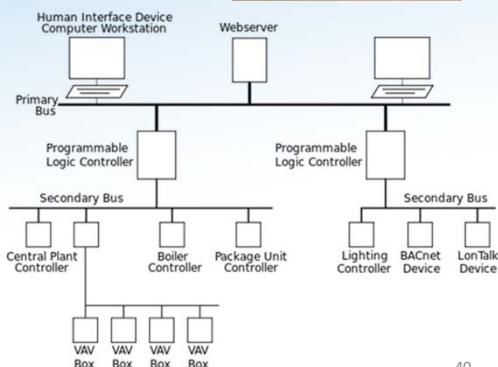
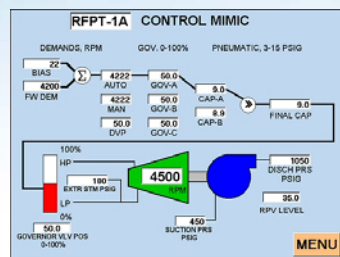
Custom Energy Savings Calculations



CONTROLS

Calculation Tools for CONTROLS:

Rocky Harmstead



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Custom Energy Savings Calculations



CONTROLS

2016 Title 24 Mandatory Code Controls

Setback thermostats when there is no EMS

Isolation area valves or dampers w/ automatic control

Vary outside air as operating conditions change
w/occupancy sensor/ ventilation control device

Hotel/ Motel guest room captive key card or occupancy
sensing control

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Custom Energy Savings Calculations



CONTROLS

Savings
Calculation
Tools

READI

Building Optimization
Analysis (BOA) Tool

eQUEST

Spreadsheet Analysis
and M&V

Project
Type

Retrofit-Add-On

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Custom Energy Savings Calculations



CONTROLS

CONTROLS – BOA Tool:

Air Handlers

Temperature dead band
Duct static pressure reset

Central Plants

Add / optimize boiler lockout

Building Simulation Analysis (BOA) Tool
May 10, 2011



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Custom Energy Savings Calculations



CONTROLS

CONTROLS – eQUEST MODEL:



Similar control
options as BOA

Requires
calibrated
model

Simplify -Use
the Wizards

Verifies inputs
and outputs

Submit entire
model(s)

Magnitude of total savings >20% site consumption to
use a model

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SPREADSHEET ANALYSIS

Trending required to confirm pre- & post- scheduling
For simple equipment scheduling (pumps, air handlers, etc.) turned on & off



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OPTIMIZATION PROJECTS for Existing EMS

M&V for central plants – Pre and post plant performance VS. Dry Bulb temperature (weather normalized)

M&V for air handlers – Pre and Post fan power and tons trended

46

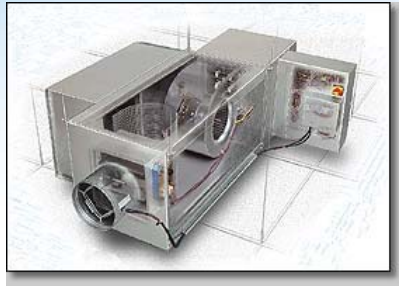
Custom Energy Savings Calculations



CAV to VAV

- Constant Air Volume to Variable Air Volume: (REA)

Rocky Harmstead



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Custom Energy Savings Calculations



CAV to VAV

- CAV to VAV – Lab Conversion Spreadsheet Analysis:

XYZ Pharmaceuticals						AH 1-01 CV to Phoenix VAV Conversion &	
Building energy use reduction-Phase I							
Air Handling System Energy Saving							
Existing Air Handling System	CFM	TSP in. H2O	Motor HP	Fan kW	Remarks	kWh	
AH 1-01	15,500	2.4	50	7.9	24 hours, constant volume	69,222	
Total	15,500		50	7.9		69,222	
New Air Handling System							
AH 1-01	9,940	2.08	20	4.4	24 Hours, variable volume, VSD was added	25,392	
Total	9,940		20	4.4		25,392	
AH 1-01 Fan Saving							
AH 1-01 Cooling Saving							
AH 1-01 Heating/Reheat Saving							
CV conversion to VAV Phoenix system							
AH-01 and EF 1-1	CV kWh	VAV kWh					
Fan Saving	145,340	54,760					
Cooling Saving	92,747	51,550					
CV Therm	16,813	VAV Therm					
Savings		6,639		3.5			
Exhaust Fan System Energy Savings							
Existing Exhaust Fan System	CFM	TSP in. H2O	Motor HP	Fan kW	Remarks	kWh	
EF 1-01	26,000	2.25	20	12.4	24 hr Const Vol.	108,858	
EF 1-02	26,000	2.25	20	12.4	24 hr Const Vol.	108,858	
EF 1-03	1,000	1	0.5	0.3	24 hr Const Vol.	2,791	
EF 1-04	6,650	1	2	1.4	24 hr Const Vol.	12,374	
EF 1-23	2,550	1	1	0.5	24 hr Const Vol.	4,745	
EF 1-24	26,000	2.5	20	13.8	24 hr Const Vol.	120,563	
Total	88,700		63.5	40.9		358,579	
New Exhaust Fan System						kWh at 60Hz/Full load	
EF 2-1	10,500	1.6	9.45	3.6	24 hr Const Vol. Variable volume with VSD	20,632	
EF 2-2	7,030	0.7	2.57	1.0	24 hr Const Vol. Constant volume with VSD	6,044	
EF 2-3	11,340	1.111	6.32	2.7	24 hr Const Vol. Constant volume with VSD	15,473	
EF 1-23	1,380	0.357	0.46	0.1	24 hr Const Vol.	405	
Total	30,250		18.8	7.4		64,779	
Savings				33.5			

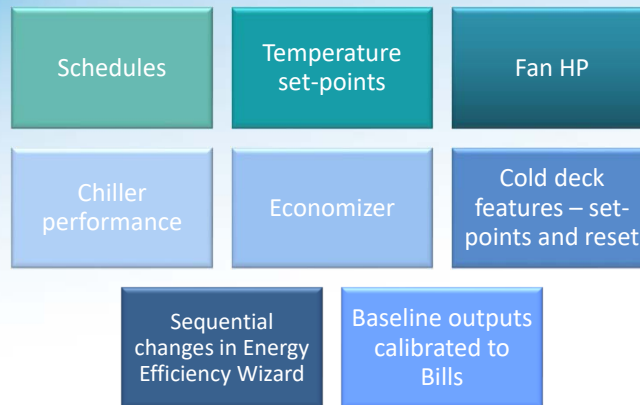
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Custom Energy Savings Calculations

CAV to VAV

CAV to VAV – eQUEST Model:

- What is Validated:



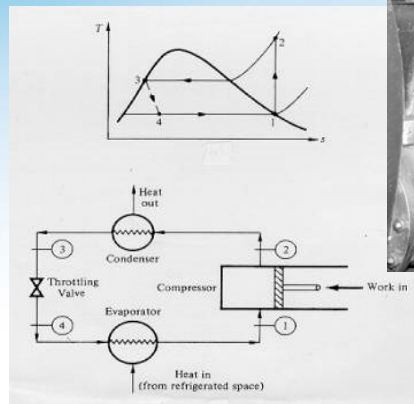
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Custom Energy Savings Calculations

CHILLERS

CHILLERS:

Rocky Harmstead



Willis Carrier (c.1921)

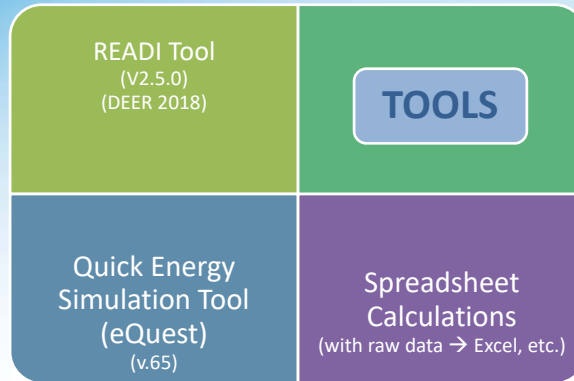
- “Centrifugal Refrigeration Machine”

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Custom Energy Savings Calculations



CHILLERS
TOOLS:



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Custom Energy Savings Calculations



CHILLERS
REFERENCES:



Title 24, Part 6
(2016)



2016 T-24 Efficiencies are located under 2016 Building Energy efficiency Standards Section 110.2 – Mandatory Requirements for Space Conditioning Equipment.



Database for Energy Efficiency Resources (DEER)

<http://www.deeresources.com/index.php/deer-versions/readi>

"Download the latest version of READI"



Climate Zone Locations

http://www.energy.ca.gov/maps/renewable/building_climate_zones.html

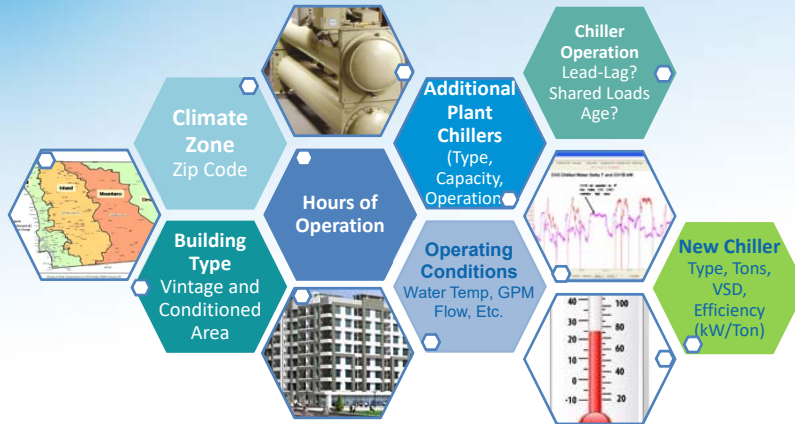


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Custom Energy Savings Calculations

CHILLERS

• Key Data for Collection:



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Custom Energy Savings Calculations

CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (READI):

Building Type – Vintage of building:

- Large Office built in 1999

Climate Zone – Zip Code:

- 92128

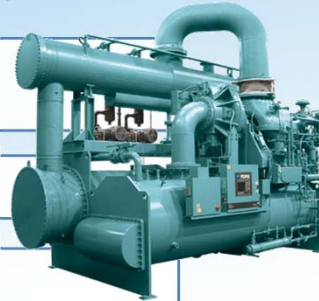
Existing Chiller:

- 350 tons, water-cooled, centrifugal

Proposed Chiller:

- 350 tons, water-cooled, centrifugal, efficiency = 0.500 kW/ton

- DEER EUL = 20 years; Title 24 = 0.560 kW/ton



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Custom Energy Savings Calculations

CHILLERS

• READI Startup Options:

READI Start-up Options

Select the Ex Ante data to access during this session:

☒ Official Ex Ante database ☐ Preliminary Ex Ante Review database

Select data valid during this period:		Include these types of data:
Period begins:	1/ 1/2018	<input type="checkbox"/> Proposed Data
Period ends:	12/31/2019	<input checked="" type="checkbox"/> Non-DEER Ex Ante Data
Select the period based on DEER versions:		<input type="checkbox"/> PG&E
<input type="checkbox"/> DEER2011/14	1/1/2013 - 12/31/2014	<input type="checkbox"/> SCE
<input type="checkbox"/> DEER2015/16	1/1/2015 - 12/31/2016	<input type="checkbox"/> SoCalGas
<input type="checkbox"/> DEER2017	1/1/2017 - 12/31/2017	<input checked="" type="checkbox"/> SDG&E
<input checked="" type="checkbox"/> DEER2018	1/1/2018 - 12/31/2018	<input type="checkbox"/> Other PAs
<input checked="" type="checkbox"/> DEER2019	1/1/2019 - 12/31/2019	
<input type="checkbox"/> DEER2020	1/1/2020 (no expiry)	

Cancel ☐ Don't use saved table preferences Okay

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Custom Energy Savings Calculations

CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (READI):

READI Start-up Options

Select the Ex Ante data to access during this session:

☒ Official Ex Ante database ☐ Preliminary Ex Ante Review database

Select data valid during this period:		Include these types of data:
Period begins:	1/ 1/2018	<input type="checkbox"/> Proposed Data
Period ends:	12/31/2019	<input checked="" type="checkbox"/> Non-DEER Ex Ante Data
Select the period based on DEER versions:		<input type="checkbox"/> PG&E
<input type="checkbox"/> DEER2011/14	1/1/2013 - 12/31/2014	<input type="checkbox"/> SCE
<input type="checkbox"/> DEER2015/16	1/1/2015 - 12/31/2016	<input type="checkbox"/> SoCalGas
<input type="checkbox"/> DEER2017	1/1/2017 - 12/31/2017	<input checked="" type="checkbox"/> SDG&E
<input checked="" type="checkbox"/> DEER2018	1/1/2018 - 12/31/2018	<input type="checkbox"/> Other PAs
<input checked="" type="checkbox"/> DEER2019	1/1/2019 - 12/31/2019	
<input type="checkbox"/> DEER2020	1/1/2020 (no expiry)	

Cancel ☐ Don't use saved table preferences Okay

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Custom Energy Savings Calculations

CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (READI):

READI v2.3.0 (Current Ex Ante Data) options: include Non-DEER and Proposed data: 1/1/2016 - 1/1/2020

View Tools Help

READI
A utility for viewing CPUC's database of Ex-Ante measure information

Intro & Help Classification Trees Measure Catalog Measures Energy Impacts Technology Costs Technologies Support Tables

Energy Impacts

Energy Impact ID: NE-HVAC-Chlr-Cent-gte300tons-0p461kwtpn-ConstSpd
Measure ID: NE-HVAC-Chlr-Cent-gte300tons-0p461kwtpn-ConstSpd
Measure Description: Water cooled centrifugal chiller (>= 300 tons, 0.461 kW/ton)

Program Admin Building Type Building Vintage Building Location Building HVAC Type
SDG&E Office - Large Existing Riverside Any

Energy Impact Values

All impacts are "per Cap-Tons"

	Whole Building Impacts			Direct End-Use Impacts		
	kWh/unit	kW/unit	therm/unit	kWh/unit	kW/unit	therm/unit
Above Pre-Existing	317	0.193	-0.00021	0	0	0
Above Code/Standard:	134	0.0824	-8.06E-5	0	0	0

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Custom Energy Savings Calculations

CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (Modified READI):

- Scaled Savings for New **0.5 kW/ton** ROB Chiller

Given:

- Above code savings for .461 kW/ton chiller =134 kWh/ton

Whole Building Impacts			
	kWh/unit	kW/unit	therm/unit
Above Pre-Existing	317	0.193	-0.00021
Above Code/Standard:	134	0.0824	-8.06E-5

- Current code for >300 ton water cooled centrifugal chiller .560 kW/ton- zero savings

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Custom Energy Savings Calculations

• CENTRIFUGAL CHILLER EXAMPLE (Modified READI):

<u>Measure Chiller Values</u>		
Title 24 kW/ton	0.56	
Measure kW/ton	<u>0.5</u>	
Delta kW/ton	0.06	
<u>DEER 2018 Values</u>		
Title 24 kW/ton	0.56	
DEER kW/ton	<u>0.461</u>	
Delta kW/ton	0.099	
<u>Impact Scale Value</u>		
$\frac{.06}{.099}$	0.606	
DEER Chiller Above Code Savings	134 kWh/ton	0.082 kW/ton
Scale Value	<u>0.606</u>	<u>0.606</u>
Measure Chiller Above Code Savings	81 kWh/ton	0.050 kW/ton
Measure Chiller capacity	<u>350</u> tons	<u>350</u> tons
Measure Chiller Savings Above Code	28424 kWh	17.5 kW

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Custom Energy Savings Calculations

CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (eQUEST):

Building Type – Vintage of building:

• Large Office built in 1999

Climate Zone – Zip Code:

• 92128

Existing Chiller:

• 350 tons, water-cooled, centrifugal

Proposed Chiller:

• 350 tons, water-cooled, centrifugal, efficiency = 0.5 kW/ton

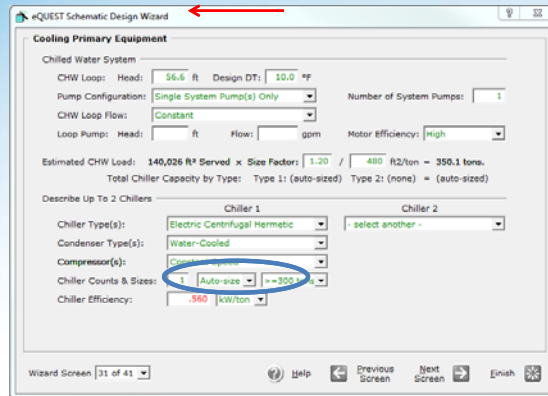
DEER EUL = 20 years Title 24 = .56 kW/ton

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Custom Energy Savings Calculations

CHILLERS

- CENTRIFUGAL CHILLER EXAMPLE (eQUEST):
 - Model is calibrated to billing data



eQUEST Schematic Design Wizard

Cooling Primary Equipment

Chilled Water System

CHW Loop: Head: 56.6 ft Design DT: 10.0 °F

Pump Configuration: Single System Pump(s) Only Number of System Pumps: 1

CHW Loop Flow: Constant

Loop Pump: Head: Flow: Motor Efficiency: High

Estimated CHW Load: 140,026 Btu Served x Size Factor: 1.20 / 400 Btu/ton = 350.1 tons.

Total Chiller Capacity by Type: Type 1: (auto-sized) Type 2: (none) = (auto-sized)

Describe Up To 2 Chillers

Chiller 1	Chiller 2
Chiller Type(s): Electric Centrifugal Hermetic	- select another -
Condenser Type(s): Water-Cooled	
Compressor(s): Constant Speed	
Chiller Counts & Sizes: 1 Auto-size >=300 tons	
Chiller Efficiency: 0.560 kW/ton	

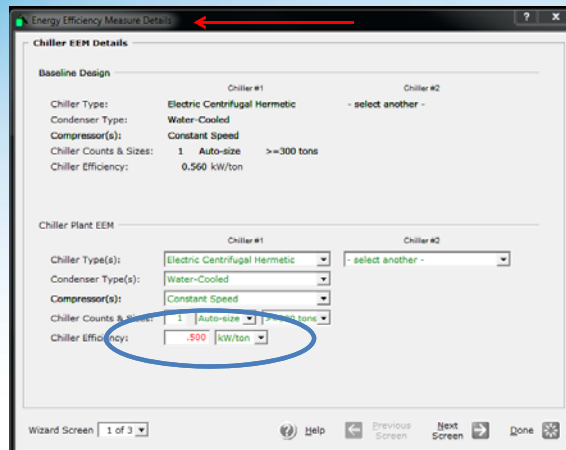
Wizard Screen 31 of 41

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Custom Energy Savings Calculations

CHILLERS

- CENTRIFUGAL CHILLER EXAMPLE (eQUEST):



Energy Efficiency Measure Details

Chiller EEM Details

Baseline Design

Chiller #1	Chiller #2
Chiller Type: Electric Centrifugal Hermetic	- select another -
Condenser Type: Water-Cooled	
Compressor(s): Constant Speed	
Chiller Counts & Sizes: 1 Auto-size >=300 tons	
Chiller Efficiency: 0.560 kW/ton	

Chiller Plant EEM

Chiller #1	Chiller #2
Chiller Type(s): Electric Centrifugal Hermetic	- select another -
Condenser Type(s): Water-Cooled	
Compressor(s): Constant Speed	
Chiller Counts & Sizes: 1 Auto-size >=300 tons	
Chiller Efficiency: 0.500 kW/ton	

Wizard Screen 1 of 3

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Custom Energy Savings Calculations



CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (eQUEST):

— Energy Savings

Annual Energy and Demand (pg 1 of 2)										
	Ann. Source Energy		Annual Site Energy		Lighting	HVAC Energy		Peak		
	Total Mbtu	EUI kBtu/sf/yr	Elect kWh	Nat Gas Therms	Electric kWh	Electric kWh	Nat Gas Therms	Total Mbtu	Elect kW	Cooling Tons
0 Base Design	15,476	110.53	1,489,923	2,212	439,363	533,617	14	1,823	679	331
1 0+Chiller Plant EEM	15,094	107.79	1,432,547	2,212	439,363	496,242	14	1,695	652	331
Incremental SAVINGS (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)										
1 0+Chiller Plant EEM	382	2.73 (2%)	37,376 (3%)	0 (0%)	0 (0%)	37,375 (7%)	0 (0%)	128 (7%)	27 (4%)	0 (0%)

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Custom Energy Savings Calculations



CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (eQUEST):

— Demand Reduction

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)											
	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
0 Base Design	148.3	20.2	152.9	0.0	194.7	29.7	49.8	83.6	0.0	0.0	679.1
1 0+Chiller Plant EEM	148.3	20.2	152.9	0.0	169.0	29.1	49.3	82.6	0.0	0.0	652.3
Incremental SAVINGS (kW) (values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)											
1 0+Chiller Plant EEM	0.00 (0%)	0.00 (0%)	0.00 (0%)	--	25.69 (13%)	0.35 (2%)	0.51 (1%)	0.00 (0%)	--	--	26.75 (4%)

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Custom Energy Savings Calculations

CHILLERS

• CENTRIFUGAL CHILLER EXAMPLE (M&V):

Measurement & Verification may be Required

Using eQUEST or spreadsheet calculations

Typical M&V is based on kW/ton saved and recorded ton-hrs

• Option B, Key Parameter, IPMVP-III

If scope of work is complex, M&V could use

• Option C, Whole Building Method

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Title-24 '2016 Chiller Efficiencies Effective January, 2017

Page 92

2016 Building Energy Efficiency Standards

TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS^{a,b}

Equipment Type	Size Category	Path A Efficiency ^{a,b}	Path B Efficiency ^{a,b}	Test Procedure ^c
Air Cooled, With Condenser Electrically Operated	< 150 Tons	≥ 10.100 EER ≥ 13.700 IPLV	≥ 9.700 EER ≥ 15.800 IPLV	AHRI 550/590
	≥ 150 Tons	≥ 10.100 EER ≥ 14.000 IPLV	≥ 9.700 EER ≥ 16.100 IPLV	
Air Cooled, Without Condenser Electrically Operated	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements.		AHRI 550/590
Water Cooled, Electrically Operated, Reciprocating	All Capacities	Reciprocating units must comply with the water-cooled positive displacement efficiency requirements.		AHRI 550/590
Water Cooled, Electrically Operated Positive Displacement	< 75 Tons	≤ 0.750 kW/ton ≤ 0.600 IPLV	≤ 0.780 kW/ton ≤ 0.500 IPLV	AHRI 550/590
	≥ 75 tons and < 150 tons	≤ 0.720 kW/ton ≤ 0.560 IPLV	≤ 0.750 kW/ton ≤ 0.490 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.660 kW/ton ≤ 0.540 IPLV	≤ 0.680 kW/ton ≤ 0.440 IPLV	
	≥ 300 tons and < 600 tons	≤ 0.610 kW/ton ≤ 0.520 IPLV	≤ 0.625 kW/ton ≤ 0.410 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons	≤ 0.610 kW/ton ≤ 0.550 IPLV	≤ 0.695 kW/ton ≤ 0.440 IPLV	AHRI 550/590
	≥ 150 tons and < 300 tons	≤ 0.610 kW/ton ≤ 0.550 IPLV	≤ 0.615 kW/ton ≤ 0.400 IPLV	
	≥ 300 tons and < 400 tons	≤ 0.590 kW/ton ≤ 0.520 IPLV	≤ 0.595 kW/ton ≤ 0.390 IPLV	
	≥ 400 tons and < 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	

Use path A for fixed speed and Path B for variable speed

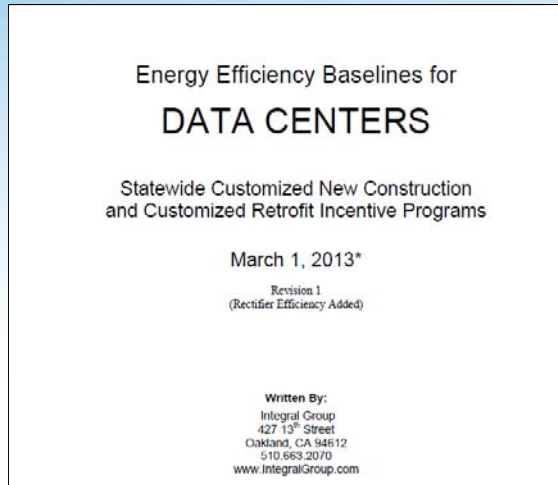
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Custom Energy Savings Calculations



Data Centers

- DATA CENTERS:
- Rod Houdyshe

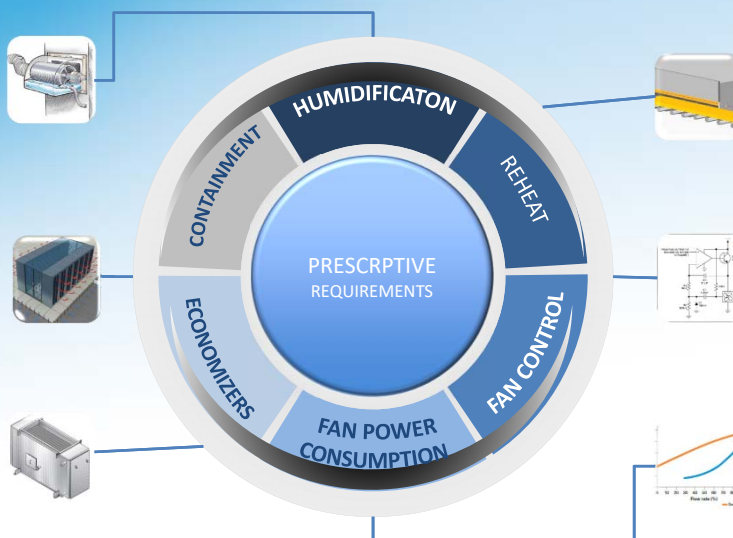


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Custom Energy Savings Calculations



DATA CENTERS



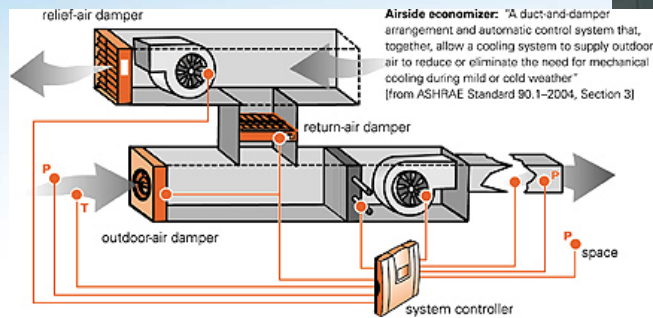
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Custom Energy Savings Calculations

ECONOMIZERS

ECONOMIZERS :

Rod Houdyshel



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Custom Energy Savings Calculations

ECONOMIZERS

ECONOMIZERS – TITLE 24:

- Each cooling fan system with a design total mechanical cooling capacity over 54,000 Btu/hr shall include either

A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside-air;

or

B. A water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 50° F dry-bulb/45° F wet-bulb and below.
(with some exceptions, 140.4(e)1)

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Custom Energy Savings Calculations



ECONOMIZERS

EXCEPTION 4 to Section 140.4(d): Zones in which specific humidity levels are required to satisfy exempt process loads.

- Computer Rooms or other spaces where the only process load is from IT equipment **may not** use this exception.
- Economizers for Computer Room **refer to code section 140.9(a)**



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Custom Energy Savings Calculations



ECONOMIZERS

- Custom Measure Economizer Calibration (Adjustment)-RCx
- No Repair of broken Economizers allowed

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Custom Energy Savings Calculations



ECONOMIZERS

ECONOMIZERS - READI TOOL FOR NEW ECONOMIZERS:

Central Systems

Energy Impacts

Measure Description: Economizer - Central system

Energy Impact ID: D03-059

Measure ID (linked): D03-059

DEER Energy Impact Values: All impacts are "per Cap-Tons"

Whole Building Impacts			Direct End-Use Impacts		
kWh/unit	kW/unit	therm/unit	kWh/unit	kW/unit	therm/unit
Above Pre-Existing	383	0.000234	-13.7	0	0
Above Code/Standard:	383	0.000234	-13.7	0	0

IOU: SDG&E **Building Type:** Office - Large **Building Vintage:** Existing **Building Location:** San Diego **Building HVAC Type:** Any

Normalizing Units: Cap-Tons **Number of Units:** 951.11 **Measure Area:** 174960 **Scale Basis:** None **Result Type:** Direct

Energy Impacts List

click on column titles to filter the list of impacts

Index	IOU	Building Type	Building Vintage	Location	HVAC Type	WB-Pre_kWh	WB-Pre_kW	WB-Pre_therm	WB-Std
105429942	SDG	ECC	Ex	C207	Any	208.4	0.000	-8.53	
105429936	SDG	ESe	Ex	C207	Any	159.5	0.001	-4.53	
105429947	SDG	ELn	Ex	C207	Any	269.8	0.000	-10.34	
105429952	SDG	Hsp	Ex	C207	Any	1169.1	0.000	-31.83	1
105429962	SDG	Htl	Ex	C207	Any	3622.7	0.017	-41.38	3
105429957	SDG	Nrs	Ex	C207	Any	864.7	0.000	-26.78	
105429968	SDG	OfL	Ex	C207	Any	382.8	0.000	-13.69	

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Custom Energy Savings Calculations



ECONOMIZERS

ECONOMIZERS - READI TOOL FOR ECONOMIZER REPAIR (RCX)

Energy Impacts

Measure Description: Economizer Maintenance

Energy Impact ID: D03-060

Measure ID (linked): D03-060

DEER Energy Impact Values: All impacts are "per Cap-Tons"

Whole Building Impacts			Direct End-Use Impacts		
kWh/unit	kW/unit	therm/unit	kWh/unit	kW/unit	therm/unit
Above Pre-Existing	212	0.00034	-2.93	0	0
Above Code/Standard:	212	0.00034	-2.93	0	0

IOU: SDG&E **Building Type:** Office - Large **Building Vintage:** Existing **Building Location:** San Diego **Building HVAC Type:** Any

Normalizing Units: Cap-Tons **Number of Units:** 731.72 **Measure Area:** 174960 **Scale Basis:** None **Result Type:** Direct

Energy Impacts List

click on column titles to filter the list of impacts

Index	IOU	Building Type	Building Vintage	Location	HVAC Type	WB-Pre_kWh	WB-Pre_kW	WB-Pre_therm	WB-Std_kWh	WB-Std_kW
105430238	SDG	ECC	Ex	C207	Any	120.1	0.000	-2.87	120.1	
105430232	SDG	ESe	Ex	C207	Any	103.7	0.001	-2.51	103.7	
105430243	SDG	ELn	Ex	C207	Any	185.5	0.001	-3.64	185.5	
105430248	SDG	Hsp	Ex	C207	Any	908.3	0.000	-24.35	908.3	
105430258	SDG	Htl	Ex	C207	Any	2321.0	0.025	-41.92	2321.0	
105430253	SDG	Nrs	Ex	C207	Any	337.0	0.000	-8.13	337.0	
105430264	SDG	OfL	Ex	C207	Any	212.5	0.000	-2.93	212.5	
105430270	SDG	RT3	Ex	C207	Any	208.6	0.000	-3.44	208.6	

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Custom Energy Savings Calculations



ECONOMIZERS

ECONOMIZERS - BOA TOOL:

General Information & General Inputs	
General Project Information	
Facility Name	(facility name)
Facility Address	(facility address)
Utility Account Number	(utility account number)
Provider Information	
Name	(provider name)
Company	(provider company)
Address	(provider address)
Email	(provider email)
Phone number	(provider phone)
Date	(date)
General Inputs	
Building Type	Office
Primary Ventilation System Type	VAV AHU / RTU w/ zone reheat
Primary Cooling System Type	Water-Cooled Chiller(s)
HVAC Heating System Type	Natural Gas Water Boiler
Zip Code	92123 (CZ7) San Diego
CA Climate Zone	7
Year Building Constructed	2001
Facility Gross Area (ft ²)	70,000
Baseline Building Energy Use	
Baseline Annual Electric Use (kWh)	1,500,000
Baseline Annual Gas Use (Therms)	15,000
Electric EUI (kWh/ft ²)	21.4
Gas EUI (therms/ft ²)	0.2
Total EUI (kBtu/ft ²)	94.6

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Custom Energy Savings Calculations



ECONOMIZERS

ECONOMIZERS - BOA TOOL:

Savings Calculator: Airside Economizer	
Project Information	
Facility Name	(facility name)
Facility Address	(facility address)
Utility Account Number	(utility account number)
Provider Name	(provider name)
Provider Company	(provider company)
Address	(provider address)
Email	(provider email)
Telephone number	(provider phone)
Date	(date)
Finding & Measure Descriptions	
Finding / Measure Number	(user to enter finding / measure number)
Finding Description	(user to enter finding description)
Measure Description	(user to enter measure description)
Baseline Project Building Characteristics	
VAV or CAV air handlers	Y/N
Water-cooled or air-cooled chillers	Y/N
Chilled Water	Y/N
Hot Water	Y/N
Fixed or variable CHW/CHH setpoints	Fixed
These inputs are for use in determining tool applicability, and do not impact the savings calculations. If multiple project building characteristics do not match tool applicability, contact your utility program administrator.	
Inputs	
Building Type	Office
CA Climate Zone	7
Year Building Constructed	2001
Baseline Lockout Temp or % Outside Air	55 deg Lockout
Air Handler Cooling Capacity (tons)	800
Savings Outputs	
Annual Electric Savings	1120183.14
DEER Peak Electric Demand Savings	1.6kW
Annual Natural Gas Savings	-16274.41
Savings and EUI (kWh/ft ²) savings or energy efficiency measure	-1.15% of Annual Use

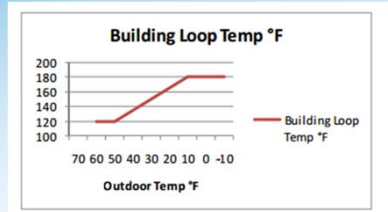
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Custom Energy Savings Calculations

BOILERS WITH DDC SYSTEMS

• BOILERS WITH DDC SYSTEMS:

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Custom Energy Savings Calculations

BOILERS WITH DDC SYSTEMS

BOILERS WITH DDC SYSTEMS:

Steam Boilers

Heating Hot Water Boilers

Domestic Hot Water Boilers

Condensing Boilers

Boiler Economizers

OSA-T Lockout/
OSA T-Reset

Example of Boiler Technologies

One for one replacement

Matching boiler system

Example of Boiler Measures **REBATE**

Existing System Redesign

Removal of Heat Exchanger and Decoupling

Examples of Boiler Measures **CUSTOM**

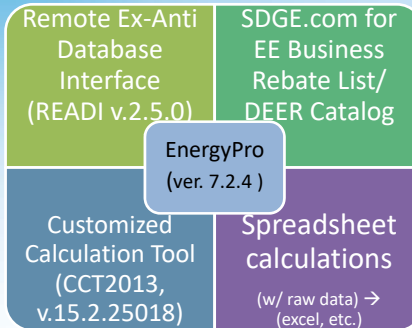
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Custom Energy Savings Calculations

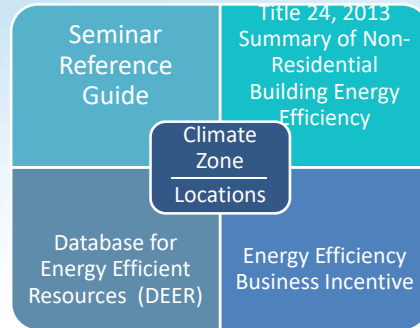


BOILERS WITH DDC SYSTEMS

TOOLS:



REFERENCES:



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Custom Energy Savings Calculations



BOILERS WITH DDC SYSTEMS

• REBATES OR INCENTIVES:

– Natural Gas Boiler Rebates (EEBR):

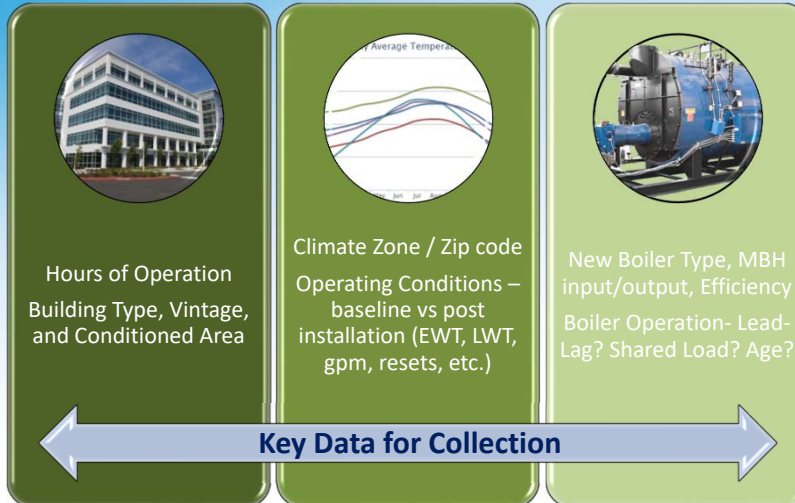
Solution	Product Code	Description	\$/Mbtuh
Storage Water Heater	various	Storage Water Heater	\$2.00
Commercial Boiler	402038	Commercial	\$0.50
Instantaneous Water Heater	402039	Small (<200MBtuh)	\$2.00
	402040	Large (>200MBtuh)	\$0.50
Process Boiler	402042	Water	\$0.50
Direct Contact Water Heater	402285	Large (>300MBtuh)	\$2.00

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Custom Energy Savings Calculations



BOILERS WITH DDC SYSTEMS



For Custom Operation – load factor schedule and capacity

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Custom Energy Savings Calculations



BOILERS WITH DDC SYSTEMS

REASONS TO CHOOSE **EEBR** OVER EEBI

Primary Reason:

Boiler technology & measure matches Rebate list

Secondary Reasons:

There are NONE – If on the list

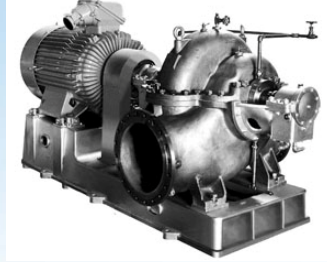
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Custom Energy Savings Calculations

PUMPS

- PUMPS with VSDs:

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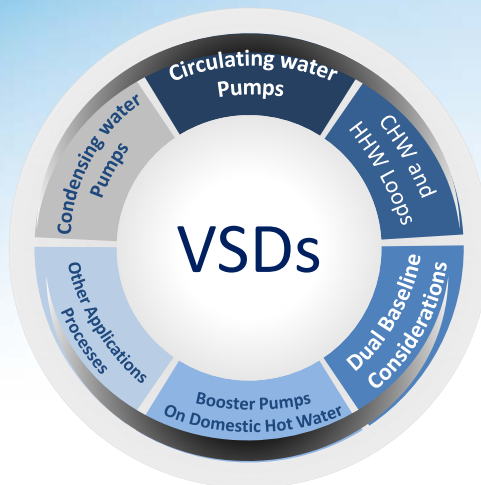


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Custom Energy Savings Calculations

PUMPS

PUMP ENERGY EFFICIENCY MEASURES:



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Custom Energy Savings Calculations



PUMPS

VSDs on CIRCULATING WATER PUMPS (WSHPs):

- Pre-installation: Begin with 33% savings

— Savings = 33% * Baseline kWh

- Verified post-installation

— Needed Data:

- Nameplate information

— HP

— PF

— Efficiency

— FLA

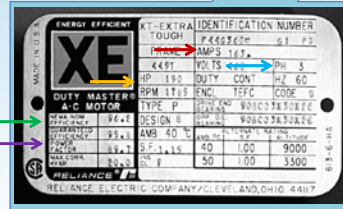
— PH

- Measured Data

— Amperes

— Voltage

- How many pumps and how they operate together



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Custom Energy Savings Calculations



PUMPS

VSDs on CIRCULATING WATER PUMPS (WSHPs):

- Calculate Baseline kW → kWh = kW * (operating hours)

— Needed Data:

Example: Slip Load Calculation

Given: Synchronous speed in rpm = 1800
Nameplate full load speed = 1750
Measured speed in rpm = 1770
Nameplate rated horsepower = 25 hp

Determine actual output horsepower.

From Equation 5

$$Load = \frac{1800 - 1770}{1800 - 1750} \times 100\% = 60\%$$

Actual output horsepower would be 60% x 25 hp = 15 hp

Poles

60 Hertz

2

3600

4

1800

6

1200

$$Load = \frac{I}{I_r} \times \frac{V}{V_r} \times 100\%$$

Where:

Load = Output power as a % of rated power

I = RMS current, mean of 3 phases

I_r = Nameplate rated current

V = RMS voltage, mean line-to-line of 3 phases

V_r = Nameplate rated voltage

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Custom Energy Savings Calculations



PUMPS

VSDs on CIRCULATING WATER PUMPS (WSHPs):

• Alternative Estimation Approach: BIN Analysis

- Assign VSD pump operating frequencies to temperature ranges
 - Justify **min/max** amps
- Determine annual hours in each temperature range
 - CZ2010 Weather Data
 - DOE Energy Plus Website (reference manual)
- Calculate the new BHP (kW) using pump affinity laws:

$$kW_{new} = \frac{kW_{full} * \left(\frac{frequency}{60} \right)^{2.4}}{eff_{VFD}}$$

OAT (°F)	VSD Frequency (Hz)	Total BIN Hours
88 - 90	60	1
86 - 88	60	15
84 - 86	60	12
82 - 84	60	27
80 - 82	60	33
78 - 80	56.9	45
76 - 78	53.8	93
74 - 76	50.6	182
72 - 74	47.5	239
70 - 72	44.4	374
68 - 70	41.3	527
66 - 68	38.1	681
64 - 66	35	671
62 - 64	35	598
60 - 62	35	577
58 - 60	35	687
56 - 58	38.6	498
54 - 56	42.1	356
52 - 54	45.7	249
50 - 52	49.3	155
48 - 50	52.9	100
46 - 48	56.4	70
44 - 46	60	37
42 - 44	60	12
40 - 42	60	7
38 - 40	60	7
36 - 38	60	4

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Custom Energy Savings Calculations



PUMPS

VSDs on CIRCULATING WATER PUMPS (WSHPs):

• Pump Affinity Law Applied: (real world / non ideal)

P		"n" FOR AIR / WATER LOOPS			cfm1 / cfm2)^n fan power bic feet per minute (ideal conditions)
(kW1 / kW2)		Fully or Mostly Closed	Semi-Closed	Mostly or Fully Open	
kW	Fixed Geometry:	2.4	2.2	2.0	
gpm					
n					

- Fully or Mostly Closed
 - Chilled water pumping
 - IT cooling systems
- Semi-Closed
 - Condenser water loop for open cooling tower
 - CRAC/CRAH for hot/cold aisles
- Mostly or Fully Open
 - CRAC/CRAH for unobstructed underfloor plenums, open returns

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Custom Energy Savings Calculations



PUMPS

VSDs on CIRCULATING WATER PUMPS (WSHPs):

- Post-Installation: Verify estimated savings
 - Log for 2 weeks
 - Operating amps and OAT
- Calculate Post-installation kW and kWh similarly
 - $kW = \frac{(Amps * Volts * PF * \sqrt{PH})}{1000 W/kW}$
 - **kWh** : Average the kW in each OAT bin
 - Extrapolate annually using TMY3 temperature data
- Calculate **savings**
 - **Annual Savings** = (Pre-install kWh) – (Post-install kWh)
 - kW reduction only from 2-5 pm, September 1st, 2nd, 3rd



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Custom Energy Savings Calculations



PUMPS

VSDs on CONDENSER WATER PUMPS – Will require

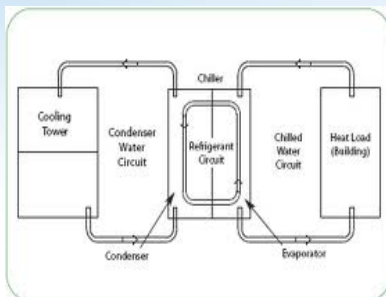
M&V

- 1 month PRE - Installation
- 1 month POST - Installation

Chiller Energy

May save pumping energy, but chiller consumption may increase

Reduced flow across chiller affects pressure drop & operating efficiency



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Custom Energy Savings Calculations

PUMPS

VSDs on PROCESS PUMPS:

- Independent of outdoor air temperatures

Item	Value	Comment
Total Pumping Horsepower (hp)	250.00	
Average Pump Load Factor	85%	
Pump Motor Efficiency	92%	
Total Pump Operating Hours	8,760	From EMS, site personnel, operating logs
% Hours Operating at 100% Load	10%	
% Hours Operating at 90% Load	20%	
% Hours Operating at 80% Load	50%	
% Hours Operating at 70% Load	20%	kWh = (70%) ^{2.4} * 8760 * 20%
% Hours Operating at 60% Load	0%	
% Hours Operating at 50% Load	0%	
% Hours Operating at 40% Load	0%	
% Hours Operating at 30% Load	0%	
Sum of % Hours Operating at Various Loads	100%	Should always equal 100%
Electric Cost (\$/kWh)	0.13	Total Consumption Cost (\$) / Total Consumption (kWh)
Pre-Retrofit Energy Consumption (kWh)	1,509,433.70	HP * 0.7457 * LF / EFF * HOURS
Post-Retrofit Energy Consumption (kWh)	938,710.90	Sum of kWh @ 100% - 30%

Custom Energy Savings Calculations

PUMPS

VSDs/BOOSTER PUMPS ON DOMESTIC WATER:

Will require **M&V**

Measured baseline kW

Constant flow hours of operation

Post-installation consumption

2-4 weeks amp logging

May require documentation of occupant behavior and/or schedules to extrapolate annual use and savings

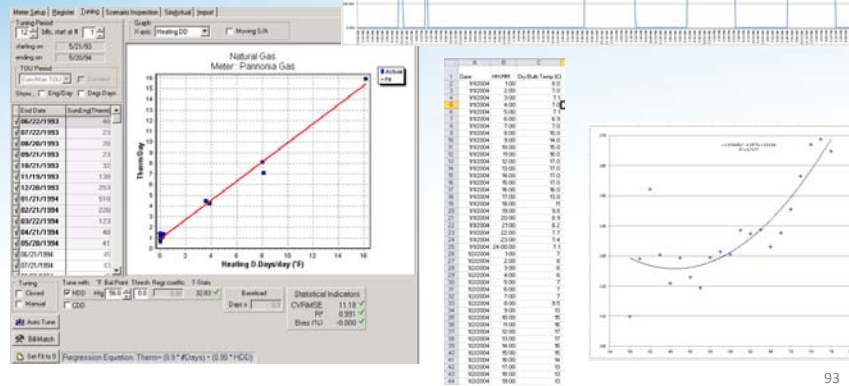


Custom Energy Savings Calculations

MEASUREMENT & VERIFICATION

MEASUREMENT & VERIFICATION:

Rod Houdyshel



Questions?

What else would you want to know?

Concerns?

Thanks for Attending!