Efficiency in Power Distribution and Motor Control

Schaedler *YESCO* – Act-129 Conference

Powering Business Worldwide

© 2010 Eaton Corporation. All rights reserved

Act 129 Commercial Buildings

In this presentation you will learn…

- About PA Act 129 and its impact on a customer
- Incentives for installing VSD drives
- Advanced VFD drive savings a case study in demand response

Intent of PA Act 129

Act 129 of 2008 was signed into law to:

- *Assure the health, safety, and prosperity of the citizens through the availability of adequate, reliable and environmentally sustainable electric service at the least cost.*
- *To adopt energy efficiency measures and to implement energy procurement designed to produce price stability.*
- *To expand the use of alternative energy and to explore the feasibility of new sources of alternative energy.*

Act 129- Reduction Targets

Utilities must reduce their *customers* usage by the following:

- A load reduction (kWh) of 1% by May 31, 2011
- A load reduction (kWh) of 3% by May 31, 2013
- A demand reduction (kW) of 4.5% by May 31,2013
- The penalty for non-compliance is no less then $1,000,000 and up to $20,000,000.

Load reduction based on usage on June ’09 to May ‘10

kW reduction based on maximum 100 hours of summer 2007

Act-129 - Variable Frequency Drives (VFD)

VFD - Fan systems - Overview

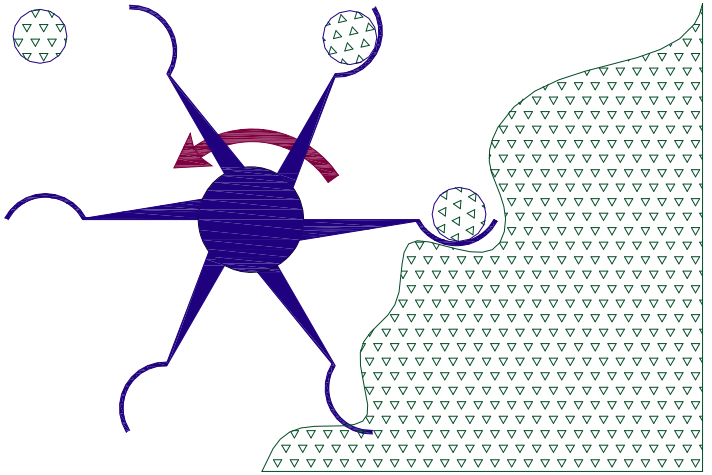
According to the DOE…

- 60% of all fans are oversized
- 10% of those oversized by 60%
- Fans are rarely at their best efficiency point
- Once installed, a fan is more easily optimized
- There are three laws used in optimization

Similar relations exist for pumps

VFD – Background- Fan Laws

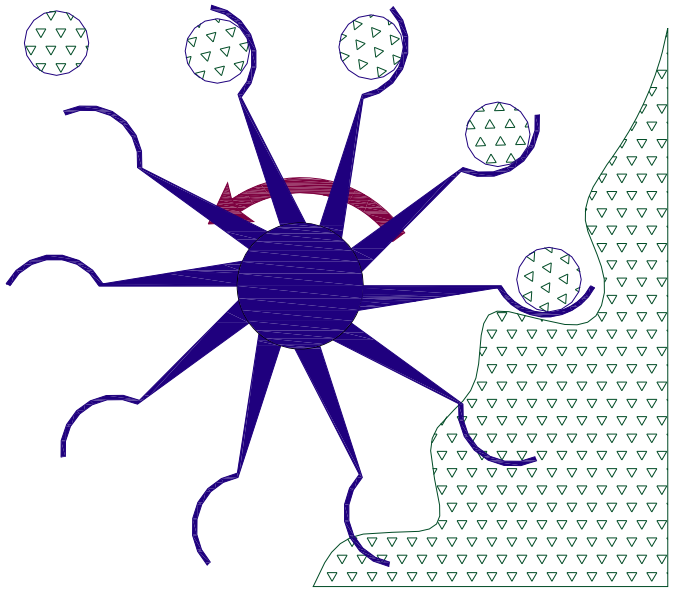
- Fan wheel acts like a shovel
- Discharges the same volume with each revolution



- In a fixed system the fan will discharge the same <u>volume</u> regardless of density.

VFD – Background- Fan Laws

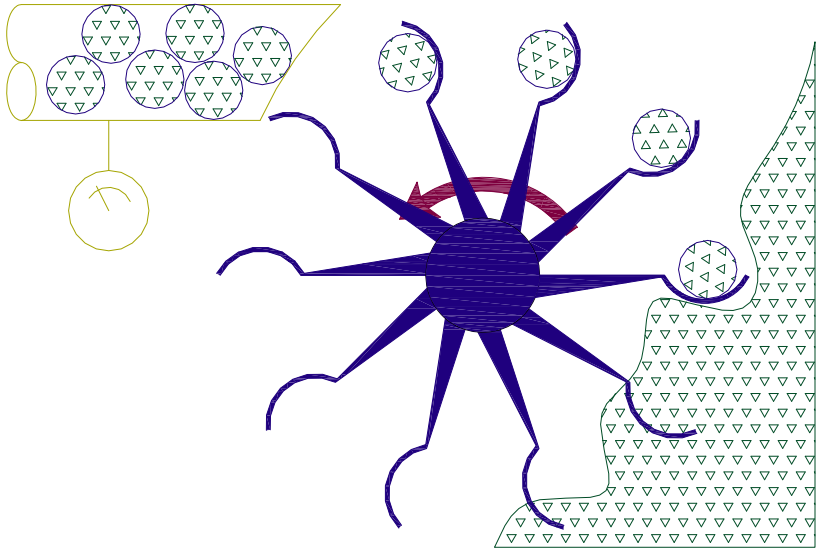
- As the speed increases,
- The volume increases
- CFM varies as RPM



$$CFM\,(new) = \frac{RPM\,(new)}{RPM\,(old)} \times CFM\,(old)$$

VFD – Background- Fan Laws

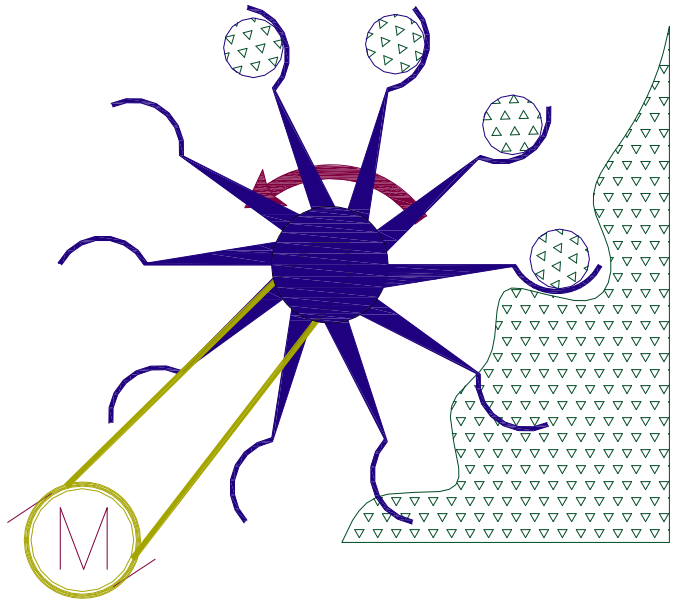
- Static pressure varies as the square of the volume
- SP varies as RPM^2



$$SP(new) = \left(\frac{RPM(new)}{RPM(old)} \right)^2 \times SP(old)$$

VFD –Background- Fan Laws

- Efficiency is a function of aerodynamics & point of operation
- HP varies as RPM^3



$$HP(new) = \left(\frac{RPM(new)}{RPM(old)} \right)^3 \times HP(old)$$

VFD – Background - System Curve

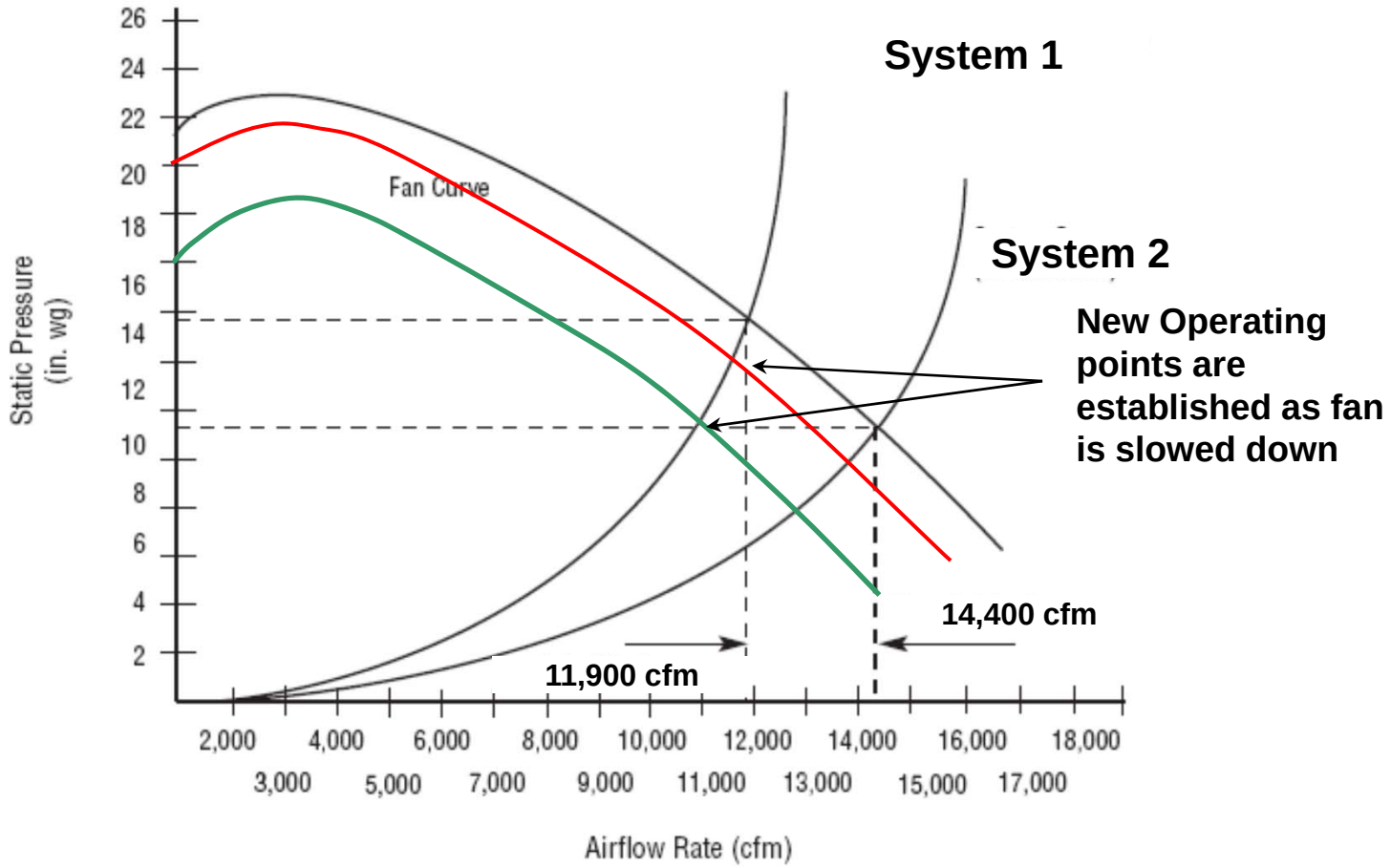


Chart: Improving Fan System Performance: A Source Book for Industry, US DOE, DOE-GO-102003-1294

Powering Business Worldwide

VFD – Background - System Curve

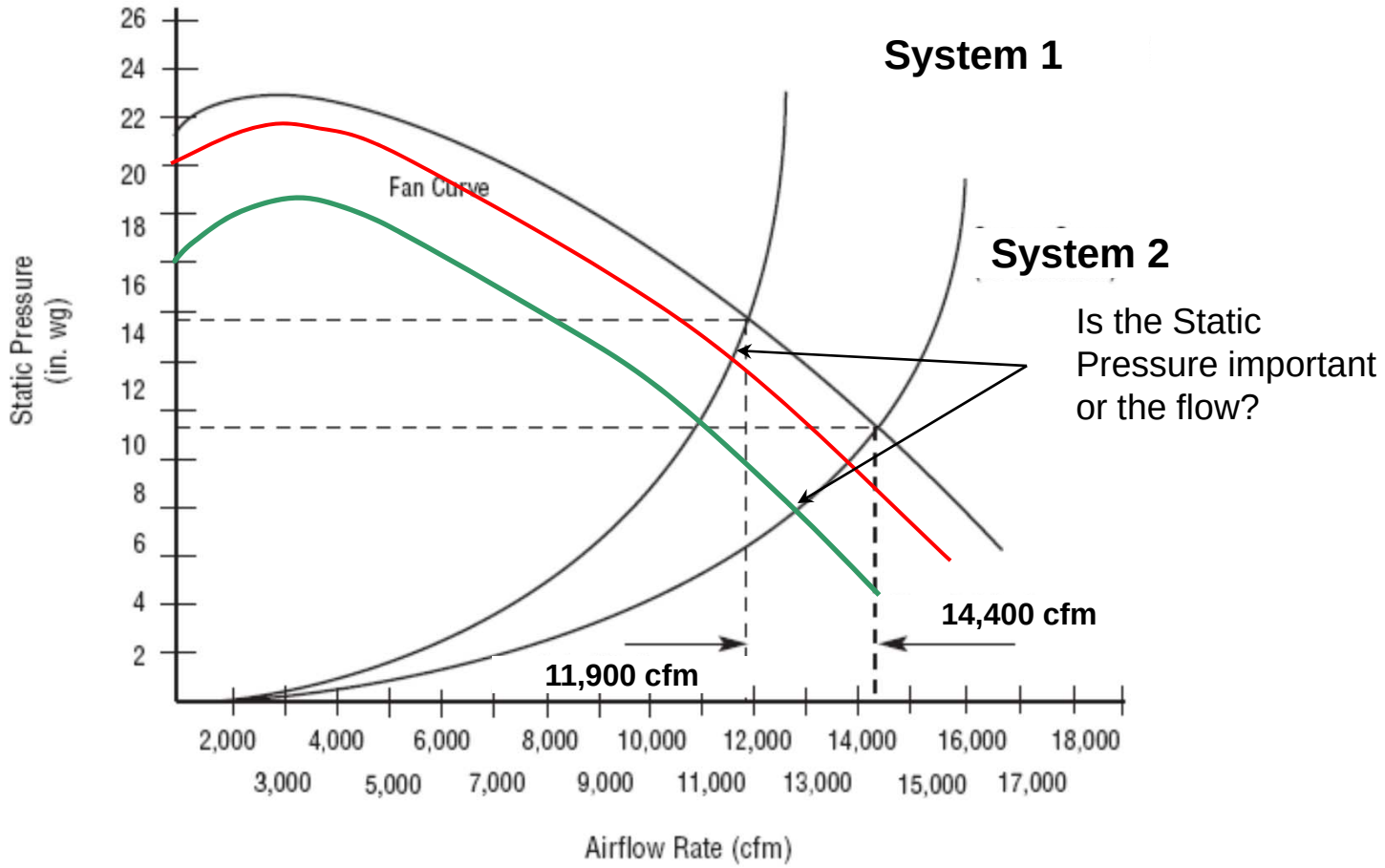


Chart: Improving Fan System Performance: A Source Book for Industry, US DOE, DOE-GO-102003-1294

EATON
Powering Business Worldwide

VFD - Drives and ACT-129

- All the power companies (EDC) will provide an incentive for installing a VFD on pumps and fans.
- The programs will vary with each EDC
- The EDC may require pre or post M&V – *this takes time*
- There are custom programs for higher voltage and higher horsepower applications, through custom
- The programs require pre-approval on larger motors (50 hp or $3,000), be careful of customer schedules application programs.

VFD – Other Conditions

- The rebates only apply to applications with pumping or air handling where
  - Flow controlled by restriction
  - Fixed flow mover has greater flow movement than required
- System must operate more than 2,500 hours
- The speed must be automatically controlled
- The restriction must be removed or disabled

* Based on Allegheny Power drives program

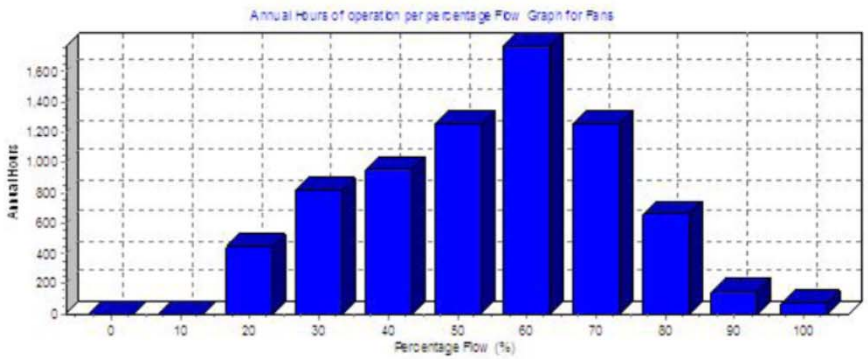
VFD – First Step – Calculate Savings

- A savings calculation will need to be made on the customer's application.
- Many manufacturer have simple web based calculators that will provide an estimate based on a "generic" curve,
  - www.eere.energy.gov/industry - DOE's ITP program
  - WWW.bpa.gov/energy/n/industrial/audit - Bonneville Power Administration
- Submit the calculation with the application

VFD – Loading Curve – Cooling Tower

Cutler-Hammer

Energy Savings Estimator



To: Comercial Office Building
Customer
1 Main Street
Pittsburgh, PA
Fax:

Prepared by:

Fan Application

Project Name: BOMA - Pittsburgh

Total Annual Hours of Operation: 7,392 Hours

Operation / Motor / AFD Data

Cost per kWh:	$ 0.09
Motor Power:	20.0 HP
Motor Efficiency:	95.0 %
Drive Efficiency:	97.0 %
Utility Incentive:	0.0 $/HP
Variable Speed Drive Cost:	$ 11,300

Annual Energy Cost per Control Method

Adjustable Frequency Drive	$ 2,292
Inlet Vane Control	$ 5,701
Outlet Damper Control	$ 7,583
No Speed Control	$ 10,444

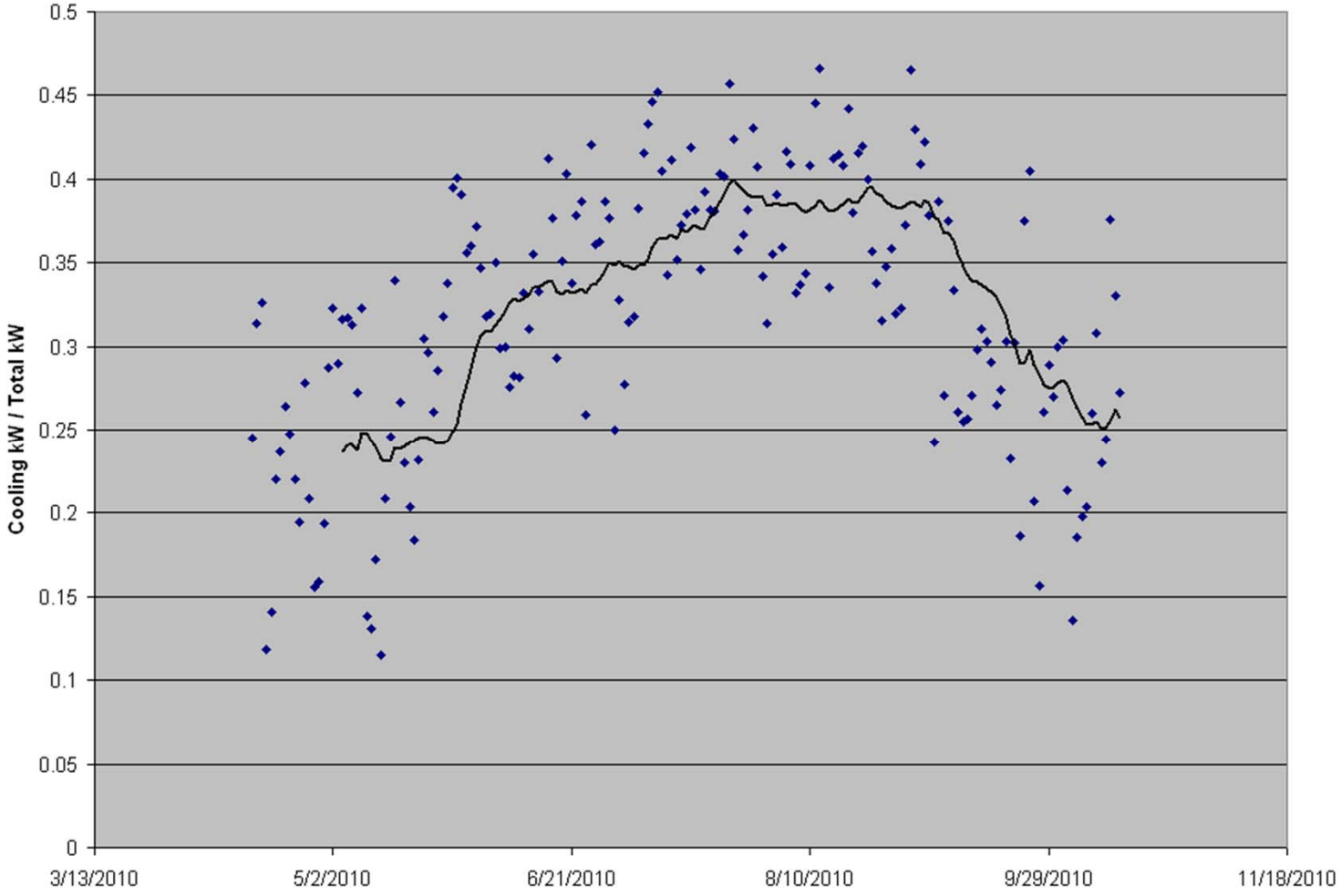
Duty Cycle

% Flow	Time (Hrs)	Time (%)
100%	73.9 Hrs	1 %
90%	147.8 Hrs	2 %
80%	665.3 Hrs	9 %
70%	1,256.6 Hrs	17 %
60%	1,774.1 Hrs	24 %
50%	1,256.6 Hrs	17 %
40%	961.0 Hrs	13 %
30%	813.1 Hrs	11 %
20%	443.5 Hrs	6 %
10%	0.0 Hrs	0 %

Most cooling towers with 20 hp motors will have a two speed fan. This reduces the savings by about ½

The savings would be <u>$5,222.00</u> per year

VFD – Actual Loading Curve - Pittsburgh



Powering Business Worldwide

VFD – Cooling Tower Economics

20 HP DRIVE COST	**$4,800.00**
INSTALLATION COST	**$6,500.00**
	$11,300.00

Savings
$5,222.00

	Duquesne Light	Allegheny Power	First Energy
Incentive	**$80.00 / HP**	**½ Drive Cost**	**$30.00 / HP**
REBATE	**$<1,600.00>**	**$<2,400.00>**	**$<600.00>**
Project Cost	**$9,700.00**	**$8,900.00**	**$10,700.00**
	ROI – 1.85 years	**ROI – 1.70 years**	**ROI – 2.05 years**

EATON
Powering Business Worldwide

VFD – 75 HP Pumping System

		Energy Audit Identified Savings
75 HP DRIVE COST	$17,000.00	
INSTALLATION COST	$8,000.00	$9,200.00
	$25,000.00	ROI – 2.72 years

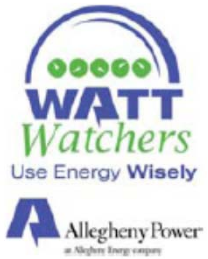
	Duquesne Light	Allegheny Power	First Energy
Incentive	$150.00 / HP	½ Drive Cost	$30.00 / HP
REBATE	$<11,250.00>	$<8,500.00>	$<2,250.00>
Project Cost	$13,750.00	$16,500.00	$22,750.00
	ROI – 1.49 years	ROI – 1.79 years	ROI – 2.47 years

EATON
Powering Business Worldwide

EE&C – How to Participate

- Identify opportunities in your facility through an Energy Audit
- Determine if the cost analysis is close to an attractive payback using the prescriptive program
- Determine if the system could provide more energy savings if a custom plan was attempted
- **Apply to the utility! Projects require pre-approval**
- Realize that the programs will continue to change always get the latest information from EDC website before making a submission.

EE&C – where to get information



Watt-Watchers section of alleghenypower.com

Questions: Call Allegheny Power's Watt Watchers Line 1-877-928-8928

www.energysavePA.com

Questions: Call 1-866-554-4430

Duquesne Light

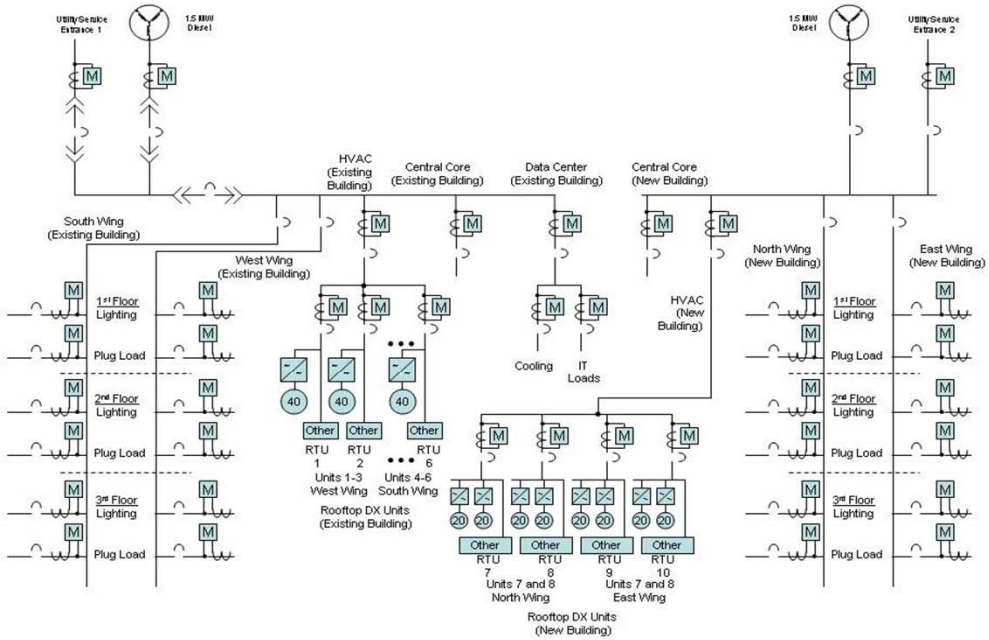
www.duquenelight.com/wattchoices

Call 412-393-7100 Opt. 4 / Opt. 5

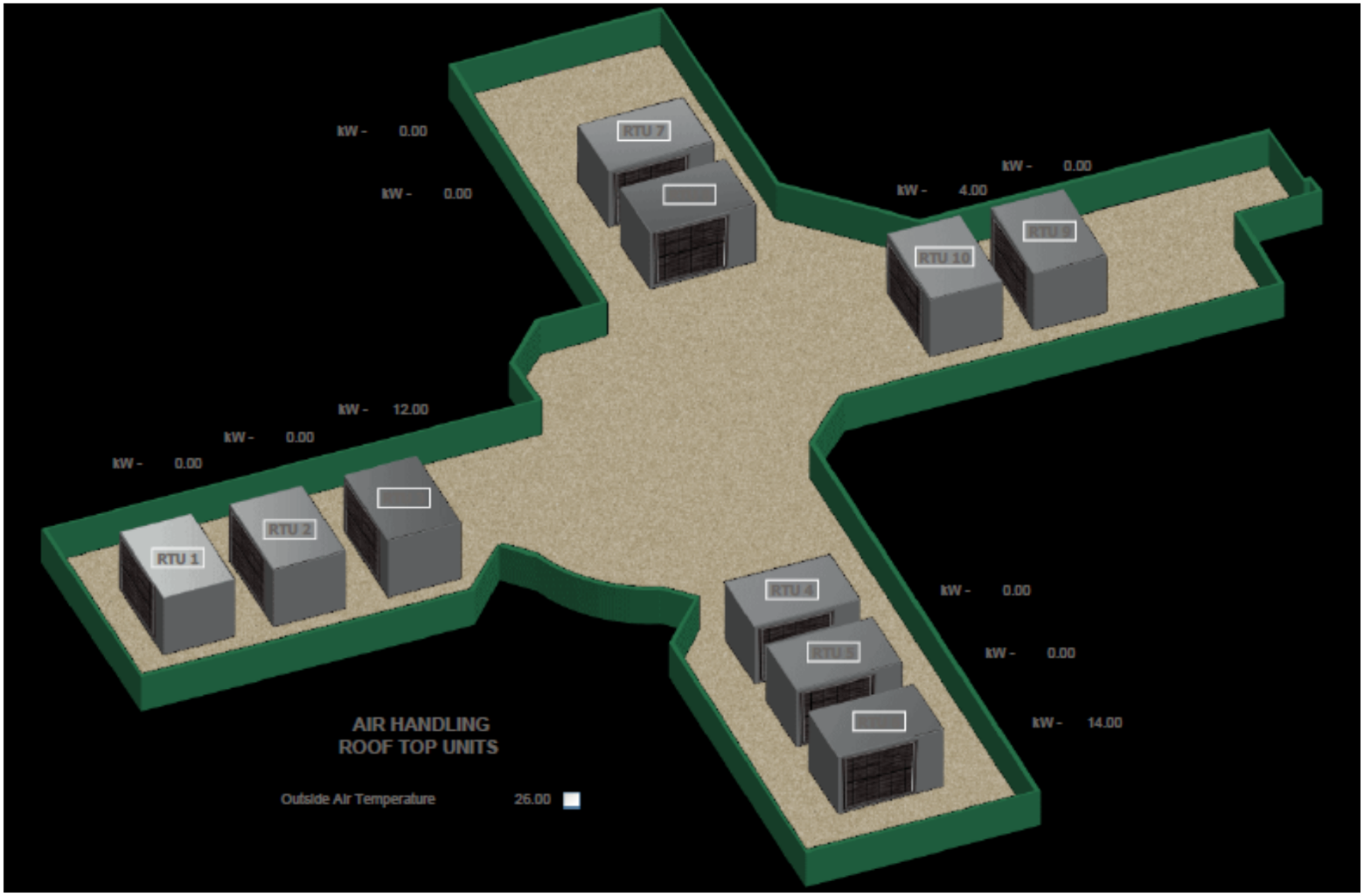
EATON
Powering Business Worldwide

Case Study – Pittsburgh Office

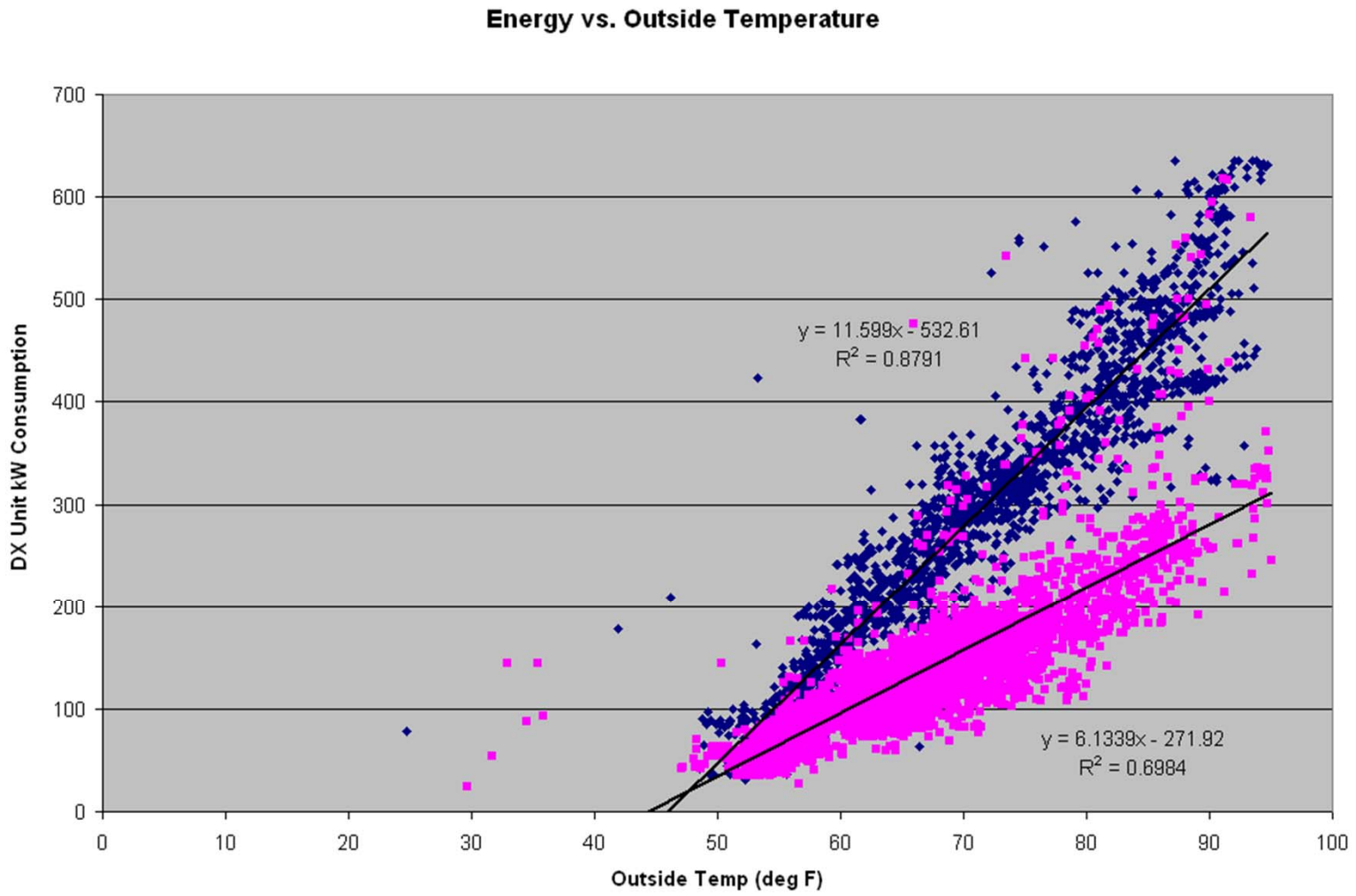
- The following is a case study of an office building located in Pittsburgh.



Demand Event – Typical HVAC

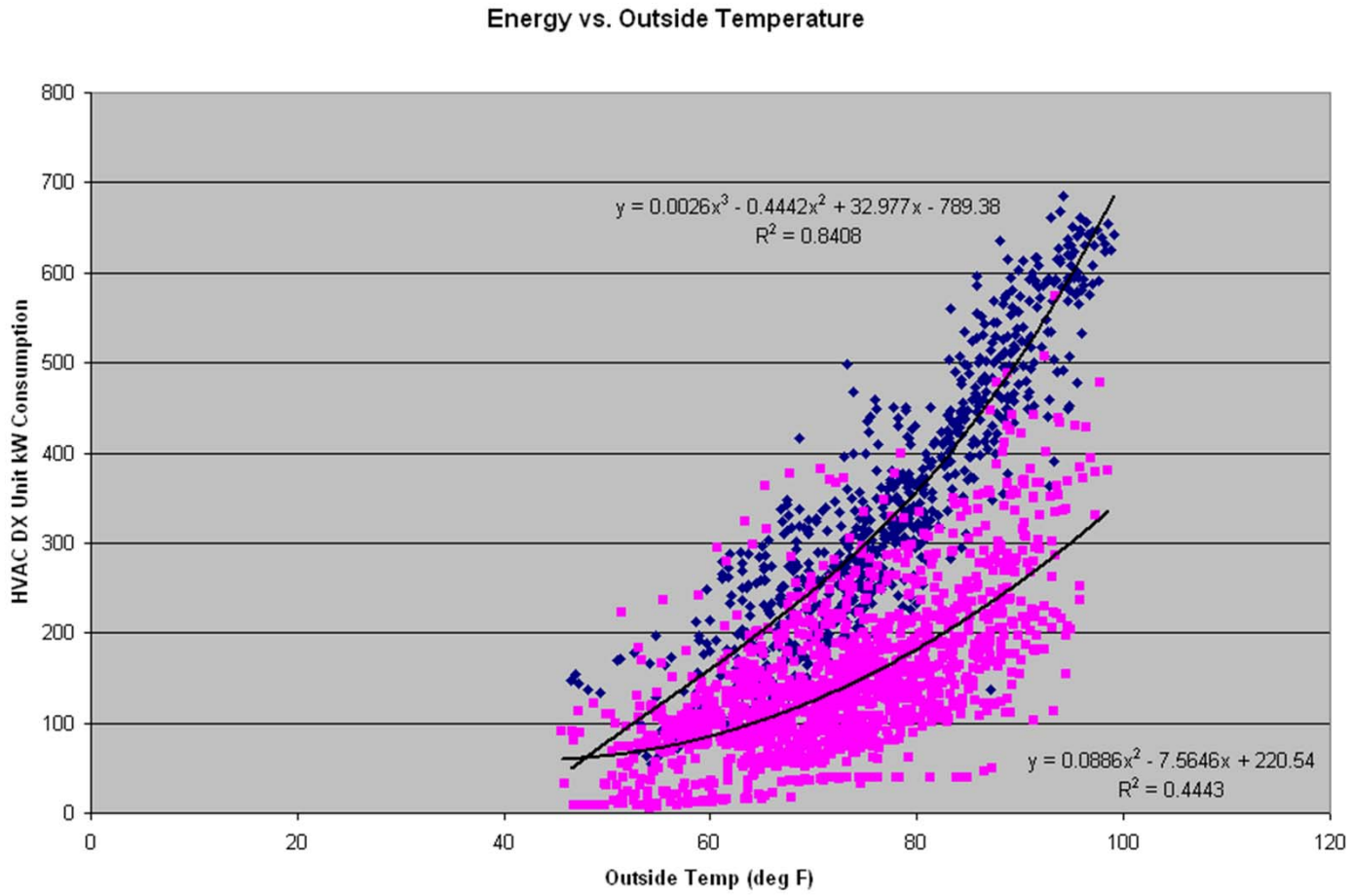


Case Study – Energy vs. OAT – No Drive



EATON
Powering Business Worldwide

Case Study – Energy vs. OAT - VSD



EATON
Powering Business Worldwide

Case Study - Results

No VFDs

Temp (deg F)	Occupied	Unoccupied
60	163 kW	96 kW
70	279 kW	157 kW
80	395 kW	219 kW
90	511 kW	280 kW

VFDs Installed

Temp (deg F)	Occupied	Unoccupied
60	152 kW	86 kW
70	234 kW	125 kW
80	337 kW	182 kW
90	476 kW	257 kW

% Energy Savings

Temp (deg F)	Occupied	Unoccupied
60	7.7%	12.3%
70	19.3%	25.8%
80	17.3%	19.9%
90	7.4%	8.8%
Average	12.9%	16.7%

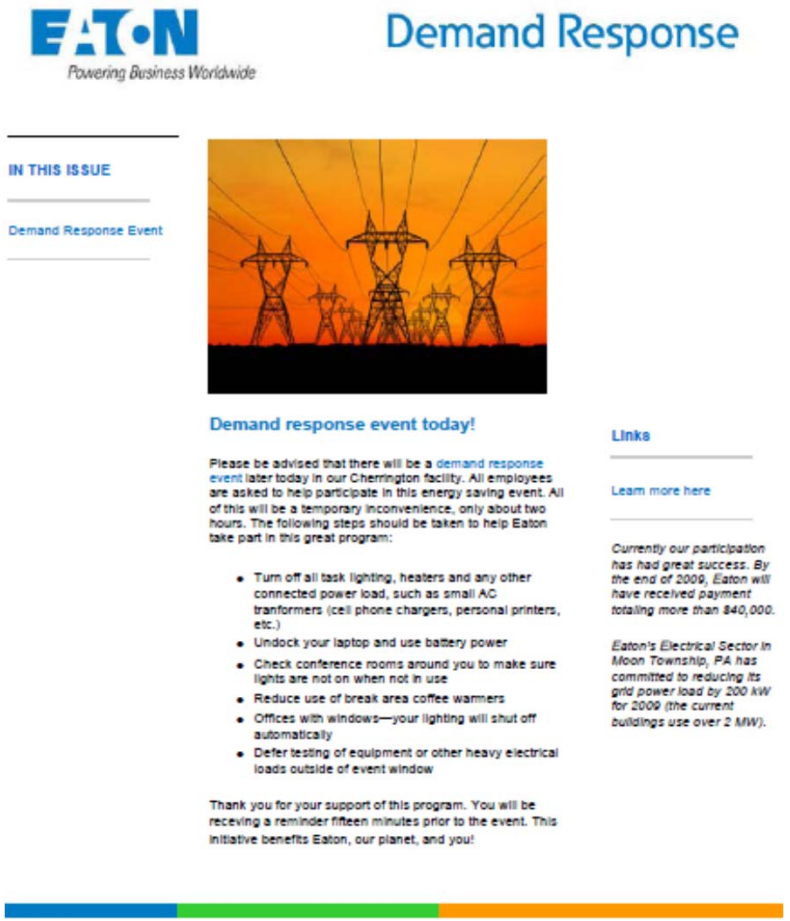
Demand Event – Moon Twp, PA

Items in typical building that could be curtailed:

- Lighting
- HVAC
- Plug loads – (Lap top computers, “personal-heaters”, phone chargers, laser jet)
- Engineering support

Things that can’t be curtailed

- Data Center



EATON
Powering Business Worldwide

Demand Response

IN THIS ISSUE

Demand Response Event

Demand response event today!

Please be advised that there will be a demand response event later today in our Cherrington facility. All employees are asked to help participate in this energy saving event. All of this will be a temporary inconvenience, only about two hours. The following steps should be taken to help Eaton take part in this great program:

- Turn off all task lighting, heaters and any other connected power load, such as small AC tranformers (cell phone chargers, personal printers, etc.)
- Undock your laptop and use battery power
- Check conference rooms around you to make sure lights are not on when not in use
- Reduce use of break area coffee warmers
- Offices with windows—your lighting will shut off automatically
- Defer testing of equipment or other heavy electrical loads outside of event window

Thank you for your support of this program. You will be receving a reminder fifteen minutes prior to the event. This initiative benefits Eaton, our planet, and you!

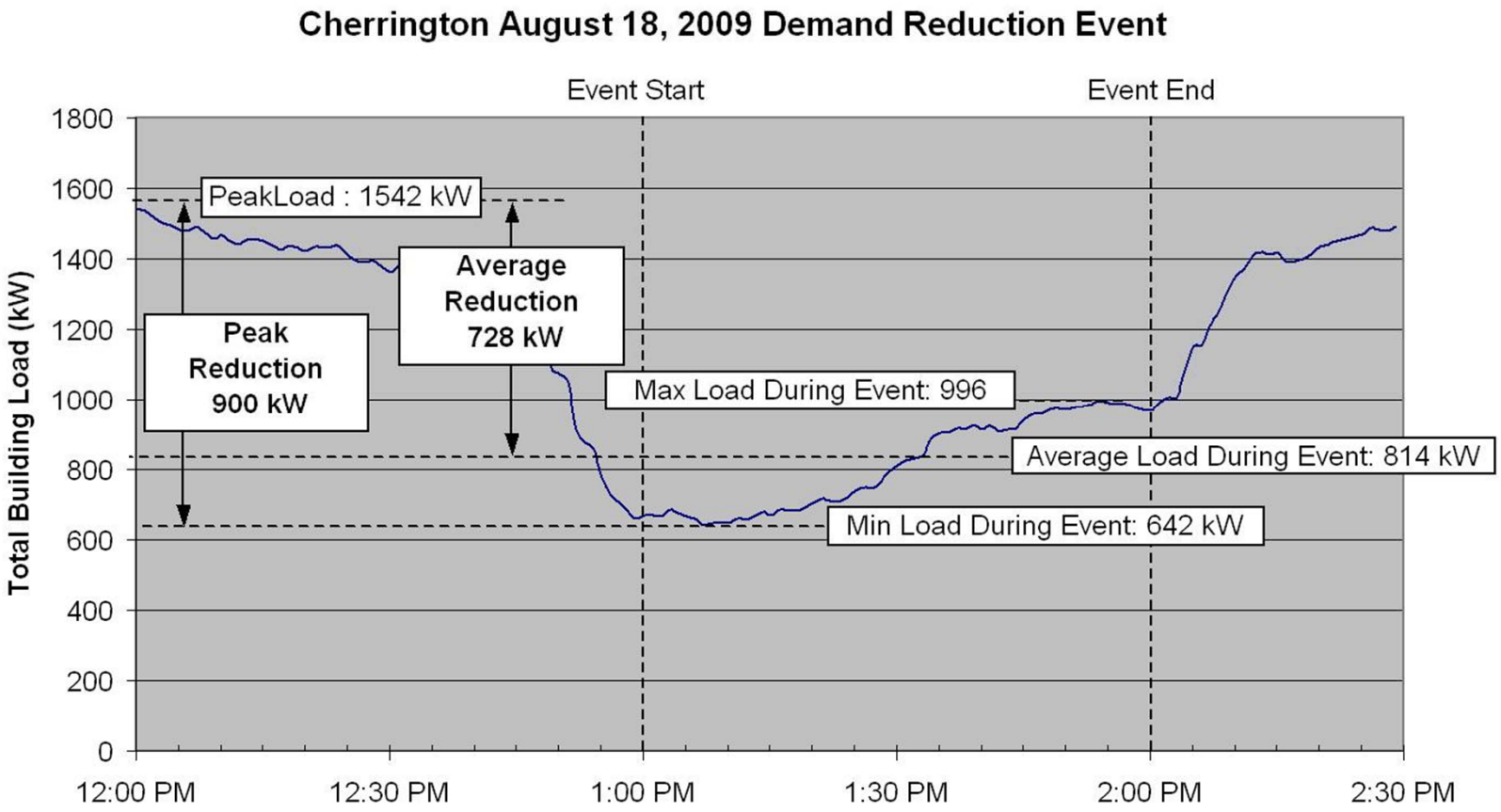
Links

Learn more here

Currently our participation has had great success. By the end of 2009, Eaton will have received payment totaling more than $40,000.

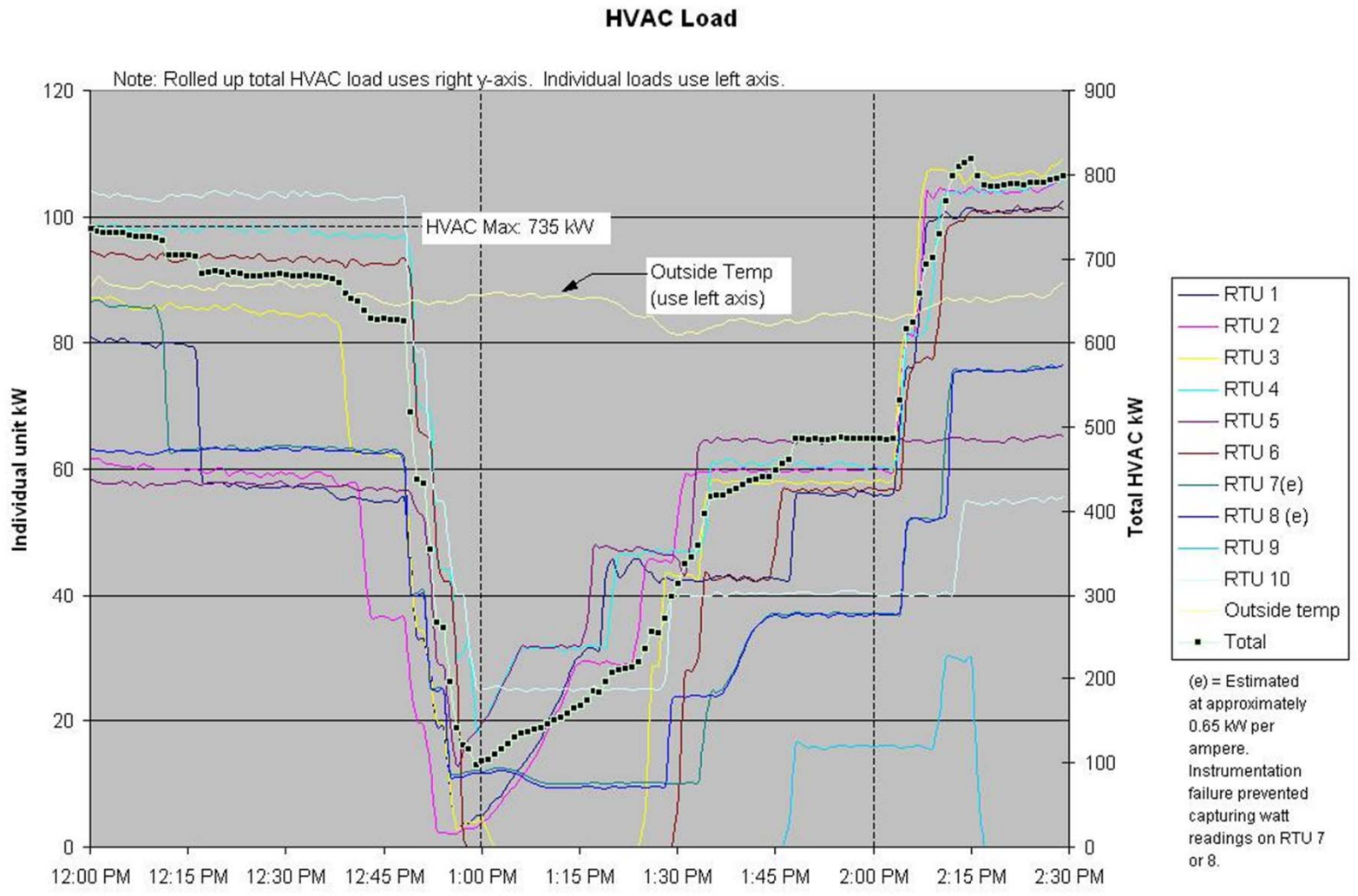
Eaton's Electrical Sector in Moon Township, PA has committed to reducing its grid power load by 200 kW for 2009 (the current buildings use over 2 MW).

Case Study – Demand Event



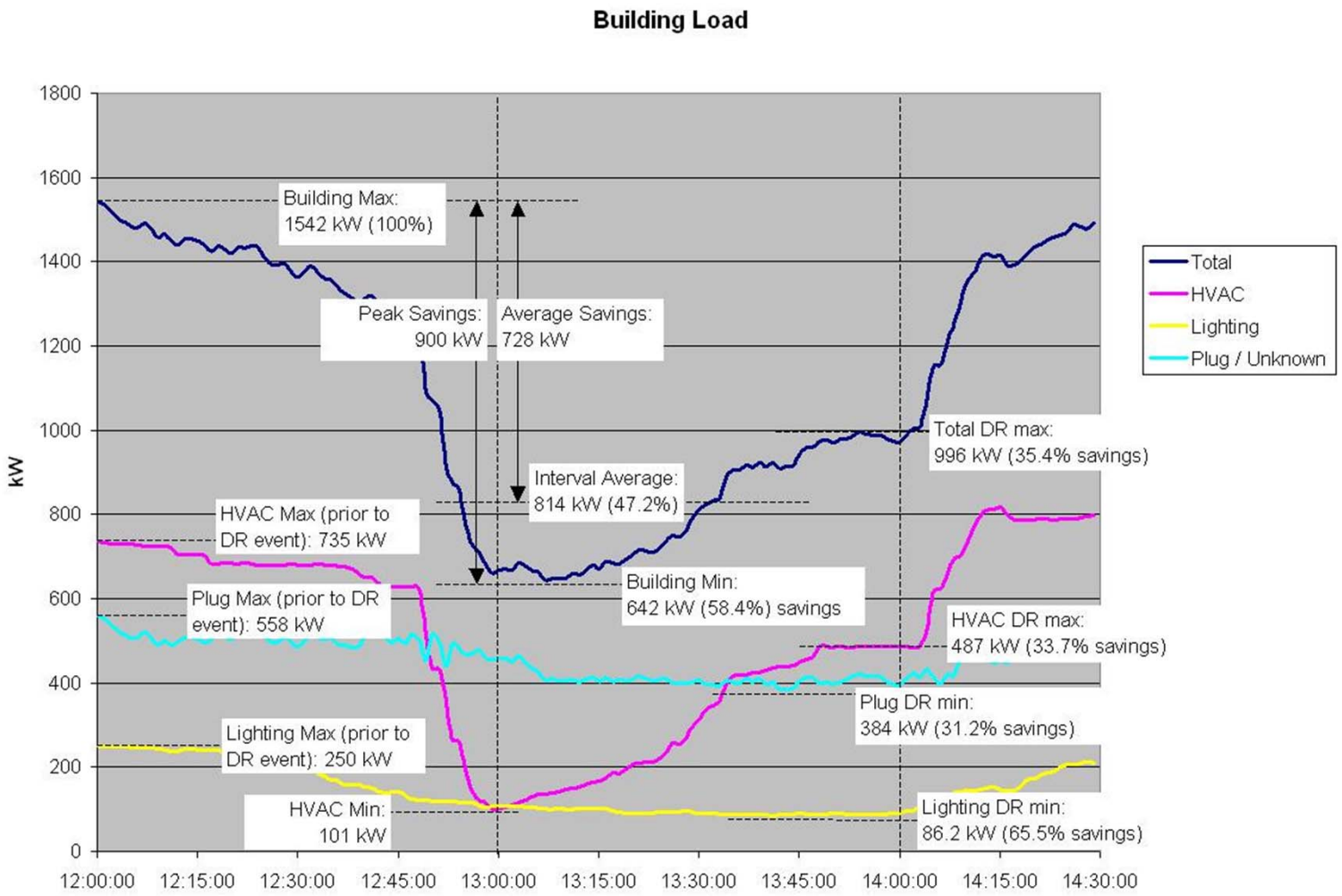
Powering Business Worldwide

Case Study - HVAC Drives – Key to Demand Event - 2009

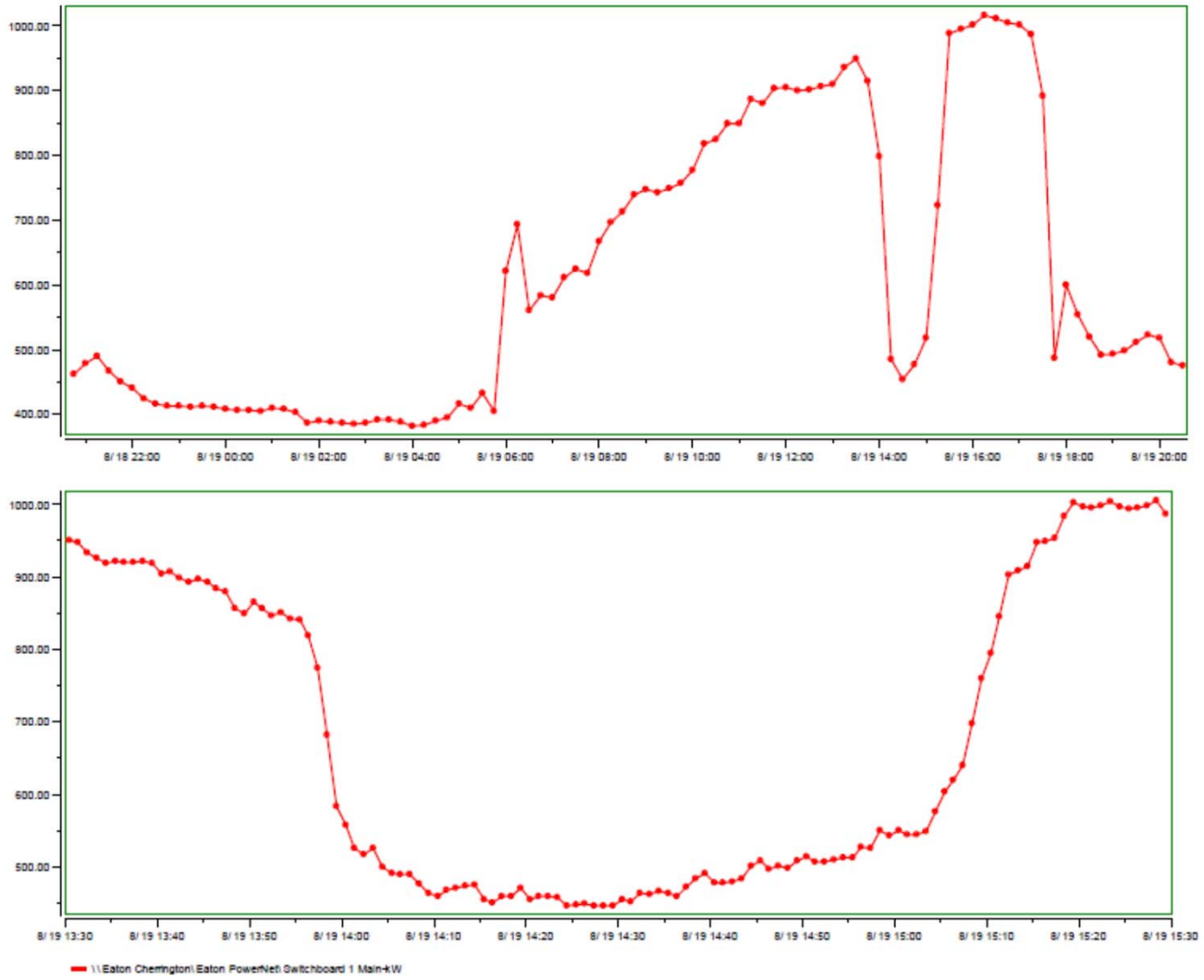


EATON
Powering Business Worldwide

Demand Event – HVAC Drives – Key to Demand Event - 2009



Demand Event – August 19, 2010



Powering Business Worldwide


Powering Business Worldwide