COLORADO
Energy Office

Energy Information Systems

CASDEM - 1/11/18

Host: Adams 12 Five Star Schools

Agenda for this morning

Time	Topic
10:00-10:15	Introductions
10:15-10:45	Adams 12 Initiatives
10:45-11:00	Review of EIS Survey Results
11:00-11:00	Break before Regular CASDEM Meeting Resumes

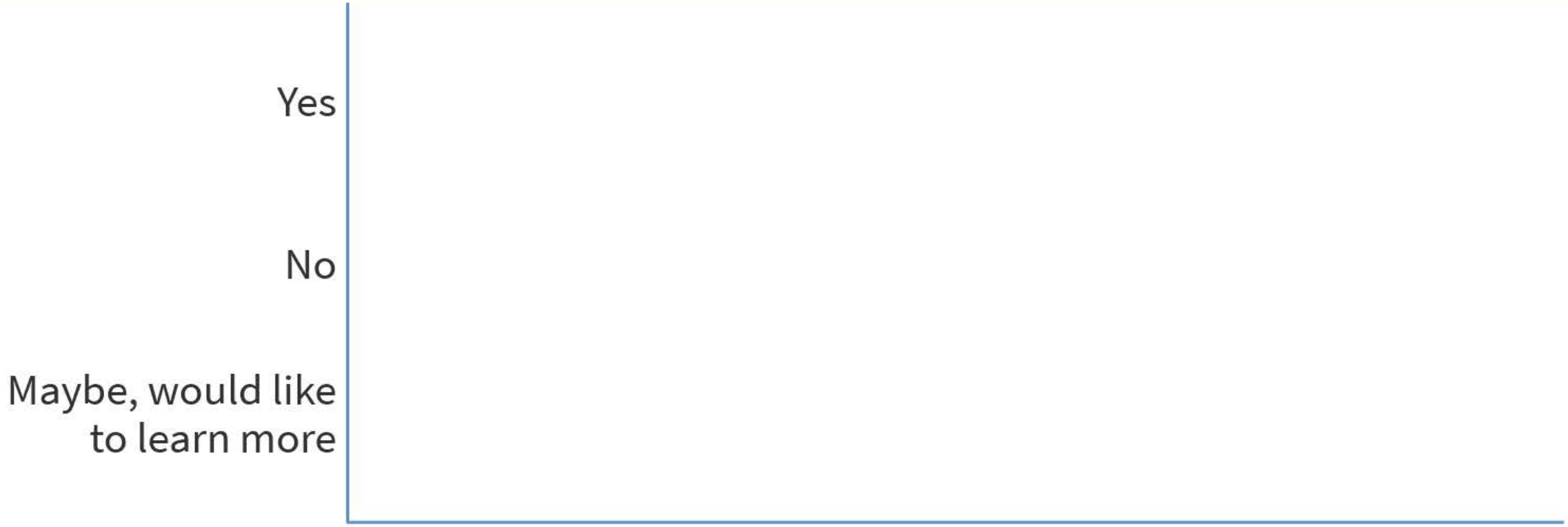
Colorado Association of School District Energy Managers

- www.CASDEM.org
- Free, open to all school district staff
- Next Meeting: March 1, St. Vrain Valley School District
  - ESS/Intro Topic: Solar PPAs

Energy Savings for Schools (ESS)

- Free on-site energy and water audits, implementation support and energy coaching for Colorado schools (rural and low income focus)
- Recognition and opportunities to engage students, real-time data on a web-based dashboard through e-gauge energy monitors
- bit.ly/CEOenergysavings
- Call Susan Blythe at 970.207.0058 for more information

This is poll everywhere, a software to encourage remote participation, real-time polling, and various additional functionalities such as allowing respondents to enter questions to the audience, making word clouds, open ended responses, etc. At first glance do you think this is something CASDEM and ESS participants would use?



Adams 12 Five Star Schools Sustainability Initiatives

Shannon Oliver

Assistant Director of Energy & Sustainability

CASDEM Meeting – January 11, 2018

Overview

- The District
- Water Conservation
- Waste Reduction
- Energy Information Systems

The District – Who We Are

- 51 schools and 9 support facilities
- 35,000 in-district and 4,000 charter/pre-school
- 4,700 employees
- 43% Free and Reduced, range from 4-92%
- 20% Spanish as native language

<u>FY-2018 Utilities Budget:</u>

- Electric $4,603,000
- Water $1,822,000
- Nat. Gas $690,000
- Waste $180,000
- Total* $7,617,000

**with salaries and other op-ex*

Water Conservation

- 23.8% increase in cost over baseline
- 6.9% increase in usage over baseline
- 23.4% increase in rate ($/kGal)

- FY17 - $2,000,872 adopted budget
- How to save on water budget?
- 10% savings = >$200,000 *

Innov8 VN Register

Dashboards

Water Resource Specialist Results

(Jan 2017 – Oct 2017)

- Position created to focus on irrigation management
- Began January 1, 2017
- Usage Savings: 41,613 kGal
- Gross Cost Savings: $121,304
- Avoided Cost: $282,979^

^(if we paid during baseline what we pay now)

Time Period (Jan-Oct)	Historic Values			Percent Change[1]	
	Usage (kGal)	Cost ($)	Rate ($/kGal)	Usage	Cost
Baseline (3-yr Avg.)	232,021	$1,200,858	$5.09	--	--
2014	212,630	$977,518	$5.10	-8.4%	-18.6%
2015	240,584	$1,282,344	$6.43	3.7%	6.8%
2016	242,848	$1,342,713	$6.28	4.7%	11.8%
2017	190,408	$1,079,554	$6.30	**-17.9%**	**-10.1%**

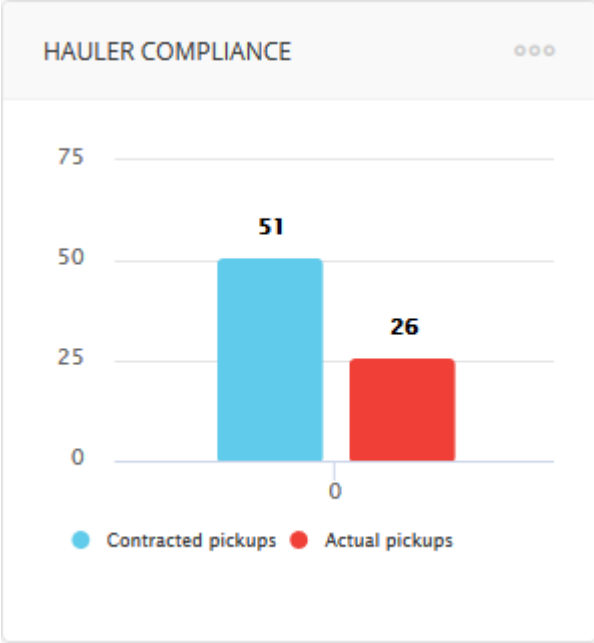
[1] Compared to 3-yr Baseline Avg. for the same period

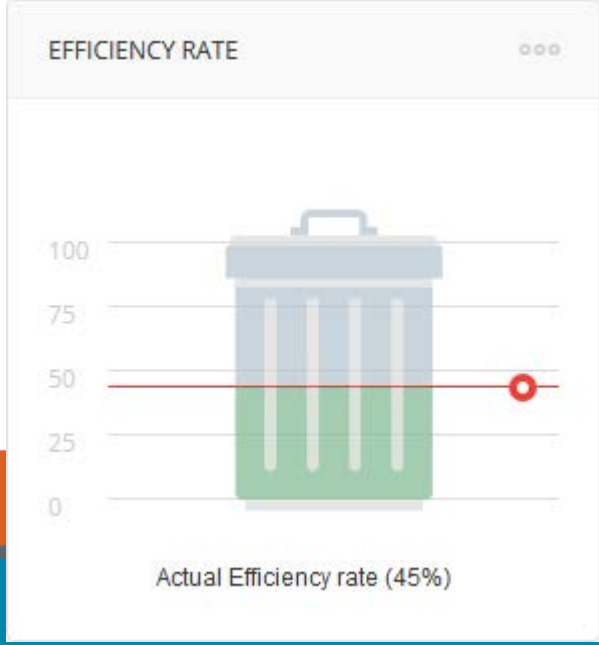
Waste Reduction - Composting Pilot

- Four schools involved
  - 1 High School
  - 1 Middle School
  - 1 K-8
  - 1 Elementary
- Commercial haul-away model (Alpine)
- Cafeteria focused
- Student/staff led
- Pre- and Post- surveys will measure KAP
- Waste tracking to assist in diversion estimates

Waste Tracking

- Piloting devices as part of compost pilot
- Volumetric waste tracking of recycle dumpsters
- Working on grant for district-wide integration of tracking
- Sustain Data





EIS Project

- Following Xcel Energy's EIS program
- Joined the Better Buildings Initiative – Smart Energy Analytics Campaign
- 3 buildings
  - 2 High schools
  - Main admin building

- Real-time monitoring of:
  - Whole building electric use
  - Whole building gas use
  - Sub-metering of chillers and large RTUs
  - Sub-metering of data center (ESC)
  - Outside Air Temp at each building
- Software portion TBD
  - Analytics through Niagara?
  - Simplistic front-facing dashboard?

Thanks for listening and attending CASDEM today!

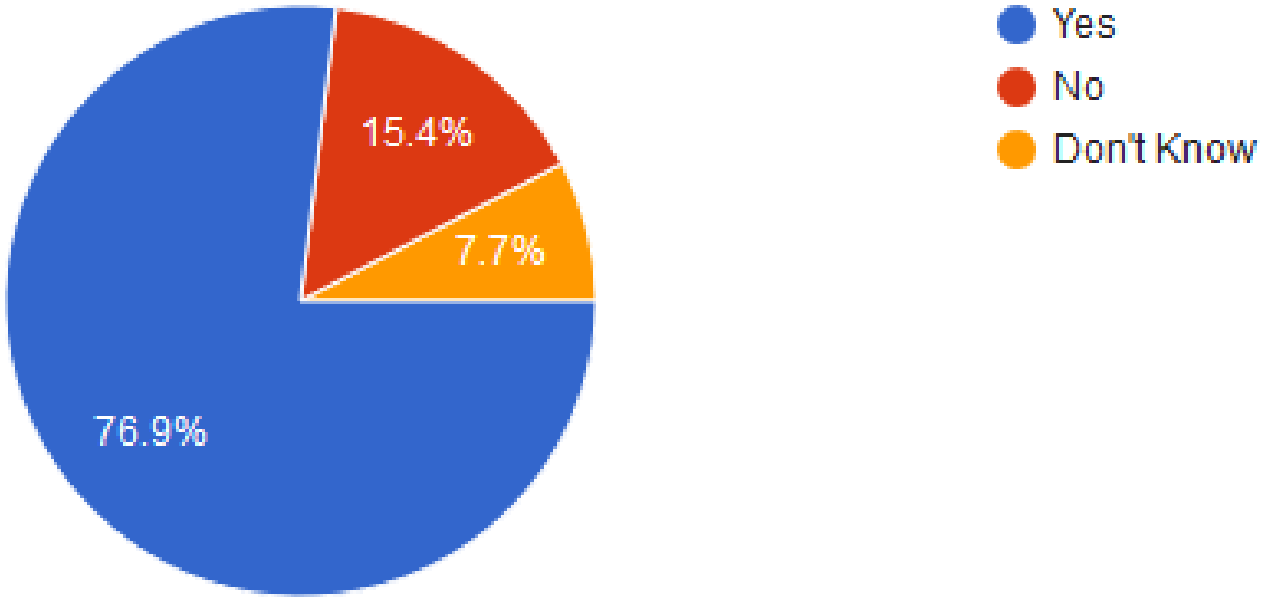
Any questions?

Utility Tracking Survey Results

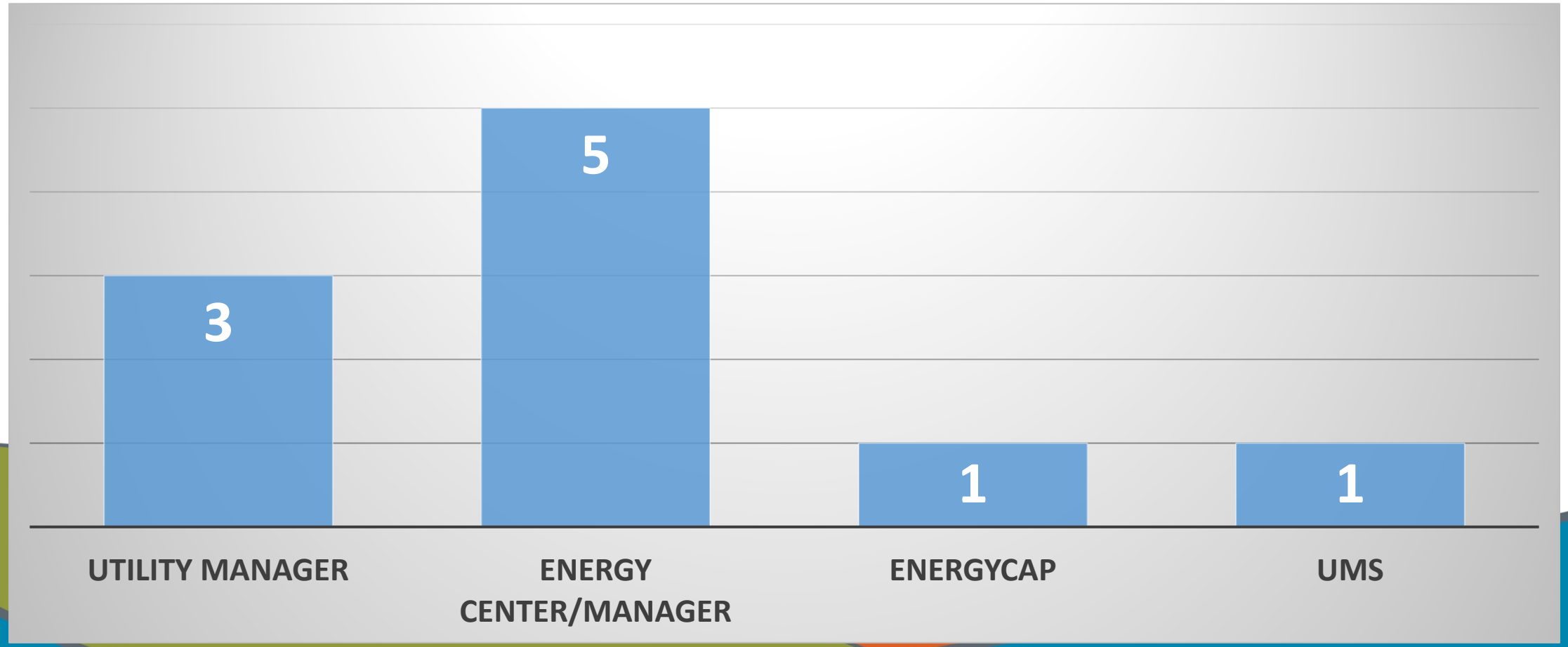
- 13 responses
- From Gilpin County 1 to El Paso 49
- From Regis Jesuit HS to DPS

Does your district currently use a utility bill tracking program?

13 responses

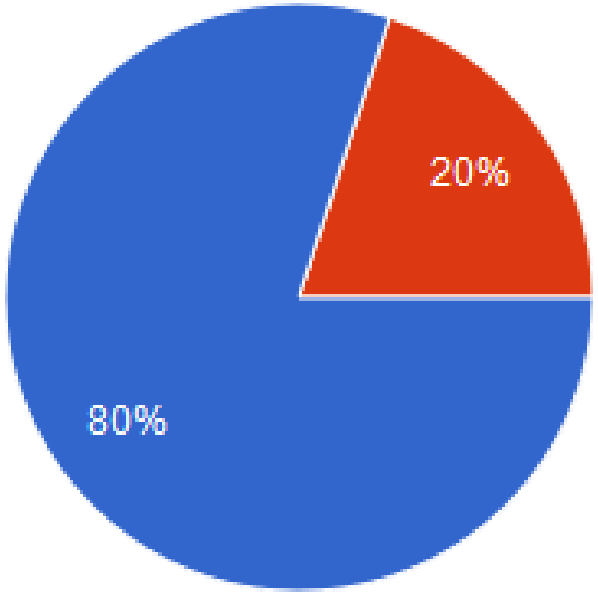


If yes, what is the program name or provider? (10 responses)



If yes, how do you pay for the program?

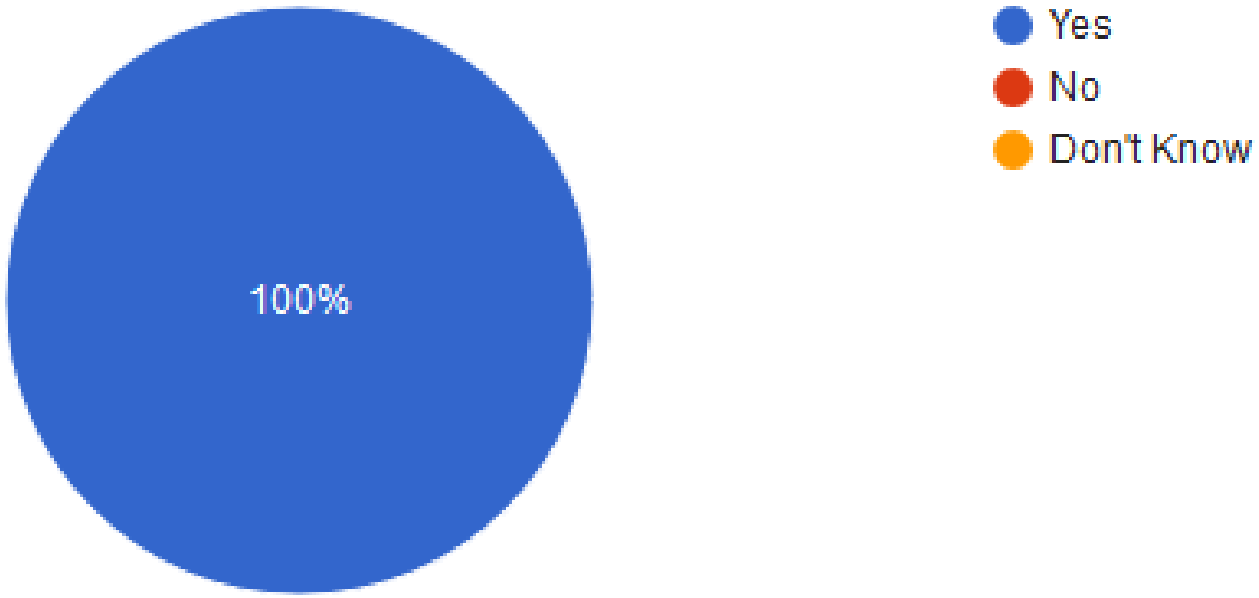
10 responses



- Recurring (monthly, annual, etc.) fee
- Upfront purchase with no recurring fee
- Don't Know

Does your district currently utilize a Building Automation System to manage heating and cooling?

13 responses



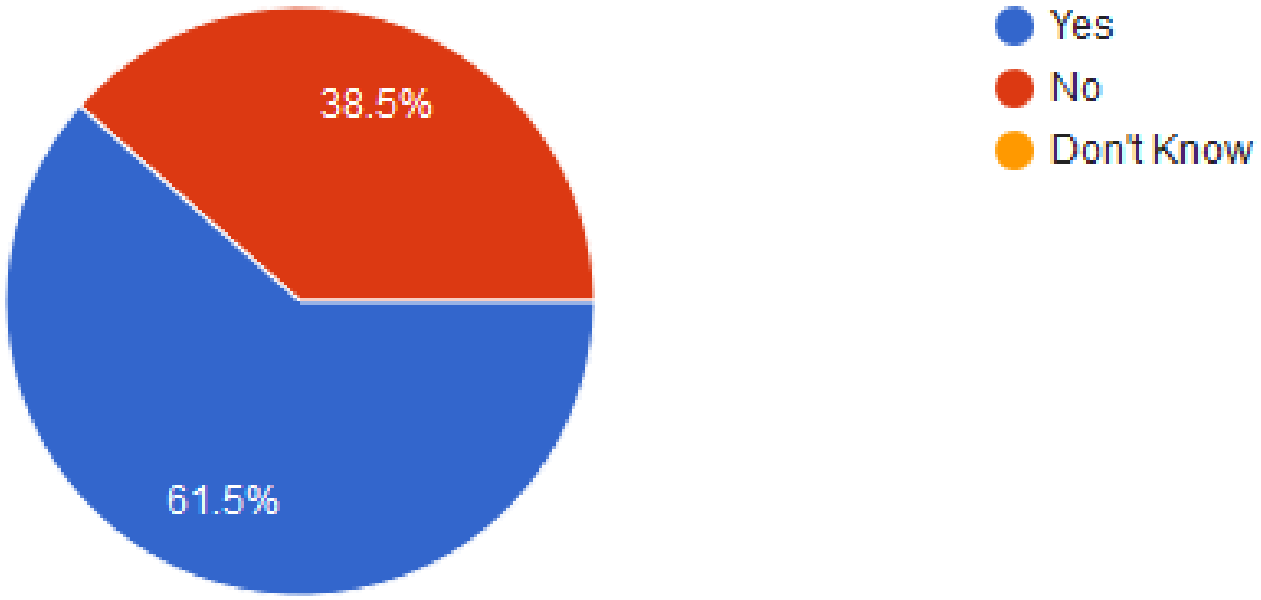
If yes, what is the program name or provider? (13 responses)

- School Dude
- iNet
- Niagara/N4 (6)
- Automated Logic (2)
- Metasys (3)
- Alerton (2)
- Set Point
- Andover
- Long
- KMC
- JCI-FX
- Delta

***4 Districts with more than 1 BAS system**

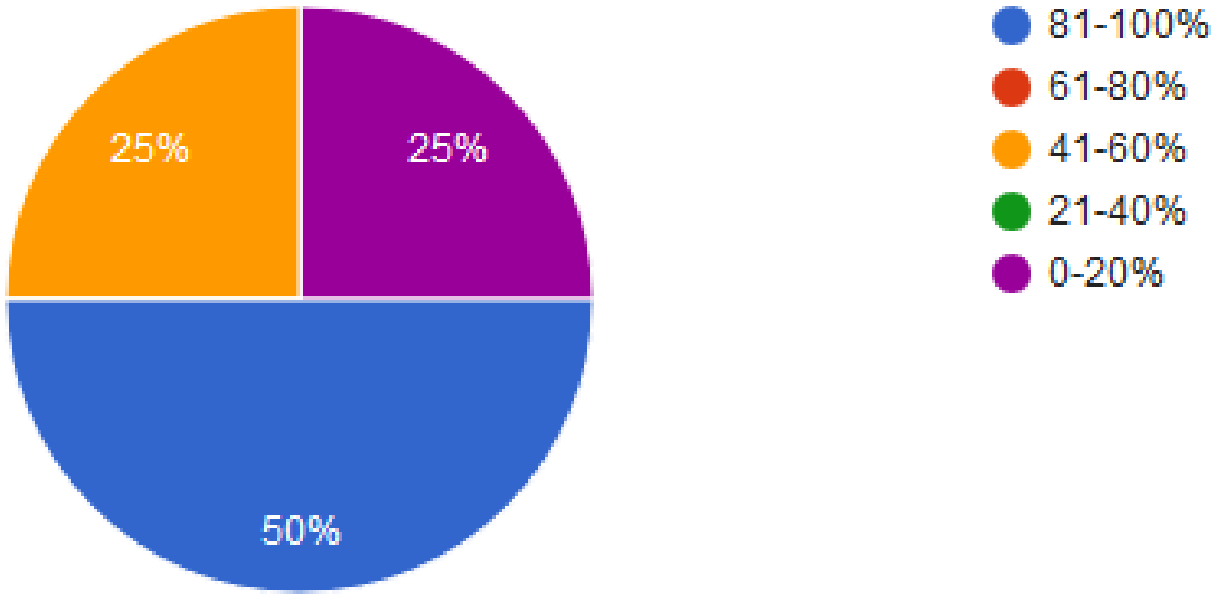
Does your district currently utilize real-time or 'smart' meters for tracking electricity use?

13 responses



How much of your district is equipped with real-time meters?

8 responses



Have you used your smart meters for bill validation? (8 responses)

- Yes, a few times (4)
- No, never (4)

What types or brands of meter(s) do you use? (8 responses)

- eGauge (5)
- Xcel pulse data (1)
- Unknown (3)
- Enernoc (1)
- Through ALC programs (1)

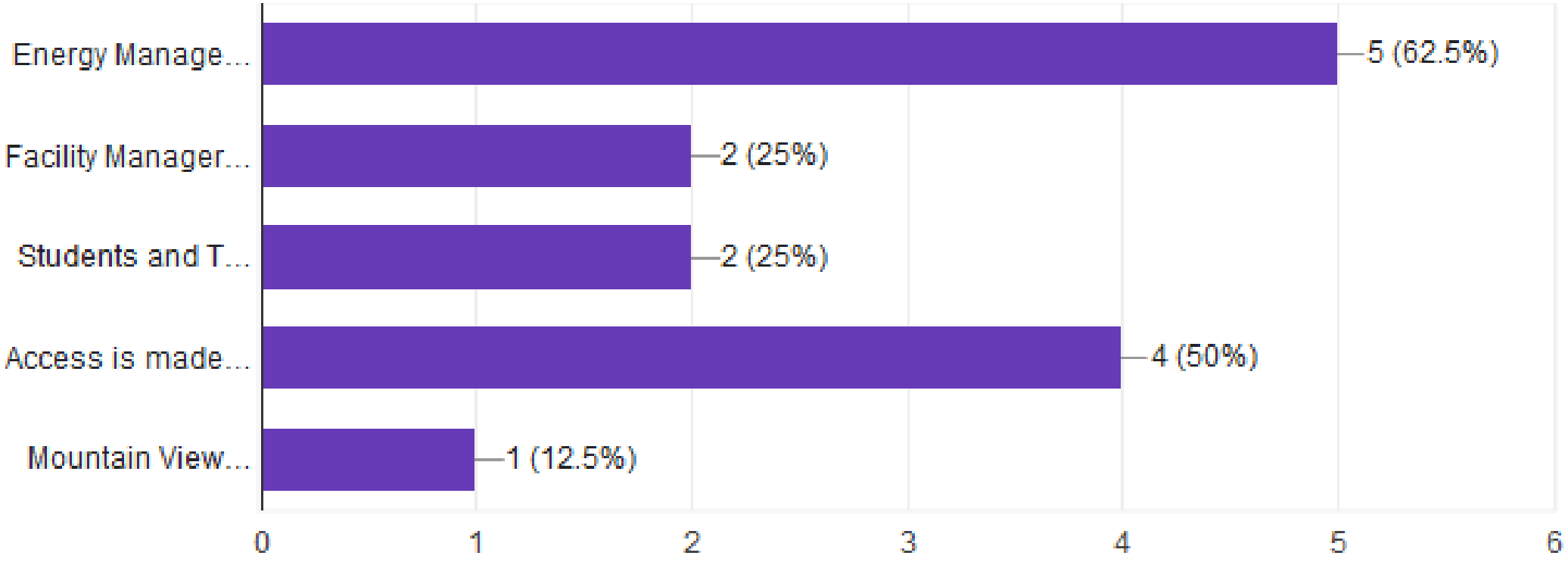
Programs used to monitor smart meters? (8 responses)

- 7 respondents use something
- 1 does not use anything

- eGauge dashboard (2)
- Power TakeOff
- SkySpark
- EnergyCenter
- Cube Resources (2)
- ALC
- Enernoc
- EnergyCap
- Vykon Energy Suite
- Building OS by Lucid

Who has access to these smart meters and their data?

8 responses



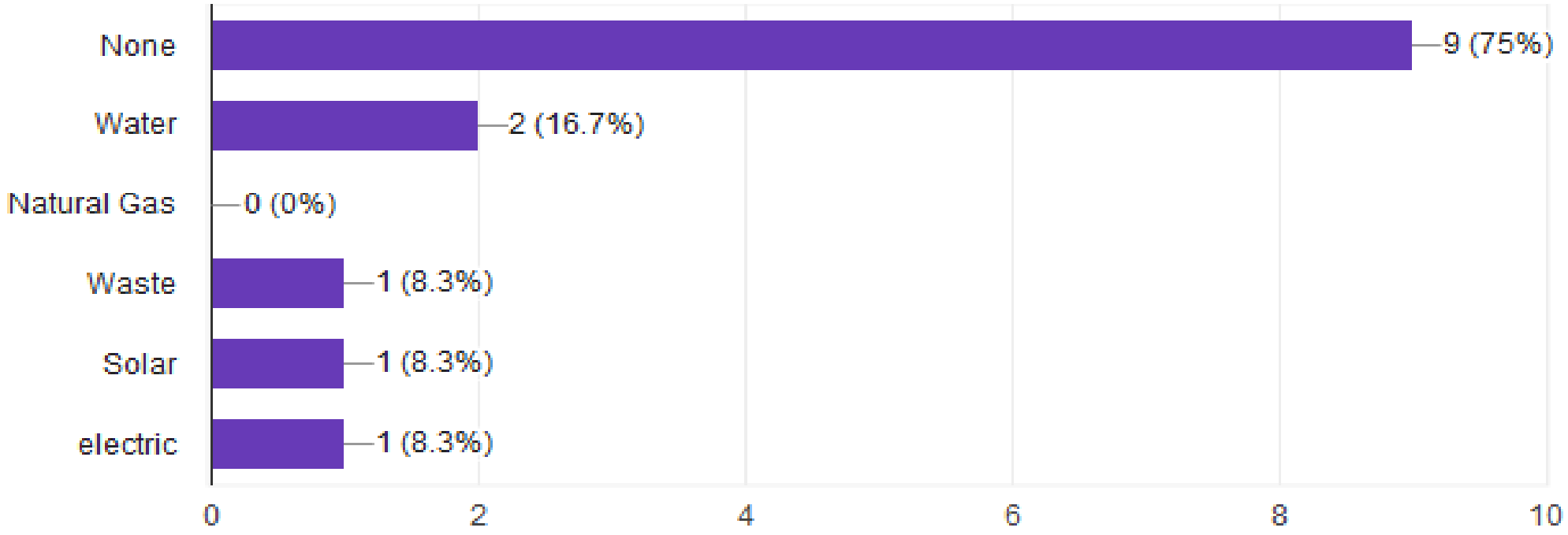
What is the greatest benefit provided by smart meters to your school district?

8 responses

Learning skills and tools to analyze conservation measures.
Not sure yet, they're pretty new
Finding BAS programming errors through heat maps
Using data as a foundation for behavioral engagement programs
Can track power usage for comparison for breaks, weather etc.
Catching excessive usage during unoccupied hours
Demand management and base load reduction
Information is not sufficiently utilized because user interface is not intuitive.

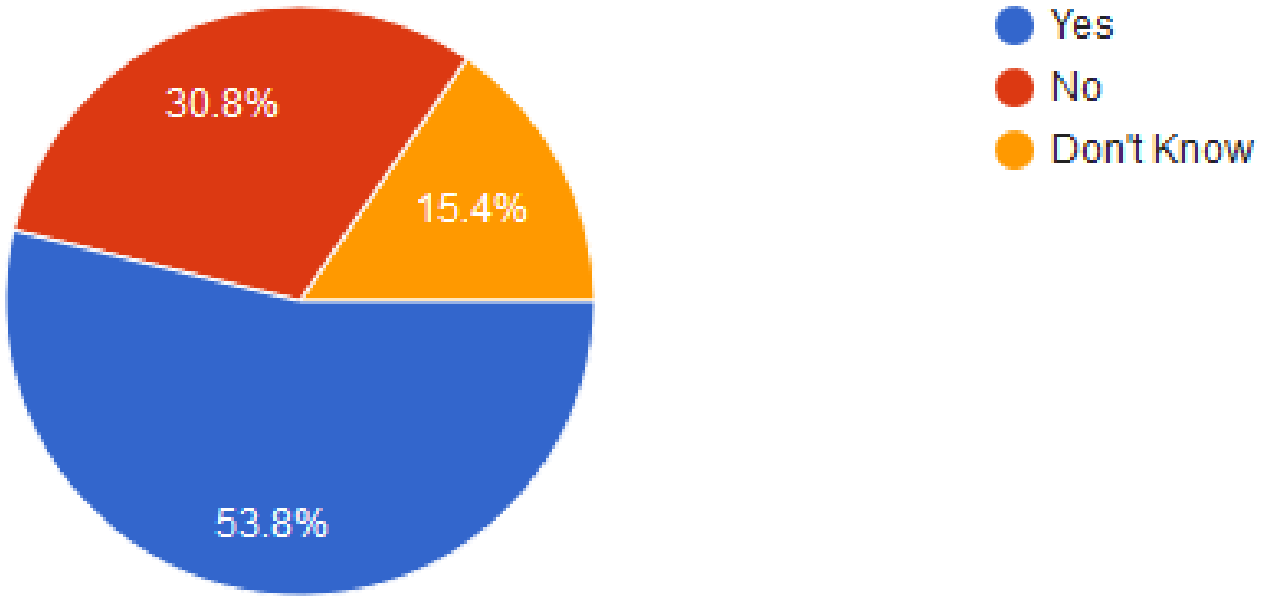
Does your district currently utilize real-time or 'smart' meters for tracking any of the following:

12 responses



Do you have plans for purchasing energy information software or additional smart-meters?

13 responses



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If yes, please describe your plans:

7 responses

Following the Xcel EIS program, currently finalizing the hardware piece and will then purchase an EIS of some kind.
future bond
Jeffco will have all sites covered by eGauges for Fall 2019 monitoring all electricity used and solar produced. Looking at pilot sites for smart water meters and natural gas.
We plan to purchase/install smart meters to track our electricity use
Would like to convert 25 schools to smart meters this year
BuildingIQ analytics to identify all high school out of normal conditions, and support automated demand response.
Researching options currently. The capability and price point of "Utility Manager" seem attractive.

Any additional questions or comments regarding utility bill tracking, smart meters or EIS?

7 responses

No (2)

There's a lot of great stuff out there, but the hardest thing is finding the time to choose the right program and monitor it closely enough to take advantage of all the benefits; esp. as I am a one person department. But luckily our electricians and HVAC staff and teachers and students use the eGauge quite often.

Dara, Hall and Shannon rock!

Interested in what might be used to track utility bill information as well as smart meters.

Curious to know what others are using...

Not familiar with EIS

Energy Information Systems

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LBNL EIS (EMIS) Definitions

System that uses

EMIS are a broad ~~family of~~ **tools** to **monitor**, **analyze**, and **control** building energy use and system performance

Whole Building Level EMIS

- Benchmarking and Monthly Utility Bill Analysis
- Energy Information System
- Advanced EIS

System Level EMIS

- Building Automation System
- Fault Detection and Diagnostics
- Automated System Optimization

* The boundaries can be fuzzy; some tools cross categories, e.g., energy information systems with FDD and benchmarking capabilities

LBNL EIS (EMIS) Examples

Benchmarking & Utility Bill Analysis

- EPA Portfolio Manager
- EnergyCAP
- Ecova
- Facility Dude
- Metrix 4
- Energy Print

Energy Manager

EIS & Advanced EIS

EIS

- Obvius Building Manager Online
- Lucid BuildingOS
- Noveda Energy Flow Monitor
- NorthWrite Energy Worksite

Power TakeOff (Xcel InfoWise)

Cube

Advanced EIS

- IBIS
- EnerNOC EfficiencySmart
- Schneider Energy Operation
- EFT Energy Manager
- eSight Enterprise

BAS

- Siemens Apogee
- Johnson Control Metasys
- Honeywell Enterprise Buildings Integrator™
- Emerson DeltaV
- Schneider Electric TAC Vista
- Novar Opus EMS
- Tridium Niagara
- Automated Logic WebControl

FDD

- Cimetrics InfoMetrics
- EZENICS
- Sky Foundry Sky Spark
- ClimaCheck
- Schneider Building Analytics
- FDSI Insight

ASO

BuildingIQ

- EIS applications
  - Data **visualization** (i.e. energy dashboard)
  - Whole building & submeter level energy **tracking & benchmarking**
  - **Peak** load **analysis**
- Advanced EIS applications
  - **Automated** interval data **analysis** with **baseline modeling**
    - Energy anomaly detection (i.e. scheduling, changes in load profile, excessive energy use)
    - Project savings verification
    - Cumulative sum

LBNL Summary of EMIS Tools

	EMIS tools	Data scope	Key uses	Costs	Energy Savings
Whole building	**Benchmarking & Utility Bill Analysis**	Monthly utility bills	▪ Peer-to peer comparison ▪ Utility bill analysis	Free - $	2.4% (median) (whole building, enabled savings)
Whole building & system	**EIS & Advanced EIS**	Hourly or 15-min meter data	▪ Energy dashboard/kiosk ▪ Benchmarking ▪ Energy anomalies alert ▪ Demand response ▪ Auto M&V	$$-$$$	8% (median), 0-33% (range) (whole building, enabled savings)
System	**BAS**	15-min or less interval sub-system data	▪ Building system control ▪ Manually troubleshooting by investigating trends	$$$$	10-15% (whole building)
	FDD		▪ Auto system or component fault notification ▪ Fault causes identification	$$$	2-11% (whole building, potential savings)
	ASO		▪ Optimal HVAC settings prediction	$$$	-

Strategic View

- Optimize for benefit of occupants and taxpayers
  - Comfort / productivity
  - Security
  - Public Support / Community engagement
- Constraints (Money, Schedule, Risk, Performance)
  - Capital costs
  - Utility costs
  - Internal labor
  - Procured labor
  - Procured hardware and software
- Performance metrics
  - Energy Use Intensity
  - Emissions
  - Utilization (CU example)

Productivity vs. Efficiency

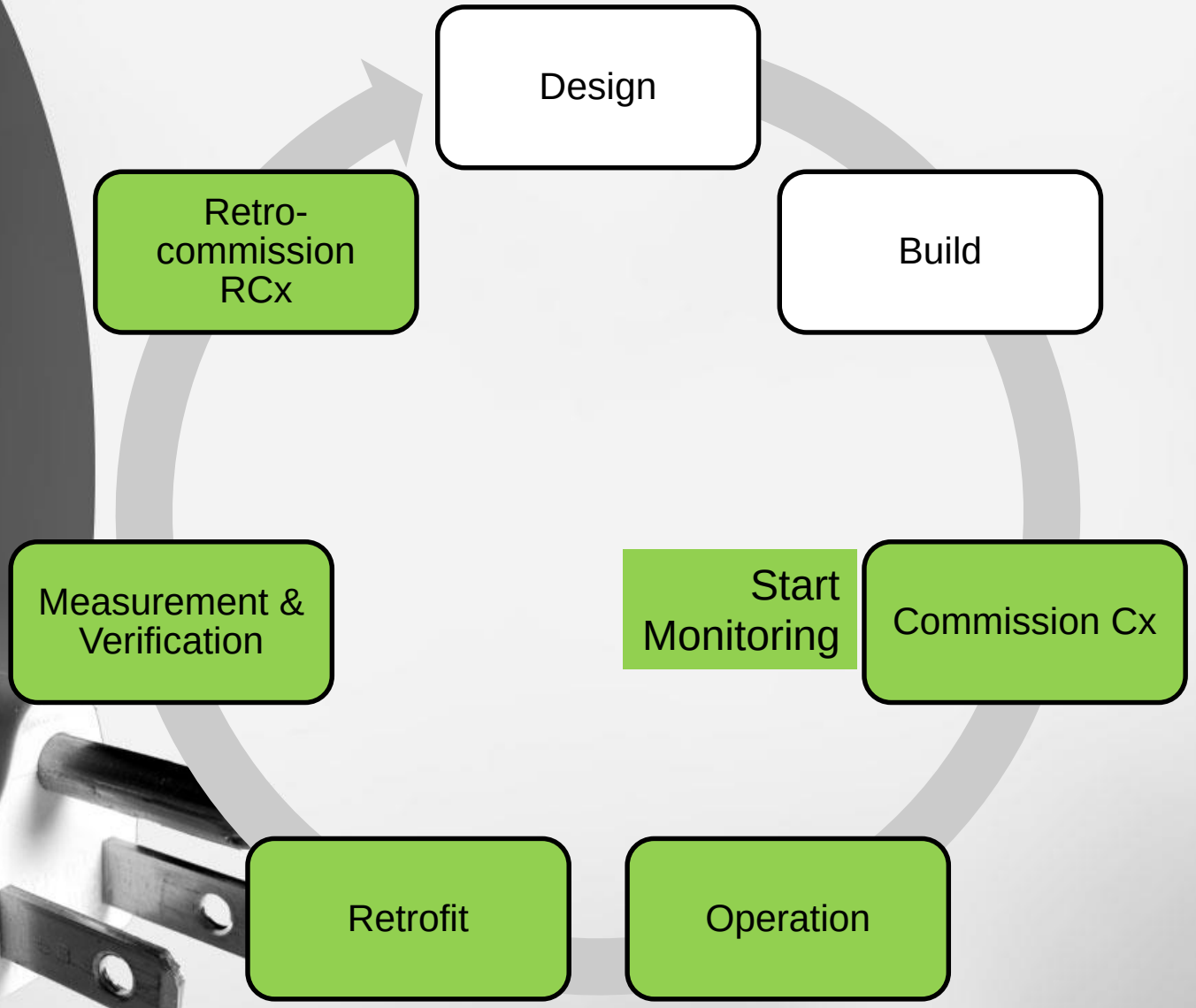
- Full occupancy
- After hours use
- Weekend use
- Year-round use

Higher EUI

- Efficient systems
- Set points
- Scheduling
- Automation

Lower EUI

Idealized Cycle



Software ≠ Process ≠ System

- Buy-in from management, district staff, building occupants, public
- Incentives
- Process
- Tools
- Software
  - Spreadsheets
  - Commercial Off the Shelf Tools (COTS)
    - Single vendor
    - Combination of vendors
  - Custom coding
- Hardware
  - Installations & commissioning
  - IT
- Implementation
- Procedures
- Training
- Data curation and backups
- Hardware, software, and firmware maintenance and longevity

LBNL

Set organizational goals

Establish roles & responsibilities

Understand organizational conditions

Define activities to meet goals

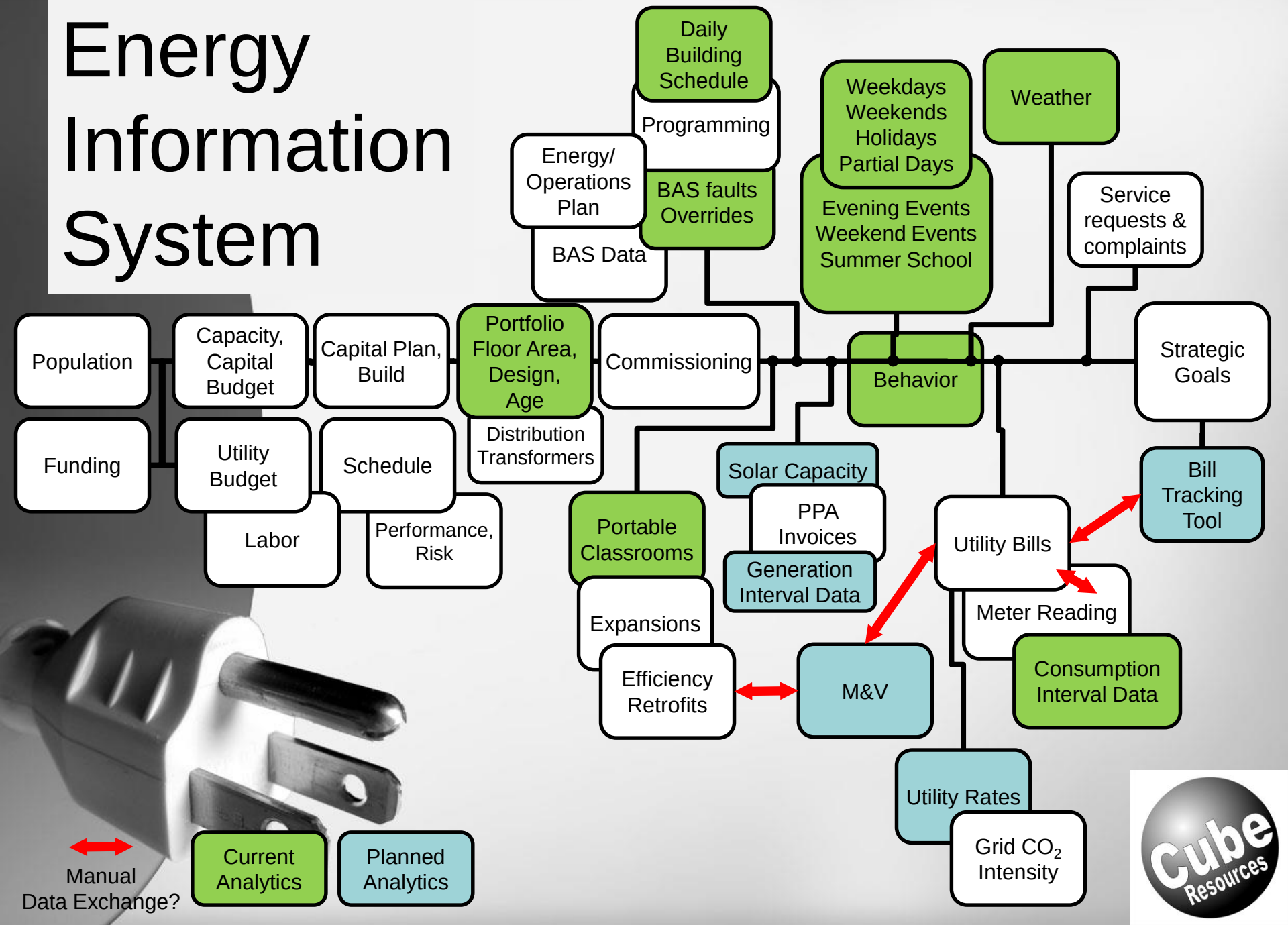
Identify required sensing, metering

Select a tool(s)

- Hidden, proprietary algorithms?
- Ownership of hardware?
- Ownership of data?
- Proprietary vs. Inter-operable?
- First cost vs. recurring costs?
- Conversion costs?
- Savings?

Cube Resources

Energy Information System



Utility Meter Reading and Billing

- Meter calibration errors
- Meter transcription errors and estimates
- Data entry errors in bill tracking software
- Payment errors
- Billing audits
- Corrections and refunds
- Treatment of error and correction in data

Data Concept

Drift will occur from just aging systems. (**Ignoring Other Factors**)

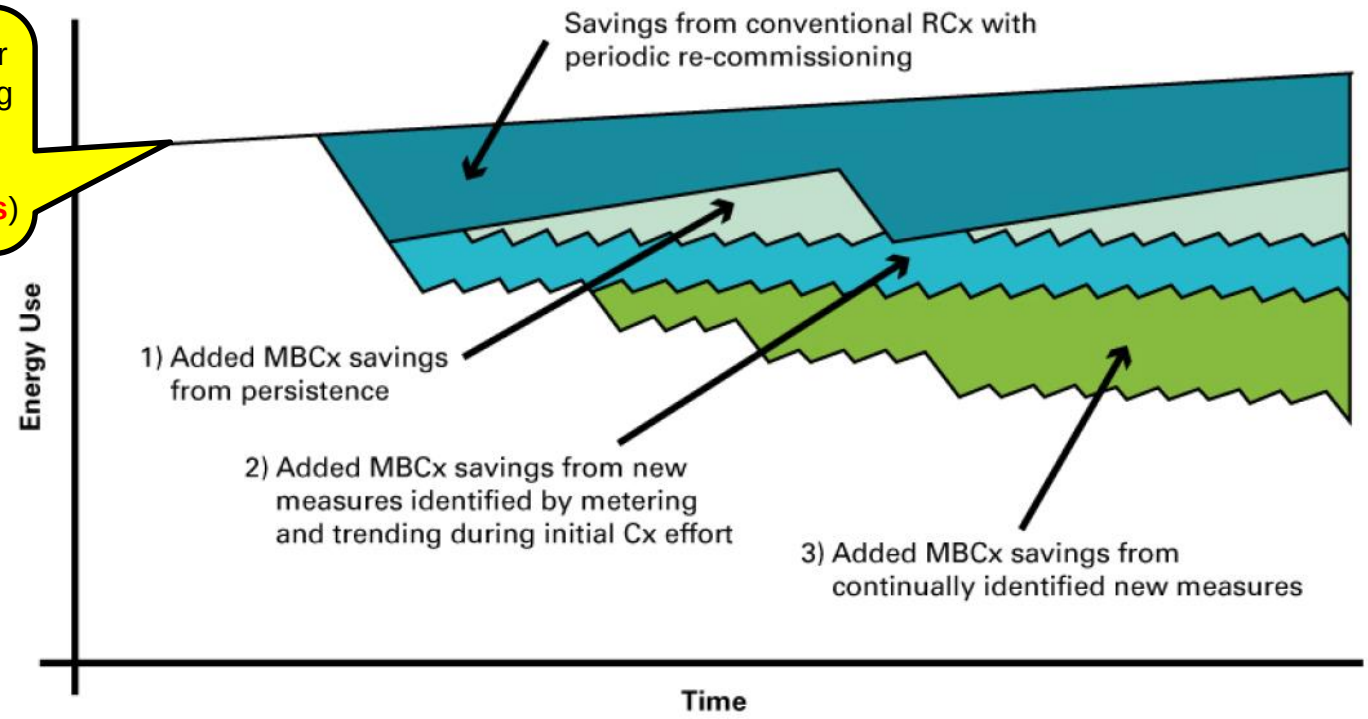
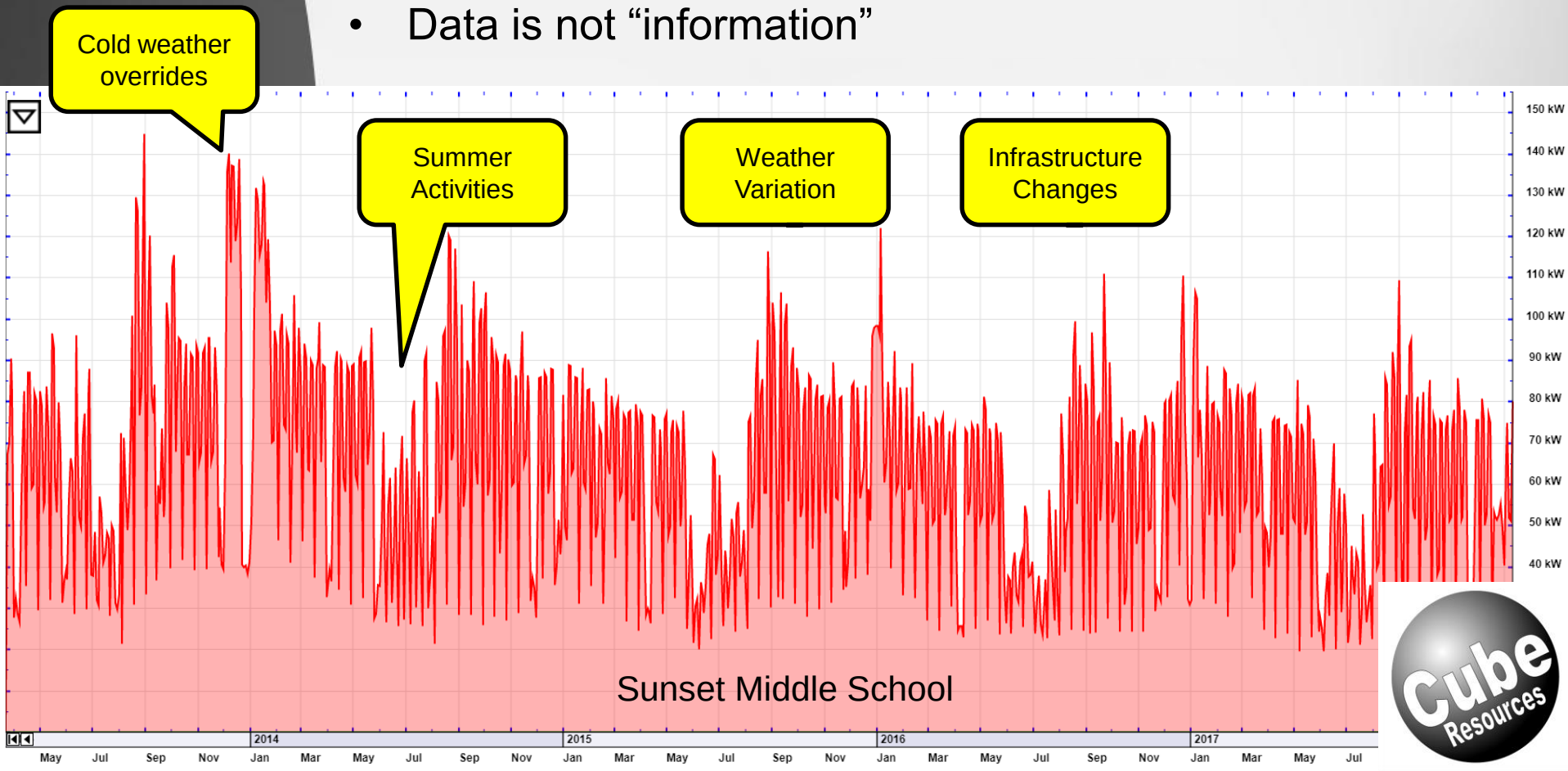


Figure 5. MBCx streams of additional energy savings relative to EBCx (Figure 1 in [1])

Lawrence Berkeley National Laboratory
Building Commissioning: Cost-benefit Assessments, Mills 2009
Improving Energy Efficiency through Commissioning, October 2013
https://cbs.lbl.gov/sites/all/files/lbnl-6495e.pdf

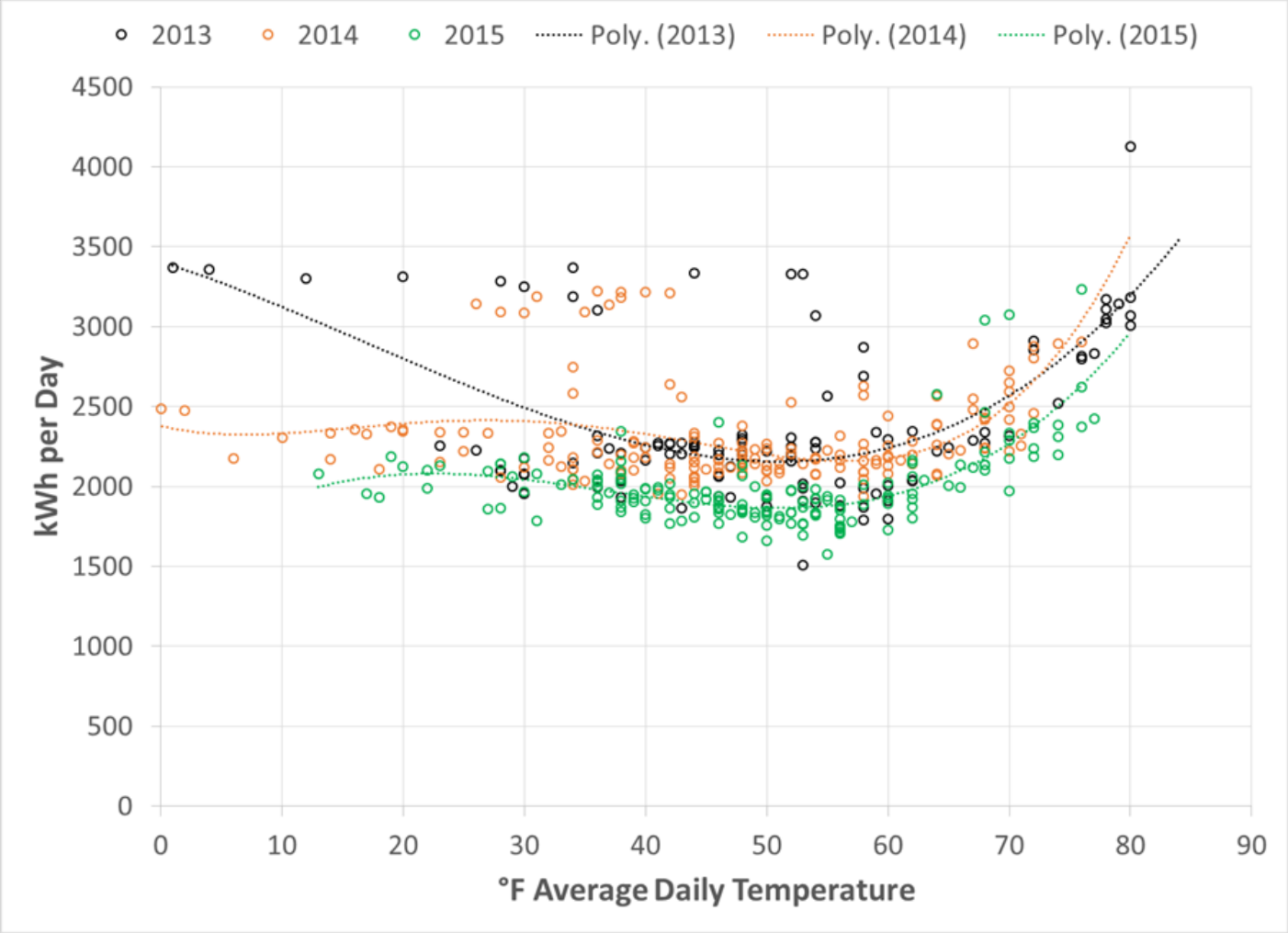
Data Reality

- Billing data is low-information
- Interval data is noisy
- Even “free” data has a cost
- Have a plan before you get too much data
- Data is not “information”



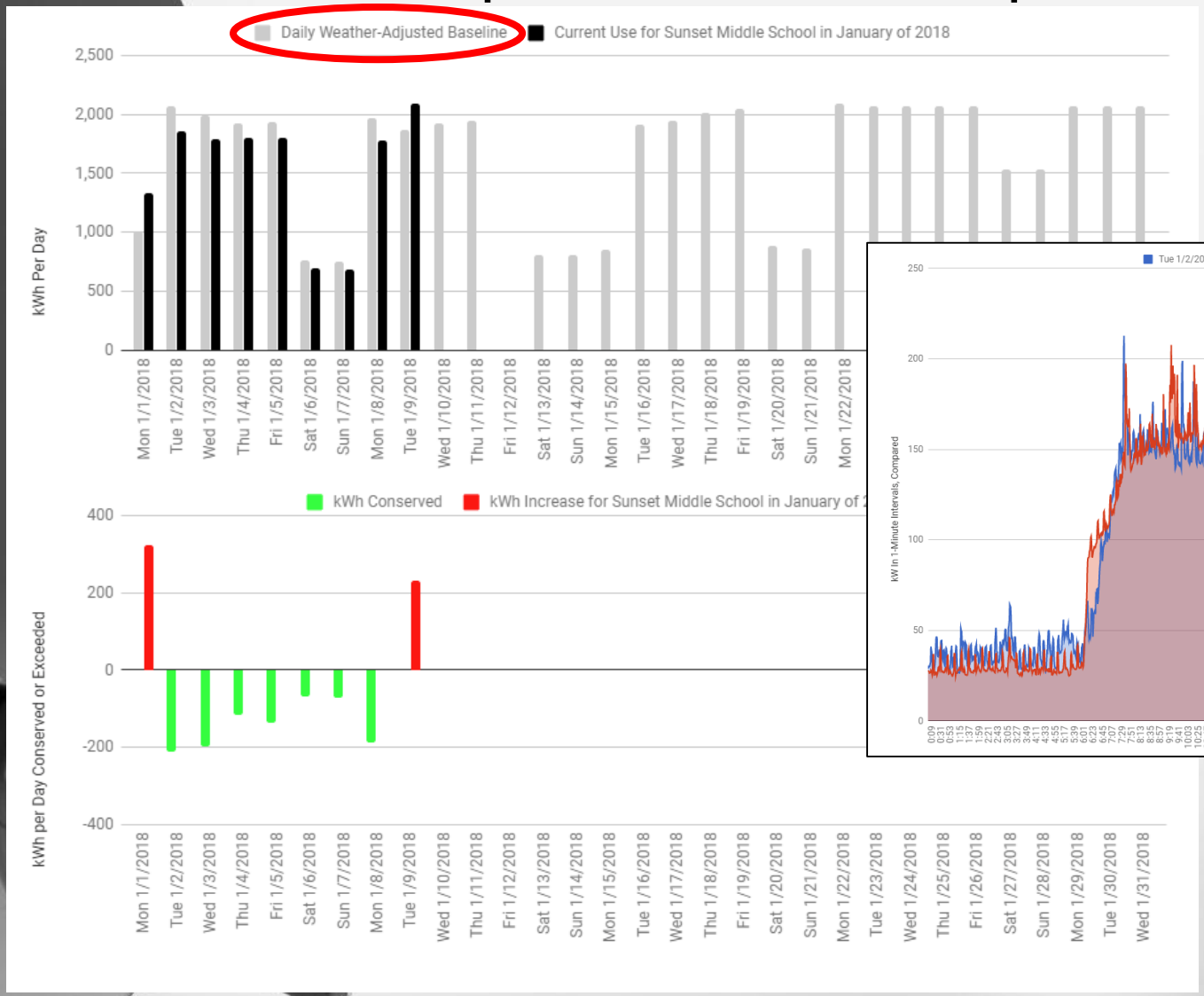
Weather Normalization

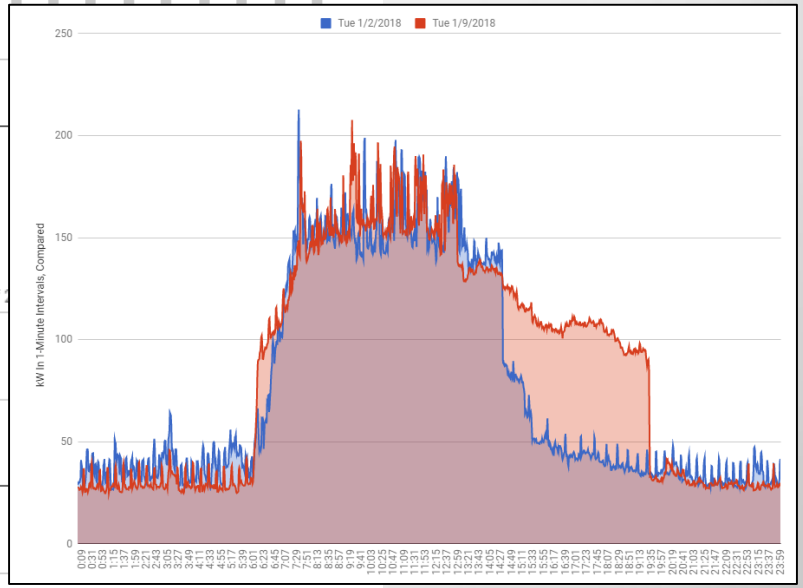
Unambiguous 2014 to 2015 54,000 kWh/year performance shift at Sunset Middle School



Occupant Feedback

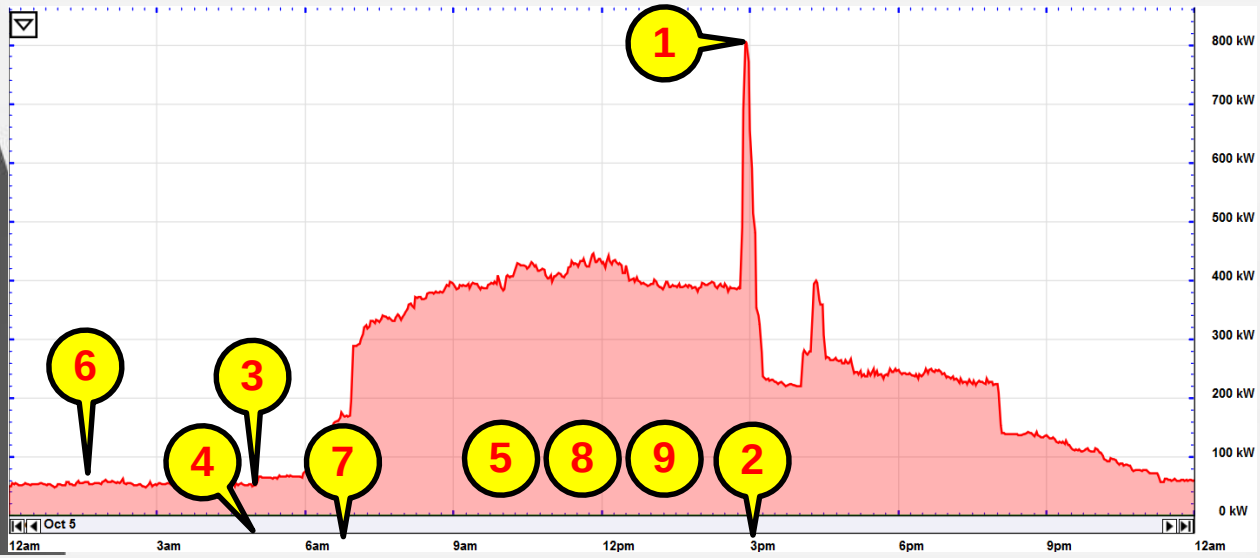
Simplified but not Simplistic





http://www.cuberesources.com/db/sv-sunse-m/

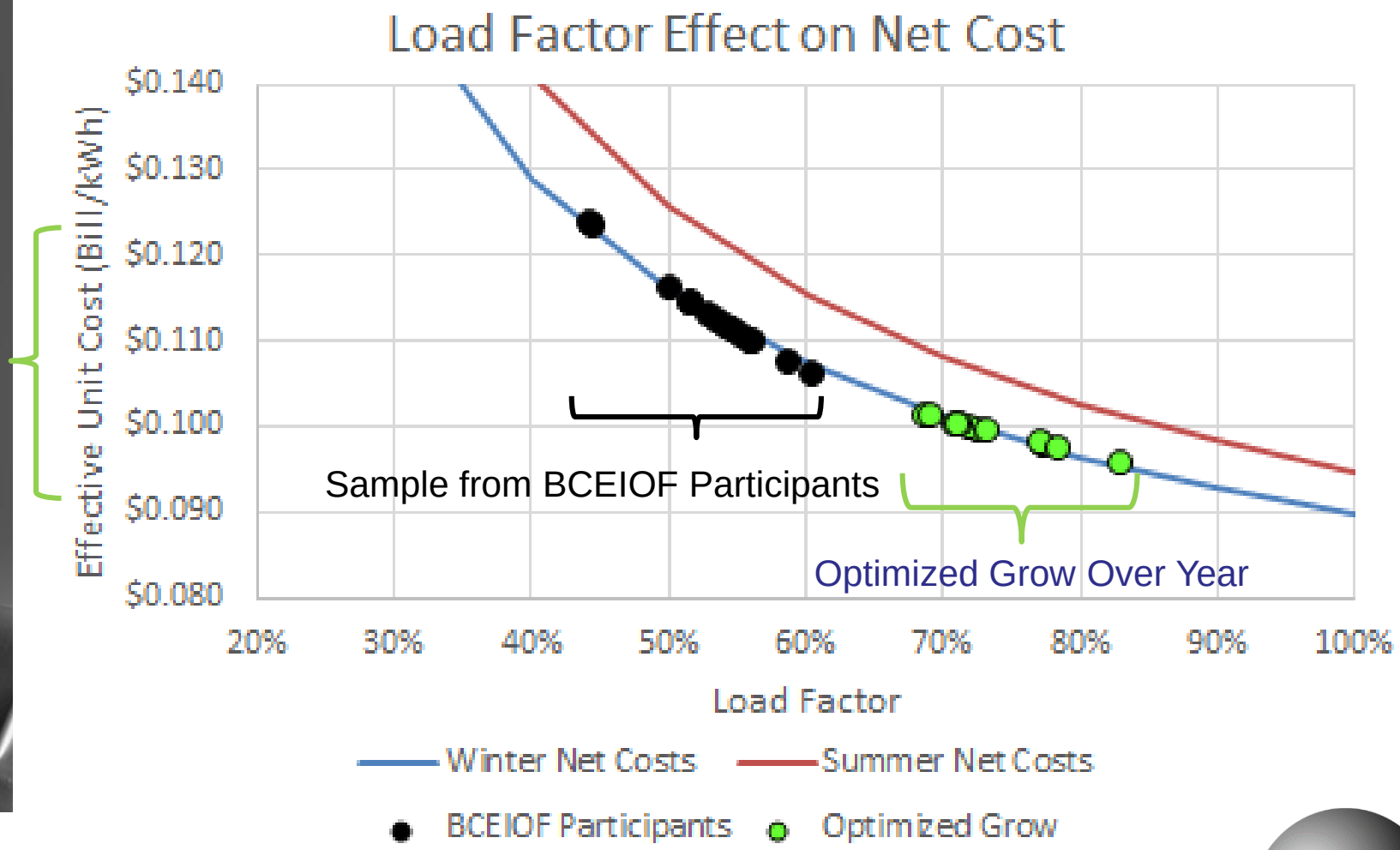
Trending Load Profile Stats



1. Peak load
2. Peak time
3. Minimum load
4. Min time
5. kWh for day
6. Overnight load
7. Start-up time
8. Load Factor
9. Significance

The benefits of high quality electrical usage interval data Magnelab
http://www.magnelab.com/the-benefits-of-high-quality-electrical-usage-interval-data/

Load Factor Effect on Costs

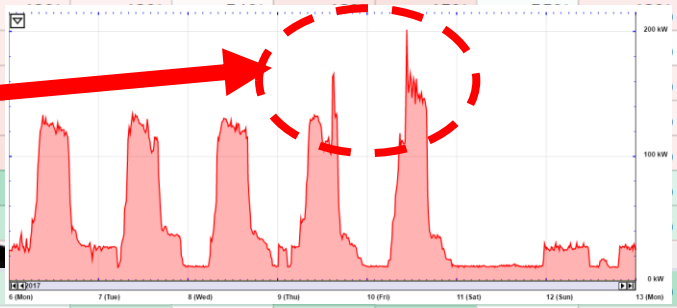


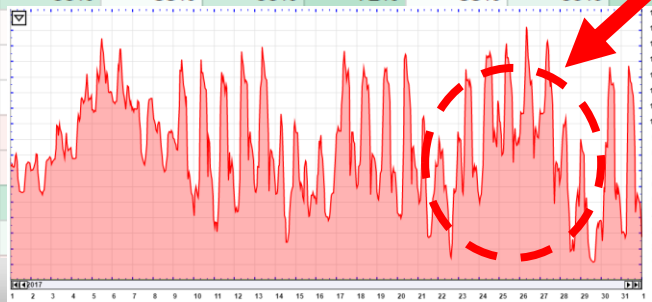
22.8% Cost Variation for same energy use

Trended Comparisons

Both high and low load factors can indicate problems

AK					Chiller									Chiller			
783		Blue Hero	Bradford I	Carmody	Chatfield I	Creighton	Little Elen	Ralston V	West Jeff	West Jeff	West Woc	Westridge	Wheat Ric	Bear Cree	Bell Middl	Campbell	Deer Cree
1261		eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge
		1ryFC	1TX2F	1rrq77	16U6M	1a_Hk	1ILE8	10C2i	1h_rw	1IjOSI	1Vo-oj	1DvTS	14SE8	19a1x	1_tX-y	1_Er1l	1WJUI
2017-02-02 Thu	Weekday	51%	48%	52%	55%	50%	46%	54%	58%	46%	61%	51%	54%	55%	58%	51%	48%
2017-02-03 Fri	Weekday	50%	48%	51%	57%	48%	50%	53%	53%	43%	66%	50%	55%	56%	58%	53%	49%
2017-02-04 Sat	Weekend	58%	47%	60%	57%	56%	68%	54%	69%	77%	33%	85%	56%	65%	84%	44%	59%
2017-02-05 Sun	Weekend	55%	49%	61%	55%	58%	66%	52%	58%	77%	50%	86%	75%	73%	85%	62%	67%
2017-02-06 Mon	Weekday	48%								47%	55%	50%	54%	54%	55%	49%	47%
2017-02-07 Tue	Weekday	47%								47%	49%	49%	50%	53%	55%	44%	47%
2017-02-08 Wed	Weekday	45%								46%	48%	51%	50%	51%	54%	49%	45%
2017-02-09 Thu	Weekday	34%								45%	48%	47%	49%	50%	54%	47%	48%
2017-02-10 Fri	Weekday	32%								39%	40%	41%	48%	53%	53%	47%	43%
2017-02-11 Sat	Weekend	40%								54%	53%	86%	71%	75%	94%	65%	65%
2017-02-12 Sun	Weekend	72%								69%	67%	90%	80%	88%	90%	76%	72%
2017-01-21 Sat	Weekend	66%								72%	54%	86%	70%	81%	89%	74%	69%
2017-01-22 Sun	Weekend	70%	55%	66%	55%	66%	72%	55%	60%	72%	60%	79%	81%	81%	85%	67%	74%
2017-01-23 Mon	Weekday	51%	49%							59%	60%	52%	55%	53%	55%	52%	55%
2017-01-24 Tue	Weekday	52%	47%							58%	67%	52%	55%	54%	56%	49%	50%
2017-01-25 Wed	Weekday	49%	48%							59%	67%	52%	52%	55%	58%	52%	57%
2017-01-26 Thu	Weekday	53%	48%							53%	65%	51%	56%	57%	58%	52%	55%
2017-01-27 Fri	Weekday	52%	49%							59%	60%	52%	53%	55%	55%	54%	49%
2017-01-28 Sat	Weekend	58%	49%							77%	53%	84%	61%	70%	82%	63%	74%
2017-01-29 Sun	Weekend	50%	59%							70%	39%	87%	73%	77%	87%	54%	69%





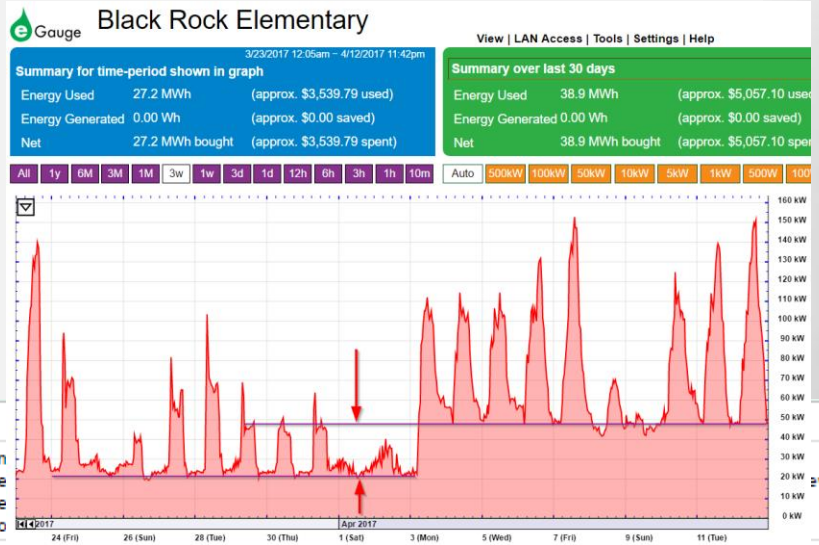
Type and Floor Area Normalization

- High baseloads
- Electric heat
- Poor load factors

Mon 2017-04-03		2,704,339		62,647		5,258		922		Selected		
Double-click for calendar. Use arrows to jump a day.		2,704,339	100%	62,647	100%	5,258	100%	922	100%	Total		
Row 424				kWh for day		Peak Load		12:00 to 1:00am			Load Factor	12:00/Peak
	Type	Square Feet			Wh/SqFt	kW	W/SqFt	kW	W/SqFt			
Blue Heron Elementary	E	55,083		1,521	27.61	133 kW	2.41	17 kW	0.305		48%	13%
Bradford Intermediate	E	46,070		1,145	24.86	108 kW	2.34	17 kW	0.374		44%	16%
Carmody Middle	M	101,254		2,626	25.94	230 kW	2.28	38 kW	0.378		48%	17%
Chatfield High	H	274,587		7,548	27.49	618 kW	2.25	79 kW	0.288		51%	13%
Creighton Middle	M	120,847		1,114	9.22	102 kW	0.84	9 kW	0.072		45%	9%
Little Elementary	E	42,229		918	21.73	81 kW	1.93	11 kW	0.263		47%	14%
Ralston Valley High	H	237,815		6,067	25.51	495 kW	2.08	94 kW	0.395		51%	19%
West Jefferson Elementary	E	47,700		1,226	25.71	122 kW	2.55	22 kW	0.455		42%	18%
West Jefferson Middle	M	103,605		1,585	15.30	146 kW	1.41	25 kW	0.241		45%	17%
West Woods Elementary	E	58,181		1,720	29.56	145 kW	2.49	26 kW	0.443		49%	18%
Westridge Elementary	E	52,665		475	9.02	39 kW	0.74	8 kW	0.155		51%	21%
Wheat Ridge High	H	207,655		4,461	21.48	379 kW	1.83	51 kW	0.245		49%	13%
Bear Creek HS	H	255,986		6,217	24.29	477 kW	1.86	134 kW	0.522		54%	28%
Bell Middle	M	128,332		3,239	25.24	280 kW	2.18	66 kW	0.512		48%	23%
Campbell Elementary	E	44,245		1,178	26.62	105 kW	2.38	19 kW	0.419		47%	18%
Deer Creek Middle	M	120,491		2,397	19.90	218 kW	1.81	21 kW	0.173		46%	10%
Eiber Elementary	E	58,066		1,127	19.41	100 kW	1.72	22 kW	0.377		47%	22%
Falcon Bluffs Middle	M	113,580		2,722	23.97	217 kW	1.91	46 kW	0.406		52%	21%
Foster Elementary	E	48,534		953	19.63	86 kW	1.78	13 kW	0.273		46%	15
Lakewood HS	H	247,535		6,914	27.93	538 kW	2.17	119 kW	0.482		54%	22
Patterson Elementary	E	49,847		936	18.78	84 kW	1.68	12 kW	0.240		47%	14
Pomona High School	H	205,816		4,656	22.62	389 kW	1.89	53 kW	0.259		50%	14
Secrest Elementary	E	46,373		1,002	21.60	87 kW	1.87	12 kW	0.249		48%	13
Vivian Elementary	E	37,843		902	23.83	80 kW	2.10	9 kW	0.236		47%	11

Trended Comparisons

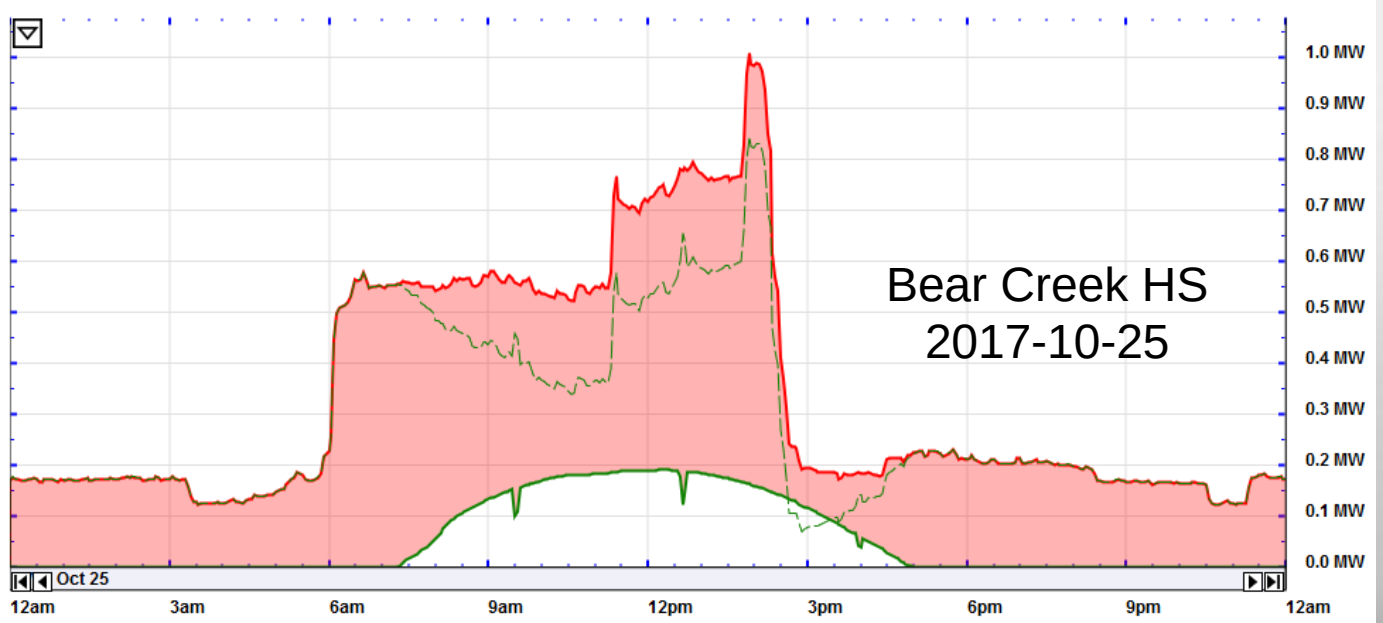
- Comparison of trended weather normalizations
  - Override
  - Infrastructure change
  - Special events



Adjustable color code															
-15%	10%	Black Rock Elementary	Burlington Elementary	Central Elementary	Columbine Elementary	Eagle Crest Elementary	Hygiene Elementary	Longm Estate Eleme Schoo							
-10%	5%	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge	eGauge
-5%		Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo	Dashbo
2017-03-31 Fri	Weekend														
2017-04-01 Sat	Weekend	-17%	-8%	10%	1%	2%	-6%	3%	4%	-9%	-1%	-12%	12%	-11%	-3%
2017-04-02 Sun	Weekend	2%	-1%	12%	-7%	4%	-12%	43%	89%	15%	-3%	-8%	4%	-12%	-8%
2017-04-03 Mon	Weekday	5%	-10%	-23%	-7%	-2%	-16%	3%	6%	-8%	6%	-5%	-5%	-11%	-4%
2017-04-04 Tue	Weekday	12%	-1%	-15%	-3%	-1%	-13%	12%	11%	-5%	0%	-2%	3%	-3%	-3%
2017-04-05 Wed	Late start														
2017-04-06 Thu	Weekday	24%	-11%	-17%	-8%	-7%	-22%	-1%	4%	0%	2%	-1%	1%	-5%	-6%
2017-04-07 Fri	Weekday	30%	-17%	-14%	-1%	3%	-13%	-6%	12%	-1%	4%	-1%	-1%		
2017-04-08 Sat	Weekend	104%	-11%	-4%	-23%	-5%	-24%	-12%	22%	6%	-14%	63%	-19%		
2017-04-09 Sun	Weekend	75%	-15%	20%	-10%	-10%	-9%	-5%	4%	1%	-3%	9%	-14%		
2017-04-10 Mon	Weekday	21%	-9%	-16%	-6%	-4%	-17%	-10%	9%	-4%	-4%	-6%	-5%		
2017-04-11 Tue	Weekday	28%	-9%	-18%	-5%	-2%	-14%	-2%	5%	0%	6%	-5%	-3%		
2017-04-12 Wed	Weekday	35%	-10%	-17%	-4%	1%	-9%	-4%	6%	1%	7%	5%	-5%		

Demand Response, Solar, Storage

- Rate models, interval data, and design
- Production monitoring, fault detection
- Programming to reduce demand
- Demand response
- Solar effects on demand
- Ice storage, Battery storage



Visualization vs. Analysis and Action

- Does monitoring map to accounts, control points
- Do visualizations answer questions?
- Do you need to download data seek answers?
- Can you isolate, compare, quantify, adjust?:
  - Programming changes
  - Schedule changes
  - Behavior
  - Energy
  - Demand
  - Costs
  - Baselines vs. Current Use and exclusions
- Support for implementation and unexpected

References

Local companies with deep technical knowledge:

eGauge: https://www.egauge.net/

Magnelab: http://www.magnelab.com/

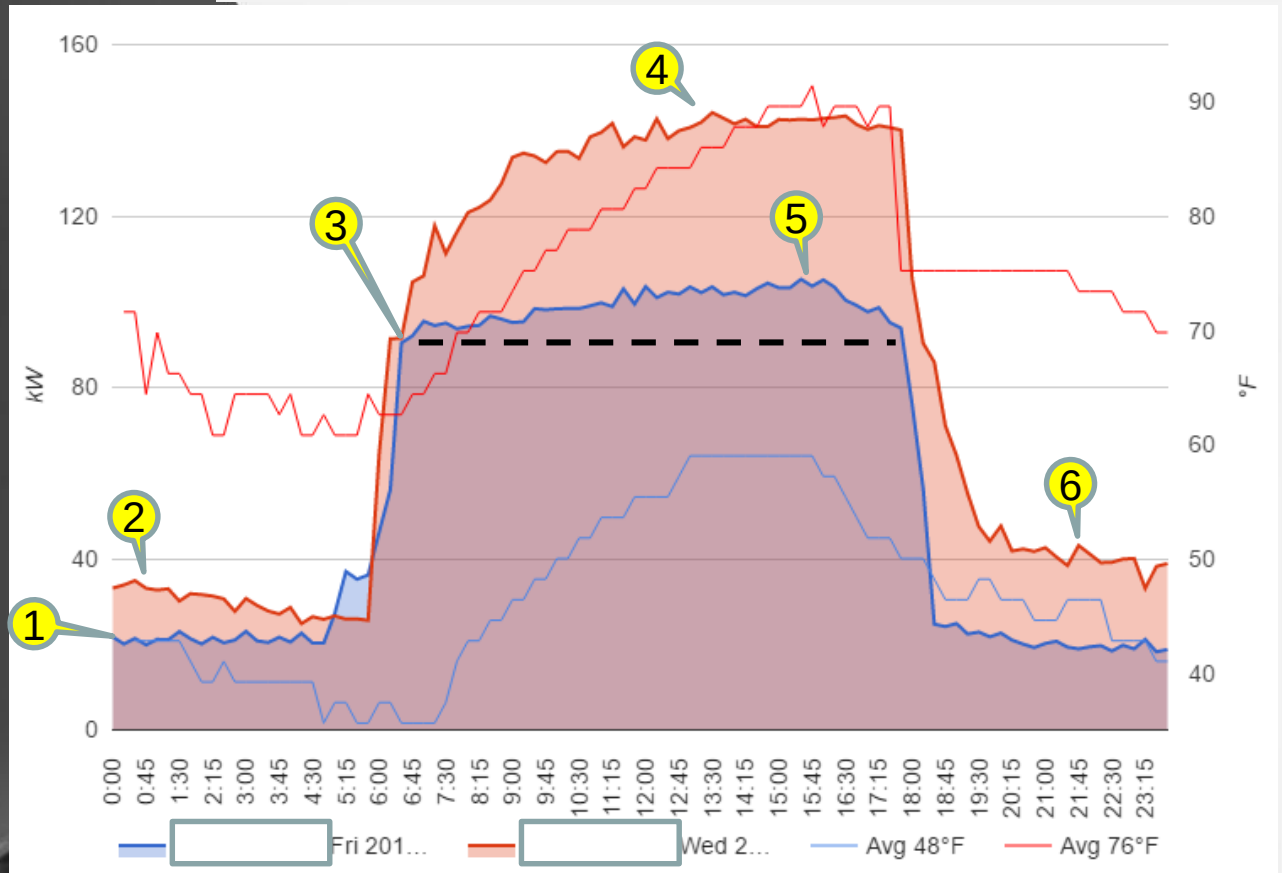
ReNew Our Schools is still going strong and the Center for ReSource Conservation has been renamed **ReSource Central**

https://resourcecentral.org/renew-our-schools/how-it-works/

References

- Laurence Berkley National Labs (LBNL)
  - EMIS: Crash Course to Successful Use, Xcel Energy Efficiency Expo, January 28, 2016
    https://www.xcelenergy.com/staticfiles/xe-responsive/assets/images/Content/MN-Xcel-Expo-2016-Xcel-EMIS-Crash-Course.pdf
  - A Primer on Organizational Use of Energy Management and Information Systems (EMIS)
    https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/A_Primer_on_Organizational_Use_of_EMIS_V1.1.pdf
  - Smart Energy Analytics Campaign | Better Buildings Initiative
    https://betterbuildingssolutioncenter.energy.gov/alliance/smart-energy-analytics-campaign
  - Better Buildings Alliance: Activities | Better Buildings Initiative
    https://betterbuildingssolutioncenter.energy.gov/alliance/activities/technology-solutions-teams/energy-management-information-systems
- NREL
- Jess Lorentz Dashboard presentation to RMAEE
  http://upkeepenergy.com/energy-dashboards-features-and-benefits/
- Magnelab white papers
  - Dara Ward
    Real-Time Electricity Savings for Schools Using Magnelab Current Transformers Magnelab
    http://www.magnelab.com/real-time-electricity-savings-schools-using-magnelab-current-transformers/
  - Cube
    The benefits of high quality electrical usage interval data
    http://www.magnelab.com/the-benefits-of-high-quality-electrical-usage-interval-data/
- Peer use cases
  - Lucid: BVSD (electricity), APS (electricity & natural gas)
  - Power TakeOff: Douglas
  - McKinstry PowerED: Pueblo, City of Boulder
  - Community Power Partnership: City of Boulder
    https://bouldercolorado.gov/sustainability/community-power
  - Smart meters: Poudre
- CASDEM BuildingIQ 2017-03-02
- CASDEM Power TakeOff 2015-09-03
- CASDEM Lucid 2015-03-05

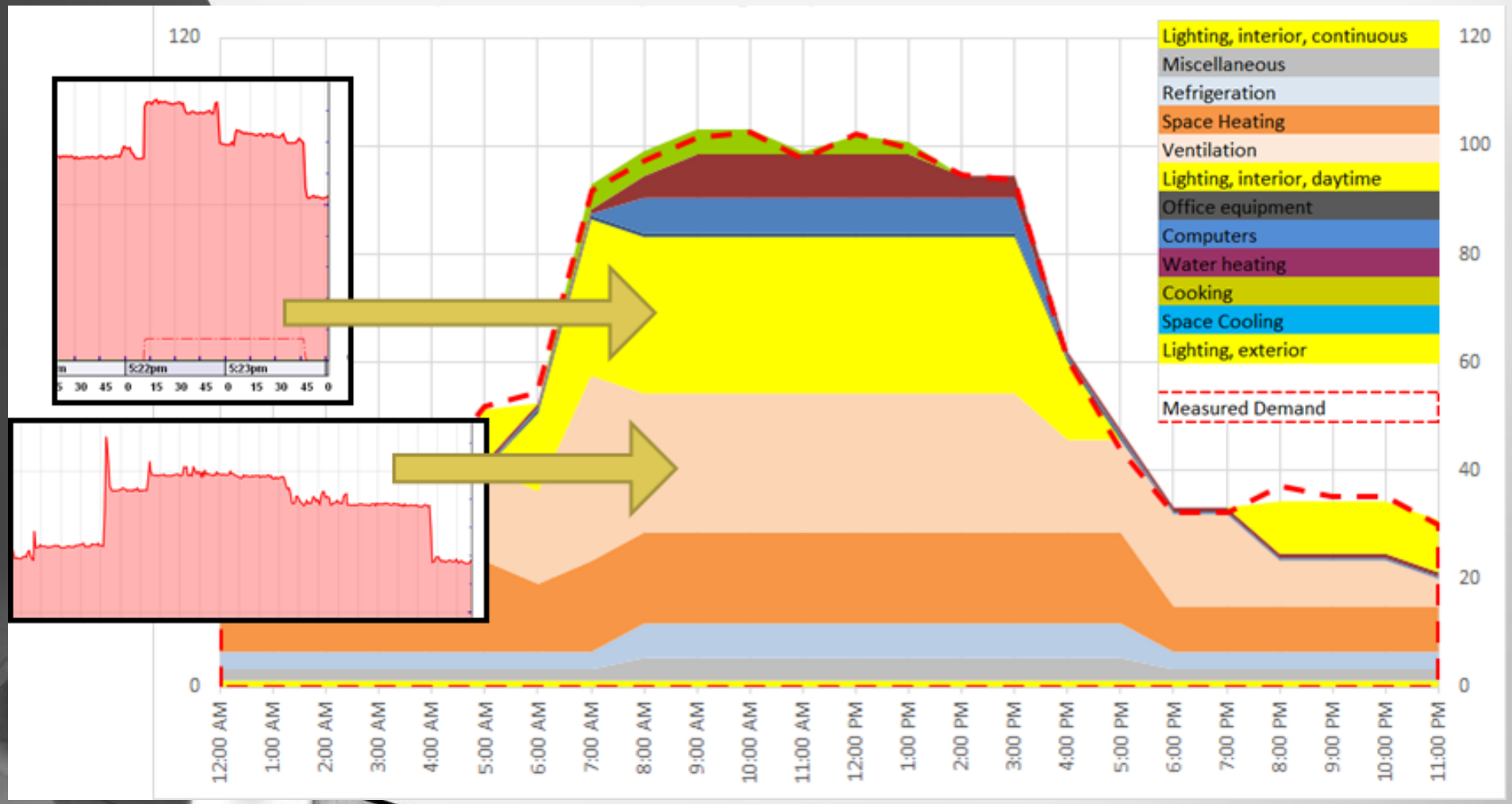
Disaggregation Via Season



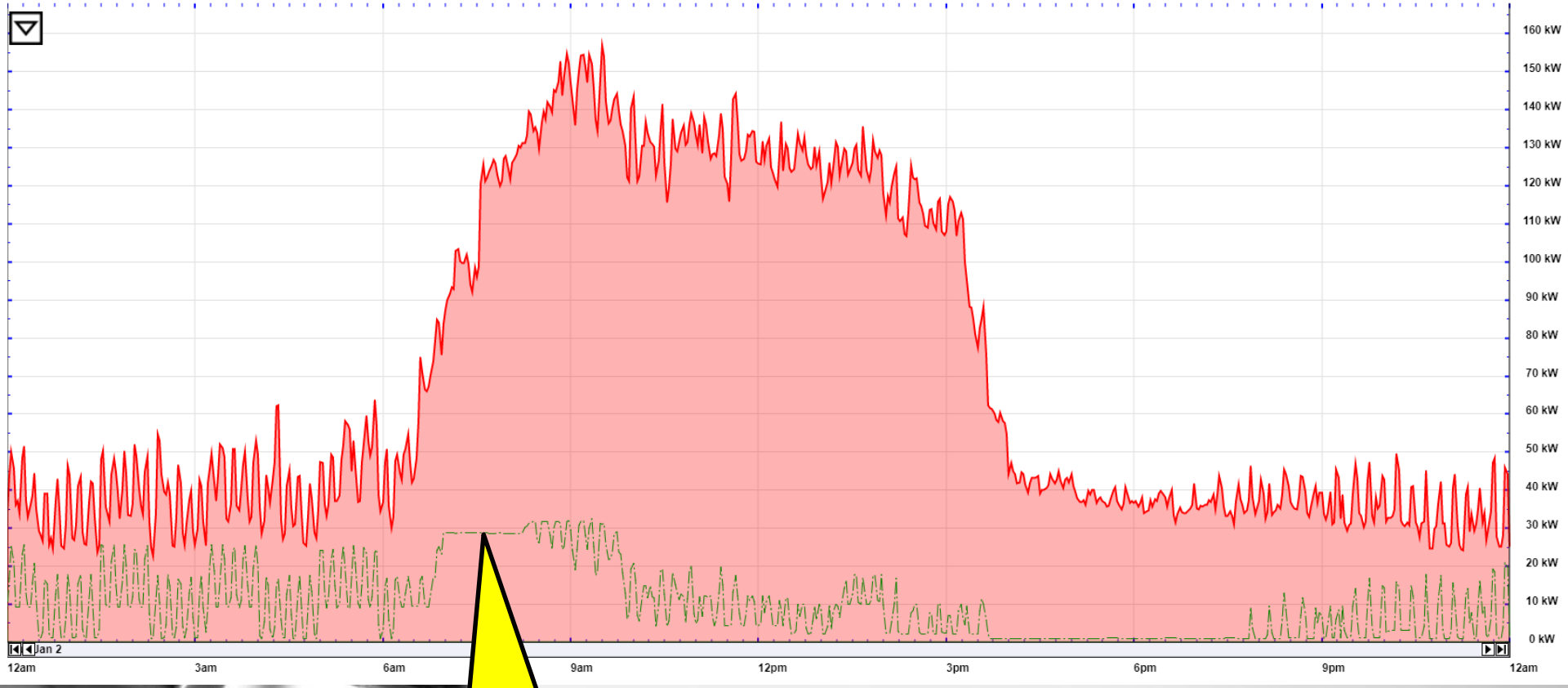
	1	2			Interval Calcs	
	2016-11-11 Fri	2016-07-13 Wed	Delta		based on 15 min	Denominator 4
	105 kW	144 kW	39 kWh	37.0%	Peak load	
	15:30	13:30			Peak time	
	18 kW	25 kW	7 kWh	36.1%	Minimum load	
	23:30	4:15			Minimum time	
	21 kW	34 kW	13 kWh	62.5%	Load from 12:00 to 1:00am	
	5:45	6:00			Start-up time (200% of baseload)	
	1,453 kWh	2,061 kWh	608 kWh	41.9%	kWh for day	
	58%	60%	2%		Load factor	

1. 20 kW overnight load is mainly vegetative lighting
2. High overnight temperatures keep AC running
3. 90 kW – 20 kW = 70 kW of bloom light load
4. AC load increases over warm day
5. AC load is still present on cool days
6. AC persists into warm evenings after lighting load is gone

Disaggregation by System Cycling

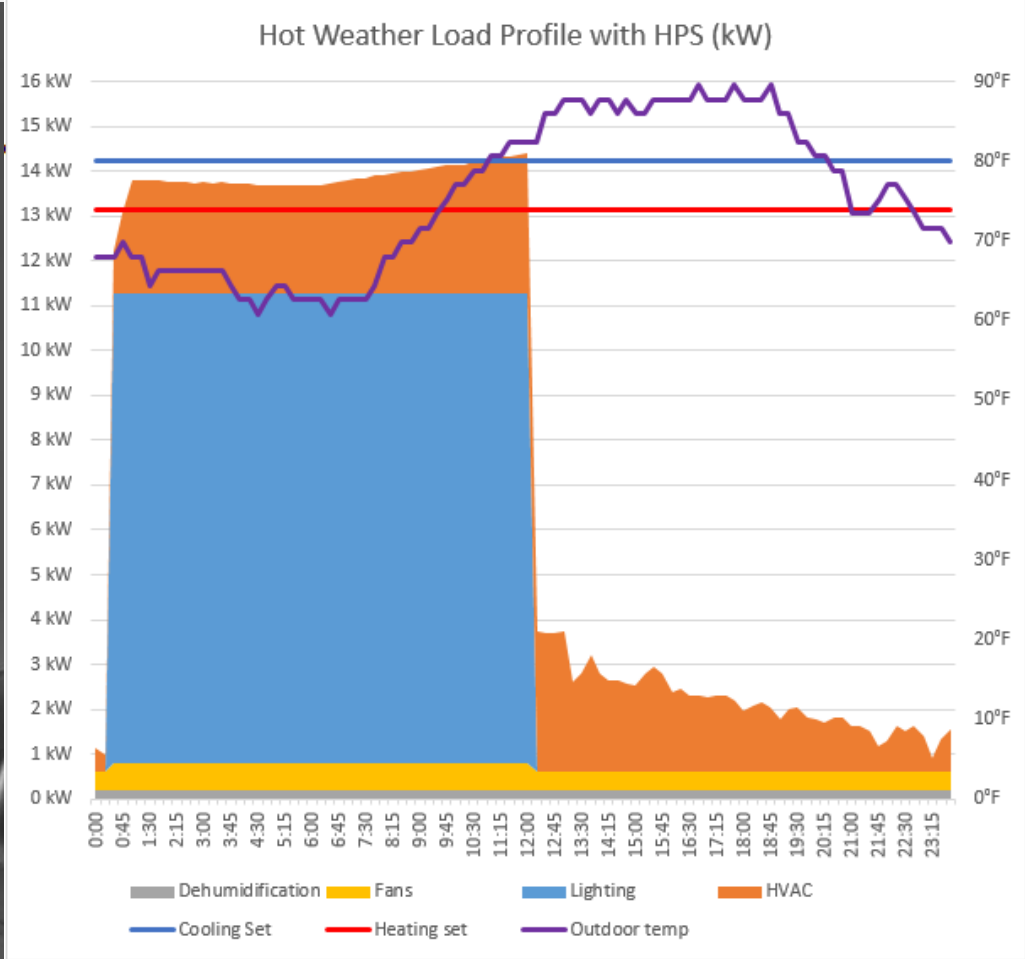


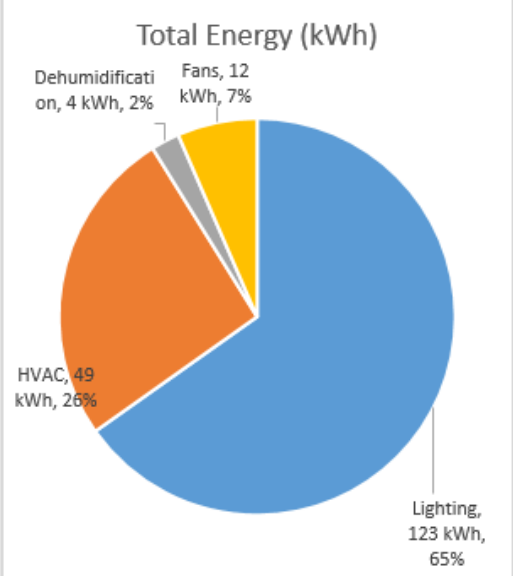
Disaggregation by Circuit Monitoring

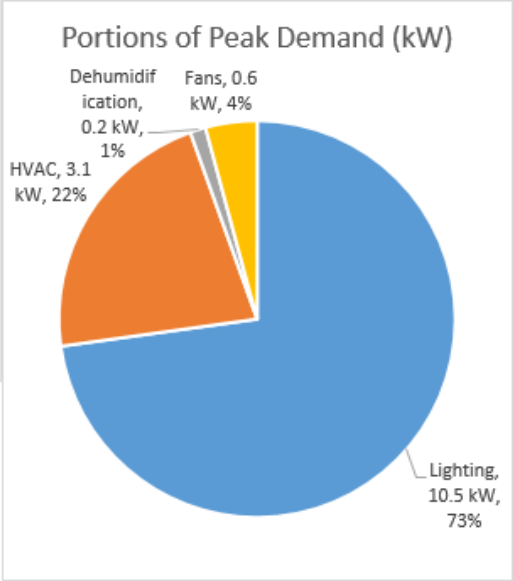


Eagle Crest Elementary portable classrooms setting peak demand 2018-01-02

Disaggregation by Circuit Monitoring, Power (Demand) vs. Energy

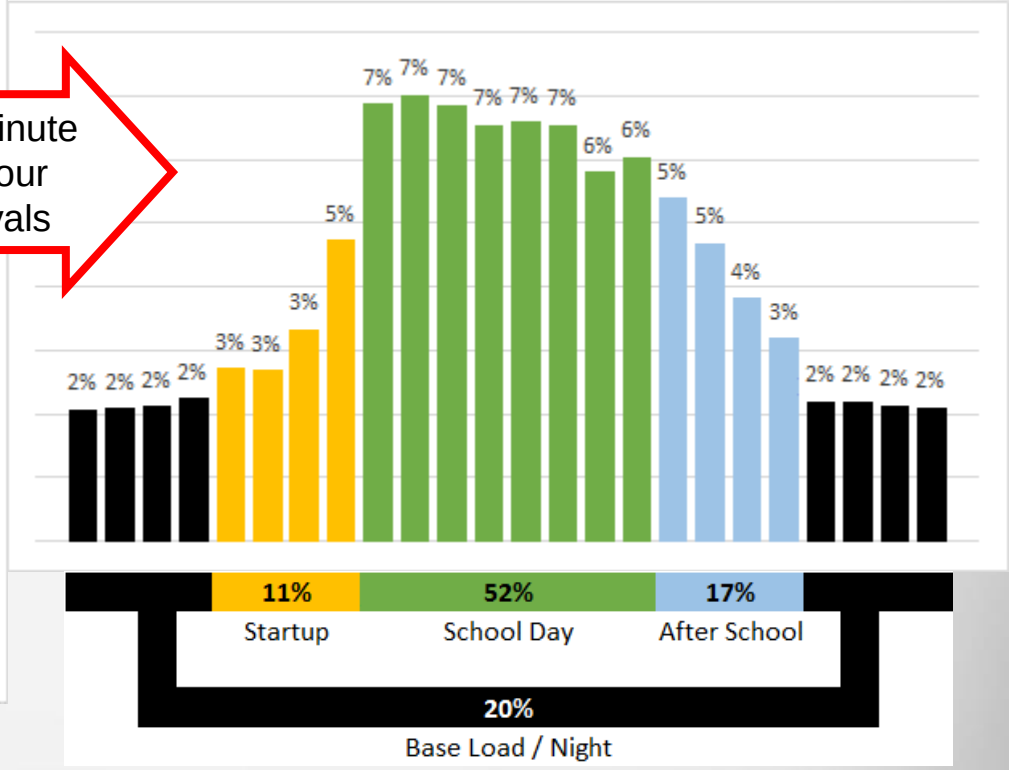






Disaggregation by Time of Day

One minute vs. hour intervals



Energy Cost:

11% is used during startup

52% is used over the school day

17% is used after school (23% if that period is started right after the bell)

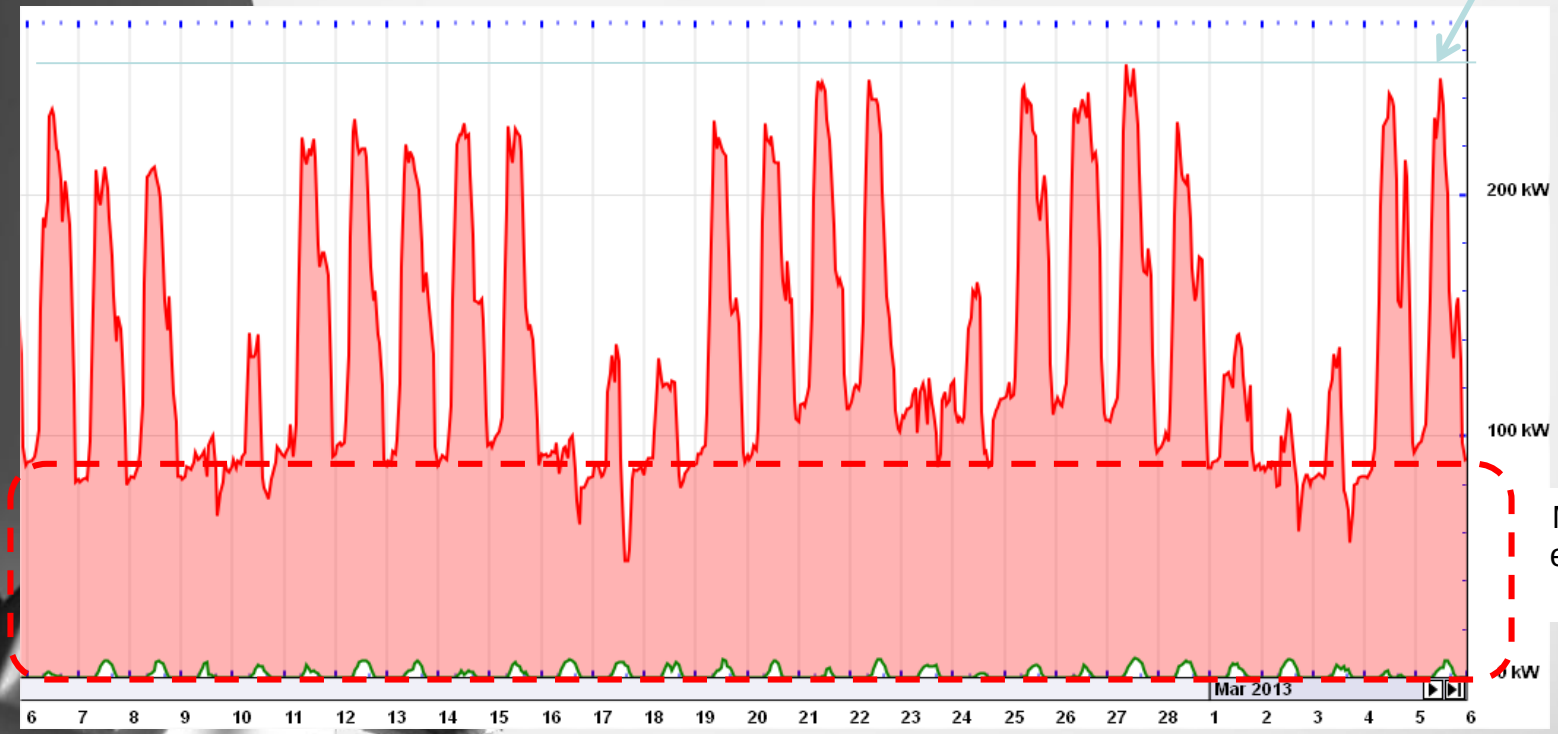
20% is used overnight (not the same thing as “base load”)

Demand Cost:

Set during school day, but baseload contributes

Base Load vs. Daily Load Cycle

276kW x $18.30/kW = $5,050
Demand charge set for month

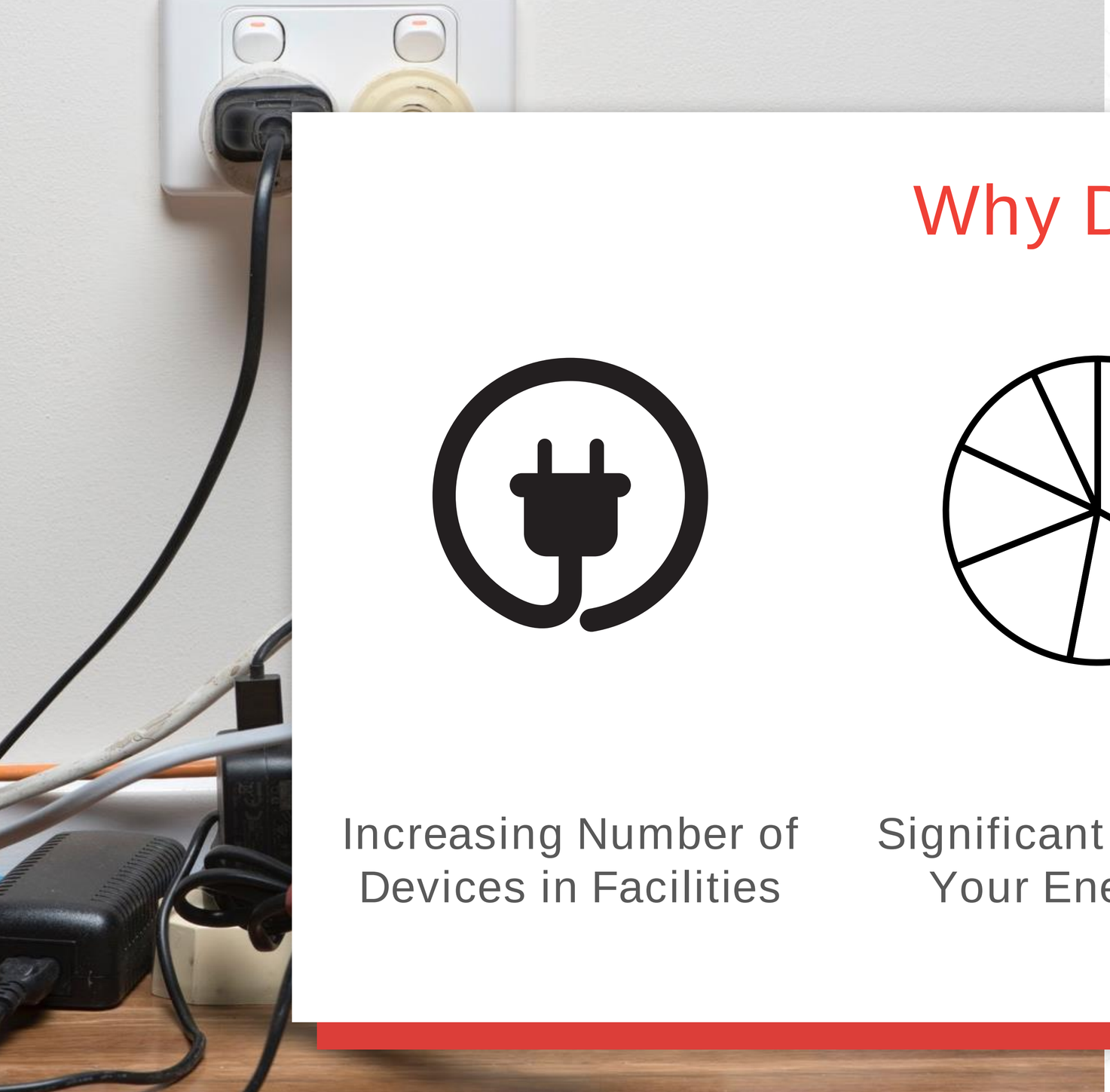


Most of the energy is in base load

Plug Load Management

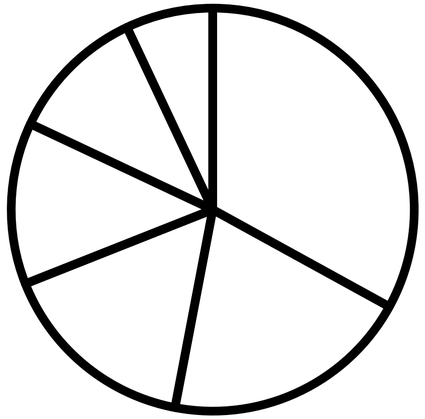
CASDEM – January Meeting

Thursday, January 11, 2018



Why Do It?

Increasing Number of Devices in Facilities



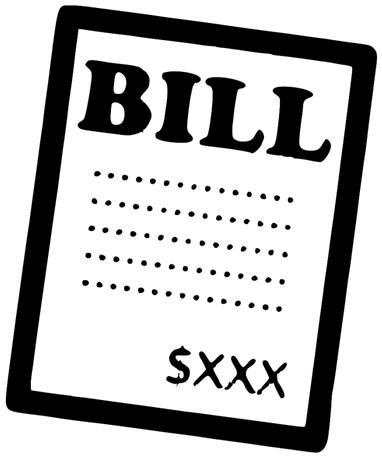
Significant Portion of Your Energy Bill

Increasing Cost of Energy

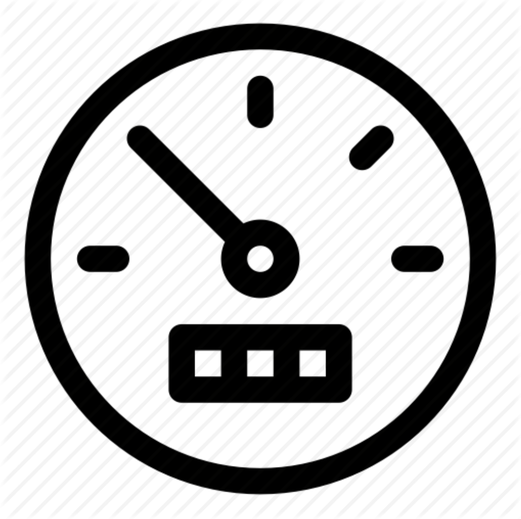
Decision Guide

Education Solutions	Strategy Considerations				Project Types				
Strategy	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	$	$$	○		✔	✔	✔	✔	✔
Advanced Power Strips (APSs)*	$	$$				✔	✔	✔	✔
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	$$	$$	○			✔	✔	✔	✔
Use Built-In Low Power States	$	$	○		✔	✔	✔	✔	✔
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	$$	$$				✔	✔	✔	✔
Integrate PPL Controls with Other Building Systems	$$$	$$$					✔	✔	
Additional Submetering and Control Options****	$$	$$				✔	✔	✔	

Methods & Considerations



Use Existing Utility Data



Sub-metering

IoT Solutions

People Problems

Controlling plug load usage through automation is the best solution to actually targeting vampire pull in your facility but can lead to push back from your end users.

Using data to engage end users seems to be the best way to gain end user buy in and adoption. We suggest a combination of the two in order to effectively reduce plug load in your facilities.

Plug Load Data

Setting a baseline of your plug load usage before implementing a project can allow you to qualify for a custom rebate through your energy provider.

Per Plug or Per Location Energy Consumption

You must be monitoring your per plug or per location plug load usage and storing that data. Typically for one month.

Scheduling Around Operating Hours

Automated scheduling that turns devices off when a building is unoccupied. And data supporting the amount of kWh saved while off.

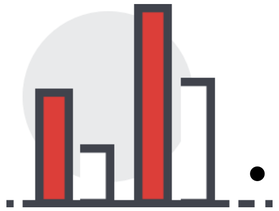
Reporting Savings to Energy Provider

Every energy provider has different requirements to qualify for a custom rebate so you must do your research beforehand.

Final Recommendations

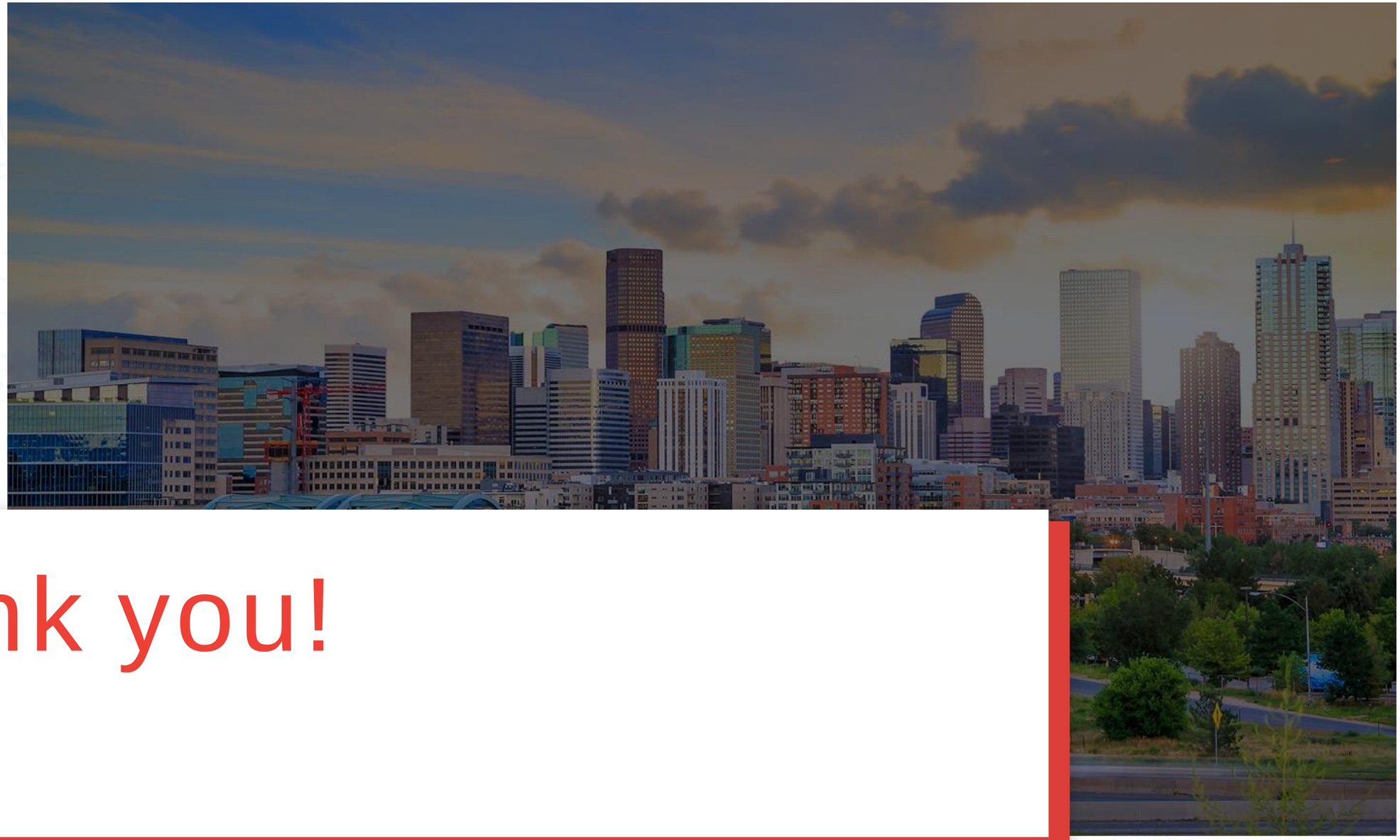
- Identify, target, and consolidate your highest plug load consuming devices.
- Run an ongoing Turn it Off campaign.

- Set a baseline and benchmark your progress.



- Use smart devices like Advanced Power Strips and Smart Plugs to better monitor and control device usage around operating hours.
- Integrate any data and above monitoring devices into your BAS for better tracking.

- Build your case and submit your information to your utility provider to secure custom energy saving rebates and offset your costs.



Thank you!

719-362-6621 | Martin@sustainsolutions.com

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

EMIS At NREL

Dylan Cutler and Stephen Frank
Presentation to CASDEM
January 11, 2018

NREL employee population has increased 88% since 2003

In 2016 NREL had 2,159 employees

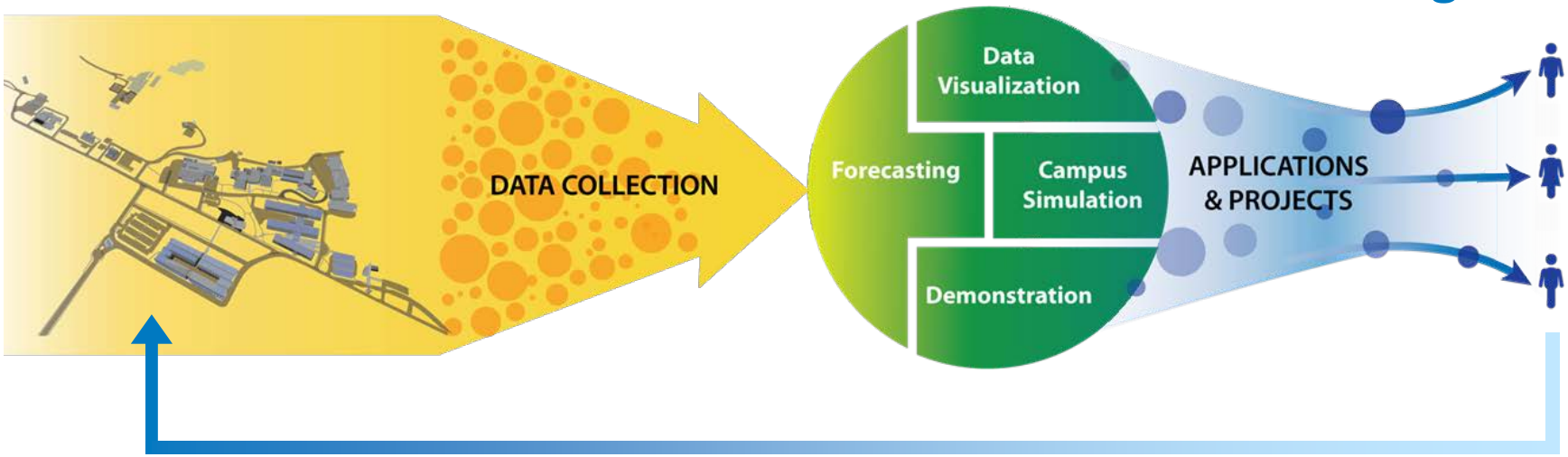
Campus building footprint has expanded from 436,941 ft^2 in 2003 to 1,136,335 ft^2 in 2016—a 160% increase

Energy **M**anagement and **I**nformation **S**ystem

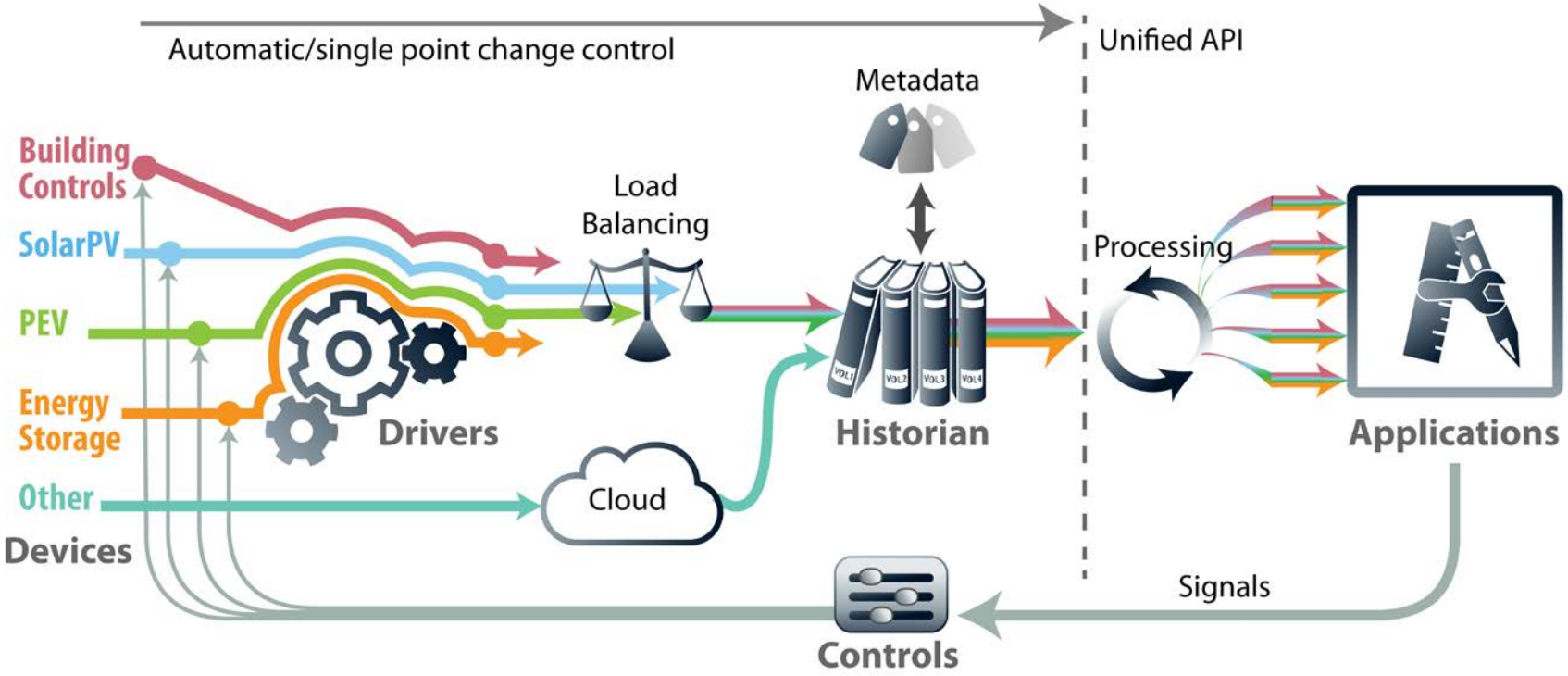
Energy **M**anagement, **I**nsight, and **S**avings

Energy **M**anagement, **I**nsight, and **S**avings

Infrastructure + Data + Analytics = Actionable Insight



Improved Operations


Automatic/single point change control
Unified API
Metadata
Building Controls
SolarPV
PEV
Energy Storage
Other
Devices
Load Balancing
Drivers
Cloud
Historian
Processing
Applications
Signals
Controls

Semantic Metadata → Informational Interoperability

SITE

Display Name
dis: "VTIF"

Tags
id: @3245
site: ✓
area: 10,000 ft^2
weatherRef: @1794 "Golden"
geoCity: "Golden"
geoState: "Colorado"
tz: "Denver"
...

SPACE

Display Name
dis: "Elec"

Tags
id: @5463
space: ✓
shape: [C(x_1, x_2), ...]
siteRef: @3245 "VTIF"

EQUIPMENT

Display Name
dis: "Electricity Meter Main"

Tags
id: @6748
equip: ✓
elec: ✓
meter: ✓
siteRef: @3245 "VTIF"
spaceRef:@5463 "Elec"

POINT

Display Name
dis: "Three-Phase Energy"

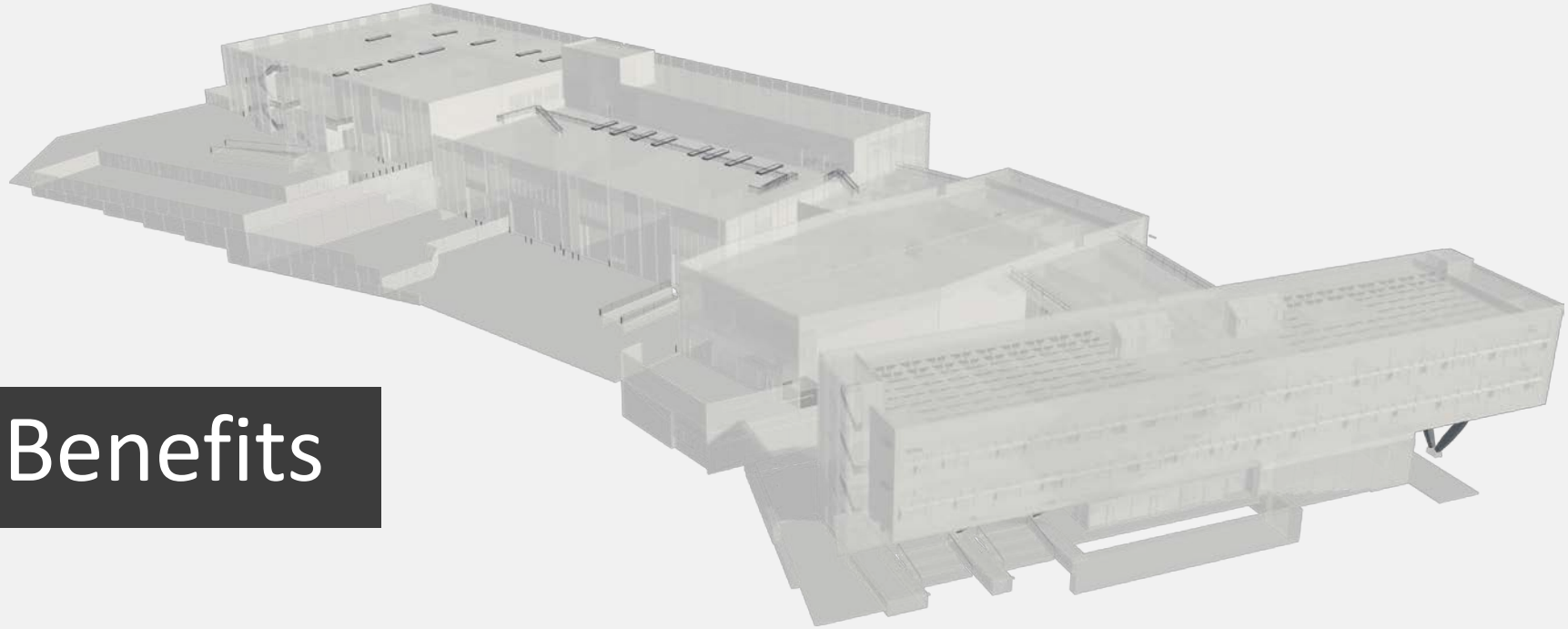
Tags
id: @1152
point: ✓
sensor: ✓
energy: ✓
unit: "kWh"
equipRef: @6748 "Electricity Meter Main"
spaceRef:@5463 "Elec"
siteRef: @3245 "VTIF"

Unique IDs are automatically generated and linked

Reference tags allow simple description of relationships

Marker tags describe intrinsic characteristics of an object

Project Haystack



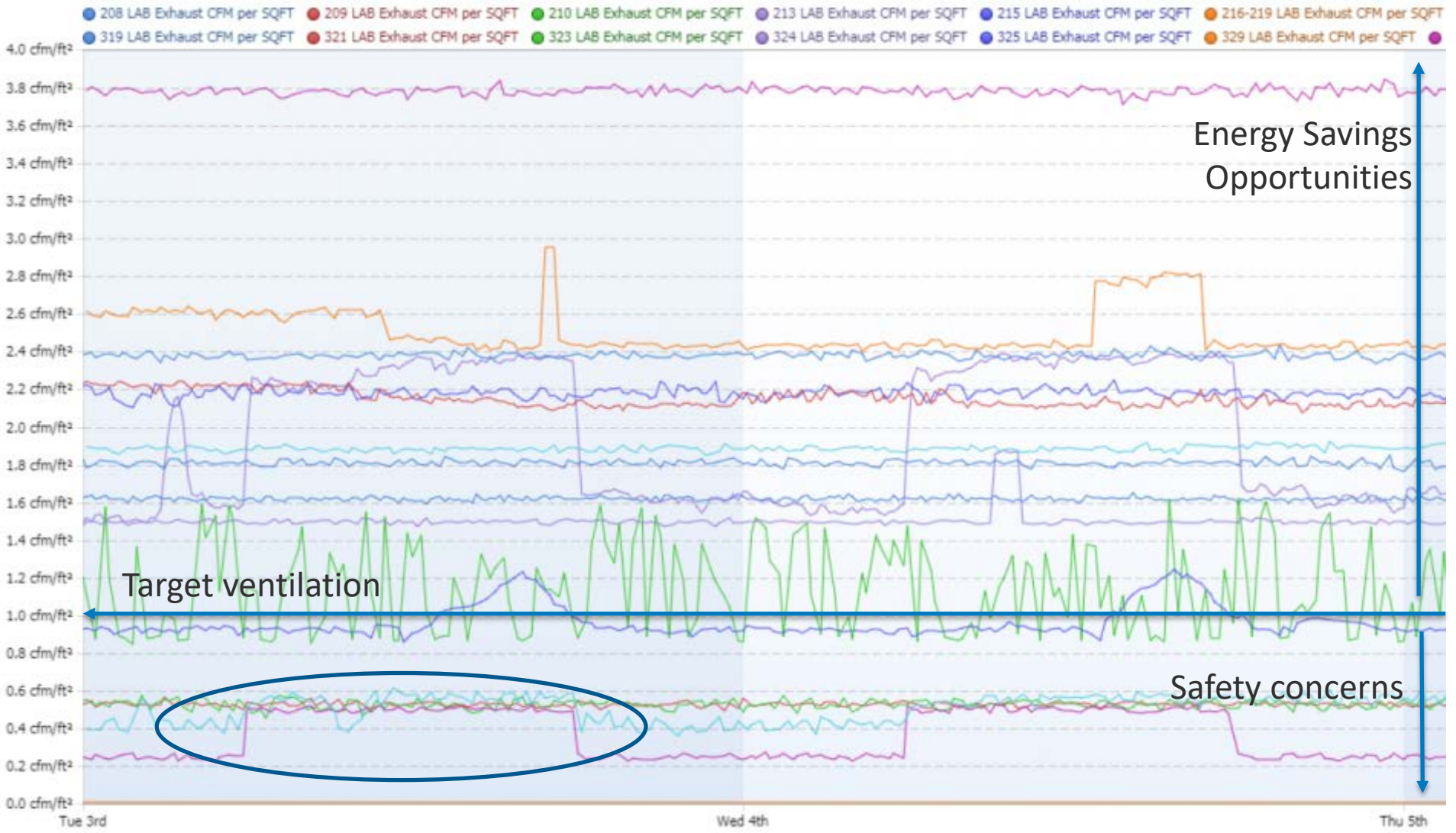
Benefits

Fault Detection and Diagnosis

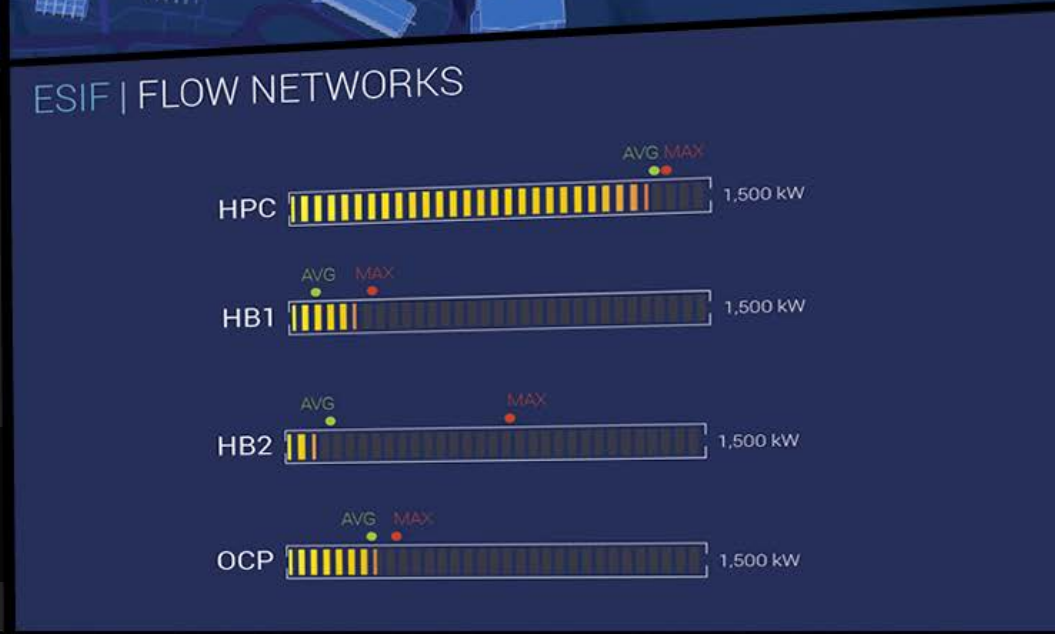
Group	Rules	dur
S&TF AHU-1 16 sparks	AHU DAT Control	3.84hr
	AHU Not Fully Economizing	13.56hr
	AHU Space Pressure Control	165.09hr
	AHU Underfloor Pressure Control	40.46hr
S&TF MAU-1 13 sparks	MAU DAT Control	39.6hr
	MAU Evap Heat Cycling	1.57hr
	PID Cmd Loop is Hunting	2hr
	Short Cycling	5.38min
S&TF FCU-2 8 sparks	Zone Temp SP Not Met	53.98hr
	Zone Temp out of Comfort Range	26.86hr

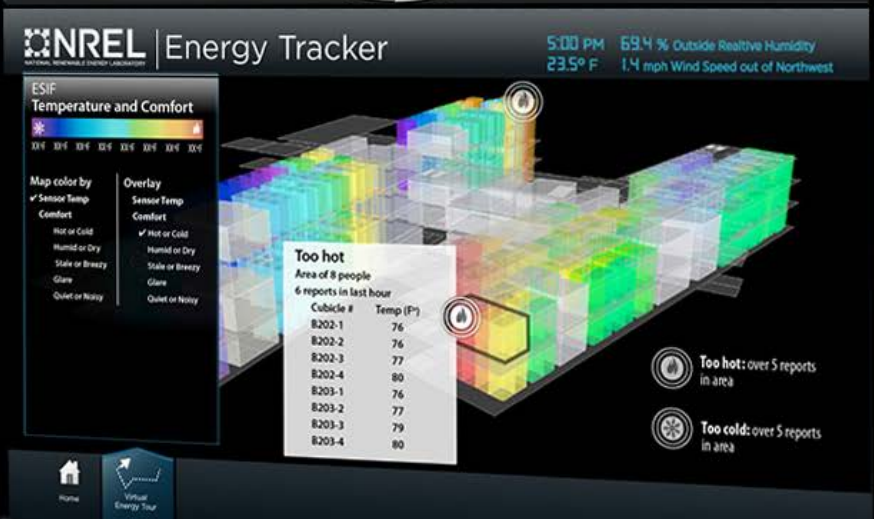
Timelines

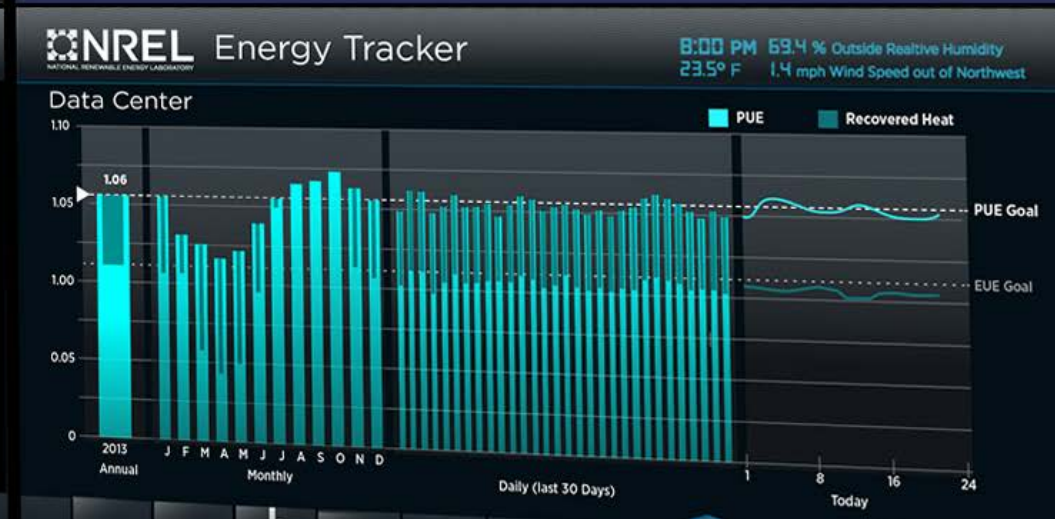
Insight into Lab Operations



Lessons Learned







Make a **Plan**

Involve **Everyone** Early

Go **Slowly**

Allow Time to **Learn**

You Need **Users**
To Achieve Results

Thank You!

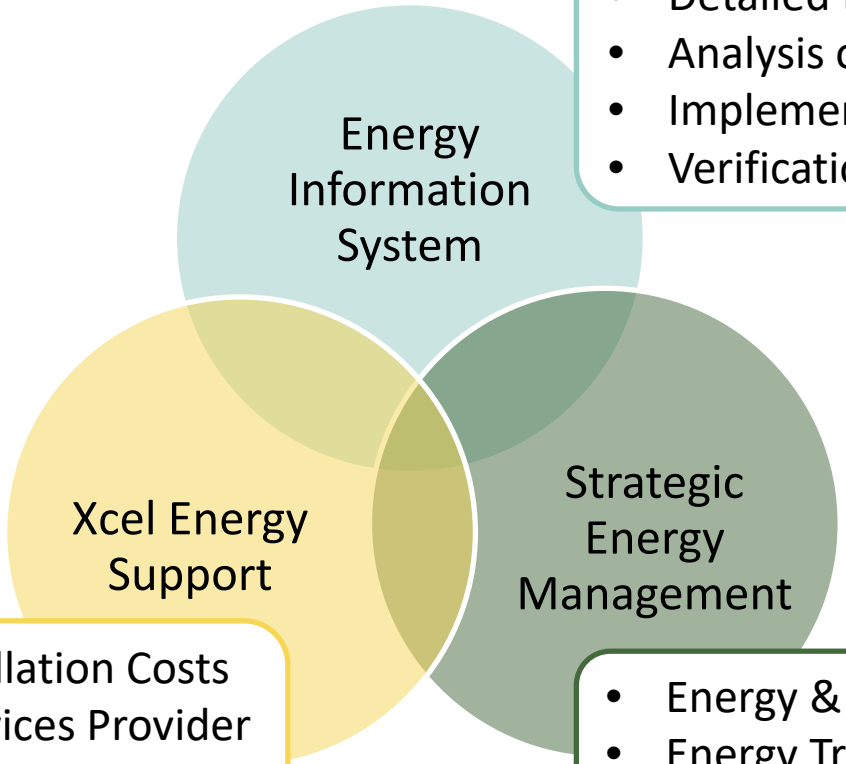
www.nrel.gov

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

EIS PROGRAM

MIKE STANEK, MICHAELS ENERGY

EIS PROGRAM OVERVIEW



- Detailed Energy Tracking
- Analysis of Energy Usage
- Implementation Assistance
- Verification of Savings

- Rebate for EIS Installation Costs
- Trusted Energy Services Provider
- Pre-approved EIS providers
- Incentives for Energy Savings

- Energy & Project Goals
- Energy Training and Prioritization
- Persistence of Savings

PROGRAM OVERVIEW

Year 1	EIS Initial Setup	Measure ID & Treatment	Annual Verification
Year 2	EIS Setup (Improvements)	Treatment & Measure ID	Annual Verification
Year 3	EIS Setup (Improvements)	Treatment & Measure ID	Annual Verification

EIS SETUP

EIS Scoping

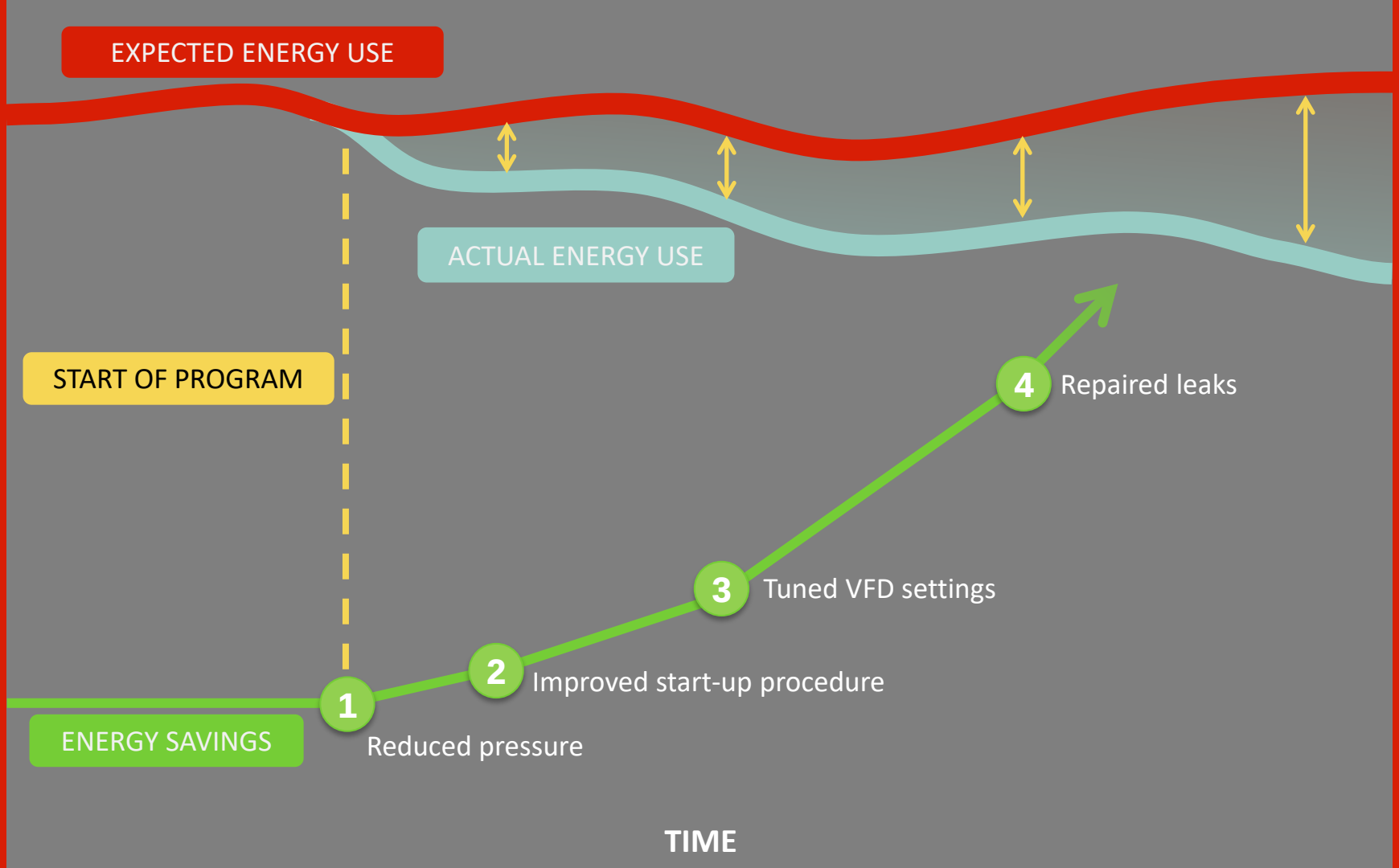
- **1-2 Day Site Visit**
- **Identify:**
  - Short term needs
  - Long term goals
  - Existing metering
  - Metering needs
  - Data collection needs
  - RFP assistance

Meter Plan

- **Document outlining:**
  - Metering/hardware needs
  - Key software needs
  - Xcel Energy minimum reporting needs

Energy Model

- **Baseline Energy Model for use in:**
  - Identifying opportunities
  - Tracking energy performance


EXPECTED ENERGY USE
ACTUAL ENERGY USE
START OF PROGRAM
ENERGY SAVINGS
1
Reduced pressure
2
Improved start-up procedure
3
Tuned VFD settings
4
Repaired leaks
TIME

EIS Installation Incentive

- Up to **30%** of installation cost*

  **Eligible costs include those related to Xcel Energy minimum requirements outlined in meter plan*

  **Incentive cap of $0.0034/kWh*

- After EIS is installed and verified

TREATMENT

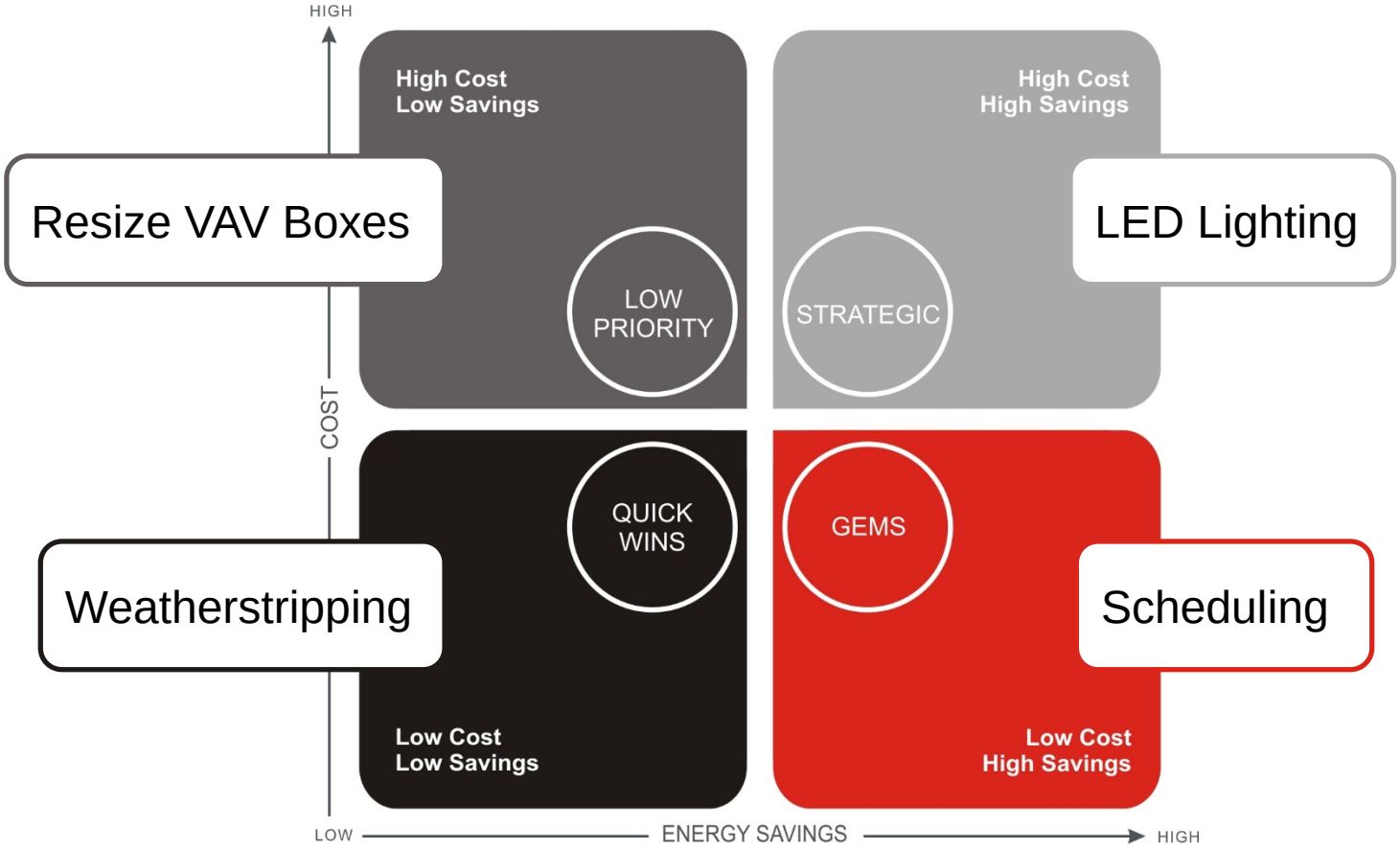
Energy Scan

- **1-3 Day Site Visit to Identify:**
  - Low-/no-cost energy efficiency opportunities
  - Capital measures
  - Energy management best practices

Implementation Support

- **Regular Scheduled Meetings:**
  - Assist w/ implementation of identified measures
  - Support in roll out of energy management best practices

TREATMENT


HIGH
High Cost
Low Savings
High Cost
High Savings
Resize VAV Boxes
LED Lighting
LOW
PRIORITY
STRATEGIC
COST
QUICK
WINS
GEMS
Weatherstripping
Scheduling
Low Cost
Low Savings
Low Cost
High Savings
LOW
ENERGY SAVINGS
HIGH

ANNUAL VERIFICATION

Annual Verification

- **Report outlining:**
  - Energy efficiency opportunities implemented.
  - Implementation costs including:
    - In-house labor
    - Equipment/materials
    - Annual EIS maintenance costs
  - Energy savings achieved

EIS Implementation Incentive

- Up to **$400/kW** or **$4/Dth** saved

  **Subject to Xcel Energy cost effectiveness requirements*

- Behavioral Measures get **$0.02/kWh** after completion of each year

  **Incremental/new savings added in subsequent years*

XCEL ENERGY EIS REQUIREMENTS

Customer Requirements

- Minimum Consumption
  - 4,000,000 Annual kWh Total
- Commitment to Energy Savings

EIS Requirements

- Energy Modeling Capability
  - Built-in
  - Calculated meters
- Tracking Energy Savings
- Data Security
- 15 Minute Interval Data Resolution

PRE-QUALIFIED EIS TOOLS

BuildingLogix
BUILDING SYSTEM OPTIMIZATION

MACH
ENERGY

niagara4

PowerTakeOff

SeaSuite
BETTER RUN BUILDINGS™

SENSEI™

SkySpark

TRANE® BUILDING ADVANTAGE™

INTERESTED?

- Contact your Xcel Energy Account Manager
- Let them know you are interested in the new:

Energy Information Systems (EIS) Program

QUESTIONS

A CUSTOMER SUCCESS STORY

MDF MANUFACTURER

- Leading Manufacturer of Medium Density Fiberboard (MDF)
- Long history of capital energy-saving projects
- Skeptical about finding much energy waste in the operations and maintenance of plant equipment

TWO-PART APPROACH

- Installed Energy Information System (EIS)
  - Tracking energy performance
  - KPIs identify periods of best performance
  - Visibility of daily energy trends

- Kicked off Strategic Energy Management (SEM) program
  - Assigned Energy Champion
  - Executive level support
  - Set aside resources

EIS Components	
Electric Data	1 Utility Meter
Weather Data	Ambient Temp & Relative Humidity
Production Data	Total Plant Output (board feet) Raw material (tons)
Efficiency Metrics	Expected Energy Model kWh/Ton KPIs

"Strategic Energy Management helped us set aside time to give energy efficiency more attention, doing that paid off by reducing our annual energy costs by $588,700."

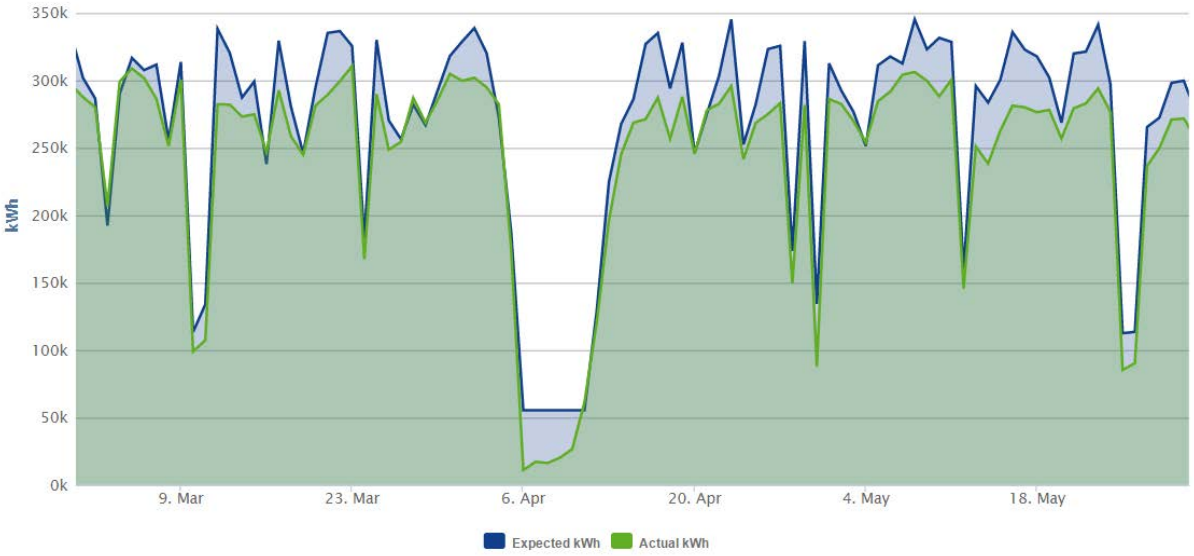
ACTIONS TAKEN - MANAGEMENT

- Adopted and communicated a corporate energy policy
- Set a first-year energy-savings goal of 5 percent
- Designated Energy Champion
- Established an energy team
- Engaged employees in energy-saving actions and tracked progress

“Energy Is Deserving Of Conserving”

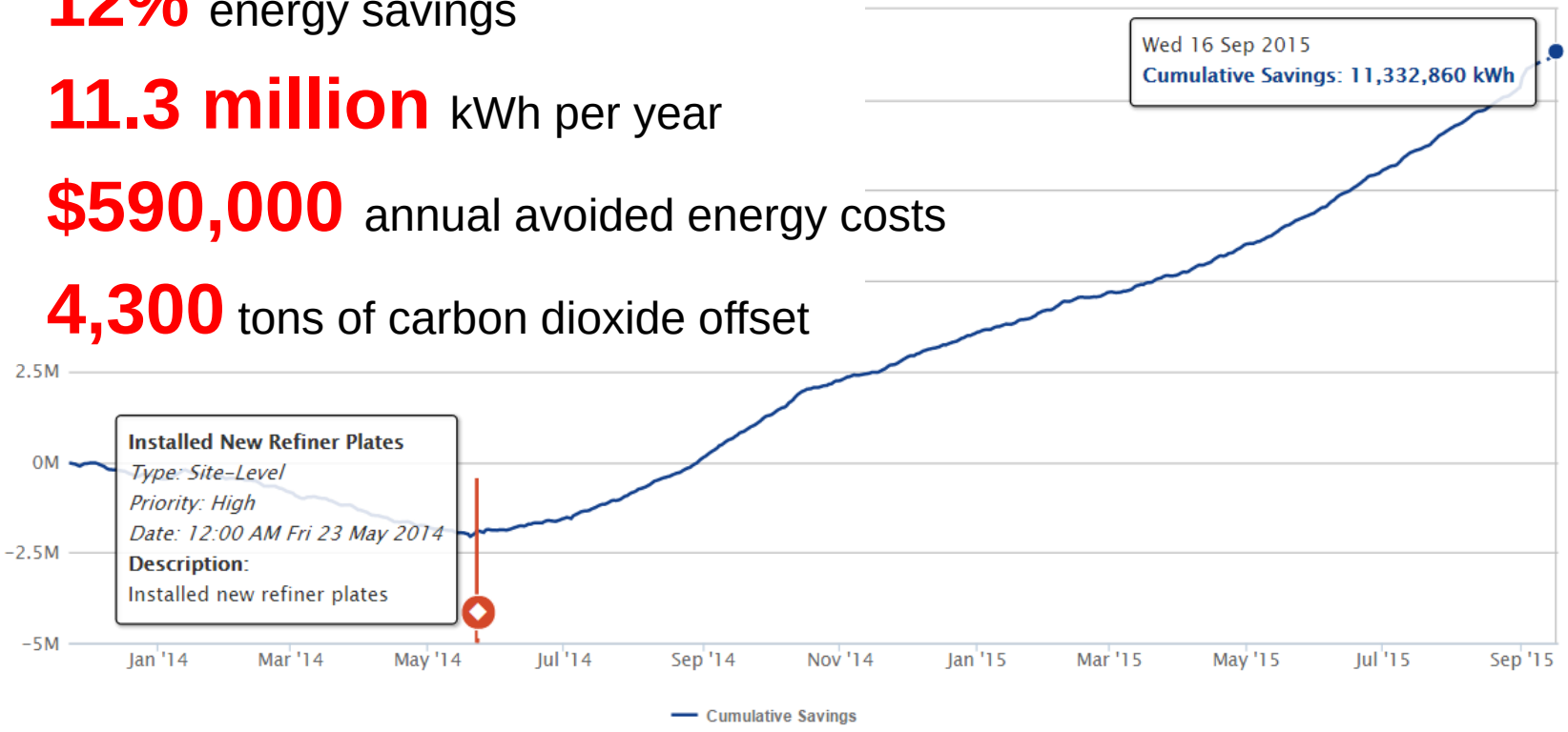
ACTIONS TAKEN – O&M

- Replaced 54-inch refiner plates with 50-inch plates
- Increased water injection rate on refiner plates
- Adjusted equipment schedules to minimize idle operation



RESULTS/SAVINGS

- **12%** energy savings
- **11.3 million** kWh per year
- **$590,000** annual avoided energy costs
- **4,300** tons of carbon dioxide offset



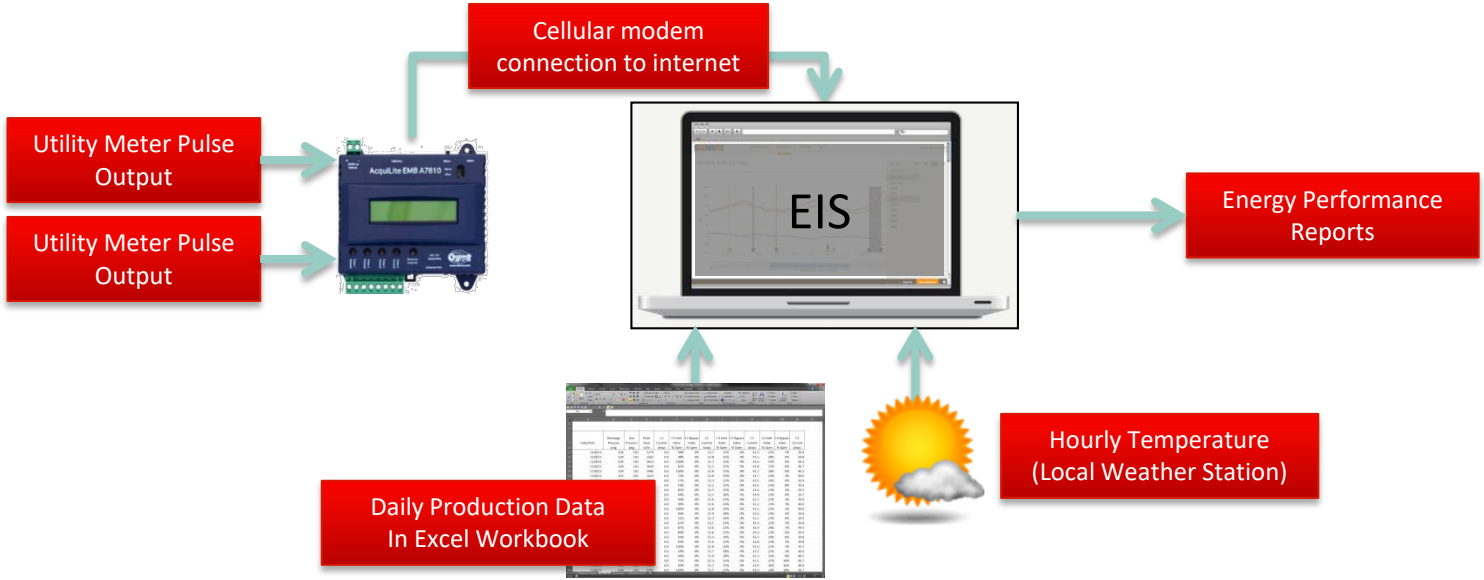
Xcel Energy®

RESPONSIBLE BY NATURE®

EIS Examples

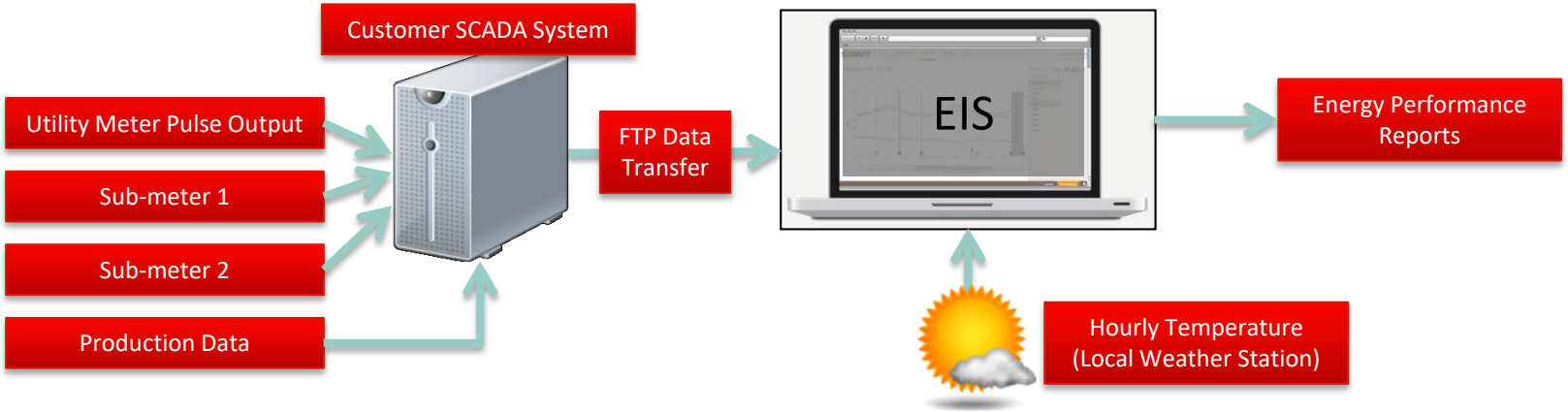
EIS EXAMPLE A - SIMPLE

- Pulse output from the utility meter (x2)
- Cellular transmission of pulse data to EIS
- Manual upload of production data
- Automatic upload of weather data
- Real time monitoring of energy savings



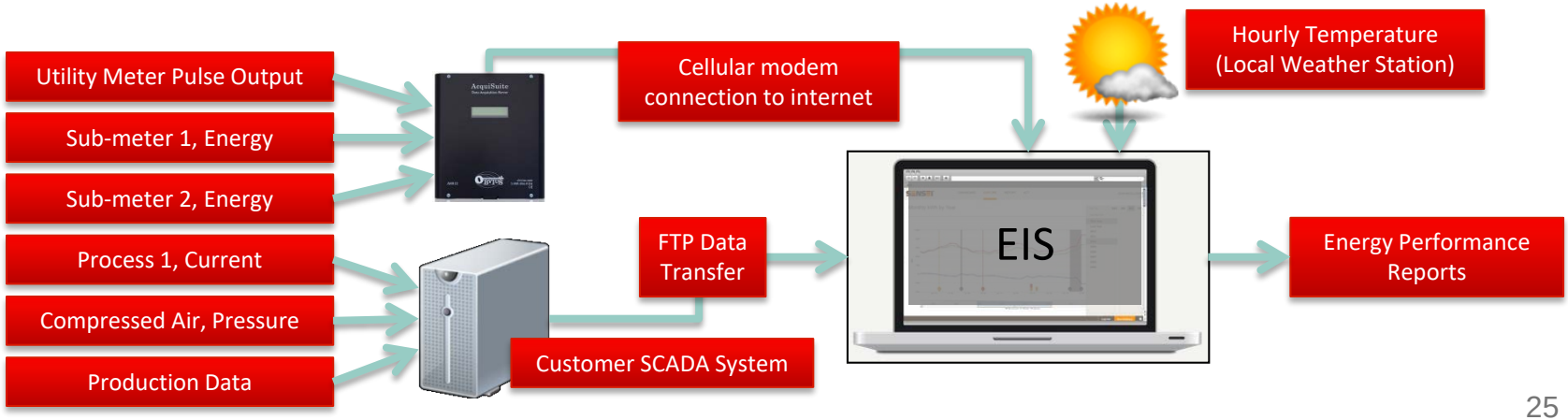
EIS EXAMPLE B – MODERATELY COMPLEX

- Pulse output from the utility meter (x2)
- Cellular transmission of pulse data to EIS
- Manual upload of production data
- FTP transfer of data from SCADA to EIS
- Automatic upload of weather data
- Real time monitoring of energy savings



EIS EXAMPLE C - COMPLEX

- Pulse output - facility's power meter (x2)
- Energy use from sub-meters and key process variables
- Cellular transmission of pulse and sub-meter data
- Upgrade SCADA system to trend new points
- FTP data transfer from SCADA to EIS
- Automatic upload of weather data
- Real time monitoring of energy savings



EIS EXAMPLES

	Example A	Example B	Example C
Setup ($)	$10,000	$17,000	$27,500
Maintenance Expense ($/yr)	$2,550	$3,300	$3,900
*Estimated 6-year Expense	$25,300	$36,800	$50,900
Estimated Energy Savings Potential (kWh/yr)	770,000	525,000	1,300,000
EIS Cost ($/kWh)	$0.03	$0.07	$0.04
Energy Metering Points	2	2	3
Analog Metering Points	0	3	8
Auto Production Import	No	Yes	Yes
Auto-Weather Import	Yes	Yes	Yes
Method of File Transfer	Cellular	FTP	FTP/Cellular
Predictive Energy Model (IPMVP Option C)	Yes	Yes	Yes
Integrated Action Item Tracking	Yes	Yes	Yes
Complexity Rating	Simple	Moderate	Complex

*Typically an additional 1 year of maintenance expense is incurred in the baseline or set-up period