



Energy Analytics

CASDEM Thurs 2019-05-02

Brad Queen

Cube Resources

Office: 303-247-1187

Cell: 303-520-3090

<http://www.cuberresources.com/>

Motivations & Goals



- Engage staff
- Maximize energy productivity
 - Comfort
 - Utilization
- Reduce energy costs
 - Demand
 - Energy
- Improve service
- Reduce labor costs & stress
- Engage students & community
- Inform management
- Emissions reductions
- Procedures
- Automation
- Fault detection
- Behavior
- Education

Right Information, People, Time



Technology is not process

“Data” is not “Information”

- Energy manager
- Building occupants (behavioral feedback)
 - Competitions
- Programmers
- Facility managers / Custodians
- Retrofit project M&V
- Re-commissioning project M&V
- Don't create **information noise**
(Alerts vs. Dashboards vs. Reporting and Prioritization & Plans)

Portfolios



- 107 school data tables, and growing
 - Jeffco
 - Saint Vrain
 - ReNew Our Schools & Colorado Energy Office
 - NREL
- 300+ eGauge sites, and growing
 - Includes APS
 - Smart Meters

Site	Read-only e	Portfolio	Type	BCEIOF, RNC	kW of Solar	Population	Square Feet	Weather	Calendar
Pueblo West HS	http://eGauge428	Pueblo 70	H	RNOS 2019 Spring			228,810	KPUB	
Vineland Elementary	http://eGauge428	Pueblo 70	E	RNOS 2019 Spring			42,193	KPUB	
Vineland Middle School	http://eGauge428	Pueblo 70	M	RNOS 2019 Spring			53,351	KPUB	
Coronado Hills Elementary	http://eGauge444	Adams 12	E	1	527	71,842			Adams 12
East HS, Low Voltage &	http://eGauge435	DPS remote	R	3	2,471				
Haxtun HS	http://eGauge444	Haxtun	H	2	244				Haxtun
Longmont Christian School	http://lcschool.ec	LCS	H	2	257				
Northwest Magnet High Sch	http://eGauge394	Omaha	H	3	1,718				
Oakwood Elementary School	http://eGauge435	Oakwood	E	1	305				
Oakwood Secondary School	http://eGauge435	Oakwood	H	2	806				Oakwood
South HS low voltage	http://eGauge435	DPS remote	R	3	1,600	323,143			DPS
STEM Lab	http://eGauge444	Adams 12	K8	2	559				Adams 12
Westgate Community Scho	http://eGauge435	Adams 12 Charter	H	2	512				Westgate
Altona MS	http://sv-alton-m	SVVSD	M	RW2018,			120,369	KLMO	SVVSD
Burlington ES	http://sv-burli-e.e	SVVSD	E	RW2018,			47,200	KLMO	SVVSD
Cool Ridge MS	http://sv-cool-r	SVVSD	M	RW2018,			120,369	KLMO	SVVSD

Site Parameters and Attributes



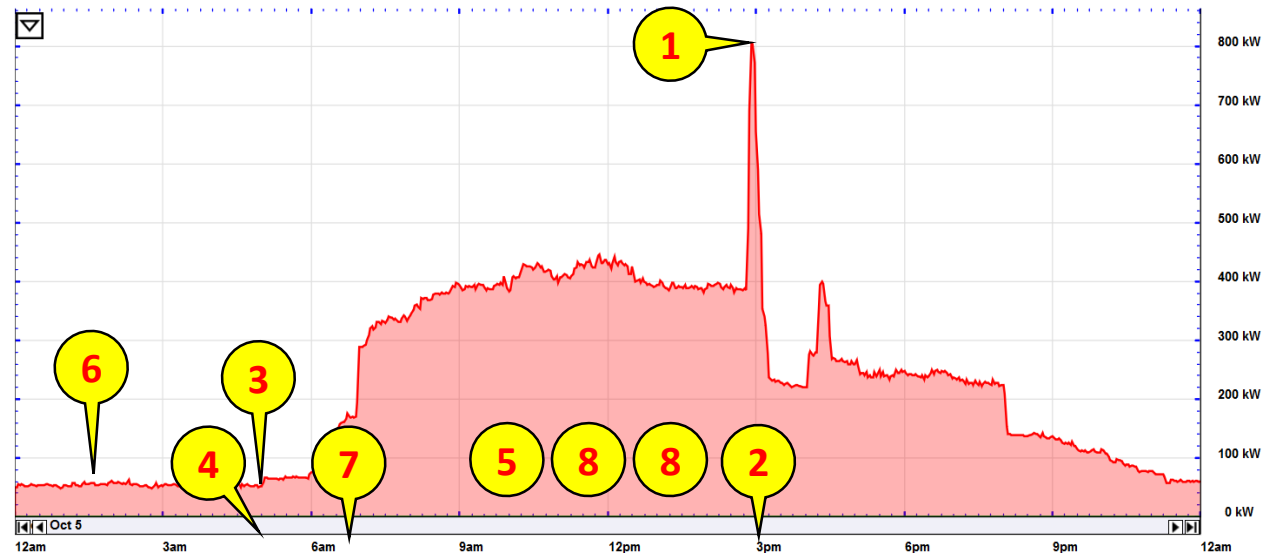
- Interval data (eGauge)
 - Bias
- Weather station
- District calendar
- Billing history
- Portfolio (District)
- Type (Elementary, Middle, High School, Admin)
- Square footage
- Vintage
- Feeder voltage (internal step-down transformers)
- **Twin buildings**
- Number & movement of portables
- **Utilization**
- Renovations, Expansions
- Recommissioning
- Utility rate class
- Solar capacity
- Population
- Competition or project group

Data Processing



- Joining data tables for energy/power, weather station, calendar
- Official system for each data source (data entry effort correction)
- API calls & data pushes
- Caching in cloud (available when school/eGauge is offline)
- Weather normalization
- KPI calculation and storage
- Discarding high frequency data
- Removing unscheduled closures (district or site), overrides, outages, faults
- Adjusting baselines or current measurements
- Scatter
- Rendering sites and portfolios
- Portfolio analysis via grouping, normalization, trending, etc.
- Cross-portfolio analysis

Load Profile Opportunities



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

Key Performance Indicators



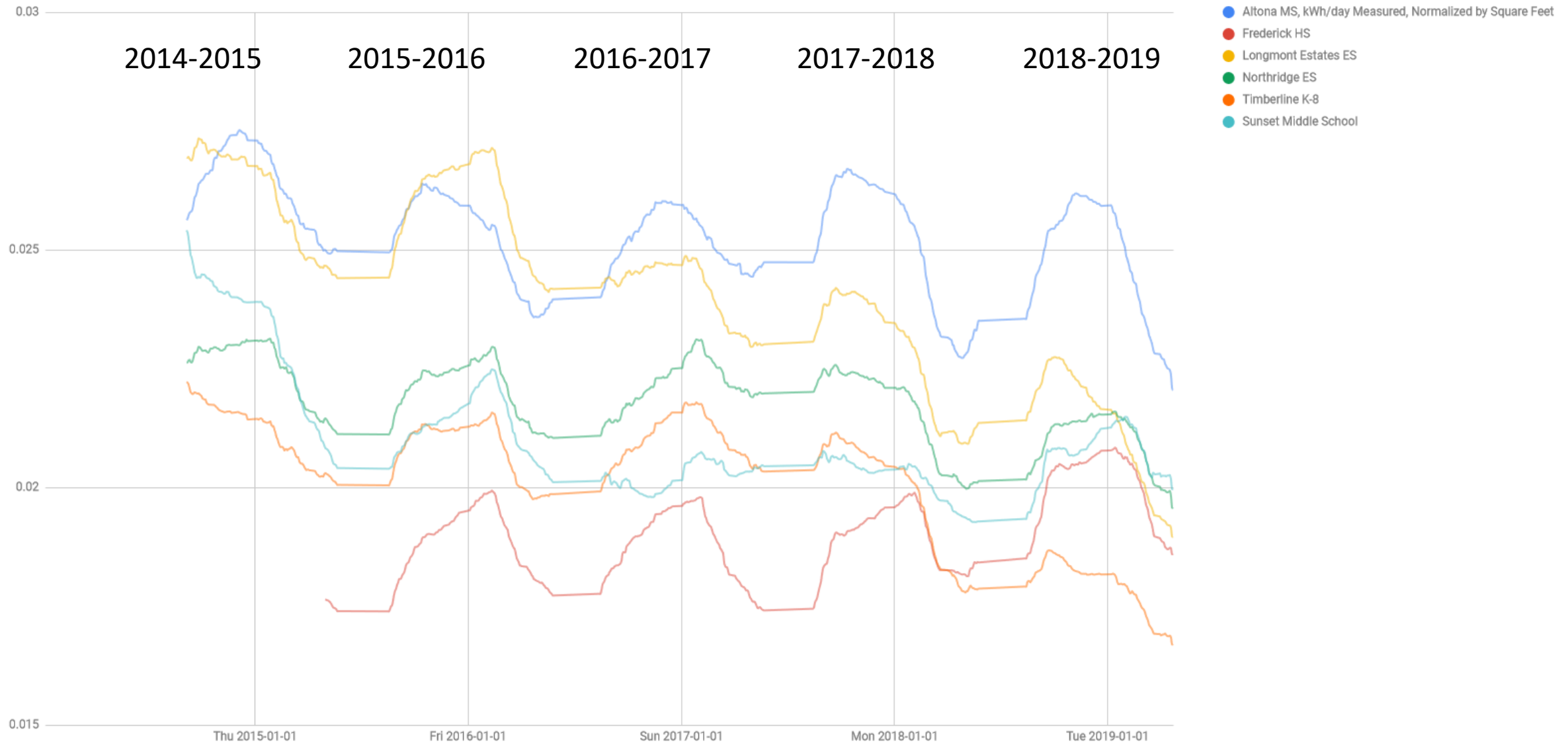
- Baseline, Nominal
- Baseline, Adjusted
- kWh/day, Measured
- kWh/day, Adjusted
- Delta
- kWh Decrease
- kWh Increase
- Peak load
- Peak time
- Minimum load
- Minimum time
- 12:00 to 1:00am
- Start-up time
- Load factor
- Significance
- Hours > 200% Base

Behavioral Conservation since 2011



Adjustable color code	Altona Middle	Burlington Elementary	Coal Ridge Middle	Eagle Crest Elementary	Erie High	Erie Middle School	Frederick High	Longmont Estates Elementary	Niwot Elementary	Northridge Elementary	Sunset Middle School	Timberline K-8	WestView Middle School		
-2,000	500														
-1,000	100	http://sv-s	http://sv-b	http://sv-c	http://sv-e	http://sv-e	http://sv-f	http://sv-l	http://sv-r	http://sv-r	http://sv-s	http://sv-t	http://sv-v	eGauge	
-100		http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	http://cub	Dashboard	
Prior to Resource Wise														Totals	
October 2018	-718	281	1,086	-2,376	318	-3,444	4,447	-3,601	-304	-1,447	-888	-11,786	-2,923	-21,355	kWh
Resource Wise Savings months														Totals	
(Savings are negative values, Excess Use are positive values)															
November 2018	-2,750	77	-1,280	-1,457	-6,306	-2,133	4,171	-3,974	-747	-1,620	157	-9,709	-2,986	-28,558	kWh
February 2019	-996	555	-4,155	-1,207	-4,521	-1,645	5,012	-2,837	-1,867	-1,942	-1,385	-6,241	-1,595	-22,824	kWh
March 2019	-3,325	356	932	-1,722	-6,539	-1,794	2,613	-2,608	-1,536	-2,712	1,117	-7,114	-2,773	-25,104	kWh
April 2019	-7,052	-383	-2,719	-1,947	-4,692	-6,340	3,656	-4,023	-2,427	-1,592	-201	-9,348	-3,926	-40,994	kWh
\$0.10 Rate for shared savings														Totals	
(Savings are positive values)															
November 2018	\$275		\$128	\$146	\$631	\$213		\$397	\$75	\$162		\$971	\$299	\$3,296	
February 2019	\$100		\$416	\$121	\$452	\$165		\$284	\$187	\$194	\$138	\$624	\$160	\$2,839	
March 2019	\$332			\$172	\$654	\$179		\$261	\$154	\$271		\$711	\$277	\$3,012	
April 2019	\$705	\$38	\$272	\$195	\$469	\$634		\$402	\$243	\$159	\$20	\$935	\$393	\$4,465	
	\$1,412	\$38	\$816	\$633	\$2,206	\$1,191	\$0	\$1,344	\$658	\$787	\$159	\$3,241	\$1,128	\$13,613	
Adjustable color code	Altona Middle	Burlington Elementary	Coal Ridge Middle	Eagle Crest Elementary	Erie High	Erie Middle School	Frederick High	Longmont Estates Elementary	Niwot Elementary	Northridge Elementary	Sunset Middle School	Timberline K-8	WestView Middle School		
-15%	10%														
-10%	5%														
-5%															
Resource Wise Savings months														Average	
(Savings are negative values, Excess Use are positive values)															
November 2018	-4.7%	0.4%	-1.8%	-4.5%	-6.3%	-3.5%	5.3%	-17.9%	-3.5%	-7.8%	0.4%	-15.3%	-5.9%	-5.0%	
February 2019	-1.7%	2.7%	-6.1%	-3.6%	-4.3%	-2.6%	6.1%	-12.4%	-8.1%	-8.9%	-3.4%	-9.5%	-3.1%	-4.2%	
March 2019	-6.2%	1.9%	1.4%	-5.7%	-6.8%	-3.1%	3.6%	-12.5%	-7.7%	-14.0%	3.1%	-12.2%	-5.9%	-4.9%	
April 2019	-10.8%	-1.8%	-3.7%	-5.9%	-4.9%	-10.5%	4.3%	-17.3%	-10.5%	-7.6%	-0.5%	-13.9%	-7.3%	-7.0%	

kWh/day/sqft, 100 Weekday-Only Moving Average

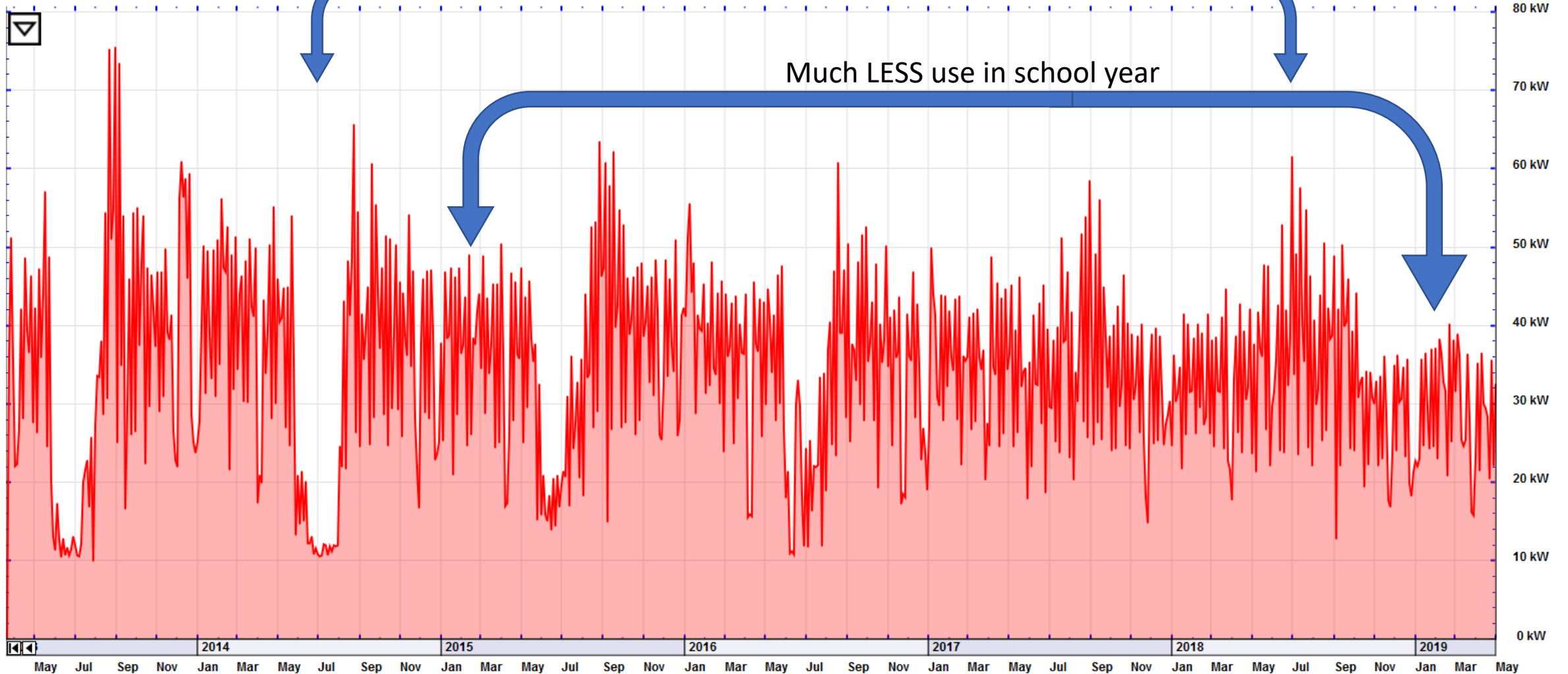


Raw Data <http://sv-longm-e.egaug.es/>

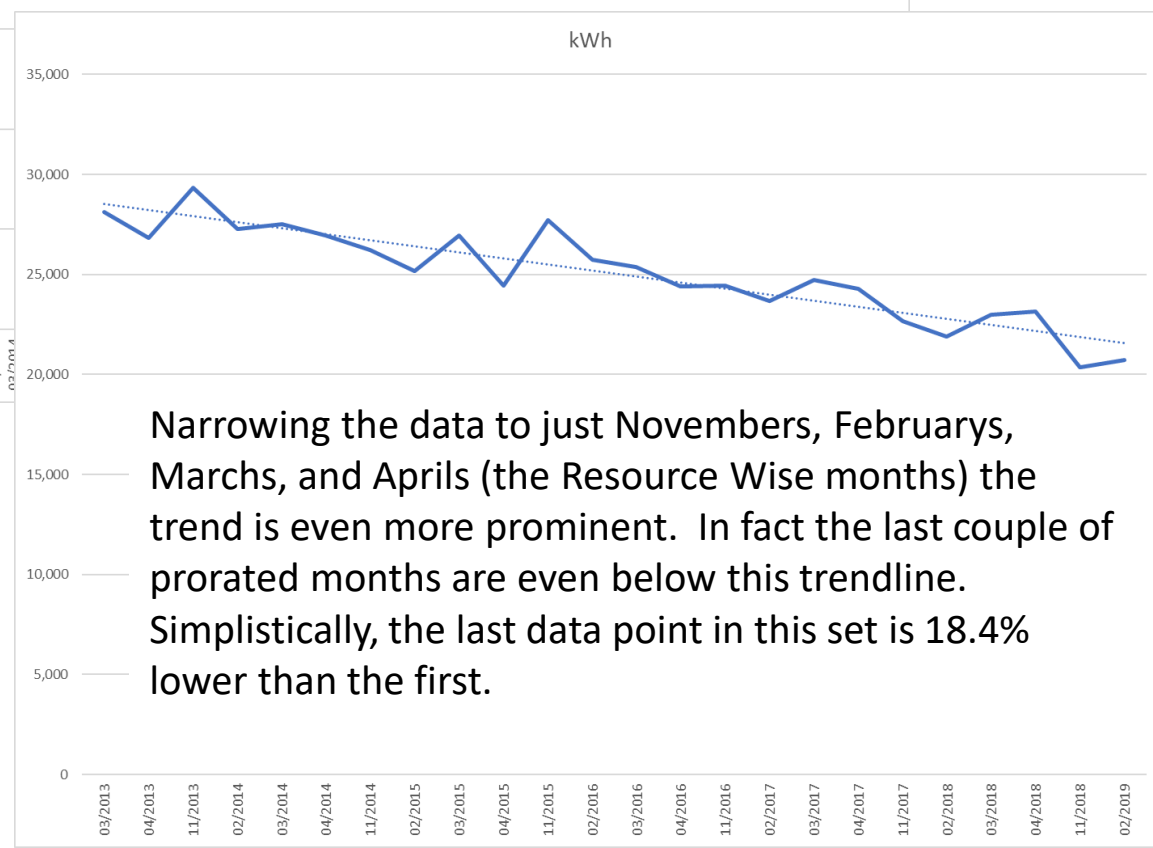
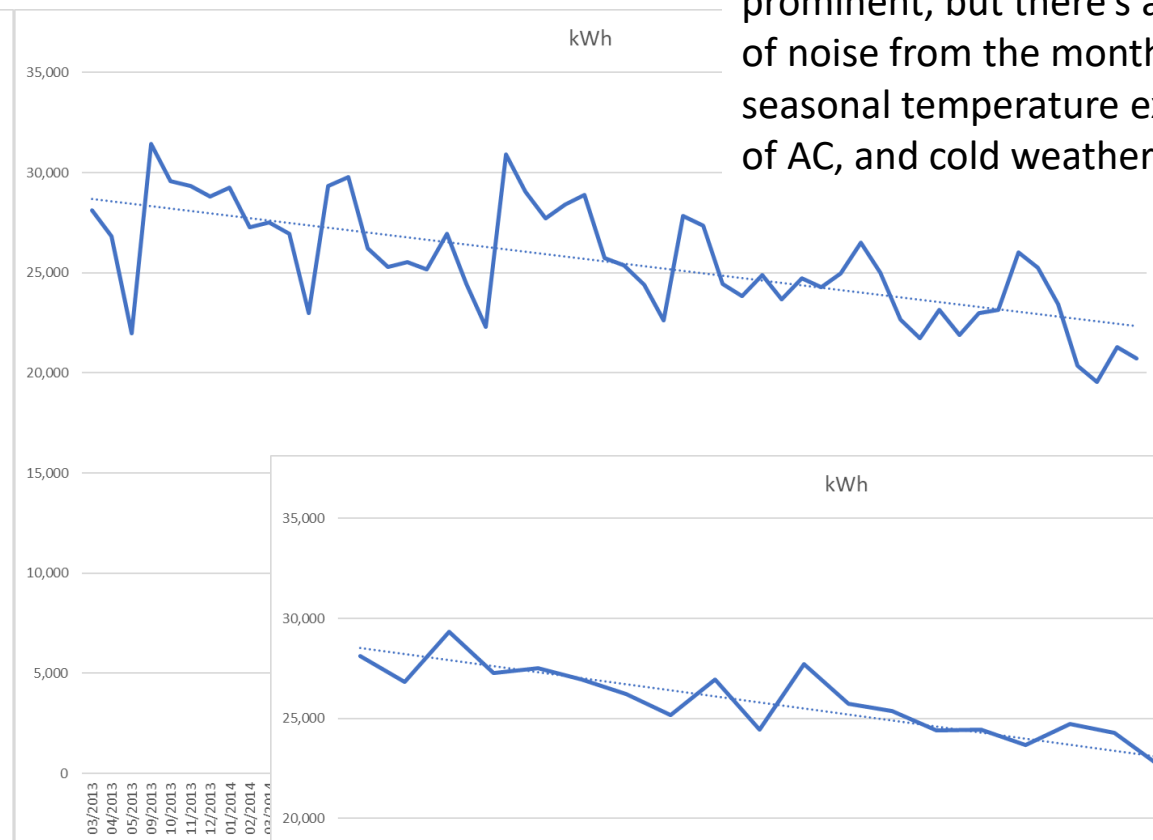
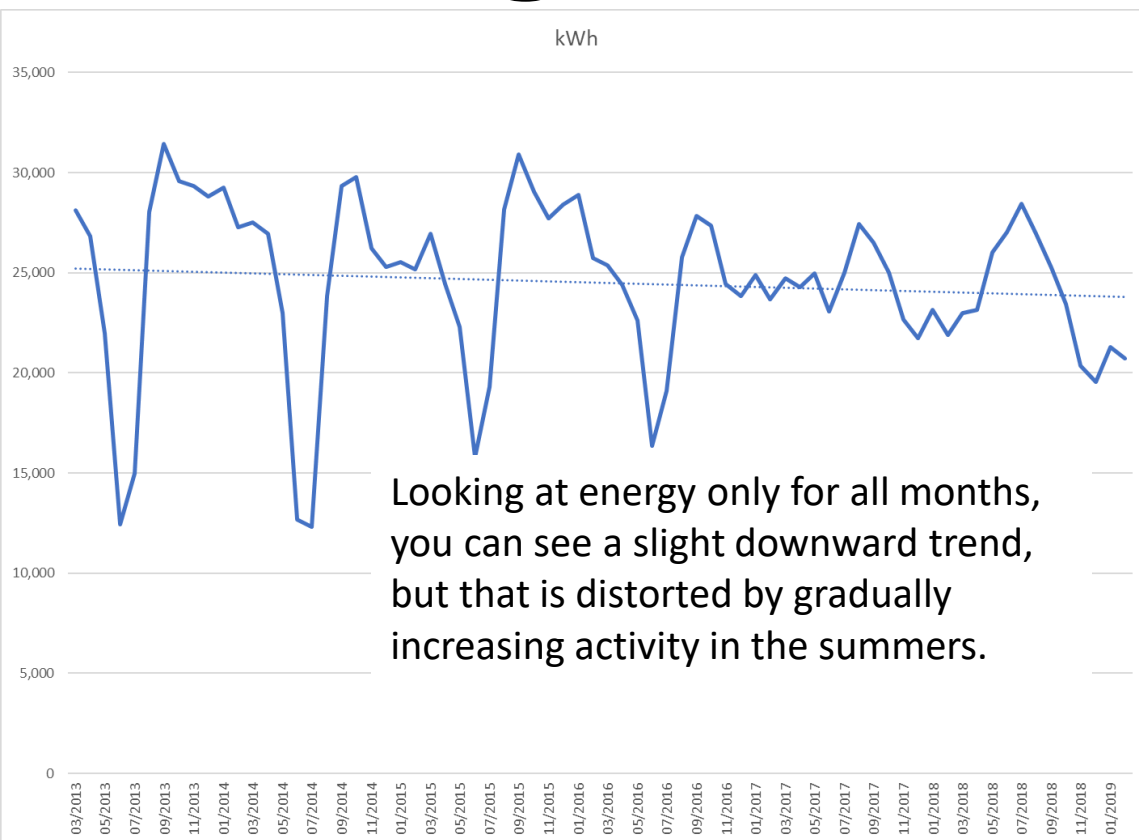


Much MORE use in summers

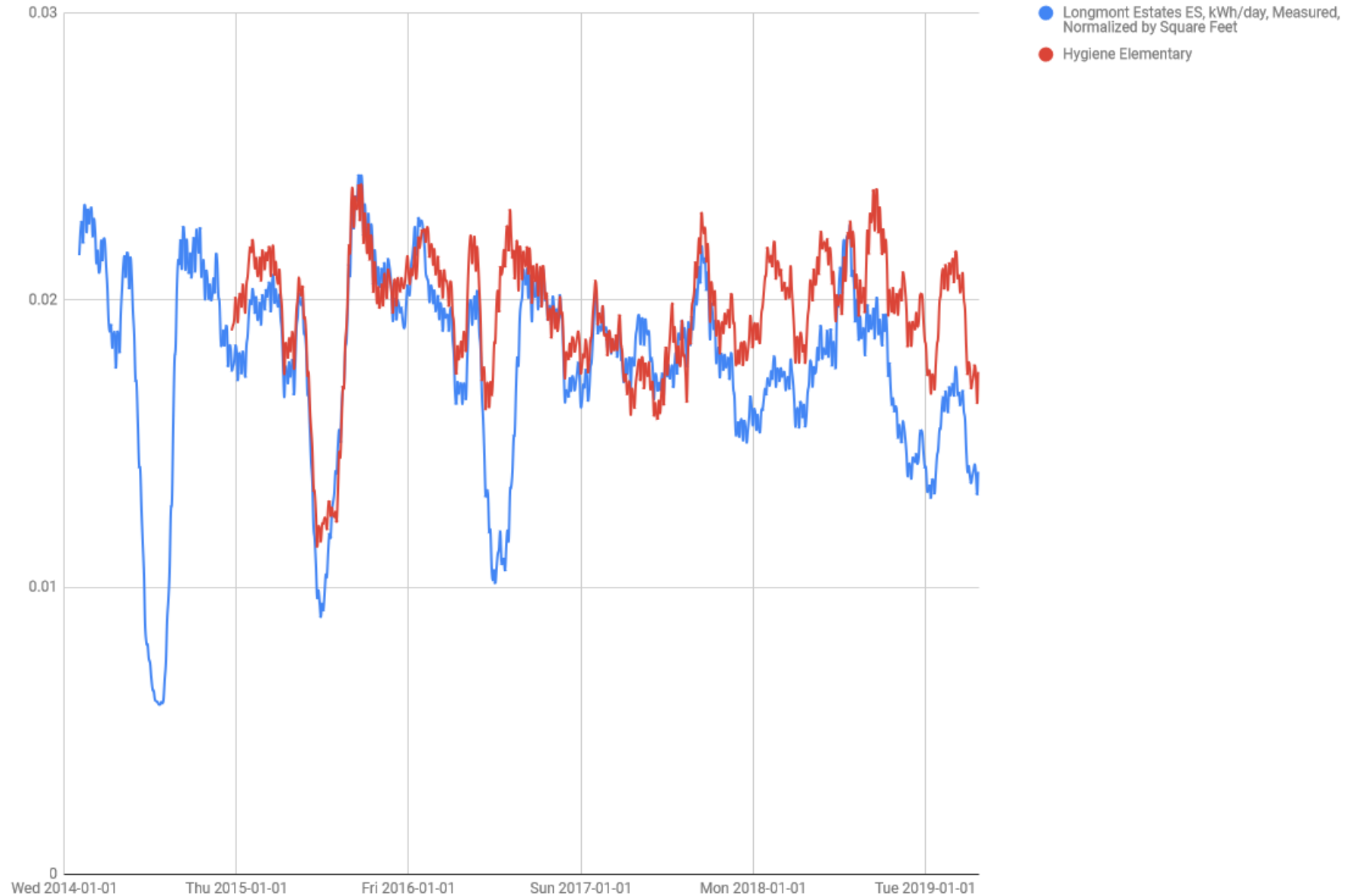
Much LESS use in school year



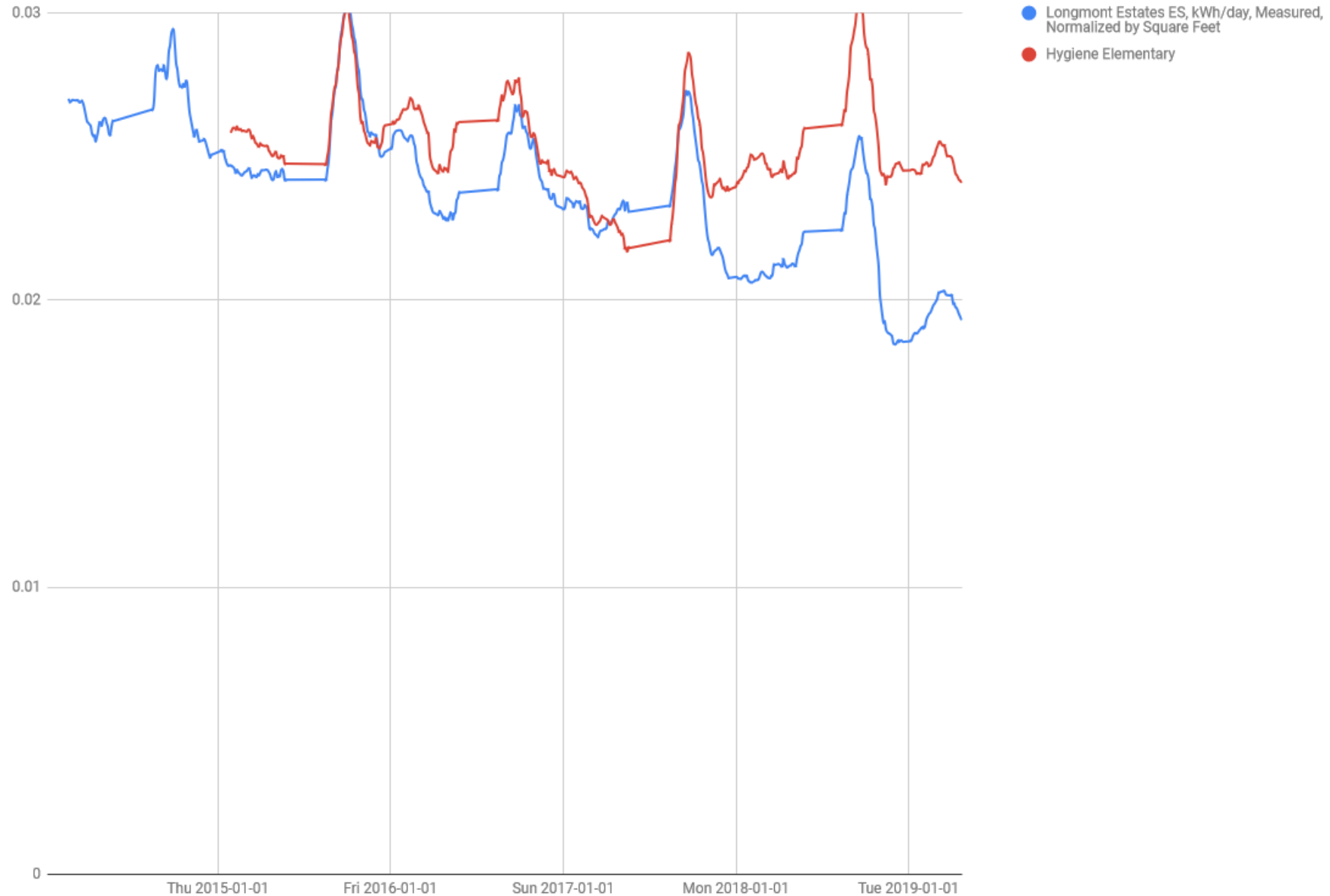
Billing Data



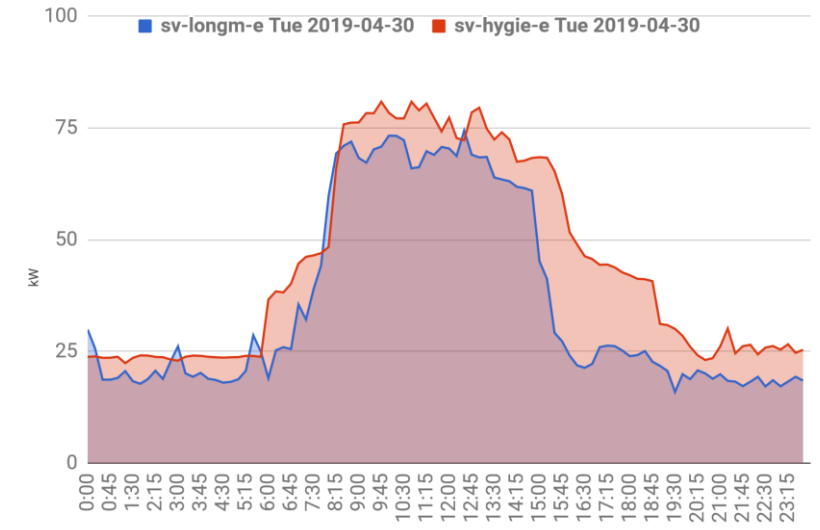
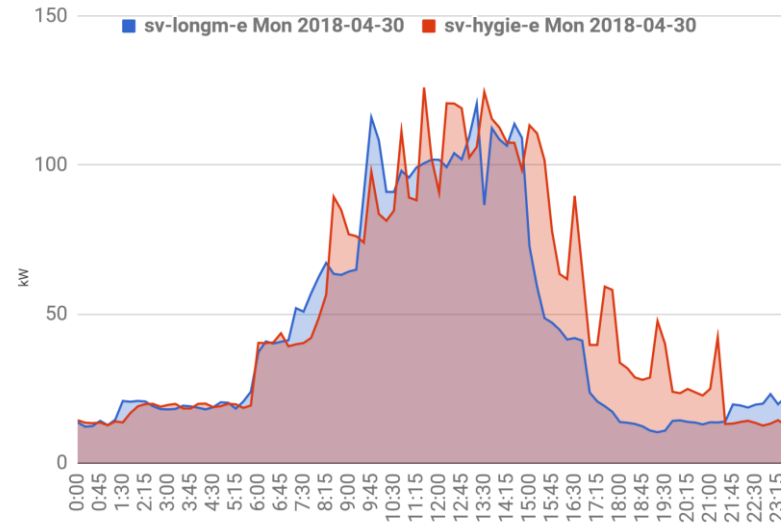
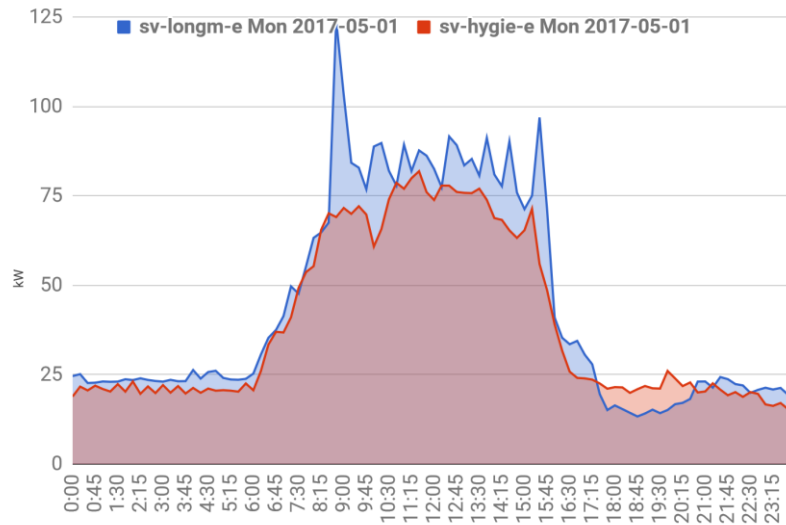
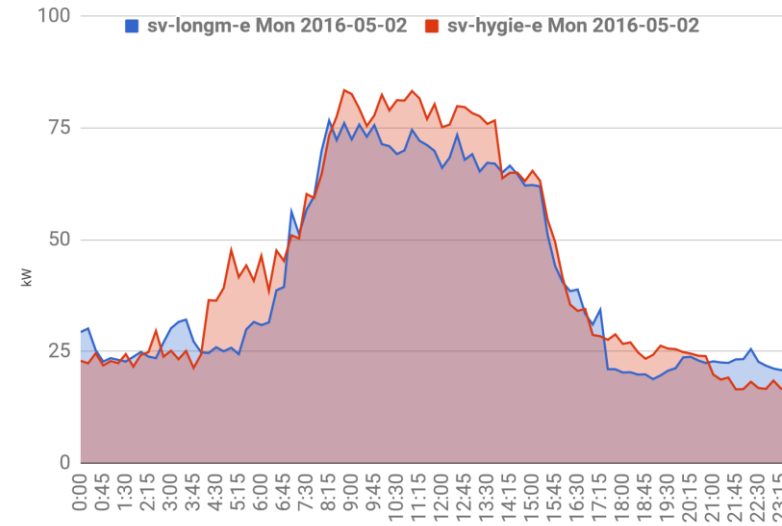
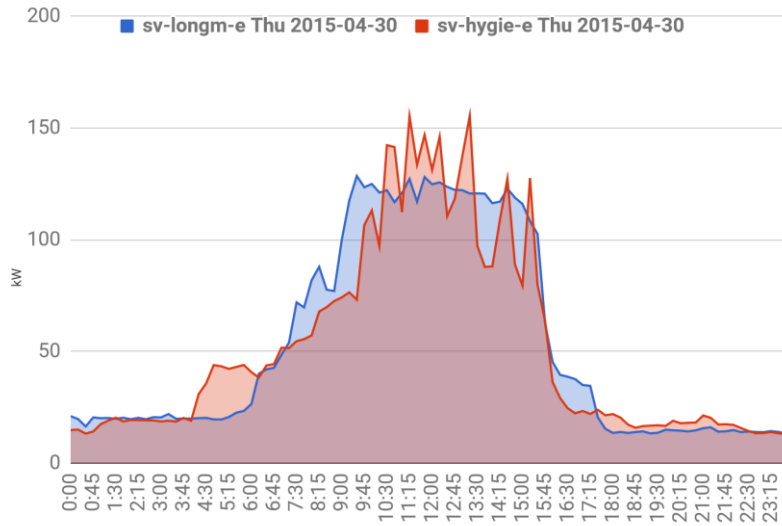
Comparing Twins



Comparing Only Full School Days



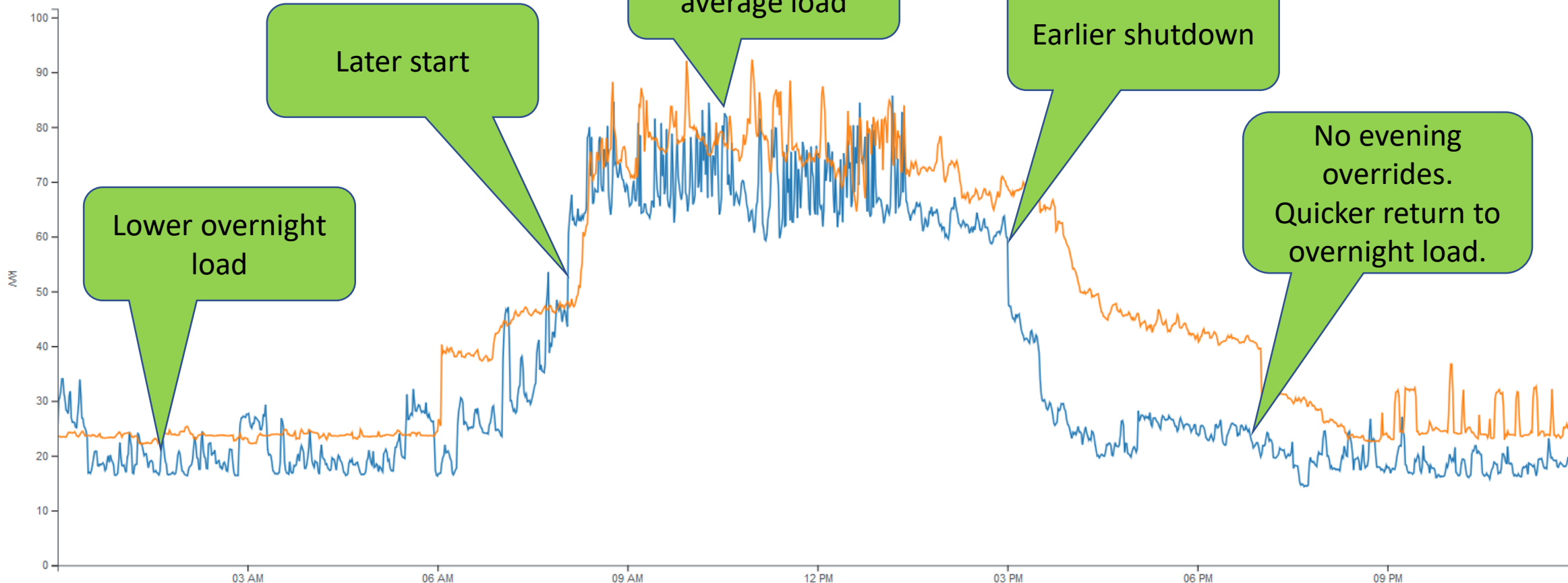
Twin Schools Compared





Twin Schools Compared

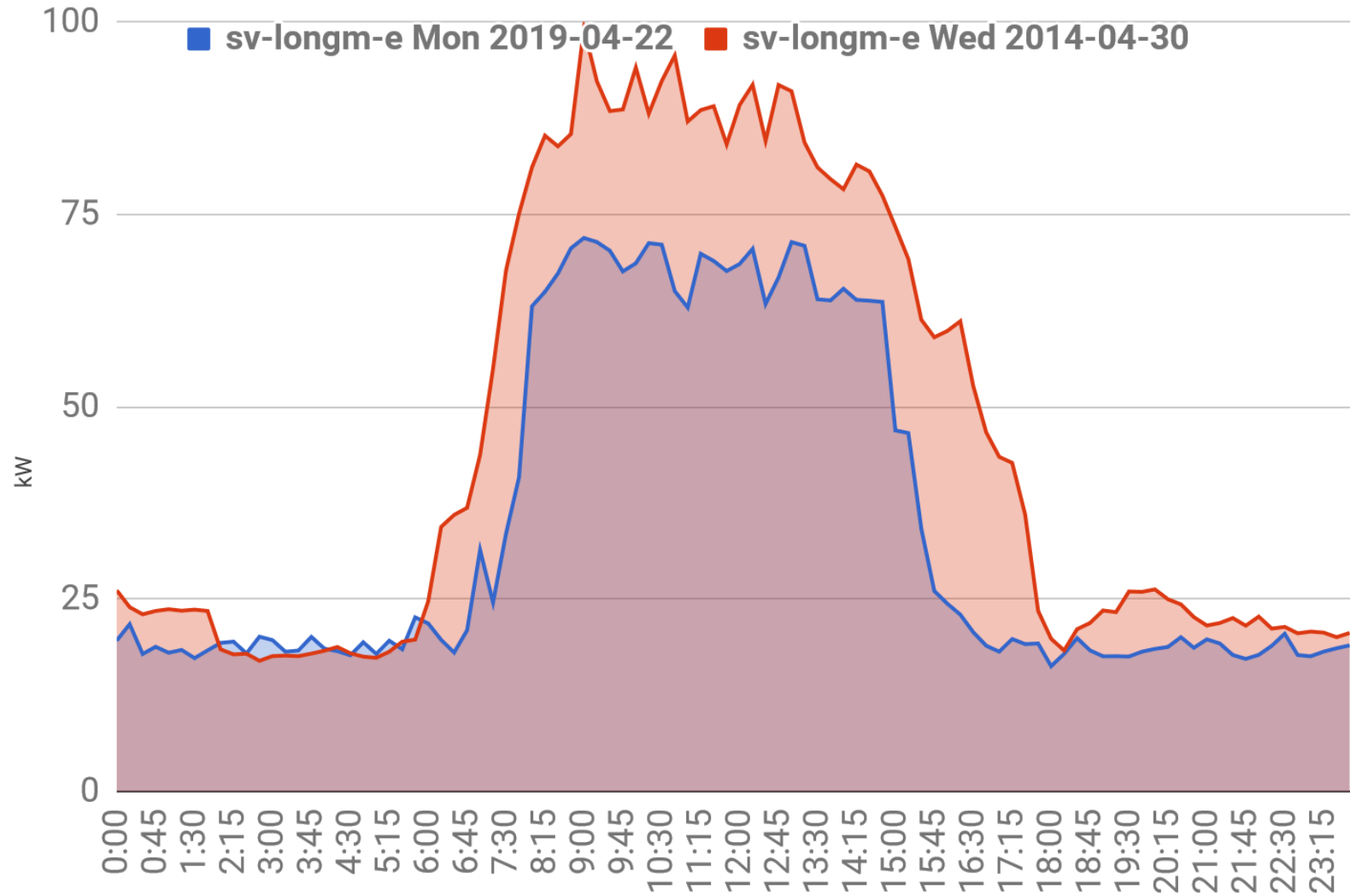


Load Profile Comparisons

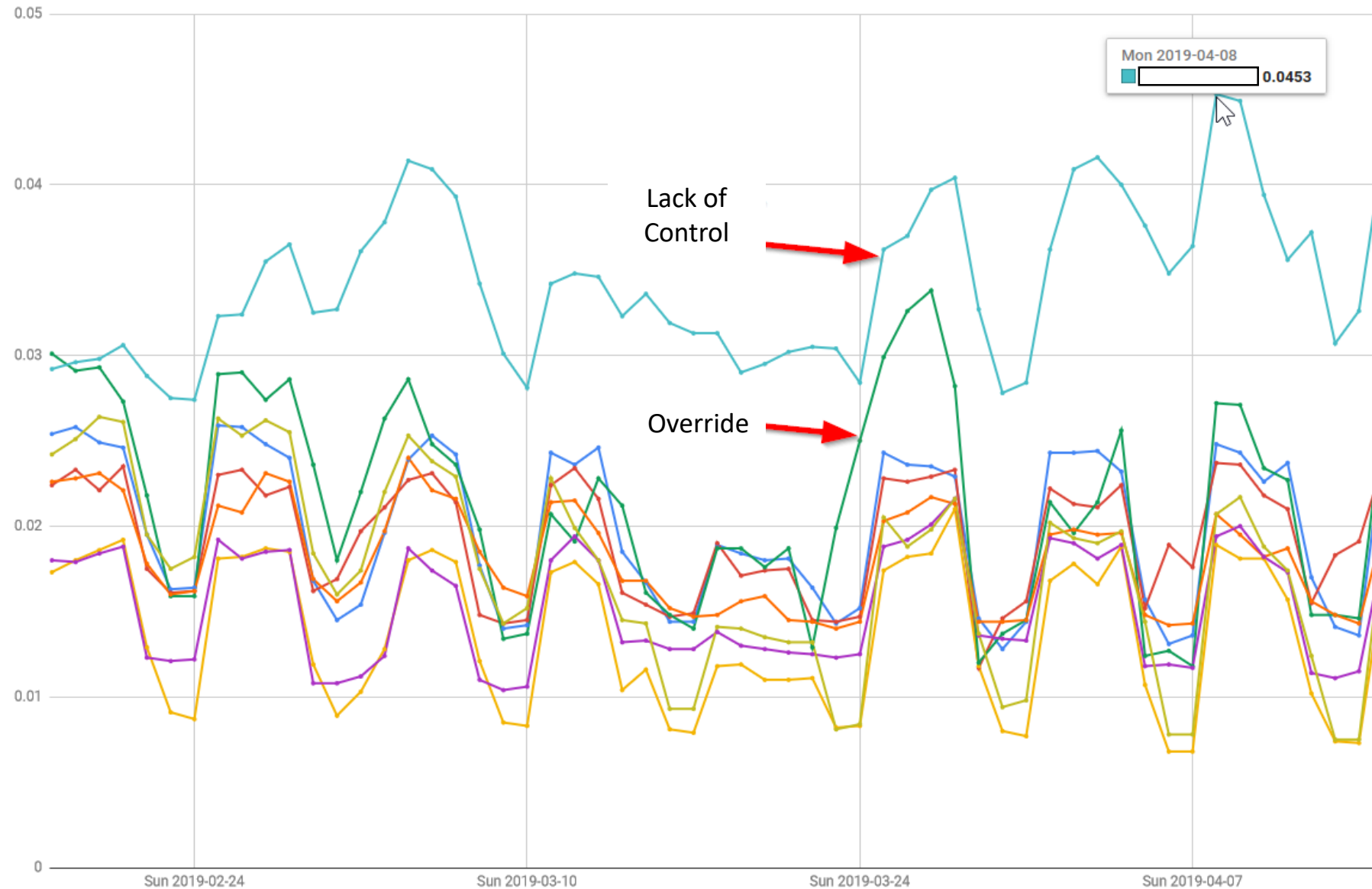


Site	Date	Time	Use (kW)	Min (kW)	Max (kW)	Total (kWh)	Load Factor
 SV-Longm-E	Tue 2019-04-30			14.4	85.7	865	.42
 SV-Hygie-E	Tue 2019-04-30			22.1	92.3	1,077	.49
				-7.7	-6.6	-213	0.07

Same School, Same Average °F, 5 Years Apart



Portfolio Comparisons (kWh/day/sqft)



Cross-Portfolio Comparisons (kWh/day/sqft)



14 High Schools
across front range

