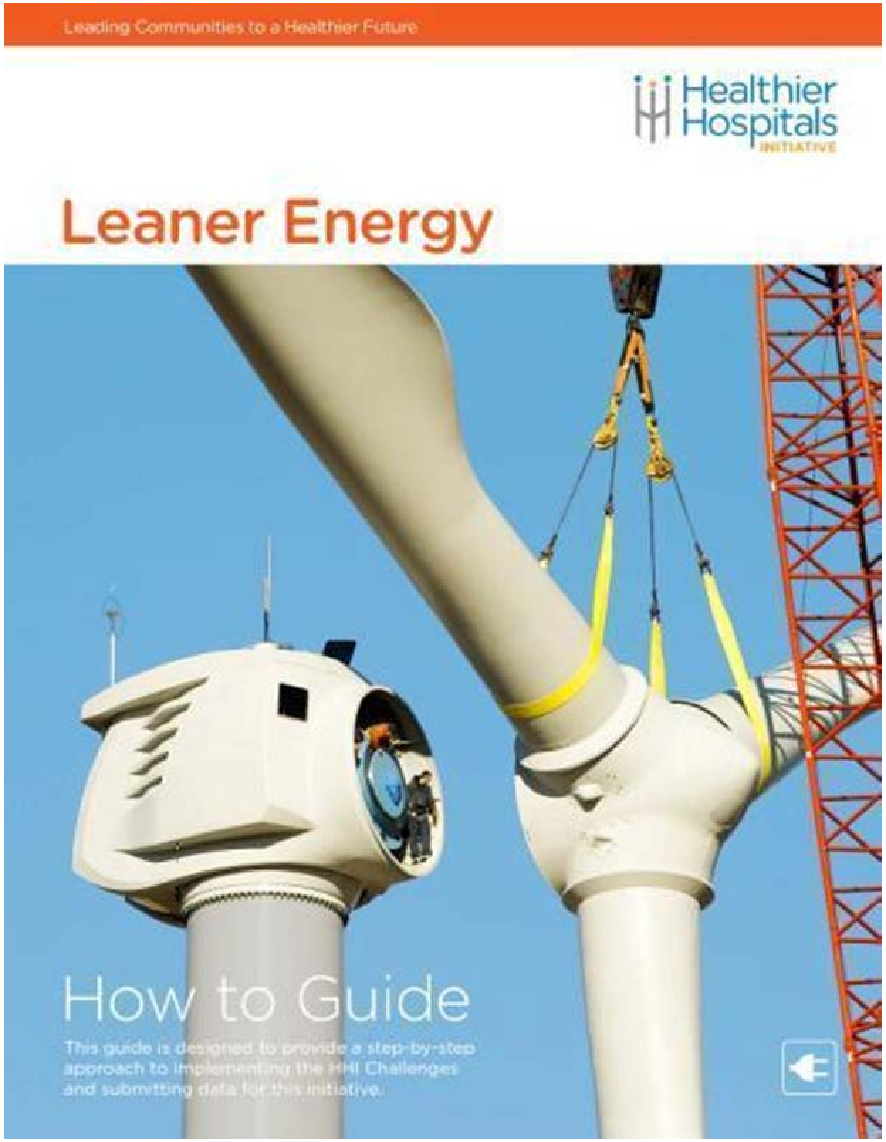


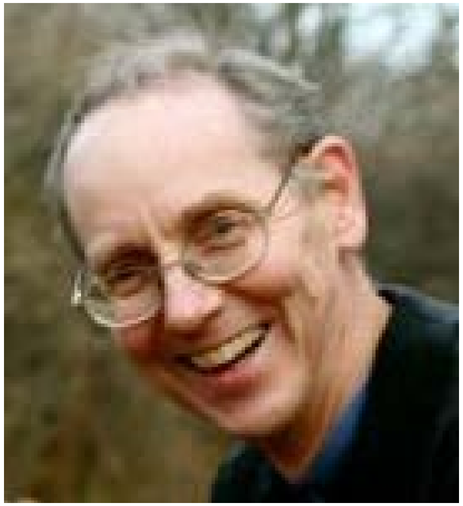
Healthier Hospitals INITIATIVE

LINKING QUALITY IMPROVEMENT AND LEANER ENERGY USE

Sharing Call Series for Quality Community--Part 3

27 March 2014

Presenters



Kevin Little
Principal
Informing Ecological
Design, LLC
IHI Improvement Advisor

Blair L. Sadler
Past President
Rady Children's Hospital
San Diego
Senior Fellow, IHI

Agenda

1. Context for our call series
2. Assignment Review
3. 30-Minute data application
4. Daily Data: control and improvement in complex buildings
5. How QI Experts can make a difference
6. What's next
7. Resources and References
8. Appendices: 1-Electric Demand; 2-Data Types

1. CONTEXT FOR OUR CALL SERIES

Our premise

- The Leaner Energy challenge requires benchmarking, monitoring, and improvement
- Facilities and sustainability managers may be challenged by these "QI" fundamentals
- QI specialists have relevant skills and understanding
- Collaboration between groups can repay itself multiple times in better environmental performance

Healthier Hospitals INITIATIVE

Leaner Energy

Level 1	Level 2	Level 3
Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by <u>three</u> percent from baseline.	Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by <u>five</u> percent from baseline.	Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by <u>ten</u> percent from baseline OR if facility is already an ENERGY STAR rated facility (> 75), maintain ES status.

Baseline: Input energy data into ENERGY STAR Portfolio Manager to track energy use and GHG emissions

Level 1 – 3% reduction

Level 2 – 5% reduction

Level 3 – 10% reduction (or >75 ES)

This Webinar Series

Session	Date	Topics
1	27 Feb 2014	Healthier Hospitals Initiative; Gundersen Health Example; Leaner Energy Challenge explained; Assignments
2	13 Mar 2014	Modeling energy use in buildings using monthly data; Assignment: try your hand on practice data or your own building's data
3	27 Mar 2014	Review of Assignment; 15-minute energy use and daily energy use: applications; Partnering with facilities/sustainability colleagues

2. ASSIGNMENT REVIEW

Method to Check Whole Building Changes in Energy Use

1. Get the right data.
2. Set a baseline period.
3. Plot the data to understand patterns and unusual values.
4. Model the energy use as a function of mean temperature or degree days.
5. Predict the energy use beyond the baseline period.
6. Compare the actual energy use and predicted use. Use a control chart to judge if there are savings.
7. If step 6 gives you a signal of savings, estimate avoided energy use and costs

Energy Model Practice Options

1. Hospital Gas Use, Appleton WI
2. Garvey School Electricity Use, Chicago IL
3. Your own building

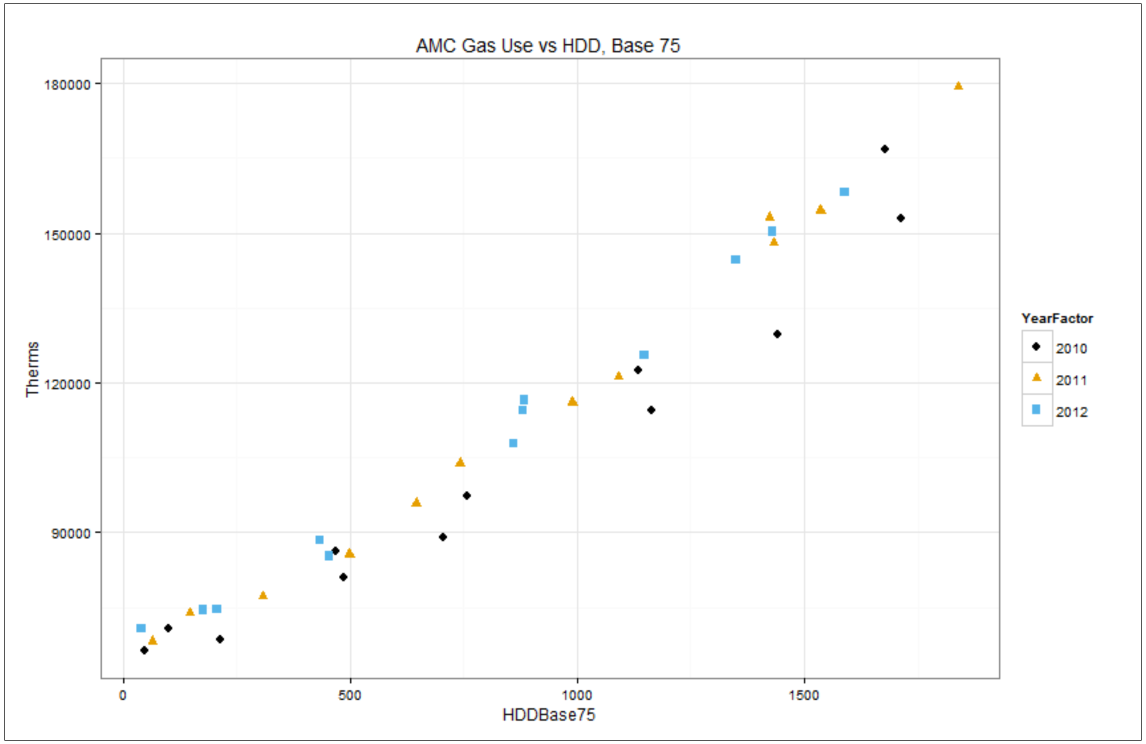
Hospital Gas Model Data Set

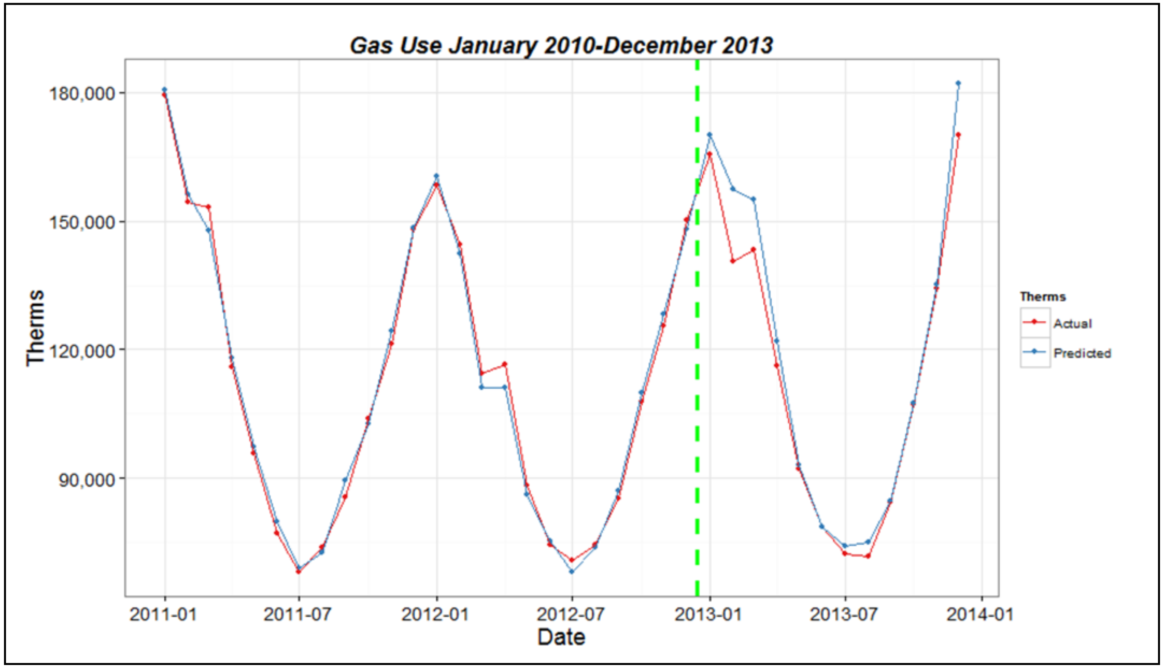
- 48 months Jan 2010 - Dec 2013
- Data Fields: Date, Therms, Avg Monthly Mean Temp, Heating Degree Days (base 65° F).
- Potential Baseline: 2010-2012, predict use in 2013.
- Data file: available as attachment and

https://github.com/klittle314/HHI_2014/blob/main/HospitalGasExercise.xlsx

Method Results

- Used 2011-2012 as baseline (2010 has different pattern)
- Used 75° F base for HDD
- A little bit of curvature in data -> quadratic fit



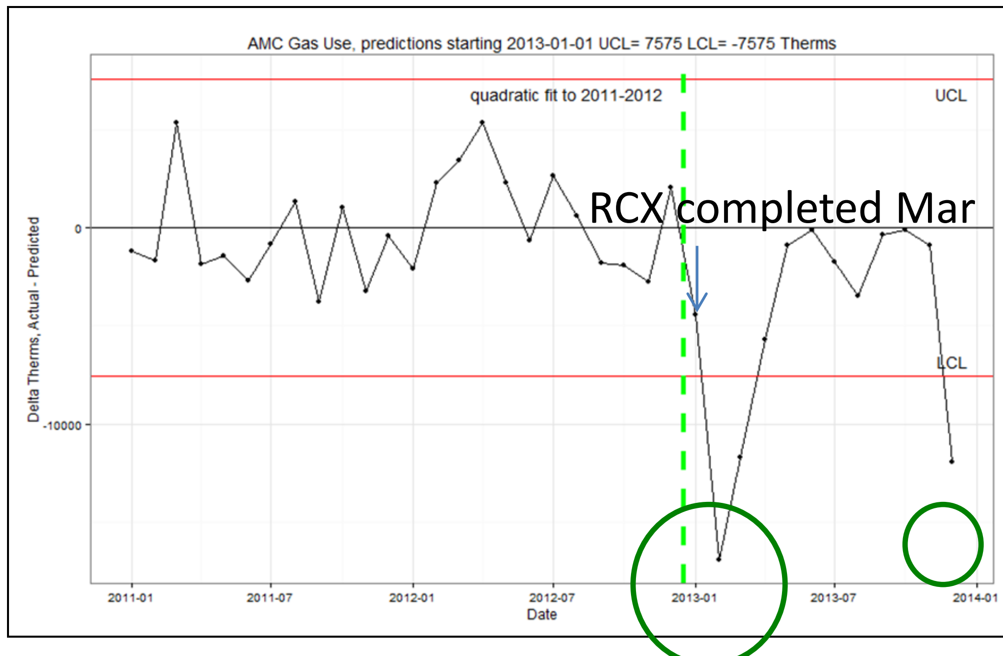


Steps 5 and 6

Evidence on control chart of lower gas use in winter months. Retro-commissioning of facility completed in Jan 2013, correlated with the change in energy use.

Step 7

$30,000 savings
308.5 Metric Tons CO_2 avoided
(equivalent to removing 64 light duty vehicles from service for 1 year)



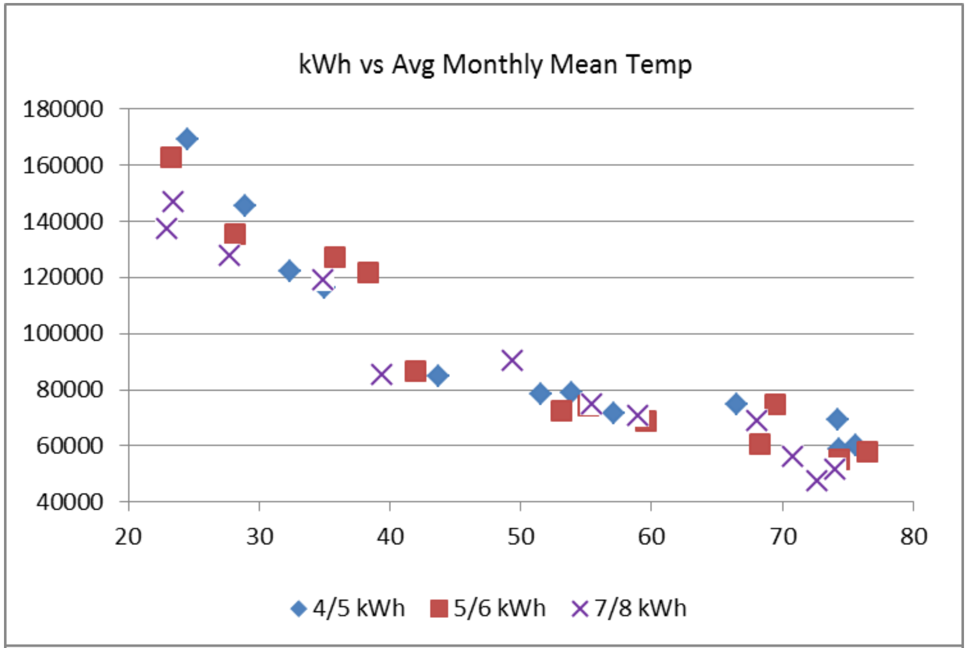
School Electric Model

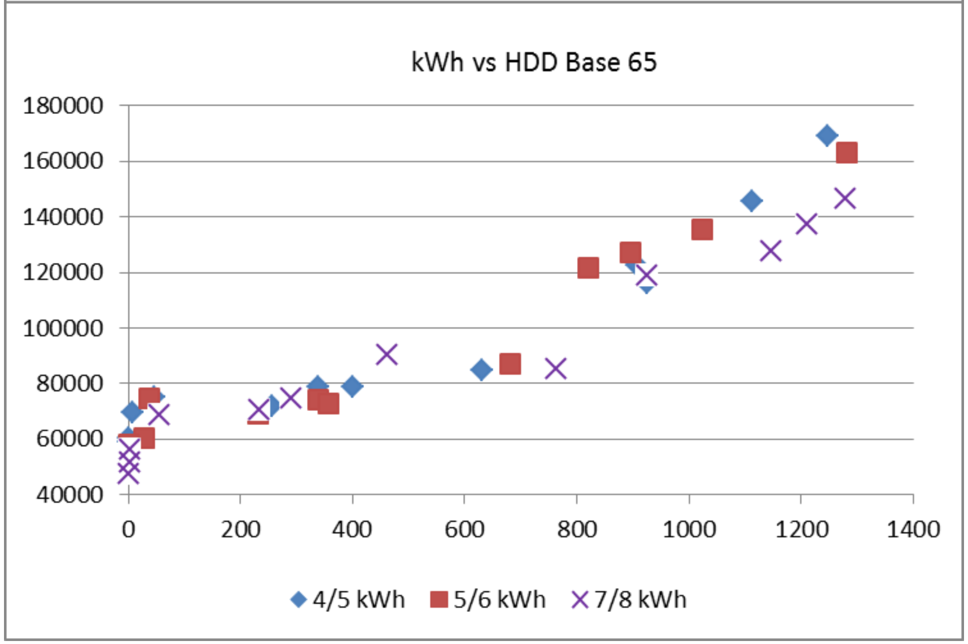
- 48 month record
- Data Fields: Date, kWh, Avg Monthly Mean Temp, Heating Degree Days (base 65° F).
- Baseline: Sept 2004 - Aug 2006
- School uses only electricity (yes, electricity for heating!)
- Data file: available as attachment and

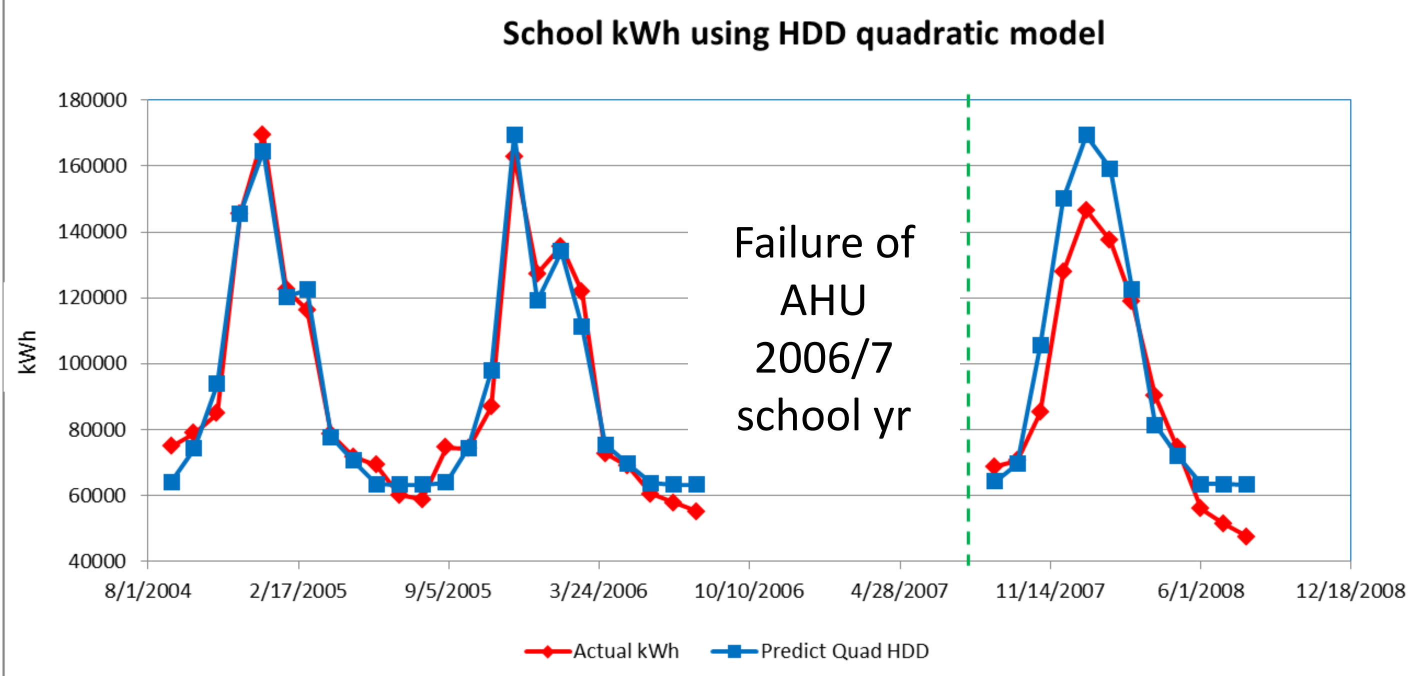
https://github.com/klittle314/HHI_2014/blob/main/SchoolElecData.xlsx

Method Results

- Worked a solution in Excel
- Omitted 2006/7 School year per problem description
- Quadratic model in HDD (base 65° F)





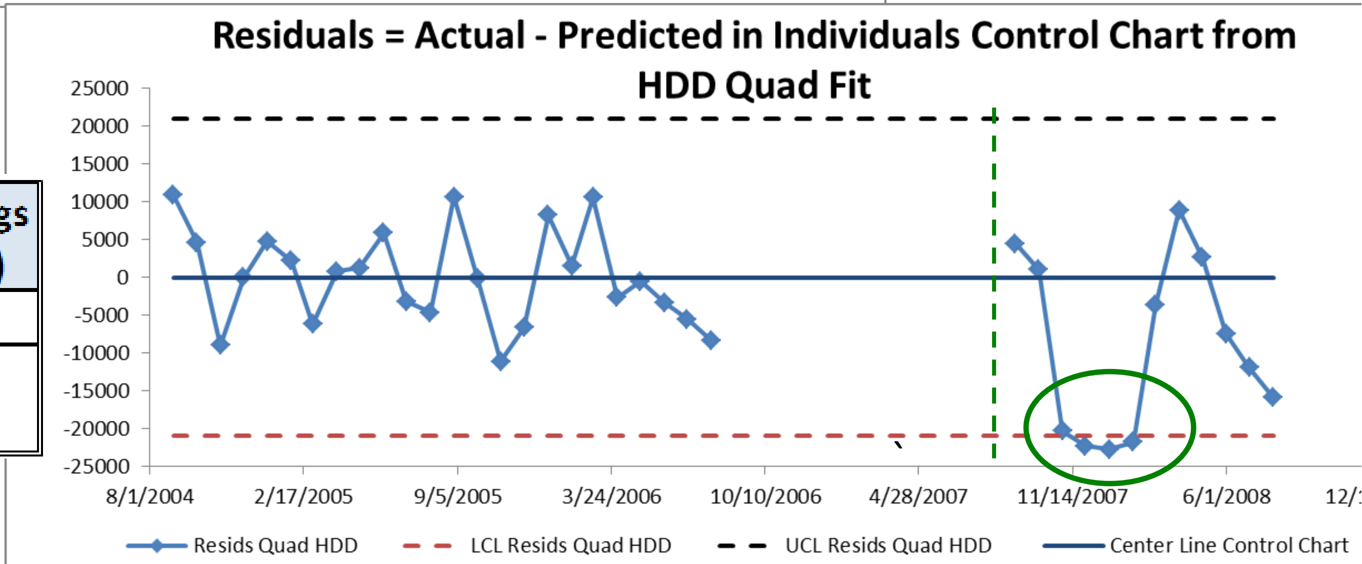


Steps 5 and 6

Evidence of savings especially in winter months

Step 7

	Dollar Savings	CO_2 savings (lbs CO_2)
full year	$8,724	174,000
Nov-Feb only	$6,964	139,000

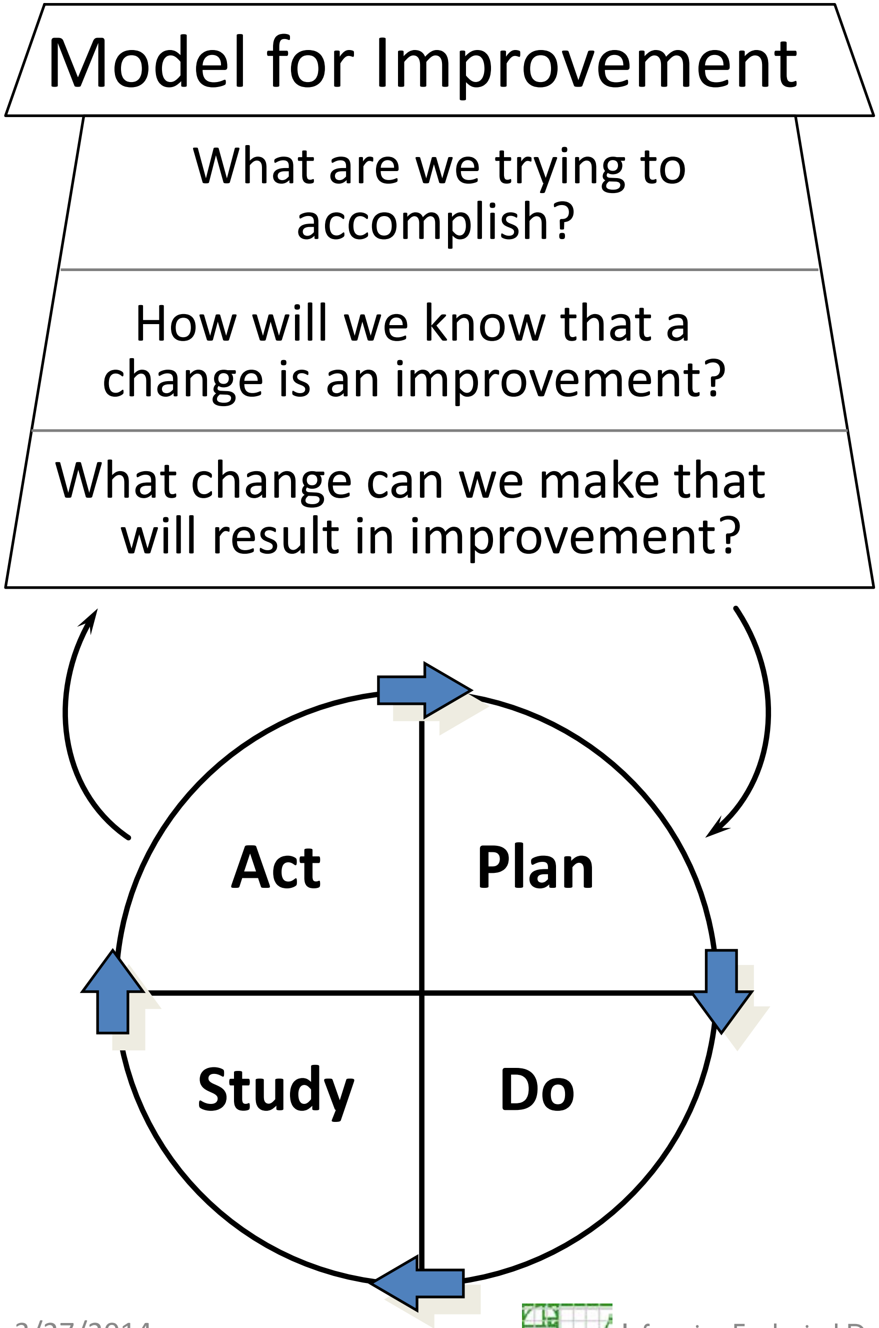


Your own building: Offer from KL still stands

1. Follow the seven steps on the "Method" slide
2. Easiest to start with a building in Portfolio Manager.
3. Want help? Email me, we'll find a time to have a web meeting to go thru details, no charge.

Beyond Monthly Data-1

3. 30-MINUTE DATA APPLICATION: WHAT KIDS CAN DO



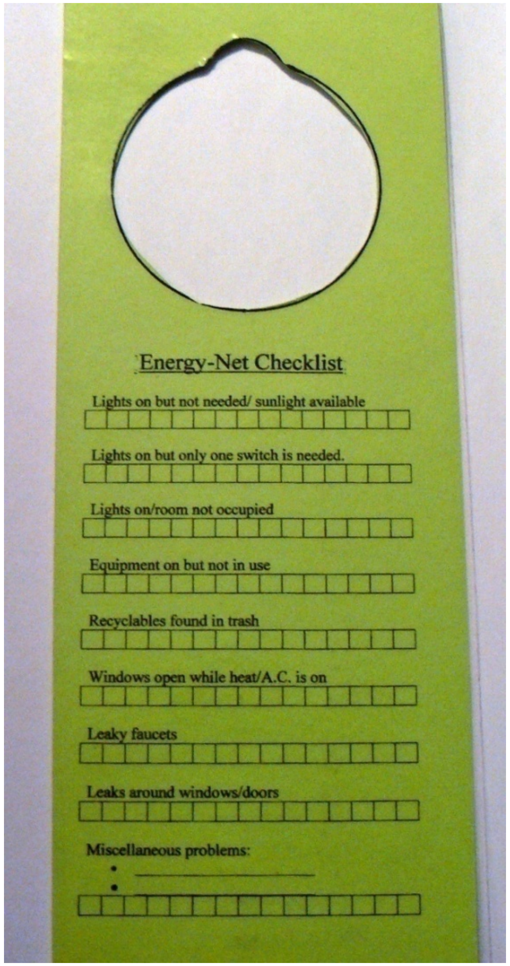
Model for Improvement is a method to take ***ideas into action***, through test cycles

Developed by Associates in Process Improvement (API), www.apiweb.org

Matching Lighting to Use: 30 minute data example

Hitch Elementary School, Chicago, IL

Case example discussed in ***The Improvement Guide*** (2009), 2nd edition, pp. 66-71



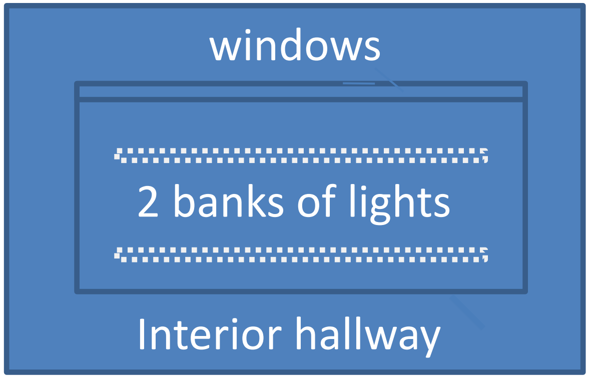
Ingredients for the Test

1. Aim: Reduce wasted energy use
2. Measures: 30-minute electric meter use; patrol compliance
3. Change Idea: Use daylight when possible in classrooms

Test Plan: Try different levels, the week before spring vacation.

- Tuesday: All lights on
- Wednesday: One bank only
- Friday: Daylight only, then vacation.

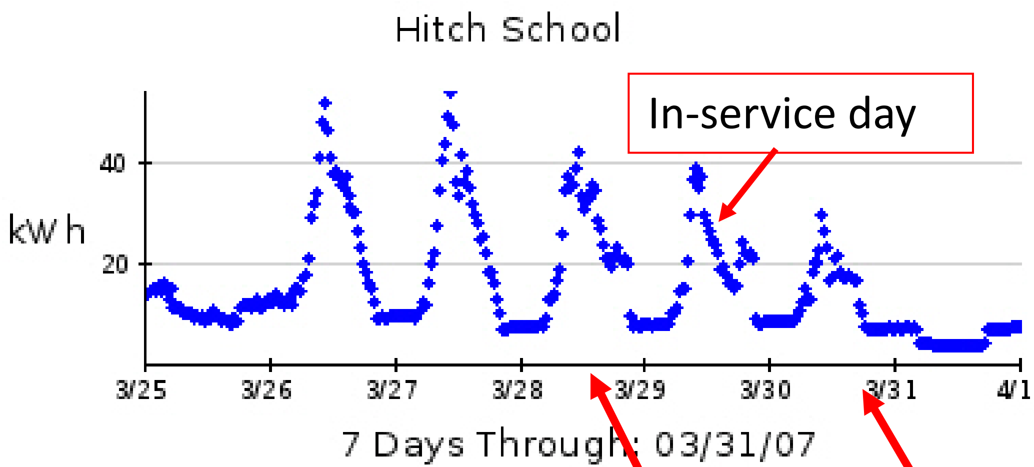
Classroom schematic



Results: School Lighting Test

WebViewer: Hitch School

Hitch School 30-minute electricity use. The data series is updated by CPS every few days. To see the most recent data, use the calendar control and go back a few days--we do not have today's data available today.



?	March, 2007						
«	‹	Today				›	»
wk	Sun	Mon	Tue	Wed	Thu	Fri	Sat
8					1	2	3
9	4	5	6	7	8	9	10
10	11	12	13	14	15	16	17
11	18	19	20	21	22	23	24
12	25	26	27	28	29	30	31

Select date

Time Span: 7 days

Marker: Dots

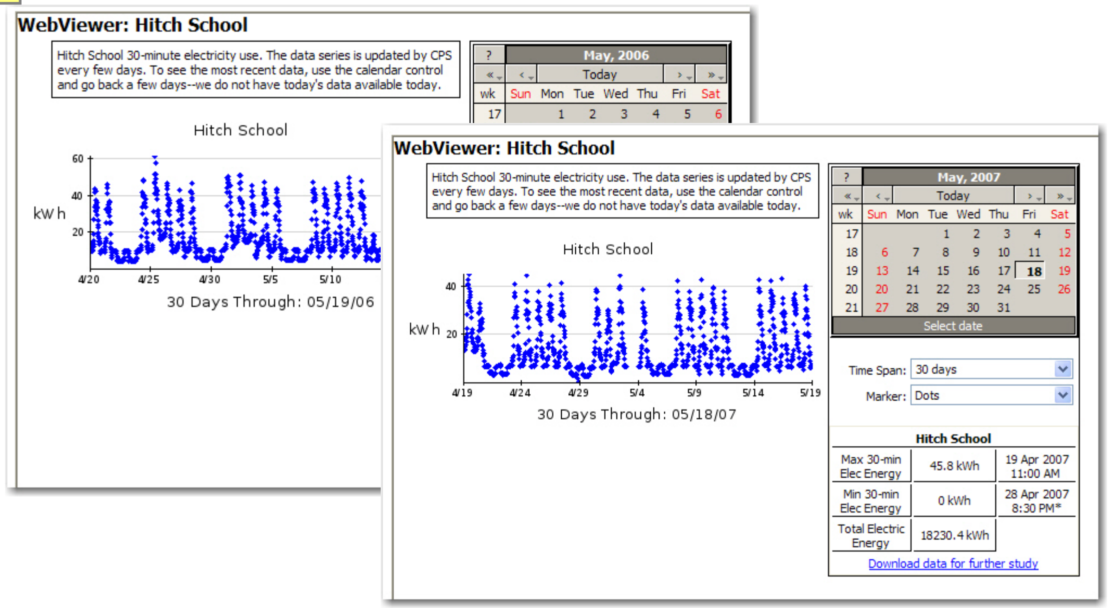
Hitch School

Max 30-min Elec Energy	54.8 kWh	27 Mar 2007 10:30 AM
Min 30-min Elec Energy	3.3 kWh	31 Mar 2007 7:30 AM
Total Electric Energy	5312.1 kWh	

Tues Test: Please use both light banks

Wed Test: Please use only one light bank

Friday Test: Please use daylight only

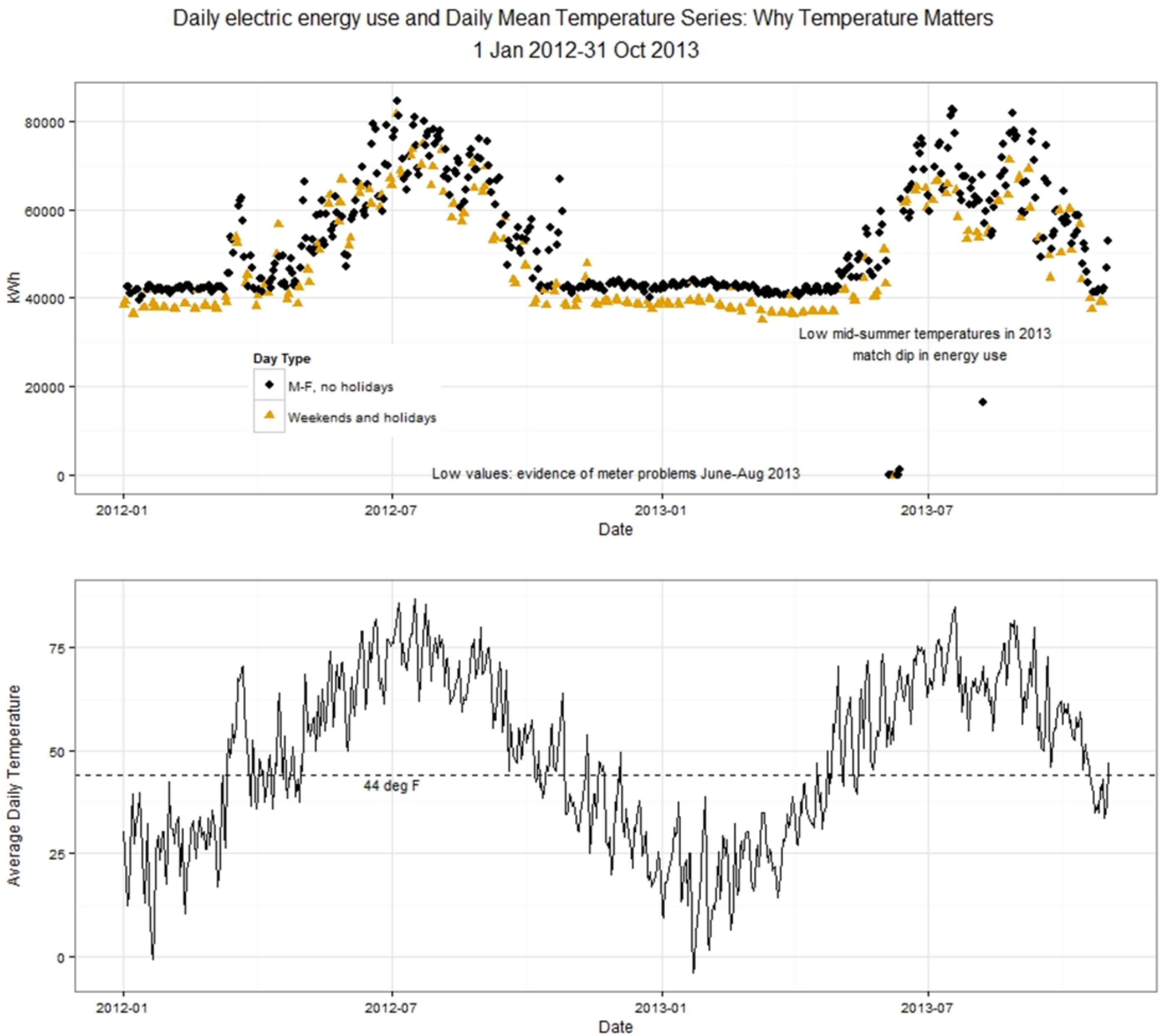


30-day period 2007 vs. 2006, more than 20% energy savings.

30 days Time Period	Total energy (kWh)	Total energy M-F 8:30 to 3:30 (kWh)	Median daily maximum 30-minute demand (kW)
4/20/2006-5/19/2006	24,690	11,130	93.5
4/19/2007-5/18/2007	19,000	9300	81.5

Beyond Monthly Data-2

4. DAILY DATA: CONTROL AND IMPROVEMENT IN COMPLEX BUILDINGS



Energy data from a hospital in Wisconsin; temperature series from nearest NOAA station

Daily Data reveals patterns hidden in monthly data E.g. effects of weekends and holidays and unusual values

Daily Data's Role in Control and Improvement

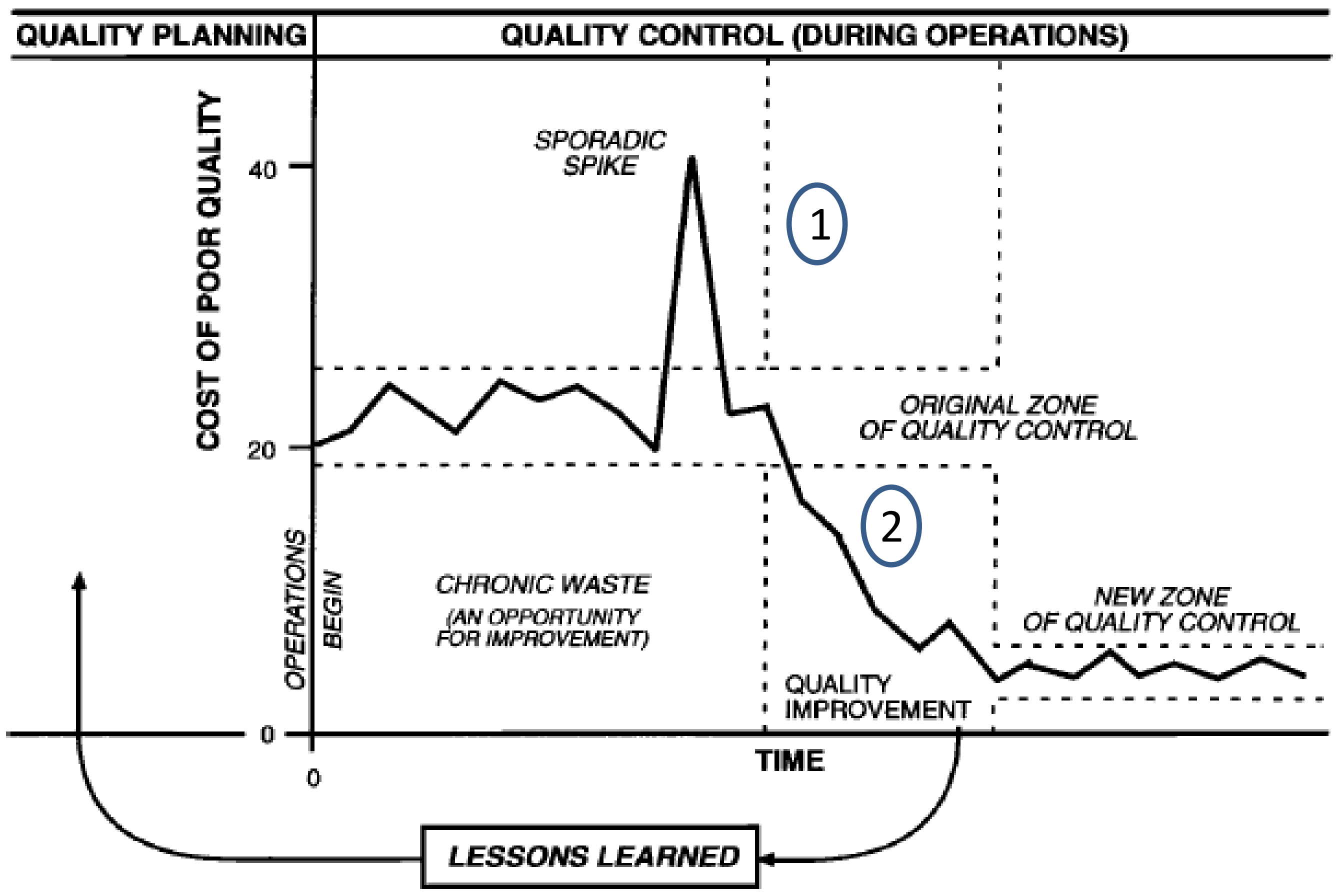
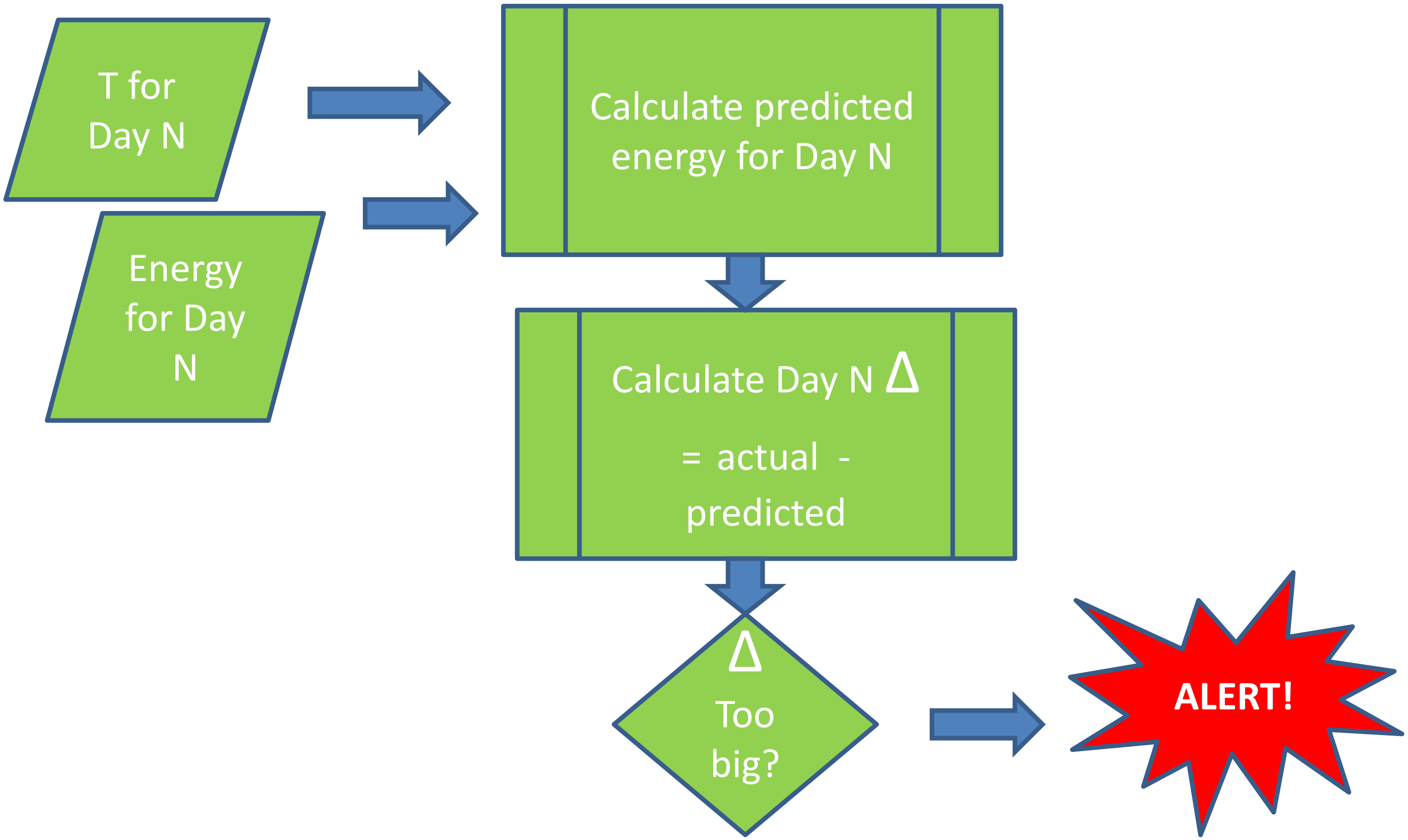
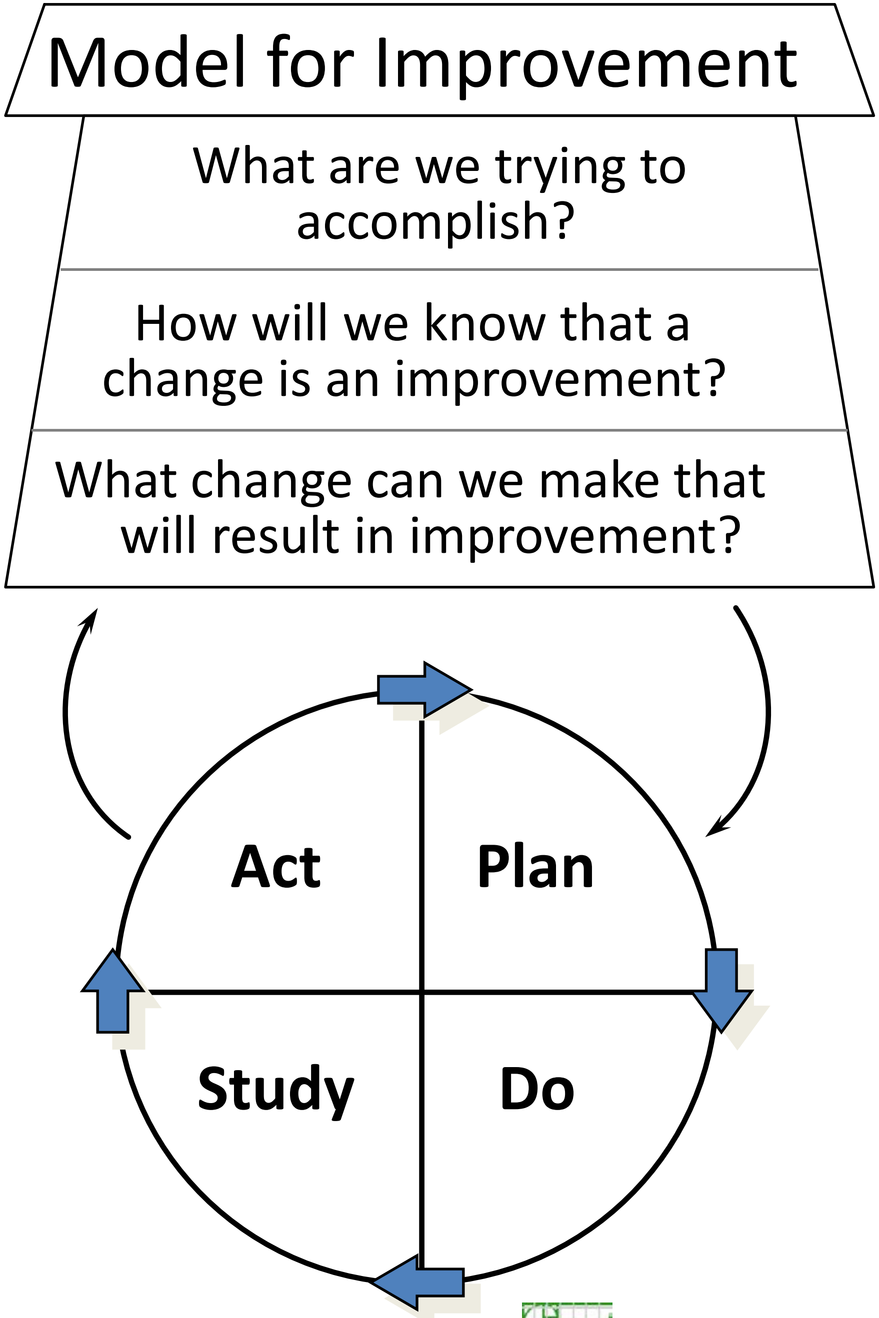


FIGURE 5.3 The Juran trilogy diagram. (*Adapted from Juran, J. M, 1989, The Quality Trilogy: A Universal Approach to Managing for Quality, Juran Institute, Inc., Wilton, CT.*)

Source: J. Juran and B. Godfrey (editors) ***Juran's Quality Handbook***, 5th edition, McGraw-Hill: New York, 1999, p. 5-8.

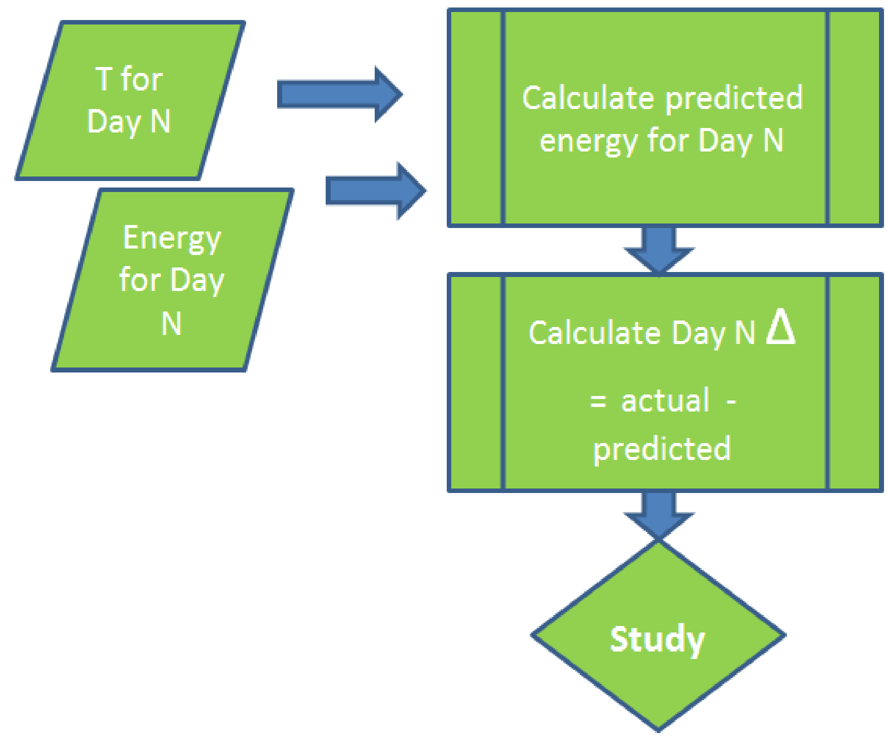
Daily Data For Control





Daily Data for Improvement

Measurement Loop



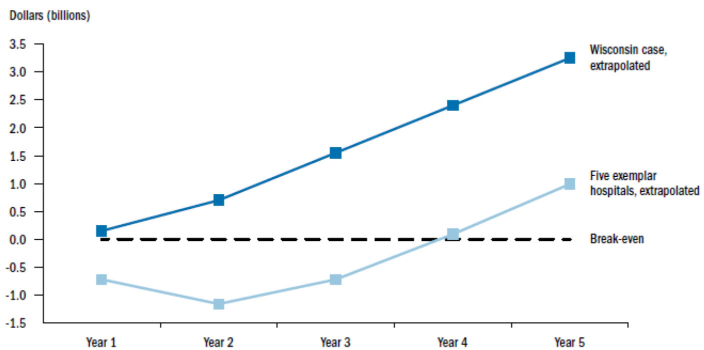
Low-Cost Energy Efficiency and Conservation Interventions in Wisconsin

Recently, publicly presented data show close to 9 percent weather-adjusted energy savings in a set of 12 hospitals in Wisconsin over three years. Based on the U.S. Environmental Protection Agency's ENERGY STAR program, the hospitals implemented a checklist of low-cost operations and maintenance activities for achieving progress towards becoming an ENERGY STAR leader.[20] Engineers with knowledge of this program indicate that 9 percent to 10 percent may be close to the maximum energy savings achievable in these hospitals without any capital investment.

The hospitals' savings resulted from systematic adjustment of thermostatic and other equipment set-points, schedules, and operating conditions, such as lower steam pressure levels. Several hospitals installed variable-speed drives and controls to allow for reduced air flow in unoccupied areas, in all cases paid for out of the operating budgets. The hospital staffs compared daily energy readings with weather-adjusted predicted energy use to guide the adjustments. With strong support from senior management, the operations staff utilized the data-driven Plan-Do-Study-Act methods used by most hospital executives in clinical areas. The Wisconsin case reported savings exceeding minimal expenses for consulting support and hardware. The total savings extrapolated from the Wisconsin example over five years outpace those made by our study hospitals (Exhibit 7).

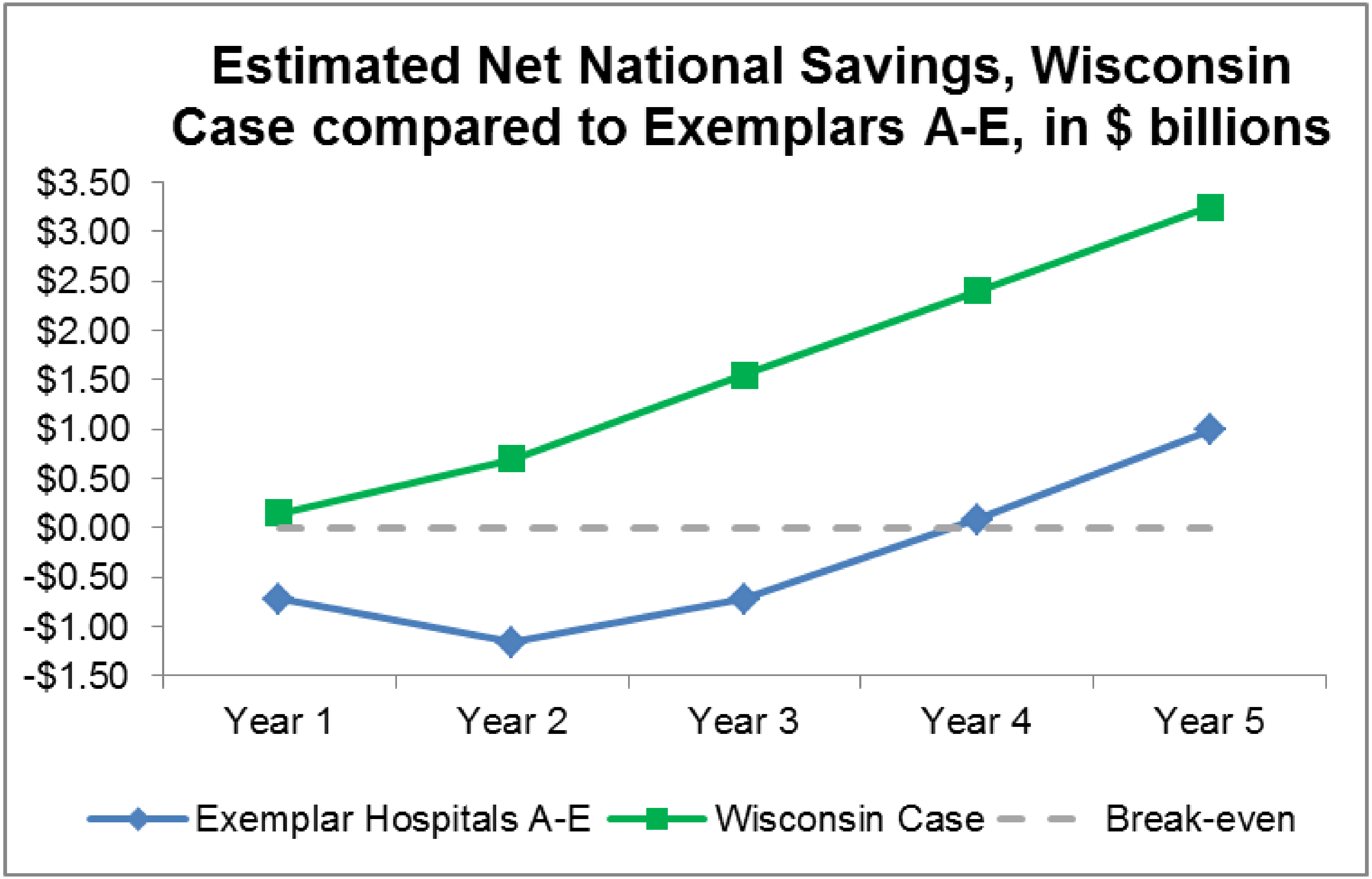
The Wisconsin case suggests that important savings are possible, with low or no capital investment, over three to five years.

Exhibit 7. Estimated Savings from the Wisconsin Case, Scaled to the National Level and Extending the Three-Year Experience to Years Four and Five



Source: Pearson Engineering, LLP, data collected from Wisconsin hospitals.

"Can Sustainable Hospitals Help Bend the Health Care Cost Curve?" S. Kaplan et al. ***Commonwealth Fund Issue Brief***, November 2012, p. 10



Estimated Net National Savings, Wisconsin Case compared to Exemplars A-E, in $ billions
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
-$0.50
-$1.00
-$1.50
Year 1
Year 2
Year 3
Year 4
Year 5
Exemplar Hospitals A-E
Wisconsin Case
Break-even

Dick Pearson, P.E., ASHRAE Fellow

Next offering of Dick's Energy Management Course: ASHRAE Summer Meeting, Seattle, WA June 2014. Dick's firm provided the case story and Wisconsin data on the previous two slides.

1. Co-author of ASHRAE book on energy audits
2. Advises you to NOT do advanced audits to start
3. Work on "Reverse Audits"

--test discretionary changes (e.g. set-points and schedules)

--build your learning and skills

--yield savings short-term

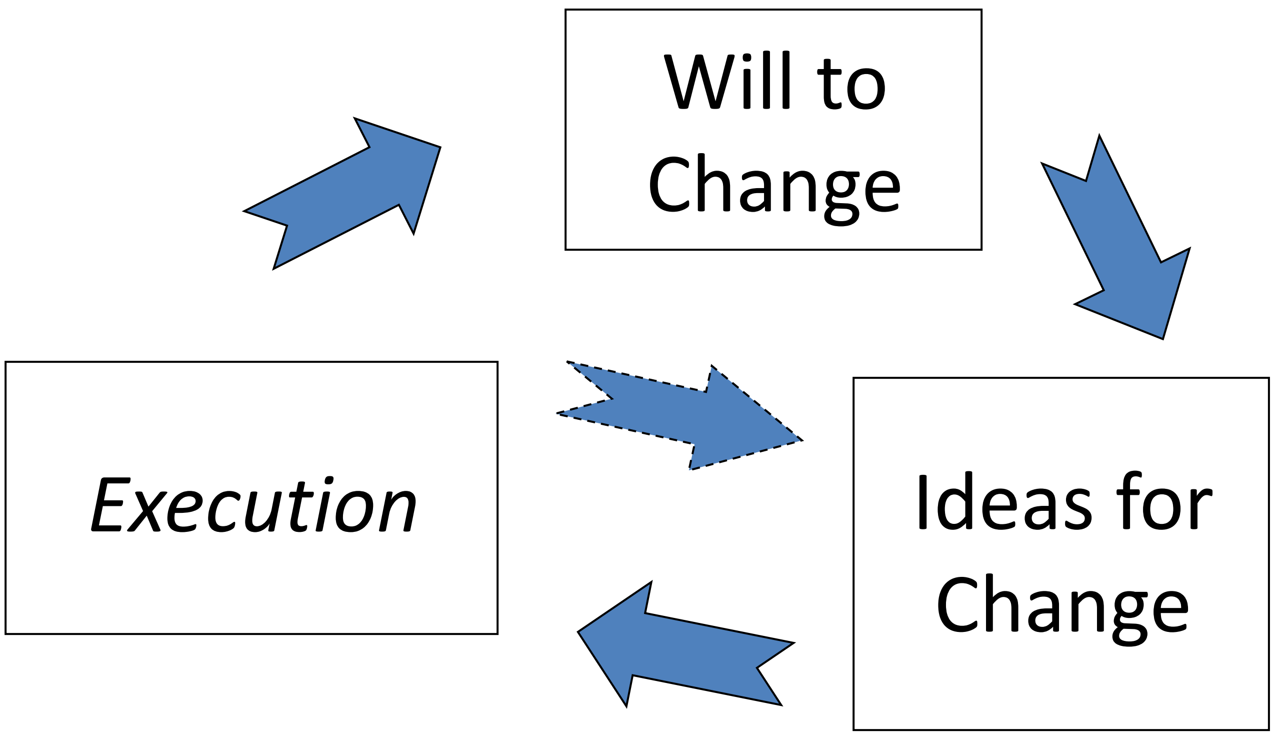
Two Ways To Experiment with Discretionary Facilities Operations

- Before/After Comparison
- On/Off Cycle (maybe more than once!)

Reference: ASHRAE Handbook, Chapter 40 Building Energy Monitoring, p. 40,8

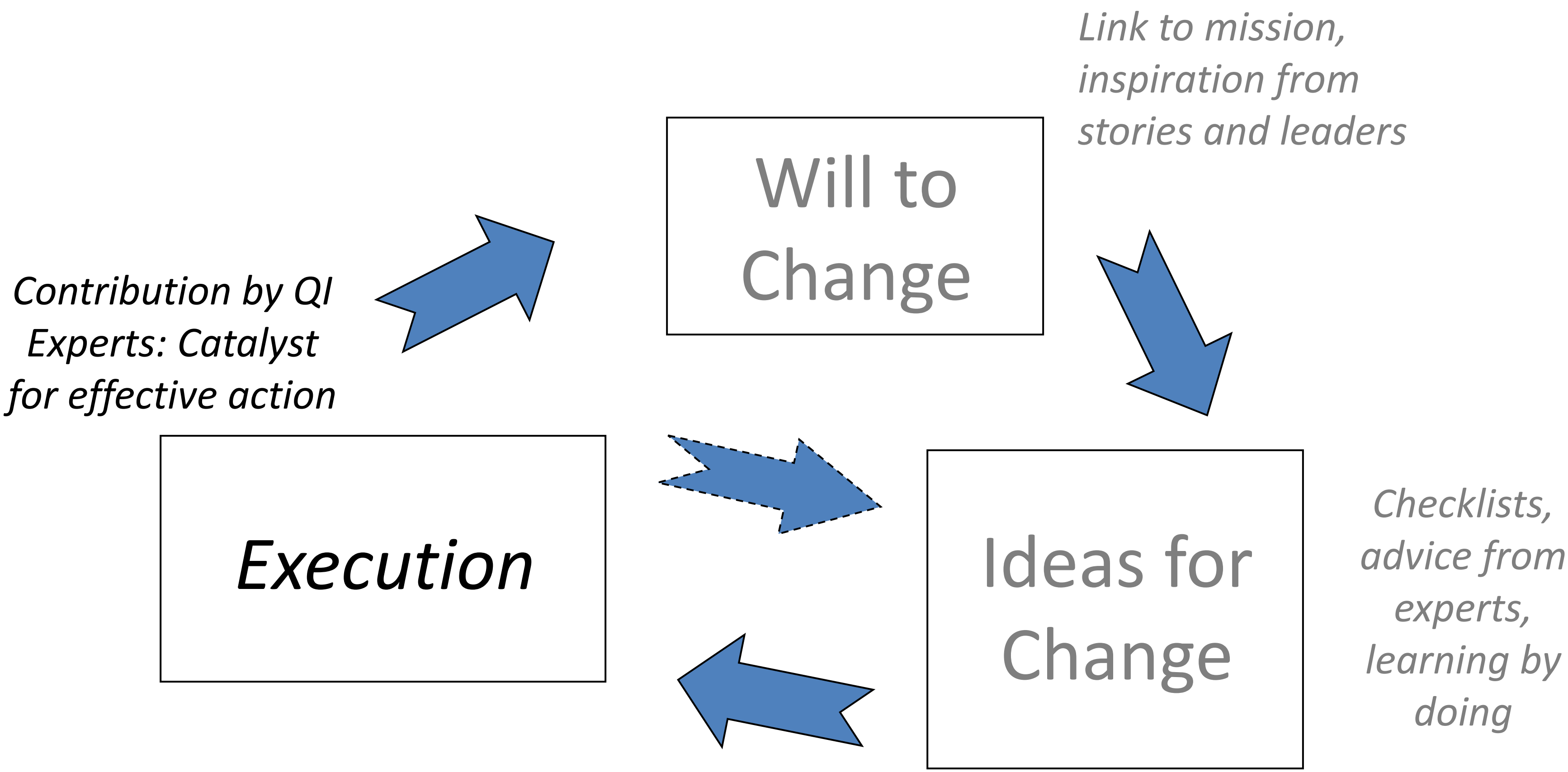
5. HOW QI EXPERTS CAN MAKE A DIFFERENCE IN LEANER ENERGY

Ingredients Needed to Change

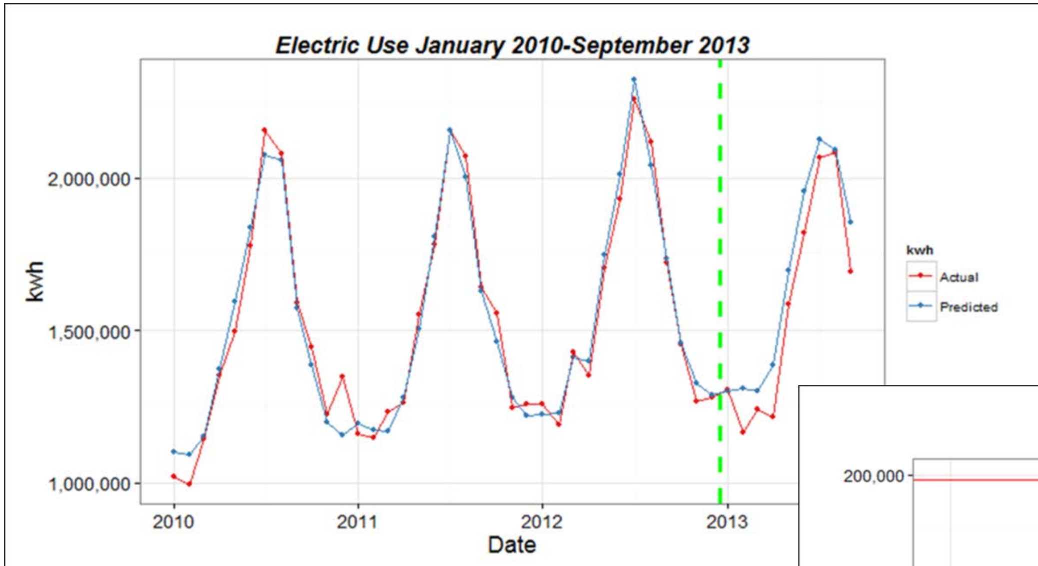


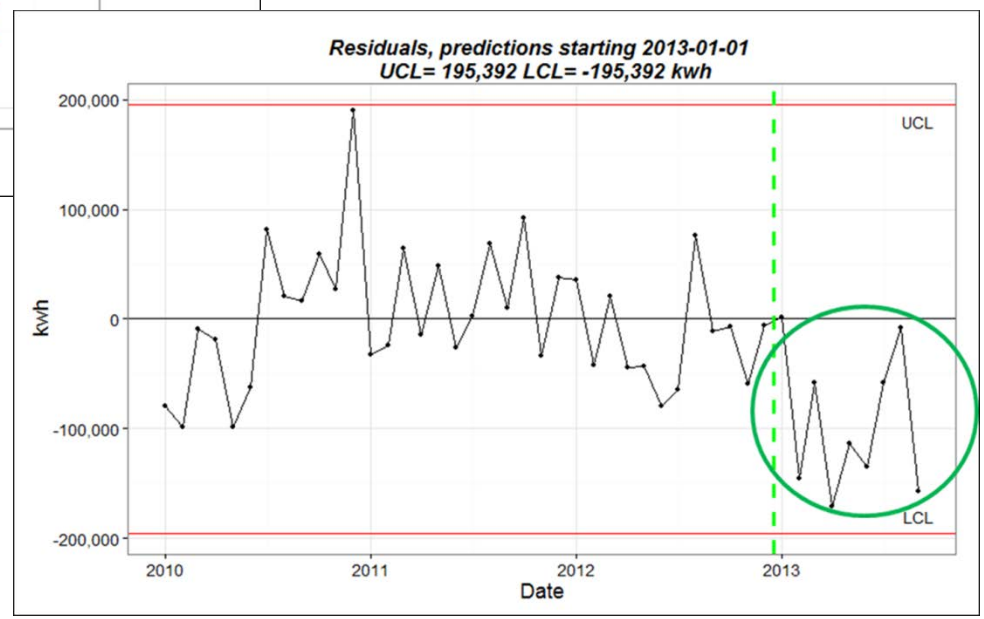
Nolan, T.W. *A primer on leading improvement in health care*. Presented at the Fifth European Forum on Quality Improvement in Health Care, Amsterdam, March 24, 2000. Used by permission.

Ingredients Needed to Change



A1. Skills in Working with Data--data cleaning, plots, models, control charts





A2. Skills in translating data of things into cost and mission impact (data of executives)

Why Health Care Providers Should Care About Clean Energy

- Pollutants from the burning of fossil fuels cause:
  - Cancer, liver disease, kidney disease, reproductive issues
  - Cardiovascular deaths and stroke[1]
- According to the Department of Energy, hospitals are 2.5 times more energy intensive than other commercial buildings[2]
  - This is inconsistent with our mission… we are responsible for contributing to disease through our wasteful consumption.
- Energy costs continue to escalate, making it more difficult to provide affordable care

Financial Case for Energy Management

• Annual gross revenue	~ $1B
• Operating margin %	~4%
• Operating margin $	~$40M
• Annual energy bill	~$5M

- Equivalent to 12.5% of annual margin
- Equivalent to $125M annual gross revenue from operations at 4% margin
- Saving energy $ does not require significant staffing or practice changes
- Investment payback with long-term margin benefits

Slides: Jeff Rich, Gundersen Envision 2/27/2014 webinar

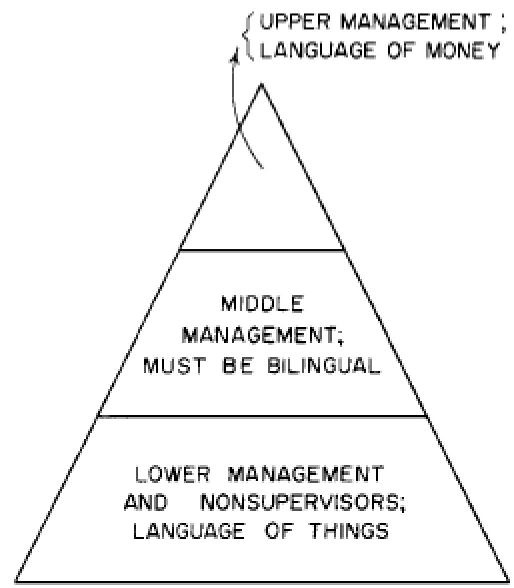


FIGURE 5.4 Common languages in the hierarchy.

$

kBTU

Source: J. Juran and B. Godfrey (editors) ***Juran's Quality Handbook***, 5th edition, McGraw-Hill: New York, 1999, p. 5.15.

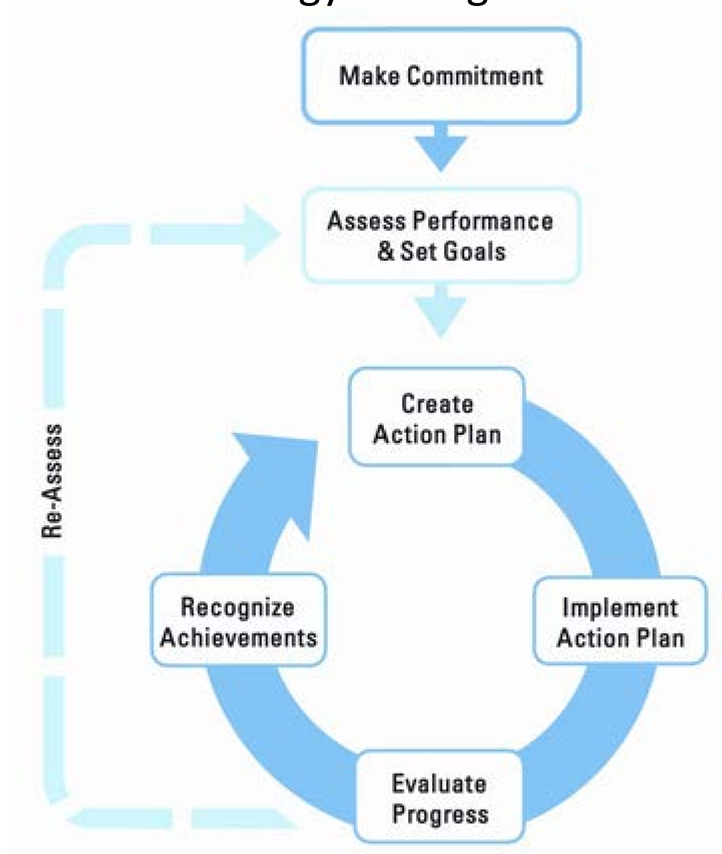
B. Knowledge of Disciplined Method to Improve

You know the improvement method used by your organization
e.g.

- Model for Improvement
- A3
- DMAIC

Opportunities:
1. Map ENERGY STAR Steps to your organization's method
2. Apply improvement discipline to energy performance--add accountability and control!

ENERGY STAR Road Map for Energy Management



http://www.energystar.gov/buildings/about-us/how-can-we-help-you/build-energy-program/guidelines

C. Application of Disciplined Method to Improve

More insights from Dick Pearson:

"Experimentation is terrifying to [almost all] facilities managers and engineers."

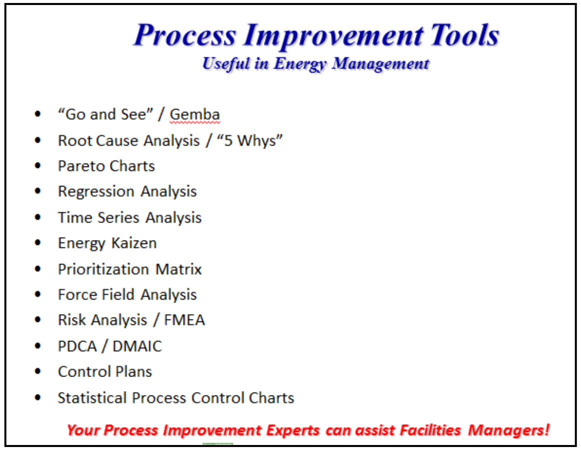
Perception of risk looms large:

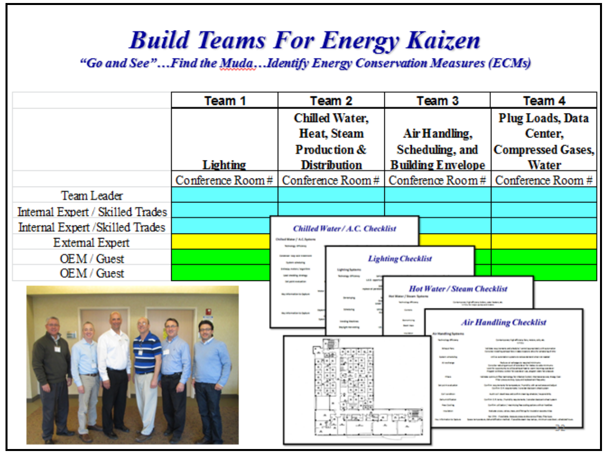
- Risk of occupant discomfort
- Risk of equipment failure

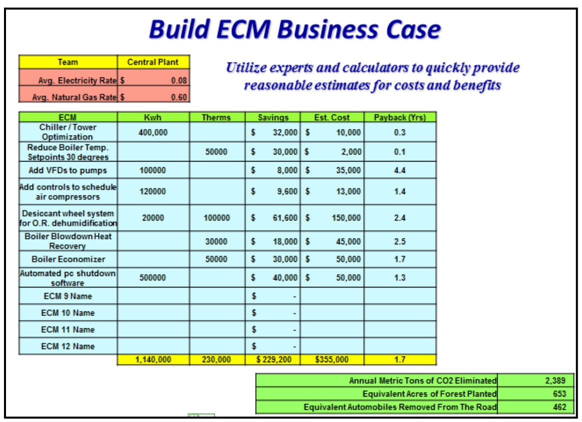
QI experts know how to run tests and monitor changes in critical areas, e.g.

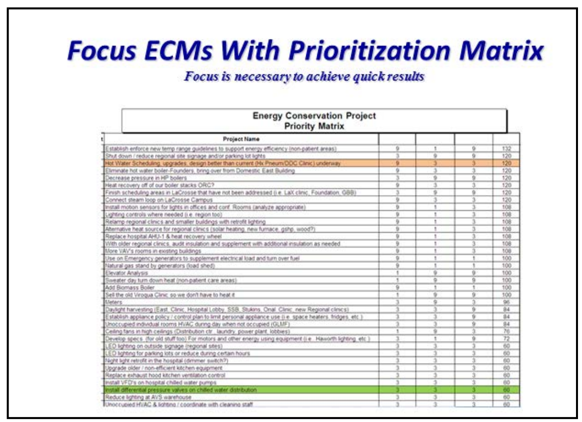
- Take SMALL steps that are reversible.
- Study your results (use data), communicate and adjust as needed.
- Engage leadership, management and staff in the tests.

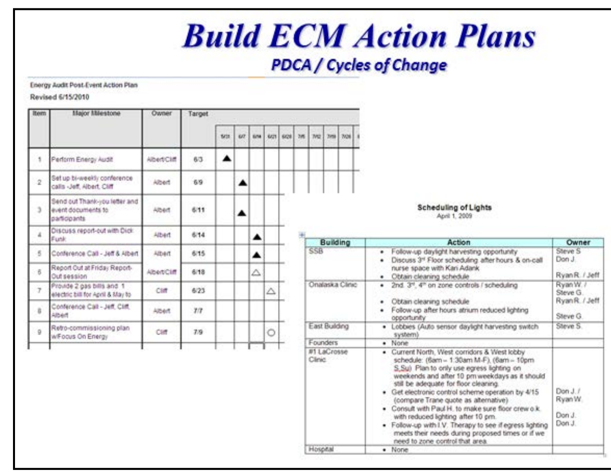
Review Jeff's slides from 2/27/14!











Examples of QI discipline in action

6. SUMMARY AND WHAT'S NEXT

Our premise

- The Leaner Energy challenge requires benchmarking, monitoring, and improvement
- Facilities and sustainability managers may be challenged by these "QI" fundamentals
- QI specialists have relevant skills and understanding
- Collaboration between groups can repay itself multiple times in better environmental performance

Healthier Hospitals INITIATIVE

What's in it for both sides?

QI experts

1. Apply your skills in arena with relatively clean data and relatively clear cause and effect links

(a vacation!)

2. Contribute to public health in your local and wider community

Facilities and Sustainability Managers:

1. Align your work with your org.'s health mission

2. Generate cost savings using organization's QI method

3. Learn to make experiments less terrifying

What can you do by next Tuesday?

1. QI Expert and Facilities or Sustainability Manager--share coffee or lunch to get to know each other (relationship building)
2. QI Expert: Offer to reformat one existing energy project in standard way (e.g. M for I, A3 or DMAIC)
3. Facilities or Sustainability Manager: Confirm use of Portfolio Manager and registration with HHI

And we will call a few of you…

As part of this webinar series, Blair and Kevin want to know whether we've hit the mark.

We'd like to call a few attendees to ask one or two open-ended questions next week.

Thanks again to ThedaCare for sharing data for examples used in this webinar series

RESOURCES AND REFERENCES

Resources

1. Healthier Hospitals Initiative, www.healthierhospitals.org

2. ENERGY STAR Portfolio Manager, www.energystar.gov

3. Energy Stewards® web connection to Portfolio Manager, www.energystewards.net

4. Gundersen Envision®, consulting and education services, www.gundersenenvision.org

5. Dick Pearson, P.E, ASHRAE Energy Management class, www.ashrae.org/education--certification/instructor-led-courses/implementing-energy-management-in-existing-buildings

6. S. Kaplan, B. Sadler, K. Little, C. Franz, P. Orris "Can Sustainable Hospitals Help Bend the Health Care Cost Curve?", The Commonwealth Fund, Issue Brief, November 2012, www.commonwealthfund.org/Publications/Issue-Briefs/2012/Nov/Sustainable-Hospitals.aspx

References: Changes to save energy

ASHRAE sources on discretionary changes

– ANSI/ASHRAE/IESNA Standard 100-2006R

– ASHRAE Handbook (2013), Chapter 35

Advocate Health presentation CleanMed 2011

http://www.cleanmed.org/2011/downloads/presentations/C-7/C7_Chan.Manshum.pdf

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Healthier Hospitals INITIATIVE

Learn what's
POSSIBLE

CleanMed2014
Creating Healing Environments



CleanMed 2014
GLOBAL CENTER FOR HEALTH INNOVATION
Cleveland, Ohio | June 2-5

INSPIRATION. EDUCATION. INNOVATION.

Join us in building a healthier future

Background for QI Experts

APPENDIX 1: ELECTRICAL POWER AND "DEMAND" CHARGES

A1. WHAT ARE DEMAND CHARGES?

Electric Energy Terms

- **Power in Watts**: Rate of Energy use (like speed, measured by a *speedometer*)

- **Energy in Watt-hours**:

  Rate of Energy use x Hours used (like miles traveled, measured by an *odometer*)

- You can compare devices or the impact of your building's use of electricity based on **power** OR based on **energy used** (if you know the hours).

Understanding demand charges

What: a charge for the largest average power use in a small period of time (e.g. 15 minutes) during a billing period.

Why: Utilities charge for demand to pay for generating capacity for peak times. They must have power plants and infrastructure ready for the hot days in summer when all our buildings are using energy for air conditioning as well as lights, computers, and other equipment.

Demand Charges: Who Pays?

1. “Large” commercial customers like hospitals pay the demand charges.
2. Large is defined by the demand level (for some utilities, this starts at a 15-minute demand > 20 kW).

Implications: Know your commercial utility rate; your residential bill typically only charges for kWh.

Car Rental Analogy to Utility Items

Electric Utility Bill	Car Rental Analogy
1. kWh during billing period x $/kWh	1. Miles traveled during rental period x $/mile
2. The peak kW over all the quarter hours of the billing period "Maximum on-Peak Demand" x $/kW	2. The peak average speed during any quarter hour of the rental period x $/mph
3. The peak kW over all the quarter hours of the past year -- "Customer Maximum Demand"	3. The peak average speed during any quarter hour of all the rental periods in the past year.
4. Varying prices for time of day and season: "on peak" and "off peak" (and future will bring real-time price adjustments)	4. Weekday vs weekend rates; congestion pricing premiums

A2. WHY SHOULD YOU CARE?

Example: A Wisconsin Hospital
31 Days billing cycle (ending 1/31/2014)

473,922 kWh (8 am – 8 pm M-F)	$36,606
750,528 kWh (other hours)	$39,620
1,823 kW Max on peak demand	$23,444
3,931 kW Customer Peak demand	$ 5,134

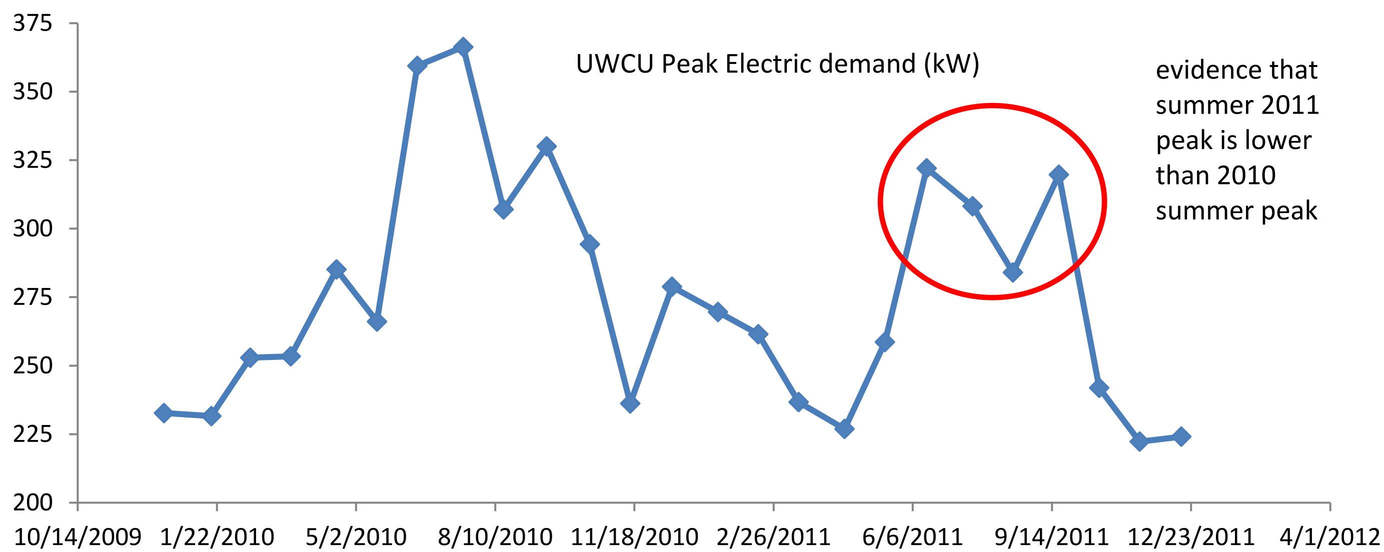
(set during summer 2013)

Demand charges are 25% of the total bill (each max kW is worth ~$13)

A3. HOW CAN YOU LEARN MORE?

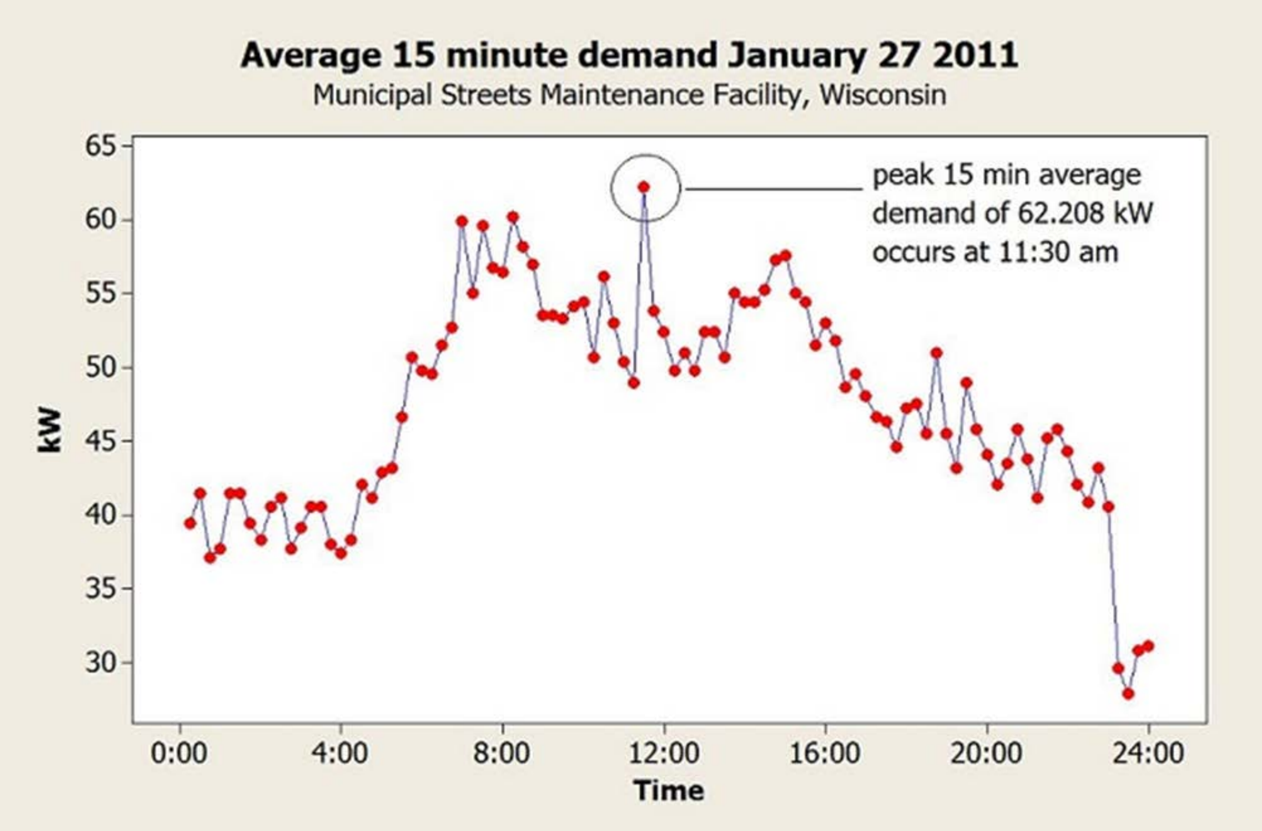
Look at Demand Over Time

1. Plot the dots.
2. The plot of kW helps you see whether you are making progress.
3. The monthly kW plot is the doorway to more exciting data.



Look at Intra-day pattern of demand

- Utilities can provide history files for many meters.
- You can buy a "real time" service from some utilities
- You can use 3rd party metering and systems



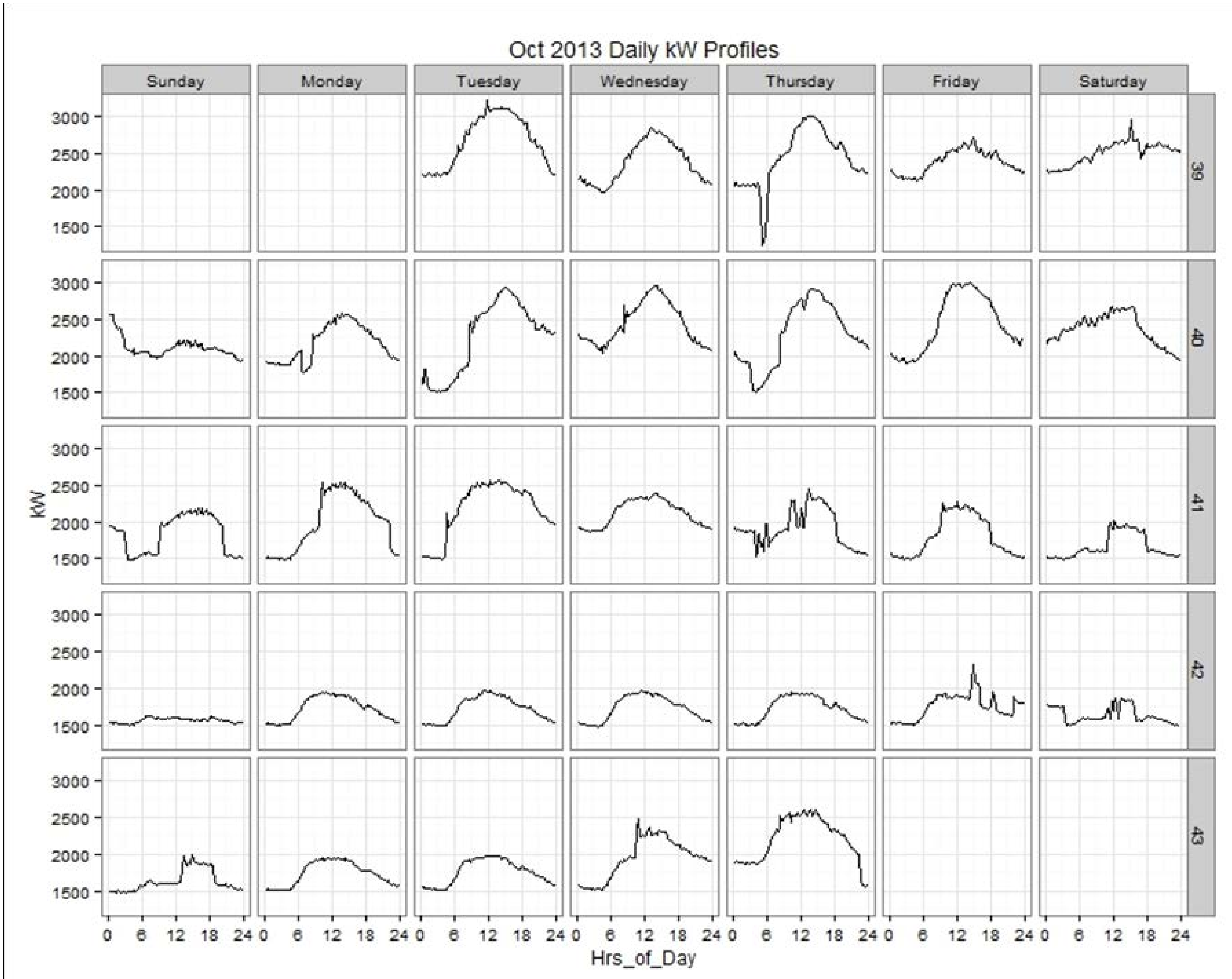
15-minute data drives Detective Work!

1. Does every work day have the same profile?
2. What is the impact of weather on the profile?
3. Are there opportunities to shift energy use so that you “shave” demand?
4. Can you see the impact of changes to operations?

Profiles of 15-minute power yield insights on building demand patterns

During on-peak times, it costs 2 cent/kWh more for energy.

If you can choose your 12 hour on peak period, as either 8 am to 8 pm or 10 am to 10 pm, M-F, what does the display say to do?



APPENDIX 2: ENERGY DATA TYPES, ADVANTAGES & DISADVANTAGES

Type of Data	Advantages	Disadvantages
Monthly utility data	• You have the data! • The "bottom line" to assess impacts over time • Basis for ENERGY STAR and HHI Leaner Energy 12-month views	• Small improvements (<5% of bill) are hard to detect • Need to adjust for weather and use levels • It typically takes several months to convince yourself of impact • HVAC changes may not be evident in spring or fall months
Daily meter data	• 30 fold improvement in sensitivity relative to monthly data • Foundation for daily feedback cycle on discretionary changes	• Requires skill in data handling and display • Can require special metering although utilities may provide daily data for large buildings.
Hourly or better meter data	• Sensitive to small changes • Good for testing on a small scale to assess impact • Less need to adjust for weather and use levels (today is pretty much like yesterday, most of the time)	• Requires skill in data handling and display • Can require special metering; electric utilities may provide 15-minute or hourly data for large buildings
End-Use logging or trending	• Specific insight on motor run times, temperature levels, rH levels, fan speeds, etc. • Simple loggers low cost and non-invasive • Building automation systems may track some points	• Requires skill in data handling and display to interpret and get the message across