

Leading Communities to a Healthier Future



Leaner Energy



LINKING QUALITY IMPROVEMENT AND LEANER ENERGY USE

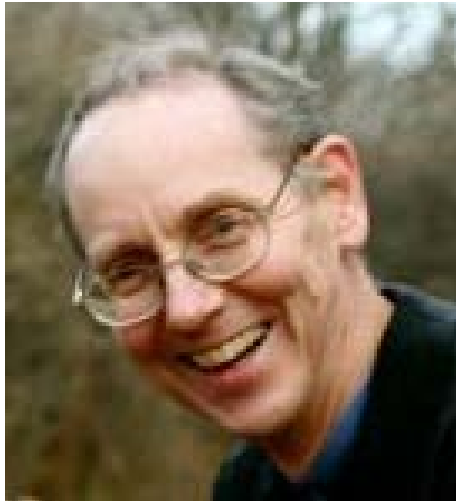
Sharing Call Series for Quality
Community--Part 2

13 March 2014

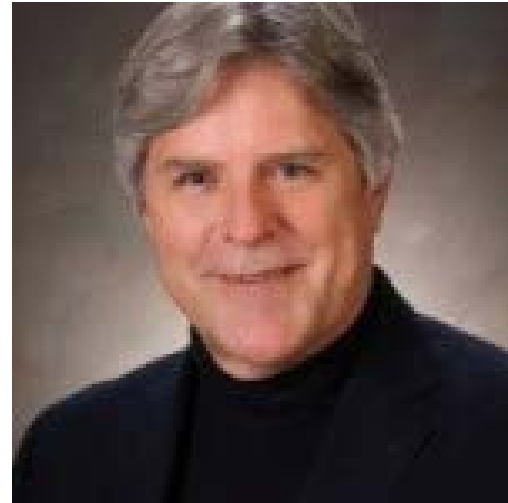
Kevin Little, Ph.D.



Presenters



Kevin Little
Principal
Informing Ecological
Design, LLC
IHI Improvement Advisor



Paul Linzmeyer
Sustainability Leader
ThedaCare

Agenda

1. Context for our call series
2. Assignments from week 1
3. ThedaCare Introduction
4. The Problem: Has energy use changed in our hospital?
5. A Refined Question and a Refined Answer
6. Your turn: data sets to try

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



Leaner Energy

Level 1

Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by three percent from baseline.

Level 2

Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by five percent from baseline.

Level 3

Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by ten 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



Two questions posed 27 Feb 2014

1. Is your organization taking part in HHI?

You can find out from the HHI website.

2. Is your organization using Portfolio Manager*?

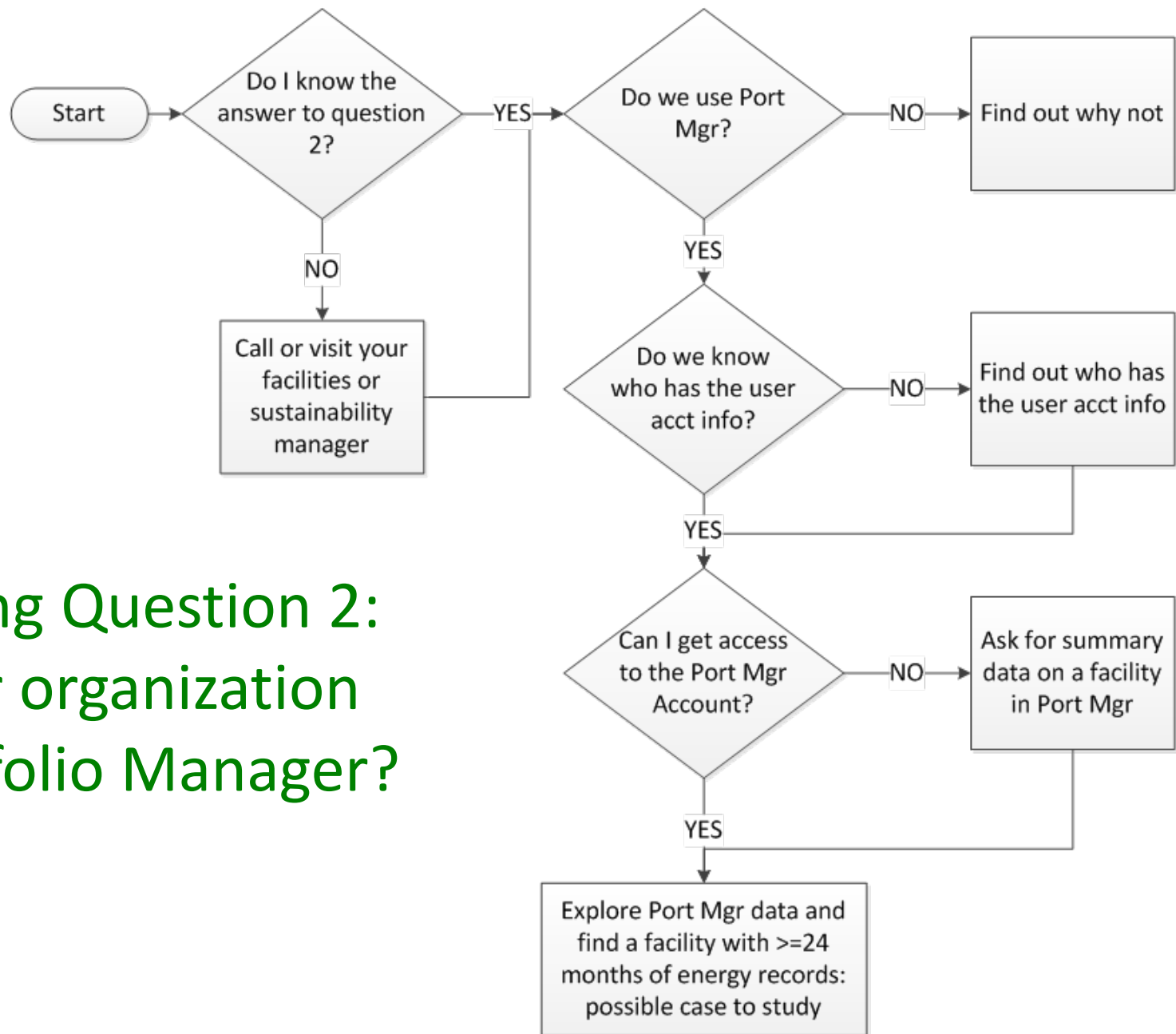
You may have to hunt for the answer.

*If your organization uses Portfolio Manager and you have at least two years of monthly data for one facility, you have the option to use your own data to develop a weather-adjusted energy model after the next webinar.

Answering Question 1: HHI Participation

The screenshot shows the Healthier Hospitals Initiative (HHI) website. The top navigation bar includes links for 'Create a New User Account', 'Login', 'Enroll Now', 'Contact', and a search bar. The 'About HHI' menu is open, showing options like 'What We Do', 'Who We Are', 'Participating Hospitals' (highlighted with a red arrow), 'Participating Hospitals Map', 'Supporting Businesses', 'Supporting Organizations', 'Frequently Asked Questions', and 'Contact Us'. The main content area features a large image of a healthcare worker and a list of HHI Challenges: Engaged Leadership, Healthier Food, Leaner Energy, and Less Waste. Below this, there's a section for 'The Spark Blog' and 'Upcoming Events'. The 'Participating Hospitals' page is also visible, showing a search filter for 'Challenges Committed' (All Challenges) and 'Alpha' (A-Z). It lists two hospitals: Mount Carmel West Hospital and Mount Carmel St. Ann's Hospital, both committed to Engaged Leadership, Healthier Food, Leaner Energy, Less Waste, Safer Chemicals, and Smarter Purchasing. An 'Enroll Now with HHI' button is also present.

1. Go to HHI website
<http://healthierhospitals.org/>
2. In the **About HHI** menu, choose **Participating Hospitals**
3. Search for a hospital that is part of your organization.
4. You can enroll as an individual and you can enroll your organization, too, if you're not already taking part.



Answering Question 2: Does our organization use Portfolio Manager?

Thanks to ThedaCare for sharing data used in our webinar!

3. THEDACARE INTRODUCTION



THEDACARE SUSTAINABILITY JOURNEY

OUR SUSTAINABILITY JOURNEY'S PURPOSE IS TO HELP REACH OUR MISSION OF CREATING HEALTHY COMMUNITIES BY GREATLY REDUCING OR ELIMINATING OUR ENERGY, WASTE AND WATER FOOTPRINT.



WHY SHOULD IT MATTER TO THEDACARE OR ANYONE ELSE

Similar to Lean, Sustainability is a cultural transformation that changes how an organization works. It requires new habits, new skills, and often a new attitude throughout the organization. It is not an additional burden, but rather an enhancement of who we currently are.

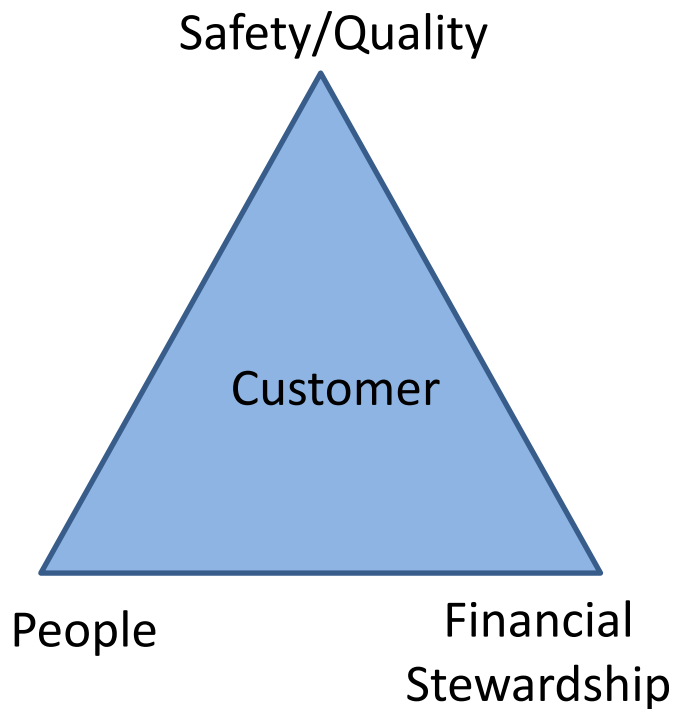


THEDACARE VALUES

Also, Sustainability practices support our Values and Behaviors:

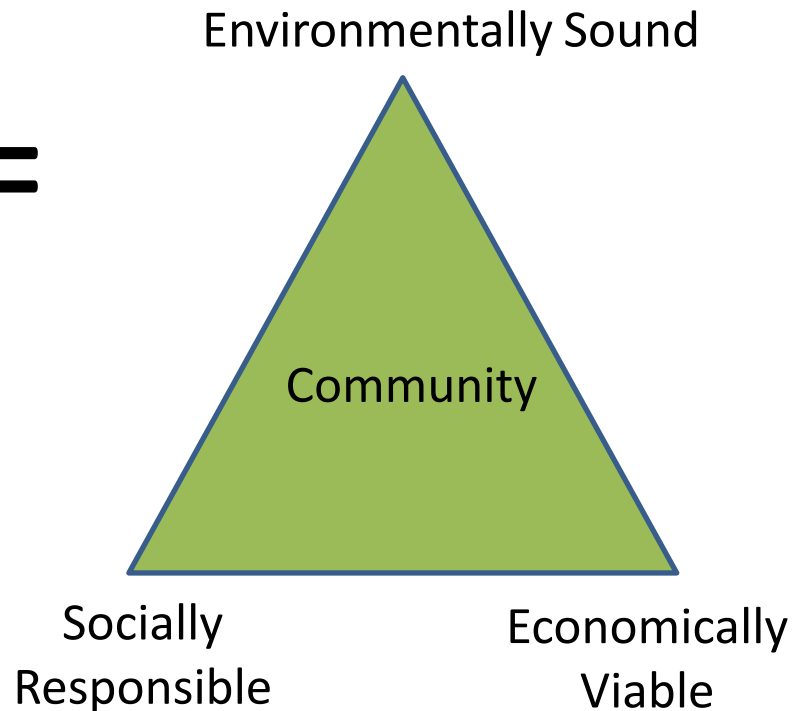
- Love our work,
- be courageous, and
- have a thirst for knowledge.





ThedaCare True North

=



Triple Bottom Line



RESULTS

- \$1.9M IN RCx PRODUCED SIGNIFICANT SAVINGS WITH ABOUT A 2 YEAR PAYBACK
 - CHANGED OUT ALL T12S
 - LED LIGHTING IN PARKING RAMP AND LOTS
 - STEAM TURBINE PROJECT
 - FEASIBILITY STUDIES FOR OR AHU OPTIMIZATION
 - FACILITIES OPERATIONS WERE TESTED FOR PERSISTENCE AND RESULTS WERE FAVORABLE

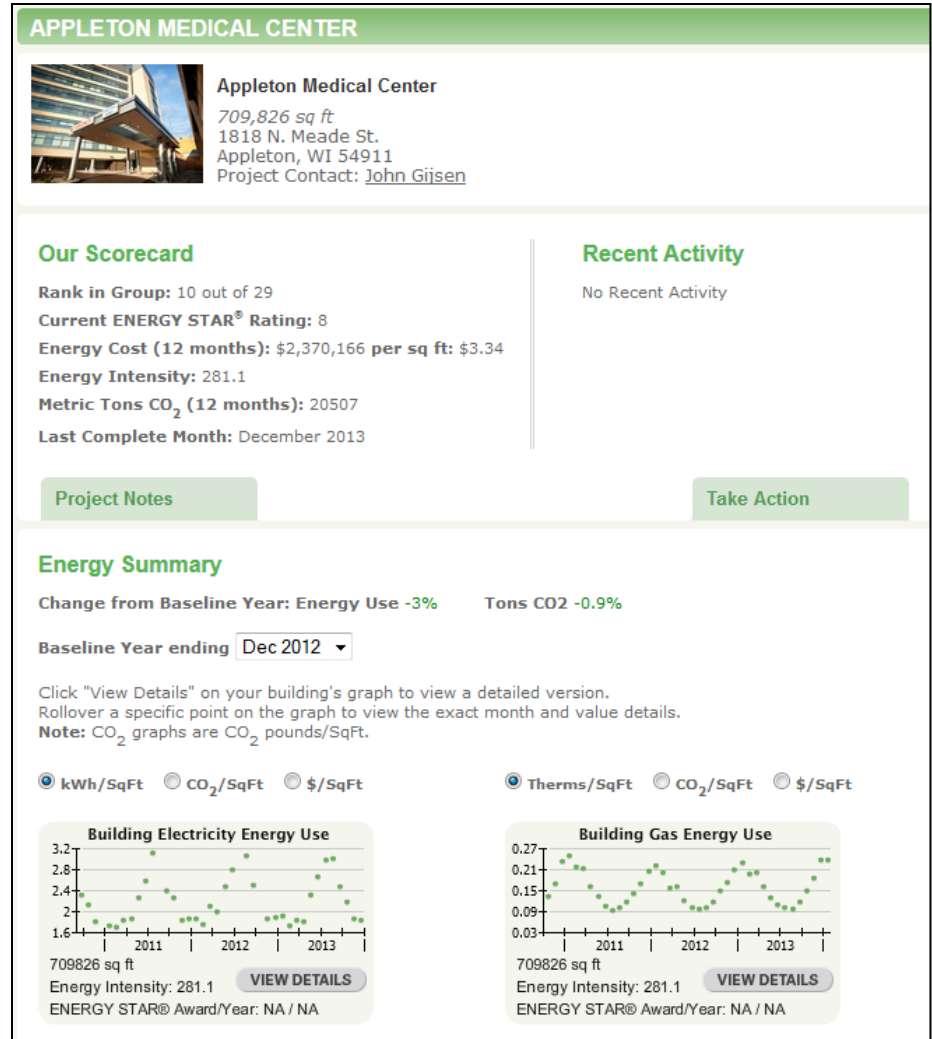


4. THE PROBLEM



Background

- ThedaCare Health System working on HHI challenges
- Have data in ENERGY STAR® Portfolio Manager and using 3rd party application Energy Stewards®
- Are we seeing changes in energy use after retro-commissioning?



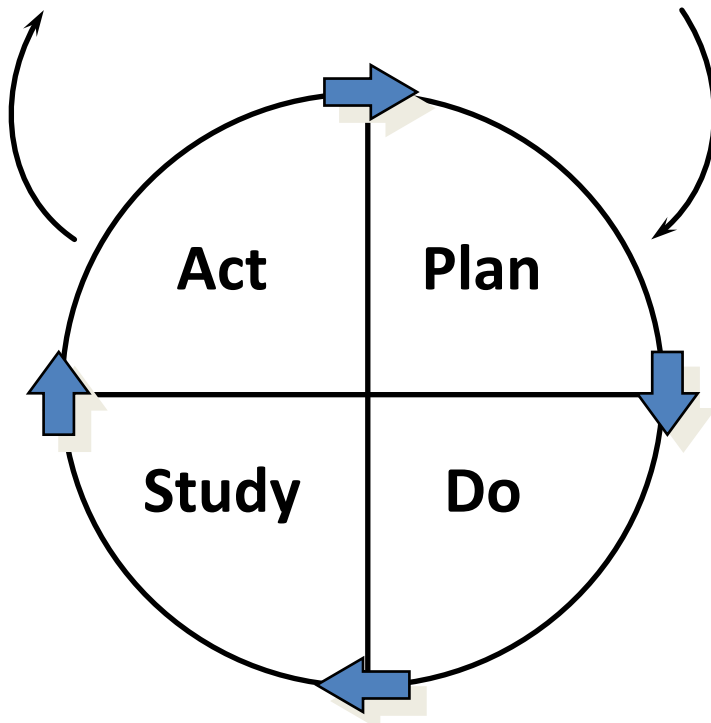


Model for Improvement

What are we trying to accomplish?

How will we know that a change is an improvement?

What change can we make that will result in improvement?



*Framework to
organize
improvement*

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

Weather Normalized Energy Intensity--recap

Inputs:

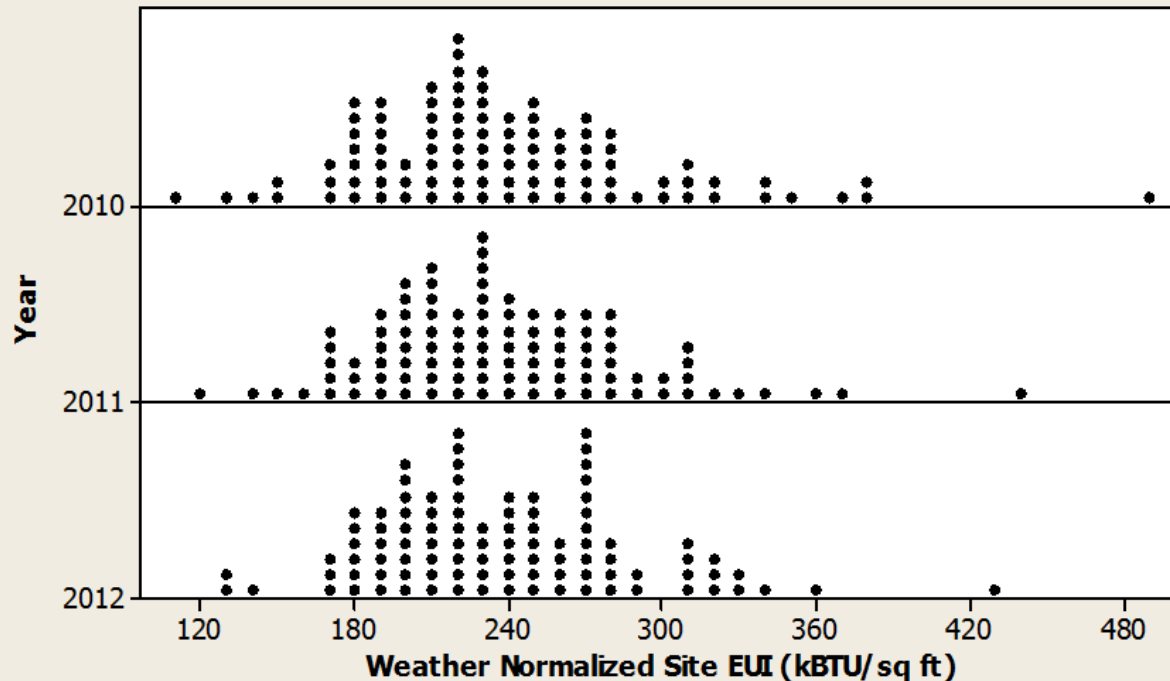
1. 12 months total energy use in kBtu
2. area of building in sq ft
3. zip code to find nearest National Weather Station

Output:

kBtu/sq ft/year adjusted to 30 year average weather conditions.

Hospital values kBtu/sq ft/yr

Dotplot of Weather Normalized Site EUI (kBtu/sq ft)



New Gundersen
Health hospital
(opened Jan 2014)
aims for **115**
kBtu/sq ft/yr

97 Hospitals from HHI Leaner Energy Challenge 2013
Median value 2012 ~ **233** kBtu/sq ft/yr

Details from Appleton Medical Center Home Page in Energy Stewards

Our Scorecard

Rank in Group: 10 out of 29

Current ENERGY STAR® Rating: 8

Energy Cost (12 months): \$2,370,166 per sq ft: \$3.34

Energy Intensity: 281.1

Metric Tons CO₂ (12 months): 20507

Last Complete Month: December 2013

*Weather-normalized
EI and CO₂
calculations from
Portfolio Manager via
automatic data
exchange*

Energy Summary

Change from Baseline Year: Energy Use -3%

Tons CO₂ -0.9%

Baseline Year ending



We have an answer!

Using Portfolio Manager
data* and arithmetic:

*3% decrease in weather-
normalized EI*

12 mos. ending Dec 2013

vs

12 mos. ending Dec 2012

*Data detective story will continue
in part 3 of webinar.

Limitations:

1. Did the change in energy use match your actions?
2. Was decrease in electricity? Natural gas? Both?
3. 12 month arithmetic is "slow" to detect impact

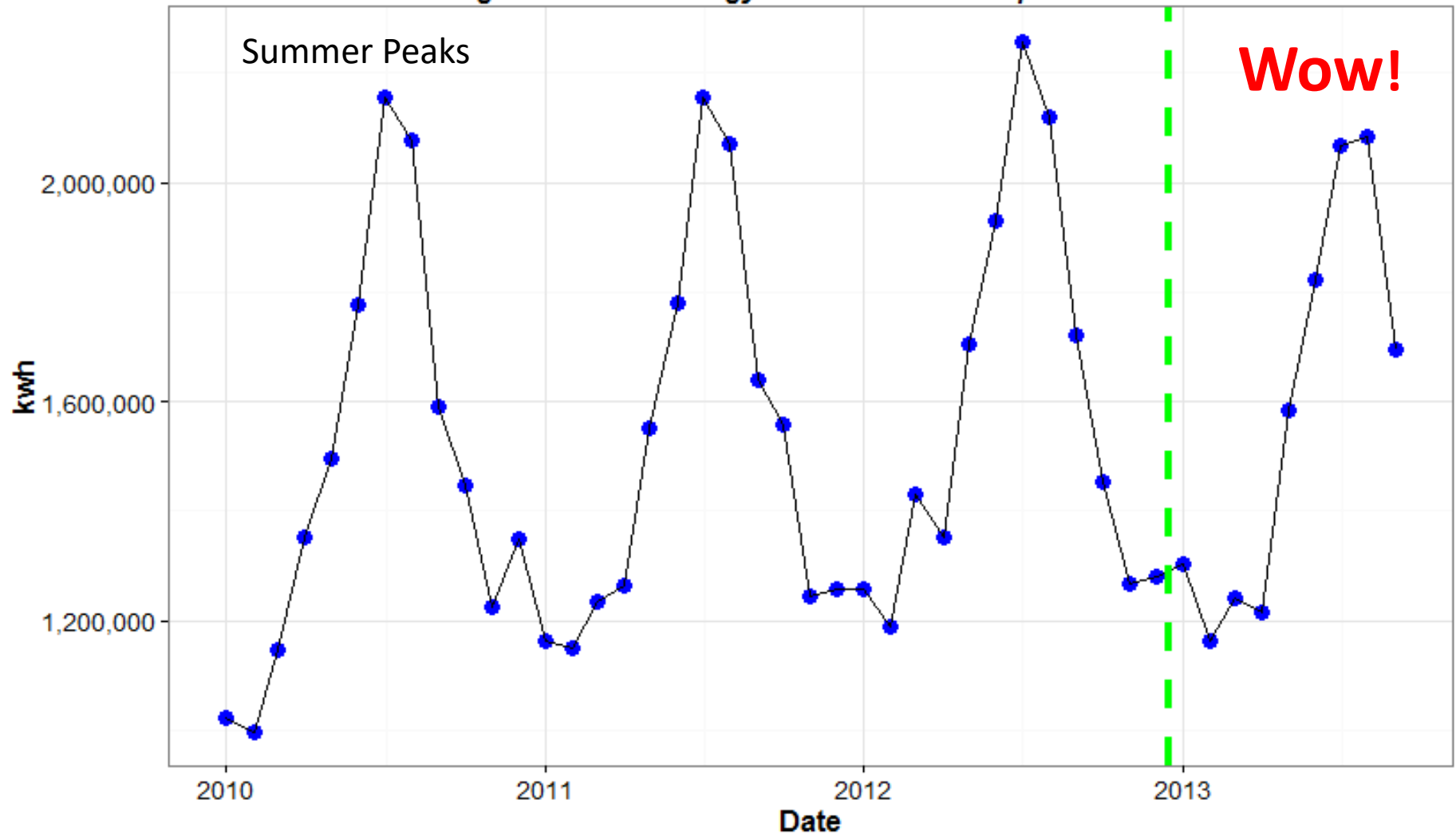


4. A REFINED QUESTION AND REFINED ANSWER



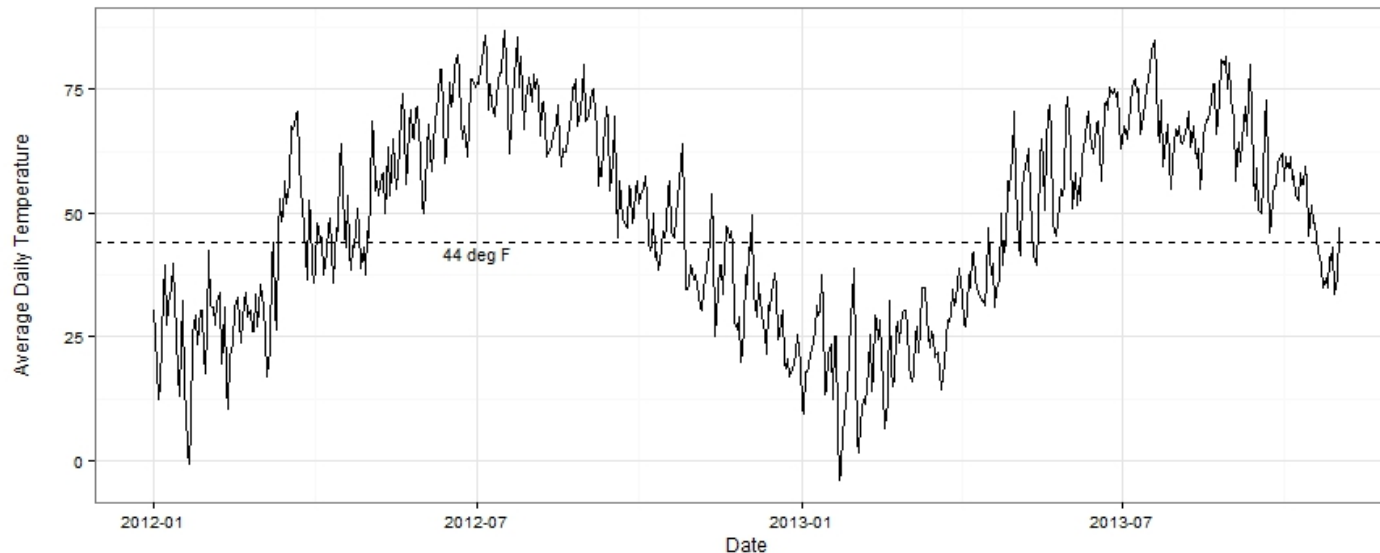
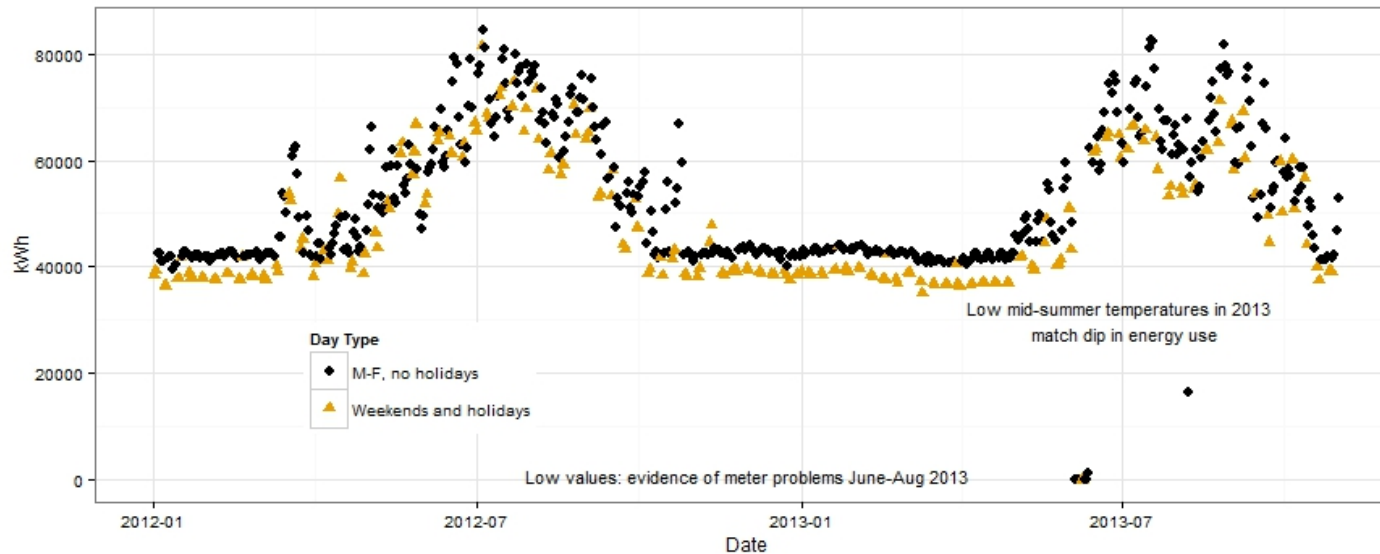
A Refined Question Posed in Oct 2013

Are we using less electric energy in 2013 than in the previous 36 months?



Daily electric energy use and Daily Mean Temperature Series: Why Temperature Matters

1 Jan 2012-31 Oct 2013



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

Reminder:
Energy use
and
temperature
are related,
so we better
look at
temperature
effects



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



1. Get the Right Data

Data Options

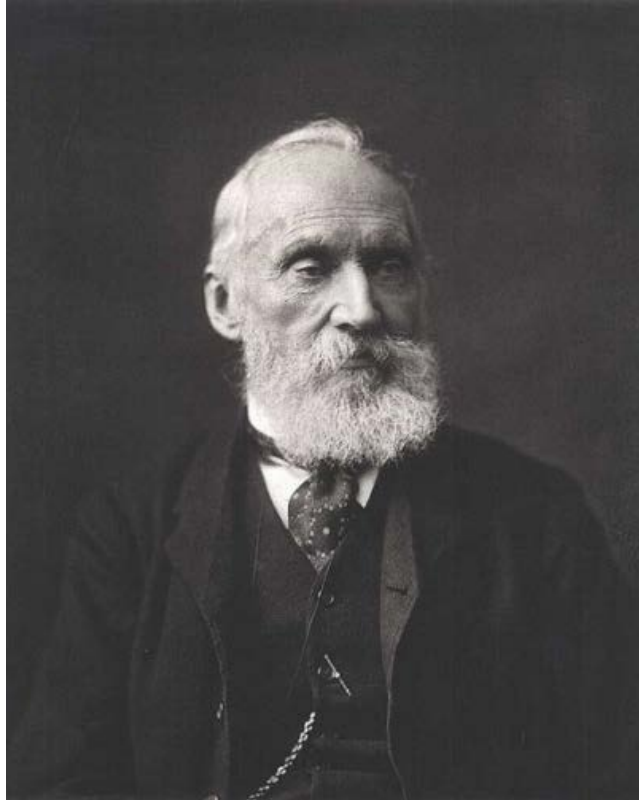
1. Use complete calendar months for energy
2. Work with "degree days" especially for heating. February is almost 10% shorter than January and energy use is therefore less

Alternative: work with energy/day, month by month

Getting started

1. Create complete months: energy use per day from bills; calculate calendar month by allocating energy per day from multiple bills
2. Calculate degree days for calendar months, varying the base

Reminder about data



Sir William Thomson, Baron Kelvin of Largs

"The more you understand what is wrong with a figure, the more valuable that figure becomes."

<http://zapatopi.net/kelvin/quotes/>

Months vary in length: Fewer Days, Lower energy use

Use "degree-day" calculation to compensate for varying lengths

EXAMPLE

Mean Temperature 3/6/2014: 20° F

Mean Temperature 9/2/2013: 75° F

Using 65° F base (typical, but you can vary base)

	<u>9/2/2013</u>	<u>3/6/2014</u>
Heating Degree Days	0	$65 - 20 = 45$
Cooling Degree Days	$75 - 65 = 10$	0

Hi Kevin!

CURRENT STATION INFORMATION:

Station Name: APPLETON

County: OUTAGAMIE

State: WI

[More Info](#)

MRCC website allows you to specify degree days with different base settings as well as get monthly summary temperatures

[Select Station](#)

Station Data

County Data

Climate Division Data

State Data

Maps of Gridded Data

Charts and Graphs

Home Links

Hourly

Daily

Monthly

Seasonal

Annual

Multi-Station

Dates:

January 2009

February 2014

To:

Between Specific Months

Monthly NCDC Normals

Ranking

[Select All](#)[Clear All](#)☐ Total Precipitation (in)☐ Total SnowFall (in)

Monthly Extremes

[Select All](#)[Clear All](#)☐ Greatest 1-Day Precipitation (in)☐ Greatest 1-Day SnowFall (in)☐ Maximum SnowDepth (in)[Send Feedback](#)[Log out](#)

MONTHLY CLIMATE DATA BETWEEN SPECIFIC MONTHS

Dates:

To:

January 2009

February 2014

Variables:

Monthly Sum/Average

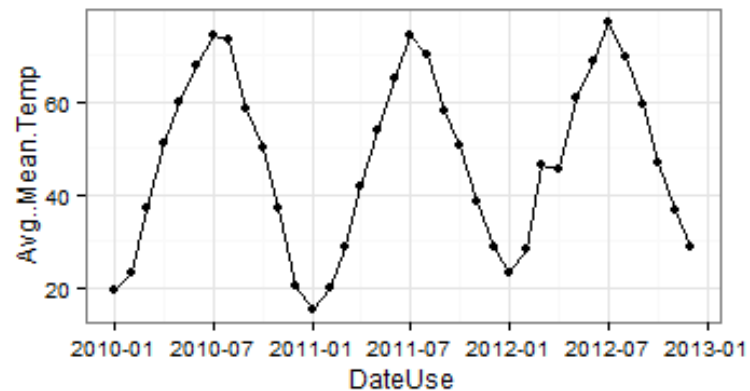
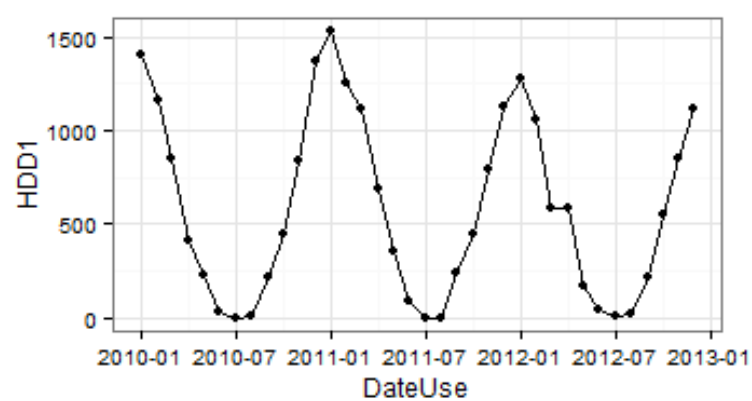
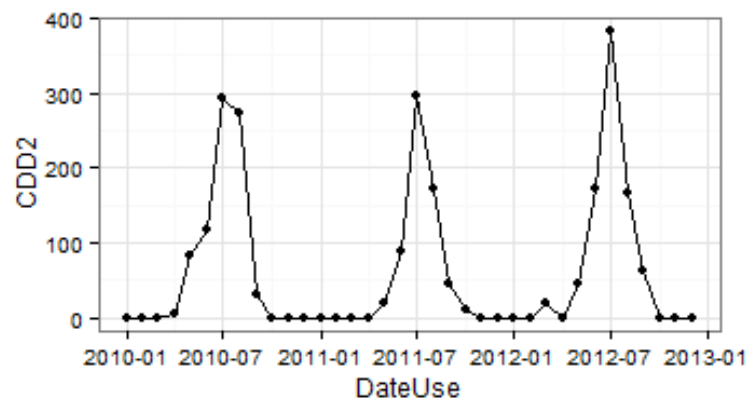
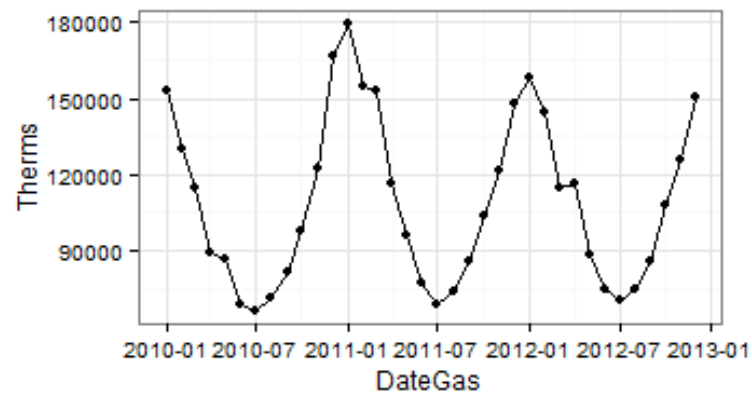
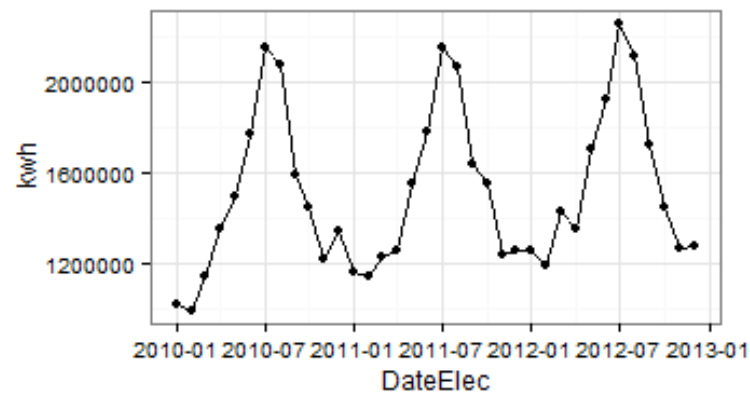
[Select All](#)[Clear All](#)☐ Total Precipitation (in)☐ Total SnowFall (in)☒ Average High Temperature (°F)☒ Average Low Temperature (°F)☒ Average Mean Temperature (°F)☐ Heating Degree Days (Base °F) 65☐ Cooling Degree Days (Base °F) 65☐ Growing Degree Days (Base 50°F)☐ Modified Growing Degree Days
(Base 50°F, Ceiling 86°F)

Monthly Extremes

[Select All](#)[Clear All](#)☐ Greatest 1-Day Precipitation (in)☐ Greatest 1-Day SnowFall (in)☐ Maximum SnowDepth (in)☐ Highest Max. Temperature (°F)☐ Lowest Max. Temperature (°F)☐ Highest Min. Temperature (°F)☐ Lowest Min. Temperature (°F)[Get Climate Data](#)

2. Set the Baseline Period

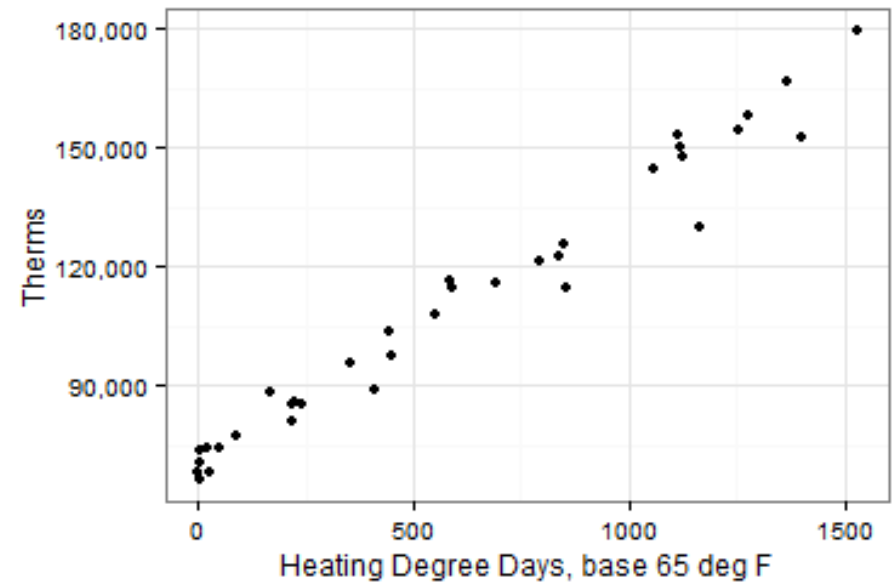
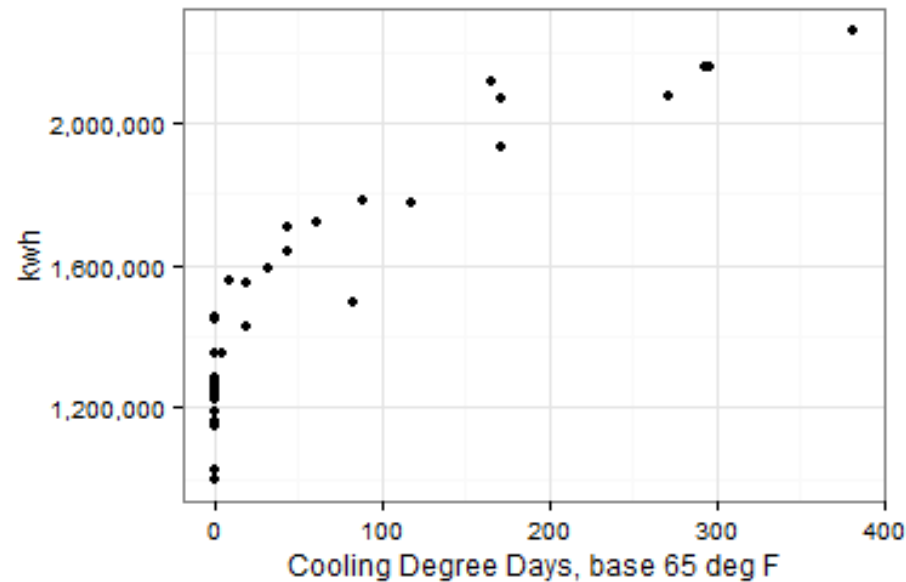
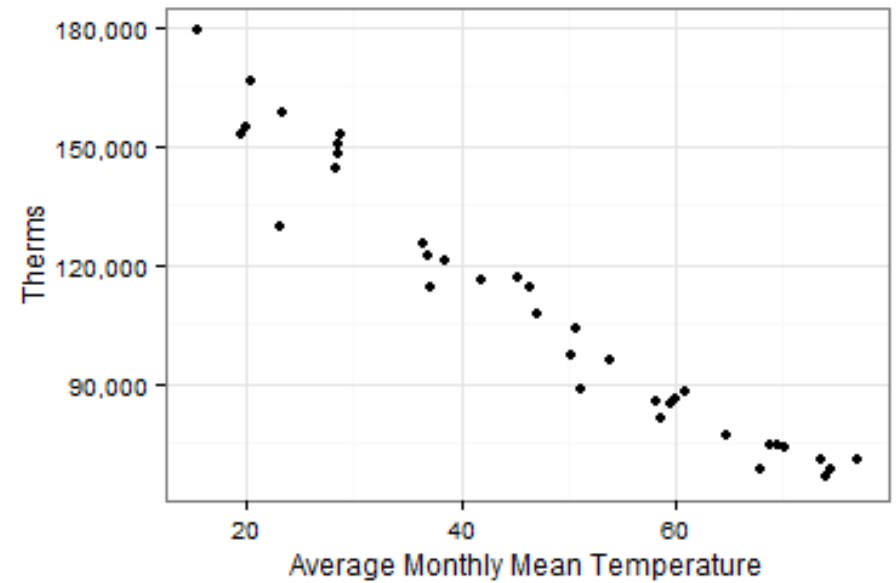
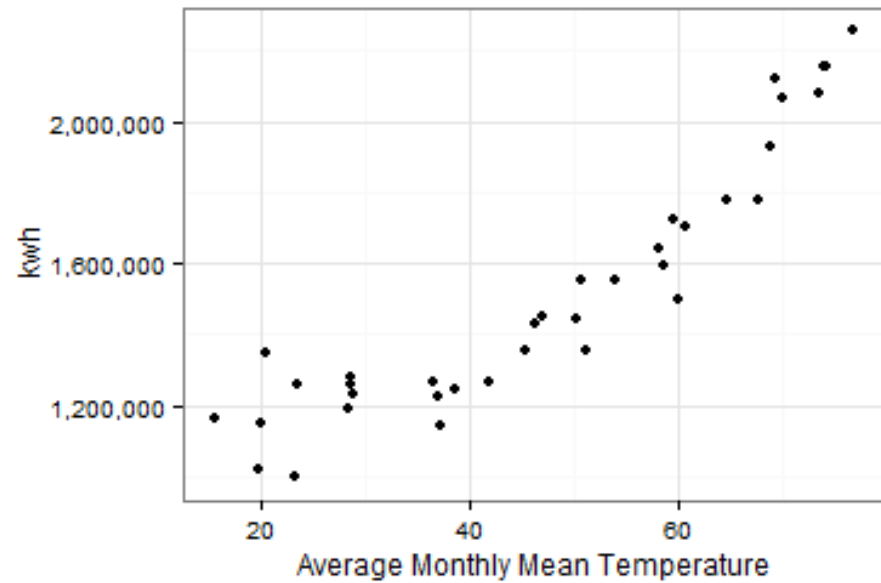
- Rational basis for comparison--relatively stable use (no major system changes, building additions, change in use)
- For monthly data modeling, 12 months is minimum.
- AMC: 36 months January 2010 - December 2012



3. Plot the Data



Energy and Temperature relationships, Jan 2010-Dec 2012





4. Model the energy use

- Three year upward trend and variation related to temperature.
- Use "regression" to create an equation

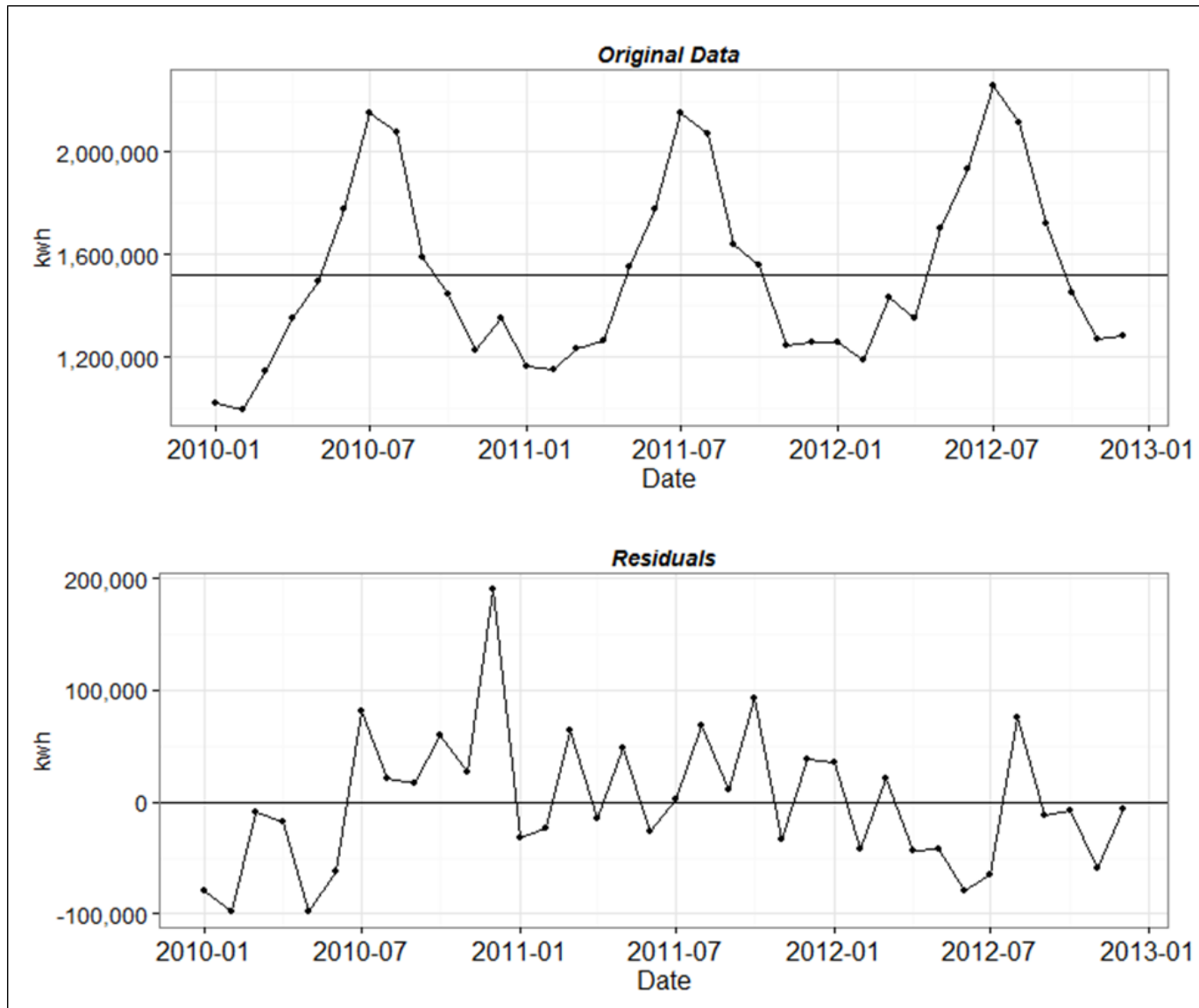
For example:

Predicted kwh =

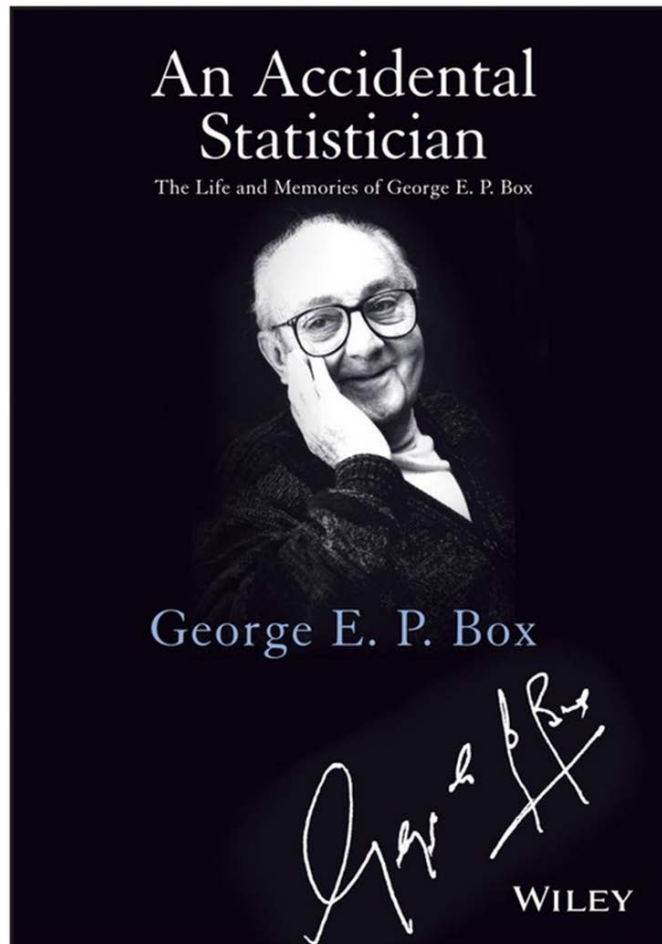
$$1,341,783 + 5596 \times \text{Month Time Step} \\ - 20455 \times \text{Average Monthly Mean Temperature} + \\ 402 \times (\text{Average Monthly Mean Temperature})^2$$



Check the Model



Is the Model useful?



"The fact that the polynomial is an approximation does not necessarily detract from its usefulness because all models are approximations.

Essentially, **all models are wrong, but some are useful.**

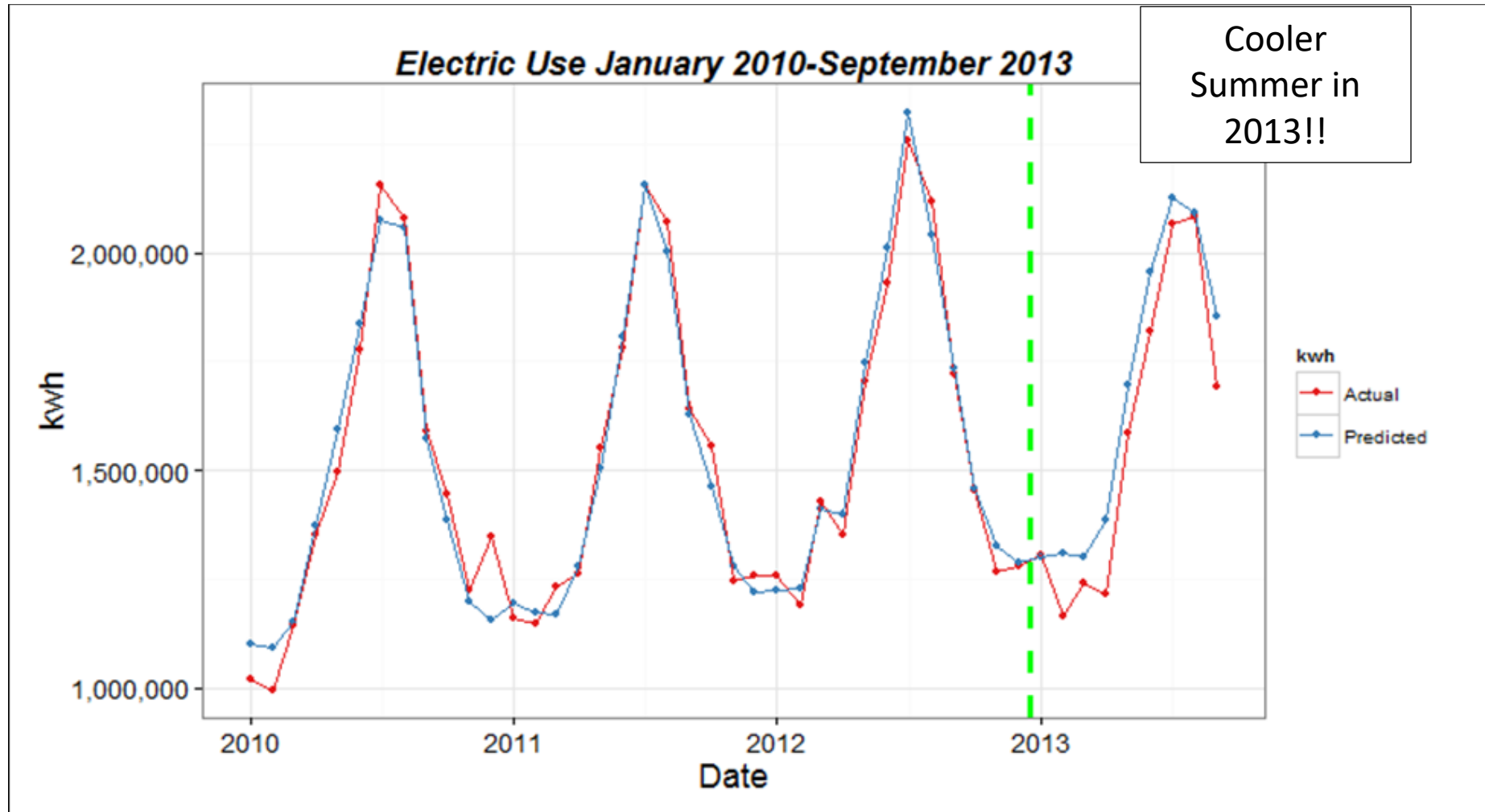
However the approximate nature of the model must always be borne in mind."

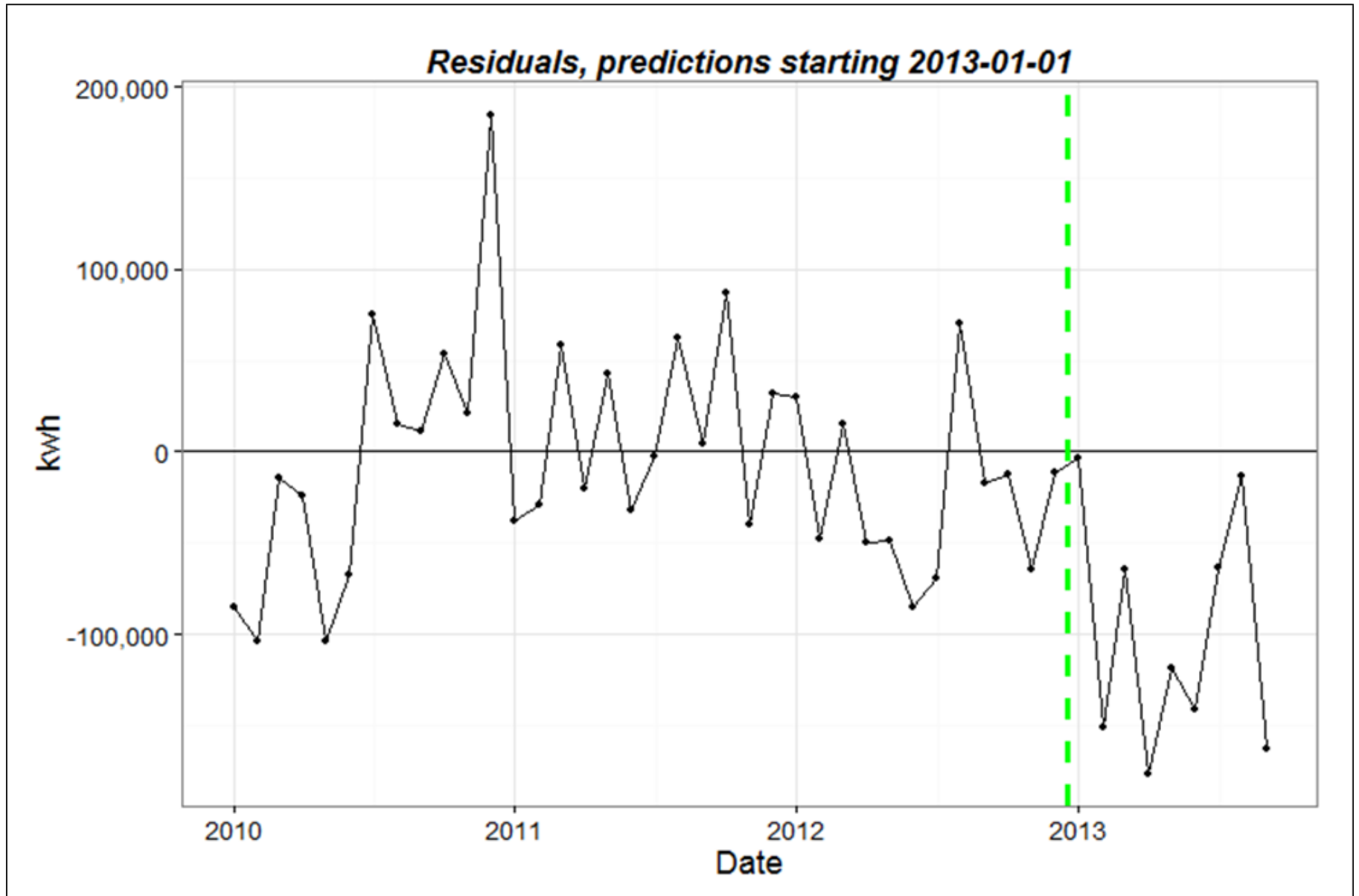
Box and Draper (1987), *Empirical Model Building and Response Surfaces* (1987) Wiley, p. 424

5. Predict Energy Use for 2013

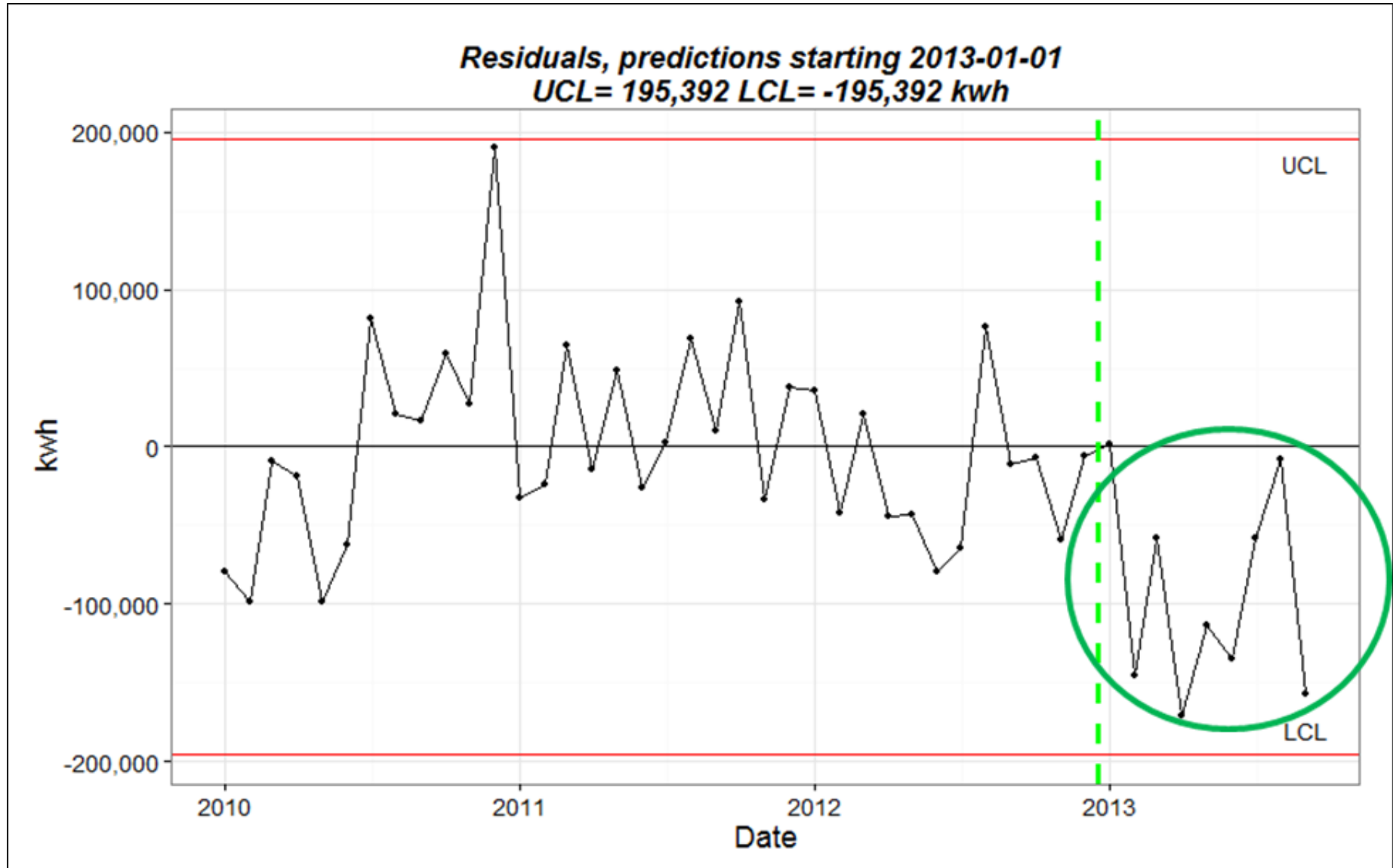
Get monthly temperature values for 2013 and use the model equation to generate predictions, month by month

6. Compare Actual to Predicted

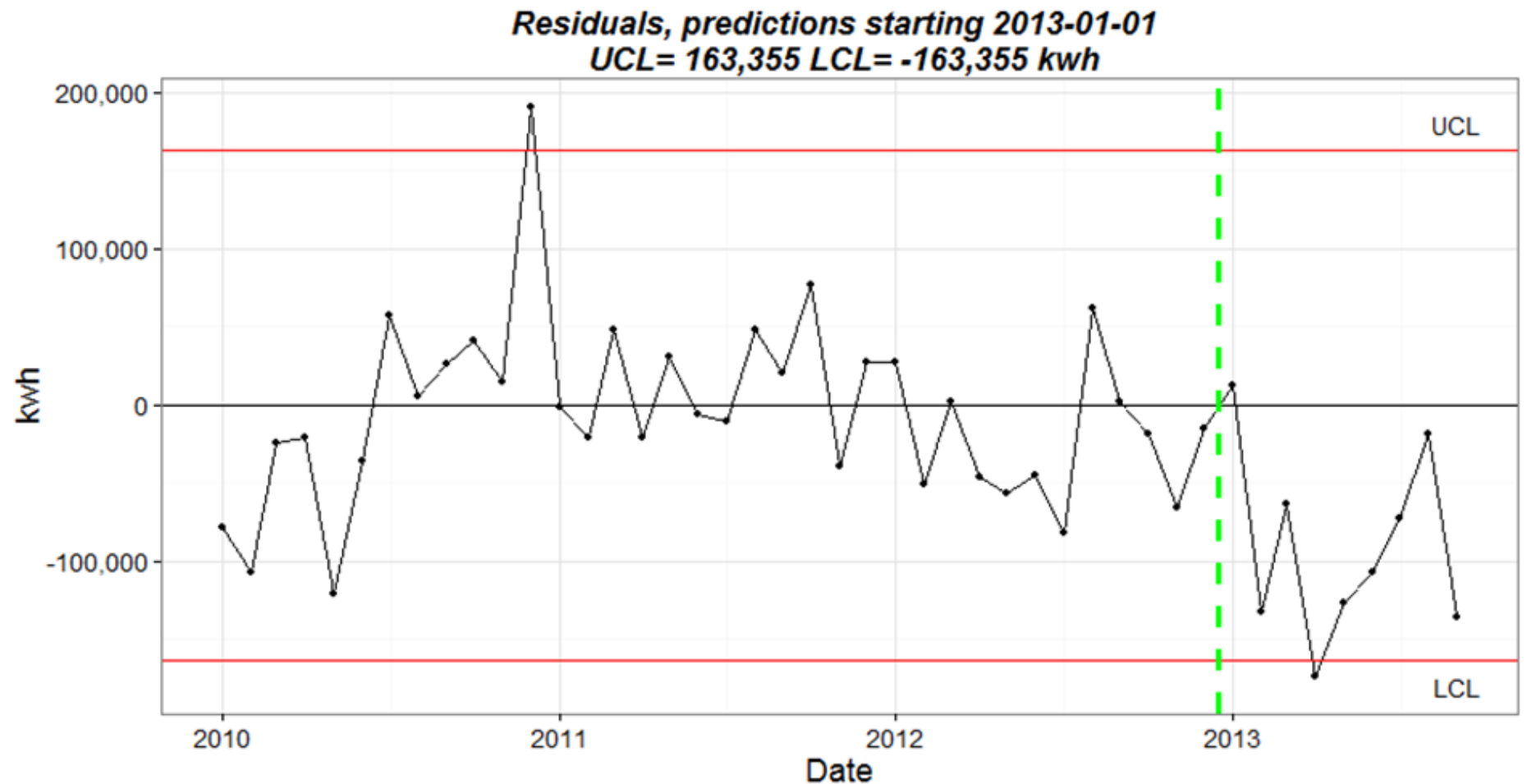




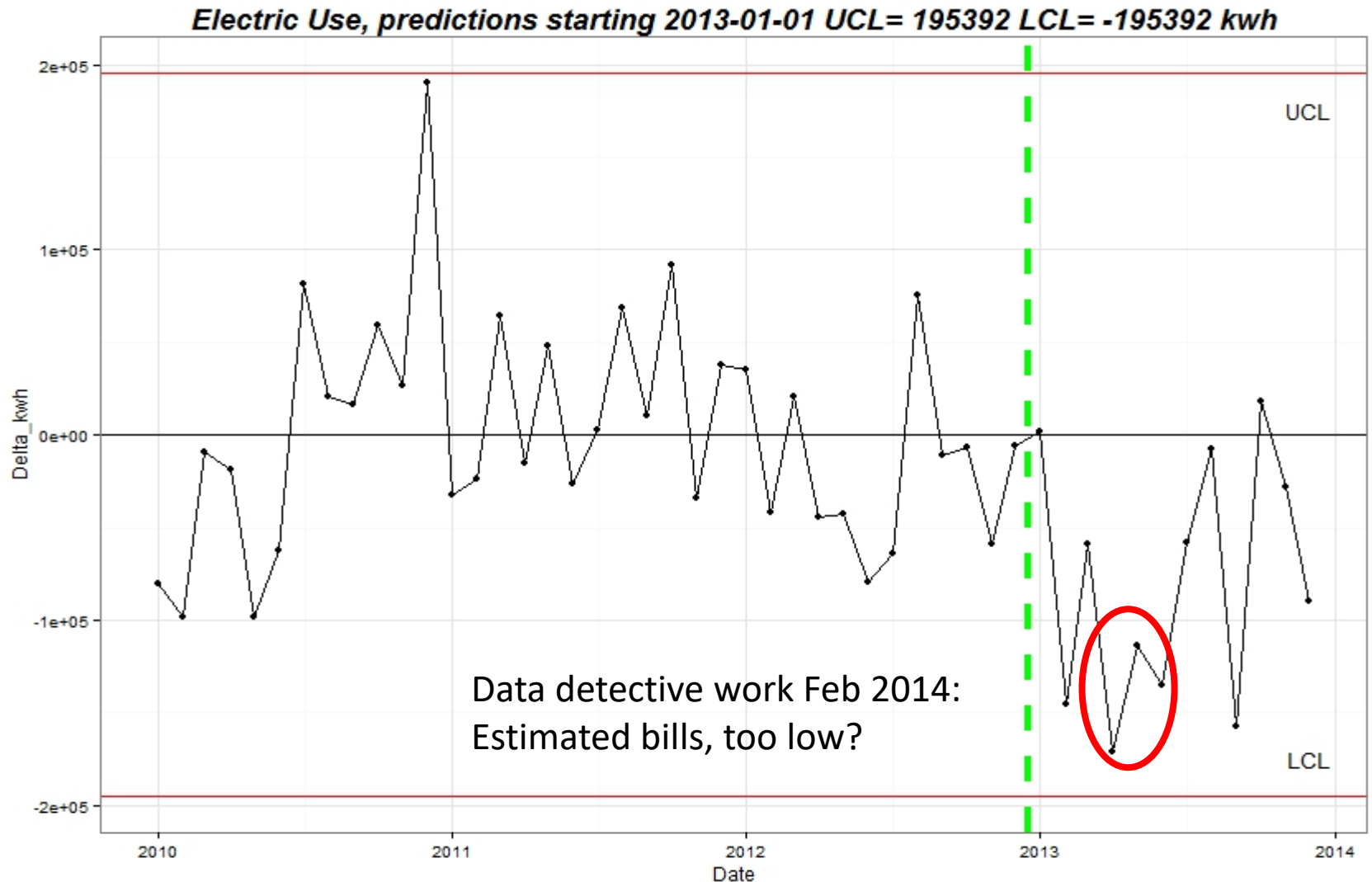
Control Chart Signal of Special Cause: 8 consecutive values below center line



Refined model--uses cooling degree days base 25° F, removes
~3 % variability from varying days in summer months



Update Through December 2013





7. Estimate avoided energy use and costs

2013 Summary Electric Energy Table

month	kwh	estimated kwh savings	kwh cost (cents)	estimated \$ savings
2013-01-01	1,304,700	-11,952	8.2	-978
2013-02-01	1,164,564	132,494	8.4	11,097
2013-03-01	1,241,590	63,949	8.2	5,219
2013-04-01	1,215,566	173,885	8.3	14,462
2013-05-01	1,584,208	126,562	8.4	10,646
2013-06-01	1,821,561	107,779	8.5	9,124
2013-07-01	2,067,926	72,441	8.4	6,052
2013-08-01	2,084,851	18,468	8.3	1,530
2013-09-01	1,694,425	136,364	9.0	12,239



Technical notes

1. Model issues
2. Control chart issues
3. Uncertainty in estimating savings

See discussion in blog post

<https://www.iecodesign.com/blog/2013/11/15/is-our-building-using-less-energy-this-year-part-2>



5. YOUR TURN: MODEL ENERGY USE, LOOK FOR CHANGES FROM BASELINE



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 www.iecodesign.com/HospitalGasExercise.xlsx

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 <http://www.iecodesign.com/SchoolElecData.xlsx>

Your own building

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.



References

Degree-day blog post

<http://www.energystewards.net/useful-ideas/what-are-degree-days/>

Summary of AMC Electricity case:

<http://www.iecodesign.com/index.php/our-blog/181-is-our-building-using-less-energy-this-year-part-1>

<http://www.iecodesign.com/index.php/our-blog/183-is-our-building-using-less-energy-this-year-part-2>

APPENDIX: TEMPERATURE DATA SOURCES







Temperature Data Sources

Sources	Barriers to Use
Outside air sensors – tied to building automation system	Extracting data; maintenance of sensors; data quality
Stand-alone temperature sensors	Extracting data; maintenance of sensors; data quality
U.S. NOAA data (public domain) Canada: http://climate.weather.gc.ca/	No cost for simple searches; cumbersome to access multiple locations; location effect?
Weather data services	Fee-based vs free; location effect?



Example of Free NOAA Data


National Weather Service Forecast Office
Twin Cities
weather.gov


[Home](#)
[News](#)
[Organization](#)
Search for:
[NWS](#)
[All NOAA](#)
[Go](#)

Local forecast by "City, St"

City, St [Go](#)

Current Hazards
Watches/Warnings
Outlooks
Submit Report

Current Conditions
Observations
Radar
Satellite Images
Observed Precip

Forecasts
Forecast Discussion
Local Area
Activity Planner
Aviation
Fire Weather
Severe Weather
Hurricane Center

Hydrology
Rivers & Lakes
Climate
Local
National
Drought
More...
Weather Safety

As part of its ongoing efforts to improve service to the public, The National Weather Service has released a local 3-month temperature outlook. Access the product for your area [here](#). Please click [here](#) to complete the feedback survey.

[Observed Weather](#)
[Climate Locations](#)
[Climate Prediction](#)
[Climate Resources](#)
[Local Data/Records](#)
[Astronomical](#)
[NOWData](#)

Observed Weather Reports

1. Product »

☐ Daily Climate Report (CLI)
☒ Preliminary Monthly Climate Data (CF6)
☐ Record Event Report (RER)
☐ Monthly Weather Summary (CLM)
☐ Regional Summary (RTP)
☐ State Summary (Temp/Precip)

2. Location »

[Minneapolis/St Paul](#)
[Saint Cloud](#)
[Eau Claire](#)
[Chanhassen](#)
[Alexandria](#)
[Redwood Falls](#)
[Mankato](#)

3. Timeframe »

☒ Most Recent
☐ Archived Data:
 September 2009
 August 2009
 July 2009
 June 2009
 May 2009
 April 2009

4. View »

[Go](#)

Storm Event Database (SPC)
Storm Data (HCDC)

Product Description:

PRELIMINARY MONTHLY DATA (CF6) - updated frequently:
 Daily weather statistics for the month, including temperatures, precipitation, degree days, wind and sky cover. In addition, monthly statistics such as average temperatures and departures from normal degree days, and rainfall are also included. This product is available for up to 5 years.

Explanation of the Preliminary Monthly Climate Data (F6) Product

These data are preliminary and have not undergone final quality control by the National Climatic Data Center (NCDC). Therefore, these data are subject to revision. Final and certified climate data can be accessed at the NCDC - <http://www.ncdc.noaa.gov>.


WFO Monthly/Daily Climate Data

000
 CZUS53 KMPX 011110
 CF6MSP
 PRELIMINARY LOCAL CLIMATOLOGICAL DATA (WS FORM: F-6)

STATION: TWIN CITIES MN
 MONTH: AUGUST
 YEAR: 2009
 LATITUDE: 44 52 N
 LONGITUDE: 93 13 W


TEMPERATURE IN F:		PCPN:	SNOW:	WIND	SUNSHINE:	SKY	PK WND											
1	2	3	4	5	6A	6B	7	8	9	10	11	12	13	14	15	16	17	18
AVG																		
12.2																		
WIND																		
12.2																		
DIR																		
12.2																		
MIN																		
12.2																		
MAX																		
12.2																		
DEP																		
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CDD																		
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WTR																		
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SPD																		
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DIR																		
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MIN																		
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PEBL																		
12.2																		
S-S																		
12.2																		
WX																		
12.2																		
SPD																		
12.2																		
DR																		
12.2																		
1																		
72																		
59																		
66																		
-7																		
0																		
1																		
0.00																		
0.0																		
0																		
13.1																		
26																		
270																		
M																		
M																		
5																		
33																		
280																		
2																		
82																		
56																		
69																		
-4																		
0																		
4																		
0.42																		
0.0																		
0																		
7.8																		
30																		
250																		
M																		
M																		
4																		
43																		
240																		
3																		
82																		
63																		
73																		
0																		
8																		
0.00																		
0.0																		
0																		
7.6																		
20																		
280																		
M																		
M																		
3																		
23																		
280																		

Free comprehensive data source for U.S.



MRCC APPLICATION TOOLS ENVIRONMENT

WELCOME TO THE cli-MATE DATABASE



PLEASE LOG IN:

Email:

Password:

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PLEASE NOTE:
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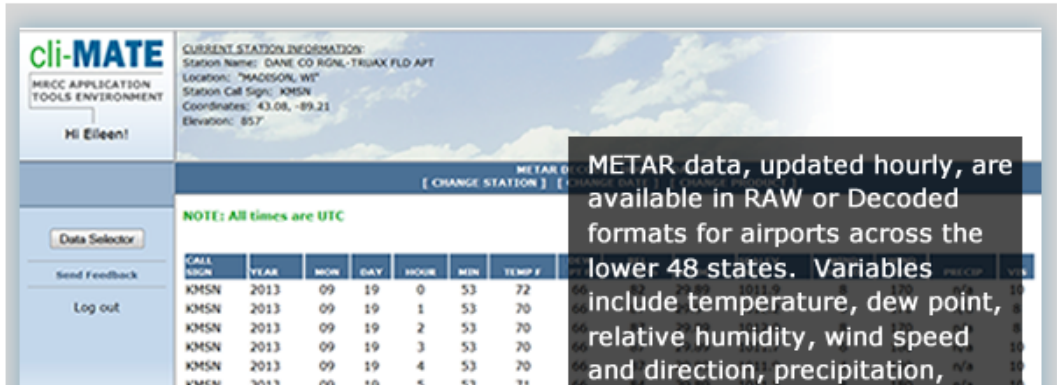
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Midwestern Regional Climate Center

Announcing **cli-MATE**: the MRCC's Application Tools Environment for accessing climate data and value-added tools. **cli-MATE** is replacing our previous subscription data tool, MACS. The best part of cli-MATE is that it is now FREE!

If you are a new user, register for free access to cli-MATE using the registration button near the top of the page. For users that would like to download and access large amounts of climate data, the MRCC is still offering services to help you with those needs.

Use cli-MATE to look up such information as raw climate data, rankings of climate information, thresholds, growing season tools, maps, graphs, and much, much more.

HIGHLIGHTED PRODUCTS
(mouse over to pause scrolling)



cli-MATE
MRCC APPLICATION TOOLS ENVIRONMENT

Hi Eileen!

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CURRENT STATION INFORMATION:
Station Name: DANE CO REG-TRIAX FLD APT
Location: "MADISON, WI"
Station Call Sign: KMSN
Coordinates: 43.08, -89.21
Elevation: 857'

METAR 0
[CHANGE STATION]

NOTE: All times are UTC

CALL SIGN	YEAR	MON	DAY	HOUR	MIN	TEMP F
KMSN	2013	09	19	0	53	72
KMSN	2013	09	19	1	53	70
KMSN	2013	09	19	2	53	70
KMSN	2013	09	19	3	53	70
KMSN	2013	09	19	4	53	70
KMSN	2013	09	19	5	53	71

METAR data, updated hourly, are available in RAW or Decoded formats for airports across the lower 48 states. Variables include temperature, dew point, relative humidity, wind speed and direction, precipitation,

<http://mrcc.isws.illinois.edu/CLIMATE/>

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57

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

<http://healthierhospitals.org/hhi-challenges/leaner-energy/webinars-and-sharing-calls>