Healthier Hospitals Initiative Leaner Energy Challenge

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27 February 2014

Our premise

- The Leaner Energy challenge requires benchmarking and monitoring, which demand data skills and savvy
- Facilities and sustainability managers sometimes are challenged by the data issues
- QI specialists have relevant skills and understanding
- A small contribution by QI specialists can repay itself multiple times in better environmental performance.

Leaner Energy Challenge, explained

Getting ready to work with energy data

Leaner Energy Challenge

Level 1	Level 2	Level 3
Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by three percent from baseline.	Reduce greenhouse gases by decreasing weather-adjusted energy intensity from metered energy use by five percent from baseline.	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)

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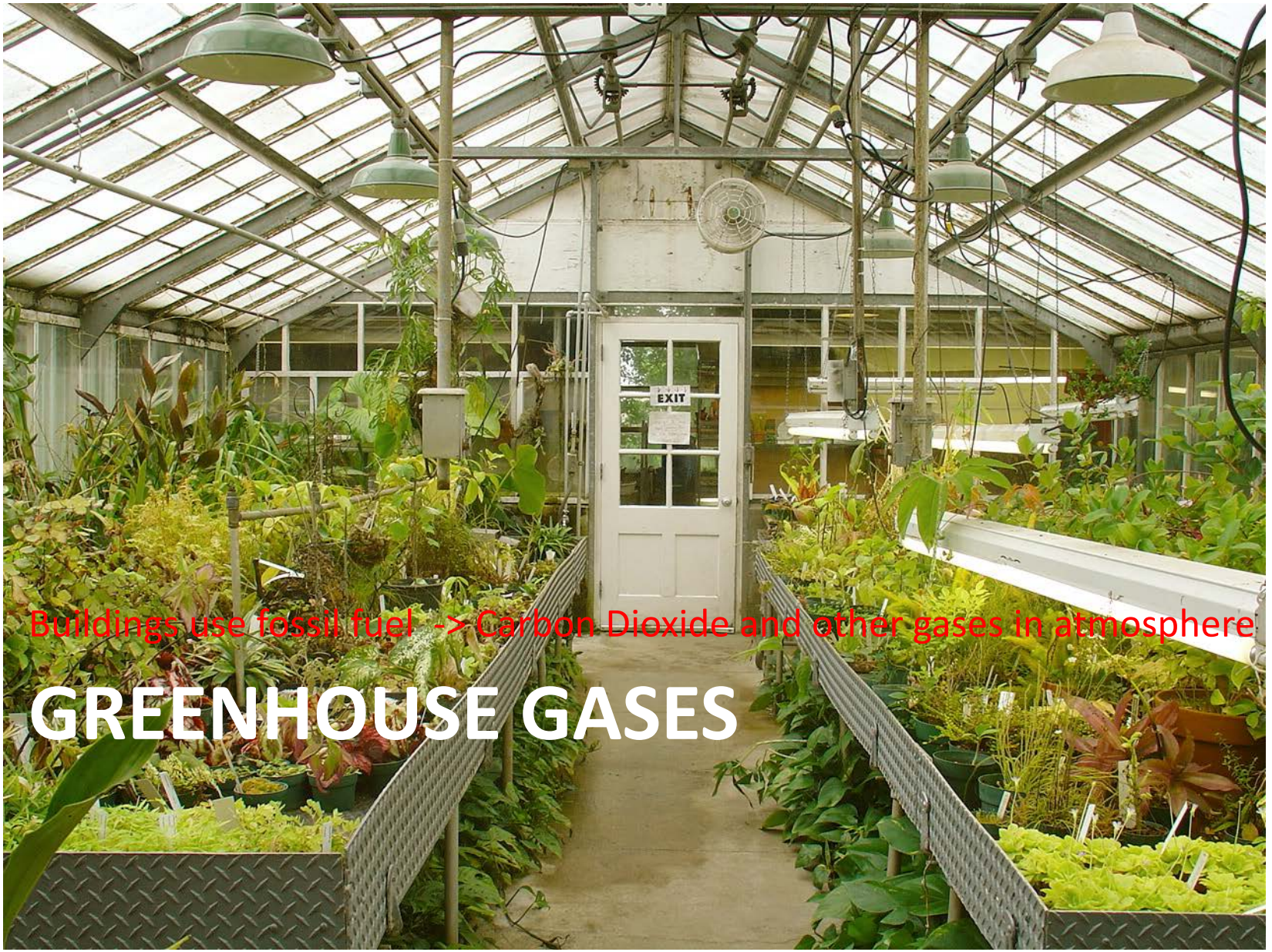
Our task: to explain the Leaner Energy Challenge, in 20 minutes

- Greenhouse Gases
- Weather-adjusted energy intensity
  - energy units, defined
  - ordinary energy intensity
- ENERGY STAR Portfolio Manager web app
- Portfolio Manager 1-100 Rating System; the meaning of 75



Buildings use fossil fuel -> Carbon Dioxide and other gases in atmosphere

GREENHOUSE GASES

Greenhouse gases (GHGs)

- Carbon dioxide, methane, nitrous oxide, & fluorinated gases are major GHGs.
- All GHGs trap heat energy in Earth's atmosphere, like glass in a greenhouse
- In practice, GHGs other than CO_2 expressed as CO_2 "equivalent" to simplify reports and math

http://www.epa.gov/climatechange/ghgemissions/gases.html accessed 12 February 2014

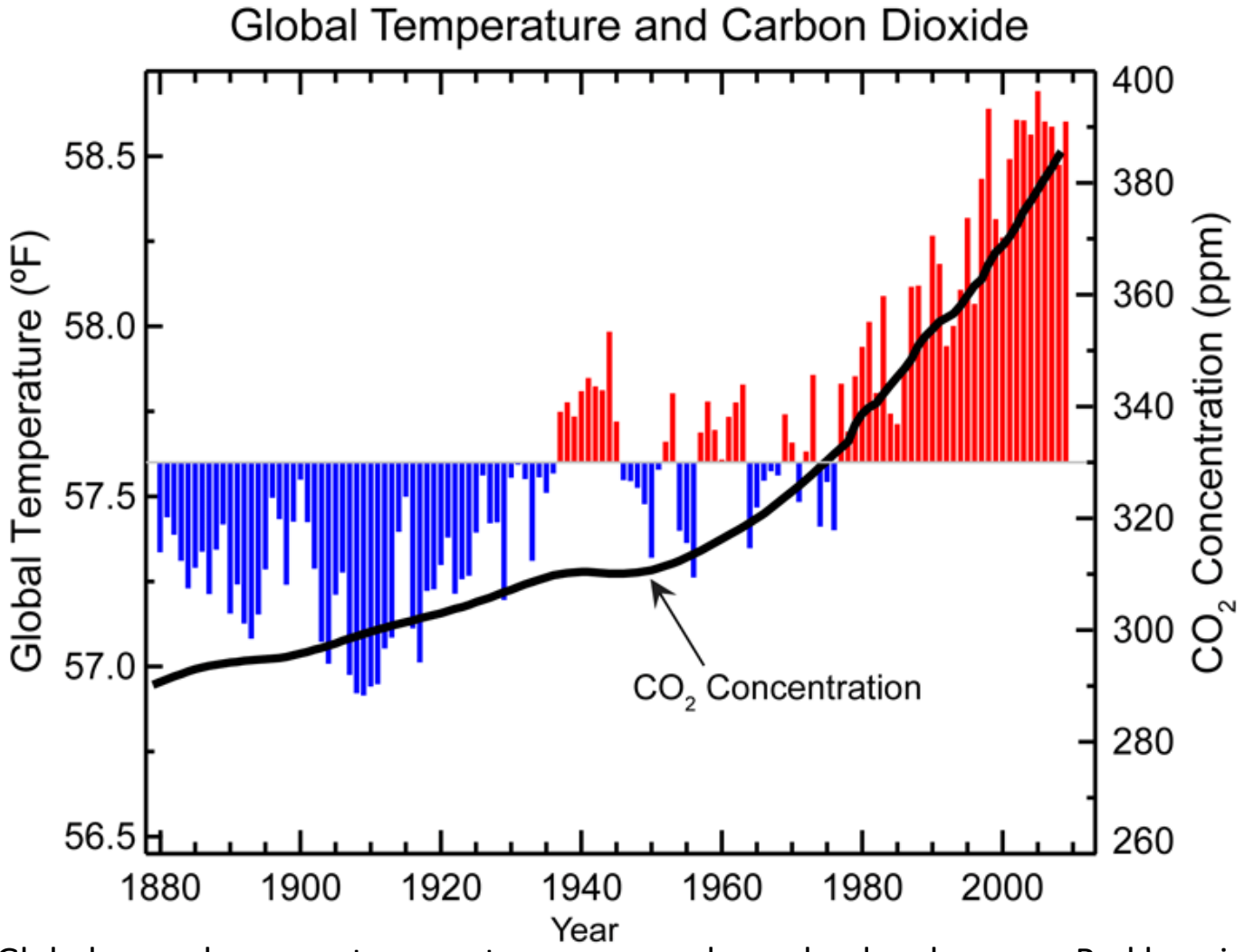
Burning coal to generate electricity for your building generates CO_2

Coal + O_2 -> CO_2 + heat energy

In more detail:

2 $C_{10}H_2$ + 21 O_2 -> 2 H_2O + 20 CO_2 + heat energy

Heat energy can boil water to make steam, to turn a turbine, to generate electricity.

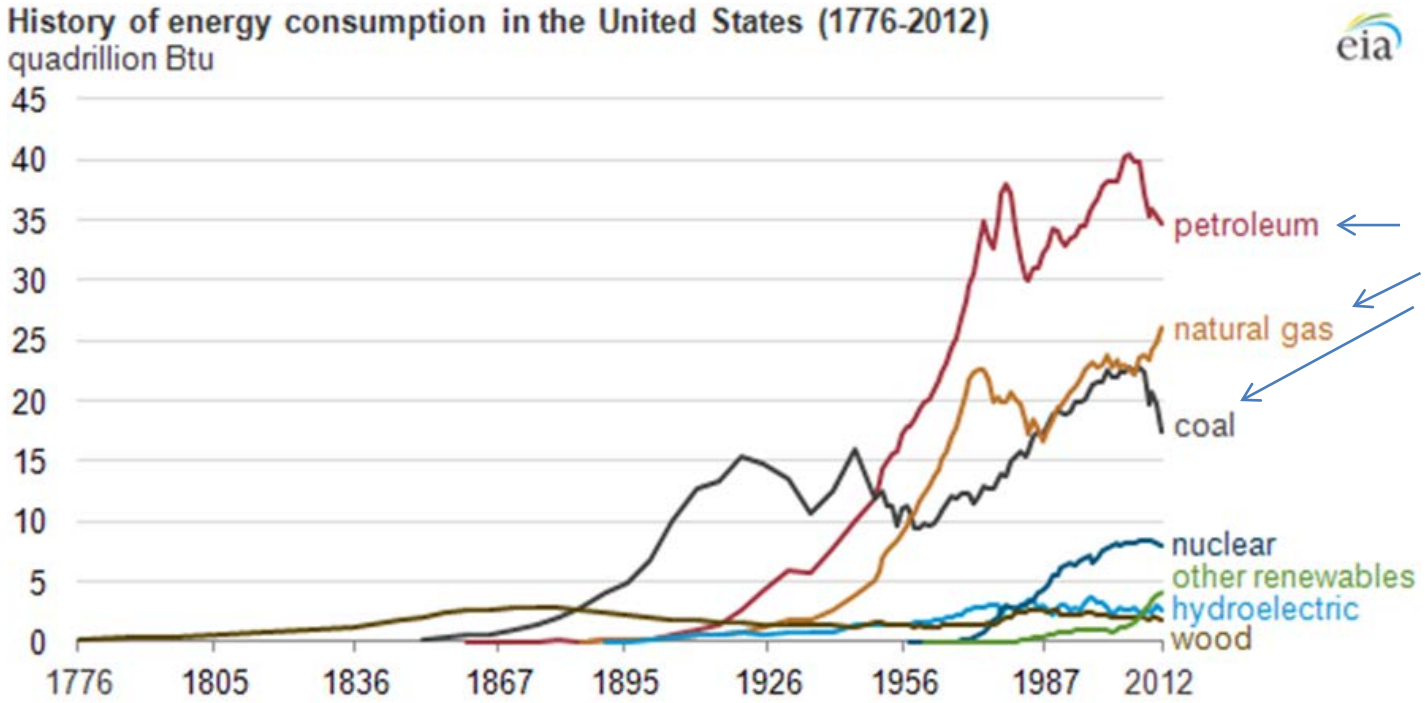


Why we care: clear data consistent with prediction that increased GHG from human activity is affecting climate

Global annual average temperature measured over land and oceans. Red bars indicate temperatures above and blue bars indicate temperatures below the 1901-2000 average temperature. The black line shows atmospheric carbon dioxide concentration in parts per million.

https://www.ncdc.noaa.gov/indicators/ accessed 17 February 2014

Coal and natural gas are the fossil fuels that generate most energy in buildings in the U.S.*



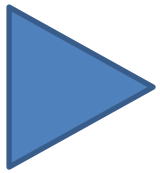
Fossil fuels= carbon from a long time ago

http://www.eia.gov/todayinenergy/detail.cfm?id=11951&src=Total-b1
accessed 20 January 2014

*generation mix varies by region of the country

October 2013 Electricity Generation in Wisconsin

Category	Net Electricity Generation GWh*	% of generation
Petroleum-Fired	2	0.04%
Natural Gas-Fired	634	13.06%
Coal-Fired	2974	61.24%
Nuclear	895	18.43%
Hydroelectric	88	1.81%
Other Renewables	263	5.42%



~75% fossil fuel

http://www.eia.gov/state/?sid=WI#tabs-4 accessed 20 January 2014

In-state generation accounted for 89% of electric energy, the other 11% was imported over transmission lines (2010 figures, latest available), accessed 20 Jan 2013
http://www.stateenergyoffice.wi.gov/docview.asp?docid=24669&locid=160

*GWh = giga-watt-hours, one billion watt hours….we'll explain units in a few minutes!

WEATHER-ADJUSTED ENERGY INTENSITY

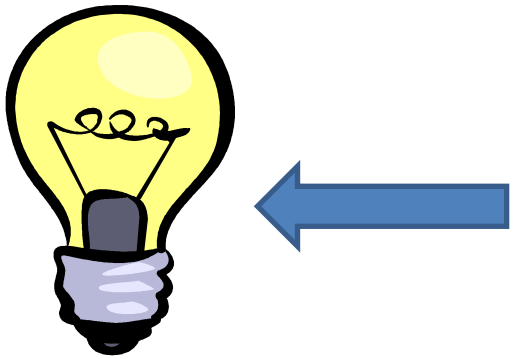
Explanation sequence

1. Energy units
2. Energy Intensity
3. Weather-adjusted energy intensity

Typical Energy Units

- Electricity: kilowatt-hours (kWh)
- Natural gas: therms = 100,000 British thermal units (BTUs)
- Metric system energy units: joules
- All energy units can be converted, one to another. Here's a calculator.

Kilowatt-hour Defined



The traditional 100 watt incandescent bulb

- Requires 100 watts of POWER to produce light (and heat!)
- In one hour, energy used to power the bulb is:

  100 watts x 1 hour =

  100 watt-hours.
- In 10 hours of use:

  100 watts x 10 hours =

  1000 watt-hours =

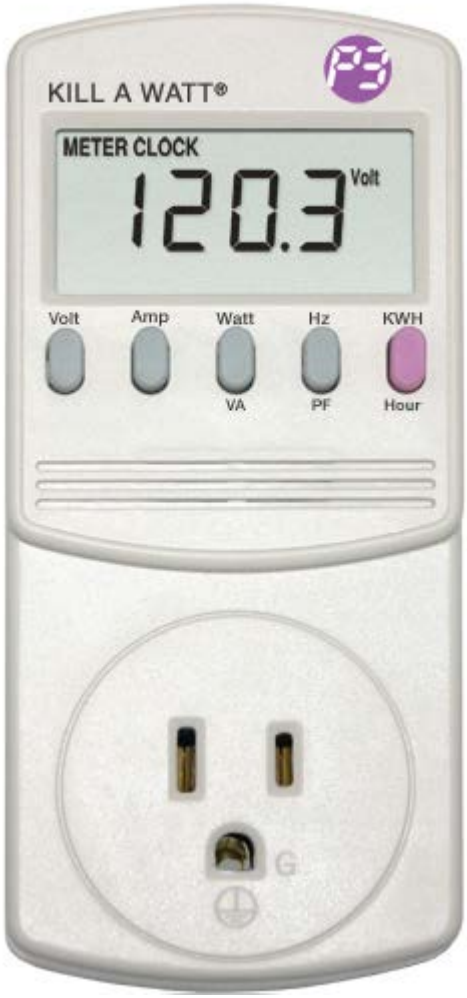
  1 **kilowatt-hour**

  abbreviated **kWh**

Commercial Buildings usually get charged both for "peak" power and energy. Come back for session 3 to learn why this matters for energy management.

Today we will focus on ENERGY.

Build your kWh energy intuition



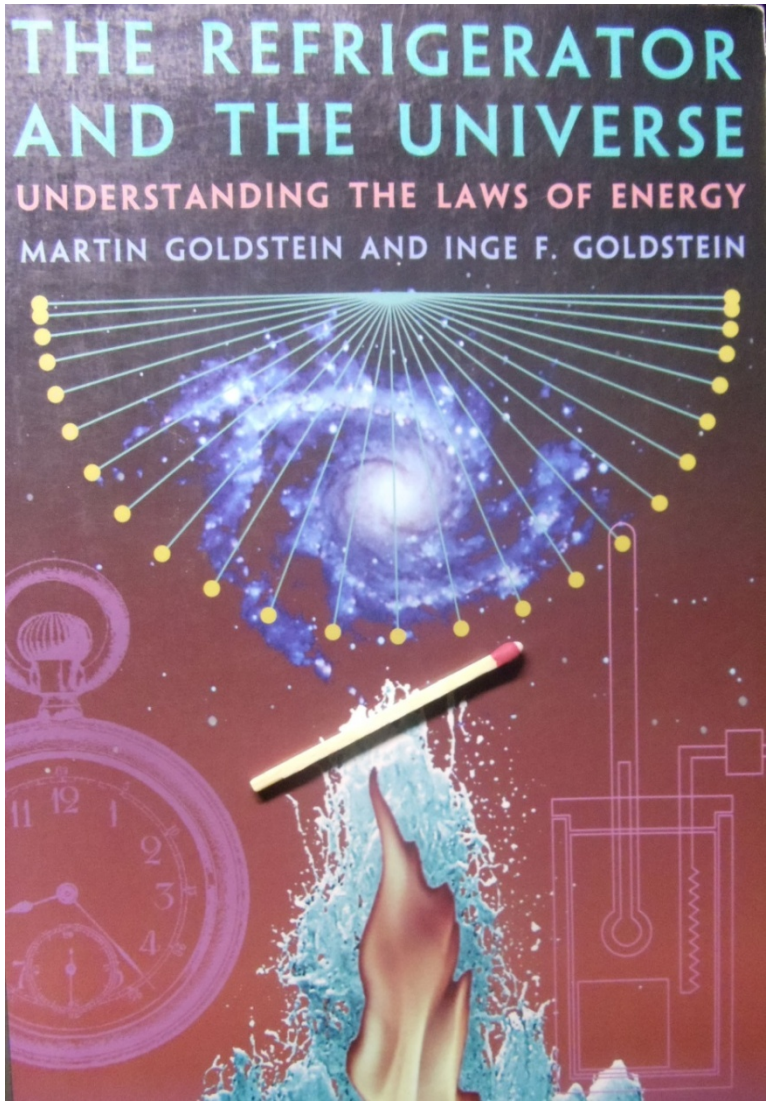
Try this at home:

Get a meter (some libraries lend them or you can buy one to experiment).

- Measure plug-in appliances (refrigerators, toasters, flat-screen TVs, phone chargers….)
- How much energy does each appliance use in an hour? In a week?
- Can you change your use?

http://www.p3international.com/

Therms and BTUs



A BTU: the heat energy in a wooden kitchen match

1 Therm: 100,000 BTUs

1 Therm: 100 kBTUs

Gas meters typically measure volume of natural gas. In the U.S., 100 cubic feet of natural gas at typical pressures is about 1 therm.

Common units, continued

- 1000 BTU = 1 kBTU
- 1 Million BTU = MBTU or MMBTU, be careful!
- 1 Decatherm = 10 Therms = 1 MMBTU
- Gas meters typically measure volume of natural gas.
- 100 cubic feet = 1 CCF ≈ 1 Therm of energy

What is Energy Intensity?

- EI = Energy use over a time interval per unit area of the facility.
- You can choose **time interval, energy units**, and **area units**.
- In U.S.: kBTU/sq ft/yr
- In Canada: giga-joules/sq meter/yr

2010 U.S. national average

in-patient facilities[1]

213.7

Model benchmarks for hospitals, climate zone 6A[2]

Pre	Post	New
1980	1980	2010
202.0	199.9	158.1

Two flavors of Energy Intensity…

Site Energy Intensity: based on energy used on site

1 kWh from a solar panel on your roof and used in your building= 1 kWh from the "grid" used in your building

Leaner Energy challenge uses **site** energy intensity

Source Energy Intensity: based on estimate of energy used to produce the energy used on site

It takes a lot of energy to deliver a kWh to your building. National grid U.S. avg ~ 3 kWh of energy to deliver 1 kWh on site.

What is *weather-adjusted* Energy Intensity?

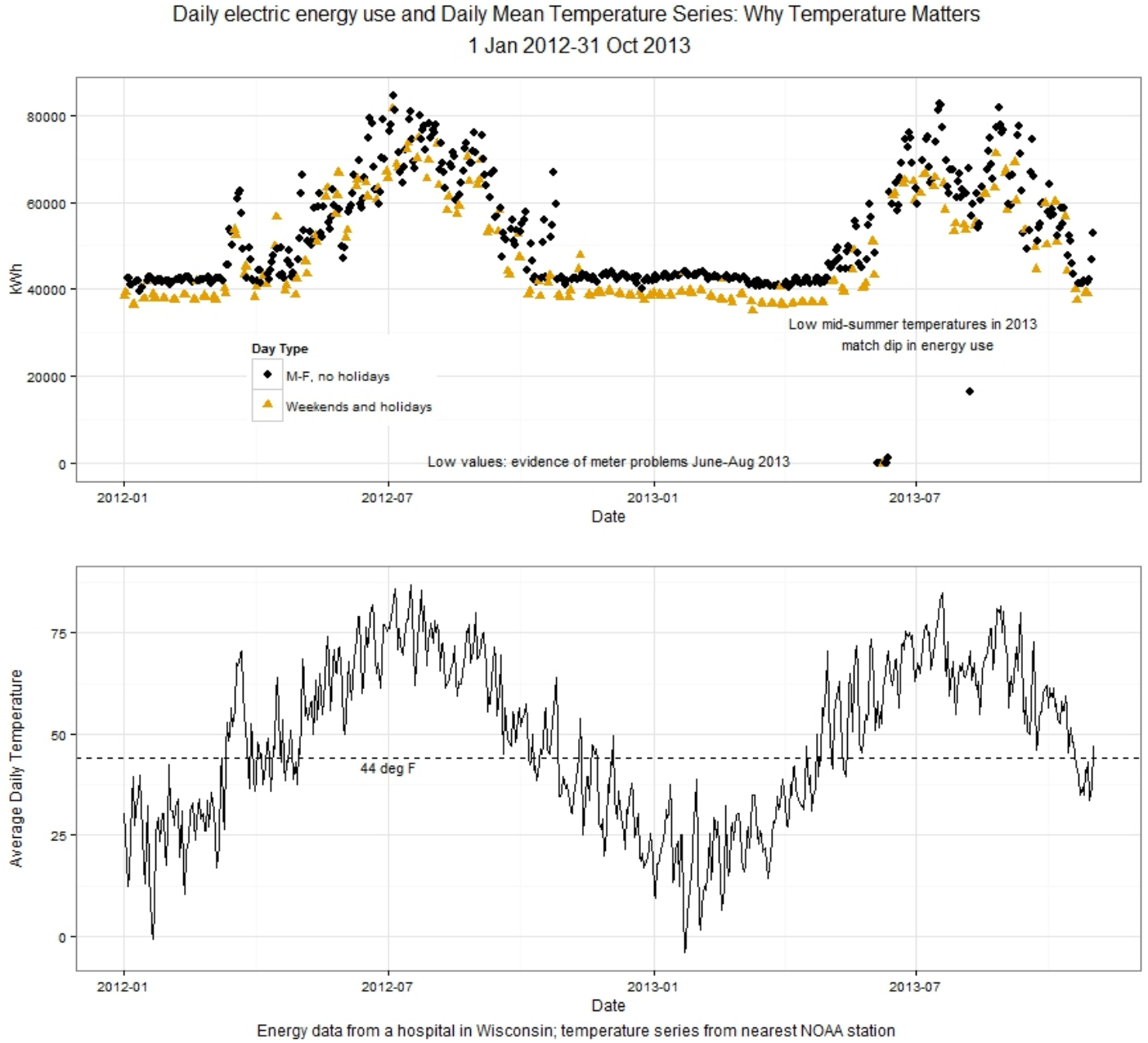
1. Weather affects energy use.
2. Variation in weather

   → variation in E.I.

1. Variation obscures understanding
2. Regression methods adjust energy use for weather (typically, just temperature), reduce variation

kBTU/ sq ft / yr

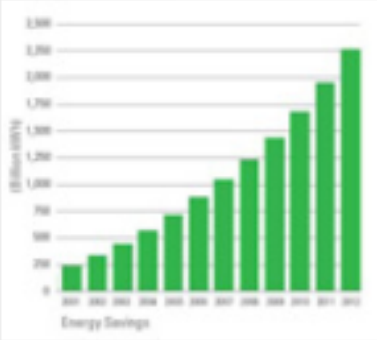
(adjusted KBTU)/ sq ft / yr


Daily electric energy use and Daily Mean Temperature Series: Why Temperature Matters
1 Jan 2012-31 Oct 2013
kWh
80000
60000
40000
20000
0
Day Type
M-F, no holidays
Weekends and holidays
Low mid-summer temperatures in 2013
match dip in energy use
Low values: evidence of meter problems June-Aug 2013
2012-01
2012-07
2013-01
2013-07
Date
Average Daily Temperature
75
50
25
0
44 deg F
2012-01
2012-07
2013-01
2013-07
Date
Energy data from a hospital in Wisconsin; temperature series from nearest NOAA station

ENERGY STAR® AND PORTFOLIO MANAGER

EPA United States Environmental Protection Agency

ENERGY STAR is a U.S. Environmental Protection Agency voluntary program that helps businesses and individuals save money and protect our climate through superior energy efficiency. Learn more about ENERGY STAR.



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With help from ENERGY STAR, by 2012, Americans had cumulatively prevented more than 1.8 billion metric tons of GHG emissions.

See 2012 Achievements.

http://www.energystar.gov/

ENERGY STAR

ENERGY STAR labels appliances …. What about buildings?

EPA has a solution: Portfolio Manager web application

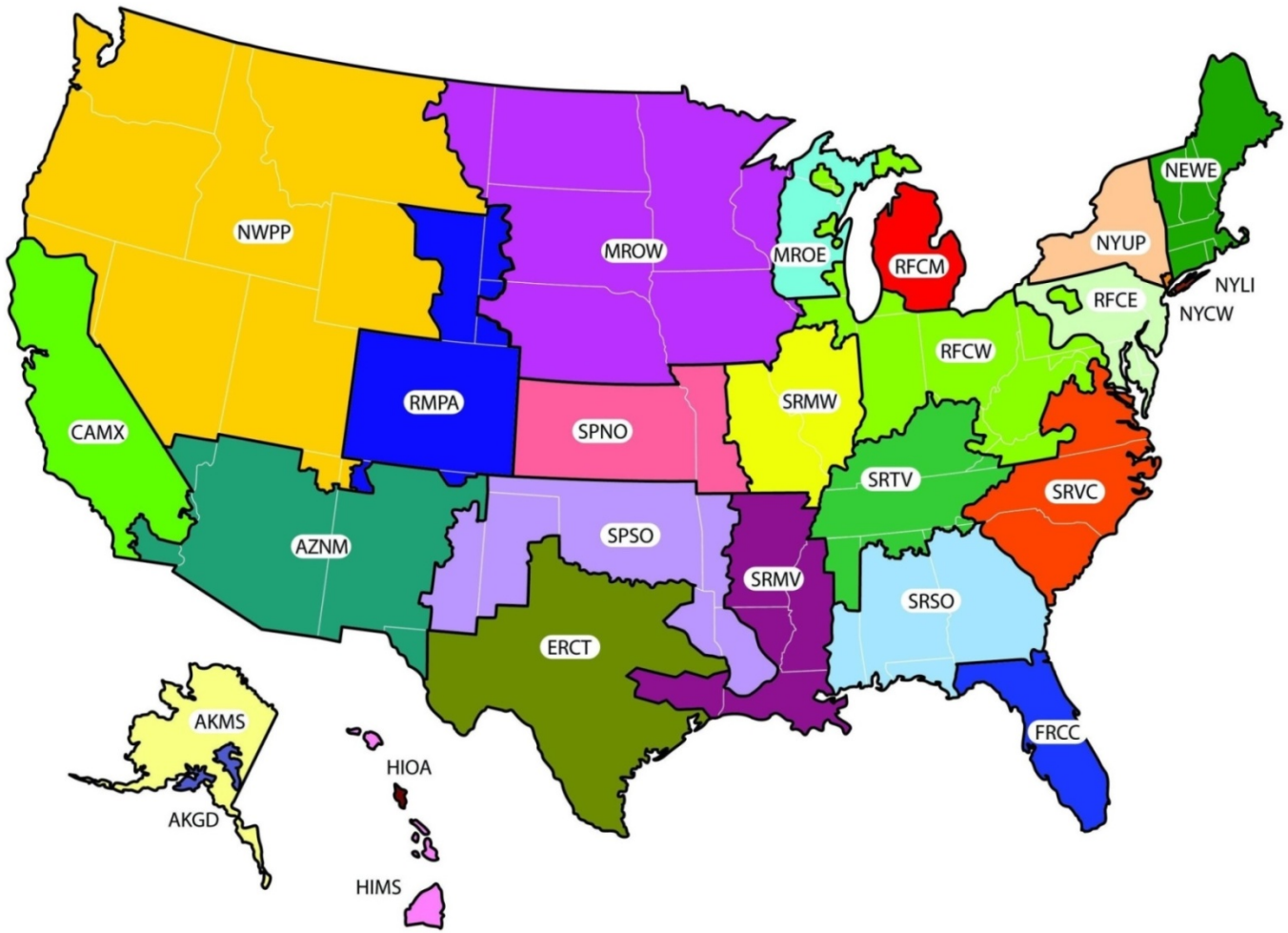
- tracks energy use
- calculates GHG emissions
- provides a 1-100 benchmark score for hospitals and medical offices
- Enables data exchange with 3rd party apps

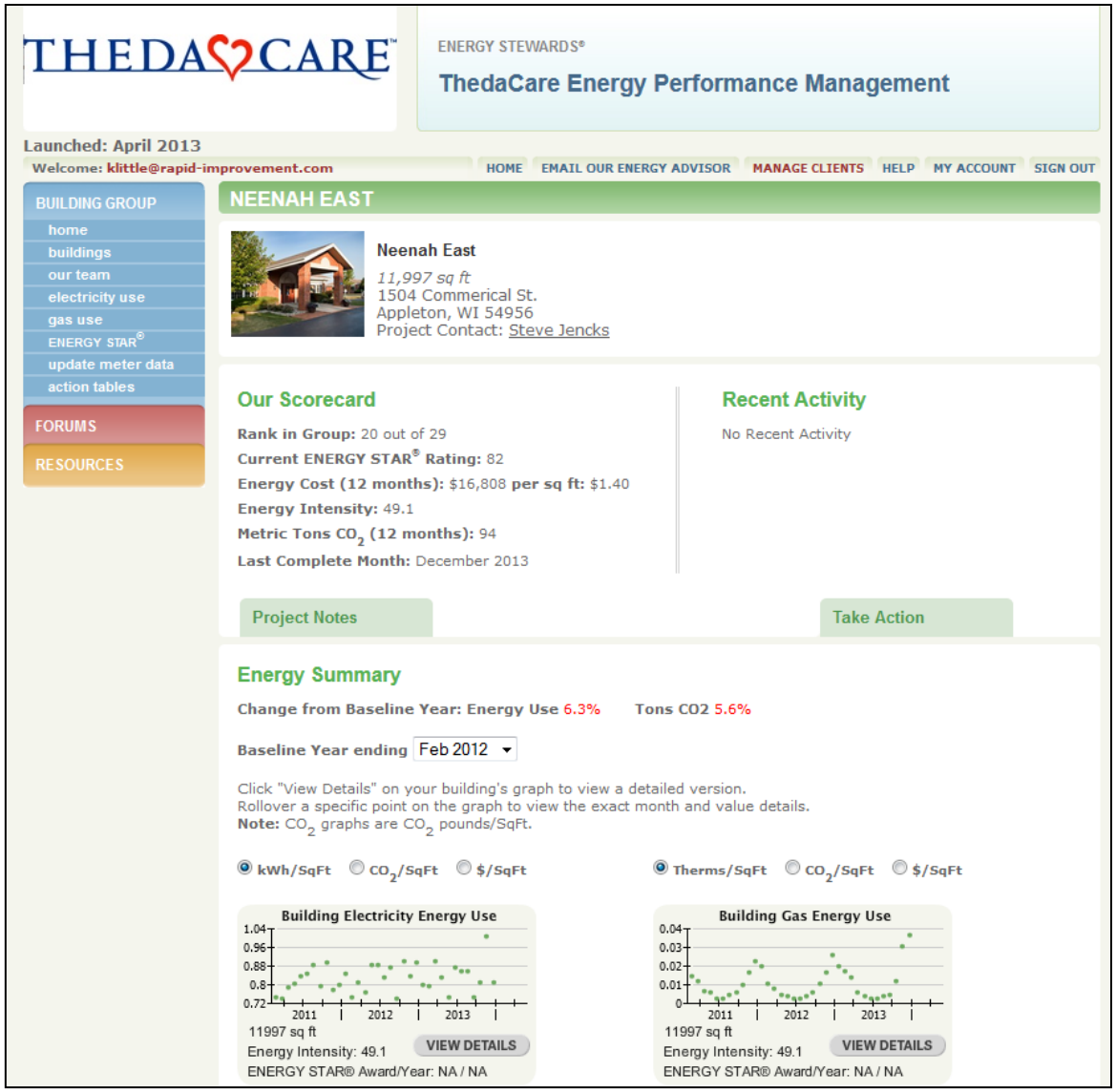
http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager?s=mega accessed 17 February 2014

Portfolio Manager Math (U.S.)

- Energy use in kBTUs
- Calculates both site & source energy
- Energy Intensity : kBTUs/sq ft/yr
- GHGs estimated for your facility
- Weather adjustment uses 30-year average weather for Energy Intensity.

GHG associated with electrical generation in ENERGY STAR Portfolio Manager are based on average fuel mix for the 26 electrical generation regions in the United States





Third party applications can exchange data with Portfolio Manager

THE PORTFOLIO MANAGER 1-100 SCORING SCALE

Comparative Metric: Benchmark Logic

Is 60 MPG high or low for this automobile?

Fuel Efficiency: *MPG*

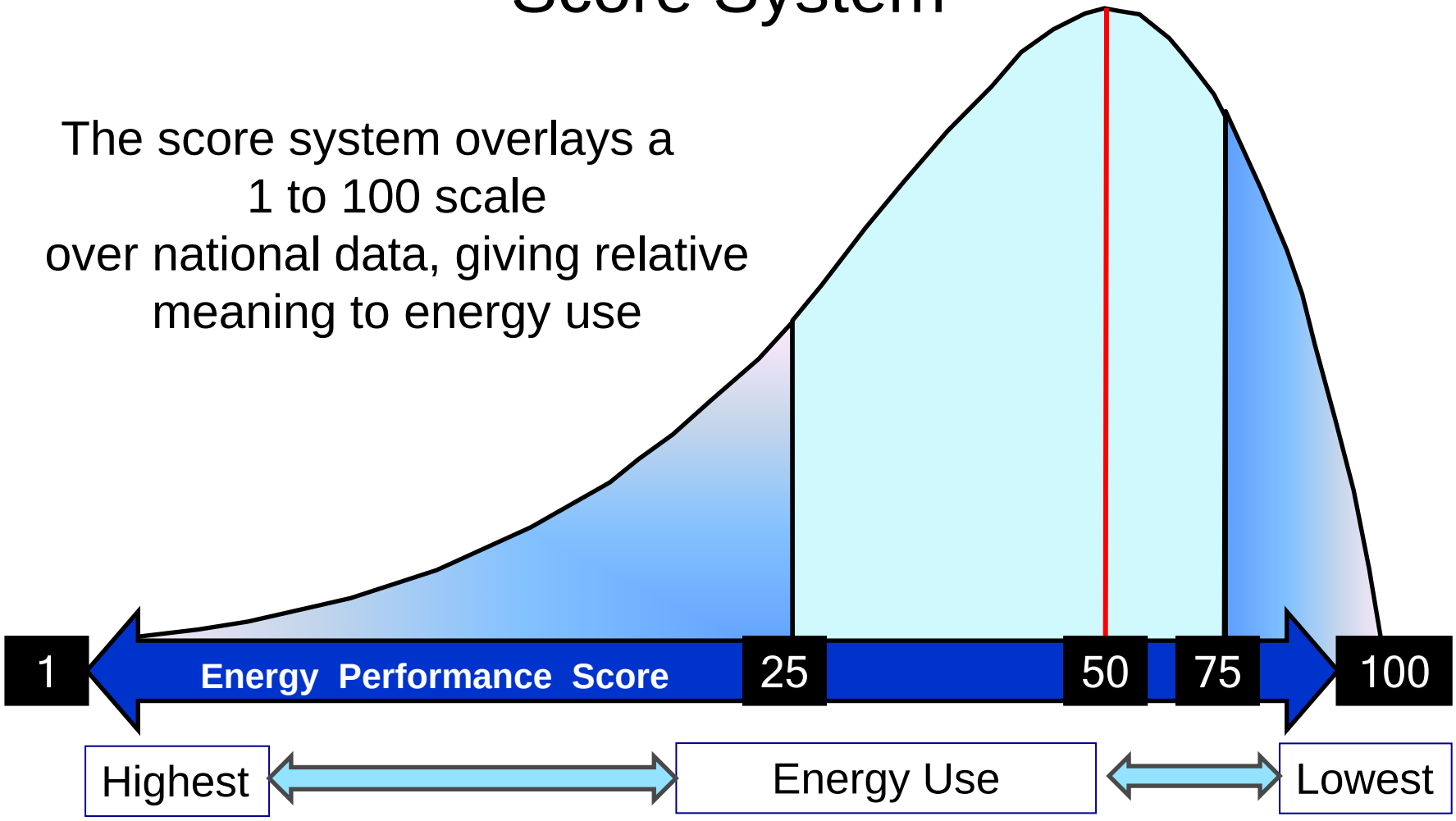
Is 90 kBtu/SF/YR high or low for this building?

Energy Performance Score: *1 to 100*

Slide courtesy EPA 2009

National Energy Performance Score System

The score system overlays a 1 to 100 scale over national data, giving relative meaning to energy use



Slide courtesy EPA 2009

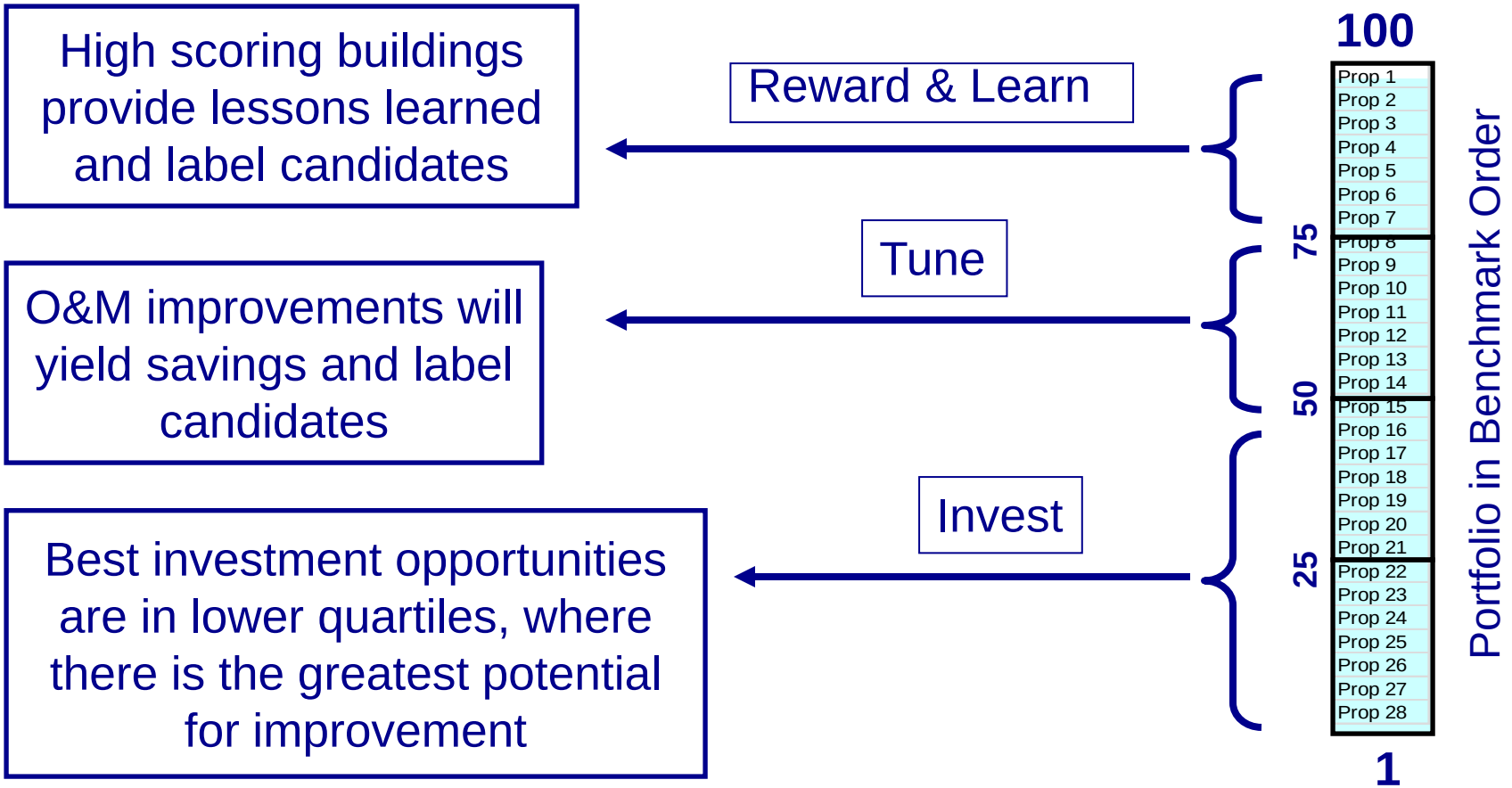
ENERGY STAR Score Basics

- Based on reference set of buildings
- Regression model built using reference set.

- Scale is fixed, independent of # of facilities using Portfolio Manager
- A facility gets a score when all its predictor values are entered.

- ASHE helped EPA build a reference set of hospitals in 2010-2011.
- Hospital predictors: energy use, weather, area (sq ft), staffed beds, FTEs, and # of MRIs.
- EPA's scale built from 191 hospitals; hundreds more hospitals use Portfolio Mgr
- The top 25% of reporting HHI hospitals in 2013 scored 70 or above

Score Helps Identify Priorities Across Portfolios



Slide courtesy EPA 2009

NEXT STEPS

Two questions to answer before session 3/13/2014

1. Is your organization taking part in HHI?

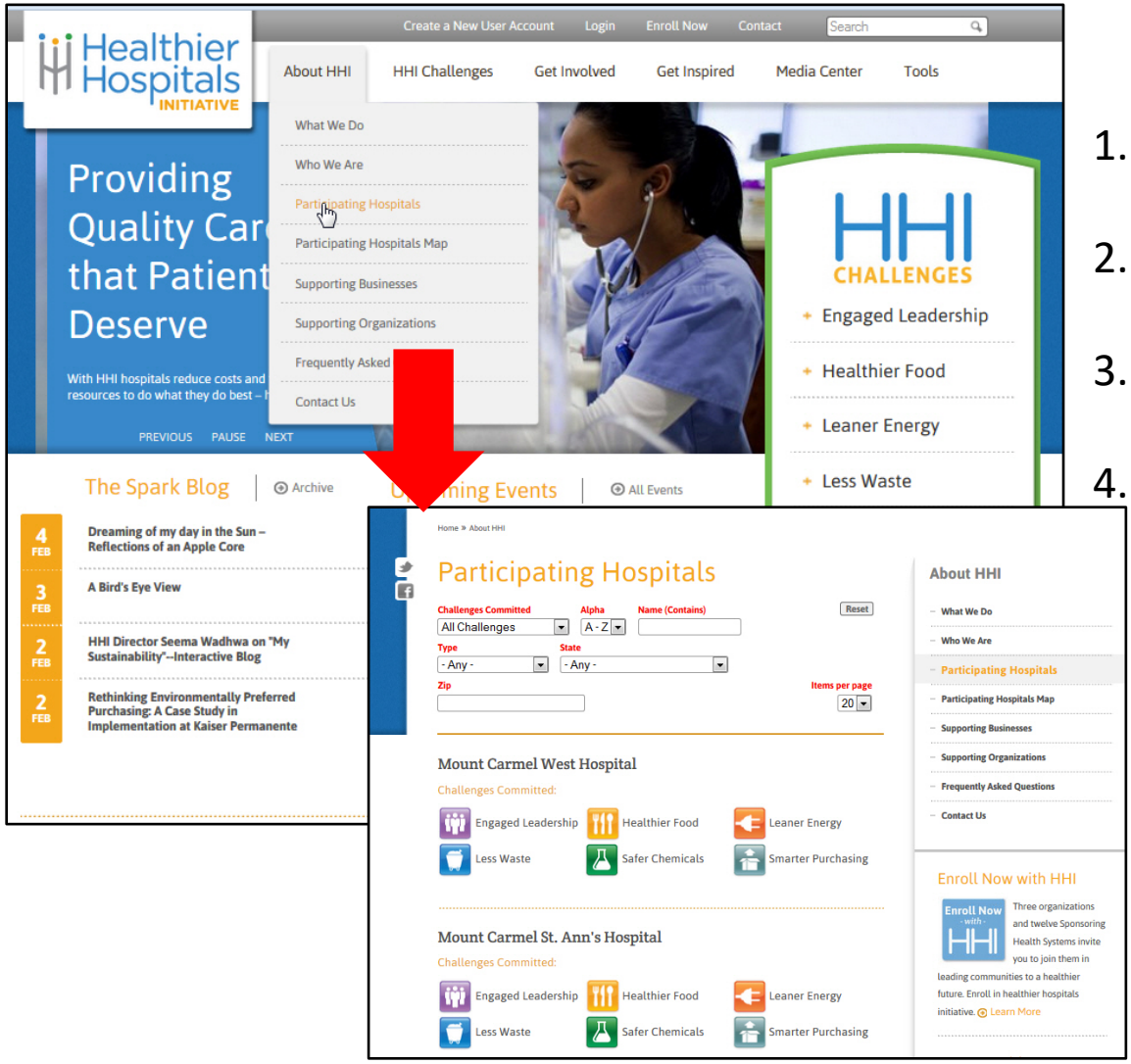
   You can find out from the HHI website.

2. Is your organization using Portfolio Manager*?

   You may have to hunt for the answer.

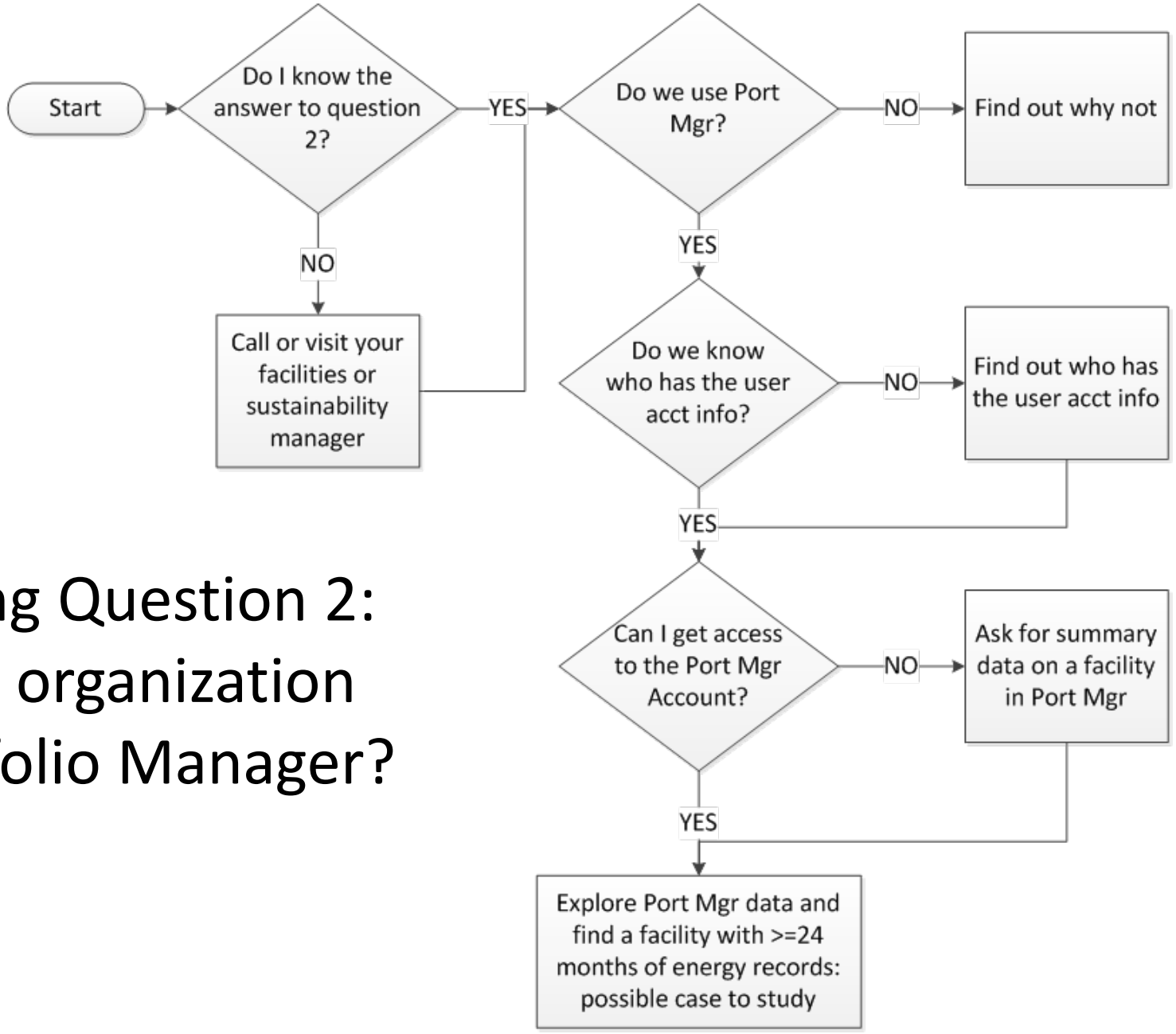
*If your organization uses Portfolio Manager and you have at least two years of monthly data for one facility, you have the option to use your own data to develop a weather-adjusted energy model after the next webinar.

Answering Question 1: HHI Participation



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.

Answering Question 2: Does our organization use Portfolio Manager?



Upcoming: Sessions 2 and 3

Session 2: Using monthly data to build and apply a weather-adjusted model for a building's energy use

Session 3: 15-minute and daily energy data: advantages and applications; connections between QI programs and energy/sustainability efforts, reprise.

Session 2: Thursday 13 March 2014 Session 3: Thursday 27 March

References

- McKay book
- Thermodynamics book
- Any articles??
- Links to Energy Star PM
- GHG methodology in ENERGY STAR Portfolio Manager, https://www.energystar.gov/ia/business/evaluate_performance/Emissions_Supporting_Doc.pdf

- http://www.energystar.gov/ia/business/evaluate_performance/General_Overview_tech_methodology.pdf Rating methodology
- http://www.energystar.gov/buildings/tools-and-resources/energy-star-score-hospitals-general-medical-and-surgical Rating description for hospitals
- Discussion of GHG emissions generated by ENERGY STAR http://www.energystewards.net/energy-star/co2-accounting-in-energy-stewards-estimates-and-limitations/ and http://www.energystewards.net/energy-stewards-platform/estimates-of-co2-in-energy-stewards-part-2/

APPENDIX: MORE ON SITE AND SOURCE ENERGY

Current Conversion Site to Source

Your "grid" electric meter only captures ~1/3 of the energy needed to deliver a kWh

Figure 1 – Source-Site Ratios for all Portfolio Manager Energy Meter Types

Energy Type	U.S. Ratio	Canadian Ratio
Electricity (Grid Purchase)	3.14	2.05
Electricity (on-Site Solar or Wind Installation)	1.00	1.00
Natural Gas	1.05	1.02
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.01	1.01
Propane & Liquid Propane	1.01	1.03
Steam	1.20	1.20
Hot Water	1.20	1.20
Chilled Water	1.00	0.71
Wood	1.00	1.00
Coal/Coke	1.00	1.00
Other	1.00	1.00

https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?4871-91ae accessed 17 Feb 2014

Site vs. Source Energy 2010 for all electric building, old ratios

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Garvey School

ENERGY STAR

Building ID: 1427605
For 12-month Period Ending: April 30
Date SEP becomes ineligible: N/A

Facility
Garvey School
10309 S Morgan St
Chicago, IL 60643

Facility Owner
N/A

Year Built: 1968
Gross Floor Area (ft²): 57,410

Energy Performance Rating[2] (1-100) 13

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	3,808,11
Natural Gas - (kBtu)[4]	
Total Energy (kBtu)	3,808,11

Energy Intensity[5]

Site (kBtu/ft²/yr)	66
Source (kBtu/ft²/yr)	222

222 = 66 x 3.340

Table 1
Source-Site Ratios for all Portfolio Manager Fuels

Fuel Type	Source-Site Ratio
Electricity (Grid Purchase)	3.340
Electricity (on-Site Solar or Wind Installation)	1.0
Natural Gas	1.047
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.01
Propane & Liquid Propane	1.01
Steam	1.45
Hot Water	1.35
Chilled Water	1.05
Wood	1.0
Coal/Coke	1.0
Other	1.0

Practical Implications

- Don’t mix site and source energy values in your analysis
- ENERGY STAR uses source values for 1-100 score
- Not all source energy calculations use the EPA method
- Site energy drives basic $ costs
- Source energy drives environmental costs

ENERGY STAR discussion

https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf?4871-91ae