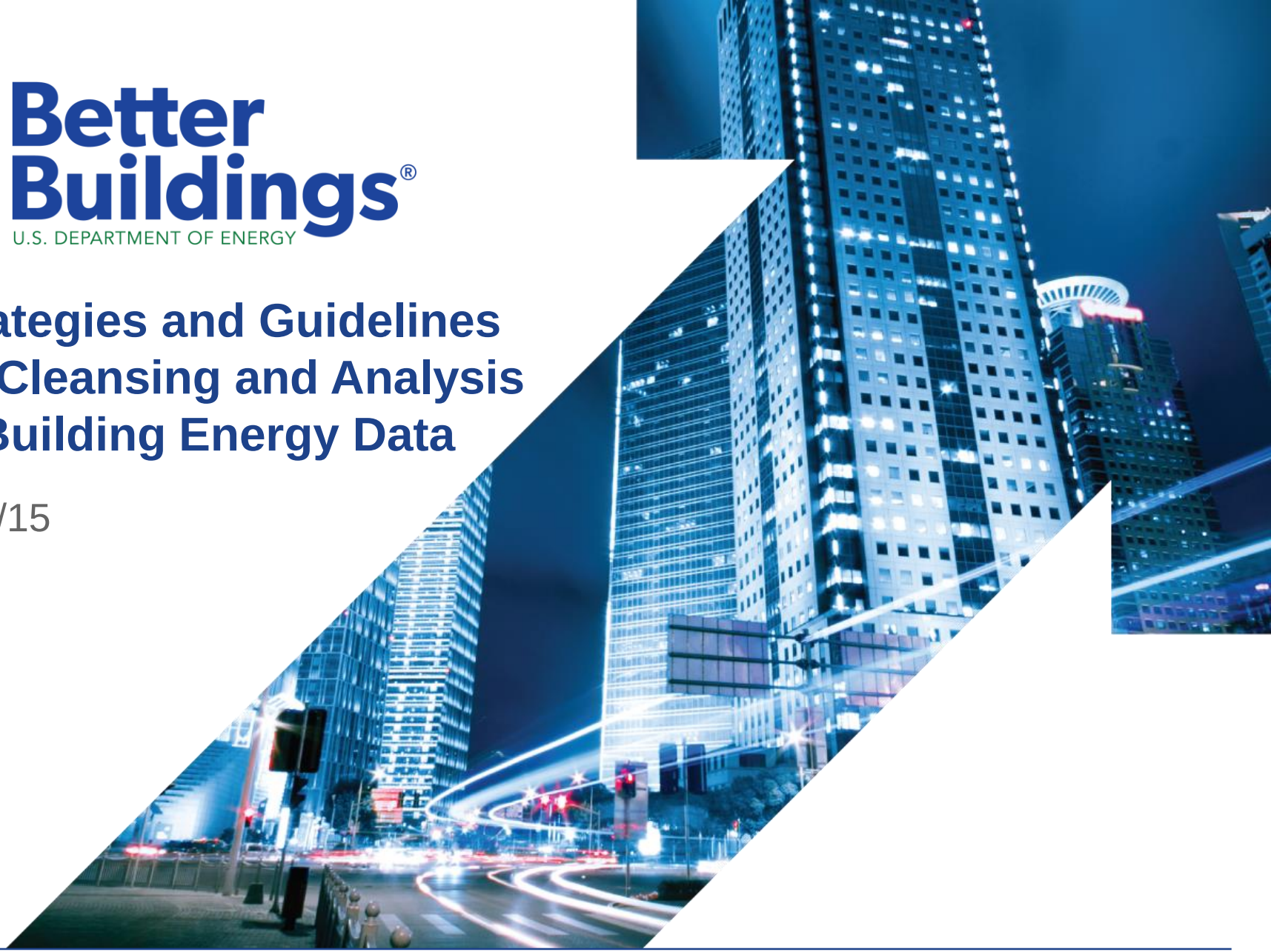
Better Buildings®
U.S. DEPARTMENT OF ENERGY

Strategies and Guidelines for Cleansing and Analysis of Building Energy Data

5/27/15



U.S. DEPARTMENT OF ENERGY

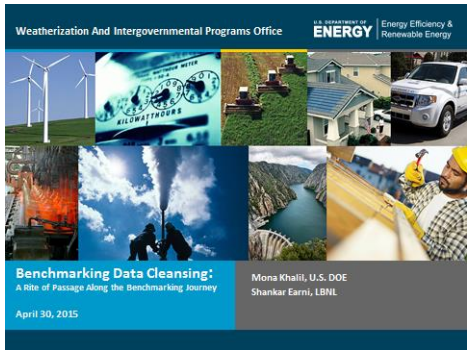
Panelists

- **Andrea Hessenius**, Massachusetts Department of Energy Resources
- **Tony O'Donnell**, Sustainability Institute at the College of New Jersey
- **Christine Liaukus**, New Jersey Institute of Technology
- **Scott Wagner**, Consortium for Building Energy Innovation

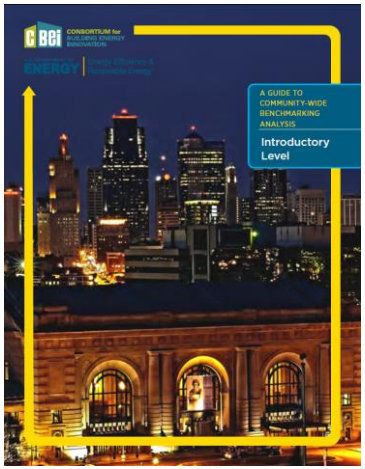
Select DOE Resources

WIP's State and Local Solution Center

- Data Cleansing Tutorial
  - Tips and guidelines on techniques for identifying errors in benchmarking data
  - Use methods from this tutorial to cleanse your dataset prior to analysis
  - energy.gov/eere/slsc/downloads/benchmarking-data-cleansing-rite-passage-along-benchmarking-journey



- A Guide to Building Benchmarking Data Analysis
  - Introductory level guide providing essentials for performing an analysis of building benchmarking data
  - Use it to cleanse, parse and evaluate energy performance and costs of benchmarked building stock
  - Forthcoming on the State and Local Solution Center



- Visit the State and Local Solution Center
  - energy.gov/eere/slsc
  - Sign up for TAP alerts: TechnicalAssistanceProgram@ee.doe.gov

Andrea Hessenius
Massachusetts Dept. of Energy Resources

U.S. DEPARTMENT OF ENERGY

Creating A Cleaner Energy Future For the Commonwealth

Massachusetts Department of Energy Resources

Massachusetts Leading by Example's Strategies and Methods for the Cleansing Data

Better Buildings Challenge Summit

May 26, 2015

Andrea Hessenius

Green Communities Analyst, Leading by Example Program

Massachusetts Dept. of Energy Resources

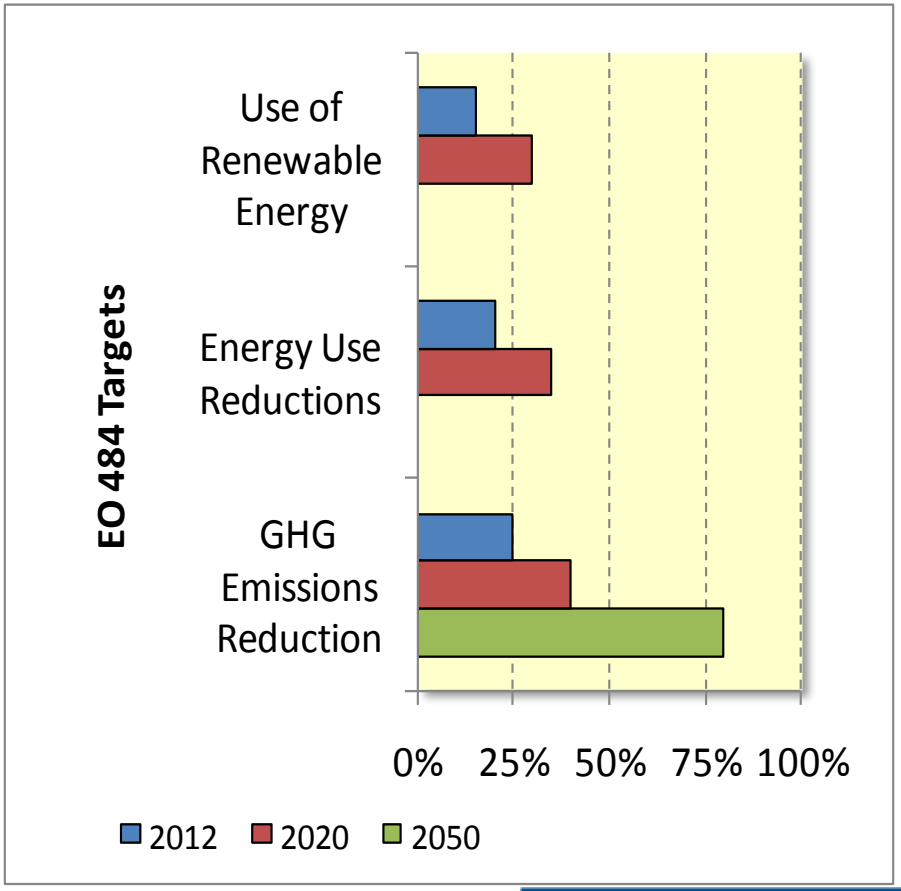
Key Discussion Points

- Leading by Example Program
- Snapshot of LBE's Data
- Data Collecting & Cleaning
- Stories from the Datasets
- Analysis & Graphs
- Reporting & Benchmarking
- Key Takeaways

Executive Order No. 484

Leading by Example—Clean Energy and Efficient Buildings

- Sets short, medium, and long-term goals for state agencies:
  - GHG emission reductions
  - Energy reductions
  - Renewable energy
  - Water conservation
- Requires all new construction to meet Mass. LEED Plus Standard
- Includes executive agencies, authorities, community colleges and university campuses, Trial Court



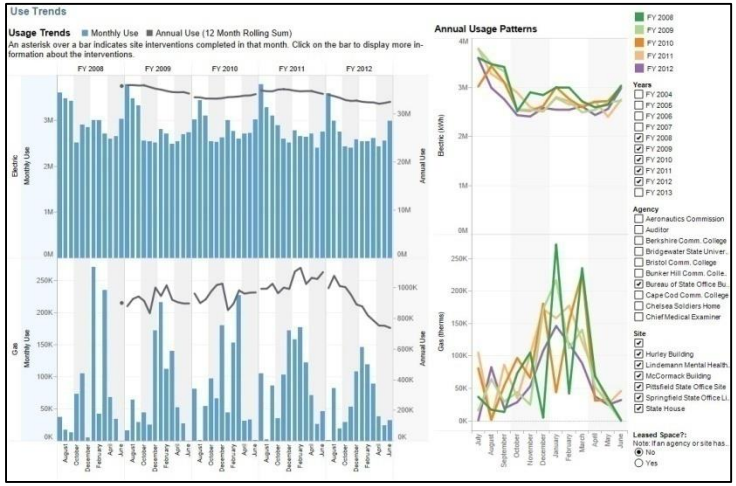
Creating A Cleaner Energy Future For the Commonwealth

DOER
Massachusetts Department of Energy Resources

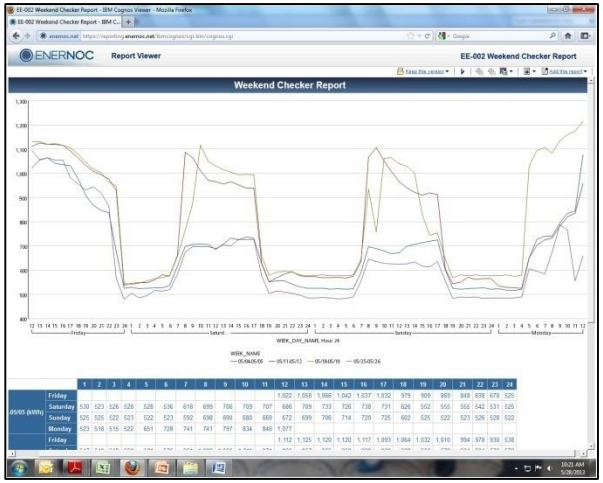
LBE Data Set in a Snapshot

- We worked closely with over 49 agencies, campuses, and authorities
- Track over 40 different fuel types at various time intervals (annual, quarterly, monthly)
- Data encompasses over 80 million square feet, includes office buildings, camp grounds, colleges and universities, treatment plants, correctional facilities
- Track multiple associated metrics including LEED certification, energy projects, on-site generation installations, weather data, student enrollment, etc

Our Data Sources in a Snapshot



- LBE Tracking Forms
- Statewide Fuel Contracts
- MassEnergyInsight (MEI)
- Enterprise Energy Management System (EEMS)
- Fiscal data from the state accounting system
- Production Tracking System (PTS)
- Weather Normalized data set
- Clean Energy Results Program (CERP)
- Energy Project Database
- Capital Asset Management Information System (CAMIS)
- And many more!



Creating A Cleaner Energy Future For the Commonwealth

DOER
Massachusetts Department of Energy Resources

What type of metrics do we collect?

- Greenhouse Gas Emissions
- Energy Use Intensity (EUI – kBtu/SF)
- Renewable % of total electricity
- Fuel consumption
- On-site generation (clean CHP and renewable), REC/ AEC accounting
- # of renewable installations
- # of LEED certified buildings by level
- LEED Building actual vs. projected
- Impacts of energy efficiency projects
- Clean energy investments
- Avoided costs
- Square Footage, Location
- Property Types & Uses
- Weather Degree Days

Statewide

By Secretariat

By Agency

By facility

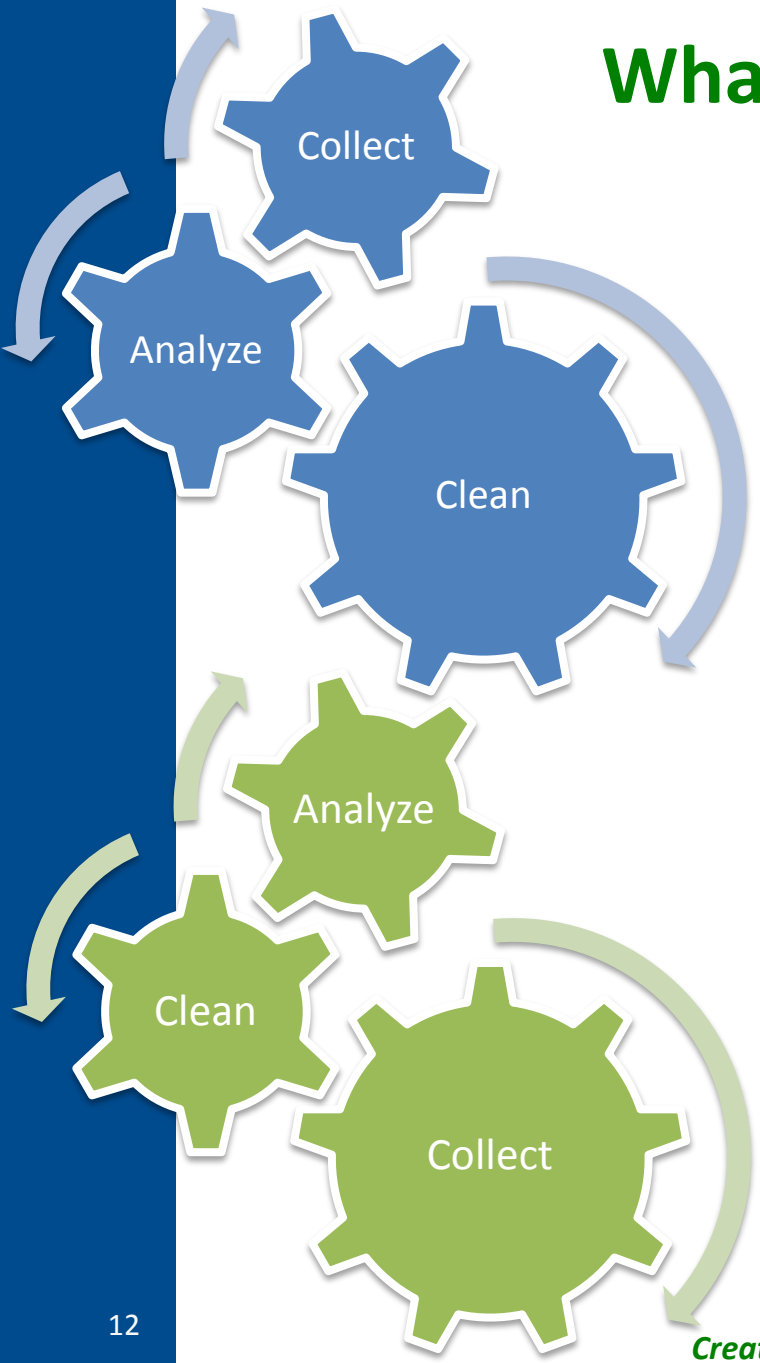
By building (if possible)

Buildings vs. vehicles

Collecting data

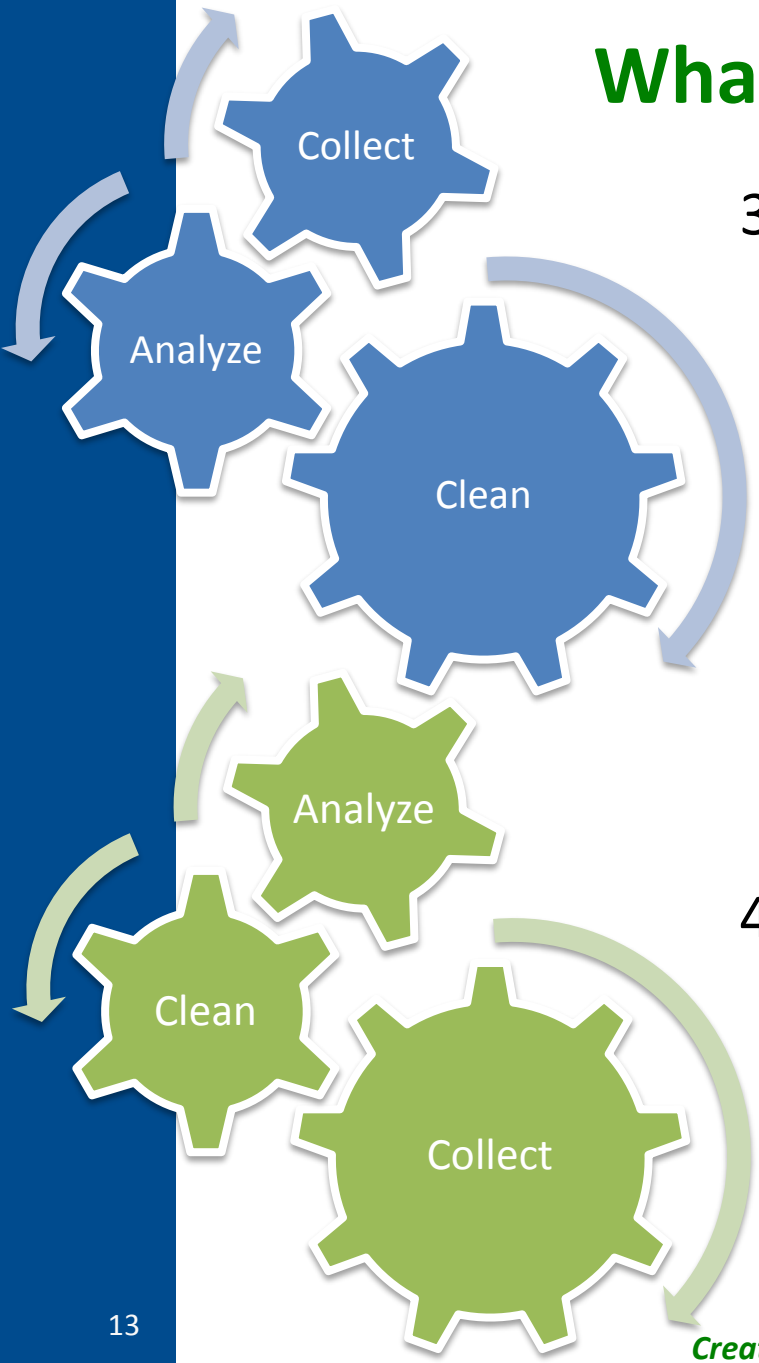
- There is no single solution, you need multiple approaches to solve many data needs
- Specify up front what you need to track
- Cross-checking data from different sources
- Very difficult to completely automate process
- Find the right system to store and collect data
- Staffing consistency is critical

What is our data cleansing process?



1. Format data in a useful manner
   - Data labeled and organized?
   - Can we access the data?
   - Do we have all the information?

2. Verify consistency both within data points and formulas/ calculations
   - Is there consistency with site names and municipalities among datasets?
   - Are we calculating baselines, weather normalization, energy rates?



What is our data cleansing process?

3. Search for potential anomalies
   - Is there a large discrepancy year to year that can't be accounted for in the data?
   - Are sites performing in similar patterns?
   - Did we follow up, make edits, & revisit the data?
   - Did we look at the whole picture or did we get lots in making the data perfect?

4. Document methodology
   - Did we track our changes?
   - Did we document our process?

Stories from the Data
Comparing Datasets

An easy place to start once the data is “clean” is to check the percentage change between years and between similar data sources. Being able to ground truth information is key in knowing that the dataset is valid

	A	D	H	I	J	N	O	P
1		% Difference LBE & MEI	% Difference	% Difference MEI & EEMS	% Difference LBE & EEMS	% Difference	% Difference MEI & EEMS	% Difference LBE & EEMS
2		FY 2008	FY 2009	FY 2009	FY 2009	FY 2010	FY 2010	FY 2010
3	Agency	Electric (kWh)	Electric (kWh)	Electric (kWh)	Electric (kWh)	Electric (kWh)	Electric (kWh)	Electric (kWh)
4	Berkshire Comm. College	-8.07%	9.59%	100.00%	100.00%	0.94%	100.00%	100.00%
5	Bridgewater State University	0.37%	-0.38%			-0.14%		
6	Bristol C mmunity College	1.83%	6.24%			11.54%		
7	Bunker	4	0.25%	31.23%	31.40%	-0.43%	7.81%	7.41%
8	Cape C			43.13%	4.46%	0.07%	0.00%	0.07%
9	Fitchb			05%			0.74%	1.47%

Does the data need to match?

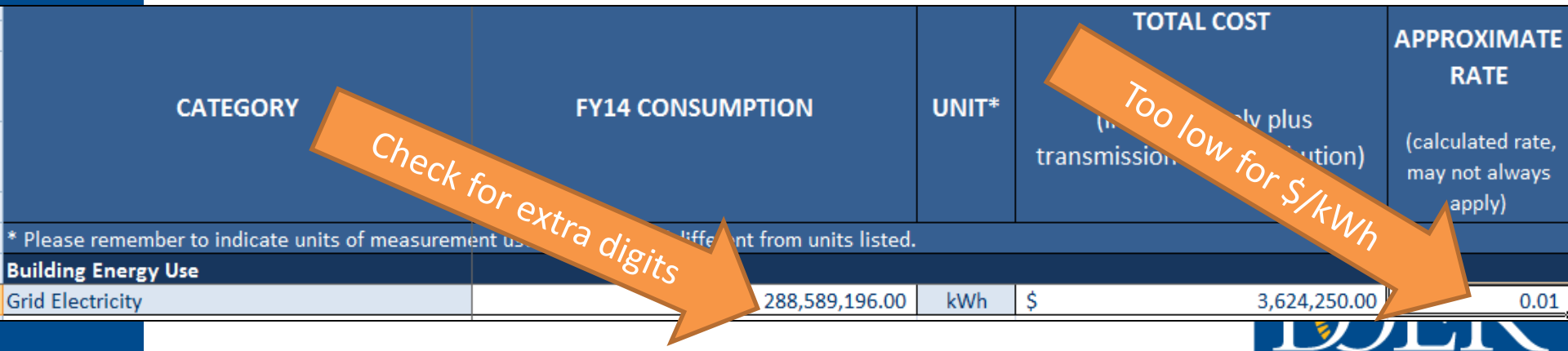
Is the difference more than 5%?

What is a tolerable % error?

Stories from the Data

Silly Fingers, Wrong Units, Extra Digits

Watch out! Entering data in the wrong unit (barrels instead of gallons, dekatherms instead of therms, mlbs instead of kBtu) can drastically change numbers... Just like putting the comma or decimal in the wrong spot. A quick check some times is to see what the fuel rate ($/Usage) is in relation to the market?



Creating A Cleaner Energy Future For the Commonwealth

Massachusetts Department of Energy Resources

Stories from the Data
Machines also make mistakes

Building reports that can track errors are also very helpful. A computer system might provide a duplicate reading for an account or data might be lost. A simple percent difference report between past data in a system helps flag errors.

Usage Variance

Agency		Electric FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
	Use (Native Units)	1,889	1,847	1,888	152			
	% diff in use		-2%	2%	-92%	-100%		
	Use (Native Units)	2,394,725	1,914,288	2,044,074	1,985,516	446,593	659	953
	% diff in use		-20%	7%	-3%	-78%	-100%	45%
	Use (Native Units)	16,221,013	16,180,324	16,096,706	17,040,146	2,154,874	507,442	464,286
	% diff in use		0%	-1%	6%	-87%	-76%	-9%
	Use (Native Units)	5,923,219	6,013,927	5,406,055	5,052,271	5,089,793	5,143,349	5,408,969
	% diff in use		2%	-10%	-7%	1%	1%	5%
	Use (Native Units)	5,469,920	5,851,400	6,142,560	5,961,760	5,966,800	5,836,960	5,941,120
	% diff in use		7%	5%	-3%	0%	-2%	2%
	Use (Native Units)	35,773,580	34,211,179	34,085,055	34,136,981	32,480,322	33,627,651	33,828,730
	% diff in use		-4%	0%	0%	-5%	4%	1%

Stories from the Data

You're using that fuel to do what?

Tracking fuels may go beyond building consumption for some partners. We've come across LNG use for fire trainings, #6 oil on marine training vessels, diesel for boating. We find it very helpful to know how fuels are consumed at state facilities as it affects some of our calculations.

Some Specific Data Challenges in MA data

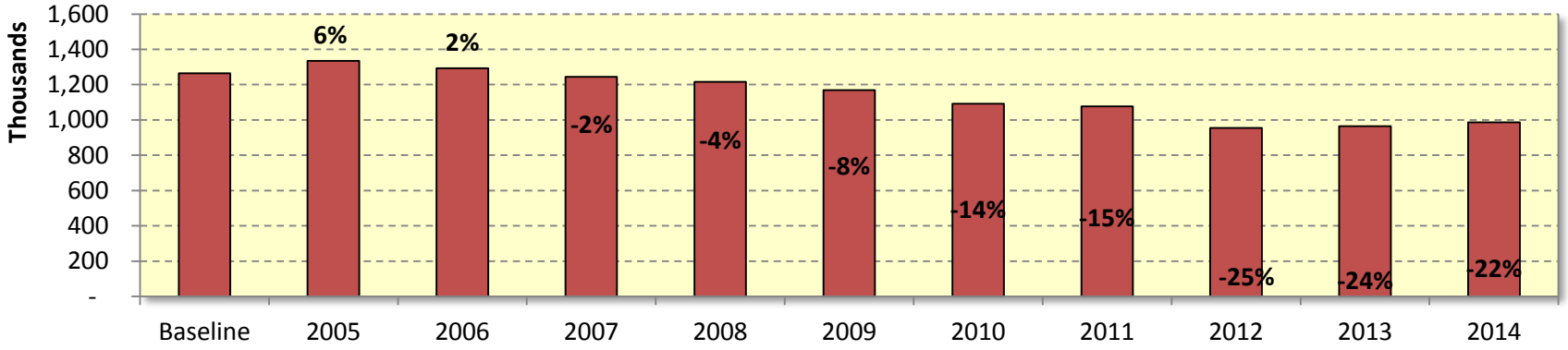
- **Annual Tracking forms provide *annual* data, not granular**
  - Not all agencies are capable of tracking own usage; frequent human errors
  - Requires follow-up and corrections
- **Tracking usage through utility accounts only gets to grid electricity & natural gas**
  - Lack of complete utility account data – how do we know what we don't have
  - Account numbers change, new accounts might be missing
  - Don't always know what buildings are on what accounts
  - Multiple buildings on one account make it impossible to determine building performance
  - Getting data from Municipal Light Plants may be difficult

Some Specific Data Challenges in MA data

- **Real time data through meters is restricted to individual locations**
  - Data quality issues, particularly for thermal meters
  - Tracking implemented measures and cost-effectiveness can be difficult
  - How to make real-time data useful and actionable
- **Statewide Contracts provide limited information**
  - Oil data only loaded once a year and only provide delivery
  - Competitive supply cost data not always available/ delayed

Data Analysis

- Compare data sets with annual information if available, search for patterns or trends
- Different types of data allow for varied analysis (building vs. agency info)
- Multiple data sources may provide different, but still useful information
- Linking different data sources to provide insightful trends
- Continuously updating and verifying data set

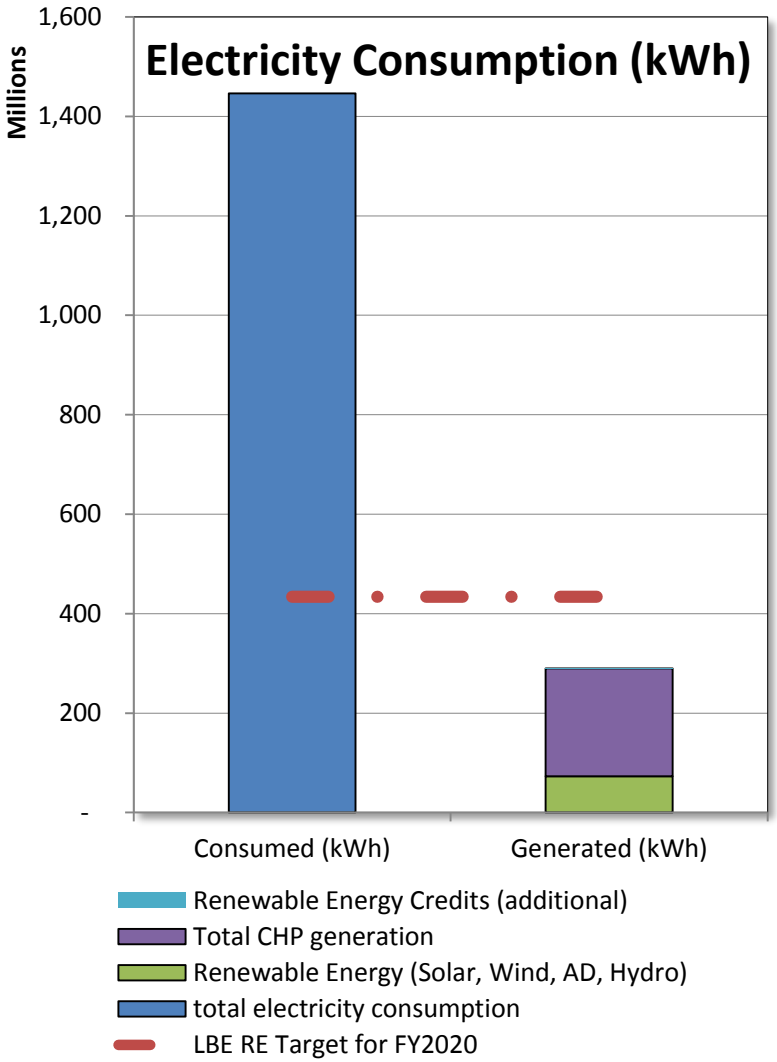


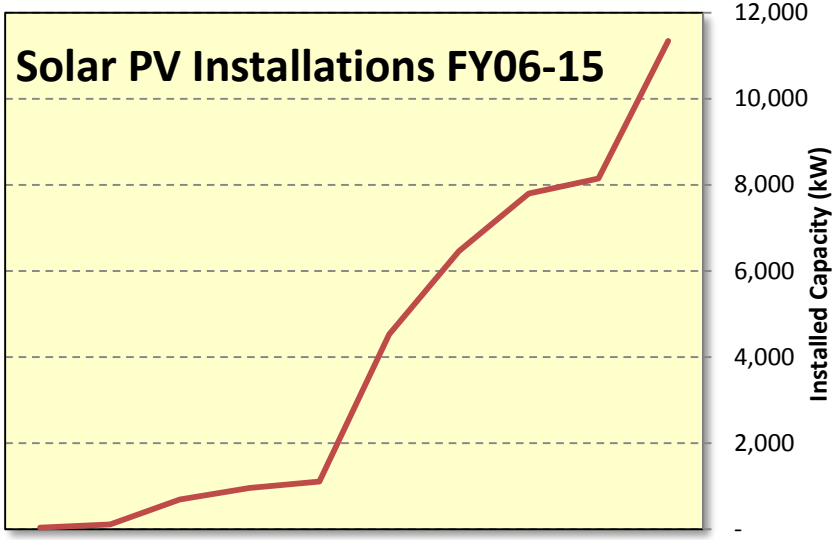
GHG Emissions Reductions (metric tons)

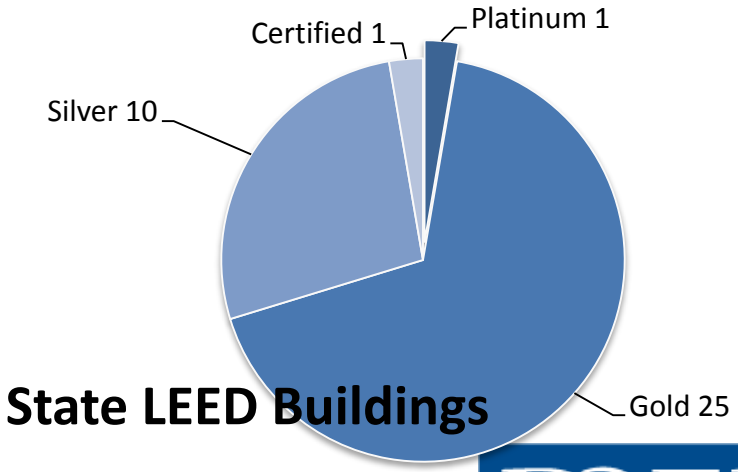
Creating A Cleaner Energy Future For the Commonwealth

Massachusetts Department of Energy Resources

Graphs & Data Visualization



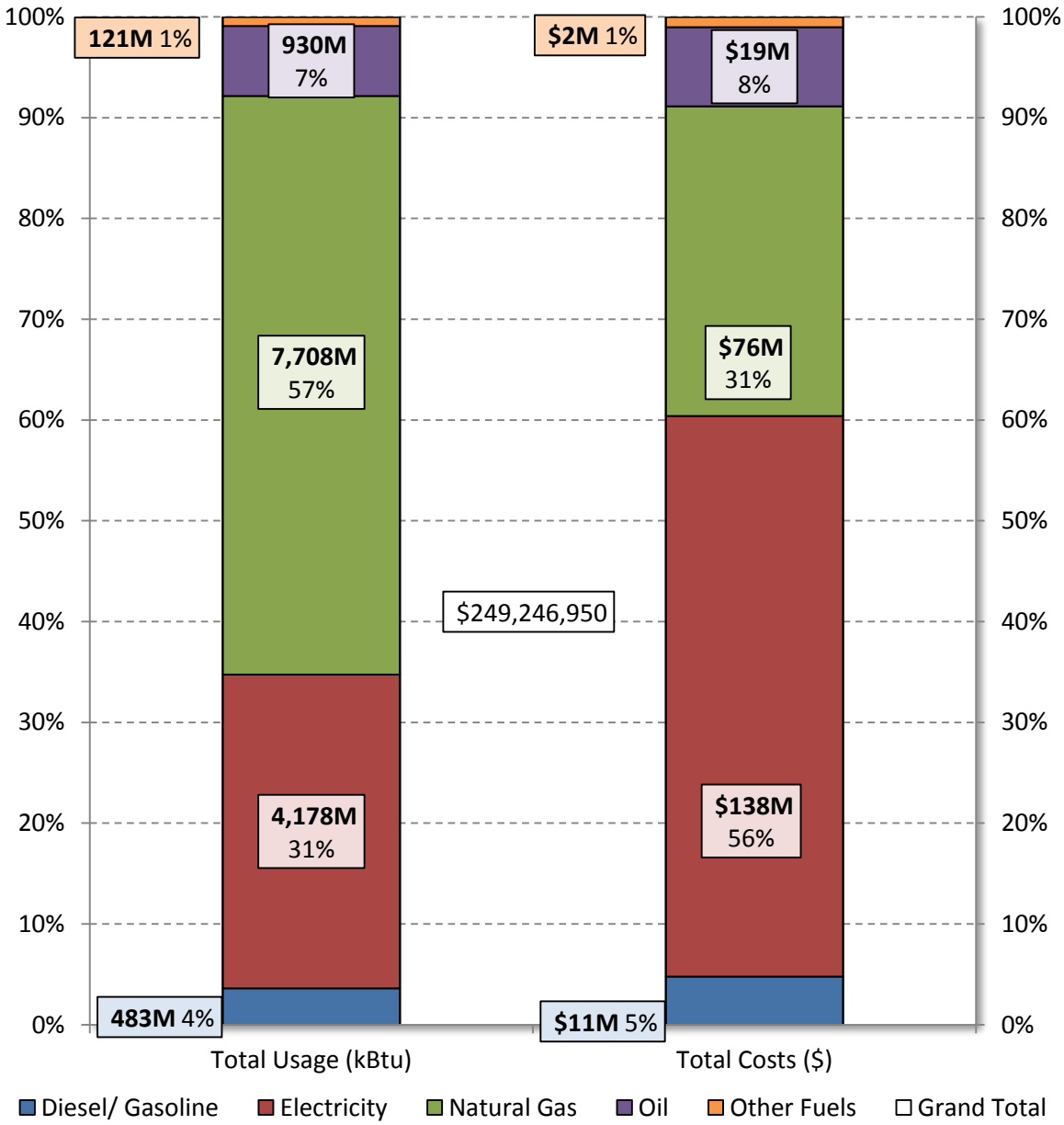




Creating A Cleaner Energy Future For the Commonwealth

DOER
Massachusetts Department of Energy Resources

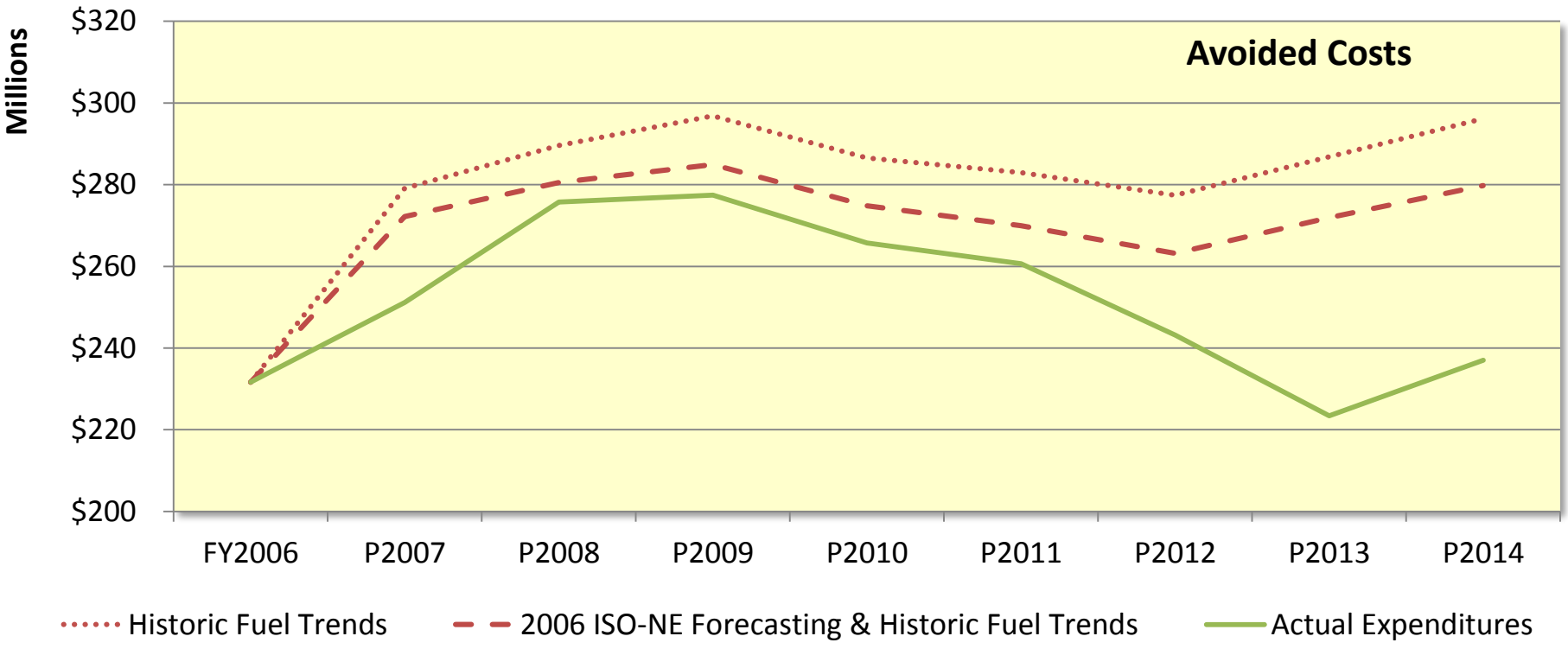
Graphs & Data Visualization



Creating A Cleaner Energy Future For the Commonwealth

Massachusetts Department of Energy Resources

Graphs & Data Visualization



Creating A Cleaner Energy Future For the Commonwealth

DOER
Massachusetts Department of Energy Resources

Our Data Reporting & Benchmarking

1. **Progress Reporting for LBE**
   - Measure progress against executive order
   - Track other progress not required
2. **Report to Better Buildings Challenge**
   - Provide US DOE progress reports on EUI reduction
3. **Track Agency Performance**
   - Provide feedback to encourage participation
4. **Provide Feedback at Facility Level**
   - Compare performance inter- and intra-agency
5. **Promote Targeted Building Level Efforts**
   - Use building EUI to compare and prioritize
   - Promote better day-to-day operations

Key Takeaways

- Identify the goals and metrics of the data analysis
- Specify up front what is needed to track
- Remember that multiple sources and solutions may be necessary, however high level data can still be useful
- Make sure to have a way of verifying data
- Use consistent baselines, retain flexibility to adjust (e.g. 3 year rolling averages)
- Keep track of your data source and any adjustments
- Hire/appoint dedicated staff with necessary skills

Be Proactive Regarding Data Challenges!

MASSACHUSETTS LEADING BY EXAMPLE PROGRAM

PUBLIC LEADERSHIP, STEWARDSHIP, COMMITMENT

Contact Information for Leading by Example

Andrea Hessenius, Green Communities Analyst
617-626-7375/ MariaAndrea.Hessenius@state.ma.us

Eric Friedman, Deputy Director, Green Communities Division
Director, Leading by Example Program
617-626-1034 / Eric.Friedman@state.ma.us

Tony O’Donnell, TCNJ
Christine Liaukus, NJIT

U.S. DEPARTMENT OF ENERGY

Data Cleansing and Analysis
for
The New Jersey Public Building Energy Efficiency Program

May 27, 2015

Tony O'Donnell, TCNJ
Christine Liaukus, NJIT

The New Jersey Public Buildings Energy Efficiency Program (NJP BEEP)

aims to reduce energy use public buildings by increasing the number of energy efficiency projects among school districts and municipalities

New Jersey Clean Energy Program (NJCEP)

Advantages

- Mature program (since 2001) with great depth of program offerings
- Provides access statewide across all major utilities

Drawbacks

- Data is cost-oriented for management. As such, there exists a poor connection between the absolute # of transactions and each individual customer
- Data is touched by many hands and is subject to significant variation in title

NJP BEEP

NJ is fortunate to have a robust Clean Energy Program, but for local government units…

- there is not a single point of entry

or

- an easily identified path

NJP BEEP

- NJP BEEP is designed to create the framework for local government units to use the Clean Energy Program tailored to their building portfolio.
- This framework is based on data from current program users.

NJP BEEP

The foundation for NJP BEEP is the Local Government Energy Audit program (LGEA).
The LGEAs included critical information on:

- Which LGU's* have participated
- What their building inventory is
- What energy conservation measures (ECMs) have been recommended per entity and per building

** - Local Government Units, defined as municipalities, school districts, and a variety of other entities in NJ with the power to own and operate facilities.*

NJP BEEP

Other Clean Energy Program sources provided:

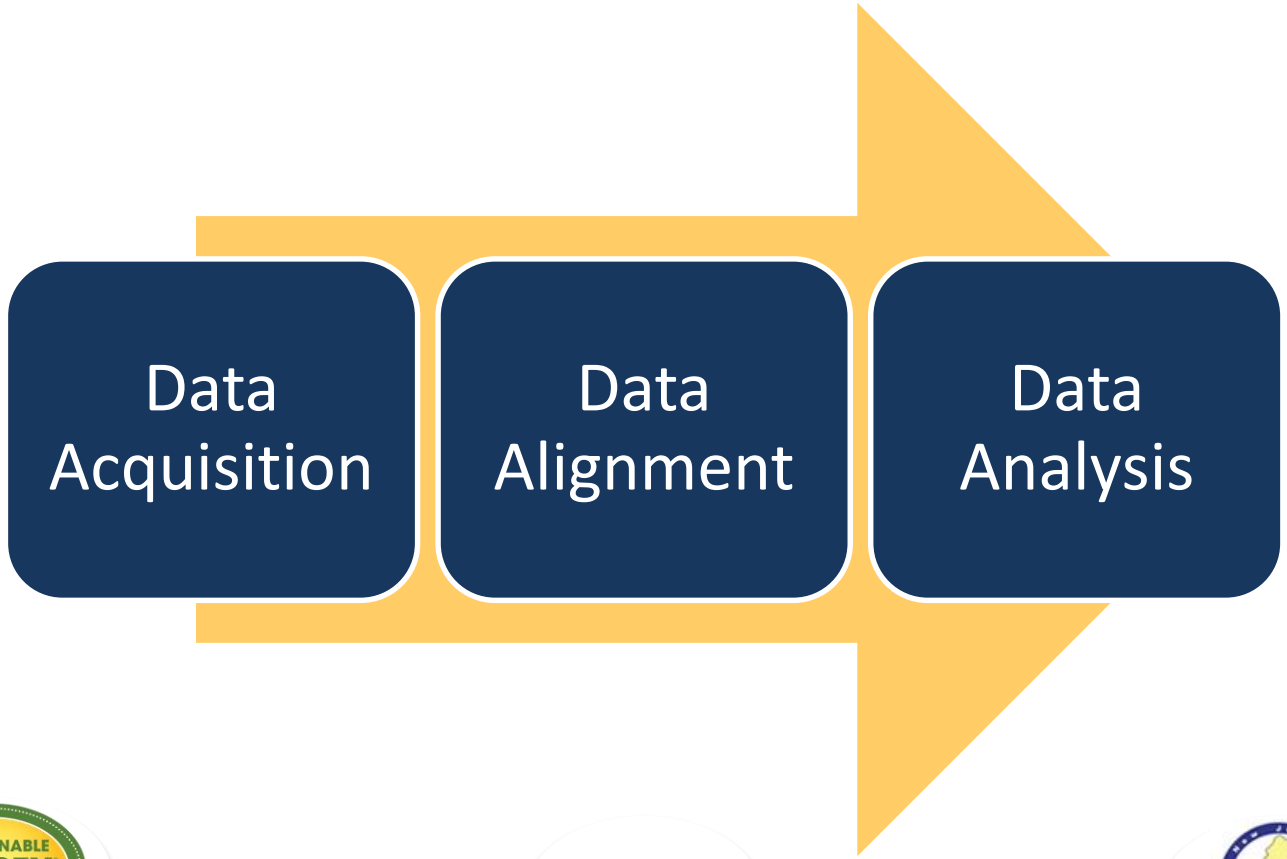
- What ECM's have been implemented

Publicly available tax assessment data provided:

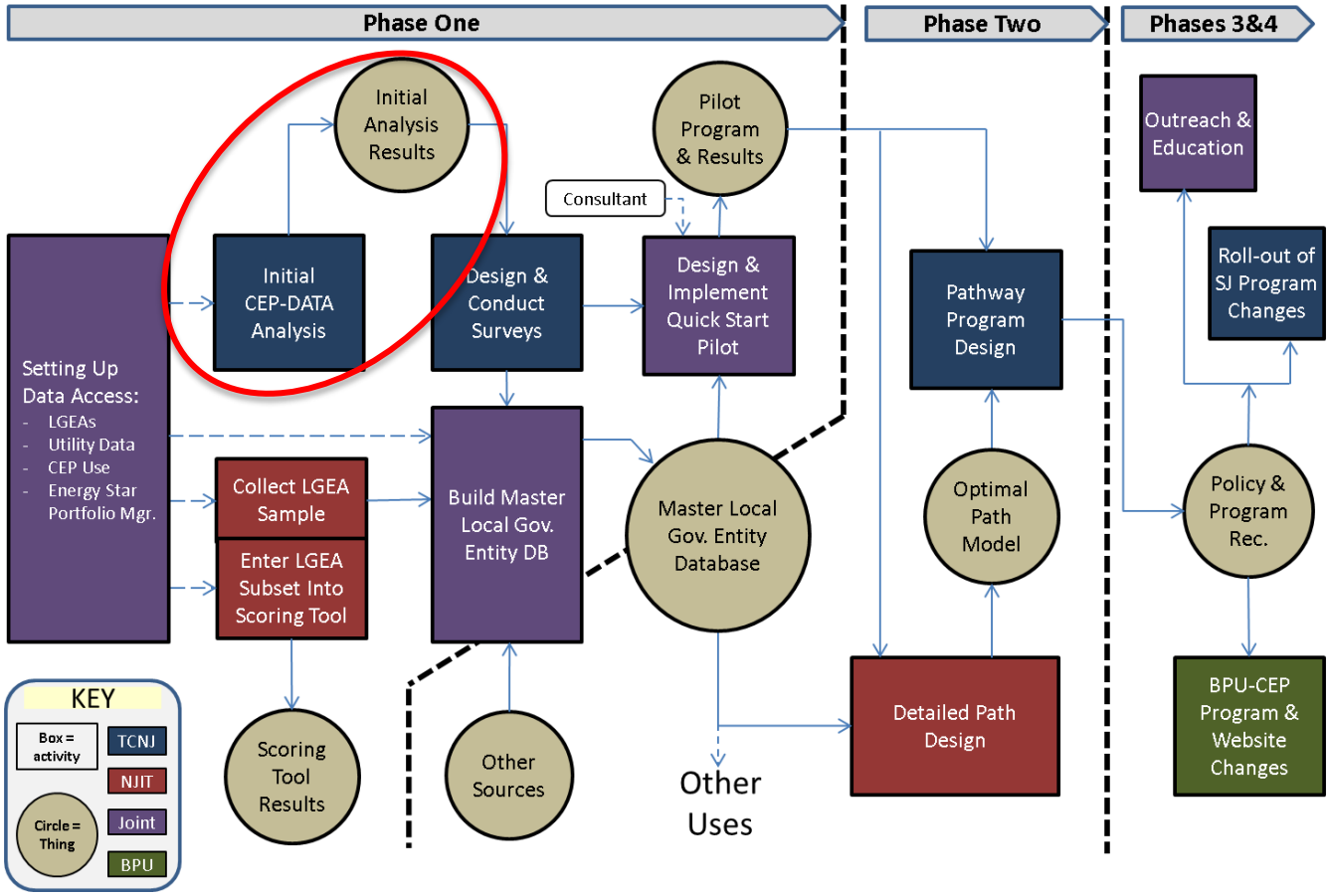
- Estimate of global public building inventory (the majority of which have not had an LGEA done)

Data Cleansing and Analysis

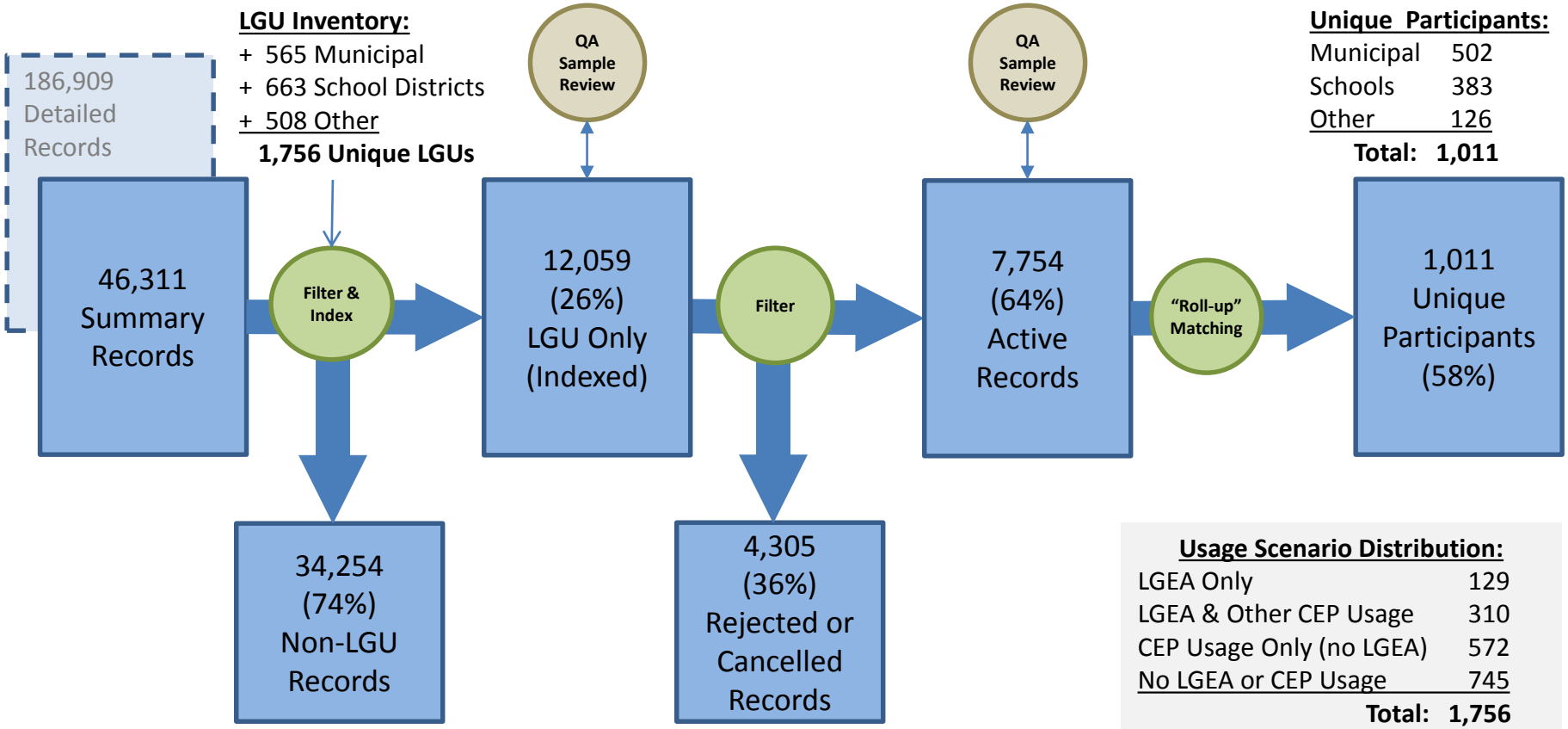
For NJ this has been a three step process



Project Work Structure



NJ-CEP Program Usage Analysis



Note: Data Sample Represents CEP Usage Between November 2000 and October 6th, 2014.

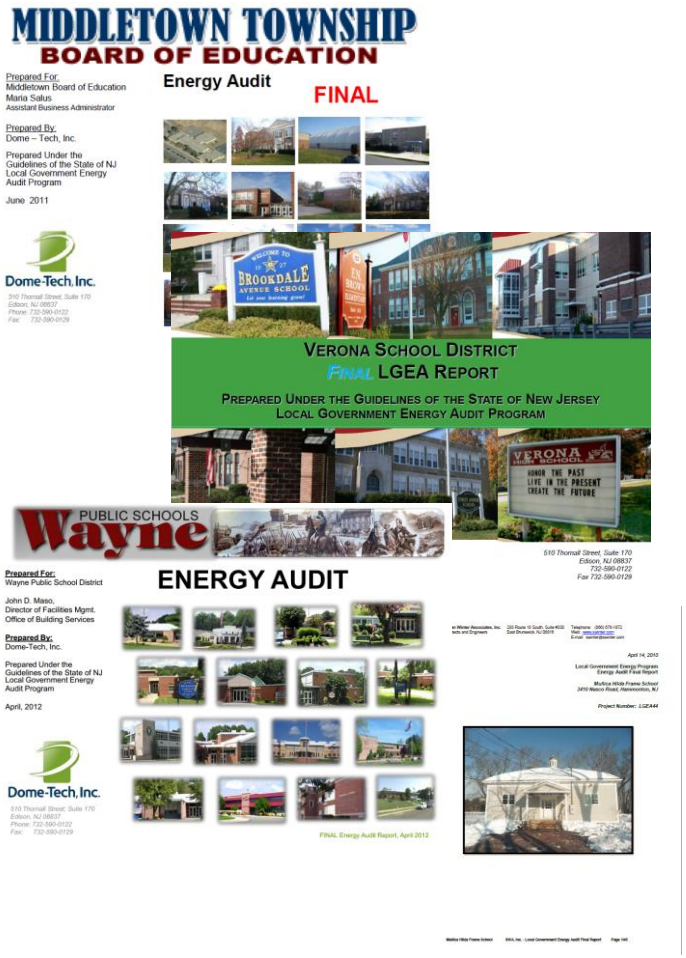
Usage Scenario Distribution:

LGEA Only	129
LGEA & Other CEP Usage	310
CEP Usage Only (no LGEA)	572
No LGEA or CEP Usage	745
Total:	**1,756**

(*) May not reflect utility program usage

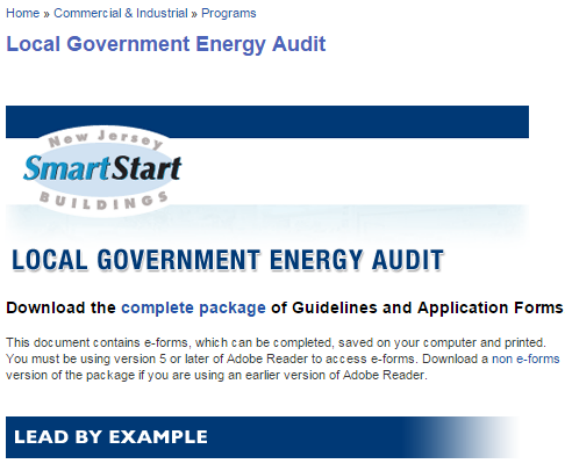
Data Acquisition

- LGEA data “trapped” in pdf format
- 439 LGEA’s for LGU level data
- 184 buildings from a selected sampling of 31 LGEA’s



Data Acquisition

- LGEA can include one building, or all buildings of a local government unit
- Completed by five pre-qualified engineering firms
- To simplify data extraction, data entry templates were created for each firm, with notations on data location.



Item	Entry	Location in report
historical annual electric use (kWh)	240,960	Table ES-1: Summary of Annual Energy Usage & Cost

Critical Data Points

- Which data points are most valuable
  - Not all LGEA's are created equal
- The data is being used for several purposes:
  - Asset Scoring Tool (AST)
  - Building Performance Database (BPD)
  - NJP BEEP data needs
- Comparison of BPD priority fields and LGEA content

A	B	C	D	E	F	G
Field Name	**Data Type**	**Exists in LGEA DB?**	**LGEA Section**	**LGEA Field**	**Notes**	**Revision**
			Site			
Source Facility ID		Y	General Building Info	Building ID		
City		y	General Building Info	City / Municipality		
State		y	General Building Info	State		
Postal Code		y	General Building Info	Postal Code		
			Comercial Facility			
Source Facility ID		y	General Building Info	Building ID		
Complete Total Energy		p	General Building Info	Energy Intensity (Qu	This information is presented through querries. This is a calculated fi	
Primary Facility Type		y	General Building Info	Select Building Type		
Year Completed		y	General Building Info	Year Completed		

Collected Building Level Data Points

- **Buildings Data**
  - Year of construction
  - Square footage
  - Heating fuel
  - HVAC: equipment, distribution
  - HVAC terminal equipment
  - DHW: equipment, fuel
  - Control System (general)
  - Historic kWh and Therms
  - EUI – existing
  - EUI - projected

- **ECM's**
  - Overall savings
  - Most Common ECMs
  - Most Common packages of ECMs

- **CEP data and LGEA Data**
  - Implemented ECM from CEP data cross checked with recommended ECM's from LGEA's

Data Alignment - Buildings Data Terminology

- Inconsistent naming- primarily an issue regarding mechanical systems…

HEATING SYSTEM			COOLING SYSTEM	
Heating, Equipment	Heating, Distribution	Heating, Fuel	Cooling, Equipment	Cooling, Distribution
N/A	N/A	N/A	N/A	N/A
Other, see Notes	Other, see Notes	Other, see Notes	Other, see Notes	Other, see Notes
Boiler, Hot Water	Steam, 1 Pipe	Natural Gas	Chiller, Air Cooled	Cold Water
Boiler, Steam	Steam, 2 Pipe	Fuel Oil	Chiller, Water Cooled	Cold Air
Steam Heat Exchanger	Hydronic, 2 Pipe	Propane	Direct Expansion (DX)	Refrigerant
Furnace	Hydronic, 3 Pipe	Electric	Unitary Equipment	
Heat Pump	Hydronic, 4 Pipe	Steam, District	Packaged Window Units	
Electric Resistance	Hot Air	Coal	Heat Pump	
	Direct		Heat Pump, Ground Source	

Data Analysis – Local Government Units

- For all 310 entities that have done both LGEAs and CEP projects:
  - Complete map into "sequence type"
  - Complete LGEA profile for each (at measure level)
    - ✓ Historical baseline for electricity and fuel
    - ✓ Recommended measures by class (# ECMs, projected savings)
  - Complete CEP-usage profile
    - ✓ By program
    - ✓ # ECMs implemented (by ECM class), projected savings
  - Complete entry of related demographic data per LGU

- Complete LGEA Profiles for remaining 129 LGEA-only entities
- Complete CEP-usage profile for 572 CEP-only entities
- Incorporate utility program data as appropriate

- Begin comparison analysis, characterization (especially usage scenarios), and scaling
- Begin "Archetype and Pathway" identification

Results Preview (An Appetizer)

For 310 Entities That Have Done LGEAs AND Used The NJ-CEP:

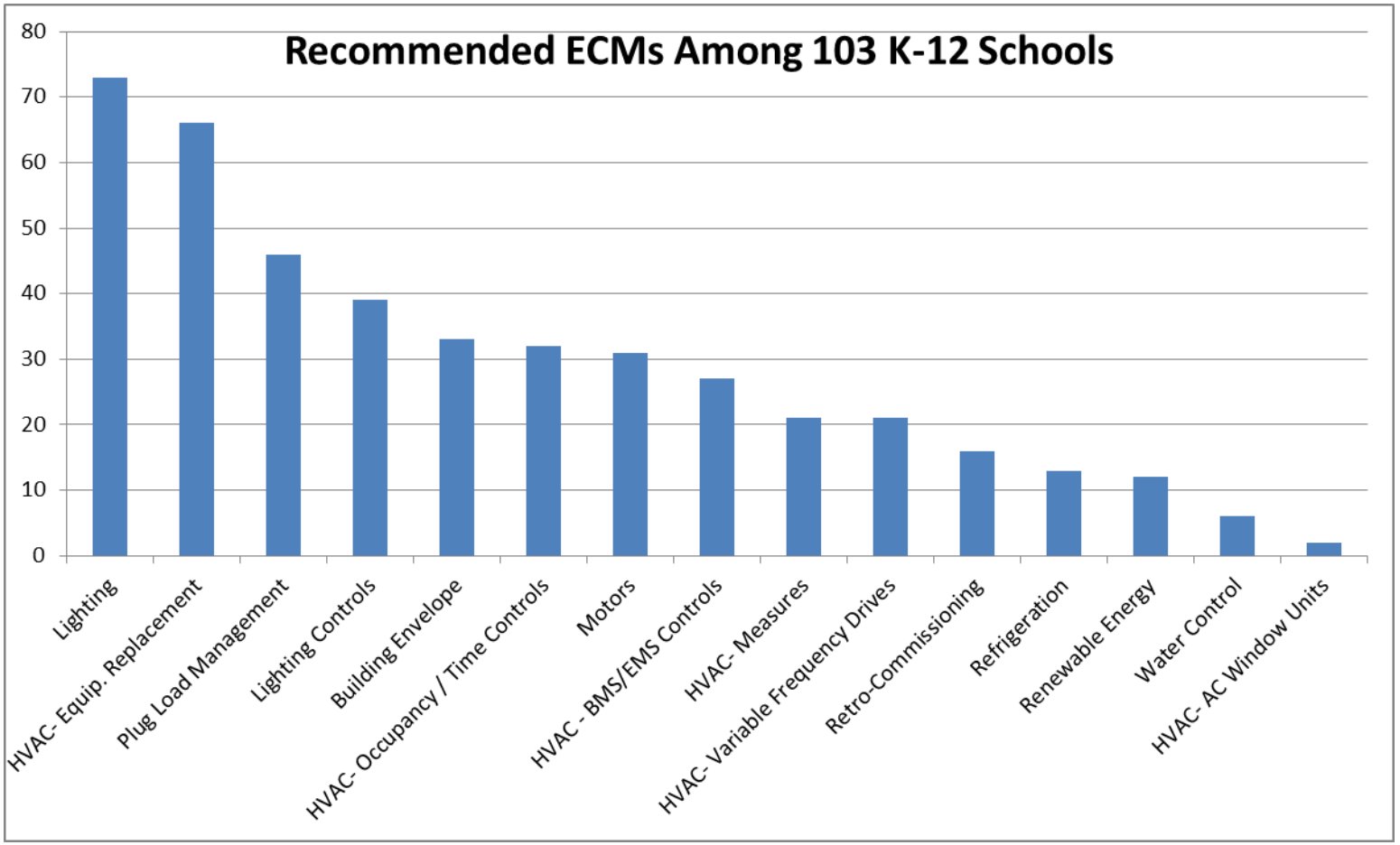
- 1,792 buildings, totaling 90,418,602 square feet
- 1,110,550,579 kWh 12-mo electricity usage
- 50,601,229 therms 12-mo natural gas usage (some oil and propane as well)
- Projected Savings (if all LGEA ECMs implemented) (*):
  - 245,880,432 kWh in electricity savings (22.1% reduction)
  - 9,699,353 therms in heat savings (19.2% reduction)

(*) LGEAs are suspected to under-represent potential savings, but measure impacts can't be simply added

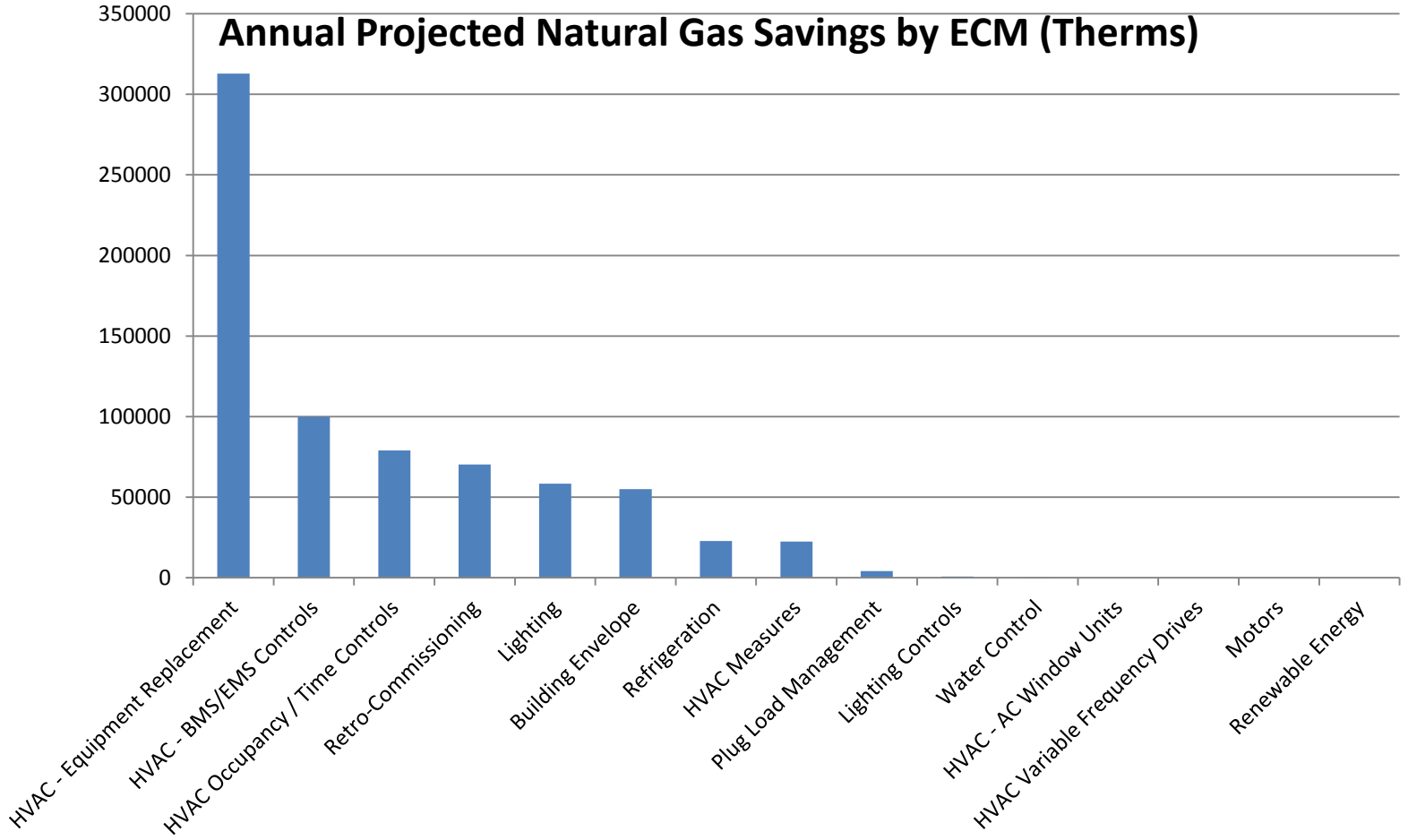
Data Analysis - Buildings

- Existing conditions for schools and municipal complexes
- Recommended ECMs
- **Completed work**

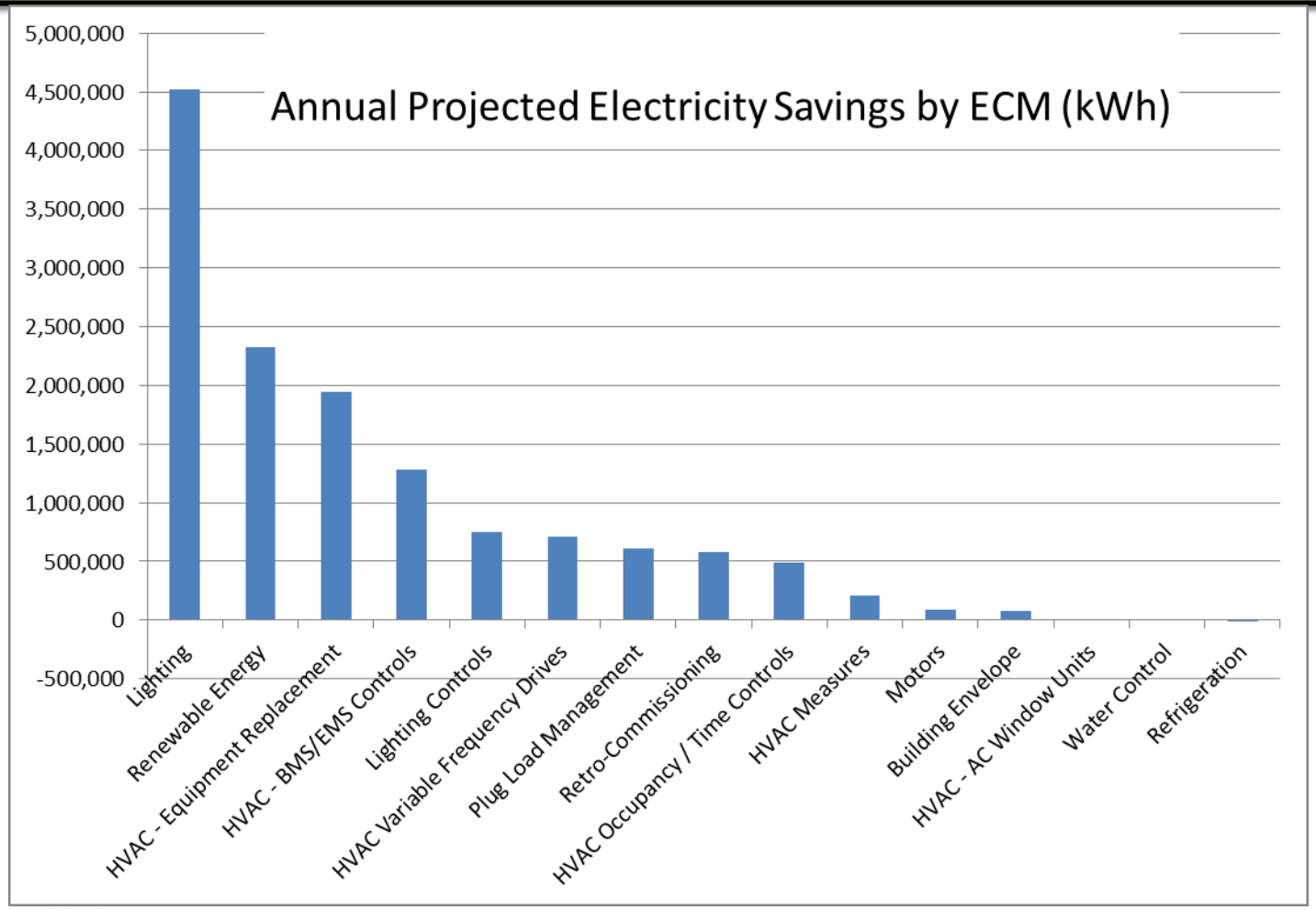
Buildings Recommended Energy Conservation Measures



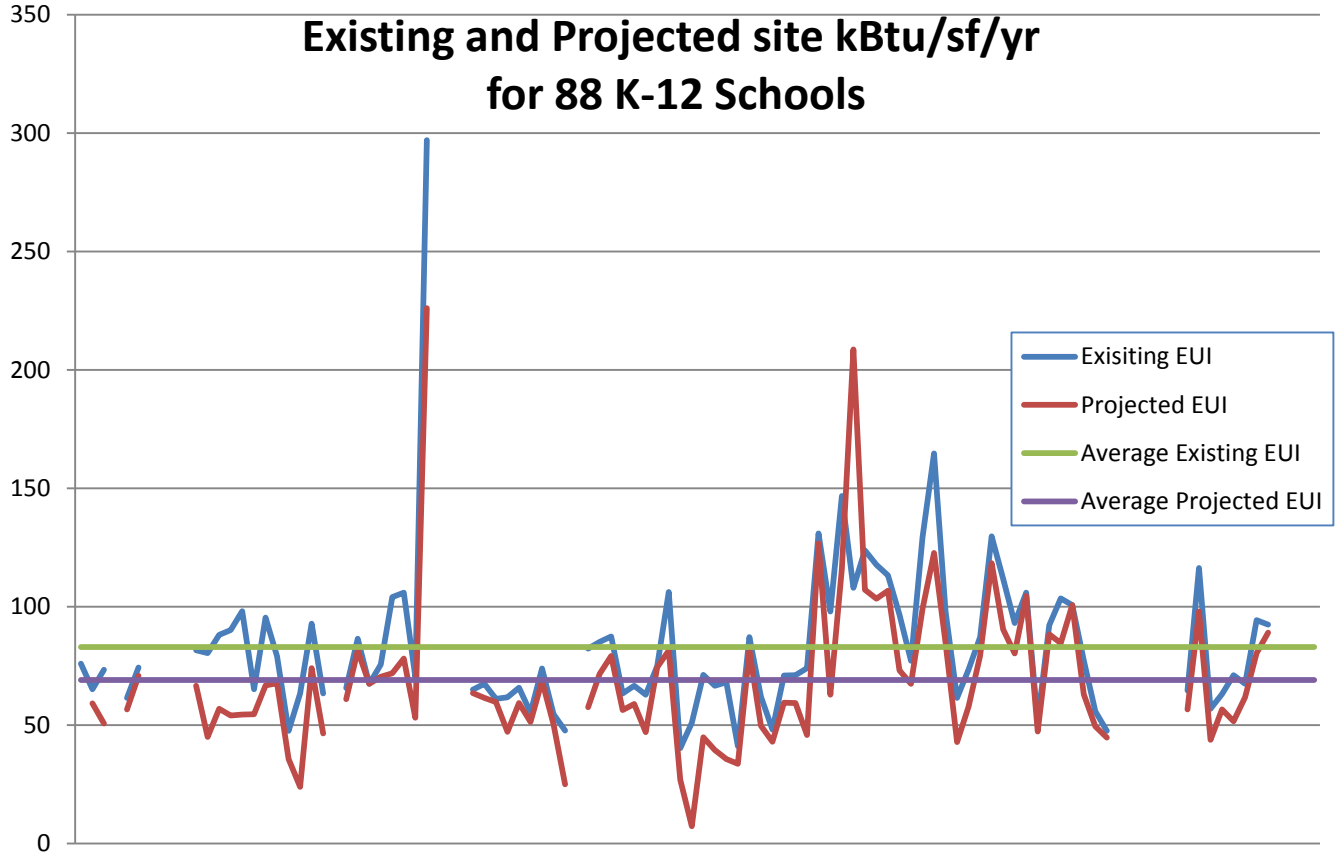
Projected Savings by Energy Conservation Measure



Electricity Savings by Energy Conservation Measure



Existing and Projected Site Energy Use Intensity



AVG Existing EUI = 83 AVG Projected EUI = 69 17% reduction

Certificate of Proficiency in Benchmarking

A training and certificate program for benchmarking building energy and water performance using ENERGY STAR Portfolio Manager®
www.benchmarkingcertificate.org

CPB is sponsored and administered by the New Jersey Institute of Technology, with funding and support from CBEI.

The Curriculum

- Portfolio Manager 101 is an introduction to the new portfolio manager.
- Portfolio Manager 201 demonstrates for participants how to use some of the more advanced features of Portfolio Manager.
- Portfolio Manager 301 address the current quality assurance/quality control issues, looking at methods to insure high quality data.
- Portfolio Manager 401 will walk students through the process of actually entering the data in to Portfolio Manager.

NJIT CBEI CONSORTIUM for BUILDING ENERGY INNOVATION


cpb
Certificate of
Proficiency in Benchmarking

Scott Wagner
CBEI

U.S. DEPARTMENT OF
ENERGY

CONSORTIUM for BUILDING ENERGY INNOVATION

Better Buildings Summit

Strategies and Guidelines for the Cleansing and Analysis of Building Energy Benchmarking Data

May 27, 2015

Benchmarking Data Issues and Challenges:

1. **Benchmarking data collected for a benchmarking program is typically self-reported by building owners/operators:** Self-reported data can contain significant errors which negatively impact energy efficiency metrics such as the Energy Utilization Intensity (EUI) and Energy Star Portfolio Manager score.

2. **Typically, all benchmarking data submitted to a benchmarking program is made transparent to the public:** This means both "good" and "bad" data is provided to the public as reported.

3. **Even after data "cleansing," benchmarking datasets can still contain incorrect data**: However, it is very difficult to identify and remove this incorrect data.

Opportunities:

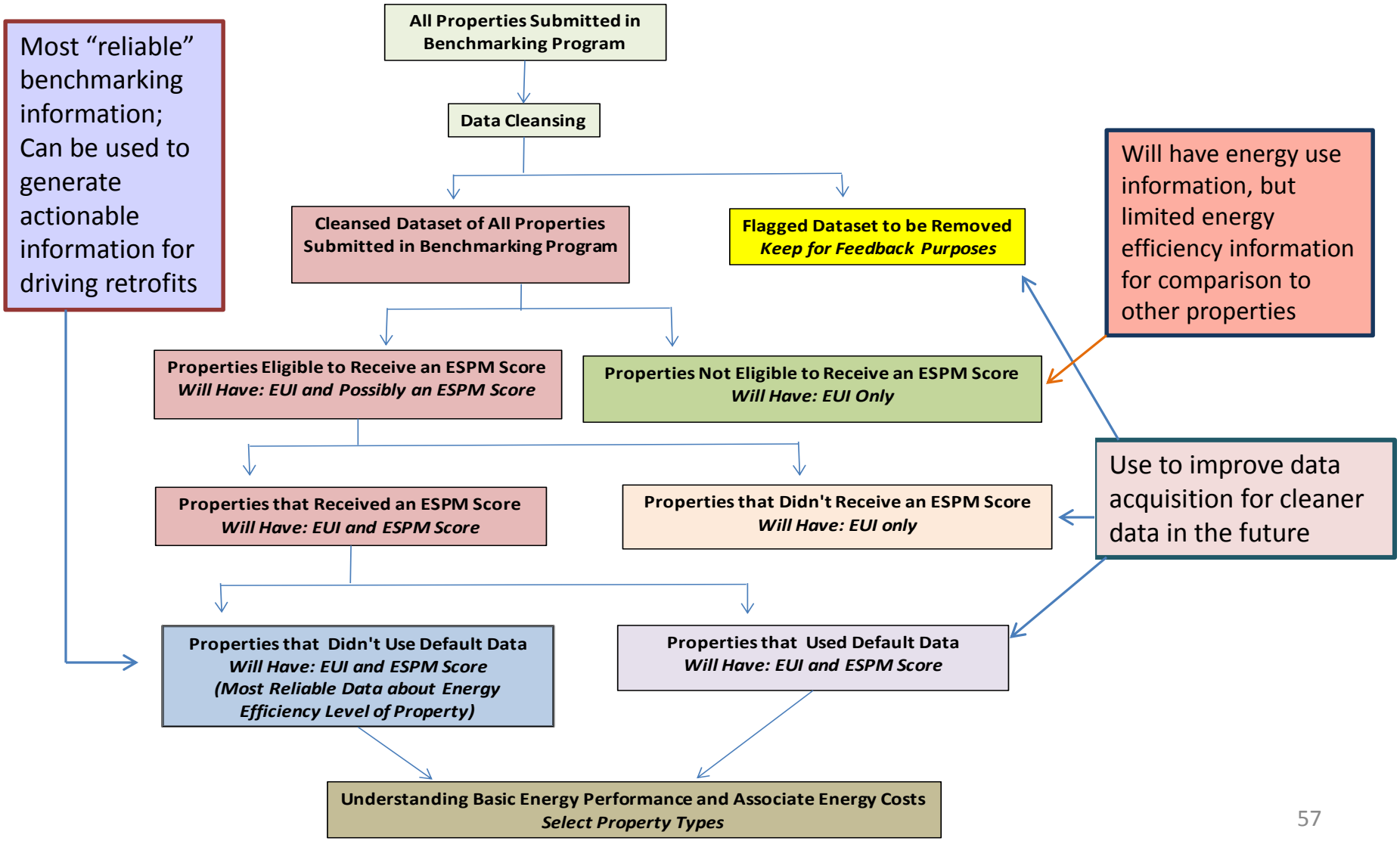
1. **Improve quality of raw data:** Provide feedback to the building owners/operators that supplied "bad" data to minimize it in future reporting; require Energy Star "certification" to input data into benchmarking program.

2. **Analysis of benchmarking data:** Geared to generate "actionable" information from benchmarking data to drive energy efficiency retrofits .

General Benchmarking Data Quality Cleansing Criteria:

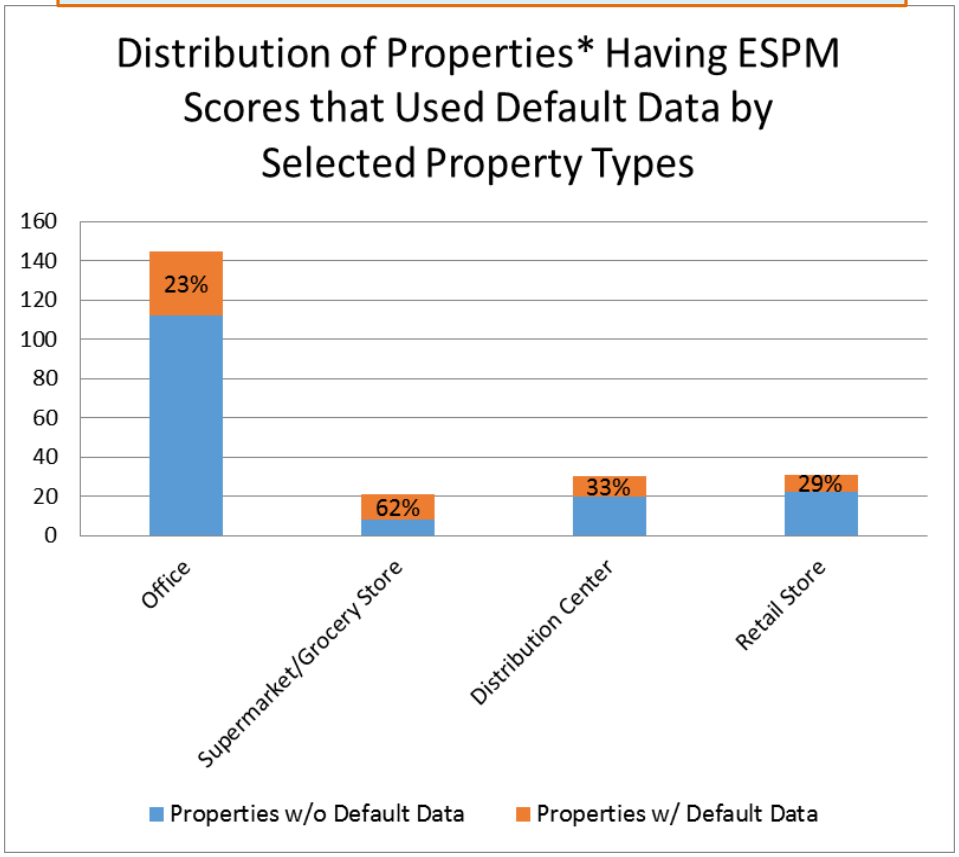
Type of Data Quality Issue:	Cleanse for Analysis:	Use for Feedback Purposes:	Criteria:	Impact:
Duplicate Property Entries or "dummy data" entries:	X	-	More than one data entry for a specific property; municipality used "dummy" buildings to test benchmarking system	Increases potential error in analysis
Too Small Building Square Footage:	X	X	Property's square footage is below minimum program requirement.	Building square footage may be incorrect
No Property Type	X	X	Property type was reclassified to "Not Available" as defined in ESPM's Primary Property Type – EPA Calculated field.	Property does not have building gross floor area defined for complete timeframe
No EUI	X	X	Property did not report an EUI.	No information about energy use
No ESPM Benchmark Score for Property Type That Should Have Received a Score	-	X	Refer to ESPM's list of 21 property types eligible to receive an Energy Star score.	No information about energy efficiency
Extremely High or Low ESPM Benchmark Score	X	X	Remove properties with score of 100, 99, 2, or 1.	Total energy use or building square footage may be too high or too low for property
Extremely High or Low EUI	X	X	In general, Properties with site EUIs less than 2 kBtu/sf/yr or greater than 800 kBtu/sf/yr, except for Industrial/Manufacturing or Waste Water Treatment properties.	Total energy use or building square footage may be too high or too low for property
Zero Electric Use	X	X	Virtually all buildings in the U.S. use some amount of electrical energy; total energy use is incorrect.	Total energy use of property was not accounted for properly
Default Data Use	-	X	ESPM indicates which properties have default data, instead of actual data, for regression equation.	Although Benchmark score may not have been calculated correctly, EUI can be used for analysis.

Flow Chart for Parsing Benchmarking Data

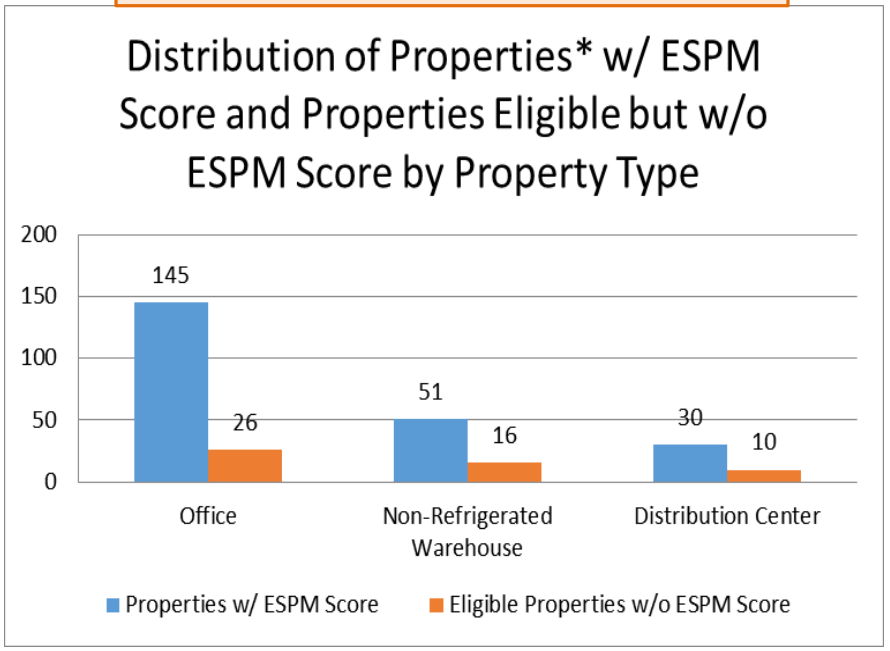


Benchmarking Data Parsing
Default Data and No ESPM Score

Can be an indication property owners are having difficulty getting actual data for ESPM inputs

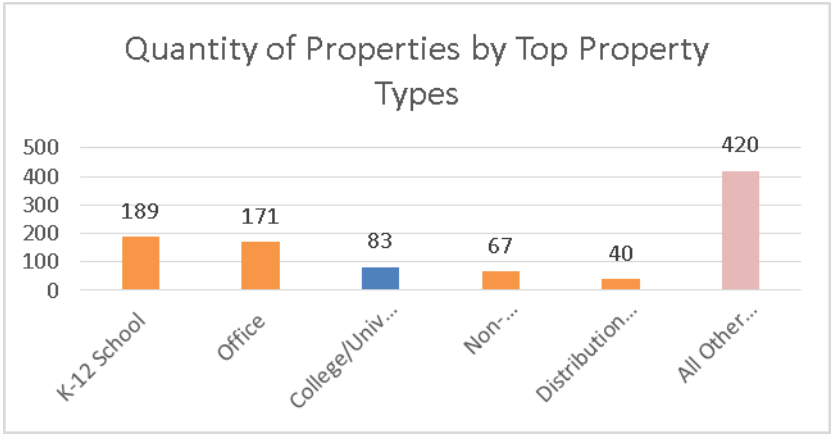


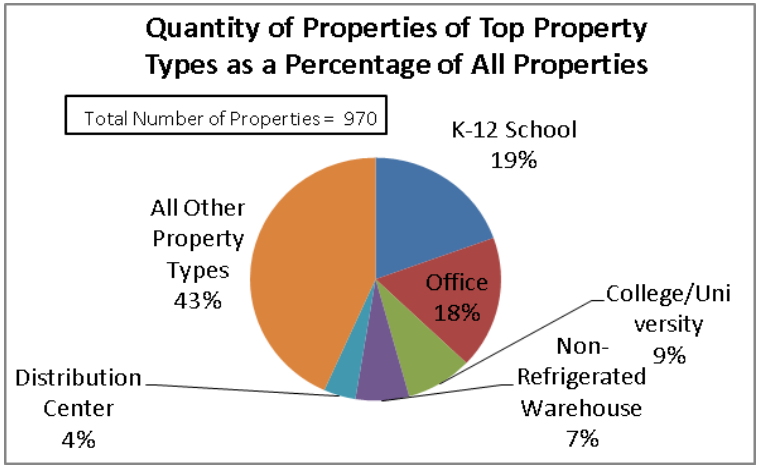
Can be an indication property owners are having difficulty with ESPM

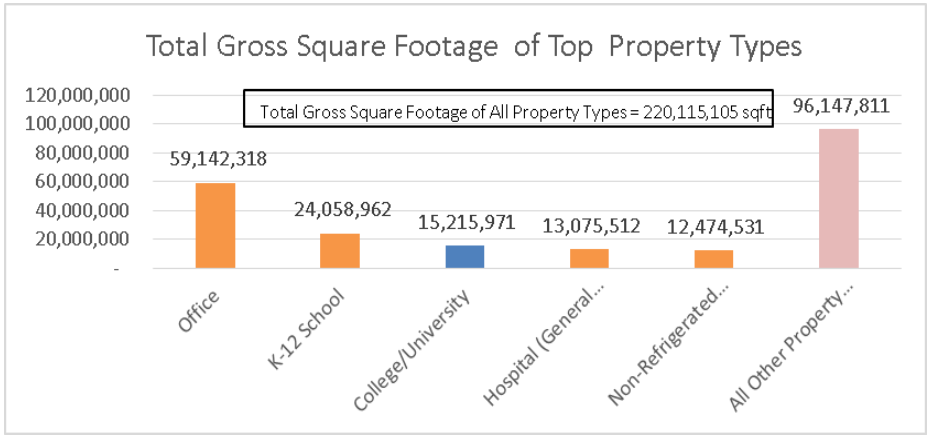


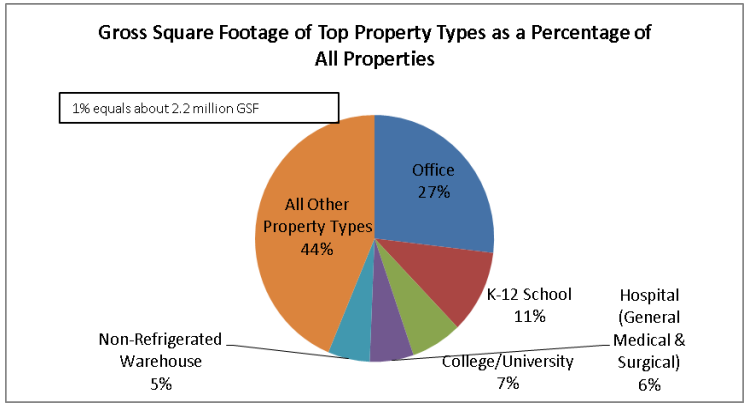
* Example Benchmarking Data - Philadelphia 2013

Benchmarking Data Analytics
All Property Types Combined
Typical First Cut Analysis of Total Building Stock
*Quantity and Square Footage**





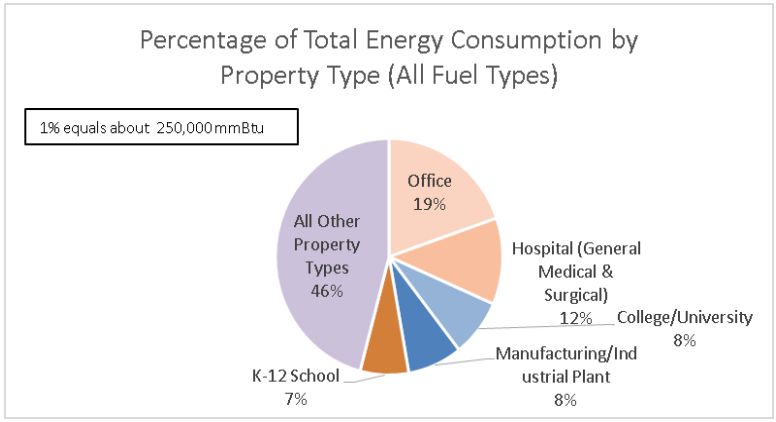


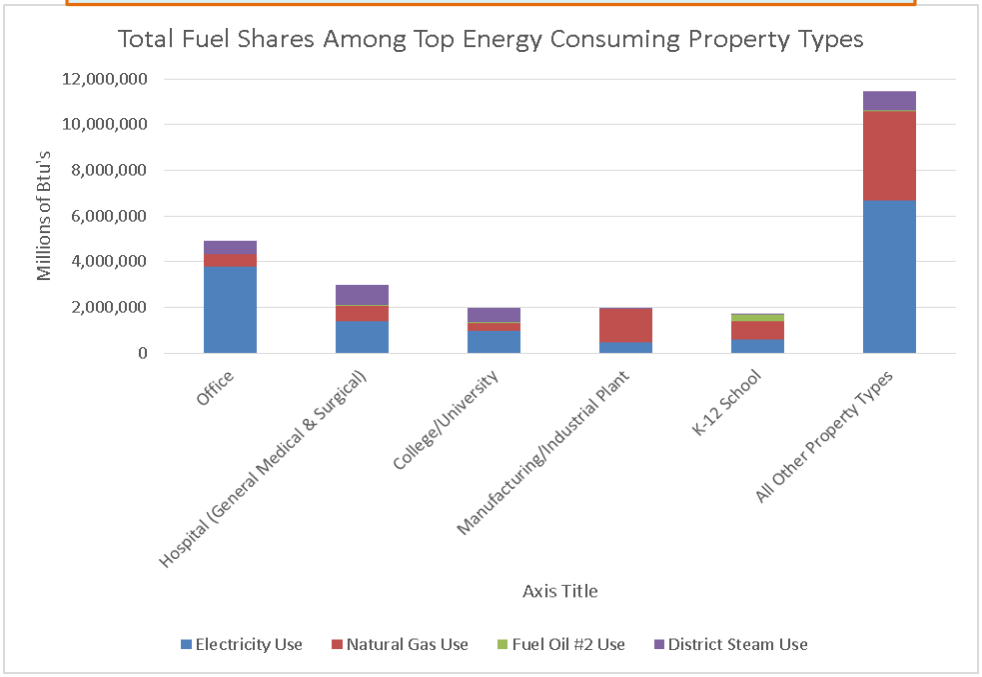


* Example Benchmarking Data - Philadelphia 2013

Benchmarking Data Analytics
All Property Types Combined
Typical First Cut Analysis of Total Building Stock
*Total Energy Consumption and Fuel Shares**

Electric Fuel Share is of importance since it can drive $/sf and changes in ESPM score

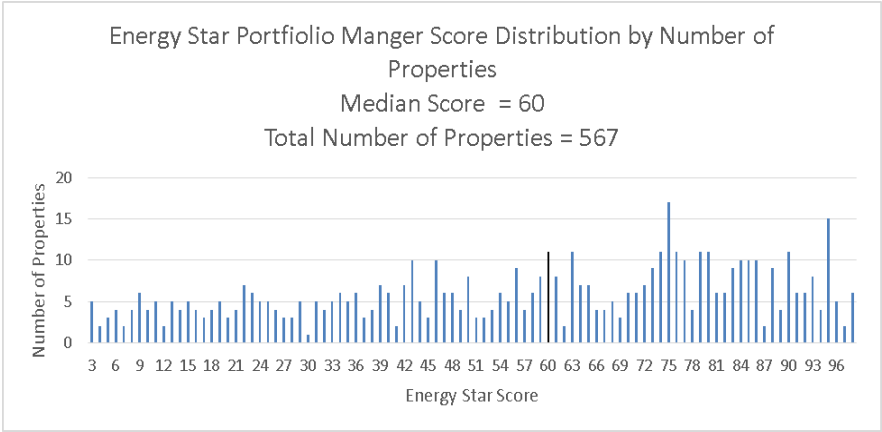




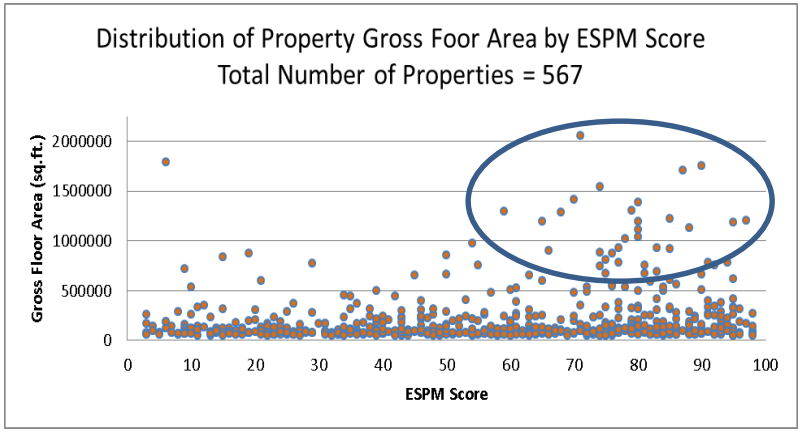
* Example Benchmarking Data - Philadelphia 2013

Benchmarking Data Analytics
*Three Important Benchmarking Indicators for Properties with ESPM Scores**

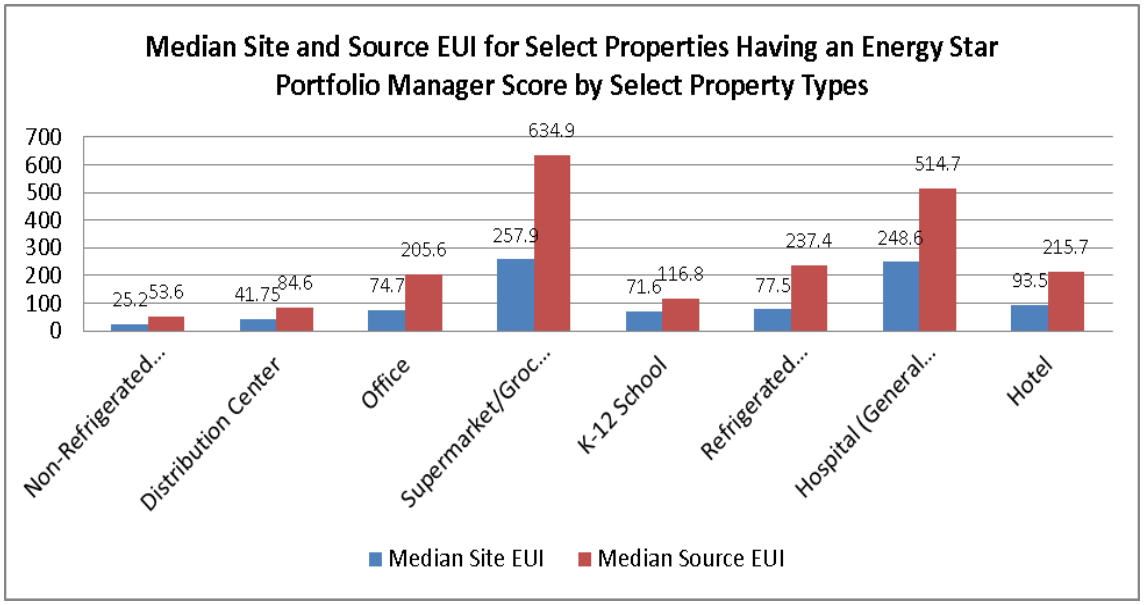
1



2



3



Indicator:

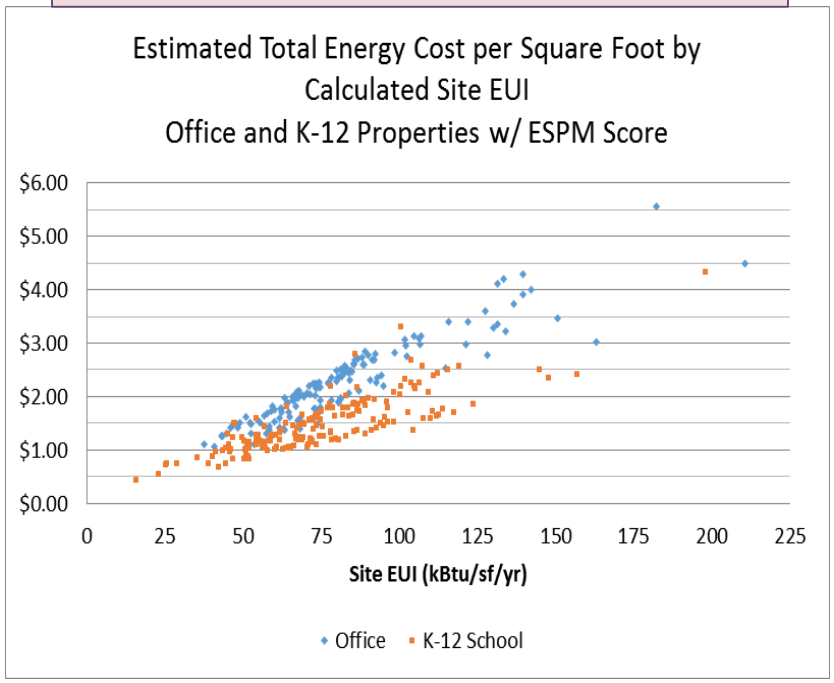
1. Median ESPM score indicates overall efficiency of total building stock.
2. Distribution of gross floor area by ESPM score indicates larger properties tend to be more efficient.
3. The larger the difference between site and source EUI indicates higher electric fuel share.

* Example Benchmarking Data - Philadelphia 2013

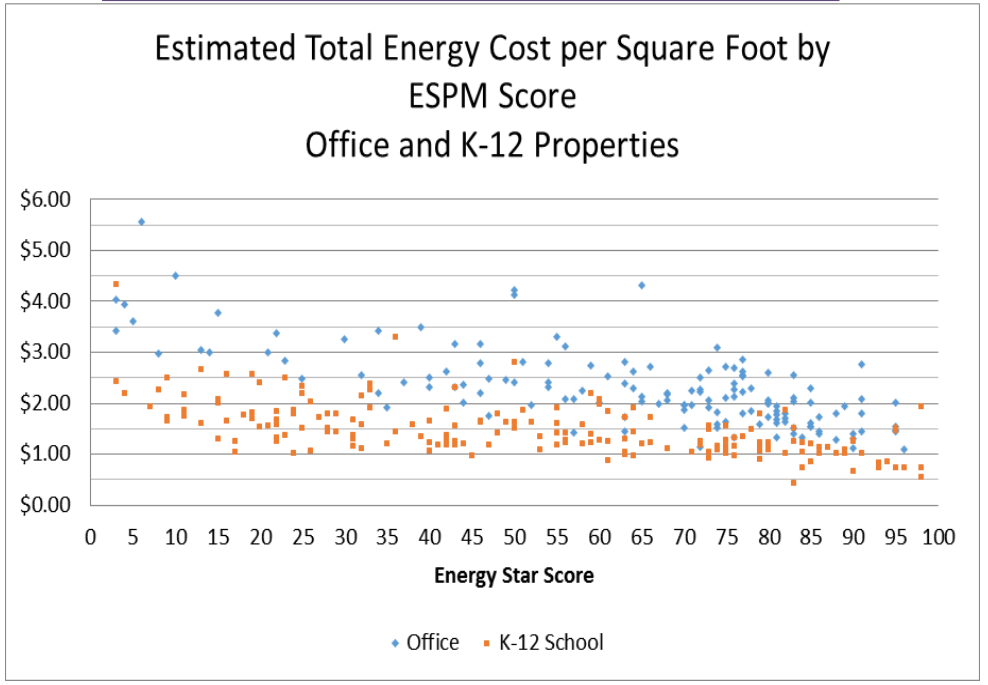
Benchmarking Data Analytics
*$/sf for Offices and K-12 Schools**

Offices: Large electric fuel share gives higher $/sf;
K-12 Schools: Small electric fuel share gives smaller $/sf

At same EUI, $/sf for K-12 Schools are typically lower than for Offices

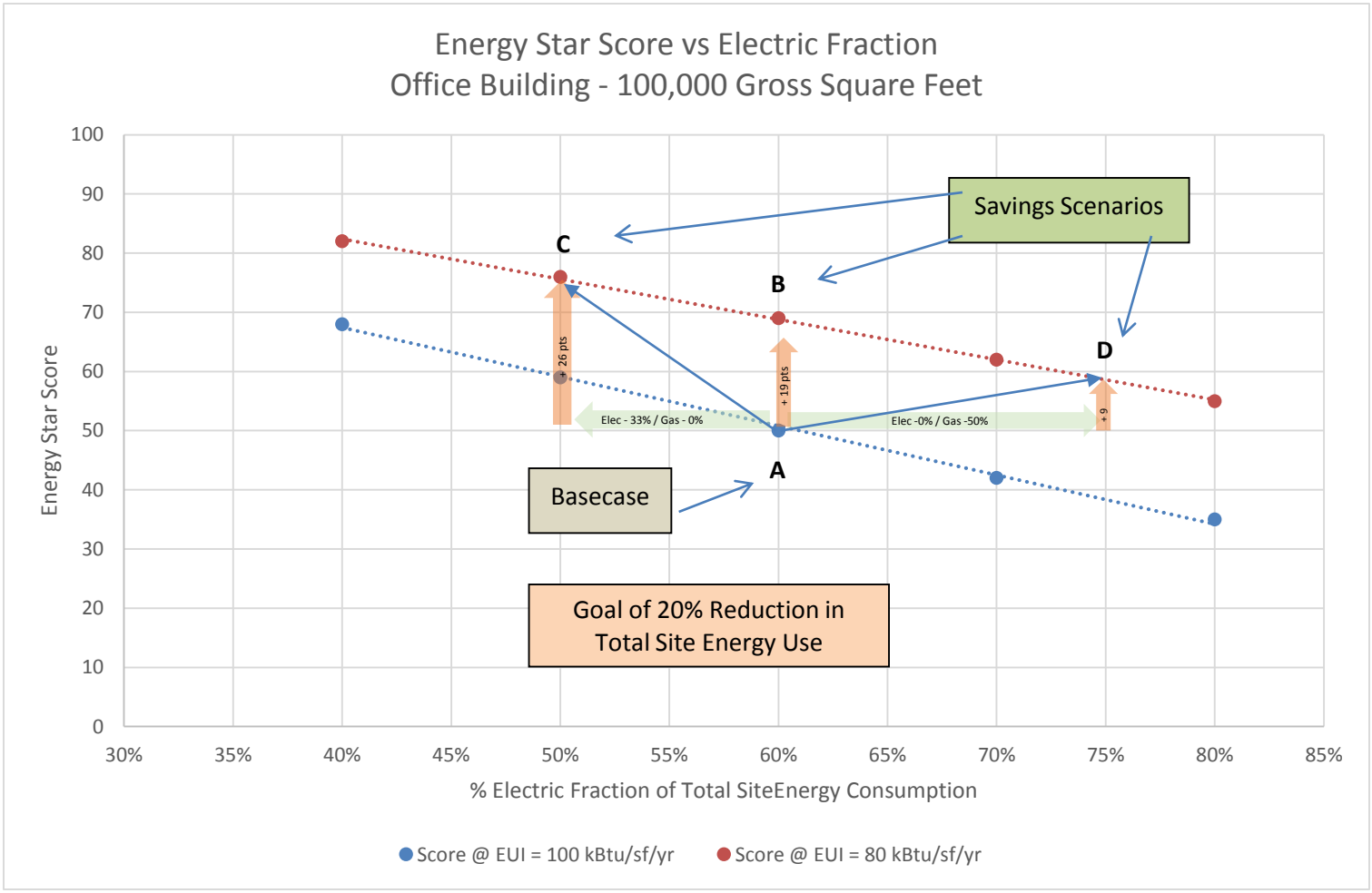


For a property type as a whole, $/sf are generally smaller for properties with higher ESPM scores

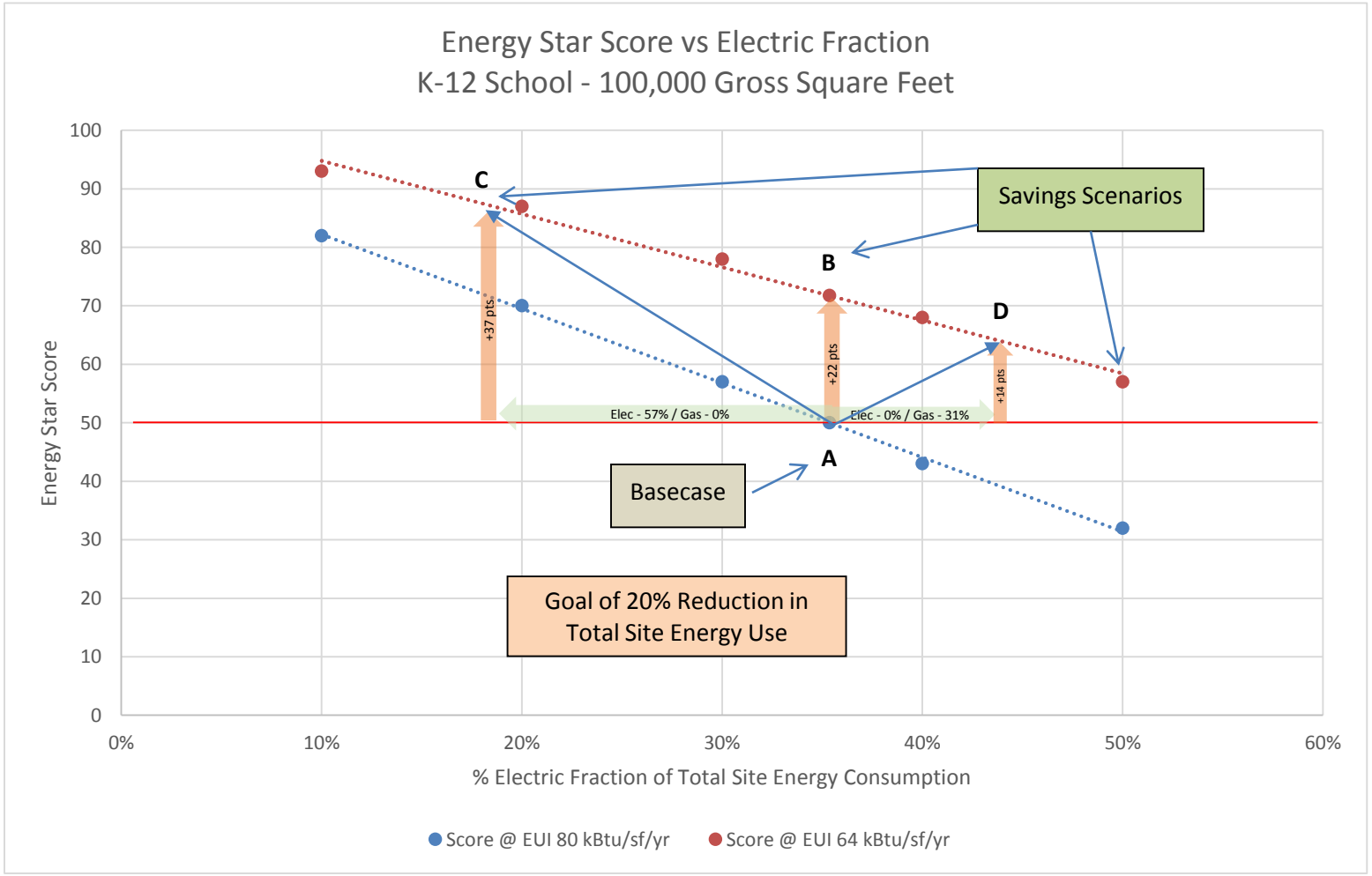


* Example Benchmarking Data - Philadelphia 2013

Maximizing Energy Star Score by Shifting the Electric Fraction (Share) Offices



Maximizing Energy Star Score by Shifting the Electric Fraction (Share)
K-12 Schools



Maximizing Energy Star Score by Shifting the Electric Fraction (Share) Summary of Results

Energy Savings Scenarios based on Energy Star Portfolio Manger Parametric Runs								
Total Site Energy Savings of 20% = 20 kBtu/sf/yr Saved for Office and 16 kBtu/sf/yr Saved for K-12 School								
	Point:							
	A		B		C		D	
	Basecase		**Savings Scenario 1**: Same % Reduction for Each Fuel Type		**Savings Scenario 2:** All Savings Are Electric		**Savings Scenario 3:** All Savings Are Gas	
	Office	K-12 School	Office	K-12 School	Office	K-12 School	Office	K-12 School
Total Energy EUI (kBtu/sf/yr):	100	80	80	64	80	64	80	64
Electric EUI	60	28	48	22.4	40	12	60	28
Gas EUI	40	52	32	41.6	40	52	20	36
% Fuel Share:								
Electric	60%	35%	60%	35%	50%	19%	75%	44%
Gas	40%	65%	40%	65%	50%	81%	25%	56%
Energy Star Score:	**50**	**50**	**69**	**72**	**76**	**87**	**59**	**64**
% Electric Savings:	-	-	20%	20%	33%	57%	0%	0%
% Gas Savings:	-	-	20%	20%	0%	0%	50%	31%

Informs benchmarking program administrators about impacts on ESPM scoring resulting from potential energy reduction goals (i.e., 20% reduction of total building energy use)

Methodology for Selecting Properties with a High Opportunity for Retrofit

Want a cross-section of properties, not a grouping of properties with the largest amount of gross floor area or largest amount of total annual energy use:

Step 1: Select properties with Energy Star Score below 75 (done for each property type)

↓

Step 2: Select properties with site EUI equal to or greater than median site EUI (selection is independent of building size and total energy use)

↓

Step 3: Select properties with $/sf equal to or greater than median $/sf (selection is independent of building size and total energy use)

↓

Step 4: Determine median % electric fraction of total annual site energy use

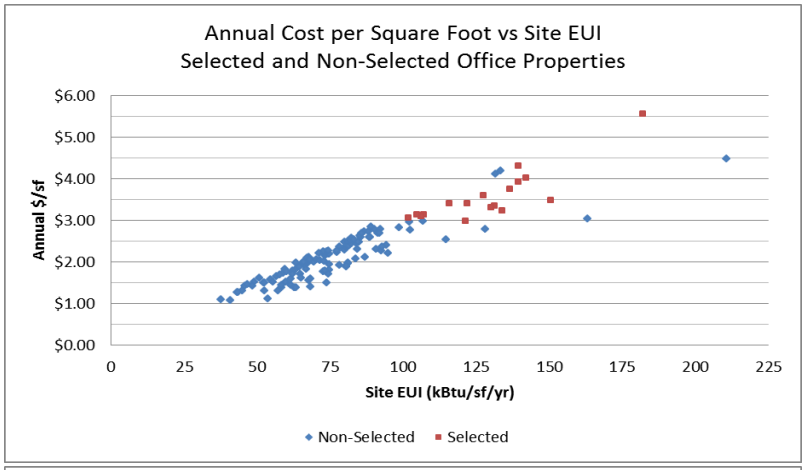
↓

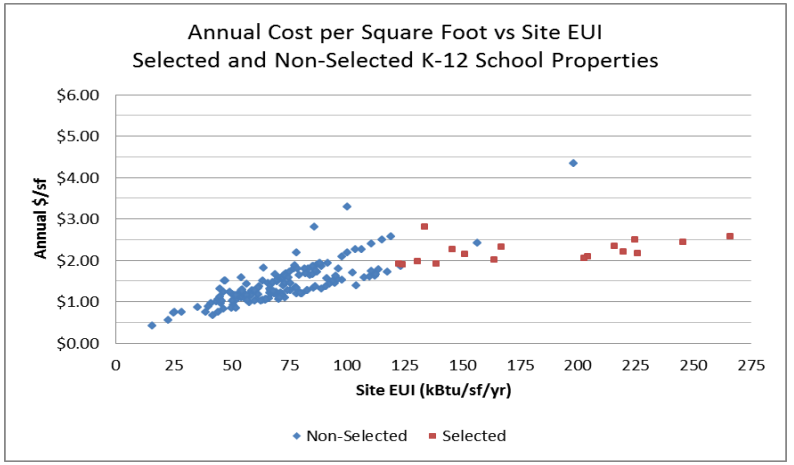
Step 5: Select properties with “reasonable” % electric fraction based on median value

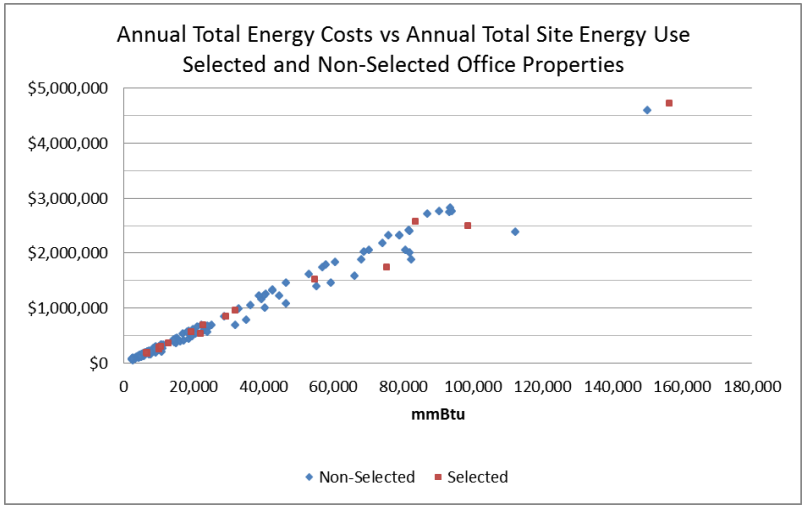
Methodology for Selecting Properties with a High Opportunity for Retrofit

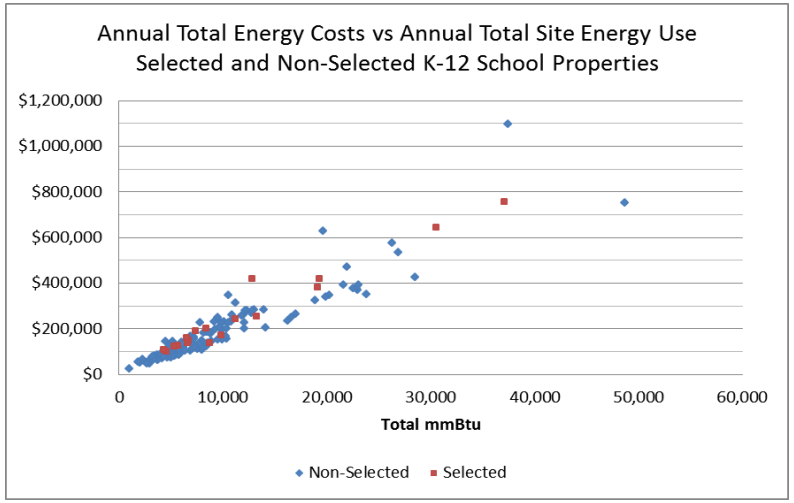
Verification of selection of candidate properties:* Offices and K-12 Schools

1. High EUI and $/sf
2. Good cross-section of properties with varying total annual energy and cost







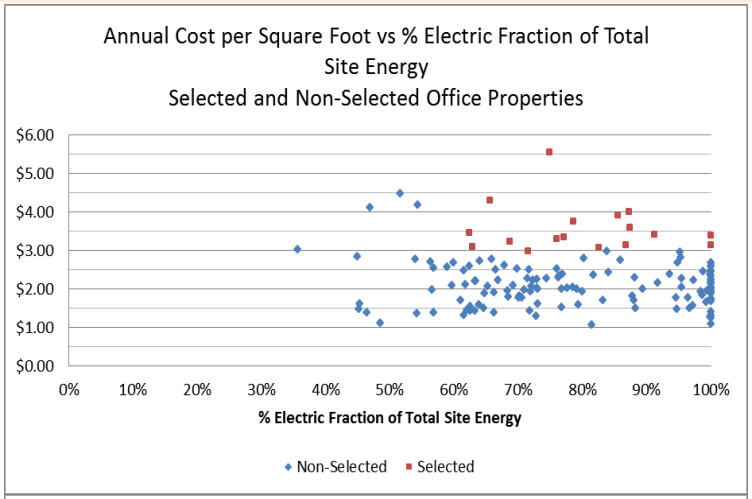


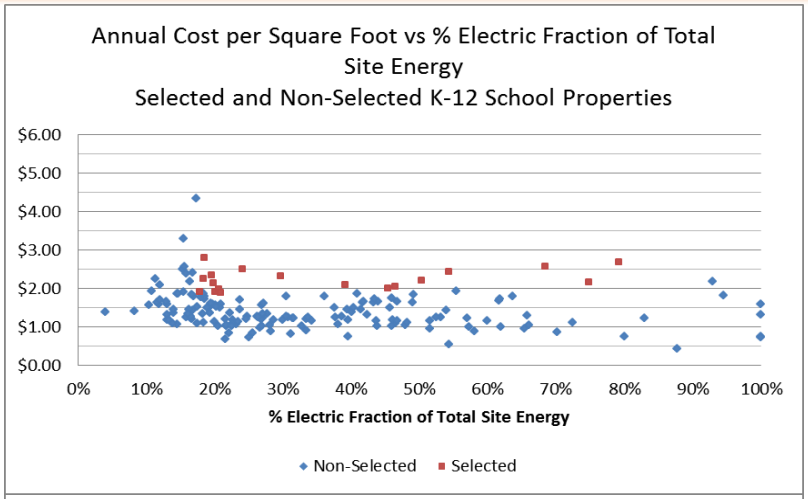
* Example Benchmarking Data - Philadelphia 2013

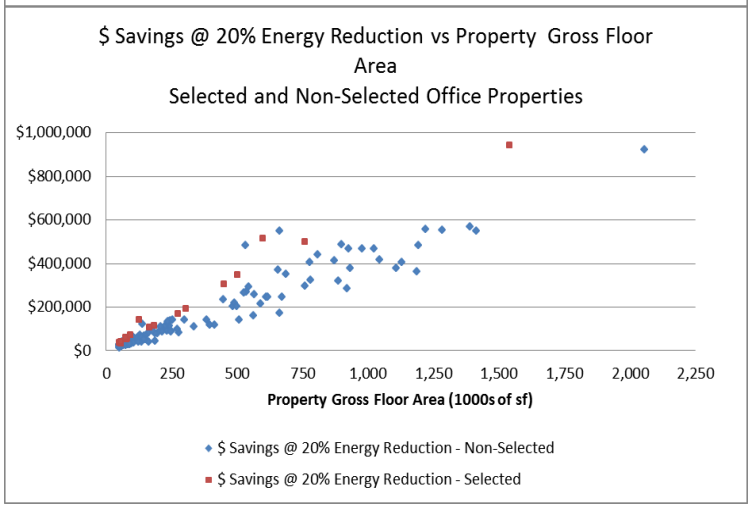
Methodology for Selecting Properties with a High Opportunity for Retrofit

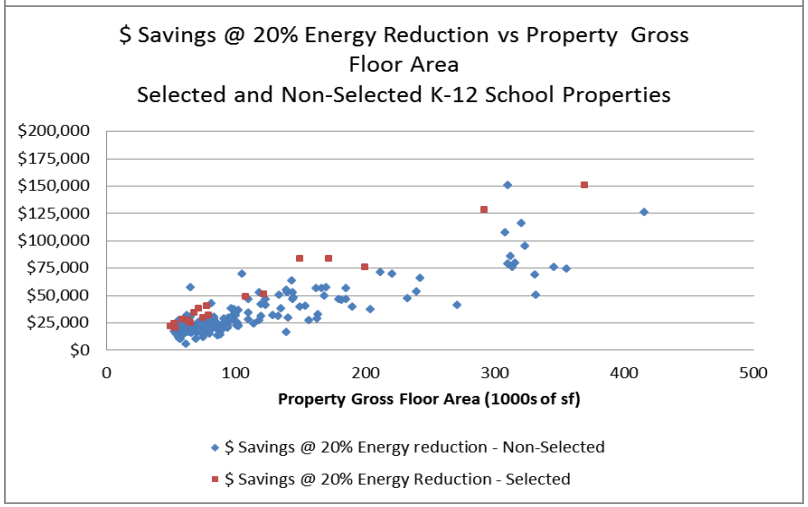
Verification of selection of candidate properties:* Offices and K-12 Schools

1. High $/sf and % Electric Fraction
2. Good cross-section of properties with largest $ savings and varying property size









* Example Benchmarking Data - Philadelphia 2013

Summary:

- *Data quality cleansing criteria*
- *Methodology for parsing benchmarking data*
- *Typical types of data analyses*
  - *Three important indicators*
- *Maximizing Energy Star score by shifting the electric fraction*
- *Methodology for Selecting Properties with a High Opportunity for Retrofit*

Next Steps:

- *Combining ESPM with DOE Asset Score tool*
- *Using interval data to benchmark:*
  - *Heating, cooling and base loads of properties (inverse modeling)*
  - *Building operation during unoccupied hours during the week and weekends (loadshape analysis)*