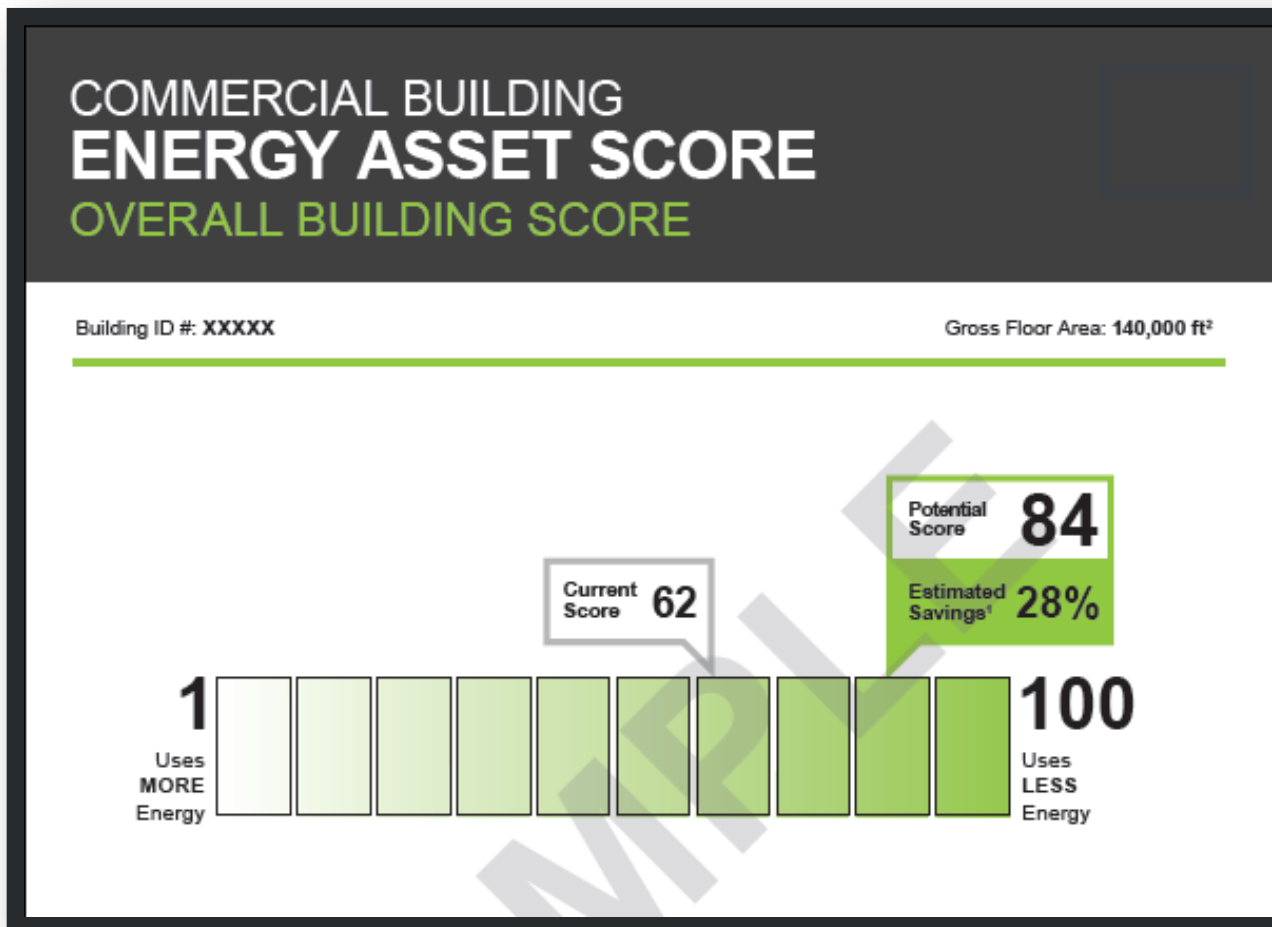


Commercial Building Energy Asset Score

2014 Building Technologies Office Peer Review



Project Summary

Timeline:

Start date: 04/01/2011

Planned end date: Major tool development to be completed by 2016; ongoing maintenance

Key Milestones:

- 1) Completed Pilot #2: 03/01/2014
- 2) Public launch of Asset Scoring Tool, 2014 version : 09/30/2014

Budget:

Total DOE \$ to date: \$4,609,230
(approximately \$1.5 million/year to date)

Total future DOE \$: TBD

Target Market/Audience:

Building owners/operators, state and local governments, federal agencies, service providers, utilities

Key Partners:

State Energy Program (DOE Grantees)
Minnesota Center for Energy and Environment
Massachusetts Department of Energy Resources (MA DOER) and Northeast Energy Efficiency Partnership (NEEP)
Building Owners/Operators & Utilities

Project Goal:

- Develop a credible scoring system for commercial buildings that can be used to inform retrofits and real estate transactions

Purpose and Objectives

Problem Statement: No national standard for consistently evaluating a building’s structure and energy-related systems independent of operations/tenant behavior exists. A national energy asset rating for commercial buildings is essential to 1) encourage effective valuation of energy efficiency in real estate transactions; and, 2) guide owner investment in capital improvements.

Target Market and Audience

- Building owners/operators, state & local governments, federal agencies, service providers, utilities
- Anticipated use cases:



Impact of Project/Contribution to Energy Efficiency

- Provide a standard, free modeling tool to help commercial building owners and operators gain insight into the efficiency of their building systems, understand efficiency potentials, motivate investment in improvements, and improve valuation of efficiency
- By 2020, use Asset Score to evaluate 5% of total commercial space* and identify 200 Tbtu primary energy use savings** and \$2 billion cost savings**.
- In the long term, use Asset Score to inform real estate transactions

* As of December 2010, 20% of total commercial building space estimated to exist in 2020 had been benchmarked using Energy Star Portfolio Manager.

** Assuming 20% energy use reduction and 2010 cost estimates.

Approach

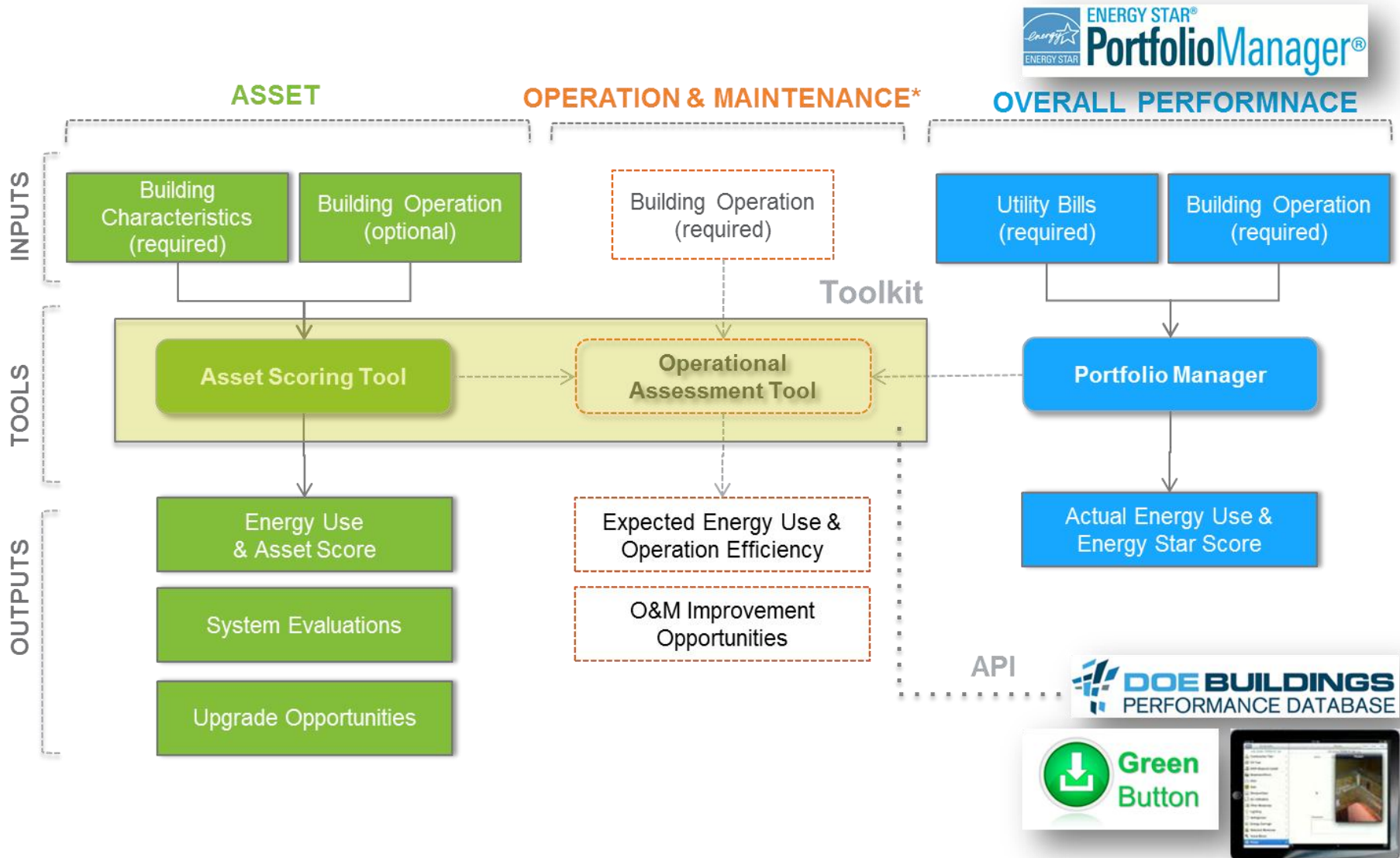
Approach:

- Create a free Asset Scoring Tool application with simplified data requirements using the EnergyPlus building modeling engine (via OpenStudio)
- Develop API to allow data exchange with other tools
- Provide a preliminary report documenting the building's Asset Score to inform owners, operators and others who have limited knowledge of building energy efficiency
- Help building owners and managers disaggregate building energy information and include a mechanism for identifying energy improvement opportunities

Key Issues:

- Determine the appropriate level of data inputs for an accurate assessment while minimizing data collection burden
- Finalize approach for weather normalization
- Determine appropriate level of EEMs
- Improve user understanding of relationship between Asset Score and Portfolio Manager

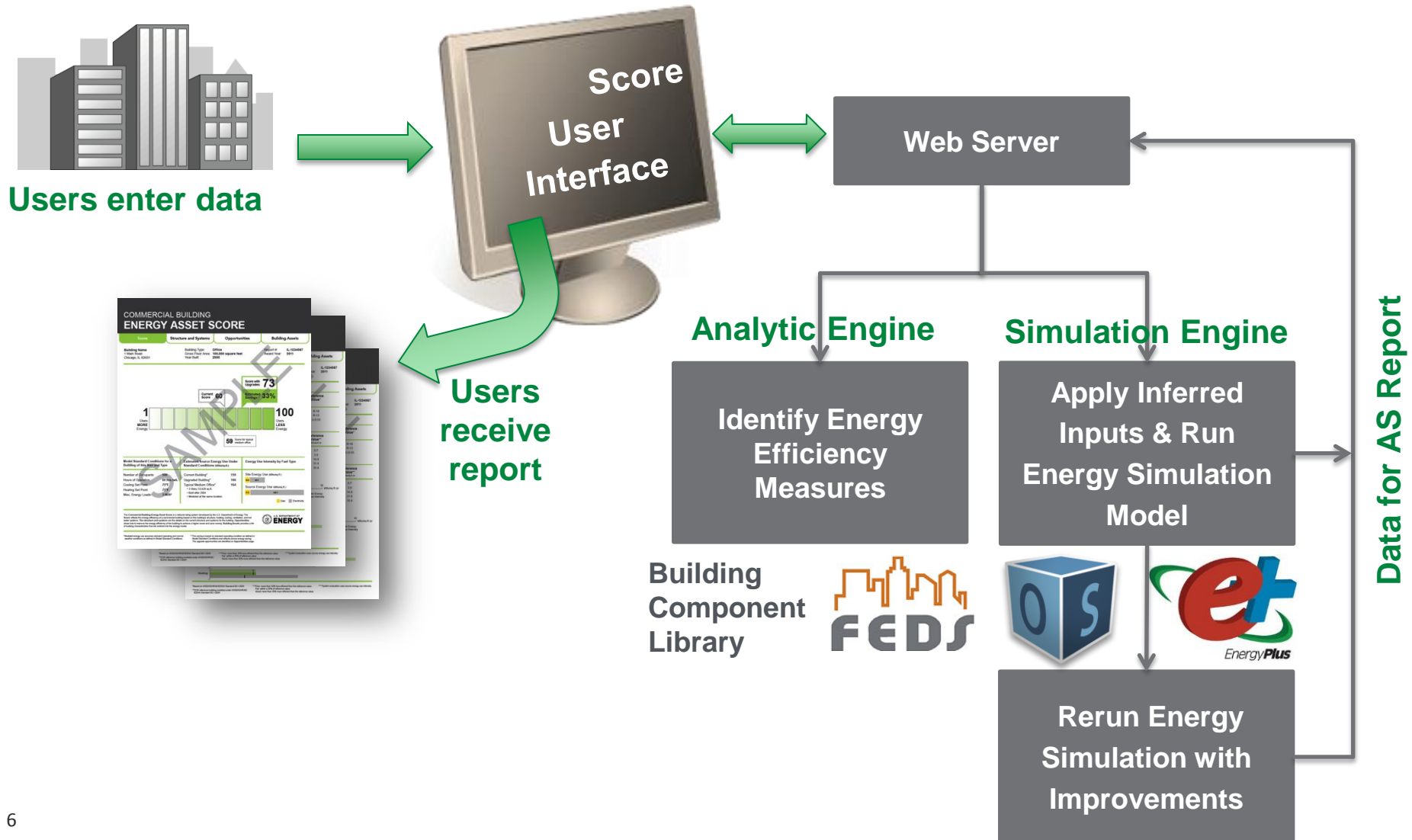
Approach



*Strategy for O&M portion is still under development.

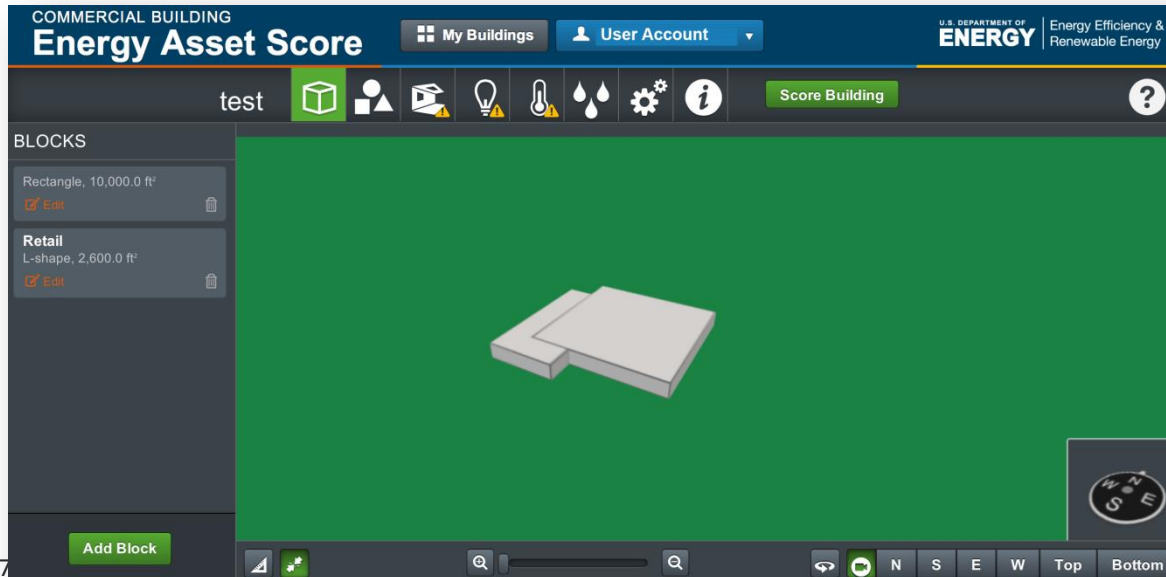
Approach

Distinctive Characteristics: An easy-to-use free tool based on centralized modeling engine, inference generator, and cost effective analysis.



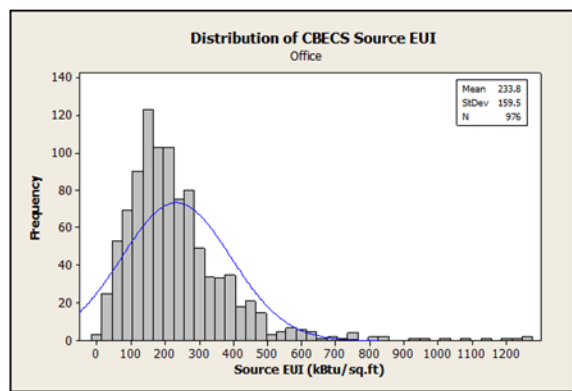
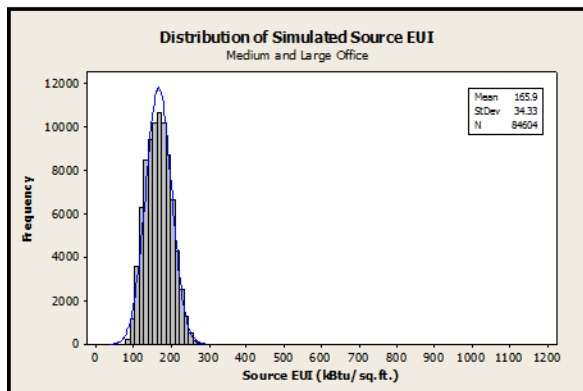
Asset Scoring Tool

- Requires approximately 30 data fields to create a building model
- 4-8 hours for data collection; 1-2 hours for data entry
- Uses EnergyPlus to generate an EUI and Asset Score
- Provides building system evaluations for envelope, service hot water, HVAC, and lighting
- Identifies cost-effective improvements
- Includes an additional "after upgrades" score that demonstrates the potential energy impact of the recommendations



Scoring Scale Development

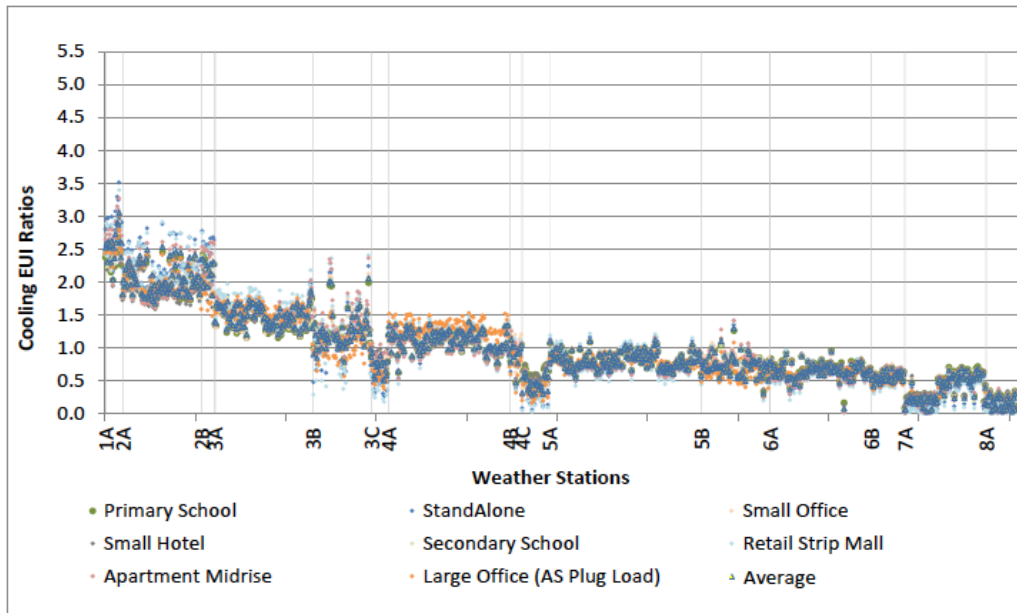
- Collaborated with NREL to develop score tables for each use type based on distributions from 750,000+ simulations
- Used CBECS distributions as references
 - e.g. for office buildings, end points on 100 point scale closely align with 10th and 90th percentile points from CBECS
- Used prototype buildings as control points to define 100 point scale
 - 65-70 score corresponds to 2004 prototype buildings
 - 80-85 score corresponds to 2010 prototype buildings



EUI	SCORE	Increment	EUI	SCORE	Increment
70	100	2	170	50	2
72	99	2	172	49	2
74	98	2	174	48	2
76	97	2	176	47	2
78	96	2	178	46	2
80	95	2	180	45	2
82	94	2	182	44	2
84	93	2	184	43	2
86	92	2	186	42	2
88	91	2	188	41	2
90	90	2	190	40	2
92	89	2	193	39	3
94	88	2	196	38	3
96	87	2	199	37	3
98	86	2	202	36	3
100	85	2	205	35	3
102	84	2	208	34	3
104	83	2	211	33	3
106	82	2	214	32	3
108	81	2	217	31	3
110	80	2	220	30	3
112	79	2	223	29	3
114	78	2	226	28	3
116	77	2	229	27	3
118	76	2	232	26	3
120	75	2	235	25	3
122	74	2	238	24	3
124	73	2	241	23	3
126	72	2	244	22	3
128	71	2	247	21	3
130	70	2	250	20	3
132	69	2	254	19	4
134	68	2	258	18	4
136	67	2	262	17	4
138	66	2	266	16	4
140	65	2	270	15	4
142	64	2	274	14	4
144	63	2	278	13	4
146	62	2	282	12	4
148	61	2	286	11	4
150	60	2	290	10	4
152	59	2	294	9	4
154	58	2	298	8	4
156	57	2	302	7	4
158	56	2	306	6	4
160	55	2	310	5	4
162	54	2	314	4	4
164	53	2	318	3	4
166	52	2	322	2	4
168	51	2	326	1	4

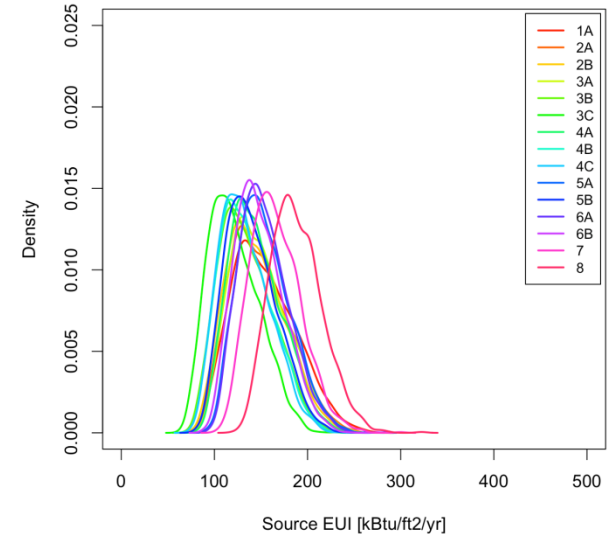
Weather Normalization

- Developed 1,000+ sets of weather coefficients using nine prototype buildings (compliant with 90.1-2004) simulated with all weather stations in EnergyPlus
- Each set of coefficients separately adjust heating, cooling, and fan energy use before a building is scored
- Validated using 750,000+ simulations

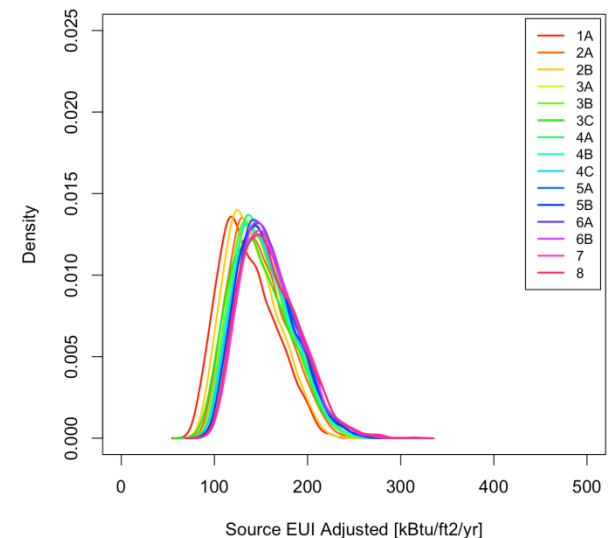


Before Weather Adjustment

Large Office



After Weather Adjustment



Progress and Accomplishments

Two pilots were conducted in 2012 and 2013 with over 200 buildings to collect feedback and test the technical and market values of the Asset Score.

Lessons Learned

- Need to provide additional easy-to-understand guidance to users to reduce user input errors
- Some data requirements are difficult to meet
 - Difficult to gather data; unavailable information
- Tool test plan needs refinement
 - Bugs led to inability to complete simulations of some buildings during Pilot #2

Findings indicated overall effective tool

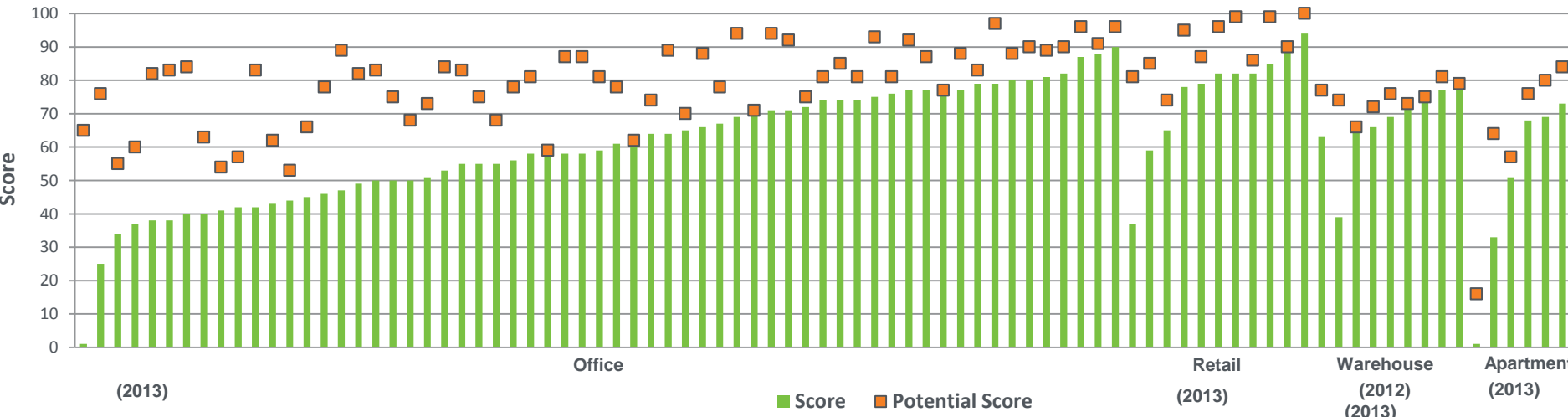
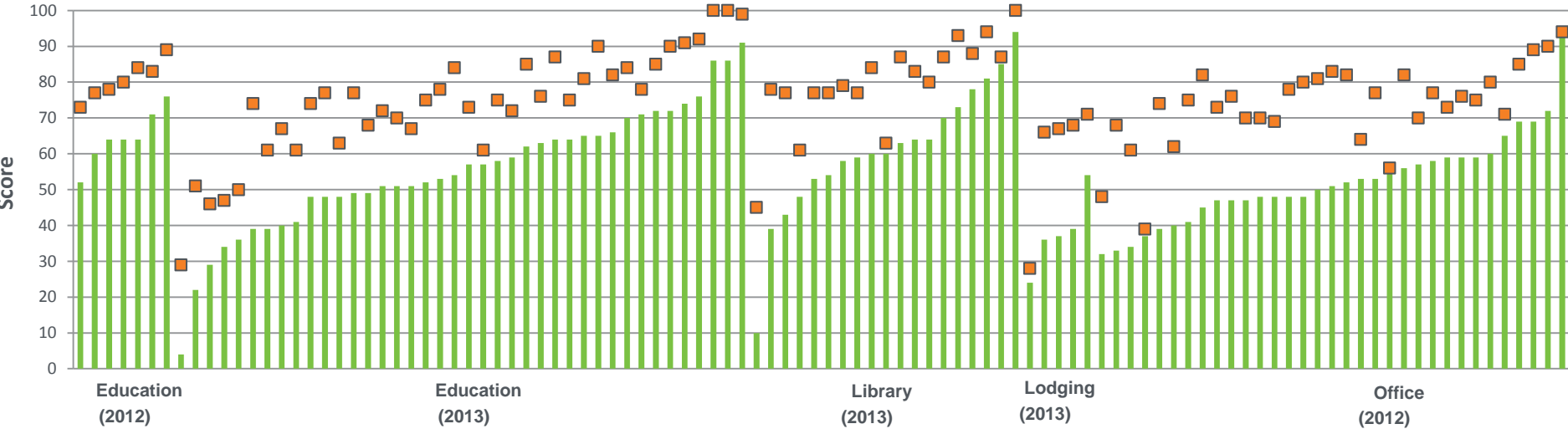
- 100 point scales are appropriate
 - Good distribution across the scales, without clustering of scores
- Whole building rating system is effective
 - No single component is a good predictor of the overall energy efficiency of a building
- Recommendation engine is sound
 - Tool identifies cost effective recommendations: enables a bottom tier building to improve its score by 65%, a mid-tier building by 31% and a top tier building by 12%
 - Identifies building sub-systems with greatest potential for energy savings

Market Impacts

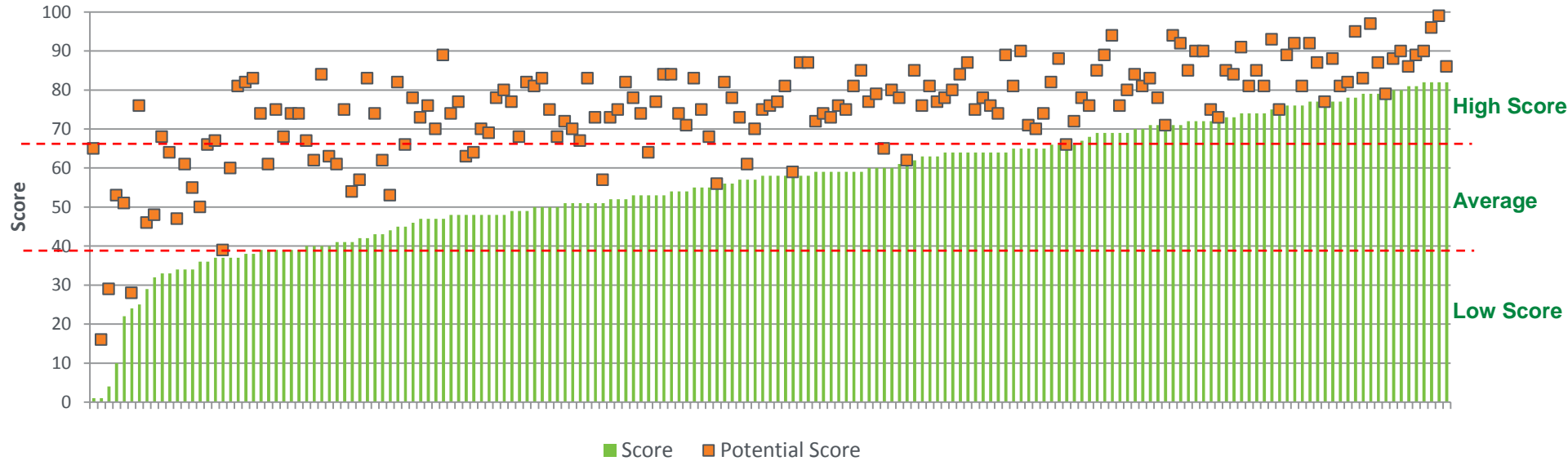
- **191** buildings
- **24 million square feet** of commercial floor area
- **278 billion Btu** site energy savings
- **838 billion Btu** source energy savings
- **8.4 million dollar** cost savings*
- **\$0.41/sq.ft.** cost savings*

*assuming \$0.01/kBtu source energy

Pilot Project Results



Pilot Project Results



Building Rank by Score	Average Score	Average Potential	Average Change in Score	% Change in Site EUI
Low Score (bottom 1/3)	31.7	60.5	28.8	-23%
Average Score (mid 1/3)	56.2	75.5	19.2	-21%
High Score (top 1/3)	79.1	88.0	8.9	-19%

- On average, lower scoring buildings have greatest potential for improving scores
- However, even those scoring in top third of scale can jump almost 10 points on average

Project Integration and Collaboration

Reached out to 200+ entities; maintain communications with 50+ key stakeholders. Highlights include:

- Regularly exchange program design ideas with stakeholder groups such as MA DOER, California Energy Commission, and Environmental Protection Agency
- Working with Minnesota Center for Energy and Environment to compare Asset Score and Portfolio Manager and analyze usefulness of Asset Score recommendations
- Working with Institute for Market Transformation and Regional Energy Efficiency Organizations to engage leading states, local governments, and utilities
- Engaging utilities to better understand what capabilities would be most useful to them
- Working with State Energy Program competitive grant recipients to obtain feedback on the Asset Score and its potential use cases
- Working with FEMP and the Office of the Federal Environmental Executive to determine best opportunities for using the Asset Score in Federal sector

Project Integration and Collaboration

Partners, Subcontractors, and Collaborators

- NREL provided simulations and analysis on scale development, weather normalization, and additional EEMs through the Building Component Library
- SRA provides communications, outreach, and tool user support, and managed the 2013 Pilot

Communications (Recent Events)

- ASHRAE 2013
- BOMA 2013
- Greenbuild 2013
- GSA Webinar
- Numerous 1:1 webinars with interested stakeholder groups

Next Steps and Future Plans

Technical upgrades to Asset Scoring Tool

- Add unconditioned basement, elevators, parking garage, commercial refrigeration and kitchens, additional HVAC systems
- Integrate onsite renewables
- Release API, link to Portfolio Manager, DOE's Standard Energy Efficiency Data (SEED) Platform & Buildings Performance Database (BPD)
- Enhance recommendations engine
- Provide “validated” score option with user authentication
- Refine sensitivity analysis, weather normalization, and scales
- Complete comprehensive test suites

Develop infrastructure for validated Asset Score

- Quality assurance protocols
- Assessor qualifications

REFERENCE SLIDES

Project Budget

Cost to Date: \$4,609,230

Additional Funding: None

Budget History

FY2011– FY2013 (past)		FY2014 (current)		FY2015 beyond (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$3,086,931	0	\$1,522,299	0	TBD	0

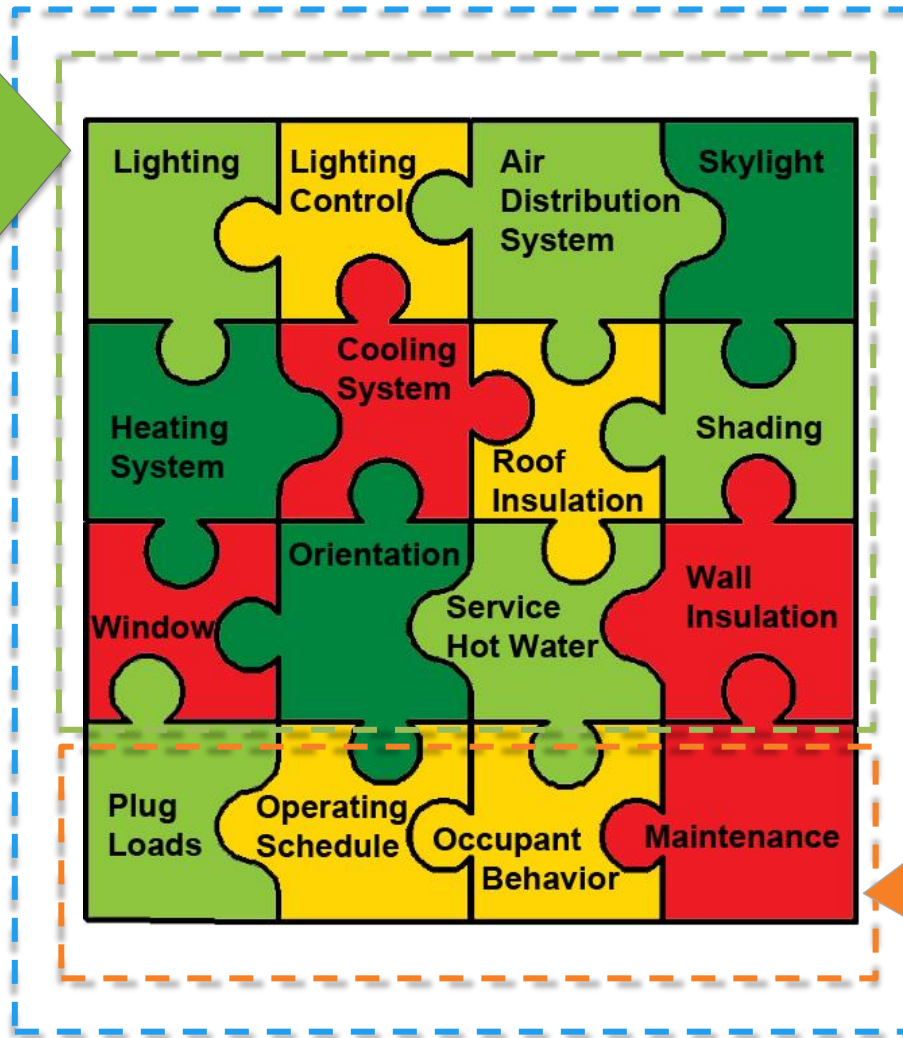
Project Plan and Schedule

Project Schedule												
Project Start: 4/01/2011	Completed Work											
Projected End: TBD	Active Task (in progress work)											
	◆ Milestone/Deliverable (Originally Planned)											
	◆ Milestone/Deliverable (Actual)											
	FY2013				FY2014				FY2015			
Task	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Past Work												
2012 Pilot	◆											
2013 Pilot						◆						
Public Release								◆				
Current/Future Work												
Improved Retrofit Recommendations											◆	
Additional Building Use Types												◆

Scope of Asset Score

Asset Score

evaluates the as-built physical characteristics (envelope, HVAC, lighting, service hot water) of a building and its overall energy efficiency, independent of occupancy and operational choices.



ENERGY STAR

benchmarks the overall building performance against peers.

Operational Assessment

evaluates the effectiveness of building operation and maintenance.