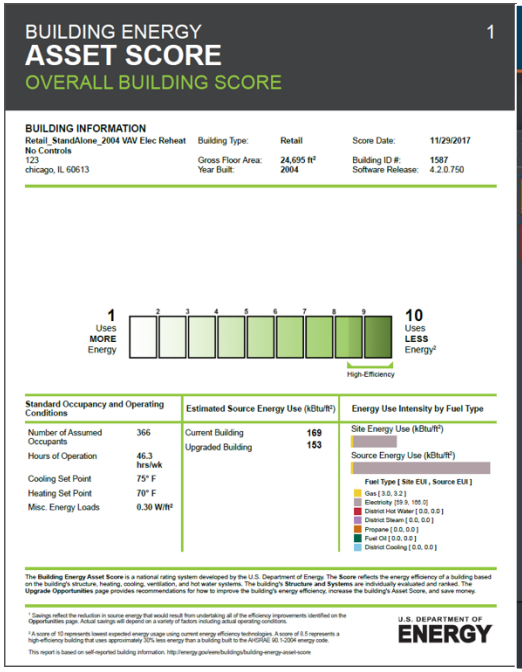
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Building Energy Asset Score


BUILDING ENERGY
ASSET SCORE
OVERALL BUILDING SCORE

1

BUILDING INFORMATION

Retail_StandAlone_2004 VAV Elec Reheat
No Controls
123
chicago, IL 60613

Building Type: Retail
Gross Floor Area: 24,695 ft²
Year Built: 2004

Score Date: 11/29/2017
Building ID #: 1587
Software Release: 4.2.0.750

1 Uses MORE Energy — 10 Uses LESS Energy² — High-Efficiency

Standard Occupancy and Operating Conditions		Estimated Source Energy Use (kBtu/ft²)		Energy Use Intensity by Fuel Type
Number of Assumed Occupants	366	Current Building	169	Site Energy Use (kBtu/ft²)
Hours of Operation	46.3 hrs/wk	Upgraded Building	153	Source Energy Use (kBtu/ft²)
Cooling Set Point	75° F			Fuel Type [Site EUI , Source EUI]
Heating Set Point	70° F			Gas [3.0, 3.2]
Misc. Energy Loads	0.30 W/ft²			Electricity [59.9, 166.0]
				District Hot Water [0.0, 0.0]
				District Steam [0.0, 0.0]
				Propane [0.0, 0.0]
				Fuel Oil [0.0, 0.0]
				District Cooling [0.0, 0.0]

The Building Energy Asset Score is a national rating system developed by the U.S. Department of Energy. The Score reflects the energy efficiency of a building based on the building's structure, heating, cooling, ventilation, and hot water systems. The building's Structure and Systems are individually evaluated and ranked. The Upgrade Opportunities page provides recommendations for how to improve the building's energy efficiency, increase the building's Asset Score, and save money.

* Savings reflect the reduction in source energy that would result from undertaking all of the efficiency improvements identified on the Opportunities page. Actual savings will depend on a variety of factors including actual operating conditions.

† A score of 10 represents lowest expected energy usage using current energy efficiency technologies. A score of 5.5 represents a high-efficiency building that uses approximately 30% less energy than a building built to the ANSI/ASHRAE/IES 90.1-2004 energy code.

This report is based on self-reported building information. http://energy.gov/eere/buildings/building-energy-asset-score

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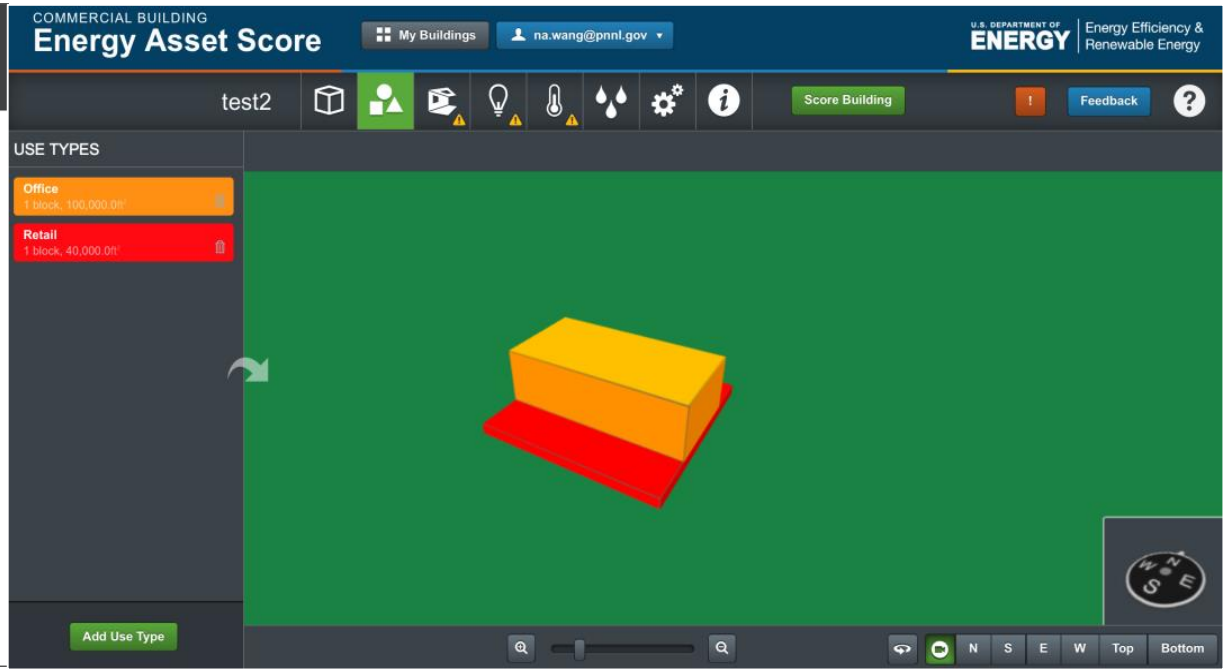


Pacific Northwest National Laboratory

Nora Wang, Ph.D.

Nora.Wang@pnnl.gov

Project Summary

Timeline:

Start date: 04/01/2011

Planned end date: Ongoing program

Key Milestones

1. Evaluation of AS in the context of zero-energy-ready buildings and high performance building modeling methodology. 12/15/2018
2. Asset Score High Performance Buildings package: 04/10/2019
3. Automated Asset Score modeling from Audit Template: 06/30/2019

Budget:

	Asset Score FY11-19	Audit Template FY15-19	Unique Building ID FY17-19
Technical Development	$5,910K	$1,055K	$530K
Field Validation	$3,441K	$845K	$220K

Key Partners:

New York City
City of San Francisco
City of Atlanta
City of Los Angeles
Institute for Market Transformation (IMT)

Project Outcome:

- A standardized tool to collect, manage, and report building data (asset, audit, retro-commissioning).
- A credible scoring system for commercial and multi-family buildings that can be used to inform investments and real estate transactions.
- A cost-effective way to quickly evaluate a building's integrated performance and encourage deep retrofits and programs towards the net zero goal.

Team

Nora Wang, Ph.D., AIA.

Project lead

12 years of versatile research experience in buildings, energy, and policies; over 50 peer-reviewed publications in building energy efficiency; Initiated Asset Score in 2011 and leading the project since then.

Supriya Goel

Modeling team lead

Mechanical Engineer, EnergyPlus expert, key member of energy codes program, participating in ASHRAE standard committees

Dave Millard

Software team lead

System Engineer, 30 years of experience in leading software development

Richard Fowler

Software testing & user support and training

Team

Juan Gonzalez Matamoros
Physics, Math

Abinesh Selvacanabady
Mechanical Engineering

Alex Vlachokostas, Ph.D.
Electrical Engineering

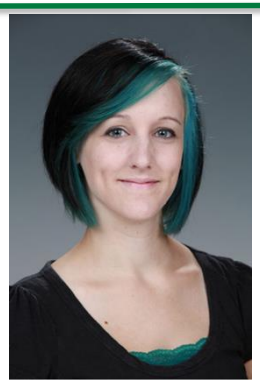
Kevin Keene
Civil Engineering

Brett Matzke
Data Science, Statistics

Modeling Team

Software Team

Edward Ellis
Software Engineer



Trisha Henriksen
Software Engineer

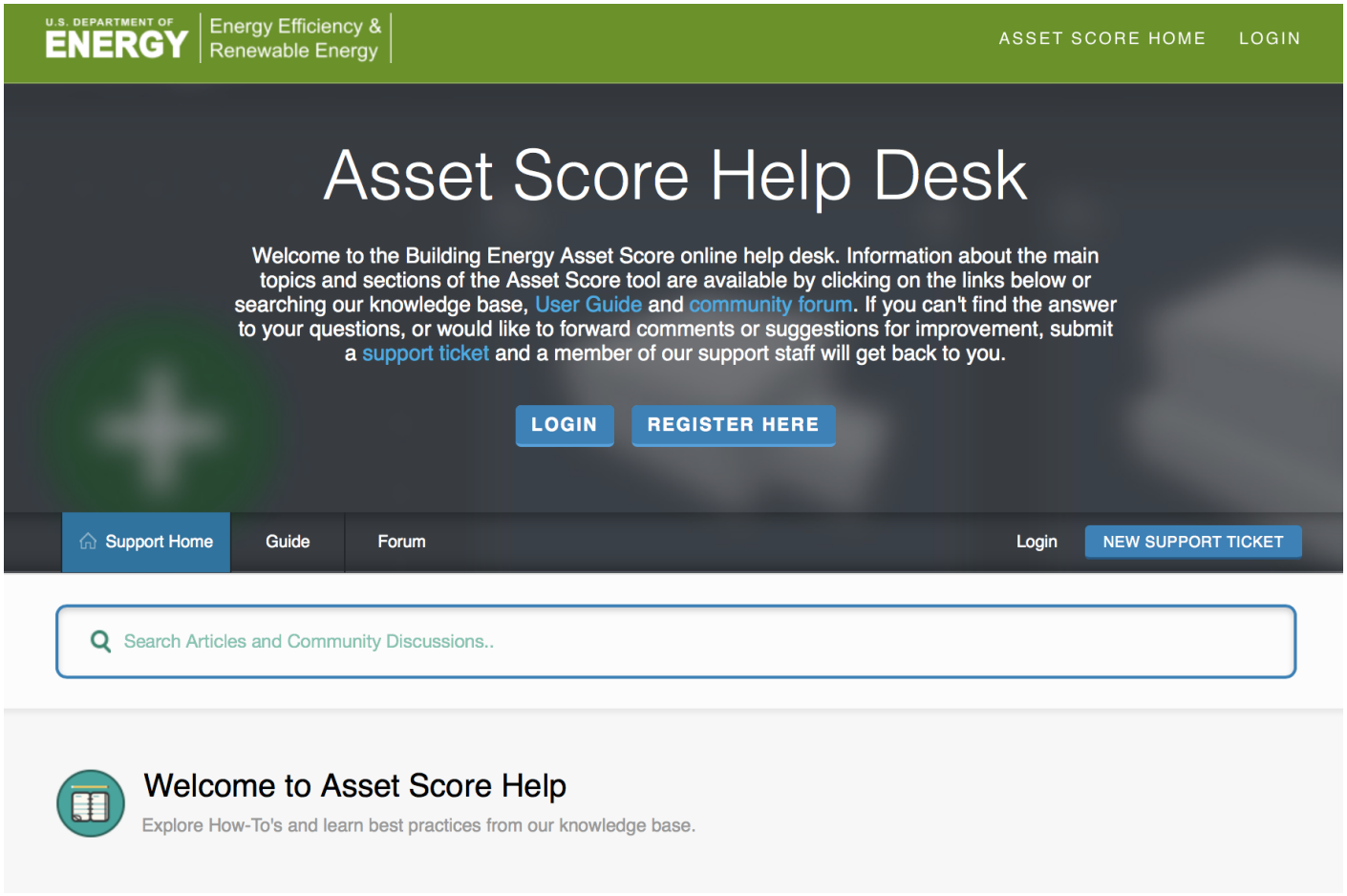
Mark Borkum, Ph.D.
Computer Scientist

Markus Kobold
Software Engineer

Team

PERFORMANCE SYSTEMS DEVELOPMENT

We Speak Building



As-Built –vs- As-Operation

Building Asset Data Includes:

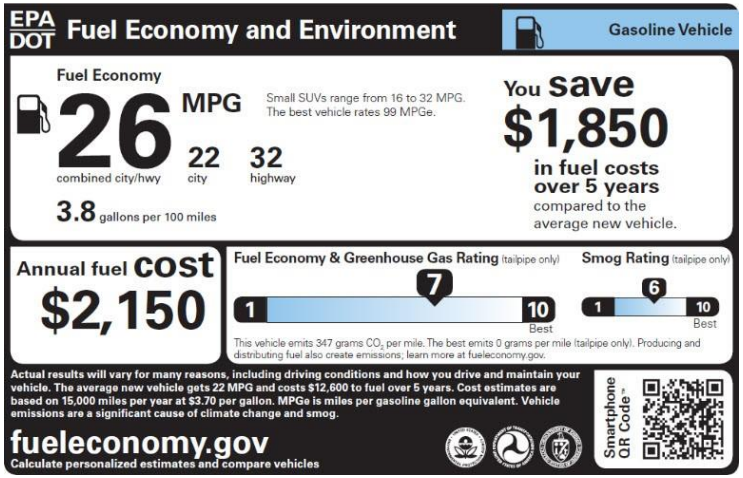
- ✓ Building attributes (geometry, conditioned space, orientation, age)
- ✓ Building envelope (roof, insulation, windows, walls, foundation)
- ✓ Building equipment (HVAC, lighting, hot water, controls)

Building Performance Data Includes:

- ✓ Occupant behavior (hours of operation, occupant density, plug loads)
- ✓ Actual energy usage (metered data by fuel type)
- ✓ Actual energy spend (utility bills)

BUILDING ENERGY ASSET SCORE
U.S. DEPARTMENT OF ENERGY

ENERGY STAR® Portfolio Manager®


EPA DOT Fuel Economy and Environment — Gasoline Vehicle

Fuel Economy: 26 MPG combined city/hwy (22 city, 32 highway)
Small SUVs range from 16 to 32 MPG. The best vehicle rates 99 MPGe.
3.8 gallons per 100 miles

You save $1,850 in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost $2,150

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 7 (1–10, Best)
Smog Rating (tailpipe only): 6 (1–10, Best)

This vehicle emits 347 grams CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fueleconomy.gov.

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 22 MPG and costs $12,600 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.70 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

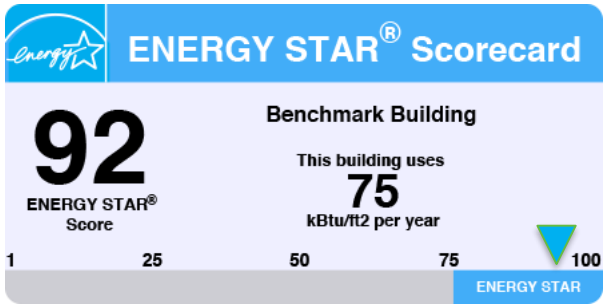
Smartphone QR Code™

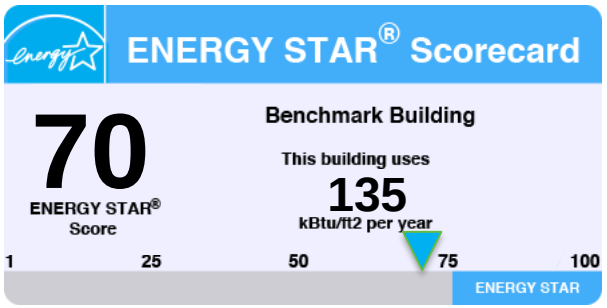
How your building *should* perform based on construction

How your building *actually* performs based on use

Challenge: Informational Asymmetry

Building owners and investors lack a reliable source of information on the efficiency of buildings apart from the operations. This hinders their ability to optimize cost-effective investment on more efficient technologies.





Which building has more efficient systems?

Challenge: Informational Asymmetry

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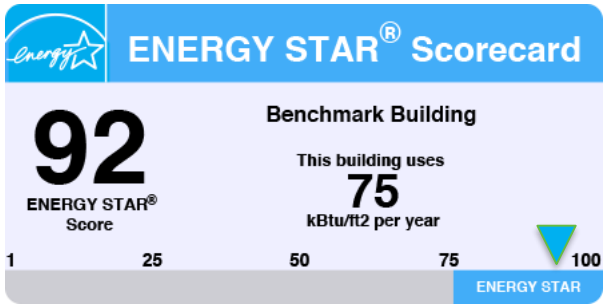
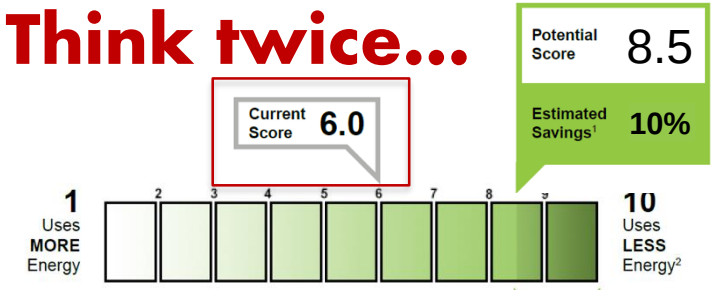
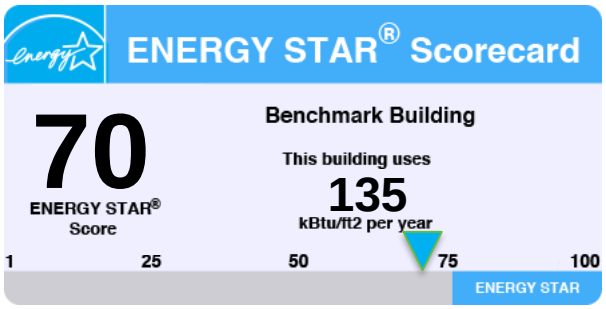


Use type: Office
Location: San Francisco
Built in: 1997
Occupancy: 60%
Hours: 10 hours, 5 days

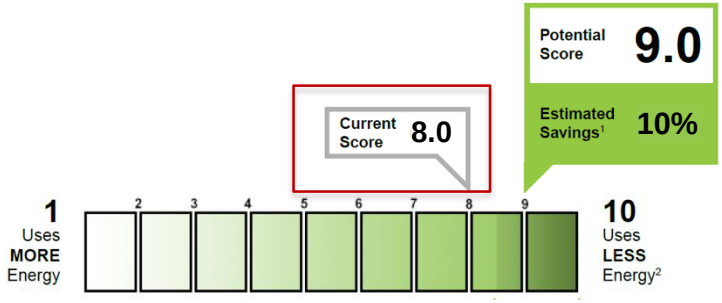
Envelope: Fair
Lighting: Superior
HVAC: Good





Use type: Office + Retail
Location: Chicago
Built in: 2012
Occupancy: 100%
Hours: 14 hours, 7 days

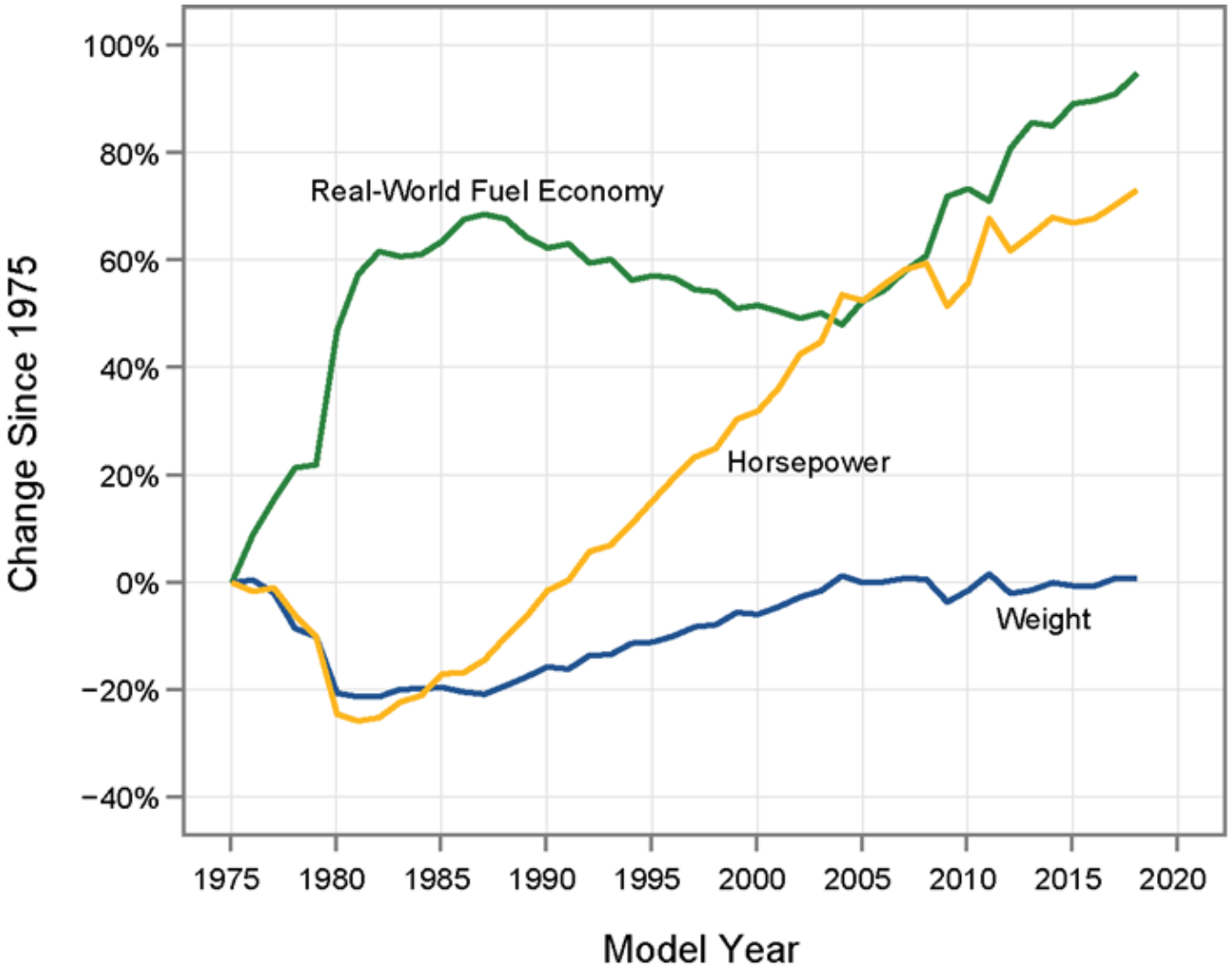
Envelope: Good
Lighting: Superior
HVAC: Superior



AS and ESPM as Complimentary Scores

Credit: Performance Systems Development

Theory of Change

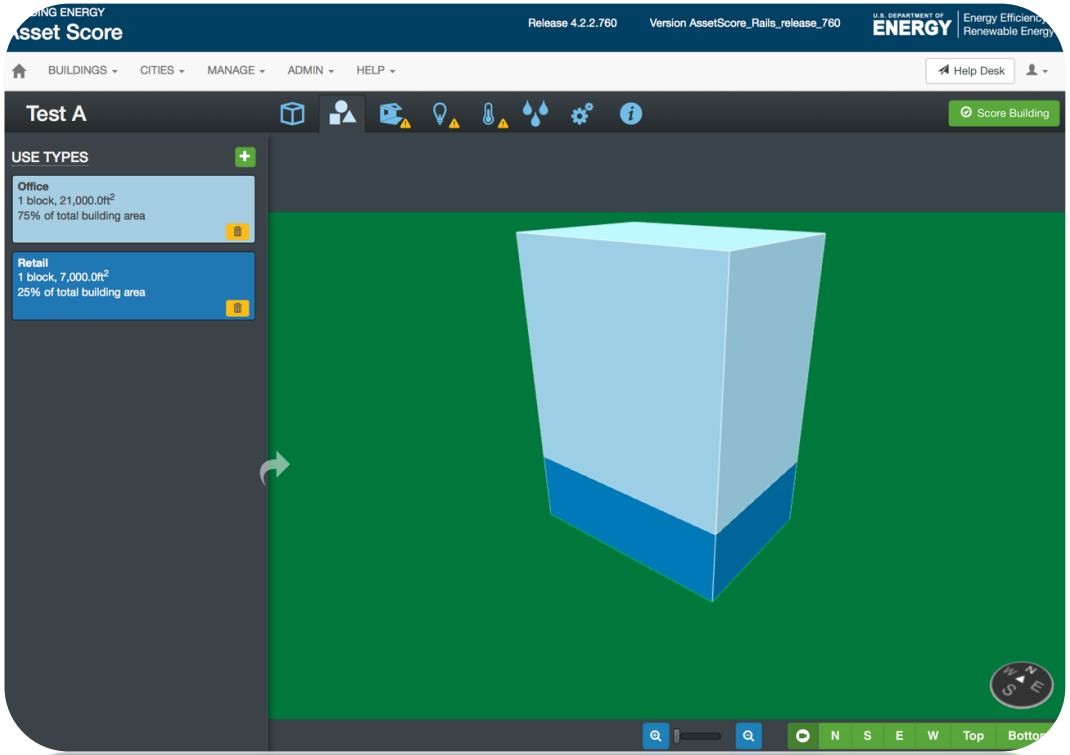


MPG rating plays a significant role in making the cars in the U.S. more fuel-efficient without hindering performance.

Souce: U.S. Environmental Protection Agency. (2017) Highlights of the Automotive Trends Report. https://www.epa.gov/automotive-trends/highlights-automotive-trends-report#report

Approach

Enable simplified building energy modeling to quantify and represent the efficiency of major building components.



Asset Score Delivers:

1) 1-10 score

2) Cost-effective upgrade opportunities

3) Recommendations to achieve ultra-high performance

Approach: Score

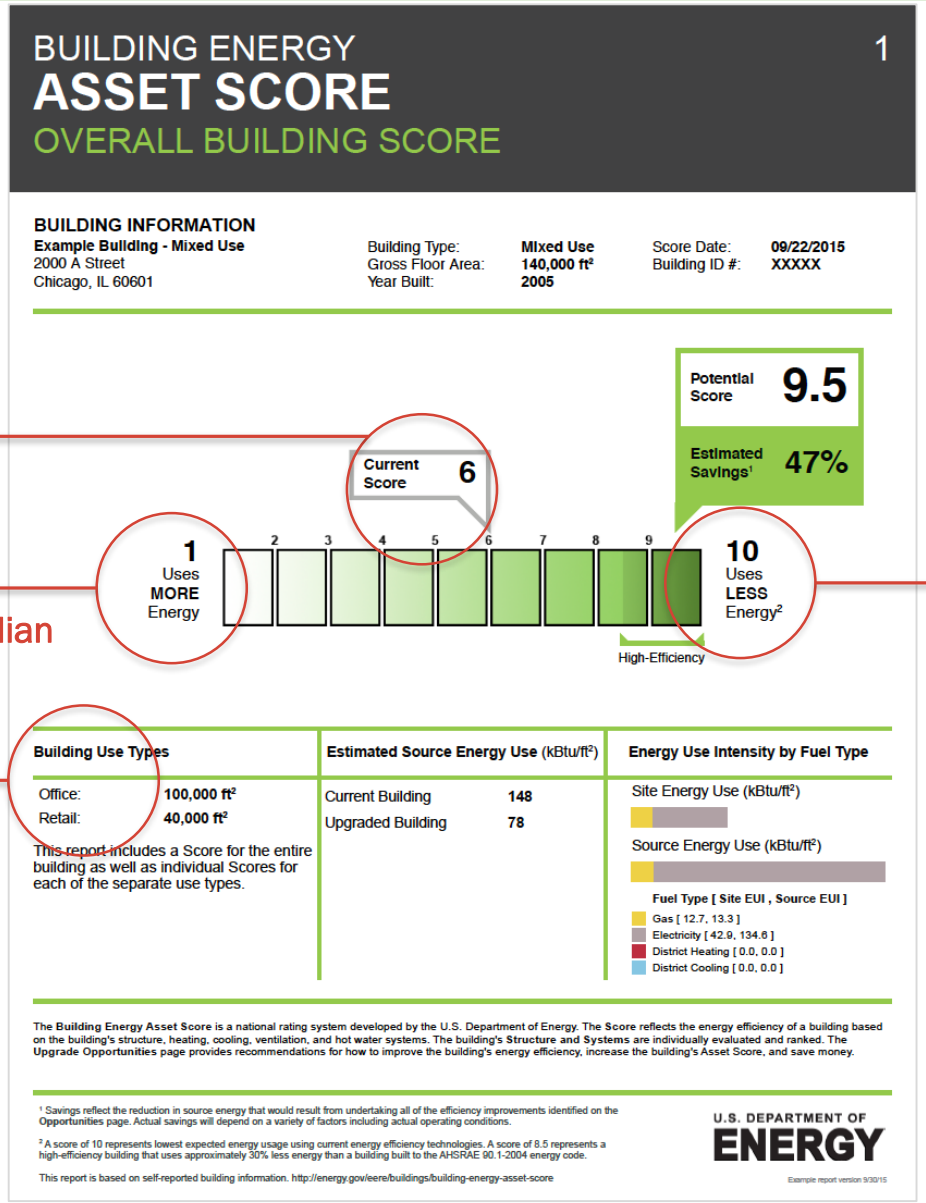
A standardized report to clearly communicate as-built efficiency

Normalized for local weather pattern and use type.

1 = least efficient buildings
5 = align with CBECS 2012 median

A mixed-use building receives separate scores for each use type and a weighted average.

Zero-energy ready without on-site generations and operational measures



BUILDING ENERGY
ASSET SCORE
OVERALL BUILDING SCORE

1

BUILDING INFORMATION

Example Building - Mixed Use
2000 A Street
Chicago, IL 60601

Building Type: **Mixed Use**
Gross Floor Area: **140,000 ft²**
Year Built: **2005**

Score Date: **09/22/2015**
Building ID #: **XXXXX**

Potential Score **9.5**

Estimated Savings[1] **47%**

Current Score **6**

1 Uses **MORE** Energy

2 3 4 5 6 7 8 9

10 Uses **LESS** Energy[2]

High-Efficiency

Building Use Types		Estimated Source Energy Use (kBtu/ft²)		Energy Use Intensity by Fuel Type
Office:	100,000 ft²	Current Building	148	Site Energy Use (kBtu/ft²)
Retail:	40,000 ft²	Upgraded Building	78	Source Energy Use (kBtu/ft²)

This report includes a Score for the entire building as well as individual Scores for each of the separate use types.

Fuel Type [Site EUI , Source EUI]
Gas [12.7, 13.3]
Electricity [42.9, 134.6]
District Heating [0.0, 0.0]
District Cooling [0.0, 0.0]

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Example report version 9/30/15

Approach: Score

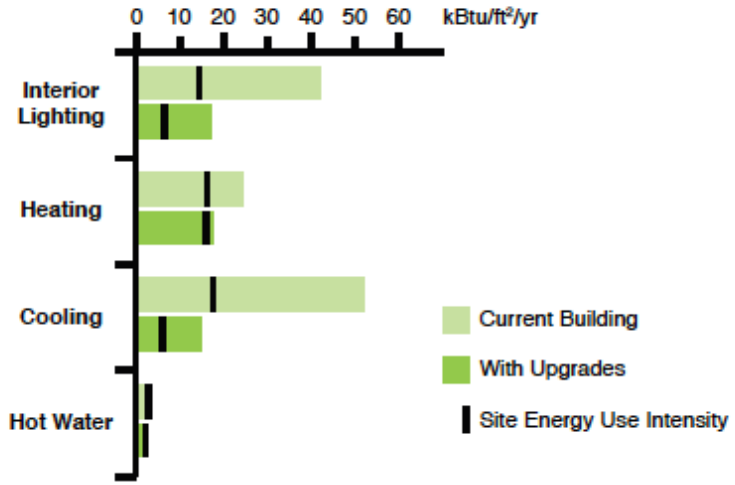
ABOUT THE BUILDING SYSTEMS

	Ranking[5]
Interior Lighting	Superior
Heating	Superior
Cooling	Good
Overall HVAC Systems	Superior

ABOUT THE BUILDING ENVELOPE

	Ranking[5]
Roof U-Value, Non-Attic (Btu/ft² h °F)	Good
Walls U-Value, Framed (Btu/ft² h °F)	Superior
Windows U-Value (Btu/ft² h °F)	Fair
Walls + Windows U-Value (Btu/ft² h °F)	Fair
Window Solar Heat Gain Coefficient	Good

SOURCE ENERGY USE INTENSITY BY END USE



A model-based system-level evaluation and an analysis of energy use by end use (before and after upgrade) provide a comprehensive insight into the efficiency and energy use of major building components.

Approach: Cost-Effective Opportunities

Cost Effective Upgrade Opportunities	Energy Savings [3]	Cost[4]
Building Envelope		
• Add roof insulation in Office Block, Retail Block - *Learn More*	High	$ - $$
• Install high performance triple pane windows in Office Block, Retail Block - *Learn More*	High	$$ - $$$
Interior Lighting		
• Upgrade T8 fluorescent lighting in Office Block, Retail Block with LED lighting - *Learn More*	Medium	$$
• Add daylighting controls in Office Block, Retail Block - *Learn More*	Low	$$
HVAC Systems		
• Add air-side economizer in Office Block, Retail Block - *Learn More*	Medium	$-$$
• Implement demand controlled ventilation (DCV) in Office Block, Retail Block - *Learn More*	Medium	$$
• Add variable frequency drive to supply fans in Office Block, Retail Block - *Learn More*	Medium	
Hot Water Systems		
• Add low flow faucets in Retail Block, Office Block - *Learn More*	Low	

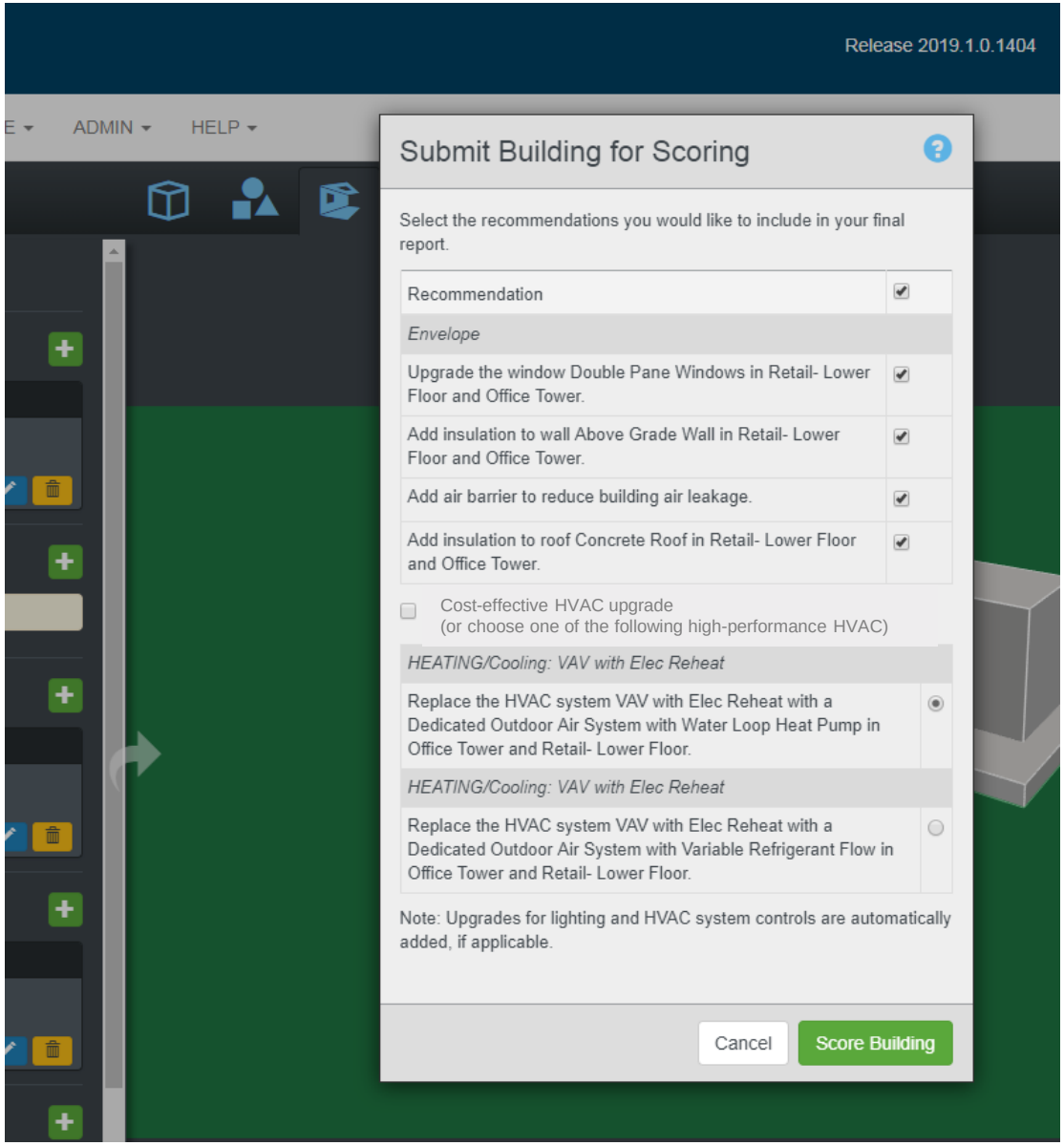
Automated cost-effective analysis to quickly identify upgrade opportunities.

Approach: Achieving Ultra-High Performance

FY19 ongoing effort:

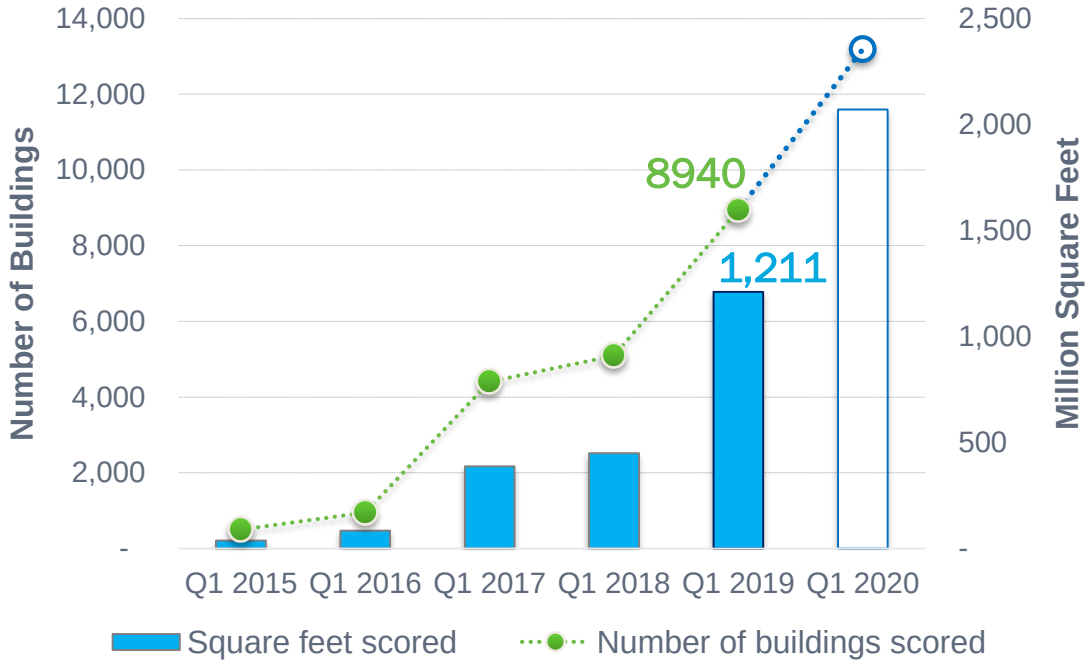
High-performance Building Package

- Allow users to enter high-performance building parameters
- Identify deep-retrofit measures



Impact

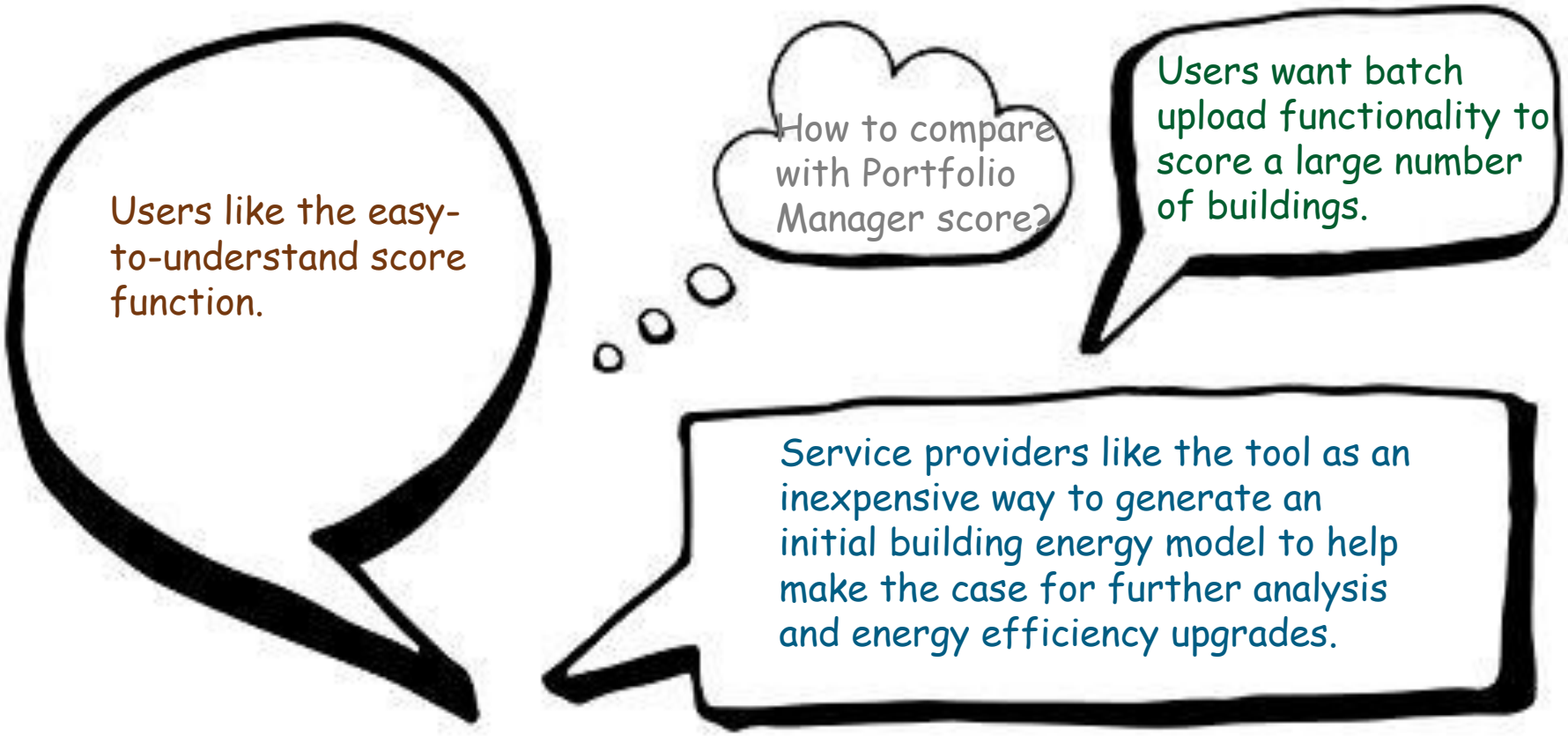
- **Near-term (Integration):** Integrate Asset Score suite of tools with existing building energy programs to support data-driven decision making for energy-efficiency investments and minimize the administrative burden of managing and exchanging data for effective program implementation.
- **Mid-term (Adoption):** Valuate 5% of total commercial space (4,350 million ft^2**) and identify 180 TBtu primary energy use savings (assuming 20% on average***) and $1,780 million cost savings.* [see reference slide]



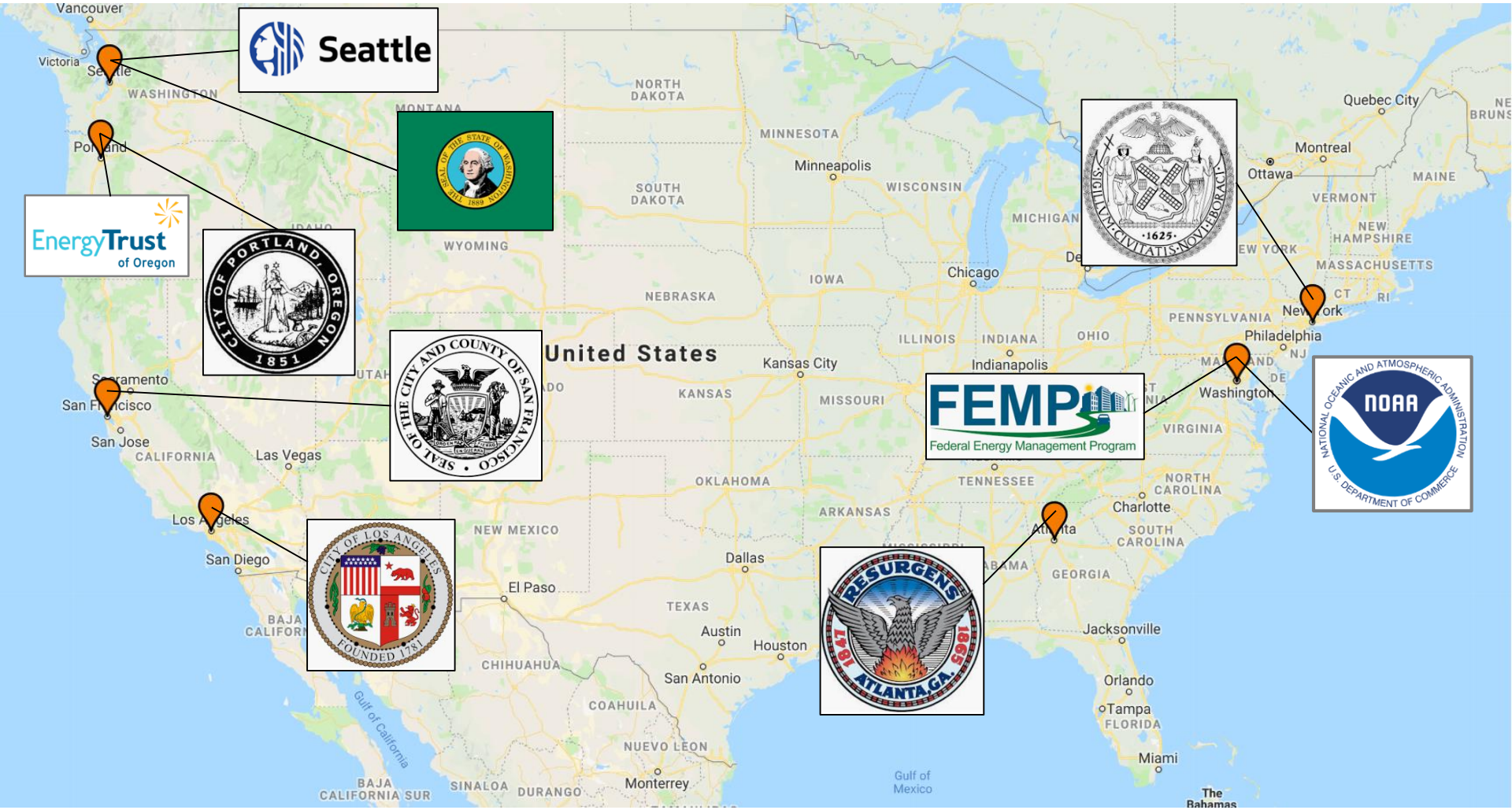
Long-term (Transformation):

Asset Score brings energy efficiency into real estate valuation and drives capital investment in high-efficiency building technologies.

Stakeholder Feedback



Stakeholder Engagement



Future Project Direction

FY19

- **Expand Use Type** (commercial kitchen for food service and exhaust fan for multifamily buildings)
- **Continue adding advanced HVAC** (central ground/water source heat pump)
- **Complete integration** with Audit Template, SEED, and Building Sync.

Beyond FY19

- **Complete use type development** (data center, commercial refrigeration, hospitals and laboratories) to include all commercial buildings
- **Continue adding high-performance building systems and EEM packages**
- Add “confidence level” to each score based on the number of user inputs vs. defaults to increase information reliability

Thank You

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REFERENCE SLIDES

Project Budget

Project Budget: $12M
Cost to Date: Through 3/2019, $11.3M
Additional Funding: Ongoing program

Budget History					
4/1/2011– FY 2018 (past)		FY 2019 (current)		FY 2020 – TBD (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$10.5M	$0	$1.5M		TBD	$0

Reference

Slide #18

*According to Energy Information Administration Annual Energy Review 2011. The total energy consumption in the commercial sector estimates for18,021 TBtu in 2011 (p.40). The total consumer expenditure estimates for energy in the commercial sector is $178,128 million in 2010 (p.79).

**According to Commercial Buildings Energy Consumption Survey 2012, the total commercial floor space is 87,043 million sq.ft.

***Based on the analysis of buildings that have been valuated in Asset Score.