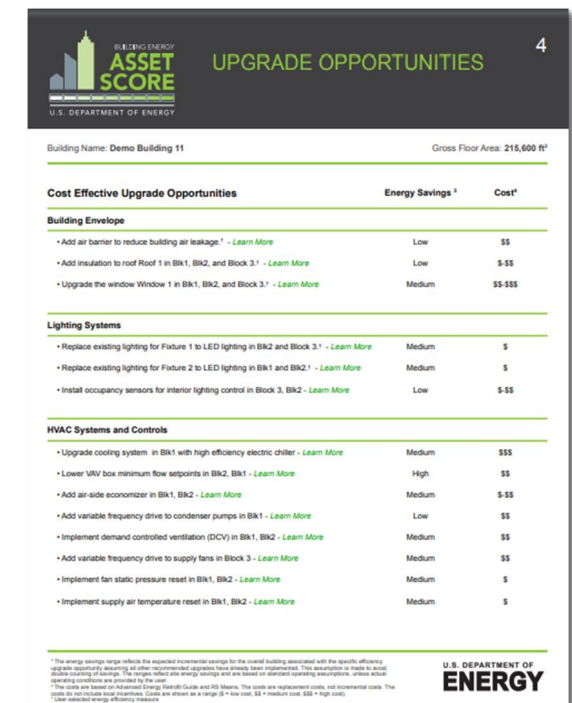
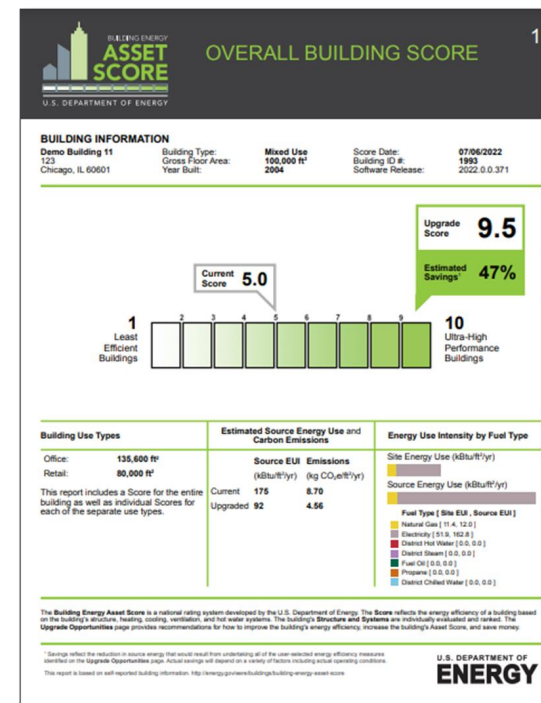
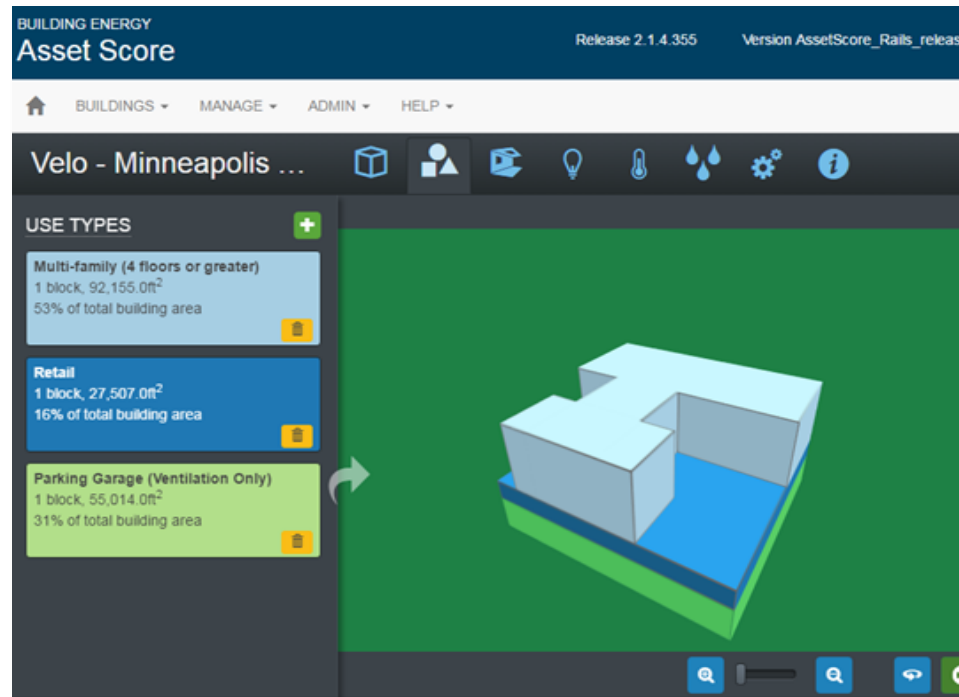


Building Energy Asset Score



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WBS # 2.5.1.50

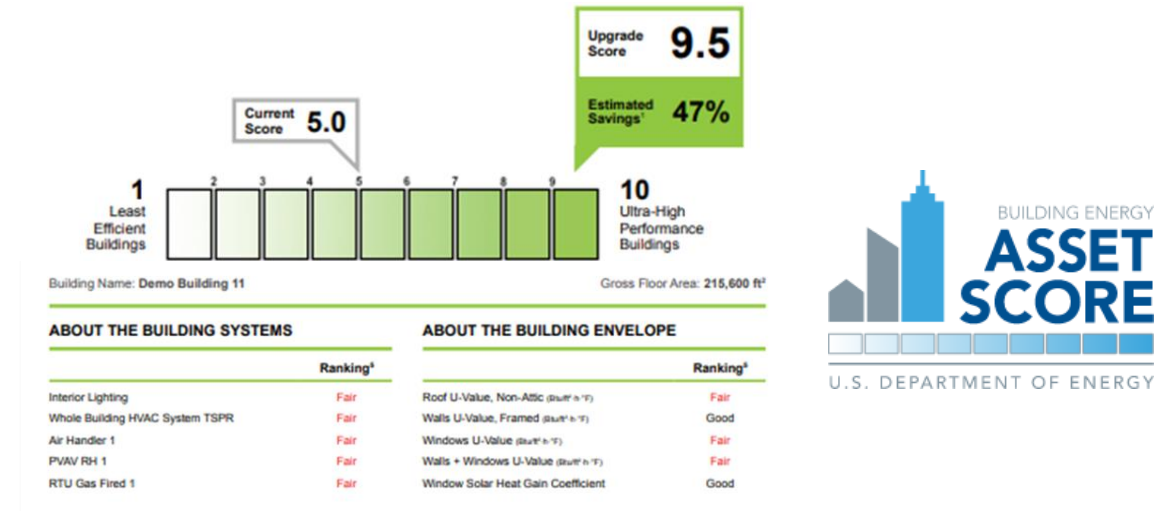
Project Summary

Objective and outcome

- Provide a simple scoring methodology to help building owners to understand their buildings' current and potential performance.
- Provide a cost-effective way to quickly evaluate a building's integrated performance and to encourage deep retrofits and programs towards the net zero goal.

Team and Partners

- Supriya Goel, PM/PI
- Software Development Team
 - Mark Borkum: Lead developer
 - Jared Chase
 - Edward Ellis
 - Juan Carlos Barajas
- OpenStudio Modeling Team
 - Juan Gonzalez: Technical Lead
 - Yun Joon Jung



Stats

Performance Period: FY12 - Ongoing

DOE budget: FY23 \$380k, Cost Share: \$0

Milestone 1: Develop the Quick Building Assessment Tool to support K-12 Schools FOA

Milestone 2: Add additional measure recommendations to allow buildings to identify electrification and decarbonization opportunities.

Problem

- Building energy audits (for existing buildings) and energy modeling (for new and existing buildings) are **time consuming** and **costly**.
- **Building owners and facility managers** need a simple approach that can work on **minimal building information** to provide **insights on current performance** of the building and the **potential for improvement**.
- The high-level assessment should be sufficient to identify buildings that have **potential for retrofits and system replacements**, and to identify appropriate projects for more detailed assessments.

*Solution: Asset Score, a **simple, web-based tool**, which can be used by **building owners/facility managers/engineers** to analyze a building, **provide insights** on the efficiency levels of its existing systems, and **identify opportunities** for improvements.*

Alignment

Asset Score tool supports multiple EERE/BTO goals

Energy Efficiency

- Provides an approach for **analyzing as-designed building efficiency** and identifying opportunities for improvement
- Provides a '**current score**' and an '**upgrade score**' based on identified energy efficiency measures



Decarbonization/ Electrification

- The **High-Performance Building recommendation engine** identifies opportunities for electrification and reducing GHG emissions
- Tool estimates **potential for reduction in emissions** (based on identified measures)



Equity and Affordability

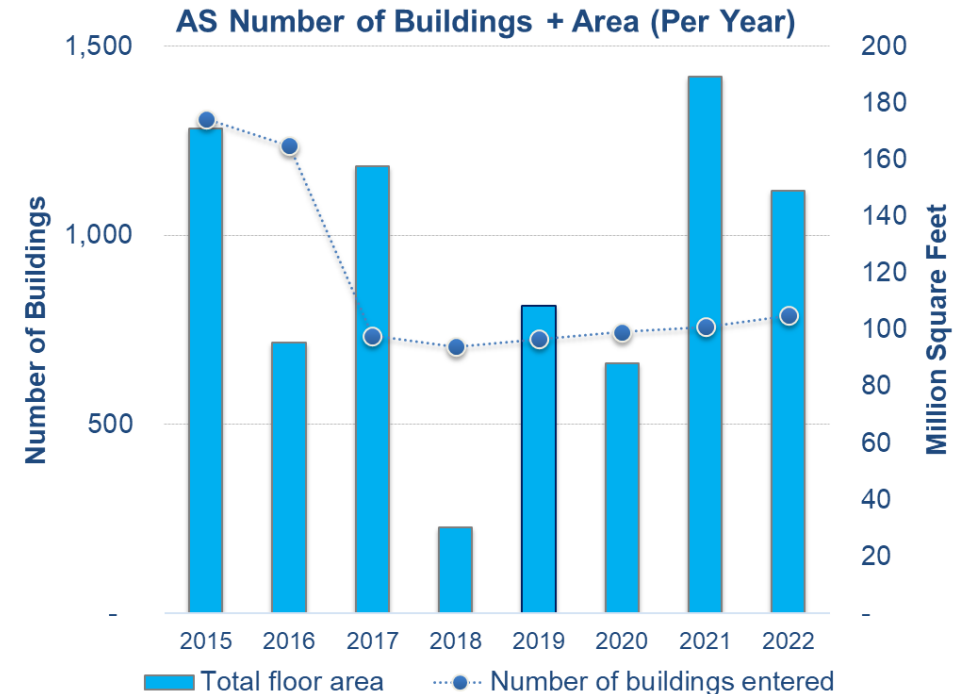
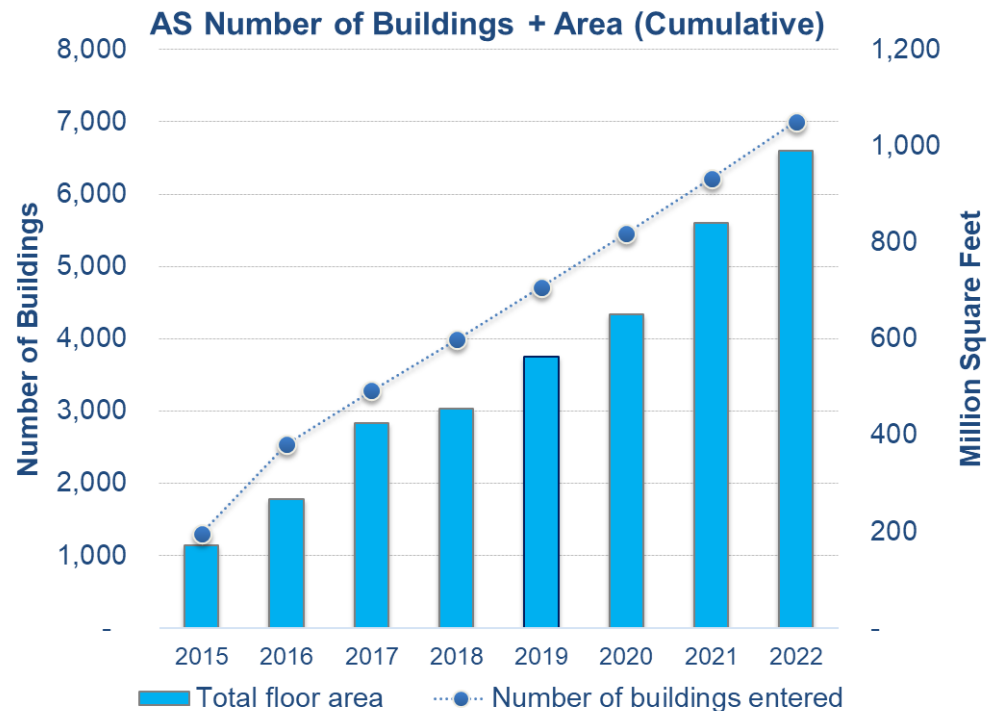
- The **Quick Building Assessment Tool (QBAT)** provides a simple interface, which reduces the level of effort/expertise required for a needs assessment
- Allows **underserved communities** to conduct assessments with minimal effort. For example: QBAT was used by school districts to apply for federal funding



Impact

Asset Score Tool's Usage Statistics (Since 2015)

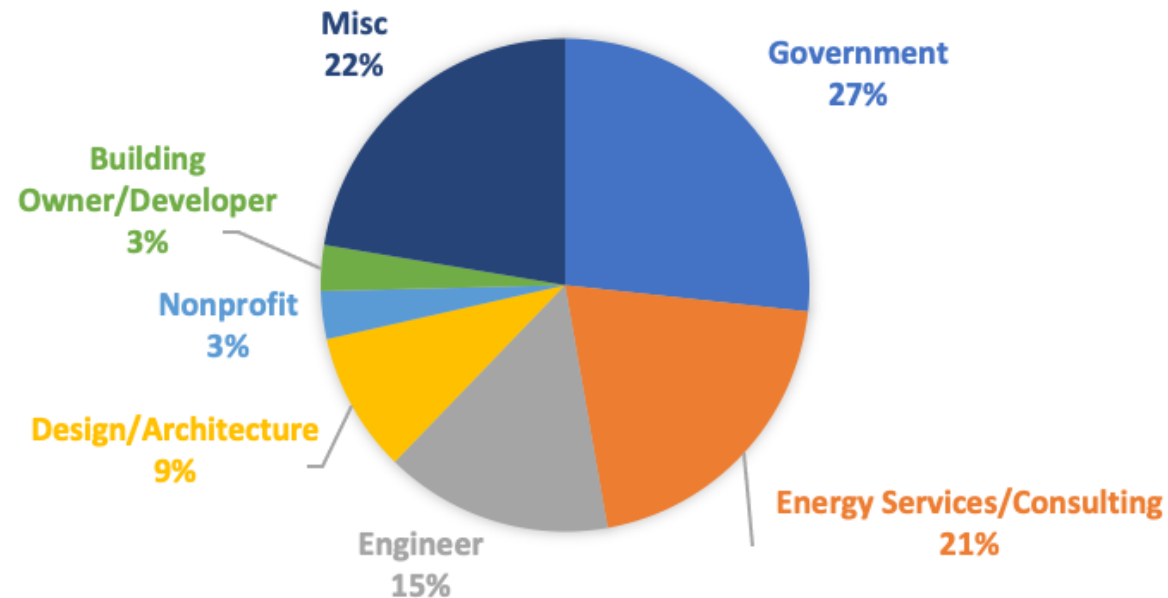
- Users: 5,900+
- Buildings: 7000+
- Area: ~1 billion ft²



Companies Using Asset Score

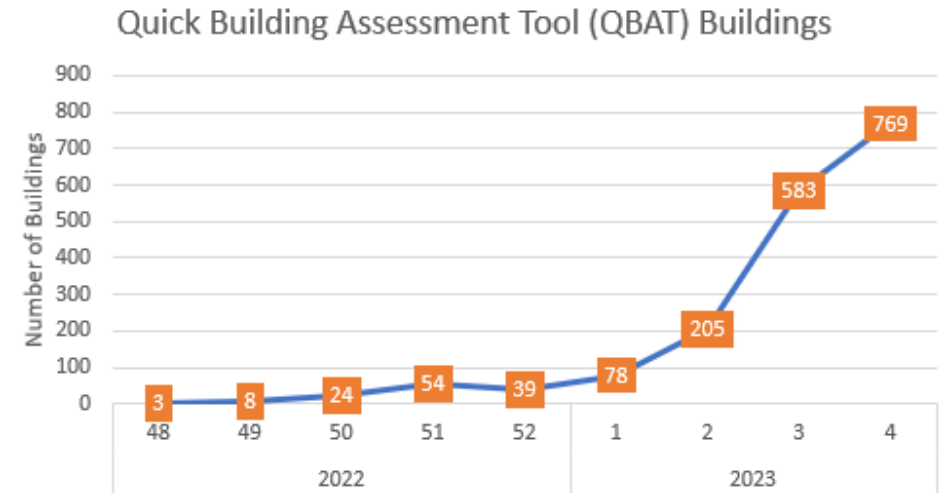
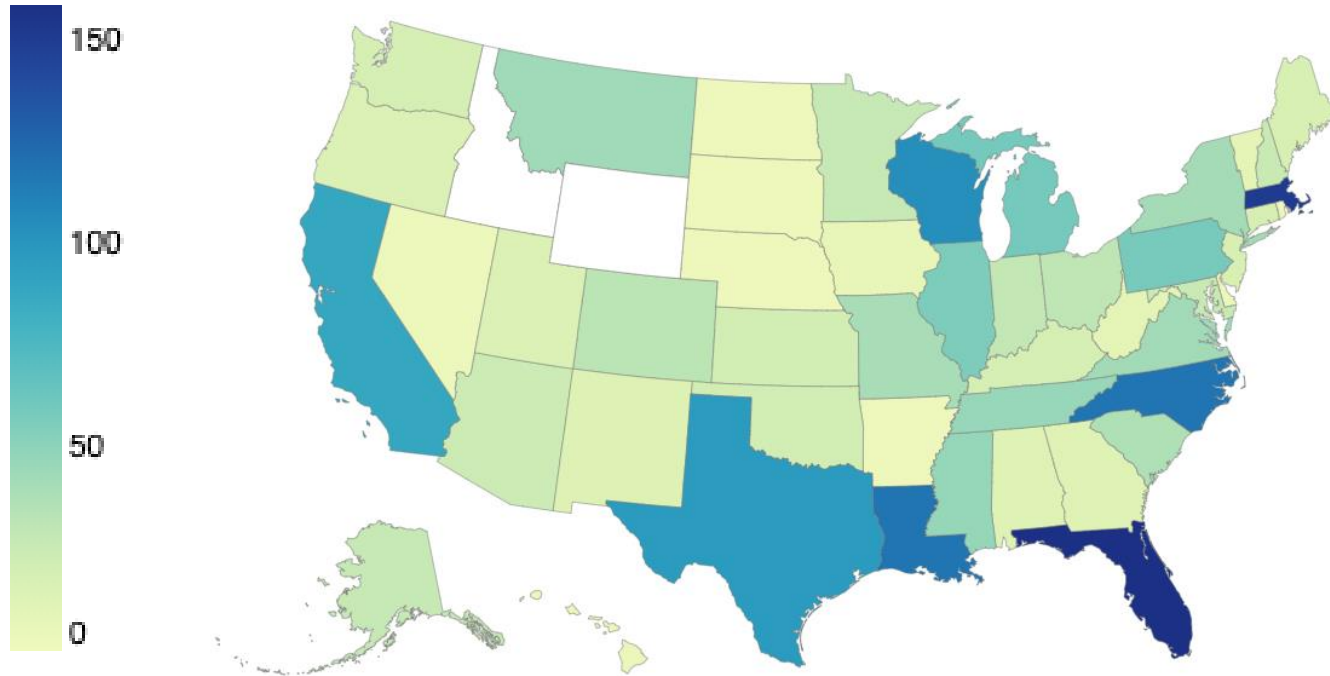
- 294 unique companies
- 8 of 25 top A/E firms by revenue (ranked by Architecture Magazine)

AS Buildings Scored by User Type



Impact

Quick Building Assessment Tool (QBAT) Usage Statistics



QBAT Building Submissions for 9 weeks before the concept paper deadline

Over 2000 buildings used QBAT to conduct a needs assessment and identify upgrade opportunities to **apply for DOE K-12 funding** to upgrade their facilities.

Over 40% of the schools were from historical redline communities.

Approach: What is an Asset Score?

ENERGY STAR Portfolio Manager

Uses building performance data to benchmark a building.

- ✓ Occupant behavior (operating hours, occupant density, etc.)
- ✓ Actual energy usage (metered data by fuel type)
- ✓ Actual energy spend (utility bills, etc.)



How your building **actually** performs based on use

Asset Score Tool

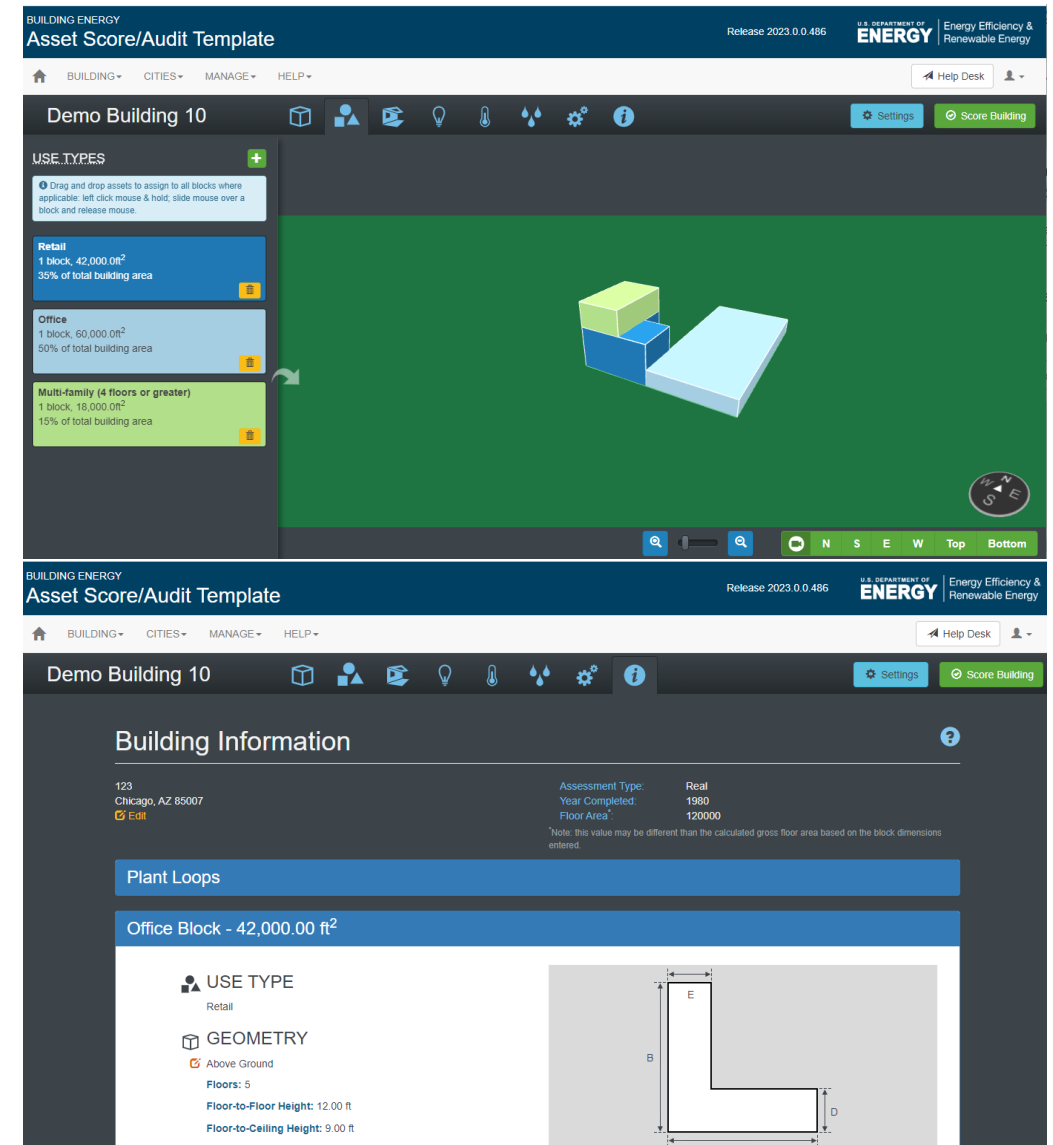
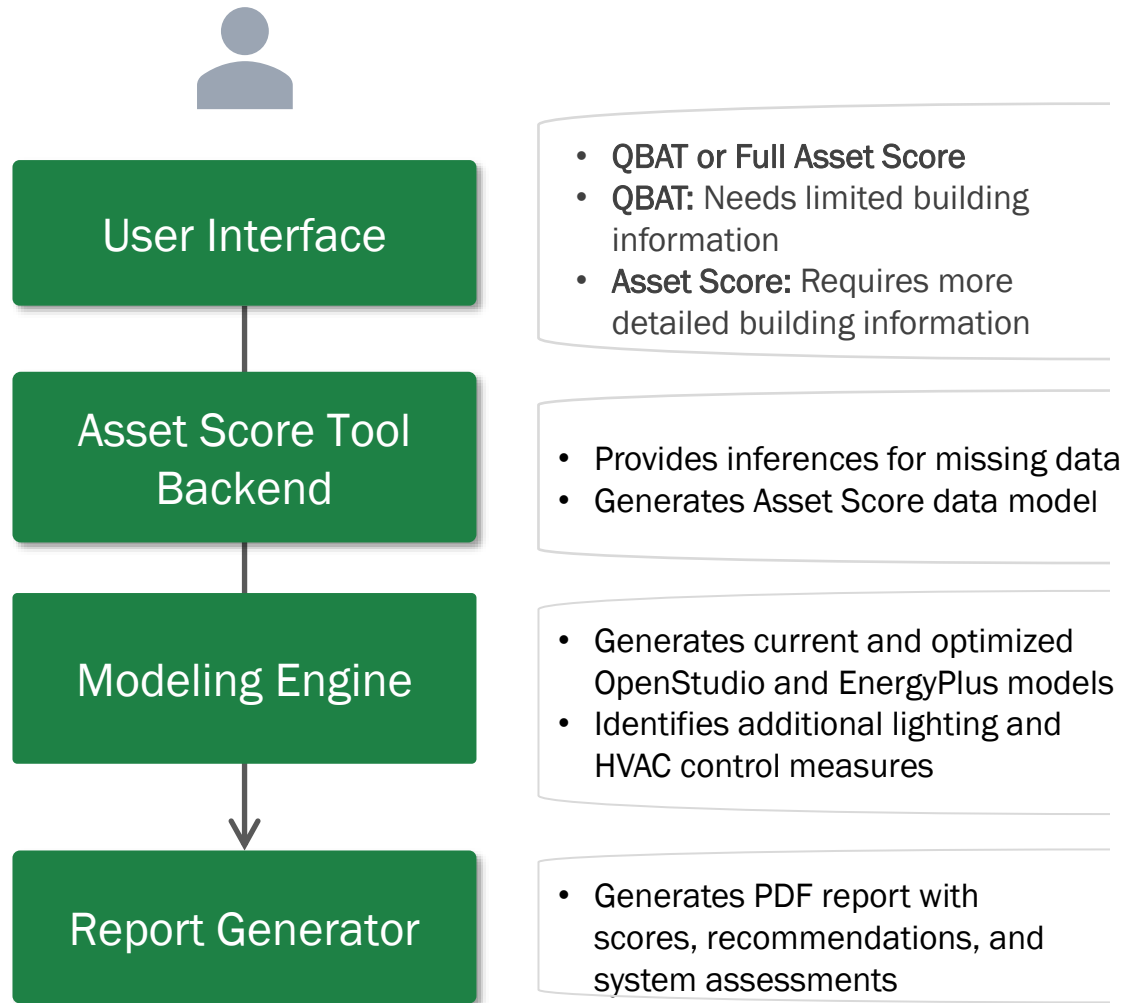
Uses building asset data to evaluate as-designed building performance.

- ✓ Building attributes (stories, orientation, vintage, etc.)
- ✓ Building envelope (roof, insulation, air sealing, windows, etc.)
- ✓ Building equipment (HVAC, lighting, hot water, etc.)



How your building **should** perform based on construction

Approach: How Does the Tool Work?

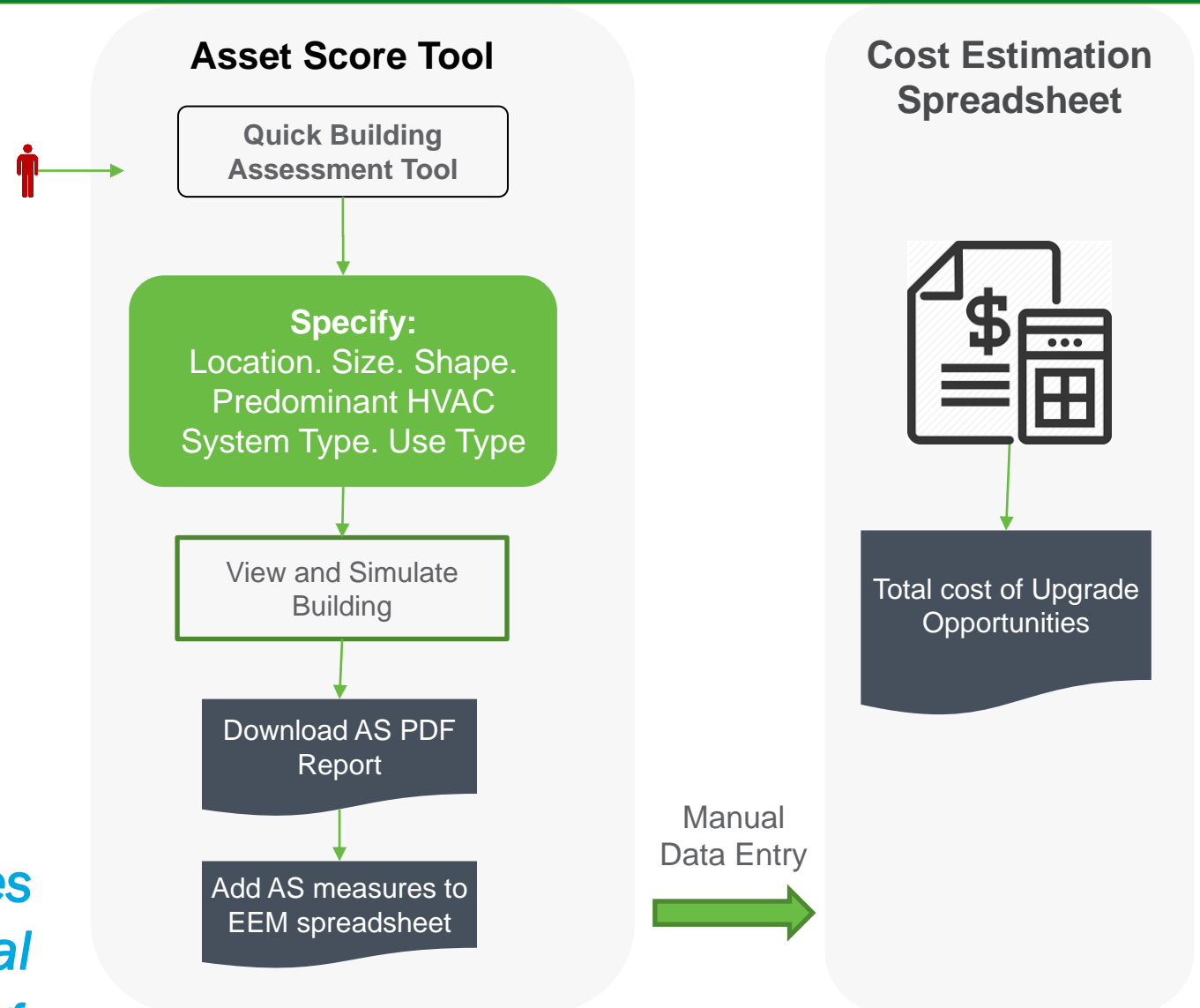


Approach: Quick Building Assessment Tool

QBAT

- Provides an easy-to-use capability for needs assessment in K-12 public school facilities to support the BIL Schools FOA.
- Using 5 simple inputs and robust inferences, QBAT creates a Full Asset Score building.
- Over 2,000, K-12 public school facilities were evaluated using QBAT, forming the basis for 1000+ concept papers submitted to DOE for ~\$5B funding.

Communities with *limited resources* were able to use QBAT with *minimal effort and apply for federal funding*



Approach: What Does the Tool Tell Me?

Energy Efficiency and Electrification

- Asset Score tool identifies energy savings measures and electrification opportunities.
- Measures can range from low-cost control improvements to whole system replacement with decoupled ventilation systems and cycling heat pumps.
- User can select measures and choose between electrification options for evaluation.

Submit Building for Scoring

The following upgrade opportunities have been identified for your building. Select the recommendations you would like to include in your asset score report.

Envelope

Recommendation	Select
Include all recommendations	<input type="checkbox"/>
Seal building envelope reducing air infiltration	<input type="checkbox"/>
Upgrade floor cavity insulation in block Multifamily Block 1 for Floor 2.	<input type="checkbox"/>
Upgrade roof insulation in blocks Office Block, Retail Block, and Multifamily Block 1 for Roof 1.	<input type="checkbox"/>
Upgrade wall insulation in blocks Office Block, Retail Block, and Multifamily Block 1 for Wall 1.	<input type="checkbox"/>
Upgrade to high efficiency windows in blocks Office Block and Retail Block for Window 1.	<input type="checkbox"/>

Lighting

Recommendation	Select
Include all recommendations	<input type="checkbox"/>
Upgrade to LED fixtures in blocks Retail Block, Office Block, and Multifamily Block 1 for Fixture 1.	<input type="checkbox"/>
Upgrade to LED fixtures in blocks Office Block and Retail Block for Fixture 2.	<input type="checkbox"/>

Heating / Cooling

☐ Provide cost effective HVAC options
OR select High Performance HVAC options from below:

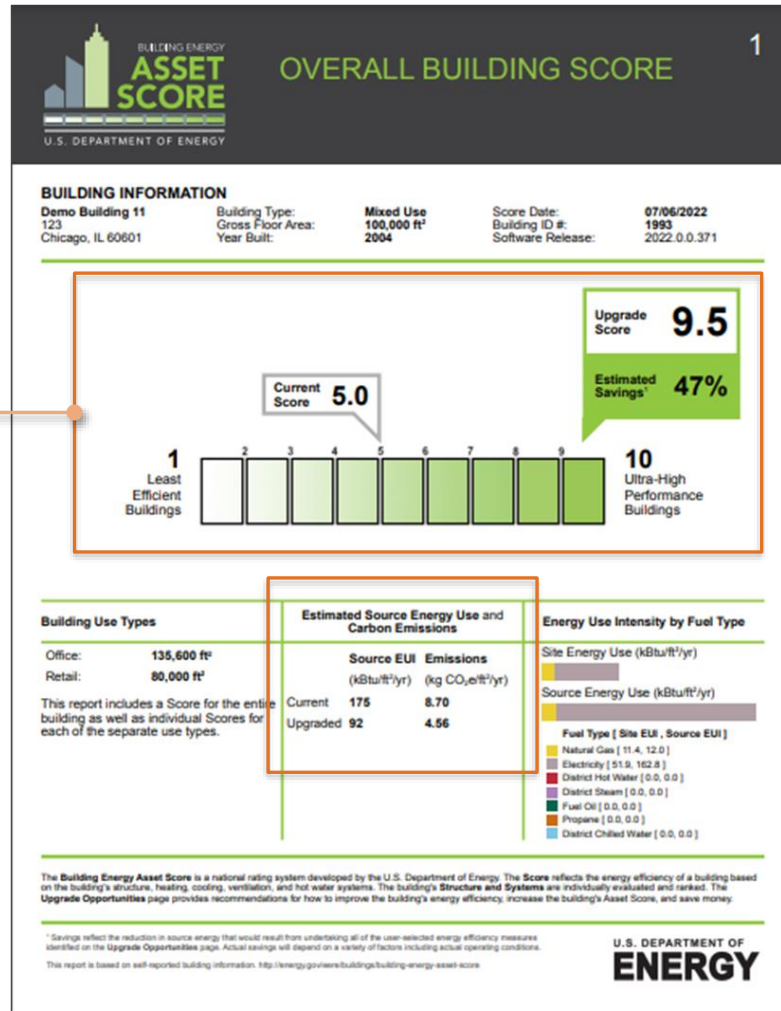
Air Handler 1

Recommendation	Select
Replace HVAC with a VRF and a DOAS in blocks Retail Block, Office Block, and Multifamily Block 1 for Air Handler 1.	<input type="radio"/>
Replace HVAC with a Water Loop HP and a DOAS in blocks Retail Block, Office Block, and Multifamily Block 1 for Air Handler 1.	<input type="radio"/>

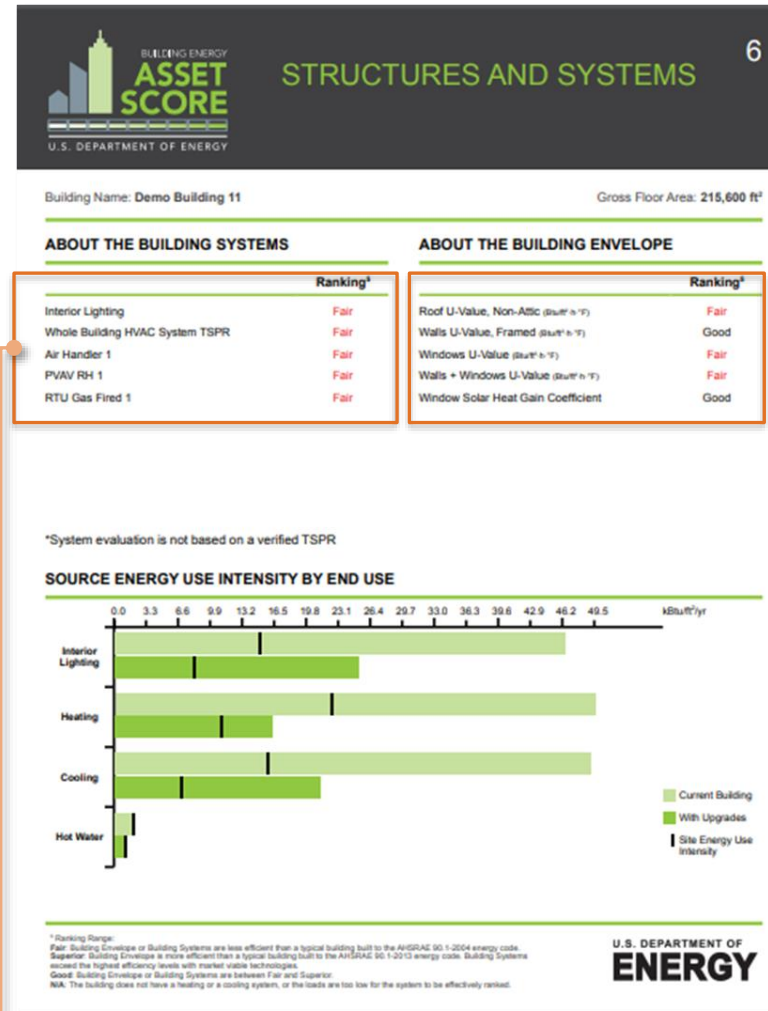
Note: Upgrades for lighting controls, HVAC systems controls, and SHW systems are automatically added, if applicable.

Buttons: Cancel, Score Building

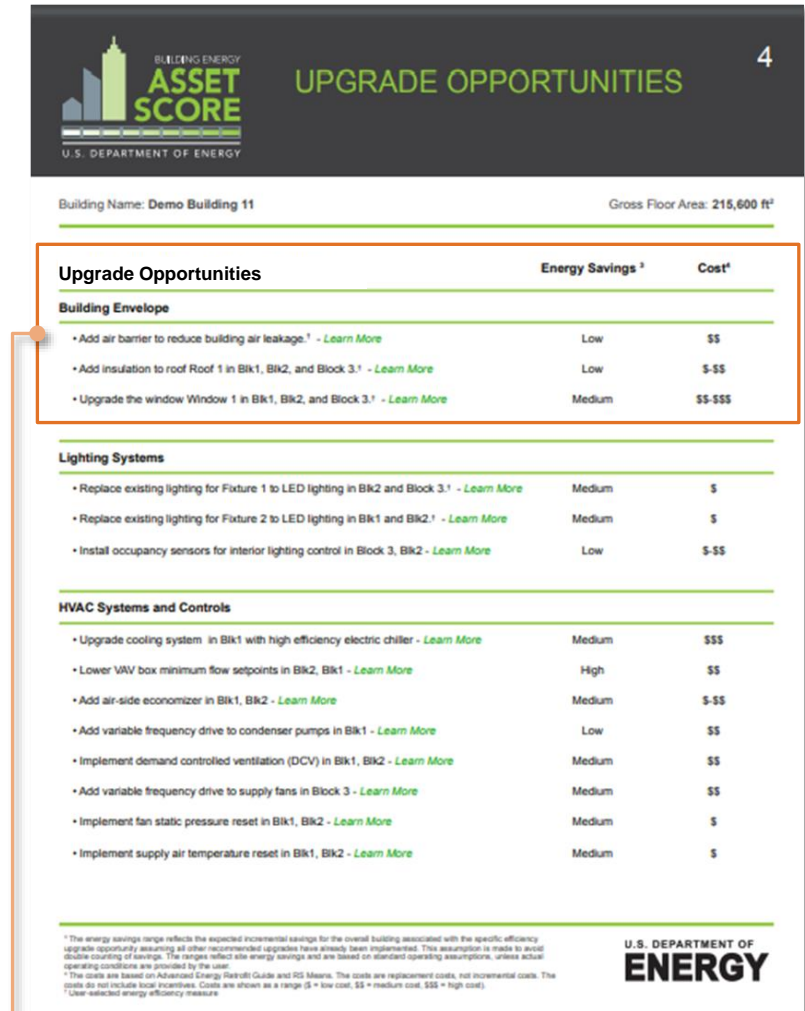
Approach: What Does the Tool Tell Me?



Current and Upgrade score to show potential for improvement




Structure and Systems assessment to identify building assets that have potential for improvement



Upgrade opportunities for additional assessment with a cost range estimate (low/medium/high)

Approach: What Does the Tool Tell Me?



3

HEALTH AND SAFETY IMPACT

Building Name: Delta Elementary School

Gross Floor Area: 98,909 ft²

Health and Safety Impact of Upgrade Opportunities

Building Envelope

Health and Safety Impact

Seal building envelope reducing air infiltration¹

Air sealing can improve thermal comfort by reducing cold drafts, and reduce occupant exposure to outdoor air pollutants, such as vehicle exhaust. It may also help with moisture and pest control by eliminating entry points. But with less outside air being provided by air infiltration, it is important to make sure that the building has sufficient ventilation after air sealing, such as by HVAC commissioning, otherwise indoor air quality may deteriorate.

Upgrade roof insulation in block Block 1 for Roof 1.¹

Better insulation may improve thermal comfort. However, adding insulation can disturb existing building materials that may contain asbestos. Consult an accredited asbestos professional to determine if this is a concern.

Upgrade wall insulation in block Block 1 for Wall 1.¹

Better insulation may improve thermal comfort. But note that adding insulation can disturb existing building materials that may contain asbestos. Consult an accredited asbestos professional to determine if this is a concern.

Upgrade to high efficiency windows in block Block 1 for Window 1.¹

Selecting windows with the appropriate heat gain and visible light transmittance can help maintain thermal comfort and improve occupant satisfaction with indoor lighting level.

Implement a cool roof in block Block 1

Cool roof can keep both the building and its surrounding area cooler on hot days. This helps to improve thermal comfort, resulting in work performance and learning benefits.

Lighting Systems

Upgrade to LED fixtures in block Block 1 for Fixture 1.¹

Indoor lighting retrofit has the potential to improve lighting quality and occupant satisfaction. Retrofits that also allow occupants to have more lighting control can provide greater flexibility to adapt and respond to changing needs.

Upgrade to LED fixtures in block Block 1 for Fixture 2.¹

Indoor lighting retrofit has the potential to improve lighting quality and occupant satisfaction. Retrofits that also allow occupants to have more lighting control can provide greater flexibility to adapt and respond to changing needs.

HVAC Systems and Controls

U.S. DEPARTMENT OF ENERGY

Health and safety impact of measures

Energy Conservation Measure (ECM) Cost Estimations

INSTRUCTIONS: Select energy conservation measures (ECMs) from the Measure columns below once you've completed the Building Parameters section above. Estimates are made using a combination of the building parameters you've provided and the data source linked in the Cost Source column to the right.

Envelope Measures		
Measure	Estimate (\$)*	Cost Source
Upgrade roof insulation (R-20)	\$141,000 to \$182,000	AERG schools (\$/ft² of roof area)
Upgrade to high efficiency windows	\$734,000 to \$965,000	Scout - Best Commercial Windows
Upgrade floor cavity insulation		
Upgrade roof insulation (R-20)		
Upgrade roof insulation (R-30)		
Upgrade wall insulation		
Install a cool roof		
Seal building envelope reducing air infiltration		
Upgrade to high efficiency skylights		
Upgrade to high efficiency windows		
Total	\$875,000 to \$1,147,000	

Miscellaneous Costs

Instructions: Enter costs related to project management and other miscellaneous costs. These costs are unrelated to the capital and installation cost of ECMs.

Project Management	\$ 10,000.00
--------------------	--------------

OVERALL COST*, **

\$733,000 to \$1,199,000

*DISCLAIMER - All installed cost estimates provided by this tool are based on high level approximations based upon literature review, subject matter expertise, and industry approximations. Every facility improvement project is unique, with various considerations for inflation, regional material costs, and regional labor costs. These estimates are NOT a guarantee for pricing. Developers of this tool accept no liability for these estimates and recommend users rely on independent quotations from accredited professionals.

**DISCLAIMER - This calculator does not include the cost of complete system replacement measures that fell outside the scope of this study as indicated by an "n/a" above.

Cost estimation spreadsheet: Provides a high-level estimate of the cost of implementation for the measures identified by QBAT

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13

Progress

11+ years of the project



2011-16	2017-18	2019-2022
<ul style="list-style-type: none">• Rating methodology research• Climate normalization methodology research• Sensitivity Analysis (to identify key AS inputs)• AS Tool development• Additional HVAC and Lighting control measures• Pilot testing of the tool	<ul style="list-style-type: none">• High-performance building capabilities• Improved recommendation engine to allow user selection of measures	<ul style="list-style-type: none">• Audit Template to Asset Score conversion capability• Carbon metrics added to AS PDF report• User interviews to understand tool usage and key features

Progress: FY23

- **FY23 So Far**
 - QBAT capability developed and released (limited to school use type and the most common HVAC systems)
 - Support for additional HVAC systems is being added in QBAT
- **FY23 - Planned Development**
 - Improve measure recommendation capability in QBAT/AS:
 - Additional support for **high-performance building measures**
 - Additional **electrification measures**: for water heating and space heating
 - **On-site renewables**: add capabilities to estimate renewable energy capacity and annual energy generation potential

Progress: Lessons Learned

Lessons Learned: User interviews to understand tool usage profiles

Score Scale

- Users expected alignment with Portfolio Manager: differences between 'Operational Score' and 'Asset Score' are not well understood.
- Scores are **useful for pre/post retrofit analysis** and for real estate due diligence.

Simplified Modeling Process

- Simplified modeling approach for quick energy use and savings estimate.
- However, the exported energy model is not very relevant for detailed assessment (e.g., for calibration).

Recommendation Engine

- **Most helpful feature of the tool.** Identifies opportunities for improvement and areas which could be assessed in additional detail upon an ASHRAE Level I or II energy audit.

Asset Score provides a unique capability for a **pre-audit feasibility assessment** for identifying **potential for savings and systems that can be improved.**

Provides an equitable capability for needs assessments!

Future Work

- **Software Development**
 - Further develop Asset Score as a **pre-audit assessment** capability.
- **Outreach**
 - **Conduct case studies** of real projects that have used QBAT or Asset Score as a pre-audit assessment tool to validate the recommendations and structure/systems analysis done by the tool.
 - **Stakeholder engagement** to get input on using Asset Score tool as an early-stage needs assessment capability for identifying potential for energy savings and electrification.

Summary

- QBAT interface to Asset Score provides a simple, equitable approach for needs assessments for buildings
- Requires minimal data and expertise to identify potential opportunities and prioritize buildings for detailed L2 audits
- Through the QBAT and measures recommendation capabilities of Asset Score tool, the tools aim to support energy efficiency and electrification

*Asset Score provides **a low cost way** to identify **decarbonization, electrification, and energy efficiency retrofit measures** for a building*

Thank You

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WBS# 2.5.1.50

REFERENCE SLIDES

Project Execution

	FY2021				FY2022				FY2023				FY2024			
Planned budget	\$ 241,351				\$ 100,329				\$ 397,308				\$ 65,801			
Spent budget	\$ 243,546				\$ 96,673				\$ 79,462							
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Past Work																
Capability to convert an Audit Template building to an Asset Score building	◆															
GHG metrics added to Asset Score PDF report				◆												
Spreadsheet based tool for cost-estimation of measures recommended by Asset Score tool								◆								
Current/Future Work																
QBAT Tool, with support for schools, deployed to production									◆							
QBAT Tool, with additional HVAC system types												◆				
Updated Asset Score tool with support for additional energy efficiency, decarbonization and electrification measures												◆				

◆ Milestone/Deliverable - Originally Planned and Missed

◆ Milestone/Deliverable - Actual, Met on Time

Asset Score project has been successful in meeting deliverables on time.

Team



Supriya Goel
PI/PM



Mark Borkum
Lead Software Developer



Juan Gonzalez
Technical Lead



Jared Chase
Software Engineer



Edward Ellis
Software Engineer



Yun Joon Jung
Software Testing and User Support



Juan Carlos Barajas
Software Engineer