Introduction and Basic Training

May 2025

Prepared for Users of BETTER. V.1.7

Contents

- **Tool Overview**
- **Analytical Methodology**
- **Using BETTER**
  - Inputting Data
  - Running Analysis
  - Utilizing Results

Acknowledgments

- BETTER is made possible by support from the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Building Technologies Office (BTO).

- BETTER is being developed under Cooperative Research and Development Agreement (CRADA) No. FP00007338 between the Regents of the University of California Ernest Orlando Lawrence Berkeley National Laboratory, under its U.S. DOE Contract No. DE-AC02-05CH11231, and Johnson Controls, with support from ICF.

Tool Overview

What is BETTER?

- The Building Efficiency Targeting Tool for Energy Retrofits (BETTER) delivers actionable insights to improve energy, emissions, and financial performance in buildings and portfolios without requiring site visits or complex modeling.
- BETTER requires minimal data inputs and short run time to:
  - Benchmarks a building's electric and fossil energy usage against peers.
  - Quantify energy, cost and greenhouse gas (GHG) reduction potentials at the building and portfolio levels.
  - Recommends energy efficiency (EE) measures to decarbonize and electrify buildings and portfolios.
- **The BETTER web app is available online at https://better.lbl.gov.**
- **BETTER's analytical engine is open-source and available on GitHub at https://github.com/LBNL-JCI-ICF/better.**

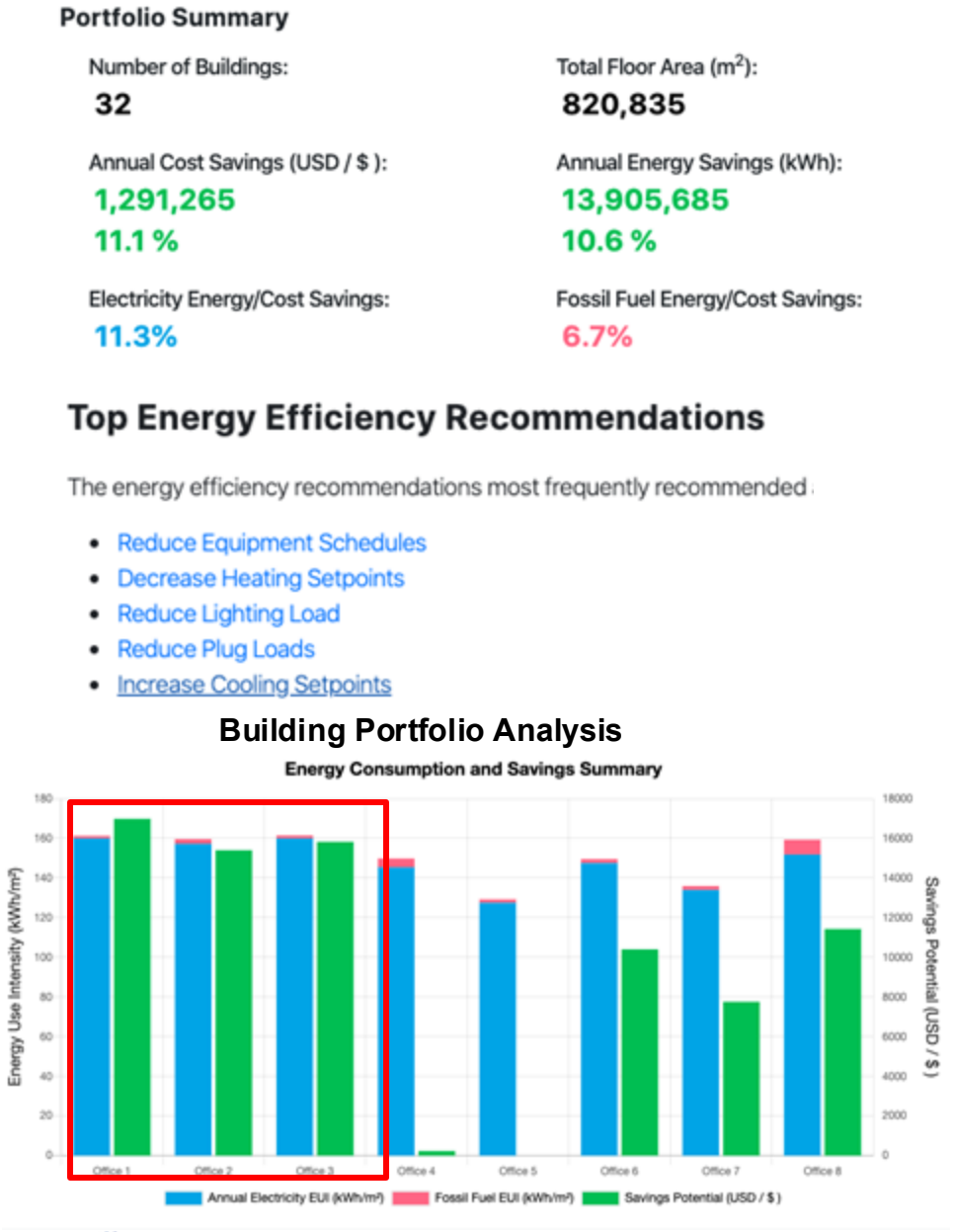
Overview

Value Delivered to Users:

- BETTER identifies immediate, cost-saving operational and technology EE improvements to reduce energy use and GHG emissions while prioritizing buildings for more in-depth audits and analysis. BETTER:
  - Replaces level 1 audits.
  - Streamlines level 2 audits.
  - Uncovers simple no-/low-cost measures to immediately cut energy costs 5-10% portfolio-wide.

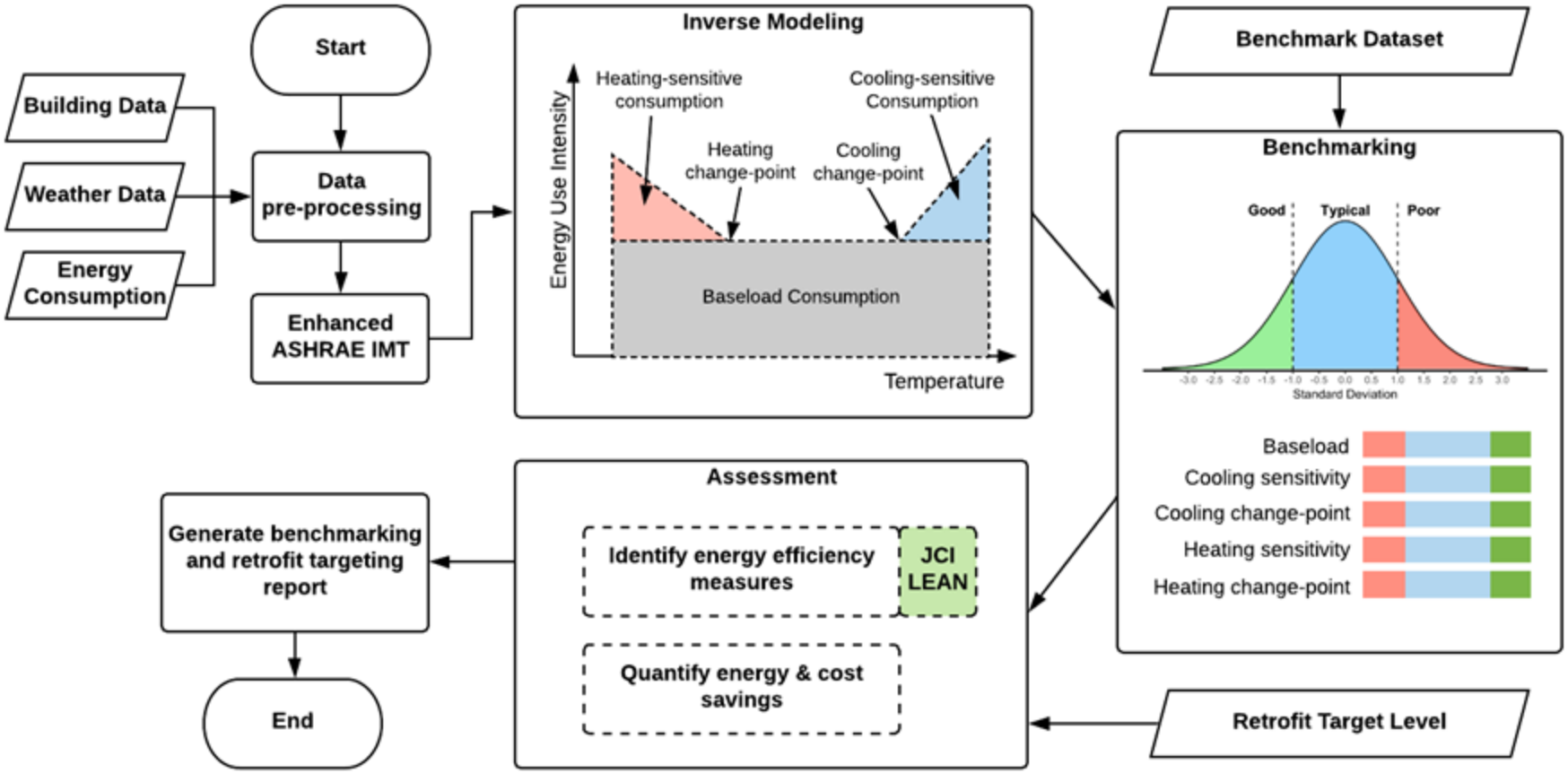
How BETTER works:

- BETTER utilizes an open-source, data-driven analytical engine and user-friendly web interface to automatically analyze a building's monthly energy usage in response to weather conditions.



Analytical Methodology

Overall Workflow



Property Information

SI Units (meters, kWh, °C)	Select Currency * :	US dollar (USD / $)

Gross Floor Area Unit: sq. meters

Building ID*	Building Name*	Location*	Gross Floor Area (Excluding Parking)*	Primary Building Space Type*
1	Office 1	Miami, FL	4982	Office
2	Office 2	Houston, TX	4982	Office
3	Office 3	Atlanta, GA	4982	Office
4	Office 4	Los Angeles, CA	4982	Office
5	Office 5	Las Vegas, NV	4982	Office
6	Office 6	San Francisco, CA	4982	Office
7	Office 7	Baltimore, MD	4982	Office

1. **Unit System**
   - Select Imperial Units (feet, kBtu, °F) or SI Units (meters, kWh, °C)
2. **Building Location (City, State/Province, Zip, Country)**
   - Used to find weather data
3. **Gross Floor Area (Exclude Parking)**
   - Used to normalize consumption
4. **Primary Building Space Type**
   - Used for benchmarking
5. **Currency**
   - Used for cost savings reporting

Monthly Energy Consumption and Cost Data

- Minimum of 12 consecutive months of energy consumption data is required.
- Gather all electricity and fossil fuel consumption data from utility bills for each billing period.
- Energy cost is optional. If no energy cost is entered, BETTER will use a default cost per unit.
- Average outdoor air temperature is optional. If no weather data is entered, BETTER will use National Oceanic and Atmospheric Administration (NOAA) data.*

Building ID*	Billing Start Dates*	Billing End Dates*	Energy Type*	Energy Unit*	Energy Consumption*	Energy Cost	Average Outdoor Air Temperature
1	1/1/2017	1/31/2017	Electric - Grid	kWh (thousand Watt-hours)	66338		
1	2/1/2017	2/28/2017	Electric - Grid	kWh (thousand Watt-hours)	55528		
1	3/1/2017	3/31/2017	Electric - Grid	kWh (thousand Watt-hours)	64180		
1	4/1/2017	4/30/2017	Electric - Grid	kWh (thousand Watt-hours)	62067		
1	5/1/2017	5/31/2017	Electric - Grid	kWh (thousand Watt-hours)	69730		

* NOAA weather data may not be available for all locations. An error message will show on the BETTER analysis reports to prompt a user to enter average outdoor air temperature data for a given location and/or billing period as appropriate.

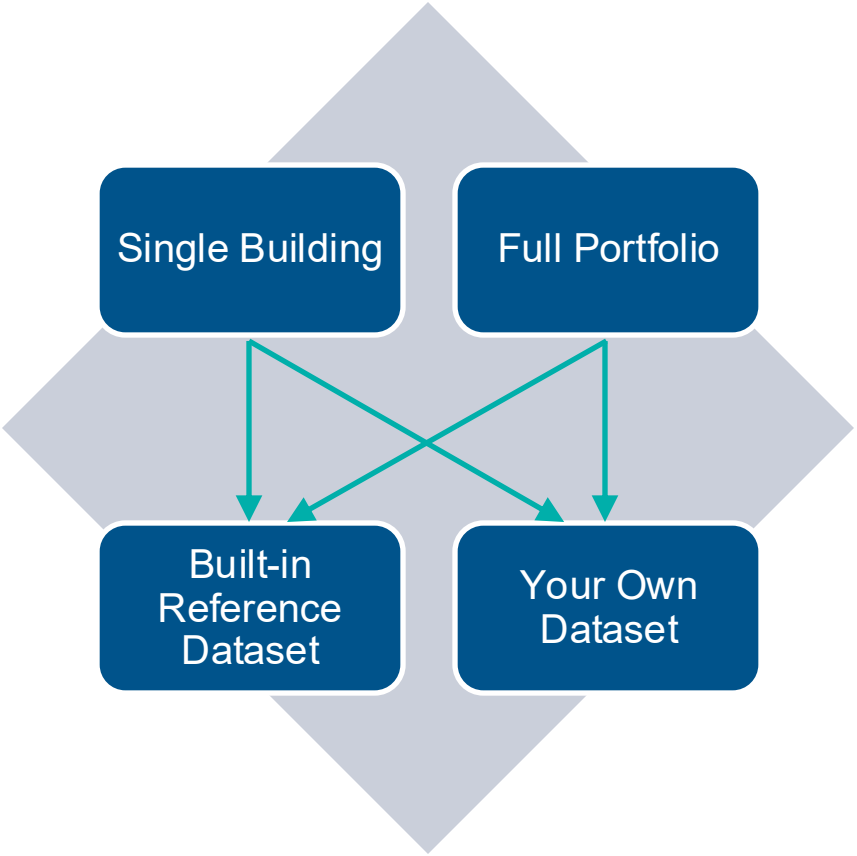
Weather Data

- **Data Source:** National Oceanic and Atmospheric Administration (NOAA)
- **Time interval:** Sub-hourly
- **Input:** Address, billing periods start and end dates

USAF	WBAN	StationID	STATIONNAME	CTRY	STATE	ICAO	LAT	LON	ELEV_M	BEGIN	END	EndYear
450320	99999	450320-99999	TA KWU LING	CH			22.533	114.15	13	19921204	20171117	2017
450350	99999	450350-99999	LAU FAU SHAN	CH			22.467	113.983	35	20040713	20171117	2017
450390	99999	450390-99999	SHA TIN	CH			22.4	114.2	8	20040713	20171117	2017
450440	99999	450440-99999	CHEUNG CHAU	CH			22.2	114.017	79	20020313	20171117	2017
450450	99999	450450-99999	WAGLAN ISLAND	CH			22.183	114.3	60	20040122	20171117	2017
470311	99999	470311-99999	MEILAN	CH		ZJHK	19.935	110.459	22.9	20040706	20171117	2017
470312	99999	470312-99999	ZHENGDING	CH		ZBSJ	38.281	114.697	71	20040706	20171117	2017
501360	99999	501360-99999	MOHE	CH			52.967	122.533	438	19730101	20171117	2017
503530	99999	503530-99999	HUMA	CH			51.733	126.633	175.6	19560820	20171117	2017
504340	99999	504340-99999	TULIHE	CH			50.45	121.7	733	19570531	20171117	2017
504680	99999	504680-99999	AIHUI	CH			50.25	127.45	166	19610801	20171117	2017
505270	99999	505270-99999	HAILAR	CH			49.25	119.7	650	19560820	20171117	2017
505480	99999	505480-99999	XIAO'ERGOU	CH			49.2	123.717	288	19570531	20171117	2017
505570	99999	505570-99999	NENJIANG	CH			49.167	125.233	243	19560820	20171117	2017
505640	99999	505640-99999	SUNWU	CH			49.433	127.35	235	19560820	20171117	2017
506030	99999	506030-99999	XIN BARAG YOUQI	CH			48.683	116.817	556.7	19600101	20171117	2017
506320	99999	506320-99999	BUGT	CH			48.767	121.917	739	19560820	20171117	2017
506560	99999	506560-99999	LONG-ZHEN	CH			48.65	126.667	305	19610801	20130120	2013
506580	99999	506580-99999	KESHAN	CH			48.05	125.883	237	19570601	20171117	2017
507270	99999	507270-99999	ARXAN	CH			47.167	119.933	997	19560820	20171117	2017
507450	99999	507450-99999	SANJIAZI	CH		ZYQQ	47.24	123.918	145.4	19560820	20171117	2017
507560	99999	507560-99999	HAILUN	CH			47.45	126.867	248	19560820	20171117	2017
507740	99999	507740-99999	YICHUN	CH			47.7	128.833	259.1	19570601	20171117	2017
507880	99999	507880-99999	FUJIN	CH			47.233	131.983	65	19560820	20171117	2017
508440	99999	508440-99999	TAILAI	CH			46.4	123.45	150	19610801	20171117	2017
508540	99999	508540-99999	ANDA	CH			46.383	125.317	150	19560820	20171117	2017
508880	99999	508880-99999	BAOQING	CH			46.317	132.183	83	19570602	20171117	2017

Dataset and Property Types

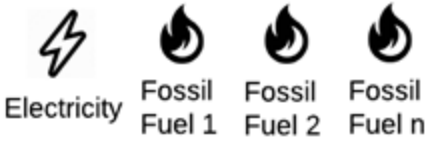
- Benchmark a single building or your full portfolio.
- Two modes of use:
  - Benchmark against a built-in reference dataset.*
  - Benchmark against your own portfolio.
- Built-in benchmarking datasets are for:
  - U.S. offices, K-12 schools, public libraries, hospitals, worship facilities, and multifamily buildings*
  - Mexican offices
  - Tunisian hotels



*At this time, the "reference" benchmark statistics for U.S. offices, K-12 schools, public libraries, hospitals, worship facilities, and multifamily buildings are not perfectly representative of the U.S. national stock because the statistics were *not* developed from the U.S. Energy Administration (EIA) Commercial Building Energy Consumption Survey (CBECS) dataset (which is representative of the U.S. national stock) but rather from *datasets developed based on voluntary contributions from U.S. industry* that are not fully representative of the U.S. national stock in terms of characteristics such as size and climate zone distribution. We are working to expand these training datasets, and hence improve associated "reference" benchmark statistics, so they are more representative of the U.S. national stock. This includes expanding the training data sets to include: *at least 30 data points for each of the 10 BETTER model coefficients for each of the eight CBECS size categories in each of the eight International Energy Conservation Code (IECC) climate zones in the United States (and possibly for each of the relevant subtypes A, B, and C in these zones). Learn more at FAQ. To contribute anonymous data to this effort, please email support@better.lbl.gov.*

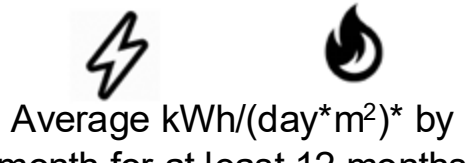
Automatic Data Pre-Processing

- Read building information (address, space type, gross floor area, etc.) and monthly energy usage and cost data



- Search for closest weather station.
- Combine different types of fossil fuel consumptions, and convert energy consumption unit to kWh.*

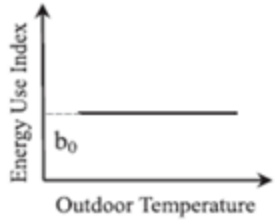
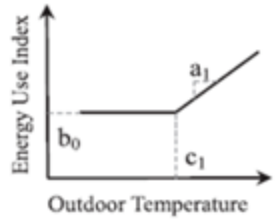
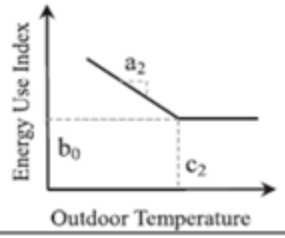
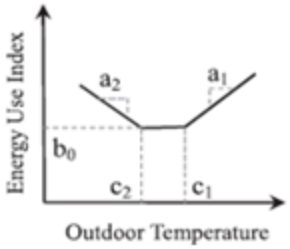
- Download sub-hourly weather file from NOAA ftp.
- Normalize energy consumption to show average kWh/(day*m^2)* by month for at least 12 months.*



- Align and aggregate weather data with energy consumption data (arbitrary billing periods).

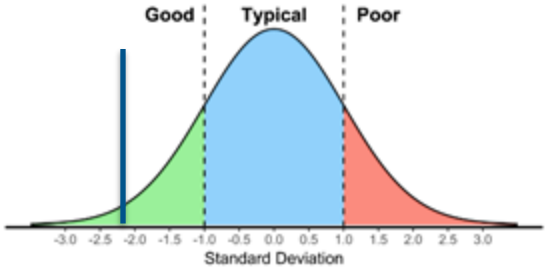
* BETTER uses kWh and m^2 as common units for calculations, but may display savings in output reports in kWh/m^2 or kBtu/ft^2, depending on the unit system selected in spreadsheet upload template.

Inverse Modeling

Model Type	Schematic Plot	Model Coefficient					Interpretation
		Baseload (b0)	Cooling Sensitivity (a1)	Cooling Change-point (c1)	Heating Sensitivity (a2)	Heating Change-point (c2)	
1P Model		X					(1). The building is not heated or cooled. (2). The heating and cooling system of the building only consumes a very small amount of the total energy.
3P Cooling Model		X	X	X			(1). The cooling system of the building starts to operate when the outdoor air temperature goes beyond the change-point. (2). The steeper the slope, the higher energy consumption growth as outdoor air temperature rises.
3P Heating Model		X			X	X	(1). The heating system of the building starts to operate when the outdoor air temperature drops below the change-point. (2). The steeper the slope, the higher energy consumption growth as outdoor air temperature drops.
5P Model		X	X	X	X	X	The building's cooling and heating systems are driven by the same fuel type. As the outdoor air temperature drops below a certain point, the heating system starts to operate. As the outdoor air temperature rises above a certain point, the cooling system starts to operate.

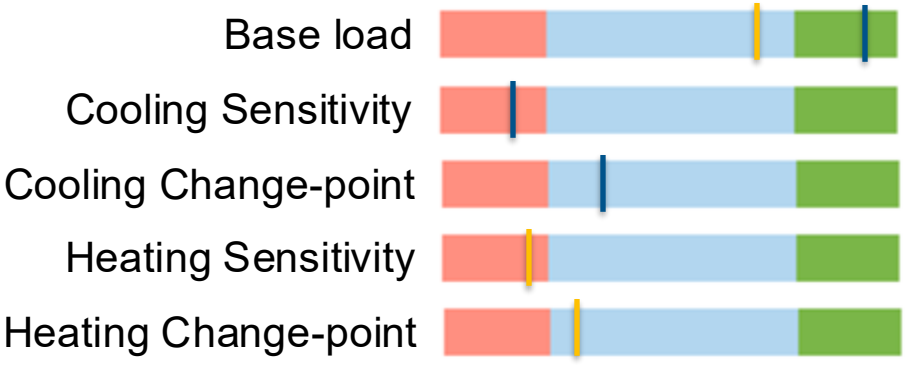
Benchmark Coefficients

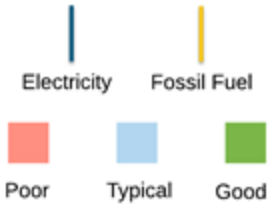
Model Coefficients → Electricity Base load →



Benchmark Statistics
- Median
- Standard Deviation

→ Electricity Base load Distribution →



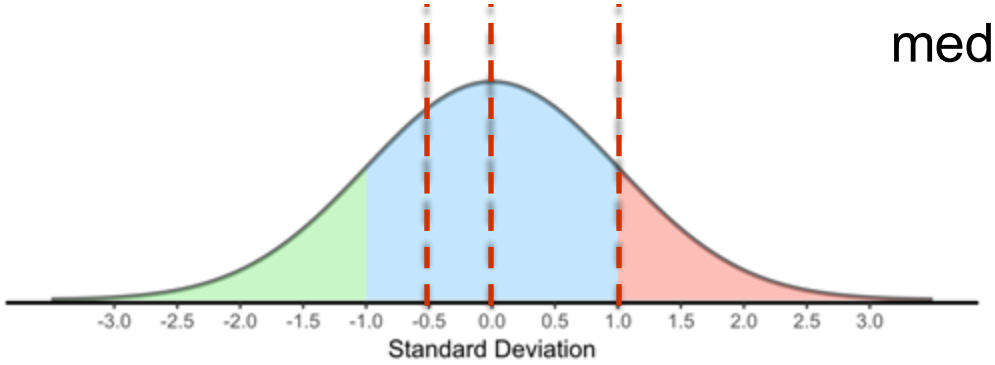


Energy Efficiency Targeting

Step 1. Specify energy efficiency target

Aggressive (½ a standard deviation better than the dataset median)

Conservative (1 standard deviation worse than the dataset median)

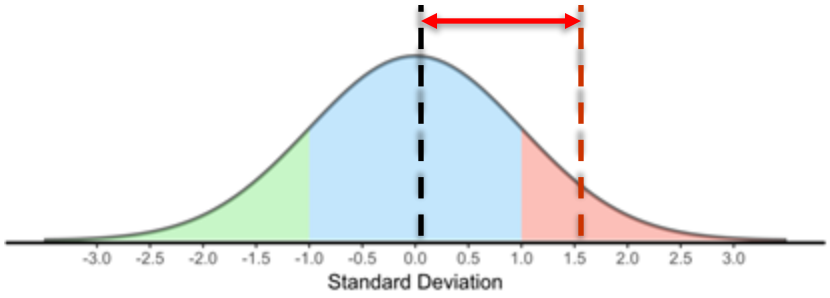


Nominal (equal to the dataset median)

Energy Efficiency Targeting

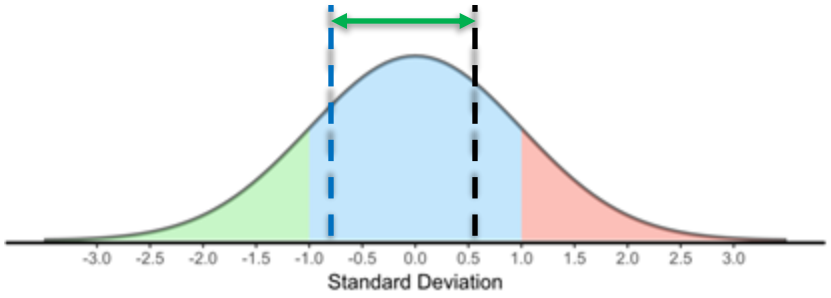
Step 2. Determine Facility Improvement Measures (FIM)

Example A.



- Current model coefficient: Poor
- Target : Nominal
- Target is better than current, need to pick FIMs

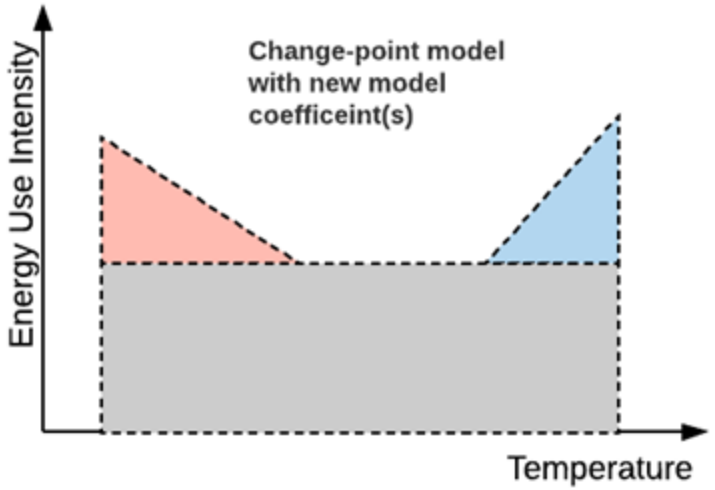
Example B.



- Current model coefficient: Typical
- Target : Conservative
- Target is worse than current, no need to pick FIMs

Energy Savings Estimation

Step 3. Calculate potential energy and cost savings



Re-run the model to get:

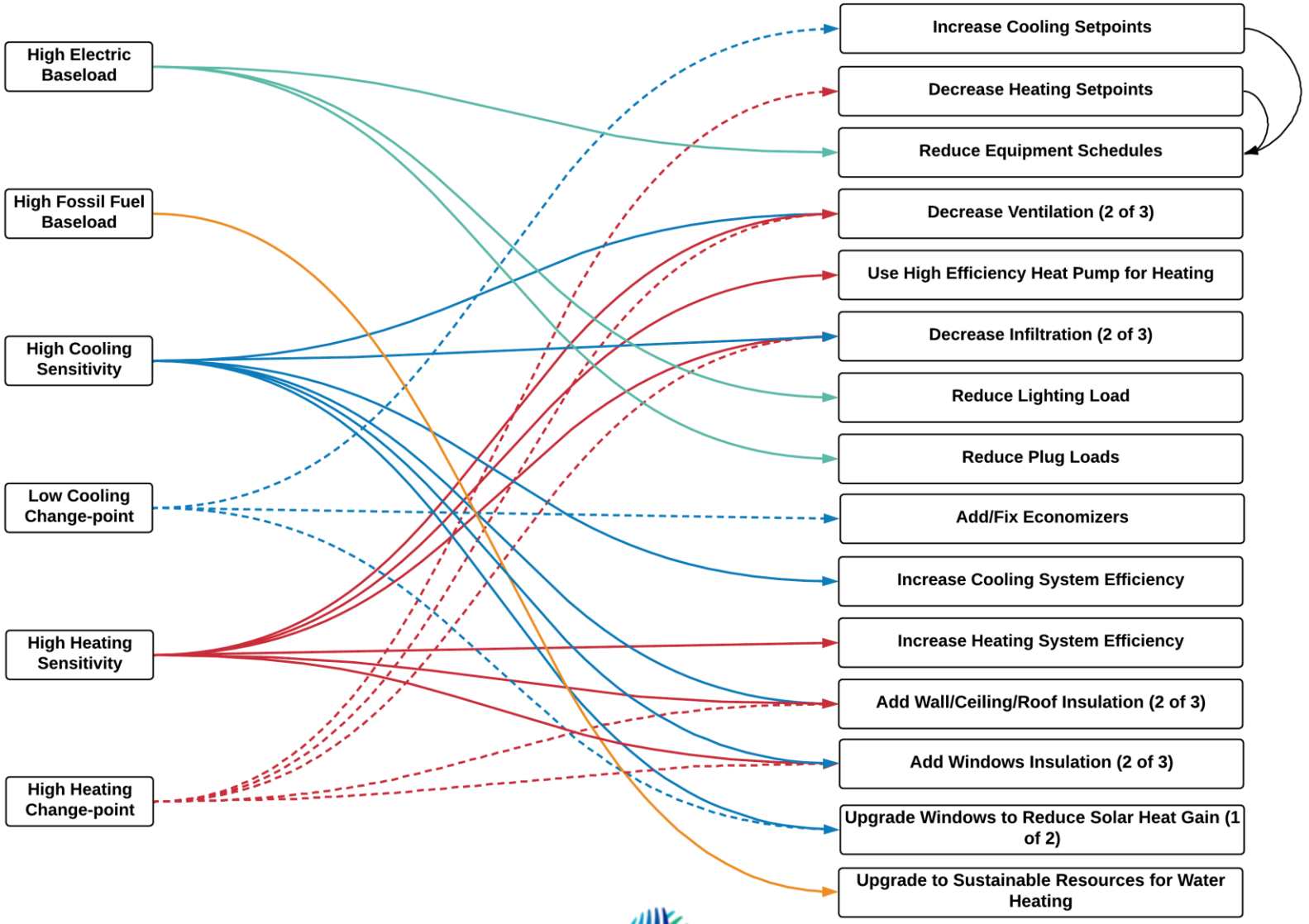
Current energy consumption

Estimated energy consumption with suggested FIMs

Estimated energy savings

Calculate associated cost

Energy Efficiency Recommendations



BETTER Interoperability

BETTER Interoperability

- BETTER can create / analyze buildings or portfolios via custom ENERGY STAR® Portfolio Manager® Excel reports and provide BETTER analytical reports as self-contained HTML files.

- BETTER can create/analyze buildings or portfolios via BuildingSync® XML files and provide BETTER analytical reports as self-contained HTML files.[1]

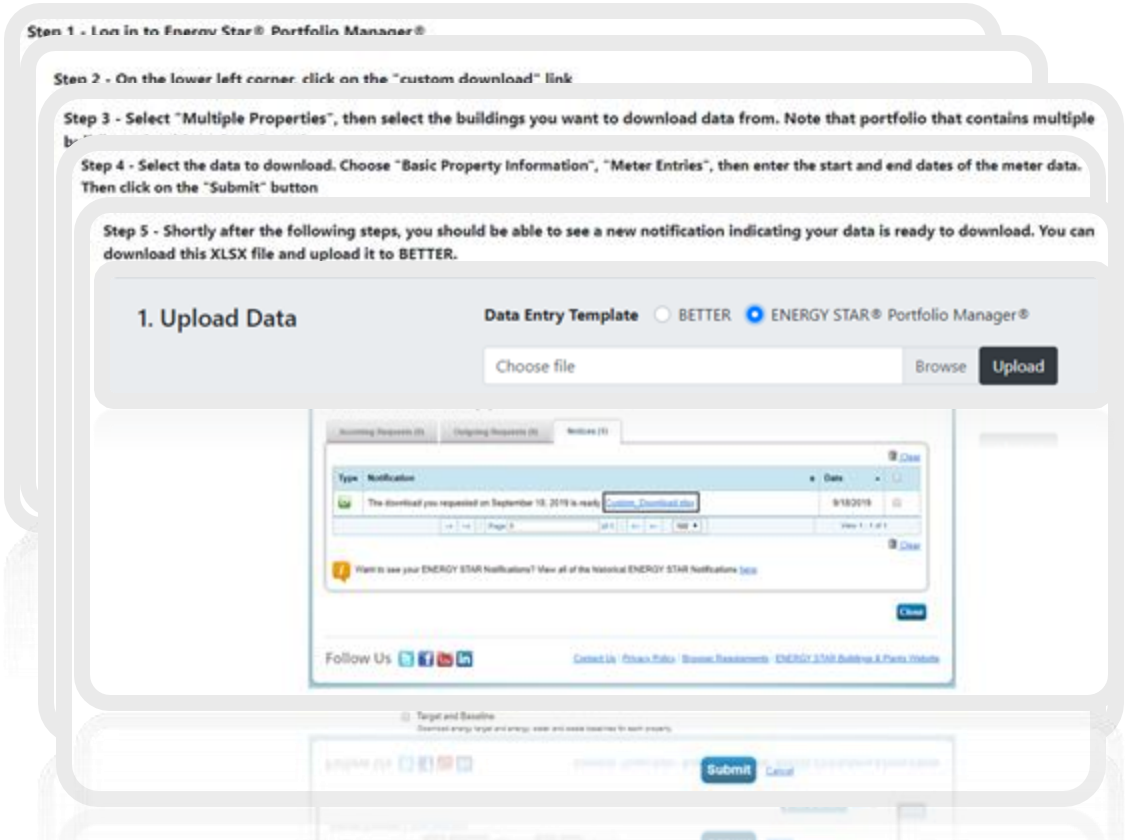
- Software developers can access BETTER via the BETTER RESTful API to: (1) create and analyze a building / portfolio in BETTER; and (2) retrieve analytical reports (in JSON and / or self-contained HTML files).

- Standard Energy Efficiency Data™ (SEED) platform can run BETTER analysis reports from the SEED platform. Contact Carolyn Szum CCSzum@lbl.gov for more information on how to access BETTER from the SEED platform.

1. BETTER will not have the capability to write a BuildingSync® XML file to transmit data to other U.S. DOE applications until sometime in the future.

Support for ENERGY STAR® Portfolio Manager ®

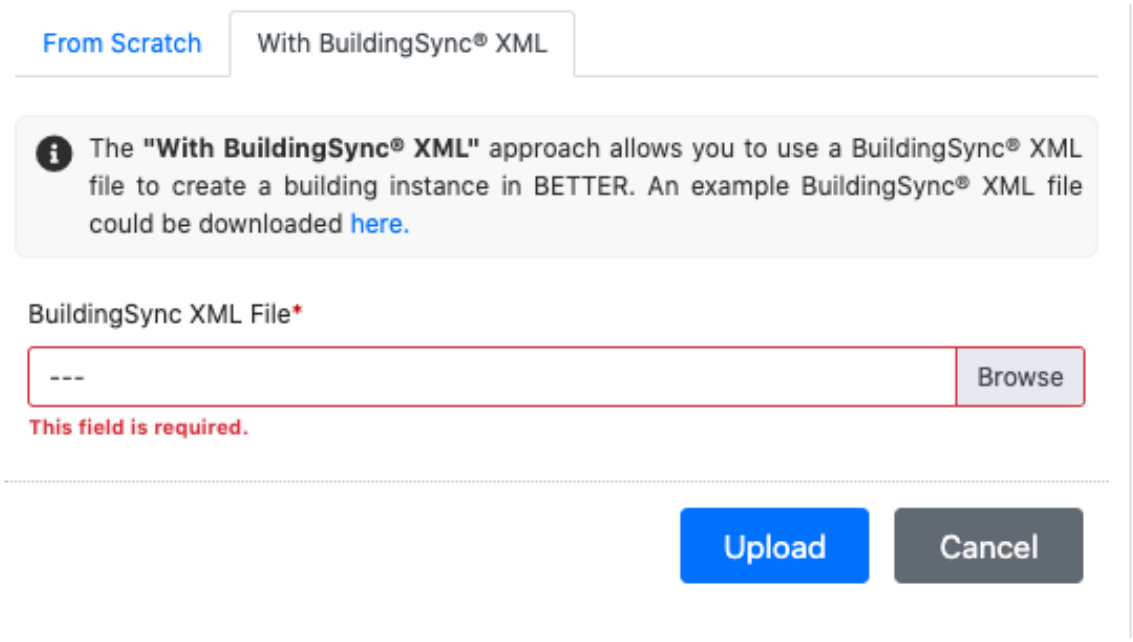
Goal: Allow a user to import multiple buildings' data stored in ENERGY STAR® Portfolio Manager ® for analysis with BETTER.



Support for BuildingSync® XML

BuildingSync® is a common schema for energy audit data that can be utilized by different software and databases involved in the energy audit process. It allows data to be more easily aggregated, compared, and exchanged between different databases and software tools.

Goal: Allow a user to upload data to BETTER for analysis using a BuildingSync® XML file.

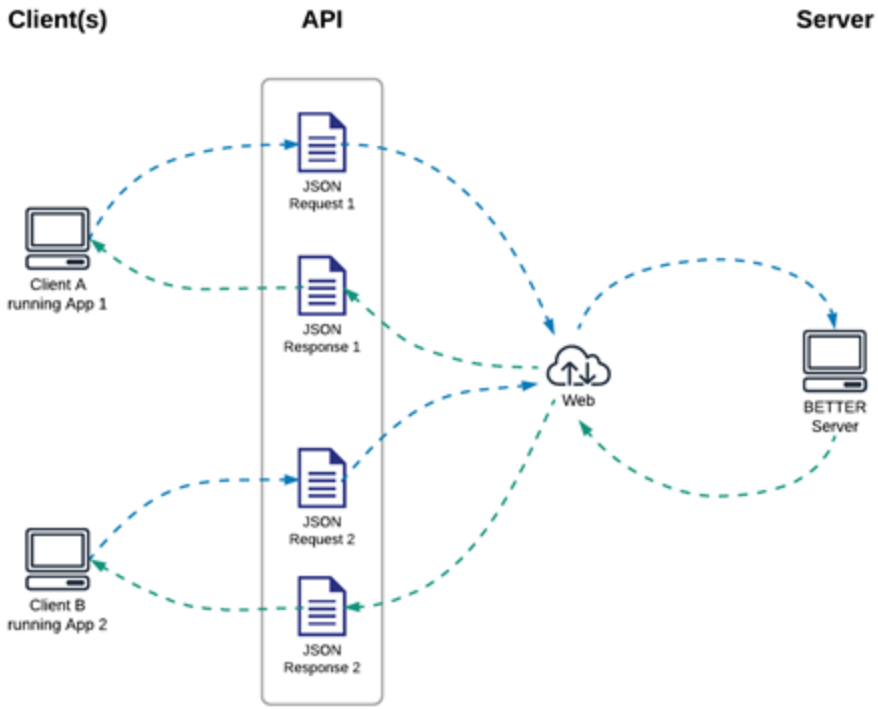


BETTER RESTful API

- **Access at: https://better.lbl.gov/docs/api/**
- **REST:** "Representational state transfer (REST) - a software architectural style that defines a set of constraints to be used for creating Web services."
- **API:** "An interface or communication protocol between a client and a server intended to simplify the building of client-side software."

- Public or private sector retrofit analysis tool that wants to add BETTER's service.

- Public or private energy management platform that wants to add BETTER's service.

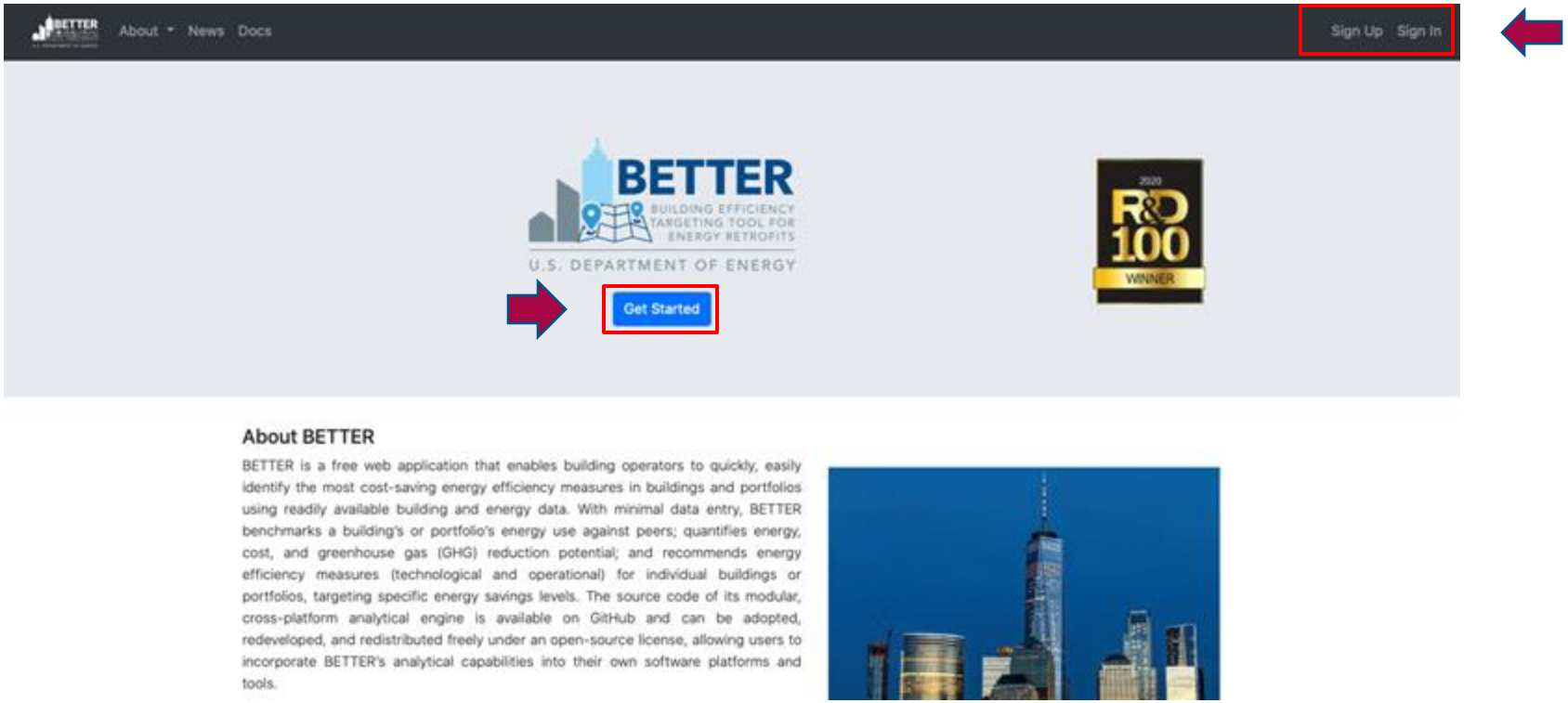


IIA. Run BETTER Using the Web App

1. **Access BETTER at: https://better.lbl.gov/.**

If you already have an account, click **Get Started** or **Sign In** to access BETTER.

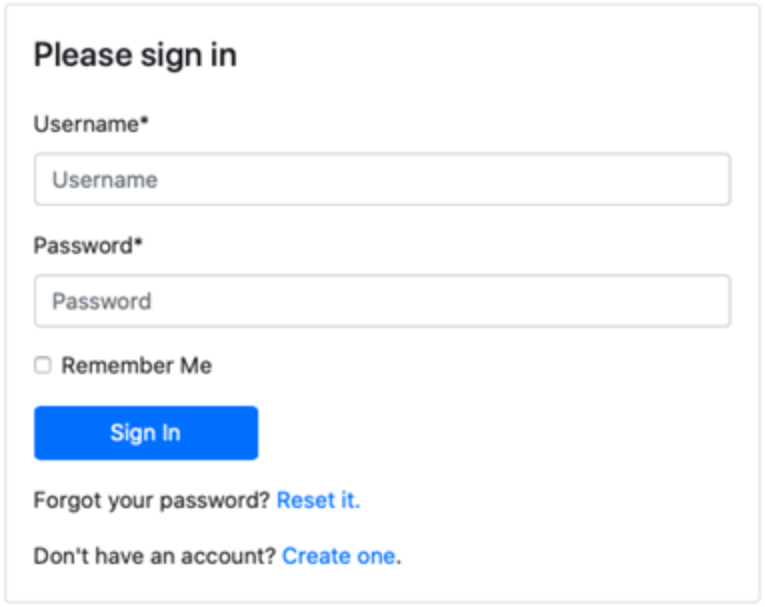
If you do not already have an account, click **Sign Up** to register and create at account.



IIA. Run BETTER Using the Web App

2. Sign In or Sign Up

Registered users will need to enter their username and password to access BETTER.



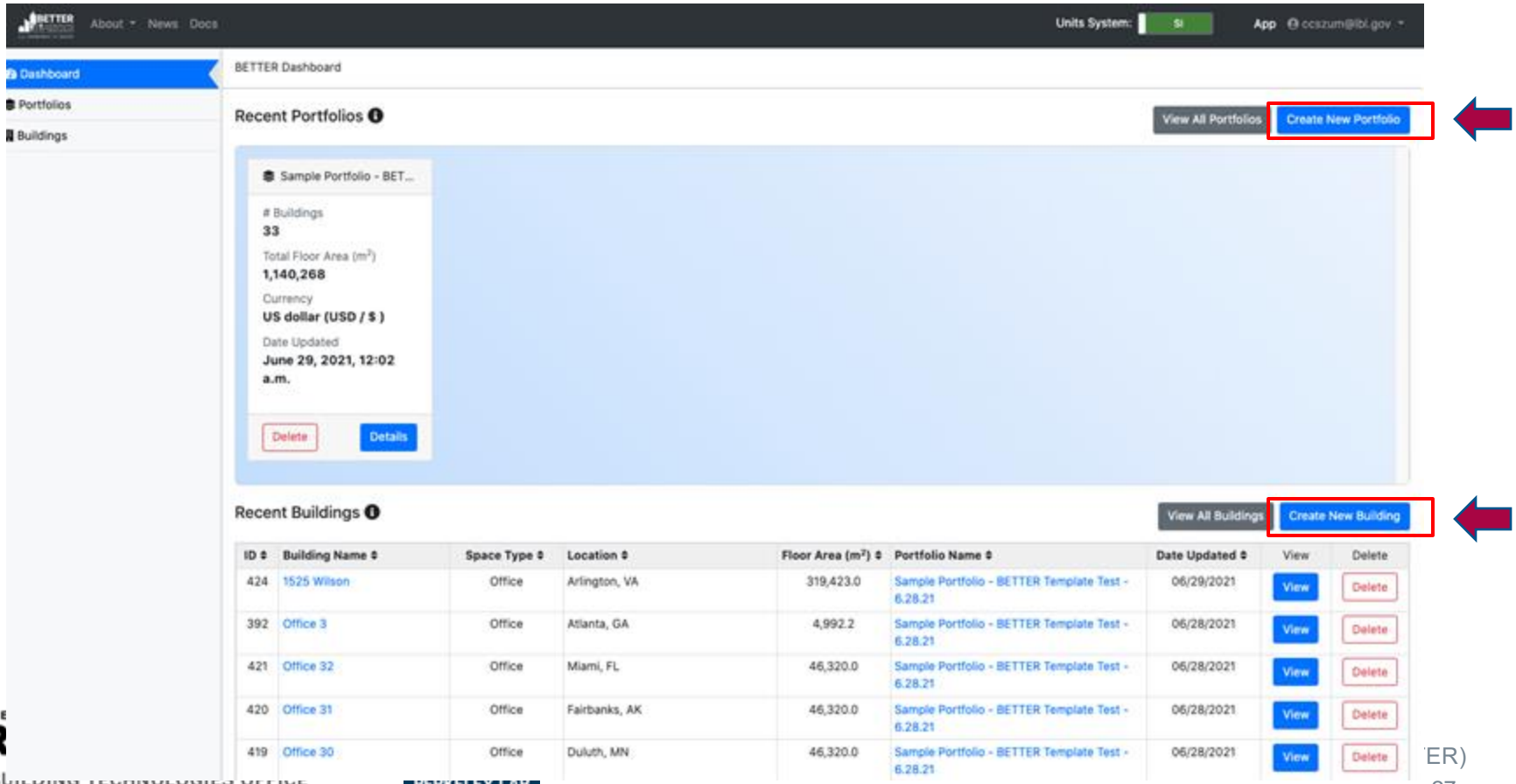
New users will need to register and create an account that only they can access by providing the following information:

- First Name
- Last Name
- Email Address
- Country
- Organization
- Industry
- Username
- Password

IIA. Run BETTER Using the Web App

3. Visit the BETTER Dashboard page

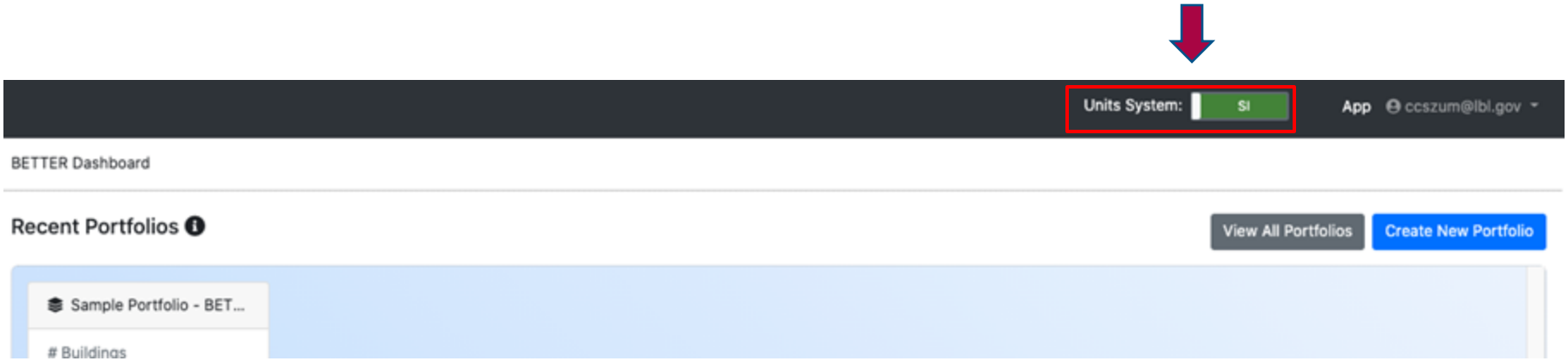
Dashboard is the main page of BETTER. This is where you can start to **Create New Portfolios** and **Create New Buildings** for analysis with BETTER. This is also where you can see the five most recently added portfolios and 10 most recently added buildings or navigate to pages to **View All Portfolios** and **View All Buildings** in your account.



IIA. Run BETTER Using the Web App

4. Select the Unit System on the Dashboard page

On the **Dashboard** page, go to upper right corner of the upper navigation bar to select the **unit system** in which you want to enter/view data in BETTER. To view/enter data in the the international system of units (kWh, square meters, °C), select **SI**. To view/enter data in the imperial system of units (kBtu, square feet, °F), select **IP**. You can change the system in which you view/enter data in BETTER at any time by changing the unit system.*



* NOTE: The exception to this is that, currently, when creating a new building or portfolio **From Scratch**, building gross floor area needs to be entered in square meters. This will be updated at a later date to allow users to enter building gross floor area in square feet.

Create a New Portfolio

IIA. Run BETTER Using the Web App

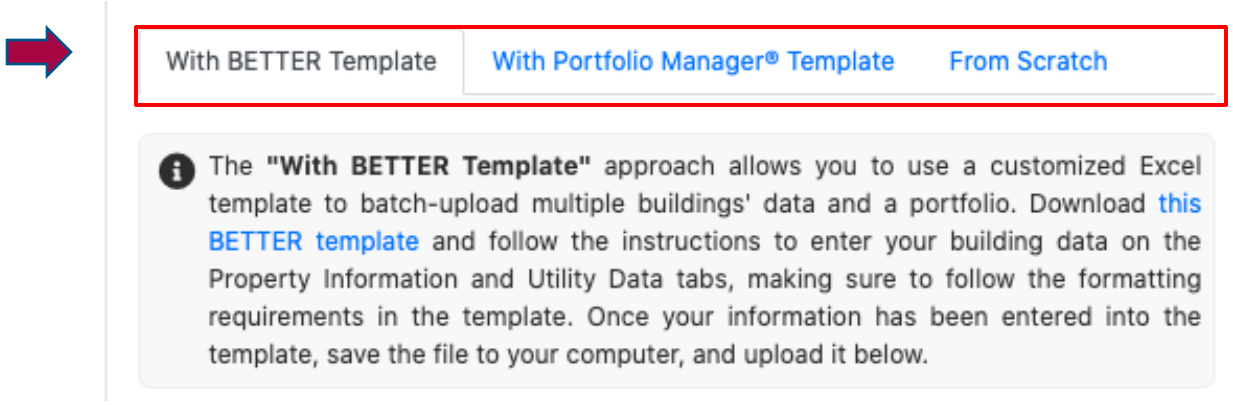
5. Create a New Portfolio on the Dashboard page

For users with portfolios they want to analyze with BETTER, clicking **Create New Portfolio** on the **Dashboard** page will direct you to the **Create a New Portfolio** page. There, users have three options to create a new portfolio:

a. **Option a:** The **With BETTER Template** approach allows users to use a customized Excel template to batch-upload multiple buildings' data and a portfolio.

b. **Option b:** The **With Portfolio Manager® Template** approach allows users to import multiple buildings' data stored in ENERGY STAR® Portfolio Manager®.

c. **Option c:** The **From Scratch** approach allows you to create an empty portfolio to which you can add buildings via the web interface or from a BuildingSync® XML file later.



Visit the appendix of this presentation for a snapshot of the data input fields in the BETTER and ENERGY STAR® templates.

IIA. Access the Web App Home to Create New Portfolio

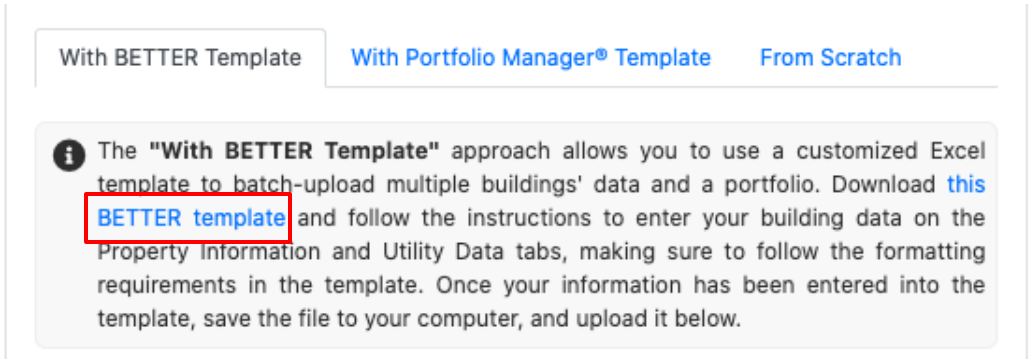
5a. Option a: Create a New Portfolio with BETTER Template

On the **Create a New Portfolio** page, click the **With BETTER Template** tab and then the **BETTER Template** link to download the customized Excel template to batch-upload multiple buildings' characteristics and energy data. Instructions for entering data are included on the Excel template itself.

Building ID*	Building Name*	Location*	Gross Floor Area (m^2)*	Primary Building Space Type*	Currency*
1	Office 1	Miami, FL	5789	Office	US Dollar
2	Office 2	Houston, TX	4982	Office	US Dollar
3	Office 3	Chicago, IL	5227	Office	US Dollar

Building ID*	Billing Start Dates*	Billing End Dates*	Energy Type*	Energy Unit*	Energy Consumption*	Cost
1	1/1/2016	1/31/2016	Electricity - Grid Purchased	kWh	124760	12456
1	2/1/2016	2/29/2016	Electricity - Grid Purchased	kWh	149320	14985
1	3/1/2016	3/31/2016	Electricity - Grid Purchased	kWh	127920	13021

Visit the appendix of this presentation for a snapshot of the data input fields for the BETTER Template.

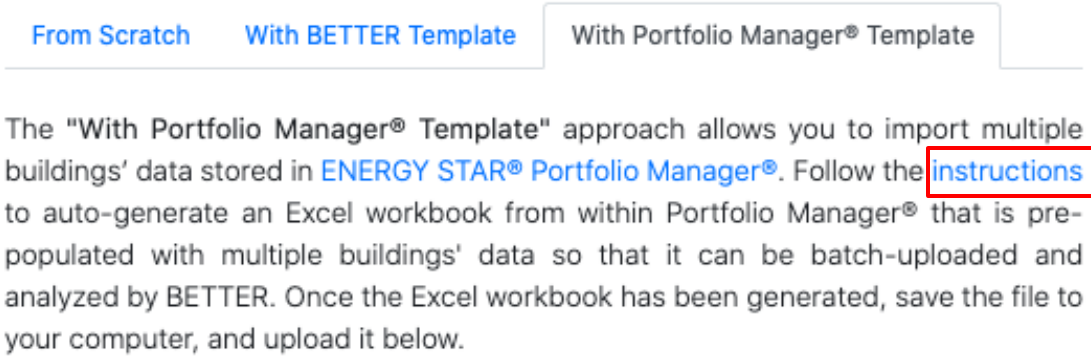


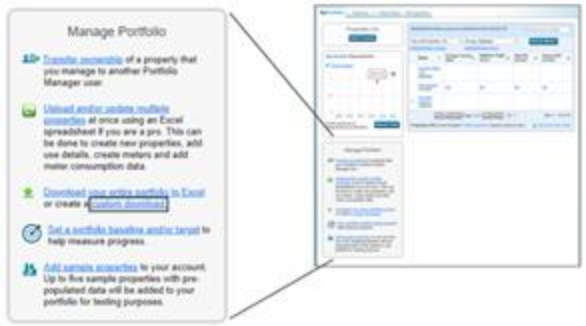
Once all required information has been entered in the BETTER Template, save it, then use the **Browse** and **Upload** buttons to select and upload the Excel file to BETTER.

IIA. Access the Web App Home to Create New Portfolio

5b. Option b: Upload Data with the Portfolio Manager® Template

On the **Create a New Portfolio** page, click the **With Portfolio Manager® Template** tab and then the **instructions** link to access step-by-step guidance on how to auto-generate a customized Excel workbook from within ENERGY STAR® Portfolio Manager® that is pre-populated with multiple buildings' data so it can be to batch-upload to BETTER.





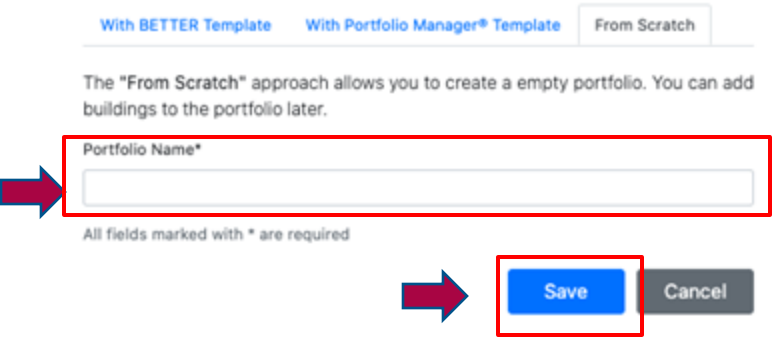
Once the Excel workbook has been generated, save it to your computer, then use the **Browse** and **Upload** buttons to select and upload the file to BETTER.

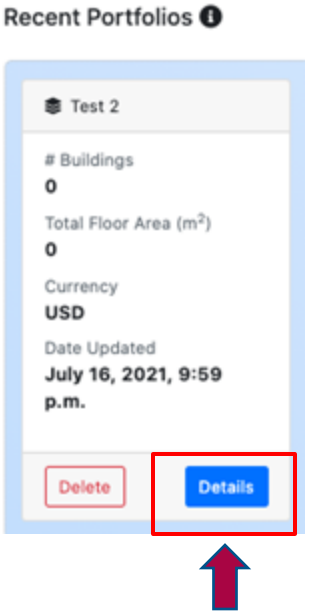
Visit the appendix of this presentation for a snapshot of the data input fields for the ENERGY STAR® Portfolio Manager® Template.

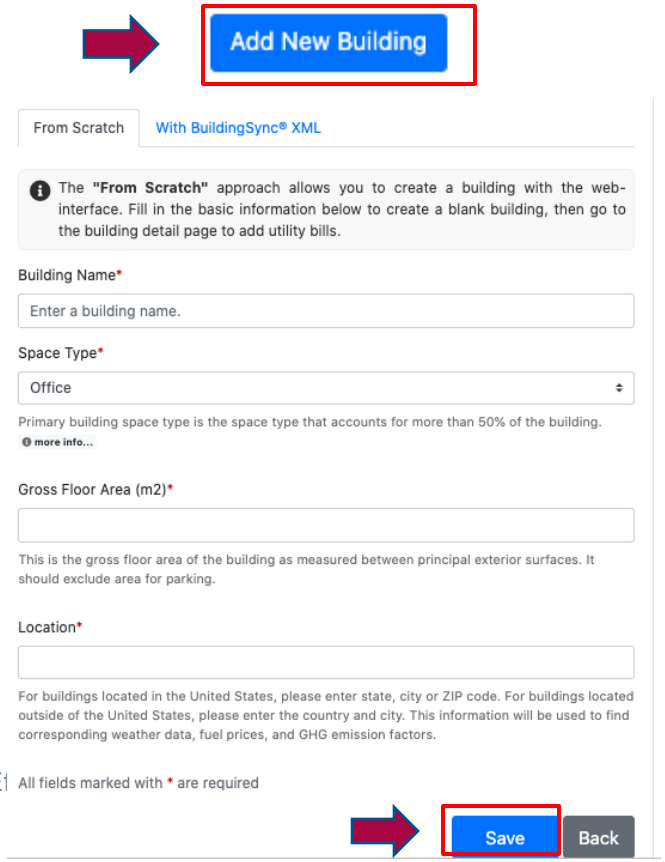
IIA. Access the Web App Home to Create New Portfolio

5c. Option c: Upload Data with the From Scratch

On the **Create a New Portfolio** page, click the **From Scratch** tab and then enter the **Portfolio Name** and click **Save**. You will be directed to the **Dashboard** page. There, click on **Details** for the portfolio you just created to arrive at the **Portfolio Information** page. Then, click **Create a New Building** to build a portfolio step-by-step by adding individual buildings **From Scratch** or **With BuildingSync® XML** files. See slides 44-55 for instructions for how to Create a New Building.



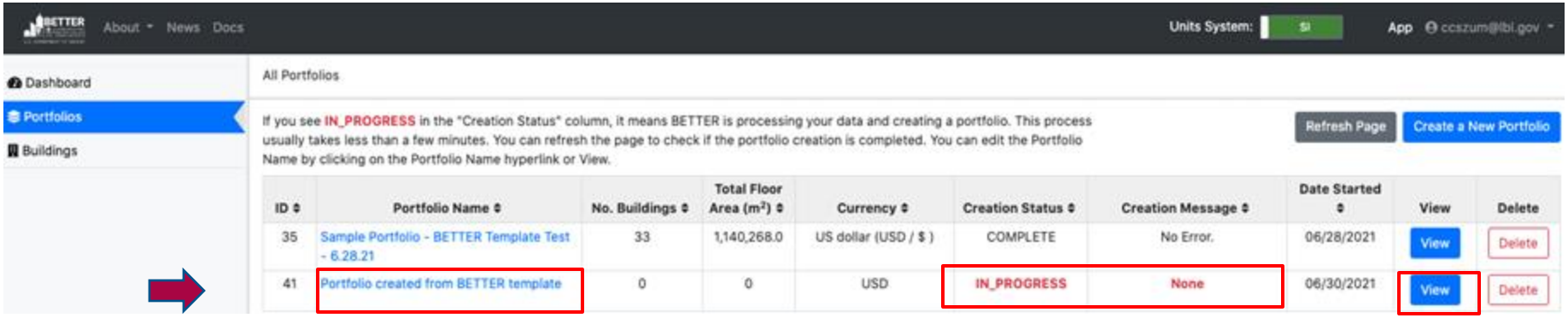




IIA. Run BETTER Using the Web App

6. Visit the Portfolio Staging page

After uploading portfolio data to BETTER, users will automatically be directed to the **Portfolio Staging** page. On this page, you will see a table listing any prior portfolios you created along with the portfolio you just uploaded.



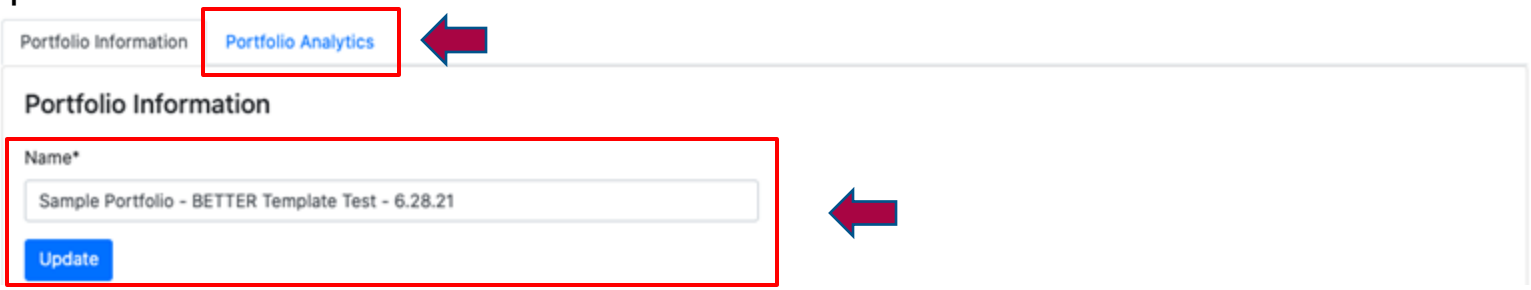
For the portfolio you just uploaded, the Creation Status will most likely say IN_PROGRESS and the Creation Message will say None. Wait a minute or two and then click **Refresh Page**.* After that, the Creation Status should switch to COMPLETE and Creation Message to No Error, which means all building and energy data for the portfolio is uploaded. Click **View** or the **Portfolio Name** to go to the **Portfolio Information** page to view all buildings in the portfolio and customize the portfolio name.

* NOTE: Depending on the size of the portfolio, you may need to click **Refresh Page** a few times until the **Creation Status** switches to COMPLETE and **Creation Message** to No Error.

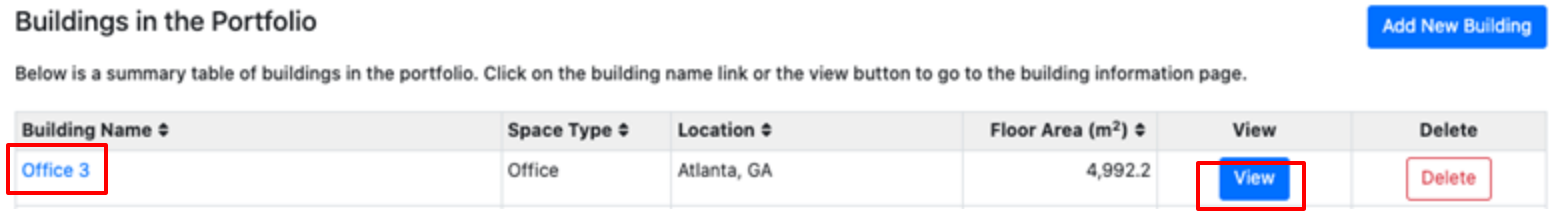
IIA. Run BETTER Using the Web App

7. Visit the Portfolio Information page

After creating a new portfolio and clicking **View** or the **Portfolio Name**, users will automatically be directed to the **Portfolio Information** page. Start by going to the **Name*** field and customizing the name of the portfolio you just created. Then click **Update**. Next, click on the **Portfolio Analytics** tab to get started creating analytical reports.



Prior to creating analytical reports, you can also review the summary table of buildings in the portfolio. Clicking on ⇕ will allow you to sort the buildings in the table (alphabetically or numerically) by characteristic (i.e., building name, space type, location, and floor area). Clicking **Building Name** or **View** will allow you to view and edit building characteristics and utility bill details for each building. **Add New Building** will allow you to add new buildings to the portfolio.



IIA. Run BETTER Using the Web App

8. Visit the Portfolio Analytics page and Create Portfolio Summary Report

On the **Portfolio Analytics** page, users can click **Add New Analytics** to create a unique analytical report for the portfolio.

Any reports created for the portfolio are also stored in a table on this page. Clicking on ⇕ will allow you to sort the reports in the table (alphabetically or numerically) by characteristic (energy savings potential, cost savings potential, etc.). Clicking on **Details** will direct you to the analytical report for review and download.

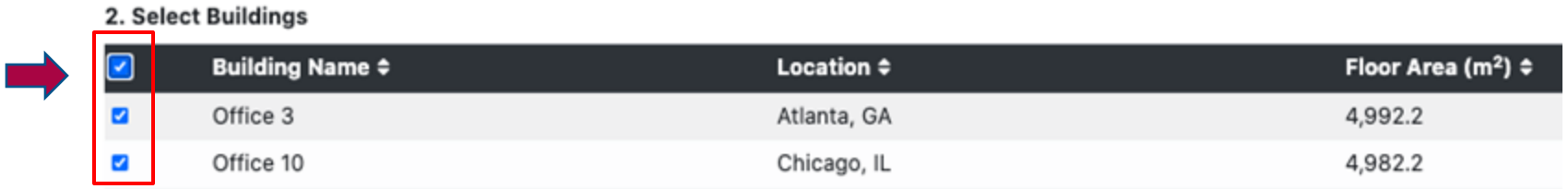
IIA. Run BETTER Using the Web App

9. Select Building Space Type and Buildings in the Portfolio for Analysis

After clicking on **Add New Analytics** on the **Portfolio Analytics** page, users will be directed to a page to select the parameters for the analytical report.

Step 1: Select the building space type for analysis. *NOTE: at this time, users cannot select the "All" option and must select one space type only per analytical run (e.g., office).

Step 2: After selecting the space type, select the specific buildings for analysis. Use the checkboxes to select any number of buildings to analyze, from a single building to the full list. Clicking the checkbox in the header row will select all buildings in the list.



IIA. Run BETTER Using the Web App

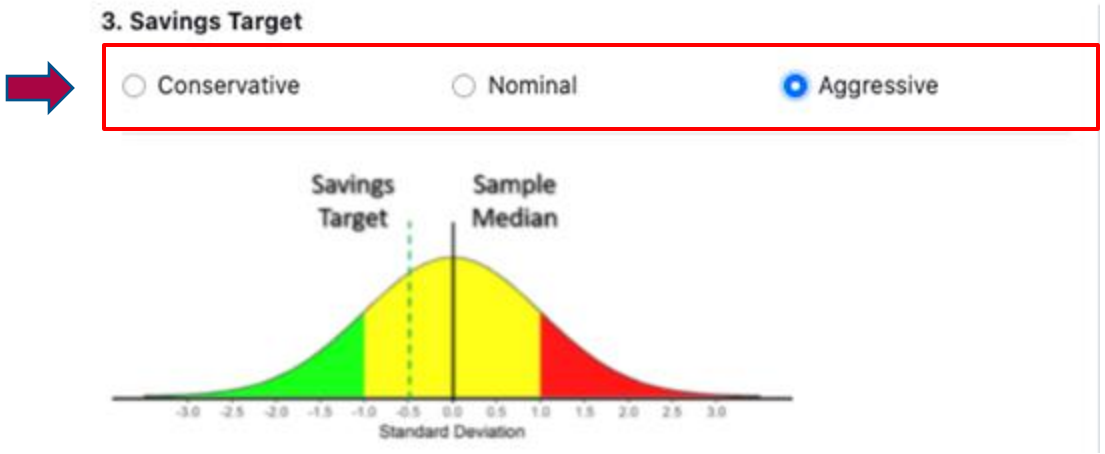
10. Select the Savings Target for the Portfolio

Step 3: Select the savings target for the portfolio from the options shown.

Conservative: The savings goal will be one standard deviation worse than the median performance of the benchmarking peer group.

Nominal: The savings goal will be equal to the median savings of the benchmarking peer group.

Aggressive: The savings goal will be one half standard deviation better than the median performance of the benchmarking peer group.



IIA. Run BETTER Using the Web App

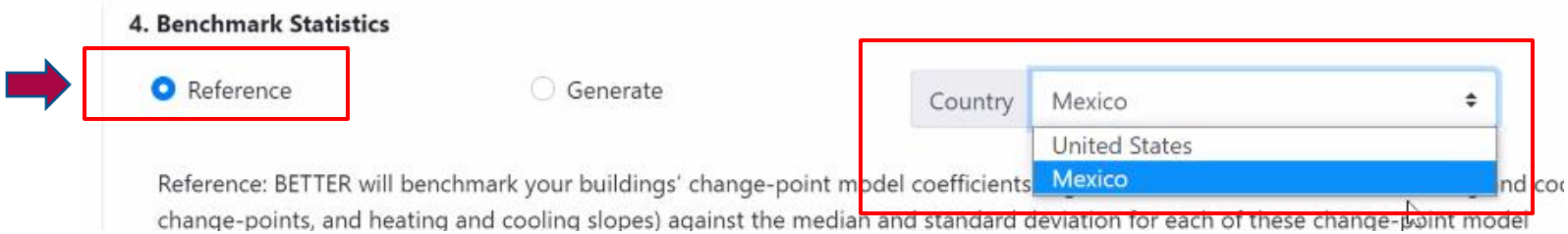
Default benchmark statistics are only available for US offices, multifamily buildings, public libraries, hospitals, worship facilities, and K-12 schools; Tunisia hotels; and Mexico offices at this time. We are working on adding statistics for new space types.

11. Select the Benchmark Statistics for the Portfolio

Step 4: Select Benchmark Statistics from the options shown.

Reference:* BETTER will automatically benchmark buildings in the portfolio against reference benchmark statistics developed by Lawrence Berkeley National Laboratory (LBNL) that match the property type(s) selected in Step 1. The reference benchmark statistics for each space type are derived from a sample of buildings and include the median and standard deviation for the electricity and fossil fuel inverse model coefficients for the sample (i.e., heating and cooling baseload, heating and cooling change-points, and heating and cooling sensitive consumption). For information on the regression model coefficient definitions, visit: https://better.lbl.gov/how_it_works/. For information on how the reference statistics were developed visit the FAQ page Analysis Settings topic.

Generate: BETTER will generate benchmark statistics based only on the buildings selected for analysis in Step 2, so your buildings will be compared against others in your own portfolio. This option will provide more accurate statistics if you selected at least 30 buildings for analysis in Step 2. Note: Generating benchmark statistics may take several minutes.



*At this time, the "reference" benchmark statistics for U.S. offices, multifamily buildings, public libraries, hospitals, and K-12 schools are not perfectly representative of the U.S. national stock because the statistics were *not* developed from the U.S. Energy Administration (EIA) Commercial Building Energy Consumption Survey (CBECS) dataset (which is representative of the U.S. national stock) but rather from *datasets developed based on voluntary contributions from U.S. industry* that are not fully representative of the U.S. national stock in terms of characteristics such as size and climate zone distribution. We are working to expand these training datasets, and hence improve associated "reference" benchmark statistics, so they are more representative of the U.S. national stock. This includes expanding the training data sets to include: *at least 30 data points for each of the 10 BETTER model coefficients for each of the eight CBECS size categories in each of the eight International Energy Conservation Code (IECC) climate zones in the United States (and possibly for each of the relevant subtypes A, B, and C in these zones). Learn more at FAQ. To contribute anonymous data to this effort, please email support@better.lbl.gov.*

IIA. Run BETTER Using the Web App

R^2 is the proportion of the variance in the dependent variable (energy use) that is predictable from the independent variable (outdoor air temperature).

12. Select the Minimum R^2 Threshold for the Portfolio

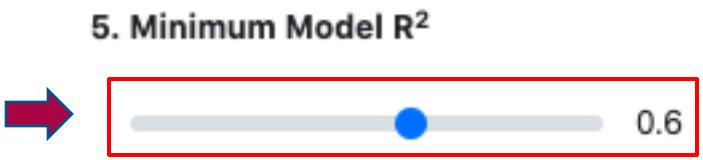
Step 5: Select the Minimum R^2 Threshold. Then click **Create and Run**.

R-squared (R2) is a statistical measure that represents the proportion of the variance for a dependent variable that's explained by an independent variable, or variables, in a regression model. In the case of BETTER, R2 indicates to what extent variations in outdoor air temperature explain variations in building energy use intensity. An R2 of 1 means that all movement in energy use intensity is completely explained by movements in outdoor air temperature. In general, we recommend users select an R2 of 0.6 or higher for a portfolio or building. If the R2 of a model is 0.6, then approximately 60% of the observed variation in energy use intensity can be explained by variation in outdoor air temperature.

When analyzing a portfolio, selecting a higher R^2 level may mean that fewer regression models are fit. As a result, BETTER may estimate lower energy/cost savings and recommend fewer energy efficiency improvements for the portfolio, but these savings/improvement recommendations will be very reliable.

When a lower R^2 is selected, BETTER may estimate higher energy/cost savings and recommend more energy efficiency improvements for a portfolio, but these savings/improvement recommendations may be less reliable than if a higher R^2 is selected.

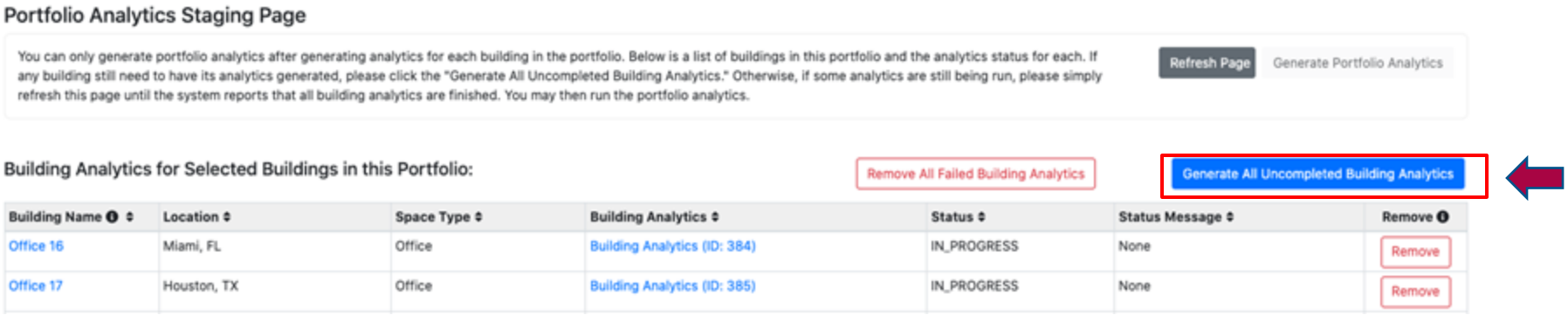
In general, we recommend users select an R^2 of 0.6 or higher for a portfolio.



IIA. Run BETTER Using the Web App

13. Visit the Portfolio Analytics Staging page

After setting the analyses parameters for the portfolios, users will automatically be directed to the **Portfolio Analytics Staging** page.



On this page, you will see a list of buildings in the portfolio and the analytics status for each. If any building still needs to have its analytics generated, click the **Generate All Uncompleted Building Analytics**. Continue to periodically click **Generate All Uncompleted Building Analytics** and **Refresh** until the system reports that all building analytics are finished. You will see Status COMPLETE and Status Message No Errors: Duration for each building when this process is complete. If BETTER cannot generate analytics for a given building, click **Remove All Failed Building Analytics**. Clicking this will not remove the building from the portfolio, just the analysis report. Once all building analytics are completed, click **Generate Portfolio Analytics** to view the **Portfolio Summary Report**.

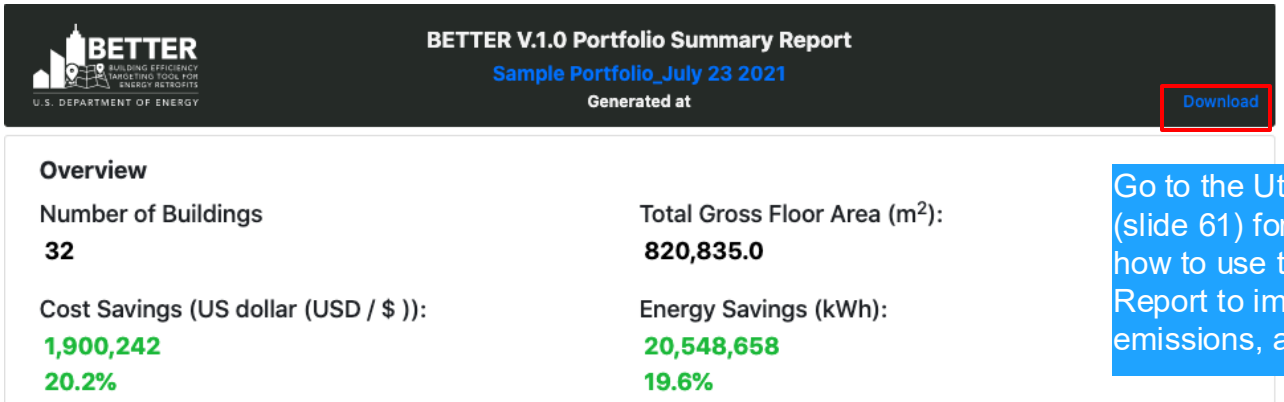
IIA. Run BETTER Using the Web App

14. View and Download the Portfolio Summary Report

After clicking **Generate Portfolio Analytics**, BETTER will direct you to an interactive **Portfolio Summary Report**. Scroll through the report to view interactive charts and graphs that provide the following information on the portfolio:

- Annual energy, cost, and GHG emissions reduction potential.
- Top 5 energy efficiency recommendations and guidance for implementation.
- Electricity and fossil energy use intensity (EUI) and cost savings comparisons by building.
- Tables and graphs to sort, rank, and prioritize buildings for upgrades.

Click the **Download** button on the upper right hand corner of the report to download an HTML version of the report which can be stored on your computer or emailed to stakeholders. Opening the HTML report in a web browser from an email or a computer by double-clicking renders it most effectively.



Go to the Utilize Results section (slide 61) for more information on how to use the Portfolio Summary Report to improve portfolio energy, emissions, and financial performance.

Users can also scroll down to the **Building Analytics List** and click on the names of individual buildings to view **Building Summary Reports** which provide a building's annual energy, cost, and GHG emissions reduction potential, energy efficiency recommendations and implementation guidance, annual utility cost and savings breakdowns by load type, etc. This **Buildings Summary Report** can also be downloaded as an HTML file for storage and sharing.

Building Name	Building Location	Building Area (m^2)	Annual Electricity Consumption (kWh)	Annual Fossil Fuel Consumption (kWh)	Annual Electricity Cost (US dollar (USD / $))	Annual Fossil Fuel Cost (US dollar (USD / $))	Annual Electricity EUI (kWh/m^2)	Annual Fossil Fuel EUI (kWh/m^2)	Annual Cost Savings Potential (US dollar (USD / $))	Annual Energy Savings (%)
Office 26	Chicago, IL	46,320.0	5,494,875	937,856	474,207.7	24,000.9	118.6	20.2	48,161	9.3 %

Create a New Building

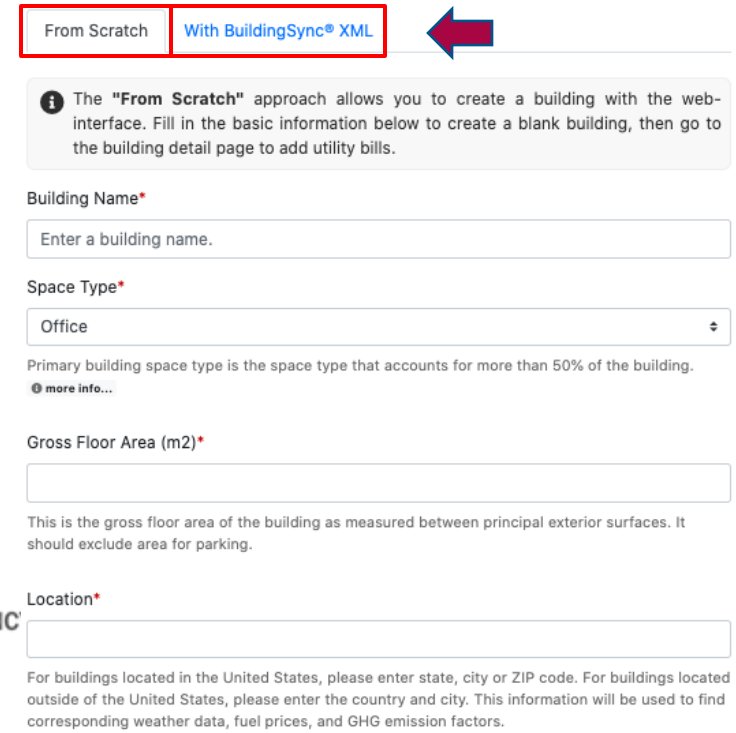
IIA. Run BETTER Using the Web App

15. Create a New Building on the Dashboard page

For users with individual buildings they want to analyze with BETTER, clicking **Create New Building** on the **Dashboard** page will direct you to the **Add a New Building** page. There, users have two options to create a new portfolio:

a. **Option a:** The **From Scratch** approach allows users to create a building on the web-interface.

b. **Option b:** The **With BuildingSync® XML** approach allows you to use a BuildingSync® XML file to create a building in BETTER. Visit https://buildingsync.net/ to learn more about BuildingSync®.

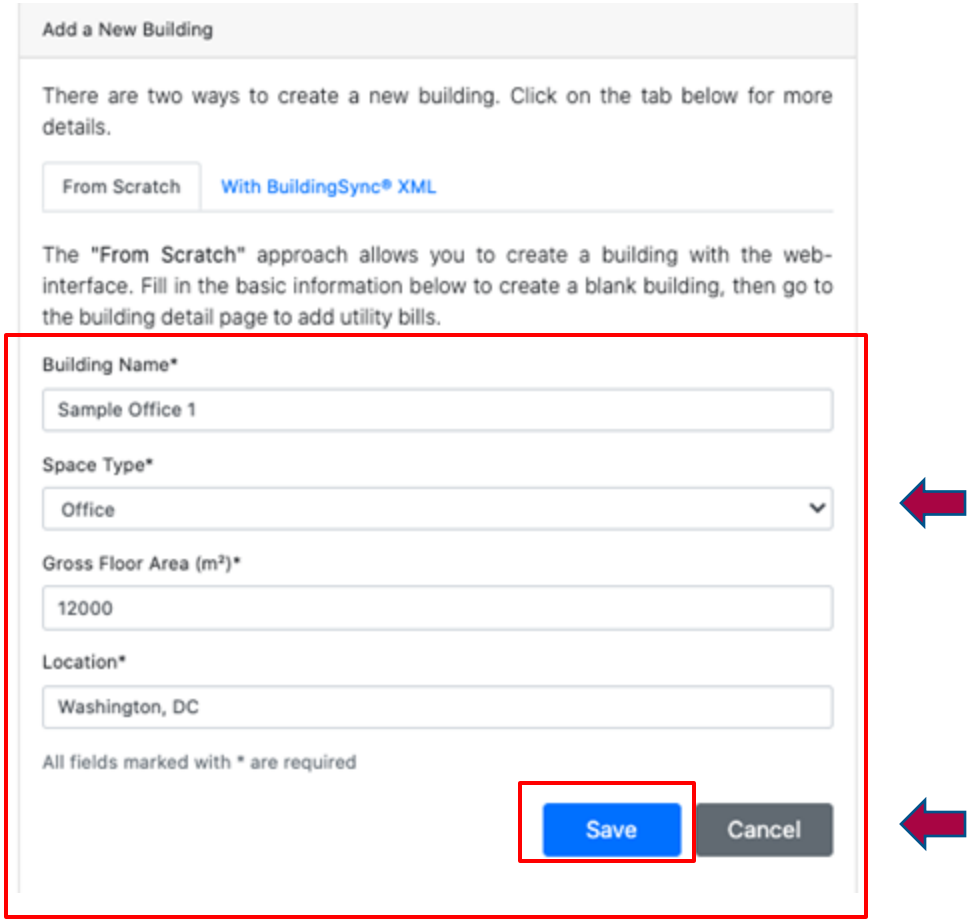


IIA. Access the Web App Home to Create New Portfolio

15a. Option a: Create a New Building from Scratch

On the **Create a New Building** page, click the **From Scratch** tab and then fill in the fields on the web interface as follows:

- **Building Name:** Enter any building name.
- **Space Type:** Select the primary building space type from the drop-down menu. This is the space type that accounts for more than 50% of the building. For example, if the building has offices that account for 60% of the gross floor area (excluding parking) and retail stores that account for 40%, then the primary space type should be “office." If no space type accounts for more than 50%, then the building is mixed use. To evaluate mixed use spaces, determine the size and monthly energy consumption for each space in the building and analyze each of these spaces separately in BETTER.
- **Gross Floor Area:** This is the gross floor area of the building as measured between principal exterior surfaces. It should exclude area for parking. *NOTE: Currently, gross floor area needs be entered in m^2 regardless of the unit system selected on the upper right navigation bar.
- **Location:** For buildings located in the United States, please enter city, state (e.g., Cambridge, MA) or ZIP code. For buildings located outside of the United States, please enter the country and city (e.g., Mexico City, Mexico).

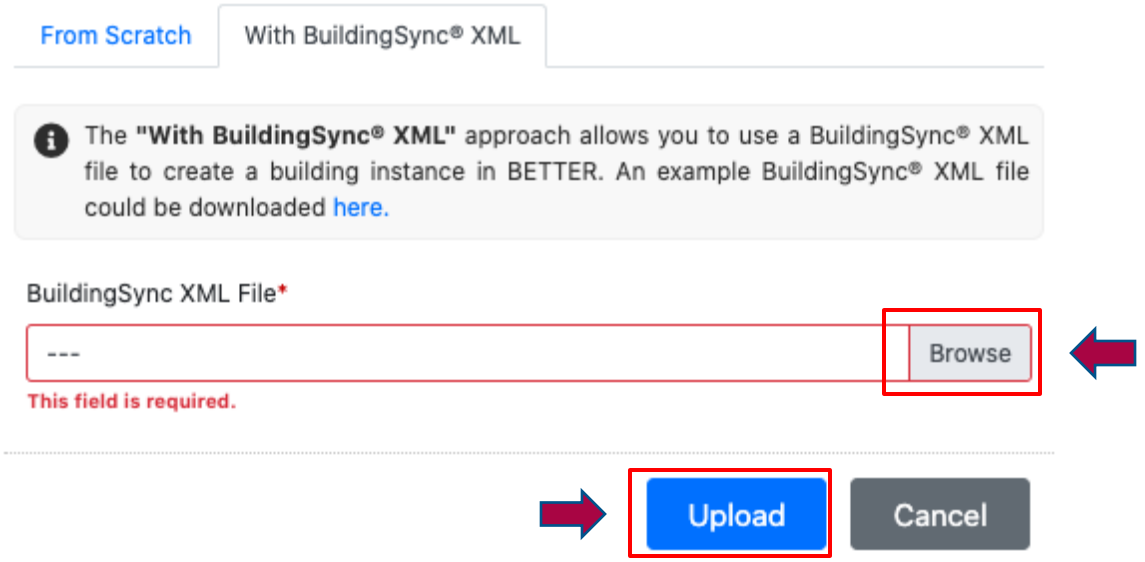


Then click **Save**.

IIA. Access the Web App Home to Create New Portfolio

15b. Option b: Create a New Building With BuildingSync® XML

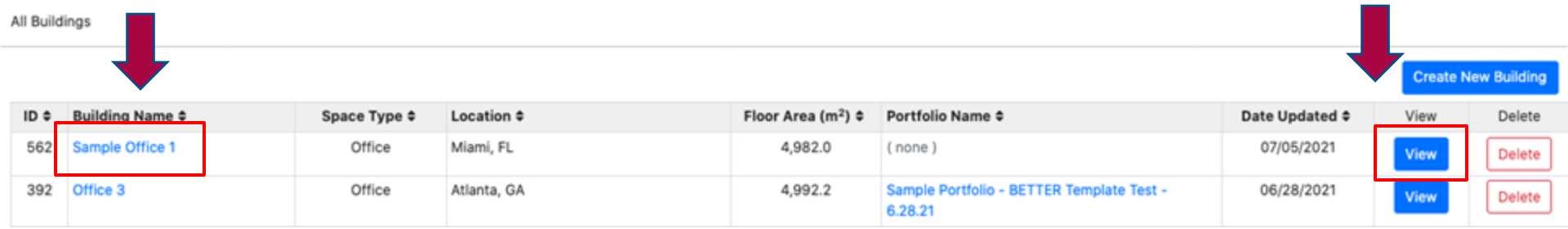
On the **Create a New Building** page, click the **With BuildingSync® XML** tab and then then choose the BuildingSync® XML file you want to upload from your computer and click **Upload**.



IIA. Run BETTER Using the Web App

16. Visit the All Buildings page

After creating a new building **From Scratch** or **With Building Sync® XML**, users will automatically be directed to the **All Buildings** page. On this page, you will see a table listing any prior buildings you created along with the building you just created. Clicking on ▲▼ will allow you to sort the buildings in the table (alphabetically or numerically) by characteristic (i.e., ID, building name, space type, location, floor area, portfolio name, and date updated). If a new building was created independent of a portfolio **From Scratch** or **With BuildingSync® XML** it will not have a Portfolio Name assigned.* Click the **Building Name** or **View** to add utility bill information to the building.



* NOTE: You cannot assign a building to an existing portfolio after creating it independently of a portfolio. The only way to add a new building to an existing portfolio is to first click on the **Portfolio Name** hyperlink, or **View** associated with the portfolio, to arrive at the **Portfolio Information** tab. Then, click on **Add New Building** to see options to add a new building to the existing portfolio.

IIA. Run BETTER Using the Web App

17. Visit the Building Information page

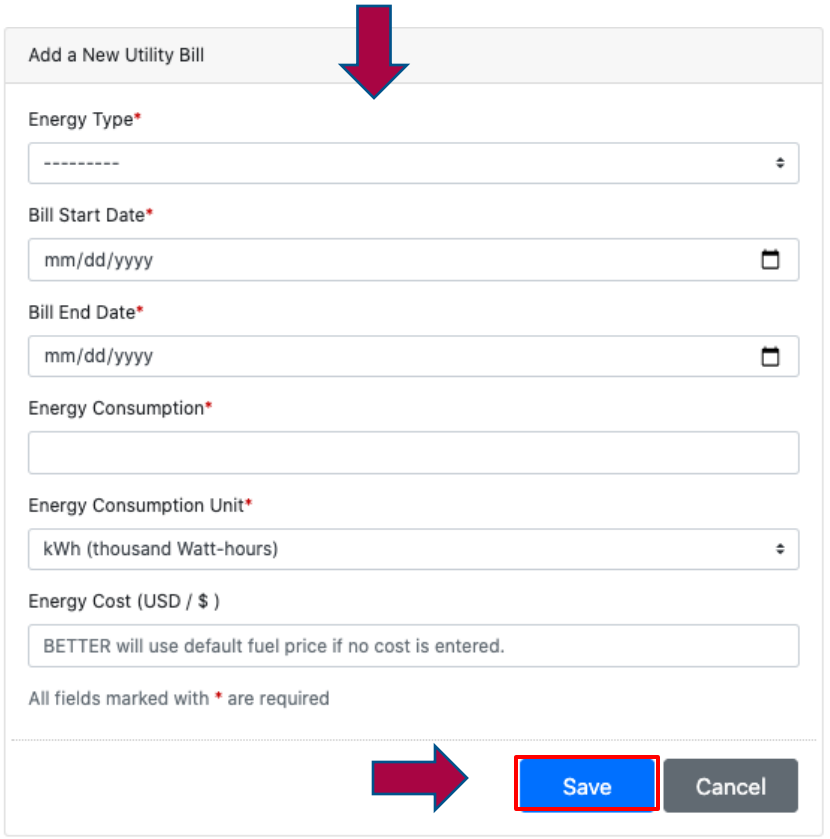
After clicking **View** or the **Building Name** on the **All Buildings** page for the building you just created, you will arrive at the **Building Information** page. Here you will see the information you just entered on the building. To make changes to this information, click **Edit Building** and replace the information in the fields and click **Save Building Info**. To add 12 consecutive months of utility bill information needed for analysis using BETTER, click **Add a Utility Bill**.

IIA. Run BETTER Using the Web App

18. Visit Add a New Utility Bill page and Add a Utility Bill

After clicking **Add a Utility Bill**, users will be directed to the **Add a New Utility Bill** page. Enter the required data as follows and then click **Save**. Repeat this process until at least 12 consecutive months of data for each fuel used in the building are entered.

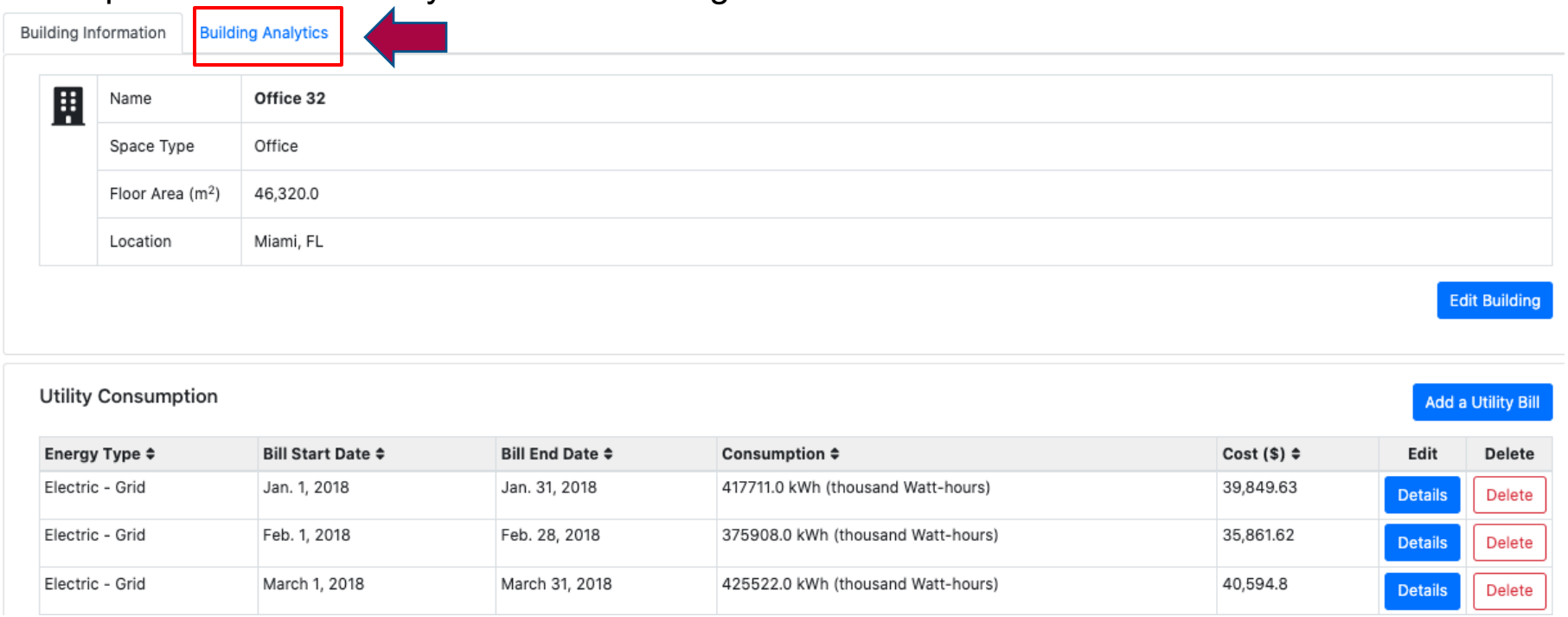
- **Energy Type:** Select the fuel type for which you are entering utility bill information (i.e., consumption and cost) from the drop-down menu.
- **Bill Start Date:** This is the start date for the utility bill for the fuel type selected. Enter in the format mm/dd/yyyy.
- **Bill End Data:** This is the end date for the utility bill for the fuel type selected. Enter in the format mm/dd/yyyy.
- **Energy Consumption:** This is the numerical consumption value for the date range and energy type you've entered.
- **Energy Consumption Unit:** Select the energy unit associated with the energy consumption from the drop-down menu. The units shown will correspond to the unit system selected in the upper right navigation bar. Check your utility bill carefully to make sure you are entering the correct unit.
- **Energy Cost (USD / $):** This is the numerical cost value in U.S. dollars (USD) for the date range and energy type you've entered**.** *NOTE: At this time, energy cost must be entered in USD. In the future, users can select to input and display cost savings in alternative currencies.



IIA. Run BETTER Using the Web App

19. Visit the Building Analytics page and Add a Building Analytics Report

After 12 consecutive months of data for each fuel used in the building has been entered into BETTER (see example below) click on the **Building Analytics** tab to select the parameters for analysis of the building.



IIA. Run BETTER Using the Web App

20. Add Building Analytics

On the **Building Analytics** tab, you will see a table listing information on any prior analytical reports run for the building. Clicking on ⇳ will allow you to sort the buildings in the table (alphabetically or numerically) by characteristic (i.e., ID, savings target, benchmark statistics, model R^2 threshold, energy savings potential, cost savings potential, GHG emissions reduction potential, and status (i.e., whether the analysis report is completed or not)). Click **Add New Analytics** to run an analytical report on the building.

IIA. Run BETTER Using the Web App

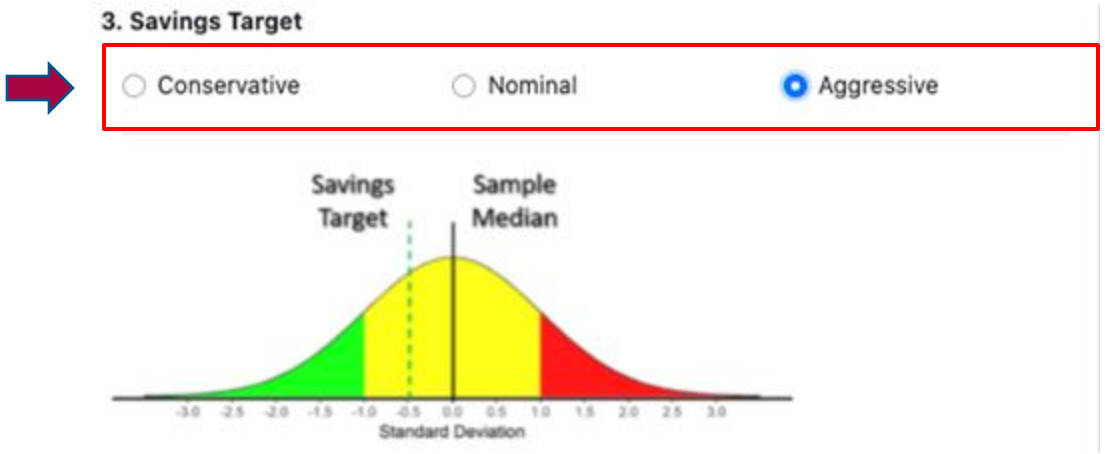
21. Select the Savings Target for the Building

Step 1: Select the savings target for the building from the options shown.

Conservative: The savings goal will be one standard deviation worse than the median performance of the benchmarking peer group.

Nominal: The savings goal will be equal to the median savings of the benchmarking peer group.

Aggressive: The savings goal will be one half standard deviation better than the median performance of the benchmarking peer group



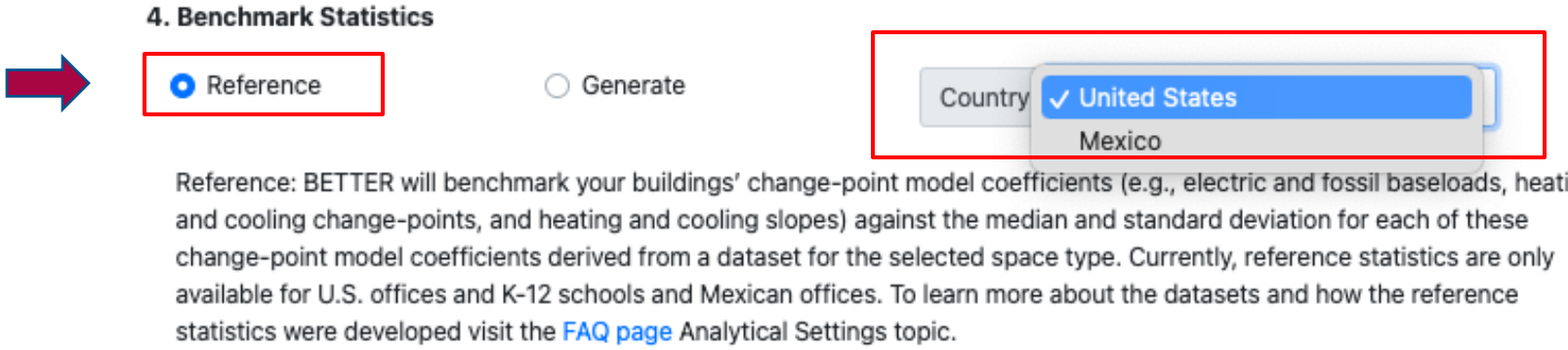
IIA. Run BETTER Using the Web App

Reference benchmark statistics are only available for U.S. offices, multifamily buildings, public libraries, hospitals, worship facilities, and K-12 schools; Tunisia hotels; and Mexico offices at this time. We are working on adding statistics for new space types.

22. Select Reference Benchmark Statistics for the Building

Step 2: Select Benchmark Statistics.

Reference:* BETTER will automatically benchmark a building against reference benchmark statistics developed by Lawrence Berkeley National Laboratory (LBNL) that match the property type(s) selected. The reference benchmark statistics for each space type are derived from a sample of buildings and include the median and standard deviation for the electricity and fossil fuel inverse model coefficients for the sample (i.e., heating and cooling baseload, heating and cooling change-points, and heating and cooling sensitive consumption). For information on the regression model coefficient definitions, visit: https://better.lbl.gov/how_it_works/. For information on how the reference statistics were developed visit the FAQ page Analysis Settings topic.



* Note: At this time, the "reference" benchmark statistics for U.S. offices, multifamily buildings, public libraries, hospitals, worship facilities, and K-12 schools are not perfectly representative of the U.S. national stock because the statistics were *not* developed from the U.S. Energy Administration (EIA) Commercial Building Energy Consumption Survey (CBECS) dataset (which is representative of the U.S. national stock) but rather from *training datasets developed based on voluntary contributions from U.S. industry* that are not fully representative of the U.S. national stock in terms of characteristics such as size and climate zone distribution. We are working to expand these training datasets, and hence improve associated "reference" benchmark statistics, so they are more representative of the U.S. national stock. This includes expanding the training data sets to include: *at least 30 data points for each of the 10 BETTER model coefficients for each of the eight CBECS size categories in each of the eight International Energy Conservation Code (IECC) climate zones in the United States (and possibly for each of the relevant subtypes A, B, and C in these zones). To contribute anonymous data to this effort, please email support@better.lbl.gov*

IIA. Run BETTER Using the Web App

R^2 is the proportion of the variance in the dependent variable (energy use) that is predictable from the independent variable (outdoor air temperature).

12. Select the Minimum R^2 Threshold for the Building

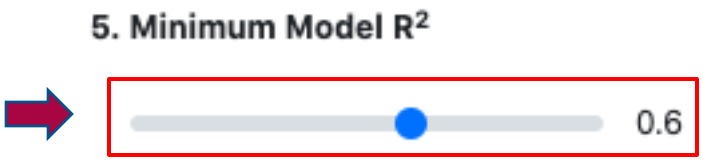
Step 5: Select the Minimum R^2 Threshold. Then click **Create and Run**.

R-squared (R2) is a statistical measure that represents the proportion of the variance for a dependent variable that's explained by an independent variable, or variables, in a regression model. In the case of BETTER, R2 indicates to what extent variations in outdoor air temperature explain variations in building energy use intensity. An R2 of 1 means that all movement in energy use intensity is completely explained by movements in outdoor air temperature. In general, we recommend users select an R2 of 0.6 or higher for a portfolio or building. If the R2 of a model is 0.6, then approximately 60% of the observed variation in energy use intensity can be explained by variation in outdoor air temperature.

When analyzing a portfolio, selecting a higher R^2 level may mean that fewer regression models are fit. As a result, BETTER may estimate lower energy/cost savings and recommend fewer energy efficiency improvements for the portfolio, but these savings/improvement recommendations will be very reliable.

When a lower R^2 is selected, BETTER may estimate higher energy/cost savings and recommend more energy efficiency improvements for a portfolio, but these savings/improvement recommendations may be less reliable than if a higher R^2 is selected.

In general, we recommend users select an R^2 of 0.6 or higher for a portfolio.



IIA. Run BETTER Using the Web App

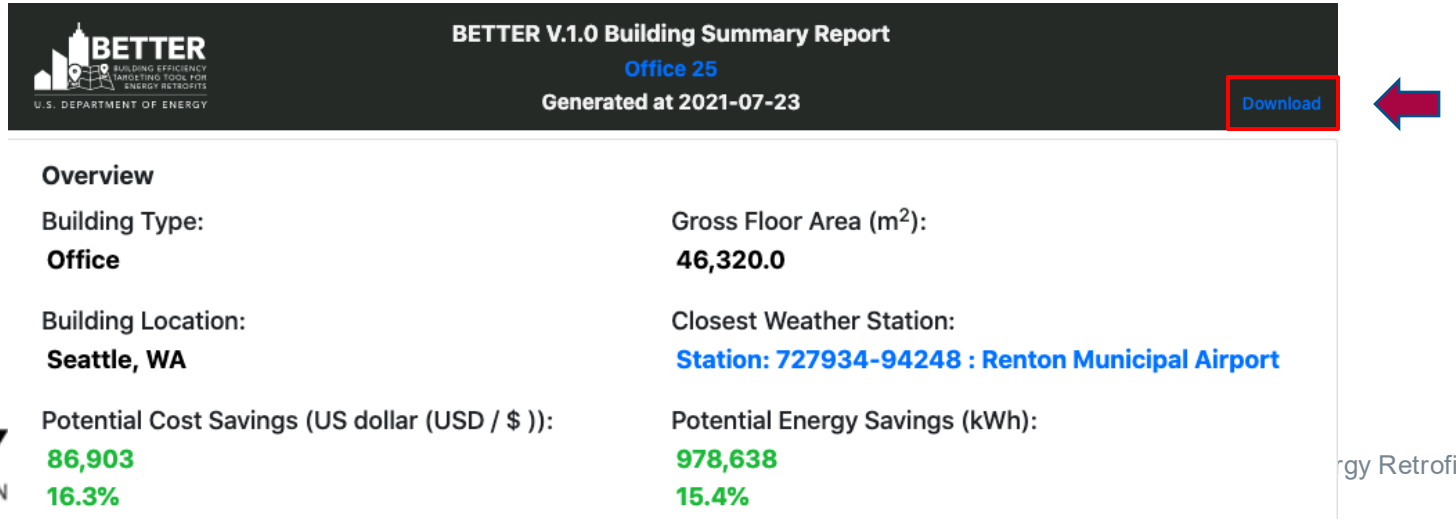
Go to the Utilize Results section (slide 61) for more information on how to use the Building Summary Report to improve building energy, emissions, and financial performance.

24. View and Download the Building Summary Report

After clicking **Create and Run**, BETTER will direct you to an interactive **Building Summary Report**. Scroll through the report to view interactive charts and graphs that provide the following information on the building:

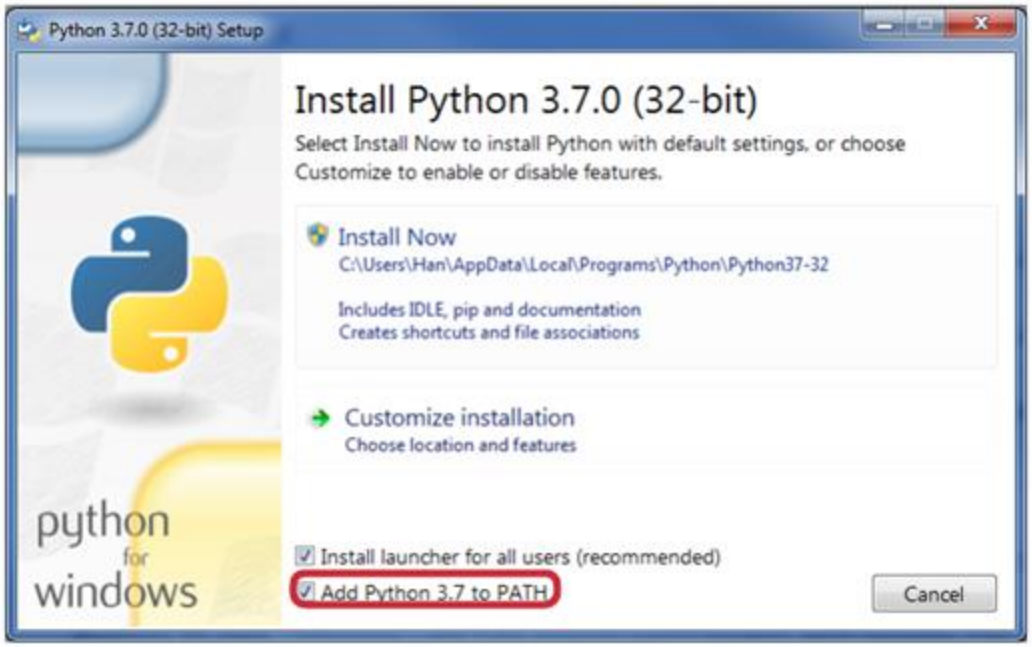
- Annual energy, cost, and emissions reduction potential.
- Energy efficiency recommendations and implementation guidance.
- Annual utility cost and savings breakdowns by load type.
- Monthly electric and fossil energy use trends.
- Electricity and fossil fuel change-point models and benchmarks.

Click the **Download** button on the upper right hand corner of the report to download an HTML version of the report which can be stored on your computer or emailed to stakeholders. Opening the HTML report in a web browser from an email or a computer by double-clicking renders it most effectively.



IIB. Run BETTER Using the Python Code

- **Download and install Python 3.6.0 or later**



During Python installation, select the "Add Python 3.x to Path" option, keep other default settings

IIB. Run BETTER Using the Python Code

2. Check that Python is installed correctly

a) Windows: open command prompt, type “where python” and hit enter. Check if the message indicates Python 3.6.0 or later has been downloaded (e.g. Python 36 stands for Version 3.6 in the screenshot)

b) MacOS: open terminal, type “which python” and hit enter

If the command doesn’t show the desired message, you need to add Python to the path (environment variables). Refer to this link for Windows, and this link for MacOS.

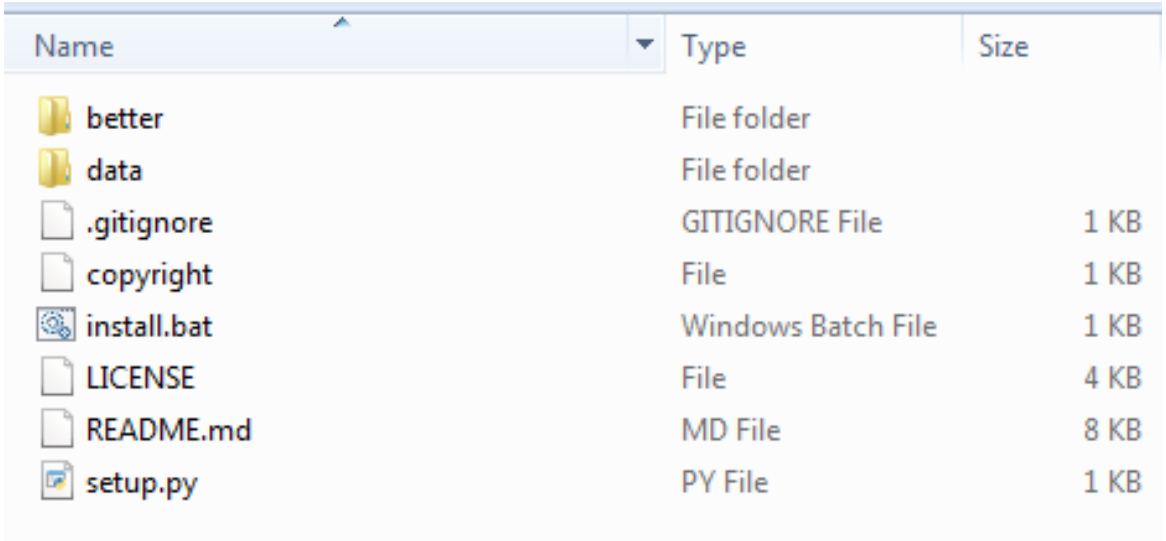
IIB. Run BETTER Using the Python Code

3. Download the source code

a) Download the Source Code zip file from the Github directory (latest release)

b) The tool directory should contain the files and folders shown below

4. Install dependencies: double-click on "setup.py". The script will automatically install dependencies if steps 1-3 were successful.



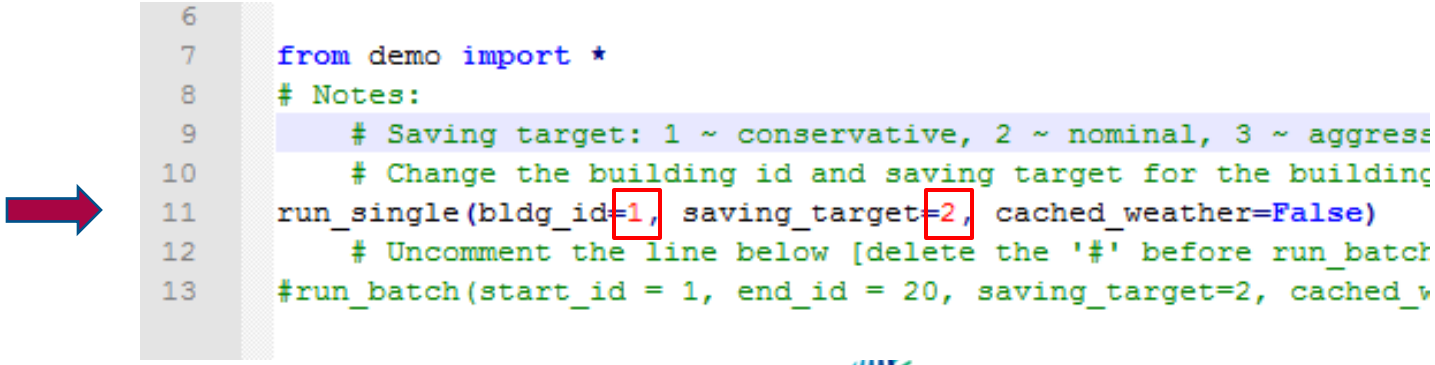
IIB. Run BETTER Using the Python Code

5. Run the tool

Note that detailed instructions will be kept up to date in the ReadMe file posted on Github.

a. Input data:
   i. Open the portfolio.xlsx file in the `./data` folder
   ii. Input data accordingly.
   iii. Save the file.

b. Run the tool:
   i. Open `./better/run.py` file using a text editor.
   ii. For a single building analysis:
      i. Uncomment line 11 (`run_single(...)`) and comment line 13 (`run_batch(…)`). Make the below edits in line 11.
      ii. Set the target building ID based on the ID in portfolio.xlsx (e.g., `bldg_id=1`).



```
6
7   from demo import *
8   # Notes:
9       # Saving target: 1 ~ conservative, 2 ~ nominal, 3 ~ aggress
10      # Change the building id and saving target for the buildinc
11  run_single(bldg_id=1, saving_target=2, cached_weather=False)
12      # Uncomment the line below [delete the '#' before run_batch
13  #run_batch(start_id = 1, end_id = 20, saving_target=2, cached_w
```

IIB. Run BETTER Using the Python Code

5. Run the tool (continued)

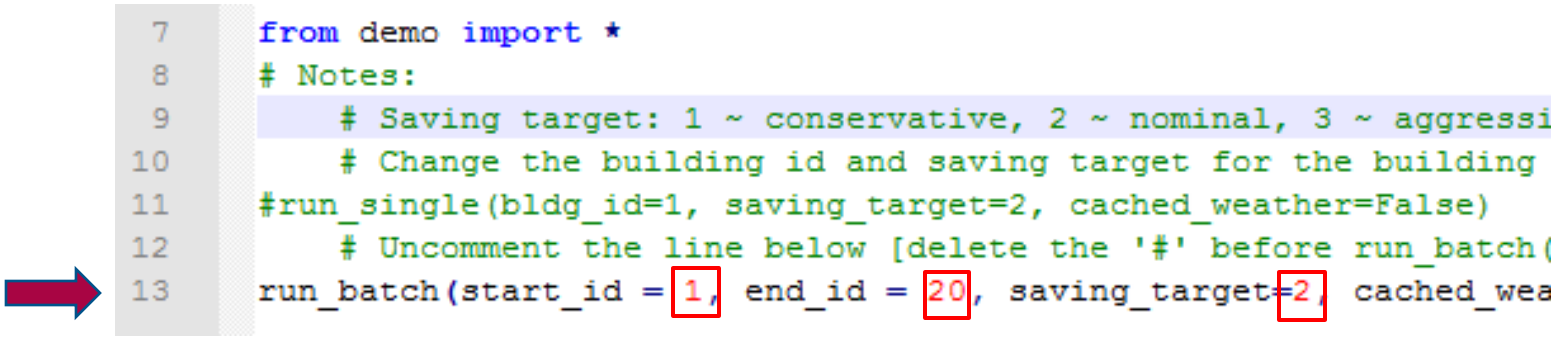
Note that detailed instructions will be kept up to date in the ReadMe file posted on Github.

iii. For a whole-portfolio analysis:
   i. Uncomment line 13 (`run_batch(...)`) and comment line 11 (`run_single(...)`). Make the below edits in line 13.
   ii. Set the start and end building IDs based on the IDs in portfolio.xlsx (e.g., `start_id=1, end_id=20`).

iv. Set the saving target level (1 = conservative, 2 = nominal, 3 = aggressive – e.g., `saving_target=2`).

v. Run the analysis by running `python run.py` from your cmd or terminal.

vi. Retrieve output reports from the `./outputs` folder.



Utilize Results

III. Utilize Results

With minimal data inputs, BETTER delivers actionable insights to improve energy, emissions, and financial performance in buildings and portfolios without requiring site visits and complex modeling.

BETTER's self-contained HTML analytical reports include the following information:

At the Portfolio Level:

1. Annual energy, cost, and emissions reduction potential.
2. Top 5 energy efficiency recommendations.
3. Electricity and fossil energy use intensity (EUI) and cost savings comparisons by building.
4. Ability to sort, rank, and prioritize buildings for upgrades.

At the Building Level:

5. Annual energy, cost, and emissions reduction potential.
6. Energy efficiency recommendations and implementation guidance.
7. Annual utility cost and savings breakdowns by load type.
8. Monthly electric and fossil energy use trends.
9. Electricity and fossil fuel change-point models and benchmarks.

III. Utilize Results

Chart 1. Portfolio Annual Energy, Cost, and Emissions Reduction Potential

Overview

Number of Buildings
32

Total Gross Floor Area (m^2):
820,845.0

Cost Savings (US dollar (USD / $)):
20.4%

Energy Savings (kWh):
20,154,954

Electricity Energy/Cost Savings:
21.1%

Fossil Fuel Energy/Cost Savings:
16.9%

GHG Emissions Reduction ($MTCO_2e$):
8,131.5
20.6%

GHG Emissions Intensity Reduction ($MTCO_2e/m^2$)
0.043

More energy and cost details

Click the **More Energy and Cost Details** link for deeper analysis.

Energy

Energy Type	Electricity	Fossil Fuel
Annual Energy Consumption (kWh)	83,289,199	15,239,777
Annual Site Energy Use Intensity (kWh/m^2)	136.4	20.1
Annual Energy Saving (kWh)	17,583,942	2,571,011
Annual Energy Saving Percentage (%)	21.1	16.9
Combined Annual Energy Consumption (kWh)	98,528,977	
Combined Annual Energy Use Intensity (kWh/m^2)	128.0	
Combined Annual Energy Saving (kWh)	20,154,954	
Combined Annual Energy Saving Percentage (%)	20.5	

III. Utilize Results

Chart 2: Portfolio Top 5 Energy Efficiency Recommendations

The energy efficiency recommendations most frequently recommended across your portfolio are:

- Reduce Equipment Schedules
- Reduce Plug Loads
- Reduce Lighting Load
- Decrease Heating Setpoints
- Increase Cooling Setpoints

Click each **recommendation** for the list of buildings in the portfolio for which the energy efficiency measure applies and resources to help implement the measure.

- Increase Cooling Setpoints (12 out of 32 buildings)

Building(s):
Office 26; Office 29; Office 9; Office 19; Office 12; Office 24; Office 13; Office 31; Office 28; Office 30; Office 23; Office 25;

Description:
Your building starts cooling at a lower temperature than a typical building. Check the occupied and unoccupied cooling setpoint during the cooling season. Cooling system and auxiliary systems' energy consumption will be reduced by increasing the cooling setpoint.

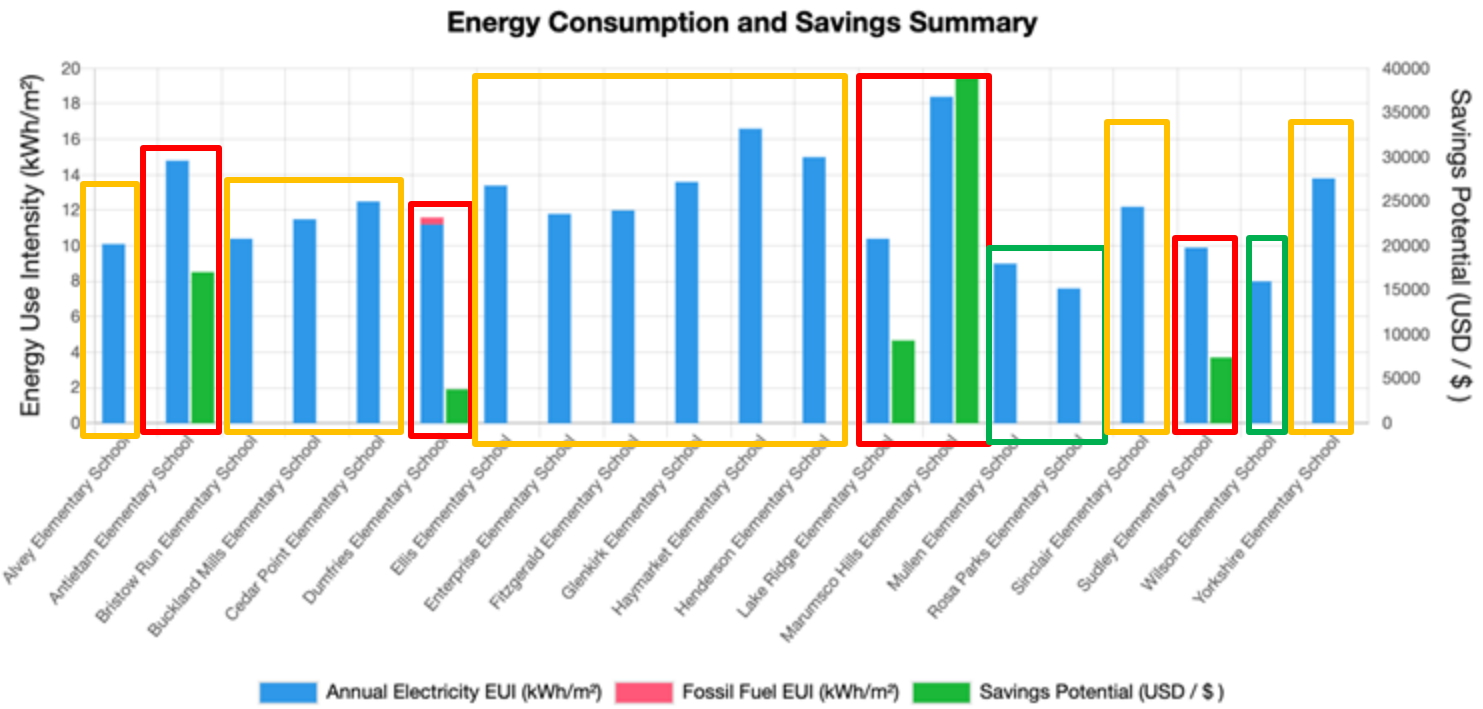
Resources:
- US Department of Energy: US DOE Energy Asset Score Recommendations Guide, pp. 17-20

III. Utilize Results

Best candidates for audits are highlighted in red.
Buildings for no-/low-cost O&M tune ups are highlighted in yellow.
Buildings to assess for best practices are highlighted in green.

Chart 3. Portfolio Electricity and Fossil Energy Use intensity (EUI) and Cost Savings Comparisons by Building

- Compare and rank buildings across a portfolio according to annual electricity and fossil EUI and annual cost savings potential.
- Buildings with high cost savings potential are good candidates for audits and further analysis.
- Buildings with high fossil EUI represent opportunities for electrification and decarbonization.



III. Utilize Results

Chart 4. Sort, Rank, and Prioritize Buildings in a Portfolio for Upgrades

- Use the ⇕ to rank buildings across a portfolio according to annual electricity and fossil EUI, annual cost savings potential, etc.
- Buildings with high cost savings potential are good candidates for audits and further analysis.
- Buildings with high fossil EUI represent opportunities for electrification and decarbonization.
- Click on any **Building Name** to view an analysis report for that particular building.

Building Analytics List

Building Name	Building Location	Building Area (m^2)	Annual Electricity Consumption (kWh)	Annual Fossil Fuel Consumption (kWh)	Annual Electricity Cost (US dollar (USD / $))	Annual Fossil Fuel Cost (US dollar (USD / $))	Annual Electricity EUI (kWh/m^2)	Annual Fossil Fuel EUI (kWh/m^2)	Annual Cost Savings Potential (US dollar (USD / $))	Annual Energy Savings (%)
Office 17	Houston, TX	46,320.0	8,076,233	81,067	638,022.5	1,933.1	174.4	1.8	243,188	38.1 %
Office 18	Phoenix, AZ	46,320.0	7,486,566	531,708	708,229.2	16,356.5	161.6	11.5	223,769	33.3 %
Office 19	Atlanta, GA	46,320.0	7,346,394	369,461	714,804.1	11,231.6	158.6	8.0	166,351	22.3 %

III. Utilize Results

Chart 5. Building Annual Energy, Cost, and Emissions Reduction Potential

Overview

Building Type:
Office

Gross Floor Area (m^2):
46,320.0

Building Location:
Albuquerque, NM

Closest Weather Station:
Station: 723650-23050 : Albuquerque Intl Sunport Airport

Potential Cost Savings (US dollar (USD / $)):
139,198
20.8%

Potential Energy Savings (kWh):
1,515,023
20.0%

Electricity Energy/Cost Savings:
21.1%

Fossil Fuel Energy/Cost Savings:
12.9%

GHG Emissions Reduction ($MTCO_2e$):
669.4
20.6 %

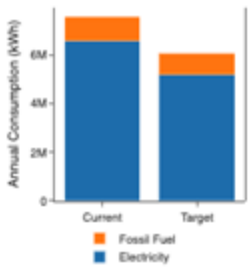
GHG Emissions Intensity Reduction ($MTCO_2e/m^2$)
0.014

Note: The annual estimates are based on the most recent 12 months of data input into BETTER.

More energy and cost details

Click the **More Energy and Cost Details** link for deeper analysis.

Energy Type	Electricity	Fossil Fuel
Annual Energy Consumption (kWh)	6,579,014	1,000,397
Annual Site Energy Use Intensity (kWh/m^2)	142.0	21.6
Annual Energy Saving (kWh)	1,386,043	128,980
Annual Energy Saving Percentage (%)	21.1	12.9
Combined Annual Energy Consumption (kWh)	7,579,412	
Combined Annual Energy Use Intensity (kWh/m^2)	163.6	
Combined Annual Energy Saving (kWh)	1,515,023	
Combined Annual Energy Saving Percentage (%)	20.0	



III. Utilize Results

Chart 6: Building Energy Efficiency Recommendations

Energy Efficiency Recommendations

- Reduce Plug Loads
- Reduce Lighting Load
- Decrease Heating Setpoints
- Increase Cooling Setpoints
- Reduce Equipment Schedules

Click **Details** for descriptions of each measure and implementation guidance.

Energy Efficiency Measures

Hide Resources ▲

Reduce Plug Loads

Your building plug load is higher than that of a typical building. Anything that is plugged into standard electric receptacles or outlets falls under the "plug load" category. Personal computers, monitors, printers, coffeemakers, and other office/lab/lighting equipment are examples of plug loads. Consider upgrading your equipment to more efficient models (e.g., ENERGY STAR certified) and operate on a schedule where possible. Advanced power strips and other monitoring devices can help you target your most energy-intensive devices.

Resources:

- US Department of Energy: Assessing and Reducing Plug and Process Loads in Office Buildings, Better Buildings Solutions Center
- US Department of Energy: Decision Guides for Plug and Process Load Controls, Better Buildings Solutions Center
- US Department of Energy: Energy-Efficient Products List
- US Department of Energy: Lessons Learned and the Future of Plug Load Controls, Better Buildings Solutions Center
- US Department of Energy: Leveraging the Advanced Power Strips (APS) Technical Specification for Commercial Buildings, Better Buildings Solutions Center
- US Environmental Protection Agency: ENERGY STAR Building Upgrade Manual Chapter 7: Supplemental Load Reduction
- US Environmental Protection Agency: ENERGY STAR Certified Products
- Lawrence Berkeley National Laboratory: Energy Efficiency Standards Group: Products

Reduce Lighting Load

Your building lighting load is higher than that of a typical building. Lighting load is a significant portion of any building's energy consumption, but lighting efficiency and controls have a big impact on lighting system performance. Consider upgrading bulbs and fixtures to improve efficiency and check existing (or upgrade to) controls that dim and turn off the lights appropriately. Take advantage of natural daylighting whenever possible. Lights near existing windows or skylights can be controlled to dim or turn off for maximum daylight utilization. Renovations to the building envelope and internal space configurations are good opportunities to improve lighting system performance.

Resources:

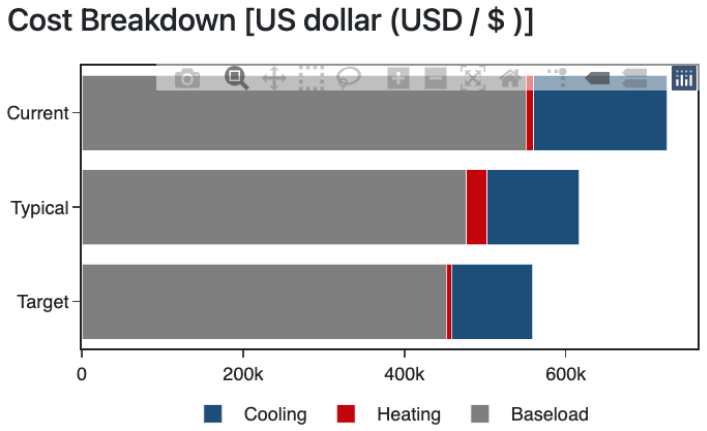
- US Department of Energy: US DOE Energy Asset Score Recommendations Guide, pp. 8-11
- US Environmental Protection Agency: ENERGY STAR Building Upgrade Manual Chapter 6: Lighting
- Lawrence Berkeley National Laboratory: Lighting and Electronics
- National Institute of Building Sciences: Advanced Lighting Systems: An Overview, Federal Energy Management Program (FEMP) course offered through Whole Building Design Guide

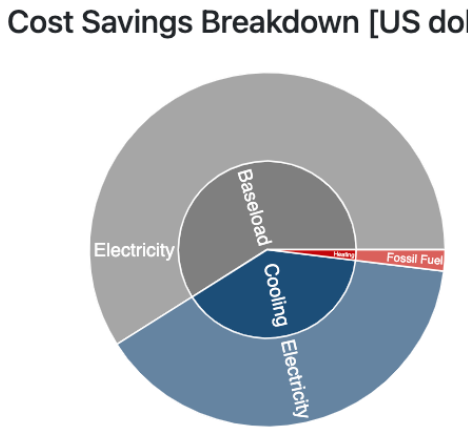
III. Utilize Results

Chart 7. Annual Utility Cost and Savings Breakdowns by Load Type

- Assess the breakdown of annual utility costs and potential savings by load type (e.g., cooling, baseload, and heating).

  - **Baseload:** constant energy use which does not depend on outdoor temperature. Associated with equipment which is in constant use such as lighting, ventilation, and appliances.
  - **Heating:** increased energy use observed in colder outdoor temperatures due to the operation of heating equipment.
  - **Cooling:** increased energy use observed in warmer outdoor temperatures due to the operation of cooling equipment.



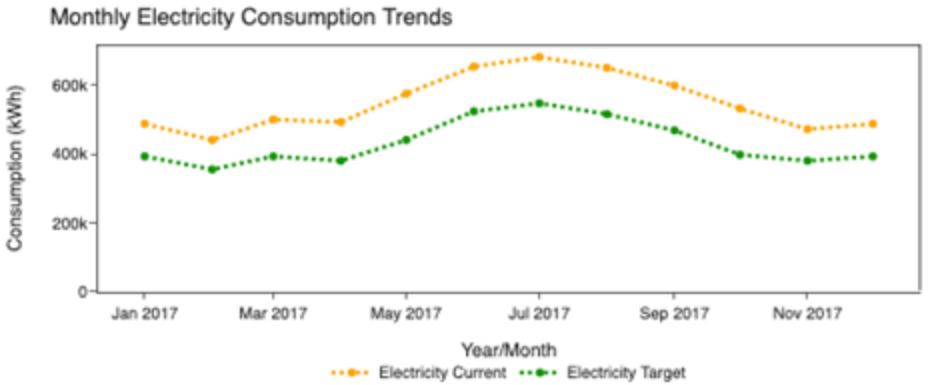


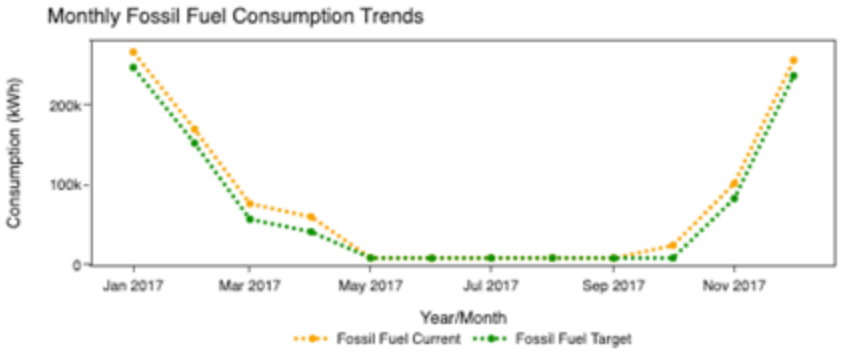
III. Utilize Results

Chart 8. Building Monthly Electric and Fossil Energy Use Trends.

Track the effectiveness of energy efficiency measures:

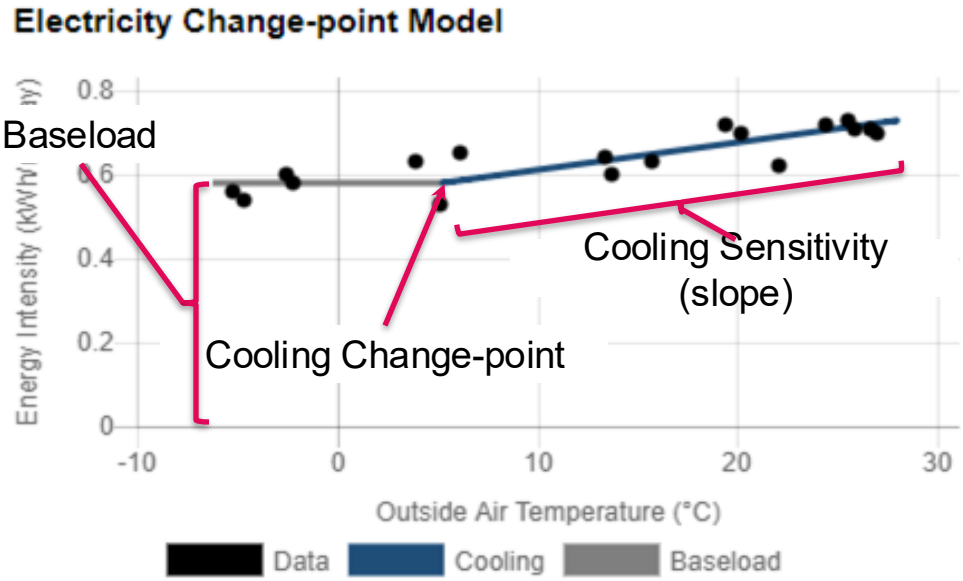
- Continue to enter energy data and run the tool.
- Monitor performance relative to potential savings.
- Generate updated recommendations.



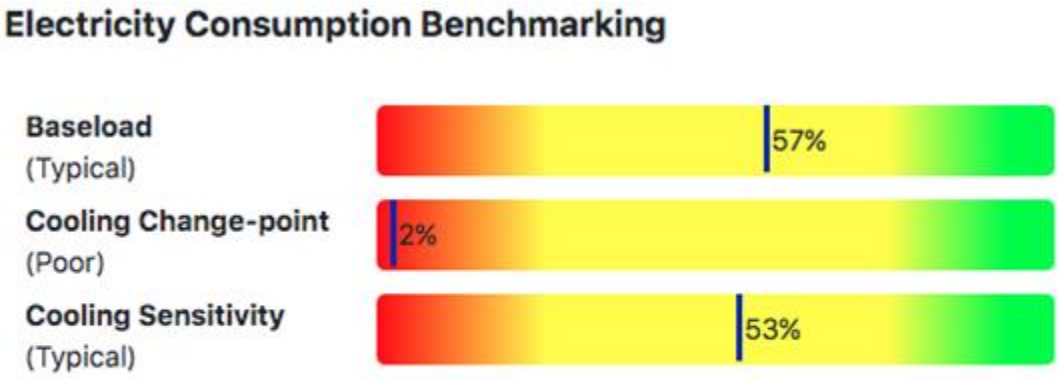


III. Utilize Results

Chart 9. Building Electricity and Fossil Fuel Change-point Models and Benchmarks



- Normalized energy use data is fit to change-point models to characterize the building's response to outdoor temperature.
- Change point model parameters (normalized by building gross floor area) are compared to the distribution of buildings in the dataset.
- Parameters that fall in the bottom of the distribution will trigger certain preset recommendations (e.g. poor baseload performance will lead to recommendations to reduce lighting and plug load use).



Note: % indicate the percentage of buildings your building is superior to.

For more information, please contact:

- Carolyn Szum, LBNL, CCSzum@lbl.gov
- Han Li, LBNL, hanli@lbl.gov
- Sydney Applegate, U.S. DOE, BTO ET Sydney.applegate@ee.doe.gov

Additional Resources

- BETTER URL: https://better.lbl.gov/
- Analytical engine source code: github.com/LBNL-ETA/BETTER_analytical_engine
- Articles, reports, and training videos: https://better.lbl.gov/news/ and https://better.lbl.gov/how_it_works/

Appendix

BETTER Template Building Information Inputs

SI Units (meters, kWh, °C)	Select Currency * :	US dollar (USD / $)

Gross Floor Area Unit: sq. meters

Building ID*	Building Name*	Location*	Gross Floor Area (Excluding Parking)*	Primary Building Space Type*
1	Office 1	Miami, FL	4982	Office
2	Office 2	Houston, TX	4982	Office
3	Office 3	Atlanta, GA	4982	Office
4	Office 4	Los Angeles, CA	4982	Office
5	Office 5	Las Vegas, NV	4982	Office
6	Office 6	San Francisco, CA	4982	Office
7	Office 7	Baltimore, MD	4982	Office

1. **Unit System**
   - Select Imperial Units (feet, kBtu, °F) or SI Units (meters, kWh, °C)
2. **Building Location (City, State/Province, Zip, Country)**
   - Used to find weather data
3. **Gross Floor Area (Exclude Parking)**
   - Used to normalize consumption
4. **Primary Building Space Type**
   - Used for benchmarking
5. **Currency**
   - Used for cost savings reporting

BETTER Template Energy Consumption and Cost Inputs

- Minimum of 12 consecutive months of energy consumption data is required.
- Gather all electricity and fossil fuel consumption data from utility bills for each billing period.
- Energy cost is optional. If no energy cost is entered, BETTER will use a default cost per unit.
- Average outdoor air temperature is optional. If no weather data is entered, BETTER will use National Oceanic and Atmospheric Administration (NOAA) data.*

Building ID*	Billing Start Dates*	Billing End Dates*	Energy Type*	Energy Unit*	Energy Consumption*	Energy Cost	Average Outdoor Air Temperature
1	1/1/2017	1/31/2017	Electric - Grid	kWh (thousand Watt-hours)	66338		
1	2/1/2017	2/28/2017	Electric - Grid	kWh (thousand Watt-hours)	55528		
1	3/1/2017	3/31/2017	Electric - Grid	kWh (thousand Watt-hours)	64180		
1	4/1/2017	4/30/2017	Electric - Grid	kWh (thousand Watt-hours)	62067		
1	5/1/2017	5/31/2017	Electric - Grid	kWh (thousand Watt-hours)	69730		

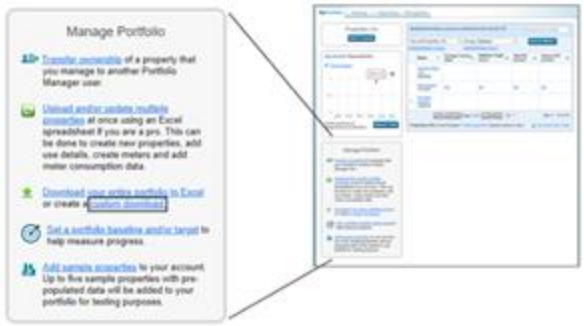
* NOAA weather data may not be available for all locations. An error message will show on the BETTER analysis reports to prompt a user to enter average outdoor air temperature data for a given location and/or billing period as appropriate.

ENERGY STAR® Portfolio Manager® Template Inputs

Property Information
- Portfolio Manager ID
- Street Address
- City
- State/Province
- Postal Code
- Country
- Year Built

Meter Entries
- Portfolio Manager Meter ID
- Meter Name
- Meter Type
- Meter Consumption ID
- Start Date
- End Date
- Delivery Date
- Usage/Quantity

Step-by-step guidance available on BETTER (https://better.lbl.gov/run_better/).



Property

Property Name	Portfolio Manager ID	Street Address	Street Address 2	City/Municipality	State/Province	Other State/Province	Postal Code	Country	Year Built
		1 Cyclotron Road	Not Available	Berkeley	California	Not Available	94720	United States	1994

Meter Entries

Property Name	Portfolio Manager ID	Portfolio Manager Meter ID	Meter Name	Meter Type	Meter Consumption ID	Start Date	End Date	Delivery Date	Usage/Quantity
b1	7946502	63303050	Natural Gas	Natural Gas	3180414283	1/1/2015	1/31/2015	Not Available	65338.33
b1	7946502	63303050	Natural Gas	Natural Gas	3180414284	2/1/2015	2/28/2015	Not Available	58134.72
b1	7946502	63303050	Natural Gas	Natural Gas	3180414285	3/1/2015	3/31/2015	Not Available	62858.33
b1	7946502	63303050	Natural Gas	Natural Gas	3180414286	4/1/2015	4/30/2015	Not Available	57974.17
b1	7946502	63303050	Natural Gas	Natural Gas	3180414287	5/1/2015	5/31/2015	Not Available	66433.33
b1	7946502	63303050	Natural Gas	Natural Gas	3180414288	6/1/2015	6/30/2015	Not Available	71758.61
b1	7946502	63303050	Natural Gas	Natural Gas	3180414289	7/1/2015	7/31/2015	Not Available	73295
b1	7946502	63303050	Natural Gas	Natural Gas	3180414290	8/1/2015	8/31/2015	Not Available	76405.28
b1	7946502	63303050	Natural Gas	Natural Gas	3180414291	9/1/2015	9/30/2015	Not Available	65691.39
b1	7946502	63303050	Natural Gas	Natural Gas	3180414292	10/1/2015	10/31/2015	Not Available	62875.28
b1	7946502	63303050	Natural Gas	Natural Gas	3180414293	11/1/2015	11/30/2015	Not Available	58813.89