

#### Introduction and Basic Training

May 2025

#### Prepared for Users of BETTER. V.1.7



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- 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**



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Building Efficiency Targeting Tool for Energy Retrofits (BETTER)

## 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:

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- 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 <a href="https://better.lbl.gov">https://better.lbl.gov</a>.
- BETTER's analytical engine is open-source and available on GitHub at <u>https://github.com/LBNL-JCI-ICF/better</u>.

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## **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.

#### Portfolio Summary

Number of Buildings:

32

Annual Cost Savings (USD / \$ ):

1,291,265 11.1 %

Electricity Energy/Cost Savings:

11.3%

Total Floor Area (m<sup>2</sup>): 820,835

Annual Energy Savings (kWh):

13,905,685 10.6 %

Fossil Fuel Energy/Cost Savings: 6.7%

#### **Top Energy Efficiency Recommendations**

The energy efficiency recommendations most frequently recommended

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

#### **Building Portfolio Analysis**

#### How BETTER works:

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





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### **Analytical Methodology**



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## **Overall Workflow**





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# **Property Information**

SI Units (meters, kWh, °C)

Select Currency \* : US dollar (USD / \$)

#### Gross Floor Area Unit: sq. meters

Building ID*	Building Name <sup>*</sup> 🖵	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
- **Primary Building Space Type** 4.
  - Used for benchmarking
- Currency 5.
  - 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	E EV_M	BEGIN	END	EndYear
450320	99999	450320-99999	TA KWU LING	СН			22.533	114.15	13	19921204	20171117	2017
450350	99999	450350-99999	LAU FAU SHAN	СН			22.467	113.983	35	20040713	20171117	2017
450390	99999	450390-99999	SHA TIN	СН			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	СН			22.183	114.3	60	20040122	20171117	2017
470311	99999	470311-99999	MEILAN	СН		ZJHK	19.935	110.459	22.9	20040706	20171117	2017
470312	99999	470312-99999	ZHENGDING	СН		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	СН			51.733	126.633	175.6	19560820	20171117	2017
504340	99999	504340-99999	TULIHE	СН			50.45	121.7	733	19570531	20171117	2017
504680	99999	504680-99999	AIHUI	СН			50.25	127.45	166	19610801	20171117	2017
505270	99999	505270-99999	HAILAR	СН			49.25	119.7	650	19560820	20171117	2017
505480	99999	505480-99999	XIAO'ERGOU	СН			49.2	123.717	288	19570531	20171117	2017
505570	99999	505570-99999	NENJIANG	СН			49.167	125.233	243	19560820	20171117	2017
505640	99999	505640-99999	SUNWU	СН			49.433	127.35	235	19560820	20171117	2017
506030	99999	506030-99999	XIN BARAG YOUQI	СН			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	СН			48.65	126.667	305	19610801	20130120	2013
506580	99999	506580-99999	KESHAN	СН			48.05	125.883	237	19570601	20171117	2017
507270	99999	507270-99999	ARXAN	СН			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	СН			47.45	126.867	248	19560820	20171117	2017
507740	99999	507740-99999	YICHUN	СН			47.7	128.833	259.1	19570601	20171117	2017
507880	99999	507880-99999	FUJIN	СН			47.233	131.983	65	19560820	20171117	2017
508440	99999	508440-99999	TAILAI	СН			46.4	123.45	150	19610801	20171117	2017
508540	99999	508540-99999	ANDA	СН			46.383	125.317	150	19560820	20171117	2017
508880	99999	508880-99999	BAOQING	СН			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, and multifamily buildings\*
  - Mexican offices
  - Tunisian hotels



\*At this time, the "reference" benchmark statistics for U.S. offices, K-12 schools, public libraries, hospitals, 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 relevant subtypes A, B, and C in these zones*). Learn more at <u>FAQ</u>. To contribute anonymous data to this effort, please email <u>support@better.lbl.gov</u>.

## **Automatic Data Pre-Processing**

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



Combine different types of fossil fuel consumptions, and convert energy consumption unit to kWh \*



Normalize energy consumption to show average ٠ kWh/(day\*m<sup>2</sup>)\* by month for at least 12 months.\*





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

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#### **Inverse Modeling**

			N	Aodel Coefficie	nt		
Model Type	Schematic Plot	Baseload	Cooling	Cooling	Heating	Heating	Interpretation
		(b0)	Sensitivity	Change-point	Sensitivity	Change-point	
		(00)	(a1)	(c1)	(a2)	(c2)	
1P Model	Energy Use Index Ontqoor Lemberature	x					<ol> <li>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.</li> </ol>
3P Cooling Model	Energy Use Index	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	Euregy Use Index a2 b0 c2 Outdoor Temperature	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	Energy Use Index $a_2$ $a_1$ $a_2$ $a_1$ $a_2$ $c_2$ $c_1$ Outdoor Temperature	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.



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#### **Benchmark Coefficients**





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## **Energy Efficiency Targeting**

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Step 1. Specify energy efficiency target



#### Nominal (equal to the dataset median)

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## **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



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## **Energy Savings Estimation**

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Step 3. Calculate potential energy and cost savings



Calculate associated cost

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#### **Energy Efficiency Recommendations**



#### **BETTER Interoperability**



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## **BETTER Interoperability**

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- BETTER can create / analyze buildings or portfolios via custom ENERGY STAR<sup>®</sup> Portfolio Manager<sup>®</sup> Excel reports and provide BETTER analytical reports as self-contained HTML files.
- BETTER can create/analyze buildings or portfolios via BuildingSync<sup>®</sup> XML files and provide BETTER analytical reports as self-contained HTML files.<sup>1</sup>
- 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<sup>™</sup> (SEED) platform can run BETTER analysis reports from the SEED platform. Contact Carolyn Szum <u>CCSzum@lbl.gov</u> for more information on how to access BETTER from the SEED platform.

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

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## Support for ENERGY STAR<sup>®</sup> Portfolio Manager<sup>®</sup>

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

b	P 3 - Select "Multiple Propert Step 4 - Select the data to down! Then click on the "Submit" butto	es", then select the bad. Choose "Basic Pr n	buildings you want to downl roperty Information", "Meter Er	oad data from. Note that ntries", then enter the start a	nd end dates of the meter	r data.	
	Step 5 - Shortly after the fol download this XLSX file and	owing steps, you sh upload it to BETTER	ould be able to see a new noti	fication indicating your da	ta is ready to download.	You can	
	1. Upload Data		Data Entry Template	BETTER 🧿 ENERGY STA	R® Portfolio Manager®		
			Choose file		Browse Upload	đ	
		According Transmitted	(injuring frequencies (i)		-		
		Type Rothcates	penied on September 18, 2019 is mady <mark>Contemportan</mark>	• Cats	- 0 -		
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## Support for BuildingSync<sup>®</sup> XML

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BuildingSync<sup>®</sup> 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<sup>®</sup> XML file.

The "With I file to creat could be do	BuildingSync® XMI te a building instan wnloaded here.	" approach al ce in BETTER	lows you to use a E . An example Build	BuildingSync® XM ingSync® XML f
BuildingSync XM	L File*			
				Browse
This field is require	d.			
			Upload	Cancel

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## **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."





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#### 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.



#### About BETTER

BETTER is a free web application that enables building operators to quickly, easily identify the most cost-saving energy efficiency measures in buildings and portfolios using readily available building and energy data. With minimal data entry, BETTER benchmarks a building's or portfolio's energy use against piers; quantifies energy, cost, and greenhouse gas (GHG) reduction potential; and recommends energy efficiency measures (technological and operational) for individual buildings or portfolios, targeting specific energy savings levels. The source code of its modular, cross-platform analytical engine is available on GitHub and can be adopted, redeveloped, and redistributed freely under an open-source license, allowing users to incorporate BETTER's analytical capabilities into their own software platforms and tools.









#### 2. Sign In or Sign Up

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

Please sign in
Username*
Username
Password*
Password
Remember Me
Sign In
Forgot your password? Reset it.
Don't have an account? Create one.

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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



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#### 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.



#### 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**



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#### 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<sup>®</sup> Template approach allows users to import multiple buildings' data stored in ENERGY STAR<sup>®</sup> Portfolio Manager<sup>®</sup>.

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**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<sup>®</sup> XML file later.



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Visit the <u>appendix</u> of this presentation for a snapshot of the data input fields in the BETTER and ENERGY STAR<sup>®</sup> 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 <sup>2</sup> )*	Primary Building Space Type*	Currency
1	Office 1	Mami, 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 <u>appendix</u> 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.





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### **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 autogenerate a customized Excel workbook from within ENERGY STAR® Portfolio Manager® that is pre-populated with multiple buildings' data so it can be to batchupload to BETTER.

From Scratch With BETTER Template

With Portfolio Manager® Template

The "With Portfolio Manager® Template" approach allows you to import multiple buildings' data stored in ENERGY STAR® Portfolio Manager®. Follow the instructions to auto-generate an Excel workbook from within Portfolio Manager® that is pre-populated with multiple buildings' data so that it can be batch-uploaded and analyzed by BETTER. Once the Excel workbook has been generated, save the file to your computer, and upload it below.

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.

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Choose file

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Visit the <u>appendix</u> of this presentation for a snapshot of the data input fields for the ENERGY STAR<sup>®</sup> Portfolio Manager<sup>®</sup> 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.

With BETTER Template With Portfolio Manager* Template From Scratch	Recent Portfolios	Add New Building
The "From Scratch" approach allows you to create a empty portfolio. You can add buildings to the portfolio later.	🕸 Test 2	The "From Scratch" approach allows you to create a building with the web-
Portfolio Name*	# Buildings O	interface. Fill in the basic information below to create a blank building, then go to the building detail page to add utility bills.
	Total Floor Area (m <sup>2</sup> )	Building Name*
All fields marked with * are required	0	Enter a building name.
Save	Currency USD	Space Type*
	Date Updated	Office +
	July 16, 2021, 9:59 p.m.	Primary building space type is the space type that accounts for more than 50% of the building. O more info
		Gross Floor Area (m2)*
	Delete	This is the gross floor area of the building as measured between principal exterior surfaces. It should exclude area for parking.
	1	Location*
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Back

Save

#### 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.

About - News Doo	About - News Docs							54	App @ ccsz	um@lbi.gov -
Dashboard	All Portf	olios								
Portfolios	If you se	e IN_PROGRESS in the "Creation Status" co	lumn, it means BET	TER is processing	g your data and creating	a portfolio. This process		Refresh Page	Create a	New Portfolio
🛚 Buildings	usually takes less than a few minutes. You can refresh the page to check if the portfolio creation is completed. You can edit the Portfolio Name by clicking on the Portfolio Name hyperlink or View.									
	ID 0	Portfolio Name ©	No. Buildings 0	Total Floor Area (m <sup>2</sup> ) 0	Currency \$	Creation Status #	Creation Message \$	Date Started	View	Delete
	35	Sample Portfolio - BETTER Template Test - 6.28.21	33	1,140,268.0	US dollar (USD / \$ )	COMPLETE	No Error.	06/28/2021	View	Delete
	41	Portfolio created from BETTER template	0	0	USD	IN_PROGRESS	None	06/30/2021	View	Delete

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**.

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#### 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.

Portfolio Information	Portfolio Analytics						
Portfolio Inform	Portfolio Information						
Name*							
Sample Portfolio - B	SETTER Template Test - 6.28.21	<b></b>					
Update							

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.

**Buildings in the Portfolio** 

Add New Building

U.S. DEPARTME Below is a summary table of buildings in the portfolio. Click on the building name link or the view button to go to the building information page.

BI	Building Name \$	Space Type \$	Location \$	Floor Area (m <sup>2</sup> ) \$	View	Delete	3ETTER)	
	Office 3	Office	Atlanta, GA	4,992.2	View	Delete		35

#### 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.

Portfolio Information		Portfolio Anal	ytics									
Portfolio	Analytic	S										
Analytics ID \$	Time Generated ¢	Savings Target ≎	Benchmark Statistics ≎	Model R <sup>2</sup> ≎	Number of Buildings \$	Energy Savings Potential (kWh) ≎	Cost Savings Potential [US dollar (USD / \$ )]	GHG Emission Reduction Potential (MTCO <sub>2</sub> e) \$	Status \$	View	Action	Delete
14	None	Nominal	Default	0.6	32	20,154,954	1,799,431	8,131.5	COMPLETE	Details	Rerun	Delete
Click the bu Add New	tton below to v Analytics	add a new a	nalytics.							1		

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.
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## 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 <u>must select one space type only per analytical run (e.g., office).</u>



**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.

2. S	elect Buildings				
	Building Name 🗢	Location 🗢	Floor Area (m²) 🗢		
	Office 3	Atlanta, GA	4,992.2		
	Office 10	Chicago, IL	4,982.2		
ĞŶ	Office of ENERGY EFFICIENCY & RENEWABLE ENERGY		argeting Tool for Energy Retrofits (BE1		

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## 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.



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Building Efficiency Targeting Tool for Energy Retrofits (BETTER)

#### **11. Select the Benchmark Statistics for the Portfolio**

**Step 4:** Select Benchmark Statistics from the options shown.

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

**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: <a href="https://better.lbl.gov/how\_it\_works/">https://better.lbl.gov/how\_it\_works/</a>. 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.

# A. Benchmark Statistics Country Mexico Generate Country Mexico United States United States Description of the section of the s

\*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 UNE applic 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 <u>FAQ</u>. To contribute anonymous data to this effort, please email support@better.lbl.gov* 

#### 12. Select the Minimum R<sup>2</sup> Threshold for the Portfolio

R<sup>2</sup> is the proportion of the variance in the dependent variable (energy use) that is predictable from the independent variable (outdoor air temperature)

**Step 5:** Select the Minimum R<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> is selected.

In general, we recommend users select an R<sup>2</sup> of 0.6 or higher for a portfolio.



5. Minimum Model R<sup>2</sup>

#### 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.

Portfolio Analytics Staging Page

You can only generate any building still need refresh this page until	portfolio analytics after generating and to have its analytics generated, please the system reports that all building and	Refresh Page Generate Portf	olio Analytics				
Building Analytics	for Selected Buildings in this	Generate All Uncompleted Bu	iding Analytics				
Building Name 🛛 🗘	Location ©	Space Type ©	Building Analytics ©		Status ©	Status Message 0	Remove 0
Office 16	ice 16 Miami, FL Office Building Analytics (ID: 384) IN_PROGRESS					None	Remove
Office 17	17 Houston, TX Office Building Analytics (ID: 385) IN_PROGRESS					None	Remove

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.

Ready to generate Portfolio Analytics



Generate All Uncompleted Building Analytics

#### Building Analytics for Selected Buildings in this Portfolio:

Building Name 0 ¢	Location ¢	Space Type \$	Building Analytics \$	Status ¢	Status Message ¢		Remove 0
Office 4	Los Angeles, CA	Office	Building Analytics (ID: 405)	COMPLETE	No errors. Duration : 0.6008 seconds.	41	Remove

## 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.

U.S. DEPARTMENT OF ENERGY	ETTER V.1.0 Portfolio Summary Report Sample Portfolio_July 23 2021 Generated at	Download
Overview Number of Buildings 32	Total Gross Floor Area (m <sup>2</sup> ): <b>820,835.0</b>	Go to the Utilize Results section (slide 61) for more information on how to use the Portfolio Summary
Cost Savings (US dollar (USD / \$ )): 1,900,242 20.2%	Energy Savings (kWh): 20,548,658 19.6%	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 (m²) ¢	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/m²) ¢	Annual Fossil Fuel EUI (kWh/m²) ≎	Annual Cost Savings Potential (US dollar (USD / \$ )) \$	Annual Energy Savings (%) ≎	ergy Retrofits (BETTER)
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 %	42

## **Create a New Building**



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

The <b>"From Scratch"</b> approach allows you to create a building with the web- interface. Fill in the basic information below to create a blank building, then go to the building detail page to add utility bills.
Building Name*
Enter a building name.
Space Type*
Office
Primary building space type is the space type that accounts for more than 50% of the building. @ more info
Gross Floor Area (m2)*
This is the gross floor area of the building as measured between principal exterior surfaces. It should exclude area for parking.



Location\*

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For buildings located in the United States, please enter state, city or ZIP code. For buildings located outside of the United States, please enter the country and city. This information will be used to find corresponding weather data, fuel prices, and GHG emission factors.

argeting Tool for Energy Retrofits (BETTER)

# **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

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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<sup>2</sup> 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.



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## **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<sup>®</sup> XML file you want to upload from your computer and click **Upload**.

From Scratch	With BuildingSync® XML				
file to creat could be do	BuildingSync <sup>®</sup> XML" approa te a building instance in BET wnloaded here.	ch allows you to TTER. An examp	o use a Buildir ple BuildingSy	ngSync® XML vnc® XML file	
BuildingSync XM  This field is require	L File*			Browse	-
			bload	Cancel	



## 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 swill 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.

All Buildings											
	-						Create N	lew Building			
ID ¢	Building Name \$	Space Type 🗢	Location \$	Floor Area (m <sup>2</sup> ) \$	Portfolio Name 🕈	Date Updated \$	View	Delete			
562	Sample Office 1	Office	Miami, FL	4,982.0	( none )	07/05/2021	View	Delete			
392	Office 3	Office	Atlanta, GA	4,992.2	Sample Portfolio - BETTER Template Test - 6.28.21	06/28/2021	View	Delete			

\* 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.

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## 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.

Building In	formation B	ding Analytics
Ų	Name	Office 32
	Space Type	Office
	Floor Area (m <sup>2</sup>	46,320.0
	Location	Miami, FL
		Edit Building



## 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 vou've entered.
- **Energy Consumption Unit:** Select the energy unit associated with the energy consumption from the dropdown 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.



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## 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.

Building	g Information B	uilding Analytics					
E	Name	Office 32					
Space Type Office							
	Floor Area (m	2) 46,320.0					
	Location	Miami, FL					
Utili	ity Consumptio	n				Eo Add a	lit Building Utility Bill
Ene	rgy Type 🗢	Bill Start Date 🖨	Bill End Date 🖨	Consumption \$	Cost (\$) <b>≑</b>	Edit	Delete
Elec	ctric - Grid	Jan. 1, 2018	Jan. 31, 2018	417711.0 kWh (thousand Watt-hours)	39,849.63	Details	Delete
Elec	ctric - Grid	Feb. 1, 2018	Feb. 28, 2018	375908.0 kWh (thousand Watt-hours)	35,861.62	Details	Delete

425522.0 kWh (thousand Watt-hours)



Electric - Grid

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March 1, 2018

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March 31, 2018



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Delete

Details

## 20. Add Building Analytics

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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<sup>2</sup> 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.

Building Information Building Analytics											
List of Building Analytics											w Analytics
ID ¢	ID Savings Target Benchmark Model R <sup>2</sup> Energy Savings Potential Cost Savings Potential [US dollar GHG Emission Reduction Potential						Action	Delete			
602	Nominal	Default	0.6	3,967	203	0.7	COMPLETE	Details	🛓 Download	Rerun	Delete

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## 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



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Reference benchmark statistics are only available for U.S. offices, multifamily buildings, public libraries, hospitals, 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: <u>https://better.lbl.gov/how\_it\_works/</u>. For information on how the reference statistics were developed visit the FAQ page Analysis Settings topic.

4. Benchmark Statistics

Reference



Generate



Reference: BETTER will benchmark your buildings' change-point model coefficients (e.g., electric and fossil baseloads, heating and cooling change-points, and heating and cooling slopes) against the median and standard deviation for each of these change-point model coefficients derived from a dataset for the selected space type. Currently, reference statistics are only available for U.S. offices and K-12 schools and Mexican offices. To learn more about the datasets and how the reference statistics were developed visit the FAQ page Analytical Settings topic.

\* Note: 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 *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 relevant subtypes A, B, and C in these zones). To contribute anonymous data to this effort, please are improve and better but contribute anonymous data to this effort, please are improved better but contribute anonymous data to this effort, please are improved better but contribute anonymous data to this effort, please are improved better but contribute anonymous data to this effort, please are improved better but contribute anonymous data to this effort, please are improved better but contribute anonymous data to this effort, please are improved better but contribute anonymous data to this effort.* 

#### **12. Select the Minimum R<sup>2</sup> Threshold for the Building**

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

**Step 5:** Select the Minimum R<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> is selected.

In general, we recommend users select an R<sup>2</sup> of 0.6 or higher for a portfolio.



5. Minimum Model R<sup>2</sup>

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.

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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.

	U.S. DEPARTMENT OF ENERGY	ER V.1.0 Building Summary Report Office 25 Generated at 2021-07-23	-
	Overview		
	Building Type:	Gross Floor Area (m <sup>2</sup> ):	
	Office	46,320.0	
	Building Location:	Closest Weather Station:	
	Seattle, WA	Station: 727934-94248 : Renton Municipal Airport	
	Potential Cost Savings (US dollar (USD / \$	S)): Potential Energy Savings (kWh):	
ſ	86,903	978,638	av Retrofits (BETTER)
N	16.3%	15.4%	55

## <u>Download</u> and install Python 3.6.0 or later



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



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#### 2. Check that Python is installed correctly

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- 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 <u>Windows</u>, and this link for <u>MacOS</u>.



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#### 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.

Name	Ŧ	Туре	Size	
퉬 better		File folder		
퉬 data		File folder		
gitignore		GITIGNORE File		1 KB
Copyright		File		1 KB
🚳 install.bat		Windows Batch File		1 KB
LICENSE		File		4 KB
README.md		MD File		8 KB
📝 setup.py		PY File		1 KB







### 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).

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Building Efficiency Targeting Tool for Energy Retrofits (BETTER)

#### 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.



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## **Utilize Results**



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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.



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

Overview	
Number of Buildings	Total Gross Floor Area (m <sup>2</sup> ):
32	820,845.0
Cost Savings (US dollar (USD / \$ )):	Energy Savings (kWh):
20.4%	20,154,954
Electricity Energy/Cost Savings:	Fossil Fuel Energy/Cost Savings:
21.1%	16.9%
GHG Emissions Reduction (MTCO <sub>2</sub> e):	GHG Emissions Intensity Reduction (MTCO <sub>2</sub> e/m <sup>2</sup> )
8,131.5	0.043
20.6%	

More energy and cost details		Energy		
Click the More	Energy Type	Electricity	Fossil Fuel	
	Annual Energy Consumption (kWh)	Electricity     Fossil Fuel       nsumption (kWh)     83,289,199     15,239,777       y Use Intensity (kWh/m²)     136.4     20.1       ving (kWh)     17,583,942     2,571,011       ving Percentage (%)     21.1     16.9		
Energy and	Annual Site Energy Use Intensity (kWh/m <sup>2</sup> )	136.4	20.1	
Cost Details	Annual Energy Saving (kWh)	kWh)     83,289,199     15,239,777       ity (kWh/m²)     136.4     20.1       17,583,942     2,571,011       age (%)     21.1     16.9       sumption (kWh)		
link for deeper	Annual Energy Saving Percentage (%)	21.1	16.9	
analysis	Combined Annual Energy Consumption (kWh)	98,528,977		
anarysis.	Combined Annual Energy Use Intensity (kWh/m <sup>2</sup> )	128	3.0	
ENERGY Office of ENER	Combined Annual Energy Saving (kWh)	20,154,954		
BUILDING TECHNOLOGIES (	Combined Annual Energy Saving Percentage (%)	20	.5 63	

#### 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



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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.



#### **Energy Consumption and Savings Summary**

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

- Use the I 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 (m²) ¢	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/m²) ¢	Annual Fossil Fuel EUI (kWh/m²) ≑	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 %







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

Overview	
Building Type:	Gross Floor Area (m <sup>2</sup> ):
Office	46,320.0
Building Location:	Closest Weather Station:
Albuquerque, NM	Station: 723650-23050 : Albuquerque Intl Sunport Airport
Potential Cost Savings (US dollar (USD / \$ )):	Potential Energy Savings (kWh):
139,198	1,515,023
20.8%	20.0%
Electricity Energy/Cost Savings:	Fossil Fuel Energy/Cost Savings:
21.1%	12.9%
GHG Emissions Reduction (MTCO <sub>2</sub> e):	GHG Emissions Intensity Reduction (MTCO <sub>2</sub> e/m <sup>2</sup> )
669.4	0.014
20.6 %	

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.

<i>F</i>				
Energy Type	Electricity	Fossil Fuel		
Annual Energy Consumption (kWh)	6,579,014	1,000,397		
Annual Site Energy Use Intensity (kWh/m <sup>2</sup> )	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 <sup>2</sup> )	163.6			
Combined Annual Energy Saving (kWh)	1,515,023			
Combined Annual Energy Saving Percentage (%)	20.0			





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#### **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**

#### 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

Hide Resources A

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## 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).

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- 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.

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Cost Breakdown [US dollar (USD / \$ )]

#### Cost Savings Breakdown [US dollar (USD / \$ )]



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#### 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.

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



#### Electricity Change-point Model

- Normalized energy use data is fit to changepoint 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).

#### **Electricity Consumption Benchmarking**





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

## For more information, please contact:

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- Sydney Applegate, U.S. DOE, BTO ET <u>Sydney.applegate@ee.doe.gov</u>

# **Additional Resources**

- BETTER URL: <u>https://better.lbl.gov/</u>
- Analytical engine source code: <u>github.com/LBNL-</u> <u>ETA/BETTER\_analytical\_engine</u>
- Articles, reports, and training videos: <u>https://better.lbl.gov/news/</u> and <u>https://better.lbl.gov/how\_it\_works/</u>




## **Appendix**



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# **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 <sup>*</sup> 🖵	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
- **Primary Building Space Type** 4.
  - Used for benchmarking
- Currency 5.
  - 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

Property

#### **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 (<u>https://better.lbl.gov/run</u> <u>better/</u>).



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