

# Capturing Human Benefits of Improving Indoor Environments





# Healthy Buildings Initiative

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## Value Propositions

Non-energy benefits, such as health and productivity improvements, can have large economic benefits—which are currently unaccounted for in energy efficiency project valuation methodologies.

Leveraging buildings to achieve broader energy goals (demand reduction, smart buildings, building-grid integration) requires gaining knowledge and developing measurement of human outcomes, which represent the best interest of building owners, business owners, and building occupants.

### 3-30-300

On average, companies spend \$3 in utilities, \$30 in rent, and \$300 in payroll per square foot per year.



**Challenges:** How to quantify occupant benefits in the context of energy efficiency decision making.

Empirical studies on IEQ have not been fully translated to building system design and operation.

Some IEQ standards for building design have not changed in the past 100 years.

Interaction of building systems and diversity of the existing installations makes it more challenging to copy healthy building strategies from one building to another.

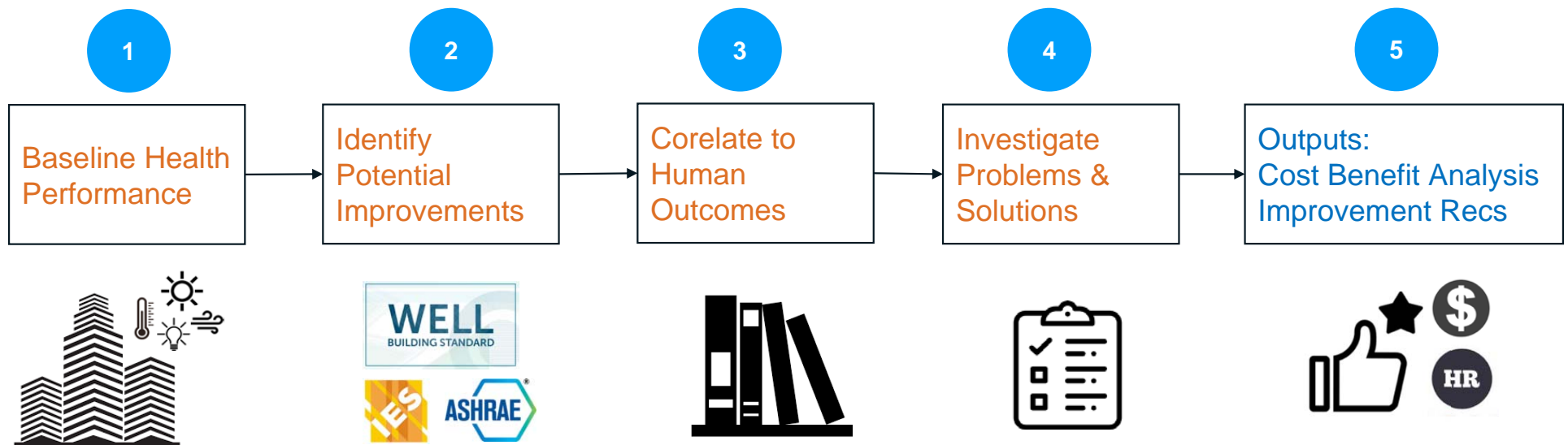




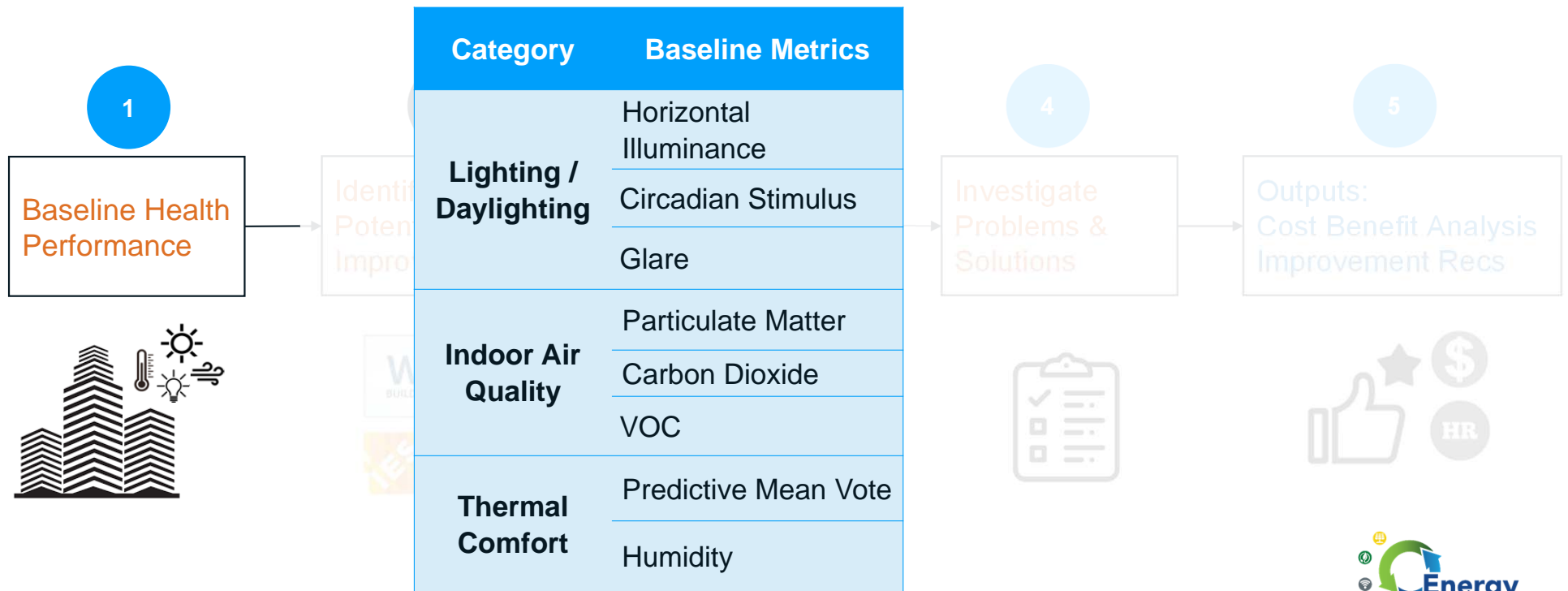
## Objectives

- Integrate occupants' health outcomes with energy efficiency measures.
- Quantify potential financial benefits from productivity gains.
- Develop a toolkit aka “program-in-a-box” (data collection guide, cost-benefit calculator, equipment library) to help facility managers make holistic decisions on building retrofits and operation.

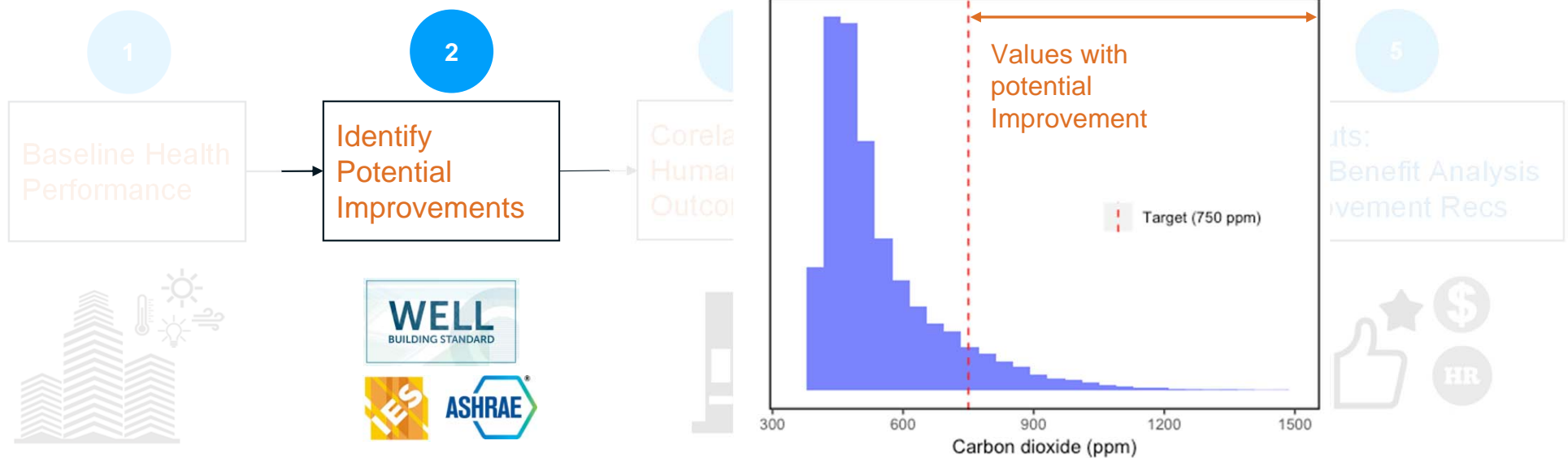
# Healthy Buildings Initiative Methodology



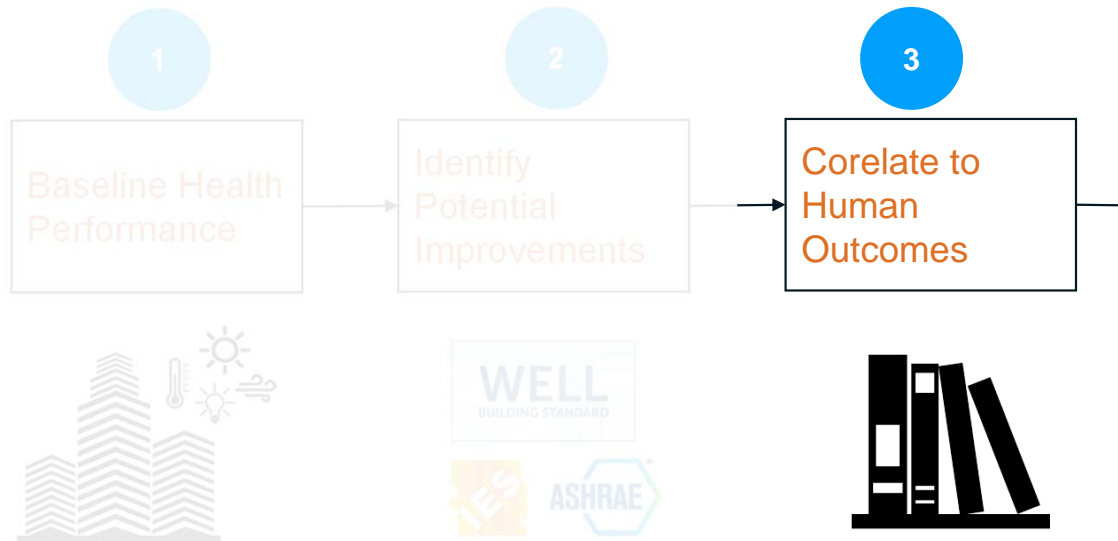
8 Primary metrics to baseline building performance.  
(10-question supplemental occupant survey)



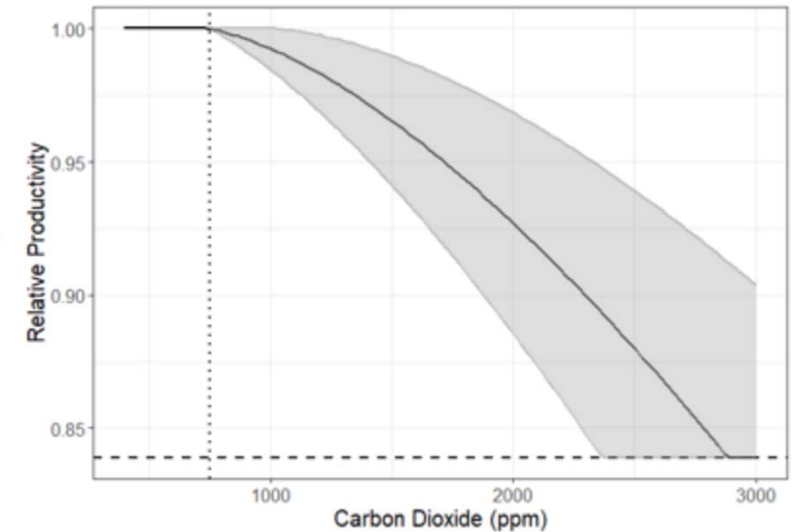
Baseline measurements are compared with target values to calculate improvement potentials.





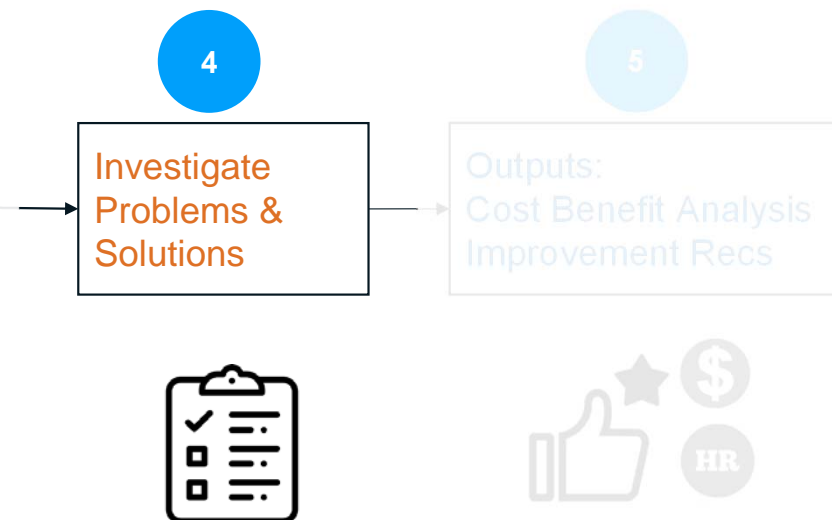


Correlations were developed for lighting (horizontal illuminance), thermal comfort (PMV), and IAQ (ventilation rate, CO<sub>2</sub>), Humidity, and Circadian Stimulus based on published empirical studies.

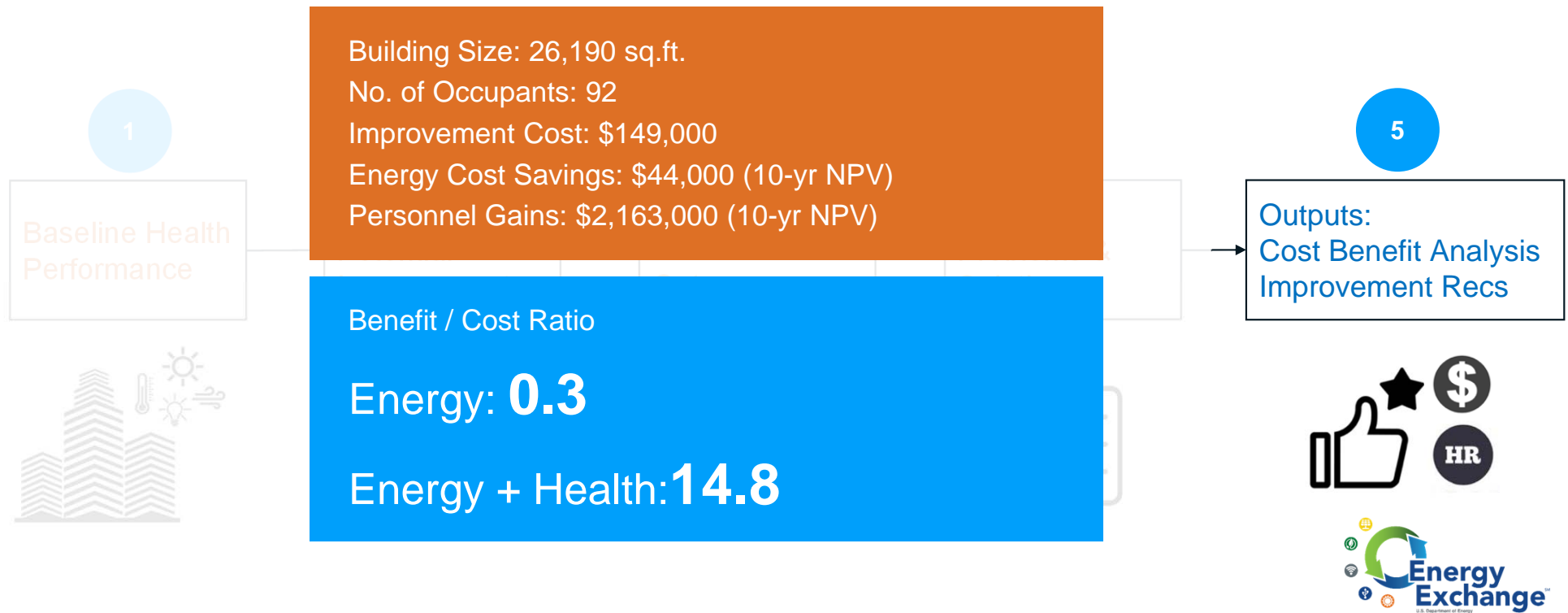


Baseline Metric	Diagnosis Metrics
Horizontal Illuminance	Task Lighting
Glare	Architectural Shading
	Window Treatment and Shading
	Desk Configuration
Particulate Matter (PM)	Air Filters MERV
	Positive Building Pressure
	Outdoor Air Intake Location
	Combustion-based Equipment
PM / CO <sub>2</sub>	Testing and balancing
CO <sub>2</sub>	Air Distribution Effectiveness
CO <sub>2</sub>	Air Distribution/Ventilation System
CO <sub>2</sub> / VOC	Outdoor Airflow Supply
VOC	Low-emitting Materials and Products
Predictive Mean Vote	Personal Thermal Devices
	Enclosure Heat Loss/Gain

A decision tree to deep dive into the area where primary metric is way below the target value and identify improvements.



## Example output from a pilot building:





## Example recommendations from a pilot building:

Issues		Recommendations
<b>Thermal Comfort</b>	Mostly too cool in open offices. Survey shows some complaints of too warm in afternoons, especially spring and summer. Lack of thermal control in open offices.	Increase temperature setpoint in open space; Provide supplemental heating (heated chairs); Add automated shading to windows to reduce solar heat gain.
<b>Indoor Air Quality</b>	No health-related issue. The building is likely over ventilated.	Reduce outdoor airflow by 40% with continuing CO <sub>2</sub> monitoring to ensure no negative impact on occupants.
<b>Electric lighting</b>	The occupant survey reveals that the occupancy sensors are not functioning properly. Some space is underlit.	Recommission occupancy lighting sensors and install daylighting sensors. Add task lighting to underlit workstations.
<b>Circadian Rhythm</b>	Survey complaints about daylight access, window proximity is good but could be better.	Lower partition walls and provide color-tuning task lighting to workstations without windows.

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Outputs:  
Cost Benefit Analysis  
Improvement Recs



# HBI “Program in a Box”

## Equipment Library



## HBI Training Materials



## HBI Calculator (Excel)

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RENEWABLE ENERGY

**Healthy Building Initiative Excel Tool**

The U.S. Department of Energy's Federal Energy Management Program (FEMP), in partnership with the General Services Administration (GSA), is currently investigating how traditional building energy efficiency measures can impact health in the federal sector through the Healthy Buildings Initiative (HBI).

FEMP is currently funding research at the Pacific Northwest National Laboratory (PNNL) to develop a framework for evaluating indoor environmental quality (IEQ) metrics and quantifying the potential financial implications related to improving occupant productivity in federal buildings. The goal of this initiative is to facilitate more holistic decision making in regard to energy efficiency and IEQ when making building upgrades.

This tool allows users to input IEQ data, occupant survey results, and other building information to receive customized improvement recommendations and the potential financial gains of investing in improving IEQ.

1. Use the "Gen. Inputs" tab to enter the number of employees, cost of employees, payback length, and discount rate in highlighted cells. Enter the optional energy and cost information.
2. Use the "Cont. Monitor Data" tab to copy and paste continuously measured temperature, humidity and carbon dioxide data.
3. Use the "Spot Data" tab to enter measurements for circadian stimulus, horizontal illuminance, and particulate matter.
4. Use the "Survey Data" tab to enter the results of the occupant survey.
5. Use the "Diagnostics" tab to enter the required additional building information, which will be based on the data entered in the previous tabs.

The "Results" tab will show the output of the analysis.

More detailed information on how to collect and enter this information is available in the accompanying training slides.

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RENEWABLE ENERGY

FEMP  
Federal Energy Management Program

If we have FEMP website link, should include –  
otherwise include bullet “FEMP website –  
coming soon!”

## Resources:

- **PNNL** Healthy Buildings Initiative website:

<https://www.pnnl.gov/projects/healthy-buildings>

- Energy and Health Nexus white paper:

[https://www.pnnl.gov/sites/default/files/media/file/EED\\_0831\\_BROCH\\_HealthyBuildings\\_v4.pdf](https://www.pnnl.gov/sites/default/files/media/file/EED_0831_BROCH_HealthyBuildings_v4.pdf)

- Case Studies

<https://www.pnnl.gov/healthy-buildings/news-and-publications>





