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

1. Baseline Health Performance
2. Identify Potential Improvements
3. Corelate to Human Outcomes
4. Investigate Problems & Solutions
5. Outputs: Cost Benefit Analysis Improvement Recs
8 Primary metrics to baseline building performance. (10-question supplemental occupant survey)

<table>
<thead>
<tr>
<th>Category</th>
<th>Baseline Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting / Daylighting</td>
<td>Horizontal Illuminance</td>
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<tr>
<td></td>
<td>Circadian Stimulus</td>
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<tr>
<td></td>
<td>Glare</td>
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<tr>
<td>Indoor Air Quality</td>
<td>Particulate Matter</td>
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<td></td>
<td>Carbon Dioxide</td>
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<td></td>
<td>VOC</td>
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<tr>
<td>Thermal Comfort</td>
<td>Predictive Mean Vote</td>
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<td></td>
<td>Humidity</td>
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</table>

Identification of Potential Improvements
Baseline Health Performance
Corelate to Human Outcomes
Investigate Problems & Solutions
Outputs: Cost Benefit Analysis Improvement Recs
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, CO₂), 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 / CO₂ | Testing and balancing
CO₂ | Air Distribution Effectiveness
CO₂ / VOC | Air Distribution/Ventilation System
 | 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:

- Building Size: 26,190 sq.ft.
- No. of Occupants: 92
- Improvement Cost: $149,000
- Energy Cost Savings: $44,000 (10-yr NPV)
- Personnel Gains: $2,163,000 (10-yr NPV)

Benefit / Cost Ratio

- Energy: 0.3
- Energy + Health: 14.8

Outputs: Cost Benefit Analysis Improvement Recs
Example recommendations from a pilot building:

<table>
<thead>
<tr>
<th>Issues</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thermal Comfort</strong></td>
<td>Mostly too cool in open offices. Survey shows some complaints of too warm in</td>
</tr>
<tr>
<td></td>
<td>afternoons, especially spring and summer. Lack of thermal control in open offices.</td>
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<td></td>
<td>Increase temperature setpoint in open space; Provide supplemental heating</td>
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<tr>
<td></td>
<td>(heated chairs); Add automated shading to windows to reduce solar heat gain.</td>
</tr>
<tr>
<td><strong>Indoor Air Quality</strong></td>
<td>No health-related issue. The building is likely over ventilated.</td>
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<tr>
<td></td>
<td>Reduce outdoor airflow by 40% with continuing CO₂ monitoring to ensure no</td>
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<tr>
<td></td>
<td>negative impact on occupants.</td>
</tr>
<tr>
<td><strong>Electric lighting</strong></td>
<td>The occupant survey reveals that the occupancy sensors are not functioning</td>
</tr>
<tr>
<td></td>
<td>properly. Some space is underlit.</td>
</tr>
<tr>
<td></td>
<td>Recommission occupancy lighting sensors and install daylighting sensors. Add</td>
</tr>
<tr>
<td></td>
<td>task lighting to underlit workstations.</td>
</tr>
<tr>
<td><strong>Circadian Rhythm</strong></td>
<td>Survey complaints about daylight access, window proximity is good but could be</td>
</tr>
<tr>
<td></td>
<td>better.</td>
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<tr>
<td></td>
<td>Lower partition walls and provide color-tuning task lighting to workstations</td>
</tr>
<tr>
<td></td>
<td>without windows.</td>
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</tbody>
</table>
HBI “Program in a Box”

Equipment Library

HBI Training Materials

Healthy Building Initiative (HBI)

Program Training Slides

Pacific Northwest National Laboratory

July 2020

HBI Calculator (Excel)

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 regards to energy efficiency and IEQ when making building upgrades.

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

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

FEMP Contact:
jeffrey.murrell@ee.energy.gov

PNNL Contact:
Kevin.Hammond@pnnl.gov
Resources:

- PNNL Healthy Buildings Initiative website:
  https://www.pnnl.gov/projects/healthy-buildings

- Energy and Health Nexus white paper:

- Case Studies