National Institute of Standards and Technology
U.S. Department of Commerce

# Industry Needs Workshop:

# Metrics and Tools for Sustainable Buildings

## Summary Report


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## ACKNOWLEDGMENTS

Thanks to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for assembling a top-notch team of 16 practicing engineers and architects for the industry needs workshop hosted by NIST in December 2010. Each workshop participant deserves special thanks for sharing his time, thoughts, and needs during the workshop. NIST appreciates the unique perspective of those faced with meeting the often conflicting and ever-growing demands of their clients. Designers somehow manage to create buildings that owners are willing to pay for while at the same time incorporating sustainability principles. Also deserving thanks are NIST researchers Joshua Kneifel, Bill Healy, Dave Butry, and Priya Lavappa, who facilitated the breakout groups by keeping participants on track and meticulously recording their thoughts. Bob Chapman, Chief of the Engineering Laboratory's Applied Economics Office, provided valuable oversight throughout, from workshop conception to execution to its summary in this report.

**Disclaimer**

Certain trade names are mentioned throughout the text. In no case does such identification imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the product is the best available for the purpose.

The policy of the National Institute of Standards and Technology is to use metric units in all its published materials. Since this report is intended for U.S. building designers who evaluate performance using customary units, it is more practical and less confusing in some cases to use the customary rather than metric units. Where possible, however, both metric units and their customary equivalents are reported.

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# INTRODUCTION

## *Purpose*

The National Institute of Standards and Technology (NIST) Engineering Laboratory supports the U.S. construction industry by conducting measurement science research, developing performance methods, metrics, and tools for engineering applications, and making critical technical contributions to standards and codes development. One of the laboratory's strategic goals is *Net-Zero Energy, High-Performance Buildings*, including a program aimed at *Improved Building Energy Performance.* Within this framework, the *Metrics and Tools for Sustainable Buildings* project develops, integrates, and applies measurement science assessing the sustainability performance of energy technologies and systems in an integrated building design and operation context.

Through *Metrics and Tools for Sustainable Buildings,* NIST is taking a lead role in providing science-based guidance to the building community on the life cycle environmental and economic performance of specific building types designed to meet and exceed current building energy codes. In order to develop sustainable building metrics and tools that will be useful to practicing designers, the project team convened an industry workshop in December 2010 to gather industry input on their needs in this area. This report compiles and assesses these needs in the context of the NIST mission and the project scope, resulting in a vision for *Metrics and Tools for Sustainable Buildings* that support the needs of practicing designers.

## *Industry Team Composition*

Under contract to NIST, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) identified, invited, and assembled a team of 16 practicing engineers and architects representing a range of subject matter expertise and U.S. climate regions. These designers were selected from among leading members of ASHRAE (consisting mostly of practicing engineers) and the American Institute of Architects (AIA, consisting mostly of practicing architects). At least four team members had design experience in each of the following subject areas:

1. Commercial building design, new buildings
2. Commercial building design, existing buildings
3. Residential building design, new buildings
4. Residential building design, existing buildings

Each team member has practiced design in his subject area within the last 5 years. Among the 16-member team, there was at least one member that practices in each of the four U.S. Census Regions. For a list of team members and their affiliations, see Appendix A.

***Workshop Process***

The agenda for the one-day workshop is given in Appendix B. At the outset, NIST defined several terms to focus the subsequent discussions:

S*ustainability* is the ability to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. In the context of buildings, sustainability applies to their energy use, environmental impacts, and economic impacts. Social equity issues also contribute to sustainability but there is no consensus about its meaning in the context of buildings.

A *metric* is a standard measure to assess performance. Without a metric to measure something we cannot know whether it is getting better or worse. Metrics can be qualitative (e.g., a LEED Silver designation) or quantitative (e.g., carbon footprints).

In the context of the workshop, a *sustainability performance metric* is a standard measure of a building's life-cycle energy, environmental, and/or cost impacts.

Similarly, a *sustainability performance measurement tool* is a technical instrument, typically software, used to facilitate sustainability performance measurement.

Since NIST did not want to bias the team by sharing its own thoughts, no information was provided on its current activities or plans until the conclusion of the workshop.

The workshop consisted of a morning breakout session focused on industry needs for metrics. There were four breakout groups: Commercial Building Design, New Buildings; Commercial Building Design, Existing Buildings; Residential Building Design, New Buildings; and Residential Building Design, Existing Buildings. Each breakout group consisted of four team members—both engineers and architects—with design experience in the topic area, and each was facilitated by a NIST researcher with subject matter expertise. A series of questions were posed by the facilitators, as shown in Appendix B. After each question was posed, team members were given about five minutes to note their responses on index cards. Then, each member in turn was asked for their top response and it was recorded by the facilitator on a flip chart. The process continued with successive responses by each team member, including clarifying questions and discussion among team members as the process unfolded.

The full team assembled after the morning breakout session. Volunteers from each breakout group took turns reporting on their group's responses, with some clarifying questions and additional thoughts raised by the full team.

The afternoon agenda mirrored that of the morning, this time with breakout sessions focused on industry needs for tools. A different series of questions were posed by the facilitators (see Appendix B), but the process of recording and reporting responses to the full team afterwards was the same. Like the morning, each afternoon breakout group consisted of four team members—both engineers and architects—with design experience in the topic area. None of the groups consisted of more than two of the same team members from the morning breakouts.

The workshop concluded with NIST summarizing its initial thoughts on what it heard throughout the day, followed by immediate feedback from the industry team.

***Report Process***

After the workshop, NIST assimilated all the index cards, flip charts, and notes taken throughout the workshop, sorting the needs for metrics and tools according to their fit with the NIST mission and the scope of *Metrics and Tools for Sustainable Buildings*. The following sections report these results and assimilate them into proposed products and timelines for the project that support the needs of practicing designers. To better convey the viewpoint of practicing building designers, the next section is primarily written in the first person.

## WORKSHOP RESULTS

***Metrics***

In Scope. I am a designer, with a client who wants a new or existing building design for a certain location and to meet a given mission and functional use. My client has a certain budget and schedule in mind and may be interested in sustainable design features provided the building's functional requirements and budget are both met. While the client may not have specified further requirements up front, I will likely meet with him/her at the outset of the project to determine the following:

- What attributes must the building provide to fulfill its mission?
- How will success be measured? (e.g.,first cost, payback period, return-on-investment, LEED rating)
- What are the priorities for making tradeoffs among attributes when compromises are necessary?

Sometimes my client is committed to build green from the start. If not, I may convince my client of the long term value of sustainability or I may not. All clients are willing to incorporate sustainable design features at no increase in first cost. More often than not, my client will ask me how my building design compares with similar buildings in the region and nation, particularly with respect to energy efficiency and carbon emissions.

My job is to develop a design strategy that achieves my client's goals. For existing buildings, I have the advantage that I can conduct an assessment of the facility to establish a baseline for building performance.

Within this context, I need *baseline sustainability performance metrics* (SPMs) to design to. Without these, I will not know whether my proposed design features make the building more or less sustainable than others in its class.

I will be using these SPMs at the preliminary design stage when major options are being considered. By and large, the building's shape and form will already have been designed.

- If I am an architect, I need SPMs to help me select major building features and materials. I want these SPMs to include the following measures:
    - Site-based Energy Use Intensity (EUI)
    - Carbon Emissions
    - Embodied energy
    - Life Cycle Assessment (LCA)-based sustainability performance metrics
    - Life Cycle Costing (LCC)-based sustainability performance metrics

- If I am an engineer, I need SPMs to help me select and specify the technologies for the building's systems. I want these SPMs to include the same measures that the architect wants.

I want to use these baseline SPMs to get real-time feedback on the sustainability performance of alternative building materials (e.g., steel, concrete, wood, aluminum, gypsum board) and system technologies. I also want benchmark SPMs for feedback on best-in-class building performance.

Some of us want these metrics to include evaluation of the following, which are often left out of SPMs:

- Integrated design considerations
- Plug loads
- Component performance
- Daylighting
- Indoor air quality
- Water consumption
- Stormwater management
- New technologies
- Acoustics
- Durability
- Recyclability
- Deconstructability/Benefits of Re-Use

Those of us designing new residential buildings want these metrics to include transit considerations.

I want these metrics, and supporting data, to have the following qualities:

- Unbiased
- Robust
- Up-to-date
- Accurate
- Transparent
- Consistent
- Simple
- Quantitative
- In absolute rather than relative terms
- Adaptable to site-specific conditions

Over time, I want these metrics to actively seek and incorporate feedback to improve upon themselves. For example, baseline metrics may require recalibration from time to time as measurement science improves and the industry evolves.

If I am designing a project for an existing building, I have ready access to more data including baseline performance values. Also, it is far more likely my client's requirements will be well specified. Countering these advantages is the reality that, at the same time, I have fewer design options due to restrictions posed by the existing structure.

If I am designing a small project such as a single-family home I cannot do many of the big things available at larger scales unless my client is motivated and willing to pay for them. I have fewer design options and less time and money to spend on measuring and analyzing sustainability performance.

Out of Scope. A number of other legitimate metrics-related issues were raised that are beyond the scope of *Metrics and Tools for Sustainable Buildings*. These can be grouped according to the reason they are out of scope.

*Beyond the NIST mission.* Before NIST launches a research project it asks itself, "Why NIST?" In other words, does the project align with the NIST mission and core competencies? NIST is a non-regulatory federal agency with a mission to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. Its core competencies are measurement science, rigorous traceability, and development and use of standards. In this context, its statutory authorities and/or policies restrict policymaking, technology development, product testing, and human subject testing. While the following industry needs articulated at the workshop are reasonable, they fall outside the scope of activities aligned with the NIST mission:

- Incorporate negative points into the LEED rating system to discourage environmentally insensitive design practices (private sector domain)
- Conduct third-party assessments of manufacturer's product sustainability claims (product testing)
- Conduct human behavior studies to determine how building occupants use energy and interact with energy technologies (human subject testing)

*Beyond the project mission. Metrics and Tools for Sustainable Buildings* was conceived and funded to address several mission-appropriate, high-priority national research needs identified by 16 Federal agencies in the White House report, *Federal R&D Agenda for Net-Zero Energy, High Performance Green Buildings*.[1] In particular, the project addresses the high-priority national

[1] National Science and Technology Council, *Federal Research and Development Agenda for Net-Zero Energy, High-Performance Green Buildings*, Report of the Subcommittee on Building Technology Research and Development, Washington, D.C., October 2008.

need for Performance Metric Integration covering energy, environmental, and economic performance at the whole building level. Its current scope excludes:

- Validating existing simulation software to better predict actual building performance
- Improving weather data used by energy simulation tools
- Estimating energy savings for automated control schemes
- Developing databases of occupant-based loads
- Developing social sustainability metrics covering intangibles such as quality of life
- Connecting human performance (occupant comfort/satisfaction/health/productivity) and building performance
- Connecting building performance with community performance

Some of these industry needs could be addressed over time by other NIST or other agency projects.

***Tools***

In Scope. We are dissatisfied with existing tools for sustainable building design. While many of us are LEED Accredited Professionals, we think the rating system is too prescriptive and needs a stronger scientific basis. While many of us use the U.S. Department of Energy Commercial Building Energy Consumption Survey (CBECS) in our work, we think its sample sizes are too small to be representative. Many of us use building simulation tools in our work, but the comprehensive tools are too difficult to use and the more user-friendly versions are too simplistic.

Many of us want a comprehensive early design tool for the whole building that we can use at the preliminary design stage when we are considering major options. Some of us, primarily architects, instead want an early design tool at the building *component* level, preferring instead to sum the disaggregated component scores ourselves.

Some of us want these tools to report metrics in ranges rather than as single point values, or as point values with a capability for sensitivity analysis. Others prefer the greater simplicity of single point values. Most cannot afford to spend a great deal of time learning and implementing complicated tools to identify more sustainable design solutions.

Some of us want these tools to be used by designers alone, while others are interested in a single tool that can be understood and applied by building operators and occupants as well.

Regardless, I want the tool to have the following qualities:

- Simple to use
- Easy-to-interpret, intuitive results

- Defaults for data inputs and initial assumptions
- Drill-down capability for detailed data and results
- What-if features

I want the tool to give me real-time feedback on the sustainability performance of alternative building materials and technologies. You can think of the tool as *Turbo Tax* for buildings, with optional defaults. I do not want a tool with extensive data input requirements because by the time I know their values it will be too late: the design will be too far along. Based on various general design parameters I set, I want the tool to output the corresponding SPMs.

A basic example of what I mean is shown in Figure 1. First I would enter the location of my building and other basic information like the energy code for the design and the building type, size, and shape. Based on this information, a rudimentary sketch of my building would be displayed. While the sketch would not show the actual placement of windows, it would apply my window-to-wall ratio equally on all facades, for all floors, and in horizontal bands.

I could then select materials for the building shell. From a list of major materials options I could drag-and-drop my selections onto the building sketch. Figure 1 shows how I've selected brick-and-concrete exterior walls with glazing and a tar/gravel roof.

Once I chose major energy systems and analysis parameters like my client's time horizon (study period), the sustainability performance dashboard across the top would show me where my current design settings place the building in relation to baseline SPM values for a similar building of that type and size in my location.

- The *Carbon* SPM accounts for life-cycle carbon dioxide-equivalent emissions attributable to both the building's materials and its energy use.
- The *Embodied Energy* SPM accounts for life-cycle energy use attributable to both the building's materials and its energy use.
- The *LCA Score* SPM accounts for a comprehensive set of life-cycle environmental impacts attributable to materials and energy use such as global warming, acidification, fossil fuel depletion, smog, indoor air quality, habitat alteration, water intake, criteria air pollutants, human health (cancer- and noncancer-related), ecological toxicity, ozone depletion, and eutrophication (water pollution).
- The *Cost-Effectiveness* SPM accounts for first and future costs associated with constructing/retrofitting and operating the building I am designing.
- The *Site-Based Energy Use Intensity* SPM accounts for the building's operating energy consumption per 0.09 $m^2$ (1 $ft^2$), excluding transmission, delivery, and production losses.

When I change my settings the dashboard will change accordingly. I can change the energy code to a benchmark code—such as one exceeding the latest version of ASHRAE 90.1—to see results for a best-in-class building. I can swap out my shell materials to test the

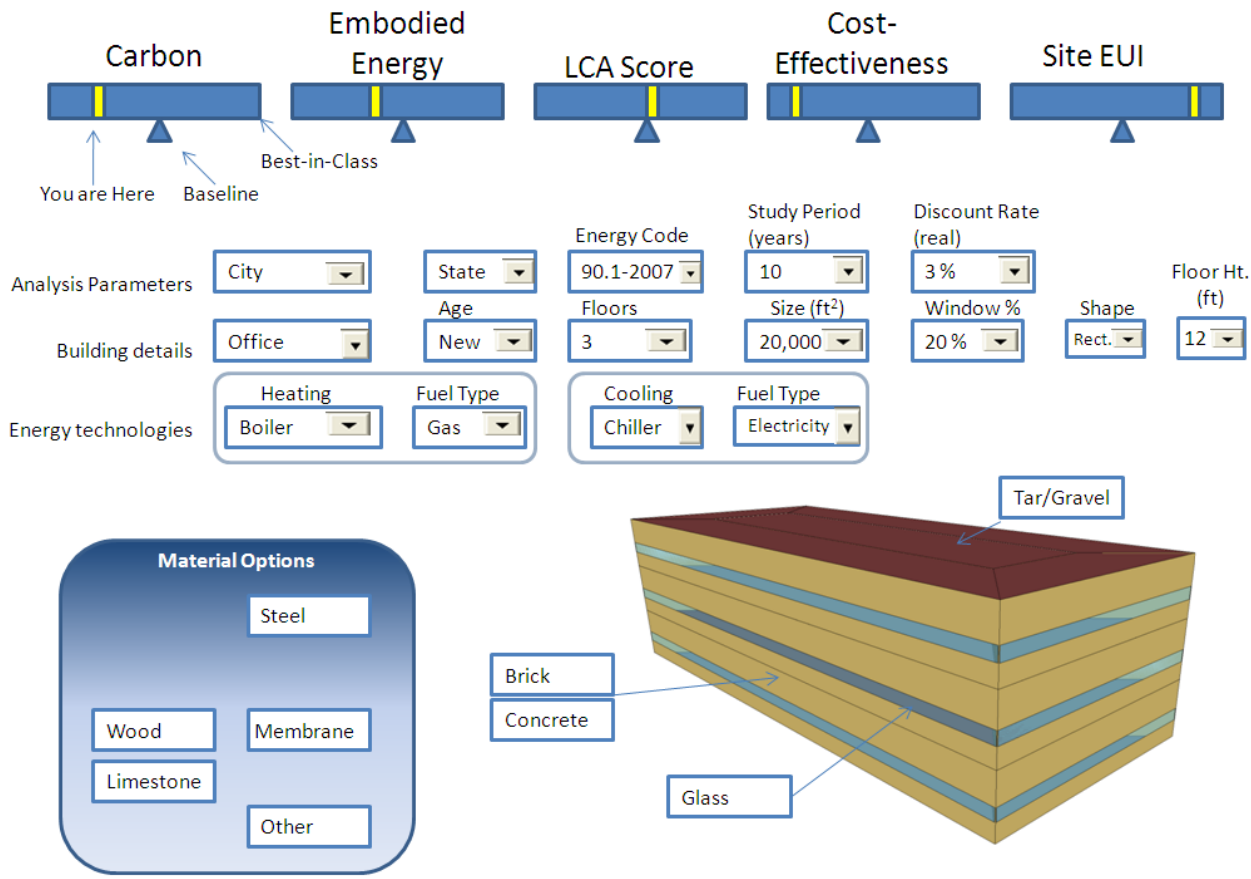


**Figure 1. A Vision for the NIST Sustainability Calculator**

importance of these selections to my building's sustainability performance. I can click on each SPM for more detailed results for the metric.

Most of us want all of the above within one year-to-three years. Once the tool is launched, we want training to be offered in its use.

Out of Scope. A number of legitimate tools-related issues were raised that are beyond the scope of *Metrics and Tools for Sustainable Buildings*. These can be grouped according to the reason they are out of scope.

*Beyond the NIST mission.* NIST's statutory authorities and/or policies restrict policymaking, technology development, product testing, and human subject testing. While the following industry needs articulated at the workshop are reasonable, they fall outside the scope of activities aligned with the NIST mission:

- Offer rebates/incentives to encourage sustainable building practices (regulatory)
- Modify utility pricing structures to encourage sustainable building practices (regulatory)

- Require building re-commissioning (regulatory)
- Accredit contractors, owners, and facility managers in energy monitoring, to avoid "giving keys to an aircraft carrier to someone driving a boat" (private sector domain)
- Develop cost-effective, commercially available submetering technologies, primarily for multifamily residential application (technology development)

*Beyond the project mission. Metrics and Tools for Sustainable Buildings* addresses the high-priority national need for Performance Metric Integration covering energy, environmental, and economic performance at the whole building level. Its current scope excludes:

- Developing energy auditing tools
- Developing submetering tools that give real-time feedback to occupants

Some of these industry needs may be addressed over time by other NIST or other agency projects.

## SUMMARY AND DISCUSSION

The industry workshop reinforced the objective and general approach of *Metrics and Tools for Sustainable Buildings*:

> ***Objective:*** *By FY 2015, develop, integrate, and apply measurement science assessing the sustainability performance of energy technologies and systems in an integrated building design and operation context.*
>
> ***Summary:*** *Building stakeholders need compelling, practical metrics, tools, and data to support investment choices and policy making related to sustainable building designs, technologies, and regulations.*[2] *NIST is addressing this high priority national need by extending to whole buildings its metrics and tool for sustainable building products known as BEES. This involves developing whole building sustainability metrics based on innovative extensions to LCA and LCC approaches involving building energy simulations. These new metrics assess the "carbon footprint" of buildings as well as 11 other environmental performance metrics, and integrate economic performance metrics to yield science-based measures of the business case for investment choices in green buildings.*

To a great extent, the workshop helped NIST flesh out a clear vision for execution and delivery of the project results to its customers. While designers are not of a single mind relative to their *specific* needs, a number of generalities are clear. Their clients want to know how their designs compare with similar buildings in the region and nation, particularly with respect to energy efficiency and carbon emissions. To answer these questions, designers need baseline sustainability performance metrics at the preliminary design stage when major options are being considered. These baseline metrics will serve as yardsticks indicating whether an option makes the building more or less sustainable than others in its class. The highest metric value will indicate best-in-class sustainability performance.

Designers want to gauge sustainability across many dimensions. One single, all-encompassing sustainability score is desirable, but not sufficient. An LCA-based score, measuring the combined life-cycle performance of a building's materials and operational energy, is a valuable indicator of overall environmental performance. Since energy consumption and related carbon emissions tend to be large contributors to overall environmental performance—and choices made at the preliminary design stage have large consequences on both—energy-focused metrics are also key. Similarly, an LCC-based metric is a valuable indicator of overall economic

[2] *Metrics and Tools for Sustainable Buildings* is also addressing the needs of a policymaking audience by evaluating the energy, carbon, and life-cycle cost impacts of states adopting more stringent energy codes.

performance. Since business decisions often disregard benefits and costs occurring over the long run, first cost and payback metrics are also key.

Above all, designers want credible SPMs. To them, this means they are state-of-the-art, quantitative metrics based on sound science and economics. The metrics use robust, accurate, and current data sets that are compatible and consistent with one another. The metrics are easy to apply and at the same time their derivation is transparent. Finally, designers do not want static metrics; rather, they want metrics that evolve to incorporate feedback as industry and science change.

When it comes to design tools reporting these metrics, the need is clear for real-time feedback on the sustainability performance of alternative building materials and technologies. To account for the synergistic effects of integrated design on energy efficiency, these tools should evaluate the impact that material and technology choices have in the context of the whole building. To accommodate the tendency for architects to focus more on material choices, and engineers more on systems choices, both types of choices should be featured prominently in the tool. The universal and driving need is for a tool that is simple and quick to use and that reports readily understood results. A dashboard-based look and feel to the interface, with minimal input from the user and optional defaults, would provide these attributes. The SPM yardsticks should be displayed as “sliders” showing design, baseline, and benchmark performance values. Real-time feedback that updates the dashboard as major design choices change would give designers the flexibility and simplicity they seek. Drill-down features could provide more detail on results for those measures of particular interest to the designer and/or client.

An unexpected outcome of the workshop is that, by and large, whether a project is for a new versus existing design, or for a residential versus commercial building, designers share similar needs and concerns. The differences relate more to the range and likelihood of options being available for existing buildings and residential projects. For an existing building design, sustainability performance is easier to assess because credible data are easier to gather and design options are more limited. The subtleties associated with residential projects are also relevant to small commercial projects, as they relate more to the size of the project than the building type. The likelihood of having the freedom to consider sustainability as a design goal decreases as the size of the project decreases. No matter the building sector or project size, or whether designing for a new or existing building, the needs for metrics and tools are the same. The differences lie in the ease of making sustainable design decisions, or whether these decisions are even made at all.

## FUTURE DIRECTIONS

### *Timeline*

Not surprisingly, the industry team would like NIST to address its major needs for metrics and tools in the short term (1 yr to 3 yr). While this rapid turnaround is not feasible, NIST proposes a roadmap for execution and delivery of *Metrics and Tools for Sustainable Buildings* that addresses the major, in scope needs by the end of 2015.

The project will deliver its results in two phases. The first phase will deliver a basic sustainability calculator with limited output metrics. In particular, the life-cycle energy and environmental impacts of a building's *materials use* will be excluded. This means the Carbon Emissions, Embodied Energy, and LCA Score SPMs will focus exclusively on the building's *operating energy use* as shown in Figure 2. Since the building's *materials costs* will be known in Phase One, the Cost-Effectiveness SPM will not be limited. Site EUI will not change either because, by definition, it evaluates only operating energy use. In sum, the tool will be focused on the sustainability of a building's operating energy and cost performance, without reference to the environmental impacts of the building materials.

The Phase One tool will not display a building sketch with materials options because building designs will be pre-defined. The calculator will evaluate the sustainability of *prototypical* new commercial and residential building designs. Yet designers will be able to evaluate these prototype designs across a wide range of building types, locations, energy codes, and study periods. New commercial buildings, for example, will have the following coverage:

- 12 building types
- 228 U.S. locations
- 5 energy codes
- 40 study periods

While the Phase One tool will not have the design flexibility envisioned for Phase Two, it will be developed in a way that these options and tool features can seamlessly be added during the second phase.

In the second phase, the vision for the tool will be realized. As shown in Figure 1, this more sophisticated calculator adds LCA-based results for the materials used in the building. This expands the Carbon Emissions, Embodied Energy, and LCA Score metrics to be fully representative of a building's life-cycle carbon footprint and energy consumption. Users will be better able to evaluate their own designs through access to a wider range of data input options. Existing building design options will be added to the tool, as will extensive drill-down reporting for each SPM. The sliders reporting the SPM values will become interactive, adding a powerful new feature to the tool: besides the phase one ability to change input values to gauge dashboard

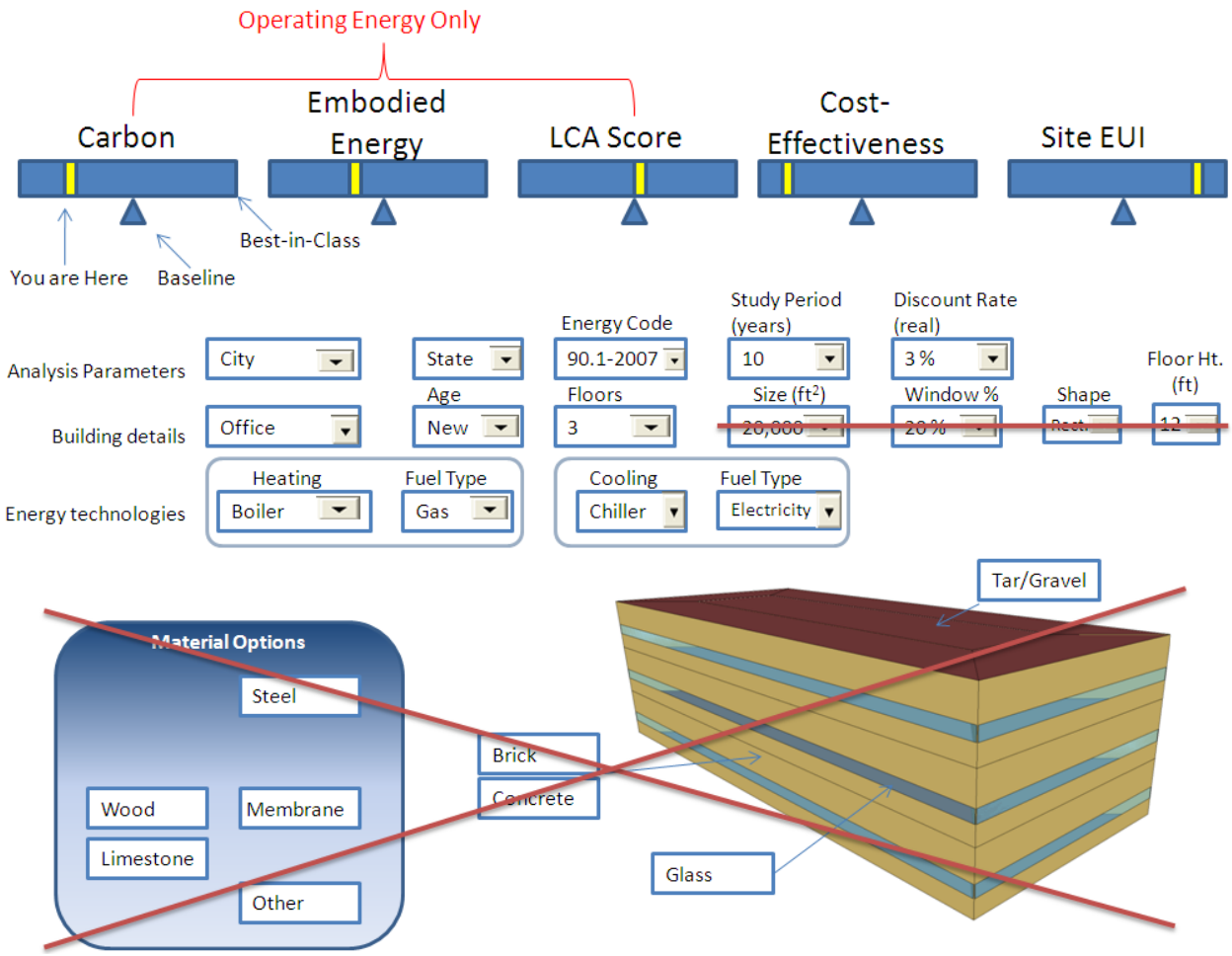


**Figure 2. NIST Sustainability Calculator: Phase One**

impacts, users will be able to set dashboard goals to gauge design parameter impacts. While the tool will report more comprehensive and flexible results, its basic look and feel to the casual user will remain the same.

While feedback from the building community at large, and other important NIST stakeholders, will inform possible metric and tool development beyond 2015, many specific needs articulated at the December 2010 workshop could be addressed in the long run. These needs, expressed by individual participants or small groups of participants, relate to aspects of sustainability performance that may be *covered* by one or more dashboard inputs or SPMs but are not *featured* in their reporting. Examples include access to transit, component performance, durability, water use, and indoor air quality. These aspects of sustainability performance can be generally addressed by adding a feature to the tool permitting users to customize the dashboard. If Water Use is of more concern to a client than Site-Based EUI, for example, designers could promote this aspect of the LCA Score to the dashboard and demote Site-Based EUI to reporting at the

drill-down level. In other words, a customizable dashboard would permit designers to highlight those SPMs particularly relevant to the project.

### *Ongoing Industry Team Collaboration*

The industry needs workshop held at NIST in December 2010 served its purpose. NIST now has a much better sense for the sustainability metrics and tool features that would be most useful to designers. This report summarizes those needs and translates those that can be addressed by *Metrics and Tools for Sustainable Buildings* into a vision for project execution and delivery to its customers. As a next step, NIST seeks feedback from industry team members on this workshop summary and project vision.

The industry team consists of leading engineers and architects with practical experience incorporating sustainable design principles into building projects. It is a diverse team representing all regions of the country in the practice of new and existing commercial and residential building design. From the discussions that took place during the workshop it was evident that, as one participant noted, “many really good minds” were at the table. NIST hopes to continue networking with the team as its project evolves for ongoing dialog and feedback. On an annual basis, NIST proposes to convene a formal meeting of the industry team—perhaps alternating between virtual and in-person meetings from one year to the next—for feedback on its progress and plans for the upcoming year. On the years it nears completion of its first- and second-generation tools, for example, NIST could share pre-release versions with the team for Beta testing followed by a web-based forum for structured feedback. In-person meetings could be held in the intervening years that focus on the full range of project activities.

## APPENDIX A. Industry Team Members

### Engineers

**Steve Beck**
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**Bill Worthen**
**Principal**, Urban Fabrick
**Vice President**, Simon & Associates, Inc
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## APPENDIX B. Workshop Agenda

**Industry Needs: Metrics and Tools for Sustainable Buildings**
**National Institute of Standards and Technology**
**100 Bureau Drive, Gaithersburg, MD**
**Administration Building, Lecture Room F**

**December 9, 2010**

8:30-9:00 Coffee

9:00-9:15 Introductory Remarks: Purpose, Agenda
Barbara Lippiatt, NIST Metrics and Tools Project Leader

9:15-9:30 Industry Team Member Introductions

9:30-10:45 Breakouts by Subject Matter Expertise: Metrics
*What decisions do you face for which you use sustainability performance metrics?*
*How do you currently make these decisions?*
*What demands for sustainability performance metrics are placed on you by codes and clients?*

*What is missing from these metrics?*

Commercial Building Design, New Buildings
Joshua Kneifel, NIST Facilitator
Room B-111

Commercial Building Design, Existing Buildings
Priya Lavappa, NIST Facilitator
Lecture Room F

Residential Building Design, New Buildings
David Butry, NIST Facilitator
Room B-113

Residential Building Design, Existing Buildings
William Healy, NIST Facilitator
Dining Room B

10:45-11:00 Break

11:00-12:00 Breakout Reports
Volunteer from each breakout group
Lecture Room F

12:00-1:00 Lunch at your own expense
Dining Room B

1:00-2:15 Breakouts by Subject Matter Expertise: Tools
*What tools do you use for sustainability performance measurement?*
*What is missing from these tools?*
*Which of these needs are short-term (1-3 years), medium-term (3-5 years) and long-term (5+ years)?*

2:15-2:30 Break

2:30-3:30 Breakout Reports
Volunteer from each breakout group
Lecture Room F