NIST Technical Note XXXX

Building Industry Reporting and Design for Sustainability (BIRDS) Tutorial for New Residential Database

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Abstract

Building stakeholders need practical metrics, data, and tools to support decisions related to sustainable building designs, technologies, standards, and codes. The Engineering Laboratory of the National Institute of Standards and Technology (NIST) has addressed this high priority national need by extending its metrics and tools for sustainable building products, known as Building for Environmental and Economic Sustainability (BEES), to whole buildings. Whole building sustainability metrics have been developed based on innovative extensions to life-cycle assessment (LCA) and life-cycle costing (LCC) approaches involving whole building energy simulations. The measurement system evaluates the sustainability of both the materials and the energy used by a building over time. It assesses the "carbon footprint" of buildings as well as 11 other environmental performance metrics, and integrates economic performance metrics to yield science-based measures of the business case for investment choices in high-performance green buildings.

Building Industry Reporting and Design for Sustainability (BIRDS) applies the new sustainability measurement system to an extensive whole building performance database NIST has compiled for this purpose. The BIRDS new residential building database includes energy, environmental, and cost measurements for 9120 new residential buildings, covering 10 single-family dwellings (5 one-story and 5 two-story of varying conditioned floor area) in 228 cities across all U.S. states for study period lengths ranging from 1 year to 40 years. The sustainability performance of buildings designed to meet current state energy codes can be compared to their performance when meeting three alternative building energy standard editions to determine the impact of energy efficiency on sustainability performance. The impact of the building location and the investor's time horizon on sustainability performance can also be measured.

This document is a tutorial to assist BIRDS users in understanding and using the BIRDS New Residential Buildings Database Web Interface, including detailed definitions for and explanation for the purpose of each input and output option.

Keywords

Building economics; economic analysis; life-cycle costing; life-cycle assessment; energy efficiency; residential buildings

Preface

This study was conducted by the Applied Economics Office (AEO) in the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST). The BIRDS new residential database web interface is designed to assess the sustainability performance (energy, environmental, and cost impacts) from the adoption of new residential building designs. The intended audience is users of BIRDS, such as researchers and decision makers in the residential building sector, and others interested in building sustainability.

Disclaimers

The policy of the National Institute of Standards and Technology is to use metric units in all of its published materials. Because this report is intended for the U.S. construction industry that uses U.S. customary units, it is more practical and less confusing to include U.S. customary units as well as metric units. Measurement values in this report are therefore stated in metric units first, followed by the corresponding values in U.S. customary units within parentheses.

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List of Acronyms

Acronym	Definition
AEO	Applied Economics Office
BEES	Building for Environmental and Economic Sustainability
BIRDS	Building Industry Reporting and Design for Sustainability
CO2e	cardon dioxide equivalent
EIS	Environmental Impact Score
EL	Engineering Laboratory
EPA	Environmental Protection Agency
FAQ	Frequently Asked Questions
HVAC	Heating, Ventilation, and Air Conditioning
IECC	International Energy Conservation Code
I-O	input-output
ISO	International Organization for Standardization
LCA	Life-Cycle Assessment
LCC	Life-Cycle Cost
NIST	National Institute of Standards and Technology
NZERTF	Net-Zero Energy Residential Test Facility
SFD	Single-Family Detached

1 Introduction

A wave of interest in sustainability gathered momentum in 1992 with the Rio Earth Summit, during which the international community agreed upon a definition of sustainability in the Bruntland report: "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). In the context of sustainable development, needs can be thought to include the often-conflicting goals of environmental quality, economic well-being, and social justice. While the intent of the 1992 summit was to initiate environmental and social progress, it seemed to have instead brought about greater debate over the inherent conflict between sustainability and economic development.

This conflict is particularly apparent within the construction industry. Frequently, well-intentioned green development plans are not executed for economic reasons, and economic development plans fail to materialize over concerns for the environment and public health. Thus, an integrated approach to sustainable construction—one that simultaneously considers both environmental and economic performance—lies at the heart of reconciling the conflict. For this reason, building stakeholders need practical metrics, data, and tools to support decisions related to sustainable building designs, technologies, standards, and codes that consider both the environmental and economic dimensions of sustainability.

The Engineering Laboratory (EL) of the National Institute of Standards and Technology (NIST) has addressed this high priority national need by extending its metrics and tools for sustainable building products, known as Building for Environmental and Economic Sustainability (BEES) (BEES 2010), to whole buildings. Whole building sustainability metrics have been developed based on innovative extensions to life-cycle assessment (LCA) and life-cycle costing (LCC) approaches involving whole building energy simulations. The measurement system evaluates the sustainability of both the materials and the energy used by a building over time. It assesses the "carbon footprint" of buildings as well as 11 other environmental performance metrics, and integrates economic performance metrics to yield science-based measures of the business case for investment choices in high-performance green buildings. The BEES approach does not consider the social dimension of sustainability due to the current lack of rigorous measurement methods.

The approach developed for BEES has now been applied at the whole building level to address building sustainability measurement in a holistic, integrated manner that considers complex interactions among building materials, energy technologies, and systems across dimensions of performance, scale, and time. Building Industry Reporting and Design for Sustainability (BIRDS) applies the new sustainability measurement system to an extensive whole building performance database NIST has compiled for this purpose (BIRDS 2014). The energy, environment, and cost data in BIRDS measure building operating energy use through detailed energy simulations, building materials use through innovative life-cycle material inventories, and building costs over time. BIRDS v1.0 included energy, environmental, and cost measurements

for 12 540 new commercial and non low-rise residential buildings, covering 11 building prototypes in 228 cities across all U.S. states for 9 study period lengths. All these variables are accounted for in the BIRDS database, as shown in Figure 1-1. See Lippiatt et al. (2013) for additional details.

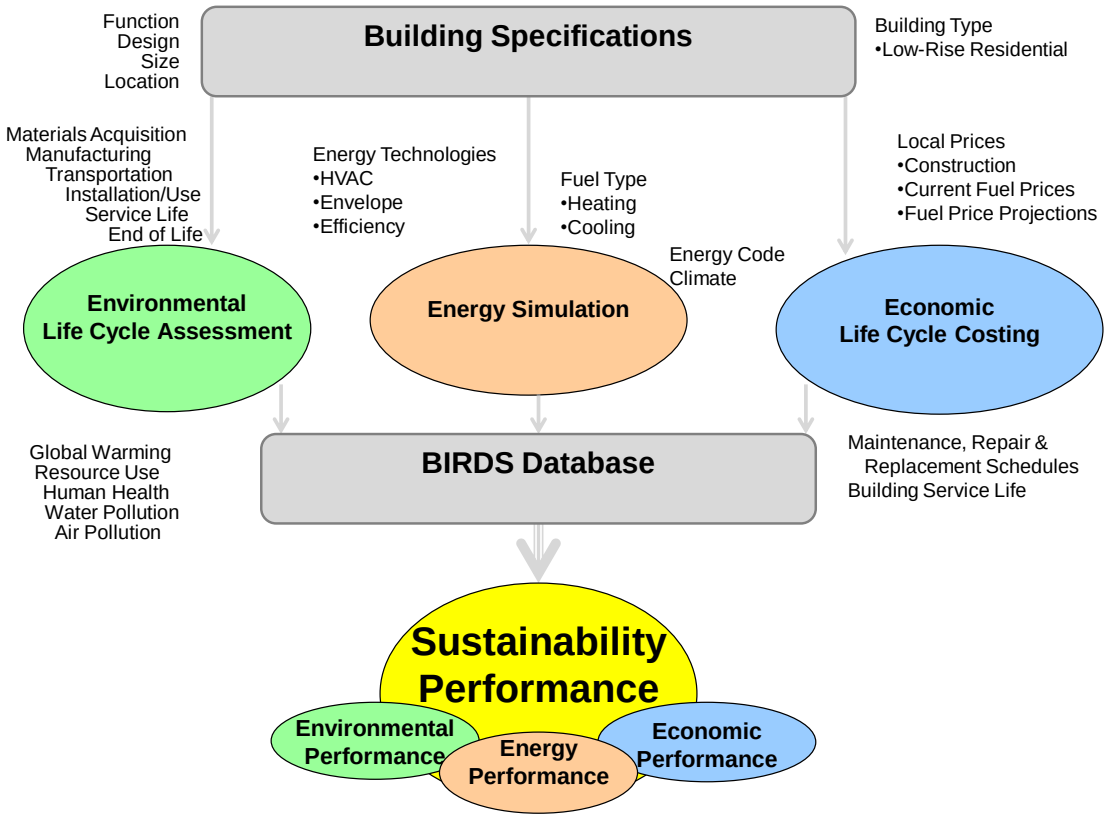


Figure 1-1 BIRDS Sustainability Framework

Similarly, the new residential building database incorporated into BIRDS v2.0 includes energy, environmental, and cost measurements for 9120 new residential buildings, covering 10 single family dwellings (5 one-story and 5 two-story of varying conditioned floor area) in 228 cities across all U.S. states for study period length ranging from 1 year to 40 years. The sustainability performance of buildings designed to meet current state residential energy codes (based on building requirements defined in the International Energy Conservation Code (IECC)) can be compared to their performance when meeting three alternative building energy standard editions to determine the impact of energy efficiency on sustainability performance. The impact of the building location and the investor's time horizon on sustainability performance can also be measured. This document displays the capabilities of the BIRDS new residential buildings database through a detailed tutorial. See Kneifel et al. (2015) for additional details related to the underlying assumptions and approaches implemented to develop the BIRDS new residential database.

2 BIRDS New Residential Buildings Database Tutorial

A user begins on the BIRDS main webpage, which is a "one-stop shop" for information related to BIRDS. In the center of the webpage, there is an introduction to the purpose and capabilities of the BIRDS databases (highlighted in Figure 2-1).

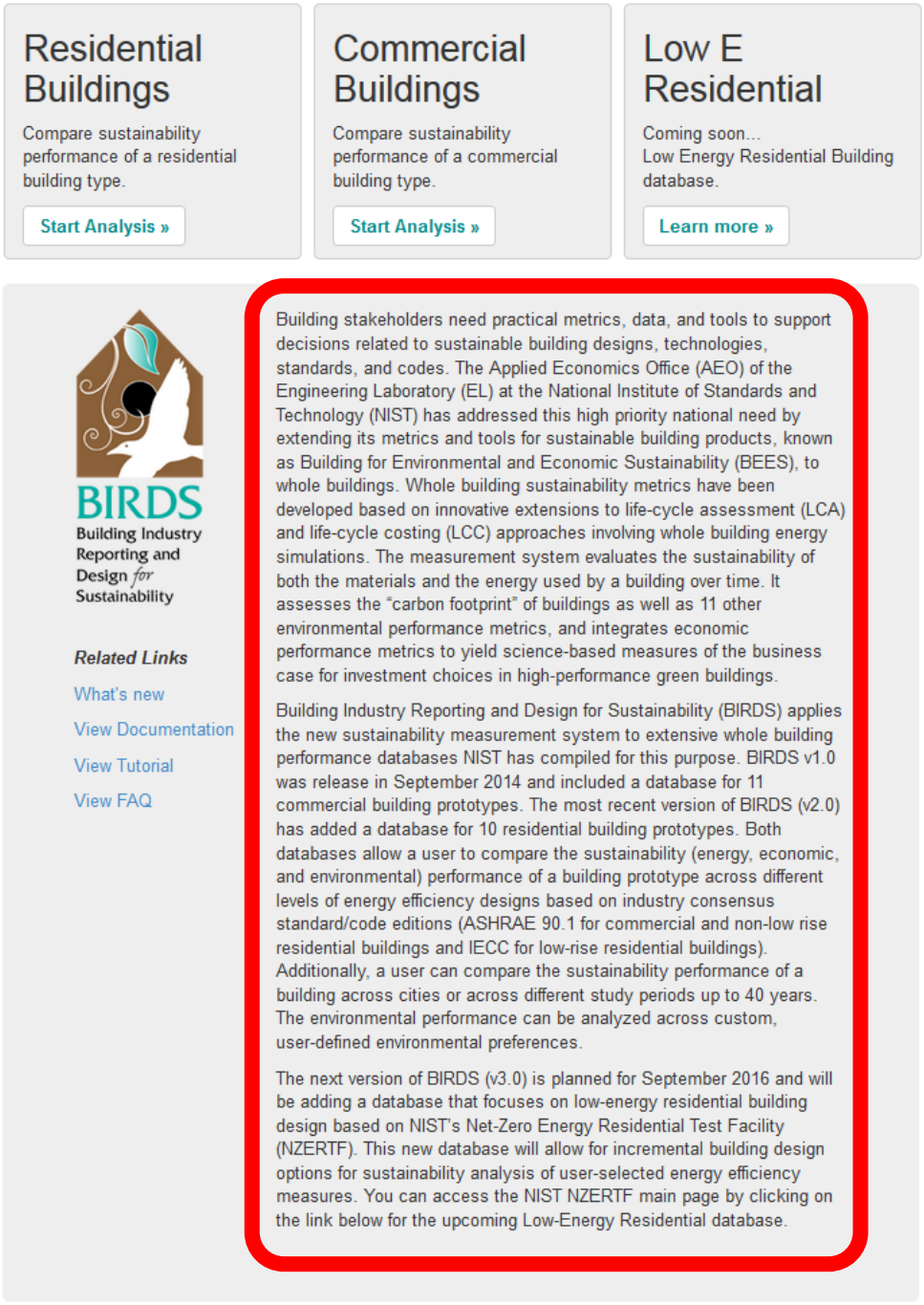


Figure 2-1 BIRDS Main Webpage - Introduction

On the left hand side of the main page, a user can access information related to BIRDS, including recent news, related publications, and other related links (highlighted in Figure 2-2). Recent news will include news articles, press releases, and announcements related to BIRDS. The most recent and/or most downloaded BIRDS-related publications are shown, which a link to the NIST publication database to allow for a complete search of BIRDS publications. Related links include BIRDS's "sister software" – BEES – that allows for comparison of individual building products and the NIST NZERTF main page as well as access to the Applied Economics Office and the Engineering Laboratory at NIST.

If the user is interested in additional information not available from the BIRDS main page or have comments to improve BIRDS, a user can contact NIST at either of the email addresses at the bottom of the main page (birds@nist.gov or joshua.kneifel@nist.gov).

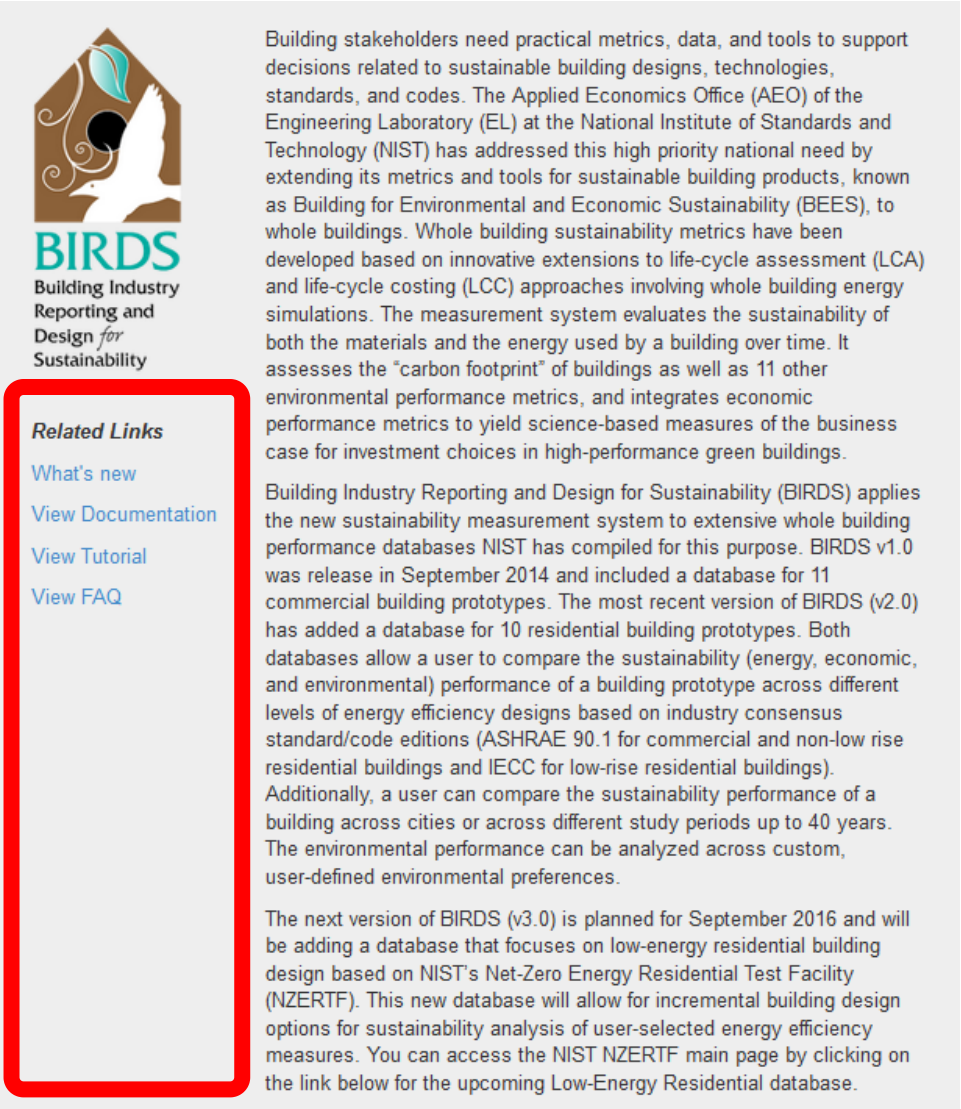


Figure 2-2 BIRDS Main Webpage – Related Links

Above the introduction are links directing you to each of the BIRDS databases (highlighted in Figure 2-3). The Residential Buildings and Commercial Buildings "Start Analysis >>" links direct you to the new residential database and new commercial buildings database, respectively. Each database allows for sustainability comparison across different building designs based on building energy code/standard. The current Low Energy Residential "Learn More >>" link directs the user to the NIST NZERTF webpage, where the user can access specifications, performance data, publications, and other information about the NZERTF. Once the Low Energy Residential database web interface is released (planned for September 2016) The link will eventually be changed to the "Start Analysis >>" link directing the user to the low-energy residential database, which will allow a user to compare the sustainability performance of incremental changes in energy efficiency measures adopted in a single-family dwelling based on the NIST Net Zero Energy Residential Test Facility (NZERTF) ranging from 2003 IECC to the NZERTF design.

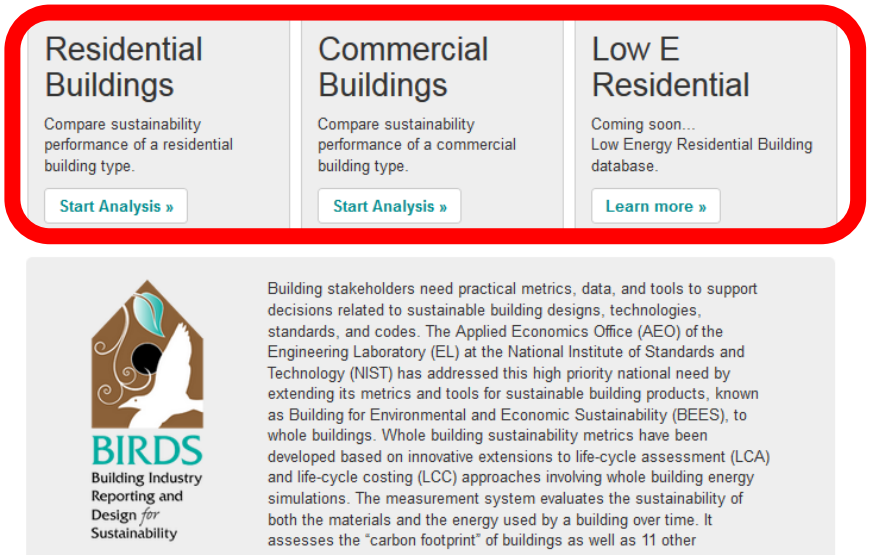


Figure 2-3 BIRDS Main Webpage – Database Links

For this tutorial, the user selects the Residential Buildings "Start Analysis >>" link and is directed to the BIRDS New Residential database web interface (highlighted in Figure 2-4).

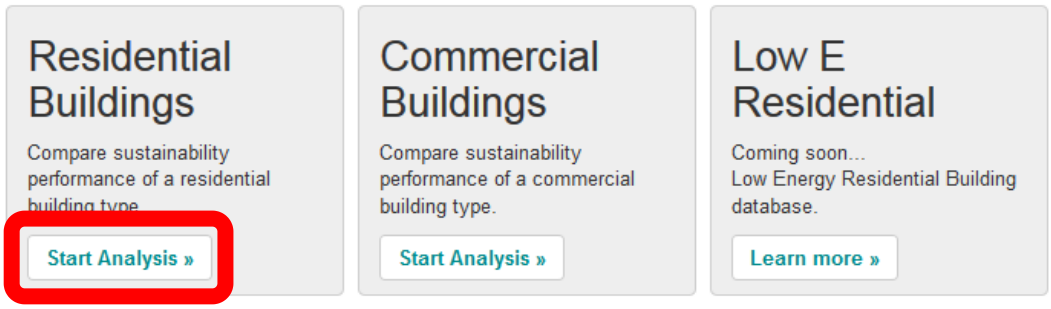


Figure 2-4 BIRDS Main Webpage – Start Analysis

The New Residential web interface defaults the user to Step 1 as shown in Figure 2-5. There are four steps in completing and viewing sustainability comparisons:

1. Select the building prototype to evaluate.
2. Select baseline values and alternatives for comparison (location, standard edition, and study period).
3. Select baseline and alternative weighting preferences for environmental performance.
4. View results graph and data.

At any step in the process, the user can access the BIRDS Home webpage, BIRDS New Residential database documentation, this tutorial, and the BIRDS FAQ at the top-right corner of the page as shown in Figure 2-5.

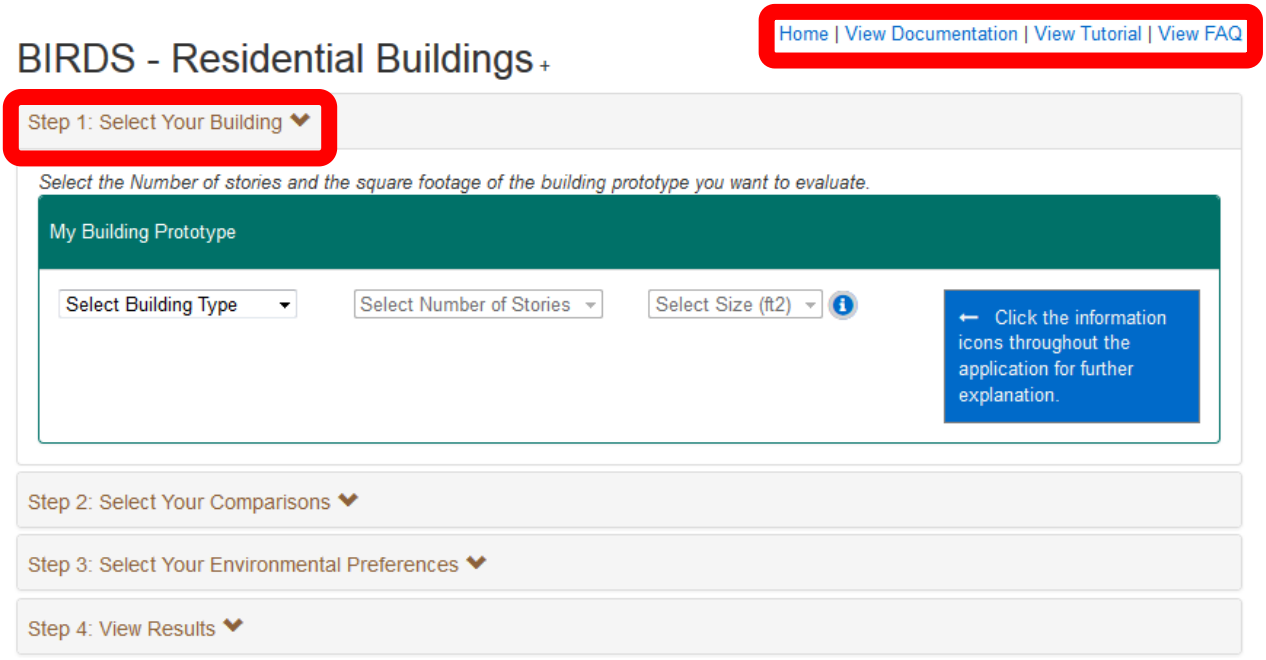


Figure 2-5 BIRDS New Residential Interface – Initial View

The remainder of this tutorial will walk the user through a detailed example and the resulting comparisons available to the user. Note that there are a variety of values that the user must select in order to view results, but BIRDS v2.0 includes further information (by clicking on the information icons) and default values (where determined necessary) to assist a user in making those selections.

2.1 Step 1: Selecting Your Building

The user completes "Step 1: Select Your Building" by selecting the building characteristics from the drop-down menus as shown in Figure 2-6 that best match to the building the user wants to analyze. The selections are sequential, and must be selected from left to right. The user first selects the Building Type, which is currently defaulted to SFD = single family detached

dwellings (i.e. houses). Second, the user selects the Number of Stories, which currently includes 1-story or 2-stories.[1] Finally, the user selects the Size (ft^2). There are five different "sizes" for both 1-story and 2-story single-family detached dwellings. Note that future versions of the new residential database could include low-rise multifamily dwellings (apartment buildings and condominiums) and/or semi-detached dwellings (townhouses), each of which could include a 3-story option.

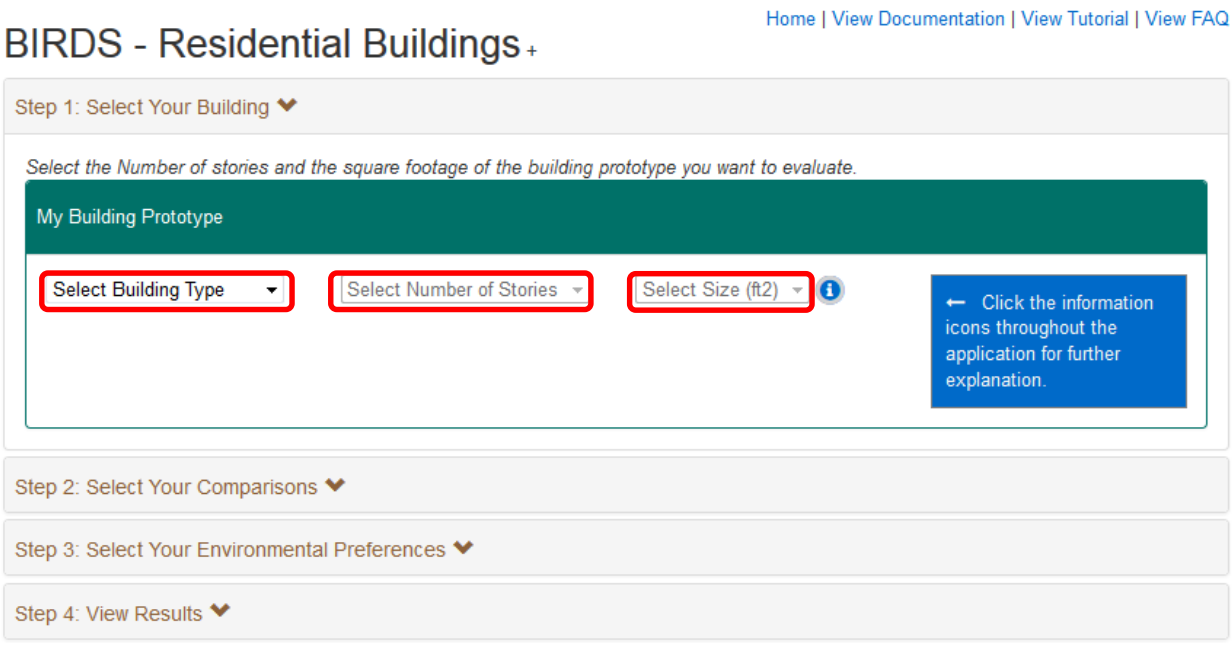


Figure 2-6 Selecting Building Type

For this tutorial, assume that the user is considering building a 1-story, 1600 ft^2 house as shown in Figure 2-7. Note that by clicking on the information icon (circled in red) the building details are expanded to be viewed by the user, which includes additional information such as orientation, floor height, percent fenestration, and heating and cooling equipment types. Since this is the first time an information icon appears, a text box has been included to alert the user of the information icon buttons. Note that future versions of the database could include additional options for the user (e.g. fuel type for heating). After selecting the building type, stories, and size the user wants to analyze, it is time to select what the user wants to compare.

[1] No 3-story houses are considered because they account for less than 4 % of all detached housing in any Census Division.

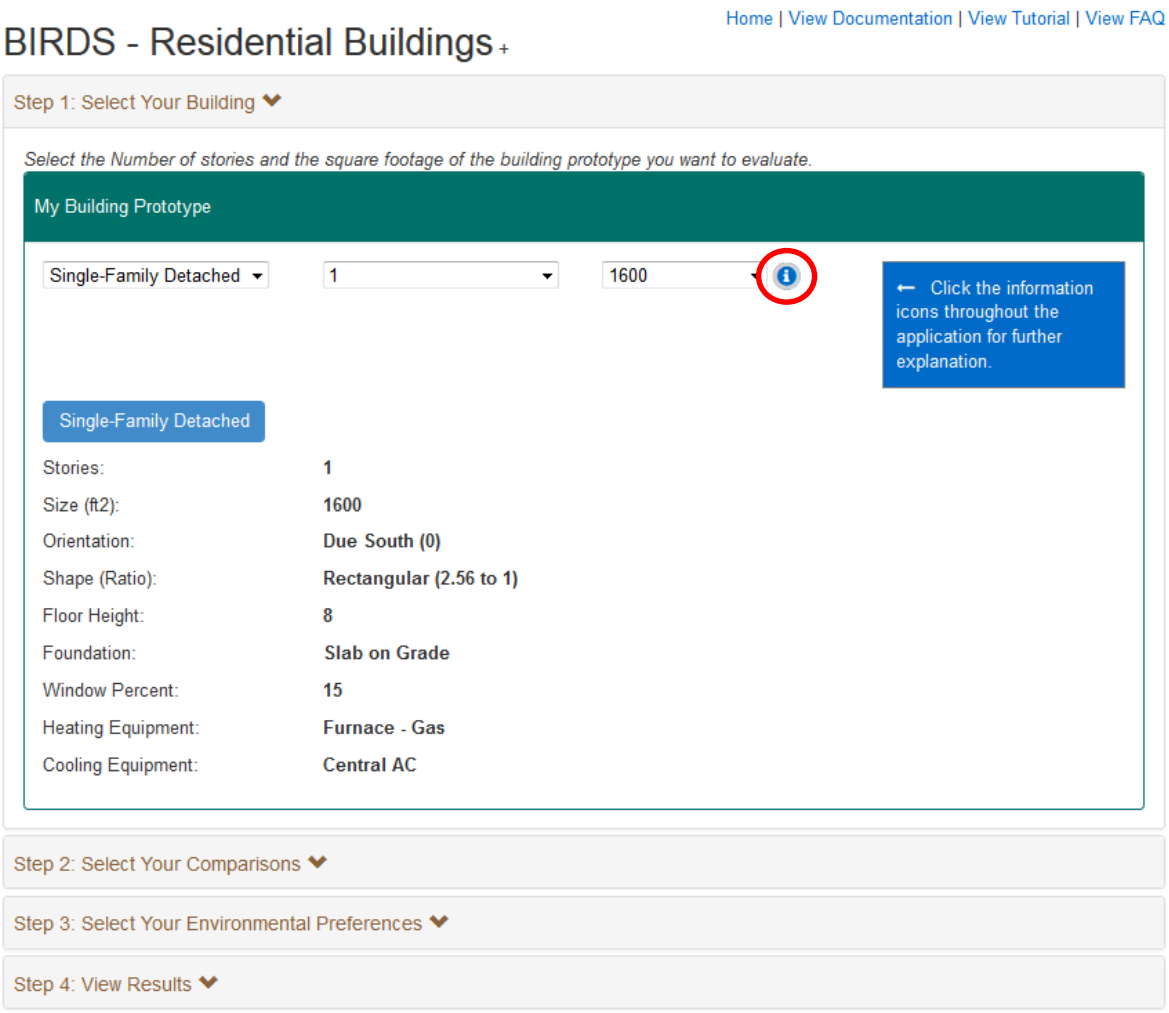


Figure 2-7 Building Prototype Details

2.2 Step 2: Selecting Your Comparisons

Clicking on the "Step 2: Select Your Comparisons" tab displays dropdown menus for the preferred Baseline Values for the building's State, City, Standard Edition, and Study Period as shown in Figure 2-8 (highlighted in red). These are the baseline values that will be used for all comparisons, and must be selected before moving. Note that all baseline values must be defined or an error will occur, and you will be diverted back to this step to select missing values. The information icon next to "Baseline Values" includes definitions of each baseline value that must be selected to assist a user that is not familiar with these factors. There is an additional information icon next to "Select Standard Edition" that includes a map with current state residential energy codes (as of July 2014).

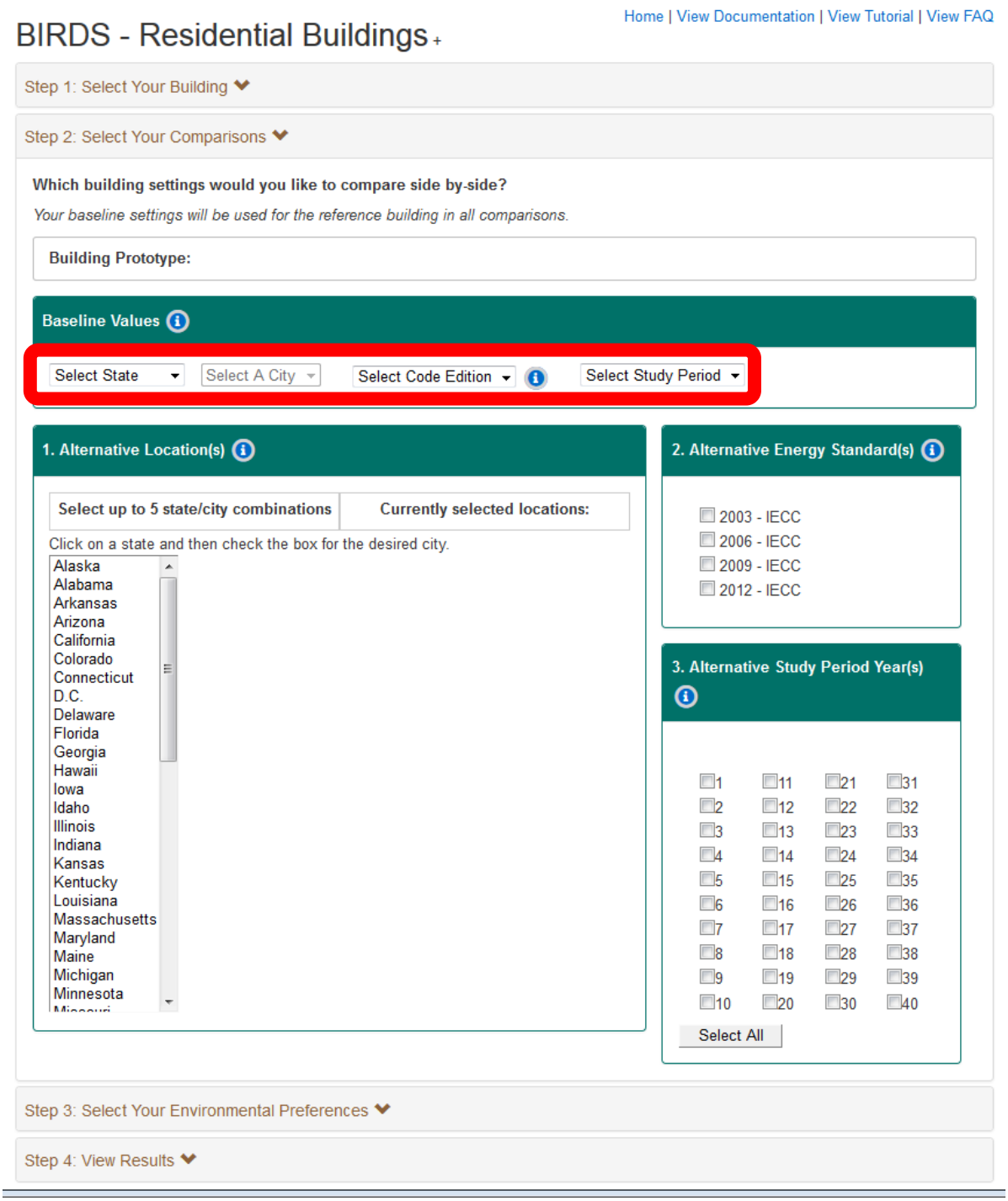


Figure 2-8 Selecting Baseline Values

For this tutorial, assume that the user is building the house in Boulder, Colorado. Based on the map in the information icon, Colorado currently requires new residential construction to meet 2003 IECC requirements. The user expects to live in the home for 5 years before reselling the house. Based on this information, the baseline values selected are the following as shown in

Figure 2-9: Baseline Location is Boulder, Colorado, Baseline Code Edition is 2003 IECC, and Study Period is 5 years.

Once the baseline values have been defined the user can select one or more alternatives to compare to their baseline across the three factors. The user can click on the information icon to obtain additional information on each set of alternative values.

Under [**1.**] the user can select alternative locations for comparison to the baseline location assuming the same code edition (2003 IECC) and study period (5 years). Assume the user wants to compare across locations is to see how much variation can occur in the results if the same house is constructed in different locations in a state to the same underlying code edition. In order to select alternative locations, the user must first select (by clicking on) a state from the scroll box. Then a checkbox list of available cities in that state will appear. When a user clicks the checkbox, the city/state combination will be added to the list to the right. Up to 5 alternative locations can be selected for comparison to the baseline location, as shown in Figure 2-9. In this example, the five remaining available cities in Colorado have been selected for comparison (Alamosa, Colorado Springs, Eagle, Grand Junction, and Pueblo). Boulder has been automatically removed from the alternative location list because it is the baseline location.

Under [**2.**] in Figure 2-9 the user can select up to three alternative energy code editions from the checkbox list at the top right, which include *2003 IECC, 2006 IECC, 2009 IECC, and 2012 IECC*. Since *2003 IECC* is the selected baseline code edition, it is not an option for selection as an alternative. For this tutorial, assume that the user wants to consider constructing the house to each of the newer editions of IECC to determine if newer editions lead to energy savings, and if so, the cost-implications from constructing to the more energy efficient designs.

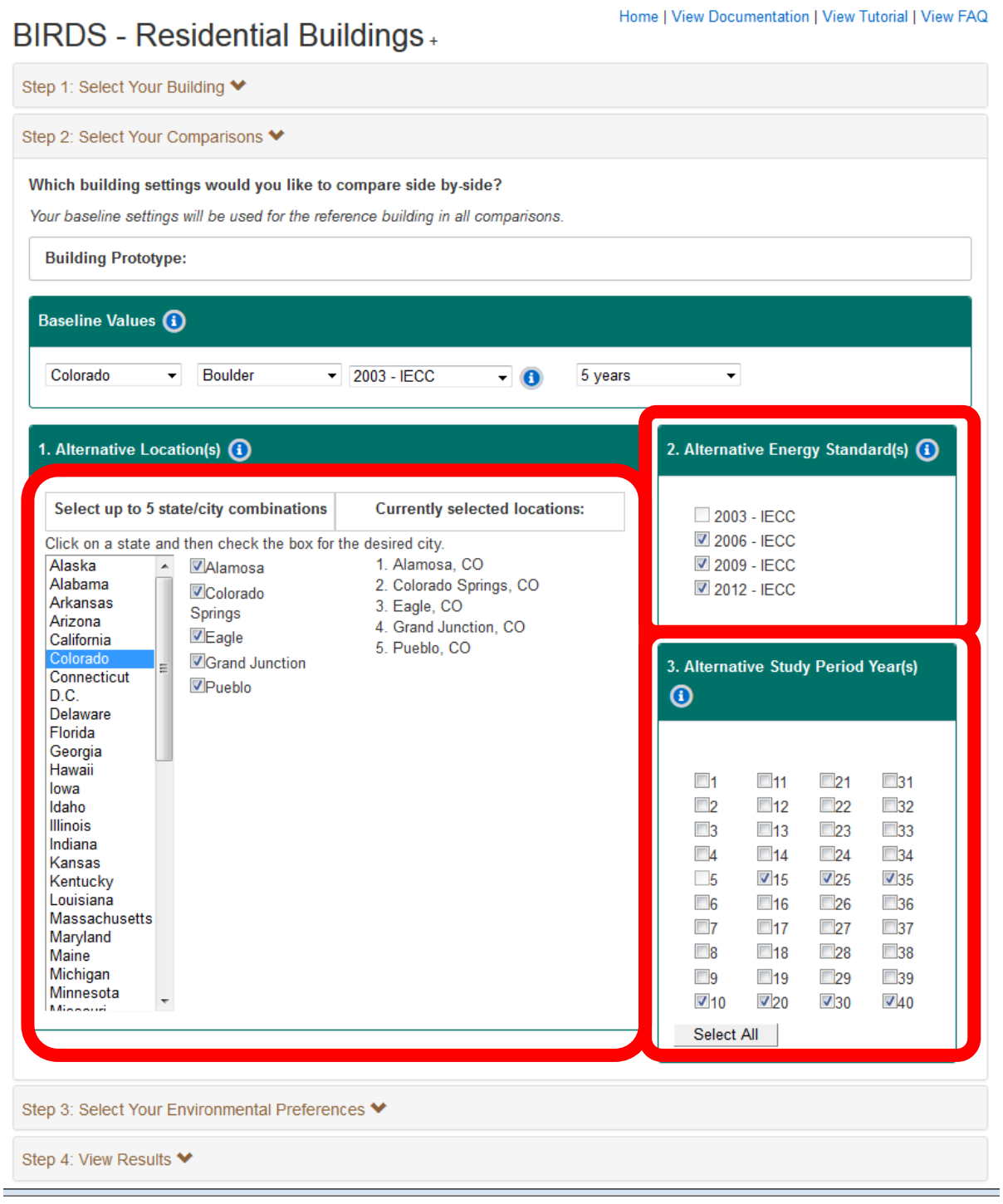


Figure 2-9 Selecting Alternative Locations, Energy Standard Editions, and Study Periods

Under [**3.**] in Figure 2-9 the user can select up to 39 alternative study periods in the checkbox list at the bottom right, which range from 1 year to 40 years and includes a "Select All" button for users that want to quickly and easily consider all study periods. For this tutorial, assume the user wants to consider longer study periods, in 5-year increments (10-years, 15-years, 20-years,

25-years, 30-years, 35-years, and 40-years) to see how the results will change if the house is owned for longer timeframes. The 5-year study period is the baseline and cannot be selected as an alternative. Once the user has defined the baseline values and the alternative values for comparison, the user needs to move onto Step 3 to define environmental preferences.

2.3 Step 3: Selecting Environmental Weighting Preferences

Clicking on the "Step 3: Select Your Environmental Preferences" displays an introductory paragraph. For further explanation of each of the environmental impact categories, click on the information icon in the text. The user must start by selecting their Baseline Environmental Weight Approach from the dropdown menu, which includes 5 options (four pre-defined and one user-defined) as shown in Figure 2-10. The weights for each of the four pre-defined approaches can be viewed by the user in the table on the right-hand side. Explanations of the source of the BEES Stakeholder Panel and EPA Advisory Board weighting approaches can be found under the information icon. For this tutorial, assume that the user selects the BEES Stakeholder Panel as the baseline. Below the Baseline selection are check boxes for the alternative weighting approaches that will be available for comparison.

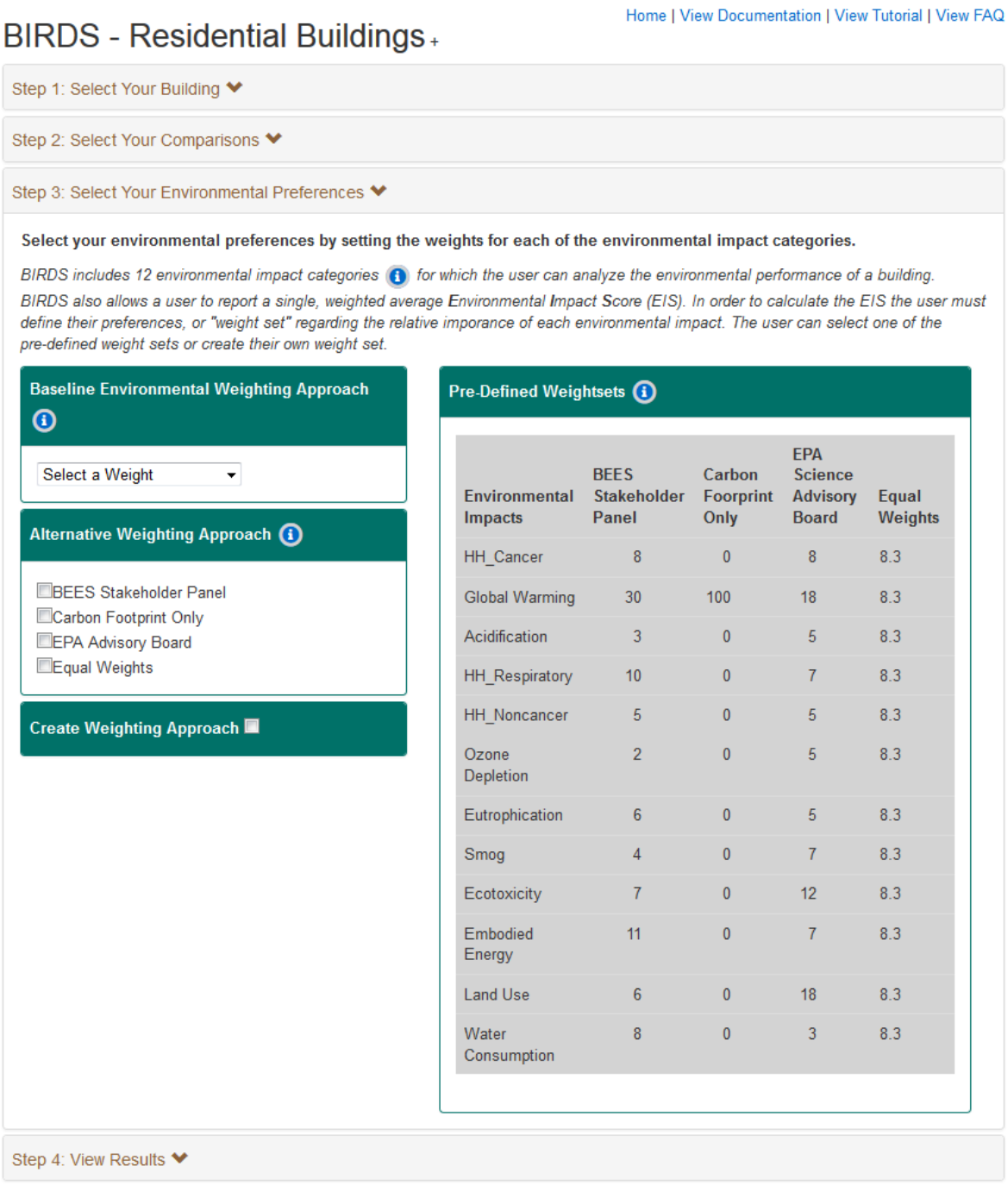


Figure 2-10 Selecting Environmental Weighting Preferences

If the user does not want to use any of the pre-defined weighting approaches, the user is given flexibility to create a custom weighting approach by checking the "Create Weighting Approach" checkbox, which can be used as the baseline or as an alternative weighting approach. As shown in Figure 2-11, checking the "My Weights" check box brings up a list of the 12 environmental impact categories. Each category must be given a weight between 0 and 100, with the sum of all 12 weights adding up to 100. Assume the user wants to place equal weight (25 %) to only four

categories (global warming, acidification, ozone depletion, and water consumption) and ignore other environmental impacts. Once a custom weighting approach is defined it will become a selection available in the Baseline Weighting Approach dropdown and as a checkbox in the Alternative Weighting Approach checkbox list. Assume that the user selects all available alternative weighting approaches, including the custom weighting approach. At this point, all the necessary user inputs have been defined and the user can now look at the results.

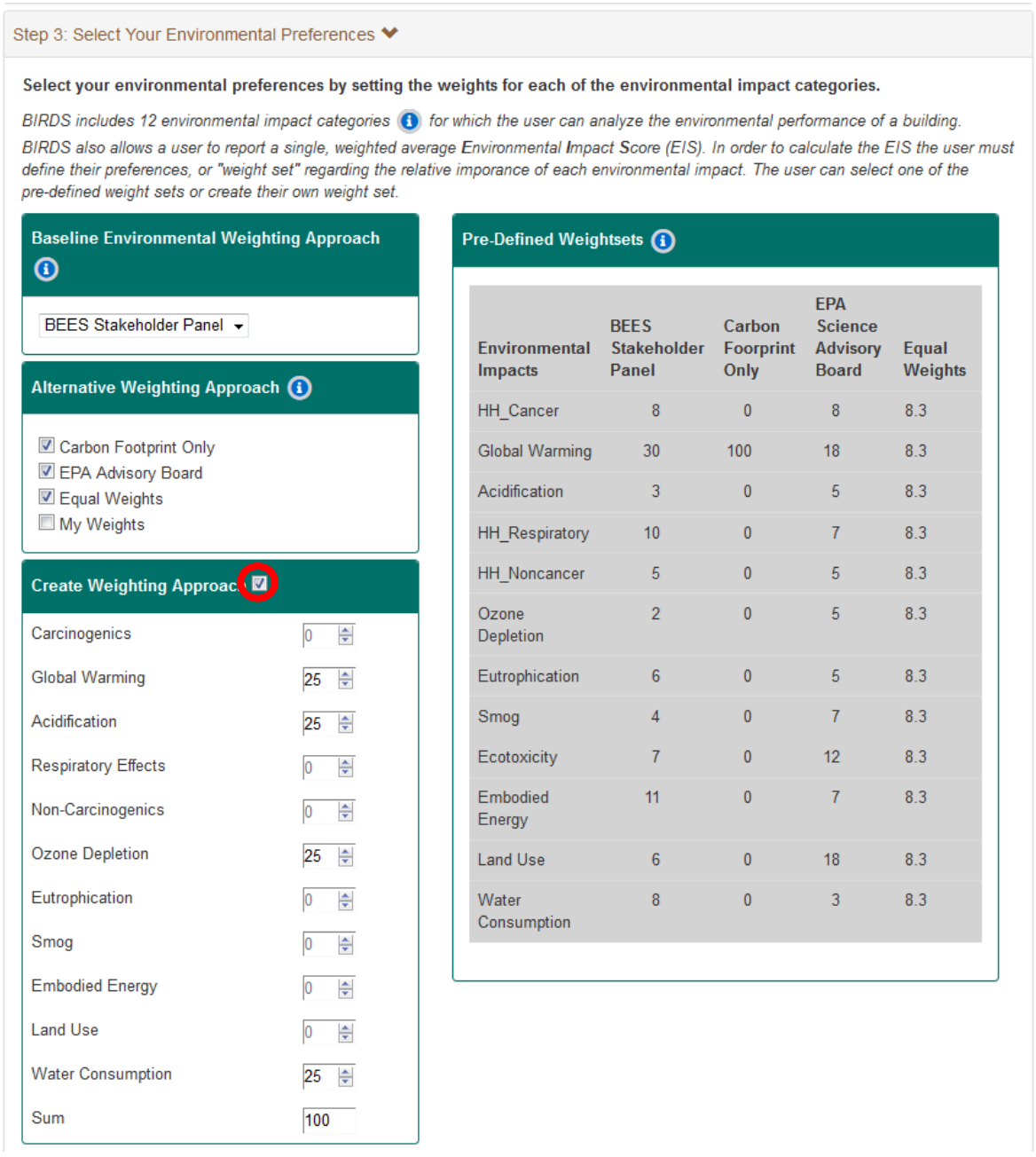


Figure 2-11 Selecting Environmental Weighting Approaches

2.4 Step 4: Viewing Results

Clicking on the "Step 4: View Results" tab will display the "Select Chart Options" section. Three different chart types are available in the application: Life-Cycle Cost, Operating Energy, or Environmental Impact Score (EIS). As shown in Figure 2-12, the user must first select the "Chart Type" from the dropdown menu, then the "Baseline" for which the comparison to be made, and the "Units" in which the user prefers the results. Note that the units include a per unit of floor area impact, which is only reported in square feet and not square meters because the tool is designed for use domestically, which predominantly uses I-P units instead of metric units. For additional information, a user can click on the information icons. Once the user has made these selections, the user presses the "View" button to see the results, at which point the graph with corresponding data table will be displayed.

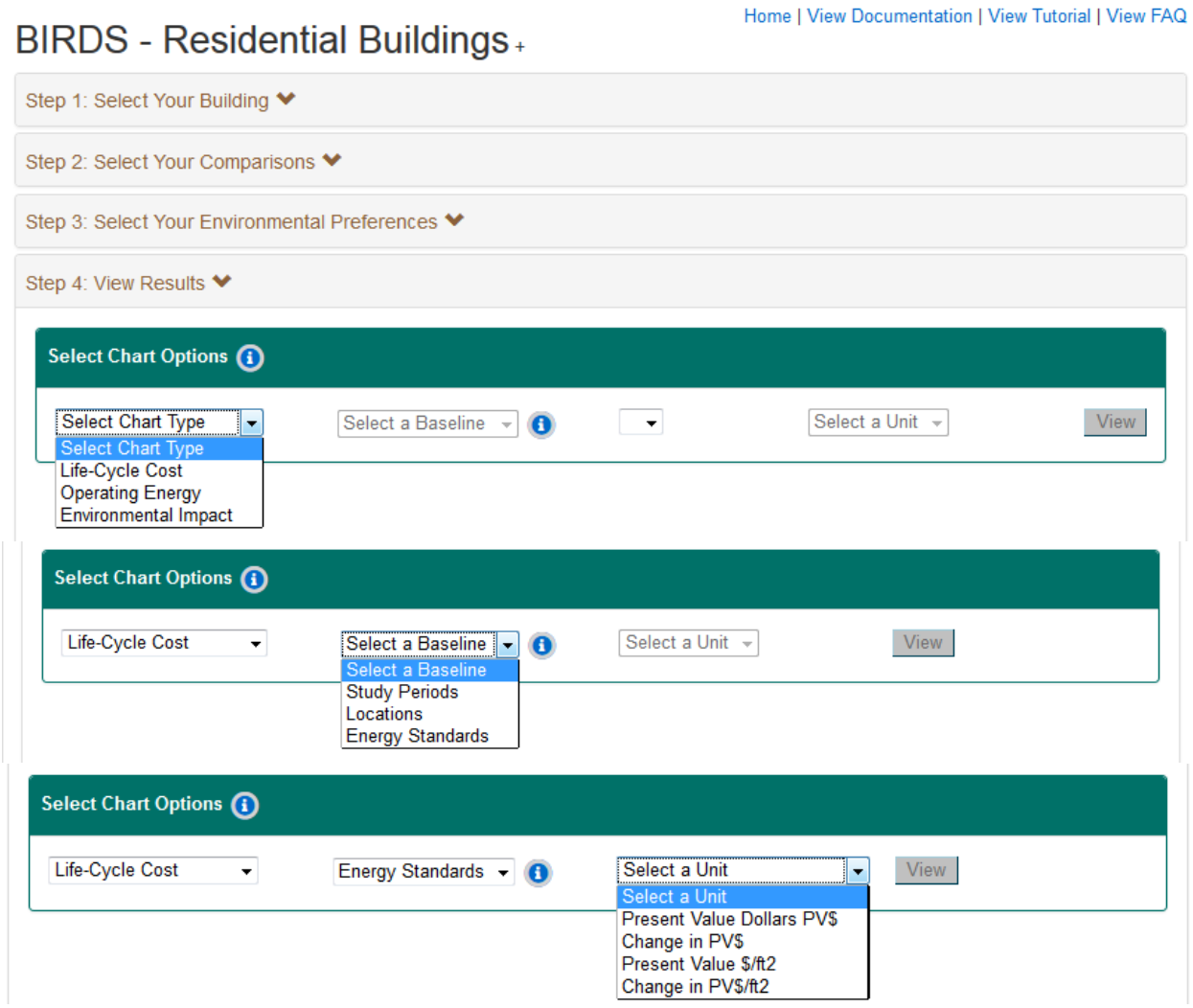
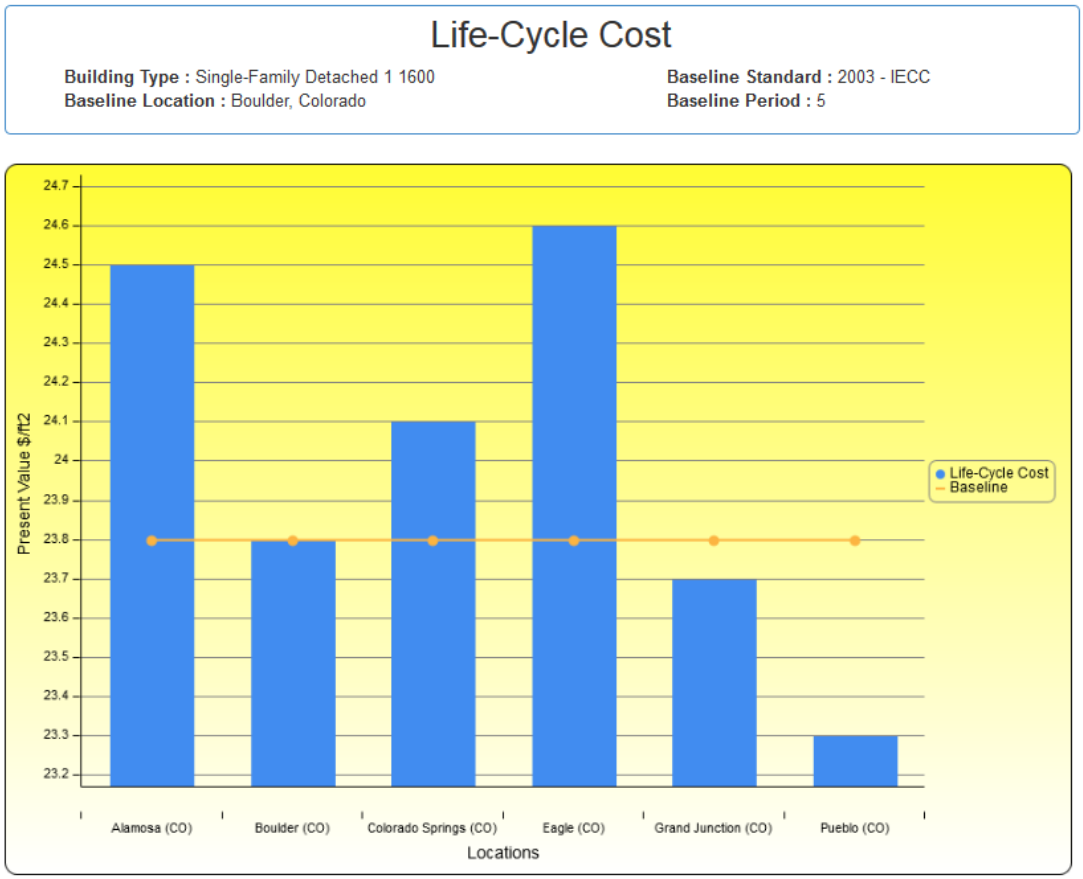


Figure 2-12 Selecting Chart Options

Assume that the first comparison the user would like to view is the life-cycle costs of the baseline building design and study period across the selected locations. Figure 2-13 shows the Life-Cycle Cost results with a graph of the total life-cycle costs per ft^2 in present value dollars for the 5-year study period for a 1-story 1600 ft^2 house built to meet *2003 IECC* across the six locations selected by the user. As can be seen in the graph, total present value life-cycle costs per ft^2 vary from \$23.30/ft^2 to over \$24.60/ft^2. Even within the same state, constructing a house to the same energy standard can lead to different costs to the owner. The baseline value line shows that two cities realize lower LCCs and three cities realize higher LCCs than Boulder.



Life-Cycle Cost	Unit	Alamosa (CO)	Boulder (CO)	Colorado Springs (CO)	Eagle (CO)	Grand Junction (CO)	Pueblo (CO)
Total	Present Value Dollars PV$	39,179	38,135	38,484	39,348	37,876	37,353
Change from Baseline	Change in PV$	1,044	0	348	1,212	-259	-783
Total	Present Value $/ft2	24.5	23.8	24.1	24.6	23.7	23.3
Change from Baseline	Change in PV$/ft2	0.7	0	0.2	0.8	-0.2	-0.5
Change from Baseline	%	2.7	0	0.9	3.2	-0.7	-2.1

Figure 2-13 Life-Cycle Cost Graph by Location for Baseline Assumptions

Two features that are difficult to display in a tutorial are that a user can (1) scroll over and view the value of each data point and (2) zoom in and out of a graph to focus on a portion of the data.

The data table displayed below the graph is more comprehensive, and includes all of the potential metrics available for comparisons across study periods for the baseline location, which include total life-cycle costs, change in total life-cycle costs relative to the selected baseline, total life-cycle costs per ft^2, change in total life-cycle costs from the baseline per ft^2, and percentage change in life-cycle costs relative to the baseline.

Next, the user decides to see how LCCs change as the study period increases in length. By changing the baseline across which to analyze the data from "Locations" to "Study Periods," selecting Present Value $/ft^2"and clicking "View," the user can now see that that LCCs increase at a decreasing rate as the study period increases in length (see Figure 2-14). The reason for this trend is that the further into the future that costs are realized, the smaller the discounted present value of those costs.

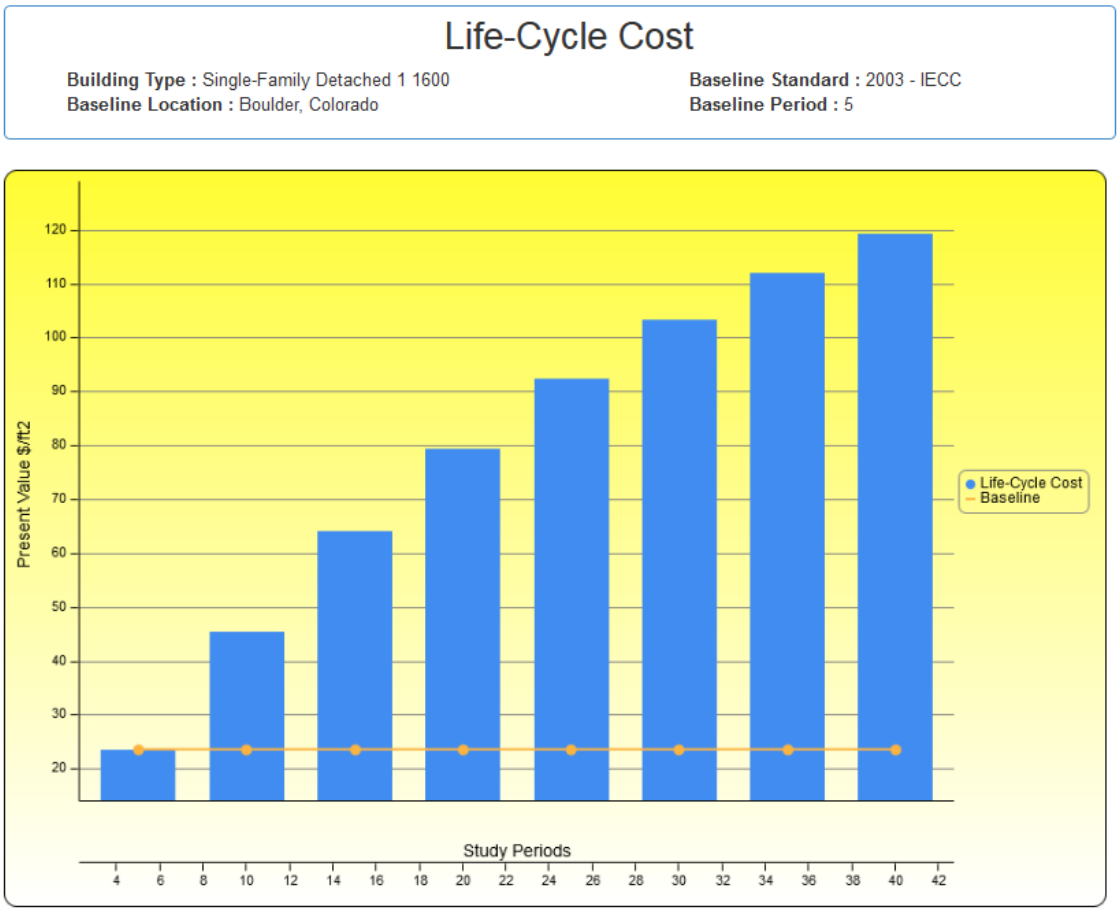


Figure 2-14 Life-Cycle Cost Graph by Study Period for Baseline Assumptions

Now the user shifts to focusing analysis on changing in the building design for the baseline location and study period. Figure 2-15 shows the Operating Energy results in annual energy

consumption per ft^2 (in kBtu) across the four standard editions. Energy consumption is relatively constant across the baseline code edition (2003 IECC) and 2006 IECC and 2009 IECC, with 2006 IECC actually slightly increasing consumption and 2009 IECC slightly decreasing consumption (within +/- 0.1 $kBtu/ft^2$). The 2006 IECC design could lead to an increase in energy consumption because of the change in climate zone characterization between 2003 IECC and 2006 IECC (fewer zones based on different combinations of heating degree days and cooling degree days). Constructing to meet the requirements in 2012 IECC leads to a 20 % reduction in energy consumption relative to 2003 IECC (15.4 $kBtu/ft^2$ versus 19.3 $kBtu/ft^2$).

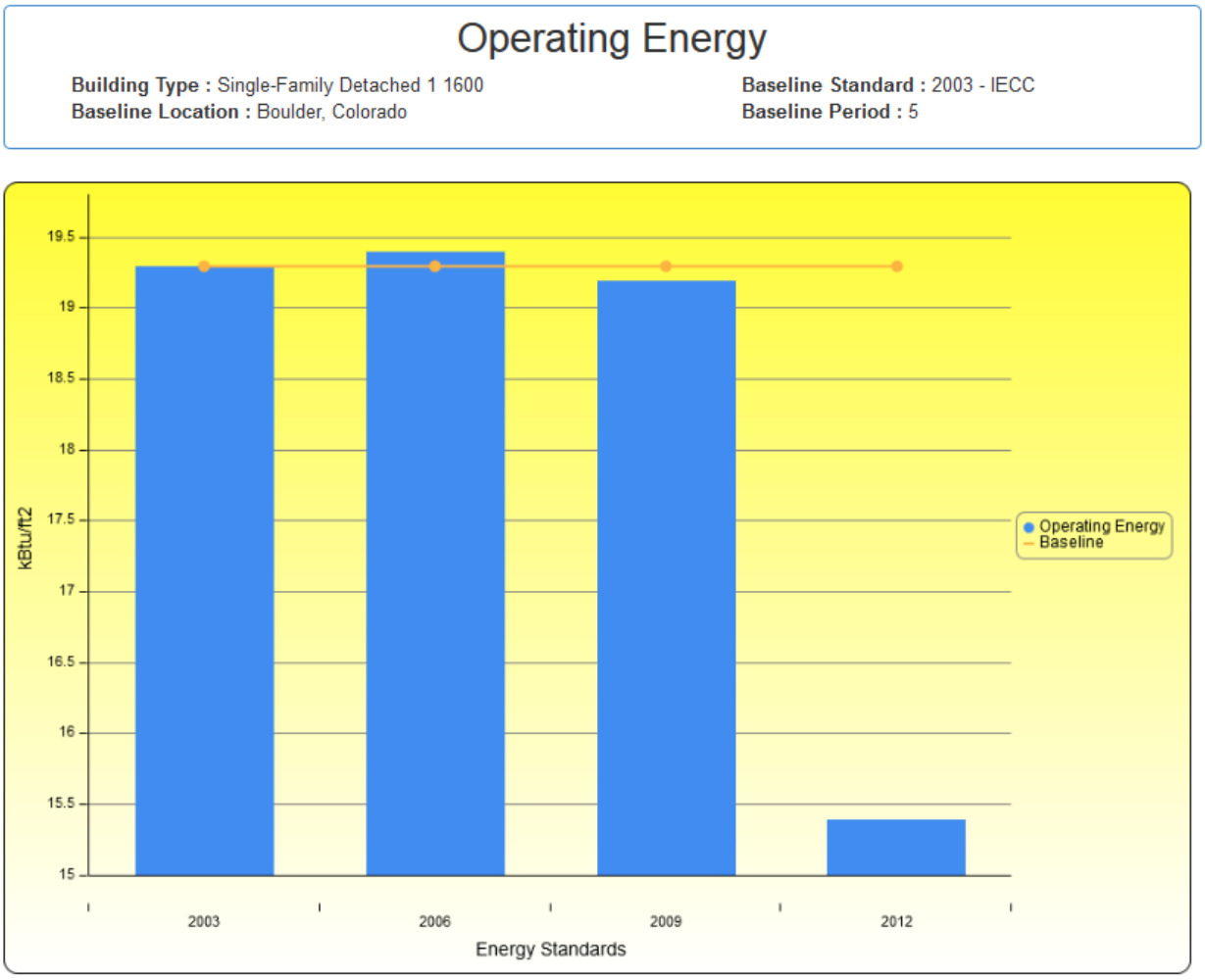


Figure 2-15 Annual Operating Energy Per ft^2 by Code Edition for Baseline Assumptions

Now the user wants to determine if the energy savings realized by constructing to 2012 IECC is cost-effective. By selecting Life-Cycle Cost – Energy Codes – Change in PV$, the user can view how LCCs differ across code editions. Figure 2-16 shows that building to meet 2006 IECC leads to the greatest reduction in LCCs relative to building to meet 2003 IECC (baseline). However, as was shown in Figure 2-15, the 2006 IECC design consumes the most energy. The 2012 IECC

design not only leads to the lowest energy consumption, it also leads to LCC savings ($286) relative to the 2003 IECC design.

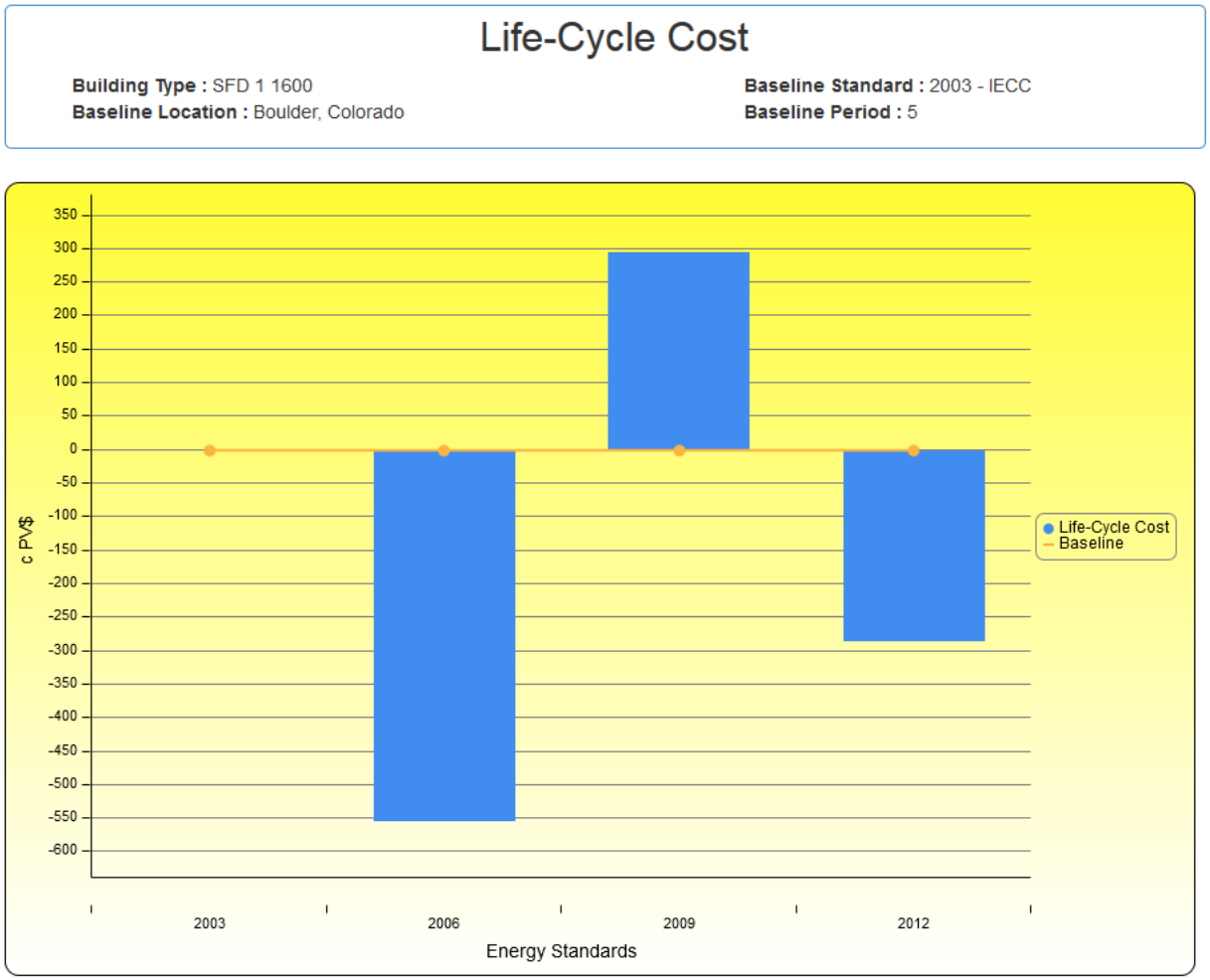


Figure 2-16 Change in Life-Cycle Costs by Code Edition for Baseline Assumptions

If the user is interested in seeing how the different building designs impact the life-cycle environmental performance of the house, then the user must make an additional selection, the environmental impact category, which can be either a single impact category or the weighted average impact (Environmental Impact Score – EIS) based on the baseline weighting approach (BEES Stakeholder Panel). In this case, assume that the user wants to look at the EIS. By selecting Environmental Impact-Energy Standard-All (weighted)-Change in Environmental Impact Score, the user sees the results in Figure 2-17, which shown that the 2012 IECC design leads to the greatest reduction in EIS.

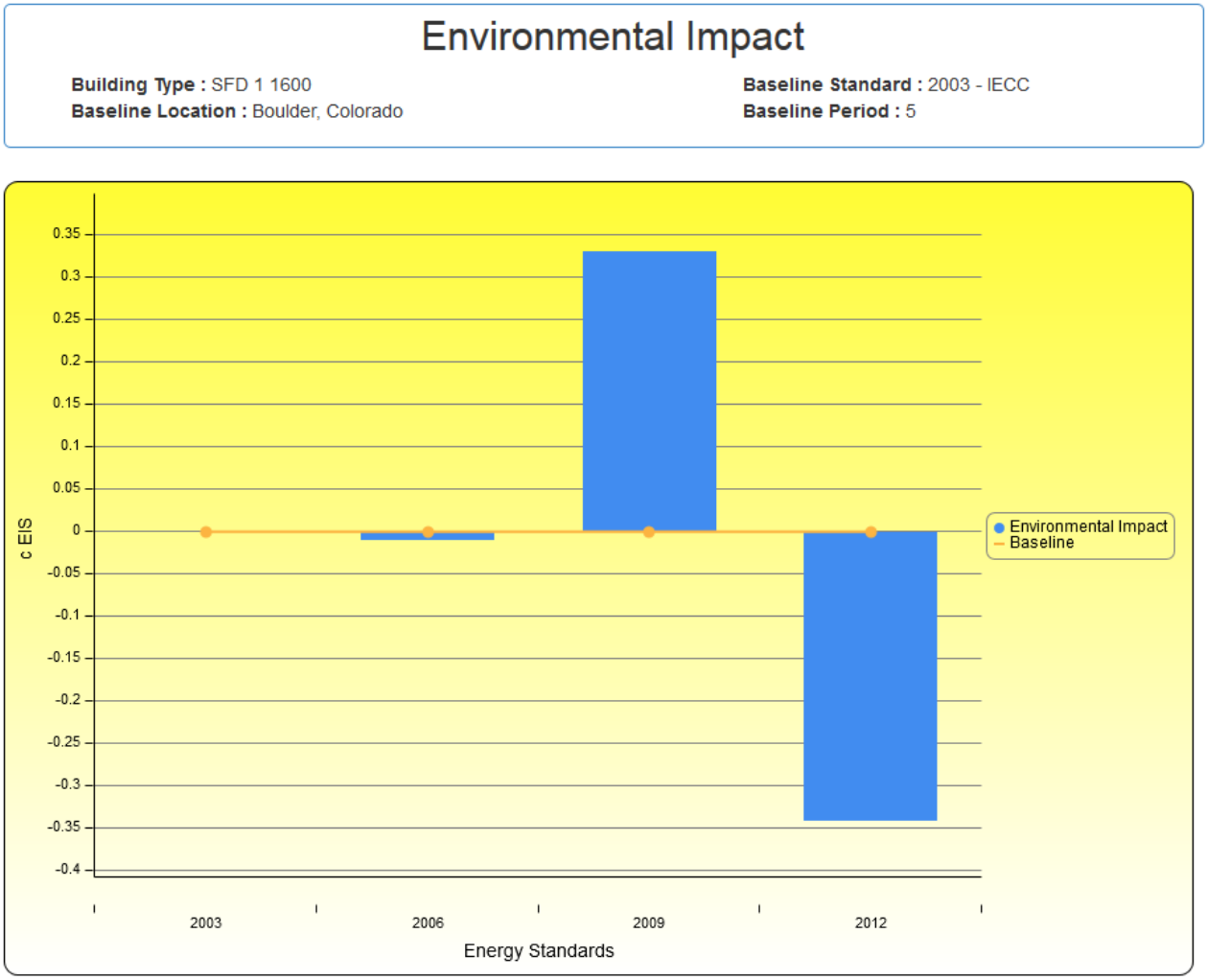


Figure 2-17 Change in Environmental Impact Score by Code Edition – for Baseline Assumptions

The user can also view each individual environmental impact category results. For example, Figure 2-18 shows a graph of the total global warming potential impacts in kilograms of CO_2e emissions. The *2012 IECC* design leads to the lowest impact on global warming potential, with a reduction of 8549 kg CO_2e flows relative to the 2003 IECC design.

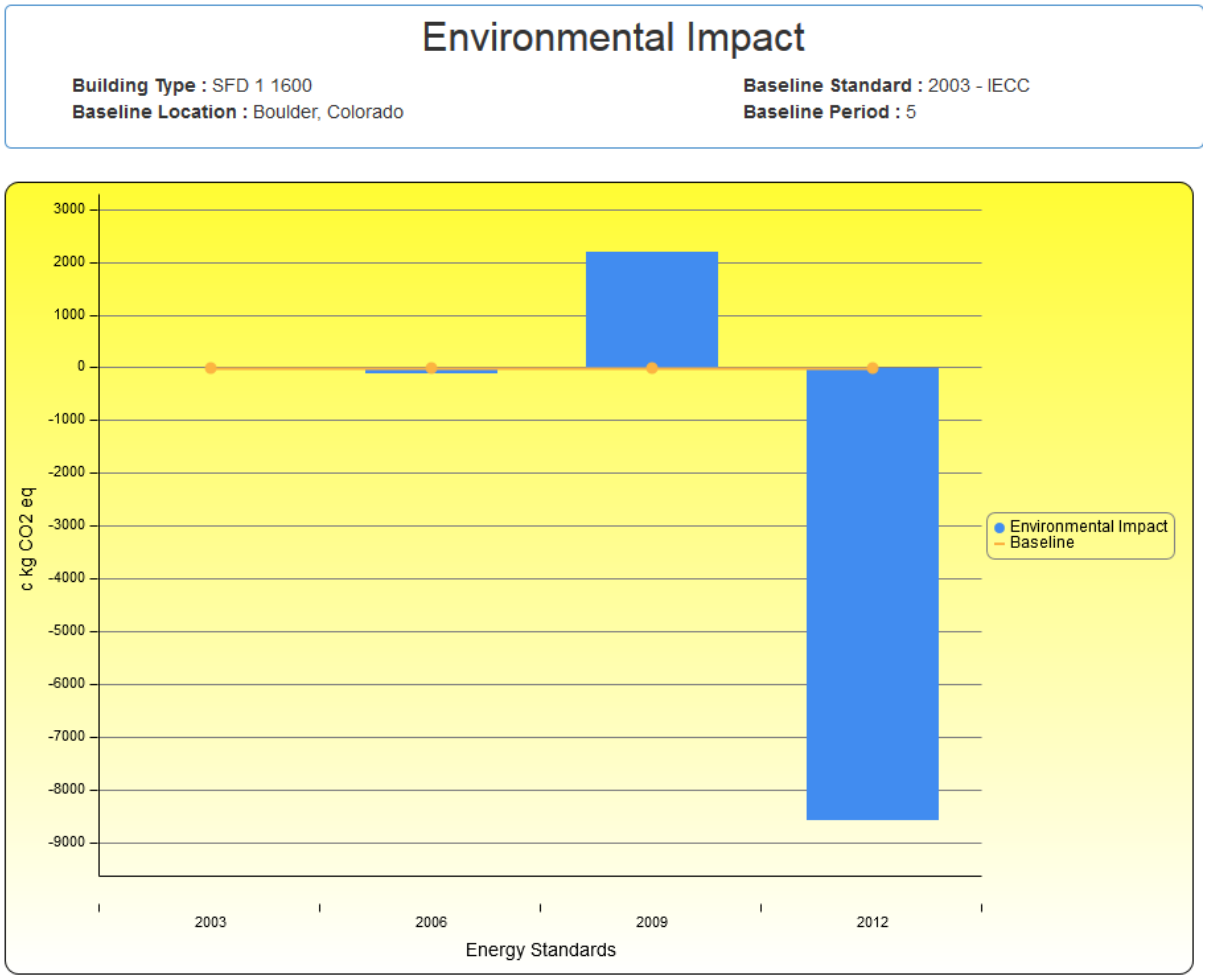


Figure 2-18 Change in Global Warming Potential by Code Edition – for Baseline Assumptions

3 BIRDS Limitations and Future Capabilities

The current version of the BIRDS web interface is limited in scope and functionality, and would be strengthened by including uncertainty, expanding the database options and metrics, and adding design flexibility to the tool.

Uncertainty analysis is needed for at least three elements of the analysis. First, consider the assumed discount rate. Although 3 % is a reasonable discount rate, in real terms, for federal government investment decisions, it may be too low of a value for an expected real return on an alternative investment in the private sector, particularly for a homeowner. Sensitivity analysis on the assumed discount rate is needed to determine the robustness of the cost results. Second, the current analysis assumes that building cooling loads are met by equipment running on electricity while heating loads are met by equipment running on natural gas, which is not the typical fuel mix for some areas of the nation. The database should be expanded to include alternative fuel source options, such as electricity in the South. Third, the BIRDS environmental impact scores do not incorporate uncertainty analysis as required by international standards (ISO 2006). While incorporating uncertainty analysis is problematic due to a lack of underlying uncertainty data, this omission should be brought into the interpretation of the BIRDS results.

Additional data are needed to refine and expand the BIRDS new residential database. The 10 prototypical single-family dwellings analyzed in this study are not representative of the entire building stock because of the assumed building geometry and assembly construction (i.e. wood-framed walls). For this reason, the results should be considered as general magnitudes for making reasonable comparisons instead of hard numbers. Future research should include additional prototypes in the database that consider other geometry and construction. The state average energy cost rates do not control for local variation in energy tariffs, which could lead to significant changes in energy costs (Kneifel and Butry 2014). By using utility-level energy cost data, the accuracy of the estimates in BIRDS could be improved.

Changing the assumed occupancy, in terms of plug and process load use and number of occupants, and HVAC equipment efficiency would have impacts on the changes in energy use. Homes with greater plug and process loads will realize smaller percentage changes in energy use because the energy efficiency measures considered in this study focus on the IECC requirements (building envelope and lighting) holding constant the efficiency of other equipment (HVAC equipment and appliances) used in the building and the number of occupants living in the building. Future research should consider the impact that improved equipment efficiency and occupant activity may have on the overall energy savings realized by energy efficiency improvements to buildings.

Based on user feedback, additional options should be incorporated into new versions of BIRDS. Additional metrics for both the existing categories of sustainability (i.e. energy, economic, and environmental) as well as new categories (e.g. indoor air quality, comfort) should be

incorporated into the BIRDS web interface. These could include the ability to dissect the higher level metrics into its components (e.g. first costs, future costs, and residual value for LCC). New graphical representation approaches and functionality should be considered, such as different chart types as well as embedded and dynamic charts.

The BIRDS results do not apply to buildings constructed in other countries where industry practices, fuel mixes, environmental regulations, transportation distances, and labor and material markets may differ. Furthermore, all buildings of a given type are not created equal. Building designs, sizes, useful lives, materials compositions, and costs will all vary for an individual building. The BIRDS results for a building prototype do not necessarily represent the performance of an individual building of that type. Future versions of the tool should permit flexibility in building design and use of materials.

Properly interpreting the BIRDS environmental performance results requires placing them in perspective. The environmental impact scores assess the life-cycle impacts of operating energy use based on inventories of localized energy simulation results and regional electricity grids. All other elements of the scores—including a building's use of materials and its water consumption over the study period—are based on U.S. average life-cycle inventory data for prototypical buildings. The baseline data for these buildings represent status quo building technologies as of 2002, the year of the latest available input-output (I-O) data from the U.S. Bureau of Economic Analysis at the time of the database development. To account for evolution in status quo technologies over time, future versions of BIRDS should incorporate newer releases of these data as they become available.

The BIRDS LCAs use selected inventory flows converted to selected local, regional, and global environmental impacts to assess environmental performance. Those inventory flows which currently do not have scientifically proven or quantifiable impacts on the environment are excluded, such as mineral extraction and wood harvesting which are qualitatively thought to lead to loss of habitat and an accompanying loss of biodiversity. If the BIRDS user has important knowledge about these issues, it should be brought into the interpretation of the BIRDS results.

The Environmental Problems approach that BIRDS uses for impact assessment does not offer the same degree of relevance for all environmental impacts. For global and regional effects (e.g., global warming and acidification) the method may result in an accurate description of the potential impact. For impacts dependent upon local conditions (e.g., smog, ecological toxicity, and human health impacts) it may result in an oversimplification of the actual impacts because the indices are not tailored to localities.

Life cycle impact assessment is a rapidly evolving science. Assessment methods unheard of a decade ago have since been developed and are now being used routinely in LCAs. While BIRDS incorporates state-of-the-art impact assessment methods, the science will continue to evolve and methods in use today—particularly those for land and water use—are likely to change and

improve over time. Future versions of BIRDS should incorporate these improved methods as they become available.

During the interpretation step of the BIRDS LCAs, environmental impact results are optionally combined into a single environmental performance score using relative importance weights. These weights necessarily incorporate values and subjectivity. BIRDS users should routinely test the effects on the environmental impact scores of changes in the set of importance weights.

Energy, environmental, and economic performance are but three attributes of building performance. The BIRDS model assumes that its building prototypes all meet minimum technical performance requirements. However, there may be significant differences in technical performance not evaluated in BIRDS, such as acoustic, fire, or indoor environmental quality performance, which may affect energy, environmental, and economic considerations.

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