NIST TN XXXX

Building Life Cycle Cost User Guide

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National Institute of Standards and Technology
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Abstract

This user guide for the Building Life Cycle Cost (BLCC) software explains how to use the software to complete life cycle cost analysis (LCCA) for federal capital investments that is consistent with the methodology and criteria established by the Federal Energy Management Program (FEMP). BLCC uses the life cycle cost methods, assumptions, and criteria contained in the FEMP rules published in 10 CFR 436, Subpart A and documented in NIST Handbook 135. An annual supplement to Handbook 135, Energy Price Indices and Discount Factors for LCC Analysis (NISTIR 85-3273), provides data for the discount rates, discount factors, and energy escalation factors used for conducting an LCC analysis in accordance with the FEMP rules, and is provided as default values in BLCC based on the type of analysis being completed.

Keywords

benefit-cost analysis; building economics; building technology; capital investment; cost-effectiveness; economic analysis; energy conservation; energy economics; life cycle cost analysis; public buildings; renewable energy; water conservation; sustainability; resilience

Disclaimers

The policy of the National Institute of Standards and Technology is to use metric units in all its published materials. Because this report is intended for the U.S. construction industry, which 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 Abbreviations

Abbreviation	Definition
AEO	Applied Economics Office
AIRR	adjusted internal rate of return
ASTM	American Society for Testing and Materials
BCA	Benefit-cost analysis
BLCC	Building Life Cycle Cost
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
DOE	Department of Energy
DPB	Discounted Payback Period
DoD	Department of Defense
ECIP	Energy Conservation Investment Program
ECM	Energy conservation measure
EERE	Office of Energy Efficiency & Renewable Energy
EERC	Energy Escalation Rate Calculator
EIA	Energy Information Administration
EISA	Energy Independence and Security Act
EL	Engineering Laboratory
EO	executive order
EPA	Environmental Protection Agency
EPACT	Energy Policy Act
ERCIP	Energy Resilience and Conservation Investment Program
ESA	energy sales agreement
ESCO	Energy service company
ESPC	energy savings performance contract
FAR	Federal Acquisition Regulation
FEMP	Federal Energy Management Program
GHG	Greenhouse gas
H.R.	House of Representatives
HVAC	heating, ventilation, and air conditioning

Abbreviation	Definition
IAQ	indoor air quality
IEQ	Indoor environmental quality
IRR	internal rate of return
ITC	Investment tax credit
LCA	life cycle assessment
LCC	life cycle cost
LCCA	life cycle cost analysis
MARR	Minimum acceptable rate of return
MILCON	military construction
MOA	memorandum of agreement
NB	Net benefit
NDAA	National Defense Authorization Act
NECPA	National Energy Conservation Policy Act
NIST	National Institute of Standards and Technology
NISTIR	National Institute of Standards and Technology Internal/Interagency Report
NS	net savings
OMB	Office of Management and Budget
O&M	operating and maintenance
OM&R	operating, maintenance, and repair
P/C	planning/construction
PBP	payback period
PPA	Power purchase agreement
PV	Present Value
SIR	savings-to-investment ratio
SPB	Simple Payback Period
SPV	Single Present Value
SREC	Solar renewable energy credit
UESC	utility energy service contracts
UPV	Uniform Present Value
UPV*	Modified Uniform Present Value
USACE	U.S. Army Corps of Engineers

1 Introduction LCCA for Federal Projects

1.1 Why Use Life Cycle Cost Analysis?

Life cycle cost analysis (LCCA) is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and ultimately disposing of a project are potentially important to that decision. LCCA is suitable for the evaluation of alternatives at different levels of project or program scope:

- Individual building systems
- New construction building designs
- Major or minor building renovation designs
- Facility and campus development and renovation master plans

Each viable alternative must satisfy all required levels of performance (including occupant comfort and productivity, safety, adherence to building codes and engineering standards, system reliability, resilience to predominant threats, and even aesthetic considerations), but may have different initial investment costs; different operating, maintenance, and repair (OM&R) costs (including energy and water usage); and possibly different useful lives. LCCA can be applied to any capital investment decision in which higher initial costs are traded for reduced future cost obligations. LCCA provides a significantly better assessment of the long-term cost-effectiveness of a project than alternative economic methods that focus only on first costs or on operating-related costs in the short run.

Energy conservation projects provide excellent examples for the application of LCCA. There are abundant opportunities for improving the thermal performance of building envelope components (e.g., walls, windows, roofs) in new and existing buildings to reduce heat loss in winter and heat gain in summer. Similarly, there are many alternative heating, ventilation, and air conditioning (HVAC) systems that can maintain acceptable comfort conditions throughout the year, some of which are considerably more energy efficient (or use less expensive fuels) than others. When energy conservation projects increase the initial capital cost of a new building or incur retrofit costs in an existing building, LCCA can determine whether these projects are economically justified from the investor's viewpoint, based on reduced energy costs and other cost implications over the project life or the investor's time horizon.

The use of LCCA may not stop when a cost-effective energy conservation project has been identified. There are often several cost-effective design alternatives for any given building system. For example, thermal insulation can be installed over a wide range of thermal resistance values in walls and roofs. Window systems are available over a wide range of thermal conductance values and with a variety of sun-blocking capability. Many of these alternatives may be cost effective, but (usually) only one can be used in each application. In such cases,

LCCA can be used to identify the optimal alternative for that application. This is generally the alternative with the lowest life cycle cost (LCC).

LCCA can also be used to prioritize the allocation of funding to several independent capital investment projects within a facility, campus, or agency when insufficient funding is available to implement them all. This application involves the ranking of projects by their savings-to-investment ratio (SIR) or by their adjusted internal rate of return (AIRR), both of which are supplementary measures of economic performance based on LCCA.

LCCA stands in direct contrast to the payback method of economic analysis. The payback method focuses on how quickly the initial investment can be recovered, and as such is not a measure of long-term economic performance or profitability. The payback method ignores costs and savings occurring after the point in time in which payback is reached. It also does not differentiate between project alternatives having different useful lives, and it often uses an arbitrary payback threshold. Moreover, the simple payback method, which is commonly used, ignores the time-value of money when comparing the future stream of savings against the initial investment cost.

LCCA is a powerful tool of economic analysis. As such, it requires more information than do analyses based on first-cost or short-term considerations. It also requires additional understanding concepts such as discounted cash flow, constant versus current dollars, and price escalation rates. The alternative, however, is to ignore the long-run cost consequences of investment decisions, to reject profitable investment opportunities, and to accept higher-than-necessary operational costs.

1.2 LCCA Requirements for Federal Projects

NIST and FEMP of the U.S. Department of Energy (DOE) provide resources to assist federal agencies in using LCCA to evaluate capital investment projects that reduce future operating and maintenance (O&M) costs of federal facilities. FEMP has published life cycle costing rules and procedures in its Code of Federal Regulations, 10 CFR 436, Subpart A [1]. These FEMP rules are to be followed by all federal agencies, unless specifically exempted, in evaluating the cost effectiveness of potential energy efficiency, water conservation, and renewable energy projects in federally owned and leased buildings. To the extent possible, these projects should be evaluated separately from non-energy and non-water-related projects in federal buildings.

For projects not related to energy or water, Office of Management and Budget (OMB) Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," [2] with annual updates to Appendix C [3], provides the necessary methodology and discount rates. The underlying methodologies used by DOE/FEMP and OMB are essentially identical. However, the DOE/FEMP discount rate is different from the OMB discount rate, and the FEMP LCC rules include a maximum study period length of 40 years (plus any planning/construction period), a

real discount rate floor (3 %) and ceiling (10 %) as specified in 10 CFR 436; OMB does not have a maximum study period length or these real discount rate restrictions.

LCC analysts in the U.S. Department of Defense (DoD) should note that there is a Tri-Services Memorandum of Agreement (MOA) on "Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design" [4]. This memorandum is fundamentally consistent with the FEMP LCC rule, as promulgated in 10 CFR 436 [1]. However, at present the MOA recommends (but does not require) the use of mid-year discounting for all annually recurring costs. Army and Navy have updated their guidance to recommend mid-year discounting for all future costs except for "terminal values" (i.e., residual value) as is specified in Naval Facilities Engineering Systems Command (NAVFAC) P-442 Economic Analysis Handbook [cite] and implemented in ECONPACK [cite]. USAF???. The MOA also recommends the lumping together of all initial investment at the midpoint of construction for projects that have a service date later than the date of study. This is different than the approach for non-military projects, which typically use the end-of-year discounting convention and recommends the phasing-in of investment costs as they are incurred over the planning/construction period. The one except is NASA, which also uses P442 and PAX ECONPACK.

1.3 Federal LCCA Resources provided by NIST

Given the complexities of LCCA and the variation in requirements discussed above by the type of federal project being analyzed, resources have been provided by NIST on behalf of FEMP, including LCCA methodology, discount rate and energy price data, and LCCA-related software, to help organize, compute, document, and report cost-effectiveness analyses. Each of these resources is relevant for this user guide and summarized below. For additional information, please see the FEMP BLCC webpage at https://www.energy.gov/femp/building-life-cycle-cost-programs.

NIST publishes two documents to assist LCCA of federal projects. First, Handbook 135 – the Life Cycle Costing Manual for FEMP – explains in detail the principles of LCCA and integrates them with FEMP criteria [5]. The LCCA methodology is also consistent with ASTM building economic standards. Additionally, Handbook 135 provides examples of applying the methodology to different types of analysis and topic areas (e.g, energy efficiency, resilience). Updates to Handbook 135 occur as appropriate, the most recent of which in 2025 (superseding the 2022 release).

Second, the Annual Supplement to Handbook 135 is released annually and provides factors calculated with the latest FEMP discount factors and energy price escalation rates for U.S. Census divisions, rate types, and fuel types. Escalation rates can be computed based on the Energy Information Administration (EIA) energy price projections in the Annual Energy Outlook used for calculating FEMP discount factors and on EIA projections with optional adjustments included by NIST for potential carbon pricing. The document includes a supplemental spreadsheet to provide easy access to the data. Additionally, the code base for

collecting source data and processing into the reported values is provided as a supplement resource to provide transparency and replicability starting in 2025.

NIST provides two software tools to assist in LCCA of federal projects. First, the Energy Escalation Rate Calculator (EERC) computes an average annual escalation rate for a specified time period based on the non-constant escalation rate projections published in the Annual Supplement to Handbook 135, which can be used as an escalation rate for contract payments in energy savings performance contracts and utility energy services contracts.

Second, the Building Life Cycle Cost (BLCC) software provides economic analysis of proposed investments in buildings and building systems intended to reduce long-term operating costs. BLCC is useful for evaluating costs and savings related to energy efficiency, water conservation, and renewable energy projects, and for selecting project alternatives with the lowest LCC. Comparative economic measures can be computed for any project alternative, including net savings (NS), savings-to-investment ratio (SIR), adjusted internal rate of return (AIRR), and payback period (PBP). BLCC is appropriate for federal, state, and local government and private sector use because it is consistent with federal LCCA requirements and ASTM building economic standards. BLCC is updated annually to include the current FEMP and OMB discount rates and the most recent DOE projections of energy price escalation rates published in the Annual Supplement to Handbook 135.

The current BLCC available to users is a desktop application (BLCC 5.3) programmed in Java with an XML file format and is provided in a downloadable executable (exe) file that installs the software on the local machine, which limits accessibility due to varying IT administrator access restrictions for some users (e.g., US military). The software is updated annually and released in parallel with the Annual Supplement to Handbook 135 and EERC. BLCC 5.3 has several limitations that have been identified since the last change to the underlying tool (more than 15 years ago).

To address these issues and improve the user experience, NIST has developed a web-based version of BLCC. The BLCC web application, which is the focus of this user guide, provides all the same capabilities and data security of BLCC 5.3 while providing an updated interface that improves the user experience and includes additional features not available in BLCC 5.3. User data (e.g., BLCC project files and results files) is only accessed and saved on the user's local machines, just like BLCC 5.3, while avoiding the need to install software on the local machine.

Key improvements include the following:

- Shift to a web-based tool from a desktop application, avoiding any installation requirements
- Simplified interface design to collect user inputs
- Better navigation capabilities
- More user friendly tips and guidance for user inputs
- More flexibility to include a variety of cost types or input values as costs or savings independent of analysis type

- Ability to evaluate a bundled project across multiple locations (e.g., different states)
- Added an "Other" cost option to allow for inclusion of both monetary and non-monetary costs and benefits that may be pertinent to the project analysis
- Combined emissions (i.e., CO_2, SO_2, and NO_x) into a single metric (CO_2e)
- Added results pages, including figures, to the user interface that did not previously exist and improved organization of results
- Provide results for energy consumption by fuel type
- Downloadable PDF and CSV results files to replace the text-based results files
- Ability to upload an existing project in the BLCC 5.3 xml file format
- Includes default data for both the current year and previous year release to allow for validation of analysis completed in the previous year, which is not feasible in BLCC 5.3
- Greater ability to change or expand capabilities in the future for improved interface maintenance and updates (e.g., alternative energy price projection and emissions rate scenarios)

The BLCC web application is built using a common software stack. The backend is written in Rust with the Actix framework. The frontend is created with React and extensive usage of RXJS.

[add details on software stack]

The BLCC web application is powered by NIST's Economic Evaluation Engine (E3) - https://e3.nist.gov/. E3 is a topic agnostic economic analysis web API that can complete LCCA and benefit-cost analysis (BCA) as well as provide sensitivity and uncertainty analysis [cite E3 technical manual]. By leveraging the calculation abilities of E3, the development of the BLCC web application could be streamlined to focus on the user interface. BLCC has been designed in a similar manner to other web applications already powered by E3, such as Present Value of PhotoVoltaics – $[PV]^2$ – (https://pv2.nist.gov/) and SITExpress (https://sitexpress.nist.gov/). E3 meets all security requirements for use by federal agencies. E3 uses an instance on Amazon Web Services (AWS), which is FedRAMP certified, and does not save any user data either in the cloud or log any information on the NIST-hosted E3 server.

BLCC is currently in "beta" version, which is a pre-release version that has gone through significant internal testing at NIST. The general look and feel as well as functionality are not expected to change in the final product. However, beta testing from a group of users is needed to try BLCC under real conditions to identify any potential issues not yet identified. Thus, the BLCC web application is being provided in parallel with the current desktop application release (BLCC 5.3-25). Note that the BLCC web application has been validated using the example files from BLCC 5.3. Any small differences in results have been determined to be a result of differences in how the two versions treat rounding of values in the calculations. However, if significant differences exist (>1 %), please contact NIST and, if feasible, provide the BLCC Project File and E3 Request (Input) File that resulted in the issue and/or a screenshot of the issue in the interface to assist in the debugging and validation. After addressing issues identified in the

beta testing, an official release of BLCC will follow, expecting to replace BLCC 5.3 for 2026. At which time, BLCC 5.3 will become legacy software and no longer be actively supported.

2 BLCC Analysis Overview

The methodology and calculations in the BLCC web application remain the same as those in BLCC 5.3. This section provides summaries of some key topics in LCCA and BLCC that are also highlighted in the BLCC 5.3 Help Menu:

- Analysis Types and Results Reporting
- Discounting
- Cost Category Summaries
- Alternative Financing
- OMB Analysis
- MILCON Analysis

Additional details for these topic areas can be found in the following Section that walks the user through each "page" of the BLCC interface.

2.1 Project Analysis Types and Results Reporting

BLCC provides economic analysis for different types of project evaluations, referred to as a "analysis type," each of which include specific default assumptions (e.g., discount rate, discounting convention) as defined below:

Federal Analysis, Financed Project: Used for an LCCA of energy savings performance contracts (ESPCs), utility energy services contracts (UESC), or other alternatively financed investments in energy or water conservation in the federal government. The criteria used as defaults are applicable to all agencies in the federal government. Alternative financing (ESPCs and UESCs) is discussed in greater detail in Section 2.4 – Alternative Financing Analysis.

FEMP Analysis, Energy Project: Follows FEMP's life-cycle costing rules according to 10 CFR 436A as they apply to energy and water conservation and renewable energy projects funded by agencies from direct appropriations.

OMB Analysis, Non-Energy Project: Supports analyses that are subject to the life-cycle costing guidelines of OMB Circular A-94 for the following types of projects: (a) cost-effectiveness, lease-purchase, internal government investment, and asset sales, and (b) public investment and regulatory analyses. OMB analysis is discussed in greater detail in Section 2.5 – OMB Analysis.

MILCON Analysis, Energy Project: Supports LCC analyses, according to 10 CFR 436A, of agency-funded energy and water and renewable energy projects for military construction in the Army, Navy, and Air Force. Energy MILCON analysis is discussed in greater detail in Section 2.6 – MILCON Analysis.

MILCON Analysis, ERCIP Project: Used for generating the "ERCIP Report" (titled "ECIP Report" in BLC 5.3) for MILCON projects funded by the DoD Energy Resilience and Conservation Investment Program to retrofit existing energy systems. MILCON ERCIP analysis is discussed in greater detail in Section 2.6 – MILCON Analysis. (*forthcoming*)

MILCON Analysis, Non-Energy Project: Supports LCC analyses of new acquisition or construction projects, lease-purchase decisions, modification of existing facilities and similar projects, the purpose of which is not primarily to assess resource conservation. Non-energy MILCON analysis is discussed in greater detail in Section 2.6 – MILCON Analysis.

For all project analysis types except MILCON ERCIP, BLCC 5.3 generates six different reports, three by project alternative - Inputs, Summary LCCA, Detailed LCCA, and Cash Flow- and three comparing project alternatives - Lowest LCC Alternative and Comparative Analysis. The Comparative Analysis report on allows for comparing two alternatives at a time. For MILCON ERCIP, only one report is generated ("ECIP") that provides all necessary documentation for reporting savings from an ERCIP project.

The BLCC web application condenses these seven reports into four results tabs – Summary, Annual Results, Alternative Results, and Inputs. Additionally, the user can easily navigate through and view data in tables and figures. Examples of what the results look like in the BLCC interface are provided in Section 3.10. All the information provided in the results tabs can also be downloaded as a single PDF that documents all inputs and results. The user can also download the results data tables in a spreadsheet (CSV format) for their use outside the BLCC interface.

2.2 Discounting in BLCC

Understanding discounting assumptions is important to correctly use BLCC for LCCA of federal projects. Below is a summary of discounting conventions and constant versus current dollar analysis as used in BLCC.

2.2.1 End-of-year or Mid-year Discounting

If end-of-year discounting is selected, all annually recurring costs (including energy and water costs) will be discounted to the base date from the end of the year in which they occur. If mid-year discounting is selected, all future costs will be discounted to the base date from the middle of the year except for residual values, which are assumed to occur at the end of the study period. End-of-year discounting is the default for all types of analyses except MILCON project analysis types. MILCON analyses require mid-year discounting, and the designated MILCON analysis types use mid-year discounting as the default.

2.2.2 Constant- or Current-Dollar Analysis

Projects financed through ESPCs or UESCs may be performed in either constant or current dollars. Current-dollar analysis is the default for financed projects in BLCC. The reason is that it may be useful to compare current-dollar energy cost savings or total operational cost savings with contract payments, which generally are escalated to reflect anticipated nominal dollar price increases. In current-dollar analysis, the discount rate and all price escalation rates need to be entered in nominal (including inflation) terms. The default inflation rate in BLCC5 is the average long-term inflation rate calculated annually for DOE/FEMP projects according to 10 CFR 436.

If the analysis of ESPC or UESC projects is performed in constant dollars, all annual cash flows will be reported in constant dollars as of the base year. Any annual cost that is expected *not* to increase at the rate of general inflation during the study period will have to be assigned a negative escalation rate. In constant-dollar analysis, the underlying assumption is that all dollar amounts increase at the same rate of general inflation and only differential rates of escalation are entered. For example, assume that the contract payment charged by an ESCO is a fixed annual amount that does not increase at the rate of inflation from year to year. In this case, the negative of the inflation rate (i.e., a differential rate of increase) must be entered to make the present value of the contract payments consistent with the present values of the other cash flows.

Note: If you switch from constant-dollar to current-dollar analysis, BLCC will automatically convert the discount rate and all rates of escalation to nominal rates with the same rate of inflation that is used to compute the nominal DOE/FEMP discount rate. Likewise, if you switch from current-dollar to constant-dollar analysis, BLCC will automatically convert the discount rate and all rates of escalation to real rates.

2.3 Types of Costs in BLCC

BLCC provides the flexibility to include any cost that is deemed impactful to the investment decisions being analyzed. The defined cost categories include:

- Capital Component Costs
- Contract-related Costs
- Operational Resource Costs (i.e., energy and water)
- Other Costs (Monetary and Non-Monetary)

2.3.1 Capital Component Costs

Capital component costs include all costs associated with the physical components being installed and operated and include investment costs, replacement costs, OMR costs, and residual value. Investment costs include any initial investment costs of the project, such as initial equipment and installation costs. Replacement costs include any costs associated with replacing capital components (e.g., furnace replacement) during the study period. Both investment costs and replacement costs may have some value either at the end of its useful life or at the end of the study period, whichever is sooner, which is known as the residual value and could be positive (e.g., salvage value, refurbishment) or negative (e.g., disposal costs). OMR costs include all non-investment costs (no potential residual value) that occur during the operational period (i.e, use phase) of the study period, and can be one-time or recurring costs.

2.3.2 Contract-Related Costs

Contract-related costs are usually relevant only for the analysis of financed projects. BLCC allows you to divide these costs into recurring (e.g., contract payments) and non- recurring costs (implementation costs). Contract costs are assigned at the alternative level because they may not be attributable to individual energy conservation measures (ECMs) (i.e., capital components).

If recurring contract costs either escalate at rates that are non-uniform from year to year or if escalation rates differ for parts of the contractor payment, separate escalation rates can be assigned to each of the contract cost components. For example, contract costs may vary at rates equal to expected non-linear energy price escalation rates (e.g., at a faster rate in the first several years of a contract and then slower in subsequent years) rather than at a constant annual rate. Alternatively, a portion of the contractor payments may escalate at energy price escalation rates, another at OM&R escalation rates, and a third may be fixed.

Note: *If the analysis is performed in constant dollars, any contract payments that do not change from year to year at the rate of general inflation (i.e., nominal dollars) need to be adjusted by the negative of the escalation rate to maintain them as constant-dollar amounts. The underlying assumption in constant-dollar analyses is that all amounts escalate at the same rate.*

BLCC 5.3 allowed the user to vary the rate of occurrence of annual contract costs using the usage indices. For example, management and administrative costs may be included in the annual contract payment during the contract term but may be incurred directly by the agency during the post-contract period. An index of 0 for a contract term of ten years and an index of 100 for the remaining years in the study period mean that annual management and administrative costs are incurred by the agency after the end of the contract term (i.e., 0% during the contract term and 100% after the contract term ends).

The BLCC web application has modified this approach by removing the usage index and allowing the user to specify the rate of occurrence directly. This makes it easier to introduce costs that recur at a constant, non-annual rate (e.g., every 3 years). However, the usage index is not available for creating a cost that recurs at a non-constant rate (e.g., recurs in year 2, 10, and 12) or a recurring cost that stops occurring before the end of the study period is reached (e.g., contract ends in year 10 but the study period is 15 years). For a cost that recurs at a non-constant rate, it is recommended to include separate costs items for each occurrence. For recurring costs that end before the end of the study period, the user should use the Value Rate of Change to adjust the calculation using the following steps:

(1) Set the Value Rate of Change to -100% for the year after the last occurrence of the recurring cost
(2) Set the Value Rate of Change to 0% for all remaining years in the study period.

This will set the value for this recurring cost to zero for all years in the study period after the cost has stopped recurring. Note that this approach can be used for any other recurring cost without a usage index (i.e., recurring OMR Costs).

UNDER DEVELOPMENT: In place of unit index, a duration input will be added to allow for the user to directly specify the length of time over which the costs should occur. When fully implemented, it will replace the value rate of change approach discussed above.

2.3.3 Operational Resource Costs

2.3.3.1 Water Costs

Water costs are entered for the entire alternative regardless of whether the alternative is evaluated as a single component or sub-divided into several components (e.g., ECMs). Water costs are assumed to be annually recurring costs starting with the service date and continuing throughout the service period. If a water cost ends before the end of the study period, the user can change the unit index to zero for years in which the cost does not occur. This approach can be applied to all recurring costs with a usage index (i.e., energy, water, other). Water-related data include the rate schedule, location, price and consumption for both use and disposal, and water price escalation rates. Note that no default data is available for water costs.

2.3.3.2 Energy Costs

Energy costs are entered for the entire alternative regardless of whether the alternative is evaluated as a single component or sub-divided into several components (e.g., ECMs). Energy costs are assumed to be annually recurring costs starting with the service date and continuing throughout the service period. If an energy cost ends before the end of the study period, the user can change the unit index to zero for years in which the cost does not occur. This approach can be applied to all recurring costs with a usage index (i.e., energy, water, other).

BLCC provides the most widely used and reported fuel types for progress toward key goals outlined in the National Energy Conservation Policy Act (NECPA), as amended (42 U.S.C. 8253-8258); Energy Policy Act of 2005 (42 U.S.C. 15852) (https://www.energy.gov/femp/federal-comprehensive-annual-energy-performance-data). The government-wide share for each fuel type covered under these goals for Fiscal Year 2023 is provided below as reported in FEMP's Federal Facility Reporting and Data under Comprehensive Annual Energy Data – Table A6 (https://ctsedwweb.ee.doe.gov/Annual/Report/Report.aspx). For BLCC, electricity, natural gas, fuel oil, coal, and LPG/Propane are explicitly included as options while the "other" energy cost category in BLCC account for the other three fuel types – other, non-electricity producing renewable energy (direct biomass combustion), and purchased steam.

- Electricity – 46.8 %
- Natural Gas – 40.5 %
- Fuel Oil – 5.1 %
- Purchased Renewables; On-Site Renewables and Adjustments – 2.6 %
- Purchased Steam – 2.0 %
- Coal – 1.3 %
- Other – 1.0 %
- LPG/Propane – 0.5 %

Energy-related data include the rate schedule, location, price, demand charges, utility rebates, and energy price escalation rates. The escalation rates are defaulted to the DOE escalation rates (i.e., those from EERC, which are retrieved automatically for the specified region, rate, and fuel type), and can be edited by the user to reflect other sources (e.g., future rates published by a utility). Note that no default data is available for American Samoa, Canal Zone, Guam, Puerto Rico, Trust Territory of the Pacific Islands, or the Virgin Islands. Analysts of federal projects in these areas should use data that are "reasonable under the circumstances" and may select "U.S. Average" if appropriate [check and cite FEMP guidance here].

Note: If annual demand charge or annual utility incentive (e.g., rebates) need to be escalated differently from the energy costs, a user can create separate costs for each with the following steps:

- *create a new "energy cost"*
- *set annual consumption to zero in the energy usage screen and price/unit in the energy cost screen*
- *edit the DOE energy price escalation rates*

Note: The duration of the energy usage index begins with the service date (since energy consumption calculations begin with the service date), while the duration for energy price escalation rates begin at the start of the study period (since all prices are entered in base-year dollars).

2.3.3.3 Operational Energy-Related Emissions

BLCC calculates air pollution emissions associated with operational energy use in buildings and building systems. Annual and life-cycle estimates are aggregated to kilograms of carbon dioxide equivalent (kg CO_2e). Emission factors are specified for each of the different end-use energy types using data published by NETL through an interagency agreement with NIST [cite source(s)]. Emission factors for each fuel type are specific to the location of the energy consumption, with the regionalization varying by fuel type based on the market structure for that fuel type (e.g., balancing authority for electricity, PADD region for oil). Note that energy consumption may occur at the primary location of the project or at a different location (e.g., different facility, state, or region of the U.S.) depending on the location specified for that energy cost. Selection of a location outside the United States will cause BLCC to default to national average values for electricity and natural gas as developed from the same sources mentioned above while the emissions rates for PADD3 are used for fuel oil and propane/LPG because PADD3 is the largest producing and exporting region.

No economic value is placed on these emissions. A user could include an economic value for these emissions by including an “Other Monetary Cost.” See Section X – Other Costs – for additional details on how to include an economic value for emissions or any other cost that does not fit into one of the default cost categories provided in BLCC.

2.3.3.4 Fuel Energy Content Conversions

In some cases, estimates of energy content per unit of volume of a fuel can vary (e.g., MJ of energy in a cubic feet of natural gas). A user can see the data that BLCC uses for energy conversions in EIA's Energy Conversion Calculators for Energy Used in the United States, which is available here: https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php. BLCC uses the values in these calculators as of April 2025.

2.3.4 Other Costs

The "Other" cost category includes any costs or benefits that do not fit into the existing cost categories. Other costs can be either monetary or non-monetary. Other Monetary costs are assumed to be directly realized costs or benefits that are included in the LCCA calculations. Other Non-monetary costs include indirect impacts or externalities that are not borne by the project owner and, thus, are not included the LCCA. However, the analyst has determined these costs or benefits to be important to include in the decision-making process. Non-monetary costs are reported separately with the user-defined quantities (using a custom "tag").

2.3.5 Residual Value

The residual value can either be specified as a total dollar amount or a percentage. The latter is the percentage of the initial installation / replacement cost in base-year dollars remaining at the end of the study period (or at the end of the expected life of the replacement, whichever is sooner). A negative rate can be entered if the residual value is a disposal cost. If the user does not want to use linear depreciation to estimate the residual value, the user can use the total dollar amount option or set the residual value in the cost to $0 or 0.0 % and create a separate investment cost that includes a one-time (negative) cost at the end of the study period equivalent to the residual value. BLCC uses the average annual rate of increase specified for the replacement cost along with this factor to compute the actual residual value in dollars.

Note: Non-capital replacement costs for MILCON analyses must be entered as non-annually recurring OM&R costs (previously called non-annually recurring routine OM&R costs).

Note: Residual values are not included in the ERCIP report because they are not allowed to be included?

Note: The initial cost financed is used only to calculate the residual value; it is not included in the LCC calculations, since any financed amounts would be included in the contract payment.

Note: In the case of mid-year discounting, residual value is the only cost calculated at the end of the last year of the study period. For example, if the study period is 15 years, then the residual value is calculated at year 15 while energy costs in year 15 are calculated at year 14.5.

2.4 Alternative Financing Analysis

BLCC can be used for alternative financing option analysis (e.g., of ESPCs and UESCs). LCC analyses can be conducted continuously throughout the different phases of project development, including to:

(1) determine the system or measure that provides the greatest energy or water savings at the lowest life-cycle cost.
(2) perform a feasibility study to determine whether the expected life-cycle cost savings of a financed project compared with the base case of "doing nothing" warrants the time and resources needed to pursue an ESPC.
(3) analyze proposals submitted by ESCOs

In the case of a building retrofit, the existing equipment continues to consume energy and require maintenance until it is replaced by the energy conservation measures, sometimes over a period of several years. The service period in this case begins at the base date, and the base and service dates coincide. Energy and non-fuel costs must be adjusted to account for the changes in usage as new equipment is installed. This is accomplished by "indexing" the energy and OM&R costs, which allows the user to specify a change in the annual energy usage or OM&R pattern.

Note to MILCON analysts: If the service date (i.e., beneficial occupancy date) is later than the base date, the initial project cost may be entered at the midpoint of construction. This procedure is suggested in the DoD Memorandum of Agreement on Criteria/Standards for Economic Analysis/Life-Cycle Costing for MILCON Design, March 1994. However, the US Army Corps of Engineers in its web site Economic Analysis Reference Guide recommends that DD 1391 front page total request should equal the initial construction costs in the analysis; also, these costs should be evenly divided throughout the lead or construction time. The BLCC cost adjustment factor (CAF) or cost-phasing feature accommodates either method.

The savings-to-investment ratio (SIR) is the ratio of operational savings to additional investment costs, calculated for the energy-saving alternative relative to a base case. In analyses of alternative financing projects, there are no initial investment costs with which to compare operational savings. It is usually contract payments that are compared with operational savings. These contract payments include interest and principal payments in addition to investment costs and may include other types of costs such as operating, maintenance, and repair costs or measurement and verification costs. When one compares savings with contract payments, it is impossible to separate operational savings (which go into the numerator) from capital investment costs (which go into the denominator). *We recommend that the SIR not be calculated for alternative financing projects because it is meaningless if not computed on capital investment costs. The same holds for the AIRR and payback period.*

The SIR is used mainly to rank projects. Lowest-life-cycle cost or its counterpart, net savings, is the measure of economic worth that is appropriate for evaluating the cost-effectiveness of an energy conservation project, whether funded by the agency or financed through an ESPC or UESC.

2.5 OMB Analysis

The OMB analysis type is designated to perform life-cycle cost analyses subject to OMB Circular A-94 [2], when the purpose of the evaluation is not primarily to assess energy-related savings. OMB Circular A-94 also excludes water resource projects. The evaluation criteria for non-energy-related projects are defined by either of the following two analysis purposes:

(1) cost-effectiveness, lease-purchase, internal government investment, and asset sales analyses
(2) public investment or regulatory analyses.

The general principles of the life-cycle cost methodology embedded in BLCC apply to all its analysis types. The agency- or criteria-specific requirements are reflected in the differing default values of each analysis type. The program requires the user to choose one of the two general analysis purposes specified in OMB Circular A-94 ("cost-effectiveness" and related analyses or "public investment or regulatory"), depending on the purpose of the study. BLCC5 will select the appropriate discount rate for the analysis purpose chosen.

OMB discount rates for cost-effectiveness and related analyses are based on Treasury notes and bonds of varying maturities and hence differ depending on the length of the study period. For public investment and regulatory analyses the discount rate is fixed at a real rate of 7% (3% real for sensitivity analyses recommended in OMB (6).

In FEMP analyses the service period, i.e., the period over which cash flows are evaluated, is limited to a maximum of 40 years. There is no limit to the length of the study period in OMB analyses. Note that BLCC does not provide analysis beyond a service period of 40 years.

If the purpose of an LCCA is primarily to evaluate the energy savings for a facility or system, the analysis should be conducted using the FEMP LCC criteria according to 10 CFR 436A. An analysis that evaluates two different facilities or systems being considered for the same use, both incorporating roughly the same degree of energy or water conservation in design and using approximately the same amount of energy (so that the purpose of the evaluation is not primarily to assess energy-related savings), should be conducted using the criteria and discount rates specified in OMB (2). However, if a project involves energy usage only peripherally, and the energy-related and non-energy-related parts of the investment cannot be readily separated, the decision as to whether to use the criteria of OMB Circular A-94 [2] or the FEMP criteria is left to the judgment of the analyst.

As of the publication of this user guide, water resource projects are subject to the *Updated Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies* provided by CEQ in 2014 [7].

2.6 MILCON Analysis

There are three analysis types related to MILCON activities, each of which is discussed below. The terminology has been streamlined in the BLCC web application. In MILCON analysis types:

- service date is equivalent to “beneficial occupancy date"
- Recurring OMR costs aligns with "routine OM&R costs"
- Replacement costs aligns with "major repair and replacement costs"
- Non-recurring OMR Costs aligns with “non-capital replacement costs” that were labeled as "non-annually recurring routine OM&R costs"

2.6.1 MILCON – Energy Project

This MILCON analysis type supports LCC studies for the Army, Navy, and Air Force when the primary purpose of the study is to assess the costs and benefits of investments in energy and/or water conservation. The analysis type is consistent with DoD's memorandum of agreement on *Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design* [4]. It also follows the rules of the DOE/FEMP *Life-Cycle Cost Methodology and Procedures* in 10 CFR 436A [1]. The rules for MILCON analyses include some DoD-specific instructions and terminology. All annually recurring costs (OM&R, energy and water costs) are discounted from the middle of the year instead of from the end of the year. (Non-annually recurring and single amounts -- for example, phased-in initial costs, major repair and replacement costs, and residual value -- are discounted from their actual date of occurrence.) In MILCON analyses related to energy or water conservation, BLCC will default to the DOE discount rate required by FEMP. The discount rate is updated annually and published by NIST in *Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis,* NISTIR 85-3273. If the service date (beneficial occupancy date) is later than the base date, the initial project costs are entered at the "midpoint of construction" or can be evenly divided throughout the planning/construction period. The midpoint of construction must be halfway between the base year and the service year (beneficial occupancy year).

2.6.2 MILCON – ERCIP Project (UNDER DEVELOPMENT)

The ERCIP analysis type simplifies the user inputs for LCC analysis (specifically the initial costs) that can be used for energy-related MILCON projects to be funded under the DoD ERCIP (formerly ECIP) for the retrofitting of existing energy systems. ERCIP projects are prioritized for funding in decreasing order of their savings-to-investment ratio (SIR). The summary table in the BLCC report provides the SIR values for each alternative.

Note that there is not a unique report for ERCIP projects like in BLCC 5.3, which included an Energy/Water Life Cycle Cost Analysis Summary table that included the SIR as one of the economic measures of the retrofit relative to the base case. Instead, when a user selects the MILCON ERCIP Project Type, BLCC will modify how it operates to meet the unique requirements for an ERCIP project, specifically:

(1) create a base case alternative with zero costs to be uses for the comparative analysis, replicating how BLCC 5.3 completes its ERCIP analysis
(2) create a blank alternative with a unique section to the Alternative Page that requires the user to input the specific investment cost line items that are needed for reporting the LCCA results for an ERCIP project

(3) Default all non-investment costs to "savings" instead of "costs" to align with the BLCC 5.3 input requirements

The user will input all other costs using the regular BLCC capabilities. Results will be displayed in the same manner as the other BLCC analysis types, which includes SIR in the Comparative Analysis Summary table.

The reason for these changes is that ECIP studies generally use investment cost differences and operational cost savings for an energy conservation project rather than the corresponding total cost data for a base case and an alternative like the other BLCC analysis types. In the case of a retrofit of functional equipment made entirely for reasons of energy and water use efficiency, this implies that the initial capital cost of the base case may be zero and that the entire investment cost of the retrofit must be justified by the operational savings. The BLCC web application defaults inputs to "cost savings" to align with the BLC 5.3 input structure, but the user can modify any item to be inputted as a cost or a cost savings as appropriate.

There are some restrictions on the input data for the ECIP report compared with the other analysis types. This may result in small differences between the life-cycle cost results for an ECIP project versus a fully developed LCC analysis using other BLCC analysis types. In the ECIP analysis type, when computing an SIR for a single project for the purpose of ranking it relative to other projects, the user should NOT include project replications that may have been used to compare the LCC of multiple, mutually exclusive, alternatives. Since replications are not included, capital replacement costs are not included. Component replacements, if any, should be entered as non-annually recurring non-energy savings. These will appear in the numerator of the SIR rather than in the denominator, like capital-related replacements. Residual values are not included in the ECIP report. The BLCC5 comparative analysis will not agree with the ECIP analysis if a residual value is included in the data file for either the base case or the alternative in a non-ECIP MILCON analysis.

In an ECIP analysis, all costs and savings are assumed to be incurred at the base date. Phase-in of investment costs and postponement of operational costs to the beneficial occupancy date (BOD) cannot be accommodated in the ECIP analysis. Using the MILCON energy analysis type, the SIR and AIRR measures are computed using the discounted present value of the phased-in capital investment costs; operational costs are assumed to be incurred only during the occupancy period. The SIR and AIRR shown in the BLCC ECIP report would agree with the BLCC comparative analysis report only if the same date is used for both the base date and BOD. SIOH (supervision, inspection and overhead), design cost, salvage value of existing equipment, and utility rebates, if any, are specifically identified in an ECIP report. The input screen of the BLCC ECIP analysis type therefore requires the user to specify the part of the project's initial investment cost (before salvage value of existing equipment and utility rebate adjustments) to be allocated to SIOH and design. Amounts of 6 % of investment cost for SIOH and 10 % for design may be used as default values. Users must also specify the absolute amount of the salvage value from existing equipment and the utility rebate, if any, for the project alternative.

2.6.3 MILCON – Non-Energy Project

This MILCON (military construction) analysis type supports LCC studies for the Army, Navy, and Air Force when the project is not primarily an energy or water conservation project. The analysis type is consistent with Tri-Services (4) and follows the rules of CFR (1). The instructions given in BLCC apply, in general, to all federal LCC analyses. However, as was mentioned in Section 2.6.1, the rules for MILCON analyses include some DoD-specific instructions and terminology.

Analysts should consider and document, as appropriate, the following alternatives:

- status quo (do nothing)
- new acquisition or construction
- leasing
- modification of existing assets (i.e., renovation, upgrade, revitalization, etc.)
- use of other government facilities (on-base or other nearby bases, DoD or non-DoD)
- basic allowance for housing
- privatization (required for utility systems)

All alternatives must be feasible from a technical point of view. Annually recurring costs (OM&R, energy and water costs) are usually discounted from the middle of the year in DoD analyses rather than from the end of the year (as in FEMP and OMB analyses). Non-annually recurring and single amounts -- for example, phased-in initial costs, major repair and replacement costs, and residual value -- are discounted from their actual date of occurrence. In MILCON Analysis - Non-Energy Project, BLCC5 will default to the discount rates published by OMB in Appendix C of Circular A-94 for "cost-effectiveness, lease-purchase, internal government investment, and asset sales." Discount factors based on these discount rates are updated each April and published by NIST in Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis, NISTIR 85-3273. For "public investment" and "regulatory analyses", OMB prescribes a real discount rate of 7 %. However, Circular A-4, released in January 2004, OMB recommends that two estimates be submitted, one calculated with a discount rate of 7 % and the other using 3 %.

If the service date (beneficial occupancy date) is later than the base date, the initial project costs are entered at the "midpoint of construction" or can be evenly divided throughout the planning/construction period. The midpoint of construction must be halfway between the base date and the service date (beneficial occupancy date). The US Army Corps of Engineers suggests a useful life of 60 years for new construction, 45 years for family housing, 25 years for renovation projects, beginning with the date of completion. Land depreciation begins at the base date. A straight-line depreciation method is recommended. The US Army Corps of Engineers recommends that analysts perform a sensitivity analysis for their evaluation results, varying input values by plus or minus 25 % for significant cost items.

3 Using BLCC

This section walks the user through each "page" that may be encountered in the BLCC web application in a logical order in which a user may experience these page in the BLCC web interface. There will be brief instructions on how to properly provide user inputs and complete an analysis, including highlighting of common questions and unique cases. The user will start on the BLCC landing page, navigate to the tool, create alternatives and associated costs, navigate to the results page, run the analysis, and view and download the results.

3.1 BLCC Landing Page

Going to https://blcc.nist.gov/ takes a user to the BLCC landing page as shown in Figure 3-1, which highlights new features of the web application and related resources. The user can navigate to BLCC by either clicking on the BLCC heading or on the "Open BLCC" button in the top right of the screen in the NIST header. Links to related resources, such as the FEMP BLCC webpage and the BLCC GitHub repository are provided in the left side of the header. Links to other resources, such as Handbook 135, are provided further down the webpage.

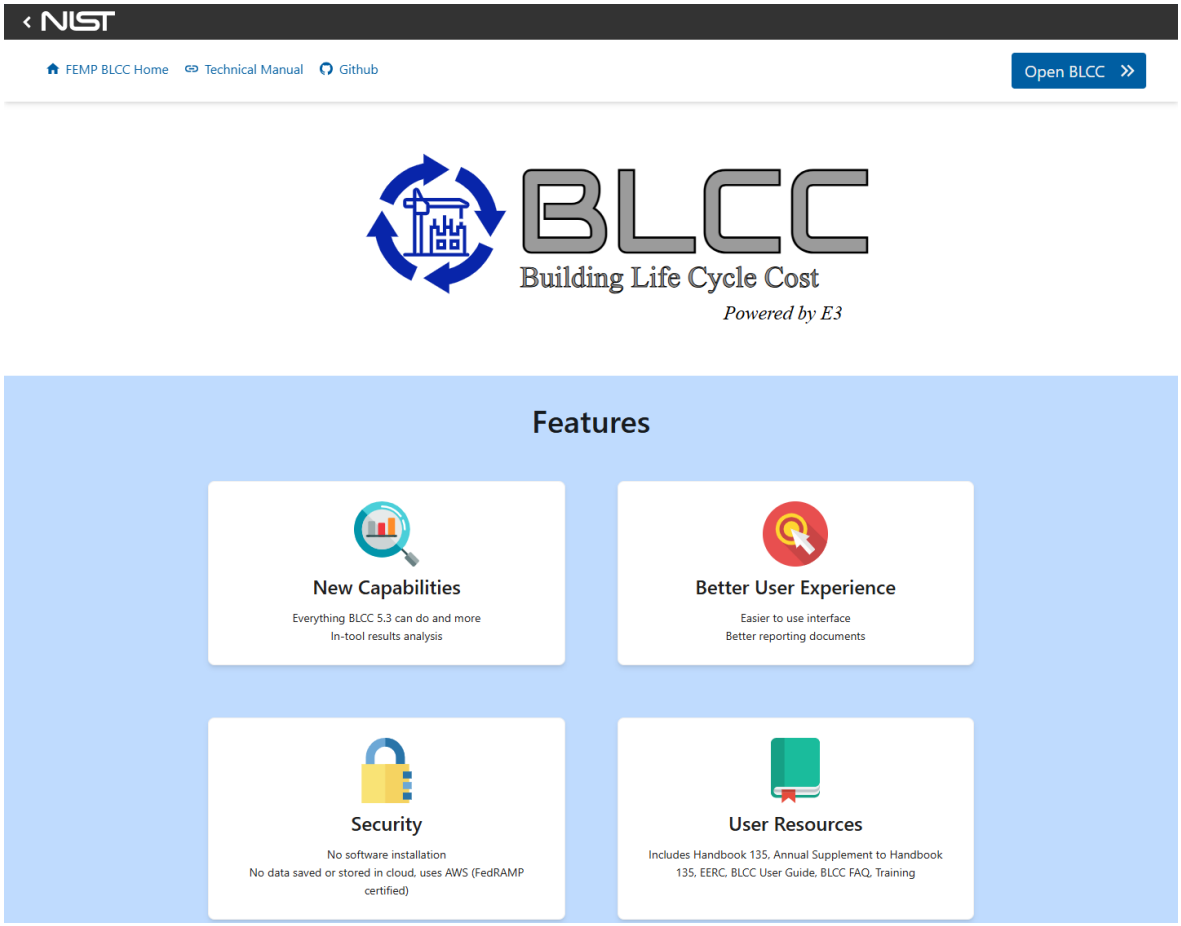

Figure 3-1 BLCC Landing Page

3.2 General Information Page

Navigating to BLCC takes you to the General Information Page, which includes the user inputs list in Table X and shown in Figure 3-2.

Table 3-1 General Information User Inputs

Category	Input	Required	Default Value	Default based on
General Documentation	Project Name	YES	NO	Not Applicable
	Analyst	NO	NO	Not Applicable
	Description	NO	NO	Not Applicable
Analysis Assumptions	Analysis Type	YES	NO	Not Applicable
	Analysis Purpose	YES†	YES*	Defaulted based on Analysis Type
	Study Period	YES	NO	Not Applicable
	Construction Period	YES	YES	Defaulted to 0
	Data Release Year	YES	YES	Defaulted to most recent year of data
	EIA Projection Scenario	YES	YES	Defaulted to EIA Reference Case
Discounting	Dollar Analysis	YES	YES*	Based on analysis type
	Discount Convention	YES	YES*	Based on analysis type
	Inflation Rate	YES	YES**	Based on analysis type and data release year
	Nominal Discount Rate	YES	YES**	Based on analysis type and data release year
	Real Discount Rate	YES	YES**	Based on analysis type and data release year
Location	Country	YES	YES	Defaulted to USA
	State	NO	NO	Not Applicable
	City	NO	NO	Not Applicable
	ZIP Code	YES††	NO	Not Applicable
Emissions	Emissions Data Source	YES	YES	Defaulted to NIST NETL
	Emissions Rate Type	YES	NO	Defaulted to Average

* Based on another selection; ** Based on two other selections
† Only required for OMB Energy Analysis Type; †† Only required if country is USA

Each of these inputs except Analyst, Description, State, and City currently require an inputted value to proceed (identified with a *). Many have have default values either to start or default values are selected based on user inputs further up the page, specifically Analysis Type and Data Release Year. These defaults are based on FEMP guidance and should not modified to ensure compliance with federal requirements unless deemed appropriate for the specific use case.

Figure 3-2 shows what the General Information page looks like when creating a new BLCC project. BLCC provides the user with warning and error messages in three separate ways. First warning and error messages are provided for each individual input field. For example, a blank field that is required is outlined in red with a red Required error message. Another example is warning messages, which are provided when an inputted value that is the technically feasible, but

unexpected for the given field. Second, a list of existing errors throughout the project are provided in a pop-up to the user at the bottom right by scrolling over in the footer as shown in the figure. Third, the same list of errors is displayed in a pop-up when the user clicks on the "Reports and Analysis" button to attempt to go to the Results pages.

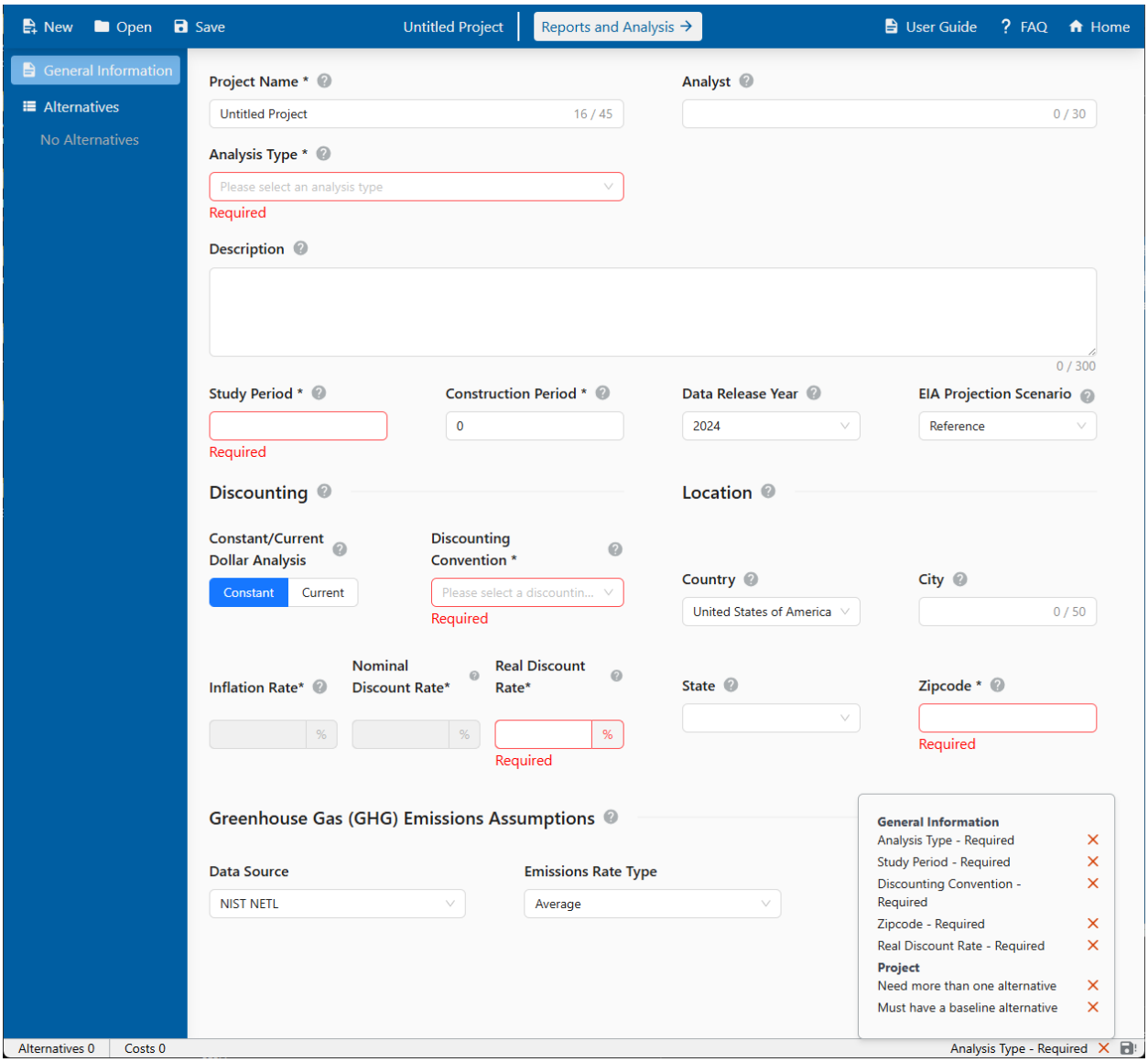

Figure 3-2 General Information Page (Blank)

If the user wants to open an existing file, they click on Open and then search their machine for the desired file. If the user opens a project created in the BLCC web application, the file will upload all information previously saved in that project file. A user can also open a BLCC 5.3 project file and upload it for modification and running in the BLCC web application. Figure 3-3 shows a user navigating to the BLCC 5.3 example project file folder and selecting the FEMP Energy example file.

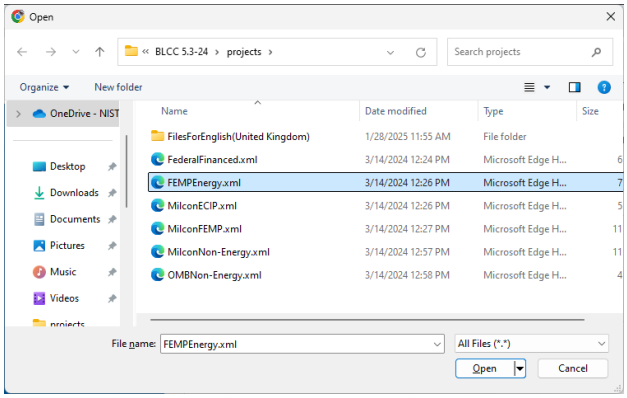

Figure 3-3 Open File Pop-Up Window

However, the old BLCC 5.3 file format is significantly different than the new BLCC web application project file format. Thus, when opening a BLCC 5.3 file, the user will receive the message shown in Figure 3-4 stating that not all information may be converted, and user should review inputs to ensure correctness.

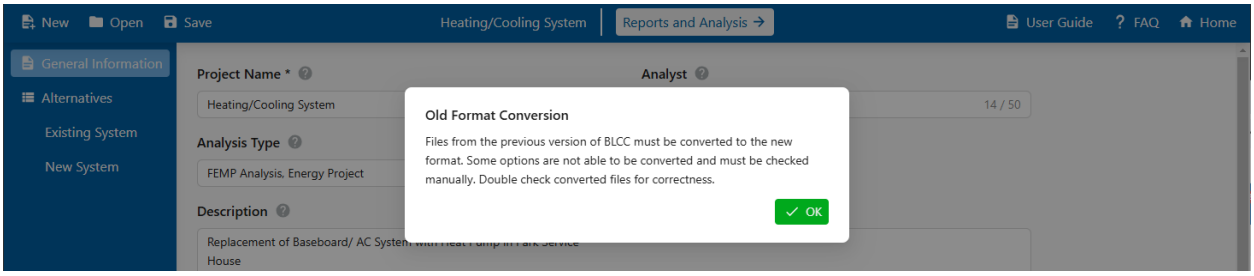

Figure 3-4 Old Format Conversion Pop-Up Notification

After opening a BLCC 5.3 file (such as FEMP Energy as shown in Figure 3-5), there are several items of which to be aware. First, unlike BLCC 5.3 where the user is required to select an analysis type before a project can be started, the BLCC web application allows the user to change their analysis type without having to start a new project. Second, unlike BLCC 5.3, there is a single screen with all generation information, including new input options such as emissions data assumptions. Third, the location must be populated by the user. Specifically, ZIP code cannot be populated from the BLCC 5.3 file because it is a new input required for the BLCC web application. The ZIP code provided on this page is treated as the primary location for the entire project and is used as the default location for all energy costs. See Section X – Energy Costs Pages for additional details on how uploaded energy cost information is handled.

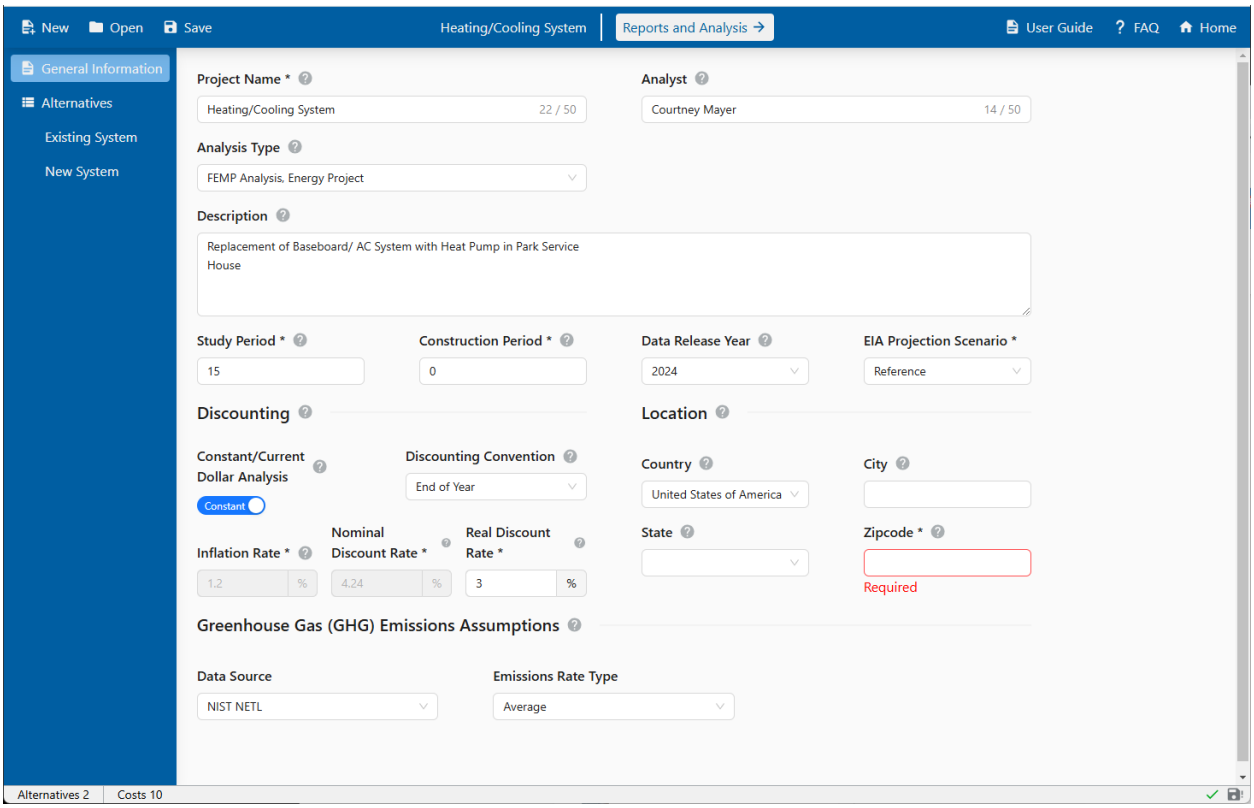

Figure 3-5 General Information Page after uploading FEMP Energy BLCC 5.3 Example

3.3 Alternatives Page

Once the user has populated the General Information Page, the next step is to create project alternatives (i.e., options). The user can navigate to the Alternatives Page by clicking on "Alternatives" in the left-hand menu. Note that this page does not exist in BLCC 5.3 but was introduced to improve the user experience. The page provides a high-level summary of each alternative, including the number of each cost type associated with the alternative. The user can select or change which alternative should be treated as the baseline (base case) for comparative analysis on this page. The user can also add, clone, or delete an alternative. For example, the user can add an alternative with the "+ Add Alternative" button in the top right of the page, which will create a pop-up window that requests the user to provide a name for the alternative as shown in Figure 3-6.

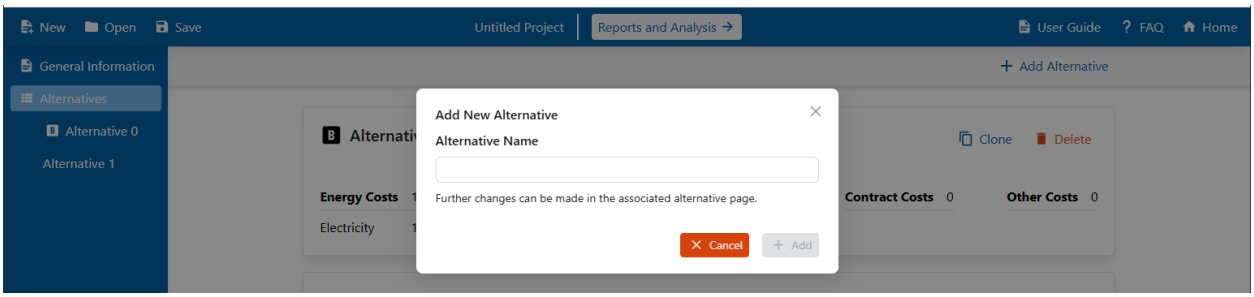

Figure 3-6 Add Alternative Pop-Up Window

If the user has opened an existing project file, the Alternatives Page will already be populated with two or more alternatives. For example, Figure 3-7 shows the alternatives for FEMP Energy. If the example file does not have a baseline alternative selected, the user must make that selection before an analysis can be run. In this example, the Existing System alternative has been selected as the baseline. The user can change the baseline by clicking on the "Set as Baseline" button on an alternative, at which point a pop-up will appear to confirm the user wants to change the baseline alternative.

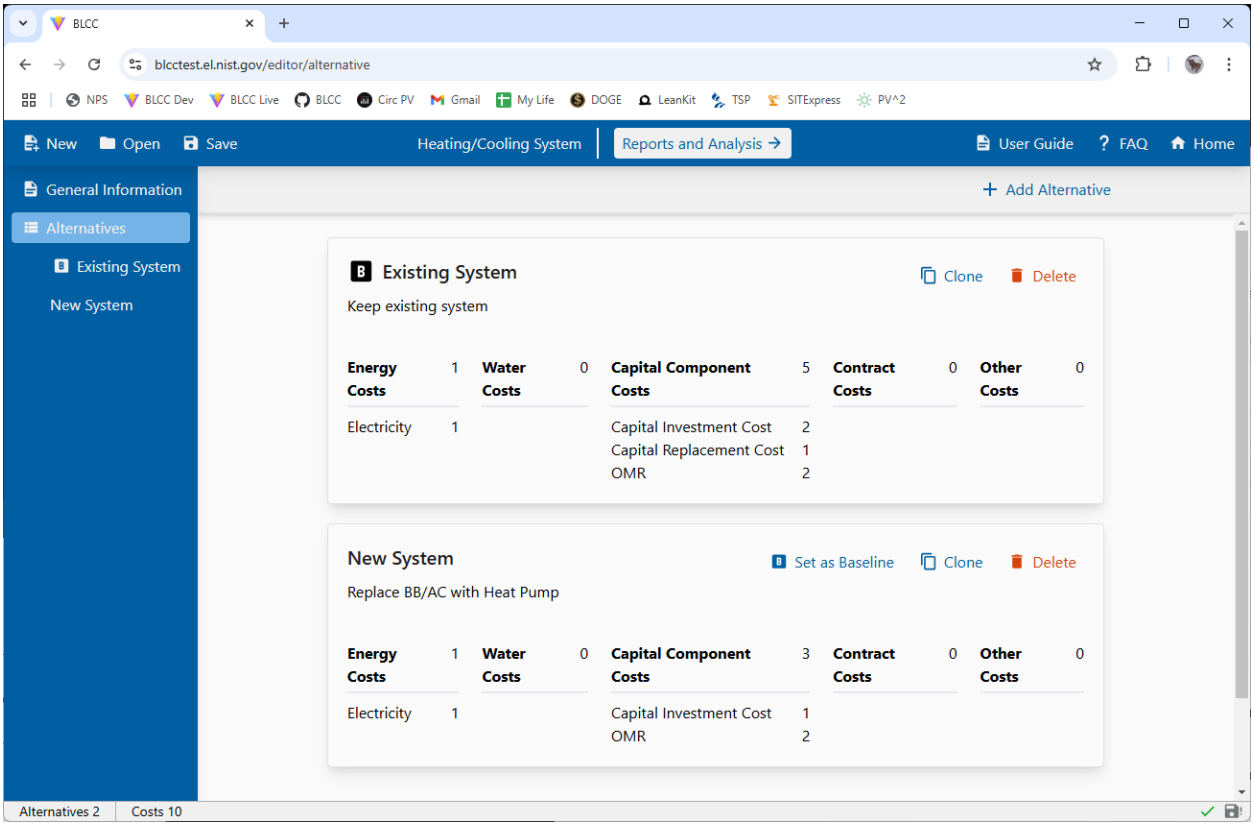

Figure 3-7 Alternatives Page (FEMP Energy)

Once an alternative has been created, the user can begin to populate the costs associated with that alternative. To do so, the user can select the alternative to edit either my clicking on the alternative summary box or on the alternative in the blue navigation bar on the left-hand side.

3.4 Alternative Page

Once an alternative has been selected, the user is taken to the Alternative Page for that specific alternative. As shown in Figure 3-8, a new alternative has no information associated with it. The user can add a description of the alternative, change whether the alternative is the baseline (base case), and add costs across the different cost types provided (Energy, Water, Capital Component, Contract, and Other). Each of these cost types and their subtypes will be discussed in the following subsections. The user can begin to populate the costs associated with that alternative by either clicking on the plus next to the specific cost type/subtype or by clicking on the +Add Cost button on the right-hand side. Every cost must be associated with at least one alternative when initially created. The associated alternative(s) can be changed at any time. Note that each alternative page can clone or delete the existing alternative as well as add a new alternative, each located in the top right of the page.

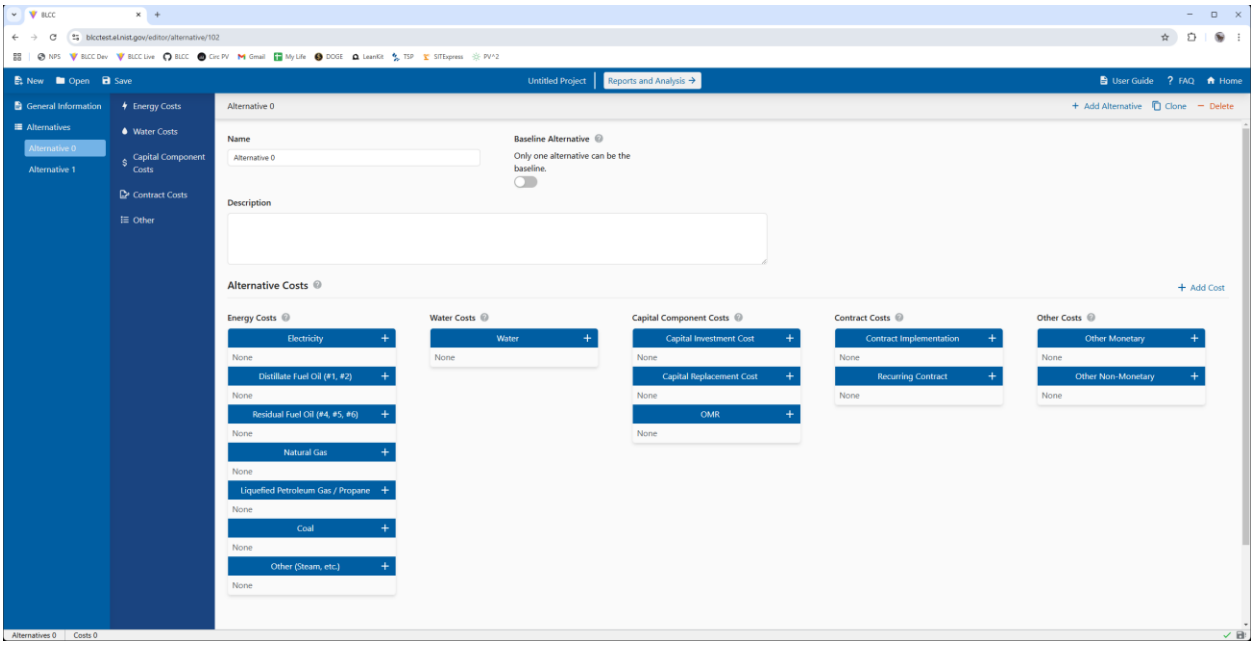

Figure 3-8 Alternative Page (Blank)

In the case the user uploaded an existing file, the user can view all the costs that were included in that file as shown in Figure 3-9, which is based on FEMP Energy. In this example, there is one Energy Cost (electricity), five Capital Component Costs (two Capital Investment Costs, one Capital Replacement Cost, and two OMR costs). There are no Water Costs, Contract Costs (Contract Implementation and Recurring Contract), or Other Costs (Monetary and Non-Monetary). The prior will be used in the examples for those associated sections below while the latter will be represented by different BLCC 5.3 example files (Water and Contract) or a new

example file that introduces a new cost type (Other) that does not exist in BLCC 5.3. To navigate to an existing cost, the user can click on the specific cost name either on the page or in the navigation menu.

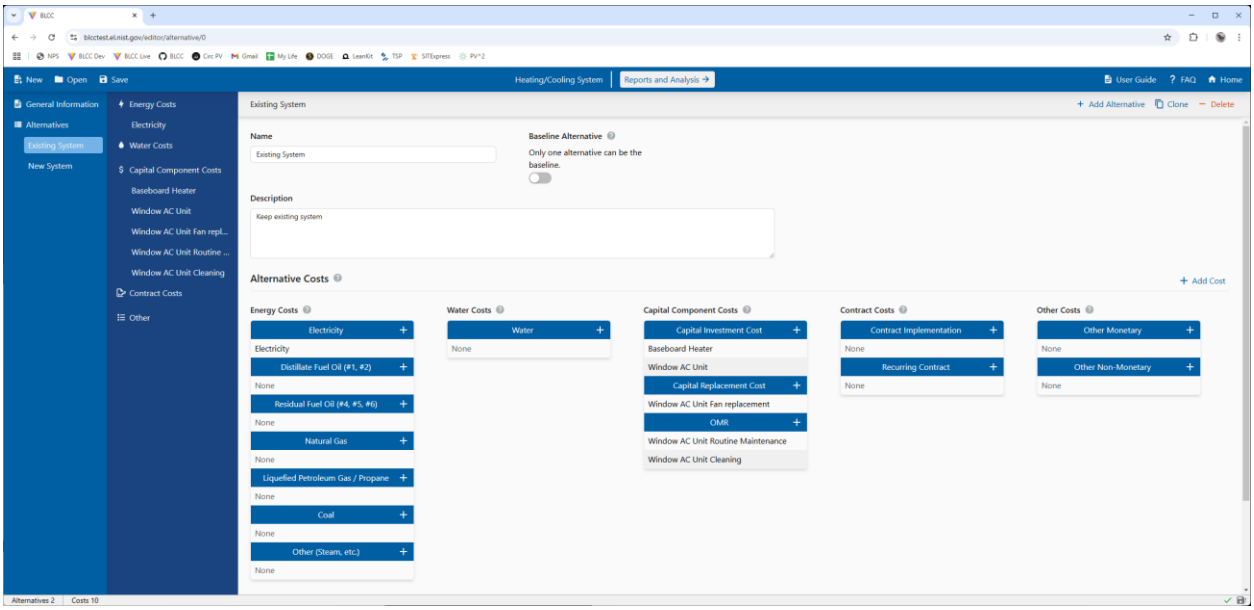

Figure 3-9 Alternative Page (FEMP Energy - Existing System)

When a user decides to add a new cost, a pop-up window will appear and may default the alternative and cost type depending on how the user decided to add the cost. For example, Figure 3-10 shows the pop-up when the user adds an Electricity Cost from the Existing System alternative page using the FEMP Energy example file. The user can decide what to name the cost, which alternatives the cost should be associated with, and the cost type/subtype. When a new cost is added, the user is taken directly to that page automatically to populate any necessary inputs.

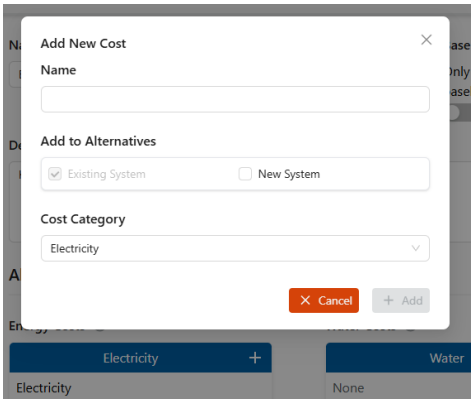

Figure 3-10 Alternative Page (Add New Cost Pop-Up)

UNDER DEVELOPMENT: If the user selects the MILCON ERCIP Project Type, the Alternative Page will provide an additional section after Alternative Details and before the customizable Alternative Costs section. The user will be required to provide these inputs. All other costs / cost savings will be inputted in the same manner as the other project types.

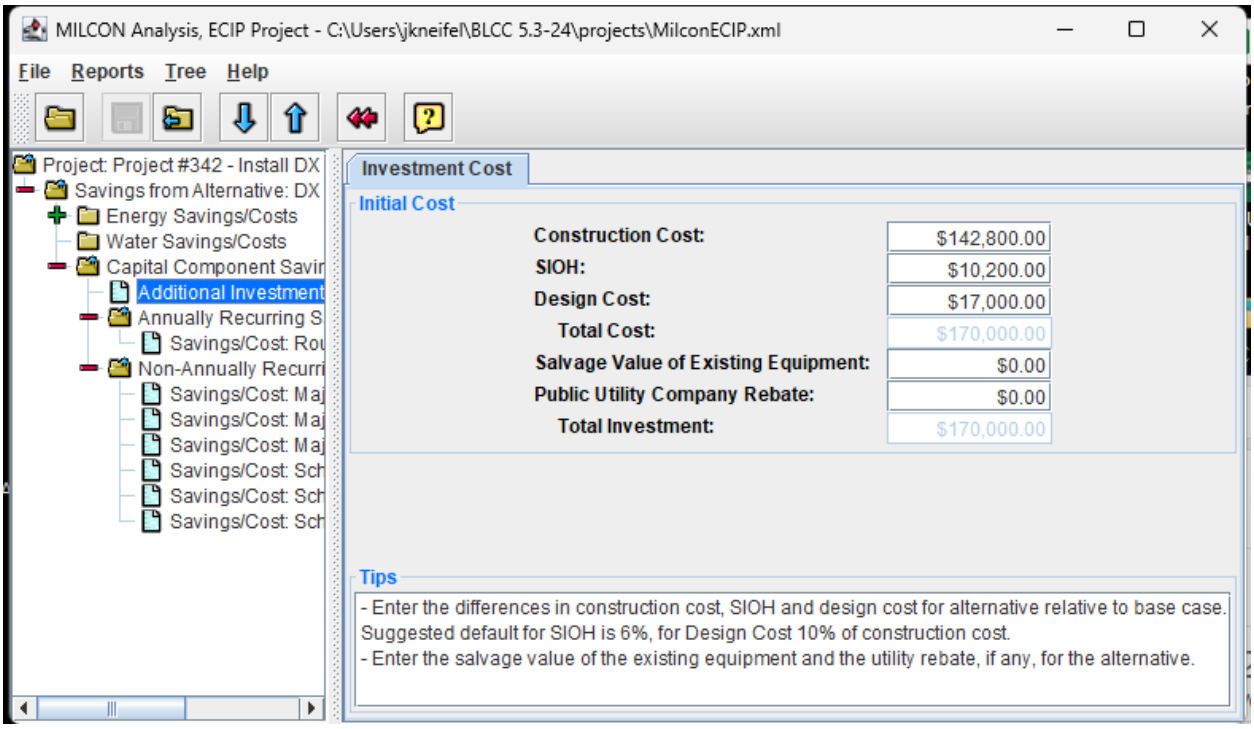

Figure 3-11 Placeholder: Alternative Page for MILCON ERCIP with Required Capital Investment Costs

3.5 Energy Costs Pages

There are seven different subtypes (i.e., fuels) of energy costs the user can select: electricity, distillate fuel oil, residual fuel oil, natural gas, liquified petroleum gas (LPG) / propane, coal, and other. Other did not exist in BLCC 5.3 and has been included to provide a more explicit way to include other energy types like district heating/cooling. The user must provide all the same information regardless of the type of fuel (excluding district heating/cooling).

Figure 3-12 shows a newly created electricity cost. The user can include a description, modify the cost name, or include the cost in additional alternatives. Depending on the Analysis Type selected on the General Information Page, the "Cost of Savings" toggle will default (not a feature in BLCC 5.3). For example, most analysis types assume all values are cost. However, the MILCON ERCIP analysis type defaults energy costs to "cost savings" because that is how BLCC 5.3 request the user to input energy-related values. The user must specify the fuel type (defaulted to the fuel type selected when the cost was created), customer section (residential, commercial, industrial), annual consumption, cost per unit, rebate, demand charge, location, escalation rates, and usage index.

As can be done in BLCC 5.3, users can customize the unit of measure for consumption. The location defaults to the project's primary location and can be modified by clicking the toggle from "Project Location" to "Custom Location," after which the user would input a new location (ZIP Code). As in BLCC 5.3, the escalation rates data default based on the selected fuel type, customer sector, and Census division of the location. The user can customize the escalation rates regardless of the selected location. The usage index defaults to a constant value of 1.00 (no change in quantity over time) and can be modified to account for changing in quantity over time.

Customized escalation rates will remain the same if the user changes the ZIP code specified for the energy cost (either customized ZIP code or primary project location ZIP code). Similarly, changing the customer type or fuel type will not change escalation rates that have been customized. Customized escalation rates can be reset anytime by the user by clicking on the Reset (circle arrow) button to the top-right of the escalation rate values. The reset will replace the customized values with the default values for the current location (either customized ZIP code or primary project location ZIP code), customer type, and fuel type.

If the user selects a location outside the U.S., escalation rates default to U.S. average values per FEMP guidance [cite], and thus does not require a ZIP code. Even if the primary location is outside the U.S., the user can still include an energy cost with a location inside the U.S. using the custom location option and providing the appropriate ZIP code.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left-hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

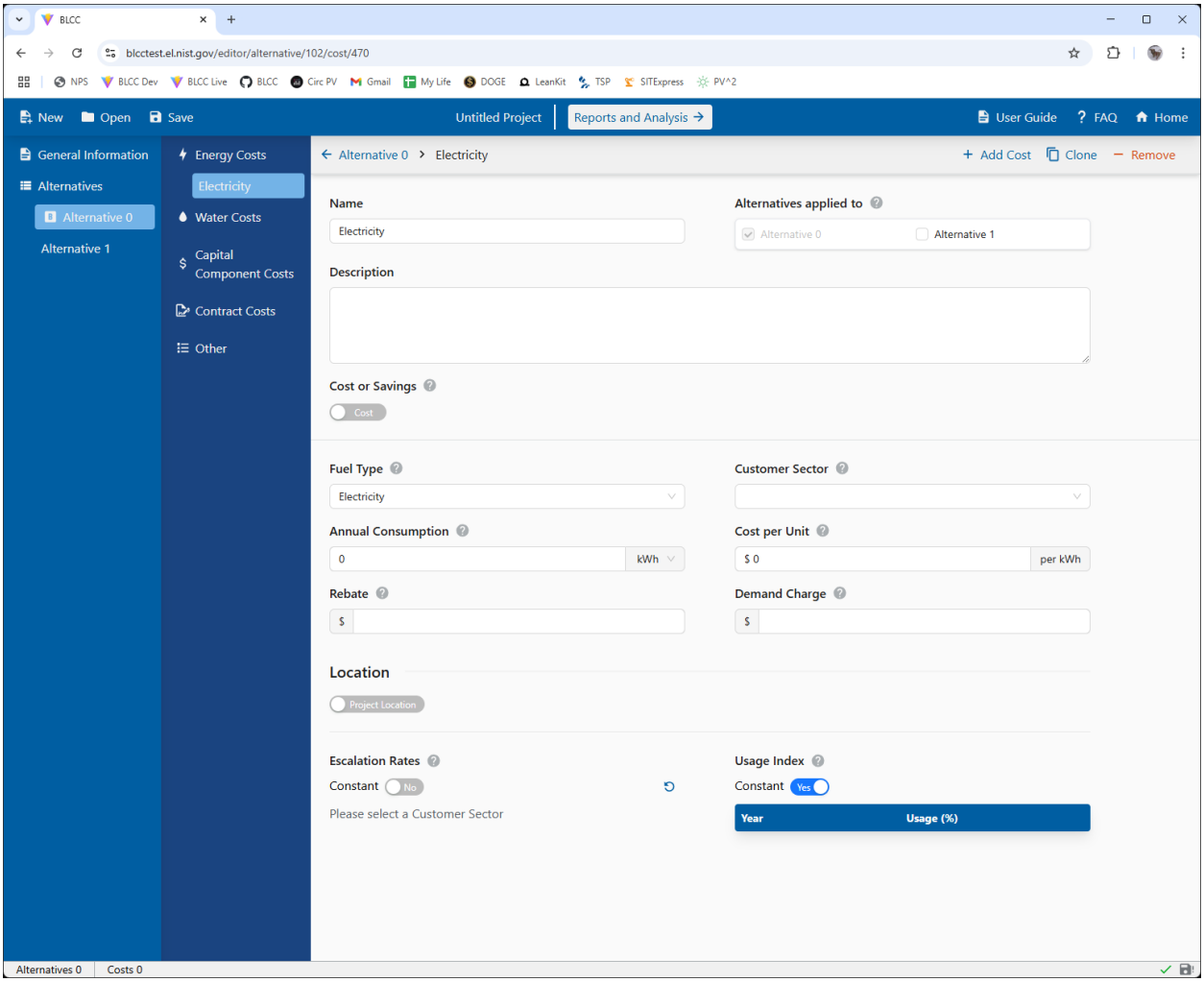

Figure 3-12 Electricity Cost Page (Blank)

If the user uploads an existing file, it may have existing energy cost(s). For example, Figure 3-13 shows the electricity cost for the Existing System in the FEMP Energy example file. All the values are auto-filled from the project file. In this example, the default values were used in BLCC 5.3, in which case the escalation rates are not saved in the BLCC 5.3 project file. Thus, the user must provide the ZIP Code on the General Information Page before the escalation rates will auto-populate. If the uploaded file has custom escalation rates (different than the default values in BLCC 5.3), the escalation rates are saved in the BLCC 5.3 project file and are auto-populated for the years of the study period. Note that BLCC 5.3 provides 25 years of escalation rates regardless of the study period, but the BLCC web application does not and will drop any year of data beyond the end of the study period.

The other fuel types are populated in the same way as electricity. A new option, Other Energy Costs, has been added to provide flexibility to include other fuel types (e.g., district heating).

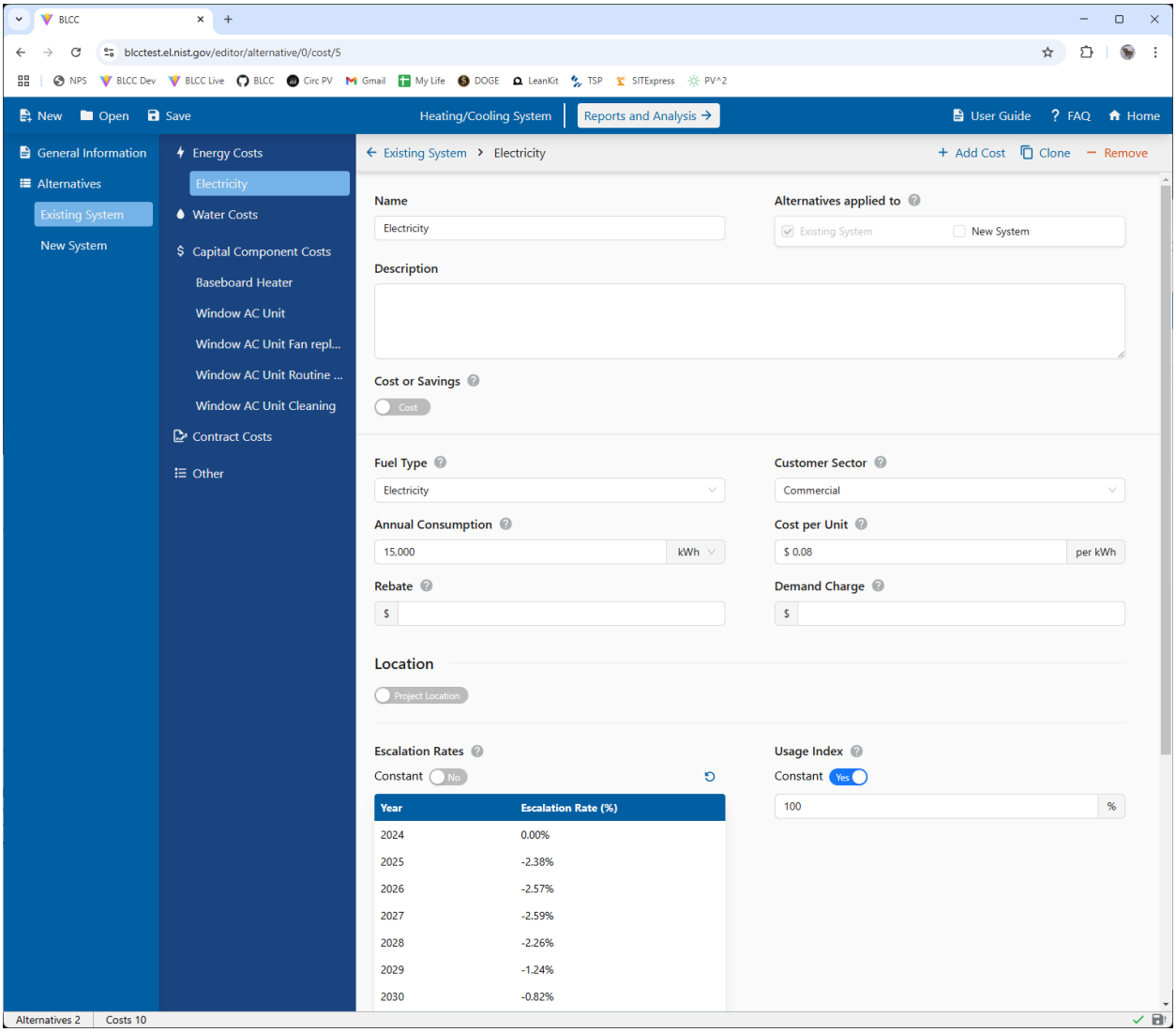

Figure 3-13 Electricity Cost Page (FEMP Energy – Existing System)

3.6 Water Cost Page

As in BLCC 5.3, water costs can be included, both in usage and disposal costs, as shown in Figure 3-14. The user can include a description, modify the cost name, or include the cost in additional alternatives. Depending on the Analysis Type selected on the General Information Page, the "Cost of Savings" toggle will default (not a feature in BLCC 5.3). For example, most analysis types assume all values are cost. However, the MILCON ERCIP analysis type defaults energy costs to "cost savings" because that is how BLCC 5.3 request the user to input water-related values. The user must specify the unit (e.g., gallons), usage quantity, usage cost per unit, disposal quantity, disposal cost per unit, escalation rates, and usage index. Usage and disposal can be inputted broken down into two or four seasons. As can be done in BLCC 5.3, users can customize the unit of measure. As in BLCC 5.3, the default escalation rates are assumed to be

constant at zero and the default usage index are assumed to be constant at 1.00. The user can customize the escalation rates and usage index values.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left-hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

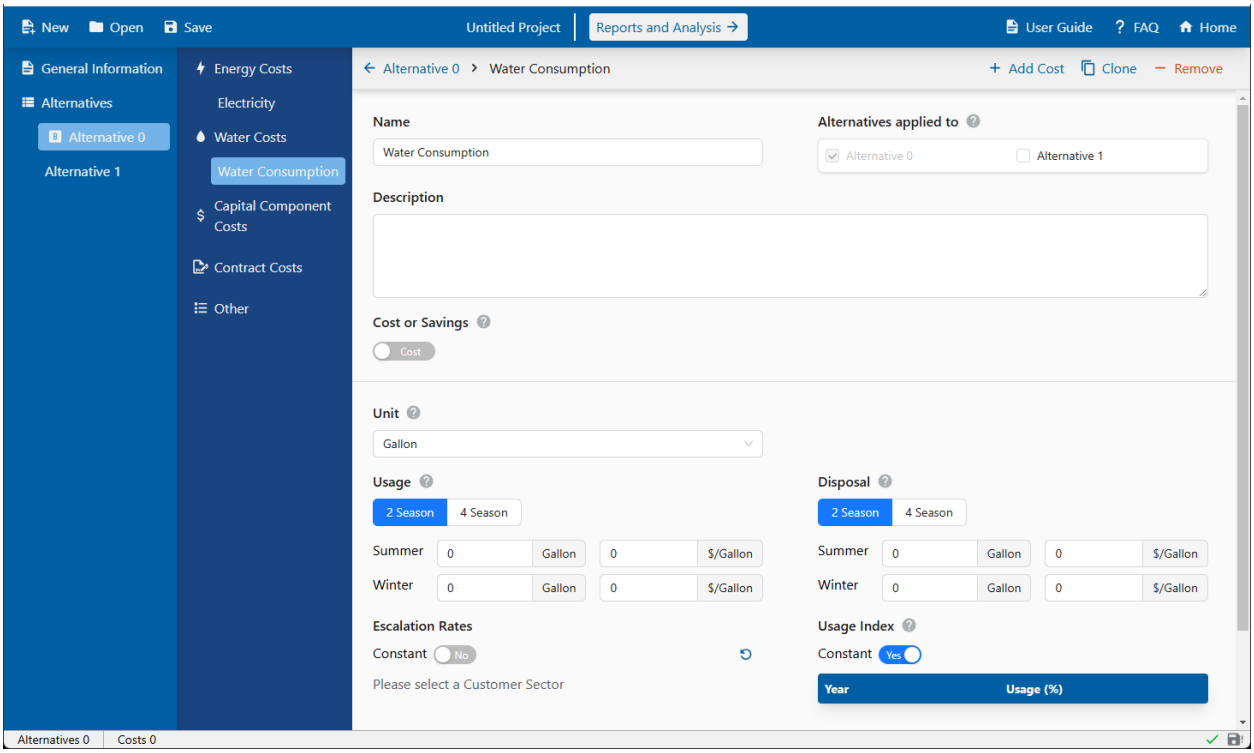

Figure 3-14 Water Cost Page (Blank)

3.7 Capital Component Costs Pages

There are three subtypes of Capital Component Costs: Capital Investment Costs (i.e., initial investment costs), Capital Replacement Costs (i.e., future investment costs), and OMR costs (i.e., future non-investment costs). The first two subtypes are essentially the same while OMR costs are treated differently than in BLCC 5.3. BLCC 5.3 treats recurring and non-recurring OMR costs as separate cost types while the BLCC web application groups all OMR costs together. However, the user can still input OMR costs to be non-recurring and recurring by allowing for customization on the OMR Page. Each of these cost types will be walked through below.

UNDER DEVELOPMENT: The capital cost pages will not be used for the MILCON ERCIP Project Type. Instead, the user will input the required investment cost information on the Alternative Page as discussed in Section 3.4.

3.7.1 Capital Investment Cost Page

Capital Investment Costs are inputted similarly to BLCC 5.3 as shown in Figure 3-15 and is the appropriate cost type for any investment costs that occur before the beginning of service date of the facility (i.e., initial investment costs). The user can include a description, modify the cost name, or include the cost in additional alternatives. Unlike BLCC 5.3, the user can input the value as a cost or a cost savings using the "Cost of Savings" toggle, which defaults to "Cost." The user must specify the initial cost (in base year dollars), amount financed, expected lifetime, annual rate of change. If the project is "phased-in" (not all investment costs are realized in the base year), the user must provide the cost adjustment factor and the percentage of the costs occurring during the phase-in period. The phase-in is defaulted to the Construction Period specified in the General Information Page. The user also must determine whether to include a calculation of the residual value (using the Residual Value toggle), which can be inputted as a total dollar amount (in base year dollars) or as a percentage of the initial investment cost.

Note: If a user wants to include a residual value separately instead of as part of a capital investment cost, it can be inputted as a capital replacement cost.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

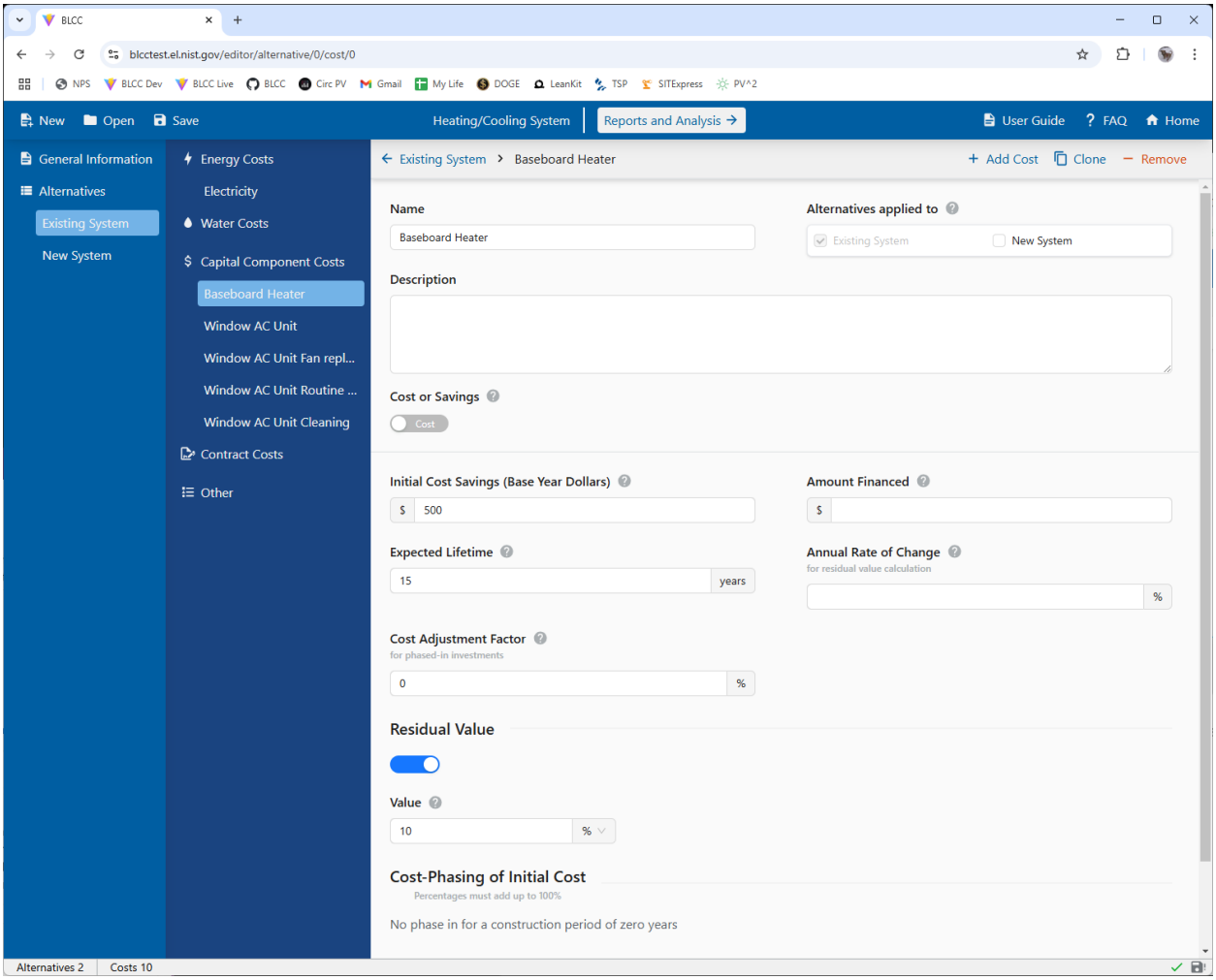

Figure 3-15 Capital Investment Cost Page

3.7.2 Capital Replacement Cost Page

Capital Replacement Costs are inputted similarly to BLCC 5.3 as shown in Figure 3-16 and is the appropriate cost type for any future investment costs that occur after the service date of the facility (i.e., future investment costs). The user can include a description, modify the cost name, or include the cost in additional alternatives. Unlike BLCC 5.3, the user can input the value as a cost or a cost savings using the "Cost of Savings" toggle, which defaults to "Cost." The user must specify the initial cost (in base year dollars), initial occurrence, expected lifetime, and annual rate of change. The user also must determine whether to include a calculation of the residual value (using the Residual Value toggle), which can be inputted as a total dollar amount (in base year dollars) or as a percentage of the initial investment cost.

Note: If a user wants to include a residual value separately instead of as part of a capital replacement cost, it can be inputted as a separate capital replacement cost.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

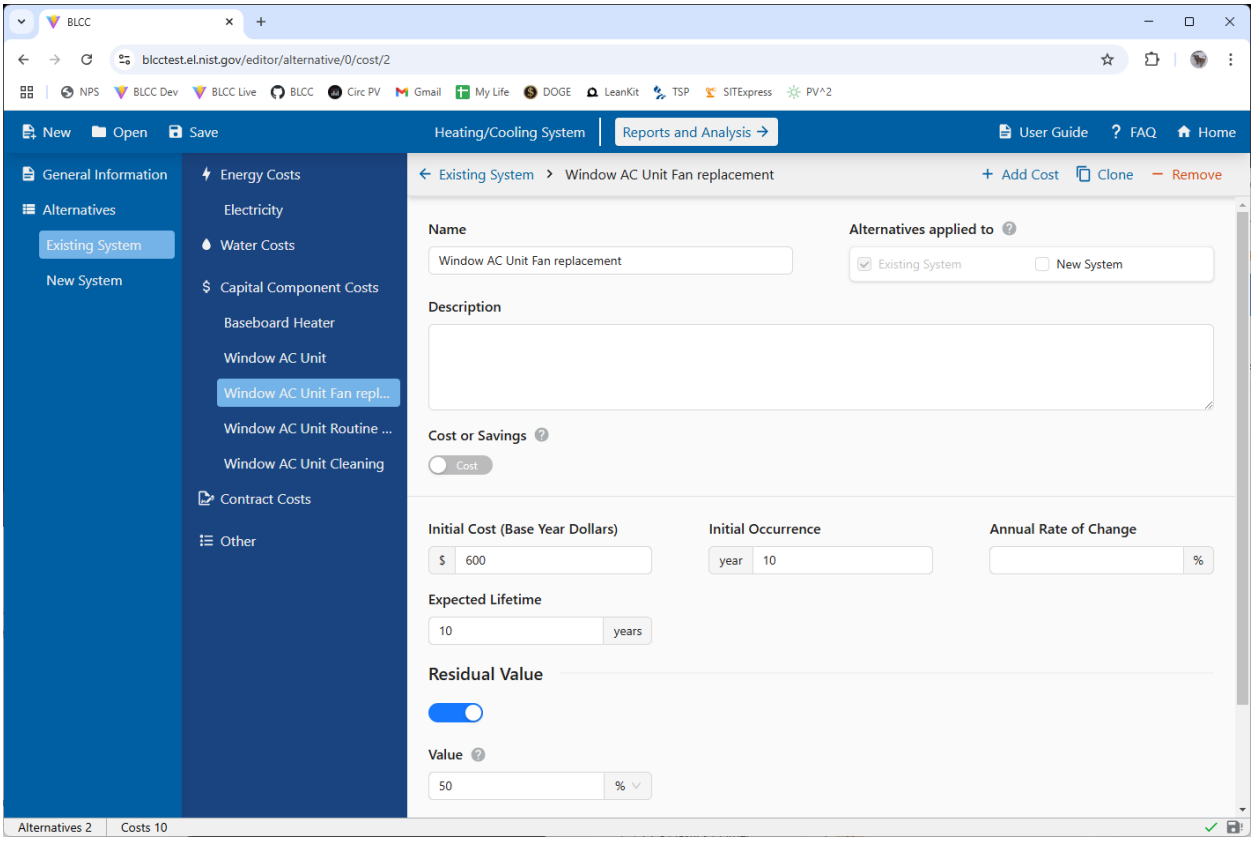

Figure 3-16 Capital Replacement Cost Page

3.7.3 OMR (Non-Recurring) Cost Page

Non-recurring OMR Costs are inputted similarly to BLCC 5.3 as shown in Figure 3-17. The user can include a description, modify the cost name, or include the cost in additional alternatives. Unlike BLCC 5.3, the user can input the value as a cost or a cost savings using the "Cost of Savings" toggle, which defaults to "Cost." Because it's a one-time cost, the user must only specify the initial cost (in base year dollars) and initial occurrence while the Recurrence toggle is "No."

Note: missing value rate of change. Should be moved above recurrence.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

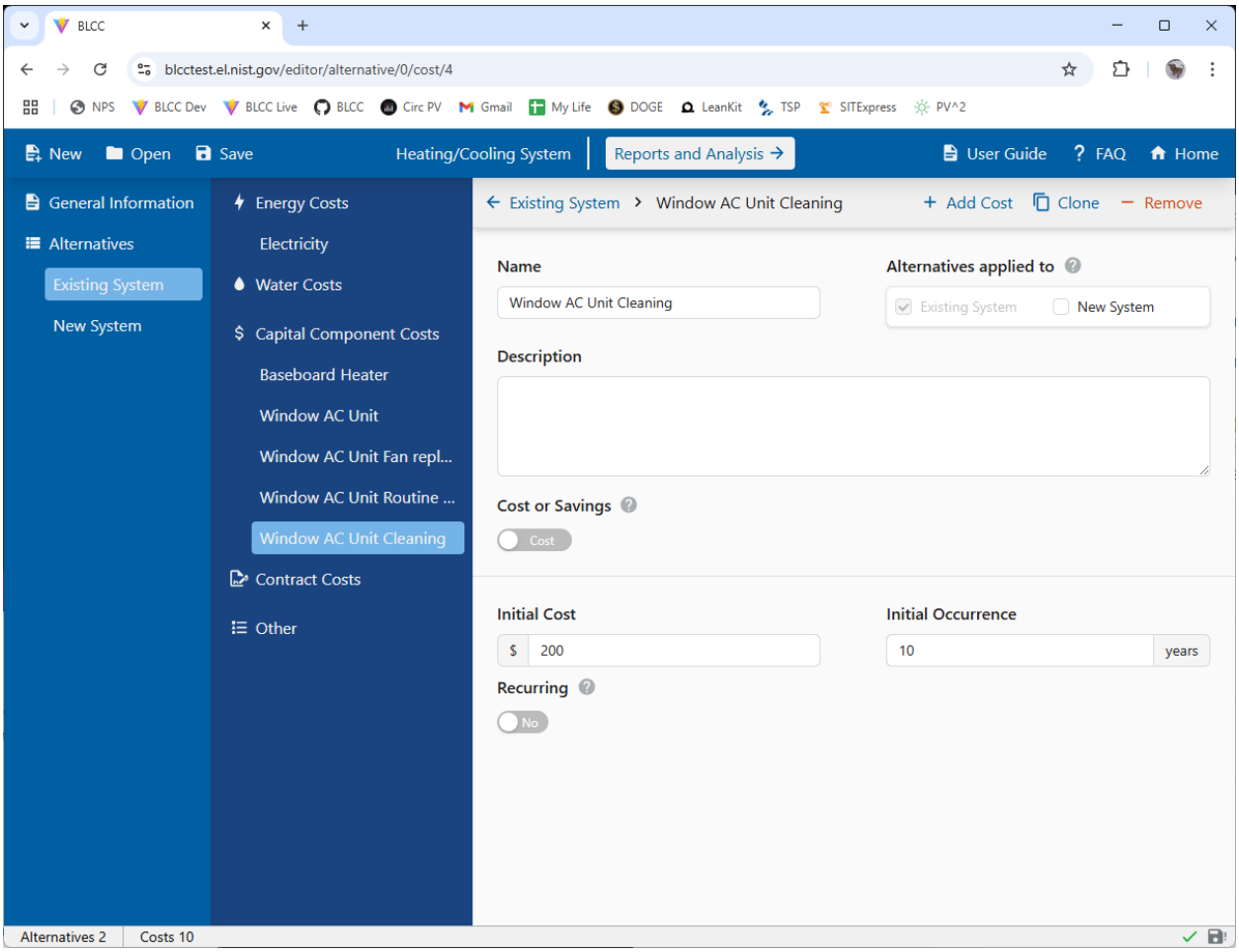

Figure 3-17 OMR (Non-Recurring) Cost Page

3.7.4 OMR (Recurring) Cost Page

Recurring OMR Costs are inputted similarly to BLCC 5.3 as shown in Figure 3-18. The user can include a description, modify the cost name, or include the cost in additional alternatives. Unlike BLCC 5.3, the user can input the value as a cost or a cost savings using the "Cost of Savings" toggle, which defaults to "Cost." Because it's a recurring cost, the user must specify the initial cost (in base year dollars) and initial occurrence as well as information on the recurrence. The Recurrence toggle is "Yes," which displays the occurrence rate and value rate of change.

For recurring costs that end before the end of the study period, the user should use the Value Rate of Change to adjust the calculation using the following steps:

(1) Set the Value Rate of Change to -100% for the year after the last occurrence of the recurring cost
(2) Set the Value Rate of Change to 0% for all remaining years in the study period.

This will set the value for this recurring cost to zero for all years in the study period after the cost has stopped recurring.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

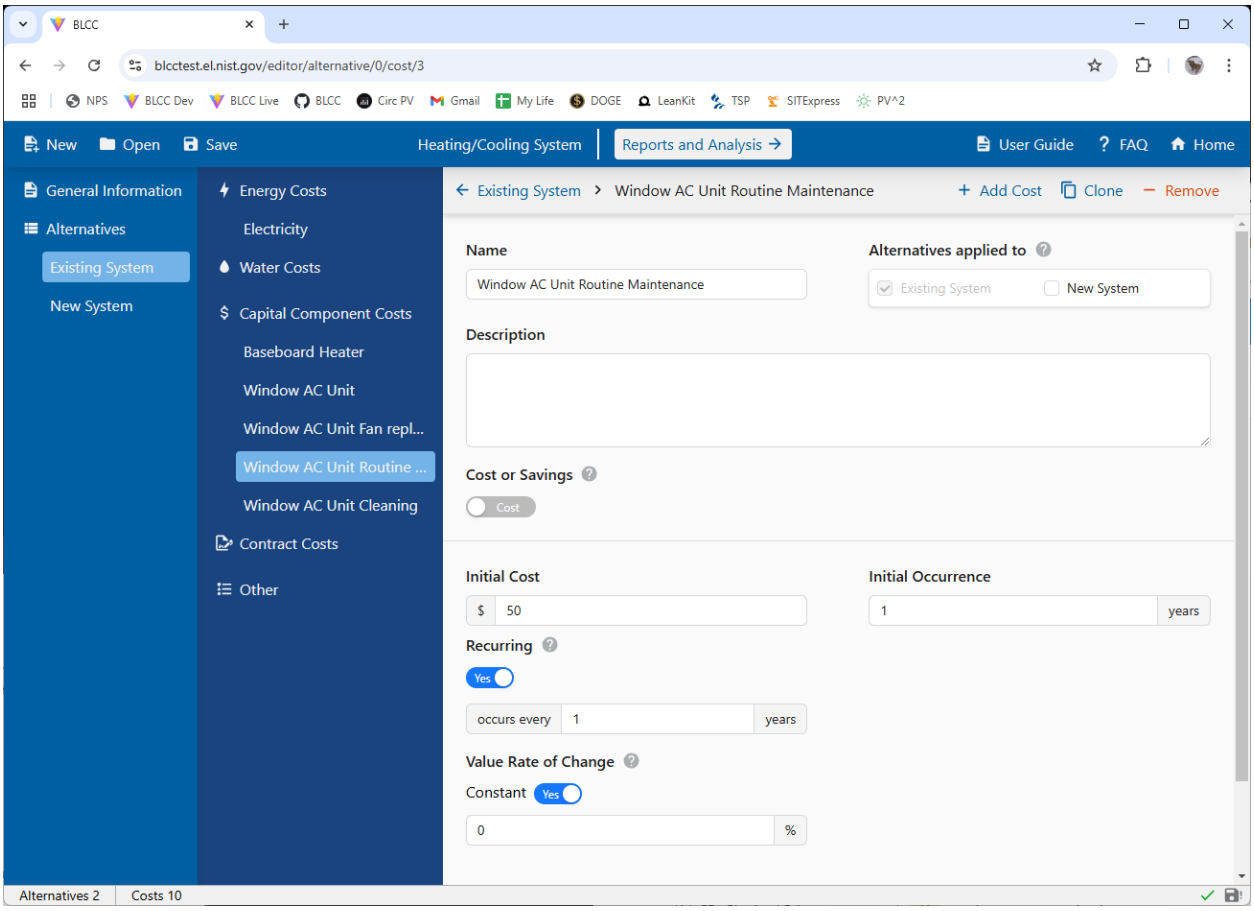

Figure 3-18 OMR (Recurring) Cost Page

3.8 Contract Costs Pages

There are two subtypes of Contract Costs: Non-Recurring Contract and Recurring Contract. Each is described below.

3.8.1 Non-Recurring Contract Cost Page

Non-Recurring Contract Costs are essentially the same as Non-Annually Recurring Contract-Related Costs in BLCC 5.3. Figure 3-19 shows a non-recurring contract cost of zero for the Lighting Retrofit alternative in the Federal Financed project file. The user can include a description, modify the cost name, or include the cost in additional alternatives. Unlike BLCC

5.3, the user can input the value as a cost or a cost savings using the "Cost of Savings" toggle, which defaults to "Cost." Because the cost is not recurring, the user must only specify the initial cost (in base year dollars), occurrence, and value rate of change.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

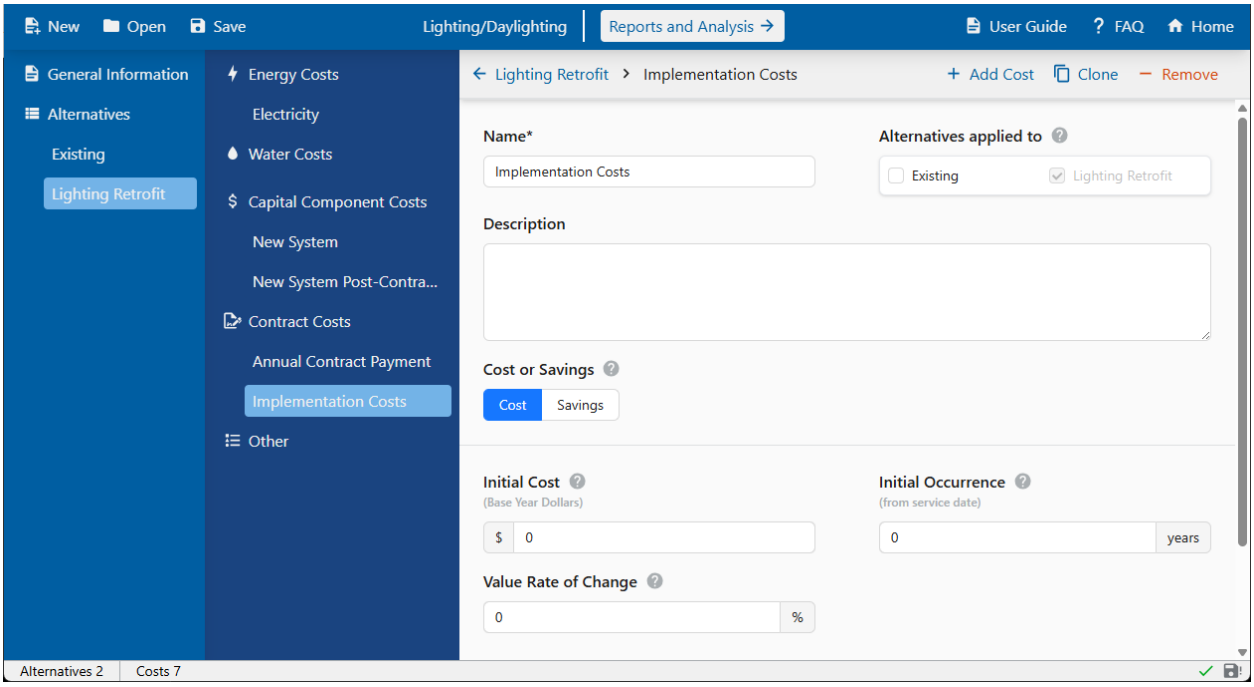

Figure 3-19 Non-Recurring Contract Cost Page

3.8.2 Recurring Contract Cost Page

Recurring Contract Costs are essentially the same as Annually Recurring Contract-Related Costs in BLCC 5.3. Figure 3-20 shows the recurring contract cost for the Lighting Retrofit alternative in the Federal Financed project file. The user can include a description, modify the cost name, or include the cost in additional alternatives. Unlike BLCC 5.3, the user can input the value as a cost or a cost savings using the "Cost of Savings" toggle, which defaults to "Cost." Because the cost is recurring, the user must specify the initial cost (in base year dollars), occurrence, value rate of change, and the rate of recurrence, which is more flexible than BLCC 5.3 because the user can specify a non-annual rate of recurrence.

For recurring costs that end before the end of the study period, the user should use the Value Rate of Change to adjust the calculation using the following steps:

(1) Set the Value Rate of Change to -100% for the year after the last occurrence of the recurring cost
(2) Set the Value Rate of Change to 0% for all remaining years in the study period.

This will set the value for this recurring cost to zero for all years in the study period after the cost has stopped recurring.

Note that contract payments are paid in nominal dollars (e.g., mortgage payments are the same every month). Thus, if a constant dollar analysis is being completed, these nominal payments must be adjusted for inflation by making the value rate of change the inflation rate multiplied by -1 (e..g, if inflation = 2.3 %, then value rate of change would be -2.3 %).

Note: value rate of change needs to be moved to outside recurrence.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

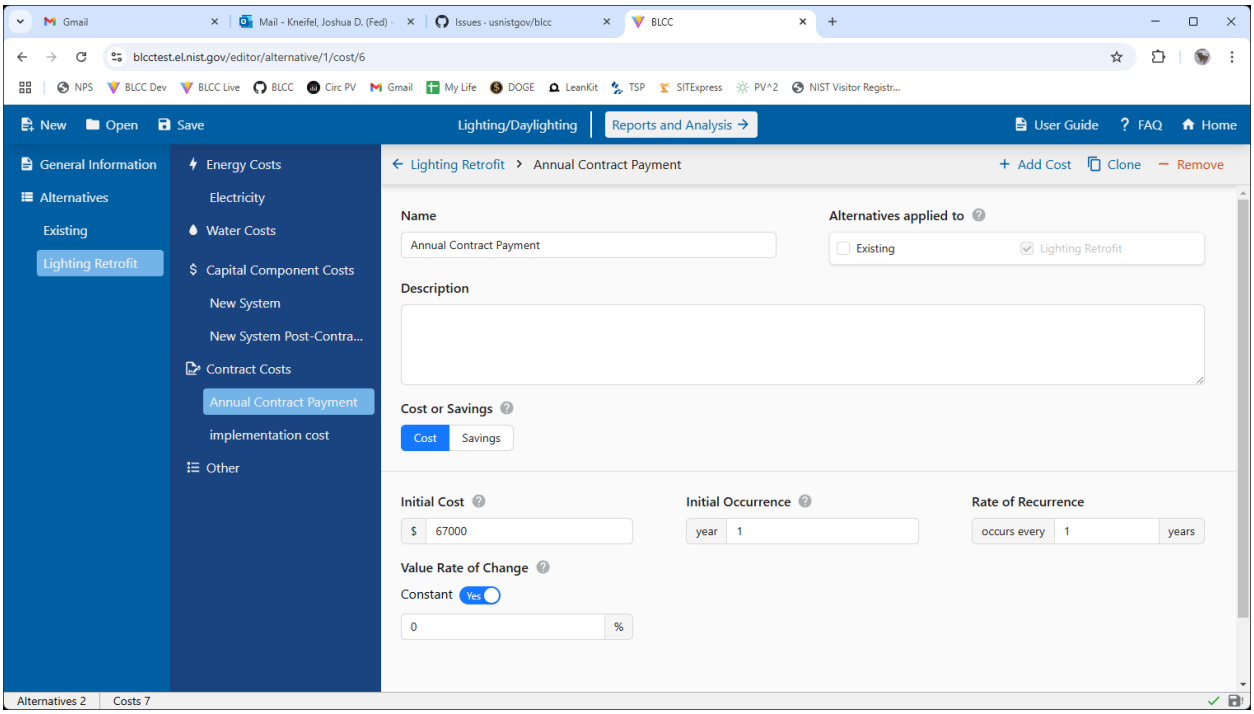

Figure 3-20 Recurring Contract Cost Page

3.9 Other Costs Pages

Other Costs does not exist in BLCC 5.3 and have been introduced into the BLCC web application to provide additional flexibility for BLCC users to include costs that do not clearly align with the pre-defined cost types/subtypes. Other can be used to include both monetary and non-monetary costs and benefits. Monetary costs/benefits are assumed to be direct costs (e.g., administrative cost savings, tax-related costs) related to the project included in the LCCA while non-monetary costs/benefits are reported separately in the specified quantity of the non-monetary impact (e.g., sick days). Monetary and Non-Monetary Cost Pages are described below.

3.9.1 Other Monetary Costs Page

As shown in Figure 3-21 for an Other Monetary cost, the user can include a description, modify the cost name, or include the cost in additional alternatives. The user can input the value as a cost or benefit (treated as a cost savings for calculations) using the "Cost or Benefit" toggle, which defaults to "Cost." The user can specify a unique "tag" that can be used to aggregate and report values from one or more costs. The tag "Other" is built in for Other Monetary Costs and used to aggregate all other monetary costs together for the LCCA. The user can also use other unique tags to allow for analysis of the unit quantities as well (e.g., Lost Work Days).

The user must also provide the number of units, unit of measure, and value per unit as well as the initial occurrence and whether the cost is recurring. If the cost is recurring, the user must also provide the rate of recurrence, value rate of change, and unit rate of change.

For recurring other costs that end before the end of the study period, the user should use the Unit Rate of Change to adjust the calculation using the following steps:

(1) Set the Unit Rate of Change to -100% for the year after the last occurrence of the recurring cost
(2) Set the Unit Rate of Change to 0% for all remaining years in the study period.

This will set the units for this recurring cost to zero for all years in the study period after the cost has stopped recurring.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

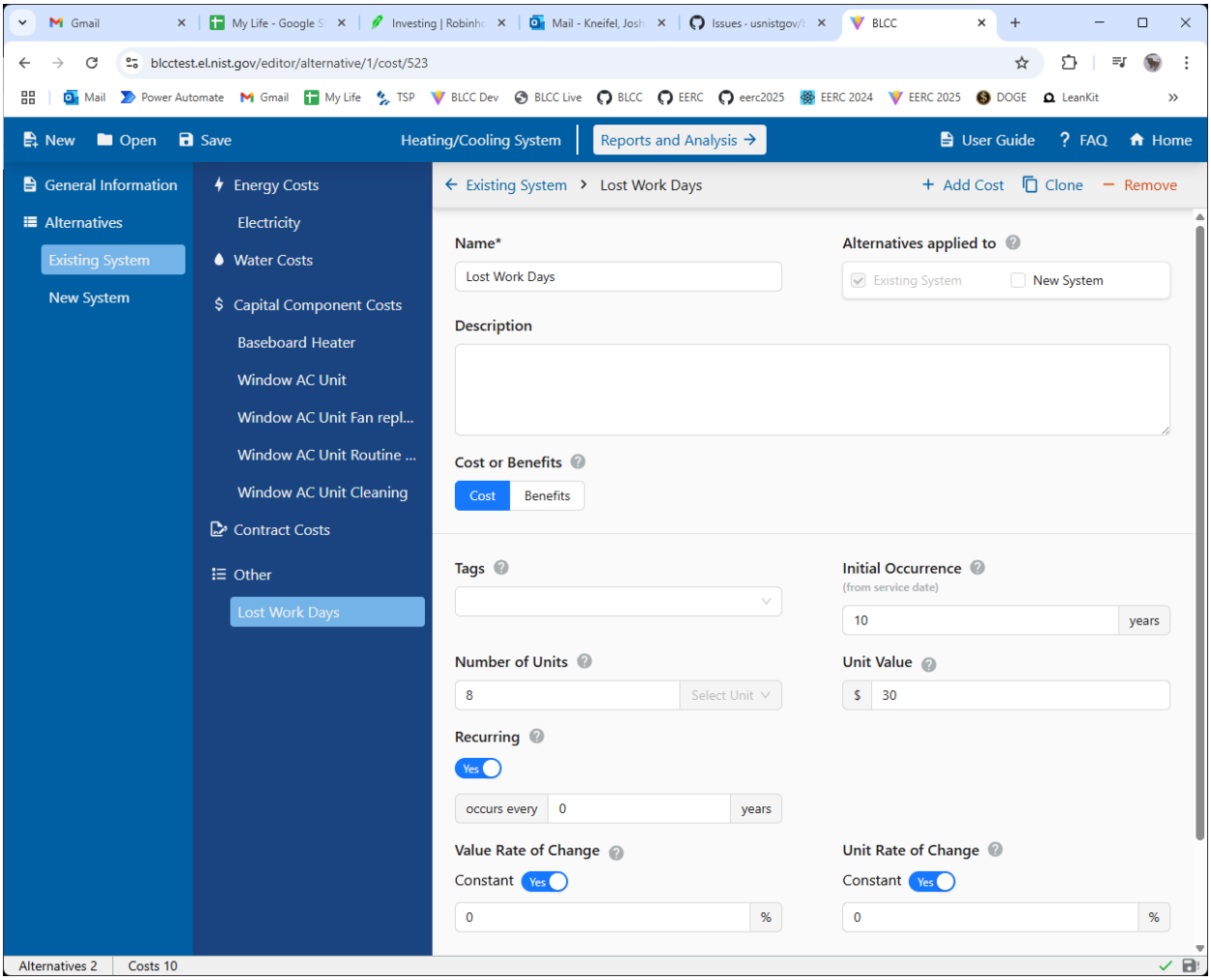

Figure 3-21 Other Monetary Cost Page

3.9.2 Other Non-Monetary Cost Page

As shown in Figure 3-22 for an Other Non-Monetary cost, the user can include a description, modify the cost name, or include the cost in additional alternatives. The user can input the value as a cost or benefit (treated as a cost savings for calculations) using the "Cost or Benefit" toggle, which defaults to "Cost." The user must specify a "tag" for Non-Monetary Costs because they are, by definition, not in dollar amounts and cannot be included in the LCCA. The user must specify a "tag" that they think best describes the cost for displaying results (e.g., sick days, increased morale, safety incidents). The user must also provide the number of units, unit of measure (i.e., metric), initial occurrence, and whether the cost is recurring. If the cost is recurring, the user must also provide the rate of recurrence and the unit rate of change.

Note: The quantities of multiple other non-monetary costs will be aggregated if their tag and unit are the same.

The user can navigate back to the Alternative Page by clicking on the alternative name either in the left hand navigation menu or on the alternative name on the top-left of the cost page header where there is a back arrow with the alternative name.

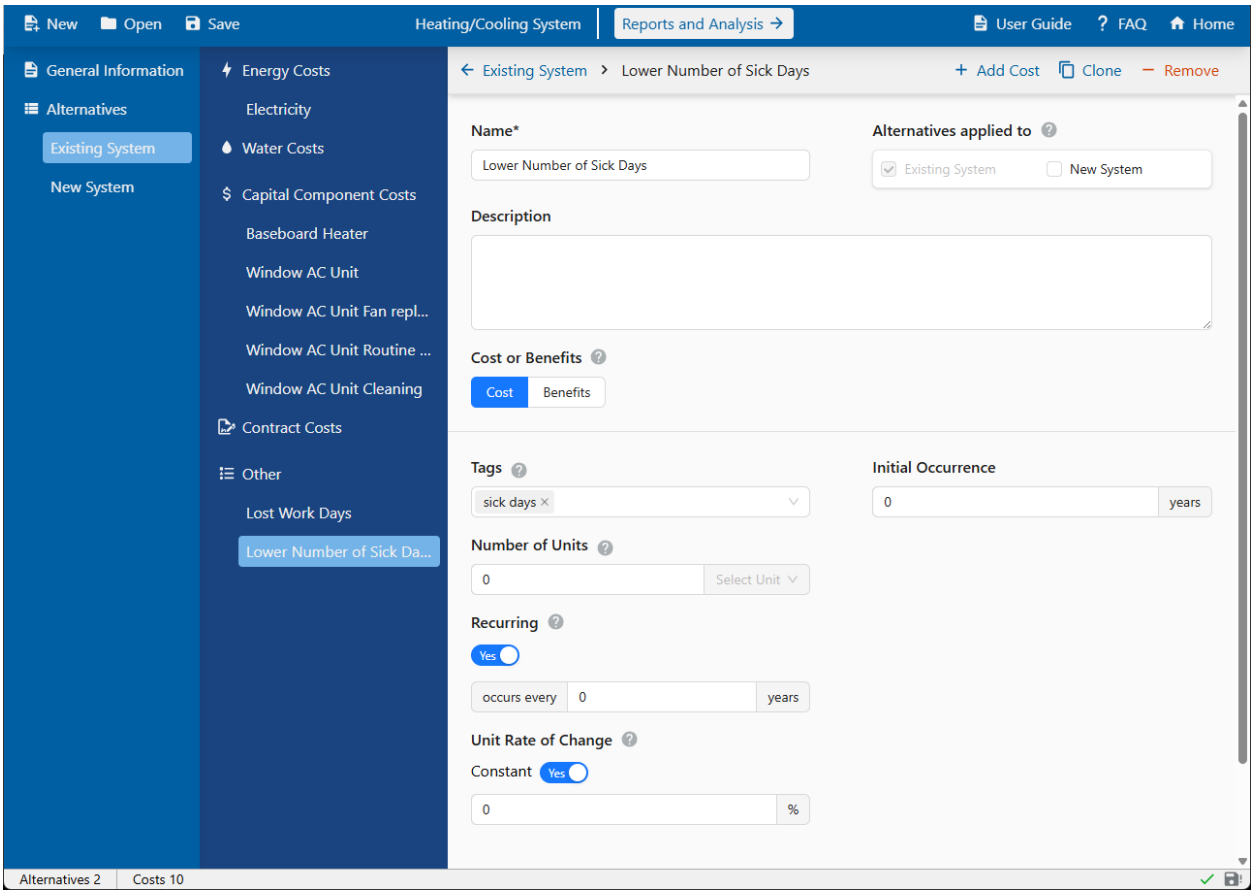

Figure 3-22 Other Non-Monetary Cost Page

3.10 Results Pages

Once all alternatives and associated costs have been inputted, the user can run LCCA by clicking on the "Reports and Analysis" button located in the middle of the BLCC header (just to the right of the project name). Clicking on the Reports and Analysis button takes the user to the results (defaulting to the Summary tab). If the project analysis has not yet been run, the user will see the page shown in Figure 3-23, which states, "No Results to Display." The user can run the analysis in two different ways: (1) by clicking on the Run button just under the "No Results to Display" message or (2) click on the Run button in the middle of the BLCC header.

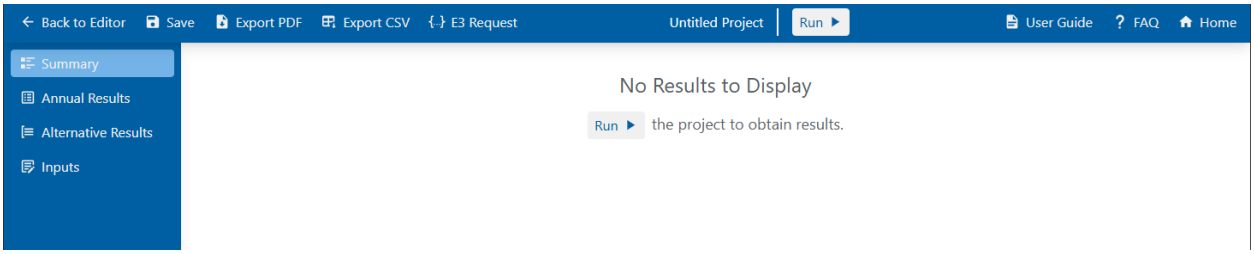

Figure 3-23 Results Page (Pre-Run)

Clicking on the Run button will process the results through the following steps:

(1) Convert the BLCC file to an E3 request file
(2) Secure send the E3 request (input) file to E3 for processing
(3) Receive the E3 response (output) file
(4) Extract information from the E3 response file
(5) Generate and display the results

The results will be displayed in the four results pages (tabs) shown on the left-hand navigation menu. The subsections below walk through each of these results pages. The user is also provided access to downloadable versions of the results for documentation and reporting as well as the E3 Request (Input) File that can be provided to BLCC technical support to assist in troubleshooting.

3.10.1 Summary Page

The user is defaulted to the Summary Page, which provides four data tables as shown in Figure 3-24:

(1) Life Cycle Results Comparison provides total investment costs, total LCC, total energy consumption, and total energy-related CO_2e emissions.
(2) Life Cycle Results Relative to Baseline Alternative provides comparative analysis metrics (NS, SIR, AIRR, SPP, DPP, change in energy consumption, and change in energy-related CO_2e emissions).
(3) NPV Costs by Cost Subcategory provides total LCC by cost subtype.
(4) Life Cycle Resource Consumption and Emissions Comparison provides total energy consumption by fuel type, total energy-related CO_2e emissions by fuel type, and total water consumption.

Each of these data tables are also provided in BLCC 5.3 results files.

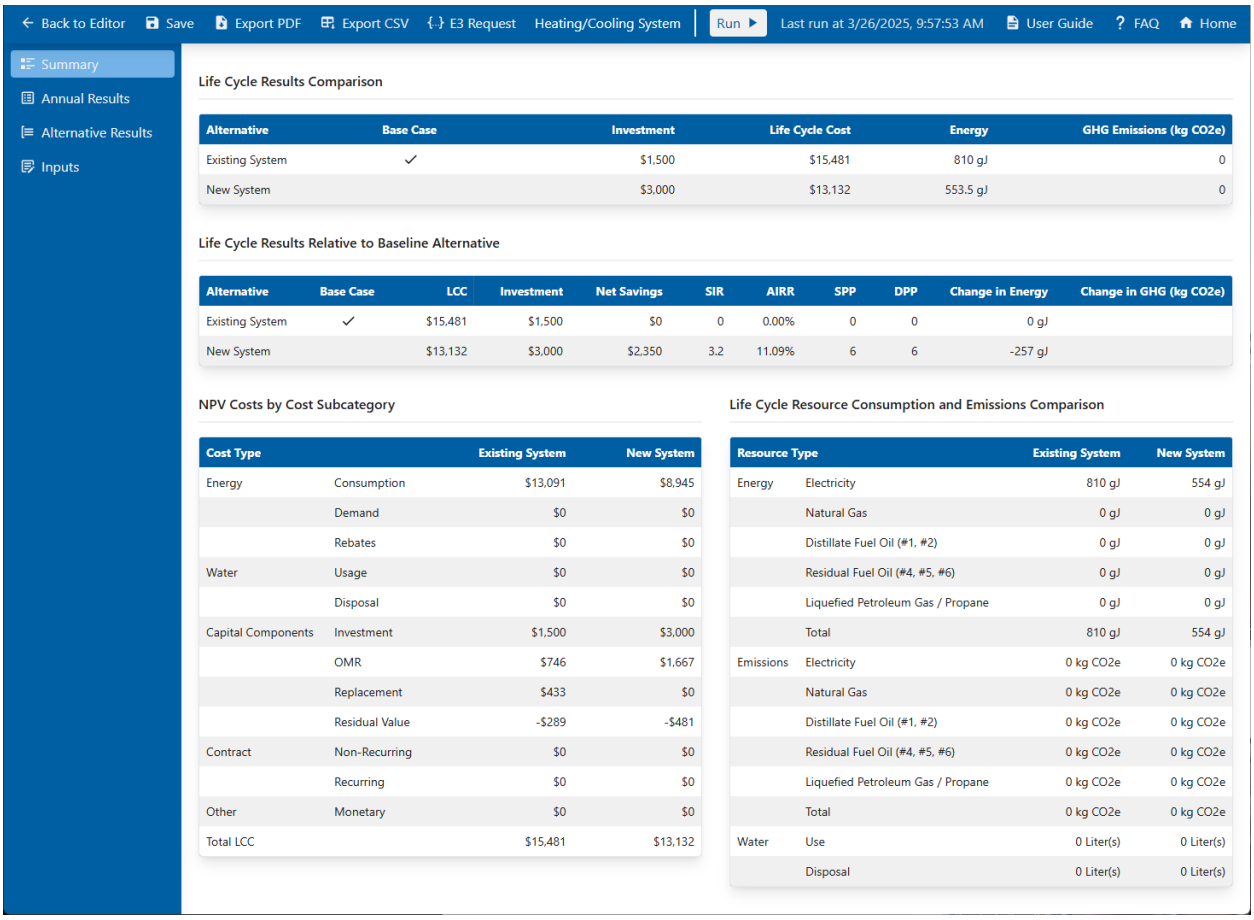

Figure 3-24 Results Summary Page

3.10.2 Annual Results Page

The Annual Results Page provides two data tables and three figures that provide annual cash flows as shown in Figure 3-25. NPV Cash Flow Comparison provides the annual NPV cash flows by alternative, which is displayed in the NPV Cash Flows figure to the right of the data table.

The Cash Flows by Alternative By Cost Type table provides the cash flows by cost subtype based on the user selected alternative. The user is provided a drop-down menu to select the alternative to view as well as the option to view non-discounted or discounted cash flows. The By Subtype figure at the bottom left below the Annual Results by Alternative data table displays a stacked bar graph by cost subtype of the data displayed in the data table. The For Selected Cost Type figure at the bottom right below the Annual Results by Alternative data table displays a bar graph that the user can view the cash flows for a single cost subtype displayed in the data table (e.g., OMR Costs).

UNDER DEVELOPMENT: An additional figure will be added to view the annual flows of any tag with significant quantities (e.g., energy consumption, energy-related emissions, water consumption, any custom tag).

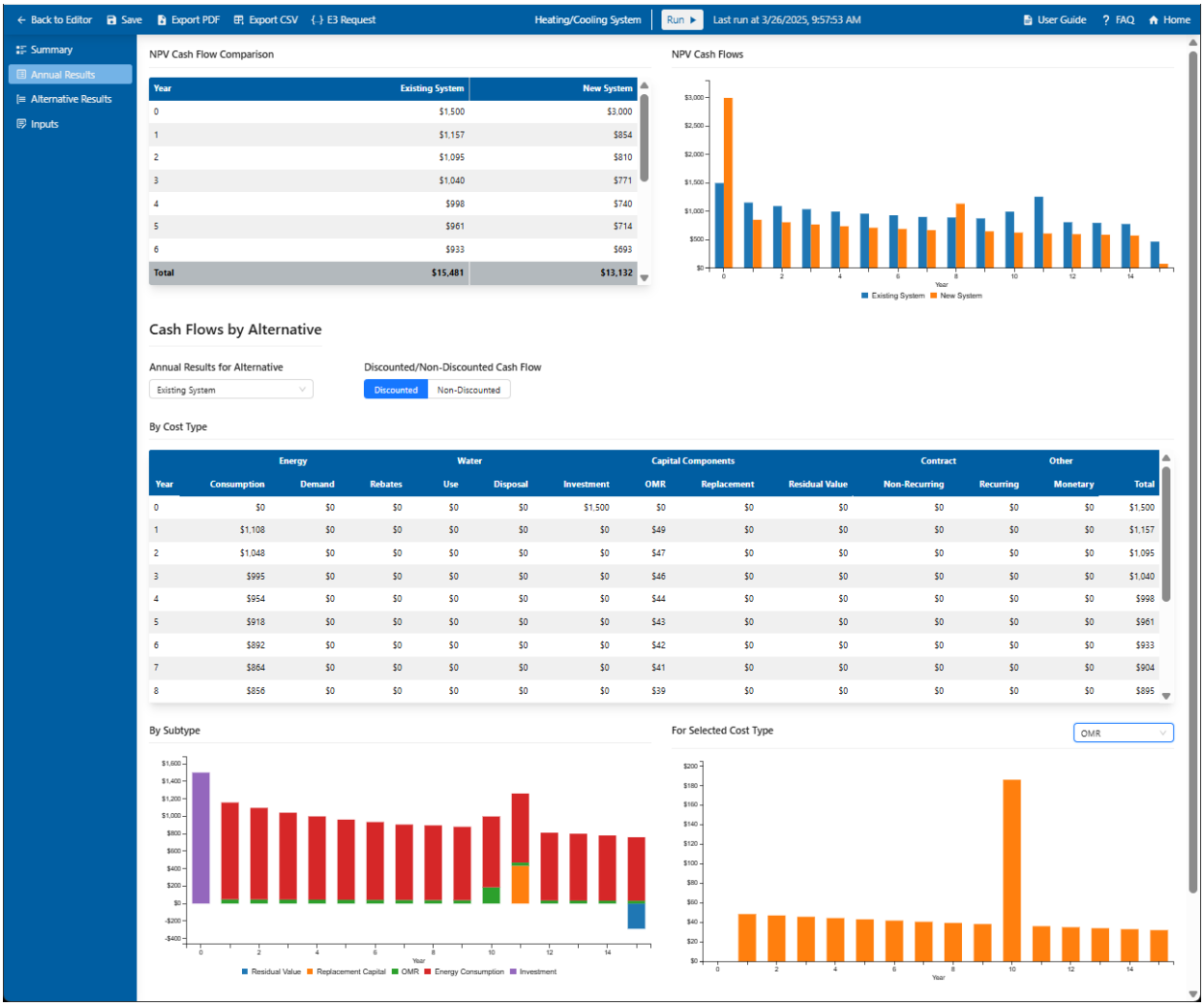

Figure 3-25 Annual Results Page

3.10.3 Alternative Results Page

The Alternative Results Page provides two tables, total LCC by cost subtype as shown in NPV by Cost Type and total resource consumption and related emissions in Resource Use and Emissions as shown in Figure 3-26. The user selects which alternative for which to display results. Additionally, there are two pie graphs, Share of LCC displays the share of LCC by cost type and Share of Energy Use displays the share of energy consumption by fuel type.

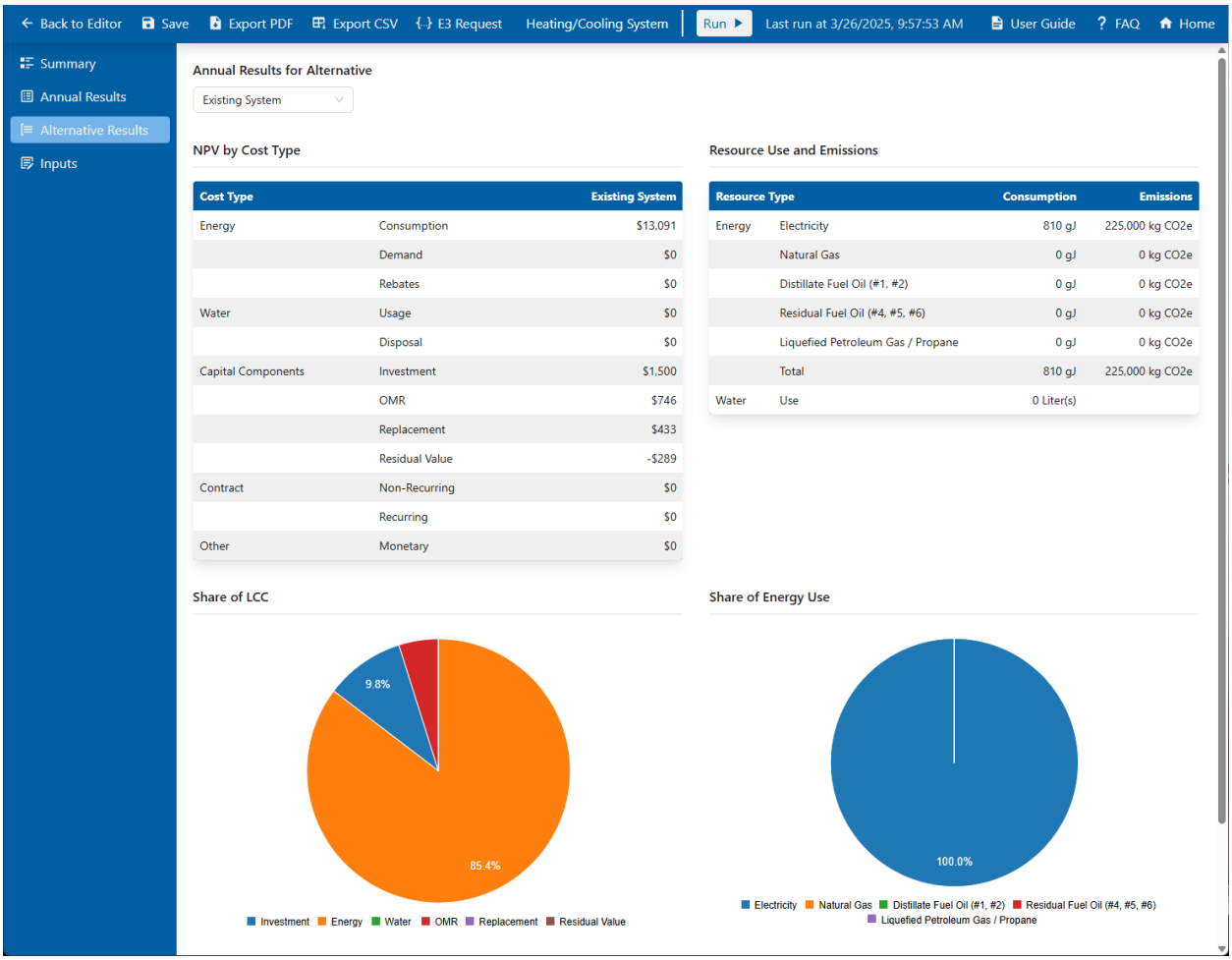

Figure 3-26 Alternative Results Page

3.10.4 Inputs Page

As shown in Figure 3-27, the Input Page displays the user inputs from the General Information Page. Additional details on the user inputs for alternatives and associated costs is available for export, which is described in more detail in the next section.

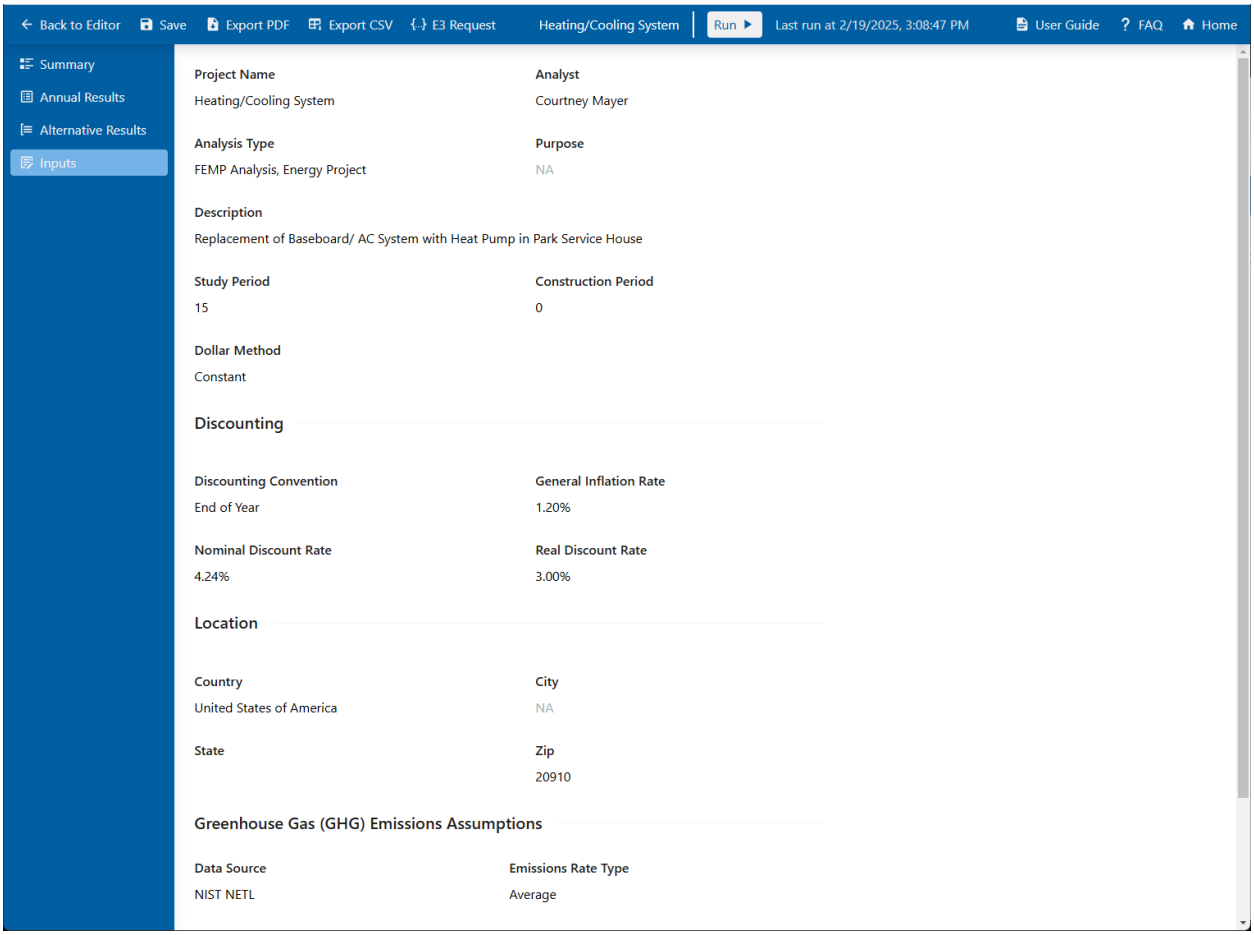

Figure 3-27 Input Page

3.11 Save, Export, Edit, and Support

The BLCC web application allows users to save the project file as well export and save project analysis results through the BLCC results header. Clicking on Save displays a pop-up window that allows the user to rename and save the current project as shown in Figure 3-28.

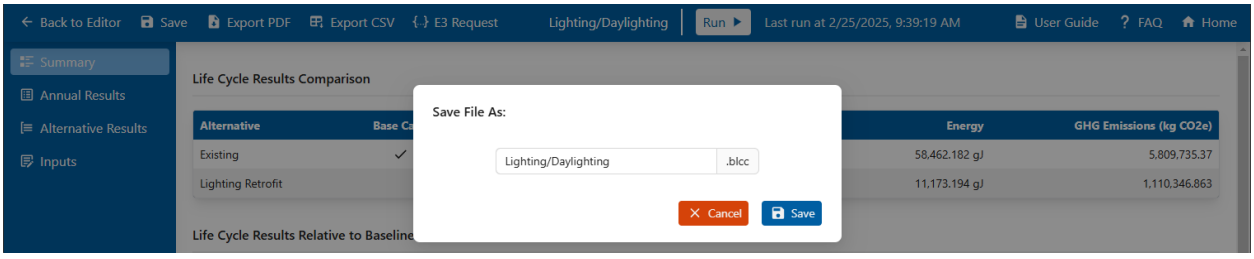

Figure 3-28 Save BLCC Project Pop-Up Window

The user can save the analysis results by clicking on either (1) Export PDF or (2) Export CSV shown in Figure 3-29. The PDF file includes all user inputs for all alternatives and costs as well as all results tables and figures accessible in the BLCC interface, which provides the user

documentation and timestamp for the analysis. The CSV file includes the results tables, which provides the user the results in a form that can easily be manipulated to create custom tables and figures as desired. Both the PDF and CSV are automatically saved with the same name as the BLCC project file to the user's default download location set in their browser. Using the same name as the project file makes it easier for the user to match the project file to the associated results files.

The user can also download the E3 Request (Input) File using the "E3" button, which is the JSON file submitted to E3 to run calculations.

For BLCC users that need assistance in troubleshooting issues, the "Debug" button can be used to download a ZIP file that includes three files:

(1) BLCC Project
(2) E3 Request
(3) Metadata (screen size, browser version and size)

Users should include this zip file in any communication for troubleshooting assistance.

BLCC provides users with warning and error messages throughout BLCC to support the user in correctly and efficiently creating, running, and analyzing a BLCC project. The user is also provided several support resources on the right side of the BLCC header, including a link to this BLCC user guide and a BLCC FAQ (UNDER DEVELOPMENT). There is also a link to the BLCC home/landing page where there are links to the FEMP BLCC webpage, Handbook 135, Annual Supplement to Handbook 135, and EERC.

The user can return to the BLCC project editor to modify inputs at any time by clicking on the "Back to Editor" button in the top-left of the header. The results that have been run (and downloadable files) will remain available to the user until the user re-runs the analysis.

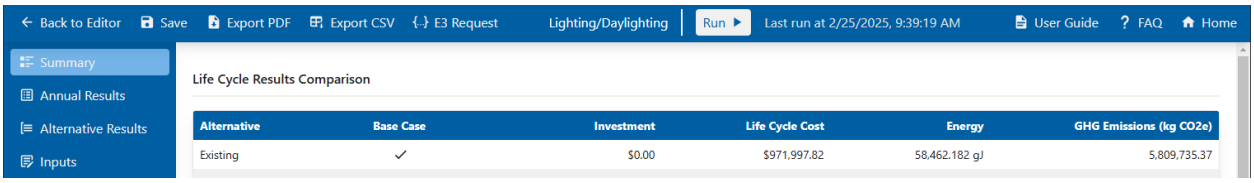

Figure 3-29 BLCC Results Header

4 Using Existing BLCC 5.3 Project Files

A file generated within the BLCC web application will successfully reload anytime in the future. Users can also upload existing BLCC 5.3 project files, but there are several items to be aware when using existing files, each of which is described below.

4.1 Uploading Project File

BLCC web application assumes the user is uploading a BLCC 5.3-2025 project file. The reason this is necessary is that inputs using default values (e.g., default energy escalation rates) are not saved in the project file and are, therefore, missing from the BLCC 5.3 project file. If the user replaces a default value with a customized value and then saves the file, the customized value will be saved in the project file and will upload successfully. There is also no record of the release year in which the project was created. To populate missing default values (e.g., defaulted values, such as discount rates, escalation rates, and unit or value rates of changes), it was necessary to infer what those values should be by assuming the BLCC 5.3 project files are originating from the most recent release (2025). Thus, if the user has a file from a previous version of BLCC 5.3, they should upload, update values would have changed between annual releases (e.g., discount rates, inflation rate, energy escalation rates), and save the file in BLCC 5.3-2025 before trying to upload the file into the BLCC web application.

Note: Even with this assumption, it is possible that not all information was successfully and correctly converted from the BLCC 5.3 project file to the BLCC web application. Specifically, values that must be inferred instead of directly populated (e.g., discount rates, escalation rates, and unit or value rates of changes) are the most likely to be incorrect. Please review your inputs to ensure all have been uploaded correctly and update any incorrect values or provide missing values.

4.2 Additional Input Requirements

When uploading an existing BLCC 5.3 file, the user is required to provide additional inputs that cannot be collected or inferred from the project file. At a minimum, the user will need to provide (1) the primary location of the project being evaluated (ZIP Code) and select which alternative is used as the baseline (base case) for any comparative analysis.

The ZIP code of the primary location for the project being evaluated is now required in the request for general information, where previously the location was only required for energy-related calculations and was selected at the state level. This new requirement is to provide more accurate energy-related emissions data. Each fuel type has its own unique regionalization due to the structure of the specific energy markets that might not align with traditional jurisdictional boundaries (e.g., balancing authorities for electricity markets). If the user is unsure of the ZIP code, the recommendation is to select a ZIP code that is located within the City in which the project is located. If the project is not located in the U.S. the ZIP Code is not required and the

location is for documentation purposes only, with escalation rates defaulting to U.S. national averages.

BLCC 5.3 does not require the user to specify the baseline alternative (i.e., base case) unless a comparative analysis report is generated, which completed the calculations "on-the-fly" in real-time. The new structure of the BLCC web application to use E3 for the LCCA calculations requires the baseline alternative be specified because all calculations for all results are made at the same time. The user can change the baseline from the Alternatives Page or on the page for the specific alternative the user wants to set as the baseline (base case). There may be additional input requirements, which are identified where feasible with error/warnings throughout the interface (e.g., missing or invalid input errors).

Beyond requiring the ZIP code and baseline selection, there are situations in which the user must check and/or provide additional information to ensure their project is accurate. One specific example that cannot be identified as an error is when the BLCC 5.3 project file included energy cost(s) with a different State (or ZIP Code if this is known) than the primary location as specified on the General Information Page. The user will need to go to the energy cost(s) and customize the location using a new ZIP Code.

Once the user uploads the existing project file, validates the inputs, and provides these additional inputs, the user can Save the project in the new BLCC project file (JSON format) to their local machine. At which time the user can successfully upload, run, and modify the file as desired.

4.3 Default Energy Escalation Rate Values Logic

Uploading an existing BLCC 5.3 file creates a need for clear logic to code how to handle default and custom values, specifically for energy price escalation rates. If there are customized escalation rate values (i.e., values providing in the BLC 5.3 project file), they will be uploaded for the energy cost to which they apply. If there are no customized escalation rate values, the assumption is that default values for the primary location were used for energy costs (i.e., assumes no energy costs are occurring outside the Census division in which the primary location is located). This leads to a few scenarios for the user.

If the user uploads a file that uses the default escalation rates of the Census division of the primary location, the BLCC web application will assume the same default values for all energy costs based on the user inputted primary location's ZIP code. The user should not have to make any modifications to the escalation rates to match those that would exist in BLCC 5.3-2025.

If the user uploads a file that used the default escalation rates of a secondary location outside the Census division of the primary location for at least one energy cost, the user will need to customize the location of those costs after uploading because the BLCC web application will assume the same default values for all energy costs.

If the user uploads a file with customized escalation rates (a single value change will make the entire set of escalation rates for a given cost item be treated as customized), those customized rates will be displayed. The user will be prompted when they input a ZIP code in the General

Information page whether to replace all custom escalation rates with the default values. The user can decide whether to keep or override those customized values. If all energy costs occur in the ZIP code primary location, no other action is needed. If any energy costs occur outside the ZIP code of the primary location, the user should customize the location for each energy cost that has a different ZIP code. The user will be prompted again about whether to keep the customized rates or replace them with the default rates for the selection ZIP code. The user can again choose which to use.

4.4 Known Differences relative to BLCC 5.3

There are several known discrepancies in how an analysis is completed in BLCC 5.3 versus the BLCC web application that may lead to differences in results when running the same file in both tools. These discrepancies are summarized here and may also be mentioned where appropriate elsewhere in this document.

First, the web application requires the user to provide the primary ZIP code for the project because the underlying energy-related emissions data varies by ZIP code and does not align with state boundaries for all fuel types. This is because the underlying data sources are also different, using data based on NIST-NETL [cite], which will lead to different emissions estimates in the results. The emissions results have also been aggregated in the web application into CO2e while BLCC 5.3 reported CO_2, SO_2, and NO_X separately.

Second, MILCON projects now discount all future costs (excluding residual values) using mid-point discounting while BLCC 5.3 uses mid-year discounting for all recurring costs and end-of-year discounting for all one-time costs. This change has been made to align with new guidance for Army, Navy, and NASA. Note that currently the BLCC web application applies mid-year discounting to residual values. This creates differences in the results between BLCC 5.3 and the web application for MILCON projects that include non-recurring future cost.

Third, rounding differences may lead to small differences in the results. Differences have been identified in the energy escalation rate calculations as well as during the LCCA completed by E3. BLCC 5.3 uses the energy price projections from the EIA published in the ENCOST file, which are rounded to 2 decimals, for energy escalation rate calculations. Meanwhile, the BLCC web application uses energy price projection data collected directly from the EIA web API without any rounding of the values, which are processed into escalation rates then uploaded directly into the web application data tables. The result is small differences in the default energy price escalation rates between the two tools, which leads to small differences in the estimates fuel costs.

The discrepancies that impact the results will be highlighted in Section X that compares the results of the BLCC 5.3 example files run in both tools.

Any additional discrepancies will be documented here in updates to this document.

5 Validation and Feedback on BLCC

Below is a summary of the validation completed using the BLCC 5.3 example files. The table provides the total LCC by alternative for each example file and the total and percentage difference relative to the results using BLC 5.3 for the same example files.
Current known issues:

- Underlying data table mismatch
- Duration does not exist, so costs continue through study period
- RV using mid-year vs EOY when mid-year is selected
- Escalation is not using mid-year when mid-year is selected
- Phase in is off by one year
- General Rounding throughout

Table 5-1 BLCC Web Application validation relative to BLCC 5.3-2025

Example File	Assumptions	Alternative	LCC		Comparison to BLCC 5.3-2025		
			Web App	5.3-2025	Diff.	% Diff.	Cause(s)
FEMP Energy	**EOY - Constant – DOE**	**Existing System**	$15,544	$15,548	$4	-0.02 %	Rounding
		New System	$13,166	$13,168	$2	-0.02 %	Rounding
Federal Financed	**EOY – Current - DOE**	**Existing**	**$965,179**	**$932,909**	**$29,879**	**3.2 %**	Energy
		Lighting Retrofit	**$891,877**	**$655,198**	**$234,540**	**35.8 %**	Contract, Energy
OMB Non-Energy	**Mid-Yr - Constant - OMB**	**Lease**	**$6,310,868**	**$6,311,032**	**$164**	**-.003 %**	Rounding
		Buy	**$5,751,829**	**$5,772,591**	**$20,696**	**-0.36 %**	RV (mid- vs EOY discounting)
MILCON FEMP	**Mid-Yr – Constant – DOE**	**Keep Existing System**	**$463,307**	**$421,091**	**$42,216**	**10.0 %**	
		Install DX Split Syst.	**$334,285**	**$318,099**	**$16,186**	**5.1 %**	Mid-Yr Esc
		Central Plant Connect.	**$395,225**	**$379,817**	**$15,408**	**4.1 %**	Mid-Yr Esc
MILCON Non-Energy	**Mid-Yr – Constant – OMB**	**Maintain Existing Services Shop**	$67,761,813	$67,655,543	$106,270	0.16 %	Esc Rates Data, OMR esc rate
		Renovate Building 172	$24,868,598	$24,636,125	$232,473	0.94 %	Phasing, Esc Rate

		Construct New Building	$28,032,721	$27,475,725	$556,996	2.03 %	Phasing, Esc Rate
MILCON ERCIP	**Mid-Yr – Constant – DOE**	**Not included yet**					
Note:							

Feedback is encouraged to assist NIST and FEMP in meeting user needs, whether its identifying bugs, providing suggestions to improve the useability, or proposing new features to improve BLCC capabilities and usefulness. Feedback can either be provided on BLCC by:

- Emailing Joshua Kneifel at joshua.kneifel@nist.gov or
- Create an Issue on the GitHub repository: https://github.com/usnistgov/blcc/issues

Please include the "Debug" zip file that includes the BLCC Project, E3 Request, and metadata in any communication for troubleshooting assistance. Additionally, a screenshot of the issue will help accelerate NISTs ability to address the problem. On a PC, a screenshot of BLCC can be taken by clicking on the BLCC web app browser window and press "ALT + PRINT SCREEN."

6 User Input Descriptions and Glossary

This section provides (1) select user input descriptions provided in BLCC as tool tips and information icons and (2) definitions for select economic terms from Handbook 135 that were deemed most relevant for BLCC users. There may be overlap in terms across the two subsections (e.g., discounting) with the input descriptions focused more on what the user needs to understand about using BLCC and the definitions only including the definition.

6.1 User Input Descriptions

To provide users with easier access to descriptions of each input in BLCC, the table below was developed with user input names, definitions, and descriptions. Much of this information has may be duplicated elsewhere in this document. However, it has been provided alphabetically for quick searching here while Section 2 and Section 3 provides information based on topic area and input page, respectively. Note that inputs considered self-explanatory have been excluded for brevity. Additionally, excluded are inputs that are discussed in significant detail in Section 2.

Table 6-1 Select User Input Definitions and Descriptions

User Input	Description
Alternative Costs	Alternative Costs for an alternative include all costs that are included in the analysis organized by common cost categories and subcategories (energy, water, capital, and contract costs). For values that do not fit into these defined categories, users can use the Other Costs category to include other monetary and non-monetary impacts. For additional details, see the User Guide.
Alternatives applied to	Costs can be applied to more than one alternative by checking the box for each alternative. If a cost is applied to multiple alternatives, changing the cost will change it both all selected alternatives. A cost must be applied to at least one alternative.
Amount Financed	In Financed Projects, the initial capital cost is divided into Initial Cost (Paid by Agency) and Amount Financed. Their sum, adjusted by the Annual Rate of Change during the Study Period, is the basis for calculating the Residual Value of the capital component. Note: The Amount Financed is used only to calculate the Residual Value; it is not included in the LCC calculations, since any financed amounts would be included in the Contract Payment.
Annual Consumption	Annual consumption during the initial year of operation is used as the basis for consumption for all future years by combining the value with the Usage Index. The user can modify the unit of measure.
Annual Rate of Change	The average annual rate at which the cost of this capital component is expected to change throughout the Study Period. BLCC uses this variable to adjust the base-year initial cost of this component before calculating its Residual Value (resale value, salvage value). If the study is performed in constant dollars, this rate of increase should not include general inflation, but instead reflect only real rates of change during this period.
Baseline Alternative	Alternative that is used as the baseline (or base case) for comparisons
Capital Costs	Costs associated with the installation, OMR, and replacement of building components.
Clone	Cloning the selected alternative or cost will create a replica that can be modified after creation.
Construction Period	The Construction Period (or Planning/Construction/Installation Period) is the timeframe it takes for the project to be completed and ready for service, and can be up to 3 years in length. The study period begins at the end of the construction period.
Contract Costs	Costs associated with the implementation and payment of contracts.

Cost Adjustment Factor	If initial capital costs are phased in over the construction phase, the Cost Adjustment Factor is the average annual rate at which the Initial Cost of this component is adjusted to its value in any year of the P/C/I Period. The Cost Adjustment Factor can, for example, be a contractual rate (sometimes equal to zero) or a rate determined by the agency. It may be different from the general Rate of Increase that represents the escalation to be expected during the Study Period for the purpose of calculating the residual value of the component. If the study is performed in constant dollars, the Cost Adjustment Factor should not include general inflation but instead reflect only real rates of change during this period. If the study is performed in current dollars, the Cost Adjustment Factor should include general inflation.
Cost or Savings	The Cost or Savings toggle allows the user to specify whether data will be inputted as a cost or as cost savings (negative costs). Headings will update based on this selection for consumption and cost per unit.
Cost per Unit	The cost per unit (in base year dollars) for the initial year of the study period is used as the basis for energy prices for all future years by combining the value with Escalation Rates.
Cost-Phasing of Initial Cost	Initial capital costs may be phased in over a Planning/Construction or Installation (P/C/I) Period. BLCC discounts from the date shown in the schedule to the base date the portion of Initial Cost allocated to any year in the P/C/I Period. Note: For MILCON analysis, if the Beneficial Occupancy Date is later than the Base Date, the Initial Cost may be entered at the Midpoint of Construction. This procedure is suggested in the DoD Memorandum of Agreement on Criteria/Standards for Economic Analysis/Life-Cycle Costing for MILCON Design, March 1994. However, the US Army Corps of Engineers in its web site Economic Analysis Reference Guide recommends that DD 1391 Front Page total request should equal the initial construction costs in the analysis; also, these costs should be evenly divided throughout the lead or construction time. The BLCC cost adjustment feature accommodates either method.
Customer Sector	The user can elect from a customer type for which default escalation rates are provided using a combination of fuel type, customer sector, and location (ZIP).
Data Release Year	Data Release Year allows the user to select the year for which the data was released in the Annual Supplement to Handbook 135. The default value is the most recent release. The base date of the analysis is assumed to start in the selected release year. Thus, selecting previously released data should only be used for validating previously completed analysis. For additional guidance, see the User Guide.
Demand Charge	Demand Charges cover, for example, fixed monthly customer charges or charges for peak power demand. Enter these costs as annual amounts in base-year dollars. The escalation rates used for energy costs are also used to escalate these demand charges.
Discounting	Discounting assumptions are used to complete the analysis and are auto-populated using default data based on the Analysis Type and Data Release Year. For additional guidance on discount rates, see the User Guide.
Discounting Convention	If end-of-year discounting is selected, costs will be discounted to the base date from the end of the year in which they occur. If mid-year discounting is selected, costs will be discounted to the base date from the middle of the year. End-of-year discounting is the default for all types of analyses, except for MILCON analyses. MILCON analyses require mid-year discounting, and the designated MILCON modules use mid-year discounting as the default.
Disposal	Disposal is the amount of water disposed in the initial year of operation. The user can provide values for either two or four seasons with unique usage and prices for each. These values are used in combination with the Escalation Rates and Usage Index to estimate future costs, which are assumed the same for both usage and disposal.

Dollar Analysis	If constant dollars (excluding inflation) is selected, the discount rate and all price escalation rates need to be entered in real terms (excluding inflation). The default values can be edited if a user prefers to perform the analysis in current dollars, but in general constant-dollar analysis is preferable if no tax or financing variables need to be included. If current-dollar analysis is selected, the discount rate and all price escalation rates need to be entered in nominal terms (including inflation). (The default inflation rate in BLCC5 is the average long-term inflation rate calculated annually for DOE/FEMP projects according to 10CFR436). The present-value life-cycle costs and supplementary measures will be the same for either constant- or current-dollar analysis if the discount rate and all price escalation rates are entered consistently either in real or nominal terms.
Emissions Rate Scenario	Emissions rate projections are based on two separate sources: (1) EIA projections and eLCI data (NIST-NETL collaboration). For details, see the User Guide.
Escalation Rates	Escalation rates account for projected cost changes and are defaulted based on the fuel type, customer type, and location (ZIP Code). The user can modify these escalation rates if desired. No default values are provided for water costs. For additional details, see User Guide.
Expected Lifetime	Enter the expected useful life (years) of the component. This is intended to be a realistic assessment of the component life, independent of the study period or depreciation life assigned to the component for income tax purposes.
Fuel Type	The user can select from a list of fuel types for which default escalation rates are provided using a combination of fuel type, customer sector, and location (ZIP).
Inflation Rate	If current dollar analysis is selected, the general rate of inflation is required and will be defaulted based on the annually published values in the Annual Supplement to Handbook 135.
Initial Cost (Base Year Dollars)	Initial Cost is the total installed cost of the component, unadjusted for price escalation. If the Initial Cost is to be phased in over one or more years from the Base Date, BLCC5 uses a Cost-Phasing Schedule and a Cost Adjustment Factor to calculate the actual component cost in any year of the Construction Phase.
Initial Occurrence	Initial Occurrence is the initial year that the cost occurs.
Location	Location is used to populate default values for energy escalation rates and emissions rates. The location provided under General Information is used as the primary location of the project and used as the default values for energy costs. If the project being analyzed includes energy costs occurring in different locations, the user can change the location for each energy cost. Default energy-related data is matched by ZIP code and is required. For additional guidance, see the User Guide.
Nominal Discount Rate	If current dollar analysis is selected, the nominal discount rate is required and will be defaulted based on the annually published values in the Annual Supplement to Handbook 135 for the selected analysis type.
Number of Units	Number of units of the impact. Other Costs provides users with the ability to include impacts that do not align with the defined cost categories, such as productivity improvements, human health benefits, resilience benefits, and environmental impacts. The user can customize the unit of measure to whatever unit is appropriate. The user can include the impacts in non-economic terms by using Other – Non-Monetary Costs or include an economic value to these impacts using Other – Monetary Costs.
Occurrence	The year of occurrence of a one-time cost.
Other Costs	Costs that do not fit into the defined categories (both monetary and non-monetary values).
Real Discount Rate	If constant dollar analysis is selected, the real discount rate is required and will be defaulted based on the annually published values in the Annual Supplement to Handbook 135 for the selected analysis type.
Rebate	A rebate is entered as an annual base-year dollar amount. (One-time rebates can be subtracted from initial costs). The escalation rates used for energy costs are also used for annual utility rebates.

Recurring	Select One-Time if the cost only occurs once. Select Recurring is the cost repeats at regular intervals over the study period.
Residual Value	This is the value of the initial cost that you expect the component to retain as residual (resale or salvage value or disposal cost). Enter a negative value if the residual value is a disposal cost. The user can provide the residual value in total dollars or as a percentage of the initial cost. The residual value is adjusted using the Annual Rate of Change.
Study Period	The study period is the timeframe over which the analysis is completed. The study period can be up to 40 years of service plus the length of the construction period, which can be up to 3 years.
Tags	Tags allow the user to create custom category name(s) for other costs, benefits, and non-monetary values the user wants to include in the analysis. Any tags a user create is available for use with additional Other Costs.
Unit	The user can select the unit of measure for water consumption, providing the ability to match the units reported in their water bills.
Unit Rate of Change	If you expect the recurring cost to change in some predictable manner (e.g., when ECMs are phased in over a period of time), you can enter Unit Rate of Change indices and their duration for each recurring cost. For example, you might enter an index of 1.00 for the first year of the service period and adjust the usage downward as new ECMs come on line.
Unit Value	Value per unit for an Other Monetary Costs. Other Costs provides users with the ability to include monetary values that do not align with the defined cost categories. Monetary costs could include costs or benefits the user wants to include that have not historically been considered, such as the value of productivity improvements, human health benefits, or resilience benefits.
Usage	Usage is the amount of water consumed in the initial year of operation. The user can provide values for either two or four seasons with unique usage and prices for each. These values are used in combination with the Escalation Rates and Usage Index to estimate future costs, which are assumed the same for both usage and disposal.
Usage Index	Usage index allows the user to adjust the quantity consumed across the study period if the consumption patterns vary from year to year. The value is indexed to the initial year of the study period (NOT year-over-year changes). The values are defaulted to 1.00 for all years (unchanged over the study period).
Value Rate of Change	The rate at which the base-year dollar amount of the recurring cost is expected to change throughout the Study Period. If the analysis is conducted in constant dollars enter the real rate (excluding inflation), otherwise enter the nominal rate (including inflation).

6.2 Glossary

Handbook 135 provides the full set of FEMP LCCA Rules, terminology, and definitions related to federal LCCA. A limited set of definitions of economic terms are provided below that were deemed most relevant to BLCC. See Handbook 135 for additional details.

Adjusted Internal Rate of Return (AIRR) - Annual yield from a project over the Study Period, considering reinvestment of interim returns.

Alternative – project option that is to be compared to the Base Case.

Annually Recurring Costs -Those costs which are incurred each year in an equal amount throughout the Study Period, or which change from year to year at a known rate.

Base Case/Baseline - The building, facility, or campus design against which an alternative design is compared.

Base Date - The beginning of the first year of the Study Period, generally the date on which the Life-Cycle-Cost analysis is conducted.

Base Year - The first year of the Study Period, generally the year in which the Life-Cycle-Cost Analysis is conducted.

Benefit-Cost Analysis – a method of evaluating projects or investments by comparing the present value or annual value of expected benefits to the present value of expected costs.

Capital Investment Costs - Costs which are paid from capital funding accounts rather than from agency operating funds. For projects subject to the FEMP Rules, these include initial investment, capital replacements, and residual values.

Cash Flow - The stream of costs and savings (expressed for the purpose of this requirement in Constant Dollars) resulting from a project investment.

Constant Dollars - Dollars of uniform purchasing power tied to a reference year (usually the Base Year) and exclusive of general price inflation or deflation.

Current Dollars - Dollars of nonuniform purchasing power, including general price inflation or deflation, in which actual prices are stated. (With zero inflation or deflation, current dollars are identical to constant dollars.)

Demand Charge - That portion of the charge for electric service based on fixed plant, equipment, and transmission costs associated with providing maximum required capacity.

Discount Rate - The rate of interest, reflecting the investor's Time Value of Money (or opportunity cost), that is used in Discount Formulas or to select Discount Factors which in turn are used to convert ("discount") Cash Flows to a common time. Real Discount Rates reflect Time Value of Money apart from changes in the purchasing power of the dollar and are used to

discount Constant Dollar Cash Flows; Nominal Discount Rates include changes in the purchasing power of the dollar and are used to discount Current Dollar Cash Flows.

Discounted Payback (DPB) Period - The time required for the cumulative savings from an investment to pay back the Investment Costs and other accrued costs, considering the Time Value of Money.

Discounting - A technique for converting Cash Flows occurring over time to time-equivalent values, at a common point in time, adjusting for the Time Value of Money.

Energy Conservation Measure - An installation or modification of an installation in a facility which is primarily intended to reduce energy consumption cost or allow the use of a renewable energy source.

Energy Cost - The annual cost of fuel or energy used to operate a building or building system, as billed by the utility or supplier (including Demand Charges, if any). Energy Costs are incurred during the Service Period only. Energy consumed in the construction or installation of a new building or building system is not included in this cost.

Escalation Rate - The rate of change in price for a good or service (as contrasted with the Inflation Rate, which is for all goods and services). See Real Escalation Rate and Nominal Escalation Rate.

Expected Lifetime – The period over which a facility or facility system continues to generate benefits or savings.

Inflation - A rise in the general price level, i.e., the price level for all goods and services. (A negative change in the general price level is called "Deflation.")

Initial Investment Costs - The initial costs of design, engineering, purchase and installation, exclusive of "Sunk Costs," all of which are assumed to occur as a lump sum at the beginning of the Base Year or phased in during the Planning/Construction Period.

Investment Costs - The Initial Investment Cost of a building or building system and capital Replacement Costs, less Residual Value, plus Disposal Cost, if any.

Life-Cycle Cost (LCC) - The total discounted dollar costs of owning, operating, maintaining, and disposing of a building or building system over the appropriate Study Period (see Life-Cycle Cost Analysis).

Life-Cycle Cost Analysis (LCCA) - A general approach to economic evaluation that encompasses several related economic evaluation measures, including Life-Cycle Cost (LCC), Net Benefits (NB) or Net Savings (NS), Savings-to-Investment Ratio (SIR), and Adjusted Internal Rate of Return (AIRR), all of which take into account all dollar costs related to owning, operating, maintaining, and disposing of a project over the appropriate Study Period.

Measures of Economic Evaluation -The various ways in which project cash flows can be combined and presented to describe a measure of project cost effectiveness. The measures used

to evaluate FEMP projects are Life-Cycle Cost (LCC), Net Savings (NS), Savings-to-Investment Ratio (SIR), Adjusted Internal Rate of Return (AIRR). Discounted Payback (DPB) and Simple Payback (SPB) are measures of evaluation not fully consistent with the LCCA but are used as supplementary measures in some federal programs.

Minimum Acceptable Rate of Return – the minimum percentage return required for an investment to be economically acceptable.

Mutually Exclusive Projects - Projects where the acceptance of one precludes acceptance of the others.

Net Savings (NS) or Net Benefits (NB) - Time-adjusted savings or benefits less time- adjusted differential costs taken over the Study Period, for an Alternative relative to the Base Case.

Nominal Discount Rate - The rate of interest (market interest rate) reflecting the time value of money stemming from both inflation and the real earning power of money over time.

Nominal Escalation Rate - The projected annual rate of change in actual (market) prices for a good or service.

Operating, Maintenance, and Repair (OMR) Costs - Non-investment costs related to the use of a building or building system, including energy and water costs.

Planning/Construction (P/C) Period - The period beginning with the Base Date and continuing up to the Service Date during which only Initial Investment Costs are incurred.

Present Value -The time-equivalent value of past, present or future Cash Flows as of the beginning of the Base Year.

Real Discount Rate - The rate of interest reflecting the portion of the time value of money attributable to the real earning power of money over time and not to general price inflation.

Real Escalation Rate - The difference between the rate of annual price change for a good or service and the rate of general Inflation.

Replacement Costs - Capital costs incurred to replace the project during the Study Period. Sometimes referred to as Capital Replacement Costs. Replacement costs as used in this handbook do not include the cost of replacing system components that are paid out of current operating budgets; these are Operation-Related Costs.

Residual Value - The estimated value, net of any Disposal Costs, of any building or building system removed or replaced during the Study Period, or remaining at the end of the Study Period, or recovered through resale or reuse at the end of the Study Period (also called Resale Value, Salvage Value, or Retention Value).

Savings-to-Investment Ratio (SIR)- A ratio of economic performance computed from a numerator of discounted energy and/or water savings, plus (less) savings (increases) in other operation- related costs, and a denominator of increased Initial Investment Costs plus (less)

increased (decreased) Replacement Costs, net of Residual Value (all in present-value terms), for an Alternative as compared with a Base Case.

Sensitivity Analysis - Testing the outcome of an evaluation to changes in the values of one or more system parameters from the initially assumed values.

Service Date - The point in time during the Study Period when a building or building system is put into use, and operation-related costs (including energy and water costs) begin to be incurred.

Service Period - The period starting with the Service Date and continuing through the end of the Study Period.

Simple Payback (SPB) Period -A measure of the length of time required for the cumulative savings from a project to recover its Initial Investment Cost and other accrued costs, without considering the Time Value of Money. SPB is usually measured from the Service Date of a project.

Single Present Value (SPV) Factor - The discount factor used to convert single future benefit and cost amounts to Present Value.

Study Period - The length of the time period covered by the economic evaluation. This includes both the Planning/Construction Period and the Service Period.

Uncertainty – lack of certain, deterministic, values for the variable inputs used in an economic analysis.

References

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[2] OMB (1992) *GUIDELINES AND DISCOUNT RATES FOR BENEFIT-COST ANALYSIS OF FEDERAL PROGRAMS*, MEMORANDUM FOR HEADS OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS.

[3] OMB (2018) *DISCOUNT RATES FOR COST-EFFECTIVENESS ANALYSIS OF FEDERAL PROGRAMS: Revisions to Appendix C of OMB Circular A-94* (83 FR 5646), (Budget OoMa).

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[6] OMB (2003) *Circular A-4* (https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A4/a-4.pdf), MEMORANDUM FOR HEADS OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS.

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