Stanford Life Cycle Cost Analysis Guide

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Introduction & Methodology

Stanford University has an ongoing commitment to building and maintaining high quality campus projects that meet the adapting needs of students, staff, and faculty. As an academic institution with a long term stake in its assets, Stanford has a vested interest in evaluating the life cycle implications of every building, to ensure its functional and financial resiliency. Each new construction or renovation project on the Stanford Campus must include a Life Cycle Cost Analysis (LCCA) to determine the lifetime costs or savings associated with energy conservation measures. A LCCA study is therefore integrated into Stanford’s existing Project Delivery Process framework. This document aims to provide a concise methodology for performing a robust LCCA. For a more detailed document containing LCCA fundamentals and Stanford University’s approach, see Guidelines for Life Cycle Cost Analysis, October 2005, which can be found online.

LCCA enables project teams to evaluate the economic performance of a building design over its entire life. It includes the total costs for each efficiency measure, from initial construction through the operation & maintenance phase, for a specific period of time. Comparing the life cycle costs of efficiency measures allows project teams to understand the trade-offs between capital cost investments and long-term cost savings while meeting the programming and budget constraints of the project. A LCCA study should be started in Schematic Design, when large system level decisions can be tested using the Schematic Design energy model. It may be appropriate to test different HVAC systems, glazing options, renewable energy systems, or shading options at this phase. As the design progresses through Design Development and Construction Documentation, these studies can be refined if needed. Additional studies at a more detailed level, including HVAC equipment, lighting controls, and other building controls, can be added to the LCCA during these phases. The results of the LCCA will show which strategies have a positive payback within the study period. A Stanford LCCA Tool has been provided with this guide for use by design teams in completing LCCA studies.

A LCCA is a part of the Stanford integrated design process and should be viewed as a tool to help make financially informed design decisions. A LCCA is not an absolute decision making tool and the results need to be viewed in the context of the project constraints.

Assumptions

The first step in developing an LCCA is establishing the following inputs for the LCCA calculation. Default assumptions are provided below. These assumptions should remain consistent across projects unless alternatives are explicitly defined by Stanford on a case-by-case basis. Initial values for the study period, discount rate, and escalation rates are included below and in the Stanford LCCA Tool as a starting point, but should be revised based on the Annual Supplement to NIST Handbook 135, or the project specific details provided by the Stanford project manager. The Annual Supplement to NIST Handbook 135 is updated regularly by the National Institute of Standards and Technology and can be found on their website.

Study Period

- **New Construction:** 30 years
- **Retrofit/Renovation:** 15 years (May vary by type of renovation; project team should discuss and confirm)
- **Labs/High-Tech Building Systems & Equipment:** 10 years

The study period establishes the length of time into the future that the life cycle cost analysis will study. Efficiency measures that yield life cycle savings within this window of time are considered favorable for implementation. This study period should be used unless otherwise instructed by the project manager.

Real Discount Rate: 3.0%

The discount rate reflects the time-dependent value of money and is used to convert cash flows occurring at different times, usually the future, to a common time, usually the present. The discount rate may include general inflation, in which case it is considered nominal. However, all Stanford University LCCAs are to use real discount rates, which do not include inflation. The discount rate should be updated based on the Annual Supplement to NIST Handbook 135, unless otherwise instructed by the Land, Buildings and Real Estate Finance and Administration group.

The current unusual global and national financial situation makes for abnormal discount rates. These values are expected to vary substantially in the next few years. The Annual Supplement to NIST Handbook 135 attempts to account for this by using a minimum discount rate.

Maintenance, Labor, & Materials Cost Escalation Rate: 1%

This escalation rate accounts for the increasing cost of labor, materials, and maintenance incurred over the study.
period. The escalation rate should be updated based on the Annual Supplement to NIST Handbook 135, unless otherwise instructed by the Stanford project manager.

**Utility Escalation Rates (Energy & Water): 1%**
The utility escalation rates account for the increasing cost of utilities, such as fuels and chilled water, incurred over the study period. The escalation rate should be updated based on the Annual Supplement to NIST Handbook 135, unless otherwise instructed by the Stanford PM.

**Utility Costs**
Stanford University life cycle cost analyses use “bundled” utility rates, which include the costs associated with operating the campus central plant in addition to fuel costs. The latest utility cost data can be found on the Stanford Building & Grounds Maintenance website. (Stanford’s Buildings & Grounds Maintenance website: http://bgm.stanford.edu/groups/build_maint/fees)

**Energy Costs: Modeled**
Building energy models completed during Schematic Design and Design Development should be used to establish energy cost differences between efficiency measures. For less complex efficiency measures, energy costs can sometimes be determined using simple spreadsheet or “back of the envelope” calculations.

**Capital & Replacement Costs: Calculated**
Capital costs, also referred to as initial or first costs, include both “hard” or construction costs (labor, materials, equipment, furnishings, etc.) and “soft” costs (design fees, permit fees, etc.). In LCCA studies, the cost differences between alternatives are usually what is important, not the total cost of the project. The team should use the additional cost compared to a baseline as the cost used for a LCCA. For example, in comparing two HVAC systems that have the same zonal equipment but varying central equipment, the zonal equipment costs can be ignored and only the costs of the central equipment developed. It is important to be as complete and thorough as possible when considering project cost variations between alternatives; all costs that vary must be captured in order to make a valid comparison. Replacement costs and the year they occur can be calculated as part of the cost estimation process or from previous project data provided by the operations & maintenance group at Stanford University.

For retrofit projects, design and construction costs are compared to a baseline cost assumption of zero, as the status quo does not require any additional cost investment. Maintenance and energy costs must still be analyzed.

The following are a few recommended paths to acquiring capital cost information. Chart 1 below highlights the suggested approaches:

1. For the most accurate cost information, teams should use professional cost estimators. Design teams should use detailed systems descriptions, drawings, and information from contractors & vendors to develop a specific cost estimate through the schematic design phase. Changes to the design should be communicated to the cost estimation team in order to ensure that the costing is adapted to reflect relevant design changes.
2. If professional cost estimation is unavailable for the project, design teams can use in-house estimation tools to establish first cost information. RSMeans, a popular cost estimation guide, is recommended. Validation from a professional cost estimator is recommended, though not required for this approach.
3. Finally, project teams will have access to an archive of LCCAs and capital cost information based on previous Stanford University projects.
Generally, strategies that have a positive payback within the defined study period should be included in the project. The following payback period threshold guidelines should be used in the decision-making process:

- 5 years or less: Required to be incorporated into the project
- 6 - 10 years: Strongly encouraged and require the approval of the Vice Provost for Land and Buildings to be exempted.
- Over 10 years: Discretionary but encouraged

Efficiency measures that have a payback that is longer than the study period and will therefore never make financial sense, can easily be accepted or rejected early in the design process and will not need to be revisited later in design. Borderline cases, where the strategy is close to the pay back threshold, may need to be carried into later design phases where the design assumptions can be refined, adding confidence in the LCCA results. The payback threshold should not be seen as a hard line, due to uncertainty in the financial and first cost assumptions.

Because LCCA results are often sensitive to changes in discount and escalation rates, the LCCA Tool includes a sensitivity analysis. This allows teams to see the life cycle savings at the end of the study period for a range of discount and escalation rates, as added information for decision-making. Design teams should note that all other assumptions listed above have an impact on LCCA results and could be varied to test sensitivity if it’s useful to the team. For borderline cases, teams may want to look at other considerations such as net present value, maintenance/operations costs versus energy costs, bundled versus unbundled energy rates, and the availability of utility incentives.

While a LCCA provides a critical financial metric for evaluating design options, it is important to consider that there may be design, program, and benchmarking reasons to include specific strategies that are not captured by this analysis.

**Documenting Results**

The results of a LCCA conducted for a project should be documented and reported to Stanford, including recommendations on which strategies to include in the project.

The reported results should include, for each alternative: a description of the measure, annual energy cost savings, first costs, annual maintenance costs, replacement cost, anticipated lifespan, and any notes on the source of this information. A LCCA Matrix is included in the Stanford LCCA Tool, which can be used to document this information. The study length, discount rate, fuel escalation rate, maintenance escalation rate, and utility rates should also be included in the report for reference.
Life Cycle Cost Analysis Timeline, New Const. & Major Renovations

The timeline establishes milestones for successfully integrating LCCA into a new construction or major renovation project’s design phases. This structure fits into the Project Delivery Process and parallels the Stanford Building Energy Performance Energy Model & Meetings Timeline.

CONCEPT PHASE

Assumptions & Benchmarks

Purpose
Department of Project Management and Project Team to identify appropriate operations & maintenance targets and confirm LCCA assumptions that will be used as benchmarks for the life cycle costing.

Deliverables
- Benchmark assumptions

SCHEMATIC DESIGN

LCCA Matrix

Purpose
Project team to establish a project-specific matrix to determine which efficiency measures provide the greatest cost benefit to the project. A LCCA Matrix template can be found in the Stanford LCCA Tool.

Deliverables
- Completed project-specific LCCA Matrix with cost estimates and assumptions.

Perform LCCA

Purpose
Complete the energy analysis, detailed cost estimation, and relevant life cycle cost analyses for the efficiency measures in the LCCA Matrix, including sensitivity analysis.

Deliverables
- Completed LCCA comparative studies

Document Results & Select Efficiency Measures

Purpose
Document LCCA results, including detailed budget and schedule implications for chosen efficiency measures. Project team to meet with Stanford to discuss LCCA results and select efficiency measures to be included in the next phase of design.

Deliverables
- Meeting minutes from workshop(s) to discuss LCCA results
- Report summarizing LCCA results, including assumptions and LCCA Matrix
- Report documenting elements included and not included in the project, with brief rationale for inclusion or exclusion

DESIGN DEVELOPMENT

Review Design Development Documents

Purpose
Project team to review DD set to ensure that design & specifications include selected LCCA measures. Update LCCA to reflect design changes and updated energy model results, if necessary. Include additional design measures in LCCA if studied as part of energy analysis.

Deliverables
- Updated LCCA study and report
- Documentation of DD review, including design changes or modifications made to LCCA during DD phase
CONSTRUCTION DOCUMENTATION

50% CD Review
Purpose
Review 50% CD set to ensure that the design and specifications conform to the LCCA study assumptions. Adjust LCCA to reflect final design and energy analysis results, if necessary. Add additional studies as appropriate.

Deliverables
- Updated LCCA study
- Documentation of CD review, including design changes or modifications made to LCCA

Bidding/Value Engineering Review
Purpose
Project manager to ensure that VE options address the impact on LCCA elements.

Deliverables
- Documentation of changes made to LCCA as a result of VE

CONSTRUCTION/CLOSEOUT

O & M Manuals
Purpose
Confirm that O&M manuals are complete and include information relevant to LCCA elements in the building. Ensure that the building manager and facilities operations representative understand specific user requirements associated with LCCA features.

Deliverables
- Documents for training building users and facilities representatives

Lessons Learned Meeting
Purpose
Conduct ‘lessons learned’ meeting with Stanford University Project Management Department, Operations group, and relevant project team members to evaluate LCCA procedures.

Deliverables
- ‘Lessons learned’ documentation to be included in post-occupancy evaluation of project

OPERATIONS

LCCA Validation
Purpose
Facilities operations representatives to monitor utility consumption and O&M costs. Stanford to perform post-occupancy evaluations to assess performance of LCCA elements and validate the study after eleven months.

Deliverables
- Report detailed results from post-occupancy evaluations, including survey results and meeting minutes from ‘lessons learned’ meeting

Retrofit & Renovations Timeline
Retrofit and renovations use LCCAs differently in the project decision making process. A LCCA is conducted before a project begins to determine whether it makes sense to proceed with the project. If the project shows payback in an appropriate timeline, the project proceeds and enters the design and construction phases. If the LCCA is not favorable, the project may not proceed.
Workbook Summary
The attached Stanford Life Cycle Cost Analysis (LCCA) Tool can be used by project teams to perform their assessments. This tool is Microsoft Excel based.

Sheet 1: Instructions
This cover sheet provides detailed step-by-step instructions on how to use the Stanford LCCA Tool.

Sheet 2: LCCA Matrix
This sheet should be used as a working document by the design team before performing the LCCA to compile information about each efficiency measure including: a description of the measure, annual energy cost savings, first costs, annual maintenance costs, replacement cost, anticipated lifespan, and any notes on the source of this information.

Sheet 3: Assumptions
The assumptions sheet contains the three main parameters for LCCA studies: study period, escalation rate, and discount rate. While most analyses will use specific values provided by Stanford University, project teams may adjust the variables on a case by case basis at Stanford’s discretion. Initial values for the study period, discount rate, and escalation rates are included in the Stanford LCCA Tool as a starting point but should be revised based on the Annual Supplement to the NIST Handbook 135 or the project specific details provided by the Stanford project manager.

Sheet 4: Inputs
The inputs sheet provides a summary of the cost information for each efficiency measure. First cost, maintenance costs, and replacement costs, and energy costs are manually entered for up to 16 efficiency measures. The spreadsheet automatically calculates the utility cost savings associated with each efficiency measure compared to the baseline design based on the energy cost inputs for each case. The first costs for each potential design should be entered into the spreadsheet as the difference between the base case and each option’s capital cost. These values are carried forward for more detailed analysis of each potential design’s payback period and cumulative savings.

Sheet 5: Results
The results sheet contains a graph that illustrates the life cycle results for each efficiency measure. Each efficiency measure pays back at the point the line crosses the x-axis.

Sheet 6: Efficiency Measure Sheets
These sheet provides detailed year-by-year cost breakdowns for each efficiency measure, with information such as annual costs, savings, and payback terms. Sensitivity analysis is also included here, enabling the project team to visualize the impact of varying discount and escalation rates on each efficiency measure’s cumulative savings.

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