Resource Life Cycle Cost Analysis (rLCCA)

Guidance for project resource investment decisions

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Learning Objectives

- Know what rLCCA is and how it fits into KC green building, energy and climate change efforts
- Understand how and when you can and must use LCCA on your projects
- Understand some basic financial terms
- Case Studies: Perform a rLCCA with specific project information
- Know where to get assistance or more information when using rLCCA on your projects

Today’s Agenda

Part 1 ❮ What is LCCA?

- Drivers for performing LCCA
- Why is rLCCA useful?
- When is it applicable?
- How to perform a rLCCA
- Problematic issues

Part 2 ❮ Guidance for performing rLCCA

Part 3 ❮ LCCA Terms and Definitions

Part 4 ❮ rLCCA Calculator

Part 5 ❮ Resources: Where to get help, summary, Q&A

Part 1:

What is LCCA?

What is rLCCA? When and why would you use it?

Life Cycle Cost Analysis

What is LCCA?

LCCA is an economic methodology for helping to select the <u>most cost-effective alternative</u> over a particular time frame.

While the term is often used in a much broader sense, for resource investments, we are using the term "rLCCA" to specify "energy" and other "resource" life cycle cost analysis

LCCA allows one to <u>overcome the "first cost limitation"</u> by looking at future costs associated with operations, maintenance & replacement.

What’s your LCCA knowledge or experience?

?

Life Cycle Cost Analysis

Drivers for using LCCA

- KC Green Building Ordinance 17709
- KC Ordinance 16927
- Meeting King County climate goals
  (Strategic Climate Action Plan)
- Better informed decisions
- Long-term cost perspective
- Increased building/asset value
- Environmental stewardship

Why Use LCCA?

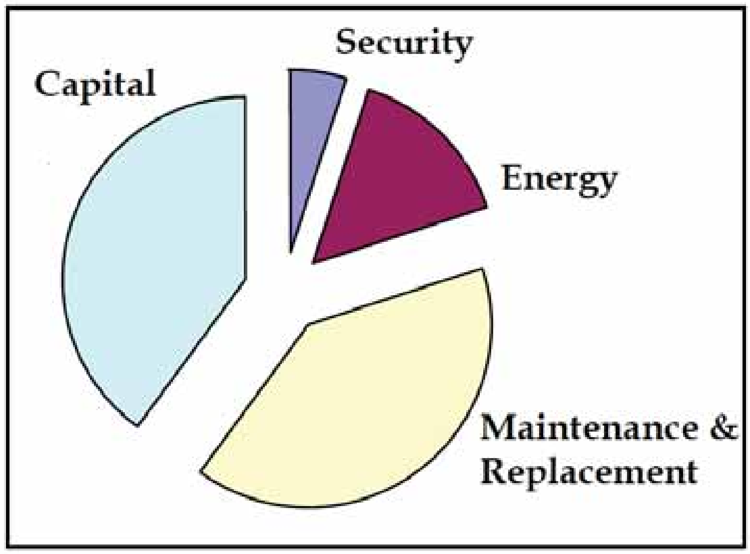
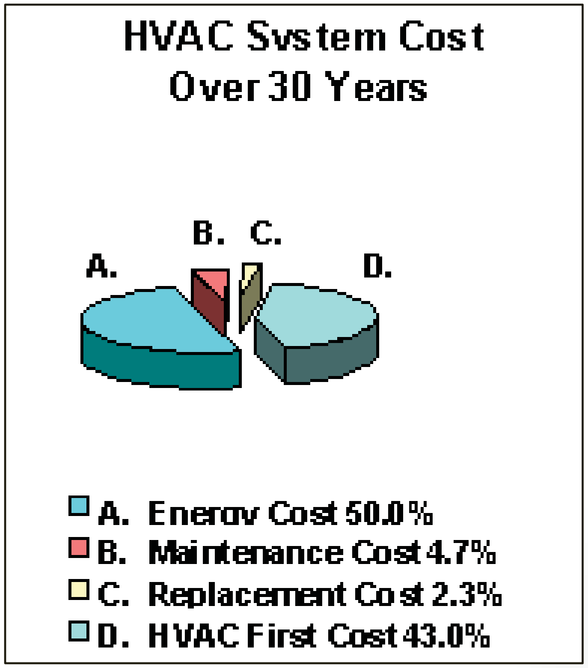


Figure 1: Total Building Costs



Resource Life Cycle Cost Analysis

When is rLCCA applicable for KC Projects?

To support the Green Building Ordinance, 17709
- New, LEED-eligible buildings
- Major building remodel projects
- Sustainable Infrastructure Scorecard Projects
- Energy and renewable energy retrofits and improvements

Ordinance 16297
- Energy-using equipment over $250,000

"Energy Loan Program"
- Fund to Reduce Energy Demand (FRED)

Resource Life Cycle Cost Analysis

*When is rLCCA **NOT** the best tool?*

- When too broad or when other drivers require a specific solution
  - Permit items
  - Comprehensive energy modeling
    - Outputs of modeling can be inputs for rLCCA
  - Whole building analysis
    - With a rLCCA, one needs to focus in on specific systems that are being examined

Resource Life Cycle Cost Analysis

What can rLCCA evaluate?

rLCCA calculations are useful for:

- <u>rLCCA Strategy Options:</u> Compare options for a single strategy
- <u>rLCCA Bundled Strategies:</u> Examine, compare and/or rank bundles of design strategies
  - Useful if resources or items to be considered are limited

rLCCA Strategy Options:

Compare options for a single strategy

KCCF T12 Lighting Retrofit

Resource Life Cycle Cost Analysis (rLCCA) - Summary

King County

		Strategy Option 1 - Name	Strategy Option 2 - Name
		Replace magnetic T12s with high efficiency T8 fixtures	Replace magnetic T12s with high efficiency LED fixtures
Financials	**Simple Payback Period (No Financing)**	**5.6**	**5.3**
	Net Present Value (NPV) ($)	**$ 138,223**	**$ 136,561**
	Years Until Positive NPV (No Financing)	6.0	6.0
	Savings to Investment Ratio	2.42	2.00
	Internal Rate of Return (IRR) (%)	22.16%	18.70%
	Project Incremental Cost Above Baseline ($)	$ 97,227	$ 136,156
	Annual Equivalent Value ($)	$ 11,926	$ 11,782
	First Year Resource Savings ($)	$ 17,397	$ 25,733
	First Year Non-Resource Savings ($)	$ -	$ -
	Net Present Value (NPV) ($)	$ 138,223	$ 136,561
	Modified Internal Rate of Return (MIRR) (%)	4.99%	3.82%

NPV Sensitivity Analysis	Real Discount Rate			Real Discount Rate Adjustment Factor		
	1.0%	3.0%	5.0%	1.0%	3.0%	5.0%
	$ 138,223	$ 138,223	$ 138,223	$ 136,561	$ 136,561	$ 136,561

			Option 1	Option 2
First Year Costs	Utilitie	Electricity Use (kWh)	329,423	217,120
	Fu	Wastewater Cost ($)	$ -	$ -
		Vehicle Fuel Cost ($)	$ -	$ -
	GHG	Carbon Use (MTE)	210.30	138.61
		Carbon Cost ($)	$ -	$ -
First Year Savings	Utilitie	Electricity Use Savings (kWh)	217,598	329,901
	Fu	Wastewater Savings ($)	$ -	$ -
		Vehicle Fuel Savings ($)	$ -	$ -
	GHG	Carbon Use Savings (MTE)	138.91	210.61
		Carbon Savings ($)	$ -	$ -

rLCCA Bundled Strategies:

Compare various design strategies

Project Selection Summary Sheet by Feature and "Roll Up" LEED Category

LEED Category	Energy Savings (kWh)	Electric Cost Savings	Natural Gas Savings (Therm)	Natural Gas Cost Savings	Water Savings (CCF)	Water Cost Savings	Total Cost Savings	ECM Cost	Simple Payback (yr)	ROI	BCR
Water Efficiency	-	$ -	-	$ -	1,759	$ 6,359	$ 6,359	$ 52,040	8.2	52.29%	152.29%
Energy & Atmosphere	122,139	$ 9,807	250	$ 293	-	$ -	$ 10,100	$ 25,207	2.5	314.72%	414.72%
Sustainable Site	-	$ -	-	$ -	-	$ -	$ -	$ -	-		
Material & Resources	-	$ -	-	$ -	-	$ -	$ -	$ -	-		
Indoor Environmental Quality	-	$ -	-	$ -		$ -	$ -	$ -	-		
TOTALS	122,139	$ 9,807	250	$ 293		$ 6,359	$ 16,459	$ 77,247	4.7	164.89%	264.89%

Ref No.	x	LEED Category	LEED Credits	Description	Energy Savings (kWh)	Electric Cost Savings	Natural Gas Savings (Therm)	Natural Gas Cost Savings	Water Savings (CCF)	Water Cost Savings	Total Cost Savings	ECM Cost	Simple Payback (yr)	ROI	BCR	Life of the Measure (yr)
1		Water Efficiency	WEc1	Landscape Design	-	$ -	-	$ -	-	$ -	$ -	$ -	-	0.0%	0.0%	-
2	x	Water Efficiency	WEc2	Rainwater Harvesting	-	$ -	-	$ -	1,745	$ 6,307	$ 6,307	$ 51,375	8.15	53.0%	153.0%	20.0
3	x	Water Efficiency	WEc3	Low Flow Fixtures	-	$ -	-	$ -	14	$ 52	$ 52	$ 665	12.71	-2.0%	98.0%	20.0
4	x	Energy & Atmosphere	EAc1.1	Efficient Interior Lighting	47,194	$ 3,790	-	$ -	-	$ -	$ 3,790	$ 2,400	0.63	2217.8%	2317.8%	20.0
5	x	Energy & Atmosphere	EAc1.1	Reduced Exterior Lighting	57,417	$ 4,610	-	$ -	-	$ -	$ 4,610	$ 5,757	1.25	897.9%	997.9%	20.0
6	x	Energy & Atmosphere	EAc1.1	Efficient Service Hot water	-	$ -	141	$ 165	-	$ -	$ 165	$ 900	5.46	71.1%	171.1%	20.0
7	x	Energy & Atmosphere	EAc1.1	High performing HVAC System	17,528	$ 1,408	109	$ 128	-	$ -	$ 1,536	$ 16,150	10.52	-3.0%	97.0%	20.0
8		Energy & Atmosphere	EAc2	Renewable energy -PV 45kW	-	$ -	-	$ -	-	$ -	$ -	$ -	-	0.0%	0.0%	-
9		Energy & Atmosphere	EAc2	Renewable energy -PV 9 kW	-	$ -	-	$ -	-	$ -	$ -	$ -	-	0.0%	0.0%	-
10		Sustainable Site	SSc7	Urban Heat Island	-	$ -	-	$ -		$ -	$ -	$ -	-	0.0%	0.0%	-
					122,139	*$ 9,807*	*250*	*$ 293*	*1,759*	*$ 6,359*	*$ 16,459*	*$ 77,247*	4.7		-	

Resource Life Cycle Cost Analysis

When are other types of analyses needed?

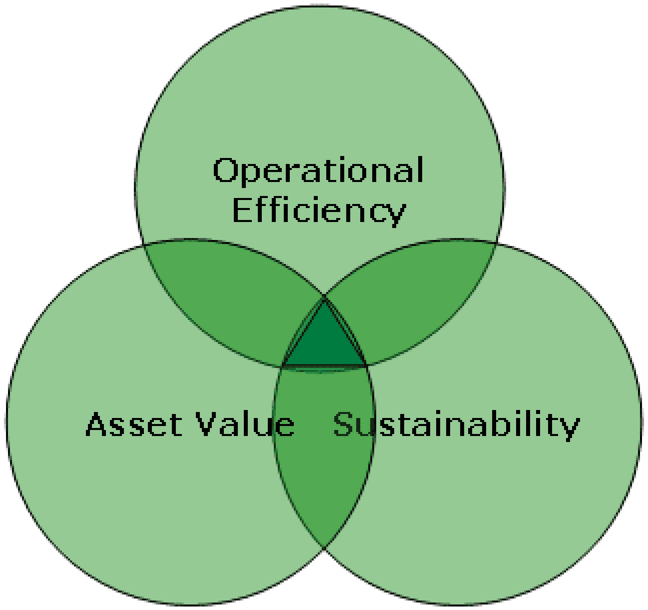
More complex analyses may be needed when:

- Looking at integrated design options for an entire building or facility
- Detailed energy modeling is needed
- For county energy and resource investments, rLCCA should fit your needs for determining whether a project makes economic sense

Resource Life Cycle Cost Analysis

Barriers when performing rLCCA

- Efficiency knowledge is limited
  - Can't analyze what you don't know
- Performance criteria come into play
  - Light levels
  - Unproven technologies
- "Perfect" information isn't available
  - Utility rates, installation costs
- Uncertain WHEN a rLCCA should be performed
- Engineers or designers are not open-minded
- Budget is not available to do anything



Part 2:

Guidance for performing a rLCCA

When should you do one? When you HAVE to do one. What types of equipment to consider?

King County rLCCA Tool

When MUST rLCCA be used

- Green Building: LEED-eligible and Scorecard projects (Ord. 17709)
- When equipment costs more than $250,000 (Ord. 16927)
  - Should consider for lower cost projects too! (over $25,000?)
- Fund to Reduce Energy Demand (FRED) County “Energy Loan” project proposals

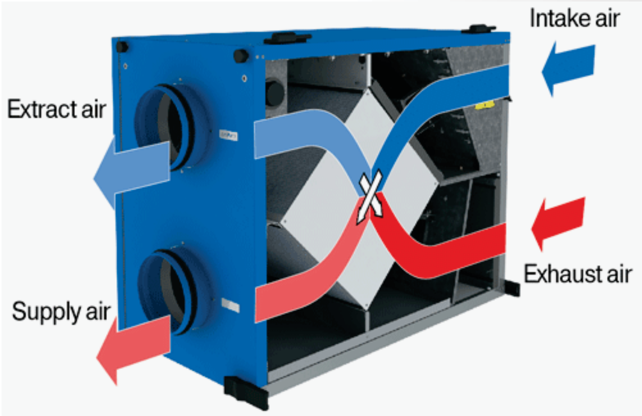
King County rLCCA Tool

Guidance for new construction projects: When to do an LCCA

Focus on three key elements on which to perform LCCA…

- Mechanical Systems
- Lighting
- Plumbing/Irrigation Systems

Examples of resource-consuming equipment and systems to analyze



Mechanical Systems

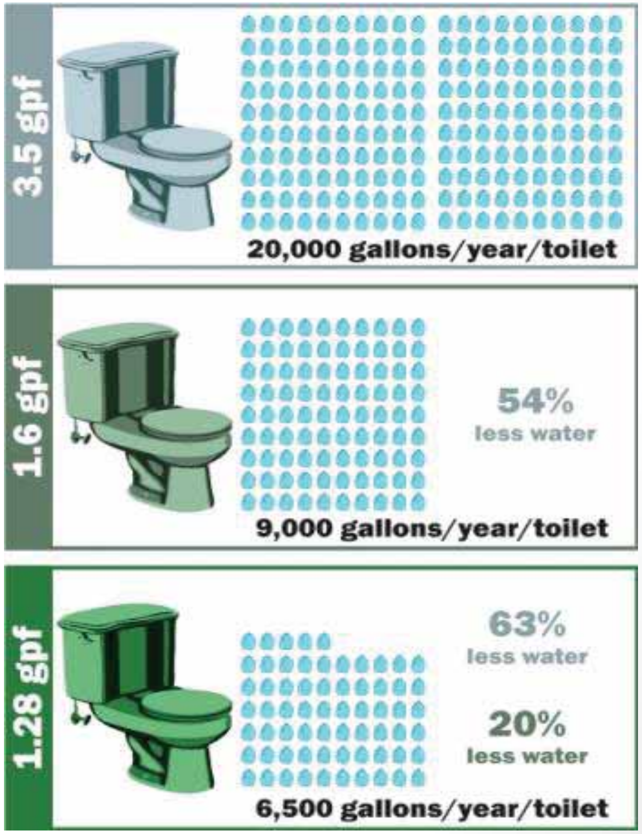
- Insulation above code requirements
- Heat recovery equipment
- High efficiency “condensing”:
  - Hot water boilers
  - Gas-fired heating units
  - Hot water tanks
- “VFDs” (Variable Frequency Drives) for motors and pumps
- “VRF” (Variable Refrigerant Flow) heating systems/heat pumps
- Cooling: High efficiency chillers or chilled beams

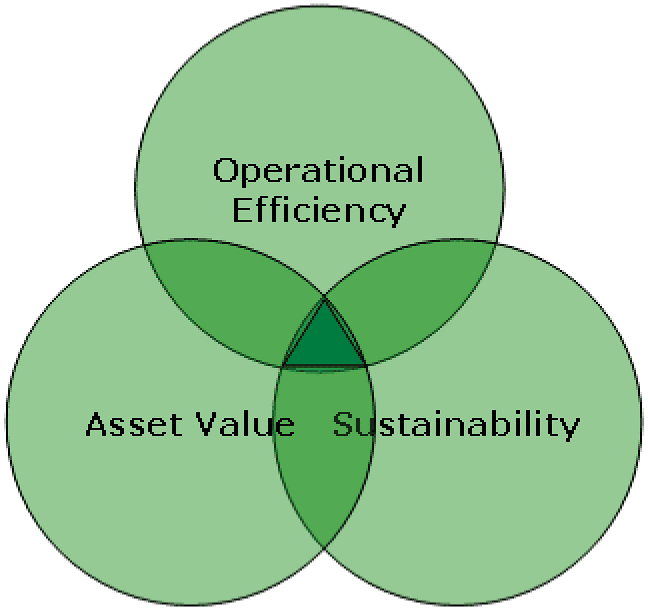
Lighting

- LED: (Light Emitting Diodes)
  - Quickly evolving and good for most locations
- T12 to T8/T5 linear fluorescent lamps
- Bi-level lights for stairwells and garages
- Controls
  - Daylight/photocell and occupancy or vacancy sensors
  - Dimming systems for non-peak/off hours

Plumbing & Irrigation Systems…and Vehicles

- Efficient toilets and urinals
  - 1.28 gallon per flush (gpf) toilets, one pint per flush urinals
- Water reuse
- Rainwater harvesting
- Drought-tolerant landscaping
- Vehicles:
  - Propane
  - Renewable Natural Gas (RNG)
  - Electric
  - Driver Training





Part 3:

Financial Terms and Definitions

KC LCCA Guide

Key Terms:

- **Simple Payback**
- Discount Rate
- Present Value
- **Net Present Value (NPV)**
- Savings to Investment Ratio (SIR)

Simple Payback

Simple Payback: *Project cost/first year savings (i.e. The time before the project is paid for, ignoring interest rates, inflation, etc.)*

Simple Payback: The length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the project, as longer payback periods are typically not desirable for investments.

…if a project costs $100,000 and is expected to save $20,000 in the first year, the payback period will be $100,000/$20,000, or five years. Two problems with the payback period method: It ignores any benefits that occur after the payback period and, therefore, does not measure the lifetime benefit/cost of the investment. Simple payback also ignores the time value of money.

Discount Rate

***Discount Rate**: The interest rate used in discounted cash flow analysis to determine the present value of future cash flows.*

Discount Rate: Also known as “Bank Rate”, the discount rate is the rate of interest which a central bank charges on the loans and advances to a commercial bank. It takes into account the time value of money (the idea that money available now is worth more than the same amount of money available in the future because it could be earning interest) and the risk or uncertainty of the anticipated future cash flows (which might be less than expected).

…Let's say you expect $1,000 dollars in one year's time. To determine the present value of this $1,000 (what it is worth to you today) you would need to discount it by a particular rate of interest. Assuming a discount rate of 10%, the $1,000 in a year's time would be the equivalent of $909.09 to you today (1000/[1.00 + 0.10]).

Nominal vs. real: the nominal discount rate includes inflation and the real discount rate does not.

Present Value

Present Value (PV): *The time value of money. The value of the savings over the "life" of the conservation action before it needs to be replaced, considering the value of where the money could have otherwise been invested (i.e. the discount rate)*

Present Value – PV: The current worth of a future sum of money or stream of cash flows given a specified rate of return. Future cash flows are discounted at the discount rate, and the higher the discount rate, the lower the present value of the future cash flows. Determining the appropriate discount rate is the key to properly valuing future cash flows, whether they be earnings or obligations.

…Receiving $1,000 now is worth more than $1,000 five years from now, because if you got the money now, you could invest it and receive an additional return over the five years.

Net Present Value

This is what Ordinance 16927 guides to use

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o$$

<u>Net Present Value (NPV</u>)*: Same as the Present Value, but taking into consideration the initial project cost.*

<u>Net Present Value:</u> The difference between the present value of cash inflows and the present value of cash outflows. NPV is used in capital budgeting to analyze the profitability of an investment or project.

NPV analysis is sensitive to the reliability of future cash inflows that an investment or project will yield.

…NPV compares the value of a dollar today to the value of that same dollar in the future, taking inflation and returns into account. If the NPV of a prospective project is positive, it should be accepted. However, if NPV is negative, the project should probably be rejected because cash flows will also be negative.

For example, if a retail clothing business wants to purchase an existing store, it would first estimate the future cash flows that store would generate, and then discount those cash flows into one lump-sum present value amount, say $565,000. If the owner of the store was willing to sell his business for less than $565,000, the purchasing company would likely accept the offer as it presents a positive NPV investment. Conversely, if the owner would not sell for less than $565,000, the purchaser would not buy the store, as the investment would present a negative NPV at that time and would, therefore, reduce the overall value of the clothing company.

Savings to Investment (SIR)

Savings to Investment Ratio (SIR): *The present value of the savings divided by the initial project cost (i.e. For every dollar invested in the project, it pays back xx times over the life of the project). Anything over 1 is good; The higher the number the better*

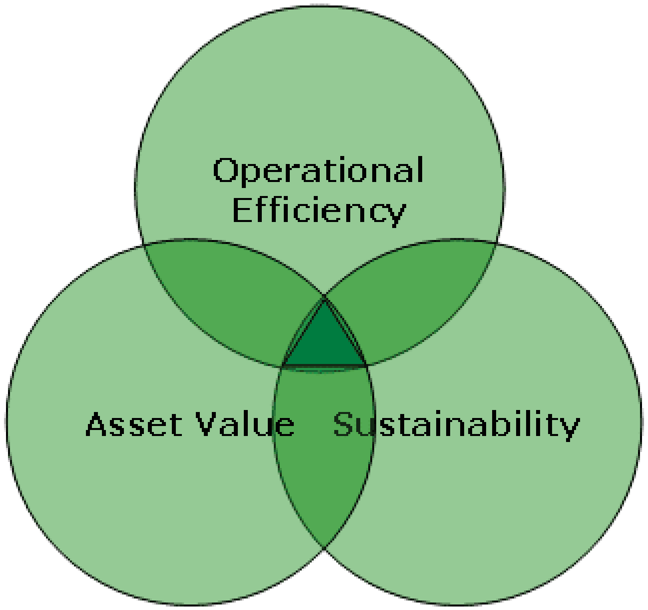
Internal Rate of Return

Internal Rate of Return (IRR): *Essentially the interest rate at which the project is paying back each year.*

Adjusted Internal Rate of Return (AIRR): *Same as IRR but assumes the money could have been invested at the discount rate.*

Internal Rate of Return: The discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero. Generally speaking, the higher a project's internal rate of return, the more desirable it is to undertake the project. As such, IRR can be used to rank several prospective projects a firm is considering. Assuming all other factors are equal among the various projects, the project with the highest IRR would probably be considered the best and undertaken first. IRR is sometimes referred to as "economic rate of return (ERR)."

…IRRs can also be compared against prevailing rates of return in the securities market. If a firm can't find any projects with IRRs greater than the returns that can be generated in the financial markets, it may simply choose to invest its retained earnings into the market.



Part 4:

rLCCA Calculator

rLCCA Calculator

- The rLCCA calculator is an excel tool that calculates Simple Payback, NPV and many of the other investment calculations detailed on the slides covered in the last section…

rLCCA Steps

Before you get to the Calculator:

- Are you looking at one or multiple scenarios?
- Perform energy modeling, if applicable (outside of today's scope)
- Research and gather data
  - Costs
  - Savings
  - Rebates
  - Maintenance assumptions – be sure they are REAL savings

Then use the calculator…

KC LCCA Calculator Guidance

Criteria	Default Value	Notes
Mechanical Systems	20 year life	
Lighting Systems	15 year life	Lamp Replacement: HID = 5 years, fluorescent = 7 years, LED = 15 years
Plumbing Systems	30 year life	

KC LCCA Calculator Input Screen

King County

Resource Life Cycle Cost Analysis (rLCCA) - Input

	Status Quo or Baseline Standard	
	Baseline Strategy Option - Name	
	Description	
	Initial Cost ($)	$ -
	Estimate Life of Strategy (Years)	
Utilities	Annual Electricity Use (kWh)	
Utilities	Electricity Rate ($ Per kWh)	
Utilities	Electricity Provider	Electricity (PSE)
Utilities	One Time Electrical Rebate ($)	
Utilities	Electricity Demand Rate ($ Per kW)	
GHG	Annual Carbon Use (MTE)	-
GHG	Carbon Value ($ per MTE)	
Maintenance	Annual Maintenance ($)	
Maintenance	One Time Equip. Replacement Cost ($)	
Maintenance	One Time Equip. Replacement (Year X)	
Maintenance	Periodic Equip. Replacement Cost ($)	
Maintenance	Per. Equip. Replacement (every # of years)	
	Last Year of Equip Expenditure	
	Est. Salvage/Resale Value ($)	$ -

	Strategy Option 1	
	Strategy Option 1 - Name	
	Description	
	Initial Cost ($)	
	Estimate Life of Strategy (Years)	-
Utilities	Annual Electricity Use (kWh)	
Utilities	One Time Electrical Rebate ($)	
Utilities	Monthly Electricity Demand Savings (kW)	
GHG	Annual Carbon Use (MTE)	-
Maintenance	Annual Maintenance ($)	$ -
Maintenance	One Time Equip. Replacement Cost ($)	
Maintenance	One Time Equip. Replacement (Year X)	-
Maintenance	Periodic Equip. Replacement Cost ($)	$ -
Maintenance	Per. Equip. Replacement (every # of years)	-
	Last Year of Equip Expenditure	
	Est. Salvage/Resale Value ($)	$ -
Loan	Term (not to exceed Estimated Life)	
Loan	Annual Debt Payment ($)	$ -
	Other Non-Financial Benefits (List below)	

KC LCCA Calculator Output Screen

King County Aquatic Center Lighting Retrofit

Resource Life Cycle Cost Analysis (rLCCA) - Summary

King County

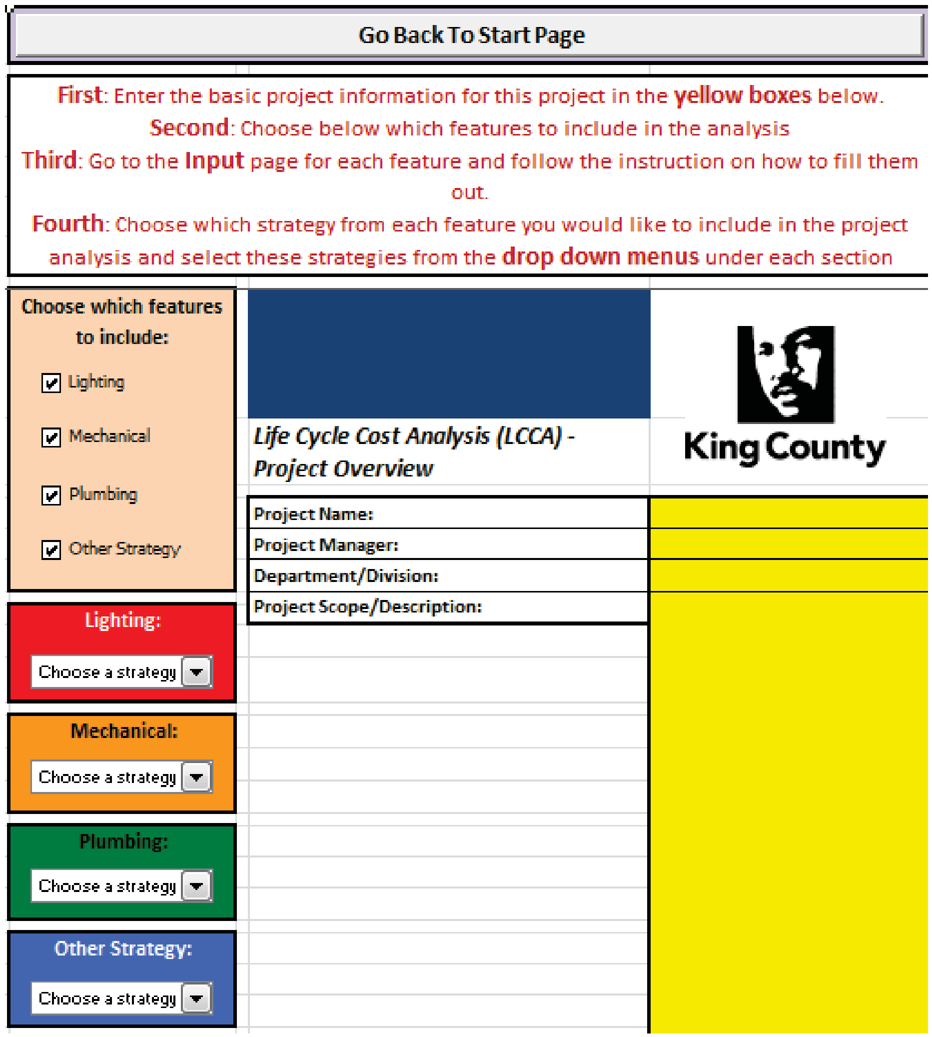
	King County Aquatic Center Lighting Retrofit
	lighting retrofit: T-8 to LED and outdoors to LED
Simple Payback Period (No Financing)	**3.9**
Net Present Value (NPV) ($)	**$ 42,734**
Years Until Positive NPV (No Financing)	5.0
Savings to Investment Ratio	2.96
Internal Rate of Return (IRR) (%)	27.43%
Project Incremental Cost Above Baseline ($	$ 21,791
Annual Equivalent Value ($)	$ 3,687
First Year Resource Savings ($)	$ 5,532
First Year Non-Resource Savings ($)	$ -
Net Present Value (NPV) ($)	$ 42,734
Modified Internal Rate of Return (MIRR) (%)	5.71%

Financials

NPV Sensitivity Analysis	Real Discount Rate		
	1.0%	3.0%	5.0%
	$ 42,734	$ 42,734	$ 42,734

First Year Co	F. Utili	Electricity Use (kWh)	33,745
		Wastewater Cost ($)	$ -
		Vehicle Fuel Cost ($)	$ -
	GHG	Carbon Use (MTE)	21.54
		Carbon Cost ($)	$ -
First Year Sa	F. Utili	Electricity Use Savings (kWh)	61,471
		Wastewater Savings ($)	$ -
		Vehicle Fuel Savings ($)	$ -
	GHG	Carbon Use Savings (MTE)	39.24
		Carbon Savings ($)	$ -

Independently Look at Different Elements

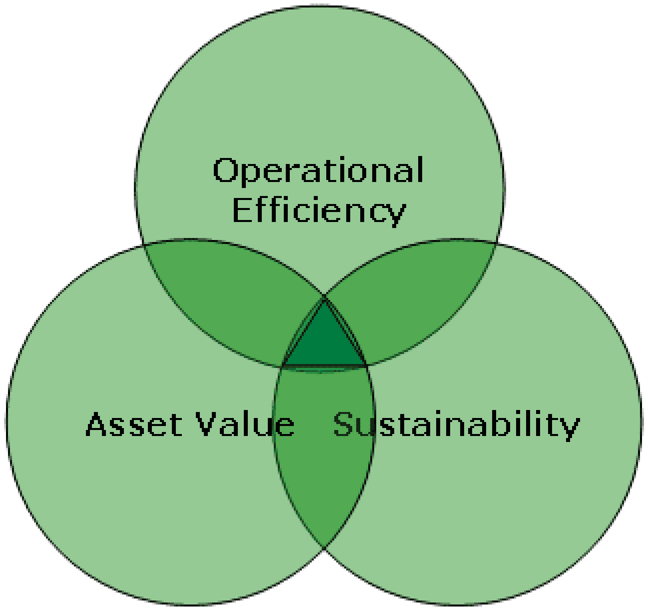


Let’s use the calculator…

Review Results

Which system/option do you choose?

- Look for highest NPV!



Part 2:

Resources, Summary and Q&A

Resources & Assistance

People

- DNRP Energy Manager
  David Broustis
  206-477-4544
  david.broustis@kingcounty.gov

- FMD Energy Manager
  Ben Rupert
  206-296-0690
  ben.rupert@kingcounty.gov

- Green Building Team:
  Nori Catabay
  206-477-5269
  nori.catabay@kingcounty.gov

Resources & Assistance

References

KC LCCA Tools
http://your.kingcounty.gov/solidwaste/greenbuilding/technical-resources.asp

RS Means
KC internal library or subscription

Whole Building Design Guide: HVAC Optimization
http://www.wbdg.org/resources/tqc.php

State of Alaska LCCA Handbook
http://www.eed.state.ak.us/facilities/publications/lccahandbook1999.pdf