LIFE CYCLE COST ANALYSIS & WASHINGTON STATE PUBLIC PROJECTS

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Recent LCCA Policy Development in Washington State

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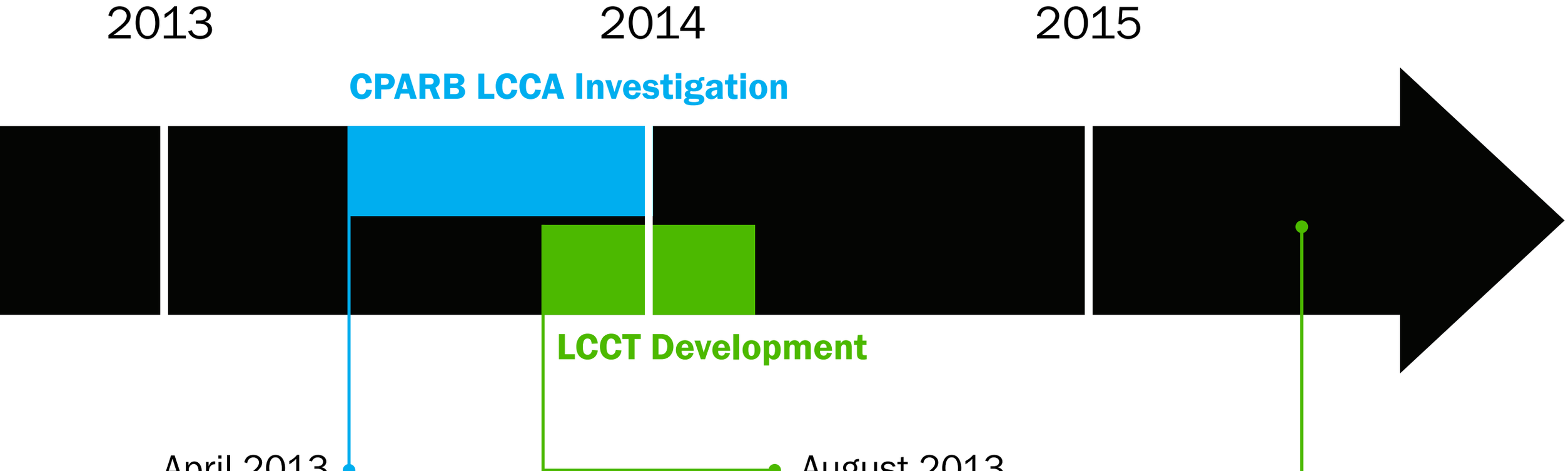
Policy Development Timeline



April 2013

Substitute House Bill 1466

CPARB to investigate LCCA and energy efficiency for D/B procurement

August 2013

Executive Order 13-03

Life Cycle and Operating Costs in Public Works

July 2015

Life Cycle Costing Tool (LCCT)

required for all new design projects

SHB 1466

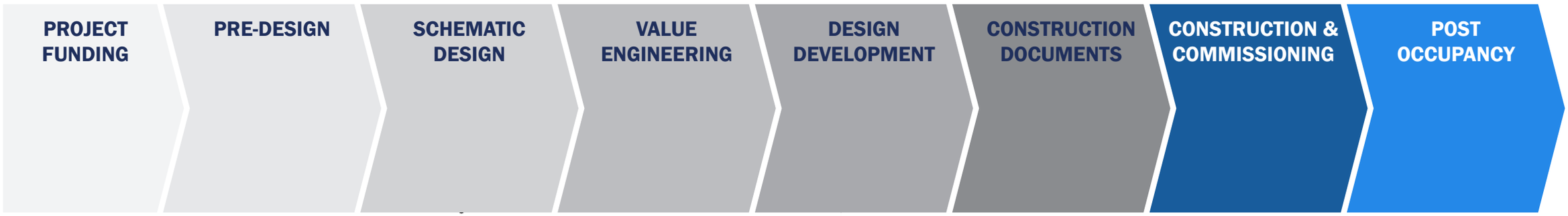
- Owners encouraged to include energy performance goals and validation requirements in RFPs

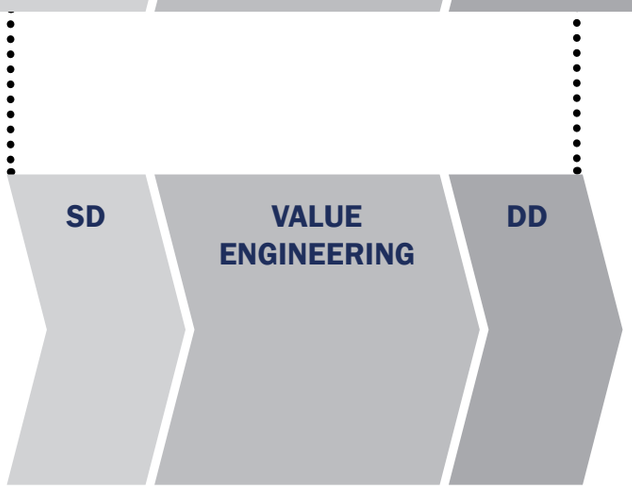
Executive Order 13-03

- LCCA - primary consideration for building design
- LCCA experience - primary consideration for firm selection (D-B-B, GC/CM, D-B)
- E.O. 13-03 - effective in 2015-2017 biennium, projects over $5 million
- Waiver is an option

Process

CPARB LCCA GUIDELINES





ELCCA PROCESS

CPARB LCCA Guidelines

PROJECT FUNDING

Evaluate development options

Identify high level performance goals

PRE-DESIGN

Establish OPR

Planning level evaluations of life cycle costs.

SCHEMATIC DESIGN

LCCA work plan

Identify systems for LCCT analysis.

“Simple Box” energy & water use modeling

VALUE ENGINEERING

Provide LCCA report to VE team

VE recommendations should optimize life cycle costs & functionality

DESIGN DEVELOPMENT

Utilize LCCA to select specific systems

CxA document set review

CONSTRUCTION DOCUMENTS

Performance Evaluation Plan (PEP)

Commissioning Plan

CxA document set review

CONSTRUCTION & COMMISSIONING

CxA coordination & performance verification

Systems start up & testing

Initial personnel training

POST OCCUPANCY

Monthly systems evaluation meetings

Track performance against OPR & PEP

On-going personnel training

2014 OFM Predesign Manual

Life Cycle Cost Analysis

Executive Order 13-03 requires agencies to perform a Life Cycle Cost Analysis (LCCA) for construction of buildings with an area of 5,000 square feet or more. In addition, Section 7039 of the 2013-15 Capital Budget (Chapter 19, Laws of 2013, Second Special Session) requires agencies to develop life cycle costs for any project valued more than $5 million. These directives ensure that project design teams consider the total cost of owning and operating the building and/or specific system components. The results of the life cycle cost analysis shall be a primary consideration in the selection of a system or building design.

Agencies should coordinate with their OFM Capital Budget Analyst to verify LCCA requirements pertaining to the predesign submittal. OFM has created a Life Cycle Cost Tool (LCCT) to be used for the analysis; the LCCT with instructions can be found at http://ofm.wa.gov/budget/forms.asp.

Building Commissioning (Cx) and Enhanced Commissioning (ECx)

As noted by DES on the Building Commissioning web page, "Commissioning is the process of ensuring that systems are designed, installed, functionally tested and are capable of being operated and maintained to perform according to the design intent." Depending on the complexity of the building or system design, the commissioning agent should be integral to the project team early in the design phase, utilized during construction, and retained through operational training.

The energy and resource conservation benefits of installing high-performing building systems come with the need to provide better training to building operators. Well-trained facility staff will result in reduced utility and operating costs, fewer occupant complaints, and a healthier work environment for tenants. As stated in the Life Cycle Cost Analysis and Energy Efficiency Report written by the Capital Projects Advisory Review Board in December 2013, "A longer post occupancy phase, commonly referred to as enhanced commissioning, is critical to achieve the long-term desired performance outcomes and optimal building operation." Agencies should consider some form of enhanced commissioning services for monitoring building energy performance and additional training to facility staff, as needed, to ensure the building systems continue to operate as originally designed.

LCCT BETA TEST

EDMONDS COMMUNITY COLLEGE
SET BUILDING

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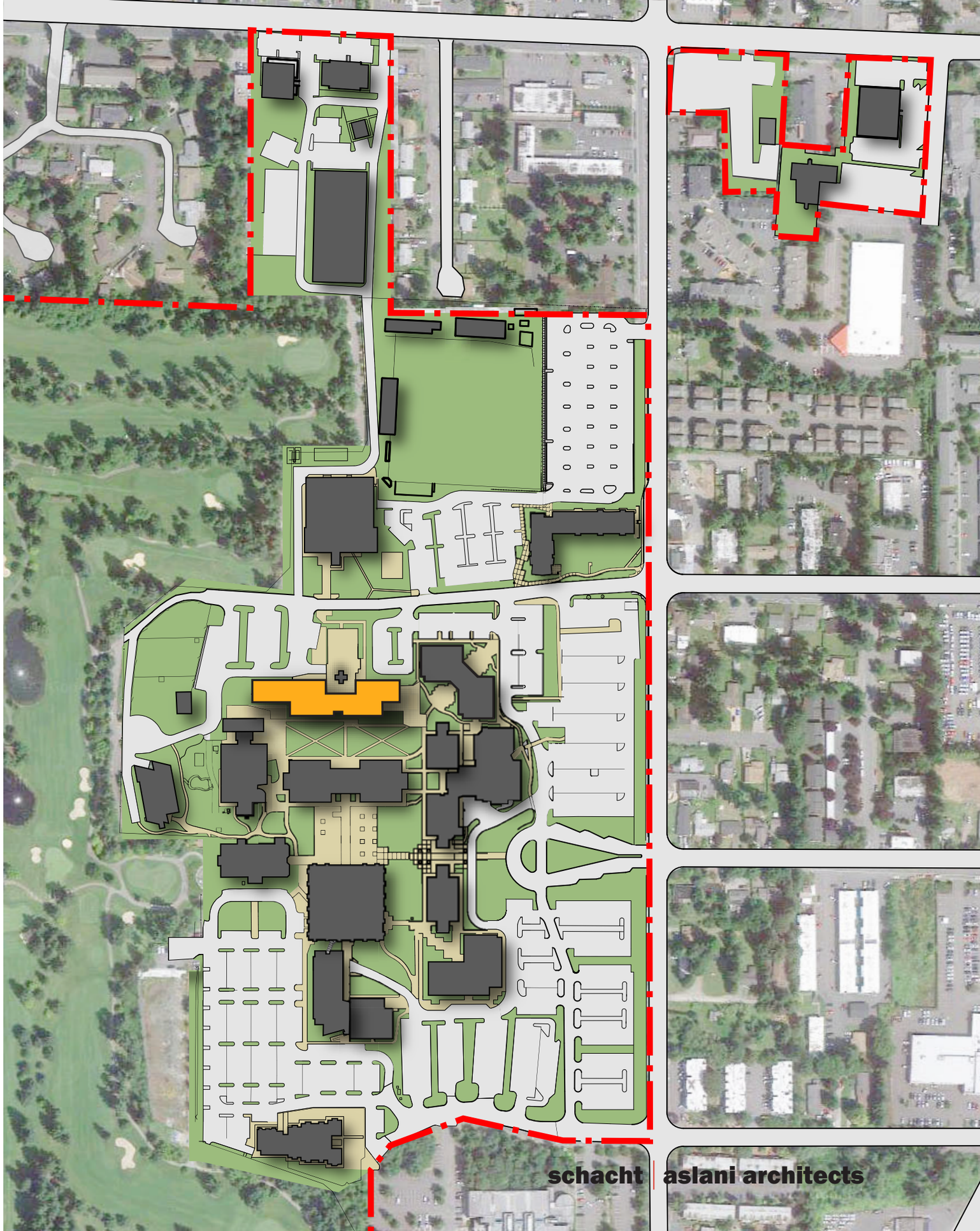
SET BUILDING

EDMONDS COMMUNITY COLLEGE



Commissioning

- Pre-Design - initiated OPR
- Enhanced Commissioning (1 yr. post occupancy)

Owner's Project Requirements

HIGH PRIORITY

- Achieve LEED Silver
- Target Energy Use Index: 60. Mean Technical College Building EUI: 141.4
- Minimize initial cost: lowest 30 yr. net present value cost

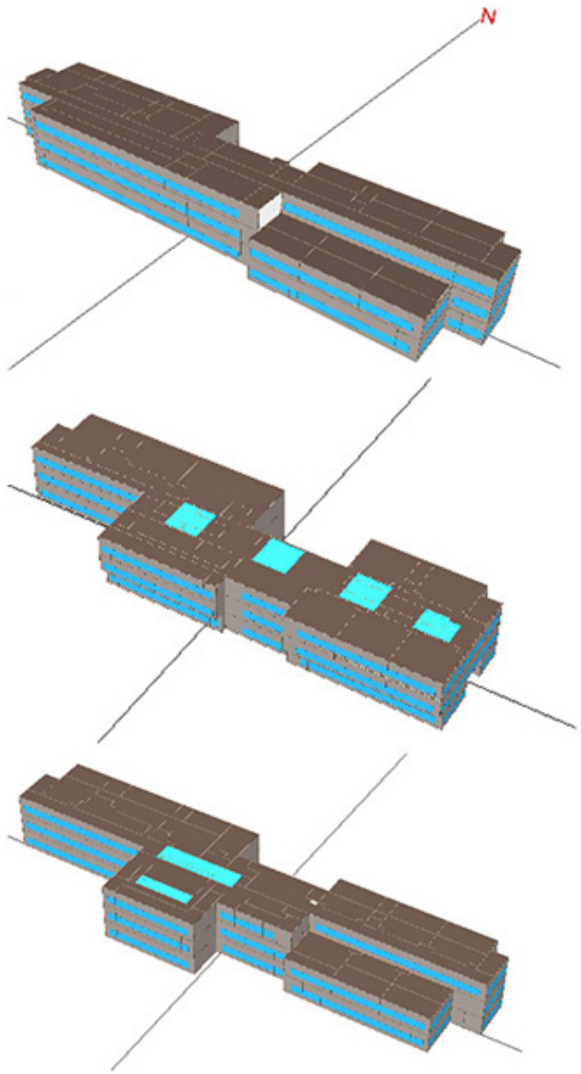
LOW PRIORITY

- Familiar or similar systems: avoid installation of untested systems.
- Natural ventilation: occupants have immediate control of their environment through operable windows.

(2014, September 1). Retrieved February 12, 2015, from https://portfoliomanager.energystar.gov/pdf/reference/US National Median Table.pdf

Shoebox Energy Models

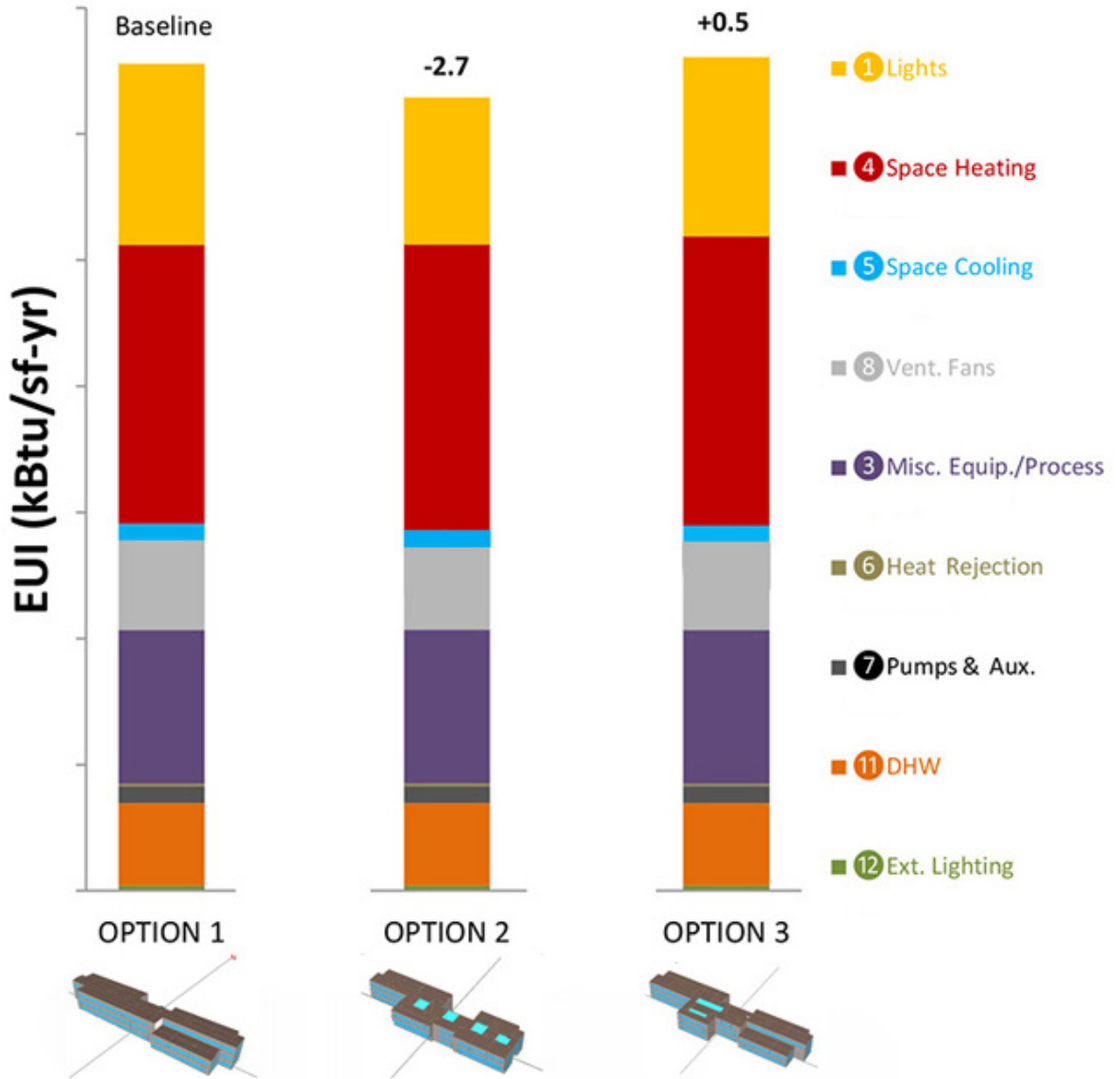
Early massing studies to evaluate daylighting performance and impact upon building energy use index



Option 1 - Baseline/Predesign

Option 2 - Whole Atrium

Option 3 - Partial Atrium



ELCCA Results

Cost Summary

SUMMARY TABLE

Alternate Number	Description	Incremental Cost ($)	Maint. Cost ($)	Annual Fuel Cost				Total 50 Yr. Life Cycle Cost ($)	Energy Usage Index (kBTU / sq. ft.)	Estimated LEED EAC1
				Electric ($)	Gas ($)	Total ($)	Savings ($)			
1	BASELINE MECHANICAL SYSTEM	$0	$32,000	$60,147	$22,116	$82,263	N/A	$11,691,246	81	18%
2	ADD HEAT RECOVERY CHILLER	$156,400	$34,400	$64,482	$14,730	$79,212	$3,051	$12,052,249	72	26%
3A	ADD CHILLED BEAMS IN LABS	$107,180	$33,000	$65,651	$15,488	$81,139	$1,124	$11,895,099	73	26%
3B	ADD CHILLED BEAMS IN CLASSROOMS	$2,455	$34,000	$60,167	$16,606	$76,773	$5,490	$11,544,396	70	28%
3C	ADD CHILLED BEAMS IN OFFICES	$49,200	$33,000	$61,494	$20,825	$82,319	-$56	$11,824,775	79	19%
4	DUAL CORE HEAT RECOVERY	$175,000	$36,800	$60,082	$21,731	$81,813	$450	$12,199,516	80	18%
5	DISPLACEMENT VENT. IN CLASSROOMS	$137,600	$32,000	$56,892	$24,447	$81,339	$924	$11,862,195	83	16%
6	LAB AIR QUALITY MONITORING	$69,900	$40,000	$60,150	$20,724	$80,874	$1,389	$12,185,006	78	21%
7A	NATURAL VENT. IN OFFICES & COMMONS	-$74,650	$33,500	$58,725	$20,298	$79,023	$3,240	$11,564,027	76	22%
7B	NATURAL VENTILATION IN CLASSROOMS	-$245,450	$35,000	$55,494	$15,044	$70,538	$11,725	$11,050,749	64	35%
7C	NATURAL VENTILATION IN COMMONS	$18,170	$33,000	$60,088	$21,418	$81,506	$757	$11,764,638	79	19%
HP	HIGH PERFORMANCE OPT (Alt 3B + Alt 7A)	-$72,195	$35,500	$59,014	$14,732	$73,746	$8,517	$11,440,039	66	32%
RE	RENEWABLE OPTION - PHOTOVOLTAIC	$96,600	$35,500	$58,252	$22,116	$80,368	$1,895	$11,807,355	80	N/A
LEED	LEED Baseline	N/A	N/A	N/A	N/A	N/A	N/A	N/A	98	

WA State LCCT

<- Primary Filter (Requires Level 1)

Office of Financial Management
Olympia, Washington - Version: 2014-C
Life Cycle Cost Analysis Tool

Alternative 1 Input Page

Open Primary Filter and Click OK to Re-filter

- ○ Manual Special Selection Only (Requires Refilter)
- ◉ Show Baseline Fields and Entered Units (Requires Refilter)
- ○ Show Differences Between Alternative and Baseline (Req. Refilter)

Total Building Annual Utility Analysis	$ 108,704	Water (CCF)	Electricity (KWH)	Natural Gas (Therms)	Diesel/#2 (Gallons)	LPG (Gallons)	District Heat (mmBTU)	1st Year Bldg. Maintenance
Annual Utility Bill [$]		$ 900	$ 85,688	$ 22,116	$ -	$ -	$ -	$ 31,204
Annual Utility Consumption Not Entered Below			751,838	22,116	-	-	-	Sum of Below
Sum of Annual Utility Consumption Below		81	319,260	-	-	-	-	$ 33,674
Total Annual Utility Consumption		81	1,071,098	22,116	-	-	-	Total Maint.
Annual Utility Bill ÷ Total Utility Consumption		$ 11.15	$ 0.08	$ 1.00	$ -	$ -	$ -	$ 64,878

SHOW	Uniformat II Elemental Classification for Buildings (Building Component List)		REF	# of Units	Useful Life (Yrs.)	Installed Cost ($/Unit)	1st Year Maintenance Cost ($/Unit)	Total Component Installed Cost ($'s)	Annual Water (CCF/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)	Annual Diesel/#2 (Gal/Unit)	Annual LPG Gal/Unit	Annual Dist. Heat (KBTU/Unit)	Remaining Life (Years) of Existing Component
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2								Entries Below for Component Specific Utility Analysis (Consumption per Unit) - Total Building						
	Match Baseline: Filter to Select All & Drag Copy O14:S14 & U14:AG14							$26,707,647							
	A	**Substructure**													
	A10	**Foundations**													
	A101001	Wall Foundations	1	94	75	$652.96		$ 61,378							
	A101002	Column Foundations And Pile Caps	1	63	75	$658.47		$ 41,484							
	A102005	Raft Foundations	1	761	75	$576.90		$ 439,020							
	A103001	Standard Slab On Grade	1	331	75	$495.15		$ 163,894							
	A103005	Pits And Bases	1	1	75	$11,025.00		$ 11,025							
	A103006	Foundation Drainage	1	825	75	$18.22		$ 15,029							
	A103098	Insulation at slab perimeter	1	825	75	$5.77		$ 4,764							
	A20	**Basement Construction**													
	A202001	Basement Wall Construction	1	2740	75	$38.00		$ 104,120							
	B	**Shell**													
	B10	**Superstructure**													
	B101001	Structural Frame	1	334	75	$3,503.81		$ 1,170,271							
	B101003	Floor Decks And Slabs	1	44985	75	$9.75		$ 438,491							
	B101098	Pads and curbs	1	1	75	$7,350.00		$ 7,350							
	B101097	Seismic joints	1	144	75	$75.60		$ 10,886							
	B102011	Structural Frame	1	115	75	$3,340.72		$ 384,183							
	B102003	Roof Decks And Slabs	1	25137	75	$5.50		$ 138,344							
	B102098	Pads and curbs	1	1	75	$11,000.00		$ 11,000							
	B20	**Exterior Enclosure**													
	B201001	Exterior Closure	1	29856	55	$25.00		$ 746,474							
	B201002	Exterior Wall Backup Construction	1	29856	55	$8.77		$ 261,762							

LCCT IS A FINANCIAL COST MODEL

- Captures initial, replacement, O&M, & the social cost of carbon
- Requires energy modeling to capture full cost of architectural components

LCCT Executive Summary

Life Cycle Cost Analysis			BEST
Alternative	Baseline	Alt. 1	Alt. 2
1st Construction Costs	$ 30,160,607	$ 30,771,346	$ 30,185,508
PV of Capital Costs	$ 43,407,662	$ 44,118,866	$ 43,491,357
PV of Maintenance Costs	$ 3,369,322	$ 3,323,196	$ 3,547,375
PV of Utility Costs	$ 5,203,073	$ 5,185,738	$ 4,472,626
Total Life Cycle Cost (LCC)	**$ 51,980,057**	**$ 52,627,800**	**$ 51,511,358**
Net Present Savings (NPS)	**N/A**	**$ (647,743)**	**$ 468,699**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

Societal Life Cycle Cost			BEST
Alternative	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	13,745	13,745	11,210
Present Social Cost of Carbon (SCC)	$ 1,055,300	$ 1,055,300	$ 860,732
Total LCC with SCC	**$ 53,035,357**	**$ 53,683,100**	**$ 52,372,090**
NPS with SCC	**N/A**	**$ (647,743)**	**$ 663,267**

Baseline Short Description
Code Minimum Building w/VAV HVAC
Alternative 1 Short Description
TPO Roof, Low Flow Fixtures, Recommended Curtain Wall and Window System w/VAV HVAC
Alternative 2 Short Description
Code Minimum Building w/High Performance HVAC + LED Lighting

LCCT Component Group Comparison

BASELINE VS. ALTERNATE 1

Scenario	Component	Present Value of Capital Costs	Present Value of Maintenance Costs	Present Value of Utility Costs	Total Present Value of Component or Group	Net Present Savings
Baseline	Hot Mop Roof	$ 466,526	$ 91,942	$ -	$ 558,469	
Alt. 1	TPO Roof	$ 670,620	$ 45,816	$ -	$ 716,436	$ (157,968)
Baseline	Code Fixtures	$ 205,152	$ -	$ 52,809	$ 257,961	
Alt. 1	Low Flow Fixtures	$ 208,176	$ -	$ 35,474	$ 243,650	$ 14,310
Baseline	Carpet + Polished Concrete	$ 1,599,231	$ -	$ -	$ 1,599,231	
Alt. 1	Carpet + Tile & Terrazzo	$ 1,710,402	$ -	$ -	$ 1,710,402	$ (111,171)
Baseline	Base Architectual	$ 1,994,277	$ -	$ -	$ 1,994,277	
Alt. 1	Alt. Architectual	$ 2,387,192	$ -	$ -	$ 2,387,192	$ (392,915)
				Total Net Present Savings		**$ (647,743)**

ELCCA vs LCCT

	ELCCA		LCCT	
Energy System Design Option	ELCCA - Life Cycle Cost	ELCCA - Net Present Savings	LCCT - Life Cycle Cost	LCCT - Net Present Savings
Primary Building Base Design	$11,691,246	N/A	$12,321,934	N/A
Alt. 2 Heat Recovory Chiller	$12,052,249	-$361,003	$12,470,341	-$148,408
Alt. 3A Chilled Beams Serving Labs	$11,895,099	-$203,853	$12,379,043	-$57,110
Alt . 3B Chilled Beams Serving Classrooms	$11,544,396	$146,850	$11,994,686	$327,248
Alt 3C Chilled Beams Serving Offices	$11,824,775	-$133,529	$12,406,448	-$84,514
Alt 4 Dual Core Heat Recovery	$12,199,516	-$508,270	$12,861,701	-$539,767
Alt. 5 - Low Wall Displacement System	$11,862,195	-$170,949	$12,588,195	-$266,261
Alt 6 - Lab Air Quality Monitoring	$12,185,006	-$493,760	$12,797,931	-$475,997
Alt 7A Natural Ventilation in Offices	$11,676,296	$14,950	$12,264,472	$57,462
Alt 7B _ Natural Ventilaton in Classrooms	$11,316,112	$375,134	$11,771,350	$550,584
Alt 7C - Natural Ventilation in Commons	$11,764,638	-$73,392	$12,377,665	-$55,731
High Performance Option Alt 3B + Alt 7A	$11,580,697	$110,549	$11,979,026	$342,907
Renewable - Solar Option	$11,807,355	-$116,109	$12,417,809	-$95,875

DIFFERENCES:

- Residual value methodology
- Discount rate
- Fuel and maintenance escalation rates

Lessons Learned

THE LCCT TOOL

- Standardizes financial assumptions and calculations
- Produces clear ‘executive summary reports’ comparing alternate designs
- Allows quick life cycle cost analysis of individual components
- Accounts for the societal cost of carbon
- Energy and envelope systems are still the greatest opportunity to save money

DATA IS CHALLENGING

- Available data and LCCA results are tied to project development
- Quality of LCCA improves as the design progresses
- O&M & useful life data requires a consistent, accessible source

Opportunities

IMPLEMENTATION

- Encourages early evaluation and collaboration between the A/E team, owner, commissioning agent & contractor
- Post-Occupancy commissioning allows for comprehensive follow through

Barriers and Constraints

- Programmatic requirements
- Existing infrastructure & limited operational budgets
- Staff resources & institutional knowledge
- Training programs