EETD Lunchtime Seminar

Trials and Tribulations of Providing Energy Modeling Services to the Green Building Industry

Presented by:

Ellen Franconi, PhD, LEED AP
Architectural Energy Corporation
Boulder, Colorado

Energy Analysis: Research vs. Design

- Research

"In a sense, it's like turning off the world for a year."

- Design Applications

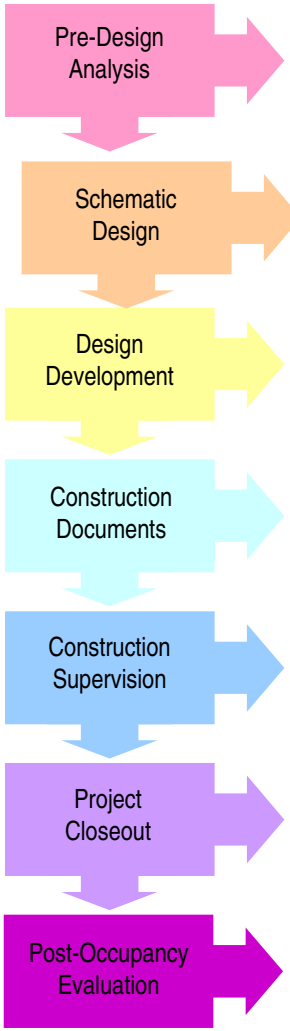
"The budget for that task was $3,500 and now we're at $8,700 …..well that's good."

"Baselines, baselines, baselines ....."

"If you can get a job with a good company do - just stay away from design work."

"LEED has ruined my job."

Architectural Design Process



Architectural Energy Corporation

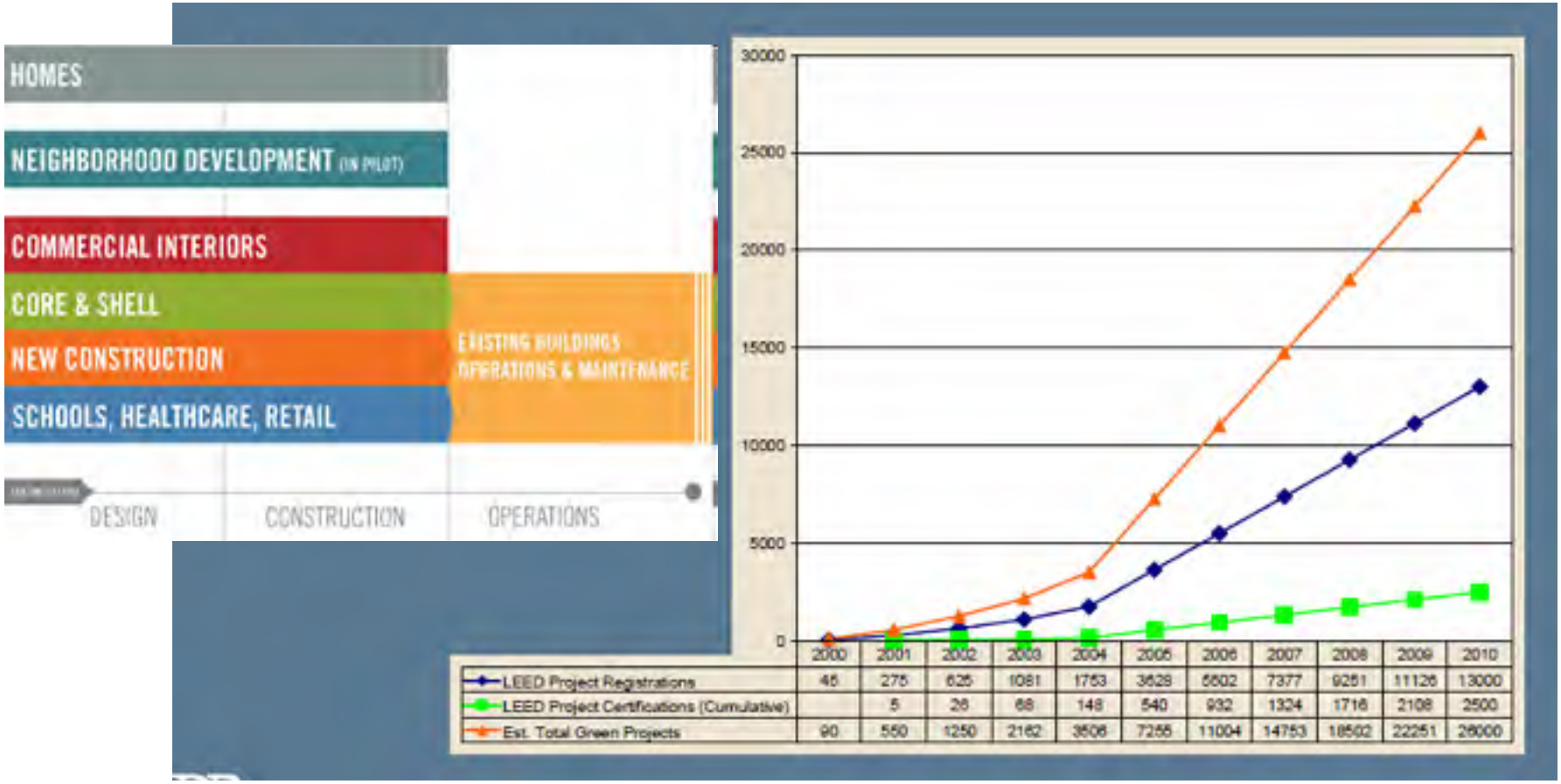
- **Sustainable Design Services**
  - **LEED**
  - **Energy Analysis**
  - **Daylighting Analysis**
  - **Commissioning**
  - **Building Energy Evaluation Team**
- **Residential Services**
- **Building Science**
- **Codes & Standards**
- **Program Management**
- **Products and Software**

Market Driver – USGBC LEED

Education & Accreditation

LEED workshop attendance:	94,916
LEED Accredited Professionals:	81,155
Greenbuild Attendees 2008:	28,224
Greenbuild Attendees 2007:	22,835

LEED	New Construction
Registered Projects	11,597
Certified Projects	1,600



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LEED Project Registrations	45	275	625	1081	1753	3629	5602	7377	9251	11126	13000
LEED Project Certifications (Cumulative)		5	26	68	148	540	932	1324	1716	2108	2500
Est. Total Green Projects	90	550	1250	2162	3506	7255	11004	14753	18502	22251	26000

Base Knowledge Required for Energy Modeling

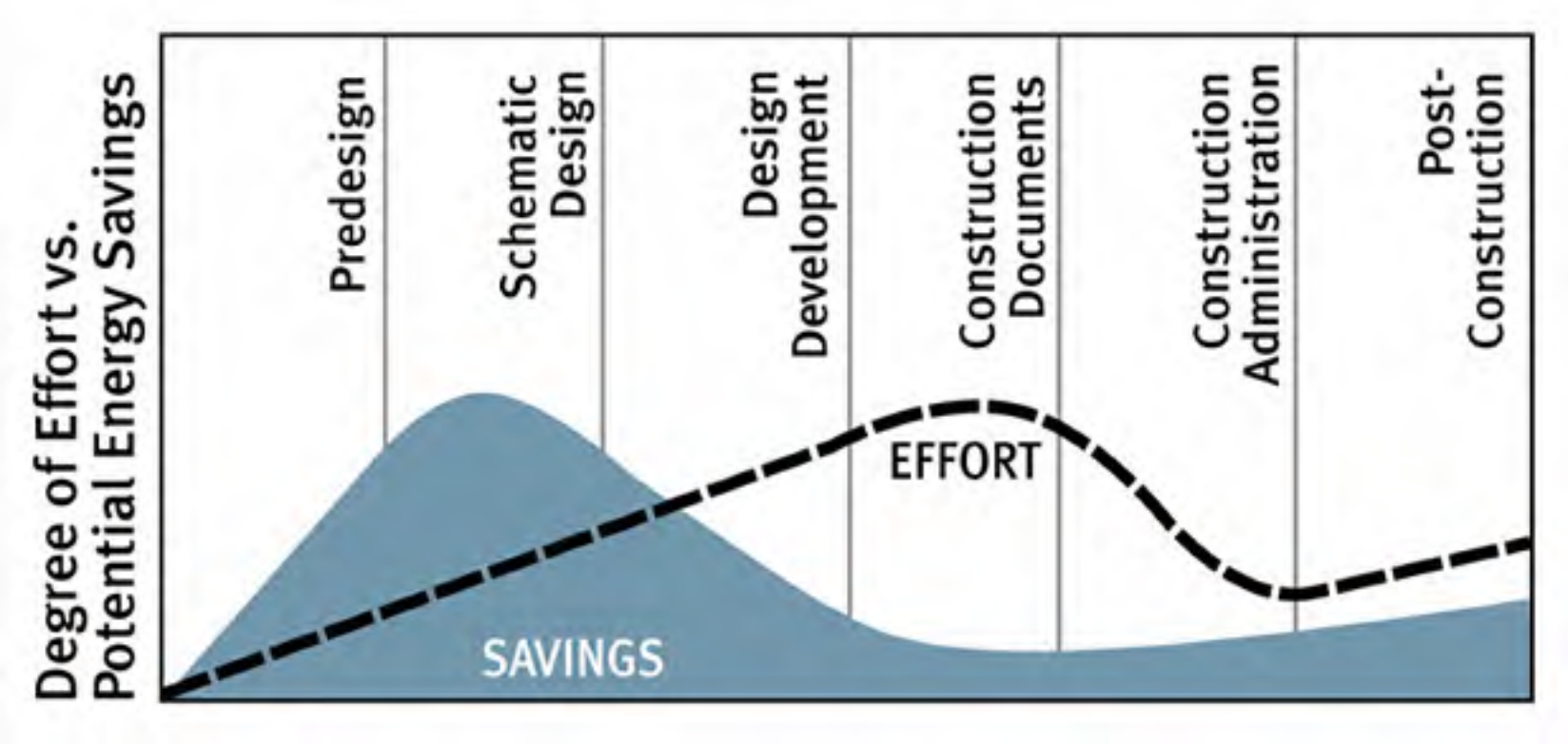
Background Knowledge

- Engineering
- Building Science
- Renewable Energy Systems
- Building Standards and Guidelines
- Climate Specific Strategies
- State-of-the-Art Technologies
- Utility Rate Structures
- Economic Analysis

Computer Software Knowledge

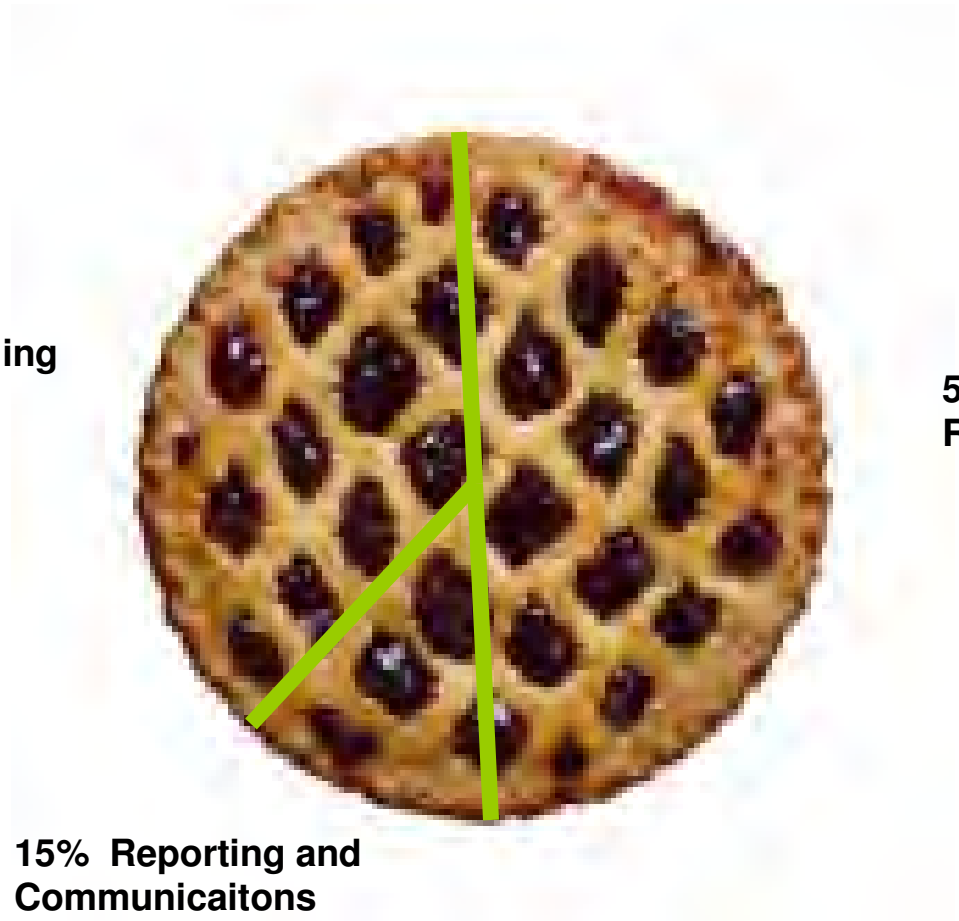
- Energy Analysis Calculation Engine (DOE-2, EnergyPlus)
- User Interface (eQUEST, Design Builder)
- Pre- and Post-Processing Tools

Tight Schedules



Green Building Analysis Work Allocation

35% Value Energy Modeling



50% Baselines and Requirements

15% Reporting and Communicaitons

Structure for Delivering Services

Core Modeling, Project Management, Specialized Expertise

Summary of GBI Market

- Tight Schedules
- Limited Budgets
- Requires Highly Trained Work Force
- Submittal Requirements Detract from Value Modeling
- High Burn Out Rate

Motivation

- GBI Growth => Challenges
- AEC (EMF) provides consultant perspective
- LBNL provides research perspective

Presentation Organization

- Sustainable Design Assistance
- Energy Modeling
- “Green Building” Requirements
- Opportunities
- Discussion

Sustainable Design Assistance

Integrating Sustainable Design Services
into the Architectural Design Process

Evolution of E2ASE

- AIA Research
- SERI/NREL

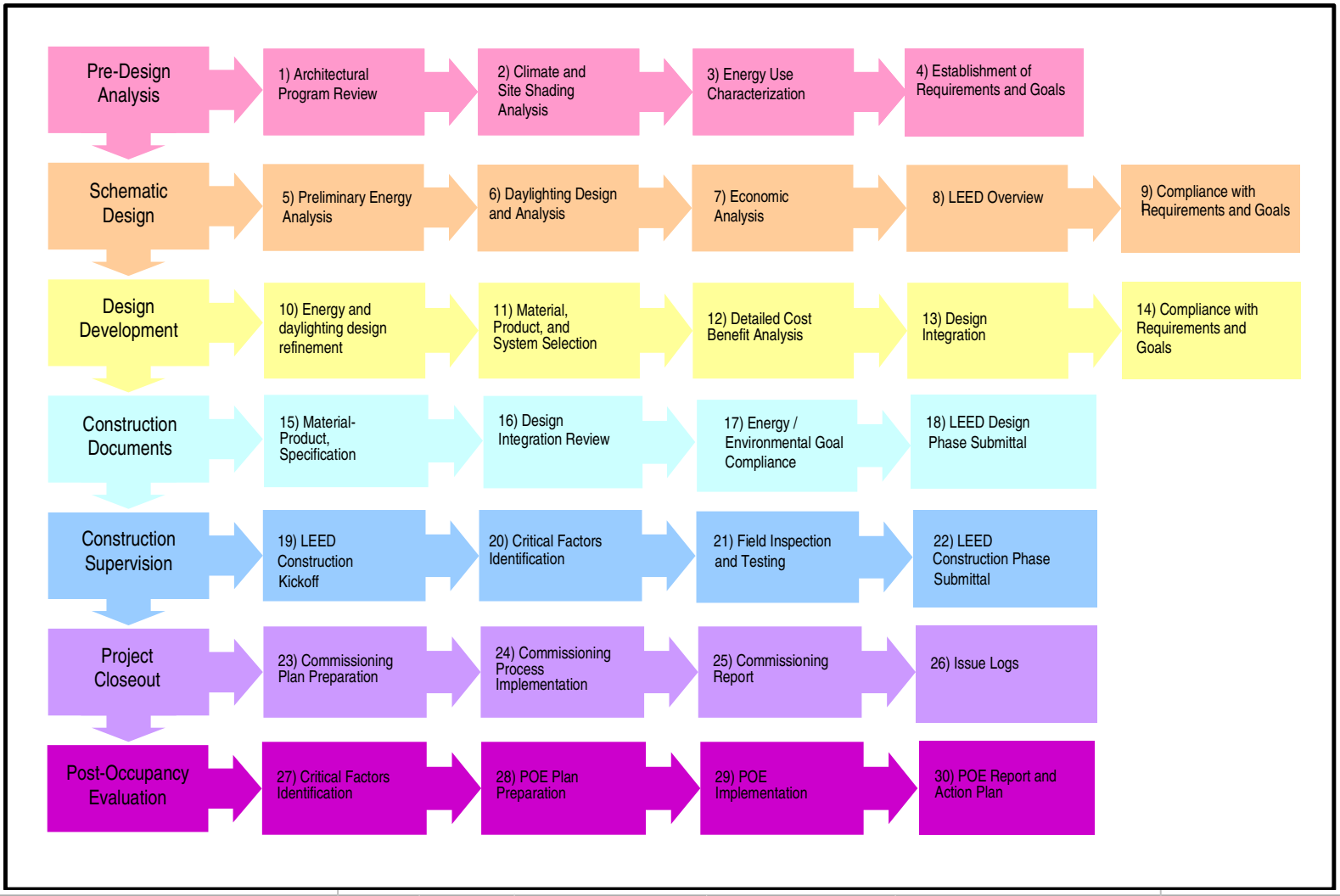
} 1973 - 1982

  - DOE Passive Solar Commercia Building Research and Demonstration Program
- 1989 Book
  - *The Design of Energy-Responsive Commercial Buildings*
- Current AEC SDA business model
- Continually being refined

Integrating Sustainable Design Services
into the Architectural Design Process

E²ASE Activities

Architectural Design Process



Integrating Sustainable Design Services
into the Architectural Design Process

PRE-DESIGN

E²ASE OBJECTIVES

- Assemble building program information
- Establish energy and environmental performance goals
- Prepare energy and environmental design guidelines

E²ASE ACTIVITIES

1) Architectural Program Review → 2) Climate and Site Shading Analysis → 3) Energy Use Characterization → 4) Establishment of Requirements and Goals

INFORMATION REQUIREMENTS

1) Architectural Program Review	2) Climate and Site Shading Analysis	3) Energy Use Characterization	4) Establishment of Requirements and Goals
♦ Site details ♦ Building functions ♦ Floor area ♦ Schedules	♦ Site location ♦ Site topography ♦ Building massing scenarios	♦ Baseline definition ♦ Building simulation model ♦ Climate data ♦ Utility rate schedule	♦ Results from Pre-Design activities ♦ Strategies review ♦ Technology assessments ♦ LEED criteria

RESULTS

1) Architectural Program Review	2) Climate and Site Shading Analysis	3) Energy Use Characterization	4) Establishment of Requirements and Goals
♦ OPR[1] information ♦ EPC[2] information ♦ Massing + blocking information	♦ Reference building design ♦ Simulation model	♦ Performance benchmarking ♦ Sensitivity studies ♦ Performance Problem Definition	♦ Energy/ environmental performance goals ♦ Project design guidelines ♦ OPR[1] completion ♦ EPC[2] completion

[1]Owner's Project Requirements- a description of building performance requirements that inform the design
[2]Environmental Performance Critiera –specific values of performance requirements (e.g. setpoints, light levels, daylight appropriateness, ventilation requirements)

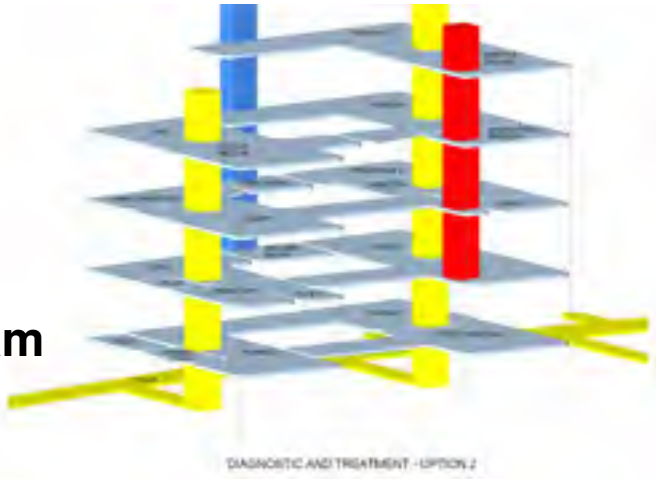
Project Review

Review Project Information

- **Project directory**
- **Schedule**
- **Programming**
- **Master Plan**
- **Massing Studies**

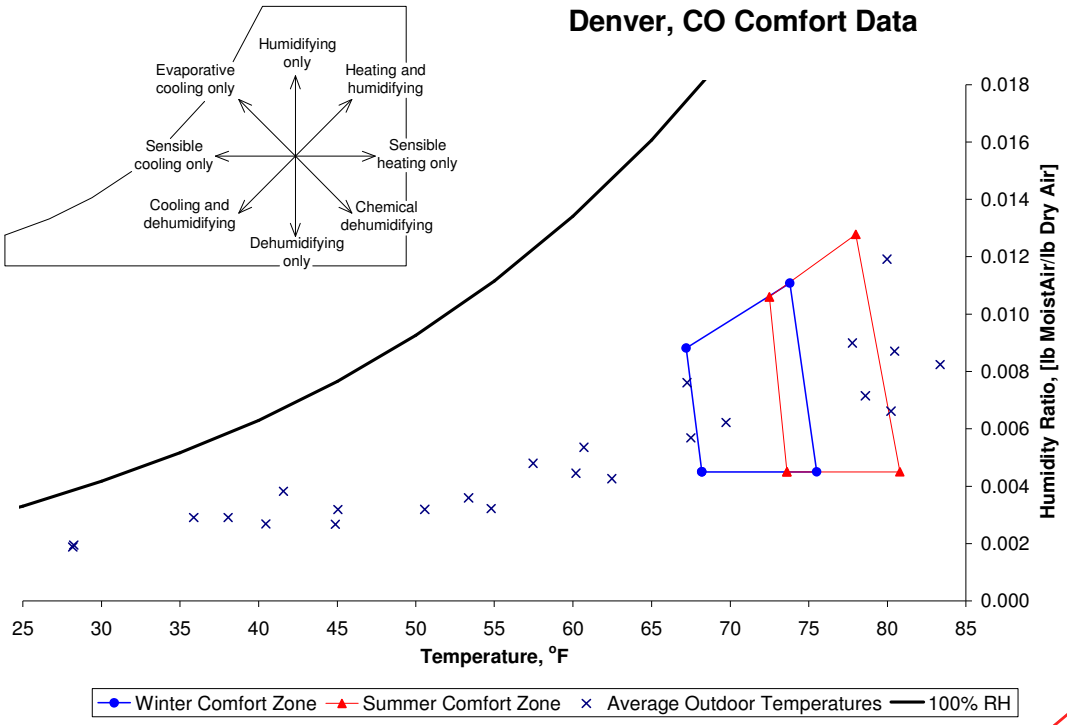
Collaborate with the Team

- **Design Charrette**
- **Meetings**



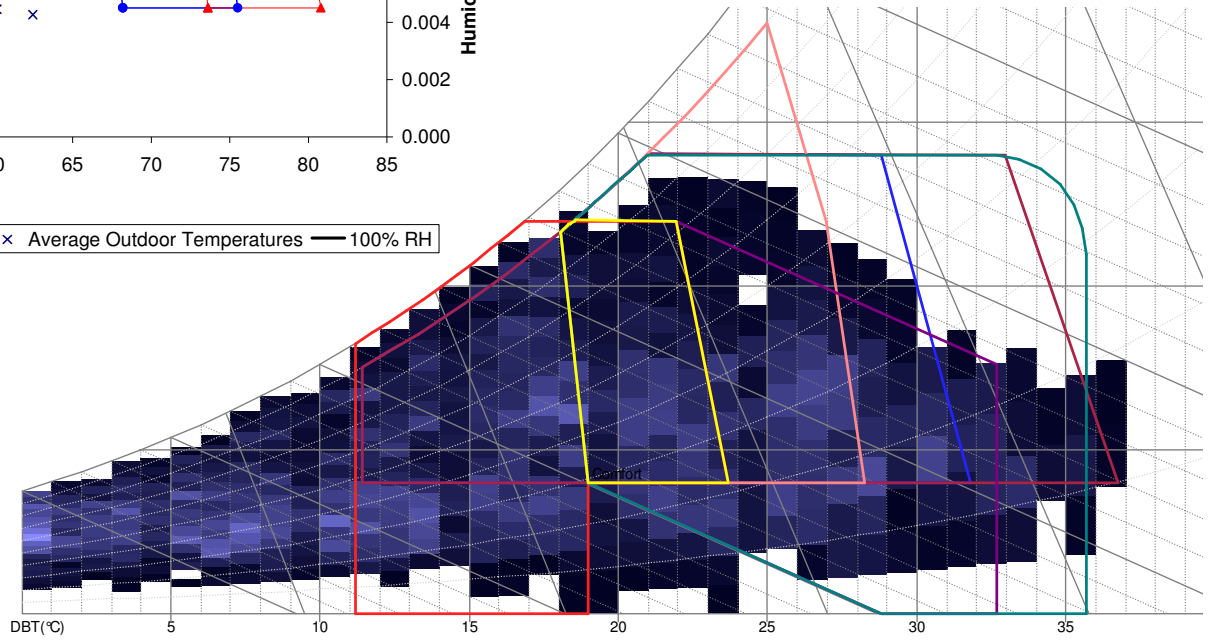
HOSPITAL BUILDING TOTALS

Service	VA Critera DNSF	Grossing Factor	DGSF
Inpatient Programs	136,603		223,804
Outpatient Treatment	135,252		207,363
Clinical Services	350,695		497,015
Support Services	165,244		204,429
	787,794		**1,132,611**
Hospital Building Gross		**0.35**	**396,414**
Total Facility Gross Square Feet			**1,529,025**



SELECTED DESIGN TECHNIQUES:

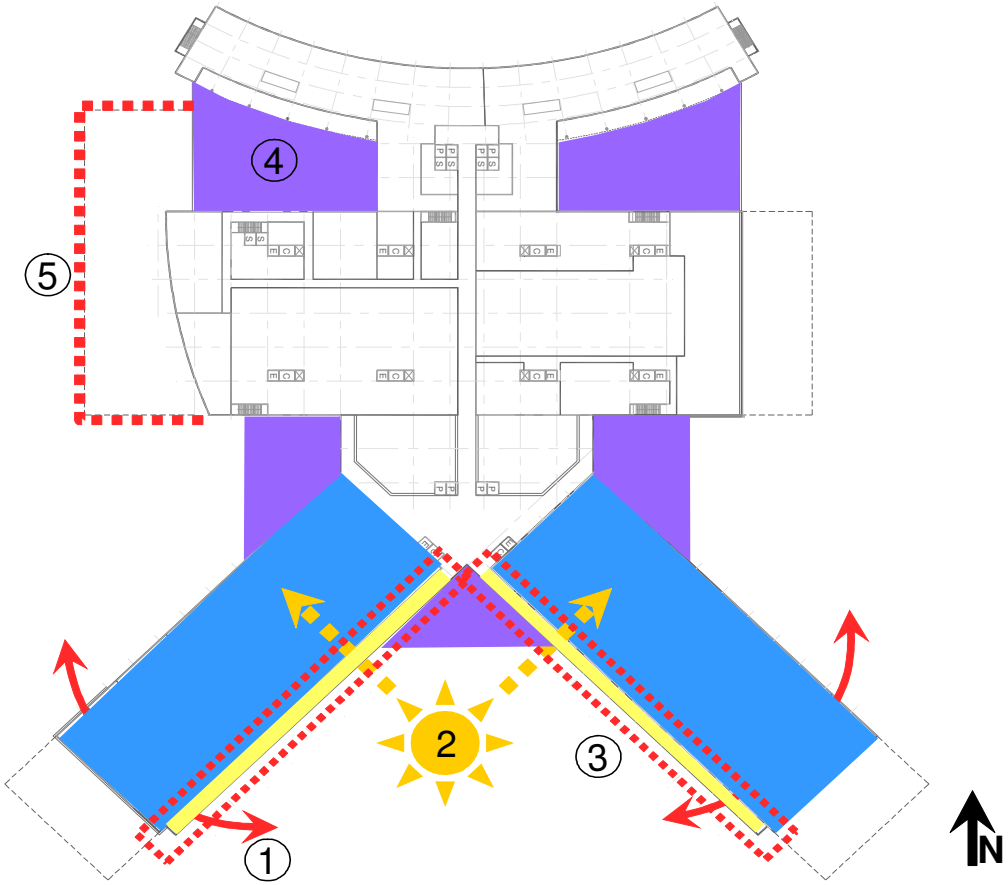
1. passive solar heating
2. thermal mass effects
3. exposed mass + night-purge ventilation
4. natural ventilation
5. direct evaporative cooling
6. indirect evaporative cooling



Psychrometric Charts

Concept Design Review

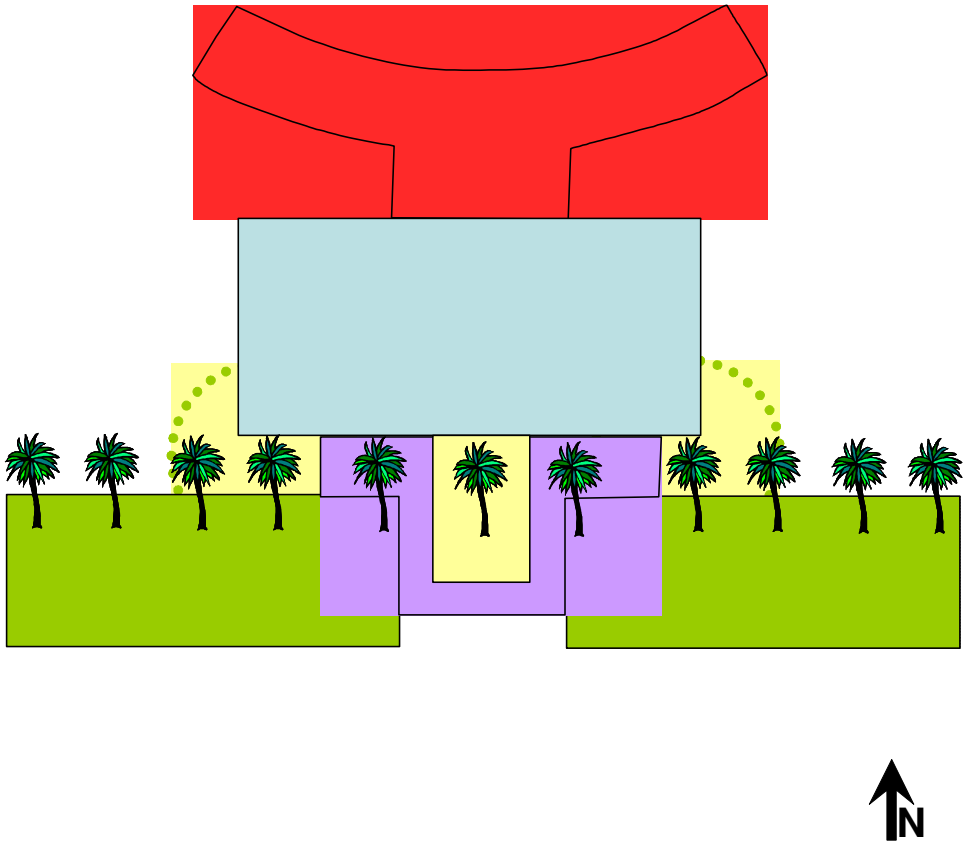
General Building Issues - Massing



Comments/Questions

1. Orientations of outpatient wings?
2. Daylight appropriateness for outpatient clinics?
3. Single-loaded corridors on outpatient wings? Double-loaded? (daylight, thermal buffer)
4. Is there a goal to provide sheltered outdoor spaces in overall design?
5. Height of west expansion? Implications on terrace shading/daylighting?

Concept Design Review

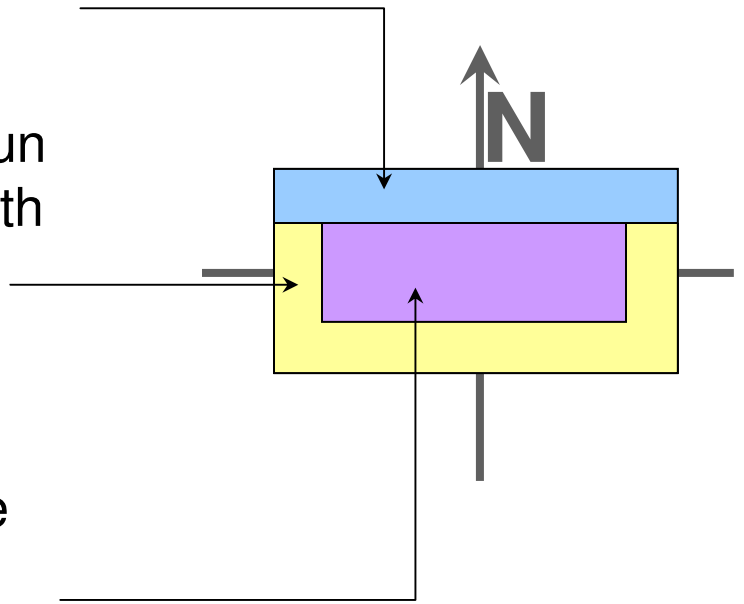


Proposed Alternative for Improved Performance

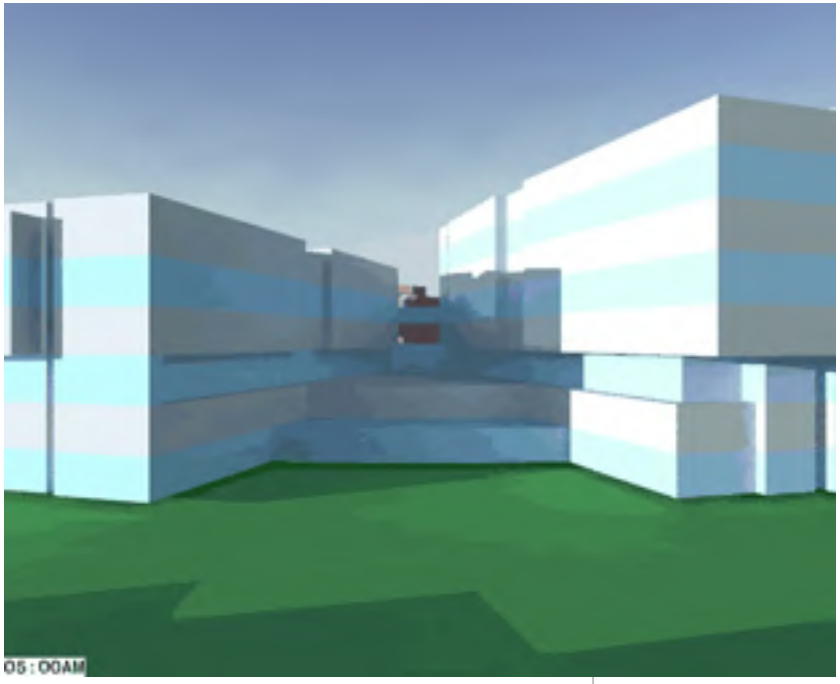
1. Rotate out-patient wings to orthogonal
2. Square up connection between outpatient and inpatient blocks
3. Integrate unconditioned atrium (Assumption: atrium is currently conditioned 4-story volume. AEC recommends reducing conditioned footprint.)
4. Potential for greenbelt intersection – integrated with transitional entryways

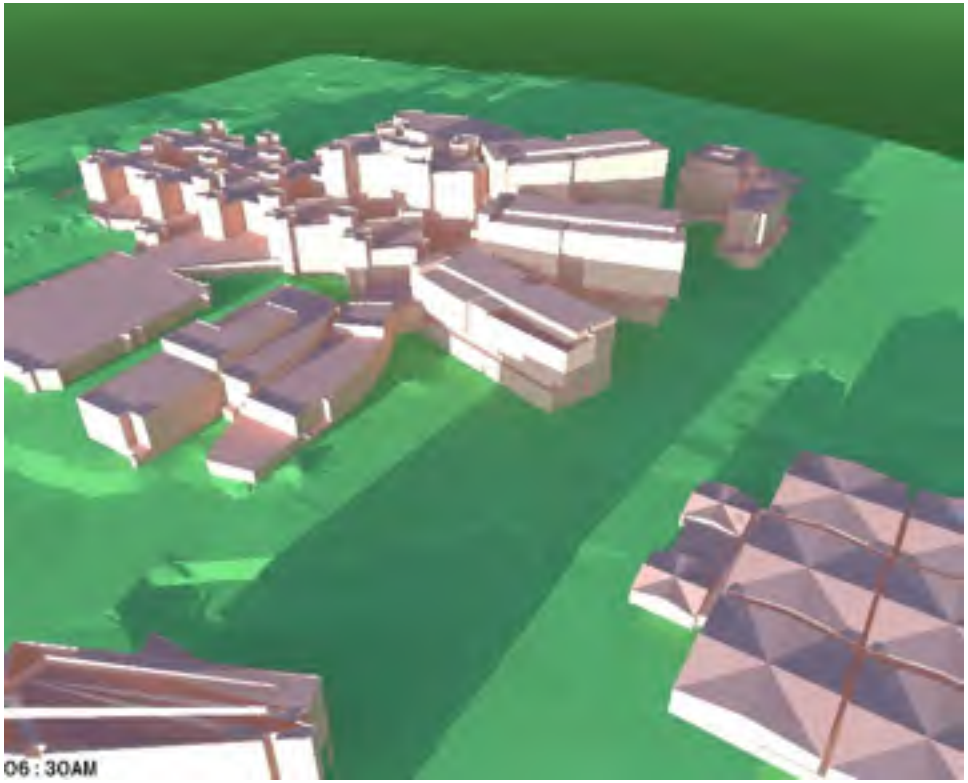
Daylighting Considerations

- Spaces with **high** daylight appropriateness but **low** glare/direct sun tolerance should be located on the north side of the building
- Spaces with **high** daylight appropriateness and **high** glare/direct sun tolerance should be located on the east, west or south perimeter zones
- Spaces with **low** daylight appropriateness should be programmed as core spaces



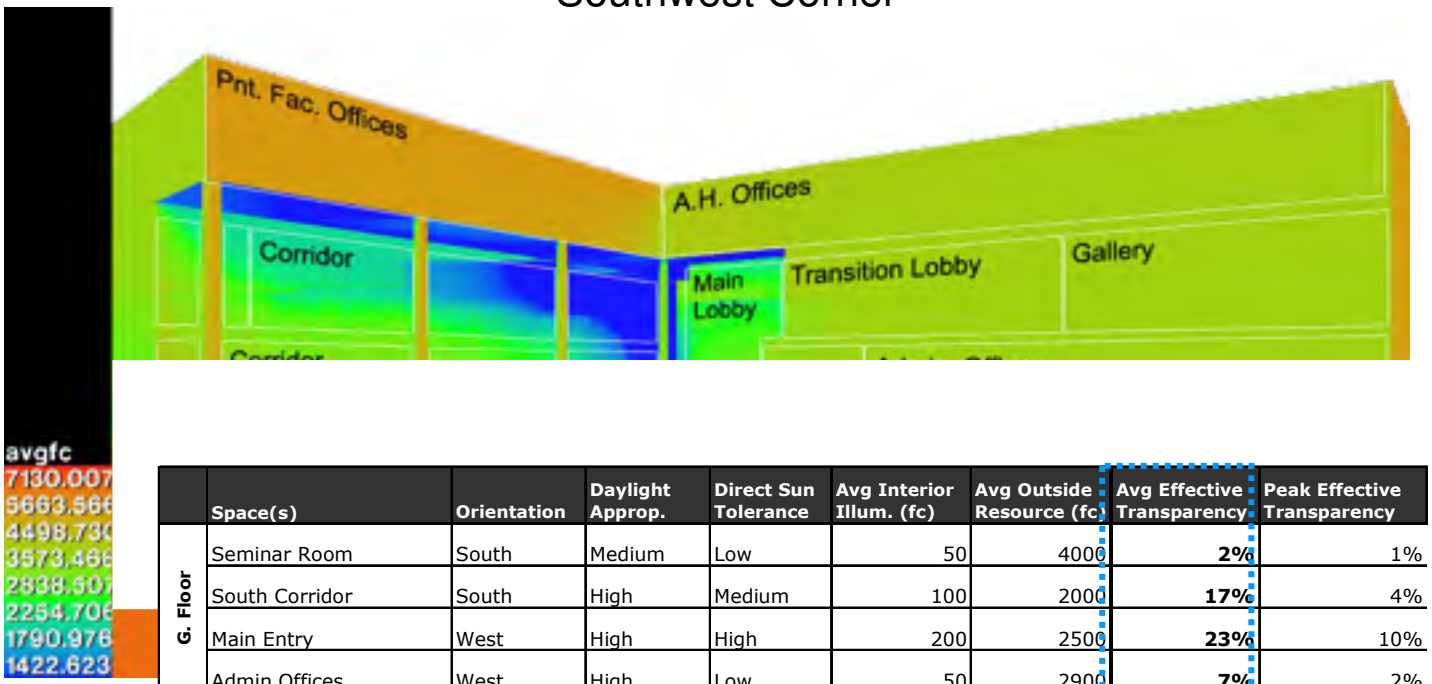
- Illustrate the extent of shading from surrounding structures and landscape
- Determine solar exposure and daylight resource available on various facades





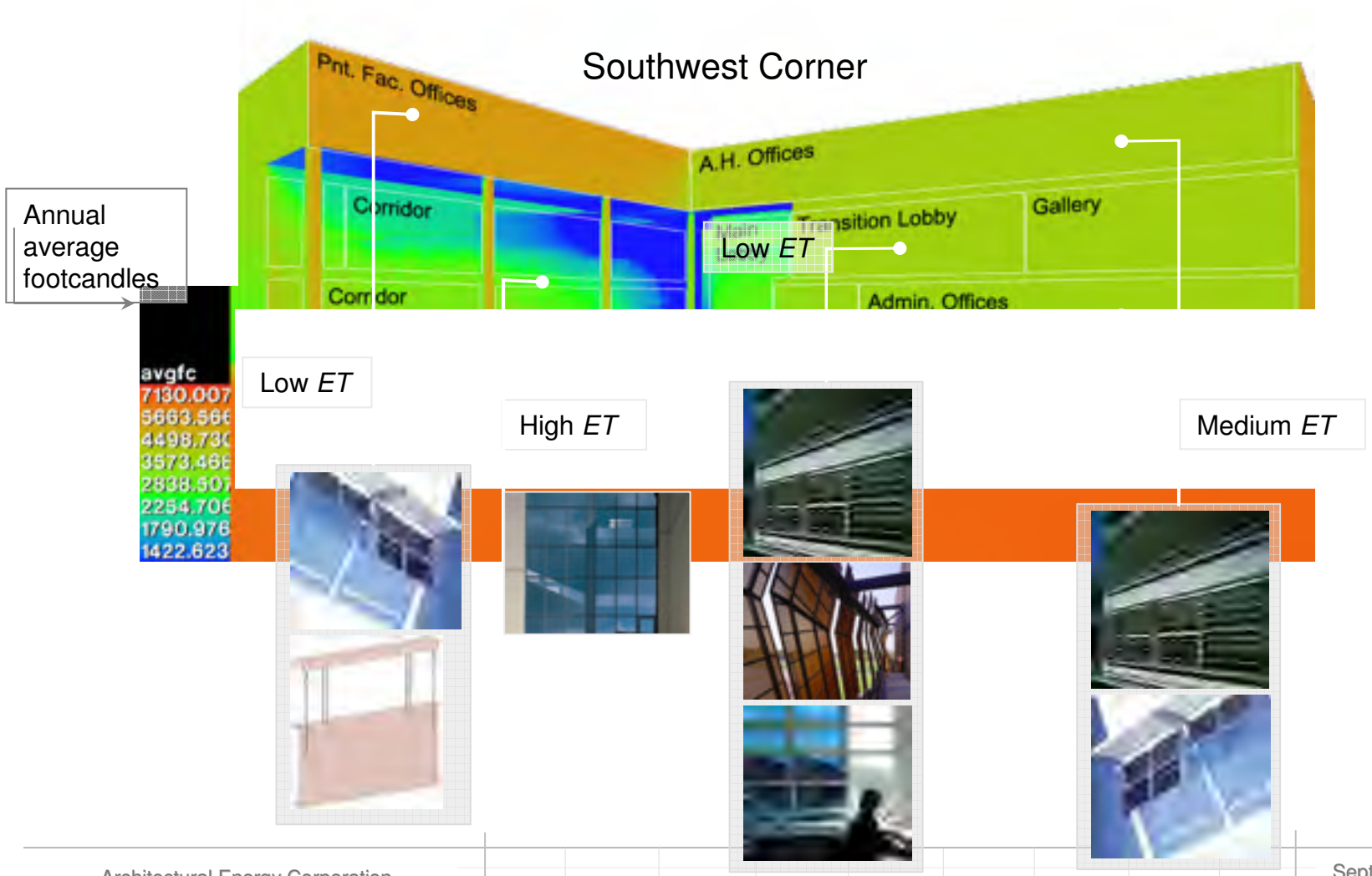
Interdisciplinary Research Center, University of Wisconsin, Madison

Southwest Corner



Daylight resource and Effective Transmittance calculated for each facade

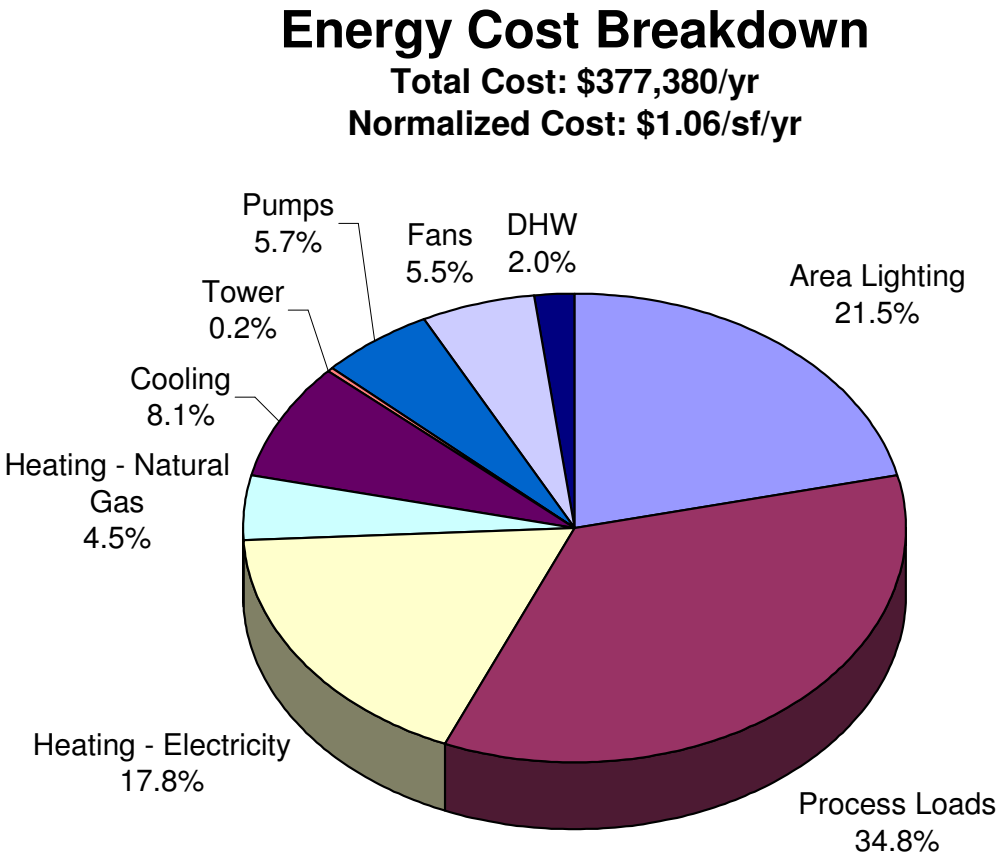
	Space(s)	Orientation	Daylight Approp.	Direct Sun Tolerance	Avg Interior Illum. (fc)	Avg Outside Resource (fc)	Avg Effective Transparency	Peak Effective Transparency
G. Floor	Seminar Room	South	Medium	Low	50	4000	**2%**	1%
	South Corridor	South	High	Medium	100	2000	**17%**	4%
	Main Entry	West	High	High	200	2500	**23%**	10%
	Admin Offices	West	High	Low	50	2900	**7%**	2%
2nd Floor	Ceramic Display	South	Medium	Medium	30	2200	**4%**	1%
	South Corridor	South	High	Medium	100	1500	**23%**	6%
	Exhibit Gallery	West	Low	Low	10	3600	**0%**	0%
	Transition Corridor	West	High	Low	50	3500	**4%**	2%
3rd Flo	Pnt. Faculty Offices	South	High	Low	50	6000	**3%**	2%
	AH Offices	West	High	Low	50	3600	**5%**	2%


Southwest Corner
Pnt. Fac. Offices
A.H. Offices
Corridor
Gallery
Low *ET*
Admin. Offices
Annual average footcandles
avgfc
7130.007
5663.566
4498.730
3573.466
2838.507
2254.706
1790.976
1422.623
Low *ET*
High *ET*
Medium *ET*

Proposed Design Results – Energy Cost:

➢ Lighting / Plug Load Dominated:

- ➢ Low envelope area to floor area ratio (high rise) with rectangle floor plate reduces heating and cooling loads
- ➢ Efficient cooling equipment (0.55 kW/ton)
- ➢ Highly effective airside economizing in Denver
- ➢ High cost of heating with electricity
- ➢ 89% of electric heating costs are from increased Demand charges



Integrating Sustainable Design Services
into the Architectural Design Process

SCHEMATIC DESIGN PHASE

E²ASE OBJECTIVES

- Develop and evaluate alternative conceptual design solutions
- Affirm or modify energy and environmental performance goals
- Select conceptual deign for further development

E²ASE ACTIVITIES

5) Preliminary Energy Analysis → 6) Daylighting Design and Analysis → 7) Economic Analysis → 8) LEED Overview → 9) Compliance with Requirements and Goals

	5) Preliminary Energy Analysis	6) Daylighting Design and Analysis	7) Economic Analysis	8) LEED Overview	9) Compliance with Requirements and Goals
INFORMATION REQUIREMENTS	♦ Project design guidelines ♦ Building requirements ♦ Design team input ♦ Building Energy Model	♦ Climate data ♦ Performance criteria ♦ Site shading analysis ♦ Space renderings	♦ Building energy analysis results ♦ Estimated construction costs ♦ Economic parameters	♦ Site information ♦ Design solutions ♦ Local code information	♦ OPR criteria ♦ LEED scorecard ♦ Design solutions
RESULTS	♦ One or more integrated design solutions	♦ Assessment of luminous environment	♦ Cost-benefit evaluation	♦ LEED scorecard ♦ LEED task list	♦ Affirm or modify energy and environmental performance goals ♦ BOD[1] completion

[1]Basis of Design – a document prepared by the design team that explains how the design solution will meet the building requirements

Early Design Building Characterization

Envelope, Internal Load, Ventilation, and Mechanical

Component	ASHRAE Baseline / Proposed Design	
	Value	**Reference**
Roof	U-0.063 (R-15.9)	ASHRAE 90.1-2004, Table 5.5-5, Assembly Maximum (Nonresidential)
Above Grade Steel-Framed Wall	U-0.084 (R-11.9)	
Mass Floors	U-0.087 (R-11.5)	
Gross Window-to-Wall Ratio	46% Avg	
Vertical Glazing U-Value	U-0.46 (overall, including frame)	
Vertical Glazing SHGC	0.26	
Exterior Shading	None	

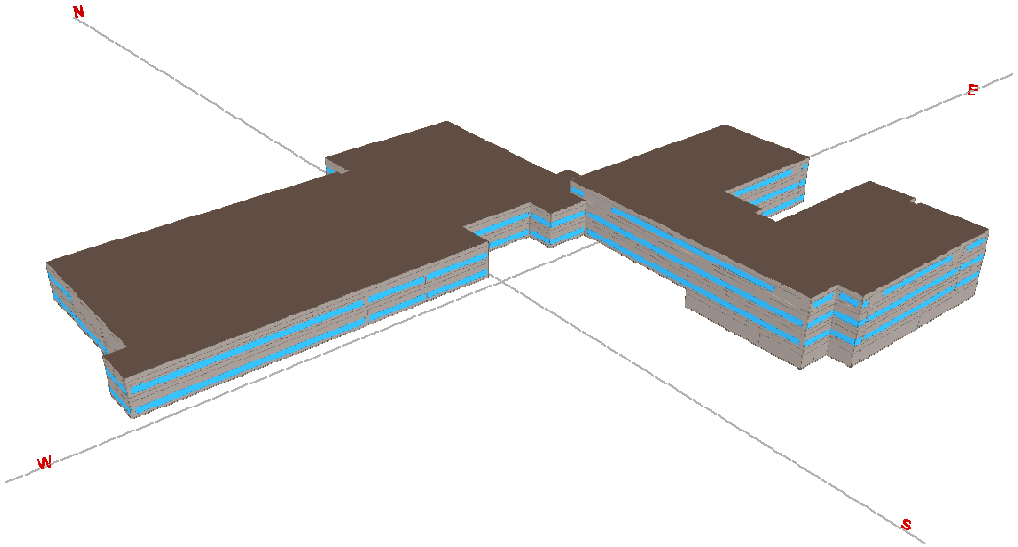
Parameter	ASHRAE 90.1-2001	ASHRAE 90.1-2004	Proposed Design
Lighting Power Density (Whole Building Method (W/ft^2)	1.3	1.0	1.0
Equipment Power Density (W/ft^2)	1.5	1.5	1.5
Occupancy (ft^2/person)	200	200	200
Ventilation Per ASHRAE 62-2004 (cfm/person)	17	17	17

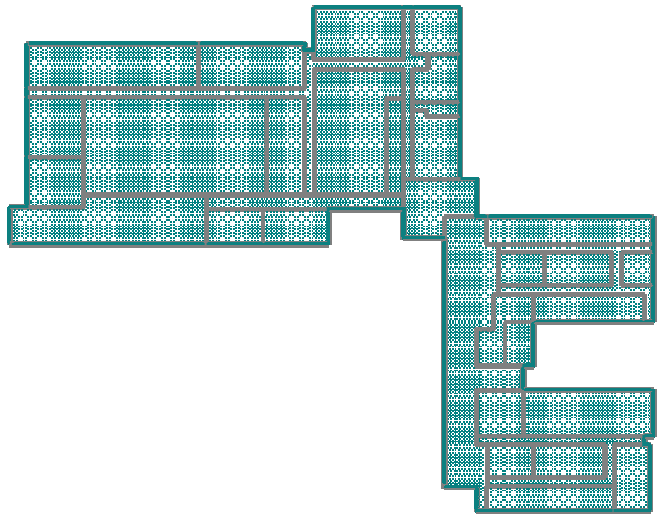
Develop Whole Building Model

- **Building Geometry and Layout**
- **Baseline Building Information**
- **Occupancy / Operating Schedules**
- **Utility Rate Schedules**

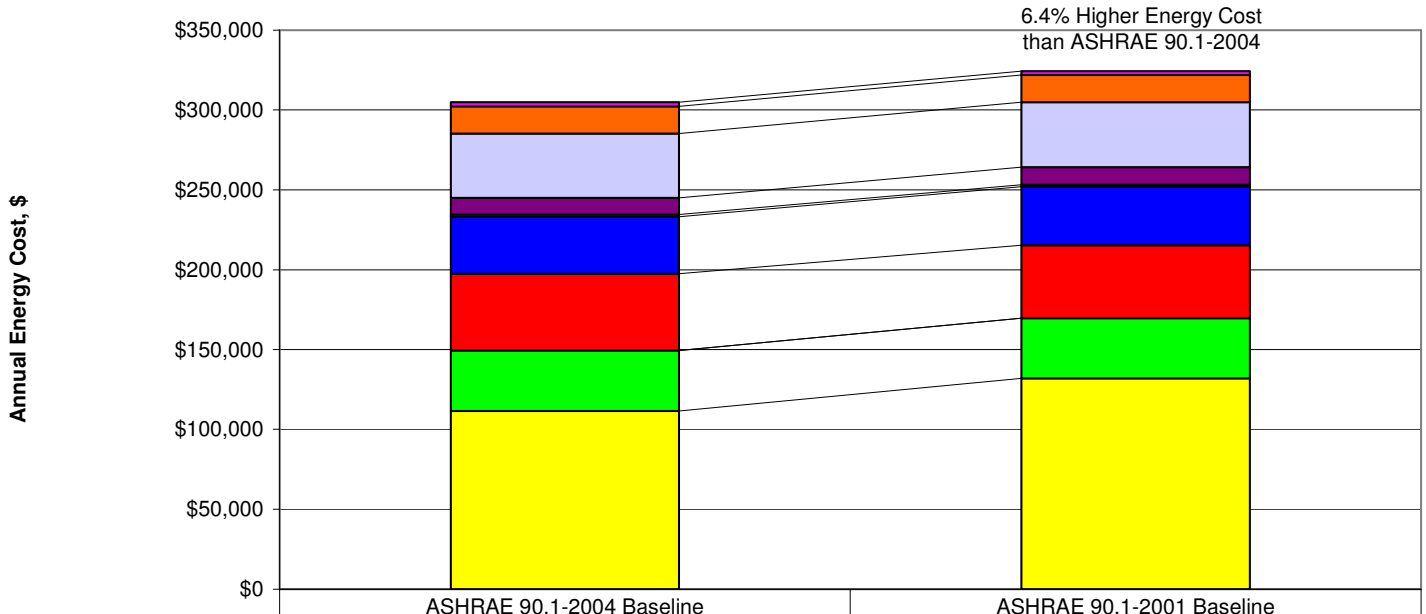
Secondary General Utility Rate Schedule

Energy Source	Cost
Natural Gas:	$1.00 / Therm – (All Therms)
Electricity:	$0.02265 / kWh (All kWh)
Monthly Demand Charge:	$14.23 / kW (June – September) $13.05 / kW (October – May)
Taxes and Surcharges:	16%



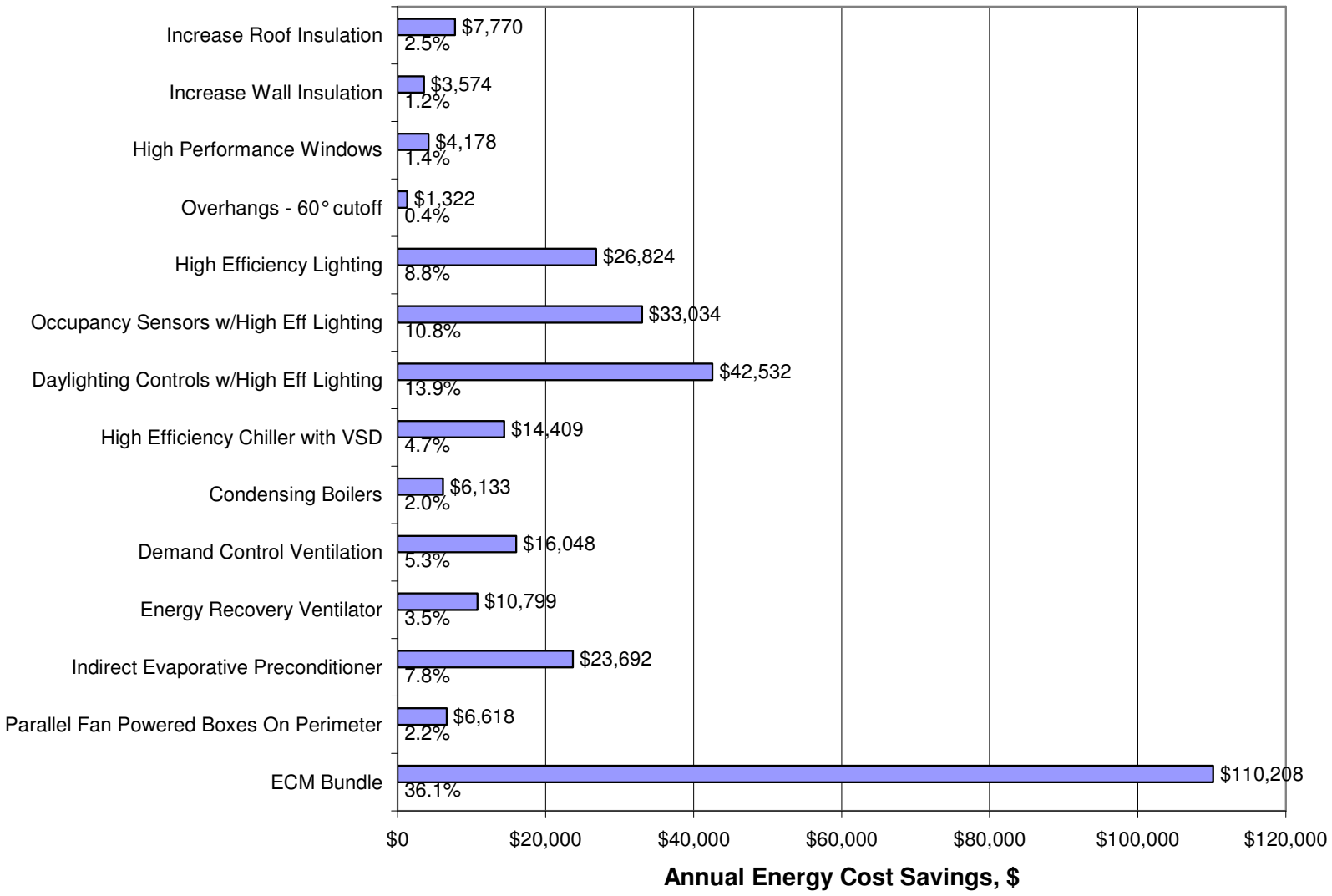


Baseline Building Energy Use Characterization



	ASHRAE 90.1-2004 Baseline	ASHRAE 90.1-2001 Baseline
Ext. Equipment	$2,566	$2,557
DHW	$17,029	$17,027
Fans	$40,190	$40,697
Pumps	$10,596	$10,793
Tower	$1,294	$1,305
Cooling	$35,649	$36,772
Heating - Natural Gas	$48,136	$45,480
Heating - Electricity	$147	$132
Plug Loads	$37,839	$37,775
Area Lighting	$111,468	$131,918

Evaluation of Energy Efficiency Strategies



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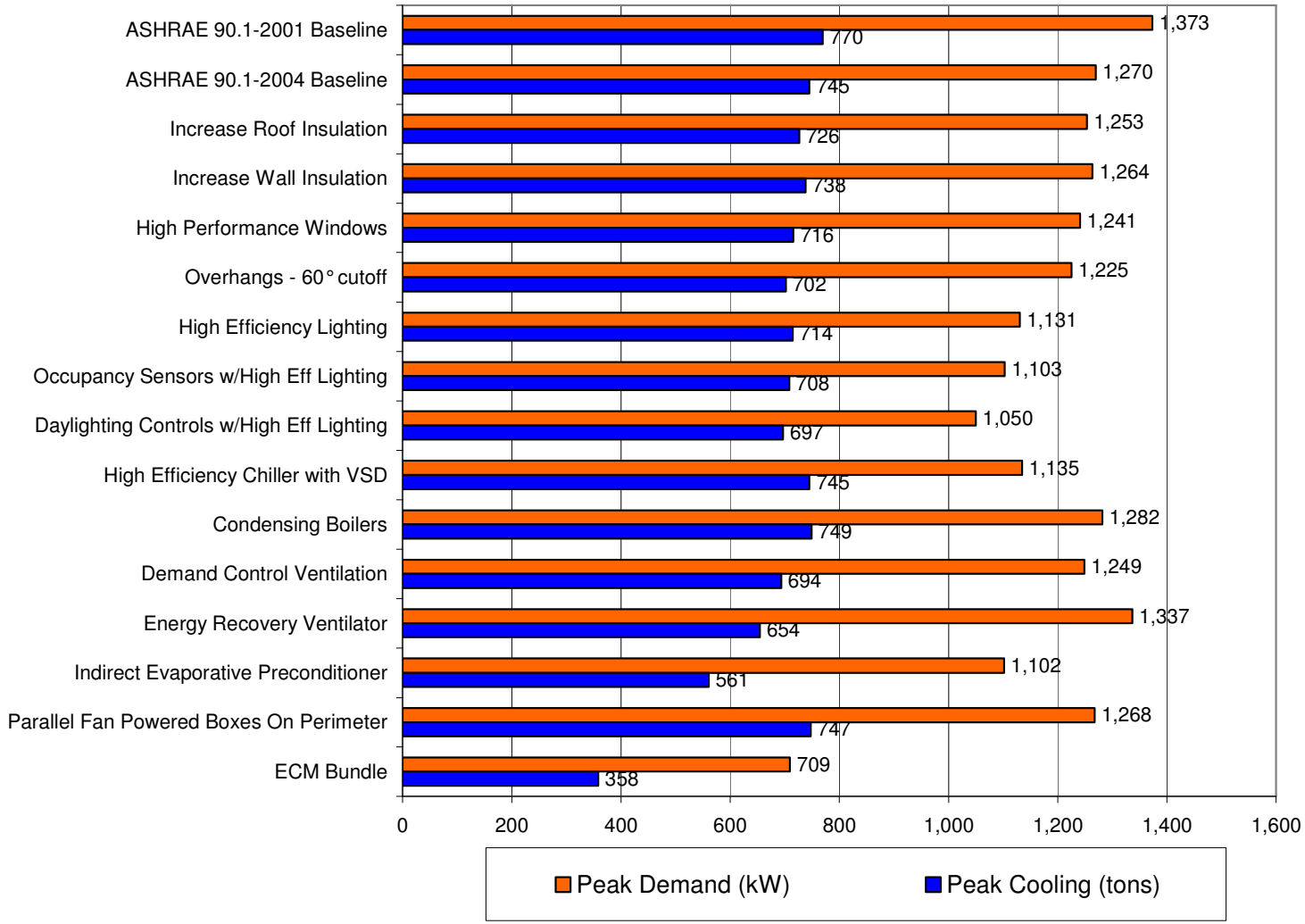


Integrating Sustainable Design Services
into the Architectural Design Process

DESIGN DEVELOPMENT

E²ASE OBJECTIVES

- Develop and evaluate design refinements
- Make initial selection of materials, products, and systems
- Complete integration of architectural, structural, mechanical, and electrical design components
- Affirm or modify energy and environmental performance goals
- Select DD design

E²ASE ACTIVITIES

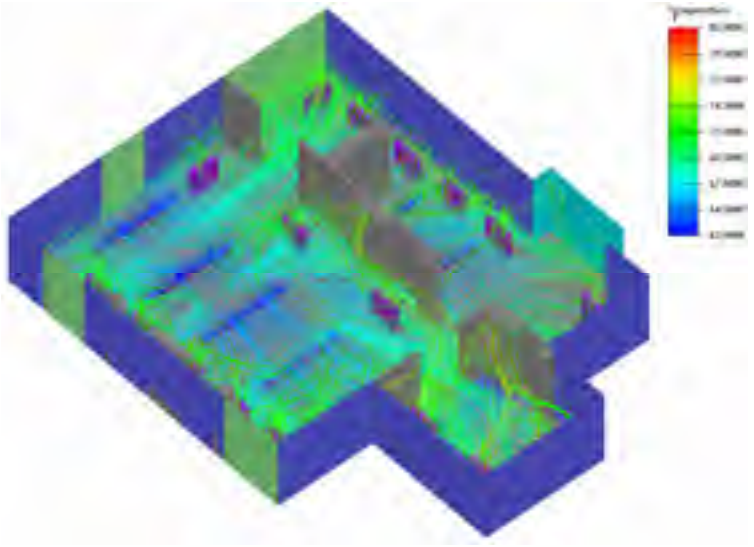
10) Energy and daylighting design refinement → 11) Material, Product, and System Selection → 12) Detailed Cost Benefit Analysis → 13) Design Integration → 14) Compliance with Requirements and Goals

	10) Energy and daylighting design refinement	11) Material, Product, and System Selection	12) Detailed Cost Benefit Analysis	13) Design Integration	14) Compliance with Requirements and Goals
INFORMATION REQUIREMENTS	♦ Design solutions ♦ Alternative design features ♦ Building energy model ♦ Lighting simulation	♦ Component characterization ♦ Manufacturers data ♦ Cost information ♦ LEED Scorecard	♦ Energy performance results ♦ Installed costs ♦ Economic parameters	♦ OPR[1] ♦ Architectural ♦ Structural ♦ Mechanical ♦ Electrical ♦ Commissioning	♦ Cost/benefit results ♦ Energy / Environmental performance results
RESULTS	♦ Daylighting recommendations ♦ Component recommendations	♦ Initial selection of energy related materials, products, and systems	♦ Cost/benefit results ♦ Selection of alternative design features	♦ Integration of energy design solutions ♦ Integration of LEED requirements ♦ Enhanced commissioning	♦ Affirm or modify energy and environmental goals ♦ DD design selection

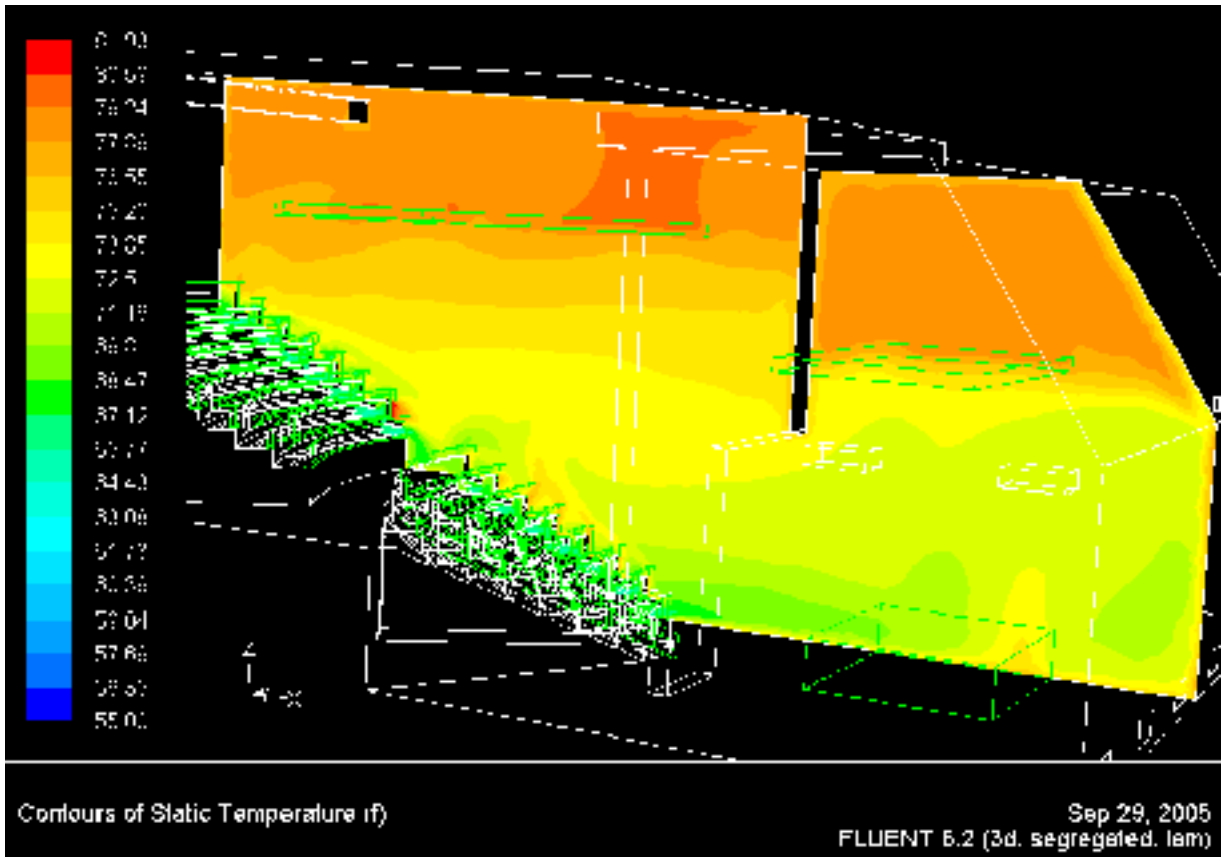
[1]Owner's Project Requirements- a description of the building performance requirements as defined by the owner that inform the design

Application in Computation Fluid Dynamics

- Performing Arts Center Auditorium
- Design solutions included
  - Overhead air system distribution
  - Underfloor air system distribution
- Design Team concern
  - Comfort
  - Energy efficiency

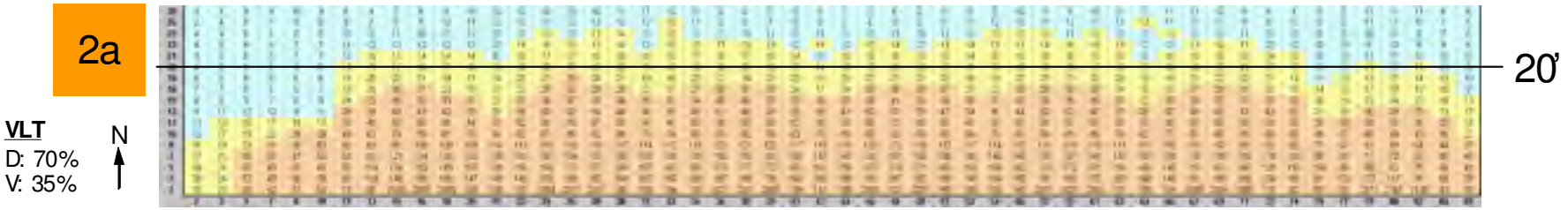


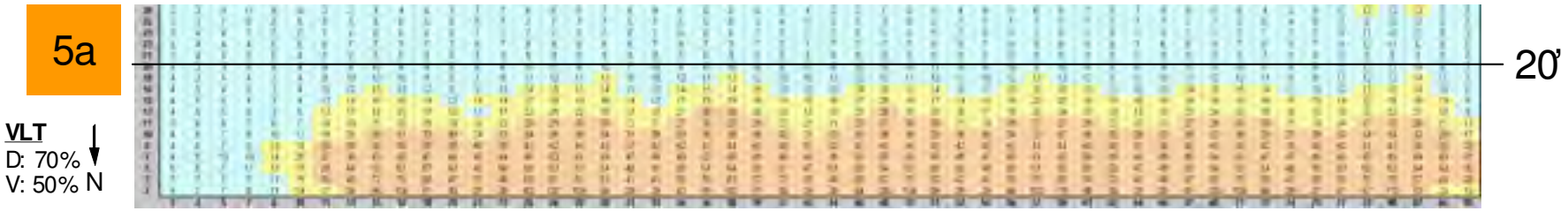
Solve heat and mass transfer equations at each mesh point



Temperature Contour Plot for Underfloor System (SAT 65 F)

Focused Daylighting Studies

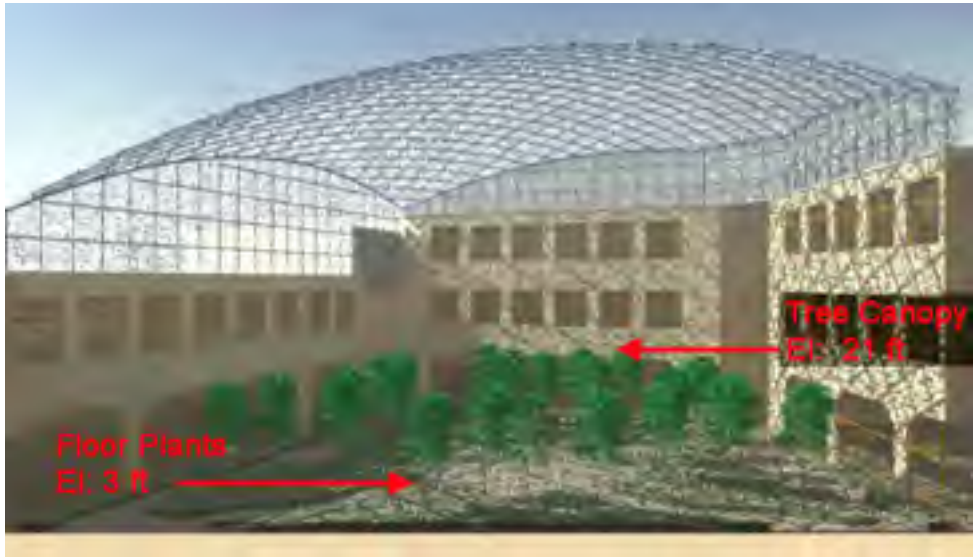


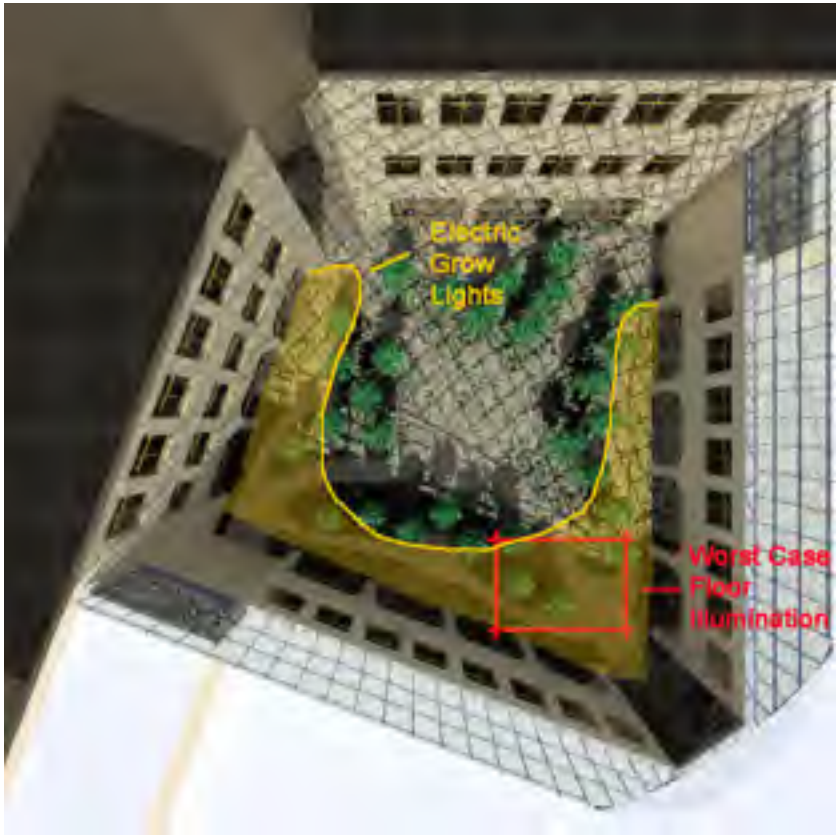


Pre-Design | Schematic Design | **Design Development** | Construction Documents

Design Refinement | *Component Selection* | *Cost Analysis* | *Design Integration* | *Goal Affirmation*

- Illuminance-hour requirements for Ficus trees
- Identified shaded areas of inadequate daylight illuminance for supplemental electric lighting

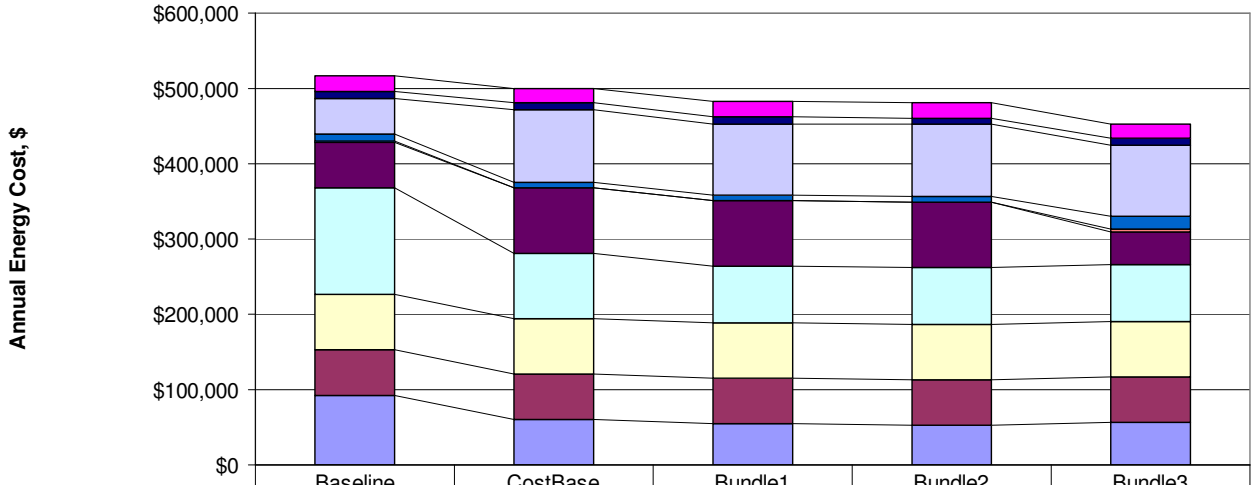




Wrigley Global Innovation Center, Chicago, IL

Design Alternates / Bundle Analysis

Model	Total Cost	Cost Savings over Baseline		Cost Savings over Cost Base	
Baseline	$516,411	n/a	n/a	n/a	n/a
Cost Base	$500,014	$16,397	3.2%	n/a	n/a
Bundle 1	$482,357	$34,054	6.6%	$17,657	3.5%
Bundle 2	$480,720	$35,691	6.9%	$19,294	3.9%
Bundle 3	$453,553	$62,858	12.2%	$46,461	9.3%



	Baseline	CostBase	Bundle1	Bundle2	Bundle3
Exterior	$19,510	$19,489	$19,505	$19,493	$19,498
DHW	$9,228	$9,228	$9,228	$9,228	$9,228
Fans	$48,427	$96,208	$95,809	$96,055	$95,230
Pumps	$9,565	$6,818	$6,796	$6,782	$17,064
Tower	$1,656	$0	$0	$0	$2,968
Cooling	$60,876	$87,307	$86,676	$86,510	$42,848
Heating	$140,289	$86,501	$75,245	$75,285	$75,285
Gas- Pool& Kitchen	$73,914	$73,914	$73,914	$73,914	$73,914
Plug Loads	$60,605	$59,728	$59,753	$59,741	$61,715
Lighting	$92,368	$60,759	$55,423	$53,717	$55,832

Integrating Sustainable Design Services
into the Architectural Design Process

CONSTRUCTION DOCUMENTS PHASE

E²ASE OBJECTIVES

- Make final selection and specification of energy-and environmental-related materials, products, and systems
- Ensure full integration of sustainable design features within construction documents
- Verify compliance to energy and environmental standard/goal
- Submit LEED design phase documentation to USGBC

E²ASE ACTIVITIES

16) Material-Product, Specification → 17) Design Integration Review → 18) Energy / Environmental Goal Compliance → 19) LEED Design Phase Submittal

INFORMATION REQUIREMENTS

- Component characterization
- Performance criteria
- Manufacturer data
- Cost estimate
- LEED Scorecard and updated task list
- Detailed equipment schedules

- Commissioning
- Architectural
- Structural
- Mechanical
- Electrical

- Final design
- Dynamic building simulation
- Climate data
- Utility rate structure

- Documents from team members
- Final scorecard

RESULTS

- Final recommendations and specifications for sustainable materials, products, LEED strategies and systems

- Construction document revision or approval
- Construction documents that can be enforced by the commissioning authority

- Energy and environmental goal verification
- Checklist of energy efficiency features

- Submit design phase documentation to USGBC

CD Review and Model Update

TABLE 1. ENERGY CONSERVATION MEASURE CHECKLIST

ECM	EDA model	Included in CD package (Yes/No)	Location	Change from Previous	Installation Verification (Yes/No: by AEC)
Tenant Lighting no greater than 0.99 w/sf (10% below ASHRAE 90.1-2004)	Bundle 1	Yes	Proposed LEED Tenant Guidelines page 6: 15% below ASHRAE 90.1-2004	5% better*	
Daylighting in Perimeter Offices	Bundle 2	Yes	Tenant Guidelines	None	
Roof Insulation R-24	Cost Baseline	Yes	Spec 07 5400: R-30 minimum	From R-24 to R-30	
Wall Insulation R-19; Tenant Spandrel Glass Insulation	Cost Baseline	Yes	Spec 07 2100: R-19 minimum; A-302	None	
High Efficiency Solarban 60 Windows	Cost Baseline	Yes	Spec 08 8000: Versalux, Low-E, U-0.30	None	
Window Shading	Cost Baseline	Yes	A-302	None	
Daylighting Controls in Lobby	Cost Baseline	Yes	EL-102	None	
Occupancy sensors in Restrooms and Stairwells	Cost Baseline	Yes	EL-101	None	
EcoSpace Elevators	Cost Baseline	Yes	Spec 14 2010: EcoSpace 2500 and 3500	None	

Supply Appropriate Green Building Submittal Documentation

BETA

LEED for Schools 2007 Submittal Template
EA Credit 1: Optimize Energy Performance

Table 1.0.2(b) - Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

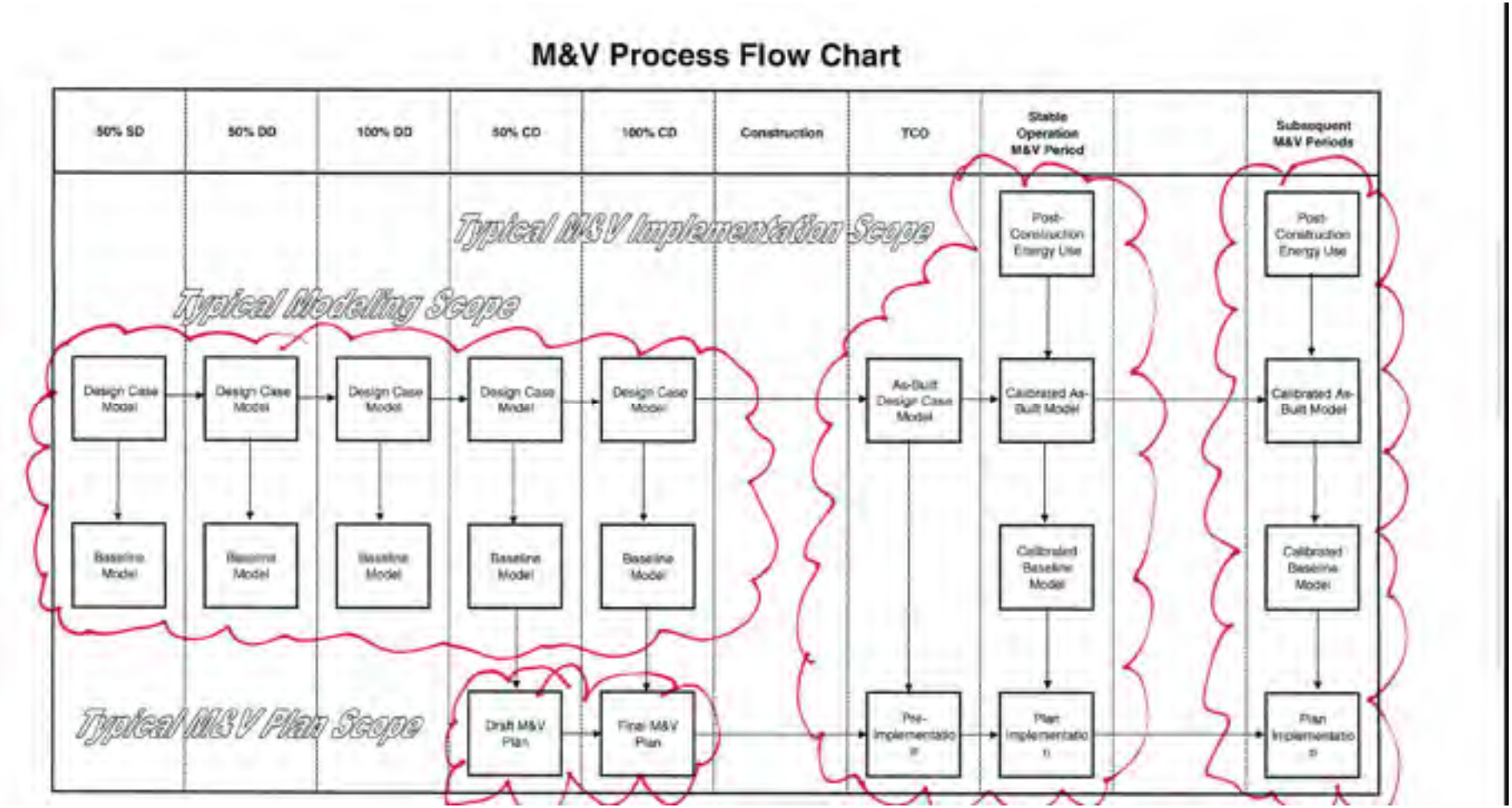
	Proposed Design		Baseline Design		Percent Savings	
Energy Type	Energy Use	Cost	Energy Use	Cost	Energy Use	Cost
Electricity	846,252 kWh	$52,001	516,888 kWh	$55,420	34 %	40 %
Natural Gas	3,153 therms	$7,267	15,725 therms	$14,276	48.2 %	49 %
	0		0		0 %	0 %
	0		0		0 %	0 %
Subtotal (Model Outputs):	1,997 (MBtu/year)	$59,328	3,335 (MBtu/year)	$67,696	40.1 %	41.9 %

On-Site Renewable Energy	Energy Generated	Renewable Energy Cost	
Photovoltaics	14,586 kWh	$1,420	(subtracted from model results to reflect Proposed Building Performance)
			(subtracted from model results to reflect Proposed Building Performance)

Exceptional Calculations	Energy Savings	Cost Savings	
Turning off emergency lights	129 (MBtu/year)	$1,451	(subtracted from model results to reflect Proposed Building Performance)

	Proposed Design		Baseline Design		Percent Savings	
	Energy Use	Cost	Energy Use	Cost	Energy	Cost
Total:	1,818 (MBtu/year)	$56,457	3,335 (MBtu/year)	$67,696	45.5 %	46.1 %

Measurement & Verification



Energy Modeling Tools

Simulation Programs Used

Commercially-Available Tools by Category	Name	Design Phase		
		Pre-Design	Schematic Design	Design Development
Whole Building Analysis	DOE 2.1E - VisualDOE	■	■	■
	eQUEST	■	■	■
	EnergyPlus		■	■
	TRNSYS			
	IES VE			
	Energy-10			
	Ecotect	■	■	
Computational Fluid Dynamics	PryroSIM/FDS		■	■
	Airpak		■	
Components	Radiance	■	■	■
	Window 5.2		■	■
	RETScreen			
	Solar Design Studio			
Other	BLCC5		■	■
	Excel	■	■	■
	Sketch Up		■	■

Environmental Performance Criteria Matrix

Schedule, occupancy, setpoints, ventilation, LPDs, daylighting

General Building Description					Occupancy			Space Conditioning					
Space Program	Subspace	Total Area, [ft^2]	Space Conditioning	Comments	Peak Occupancy #/1000 ft^2	Hrs of Operation (M-F)	Hrs of Operation (S-S)	Heating Setpoint (F)	Cooling Setpoint (F)	Setbacks	Humidity (%)	ASHRAE 90.1 Space Type	Special HVAC Requirements / Comments
1st Floor Activity and Support	Leisure Pool	8,787	Conditioned		-	6-21	6-18	68	74	62/80			
	Therapy Pool	1,606	Conditioned		-	6-21	6-18	68	74	62/80			
	Pool Mechanical	1,386	Heated Only			N/A	N/A	50	N/A	N/A			
	Gym	6,864	Conditioned		30	7-21	8-18	68	74	62/80			
	Lockers	2,862	Conditioned			7-21	8-18	68	74	62/80	N/A		
	Cabanas	1,211	Conditioned			7-21	8-18	68	74	62/80	N/A		
	Storage	488	Conditioned			N/A	N/A	62	80	N/A	N/A		
	Office	223	Conditioned		5	7-21	8-18	68	74	62/80	N/A		
	Guard	372	Conditioned			7-21	8-18	68	74	62/80	N/A		
	Indoor Play	727	Conditioned		30	Intermittent	Intermittent	68	74	62/80	N/A		
General Support	Electrical/Mechanical	613	Conditioned			N/A	N/A	62	80	N/A	N/A		
	Server	251	Conditioned			N/A	N/A	68	68	N/A	N/A		
	Office	1,477	Conditioned		5	8-17	N/A	68	74	62/80	N/A		
	Storage	1,152	Conditioned			N/A	N/A	62	80	N/A	N/A		
	Work Areas	1,175	Conditioned		5	8-17	N/A	68	74	62/80	N/A		
	Break	270	Conditioned		10	8-17	N/A	68	74	62/80	N/A		
	Conference	286	Conditioned		50	8-17	N/A	68	74	62/80	N/A		
	Restrooms	558	Conditioned			7-21	8-18	68	74	62/80	N/A		
	Game Room	507	Conditioned		30	8-18	8-18	68	74	62/80	N/A		
	Desk	306	Conditioned		10	7-21	8-18	68	74	62/80	N/A		
	Baby Sitting	775	Conditioned		25	Intermittent	Intermittent	68	74	62/80	N/A		
	Party Room	1,221	Conditioned		30	Intermittent	Intermittent	68	74	62/80	N/A		
	Lobby Lounge	3,335	Conditioned		150	6-21	6-18	68	74	62/80	N/A		
2nd Floor Activity and Support	Aerobics	1,689	Conditioned		40	6-21	6-18	68	74	62/80	N/A		
	Free Weights	1,030	Conditioned		10	7-21	7-18	68	74	62/80	N/A		
	Track and Open Workout	8,686	Conditioned		40	7-21	7-18	68	74	62/80	N/A		
	Storage	250	Conditioned			N/A	N/A	62	80	N/A	N/A		
	Electrical	63	Conditioned			N/A	N/A	62	80	N/A	N/A		
	Restrooms	121	Conditioned			6-21	6-18	68	74	62/80	N/A		

Baseline Tables

Envelope, Lighting, HVAC Systems, Plant

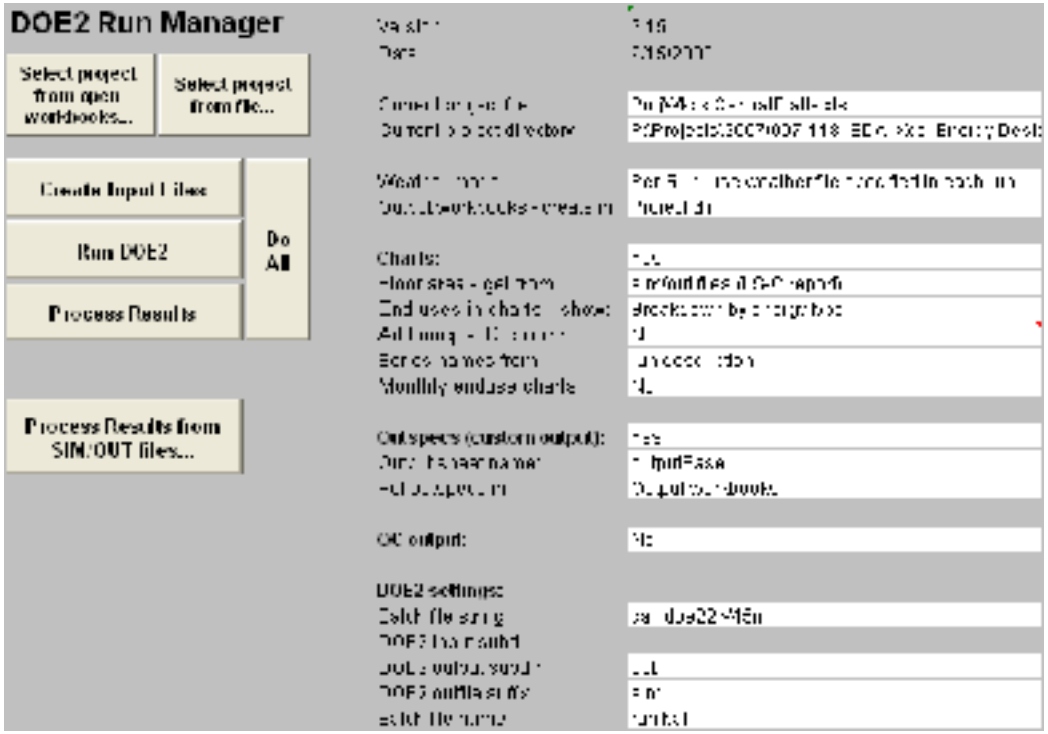
Component	Proposed Design	ASHRAE Baselines
Central System	VAV with HW / CHW central coils, 10% min OA (based on ASHRAE 62-2004)	(same as proposed)
VAV Terminal Units	perimeter parallel fan-powered zone boxes with electric reheat	Perimeter VAV zone boxes with hydronic reheat
	40% minimum position in core zones, 30% in perimeter zones 40°F max reheat deltaT	40% minimum position in core zones, 30% in perimeter zones 40°F max reheat deltaT
Supply/Return Fans	Supply Fans: 3.5 TSP Return Fans: 1.17 TSP Variable Speed Drives On one hour early, off one hour late. Night cycling.	(same as proposed)
Supply Air	55°F cooling supply air temperature 85°F/75°F max/min heating supply air temperature	(same as proposed)
Economizer	Delta Enthalpy economizer	(same as proposed)
Energy Recovery	None	(same as proposed)
Heating/Cooling Temp Control	Coldest Reset 75°F/65°F min heating/max cooling supply air reset temperature	(same as proposed)
	Central heating used for night and morning warm-up (no electric reheat)	
CW / HW Loops	High efficiency pumps with Variable Speed Drives Operation based on demand, 20% minimum flow	(same as proposed)
Cooling System	Water-cooled, electric centrifugal chiller 0.55 kW/ton	Water-cooled, electric centrifugal chiller 0.59 kW/ton
Heating System	Gas-fired Condensing Boiler 95% Efficiency	Gas-fired Boiler 80% Efficiency
Equipment Size	Autosized by DOE2.2	(same as proposed)
Temperature Setpoints	occupied: 76°F Cooling ; 70° Heating unoccupied: 82°F Cooling ; 64° Heating	(same as proposed)
Domestic Water Heating	Electric Hot Water Heaters 1 gal/person/day	(same as proposed)

Input Conversions

- Wall Insulation
  - Effective U-value for Stud Walls
- Windows
  - COG U-Value to Assembly w/o film coefficients
- Fan Power
  - Convert proposed design fan hp or bhp to W/CFM
  - Calculate baseline fan power using Appendix G Methodology
- Equipment Performance
  - Convert EER/SEER to EIR
  - Convert kW/ton or COP to EIR
  - Set cooling tower design temperature based on design wetbulb
  - Establish baseline cooling tower pumping W/GPM through iterative process
- *Controls and other design characteristics*
  - *Reflect in Proposed Design and Baseline input parameter specification*

Managing Run Input and Output

AEC Runmanager

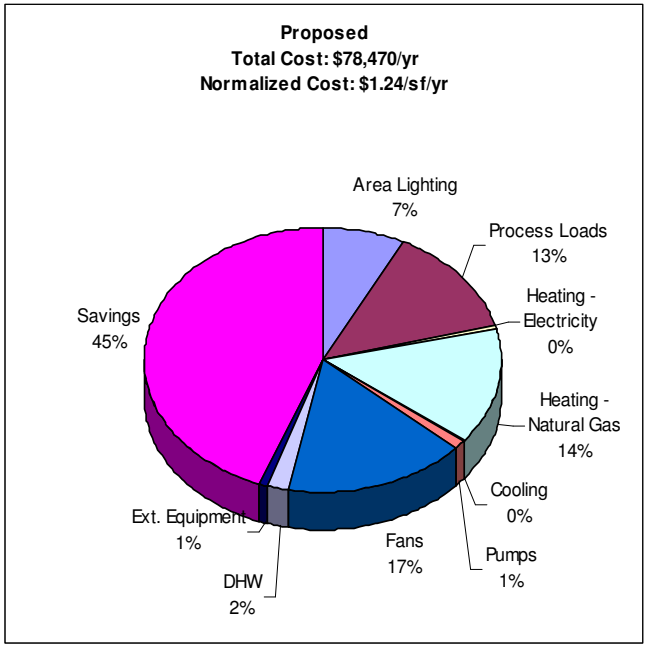


$LOADS		
$ PARAMETERS: $		
.. PARAMETER "Orientation"	0	0
.. PARAMETER "SC All Glz"	0.39	0.442
.. PARAMETER "U All Glz"	0.57	0.4
.. PARAMETER "R Grg Shed Roof"	15	30
.. PARAMETER "R Wall Garage Prpsd"	5	5
.. PARAMETER "Garage Shed Roof Abs"	0.7	0.3
.. PARAMETER "Garage Typ Wall Lyrs"	"ASHRAE Wall Layers"	"Garage Typ Wall Layers"
.. PARAMETER "Daylt Garage"	NO	NO
.. PARAMETER "Daylt Other"	NO	YES
.. PARAMETER "Shop LPD"	0.70	0.50
.. PARAMETER "Office LPD"	1.10	0.86
.. PARAMETER "Corridor LPD"	0.50	0.50
.. PARAMETER "Lockers LPD"	0.90	0.85
.. PARAMETER "Muster LPD"	1.30	0.86
.. PARAMETER "Kitchen LPD"	1.30	1.30
.. PARAMETER "Reception LPD"	1.10	0.86
.. PARAMETER "Storage LPD"	0.30	0.62
.. PARAMETER "Break Rm LPD"	1.30	0.86
.. PARAMETER "Warehouse LPD"	0.80	0.80
$Common System Parameters		
.. PARAMETER "Svc Grg Cool Btu"	AUTO	100
.. PARAMETER "Svc Grg Evap Type"	NONE	INDIRECT-DIRECT
.. PARAMETER "Svc Grg Supply Temp"	55	62
.. PARAMETER "Svc Grg Econo T"	70	105
.. PARAMETER "Thermostat Type"	REVERSE-ACTION	PROPORTIONAL
$Independent System Parameters		
.. PARAMETER "Svc Grg Bsln Cool EIR"	0.364	0.364
.. PARAMETER "Svc Grg BB Cap"	-100	-2000000
.. PARAMETER "Svc Grg Min Flow Ratio"	1	0.75
.. PARAMETER "Svc Grg Exh Fan Sch"	"Garage Exh Bsln % Sch"	"Garage Exhaust % Sch"
.. PARAMETER "Gar Sys OA % Sch"	"Bsln Gar Sys OA % Sch"	"Prpsd Min Gar OA-Flow %
.. PARAMETER "Grg Min Flow Sch"	Bsln Min Gar FLOW % Sch	"Prpsd Min Gar OA-Flow %
.. PARAMETER "Svc Grg HR Flag"	NO	YES
.. PARAMETER "Svc Grg Exh kW/cfm"	0.00037	0.00057
.. PARAMETER "Svc Grg Sup kW/cfm"	0.00093	0.00144
.. PARAMETER "Svc Grg Heat Set T"	90	70
.. PARAMETER "OW MUA3 Cool EIR"	0.352	0.352
.. PARAMETER "OW MUA3 Heat Set T"	90	70
.. PARAMETER "OW MUA3 HR Flag"	NO	NO
.. PARAMETER "OW MUA3 Exh kW/cfm"	0.00037	0.00057
.. PARAMETER "OW MUA3 Sup kW/cfm"	0.00093	0.00144
.. PARAMETER "OW MUA3 Terminal Type"	SVAV	PARALLEL-PIU
.. PARAMETER "FM EC12 Cool EIR"	RAMETER "FM EC12 Cool	0.324
.. PARAMETER "FM EC12 HR Flag"	NO	NO
.. PARAMETER "FM EC12 Exh kW/cfm"	0.00058	0.00056
.. PARAMETER "FM EC12 Sup kW/cfm"	0.00058	0.00056
.. PARAMETER "OW EC345 Cool EIR"	0.324	0.324
.. PARAMETER "OW EC345 HR Flag"	NO	NO
.. PARAMETER "OW EC345 Exh kW/cfm"	0.00058	0.00056
.. PARAMETER "OW EC345 Sup kW/cfm"	0.00058	0.00056
.. PARAMETER "Boiler HIR"	1.333333333	1.075268817
.. PARAMETER "PV Cap"	0.1	50
.. $ Ellipsis req'd after each param		
##include	OfficeFleet3.in	OfficeFleet3.in

Managing Run Input and Output

AEC Runmanager

	Baseline	Proposed
Floor Area (sf)	63,182	63,182
File	AE-Baseline0.sim	Proposed.sim
Date and time	6/25/2009 15:58	6/25/2009 15:58
Total Costs ($)	Baseline	Proposed
Electric - Total	$86,709	$55,256
Electric - Demand	$53,020	$32,972
Electric - Consumption	$33,689	$22,284
Natural Gas	$53,756	$23,214
Total	$140,465	$78,470
Savings	$0	$61,995
Percent Savings	0.00%	44.14%



SV-A: System Name	SV-A: System Type	SV-A: System Area (sf)	SV-A: System OA fraction	SV-A: Supply Fan (cfm)	SV-A: Return Fan (cfm)	SV-A: Supply Fan (kW)	SV-A: Return Fan (kW)	SS-A: Peak Cooling Load (kBtu/hr)	SS-A: Peak Heating Load (kBtu/hr)
S1 PIU Occupied Office	PIU	16548	0.175	16650	16650	15.612	6.211	317.131	-473.522
S2 PVVT UnOccup Off Wrhs	PVVT	2560	0.142	1748	1748	1.022	1.022	39.238	-67.479
S3 PVVT UnOccup Off Wrhs 2	PVVT	3500	0.16	2117	2117	1.238	1.238	47.137	-70.532
S4 PVVT UnOccup Off Wrhs 3	PVVT	6320	0.16	3824	3824	2.236	2.236	78.786	-132.438
S5 PVVT Fleet NW Corner	PVAVS	1488	0.211	2987	2987	1.747	1.747	73.232	-53.298
S6 PVVT Fleet NW Corner 2	PVAVS	3423	0.416	2259	2259	1.321	1.321	60.262	-114.784
S7 PVVT Freds Garage	PVVT	29342.5	0.807	57542	47129	53.956	7.256	1396.094	-4832.051

Green Building Submittal Requirements

LEED NC EAc1 (Energy Optimization)

- *Performance Requirements*
  - NC v. 2.2 – 14% below 90.1-2004 (June 2008)
  - NC v. 2009 – 10% below 90.1-2007 (July 2009)
  - 25% plug loads else explain
  - Same level of service between Baseline and PD
  - Adhere to Credit Interpretation Requests (CIRs)
  - Adhere to District Energy System/ CHP White Papers
- *Submittals (2 chances else paid for appeal)*
  - *16-page PDF form w/ ~ 300 entries*
  - *Zones out of range documentation*
  - *Explanation of exceptional calcs or CIRs*

LEED NC EAc1 (Energy Optimization)

- *Challenges*
  - *Modeling focus may differ for LEED projects*
  - *Submittal acceptance not guaranteed*
  - *Reviewers' checklists are a moving target*
  - *Keeping up with CIRs not easy*
  - *CIRs not always consistent with ASHRAE's intent*
  - *LEED reviews and CIRs now will be addressed by GBCI*

LEED NC EAc5 (M&V)

- *Intent*
  - *Provide on-going accountability of energy performance*
- *Performance Requirements*
  - Develop and implement M&V Plan in accordance with IPMVP Volume III
- *Submittals*
  - *M&V Plan*
  - *Identification of persons involved to implement*

LEED NC EAc5 (M&V)

- *Challenges*
  - *Intent and focus of reference document seem inconsistent*
  - *USGBC has provided limited guidance to date on interpretation flexibility*
  - *Modeling firm may not be M&V firm*

Commercial Building Federal Tax Deductions

- Requirements
  - Use approved energy modeling software
  - ASHRAE 90.1-2004 Appendix G
  - ASHRAE 90.1-2001
  - Title-24 operating schedules
- Submittals
  - Simple forms

Commercial Building Federal Tax Deductions

- *Challenges*
  - *eQUEST not approved*
  - *Baselines, baselines, baselines ….*

EPAct 2005 for Federal Facilities

- *Performance Requirements*
  - Reduce energy use to 30% below 90.1-2004 with process loads excluded
  - Reduce fossil fuel related energy consumption to 55% 2003 levels in 2010
- *Submittals*
  - *Typical report with performance calc*

EPAct 2005 for Federal Facilities

- *Challenges*
  - *Subject to interpretation - "if cost effective to do so"*
  - *Method to demonstrate compliance with fossil fuel reduction requirement unclear*
    - *CBECS 2003*
    - *Source energy use*
    - *Target finder or CBECS published table*

Summary of Application Challenges

- Too many baselines
- Many different way to interpret baselines
- LEED => commodity modeling
- Big analysis bottle neck in SDs
- Modeling requirements differ over building life cycle

Opportunities

- *Private Sector*
  - *Get involved with organizations setting requirements (USGBC, ASHRAE, DOE)*
  - *Educate your clients*
  - *Differentiate yourself by your expertise*
  - *Provide tools and training*

OR

Opportunities – Short Term

Professional / Federal Organizations

ASHRAE, USGBC, IBPSA, IPMVP, DOE

- *Provide pre-processing calculators*
- *Provide parametric capabilities in spreadsheet-like format Provide simplified methods in addition to sophisticated energy modeling software*
- *Compile metrics specifically to support QC efforts*
- *Use market expansion as opportunity to retrain the work force (technicians, core analysis, specialists)*
- *Develop continuing education curriculum*

……and do it right away

Opportunities – Long Term

Professional / Federal Organizations

ASHRAE, USGBC, IBPSA, IPMVP, DOE

- *Provide modeling certification testing*
- *Coordinate on baseline interpretations / definitions*
- *Promote consistent interpretations of baselines*
- *Include baseline creation within software*
- *Expand dataset for benchmarking performance with absolute performance scale*
- *Develop modeling resources (Wiki, case studies, simplified methods, strategy filter)*
- *Perform research to support elegant integrated design solutions*

Discussion

Issue	Short Term	Long Term
Modeling Services	ASHRAE Certification	
Baselines (Coordination, Interpretation, Wizards)		COMNET
Performance Benchmarks	CBECS	CA ruling
Modeling Over Building Life		
Modeling Resources	Case Studies	Wiki