Sensitivity Analysis: Effect of windows Area on annual energy performance

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CEERE, Umass

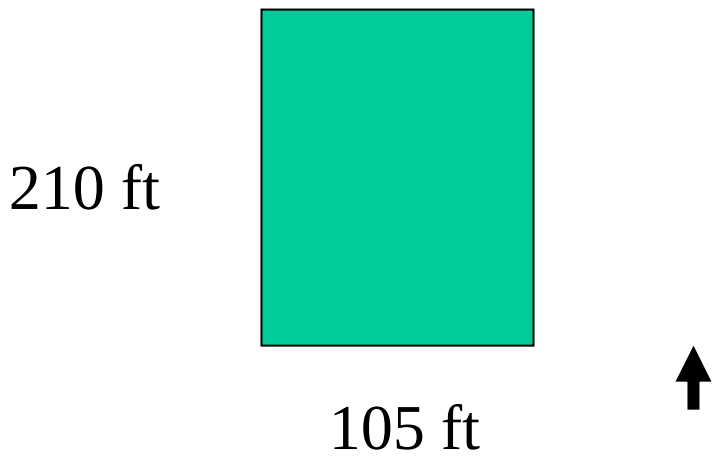
Description of building

Area of building :	176,904 ft^2				
No of Floors:	9				
Window area :	N	S	E	W	Total
	7305	7456	15277	14964	45002

Type of windows:

Type:	GL-1A,	GL-1B,	GL-2A,	GL-3A,	GL-3B,	GL-3C,	GL-4B
%	48.9,	21.7,	7.7,	1.2,	15.6,	4.7,	0.2

Building Plan:~~



Defaults for the analysis:

Construction

Wall: U-VALUE = 0.1431 BTU/HR-SQFT-F

[Steel Siding (AS01), Plywd 5/8in (PW04), Polystyrene 1in (IN33), EWall Cons Mat 3 (0.91), GypBd 1/2in (GP01)]

Roof: U-VALUE = 0.0428 BTU/HR-SQFT-F

[Blt-Up Roof 3/8in (BR01),Plywd 5/8in (PW04),Polyurethane 3in (IN46),Roof Cons Mat 4 (2.8)]

Systems:

Cooling: DX Coils

Heating: DX Coils (Heat Pump)

Type: Split type single zone heat pump

Occupant Density:	150 sf/person
Lighting :	1.3 W/sq ft
Task lighting:	0.4 W/sq ft
Plug load:	1.5 W/sq ft
Ventilation:	15 CFM/person
Schedule:	US office

Thermostat set points:

Cooling :	76 (occupied)	82 (unocc)
Heating :	70 (0ccupied)	64 (unocc)

Design Temperatures:

	Indoor	Supply
Cooling	75	55
Heating	72	105

Window Types (for sensitivity analysis):

Performance		U Value	Transmittance
Bad (B)	SG-CL	1.003	0.898
Average (A)	DG-CL	0.547	0.812
Good (G)-H	TR-low-e	0.186	0.696
Good (G)-C	DG-Ref	0.353	0.045

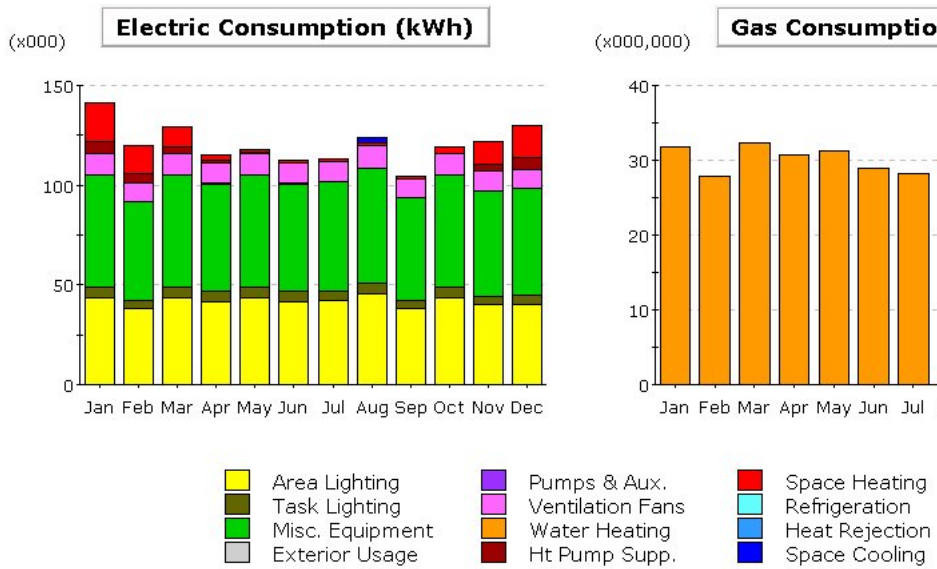
Variations considered:

- Windows: [80% Major, 20% Minor], [95% major, 5% Minor]
- Locations: California, Amherst (MA), Adak (Alaska), Dallas(Tx), Lake City (FL),

- 9 Combinations:

GG	GA	GB
AG	AA	AB
BG	BA	BB

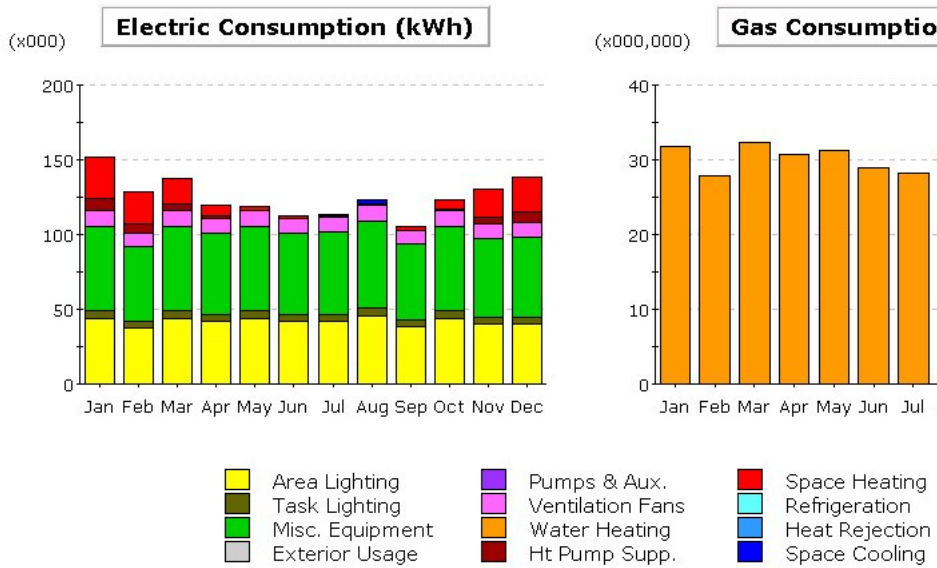
Annual Energy consumption for Alaska (GG, 80%20%)



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	0.3	2.8	-	-	-	-	3.0
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	19.3	14.0	9.5	2.7	1.7	1.6	1.3	1.4	1.5	3.1	11.1	16.6	83.7
HP Supp.	6.4	4.8	3.7	1.4	0.7	0.3	-	0.0	0.0	0.4	3.7	5.8	27.2
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	10.5	9.1	10.5	10.1	10.5	10.1	10.1	11.0	9.1	10.5	9.6	9.6	120.7
Pumps & Aux.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	56.4	49.7	56.4	54.2	56.4	54.2	55.0	57.8	51.3	56.4	52.7	53.5	654.0
Task Lights	5.0	4.4	5.0	4.8	5.0	4.8	4.8	5.3	4.4	5.0	4.6	4.6	57.8
Area Lights	43.7	37.9	43.7	41.7	43.7	41.7	41.9	45.5	38.1	43.7	39.9	40.0	501.5
Total	141.5	119.9	128.9	115.0	118.2	112.8	113.3	123.9	104.5	119.2	121.7	130.2	1,449.0

Annual Energy consumption for Alaska (GB, 95% 5%)



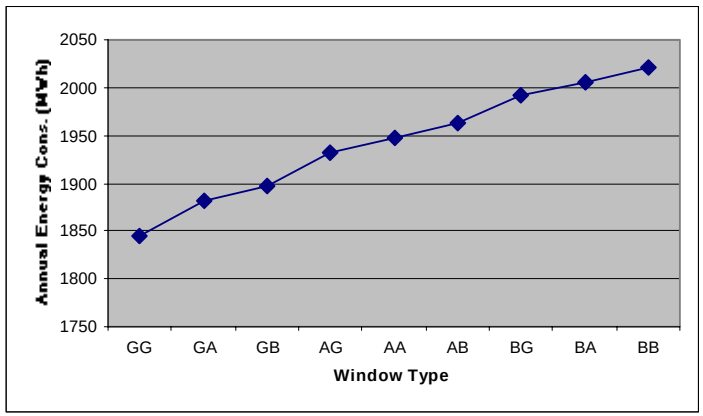
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	0.2	2.7	-	-	-	-	3.0
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	28.0	21.1	17.2	7.3	2.4	1.5	1.0	0.8	2.3	6.9	18.9	23.7	131.1
HP Supp.	8.0	6.2	5.0	1.6	0.5	0.2	-	0.0	0.0	0.8	4.7	7.0	34.1
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	10.5	9.1	10.5	10.1	10.5	10.1	10.1	11.0	9.1	10.5	9.6	9.6	120.7
Pumps & Aux.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	56.4	49.7	56.4	54.2	56.4	54.2	55.0	57.8	51.3	56.4	52.7	53.5	654.0
Task Lights	5.0	4.4	5.0	4.8	5.0	4.8	4.8	5.3	4.4	5.0	4.6	4.6	57.8
Area Lights	43.7	37.9	43.7	41.7	43.7	41.7	41.9	45.5	38.1	43.7	39.9	40.0	501.5
Total	151.7	128.4	137.9	119.8	118.7	112.6	113.1	123.3	105.3	123.5	130.5	138.5	1,503.2

Annual Energy consumption (Amherst)

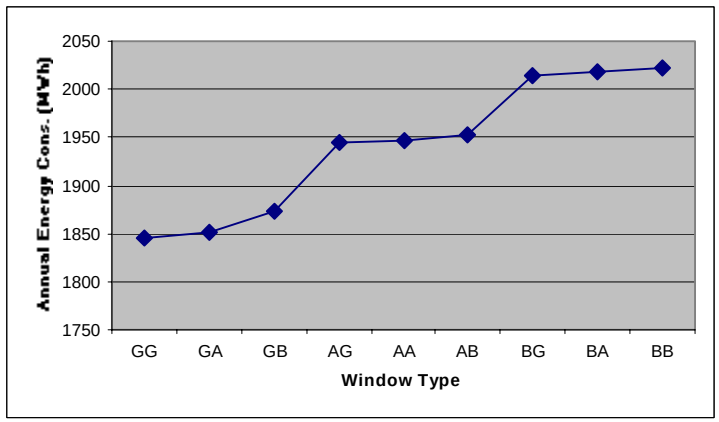
80% 20%

Energy consumption		
	MWh	Diff (%)
GG	1449	-
GA	1474.2	1.74
GB	1503.2	3.74
AG	1550.5	-
AA	1578.7	1.82
AB	1610.7	2.03
BG	1680.6	-
BA	1707.3	1.59
BB	1737.3	3.37



95% 5%

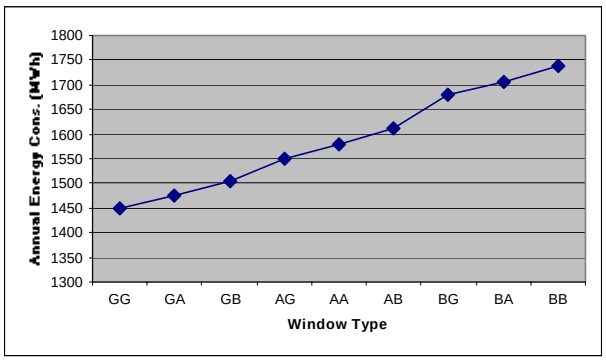
Energy consumption		
	MWh	Diff (%)
GG	1844.9	-
GA	1850.8	0.32
GB	1872.2	1.48
AG	1944.5	-
AA	1947.4	0.15
AB	1951.7	0.22
BG	2014.2	-
BA	2017.6	0.17
BB	2021.5	0.36



Annual Energy consumption (Alaska)

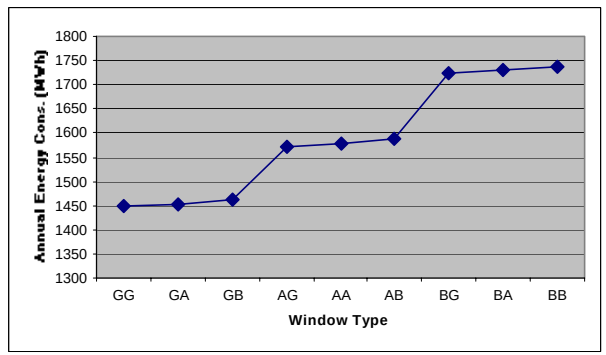
80% 20%

Energy consumption		
	MWh	Diff (%)
GG	1449	-
GA	1474.2	1.74
GB	1503.2	3.74
AG	1550.5	-
AA	1578.7	1.82
AB	1610.7	2.03
BG	1680.6	-
BA	1707.3	1.59
BB	1737.3	3.37



95% 5%

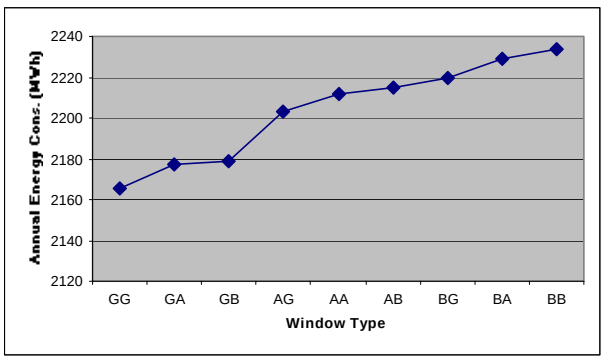
Energy consumption		
	MWh	Diff (%)
GG	1448.9	-
GA	1452.1	0.22
GB	1460.7	0.81
AG	1571.7	-
AA	1578.9	0.46
AB	1587.3	0.53
BG	1724.1	-
BA	1730.3	0.36
BB	1737.4	0.77



Annual Energy consumption (Dallas)

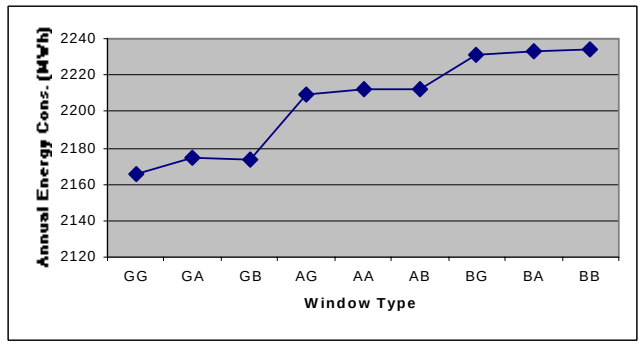
80% 20%

Energy consumption		
	MWh	Diff (%)
GG	2165.7	-
GA	2177.3	0.54
GB	2179.2	0.62
AG	2202.9	-
AA	2211.6	0.39
AB	2215.1	0.16
BG	2219.4	-
BA	2229.4	0.45
BB	2234	0.66



95% 5%

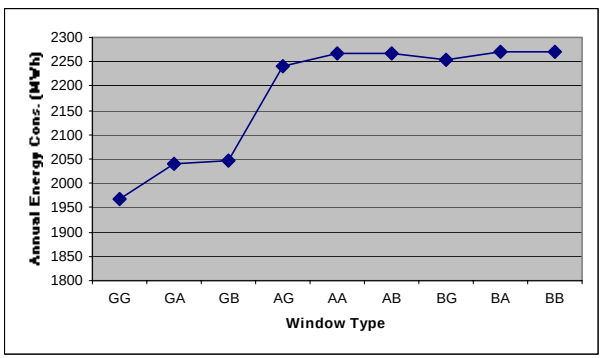
Energy consumption		
	MWh	Diff (%)
GG	2165.9	-
GA	2174.2	0.38
GB	2173.8	0.36
AG	2209	-
AA	2211.8	0.13
AB	2212.4	0.03
BG	2230.9	-
BA	2232.6	0.08
BB	2234.2	0.15



Annual Energy consumption (Florida)

80% 20%

Energy consumption		
	MWh	Diff (%)
GG	1968.4	-
GA	2041.3	3.70
GB	2047.1	4.00
AG	2240.4	-
AA	2267.4	1.21
AB	2268.5	0.05
BG	2253.5	-
BA	2270.4	0.75
BB	2271.4	0.79



95% 5%

Energy consumption		
	MWh	Diff (%)
GG	1968.5	-
GA	1992.5	1.22
GB	1995.5	1.37
AG	2285.4	-
AA	2267.8	-0.77
AB	2268	0.01
BG	2263.1	-
BA	2273.1	0.44
BB	2273.3	0.45

Conclusions

• 20% windows are not modeled: the max. difference in energy consumption is : California, Florida, Amherst ( ),