A PAPER ON APPLICATION OF GREEN TECHNOLOGY IN REAL ESTATE SECTOR

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Abstract:- *This paper proposes to study about energy performance and life cycle cost of a particular green technology i.e. electro chromic systems for smart windows make it possible to enhance energy efficiency in the construction sector, in both residential and tertiary buildings. The dynamic modulation of the spectral properties of a glazing, within the visible and infrared ranges of wavelengths, allows one to adapt the thermal and optical behavior of a glazing to the ever-changing conditions of the environment in which the building is located. This allows appropriate control of the penetration of solar radiation within the building.The review aims at a critical review of the relevant literature concerning the benefit obtainable in terms of energy consumption and visual comfort, starting from a survey of the main architectures of the devices available today.*

Keywords:- ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers), Department of energy,Electrochromic Glass,Heating Vantilation and Cooling,Lawrence Berkley National Lab,Life Cycle Cost,LEED,Solar heat gain coefficient,Visible transmittance,Window wall ratio.

1. INTRODUCTION

This paper attempts to provide the reader a complete information about the efficiency of a building using a green technology. The building sector is considered to be the largest single energy consumer in Europe, absorbing approximately 40% of final energy for heating, cooling, ventilation, artificial lighting, and various appliances. Specifically, non-residential buildings are responsible for 14% of the total energy use in the. About 75% of buildings are still energy inefficient and greenhouse gas emissions created by building energy use are a main cause of global warming and climatic change . As a result, energy conservation has become one of the main targets of energy policies and has a significant effect on the decision-making process of architectural design. Recently, building facades can be designed with a higher Window Wall Ratio (WWR) than the code prescriptive maximum through the use of high-performance glazing systems, including different dynamic switchable glazing that may or may not be used in combination with interior or exterior shading. It has been estimated that the WWR of office buildings built in Europe before 1980 is approximately 30%, while offices that were constructed later have a WWR of 60%. Modern architectural trends include office buildings with high WWRs to take advantage of the available daylight and decrease electric lighting use.

2. LITERATURE REVIEW

Electro chromic glass is a window material that darkens when a voltage is applied to the glass.This darkening of the glass reduces the transmission of visible and infrared sunlight. When this glass is used in a typical double-paned window, it helps reduce the heat load in a building that comes from solar irradiance. The electrochromic device, applied to a single glass surface, is formed via a stack of five thin coatings applied to the inner surface of the outer pane of glass in an insulated glass unit (IGU).

All energy calculations in this proposal include this small energy consumption.Impact on Leadership in Energy and Environmental Design (LEED) and American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Requirements Use of dynamic glass is explicitly recognized and accepted by the current ASHRAE Standards. ASHRAE 90.1–20166 describes the specific treatment of dynamic glass in determining project compliance either by the prescriptive or performance paths. With technology/product acceptance ensured, dynamic glass is a preferred project component based upon its energy performance and code-required savings objectives.

Previous studies have pointed out a correlation between the lack of windows in the workplace and job dissatisfaction, feelings of isolation, depression, claustrophobia, restriction, and tension. Some researches concluded that sunlight penetration has a considerable and direct impact on job satisfaction and reduces the intention to quit. Due to which it was also deduced that a view of natural elements can offset the negative effect of occupational stress on intention to quit more effectively than residential and urban scenes.. In the past, architects have been hesitant to include large window areas in their constructions due to their higher thermal transmittance values compared to the opaque elements of the building envelope.

2.1 Advantages of this technology

1. Cuts solar heat by 75% in the summer: Dynamic glass has an SHGC that can be tuned as low as 0.09 in the summer compared to 0.38 for a typical static low-e window. Dynamic windows can cut solar heat gain by approximately 75%, thereby reducing the cooling load on peak days and throughout the cooling season. For installations with older generation clear glass, the current SHGC may be as a high as 0.60, allowing for greater potential savings.

2. Increases solar heat by 33% in the winter: With an SHGC that can be tuned as high as 0.46 (versus the 0.38 for typical low-e glass), dynamic windows can allow 33% more passive solar heating than static low-e, reducing heating load in the winter.

3. Reduces whole-building peak-load: Replacing existing clear glass with low-e glass can reduce a buildings peak load by approximately 20%. Use of dynamic glass can double this benefit to a 20+% peak load reduction. This peak load reduction can result in smaller, less expensive replacement HVAC systems during renovation cycles.

4. Reduces transmitted light by 95%: With a visible light transmittance (Tvis) that can be tuned as low as 3%, dynamic windows can reduce the incoming light by 95% below low-e (Tvis ~70%). This light mitigation can prevent glare and visual discomfort in a variety of working environments. It also has the secondary benefit of improving occupant comfort without compromising outdoor views lost via the use of blinds and shades.

5. Significantly improves daylighting: With shade-free operation and Tvis that can be tuned as high as 58%, dynamic windows can allow for higher average daylight use over low-e with blinds, thereby reducing artificial lighting energy. Analysis of multiple office building in various settings has revealed that typical natural light levels are 2–3 times higher (a 100– 200% increase) for workspaces with dynamic glass versus blinds and shades.

3. METHEDOLOGY

- ➢ Build Base case: ASHRAE compliant office prototype building
- ➢ Introduce market available electrochromic windows
  - • Selection of Control trigger
  - • Definition of control trigger range -: Sensitivity check for trigger range with respect to each orientation.
- ➢ Simulate the building energy performance:
  - • Specify daylighting and non-daylighting
  - • Specify 20% and 40% Window Wall ratio
  - • Specify Orientation with electro chromic glazing
- ➢ Calculate life cycle cost of electro chromic windows.
  - • Input glass investment cost
  - • Input Fuel Price Escalation (Electricity)

4. TOOLS USED

DOE-2 is energy simulation software used to analyze the energy performance of the building. It is one of the most developed tools used for building energy simulations and features a user interface which facilitates easy input of building parameters. E QUEST was designed to allow you to perform detailed analysis of today's state-of-the-art building design technologies using today's most sophisticated building energy usage simulation techniques but without requiring extensive experience in the "art" of building performance modeling. (eQUEST, DOE-2). DOE-2 has been developed for use by architects, engineers and other energy agencies to analyze the building energy performance before starting the project. This tool helps to analyze the complex algorithms related to building energy performance by yielding output in the form of simple statistical data, which can be interpreted by non-technical individual.

4.1 Models in Equest

Model used as base case is compliant with prototype commercial office building according to ASHRAE. All the variables are as per ASHRAE . Window-wall ratio is taken from prototype building i.e. 40%. Glass type used in base case has similar properties as ASHRAE glass. All other remaining parameters including the HVAC systems are taken from appendix . Refer Table1. for design parameters assumed for base case simulation run.

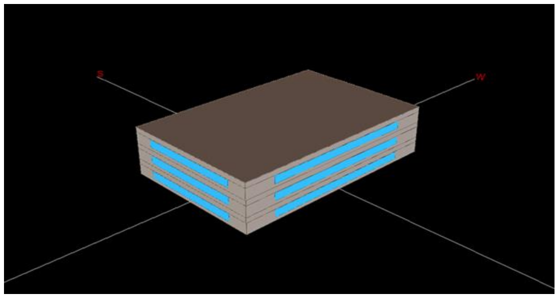

Figure 1: simulated eQUEST model for medium office building.

General	
Building Prototype	Medium Office
Total Floor Area	53,600 sf
Building Shape	Rectangular (163.8 X 109.2 ft)
Aspect Ratio	1.5
Number of floors	3
window wall ratio	40%
Shading Geometry	None
Thermal Zoning	Perimeter zone depth: 15 ft. Each Floor has Four perimeter and one core zone. Percentage of floor area: Perimeter 40%, Core 60%
Floor to floor height	13ft.
Floor to ceiling Height	9 ft. (4ft. Above ceiling plenum)
Glazing sill height	3.35 ft
Exterior walls	Steel Framed Wall
Roof	Insulation entirely above deck, metal deck roof
Foundation	8 inch concrete slab-on-grade floors (unheated)
Interior partitions	2 X 4 uninsulated stud wall
`Internal mass	6 inches standard wood (16.6 lb/ft^2)
Infiltration	Peak: 0.2016 cfm/sf of above grade exterior wall surface area (when fans turn off) off Peak: 25% of peak infiltration rate (when fans turn on)
Internal Loads & Schedules	
Lighting power density (W/ft^2)	Building average, 1.00
Plug load power density (W/ft^2)	Building average, all zones 0.75

Occupancy	268 Total (5 person/ 1000 sf)
HVAC	
System Type	
Heating type	Gas furnace inside the packaged air controlling unit
Cooling type	Packaged air controlling unit
Distribution and terminal units	VAV terminal box with damper and electrical reheating coil. Zone control type: minimum supply air at 30% of the zone design peak supply air.
HVAC Control	
Thermostat set point	74^{0}F Cooling/ 72^{0}F Heating
Thermostat setback	80^{0}F Cooling/ 60^{0}F Heating
Supply air temperature	Maximum 110^{0}F, Minimum 52^{0}F
Ventilation	20 cfm/person
Demand control ventilation	No
Energy recovery	No
Supply Fan	
Fan type	Variable air volume
Supply fan total efficiency (%)	57% to 60% depending on the fan motor size
Supply fan pressure drop	3.5" water
Service Water Heating	
SWH type	storage tank
Fuel type	Natural gas
Thermal efficiency (%)	80%
Tank volume (gal)	260
Water temperature set point	120^{0}F
Misc.	
Exterior Lighting	
Peak power	2730 W

4.2 Selection of Control Trigger

e-QUEST, DOE-2 software was used to studying the behavior of electrochromic glass and to determine the most appropriate control trigger. e-QUEST does not have any default control trigger for electrochromic windows. The available control triggers options in e-QUEST are total solar radiation, solar transmittance, outdoor temperature, space loads and daylighting level. e-QUEST has the limitation of analyzing a single control trigger during each simulation

4.3 Initial Cost

Specification	ASHRAE glass	SAGE EC glass
Glass Cost	Rs 1520	Rs 4750
Controls and Wirings	--	Rs 840
“Occupant override” wall switches:	--	Rs 52.5
Total:	**Rs 1520/ sq.ft**	**Rs 5642.5/sq.ft**

Table 1: Cost of glazing system per square foot.

5. ENERGY RESULTS

To reduce the energy consumption, several possible control triggers, which modulate the property of electro chromic glass, were studied. During the process of selecting the most appropriate control trigger, and associated trigger range was established using simplified glass method.

Sr No	Specification	Space Cooling	Lighting	Space Heating	Electricity mKwh	Natural Gas M Btu	Energy Bills	Energy Savings (%)
0	Base Case	161.52	113.4	114.11	596.52	226.19	$80,434	
1	Space Load	141.4	119.9	128.33	569.26	240.57	$77,002	4.27%
2	Outdoor Temperature	164.3	116.97	136.26	602.36	248.38	$81,418	-1.22%
3	Total Horizontal Radiation	167.89	115.71	155.51	606.95	267.57	$82,209	-2.21%
4	Daylighting	154.92	112.44	154.17	582.41	266.37	$78,980	1.81%

Table 2: Energy Savings for different control triggers

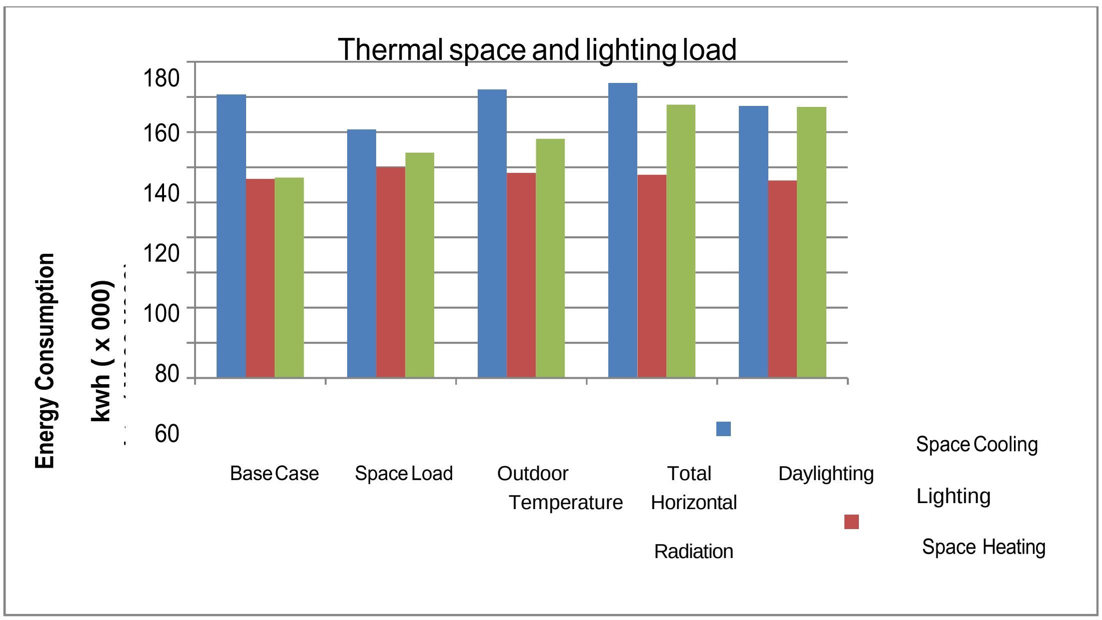

Figure 2: Comparison of space conditioning and lighting energy consumption for different control triggers.

Before analyzing different variable which includes building parameters and economic variables, it is very important to learn the real-time tradeoff between reduced energy consumption and payback period with respect to selection of orientation which is justified for installation of electrochromic windows.

	Orientation				Energy Consumption		Simple Payback (years)	Net Savings
	South	East	North	West	Electric. (Kwh X 000)	N. Gas (Btu X000000)		
1	SAGE	SAGE	SAGE	SAGE	591.75	224.25	90.73	-$414,753
2	SAGE	SAGE	ASHRAE	SAGE	596.07	211.09	76.4	-$269,089

3	SAGE	SAGE	SAGE	ASHRAE	599.5	227.28	89.28	-$344,519
4	SAGE	ASHRAE	SAGE	SAGE	603.69	227.62	105.58	-$339,761
5	SAGE	SAGE	ASHRAE	ASHRAE	603.79	214.53	71.04	-$198,855
6	SAGE	ASHRAE	ASHRAE	SAGE	607.82	217.11	88.37	-$194,097
7	SAGE	ASHRAE	ASHRAE	ASHRAE	612.40	219.82	83.52	-$123,863

Table 3: Tradeoff between reduced energy consumption and payback period with respect to selection of orientation

Thus, the electrochromic windows were only simulated in south and east façade while the north and west façade featured ASHRAE glass. Relative to the proposed case with SAGE glass in all orientation, the case which features electrochromic on only south and east façade demonstrate a comparable annual energy cost, however initial glass cost was much less. As a result, the simple payback and net saving were more favorable for south and east façade configuration.

Orientation				Glass Cost	HVAC cost	Energy Cost		
South	East	North	West			Electric	N. Gas	Total
SAGE	SAGE	SAGE	SAGE	$747,419	$519,633	$77,580	$2,252	$79,832
SAGE	SAGE	ASHRAE	ASHRAE	$480,179	$547,962	$79,488	$2,244	$81,732
Savings				$267,240	-$28,329	$1,908	-$8	$1,900

Comparison between SAGE electrochromic in all orientation and south/east orientation for

6. CONCLUSION

Electrochromic window can switch its thermal and optical properties by using control trigger. The ideal concept of architects that energy consumption increases with the increase in window wall ratio needs to be changes. In case of electrochromic technology, the difference of the energy saving increases with the increase in window wall ratio. Thus, thought that the energy consumption with increase in window wall ratio needs to be changed by introducing electrochromic glass technology, as the increase in Window wall ratio reduces significant amount of energy consumption.Electrochromic windows reduce the annual energy consumption for all orientation, however the reduction in annual energy consumption for north and west façade is too low, and that installation of this technology is not worth paying. All the above listed performance factors and LCC parameters were simulated to lower the annual energy consumption and shorten simple payback period for electrochromic technology, still the net saving at the end of LCC span is negative, which indicates that the economic value for electrochromic technology needs to be lowered at least 50% to penetrate the commercial market. If the initial cost for manufacturing glass is lowered 50% due to mass production or any rebates offered for installing this technology can make this technology feasible.

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