Electrochromic Windows: Return on Investment Analysis

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In recent years, sustainability in construction has become a topic of undeniable interest. With sustainability certifications becoming more prominent and desirable, members of the construction industry have begun to seek alternatives for standard systems to keep up with market trends. One of the main issues that the construction industry faces is accessibility of technology. While there are new products and technologies being released frequently, members of the construction industry lack knowledge on the specific details and implications of working with newer systems. One piece of technology that was recently introduced is electrochromic glass, or smart glass. Electrochromic windows analyze sunlight and heat exposure in their surrounding environment and change their opacity accordingly to better utilize the natural environment to increase indoor environmental quality. This report will explore the advantages, accessibility, and feasibility of utilizing electrochromic windows, ultimately concluding in a Return on Investment (ROI) analysis. There currently is limited data on the usage and/or effectiveness of this technology as it is relatively new, having only appeared in the industry 12 years ago. Through material data analysis and conducting an interview with a smart glass supplier, the current effectiveness and implications of electrochromic technology have been analyzed in this report.

Key Words: Sustainability, Return on Investment, Technology, Glazing, Indoor Environmental Quality

Introduction

Indoor environmental quality control is a cornerstone of creating a functional building. In order to keep up with market trends, the construction industry is beginning to explore alternatives to standard systems. Additionally, third-party certifications, such as LEED (Leadership in Energy and Environmental Design) credentials, increase a building's value and are becoming highly sought after by building owners and contractors, alike.

One way to achieve a higher LEED rating is by reducing building energy consumption. This includes costs for heating, cooling and lighting. Electrochromic glass, or smart glass, is an emerging technology that works to utilize natural lighting and heat for the benefit of the building and its occupants through altering its opacity. This technology can greatly reduce energy and capital spent on temperature control and lighting, especially for buildings with large glazing systems that are exposed to the sun. While smart glass comes at a higher purchasing price than regular glazing, an electrochromic window system has the ability to influence building energy and atmosphere, indoor environmental quality, and innovation in the design process – all three of which are key categories in the LEED rating system. Due to higher pricing and the relative newness of the electrochromic technology, the construction industry is generally uninformed on its feasibility.

Literature Review Discussion

Electrochromic technology is a relatively new in the construction industry. As a result of this, there are only a few suppliers in the United States, which makes product data scarce. One of the main features of electrochromic technology is its energy-saving capabilities. There have been numerous articles written on the advantages of electrochromic technology, however a financial analysis including a return on investment is nonexistent on the internet. This report utilizes data obtained from an interview with a sales representative of Halio, Inc. Through various case studies conducted within the Halio organization, comparative financial data has been gathered and compiled for the sake of market competitiveness. Keeping this in mind, the numbers in this report are derived from industry averages, and only the cost of Halio, Inc. products were provided. An ROI analysis would not be achievable with the current data available to the public for electrochromic devices. Additionally, the financial data relies on case-studies with specific environmental conditions to the buildings' geographic locations. Electrochromic technology may not be applicable in every project depending upon the building's exposure to the environment.

About Electrochromic Technology

Appearing around 2010, electrochromic systems have been a great example of increasing mechanization in construction materials. Currently, there are three major companies in the U.S. that produce electrochromic products: Halio, Sage Glass, and View. All three utilize the electrochromic technology in different ways, with Halio producing the most advanced units. Electrochromic devices are great alternatives to standard glazing systems for modern building designers due to their ability to allow for more design freedom. By eliminating the need for shades or shade structures, electrochromic windows open a new avenue for attractive, functional exterior glazing systems.

Electrochromic technology is advantageous for many reasons, including the sustainable ability to control indoor environments, savings on energy, aesthetics, and design, as well as higher levels of comfort for building occupants. While smart glass units are more expensive than standard glazing, they provide a multitude of long-term benefits that are difficult to obtain without major building design implications. Electrochromic technology is essentially an electronic screen inserted between two panes of glass that responds to a central weather and sunlight monitoring system. Throughout recent years, smart glass suppliers have been improving their technology to increase its useability, including creating applications for phones that allow the user to manually alter the amount of tinting in the glass. As seen below, the electrochromic device contained within Halio's units is a thin sheet of energy conducting material that is connected to the central data system via the data line visible at the bottom right or the device. Recent developments have worked to create a product with both a practical application and a streamlined control system.

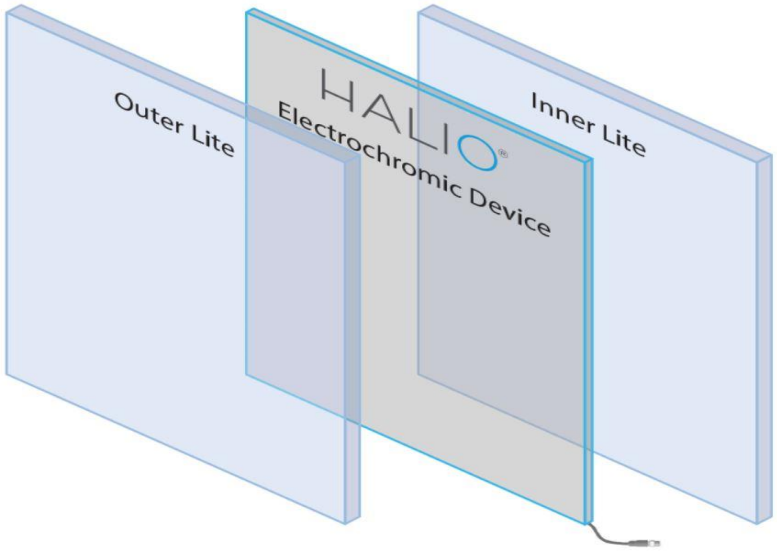

Figure 1 – Halio Glass Product Assembly Diagram
Source: (Halioinc.com)

Current Utilization of Electrochromic Technology

Smart glass has yet to become a highly sought-after design implementation as the construction industry is generally slow to adapt to new processes and products. However, there has been a minor shift in industry standards in recent years, with a higher focus on sustainable buildings and visual splendor in order to keep up with market trends. In an interview conducted with Crystal Peterson of Halio, Inc., information regarding the product's marketability was disclosed, and Halio as a company expects a compound annual growth rate of 17.8% (Peterson). In another study conducted by GlobeNewswire, the smart glass market is predicted to hold value around $9,083,000,000. Geographically, electrochromic suppliers conduct much of their business in Asia and the Pacific Region due to location of supply chains.

While Halio's business dealings are not on public record, there are examples of projects that have utilized Halio electrochromic glass. Most notably in South San Francisco, there are multiple commercial office buildings owned by Alexandria Real Estate (ARE) that contain large glazing walls that are fully exposed to sunlight. In an interview with Cory Keller, VP of Operations for Truebeck Construction, the general contractor assigned to the ARE projects, it was disclosed that the Halio window units were a challenge for the contracting team to work with due to a lack of experience with the product and the introduction of new technical systems to the building design. While there are examples of product utilization, smart glass has yet to emerge in the mainstream market. In the below figure, we see a photo taken from a "smart home" in San Francisco, CA. Note the varying tint levels on the Halio, Inc. electrochromic windows help to allow for plenty of natural lighting and heat control.

Figure 2 – Halio Glass Product Display
Source: (Halioinc.com)

Methodology

The primary methodology used for this report consists of interviews with material suppliers to obtain quantitative data on the product, as well conducting an interview with a construction management professional to portray the market's current general view and experiences with the product. The analysis will include an evaluation of cost implications associated with smart glass, as well as the advantages and disadvantages of utilizing this technology, using data obtained from the interview with the Halio, Inc. representative.

The objectives of this report are as follows:

- Conduct an interview with smart a glass supplier to obtain product data and details
- Retrieve testimony from construction management professional regarding experiences with smart glass technology
- Complete a return on investment (ROI) analysis of electrochromic products in comparison to standard glazing systems
- Give an objective analysis of electrochromic technology's effectiveness and current market feasibility

Results

Sustainability and The Construction Market

A new standard for buildings caters towards sleek exterior designs, which does not leave much freedom to add shade structures without altering a building's aesthetic appeal. Many designers are searching for new materials and construction technology to increase the value and aesthetics of buildings. In addition to a building looking pristine, other sought after building features are sustainability and focus on green technology. According to Lynn Pollack, of GlobeSt.com, buildings with "LEED-certified assets have commanded a 21.4% higher average market sales price per square foot over their non-LEED counterparts". Choosing electrochromic technology gives a building owner the opportunity to create a competitive edge for their organization's PR messaging, as well future-proof their building against climate change and shifting building codes. Currently, "39% of Global CO2 is generated by buildings and building construction" (GABCA). Reportedly, Halio glazing can reduce a building's CO2 emission by 16%-20%. This includes the reduced requirement for building energy consumption related to heating and cooling, of which Halio cuts the need by up to 20%. The below figures outline global CO2 emissions and their sources, as well as Halio's advantages in sustainability.

Figure 3 – CO2 Emissions and Halio Advantages
Source: (Halio, Inc.)

IMPLICATIONS OF TECHNOLOGICAL DEVELOPMENT

Many design professionals consider price as well as quality when choosing building materials. Though new devices and technology are generally more expensive than their standard counterparts, there are benefits to efficiency and quality with more current products. The prospect of investing more capital early into a higher quality building is subjective, but there are undisputable benefits to building functionality and value over time. An important note to acknowledge is that upfront costs of a product such as Halio glass may be a deterrent, thus making the utilization of this technology less feasible, especially for smaller organizations with less resources to take advantage of.

For example, if an owner of a construction project has other ventures, they may not have enough extra capital in their budget to pay a higher project price up-front for more expensive technology. Electrochromic windows are electrical units, which means there will be a higher cost associated with the installation of wiring and the windows themselves. Additionally, financially front-loading a construction project with payments has the potential to lead to cash-flow issues for stakeholders in the future.

COSTS OF STANDARD GLAZING VS. COST OF HALIO

Contained in the "Halio Product" chart is the cost breakdown for the 4,359 SF of glazing for the building in question. The analysis takes into account both the product cost and expense for the electrical system incorporated with the Halio glass. The "Standard Glazing" figure refers to the costs associated with a standard window system. The items in the leftmost column denote additions that can be implemented to standard glass units, broken down into cost per square foot, linear foot, or kilowatt hours. The "minimum" column represents the cost of a standard grade window system for the building that does include any additional technology to the glazing units. The "maximum" column represents the cost of standard glass in the most extreme case of additional modification to increase the functionality and indoor environmental quality control capabilities.

Table 1
Cost of Halio Product

HALIO PRODUCT	
Total SF of Glass	4,359
Total SF of Building Floor Plate	29,540
Budgetary Price for Glass	$174,360.00
Budgetary Price for Electronics	$87,180.00
Budgetary Price Total	$261,540.00

Table 2
Cost of Standard Glazing + Additional Fees for Modifications

STANDARD GLAZING + ADDITIONAL FEES FOR MODIFICATIONS	MINIMUM	MAXIMUM
Low-E Glass Cost @ $15 - $25 (per SF.)	$65,385.00	$108,975.00
Low-Iron Glass [Ultra Clear] @ $1 (per SF.)	$0.00	$4,359.00
Accoustical Rating STC 42 [Add Lamination] @ $5 (per SF.)	$0.00	$21,795.00
Interior Blinds or Shades @$12 - $40 (per SF)	$52,308.00	$174,360.00
Safety Glass - HT or FT @ $2 (per SF.)	$0.00	$8,718.00
Exterior Winow Treatments / Shade @ $0 - $80 (per SF)	$0.00	$348,720.00
Dry Wall Pockets for Electric Shade @ $85 (per LF)	$0.00	$37,422.02
HVAC Right Sizing @ $50 (per SF Floor Plate)	$0.00	$147,700.00
10 Year Energy Savings 2kWh - 4KWh @ $0.18 (per kWh)	$106,344.00	$212,688.00
Totals	$224,037.00	$1,064,737.02

HALIO ROI

The chart below analyzes the cost of using Halio's electrochromic product in comparison to standard glazing systems. The minimum category denotes window systems with standard grade rating, and the maximum category denotes the cost of a standard system in the most extreme case of additional modifications. As seen, for a building with 4,359 SF of glazing, the Halio product upcharge amounts to $37,503. Considering annual energy savings of $11,800 (Halio, Inc.), the breakeven point for the glazing cost will be achieved in 3 years and 3 months upon completion of the project.

Table 3

Comparison of Minimum and Maximum Standard Glazing Costs to Halio Cost

NET HALIO UPCHARGE vs. STANDARD	
HALIO Budgetary Price Total	$261,540.00
Standard Glazing System Total	
(Minimum)	$224,037.00
(Maximum)	$1,064,737.02
HALIO Upcharge	
(Minimum)	$37,503.00
(Maximum)	-$803,197.02

The breakeven point for the ROI is dependent upon square footage of the building and how much glazing is included in the building design. For example, a 29,540 SF building, containing 4,359 SF of glass, can have its Halio ROI calculated using the annual energy savings data provided by Halio. A reported average of $11,800 is saved on energy costs throughout projects in which Halio products are utilized. Using this average, the Halio windows will pay for themselves through energy savings over time. For the $261,540 Halio system cost, a return on investment will be achieved in 22.16 years. This number does not include money saved on construction costs, glazing alternatives, and gain in building value.

Best Practice and Conclusion

After reviewing several aspects regarding the feasibility of electrochromic technology, many situational implications arise to consider prior to the deliverance of a clear answer. Electrochromic windows are complex units that require a higher level of investment and expertise to successfully utilize. As the product becomes more popular, the industry will gain more knowledge on how to best use it. At peak effectiveness, electrochromic technology has the ability to dramatically alter the quality and value of a building, increasing the comfortability of its occupants and the indoor environmental quality. Despite the advanced features and functionality of an electrochromic product such as Halio, adequate designing capabilities are needed to maximize window efficiency and take full advantage of the surrounding environment. Considering the above points, and the 3 year and 3 month return on investment period analysis in the "Halio ROI" section of the report, electrochromic windows are a fantastic alternative to standard glazing systems if they can be afforded. The complexity and higher cost of this technology is its main obstacle in achieving competitive utilization rates in the market. Additionally, the construction industry will be forced to shift its focus to sustainable practices to combat increasing stresses on the environment and accessibility of resources, making electrochromic technology an attractive option for designers.

Future Research

Demand for electrochromic windows is on the rise as the construction industry shifts its focus to sustainable practices. While technology advances, the cost of it goes down, leading to an increase in accessibility of newer systems. The market for sustainable practices is bound to see a future increase, creating a new standard for buildings. Data shown in this report suggests that more attention will be given to green buildings in new projects, which inevitably means more usage of electrochromic technology. Future research on this matter could be conducted through tracking suppliers' annual revenues, as well as monitoring the market value of sustainable buildings, such as those with LEED certifications. Electrochromic technology's recent introduction into the construction materials market leaves a lot of room for future development.

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