TOWARD A SUSTAINABLE CAMPUS

ELECTROCHROMIC WINDOWS FOR THE HEALTH SCIENCE EDUCATION BUILDING (HSEB)

PROJECT OVERVIEW

The University of Washington's new Health Science Education Building (HSEB) located on NE Pacific Street on the South end of campus will serve students, faculty and staff for the next fifty years. At the heart of the building, an electrochromic glazing (EC) system contributes to UW campus sustainability by maximizing energy performance, and improving the classroom experience while showcasing a building envelope technology that sets new sustainability standards on campus. It is crucial for University of Washington to invest in new building technologies that can reduce building energy consumption while at the same time improving the student experience and supporting the institutional mission of the University.

ADVANTAGES OF EC GLAZING

Compared to the baseline window glazing option, electrochromic (EC) glazing directly impacts occupant's physical and psychological comfort by improving interior daylight and temperature conditions. Additionally, EC glazing provides better views outside without the need for blinds and saves energy by reducing the cooling load.

WELLNESS

- Increase student health and wellness
- Improve education outcomes

ENERGY

- Increase thermal comfort
- Reduce building peak cooling load

VIEWS

- Optimize interior daylight conditions
- Eliminate blinds and mainenance

PROJECT GOALS

In order to achieve carbon neutrality by 2050 and to respond to the climate change emergency, it is necessary for University of Washington to invest in new building technologies that can reduce building energy consumption while at the same time improving the student experience and supporting the institutional mission of the University.

Designing and implementing an Electrochromic (EC) glazing system on the Health Sciences Education Building would contribute to UW campus sustainability by maximizing energy performance and by showcasing new building envelope technology that sets new sustainability standards on campus. A primary goal is to increase student health and wellness within the built environment and EC windows provide feasible solutions to address issues of health and wellness.

Rendering by Miller Hull Architects

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TECHNOLOGY

Smart-tinting glass looks natural in appearance with a cool, grey tint color. The glazing is made from five layers of ceramic material coated onto a window pane. A small electrical current is sent through the ceramic coating which causes lithium ions to transfer layers. This process creates a tint, darkening the glass on demand to control glare and to reduce unwanted solar heat entering the space in the summer. Test results show EC glazing can significantly reduce the amount of air-conditioning needed to maintain comfort. The amount of sunlight transmission is controlled by the amount of voltage released into the window pane and ranges anywhere between 0% and 99% light transmission.

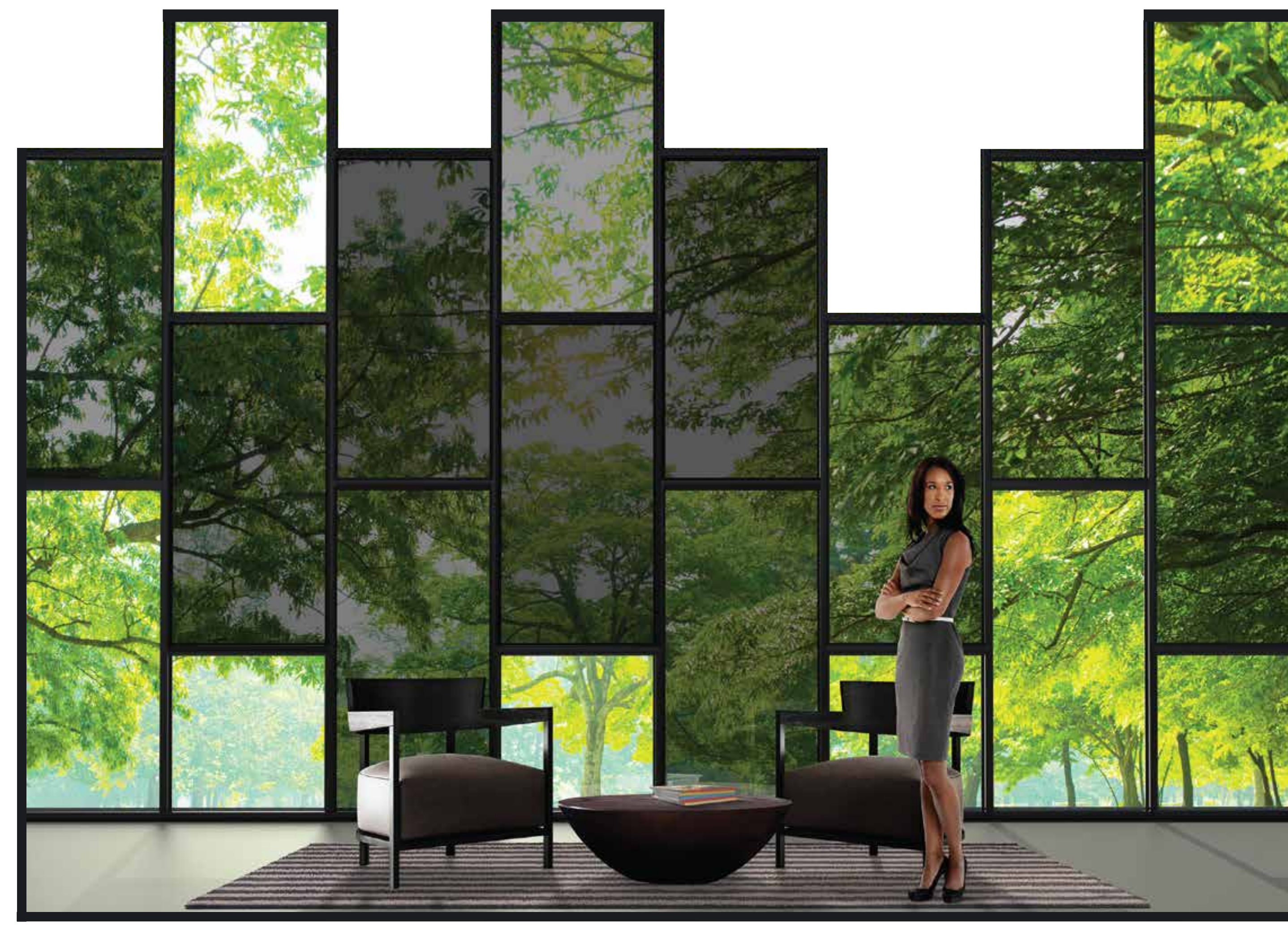
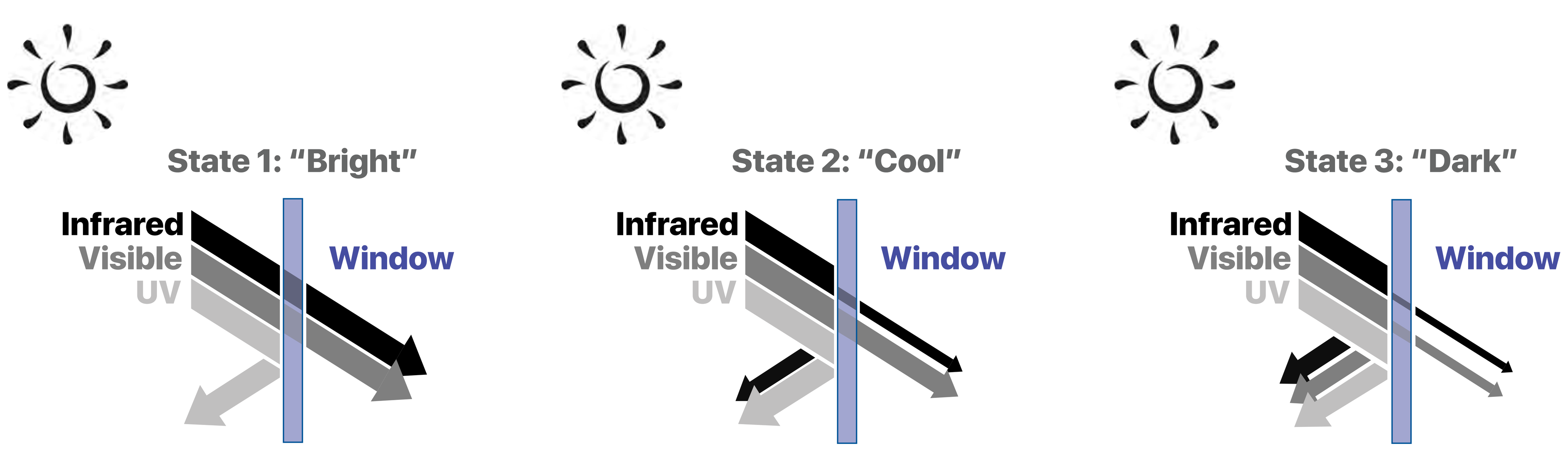


Image: Halio by Kinestral Technologies

EC GLAZING VS CONVENTIONAL GLAZING

EC glazing is a unique product which benefits people's comfort while minimizing the building's heating and cooling loads, allowing for a campus environment that is greener, more efficient and healthier. Transmission of light in conventional glazing is fixed without the ability to adapt to changing weather conditions. With EC glazing, HSEB occupants will receive the optimum light quality no matter the forecast.



Halio by Kinestral Technologies

CLEAR STATE

In the clear state, EC glazing looks like conventional glass. During times of the day without direct sunlight such as the morning and evening, the windows will appear to be clear. There will also be many days in the cloudy winter which will allow for the windows to be as clear as possible.

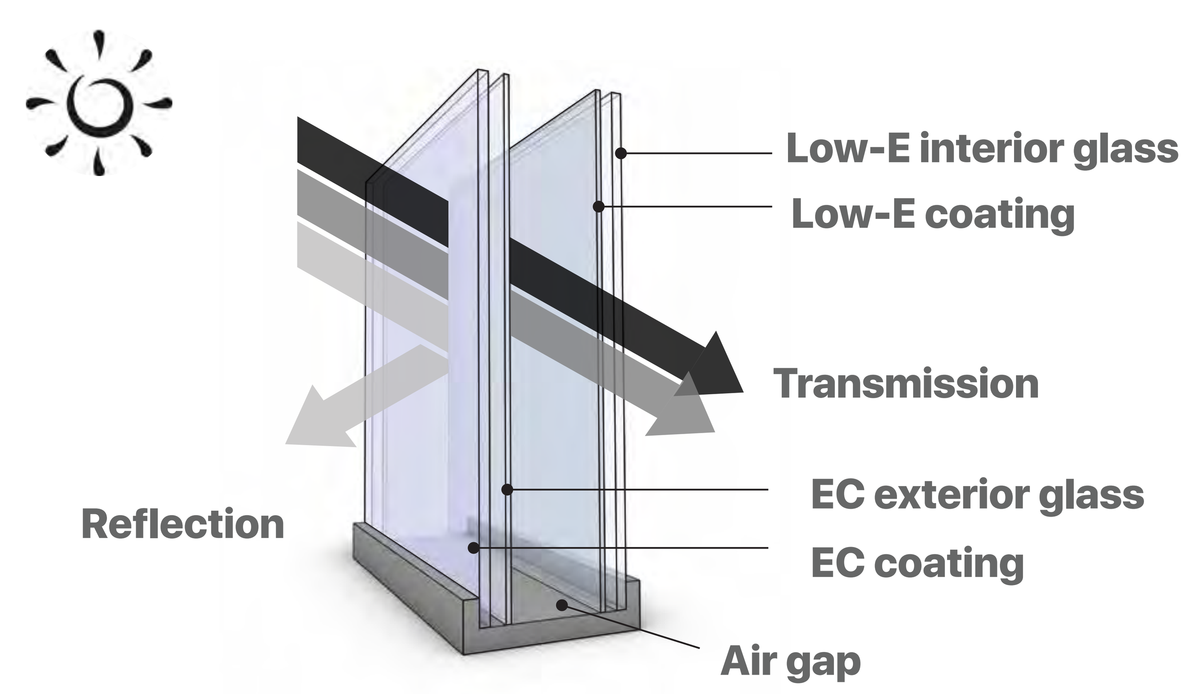
TINTED STATE

EC glazing reacts to sunlight conditions and responds in real time. Depending on the sunlight intensity the windows will quickly change their appearance into a cool grey shade. In the tinted state, sunlight transmission is blocked by the lithium ions within the window pane.

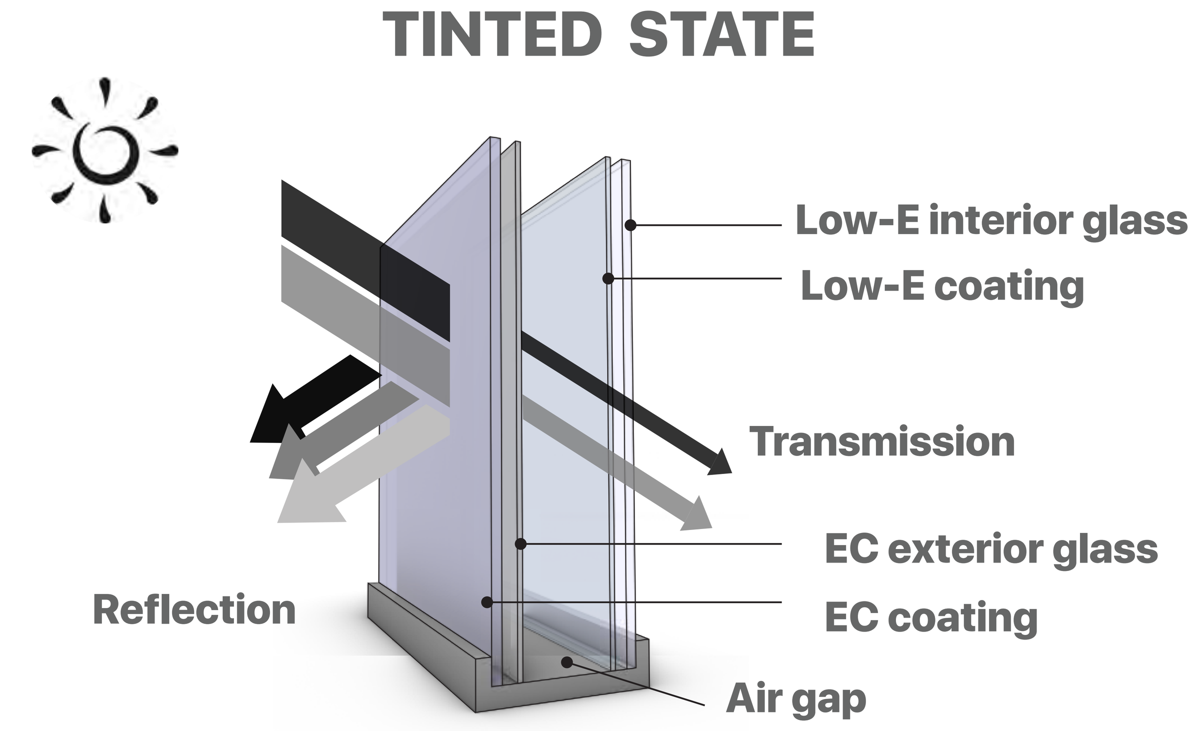
EC GLAZING COMPONENTS

- System for operation (manual or auto)
- Transparent ion conductor
- Cathode (negative charge)
- Anode (positive charge)
- Low voltage current

CLEAR STATE



TINTED STATE

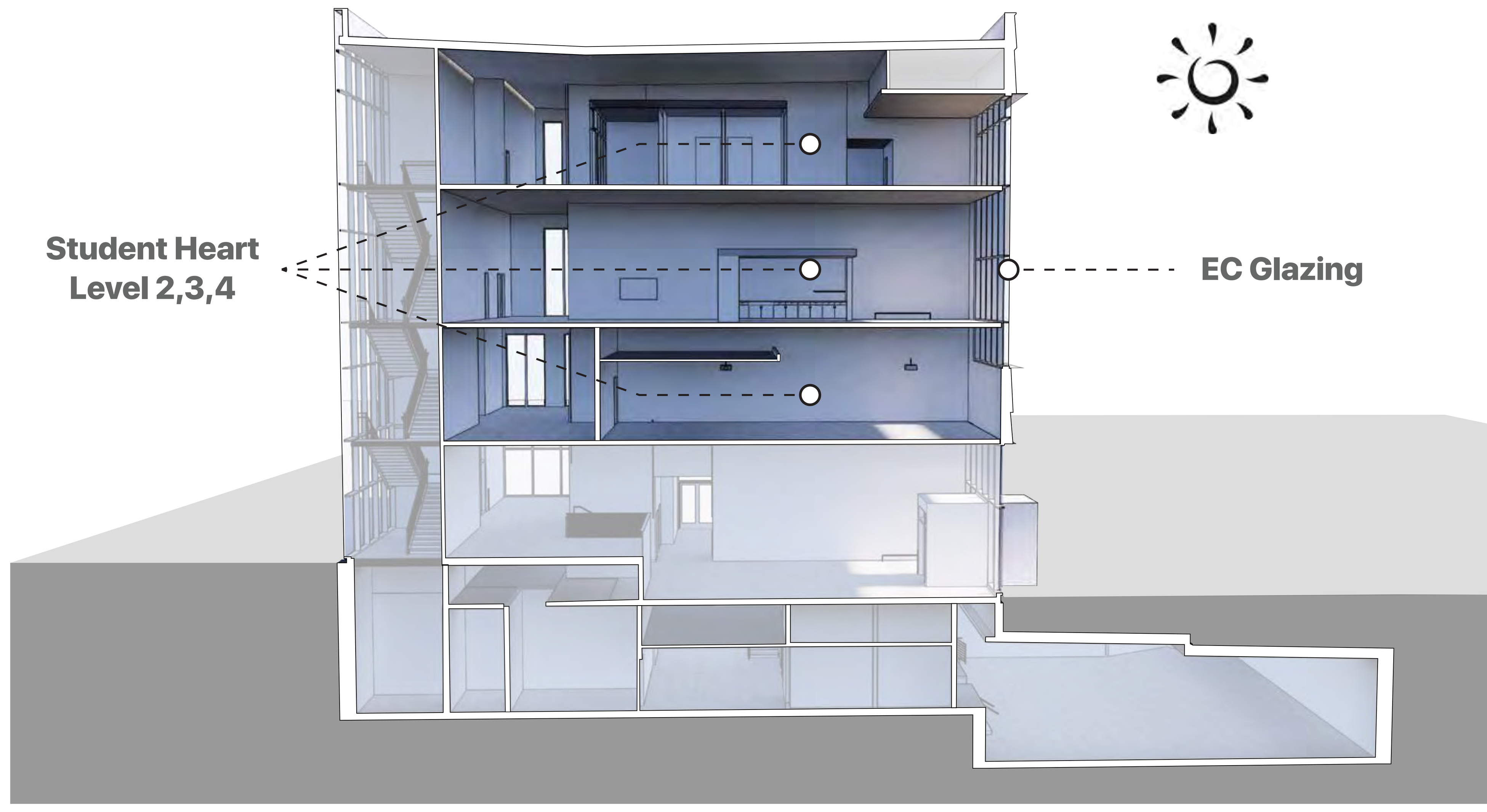


TOWARD A SUSTAINABLE CAMPUS

ELECTROCHROMIC WINDOWS FOR THE HEALTH SCIENCE EDUCATION BUILDING (HSEB)

SIMULATION OVERVIEW

To test the performance of electrochromic glazing in the HSEB project, three simulations were conducted: luminance analysis, annual illuminance, and energy-saving performance. The study area is at the three-story "Student Heart" where EC glazed windows are installed. The HSEB study area includes multi-use zones and areas for group collaboration. Each simulation analyzes specific daylighting, glare, and energy values which impacts occupants and the building.



Model by the Miller Hull Partnership

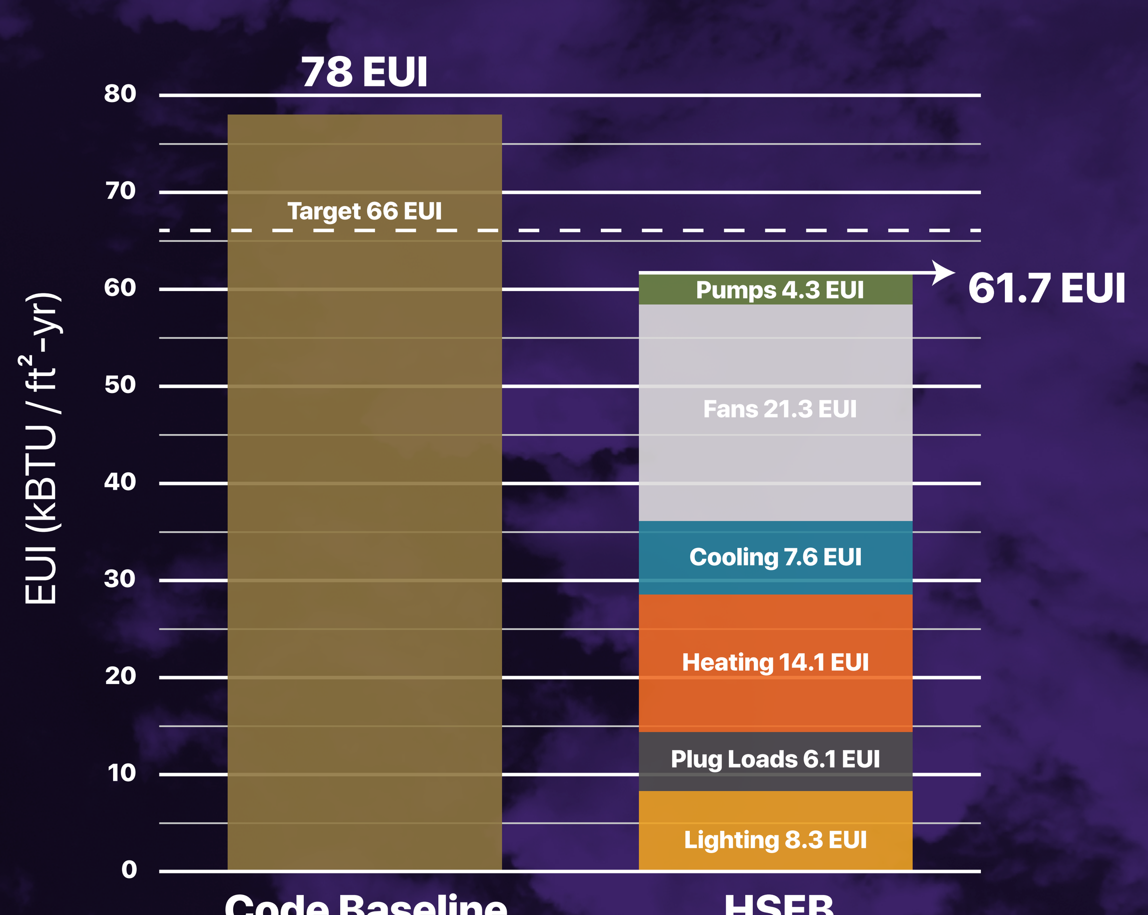
ENERGY USE INDEX (EUI)

EUI is a basic measure of a facility's energy performance. It expresses the total amount of energy used by a building in a year per unit of area, typically kBTUs/ft^2.

The proposed design exceeds the Green Building Standard by 7%. The design team estimates that EC glazing will reduce peak cooling requirements of the building by 30%. However part of the intent of using the EC glazing is to enable larger windows for a better user experience, while maintaining a high level of energy performance.

HSEB ENERGY USE

Analysis by PAE Engineers



The HSEB is 15% more efficient than the baseline of Seattle Energy Code (78 EUI). EC glazing attributes to reduce lighting, heating, and cooling loads.

LUMINANCE ANALYSIS

Sections are cut through the student heart in the simulation model. A false-color luminance scale illustrates the differences between lighting conditions with and without EC glazing. The simulated variables include the different states of tint for EC glazing, sky conditions, and several significant dates of the year. The false color scale is modified in order to read clearly to non-technical audiences. For instance, green illustrates a well-lit interior, yellow for over-lit, and purple for too dark.

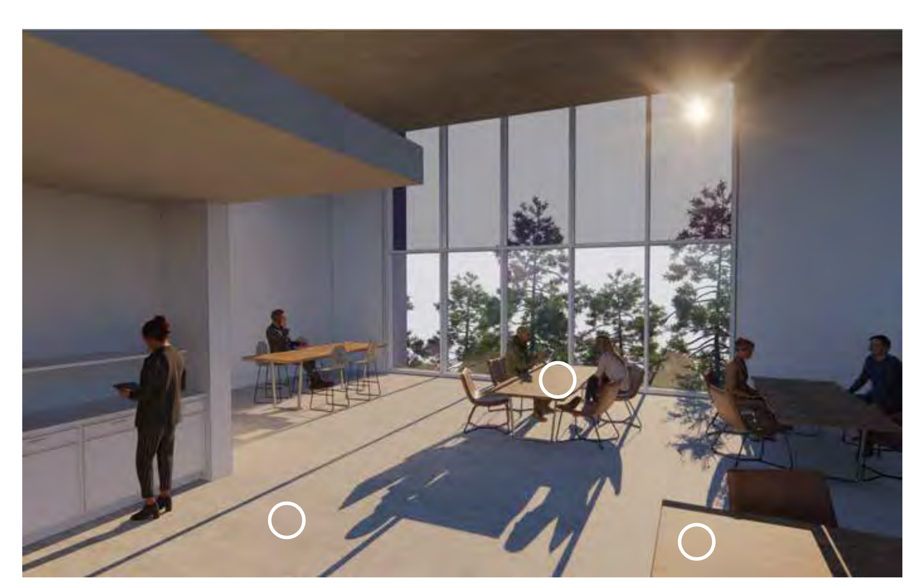
Luminance is the intensity of light emitted from a surface per unit area (cd/m2) in a given direction, it's often used to evaluate glare.

Model by the Miller Hull Partnership

CONTINUOUS DAYLIGHT AUTONOMY (cDA)

Daylight autonomy is the percentage of time that a space can operate without electric lighting, just natural daylight. It is used as a measurement in the design of buildings to assess how effective a building design is at using daylight. The simulation is based on annual data and predetermined daylight levels. The goal is to determine how long an individual can work in a space without requiring electrical lighting. Continuous daylight autonomy is similar to daylight autonomy but attributes partial credit when daylight is below the minimum threshold of acceptable daylight intensity. The main benefit of continuous daylight autonomy is that it can be used as an estimate of how much lighting energy can be saved by bringing daylight into the space.

Illuminance refers to the amount of light falling onto a given surface area.



Model by the Miller Hull Partnership

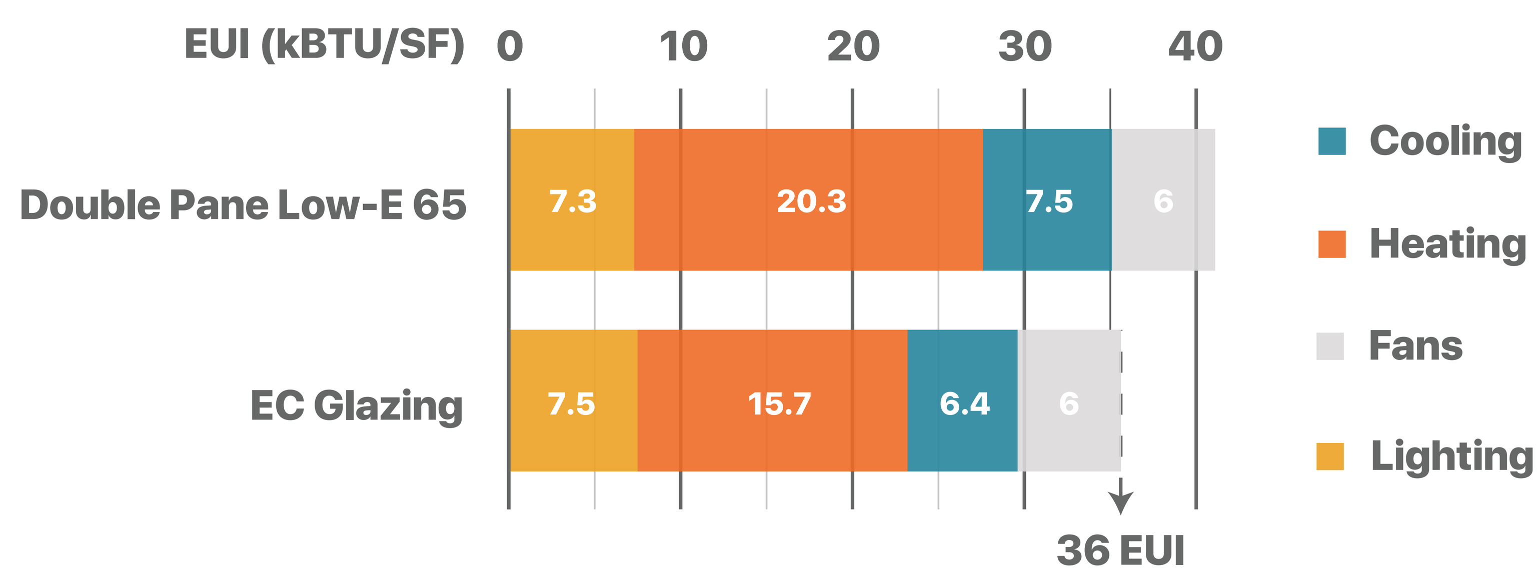
ENERGY-SAVING PERFORMANCE

A three-story energy model representing the multi-use zones and collaboration areas in the student heart are used for simulations to analyze building performance. Parameters of heating/cooling loads, lighting density, and equipment loads are simulated to gauge the energy use in the study area. A comparison between the use of baseline windows versus EC glazed windows will be analyzed throughout all simulations.

SIMULATION RESULTS

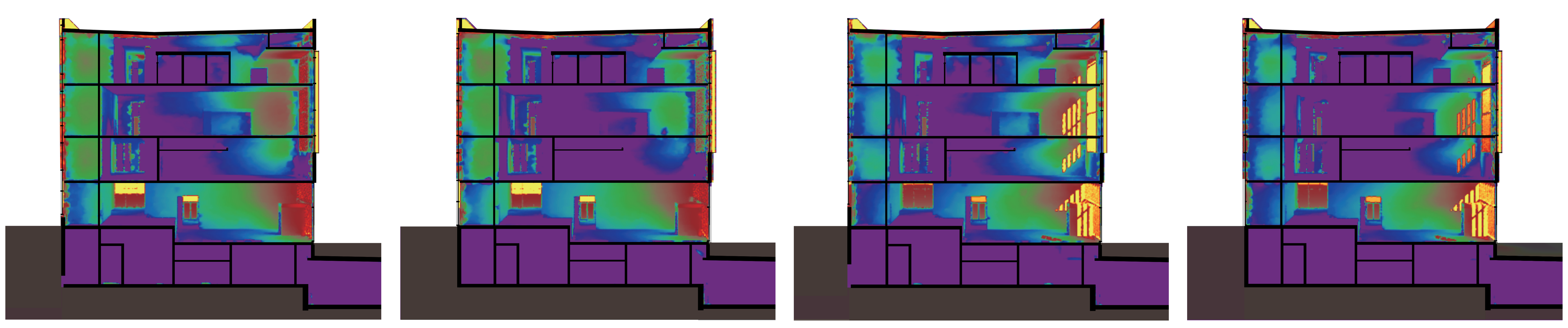
In a simplified test model of the HSEB "Student Heart," our simulation results show EC glazing will reduce cooling and heating loads. Compared to the baseline glazing option, EC glazing allows for a lower energy use idex (EUI). Incorporating EC glazing with high efficiency heating, ventilation and air conditioning systems provide the best energy-savings.

The bar graph illustrates two options for glazing scenarios. When comparing the baseline glazing option to EC glazing, the energy use shows to be significantly lower for the heating and cooling systems. The baseline scenario results in 41 EUI and the EC glazing scenario results in 36 EUI.



FALSE-COLOR LUMINANCE DISTRIBUTION

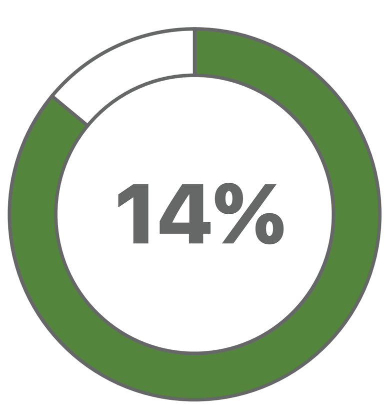
Four significant dates potentially having excessive heat and glare issues in the building were tested for luminance distribution. As shown in the images above, on both June 21st and September 21st EC glazing is able to increase the green (well-lit) condition, which contributes to more visual comfort to the occupants.



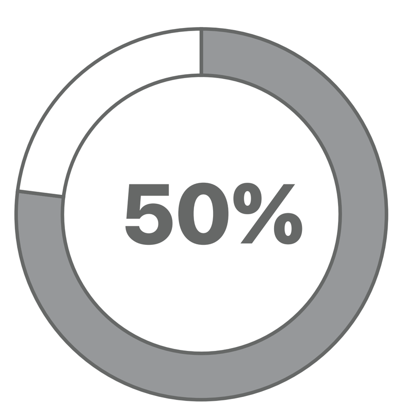
June 21st 16:00, Baseline glazing | June 21st 16:00, EC glazing 30% VLT | Sep 21st 16:00, Baseline glazing | Sep 21st 16:00, EC glazing 30% VLT

STUDENT HEART SIMULATION RESULTS

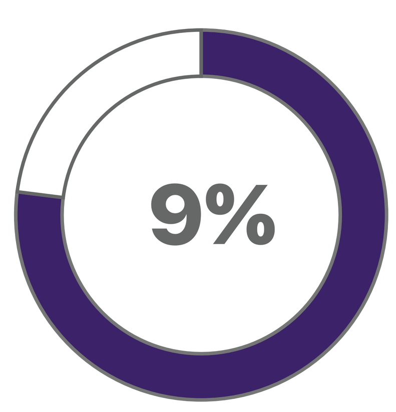
For the Student Heart, we simulated the experience of daylight and views, the energy savings impacts of EC glazing, and life cycle cost analysis (LCCA) of the inclusion of EC glazing over a 50 year building life span.



Energy Savings Attributable to EC Glazing



% Of Time With No Need For Electric Lighting



Reduced Life Cycle Cost Over 50 Years

LIFE CYCLE COST ANALYSIS

The LCCA is a tool to determine the most cost-effective item when comparing alternatives. For this project, we compared the baseline glazing option to EC windows with and without grant funding.

LCCA GLAZING OPTIONS:

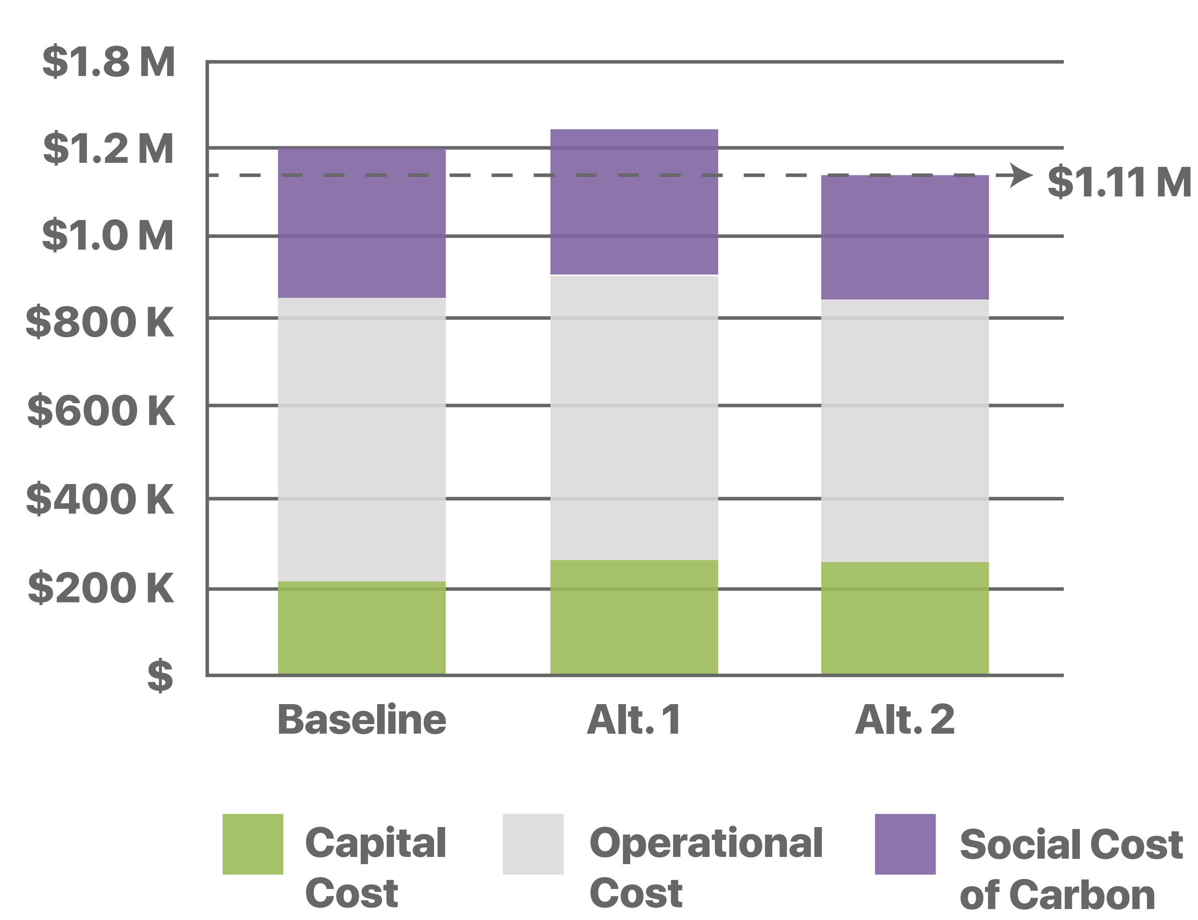
- Double Glazed Low-e
- EC Glazing With Grant Funding
- EC Glazing Without Grant Funding

LCCA COST VARIABLES:

- First cost , utilities cost, maintenence, replacement cost

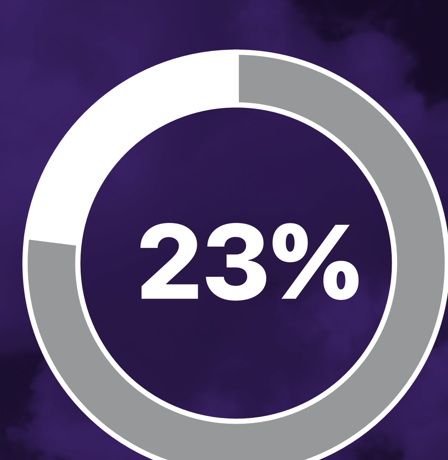
In order for EC glazing to be a successful investment, it must perform more efficiently than the baseline scenario to offset its premuim cost. The investment must also have a lower social cost of carbon (SCC) in comparison to alternate scenarios. At 7% higher efficiency than the baseline option, EC glazing will be the best investment for the life cycle cost (LCC) and the SCC.

The graph illustrates the baseline glazing option compared to EC glazing (Alt. 1) and EC glazing with grant funding (Alt. 2).



CONCLUSIONS

EC glazing is able to reduce the cooling peak load. As a result, the HSEB study areas have a 14% reduction on cooling energy use compared to the baseline glazing option. When combined with high efficiency cooling and heating equipment, HSEB consumes 23% less annual net energy use compared to the code baseline scenario.



Total Building Energy Savings

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