ComEd
Energy Efficiency Program

COMMERCIAL INTERIOR INSULATED SHADES EXECUTIVE SUMMARY

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LEGAL NOTICE

1.0 EXECUTIVE SUMMARY

Interior insulating shades provide extra thermal insulation to minimize heat loss and heat gain through the glazing units. This report summarizes the measured heating, ventilation, and air conditioning (HVAC) energy savings associated with the installation of motorized interior insulating shades in an office space in Willis Tower, Chicago, IL, between May 2021 and March 2022. The office space studied during the 10-month period is conditioned by two HVAC systems— (1) a variable air volume (VAV) system that serves the core and perimeter spaces and provides the required outdoor air ventilation, and (2) induction unit system below the windows that serve the perimeter spaces and partly contribute to the outdoor air requirement. In order to measure and quantify the HVAC energy consumption under various experimental scenarios, sensors (i.e., to capture more than 190 variables) were installed and utilized throughout the office space to measure VAV air flow, diffuser air temperature, and relative humidity, as well as the induction unit system's air velocity and heat flux / temperature. The sensors collected data in 1- to 5-minutes intervals and provided a uniquely detailed and quantitative picture of the HVAC energy flow of the office space during the study period.

The purpose of this study was to objectively compare the HVAC energy consumption of the office space under various window treatment conditions, during heating, cooling, and shoulder seasons. All windows in the office space were equipped with motorized and programmable shades. The new motorized shades direct the shade cloth flush against the mullion, creating a thermal barrier similar to double pane glazing systems. Four conditions / strategies for the window treatment were deployed during the study:

(i) On-Schedule: Regular seasonal schedules varied the positions of the shades in a pre-defined schedule
(ii) Dynamic: Positions of the shades varied based on indoor and outdoor conditions (temperature, time of day, and occupancy) for different seasons
(iii) Baseline: The motorized shades were disabled, and occupants can only use mini blinds to adjust window coverage
(iv) Manual Control: Using a switch, occupants can set the motorized shade position based on their preference

The overall data collection of this study captured five (5) full 2-week strategy cycles (i.e., (i) through (iv)) and one full 1-week strategy cycle (i.e., (i) though (iv)). In total, 44 weeks of data were collected.

The non-weather normalized data show that the strategies using interior insulating shades (Strategies i, ii, and iv) all provided HVAC energy savings when compared to the mini blinds baseline (Strategy iii). Overall, a comparison between each motorized shade strategy to the baseline, On-Schedule showed 25 percent less consumption for the heating season while the Manual and On-Schedule strategies consumed 25 percent and 22 percent less than the baseline for the cooling season.

For this 10-month study, 39 motorized Parata Shades were installed in the Equity Office space in Willis Tower, and the measured annual energy consumption savings was nearly

123,838 kWh, which equates to an energy savings of $11,108 when using an electricity rate of $0.0897 / kWh. The actual all-in cost for the installation of the motorized shades, controls and power for this study was perhaps not a good "baseline" due to Covid-19 related challenges with supply chain, materials, and labor. However, we expect the installation of 39 shades with controls and power to be approximately $61,994. Benefiting from the lessons learned in this study and utilizing the best strategies for the cooling, shoulder and heating seasons would thus yield a payback period of 3.1 years without the consideration of power supplies and installation and a total simple payback period of 5.6 years for this office space before any incentive or rebate program was introduced.

The results obtained in this study can be extended to other commercial buildings at scale to realize heating and cooling energy savings with the installation of interior insulating shades. Given that Willis Tower is an all-electric building built in the 1970s with single-pane windows, we believe that the first beneficiaries (i.e., "ideal" candidate buildings that would show the most reduction in energy consumption) of this intervention are structures with these attributes:

- High window-to-wall ratio
- Built before the mid-1980s with single-pane windows
- Electric heating
- Utilize perimeter zone heating and cooling systems

It would be extremely interesting to upgrade an entire building with insulating interior shades and compare its energy consumption to historical data. Since HVAC systems serving individual zones and spaces within a larger commercial building are rarely metered separately, a whole-building upgrade would be the most demonstrative of the energy savings. We also believe rollout to other building types and ages would yield energy savings and should be pursued.

Lastly, to better understand the user experience, we conducted a survey of the occupants of the space. The results of the survey indicated that (i) 80 percent of the occupants prefer the new motorized shades compared to the old mini blinds, (ii) 70 percent of occupants believe the new motorized shades are easy to use, and (iii) occupants were very well engaged (90 percent of them) in adjusting the shades (i.e., mostly in common areas such as the kitchen) compared to the 50 percent engagement with the old mini blinds. In addition, occupants overwhelmingly prefer the shades to be in the up position to benefit from the outside view and daylight even during winter days. Finally, the occupants prefer to control shades themselves rather than the On-Schedule or Dynamic strategies. Based on the user experiences, it seems the Manual or On-Schedule strategies with additional vacancy or occupancy features could address both user outdoor view preference and capturing heat inside of the building