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Commercial Interior Insulated Shades

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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 a high-rise building in 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-minute 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

For this 10-month study, 39 motorized Parata Shades were installed on a floor of a in a high-rise commercial building in Chicago. 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). During the actual year data analysis, the daily energy consumption analysis showed that the insulating interior shades for the Dynamic and

Manual strategies can save up to 20.5% and 11.8% energy consumption compared to the Baseline strategy. Furthermore, the Dynamic strategy performs better in the heating season, saving up to 27% of daily energy consumption compared to the Baseline strategy. During the cooling season, the Dynamic strategy also performed better than the Baseline strategy, saving up to 22% when compared to the Baseline strategy.

The simple payback period has a wide range for both the actual data and the weather normalization data approach. The best practice strategy showed the best payback period ranged from 21.9 years to 6.9 years for the degree days analysis and 27.9 to 9 years for the outdoor air temperature analysis. For example, the simple payback period is 15.1 years, considering a rate of $0.13/kWh in 2023 using a degree days-based energy analysis.

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 the pilot building 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

Lastly, to better understand the user experience, a survey of the occupants of the space was conducted. 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.