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Triple Bottom Line Analysis for San Francisco International Airport

Electrochromic Glazing

Triple Bottom Line Results Summary

This analysis evaluates the financial, social, and environmental benefits of installing a glazing alternative at SFO. This analysis looks at the costs and benefits, over a 50 year study period, of installing electrochromic glazing instead of using unshaded glass, using the Sustainable Return on Investment (SROI) framework – an enhanced cost-benefit analysis. The results are summarized below.

The metrics provided include the **financial net present value (NPV)**, which is defined as the costs and benefits that involve real cash flows to an organization projected into the future over the study period and discounted to current dollars. The **sustainable NPV** adds the broader quantified and monetized **social and environmental value** to the financial impacts to produce the triple bottom line results. The **benefit cost ratio (BCR)** is also provided (for both the financial and sustainable costs and benefits), and is defined as the total projected future benefits divided by the total costs of the project, discounted to current dollars. A BCR between 0 and 1 indicates costs exceed benefits, while a ratio greater than one indicates benefits exceed costs. All costs and benefits included due to the investments being analyzed are compared to a "base case", and as such, impacts and metrics are incremental results.

	NPV	BCR
Financial Project Metrics	(3,287,126)	0.00
Sustainable Project Metrics	2,968,498	1.90
Social & Environmental Value	6,255,624	

Overall, the project has a **positive sustainable NPV of $2,968,498**. This equates a **BCR of 1.90**. The financial NPV is equal to -$3,287,126. The financial NPV includes life cycle costs including capital expenditures required to purchase and install electrochromic glazing. **This project generates net positive social and environmental benefits of $6,255,624.** This reflects the value of the benefits of increased productivity due to thermal comfort for passengers doing work near the windows. Studies show that temperatures outside of 68ºF to 73ºF range can cause productivity loss. Window glare can lead to increased temperatures in the perimeter area on certain days and certain times of the day. The electrochromic glazing can reduce the temperature to within the range, producing a productivity benefit. Only a fraction of the passengers that were on "business travel" were assumed to be working at the terminal. To monetize the productivity benefits due to thermal comfort, the passengers' average salaries were used.

Detailed Results for Electrochromic Glazing

The following chart provides additional details on the separate impacts from installing electrochromic glazing that are driving the final results.

Cost/Benefit Category	Present Values ($)		
Thermal Comfort	6,255,624		Social & Environmental
Capital Expenditures	(3,287,126)	Financial	

The line items above, when added together, equal the sustainable NPV. The item(s) labelled green provide the total social and environmental value of the project, while the item(s) labelled blue are the financial benefits or costs, which provide the financial NPV.

Where appropriate each cost and benefit has a range of potential values - the probabilistic assessment accounts for the inherent risk and uncertainty in the project parameters, using a Monte Carlo simulation –a best practice in economic analysis. The risk analysis results show that at a 95% confidence interval, the total project NPV is between $2,529,339 and $3,325,466.

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Impacts and Assumptions

- The life cycle cost impacts for electrochromic glazing include only the additional capital expenditures required to install.
- Studies show that temperatures outside of the 68°F to 73°F range can cause productivity loss. Window glare can lead to increased temperatures in the perimeter area on certain days and certain times of the day. The electrochromic glazing can reduce the temperature to within the range, causing a productivity benefit. Only a fraction of the passengers that were on "business travel" were assumed to be working at the terminal. To monetize the productivity benefits due to thermal comfort, the passengers' average salaries were used.
- SFO passenger survey data was used to determine how long people spent at the airport on average, the percentage of travellers that fly for business, and the average salary of the business person using SFO.
- It was assumed that only 50% of business travellers work at the airport as they wait to board, and only 50% of their time at the airport was spent on productive work.
- It was provided that 50% of the passengers were affected by the area near the windows, 25% of passenger hours per day were affected by the glare, 60% of days per year were affected, and 25% of the perimeter area was affected.
- The analysis assumes that all amounts are in 2016 dollars, and because of this it was also assumed that the project's benefits and costs are incurred as of 2016 (for the 50 years onwards and including 2016).
- Multiple sources have been used to determine the annual energy escalation rates (for natural gas and electricity), specific to each year.

Inputs

The chart below provides the inputs used in the analysis and their sources.

Category	Inputs	Unit	Source
Real Discount Rate	4.5	%	Autocase
Study Period	50	years	Autocase
Expected value cost range for CapEx, O&M costs, replacement costs and residual values	-15 and +20	%	Autocase
Electricity Rate	0.157	$/kWh	Autocase
Natural Gas Rate	14.64	$/MMBtu	Autocase
Incremental capital expenditures for electrochromic windows (compared to base case)	3,420,000	$	User Input
Incremental energy impacts (e.g., heating/cooling) from electrochromic windows compared to base case	negligible	MMBtu/Yr	User Input
Incremental change in temperature (compared to base case) for area near window due to electrochromic windows	+2F for 3.75% of total passenger hours	degrees F	User Input
Incremental O&M costs for electrochromic windows (if applicable) compared to base case	0	$/Yr	User Input
Replacement costs for electrochromic windows	1,000,000	$	User Input
Useful life of electrochromic windows	life of façade (50 years)	Years	User Input
% of passengers affected by area near window (i.e., % of passengers/area affected by increased temperature due to glare)	50	%	User Input
Replacement costs of base case unshaded glass	same as original cost, escalated over time	$	User Input
Useful life of base case unshaded glass	50	Years	User Input