Life Cycle Analysis

“An assessment of achieving a Net Positive footprint through the reductions in heat gains & losses by applying the *IN’FLECTOR* Window Solar Screens”

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1.0 Abstract

It is becoming evident that climate change is happening and we have started to witness the dramatic consequences of this change in many levels and on a global scale. The primary question that we should all ask to ourselves is (are we doing enough to fight this climate change? Is doing less bad work to our environment will help us overcoming the global climate challenge? And how can we reach a Net positive environmental impact?). The purpose of this paper is to examine the contribution attributed to the use of solar window screens in my house on my annual carbon footprint, and to evaluate how this strategy can help me towards offsetting my annual carbon footprint. The following sections contain a methodological approach in applying Life Cycle Inventory Assessment (LCIA) as per the standard ISO 14041 principles (ISO14001, 2004) to evaluate the (In’Flector Solar screens) environmental impact, and their contribution to help me reaching a Net positive impact on the environment. The outcome of this study was really encouraging, where I have found a potential reduction of 35% of my annual footprint based on a 5 years (lifetime) usage of the In’Flector Solar screens. Details of the analysis are contained within the following sections.

2.0 Introduction

“Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased” (IPCC, Working Group I, 2013, p. 3)

This is not our first wakeup call, but now and more than ever we have a growing global consensus to work together in reducing the impact of this change, with a solid believe that sustainable development is the way forward to preserve our environment for the future generations. To this extent, the objective of this paper is to evaluate the potentials of achieving a Net Positive environmental impact at an individual level, represented by the total possible reductions on my annual footprint from deploying one strategy, at this case, it is the use of the Inflector solar window screens; and by using Open LCA application to calculate the required amount from the cooling & heating energy reduction (the functional unit) to be replicated/ adopted by others; in order to offset my annual footprint, aka a handprint action (Norris, 2012). In the following sections, there is a detailed description of the calculation methodology, including the LCA goal & scope, functional units & boundary, the final results along with interpretation and discussion for the key findings of this study.

2.1 Project/ Product Description:

Install **Window Solar Screens** in order to reduce the heat gains & losses through my apartment’s Window (**The Product Function**). Then measure the associate reductions in annual cooling/ heating energy consumptions, as a positive impact on the environment, which will help me in reducing my annual footprint, and how much would it takes to become a Net-Positive.

2.2 Background info on Window Solar Screens:

(Example: IN’FLECTOR)

“Winter Benefits

During the winter, your In'Flector Window Insulators are placed so that the platinum side is facing into your home, reflecting the thermal heat back into the building and reducing heat loss through Window.” (inflector, 2013)

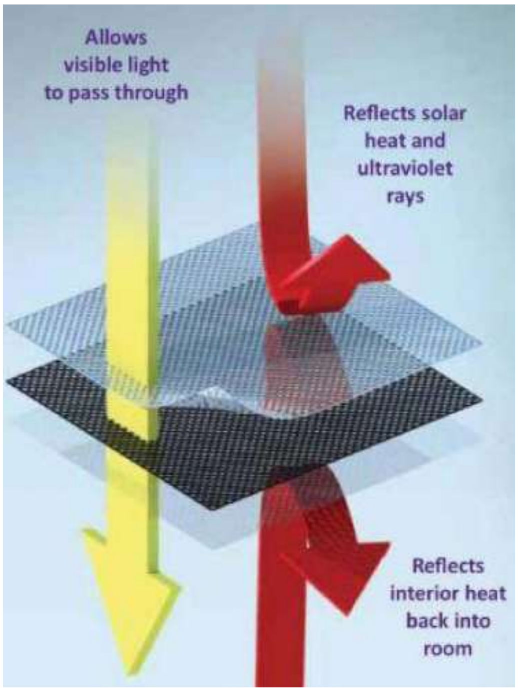

Figure 1: Illustration of how In'flector works (inflector, 2013)

“Summer Benefits

During t he summer, your ln'Flector Window insulators are positioned so that he platinum side faces outwards, 72% of the radiant heat is reflected back out through the window, reducing the greenhouse effect in buildings” (inflector, 2013)

Note: Although the above extracts taken from In’flector manufacturer website, the material technical data sheet & laboratory tests, describe an aluminum material instead of platinum, as opposed to the above quoted statement.

“The solar screen material is a three-layer material consisting of a transparent polyester film, a perforated vinyl screen, and a perforated aluminum film.” (Keith Sylvester, 2002)

2.3 Positive views for the project selection

- As per the Department of Energy (DOE): “*Heating and cooling your home uses more energy and costs more money than any other system in your home -- typically making up about **54%** of your utility bill”*

- As per the Department of Energy (DOE): “*Window can be one of your home's most attractive features. Window provide views, daylighting, ventilation, **and heat** from the sun in the winter. Unfortunately, they can also account for **10% to 25%** of your heating bill by letting heat out”*
- Based on a research done by The Department of Construction Science, Texas A&M when using the window solar screens (Keith Sylvester, 2002): *“the U- value of the window system improved by an average of **41%** for the winter condition and **36%** for the summer condition”*
- Based on a research done by Building Research Establishment when using In’flector window solar screens (bre, Stephen Hobbs, 2011): *“It typically reduces heat gain loss by around **35-40%**”*

3.0 The Goal and Scope Definition

As mentioned under the introduction section of this paper, the main goal of this study is to measure the total contribution in reducing my annual footprint, from using the “In’flector” solar window screen product, based on the total (35%) thermal energy losses/ gains saved, and their associate impact on my total energy consumption for cooling and heating. Ultimately, calculating the required amount from the functional units to be replicated/ adopted by others; in order to achieve the Net Positive impact on the environment.

Note: to be on the conservative side, I opted using the lower thermal energy reduction percentage of **35%** for the “In’flector” product (bre, Stephen Hobbs, 2011).

Project Region: California

3.1 Methods and Materials

The Scope of the LCA study in the project is to model the environmental impact of two options:

A. Total Cooling & Heating energy required when using a typical window assembly (without solar screen) for a total Window area of 1.0 M2 **(The Baseline Case)**

Under this option, and considering the time constraint of the study, the study will be based on a typical double glazing commercial window with U-value <1.1 W/m2K. And with the following reference flows:

- Double panes glass
- Typ. Aluminum framing assembly (50mm x 50mm x3mm) extruded section.

- Packaging (cardboard)
- Space Cooling energy
- Space heating energy

B. Total Cooling & Heating energy required when using a typical window assembly with (Solar Screen (In’flector)) for a total Window area of 1.0 M2 **(The Proposed Case)**

Reference flows:

- Window with framing assembly (option A)
- In’flector Transparent Polyester film
- In’flector Perforated Vinyl screen
- In’flector Perforated Aluminum film
- In’flector (PVC) frame
- 8 numbers of S. steel M 4mm screws
- In’flector Transport
- Packaging (cardboard)
- Disposal
- Space Cooling energy under (option A) x 0.65
- Space heating energy under (option A) x 0.65

3.1.1 Analysis Background: Baseline Description

Since the main function of the In'Flector screens is to reduce the amount of Thermal energy passing through a window, therefore, reducing required cooling and heating energy consumptions. Hence, the baseline case focus will be on the amount of cooling and heating energy required to offset thermal heat gains/ losses in a house (my apartment) located in California with typical window system, Following baseline data will be required:

1. Thermal heat amount (BTU’s/M_2/Year)/ (KWh/ M_2/Year) transferred through a typical double glazing window of with U-value <1.1 W/M_2K. This amount will be derived from my annual cooling & heating energy consumption, based on the reported (10 - 25%) thermal losses through typical Window cited from the DOE published literature (DOE). To be on the conservative side, I will use the lower value of (10%) and will multiply this percentage with my annual total cooling& heating energy consumption calculated in point 2 below.
2. The amount of Cooling / Heating Energy used to offset the thermal heat amount under point (1) above: To have a precise amount for these loads, this can be achieved through sub-metering system for both space cooling and heating consumptions, or by an

energy simulation for my house energy performance. For the required data on my space heating load, the same will be sourced from my annual gas energy bill in (BTU’s). However, for space cooling, the previous methods are considered as a second option to obtain the required data; given the time constraint of this study. Hence, to estimate my space cooling annual consumption (KWh/year), I have referred to the published studies on household energy consumptions for heating & cooling in the house sector in California, where I found that an annual average space cooling energy consumption amount = 2,492 (KWh/year), accounting for 29% from the total annual household electricity consumption. Also, the annual average space heating energy consumption amount = 1,391(KWh/year), accounting for 17% from the total annual household electricity consumption. Please refer to the extract info and tables below:

“*The DOE Energy Information Agency (EIA) 2005 Residential Energy Consumption Survey (RECS) to provide estimates of cooling and heating energy for the sample households using central air conditioner and central heat pump equipment…, the household energy consumption for the individual surveyed households in RECS is obtained by EIA from the energy suppliers via monthly energy bill records. EIA uses a conditional demand analysis (CDA) model to further break down the household energy use into end-use energy consumption estimates (e.g., cooling, heating, lighting, and hot water energy), which it reports as annual end-use energy in the survey results”* (DOE E. , 2012, p. 6)

Division or State	Number of Observations	Min *kWh/yr*	Max *kWh/yr*	Average *kWh/yr*
New England	1	432	432	432
Middle Atlantic	10	214	2,182	1,460
East North Central	20	455	6,938	2,315
West North Central	12	234	5,634	2,413
South Atlantic	108	445	11,059	3,442
East South Central	54	1,157	11,586	3,968
West South Central	6	1,246	9,573	4,545
Mountain	23	3,220	12,893	7,194
Pacific	13	78	3,221	1,060
New York	1	761	761	761
California	11	312	6,449	2,492
Texas	15	2,166	11,363	6,423
Florida	65	1,805	17,380	6,738
National	339	78	17,380	4,264

Table 1; Space Cooling Energy Consumption Statistics at regional Level, CHP Stock (DOE E. , 2012, p. 9)

Division or State	Number of Observations	Min kWh/yr	Max kWh/yr	Mean kWh/yr
New England	1	2,399	2,399	2,399
Middle Atlantic	10	581	5,177	2,871
East North Central	20	1,911	10,037	4,237
West North Central	12	926	4,778	2,702
South Atlantic	108	0	6,412	2,692
East South Central	54	0	5,667	2,468
West South Central	6	354	4,434	2,386
Mountain	23	424	1,630	891
Pacific	13	2,171	5,251	3,621
New York	1	3,409	3,409	3,409
California	11	324	3,850	1,391
Texas	15	998	3,788	1,671
Florida	65	200	1,470	625
National	339	0	10,037	2,179

Table 2; Space Heating Energy Consumption Statistics at regional Level, CHP Stock (DOE E. , 2012, p. 16)