

The logo for Onyx Solar, featuring the word "onyx" in a lowercase, sans-serif font with a power symbol (a circle with a vertical line) to its left, and the word "SOLAR" in a smaller, uppercase, sans-serif font to its right. The logo is set against a black square background.

onyx  
SOLAR

A white ribbon-shaped badge with a black border. It contains the text "glass magazine award winner" in a sans-serif font, with "2015 MOST INNOVATIVE GLASS" in a smaller font below it. To the left of the text is a stylized logo consisting of three blue and green triangles forming a larger triangle.

glass  
magazine  
award winner  
2015 MOST INNOVATIVE GLASS

# LOW-E PHOTOVOLTAIC GLASS TECHNICAL GUIDE



# PHOTOVOLTAIC LOW-E GLASS



Onyx Solar's Low-e photovoltaic glass has been awarded Most Innovative Glass Product by the National Glass Association of the US and Window & Door Dealers Alliance.

**D**etermining the best type of glazing for the particular needs of a building is never an easy task. Amongst many variables in designing energy efficient buildings, the composition of glazing is a key factor. Consequently, failing to select the right type of glazing can negatively affect comfort level in interior spaces. This is especially important for office spaces where the occupants' comfort has a significant effect on their

productivity level. At Onyx Solar®, we know that the best way to save energy is not having to consume it in the first place. With this goal in mind, we provide fully customized multi-functional energy solutions that provide enhanced thermal insulation. Our solutions are adaptable to all buildings and able to meet every client's needs. Furthermore, they are able to generate their own energy from a limitless resource: the sun.

## SELECTIVE INFRARED RADIATION FILTER

Infrared radiation carried by natural sun light can cause a heat build-up inside a building; this situation leads to thermal imbalance during summer time and increases the use of HVAC systems<sup>2</sup>.

Measurements carried out with Onyx Solar® ThinFilm photovoltaic glazing show a significant decrease in radiation transmission of the 780nm-2500nm range (near

infrared, N-IR). The ThinFilm photovoltaic glazing of Onyx Solar® decreases infrared transmission up to 90%.

The double laminated ThinFilm of Onyx Solar® filters between 85 to 95% of the total infrared radiation. The conventional double laminated Low-E glazing, on the other hand, only filters between 80 to 85%.

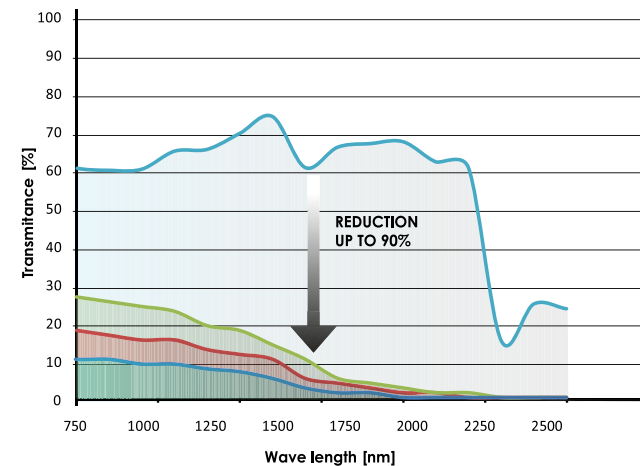
|| Glass with lower solar heat gain coefficient reduces cooling loads.

Perkins & Will, Research Journal, Chicago, Illinois Vol 02.02.

|| A thoughtfully designed workspace that enhances the wellbeing of the employees is a powerful tool for improving the productivity level.

HOK

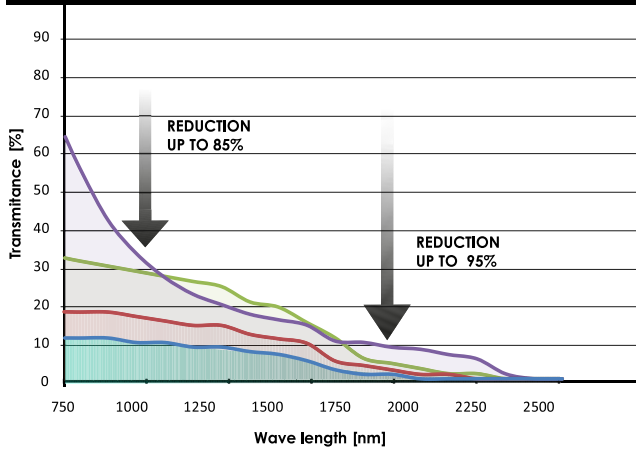
### INFRARED TRANSMISSION



— Onyx Solar 10% — Onyx Solar 20% — Onyx Solar 30% — Laminated 5+5  
 Chart compares infrared transmission between a traditional laminated glass and the Onyx Solar® ThinFilm<sup>3</sup> glazing. Lower IR transmission values mean increased thermal comfort in interior spaces.

<sup>1</sup> C. Huizenga, et al. Results of a Large Indoor Environmental Quality Survey. Center for the Built Environment, University of California.  
<sup>2</sup> Natural light usage for the illumination of buildings. Ministry of Industry, Tourism and Commerce 2005.  
<sup>3</sup> Measures carried out with an spectrophotometer Spectrometer Lambda 900 UV/VIS/NIR from Perkin-Elmer, counting on a integrating sphere of 150mm diameter.  
<sup>4</sup> Notice that in the previous case it was analyzed the decrease compared to a conventional glazing, while this case compares the decrease regarding the total incident radiation.

## INFRARED RADIATION TRANSMISSION



- Onyx Solar 10%
- Onyx Solar 20%
- Onyx Solar 30%
- Laminated Low-E 6+6

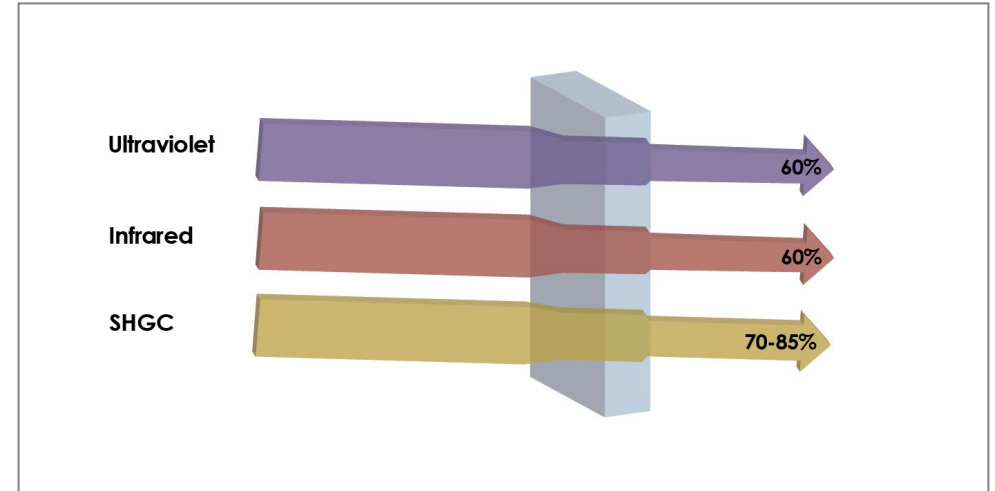
Chart above compares the infrared radiation transmission in conventional laminated Low-Emissive glass and the laminated Onyx Solar® ThinFilm glass.



*Thermal comfort is a fundamental design element that can significantly improve the productivity level in workplaces.*

HOK

## OPTICAL PROPERTIES OF CONVENTIONAL GLASS



Main optical properties for a conventional glass. Allows large amounts of harmful radiation and solar heat gain to pass through the glass.

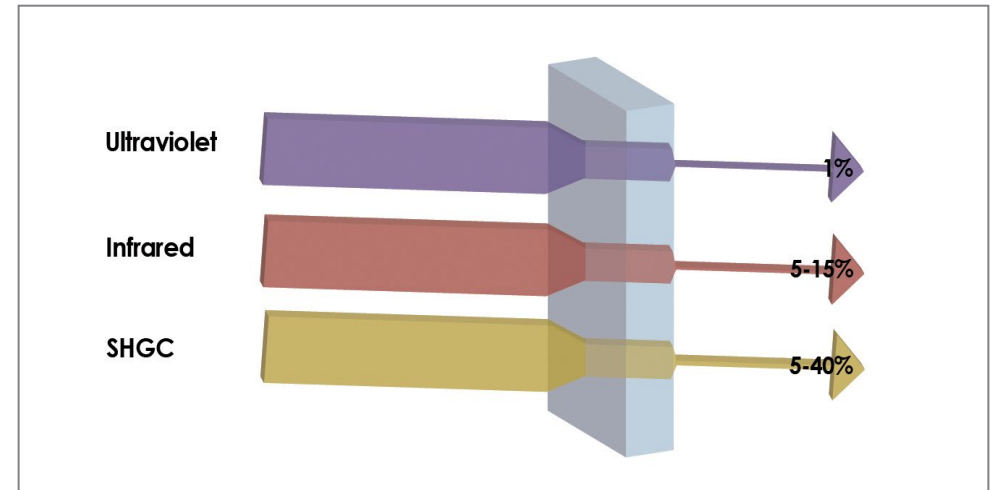
# OPTIMIZED SOLAR FACTOR

Taking into account a glazing's solar properties is important for achieving optimal comfort levels in interior spaces. Due to the greenhouse effect, the indoor temperatures rise as the g-value increases. The g-value and the SHGC (Solar Heat Gain Coefficient) indicate the amount of energy that passes through a glazing.



The *ThinFilm* by Onyx Solar® provides great shielding from such factors, limiting the g-value within to a degree of 10-40%, making it an ideal choice for enhancing thermal comfort level.

## OPTICAL PROPERTIES OF ONYX SOLAR® THINFILM



Main optical properties for Onyx Solar® ThinFilm glass. A significant amount of harmful radiation and heat gains are filtered by the glass.



## SELECTIVE UV FILTER

Another key factor to consider when choosing the right glazing is the negative impact of ultraviolet (UV) radiation on interiors, furnishings, and people. For this reason, **Onyx Solar® introduces an architectonic photovoltaic glazing able to filter up to 99% of the ultraviolet radiation.**

*"To see the kind of damage that untreated glass can cause, take a close look at the furnishings in your home that are under direct sunlight exposition" says Perry Robins, MD, President of the Skin Cancer Foundation. "If the sun has faded the color of your sofa, it can just as easily damage your skin when you sit there."*

*"While it's more widely understood that the sun can be harmful outdoors, not many realize the negative effect it has indoors. Both ultraviolet A and B radiation from the sun can harm your skin and lead to skin cancer." Perry Robins, MD.*

## NATURAL ILLUMINATION

The glazing system at Onyx Solar® provides complete flexibility with regards to glass transparency without compromising natural light diffusion into the interior. This is achieved through the precise laser etching over the active silicon film that is applied onto the surface of the glass.

With this system, *ThinFilm* of Onyx Solar® allows more natural sunlight through the glass but filters harmful radiation. As a result, it enhances the comfort level of the interior while simultaneously illuminating the space.

Depending on the amount of silicon film removed by the etching, the light transmission can vary from 10 to 30%, which is normally the optimal range for interior space. By outperforming conventional glazing systems, Onyx Solar's adaptable solutions are the best alternative in the market.



## REFLECTION OF LIGHT

Regarding the light reflection produced by the photovoltaic glass, values go from 7 to 9%. These values are similar to conventional glazing which normally ranges from 6 to 10%.



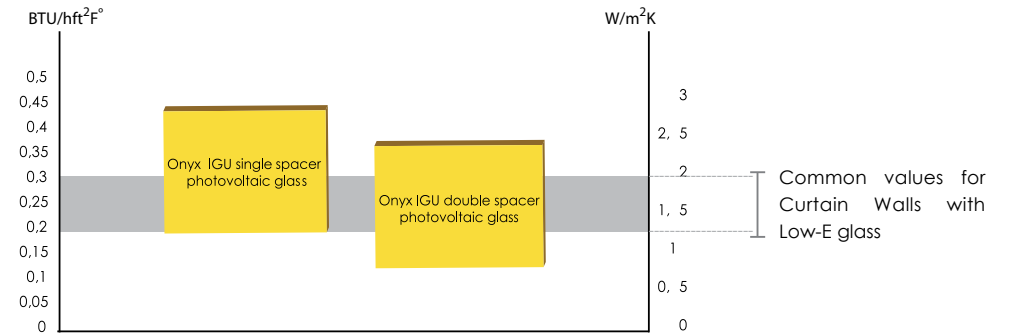
# THERMAL INSULATION

The amount of thermal properties transmitted through the glazing is measured by the U-value. This measurement indicates the amount of heat going through the glazing, consequently causing the glass to have different temperature on its outside and inside-facing surfaces (i.e. thermal gradient).

The lower the U-value the better it is for a building in terms of energy efficiency.

In addition, **the Low-E photovoltaic glass of Onyx Solar® can be built as an Insulating Glass Unit (IGU), which offers u-values as low as 0.73 W/m²K (0,13 BTU/hft²F°), making it the best performing Low-E glazing on the market.**

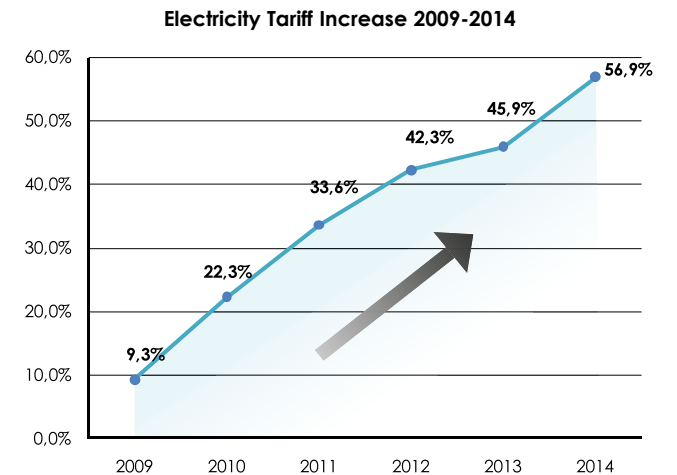
## U VALUE



A graph showing the U-values between two types of glazing. The lower the U-value, the more energy efficient the building will be. (1 W/m²K=0,1761 BTU/hft²F°)

# CLEAN ENERGY PRODUCTION

Besides the filtering and insulation qualities, it is also important to highlight the energy production capability of our photovoltaic glazing system. This is made possible by the precise active layers of photovoltaic material, CVD, layered over one of the glass surfaces. As an example of its effectiveness, 100 sq.meters of photovoltaic glass in a city like Los Angeles could power 250 street lights throughout a life cycle of more than 25 years.



In a world where the price of electricity is constantly rising, our clients can sharply cut costs by generating free and clean solar energy.

The photovoltaic glass developed by Onyx Solar® is an ideal multifunctional alternative to the conventional Low-E glass that is commonly used today.

Onyx Solar® glazing is designed to provide optimal thermal and optical properties while simultaneously generating free clean solar energy.



The pictures shown above belong to San Anton Market located in Madrid. This skylight is composed of photovoltaic glasses with L vision (20%) transparency.

Our glass is available in the following transparencies:



LIGHT TRANSMISSION	PEAK POWER GENERATED
<b>DARK (0%)</b>	<b>58 Wp/m<sup>2</sup></b> 5.39 W/ft <sup>2</sup>
<b>M VISION (10%)</b>	<b>40 Wp/m<sup>2</sup></b> 3.72 W/ft <sup>2</sup>
<b>L VISION (20%)</b>	<b>34 Wp/m<sup>2</sup></b> 3.16 W/ft <sup>2</sup>
<b>XL VISION (30%)</b>	<b>28 Wp/m<sup>2</sup></b> 2.60 W/ft <sup>2</sup>

	ONYX SOLAR GLAZING	CONVENTIONAL LOW-E GLASS	CONVENTIONAL GLASS	CONVENTIONAL PV PANEL
Selective IR Filter	✓	✓	✗	✗
Selective UV filter	✓	✓	✗*	✗
Solar factor/ SHGC	✓	✓	✗	✗
Natural lighting	✓	✓	✓	✗
Thermal performance U < 2 W/m <sup>2</sup> K U< 0,35 BTU/hft <sup>2</sup> F°	✓	✓	✗	✗
Acoustic performance	✓	✓	✓	✗
Electricity generation	✓	✗	✗	✓
Low-emissive properties	✓	✓	✗	✗
Aesthetic integration in buildings (customized sizes, colors and buildup)	✓	✓	✓	✗

\* UV filter is only achieved by laminated glass

## PHOTOVOLTAIC ESTIMATION AND RETURN ON INVESTMENT



Onyx Solar's new app "Photovoltaic Estimation and Return on Investment" is now available for free on Onyx Solar® website, Apple Store, and Play Store.

A new feature on the app provides a sample Feasibility Study which shows the economic advantages of using photovoltaic insulation glass of Onyx Solar® over a traditional one for a building. Additional features include return on investment, average reduction in HVAC energy demand, total solar electricity generated, and the cost of kWh by using Onyx Solar® photovoltaic glass.

The new app also allows you to calculate annual energy generation from our photovoltaic system and its equivalence in eliminated CO<sub>2</sub> emissions, number of supported light fixtures, barrels of fuel saved, and even the distance traveled by an electric vehicle.

PHOTOVOLTAIC GLASS INNOVATION  
 SKYLIGHT GREENBUILDING SUSTAINABILITY CLEAN ENERGY FROM THE SUN BIPV SKYLIGHT DESIGN BIPV  
 ARCHITECTURE BUILDING WALKABLE ROOF TECHNOLOGY GENERATION ONYX SOLAR SUSTAINABILITY PHOTOVOLTAIC GLASS  
 BIM ARCHITECTURE PHOTOVOLTAIC WALKABLE ROOF INNOVATION TECHNOLOGY GENERATION ONYX SOLAR SUSTAINABILITY PHOTOVOLTAIC GLASS  
 LEED CERTIFICATION WALKABLE ROOF BIPV CURTAINWALL DESIGN INNOVATION ARCHITECTURE PROJECT PHOTOVOLTAIC FACADE ENERGY BUREAU ARCHITECTS  
 ECOTECH REVIT SIMULATION ANALYSIS ROOF LEED BIM BIPV SUSTAINABLE PROJECTS



**SPAIN (Avila)**

C/ Río Cea 1, 46 • 05004  
 Phone: +34 920 21 00 50  
 info@onyxsolar.com

**UNITED STATES (New York)**

1123 Broadway, Suite 908, NY 10010  
 Phone: +1 917 261 4783  
 usa@onyxsolar.com

[www.onyxsolar.com](http://www.onyxsolar.com)

© Copyright Onyx Solar Energy S.L. - All Rights reserved



Printed on Igloo offset FSC RECYCLED CREDIT.  
 100% recycled



EUROPEAN UNION  
 European Regional Development Fund  
 Investing in your future