PILKINGTON

NSG GROUP

Solar Energy range

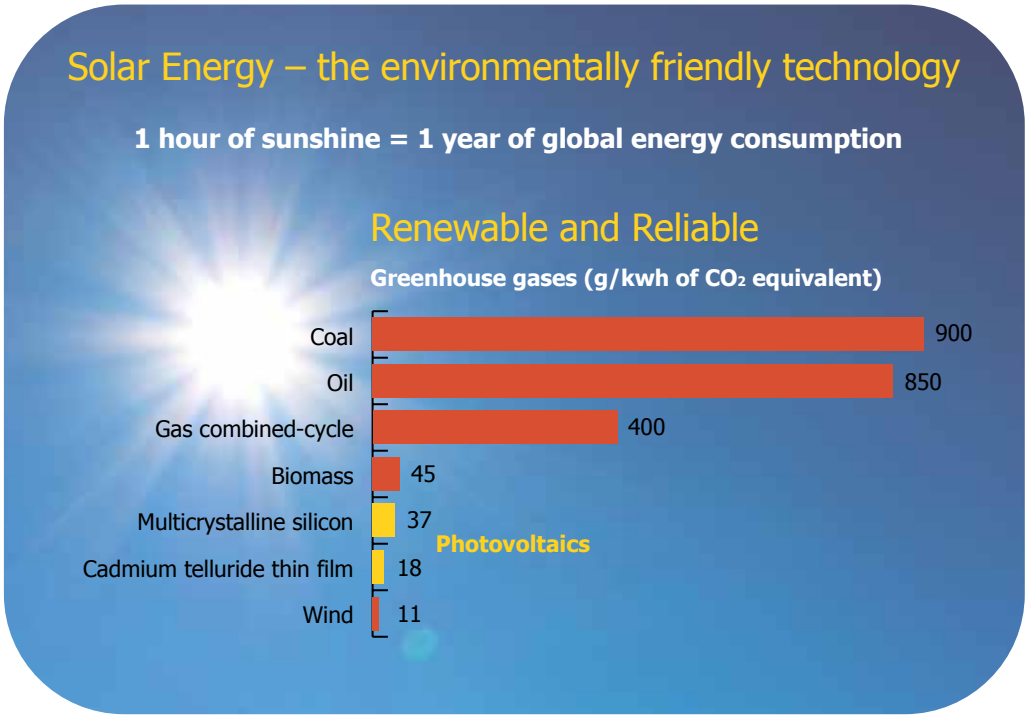
NSG **TEC**™
Pilkington **Microwhite**™
Pilkington **Optiwhite**™
Pilkington **Sunplus**™

Moving from hydrocarbon dependency to renewable energy
The use of solar energy glass and the NSG Group

Over the past few years, legislation has been introduced around the world to address the issue of renewable energy, spurred on by the Kyoto protocol and subsequent national targets.
It is increasingly recognized that a move from hydrocarbons is essential as supplies are finite and global warming is a reality.

Solar energy panels offer alternative solutions for a range of energy requirements, from small scale domestic applications to large scale solar power stations, from cloudy northern rooftops to hot sunny deserts.

Glass is an integral and important element of these solar panels.
Our wide range of high quality products are used in the three leading solar technologies aimed at converting solar energy into electricity: thin film photovoltaics, crystalline silicon photovoltaics and concentrated solar power applications.
In addition to the generation of electricity, our glass products are also used in solar applications that generate hot water.



Source: EPIA

Source: Juwi Solar

Converting solar energy into electricity

Thin Film Photovoltaics

Characteristics

Thin film photovoltaic modules produce power at low cost per watt. They are ideal for large scale solar farms, as well as Building Integrated Photovoltaic applications (BIPV). They benefit from generating consistent power, not only at elevated temperatures, but also on cloudy, overcast days and at low sun angles.
For BIPV applications, thin film modules have excellent aesthetics. They also benefit from a relatively small drop in power output under partial shadowing when compared with crystalline silicon modules. This gives thin film modules greater design flexibility when integrated into the building envelope.

Thin film photovoltaic (PV) modules consist of a stack of extremely thin photosensitive layers sandwiched between a top Transparent Conductive Oxide (TCO) coating and a back contact. The photovoltaic layers are laminated between a TCO coated front glass such as NSG **TEC**™, and a low cost backing material, such as standard or thermally strengthened Pilkington **Optifloat**™ Clear glass.

Source: Kaneka, VISOLA

There are a number of thin film photovoltaic technologies including amorphous silicon (a-Si), tandem (a-Si/µ-Si) – a combination of amorphous and microcrystalline silicon, cadmium telluride (CdTe), copper indium (gallium) diselenide (CIS, CIGS) and dye-sensitised solar cells (DSSC). a-Si, a-Si/µ-Si, CdTe and DSSC are deposited directly onto NSG **TEC**™; CIS and CIGS tend to be deposited onto a molybdenum coated glass substrate.

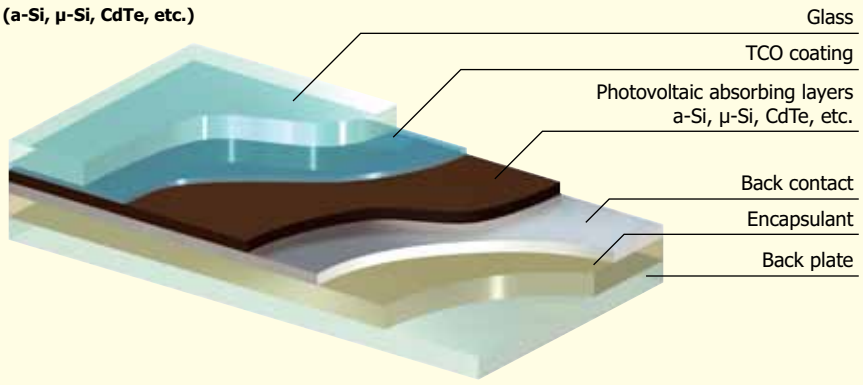
Our products

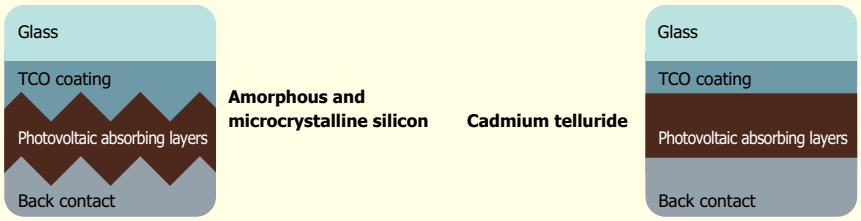
NSG **TEC**™ is a group of products, including a comprehensive range of TCO (Transparent Conductive Oxide) coated glass, optimised to suit a variety of thin films photovoltaic technologies, with different haze and conductivity levels. All our NSG **TEC**™ products are manufactured using a patented chemical vapour deposition process to produce a durable, on-line pyrolytic coating that may be heat strengthened or fully tempered, providing complete flexibility for module production.

Each of our products within the range is targeted at a particular thin film photovoltaic technology. For a-Si, a-Si/µ-Si, CdTe and DSSC technologies, properties such as light transmittance, TCO conductivity (sheet resistance) and light trapping (haze) can be optimized to meet individual customer requirements.

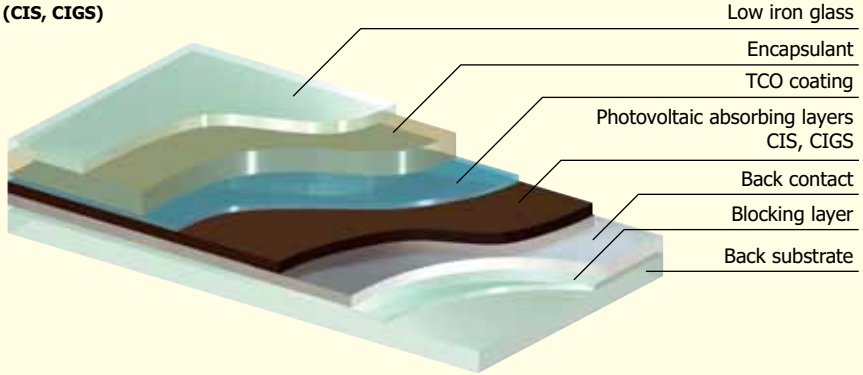
Thin Film Photovoltaics

Generic superstrate construction
(a-Si, µ-Si, CdTe, etc.)





Generic substrate construction
(CIS, CIGS)



NSG **TEC**™ Sodium Block is used for CIS/CIGS applications. It includes a sodium barrier layer, which offers manufacturers improved product stability and increased process throughput.

Our NSG **TEC**™ products are available in either standard or low iron glass composition depending on the substrate/coating combination.

NSG **TEC**™ range product features summary:

- high light transmittance, medium to high conductivity, low to high haze properties to suit all thin film photovoltaic applications;
- coating properties are resistant to heat (i.e. unaffected by very high processing temperature);
- can be fully tempered/toughened or heat strengthened without damage to the coating or drop in performance;
- durable on-line pyrolitic coating, making the product easy to transport, store, handle and process, reducing costs and lead times;
- available on standard clear or low iron glass, depending on the coating type;
- NSG **TEC**™ C15 available with a choice of buffer layers (NSG **TEC**™ C15M and NSG **TEC**™ C15D);
- sodium blocking performance;
- unlimited shelf-life;
- available in a wide range of thicknesses, from 2.2 mm to 6 mm.

The properties of our main NSG **TEC**™ products are summarised in the table below:

	NSG **TEC**™ A7	NSG **TEC**™ A9 NSG **TEC**™ A10	NSG **TEC**™ C10 NSG **TEC**™ C10X	NSG **TEC**™ C15 NSG **TEC**™ C15D NSG **TEC**™ C15M	NSG **TEC**™ A9X NSG **TEC**™ T11X NSG **TEC**™ 12X	NSG **TEC**™ Sodium Block
Light transmittance	High	High	High	High	High	Very High
Conductivity	High	High	High	Medium	High	None
Haze	Medium	High	Low	Low	High	Very Low
Sodium blocking layers	Yes	Yes	Yes	Yes	Yes	Yes
Technologies	Amorphous silicon DSSC	Amorphous silicon	Cadmium telluride DSSC	Cadmium telluride DSSC	Tandem Amorphous silicon	CIS/CIGS

The NSG **TEC**™ descriptive names indicate the technology to which the products are most suited as well as the corresponding technical values.

	Technology	Sheet resistance	Glass composition
NSG **TEC**™	A = amorphous silicon (a-Si) T = tandem (a-Si/µ-Si) C = cadmium telluride (CdTe)	7 to 15 Ohms/sq	X for low iron

Pilkington **Optiwhite**™ may also be used as a base for TCO deposition, or as a top cover plate for CIS and CIGS thin film PV.
Pilkington **Optiwhite**™ is an ultra clear float glass with a very low iron content, which maximises the solar energy transmittance and, therefore, the efficiency of the module.

Our range of products includes the standard and well established low iron Pilkington **Optiwhite**™ and Pilkington **Optiwhite**™ S, which was developed especially for the solar industry and offers even greater solar transmission.

Pilkington **Optiwhite**™ and Pilkington **Optiwhite**™ S features summary:

- very high light transmittance and solar heat transmittance;
- consistent lifetime performance following prolonged exposure to the sun (no solarisation);
- available in annealed or tempered/toughened form;
- available in a wide range of cut-sizes and jumbo plates, from 2 mm thickness and upwards.

Crystalline Silicon Photovoltaics

Characteristics

Developed from the microelectronics technology industry, crystalline silicon (c-Si) is the most widely used solar technology. Due to their high efficiency, crystalline silicon modules are best suited to applications where space is at a premium.

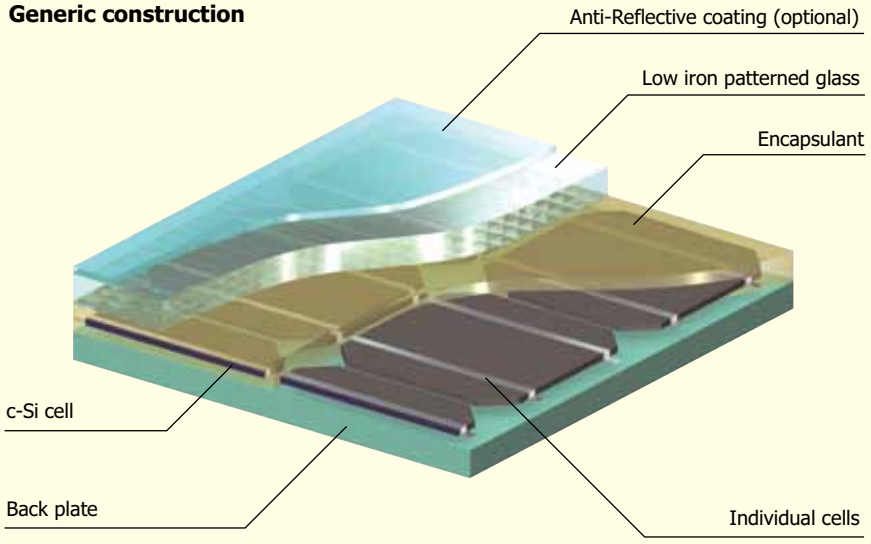
In crystalline silicon modules, cells are connected together and then laminated under toughened, high transmission glass to produce reliable, weather resistant modules.

There are two types of crystalline silicon modules:

- mono-crystalline silicon, produced by slicing wafers from a high-purity single crystal ingot;
- multi-crystalline silicon, made by sawing a cast block of silicon first into bars and then into wafers.

Mono-crystalline modules typically have higher efficiencies than those of multi-crystalline.

Crystalline Silicon Photovoltaics using a patterned surface Generic construction



The glass type normally used for this technology is low iron rolled glass such as Pilkington **Sunplus**™, often in toughened form, combined with an Anti-Reflective (AR) coating, to ensure that the maximum solar radiation reaches the PV cells. It is also possible to use low iron float glass such as Pilkington **Optiwhite**™.

Our products

Pilkington **Sunplus**™ is a glass specifically developed for use in crystalline silicon modules. This high performance low iron glass has very high solar energy transmittance. When toughened, its strength and durability make it the ideal choice for this application.

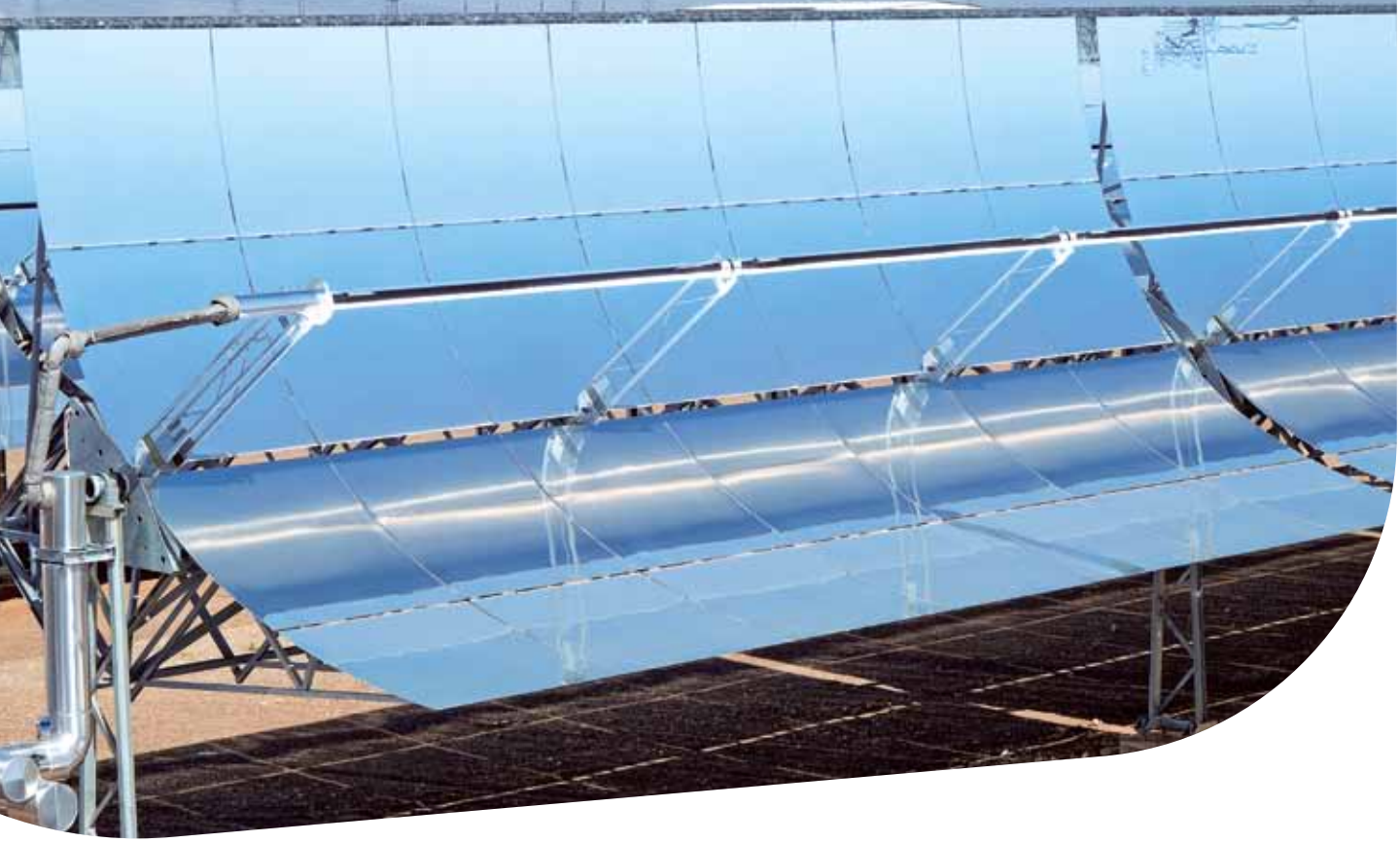
Our range of Pilkington **Sunplus**™ products include:

- Pilkington **Sunplus**™ SM: ultra high solar energy transmittance and low light reflectance due to a combination of a prismatic pyramidal pattern on one surface (S), and a matt pattern on the other (M);
- Pilkington **Sunplus**™ MM: ultra high solar energy transmittance and low light reflectance due to the matt pattern surfaces on both sides;
- Pilkington **Sunplus**™ SM AR: ultra high solar energy transmittance with Anti-Reflective properties due to the application of an AR coating, designed and optimised for crystalline silicon technologies.

Pilkington **Sunplus**™ is used extensively for the cover glass in crystalline silicon solar modules. Where there is a need to match other building components, toughened Pilkington **Optiwhite**™ can be used as an alternative cover plate.

Pilkington **Sunplus**™ range features summary:

- ultra high solar energy transmittance and low light reflectance;
- choice of patterns, either SM or MM to suit the specific application;
- the pyramidal pattern can assist in the laminating process during module manufacture, but can be used on the external surface if desired;
- SM product available with Anti-Reflective (AR) coating for optimal solar energy conversion;
- consistent lifetime performance following prolonged exposure to the sun (no solarisation);
- available in fully tempered/toughened form to provide excellent strength with resistance to hail, mechanical impact and thermal stress;
- available in various cut-sizes or stock sizes in standard thicknesses of 3.2 mm and 4.0 mm; other thicknesses available on special request.



Source: Flabeg

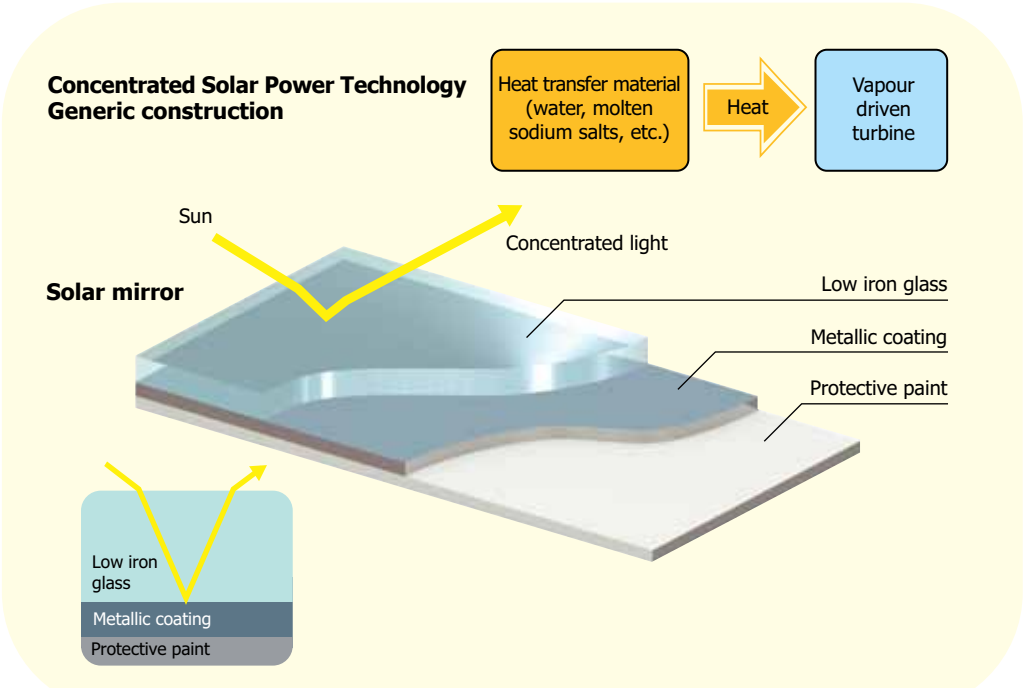
Concentrated Solar Power Technology

Characteristics

Concentrated solar power technology uses mirrors to concentrate sunlight.

The concentrated sunlight can either be directed onto a heat transfer material which generates electricity through a turbine, or onto a very high performance photovoltaic cell, which converts it into electricity. Concentrator systems require direct sunlight and they generally follow the sun's path during the day through an axis tracking system. Typical examples are parabolic troughs and heliostat power towers.

The high performance mirrors are manufactured using metallic reflective coatings and weather protective paints deposited onto very high performance low iron float glass.



Since the sunlight has to travel through the glass twice before reaching the heat transfer material, very high light transmittance, low absorptance glass such as Pilkington **Optiwhite™ S**, Pilkington **Microwhite™** or low iron NSG **TEC™** Sodium Block is required for this application.

Our products

Pilkington **Microwhite™** is our Pilkington **Optiwhite™** in its extremely thin version (glass thicknesses down to 1.0 mm). Pilkington **Microwhite™** is a low iron float glass substrate used for solar mirrors. It is particularly suited to parabolic dish technologies in concentrator solar thermal applications.

NSG **TEC™** Sodium Block on low iron glass can also be used as substrate for solar mirrors. It includes a sodium barrier layer for improved product shelf-life and durability, which can offer solar mirror manufacturers improved stability.

Pilkington **Optiwhite™** S and Pilkington **Microwhite™** features summary:

- very high solar heat transmittance;
- very high light transmittance;
- consistent lifetime performance following prolonged exposure to the sun (no solarisation);
- available in annealed or tempered/toughened form for Pilkington **Optiwhite™** S; available in annealed form only for Pilkington **Microwhite™**;
- available in a wide range of cut-sizes and jumbo plates from 2 mm thickness and upwards for Pilkington **Optiwhite™** S; available in cut-sizes from 400 × 600 mm up to 1000 × 1800 mm, and in thicknesses down to 1.0 mm for Pilkington **Microwhite™**.

NSG **TEC™** Sodium Block

- available on low iron glass with very high solar heat transmittance and light transmittance;
- consistent lifetime performance following prolonged exposure to the sun (no solarisation);
- durable on-line pyrolitic coating, making the product easy to transport, store, handle and process, reducing costs and lead times;
- sodium blocking performance
- unlimited shelf-life
- available in annealed or tempered/toughened form
- available in a wide range of cut-sizes and thicknesses, from 2.2 mm to 6 mm.

Source: Flabeg

Converting solar energy into hot water

Solar Thermal Collectors

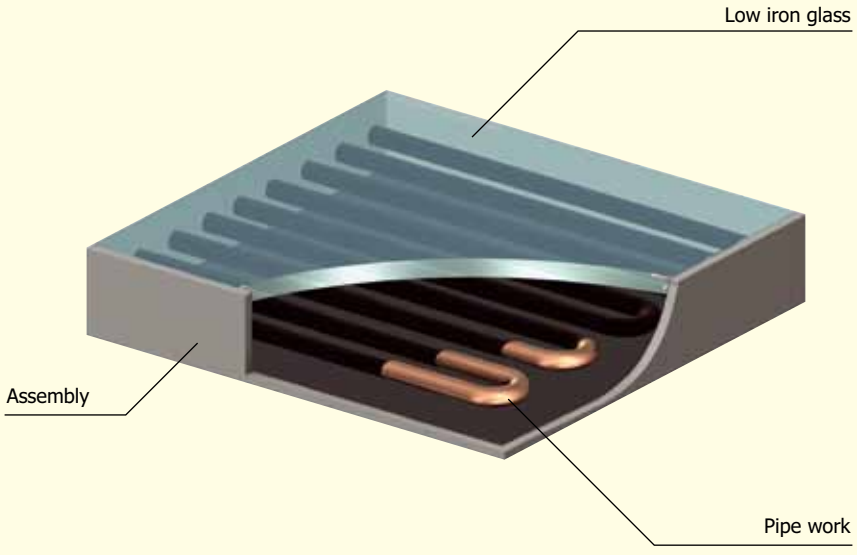
Characteristics

Solar heating systems are generally composed of solar thermal collectors, a water storage tank or interconnecting pipes and a fluid system to move the heat from the collector to the tank. The sun's energy is used to heat water flowing through the interconnecting pipes. The water can be heated for a wide variety of uses, including domestic, commercial and industrial applications.

Flat-plate solar collectors consist of an insulated box which contains a dark absorber plate under a glass cover, that hermetically seals the system while maximizing the energy input. The glass cover plate will transmit the sunlight while protecting the system from harsh weather.

Toughened, high transmittance glass is required for this application; our Pilkington **Sunplus**™ and Pilkington **Optiwhite**™ are ideal for such applications.

Solar Thermal Collectors
Generic construction



Our expertise in solar technology

Drawing on the combined strengths of Nippon Sheet Glass and Pilkington, NSG Group has been closely associated with the leading companies within the crystalline silicon and thin film photovoltaic industries for many years. This collaboration has come about, in part, as a result of the historical expertise in on-line coating of both Pilkington and NSG, which has enabled us to become the worldwide leading producer of high quality, high volume TCO glass, with manufacturing sites in all main regions.

Furthermore, we have been a technological leader in low iron glass compositions for twenty-five years. This is why we are able to offer all the support and guidance required by our valued solar customers.

NSG Group has a global solar energy organisation, delivered through a local presence, that enables us to give one face to our customers wherever they are based and regardless of their solar technology. With offices across the world, including Japan, China, Germany, USA, India and the UK, we provide the first class service that our customers deserve.

CE

CE marking confirms that a product complies with its relevant harmonised European Norm.
The CE marking label for each product, including declared values, can be found at www.pilkington.com/CE

NSG GROUP

Pilkington Group Limited
European Technical Centre
Hall Lane, Lathom Nr Ormskirk L40 5UF, United Kingdom
marketing.communications@nsg.com
www.pilkington.com/solarenergy