*Fourth generation technology gives expected lifetime of 20 years*

# AMORPHOUS SOLAR PANELS NOW AFFORDABLE AND RELIABLE

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More than a decade ago, the first generation of innovative thin film amorphous silicon solar panels has been introduced on the market. Over the past decade, the quality of amorphous solar panels has been greatly improved. After several years of innovation and field testing, Free Energy Europe has now developed a fourth generation technology that ensures a high reliability solar panel, with an expected lifetime of 20 years. These fourth generation amorphous silicon solar panels have a comparable quality to crystalline solar panels. The price is more affordable, notably for systems smaller than 35 Watts.

**Affordable application**

Thin film amorphous silicon solar panels presently find their application primarily in rural power supply in developing countries. Panels of $12W_p$ can be found in the shops in over 30 countries. Because of the limited price (60-80 USD in the shops), these panels can be bought on cash basis by the rural end-user. The end-users use the panels primarily for battery charging, which allows them to have electric lighting, radio, or television.

In addition, the amorphous silicon solar panels are particularly suitable as power source in independent electrical equipment. The panels are currently sold for electric fencing, parking meters, etc. For these applications, solar power presents the most cost-effective solution.

**Quality issues important**

Thin film amorphous silicon solar panels consist of a very thin layer of silicon, deposited on, for instance, a glass substrate.

The amorphous silicon layer stabilises after the first months of use. In general, a stabilised solar cell behaves like a semi-conductor and has negligible ageing effects.

The lifetime of amorphous silicon solar panels is therefore not limited by the cell itself, but by its protection. The thin film of active material is very sensitive to the impact of corrosion. Notably in areas with high air moisture content, this may cause rapid deterioration of the panels, if not properly framed.

The focus of quality improvement of amorphous silicon solar panels has therefore primarily been on finding a moisture proof framing.

With our unique fourth generation framing, Free Energy Europe now has the corrosion problem under control. This paper describes the various framing technologies that have been used in the past and the solution that we have found to make amorphous silicon a reliable technology.

**Simple aluminium frame (1985-1990):**
The first process that was used to protect thin film solar panels from moisture was a simple aluminium framing (figure 1).

In these first generation amorphous panels, the back side of the front photovoltaic glass plate was protected by a second glass, glued with resin. An adhesive tape was then applied around the resulting laminate. The final frame, made of aluminium profiles, was mounted by screws at the corners. An additional silicon glue was introduced in the aluminium profile just before mounting.

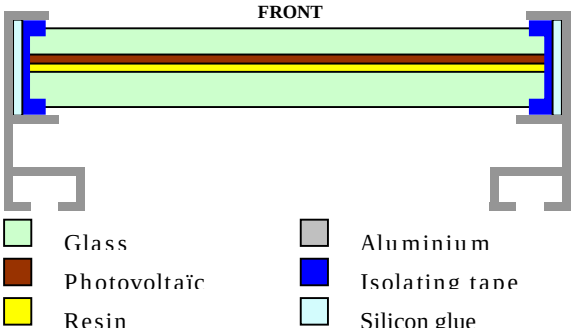



*Figure 1. Cross section of simple aluminium framing*

With this simple aluminium framing technology, in hot and wet climates, moisture penetration resulted in corrosion of the active layers, starting at the frame corners and expanding quickly to the rest of the module. Available statistics showed more than 10% failure rate at site.

For Free Energy Europe (NAPS at the time), this was a good reason to drop this technology and look for a more suitable humidity barrier.

**Polycarbonate frame (R&D level 1990)**
A first option that was investigated, was polycarbonate framing. In this option, the back side of the photovoltaic plate was protected by a back glass glued with resin. The adhesive tape was replaced by a polycarbonate profile glued to the glass around the laminate. The internal part of the profile contained hydrophobic material acting as a moisture barrier (figure 2).

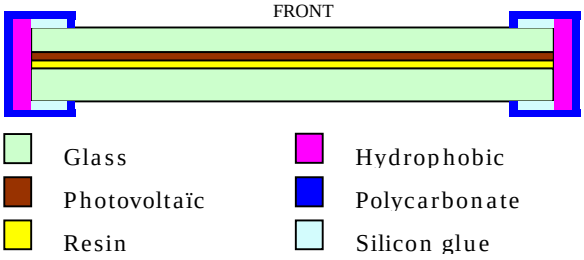



*Figure 2. Cross section of polycarbonate framing*

The humidity barrier ability was good, but the polycarbonate profile could not sustain temperature variations. When exposed to external temperature variations, the polycarbonate frame appeared to be breaking at the corners.

Therefore, this solution has never been launched in production.

**Polycarbonate with aluminium frame (1991-1996)**
This solution has been brought into production in 1991. The design combined the advantages of the mechanical strength of aluminium frame with the improved moisture barrier of the polycarbonate frame. The cross section can be seen in figure 3.

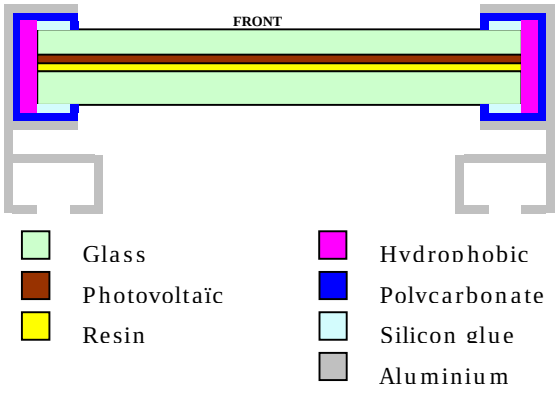



*Figure 3. Cross section of polycarbonate with aluminium framing*

Still, there was a weak point to this framing design. Energy output was made

through a connector. Two types of problems occurred through this connector:

- aluminium foils coming out from the laminate were truncated after some time;
- water went into the connector junction box developing corrosion of the contacts.

The default rate has been estimated to reach 3-5% of production, often on locations near the seaside. This design has therefore been dropped, primarily because of the connector problems.

**Fourth generation framing: polymer injection (1996-up to now)**

Hence, Free Energy Europe embarked on the development of a break-through framing technology, to finally solve all on-going framing problems.

In 1996, the fourth generation framing has been introduced into the market. The front photovoltaic plate is still protected by a back glass glued with resin. Cable wires are directly soldered to the corners of the laminate, without any connector. After appropriate adhesion treatment on glass, advanced polymer material is injected around the laminate.

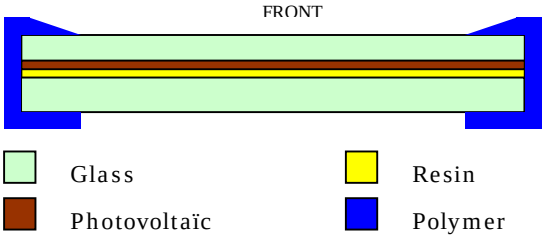



*Figure 4. C*ross section of polymer injection framing

**Results**

The results of having this framing technology two years in the market have been very positive. The composition of the polymer has been fine-tuned.

Now the reported failure rates have fallen below 1%. Also the end-users in the market have noticed the quality improvement and are specifically asking for “quality panels from France”.

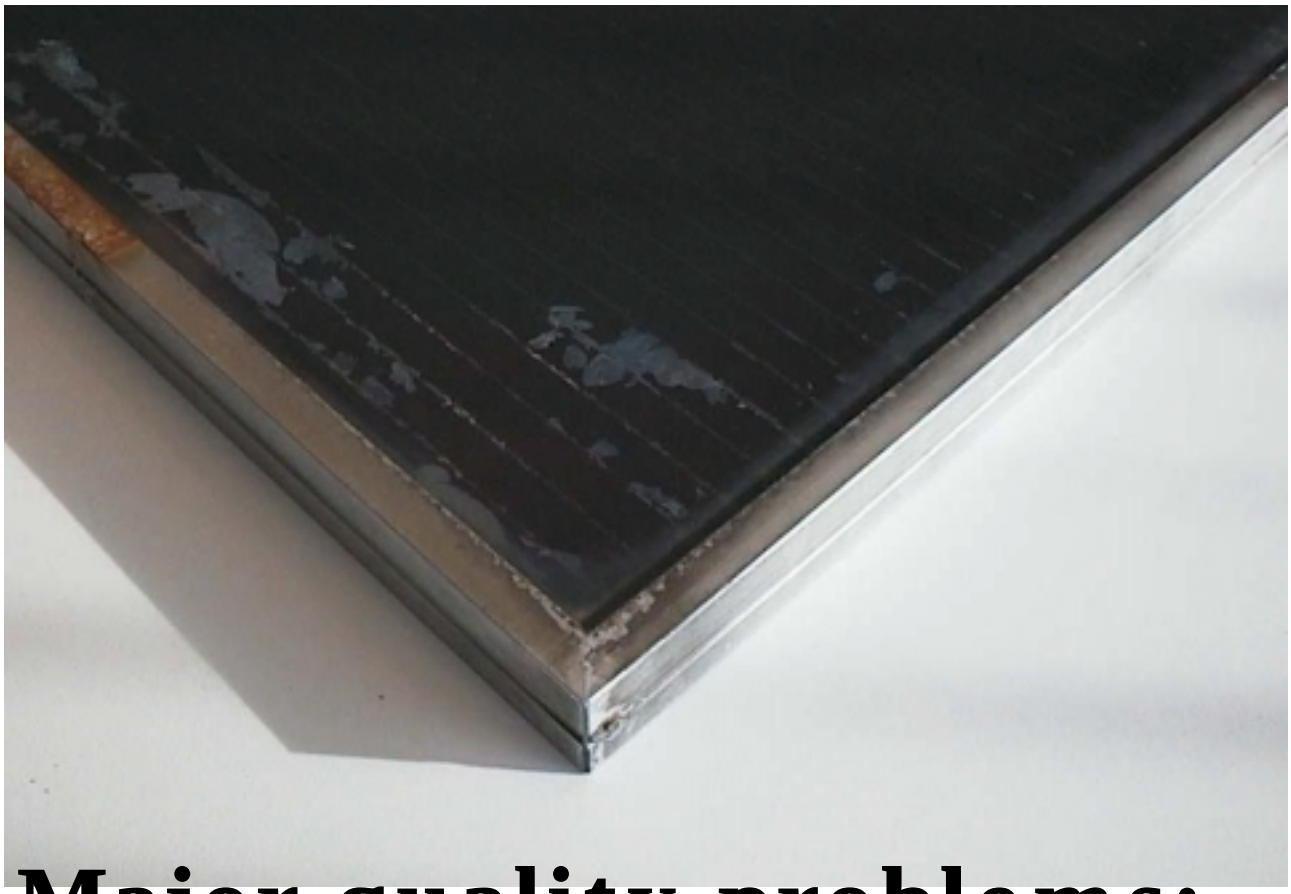
## *CONCLUSION*

*The conclusion is that the fourth generation framing technology is able to offer the reliability that is so much needed by the end-users.*

*Free Energy Europe can now offer high quality and reliability of thin film solar panels, far ahead of the competition.*

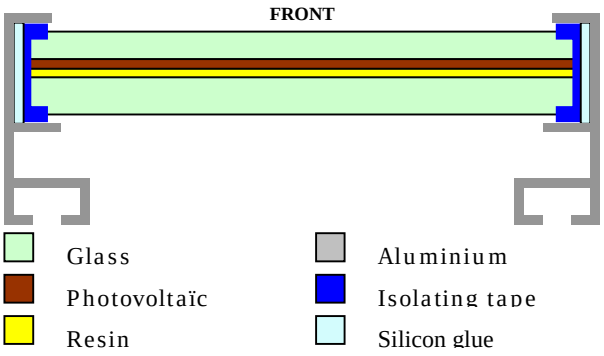
*The expected lifetime of our panels in the field is up to 20 years.*

# 1985-1990:
# 1st Generation "Chronar"



# Major quality problems:

- ⇨ Simple "open" aluminum framing
- ⇨ Easy moisture penetration
- ⇨ Early corrosion and power degradation
- ⇨ Very high failure in the field (>10%)



# 1990-1991:
# 2nd Generation "Lab only"

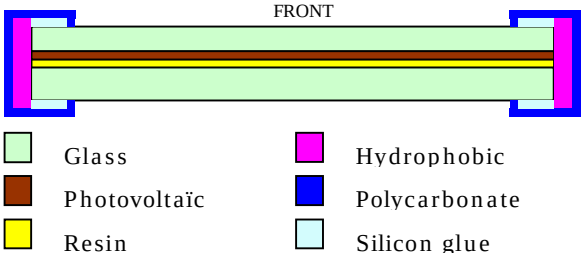
# Insufficient solution:

⇨ Simple polycarbonate framing

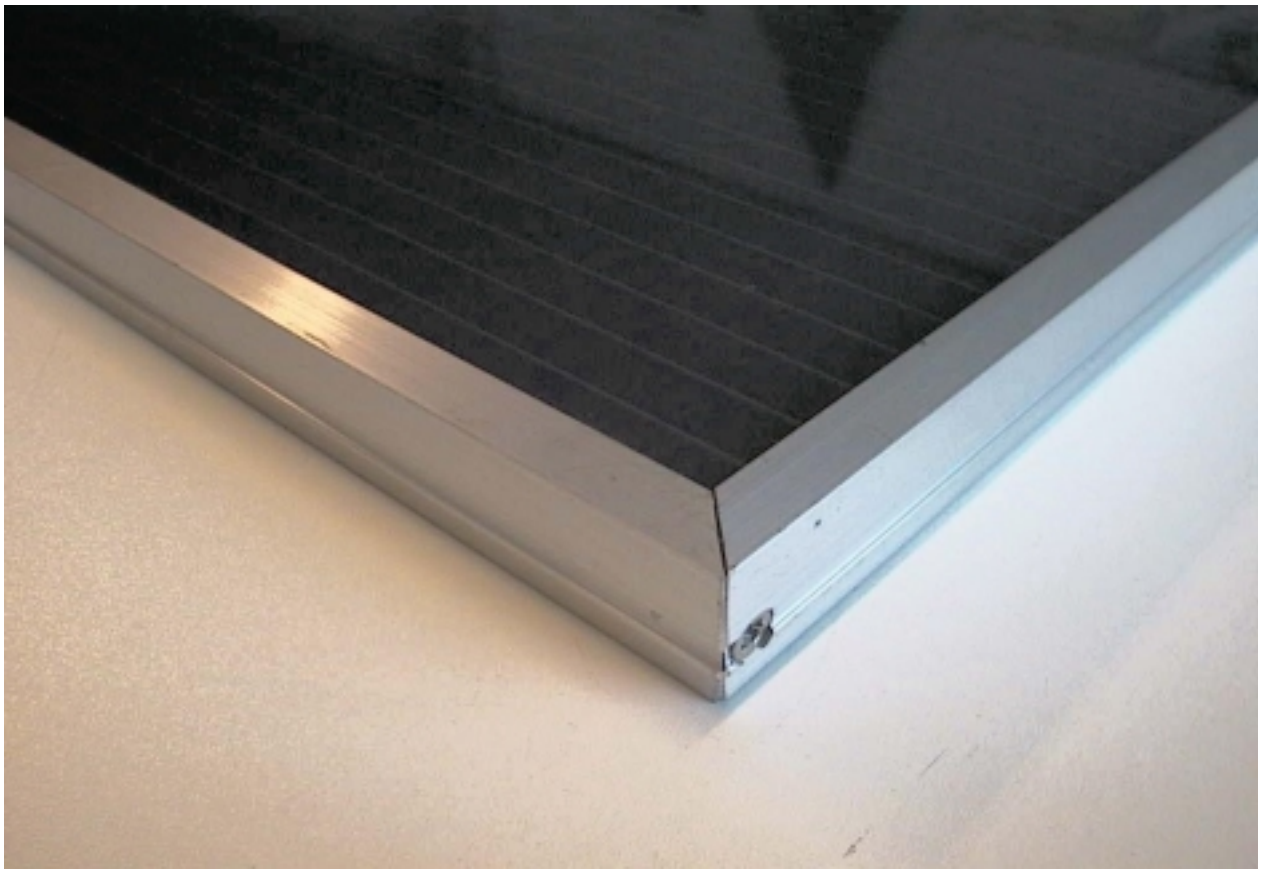
⇨ Enhanced moisture barrier

⇨ Very weak in temperature variations

⇨ Never brought on the market



# 1991-1996:
# 3rd GENERATION "NAPS"



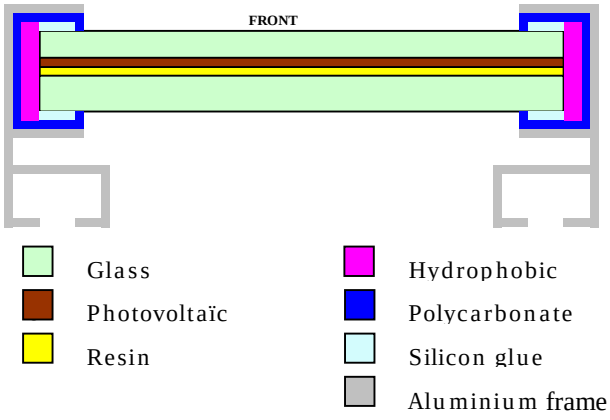
# Reduced quality problems:

⇨ Hybrid polycarbonate - aluminum framing

⇨ Enhanced moisture barrier

⇨ Corrosion sensitive connector

⇨ High failure rate in specific markets (± 5%)



# 1996-.... 4th Generation "Free Energy Europe"

# First quality product:

- ⇨ Advanced polymer injection framing
- ⇨ High moisture barrier
- ⇨ Close to IEC certification
- ⇨ Very low failure rate in the field (<1%)