Harnessing the Sun - A Smart Investment

By Ilan Ron*

As a result of recent economic circumstances, both the private individual and the corporate entrepreneur should consider the option of setting up a grid-tied photovoltaic system as a fruitful investment yielding an annual fixed percentage revenue for 20 years. It should be viewed as a long-term deposit, which brings in an annual return of 10-16 percent, depending on the cost of installation and geographic region. Anyone looking for a "green" and solid investment with a touch of economic and energy independence will find that this makes good sense. It should be noted that according to safety regulations, in the event of a power cut, the solar unit cannot be used as a back-up.

Long-term installation

If there is a prominent characteristic in the installation of a photovoltaic system, it is the long-term aspect. The contract with the Electric Company is for 20 years, at a fixed, index-linked rate.

Ideally, the system should operate without moving parts or the need for significant maintenance. The aim is to invest a one-time sum plus effort in order to assure a predetermined future that will yield profits and economic security to the owners of the system.

All the above lead to the choice of products and technologies that should last for many years and will efficiently provide a stable output.

The importance of quality

A photovoltaic system has two major components: the solar panels (modules) and the inverters. However, if we look closely, we will see that the quality of the wiring and the connectors plays no small part. Imagine having to climb on to the roof of the building after 10 years to look for the errant cable that is causing the system to malfunction, then taking it apart and replacing it, and most probably the other cables too.

In such long-term planning, reliability and quality are very important, and good quality is worth the price. The following are the system's main components, their life expectancy and "must know" items about them:

A) Solar panels (modules)

A solar panel should last up to 25 years - the manufacturer's warranty usually covers up to 20 years. What can cause problems are environmental

damages such as the weather (all installations in Europe have sophisticated anti-lightning protection), as well as vandalism. Also there is a gradual lessening of efficiency due to the build-up of dust. This issue can be significantly reduced by applying innovative coatings that repel deposits.

Today's emerging thin film technology seems to be the right direction and may well rule the market until the next technological breakthrough.

Thin film solar cells have less area efficiency than the legacy crystalline cells but render more energy per year due to their ability to use diffused light and their heat resilience. TF modules also cost much less than silicon ones.

Concentrated solar cells (CPV) will also play a major role, since they are far more cost effective. They also may serve as a dual energy source by producing heated water. However, CPVs require the use of solar trackers, which is less applicable for domestic use.

Building integrated PV solar modules (BIPV) will play a larger role in our life but will mainly be incorporated in new construction.

B) Inverters

The financial planning model of the grid-tied system assumes that the inverter is replaced after 10 years. In effect, based on some superior quality inverters on the market, the life expectancy of the inverter exceeds 15 years. Manufacturers usually give a five-year basic warranty plus an extended 10-year warranty (for a fee).

The internal allocation of the loads and the uniform distribution of cumulative working hours are the key to extending the inverter life. And the corresponding internal architecture should address this issue.

The inverter is the system's component most susceptible to malfunction. If the inverter breaks down, it means immediate loss of earnings. It is therefore important to read the small print and to take into account the kind of warranty and the inverter manufacturer/installer's time of response.

Transformer or transformer-less?

Inverters can be built in two architectural types:

1. High-frequency transformer (HF)

The transformer constitutes a sheer galvanic insulation, thus preventing many possible safety hazards.

2. Transformer-less (TL)

A TL inverter may provide higher efficiency (about 1.5% above HF), but it also has a potential of insulation and safety problems.

Cables and connectors

Since the cables that connect the solar panels to the inverters are installed outdoors, they must withstand extreme environmental conditions for 20 years or more. Such requirements are defined by a German standardization body (DKE). This body, which is practically the world leader in this discipline, defines the requirements and the associated tests to be performed in order to receive the stringent TUV standard: 2PIG 1169/08.2007 TUV. These include resistance to ammonia, erosion by the ozone, long-term withstanding of high temperatures of above 100 degrees etc. Therefore, it is recommended to use special cables for photovoltaic systems that comply with this standard.

The cost of the cables does not exceed 3% of the total system cost and is not worthwhile compromising on.

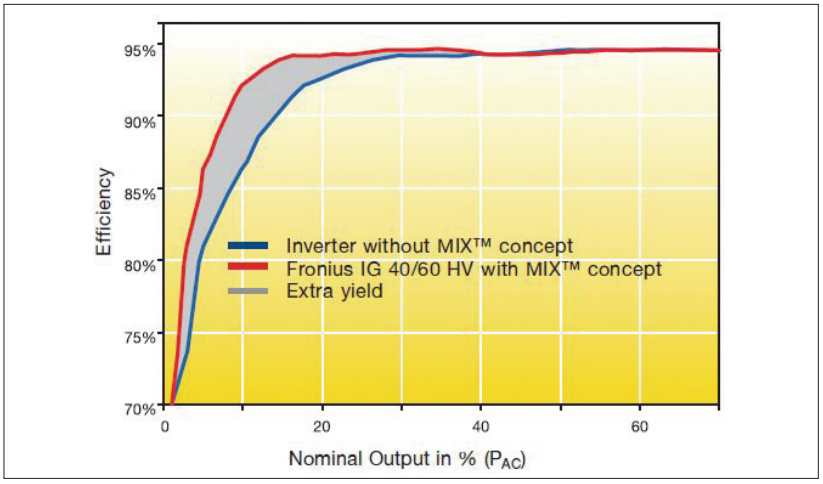
In the field of connectors, there are also TUV standards that should be adhered to.

Efficiency versus energy harvesting

De facto efficiency of the inverter

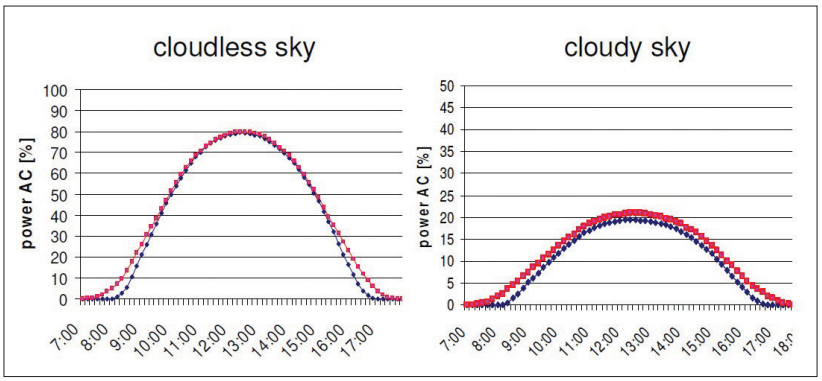
Inverter efficiency is a key factor to the system's energy harvesting. In this matter one should pay more attention to the weighted efficiency, which is also known as Euro efficiency, and not to the peak efficiency, which only refers to one workload and does not represent the actual workings of the instrument.

Generally speaking, the more difference there is between the peak efficiency and the Euro efficiency, the less uniform is the inverter's operation.

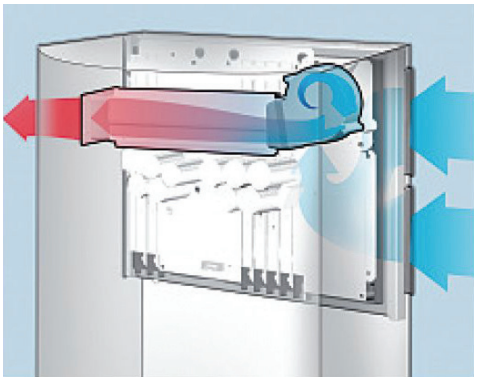


Extra yield achieved by flat curved inverter

High quality grid tied inverter



Extra yield during daytime hours



Fronius advanced active cooling system

In examining the overall inverter efficiency, one must take into account the performance at several different workloads of the inverter.

Inverters with high efficiency at the lower workloads may harvest more energy at the daylight boundaries. Inverters with lesser efficiency at the higher workloads may not properly harvest the best daylight hours.

Energy harvesting

After all this has been said, the important issue is the amount of compounded energy produced by the inverter. In this respect, the technical specifications provide very little information. An important difference, which is not easy to assess, is the ability to utilize the hours at the beginning and end of the day, during which the load on the inverter is only partial.

The following flat power curved inverter harvests more energy on day boundaries and cloudy skies.

Environmental aspects

A photovoltaic system is designed to work in outdoor conditions. The main factors affecting it are:
▪ Temperature ▪ Dust ▪ Wind ▪ Lightning

Temperature and power

Ambient temperature has an effect on the working efficiency of both the solar panels and the inverters. In principle, as the temperature rises the working efficiency will decrease.

Inverters, just like any other power system, have a temperature limit at which the maximum available power begins to decrease as the temperature rises. This is a physical phenomenon, and also a result of a built-in mechanism that protects the inverter from overheating. This process, called power de-rating, significantly affects the point where the inverter can truly operate efficiently in a hot environment. In practice, inverters without active cooling (fans) will begin de-rating at lower ambient temperatures, so that in fact they will not supply their maximum nominal power.

Consequently, to reduce the effect of high temperatures, even though inverters are usually designed for external installation, it is advisable to install them where there is minimal overheating, such as in the shade or even inside a building.

Environmental protection class catch

The IP standard describes the sealing of a certain instrument against the penetration of water and foreign objects.

The standard assigns two digits. The left-hand one describes the sealing against foreign bodies; the right-hand one describes water resistance.

IP67 protection class relates to an instrument that is completely sealed against water and dust infiltration. However, there is a catch here, since sealing makes the heat dissipation much more difficult. Such a type of instrument will be much more sensitive to heat and would reach power de-rating at lower ambient temperatures.

IP44 protection class is sufficient in the majority of cases, except for extremely dusty sites, where an additional level of filtering should be considered.

Grounding methods

Grounding of the system's DC side is usually required for several reasons:
1. The use of thin film technology, which imposes the need for grounding of the negative pole to prevent damage to the TCO layer of the panels
2. Prevention of the danger of electrocution as a result of a malfunction of the solar panel
3. Grounding of the frame to prevent damage by lightning

It is important to consider the significance of the implementation of a TL inverter when the DC side is grounded, as this might cause potential safety hazards, as can be seen in the following illustration.

Lightning & surge protection

Although lightning storms are rare in our part of the world, the damage that could be caused during such a storm can be considerable, since damage could be caused by the electromagnetic surge that the lightning creates. To minimize this, it is advisable to install surge protection devices to at least each string of panels (near the panels).

Summary

With the rising popularity of grid-tied PV systems installations in our sun-drenched country, I hope one has gained some insight into what to look for when engaging in this relatively new venture.

*CEO, Eneright Technologies LTD.
Contact: ilan.r@eneright.com