ET3034TUx - 8.3 - Economics of PV systems

Welcome back.

So far you have seen the main PV system topologies, their design rules and some examples of specific PV systems.

We shall now discuss the PV system economics and the environmental considerations.

I shall first start with the basic ideas involved in discussing the economics of PV systems.

The economics in the field of photovoltaics can be discussed at several levels, like at the levels of consumer, manufacturers, PV installers or technology level while compared to other sources at grid scale.

In this block I'd mainly discuss the economics at technology level.

At the consumer level, however, I'd briefly touch upon the idea of payback period.

What is the payback period?

The payback period in finance is simply defined as the length of time required to recover the cost of an investment.

So how can this be translated at the consumer level, when a homeowner installs rooftop PV system and expects the system to pay itself back?

In the case of a PV system user, the initial investment in terms of system cost is recovered over the years as the PV system offsets the electricity bills.

We can understand this idea in a simple example.

Let's say for instance, family Smith has installed a PV system of 1 kWp at an initial investment cost of €4000.

The family's usual electricity consumption is such that on an average, it incurs an electricity bill of €2000 per year.

After installation of the PV system, roughly €800 worth of electricity consumed by the family is provided for by the PV system.

In this graph, we see a straight line, denoting the fixed investment costs in the beginning.

As the family consumes more of the clean power produced by the PV system, it offsets the electricity bill accordingly.

In this example, the amount saved is €800 per year.

In other words, the family earns a return of €800 per year on the PV investment.

As the years progress, the savings accumulate, and there comes a point in time when the accumulated savings are greater than the original investment.

The period of time elapsed until that point is called the payback period.

In this case, family Smith's PV system has a payback period of 5 years.

Note that the payback period depends on the location of implementation of the PV system.

Of course, the sunnier the location, the greater the PV yield and the faster the payback.

Also, the savings by the PV system not only depends on PV yield but also the grid electricity costs.

Finally, the initial PV system costs are also a major factor in deciding the payback period.

Note that this calculation can become more complex as more parameters are factored in.

For instance, if we are considering a significant period of time, usually it's a practice to also take into account the time value of money.

That is, for example, €1000 today will have a different buying power 10 years from now.

Then there are also policy based factors.

For example, subsidies and feed-in tariffs can affect the initial investments and savings.

Let us briefly discuss the concept of feed-in tariffs in PV systems.

At the consumer level, feed-in tariff is the rate at which a consumer is paid for the electricity that the grid-connected PV system contributes to the local grid.

There could be two kinds of feed-in tariffs, gross and net.

Gross feed-in tariffs are paid for all the electricity the panels produce, irrespective of the domestic electricity consumption of the consumers.

Net feed-in tariffs promise a higher rate for the surplus electricity fed into the grid after domestic use of the consumers is subtracted.

Now we must not confuse the payback period of the PV system with the energy payback time, which is a different concept, and I shall discuss this in the next block with the environmental considerations.

Now let us go to the concept of levelized cost of electricity, or LCOE.

It is the cost per kWh of electricity produced by a power generation project.

It is usually used to compare the lifetime costs of projects based on various power sources.

The concept of LCOE allocates the costs of an energy plant across its useful lifetime, to give an effective price per kWh.

It is similar to averaging the upfront costs of the production over a long period of time.

The LCOE calculation could get very complex, depending on the various parameters considered.

In the simplest of terms, if we know the annual PV yield for the system over its lifetime, and the accompanying system costs, the LCOE can be found out as shown by this formula.

Here A_t is the total annual cost in year t, I_0 is the initial investment, and E_t is the annual energy yield or electricity.

r is the discount rate, which is a factor used to discount future costs and translating them into present value.

Based on the site of the PV generation and the cost of materials, the LCOE of the PV project could vary a lot.

Also, the discount rates used for evaluation will have an impact on the LCOE value.

For the power producer, the LCOE is a valuable indicator of the cost competitiveness of a certain energy technology.

It is also a good price point indicator, that is, the power producer will have to sell the power at a price greater than the LCOE to make profit.

Of course, the policies structured around PV energy like feed-in tariffs, subsidies and other incentives will all play a role in determining the grid power prices.

Finally, we come to the much popular term grid parity.

Grid parity is the situation at which the PV power can be generated at a levelized cost that is equal to the power price from the conventional electric grid.

This could be generalized to other renewable energy technologies as well.

But there is one significant difference between PV and other renewable technologies like wind turbines or hydro dams.

Compared to these other sources, like wind turbines or hydro dams, PV can be scaled down to the level of a single module.

This means that the PV power is now effectively competing with the retail grid price, which conventionally includes other costs like transmission, distribution, etc.

Therefore, compared to wholesale price, PV grid parity for retail grid prices can be reached faster, as shown in the graph.

The graph is depicting the volume of PV implementation on x axis, which can be directly correlated with time, as the past decade has seen the implemented PV volume rise tremendously.

As capital costs decline with increasing volumes, PV power is expected to be cheaper.

On the other hand, cost of fossil fuels, due to the availability and emission costs are expected to rise, thereby increasing the conventional grid costs.

Also, as discussed before, the solar levelized costs will depend also on the site location, as sites having more sun hours will have a lower LCOE.

Grid parity occurs when the solar and grid lines in the graphs cross.

Of course, the grid parity could be reached faster with the help of incentives and subsidies.

However, a school of thought disregards such a grid parity that has occurred with the aid of subsidies.

It is said that the true grid parity is when the PV power prices would fall below the grid prices without any subsidies.

Solar grid parity without subsidies is a much rarer phenomenon, at least right now.

As an example, PV power producers already claimed true grid parity in the sunny country of Spain earlier in the year.

The grid parity is a very important indicator of the usefulness of a renewable energy technology.

The closer a technology is to the grid parity, the easier is its integration in the energy mix of the region.

With the advancements in technology and the maturity of manufacturing processes, grid parity for solar is expected to be a more popular occurrence in several places around the world.

I hope you now have a better idea of the economics involved around the field of photovoltaics.

In the next block, we will focus on environmental considerations for PV systems.

See you in the next block.