What is the problem with rooftop solar systems?

Dr Tilak Siyambalapitiya

All problems have solutions; some solutions are unknown, yet to be discovered or invented. Other solutions are known, but there may be technical or commercial limitations. The debate on how far to go with rooftop solar PV, is in the second category for which solutions are known, with a flavor of the first category.

In 2008, the Ministry of Power and Energy requested for Government approval to introduce "net metering". The approval was received and implemented from 2010. A "net metered" customer may produce electricity using any form of renewable energy (solar, wind, hydro, wood, waste), use the amount of electricity he wants at that moment, and send the surplus electricity to the grid. Renewable resources of energy have many strengths, but they also have many weaknesses: seasonality and intermittency, absence of dynamically stored energy. The customer can use the grid as an energy "bank" to overcome this weakness; deposit his surplus energy and take that back when required. When cloud movement is erratic or wind flow changes by the minute, the "net metered" customer is not affected. The grid looks after his supply and keeps it stable. So the grid is a bank, an energy bank.

Grid is the Bank

This is different to a bank where funds are deposited. This is an energy bank and it has to provide the required capacity and energy, right at the instant the customer asks for it, at the flip of a switch. Therefore, the grid requires to have a strong source of generation, a source not subject to the same uncertainties of wind or solar energy, or the seasonality of hydropower.

So this brings us to the question: why should more new power plants be built? Why can't we produce all electricity from solar? This is because the bank (meaning the grid) should have adequate and strong capacity to look after "solar" customers. Otherwise the whole electricity supply system will collapse, and no one will have electricity. This means, if more solar and wind have to be used for electricity production, they have to be backed with strong sources of generation at the grid. What are these strong sources the grid can have: anything that does not have the weaknesses of wind, solar, hydro, biomass, water. That is basically electricity production that has storage: oil, coal, gas or nuclear power, where the fuel can be stored; fuel shortages can be replenished by purchasing. We cannot buy wind, because it flows freely. When there is a shortage of gas, we can buy gas or oil or coal, and bridge the gap.

Customer's own bank

A customer who has a rooftop solar electricity system, too, can have his own "strong" source, and disconnect from the grid. What are they? He can have a battery, to store his surplus energy, and use it when there is a shortage. What if there would be several consecutive days of poor sunshine, and the batteries are fully drained out? Then the customer can also keep a diesel generator, to help him to supply electricity.

Now, the customer is off-grid. He is no longer a "net metered" customer, and he has his own bank.

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The batteries and the standby generator have costs: investment, maintenance and replacement. Additionally, they need some regular care.

Many customers therefore, would like the grid to continue to be his bank, and save him from the trouble of buying batteries and a generator, and maintaining them. Especially, the smaller household customers would prefer reliable and hassle -free electricity supply. In fact, rooftop solar panels have attracted the households to fix them, because they have no moving parts, nothing to maintain or lubricate. Simply plug and use.

An estimated 20,000 households in the country now have solar panels on their rooftops. They use the strength of the grid, use it as a bank, but pay nothing to the grid. This is because they bank their surplus electricity during the day, use it in the night, and hence their electricity bill is nearly zero. However, the grid has to be maintained, and users have to pay such costs. As they are not presently required to pay but use the grid, who pays their cost contribution to the grid?

Who pays?

The cost of keeping the grid is paid for by people and companies who do not have the means to buy solar panels, or who do not have a roof (because they live in apartments), or whose roof is not strong enough to mount the panels. They pay the costs of the grid for those who are using the grid as the bank. Countries have resolved this problem by changing the electricity pricing structure, with a split between capacity costs (this is a fixed cost) and an energy cost (a variable cost). Thus, if a customer has an electricity connection, a fixed cost per month has to be paid, irrespective of whether he takes energy from the grid, puts energy back into the grid, or does both.

In the Sri Lanka context, such costs are called capacity costs. In 2017, the last time it was calculated by the regulator PUCSL, it worked out to about Rs 3225 per kilowatt of peak coincident demand per month, per customer. An urban customer uses about 1 kilowatt at peak, but a rural customer uses only about a quarter of that. So, simply put, an urban customer has to pay Rs 3225 per month, and a rural customer has to pay Rs 800 per month, and thereafter, the rest of the bill can be zero, if his solar panels produce all the electricity he needs. For commercial buildings with solar panels, the fixed cost will be somewhat lower, because they use electricity only during the day.

Banked during the day and used in the night.

The second problem

A fundamental requirement of an electricity system is to be in dynamic equilibrium. This requires a certain amount of stored energy available in the grid, to be immediately converted to electricity. I am not referring to the fuel in tanks or coal in the stockpile. The extra power should be available instantly, as soon as a cloud covers the solar panels. There is no time to wait, even for one second.

Advanced power systems have 8 to 10 seconds of stored energy. This means, if there is a sudden shortage of electricity production, either on customer's solar panels or the electricity supplier's power plants, this "stored" energy will immediately be converted to electricity to keep the supply stable, until more fuel can be supplied to power plants, to raise their outputs.

When doing this, the supplier's generators will slow down, and release their stored energy as electricity. They will be restored to their normal speed within a few minutes, once more fuel is brought into the system. The initial few seconds is critical; if the supply is not assisted with more "instant" electricity production, the entire grid risks a collapse.

Then we call it a national blackout.

Generators with large dynamic storage required to provide that stored energy are nuclear, coal, gas or oil-burning rotating generators. They rotate at speeds up to 3000 revolutions per minute, and work as the "flywheels" of the grid. Any shortage or surplus of electricity production will be instantly corrected, preventing the grid drifting toward a blackout situation. This happens many times a day, and such events are not even reported, because that's how a grid is designed to operate.

Operate to keep the electricity supply reliable, cherished by customers.

The above would be useful to those in society to understand how a grid operates and the role of renewable energy on it. I have not elaborated the benefits of renewable energy, which are well known.