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When Nikola Tesla invented three-phase power nearly 140 years ago, he wouldn"t have thought that it would create complications for homeowners with a solar power system and three-phase supply. But here we are!

Both three-phase electricity and solar panels are hugely beneficial, but their combination can cause issues in places with phase-accurate billing, such as here in New Zealand. But the much-respected inverter brand Fronius now offers a solution to these issues. Here"s a closer look at the problems with having a solar power system on a three-phase home, and how Fronius tackles these problems.

Three-phase power is a beautiful invention of electrical engineering. It uses three different phases of alternating current instead of one, allowing us to have higher transmission voltage and safer, more reliable systems, particularly where power-intensive appliances are used.

Three-phase systems are "load-balanced", which means every phase must have the same amount of power flowing through it for optimum performance. When you have a solar power system on a 3-phase home, your installer will probably use a single-phase inverter with your solar panels.

Typically, these inverters have symmetric generation, where the power output is divided equally among the three phases. For example, consider a home solar system generating 3 kW of power that"s converted from DC to AC in a 3-phase, symmetrical inverter. As a result, you have 1 kW of power output for each phase.

So far, so good - we"ll just use the 1 kW each for whatever appliances are connected to each phase. Now consider this scenario, which is typical in NZ - your system is interconnected with the grid, and all the available power in each phase isn"t always utilised. Here"s a diagram representing this case:

The problem with this arrangement is that instead of sending that 0.8 kW back to the grid, you could have used it for your first phase where you"re short of 0.5 kW. Unfortunately, in NZ, energy sent to the grid (exported) and energy bought from the grid (imported) are not valued at the same rate, in which case it would not have mattered how much power goes where.

According to the Sustainable Energy Association of New Zealand (SEANZ), the difference between imported and exported power can be over 20 cents per kWh. In other words, if you could use the power that flowed back into the grid instead of buying power from the grid for another phase, you could save 20 cents for each unit of energy. This number is so large that you can see a huge impact on your monthly bills, drastically reducing the worth of your solar power system.

Here"s how Fronius describes this whole issue in brief: "In standard inverters, power is symmetrically

generated but the site is imbalanced due to household load variations, leading to the risk of purchasing expensive electricity from the grid on certain phases."

In NZ, you may choose to limit your inverter"s export to zero watts, which means no unnecessary export. However, in a symmetric inverter, the weakest phase will have a natural zero export, but the other two phases may be limited to the same generation even though load requirements are higher. This means you end up importing energy from the grid for the other two phases. Take a look at this example below:

In this example, the second phase needs the lowest amount of energy - 5 kW, so the inverter limits the output to 5 kW to avoid any export. However, because its operation is symmetrical, the inverter also limits both other phases at 5 kW. Now, the loads connected to these two phases require more than 5 kW of power, and they end up importing it from the grid. Ultimately, we have a system where enough power was available and yet we ended up buying expensive energy from the grid.

Both the above-discussed problems with three-phase systems occur because of symmetrical power delivery through all three phases. One way to address this problem is to attach your solar power system and inverter to just one phase and self-consume all power through this phase. However, this needs a complex, possibly more expensive installation process. Plus, it may also cause network reliability issues due to unbalanced circuits.