

Part +
01 -

Developing the Power Conditioner

The Road to an Integrated Battery Solution for Solar Power Systems

Many homes nowadays can be fitted with a solar photovoltaic power system (solar power system). Residential solar power systems use a power conditioner to convert the direct current power generated by solar panels into alternating current power for supply to the electrical appliances (the load) in the home (●Fig. 1). Energy from a power company may be input to the home when the solar panels generate insufficient power, and energy from the solar panels may be sold back to the power company (reverse flow).

Since the 1990s, GS Yuasa has been a pioneer in developing the power conditioner, which plays a central role in the solar power system. Taking advantage of its long experience as a manufacturer of storage batteries, GS Yuasa proposed the integrated battery solution, and in 2000 invented the key technology for its implementation. This article describes our technological advances, from the first power conditioner to the invention of a solar power system with an integrated battery solution.

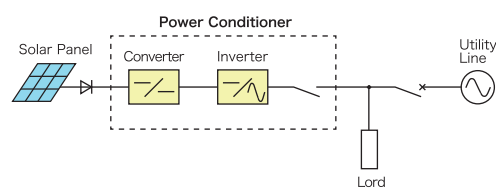
1. The "LINE BACK" Series

GS Yuasa began sales of LINE BACK in 1993. LINE BACK was the first grid-connected power conditioner, and could be connected to the power company's utility line (●Fig. 2). This was the same year that Japan's Ministry of Economy, Trade and Industry (METI) revised its technical requirements for grid-connected technologies. Thus it became feasible to provide utility grids capable of accepting energy generated by the solar power system of a household. The LINE BACK power conditioner is based on METI's revised requirements. Consequently, it was the first device to be certified under the Grid Connected Inverter Certification established by the Japan Electrical Safety & Environment Technology Laboratories (JET), and has Certificate No. 0001 (1994)¹.

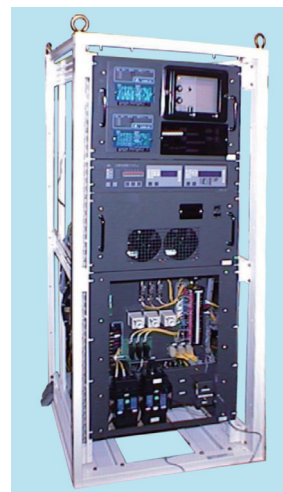
Generally, a solar power conditioner contains an isolation transformer that amplifies the power from the solar panels. In 1995, GS Yuasa decided to replace this component in the LINE BACK EX with an electrical circuit called a boost chopper. Selecting the sensor that controls the electrical circuit needed to prevent direct current from flowing back into the power company's utility line, without using an isolation transformer, required very serious thought. However, excluding the very large isolation transformer led to a significant reduction in the size, weight, and cost of the final device (43% less volume, and 32% less weight, to be precise)².

GS Yuasa then went after a transformer-less design and managed to create a smaller, more lightweight device, the LINE BACK FX in 1997. The LINE BACK FX is designed as a 4.5 kW inverter for residential use. The LINE BACK FX also acquired JET Certification and is available to a wide range of markets from residential to public facilities.

●Fig. 1 Typical Solar Power System



●Fig. 2 A LINE BACK Unit

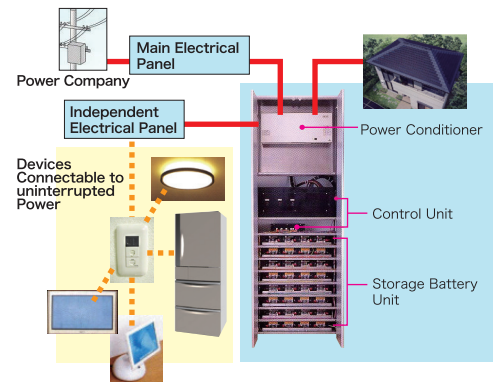


2. The Power Solar System

In 2003, GS Yuasa proposed a novel idea for residential solar, namely, to combine the solar power system with rechargeable storage batteries in order to provide an energy storage function. In addition to allowing a user to sell surplus energy from the solar panels to the power company, this system would also charge the storage batteries at night so that the storage batteries could supplement the solar panels in the day time when the panels were unable to generate sufficient power³.

Without the ability to store energy, a solar power system is unlikely to have enough power to serve the needs of a household; this is particularly apparent when, for instance, the power company must shut down the utility line for an emergency, such as in a natural disaster. Solar panels are also unable to generate sufficient power at nighttime, so when there is a continuous power outage, it may be impractical for the household to continue to use electricity at night. The Power Solar System is equipped with a storage battery unit made up of multiple storage batteries. Therefore, this system is able to provide stable power regardless of whether it is daytime or nighttime, thus making it possible to have homes more resistant to disaster (●Fig. 3).

●Fig. 3 The Power Solar System



3. Inventing Key Technology: Preventing Reverse Flow from the Storage Battery

Prior to the development of the Power Solar System, in 2000 GS Yuasa invented technology essential to realizing a solar power system with an integrated battery solution.

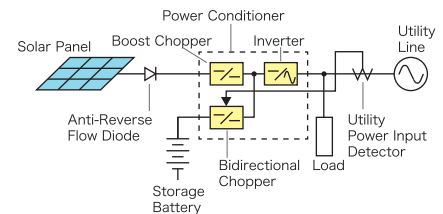
While the METI guidelines permit the reverse flow of energy from a residential solar power system back into the power company's utility line, the reverse flow of the energy accumulated in the storage battery is not permitted. Technical measures are therefore needed to prevent energy from flowing from the storage battery back to the utility line.

GS Yuasa proposed to continue accepting a small amount of energy from the utility line while supplying the load with power from the solar panels and from the storage battery (●Fig. 4). More specifically, a utility power input detector senses the power input from the utility line, and the Power Solar System controls the power conditioner (a bidirectional chopper connected to the storage battery) so that the energy input from the utility line does not fall below a certain amount.

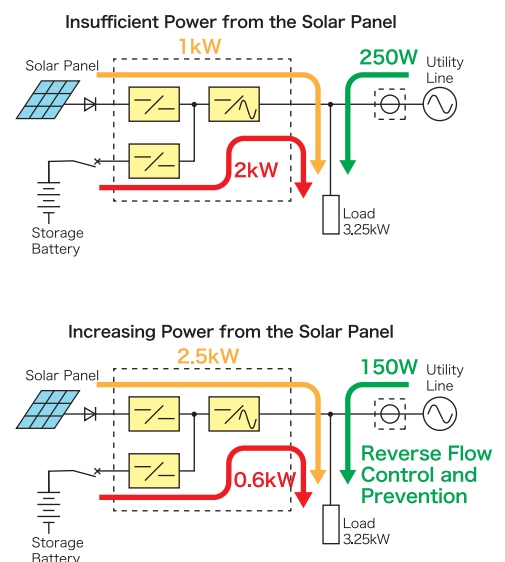
At night, when the solar panels are unable to generate sufficient energy, the power conditioner maximizes the energy supplied from the storage battery and makes up the difference with the energy from the utility line to serve the needs of the electrical devices in the household (top, ●Fig. 5). As the energy from the solar panels increase from morning to midday, the power conditioner maximizes extraction of usable energy from the solar panels, and extracts the remainder supplied by the storage battery. At this point, if all the energy required is supplied by only the solar panels and the storage battery, energy from the storage battery may flow back to the utility line. By continuing to receive a small amount of energy from the utility line, electricity continues to flow from the utility line to the load (bottom, ●Fig. 5). Thus, it is possible to reliably prevent energy from the storage battery from flowing in reverse to the utility line.

In this article we discussed GS Yuasa's development of its first power conditioner, as well as its pioneering solar power system with integrated battery solution. In Part Two, we will introduce the further development of the power conditioner.

●Fig. 4 Overview⁴



●Fig. 5 Preventing Reverse Flow from the Storage Battery



1. GS News Technical Report Volume 53, No.1, published 1994
2. GS News Technical Report Volume 54, No.2, published 1995
3. GS News Technical Report Volume 62, No.1, published 2003
4. Japan Patent No. 4765162 (Filed in 2000)