Commercial resilience and operational independence in C&I applications

There is no single solution for renewable energy in the commercial and industrial (C&I) space today. Every system is unique, depending on load profile, available space, budget, grid constraints and many other factors. The implementation of a renewable energy system is a business decision that begins with a question: What do you want to achieve? The answer to that question informs the direction that the installation will take.

Often, the answer relates to the energy grid, and specifically to how much independence a business wants from it. Companies need power and, in the past, had no other choice than to buy 100% from the grid. The solar industry is offering alternatives that provide different degrees of independence from the grid, both commercially and in terms of supply reliability.

Five degrees of freedom

1. Grid-tied solar without storage

For a long time, a simple grid-tied solar system was the standard in C&I installations, just like in residential spaces. Solar modules mounted on roofs provide power to the facility only when the sun is shining and the business is using electricity at the same time. Any excess is exported to the grid, if allowed, and deficits are covered by the grid. In this way, a noticeable amount of energy is produced locally, bringing cost savings and supporting ESG goals. The installation and system layout are usually simple and the investment is manageable.

Depending on the system size and the load profile, such an installation can increase commercial independence to a degree. It dampens price fluctuations for power from the grid. The operation of the inverters in the system is still dependent on the grid though, and in the case of a power outage, the solar system shuts down as well.

2. Grid-tied solar with limited backup

Limited backup is the first line of defence against power outages. It is not designed to keep the entire operation running, but to maintain critical systems online during grid failures. Under normal operating conditions, the system behaves like a standard grid-tied installation while the integrated storage enhances energy flexibility, self-consumption, and overall system resilience.

Businesses that need uptime of critical functions can get a real benefit from this kind of storage implementation, but they are still grid-dependent for full operations. Investment depends on the size of the critical load and the uptime required.

Flexible tariffs

This is a good time to mention flexible tariffs, also known as dynamic tariffs. The simple mechanism of a period where you can buy cheaply and sell at higher prices, so-called arbitrage, benefits any battery connected to the grid. Even if the sun is not shining to provide the cheapest possible energy, the battery charges when the price is low and makes that power available when costs go up. A smart energy management system (SEMS) is essential to take full advantage of all factors and optimise the system for the best return on investment.

3. Grid-tied systems with energy arbitrage

The next solution level makes the most out of flexible tariffs with sizing that is optimised to also reduce demand charges significantly. This requires capacity and power output to support operational demand during periods of high consumption. Manufacturing companies often have a load profile with high peak consumption that causes high demand charges from utilities (peak shaving).

By reducing these charges, in addition to power arbitrage, businesses can significantly reduce their energy costs and achieve the breakeven point for their investment within 5 to 10 years. Amortisation depends heavily on the system and can only be determined by individual consultation.

Additionally, a larger battery can provide a more extensive outage protection, for example by providing enough power for a safe shutdown procedure in manufacturing applications. Still, these systems are not designed to keep the full operation going after the grid fails. Usually, they are not sized to provide full load coverage over an extended period of time and cannot regulate fluctuation in the electricity system caused by uneven loads. These fluctuations are normally compensated for by the grid and would require a grid-forming system.

4. Microgrid and hybrid systems

For a system to truly disconnect from the grid and fully maintain operation, it needs to provide stable electricity in an environment with fluctuating power demand and generation. This usually requires a high investment in both peak power output and storage capacity, as well as grid-forming components like specific power conversion systems (PCS).

Even more than before, a smart energy management system (SEMS) is required to balance solar generation, batteries and loads. Such an installation can run independently for hours, days or longer. Extended island operation can be achieved with backup generators, which are also controlled by the SEMS.

Hospitals, campuses, industrial sites and critical operations often require a high level of operational resilience that can be achieved with a solar storage system. In the past, these

450 kWp solar installation with GoodWe lightweight modules in Switzerland for onsite power generation and direct consumption

GoodWe has installed nine ESA C&I energy storage systems at their factory in Guangde, China, with 1.125 MW output power and 2.35 MWh storage capacity

cases had to rely on generators that were idle most of the time. A solar storage system is active every day and provides high levels of independence from electricity price fluctuations and the grid itself.

5. Off-grid systems

An off-grid system represents an extreme edge case where the installation is not connected to the grid at all. Any power that is consumed onsite must be produced onsite. This can be the case in areas with prohibitively high grid connection costs or remote and temporary operations like mining.

A true off-grid system requires multiple redundancies on the power generation side, as solar alone is too intermittent to guarantee continuous operation. Generators and other sources like hydropower can make an off-grid system viable.

Conclusion

In the commercial and industrial sector, the discussion around 'energy independence' has matured considerably. The market has moved beyond simplistic narratives of self sufficiency and into a more technically nuanced conversation around controllable autonomy, operational resilience, and strategic grid interaction.

For large commercial users, the grid is no longer viewed purely as an energy source. It is treated as one component within a broader distributed energy architecture that may include onsite PV, battery energy storage systems (BESS), dispatchable generation, EV infrastructure, thermal loads, and intelligent control layers.

The key design question is no longer whether a facility can reduce imported electricity consumption. The more relevant question is how independently the site can maintain operational continuity under varying economic and grid conditions.

That distinction fundamentally changes system design priorities.

Applications and equipment

Installers in the UK and Europe are getting more familiar with the shifting requirements and goals in the C&I sector and partnering with experienced manufacturers that can deliver reliable equipment for any application and the required support to get them running. GoodWe is one of these manufacturers that has emerged in recent years with a wide range of solutions for the C&I sector and a local network to support commissioning.

Starting at the power generation level, the company's BIPV unit provides lightweight solar panels that can be installed on roofs with lower structural load capacity. A wide range of grid-tied solar inverters for C&I applications with capacities between 30 kW and 125 kW offer options for a wide range of applications and can be integrated together with battery storage units and PCS into systems with varying levels of independence. GoodWe also offers grid-forming capabilities with a recently launched 500 kVA on/off-grid switching cabinet for their ESA 125 kW/261 kWh energy storage system.

Technical solution

When the system operates independently from the grid, the inverter (PCS) needs to switch to V/F control to actively maintain the system's voltage (V) and frequency (f) stability. The inverter directly controls the fixed amplitude (V) and frequency (f) of the AC voltage through dual closed-loop control, ensuring that the voltage amplitude and frequency remain stable within the set range.

When multiple V/F-controlled inverters operate in parallel, the current PCS solution employs fast communication between primary and secondary units, where the primary unit's current set point is given to the secondary units. Through grid synchronization or carrier synchronisation (IO level signal) the secondary units remain in phase with the primary unit. Based on the current target and phase, current sharing and system stability are achieved.

Showcase at GoodWe manufacturing base

GoodWe built and continues to develop an energy system showcase at their own manufacturing site in Guangde, China. The system consists of a 4.7 MW photovoltaic system that generates approximately 4.8 million kWh of green electricity annually, along with a 5.2 MWh energy storage system. An intelligent microgrid, integrated with the WE Smart Energy Management Platform, enables coordinated management of solar generation, energy storage, EV charging, and onsite electricity consumption.

By mid 2025, renewable electricity made up 41% of the facility's total energy use, keeping the site on track to reach peak carbon emissions by 2027 and achieve carbon neutrality by 2030. The facility is also exploring green power trading and virtual power plant operations to further translate carbon reduction efforts into measurable environmental and economic value.

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