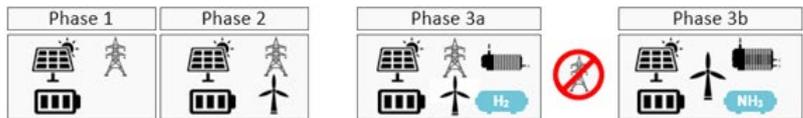


# GenCell BOX™ Deployment at European Telecom Site

## PROJECT BACKGROUND

Committed to providing high-speed network performance to its customers, a leading global telecom provider operates over 100 locations in a regional district with expanded LTE and 5G coverage providing household coverage of 99%. In 2017 the company expanded Internet access with bandwidth of 100 Mbps and FTTC (Fiber to the cabinet) to support high transmission fast connections.

While providing expanded services to customers is key, in alignment with the huge power and extreme weather challenges facing Europe, the telecom provider is also committed to proactively focusing on climate issues. On the one hand digital technologies enable carbon savings at a factor of 4.8, but challenged by a still significant CO2 footprint and high electricity consumption, the operator is doubling down its efforts on energy efficiency and reduced consumption, on innovation for resilience and on achieving carbon neutrality, both in the realm of its own operations and energy procurement, but also with regard to supply and distribution chain and with regard to the usage of its products.



	Phase 1	Phase 2	Phase 3a	Phase 3b
Basic Use Cases	Inventory Management	☑	☑	☑
	Performance Management	☑	☑	☑
	Fault Management	☑	☑	☑
	Configuration Management	☑	☑	☑
	Health & Safety		☑	☑
Renewable Energy Production	MSM* supported by stable power grid	☑	☑	
	MSM* at instable grid with emergency power supply		☑	
	MSM* in grid-autonomous situation		☑**	☑
* MSM = Multi-Source-Management				
Smart Energy Solutions	Peak Power Shaving (static)	☑	☑	
	Peak Price Shaving (static)	☑	☑	
	Peak Price Shaving (dynamic)		☑	

\*\* for PoC only → actually not planned for implementation

In terms of resilience, the telecom provider is focused on innovation for resilience, exploring decentralized power supply across Europe. With ambitious zero-emissions targets, the operator also aims to be even more resilient and reduce dependence on the electricity grid by finding alternatives for costly electricity peak savings. To this end, the operator decided to carry out a test using hybrid renewable power sources integrating electricity provided from photovoltaic panels, wind power, lithium-ion batteries and fuel cells at one antenna sites. From the environmental perspective, faced with the likelihood of more frequent extreme weather events in Europe interrupting telecom network services, the provider aims in emergency circumstances to eliminate the use of pollutant diesel generators.

## GenCell in Numbers:

H2 consumption	70g/kWh
Average load	2kW
Temperature range	-10°C - +20 °C
Pressure	300 bar
Efficiency	52%
Longest duration of autonomous FC operation during final testing phase	24 hours

## SOLUTION:

The live testing site, managed by a leading energy management system (EMS) provider, transmits data and signals to customers across the district. The project team was assigned responsibility to test the techno-economic and environmental viability of the use case of incorporating fuel cells to provide additional power when renewable energy and battery resources could not supply sufficient power, also assessing the cost of equipment and fuel.

Following the successful completion of an initial 168 hours continuous/uninterrupted testing round of the G5.2 fuel cell at GenCell's testing facilities, a shelter containing the G5.2 unit 48 VDC was shipped to a live telecom site in Europe for further testing. GenCell and the EMS provider created an interface between the GenCell fuel cell and the network protocol. The fuel cell was connected to standard hydrogen gas cylinders, which can be delivered in single cylinders or in bundles.

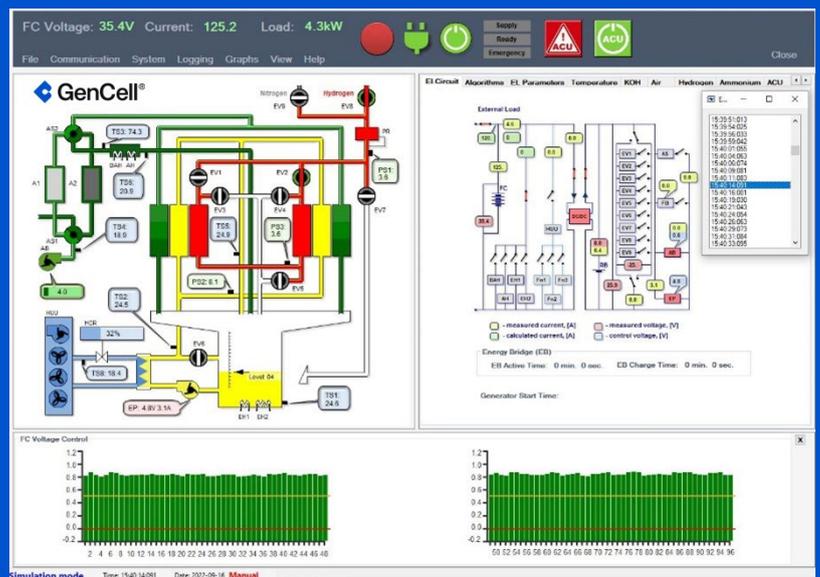


Figure 1: Generator powers load; all parameters OK.

## EQUIPMENT PERFORMANCE

The telecom transmitting equipment with its continuous power load requirement was connected to the EMS network equipment, incorporating lithium batteries, which in turn was also connected to power resources from the grid, wind, solar PV and the GenCell fuel cell. GenCell's technical service group who came on site in July 2023 to commission the equipment tested the different combinations of power supplied by different resources. When only solar PV and the fuel cell were activated together, during cloudy conditions the solar output decreased while the fuel cell power output increased.

As shown in the accompanying graph, in early morning the power from the sun was low, reaching a peak in midday. From 9 am power would kick in from the PV while the FC was idle, kicking in during cloudy conditions and in the evenings. At night the fuel cell fully met the power load while in parallel charging the batteries from 75% to 100% - by 4 am the batteries were fully charged and the fuel cells powered only the telecom transmission load. In a test of 24 hours, average hydrogen fuel consumption was measured to be some 70 g/kWh. The GenCell equipment operated to spec continuously, carrying out Modbus and signal testing and continuously collecting data.

The combination of solar PV and fuel cells proved to be very complementary in conditions of variable irradiance, where the fuel cell carried the load at night and the solar PV during strong daylight.

The tests proved the justification of operating a green microgrid to power continuous connectivity without any grid power at all. When the batteries operated at full capacity in the summer, the role of the fuel cell is more of an EPS (emergency power system), an "insurance policy", but in winter conditions the fuel cell had a regular contribution to the power capacity for the load.

In case of emergency, the site operates according to a system for prioritization of the towers and also has access to a mobile backup power system, but at present the system works on solar PV and battery only. Although not fully autonomous, the site uses minimal grid power consumption.

The GenCell GEMS™ software system ran continuously throughout the year, collecting data re pressure, temperature, H2 consumption levels, power load and all other relevant measurements. The software transmitted data via modBUS RTU2TCP to the EMS provider's network management system; during the performance management testing, GenCell compared the GEMS data to these readings and the data was identical.

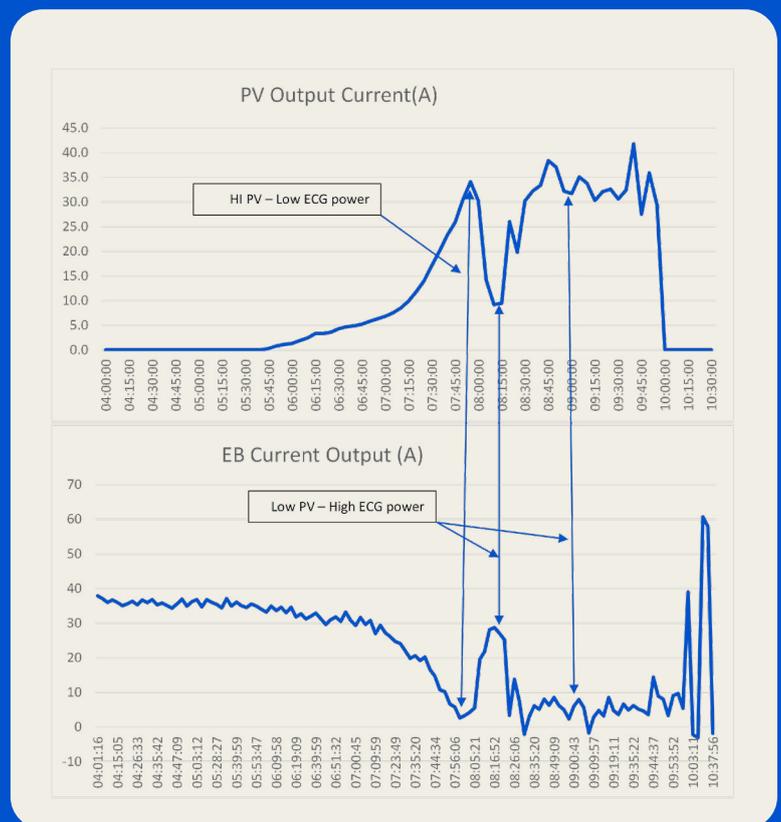


Figure 2: Output current from EB in EMS provider's test results

## TESTING TRAINING AND TECHNICAL SERVICES

A third-party service provider was responsible for installation, cabling and connections. Testing was carried out on different occasions throughout 2022. In September 2022, GenCell sent its technicians on-site to carry out thorough tests of the GenCell G5.2 performance management system. In November 2022, the EMS provider confirmed that the GenCell system works satisfactorily in accordance with operating manuals. In March 2023 GenCell carried out training to the EMS provider's on-site technical support team to enable them to provide optimized technical services for the equipment. Final testing and commissioning was carried out in 2023.

Maintenance and servicing were carried out, wherein in accordance with power conditions and the state of the charge of the batteries, the EMS system signaled to the fuel cell system to initiate or stop the operation of the fuel cell.

## COMMISSIONING

During the commissioning phase, GenCell carried out continuous 24-hour autonomous site testing. Grid power was turned off completely and the site was powered only by solar PV, batteries and the fuel cell. All the equipment performed to spec. During the testing, many potential hurdles were overcome. The weather conditions were rainy and cloudy, but nevertheless the fuel cell operated successfully. The hydrogen fuel

supply sustained the load throughout the testing period, especially during the night, when the fuel cells both sustained the load and in parallel charged the batteries. Indeed, in the evening the entire broadcast of the Women's World Football Championship was displayed without interruption!

As per the experience on-site, GenCell enhanced the design of the GenCell BOX communication protocol to fully comply with ETSI telecom requirements.

During the course of the project the telecom operator's and GenCell project teams enjoyed a close and positive collaboration; the GenCell Customer Success team delivered comprehensive education, data collection and knowledge sharing about all the different use cases. In sum, the test empirically demonstrated that in today's challenging and extreme climate conditions, the fuel cell is operationally beneficial and essential for a fully green power system.

## PERMITTING

The project team gained important experience and expertise towards obtaining permits for novel hydrogen technology that will contribute to accelerating future permitting processes.



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