CLEAN ENERGY BY SWEDEN

AZELIO.COM/TECHNOLOGY

AZELIO

Azelio TES.POD® energy storage system availability

AZELIO.COM/TECHNOLOGY

Torbjörn Lindquist, Karin Kjellin, Niccolò Oggioni - Azelio

Azelio TES.POD energy storage system availability

Azelio has gathered operational data from the TES.POD unit at the Noor Energy 1 site in Dubai, to assess the availability of the system. The TES.POD is part of a hybrid energy system with batteries, diesel generator and solar PV panels. The total availability during the 90-day period was 91%, including all downtime due to maintenance. The total downtime includes 7% of planned maintenance, and excluding work carried out specifically to address initial commissioning issues, the availability is 98% - which is above the industry standard for energy storage systems.

INTRODUCTION

The TES.POD energy storage unit at Noor Energy 1 at Mohammed bin Rashid Al Maktoum (MBR) Solar Park in Dubai provides renewable power on demand around-the-clock to the Visitor Center, as part of an off-grid microgrid system. This report aims to review the TES.POD's operational data and validate system availability performance against its technical specification. The 3-month operational data collated for this purpose was collected during September to December 2022, when the entire microgrid system was operationally complete.

The hybrid energy system is designed to deliver energy to the Visitor Center (figure 1), and provides the full building load without being connected to the Dubai Electricity & Water Authority (DEWA) conventional grid system. To enable the use of renewable power also during night-time, the Solar PV hybrid system includes battery storage and the Azelio TES.POD. The system is completely managed by an Energy Management System (EMS), which controls the power flows in and out of each component.

Figure 1 Noor Energy 1 Visitor Center at MBR Solar Park, Dubai

The TES.POD shown in Figure 2, comprises a Stirling engine (as power conversion unit) and a thermal energy storage unit. The Thermal Energy Storage (TES) system utilizes a phase change material that is heated to around 600° C (1110° F) by electricity, and a heat transfer fluid that transfers the heat to the Stirling engine to produce power.

Figure 2 The TES.POD installation at Noor Energy 1

STATE DEFINITIONS

The availability calculation is based on the TES.POD state signal, which represents the operational status of the unit at any given time. This integer signal can only assume one of the values at every timestep, as described in Table 1.

The state signal was sampled at a 2-Hz-frequency. To ease data analysis and calculations, it was then down-sampled to a 1-minute frequency.

Table 1 State definitions

STATE	DESCRIPTION
00 - INVALID	State error
01 - INIT	Commissioning
02 - IDLE	In operation & awaiting a state change triggered by the Energy Management System (EMS), operators or faults
03 - SAFE STATE	Special unit state designed for specific maintenance. Similar to state 9
04 - CHARGE	Charging
05 - ANTI-FREEZE	Charging at low power to avoid sub-cooling of the storage material &/or freezing of the heat transfer fluid
06 - DISCHARGE	Discharging
07 - COOL DOWN	Discharging to state of charge levels below 0% to perform maintenance
08 - STOPPING	Stopping its current operation to move to a different state
09 - HARD SERVICE	Service due to a fault &/ or for preventive/ scheduled maintenance
10 - STOP ON FAULT	Stopping its current operation due to an alarm that was triggered by a fault. Unit state will then change to state 11
11 - FAULT	Not available due to a fault

AVAILABILITY

Availability is defined as the portion of time the TES.POD unit was operational and available to supply services over a certain period. In this case, the availability was calculated over a 90-day period, from 14 September 2022 to 13 December 2022.

The TES.POD at Noor Energy 1 was deemed available every time its state signal showed any value other than 03 (Safe state), 09 (Hard service), 10 (Stop on fault), or 11 (Fault). Having the unit in one of the aforementioned listed states meant that the system was undergoing scheduled (planned) maintenance, or unplanned outage due to equipment fault.

Table 2 shows the total state signal distribution over the 90-day period. As mentioned previously, the TES.POD is fully controlled by the EMS, as it is completely integrated in the site energy system. The expected idle time at this site, according to the preferred control strategy chosen by the EMS, is around 30%. This figure is higher in the dataset due to commissioning and integration issues on a system level, unrelated to the TES.POD itself.

Table 2 State signal of distributions

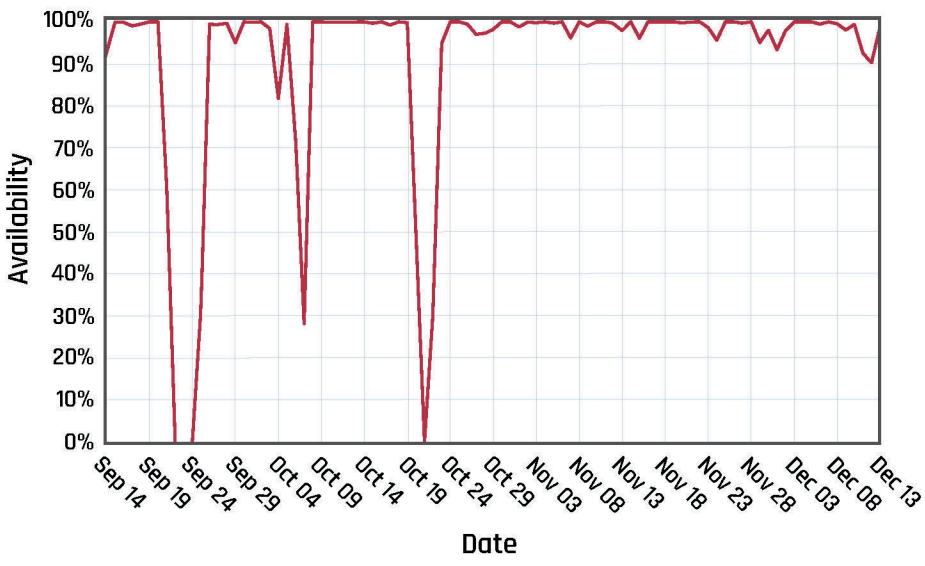
STATE	HOURS	SHARE
00 - INVALID	0	0%
01 - INIT	0	0%
02 - IDLE	917	43%
03 - SAFE STATE	130	6%
04 - CHARGE	454	21%
05 - ANTI-FREEZE	0	0%
06 - DISCHARGE	585	27%
07 - COOL DOWN	0	0%
08 - STOPPING	6	0%
09 - HARD SERVICE	37	2%
10 - STOP ON FAULT	1	0%
11 - FAULT	30	1%

Overall availability was then calculated as the ratio of total time in available states (00 to 02, 04 to 08) to the total period duration (90 days).

Given this definition, the availability was 91%, accounting for both planned maintenance and unplanned outages due to fault.

Figure 3 illustrates the variation of daily availability over the 90-day period. Apart from two major planned maintenance services (the first one occurring around 22 September and the second around 21 October), on average the unit was available for more than 95% every day.

Figure 3 Variation of daily availability

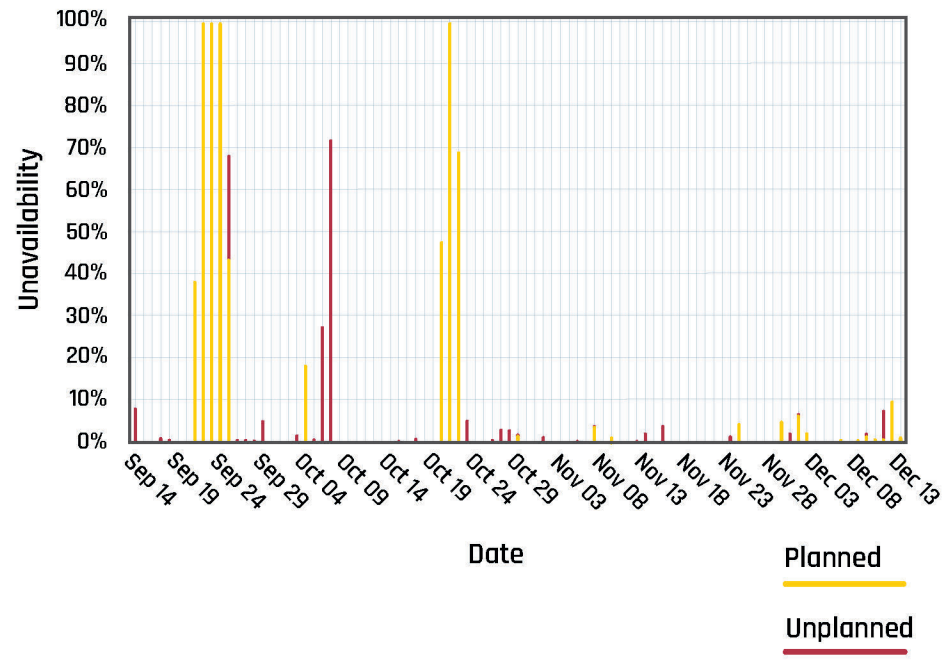


Unavailability due to planned maintenance and unplanned outages was identified from the data. An unplanned outage is defined as when, during normal operation, a fault state leads to downtime in one of the states 09 (Hard service) or 11 (Fault). A planned maintenance is identified in the dataset as time in the 09 (Hard service) state not preceded by a fault state.

Unplanned outages accounted for 2% unavailability of the total dataset, while planned maintenance accounted for 7% of the total dataset.

Figure 4 demonstrates the daily unavailability and differentiates between planned and unplanned outages.

Figure 4 Planned and unplanned unavailability



CONCLUSIONS

The overall availability of the TES.POD system is 91% over the 90-day period in 2022. This result is lower than the typical requirements of 95-97% for commercial energy storage plants. However, it should be noted that planned maintenance does not ordinarily count towards availability targets in such cases, and if unplanned outages only are considered, the availability of the TES.POD system is recorded as 98%.

Although the planned maintenance of 7% is higher than would be expected from a commercial energy storage plant, this result accounts for an expected increased level of maintenance required while initial commissioning issues are addressed. This installation represents one of the first customer deployed TES.POD systems, and planned maintenance will be reduced over time and when measured on an annual basis.