Name of research institute or organization:

Test Centre, armasuisse S+T,
Federal Department of Defence, Civil Protection and Sport DDPS

Title of project:

Performance of Methanol Fuel Cells in Alpine Environments

Project leader and team:

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Project description:

The long-term use of scientific measurement or monitoring equipment on remote alpine sites is often confined to the vicinity of permanent installations or to available mobile energy sources. While combinations of solar panels and rechargeable batteries are readily available, their power output is limited by the surface area of the solar panels (larger battery packs provide more energy but need a large array of solar panels to be recharged within a reasonable amount of time). Additionally, during prolonged periods of unfavourable weather, the solar panels may not be able to compensate the energy needs of the equipment resulting in prematurely drained batteries.

Methanol based fuel cells are not only small and safe to handle but also provide a fair amount of energy. Teaming fuel cells with solar panels and batteries, therefore, seems to be a sensible approach to a fail-safe power supply for unattended measuring campaigns in remote areas. However, available commercial fuel cells are not built for alpine environments where they have to cope with bad weather, temperatures below freezing, low atmospheric pressure and very dry air.

Figure 1. Methanol Fuel Cell in its weatherproof aluminium box with the attached auxiliary solar panel on the lower platform of the Sphinx observatory during the May trials.

The case of the "lost" 1000 Wh, as noted in last year's report, was solved in lengthy component level laboratory tests in early 2017. Suspicions of a problem with the charge

controller were confirmed and, consequentially, the ill-suited component was replaced. Before packing and shipping the system to the Sphinx observatory, it had to pass a series of additional performance tests in its new configuration at moderate altitudes (500 m.a.s.l.).

Eventually, a 5-day test run with the military grade methanol-based fuel cell with a nominal power output of 130W in a weatherproofed aluminium box was carried out at the High Altitude Research Station Jungfraujoch in May 2017. The fuel cell in its housing was placed on the lower platform of the Sphinx observatory. A 45 W light bulb was used as electrical load to drain the battery and force the fuel cell to recharge. Every 15 minutes a set of 36 operational parameters from the fuel cell was logged. Additionally, and a direct consequence of last year's mystery of the lost 1000 Wh, the power output of the solar panel was logged every 10 seconds.

During the campaign, the fuel cell performed according to specifications.

The campaign on the Jungfraujoch took place in perfect conditions: Three days of unspoiled sunshine with temperatures constantly below freezing and two days of solid cloud cover with partial snowfall. Mixed conditions, rather than constantly clear skies, help in emphasizing the impact of the solar panel on the overall operating hours of the fuel cell and their distribution over the course of a day. With the old charge controller, the fuel cell had to produce 4100 Wh during five days with sunny conditions. With only three days of pure sunshine in 2017, the fuel cell produced only 3000 Wh during the five-day campaign, augmented by 1500 Wh courtesy of the solar panel.

The numerous campaigns at the High Altitude Research Station Jungfraujoch during the last couple of years showed that commercially available fuel cells are capable of performing according to specifications even at high altitudes. The stand-alone solution which was the centre point of this year's tests proved to be perfectly suited for continuous unattended operation in alpine environments. By adding a solar panel, the operating time of the fuel cell on one tank of methanol (10 ℓ) was more than doubled.

For the follow-up campaigns in 2018 the internal design of the weatherproofed box will be finalised and the interplay of the components further optimised. Additionally, a second system will be built on the basis of the configuration level of the first system at the end of the low temperature tests taking place in February 2018.

Key words:

Methanol Fuel Cell

Collaborating partners/networks:

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