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 winter trials.*

Two 5-day test runs with a military grade methanol-based fuel cell with a nominal power output of 130 W in a weatherproofed aluminium box were carried out on the High Alpine

Research Station Jungfraujoch, in June and in December 2015. The fuel cell in its housing was placed on the lower platform of the Sphinx observatory. A 60 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.

During both campaigns the fuel cell performed according to specifications.

The June campaign was the first to feature the complete setup with the auxiliary solar panel attached. Due to budget constraints a solar panel which was already in service with armasuisse S+T for the better part of the last 25 years was used. While the performance of solar panels is known to degrade with time, the panel used should still have been able to recharge the battery – just not as fast as 25 years ago. However, this one has seen a few airlifts too many. As a result, power output was reduced to about 5W (<10%), even on a clear day. For reasons unknown, the charge controller decided that this should be enough to charge the battery without the help of the fuel cell, although power consumption was constantly between 65 W and 70 W. This, of course, led to a premature end of the solar panel's use as auxiliary power supply after the second day.

Performance tests on moderate altitudes (500 m.a.s.l.) during summertime were used to optimise the operating parameters of the charge controller and to assess the damage on the solar panel. While the former led to minor tweaks of the operating parameters, the latter revealed that some of the cells of the solar panel were broken beyond repair, sealing the fate of the panel.

For the December campaign on the Jungfraujoch we were given an old solar panel by one of our partners. Although this one was 20 years old as well, it still managed to deliver 90% (45 W) of its original nominal power output. With the setup now sorted and all components working as planned, the methanol consumption of the fuel cell for the five-day test run could be reduced from 9.5 ℓ (December 2014) to 5.3 ℓ, despite the short days and the bad weather.

The campaigns at the High Alpine Research Station Jungfraujoch 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. With the addition of a solar panel (even an old one) operating time on one tank of methanol (10 ℓ) could almost be doubled.

For the follow-up campaigns in 2016 the internal design of the weatherproofed box will be finalised and the interplay of the components optimised. Additionally, a new solar panel with a nominal power output of 70-100 W will be evaluated and integrated into the system.

Key words:
Methanol Fuel Cell

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