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Off-Grid Energy Systems with Fuel Cell Technology: A Challenge for Technical Training

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1 Introduction

Renewable energies are already considered a solution today for dealing with the expected energy shortage in the 21st century. The hydrogen-based fuel cell is part of this solution. As a complementary technology, it will be used in future off-grid energy systems together with hydrogen generators and hydrogen storages, forming a reliable and clean storage solution for sustainably generated energy.

The ability to combine different energy sources, storage technology and loads to an autonomous energy system granting the same security of energy supply as a user could expect from the national grid will be the key qualification requirements of tomorrow's system integrators. Both energy management know-how and profound knowledge about the diverse energy generation and storage technologies must therefore become part of today's technical training. It has to familiarize the engineers of tomorrow with this technology.

2 Off-grid Energy Systems for Learners

Based on its experience as a system integrator for energy storage solutions with fuel cells and batteries as well as the development of didactic equipment for technical training, Heliocentris has developed a full-fledged hybrid and off-grid energy system, which is tailored to conveying practical knowledge in the field of energy management – the New Energy Lab.

The system combines renewable energy generation from solar, wind and fuel cell power with modern energy storage technology to create an autonomous hybrid system. Optimized for the requirements of universities and vocational schools, the technology can be explored as a single process or at the level of the overall system. The system generates enough power to operate typical household appliances.

Learners can set up an autonomous power supply and learn about the interrelationships of various aspects of power management by experimenting with the parameters of the system components. The public power supply grid can be used as a backup to simulate the combined use of renewable and conventional energy sources, such as a diesel generator. The system can be used to simulate and analyze typical scenarios, such as operation at night or during periods of no wind. Extensive measuring technology, central monitoring and control software and an electronic load make it possible to record characteristic curves and system data.

The range of features and the components to be included in the system can be customized to suit individual requirements of the academy or technical training centre.

The system forms the basis for several learning objectives:

- Introduction to solar, wind, and fuel cell technology
- Design of hybrid systems

- Operation of hybrid systems
- Examination of renewable energy sources
- Autonomous operation of real-world consumers
- Observation of different scenarios: night-time operation, periods of no wind, peak loads

3 Energy Lab Components

Especially for institutions with departments entirely dedicated to renewable energy studies, the system offers various advantages. Unlike regular training equipment, which usually resembles the reality on a smaller scale, the New Energy Lab is a real energy system. Training can therefore be conducted in a realistic setting. The system includes measuring technology feeding data into a central monitoring and control software, which is also used to parameterize the system's components. This integration allows for deriving valuable insights on energy management, which cannot be obtained with regular off-grid systems.

The system includes the following components:

- Photovoltaic module: 400 Wp - 4 kWp
- Small wind power module: 400 Wp - 2.5 kWp
- Fuel cell module: 1200 W
- Battery bank: 100 - 300 Ah
- Electrolyser: 30 - 60 Sl/hour
- Hydrogen storage canister: 1500 - 4500 Sl storage capacity (metal hydride canister)
- Central energy management module
- System controller with monitoring and control software
- Measuring technology (e.g. wind velocity gauge, H2 flow meter)
- Electronic load
- Service

The New Energy Lab from Heliocentris is offered as a turnkey solution. Comprehensive service – from consultation to installation and training of users – is included.

4 System Scheme

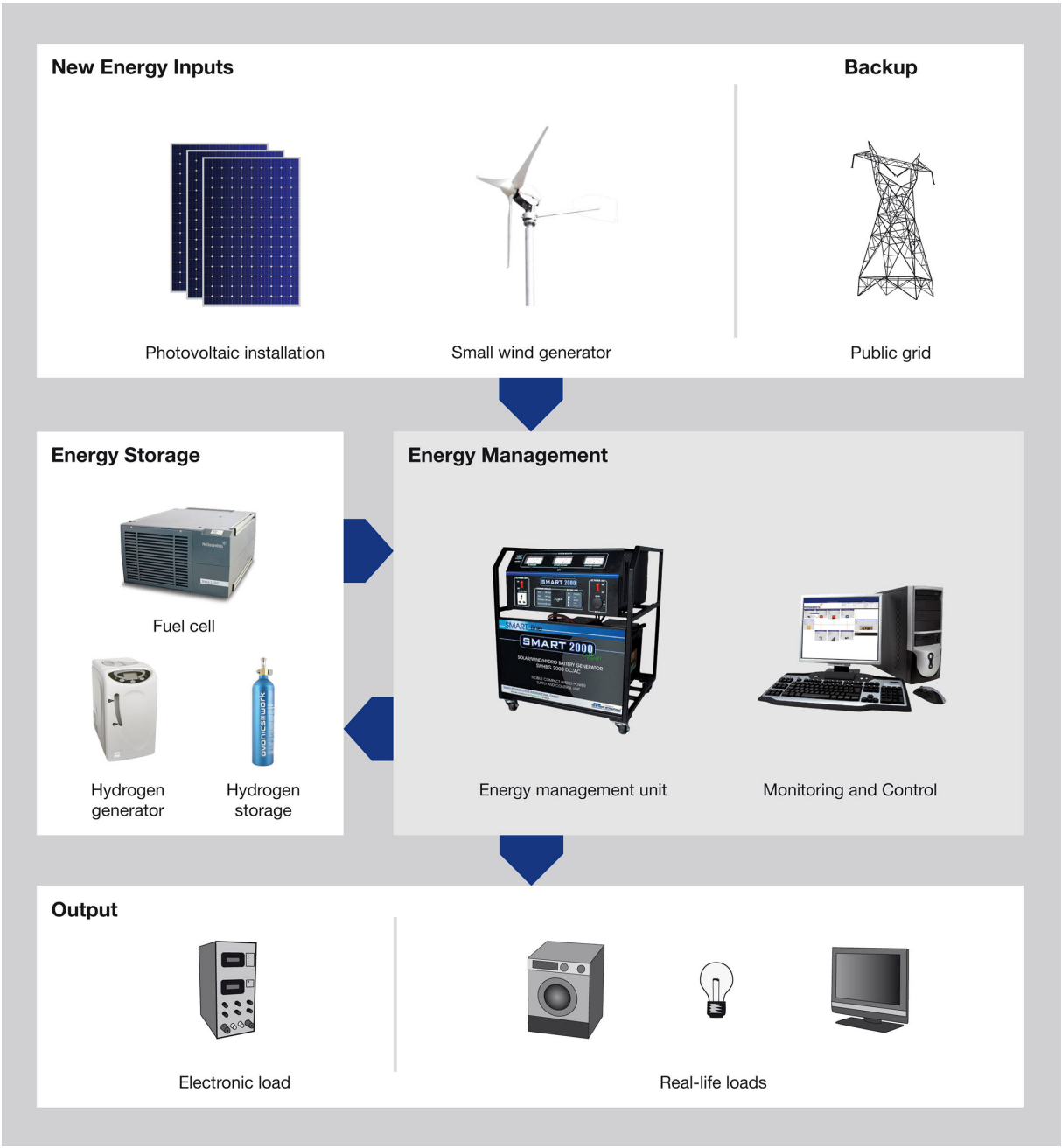

Figure 1: System scheme.

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