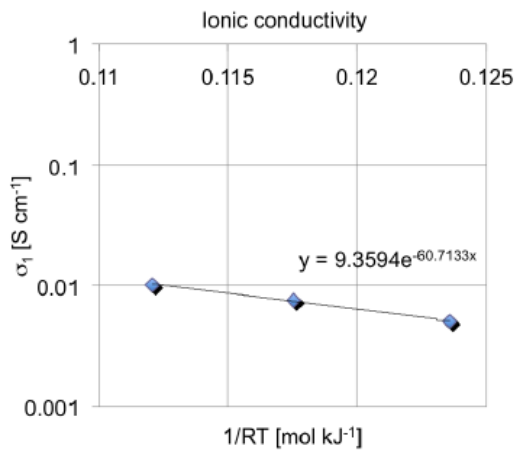# Main S&T results and foregrounds - Figures

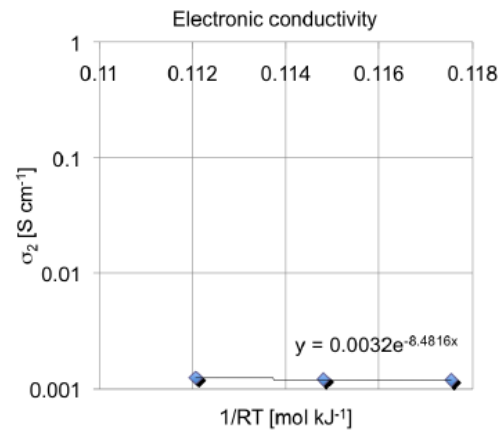Figure 1. Ionic conductivity relation

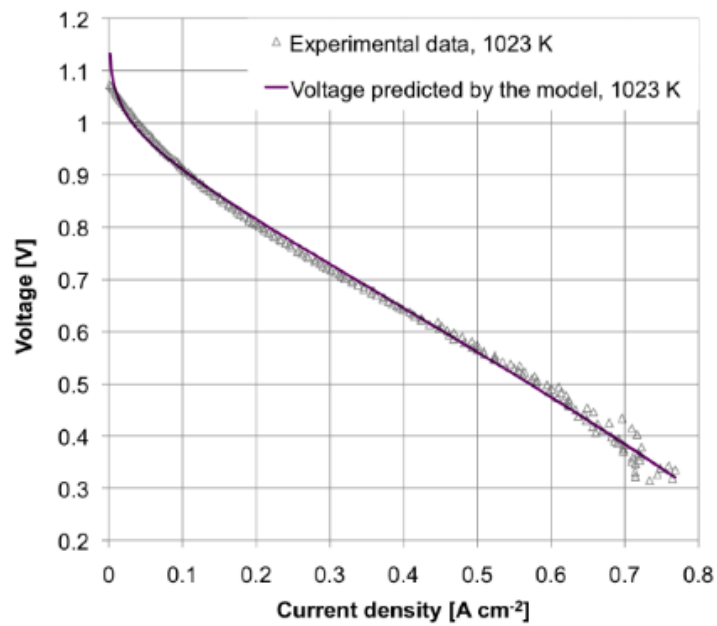Figure 2. Electronic conductivity relation

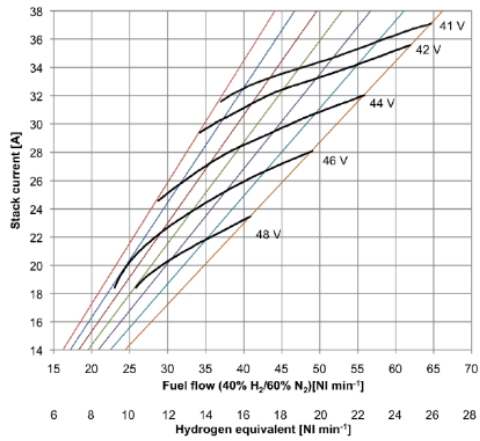Figure 3. Model prediction vs. experimental data

Figure 4. Stack current-voltage map obtained from model at nominal operating Temperature
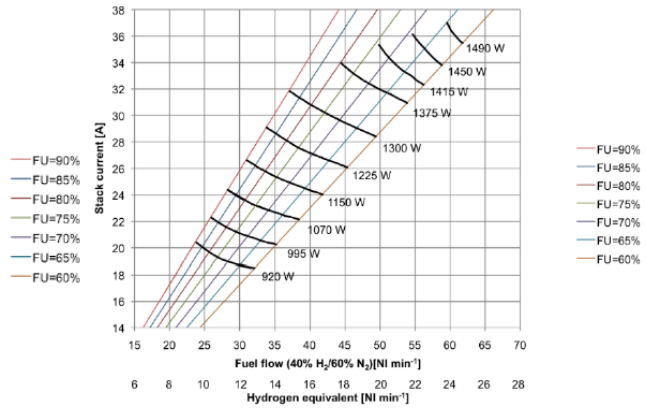

Figure 5. Stack current-power map obtained from model at nominal operating Temperature
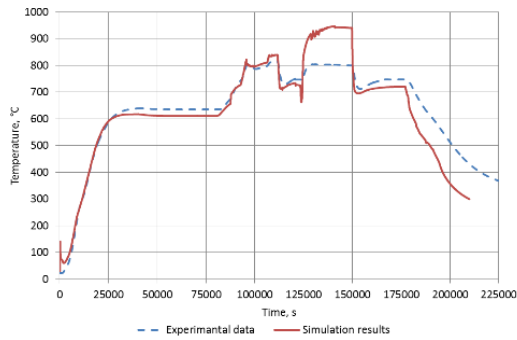

Figure 6. Validation of the model using reference data set. Figure shows the cathode outlet temperature measured experimentally and predicted by the model
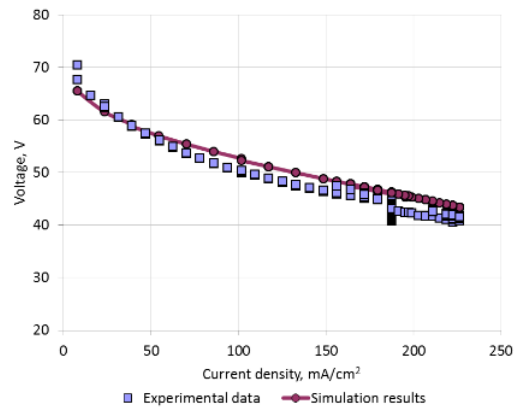

Figure 7. Model validation – Stack voltage measured experimentally and values obtained from the model
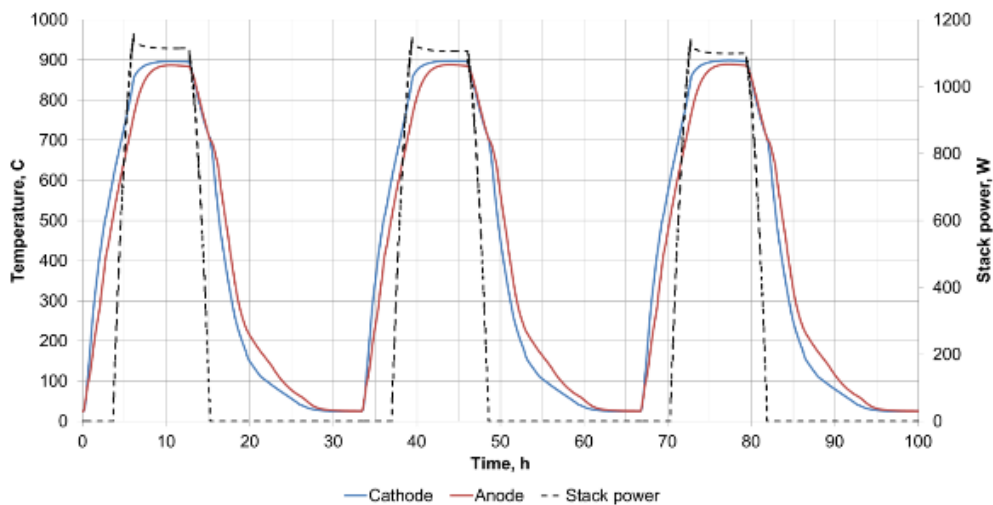

Figure 8. Model prediction for three thermal cycles of a SOFC stack with degradation rate of
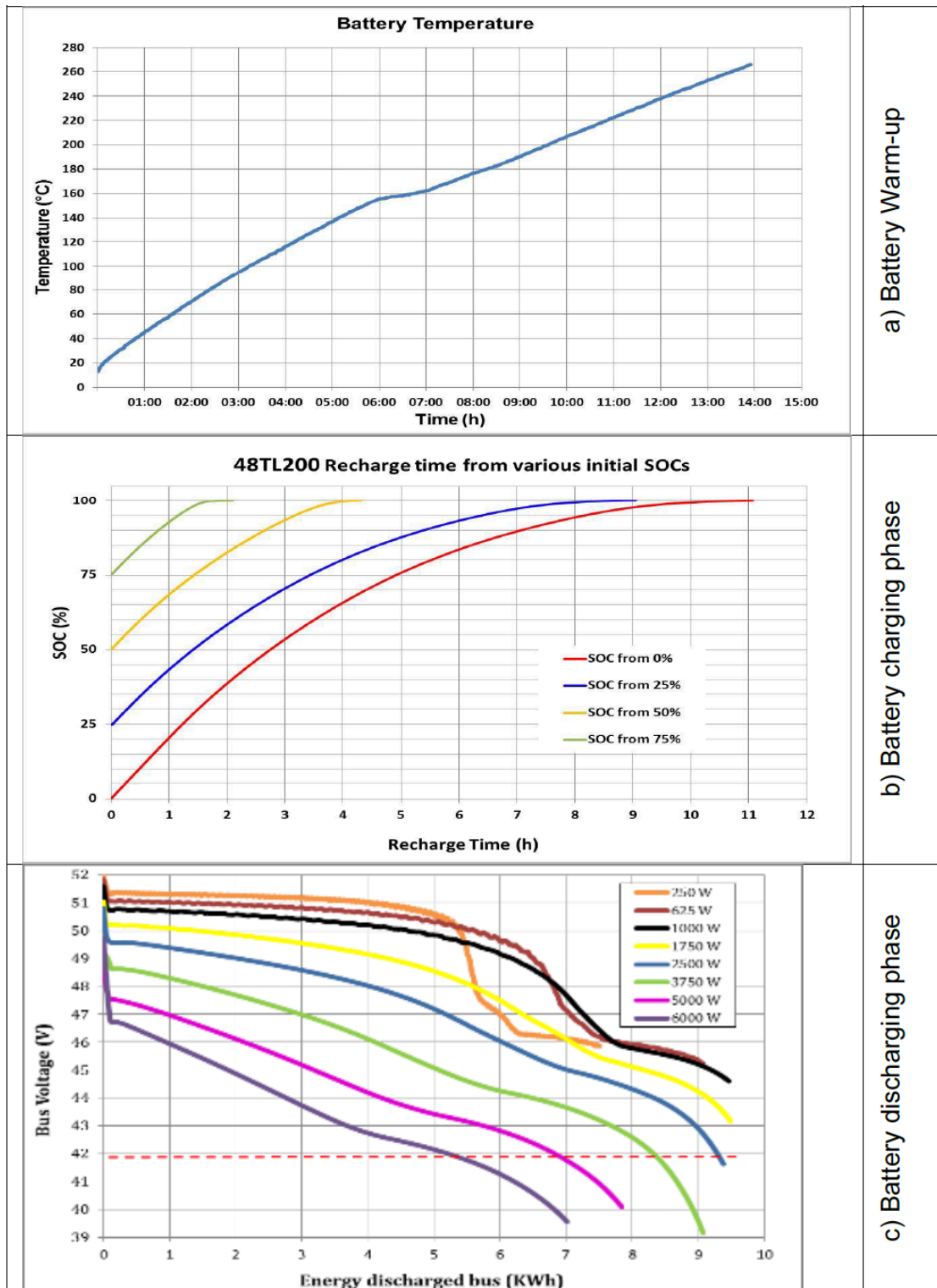
0.525% per cycle

Figure 9. To determine the equivalent electric circuits of the battery, the laboratory activity recorded data during the warm-up of the battery (a), the charging phase (b), and the discharging phase (c).
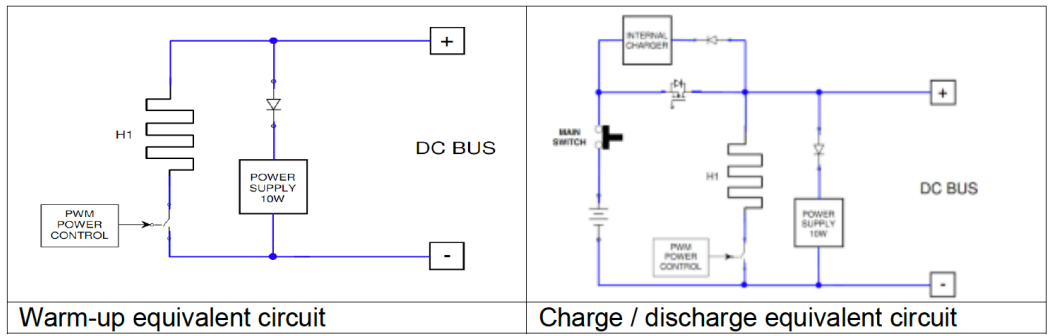
| Warm-up equivalent circuit | Charge / discharge equivalent circuit |

Figure 10. The equivalent electric circuits for the battery in different processes (a: warmup phase, b: charge/discharge phase).

Figure 11: Example of performed simulation: 2 weeks long operation of the SOFC-SNC hybrid following the base-load station power demand profile (upper) and excess power generated by the system (bottom)
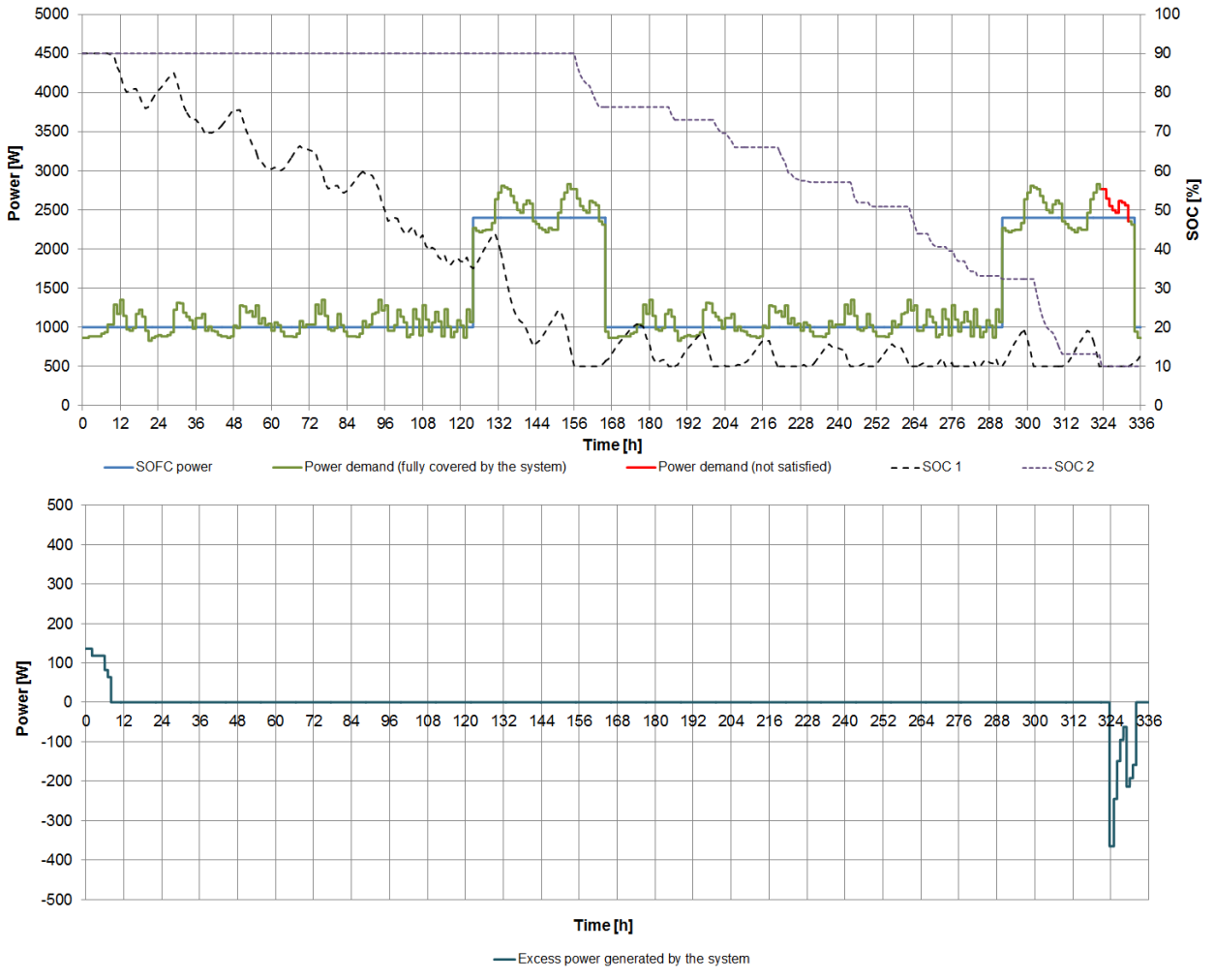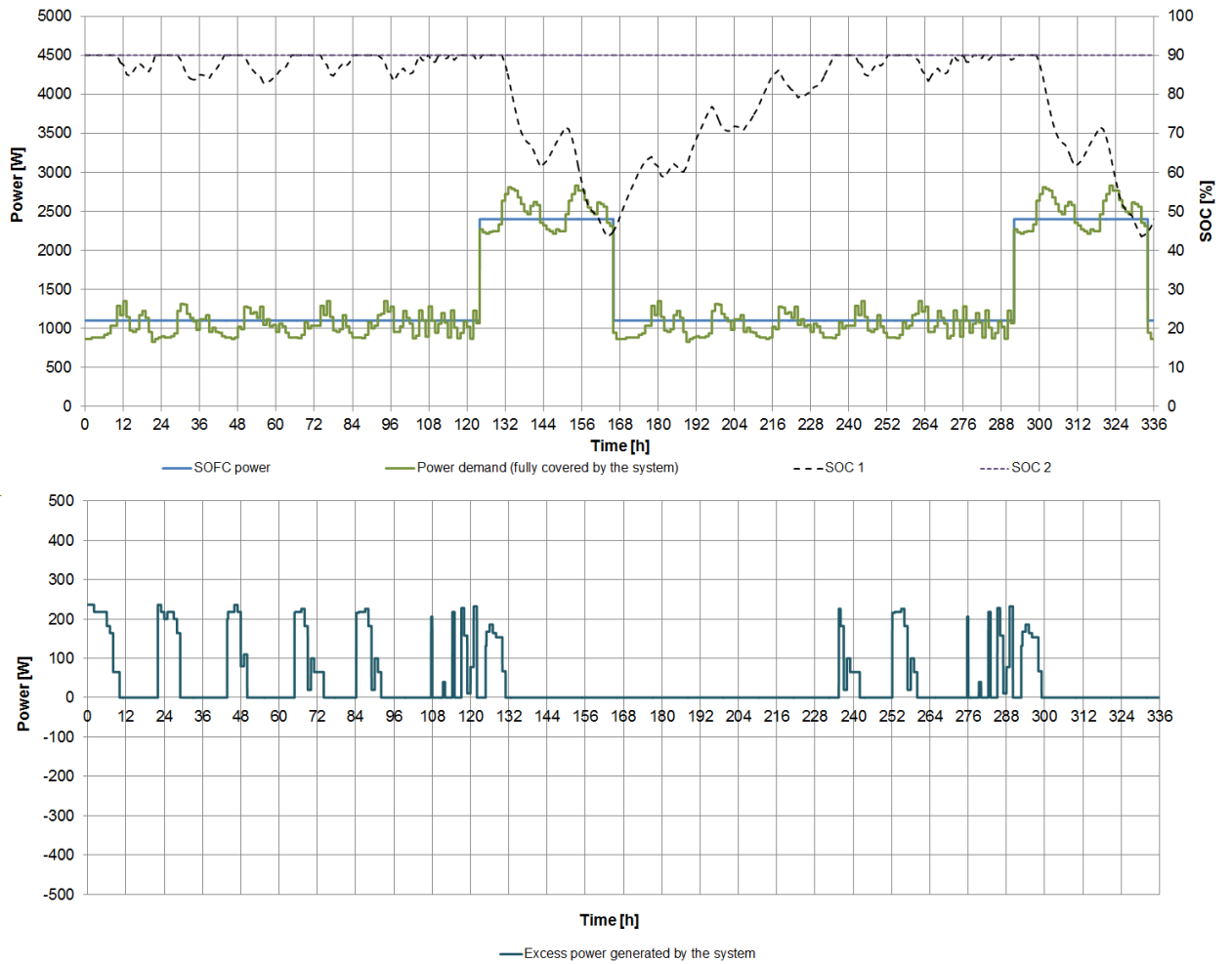
Figure 12: Example of performed simulation: 2 weeks long operation of the SOFC-SNC hybrid following the base-load station power demand profile (upper) and excess power generated by the system (bottom)
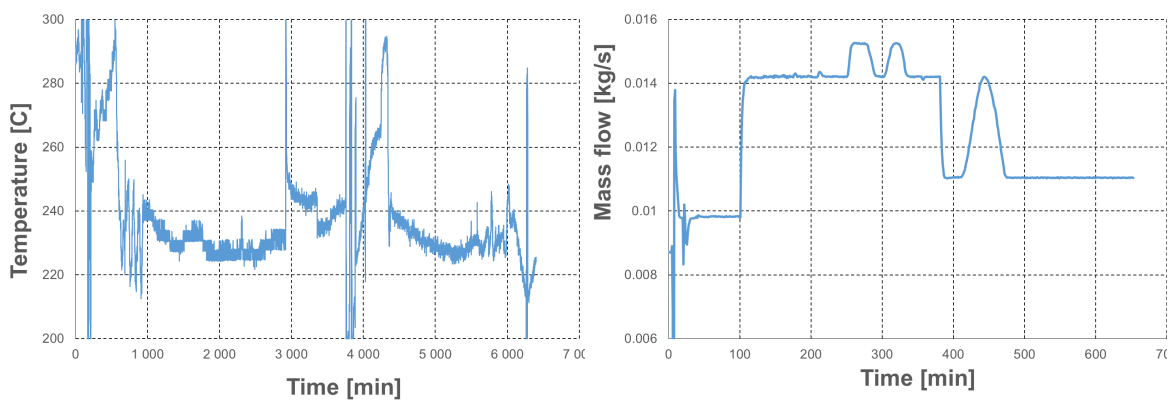

Figure 13: Flow and temperature data of residual gas from cogeneration system with SOFC cell stack

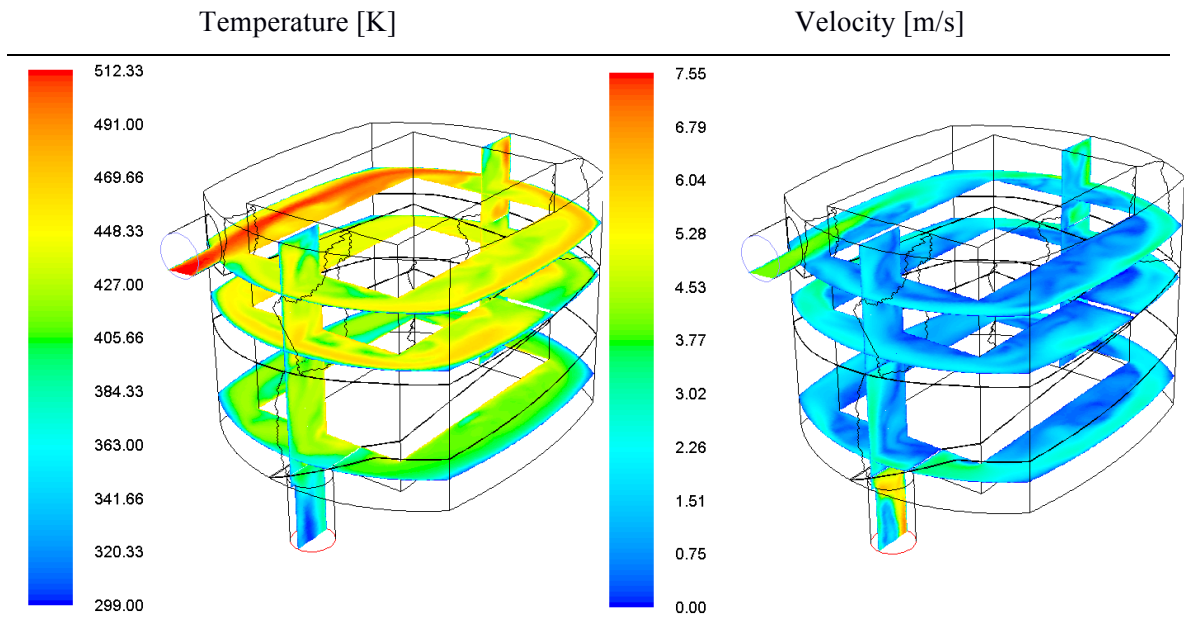Temperature [K]   Velocity [m/s]

Figure 14. Profile of temperature and flow in case of heating the battery (operating at 200°C) with waste gas 239°C
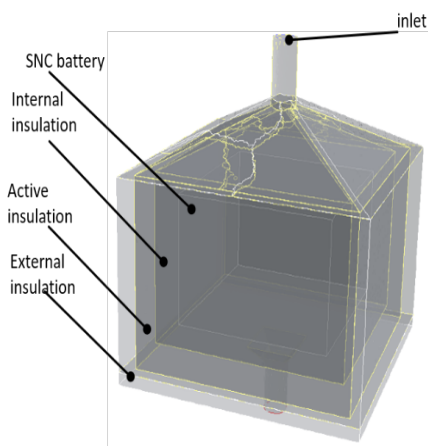

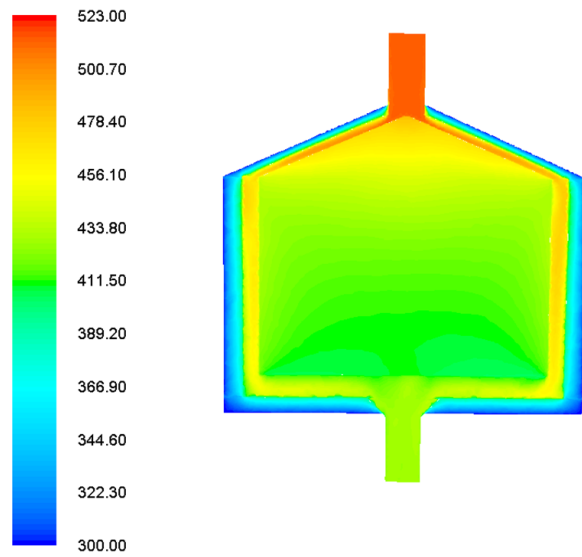Figure 15. Construction of active insulation of SNC battery

Figure 16. Temperature profile of SNC battery with all layers of insulation
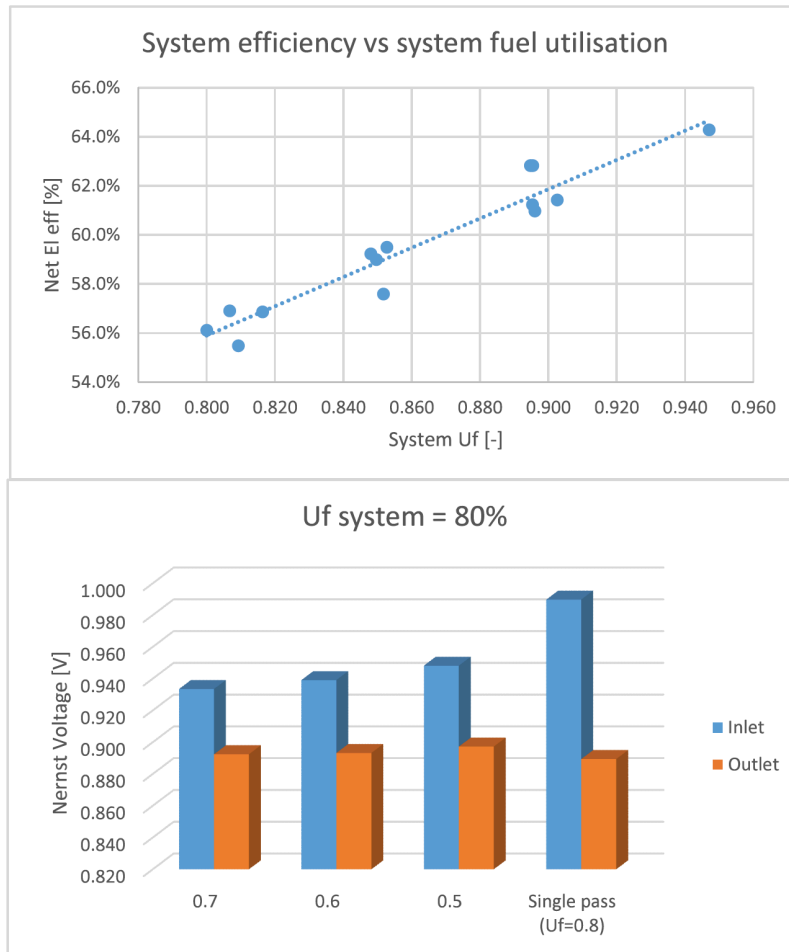
Figure 17. Calculated system efficiency as function of fuel utilization and Nernst voltage at the inlet and outlet of the considered SOFC stack

Figure 18: The first SOFC generator delivered and installed at HEIG laboratory in Yverdon (CH)
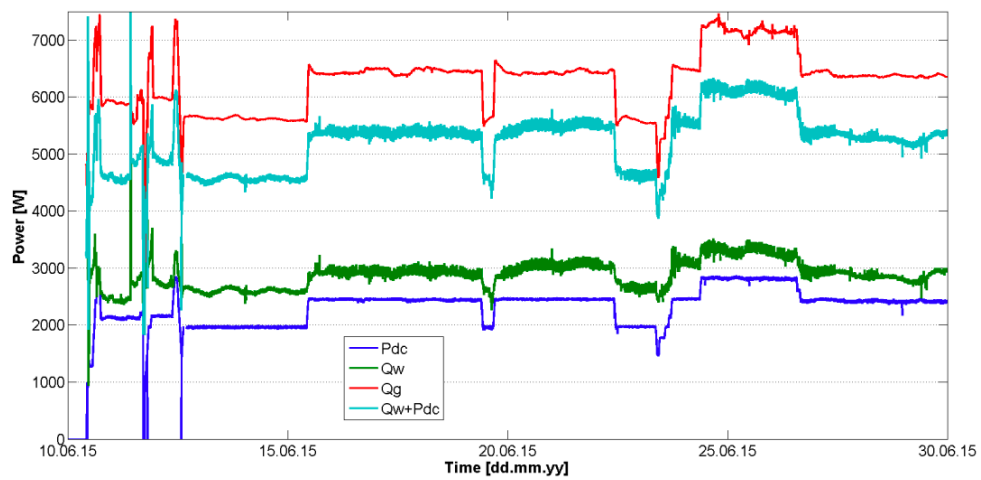

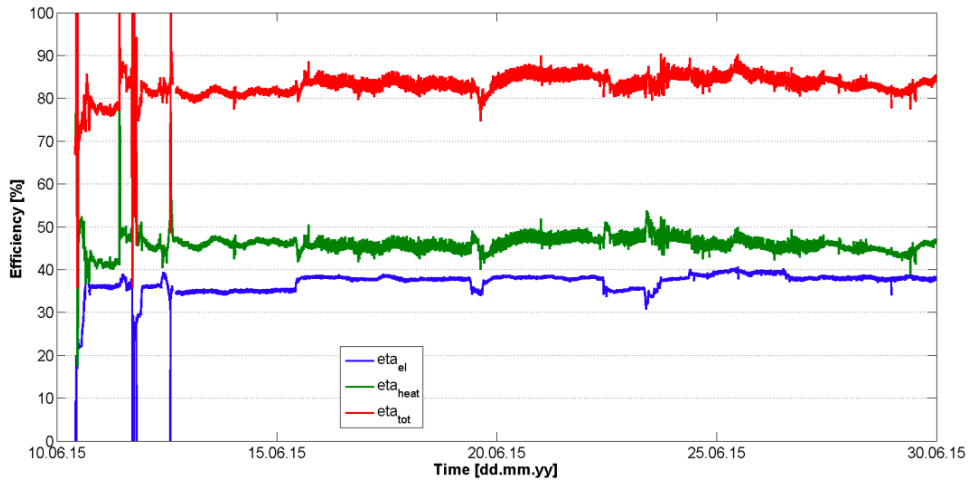Figure 19: Gas consumption and electrical and thermal power production.

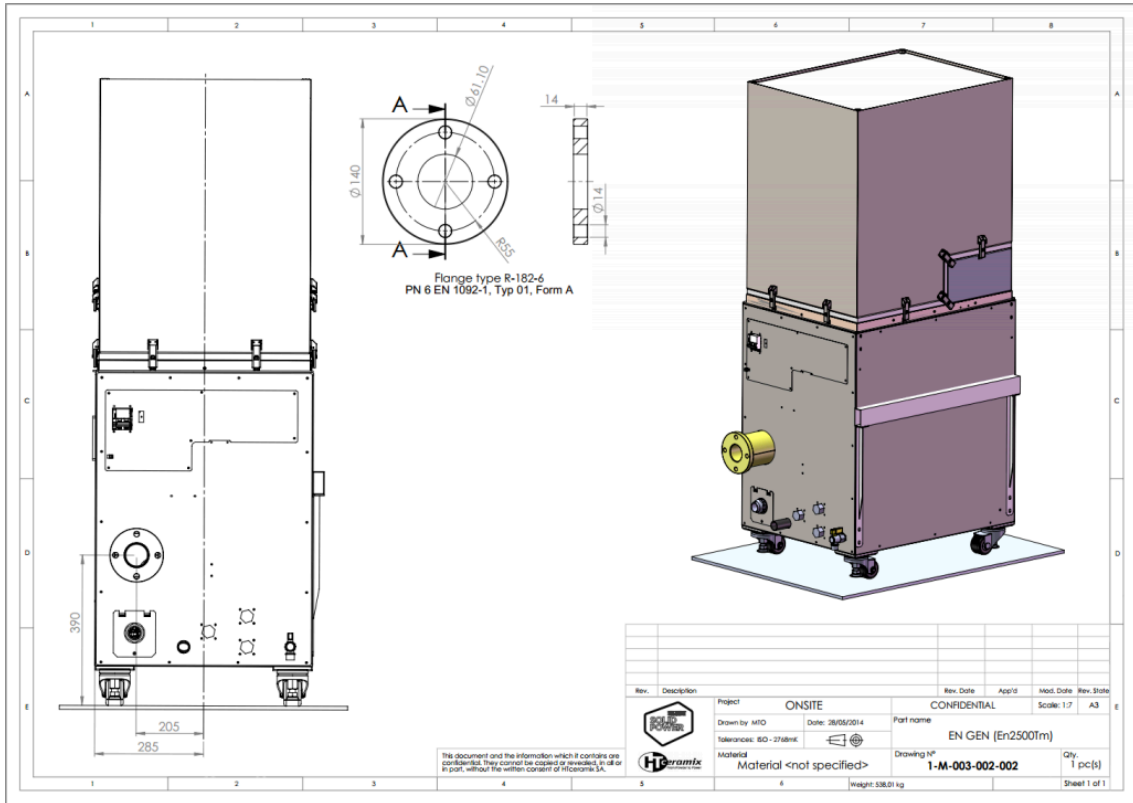Figure 20: Electrical (DC), thermal and total efficiency.

Figure 21: Design of ONSITE SOFC-subsystem and the interface specifications.
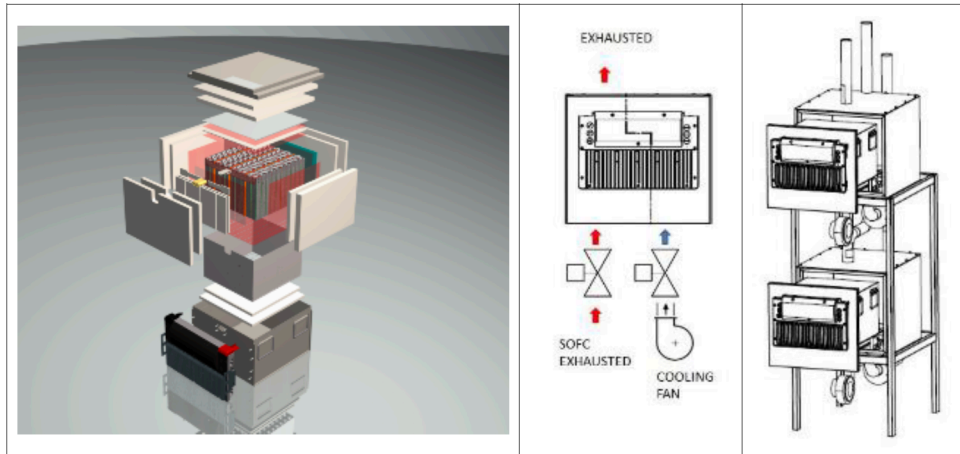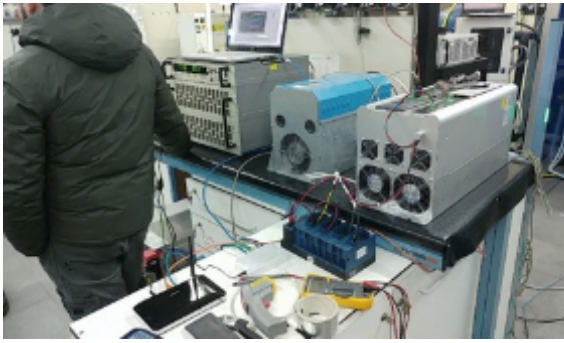
Figure 22 (a,b,c): A 3D sketch of the battery (a); The BoP (valve and fan) scheme to recover heat from SOFCs (b); the double module integration assembly (c)

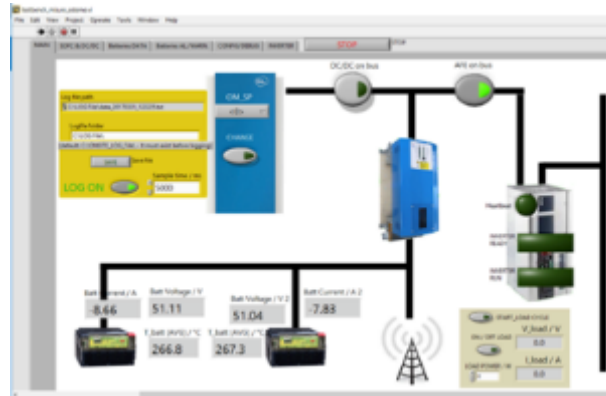Figure 23: first during test at HTC premises in Yverdon (Figure 23).

Power conversion system arrangement and test

SNC batteries installation and test

SOFC sub-system tests

Software interface / application validation

Figure 24: Devices constituting the "base unit" 5 kW SOFC/SNC hybrid system

Figure 25: The developed sheltered system: control equipment and SNC batteries compartments

Figure 26: The developed sheltered system: SOFC generator, power conversion compartments and software interface

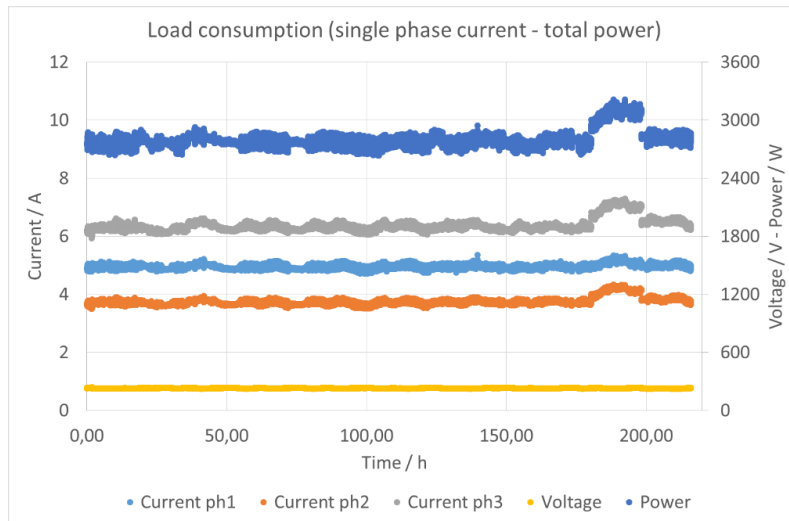Figure 27: The developed system at the field trial site

Figure 28: Load behavior (1-week) in the standard configuration: measured through the power meters and locally acquired by the system supervisor
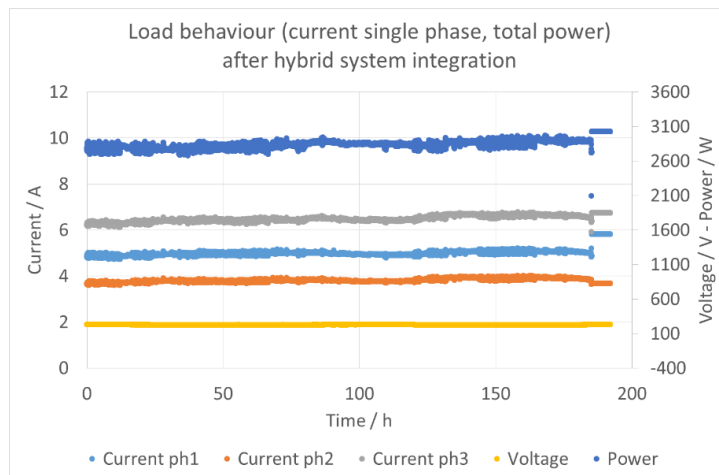

Figure 29: Load behavior (1-week) with hybrid system integration: measured through the power meters and locally acquired by the system supervisor
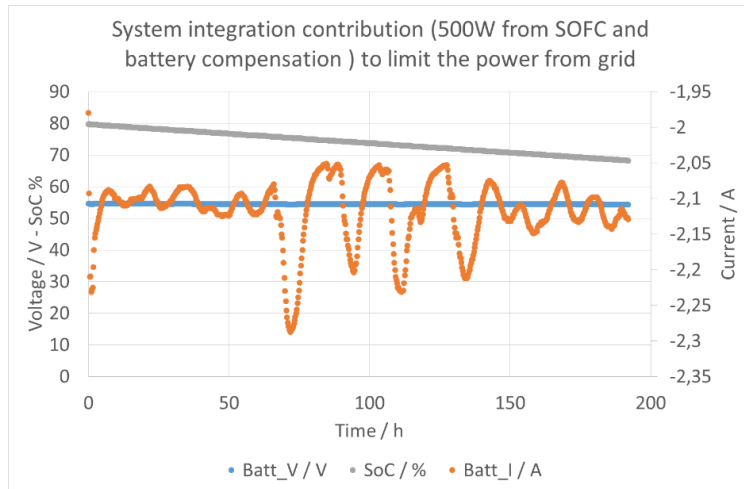
Figure 30: Battery (partial) compensation of the load fluctuations: continuous discharge during the eight-day integration test

SOFC sub-systems installed and connected with the SNC batteries

Final 10 kW SOFC/SNC hybrid system installed and connected with the adsorption chiller

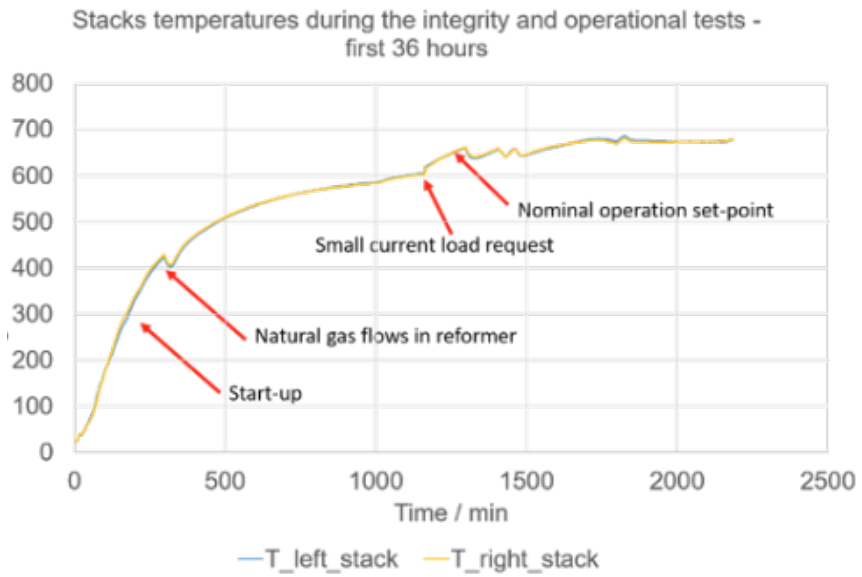Figure 31: 10 kW SOFC/SNC hybrid system assembled in lab

Figure 32: Stacks temperature trends during the start-up of the integrity verification test of the former SOFC module tested
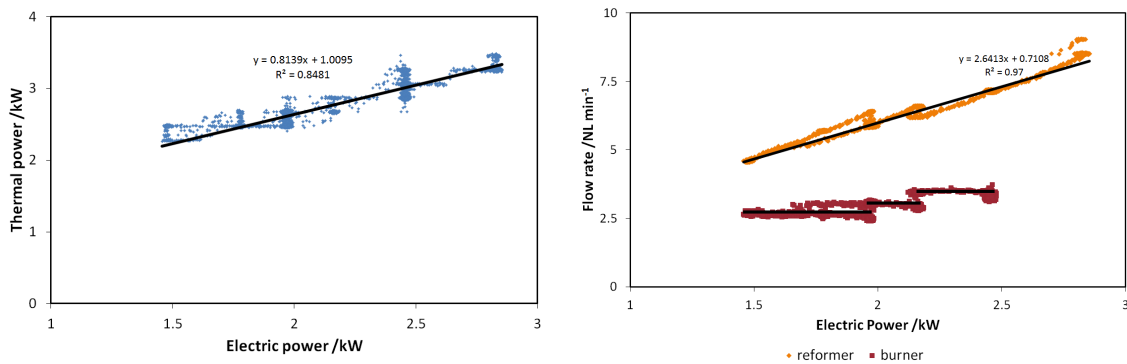

Figure 33: thermal power extracted from the SOFC as a function of its electric power output, and flow rates of the reformer and the burner as a function of the electric power output of the SOFC
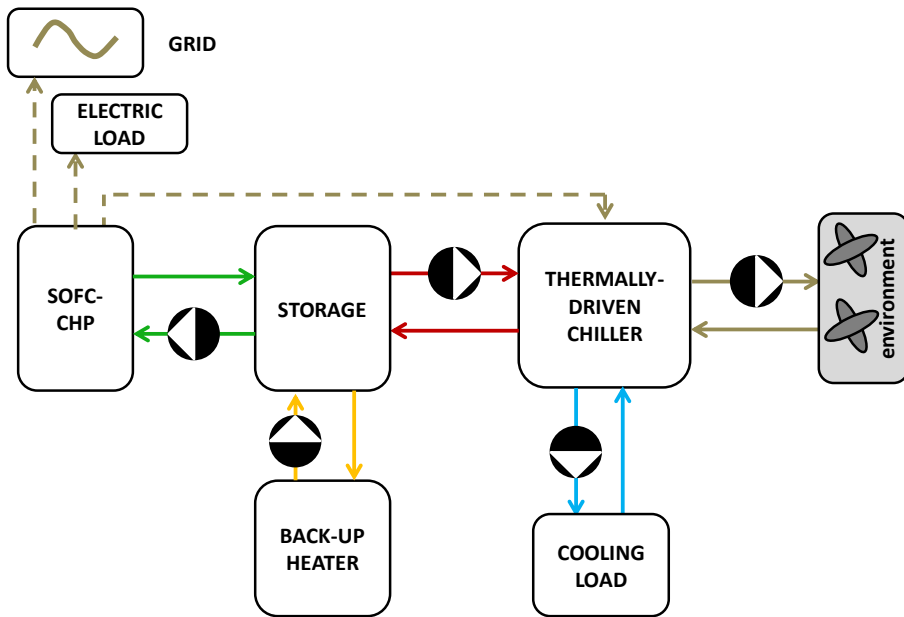
Figure 34: schematic of the SOFC/CCHP system