Identification of equivalent circuit models for sodium-ion batteries

Thesis objectives
An Equivalent Circuit Model (ECM) of a battery is an ordinary differential equation model (or, simply, an RC circuit) that captures the dynamics of the battery terminal voltage as a function of its charging/discharging current. ECMs are the basis of many applications, such as state-of-charge estimators, state-of-health estimators, and optimal battery control and scheduling. This thesis objective is twofold. First, it aims to identify ECMs of low-temperature sodium-ion batteries and estimate their parameters. Second, it will apply the developed models for the optimal control of a hybrid power plant (i.e., a conventional generation unit coupled with a sodium-ion battery to improve the dynamic performance of the system).

The main steps of the thesis work are:

- literature review of existing models
- measurement campaign using a sodium-ion battery
- model identification and model parameter estimation
- model validation
- development of an optimal control for a hybrid plant

Sodium-ion batteries are rechargeable batteries that use sodium as a charge carrier. Compared to more conventional lithium-ion batteries, they have lower energy density but considerably higher power density (making them suitable for power-intensive applications in power grid applications) and less environmental impact thanks to using sodium.

Supervision and work settings
The thesis is under the supervision of Prof. Fabrizio Sossan (HESSO-VS) and Prof. Jan Van Herle (EPFL-VS), whose laboratories are both located in Sion (VS). Practical experiments will be carried out in the "GridLab" laboratory of HESSO-VS. Remote work is possible when not working in the laboratory and when not exchanging with the supervisors and can be organized accordingly.

Required skills
Scientific coding, Optimization, Functional understanding of electricity notions.

Skills to acquire
grey-box modeling, applied optimization, battery applications.