DATAZERO: DESIGNING AND OPERATING DATACENTERS POWERED BY RENEWABLE ENERGY-BASED STAND-ALONE MICROGRIDS

R. Roche[1], S. Caux[2], J. Lecuivre[3], J.-M. Pierson[4], D. Hissel[1], J.-M. Nicod[1]

1. FEMTO-ST, FCLAB, CNRS, Univ. Bourgogne Franche-Comte
2. LAPLACE, Université de Toulouse, INPT, UPS, CNRS
3. EATON Industries France, 38334 St Ismier cedex
4. IRIT, University of Toulouse
e-mail: robin.roche@utbm.fr

Abstract – This paper describes the DATAZERO project, which focuses on the design and operation of datacenters powered by renewable energy and without any emission of greenhouse gas. It describes the selected supply system architecture, in the form of a stand-alone microgrid, as well as the proposed modules for the operation of both power and information technology (IT) sides. The operation philosophy relies on a negotiation between both sides, i.e., between using (and aging) components and reducing the quality of service for IT tasks.

Keywords – datacenter, microgrid, renewable energy, degradation, energy management.

1. INTRODUCTİON

In a context of rising climate change consequences, it has become crucial to facilitate the development of greener datacenters, capable to operate without emission of greenhouse gases [1]. The DATAZERO project, funded by the French National Research Agency from 2015 to 2019, brings together academic (FEMTO-ST, IRIT, LAPLACE) and industry (EATON) partners to help tackle challenges related to the design and operation of MW-scale datacenters solely powered by renewable energy.

2. MİCROGRİD STRUCTURE

The proposed power supply system is a stand-alone microgrid (Fig. 1). It includes renewable energy sources in the form of PV panels and wind turbines, storage units, in the form of supercapacitors, batteries (for short-term storage), and hydrogen storage (combining fuel cells, tanks and an electrolyzer for seasonal storage). This structure enables meeting all datacenter power and energy requirements without any direct emission, and while considering load and generation dynamics.
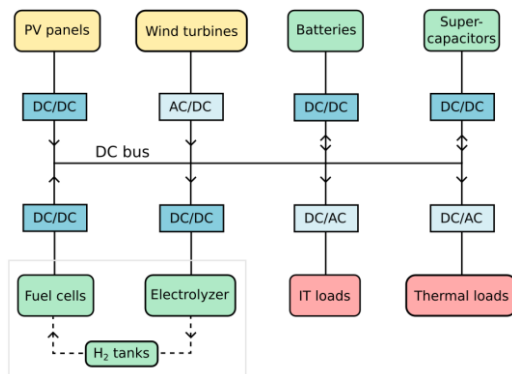

Fig. 1. Datacenter power supply infrastructure.

3. SİZİNG AND ENERGY MANAGEMENT

Models of these different components are established, and include degradation processes which reduce components performance over time. These models are then used for determining the optimal size of the components, and in the modules described in Fig. 2. For example, the power decision module (PDM) is in charge of scheduling the operation of the components in advance, and of dispatching the power load in real time among the components, accounting for forecasting errors. A similar module (ITDM) exists on the IT side for scheduling IT tasks on servers.
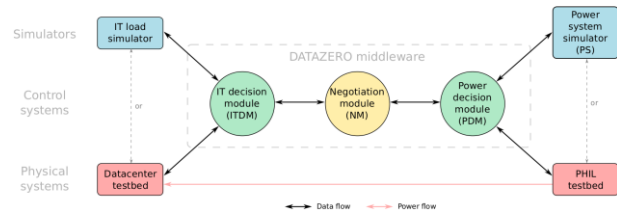

Fig. 2. Overview of the DATAZERO modules.

The negotiation module than handles a negotiation with the IT side to determine the datacenter operation. For example, in the advent of a sudden decrease in PV output, the system can decide to discharge the batteries, or to postpone some IT tasks to be run on the servers.

After simulations will have enabled to verify the correct operation of the designed models and algorithms, a reduced scale power hardware-in-the-loop (PHIL) experiment will be conducted to validate the proposed systems.

ACKNOWLEDGEMENT

REFERENCES

[1] W. Deng, F. Liu, H. Jin, B. Li and D. Li, "Harnessing renewable energy in cloud datacenters: opportunities and challenges," in IEEE Network, vol. 28, no. 1, pp. 48-55, January-February 2014.