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ScienceDirect

Energy Procedia 122 (2017) 919–924

Energy Procedia

www.elsevier.com/locate/procedia

CISBAT 2017 International Conference – Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale, CISBAT 2017 6-8 September 2017, Lausanne, Switzerland

Positive energy building with PV facade production and electrical storage designed by the Swiss team for the U.S. Department of Energy Solar Decathlon 2017

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Abstract

In the framework of the Solar Decathlon 2017 in Denver, Colorado, the Swiss team will propose a community house powered by solar energy and smart grid interaction. Thanks to an integrated design with multi-oriented façades, which were boosted by customized opening gates equipped with c-Si PV panels and power optimizers, a net positive energy building has been realized. An energy management system has been implemented to monitor and control the 9.715 kWp PV system and the electrical storage of 10.8 kWh capacity. The realized microgrid has been modelled and simulations have been performed using hourly meteorological data. As first results, measured BIPV production during the building commissioning has been compared with the simulated production at Fribourg.

Peer-review under responsibility of the scientific committee of the CISBAT 2017 International Conference – Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale

Keywords: U.S. Department of Energy Solar Decathlon 2017; Photovoltaics; BIPV; Power optimizers; Hourly simulations; Electrial storage, Microgrid; Energy management.

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1876-6102
Peer-review under responsibility of the scientific committee of the CISBAT 2017 International Conference – Future Buildings & Districts – Energy Efficiency from Nano to Urban Scale
10.1016/j.egypro.2017.07.410

1. Introduction

1.1. The U.S. Department of Energy Solar Decathlon 2017

The Swiss Living Challenge (www.swiss-living-challenge.ch) is a project developed by more than 50 students from different backgrounds (engineering, architecture, communication, marketing, etc.) whose goal is to design and build an innovative sun-powered house to participate in the Solar Decathlon 2017 in Denver, Colorado (www.solardecathlon.gov). Launched in 2002 by the U.S. Department of Energy, this competition soon became the most internationally awaited and visible event in the field of the built environment of the future (more than 90'000 visitors in 2015). Boosted by a strong collaboration between the École polytechnique fédérale de Lausanne (EPFL), the School of Engineering and Architecture of Fribourg (HEIA-FR), the Geneva School of Art and Design of Geneva (HEAD) and the University of Fribourg (UNIFR), our team will confront thirteen other universities to defend Europe's know-how in sustainable development. The aim of the project is also to launch strong and long term collaboration between universities and industrial partners.

1.2. Passive building design and energy efficiency

Designing an energy efficient and low consumption building was one of the main objective of the project. Therefore, some key elements were gathered in the passive design, such as a well-insulated and tight building envelope, windows providing sufficient natural light, zenithal windows providing natural ventilation and solar protections. Our building is a community house called 'NeighborHub' which comprises two main zones : a conditioned space called 'Core' where the comfort conditions must be very well controlled, and a tempered space called 'extended skin' providing less restrictive comfort conditions and allowing various collective activities to happen 50% of the year (see Fig 1. a, b). In the concept, the extended skin is used for the electricity production with BIPV elements.

(a) (b)

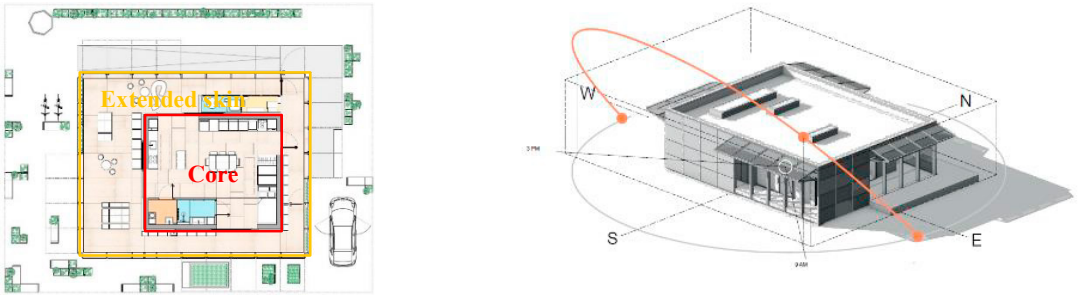

Fig. 1. (a) Plan view of the NeighborHub with the 'core' space (red) and the 'extended skin' space with BIPV elements (orange); (b) Shaded axonometric 9 a.m., Source U.S. Department of Energy Solar Decathlon competition 2017 Denver, Colorado, Delivrable D6 & D7 Swiss Living challenge.

1.3. The strategy for energy production

Nowadays, photovoltaic panels are mostly installed on roofs with optimum inclination and orientation to maximize the return on investment. Thanks to the dramatic drop of photovoltaic prices and the improvement of photovoltaic conversion efficiency, PV on facades now represent a good potential for PV production. Moreover, with the territorial densification currently happening in most European countries, including Switzerland with its LAT (laws on land use planning), the solar potential of facades should be better exploited. Solutions to introduce new