Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 122 (2017) 181–186

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

The energy hub concept applied to a case study of mixed residential and administrative buildings in Switzerland

A.T.D. Perera [a]*, Dasaraden Mauree [a], Jean-Louis Scartezzini[a]

[a] *Solar Energy and Building Physics Laboratory (LESO-PB), Ecole Polytechnique Fédérale de Lausanne (EPFL), CH-1015 Lausanne, Switzerland.*

Abstract

The concept of Energy Hub (EH) is getting popular as a method to integrate non-dispatchable energy sources at building and neighbourhood scale with the support of energy storage and grid. It is interesting to study the effectiveness of EH concept to integrate solar energy and wind energy at both building and neighbourhood scale considering the real-time price and curtailments in the grid. This paper presents a case study conducted to evaluate the effectiveness of EH in integrating solar energy in the SwissTech Convention Centre (STCC) and Quartier Nord on the EPFL campus in Lausanne considering both building and neighbourhood scale. The results depict that EH is more effective when both compared to standalone operation and grid integrated mode (considering grid curtailments and RTP) in the process of integration of renewable energy sources. Interacting with the grid seems to be more economical when compared to storage. Grid curtailments cause the storage to operate more frequently in both charging and discharging cycles.

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: Building energy system; Distributed energy systems; Energy Hubs; Renewable Energy Intergration

* Corresponding author. Tel.: +41 21 693 55 56
E-mail address: dasun.perera@epfl.ch

1876-6102 © 2017 The Authors. Published by Elsevier Ltd.
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.2017.07.342

1. Introduction

Energy requirements in urban areas are rising very fast and this trend is expected to continue with the increase in the urban population (70% by 2050). New buildings are built according to more and more stringent norms which can make them either net-zero or energy positive buildings. Decentralized urban energy systems are hence drawing a lot of attention from the research and industrial community as a possibility towards more sustainable urban areas responding to stringent limitations for fossil fuel based power generation and global concern on greenhouse gases (GHG) emissions.

The stochastic nature of both demand and solar photovoltaics (SPV) energy potential makes SPV integration into buildings more challenging. The concept of Energy Hub (EH) [1]–[5] is getting popular as a method to integrate non-dispatchable energy sources at building and neighbourhood scale with the support of energy storage and grid. In a previous study, a district on the EPFL campus, Switzerland [6], [7] was analysed to implement renewable energy. However, the analysis did not account for the various energy vectors that could be considered and integrated in order to increase the autonomy of the energy system. There have been no studies on the effectiveness of energy hub (EH) to integrate solar energy and wind energy at both building and neighbourhood scale considering real-time price (RTP) and curtailments in the grid. This study presents a case study conducted to evaluate the effectiveness of EH in integrating solar energy in the SwissTech Convention Centre (STCC) and Quartier Nord on the EPFL campus in Lausanne considering both building and neighbourhood scale.

In the next section we describe the models used in the current study. We then show the results obtained and discuss them. In the final section we conclude on the most important findings in this study and give a few perspectives to further develop the concept of implementation of decentralized energy systems.

Nomenclature

EH	Energy hub
EPFL	Ecole Polytechnique Fédérale de Lausanne
GHG	Greenhouse gases
ICG	internal combustion generator
RTP	Real time price
SPV	Solar photovoltaics
STCC	SwisstTech Convention Centre
ToU	Time of Use

2. Methodology

2.1. Brief description of the CitySim software

CitySim [8] is a large-scale dynamic building energy simulation tool developed at the EPFL. The tool includes an important aspect in the field of simulating multiple buildings: the building interactions (shadowing, light inter-reflections and infrared exchanges). Furthermore, CitySim is based on simplified modelling assumptions to establish a trade-off between input data needs, output precision requirements and computing time. It also takes into account the occupancy profile and thermal comfort of the occupants throughout the year.

2.2. Overview of the energy system

The EH consisting of wind turbines, SPV panels, battery bank, internal combustion generator (ICG) operating connected to the main grid is considered in this study (see Fig. 1). Global solar irradiation on horizontal surfaces and wind speed are taken into account on an hourly time scale. The computational model is described in Ref. [9]–[12]. Energy demand for multiple energy services (heating and electricity) is taken from Citysim, and standard occupancy profiles are used. The electricity price in the grid is taken based on the Time of Use (ToU) scheme. Grid