Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 105 (2017) 4458 – 4463

Energy Procedia

The 8th International Conference on Applied Energy – ICAE2016

# Strategy for renewable energy storage in a dynamic distributed generation system

Yu Luo[a], Yixiang Shi*[, a], Yi Zheng[a], Zhongxue Gan*[,b], Ningsheng Cai[a]

[a,]*Key Laboratory for Thermal Science and Power Engineering of Ministry of Education, Department of Thermal Engineering, Tsinghua University, Beijing 100084, China*

[b]*ENN Science & Technology Development Co., Ltd, Langfang 065001, Hebei Province, China*

**Abstract**

Renewable energy (RE) is expected to be the major part of the future energy. Presently, the intermittence and fluctuation of RE lead to the limitation of its penetration. To solve this problem, energy storage device is in demand. In this paper, the energy storage strategy was designed to improve the RE penetration and dynamic operation stability in a distributed system coupling wind generators, internal combustion engine and RSOFC. By compromising the relative deviation of power supply and demand, RE penetration, system efficiency and capacity requirement, the strategy that no more than 36% of the maximum wind power output is directly supplied to users and the other is stored by the reversible solid oxide fuel cell is optimal for the distributed system. This strategy can better utilize the wind power and remarkable alleviate the wind curtailment problem.



Peer-review under responsibility of the scientific committee of the 8th International Conference on Applied Energy.

*Keywords*: Renewable energy penetration; Dynamic system simulation; Energy storage strategy; RSOFC; Li-ion battery

## 1. Introduction

Renewable energy (RE) is greatly developed worldwide due to its sustainability and cleanness. Nevertheless, the characteristics of intermittence, fluctuation and dependence on the weather lead to the difficulty in feeding into grid and improving the renewable energy penetration. The data published by National Energy Administration of China showed the ratio of curtailed solar energy was 10% and the ratio of curtailed wind energy reached 15% in 2015[1, 2]. With the prospect of future energy has been

Corresponding author. Tel.: +86-10-62789955; Fax: +86-10-62789955.
Email: shyx@tsinghua.edu.cn.
Corresponding author. Tel.: +86-316-2595905; Fax: +86-316-2595905.
Email: ganzhongxue@enn.cn.


Peer-review under responsibility of the scientific committee of the 8th International Conference on Applied Energy.
doi:10.1016/j.egypro.2017.03.946

described as the “energy internet”, RE will play a major role in the future primary energy, which is achieved by the super-large-scale distributed generation and energy storage systems[3, 4].

The dynamic simulation platform is an indispensable tool to study the behavior and optimal strategy in a distributed renewable energy storage system. T. Senjyu et al.[5] proposed a distributed system coupling diesel generator, fuel cell and aqua electrolyzer to use renewable energy in a small, isolated island. Similar researches show pumped-hydro energy storage, compressed air energy storage, power-to-gas/liquid (PtG/PtL, for gas/liquid fuels storage), CES, batteries, flywheels and SMES are available energy storage technologies[6-12]. However, only pumped-hydro energy storage, compressed air energy storage and gas/liquid fuels storage are alternative selections to seasonal energe storage[6-8]. PtG by reversible solid oxide fuel cells (RSOFC) is a high-efficiency and economically feasible method [7], which can also build a bidirectional connection between natural gas and electricity [4].

## 2. System configuration

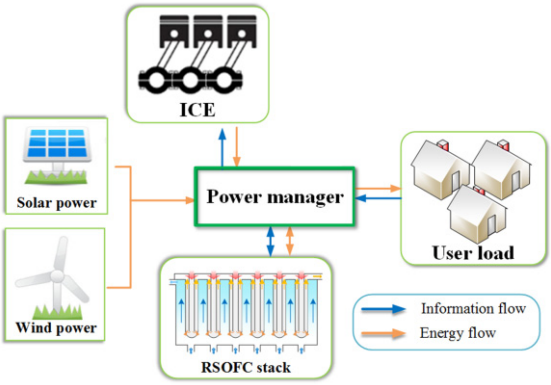


Fig. 1. System configuration

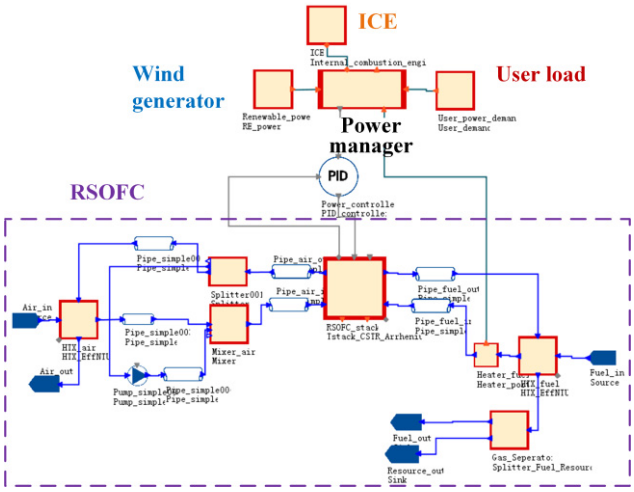


Fig. 2. System platform in gPROMS