Energy 71 (2014) 148–159

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

# A dynamic power management strategy of a grid connected hybrid generation system using wind, photovoltaic and Flywheel Energy Storage System in residential applications

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ARTICLE INFO

*Article history:*
Received 26 July 2013
Received in revised form
8 March 2014
Accepted 14 April 2014
Available online 20 May 2014

*Keywords:*
FESS
Grid connected
Clipping consumption
MPPT
LPPT
Constraints

ABSTRACT

A global supervisory strategy for a micro-grid power generation system that comprises wind and photovoltaic generation subsystems, a flywheel storage system, and domestic loads connected both to the hybrid power generators and to the grid, is developed in this paper. The objectives of the supervisor control are, firstly, to satisfy in most cases the load power demand and, secondly, to check storage and grid constraints to prevent blackout, to reduce energy costs and greenhouse gas emissions, and to extend the life of the flywheel. For these purposes, the supervisor determines online the operation mode of the different generation subsystems, switching from maximum power conversion to power regulation. Decision criteria for the supervisor based on actual variables are presented. Finally, the performance of the supervisor is extensively assessed through computer simulation using a comprehensive nonlinear model of the studied system.



## 1. Introduction

The sustainable greenhouse energy supply leads both developed and developing countries to make and implement new policies to improve efficiency in energy consumption, and to adopt new revolutionary alternatives. Variable energy demands, intermittent availability of renewable resources, different technological alternatives to satisfy the different demands, and the possibility of integrating storage and energy production systems give rise to the exigency of defining criteria and strategies able to improve efficiency and energy supply, and its environmental and economic sustainability [1,2,3]. Methods and models able to optimize such hybrid systems for the specific case of a house are also welcomed because of the relevance that a "Greenhouse" might have in terms of environmental sustainability and energy efficiency [4,5]. The need for change in the current electricity grid and power design and operation in order to meet such challenges has been recognized and discussed for several years under different labels: there is an urgent need for a more flexible, reliable and smarter grid [6].

The smart grid (SG) comprises everything related to the electric system, such as a smart transmission system (STS), an energy management system (EMS), advanced distribution management, advanced metering, demand response (DR), and electric storage system (ESS) [7–12].

In Ref. [13], a synthesis of power flow controls for STS is developed. Similarly, in recent years numerous researches have been conducted on development of DR for managing the electricity consumption of customers. Refs. [14–18] details how smart homes will be a key component of smart grids. So bidirectional feedback on energy use help householders reduce their energy demand, contributing further to lower energy bills, security of energy supply and reduction of carbon emissions. Among these SG applications, EMS is an important control mechanism for managing the power flow in response to supply, storage and consumption conditions. Many works, as in Refs. [19–22], argue for the need for EMS in smart grids in order to facilitate better integration of fluctuating renewable energy.

In this context, this paper presents a new dynamic power management strategy (PMS) for micro smart grid system based

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http://dx.doi.org/10.1016/j.energy.2014.04.039
0360-5442/

on bidirectional power flows, i.e. the consumers are also producing to the grid. This study focuses on PV-Wind systems for residential sector [23,24] in the context of a liberalized electricity market with a restriction in renewable energy subsidies. In this framework, the objective is to produce clipping grid consumption by optimizing the use of renewable energies, incorporating a storage system. Thus, the paper proposes a control strategy that makes it possible to operate in both modes: at either maximum (MPPT) or limited power point tracking (LPPT), according to the supervisor operation mode. This application provides services both for domestic users and for the distribution network manager. In fact, the intermittent property of renewable power system requires supplementary energy such as the utility grid or storage system to meet load demand. So, network customers will be affected according to the variable electricity pricing which becomes increasingly common, with a high rate correlated with peak demand. In this case, the clipping peak consumption can significantly reduce energy costs and also the power subscription

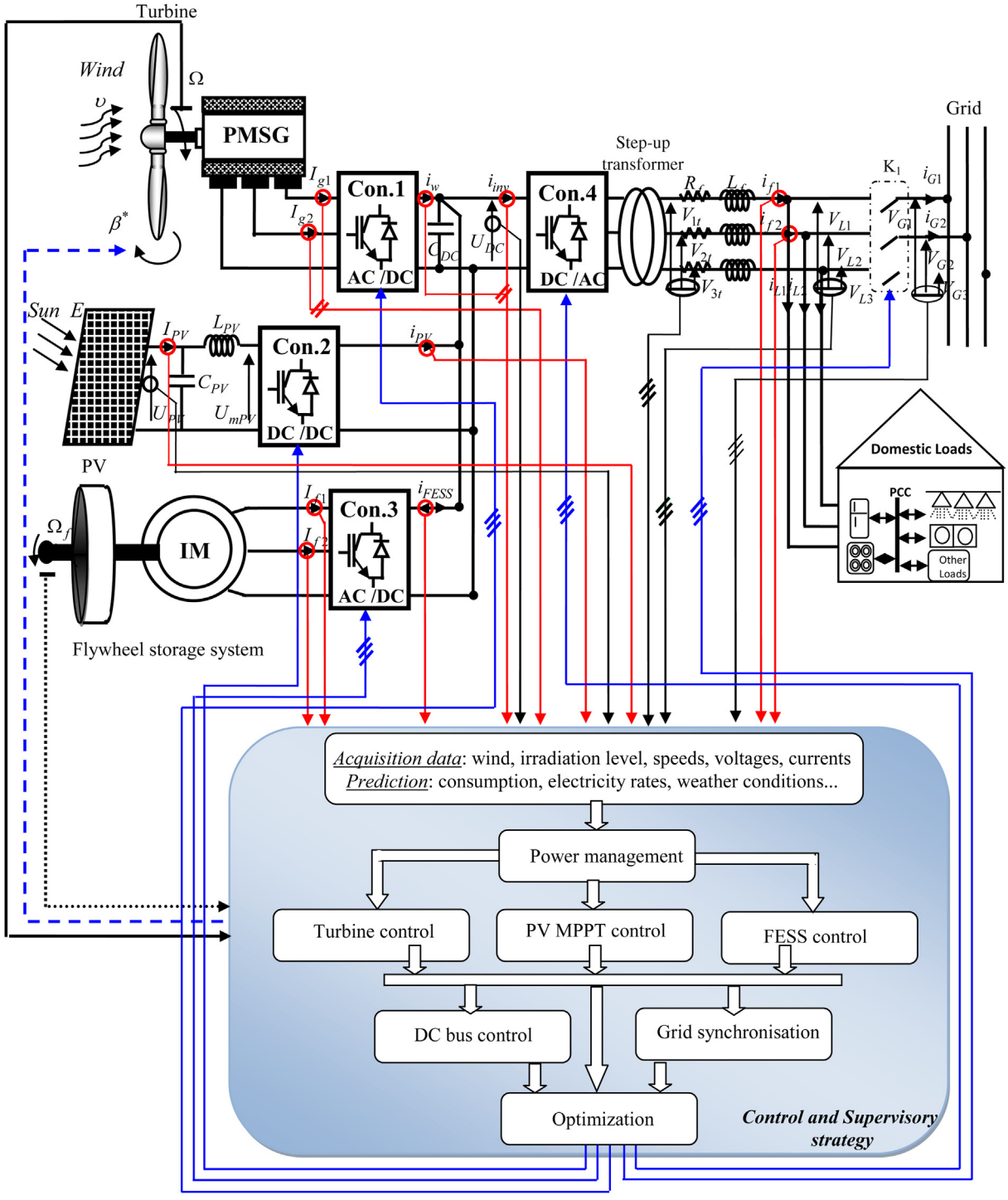


**Fig. 1.** Architecture of the studied micro-grid power generation system turbine PMSG Con.1 Con.2 AC/DC DC/DC.