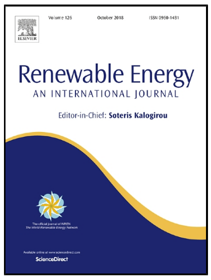

Optimal Sizing and Energy Scheduling of Photovoltaic-Battery Systems Under Different Tariff Structures

Orlando Talent, Haiping Du

PII: S0960-1481(18)30646-3

DOI: 10.1016/j.renene.2018.06.016

Reference: RENE 10172

To appear in: *Renewable Energy*

Received Date: 21 June 2017

Accepted Date: 04 June 2018

Optimal Sizing and Energy Scheduling of Photovoltaic-Battery Systems Under Different Tariff Structures

Orlando Talent[a]*, Haiping Du[a]
[a] School of Electrical, Computer & Telecommunication Engineering
University of Wollongong, Wollongong, NSW, 2500, Australia
*Corresponding Author: Email address: oot899@uowmail.uow.edu.au Phone: +6199373301

***Abstract*— This paper builds upon previous research to develop a new mixed integer linear program (MILP) for optimal PV-battery sizing and energy scheduling. Unlike previous formulations, the MILP optimises under both time-of-use (TOU) and demand tariff structures. Optimisation is based on the highest system net present value (NPV). One residential and one commercial customer are used as case studies to contrast optimisation under TOU and demand tariff structures. Optimal PV-battery sizing is not found to be affected by the tariff structures analysed. Optimal solutions under both tariffs prefer larger PV systems coupled with small battery systems. Energy consumption from the grid under TOU tariff optimisation reflects a scaled profile of the consumer's energy demand curve. Peak consumption from the grid is heavily reduced under demand tariff optimisation to decrease the associated demand charge. In the residential case study, peak grid consumption over one year is reduced from 5.98 kWh to 2.25 kWh under demand tariff optimisation. In the commercial case study, peak grid consumption over one year is reduced from 450.3 kWh to 348.6 kWh. The reduction of peak grid consumption is achieved by using the stored energy in the battery.**

***Index Terms*—** MILP, battery, PV-battery, optimisation, tariff

1. INTRODUCTION

The main aim of this paper is to address the optimal system sizing and power dispatching problem regarding PV-battery systems. Specifically, a mixed integer linear program (MILP) is developed to select the optimal PV and battery size for a specific location under both time-of-use (TOU) and demand tariff structures. A second MILP is also developed to optimally schedule the energy of a PV-battery system, with the goal of minimising the electricity bill.

Two key issues surrounding renewable technologies are the cost premium and energy reliability when compared to conventional electricity sources such as coal and gas. Conventional, non-renewable power plants scale output power to meet the varying grid load. Power generation from renewable sources such as wind and solar, however, are inherently less predictable due to natural variation in weather.

Despite these challenges, installed renewable energy capacity is growing at an accelerating rate [1]. Some studies have shown the feasibility of moving to 100% renewable sources, despite their intermittence [2-4]. As renewable technology has developed, the cost per unit energy ($ / kWh) has decreased rapidly too. In some cases wind is in parity or undercutting coal in cost per unit energy [5].

The solution to the inherent intermittence of some renewable electricity generators is energy storage. Common energy storage media include batteries, capacitors, thermal energy storage, compressed air, pumped water and flywheel storage. All storage media allow excess energy to be stored for later use, when electricity demand exceeds production. Through energy