Energy Management Investigation of Multi-Level Grid Power Supplying Micro-Grid Using Reinforcement Learning and Improved PSO Optimization

Nabil Jalil Aklo[1, a)], Mofeed Turky Rashid [2, b)]

[1] *University of Thi-Qar, Thi-Qar, Iraq*
[2] *University of Basrah, Basrah, Iraq*

[a)] Corresponding author: nabilj.aklo@utq.edu.iq
[b)] mofeed.rashid@uobasrah.edu.iq

Abstract. In this paper, a central Energy Management System (EMS) has been proposed in Micro-Grid (MG) installed in a rural area. The MG is connected to the Utility Grid (UG) by three different levels of power supplying during three intervals along the proposed time horizon to decrease the burden on the UG in the peak intervals, at the same time increase the use of Renewable Energy Resources (RER) to decrease the cost of energy. The inherent uncertainty of RER has been overcome depending on the autonomous optimization approach using Deep Reinforcement Learning (DRL) without depending on the mathematical model of the system (free-model based). The EMS draws the optimal policy for the work of energy resources in the MG and makes the best decisions in order to schedule the operation of these resources to ensure access to the lowest energy prices taking into consideration the limitations of the three levels of power supplying across Point of Common Coupling (PCC). The simulation has been applied to actual data of the rural area in Ontario City. The method is verified and compared with Improved Particle Swarm Optimization (IPSO).

Keywords: Energy management system; Reinforcement Learning; Renewable Energy Resources; Deep-Q-Network; Point of Common Coupling.

INTRODUCTION

In recent years, hybrid Renewable Energy Resources (RERs) have become more popular for supplying electricity in rural places, where the grid extension is regarded as too costly [1]. RERs offer a promising prospect to cover the fundamental demand for electricity in isolated and remote regions [2].

The substantial increase in energy demand due to increased households and industrialization use requires greater penetration of the Utility Grid (UG) and renewables to close the energy gap between suppliers and prosumers. According to the United Nations' 2014 energy report, roughly 17.8% of the world's population lacks access to electricity and the traditional energy resources are limited and emit hazardous gases that are major contributors to climate change [3]. Furthermore, natural disasters frequently create grid blackouts, and conventional resources (diesel, gas) are incapable of handling these worst-case circumstances. So keeping the aforementioned issues in mind, traditional and central energy resources can be gradually phased out and replaced by RERs to enhance the energy system's technical, economic, and social metrics [2]. The individual usage of RER, on the other hand, introduces unreliability and security concerns, as well as raising the system's cost, therefore, a hybrid energy system can be employed as a reliable, sustainable, cost-effective solution, and low-carbon to supply the load demand [4].

Hybrid energy systems are defined as a combination of conventional and renewable energy resources constructed with Energy Storage Systems (ESS) that are utilized to supply load demand in a reliable, cost-effective, and environmentally friendly manner, either in grid-connected or isolated modes [5]. The system must be well-designed

The Fourth Scientific Conference for Electrical Engineering Techniques Research (EETR2022)
AIP Conf. Proc. 2804, 050009-1–050009-8; https://doi.org/10.1063/5.0154603
Published by AIP Publishing. 978-0-7354-4637-3/$30.00