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Robust Energy Efficient Management of a Microgrid

Muhammad Shiraz[1,*] and Sadaqat Ali[1]

[1]NFC Institute of Engineering and Technology, Multan, Pakistan

Abstract

Proposed is the energy efficient management system to develop a robust micro grid with lesser loss of probability and efficient with energy. We have presented techniques from the related work and find the optimized technique as well. Our research mainly depend upon the Particle Swarm Optimization in which we divide the grids into local and global solutions to find the optimized solution for the power supply and to overcome the nonlinear loads. We then compared the PSO with LEACH (Low energy adaptive clustering hierarchy) and found that PSO is the best solution for energy efficient management system.

Keywords: Energy Efficient, Leach, PSO, Optimization.

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1. Introduction

1.1. Overview

We have Proposed a technique for the energy efficient management system to develop a robust micro grid with lesser loss of probability and efficient with energy. We have presented techniques from the related work and find the optimized technique as well. Our research mainly depend upon the Particle Swarm Optimization in which we divide the grids into local and global solutions to find the optimized solution for the power supply and to overcome the nonlinear loads. We then compared the PSO with LEACH (Low energy adaptive clustering hierarchy) and found that PSO is the best solution for energy efficient management system burdens incorporate HVAC

1.2. Energy Management Systems Techniques

The microgrid EMS must almost certainly interface with them flawlessly. At last, different kinds of energy parts from various sellers are sent and interconnected in the microgrid, yet the greater part of despite everything them utilize restrictive conventions, which thwarts them from interoperating with one another [3].

1.3. Optimization Techniques

In past, various techniques utilized for microgrids, these were improved using many optimization algorithms. Power generation scheduling was improved in [1] using an artificial fish swarm algorithm (AFSA), whereas, in [2], day-a-head enhanced scheduling was introduced using a harmony search (HS) and differential (DE) algorithms. Different references has been given for utilizing these concepts as well as accuracy also becomes well after using optimization algorithms.

1.4. Centralized Power Plants

Various drawbacks of customary centralized power plants, for example, the mind-boggling costs of powers, ecological issues, low proficiency, staggering costs of transmission organize advancement, and the developing interest for the power have as of late given various challenges in the power frameworks. Microgrid is a little conveyance framework with nearby Distributed Energy Resources which is associated with the conventional centralized electrical framework yet can work self-governing. A microgrid could be a kind of fast matrix furnished with the actuated PC correspondence advances also, insightful meters giving greater adaptability and dependability to control also, insurance of the framework. The microgrid administrator advances the given energy by the nearby Distributed Energy Resources and the customary centralized age to supply the nearby loads. Communication among Distributed Energy Resources and the framework is the real tuft of a microgrid. This communication gives stockpiling and adaptability capacities required for interest management [3]. Photovoltaic (PV) framework is a standout amongst the best Distributed Energy Resources in microgrids. Neighbourhood age and diminishing the stop up rate of the transmission systems are the fundamental favourable circumstances of the PVs. Anyway the vulnerability of the sun

*Corresponding author. Email: Sheraz.chaudhary88@gmail.com

energized light accessibility of lattice tie PVs may give a few issues in dynamic and responsive power equalization and voltage guideline in microgrids [4]. Ideal dispatches of sustainable power source assets (RESs) have been tended to in a few works [5–13]. In [5], two sub-issues of appropriation arrange reconfiguration and circulation framework task are coordinated considering the vulnerabilities related with wind, PV and load variety. In [9], a multi-target improvement definition joining both of the structure issue and the ideal activity of scattering framework is appeared. In [13], a summed up model is proposed for conveyance framework ideal arranging thinking about three points of perspective on present day scattering systems. Initial, a probabilistic approach considering the hourly weight profile is utilized; second, it is normal that the circulation framework can work with one or various microgrids working in islanding mode; at last the entrance measurement of RESs is considered.

1.5. Photovoltaic Systems

The challenges with the matrix tie PV frameworks have been tended to in a few investigations. The impacts of utility-scale PV units on exceptional (transient and little flag steadiness) and static (voltage adequacy) of the transmission framework are investigated in [14] and [15], including model of the PV display and converter, similarly as related control frameworks. Transports voltages breaking points are constrained by evolving feed-in responsive power from the utility-scale PV units. A power factor control is utilized to obtain the open power set point. A voltage and repeat control is proposed in [15], planning the controls for the PV inverter and most extraordinary power point following. In [4], the vulnerability in sun based age is stochastically demonstrated in the ideal activity of conveyance organize. Demonstrating of reasonable PV age in the proposed stochastic definition improves the expense of influence arrangement and limits the warm disaster. In [16], a probabilistic multi-target strategy is displayed for the task of appropriation systems improving the framework voltage and power factor control. The vulnerabilities related with sun based irradiance of PVs and unequal loads are displayed. In [17], a systematic model is proposed for ideal dispatch of PV inverters in appropriation feeders concentrating on both dynamic and responsive power creation; the ideal PV inverters dispatch are agreed to the auxiliary administrations arrangement.

1.6. Solar Irradiations

Solar irradiation and along these lines PV dynamic power age are normally accessible amid the inside hours of the day; so the PV inverters are pointless and with no monetary advantages amid a vast piece of the 24 h that is all. This accessible inverter cutoff can be used to pass on responsive influence for influence disaster decrease and voltage guideline amid hours with low solar irradiation [1]. This capacity to control the responsive influence gives a few auxiliary administrations, for example, blockage management, influence mishaps decrease and power/voltage control [21]. Microgrid energy management issue has been tended to in a few works [22–26]. In [22], a multi-target structure is proposed for ideal energy management of the framework tied microgrid considering wind speed figure. Wavelet neural framework is utilized to improve the accuracy of the breeze power estimate. In this work, economical dispatch based NSGA-II is utilized to explain the proposed multi-target improvement issue (MOP). Another microgrid energy management plot with the goals of microgrid activity cost minimization and contamination emanation minimization is displayed in [23].

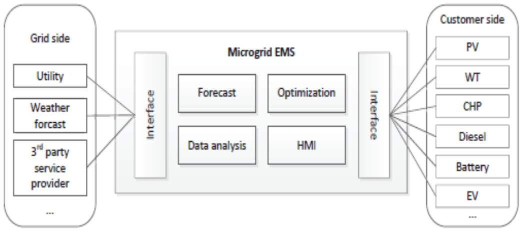

Figure 1. Microgrid Electric Management Systems

1.7. Research Problem and Solutions

The point of this work was the trial appraisal of energy management procedures in a genuine condition including a place of business, a PV system with capacity and a module electric vehicle. The interconnection of these components involved a novel trial small scale matrix where an energy management procedure must be actualized. The procedure must guarantee that:

(I) it is good with the business equipment utilized,
(II) the example time is low enough to maintain a strategic distance from the consumption of the batteries while the power balance is accomplished regardless of whether the electric vehicle out of the blue withdraws, furthermore,
(III) it is computationally quick enough to be executed continuously even in a low power utilization single-board PC (SBC). The main thought was to plan a technique dependent on model prescient control (MPC) with the expense of the power devoured from the open network as a goal work.

Be that as it may, the computational time of the goals of the streamlining issue might be longer than 60 s. In [15], a MPC is connected to a small scale lattice made out of sustainable power sources and electric energy stockpiling with an example time of 10 min, without getting expansive reductions of working expenses in correlation with a standard based control, particularly when the estimating blunders increment. The standard based control exploits its low computational expenses, enabling it to be actualized progressively with an example period not longer than 60 s, as requested by the smaller scale matrix under investigation. Hence, the proposed methodology in this research tended to a standard based control whose yields were identified with an arrangement of transfers interfacing the diverse power sources.

1.8. Objectives

a. To investigate the cost in EMS for different time spans
b. To introduce a best optimization technique that will result the minimum energy cost
c. To investigate the best optimized technique after comparing it with other ones.

2. Literature Review

In past, various techniques utilized for microgrids, these were improved using many optimization algorithms. Power generation scheduling was improved in [1] using an artificial fish swarm algorithm (AFSA), whereas, in [2], day-a-head enhanced scheduling was introduced using a harmony search (HS) and differential (DE) algorithms. Different references has been given for utilizing these concepts as well as accuracy also becomes well after using optimization algorithms particle swarm optimization (PSO), lambda rationale, and lambda iteration. In reference [4], additive-increase-multiplicative-decrease. Various drawbacks of customary centralized power plants, for example, the surprising expenses of forces, ecological issues, low proficiency, mind-boggling expenses of transmission arrange advancement, and the developing interest for the power have as of late given various challenges in the power frameworks. Microgrid is a little dissemination framework with nearby Distributed Energy Resources which is associated with the conventional centralized electrical system yet can work self-governing. A microgrid could be a kind of canny matrix outfitted with the moved PC correspondence advances also, wise meters giving greater adaptability and dependability to control also, insurance of the framework. The microgrid administrator advances the given energy by the nearby Distributed Energy Resources and the customary centralized age to supply the nearby loads. Communication among Distributed Energy Resources and the framework is the real plume of a microgrid. This communication gives stockpiling and adaptability capacities required for interest management [3]. Photovoltaic (PV) framework is a standout amongst the best Distributed Energy Resources in microgrids. Neighbourhood age and diminishing the obstruct rate of the transmission systems are the fundamental favourable circumstances of the PVs.

3. Methodology

3.1. Research Methods

We have presented techniques from the related work and find the optimized technique as well. Our research mainly depend upon the Particle Swarm Optimization in which we divide the grids into local and global solutions to find the optimized solution for the power supply and to overcome the nonlinear loads. We then compared the PSO with LEACH (Low energy adaptive clustering hierarchy) and found that PSO is the best solution for energy efficient management system.

- To investigate the cost in EMS for different time spans
- To introduce a best optimization technique that will result the minimum energy cost
- To investigate the best optimized technique after comparing it with other ones

3.2. Efficient Energy Management System (EEMS)

Proposed is the energy efficient management system to develop a robust micro grid with lesser loss of probability and efficient with energy. We have presented techniques from the related work and find the optimized technique as well. Our research mainly depend upon the Particle Swarm Optimization in which we divide the grids into local and global solutions to find the optimized solution for the power supply and to overcome the nonlinear loads. We then compared the PSO with LEACH (Low energy adaptive clustering hierarchy) and found that PSO is the best solution for energy efficient management system.

3.2.1 Case 1

All DGs can just be operated within their particular minimum and maximum breaking points. Also, there is no power that can be transferred from the utility or the main matrix. In this way, the microgrid operates in islanded mode.

3.2.2 Case 2

All DGs can work within their cutoff points and the microgrid can purchase restricted power from the utility just when DGs cannot supply the mentioned load.

3.2.3. Case 3

The microgrid has the facility of storage batteries and all DGs can work within their cutoff points. The microgrid can purchase restricted power from the utility just when DGs and battery cannot supply the mentioned load. As appeared in Figure 2, it is pertinent that if the generated power from DGs is greater than the load, the surplus energy is utilized to charge the battery bank. In the case where the battery bank is completely charged, no extra power will be generated from the DGs. Then again, if the power generated by DGs is not exactly the mentioned load, the shortage of power is given by the battery bank. On the off chance that DGs and the battery bank cannot supply the load, the deficiency of power is purchased from the main matrix

3.3. Optimization Problem

As we have discussed before that the optimization for the power loss in the microgrid is not so much costly and it can reduce the cost of EMS which a have great e-constraint that can cause a loss in power but optimization techniques such as PSO can develop to reduce these costs and constraints

3.4. Optimization Algorithms

To take care of the thought about optimization issue, an enhanced variant of the PSO is created. This transforms the EMS framework into an increasingly efficient one; i.e., EEMS. In the following two segments, the classical variant of the PSO and the enhanced form will be explained. It merits explaining here that using an enhanced form of the PSO, which is a modern metaheuristic, instead of any other classical strategy is motivated by the advantages of modern metaheuristics over classical techniques. Among these advantages is their ability to adapt to any issue with no/or couple of modifications, which allows them to be easily applied to various cases.

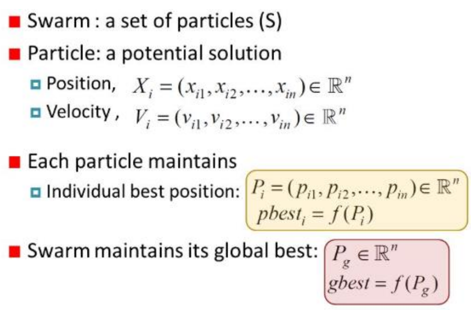

Figure 2. Particle Swarm Optimization Main Steps

3.5. Particle Swarm Optimization

a comparative report was carried out between metaheuristic algorithms inspired by competitions including the PSO. The PSO has been ranked first for unimodal issues and equally ranked first with two distinct algorithms for multimodal issues. In reference [42] the PSO was used for circular antenna arrays optimization to maximize sidelobes levels decrease. The inputs required by the PSO are:

Proposed PSO trial appraisal of energy management procedures in a genuine condition including a place of business, a PV system with capacity and a module electric vehicle. The interconnection of these components involved a novel trial small scale matrix where an energy management procedure must be actualized. The procedure must guarantee that it is good with the business equipment utilized, the example time is low enough to maintain a strategic distance from the consumption of the batteries while the power balance is accomplished regardless of whether the electric vehicle out of the blue withdraws, furthermore, it is computationally quick enough to be executed continuously even in a low power utilization single-board PC (SBC). The main thought was to plan a technique dependent on model prescient control (MPC) with the expense of the power devoured from the open network as a goal work. Be that as it may, the computational time of the goals of the streamlining issue might be longer than 60 s. In [15], a MPC is connected to a small scale lattice made out of sustainable power sources and electric energy stockpiling with an example time of 10 min, without getting expansive reductions of working expenses in correlation with a standard based control, particularly when the estimating blunders increment. The standard based control exploits its low computational expenses, enabling it to be actualized progressively with an example period not longer than 60 s, as requested by the smaller scale matrix under investigation. Hence, the proposed methodology in this research tended to a standard based control whose yields were identified with an arrangement of transfers interfacing the diverse power sources.

• The goal work (noted as ObjFunction) which can be a mathematical express work or a progressively complicated one;

• The component of the issue (noted as ProblemSize) which speaks to the quantity of structure variables of the treated issue;

• The quantity of players which is equivalent to the population size in other population-based optimization algorithms (noted as PlayersSize);

• The quantity of teams in the league noted as (TeamsSize)

• The maximum number of installations (noted as MaxNFix) which is equivalent to the maximum number of iterations in other optimization algorithms. The main yield of the PSO is the best arrangement obtained for the treated issue i.e., the MVP. Be that as it may, different yields can easily be obtained, for example, the value of the best target capacity obtained or the evaluation of this last value during the optimization procedure. After reading the inputs, the PSO starts with the initialization step

3.6. LEACH vs PSO

LEACH is an algorithm where its mainly deal with energy productivity yet is has a few drawbacks which we examine later in chapter 4 PSO mainly contains four phases: Clustering; microgrids most limited moving grouping searching based on ACO; further improvement of the planned path using anchor power based on PSO; and matrix range adaption for energy balancing and anchor power merging for decreasing the time.

PSO is an algorithm wherein we separate framework into global and local systems and discovered arrangements. During each round, the portable agent needs to traverse all the lattices in this segment, we use the PSO algorithm for most brief path choice. We utilize an undirected complete graph G=<V, E> to speak to the system and V means the arrangement of smaller scale matrices and E indicates the arrangement of edges between any two miniaturized scale lattices. The following advances are utilized to direct the ACO algorithm.

Stage 1: m ants are randomly placed in n networks and a matrix with mxn measurement is utilized to record each ant's traveling path.

Stage 2: The plausibility of next nearest matrix that ants will pick

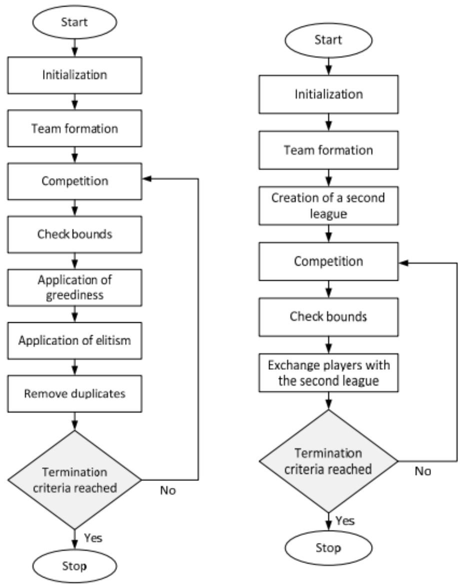

Figure 3. PSO (left) vs LEACH (right)

3.7. Performance of EEMS

The performance of the EEMS based on the proposed PSO trial appraisal of energy management procedures in a genuine condition including a place of business, a PV system with capacity and a module electric vehicle. The interconnection of these components involved a novel trial small scale matrix where an energy management procedure must be actualized. The procedure must guarantee that it is good with the business equipment utilized, the example time is low enough to maintain a strategic distance from the consumption of the batteries while the power balance is accomplished regardless of whether the electric vehicle out of the blue withdraws, furthermore, it is computationally quick enough to be executed continuously even in a low power utilization single-board PC (SBC). The main thought was to plan a technique dependent on model prescient control (MPC) with the expense of the power devoured from the open network as a goal work. Be that as it may, the computational time of the goals of the streamlining issue might be longer than 60 s. In [15], a MPC is connected to a small scale lattice made out of sustainable power sources and electric energy stockpiling with an example time of 10 min, without getting expansive reductions of working expenses in correlation with a standard based control, particularly when the estimating blunders increment. The standard based control exploits its low computational expenses, enabling it to be actualized progressively with an example period not longer than 60 s, as requested by the smaller scale matrix under investigation. Hence, the proposed methodology in this research tended to a standard based control whose yields were identified with an arrangement of transfers interfacing the diverse power sources. The interconnection of these components involved a novel trial small scale matrix where an energy management procedure must be actualized. The procedure must guarantee that: it is good with the business equipment utilized, the example time is low enough to maintain a strategic distance from the consumption of the batteries while the power balance is accomplished regardless of whether the electric vehicle out of the blue withdraws, furthermore, it is computationally quick enough to be executed continuously even in a low power utilization single-board PC (SBC). The main thought was to plan a technique dependent on model prescient control (MPC) with the expense of the power devoured from the open network as a goal work.

4. Results

4.1 Simulations

The point of this work was the trial appraisal of energy management procedures in a genuine condition including a place of business, a PV system with capacity and a module electric vehicle. The interconnection of these components involved a novel trial small scale matrix where an energy management procedure must be actualized. The procedure must guarantee that: it is good with the business equipment utilized, the example time is low enough to maintain a strategic distance from the consumption of the batteries while the power balance is accomplished regardless of whether the electric vehicle out of the blue withdraws, furthermore, period not longer than 60 s, as requested by the smaller scale matrix under investigation it is computationally quick enough to be executed continuously even in a low power utilization single-board PC (SBC). The main thought was to plan a technique dependent on model prescient control (MPC) with the expense of the power devoured from the open network as a goal work. Be that as it may, the computational time of the goals of the streamlining issue might be longer than 60 s. In [15], a MPC is connected to a small scale lattice made out of sustainable power sources and electric energy stockpiling with an example time of 10 min, without getting expansive reductions of working expenses in correlation with a standard based control, particularly when the estimating blunders increment. The standard based control exploits its low computational expenses, enabling it to be actualized progressively with an example. Hence, the proposed methodology in this research tended to a standard based control whose yields were identified with an arrangement of transfers interfacing the diverse power sources.

Proposed is the energy efficient management system to develop a robust micro grid with lesser loss of probability and efficient with energy. We have presented techniques from the related work and find the optimized technique as well. Our research mainly depend upon the Particle Swarm Optimization in which we divide the grids into local and global solutions to find the optimized solution for the power supply and to overcome the nonlinear lo

ads. We then compared the PSO with LEACH (Low energy adaptive clustering hierarchy) and found that PSO is the best solution for energy efficient management system. An EEMS based on an enhanced adaptation of the most valuable player algorithm is proposed and created to upgrade the operation of a microgrid by minimizing the operating cost. The EEMS aims to plan various wellsprings of energy based on a picked case. In the principal case, the power generated from DGs is always greater than the referenced load. In the resulting case, the EEMS can purchase energy from the lattice exactly when the DGs cannot supply the referenced load. Sustainability 2019, 11, 3839 25 of 28 in the last case, a battery storage is added to the microgrid, which is the second wellspring of intensity after DGs, while the main framework is the last decision. Clearly more cases can be added to the EEMS later on. In comparison to other optimization algorithms, the proposed EEMS using the PSO achieves better results and can determine the optimal scheduling of various DGs, battery storage, and the power required from the framework based on the picked case. Also, four cases for two various microgrids were investigated. For Case 1, the daily cost decrease varies from 3.781% for the LEACH (the second-best strategy after the PSO) to 24.925%. Similarly, for Case 2, it varies from 0% for the PSO to 5.126% for the EM. For Case 3, it varies from 0% for the PSO to 4.872% to LEACH. Finally, for Case 4, the daily cost decrease varies from 1.455% for the PSO to 10.039% for the LEACH. Additionally, it is found that the EEMS using the proposed PSO offers the most financially savvy response for each hour ensuring its efficacy and robustness. Proposed is the energy efficient management system to develop a robust micro grid with lesser loss of probability and efficient with energy. We have presented techniques from the related work and find the optimized technique as well. Our research mainly depend upon the Particle Swarm Optimization in which we divide the grids into local and global solutions to find the optimized solution for the power supply and to overcome the nonlinear loads. We then compared the PSO with LEACH (Low energy adaptive clustering hierarchy) and found that PSO is the best solution for energy efficient management system.

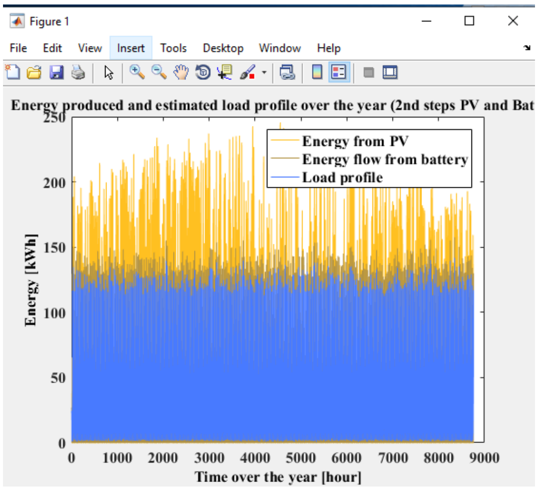

Figure 4. Energy Produced and estimated load profile over the year (Comparison of Time with Energy)

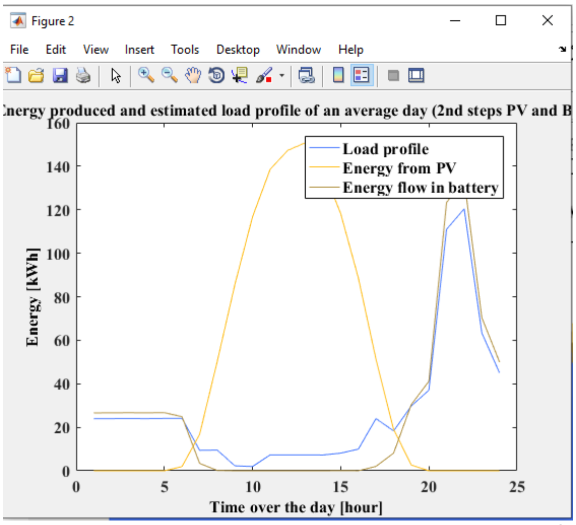

Figure 5. Energy Produced and estimated load profile over day (Comparison of Time with Energy)

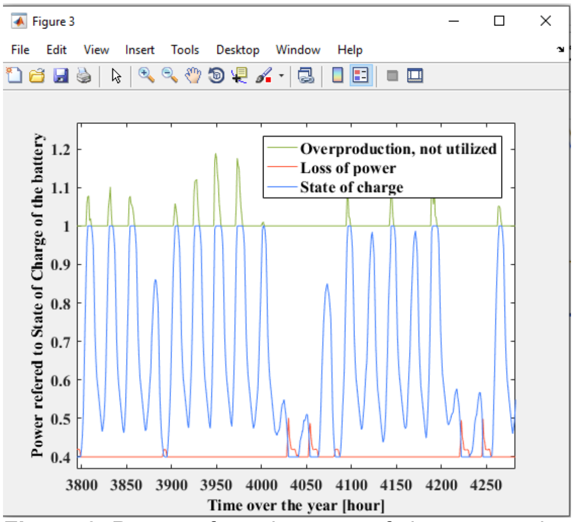

Figure 6. Power referend to state of charge over the year for overproduction, loss and state of charge

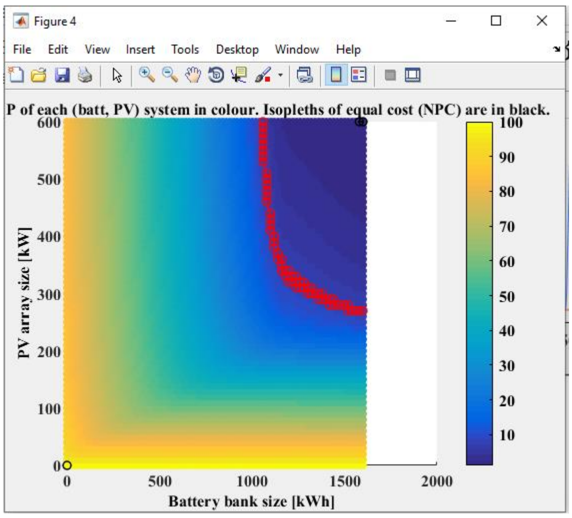

Figure 7. Battery size vs PV Array size causing Isodepth of equal cost NPC in black

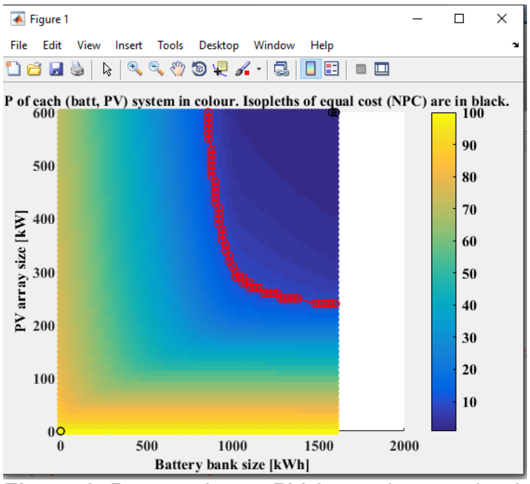

Figure 8. Battery size vs PV Array size causing Isodepth of equal cost NPC in black up to 5000

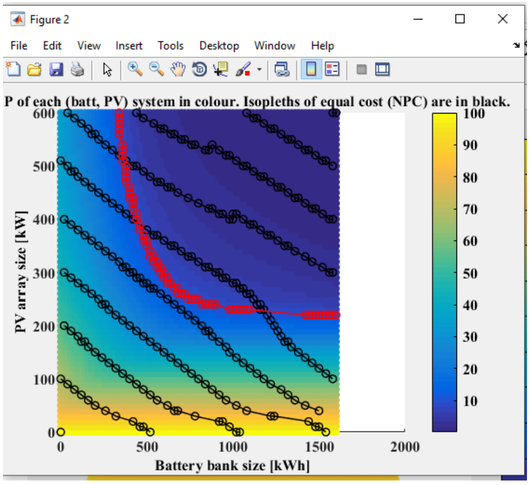

Figure 9. Battery size vs PV Array size causing Isodepth of equal cost NPC in black up to 2000

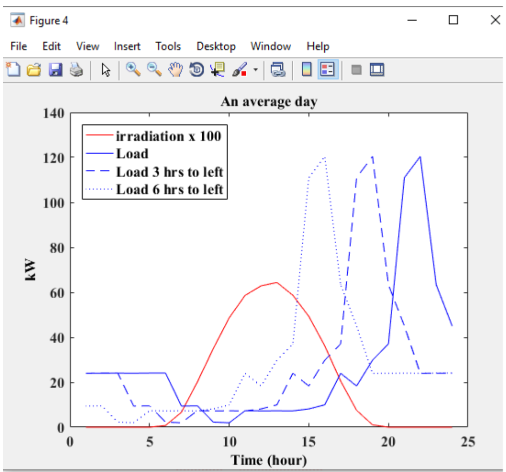

Figure 10. Irradiation and Load at average day

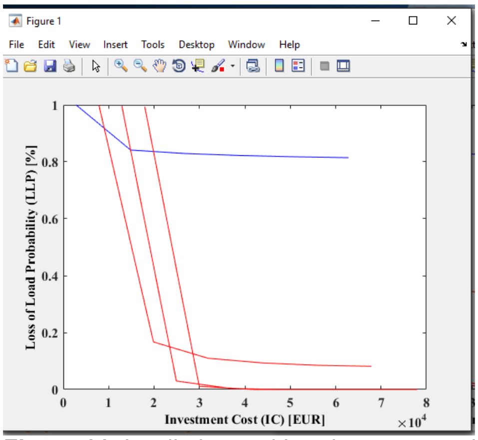

Figure 11. Irradiation and Load at average day and its cost in Euro

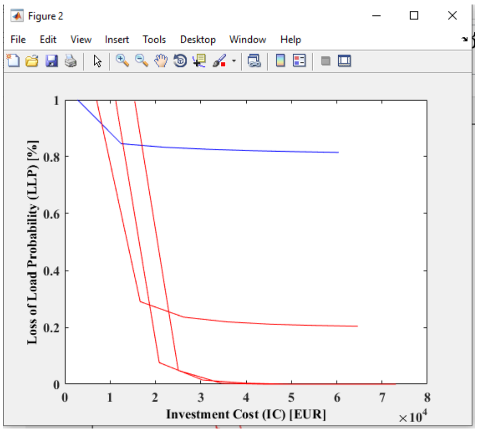

Figure 12. Irradiation and Load at average day with Loss Probability

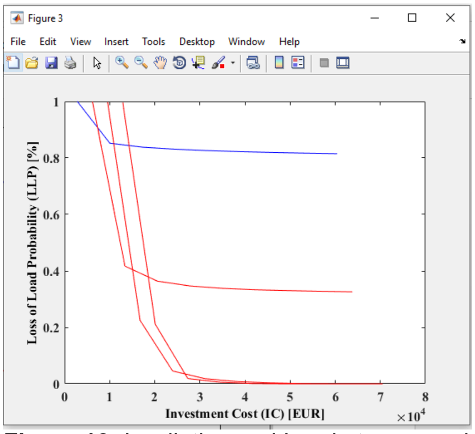

Figure 13. Irradiation and Load at average hours

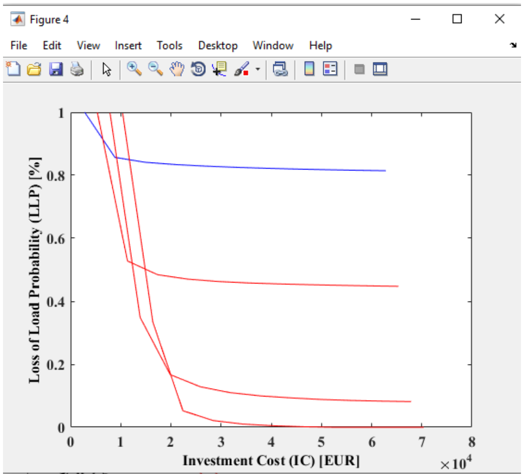

Figure 14. Irradiation and Load at average 6 hours

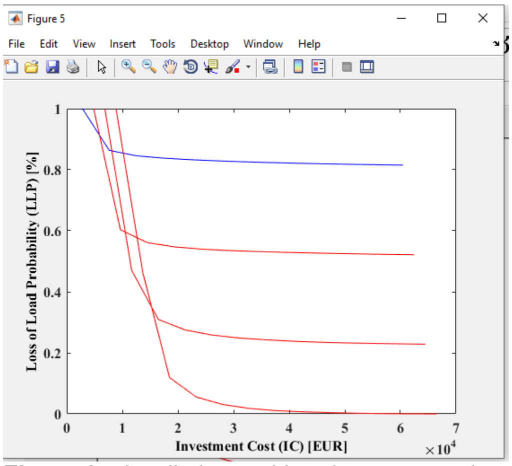

Figure 15. Irradiation and Load at average three hours

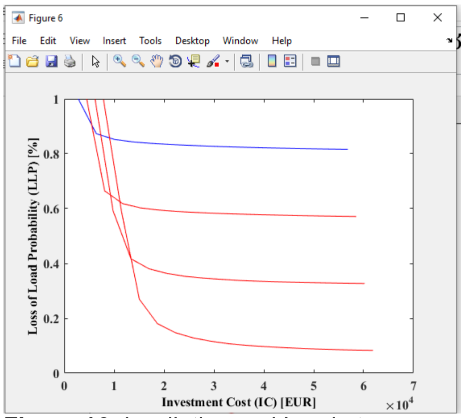

Figure 16. Irradiation and Load at average two hours

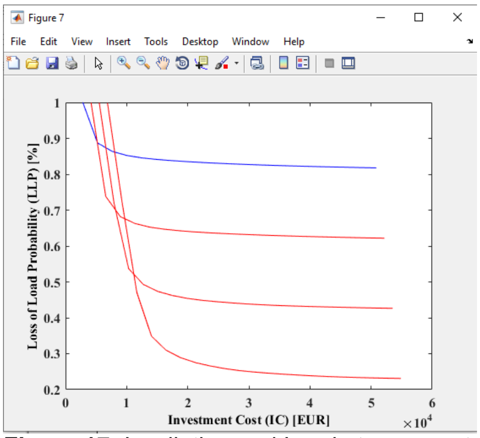

Figure 17. Irradiation and Load at average two years

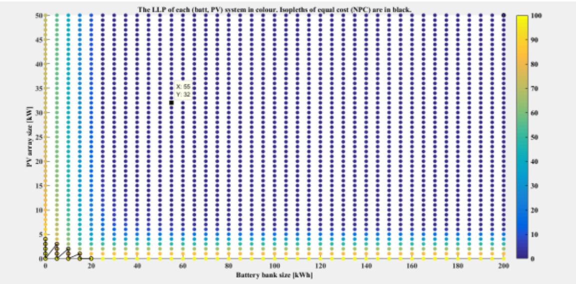

Figure 18. LLP of each battery size with PV size

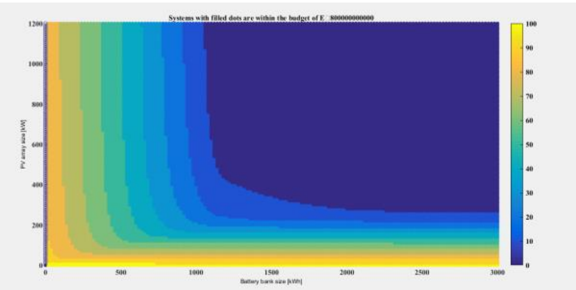

Figure 19. Budget for each LLP of the system

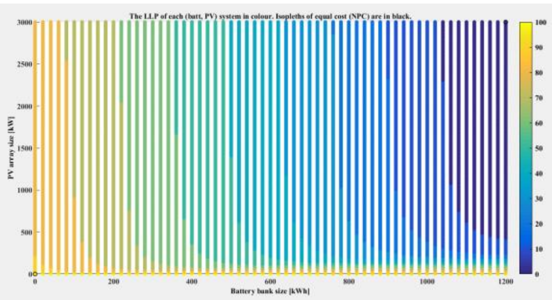

Figure 20. LLP of the system

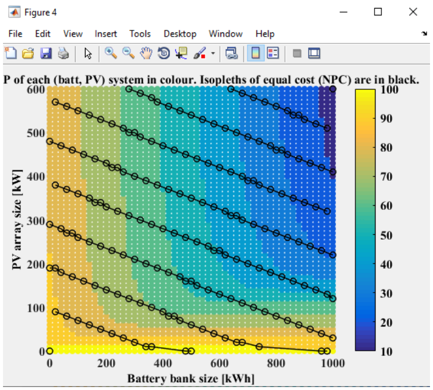

Figure 21. Isodepth of Equal Costs at 1000 to 600

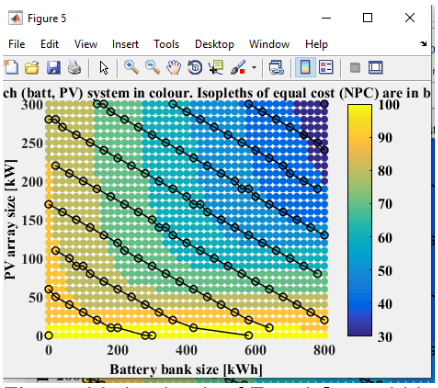

Figure 22. Isodepth of Equal Costs 300 to 800

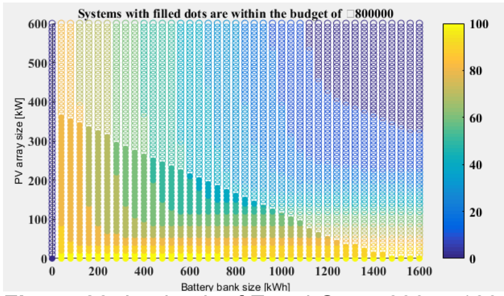

Figure 23. Isodepth of Equal Costs 600 to 1600

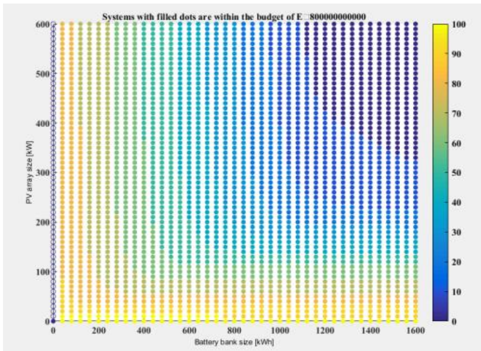

Figure 24. 700 to 1600

5. Conclusion

The point of this work was the trial appraisal of energy management procedures in a genuine condition including a place of business, a PV system with capacity and a module electric vehicle. The interconnection of these components involved a novel trial small scale matrix where an energy management procedure must be actualized. The procedure must guarantee that it is good with the business equipment utilized, the example time is low enough to maintain a strategic distance from the consumption of the batteries while the power balance is accomplished regardless of whether the electric vehicle out of the blue withdraws, furthermore, it is computationally quick enough to be executed continuously even in a low power utilization single-board PC (SBC). The main thought was to plan a technique dependent on model prescient control (MPC) with the expense of the power devoured from the open network as a goal work. Be that as it may, the computational time of the goals of the streamlining issue might be longer than 60 s. In [15], a MPC is connected to a small scale lattice made out of sustainable power sources and electric energy stockpiling with an example time of 10 min, without getting expansive reductions of working expenses in correlation with a standard based control, particularly when the estimating blunders increment. The standard based control exploits its low computational expenses, enabling it to be actualized progressively with an example period not longer than 60 s, as requested by the smaller scale matrix under investigation. Hence, the proposed methodology in this research tended to a standard based control whose yields were identified with an arrangement of transfers interfacing the diverse power sources.

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