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RESEARCH – CREATE - INNOVATE (project code: T1EDK-00399)

pcim ASIA Hybrid Platform

Estimation of the Battery Capacity in the Microgrid of a Nearly Zero Energy Building According to the Desired Degree of Energy Autonomy

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Presentation Summary

- Introduction to BSS sizing and planning, and nZEB concept.
- Aim of this paper.
- Optimization variables.
- Proposed estimation methodology and algorithm.
- Simulation results.
- Conclusions.

Introduction to nZEB and Sizing

- Nearly Zero Energy Building (***nZEB***)
  - High energy performance
  - Higher priority to energy savings and efficiency improvement
  - End-Use energy consumption reduction
- RES and BSS sizing
  - RES development and availability
  - Diversity of offered technologies (WT, PV, ESS)
  - Battery Management Systems (BMS)
  - Urgent need for coordination and cost reduction

Aim of this paper

…is to propose an integrated method based on the genetic-algorithm technique to estimate the proper capacity size of a BSS that should be installed in a nZEB, in order to reach the desired degree of energy autonomy.

Specifically:

- Grid-connected nZEBs
- Balance Cost-Efficiency
- Genetic algorithm technique
- Adaptive cost function
- Various operating scenarios

Control Variables (1)

- The ***energy autonomy degree (EAD)***

$$\mathrm{EAD} = \frac{E_{RES}}{E_{cons}}$$

- The ***BSS utilization degree*** (BUD)

$$\mathrm{BUD} = \frac{E_{RES}}{C_{eBSS}^{nom}}$$

- The satisfaction degree of the ***energy peak demands (EPD)***

$$\mathrm{EPD} = \frac{E_{pp\_cons}}{C_{eBSS}^{nom}}$$

- The satisfaction degree of the ***power peak demands (PPD)***

$$\mathrm{PPD} = \frac{E_{pe\_cons}}{C_{pBSS}^{nom}}$$

Control Variables (2)

$$EAD = \frac{E_{RES}}{E_{cons}}$$

$$BUD = \frac{E_{RES}}{C_{eBSS}^{nom}}$$

... are used as ***target values*** for the energy autonomy and BSS utilization

$$EPD = \frac{E_{pp\_cons}}{C_{eBSS}^{nom}}$$

$$PPD = \frac{E_{pe\_cons}}{C_{pBSS}^{nom}}$$

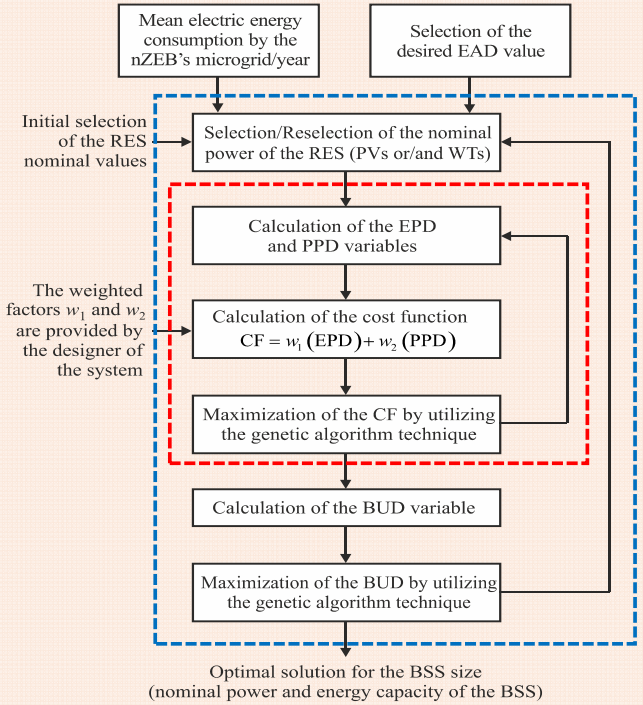
... are utilized as ***scoring variables*** for the achievement of the above target values for the EAD and BUD

are considered in the optimization algorithm to define the cost function

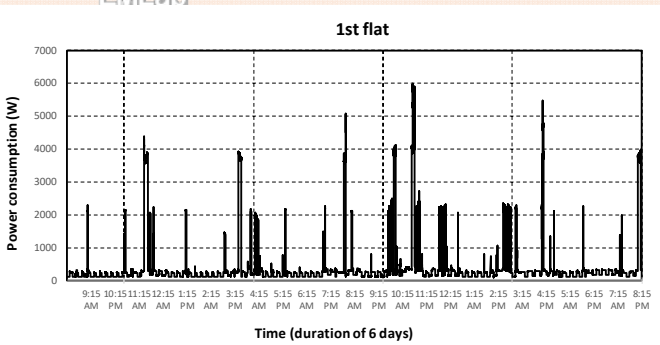
$$CF = w_1(EPD) + w_2(PPD)$$

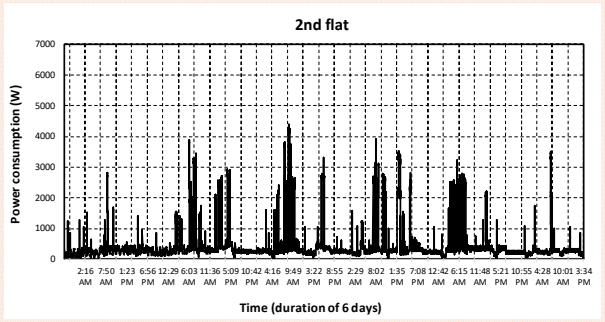
...maximized by the utilizing the genetic algorithm technique in order to determine the optimal sizing of the BSS,

Algorithm of the BSS estimation method

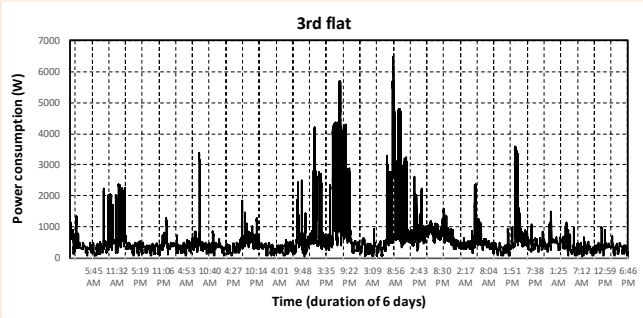


Simulation Results (1)





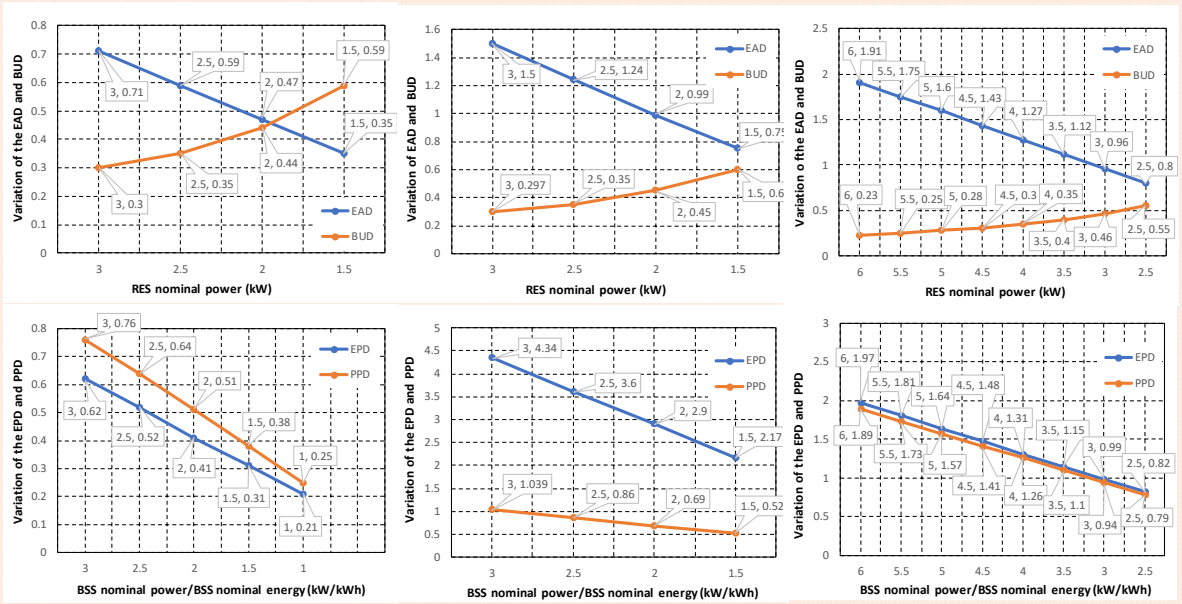
1st flat of 60m^2 at the 1st floor of the building



2nd flat of 80m^2 at the 2nd floor of the building

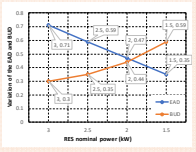
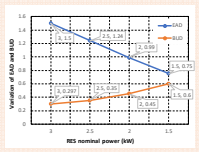
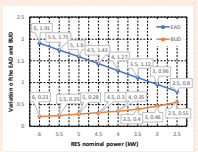
3rd flat of 140m^2 at the 3rd floor of the building.

Simulation Results (2)

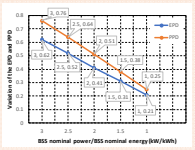
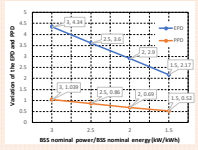
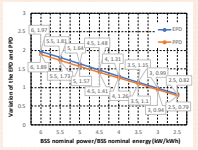


1st flat 2nd flat 3rd flat

Simulation Results (2)

1st flat

2nd flat

3rd flat

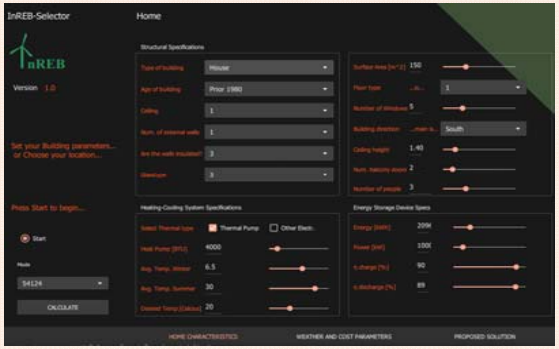
From the above analysis, it is concluded that for a given value of the EAD and at any specific selection of the nominal power and energy of the RES, there is a certain value for the size of the BSS that can optimize the BUD, EPD and PPD variables

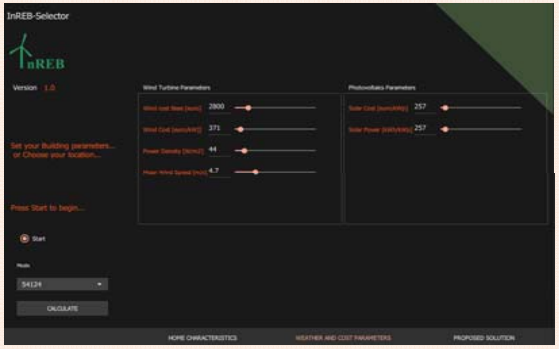
Simulation Results (3)

TABLE I
OPTIMAL SIZING OF THE BSS

Variable	1st flat	2nd flat	3rd flat
BSS nominal power	2.9 kW	2.5 kW	5.3kW
BSS nominal energy capacity	3.1 kWh	2.8 kWh	5 kWh

Graphical Interface of the calculation program





Conclusions

- ***An integrated BSS estimation method*** for a nZEB's microgrid, based on the genetic-algorithm technique, has been proposed.
- It is based on a ***correct balance between the installation cost and the potential efficiency improvement*** of the nZEB.
- ***Selective simulation results*** from a real nZEB microgrid have been presented to validate the effectiveness of the suggested method.

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Thank you for your attention

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