X SICEL 2021

Transición energética en la 4ta revolución industrial

Universidad Tecnológica de Pereira

UNIVERSIDAD NACIONAL DE COLOMBIA

XSICEL 2021
Transición energética en la 4ta revolución industrial

Analysis of the Impact of Dispatch Strategies in the Sizing and Operation of Microgrids using HOMER Pro Software

Jersson Ferney García García
Yennifer Bibiana Sarmiento Ariza
Lizeth Tatiana Campos Rodríguez
German Alfonso Osma Pinto

Escuela de Ingeniería Eléctrica, Electrónica y Telecomunicaciones
Universidad Industrial de Santander, Bucaramanga, Colombia

Contents

I. Introduction

II. Problem

III. Methodology

IV. Results analysis

V. Conclusions

I. Introduction

Energy transition

Increased use of renewable energy sources

Reduce dependence on polluting sources and environmental impact

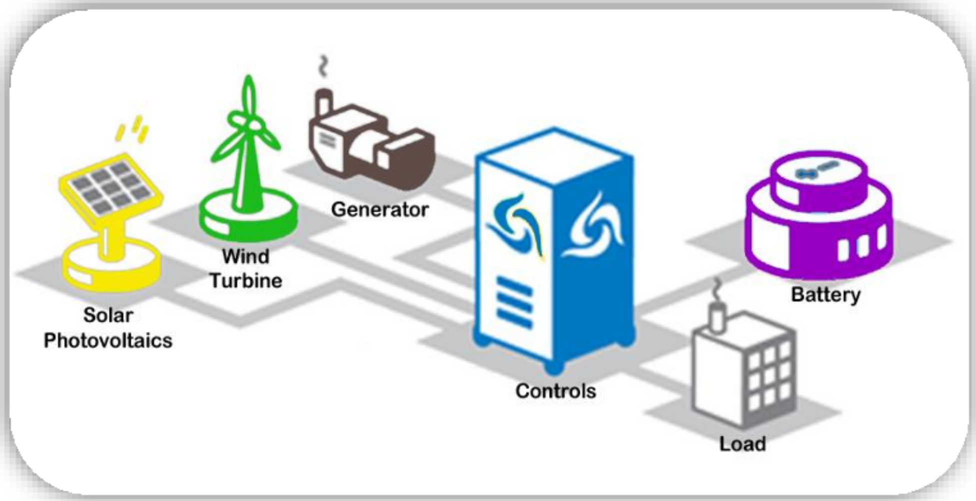
New solution alternatives in the current energy system such as **microgrids**

https://bit.ly/3jzOefS

I. Introduction

Microgrid

A MG is a group of interconnected loads and distributed energy resources that act as a single controllable entity.

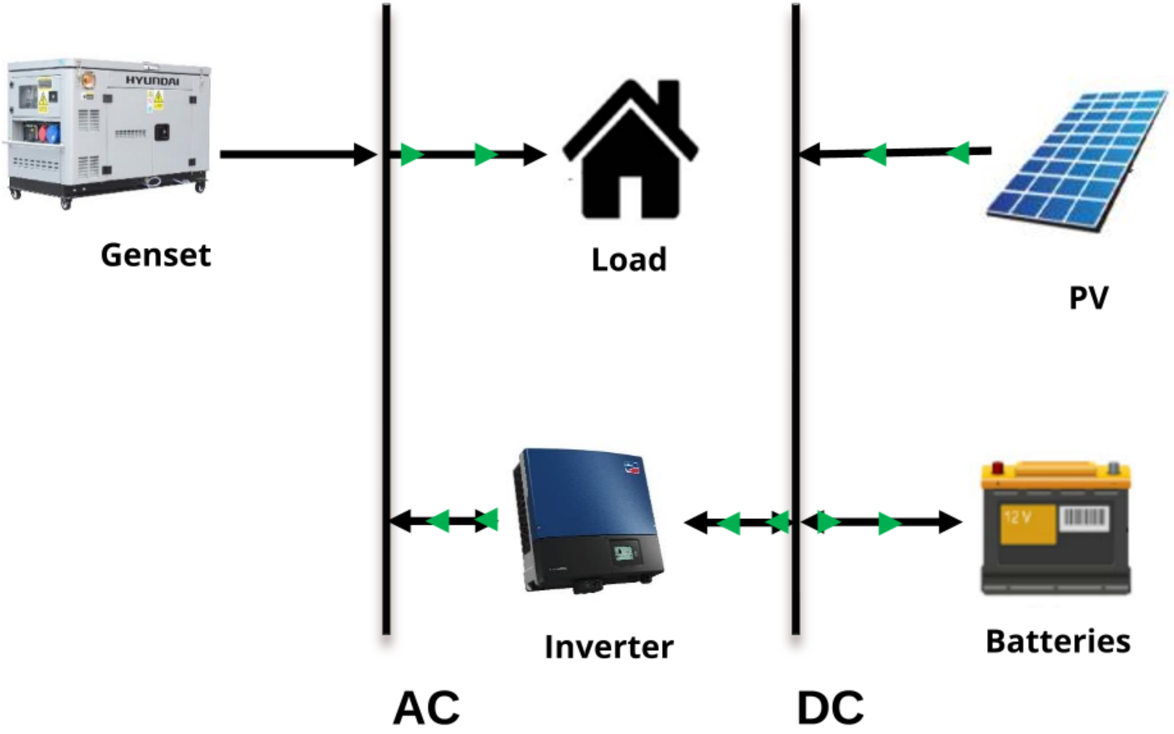


https://bit.ly/3BE8qU5

I. Introduction

Energy dispatch

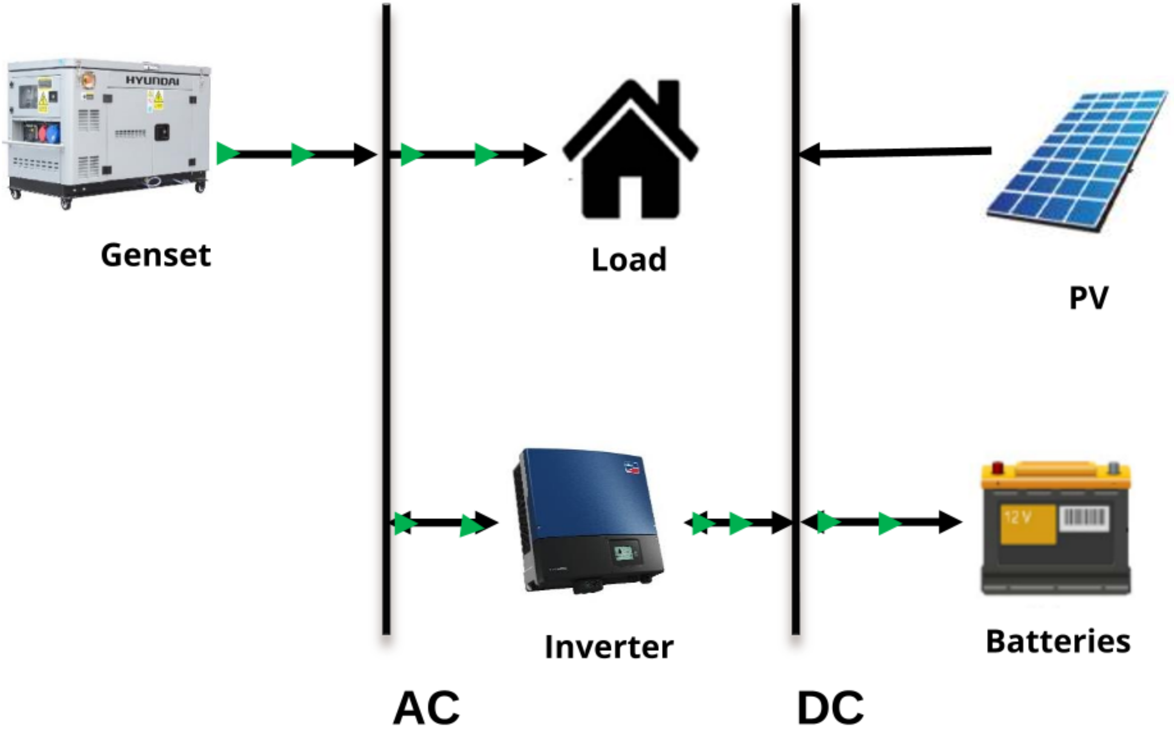
Manages the different components of a system to satisfy the load reliably and efficiently



I. Introduction

Energy dispatch

Manages the different components of a system to satisfy the load reliably and efficiently



I. Introduction

HOMER Pro

This software runs an evaluation of a set of possible sizing solutions for a MG through its optimizing algorithm and sensibility analysis

- Cycle Charging **CC** → Charge the batteries with genset
- Load Following **LF** → Charge the batteries with renewable sources
- Combined Dispatch **CD** → Take into account CC and LF
- Generator Order **GO** → Use several gensets
- Predictive Dispatch **PS** → Manages from forecast
- Matlab Link **ML** → Create your own dispatch algorithm

I. Introduction

Considerations	Cycle Charging	Load Following	Generator Order	Combined Dispatch	Predictive
Components					
Generator	✓	✓	✓	✓	✓
Photovoltaic panels	✓	✓	✓	✓	✓
Wind turbines	✓	✓	✓	✓	✓
Converter	✓	✓	✓	✓	✓
Batteries	✓	✓	✓	✓	✓
Boiler	✓	✓	X	✓	✓
Electrolyzer-Hydrogen Tank	✓	✓	X	✓	✓
Hydro	✓	✓	X	✓	✓
Hydrokinetic	✓	✓	X	✓	✓
Number of generators					
Single generator	✓	✓	X	✓	✓
Multiple generators	✓	✓	✓	X	X
Type of system					
Sistema On-grid	✓	✓	X	X	X
Sistema Off-grid	✓	✓	✓	✓	✓

Characteristics of dispatch strategies

II. Problem

The influence of

- Control strategy
- The on-site energy potential

on the sizing of isolated MGs

Article	Topic
• Techno-economic analysis of off-grid solar/wind/biogas/biomass/fuel cell/battery system for electrification in a cluster of villages by HOMER software[12]	• Analyzes the most adequate architecture of a hybrid energy system to satisfy the load
• Modelling and optimisation studies for generator dispatch strategies for deployment of an off-grid micro-grid in South Africa [16]	• Studies which of the dispatch strategies is optimal for the hybrid energy system.
• Feasibility design and techno-economic analysis of hybrid renewable energy system for rural electrification [17]	• Seeks a hybrid architecture, technically and economically viable considering different operational strategies
• Optimization of load dispatch strategies for an islanded microgrid connected with renewable energy sources [5]	• Evaluate the design and optimization of a MG for several dispatch strategies

III. Methodology

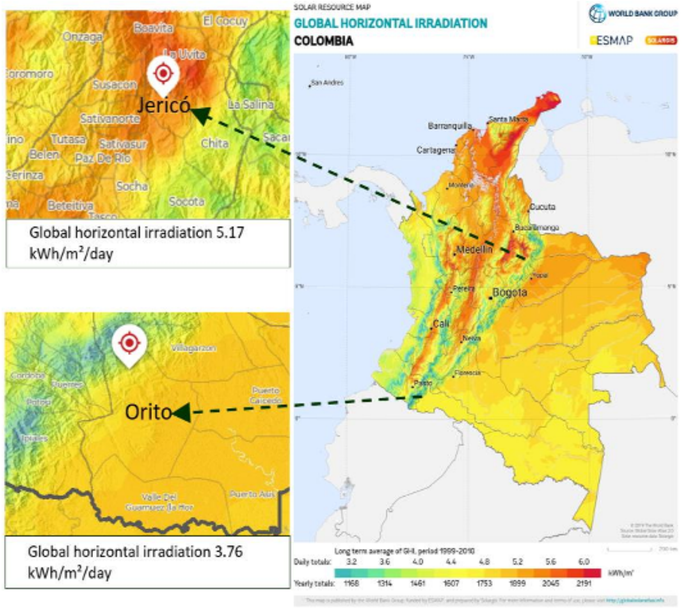
Considering five dispatch strategies for two rural areas

Jericó, Boyacá

Orito, Putumayo

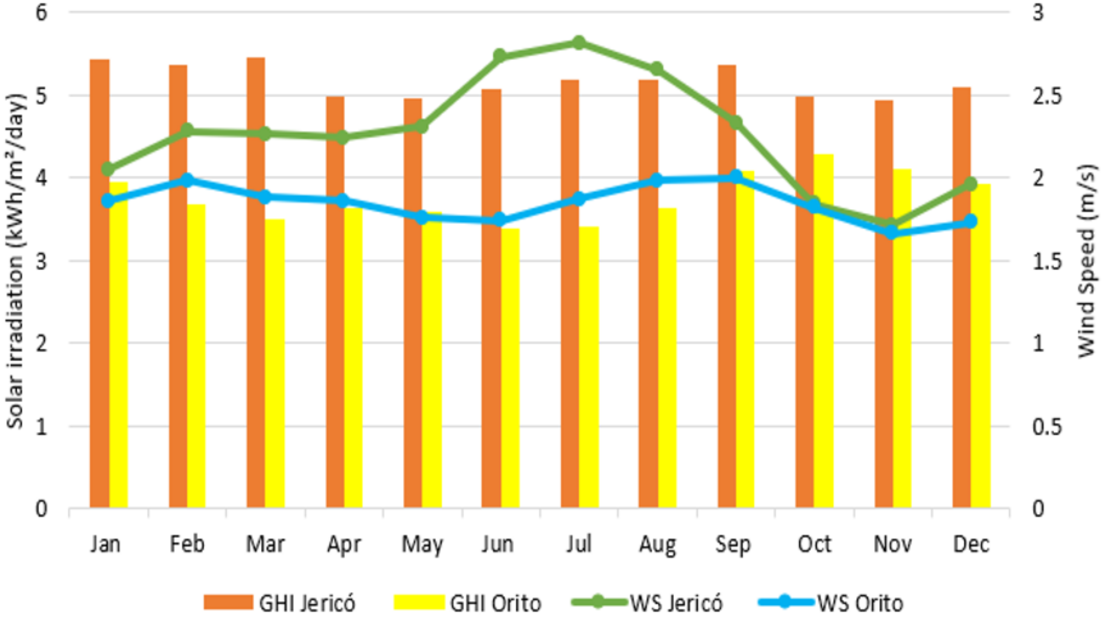
where access to electricity supply is limited

Location



III. Methodology

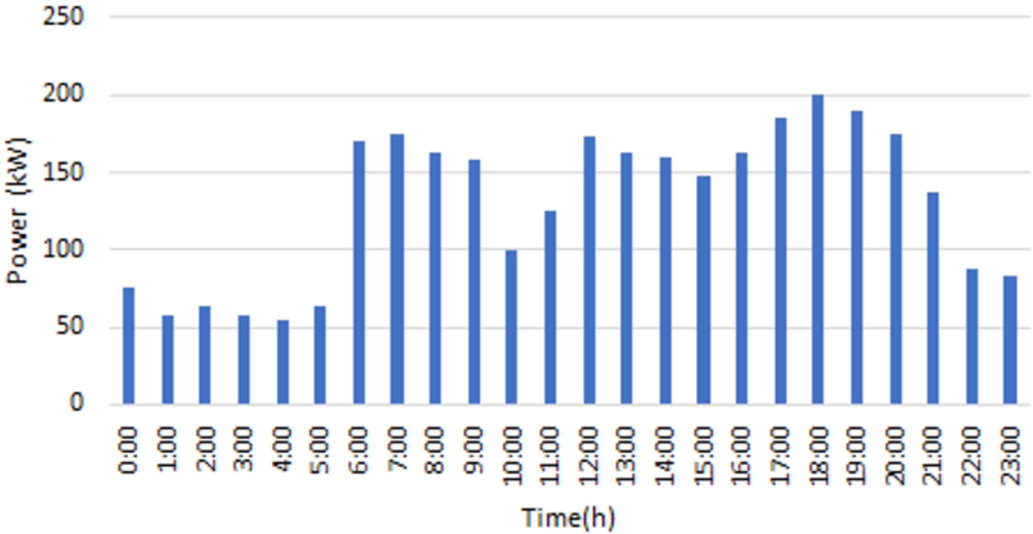
Irradiation and wind speed



Jericó has more irradiation and wind speed than Orito

III. Methodology

Load



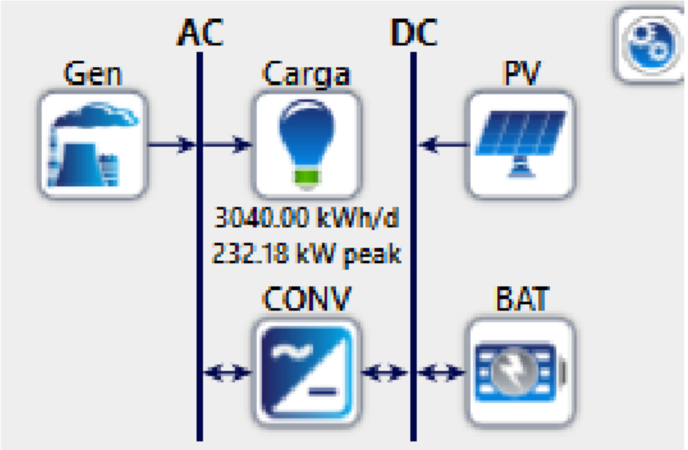
Daily demand community profile

The average energy consumption is 3.04 MWh/day

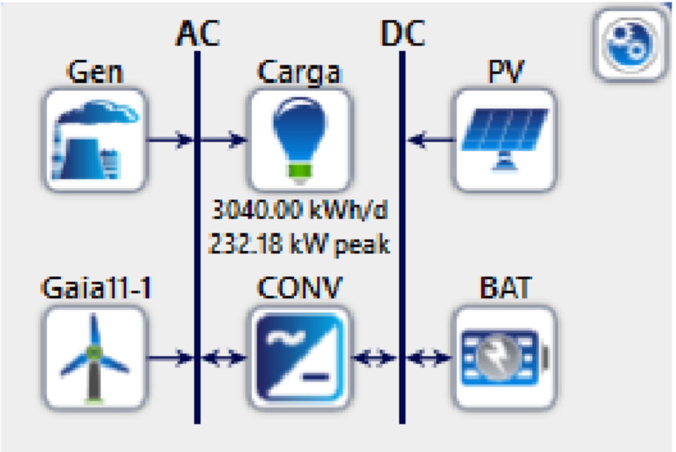
III. Methodology

Scenarios

Scenario I



Scenario II

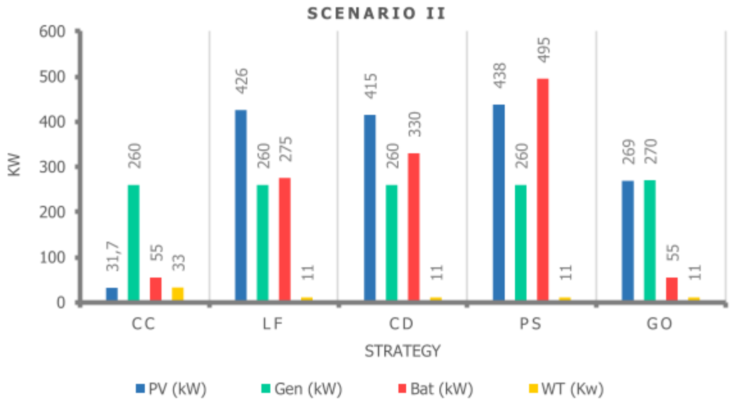


Each scenario analyses the two populations

IV. Results analysis

Population 1- Jericó

- Capacity of the components for the different strategies in the scenarios

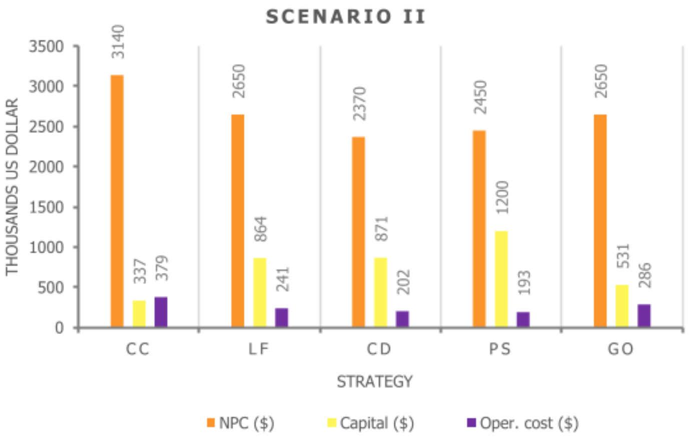


- The capacity of the components is different as the dispatch strategy varies

IV. Results analysis

Population 1- Jericó

- NPC, capital cost and operating cost for the different strategies in the scenarios

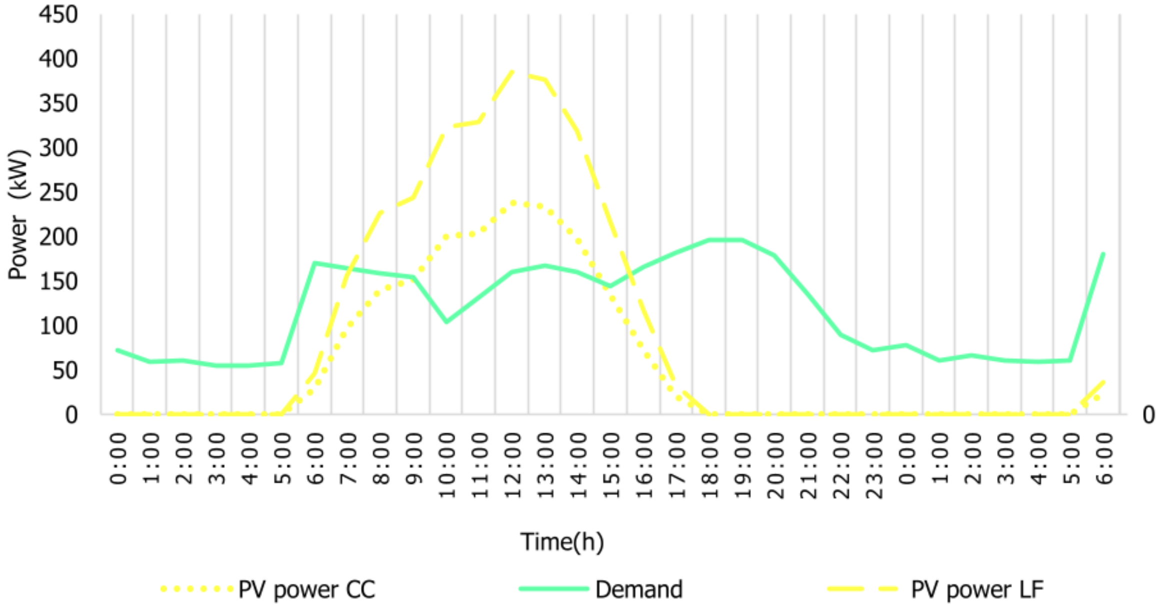


- The NPC of the architectures in Scenario II is higher for all strategies concerning the Scenario I.

IV. Results analysis

Comparison between dispatch strategies

- **CC and LF strategy curves**

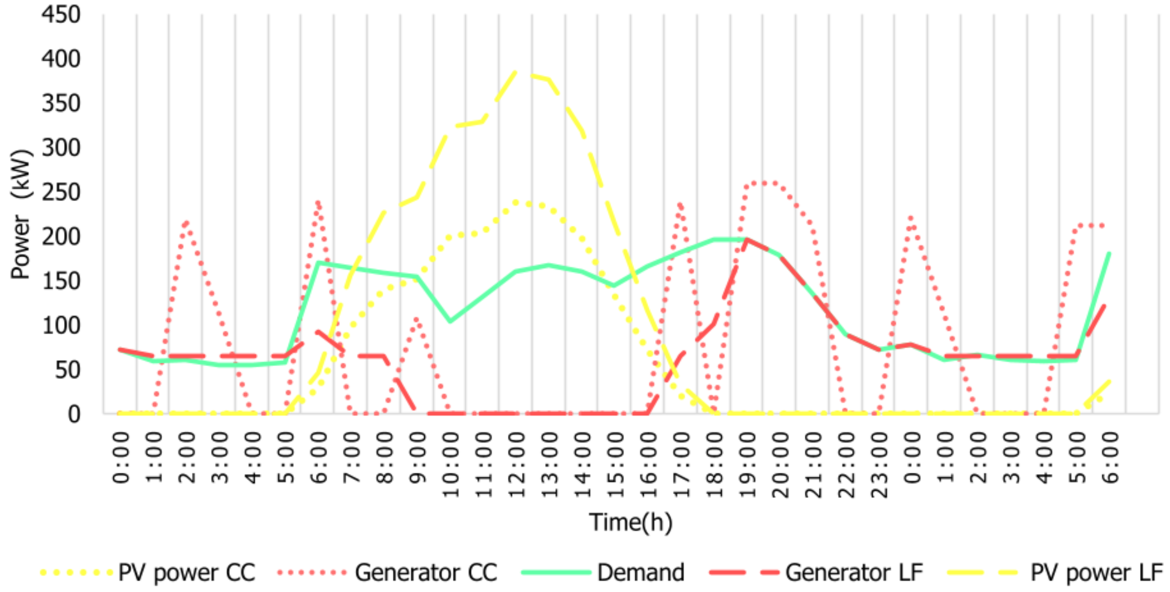


- The PV power delivered in the LF strategy is greater than that delivered in the CC strategy

IV. Results analysis

Comparison between dispatch strategies

- **CC and LF strategy curves**



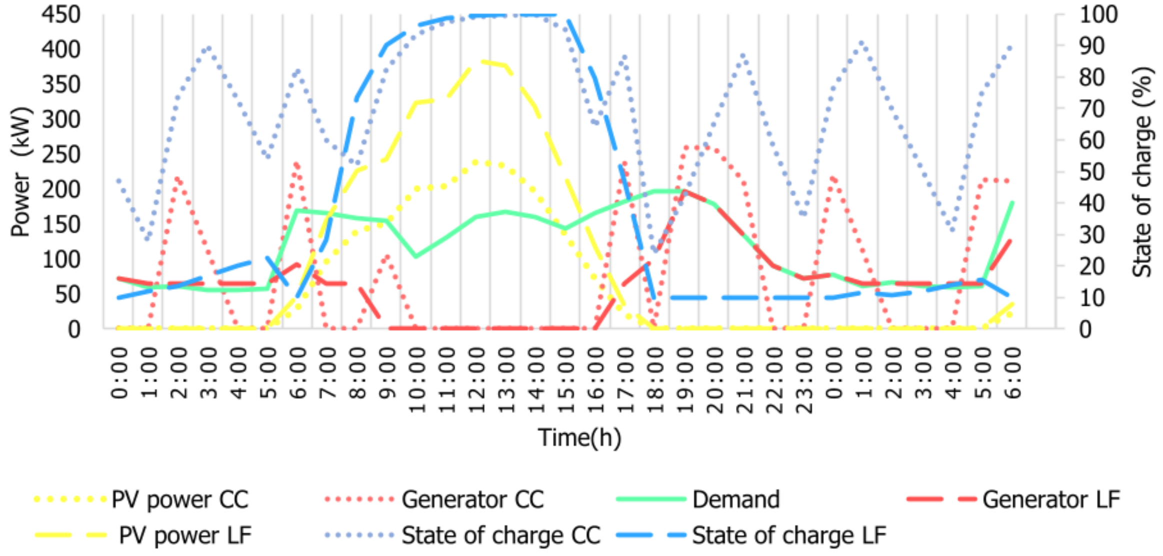
CC: genset produces energy at maximum power

LF: genset only supplies the energy necessary to meet the load.

IV. Results analysis

Comparison between dispatch strategies

- **CC and LF strategy curves**



CC: charges the batteries with both the renewable sources and the genset

LF: Charge the batteries with renewable sources

IV. Results analysis

Comparison between dispatch strategies

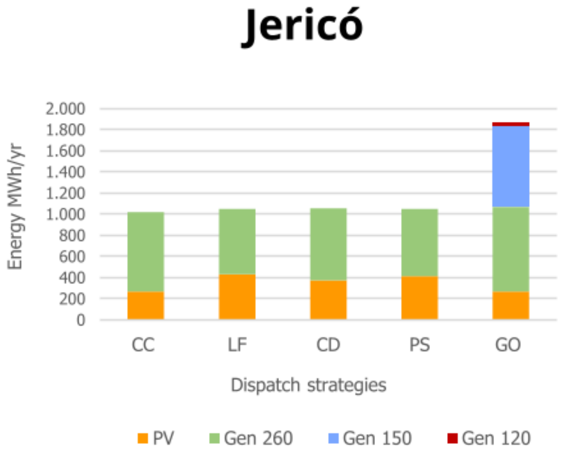
Cycle charging	Order generator
Genset works when the batteries are discharged	Use several gensets and prioritize their use

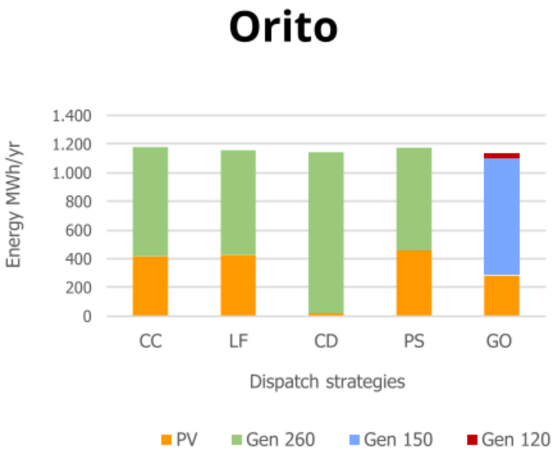
Load following	Predictive dispatch
Only excess energy from renewable sources charges the batteries	Renewable sources and the genset charge the batteries

IV. Results analysis
Population 2- Orito

- The capacity of the components varies according to the energy potential

Strategy	PV (kW) Jericó	PV (kW) Orito
	Sce I	
CC	268	418
LF	433	429
CD	376	20.9
PS	414	459
GO	269	282





- Homer Pro defines the capacity and use of the components according to the lowest cost

IV. Results analysis

Population 2- Orito

Component capacities and costs

Strategy	PV (kW)	Gen (kW)	Bat (unit)	Conv(kW)	NPC ($)	COE ($)	Oper. cost ($)	Capital ($)
CC	418	260	6	213	2.58 M	0.314	235,092	838,071
LF	429	260	4	201	2.84 M	0.345	278,718	773,231
CD	20.9	260	1	0.614	3.02 M	0.367	386,096	160,237
PS	459	260	9	213	2.64 M	0.322	224,198	984,291
GO	282	150/120	1	124	2.75 M	0.335	305,902	486,548

IV. Results analysis

Population 2- Orito

Component capacities and costs

Strategy	PV (kW)	Gen (kW)	Bat (unit)	Conv(kW)	NPC ($)	COE ($)	Oper. cost ($)	Capital ($)
CC	418	260	6	213	2.58 M	0.314	235,092	838,071
LF	429	260	4	201	2.84 M	0.345	278,718	773,231
CD	20.9	260	1	0.614	3.02 M	0.367	386,096	160,237
PS	459	260	9	213	2.64 M	0.322	224,198	984,291
GO	282	150/120	1	124	2.75 M	0.335	305,902	486,548

The CC strategy has the least NPC

V. Conclusions

- The capacity and quantity of components vary when changing the dispatch strategy despite having the same load profile and energy potential. Furthermore, for the same dispatch strategy, the capacity of the components can change according to places that have a different energy power as far as this is economically feasible.

- The control strategy performs energy dispatch not only based on its operating principle, but also according to the energy potential, component capacity, net load, and energy production costs of each generation source.

- This research may continue with the analysis of storage system management by varying the battery model. Also, include the Matlab Link management strategy for operating instructions that are not covered in this document.

VI. References

[1] I. Duque, D. Lotero, M. Lotero and S. Sandoval, Transición energética: Transición energética:2021. [Online]. Available: https://www.minenergia. gov.co/libro-transicion-energetica.

[2] S. Abu-Elzait and R. Parkin, "The Effect of Dispatch Strategy on Maintaining the Economic Viability of PV-based Microgrids," Conf. Rec. IEEE Photovolt. Spec. Conf., pp. 1203–1205, 2019, doi: 10.1109/PVSC40753.2019.8980548.

[3] P. Arévalo, D. Benavides, J. Lata-García, and F. Jurado, "Energy control and size optimization of a hybrid system (photovoltaic-hidrokinetic) using various storage technologies," Sustain. Cities Soc., vol. 52, 2020, doi: 10.1016/j.scs.2019.101773.

[4] S. Jin, H. Kim, T. H. Kim, H. Shin, K. Kwag, and W. Kim, "A Study on Designing Off-grid System Using HOMER Pro - A Case Study," in IEEE International Conference on Industrial Engineering and Engineering Dispatch, 2019, pp. 1851–1855, doi: 10.1109/IEEM.2018.8607423.

XSICEL 2021

Transición energética en la 4ta revolución industrial

Thanks!