Resilient Hybrid Energy Architecture with Low CO_2 Emission: Study of Agadir and Al Hoceima Cities in Morocco

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Abstract- The great interest today in switching to clean energy due to the many complex challenges that our planet is facing, particularly climate change and the rise of energy fossil cost, leads us to establish more resilient, smarter, and ecological new electrical architectures. Indeed, the city of the future will integrate several micro-grid systems that contain renewable energies as a primary resource. In our study, we have suggested a resilient hybrid architecture system that includes renewable energy resources. For this purpose, we have considered two different cities known by their seismic activity in Morocco, which are: Agadir in the southern region and Al Hoceima in the north of the country. In order to evaluate the reliability of the produced energy in these cities and to compare the CO_2 emission avoided, we have made a simulation in Homer grid by integrating outage duration sensitivity. It has concluded that the most cost-effective solution comprised a 1 kWh Li-Ion battery, a 2.8 kW fuel generator, and 1.7 kW of solar power. This article explores ways in which organizations related to the energy sector can minimize the negative effects of significant catastrophes and increase resilience of their energy infrastructure.

Keywords Hybrid architecture, homer grid, renewable energy resources, CO_2 emission, resilience.

1. Introduction

The twenty-first century is the digital age. To fulfil today's demand for more resilient, efficient, and dependable power systems, digitization of design and operation is unavoidable. Cities must reach net-zero emissions to reduce global temperature increases to 1.5°C or below [1]. The use of a hybrid renewable energy system in a smart grid system enables us to respond to today's difficulties, such as: global warming, oversaturation and fragility of existing electrical networks, and peak consumption management. As a result, it is vital to manage with this issue while preserving service quality. In Morocco, the share of renewable energy is expected to reach 52% of the electricity generated by 2030[2]. Numerous initiatives are made, and numerous solar and wind projects are developed. The Moroccan agency named National Electricity Regulatory Authority "ANRE" created in 2018 has a main focus on the regulation of electricity and the contribution to the effective regulation of the electrical sector [3]. Distribution network management is challenged by the quickly expanding decentralized energy production (solar, wind).

In fact, since the current electrical system was built to provide electricity to users in a single direction, it now needs to take into consideration the flow of energy from users who become producers. The balancing network is further complicated by the intermittent nature and degree of unpredictability of these energy sources. In summary, distributed generation has advanced thanks to new energy-generating and renewable energy technologies. This renewable energy integrated to the energy architecture will have a significant impact on grid stability. It is therefore essential that some solutions enhance the economics and dependability of the new grid-connected power system using renewable resources [4-7]. Hybrid power plants and micro grids can help to accelerate development by providing dependable power and reducing pollution and CO_2 emissions [8-9]. Given the exposure to possible outages they confront, many organizations today view increased resilience as an inherent value. Major weather disasters in recent years have revealed weaknesses in our energy infrastructure, leaving many without power for days or weeks at a time, imposing a heavy cost in terms of lost productivity and quality of life. Different case studies have used software tools like Homer grid to design the optimal sizing of a Hybrid Energy System [10-12]. At the Moroccan academic level, there are very few researches on the environmental and resilient impact of hybrid energy systems in case of natural disasters and power outage. In this purpose, Boussetta in reference [13] has examined the pre-feasibility of a PV-Wind Hybrid Micro grid System to predict a more cost-effective configuration. Whereas a technical research on reducing CO_2 emissions through the use of dependable renewable energy sources has been investigated by Marzband in ref [14]. As for the techno-economic evaluation of a hybrid system in disaster-affected areas, has been studied by Kasaeian in ref [15] to emphasize the significance of the salvage factor in determining the economic feasibility of renewable energy systems.

Grid outages are severely affecting critical infrastructure. More so than ever before, they are significantly decreasing services, which have a negative impact on finance and safety. Our case study examines two Moroccan cities that employ renewable energy to promote and empower residential load. In addition to the carbon footprint analysis, we investigate the impact of power outages on the architecture of the studied systems. The purpose of this paper is to suggest a homer-based optimal configuration, exploring the functionality of this relevant software and proposing a technical, economic, reliable, and environmental solution. Our work is organized as follows: the description of hybrid optimization program used in hybrid energy systems. Then in section 3 we introduce the Homer grid modelling. After that, we develop in section 4 different simulations done for Agadir and Al Hoceima areas. And then we introduce the resilience sensitivity analysis in the fifth section in which we evaluate the feasibility of each system proposed for the two cities involved in this study. Finally, we conclude with the importance of using Homer software in modelling critical energy system architectures.

2. Hybrid Optimization Program

Nomenclature

Homer: Hybrid Optimization of Multiple Energy Resources
HOGA: Hybrid Optimization by Genetic Algorithm
PV: photovoltaic
Gen: fuel generator
NREL: national renewable energy laboratory
NASA: National Aeronautics and Space Administration
NPC: net present cost
TNPC: total net present cost
CO_2: Carbon dioxide
LCOE: levelized cost of energy
O&M: operation and maintenance
ROI: Return on investment
RE: Renewable energy
HRES: Hybrid renewable energy system
ANRE: National Electricity Regulatory Authority
HOGA: Hybrid Optimization by Genetic Algorithms
MTBF: mean time between failures
MTTR: mean time to recovery
SOC: state of charge
GA: Genetic algorithm
AI: Artificial intelligence
PSO: particle swarm optimization
MOPSO: multi-objective particle swarm optimization
EA: evolution algorithm
DP: dynamic programming
ABC: artificial bee colony
MLUCA: multi-objective line-up competition algorithm
MILP: mixed integer linear programming
NSGA-II: elite non-dominated sorting genetic algorithm
GWO: grey wolf optimization algorithm
SA: simulated annealing
HS: harmony search
MENA: Middle East and North Africa

2.1. Challenge

There are different methodologies for sizing and modelling hybrid systems. These methods as shown in figure1 are ranging from traditional methods to methods using digital software [16-19]. Recently, several researches have studied the designing of hybrid architecture in case of outage caused by natural disasters particularly the earthquakes. Homer software is the most used software to provide solution for modelling resilient and reliable architectures.

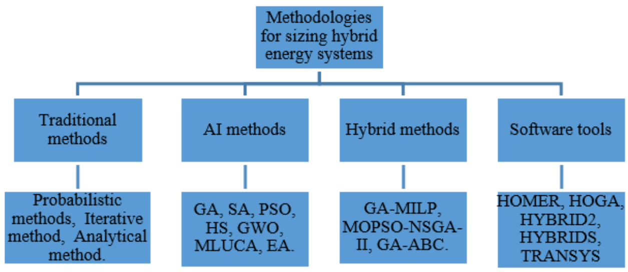


Fig. 1. Methodologies for sizing hybrid energy systems.

The question is how to design a micro grid that will be cost-effective, reliable, and clean in seismic locations.

In this study, we have investigated the case of Morocco, and we have studied a simulation for two important cities known by their seismic activity, in order to predict more reliable novel energy architecture.

2.2. Comparison of Numerical Sizing Software

Table 1 below provides a comparison of the most commonly used hybrid optimization software in energy hybrid architectures.

Table 1. Advantages and disadvantages of hybrid optimization programs [17, 20-21]

Software	Advantages	Drawbacks
HOMER	- simple to comprehend - friendly to the user - provides efficient graphical representation of results - data handling capacity per hour	- black box code used - linear equation based model - time series data in a form of daily average can't be imported
RETScreen	- strong product database - meteorological database from NASA only - financial analysis - easy to use(excel base)	- restricted options for visualization and search features - less data input option
HYBRID2	- -user friendly - multi electrical loads option - detailed dispatching option	some simulation errors are shown despite the fact that the project is written successfully
HOGA	- -mono or multi objective optimization tool - needed little computational time - option to purchase and sell energy	- free EDU edition has some analysis limitations - absence of thorough sensitivity analysis and probability calculations

A recent study [22] showed the algorithms and software that have been used the most in hybrid system optimization. HOMER tool was used more than other techniques as described in figure 2. Another study has compared the optimization of HRES using HOMER and iHOGA software [23].

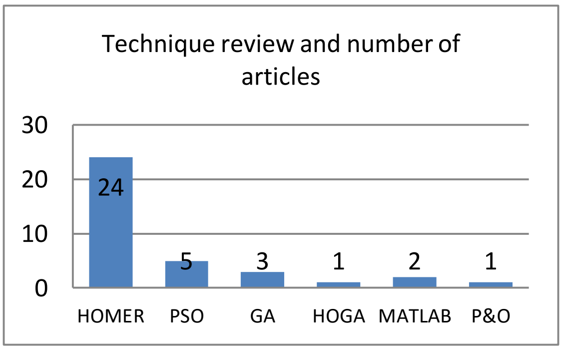


Fig. 2. Frequency of use of optimization techniques [22].

The modelling logic of HOMER is less complex than that of many other time-series simulation models for micropower systems, including Hybrid2, in order to limit input complexity and enable quick calculation to make optimization and sensitivity analysis possible [24-27]. On the other hand, in comparison to the statistical models that do not do time-series simulations, like RETScreen , Homer is more accurate and more adaptable in its ability to simulate a diverse array of systems.

3. Methods and Procedure

3.1. Introducing the Modelling Platform

HOMER (Hybrid Optimization Model for Electric Renewables) is a software tool that can be used to simulate and optimize the design and sizing of hybrid energy systems, such for a community load residential or industrial area.

Here are some HOMER characteristics that are important for developing a hybrid energy system.

1. HOMER can simulate the performance of a variety of renewable energy technologies, including wind turbines, PV panels, and energy storage systems.

2. The user can enter information about the solar and wind energy available, as well as the electrical needs of the area under study.

3. It employs optimization algorithms to determine the system's ideal configuration, taking into account the size of the Panels and wind generator system, the storage capacity, and any other components.

4. It can take into consideration many restrictions, such as price, availability, and space, to make sure the final design is both technically and economically feasible.

5. Using sensitivity analysis, HOMER can estimate how various factors, such as the carbon limit, component costs, and power outages, may affect the system's overall performance.

The study and design of electrical microsystems can be difficult due to the vast array of design options and the unpredictability of crucial factors like load size and variation in fuel price. In addition to that, renewable energy sources make things more problematic because their power production might be seasonal, intermittent, non-dispatchable, and uncertain. HOMER was developed to deal with these problems. The HOMER Micropower Optimization Model was developed by the U.S. National Renewable Energy Laboratory (NREL) as a computer model to assist in the design of micropower systems and to make it simpler to evaluate various power production technologies for a range of applications [28-32]. With any combination of photovoltaic (PV) modules, wind turbines, microturbines, biomass power, small hydro, fuel cells, batteries, and hydrogen storage, HOMER can simulate grid-connected and off-grid micro power systems. This program is based on performing three basic functions: simulation, optimization, and sensitivity analysis [33-36].

Figure 3 represented the flow-chart of the main steps used in this approach.

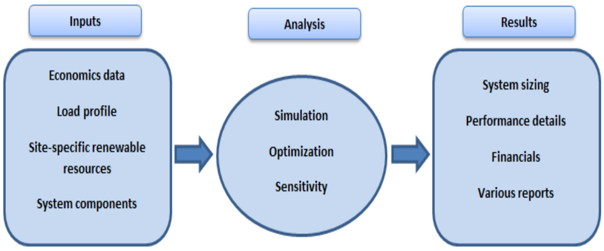


Fig. 3. Methodology used in Homer.

To assess the technical viability and life-cycle costs of a particular micropower system configuration, HOMER simulates the operation of that configuration every hour of the year. Additionally, during the optimization process, HOMER simulates a wide range of potential system configurations. During the sensitivity analysis phase, HOMER runs a number of optimizations to evaluate how uncertainties or alterations in model inputs affect the outputs of the system. The optimization part is enclosed by the sensitivity analysis part because numerous optimizations are included in a single sensitivity analysis.

3.2. Procedure

The optimization program should take into account the daily demand, the choice of energy sources, and network cost if necessary, regardless of whether the site is remote or connected to the grid. Figure 4 depicts the primary phases to follow in modeling with Homer program.

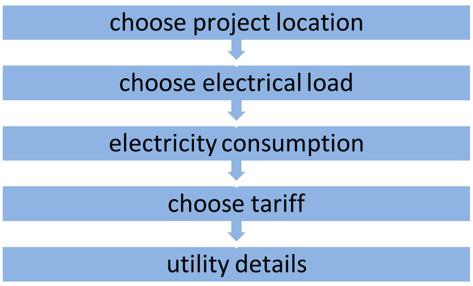


Fig.4. Phases in modeling in Homer grid.

Concerning the load profile, there are four types of load that could be simulated. These types are illustrated in Figure 5 below. In this study, we chose a residential area to power a 22 kW load.

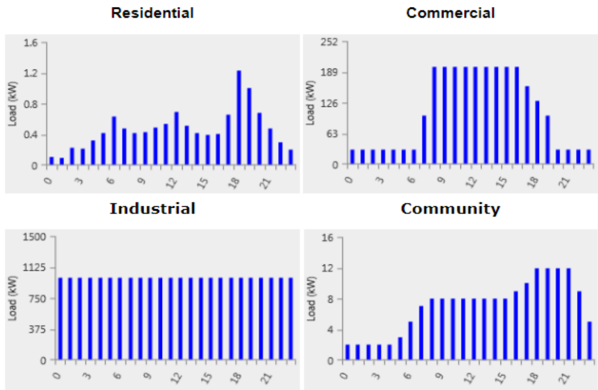


Fig. 5. Load profile in Homer grid.

3.3. Calculations

HOMER's principal function is to simulate a micropower plant's long-term performance. This simulation capability is essential to its higher-level capabilities, such as optimization and sensitivity analysis. The simulation approach analyzes the behavior of a defined system configuration, comprising specific-sized system components and an operational strategy dictating their interactions, within a particular context over an extended timeframe. HOMER simulates the operation of a certain system configuration hourly over a period of a year. HOMER progresses hour by hour throughout the year, computing the available renewable energy, matching it against the electric load, and determining the optimal actions for surplus renewable energy or additional energy needed. It constantly assesses whether to use excess renewable energy or efficiently procure extra energy (e.g., from the grid). After a year's worth of computations, HOMER evaluate if the system aligns with the user's defined constraints such as meeting a specific percentage of total electrical demand, achieving a certain renewable energy contribution, or adhering to pollutant emission levels. Furthermore, HOMER computes various parameters essential for evaluating the system's life-cycle cost, including annual fuel consumption, generator operating hours, anticipated battery lifespan, and the amount of grid electricity purchased annually.

Total Net Present Cost (NPC) is the metric used by HOMER to evaluate the system's life-cycle costs.

To determine the total net present cost, HOMER uses the following equation [37]:

$$C_{npc} = {C_{ann\_tot}}\Big/{CRF(I, R_{pro})} \qquad (1)$$

Where:

C_{npc} is the total net present cost [€]

I is the actual real interest rate [%]

CRF is a function of capital recovery factor

Rpro is the project lifetime [yr]

4. Simulation: Case Study of Agadir and Al Hoceima Cities

4.1. Sites Location

We chose to carry out a simulation on two cities in Morocco, the most affected by earthquakes. We assumed that the architecture to be proposed must respond to the problems of unavailability of electricity during a certain period of the year.

Fig. 6a: Agadir city Fig. 6b: Al Hoceima city

Fig. 6 Agadir and Al Hoceima cities location.

Below are the coordinates of the areas to be studied.

Table 2. Sites coordinates

Location	Latitude	Longitude
Agadir, Morocco	30 degrees 25,67 minutes N	9 degrees 35,89 minutes W
AlHoceima, Morocco	35 degrees 14,67 minutes N	3 degrees 55,90 minutes W

The areas of Agadir and Al Hoceima are more reported by the seismic monitoring networks [38-39]. The city of Agadir is located in an area of high seismic activity due to the influence of the alpine seismic zone, which extends from the Rock of Gibraltar to Indonesia. The city of Al Hoceima has been also struck by numerous destructive earthquakes. These strong earthquakes cause a blackout of electricity and telephone connections.

4.2. Basic Architecture

The proposed design utilizing the various energy resources available is shown in the Figure 7 below. The system consists of a fuel generator, batteries, solar panels and grid. Homer software specifies the components specifications, and provides estimates of various costs such as the life cycle costs, operation and maintenance (O&M) cost, total net present cost (TNPC), and cost of energy (COE**).** The system will power 16kW primary load and 6kW secondary load (non-critical load).

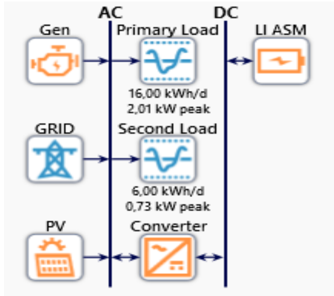


Fig.7. Hybrid architecture based on fuel generator.

4.3. Simulation for Agadir City

To get the meteorological data we have used NASA database that is integrated in Homer software. The figure 8 below illustrated the solar radiation average at the selected place.

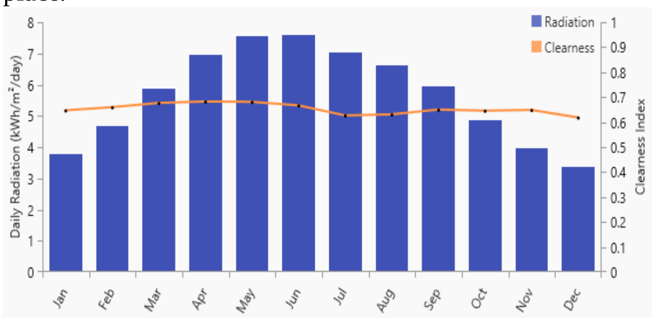


Fig.8. Average daily radiation per month through the year 2022 for Agadir city.

From the diagram above, the annual average of solar global horizontal irradiance GHI is 5.68 kW/m²/day

4.3.1. Technical analysis

In our architecture, the year to model is 2022. Once the simulation is launched, Homer grid calculates all possible combinations. As a result, the best economic solution consisted of 1 kWh Li-Ion battery, a 2.80kW of fuel generator, and 1,67kw of solar power.

Monthly electric production and fraction of energy produced are presented in Figure 9 and Table 6 below.

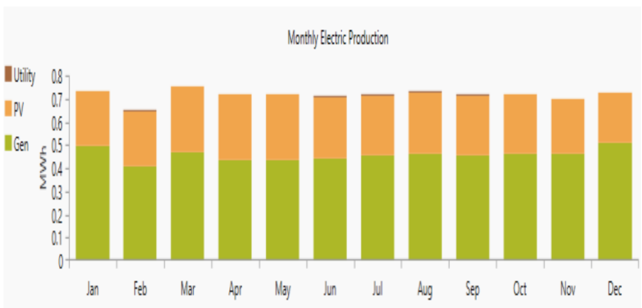


Fig. 9. Monthly electric production for Agadir.

The Table 3 below explores the proportion of energy to be used for this system. It includes the fraction of each energy component of the winning architecture design.

Table 3. Decomposition of the winning system architecture

System design	**PV (kw)**	**Gen (kw)**	**Battery kWh**	**Converter (kw)**
PV/Gen/battery	1.67	2.80	1	0.495

The fraction of solar energy is 35.8% and the fraction of fuel generator is 63.9% as mentioned in Table 4.

Table 4. Fraction of energy produced

Production	**Kwh/yr**	**Rate %**
PV	3070	35.8
Generator	5489	63.9
Grid	25.2	0.293
Total	8585	100

3.1.1 Economic analysis:

Table 5 displayed below provide economic data for the studied system design.

Table 5. Economic benefit for base winning architecture

System design	NPC euro	Simple payback (y)	Levelized COE euro/kwh	ROI %
PV/GEN/battery/ grid	30341	7.3	0.276	8.9

Resultantly, the payback period for our system architecture is 7.3 years, with a ROI of 8.9%.

4.3.2. Simulation for Al Hoceima City

To get weather information, we used the NASA database that is built into the Homer program. Figure 10 below depicts the average solar radiation for the city.

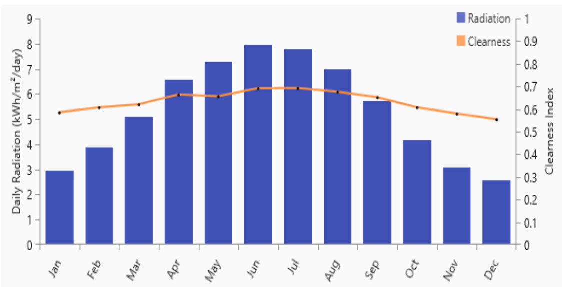


Fig. 10. average daily radiation per month through the year 2022 for Al Hoceima city.

The annual average of solar global horizontal irradiance GHI is 5.33 kW/m²/day.

4.3.3. Technical analysis

The year 2022 is taken as the basis for our architecture.

Figure 11 and Table 6 below showed the monthly electric production and the fraction of energies for the cost effective solution.

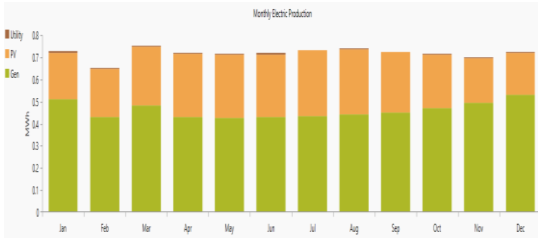


Fig. 11. Monthly electric production for Al Hoceima.

As shown in Table 6, the best economic solution consisted of 1 kWh Li-Ion battery, a 2.80kW of fuel generator, and 1,74kw of solar power.

Table 6. Decomposition of cost effective architecture

System Design	PV (kW)	Gen	Battery	Converter (kW)
PV/Gen/Battery	1.74	2.80	1	0.490

The fraction of solar energy is 35.3% and the fraction of fuel generator is 64.2% as mentioned in Table 7.

Table 7. Fraction of energy produced

Production	**Kwh/yr**	**Rate %**
PV	3044	35.3
Generator	5530	64.2
Grid	41.6	0.482
Total	8616	100

4.3.4. Economic analysis

Table 8 displayed below provides economic data for the studied system design.

Table 8. Economic benefit for lowest cost system

System design	**NPC euro**	**Simple payback(y)**	**Levelized COE euro/kwh**	**ROI %**
PV/GEN/ battery/grid	30 821	8	0.279	8.0

As a result, the payback period for this system architecture is 8 years, with a ROI of 8 %.

4.3.5. Emission analysis

Environment analysis in different location was studied using Homer software. A. Razmjoo in ref [14] presented a technical analysis investigating energy sustainability utilizing

reliable renewable energy sources to reduce CO_2 emissions in a high potential area. In ref [40-41] an environment analysis for hybrid energy system was performed at different locations in India. Emissions analysis for the hybrid systems with various RE fraction was performed by Atef S. Almashakbeh in ref [42].
The Table 9 below shows the total CO_2 emission in t/year.

Table 9. Annual carbon dioxide emissions

Location	Annual total (metric tons)	Units
Agadir	4.2	t/yr
Al Hoceima	4.3	t/yr

The value obtained of CO_2 emission in PV/battery/Generator/grid was 4.2t/year for Agadir and 4.3t/yr for Al Hoceima.

The Table 10 below shows the total CO_2 emission in kg/year for the all combinations suggested for Agadir city.

Table 10. Total gas emission for the different architectures

Quantity	CO_2 emission Kg/yr	NPC euro
PV+Gen+Storage+Grid	4202	30 341
PV+Gen + Grid	4254	30 571
Gen+Storage+Grid	6249	34 987
PV+Storage+Grid	443	41 121
Storage+Grid	5080	114 776

It's concluded that the value obtained of CO_2 emission in PV/Storage/grid is the lowest. Therefore, it allowed for avoiding 3759kg/year of CO_2 emission compared to the economic architecture, however, their cost is very high. Finally, this compromise between economic and environmental factors must be taken into consideration in the pre-feasibility study of the installation.

4.3.6. Discussion of results

As a comparison, the GHI for Agadir area is higher than that for Al Hoceima area.

The simulation carried out enables the proposal of various architectures, classified based on economic price. Decisions can also be made considering environmental criteria. Indeed, if we take the CO_2 emission factor as a decision-making criterion, we can opt for the PV+Storage+Grid architecture which has an emission quantity of 443kg/y, the lowest among the possible architectures but with an NPC of 41121 euros.

The payback period for Agadir area (7.3year) is more interesting than that for Al Hoceima city (8years). This is primarily due to the difference of investment in PV installation. The solar power system designed for the Agadir area includes a capacity of 1.67 kW, whereas the system for Al Hoceima city comprises 1.74 kW.

5. Reliability and Resilience Analysis

This section defines reliability and resilience concepts and makes an overview of the natural disasters that could be a factor of outage power.

5.1. Reliability

Reliability models shorter outages that occur multiple times each year. The non-critical load will not be served during the outage. According to IEC 60050, reliability can be described as an entity's capacity to fulfill specific function under given conditions at a particular time or within a particular time frame assuming that the provision of necessary resources is ensured.

In practical terms, it represents the percentage of time when an electrical system is functioning, ensuring a reliable power supply to powered equipment.

It is expressed as a rate of availability:

$$Disponibility\ D(\%) = (1 - {MTTR}/{MTBF}) \times 100 \quad (2)$$

Where: MTTR (Mean Time To Recovery) is the average outage duration refers to the mean duration required for the system to be restored to operational status after a failure. This duration encompasses the identification of the failure's cause, the repair process, and the restoration of service.
MTBF (Mean Time Between Failure operating) is the average uptime duration is a metric that calculates the mean period during which the system operates successfully before encountering a failure.

The availability rate is expressed as a challenging-to-calculate probability function, often assessed using statistical values for MTBF and MTTR. MTBF serves as a fundamental indicator of a system's reliability, usually quantified in hours. A higher MTBF value indicates greater product reliability. Equation 3 demonstrates this correlation.

$$Reliability = e^{-({Time}/{MTBF})} \quad (3)$$

A failure refers to an event that leads to:

- Complete system shutdown (end of operation)
- In fault-tolerant systems, operation continues in degraded mode without stopping.

1 - D (%) is the rate of unavailability.
For instance, 99.98% availability corresponds to 0.02% of downtime.

Figure 12 below presents a visual representation of the concepts of MTBF and MTTR

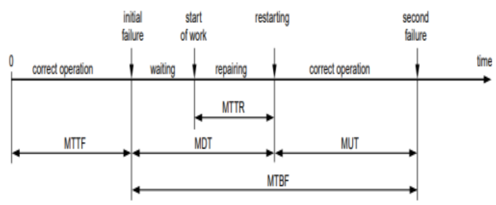


Fig. 12. Illustrative diagram of MTBF and MTTR.

5.2. Resilience

5.2.1. Natural hazards in Morocco

As per the information provided by the Global Facility for Disaster Reduction and Recovery, Morocco is one of the MENA countries with the highest risk of disaster. The most serious hazards of nature are earthquakes, tsunamis, intense heat, floods, and wildfires [43].

a) Morocco Earthquake Statistics

In the previous ten years, Morocco experienced a total of 212 earthquakes with a magnitude of four or higher within a 300-kilometer radius. This amounts to an average of 21 earthquakes year, or 1 each month. Every 17 days on average, an earthquake will occur close to Morocco.

Notably, in 2016, Morocco witnessed a significant surge in earthquake activity. Figure 13 illustrates that there were a total of 55 earthquakes with a magnitude of 4 or higher within 300 kilometers of Morocco that year. The most powerful earthquake recorded near Morocco in the last 5 years took place on September 8, 2023, at 23:11 local time. It had a magnitude of 6.8 and struck at a depth of 19 kilometers, approximately 74 kilometers south-southwest of Marrakesh [44].

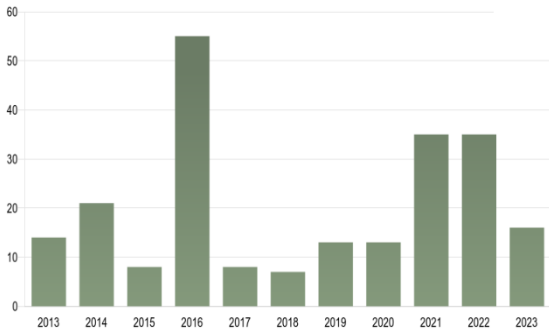


Fig. 13. Earthquakes with a magnitude of 4 or higher occurring within a 300-kilometer radius of Morocco on an annual basis.

5.2.2. Outage simulation

Resilience models a significant outage that happens at most once a year. Several case studies have studied areas affected by natural disasters. [15,45].

We have focused specifically on the case of Agadir and Al Hoceima cities, in which we have predicted that they would have an outage every 5 years causing 03 days shutdown. Figure 14 provides a visual window for configuring resilience parameters in the Homer program.

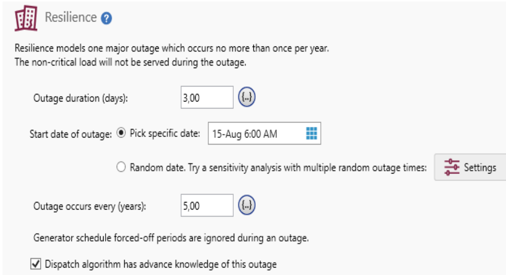
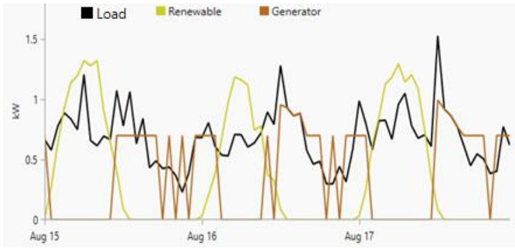


Fig.14. Resilience setting in Homer software.

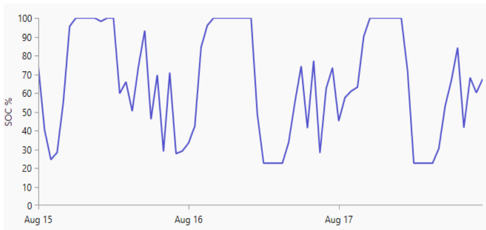
The outage's commencement date is set to a specific date, which, in this case study, is August 15th

5.2.3. Results and discussion

After setting an outage period as sensitivity input, we got the simulation results below as shown in figures 15 and 16.

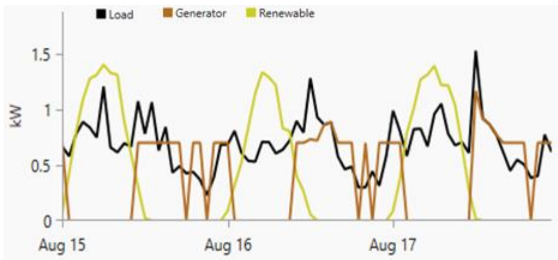


a) Power profile for Agadir area

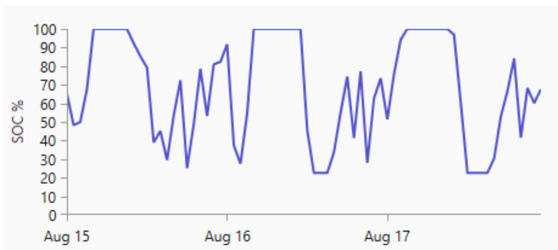


b) Battery state of charge

Fig. 15. Battery SOC and Power profile for Agadir area.



a) Power profile for Al Hoceima area



b) Battery state of charge

Fig. 16. Battery SOC and Power profile for Al Hoceima area.

Based on the preceding figures, it is evident that solar energy charges the battery throughout the day, and subsequently, the stored energy powers the load during the night. This case underscores the importance of constructing a robust infrastructure capable of withstanding any outage caused by natural catastrophe.

6. Conclusion and Future Directions

In this study, different architecture systems in Agadir and Al Hoceima cities were performed to supply 22kw of residential load. The most cost-effective solution comprised a 1 kWh Li-Ion battery, a 2.80 kW fuel generator, and 1.67 kW of solar power for Agadir area. The best economic solution for Al Hoceima location consisted of 1 kWh Li-Ion battery, a 2.80kW of fuel generator, and 1,74kw of solar power.
The main results of this study are summarized below:

At the economic level, the combination of the fuel generator, PV and battery has produced the best results of NPC, COE and ROI.

At the environmental level, the PV/Storage/grid architecture has permitted to avoid more than 3700kg of carbon dioxide compared to PV/Gen/battery/grid architecture.

The technical-economic architecture did not prioritize environmental concerns. In fact, an emission factor could be included and set at the desired value while ensuring a feasible financial project.

At the resilience level, this case study has highlighted how to design new energy architectures integrating risk outages in critical locations to withstand any natural disaster.

The primary focus of this study was to demonstrate the viability of employing various hybrid architectural systems. This was achieved by evaluating the environmental aspect and conducting a techno-economic analysis utilizing HOMER software.

The most important aspect in designing the hybrid architecture was the addition of energy storage to make sure that power is available whenever it is needed and ensuring system resilience.

Ultimately, this balance between economic and environmental criteria's must be included in the installation's pre-feasibility assessment to encourage green energy integration and respect the environment.

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Data Availability Statement

Data is based on open literature resources such as reports and articles, and Homer simulation program.

Conflicts of Interest

The authors declare no conflict of interest

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