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SCIENTIFIC CULTURE, Vol. 12, No. 2.1, (2026), pp. 1811-1822
Open Access. Online & Print

DOI: 10.5281/zenodo. 122.126144

SUSTAINABLE AND COST-EFFECTIVE RENEWABLE ENERGY HYBRID PHOTOVOLTAIC SYSTEMS IN JAZAN, SAUDI ARABIA: A TECHNO-ECONOMIC PERFORMANCE EVALUATION

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Received: 20/11/2025
Accepted: 25/12/2025

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ABSTRACT

Solar energy has the ability to sustainably supply a sizable amount of the electricity needed by cities. Since thermal storage is far less expensive than battery storage, PV systems are typically thought to be more suitable for baseload power than PV systems. Energy sources in Saudi Arabia can be divided into two groups: conventional energy, such electricity and petroleum products, and unconventional energy, including solar, wind, and hydro. Saudi Arabia has been given access to moderate wind speeds, a sizable amount of solar radiation, and hydro and biomass energy resources. The use of new and renewable energy sources that are currently available in Saudi Arabia is one of the most important considerations in the strategic planning of fossil fuel alternatives to meet the local energy demand. The Kingdom of Saudi Arabia provides a valuable case study in renewable energy. It has long relied on renewable energy sources to meet its energy needs, and installing grid-connected electric systems for its citizens in the future will not be viable. Wind resources are one of the hybrid choices available in the country. Using HOMER software, the most effective and technically feasible renewable-based energy saving system for a range of families has been determined. This approach maximizes hybrid systems that rely on renewable resources. It is used for simulation purposes with 50 home appliances and shows that the cost of energy varies each unit (3.4 KWh).

KEYWORDS: Homer, Integrated Photovoltaic, Sustainability, Riyadh, Saudi Arabia.

1. INTRODUCTION

The National Renewable Energy Laboratory (NREL) in the United States created the HOMER (Hybrid Optimization Model for Electric Renewables) micro-power optimization algorithm, which was used to determine the best energy-efficient renewable-based hybrid system alternatives for the region [1]. The most technically and financially feasible choices for both individual home users and groups of 10 and 50 home users have been determined through analyses.[2]. According to National Renewable Energy Program projections, 15,108,701 MWh of electricity will be produced annually by 2024, providing power for 692,557 households. An extra 7,870 jobs are expected to be created by the National Renewable Energy Program's activities by the end of 2024. By 2024, it is projected that the reduction in the use of fossil fuels will result in a yearly drop of 9,828,156 tons of carbon dioxide (CO_2) emissions.[3] Consumption of electricity and water are increasingly significant issues in Saudi Arabia. Drought conditions resulting from the lack of natural water sources and the elevated costs associated with desalinated water production necessitate effective and sustainable water management strategies. Condensate recovery from building cooling systems represents a sustainable approach to water management (Guz, 2005). Conversely, the residential building sector accounts for fifty percent of total energy consumption, primarily due to poorly constructed buildings and the challenges posed by hot-dry and hot-humid climates. In these climates, dust storms frequently occur, leading to the accumulation of dust on building roofs, which can result in increased solar radiation absorption by the building due to the high solar absorptivity of dust. The recent estimation of dust accumulation's impact includes the implementation of a developed solar absorptivity model as a function of dust accumulation (Algarni and Nutter 2015). Additionally, the influence of dust accumulation on building energy performance across 13 regions in the Kingdom of Saudi Arabia has been projected; dust storms were identified as having a considerable effect on elevating building cooling loads (Algarni and Nutter, 2016).

2. MATERIALS AND PROCEDURES:

This section offers a thorough explanation of the study area, the data used, and the analysis techniques used in order to answer the scientific question of whether the rainy season in the Jazan region has changed.

2.1. Research Domain

Situated in the southwest of Saudi Arabia, the 13,457 km2 Jazan region is distinguished by its unique physical, environmental, and cultural variety (Figure 1). It is among Saudi Arabia's most densely populated provinces [24]. Geographically, Jazan includes the lowlands, the Alhazoun forest district, and the inland Al-Sawawat Mountains [25,26,27]. While the coastal districts are among the hottest in the nation, with temperatures ranging from 31 °C in January to 40 °C in July, the highland areas have a comparatively wetter environment AS SHOWN IN FIGURE 1). Nevertheless, Jazan receives only 162 mm of rain on average each year (https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,j-z-n,Saudi-Arabia, accessed on 4 February 2025). With Jazan renowned for producing premium tropical fruits like apples, figs, mangoes, bananas, grapes, papayas, plums, and many citrus kinds, agriculture plays a significant role in the region's economy. In addition, the area grows cereal crops such barley, millet, and wheat, as well as coffee beans [28]. With 16 governorates and more than 100 islands in the Red Sea, Jazan provides a range of tourism attractions, such as historical sites. In order to encourage regional economic development, the Saudi government has also started a number of significant economic initiatives in Jazan. Examining the noted shifts in seasonal rainfall in the area over the past few years is essential given the significance of Jazan in Saudi Arabia.

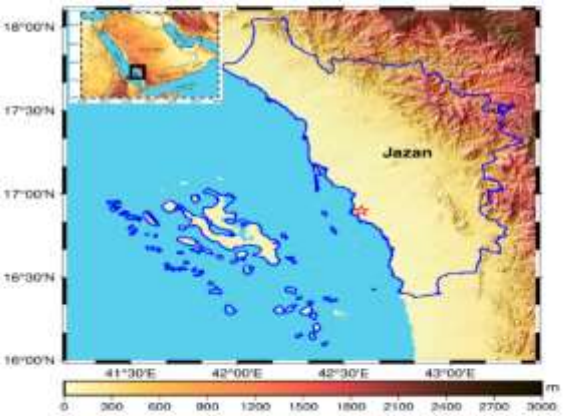


Figure 1: Regional Elevation Map (Inset) With Jazan Province in Southwest Saudi Arabia.

The red star indicates the location of the surface observation station at Jazan (42.58° E and 16.90° N significance in Saudi Arabia, it is critical to examine the changes in s2.Part 2. Information

The daily rainfall data were collected from the Jazan surface observation station of the National Center for Meteorology (NCM). Located at an elevation of barely 4 meters above sea level, this station covers the years 1978–2024 and is located at 42.58° E and 16.90° N. In addition, spatial rainfall plots in and around Jazan were created using high-resolution (0.05 degrees) Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS, [29]), which are available from 1981 to the present. From January 1940 till now, global climate data for synoptic conditions in and around the Jazan region are available from the fifth generation ECMWF (ERA5, [30,31]) atmospheric reanalysis. When compared to observational point data alone, gridded data provides a clearer picture of the spatial distribution of rainfall and meteorological conditions, as well as their variations, in and around Jazan. Also compared to observations for the analysis period are CHIRPS data derived from the Jazan station location. Daily precipitation records from 1978–2024 were used to compile the rainfall statistics for the Jazan region. Nevertheless, using specialized indices, we analyzed the most extreme cases of rainfall, including heavy, very heavy, and extremely heavy rainfall, as well as the maximum rainfall for one day and five days. Identifying climatological patterns in rainfall required aggregating daily surface observational data into monthly and yearly averages for the period 1978–2024. The Climpact2 program, which takes daily rainfall, maximum temperature, and minimum temperature as inputs, was used to compute the rainfall extreme indices at the Jazan station. The Expert Team on Sector-Specific Climate Indices (ET-SCI) created the cutting-edge software application Climpact to compute climate indices that are important for industries including water management, agriculture, and health.

Rainfall trends, including increases and decreases as well as extremes, were better understood with the use of regression analysis applied to the time series data. The F-test [32] and the Mann Kendall trend test [33,34] were used to determine the significance of these trends and to identify the levels of confidence associated with them. The complete historical dataset spanning 47 years (1978–2024) was split in half using the rescaled adjusted partial sums (RAPS) method so that we could study changes in the climate and climate extreme indices. The shift for a variable was defined as the change from the first to second half. In order to examine potential changes in structural breaks or changes in the mechanism that generates the data, RAPS was also used to analyze the time series data. Regardless of the number or quality of the time series, RAPS is usually employed for hydrology time series analysis [35,36,37,38]. the area's seasonal precipitation throughout the past few years.

2.2. *Climate in Jazan: A Professional Overview*

Jazan, located in the southwestern corner of Saudi Arabia along the Red Sea coast, exhibits a distinctive climate shaped by its geographical features, proximity to the sea, and prevailing tropical winds. Recent climate observations and forecasts indicate both enduring patterns and notable shifts linked to broader climate change trends.

2.2.1. *Temperature and Humidity*

Jazan is characterized by consistently high temperatures throughout the year. Average maximum daytime temperatures range from about 29°C in the cooler months (January) to 35°C in the peak of summer (July and June), with recorded extremes reaching up to 41°C and lows down to 18°C23456. Nighttime temperatures remain warm, typically not dropping below 24°C in most months2. Relative humidity is notably high due to the city's coastal location, averaging between 61% in July and 79% in December, with occasional peaks up to 99%346. This high humidity, especially in summer, contributes to a hot and oppressive atmosphere, particularly in the low-lying coastal areas.

2.2.2. *Rainfall Patterns*

Historically, Jazan has been known for its arid to semi-arid conditions, with an average annual precipitation of around 162 mm2. However, recent data and forecasts from the Saudi National Center of Meteorology (NCM) and the Regional Climate Change Center (RCCC) suggest a shift toward a more tropical, rainy climate, likely influenced by ongoing climate change341.

Rainfall in Jazan is highly seasonal and geographically variable:

- The majority of precipitation occurs during the summer months-July, August, and September-with these months accounting for up to 76% of annual rainfall in some mountainous areasAnnual rainfall varies significantly with elevation, ranging from 100 mm in coastal plains to as much as 450 mm in the highlands
- Rain events are often accompanied by strong winds, thunderstorms, and occasional flash floods, particularly in mountainous regions where water rapidly descends toward the coast
- Wind Patterns and Weather Phenomena
- Jazan’s climate is influenced by several wind systems:
- Northwestern winds prevail from May to September, while monsoon winds dominate in

June and August, sometimes bringing sandstorms and dust events

- Wind speeds average around 26 km/h annually, increasing to over 30 km/h during the summer months. These wind patterns, combined with high humidity and temperature, create challenging weather conditions, especially during the hot season.

2.2.3. *Geographical and Climatic Diversity*

The region’s climate varies markedly between the coastal plains and the mountainous interior:

- Coastal areas experience hot, humid summers and mild winters, with consistently high humidity.
- As elevation increases toward the east, temperatures moderate and rainfall becomes more frequent and intense, supporting diverse agriculture and lush vegetation in the highlands.

Recent Trends and Climate Change There is growing evidence that Jazan’s climate is undergoing significant changes. The shift toward a rainier, more tropical pattern is attributed to broader regional climate change, with increased variability in rainfall and more frequent extreme weather events. These changes have important implications for agriculture, infrastructure, and local livelihoods as in figure 2 .

3. THE POSSIBILITIES FOR INTEGRATED PHOTOVOLTAIC SYSTEMS IN BUILDINGS

Large utility-scale solar power projects that cover huge areas of desert have often been thought of by people who plan energy use. There are many good things about this idea, but economics needs to be looked at more closely. Getting land and getting it ready for installation of ground-mounted solar systems is necessary Figure3 (a):. Either the cost of building or getting the land ready could be high. Large-scale stand-alone PV growth has been stopped in Saudi Arabia and many other developed countries because there isn't enough empty land. That Increasing numbers of individuals are getting interested in solar energy, and most believe that distributed photovoltaic systems that generate power at or near the point of consumption will be the first to become widely available. It makes sense to employ dispersed solar system[6] Follow up with the grid, especially in places where demand is highest in the summer. -Get rid of the costs and losses of transmission and marketing. -usually don't have the right permissions (NASA surface weather and solar energy [7] The notable advantages that render photovoltaic (PV) power systems for individual buildings the most appealing distributed applications include: - The substantial electricity consumption by the buildings and processes they accommodate; - The PV system and the land supporting it are exempt from real estate fees.

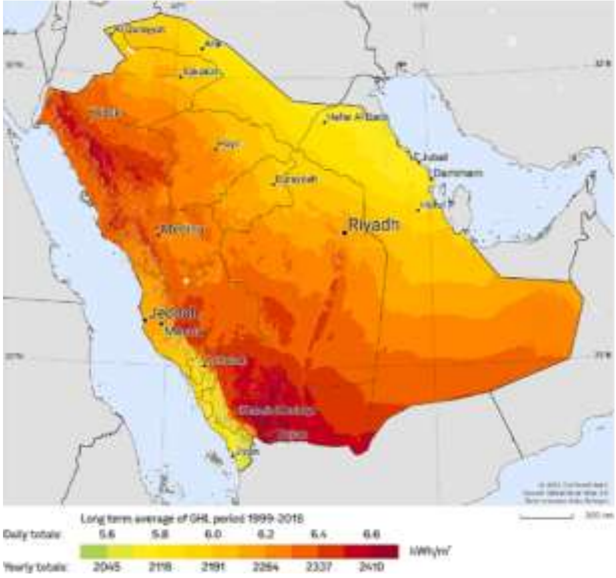


Figure 2: Solar energy potential in the Kingdom of Saudi Arabia.

3.1. *Performance of Photovoltaic Systems*

Researches have demonstrated that PV systems in Riyadh can achieve significant energy outputs, particularly in dry conditions with low humidity. Multiple PV installations in Riyadh were compared, and the results showed that the systems there reliably generate a lot of power, even during peak demand times. Possibilities & Public Service Initiatives Renewable energy, and solar power in particular, is highlighted in Saudi Arabia's Vision 2030.

The government has initiated several projects, including the Sakaka Solar Power Plant, which showcases advanced photovoltaic technology and aims to diversify the energy mix while reducing carbon emissions2. The plant is expected to generate over 930 GWh annually, powering approximately 55,000 homes2. Riyadh's solar resources present a significant opportunity for renewable energy development. The combination of high solar irradiance, supportive government policies, and ongoing research into optimizing PV system performance positions Riyadh as a leader in solar energy within the region.[8Jazan solar resources present a significant opportunity for renewable energy development. The combination of high solar irradiance Figure3 (b):, supportive government policies, and ongoing research into optimizing PV system performance positions Riyadh as a leader in solar energy within the region.[9]

4. ASSESSMENT OF HYBRID ALTERNATIVES FOR A COST-EFFECTIVE RENEWABLE ENERGY SYSTEM

A main source of energy and backup secondary power storage units are commonly combined in hybrid energy systems. Martin's most energy-efficient system has been improved [10] taking into consideration various loads and combinations of wind and photovoltaics utilizing HOMER [11]. Figure 2 shows the fundamental concept of a hybrid energy system for producing electricity. Figure 4(b) shows the proposed design in operation with the HOMER simulation program. HOMER examines at the energy balance to determine how a system might function with 9,690 hours in a year. By comparing the system's energy production capability with the electric and thermal demand, HOMER calculates the amount of energy entering and leaving each system component for each hour. Hourly choices are also made by HOMER on the operation of fuel-powered generators and the charging or discharging of batteries in systems that use these components Figure 4(a). [12] For every arrangement that anyone wants to think of, HOMER does these energy management calculations. It then estimates the system's installation and operating costs throughout the project's lifespan and determines if a design is viable, defined as its capacity to supply power under the given circumstances. Initial investment, replacement, operational and maintenance, fuel, and interest expenses are all factors in determining the total cost of the system.[13].

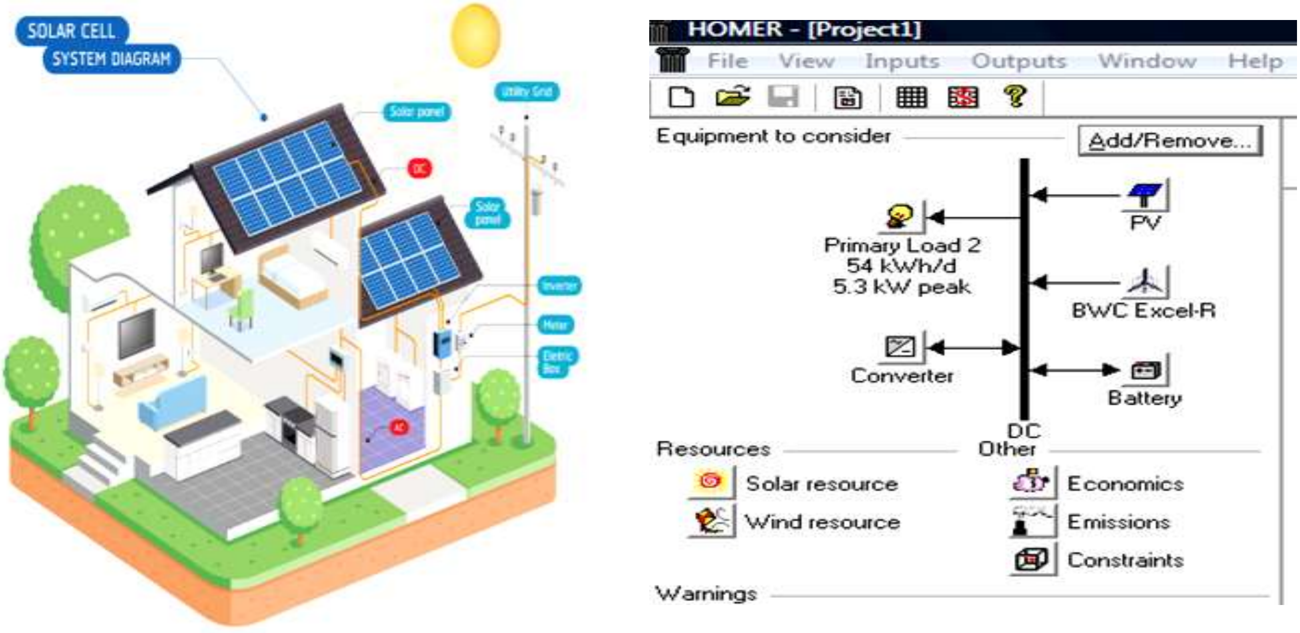


Figure3 (a): The Diagram representation of a hybrid energy system. (B) HOMER proposed a hybrid system: The sections following address the load, resources, financial constraints, controls, and additional characteristics used by HOMER

Table 1: Minimum Equipment for a single in middle income householder

Equipment	Numbers	LOAD (W)	Used Per Day
LED Lamps	18	33	8
TV	2	45	12
Other appliances	8	27	12

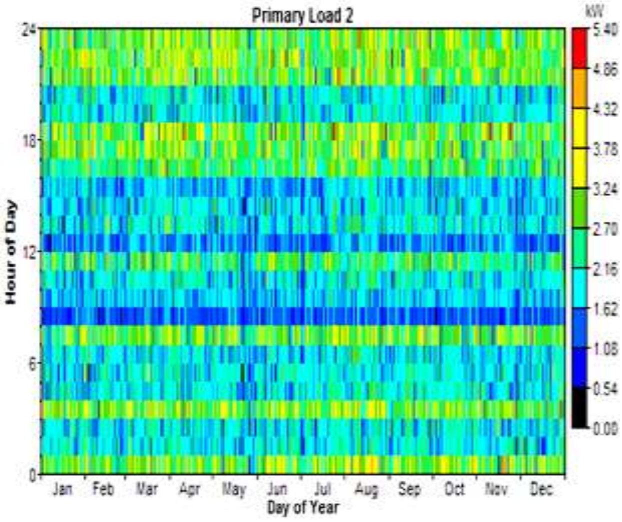
HOMER software simulates the performance of photovoltaic (PV) systems in Riyadh through a comprehensive analysis that incorporates various inputs and methodologies. Here's a detailed overview of how HOMER operates in this context:

4.1. Data Input and Resource Assessment

- HOMER utilizes regional solar radiation measurements. which for Riyadh norms around 6.95 kWh/m^2/day. This data is crucial for estimating the energy generation potential of PV systems throughout the year

- Load Profiles: The software requires hourly electricity demand data over a full year (8,760 hours) to accurately model the energy consumption patterns typical for residential *buildings in Riyadh*[14]

A common load system for a single house in remote locations was taken into account throughout the evaluation (see Table 1). A daily and 2.3-monthly load profile for a year is produced by HOMER using monthly average hourly load demand (as seen from a Sudanese perspective) as input (Figure 5). With this approach, it has been found that each household user uses about 338 Wh per day, with a peak demand of over 115 W. Grid-connected PV systems' system configuration modeling accounts for initial funding, ongoing expenses, and maintenance fees.[14, 15].



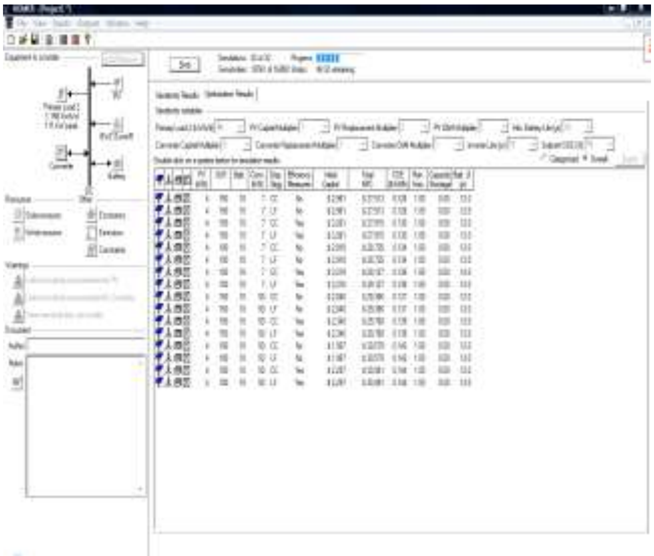


Figure 4 (b) Shown Hybrid System in HOMER.
Subsequent sections include information regarding the load, resources, controls, economic constraints, and additional characteristics of HOMER. (B) A Schematic Illustration of a Hybrid Energy System.

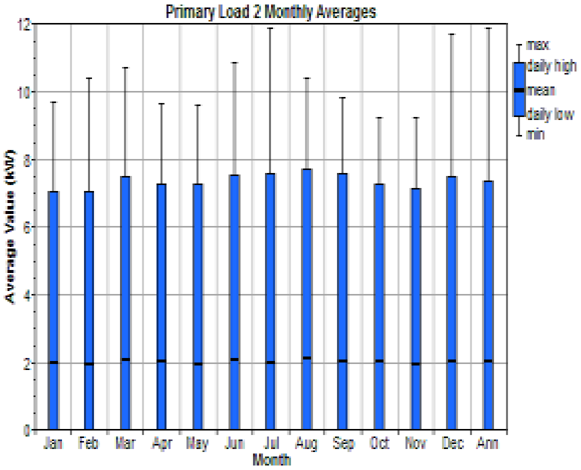


Figure 5): The additional principal load ((a) hourly-(b) annually)

4.2. Simulation And Optimization:

- HOMER conducts simulations to evaluate the performance of various setups under diverse scenarios. It evaluates energy generation from solar panels utilizing solar irradiance data.

- Cycles of battery charging and draining.
- Equilibrium of power to guarantee that energy provision satisfies demand.
- The application uses optimization methodologies to find the most cost-effective system designs by reducing the Remaining Current Charge) [16].

4.3. Results And Discusions

As hourly data was not accessible, NASA provided monthly average global radiation numbers. Using the latitude data from the specified location, Homer provides the clearness index (figure 3). Homer uses the Graham technique to provide simulated hourly data for a year.[17], Approaches for absorbing the sun's rays and generating artificial hourly radiation for use in power generation [16]. It produces a data series that includes authentic autocorrelation as well as daily and hourly changes. Figure 4 displays (a) the probability distribution curve for wind speed and (b) the average hourly wind speed over a one-year period. Wind was approximated using monthly averaged observed data from SEI, using characteristics such as height of 30m, elevation of 3m above sea level, and 0.1 m of surface roughness. Homer combined these monthly average data to create hourly data for a year using additional variables such as a Weibull factor "k" of 2.6, an autocorrelation factor (which indicates wind speed randomness) of 0.85, a diurnal pattern strength (which represents the variation in wind speed throughout a day) of 0.35, and the hour of peak wind speed at 22.[18].

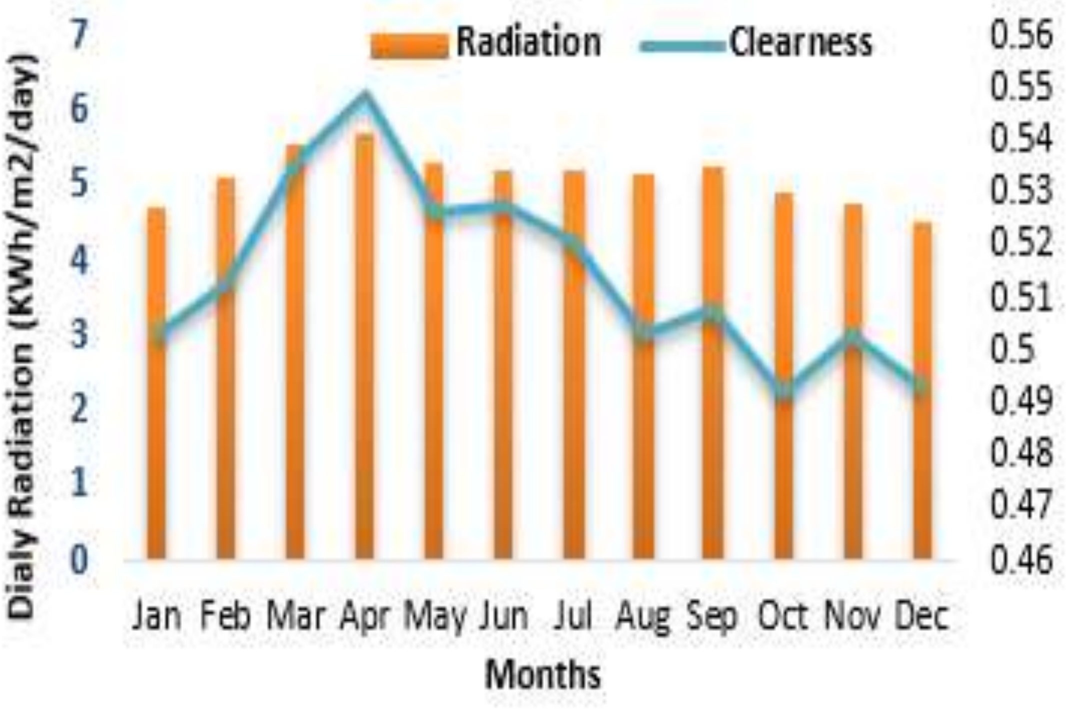
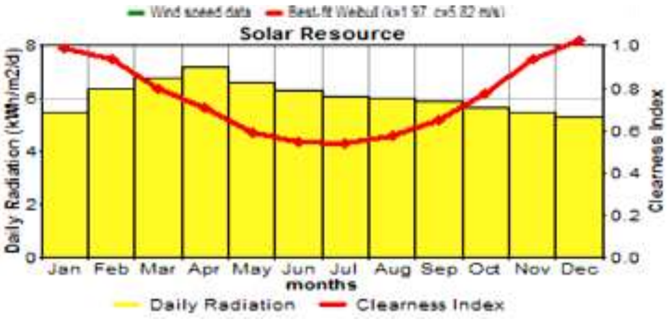


Figure 6: global solar radiation monthly average in Jazan



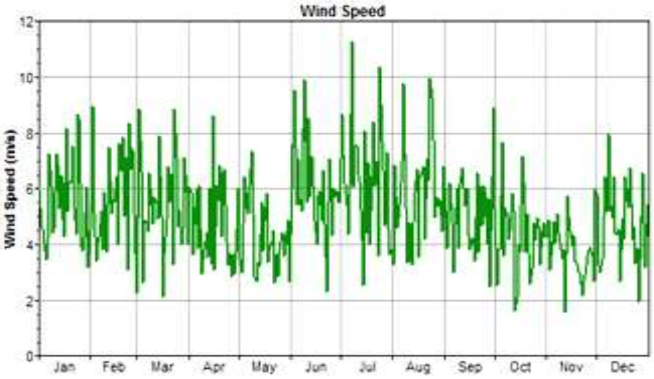


Figure7: Global solar radiation (a), average global solar radiation (b), daily solar radiation clarity (c), and global solar radiation

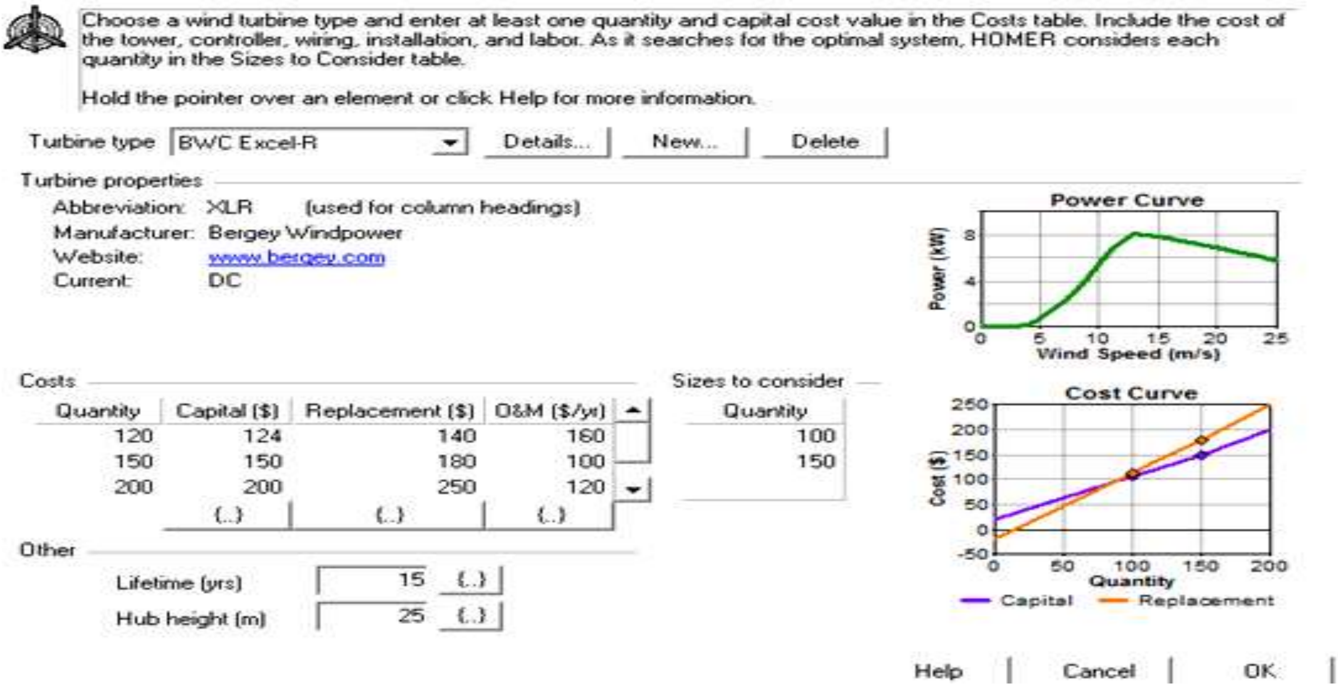
4.4 Elements of Hybrid Systems.

The Module Utilized by The Rooftop Solar Panels:

The average price of a solar energy module, includes installation, has been assessed to be 220 SP/W in Saudi Arabia. The modules have a life of 25 years and are inclined at 21° with no monitoring capability. (1 USD = 3.77SR 2024)

Winds producers:

Due to the limited demand of a single house system, low-capacity wind turbines are much more expensive per KW than high-capacity ones as in Figure 7-a,b,c . Furthermore, few low-capacity wind turbines are available on the market. Research and development are currently underway to allow low-capacity turbines with cut-in speeds of approximately 3.0 m/s. These calculations are based on a Synergy S 4000 turbine with a capacity of 0.8 KW. The anticipated cost of one turbine, including the tower and installation, is 90.000SR. Southwest Wind Power's W180 turbine, which has a 3 KW capacity and costs 400000 SR per unit, is being tested for loads larger than 1 KW. It requires tower installation. Alternative research focused entirely on wind and photovoltaics Figure 8.
[19] .



Choose a wind turbine type and enter at least one quantity and capital cost value in the Costs table. Include the cost of the tower, controller, wiring, installation, and labor. As it searches for the optimal system, HOMER considers each quantity in the Sizes to Consider table.

Hold the pointer over an element or click Help for more information.

Turbine type: BWC Excel-R

Turbine properties

Abbreviation: XLR (used for column headings)
Manufacturer: Bergey Windpower
Website: www.bergey.com
Current: DC

Costs

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
120	124	140	160
150	150	180	100
200	200	250	120

Sizes to consider

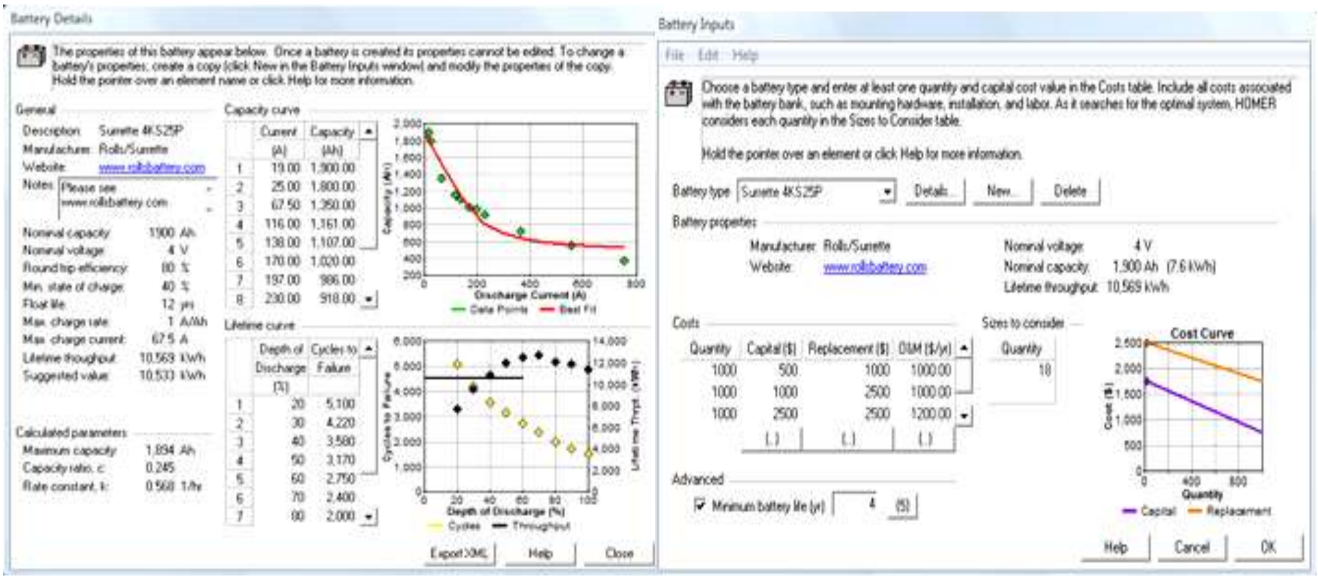
Quantity
100
150

Other

Lifetime (yrs): 15
Hub height (m): 25

Figure 8: Wind Turbine Input.

Batteries and Controller of Operations: The battery and controller become crucial components of the system as it focuses on the DC load. Each Trojan Company battery with charge controller cost 11.000.00 SR Figure 9 a-b . The batteries used were Trojan T-109 models with nominal voltages of 8V and capacities of 334 Ah.[19, 20]. According to an assessment, with 25 families, the system has a low energy cost (KWh). Table 3 displays each house combination's load demand together with the system design and financial breakdown.[21]. For the 25 -home system, a thorough analysis and system architecture have been provided. Figure 10: This research assists stakeholders in making well-informed choices on investments in Riyadh's renewable energy technology.[14].



The properties of this battery appear below. Once a battery is created its properties cannot be edited. To change a battery's properties, create a copy (click New in the Battery Inputs window) and modify the properties of the copy. Hold the pointer over an element name or click Help for more information.

General
Description: Surrette 4KS25P
Manufacturer: Rolls/Surrette
Website: www.rollsbattery.com
Notes: Please see www.rollsbattery.com

Nominal capacity: 1900 Ah
Nominal voltage: 4 V
Round trip efficiency: 80 %
Min. state of charge: 40 %
Float life: 12 yrs
Max. charge rate: 1 A/Ah
Max. charge current: 67.5 A
Lifetime throughput: 10,569 kWh
Suggested value: 10,533 kWh

Calculated parameters
Maximum capacity: 1,894 Ah
Capacity ratio, c: 0.245
Rate constant, k: 0.568 1/hr

Capacity curve

	Current (A)	Capacity (Ah)
1	19.00	1,900.00
2	25.00	1,800.00
3	67.50	1,350.00
4	116.00	1,161.00
5	138.00	1,107.00
6	170.00	1,020.00
7	197.00	986.00
8	230.00	918.00

Lifetime curve

	Depth of Discharge (%)	Cycles to Failure
1	20	5,100
2	30	4,220
3	40	3,580
4	50	3,170
5	60	2,750
6	70	2,400
7	80	2,000

Choose a battery type and enter at least one quantity and capital cost value in the Costs table. Include all costs associated with the battery bank, such as mounting hardware, installation, and labor. As it searches for the optimal system, HOMER considers each quantity in the Sizes to Consider table.

Hold the pointer over an element or click Help for more information.

Battery type: Surrette 4KS25P

Battery properties
Manufacturer: Rolls/Surrette
Website: www.rollsbattery.com
Nominal voltage: 4 V
Nominal capacity: 1,900 Ah (7.6 kWh)
Lifetime throughput: 10,569 kWh

Costs

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1000	500	1000	1000.00
1000	1000	2500	1000.00
1000	2500	2500	1200.00

Sizes to consider

Quantity
18

Advanced
☑ Minimum battery life (yr) 4

Figure 9: Battery analysis,
(a) Battery Details, (b)Battery Inputs

Table 2: HOMER analysis and results

Household	Load	Solar Panel (KW)	Winds Producer (the amount)	Battery (quantity)	Minimum Prices SR	NPC Total	COE (SR/ KWh)
Single	667 Wh/day 230 KW Mount	0.30	0	4	102,891	99,455	**49.7**
20	12.5 KWh/day 4.6 KW Mount	2.0	1	32	680,600	896,890	**22.6**
30	20.2 KWh/day 7.6 KW	4.0	1	48	978,910	2,234,600	**23.6**
40	26.9 KWh/day 9.7 KW	5.5	2	48	2,188,440	2,456,660	**21.5**
50	**33.6 KWh/day 12.6 KW**	**7.5**	**2**	**16**	**2,567,333**	**2,987,987**	**20.2**

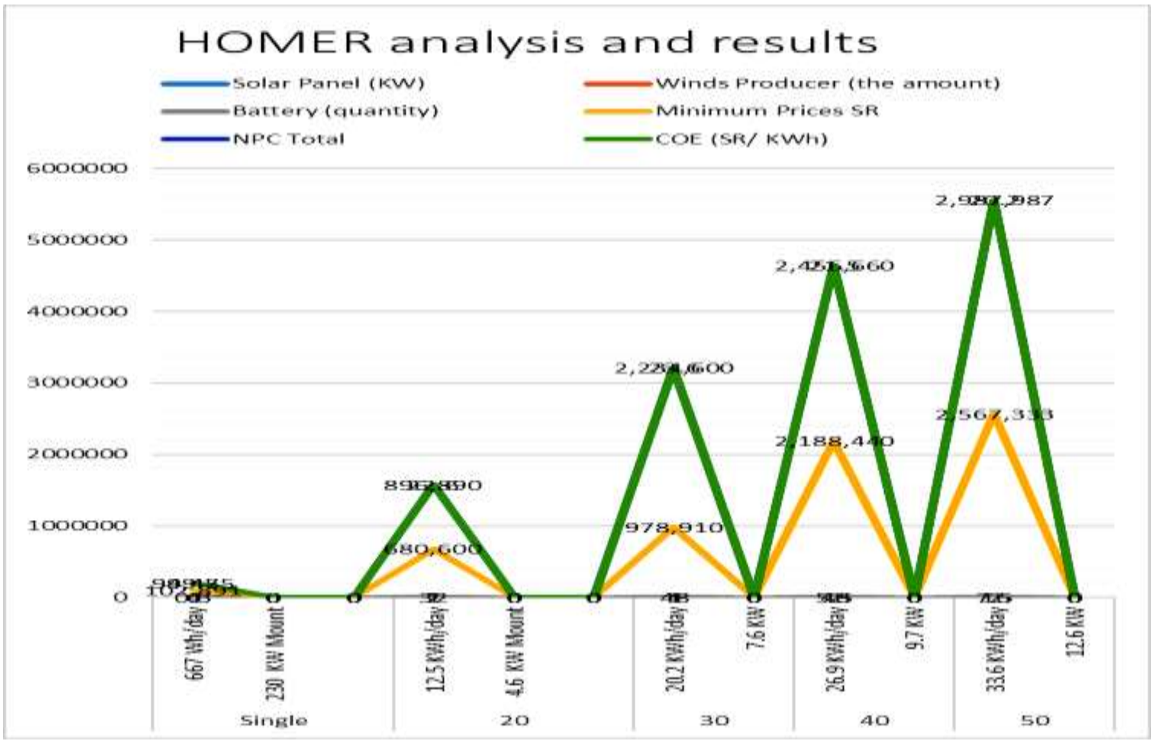


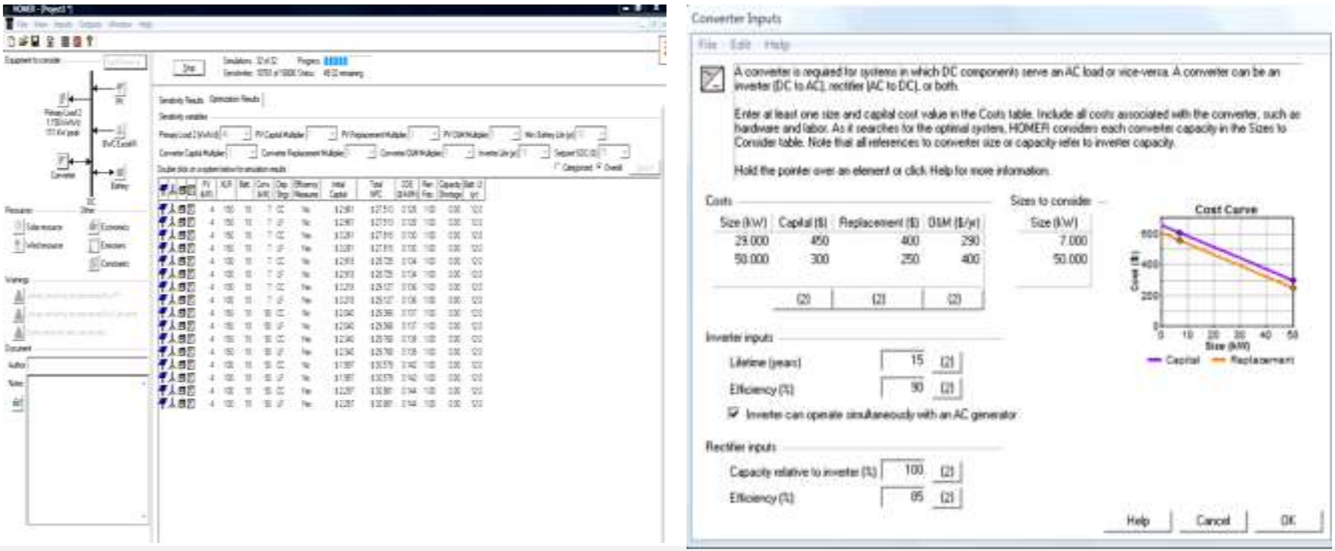
Figure 10: Homer Analysis And Results.

4.5. Constraints And Economics

HOMER provides detailed economic analyses, including:

- Calculation of NPC, which reflects the total lifecycle costs of the energy system.
- Sensitivity analysis to understand how changes in input variables (like fuel prices or solar panel costs) affect system performance and economics.

Considering an estimated economic benefit rate of 4% per year, the project is expected to last for 25 years[22]. Depending on the user's load, the system can support anywhere from one user to a large number of users (10 to 25), which has resulted in an annual operating and maintenance cost of 5000 SR. Ten percent of the system's hourly demand is its functional reserve, indicating that it has sufficient capacity. 50 families make up the system, and an investigation shows that its cost per kilowatt-hour is affordable [23] in additional to the outcome of the hybrid system design's modeling and optimization using the Homer program. A 20-year payback period, a 76% return on investment, and a 65% reduction in greenhouse gas emissions are the outcomes of simulations showing that the grid/renewable energy source (RES) hybrid configuration has the same net present cost (NPC) as grid-only supply at 2020 pricing. Three Vest WECS units (1.9 MW each), 4,000 batteries, and a 900-kW converter are projected to have a minimal net present cost (NPC) of $29.3 million after 20 years. This is still true even though a RES-only system might generate all the electricity needed [24] The duration of the compensation term and the benefits to costs ratio were set at about two years, eight years, and sixteen percent, respectively. The investigation of energy consumption, environmental impact, and remote accessibility in Table 2 .24 indicates that most coastal states are appropriate for residential systems.[24] . It was determined that integrating a 15 kWh PV system with a 200-kWh battery storage capacity is the best way to make use of the two diesel generators that are currently available, given a daily requirement of 308 kWh Figure 11. A minor adjustment to the diesel-powered generator's operating strategy can successfully handle future demand increases. Because of the improved operational efficiency of the PV generators, the configurations of this system have lower overall net current costs even if they require more starting resources. It is evident from the photovoltaic system that when sun radiation decreases Figure 12, so do system emissions. The incentive program also considers if there is enough electricity available for household use, which is necessary for the residents of this particular location [25].



Converter Inputs

A converter is required for systems in which DC components serve an AC load or vice-versa. A converter can be an inverter (DC to AC), rectifier (AC to DC), or both.

Enter at least one size and capital cost value in the Costs table. Include all costs associated with the converter, such as hardware and labor. As it searches for the optimal system, HOMER considers each converter capacity in the Sizes to Consider table. Note that all references to converter size or capacity refer to inverter capacity.

Hold the pointer over an element or click Help for more information.

Costs

Size (kW)	Capital ($)	Replacement ($)	O&M ($/yr)
29.000	450	400	290
50.000	300	250	400

Sizes to consider

Size (kW)
7.000
50.000

Inverter inputs

Lifetime (years): 15

Efficiency (%): 90

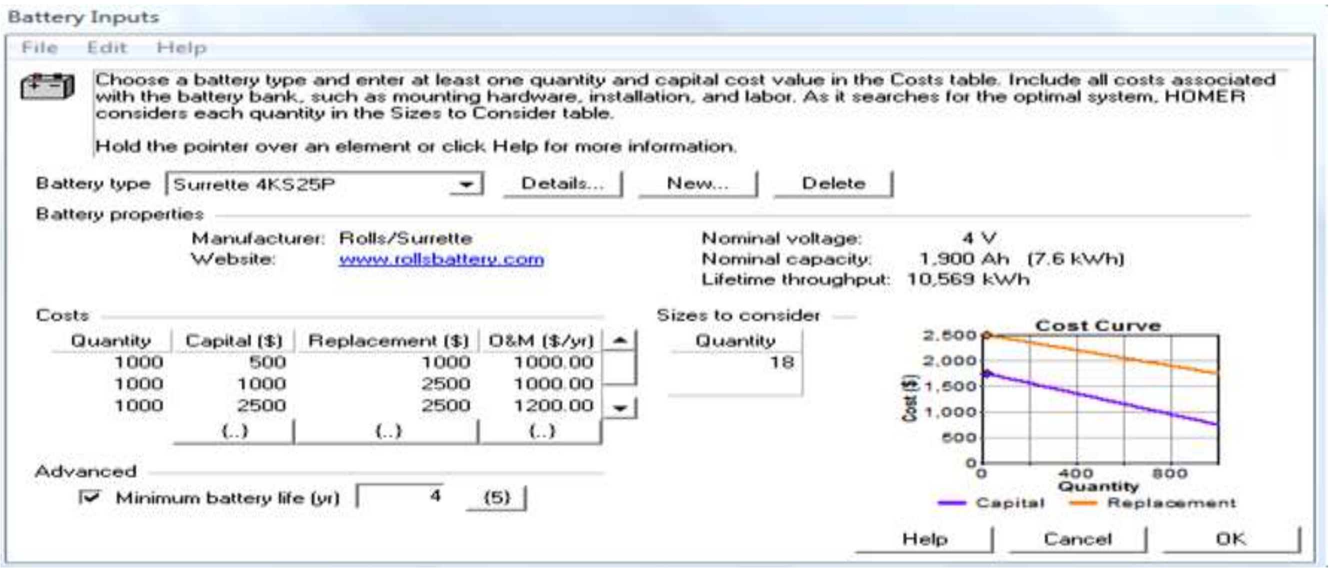
☑ Inverter can operate simultaneously with an AC generator

Rectifier inputs

Capacity relative to inverter (%): 100

Efficiency (%): 85

Figure 11: Results of the 25-home simulation system



Battery Inputs

Choose a battery type and enter at least one quantity and capital cost value in the Costs table. Include all costs associated with the battery bank, such as mounting hardware, installation, and labor. As it searches for the optimal system, HOMER considers each quantity in the Sizes to Consider table.

Hold the pointer over an element or click Help for more information.

Battery type: Surrette 4KS25P

Battery properties

Manufacturer: Rolls/Surrette

Website: www.rollsbattery.com

Nominal voltage: 4 V

Nominal capacity: 1,900 Ah (7.6 kWh)

Lifetime throughput: 10,569 kWh

Costs

Quantity	Capital ($)	Replacement ($)	O&M ($/yr)
1000	500	1000	1000.00
1000	1000	2500	1000.00
1000	2500	2500	1200.00

Sizes to consider

Quantity
18

Advanced

☑ Minimum battery life (yr): 4

Figure 12 homer analysis and results

5. CONCLUSION

A wind-photovoltaic (PV) combination system is more efficient than a single-home system for 25 homes, according to the estimates. If the price of the turbine were to decline, the total cost of electricity would be quite low. We have established a 30-year project lifespan and a real interest rate of 6% annually. (Even though the system is designed for both single users and large numbers of home users, such 10 to 25, operation and maintenance costs are low due to the low user demand.).

Acknowledgments: We Are Delighted to Convey Our Admiration and Respect for The Architecture Department of The University Prince Sultan Faculty of Architecture and Design. We Are Grateful to The Faculty e Dean, The Vice Dean, And the Chair of The Architecture Department for Their Assistance and

The Exceptional Facilities.

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