

Analysis of PV Solar Based Microgrid System for Chilmari Using HOMER-Pro

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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July, 2025

DECLARATION

We hereby declare that this project “**Analysis of PV Solar Based Microgrid System for Chilmari Using HOMER-Pro**” This work is our own and was conducted in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering at Daffodil International University as part of the requirements for the Bachelor of Science degree in Electrical and Electronic Engineering. It has not been previously submitted in a thesis or dissertation to this or any other institution for any degree, diploma, or other qualifications. I have identified potential risks associated with this research, obtained necessary ethical and/or safety approvals where applicable, and recognized both my responsibilities and the rights of the participants.

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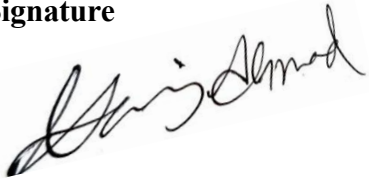
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APPROVAL

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Dedicated
To
Our
Parents

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LIST OF ABBREVIATIONS

PV = Photo Voltaic.

MCCB = Molded Case Circuit Breaker.

O & M = Operation and Maintenance.

MPPT =Maximum Power Point Tracking.

ATS = Automatic Transfer Switch.

AC = Alternating Current.

DC = Direct Current.

NASA = National Aeronautics and Space Administration.

NPC = Net Present Cost.

LCOC = Levelized Cost of Coating.

CAPEX = Capital Expenditure.

OPEX = Operational Expenditure.

PWM = Pulse Width Modulation.

WBS = Work Breakdown Structure.

RES = Renewable Power Sources.

DIU = Daffodil International University

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We extend our deepest gratefulness to our administrator, Ms. Kanij Ahmad, Assistant Professor of the Department of EEE, Daffodil International University, for granting us the occasion to work on this poignant idea and for strictly overseeing every aspect of its development. We unfeignedly appreciate her fidelity in supporting, motivating, and guiding us throughout this design. Her inestimable advice and backing were necessary in its completion. We're truly thankful for the occasion she has given us to be part of this bid.

ABSTRACT

With the adding demand for electricity and the reduction of non-renewable energy sources, the need for sustainable and effective energy results has come pivotal. pastoral electrification remains a major challenge in numerous developing regions, where access to a stable and dependable power force is frequently shy. Photovoltaic (PV) solar- grounded microgrid systems offer a promising volition for delivering electricity to out- grid and remote areas. still, the intermittent nature of solar energy and issues related to grid stability present significant obstacles to their wide relinquishment. This study aims to dissect a PV solar- grounded microgrid system for pastoral electrification using HOMER- Pro, an extensively employed software for optimizing mongrel renewable energy systems. The exploration focuses on assessing the feasibility, effectiveness, and profitable viability of integrating a solar- powered microgrid into pastoral energy structure. It examines colorful system configurations, including standalone and grid- connected models, to identify the most effective design that ensures both maximum energy generation and system trustability. crucial parameters similar as solar radiation vacuity, variations in cargo demand, battery storehouse capacity, and overall system cost are considered in developing an optimized model. likewise, the study explores the part of Maximum Power Point Tracking (MPPT) technology and Commensurable-Integral (PI) regulators in inverters to ameliorate power quality and maintain grid stability. A well- structured control system is designed, incorporating an MPPT- grounded BOOST motor, an inverter, and an LC sludge. also, a profitable analysis is performed in HOMER- Pro to compare different system configurations grounded on crucial fiscal criteria similar as Net Present Cost (NPC), Levelized Cost of Energy (LCOE), and overall system trustability. The findings of this study give precious perceptivity into the design and optimization of PV solar- grounded microgrids for pastoral electrification. The exploration highlights that with effective control strategies and proper system optimization, solar microgrids can serve as a cost-effective and sustainable result to address energy access challenges in remote areas. The results of this study can be used as a reference for policymakers, energy itineraries, and experimenters working toward expanding pastoral electrification through renewable energy technology.

CHAPTER 1

INTRODUCTION

1.1 Introduction

In state-of-the-art world, the developing call for power, blended with the speedy depletion of fossil gasoline reserves, has heightened the urgency for sustainable and renewable power solutions. Among the numerous renewable sources, sun power sticks out as a promising and green alternative because of its good-sized availability and accessibility. [1] However, conventional centralized electricity technology and distribution networks regularly battle to supply constant power to far off and rural regions, wherein grid enlargement isn't financially viable. [2] As a result, sun-primarily based totally microgrid structures have emerged as an effective, decentralized answer for rural electrification. [3]

A sun-primarily based totally microgrid gadget integrates photovoltaic (PV) panels, power garage units, and electricity manage mechanisms to make certain a strong and uninterrupted power supply. Unlike traditional grid structures, microgrids can feature autonomously or along with the primary grid, supplying flexibility and resilience towards electricity disruptions. These structures now no longer best lower reliance on fossil fuels however additionally make contributions to decreasing carbon emissions, making them a sustainable opportunity withinside the combat towards weather change. [4] [5] [6]

Despite their several benefits, solar-primarily based totally microgrid structures stumble upon demanding situations inclusive of power intermittency, electricity first-rate concerns, and economic constraints. Implementing superior technology inclusive of Maximum Power Point Tracking (MPPT) controllers, optimized battery storage, and green load control is essential for enhancing their reliability and average performance. [7] This thesis examines the feasibility, optimization, and monetary sustainability of solar-primarily based totally microgrids the usage of HOMER-Pro, presenting precious insights into their position in selling rural electrification and long-time period power security. [8] [9] [10]

1.2 Problem Statement and Proposed solution(s)

The developing want for reliable energy in rural and faraway places, alongside the usage of fossil fuels walking out, creates a massive hassle for buying electricity. Solar microgrid structures are a very good idea, however they've a few issues. For example, sun strength relies upon on weather, so it is now no longer continually available. Also, there may be issues with the first-rate of the strength and the fee to installation those structures are high. These issues could make it tough to apply sun microgrids widely, in particular in regions that do not have plenty cash or technical knowledge. To restoration those issues, this takes a look at indicates the usage of higher generation like MPPT controllers to get the maximum out of sun electricity and make it paintings higher. Adding electricity garage and clever approaches to manipulate energy use can assist preserve the strength constant and reliable. Using equipment like HOMER-Pro for fee making plans will make sun microgrids extra low-priced and sensible for bringing energy to rural regions.

1.3 Aims

System Design and Optimization – Utilize HOMER Pro software program to increase and decorate a sun-primarily based totally microgrid device, making sure fee performance and gold standard strength generation.

Operational Performance Analysis – Investigate the microgrid's overall performance beneath Neath numerous conditions, together with fluctuations in sun irradiance, load variations, and strength garage capabilities.

Energy Independence and Reliability – Assess the functionality of a sun-primarily based totally microgrid to characteristic in each grid-related and standalone modes at the same time as retaining strength protection and sustainability.

Environmental Impact Evaluation – Analyze the ecological benefits of a sun-powered microgrid as compared to standard grid electricity, that specialize in carbon footprint reduction.

Economic Analysis – Study the lifecycle costs, go back on investment (ROI), and payback duration of a sun microgrid device in assessment with conventional energy sources.

Hybrid Renewable Energy Integration – Investigate the capacity of incorporating extra renewable strength sources, which include wind or battery garage, to enhance microgrid performance and reliability.

1.4 Procedures

Define Project & Load Data – Create a brand-new mission in HOMER Pro, set location, and input/load strength call for data.

Add System Components – Configure sun PV, battery storage, inverter, and elective diesel generator.

Set Economic Parameters – Define capital cost, O&M costs, lifetime, and grid tariffs.

Configure Constraints & Control – Set dispatch strategy, renewable fraction, and grid import/export rule.

Run Simulation & Analyze Results – Optimize gadget layout primarily based totally on NPC, LCOE, strength stability and emissions.

Select Optimal System & Report – Choose the pleasant gadget, export results, and behavior sensitivity analysis.

1.5 Gantt Chart

Activities	January	February	March	April	May	June
Initiation	←→					
Planning	←→					
Data Analysis		←→				
Design			←→			
Simulation and Optimization			←→			
Report Discussion				←→		
Evaluation					←→	
Final Report Submission					←→	
Documentation						←→

Table 1.1: Gantt Chart

1.6 Organization

It's time to consolidate our modern-day dreams right into a clean and concise making plans record for our portfolio. Regarding our studies topic, this paper will spotlight the important thing subject matters blanketed withinside the course. Ultimately, it's going to additionally assist us put together for a better studies thought we can also additionally pursue withinside the future. Stay tuned for Course five on this series, "Why Preparing Matters," with the intention to manual us via each degree of making plans our studies thought in detail.

Research tasks are initiated for diverse reasons. They assist manual our studies, making sure it's miles well-established earlier than proceeding. Additionally, they may be critical for securing approval to behavior the study. Since studies may be expensive, the thought can also function a method to request funding.

While we don't want to completely draw close a look at inspiration at this stage, it is useful to recognize our targets. When the time comes, our inspiration must at the least encompass the subsequent components:

A identify for our look at topic, together with complete history records that offers a well-reasoned, fact-primarily based totally justification for our studies subject.

An overview of the educational literature at the topic, outlining the targets of our look at and its expected impact. We need to gift proof helping the importance of the studies and spotlight.

The anticipated consequences of the study, which include an in-depth studies plan that outlines the selected methodology, facts collection, and evaluation strategies, in addition to the reasoning in the back of those decisions, ought to be virtually defined. Additionally, we want to cope with the study's limitations, a practicable timeline for completion, and any moral troubles that could get up all through the studies. It is critical to spotlight how we plan to control those moral concerns. The ethics utility and different associated factors can be protected in Course four of this collection, Why Ethics Matter. The notion needs to additionally consist of statistics on essential resources, budget, and the procedure for sporting out the study. Furthermore, it's miles critical that the notion is concise and clear, as our studies supervisor, ethics committee, approver, or investment frame might not have the time or inclination to study a prolonged document. If we are nevertheless withinside the early ranges of the studies, the complete notion may make the effort to complete, however similarly guides on this collection will offer extra guidance.

"On our journey, let's first installed a few attempts to finish one ultimate crucial task, so we are able to consist of it in our portfolio.

Develop a concise making plans report for our portfolio that addresses every of the subsequent criteria, primarily based totally on our discussions so far.

Provide an in-depth clarification of our studies query and provide an explanation for why we remember it important.

Who is the target market for this have a look at? Think approximately individuals who could be inquisitive about our findings. Do we've a concept to manual us? If yes, how did we expand this concept? Which qualitative technique aligns nice with our studies query? Provide a short justification in your choice. Describe the individuals withinside the have a look at and the technique we're going to use to collect the desired data.

What biases, assumptions, or non-public views may have an effect on our studies and have an effect on our methodology, thinking about the identification audit?

Once we are finished, proportion a hyperlink to our report on this paper. Take a while to study the paintings of as a minimum different organization participants and provide optimistic feedback.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this paper we speak approximately examine a PV solar-primarily based totally microgrid machine for rural electrification the usage of **HOMER-Pro**, a broadly applied software program for optimizing hybrid renewable electricity systems. The studies specialize in comparing the feasibility, efficiency, and monetary viability of integrating a solar-powered microgrid into rural electricity infrastructure.

2.2 Related Research

We Recent research have applied HOMER Pro to investigate PV sun-primarily based totally microgrid structures for rural electrification. One such examine is "A Thorough Analysis of PV Solar primarily based totally Microgrid System for Rural Electrification the usage of HOMER-Pro" via way of means of Md. Abdullah Al Mamun, Mamunur Rashid, and Tawsif Hossain Chowdhury, posted in December 2019. [11]

This study makes a specialty of Durgapur, a far-off village in Bangladesh without a current energy supply. The examine employs HOMER Pro to assess the feasibility and monetary factors of integrating PV sun panels and diesel mills to satisfy the day-by-day power call for of 33. three kWh for 50 households. The findings imply that sun panels, with a mean sun radiation of 4. eight kWh/m²/day, can offer 86% of the once-a-year power production, ensuing in a per-unit power fee of \$0.494 (39 BDT) and a widespread discount in carbon emissions as compared to fossil gasoline Another applicable observe is "A Case Study on PV Assisted Microgrid Using HOMER Pro for Variation of Solar Irradiance Affecting Cost of Energy" via way of means of Sahil Mehta and Prasenjit Basak, provided on the 2020 IEEE ninth Power India International Conference. [12] This study analyzes a grid-linked microgrid version on the Thapar Institute of Engineering and Technology in Patiala, India. The observe examines how versions in sun irradiance effect the fee of energy, using HOMER Pro to version and optimize the system's performance.

This research displays the utility of HOMER Pro in designing and optimizing PV sun-primarily based totally microgrid structures for rural electrification, highlighting each technical feasibility and financial viability.

2.3 Compare and Contrast

A sun-powered microgrid device the usage of HOMER Pro software program is designed for each off-grid and grid-linked applications, combining sun photovoltaic (PV) panels with electricity garage and/or backup generation (consisting of diesel). HOMER Pro is used to simulate and optimize those systems, thinking about elements like cost, reliability, and environmental impact. It allows customers to version special configurations, examine electricity demand, and perceive the maximum cost-green and sustainable answer for electrifying rural or faraway areas. The software program aids in optimizing the size, operation, and overall performance of sun-primarily based totally microgrids to make certain green electricity manufacturing and distribution.

2.4 Summary

A sun-primarily based totally microgrid device for rural electrification the usage of HOMER Pro software program is an answer geared toward turning in sustainable and cost-powerful strength to faraway or off-grid regions. The device combines sun photovoltaic (PV) panels with power garage and backup generation, including diesel, to meet the power necessities of rural communities. HOMER Pro software program is applied to version and optimize the device through assessing elements like power demand, cost, reliability, and environmental impact. By simulating one of a kind configurations, the software program enables pinpoint the maximum green and cost-powerful layout for rural electrification, making sure dependable and sustainable power supply.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

The gadget should be suitable for its supposed reason and effectively designed, positioned, cleaned, maintained, and installed.

1. Ideal for designing and trying out components, in-method devices, and very last products.
2. Capability to provide constant and reliable outcomes.

System Architecture

Component	Name	Size	Unit
PV	Fronius Primo 8.2-1 with Generic PV	8.25	kW
PV dedicated converter	Fron8.2 converter	8.25	kW
Storage	PowerPlus Energy LiFe2413N	14	strings
Dispatch strategy	HOMER Cycle Charging		

Schematic

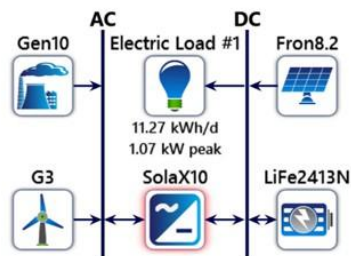


Fig 3.1: Grid Connected PV System.

3.2 Materials

We are using here so many component

3.2.1 PV Array: A *photovoltaic (PV) array* includes more than one sun panels connected collectively to generate power from daylight. These panels incorporate sun cells that use semiconductor substances to provide direct current (DC) strength while daylight hits them. PV arrays are scalable and extensively utilized in homes, businesses, and microgrids to deliver environmentally pleasant and renewable energy.

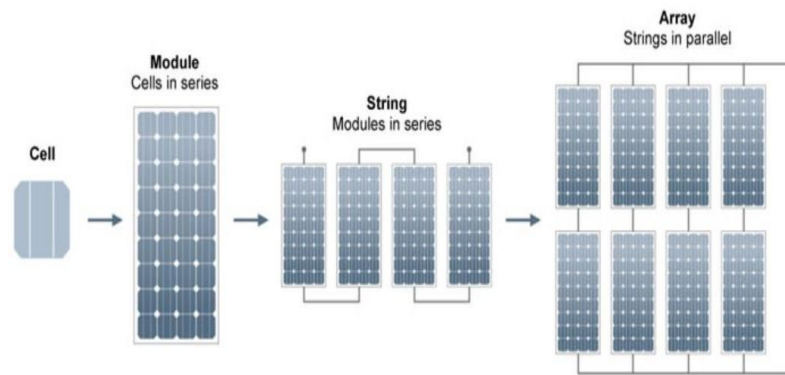


Fig 3.2: PV Array.

- **Model:** Mono-Crystalline 550W Solar Panel.
- **Number of Cells:**144 (6X24).
- **Power Output:** 450-550W.
- **Voltage:** 12V/24V
- **Cell Type:** Mono-PERC (Passivated Emitter Rear Cell).
- **Weight:** Approx. 28 kg.
- **Frame:** Silver anodized aluminum alloy.
- **Quantity:**15pcs.
- **Dimensions:** Approx. 2278 x 1133 x 40 mm.
- **Price:** 15000X15= 225000 tk.

3.2.2 Converter: A sun converter, frequently called a sun inverter, performs a important function in a sun power machine. It transforms the direct current (DC) produced via way of means of sun panels into alternating current (AC), that is well matched with maximum domestic home equipment and electric systems. In addition to this conversion, sun converters additionally adjust power flow, guide grid interaction, and offer machine tracking and protection. Various sorts are available, inclusive of string inverters, microinverters, and hybrid inverters, relying at the machine's layout and power requirements.



Fig 3.3: 10KW Converter

- Hybrid Converter (Wind + Diesel compatible).
- Hybrid Converter (Wind + Diesel compatible) 12KW = 400,000tk.
- ATS for Diesel Generator 10KW-15KW = 30,000tk.
- MPPT Wind Charge Controller 10KW = 90,000tk.
- **Total Cost: 5,20,000tk.**

3.2.3 Charge Controller: A sun charge controller is a vital thing in photovoltaic (PV) structures that regulates the voltage and present day flowing from sun panels to batteries. It prevents overcharging, deep discharging, and opposite present-day flow, making sure battery toughness and machine efficiency. There are foremost types: Pulse Width Modulation (PWM) and Maximum Power Point Tracking (MPPT), with MPPT controllers being greater green with the aid of using optimizing electricity extraction. The sun price controller complements the reliability and overall performance of sun electricity garage structures, making it an important detail in off-grid and hybrid sun applications.



Fig 3.4: Charge Controller

3.2.4 Battery: A sun battery is an strength garage tool that shops extra energy generated through sun panels for later use. It complements the performance and reliability of photovoltaic (PV) structures through presenting backup strength all through low daylight conditions, grid outages, or top call for periods. Solar batteries assist maximize self-consumption, lessen reliance at the grid, and make a contribution to sustainable strength solutions. Common kinds encompass lithium-ion, lead-acid, and go with the drift batteries, every with various capacities, lifespans, and performance levels.



Fig 3.5: Solar Battery

- **Model:** 25.6V 100Ah Lithium Iron Phosphate Battery.
- **Daily Load Demand:** 30 kWh.
- **Battery Energy Capacity:** 2.4 kWh.
- **Battery Type:** Lithium-Ion (24V, 100Ah).
- **Number of Batteries Required:** 13 Pcs.
- **Cost per Battery:** 54,500tk.
- **Total Battery Cost:** 708,500tk.

3.2.5 Backup Generator: A 10-kW diesel generator is a dependable energy supply normally utilized in micro grid structures to offer backup or number one strength supply, mainly in faraway or off-grid areas. It operates with the aid of using changing diesel gasoline into electric power thru an inner combustion engine. In micro grid, this generator guarantees steady energy availability throughout top masses or while renewable reasserts like sun or wind are insufficient. Its benefits consist of excessive power density, short start-up, and robustness, alevin though it additionally includes better gasoline and preservation expenses in comparison to renewable. It is right for hybrid structures wherein power reliability is critical.

- ✓ **Type:** Diesel Generator.
- ✓ **Capacity:** Emergency needs.
- ✓ **Fuel Efficiency:** ~30–40%.



Fig 3.6: Generator

- **Required Load:** 10 KW.
- **Recommended Size:** 10–12 kVA.
- **Type:** Diesel Generator.
- **Voltage:** 230V.
- **Fuel Consumption:** 2.5–3 L/h at full load.
- **Cost:** 450,000 tk.

3.2.6 Wind Turbine: A 3kW wind turbine is a small wind electricity gadget able to producing up to three kilowatts of power from wind power. It is normally utilized in homes, farms, and small companies wherein there's a constant wind flow. The gadget consists of blades (rotor), a generator enclosed in a nacelle, a assisting tower, and a manipulate unit. Typically established on towers 10 to twenty meters high, it is able to generate about three hundred to six hundred kilowatt-hours of power in line with month, relying on neighborhood wind conditions. It is right for standalone or hybrid renewable setups whilst mixed with sun panels and battery storage.



Fig 3.7: 3KW Wind Turbine

- **Brand Name:** FLTXNY POWER.
- **Type:** Wind Power Generator.
- **Model Number:** FK-3000/5000.
- **Rated power:** 3000w.
- **Output:** AC 220v.
- **Color:** White.

3.2.7 Weather Sensors: A “climate sensor” in a sun-primarily based totally microgrid device video display unit’s key environmental parameters which include sun irradiance, temperature, wind speed, and humidity. These sensors assist optimize the overall performance of sun panels through presenting real-time facts that may be used for strength forecasting, device control, and overall performance analysis. Accurate climate facts permit higher load control and improve the general performance and reliability of the microgrid, especially in variable weather conditions.



Fig 3.8: Weather Sensor

3.2.8 Distribution Cables:

- **Type:** Copper or Aluminum.
- **Cable Name:** Walton – Offers XLPE- or PVC-insulated battery cables for automotive, solar applications.
- **Voltage Rating:** Low-voltage distribution.
- **Sizing:** Based on system load.



Fig 3.9: Distribution Cable

3.2.9 Electrical Protection Devices: A DC MCCB (Molded Case Circuit Breaker) is an electrical safety tool used to mechanically interrupt DC circuits withinside the occasion of overloads or quick circuits. It performs a important position in safeguarding additives inside sun systems, battery garage setups, and DC microgrids. Designed particularly for direct modern applications, DC MCCBs can manipulate the non-stop waft and excessive arc power ordinary of DC power, making sure secure and reliable operation in DC electric networks.



Fig 3.10: MCCB

- **Description:** M.C.C.B - Molded Case Circuit Breaker, Compact NSX400S, TMD, Rated current 400A, Breaking capacity 100kA at DC, Trip unit rating 400A, 3 Poles 3t, control-type: Toggle.

3.2.10 Load Management & Monitoring

- Measures energy consumption per household.
- Allows for prepaid or postpaid billing models.
- IoT-based monitoring for real-time performance tracking.
- Includes a web-based dashboard for analytics.

3.2.11 Installation & Maintenance Tools:

- Solar Panel Cleaning Kit.
- Electrical Testing Equipment (Multimeter, Clamp Meter).
- Safety Gear (Gloves, Helmets, Insulated Tools).

3.3 Methods

HOMER Pro Software

HOMER Pro is specialized software program designed for the modeling, analysis, and optimization of photovoltaic (PV) structures and renewable strength projects. It offers superior simulation equipment to assess the overall performance of sun strength structures, thinking about elements including sun radiation, shading, strength yield, and monetary feasibility. The software program is typically utilized by engineers, researchers, and strength experts to optimize device designs and enhance efficiency.

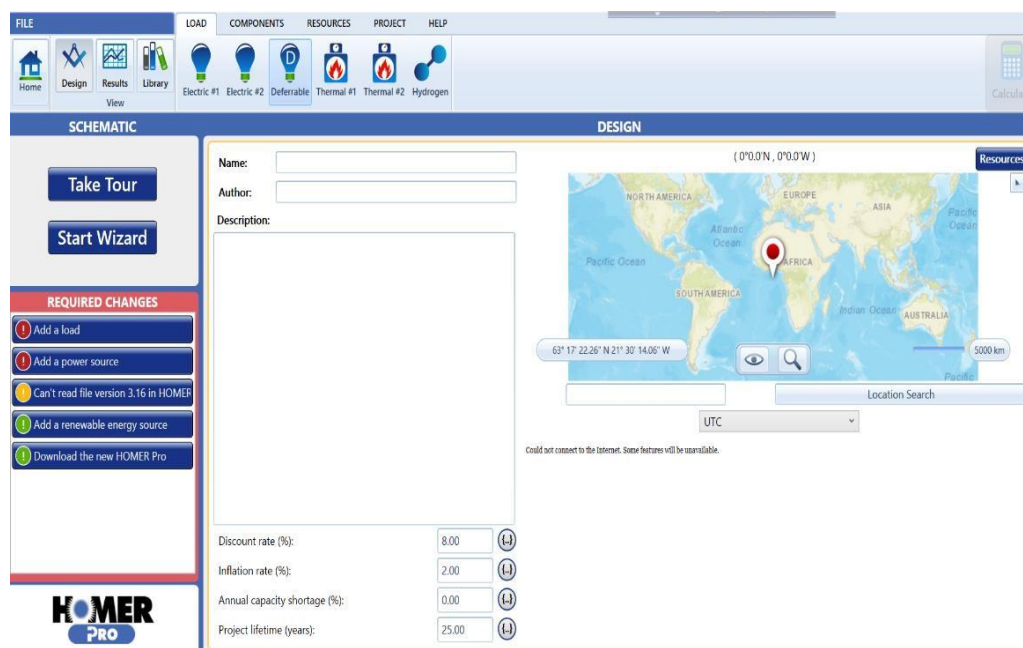


Fig 3.11: HOMER Pro Software

3.3.1 Steps in HOMER Pro

1. Define Load Profile

- Identify daily and seasonal energy consumption.
- Rural areas may have residential, commercial, and community loads.

2. Input Renewable Energy Resources

- Solar radiation data (HOMER can import from NASA or other sources).
- Wind speed if adding wind turbines.

3. Select System Components

- PV panels, batteries, inverters, charge controllers, and elective diesel generator.
- Specify costs, efficiencies, and lifelongs of components.

4. Economic & Optimization Analysis

- Capital costs, operational costs, and internet gift cost (NPC).
- Sensitivity evaluation for exclusive conditions (gas price, battery life, etc.).
- Compare gadget configurations for the maximum cost-powerful and sustainable solution.

3.3.2 Results & Interpretation

HOMER provides an optimized system with economic and technical feasibility.

Examine outputs like cost per kWh, renewable fraction, and CO₂ emissions.

Step 1: Define the Project and Site Information

- **Open HOMER Pro** and create a **new project**.
 - ✓ **Enter location details:**
 - ✓ Click on **“Resource”** → **“Solar”**
 - ✓ Use **latitude & longitude** of your rural site.
 - ✓ Import **solar radiation data** from NASA or other sources.
- **Define Project Lifetime:**
 - ✓ Set a simulation period (e.g., 25 years for PV systems).

Step 2: Define Load Profile

- **Go to “Loads” Tab** and add the rural area's energy demand.
 - ✓ **Input daily load data** (kWh per hour):
 - ✓ **Residential loads:** Lighting, TV, fans, phone charging, refrigerators.
 - ✓ **Commercial loads:** Shops, irrigation pumps, workshops.
 - ✓ **Community loads:** Schools, clinics, streetlights.

If load data is unavailable, estimate it based on the population and appliances used.

Step 3: Input Renewable Energy Resources Solar PV

- Click on “Components” → “PV” → Add a Solar Panel
- Define system parameters:
 - ✓ Size range: 1kW to 100kW (adjust based on demand).
 - ✓ Capital cost: Use typical cost (\$500–\$1000 per kW).
 - ✓ Lifetime: 25 years.
 - ✓ Efficiency: Around 15–20%.
 - ✓ Battery Storage

- Click on “Components” → “Battery” → Add a Battery Model
- Define parameters:
 - ✓ Battery type: Lithium-ion (high efficiency) or Lead-acid (low-cost).
 - ✓ Size range: 1kWh to 500kWh.
 - ✓ Cost: \$100–\$500 per kWh.
 - ✓ Round-trip efficiency: ~85%.

Step 4: Converter (Inverter & Charge Controller)

- Go to “Components” → “Converter”
- Define:
 - ✓ Efficiency: ~95%.
 - ✓ Capital cost: \$200–\$500 per kW.
 - ✓ Cost per liter of fuel: ~\$1.

Step 5: Define Economic Parameters

- Click on “Economics” and set:
 - ✓ Project lifetime: 25 years.
 - ✓ Interest rate: ~6–10% (varies by funding source).
 - ✓ Fuel cost: If using a generator.

Step 6: Run Optimization & Sensitivity Analysis

➤ **Click “Run” and let HOMER analyze different system sizes and configurations.**

1. Review Results:

- ✓ **Optimal system configuration** (based on lowest Net Present Cost).
- ✓ **Renewable fraction** (percentage of energy from solar).
- ✓ **Levelized Cost of Electricity (LCOE)** (\$/kWh).
- ✓ **Battery state of charge over time.**

Step 7: Analyze & Finalize the System

- ✓ **Compare multiple designs** (PV-battery vs PV-diesel-battery).
- ✓ **Adjust system sizes if needed for cost-effectiveness.**
- ✓ **Export reports for stakeholders and decision-making.**

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Results

A 10-kW sun-primarily based totally microgrid device is designed the usage of HOMER Pro to offer dependable and sustainable power for rural or off-grid areas. HOMER Pro software program is used to simulate, optimize, and carry out monetary evaluation of the hybrid device. The device usually is predicated on sun photovoltaic (PV) panels with battery garage and non-obligatory diesel or wind backup to make sure electricity deliver in the course of cloudy days or nighttime. The layout consists of deciding on suitable components (sun panels, inverters, batteries, and controllers), estimating day by day electricity demand, and reading costs (initial, operational, and leveled fee of electricity). The end result is a fee-effective, environment-pleasant strength answer tailor-made to fulfill a day-by-day load of about 10 kWh.

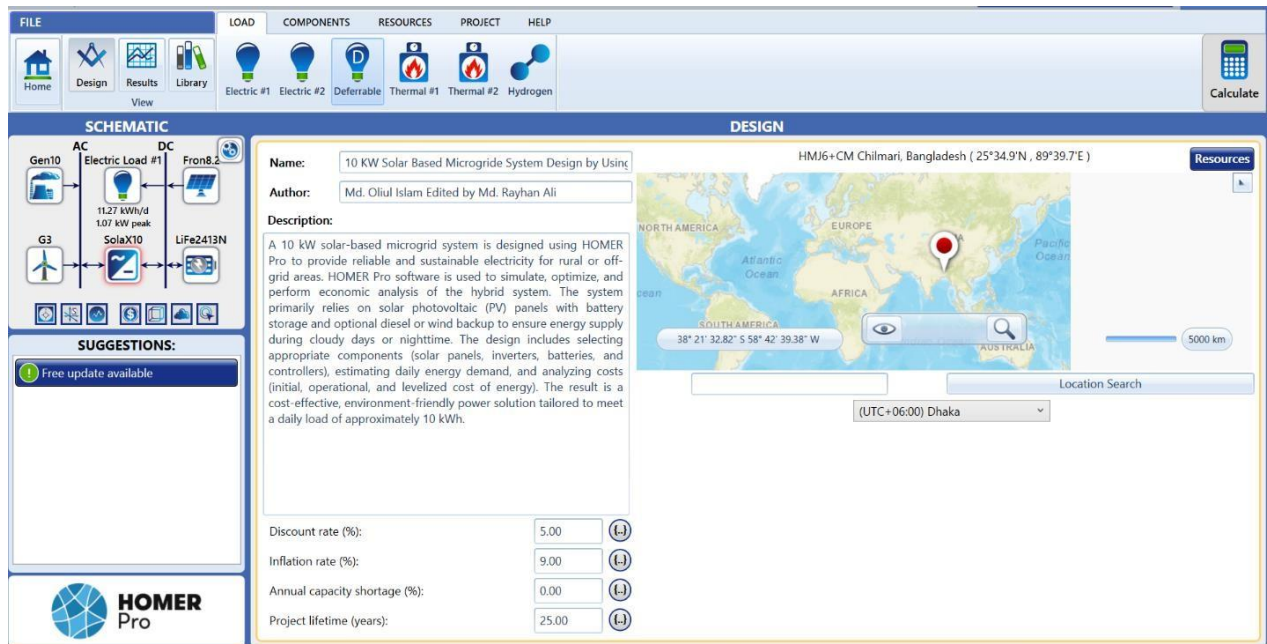


Fig 4.1: System designed by using HOMER Pro

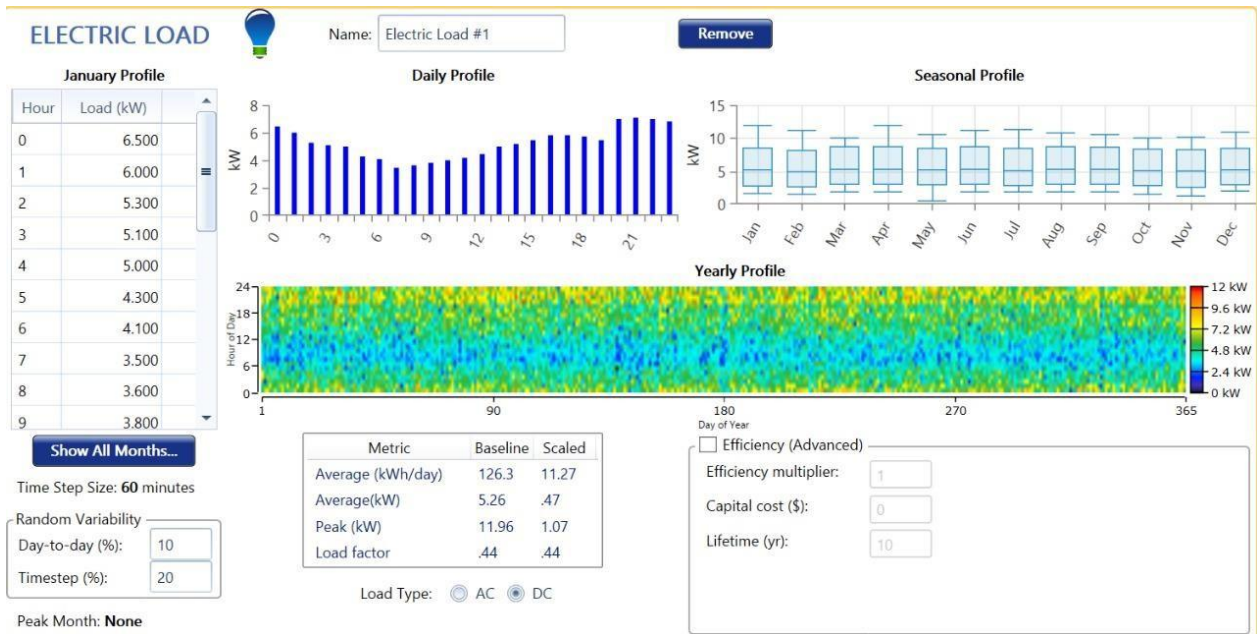


Fig 4.2: Electric Load.



Fig 4.3: Monthly Electric Production.

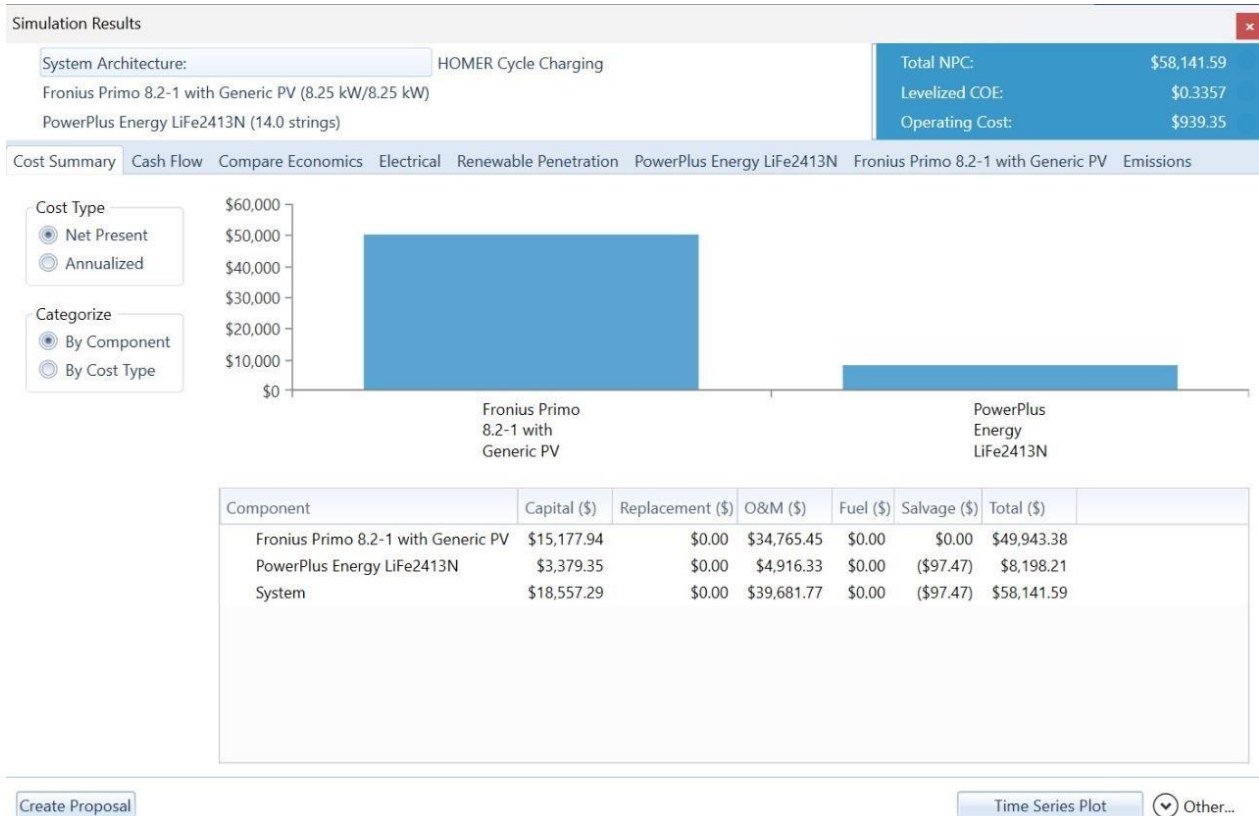


Fig 4.4: Cost Summary.

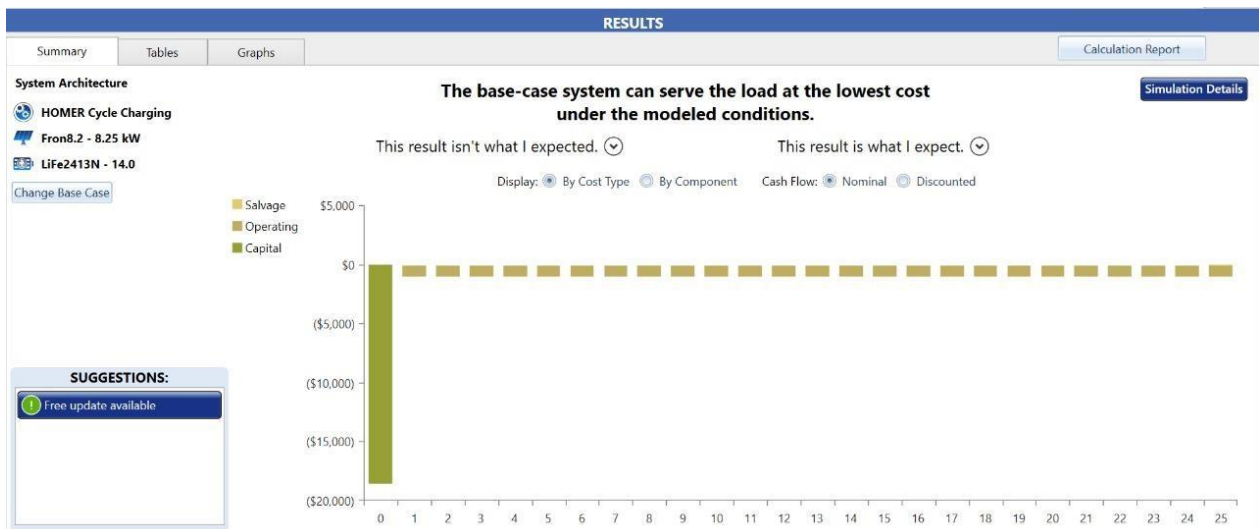


Fig 4.5: The base-case system can serve the load at the lowest cost under the model conditions.

4.2 Cost Summary:

The bar chart labeled "Cost Summary" illustrates a comparative breakdown of costs for 2 additives in a hybrid renewable power system: the Fronius Primo 8.2-1 with Generator (proven in purple) and the PowerPlus Energy LiFe2413N Battery (in mild blue). The capital fee for the Fronius Primo is approximately \$15,000, whilst the battery's capital fee is around \$3,000, bringing the full capital funding to roughly \$18,000. In contrast, the working fee is substantially higher—around \$35,000 for the Fronius Primo and \$5,000 for the battery—totaling about \$40,000 in working costs. The chart highlights that working prices are the dominant expense, mainly for the Fronius Primo unit. Capital prices are relatively a whole lot lower, with the battery creating a smaller common contribution to each capital and working prices.

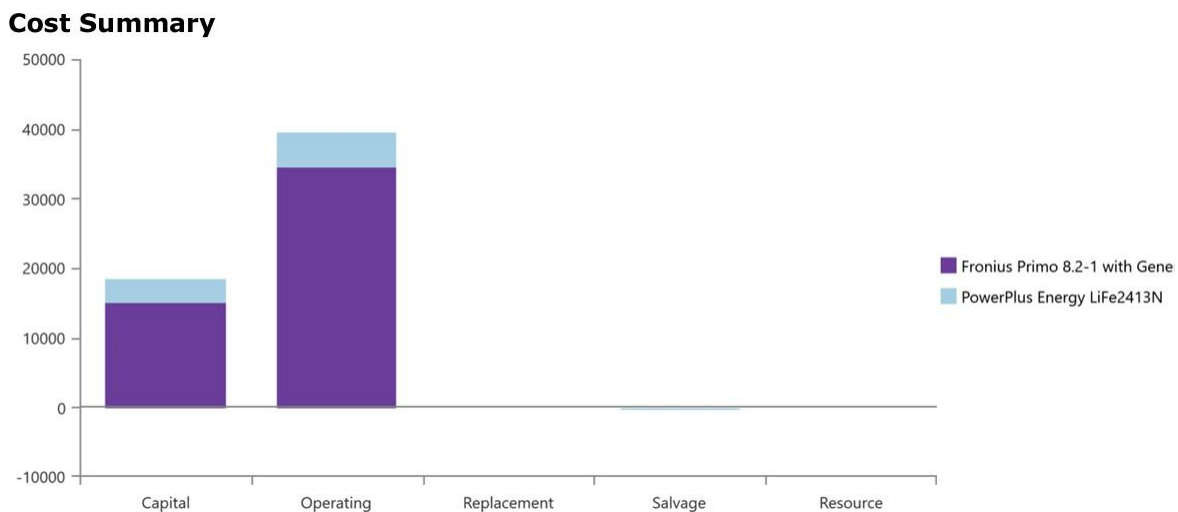


Fig 4.6: Cost Summary

Optimization Result

Architecture	PV	✓	✓	✓	✓
	Wind			✓	✓
	Diesel Generator		✓	✓	
	Battery	✓	✓	✓	✓
	Conveter		✓	✓	✓
	Fron8.2 (KW)	8.25	8.25	8.25	8.25
	G3			1	1
	Gen10 (KW)		10	10	
	LiFe2413N	14	14	14	14
	SolX10 (KW)		10	10	10
Cost	NPC (\$)	\$58,142	\$116,720	\$132,886	\$137,896
	COE (\$)	\$0.34	\$0.67	\$0.77	\$0.80
	Operating cost (\$/yr)	\$939.35	\$1,233	\$1.46	\$1,669.00
	Initial Capital (\$)	\$18,557	\$64,755	\$71,238	\$67,559
Fron8.2	Capital Cost (\$)	\$15,178	\$15,178	\$15,178	\$15,178
	Production (KWh/yr)	14,050	14,050	14,050	14,050
G3	Capital Cost (\$)			\$6,483	\$6,483
	Production (KWh/yr)			1,777	1,777
	O&M Cost (\$)			\$200	\$200
LiFe2423N	Autonomy (hr)	38.2	38.2	38.2	38.2
	Annual Throughput (KWh/yr)	2,479	2,479	2,479	2,479
	Nominal capacity (KWh)	17.9	17.9	17.9	17.9
	Usable Nominal capacity	17.9	17.9	17.9	17.9

Table 4.1: Optimization Result.

4.3 Cash flow:

The cash flow chart generated by **HOMER Pro** software illustrates the **financial performance of two energy system components over a 25-year project life**, broken down by **Capital**, **Operating**, and (potentially) **Salvage** costs.

Year 0: High capital investment is made.

Years 1–25: Operating costs are incurred annually.

Fronius Primo (inverter/generator system) has the highest capital and operating costs.

Power Plus Energy battery system contributes less to both.

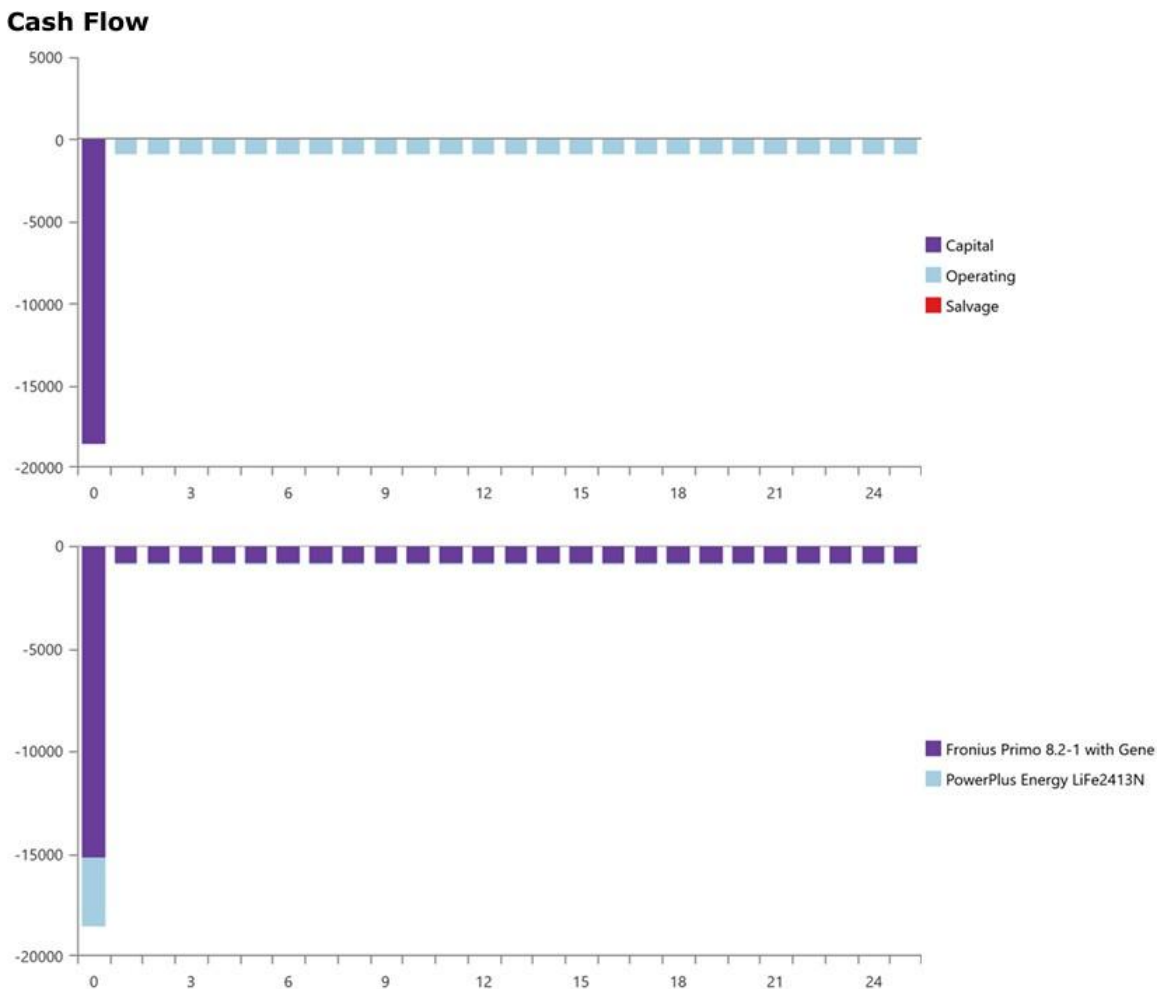


Fig 4.7: Cash flow

4.4 Proposed Annual Cash Flows:

The preliminary segment of the proposed device entails a large capital funding of around \$17,000. Throughout years 1 to 25, it incurs small, constant working fees annually, depicted as quick bars above the x-axis. In summary, the device needs a excessive prematurely price however blessings from minimum and predictable working fees over its lifetime.

Proposed Annual Nominal Cash Flows

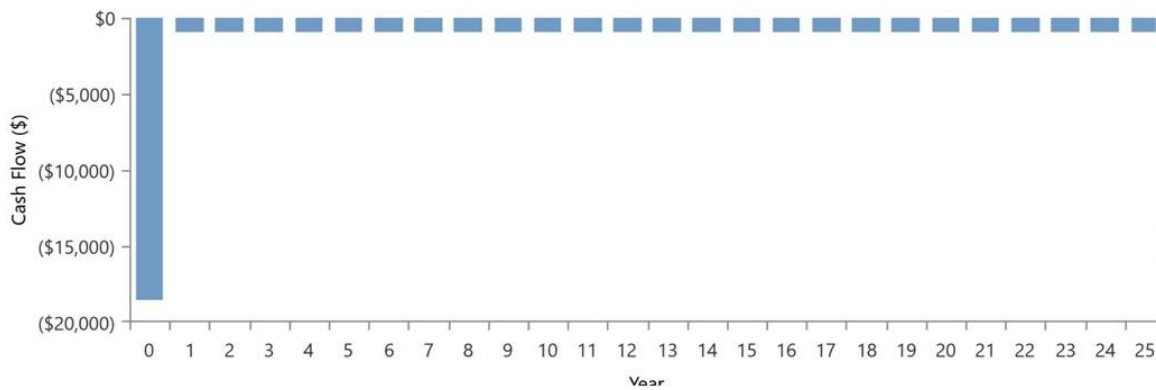


Fig 4.8: Proposed Annual Cash Flows.

4.5 Base System Annual Nominal Cash Flows:

The base device includes little to no prematurely capital investment, making it greater available initially. However, it incurs continually better annual working charges in comparison to the proposed device. This shows that at the same time as the bottom device has decrease preliminary costs, it effects in more long-time period operational charges over time.

Base System Annual Nominal Cash Flows

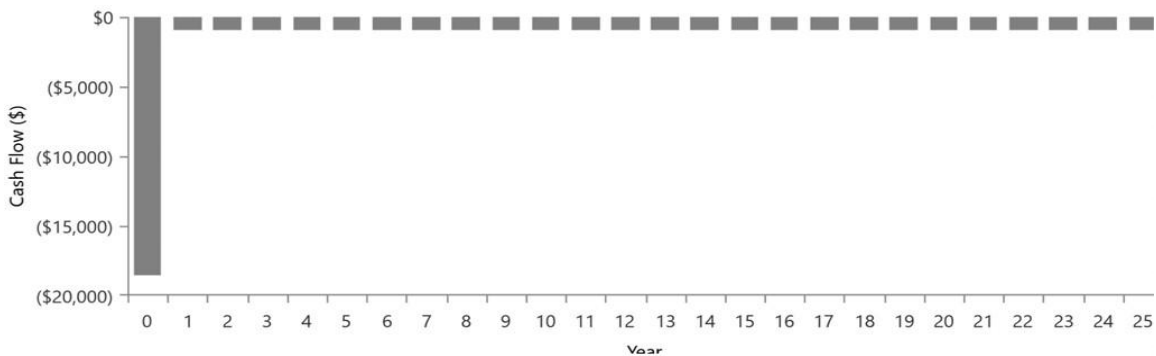


Fig 4.9: Base System Annual Nominal Cash Flows.

4.6 Cumulative Discounted Cash Flows:

The chart illustrates the total cumulative cash flow over time, factoring in the time value of money. Over a 25-year period, both systems yield negative cash flows. However, the proposed system shows a slightly smaller loss, indicating greater long-term cost efficiency, even though it requires a higher initial investment.

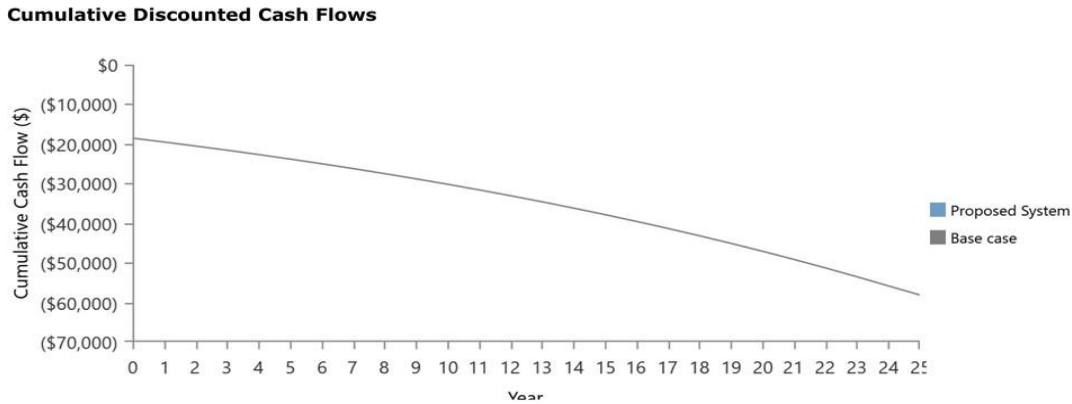


Fig 4.10: Cumulative Discounted Cash Flows.

4.7 CURRENT SYSTEM:



The electric needs of HMJ6+CM Chilmari, Bangladesh are met with 8.3 kW of PV and 18 kWh of battery capacity. Your operating costs for energy are currently \$939.35 per year. We recommend not making alterations to the current system because it is the most economical choice.

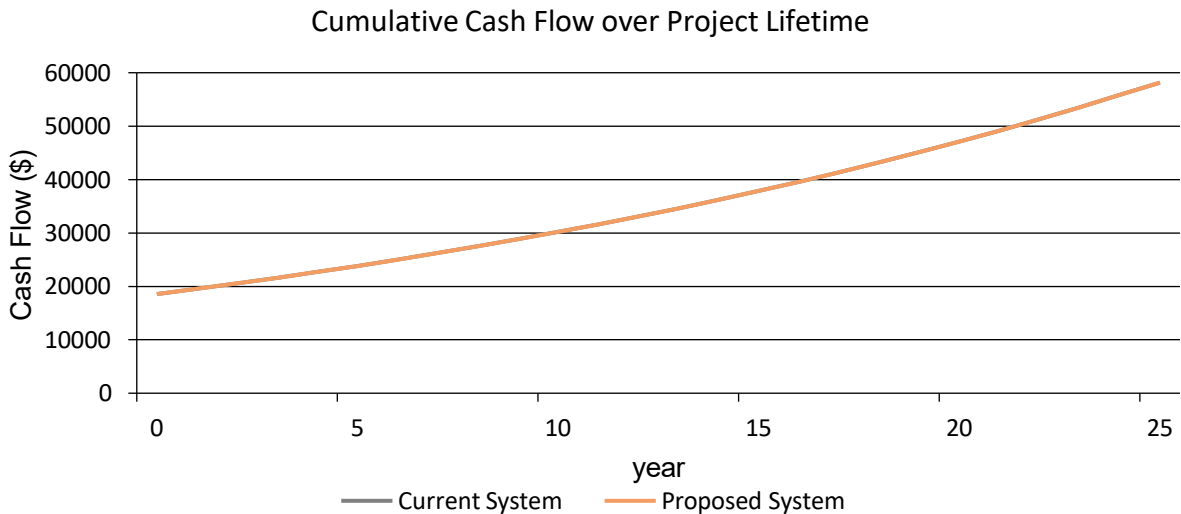


Fig 4.11: Cumulative Cash Flow over Project Lifetime.

4.8 Electric Consumption:

This microgrid requires 11 kWh/day and has a peak of 1.067 kW. In the proposed system, the following generation sources serve the electrical load.

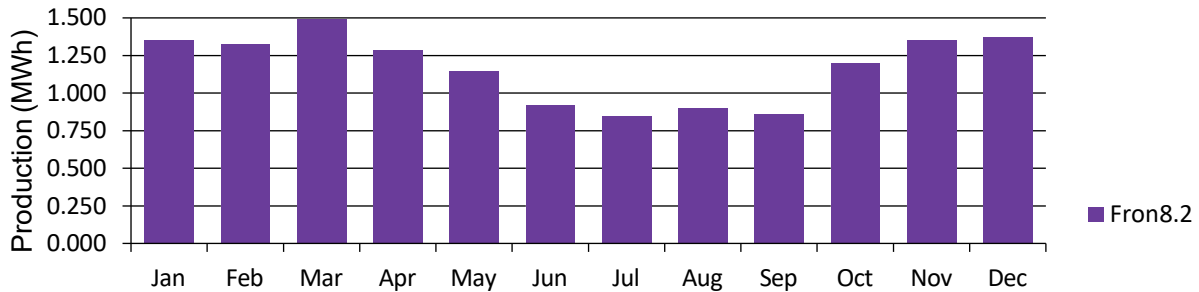


Fig 4.12: Electric Consumption

4.9 Annual Operating Costs Over a 25-year:

This HOMER Pro chart indicates the once a year working fees over a 25-yr length for the proposed machine. Each yr, the Fronius Primo PV machine fees \$825, and the PowerPlus battery fees \$116.sixty seven, totaling \$941.sixty seven annually. Costs stay constant, indicating stable, low long-time period costs after the preliminary investment.

Cash Flows

Project Lifetime		25 years		Expected Inflation Rate		9.0%		Nominal Discount Rate		5.0%		Real Interest Rate		-3.7%	
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fronius Primo 8.2-1 with Generic PV	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)
PowerPlus Energy LiFe2413N	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)
Year	16	17	18	19	20	21	22	23	24	25					
Fronius Primo 8.2-1 with Generic PV	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)	(\$825.00)					
PowerPlus Energy LiFe2413N	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)	(\$116.67)					

Fig 4.13: Annual Operating Costs Over a 25-year:

CHAPTER 5

PROJECT MANAGEMENT

5.1 Task, Schedule and Milestones

Including a Gantt chart within the creation enables define the paintings timeline, at the same time as the Work Breakdown Structure (WBS) is used to arrange tasks. Each assignment might also additionally require a completely unique WBS, and locating the only shape for our crew might also additionally take a few times. The number one goal is to beautify visibility for all stakeholders and illustrate the collection of tasks. A Gantt chart is a famous instance of a WBS representation. Our WBS may be established as a Gantt chart to focus on assignment milestones and venture dependencies. While the terms "Gantt chart" and "WBS" are regularly used interchangeably, they discuss with extraordinary control tools. The WBS serves as the inspiration of the Gantt chart, assisting to interrupt the assignment into possible sections. It gives a hierarchical breakdown of all required efforts to finish the assignment. Meanwhile, the Gantt chart offers a complete framework for next planning. This record outlines the assignment's control and manipulates processes.

5.2 Resources and Cost Management

5.2.1 Resource Allocation

Resources required for mission execution include:

- **Technical Resources:** PV panels, inverters, batteries, HOMER-Pro software.
- **Human Resources:** Engineers, technicians, economic analysts.
- **Financial Resources:** Budget allocation, investment sources (authorities grants, non-public investment, etc.).

5.2.2 Cost Estimation

The expected value additives include:

- **Capital Costs:** PV panels, inverters, battery storage.
- **Operational Costs:** Maintenance, labor, gadget monitoring.
- **Total Project Budget:** Based on HOMER-Pro optimization results.

5.3 Risk Management:

Risk Type	Description	Mitigation Strategy
Data Inaccuracy	Load profile or resource data mismatch	Use validated and reliable data sources
Cost Variation	Equipment price fluctuations	Use average market prices and adjust margins
Software Errors	HOMER-Pro simulation bugs or configuration faults	Maintain backups and validate input parameters
Environmental	Unpredictable weather affecting solar/wind output	Use long-term average meteorological data

Table 5.1: Risk Management.

5.5 Project Timeline:

Phase	Activities	Duration
Initiation	Topic selection, literature review	2 weeks
Planning	Data collection, load assessment	3 weeks
Design	System configuration in HOMER-Pro	3 weeks
Simulation & Optimization	Technical and economic simulation in HOMER-Pro	2 weeks
Evaluation	Results analysis, interpretation	1.5 weeks
Documentation	Report writing, editing, and submission	2.5 weeks

Table 5.2: Project Timeline.

5.5 The scope of this task includes:

- Load evaluation for the Chilmari area.
- Collection of meteorological and monetary data.
- System modeling and simulation the usage of HOMER-Pro.
- Environmental and technical overall performance evaluation.
- Cost analysis CAPEX, OPEX, LCOE and NPC.
- Component Selection PV Panels, Batteries, Converter, Wind turbine and generator.

5.6 Conclusion:

The success control of this microgrid task relies upon at the strategic software of task control principles. Through based planning, green use of resources, and systematic threat control, the task goals to supply a sustainable and cost-powerful solar-primarily based totally electricity answer for Chilmari. The equipment and methodologies followed make certain excessive reliability, adaptability, and alignment with real-global electricity challenges. Component Selection PV Panels, Batteries, Converter, Wind turbine and generator.

CHAPTER 6

IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

The transition from conventional fossil gasoline-primarily based totally electricity era to renewable power sources (RES) is pushed with the aid of using improvements in era and developing environmental concerns. This shift complements sustainability however introduces demanding situations together with low-inertia systems, integration complexities, and new manipulate dynamics. In rural regions, PV sun-primarily based totally microgrids provide a feasible answer for sustainable power era, lowering dependency on centralized grids and enhancing power access. Economic blessings consist of decrease power costs, decreased gasoline consumption, and minimized transmission losses. HOMER-Pro, a software program device for optimizing microgrid designs, performs an important function in assessing machine feasibility with the aid of using thinking about monetary and operational constraints. The adoption of sun microgrids extensively decreases greenhouse fuel line emissions and pollution, making it an environmentally sound.

The societal effect of sun-primarily based totally microgrids in rural regions is profound. They decorate the first-rate of existence with the aid of using presenting solid power for lighting, education, healthcare, and neighborhood businesses. This fosters monetary growth, reduces rural-city migration, and promotes network development. Moreover, decentralized electricity era strengthens power safety and resilience towards grid failures.

6.2 Environmental and Ethical Considerations

One of the number one benefits of PV sun-primarily based totally microgrids is their minimum environmental footprint. Unlike fossil fuel-primarily based totally energy plants, sun strength technology does now no longer produce direct emissions, mitigating weather alternate impacts. However, demanding situations along with land use, aid extraction for PV manufacturing, and end-of-existence disposal require strategic control to hold environmental integrity.

Voltage balance is an essential thing of microgrid performance. Efficient strength garage and cargo control techniques have to be carried out to stability technology and consumption.

Additionally, moral considerations, along with honest pricing, accessibility, and accountable waste disposal of sun components, have to be addressed to make certain long-time period sustainability.

6.3 Utilization of Existing Standards

- 1. Cooling System Optimization:** The effectiveness of cooling structures needs to be evaluated at some stage in the layout Stage to save you overheating and make sure most useful performance. Regular preservation and tracking of cooling mechanisms are essential to preserve performance over the operational lifespan.
- 2. Inverter and Electrical Safety:** Common troubles such as "isolation faults" can affect inverter overall performance. These faults arise because of moisture, bad installation, or cable damage. Preventive measures, along with right DC cable placement, water resistant sealing, and selecting suitable safety levels (IP ratings) for inverter enclosures, can decrease overall performance losses and protection hazards.
- 3. HOMAR Pro Based Simulation:** HOMAR Pro is an effective simulation device for microgrid analysis, supplying superior modeling competencies for electricity systems. It allows correct evaluation of gadget performance, optimization, and integration of renewable electricity sources.

➤ **Key aspects of HOMAR Pro simulation include:**

- ✓ **System Modeling** – Provides comprehensive modeling of microgrid components, including generation, storage, and loads.
- ✓ **Optimization & Analysis** – Allows for economic and technical optimization of energy dispatch and grid stability.
- ✓ **Error Handling & Debugging** – Ensures smooth simulation processes with robust mechanisms to detect and resolve computational errors.

CHAPTER 7

CONCLUSIONS AND FUTURE TRENDS

7.1 Conclusions

The evaluation of a photovoltaic (PV) sun-primarily based totally microgrid machine for rural regions the use of HOMER-Pro highlights the huge capacity of renewable strength to cope with the strength demanding situations confronted via way of means of faraway regions. HOMER-Pro presents a complete platform for modeling, optimizing, and studying the technical and monetary overall performance of microgrids, making sure an green and cost-powerful strength solution.

The use of PV structures in rural microgrids can substantially decorate strength reliability and decrease dependence on traditional, expensive, and regularly unreliable energy sources. HOMER-Pro's optimization algorithms can pick out the maximum in your price range blend of PV, battery storage, and different renewable strength sources, making sure less costly and sustainable strength manufacturing for off-grid groups. PV-primarily based totally structures appreciably lessen carbon emissions, making them an environmentally pleasant opportunity to standard energy technology methods. Rural groups can reap extra strength safety and independence via way of means of adopting microgrids powered via way of means of sun strength, decreasing vulnerability to grid disruptions and gas deliver shortages.

HOMER-Pro serves as a vital tool for assessing and optimizing PV-based absolutely microgrid structures, making it a treasured beneficial aid for rural electrification tasks aiming for sustainability, cost-efficiency, and resilience.

7.2 New Skills and Experiences Learned

7.2.1 HOMER-Pro Software Proficiency: Gaining hands-on enjoy with HOMER-Pro has allowed for a deep information of its talents in simulating and optimizing microgrid systems. The tool's capacity to version electricity generation, storage, and distribution has more advantageous my technical talent in studying renewable electricity systems.

7.2.2 Understanding of PV System Design and Optimization: The technique of designing and optimizing a photovoltaic-primarily based totally microgrid has furnished precious insights into choosing the proper stability of sun panels, battery storage, and different machine components. This revel in has helped enhance my decision-making talents in developing cost-powerful and green power solutions.

7.2.3 Economic and Technical Analysis: Through this project, I've discovered the way to check each the technical and financial components of a microgrid system, from electricity manufacturing and intake to price breakdowns and go back on investment (ROI). This ability is crucial for comparing the viability of renewable electricity answers in rural areas.

7.2.4 Renewable Energy Integration in Rural Areas: The challenge has deepened my information of the particular demanding situations confronted with the aid of using rural regions in phrases of power access. I now have a higher draw close of a way to combine renewable power structures like sun into off-grid groups and the blessings they bring, which includes power independence and decreased environmental impact.

7.2.5 Error Handling and Debugging in Simulation Tools: Working with HOMER-Pro has highlighted the significance of precision in simulation modeling. I've won precious revel in in blunders detection, debugging, and making sure that simulations run correctly, main to greater correct and dependable results.

7.2.6 System Optimization Skills: I've discovered the way to optimize microgrid overall performance through thinking about different factors which includes strength generation, storage, and distribution strategies. This entails fine-tuning the device to make certain it offers dependable electricity whilst minimizing prices and environmental impact.

7.3 Future Trends

The destiny of PV solar based totally microgrid structures in rural regions is pushed through development in power storage, clever grid era, and AI-primarily based totally optimization. Improved battery era will decorate power reliability, whilst AI and device studying will permit predictive analytics for higher grid management. The integration of IoT will permit real-time tracking and far off manipulate of microgrids. Government rules and monetary incentives will similarly boost up adoption. Additionally, hybrid microgrid fashions combining sun with wind or biomass power will decorate sustainability. HOMER-Pro will hold evolving to help those advancements, making rural electrification greater efficient, cost-effective, and resilient.

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