Research Report

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June 11, 2023

Contents

1 Literature Review

This literature review aims to explore current applications and trends in IT solutions for sustainable energy systems in indigenous areas. The focus is on developing a practical and cutting-edge application for Phu Tho province, emphasizing renewable energy technologies and decentralized energy for rural environments. The review will provide an overview of the target area's energy situation, demand, and theoretical foundations derived from existing software tools. The goal is to create an adjusted and applicable version of these tools.

1.1 Description of technology tools

Rising energy consumption as a result of urbanization, population growth, and industry has an influence on quality of life. Rural towns require stable energy for socioeconomic development. Hybrid energy systems, which combine fossil and renewable fuels, provide benefits including increased efficiency, less storage needs, improved reliability, and lower life cycle costs. They do, however, need a significant upfront investment in terms of money, space, and infrastructure.
Software tools for hybrid systems are being studied, reviewed, and conducted as several names, according to (Sinha & Chandel, 2014), 19 software with their main features and current status are presented. Nonetheless, HOMER and RETscreen are the two most appropriate and widely-used pieces of software that can be utilized as references for our system since we consider and analyze available software that can be used in this scenario. Natural Resources Canada (NRCan) created RETScreen, a comprehensive software tool, to evaluate renewable energy and energy efficiency projects. It is frequently used for feasibility studies, energy production analyses, and assessments of greenhouse gas emission reductions since it has an intuitive user interface and strong analytical features. RETScreen enables new and retrofit projects with capabilities including financial analysis, project size, and performance review. Additionally, it gives users access to hydrological data, energy resource maps, climate databases, and global climate data from NASA. A sizable section of the world's population benefits from RETScreen, which is used in more than 222 nations and territories and is available in 36 languages. ,(Owolabi et al., 2019). The U.S. National Renewable Energy Laboratory (NREL) created the Hybrid Optimization Model for Electric Renewables (HOMER) computer model in 1992 to aid in the design of micropower systems and to make it easier to compare power production technologies across a variety of applications. A power system's physical behavior and life-cycle cost, or the entire cost of building and maintaining the system during its lifespan, are both modeled by HOMER. HOMER enables the modeler to evaluate several design alternatives according to their technical and financial advantages. According to (Pavlovic et al., 2013) HOMER was designed to overcome these challenges. HOMER simulates and optimizes stand-alone and grid-connected power systems comprising any combination of PV arrays, wind turbines, run-of-river hydropower, biomass power, internal combustion engine generators, microturbines, fuel cells, batteries, and hydrogen storage, serving both electric and thermal loads (by individual or district-heating systems), especially solar power. So we can see that it is feasible to combine the software's benefits and drawbacks with issues unique to our target region to create a brand-new program that is ideal for our approach to combating energy poverty in the region.

1.2 Software Applied cases

In 2012, Alireza Hajiseyed Mirzahosseini and his colleagues published a paper in which the RETscreen mode was used for performing energy production analysis, financial analysis, and GHG emission analysis. During analysis, similar to how it was used to determine the technical viability of grid-connected solar PV in Bangladesh, RETScreen simulation software has been used in other studies to evaluate the viability of solar photovoltaic as a source of power. A typical yearly output of 1729 MWh was predicted for the system. Each location in that nation would be able to reduce its yearly greenhouse gas emissions by at least 1423 tons using the suggested technique. Using RETScreen modeling software, the viability of a 10 MW solar power station in Abu Dhabi was also investigated. The first findings demonstrated a sizeable amount of potential energy generation, generating 24 GWh and avoiding more than 10,000 tons of GHG emissions energy (Mirzahosseini & Taheri, 2012). Also in 2014, Rohit Sen has publish a paper that titled "Off-grid electricity generation with renewable energy technologies in India:" using HOMER, and RETscreen. Using an Indian village as an example, they calculate the potential demand, list the resources that are available, use HOMER software to model electricity generation based on various RET combinations, choose the best option based on the cost of electricity generation, and then compare these performance indicators to grid extension-related costs, (Sen & Bhattacharyya, 2014).

2 Project background

Using software technology, renewable energy sources, and effective power management, this project aims to create a safe and sustainable energy system for Phu Tho. The effort intends to offer the community a dependable and ecologically sustainable energy supply by employing solar energy, demand-side management, and smart grid technologies. Individualized energy monitors and real-time monitoring will support sustainable energy consumption and allow for well-informed decision-making. Through the construction of a cost-effective and secure energy infrastructure, this project aims to enhance social and economic development, safeguard the environment, and enhance quality of life in Phu Tho.

3 Methodology

The literature review briefly looked at software tools. In the methodology, their applications and techniques will be examined deeply in order to advance and create the best performance for the project. It must first comprehend the benefits and drawbacks of each software and why combining them would create a platform for energy monitoring that is more comprehensive. To figure it out, a study titled "Performance assessment of a 20 MW photovoltaic power plant in a hot climate using real data and simulation tools" (Bentouba et al., 2021) analyzes the energy output of a real 20 MW photovoltatic power plant in Egypt and contrast the results of RETscreen Expert and HOMER Pro.

With variations between their anticipated yearly energy yield of only 0.05 percent, the study con-

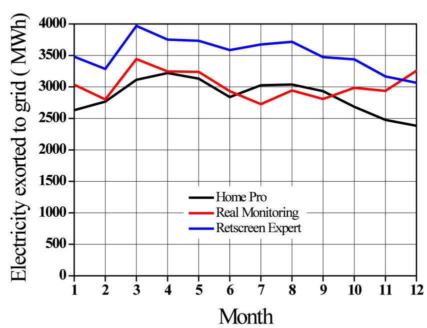

Figure 1: 2
018 Performance ratio based on genuine data from HOMER Pro and RETScreen Expert.

cluded that both methods produce reliable estimations of the power plant's energy production. Both tools are well-designed and user-friendly, with HOMER offering more in-depth technical details on the power plant's parts. Regarding the drawbacks, the study discovered that RETScreen is only capable of analyzing individual cells and requires the user to manually enter PV power numbers for each panel. However, HOMER can only research small-scale projects and is less suited to analyzing large-scale commercial energy systems. In-depth analysis of each program reveals that HOMER requires a learning curve for users unfamiliar with renewable energy systems and has limitations in accommodating all generator types. However, by combining data from RETScreen and Phu Tho's solar radiation information, we can optimize solar panel deployment. RETScreen offers standardized project evaluation, a wide range of weather data, energy efficiency techniques, and renewable energy technologies. It excels in performance analysis and GHG emissions assessment but has limited optimization capabilities compared to more advanced programs like HOMER. Overall, HOMER works in conjunction with the user-friendly simulation display to monitor the statuses of generators and transform generated power into a sufficient flow. The study would be more beneficial with RETScreen for activities like determining how much energy a location requires and scheduling the amount of applications that will be most advantageous for power-saving and building. Additionally, it calculates the amount of energy needed for each family and offers customized energy sales. Finally, RETScreen also includes an emission analysis, which means it manages the emissions produced by the generators, making it environmentally beneficial, especially given that our setting is a national park.

3.1 Problem Statement

Limited access to economical and trustworthy energy sources is a critical concern in Phu Tho and surrounding areas. Due to the insufficient supply of reliable energy resources, the community is faced with socioeconomic difficulties and environmental damage. This impedes development in important areas like economic growth and life quality. The current energy infrastructure is unable to keep up with the rising energy needs. Traditional energy sources are unstable, ineffective, and unsustainable from an environmental standpoint. A sustainable energy system that incorporates renewable energy sources, effective power management, and community involvement is urgently required to address these issues. Phu Tho can satisfy its energy requirements, advance socioeconomic development, and protect the environment through putting in place a secure, dependable, and affordable energy system.

4 Project Goals and Objectives

4.1 Project Goals

The Goals of the Project contains two main goals, which is:

4.1.1 Renewable Energy Integration

1. To lessen dependency on fossil fuels and support a sustainable energy system, increase the proportion of renewable energy sources in the energy mix.

2. Promote the creation and use of solar renewable energy technologies.

4.1.2 Energy Efficiency and Conservation

1. Reduce energy consumption and enhance the functionality of the entire energy system by implementing energy efficiency measures.

2. Encourage end users to exercise energy saving and inform the public about effective energy usage.

4.2 Project Objectives

The key project goals have been broken down into a set of objectives that will provide a more detailed procedure for fulfilling the project's primary criteria.

- Install an accumulator so that the system can be technically and economically analyzed to help developers maximize the revenue from their energy storage or hybrid projects.

- Install the software system based on SETscreen at the culture house so that everyone can track, manage and analyze how many solar panels each family need to sustain their living energy, thus install the solar panel

5 Desired outcomes and benefits

5.1 Accurate Rural Energy Planning:

- Our new project will allow for more thorough and accurate rural energy planning. The integrated system can evaluate the viability and cost-effectiveness of renewable energy projects specifically for rural areas by utilizing HOMER's sophisticated optimization algorithms and RETScreen's thorough technical and financial analyses. As a result, planning results are improved, resources are used effectively, and the implementation of sustainable energy solutions in rural areas is made easier.

5.2 Climate Resilience and Environmental Sustainability:

- The integrated system encourages climate resilience and environmental sustainability in rural regions. In order to reduce greenhouse gas emissions and lessen the effects of climate change, HOMER and RETScreen promote the use of renewable energy sources and improve system design. Additionally, the integration encourages the use of energy storage technology, improving system resilience against climate-related events and enabling better management of intermittent renewable energy sources.

6 Learning issue/problem (individual)

Understanding solar energy algorithms, design ideas, and practices is one learning difficulty and challenge that could develop in the project. Numerous mathematical methods, systems ideas, and analytical techniques may need to be studied by users. By offering thorough cheat sheet documentation, instructional videos, and developer assistance to help users use the software tools and build the knowledge and abilities required for constructing solar energy systems, this learning challenge may be resolved.

7 Project Scope and Exclusions

The following features of a sustainable energy system will be included in order to fulfill the goals and objectives listed above:

7.1 System Design and Optimization:

- Improving solar renewable energy system designs to address the particular requirements and difficulties of rural areas. This entails figuring out the best placement and arrangement of renewable energy sources, energy storage technologies, and grid connectivity choices while taking energy demand, resource availability, and load profiles into account.

8 Project Deliverable

The final project deliverables include:

- Description of the project
- Reference that supports the project
- A presentation to persuade listener or investor

9 Project Management Plan

9.1 Timeline

The overall timeline of the project is as follows:

Sustainable Energy software Project	**Week 6**	**Week 7**	**Week 8**	**Week 9**	**Week 10**	**Week 11**
Build an UML diagram	X					
Design the frontend or user interface	X	X				
Design the backend and database side	X	X				
Writing code for the frontend of software		X	X	X	X	
Writing code for the backend of software		X	X	X	X	
Writing test case and testing			X	X	X	
Pre-Alpha release			X			
Alpha release				X		
Beta release					X	
General availability						X

9.2 Goals and Milestone

- Build a UML diagram
  Finishing drawing and noting the UML diagram Taking ideas from teammates
- Design the front end
  Create using Figma Make sure the interface is user-friendly and informative
- Design the back end
  Using the respiratory pattern and applied object-oriented programming, create the backend. Verify that the code is clear and contains just brief functions.
- Writing code for front end
  Using reactJS to design application overall
- Writing code for backend.
  Creating the software classes Adding properties, methods, and variables for each class
- Writing test case and testing
  Noting the components that will be tested and creating test instructions that contain test requirements utilizing NUnit test kits when writing test cases Performing the test
- Pre-alpha phase
  Testing software by devs
- Alpha phase
  Push code to github for users to download and experience
- Beta phase
  Available for download from our website, so people may test and report errors
- General availability
  Release and publicize software across several platforms

9.3 Team breakdown and duties

Name	Role
Tran Hoang Hai Anh	Project manager, developers
Nguyen Manh Dung	Project owner, developers
Tran Yen Nhi	Software checker and advisor
Nguyen Tran Yen Binh	Tester
Tran Hai Long	System Spectator (did nothing)

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