IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 2, 2022

DESIGN AND SIMULATION OF OPTIMUM UTILIZATION OF RENEWABLE ENERGY SOURCES IN REMOTE AREAS

[1]Dupathi Rajeswari, [2]Manchala Venkatesh, [3]Pobbathi Jayaprakash, [4]Golla Shiva Kumar, [5]Mallepogu Rajesh, [6]Mr. P. Pedda Reddy

[1,2,3,4,5,6] Department of EEE, St. Johns college of Engineering and Technology, Yemmiganur, AP

ABSTRACT:

The use of a renewable energy hybrid system is a very promising, cost-effective, and dependable solution for providing electricity to rural regions. Hybrid energy systems are being used to minimize the consumption of fossil fuels in order to mitigate environmental impacts.

However, the study of hybrid systems is inherently complex, necessitating the use of computing tools.

For the purpose of designing, analyzing, and optimizing software. The purpose of this work is to provide a range of essential software tools needed for the design, analysis, and optimization of hybrid systems. The software mentioned include HOMER, RET Screen, PVsyst, and iHOGA.

Key terms: Hybrid energy, software tools, and renewable energy.

I. INTRODUCTION

In this modern day, the population is steadily growing, resulting in a power shortage. A reliable and protected source of electricity is vital for the development of the economy. In the majority of rural regions, the absence of power is mostly due to the lack of cost-effective grid connections. In such cases, a viable solution is to implement stand-alone hybrid systems to provide energy to these remote areas. The global issue of fossil fuel reserves contributes to environmental pollution via emissions. Conversely, renewable energy sources are naturally abundant and may provide power without any expense. However, there is only one renewable energy system that is both cost-effective and dependable. This is because other renewable energy systems are seasonal and not available consistently throughout the year. Therefore, we are moving towards a hybrid system.

The hybrid system solution is intricate, necessitating the use of software tools for design, analysis, simulation, economic evaluation, and optimization planning [1–5]. Currently, simulation is widely used around the globe. Consequently, software has become affordable

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 2, 2022

and accessible for learning purposes. Several software programs have been created to address issues related to optimal design or size, which ultimately results in expensive installation costs. This study will examine the software programs HOMER, RETScreen, PVsyst, and iHOGA. The range of values is from 1 to 3.

Table 1 Free version software tools [2]

Software name	Manufacturer/developing institute	Cost
HOMER	Mistaya Engineering, Canada	Free
RETScreen	Natural Resources Canada	Free
PVsyst	Institute of Environmental Sciences (ISE), University of Geneva, Switzerland	Free
iHOGA	University of Zaragoza, Spain	EDU version is free

Table 2 Priced version software tools [2]

Software name	Manufacturer/developing institute
INSEL	German University of Oldenburg
TRNSYS	University of Wisconsin and University of Colorado
iGRHYSO	University of Zaragoza, Spain

1.1 Available Software for Hybrid System Simulation

Table 1 presents a list of significant hybrid system simulation software tools, along with their respective manufacturers or development institutions and availability. This information is further detailed in Table 2.

II. SOFTWARE TOOLS

2.1 HOMER

HOMER stands for Hybrid Optimization Model for Electric Renewable. The program, created in 1993 [6], is extensively used. HOMER does both optimization and sensitivity analysis. The system utilizes HOMER to conduct an energy balance calculation, taking into account various numbers and sizes of components. The program has provided a list of configuration results arranged based on the Total Net Present Cost (TNPC). Sensitivity analysis involves the examination of different variables, such as wind speed and fuel cost, to assess their impact. HOMER presents simulation results in both tabular and graphical formats, based on many potential setups. These data facilitate the comparison of various configurations and the assessment of their economic advantages. HOMER Pro 3.1 was launched on January 20, 2015 and it includes all available features

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 2, 2022

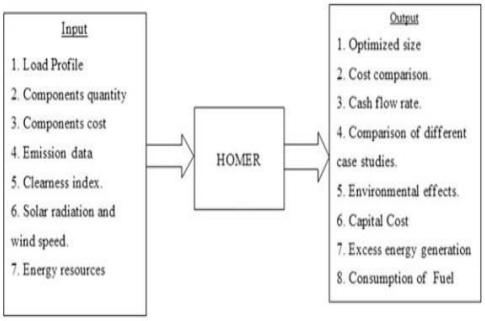

Fig. 1 Schematic representation of HOMER [1, 2]

HOMER 2 functionality has been enhanced and expanded in HOMER Pro. The update to HOMER Pro 3.1 is free and introduces two more modules: advanced grid and hydrogen. HOMER is widely used globally, with a user base exceeding 110,000. HOMER Pro version 3.1 introduces significant enhancements, such as the addition of graphing functionality and the possibility for users to include their own batteries and wind turbine. Additionally, other new features and capabilities have been included. The release date of HOMER 3.3 is July 2015 [2, 7]. Figure 1.

2.1.1 Analysis Capabilities

1. Analysis of the economy
2. The study and evaluation of historical market data, such as price and volume, to predict future price movements and make investment decisions.
3. Photovoltaic System
4. Wind System
5. Power source
6. Data storage medium
7. Bio-energy refers to the energy that is derived from organic matter, such as plants or animal waste.
8. Hydro energy refers to the energy generated by the movement of water..

2.1.2 Advantages

1. It has the ability to handle data on an hourly basis.
2. It presents outcomes in both graphical and tabular formats.
3. HOMER is very comprehensible and readily available.
4. Graphs may be imported into users' papers.
5. It may evaluate the sales or procurement of energy from the power grid.
6. The computational time is minimal.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 2, 2022

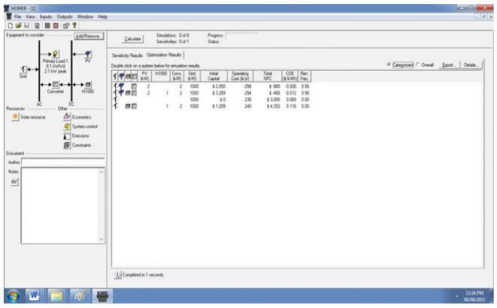

Fig. 2 Simulation result of HOMER [2]

2.1.3 Disadvantages

1. It permits the use of just imperial units.
2. Importing time series data in the form of daily averages is not possible.
3. The thermal system lacks analytical capability.
4. Fig. 2 does not include the variation in bus voltage.

2.2 RETScreen

The Renewable Energy Technologies Screen (RETScreen) is a tool designed by the Ministry of Natural Resources in Canada for assessing the economic and environmental costs of renewable energy technologies. The tool is readily accessible without cost [2, 5]. The database contains information on global climate from over 5000 ground stations, as well as energy resource maps, hydrological data, and product data. There are two available versions of RETScreen: RETScreen Plus and RETScreen 4. The assessment of energy efficiency is conducted using RETScreen Plus. RETScreen Plus is a software utility for managing energy that is designed to be used on Windows operating systems. RETScreen 4 utilizes Microsoft Excel as its foundation and is designed for the purpose of doing energy project analysis. The system offers energy analysis, cost analysis, sensitivity or risk analysis, emission analysis, and financial analysis for users [2, 7]. (Figure 3).

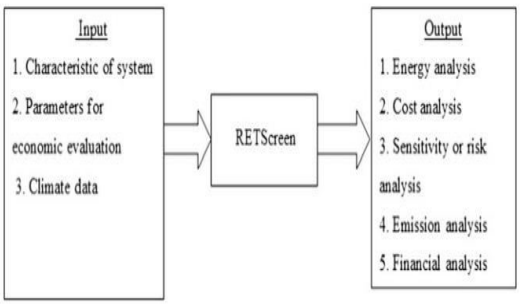

Fig. 3 Schematic representation of RETScreen [1, 2]

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 2, 2022

2.2.1 Analysis Capabilities

1. Economic analysis
2. Technical analysis
3. PV system
4. Wind system
5. Storage device.

2.2.2 Advantages

1. Main strength is financial analysis
2. Easy to use due to EXCEL-based software.

2.2.3 Disadvantages

1. Data or files cannot be imported
2. Lots of limitations for search
3. Less data input
4. Generator, hydro energy, bio-energy, thermal system analysis cannot be performed (Fig. 4).

2.3 PVsyst

PVsyst is a software application used for several types of systems, including grid-connected, stand-alone, pumping, and DC-grid systems. It carries out sizing, simulation, and data analysis. The supported operating systems for this product are Windows 7, Windows 8, and Vista [2]. PVsyst provides many tools to accurately assess and analyze shading effects.

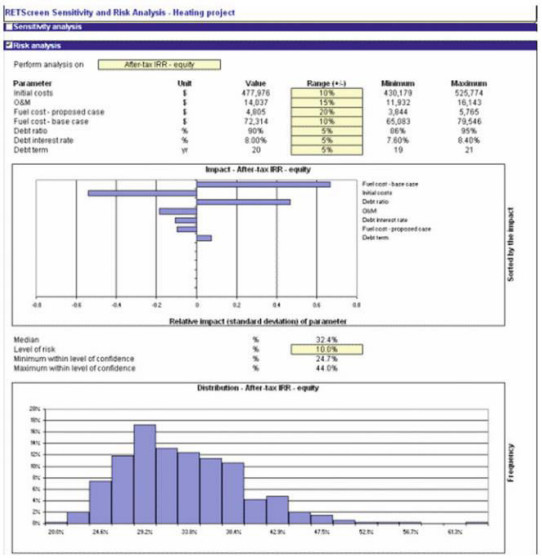

Fig. 4 Sensitivity and risk analysis result of RETScreen [2]

the ability to specify various PV fields and simulate PV systems with different orientations and characteristics. The output includes graphs illustrating the behavior of components,

specifically the behavior of an electrical PV array under partial shade. These graphs are compared to a clear day model. Additionally, the program generates synthetic files for meteorological data on an hourly basis, based on monthly values. It also does rapid calculations on hourly meteorological plots and calculates irradiation. The most recent version, 6.35, was published on March 24, 2015 [2, 8]. (Figure 5).

2.3.1 Analysis Capabilities

• Economic analysis

• Technical analysis

• PV system.

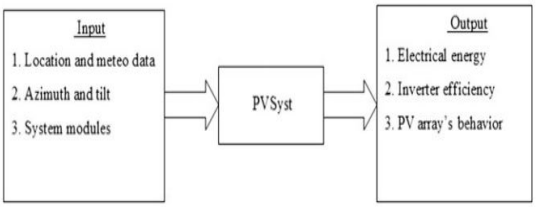

Fig. 5 Schematic representation of PVsyst [2]

2.3.2 Advantages

- It generates a loss diagram to pinpoint the vulnerabilities in the system's architecture.
- This system evaluates the actual operational characteristics of the system and detects minor operational issues.
- The graphs and tables of the results may be exported to other applications.
- Preliminary cost estimate provided

2.3.3 Disadvantages

- The hidden parameters could not be modified due to a problem.
- There is a simulation error in versions 6.33 and 6.34.
- Occasionally, there are inaccuracies in the representation of the quantity of strings shown in Figure 6.

2.4 iHOGA

The technique used is a modified form of Hybrid Optimization using Genetic Algorithm. iHOGA is a product of the University of Zaragoza, located in Spain. It was formerly known as HOGA. This is the revised iteration of the iGRHYSO. iHOGA has two versions: EBU and PRO [2, 5]. The educational edition of iHOGA is accessible for free but has some limits, whereas the professional version is a paid version with no constraints. iHOGA is only accessible in the Spanish language. The software is compatible only with Windows XP, Vista, 7, or 8. This program is used to analyze the impact of temperature on the generation of

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 2, 2022

electricity via solar systems and the production of energy by wind turbines. It computes the emissions produced over the whole life cycle. This tool also takes into account various forms of power sales or purchases from the grid. This program provides the capability to export data. iHOGA provides models that are very precise. The system employs a genetic algorithm to do multi- or mono-objective optimization. Version 2.2 was published in November 2013 [2]. (Figure 7).

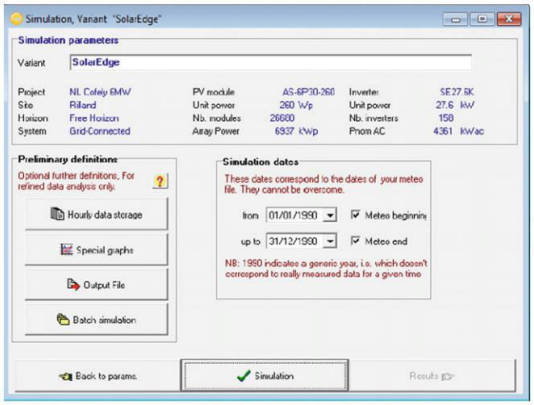

Fig. 6 Simulation result of PVsyst [2]

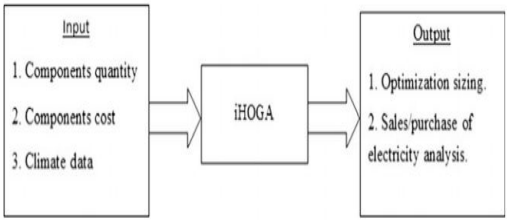

Fig. 7 Schematic representation of iHOGA [2]

2.4.1 Advantages

- iHOGA utilizes genetic algorithms to efficiently optimize hybrid systems.
- It does probability analysis.
- iHOGA provides highly accurate models for resources, components, and economical calculations.
- It optimizes the slope of PV panels.
- iHOGA is capable of simulating any instance of net-metering.

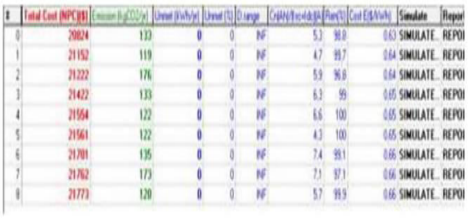

Fig. 8 Simulation result of iHOGA [2]

2.4.2 Disadvantage

- The EDU version includes restrictions on the overall average daily load.
- An Internet connection is necessary to activate the license (Fig. 8).

III. CONCLUSION

In the present period, there have been significant breakthroughs in the area of software programming that allow for the analysis of hybrid systems without any expense. All of the software tools listed in this article are easy to use. These software tools enable us to quickly assess the hybrid system. This article will provide valuable insights into the management of existing software.

REFERENCES

1. Kumar, P., Bade, A., Patil, D., Jadhav, A., Patil, S.: Optimal design solution for distributed power generation using HOME. In: 3rd International Conference on Electronics and Communication Systems, pp. 1048–1051 (ICECS 2016)

2. Kumar, P.: Analysis of hybrid systems: software tools. In: International Conference on Advances in Electrical, Electronics, Information, Communication and Bio-Informatics (AEEICB16), pp. 329–332

3. Ellabban, O., Abu-Rub, H., Blaabjerg, F.: Renewable energy resources: current status, future prospects and their enabling technology. Renew. Sustain. Energy Rev. 39, 748–764 (2014). Elsevier

4. Elhadidy, M.A., Shaahid, S.M.: Parametric study of hybrid (wind + solar + diesel) power generating systems. J. Renew. Energy 21, 129–139

5. Kumar, P.: Optimal design configuration using HOMER. Proc. Technol. 24, 499–504 (2016)

6. Zhao, D., Li, Y., Liu, Y.: Optimal design and sensitive analysis of distributed generation system with renewable energy sources. In: China International Conference on Electricity Distribution, pp. 456–460, (CICED 2014). ISSN: 2161-7481

7. Zoulias, E.I., Lymberopoulos, N.: Techno-economic analysis of the integration of hydrogen energy technologies in renewable energy -based stand-alone power systems. Renew. Energy 32 (4), 680–696 (2007)

8. Markvart, T.: Sizing of hybrid PV-wind energy system. Solar Energy 57(4), 227–281