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Microgrid Model on Homer Software

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Abstract: A new concept in power generation is a microgrid. The Microgrid concept assumes a cluster of loads and microsources operating as a single controllable system that provides power to its local area. This concept provides a new paradigm for defining the operation of distributed generation.

The microsources of special interest for MGs are small (<100-kW) units with power electronic interfaces. These sources are placed at customers sites. They are low cost, low voltage and have a high reliability with few emissions. Power electronics provide the control and flexibility required by the MG concept. A properly designed power electronics and controllers insure that the MG can meet the needs of its customers as well as the utilities. The goal of this project is to build a complete model of Microgrid including the power sources, their power electronics, and a load and mains model in THE HOMER.

The HOMER Micropower Optimization Model is a computer model developed by the U.S. National Renewable Energy Laboratory (NREL) to assist in the design of micropower systems and to facilitate the comparison of power generation technologies across a wide range of applications. HOMER models a power system's physical behavior and its life-cycle cost, which is the total cost of installing and operating the system over its life span. HOMER allows the modeler to compare many different design options based on their technical and economic merits. It also assists in understanding and quantifying the effects of uncertainty or changes in the inputs.

Keywords: microgrid, microsources, HOMER, microturbines, micropower

I. INTRODUCTION

The HOMER Micropower Optimization Model is a computer model developed by the U.S. National Renewable Energy Laboratory (NREL) to assist in the design of micropower systems and to facilitate the comparison of power generation technologies across a wide range of applications. HOMER allows the modeler to compare many different design options based on their technical and economic merits. It also assists in understanding and quantifying the effects of uncertainty or changes in the inputs. A micropower system is a system that generates electricity, and possibly heat, to serve a nearby load. Such a system may employ any combination of electrical generation and storage technologies and may be grid-connected or autonomous, meaning separate from any transmission grid. Some examples of micropower systems are a solar–battery system serving a remote load, a wind–diesel system serving an isolated village, and a grid-connected natural gas microturbine providing electricity and heat to a factory. Power plants that supply electricity to a high-voltage transmission system do not qualify as micropower systems because they are not dedicated to a particular load. HOMER can model grid-connected and off-grid micropower systems serving electric and thermal loads, and comprising any combination of photovoltaic (PV) modules, wind turbines, small hydro, biomass power, reciprocating engine generators, microturbines, fuel cells, batteries, and hydrogen storage. The analysis and design of micropower systems can be challenging, due to the large number of design options and the uncertainty in key parameters, such as load size and future fuel price. Renewable power sources add further complexity because their power output may be intermittent, seasonal, and nondispatchable, and the availability of renewable resources may be uncertain. HOMER was designed to overcome these challenges. HOMER performs three principal tasks: simulation, optimization, and sensitivity analysis. In the simulation process, HOMER models the performance of a particular micropower system configuration each hour of the year to determine its technical feasibility and life-cycle cost. In the optimization process, HOMER simulates many different system configurations in search of the one that satisfies the technical constraints at the lowest life-cycle cost. In the sensitivity analysis process, HOMER performs multiple optimizations under a range of input assumptions to gauge the effects of uncertainty or changes in the model inputs. Optimization determines the optimal value of the variables over which the system designer has control such as the mix of components that make up the system and the size or quantity of each. Sensitivity analysis helps assess the effects of uncertainty or changes in the variables over which the designer has no control, such as the average wind speed or the future fuel price. Fig. illustrates the relationship between simulation, optimization, and sensitivity analysis. The optimization oval encloses the simulation oval to represent the fact that a single optimization consists of multiple simulations. Similarly, the sensitivity analysis oval encompasses the optimization oval because a single sensitivity analysis consists of multiple optimizations.

II. MICROGRID

Recent developments in the electric utility industry are encouraging the entry of power generation and energy storage at the distribution level. Together, they are identified as distributed generation (DG) units. Several new technologies are being developed and marketed for distributed generation, with capacity ranges from a few kW to 100 MW. The DG includes micro turbines, fuel cells, photovoltaic systems, wind energy systems, diesel engines, The Microgrid (MG) concept assumes a cluster of loads and micro sources operating as a single controllable system that provides both power and heat to its local area. This concept provides a new paradigm for defining the operation of distributed generation. The micro sources of special interest for MGs are small (<100-kW) units with power electronic interfaces. These sources are placed at customers sites. They are low cost, low voltage and have a high reliability with few emissions. Power electronics provide the control and flexibility required by the MG concept. A properly designed power electronics and controllers insure that the MG can meet the needs of its customers as well as the utilities. Defined characteristics of MGs as;

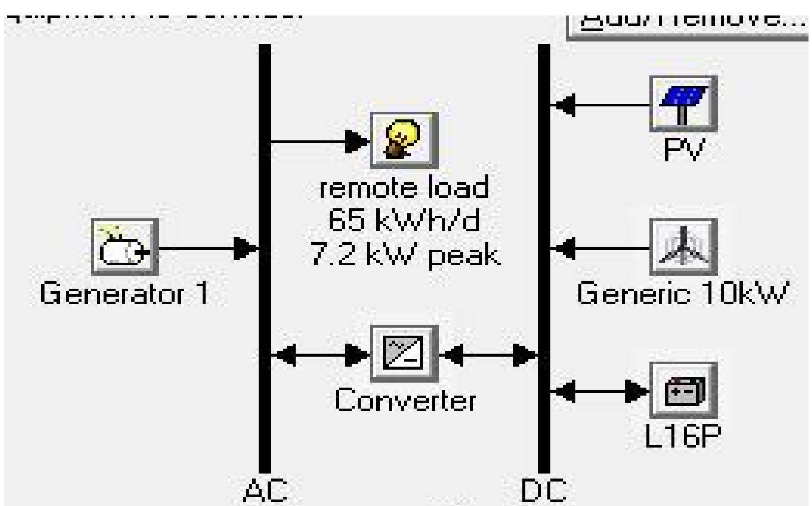
A. Not centrally planned (by the utility)
B. Not centrally despatched.
C. Normally smaller than 50-100 MW.
D. Usually connected to the distribution system.

Implementing an MG can be as simple as installing a small electricity generator to provide backup power at an electricity consumer's site, or it can be a more complex system that is highly integrated with the electricity grid that consists of electricity generation, energy storage, and power management systems. They comprise a portfolio of technologies, both on supply side and demand-side that can be located at or near the location where the energy is used. MG devices provide opportunities for greater local control of electricity delivery and consumption. and gas turbines. They also enable a more efficient use of waste heat in combined heat and power (CHP) applications, which boosts efficiency and lowers emissions. The CHP systems provide electricity, hot water, heat for industrial processes, space heating and cooling, refrigeration, and humidity control to improve indoor air quality and comfort.

III. MICROGRID ARCHITECTURE

The idea of the system is wide introduction of renewable energy sources into power system. Because classic power system is not prepared for high penetration of RES, new one is proposed. The most important difference between DC microgrid and classic power system is relatively high storage capacity. Also power sources have higher dynamic then thermal power plants. Hence rapid changes in power demand and power generation can be met.

IV. SOFTWARE MODEL



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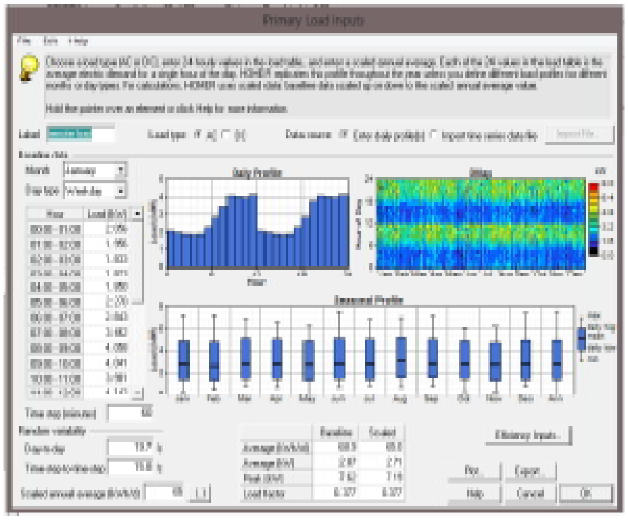
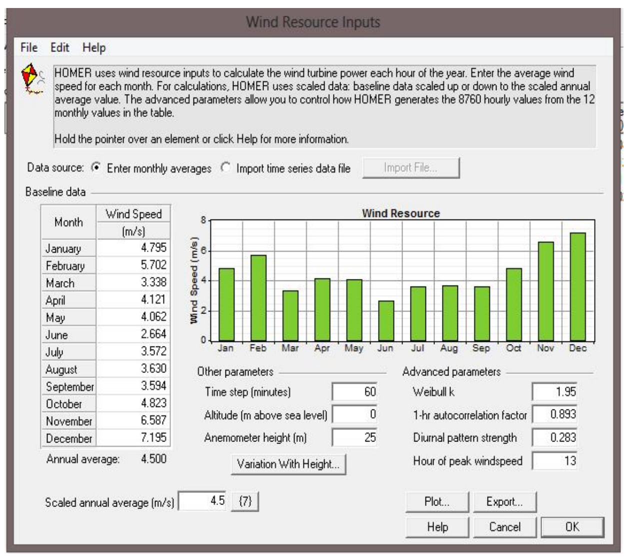
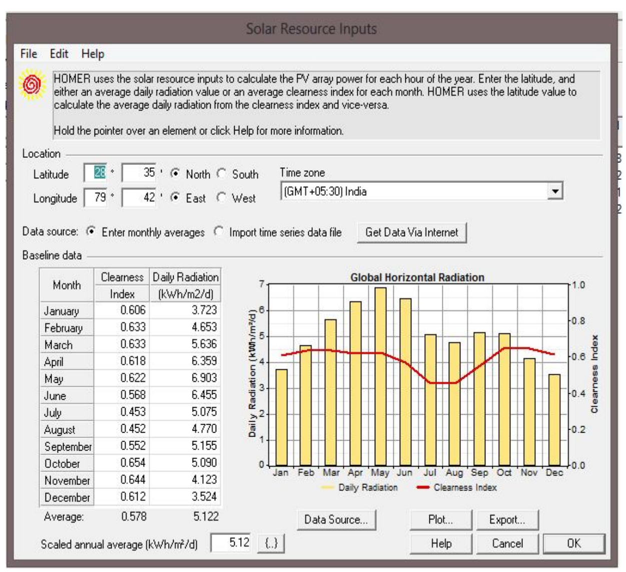
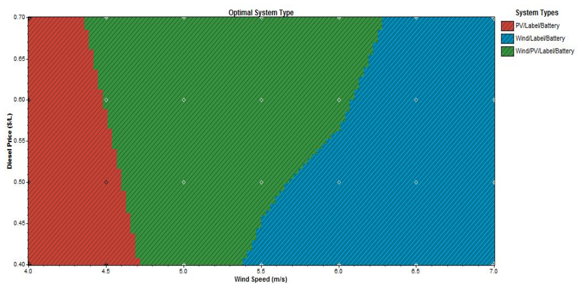






V. SIMULATION RESULT



VI.FUTURE WORK

The next step in research is to consider MG as asystem. It is important to learn more about how the sources interact with each other. More specifically their relationship to each other needs to be defined. If all goes as anticipated and the MG system is developed, the control of the system will likely be imbedded within the electronics. It is possible to use specialised controllers to get a more stable response and to use each power source more efficiently. This should certainly be researched and considered once the power sources interaction and relationship with each other and the mains have been defined. Other aspects that could be developed further are the individual sources within the MG. This could be done at two levels. The first is the consideration of other variables for each source. For example, the wind speed is not considered for the PV array and in some conditions it would prove quite significant. Also, working in pu is more desirable than actual values: the full conversion of the microsources to pu would be useful. The other way is to keep the model up-to-date with the technology. In the area of PV arrays and micro turbines technology is rapidly changing and improving. With the actual data of particular place we design a microgrid with suitable resources according to load requirments.

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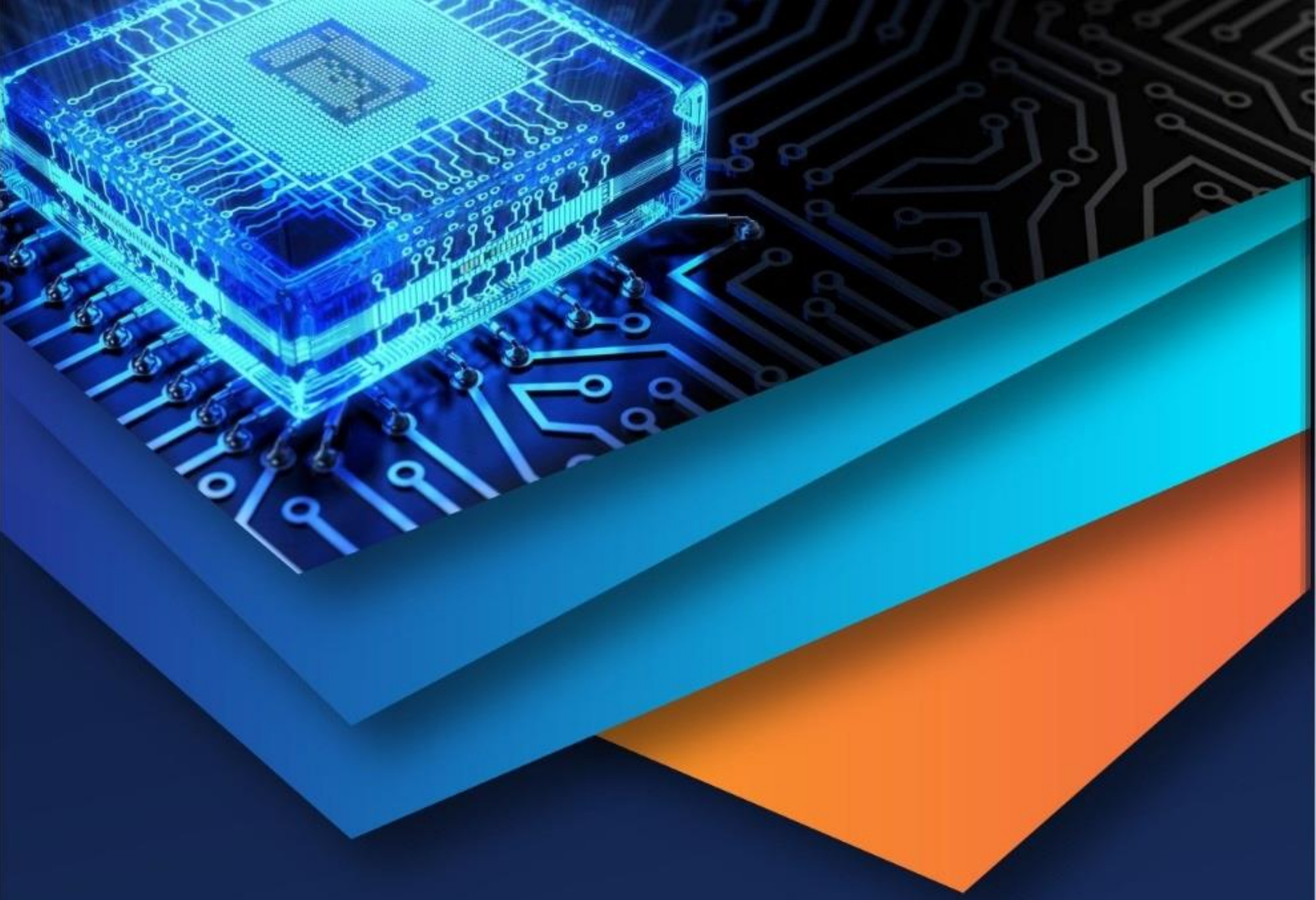

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