OBJECTIVES

➢ Prepare a complete hybrid system design
   - Optimize the best hybrid system configuration for a typical home in each state.
   - Perform an economical study.
   - Perform a sensitivity analysis to find a suitable system type for each case in the future.

METHODOLOGY

➢ Data Gathering: Evaluate the load profile for a typical home in each state.
   • Average electricity load for all states (30.25 kWh/day) and peak load (5.34 kW).

➢ System sizing: Choosing the technology and finding the power capacity for each device.

➢ Hybrid System Components:
   • Two renewable energy sources (PV solar panels and Wind Turbines).
   • Diesel generator as a secondary non-renewable standby source.

➢ Resources (Wind):
   • The average wind speed in the U.S. (5.17 m/s)
   • The highest wind speed is in Hawaii with 6.76 m/s
   • The lowest wind speed is in Georgia with 3.92 m/s

➢ Resources (Diesel):
   • The average diesel rate in the U.S. ($0.746/L)
   • The highest diesel rate is in California with $0.94/L
   • The lowest diesel rate is in New Mexico with $0.667/L

➢ System cost optimization: Evaluate all configurations for each state.
   • The economic viability of this hybrid system is to be analyzed on a life-cycle cost basis, and complete system optimization is conducted with the aid of the Hybrid Optimization model for Multiple Energy Resources (HOMER) software. HOMER is a computerized application developed by the National Renewable Energy Laboratory (NREL) in the United States.
   • HOMER software simulates system configurations with all the combinations of components that specified in the component inputs, it discards from the results all infeasible system configurations, which are those where the load is given do not adequately meet either the available resource or the specified constraints. Systems were simulated with five million possible alternatives with feasible solutions.
   • The cost-effectiveness of a system configuration is based on the net present value. The net present value (or life-cycle cost) of a component is the present value of all the costs of installing and operating that component over the project lifetime, minus the present value of all the revenues that it earns over the project lifetime.
   • Finding and comparing the levelized Cost of Energy (COE) for each state: HOMER defines the levelized cost of energy (COE) as the average cost per kWh of the useful electrical energy produced by the system.

➢ Environmental survey: Calculate the different pollutants produced annually by the proposed hybrid systems.
   • In the proposed systems and during renewable sources’ operation, power systems do not emit substances that may threaten human health or the environment. In fact, through the savings in conventional electricity production, it can lead to significant emission reductions.

RESULTS

➢ In all states and for a typical home a PV/diesel generator/battery system was found to be the most suitable solution.
   • The battery and the diesel generator are having higher NPC values due to the need to store energy and power the building at night.

➢ Levelized Cost of Energy (COE):
   • The average COE in the U.S. ($0.435/kWh)
   • The highest COE is in Alaska with $0.521/kWh
   • The lowest COE is in New Mexico with $0.395/kWh

➢ The Daily Radiation and Diesel price for each case have a strong effect on how the system will produce electric power.

➢ The emission values for hybrid systems are between 45-75% less than emission values for diesel systems for the same case study.

CONCLUSION

➢ Various energy sources (Solar, Wind and conventional) and storage system (battery) were considered in this analysis.

➢ In all states and for a typical home a PV/diesel generator/battery system was found to be the most suitable solution.

➢ The Daily Radiation and Diesel price have a strong effect on selecting the best configuration for each state and the COE values.

➢ A hybrid system has 45-75% fewer emissions than a conventional system.

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