Small Scale Wind Turbine For Back Up Power Generation

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Abstract

- A small-scale wind generator system can be designed as a backup power generator.
- This type of system can provide temporary power when access to either the power grid or combustible fuel sources for traditional generators are not available.
- Adapting to this type of “off-the-grid” power generation as natural disasters are having a greater and more frequent impact on infrastructure could be ideal to many communities.
- In this research project, a wind generator system that can provide sufficient power to operate a household refrigerator and charge mobile devices has been modeled.
- This provides safe refrigeration for food or medicine and to communicate in an emergency.
- The system is modeled using two 12 V deep cycle batteries both rated at 75-watt hours of capacity.
- Wire sizing and current requirements are derived from the MPPT controller design and maximum wattage output of the generator and the battery voltage.
- The system is designed to meet the criteria such as the system should not be permanently affixed to a structure and power generation should be sufficient to power a household refrigerator and charge mobile devices as needed.

Introduction

- Every year, the US Gulf Coast and Eastern Seaboard experience varied degrees of hurricane season damage.
- The residents of these coastal villages, in particular, take numerous precautions to get ready for hurricanes.
- While many of the precautions taken to address the immediate, secondary, and lingering effects of a hurricane or tropical storm are temporary, some are permanent.
- On September 28, 2022, Hurricane Ian made landfall in southwest Florida, as depicted in Fig.1.
- The storm became a strong category 4 hurricane just before touching down.
- A large amount of infrastructure damage is visible in the aftermath from the first impact area across central Florida.
- This damage extended beyond simply the basic and quickly repaired electricity distribution grid.
- By flooding and surge, the storm blocked access to roads and even bridges.
- Several homes and neighborhoods are still unreachable a month after the hurricane because of flood damage.

Fig. 1 Hurricane Ian Track

Use Case:

- Backup power, often known as emergency power generation, is by design meant to be momentary and small-scale.
- Most backup power systems are used to provide a level of safety and comfort while waiting for the utility power grid to be connected again, rather than to completely eliminate all the risks and discomforts associated with being cut off from it.
- The following requirements should be met by a system created for these circumstances.1) The system shouldn't be fixed to a structure indefinitely
  2) Electricity generation ought to be adequate to run a home refrigerator and charge cellphones as necessary. Its power ranges between 400 and 600 watts.

System Design

- The use of wind turbines on personal sailing ships served as inspiration for the design of this device.
- These commercially available tiny wind turbines are toughened for operation around corrosive and moist conditions.
- Together with the wind generator itself, the generator package also contains a manual and automatic brake controller and a Maximum Power Point Tracking (MPPT) charge controller.
- A mounting tower, battery storage, a DC/AC inverter, and any necessary wiring and packing are other parts that would be needed.

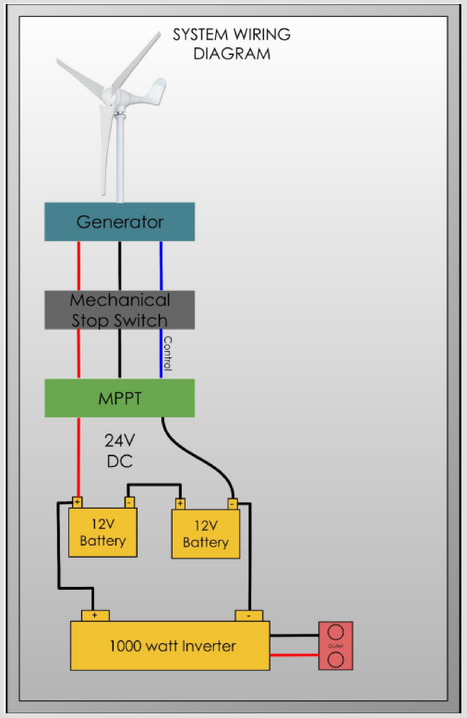

Fig. 2 Wiring Diagram

Fig. 3 AutoMAx 600 W Wind Turbine Generator Kit

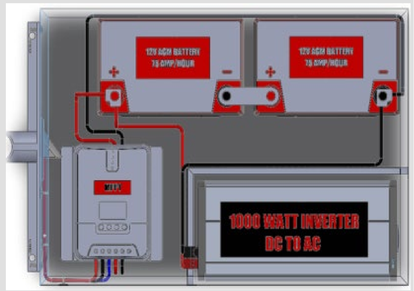

Fig. 4 Wire Routing

- The overall goal of the system design was to provide a compact wind turbine generator package that could be used as a backup or temporary power source.
- Since a conventional combustion-powered generator is either not an option or is simply not desirable, the system as it is now configured is meant to offer backup power generation rather than the highest level of power generation.
- The wind turbine's tower, or mast, is 10 feet tall and made of 1.5" schedule 40 pipe.
- The ideal height for a wind turbine, according to the manufacturer, is 20 feet or more.
- The National Renewable Energy Laboratory advises that wind turbines that are permanently installed be at least 30 feet above any nearby obstructions.
- A single 10-foot structure that can be put together by one person without the aid of a boom or bucket truck is chosen.
- The tower is attached to the base structure of the control tower and further fastened at three locations.
- Ratcheting style straps will make installation simple while also securely fastening the system.
- A hefty hitch pin and cotter pin are used to attach the tower mast to the base control box through a machined plate.
- This style is reminiscent of car trailer hitches.
- The machine plate has spaces for future installation of grounding stakes.
- The control box will help to provide a stable basis for the generator and tower and could weigh up to 150 pounds.
- The industrialization of this concept should incorporate casters or rubber wheels even if they are outside the scope of this design.
- To facilitate transportation, a pole-style handle may be readily modified to make use of the mast mounting feature.

Electrical Loads:

- Three aspects determine how the desired electrical output is delivered.
- In this scenario, the major application will be to power a domestic refrigerator.
- The first is the load demand of the appliances.
- The second factor is the system's watt-per-hour capacity.
- The capacity of the power generator to replenish the batteries will be the deciding factor.
- Considering that the DC to AC converter has an efficiency rating of 90%, the real capacity of the batteries is reduced to 135 amp hours till full depletion.

Results

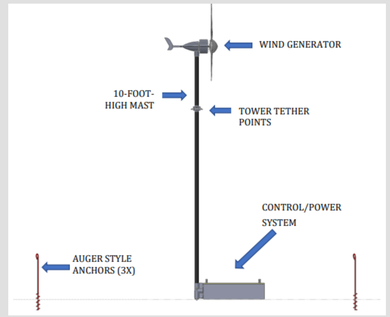

Fig. 5 Overall System

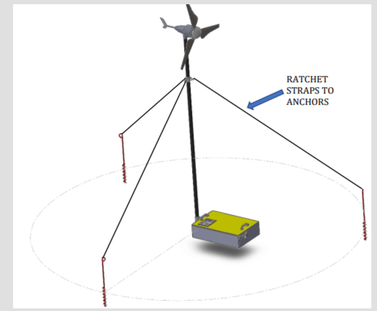

Fig. 6 Structure side view

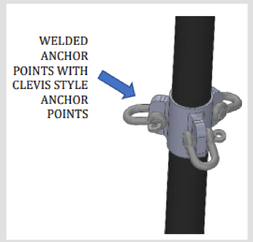

Fig. 7 Mast Anchor Details

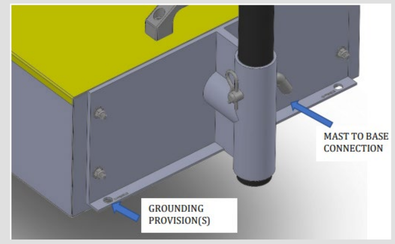

Fig. 8 Mast to Base connection

Conclusion

- The batteries in this system, like those in many other energy storage systems, are expensive and have an impact on the system's efficiency as a whole.
- The cost, capacity, and type of today's cutting-edge batteries for renewable energy systems vary substantially.
- The best battery for this system would be a specially made one with a kind of construction utilizing a bank of batteries similar to those found in electric lawn movers.
- Just adding a short-term wind generator to a residence that already has a commercially available power bank installed could be excellent for protracted power grid isolation.

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