University of New Haven

# A Sustainable and Reliable Hybrid Microgrid System for Rapidly Deployed Military and Isolated Town Environments


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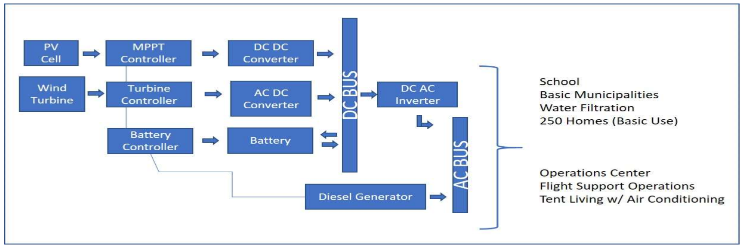
## Introduction

The United States Military spends countless dollars on energy costs, specifically oil. Likewise, isolated town communities are without modern conveniences and support because of energy costs, as well as availability. A unique set of military units travel around the world at a moments notice to support airfields, mechanized initiatives and strategic support operations. These units can benefit from a solar, wind and generator solution to provide sufficient power to those installations. The research carried out was conducted using requirements from both an isolated town, as well as from the previously mentioned military unit. The desired outcome would be a MATLAB® simulation using Simulink and Simscape tools to design a hybrid smart grid to lower logistical footprints and enable power in both environments.

## Method

The research involved creating a blended solution hybrid smart grid for an isolated town in the mountains and a military outpost in the desert. The needs of both environments included 1000 people and operating either community for a 24-hour period. The military environment used approx. 4MWh under maximum load and the military personnel living in tents while maintaining a highly technical operations headquarters. The isolated town environment used approx. 5.2MWh but included a school, water filtration plant of 2 million gal/month and a basic municipality/government center.




| PV Cells | Wind Turbine | Generator | Duration |
|---|---|---|---|
| (250) 195-265W @ 20 C/ 1200 ir | (4) 10-75 kWh @2-5 m/s - 17 m diam. | (3) 40kWh operates at 96 gal/day | 24 hours |

The approach was to ensure the signal conditioning was appropriate for the photovoltaic panel and wind turbine, and having it reintegrate it into the larger grid to be distributed into the town/military installation. I used a maximum power point tracker controller which monitored max power and regulated the photovoltaic array's based on the irradiance level and the temperature values. A Dc/Dc converter was used to help the signal conditioning since the battery will not charge and will gave errors in the simulation. The wind turbine simulation required parameters including the blade length, wind speed and verify the torque conversion based on the specifications I found from the manufacturer. For the simulation a AC/DC converter/rectifier was used so the design could use the output generated by my Simscape wind turbine. I simple battery charge controller was used to enable battery charge during off-peak times and it supports night simulations when the photovoltaic arrays were reporting zero irradiance. However, the workaround included a 40kWh generator in the design which directly fed into the electrical grid of both the military and isolated town.

## Results

The performance of the hybrid network needed 400 sqm of solar paneling that operated between 195Watt-265Watt depending on temperature and irradiance, four 17meter diameter wind turbines which operated at 75kWh at 5 m/s or 10 kWh at 2 m/s, as well as, three 40kWh diesel generators that used approximately 96 gallons of diesel gas a day to operate (mostly at night).

## Conclusions

The benefits resulted in saving 480 gallons of fuel a month since you're using 2 less generators and using 250 solar panels (one panel for every roof of a family of 4) instead of the original 823 panels which would power the entire town by itself. The biggest trial was wind power because the photovoltaic cells were more researched and more widely used in commercial applications, so there was a steeper learning curve. The wind power would need to be more accurately represented rather than inputting a consistent value for wind speed. The 480 gallons of fuel savings per month would be greatly decreased if there was no wind or half the speed for long periods during the day. Ultimately, the town and military does not have to transport approx. 2880lbs of fuel/month according to these models.

## References and Acknowledgements


Yashwant S., S.C. Gupta and Aashish Kumar B. *PV-wind hybrid system: A review with case study Sawle et al., Cogent Engineering (2016)*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