CHRES

CONSORTIUM OF HYBRID RESILIENT ENERGY SYSTEMS

DE-NA0003982

# Portable Power Station with Several Source of Energy for Emergencies

RYAN I. RODRIGUEZ TIRADO

ADVISOR: PROF. DANIEL E. MERA ROMO, PHD

PROF. DIEGO A. APONTE ROA, PHD

PREC PUERTO RICO ENERGY CENTER

UNIVERSIDAD ANA G. MÉNDEZ

UAGM Recinto de Gurabo

# Introduction

- This research main goal is to create a project that concentrates on the well-being of families affected by shortages on electrical services around the island due to atmospheric disasters
- This project presents the design and construction of a portable power plant with 3 sources of renewable energy: solar, wind and mechanical bike. The system has batteries for energy storage.
- This way, it can be able to fulfill the needs of families with health conditions in situations where there is shortages of energized services.

# Objectives

- Taking measurements for the Solar panels, wind turbine and mechanical generator.
- Use the power station to power up critical devices such as a fridge and medical equipment.
- Taking measurements with the weather station.
- Validate the results.

# Electrical Equipment for Emergencies

Table 1

| Electronic Equipment | Quantity | Watts | Hours | Wh/day | KWh/day | Safety Margin 20% | Wh/Month |
|---|---|---|---|---|---|---|---|
| Lightbulb | 5 | 10 | 6 | 300 | 0.3 | 360 | 9000 |
| Fridge | 1 | 400 | 6 | 2400 | 2.4 | 2880 | 72000 |
| Fan | 3 | 100 | 6 | 1800 | 1.8 | 2160 | 54000 |
| Nebulizer | 1 | 90 | 1 | 90 | 0.09 | 108 | 2700 |
| Phone charger | 4 | 7.5 | 4 | 120 | 0.12 | 144 | 3600 |
| **Total** | | **607.5** | | **4710** | **4.71** | **5652** | **141300** |

# Recap of the Photovoltaic Calculation

- Lmd,AC = Average daily consumption in alternating current
- Ninv = Efficiency of inverter
- Nbat = Efficiency of battery
- Ncon = Efficiency of conductors
- HPS = Peak sun hour
- QAH = average energy consumption in AH/day
- Lmd = average daily consumption
- Vbat = Battery voltage
- NT = Total of Solar Panels

Table 2

| |
|---|
| $Lmd = \frac{Lmd, AC}{\frac{Ninv}{Nbat * Ncon}} = \mathbf{5,652}\ Wh/day$ |
| $Q_{AH} = \frac{Lmd}{Vbat} = 405.29AH$ |
| $N_T = \frac{Lmd}{Pmpp*HPS*PR} = 1.62 \equiv$ 2 solar panels of 600 W or 3 panels of 400 W |
| $I_{input} = 1.25 * I_{MOD,SC} * N_P = 45.52\ A$ |
| $I_{output} = \frac{1.25 * (\frac{P_{AC}}{N_{INV}})}{Vbat} = 66.03\ A$ |
| $P_{inv} = 1.2 * P_{AC} = 729W$ |
| $P_{inv} = 1.2 * P_{AC} * 3 = 1647.5W$ |

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# Circuit Diagram

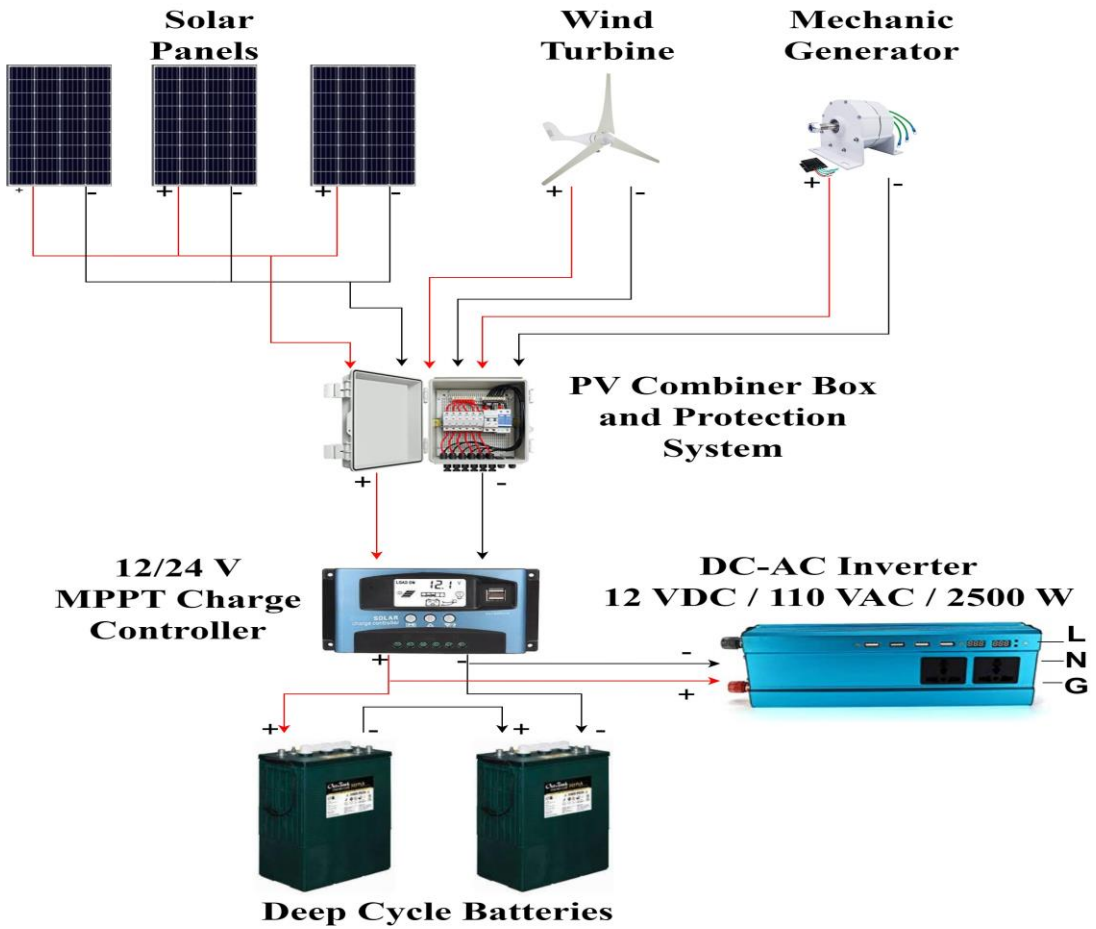


Fig 1. Circuit Diagram [1]

# List of Components

Table 3

| Quantity | Description | Electric Specs | Price | Total |
|---|---|---|---|---|
| 1 | Combiner Box of 6 String | • Current Rating: 63Amps<br>• Voltage: 250 Volts | $166.00 | $166.00 |
| 1 | Inversor 12V | • Power: 2500 watts<br>• Voltage: 12 Volts (DC) | $210.00 | $210.00 |
| 1 | 3 Phase Generator | • Voltage: 48 Volts<br>• Output Power: 2000 Watts | $362.45 | $362.45 |
| 1 | Baterry Cable 2/0 | • Material: Copper<br>• Voltage: 600 Volts | $96.13 | $96.13 |
| 1 | Cable PV #10 | • Max Current: 30Amps | $120.21 | $120.21 |
| 44 | MC 4 | • Rated current: 30A<br>• Rated voltage: 1000V DC | $26.00 | $26 |
| | | | Total | $980.79 |

# Sainlogic Weather Station


Fig. 2 Weather Station [2]

Fig. 3 Weather Station on ceiling

# Portable Power Station

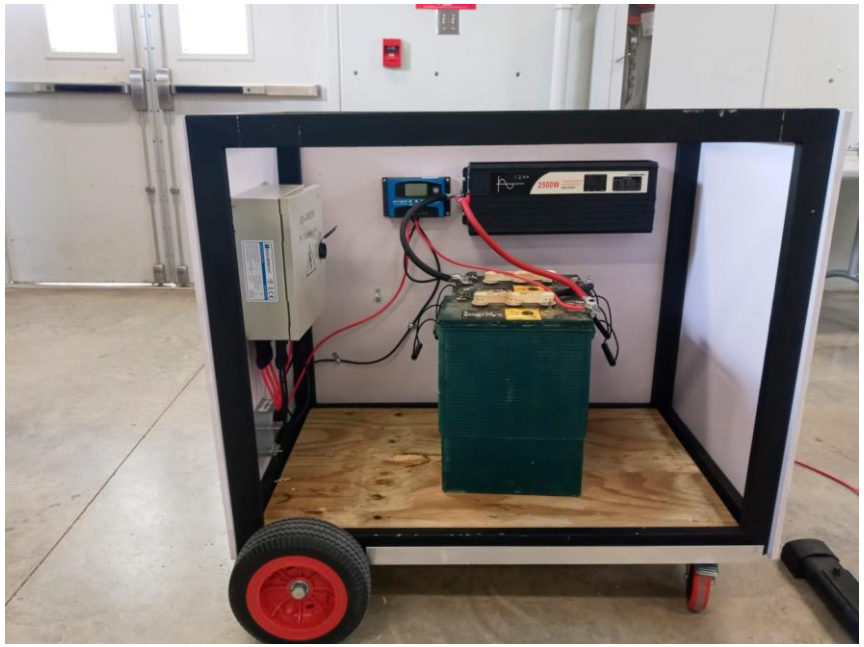

Fig 4. Power Station

Fig 5. Combiner Box

Fig 6. Outlets for electrical equipment

# Three Main Sources of Renewable Energy

Fig 7. Wind Turbine

Fig 8. Solar Panels


Fig 9. Mechanical Bike Generator

# Solar Panel Generation

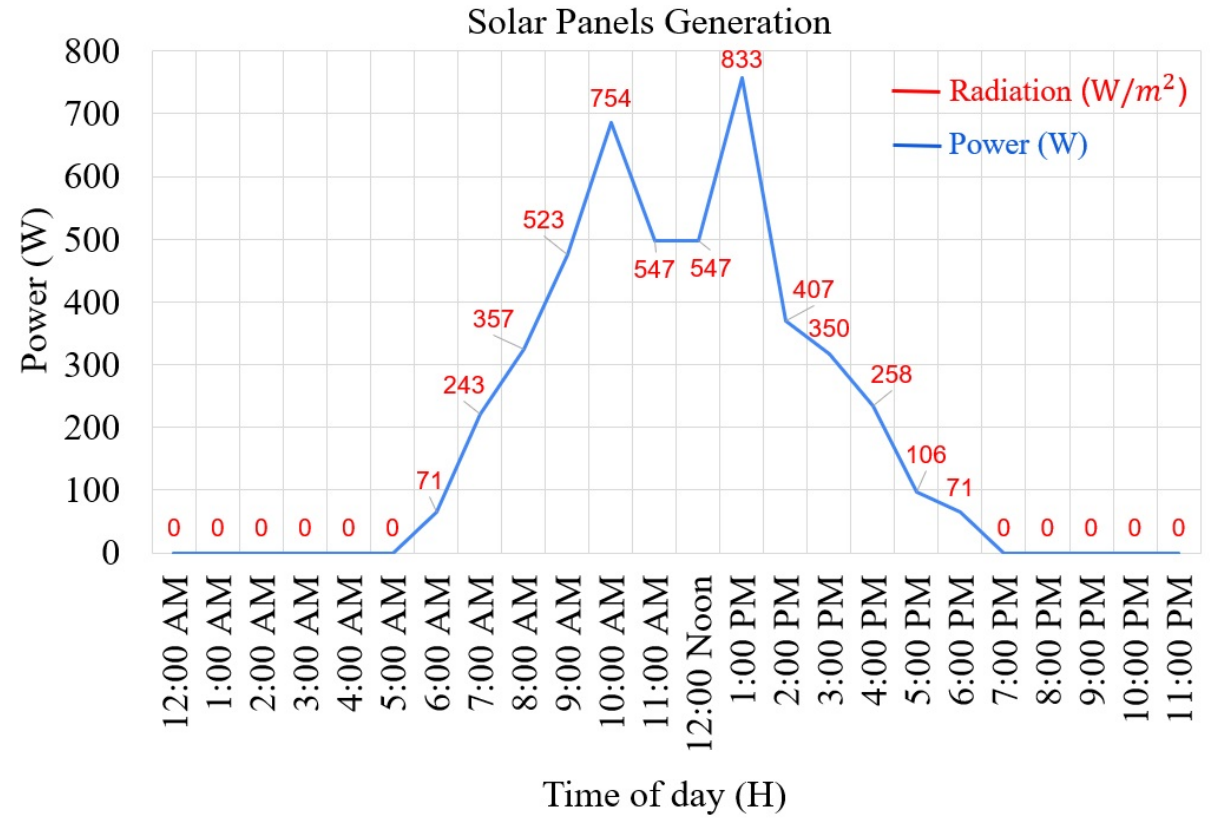


Fig. 10. 10 days average generation

# Wind Turbine Generation

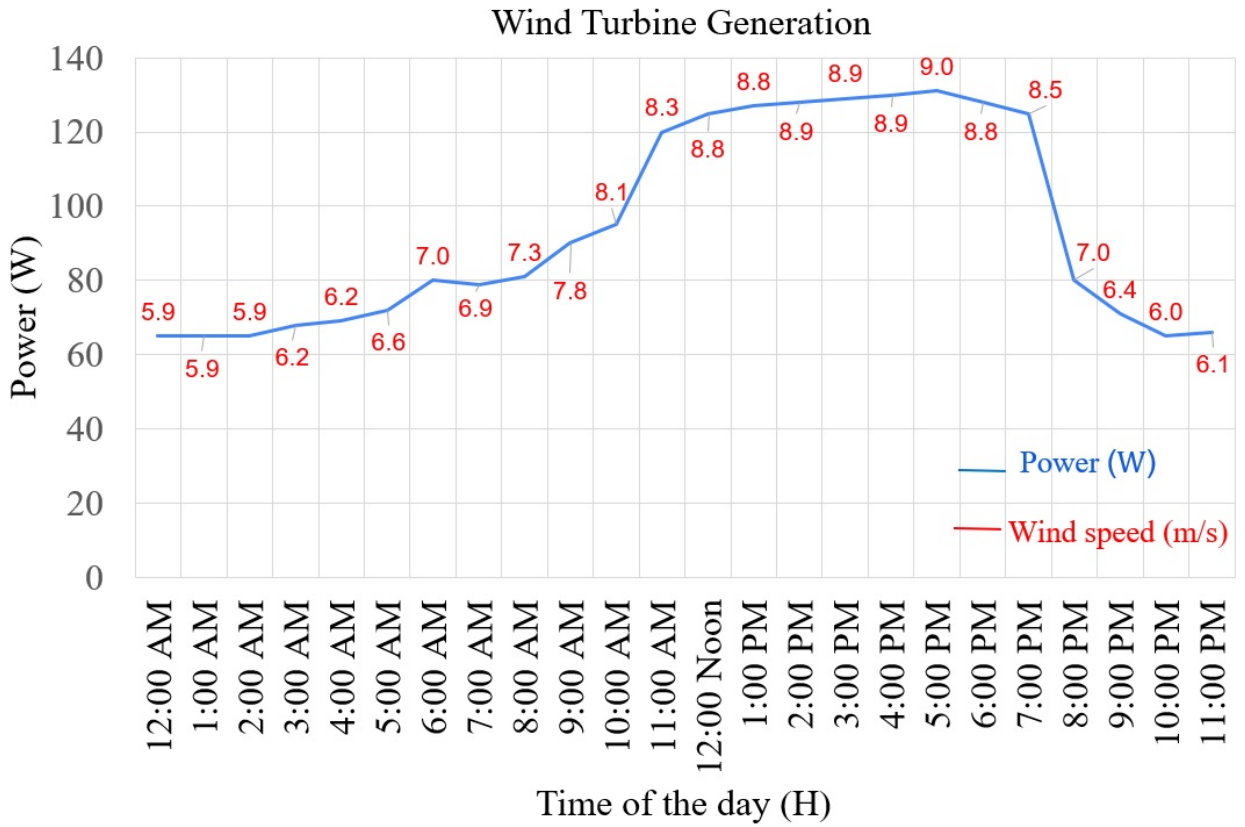


Fig.11. 10 days average wind turbine generation

# Mechanical Bike Power Generation

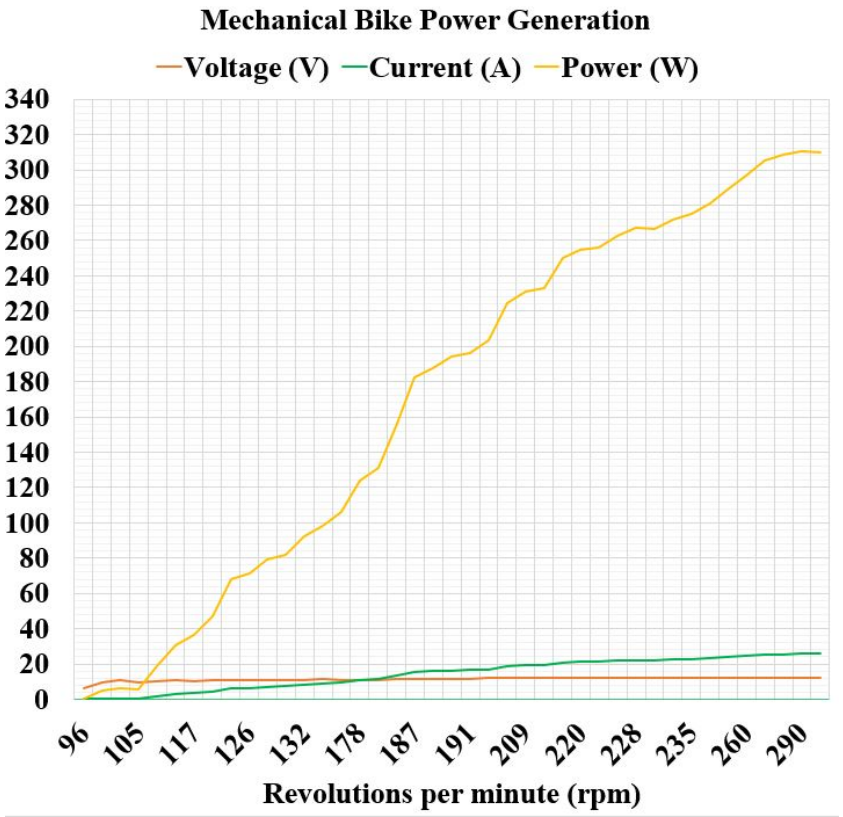


Fig. 4. Power generation vs bike rpm

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# Conclusions

- The system worked very well, powering different loads including a residential refrigerator, a nebulizer, and laptop/cellphone chargers.
- The system was designed for 24 hours of autonomy. However, while the batteries were successfully charged to 100%, they only retain the charge for 6 hours without connecting any load. The batteries need to be replaced.
- Experiments in Yabucoa demonstrate a high potential for solar generation, but with the wind turbine, the generation potential is lower, reaching a maximum of 120 W in the best-case scenario.
- Mechanical generation allows for the production of additional energy while promoting healthy exercise.

# Future Work

- Daily measurements for the use of electrical equipment.
- Connection of the Wind Turbine to the Power Station.
- Replace the batteries and test again.

# References

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