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Case Study 1: Hybrid Solar and Wind Power Generation Prototype Model Tailored and Implemented at CPDAM Frostburg State University

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Abstract:

This case study presents the design, development, and implementation of a residential-scale hybrid solar and wind power generation system installed at the Center of Product Design and Advanced Manufacturing (CPDAM) at Frostburg State University (FSU). The "WISE" system integrates a 2-kW photovoltaic (PV) array and a 1.8 kW wind turbine mounted on a 45-ft monopole tower, jointly supplying a small residential-type building through a grid-tied configuration with net metering. Extensive resource assessment was conducted using three Davis Weather Pro® stations and long-term solar-insolation modeling. The hybrid system incorporates advanced inverter/charger technology, MPPT algorithms, remote monitoring, and automatic generator start capability, enabling reliable, scalable operation for both on-grid and backup modes. Real-time performance data collected throughout the year confirms stable output in varying weather conditions and validates the system's technical and educational value. The project demonstrates a viable residential renewable energy model, strengthens regional sustainability efforts, and provides experiential learning opportunities for engineering and technology students at Frostburg State University.

Key words. Hybrid, photovoltaic, PV array, thermostat, auto generator, Solar charger

Abbreviation	:	Definitions
CPDAM	:	Center of product design and advance manufacturing
MPPT	:	Maximum Power production tracking
SCC	:	Solar charger control
PV	:	photovoltaic
FSU	:	Frostburg State University
MEA	:	Marland Energy Administration

1 Introduction

CPDAM is dedicated to creating a state-of-the-art equipment and testing laboratory that is accessible to the region's industry, community, FSU employees, and students. Our goal is to provide comprehensive services to businesses of all sizes small, medium, and large to support their growth and innovation. We are particularly focused on assisting startup companies in the region with product development, offering expertise and resources to help bring their ideas to life. Additionally, we offer training and workshops on the use of advanced equipment and software, benefiting the industry, community, and FSU members. We actively seek partnerships with local businesses, industry leaders, and community organizations to expand our impact and foster collaborative innovation. This center actively engages students in real-world, cutting-edge knowledge related to system and product design, as well as advanced manufacturing. We invite industry professionals, community members, and FSU partners to collaborate with our faculty, staff, and students to foster innovation and excellence in every project we undertake as shown in Figure 1 and 2 [1],[2].

Fig.1 center of Product Design and Advance Manufacturing

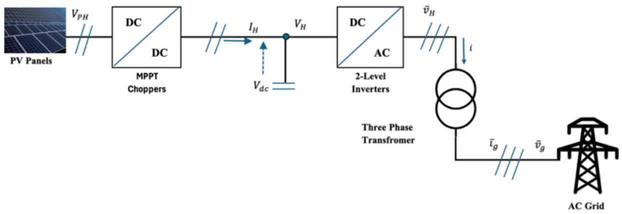


Fig.2 Solar system power generation schematic

2. Hybrid System Design and Site Selection

The initial requirements for the system have been clearly articulated in the interagency agreement between MEA and FSU. This agreement outlines the establishment of a grid-tied hybrid demonstration system featuring approximately 2 kW of photovoltaic (PV) energy and 1.8 kW of wind power to supply a small building effectively. With the size and configuration firmly established, the project's design phase has been streamlined to focus on selecting optimal locations and components, proposed location are described below in Figure 3. This project aims to showcase a compelling residential application, with four strategically chosen structures on the FSU campus equipped with a robust 120/240-volt distribution system [3].

To rigorously assess the wind and solar resources available at these sites, we have installed three state-of-the-art Davis Weather Pro® weather stations at locations 2, 3, and Tawes Hall. Given their proximity, Tawes Hall is assumed to experience weather conditions akin to those at locations 1 and 4, ensuring a comprehensive comparison. Each weather station is outfitted with an anemometer and a wind direction gauge, while the stations at Tawes Hall and Location 3 are further enhanced with solar radiation sensors. These stations seamlessly communicate with data loggers housed in a wireless console unit, which are configured to record all pertinent weather data synchronously every 5 minutes [4].

As illustrated in Figure 4, high-speed winds are observed more frequently at locations 1 and 4, a finding consistent with the higher elevation of these sites compared to locations 2 and 3. This vital data positions us to make informed decisions and optimize the hybrid system's efficacy, underscoring the project's potential impact.

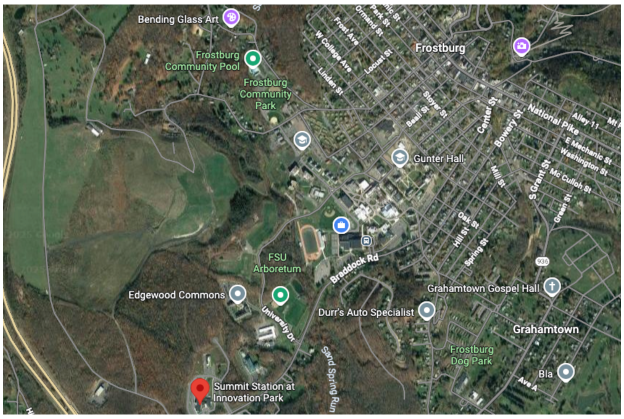
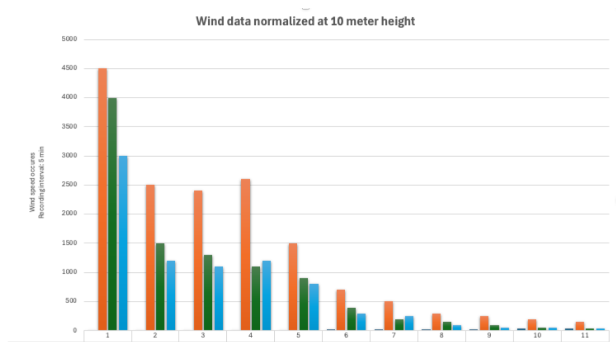


Figure 3 shows the possible location of the CPDAM (Google Earth)



	1	2	3	4	5	6	7	8	9	10	11
Wind Speed (Miles/hr)	0	4	8	12	16	20	24	28	32	36	40
Tawes (L1 and L4)	4500	2500	2400	2600	1500	700	500	300	250	200	150
Braddock (L3)	4000	1500	1300	1100	900	400	200	150	100	50	40
Edgewood (L2)	3000	1200	1100	1200	800	300	250	100	50	60	35

Figure 4 Wind data normalized at 10-meter height

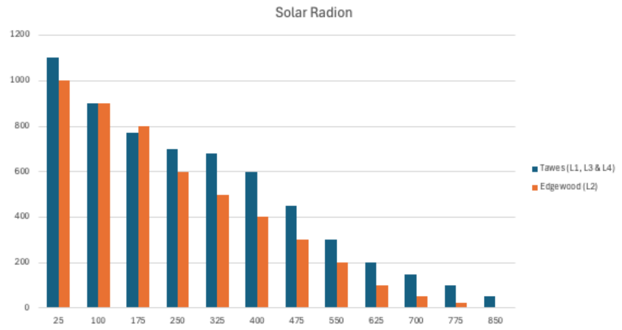


Figure 5 Solar Radiation at different location

The building's south-facing roof with a 45-degree tilt offers nearly optimal conditions for photovoltaic (PV) generation at this latitude. To evaluate the solar energy potential accurately, we utilized Asset® software, which analyzes the panoramic view for the solar array and incorporates a 30[3]-year solar insolation database from the PV Performance Calculator by the National Renewable Energy Laboratory, providing detailed technical insights for system design [5].

The site assessment findings, illustrated in Figure 5, provide significant insights into the building's solar potential. While the surrounding buildings and trees introduce an average shading of 14% throughout the year, the site still benefits from an impressive average of 3.61 hours of direct sunlight per day.

The PV array consists of ten high-performance modules, as detailed in Table 1, mounted flush on the south-facing roof to maximize energy capture. The system's operation is managed by the HIP 200 BA3 control system, ensuring efficient and reliable performance, which underscores the system's design robustness and sustainability benefits. The electrical characteristics of the selected wind power turbine are shown in Table 2. The selected product has an inverter enclosed in the nacelle and provides a 12/240 60 Hz output for direct grid connection [6].

3. Hybrid System Installation

A. System overview

This power system offers a versatile, adaptable solution, featuring devices, components, and optional accessories that can be tailored for any application—whether off-grid, grid-tied, or backup. It supports up to four inverters in parallel, enabling users to confidently scale to larger 120/240-volt, 3-wire, single-phase systems and ensuring reliable performance for diverse energy needs at CPDAM FSU. Figure 6 illustrates the configuration of the solar panel equipment, while Figure 7 depicts the wind power delivery equipment configuration [7].

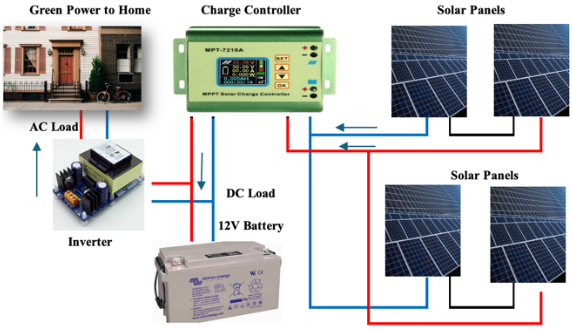


Figure 6: Power System Installation Diagram – Solar Power

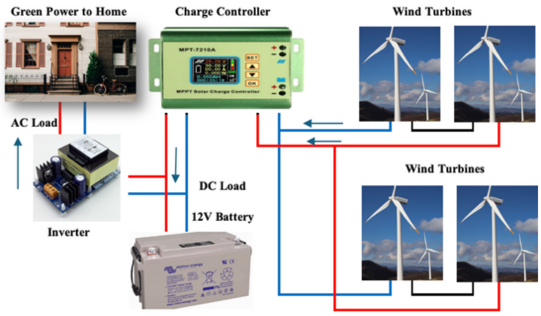


Figure 7: Power System Installation Diagram – Wind Power

B. System Components and Accessories

Inverter/Charger: This modular building block sine-wave inverter/charger is designed for both residential and commercial applications, including stand-alone, grid backup, and grid-tie systems with battery energy storage. The ability to support parallel installation for increased capacity should make the audience feel assured of future scalability. The Series Inverter/Charger is a self-contained unit that functions as a DC-to-AC inverter, battery charger, and AC transfer switch. Up to four inverters can be installed in parallel to create larger systems with 120-240 volts, 3-wire, single-phase configurations, increasing capacity [8].

This modular system includes the following components: a mounting panel, DC terminal covers, a network terminator, a battery temperature sensor, an air filter, mounting hardware, and an AUX port connector. Emphasizing the completeness of the package can help the audience feel confident in the system's readiness and reliability as shown in Figure 8.

Figure 8: Inverter Charger

System Control Panel: The System Control Panel boasts a vibrant, backlit liquid crystal display that effectively presents system configuration and diagnostic information for all devices connected to your network as shown in Figure 9. When integrated as an accessory for the Power System, it revolutionizes control by replacing multiple panels, delivering a unified interface that empowers you to configure and monitor your entire Power System with unparalleled ease and efficiency [9].

Figure 9: Control panel

Automatic Generator Start: The Automatic Generator Start can automatically activate a generator to provide power to an Inverter/Charger, helping recharge depleted batteries or assist with heavy loads effortlessly as shown in Figure 10. Automatic Generator Start adds reliable intelligence to power management, reducing the need for constant monitoring of batteries and inverter loads. It is compatible with popular generators and can be confidently configured to start the generator in response to low battery voltage, thermostat operation, or load size on the inverter battery, ensuring consistent performance. A quiet time setting prevents the generator from starting at inconvenient times. LEDs display the status of the Automatic Generator Start, while all user-defined settings are programmed through the System Control Panel[10].

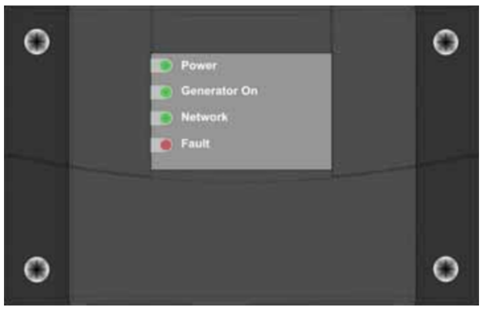


Figure 10: Automatic Generator

The generator must be either a 120V/240V, 2-wire or 3-wire model with Auto Start capability. The inverter/charger will not accept power from a 120V generator unless it has been converted to a 120V, 2-wire, single-phase unit. Jumpers are used to reconfigure a standard 120V/240V, 3-wire, split-phase generator to accept a 120V, 2-wire, single-phase connection. Please use the jumpers to adjust the transformer wiring. Be sure to follow the Split-Phase-to-Single-Phase Conversion Instructions [11].

MPPT Voltage Range: The SCC's maximum power point tracking (MPPT) algorithm is designed to optimize the energy output of photovoltaic (PV) arrays to their full potential, provided the operating voltage remains within the MPPT operational window. Operating outside this range can significantly reduce system efficiency, so it is essential to monitor and maintain proper voltage levels. The consequences of operating outside this range are outlined in Table 3, underscoring the importance of adhering to these parameters for optimal energy production. MPPT stand for maximum power point tracking, which is a technique that optimize the power output of the solar panels by constantly adjusting the voltage and current conditions of the solar irradiance and temperature as shown in Figure 11. [12][13].

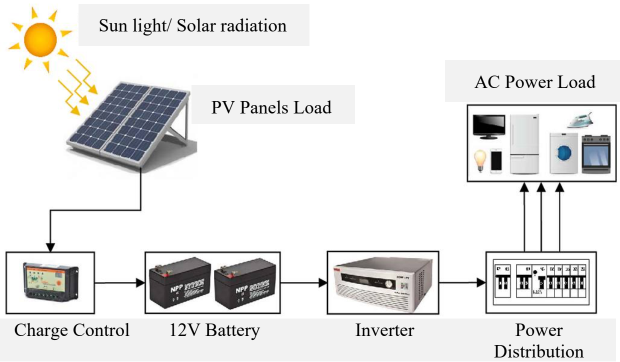


Figure 11: Power Conversion schematic in Solar system

Table No.3 MPPT Operations window

Voltage	Effect of Array voltage	Series Inverter charger mode
VOC<VBATT System battery voltage	SCC not operating	Low light
VMPP < VBATT	Harvest of solar energy less than optimal	charging
VMPP< VBATT to 120 VDC	Maximum harvest of solar energy	Charging (MPPT window)
120 VDC<VMPPV140VDC	SCC reduces the output current limit to protect the unit from voltage spikes	Input voltage derating
VMPP>140 VDC (or VIC> 140 VDC	SCC shutdown. Unit may be damaged if VOC> 150 V	Over voltage fault

4. Safety Instructions and Protection

Before using the inverter, read all instructions and cautionary markings on the unit, the batteries, and all appropriate sections of this manual.

1. The inverter is designed to be permanently connected to your AC and DC electrical systems. The manufacturer recommends that all wiring be performed by a certified technician or electrician to ensure compliance with the local and national electrical codes applicable in your jurisdiction, helping users feel assured of safe installation.
2. To avoid the risk of fire and electric shock, ensure that existing wiring is in good condition and that the wire is not undersized. Do not operate the inverter with damaged or substandard wiring, encouraging users to prioritize safety and responsibility. Do not operate the inverter if it has been damaged in any way. If the unit is damaged, see your warranty.
3. This unit does not have any user-serviceable parts. Do not disassemble the inverter except where noted for connecting wiring and cabling. See your warranty for instructions on obtaining service. Attempting to service the unit yourself may result in a risk of electrical shock or fire.
4. Remember, internal capacitors remain charged after all power is disconnected, so stay alert and cautious during maintenance. To reduce the risk of electrical shock, disconnect both AC and DC power from the inverter before attempting any maintenance, cleaning, or work on components connected to it. Putting the unit in Standby mode will not reduce this risk.

5. Functional Test - Multiple Inverters

To perform a functional test on multiple inverters:

1. Thoroughly check and verify all wiring and cable connections to ensure a safe and efficient setup.
2. Measure the DC voltage at the inverter terminals to confirm it falls within the acceptable range and has the correct polarity. For optimal performance, the standard ranges are 23 to 32 VDC for 24V systems and 46 to 64 VDC for 48V systems.
3. Switch the INV1 DISCONNECT to the ON position to activate the inverter.
4. Pay close attention to the inverter display during the startup self-test, where all LEDs will flash briefly. After completing the self-test, the inverter will display "5tb." (Remember, the Fault/Warning LED may flicker initially but should turn off soon after. If it remains illuminated, verify that a battery temperature sensor is properly connected. If the inverter has been pre-configured, it might proceed directly into normal operating mode.)
5. Finally, utilize the XW System Control Panel to set the First (Master) Inverter Device Number for effective system management.

a) Go to the inverter's Advanced Settings menu by pressing Down arrow + Enter from the System Status screen and then simultaneously pressing Enter + Up arrow + Down arrow.
b) Select Multi Unit Config menu.
c) Change Dev Number from 00 to 01. The inverter will now appear as XW6048-01 in the device list.
d) Press Exit to go back to the System Status screen.

1. To ensure optimal performance, switch the INV2 DISCONNECT to the ON position.

2. Next, observe the inverter display as it conducts its startup self-test—this is an important step, as all LEDs will flash momentarily. Once the self-test is

successfully completed, the inverter will display "5tb." If your inverter has already been pre-configured, it may seamlessly transition into normal operating mode or alert you with an "F66" warning.

3. Finally, take advantage of the Xantrex System Control Panel to carefully set your Second (Slave) Inverter Device Number and select the appropriate Inverter Mode for your needs. This process is essential for maximizing efficiency and ensuring reliable operation.

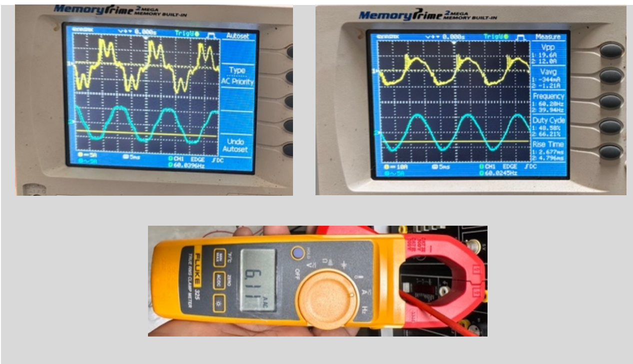


Figure 12: Function test result outcomes

6. Education outcomes of the project

Students will develop critical skills to evaluate the technical and practical feasibility of hybrid renewable energy systems by analyzing data from an innovative real-world installation that features a 2-kW solar photovoltaic array and a 1.8-kW wind turbine. This hands-on experience aims to inspire confidence in their ability to assess real-world energy solutions, fostering a sense of achievement and motivation. Through this comprehensive case study, students will examine energy production trends, assess the system's reliability, and understand how grid-connected net metering enables self-sustaining energy operations. This initiative has generated considerable interest in wind and solar energy at **Frostburg State University**. Faculty members from various disciplines, including sociology, English, geography, and interdisciplinary studies, have incorporated related term projects and discussions concerning wind and solar energy, encompassing:

- **ENES320: Wind/Solar-Powered Generation System Design**
- **ENES401: Fundamentals of Energy Engineering**
- **ENGL338: Technical Writing**

Additionally, students will enhance their ability to compare cutting-edge renewable energy technologies, calculate the balance between energy demand and generation, and identify key factors influencing system performance, such as environmental conditions, equipment configuration, and load characteristics. By the end of this module, students will be empowered to apply sustainability principles to engineering design decisions and propose strategic solutions for optimizing small-scale hybrid energy systems tailored for educational, residential, or community use

7. Results and Discussion

Appendix A presents a comprehensive process schematic that clearly outlines the system's components, aiding stakeholders in understanding system architecture. Appendix B provides a detailed 12-month overview of our hybrid power production, highlighting our achievements. This project has not only realized our ambitions but has also dramatically exceeded our expectations for solar and wind energy, in line with our groundbreaking design framework. Our solar power system, prominently showcased in Table No. 1, captures the sun's energy with high-efficiency solar panels, transforming sunlight into direct current (DC) electricity. This DC power is expertly converted into alternating current (AC) by our sophisticated inverter, ensuring a smooth and efficient transfer of energy to the grid often accompanied by the advantages of net metering or for storage in high-capacity batteries, which guarantees dependable off-grid and backup power solutions. We also actively promote community solar initiatives, encouraging shared access that empowers residents and fosters collective engagement in renewable energy practices.

Our wind energy system, elaborated in Table No. 2, harnesses the power of nature through specialized turbine blades designed to capture wind energy effectively. This harvested energy is transformed into electricity by our robust generator, with voltage carefully boosted at the substation to ensure the most efficient power delivery possible. This versatile, adaptable setup effectively supports both off-grid and on-grid operations at CPDAM.

Figures 13 and 14 clearly demonstrate our hybrid power delivery performance in January and June, showcasing consistent reliability and efficiency even during adverse weather conditions. Appendix B offers a comprehensive 12-month data overview from CPDAM FSU, confirming the system's robustness and effectiveness. This initiative advances renewable energy technology and contributes to building a sustainable future for upcoming generations.

Table No.1 Electrical characteristics of PV Based

Rated Power	P_{MAX}	W	200
Maximum Power Delivery voltage	V_{PMX}	V	55.8
Maximum Power current flow	I_{PM}	A	3.59
Open circuit voltage	V_{OC}	V	68.7
Short circuit current	I_{SC}	A	3.83
Minimum Power	P_{MIN}	W	180
Maximum system voltage	V_{SYS}	V	600
Cell Efficiency		%	19.7
Module Efficiency		%	17
Power per square foot		W	15.8

Table No.2 Electrical characteristics of Wind Turbine

Rated Power	1.8 kW
Weight	154. | 70 Lbs/kg
Rotor Diameter	12 | 3.72 Ft/m
Swept Area	68.7 Ft^2/m^2
Type	Downwind rotor with stall regulation control
Direction of Rotation	Clockwise looking upwind
Blade material	Fiberglass reinforced composite

Number of Blades	3
Rated Speed	50-325 rpm
Tip Speed	66-213 f/s 9.7 63 m/s
Alternator	Spotless permanent magnet brushless
Ya control	Passive
Grid feeding	120/240 VAC 50-60 Hz inverter enclosed
Braking system	Electronic stall regulation w/ redundant relay switch
Cut in wind speed	8 mph | 3.5 m/s
Rated wind speed	20 mph | n9 m/s
Survival wind speed	140 mph | 63 m/s

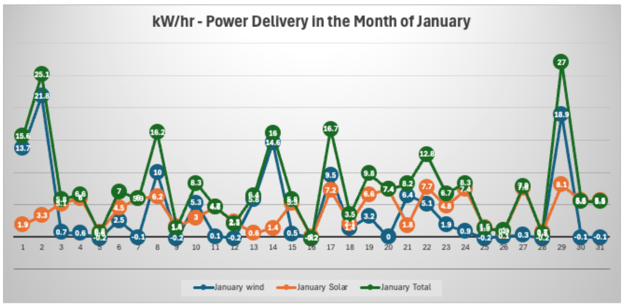


Figure 13: Power Delivery in the Month of January

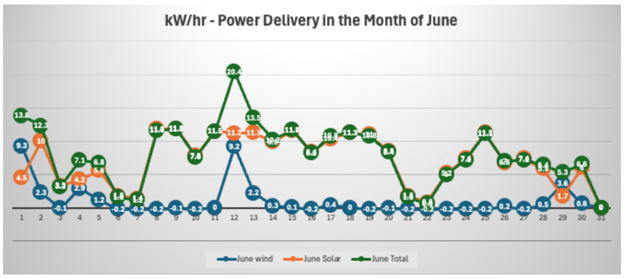


Figure 14: Power Delivery in the Month of June

8. Conclusion

The hybrid solar and wind renewable energy system at CPDAM FSU stands as a remarkable example of technical excellence, showcasing its outstanding viability, unwavering reliability, and significant educational contributions. Throughout the changing seasons, performance data has consistently revealed that the carefully designed photovoltaic (PV) array, coupled with a robust wind power setup, effectively fulfills the building's energy requirements while simultaneously channeling surplus electricity back to the grid through the net metering process. The system's innovative modular design, state-of-the-art inverter/charger technology, and advanced maximum power point tracking (MPPT) controls ensure seamless and efficient energy production, even in the face of unpredictable weather conditions, underlining its impressive operational success. However, this project transcends mere technical achievement; it serves as a vital enhancement to engineering education, providing students with invaluable hands-on experiences that encompass the full spectrum of renewable energy, from design and installation to real-time system monitoring. The hybrid system beautifully embodies FSU’s unwavering commitment to sustainability and acts as a catalyst for regional innovation, presenting an inspiring model for community-driven clean energy initiatives. By continuously collecting performance data and implementing strategic improvements, we can not only bolster ongoing research but also weave this cutting-edge technology into the academic curriculum, thus expanding the campus’s renewable energy endeavors and reinforcing its profound educational impact.

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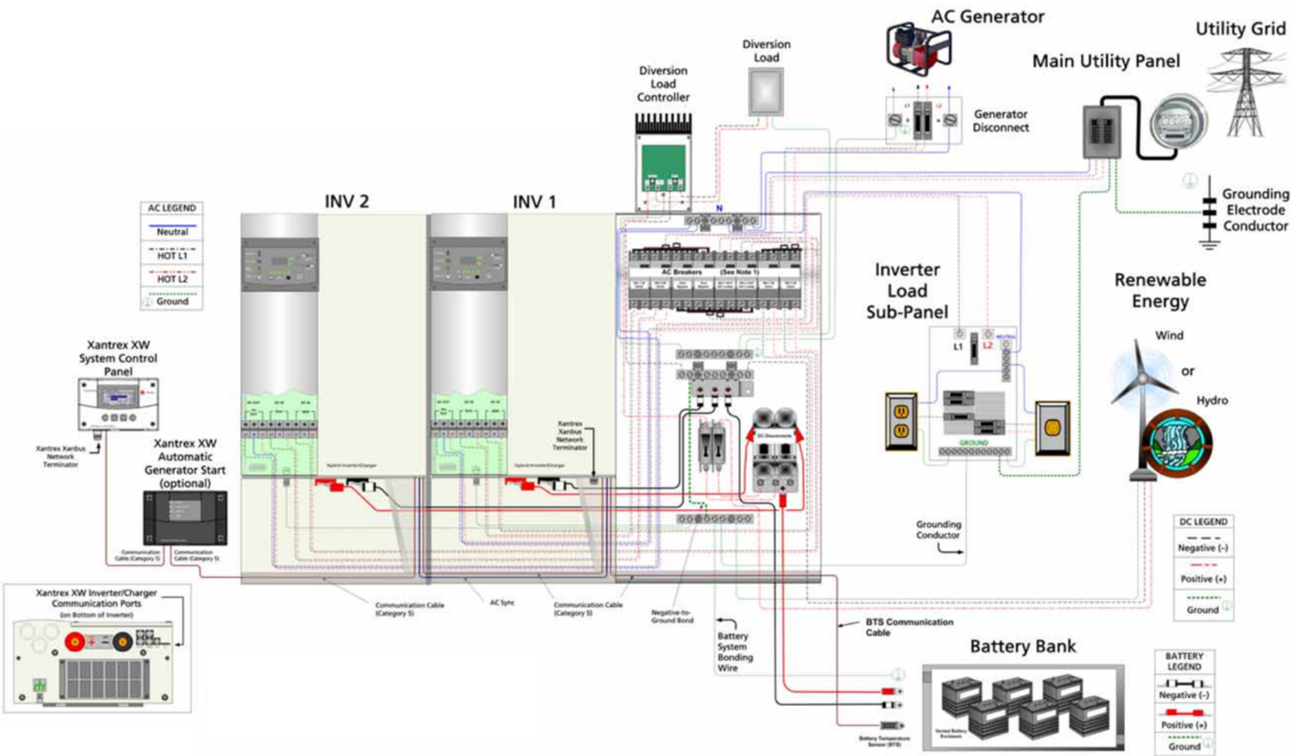
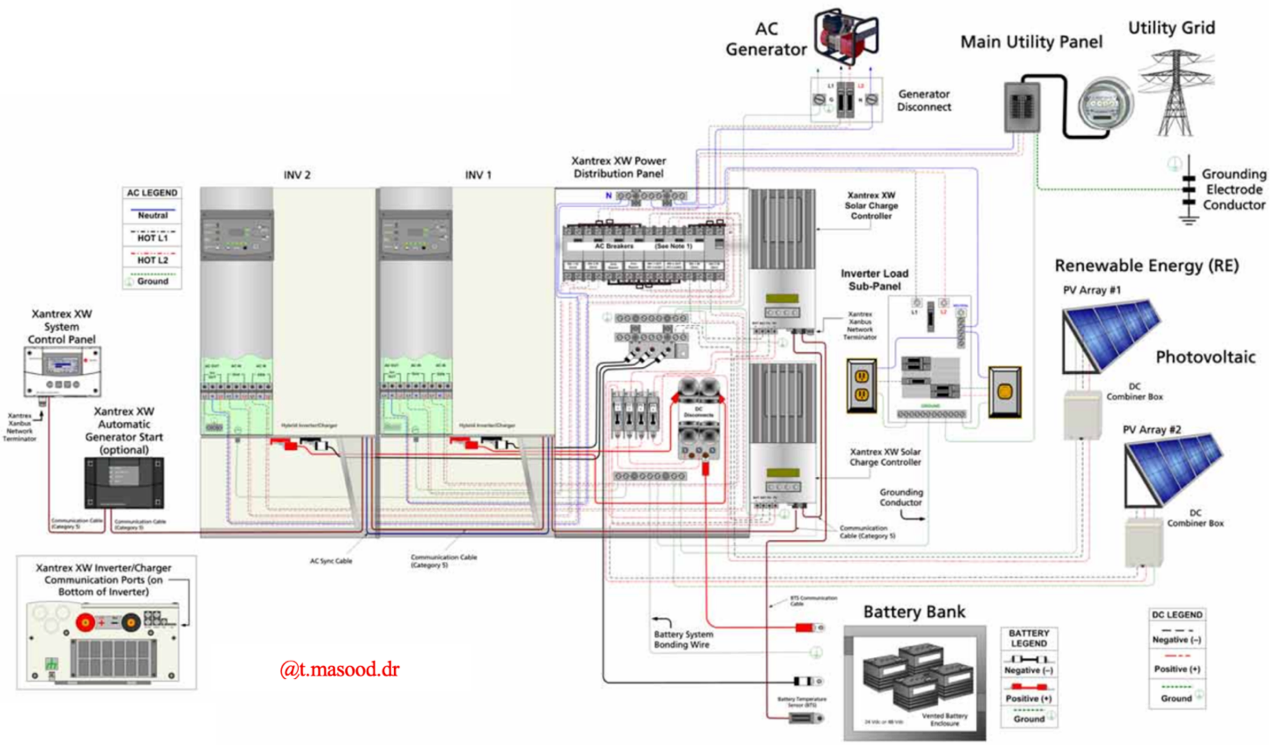
Appendix A

Dual Inverter system Renewable Energy Wind Power Generation System



Dual Inverter system Renewable Energy Solar Power Generation System



Appendix B

12 months Hybrid Power production

	January			February			March			April			May			June			July			August			September			October			November			December		
Day	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total	wind	Solar	Total
1	13.7	1.9	15.6	4.6	5.6	10.2	16.9	5.3	22.2	9.3	4.5	13.8	16.9	5.3	22.2	9.3	4.5	13.8	16.9	5.3	22.2	9.3	4.5	13.8	-0.2	10.9	10.7	-0.2	9.6	9.4	1.2	4.6	5.8	6.6	6.6	13.2
2	21.8	3.3	25.1	7.9	0.2	8.1	-0.2	6.4	6.2	2.3	10	12.3	-0.2	6.4	6.2	2.3	10	12.3	-0.2	6.4	6.2	2.3	10	12.3	-0.2	10.6	10.4	-0.2	9	8.8	-0.2	8	7.8	-0.2	0.3	0.1
3	0.7	5.1	5.8	0.5	1.6	2.1	-0.2	8.9	8.7	-0.1	3.3	3.2	-0.2	8.9	8.7	-0.1	3.3	3.2	-0.2	8.9	8.7	-0.1	3.3	3.2	0.3	10.3	10.6	0	9.1	9.1	1.3	7.8	9.1	28.5	1.6	13.3
4	0.6	6	6.6	-0.2	4.9	4.7	0.5	0.6	1.1	2.9	4.2	7.1	0.5	0.6	1.1	2.9	4.2	7.1	0.5	0.6	1.1	2.9	4.2	7.1	0.1	10	10.1	-0.2	7.2	7	1.4	3.3	4.7	15	5.6	20.6
5	-0.2	0.8	0.6	0.6	0.7	1.3	13.9	2.6	16.5	1.2	5.6	6.8	13.9	2.6	16.5	1.2	5.6	6.8	13.9	2.6	16.5	1.2	5.6	6.8	-0.1	9.2	9.1	-0.2	5.5	5.3	-0.1	6.9	6.8	0.2	0.2	0.4
6	2.5	4.5	7	5	1.6	6.6	-0.2	9.6	9.4	-0.2	1.8	1.6	-0.2	9.6	9.4	-0.2	1.8	1.6	-0.2	9.6	9.4	-0.2	1.8	1.6	-2	9.6	7.6	-0.2	8.3	8.1	12.8	4.3	17.1	-0.1	5.4	21
7	-0.1	6	5.9	13.5	1.1	14.6	-0.2	1.1	0.9	-0.2	1.4	1.2	-0.2	1.1	0.9	-0.2	1.4	1.2	-0.2	1.1	0.9	-0.2	1.4	1.2	-0.1	9	8.9	0	6.5	6.5	4.4	1.6	6	0.1	1.3	1.4
8	10	6.2	16.2	0.4	0.6	1	15.7	0.8	16.5	-0.2	11.8	11.6	15.7	0.8	16.5	-0.2	11.8	11.6	15.7	0.8	16.5	-0.2	11.8	11.6	-0.1	8.8	8.7	-0.1	6.4	6.3	-0.2	4.2	4	-0.1	0.4	0.3
9	-0.2	1.6	1.4	3.1	1.2	4.3	12.4	9.9	22.3	-0.1	11.9	11.8	12.4	9.9	22.3	-0.1	11.9	11.8	12.4	9.9	22.3	-0.1	11.9	11.8	-0.1	4.7	4.6	2.2	6.5	8.7	-0.2	0.9	0.7	-0.2	0.3	1.7
10	5.3	3	8.3	16.5	4.2	20.7	0.6	6.4	7	-0.2	7.8	7.6	0.6	6.4	7	-0.2	7.8	7.6	0.6	6.4	7	-0.2	7.8	7.6	0.2	8.9	9.1	2.1	7.2	9.3	0	0.7	0.7	1.7	1.3	3
11	0.1	4.6	4.7	2	4	6	1.4	9.5	10.9	0	11.5	11.5	1.4	9.5	10.9	0	11.5	11.5	1.4	9.5	10.9	0	11.5	11.5	2.4	2	4.4	4.5	3.4	7.9	-0.2	2.9	2.7	-0.1	0.4	0.3
12	-0.2	2.3	2.1	-0.2	7.2	7	12.4	10	22.4	9.2	11.2	20.4	12.4	10	22.4	9.2	11.2	20.4	12.4	10	22.4	9.2	11.2	20.4	2.3	11	13.3	3.3	5.3	8.6	3.5	2	5.5	4.4	1.3	3.3
13	5.8	0.6	6.4	1.4	1.1	2.5	1.1	8.8	9.9	2.2	11.3	13.5	1.1	8.8	9.9	2.2	11.3	13.5	1.1	8.8	9.9	2.2	11.3	13.5	-0.1	10.8	10.7	1.7	8.7	10.4	2.1	3.5	5.6	2.7	0.3	3
14	14.6	1.4	16	0.1	0.9	1	-1	6	5	0.3	9.9	10.2	-1	6	5	0.3	9.9	10.2	-1	6	5	0.3	9.9	10.2	-0.1	2.4	2.3	0.8	8.2	9	-0.2	1.5	1.3	6.6	1	7.6
15	0.5	5.3	5.8	9	8.8	17.8	0.9	6.6	7.5	0.1	11.6	11.7	0.9	6.6	7.5	0.1	11.6	11.7	0.9	6.6	7.5	0.1	11.6	11.7	-0.2	7.4	7.2	-0.2	7.7	7.5	7	2.1	9.1	-0.2	0.3	10.6
16	-0.2	0	-0.2	0.4	1.7	2.1	2.6	1.7	4.3	-0.2	8.4	8.2	2.6	1.7	4.3	-0.2	8.4	8.2	2.6	1.7	4.3	-0.2	8.4	8.2	3.8	9.3	13.1	-0.2	6.8	6.6	7.7	2.6	10.3	15.4	1.7	37.7
17	9.5	7.2	16.7	-0.2	8.9	8.7	-0.2	10.8	10.6	0.4	10.4	10.8	-0.2	10.8	10.6	0.4	10.4	10.8	-0.2	10.8	10.6	0.4	10.4	10.8	-0.1	10.9	10.8	-0.2	5.5	5.3	10.6	1	11.6	9.1	1.1	10.2
18	1.4	2.1	3.5	8.6	1.8	10.4	-0.2	1.4	1.2	0	11.3	11.3	-0.2	1.4	1.2	0	11.3	11.3	-0.2	1.4	1.2	0	11.3	11.3	-0.1	10.8	10.7	-0.2	3.8	3.6	-0.2	1.2	1	0.7	5.5	47.9
19	3.2	6.6	9.8	13.8	2.5	16.3	2.9	1.1	4	-0.2	11	10.8	2.9	1.1	4	-0.2	11	10.8	2.9	1.1	4	-0.2	11	10.8	-0.2	10.6	10.4	1.9	0.5	2.4	-0.2	0.4	0.2	2.2	0.5	2.7
20	0	7.4	7.4	0.8	7.6	8.4	21.9	10.6	32.5	-0.1	8.5	8.4	21.9	10.6	32.5	-0.1	8.5	8.4	21.9	10.6	32.5	-0.1	8.5	8.4	-0.2	10.1	9.9	7.4	6.8	14.2	1.2	0.6	1.8	0	4.2	4.2
21	6.4	1.8	8.2	-0.2	0.4	0.2	8.3	11.2	19.5	-0.2	1.8	1.6	8.3	11.2	19.5	-0.2	1.8	1.6	8.3	11.2	19.5	-0.2	1.8	1.6	-0.2	9.9	9.7	-0.1	8.4	8.3	0.1	2.5	2.6	-0.2	0.9	6.9
22	5.1	7.7	12.8	-0.2	5.9	5.7	0.8	2	2.8	-0.2	0.8	0.6	0.8	2	2.8	-0.2	0.8	0.6	0.8	2	2.8	-0.2	0.8	0.6	1.8	8.9	10.7	-0.2	7.8	7.6	6.2	1.1	7.3	-0.2	0.2	0
23	1.9	4.8	6.7	0.7	1	1.7	0	11.9	11.9	-0.2	5.2	5	0	11.9	11.9	-0.2	5.2	5	0	11.9	11.9	-0.2	5.2	5	-0.2	10.6	10.4	0.3	1.1	1.4	2.4	2.4	4.8	7.6	0.2	7.8
24	0.9	7.4	8.3	-0.1	1.7	1.6	0.5	7.8	8.3	-0.2	7.4	7.2	0.5	7.8	8.3	-0.2	7.4	7.2	0.5	7.8	8.3	-0.2	7.4	7.2	-0.2	10.2	10	-0.1	1	0.9	-0.2	7.1	6.9	22.8	6.3	7.8
25	-0.2	1.5	1.3	0.7	9.1	9.8	1.4	11.5	12.9	-0.2	11.3	11.1	1.4	11.5	12.9	-0.2	11.3	11.1	1.4	11.5	12.9	-0.2	11.3	11.1	-0.1	6.5	6.4	-0.2	0.8	0.6	-0.2	6.8	6.6	1	6.1	7.1
26	0.1	0.9	1	4	2.1	6.1	18.1	11.2	29.3	0.2	6.8	7	18.1	11.2	29.3	0.2	6.8	7	18.1	11.2	29.3	0.2	6.8	7	0	5.9	5.9	-0.2	0.3	0.1	0.9	0.5	1.4	-0.2	2.3	2.1
27	0.3	7.6	7.9	9	0.7	9.7	-0.2	0.8	0.6	-0.2	7.4	7.2	-0.2	0.8	0.6	-0.2	7.4	7.2	-0.2	0.8	0.6	-0.2	7.4	7.2	0.1	5.9	6	9.2	6.9	16.1	13.1	2	15.1	3.1	0.8	9.2
28	-0.2	0.7	0.5	1.7	4.4	6.1	3	2.8	5.8	0.5	5.9	6.4	3	2.8	5.8	0.5	5.9	6.4	3	2.8	5.8	0.5	5.9	6.4	4.7	8.7	13.4	1.8	7.4	9.2	0.7	6.4	7.1	-0.2	1.8	1.6
29	18.9	8.1	27	-0.2	4.6	4.4	-0.1	11.6	11.5	3.6	1.7	5.3	-0.1	11.6	11.5	3.6	1.7	5.3	-0.1	11.6	11.5	3.6	1.7	5.3	-0.1	9.9	9.8	-0.2	8.1	7.9	11.7	4.4	16.1	4.5	4.6	9.1
30	-0.1	5.6	5.5	0	3.2	3.2	-0.2	8.4	8.2	0.6	6	6.6	-0.2	8.4	8.2	0.6	6	6.6	-0.2	8.4	8.2	0.6	6	6.6	-0.2	9.9	9.7	-0.2	7.9	7.7	3.9	6.2	10.1	-0.2	0.3	10.7
31	-0.1	5.6	5.5	0	0	0	-0.2	8.4	8.2	0	0	0	-0.2	8.4	8.2	0	0	0	-0.2	8.4	8.2	0.6	6	6.6	0	0	0	-0.2	7.9	7.7	3.9	6.2	10.1	4.4	4.2	8.6
Total	122	128	249	103	99.3	202	132	206	338	30.1	222	252	132	206	338	30.1	222	252	132	206	338	30.7	228	258	10.9	264	275	31.9	190	222	94.2	106	200	135	67	202
Average	7.61	7.98	15.6	6.44	6.21	12.6	8.28	12.9	21.1	1.88	13.9	15.7	8.28	12.9	21.1	1.88	13.9	15.7	8.28	12.9	21.1	1.92	14.2	16.2	0.68	16.5	17.2	1.99	11.9	13.8	5.89	6.61	12.5	8.42	4.19	14.8
Max	**122**	**128**	**249**	**103**	**99.3**	**202**	**132**	**206**	**338**	**30.1**	**222**	**252**	**132**	**206**	**338**	**30.1**	**222**	**252**	**132**	**206**	**338**	**30.7**	**228**	**258**	**10.9**	**264**	**275**	**31.9**	**190**	**222**	**94.2**	**106**	**200**	**135**	**67**	**202**