PORTABLE CHARGING STATION FOR ELECTRONIC DEVICES USING SOLAR AND WIND FOR CAGBALETE ISLAND, QUEZON

COST

The table for this constraint pertains to the cost-effectiveness of the components. The weight of the components in this design leans toward the significance and the financial burden that the prototype would require. The score is determined by the significance of the particular component that could help alleviate the budget for the project while maintaining the desired function of the component. The general components to be used in the three designs are the programming language, solar panel, wind turbine, charge controller, coin acceptor, two charging modules for wired and wireless, and the controller device. For the programming language, C will be used to utilize the controller device Arduino UNO.

Arduino UNO is a microcontroller board using the ATmega328P chip. It has everything needed to make the microcontroller work, including six analog inputs, a 16 MHz ceramic resonator, six digital input/output pins, a USB port, a power jack, an ICSP header, and a reset button. Monocrystalline photovoltaic PV solar panels would be used for all the designs. Solar will serve as a power generator, converting sunlight into electricity to power up devices. For the Vertical Wind Turbine, it will be examined along with the discussion, in which we'll be able to conclude the best fit material to use for the proposed prototype. Charge controller, the MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader will be integrated into all the designs. The charge controller monitors and controls the voltage and current flowing to the loads. Battery system receives any excess power, preventing overcharging and guaranteeing that the batteries maintain their charge level. Two charging modules with fixed voltage value and amperage that can be bought in the market; 27W Wireless Fast Charging Module 5V/2.5A - 3A and the DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A (USB power charger port) will also be applied among all designs. As mentioned earlier, the wind turbine and the battery are the two different components of each design. Implementing the wind turbine for the prototype would act as the other power generator. Like an airplane's wings or a helicopter's rotor blades, a wind turbine uses the aerodynamic force produced by its rotor blades to transform wind energy into electrical power. Darius Helix Vertical Axis Wind Turbine is used for design A, Savonius Vertical Axis Wind Turbine is used for design B, and Triple Bladed Horizontal Axis Wind Turbine for design C. The other component that will be integrated is the battery. This component would be the energy storage that the solar panel and the wind turbine generate. The considerations for each design A, B, and C are the 12V Recharge Lithium-Iron (LiFePo4) Battery Pack), 12V Recharge Lead Acid (Battery Pack), and 12V Recharge Lithium-Polymer (LiPo) (Battery Pack), respectively.

Design A					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	0.25	0.0625
Vertical Wind Turbine (Distributed/"small" wind)	Darius Helix Vertical Axis Wind Turbine	0.2	5	1	0.25
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	5	1	0.25
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	3	0.6	0.15
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	4	0.4	0.1
Coin Acceptor (Input Device)	CH-926	0.05	3	0.15	0.0375
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	4	0.2	0.05
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	4	0.2	0.05
Controller Device	Arduino UNO	0.1	4	0.3	0.075
		1			1.025

Design B					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	0.25	0.0625
Vertical Wind Turbine (Distributed/”small” wind)	Darius Helix Vertical Axis Wind Turbine	0.2	4	0.8	0.2
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	5	1	0.25
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	3	0.6	0.15
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	2	0.2	0.05
Coin Acceptor (Input Device)	CH-926	0.05	3	0.15	0.0375
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	4	0.2	0.05
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	4	0.2	0.05
Controller Device	Arduino UNO	0.1	4	0.3	0.075
		1			0.925

Design C					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	0.25	0.0625
Vertical Wind Turbine (Distributed/”small” wind)	Darius Helix Vertical Axis Wind Turbine	0.2	3	0.6	0.15
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	5	1	0.25
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	3	0.6	0.15
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	3	0.1	0.025
Coin Acceptor (Input Device)	CH-926	0.05	3	0.15	0.0375

Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	4	0.2	0.05
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	4	0.2	0.05
Controller Device	Arduino UNO	0.1	3	0.3	0.075
		1			0.85

Furthermore, the best possible design in terms of cost, the researchers chose design A. For the wind turbine, **Darius Helix Vertical Axis Wind Turbine** is the best choice because of its versatility in handling turbulent flows, omnidirectional energy capture, compact construction, reduced noise and vibration, and scalability for a wide range of applications. Helical turbines are more energy-efficient than standard turbines making them cost worthy through building the prototype.

The cost-effectiveness of these general components derives from their strategic selection and features: Choosing the C programming language for the Arduino UNO microcontroller board aligns with affordability and versatility due to C's open-source nature and efficient resource utilization, while the Arduino UNO, an accessible and budget-friendly microcontroller board, contributes to this cost-effectiveness; Monocrystalline Photovoltaic PV Solar Panels are chosen for their high efficiency in sunlight conversion, offering long-term cost-effectiveness through durability and superior energy conversion rates; The MPPT Solar/Wind Hybrid System Charge Controller maximizes energy utilization from solar and wind sources, ensuring efficient power management and enhancing overall system efficiency, showcasing its cost-effectiveness; Selected Charging Modules like the 27W Wireless Fast Charging Module and the DC-DC Fast Charge Module offer cost-efficient and efficient power transfer catering to varied device-charging needs; Wind Turbines (Darius Helix, Savonius, and Triple Bladed Horizontal Axis) balance efficiency and suitability for power generation while considering initial cost, maintenance, and energy output, contributing to their cost-effectiveness; Battery Systems

(24V Recharge Lithium-Iron, Lead Acid, Lithium-Polymer) are chosen based on their performance, durability, and cost balance, aiming for adequate energy storage at a reasonable cost over their lifespan. This cost-effectiveness results from a meticulous equilibrium between functionality, efficiency, durability, and initial investment, ensuring peak performance while minimizing long-term expenses.

Therefore, design A is cost-effective because it carefully selects components that balance functionality with lower costs. It prioritizes cost-efficiency without compromising performance. It aims to minimize expenses while fulfilling required functions by utilizing simpler, more readily available technologies and standardized parts. Choosing specific components, such as the Darius Helix Vertical Axis Wind Turbine and a specific type of battery, contributes to its cost-effectiveness compared to other designs.

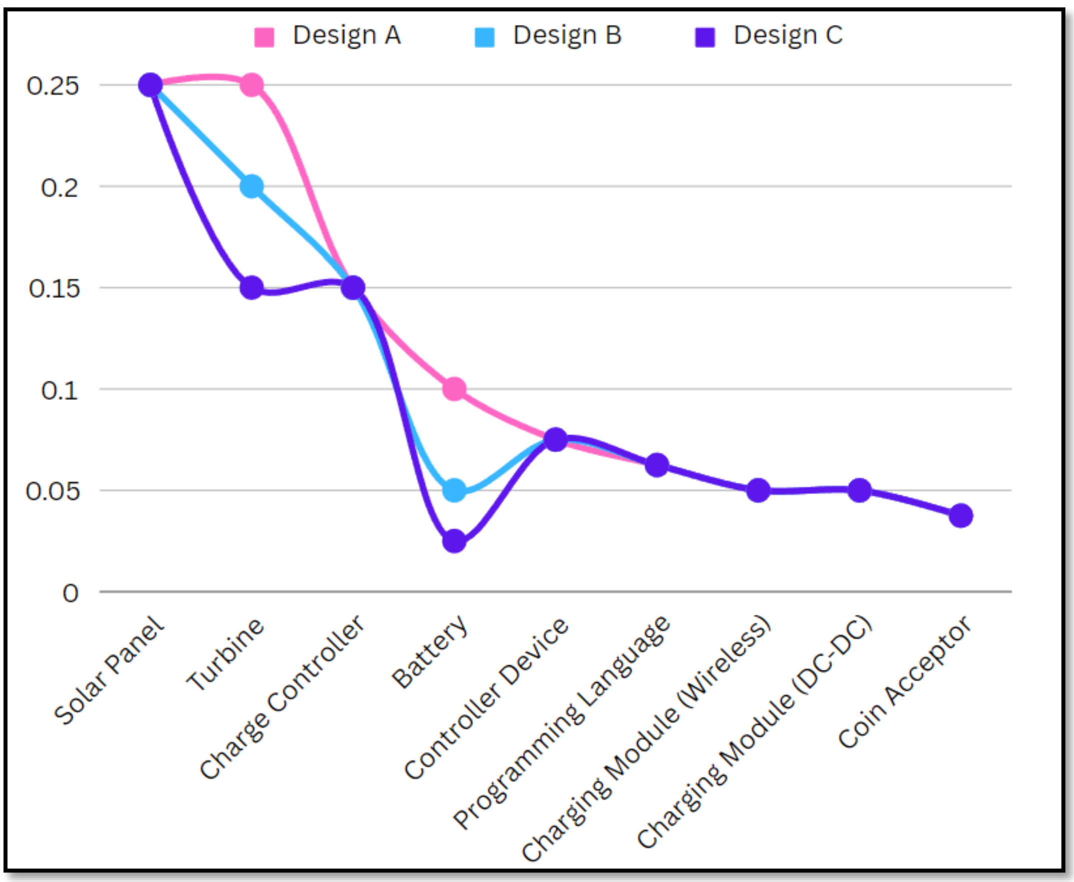

Figure 1: *Cost-effectiveness of each component/material.*

SECURITY

The tables for this constraint pertain to security. The weight of the components in this design leans toward the software and programming language of the prototype. The score is determined by the significance of the particular component that could protect and secure the prototype's software and the user's data when in use. The general components to be used in the three designs are the programming language, solar panel, charge controller, coin acceptor, two charging modules for wired and wireless, and the controller device. For the programming language, C will be used to utilize the controller device Arduino UNO.

Arduino UNO is a microcontroller board using the ATmega328P chip. It has everything needed to make the microcontroller work, including six analog inputs, a 16 MHz ceramic resonator, six digital input/output pins, a USB port, a power jack, an ICSP header, and a reset button. Monocrystalline photovoltaic PV solar panels would be used for all the designs. Solar will serve as a power generator, converting sunlight into electricity to power up devices. For the charge controller, the MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader will be integrated into all the designs. The charge controller monitors and controls the voltage and current flowing to the loads. The battery system receives any excess power, preventing overcharging and guaranteeing that the batteries maintain their charge level. The two charging modules are the 27W Wireless Fast Charging Module 5V/2.5A - 3A and the DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A. (Lagyan explanation pa). The wind turbine and the battery are the two different components of each design. Implementing the wind turbine for the prototype would act as the other power generator. Like an airplane's wings or a helicopter's rotor blades, a wind turbine uses the aerodynamic force produced by its rotor blades to transform wind energy into electrical power. Darius Helix Vertical Axis Wind Turbine is used for design A, Savonius Vertical Axis Wind Turbine is used for design B, and Triple Bladed Horizontal Axis Wind Turbine for design C. The other component that will be integrated is the battery. This component would be the energy storage that the solar panel and the wind turbine generate. The considerations for each design A, B, and C are the 24V Recharge Lithium-Iron (LiFePo4) Battery Pack, 24V Recharge Lead Acid Battery Pack, and 24V Recharge Lithium-Polymer (LiPo) Battery Pack, respectively.

Design A					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.3	5	1.5	0.375
Vertical Wind Turbine (Distributed/"small" wind)	Darius Helix Vertical Axis Wind Turbine	0.05	4	0.2	0.05
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.05	4	0.2	0.05
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.05	4	0.2	0.05
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.05	4	0.15	0.0375
Coin Acceptor (Input Device)	CH-926	0.2	5	1	0.25
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	3	0.15	0.0375
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	3	0.15	0.0375
Controller Device	Arduino UNO	0.2	4	1	0.25
		1			1.1375

Design B					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.3	5	1.5	0.375
Vertical Wind Turbine (Distributed/"small" wind)	Darius Helix Vertical Axis Wind Turbine	0.05	4	0.2	0.05
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.05	4	0.2	0.05
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.05	4	0.2	0.05
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.05	2	0.15	0.0375
Coin Acceptor (Input Device)	CH-926	0.2	5	1	0.25
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	3	0.15	0.0375
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	3	0.15	0.0375
Controller Device	Arduino UNO	0.2	4	1	0.25
		1			1.1375

Design C					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	1.5	0.375
Vertical Wind Turbine (Distributed/"small" wind)	Darius Helix Vertical Axis Wind Turbine	0.2	4	0.2	0.05
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	4	0.2	0.05
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	4	0.2	0.05
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	3	0.15	0.0375
Coin Acceptor (Input Device)	CH-926	0.05	5	1	0.25

Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	3	0.15	0.0375
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	3	0.15	0.0375
Controller Device	Arduino UNO	0.2	4	1	0.25
		1			1.1375

For each design iteration (A, B, and C), parts such as the programming language (C) used for the Arduino UNO microcontroller, charge controllers, solar panels, charging modules, wind turbines, and batteries will be used. The material supplied will have the same consideration in terms of security. For the controller device, the software architecture on the microcontroller and the stability of the programming language (C programming for Arduino UNO) are crucial from a security perspective. Furthermore, by guaranteeing dependable power management, the charge controllers' ability to monitor and regulate voltage and current flow—particularly in avoiding overcharging and preserving battery health—indirectly supports the system's security.

Other hardware elements, like solar panels, charging modules, wind turbines, and battery types (LiFePo4, Lead Acid, and LiPo), may also have security implications. These could include issues with dependability, durability, and potential vulnerabilities that could indirectly affect the system's overall security.

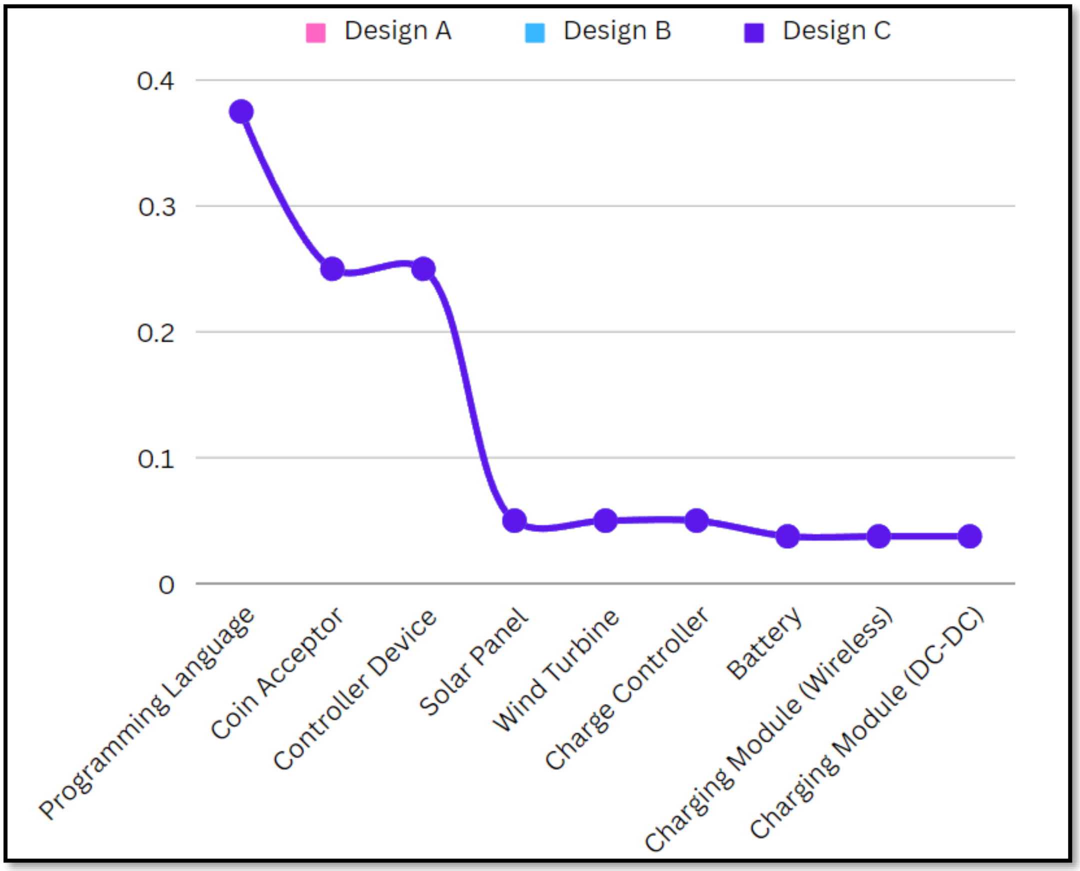

Figure 2: *Security compatibility of each component/material.*

DEVELOPMENT

The table regarding this limitation focuses on development. The composition of the elements in this blueprint leans towards efficiency, which is essential for the improvement required by the prototype. Evaluating each component's importance contributes to achieving the desired functionality of the prototype while ensuring optimal performance and capability. The primary elements common to the three designs encompass the programming language, solar panel, charge controller, coin acceptor, two charging modules (wired and wireless), and the controller device. The c programming language will be utilized for the Arduino UNO controller device, which employs the ATmega328P chip and has necessary features such as analog and digital inputs/outputs, a USB port, a power jack, an ICSP header, and a reset button. For the

Vertical Wind Turbine, it will be examined along with the discussion, in which we'll be able to conclude the best-fit material to use for the proposed prototype.

Monocrystalline photovoltaic PV solar panels will be employed across all designs to harness sunlight and convert it into electrical power for devices. The MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader will be incorporated into each design to monitor and regulate voltage and current to the loads, preventing overcharging of the battery system and ensuring battery charge maintenance. The two charging modules are the 27W Wireless Fast Charging Module (5V/2.5A - 3A) and the DC-DC Fast Charge Module (6~32V to 5V/2.5A - 3A).

The wind turbine and battery are unique components for each design. Incorporating a wind turbine serves as an additional power generator, utilizing aerodynamic force to convert wind energy into electrical power. Design A uses the Darius Helix Vertical Wind Turbine, Design B employs the Savonius Vertical Axis Wind Turbine, and Design C utilizes the Triple Bladed Horizontal Axis Wind Turbine. The battery is an energy storage system for the power generated by the solar panel and wind turbine.

The specific considerations for Designs A, B, and C are the 24V Recharge Lithium-Iron (LiFePo4) Battery Pack, 24V Recharge Lead Acid Battery Pack, and 24V Recharge Lithium-Polymer (LiPo) Battery Pack, respectively.

Design A					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	0.25	0.0625
Vertical Wind Turbine (Distributed/"small" wind)	Darius Helix Vertical Axis Wind Turbine	0.2	5	1	0.25
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	4	1.2	0.3

Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	3	0.6	0.15
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	4	0.4	0.1
Coin Acceptor (Input Device)	CH-926	0.05	3	0.075	0.01875
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	4	0.1	0.025
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	4	0.1	0.025
Controller Device	Arduino UNO	0.1	4	0.1	0.025
		1			0.95625

Design B					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	0.25	0.0625
Vertical Wind Turbine (Distributed/”small” wind)	Darius Helix Vertical Axis Wind Turbine	0.2	4	0.8	0.2
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	4	1.2	0.3
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	3	0.6	0.15
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	3	0.3	0.075
Coin Acceptor (Input Device)	CH-926	0.05	3	0.075	0.01875
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	4	0.1	0.025
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	4	0.1	0.025
Controller Device	Arduino UNO	0.1	4	0.1	0.025
		1			0.88125

Design C					
Components	description	weight	cell-index factor	score	score function
		a	*b*	*c=a*b*	*d=c*25%*
Programming Language	C	0.05	5	0.25	0.0625
Vertical Wind Turbine (Distributed/"small" wind)	Darius Helix Vertical Axis Wind Turbine	0.2	4	0.8	0.2
Solar Panel	Monocrystalline Photovoltaic PV Solar Panel	0.2	4	1.2	0.3
Charge Controller	MPPT Solar/Wind Hybrid System Charge Controller with Dump Loader	0.2	3	0.6	0.15
Battery	24V Recharge Lithium-Iron (LiFePo4) Battery Pack)	0.1	4	0.2	0.05
Coin Acceptor (Input Device)	CH-926	0.05	3	0.075	
Charging Module	27W Wireless Fast Charging Module 5V/2.5A - 3A	0.05	4	0.1	0.025
Charging Module	DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A	0.05	4	0.1	0.025
Controller Device	Arduino UNO	0.1	4	0.1	0.025
		1			0.85625

Programming Language and Controller (C language, Arduino UNO): Using C language with the Arduino UNO microcontroller board guarantees effective development, simplified coding, and adaptability—all of which are essential for quick prototyping and successful functional testing, which speeds up the prototype's improvement phase.

Monocrystalline Photovoltaic PV Solar Panels: The installation of these panels ensures reliable and effective solar power generation, enabling uninterrupted testing and development and providing a steady power source for further advancements.

Charge Controller for MPPT Solar/Wind Hybrid Systems: By integrating this controller into all designs, it is possible to preserve battery health, avoid overcharging, and regulate energy optimally. This feature guarantees the prototype's constant functioning while facilitating continuous development and testing.

Charging Modules (Wired and Wireless): The selected charging modules provide flexible and effective power transfer methods, guaranteeing easy charging throughout development stages and meeting various testing needs without sacrificing effectiveness. Two charging modules with fixed voltage value and amperage that can be bought in the market; 27W Wireless Fast Charging Module 5V/2.5A - 3A and the DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A (USB power charger port) will also be applied among all designs.

Wind Turbine (Darius Helix Vertical Wind Turbine): By adding the Darius Helix Vertical Wind Turbine to the mix, you can ensure sustainable energy production, which permits ongoing growth even in areas with sufficient wind resources and lessens your reliance on conventional power sources.

The 24V Recharge Lithium-Iron Phosphate (LiFePo4) Battery Pack is an option that guarantees dependable and steady energy storage for the battery system. This characteristic allows for extended stages of development and continuous testing, both essential for effectively optimizing the prototype's performance.

Every element in Design A contributes substantially to the prototype's progress by guaranteeing a steady power supply, effective energy use, and simplified development procedures, eventually speeding up improvements and efficiency gains.

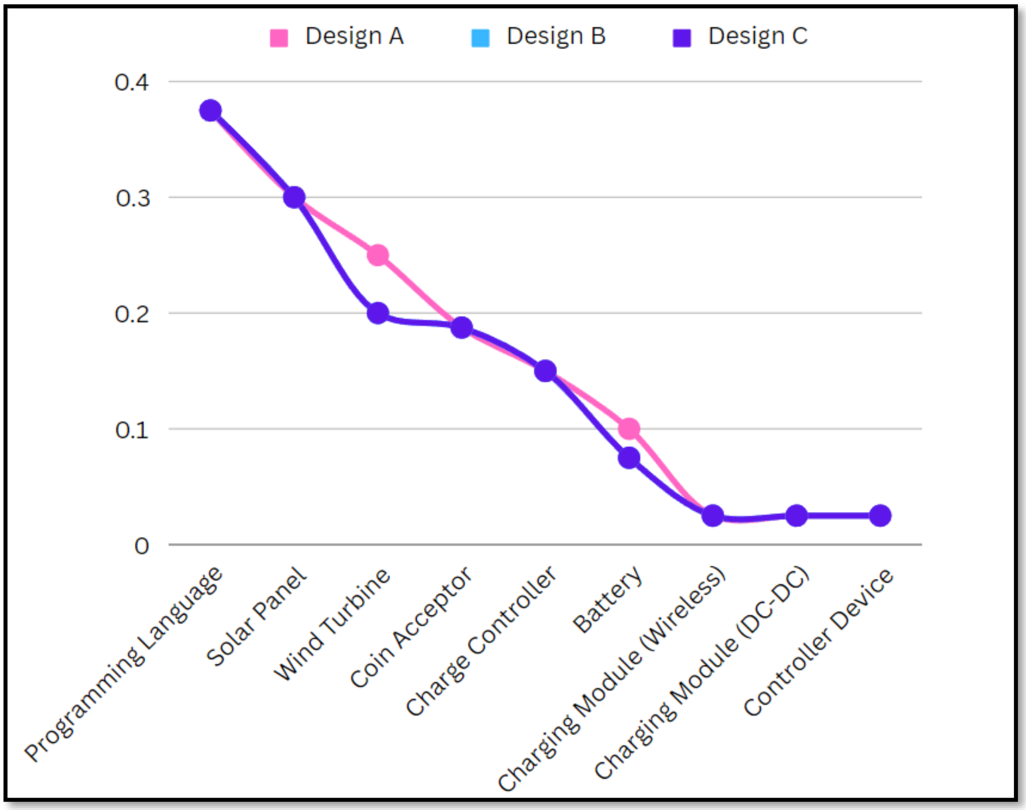

Figure 3: *Development for each component/material.*

LEVEL OF ACCEPTANCE:

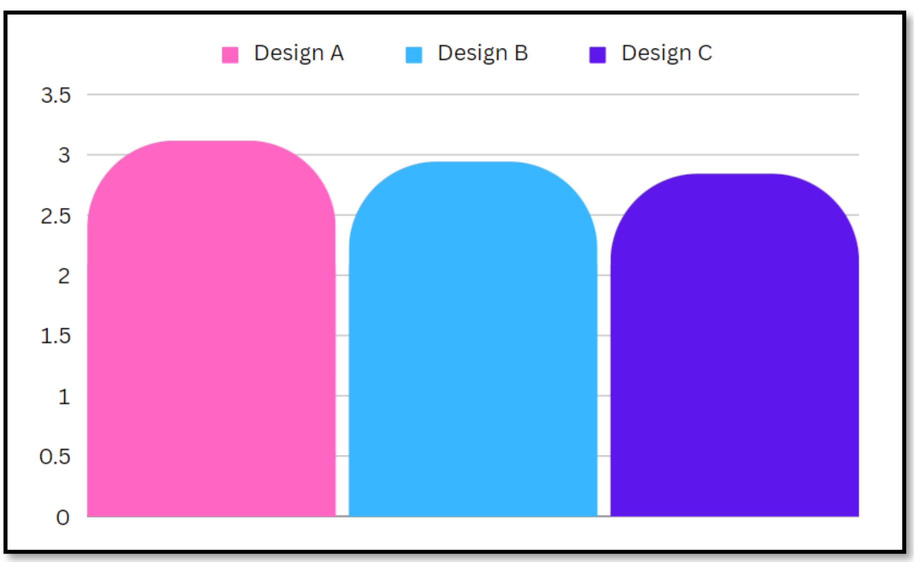

Figure 4: *Summation of Cost, Security, and Development.*

Cost, Security, and Development	Summation	
	A	3.11875
	B	2.94375
	C	2.84375

Discussion:

In the table shown above, three factors were listed, namely, Cost, Security, and Development, to determine which design is acceptable. We can observe that Design A has gathered the highest acceptance among the other designs. Some factors that lead us to Design A is that the components are easily found and produced, as they are cost-effective than the other designs. Designs B and C may have cheaper components such as the battery implemented in the prototype, the level of effectiveness would not be ideal, which further leans toward Design A being desirable. Additionally, the development of Design A is better and more capable to handle the needed power of the components used in this prototype. Meanwhile, the security of all designs remains constant due to its consistent software and programming language.

The components used for the best design, which is Design A, are the following: For the hardware components, the prototype comprises a Darius Helix Vertical Axis Wind Turbine which will gather energy using the wind from all directions.

Monocrystalline Photovoltaic PV Solar Panel that will harness energy from sunlight and will also enable continuous testing and development as well as a reliable source of funding for further advancements.

Charge Controller for MPPT Solar/Wind Hybrid Systems with a dump loader responsible for monitoring and controlling the voltage and current flowing to the loads. This also prevents the batteries from overcharging and guarantees a maintainable charge level. This feature guarantees the prototype's constant functioning while facilitating continuous development and testing.

24V Recharge Lithium-Polymer Battery Pack will ensure that the battery system has consistent and reliable energy storage and a long lifespan. This feature enables longer development cycles and ongoing testing, which is necessary to maximize the prototype's functionality efficiently.

CH-926 Coin Acceptor will be in charge of accepting five (5) kinds of peso coins and starting charging for the prototype. This feature enables the prototype for further development of the system.

7W Wireless Fast Charging Module 5V/2.5A - 3A and DC-DC Fast Charge Module 6~32V to 5V/2.5A - 3A (USB power charger port) these two charging modules have a fixed voltage value and amperage and are accountable for providing flexible and effective power transfer methods for easy charging.

The Arduino UNO Microcontroller used in this design will guarantee effective development, simplified coding, and adaptability—all of which are essential for quick prototyping and successful functional testing, which speeds up the prototype's improvement phase.

The researchers utilized the C programming language for the software used for Design A. This ensures that the program is compatible with the Arduino UNO microcontroller and is easier for when developing and advancing the prototype system.