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Harvesting Sea Wave Energy By Using Point Absorber and Blockchain Technology

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ABSTRACT

In the current era of modern innovations, the applications of energy trading using secure software systems are increasing dramatically. The concept of energy generation using sea waves is slowly emerging. Moreover, to the best of our knowledge, the use of blockchain in this domain is in its infancy. In this research work, the Point absorber energy converter will be analyzed for power generation, which works with the power of the incoming and the outgoing waves. This system is more efficient and economical compared to old converters. The power in waves has potential force, which can be converted into kinetic force. This kinetic force is used to rotate the alternator, which produces useful power and this power can be stored in batteries or used directly by using various methods. The main benefit of this WEC is that it can be cone in very shallow waters and does not require deep waters to generate power. There is also another positive factor of this converter is that when the wave enters the converter's incoming as well as the outgoing waves in the front and back direction and the height of the waves come onward, the shore the height of the water increases and decreases as the waves recede. This level changes in height and is used to move another alternator, which, is used on the same structure. The alternators used in the research are based on the axial flux alternator, which works on low rpm and has a power density much higher than the radial flux motor. For energy, trading, and control blockchain method has been employed considering power shortage and theft in our country and globally. The results of the paper reveal that the proposed system can be very effective if applied on a large scale.

KEYWORDS
Renewable Energy, point absorber, blockchain, Hybrid Power system, Tidal energy, and storage system

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INTRODUCTION

The rise of the energy crisis in recent years has captured the attention of academia and energy experts to devise new ways of energy generation. It is not a hidden fact that the power crises in many countries is worsening over the last ten years, especially the developing nations such as Pakistan. The reliance on fossil fuels is the major cause of global warming and greenhouse gases. The fossil fuel reserves are also depleting. Keeping in view these situations, advances have been workout in the field of renewable energy and are on implemented stage. There are many sources available in nature, such as solar, wind, geothermal, hydro, and ocean power. All these energy resources depend on the location and conditions but free energy resources. Now day's researchers are focusing on solar and wind power but few focus on sea wave power in many Asian countries like Pakistan. Sea wave energy is the best energy resource for People living near the sea and must install in these countries with optionally with solar and wind power system at the commercial level to avoid load shading in the future. The sea wave energy is cheap but the initial installation cost is high but still running is cost low as compared to other energy resources. After the installation of the sea wave system, the huge electricity bills can be avoided at the commercial and domestic levels. This system will be more attractive in the future because scientists are working on its lightweight structure and long life by using Nanotechnology. Normally the temperature near the sea is low and the pressure of the breeze is more as compared to the city. Due to the use of fossil fuels pollution and temperature is becoming high. In effect the season is changing as in Pakistan the winter season is shirking and summer is lasting long for a time due to pollution affecting the green belt around the earth which protects the earth from heat layers. The sea wave energy system can provide cheap electricity to coastal areas and can share the main gird load. If a hybrid power model is implemented, such as the combination of solar, wind, and sea wave power system the major burden on the main grid can be shared. By using the blockchain, the energy can be traded safely with the main grid. The potential of sea waves for generating energy depends on the height of the waves as given in figure 1.

All these energy resources are fall in the category of free energy resources and available for maximum time. Power from all these sources is more than enough to provide power to the total global needs. The earth is nearly 70 % covered with water from the oceans and seas; it has been estimated that the power obtained from this source is about two terawatts [1].

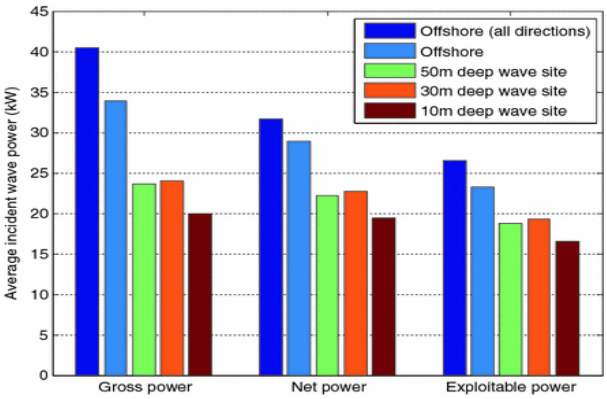

Fig: 1. The power potential of sea wave

The generation of waves depends on the gravitational forces of the moon and the sun as well as the winds and sometimes-seismic disturbances. Commonly the waves created are by wind or also known as swell [2]. In recent years, the research works on sea waves and tidal energy have increased because this system has many advantages as compared to the other systems. Pakistan has the potential to produce electricity by using the WEC but still no, work has started instead the coastline is 1,050 km long (652.44 miles) and faces the Arabian Sea given in figure 2.

Fig: 2. Pakistan's coastline length (1,050 km)

RELATED WORK

Clean energy means environment-friendly no pollution or hazardous gases the zero CO_2 generation. Shahrouz Abolhosseini, Almas Hashmi, and john Altmann discuss the importance of emission of greenhouse gases such as CO_2 as a globally concerned matter and present two solutions such as increasing efficiency and enhanced renewable energy deployment [3]. Most research work has been done on solar power and wind energy as clean sources of energy without considering the ideal location of these systems such as near the sea where the speed of the wind is suitable for wind turbines and sea wave energy. Felix A. Farret & Simoes represent the model of sea waves but as a single energy source [4]. In Smartgrid consumers are connected & power is in distributed form. The researchers are searching for a more powerful and big fully distributed power system peer-to-peer network for the future [5]. In this paper, the authors investigate the advantages of the Microgrid such as the issue of consuming power in distributed power systems and its effect on generation and the Smartgrid [6, 7]. According to Shen and Pena-Mora, the three essential parts of the blockchain is smart contracts, distributed network, and crypto token. This shows the business logic, database, and working process respectively. The blockchain has evolved in the system over the last decade, from blockchain 1.0 to 3.0, Blockchain is now becoming famous for Energy trading systems because it is safe, sure, and easy to adopt [8].

Blockchain technology still has many opportunities and challenges in the market and technical issues such as a high bulk record of files, storage system, and security issues [9]. Moreover, previous studies have presented the benefits of the blockchain for the energy storage system. For instance, using the blockchain, the energy can be traded more efficiently and more profit can be generated [10]. The energy storage system plays an important role in a blockchain system to control the variation and losses in the system but an efficient energy storage system is required to provide energy with no delay or loss [12]. For instance, the multiple uses of stationary battery storage systems based on blockchain are considerably significant [13]. Furthermore, some studies presented the working of the solar system with Microgrid in stand-alone mode. The simulation results proved that the solar system in stand-alone mode significantly shows good performance [14]. In addition, a recent study investigated the decentralized blockchain energy system, which consists of small, medium, and low voltage connected units. The capacity photovoltaic cell capacity is installed near the energy user side. The Microgrid is a decentralized system, which may operate on or off the grid depending on the conditions [15] [21]. In modern energy markets, prosumers cannot be instantly rewarded for the energy they sell back to the grid. Instead, the utility companies purchase excess energy produced by the prosumer as a monthly credit [16]. Similarly, another study discussed the operation and control of Microgrids using IoT. The study outlined that the internet speed must be high and a secure method can be used to control devices through the internet [17]. Likewise, a recent study proposed a model for energy trading using a decentralized blockchain scheme among neighbors. In the presented model, the seller who wants to sell their energy makes announces on the network the amount of extra-generated energy and the price on the bid board to the consumers in the same blockchain network [18]. The consumer, who wants to buy energy in bidding communication with the energy producer, If the agreement is set, the miners in the peer-to-peer network will execute and transaction.

Recently, the applications of the use of blockchain technology in green have gained significant attention from the academia and software industry. In recent studies by [19] and [20] the use of blockchain in energy trading has been demonstrated based on Smartgrid and Microgrid energy systems. The results of both studies reveal that energy trading can be made secure by using blockchain eliminating power loss, demand-supply issues, and the concept of centralized systems. Similarly, [22] conducted a literature review on blockchain energy systems and outline the significance of this domain.

In our system, we propose the use of sea wave energy to generate electricity based on blockchain. The use of sea

waves for energy generation is a new concept and its application with blockchain is in infancy. Hence, the proposed system provides a new method of trading sea wave energy using blockchain technology.

BENEFITS OF SEA WAVE POWER GENERATION

Since power is produced by the use of fossil fuels and then is transferred from a point to the users, through a series of lines and transformations the cost incurred is enormous and the result is environmentally harmful and costly. To curtail both adverse factors it is required to venture into alternate sources of energy to provide power to the end-user. For this purpose, the wave point absorber for the power generation system was selected in this research work. This type of energy has the potential to make a huge amount of power and is clean and environmentally friendly. The significance of the research work cannot be undermined and it is evident that this source of energy is both useful and freely available to us. The other significant factor is that if a system is implemented for energy in Pakistan, a lot of benefits can be achieved because the mechanical sources available to start large projects as well as the costal line of Pakistan is very big as given in the last section figure 2.

ISSUES AND CHALLENGES

The world is facing two kinds of problems at present. The first is the shortage of power. The demand has increased to an extent that the supply is lagging in its production. In addition, the other problem is that due to the dependence on fossil fuel (major production of power) the environment of the world has been changed at the worst level. This is known as global warming. Due to this climate, negative changes have occurred which results in hurricanes, storms, earthquakes, tsunamis, and other disasters. The impact of these changes should be minimized in the future to avoid further devastation. The solution lies in the quest and development of alternate sources of energy to harvest power. All forms of renewable energies are clean and leave no carbon footprint. This system does not affect global warming and climate change. Many issues and challenges are present and need to address in the future such as lightweight structure, lifetime, and losses due to moisture of sea wave power systems.

POSSIBLE SOLUTION

In this paper, a solution is presented, which is demonstrated in a lab environment at a small scale due to limited resources and budget. However, the power production from this module can be enhanced such as by taking many absorbers and placing them in an appointed location or making a big power generation system to make power on the point absorbing method. The problem, encountered, will be solved only by this one source since the potential of power from the sea is immense. Second, the method of power trading, control, management, cost of electricity, and efficiency will be analyzed.

The use of blockchain technology became prominent after 2015 [23]. It is a decentralized and distributed ledger that provides more security, transparency, consensus mechanisms, and immutability for storing data [24]. The first use of blockchain was based on the finance market. However, it is now being integrated into other domains as well, especially the energy market. In sea wave energy generation, the application of blockchain is infancy, our system contributes toward fulfilling the gap found in this domain.

The use of blockchain has shown great benefits in other energy systems such as wind, solar, hydroelectricity, etc. Hence, it can benefit the community in trading sea wave energy more securely. There are a few risks of blockchain technology such as the 51% attack, however, the benefits of the blockchain technology outweigh its risks hence to the best of our knowledge we consider blockchain technology as the most ideal for energy trading based on sea wave energy.

PROPOSED MODEL

The lab module of the wave power system is shown below in the figure. 3. Four main renewable power systems selected as input resources are solar, wind, tidal, and wave energy systems. The selected systems are ideal for sea site off share location and tidal and wave energy naturally exists on the major site of the Globe. The energy systems can be cascaded to produce huge energy in the system and this energy can be stored in the system.

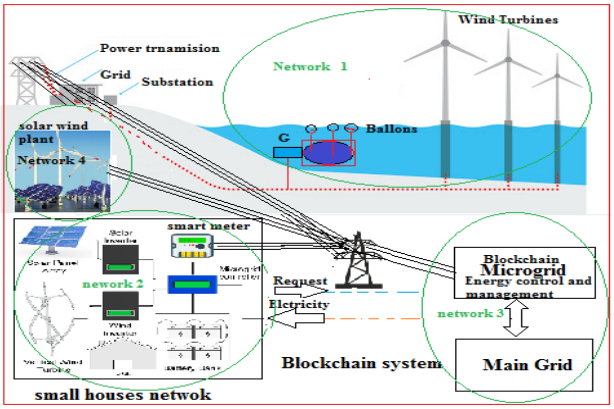

Fig. 3 Proposed model

There are three parts of the system tidal waves, sea wave energy system, and energy storage system, and blockchain is used to control and management of energy as shown in figure 4.

First, the user in the blockchain system request to send to the nearest path to find energy if the energy is not available network then it is forwarded to the sea wave storage system through. If the energy is not available, then the request sends to the Microgrid in the network. The energy management system checks the demand and sends it to the storage system using blockchain. If the demand meets the requirement the bid is sent to the user, as shown in figure 7. After the agreement, the system starts supplying the electricity and in the end, the bill is sent to the users. This process passes through all users in the network. So no secret deals can be performed all processes and bids are clear to all users in the network. This process is done by using the blockchain technique.

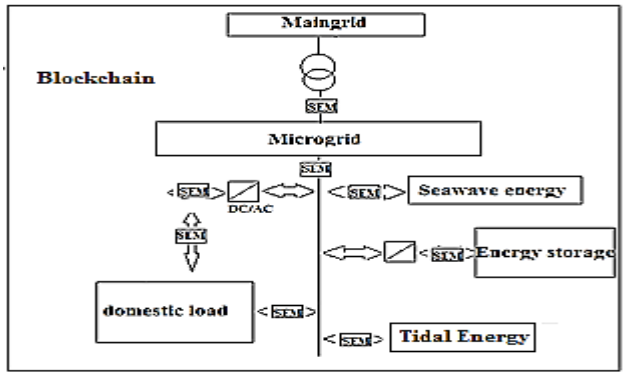

Fig: 4 the proposed model

The A, B, C, D & EPM&C. the user has five options. When a user sends the request for purchasing the electricity as shown in figure 5. The proposed explained in the next section.

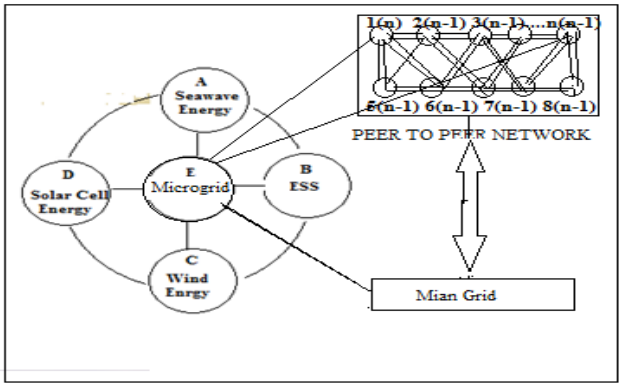

Fig: 5. Proposed network diagram

The complete steps for purchasing the energy using the blockchain are given in figure 6. The energy resources are tidal and sea wave energy.

METHODOLOGY

The lab module diagram of the proposed system is given in given in figure 7. The model was implemented with a systematic plan, which was to first design the setup of the project. Finally, it changed to a fixed version. The system, which was required, was a fixed system, which could be installed in shallow waters and could operate by the incoming and outgoing waves. The height of the waves could be as less as "1" foot to operate the system. For this reason, we made the SHS farm. The good part about the alternator is that water does not affect the performance of the alternator even if the alternator is splashed with water. This is done by coating the alternator with bituminous paint. This paint gives very good protection against corrosion and prolongs the life of the system. The system was made and fabricated and the alternator was mounted on top of it. This was the alternator, which meant for the horizontal movements of the system.

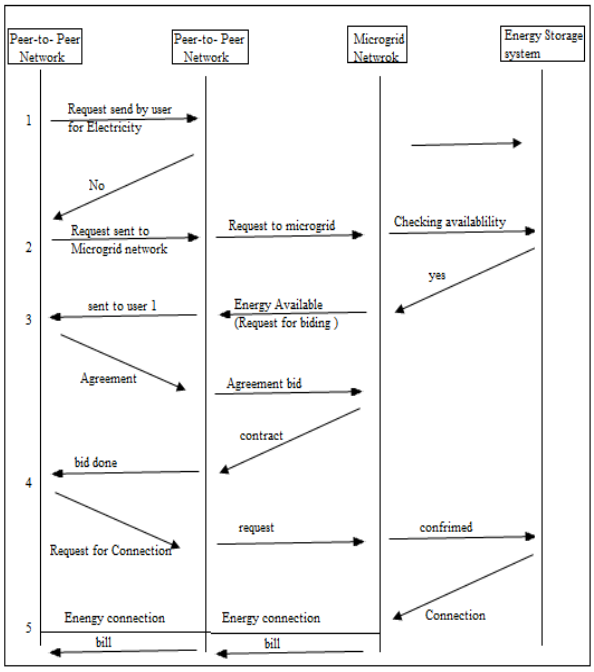

Fig. 6 Flowchart steps for purchasing electricity

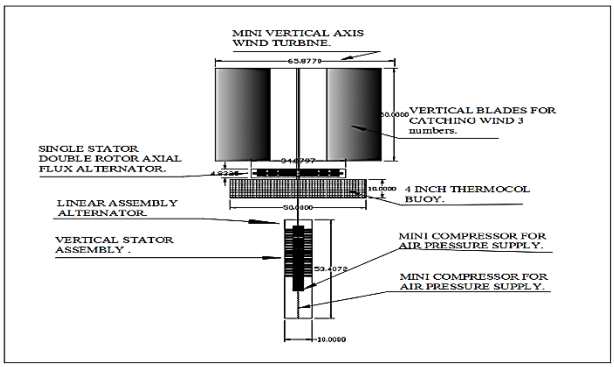

Fig: 7. Block diagram of the system

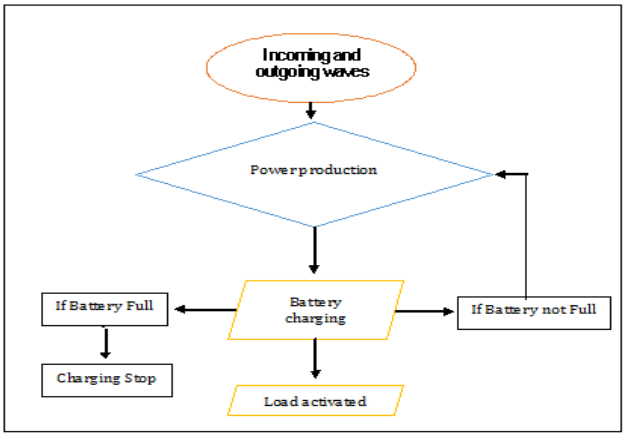

Fig 8. Flowchart of the proposed system

The flow chart of the system is given in figure 8. The input is incoming outgoing waves. With this movement of waves, power is produced and stored in the battery.

In table 1, the rpm is calculated for different heights of the wave. The maximum height of the maximum rpm means maximum power, but it depends on the design of the system. In our system, the maximum power can be obtained with low height, which is ideal where the height of the average waves is low such as in Pakistan.

Table 1: Wind Turbine efficiency Profile

Wave height	Voltages on Load	Amperes on Load	RPM
6”	3v	.08	60
12”	10v	.5	120
15”	12v	1	230
20”	16v	1.2	340
24”	19v	1.5	400

In table 1, voltage, current, and RPM are given according to the wave heights. As the height of the wave increase, more rpm can be generated and more power can be obtained.

SIMULINK MODEL

User node 1 sends the request to user 2. If the requirement fulfills the bid done and electricity is connected, on another hand if electricity is not available then the request is forwarded until the demand is fulfilled in the peer-to-peer network otherwise the demand sends to the Microgrid or direct to the wave energy control center. After the bid is done the electricity is provided on-demand and in the last step, the bill is sent to the consumer as shown in figure 9.

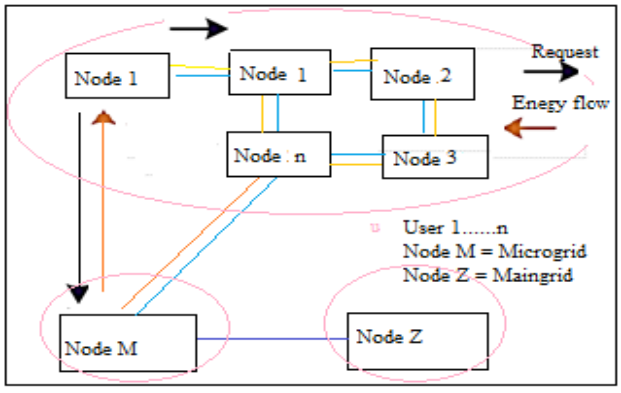

Fig: 9 Proposed network Model

MATHEMATICAL MODEL

If the angle between earth and moon gravity is 90 degrees,

it power will effect

$$P = C*E = \rho H / (16\omega) = \rho.g A / (4\omega) \qquad (i)$$

For the more depth of the ocean where the water level is at more depth more than half the is λ/2, so, the energy is

$$P = \frac{pg^2}{64\pi} H_{m0}^2 T_e \approx \left(.5 \frac{kw}{m^3.8}\right) H_{mo}^2 T_{e1} \qquad (ii)$$

Where

P = wave energy flux per unit

ρ = presents the water density

g = acceleration by gravity

The mathematical equations are presented to calculate the

Power of the wave energy

$L_{max} = P_{max}\ E = \lambda n 2\pi$ (iii)

Condition

n = 1 if body is in heave motion;

n = 2 if body is in surge motion

P_{max} = Maximum Extractable power;

L_{max} = Absorption width at maximum power

λ = ocean wavelength;

E = ρg2TH264π (iv)

ρ = seawater density;

g = gravitational acceleration; T = wave period

H = significant wave height

Efficiency η= P P_{max} (v)

The power, P, of an idealized ocean wave, is approximately equal, to H (m), multiplied by the wave period, t (in seconds).

P (kW) per meter of wavefront:

P ≈ H2t (kWm-1) ……. (vi)

P is the average power produced at a particular period.

P = ρg2Th2l32πρg2Th2l32π (vii)

.Table.2 Module Output result

Height (cm)	Wave Length(m)	Power (W)
10	.316	31
20	.2	78

In table 2, the power is calculated for the maximum height of the waves from other systems. as compared to our system it is quite clear that our work is at low heights of the waves. The available power, losses, and demand are given below

$$P_{losses\ total} = P_{total\ generation} - P_{total\ demand} \quad \text{(viii)}$$

From above the tables and calculations, it is quite clear that the lab module has high efficiency for producing the power with the floating balloons on the surface of the water. This system is a cost-effective and easy power generation method and has no harmful components for the marine system. This module at a commercial scale can be used to obtain power from the sea wave. By using the above equations, from the different types of the waves the power is calculated, the maximum power is from 3 waves, Water Deep Distance Related to Minimum Power (M) given in table 3.

Table: 3 Power Calculations

Wave in the Group	Max Wave Power W/M	Deep distance Related to Maxi Power(M)	Mini Wave Power W/M	Deep Distance Related to Minimum Power(M)
2	46.82	0.58	39.47	8.83
3	32.24	0.30	23.64	88.80
5	19.15	0.14	14.18	3.04

The design was completed on AutoCAD. The design was extended because it did not meet the complete specifications, we had intended. The Arduino Nano programming code language is the C language used for the coding of Arduino and Arduino microcontroller boards like Uno, MEGA, Pro Mini, Hummingbird Duo, and every other type use the same language codes for programming. This language is in a form of a simplified version type of the Java language applied for specific programming needs of creating sketches, and programs for these microcontrollers.

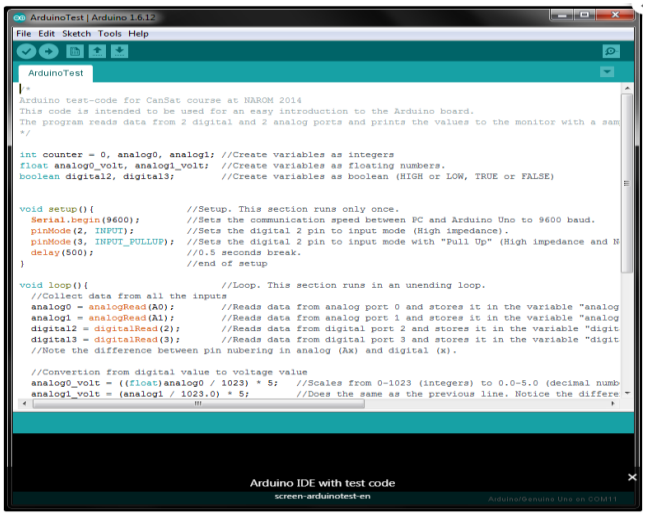

Fig 10: Software program used in the model

CONCLUSION

After analyzing the data and results of the research, which proves that, the system is truly remarkable innovation in the field of power generation by waves. The system can be made in Pakistan as we have the engineering facilities and the setup to produce this project is a complete system assembled for use, locally. It can generate power for a longer time is dependable and maintains consistency. The energy sources for the system are the twin alternators, which have efficient power generation capacity. The complete system is a compact system and portable. It can be used for any site onshore power acquisition depending on wave height. The main goals and objectives, which were defined achieved satisfactory results. By using simple electronic circuitry to monitor, the power output obtained and this can perform as the user has a real-time load result and production result on the mobile or laptop. In short, if this system produces industrially as a product the cost of the system will reduce and many benefits can be achieved.

FUTURE WORK

The paper has defined its practicality and it is imperative that work on the paper must be done in the future with more enhanced applications to reap the full benefits of the system. Using another power source as a solar PV panel will enhance the power output of the system and can make the system more effective. Further Market feasibility can be done to assess the viability of the product in the local market as well as for exports. If this project is implemented on a professional level, it can support the national power grid, which can help to solve the power crises, especially in our country.

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CREDIT AUTHOR STATEMENT

Afshaar Ahmed: Methodology and Research implementation **Syed Faraz Liaquat:** Data visualization and investigation **Huma Hasan Rizvi:** Result Comparisons **Manzar Ahmed**: Writing-Original Draft Preparation **Jeffery Ali Rizvi:** Data visualization and investigation, Data curation **Mishaal Ahmed:** Final Evaluation of Experiments, Final Manuscript Preparation, Proof-Reading.

COMPLIANCE WITH ETHICAL STANDARDS

It is declared that all authors don't have any conflict of interest. Furthermore, informed consent was obtained from all individual participants included in the study.

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