clean technologies

Review

Advanced Electric Battery Power Storage for Motors through the Use of Differential Gears and High Torque for Recirculating Power Generation

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Abstract: Electricity has become one of the most important factors contributing to both the livelihoods of individuals and global economic development. Most electricity generation is still derived from burning fossil fuels that contribute to environmental degradation. The aim of this research, through innovative design, was to create clean circular technology through the utilization of electronic devices that control and send optimally timed commands to two 72-volt batteries (DC) that store and distribute energy. This new form of electric power generation was adapted to be used with a three-way differential gear system. The speed of transmission was adjusted, and shaft rotation was connected to a 7.5 kw/h DC power motor with two 15 kw/h alternators in three phases to generate high torque power at the desired rate of 3000 RPM and electricity. The first set of alternators generated the electrical energy to be distributed. The circuit system of battery set one was used for storage and slowly fed to the motor, which was kept continuously running for hours. The second alternator distributed the generated voltage to the secondary battery, which stored backup power and provided the main power to the grid. This system is especially appealing for those looking to improve energy efficiency and contribute to the green economy, as this system can be applied to power charging stations for electric vehicles or used as a backup power source for buildings.

Keywords: clean circular technology; backup power storage; power grid; power charging station; energy efficiency; sustainability

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1. Introduction

Fossil fuel energy, or energy derived from petroleum, coal, or natural gas, is the primary source of emissions worldwide. As stated by the national and global agenda for diverse issues, high carbon dioxide (CO_2) is a key source of global warming and natural disasters, leading to climate change and environmental concerns affecting the world. As a result, significant amounts of money have been invested in clean energy to replace the traditional fossil fuel energy industry. This has come with considerable blowback from both the fossil fuel industry and government interests due to such drawbacks as price and difficulty in implementation. The primary forms of clean energy these days are pressurized energy from nitrogen gas [1], geothermal energy, hydropower, solar energy, tidal energy, etc., which all aim to replace the conventional energy uses that harms the environment [2–4].

In Thailand, the most popular alternative energy solution currently is solar energy because it is simple to use and install. It can also be adapted to fit either a single home or larger industry productions [5]. The main benefit for consumers is a reduction in the cost of electricity in the long run [4], which must be exchanged for the value of an investment in terms of limitations for total electric power consumption. The decision to switch to renewable energy usually depends on the cost of the initial investment and prospective return. There are also limitations in the intermittent functionality of the technology, especially the shortage of raw materials for use as fuel for combustion [6]. For a clean technology, such as a solar cell that generates only 5 h of electricity per day on average [7], that can create problems in terms of overall production, especially for manufacturing or other industries. There is also an issue of when the technology deteriorates and needs to be destroyed. This could prove costly due to hazardous materials employed by new technologies such as solar panels. That is, it will still be a problem that may cause pollution that will affect the environment in the future.

The technology of generating electric power can be easily explained through an examination of an electric generator by relying on the principle that there must be an energy source [8,9] to drive the shaft of the generator to create a constant rotation of the shaft. The rotation of the axle shaft can be accomplished in many ways, which depends on the design engineering principles of the manufacturers and their intent. For example, the alternator can be set to generate electricity at 10 kw/h by specifying the rotation of the spindle shaft with a speed level of 1500–3000 RPM, etc. [10], which is the necessary amount of stable energy needed for some production lines or for certain machines to operate. Innovative technology is the energy storage and distribution of electricity in a circular motion [11]. It is also the energy that occurs without the use of a power plant source or by using electricity from any grid [11,12]. The end goal is to obtain more free energy from existing sources in nature or that can be manually generated with new innovations in related technologies such as the power of the electromagnetic push-type motor [13,14] or of flowing water. This list includes energy from sunlight, wind, geothermal, high-pressure energy from nitrogen gas, etc. Also important to mention here is the need for appropriate storage, which in this case requires lithium nickel manganese-a batteries that have been developed to provide high power storage [15–17]. They can store a lot of energy, have a long service life, and increase the compression and discharge cycle. Therefore, they are commonly used in hybrid cars and electric bikes [18]. This was found to be the most prominent electric power supply in this research review process.

This research reviewed innovative technologies and the possibilities for new energy storage applications. Batteries are used as a renewable energy alternative for both energy storage and distribution. With the motor brushless (BLDC) for applications requiring high reliability [19,20], efficiency, and power per volume, it is a high-efficiency motor capable of delivering a large amount of torque in a wide range of powers [21]. The connection of the high-torque power axle shaft was reviewed through a three-way power transmission of the differential gear system to connect the axle to power generator technology. The focus was on reviewing the power transmission gear system that generates torque at the axle shaft of the power generator [22–25]. The primary goal was to achieve efficiency in continuous operation and for the rotation of the axle shaft of the machine to have a fixed rate of rotation as specified, as is necessary to produce the required amount of electrical power. The reviews of this new process and discoveries made will lead to the expansion of the application of renewable energy innovations and increased methods of energy storage in a new form of battery that is more practical and sustainable. This can be applied in the charging of electric vehicles and for use in the home to replace the less efficient solar energy in the near future.

2. Materials and Methods

2.1. The Design Principle Aims to Test the Feasibility and Maximum Efficiency of Energy Storage from the Main Power Battery

The initial test was to supply adequate electric power to start a 7.5 kw/h brushless DC BLDC motor, which is the main power source [26]. Then a high-torque-driven power was generated according to the specified rotation settings to generate enough power through a 3-way torque gear transmission and 2 sets of power generators designed to be installed together with a size of 15 kw/h [27], which allowed the first set of power generators to generate electricity. The additional voltage of 230 flowed through the storage into a 72 V 100 Ah primary power battery to generate electricity, power the motor with a power battery pack, and then to the second power generator, which generated electricity to flow to the second battery pack in preparation to store energy for use as a revolving system with the motor.

1. The brushless DC (BLDC) motor with a size of 7.5 kw/h 72-volt, 6500 RPM speed, and 100 Nm torque served as the main source of generating torque to drive the shaft of the power generator. The BLDC motor was a permanent magnet synchronous motor [28].
2. The differential gear was responsible for transmitting power from the motor through the gear set and torque to the generator to generate rotational power, causing the shaft to move. It was also a torque connector to transmit power.
3. The power generator with a size of 15 kw/h, 400-volt, and 3000 RPM speed served to generate electricity and transfer that electricity to storage in the battery.
4. The belt and sprocket served to transmit tensile force and the torque transmitted from the gear system and motor.
5. The lithium-ion battery (NMC) with a voltage of 72 v and a current of 100 Ah served to store and distribute electrical energy.
6. The electrical control system and automatic switching power supply (ATS) controls switched the operation of the electrical system to automatically work during the time when the electricity from the grid power supply was turned on or off.
7. The maximum power point tracking (MPTT) acted as a charge controller. It was applied to the operation of DC generators such as solar panels or wind turbines to more efficiently and stably generate electricity [29].
8. The microcontrollers (MCU) served to control the complex functions of the motors and enabled increased energy efficiency and reduced carbon dioxide emissions to effectively support its use.
9. The solid-state relay (SSR) was an electronic device that acted as a switch that did not use contacts to cut or connect the circuit system using the technology of a semiconductor without moving parts. Therefore, there was no sound while cutting or connecting the contacts. It could also stop charging the battery to prevent overcharging while also protecting the battery from damage by working with high currents and automatically cutting off the circuit when the battery power is low-full.
10. The inverter system converts alternating current (AC) from a common power supply with constant voltage and frequency to direct current (DC) by a converter circuit. The DC power was then converted into AC that could be scaled for voltage and frequency.

2.2. The Process of Generating Electricity and the Transfer from a Generator to Battery Storage

A review to test the working principle of a 12- volt DC motor connected to a shaft to an alternator with a maximum voltage of 200 volts with a brushless 3-phase electric type was used to generate electric power by measuring the voltage with a voltmeter [30]. Electrical energy from the alternator flowed to the storage system to await commands for the distribution of electricity to the battery with an electric current of 5 Ah 12 volts in 2 sets [31]. By controlling the complex operation of the motor with the circuit system, the microcontrollers (MCUs) could be [32–34] in continuous operation to increase energy efficiency and reduce carbon emissions. It also supported switching the charging of the battery in a more efficient way, as shown in Figure 1 and Table 1.

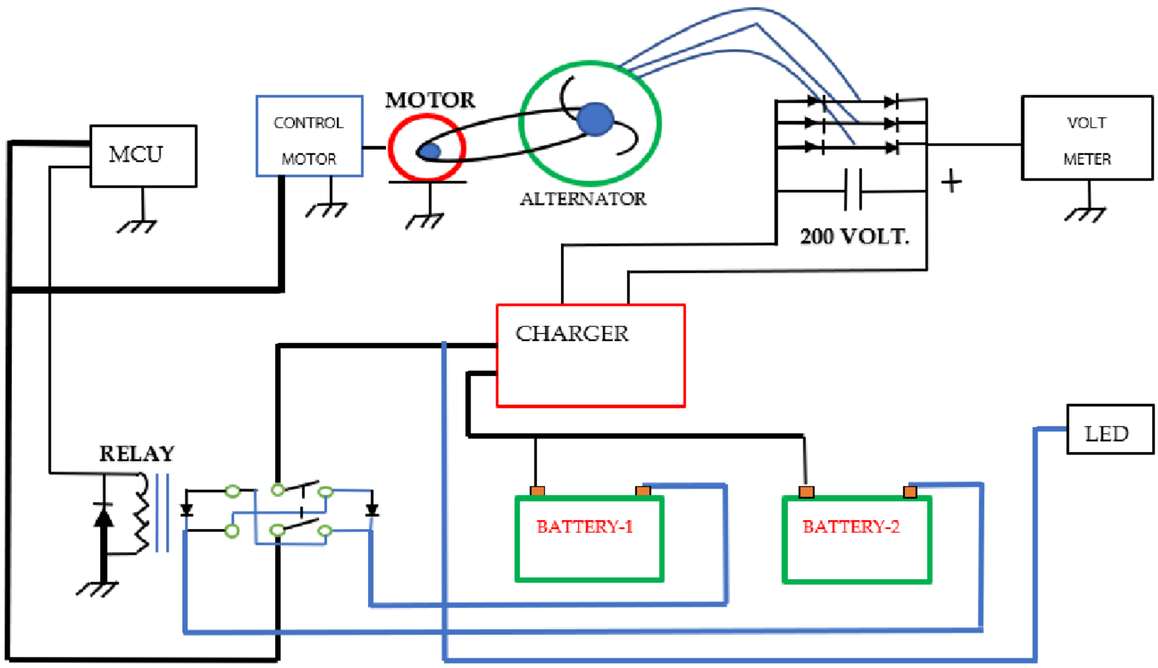

Figure 1. Continuously circulating electrical power diagram design in a motor-driven system.

Table 1. Core technology for continuous cyclic power generation in motor-driven systems.

Parameters	Value
Motor 775 DC Volt	12
Alternator 3 Phase Volt	200
Battery 5 Ah Volt	12

2.3. The Drive System Connection through a Gear Drive Increases the Power from the Motor by Transmitting the Torque Power to the Generator

To test the working principle of using a gear system to increase the rotation of the axle shaft, the gear motor size was 3 Hp with a voltage of 230 and a speed of 150 RPM. It was equipped with a 3-way boost gear that helped pass the torque at 100 Nm at the rate of 1:10 to generate enough torque power for the generator [35]. A size 1 phase voltage of 230 volts for 2 sets was used to produce electricity at a rate of 1500 RPM. The working principle of the power generation system in this form was using electricity on the grid voltage of 230 volts through the control cabinet by the main distribution board (MDB) for testing and to clearly measure the results of the torque transmission of the gear. It was installed to connect the shaft between the motor and alternator [36], as shown in Figure 2 and Table 2.

Table 2. High-torque technology for driving motors and generators.

Parameters	Value	Unit
Motor Gear 1st Phase 3 Hp	230	Volt
Motor Revolutions per minute	150	RPM
Alternator 1st Phase	230	Volt
Alternator Revolutions per minute	1500	RPM
Differential gear 3-way torque	100	Nm
Electricity on the grid	230	Volt

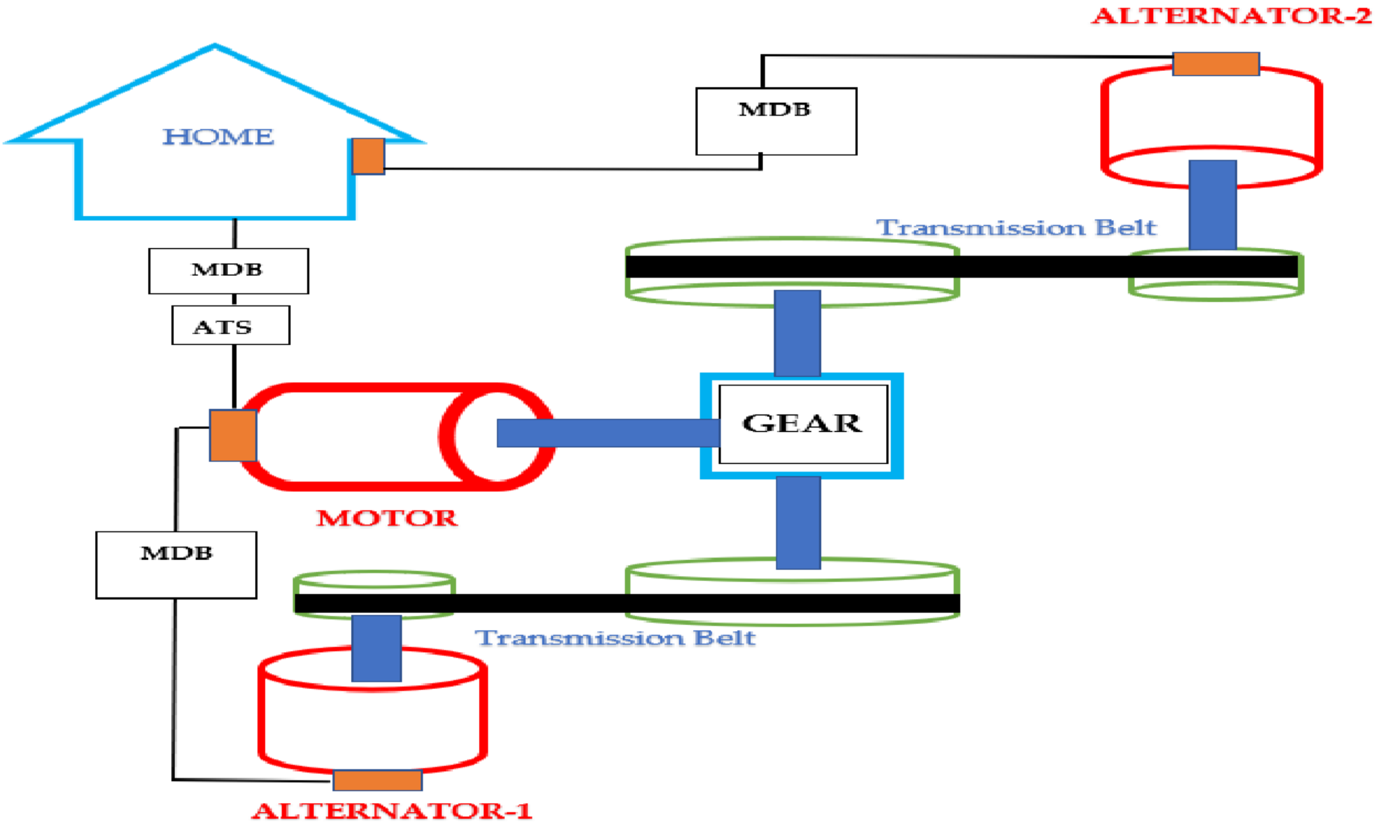

Figure 2. Axle shaft connection diagram between motor and generator with gearbox system.

2.4. The Prototype Technology with Connection of the Complete Cyclic Power Principal Structure System

We designed a review to analyze the feasibility of the prototype technology using a BLDC 7.5 kw/h motor with a maximum speed of 6500 RPM and axle mounted with an alternator size of 15 kw/h. We also used 3-phase 400 volts with a 3000 RPM speed and 2 sets bypassing the torque to the differential gear system and increasing the torque to 100 Nm [37]. Then 2 sets of ion battery systems (NMC) with a size of 72 volts were installed. A current of 100 Ah was achieved by specifying that battery set 1 received an electric charge from alternator set 1 to distribute electricity to the BLDC motor and battery set 2 to support an electric charge from alternator set 2 and to wait for distribution through the electric power to prepare for the grid. The control of the entire circuit system with the main distribution board (MDB) can be seen in Figure 3 and Table 3.

Table 3. Technology for interfacing with cyclic power generation circuits in the system.

Parameters	Value	Unit
BLDC motor 7.5 kw/h	72	Volt
Motor revolutions per minute	6500	RPM
Alternator 15 kw/h 3-phase	400	Volt
Alternator revolutions per minute	3000	RPM
Battery 100 Ah	72	Volt
Differential gear 1:4 torque	100	Nm

2.5. Electrical Units of Measurement

Electrical measurements are essential in the operation of electrical equipment. Electrical measurements require instruments to measure various values such as electric current, voltage, electric power, electric power, etc. Various measuring instruments were employed in this research. as shown in Table 4. Choosing and using the right tools had a considerable impact on the accuracy and outcome of the results. This led to the effective management of electricity [38].

Table 4. The international units of measurement by the International System of Units (SI) define important basic electrical units and other practical electrical measurement units. Our research employed the following definitions [39].

Electrical Unit of Measurement.	Definition of Electrical Measurement Units	Unit	Types of Electrical Measuring Instruments
Voltage	Voltage is the force that causes electrons to move or the force causing the flow of electric current.	Volt	Voltmeter
Current	Electricity is caused by the movement of electrons from one point to another within a conductor.	Ampere	Amp meter
Resistance	Electrical resistance is the resistance to the flow of electric current. The higher or lower the value depends on the type of object.	Ohm	Ohmmeter
Power	Electrical power is the rate of change of electrical energy used to generate energy in various forms, such as heat energy, light energy, and mechanical energy.	Watt	Power factor meter
Capacitance	Dielectric separation is an elaborate method where the dielectric determined the value of that capacitor.	Farad	Multimeter
Revolutions per minute	Using a light source such as a laser or infrared light to measure rotational speed or a haft rotation speed measuring instrument.	RPM	Tachometer

Safety standards for electrical measuring instruments (under safety standards EN61010 Series and JIS C 1010 Series) are divided into categories from CAT II to CAT IV based on the rated voltage and overvoltage occurring at the measurement point.).

Technical Considerations in Selecting Measuring Instruments.

(1) Desired measurement area (range).
(2) Accuracy level in general, the required accuracy level should be about ±0.5% to ±2.0%.
(3) Usage characteristics such as touching or not having to touch something to be measured. Portable or fixed existing equipment must be customized for the installation of measuring tools or not (non-destructive) in general. A non-contact, portable, and non-adjusting measuring instrument should be selected for the existing energy equipment that is suitable and convenient for more frequent use. Most of today's record-keeping methods are digital recording systems that can record data either at specified recurring intervals, appointed times, or continuously.
(4) Duration, the primary purpose of use, and response time (measure time or sensitivity).
(5) Safety standards of electrical measuring instruments.

2.6. Cost Comparison for the Implementation and Construction of the Technology

Here we detail the estimated project costs of operations, including any energy costs or cost estimation, as shown in Table 5 below. The cost should be calculated by all organizations, as it is a useful metric for assessing the overall cost of technology and investment [4,40–42]. To properly assess the cost, energy consumption in all systems and for all functions must be taken into consideration, along with the cost of system downtime [43], as shown in Table 5.

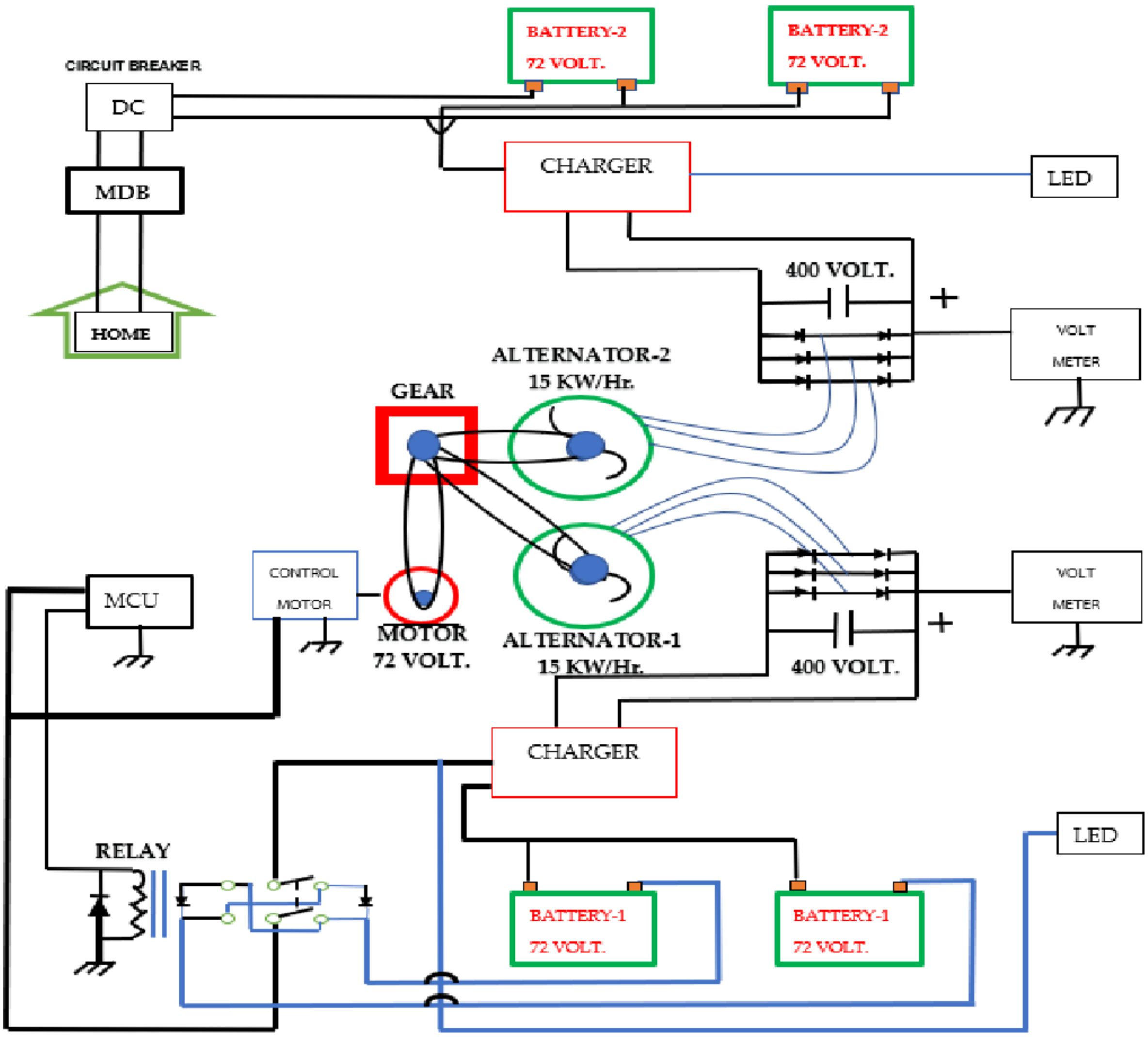

Figure 3. Diagram design of a complete circulating electric power technology circuit.

Table 5. Cost comparison for the implementation and construction of the technology [1].

Parameters	Cost Unit/Operations kw/h/USD	Cost Unit/Construction Mwe/USD
Solar power Average capacity achievable/day/5 h	0.181	600,000
Wind power Average capacity achievable /day/24 h	0.151	1,500,000
Hydropower Average capacity achievable /day/24 h	0.045	3,000,000
Nuclear Power Average capacity achievable /day/24 h	0.030	5,000,000
Nitrogen power Average capacity achievable /day/24 h	0.045	2,000,000

Note: Data analysis in Thai baht (1 USD = 35 THB).

3. Results and Discussion

3.1. Analysis of Electric Power Generation from Power Generators for Storage into Batteries and Distribution of Power to Motors

Circular energy generation contains key technological components such as main power motor engines [44,45], power generators and batteries. It describes the interconnection of technology and equipment systems. In this case, we looked at the operation of a 12-volt main motor used to generate energy by mechanical means [46,47]. Torque was generated to drive the shaft of a 12-volt three-phase electric generator to generate electricity to store in two small 12-volt batteries, which acted as storage and supplied power to the motor. The set of batteries served to store energy and supply power to the motor as well [48,49] and was controlled by the system's microcontrollers (MCU) [32–34]. The installation of automatic control circuit relays [50] was used in the system for controlling the operation and turning electrical equipment on and off, and alternately switching the charging of the two batteries to be continuously full every hour. The module system functioned as a battery charge controller, continuously maintaining a full charge of 12 volts and setting the charging system higher than the volt level in the battery [51]. It automatically signaled to cut off the charging system to the battery [52], as shown in Figure 1. Power was supplied by the battery to a 12-volt DC motor which was connected to the shaft and the generator with a maximum voltage of 200 volts. The voltage was measured with a voltmeter, and the speed was controlled by a bridge rectifier circuit [53]. It was used to adjust the rotational speed of the generator shaft, to produce electricity as specified and convert alternating current (AC) to direct current (DC) to be stored in the battery in a circulating form again [46–48,53]. The electricity flow was continuously supplied to the main power motor (DC) and to the self-running system. Charging numbers were displayed with the light-emitting diode (LED) type of DC circuit, and a 12-volt LED light bulb [54]. This experimental design yielded very good results after testing for a full 24 h of self-running operation.

3.2. Analysis of the Connection of the Drive System from the Motor to the Generator

The test design was equipped with an induction motor with a 7.5 kw/h current, a three-phase 750 RPM speed, and 100 Nm of torque to the power generator. The torque powered the electricity generator with a 15 kw/h and three-phase current speed of 3000 RPM with two sets by starting the motor with electricity from the grid system. As shown in Figure 2, the installation of a control system with an automatic switching power supply system (ATS) served to switch the operation of a manually operated electrical system to automatically work [55]. The motor started working by controlling the rate of rotation through the inverter system as specified from 50–60 Hz. Then the motor transmitted torque to a differential gear connected to the shaft [48,56] of tow alternators, as shown in Figure 2. The first set of power alternators generated electricity at a speed of 3000 RPM and was transmitted through the system of [57] wires connected to the motor and controlled by the ATS, which allowed the motor to continuously run [58]. Electric power from the alternator from the first and second sets produced electricity at 15 kw/h and at 230 volts with a speed of 3000 RPM and distributed electricity through the electrical control cabinet (MDB) to the grid. However, the test design in this system induced magnetic induction in the motor and power generating systems [59] when there was a load of power supplied to the grid system.

3.3. Analysis for Storage and Distribution of Electrical Energy from Batteries for Continuous Cyclic Operation in the System

According to a review of the working model for the generation of renewable electric power to occur in the system [60,61], as shown in Figure 3, it was possible to design a BLDC motor with a size of 7.5 kw/h with 72 volts to create a maximum speed of 6500 RPM and 100 Nm to drive an alternator at a speed of 3000 RPM for two sets of 15 kw/h three-phase 400 volts and increase the rate of rotation to be adequate to support the torque according to specification. The voltage of the alternator must be higher than the voltage of the BLDC motor [62]. Installing an inverter system was necessary to control the rotational speed of the spindle shaft through the differential gear [63] and to convert alternating current (AC) from a common power supply with constant voltage and frequency into direct current (DC) by the converter circuit [64]. A lithium-ion battery (NMC) with a voltage of 72, current of 100 Ah, and consisting of two sets was used. Battery set one supported a charging current from alternator set one, controlled by maximum power point tracking (MPTT) to charge as a controller [65]. Then the electric power obtained in this step was distributed to start a BLDC motor designed to continuously work [48], and microcontrollers (MCU) [32–34] were circuits used to control the operation of the electronic signal cut off when the battery was fully charged and also a signal to turn the system on when the battery is running low by setting a specified time depending on the design. We can also determine the amount or capacity of the battery that can be stored [66–69] and utilize the second set of batteries to support the charging current from the second set of alternators controlled [70] by maximum power point tracking (MPTT) acting as the charge controller [64]. Electric power obtained at this stage was controlled by the automatic transfer switch to run the operation automatically [70,71] by transmitting electron signals to the BLDC motor continuously over the24 h period [72,73]. This is further enhanced by the installation of a capacitor or condenser circuit system to filter DC power output to be smoother [74,75] and filter the broadcast signal and links between circuit coupling and frequency in order for the entire process to work more efficiently as shown in Table 6.

Table 6. Circulation of electric power systems.

Parameters	Value	Unit
BLDC motor 7.5 kw/h	72	Volt
Motor Revolutions per minute	6500	RPM
Motor torque	100	Nm
Alternator 15 kw/h 3-phase	400	Volt
Alternator revolutions per minute	3000	RPM
Battery 100 Ah	72	Volt
Differential gear torque	100	Nm
Electricity off-grid output	230	Volt
Available	24	h

3.4. A Comparative Analysis of Power Plant Costs between Existing Technologies and Innovative Technologies

There are a host of possibilities for new innovations in circular energy and their real-world applications. However, to be competitive with a group of advanced power generation technologies [76,77] such as solar, wind, hydro, and nuclear power, and newly discovered sustainable clean energy technologies such as nitrogen power, the key issue is the cost to the consumer. When comparing estimates in terms of operating costs per unit of electricity kw/h/USD and comparing the costs for building a power plant per unit of Mwe/USD [1,78], it was found that solar power had the highest operating costs, including expenses such as maintenance of technology materials, and labor costs of approximately 0.181 kw/h/USD and an estimated 600,000 Mwe/USD in investment cost for power plant construction. [7]. Wind power operating costs were slightly less and including expenses such as maintenance of materials, equipment, technology, and labor costs were 0.151 kw/h/USD, while the costs for investment in the construction of a power plant were higher, estimated at 1,500,000Mwe/USD. Hydropower was significantly cheaper to operate at 0.045 kw/h/USD and had an estimated 3,000,000 Mwe/USD investment for power plant construction. Nuclear power had the cheapest operating costs at 0.030 kw/h/USD but the most expensive cost for power plant construction at roughly 5,000,000 Mwe/USD. Finally, nitrogen power had overhead operating costs of 0.045 kw/h/USD and projected investment expenses for power plant construction of 2,000,000Mwe/USD [1], as shown in Table 7.

Table 7. Cost comparison for Implementation and construction of Technology [1].

Parameters	Cost Unit/Operations kw/h/USD	Cost Unit/Construction Mwe/USD
Solar power (average capacity achievable/day/5 h)	0.181	600,000
Wind power (average capacity achievable/day/24 h)	0.151	1,500,000
Hydropower (average capacity achievable/day/24 h)	0.045	3,000,000
Nuclear power (average capacity achievable/day/24 h)	0.030	5,000,000
Nitrogen power (average capacity achievable/day/24 h)	0.045	2,000,000
Motor power (new innovation) (average capacity achievable/day/24 h)	0.030	1,500,000

Note: Data analysis in Thai baht (1 USD = 35 THB).

A comparative analysis of the cost of power plant technology found that energy storage and renewable electric motor power have operating costs, including expenses such as the maintenance of equipment and labor of 0.030 kw/h/USD and an estimated cost of investing in the construction of a power plant at 1,500,000 Mwe/USD. This can be classified as clean energy at a comparatively low cost. While solar power plant construction is cheaper, there are limitations in energy production because they rely on the use of sunlight for energy production [7] or, in some cases, can be limited to only 5 h of work per day on average. Motor power also came in at the cheapest rate of operations at 0.030 Kw/USD, tied with nuclear power [79]. Construction costs of motor power are significantly lower than nuclear, nearly four times cheaper in fact. Also noteworthy, motor power is capable of producing safe and long-term energy in 24 h cycles because the power is unconstrained in terms of technology, location, and generation environment. This is especially true when this new technological innovation is applied to the electromagnetic power system or magnetic bearing to the machine shaft to reduce friction in the rotation system [13,80–85]. It also reduced energy consumption in the system by almost 50% [1] and led to electrical energy in the system. Motor power is a green technology with significant potential to be a major player in the field of sustainable energy in the future.

4. Conclusions

Motor power is the combination of utilizing maximum efficiency practices gleaned from electromechanical engineering process principles and applying them to the clean technologies available today. The application of the battery storage circuit (NMC) system with a 72 voltage and 100 Ah is currently used in combination to generate electric power along with separating circuit of a two-battery system for energy storage to distribute electricity to a BLDC motor with 7.5 kw/h DC voltage of 72 volts has shown to be a clean and effective method in our study. Additionally, the adaptation and installation of a differential gear, a three-way system, increases the torque of the axle shaft to the two alternators. Electricity is distributed to the BLDC motor by devising the use of the Maximum Power Point Tracking (MPTT) as a charge controller for the battery circuit and storing energy. The second set of alternators was designed to generate electricity for the circuit of an additional battery for storing energy in preparation for the distribution of the electricity to the grid, and microcontrollers (MCU) were used to control complex motor operations and lead to the maximum output with minimal expenditure. This made it possible to increase energy efficiency and reduce carbon emissions generated in the system, including adding a system circuit solid state relay (SSR) so a signal could turn electrical equipment on and off and control various circuits in the system and automatically cut off or charge the battery when the voltage was full or low.

5. Patents

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