HYBRO BIKE WITH DIGITAL FEATURES

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Certification

This is to certify that Mir Asfand Ali Khan (BEEP/F18/0137), Syed Mohammad Rameel (BEEP/F18/0125), Abbas Ali (BEEP/F18/0127) and Mohammad Anwar (BEEP/F18/0104) have successfully completed the final project **HYBRO BIKE WITH DIGITAL FEATURES,** at the **Hamdard University**, to fulfill the partial requirement of the degree **B.E (Electrical).**

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Project Title (HYBRO BIKE WITH DIGITAL FEATURES)

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving		
	Attribute	**Complex Problem**
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.
4	Familiarity of issues	Involve infrequently encountered issues
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.
7	Consequences	Have significant consequences in a range of contexts.
8	Interdependence	Are high level problems including many component parts or sub-problems
Range of Complex Problem Activities		
	Attribute	**Complex Activities**
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.

Abstract

Since the gas expenses are now no longer simplest in Pakistan however for the duration of the sector are growing every day therefore there's a remarkable want to look for an opportunity to preserve those herbal resources. Thus, a solar bike is an electric-powered automobile that gives that opportunity with the aid of using harnessing solar power to price the battery and therefore offers the desired voltage to run the motor. Since Pakistan has been blessed with 9 months of sunny weather, therefore, the idea of a solar Hybrid (Hybro) bike could be very pleasant in Pakistan. Hybrid bike (Hybro) combines using solar power in addition to the use of lithium-ion batteries with the aid of using the use of BMS gadget to price the battery to run the bike. Thus, the solar hybrid (Hybro) bike can grow to be a completely crucial opportunity for the fueled cat therefore its production is essential. In the modern world, battery-powered electric-powered bikes are displacing significantly polluting inner combustion engines. The maximum critical hassle with E-motorcycles in Pakistan is the incapability to price them on a normal basis. As a result, we are operating on a hybrid (Hybro) bike prototype with virtual elements. To lessen our utilization and provide long- variety insurance to our prototype, we're putting in an extra sun panel with batteries and a right away electricity supply.

Keywords: Bike, Prototype, Solar, Hybrid, Battery Management.

Undertaking

I certify that the project **HYBRO BIKE WITH DIGITAL FEATURES** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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ABBREVIATIONS

SR .No	Acronym	Definition
1	Nitrogen Oxide	NOx
2	Greenhouse Gases	GHG
3	Volatile Organic Compound	VOC
4	Electric vehicle	EV
5	Hybrid Electric Vehicle	HEV
6	Plug-in Hybrid Electric Vehicle	PHEV
7	Internal Combustion Engine	ICE
8	International Energy Agency	IEA
9	The International Renewable Energy Agency	IREA
10	Lithium-ion batteries	LIBs
11	Brushless direct current	BLDC
12	Lithium ion	Li-ion
13	Battery Management System	BMS
14	Safety Operating Area	SOA
15	Nickel metal-hydride battery	NiMh
16	Open circuit voltage	OCV
17	State of life	SOL
18	Remaining useful life	RUL
19	Iron	Fe
20	Oxygen	O
21	Phosphorous	P
22	Electroluminescence	El
23	Tedler Polyester Tedler	TPT
24	Watt	W

25	Ampere	A
26	Voltage	V
27	Force	F
28	Omega	Ω
29	Mass	M
30	Radius	r
31	Power	P
32	Linear distance travel	LDT
33	Direct Current	DC
34	Alternating Current	AC
35	Meter	M
36	Meter per second	m/s
37	Pi	Π
38	Artificial Neutral Network	ANN
39	Energy conversion control	ECC
40	High voltage integrated circuit	HVIC

CHAPTER 1 INTRODUCTION

1.1 Motivation

Due to the ongoing fossil fuel crisis Car exhaust is not only stinky, it is deadly. Pollution from cars, trucks, planes, trains and ships poses threats to both public welfare and the environment.

Today, Pakistan's transport sector is one of the country's major sources of pollution. Particulate matter, volatiles Nitrogen oxides (NOx) are just a few of the pollutants found in vehicle exhaust, along with other greenhouse gases such as carbon dioxide.

But the multifaceted effort to decarbonizes our economy and reduce greenhouse gas emissions also includes electric vehicles, which emit little to no greenhouse gases. This is where electric vehicles (EVs) come in, offering a huge opportunity to reduce greenhouse gas emissions.

Electric cars emit fewer climate-damaging emissions over their lifetime than gasoline-powered cars. And not only are electric cars today cleaner, their emissions have actually decreased over time as the power grid becomes cleaner both in Karachi and across the country. The EV outperforms its battery- powered counterparts even after factoring in the cost of early life cycle dismantling and battery manufacturing.

In fact, electric vehicles “pay for themselves” after 6 to 16 months of operation on their first emissions. E-bikes could help Pakistan's economy as the government launched an electric vehicle program for 2020-2025. Doing these in limited areas and regulating with the government is a good starting point. In response to the demands of the times, we took the lead in developing prototypes. If successful, it will be very useful in the future as it will not consume fossil fuels and contribute to the national economy.

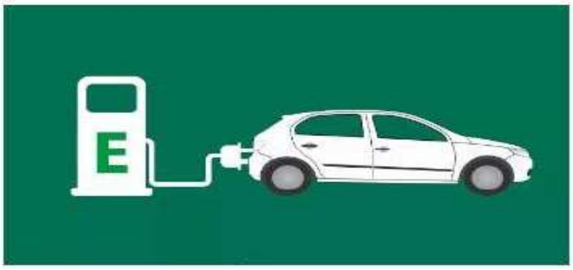


Figure 1 Transition to EV

1.2 Problem Statement

In 2020, Pakistan imported about 22.54% of the gasoline it consumed. About 34% Pakistan’s total energy demand and 75% of Pakistan's oil consumption come from transportation. Maintaining the recent trend of declining oil imports will require the adoption of more energy efficient vehicles, such as hybrids and plug-in electric vehicles [4].

Pakistan's oil consumption will benefit. The introduction of more energy-efficient vehicles, such as hybrids and plug-in hybrid electric vehicles is an important part of continuing the successful trend of reducing oil imports. This contributes to the diversification of Pakistan's shipping fleet and supports the country's economy. Using energy sources such as electricity for transportation also provides resilience [4].

Green Line, Orange Line and Red Line are examples of electric vehicles. Electric bicycles and electric vehicles are now in demand to reduce the consumption of fossil fuels. This will reduce fuel imports as it will make it difficult for Pakistan to import large amounts of fuel that will cost millions of dollars in the future. Using regenerative braking increases vehicle economy and recovers wasted energy when braking often uses much less fuel than comparable conventional vehicles. All-electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs), often referred to as battery electric vehicles (PHEVs), both rely entirely on energy produced in Pakistan from natural gas, coal, nuclear, wind and hydropower [39].

The development of electric vehicles (EVs) will help reduce CO2 emissions and dependence on oil. However, the benefits of switching from internal combustion engines to electric vehicles may be offset by significantly higher emissions of air pollutants from certain power plants. The purpose of this study was to examine the social implications of the introduction of electric vehicles in Pakistan under different energy production scenarios, including climate change and health impacts.

They are exclusively here to reduce pollution, which is on the rise. Our world's future depends on how we save the environment and implement more environmentally friendly projects like this.

The findings suggest that nations that depend on low-polluting fuel blends may save millions of rupees annually in avoided external expenses. Benefits are accessible across Pakistan, especially for those in smaller countries. While pollution from power plants has a broad influence, pollution from vehicles has a local one. The introduction of electric vehicles and replacement with internal combustion engines will lead to an increase in air pollution emissions from power plants and a reduction in local road pollution, which is common in urban areas. These differences in type, size, and location of emissions need to be weighted to provide a complete picture of environmental impacts, human health impacts, and associated external costs.

Figure 2 Green Transports.

1.3 Objectives:

By manufacturing Hydro bicycles with digital capabilities, we would like to achieve the following objectives.

- The Financial Savings
- Easier Maintenance
- User-Friendliness
- They're fantastic for road trips.
- They are more environmentally friendly and better for commuting.

1.4 Applications:

Below are applications for Hydro bikes:

1.4.1 Renewable Energy Storage:

One of the most promising technologies for reducing emissions in global transportation is the use of electric vehicles (EVs). . About the power source they consume. The electric car revolution has begun. According to the International Energy Agency (IEA), there will be more than 250 million electric passenger vehicles by 2030, and more than 10 million electric drives and other mass transit vehicles, according to the International Renewable Energy Agency (IRENA). You may run on the road inside.

1.4.2. Public Transport:

As we've already discussed how to minimize our carbon footprint and greenhouse gases, transport accounts for about one-fifth of the world's CO2 emissions. Additionally, road vehicles are responsible for nearly 75% of these pollutants. There is a clear need for greener transport and energy systems around the world. So how green are electric cars, and what impact do they have on the environment? There are a few things to consider when digging into these questions.

Figure 3 Urban Mobility Days

1.4.3. Cost Efficiency:

Buying an electric vehicle is now cheaper than ever. After considering subsidies and other concessions, it is now priced similarly to petrol and diesel. If you're looking to buy a used car, you have many options, both online and at your local dealer. Electric vehicles have noengine fluid and have fewer mechanical parts than internal combustion engines, resulting in lower maintenance costs.

It uses regenerative braking to slow the vehicle, resulting in significantly longer brake pad life than similarly sized petrol and diesel vehicles.

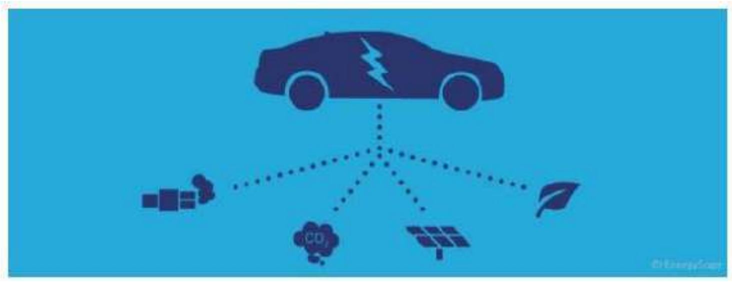


Figure 4 EV Benefits

1.4.4. Better battery

High energy density, long life, and high efficiency are all hallmarks of lithium- ion batteries (LIBs). From this perspective, we were able to thoroughly study all the elements of LIB, including its working mechanism, battery design and structure, strengths and weaknesses. Furthermore, grid functions like frequency regulation, peak shifting, integration of renewable energies and power management are taken into consideration when evaluating the performance of LIBs used in grid-level energy storage systems [9]. Additionally, in order to shed light on the advancement of grid-level energy storage systems, the limitations that have been encountered in the application of LIBs are discussed, along with alternate research directions for resolving these issues.

CHAPTER 2

LITERATURE REVIEWS:

Electric vehicles are not new to the world, but with to technological advancements and growing attention to pollution management [18], they now have the reputation of being the form of transportation of the future. An electric vehicle's batteries, motors, frame, and solar system are its key components. Our section will describe various research projects that influenced our decision to include the following sections in this project [6].

2.1 Research on different Motors Used in E-Vehicle:

The DC Series motor's strong starting torque capacity makes it a fantastic option for traction applications. It was the motor that saw the most use for traction applications in the early 1900s. The advantages of this motor include easy variable speed and the capacity to withstand a sudden increase in load. All of these characteristics make it the ideal traction motor.

A major drawback of DC series motors is the high maintenance required for the brushes and commentator. These engines are used in Indian Railways. DC brushed motor is the category this motor belongs to [6] Series DC motors are often used for short periods in open-loop control, providing high torque with very low current consumption and small dimensions. As mentioned, the speed regulation is poor. This is mainly for that reason. However, this type of motor can be fully exploited if an effective closed-loop controller is developed.

However, most control systems for these types of engines generally rely on dynamic cancellation and require accurate models. The brushless DC motor is similar to using permanent magnets. It is called a brushless system because it has no commentator and brush arrangement [37]. The BLDC motor requires no maintenance as the commutation of this motor is electronically managed. Among other traction characteristics [59], BLDC motors offer high starting torque and high efficiency of 95-98%. A power-dense design approach is well suited for BLDC motors [43]. BLDC motors are the most popular motors for electric vehicle applications due to their traction characteristics. [18] The stator of a BLDC motor consists of a stack of steel plates and the windings are inserted into slots cut axially along the perimeter of the stack. Although the winding arrangement is different, the stator design is often similar to induction motors. In BLDC motors, the three stator windings are often combined in a star configuration. Each of these windings is made by connecting several coils to form a winding.

Feature	**BLDC Motor**	**Brushed Motor**
Communication	Electronic Communication	Brushed Communication
Maintenance	Less	Periodic
Life	Longer	Shorter
Speed/Torque Characteristics	Flat	Moderately Flat
Efficiency	High	Moderate
Output Power	High	Low
Speed Range	Higher	Lower
Electric Noise	Low	Arcs in-brushed generated voice
Cost of Building	Higher	Low

Table 1 BLDC vs. Brushed Motors.

2.2 Researches on different batteries used in E-Vehicle

There are alternative technologies, some of which are very old, even if the lithium-ion battery has established itself as the main option for the electric car today. Read below for an overview of the primary battery technologies used in the automotive industry, from accumulators to lithium-ion batteries. Golf carts, the most common electric vehicle, have used lead-acid batteries for many years. Although less efficient than other cell types, they can power low-power electric vehicles like golf carts. Lead-acid batteries are easy to replace and require little maintenance. Unlike other types of batteries, a mechanic can repair and replace batteries without contacting the manufacturer. As lithium-ion batteries become more affordable and available, the use of lead-acid batteries is declining, and some golf carts are switching to using lithium-ion batteries instead of lead-acid batteries. The negative electrode of a lead-acid battery is made of porous or spongy lead. Because lead is permeable, it can grow and dissolve more easily [22]. The positive electrode is made of lead oxide. Immerse both electrodes in an electrolyte of sulfuric acid and water. When the two electrodes come into contact due to physical movement of the battery or changes in electrode thickness, a chemically permeable but electrically conductive membrane separates them [14]. This membrane also prevents electrolyte short circuits.

Another type of battery is now overtaking the lithium-ion battery as the most commonly used type in electric vehicles. Since the 1970s, lithium-ion batteries have been the most promising and have experienced rapid growth. Battery Lithium-ion batteries are used in electric vehicles and small electronic devices due to their long life and high energy density [33]. No matter how complex a system is, it will deteriorate with age and use. Failure of expensive lithium-ion batteries is a problem. Battery management systems can be used with predictive technology and condition-based maintenance to improve protection and reliability of complex equipment. Using a predictive approach, data gleaned from battery health information can be used to prevent catastrophic malfunctions and failures. It also applies when planning future repairs [45]. Assessing battery health and predicting battery life are the only critical components required for these applications. A battery's life cycle is defined as the number of charge cycles, or time remaining before it is depleted. Building a predictive model requires advanced data processing methods and an understanding of battery aging processes. The widespread use of renewable energy in power grids is a result of the rapid expansion of renewable energy sources and the continued development of battery storage technology. Battery degradation is a critical issue when battery energy storage devices are involved in operational strategy optimization and system design. Assessing battery health and the remaining life of a motorcycle has become a growing research focus and challenge in many engineering disciplines.

The next a generation of energy batteries could be lithium-sculpture batteries that are lighter and much cheaper than current models if scientists can extend their lifespan [8].

The main attraction is that they have significantly higher energy capacity than comparable batteries built with current lithium-ion (Li-Ion) technology. So you can work longer on one battery charge. It should be fairly easy to bring into production, as it can be made in factories that also make Lithium Ion batteries [8]. Sulfur, a cheap raw material produced as a by- product of the oil industry, replaces expensive cobalt, which is susceptible to fragile global supply chains. The main problem is that current lithium-sculpture (Li-S) batteries cannot be recharged frequently enough, making them uneconomical. It all depends on the chemistry inside.

Charging Li-S batteries leads to the accumulation of chemical deposits that shorten the life of the cell and cause cell degradation. At the battery's negative electrode, the lithium anode, the deposits grow into thin, tree-like shapes called dendrites. The anode and the electrolyte, the medium in which the lithium ions oscillate back and forth, are damaged by the deposits [8]. Various publications have reported that the lithium-sculpture battery can withstand hundreds of cycles, but this depends on other factors such as capacity, charging speed, resilience, and safety. It can only be achieved through sacrifice. According to Nicholas Kato, Irving Langmuir Distinguished University Professor of Chemical Science and Engineering and principal investigator of the study, the current goal is to increase the cycle rate by hundreds of times from the previous 10 cycles while reducing the cost of several It is to develop a battery that meets the criteria. Sulfur and lithium combine to form small molecules that combine with the lithium in the battery, reducing its capacity [38]. This is another problem with lithium-sculpture batteries. A lithium polysulfide composed of lithium and sulfur and the lithium ions from the lithium had to be prevented from migrating to the backside and sculpture. This property is known as ion selection.

2.3 Research on Solar Energy:

Due to a number of causes, including political support programmers, an increase in product options, a decrease in price, and the desire of certain people to protect the environment, the usage of electric mobility has considerably expanded in several nations over the past few years. Recently, businesses like Tesla and Sonnet from Germany have begun to provide packages that include an EV and solar-power charging apps [27] after realizing that there is a growing demand from customers for integrated offers of electric vehicles and renewable energy. Additionally, according to marketing literature, complementary goods that are sold as a package for a single price—like solar energy and electric vehicles— increase consumer value since they provide customers with advantages including complementarily, risk reduction, and convenience. A short search of the literature revealed that there aren't many studies that examine or assess the potential of a solar-EV hybrid. However, a number of research studies have examined the potential for bundling EVs with additional services. For instance, Heinz et al, evaluated the impact that a single add-on service might have on the acceptability of EVs (such as a mobility guarantee, vehicle-to-grid, IT-based parking, smart charging system, charging station searcher, etc.) [3].They discover that the presence of extra services may improve consumers' propensity to purchase electric vehicles, albeit the type of add-on service that is offered as part of the package has a significant impact on how powerful the effect is.

Since electricity is always required to charge an electric vehicle, community solar can be considered as an addition to EV ownership as it provides a source of clean solar energy that can be used for this purpose [3]. In addition, many users are specifically looking for solar power to charge their electric vehicles, highlighting the compatibility between solar power and electric vehicles [27]. Literature suggests that simultaneous use also increases the profit of one or more commodities, leading to a more favorable valuation of the bundle.

Combining electric vehicles with local solar energy could provide a new means of charging the local community. Of solar energy can minimize the uncertainty of choice and knowledge. In addition, many scientists argue that product bundling increases consumer acceptance because the product spillover reduces customers' perception of risk.

The majority of countries currently or in the past using solar energy for power generation have solar energy-specific policies [29]. The enactment of solar energy laws in these countries has resulted in a significant increase in photovoltaic production.

Financial incentives for residential solar systems typically include feed-in tariffs, tax incentives, and a one-time premium to install these systems.

These government incentives have led to a significant increase in the introduction of electric vehicles is politically supported in some countries, as is the promotion of solar energy. According to a study by Barth et al. This is especially important with respect to the acceptance of electric vehicles. [48] Suggests that electric vehicles are considered more expensive than gasoline and diesel vehicles.

As a result, further research shows that financial support based on policy change can increase the willingness to buy electric vehicles [12].

Describes several literary types of solar panels. Both mono crystalline and polycrystalline photovoltaic energy performs the same functions throughout the photovoltaic system. The underlying science is simple. Both capture solar energy and convert it into electricity. Both are made of silicon, a common and extremely durable material used in solar panels. Solar panels made of mono crystalline and polycrystalline materials are produced by various companies. Mono crystalline solar panels are made from mono crystalline solar cells, also known in the industry as “wafers”. To produce single crystal wafers, silicon single crystals are shaped into cylinders. On the other hand, polycrystalline solar modules are also made of silicon. However, instead of using single crystals of silicon, manufacturers combine multiple pieces of silicon to form wafers for screens. Polycrystalline solar cells are also called polycrystalline or polycrystalline silicon [7].

2.3.1 Advantages of Solar Energy:

1. Renewable Energy Source

The fact that solar energy is a 100% renewable energy source is one of the many advantages of solar power. It can be used worldwide and can be accessed every day. Unlike other energy sources, solar energy never runs out. Experts estimate that it will take humans at least 5 billion years for the sun to disappear, as we can harness solar energy for as long as the sun exists [35].

2. Reduced electricity bills:

The electricity generated by the photovoltaic system can partially cover the required energy, resulting in lower energy costs. How often you save money on your account depends on your energy or heating/cooling consumption and the size of your solar system. Not only can you reduce your electricity bill, but you can also get paid for the extra energy you put back on the grid. If you generate more energy than you consume (considering that your PV system is connected to the grid). [20]

3. Various Applications:

The use of solar energy is widespread. It can generate electricity or heat (photovoltaic) (solar heat). Solar energy can be used to generate electricity in remote areas without access to the grid, to distill water in areas where drinking water is scarce, or to power satellites in orbit. Solar energy can also be integrated into building components Sharp announced a transparent solar panel. [17]

4. Minimal maintenance costs:

Photovoltaic systems require almost no maintenance costs. It just needs to be kept clean, so cleaning it a few times a year should do the trick. If you are unsure, you can always turn to professional cleaning companies that offer this service. Reputable solar panel manufacturers often offer 20- 25 year warranties. Since there are no moving parts, there is no wear and tear.

The inverter, which converts solar energy into electricity and heat for continuous operation, is often the only component that needs replacement after 5 to 10 years. Both inverters and cables require maintenance to keep your solar energy system running as efficiently as possible [26]. Therefore, after paying the purchase price of the solar system, maintenance and repair costs should be minimal.

5. Technological Advancements:

The solar energy industry is constantly innovating, and improvements will accelerate in the coming years. Advances in nanotechnology and quantum physics could improve the efficiency of solar panels, doubling or even tripling the amount of power a photovoltaic system can generate.

2.3.2 Disadvantages of PV:

1. Cost:

Initial investment for PV system is quite high. This includes installation, wiring, batteries, inverters and solar panel prices. However, it is logical to assume that costs will fall in the future as solar technology continues to evolve.

2. Weather dependent:

Cloudy or rainy days can still capture solar energy, but the solar system is less efficient. Photovoltaic (PV) modules cannot efficiently collect solar energy without sunlight. Therefore, a few days of cloudy weather or rain can have a significant impact on the power grid. Remember that solar energy can also be harvested at night. If you live in a cold place, an evacuated tube solar water heater is a great alternative for winter.

3. Solar energy storage is expensive:

Unless solar energy is stored in bulk batteries, it must be used immediate. These batteries can be recharged during the day so that off-grid solar systems can use the energy at night. This is a great way to continue using solar energy, albeit at a higher cost. In most cases, it makes more sense to use only solar power during the day and grid power at night. Solar energy is often magnified throughout the day and can meet most needs [13].

4. Takes up a lot of space:

To generate more power, we want to make the most of the available light, so we need more PV panels. Many roofs cannot support the required number of PV modules due to space requirements. Some panels can be placed in the garden instead, but need sunlight. Even if you don't have the space to install all the panels you need, install a few to cover some of your energy needs can do [29].

5. Not All Types of Roofs Are Compatible With Solar Panels:

A mounting system, commonly referred to as "racking," is attached to your roof in order to install rooftop panels. Older or historically significant homes may employ roofing materials like slate that are challenging for solar technicians to deal with, creating a barrier to the use of solar energy. Skylights and other rooftop modifications, like as roof decks, are another common feature of houses and apartment complexes, which can complicate or increase the cost of photovoltaic system [7].

Features	**Mono**	**Poly**
Life span	25+ years	25+years
Efficiency	High	Low

Cost	Expensive	Less Expensive
Temperature Coefficient	Lower temperature coefficient/more effective when temperature changes	Higher temperature coefficient/less effective when temperature changes
Aesthetic	Solar cells are a black hue	Solar cells have a blue-ish hue

Table 2 Difference of Mono & Poly

2.4 Research on EV Charging:

Since the industrial revolution, regulating the demand for electricity has become a key challenge for maintaining the smooth operation of modern society. Three types of load forecasting exist: short-term oriented forecast load (forecasts made one to two months out), medium-term oriented forecast load (forecasts made one to two months out), and long-term oriented forecast load (forecasts made one to ten years out) (1 hour to 7 days ahead).The strategy estimated the charging power and limit of charging facilities based on the forecast of an EV population as well as the influencing factors. Finally, load requirements can be covered with a percentage of piles and wagons. Calculate the number of short-term and long-term EVs using the modulus of elasticity method [30]. The scarcity of fossil fuels, responsible for excessive carbon emissions and oil-induced global warming, has led to widespread acceptance of sustainable energy sources.

Electric vehicles powered by renewable resources can be classified as zero-emission vehicles at all stages of operation. However, with its huge battery potential and incredibly stochastic individual charging methods, the rapidly evolving EV market poses new challenges to the design of explainable presentation in model design [30].

ANN successfully performed the load prediction task due to its powerful adaptive learning and generalization capabilities. Charge depletion mode and charge float mode are two ways an electric vehicle can operate. In starvation mode, an electric vehicle (EV) turns off the engine and draws power until the SOC threshold is reached. SOC is a measurement that approximates the quiescent state of charge of the battery. The minimum amount of energy that must be permanently stored in the battery is specified by the SOC limit. ICE provides energy to propel the vehicle and manages battery charging near minimum SOC until the EV reaches minimum SOC. At this point the EV switches to trickle charge mode [50]. By avoiding the charging trickle mode, electric vehicles can significantly reduce their dependence on fossil fuels and greenhouse gas emissions. A third option, called mixed loading, was left to improve fuel efficiency. During the drive cycle, the gasoline-mixed mode makes efficient and powerful use of the internal combustion engine and the electric motor, allowing for long driving times while significantly reducing greenhouse gas emissions [50].

A larger battery limit makes sense as float and mixed charging modes can be avoided to reduce greenhouse gas emissions. However, according to the researchers, the cost and energy efficiency associated with larger battery capacities reach asymptotic values, so unlimited capacity is not strictly necessary.

According to research, a touring car battery should have a capacity of about 11. At 6 kWh without the internal combustion engine, it will travel 40 km at a speed of 40-30 km/h. Considering a typical American car he only drives an average of

30 miles per day, this is a reasonable battery size. Regardless of the battery's actual capacity, the SOC will decrease as trips occur and the battery is depleted. In order to keep the battery's SOC in the ideal range (determined by the minimum SOC and maximum battery capacity), the battery needs to be recharged regularly due to its limited capacity. To reduce overall energy consumption and achieve a longer Alberta Energy Regulator (AER), it is usually necessary to maintain a high SOC at the start of the trip. However, a high SOC will accelerate battery degradation [30].

Charging multiple EVs simultaneously can cause additional electrical loads to impact the grid in a variety of ways, including dramatic voltage

changes, overheating, increased power loss, and accelerated aging of transformers and wiring. There is. The use of large-scale EVs is due to economic development and ever-more stringent requirements of environmental protection, making it a safe development. EVs, which have advantages such as energy saving and drain reduction, are indispensable for the advancement of new energy.

Previous studies have proposed various planning schemes for EV charging. However, the method used in current research, which mainly uses centralized algorithms to maximize charging performance and reduce costs. May not be applicable to EV charging stations with a large EV population. Once EV charging is implemented, the overall load profile of the electrical structure will change. The use of many electric vehicles has a significant impact on the power system. Finding the ideal ch requiring information about future base loads, charging times, and arrival times for electric vehicles.

To arrive at the ideal cost-saving solution, a practical solution requires a least- squares load forecasting model. Due to changes in modern power grid systems, a variety of variables affect load demand, including weather, real-time electricity prices, holidays, as well as urban sprawl and human activity. Older load forecasting methods cannot provide a variety of forecasting models with sufficient forecasting accuracy. In this sense, accurate load forecasting is a key indicator of optimal EV charging planning.

CHAPTER 3

MACHINE PARTS

3.1 Mechanical Considerations:

The main function of the machine enclosure is to keep moisture, dirt, dust, unwanted. To protect a machine from elements such as objects, engine smoke. This goal goes beyond protecting employees and viewers.

3.1.1 Traction Required

In order for the car to move, the tires require a traction of Ft. The force Ft on the sidewalls of the vehicle tires causes the vehicle to move. Equation (Eq.) describes the traction force required to move the vehicle on the ground. Ft 1/4 Fa Fri.

3.1.2 Calculation of force required to accelerate

Ft 14 Fa. Fr;

Fa is the force required to accelerate the vehicle in a straight line. Fr is the force required to overcome a traffic obstacle, Fg is the force required to counteract the effects of gravity. The car sends a positive signal when going uphill and a negative signal when going downhill. The value of linear acceleration occurring in a vehicle of mass m kg and weight W is given by equation (1). (3): Fa = mw ∗ a.

Axles, front and rear axles, actuators, and control panels are just a few of

the mechanically rotating components found on bikes. according to the formula.

(4) Vehicle equivalent mass (me) greater than static mass is increased by 10% to 20%

.

3.1.3 Calculation of force required to overcome vehicle

resistance

We=ga (4) where me is expressed in kilograms, Fa is a number and an is expressed in meters per second. The friction forces present in the axles and tires during launch are an example of mechanical resistance that opposes vehicle movement. This is independent of both vehicle mass and speed. Wind resistance increases as vehicle speed increases assume that Fr represents the vehicle drag in (N/ton) (5). according to the formula.

Fr = m*r

3.1.4 Calculation of Force Overcoming Gravity

The force Fg has two components and is affected by the elevation axis when the vehicle is traveling uphill. Sin by formula. (6):

Fg 1/4 W sin 1/4 mg sin (6)

Fg is again given by equation (1). (8) C is for the slope % given in equation (1). (7):

C% 1/4 Y=X: 100 1/4 100 sin (7) Fg 1/4 m*g*C.

Ft ¼ Fa þ Fr þ Fg (9)

3.1.5 Tire Total Pull

Ft ¼ me*a þ m*r þ m*C (10)

r is measured in N/Kg. Uphill is positive, downhill is negative.

3.1.5 Drive power to move the tires

The power Po required to drive thevehicle is calculated according to the formula:

(11) When moving at a constant velocity V of m/s:

Po = Ft V (11)

When the transmission efficiency is , the required power is supplied by the electric motor. use the formula (12) Pm can be calculated. PM 1/4 Po 1/4 Ft V

3.2 Mechanical Structure

3.2.1 Solar and Battery Pack Frames

The main beams and joints of thevehicle frame are 1.5 inch x 2 mm thick hollow rectangular steel metal beams. . Iron beams 1 and 2 have a length, height, and width of 1.2 meters, 1.5 meters, and 1 meter, respectively. Bending stress is determined at the intersection of beams 1 and 2. The total mass of the driver, two 65 volt battery banks and the solar panel is calculated to be 125 kg. Gravity through gross weight is calculated using the following formula: $F\omega = \omega * ag$

$F\omega=125*9.8=1225N$

Figure 5 Solar Frame

Figure 6 Solar placement plate

3.2.2 Hybro Bike Overall Design

The body of the car is the most important component. A two-wheeler is well balanced for its purpose. A conventional internal combustion engine weighs more than an electric motor. A battery, solar panel and motor make up the whole structure. Other components such as digital meter handles, gauges, etc. Not much mass. A 6*4 inch rectangular plate replaced the ICE's battery pack. Details of our solar frames are listed above. Our motor is mounted on a rear tire with an 8.5" radius. I chose tires that are slightly larger than the standard wheels because the engine is built in.

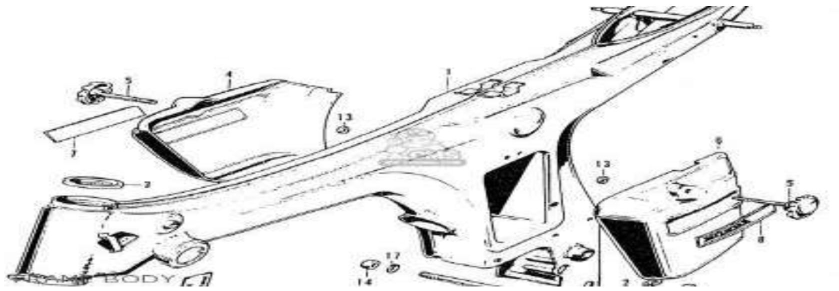


Fig 7 Bike handles design

Chapter 4

Electrical Components

4.1 BLDC Motor

In this configuration, the rotor is on the outside of the motor and the stator is on the inside. It is sometimes called a hub motor because the wheel is directly connected to the outer rotor [6].

Such a motor does not require a separate gearbox. In some cases, planetary gears are built directly into the motor. This engine does not require a transmission system, thus reducing the overall size of the vehicle. Also, there is no need for a mounting location for the engine. Motor size constraints limit power output in runner configurations. This motor is highly preferred by e-bike manufacturers such as Hullikal, Torn, Spiro and Light speed Bikes. It is also used by motorcycle manufacturers [6].

4.1.1 How BLDC Works

On the other hand, brushless motors are more complicated despite the same electromagnetic theory. In other words, a motor that does not use brushes for commutation and is the result of efforts to increase the effectiveness of brushed DC motors. An oversimplification of this description raises questions about how well motors work and how brushless motion is enabled. In contrast to brushed motors, brushless motors are constructed differently. In brushless DC motors, the permanent magnets act as rotors in brushed DC motors, while they are stationary in brushed DC motors but rotate within the stator. Simply put, permanent magnets and coils are used to create the rotor and stator of a brushless DC motor [61].

Brushless motors do not require brushes to power the armature, making shifting more difficult and done electronically using a separate set of electronic components to create the motion. There are two types

of his commutation algorithms for brushless DC motors: sensor

based commutation and mindless commutation. But due to my requirement, I used the control panel as a switch that also conducts the

voltage from the battery.

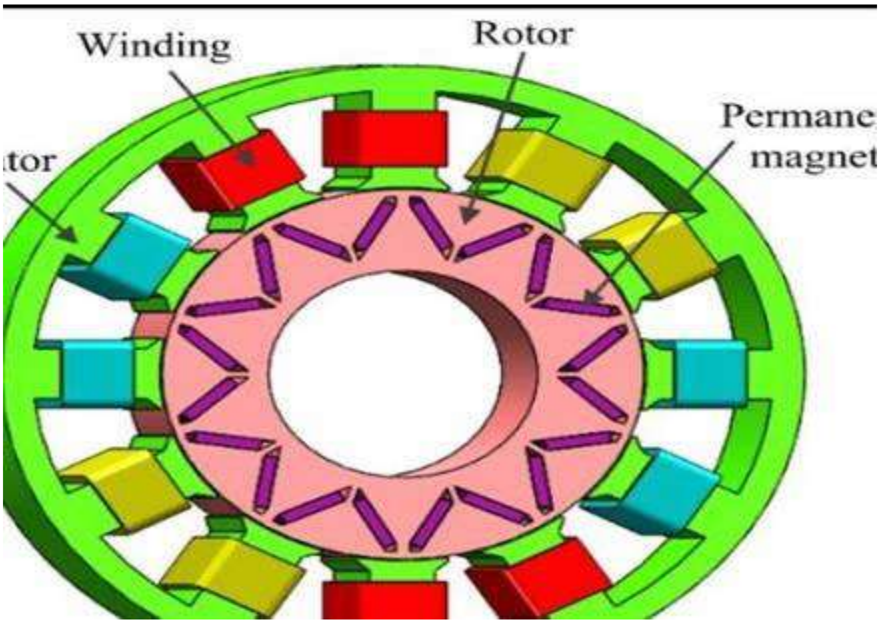


Figure 8 Internal of BLDC [7]

4.1.2 Advantages and Disadvantages

In a brushed DC motor, the rotating commutator is in constant contact with the brushes. This creates a significant amount of friction which results in loss of energy as heat and gradual wear of the brush. Brushed DC motors are therefore less efficient and routine maintenance becomes a problem. This friction creates heat and wear. Brushless DC motors, on the other hand, are virtually frictionless, so they are more efficient, require less maintenance, and last longer than brushed DC motors [62].

However, due to their simpler design, brushed DC motors are significantly cheaper than brushless motors. Brushless DC motors, on the other hand, are very expensive due to their complex construction, both in terms of the motor itself and the additional electronics required to drive it.0

4.1.3 Factors to consider when choosing between brushless and Brushed DC motors

Torque, power rating, and other basic application requirements:

1. Foot Cycle
2. Efficiency

3. Control/Drive
4. Cost

Foot Cycle

The term "lifetime" refers to the amount of time and duty cycle a motor must operate before it fails. . This is very important as brushed DC motors are prone to wear due to friction between the brushes and the commutator, as mentioned earlier. Therefore, when using a brushed DC motor, it is important to ensure that it is an application where the motor will perform throughout its life or where maintenance of the motor is considered common and affordable. If motor maintenance is not a viable option, brushless DC motors are typically a viable option for long life applications [63].

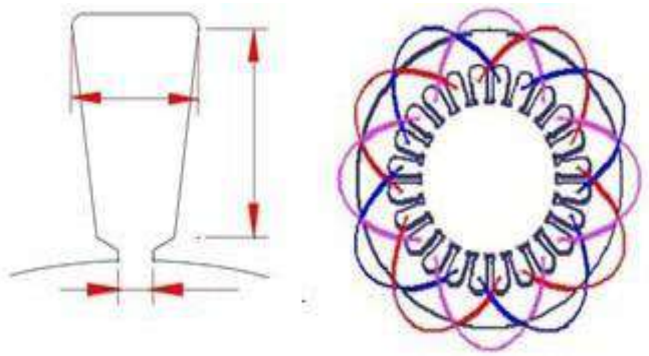


Figure 9 Cycle of BLDC

Efficiency:

Brushless DC motors are generally more efficient than brushed DC motors, but coreless brushed motors can be more efficient than comparable brushless motors [41]. Before making a selection, it is important to evaluate the overall efficiency you need and compare that to the efficiency of your individual motors. Brushless DC motors are generally advantageous when efficiency is important.

Controller:

This is one of the biggest drawbacks of using brushless DC motors. They are more difficult to control than brushed DC motors due to additional requirements such as controllers and other components. Brushed DC motors are easily powered by simply inserting a battery into the terminals. Make sure your project and associated electronics require a brushless DC motor. B. Controller, Available. Brushed DC motors are simple, but may not be suitable for applications requiring high precision. Connecting a brushed DC motor to a controller such as an Arduino is fairly easy, but connecting a BLDC motor to an Arduino Uno is much more difficult [63].

Cost:

Due to the complexity of the design, brushless DC motors are much more expensive than brushed DC motors. Before choosing a brushless DC motor, make sure the additional costs are within your project budget. Before making a decision, consider the cost of additional accessories required to operate your BLDC.

Figure 10 Tires with BLDC inside

4.2 Battery Management System

Battery packs (arrays of battery cells) are electronically configured to provide a desired range of current and voltage for a specified period of time under expected load conditions should be placed in In a row-by-row matrix configuration [2]. The device that controls this battery pack (BMS) is the battery management system.BMS often performs the following checks:

- Monitoring the battery
- Providing battery protection
- Estimating the battery's operational state
- Continually optimizing battery performance
- Reporting operational status to external devices [21]

In this context, monitoring and control functions are used explicitly to refer to specific cells or groups of cells known as modules of the overall battery pack assembly [12]. Rechargeable lithium-ion batteries are the most energy-dense option for battery packs in a variety of consumer products, from laptops to electric vehicles. They perform reasonably well, but when used outside of their relatively small safe operating area (SOA), they have consequences ranging from severely compromising battery safety to severely degrading battery performance [36]. There is a possibility. The BMS job description is clearly challenging given the overall complexity and potential range of control disciplines such as thermal, hydraulic, digital, controls and electrical [2].

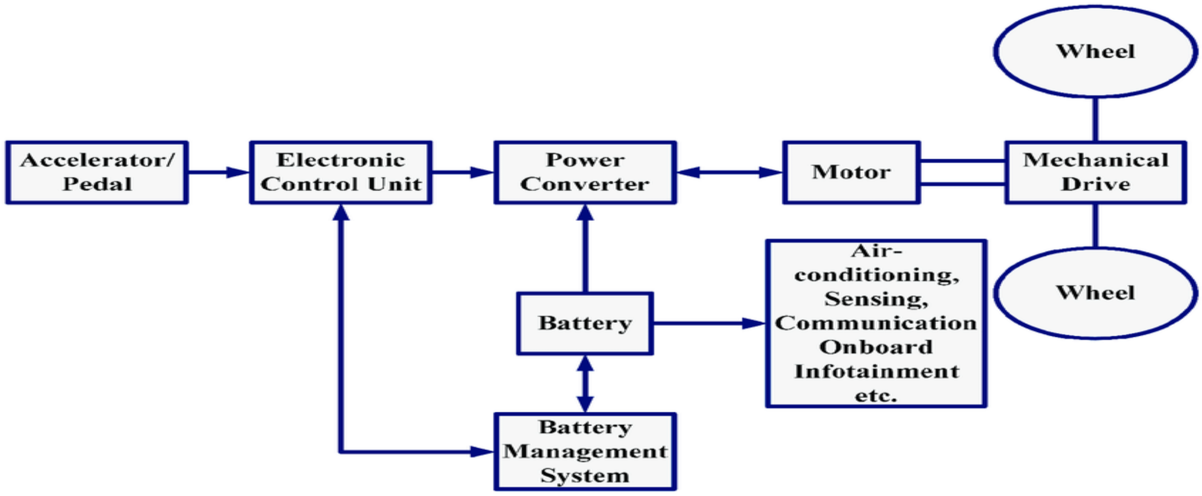
Figure 11 BMS

4.2.1 How does the battery management system work?

There are no standards. The level of technical design and the actual functionality used is usually related to:

- Battery usage and safety, durability or warranty issues.
- Battery packs cost, size and complexity.
- Certification requirements imposed by various government regulations. Non- compliance can result in severe fines and other consequences.

Two key components of his BMS design are capacity management and battery pack protection management. This section explains how these two features work [64]. The two main areas of battery pack safety management are electrical protection to prevent battery damage from operation outside the SOA and passive and/or active thermal protection to keep the pack within the SOA. Thermal management including



regulation.

Figure 12 BMS Flow Chart

4.2.2 Electrical protection:

Lithium ion cells only function within this voltage range. These SOA limits are ultimately determined by the underlying chemistry of the selected lithium-ion cell and the current temperature of the cell. These SOA voltage limits are further adjusted periodically to extend battery life as each battery pack experiences high levels of power cycling, discharging due to load demand, and recharging from different sources.BMS needs to be aware of this in order to issue commands based on whether these limits have been reached [2].

Battery cell manufacturers often specify maximum continuous charge and discharge current limits in addition to peak charge and discharge current limits. A unit-based BMS ensures maximum conti nuous current application [2]. However, this can be done in advance to allow for sudden changes in load conditions, such as rapid acceleration of an electric vehicle [12].

The BMS can add peak current monitoring by combining currents and deciding whether to shut off available current or completely stop pack current after a delta time. This allows the BMS to withstand high peak loads and respond almost instantly to strong current spikes such as power surges, as long as they are not overwhelmed for long periods of time. B.

A short circuit not detected by household fuses.

4.2.3 Electrical Management Protection: Voltage:

This is the only voltage range in which the Lithium Ion cell can function. The underlying chemistry of the lithium-ion cell chosen and the current temperature of the cell ultimately set these SOA limits [2]. These SOA voltage limits are often further adjusted to extend battery life, as each battery pack experiences high current cycling, discharge by load demand, and charging from different energy sources. BMS issues commands based on whether you are approaching these limits, so you need to be aware of these limits. For example, the BMS may require the current to be gradually reduced as the upper voltage limit is approached, or to stop charging current completely when the limit is reached. This constraint is often used in combination with additional spontaneous voltage hysteresis considerations to prevent control chatter associated with the termination threshold [2]. However, once the reduced voltage limit is reached, the BMS will prompt active problem loads to reduce their current demand. To achieve this, the permissible torque of electric vehicle traction motors can be reduced. To avoid irreversible damage, it is clear that BMS must put the driver's safety first while protecting the battery pack.

4.2.4 Thermal Management Protection: Temperature

Lithium-ion batteries seem to have a wide temperature range, but as the temperature drops [30], the chemical reaction rate slows down significantly, reducing overall capacity. Although they can operate at much lo metallic lithium plating behavior during sub- zero charging. Cells are irreversibly damaged, resulting in reduced performance and increased risk of failure under conditions of high stress such as vibration. By heating and cooling the battery pack, the BMS can regulate its temperature. The thermal management achieved is entirely dependent on the BMS and product unit design parameters, which can take into account battery pack size, cost, performance goals, and target market. Regardless of the type of heater you are using, it is usually more efficient to use an external AC power supply or backup battery to power the heater as needed. However, if the electric heater consumes less power, it can be heated with energy from the mains supply. When using thermo-hydraulic systems, electric heaters are used to heat the coolant. This coolant is pumped and distributed throughout the package assembly [2]. There are several techniques used by BMS design professionals to inject small amounts of thermal energy into the

package. For example, power control can be achieved by controlling various power electronics in the BMS. Less effective than direct heating, but still usable. Cooling is particularly important to reduce power loss in lithium-ion battery packs.

For example, if a battery is most efficient at 20°C, increasing battery temperature to 30°C can reduce power efficiency by up to 20%. The battery should be charged and refreshed regularly at 45°C (113°F). Otherwise, performance can drop dramatically by 50% [2].

Battery life can be affected by premature aging and deterioration with repeated exposure to significant heat generation, especially during rapid di electric car, the electric car is just driving on the road. When the includes an airspeed sensor to tactically auto-adjust the drop spoiler for optimal airflow, it can be more complicated than it seems. When the vehicle is stationary or traveling at low speeds, using an actively temperature-controlled fan can be beneficial, as this will help equalize the temperature of the pack with the ambient temperature can lead to elevated initial load temperatures on very hot days. A possible add-on system, the Thermo- Hydraulic Active Cooling, typically consists of a cooling plate attached to the battery pack assembly, hoses and tubes, a manifold, a cross-flow exchanger, and ethylene pumped by an electric motor drive. Use glycol coolant pump. The refrigerant has a predetermined mixing ratio.

4.2.5 Capacity Management

The BMS monitors the temperature of the entire pack and adjusts a series of valves to keep the temperature of the entire battery within a predetermined range for optimal battery performance. This is a significant battery performance advantage of BMS [2].

Battery packs can lose all value over time if basic maintenance is neglected. The fundamental problem is that the "stacks" of battery packs are not perfectly equal and inevitably have some variation in leakage and self-discharge rate. Leakage is battery chemistry, not a manufacturer issue, but statistically speaking it can be affected by slight differences in the manufacturing process. Initially, a battery pack may contain well-matched cells, but over time, the similarity between cells is further reduced by self discharge, high temperature, Charge/discharge cycling, and again [2].

Recall, however, that we have already discussed the possibility of using high- performance lithium-ion cells when adherence to the SOA is not strictly required. As we learned earlier, lithium-ion batteries do not react well to overcharging and therefore require electrical protection. When they are fully charged, they cannot accept additional current, and voltage can rise rapidly and dangerously when additional energy is applied. Not a perfect position. It can cause long-term damage and create hazardous working conditions. The voltage across the battery bank is determined by series cell arrangement of the battery pack, and the variation between adjacent cells makes charging the stack difficult [2]. Charging current can be cut off when an upper cutoff threshold of 4.0 volts is reached.

At this point, each cell charges equally at a reasonably balanced rate. In an unbalanced condition, the top cell reaches its charge limit before the other cells below it, so the charging state of the legs must be stopped before this happens.

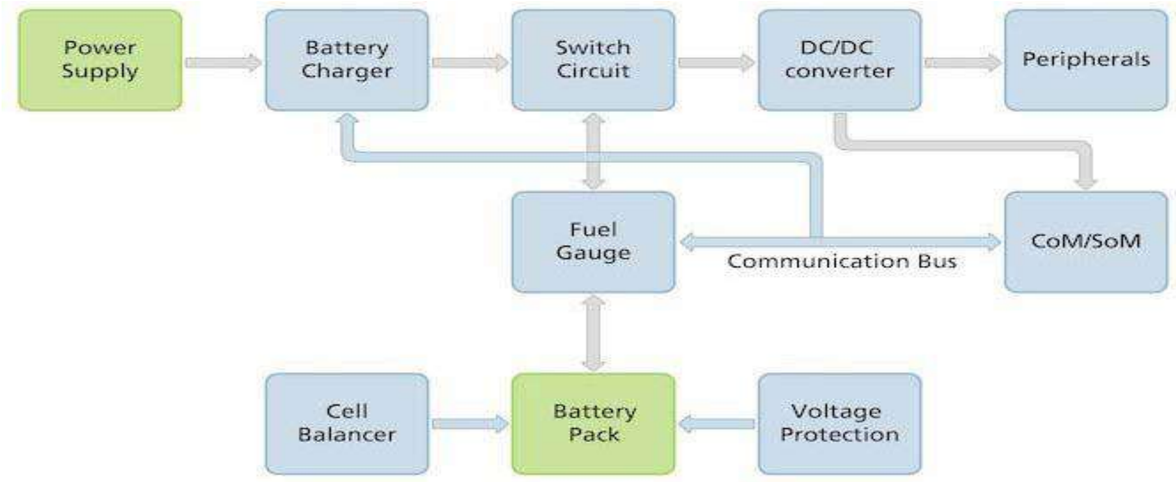


Figure 13 Network of BMS

4.2.6 Comparison of BMS of low-end and high-end shavers

Figure 14 shows his BMS of a budget-friendly shaver, focusing on equipment costs. You can power it with one rechargeable NiCd or NiMH battery that comes with your shaver. Additionally, PM has been added to Razor. On/off position switch connects battery and motor [1].

High voltage integrated circuits have both ECC and CHC control functions. In a switching determined power supply, this HVIC controls the high voltage switch in a fly back arrangement and manages the charging current (SMPS). The voltage across the rectifier diode D, the voltage across the resistor R1, and the output voltage of the PM serve as control signals for the HVIC. The mode of the HVIC affects the value of output current. The output current is strong until "battery full" detection. This finding leads to a decrease in output current. These two charging modes are linked via voltage regulation mode. This mode is used when the engine is on while charging. In this case, the PM keeps the battery voltage constant, which keeps the shaver motor supply voltage constant [1].

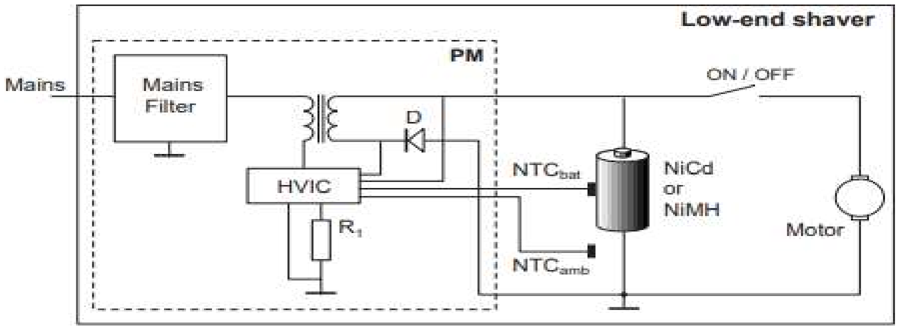


Figure 14 Low End Shaver [1]

To enable shaving, a certain amount of power must be transferred to the motor. The PM's output current is relatively high when the user shaves while the shaver is connected to mains power. This is because only NiCd or NiMH batteries are used, resulting in relatively low battery voltages. You don't want to use a series resistor to measure current. Using a high current value for the razor's dimensions would result in excessive temperatures inside the device. Therefore, additional measurements must be made to determine the value of the output current [1].

This is accomplished by monitoring how long the high voltage switch on the primary side of the transformer remains open and how long current flows through diode D to the battery.

To determine this time, the voltage across diode D is monitored. The peak voltage across R1 on the line side of the transformer can also be used to estimate the peak current when diode D starts to flow. Since the current through diode D drops linearly to zero, the maximum current, the length of time the current is flowing, and the total switching period T can all be used to calculate the average current. One way to determine when a NiCd or NiMH battery is "full" is to measure the temperature rise of the battery after charging. The two NTCs in Figure 15 calculate the temperature difference between the battery and the ambient air. The PM switches to low current when the temperature difference between the battery and its surroundings reaches a threshold described by the HVIC. Accounting for self-discharge, this current keeps the battery state of charge constant. Slow drip current is the most common explanation for such low currents. His BMS for the budget cutter has proven to be cost effective. A simple charging algorithm allows a sufficient number of charge cycles before battery capacity drops to insufficient levels [1]. However, notification of battery information to the user was not implemented. This situation is uncomfortable for premium razors. For this reason, high-end razors are equipped with microcontrollers and LCD screens to provide various information to the user. As already indicated, the complexity of BMS depends on additional features. This diagram shows his BMS for high-end razors. The shaver is powered by two NiCd or NiMH batteries connected in series. A timer control module (TCM) is available. Once connected to the engine with the ON/OFF switch, the battery [1].

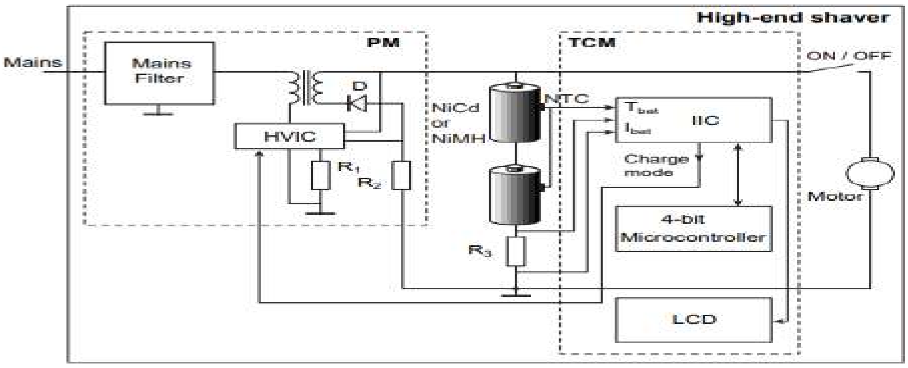


Figure 15 High End Shaver [1]

Similar to the previous example, his HVIC for PM parts now includes ECC functionality. The HVIC adjusts the PM output current according to the appropriate value sent from the TCM module throughout the charging process. When the motor is turned on during charging, the HVIC switches to output voltage control. The current generated by the PM in this mode is smaller than in the low-end razor situation, so it is tempting to measure the current using resistor R2 [2].

CHC functionality is now part of TCM. A microcontroller communicates with the rest of the system through an interface IC (IIC). Battery current and temperature are measured by the IIC. Measure temperature using NTCs near both batteries. Measure the voltage across resistor R3 to determine the battery current. The IIC calculates the SoC of the battery by adjusting the counter value during charging and decreasing the counter value at a rate inversely proportional to the amount of current during discharging. Charge in and out of the battery is measured using the coulomb counting method. The counter will decelerate at the set speed to compensate for lack of external battery power. This rate is inversely proportional to the measured battery temperature, so it increases with increasing temperature higher temperatures lead to more self-discharge, which corresponds to how a real battery behaves [2]. The SoC display approach has shown sufficient accuracy for use with Razor. Based on the value of the counter, the IIC tells the HVIC which charging current to use. When the counter reaches 80% of full reference, the IIC signals the HVIC to switch from normal charging current to reduced top-off charging current. Reducing the charge current at this point will keep the charging efficiency high and prevent the battery temperature from rising significantly. This is because charging efficiency starts to drop at high currents at the end of charging. When the counter reaches 100% full reference, the IIC tells the HVIC to switch to a smaller trickle charge current. The SoC value determined by the IIC is used by the CPU to calculate the Minute Left or

Shaves Left value. Via the LCD, the IIC notifies the user of the battery status [1].

4.3 Lithium-Ion Battery

Lithium Ion batteries are widely used in consumer devices due to their high energy and power density, long service life and environmental friendliness [19]. Creating battery packs for use in high-end applications such as electric vehicles (EVs) and energy storage devices requires combining large numbers of batteries in parallel and series [5].

As a result, there are cost, stability, consistency, and security issues [57]. These problems limit the application of lithium-ion batteries. Lithium-ion battery safety and reliability are affected by charge rate, temperature, and voltage range. Exceeding these limits can rapidly degrade battery performance and pose a safety hazard. Furthermore, to ensure reliable operation of lithium-ion batteries, it is essential to evaluate the battery capacity and estimate the RUL over the life of the battery. In addition, cell sorting strategies are critical steps to ensure cell reliability and safety. These techniques separate qualified cells from non-qualified cells based on quantitative requirements such as capacitance, resistance and open circuit voltage [5].

Lithium Ion is a key component of the electrochemistry of Lithium Ion (Li-Ion) batteries, a highly effective battery technology. During the discharge process, the lithium atoms in the anode are ionized, blocking electrons. Lithium ions move from the anode through the electrolyte to the cathode where they recombine with electrons and become neutral [23].

Lithium ions are so small that they can pass through the barrier that separates the cathode and anode. Thanks in part to lithium's compact size, lithium-ion batteries are capable of very high voltage and charge storage per unit mass and volume [10] (his third size after hydrogen and helium). Electrodes in Lithium- Ion batteries can be made from a variety of materials [32]. The most commonly used cathode and anode materials in portable electronic devices such as laptops and mobile phones are lithium cobalt oxide (cathode) and graphite [55]. Other cathode components are lithium iron phosphate and lithium magnate used in hybrid and electric vehicles. Ethers, a type of organic contaminant, are commonly used as electrolytes in lithium-ion batteries [51].

Figure 16 Li-ion battery cells

4.3.1 Lithium-ion battery classification:

Lithium-ion batteries are widely used in consumer technology due to their high energy and power density, long service life and environmental friendliness [19]. Manufacturing battery packs for use in high-power applications such as electric vehicles (EVs) and energy storage systems requires many batteries in parallel and series. This raises issues of cost, stability, consistency, and security. These issues limit the use of lithium-ion batteries [5]. Recently, research on differences in cell-to-cell parameters such as resistance, OCV, and SOC, which are closely related to cell sorting, has attracted attention [5].

Battery classification refers to the process of grouping similarly performing batteries using various techniques to increase battery consistency and reduce the impact of initial battery-to-battery variation on usage efficiency and longevity increase. This section describes various techniques for classifying lithium-ion batteries.

4.3.2 LIB Safety:

LIBs are widely used in industries such as consumer electronics due to their high energy density, high voltage and long life. Due to the devastating consequences, LIB security has long been recognized as one of the most important issues. Explosion events, even for small mobile phones, can cause severe damage to applications and are a compelling safety concern. It can also result in millions of dollars in losses [9]. Unlike consumer devices, electric vehicles are powered by high-energy battery packs containing many battery cells connected in parallel and series. Security issues are growing in importance and complexity. The special operating conditions of electric vehicles pose significant challenges to LIBs, allowing battery packs to withstand different types of travel, extreme temperatures, humidity, fast charging, and other conditions.

Problems that can cause electric vehicle failures include car crashes, hard object penetration, overcharging, over-discharging, water immersion, over-heating, battery leaks, and electrical system failures.

Figure 17 Li-ion battery packs

4.3.3 Charging and discharging if the

state of charge is very low, charge at a reduced constant current rate. This is typically about 1/10th of the full rate discussed in the next section. During this time, the voltage of the battery increases, and when it reaches a certain value, the charging rate is maximized. Depending on how low the initial voltage of the battery is, some chargers split this trickle charge step into two steps: pre-charge and trickle charge [1]. The full charge phase begins when the battery voltage is high enough at start-up or when the battery is fully charged. During this constant-current charging phase, the battery voltage continues to rise slowly [19].

4.4 DIGITAL FEATURES

4.4.1 Digital Voltmeter

This simple LED voltmeter works with our battery and has a 2-pin e-bike kit connector. The meter's electronics are fully potted, waterproof, and not battery powered. A 30 inch 2 pin to Anderson adapter cable is included to connect the meter to a variety of different batteries. This voltmeter is very useful for checking your battery at home connect to the battery while charging to ensure the charger is working, or connect to the second lead of the battery (get an XLR adapter for our batteries) and monitor the voltage drop to check for low battery. If there is no connection, or if the polarity is reversed, the display will not light up and instead the battery voltage will be displayed immediately and correctly (battery not wired correctly). With such a long cable, you can use it while watching the charge level of the battery. This is much easier than using a digital multi meter with different settings, internal batteries, etc.

For someone who wants to work on an e-bike but doesn't want to know too much about electronics.

Figure 18 Voltmeter

4.4.2 Digital Speedometer

Digital speedometers are often found only in high-end cars and motorcycles. What to do if the bike's mechanical speedometer is broken? After the gearbox is mechanically worn out, the cable has to be replaced. Here we describe how to build a motorcycle speedometer coulometer based on a microcontroller. This circuit uses a microcontroller, an LCD display, and a few easily accessible components.

It's a great alternative to mechanical speedometers and can be assembled by beginners with only basic assembly skills.

Digital micro controller speedometer with meter:

1. Electronic display
2. Speed in km/h
3. The distance traveled is displayed.
4. Readings stored in non-volatile memory
5. Reliability using microcontroller
6. No mechanical degradation
7. Self-made speed sensor / speed sensor
8. Auto-zero after 9999 km
9. Easy to assemble and can be mounted on the bike

Figure 19 Digital meter

4.5 Solar panel

Although they may seem the same, each has its own features and specifications. Minor differences in specifications may determine the suitability of the solar panel for your Hybro bicycle needs.

4.5.1 Specifications

Below are the specifications for the solar used in the Hybro bike. Recall that we used two solar panels for this project:

1. Dimensions: 530 x 660 x 25 mm
2. Cell: Monocrystalline
3. Tolerance: +3%
4. Short Circuit Current (Isc): 3.03 A
5. Weight: 4.3 kg
6. Maximum System Voltage: 600V
7. Model: DSP-50M
8. Open Circuit Voltage (Voc): 22.50V
9. Rated Voltage (Vmp): 18V
10. Current at max output (Imp): 2.78A [34]

An ideal entry level panel for solar users new to e-bikes is a 50 watt 12 volt monocrystalline solar panel. This essential part comes with an MC4 cable, making it easy to create and extend your solar system. Two of them used 50 watt solar panels. It's small but impressive, and it's capable of recharging the battery even after it's been depleted while driving. Driving does not cause "range anxiety" [34].

The amount of power required for the bike can be determined using the BMS, which also helps power the digital meter. Two 50W solar panels were used to generate a total of 100W of power.

Figure 20 Solar panel

4.5.2 Reliability

Using advanced encapsulation materials with multi-layer sheet metal lamination for better cell performance and longer life EL tested solar modules are guaranteed no hotspot heating bypass diodes ensure excellent performance in low light conditions and reduce power loss due to shading [46]. The TPT's back seat ensures consistent performance over time. Less than 5% of his solar panels are expected to fail each year over its lifetime. Where you live and the type of solar panels installed are two variables that affect the life of your solar panels. Solar panels are more likely to fail in extremely hot and humid climates. Solar panels are more likely to live longer in warmer, drier environments. If you live in a cool place, solar panels can last for years [46].

4.5.3 Eco-Friendly

Solar panels are reliable by providing green power that does not pollute the environment. For example, fossil fuels release toxic gases into the atmosphere. The manufacturing and installation of solar panels and other solar energy devices creates small amounts of pollutants. However, solar energy is more environmentally friendly than generating electricity from fossil fuels.

The earth is moving towards environmental protection. Environmentally friendly energy sources are more popular these days. Solar panels aid in the global trend toward environmental preservation.

When employed, solar cells, solar energy systems, and solar power plants don't release any greenhouse gases or contaminate the air. Solar energy has a beneficial, indirect effect on the environment if it replaces or reduces the use of other energy sources with bigger environmental implications [4]. Environmental issues do, however, arise with the development and deployment of solar energy systems.

Solar energy technology requires the use of energy-intensive materials such as metals and glass [25]. When conducting survival or so-called cradle-to-grave environmental analysis, solar energy systems can be linked to environmental issues related to the production of these materials. Studies by many organizations and scientists have shown that photovoltaic systems can produce the same amount of electricity in one to four years as was used to manufacture them [16]. Most solar power systems can operate for 30 years or more.

Hazardous chemicals used in the manufacture of photovoltaic systems and modules should be properly controlled to prevent their release into the environment [4]. Some PV cell technologies use heavy metals. After their useful life has passed, these cells and PV modules may need to be treated differently. Some solar heating systems use potentially hazardous liquids to transfer heat. Leakage of these fluids can harm the environment. In the United States, environmental regulations govern how hazardous materials are used and disposed of [31]. The U.S. Department of Energy has funded a number of programs to address the longevity issue of solar energy technology, including recycling and reuse of materials used to manufacture PV cells and panels. Many states have enacted laws encouraging the reuse of PV module material.

Like any other type of power plant, large solar parks can have impacts on the local or nearby environment [15]. Construction site clearing and power plant sites can cause permanent damage to native plant and animal habitats. However, farm owners can benefit economically and environmentally by installing solar energy systems on farms or land with minimal agricultural value [24].

Some photovoltaic systems require water to cool the turbine engine and to wash the solar concentrators and panels. In some arid regions, washing collectors with large amounts of groundwater or surface water can reduce ecosystem dependence on these water sources. In addition, the strong rays of the sun from solar energy towers can kill animals and insects flying towards them.

4.5.4 Geographic Flexibility

Wide geographical access makes solar panels more reliable. Get access to solar energy with solar panels wherever you are. Solar energy can be used anywhere in the world. Solar energy is more readily available closer to the equator. Most people don't realize that solar energy can be used everywhere. In areas with little sunlight, a 1-kilowatt solar panel can generate up to 2.9 kWh of electricity per day. Some regions have additional benefits when it comes to solar energy.

Renewable energy capacity has doubled in the last five years as the world seeks cleaner forms of electricity [54]. But a study released Tuesday showed that producing all that solar energy could have a negative impact on the environment. It requires corrosives, energy and water, both of which contribute to greenhouse gas emissions. It also creates waste. These issues could make solar energy less toxic and less effective in fighting global warming.

A new analysis of 37 solar manufacturers, the Solar Dashboard, shows that some companies outperform others. Chinese producer Trina was his number one, followed by California-based Sun Power [11].

The Silicon Valley Toxics Coalition (SVTC), a San Francisco-based nonprofit that has been monitoring the environmental impact of the high-tech sector since 1982, has developed an annual scorecard. According to his fifth scorecard for the group, the industry is becoming more transparent, not less transparent, about the quality of its manufacturing processes [11].

The organization believes scorecards promote transparency in the industry. The industry is still in its early stages and is often focused on survival and growth rather than solving the unclean aspects of green energy sources.

4.6 Charger of bike:

With the increasing spread ability of EV loads, RECHARGE project researchers are investigating new intelligent charging control strategies. Utilities can now avoid the need for grid changes required as a result of unregulated widespread charging while continuing to meet the growing energy demands of EV users. Such control techniques address load issues across a range of distributed feeds or utilities [28].

The main advantage of EV fast charger is that it can quickly charge your car. However, the cost of fast-charging applications can be greatly affected by peak power consumption prices. Investigate the use of stationary energy storage technology to reduce consumption costs as a solution. I am currently using a 20Ah, 72V charger, which maximizes both efficiency and speed, and charges the battery quickly [28].

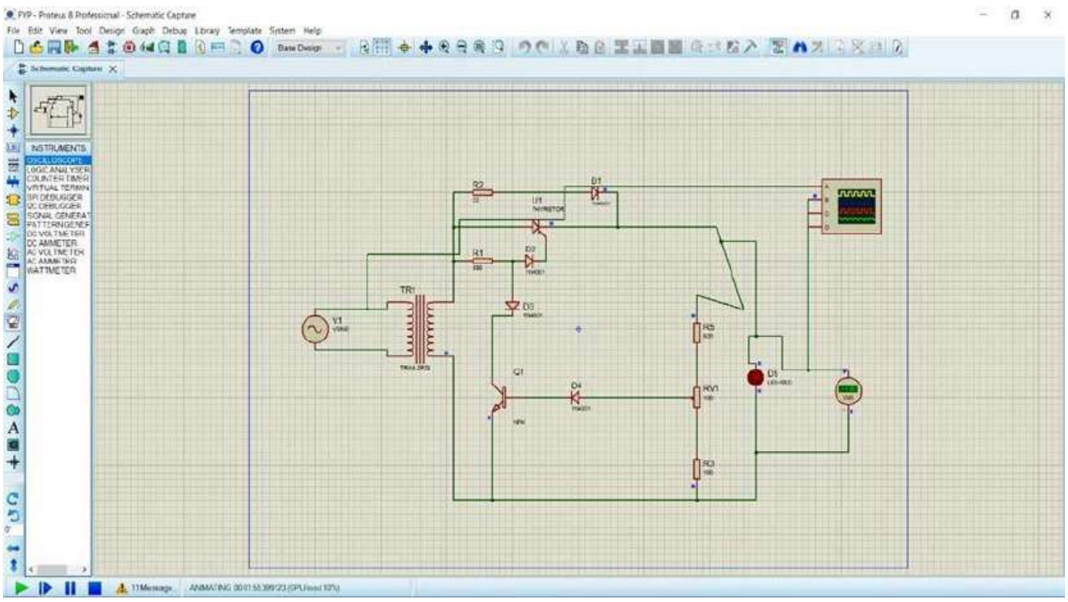


Figure 21 Simulation of Charger

Figure 22 charger

4.6.1 Conventional Charging Methods:

There are two methods for charging batteries in the Bidirectional Charger. A fully digital and intelligent strategy that combines a permanently stable charging current with a moderate amount of charging pulse current is one of the fast charging algorithms and methods. These techniques take into account both the battery's current state of charge and its history of charging and discharging. However, the impulse charging method has been found to be the most advantageous, effective, and quickest to charge. Basically, it consists of generating a long charge pulse followed immediately by a fast discharge pulse followed by a "wait" period. Battery packs tend to heat up during fast charging. The use of thermoelectric generators (TEGs) has been proposed for use in the automotive industry to speed up the battery cooling process and extend life. These coolers can be placed between his two connections of a pair of cells or a pair of plates. A power flow management algorithm was developed that requires each energy storage device to be charged to a specific SOC before the entire system can function. Hybrid PWM technology has also been developed to reduce converter temperature rise without significantly increasing switching losses [40].

Such an approach switches half of the total number of switches at high frequencies (on the order of tens of kHz) and the other half at system frequencies (50 or 60 Hz). These technologies have a good track record.

4.6.2 Thermal Management in Battery Fast-Charging:

Due to resistive (Ohmic) losses and electrochemical reactions that take place during the charging and discharging of the battery, vehicle batteries are prone to temperature rise when being charged quickly. The usage of thermoelectric generators (TEG) has been suggested as a way to quicken the cooling process in batteries, lengthen their lifespan, and utilize them in the automobile industry. Between the two terminals of a cell pair or a plate pair, these coolers can be positioned. A power-flow management algorithm has been devised, according to which each energy storage device must be charged to its specific SOC before the system as a whole operates. In order to lower the temperature rise in converters without significantly increasing switching losses, a hybrid PWM technique has also been developed. Such approaches involve switching half of the total number of switches at a high frequency (on the order of tens of kHz), and the other half at the system frequency (50 or 60 Hz). These techniques have a great track record of success [42].

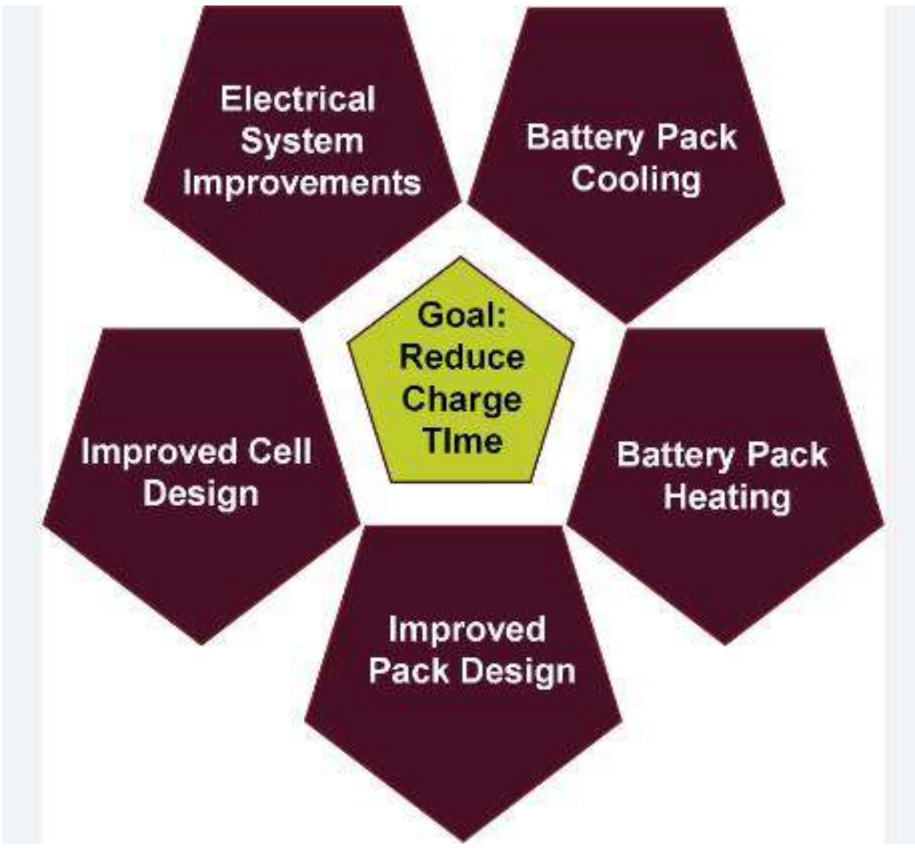


Figure 23 Thermal reduction cycle [38]

4.6.3 Additional charging applications:

Two additional functions Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H). PHEV integration studies are connected to mains and can also be done via bi- directional chargers. V2H is the equivalent of connecting a PHEV to the home circuit to meet the household's power needs, while V2G is the equivalent

of connecting his PHEV to the grid and using the power of the car's battery

to meet the grid's needs increase. In the next section, we examine the impact of his V2G on grid stability, but we do not examine the impact of V2H in this work.

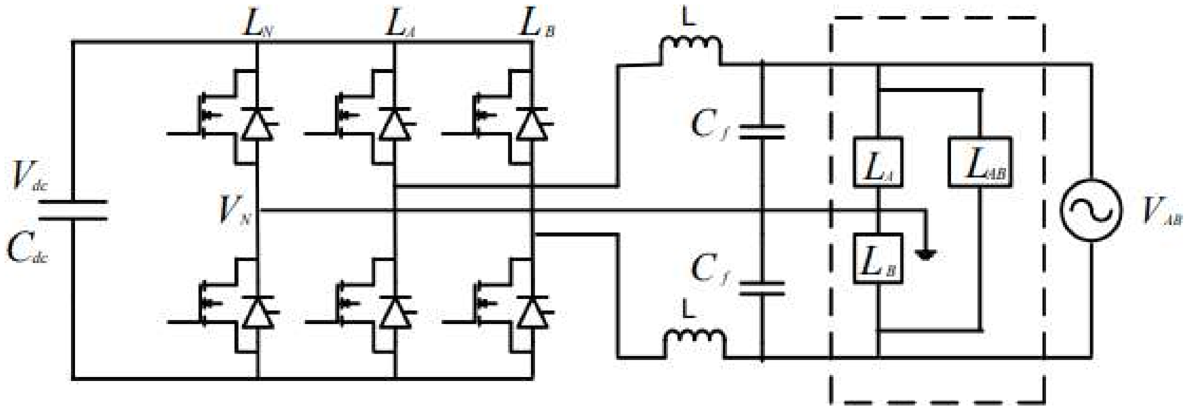


Figure 24 V2G [48]

Three modes of operation, charging, V2G and V2H, were developed as control strategies for the line-side converter of the single AC power charger shown in the figure. Gc(s) and Gf(s) are the compensators of the structure in the figure representing the control scheme for V2G mode. The V2G feature takes into account the state of the battery pack, while the MPPT feature for solar and wind power systems tries to get the best possible performance from the power supply. Hence, the reference current iL* is calculated based on the actual power demand of the grid, not the DC voltage loop [30]. Phase data is obtained using a PLL [48].

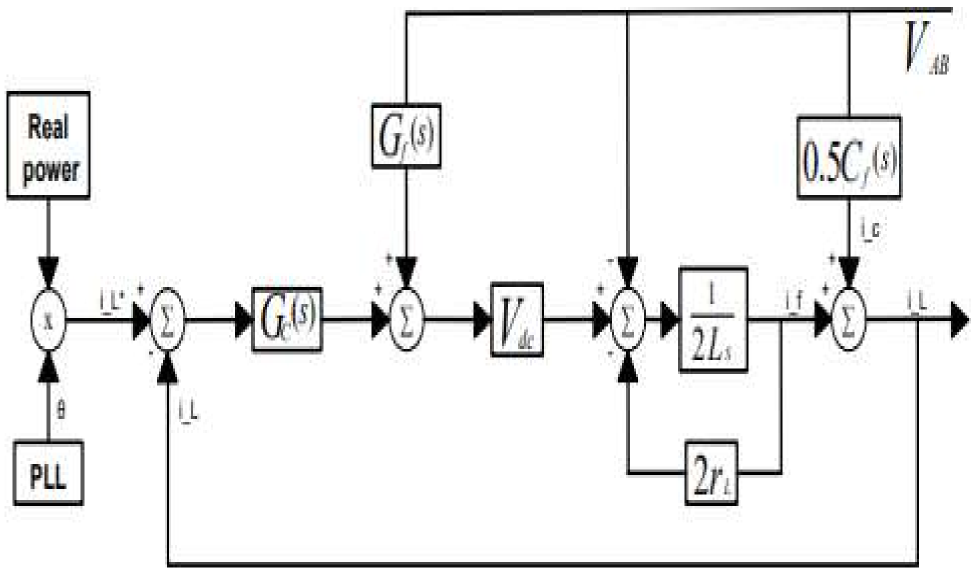


Figure 25 [48]

shows a charge mode control system using a structure with an inner current loop and an outer voltage loop. A PI controller is also included to generate the reference current magnitude along with the phase (via the PLL) [48].

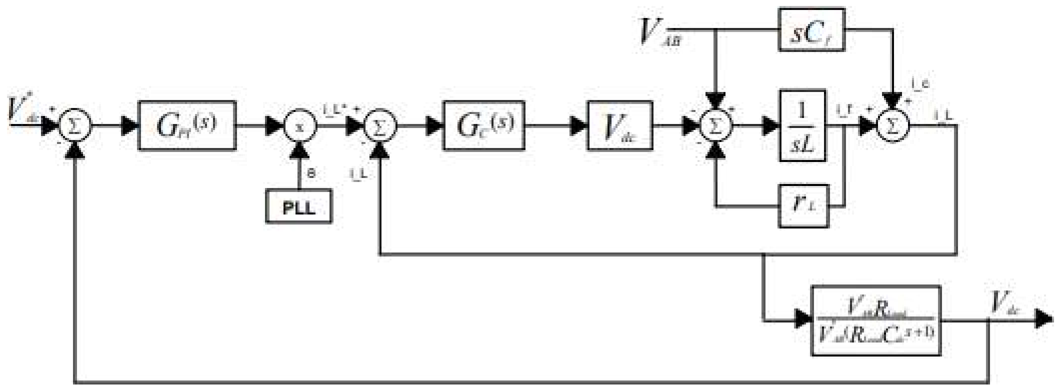


Figure 26 [40]

Two different types of harmonic loads were present in the previous two modes of operation. Input current reference.

As a result, the current loop reference suffers from harmonic pollution which is undesirable. The second is the second harmonic of the intermediate circuit voltage. Therefore; the control method was improved by adding an internal voltage reference and a second order notch filter to the previous design

Chapter 5

Calculations

when creating an engineering project ensure that all necessary calculations are performed. Engineers need to realize that working as a technician is not a choice. You have to act like a real engineer. First,

we will discuss the dimensions of the Hybro bike and all its mechanical and electrical components. Full calculations are present in this chapter.

- Vehicle lateral weight
- Required speed
- Wheel size
- Engine efficiency
- Rolling resistance
- Vehicle area
- Curve density
- Coefficient of drag
- 44 Bike wheel size = 70 kg
- 4 = 17 inches

Where all these values and constants are essential to the calculation.

5.1 Load/no load power consumption:

- When the bike is loaded, the power consumption is 15-18 Amps.
- A bike weighing 58 kg has a speed of about 33-36 km/h.
- With a weight of about 69 kg, the speed is about 29-32 km/h.
- Weight 77 kg and speed is about 24-28 km/h.
- Idle current consumption is 5 Amps.
- Idle speed is about 40 km/h.
- In idle mode, current consumption is zero amps

All these assumptions are based on our basic understanding. However, all aspects of this information must first be calculated in order for the assumptions to be confirmed in subsequent calculations. To do this, we first need to calculate the battery backup.

Speed=Distance/Time (by this we can determine each factor)

Battery backup:

Motor load =1500W Battery=60v-20Ah A=P/V=1500/60=25A

So,

Ah/A=20/25=0.8h (48 min) Max speed= 35 km/h 35/60= 0.58

Now if we take approx 45 min in maximum speed= 0.58*45=26 Km/h (Approx).

Now after calculating this we'll go for that how much our bike travels with respect to its load by person

KM recharge trip per person.

- When the bike is fully charged, it can travel about 30-35km.
- Drive at about 27 km/h at maximum speed.

Calculate:

Top speed = 35 km/h 35/60= 0.58 km/s.

About 45 minutes at top speed = 0.58 * 45 = 26 km (approx.) Radius = 8.5" = 0.2159 m

Bike Length = 74.1" Width = 29.6"

Top Speed = 35 km/h = 9.7 m/s

Straight Line Distance:

LDT=2πr LDT=2*3.142*0.2159 LDT =1.355

RPM= Total distance covered per hour

Linear distance

= 25000

1.355*60

RPM=430.5 per min

Power= [(mass*gravity*velocity*rolling resistance) + (air Density*coefficient of drag*area m^2*velocity^3)]

= [(70*9.8*9.7*0.02)+(0.64*0.5*1.41^2*912.5)] Power= 713.64 W.

This is the power bike will consume at maximum speed i.e.: 35 Km/h it's just approx value for accurate value.

Drag coefficient:

0.5 to 1 range, double that of modern cars. Drag, also called fluid drag, always opposes the movement of objects immersed in a particular fluid. As a result, another definition of drag is the force that opposes or counteracts the motion of objects within a fluid. Drag always acts in the opposite direction to flow velocity [49].

Drag can be used as an example of drag. This is to always prevent objects falling from a certain height from reaching terminal velocity.

Like kinetic friction in that it opposes the movement of an object through a fluid and is only present when the object is in motion, drag is similarly reactive in nature.

Drugs can be divided into two categories: skin drugs and form drugs. The drag that occurs when a fluid is displaced by a moving object is called form drag due to the fluid. Fluids moving across the surface of large vehicles primarily cause skin drag. This is the kinetic frictional force.

Fluid density, velocity squared, cross-sectional area, and drag coefficient all directly affect the amount of drag. The degree of friction between the tire and road surface, gravity, inertia, vehicle weight and air resistance play an important role here.

Rolling resistance:

Rolling resistance slows you down when coasting in a car or bicycle. The higher the rolling resistance, the more power required to move the vehicle. This reduction translates into gasoline savings, as 3-11% of the gasoline used in passenger cars is required to counter this electricity. The resistance you feel when rolling a tire on a flat surface. A motorcycle tire has a rolling resistance coefficient of about 0.02 m/s2 [53].

Chapter 6

Experimental Setup

6.1 First remove the internal combustion engine from the bike, including oil and air filters etc. Then modify the bike to match the electrical components. Replaces the standard 70 rear wheel with a larger wheel to accommodate the motor.

6.2 We installed a battery pack with two 65v packs where the motor was to keep the bike and wheels balanced. As you can see from the picture above, the motor is mounted inside the rim of the wheel. Next, I put the BMS control panel in place of the typical CD 70 toolbox.

6.3 The solar frame was assembled from his two horizontal bars of the above dimensions, from the bike's front footrests and rear handlebars. I made a rectangular housing and installed two 50W solar panels in it.

6.4 By connecting the battery pack to the BMS and connecting the motor to the BMS, you can ensure that the BMS only supplies the required voltage. Also connect the solar panel so that the battery can be charged. BMS helps adjust temperature, voltage, and current trends according to the environment.

6.5 Two digital measuring devices are connected, one of which is a voltmeter which indicates the voltage remaining in the battery or the voltage required. The other is set to display RPM, indicator, speed and distance in kilometers per hour. It connects directly to the BMS to supply only the voltage required to run the digital meter

Chapter 7

Experimental Results

7.1 Our main concern was global warming. So by phasing out the internal combustion engine and replacing it with an electric motor, the environmental risks posed by the ICE engine are completely eliminated. The result is not only less gas pollution, but also less noise pollution. This is because, as we all know, the electrical system has no voice.

7.2 Our battery pack, the main component, produces about 60V. This is enough voltage to power the motor and get the bike started and running. The calculated bike speed is the vehicle speed. The only thing left forus is to charge the battery when it runs out in a reasonable amount of time, as the BLDC motors we use require little to no maintenance.

Figure 27 Wheel with bike

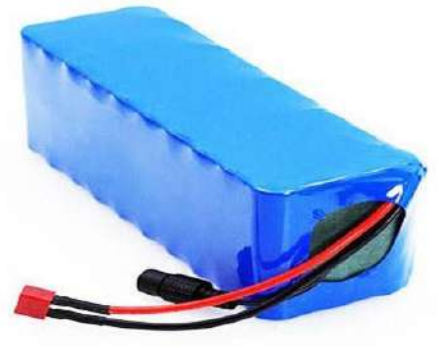


Figure 28 Final battery pack

7.3 With the above measurements, the frame is complete, properly balanced and easy to ride. When connected, Solar provides backup charging for the battery and supports the operation of digital functions. If the battery is fully discharged, Solar can use the charge provided to determine the remaining battery life of the battery.

Figure 29 Final bike(a)

Figure 30 Final bike (b)

7.4 By attaching her BMS to the bike, the brain of the project, she can control motors, digital displays and solar arrays, as well as adjust the voltage from solar to battery to motor. The BMS also acts as a safeguard by controlling short circuits that can damage the bike's battery pack if a short occurs from the battery pack. Temperature regulation is very important as temperature varies from city to City.

7.5 The term “hybro bike with digital features” in the project name clearly indicates that this feature sets our bike apart from the rest. It is rare in Pakistan as few people use the digital features of electric bikes. Combining two different types of digital displays might seem easy, but it was difficult. With BMS support, Pakistan's future restrictions can now be digitized.

7.6 Results for an ideal planning model for electric vehicle charging are presented. A model that aims to reduce the total cost by maximizing the charge perform of EVs. These insights can help achieve the ideal charging schedule for electric vehicles. Here are the results of the second stage of this work. This aims to reach all public transport with the lowest possible energy consumption, taking into account traffic congestion situations. This section compares the expected load to the actual base load for the next day. Using a linear regression technique, the expected load and actual base load are plotted in FIG.

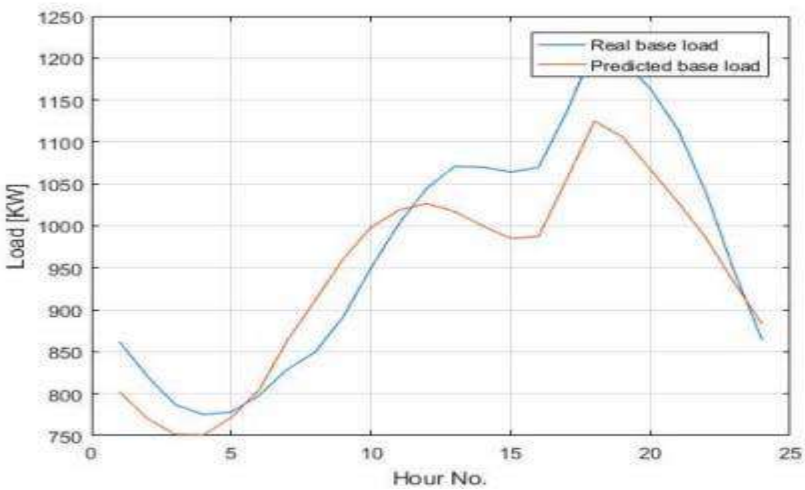


Figure 31 Load of 50 kg

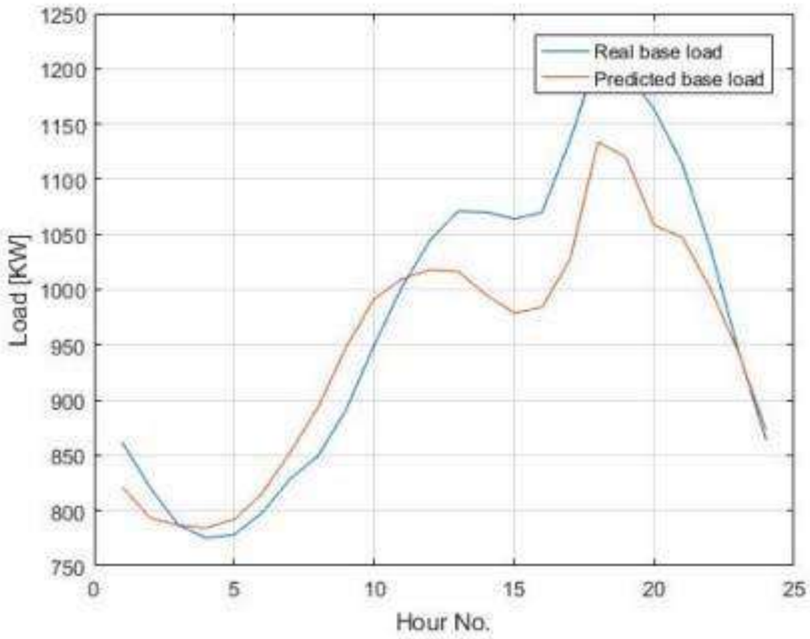


Figure 32 Load of 60 kg

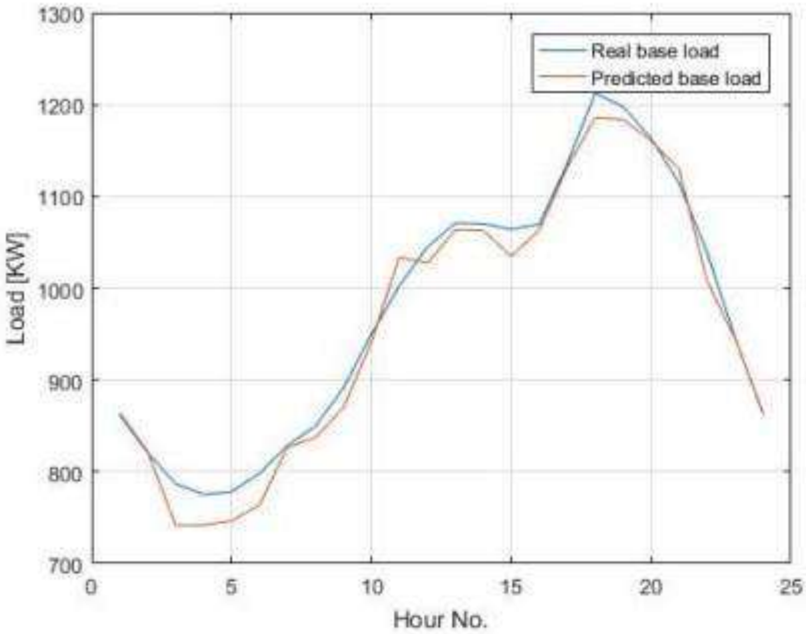


Figure 33 Load of 80 kg

7.7 Four inherent advantages of high energy density, high power density, charge and discharge times in minutes and environmental friendliness make the combination of flywheel and super capacitor is excellent. Additional fixed storage device options for EV chargers.

7.8 Following table includes the complete cost of our bike including the price of materials that we have used:

Sr.No	**Components Name**	**No. of Items**	**Cost**
1	Charger	1	10,000/-
2	BLDC Motor	1	30,000/-
3	Bike Body	1	12,000/-
4	Lithium-ion Battery	1	25,500/-
5	Solar	1	18,000/-
6	Rim	2	1,800/-
7	Wiring	1	3,000/-
8	Solar Frame	1	10,000/-
9	BMS	1	10,000/-
10	Total Cost		Rs.120,300

Table 3

Chapter 8

Conclusion and Future Work

8.1 Thus, in this capstone project, we succeeded in creating a Hybro bike with digital capabilities as well as in meeting more modest objectives related to reliability and sustainability that were indicated in the proposal. The bike was constructed within the specified time frame, and all of the parts used in it were either created by us or acquired since acquiring them would have cost more than building it. The bike can currently perform calculations at their maximum speed and provide the necessary current and voltage.

8.2 Future plans for this project include the use of alternative battery types in addition to lithium-ion batteries, as they may be more reliable than lithium-ion batteries in terms of powering bicycles. increase. The various batteries used can operate comfortably at temperatures as high as 60°C and as low as -20°C without worrying about battery burnout or freezing. More voltage can be added to these batteries as the bike will be faster and more maneverables.

8.3 The material of the solar frame used can be changed. Other materials can be used as long as they are compatible with the bike and support the weight of the solar panel. Cube boxes are more aerodynamic than the curved shapes that are mostly used in modern conventional cars, so you can change the designs that are created. Architecture can also affect the number of solar panels used. Larger ones can be used if desired or acceptable to our design optimization [44] .

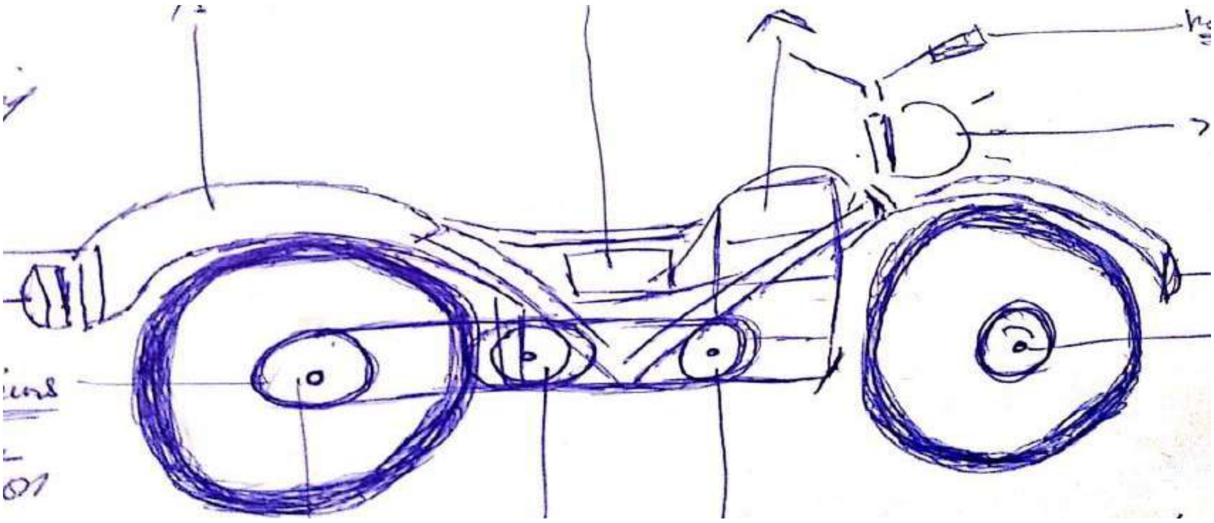


Figure 34 Ideal model bike

8.4 Optimization of the combination of flywheel and super capacitor in terms of energy and power sizing.

8.5 Influence of battery charger on mains voltage quality.

8.6 Designing more efficient converter systems for flywheel and super capacitor charging schemes [47].

8.7 Ultimately, more green energy will be needed to actually power the bike. A hybrid bike can only run entirely on solar energy. This may seem a little silly, but in my opinion the only way to really provide energy is not only to help the sub continental region, but it can be vulnerable in a few years. You can also save lithium ore. Good performance of calculations and panels [56].

Figure 35 Future bike frames [55]

8.8 Despite the growing popularity of electric vehicles, electric motorcycles seem to have died out and are rarely seen on the road. Why is that, and what does the future of electric motorcycles look like? Electric motorcycle riders are less common than electric vehicles for many reasons. One of the main reasons is that, unlike electric vehicles, there are not many variations, giving users less choice. Additionally, bicycles produce less pollutants than many cars, so there is less pressure on drivers to switch to bicycles. As with electric vehicles, there are also range and infrastructure issues, but these are areas of constant improvement.

8.9 Unfortunately, motorcycles are now waiting for a little improvement in battery technology. For an e-bike to really take off, the charging time would have to be reduced to about 15 minutes, or the undercharge range would be closer to 500 miles [58].

8.10 Self-driving cars have been discussed for some time. Vehicle autonomy levels 3-4 seem like a logical next step. Bikes' advanced warning system has improved significantly over the past five years with AI and big data capabilities.

8.11 More and more vehicles are at automation level 3 and above. Vehicles capable of independent decision-making are classified by the Society of Automotive Engineers (SAE) as Level 3 or Level 4 autonomy [58].

8.12 So far three different models have been used for load forecasting, so a hybrid of these three models can be used in the future to reduce errors and increase accuracy. Then the interval with a given number of EVs is taken into account while minimizing the EV charging cost. However, future changes in the optimization model may allow the system to accommodate randomly arriving EVs.

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