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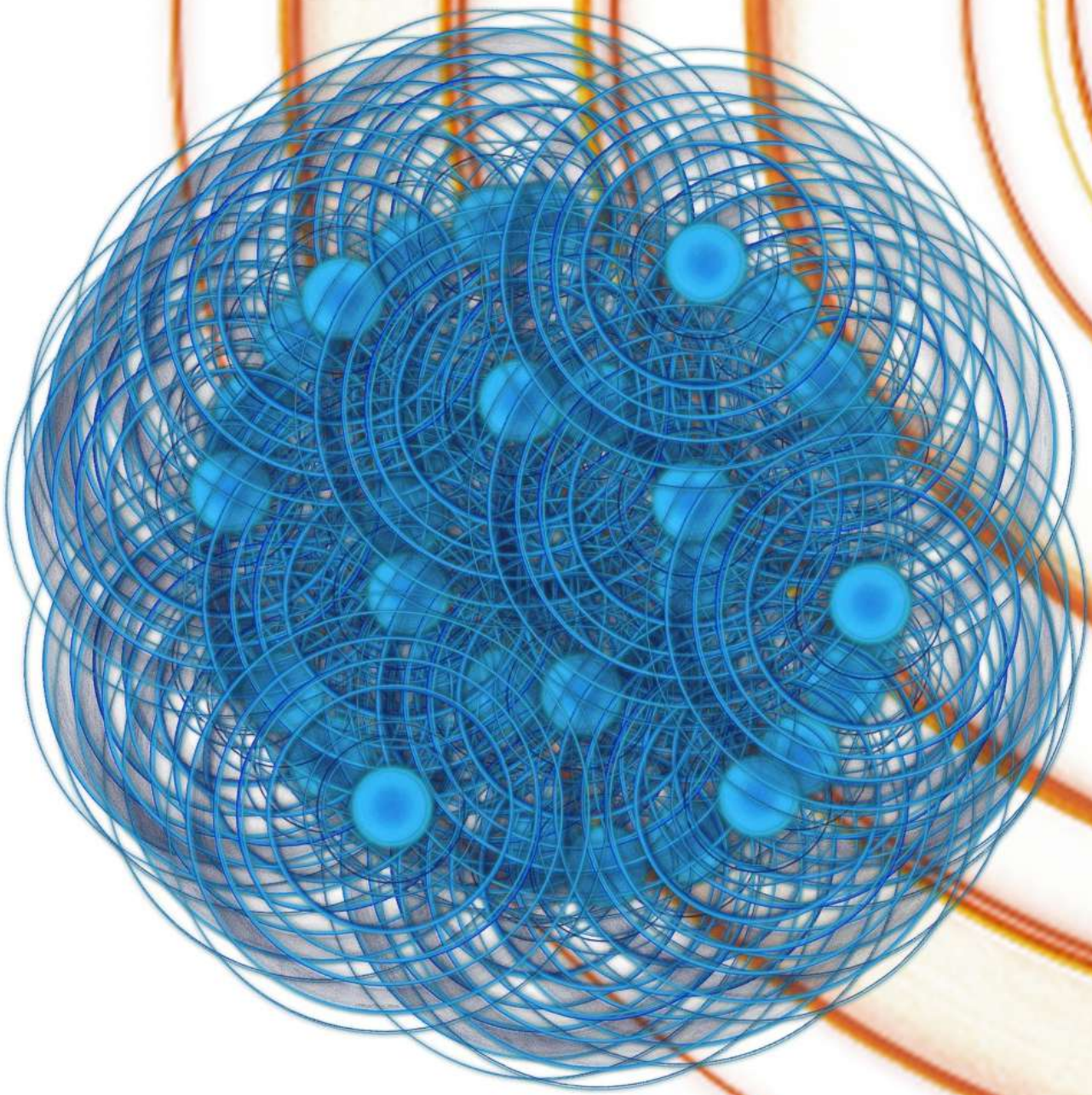
ELEKTRON

Transforming Humanity through Technology



A Publication of Department of Electrical Engineering
University of Engineering and Technology, Lahore.

Message from the Vice Chancellor

University of Engineering and Technology is an institution, which has always nurtured its students to set and achieve lofty goals by providing them the freedom to polish their skill set through curricular and co-curricular activities. A commendable product of such efforts and skills is Elektron, a magazine by the Department of Electrical Engineering, produced by the students of the EED, UET Lahore. Elektron reflects the creative minds of the students of Electrical Engineering and their abilities to breathe life into their innovative ideas.

To make this magazine a constant source of guidance and inspiration for the masses, the work done by the team Elektron is indeed, highly appreciated and acknowledged. The efforts put forth by the team Elektron should serve as a motivation for other students of UET Lahore to embark upon similar initiatives. I wish them best in their future endeavours.

Stay Blessed.

Prof Dr. Habib Ur Rehman

Vice Chancellor
University of Engineering and Technology, Lahore

Message from the Chairman

The aphorism “publish or perish” asserts the importance of publishing the scholarly work by the faculty and students. The Department of Electrical Engineering, historically, has been highly reputed for its outstanding undergraduate program. It has never been more important to involve undergraduate students in research. To publish the work carried out by under graduates has always been a challenge, due to the lack of availability of proper forum of this purpose, This is no more a limitation due to the introduction of the Elektron magazine. The Elektron team has put an extensive effort to make the idea a realization. The Elektron provides an excellent opportunity to both undergraduate as well as graduate students to publish their work. I believe this initiative will go a long way and will be pivotal in defining the careers of many.

Prof Dr. Muhammad Tahir

Chairman
Department of Electrical Engineering,
University of Engineering and Technology,
Lahore

In Pakistan, the students at the pre-university level are often curious about opting their areas of professional education. However, it is observed that the students at those levels do not have access to the relevant knowledge to help make their minds taking suitable decision. Elektron magazine is an effort of the department of electrical engineering of UET Lahore, to remove this knowledge deficit of the pre-university students

Message from the Editor-in-Chief

Specially, this magazine is an attempt to provide some knowledge to both the foundations and advances of the domain of science and engineering, in general and electrical engineering and its applications, in particular. Link among religion, philosophy and science is another relevant area of study, published under the scope of this magazine. Other than helping pre-university students, Elektron is also publishing articles to enhance the knowledge of early semester students of electrical engineering, professional scientists, engineers, specially, electrical engineers, and of the other readers interested in learning and knowing about foundations and advances of science and engineering.

Elektron invited the articles with very broad scope, but the preferred areas of interest are, but not limited to

- Religion and Science Contribution of Muslims in the Field of Science
- Science and Philosophy (a union)
- Technical Innovations in Electrical and Electronics Engineering
- Engineering Mathematics
- Engineering Protocols and Ethics
- Engineering Book Reviews
- Works of a Renowned Researcher
- Engineering Case Studies

I hope, this issue of Elektron will also gain your attention and appreciation.

Dr. Muhammad Salman Fakhar

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بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

اِقْرَاْ بِاسْمِ رَبِّكَ الَّذِيْ خَلَقَ ۚ ﴿١﴾ خَلَقَ الْاِنْسَانَ مِنْ عَلَقٍ ۚ
﴿٢﴾ اِقْرَاْ وَرَبُّكَ الْاَكْرَمُ ۙ ﴿٣﴾ الَّذِيْ عَلَّمَ بِالْقَلَمِ ۙ
﴿٤﴾ عَلَّمَ الْاِنْسَانَ مَا لَمْ يَعْلَمْ ؕ ﴿٥﴾

Read, ˹O Prophet,˺ in the Name of your Lord Who created— created humans from a clinging clot. Read! And your Lord is the Most Generous. Who taught by the pen— taught humanity what they knew not.
(QS. Al-'Alaq : 1-5)

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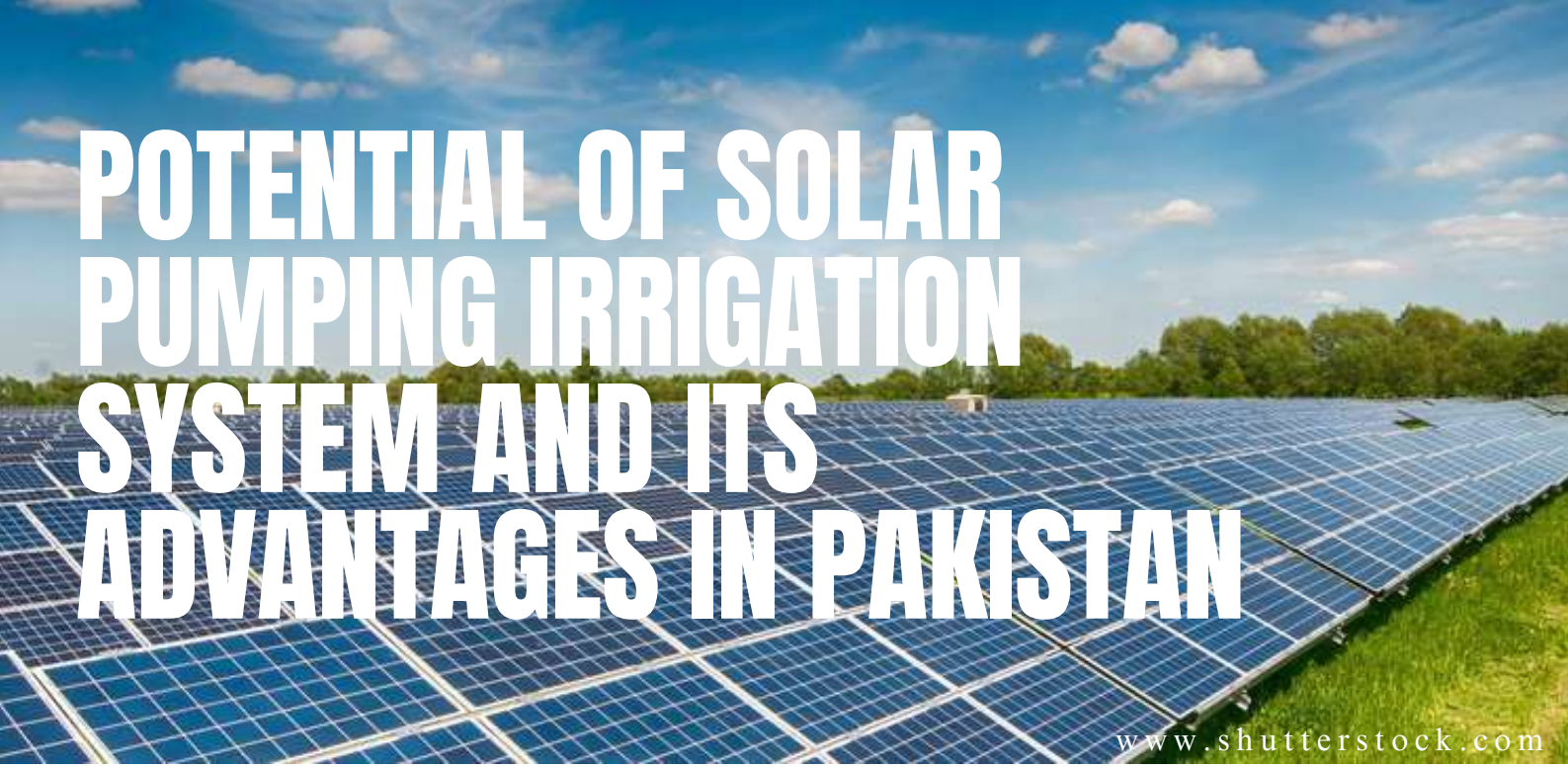

POTENTIAL OF SOLAR PUMPING IRRIGATION SYSTEM AND ITS ADVANTAGES IN PAKISTAN

ABSTRACT

This article presents the Potential of solar pumping irrigation system and its advantages in Pakistan. Pakistan's economy is predominantly agro-based, and the success of the agricultural industry depends on consistent and economical supply of energy. Sadly, Pakistan has had significant problems with traditional energy sources since 2005. As a result, all economic sectors, including agriculture, are not operating at their best. The current issue of irrigation water shortages will have a significant impact on the growth of crops that require a lot of water, such as rice and sugarcane. A crucial component of irrigation services is energy. Solar pump irrigation systems are starting to be a viable solution for both large-scale and small-scale farmers. Pakistan's national water usage grew by 20% over the previous 33 years, from 153.4 billion cubic meters (BCM) in 1975 to 183.5 BCM in 2008. There has been a 156% rise in population. Due to the growing disparity between supply (water availability) and demand (increasing population), the water shortage has gotten worse. With the help of these solar irrigation technologies, there will be a certain difference in the helping the healthy environment for Pakistan.

INTRODUCTION

Our planet's most potent source of renewable energy is the sun. According to estimates, the sun provides an hour's worth of energy at an average rate of 1000 watts per unit earth 2 area (m). PV systems may be utilized to catch incident solar radiation and create power for later use. Solar energy is the term for the energy that is captured from the sun and is regarded as the most dependable renewable energy source currently on the market.

Water may be pumped using solar energy, and distant regions benefit greatly from these solar-powered pumping devices. But only if they are well-designed and combined with high-efficiency irrigation techniques like drip, bubbler, sprinkler, or bed and furrow irrigation will solar-powered pumping systems be financially viable. Pakistan's economy is predominantly agro-based, and the success of the agricultural industry, along with other elements, is influenced by the consistent and economical supply of energy. Sadly, Pakistan has had significant problems with traditional energy sources since 2005. As a result, all economic sectors, including agriculture, are not operating at their best. All life on earth depends on water in some way. For instance, humans, animals, crops, and the environment all require water.

Water must frequently be lifted using energy from its source to the location where it is needed (i.e. the point of use). Pumps are often used to transport water from water sources, which may be subterranean or surface water bodies like ponds, lakes, rivers, streams, etc., to its final consumption locations, which can be a herd, cultivated field, or home overhead tank. However, the energy/power needed for these pumps may be both costly and unreliable. g40 percent of the world's population, many of whom continue to live in poverty, rely on agriculture as their primary source of income, making it the single largest employment in the world. One strategy that might increase yields, lessen sensitivity to shifting rainfall patterns, and permit diverse farming strategies is irrigation. As a result, irrigation is frequently viewed as the catalyst for rural development, revenue generation, job creation, and assistance in ensuring food security. A crucial component of irrigation services is energy. Due to falling SPIS investment costs and the implementation of SPIS subsidy schemes, solar technologies are starting to be a viable solution for both large-scale and small-scale farmers. SPIS provide stable and affordable electricity, perhaps reducing irrigation energy costs. Due to the rapid growth of SPIS, there is a chance to not only introduce clean, climate-smart, and creative energy technology, but also to strategically consider how this technology can be used to promote more feasible use of groundwater resources, to develop inclusive financial and management structures, and to promote more integrated thinking about solutions pertaining to the water-energy-food nexus [1].

LITERATURE REVEIW

Pakistan is on the list of countries with a shortage of water, this is one of the biggest issues they face. The current issue of irrigation water shortages will have a significant impact on the growth of crops that require a lot of water, such as rice and sugarcane More than a million water pumps are operational in the Punjab, of which roughly 750,000 use diesel-powered engines and about 70,000 use grid electricity .However, the country's acute energy crisis has compelled farmers and academics to hunt for other sources of energy for agricultural irrigation due to the rising cost of fuel and erratic grid electricity. Although solar irrigation systems provide a possible replacement for diesel-powered tube wells, Pakistan has had significant difficulties in implementing this technology on a large scale. Farmers are unable to invest in solar energy on the one hand because of the high initial costs and the inferior discharge capacity of solar pumps to those fueled by diesel. Second, rather of using piped flows of high-efficiency irrigation systems, more than 90% of Pakistan's irrigation is done by flood irrigation (HEIS).

The majority of farmers are not ready to switch from flood irrigation to HEIS practices, despite attempts by provincial governments to encourage solar through HEIS (Higher Efficiency Irrigation System). Pakistan's national water usage grew by 20% over the previous 33 years, from 153.4 billion cubic meters (BCM) in 1975 to 183.5 BCM in 2008. On the other side, there has been a 156% rise in population. Due to the growing disparity between supply (water availability) and demand (increasing population), the water shortage has gotten worse over the past three decades. The private sector in Pakistan has been instrumental in advancing SIPs. Only majority of the farmers could be able to invest in SIPs since there were so few subsidy programs for them, which were again offered by the private sector. Large-scale farmers who utilized their finances constituted the bulk of farmers who used SIPs. These farmers have acquired large-sized SIPs that are more than 5 HP due to their extensive landholdings (> 10 ha) and deep-water tables (> 25 meters in areas where SIPs have been placed). Although the cost of these systems ranges from USD 9,000 to 20,000, recent years have seen a sharp decline in pricing [2].

DESIGN PROBLEM

The goal of designing a solar-powered irrigation system is to efficiently satisfy the anticipated water need by carefully choosing each system component. A thorough understanding of electrical circuitry, pipe hydraulic systems, crop water demand timing, and current market data are essential for effective system design. Below is a step-by-step, straightforward technique that practitioners may use to support the design process. The process for developing both small- and large-scale solar irrigation systems will largely stay the same. The peak water requirements can be used as the design criterion for solar-powered irrigation systems, as has been done in this research, or the lowest solar energy availability in a year, which will ensure that peak water demands are met when solar energy availability is also at its highest. Both will yield comparable results, but generally speaking, a peak water requirement-based strategy is simpler to implement [3].

A. Determine the peak water Requirement

Estimating the water demand is the first stage in the design process. The design and cost of the solar system will be determined by the water need calculation; thus, it must be done carefully. The magnitude and planned usage of the use will also affect the water consumption. For instance, if a crop field has to be irrigated by a solar system, the amount of water needed will depend on the crop and the size of the area (and in turn crop water requirements). The kind and quantity of animals in the herd, as well as the peak water needs of each animal, known if a solar pumping system is to be created for feeding cattle.

B. Assess the Water Source

The next stage is to determine where the needed water will be obtained by solar pumping, including whether it must be drawn from groundwater or from bodies of surface water such as ponds, mini-dams, streams, etc. Typically, a submersible (positive displacement) pump is needed to pump water from a well. The use of a surface pump (diaphragm, centrifugal, etc.) is an option if the water needs to be pumped from a surface source and the pump site is close to the source [5].

C. Determine System Layout

The full solar pumping system should be laid out. Locate the water source, PV array, pumping unit, pipe routes, and distribution places with pinpoint accuracy on a map (Figure 11). The ownership of the pipe lines, water supply, and property must be established. Make a cross section using the following locations and elevations: water supply Pump together with all of its specifications? PV solar panels with all of their details? Considering their size and location, what are storage tanks? Points of water consumption (risers placed in key areas) paths for pipeline key areas with pressure gauges to monitor pump performance.

D. PV Panel Location and Peak Solar Hours

The best solar panels operate in direct sunshine. They should be placed with the majority of their surface perpendicular to the sun's beams. The only thing to add to what has already been said is that the PV panel position should be as close to the pumping unit as is practical and shade-free. Its position must also take into account security against theft and damage.

Figure 1

A sample layout of typical solar-powered pumping system from www.shutterstock.com

Peak solar hours are when incident solar radiation is expected to be 2 available at 1000 watts per meter. Calculating these peak solar hours, which differ from sunlight hours in that they are obtained by summing the total daily radiation received for each hour and then dividing by 1000.

E. Pump Selection and Power Estimation

Once the planned flow rate has been calculated and the TDH has been determined, the pumping unit may be chosen using various pumping curves or tables that the pump manufacturers give. The example pump selection table and pumping curves are shown below to help with choosing the right pump and determining how much power it needs using TDH and intended flow rate values.

E. PV Panel Selection and Configurations

Once the pump's power requirements have been established, a PV solar panel and its size (i.e., array) may be chosen to supply the chosen pump. Peak Wattage is the wattage used to rate solar panels (Wp). Generally, it is a good idea to 20% oversize the PV panel array to allow for system mechanical and electrical losses. If a sprinkler cleaner/cooler is not installed, the PV panel array should be increased by an additional 25–30% owing to the effects of temperature and dirt.

PPOTENTIAL BENEFITS OF SOLAR-POWERED IRRIGATION SYSTEM

The key benefits of solar-powered irrigation systems are as follows:

- Operational costs for direct usage are quite low.
- Easier to use and maintain than the standard method.
- Mechanisms for pumping gasoline
- Flexibility of using batteries or direct coupling for irrigation applications
- Daily unbroken pumping for five to ten hours is feasible.
- Suitable for rainfed and isolated watersheds
- Extended working life
- Able can be linked effectively with various drip, bubbler, micro sprinklers, and rain guns
- Possibility of multiple applications on a farm (with sophisticated circuitry, irrigation and agricultural electrification are both conceivable from the same investment in PV panels).
- Due to minimal emissions of greenhouse gases during the irrigation process, it helps to stabilize the climate.
- Pumping system that adapts to the weather (higher flows during the summer when water requirements are likewise high, and vice versa for the winter

CONCLUSION

It is concluded from the above discussion that the number of tube wells in the nation rose from 0.71 million in 2001–2002 to 1.32 million in 2013–2014, representing an average annual growth rate of roughly 4.9%. Also, the Total tube well installations by province indicates that Punjab accounted for 78% of them in 2013–14, followed by Sindh (17.5%), Baluchistan (3.2%), and Khyber Pakhtunkhwa (1.2%).20% of Pakistan's land is irrigated by tube wells, while 44% is watered using canals and tube wells together. Baluchistan has the highest proportion of land that is irrigated by tube wells (38%), followed by Sindh (21%), Punjab (20%), and Khyber Pakhtunkhwa (12%), even though Punjab has the most agricultural land.

The management of groundwater has become more challenging as a result of the speed at which it has being used. Their behavior is quite dynamic when it comes to using groundwater. Farmers know nothing about any potentially harmful interactions that may arise from the irregular and inconsistent nature of groundwater pumping. Their main concern is increasing water pumping to satisfy the increasing crop water needs. Due to minimal emissions of greenhouse gases during the irrigation process, it helps to stabilize the climate.

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OUR ACHIEVEMENTS

UETRV_ PCORE

An SoC design

Features

- 32-bit RISC-V ISA core that supports base integer (I) and multiplication and division (M), atomic (A) and Zicsr (Z) extensions (RV32IMAZicsr).
- The M-extension is implemented as a coprocessor.
- Memory-management-unit (MMU) module is shared by instruction and data memory (alternatively called load-store-unit (LSU)) interfaces of the pipeline.
- MMU has shared Page-table-walker (PTW) and there are separate TLBs (translation look aside buffers) for instruction and data memory interfaces.
- A-extension is implemented as part of the LSU module.
- Supports user, supervisor and machine mode privilege levels.
- Support for instruction / data (writeback) caches.
- Sv32 based MMU support and is capable of running Linux.
- Cache sizes and TLB entries are configurable.
- Intergated PLIC, CLINT, uart, spi peripherals.
- Uses RISOF framework to run architecture compatibility tests.

A BREAKTHROUGH LINUX BOOTABLE RISC-V SOC PRESENTED TO THE OPEN SOURCE COMMUNITY BY UET'S ELECTRICAL ENGINEERING DEPARTMENT

The Department of Electrical Engineering at UET is proud to unveil UETRV_Pcore, a RISC-V (RV) processor based Linux bootable System-on-Chip (SoC) that has made its mark in the open-source community, led by Dr. Muhammad Tahir and a team consisting of Mr. Ali Imran, Mr. Abdul Wadood, Mr. Usama Zubair, Ms. Shehzeen Malik, and Mr. Umer Shahid. UETRV_Pcore enables Linux booting with minimalistic requirements, unlocking new possibilities for resource efficient computing for diverse embedded applications. Building upon their past successes with the SermoSoC and UETRV-ESoC projects, UETRV_Pcore further solidifies the department's commitment to research and innovation in the field of advanced computing systems. UETRV_Pcore is a RISC-V based application class SoC, integrating a 5-stage pipelined processor, memory, and peripherals

DESIGN

UETRV_Pcore harnesses the power of the widely acclaimed open-source RISC-V instruction set architecture (ISA), showcasing the department's pioneering achievement. At its core lies a 5-stage pipelined RISC-V processor, supported by a robust memory subsystem and a range of integrated peripherals. UETRV_Pcore leverages the RV32IMAZicsr Instruction Set Architecture (ISA) based on User-level ISA Version 2.0 and Privileged Architecture Version 1.11, operating seamlessly in M/S/U modes. Fig 1 is showing its simplified block diagram.

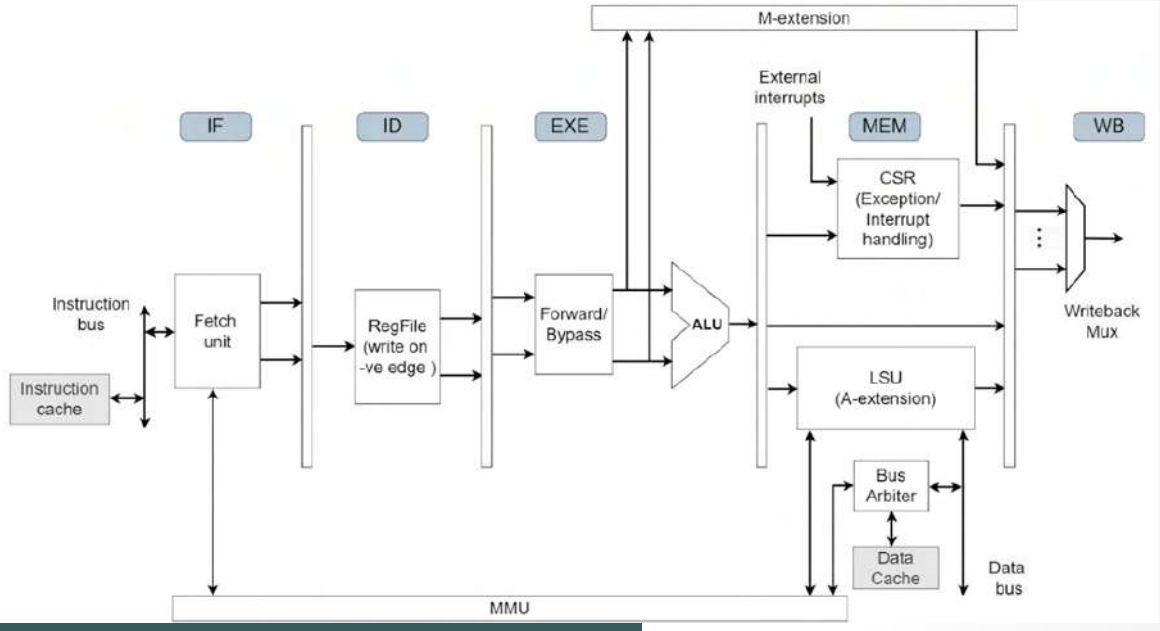


Figure 1. A Simplified block diagram of UETRV_Pcore

BOOTING LINUX WITH MINIMUM RESOURCES

UETRV_Pcore's groundbreaking feature lies in its ability to boot the Linux operating system using minimal hardware resources. Through meticulous optimization and resource allocation, the SoC ensures a smooth boot process. The bootloaders and firmware have been developed to comply with open-source standards, facilitating collaboration and customization. Memory initialization, device tree configuration, and kernel execution have all been fine-tuned to maximize efficiency and enable Linux operation on resource-constrained systems.

EMBRACING THE OPEN-SOURCE COMMUNITY

Recognizing the power of open-source collaboration, UETRV_Pcore has been presented to the open-source community. By embracing open-source principles, UET invites contributions, feedback, and innovation from a global network of developers, researchers, and enthusiasts. The SoC's design files, documentation, and associated software tools are made freely available, fostering transparency, knowledge sharing, and continuous improvement.

POTENTIAL APPLICATIONS AND USE CASES

UETRV_Pcore holds immense potential in resource-constrained systems and Internet of Things (IoT) devices. By leveraging its resource efficiency and integration capabilities, the SoC enables advanced edge computing applications. The open-source community can explore and contribute to the development of tailored solutions, expanding the horizons of intelligent and connected devices.

PERFORMANCE AND FUTURE ENHANCEMENTS

UETRV_Pcore has undergone rigorous performance evaluations, showcasing its resource utilization, benchmarking against alternative architectures, and power efficiency considerations. The results highlight its exceptional performance within the constraints of minimal hardware resources. UET's team, in collaboration with the open-source community, will be actively working on future enhancements, including additional ISA support, specialized accelerators, and enhanced security features.

CONCLUSION

UETRV_Pcore's presentation to the open-source community marks a significant achievement for the Department of Electrical Engineering at UET. By embracing open-source principles, UET invites collaboration and innovation, shaping the future of resource-efficient computing. UETRV_Pcore's Linux bootable capability with minimal hardware resources positions it as a pioneering solution, offering immense possibilities for energy-efficient computing and driving advancements in IoT and edge computing. By sharing the core's comprehensive design, hardware implementations, and software adaptations, the department aims to nurture collaboration, drive innovation, and contribute to the growth of the RISC-V ecosystem.

POWER QUALITY ISSUES DUE TO INVERTERS / CONVERTERS USED IN RENEWABLE GENERATION SOURCES

ABSTRACT

Renewable energy resources are environment friendly but their integration with power systems poses several operational challenges such as power system instability, reliability, power quality, and protection. Power Quality is one of the major issues with the integration of renewable energy. Considering the converters, inverters, and power electronics equipment used in renewable energy resources, power quality is affected due to harmonic distortion, commutation failure, switching losses, and many more. Power quality control is essential for the sustainable, reliable, and normal operation of our power system. This article introduces the various power quality issues due to converters and inverters in Renewable energy resources.

INTRODUCTION

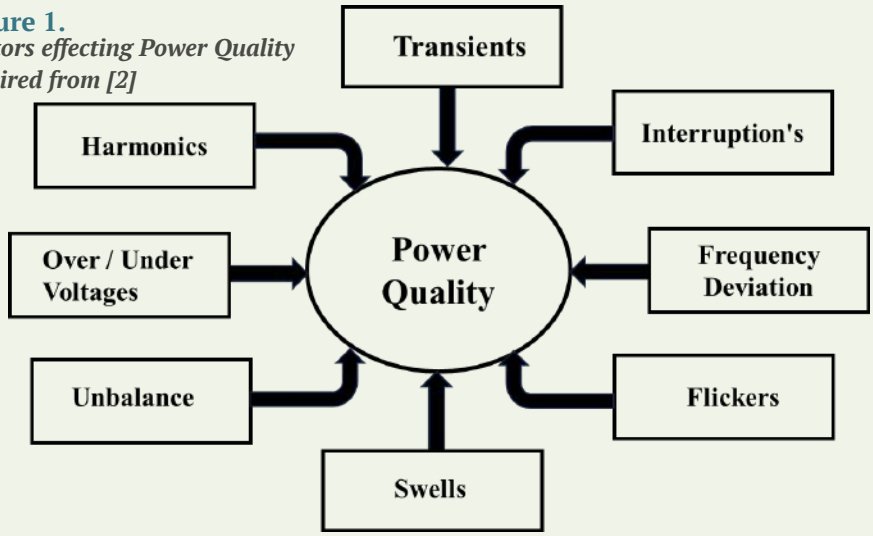
The key focus of the current research in the world is to decarbonize the power system. For the De-carbonization of power systems, renewable energy generation resources (green energy resources) are preferred over non-renewable energy generation resources. Due to the high penetration of renewable energy resources, the power flow is changed from uni-directional to bi-directional. Due to bi-directional power flow, many challenges are raised regarding power quality due to converters and inverters.

Power Quality aspects are frequency, voltage dip, voltage swell, stability, transient voltage variations, transient currents, commutation failure, harmonic distortion, etc The typical issues with power quality are listed in Figure 1. To generalize, power quality issues cover many power system problems like impulsive and oscillatory transients, different types of interruptions, voltage sags and swells, imbalance, under and over voltages, notching, noise, harmonics and inter harmonics, voltage fluctuations and flickers, and power frequency variations [1].

LITERATURE REVEIW

In [3] presents an adaptive overcurrent protection scheme with high penetration of renewable-based distributed energy resources. In [4] issues and control aspects of renewable-based distributed energy resources for meeting power system needs and connecting distributed energy sources are discussed. The power system's power quality, which emphasizes significant power quality concerns like flicker, voltage drop, etc., can be improved by enhancing the local grid's power quality [5]. The numerous power quality concerns in wind energy and came to the result that advances in power electronics, which result in quick switching devices with reduced losses, can improve wind power quality. This study also underlines the benefits of adopting smart grid technology to improve wind power quality [6]. A comparison of modelling, simulation, and testing for the voltage and different waveforms from a DC/AC converter in renewable energy systems is presented

Figure 1.
Factors effecting Power Quality inspired from [2]



in [7]. In this article presents various power quality issues due to converters and inverters due to renewable energy resources.

POWER QUALITY ISSUES

For effective power quality, the inverters (DC/AC) used in renewable energy systems have to generate a waveform that is close to the waveform of the distribution grid of our existing power system. How much the inverter waveform is close to the sinusoidal waveform of the distribution grid, the less will be the total harmonic distortion and the power quality of our system can be improved. To generate the desired waveform, such an inverter topology is for users that can generate a high number of voltage levels using minimum power electronics switches (MOSFETs/IGBTs, etc).

Power quality can be made effective by controlling commutation failure as it is one of the major issues in power electronics converters. Thyristors used in converters are not self-commutated means once thyristors are on, they cannot be turned off unless the external load is attached which forces the DC to go to zero.

Due to Distributed generation, control equipment at the local end and two-way communication between local end generation and centralized generation are very important. The frequency of the system is inversely related to the active power. For effective power quality, the frequency of the power system should be maintained at 50 Hz. So, adjustment of our local and centralized generation according to changing loads can only be possible with effective two-way communication between local and centralized end generation.

. Due to rejection and injection of load, transient voltages also appear. It is also one of the major issues of power system quality. These are the high voltages for a short duration that can damage our power system's equipment. The level of voltage surges can be decreased by effective and timely control of generation according to varying loads. For effective power quality, the protection scheme used should be able to set protective relaying parameters based on point of common coupling (PPC) information

CONCLUSION

The key issues regarding power quality are discussed in this article. These key issues are harmonic distortion, commutation failure, switching losses, changes in frequency due to load variations, voltage fluctuation, system stability, transient voltage variations, etc. These issues can be addressed by fast switching components with fewer losses, effective bi-directional communication between centralized and de-centralized generation, integrating various smart grid technologies, mitigation methods by the use of various power electronics devices, FACT devices to compensate reactive power and voltage flick compensation and active filters.

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Government of Pakistan is working to improve the state of the country's electrical supply network. The government has launched a number of initiatives, including the China-Pakistan Economic Corridor (CPEC), which comprises a number of energy projects, including the construction of new power plants and transmission lines. For more information https://power.gov.pk/

ELECTRIC VEHICLES POTENTIAL AND CHALLENGES IN PAKISTAN

ABSTRACT

In 2022, Pakistan's first-place ranking in the international Air Quality Index (AQI) Ranking (Lahore with 434 US-AQI) has made it unavoidable to turn dramatically towards the world's top 100 climate change solutions. Among these alternatives, "usage of electric cars" is one of the most effective and relevant. On the other hand, Pakistan's economic rating by the World Bank in terms of GDP (Gross Domestic Product) per capita of 140/213 makes it difficult to implement this life-saving prescription. This article will discuss some of the components of this difficulty. Acceptance of EVs (Electric Vehicles) on a broad scale in Pakistan would result in the alleviation of several key concerns such as pollution from carbon emissions, reliance on fuel sources such as petroleum and diesel, and so on, as well as the well-being or prosperity of the economy. However, Pakistan has encountered several climate change issues, which have resulted in several diseases posing a concern for the public, hence Pakistan has opted to move the public transportation of ICEs (Like Combustion Engine, Fuel Tanks, and Exhaust Systems) to EVs (Concerned with Electric Motors, Packs of the batteries like lithium-ion & converters or along with inverters) together with the many policy alternatives not only with customers but also with global stakeholders, and the primary issue with car makers.

INTRODUCTION

The dream of electric vehicles commercial business within a year by Henry Ford and Thomas Edison was hijacked by internal combustion engine vehicles. Acceptance of EVs (Electric Vehicles) on a large scale in Pakistan will result in reduced pollution, dependency on fossil fuels, and economic success. In today's world, there are many environmental issues because the ICE's resources are extensively responsible for climate change as well as environmental damage due to the release of dangerous chemicals.

Among the top pollution ratings in the world, Lahore ranks first in terms of pollution, with 109ug/m3 (It indicates that one cubic meter of air has 109ug of pollutants). In Pakistan's solution, the government takes efforts to decarbonize the transportation sector by expanding the vehicle industry to take a friendly step in the solution of the good environment.

As researchers discover new techniques for the future to reduce our reliance on fossil fuels, EVs are being established to reduce the emission of harmful gases and alternatively provide us with a friendly environment, particularly in the transportation sector, and one of the most prominent examples in Lahore, Pakistan is the Orange Line Train, which is not only environmentally friendly but also financially beneficial because it runs on electricity. EVs are usually powered by batteries, however, some hybrid vehicles are powered by both ICEs and batteries [1].

EVs can go roughly 500km on a single charge, but the primary difficulty is charging it again in a short period, which now takes approximately 35 hours, but this issue will be resolved shortly by the changeable battery function[2].

- It is vital to take efforts toward EV deployment in Pakistan. After comparing EVs to FFVs, we can observe which is more helpful from an economic standpoint in Table 1. There are four types of EVs available:
- BEVs (Battery Electric Vehicles), which rely on batteries based on capacity and distance covered.
- FCEVs (Fuel Cell Electric Vehicles), have zero emissions that rely solely on the H2 and O2 existing in the air and function based on the chemical reactions of the cells (Fuel cells) and motors driven by these substances.
- HEVs (Hybrid Electric Vehicles), which rely on both the ICEs and the battery packs too named mostly hybrid.
- In terms of range, PHEVs (Plug-in Hybrid Electric Vehicles) rely on a battery pack stack.

while ICEs rely on a battery pack stack as well. According to an economic study, Pakistan's transportation system consumed 47% of imported liquid fuels, while the power generating sector used just 23% as of today, and this trend is expected to continue.

This report provides a comprehensive overview of EV development and investigates some of Pakistan's main challenges and adaptation potential.

The following are the key contributions of this paper. The impact of GHG (Green-House Gases) emissions on the environment, humans, and the domestic economy, is detailed in the preceding section. Obstacles that are impeding the adoption of EVs in Pakistan. Future growth of EVs in Pakistan in terms of prospects and potential in terms of a suitable environment and economic development.

This article will inform you about the advantages and disadvantages of adopting electric vehicles in Pakistan, as well as their maturation and chances. Concerning the hurdles or challenges with Electric Vehicles There are certain substantial societal barriers in front of EVs in terms of adoption in Pakistan to penetrate the current market, including financial incentives, market price, and technological flaws. Similarly, the recommendations in parallel to the hurdles merely promote the growth of the EV sector to provide a stable future and the betterment of the environment.

CHALLENGES IN EVS IMPLEMENTATION

This article's section will address some of the major barriers to EV implementation in Pakistan. We can say that for the integration of EVs at a low cost, not only investors and businesses but also government officials, should take solid steps to implement these things

Table 1.

Comparison of FFVs and EVs with the assumption of 0.5 million EV cars on the road [3]

FFV	EV
Fuel Consumption (0.96 billion liters/year)	Power requirements (670 MW)
Carbon Emission (2.2 billion kg/year)	Monetary Savings (0.169 billion dollar)
	Fuel Savings (0.688 billion liters/year)
	Emissions avoided (1.47 billion kg/year of carbon)

things and overcome the barriers that EVs implementation is facing, with government officials playing a major role in encouraging customers and producers. The following are the main obstacles to EV adoption

A. Subsidies for Capital and Taxes

Throughout the study, it is clear to everyone that the capital expenditures for FFVs (Flexible fuel vehicles) cars are nearly twice, or that the first investment is tough, while the operating expenses are roughly a third of those of the FFVs. For automobile components imports, there is presently no visible distinction between CBU (Complete Built-Up), SKD (Semi Knocked Down) and CKD (Completely Knocked Down) (terms referring to the manufacture of the car or other vehicle taxation).

As a consequence of all of these taxation terms, taxes and customs on EVs can be reduced by a total of 4-5%, practically lowering capital expenses to an ideal cost. As a consequence, the government will take action to ease CBU imports, and the EV producer will be given full assistance in the CKD components for the importation of EV components and the localization of EVs in Pakistan[5].

Furthermore, the governments, including the federal and local governments, will reduce the registrations and taxes on EVs for the betterment of the environment by promoting the EVs by replacing the FFVs on the roads, through the government can overcome the market failure and the level of the EVs will be retained like the other vehicles or went towards the improvement as consumers will move towards the EVs instead of the FFVs. Most countries have already offered incentives for the adoption of EVs to encourage customers to buy and use them.

B. Policy on Charging Infrastructure

Including EV charging stations at every acceptable distance along roads and highways is a crucial step toward capital expenditure in charging stations for Pakistan's expanding EV usage. It is challenging to deploy intelligence-based metering infrastructure to better handle the complete system, combining power level monitoring with a reliable system of billing for governance improvement. Furthermore, more options with different chargers, enjoy the numerous charging port options, including slow and fast ones for different uses but for the same product with different charging speeds, are required at each station to properly utilize charging stations. Users may profit from the

Table 2.

Across various sectors the emission of the GHG, taken from [4]

Sector	Emissions (%age)
Commercial	2.84%
Agriculture	5.16%
Fugitive	8%
Transport	22.69%
Manufacturing	22.93%
Electricity	28.67%

advantages of sluggish charging ports at lower speeds without the need to hustle; Customers who are short on time will profit from quick charging ports, which require more energy to buy a replacement and take fewer hours to accomplish. Additional investment is required to avoid the development of charging stations on the markets[6].

C. EVs pricing policy

Economic incentives, such as tax exemptions or excise fees, have emerged as a key strategy for decreasing EV beginning prices and promoting technological progress. Despite these potential advantages, In Pakistan, the upfront cost of EVs is considerably more than that of FFVs with the same engine power, indicating that various buyers are reluctant to spend to develop a great market. Additionally, EVs are insanely expensive and a barrier to revenue management owing to technological restrictions and growing battery prices

The Republican Establishment has said that EV importation will be taxed at 1-2% of the standard sales tax, although such policies may benefit primarily manufacturers and the wealthiest 1-2% of the community. Such constraints have minimal impact on the Adoption of electric vehicles in Pakistan, and the government's target of having to replace FFVs with EVs by 2025 might not be met by the end of the year[7].

OPPORTUNITIES/POTENTIAL FOR EVS IMPLEMENTATION

The implementation of electric vehicles has already made it easier to replace the vehicles and the respective systems, such as the power system, while at the same term considering the future of the transportation system as beneficial not only for the people but also for the environment, as in the future the system and the charging facilities will be improved, enhancing the efficiencies of charging and decreasing respectively the time regarding charging. Finally, as a consequence of the significant expansion of consumers, suppliers, state agencies, and stakeholders, government planners feel that EVs will be advantageous to both customers and company holders.

A. Economic development authority

Economic development continues to support the ever-increasing factors in public, ranging from the health of the public to the employees as well as the education and the industrial sectors too just by thinking for the quality-of-life improvements. EV adaptations, like any new technological technology, may open up a slew of exciting economic options for Pakistan. As a result, limiting transitory effects and maximizing the positives of interconnected growth necessitates a creative and credible strategy. This section provides a brief overview of the probable economic advantages of the Adoption of electric vehicles in Pakistan.

B. Increased Employment Prospects

Many individuals in Pakistan are today unemployed, despite their education, which is a huge macroeconomic worry. The widespread usage of EVs is expected to increase competition for existing and new jobs, with batteries and chargers making driving job development.

The NREL (National Renewable Energy Laboratory) estimates that developments in Energy efficient technologies will generate over 1 million new jobs per year. In India, the Ministry of creating skills and Development is striving to produce performance and productivity for the EV industry[2]. It necessitates the establishment of capable and qualified personnel with an extensive understanding of battery, advertising, delivery, and EV system architectures. Yet AIE (Asset Integrity Engineering) thinks that a shift to electric vehicles might produce in twice quite so many additional job possibilities.

C. Reduce Fossil Fuel Dependency

The transportation industry in Pakistan is now primarily reliant on hydrocarbon fuels, the vast bulk of which are transported from bordering countries. A poll found that more than 13.3 $ dollars are spent annually on imported oil, which is expected to rise by roughly 30.7 billion $ by 2025 in the normal condition of the economy [8]. Fuel prices are not permanent, but are prone to significant rising prices, which not only raises the annual cost of imported goods but also has significant implications for such transport and electricity sectors. The majority of governments have reduced their consumption of fossil fuels by adopting Electric vehicle technology.

D. Possibility of industry growth

Because it contributes to developing technology, lowers unemployment and inflation, and enhances export commerce, the industry is considered the core of a government's economic success. Nations at the top of the trade chain have outstanding industrialization, high-tech innovation, and environmental assets. China has seen extraordinary prosperity in recent decades, reducing hurdles to a major economic slump and making it a worldwide manufacturing and export engine. The automobile sector is one of the speediest in Pakistan, with a 7-8 % CAGR in the Asia-Pacific area and is estimated to reach 11 billion $ by the end of 2025 [9]. Both lawmakers and producers must acknowledge that electric vehicles (EVs) are the destiny of the transportation system so that the realistic solution to launching them is considerably more effective and reasonable than depending just on the legal system.

E. Environmental sustainability opportunity

The demand for environmental sustainability has heightened international concern about climate change. Human activity greatly increases overall GHG emissions such as CO2, as technical and societal advances have a big effect on climate change. From 1970 to 2004, human-induced GHG emissions increased the most, notably from the energy, industry, and transportation sectors. Pakistan's transportation industry is also the most dangerous to the country's ecology since several significant cities have been designated as among the most polluted in the world. The negligible emission of toxic chemical technology saves major health consequences, prevents the greenhouse effect, and, most critically, reduces the expenses of environmental issues.

CONCLUSION

The issues of rapid decarbonization, especially considering how quickly electrifying public transportation may help mitigate climate change. As a consequence, a practical and realistic approach must be followed to reduce CO2 emissions while simultaneously enjoying and leveraging the tangible opportunities of rapid developments in EVs. This research provides a summary of the current Development of suitable and tackles several critical obstacles and potential adjustments. Government policy influences the progress of the automobile industry: various policies result in different techniques and industry performance; subsidies, for

example, have an impact on industrial growth. Another major source of worry in developing countries is the lack of technological capabilities, market knowledge, and skill in analysing and assessing the economic benefits and downsides of EVs and ICEs.

In conclusion, the government must unite companies and organizations to raise awareness of electric vehicles (EVs) through various programs and endowment scholarships for other nations. Reduced exploration expenses will aid in the adoption of vast EV systems, which will provide a variety of rentable options, including commercialization, environment protection development, and most importantly, the vitality of advancement in the field of advanced technology. If diversified corporate growth is to boost Pakistan's economy while also providing considerable financial rewards to automakers, this operation should not be delayed any longer.

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DEMAND SIDE MANAGEMENT CONCEPTS, AND FEATURES

ABSTRACT

With the increase in global population, the demand for electricity is continuously increasing day by day. With this increase in demand, electric utilities must generate more electricity to provide an uninterruptible supply to consumers. This causes an increased burden of installing and commissioning new generation sources. In modern power systems, a new concept of Demand side management has been introduced by which the loads present on the consumer side can be managed using different DSM techniques instead of increasing generation on the source side. The main goal of Demand side management is to modify the daily load curve by using techniques such as shifting loads to off-peak hours and equalizing the consumption of electricity over 24 hours. To accomplish this, we need smart metering and digital communication networks for bidirectional data transmission between utilities and consumers. To help enthusiasts of smart grid concepts, this article presents the concepts of Demand side management and also discusses different techniques used in Demand side management, in a short collection, inspired by different literature available.

INTRODUCTION

Demand-side management plays an important role in the smooth functioning of power systems. Modifying the load curve is generally based on four strategies: Energy efficiency, Time of use, Spinning reserve, and demand response. Demand response programs were introduced to temporarily reduce the load for a specific period. These programs are categorized as Incentive based, Time-based, and Demand reduction bids. DSM can be achieved by valley filling, peak clipping, load shifting, load reduction, load growth, and flexible load shaping. The hybrid WAOSCA algorithm can be used for electricity market pricing problems and the economic impact of grid contribution on a microgrid system [1]. Energy internet (EI) integrated with the smart grid is an emerging technology that enables the smart grid's cyber security, data monitoring, and demand response management [2].

Energy management systems (EMS) allow residential customers to monitor, analyze and decide the switching of load using sensory data. The prime focus of EMS is the improvement of consumer load patterns or reduction of peak load through automated demand response. An energy information system (ESI) is a gateway between the utility and the end user energy management system. It is used for the exchange of energy-related data.

A smart thermostat is a device that can be controlled remotely to operate load at desired temperatures. Usually, these thermostats are coupled with proximity sensors, motion detectors, and some machine learning algorithms to help devices in order to adapt the temperature and other environmental conditions defined by the consumer.

A smart grid is defined as a combination of sensors equipped with modern technology in the power system. The security of the power system is very important for its smooth operation. Recently, A classifier based on an Adaptive Deep neural network along with a squirrel search algorithm has been developed that can classify the intrusion or dishonest entities within the system and helps in the operation of priority load [3].

Optimum residential demand-side management can be achieved using fuzzy logic. Due to the deterministic nature of Fuzzy logic, it can be applied to control load and help in load-shifting peak reduction.

Research has focused on designing a DSM controller based on the oppositional slime mould algorithm (OSMA). Evaluation of DSM controllers based on different algorithms comparison has revealed that the OSMA has enhanced the optimization capability of SMA [4].

BREIF REVIEW OF DSM TECHNIQUE

A. Night time heating with load switching

Demand-side control strategies such as electric night heating can be employed to good advantage. The utility creates the tariff in a way that promotes the customers' usage of night storage heaters. This, in turn, raises the load at night and aids in obtaining a load curve that is balanced over 24 hours.

B. Direct Load Control

Demand-side management's direct load control technique uses loads that can be turned on and off for brief periods. The most often used loads are water heaters and air conditioners. A communication path is built between the utility and direct control loads through radio signals or power cables. Directly controlled loads can be enabled or disabled by utilities for a brief length of time. Low power costs are given to users who participate in direct load control programs [5].

C. Load Limiters

Individual consumers' use of power within a specific time period can be restricted using load limiters. The restrictions are adjusted at that specific time based on system conditions. Additionally, this method gives users an option over which load to use and which to turn off [5].

D. Frequency regulation

The balance between generation and demand is crucial to keep the system frequency within permitted limits in power systems. Asymmetry between these two will lead to over or under-frequency, which is bad for system stability and may cause it to crash. Frequency regulation is employed in this DSM technique to maintain the system's frequency. It will signal loads to turn off so that frequency can be restored to its initial constant value if there is a loss of generation from the source side and frequency dips somewhat. Aluminum smelters are one example of a large industrial customer that takes part in this activity [5].

E. Time-of-use pricing

Time of usage (ToU) pricing is a DSM strategy created by utilities to charge customers based on when they use power, such as during peak or off-peak hours. Peak usage times typically have higher rates than off-peak times. This encourages customers to utilize their high loads at off-peak times, which helps to ensure consistent daily electricity use. This strategy is commonly utilized in Europe to persuade people to use electric heaters during non-peak times in places where electric heating is used [5]. Pakistan has implemented ToU pricing to encourage energy saving and load control. With higher prices during peak hours and reduced rates during off-peak hours, these tariffs change depending on the time of day

For more details on the policy and tariffs, interested readers can visit the website of NEPRA.
https://www.nepra.org.pk/

F. Smart Metering and Real-time pricing

Smart meters are a key DSM approach for real-time pricing. This method uses bidirectional smart meters to show the users the real-time cost of the electricity being utilized at a specific moment. For instance, the cost of electricity consumption per unit will be higher under peak load conditions than during off-peak times. Customers will be compelled to reduce their electricity usage when the tariff rates are high as a result. This is feasible only with the installation of smart meters and communication infrastructure on the remises of consumers and utilities. LAN and WAN communication protocols are typically used to transmit bidirectional data between utilities and customers in real-time.

A home energy management system that can efficiently control the house load in accordance with real-time tariffs must also be installed in the consumer's premises to apply this strategy [5]. The regulatory body in charge of policing Pakistan's electricity industry is called NEPRA. Power distribution companies (DISCOs) must install smart meters, according to legislation they have made regarding smart metering.

CONCEPTS OF DEMAND SIDE MANAGEMENT

Demand side management is the planning, implementation, and monitoring of utility activities for the distribution network intended to affect customer electricity consumption in ways that would create desirable changes in the load shape [6]. The three key strategies are given below:

- Energy Efficiency
- Spinning Reserve
- Demand Response

A. Energy Efficiency (EE)

Through the application of energy efficiency improvement techniques, the major objective of these adjustments is to lower the load profile at the device level. This energy efficiency translates to the results achieved by supplying more output power for every unit of power given as an input to the appliance, always leading to a reduction in consumption rather than focusing on an event-driven strategy for load reduction [7].

B. Spinning Reserve

The spinning reserve is the backup power that is available to the electric grid system and can be used by the distribution network operator (DNO) to balance the difference or deficit between demand and generation in the event of a sudden drop in generation evels. Unexpected damage to the generating units, incorrect load projection, and dispatching schedules can all lead to an interruption in the delivery of electricity.

C. Demand Response

According to the definition of demand response (DR), it is "End-user customers' deviations from their typical patterns of consumption in reaction to

variations in electricity pricing over time or to incentive payments intended to encourage less use of power during periods of high wholesale market prices or when system dependability is in jeopardy." [8].

CONCLUSION

In this article, different concepts and techniques used in demand-side management have been presented in a concise form for the learning enthusiast of smart grids. DSM has the potential to provide several benefits, i.e., economic, system reliability & environmental. Economically, it can help by avoiding large investments in installing new power plants for increasing demand. It helps in increasing system stability by avoiding emergencies and blackouts. DSM can also help to save our environment by reducing the burden on thermal power plants (which emit greenhouse gases) and increasing the role of renewable and distributed generation in the system.

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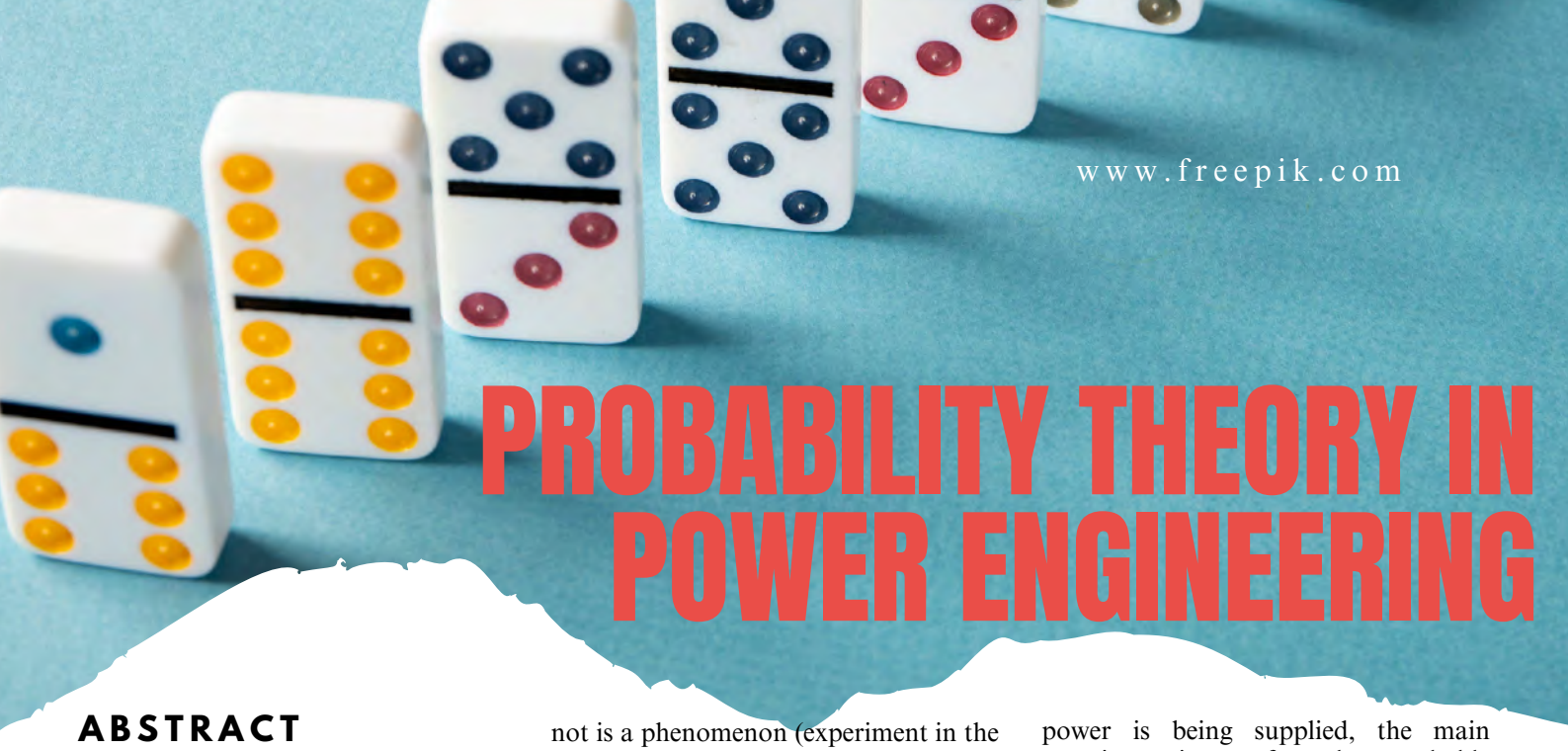

PROBABILITY THEORY IN POWER ENGINEERING

ABSTRACT

Many students of engineering, especially electrical engineering, find the intensive applied mathematics courses difficult to learn, especially the course in applied probability theory. Their feeling it difficult naturally lead their minds to questions of sort – why we are studying this course in our undergraduate or graduate engineering program. Being a more than ten years experienced teacher in electrical engineering and being an applied mathematics researcher, I have realized that the students find the probability theory course not interesting because they do not get sufficient insight on where and why this subject is applied in their domain of specialty in electrical engineering. Especially, the power engineering students don't get much insight into the application of probability theory during their undergraduate level, though there are numerous applications of probability theory taught in the graduate level courses. This article is an attempt to introduce power engineering students to the importance of probability theory in the field of power engineering.

INTRODUCTION

Probability theory is the domain of study that deals with the phenomenon of nature having uncertainties or variabilities. Any phenomenon, or experiment, that is more inclined to invite either variability or uncertainty leads to discussing the probabilistic models, explaining or modeling those variabilities and uncertainties [1]. The experiments can be of discrete or continuous nature, for example to realize if a person will be successful or not is a phenomenon (experiment in the language of probability theory) discrete in nature whereas to gauge the wind speed behavior throughout the year at certain wind regime is an experiment of continuous nature. Power engineering deals with several problems of the form which deals with such types of experiments which are probabilistic in nature, and thus demands the understanding of probability theory. In the following section, a slight introduction to those domains is given to encourage the power engineering students to realize the importance of courses in probability theory [2].

APPLICATIONS IN POWER ENGINEERING

Probability theory has the following very important applications in the field of power engineering.

A. Reliability Analysis

Energy Power systems reliability deals with finding the probabilities of the successful operation of electrical grid, or generation, transmission or distribution levels keeping in view different factors that include the uncertain behavior of factors or parameters governing that system [3]. For example, for any uncertainty, say an occurrence of a fault, the system frequency may drop. So, under any such probable circumstances, the reliability analysis studies let us understand how different uncertainties be mathematically modelled and how the system will operate in such conditions. This helps in making the system operate robustly and reliably [3].

B. Load Forecasting

Whenever in some locality, electrical power is being supplied, the main question arises – for what probable increase in load for a number of years in future, the power will be supplied? Now, since no one has seen the future, the answer to such questions is based upon anticipations about the growth of the loads being connected to the grid on a particular locality. This anticipation is made by realizing the probabilistic trends or probability density functions of the future addition of the loads, based on the past trends of load being added to the system [4].

C. Renewable Energy Integeration

Renewable energy generation sources are usually intermittent in nature, for example wind generator is based upon changing wind profile of a particular wind regime throughout a year and solar PV generators are dependent upon the uncertain behavior of the availability of sun light on a particular site. So, naturally, if on any site of interest, before making a decision of installing a wind turbine, based on the past trends of wind profile in that area, future estimates of the wind profile is guessed in the form of wind probability density functions to first decide, which type or design or wind turbine assembly is required suitable to this wind regime and then what estimated units of electricity be generated per year by this wind turbine assembly in this area. For example, the wind profiles are often modelled using Weibull PDFs and its special case of Raileigh PDF [5].

D. Risk Assessment and Contingency Analysis

In this area of power system study, the simulations are performed by excluding

excluding some preexisting attribute of the system, to check and gauge the risks associated. For example, in a power system, by dropping or outing one transmission line to study how much load will be put on the remaining online power system [6]. Probability theory helps in modeling the mathematical form of such contingency problems in the form of probability density function of the outages of certain part of power system.

E. Optimal Power Flow and Economic Dispatch Studies

In these studies, where optimal operation of generating units and thus optimal power flow through power network are to be studied, depends a lot on the variable behavior of the load throughout the period of power system operation. The studies are usually made on the variability of load modelled by using different probability density functions. Specially, if on a grid or power system bus, a renewable generation is connected, its intermittent nature, that is modelled by some PDFs, has also an impact on the optimal power flow studies, that are then known as probabilistic optimal power flow studies [7].

F. Insulation Coordination

Insulation coordination is a branch of high voltage engineering that deals with the probabilities of the failures of an insulator under high voltage stresses. To realize if an insulator is successfully made, it is passed through certain high voltage tests. Discrete Random variables like Poisson distributions can be of interest in realizing the testing of these insulators [8].

G. Assets management

Probability theory helps in assets management and maintenance planning as aids in providing the mathematical models or PDFs of the probability of failure or decay of the asset. Therefore, it helps the maintenance staff to prioritize the assets to provide maintenance and thus helps in making the system more reliable.

CONCLUSION

The electrical engineering students commonly and power engineering student especially, need to realize the importance of the undergraduate and graduate level courses on applied probability as they gear them up with the required mathematical tools that are used in several domains and dimensions of power engineering. Since the courses taught are core in nature for all the electrical engineers, therefore, a field specific stress is not able to be provided in such core level courses. However, the students also need to try by searching the importance of such courses on their own to fuel their interest in such mathematics intensive courses.

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بِسۡمِ اللّٰہِ الرَّحۡمٰنِ الرَّحِیۡمِ

اَفَلَا یَنۡظُرُوۡنَ اِلَی الۡاِبِلِ کَیۡفَ خُلِقَتۡ ﴿۱۷﴾ وَاِلَی السَّمَآءِ
کَیۡفَ رُفِعَتۡ ﴿۱۸﴾ وَاِلَی الۡجِبَالِ کَیۡفَ نُصِبَتۡ
﴿۱۹﴾ وَاِلَی الۡاَرۡضِ کَیۡفَ سُطِحَتۡ ﴿۲۰﴾ فَذَکِّرۡ اِنَّمَاۤ
اَنۡتَ مُذَکِّرٌ ؕ ﴿۲۱﴾

Do they not ever reflect on camels—how they were ˹masterfully˺ created; and the sky—how it was raised ˹high˺; and the mountains—how they were firmly set up; and the earth—how it was levelled out?So, ˹continue to˺ remind ˹all, O Prophet˺, for your duty is only to remind.
(QS. Al-Ghashiyah : 17-21)

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