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A Review on PV- Doubly Fed Induction Generator Wind Turbine Technology

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Abstract - Wind energy conversion systems are becoming very popular these days, and wind energy generating stations use wound rotor induction machines a lot. This is because wound rotor induction machines can be used with wind turbines with variable speeds. This makes it possible to get as much energy from the wind as possible. Also, using a Doubly Fed Induction Generator (DFIG) configuration with back-to-back pulse width modulated voltage source converters (VSC) is one of the best topologies that are currently available for wind power systems with induction generators. This topology works for both systems that are connected to the grid and systems that work on their own. In this work, a quick look at all of the control schemes for both the stator side converter and the rotor side converter is given in a stator flux-oriented reference frame, and the results are compared based on cost, efficiency, power consumption, and harmonics.

Keywords V2G and G2V three -phase inverter, MPPT, BSS,solar,DFIG

I INTRODUCTION

Since the need for power is always growing and fossil fuels are becoming harder to find, more renewable energy sources are being used. This could be good for the economy and the environment. WECS is a major source of electricity for power grids, and the amount of electricity generated by the wind is growing quickly every day. based on the results of the Global Wind Energy Report, The way they are set up is what makes the (HAWT) and the (VAWT) different types of wind turbines (WT) (VAWT). The HAWT, which has a variable speed mode, is the most useful and often-used type of WT. By changing how fast the rotor spins, the WT is able to get more energy out of it. This type of operation, where the speed of the wind can be changed, not only reduces the mechanical stress on the drive train, but it also makes the power output more even. With the help of an optional gearbox and a generator that is attached to the WECS, wind energy is turned into electricity. The WT comes after this. Even though other kinds of generators have been used, the most common ones are the (DFIG) and the (PMSG). In today's energy market, which is getting more and more competitive, it is widely agreed that simple, reliable, effective, and cost-effective WECS are very desirable. The nonlinear aerodynamic system, the complexity of the system's mechanics, and the fact that it has a number of faults all make it hard for the WECS to work. To make sure the WECS is safe, WECS must be able to stand with the grid if there is a momentary overvoltage at the point where the grid connects to the WECS. At the moment, a lot of research is being done on how WECS works, and much of it is focused on coming up with new ways to control it. Many researchers have looked at different parts of the WECS and written reviews. These studies have been shared. The grid systems that are connected to WECS are the focus of research because the effect of WECS in large ratings has a big effect on the grid. Still, the research points toward low-rated WECS that can be used by a single person. In contrast to the more common wind turbines with a fixed speed, which are the focus of Chapter 3, this chapter looks at wind turbines with a variable speed. In this kind of set up, comparisons are also made between direct-drive and indirect-drive turbines. 4, proposes a way to control the voltage and frequency of a stand-alone DFIG without a speed sensor. This is based on the root mean square (RMS) detection method. Evaluations that talk about power electronics topologies will not be taken into account. 5 just put out a full review of the four control methods that are most often used for (MPPT). MPPT into two groups based on how the power was measured: direct or indirect power controllers. They did a detailed analysis of the two groups, taking into account many important parameters during implementation. They did this by putting MPPT power controllers into two groups: direct and indirect. Tiwari and Babu's work was based on the structure of different pitch-angle-based controllers, from the older ones to the newer ones. Because wind power is hard to predict, power smoothing management is becoming more and more popular. Based on an analysis of simulation results, the kinetic energy of the inertia control method is a better way to smooth out power than pitch control with FLS and DC link control by d-axis current. 8 and 9 looked at the control techniques for the (RSC) and the (GSC), which are used in grid-interfaced WECS. They showed how (FOC), also called (VOC), are similar and different (DPC). Also, the performance of the VOC in relation to the different current controllers is talked about. Energy storage-based approaches that don't have energy storage systems installed next to each other do this to protect the WECSs in case of a line fault and keep the connection needed for low voltage ride through (LVRT). 10 They talk about how the chopper circuit-based fault protection method is becoming more popular because it is easy to use, can handle low voltage ride through (LVRT), and costs less because it doesn't need an energy storage system. By taking this step, the DC link capacitor is protected from the unwelcome changes in DC link voltage. The number 11 brought a review of control strategies for direct-drive PMSG-based WECSs that don't use position or speed sensors. The observers for the unmeasured signal were the main focus of this review. This kind of control can make the control more reliable when sensors go bad, which is important for lowering costs. On converter fault diagnosis, 12 topics were looked at. These included model-based and pattern-based approaches, as well as the problems. Chapter 13 talked about everything from whether or not WECS could work to how it could be used. It also talked about its adaptive and robust control. 14 gave up-to-date summaries of a wide range of WT control methods, along with assessments of how well they work based on research from as recently as 2016. Also, an internal faults review has been done, with more focus on model-based fault detection and control. 15 The review mentioned above did not, however, look into fault-tolerant control in more detail. On the other hand, research has made progress that goes beyond that.

The doubly-fed induction generator (DFIG) is now more popular and technologically advanced than any other type of wind turbine. To keep the grid from falling apart, DFIG must keep its connection to the grid working well and produce extra reactive power to allow voltage recovery when the grid voltage drops to between 0.2 and 0.9 pu[1-2]. In the absence of such safeguards, the reliability and safety of the power system could be compromised in the event of an accidental withdrawal of generators or rejection of loads during extreme voltage dips. Because of this, it is important to study and research DFIG reactive power compensation.

II RELATED WORK

Sobhy S. Dessouky et al. (2018) most important challenge in wind energy is maximising the quantity of power generated at any given wind speed. Several ways of mechanical sensor and system characteristic knowledge are necessary to monitor the maximum output power point. These tactics will increase prices in the actual world in order to increase maximum power point tracking. Using DFIGs and the MPPT control scheme, this paper proposes a way for obtaining the maximum power from a wind turbine based on perturb and observer approaches. A thorough model of DFIG system configurations is created using Matlab/Simulink. The simulation results demonstrate that the system operates effectively and that the suggested control mechanism increases wind power integration into the grid

Essam. H. Abdou et al. (2018) wind speed estimate (WSE) is used in the paper to extract the greatest. The wind speed is estimated using the rotor speed. The optimal shaft speed is chosen based on wind speed. An MPC system is also used to monitor rotor speed and estimate its optimal value in response to variations in wind speed. The simulation results revealed that the recommended MPPT technique may generate the optimal rotor speed for maximising output power

Xinglong Wang et al. (2017) Wind farms based on DFIG (Double-Fed Induction Generator) must be explored in high-altitude mountainous locations.The properties of wind farms in high-altitude mountainous locations can be explored first. Second, a short review of the simplified wind farm modelling technique is in order. In the third stage, a complex wind farm modelling approach based on PSS/E and a user-defined model is offered, together with temporal and geographical wind speed distributions. A case study comparing a complete model and a simple model was conducted on a Guizhou wind farm to assess the applicability of the three comparisons.

Parminder Singh (2014) In the past few years, alternative energy sources like wind power have been getting more and more attention. A DFIG is used for wind power. Wind turbines with DFIG must have stable voltage so that they can keep running without stopping even if the grid goes down. These wind farms must be able to hook up to the power grid directly. By changing the speed, frequency, and voltage of a DFIG-based wind turbine, you can control how much active and reactive power it puts out. By using the Simulink tool, Simpowersystem can look at how different DFIG operating conditions affect the output of the system. The vector control computing method is used to model and simulate induction machines in MATLAB/SIMULINK. In this study, the changes in torque, rotor speed, stator current, and rotor current on the rotor side of a DFIG are looked at. When looking at the grid-side converter, however, changes in voltage and current source, as well as changes in active and reactive power, can be seen. Once the mistake has been fixed, the control scheme puts the DFIG back to normal.

Preeti Sonkar et al. (2017) power sector has showed an interest in renewable energy sources in order to meet the ever-increasing demand for power. Wind energy is the fastest-growing renewable energy source, necessitating the usage of wind turbines to manage the frequency of the grid. Wind turbines are used for grid frequency adjustment utilising inertial control and droop control techniques. This article investigates the frequency response of a DFIG-based wind turbine for the ARMA wind speed model. The current situations have been simulated using MATLAB/SIMULINK. The results of the simulation suggest that wind turbines with inertial control and droop control can have a favorable impact on the environment

Xie Hua et al. (2018) system's frequency management need is increasing as a result of the increased penetration of wind power. Wind turbine control technique research is critical for primary frequency regulation. An inertia and droop control strategy for DFIG wind power is suggested based on the design of this study. To implement the control approach, a DFIG wind turbine model is created using RTDS. The wind turbine's simultaneous frequency tracking and efficient primary frequency regulation are proved by simulation results produced utilising the aforementioned control approach.

A**njali V. Deshpande et al. (2019)** Renewable energy sources are gaining pace and beginning to make a substantial contribution to the global energy mix as a result of increased power demand and the constraints imposed by traditional energy sources. Wind power plants are currently being created all over the world to supplement the regular grid due to technological improvements. As a result, wind power's contribution to the power system is growing at a quicker rate, making it vital to understand how wind power influences the system's features. which may be used to evaluate wind-integrated power systems. According to this article, a double-fed induction generator (DFIG) may be utilized efficiently for variable-speed wind power generation

Jin Ma et al. (2018) the usage of precise models is the only way to ensure the authenticity of a simulation. Modeling of (DFIG) for study of power system stability has attracted researchers' interest in recent years due to its extensive application in wind power production. Wind turbine manufacturers have constructed models that are not only difficult to grasp, but also proprietary and adapted solely to their own models. A variety of generic models that have been simplified are available. Among these, the model is the most often used for analysing the stability of power systems. Until recently, the model's validation has been based on limited real-world data or chosen simulated scenarios. As a result, due to a lack of systematic and theoretical evaluation of its validity, it is probable that the current-source based model may be improperly utilised in real engineering practises. This paper investigates the validity of the current-source model in the presence of both symmetrical and asymmetrical faults. Our practise of modelling and analysing .

Welcome Khulekani Ntuli (2022) In this piece analysed and compared: Fuzzy logic controller-based WECS with a voltage source converter (VSC) and a DFIG; fuzzy PID controller-based WECS with a VSC and a DFIG. The voltage/current or power out signals, as well as the dc-link voltage, are smoothed out to decrease settling time and overshoot/undershoot oscillations, hence minimising steady-state inaccuracy. By utilising the grid-side converter, the active and reactive can be brought back to their nominal levels. To keep the DFIG's active power output constant, the rotor side converter also controls the rotor speed. To achieve satisfactory system control, we employ the vector control method.

Shaomin Yan (2019) : In this research, a two-level optimal design was made to reduce the gearbox ratio and improve the economic value of the DFIG system in a DC grid. With the help of two voltage source converters, one on the rotor and the other on the stator, which connect the DFIG to the DC grid, the synchronous speed, current, and voltage of a DFIG system can be changed. In this paper, we get rid of the limitations of the AC grid and give a two-level optimal method for controlling the system current and generator poles while taking into account the costs of the whole system. With the first-level optimal technique, the poles of the generator are changed and the gearbox ratio is lowered. A second-level optimal method is also used to control the current in the system and lower the gearbox ratio. Lastly, simulations are run to test the system architecture's reliability.

Subinay Vajpayee et al. (2020) shows how a double-fed induction generator with phase-locked loop (PLL) control can help synchronise the grid in real time. (DFIG stands for "Double Fed Induction Generator") (DFIG). This article shows how not having a uniform voltage can hurt traditional PLLs that use dq conversion. All simulations and model building were done with PSCAD. Even though the grid voltage is symmetrical, the positive sequence component that is not symmetrical makes the PLL much more stable. The proposed method is fast and stable, making it perfect for use in wind turbines. It can also be used in DFIG's wind power system when the main grid is down. So, the system was made so that it could be used for both normal and unusual things. The system's reliability was greatly improved by adding a phase-locked loop (PLL).

PV-DFIG- From a topological point of view, a boost converter and a DC-DC converter connect the solar photovoltaic array to the DFIG-based WECS's DC link. But when a DC-DC converter is added to the grid-side converter, switching losses and costs go up. The people who wrote [15] showed that their wind-solar PV system with a BES can work on its own. A boost converter connects the DC link of the DFIG, which is powered by a wind turbine, to the solar PV array. But because it is directly connected to the DC link, the current going through the BES is not controlled. Also, microgrids that use DG, wind, and solar energy sources have been made and written about [16–18]. In [16], the authors talk about how to plan the BES's capacity for an island microgrid that is powered by wind, solar, and diesel. But the idea of making DG as fuel-efficient as possible hasn't been brought up yet. In [17], a wind-diesel microgrid for a fuel-efficient zone that stores energy in batteries was put to the test. But because the BES current is connected directly to the DC link, it can't be controlled. Also, connecting just one RE source makes it more likely that the vehicle will leave the fuel-efficient zone. Venkatraman et al. [18] showed a wind-solar-diesel microgrid that stores energy in batteries. But when developing the source and load controllers, the best way for DG to work was not taken into account. In a microgrid, the BES is very important when there is an imbalance between supply and demand. It also makes it easier to get the most electricity out of wind and solar power, especially when production is higher than demand. There have been a lot of studies on different maximum power point tracking (MPPT) methods, both for wind and solar, to get the most power from a given wind speed and amount of sunlight. [12],

DFIG Wind Turbine

Figure 1 shows how the DFIG wind turbine works on the inside and how its control system works. The main parts of the DFIG are a grid-side converter (GSC) and a rotor-side converter that are connected back-to-back (RSC). The RSC and GSC are what connect the rotor windings to the power grid. The stator windings, on the other hand, are what interface with the power grid. By cutting the rotor off from the power grid, the converters can handle 30% more power than the wind turbine 3. Because of this, the price of converters and the harmonic filter has gone down a lot. Also, because the converter is smaller, it loses less power and is more efficient. The fact that a DFIG wind turbine can change both its active and reactive power outputs stands out as one of its most important features (PDFIG, QDFIG, respectively). The control system in Fig. 1 can be used to control PDFIG and QDFIG separately. 1, which is based on a method called "vector control." This control system has three parts: the speed controller, the voltage controller, and the pitch angle controller. When used in this way, the main control goal of a DFIG is to stop the power system from oscillating. The results of the research show that the control in the RSC has a much bigger effect on damping the oscillation mode than the control in the GSC. Because of this, the RSC is a great way to stop power from going up and down. The speed controller can use the current going through the RSC's quadrature axis (iqr) to control the active power output. The voltage controller can use the current going through the RSC's direct axis (idr) to control the reactive power output. Both of these controls can be found on the RSC's output. Because the DFIG can change how much reactive power it puts out, it doesn't need reactive power compensation like a fixed-speed wind turbine does. This feature not only keeps the DFIG terminal voltage stable during steady state and grid disturbances, but it also saves money by getting rid of the need to install reactive power balancing devices.

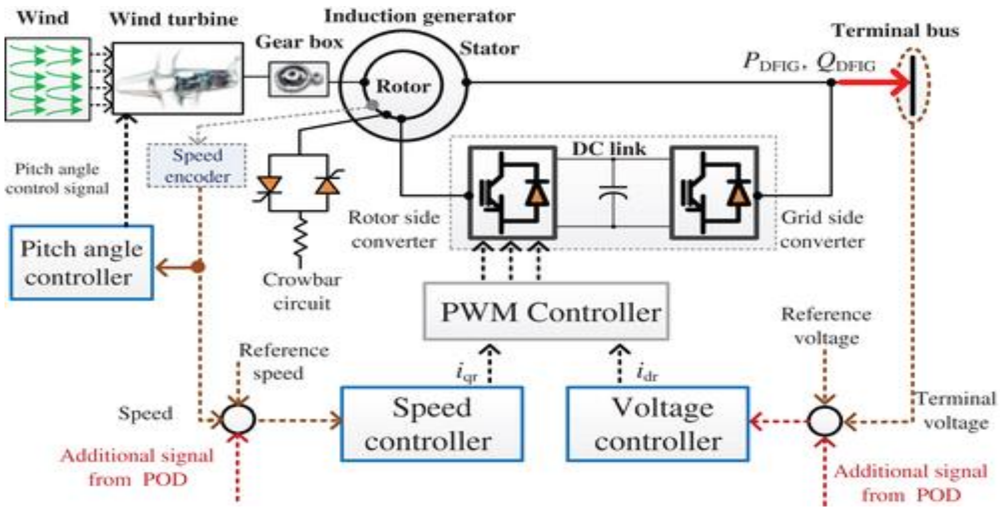

Fig DFIG wind turbine

Figure 1 shows that the rotor circuit is linked to the crowbar circuit, which is made up of two thyristors that don't work together and a resistor. The purpose of the crowbar circuit is to give a way around and restrict the amount of current that can pass through the rotor circuit, which is extremely high. Neither the rotor nor the power grid are severed in the event of an error, therefore rotor circuit protection can continue unabated. As a direct result of this, the DFIG wind turbine's ability to ride through faults (low voltage) has gotten a lot better. The resistance needs to be low enough so that the converter terminal doesn't get too much voltage. On the other hand, it should be high enough to limit the high current in the rotor. This is done to keep the rotor from getting too hot.

III Impact of DFIG Wind Turbine on the Power System Dynamic

A- Frequency stability

Frequency stability is the ability of a power system to keep the same frequency after a severe system upset that causes a big difference between power generation and power use. It depends on how well the load and the generation can be kept in balance or brought back into balance. The instabilities show up as sustained frequency swings, which, in the end, cause generators and/or loads to trip. The widespread use of DFIG wind turbines in power systems makes the frequency instability of those systems worse for a number of reasons that will be explained below.

1. The large output power fluctuations caused by DFIG wind turbines cause severe system frequency variation when the percentage of these turbines integrated into power systems increases. Because of this, With the right frequency relays in place, wind farms can be cut off from the grid. Frequency instability is worsened, and power oscillations become more noticeable, as a result of this. Due to the fact that the back-to-back converters severe the link between the power grid and the DFIG rotor, the DFIG rotor is unaware of any changes in the power grid's frequency.. Because of this, the large number of DFIG wind parks has a big effect on lowering the apparent system inertia. This not only speeds up the rate at which the frequency of the system changes, but it also lowers the point at which the frequency drops the most when generators are turned off. Because of what has just been said, this also means that the time it takes for the spinning reserve to make up for the difference in power will be shorter. This influence can be seen in the form of small power systems, isolated microgrids or weak grids, and isolated island grids like those found in Ireland and the United Kingdom.

B- Transient stability

According to Reference 12, transient stability is the ability of the power system to stay in sync even when there is a major disruption, like a short circuit. It depends on where the system was running before the problem and how bad the problem is. When there isn't enough synchronising torque, instability usually shows up as a change in angle that doesn't happen at regular intervals.

When the inertia of the DFIG rotor is disconnected from the power grid, not only does the effective system inertia go down, but the synchronizing torque goes down as well. This is because the traditional synchronous generators aren't used when there are a lot of DFIG wind turbines. After a system failure, these factors add to an increase in the total angular acceleration or deceleration of synchronous generators. The transient stability performance of the system is directly threatened by these possible events.

In previous work, the effect of large DFIG wind farms with less inertia on the level of transient stability margin reduction was studied. This was done so that researchers could learn more about how the two were linked. you have to run a time-domain nonlinear simulation under any initial operating conditions and faults that are put in. This can be done in any operating condition at the start. The study's results show that adding more DFIG installations has both negative and positive effects on transient stability. Time simulation is used to test a new transient stability index that uses sensitivity analysis. Here is where you can find the paper. The study shows that putting DFIG wind turbines in the right place makes the power system more stable during sudden changes. If DFIG wind turbines are put in places other than where they were first put, the stability margin gets worse.

The energy function method will be used to figure out how to solve these problems. To figure out how less inertia affects the system's transient stability, you need to use an energy function based on the potential energy boundary surface approach. With the direct computation of the critical energy and the critical fault clearing time, the study shows that DFIG wind turbines reduce the effective system inertia, which lowers the critical clearing time and transient stability margin of the system. This happens because the transient stability margin has been cut. Also, the method proposed for DFIG wind turbines to help with inertia can be used to estimate how much more inertia is needed when other machines cause the inertia to drop. According to the results of the study in Reference 22, which used the transient energy margin evaluation, however, research into the DFIG wind turbine's potential for enhancing the reliability of electrical systems in the face of unexpected fluctuations has been conducted. There are both static and dynamic parts to the DFIG converter controller. Modifying the RSC controller to take the DFIG terminal bus frequency as feedback allows for the input torque reference to be varied. This makes it possible for the active power output of a DFIG to be changed after a fault. The DFIG's fixed structure controller is in charge of making this change happen. By doing this, the power output of synchronous generators next to each other is changed, and the margin for transient stability is increased.

C- Small-signal stability

Reference 12 says that "small-signal stability" is how well the power system can handle small changes that could cause problems. How the system starts is very important. If there isn't enough synchronising torque, the rotor's angle can change because of a non-oscillatory disturbance. If there isn't enough damping torque, the rotor's oscillations can get bigger. The small-signal stability problem is linked to oscillation at frequencies between 1.0 and 2.0 Hz in the local plant mode and between 0.2 and 0.8 Hz in the inter-area mode.

DFIGs don't add any new oscillation modes to the system because they don't work in sync and are separated from the grid by converters. Their ability to change how modes of oscillation are dampened is limited, but it is possible through the four processes we will talk about below. But look at what's been going on in Texas 31, Minnesota 32, and Hebei province in the past few months.

D-Ancillary Services from DFIG Wind Turbine

As more and more DFIG wind turbines are connected to power grids, they will probably start to provide both active and reactive power. With the help of advanced wind forecasting and power smoothing techniques, modern power utilities can use DFIG wind turbines as a source of power that can be used when needed. So, DFIG wind turbines can help power systems. A lot of national grid codes for DFIG wind turbines also require that they offer auxiliary services. Here is a summary of what researchers have learned about how to control the frequency, voltage, and power oscillations of DFIG wind turbines.

E- Frequency control

DFIG wind farms can change the frequency of the grid in two ways: through inertia and power reserves. The first way to lower the frequency nadir at the start of a disturbance is to temporarily release the kinetic energy stored in the DFIG rotor. The second way is to keep putting the stored energy into a wind turbine that doesn't make enough power. So, DFIG wind turbines can only help control the primary frequency when they are not loaded. This is true even though their control effect is better than that of loaded turbines. To put it another way, DFIG wind turbines are run by following the curve that shows the highest power point. Wind power is going away because of this. DFIG wind turbines with power reserve control make it easier to control the frequency. This has been written about in a number of academic books and journals. The inertial control that was used in prior testing is now put through its paces.

F-Conventional inertial control of DFIG wind turbine

The maximum ROCOF loop can be used in ROCOF loop in conventional inertial control to retain the maximum ROCOF while eliminating the negative impact of the frequency rebound. The detrimental consequences of the ROCOF loop are mitigated as a result of this. The frequency nadir is raised, and more energy is lost as momentum before and after the frequency bounce than with conventional inertial control.

IV CONCLUSION AND FUTURE TREND

In this article, we talk about and analyse a number of ways to figure out how DFIG wind turbines affect the dynamic performance of power systems. These ways include frequency stability, transient stability, small-signal stability, and voltage stability. The DFIG's advanced control approaches for grid service support have been talked about. Power oscillation damping, frequency control, and voltage control are some of these control methods. Here is a short summary of what happened and what is likely to happen in the future:

Using DFIG wind turbines instead of synchronous generators lowers the effective system inertia and makes it harder to control the synchronising torques. This has a big effect on how well the power system responds to changes. Even so, the controlled output power of DFIG wind turbines can be used to help improve the way the electricity system works when it is combined with the right regulations.

When it comes to how they affect the frequency, DFIG wind farms not only make the frequency nadir worse, but they also make the ROCOF go faster. The latent inertia of DFIGs can be extracted using inertial control, which will help with both of these problems. The most important part of this control is figuring out how to change the controller gains so that more of the DFIG rotor's stored kinetic energy can be used. There is a big need for better inertial control technologies that can add more kinetic energy and keep things running smoothly.

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A review of the future of district cooling systems (DCS) and its impact on smart city energy management

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Abstract

Research shows that the building sector uses 40% of all the energy that is made and contributes a lot to greenhouse gas emissions. The DCS system is a good method for managing energy and cooling in smart cities. The aim of this paper is to review the various technologies involved in this. Mid-class families in countries such as India cannot currently afford the refrigeration system; it is necessary to have the benefits of the DCS system to meet their needs, and it is very cost-effective. District cooling systems (DCS) are popular because they are cheap, save a lot of energy, and are more cost-effective than traditional cooling systems that use renewable energy .This review also looks at what DCS can do with renewable energy .The DCS system provides effective cooling with proper ventilation, and it is the cheapest technology, so you do not need to purchase a different air conditioner.

Keywords*:* Smart city, Energy Management, DCS, Chiller, ICS, ITS, Cooling system, Air conditioning

1. INTRODUCTION

District cooling is a cutting-edge and effective method for cooling large groups of buildings in urban areas and on college campuses. In a DC system, a central plant is home to sizable, extremely effective industrial grade equipment that creates chilled water for transmission to customer buildings through an underground network of insulated pipes [1]. In order to provide air conditioning, cold supply water enters the building and passes via a heat exchanger, absorbing heat from the building's interior [2]. District Cooling saves on capital expenditures associated with the installation of chillers and cooling towers are liberates precious rooftop and building space [3]. By combining the cooling requirements of various buildings, district cooling saves energy, water, and minimizes emissions. By using district cooling, can minimize costs and operating expenses related to huge individual chiller facilities 50% - 70% electricity demand in a building [4,5]. This paper gives a small review of the research on DCSs and how they can be used. DCS is explained in terms of its traits and problems.

The performance and progress of DCS systems that are integrated with sustainable energy technologies, such as systems that combine cooling, heating and thermal storage systems, are summed up [6]. The work done to improve the DCS is looked at and put into groups. It is well known that DC systems have the potential to help save a lot of energy, improve operational cooling ability, efficiency, flexibility, and reliability, and lower the cost and environmental impact of building air conditioning [7, 8].

2. Review Methodology

More than 102 papers that were relevant to the paper were examined from Scopus, Science Direct, Google Scholar, and the Web of Science. And to introduce several techniques for achieving the necessary cooling impact from the district cooling system, a summary sheet of the chosen research paper is created.

3. Literature Review

U.S. Choi et al. (1992) [9] Ice-water slurry, a friction-reducing additive, and the two-part combination have been compared in District Cooling Systems (DCS). The impact of the fluids on price and cooling capacity was examined individually for the new and the old DCS. Two criteria were used in each scenario to compare the fluids: constant pumping power, which offers the most advantage, and constant velocity, which is more practical. It has been demonstrated that utilising conventional district cooling technology would be highly expensive to enlarge the pipes in order to improve cooling capacity by the same amount as the ice-water slurry system. Keywords include cost-saving projections, district cooling systems, ice slurry, and a friction-reducing additive.

Wenjie Gang et al. (2015) [10] have noticed that DCS is simple to combine with renewable resources in the area in regions where heating is the primary focus. It’s important to investigate integration in both cooling-dominated and heating-required regions. A DCS can be cooled by water, ice, and PCMs. There is a need for better design and regulation of DCSs that incorporate heat storage devices. By increasing the difference in temperature between the return(hot) and supply(cold) water and reducing pipe resistance, the chilled water system's energy consumption can be reduced.

Xin Zhou et al. (2016) [11] study examines that impact of conventional air conditioning systems are responsible for energy consumption. But same time a district cooling systems in residential buildings used less energy. The system performance using simulations and field measurements in a residential building has determined in this study. Five separate AC use modes, ranging from mode A (the most frugal) to mode E (the least frugal), were categorised in a reduced-order and an AC-CP model that was created to represent conventional air conditioning systems consumption in the residential building area. This organisational strategy investigated the unpredictability of user composition. Some of the things he saw were the analysis of district cooling systems and the effect of various A.C. use modes on energy savings. According to the simulation results, there can be a 4.5-fold-variance in district cooling system(DCS) efficiencies depending on the AC use modes and user compositions. The performance of the district cooling system is impacted by the distributed cooling load requirements throughout houses and hours.

Luca Pampuri et al. (2016) [12] Even in moderate climates, space cooling is becoming an important and often overlooked energy need. Most of the time, electric appliances inside a building cool the space. This means that there will be a lot of problems in the summer when people use the most electricity. We need analytical methods for figuring out how much energy is used to cool spaces in cities or regions. This report is about research that was done in the southern part of Switzerland's Canton Ticino. It is based on real data from the local electricity company. The study looks at how much electricity big users use to find out if there is a big need for cooling, how this need affects electricity use, and if this need can be met by district cooling system (DCS).

Chengchu Yana et al. (2017) [13] have study effect of building load on DCS energy performance. The study indicated that when the Gini coefficient rises from 0.25 to 0.55, S-COP and COP-Plant decreased by 5.8% and 2.5%, respectively. Energy savings of up to 50% and 4% in total DCS energy consumption can be attained by carefully planning the grouping structure of secondary chilled water pumps. Chilled water distribution systems are more crucial in determining DCS energy performance than building cooling loads, according to the grouping coefficient, which has a greater impact on energy savings than the Gini coefficients of cooling loads.

G. Franchini et al. (2018) [14] have noticed that The two cooling plants studied use a single-stage absorption chiller with evacuated tube collectors and a two-stage absorption chiller with parabolic trough collectors (PTCs) (ETCs). To reduce costs and obtain a 0.7 annual solar fraction, an optimization technique determines the sizes off all major components. Over the course of a year, two plant layouts were simulated to assess energy performance under various operating situations. Efficiency and investment cost comparisons were made possible by the optimization based on component unit costs. This is because the two-stage absorption chiller has a greater efficiency (COP 1.39 vs. 0.723 at design circumstances) and the concentrated solar devices have access to a lot of direct normal irradiation (2296 kWh/m^2) (PTCs).

Abrar Inayata et al. (2019) [15] have noticed that Fossil fuel use damages the environment when trying to meet rising energy needs. There ought to be a way to stop using fossil fuels without sacrificing contemporary lifestyles. 40% of all energy used for dehumidification, heating, and cooling in a building. The majority of the world's greenhouse gas emissions come from buildings. Buildings receive central cooling from DCS. It's for networks in homes, businesses, and industries. Excellent energy economy, enhanced comfort and safety, lower operating and maintenance costs, and effective management and operation are all features of DCS. Using DCS with renewable energy is highly possible.

Valerie Eveloy et al. (2019) [16] gave A review on aiming on the requirements of cooling- subjugated regions, a small review of existing and emerging technologies of district-cooling system (DCS), operational factors, economic factors, and environmental factors, as well as analysis and optimization approaches, is offered. The incorporation of renewable energy sources with cooling/storage technologies, with a focus on heat-absorbing refrigeration, in a DCs design and analysis studies is examined. Published approaches for DC system analysis, modelling, and optimization are examined in terms of their goals, areas of application, sustainability-related standards, and major conclusions.

Maria Jangsten et al. (2020) [17] have analysis in 37 buildings and make a report of As the need for cooling in cities grows, Low delta-T, which is the difference in temperature between the water that goes in and the water that comes back out, often affects how well they work. The distribution system and the attached buildings' minimal temperature differences in DC systems with heat exchangers have not been extensively studied.

1. Operation on the primary side of the heat exchanger's saturation zone.
2. Secondary supply temperatures that aren't designed to meet the building's present cooling needs and/or when applied using secondary set points that don't take the outside temperature into consideration.
3. Low temperatures for the secondary return.

Kahramaa(2021) [18] (Qatar General Electricity and Water Corporation) According to Kahramaa, the district cooling system, the most energy-efficient way to cool a building, will reduce carbon emissions by roughly 10 million tonnes over the course of the next 15 years. The district cooling system covers 19% of the over-one-million-tonne cooling capacity. The DC plants power all of the FIFA World Cup Qatar 2022 stadiums. In Qatar, an air conditioning consumes 60 to 70 percent of total electricity, but district cooling can full fill same cooling requirement with using 40 percent less- energy compare to a conventional cooling methods. This results in significant financial savings. District cooling can help the economy, the environment, and society as a whole. Qatar saved 827 MW in electricity distribution capacity and 125 MW in electricity producing capacity between 2013 and 2019 by utilising district cooling. The research period saw a reduction in CO_2 equivalent emissions of 8,238 metric tonnes due to the usage of less fuel. District cooling (DC) is a method in which a central cooling plant distributes chilled water via a web of water pipes to multiple buildings.

Peipei Yu et al. (2021) [19] have noticed that important power constraint for the power reduction stage is ensured by a safe layer. Using a self-adaptive target technique, power rebound is minimised during the power recovery stage. During training, numerical calculations demonstrate that the DCS's operating power is consistently below the power cap, providing operating reserve "safety." Smooth recovery from a peak power rebound is possible for DCS operational power. The temperature variations in each building are kept to +_1°C for comfort. Usually, the skilled agent of the safe-DRL approach is able to treat DCS. If the physical system has changed, retrain the agent using the new system's historical data.

WeiZhang and WenpengHong (2022) [20] has suggested that one of the greatest cooling strategies for supplying a renewable, without dust or bacteria, and more effective cold water supply to cooling area is the aim of district cooling system (DCS). However, there is currently not enough research on the cooling control policy for each unit when the multiple cold sources in the DCS are pooled for cooling, especially when they are paired with ice thermal storage (ITS). This research provides a thorough out assessment of DCS and ITS performance in a sub-tropical zone and establishes suitable control parameters.

4. REVIEW RESULT

This paper gives an overview of the research and uses of DCS that have already been done. It is about how DCS can be used with different energy technologies, how design and operation can be optimized, and what else needs to be done. Combining DCS with the renewable energy and Integration with CCHP systems is most common in places where heating is the most important and needs to be studied in places where cooling is more important than heating. Most buildings in Asia that use DCSs are businesses and public buildings.

The work on designing the DCS is looked at from both a global and a subsystem point of view. The chilled water distribution system was the main focus of the subsystem design optimization. More research needs to be done on how to optimise the design of the parts of DCSs and multiple-stage construction in real-world applications. Over the coming decades, sustainable district cooling (DC) systems will become more crucial. This is because energy consumption in hot, humid areas is driven by economic expansion and population growth, while cooling loads are impacted by climate change. In this article, it examined that both current and future low-carbon energy-based sustainable space cooling systems that might be used in DC. In this article, challenges, existing situation, and future energy, environmental, and economic potential of DC in the GCC region, as well as the possibilities for modifying DC technology and controlling the market has discussed.

5. CONCLUSION AND FUTURE SCOPES

In terms of high-rise buildings, I don't see much of a challenge or change, but if you talk about smart cities or smart solutions, district cooling is something that is likely to grow in a big way. This has mostly to do with HVAC. We already have a plan in place in GIFT City, Gujarat. In many Middle Eastern and European countries, the idea is a common one. It involves a central cooling plant that sends chilled water to nearby buildings or whoever the customers are. The only heat transfer happens at the user end, where the chilled water is used for HVAC needs. Having a separate HVAC or chiller plant for each building is likely to become outdated in the future. Like with electricity, where each person has a metre that tracks how much they use, chilled water will also be metered in the future. Something like this hasn't caught on in India yet, but I think it will soon. In high-rise buildings, firefighting is the main problem, which is a big problem because the fire department isn't well-equipped to serve as expected because its equipment has limits on how high it can reach. For fire fighters to be able to put out any kind of fire, the fire detection and suppression systems inside a building have to be very strong.

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Introduction to Water Supply Management with Urban Planning and Grid System in Smart Cities

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Abstract

Water supply and consumption is always a field of concern for any country. In the recent times, there was water scarcity in many places around the globe. Population expansion with time is booming. Water is a basic need to survive. Water is required for drinking, washing, household and industrial activities, etc. Hence, it is essential to conserve water at every stages of development. There has been exploitation of portable water all around the globe at all scales, starting from houses to large industries. Irregularity of rainfall has resulted in reduction of portable water and water supply. Increased discharge of effluent to the existing water treatment plants has caused over-working of machines and over energy consumption. With increase in population and urbanization, water supply has to be sufficient as well as satisfy the sustainability parameters. Hence, regular monitoring and regulating is needed to satisfy the present water demand as well as conserve efficiently for the future. Thus, smart cities are the future!

Keywords: Water supply, monitoring, conserve, energy consumption, sustainability, etc.

1. INTRODUCTION

Water resource engineering is always keen to develop new frameworks and regulations that help to conserve water and also supply water in satisfactory amount. Keeping in record of the fresh water sources, water supply, water scarcity and waste-water generation, there has been a constant development with time [1]. Construction of dam, canal, and catchment area may not be always a solution. Construction of a structure has many impacts on the environment. An EIA (Environmental Impact Assessment) is mandatory to build any of these structures [2]. Also, mass concreting may result to increase in surrounding temperature. Then how to deal with management of water, from stock to supply? This will surely be answered in this paper through an analytical approach.

2. METHODOLOGY

2.1 Need of Smart Cities

The architecture of urban planning includes practice of designs that accommodate commercial, residential, industrial, eco-friendly environment and energy sufficient factors. With increasing demand in water, more and more amount of water is to be drawn from the ground water or from water reservoirs. Also, more water supplies will lead to more waste water. Hence, the overall system puts tremendous pressure on constant energy supply.

People are switching to cities for employment and better living. Hence, the weight of the cities is going to increase by 68%, as predicted by statistics [3]. Smart cities are the only option to facilitate the present and upcoming issues. However, any developmental activity puts immense load on energy supply.

Smart cities facilitate clean and renewable energies and the operation of sustainable distributed systems that can be widely discussed. A smart city has extensive use of IT services, efficient flow of products, intelligent governance system and cloud based real-time data monitoring system [4]. This allows a smart city to keep an eye on the services, energy consumption in each sector and track the standards of existing infrastructures with future standard.

2.2 Grid Technology

Application of Grid approach to differentiate the whole area into parts is an efficient scientific approach to understand the root causes of the problems and develop solutions that will benefit the area as whole. Smartgrid technology is being implemented in smart cities to me it more efficient and monitor the load on energy supply and distribution. With the help of smart grid technology, information is available to both the consumer and producer. It can facilitate real-time data of energy produced, stored and consumed. A small part can be monitored to improve the efficiency of the whole part. DER (Distributed Energy Resources) like Solar, wind, etc can be designed using this technology to optimize the area usage [5][6].

3. APPROACH

Taking an example, let there is a smart city with few houses, industries, facades, etc. The whole area is divided into small parts, considering each part has sufficient area to accommodate the facility. The water supply line connects all the household needs, industrial needs and facade maintenance needs. A separate line is constructed to guide the sewage water to treatment plant. Installation of water flow meter at each small part (squares) is done to monitor the water consumption by the entity [7]. The real time data is also available to the waterworks body. If the entity consumes more water than designed value, then an alert will be sent to the entity to control the consumption of water. Also, water level detectors in sewage tunnels will help in monitoring discharge of sewage water in the treatment plant. Regular monitoring of water supply and treatment will help conserve water and reduce pressure on the mechanical equipment [8]. Hence, it proves to be energy efficient process to sustain a good quality of life. In smart cities, this system can be easily implemented as there are various inter-connected communication links and flow of data. Through IoT, data can be stored in cloud and accessed from anywhere and at anytime [9].

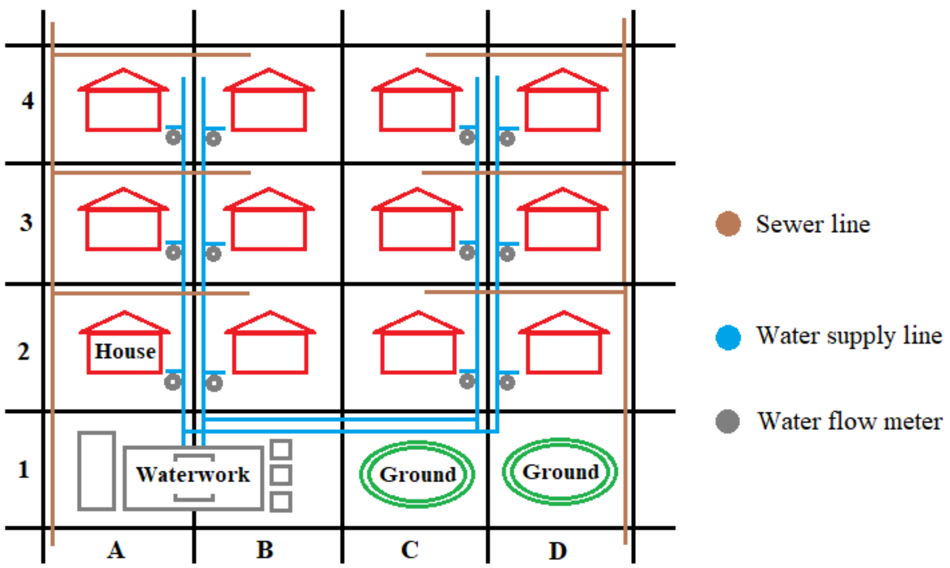

Figure 1 – Whole to part area division in smart cities

Figure 2 – Water flow meter

4. RESULTS AND DISCUSSIONS

As per provisions laid by IS: 1172-1957, it recommends water consumption in different sectors as listed below in Table 1:

Description	*Amount of water (lcpd)*
1. For communities with population upto 20,000	
(*a*) Water supply through stand post	40 (min.)
(*b*) Water supply through house service connection	70 to 100
2. For communities with population 20,000 to 100,000	100 to 150
3. For communities with population above 100,000	150 to 200

Table 1: Water consumption in different sectors

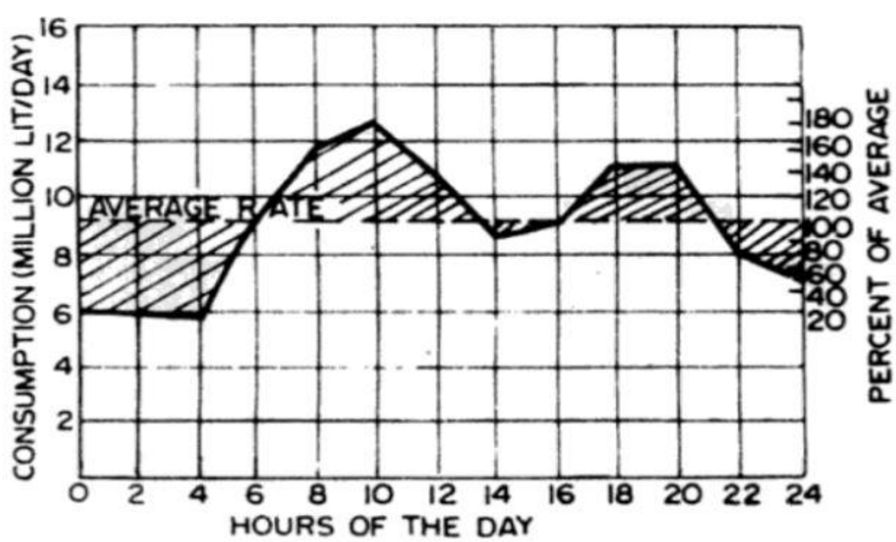

Figure 3: Water consumption variation in different hours of a day

The meter provides a low-cost alternative to existing solutions, with an estimated cost of 12% of the commercially available unit. The implementation of the Advanced Metering Infrastructure (AMI) widely regarded as one of the first steps in the digitization of the electrical grid control systems, generates new threats to the network, such as the fabrication of reads energy meter, manipulation of energy costs, the sending false control signals and malicious code.

5. CONCLUSION

Smart cities form the basics of sustainable development in the modern world. Along with the expansion of population and urbanization, load on agriculture, water supply and electricity has increased tremendously. Today, one can hardly think of a day without electricity. Also, recent scenario on water scarcity has put scientists and researchers develop and form strategies to conserve water and monitor water supply and treatment. With the help of implementation of new inventions and processes, energy consumption can be optimized. There are various instruments available to monitor the energy consumption. Every process has a certain impact on the energy usage and environment. People must be concerned towards the use of natural resources. Every element of nature needs to be conserved and used with utmost responsibility.

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Comprehensive review on Energy and Efficiency performance of water chillers

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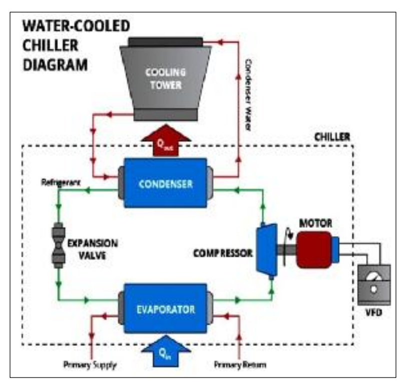
Abstract

Researchers Researchers are still focused on creating energy-efficient equipment and controlling methods because refrigeration and air conditioning systems like heating, ventilation, air-conditioning, and refrigeration (HVAC&R) water chiller systems, still consume a lot of energy in both commercial and residential buildings, and their operation is critical to ensuring the thermal comfort as well as other industrial purposes. The aim of the paper is to find out a technology to enhance chiller efficiency for energy management and energy savings in smart cities for chiller-based HVAC systems. HVAC&R equipment is a critical technology for minimizing building electrical energy usage. Few studies related to the overall system performance or the field experiments where some dynamic system characteristics might be lacking up to now. This paper provides a short overall review of enhancing the stability, efficiency, and reduction of electricity consumption of a water chiller refrigeration system employed in the industry and commercial buildings as well as in smart cities. If a system is a "closed loop" free of impurities, the water chiller will run more efficiently and last longer.

Keywords. Power consumption, Energy management, HVAC&R, Water chillers, Energy conservation, Smart city.

1. INTRODUCTION

A water chiller is a device that cools fluid below the surrounding air's temperature by removing heat from the water and transferring it to air through a heat exchange process using the basic components are a compressor, condenser, evaporator, and expansion devices with the mysteries of refrigeration cycles [1,2]. To achieve world-class manufacturing or reliability-centered maintenance in small, medium, and primarily large industries, the use of industry 4.0 technologies is critical [3]. The design of the water chiller for the industry level is customized by considering the client's requirements, and the appropriate product is recommended in smart



cities to increase energy efficiency and reduce repairs and increase reliability [4,5]. Refrigerant control is a successful instrument for increasing chiller efficiency as the effectiveness of a chiller can be impacted by contaminants in the refrigerant circuit because any leak allows air and moisture to enter the system and low-pressure chillers are more prone to contaminants[6,7]. The efficiency of the water chiller in HVAC systems decreases due to the loss of refrigerant via leaks. When technicians notice losses, they can able to find the leak if an appliance uses more refrigerant than recommended [8]. The cost of replacing refrigerants is reduced with prompt detection and correction, and chillers will continue to run as efficiently as possible improvements in efficiency[9]. Refrigerants can leak out of old chillers by 11-15% annually. Modern chillers with high-performance seals and specially designed pressure vessels can reduce annual loss to 0.1%[10]. An estimated 56.6% of a semiconductor factory SF's total electrical energy revenue goes toward powering the building's various facility systems in smart cities. About 27.2% of all electricity is used by the building's system [11]. Therefore, the government's energy-saving policy will center on research into ways to reduce energy consumption in smart cities' HVAC chiller systems, which is crucial work toward lowering the operating costs of SF[12].

2. KEY FINDINGS OF THE RESEARCHERS

Author: Type of Job	**Major issue present in Job**	**Techniques used by the researcher**
Rami Mansouri et al. (2022)[13] ; Energy performance and Environmental Impact	Global warming is caused by powerful greenhouse gases called refrigerants (CFCs, HCFCs, and HFCs). The carbon footprint concept is used to assess the environmental impact of food transport refrigeration systems on global warming.	TEWI values for various refrigerants were compared using the standardized technique created by AIRAH (Australian Institute of Refrigeration, Air conditioning, and Heating). We took into account the specifications of 240kW air-cooled vapor compression chillers that are commercially available.
Burky Anduv et al. (2021)[14] ; Energy efficiency	Finding defects is challenging based purely on visual inspection of maintenance employees.	Building automation systems (BASs) are frequently employed in contemporary construction. Developing trustworthy failure detection and diagnostic (FDD) techniques.
Yuying Sun et al. (2020) [15] ; Energy	Constant-speed air-cooled water chillers (CAWCs) are typically on-off operated with a fixed set	This article builds a general neural regression network (GRNN) model to reset two of a CAWC air conditioner (A/C) in real-time to

performance	point of chilled water return temperature, reducing their efficiency dramatically under part load conditions.	predict the best two values and achieve better control, developed by an optimal control method which can improve the indoor thermal environment and reduce the energy consumption of the air conditioning system by 11.0% during the cooling season.
Yijun Wang et al. (2019) [16] ; Energy conservation	The numerous chillers that are set up to produce chilled water for air conditioning account for a sizeable portion of their energy consumption.	Adding fresh load situations to the map periodically can enhance the performance in energy savings which is tested for eight weeks from August to September. During May to November the online chiller loading (OCL) indicates that the proposed strategy can achieve considerable energy saving. This is because the points on the near-optimal performance map guiding the proposed strategy have the chillers' best COP, and they can indicate near-optimal control for the chillers to save energy.
Yundan Liao et al. (2019) [17] ; Energy conservation	The stability of the system and additional cost brought by the sequencing activities are typically not taken into account in conventional chiller sequencing control. Operators turn off automated control mostly because of those quick or pointless sequencing activities.	By incorporating a cooling load forecast based on the ARX model into the standard chiller sequencing control logic that is based on the total cooling load. Study goal was to correctly limit the number of chiller switches in order to improve system stability and reduce operating costs. The duration of overcooling and under-cooling will lengthen as a result.
I Nyoman Suamir et al. (2018)[18] ; Energy consumptio n	The building chillers being studied are less energy-efficient and use more electricity.	Operation of chiller and energy conservation would benefit greatly from maintaining the quality and effectiveness of cooling towers. When a cooling tower with lower efficiency was used to operate the chiller, performance suffered.

F.J.S. Velasco (2018)[19] ; Energy efficiency	A 15% decrease in R450A's cooling capacity when compared to R134a. R1234ze (Cooling)'s capability has decreased by 25% compared to R134a.	The impact of compressor technology on this type of VCRS' overall performance. R513A is employed as a drop-in replacement for R134a.
Fu Wing Yu et al. (2016) [20] ; Energy performance	Constant-speed water-cooled centrifugal chillers' real working performance results in high power consumption, a low-performance coefficient, and high capital costs for commercial structures.	Replacing of water-cooled constant speed centrifugal chiller with a variable speed-controlled oil-free centrifugal chiller of the same capacity increased the average efficiency from 0.6 to 1 and the average system COP from 6.2 to 10.3. This reduced total power consumption by 9.6%.
A. Beghi et al. (2016)[21] ; Fault detection and diagnosis of HVAC water chillers by driven Data.	Less feedback datas are responsible malfunctioning operation is a significant obstacle in the development of effective Fault Detection and Diagnosis (FDD) procedures for HVAC installations. HVAC chiller system malfunctions can result in user discomfort, energy loss, system unreliability, and shortened equipment life.	For defect detection and isolation, a semi-supervised data-driven methodology is used. It uses Principal Component Analysis (PCA) to isolate factors associated with defects by separating anomalies from normal operating variability. The FDD algorithm uses data particularly gathered through laboratory tests to evaluate the performance of two types of systems: frictionless centrifugal and screw chiller systems.
Qi Jie Kwong et al. (2016)[22] ; Energy conservation	The advantages of radiant cooling systems in terms of energy efficiency and cost savings have been identified in numerous earlier studies. However, there may be a lack of statistics on the way to analyzing preliminary funding and preservation costs, especially for the slab-included model.	1. Radiant ground cooling is used in many buildings to maintain thermally acceptable conditions and some of the aforementioned research utilizing simulation and experimental approaches has acknowledged its efficiency in decreasing energy usage. 2. It also cuts the energy use in a tropical structure by 34%.

Leandro dos Santos Coelho et al. (2014)[23] ; Electrical energy conservation	If the chillers are handled incorrectly, the multi-chiller system's electrical energy consumption rises.	By utilizing the CSA (Cuckoo Search Algorithm), based on the infestation of certain cuckoo species chicks and their fighting behaviour, they can reduce power consumption. However, we can apply a more sophisticated technique called DCSA (Differential Cuckoo Search Algorithm),
Tzong-Shing Lee et al. (2012)[24] ; Energy Performance	VV-style finned tube condenser coils in large air-cooled water chillers are often designed with a top fan. This often results in uneven flow distribution and fluctuating wind speeds, lower than desirable heat transfer coefficients in the condenser, and impacts chiller energy and efficiency.	The impact of different condensing coil arrangements, such as variable fin configuration (VFC) or variable row configuration (VRC), on lessening airflow misdistribution across tiny air-cooled condensers. The VRC-designed condenser are analysis to optimize airflow distribution and improve heat transfer performance, increasing average wind speed and overall heat transfer coefficient by approximately 10.3% and 5.3%, respectively.
Kuei-Peng Lee et al. (2012)[25] ; Energy efficiency	Determining the ideal temperature settings and reducing chilled water system energy use for cooled and chilled water.	According to a model that employed a hybrid optimization technique that includes the Hooke-Jeeves and particle swarm optimization algorithms, the optimized settings lowered the entire energy required by the water chiller by 11.1% in the winter and 9.4% in the summer.

3. RESULT OF REVIEW

This paper takes a look at the water chillers, used in HVAC systems in smart cities that have been developed so far and are still being studied to improve further. Few reviews have been written regarding how to improve the chiller's effectiveness and how to use less energy. The refrigerant utilized in the chiller is also discussed. The review is on the numerous studies and experiments carried out by our researchers. The study also discovered that the chiller would operate at a higher condensing temperature as a result of the rise in cooling water temperature exiting the cooling tower, which was a significant effect of connecting an inefficient cooling tower to the chiller. ARX model, GRNN model, FDD techniques and CSA algorithm, OCL strategies and many more algorithms-stragies and models can be used to increase stability, energy performance, and reduction of power consumption. We can also use R134a instead of R513a to increase cooling capacity.

4. CONCLUSION

After going through all the experimental paper that has been published by our researchers, we come to a conclusion that is as follows –
1. Stability of the system can be improved and also cost will reduce by adding a number of switches to the chiller.
2. The performance will increase if a higher-efficiency cooling tower will in use.
3. Energy can be saved by adding fresh load situations to the map periodically which also helps in enhancing the performance.
4. Cuckoo Search Algorithm is also a technique that can be used to reduce the electricity usage by the chillers.
5. The application of parallel processing to enhance simulation results without compromising accuracy is another area in need of attention from the growing research community.
6. ARX model can be used to incorporate robustness-adaptiveness and influence co-efficient estimation by sequencing control logic that can be used in standard chiller to increase the stability and reduced the operating cost.

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Advancements in Solar Stills for Smart City Application- A Review

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Abstract

Today's major challenges are water and energy. Groundwater overuse has caused a drinking water deficit. To get additional water, deep tube wells are drilled. Deep tube well water requires more energy. Today's problems also include energy. New water and energy research can overcome these problems. Groundwater is generally salty, and inhumane. This requires new water-correcting technology. RO technology is the best. However, this method wastes more water. For this reason, researchers are creating further technologies, with solar-powered water purification being the most effective and causing the least water damage. In the current work, all research done in this field is compiled together.

Keywords*:* Solar Still, Heat Pipe, Hybrid Solar device, Evaporation-Condensation, Smart city , Energy, Performance

1. INTRODUCTION

Research papers are selected for the literature review on the double slope solar still having various production techniques to improve the productivity of the solar distillation devices. All research papers are selected as the present scope of the work on solar still research work [1]. There may be an urgent need for clean, pure consuming water in many nations [2, 3]. Regularly water assets are brackish and or comprise harmful bacteria and therefore cannot be used for consumption [4]. In addition, there are numerous coastal places in which seawater is abundant but potable water is not to be had. Pure water is likewise wished for in some industries, hospitals, and colleges. Solar water purification is particularly successful in low-water areas like Rajasthan, where residential electricity is scarce [5]. Researchers created solar stills using solar energy-based distillation (Solar distillations). Distillation has industrial applications [6]. Since the government began giving everyone clean water. In these areas without energy, solar plants have been developed [7, 8]. Saline water is cleaned using solar thermal energy in a small space by sun distillation. Glass hangs over this space [9]. Total energy loss is avoided by insulation. This device allows you to easily collect pure water by tilting the glass. Evaporation and condensation are the mechanisms that solar distillation uses. Among the many applications of solar energy are those for heating, drying, cooking, and power generation [10]. A wide variety of machines can be powered by solar energy, including automobiles, planes, boats, satellites, and even calculators. We can't rely on solar energy forever [11].

2. METHODOLOGY

A suitable topic and keywords have been selected from my research field and from my research interest. Various research papers have been studied and formulated a clear objective. Based on objectives and keywords more than 160 scopes and sci-papers from various research sources have been downloaded and from these, important papers have been selected for the review process and prepared a specific research hypothesis that is to be explored. A result has been founded and concluded after reviewing various papers with my best.

3. REVIEW OUTCOMES

K.S. Maheswari et al [12], In their research report, the researcher analyzed clear glass covers. This uses a double-slope solar still. Researchers hope to boost solar still production. PVC pipe might replace transparent glass in this research. Glass is weaker than PVC. PVC has downsides. Clear glass may disperse solar radiation more than PVC pipes; thus, the conclusion of the study is to avoid PVC in low-solar-radiation areas but utilize PVC sheets in high-solar-radiation areas.

RahulAgrawal et al [13] This research produced a Modified Solar Still. PCM materials boost productivity in this task. This study employed binary eutectic Phase change materials (palmitic acid and stearic acid) and steel wool fibber PCM (SWF). This report contains all experimental findings utilizing both materials. Four distinct experiment settings are designed in this work to discover the most ideal cases: MDSSS-1 (PCM with 4 cm water depth), MDSSS-2 (PCM with 3 cm water depth), MDSSS-3 (PCM with 2 cm water depth), and MDSSS-4 (PCM + SWF with 2 cm water depth). All four examples are compared to a both side tilled solar still. MDSSS-4 has the finest both side tilled solar still results.

S. Joe PatrickGnanaraj and V. Velmurugan[14]This project aimed to enhance solar still distillate yield. Traditional stills were altered inside and externally. Three solar stills (corrugated basin, black granite, wick) were designed. One had outside reflectors. Finally, an entirely new one was erected. Conventional and modified stills were compared and analyzed. In finned corrugated basins and outside reflectors, water temperature climbed fast during the day. In declining and off-sunlight hours, black granite kept the water warmer. Forenoon production utilized exterior reflectors. Black granite increased daytime and night-time production. Traditional stills collected 1880 ml/m2d. The finned corrugated basins, black granite, wicks, reflectors, and internal and external improvements increased distillate production by 58.47, 69.84, 42.333, 93.393, and 171.43% over the typical still.

Modi, K.V., Jani, H.K. & Gamit [15] This study examines the impact of nano-particles on a single-basin double-sloped solar still utilizing using different different position of glass covers and with different water depths. Two single-basin dual-slope solar stills were tested. At varying water depths, a still without nanoparticles and one containing 0.1% Al_2O_3 nanoparticles were compared. Glass was covered East–West and North–South. Al_2O_3 nanoparticles enhanced North–South distillation by 19.40%, 28.53%, and 26.59%. CuO nanoparticles increased yield by 58.25% and 56.31% for 19.95 mm and 9.97 mm water depths, respectively. At 19.95 mm and 9.97 mm water depths, the still containing 0.1 percent CuO nanoparticles showed higher productivities. CuO nanoparticles increase single-basin dual-slope solar still thermal performance.

N.Muthu Saravanan et al[16] Pollution, urbanization, climate change from fossil fuel usage, and a lack of storage knowledge are causing water shortages. Beaches lack fresh water. This requirement motivated a low-cost, renewable energy-based desalination method. Solar stills purify waste or brackish water. Built and tested under normal conditions, the solar still. Kanchey marbles are studied as solar still energy storage. Kanchey stones improve solar stills by 16.32%.

S STuly et al[17]This study explores the effects of a solid quadrangular fins and paraffin-wax as a heat storage material and an outward condenser on an active both side tilled modified solar still. Five scenarios evaluate modified, finned, and classic double slope SSs. The greatest double slope SS productivities are 3.1, 2.72, and 2.5 L/m^2. SS efficiency is 39.74% with external condenser and 30% without. A condenser boosts modified SS production by 10%. Reformed SS is 14.23% more efficient than finned and regular SS. Traditional, finned, and modified SS had CPLs of 0.014, and 0.012 \$/L/m^2, respectively. SS modification may be a cheap approach to meet rural water needs.

Abdulla et al [18] has examined a hi-tech purification arrangement of humidification and de-humidification (HDH) unit associated by six wick solar water distillation system. Different pressing materials (pen cushion and thorn pad) and water flow rates (1.1, 2.0, 3.2, and 4.0 kg/min) were tested. Dehumidifiers made humidifier vapor thick. Desalination was tested day-and-night. Wick stills were evaluated. The HDH unit's salty high-temperature water fed the wick stills. Aspen cushions in the humidifier produced more freshwater than thistle trees. The best distillate was made in an HDH unit at 4.0 kg/min. At 4.0 kg/min, usual picked up yield proportion (GOR) increased from 2.56 for an HDH unit working during the day to 4.55 in the afternoon and night-time. Cross-breeding increased the GOR from 5.13 to 5.72 by increasing the water flow rate from 2.0 to 4.0 kg/min.

Pounraj et al[19] finished the test to manufacture water and power. In this, a solar PV-powered Peltier framework was coupled to a crossover PV/T dynamic solar still. The Peltier in this still improves disappearing and build up distillation. The dynamic half-breed PV/T framework was tested and found to be the best. The suggested dynamic cross-breed solar PV/T still is 30% more efficient than the traditional latent still and 38% more efficient than the genuine solar PV framework.

Naroei et al[20] studied hybrid SS and upgraded the warm efficiency of a solar water heating system using a solar tracker. Lab-scale robotics allows solar panels to tilt and spin. The control system is adjusted to face the solar panels all day. The sun's location on the celestial circle is determined by its solar stature and azimuthal point. Warm conductivity is generated by adjusting the solar panels, heat exchanger, and capacity system. A solar pyranometer measures the sun light force. Solar tracker results show a 40% increase in overall stored heat energy compared to fixed solar panel angles. Summer is great for low slants, while winter requires steeper slants.

Manokar et al[21]studied the efficiency of a P-V panel incorporated solar water still to get more pure water and amount of electricity. The framework's performance is analyzed from several viewpoints, including pure water production rate, efficiency, PV panels and exergy efficiency. Using this type combined solar still obviously we will get maximum distillate (7.2 kg). 7.2 kg, 4.5 kg, and 3.5 kg of freshwater produced. Daily vitality and efficiency of exergy of a tilled solar panel based solar water stiller with side wall and bottom protections are greater considered to various circumstances. Day-by-day efficiencies of 34.3%, 38.5%, and 71.4% and exergy efficiencies of 1.35%, 2.37%, and 4.53% were obtained for an inclined solar panel basin solar still with no protection, sidewall protection, and side wall plus bottom protection, respectively.

Rabhi et al[22] show a solar still with rod balances and an outward condenser. An experimental investigation compares the improved solar still with stick balances safeguard condenser to the standard still. This study compares the warm conduct (shield and glass temperature changes) and pure water production capabilities of a solar still with stick blades for the shield and condenser. All analyses are done in Gaffs-meteorological Tunisia's conditions. Experiments are shown, measured, and discussed to illustrate the modified solar still's usefulness.

Rashidi et al[23] examined exergy for a double sided sloped solar still heated by thermoelectric modules to improve its thermal performance. Thermo electric modules were used to warm water and improve the solar still's effectiveness. The results are from 10 days and nights of testing at Semnan. Finally, the cost per litre of water production has been determined. The results indicated that heat sink and thermoelectric heating increase water temperature. This predicts a drop in productivity when night falls. Exergy efficiency also increases during testing seasons. The framework's exergy efficiency is about 26% at 2 p.m. Life cycle analysis shows that distilled water costs 0.15 and 0.25 $\$/L/m^2$ during the day and night, correspondingly.

Ahmed Rahmani et al[24] studied the influence of the condenser zone on NCL solar still highlights in summer and winter. PC code predicts the influence of condenser zone and twist speed on daily yield in summer and winter. The results showed that nevertheless daily production increases with condenser area until a fundamental value beyond which its effect becomes unimportant. The wind effect is stronger for small condenser areas, according to research. The re-enactment shows that NCL solar still's highest daily production in summer and winter is 4.73 kg/m2 and 2.71 kg/m2, respectively.

Sarray et al[25]Heat and mass exchange wonders and the entropy rate of sticky air in a single solar are studied. By examining the district area and time (day and month), the following should be considered: Minimum glass cover thickness, water depth, and glass cover slant point should be comparable to the locale scope for maximum solar still efficiency. Solar power, daytime, and water salinity affect still production. Summer's long days increase productivity. Salty treated water reduces solar still production. Increasing the water temperature increases both heat exchange via dissipation and water vapor exchange by dispersion, boosting still production. Preheated saline water with solar energy seems ideal and least difficult for this circumstance. Warm solar disasters are caused by conduction between the basin plate and the surrounding.

Manokar et al[26]studied two solar still wall and absorber plate combinations. Finned acrylic and galvanized iron solar stills are studied. This study used a simple single basin solar still, adjusting water depth from 10mm to 30mm, local time, and absorber plate material. Acrylic is more productive than galvanized iron, according to his analysis. Acrylic solar stills lose little heat.

Kumar et al[27]tested a wedge-shaped pyramid solar-still with an tilled solar still. Field experiments validate theoretical analysis in their study. This work constructs a 0.650.650.15 m solar still with an angled glass covering. This study's input parameters include sun intensity or year, basin area effective utilization, and raw water depth. Field experiments calculate yield and efficiency. Experiments in this study reach 50°C. Pyramid with slanted solar still yields 7.52 kg/m.

4. RESULT

This work designs four experiments to find good cases. 4cm PCM, 3cm PCM, 2cm PCM, 2cm PCM + SWF. All four are double-slope solar stills. The best double slope results are from MDSSS-4. It can be observed that CuO nanoparticles increase productivity compared to Al2O3 nanoparticles. It has been noticed that the effect of wind is stronger for a condenser if its area is small in NCL solar still and increased daily production. It studied exergy for double side-sloped solar water still heated by thermo-electric modules to improve thermal performance. Thermoelectric modules were used to expand the solar still's efficiency. The dynamic solar PV/T hybrid still is 30% more efficient than the traditional latent still and 38% more efficient than the genuine solar PV framework. An angled solar panel based basin still with side wall (all side) and foot(base) protection produced the most distillate (7.2 kg). A solar still with sidewall and bottom protection produced 7.2 kg, 4.3 kg, and 3.5 kg of fresh water.

Hybrid SS and solar tracker efficiency were studied. Solar trackers increase stored heat energy by 40% compared to fixed panel angles. It has been observed that acrylic is more productive than galvanized iron. Nano paint is another future scope for solar still productivity improvement.

5. CONCLUSION

After review of various research papers some important research gaps are identified and present in this section, which are following:
1. It was found that the use of cloth materials can improve the efficiency of the solar still, so use of cloth is solar distillation is better option.
2. Double slope solar still shows the better performance than the single slope solar still, so in present study double slope solar still is selected for the study.
3. Revolution of the cloth material in the solar still setup can improve the water distillation of the solar still, so revolving cylinder is used for the present study.
4. The conclusion of the study is to avoid PVC in low-solar-radiation areas but utilize PVC sheets in high-solar-radiation areas.
5. It is clearly indicated that by increasing the water depth in solar still basin the fresh water production is decrease due to large quantity in the solar still which required time for the proper latent heat generation in the solar still.

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Study of Green Indices of Smart City Ajmer using Remote Sensing and GIS

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Abstract.

Urbanization impacts the vegetation redundancy across the globe which turns and results into climate change manoeuvring. The paper particularly replicates the same on the basis of remote sensing data of vegetation for smart city Ajmer. Ajmer city had gone under lot of anthropogenic construction activities and few are still going on. These betterment activities for city are leading and shaking the vegetal cover of city. Entire year NDVI values are divided in four quarters and summer season and pre-summer season have lesser values of NDVI as compared to monsoon and winter season.

Keywords. Remote Sensing, Smart City, MODIS, NDVI, Variation.

1. INTRODUCTION

The physiological needs of component species and vegetation-modified environment link the vegetation and environment state spaces [1]. Most forest ecosystems need vegetation. Soil and water conservation are crucial [2]. Urban air pollution triggers 7 million premature deaths every year world - wide. In light of human pollutants, urban air quality is bad [3]. The vegetation barrier affected pollutant deposition dynamics and amplified the effect of plant hurdles against air pollution [4]. It may give insights for using new road clean infrastructures to ameliorate air quality [5]. Land cover influences and vegetation conditions govern the proliferation of vegetation types and forest sustainability includes determining the most effective variables [6]. Spatial and temporal soil complexity determines biodiversity distributions. Assessing the link between water and plants is vital for environmental restoration and management to show plant-environment interconnections. Satellite - derived datasets on growth of plants, gusto, and dynamism may be used in environmental monitoring, conservation of natural resources, agricultural production, lumber, urban green infrastructures, as well as other sectors. These categories of agricultural information provide a realistic framework for macro and resource management of agricultural production and, in many cases, crop yield forecasting and projections [7]. Nondestructive and noncontact remote sensing techniques capture crucial information via separated device (from target) for climate and environmental investigations [8]. Remote Sensing gets insight to response of a material with incident radiation on the basis of absorption, reflection, transmittance and scattering. Prospecting efforts in hyper spectral remote sensing platforms are indeed a vulnerable utility for land and climate monitoring applications like plant stress and chlorophyll content parameterization, surveillance of various vegetation classes along with water activity, mundialization of leaf pigment, change detection, and physical and biological crop yield. Spatial structural arrangement, biomass (live and senesced), moisture content is characterized by Leaf Area Index (LAI) in recognized spectral property determination by emphasizing processes for hypothesis testing of classified applications indulging new generation sensors like Compact Airborne Spectrographic Imager (CASI) and Airborne Visible Infrared Imaging Spectrometer (AVIRIS). In addition to that hyper spectral remote sensing provides a better approach for mapping, classifying, characterizing and modelling of green cover by inculcating Principal Component Analysis in best waveband selection. GIS helps organize, store, access, manipulate, update, and synthesize multi-sourced data related with geographic locations [9]. The Normalized Difference Vegetation Index (NDVI) is derived from the ratio of the amount of near-infrared light (NIR) reflected by leaf surface to the amount of red light (Red) reflected by leaf surface, recorded by a satellite sensor, and evaluated in a geographic information system (GIS) [10]. As a rule, leaves will soak up any sunlight that falls within the photo synthetically active radiation range. While green leaves strongly absorb blue and red spectral regions of incoming solar light, they do not considerably absorb NIR. This means that NDVI may be used to keep tabs on plant photosynthesis over time and to make quick work of comparing plant growth across different regions [11]. It may be used to map and anticipate the amount of land degradation, as well as to map and analyse the incidence and effect of disturbances including drought, fire, flood, and frost [12].

2. DATA

This article calculates VI and NDVI for smart city Ajmer during 2003-2013. Data from the USGS Earth Resources Observation and Science Centre’s Land Processes Distributed Active Archive Centre (LP DAAC), part of NASA's Earth Observing System Data and Information System (EOSDIS), were utilized in this study (EROS) [13]. Canopy greenness is a metric of photosynthetic activity, chlorophyll, and canopy structure, and may be compared across space and time using MODIS vegetation indices [14]. With NOAA's AVHRR NDVI time series record, NDVI provides historical and climatic coherence. EVI diminishes oscillations between the canopy and the earth and increases sensitivity in dense foliage. The dynamics of vegetation on a global scale may be summed up in two components. Vegetation indices are calculated daily using the surface's bidirectional reflectance. VIs with low-quality pixels is removed by a MODIS-specific compositing process [15]. To composite, constrained view angle picks a pixel with one of the remaining high VI values (from the two highest NDVI values it selects the pixel that is closest-to-nadir) [16]. With the VI method, both MODIS data sets are integrated over a span of 16 days, with the resulting temporal resolution being improved. The latest version of Terra MODIS's vegetation indices (MOD13Q1) is produced every 16 days, with a spatial resolution of 250m. Two plants are included in MOD13Q1. NOAA-AVHRR NDVI uses NDVI as its continuity index [17]. EVI makes it possible to detect changes in high biomass areas with greater precision. A pixel's value is determined by the software and it is set to 16 days [18]. There were few clouds in the sky, and the NDVI/EVI values were high. Multi-day temporal resolution, temporal coverage beginning on February 18, 2000, worldwide coverage, sinusoidal coordinates, a 250m pixel size, and 12 Science Data Sets are all features of Terra MODIS (MOD13Q1.006-version 6) [19].

3. STUDY AREA

The research region is between 26°20′ N and 26°35′ N and 74°33′ and 74°45′ E. Ajmer is 132 kilometres from Jaipur, Rajasthan's capital, and surrounded by Aravalli hills. Ajmer is an important historical and educational centre in Rajasthan.

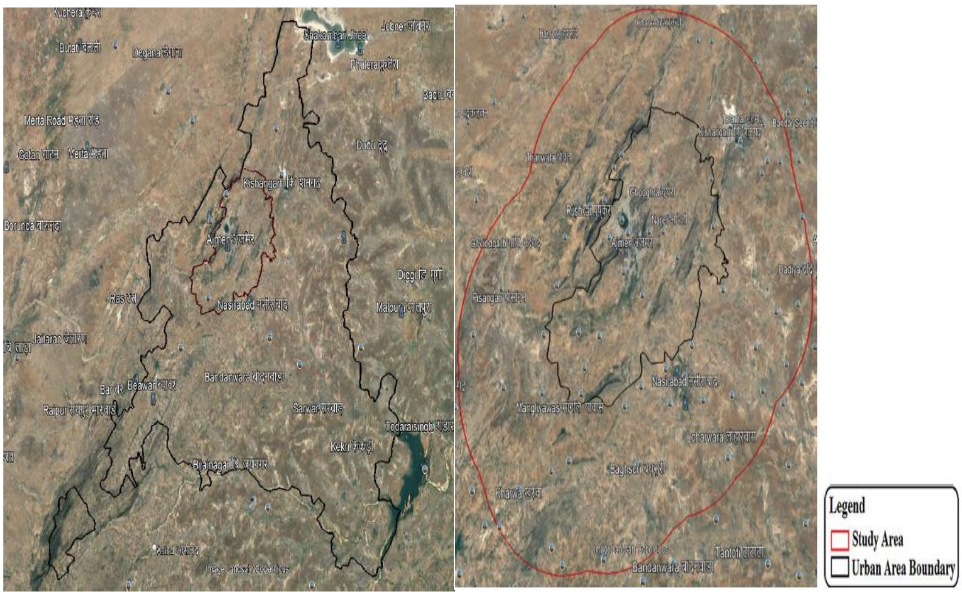

Figure 3.1. Geological Location of Study Area

Smart City has a semi-arid, hot summer and chilly winter environment, short monsoon. The Aravalli Mountain range in western India stretches 482 kilometres from northeast to southwest through Rajasthan. Ajmer district spans 8,481 square kilometres and is bordered by Nagaur, Jaipur, Tonk, Bhilwara, and Pali. Ajmer city is selected as study area due to mixed geographical conditions like hilly terrain, lake and desert area.

4. METHODOLOGY

The particular study of NDVI for Ajmer city using GIS and satellite data involves selection of Ajmer City coordinates sample along with creation of shape file of city area and buffer zone of 10kms. Afterwards the required data set for the time duration have been collected in Hierarchical Data Format (HDF) and then reformatted into Geo-TIFF format using MODIS re-projection tool (MRT) [20]. After quality checking and using a scale factor of 0.0001, the output data sets were operated under statistical analysis.

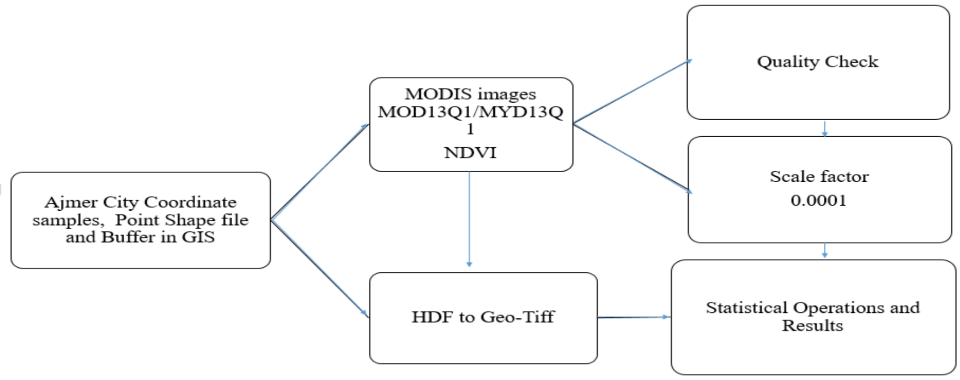

Figure 4.2. Methodological Layout

5. RESULTS AND DISCUSSIONS

Normalized Difference Vegetation Index is calculated for the period of 2000-2022 by examining 23 images per year. These results are divided among the four quarters in a year to check the monthly as well as annual comparisons. Generally, NDVI values lies in between -1 to 1 and same range is established in the results. Trend analysis and correlation coefficient with maximum, minimum, average and variance values were also calculated as in Table5.1.

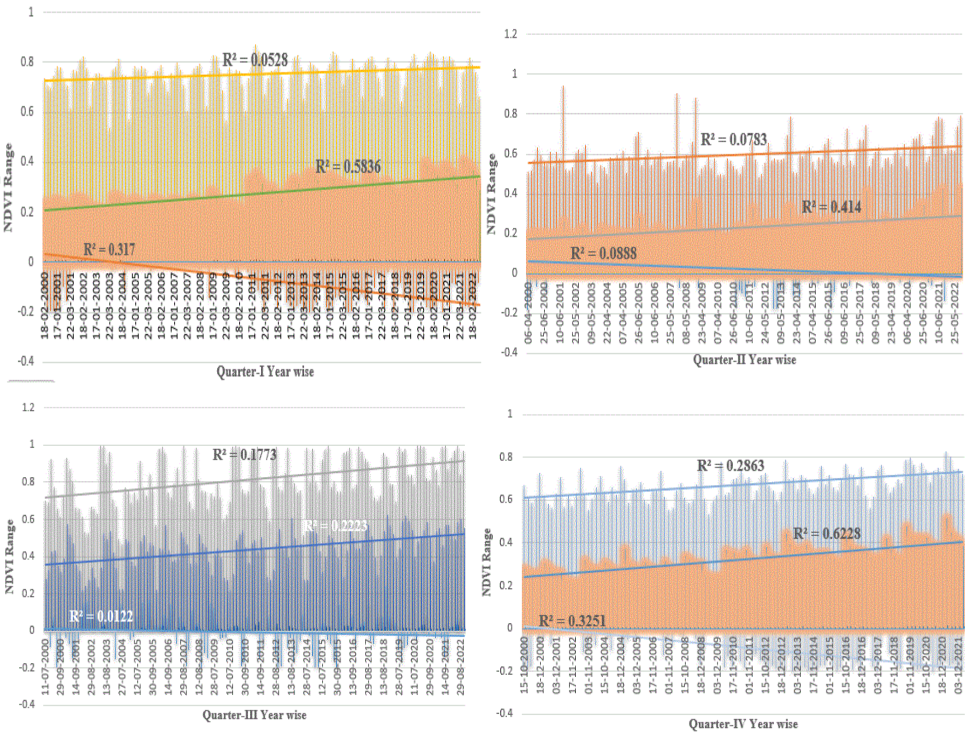

Figure 5.3. Quarter wise variation in NDVI from 2000-2022

After summers in all the years the average NDVI values for quarter III and IV showing increase on comparing previous quartes. The trend line and coffiecent of co-relations are 0.1773 and 0.2863 for Q-3 and Q-4 while Q-1 and Q-2 are having 0.0528 and 0.0783 for maximum NDVI values as shown in Fig.5.1.

Table 5.1: Annual Quarter wise distribution of NDVI

Year	NDVI values for Quarter-I			NDVI values for Quarter-II			NDVI values for Quarter-III			NDVI values for Quarter-IV		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
2000	-0.11	0.74	0.24	-0.02	0.56	0.19	-0.20	0.66	0.35	-0.17	0.59	0.26
2001	-0.19	0.79	0.24	0.01	0.94	0.26	-0.13	0.66	0.36	-0.07	0.56	0.27
2002	0.04	0.77	0.25	0.09	0.60	0.23	0.09	0.66	0.29	0.07	0.57	0.21
2003	0.11	0.75	0.21	0.03	0.54	0.23	-0.01	0.71	0.42	-0.04	0.61	0.27
2004	-0.03	0.78	0.26	0.07	0.57	0.20	-0.05	0.69	0.38	-0.10	0.66	0.27
2005	0.12	0.79	0.25	0.11	0.71	0.28	0.17	0.84	0.48	0.03	0.65	0.29
2006	-0.01	0.77	0.24	0.02	0.58	0.24	0.07	0.74	0.44	0.13	0.65	0.27
2007	0.12	0.75	0.24	-0.01	0.90	0.21	-0.19	0.79	0.47	-0.03	0.56	0.28
2008	0.04	0.78	0.25	0.10	0.88	0.35	-0.12	0.75	0.45	0.00	0.60	0.30
2009	0.01	0.83	0.27	0.05	0.58	0.23	-0.04	0.60	0.29	0.01	0.60	0.24
2010	0.06	0.75	0.22	0.08	0.54	0.17	-0.19	0.76	0.54	-0.18	0.70	0.35
2011	-0.12	0.79	0.32	0.08	0.67	0.33	-0.15	0.79	0.50	-0.12	0.60	0.31
2012	-0.13	0.77	0.30	0.08	0.57	0.24	-0.20	0.77	0.55	-0.17	0.64	0.33
2013	-0.17	0.75	0.32	0.02	0.79	0.33	-0.12	0.74	0.45	-0.20	0.70	0.37
2014	-0.20	0.80	0.35	0.00	0.64	0.23	-0.20	0.80	0.53	-0.20	0.65	0.36
2015	-0.18	0.77	0.34	0.02	0.68	0.28	-0.16	0.81	0.45	-0.18	0.66	0.32
2016	-0.20	0.75	0.30	-0.02	0.73	0.30	0.09	0.77	0.50	-0.19	0.71	0.37
2017	-0.15	0.80	0.34	0.10	0.74	0.41	-0.05	0.78	0.51	-0.18	0.62	0.32
2018	-0.04	0.82	0.32	0.07	0.58	0.28	0.08	0.80	0.57	-0.11	0.63	0.37
2019	-0.14	0.71	0.31	0.00	0.65	0.25	-0.08	0.84	0.59	-0.15	0.80	0.43
2020	-0.15	0.80	0.40	0.09	0.64	0.35	0.08	0.82	0.59	-0.20	0.74	0.39
2021	-0.20	0.82	0.38	0.08	0.78	0.42	-0.14	1.00	0.57	-0.17	0.80	0.45
2022	-0.20	0.76	0.41	0.10	0.79	0.43	0.02	0.97	0.56	-0.20	0.74	0.41

In the winters average NDVI values are found in Q-1 and Q-4 due to prevailing favourable environmental conditions for the growth of vegetation also the corelation coffiecient lies in the range of 0.58-062. The average NDVI values settled for all the quarters 0.3-0.85. The highest values for average NDVI values lies in Q-3 and Q-4. The minimum NDVI lasted 0 to -0.25 for Q-1, 0 to-0.5 for Q-2, 0 to -0.3 for Q-3 and 0 to -0.2 for Q-4 respectively. The cofficient of corelation for minimum NDVI values is highest i.e.0.3251 for Q-4 and lowest in the summer and post summer season 0.0122 along with 0.0888 for Q-2 and Q-3 respectively.

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A study on the application of the grey wolf optimizer for find the parameter of photovoltaic model

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1. Abstract.

Modeling the PV cell is crucial for many photovoltaic PV applications. However, the model parameters are typically absent from the datasheet that the manufacturers supply and they alter as a result of degradation. The dwindling supply of fossil fuels and the carbon emissions that cause global warming and climate change have caused power producers to turn their attention away from traditional energy sources and toward sustainable energy alternatives. The most popular solution to these issues is solar cells. To obtain high efficiency, it is crucial to estimate solar cell parameters precisely before installation. Applications of several optimization techniques for solar cell parameter estimation have been investigated in recent years. The intelligent grey wolf optimizer (IGWO), an improved version of the grey wolf optimizer (GWO), has recently been introduced. It incorporates opposition-based learning and a sinusoidal truncated function as a bridging mechanism. Voltage and current measurements are taken at three crucial moments for estimating the PV cell parameter values. There are three points(open circuit, short circuit and maximum power point) for the single diode model and the double diode model . On these two models and for three films, the findings of IGWO are contrasted with those of other GWO variations. Keywords: Photovoltaic (PV) module, grey wolf optimization algorithm, model parameters I.

Keywords. Photovoltaic (PV) module, GWO, IGWO

2. INTRODUCTION

For PV systems, various models have been put forth in the literature. The most well-known models in literature are thought to be the single diode model (SDM) and double diode model (DDM). A semiconductor PN junction called a PV cell is used to convert solar current into an electrical current. Nonetheless, the main model of the solar cell have to take into the terms of loss of light and current that mainly represented by the diodes. The main model of the solar cell can be basically shown by an ideal current source. More losses are represented by the model with more diodes. One diode in the SDM symbolises the loss in the quasi-neutral zone. Five calculated parameters make to an SDM. By including a second diode in the model, DDM is created to represent the loss in recombination at lower irradiance. Seven factors in total have been estimated for DDM

One (single) diode model and two (double) diode model

A one diode model is favored for its precision, quick convergence, and clarity is The I- V characteristic of a single diode model can be represented numerically as :

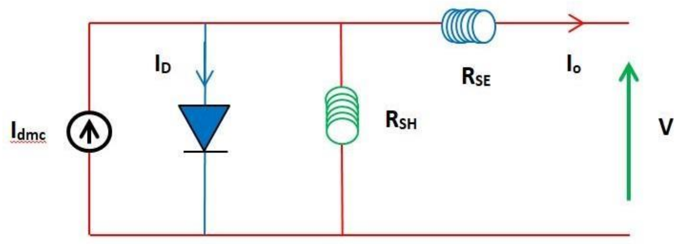

Figure 1. Representive circuit of PV module (one Diode Model)

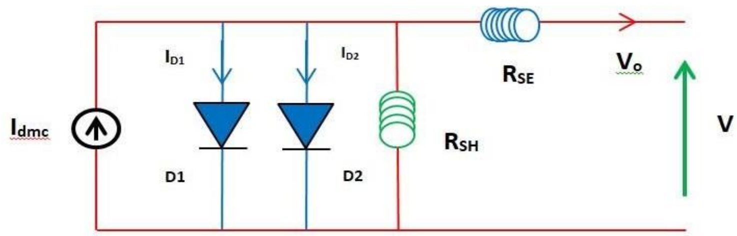

Figure 2. Representive circuit of PV module (two Diode Model)

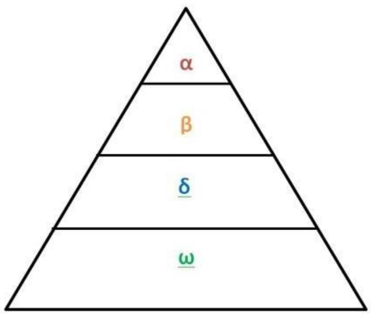

Figure 3. As per dominance up to down hierarchy of Grey Wolves

$$I_O = I_{dmc} - I_{rsc}\left[exp\left(\frac{q(V + IR_{SE})}{\psi KN_S T}\right) - 1 - \left(\frac{V + I_O R_{SE}}{R_{SH}}\right)\right] \quad (1)$$

We need deep understanding of pv cell parameter for design and process of optimization. Here it is 3 case at 3 crucial points.

Case-1 V = $VOC$and IO = 0 at open path, then Eq. (1) reduces to:

$$I_{dmc} = I_{rsc}\left[exp\left(\frac{qV_{OC}}{\psi KN_S T}\right)\right] + \frac{V_{OC}}{R_{SH}} \quad (2)$$

Case-2 V = 0 and IO = ISC for short circuit path, then from Eq. (1) we find:

$$I_{dmc} = I_{SC} + I_{rsc}\left[exp\left(\frac{qR_{SE}I_{SC}}{\psi KN_S T}\right) - 1\right] + \frac{R_{SE}I_{SC}}{R_{SH}} \quad (3)$$

from Eqs. (2) and (3), we get,

$$I_{rsc} = \frac{I_{SC} + \frac{R_{SE}I_{SC}}{R_{SH}} - \frac{V_{OC}}{R_{SH}}}{exp\left(\frac{qV_{OC}}{\psi KN_S T}\right) - exp\left(\frac{qR_{SE}I_{SC}}{\psi KN_S T}\right)} \quad (4)$$

Substituting equation Eqs 4 into 2:

$$I_{dmc} = \frac{\left(I_{SC} + \frac{R_{SE}I_{SC}}{R_{SH}} - \frac{V_{OC}}{R_{SH}}\right)\left[exp\left(\frac{qV_{OC}}{\psi KN_S T}\right) - 1\right]}{exp\left(\frac{qV_{OC}}{\psi KN_S T}\right) - exp\left(\frac{qR_{SE}I_{SC}}{\psi KN_S T}\right)} + \frac{V_{OC}}{R_{SH}} \quad (5)$$

Case-3 $V = V_{MPP}$ and $I_O = I_{MPP}$ at Maximum Power point,Eq. (1) reduces in:

$$I_{MPP} = I_{dmc} - I_{rsc}\left[\exp\left(\frac{q(V_{MPP} + R_{SE}I_{MPP}}{\psi KN_S T}\right) - 1\right] - \frac{V_{MPP} + R_{SE}I_{MPP}}{R_{SH}} \quad (6)$$

And hence we can get the euation of double diode model too.

3. NUMERICAL DATA

Into Three different types of solar cell modules—monocrystalline, polycrystalline, and thin-film—are taken into consideration in this work. The typical data provided by the designer shown as. It goes without saying to state that the designer provides data for voltage and current at three critical locations under standard test conditions of 1000 W/m2 and 25 °C.

Increasing the number of diodes improved the model's accuracy, but it also made it more complicated. By include a third diode in the model, the 3 diode model (TDM) is made for reflect the leakage in grain bound-arise in Photovoltic systems. Nine parameters in all are estimated for TDM. Increasing the number of diodes improved the model's accuracy, but it also made it more complicated. The difficulty of estimating these models' parametersusing optimization techniques has been covered in numerous earlier studies To estimate the PV parameters of TDM, the Grasshopper Optimization Algorithm was introduced in. As per , to calculate the parameter value of PV panel of SDM and DDM, a quick grey wolf optimizer was initially presented. The goal of the intelligent grey wolf optimizer is to improve the exploration and exploitation stages of the grey wolf optimizer (GWO) by incorporating opposition-based learning.

Table 1 Electrical parameters for PV cells at standard test conditions

Type	Monocrystalline [36]	Polycrystalline [37]	Thin-film [36]
Number of cells in series, N_S	36	54	36
Temperature coefficient (I_{SC},$K_{I,SC}$) (amp/°C)	0.8×10^{-3}	3.18×10^{-3}	0.35×10^{-3}
Temperature coefficient (V_{OC},$K_{V,OC}$ (volt/°C))	− 0.0725	− 0.123	− 0.1
Voltage at maximum power point, V_{MPP} (volt)	17.20	26.3	16.60
Current at maximum power point, I_{MPP} (amp)	4.95	7.61	2.41
Open circuit voltage, V_{OC}	22.20	32.9	23.30
Short circuit current, I_{SC}	5.45	8.21	2.68

4. BRIEF OVERVIEW OF GWO AND DEVELOPMENT OF INTELLIGENT GREY WOLF OPTIMIZER (IGWO)

Grey wolf optimizer A population-based swarm intelligence approach used today. This approach was suggested by and is inspired by grey wolf behaviour. Grey wolves naturally possess a hunting strategy and a hierarchy of leadership, and GWO replicates these benefits. A member of the candidate family is a grey wolf. Grey wolves typically reside in groups of 5 to 12 individuals. In total, there are four groups of wolves: "α wolves" refer to the dominant and most dominating wolves in each of the four subcategories. β wolves are ranked second to alpha wolves in terms of dominance. The β wolves are used to help α wolves when decide judgments or performing other projects. The delta wolves follow the directions given by the alpha and beta wolves. Omega wolves are in the bottom rank in the hierarchy. They serve as the scapegoat for the wolf group. References discuss a few GWO applications. The following are some of the key steps that the algorithm elaborates: prey encircling•

prey encircled mathematical representation by the grey wolves given as:

$$\vec{N} = |\vec{M}.\vec{Y}_P(t) - \vec{Y}(t)| \qquad \text{……….7}$$

$$\vec{Y}(t+1) = \vec{Y}_P(t) - \vec{K}.\vec{N} \qquad \text{…………..8}$$

$$\vec{N}_\alpha = |\vec{M}_1.\vec{Y}_\alpha - \vec{Y}|, \quad \vec{N}_\beta = |\vec{M}_2.\vec{Y}_\beta - \vec{Y}|, \quad \vec{N}_\delta = |\vec{M}_3.\vec{Y}_\delta - \vec{Y}| \qquad \text{……9}$$

$$\vec{Y}_x = \vec{Y}_\alpha - \vec{A}_x.(\vec{D}_\alpha), \quad \vec{Y}_y = \vec{Y}_\beta - \vec{A}_y.(\vec{D}_\beta), \quad \vec{Y}_z = \vec{Y}_\delta - \vec{A}_z.(\vec{D}_\delta) \qquad \text{……10}$$

$$\vec{Y}_{(t+1)} = \frac{\vec{Y}_x+\vec{Y}_y+\vec{Y}}{3} \qquad \text{………..11}$$

here t=current iteration, Y→= position vector of Grey Wolf , coefficient vectors= $K\vec{}$ and $M\vec{}$, and $Y\vec{}$, p= the position vector of the prey. We can calculate the vectors $K\vec{}$ and $M\vec{}$ as follows:

4. Intelligent GWO

A more modern version of GWO is IGWO [10]. Two changes have been made for better exploration and exploitation in order to expand the search capability. The first uses a sinusoidal truncated function to integrate a control parameter for enhanced exploitation and exploration. Opposition-based learning is employed in the 2nd modification to improve exploration.

$\vec{c}$ is varies as a crop sinusoidal function rather than to decrease linearly as per Eqs. (12) and (13). Grey wolves nicely moving after hunting, this step is copy by linear decrement in $\vec{c}$ .During along, the values of $\vec{c}$ are top in 1st half where as in other half values of $\vec{c}$ down very rapidly as compared with the classical GWO which is shown in Fig. 4. .

$$K = \pi * \frac{Current\ Iteration}{Maximum\ Iteration} \qquad \ldots\ldots\ldots\ldots\ldots 12$$

$$C = 2 * [1 - \sin^2(\frac{K}{2})] \qquad \ldots\ldots\ldots\ldots 13$$

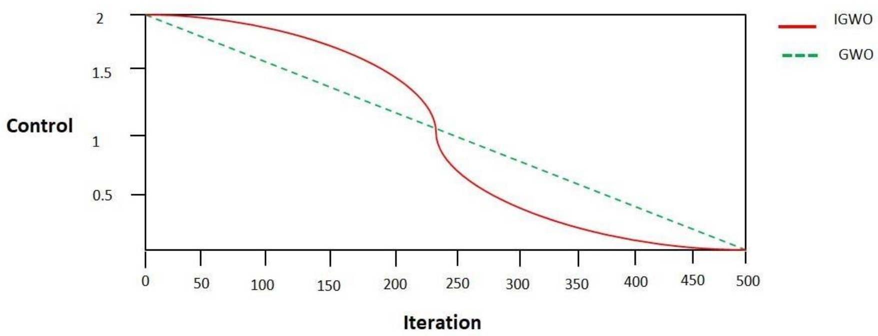

Figure 4. By using sinusoidal truncated function variation of control parameter

Opposition based learning• the search process begins with an educated prediction or a random starting point. Convergence can happen faster if the starting point is close to the ideal solution. On the other hand, convergence takes longer if the chosen initial point is distant from the ideal site

Definition 1: y[a,b] is a real number, then the opposite number of y is defined by:

$$\breve{y} = a + b - y \qquad \ldots\ldots\ldots\ldots 14$$

Definition 2:

Let a point in Q dimensional space is A=($y1$, $y2$, … … … , yQ), where $y\epsilon R$, ∀ $t\epsilon$(1, 2, … … … . .Q) and it is bound by [a,b], the across from points matrix can be given by

$$\bar{A} = [y_1, y_2, y_3, \dots \dots \dots \dots \dots \dots . . y_Q] \qquad \dots\dots\dots\dots\dots 15$$

Hence, $\bar{y}_i = [a_t + b_t - y_t]$ 16

5. DISCUSSION

0 50 100 0 150 200 250 300 350 400 450 500 0.5 1 1.5 2 Control Iteration Figure 5: By using sinusoidal truncated function variation of control parameter IGWO GWO In contrast to forward produce approaches on GWO, the variant IGWO highlights the value of a mechanism for connecting the exploration and exploitation phases . However, the authors of reference have suggested a chaotic method. With these algorithms, the importance of effective bridging between the exploration and exploitation stages has been effectively demonstrated. Additionally, the application of opposition theory has been highlighted. These examples provide sufficient scientific evidence that the optimization capabilities of an algorithm can be significantly improved by an adaptive bridging between the phases of population diversification and intensification as well as some initial population diversification using opposition-based learning

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Ecological Footprint Assessment of Building Materials

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Abstract

Building materials are responsible for huge resource utilizations during the building lifespan, therefore, the study of environmental impact of building materials is very important. This study is evaluated on the environmental impact of different building materials on the planet. The presented approach needs information from the process on energy use and/or carbon dioxide emissions lifecycle analysis (LCA) research and information on agricultural and forestry land are used to calculate the value of a material's Ecological Footprint. The findings in this study can also support and facilitate the discussion of the meaningful targets required to achieve the United Nation Sustainable Development Goals.

Keywords. Building Materials, Ecological Footprint, Sustainability, Environment Assessment, Carbon Emissions.

1. INTRODUCTION

The most significant element impacting natural resource consumption, enormous energy demand, greenhouse gas (GHG) emissions, waste assimilation, etc. is due to urbanization. [1]. Around the world, the construction industry is responsible for about 40% of the material use. [2], approximately 32% of the world's total energy consumption, but only 19% of the GHG emissions related to energy [3]. Indian construction industry’s annual growth rate at 5.6% from 2016 to 20; by 2025, it may increase yearly to 7.1% [4]. However, buildings in India utilise one-third of all the power produced and one-quarter of all the primary energy consumed globally [5].

The usage of building materials (30%), C&D waste production (25%), water use (25%), and land use (12%), of which 10-20% is consumed during the duration of the building, all have an influence on the environment [6]. There have been numerous studies on the use of energy [4,5], greenhouse gas emissions [5], C&D waste creation [10], transportation of building materials and trash [4], and water use [5] in buildings. By 2030, it is anticipated that India will utilise almost 15 billion tonnes of materials, and by 2050, it will rise to 25 billion tonnes. [4].

The environmental impact analysis of construction materials is the main topic of this study. The Ecological Footprint of different types of building materials have been estimated. This study is important because, in the near future, a large infrastructure improvement will be required to improve living standard in India as well as to achieving the vision of ‘House to All’. This study will be useful for determining the construction industry's environmental impact and for outlining a strategy for producing sustainable building materials. A study of this kind would be useful in determining how the country's building sector's energy efficiency might be reduced to decrease the ecological footprint on environment.

2. METHODOLOGY

2.1 EF of Building Materials (EF_m)

Building materials have some significant environmental impact. In this study, the EF_m has been estimated based on two parameters: (1) manufacturing impact, (2) natural impact. While extracting materials, neglecting the usage of the land. The EF_m has been calculated by Eq. 1 [1]:

$$EF_m = \underbrace{\sum \left(\frac{(Ci+Ri).Emi}{Af/(1-Aoc)}\right).e_{CO2\,land}}_{\text{Manufacturing impact}} + \underbrace{\sum \left(\frac{Cwi}{Ywi}\right).e_i}_{\text{Natural impact}} \qquad (1)$$

2.2 Details of Building Materials

Cement, bricks, steel, aggregates (fine and coarse), glass, aluminium, and other basic materials are taken into consideration.

2.2.1 Cement

Essentially, Portland cement is made of combinations of lime (calcium oxide, CaO) mixed with silica (silicon dioxide, SiO_2) and alumina (aluminium oxide, Al_2O_3). The embodied energy of Ordinary Portland Cement (OPC) is reported as 2.38 MJ/kg to 3.72 MJ/kg for the Indian cement industries [1].

2.2.2 Bricks

Bricks are responsible of significant amount of environmental impact [5]. The comparative environmental impact assessment of different types of bricks should be examined. The details of some general bricks are given in Table 1.

Table 1 The details of different types of bricks and blocks

Building material	**Embodied Energy**	**Remarks**
Fired Clay Brick (230×115×75 mm^3)	1.2 – 4.14 MJ/kg	Clay is main component
Compressed Stabilised Earth Block (CSEB) (Size: 300x150x100 mm^3)	2.75 – 3.75 MJ/block	Clay and sand are main materials
Fly Ash Brick (FAB) (Size: 230x115x75mm^3)	800–4750 MJ/ m^3 of bricks.	60% fly ash, 30% sand, and 10% cement (made of lime and gypsum)
Sun-dried Brick (SDB) (Size: 230x115x75mm^3)	0.033 – 0.187 MJ/1000 bricks	Raw material extraction and manual casting.
Autoclaved Aerated Concrete Block (AAC) (Size: 400x200x200 mm^3)	3.2 - 4.0 MJ/kg	Light weight and low-density block

2.2.3 Steel

Steel reinforcement has been used to enhance the concrete tensile strength. Different grade of steel bars is available in different sizes (diameter) like 8mm, 10mm, 12mm, 16mm, 20mm, 25mm and 32mm. Embodied Energy of steel production is reported as 16.4–34.23 MJ/kg [5].

2.2.4 Aggregate

Rocks that have been crushed are typically used as aggregates in building construction. At 0.04 to 0.083 MJ/kg, aggregates' embodied energy is quite low [3]. The 4.75 mm IS sieve size retained the coarse particles. The ideal coarse aggregate consists of angular-shaped, screened crushed rock that is devoid of organic materials, dust, clay etc. The fine aggregate retained on an IS sieve with 0.075 mm. It should be free of organic debris, loam, and clay, and should be clean screened dusts. The details of size of aggregate mention in Table 2.

Table 2 Details of aggregate size

Types of Aggregates	Size (mm)
Coarse aggregate	4.75 mm - 40 mm
Fine aggregate	0.075 mm - 4.75 mm
Filler or Dust	< 0.075 mm

2.2.5 Ceramic Tiles and Granite/Marble Slab

A composition for ceramic tiles that was made from resources including granite and contains the elements listed below, expressed in weight percentages depending on the composition's overall weight: SiO_2 (56–64 wt%), Al_2O_3 (15–17 wt%), K_2O (2–3 wt%), Na_2O (0.5–1.5 wt%), CaO (5–5.7 wt%), MgO (0.5–0.6 wt%), and L.O.I. (7–9 wt%). According to the research, ceramic tile has an embodied energy value of 2.20–14.87 MJ/kg., polished marble and granite stone slabs have an embodied energy of 1.53-2 MJ/kg and 0.01-13.90 MJ/kg, respectively [4,5].

2.2.6 Glass

Glasses are made from sand (silicon dioxide, or SiO2), limestone (calcium carbonate, or CaCO3), and sodium carbonate (Na2CO3). Float glass is believed to have an embodied energy of 7.88 to 15 MJ/kg [5].

2.2.7 Wooden Materials

It is an organic substance made of naturally occurring cellulose fibres, which are strong under tension, embedded in a lignin matrix, which resists compression. Wood has been used to build things like windows, doors, and furniture in construction industry. Embodied Energy of wooden product is reported as 4.60–34.1 MJ/kg.

2.2.8 Insulation Materials

Different natural including minerals, vegetable fibres, animal products, and synthetic substances, are used to make insulation materials. The details of insulation materials are mentioned in Table 3.

Table 3 Embodied energy of insulation materials

Insulation	
Material Description	**Embodied Energy in MJ/kg**
General Insulation	45.00
Cellular Glass	27.00
Cellulose	0.94 to 3.3
Cork	4.0
Fibre glass (Glass Wool)	28.0
Flax (Insulation)	39.5
Mineral Wool	16.6
Paper Wool	20.17
Polystyrene	See Plastic
Polyurethane	See Plastic
Rock Wool	16.80
Wood Wool (Loose)	10.80
Wood Wool (Board)	20.00
Wool (Recycle)	20.90

3. RESULTS AND DISCUSSUON

The building materials manufacture such as cement, bricks, steel, ceramic tiles and insulation materials etc. require a large quantity of natural resources and energy. The small amount of embodied energy (or embodied carbon emissions) in one ton of building material, when used in large quantity in a building, results in construction contributes huge amount of GHG emissions and high constructional Ecological Footprint of building. Therefore, Ecological Footprint of building materials are estimated as follows:

3.1 Cement: Each building material has a vastly different amount of embodied energy (or emissions), especially cement because cement manufacture requires a lot of energy. The EF of cement is estimated as 0.042 – 0.072 gha/ton.

3.2 Bricks: A comparative environmental effect evaluation based on ecological footprint has been estimated in this study since bricks have a considerable ecological impact. Table 4 provides specifics regarding the Ecological Footprint Assessment of ordinary bricks.

Table 4 The details of Ecological Footprint of brick/block

Building material	**Ecological Footprint [6]**	**Remarks**
Fired Clay Brick (230×115×75 mm^3)	0.07 – 0.32 gha/1000 bricks	Density:1800-2400 kg/m^3; (1 m^3 = 600 bricks)
Compressed Stabilised Earth Block (CSEB) (Size: 300x150x100 mm^3)	0.053 – 0.073 gha/ 1000 blocks	--
Fly Ash Brick (FAB) (Size: 230x115x75mm^3)	0.026 – 0.154 gha/ 1000 bricks	--
Sun-dried Brick (SDB) (Size: 230x115x75mm^3)	6.4×10^{-7} – 3.6×10^{-6} gha/1000 bricks	--
Autoclaved Aerated Concrete Block (AAC) (Size: 400x200x200 mm^3)	6.2×10^{-5} – 7.7×10^{-5} gha/kg	--

3.3 Aggregates

It is the most voluminous ingredient in most building materials, and it has the highest mixture weight in building construction. The Ecological Footprint of aggregate production is estimated as 0.0008 – 0.0016 gha/ton.

3.4 Ceramic Tiles and Granite/Marble Slab

The Ecological Footprint of ceramic tiles is estimated as 0.04 – 0.29 gha/ton. The EF of polished granite and marble slab is estimated as 0.0002 – 0.27 gha/ton.

3.5 Glass

Glass has an estimated 0.15 to 0.2 gha/ton ecological footprint.

3.6 Wooden product

The Ecological Footprint of wooden product is estimated as 0.11 – 0.69 gha/ton.

3.7 Insulation Materials

Insulation materials come from different sources like minerals, vegetable fibres, animal products, and synthetic compounds. The Ecological Footprint of Insulation materials is estimated as 0.018 – 0.873 gha/kg.

4. CONCLUSION

Construction sector plays very important role in the development of any nation. This construction result in generating the CO_2 emissions and effect the ecosystem of the planet. Materials processing of building materials consume energy resources and manpower and at the same time emersion of CO_2 effect the ecological footprint on the globe. The Ecological Footprint of different construction materials estimated in this study. Ecological Footprint of cement is as 0.042 – 0.072 gha/ton which is important building material in construction. It indicated that the partial replacement of cement in concrete in construction to reduce overall Ecological Footprint of the construction.

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Prediction of load profile in the presence of electric vehicles for microgrid: A Review

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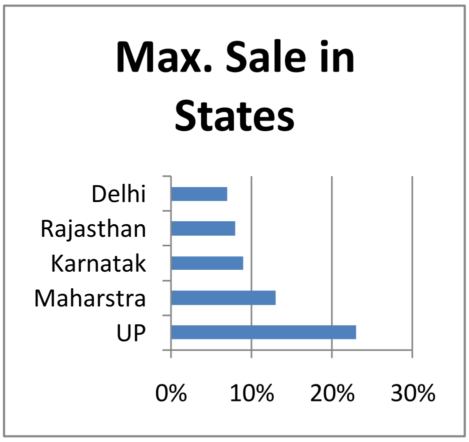
Abstract: This is right time to move towards pollution free traffic and penetration of electric vehicles are the key to maximising the benefits of low-carbon electricity and clean transportation. As the EV industry growth rate increasing in the coming future which in turn the requirement of charging stations to supply EVs. But uncontrolled charging may cause the grid to experience more peak load, needing distribution-level improvements. This paper proposes a conceptual framework to know the peak load of the system, energy requirement in a day, month & year for prediction of load profile to manage the electricity demand in the presence of EVs.

Key Words: EVs, load profile, micro-grid, load forecasting.

1. Introduction

EVs are considered to be a sustainable alternative to the internal combustion engine vehicles (ICEVs). Transportation sector account for approximately 28 % of the global greenhouse gas (GHG) emissions [1]. Since EVs having batteries with high energy storage capacity will require the increased electricity consumption. The EVs charging patterns will disrupt the load profile. Due to issues such high initial costs, battery deterioration, a lack of adequate charging infrastructure, and range anxiety, the adoption of EVs is still slow [3]. Governments around the world implement a variety of policies and incentives to encourage the use of EVs and to overcome the barriers that prevent a complete transition to electrified transportation. According to the International Energy Agency's "Global EV Outlook 2021," the total number of EVs is expected to reach 145 million by 2030 [4].

In the global EV market India is a big market in comparison to other countries. Figure (1) shows the deployment of electric vehicles in various countries. At present **870141** EVs have been registered in India [5]. It is forecasted that India will be the fourth largest market for EVs by the year 2040 [6].



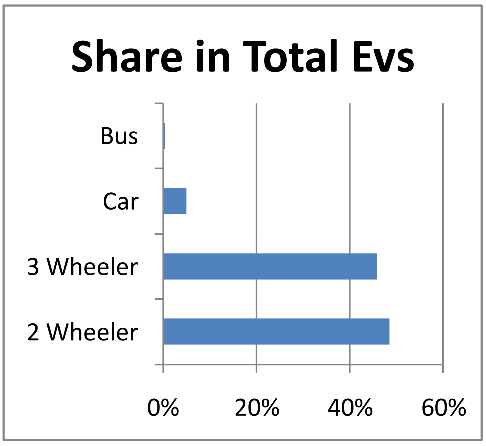


Fig. 1: Max. Sale & Share of EVs

According to JMK research and analytics report in December 2021 first time EVs sale crosses the figure of **50000** units (i.e. 50866). It was **42055** in November. Due to rise in price of petrol-diesel the sale of EVs increasing. It is expected that in 2022 the sale of EVs would be more than **10 Lac.** In the next 5 years total number of EVs would be expected more than 12 % in the country [7].

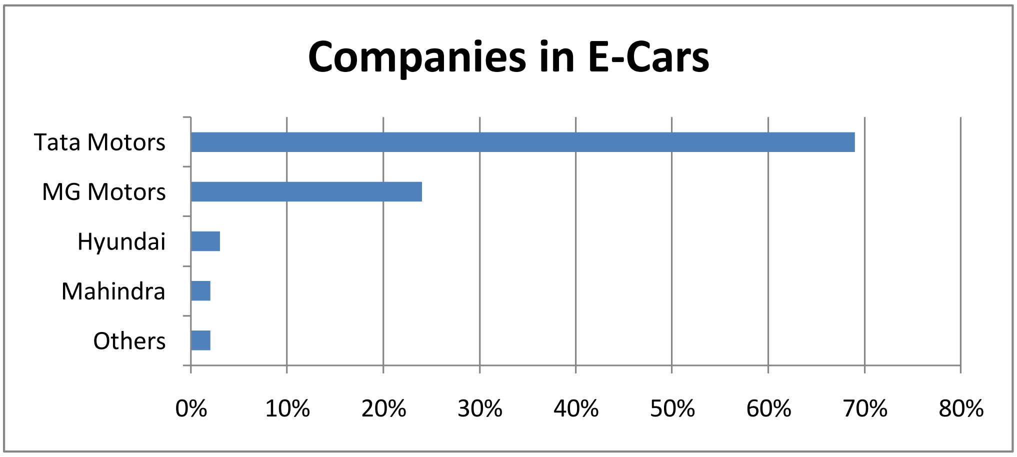


Fig. 2: Companies in E-Cars

From fig.1 & 2 it is obvious that maximum sale of EVs registered in Uttar Pradesh in India. Rajasthan is fourth largest state in sale of EVs. Almost 95% share in total EVs is of two and three-wheeler vehicles. In India for E-cars Tata Motors is leading company.

2. Modes of EV integration with the electrical grid

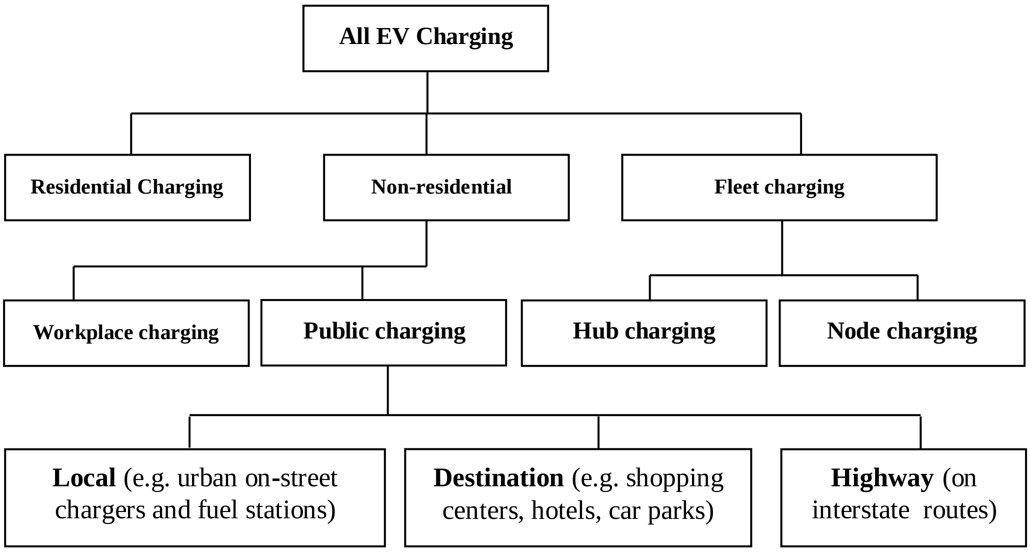
(1) Unidirectional mode (2) Bi-directional mode

Unidirectional mode is also known as G2V mode. Into this mode Electric power flows from grid to vehicle i.e. battery is charging. The goal of this mode is to reduce the impact on the distribution system or the cost of charging [8-10]. From generation to transmission & transmission to distribution, power flow is uni-directional [8]. Vehicle-to-grid technology allows for the bidirectional flow of energy between EVs and the grid (V2GInformation and communication technologies (ICT) are combined with the electric vehicle charging infrastructure to achieve this. In bidirectional mode, an EV is both a load and a distributed generation and storage system for the grid. When grid is in peak period, EV battery send the energy back in the grid, known as peak load shaving [11, 12]. A research letter claims that peak load reduction is not at all as essential as V2G mode in the auxiliary market: spinning reserve & voltage management. In contrast to peak load shaving, spinning reserve is the additional generation that may be created or made available, and it is compensated for both the availability and the time it is asked for deployment, making the deployment of EVs in the provision of ancillary services highly economically possible. Additionally, compared to peak load shaving, which only requires a few hundred hours per year [18], voltage regulation is necessary more than 300 times per year[19]. Only energy was transferred from EVs to the distribution system when V2G first started. However, two new energy transfer modalities have emerged as a result of scientific advances (V2H and V2V). According to Assad Mohammad in his study [3], the bidirectional energy transfer from EV is now classified as follows:

i) Energy transmission from an electric car to a distribution network is known as vehicle-to-grid (V2G).
ii) Energy transmission from an electric car to home or building is known as vehicle-to-home/building (V2H/V2B).
iii) Energy transmission from one electric vehicle to another electric vehicle is known as Vehicle-to-vehicle (V2V).

3. EV Charging and Control Methodologies

Appropriate charging infrastructure is a must for this paradigm shift to sustainable transportation, promoting EV use as a practical choice for short- and long-distance travel.



Based on the occupancy patterns and parking provisions in the various types of the buildings, charging infrastructure for EVs must be 20% of total parking capacity of the building [21]. The basic infrastructure of EV charging is shown as below [22]:
Charging infrastructure requirements for public charging station must include: connection and metering, charger types, additional charger, no. of charging points etc. Guidelines and standards for charging infrastructure are prescribed and notified by ministry of power [21]. At least one charging station must be available within the range of (3Km* 3Km) and battery swapping station may be added with charging station.

4. Key factors affecting load profile

As we know the nature of electrical load is resistive, inductive and capacitive. All natures of power system load can be broadly classified into domestic, commercial, industrial and agriculture load & how they affect the electricity market [24-26]. With electrical vehicles on microgrids load depends on the followings:

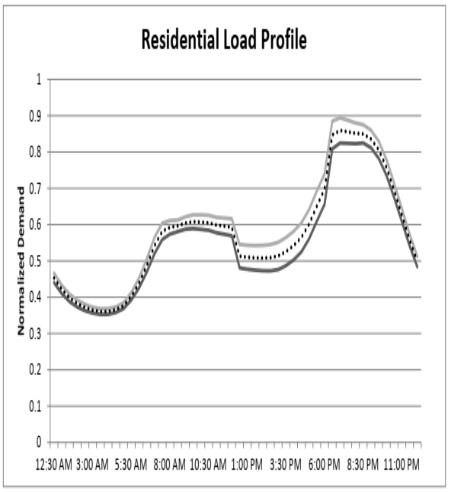
- Universities
- Shopping centers
- Airport parking
- Public car parks
- Workplace charging
- Apartment buildings
- Hotel parking
- Local parking
- Highway charging
- Dedicated fast charging stations
- Taxi fleets
- Bus fleets
- Clusters of local and destination chargers

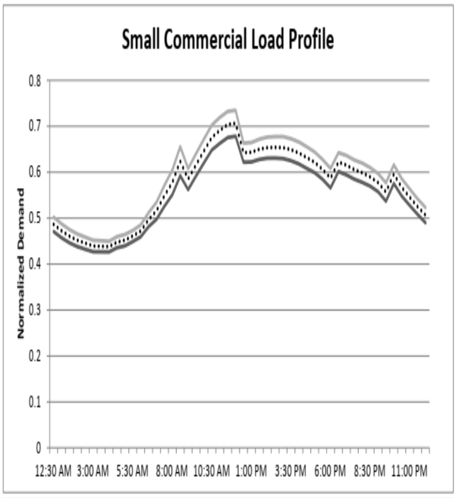
5. Estimating load profile & prediction of load

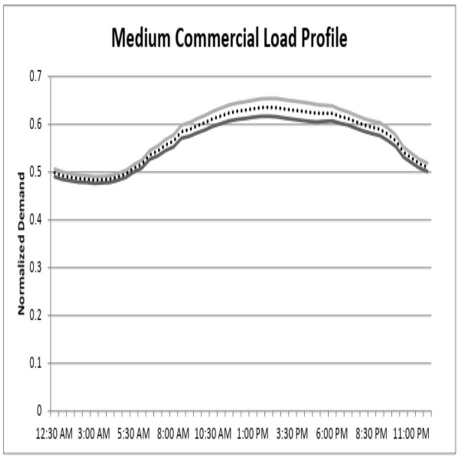
The calculation of load profiles consists of two major tasks:
(1) Selection of a portion of individual profiles, and (2) Expansion to the total population
This decision is made after calculating the individual charging profiles, which identify each individual's electricity usage and demand from the grid..

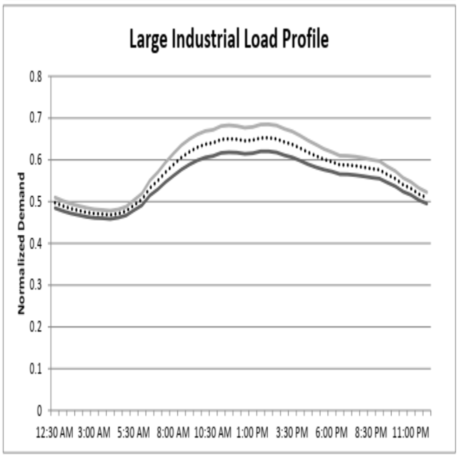
5.1 Prediction of load

Given the uncertainties surrounding vehicle adoption rates as well as the future growth of the transportation sector in terms of the mix of mobility types and infrastructure solutions for charging, predicting the load profile due to EVs on distribution networks is a challenging task. At the same time, the energy market is being disrupted by a shift toward renewable energy sources, both on a grid scale and through distributed generation.. Following graphs shows the individual load profiles [30-33]: (Residential; Small commercial; Medium commercial; & Large industrial load profile). From the observation of the graphs it can be concluded that (i) during evening hour residential load profile shows maximum demand & small commercial load profile indicates that load is maximum during noon hours, (ii) medium commercial & large industrial load profile indicates flat load demand from morning to evening hours.









5.2 Approaches

Distributors need to make sure the network has the capacity to accommodate the variety of charging infrastructure being built as the EV market matures. This will most likely be done through a variety of techniques, such as:

- Making use of "smart" EV charging
- Pricing cues to encourage charging outside of times of high demand
- Promoting the use of high-powered public chargers when network capacity is available
- Specific network improvements
- Identify possible network charging hotspots, or locations where heavy charging demand may be experienced (such as shopping malls, quick chargers, workplace chargers, etc.).

6. Proposed methodology & mathematical model

- **Renewable energy generation forecast**
- **Net load forecast**

Usually following three types of model can be used for renewable energy generation and net load forecast.

(1) The autoregressive model (AR) is a time-series regression model. The output of this model can be expressed as a linear combination of previous outputs/measured values.

(2) Exogenous input autoregressive model (ARX)

ARX model is an extension of the AR model that includes external inputs such as renewable energy generation forecast values.

(3) Regression with Support Vectors (SVR)

The supervised machine learning algorithm underpins the Support Vector Regression technique.

6.1 Methodology steps

Step 1: Electric Load forecasting

- Knowledge-Based Approaches
- Data-Based approaches
- Utilize abundantly available historical data available with utilities
- Persistence forecast model

Step 2: Load profile analysis

- Clustering to determine the Active and passive load

Step 3: Household load flexibility

- Disaggregated load profile
- Evaluate the flexibility of Energy consumption

Step 4: Prediction of household flexibility

- Prediction of disaggregated load profile

6.2 Mathematical model

Persistence forecast model

$$P(t+k/t) = \frac{1}{T}\sum_{i=0}^{n-1} P(t-i.\Delta t)$$

Where $P(t+k/t)$ is the forecast for time (t + k) calculated at instant t; T is the prediction interval length, and n is the number of historic measurements; $P(t-i.\Delta t)$ is the measured power for time t and the previous i time steps within T; and Δt is the measured time series time step length. During the forecast algorithm implementation, data is available every minute for 24 hours.

7. Conclusion

The impact of EVs on the electricity sector is determined by the following factors:

- Market penetration
- Charging timing (peak/off-peak)
- Charging duration (slow/fast)
- Load and demand management
- Power sector structure
- Access to renewable energy sources

Future power systems must use the most flexible renewable energy sources possible, just as future transportation must become increasingly electrified. Smart charging reduces the load impact of electric vehicles while enabling increased solar and wind power usage.

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Newer Dimension in Harnessing Wind Energy

T. K. Sen, S. Paul, U. Gurnani

Abstract

Harnessing the wind energy and development thereto remains a good consideration since the era of windmills. Many a wind energy converter system (WECS) are in use in practice. Most of such windmachines have basic construction with a single bladeset mounted on a shaft to rotate. What may be the impact of having multiple number of bladesets mounted on the same shaft? Experiment with two bladesets mounted on a shaft provides encouraging hints for venture towards probe and progress as newer dimension in more gainful harnessing the wind energy.

Keywords Windmills, WECS, bladeset, aerodynamics, power coefficient, torque coefficient, rotor, efficiency

1. INTRODUCTION

In the study regarding new and newer technology and harnessing of secondary source of energy, the wind energy being freely available and non-polluting resource of renewable energy remains a widely cultivated dimension in the field of Research and Development. Wind energy potential available in the natural wind over the earth's surface is estimated to be in the order of $1.6*10^7$ MW, which is comparable to the energy consumption on the earth.

Windmills have been in use since long time ago for various purposes viz grain crushing, water pumping like mechanical work. The progressive development activities have brought into reality the methods and processes for conversion of the kinetic energy of the moving air into useful mechanical or electrical or suitable form of energy. Varieties of Wind Energy Converter System (WECS) are in use serving general and specific purposes.

Windmill demonstrated the philosophy behind utilizing the wind energy with the underlying concept of rotating a shaft by way of intercepting the linear motion of moving air by a radial bladeset mounted on the shaft to be rotated.

Windmills (figure 1) located near seacoast or mountains exploited the higher speed of wind at higher altitude. Progressive work provided various findings and data related to speed and behavior of wind, the efficient conversion of wind energy primarily into mechanical energy and other useful form of energy. Measurement of wind speed indicated 20-25 % higher speed at about 10m higher altitude and a non –linear relationship between wind speed and altitude from the earth surface (figure 2).

The development of windmachines and system apparently were focused on many aspects including the probe and progress to theoretical and practical cultivation regarding the following outlines.

a) Deriving wind power from wind of high speed/ high energy domain
b) Constructional and technical features related to types of WECS
c) More efficient conversion of wind energy to mechanical and subsequent suitable form of energy
d) Design of wind rotor
e) Performance and control of WECS

The effect of mounting multiple number of bladesets on the rotor shaft and the investigations there to may render the state-of-the-art newer dimension and technology in improving the exploiting of wind energy. The inter and intra relation of parameters and modification of construction and performance remains a feasible novel addition and prospect in the field.

2. DEVELOPMENT – OUTLINES

2.1 Types of Wind Energy Conversion System (WECS)

Windmills of earlier times, pioneer in field, led to the investigation and development of WECS of varieties categorized into horizontal axis and vertical axis types of equipment.

The horizontal types include

a) Dutch-type grain grinding windmills
b) Multiblade water pumping windmills
c) High-speed propeller type windmachines

The vertical axis turbines come into two different basic design a) The Savonius rotor, b) The Darrieus rotor

Various types of WECS have typical constructional features and design of bladeset to face and interfere the wind input for the purpose of rotating the rotor shaft towards conversion to mechanical energy primarily. A few types of WECS are indicted in figure 3.

2.2 Solidity

Solidity is the ratio of the projected blade area and the area of the wind interfered by the blade.

The multiple water pumping windmills of high torque and low speed has solidity nearly 0.7. The high-speed low torque horizontal axis wind machines have the solidity range from 0.01 to 0.1 and suitable for electric power generator.

Tip Speed Ratio: It is dependent on R, N and V as given by

TSR $\lambda = \frac{2\pi RN}{V}$……………………………………………………………………………………….(1)

λ = TSR (non-dimensional)

R = Radius of the swept area by the bladeset (m)

N= Rotational speed of the shaft (Revolution per second)

V = The wind speed without rotor interference (m/s)

The TSR of water pumping windmachines is generally low and of high-speed wind machines is high, even may be about 9.

2.3 Efficiency of wind energy conversion and limit

It is considered an ideal converter in the form of a disc of area A which extracts some power from that contained in the wind flowing through it (figure 10. (a))

V_1 = the velocity of the incoming air unaffected by the rotor interference,

v = the velocity of the air passing through the disc,

V_2 = the velocity of the outgoing air at some infinite distance from the disc,

p = the pressure at incoming and outgoing air

$p^+ - p^-$ = the pressure difference between two sides of the disc,

α = factor for axial interference by radial bladeset.

It is assumed that the flow of wind is axial and that no rotational kinetic energy is imparted to the air stream. Some relations are obtained

$p^+ - p^- = \rho(V_1^2 - V_2^2)/2$…………………………………………………………………………….……….(2)

ρ = density of air assumed constant throughout the flow.

The thrust T on the disc is given by

$T = \rho A(V_1^2 - V_2^2)/2$……………………………………………………………………………...……(3)

$v = (V_1 + V_2)/2$…………………………………………………………………………………………..(4)

Considering the axial interference factor α, it appears

$v = V_1 (1- \alpha)$ …………………………………………………………………………………………….………………(5)

$V_2 = V_1 (1- 2\alpha)$ ………………………………………………………………………………...…………………..(6)

Power extraction is given by drop in kinetic energy of the air stream per unit time,

$P_1 = 2 \rho A V_1^3 \alpha (1- \alpha)^2$……………………………………………………………………………………………(7)

i.e., the power output is a non-linear function of α.

At that two extreme values α = 0 and 1, the power output is zero. There is some maximum value of power output at some value of α between 0 and 1. It follows that at α = 1/3, the power extraction appears to be maximum

$P_{max} = 16 P_0 /27$ ………………………………………………………….…………………….…………..(8)

Which is reached when $v = 2 V_1 /3$

This means that the maximum theoretical power extractable from wind is 16/27 of the power P_0 contained in the wind.

2.4 Basic Principle of Wind Energy Conversion

The kinetic energy contained in the moving air given by

$P_1 = \rho A V_1^3/2$……………………… ………………………………………………………………….…………(9)

indicates that this power is proportional to the cube of the wind velocity and also proportional to the area A swept by the bladeset vis-a-vis to the square of the diameter of the bladeset.

The Physical conditions in a wind turbine allows extraction of a part of the available power of the input wind the speed of which subsequently decreases to the minimum at the 'wake'. (Figure 4)

Subsequently the wind stream regains energy from the surrounding air and the free wind speed is restored at a sufficient distance from the rotor. In the process there is corresponding change in air pressure and pressure drop ΔP across the rotor bladeset and consequently the pressure increases to the ambient pressure. The power extraction corresponds to the product of the pressure drop with the wind speed. More is the wind speed and the pressure drop more is the rotor power. But there may appear an increase or decrease of wind speed or the pressure. Hence for the given free wind speed there is a maximum value of rotor power.

2.5 Power Coefficient (C_P)

The power coefficient (C_P) given by the ratio of the power of wind rotor and the power available in the wind provides for the efficiency of conversion of wind energy into mechanical energy.

The graph of the power coefficient against the TSR appeared important in the characteristics of wind energy converters. Typical curves for different types of wind machines are shown in figure 5. It indicated that more is the value of TSR λ, more may be the value of power coefficient C_p in many a cases. When TSR value is nearly 9, the power coefficient tends to reach almost the Betz limit of 16/27 or 0.593.

Even though the power coefficient of an ideal rotor, with propeller type blades of proper aerodynamic design may approaches the Betz limit 0.593, such rotor may not be able to withstand high speed wind. As such the C_P value is kept at 0.4 – 0.45 in practice. In case of conversion into electric power some of the rotor energy is lost and the overall electrical power coefficient of an aerogenerator in practice is about 0.35 or 35%.

2.6 Aerodynamics Of Wind Rotors:

It has been studied the aerodynamics of an aerofoil and developed relations for the various forces acting on a wind mill blade. It provides some typical exposition regarding logical structure which enables estimation of various forces and stresses for preliminary design consideration, although actual design procedure used in industry may involve many complications, particularly for high speed propellor type turbine with electrical power generation. Analysis may progress with vector diagram indicated in figure 6 using the Blade-Element Theory.

The derivations indicated that torque and the aerodynamic power depend on the angle *I*, the angle of inclination, which in turn, depends on the wind speed and rotational speed. The lift and drag coefficients depend on the angle of attack *i*, which is equal to $I - \alpha$ and can be varied by varying the pitch angle α. Thus, a control strategy may be developed whereby a maximum amount of power can be produced at any wind speed by suitably changing the pitch angle α i.e., a design feature of the blade.

The equation for aerodynamic efficiency provides the clue for designing a blade. The typical features like lift coefficient (C_L), the drag coefficient (C_D), angle of incidence provide guidelines for optimizing the aerodynamic efficiency towards better conversion of wind energy to mechanical one.

2.7 Wind Turbine Rotor

The performance of wind turbine much depends on the design of wind rotor. The efficient design of a blade maximizes the lift and minimizes the drag. It needs to be considered that wind velocity is constant throughout the rotor area, but the blade velocity increases from inner edge to the tip. Thus neither the magnitude nor the relative velocity is constant throughout the length of the blade. This reflects the importance of blade design of various designed feature involved in the performance of wind machine and control of it. Obviously the design of rotor includes a) diameter of the Rotor, b) choice of the number of blades in the bladeset, c) choice of blade profile and material, d) determination of blade chord, e) choice of pitch angle α (= $I - i$)

2.8 Power- Speed Characteristics

The rotor speed is the factor for extraction of mechanical power from the wind. For each wind speed there is an optimum turbine speed at which the extracted wind power at the shaft reaches the maximum. This is indicated in the $C_p - \lambda$ curve. Also the C_p depends on the pitch angle. Such dependence and variation are indicated in figure 7.

That the optimum value of C_p, say $C_{p\text{-}opt}$ corresponds to optimum value of λ, say λ_{opt}, needs the rotor speed to be adjustable with varying wind speed so as to adhere to the value λ_{opt} for optimum mechanical power output from the wind machine. With $\lambda = \omega R/V$, the maximum value of shaft mechanical power P_{max}, for any wind speed may be expressed as

$$P_{max} = C_{p\text{-}opt}\, \pi\, (R^5/ \lambda_{opt}^3)\, \omega^3/2 \qquad (10)$$

It indicates that the maximum power extractable from wind is proportional to the cube of the rotor speed (ω^3).

2.9 Torque-Speed Characteristics

For proper matching of the load with stable operation of the electrical generator, the typical torque speed characteristics of the two-blade propeller type wind turbine is indicated in figure 8. This profile follows from the power curve, since T is proportional to P/ ω. At the optimum operating point ($C_{p\text{-}opt}$, λ_{opt}) the relation between aerodynamic torque and rotational speed reduces to, with usual notations

$$T_m = \rho\, C_{p\text{-}opt}\, \pi\, (R^5/ \lambda_{opt}^3)\, \omega^2/2 \qquad (11)$$

It indicates that the torque varies with square of the rotational speed and in terms of C_p the aerodynamic torque becomes

$$T_m = \rho\, C_T\, \pi\, R^3\, V^3/2 \qquad (12)$$

Where $C_T = C_p/ \lambda$, is called the Torque coefficient.

2.10 Wind Turbine Control Strategy

For every wind turbine there are several different ranges of wind speed and different speed control strategies. The power vs. wind speed characteristics of variable speed wind machines (figure 9) shows the importance of Cut-in speed and the Furling speed (Cut-out speed). There may be various control strategy for different range of wind speed or for constant speed windmachines. Such control measures also depend on the performance variable including the shaft rotational speed.

3. NEWER DIMENSION

Most of the investigations and development in the field of harnessing wind energy apparently have been based on mainframe equipment in WECS in tune with the conventional wind mills, where all important rotation of the shaft with mechanical energy remains the objective to be accomplished with only a single bladeset mounted on the shaft to interfere the incoming moving air. The findings and results in theory and practice have been used for developing WECS.

World body on energy matters continuously emphasized for new and newer technology or method for better and better exploitation of renewable energy resources. In the field of harnessing wind energy, inspite of good achievement, the question is whether there is scope for further improvement with additional dimension.

3.1 Probe and Progress

Obviously the question arises regarding the impact on the process of conversion and control if there is more than one bladeset mounted on the shaft. Schematics may be indicative in figure 10.

The probe and analysis regarding dynamics of both the schemes (a) and (b) may be considered to follow primarily the same derivation principle as have been opted and established earlier.

3.2 Experiment

Although it is considered that the research on wind energy appeared Capital intensive, some preliminary steps undertaken in finding the primary effect of using two bladesets mounted on the same shaft provides thought provoking indication towards gain and development.

3.3 Observation

With experiment undertaken it appears the finding may provide good clues for further evolution and scope for more progress.

The experimental observation are obtained with the rotation of same shaft with one bladeset and two bladesets, herein identical pair of bladesets with angular phase difference (Table 2). The rotation with two bladeset observed experimentally reflect different magnitude of rotation of the same shaft for same wind source. In some cases, compared to the rotation of the shaft with one bladeset, the rotation of the shaft with first and second bladeset are faster and in some other cases the rotation are slower.

It implies that the position of the second bladeset with respect to the first bladeset is too important and also justifiable in accordance with the basic principle of wind energy conversion.

For first bladeset there is a position of 'Wake' (figure 4) and pressure profile. As such the distance l between the two bladeset, setting the position of second bladeset becomes significant.

4. VALIDITY

4.1 Wind Power Conversion

The energy obtained in the moving air being proportional to cube of linear velocity of the wind interfered by a radial blade, the first and second bladeset both interfering the wind are supposed to cause rotation of the shaft when the wind speed before the first bladeset and before the second bladeset are more than cut-in speed. As such by adjusting the position of second bladeset with respect to the 'Wake' after the first bladeset, the power due to the second bladeset would be effectively additional to the power converted due to the first bladeset.

Thus, where suffix 1 and 2 belong to first and second bladeset, it appears with usual notation,

$P = P_1 + P_2$

$= \eta_1 \ \rho A_1 V_1^3/2 + \eta_2 \ \rho A_2 V_2^3/2$ ……………………………………………………………………………..(13)

It indicates that the second bladeset helps in getting better conversion of wind energy to mechanical energy of the shaft and the improvement in power coefficient of the system.

4.2 Rotation of the shaft

The power is the multiplication of torque and angular velocity. So addition of power contributes to the torque and/or the rotation of the shaft. The change of torque will correspond to the increase or decrease in rotation of the shaft.

4.3 TSR

For the two bladesets it would appear

$\lambda_1 = \pi R_1 N/V_1$ and $\lambda_2 = \pi R_2 N/V_2$ ………………………………………………………………………………….(14)

as the shaft being common will have only one N for both the bladesets. This indicates that R_1/V_1 and R_2/V_2 have effect on the magnitude of λ_1 and λ_2. The figure 7 may correspondingly undergo some modification.

4.4 Aerodynamics of Wind Rotors with Two Bladesets

For the two bladesets of aerofoil shaped blade, there would be two separate diagrams like figure 6 although the rotation of the shaft is same for both the bladesets mounted. The value of axial speed of wind would be V_1 and V_2, but speed of the blade element will be $2 \pi r N$ since the value of N is same for both the bladesets i.e., $u_1 = u_2$. With such condition, the two vector diagram may be superimposed giving the evolving finding and derivation and relation regarding the various parameters concerned viz. Lift force, Drag force, Moment, Efficiency and others, keeping in mind the values of V_2 depend on the distance of the second bladeset from the first bladeset.

Estimation in system (b) (figure 10) with two bladesets much depends on the position of the second bladeset with respect to the 'Wake' of the system (a) and this 'Wake' and other parameters correspond to the free wind behavior before the first bladeset. It reflects that the input condition for the second bladeset depends on the output condition of the first bladeset which output condition is made by the input condition for the first bladeset. It means that impact of second bladeset is largely dependent on the performance of the first bladeset with its given input conditions. The adjustment of the distance between the two bladesets confirming the wind velocity at the exit of the first bladeset is not less than the Cut-in velocity for the second bladeset, the overall phenomena is likely to improve the considerations of conversion of wind power both at first bladeset and second bladeset.

In case where the rotation of the shaft due to first and second bladeset is more than that with only the first bladeset, it means that less than cut-in velocity of wind may also cause rotation of the shaft.

In case when the rotation of the shaft with two bladeset is less than that with only the first bladeset it indicates that when the free wind speed is more than the cut out speed, the adjustment of the position of the second bladeset may help retarding the shaft rotation and help protecting the wind machine from damage. Thus the total power availability in the range of lower cut-in speed to higher Furling (cut-out) speed would be more beneficial.

The adjustability of the position of the second bladeset having effect of increasing or decreasing the shaft rotation stands as a feasible consideration in the control of rotation of shaft. If the second bladeset is mounted on a hub which can slide over a spline shaft, it provides the control on the rotation from cut-in speed to cut-out speed of wind, thus amounting to additional method in controlling the wind machine over and above the prevailing controlling system.

5. CONCLUSION

It may provide good clues that the impact of second bladeset yield corresponding changes in the technological and performance parameter and the selection of favorable changes help improve and modify the WECS for better gain with newer dimension. It remains a state-of-the-art newer technology and dimension towards R&D and an additional feature and novelty in the field of harnessing the wind energy.

6. FIGURES AND TABLES

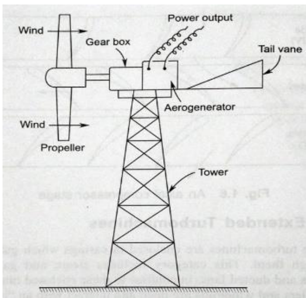


Figure 1: A Windmill (extended turbomachine)

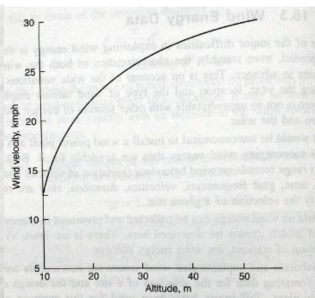
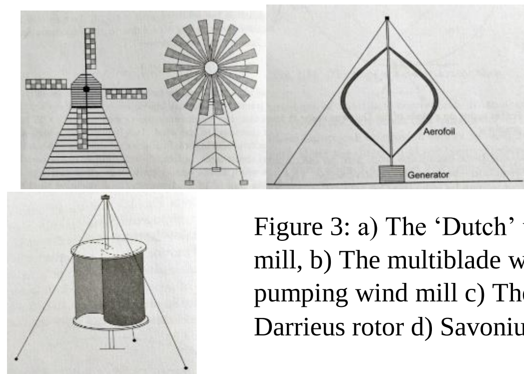


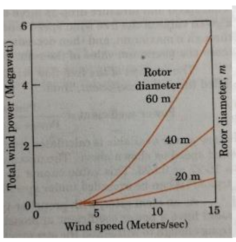
Figure 2: variation of wind velocity with height above ground (a typical curve)

(a) (b) (c)



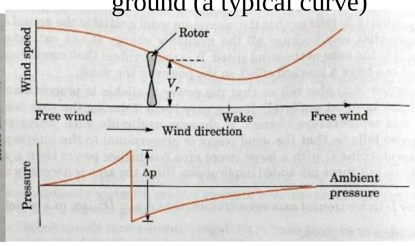
(d)

Figure 3: a) The 'Dutch' wind mill, b) The multiblade water pumping wind mill c) The Darrieus rotor d) Savonius rotor



(a)

Figure 4: (a) Dependence of wind rotor power on wind speed and rotor diameter



(b)

Figure 4: (b) conditions in traversing a wind rotor

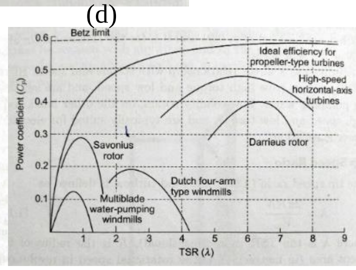


Figure 5: curve for C_P vs TSR for different types of wind mills

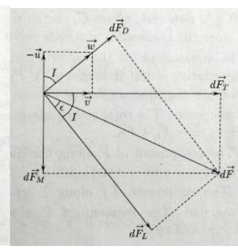


Figure 6: Vector diagram of the velocities and forces, the blade vector is normal to the plane of the diagram

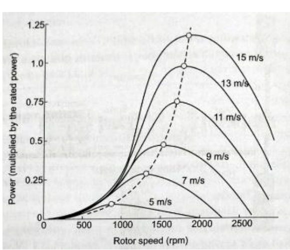


Figure 7: (a) The typical power vs speed characteristics of a wind turbine

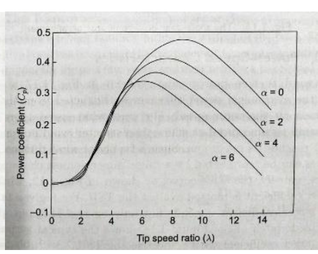


Figure 7: (b) The typical curve of power coefficient vs TSR for various values of pitch angle α

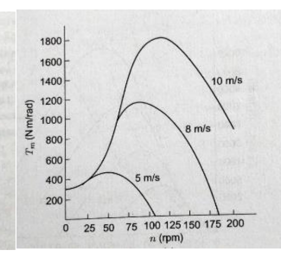


Figure 8: The torque-speed characteristics of two blade propellor type rotor

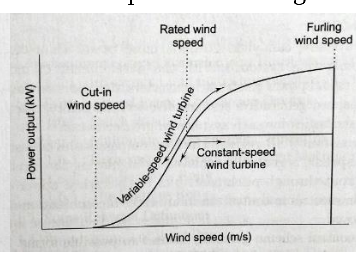
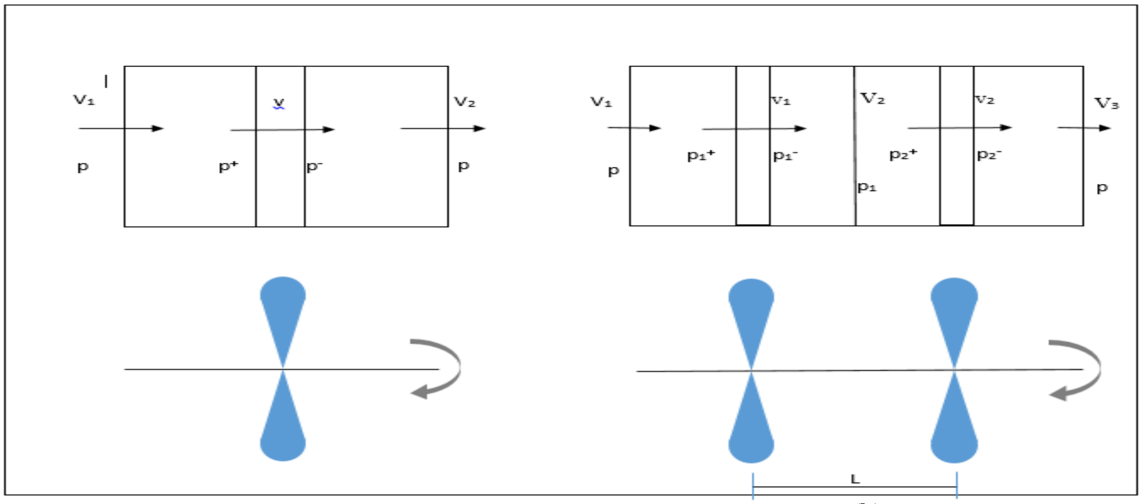


Figure 9: The typical power vs speed characteristics of variable speed wind machines

Experiment with Single and Double blade sets				
S. No	**Wind Input (kmph)**	**Blade Set 1**	**Blade Set 2**	**Shaft speed (rpm)**
01	37.7	Active	Active	280
02	37.7	In-active	Active	200
03	37.7	Active	In-active	230

Table 1: Observation from Experiment 1 with Wind Input velocity



(a) (b)

Figure 10: Schematic of WEC with (a) one bladeset (b) two bladesets

Experiment with Single and Double blade sets				
S. No	**Wind Input (kmph)**	**Blade Set 1**	**Blade Set 2**	**Shaft speed (rpm)**
01	13.3	Active	Active	80
02	42.5	In-active	Active	382
03	25.8	Active	In-active	225

Table 2: Observation from Experiment 2 with varying Wind Input values

Experiment with Single and Double blade sets				
S. No	**Wind Input (kmph)**	**Blade Set 1**	**Blade Set 2**	**Shaft speed (rpm)**
01	12.6	Active	Active	115
		In-active	Active	107
		Active	In-active	143
02	26.9	Active	Active	251
		In-active	Active	239
		Active	In-active	310
03	40.9	Active	Active	439
		In-active	Active	392
		Active	In-active	472

Table 3: Observations from Experiment 3 with varying Wind Input values

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Role of Microbially Enticed Calcite Precipitation in Stabilization of Cohesive Soils

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Abstract.

A novel soil-improving technique called "bio grouting" is based on microbiologically calcium carbonate precipitation that was induced. A solution containing urea is added to the soil before bacteria that can turn urea into ammonium and carbonate, tailed by solution of urea & calcium chloride. The calcium then precipitates with the carbonate that is formed, the Clay particles are connected by bridges made of carbonate crystals, increasing the strength within the soil mass. The objective of this endeavour is to identify the ideal bacillus composition solution containing subtilis bacteria to stabilise soil and assess the mechanical properties changes of the soil's stabilising bacillus subtilis bacteria solution and combination of cure times and a cementation solution. Bacillus subtilis bacteria are inserted into the soil in amounts ranging from 10 mL to 30 mL, and the curing duration is between 7 and 28 days. According to the results of a laboratory test measuring unconfined compressive strength, samples injected with bacteria tested at 1.70 kg/cm2 and samples tested without bacteria tested at 1.20 kg/cm2. Using the bio-grouting approach to stabilise clay soil with bacteria results in an increase in the soil's bearing capacity.

Keywords. Bio-Grouting, Bacillus Subtilis, Ground-Improvement, Cohesive soil, UCS.

1. INTRODUCTION

The most crucial component in any work involving building foundation and structure is the soil [1]. Ground settlement, especially in areas that are very susceptible to settlement, such clay soil, can cause structural failure. Many different approaches of improving soil that exhibits swelling-shrinkage characteristics have been used, including soil stabilisation. In order to enhance one or more of the features of a natural soil material, a particular soil may be apportioned, added, or withdrawn, or another chemical substance may be introduced. This process is known as soil stabilisation. Mixing natural coarse- and fine-grained soil to create a mixture that produces sufficient internal friction and cohesiveness is one of the most popular stabilising techniques. Some examples include stabilisation, which uses a grouting technique with various materials as suspense (cement, clay-cement, bentonite, pozzolana etc.) or emulsions (asphalt, etc.) that are not environmentally friendly [2]. Therefore, it is strongly advised to identify ecologically friendly alternatives for grouting methods. One of such alternatives is the use of microorganisms (called as bacteria) that may create calcite and can turn sand into sandstone. This process called as "bio-grouting". There have been a number of initiatives completed earlier, such as the Microbiologically enticed Cementation for Checking Sand Response to Undrained Shear [3]. Bacillus pasteurii was the microbe used in this experiment. Another effort is ground improvement using microbially enticed carbonate precipitation, which is used as a material for soil improvement [4]. The work uses bacteria Sporosarcina pasteurii, a species of bacterium with a high concentration of the urease enzyme, were used in the method. Last but not least, Bacterial carbonate precipitation for bio grouting looked for alternative materials that might be used to improve soil strength by exploiting microorganisms demands without considering the data volume. The majority of bio grouting research involve bacteria, particularly B. subtilis, which produces the urease enzyme [3]. A nutritional thesaurus containing yeast extract (20 g/L), a trace amount of nickel chloride (10 M) and ammonium chloride (10 g/L), is used to cultivate these microorganisms aerobically in the lab, and the cultures are harvested after roughly 24 hours. Solution of urea & calcium chloride is added to the soil along with the suspension containing the bacteria. The hydrolysis of urea into carbonate and ammonium is catalysed by the microbial urease. When calcium ions are present, the carbonate ions that are formed precipitate as calcite crystals, which cement the gaps within the sand grains.

$$CO\,(NH_2)_2 + 2H_2O \rightarrow 2NH^{4+} + CO3^{2-}$$

$$Ca^{2+} + CO3^{2-} \rightarrow CaCO_3\,(s)$$

The idea of biologically treated soil enhancement technology put out by [5] and many other researchers have already tried it [3], [4], [6], [7] etc. Although there are many other types of bacteria in soil, Bacillus subtilis is frequently utilised to produce microbial cementation of soil particles. This is due to the fact that Bacillus subtilis converts urea into ammonia, which raises the pH of the surrounding environment and causes CO^{2-} and Ca^{2+} to precipitate as $CaCO_3$.

2. MATERIALS AND METHODS

2.1. Microorganisms

The catalase-positive bacteria Bacillus subtilis (gram –positive), also referred as the grass bacillus or hay bacillus, is found within soil and the ruminant & human gastrointestinal tracts. Bacillus subtilis, a rod-shaped member of the genus that can create a hard, protective endospore that allows it to withstand against harsh environmental circumstances. Though there is evidence to suggest that B. subtilis is facultative aerobe, it has already previously been categorised as compel aerobe. B. subtilis is most well-studied gram-positive bacterium, which is also used as a model to research bacterial cell development and chromosome replication. B-subtilis is one among the bacterial leaders in the synthesis of secreted enzymes which is utilised on a large scale in biotechnology businesses.

2.2. Cohesive Soil

Locally accessible clay soil was utilised for this research. If a particle's size is less than 0.002 mm, it is considered to be clay. The properties of cohesive soil involve its tiny grain size, that is below than 0.002 mm, low permeability, cohesiveness, high increase in water capillary, sluggish process of consolidation and high degree of swelling-shrinkage. In terms of the chemical and physical characteristics of soil, clays play a significant role. The amount of clay-sized particles, which have a significant impact on soil physical qualities such as aggregation, porosity, water transport and storage, aeration, and workability, is chemically active.

2.3. Bacteria Culture

Because of its potent inhibitory action versus commercially significant avocado post-harvest pathogens, B. subtilis (B246), which was first derived out of the avocado phylloplane (Korsten et al,1988), was chosen for improving mass cell making. The antagonists were lyophilized with 30% v/v glycerol-solution Ringer's at -78 °C while being maintained over standard 1 nutritional agar (STD) (Biolab) slants. For each starter volume used—20-, 50-, 100-, and 200-ml STD broths—six replicates were prepared. B. subtilis 107 cells/ml were used to inoculate each starter volume; they were acquired by washing 24-hold STD slant in sterile quarter-strength Ringer's solution (Merck). Under a Zeiss phase contrast microscope, counts were performed using a Petroff-Hausser counting chamber and modified as necessary. At room temperature (22–28 °C), inoculated starting quantities were put on a rotary shaker (76 rpm). Following a 24-hour shaking incubation period, the complete volume of each starter culture was introduced to distinct 1,3 (STD broths in 2,5 I Erlenmeyer flasks.

3. TEST SETUP

The test is conducted in a prefabricated mould that contains an entrance, an outlet, and flow control. The tool is an acrylic split mould having internal diameter (ID) of 40 mm & a height 80 mm. Set-up comprises an effluent collector, an inlet and output valve, a prefabricated mould, and a reagent tank.

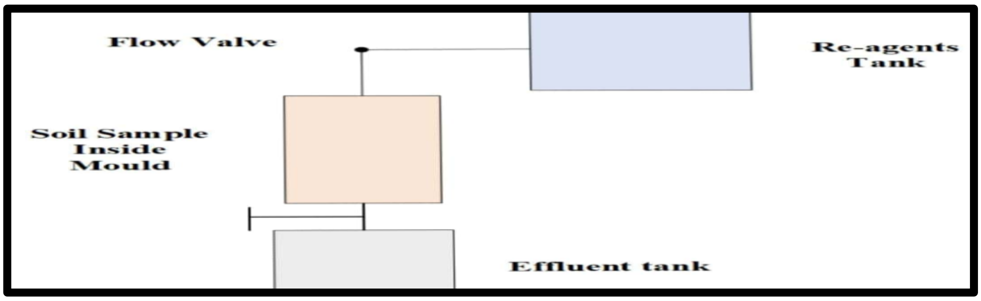

Figure 3.1. Depiction of a typical experimental study setting

4. TREATMENT OF SOIL

Prior to being treated in the prefabricated mould, the soil was compacted at their respective MDD and OMC. To evenly saturate the sample, soil was first cleaned with tap water. The soil sample was given time to pass through a bacterial suspension. The bacteria were given two hours to adhere to the soil grains during the fixing period. After two hours, the soil was treated with a 0.5M urea solution and a 0.5M calcium chloride solution, which were left to react in the soil for 24 hours. This process was done once more 24 hours later. For two weeks, this process was continued.

5. RESULTS AND DISCUSSIONS

A specific instance of a triaxial compression test in which the all-around pressure is equal to zero is the unconfined compression test. Only saturated samples that are able to stand without any lateral support are used for the tests. Therefore, the test is only applicable to cohesive soils. The test, which is undrained, is conducted under the premise that no moisture will be lost. One of the easiest and quickest tests for figuring out how strong cohesive soils are in shear is the unconfined compression test. Following were the outcomes:

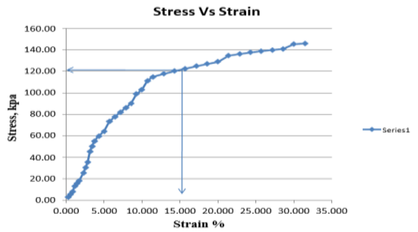

Figure 5.1. Stress vs strain (without treatment)
Unconfined compressive strength (q_u)=120 kPa
Cohesion of soil (c) = 60 kPa

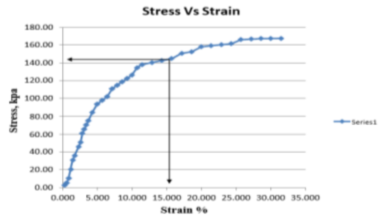

Figure 5.2. Stress vs strain after 7days curing
Unconfined compressive strength (q_u)=142 kPa
Cohesion of soil (c) = 71 kPa

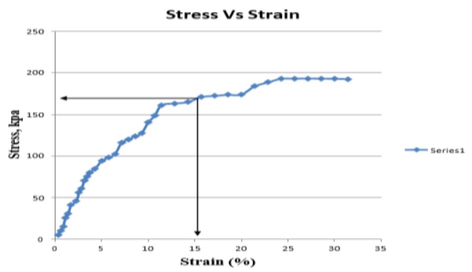

Figure5.3. Stress vs strain after 28 days curing.
Unconfined compressive strength (q_u) = 170 kPa
Cohesion of soil (c) = 85 kPa

The increase in soil characteristics earlier and after introducing bacteria is the only parameter this study used to judge the automatic suitability of Bacillus subtilis as a material for soil improvement based on the results of testing and their analysis. The results of this study can therefore be used to guide for future researchers and studies. For the purpose of reducing the amount of special treatments that must be carried out during the mixing process, It has been suggested that Bacillus subtilis should be the subject of further research. In order to check and compare the response of such bio-grouting process to different types of soil, it is also necessary to combine Bacillus subtilis with other types of soil.

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Biographies

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Residential House Design with Solar Analysis to Optimize Energy Consumption

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Abstract.

Energy consumption is a sector of keen interest since the discovery of electricity. Continuous research work is being done in this field. Now a day, people have become more cautious towards the consumption of energy at home, office or workplace. Various parameters have been developed to determine a device's energy efficiency. A house is comprised of multiple electronic gadgets, working all at a time or one after another. A house fully dependant on the mains supply, will hence, is more costly as the devices all together draw huge energy. This is main reason why people are switching to renewable source of energy. Today, some houses have installed solar panels at the roof to provide electricity partially, parallel to the mains supply.

But to make the house even more energy efficient, certain design factors should be considered. A house while its construction, must be based on the standards laid by the Indian Standard and Indian Green Building Council. Owing to these standards, one can understand and implement better energy efficient techniques. In this paper, the primary work is on the design of a house with respect to the path of the sun. The study will revolve around how to design a residential house in accordance with all the natural factors, Indian Standards and Green Building specifications.

Keywords. Solar Energy, Energy Efficiency, Green Building, Design, Sustainability, etc.

1. INTRODUCTION

People always favour comfort over hard-work, when it comes to living in own house. For example, a person will choose to switch on an AC rather fill water in a cooler and then switch it on. Change of lifestyle has evolved electronic gadgets to smoothen the living. Today, almost every device is available for every task. But deploying a device has energy consumption too. May be the device runs on low power, but consumption can't be ignored. Hence, choosing limited number of electronic devices to carry out day to day work with least compromise in the standard of living is a matter of great concern. When a dream house is being constructed, the architect or the engineer has to keep several factors in mind like cross-ventilation, luminance, aesthetics, architectural consideration, structural framing, etc[1][2].

Also, the position of the house has a major impact on the consumption of energy. During daytime, the sun radiates light as well as heat. If proper planning is not done to obstruct the sunrays partially, then the fans and the ACs in the house will have to work for more hours than normal. Say, the kitchen is not well ventilated, and then the warm gases will scatter all around the house and make the interior temperature hot and humid. So, fans need to work for more hours, even, air purifiers might be deployed to help. In winter, sunrays act as natural warmers. The more the sunrays enter the house, the warmer the house will be. But in summer, that will be a problem. So all these revolves around the concept of designing a house based on analysis of solar path.

2. DESIGN OF INFRASTRUCTURE AND METHODOLOGY OF RESEARCH

Figure 2.1. Typical Proposal of a Residential Building

The United Nations has led several sustainable developmental goals for a sustained environment in future by adopting some scientific practices[3]. Hence, through the method of passive design of a building and tools like Autodesk Revit, it is possible to discuss the analytics of the project, owing to the norms laid by the Indian Standard codes and Green Building rating specifications.

2.1. Solar Path Simulation

The approach to obtain a sustainable design for any building can be classified in three ways[4]. First, the basic building design factors like site location, landscaping, orientation, construction materials, etc. Second, the passive systems like ventilation, heating-cooling, day-lighting, comfort, etc. And third, the electronic and mechanical devices deployed in the building like ACs, chillers, heat pumps, furnaces, solar heaters, etc[5]. All these factors help engineers and architects to determine the comfort and aesthetics of the building. A simple and modern house is planned and designed through software. A green site is chosen and designed accordingly. A three dimensional model is designed in software to observe the solar path over various seasons and time[6]. From the observations and simulations, it is evident that the position of sun is almost overhead during the day with an altitude angle of 83° during April-May season and during the December-January season, the sun is seen much inclined and with an altitude angle of 54°[7]. Figure 2.1.1 and Figure 2.1.2 describes the solar analysis performed on a conceptual residential house with directions respectively. This helps to understand and improve the position of the house for better energy efficiency.

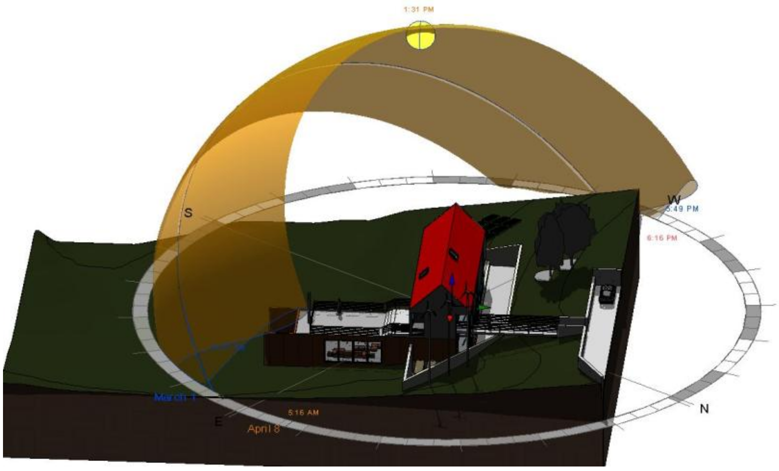

Figure 2.1.1. Solar Analysis model with solar path simulation

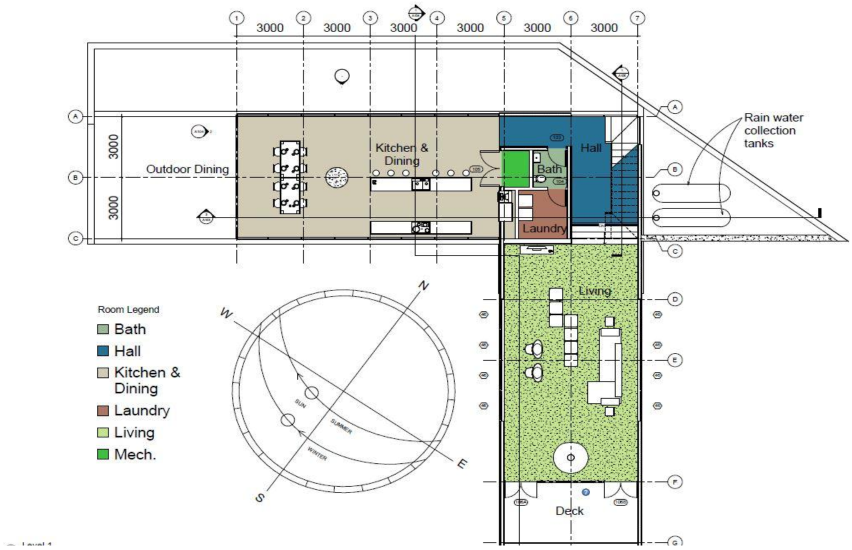

Figure 2.1.2. Proposed house plan with direction

2.2. *Selection of Material*

Most of the materials used in the building are sourced near the project site. Utilization of construction waste as raw material can be good process to eco-friendly construction. Fly-ash bricks, glass, aluminium and ceramic tiles, which have post consumer and industrial waste, are used in constructing the building to encourage usage of recycled materials. Bagasse based composite wood can be used for making the furniture. Use of low Volatile Organic Compound (VOC) paints and coatings, adhesives, sealants and carpets can also enhance the building to be green and efficient[8]. Energy efficient lighting design through LEDs is also enacted. All these factors result in less carbon footprints in the environment due to construction.

2.3. *Energy Efficient Applications*

In modern homes, there are a variety of electronic devices used to comfort us. Deploying more and more electronic devices increases the carbon footprints on the environment and causes pollution[9][10]. Also, the position of the house impacts a major role in application of electronic devices at home. Like, from solar path analysis model, it is observed that north facing façade houses are better than south facing ones. Hence, it has greater sunlight than other homes. Hence, natural ambience can be established at that home without deploying much electronic devices. Cross-ventilation in the home ensures good air flow and maintains air quality. The house exposed to sunlight all the time, the walls will absorb more heat and hence, the interior will get heated up. In that case, ACs is mandatory. But the number of ACs can be reduced if the house location was adjusted as per solar path analysis. Hence, from light saving to maintaining ambient temperature, a house designed using solar path analysis model and green building specifications, can be much efficient in terms of energy and serviceability.

3. RESEARCH OUTCOMES AND OBSERVATION

A study is performed with a 3D model of a house in a conceptual design environment and project climate settings[11]. Solar study was performed to analyze how the shade from the landscape and surrounding models are affecting the site. Different views of the conceptual design are given below in figure 3.1 and figure 3.2 respectively.

Figure 3.1. Exterior view of the proposed residential model

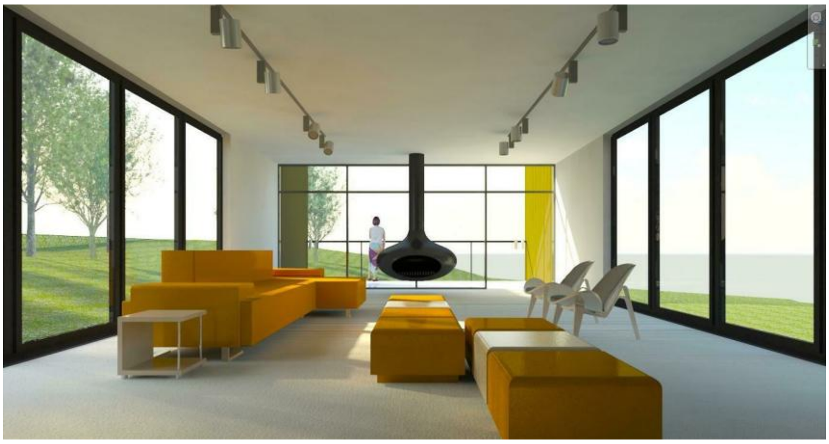

Figure 3.2. Interior view of the proposed model

4. CONCLUSION

The demand for energy is increasing rapidly with increase in population and urbanization. The global construction industry produces the maximum carbon footprints in the environment. Hence, designing and planning of a project before the construction can help monitor and reduce the carbon emissions. There are billions of houses around the globe. Let's say, using solar analysis and green building specifications, if only 1 unit of energy can be conserved per house per day, then the gross savings in energy around the globe will be gigantic. Hence, energy management is a key point to focus at the present. Implementing preventive measures from the beginning of a project will result in energy efficiency for the whole service life of the project. And the conservation figures will be green enough. Introduction of BIM (Building Information Modelling) has proved a great step towards sustainable construction, engineering and architecture. Also, building energy parameters help monitor the energy usage time to time. Combining all the factors, it will be possible to fully rely on renewable energy for all needs at housing level.

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Adiabatic cooling and its future aspects in commercial building and others: A review

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Abstract

In warm conditions, to maintain cool atmospheric temperature air conditioning plays a crucial role. To control ventilation and cooling procedure in buildings commercial cooling systems are very essential, but they consume more power and are responsible for the emission of CO_2. Energy-efficient air conditioning frameworks can reduce energy consumption and CO_2 emissions. The aim of this paper is to find out various technologies involving evaporative cooling and energy management in smart cities. Evaporative cooling has gained researchers' attention in recent years and is very energy efficient and environmentally friendly in the air conditioning industry. However, this technology consists a lot of challenges. Evaporative cooling technologies are energy-efficient and cost-effective. Energy-efficient state of art technology has become the research focus around the world, especially for the power grid. Insufficient evaporation from inadequate and non-homogenous pre-cooling pad water distribution lowers cooling performance.

Keywords. Adiabatic cooling, chiller HVAC systems, Building cooling requirements. DEC, GHEs.

1. INTRODUCTION

In the modern world, energy management is an important aspect of the research field to reduce global warming. Several researchers have worked to find out the best possible way to reduce greenhouse gases emission [1, 2]. Due to greenhouse gas emissions, the temperature at the earth's surface has increased sharply. One of the main reasons for global warming is the conventional Air Conditioning System, due to its large consumption of electricity [3, 4]. Several kinds of research have been made to partially replace the conventional air conditioning system to reduce the consumption of electricity and in turn, reduce global warming and the use of refrigerants which affects the environment [5]. This review paper focuses on the use of adiabatic cooling in various fields and energy management in smart cities. Evaporative cooling, sometimes known as adiabatic cooling, cools the air by evaporating water [6, 7]. Water evaporates as a stream of air during evaporative cooling. This transformation requires heat from the air, which cools the air [8]. The amount of water that can be evaporated is directly proportional to the amount of sensible heat that can be absorbed [9,10]. This evaporative cooling method can be implemented in smart cities with new approaches and modern technologies [11, 12]. In DEC (Direct evaporative cooling) technique, the air is in contact with evaporated water, increasing its water content [13]. And in IEC (Indirect Evaporative Cooling) technique, evaporation takes place inside a heat exchanger, and the moisture content of the cold air remains completely unchanged [14]. DEC can only be used in places where the relative humidity content is very low [15]. This is due to the fact that high evaporation rates might cause an increase in relative humidity, which can lead to discomfort [16].

2. METHODOLOGY

More than 100 papers have been studied from Scopus, Science Direct, Google Scholar, and Web of Science in relevance to the paper. And a summary sheet of the selected research papers is developed to introduce various methodologies to achieve desired cooling effect from the evaporative cooling system.

3. REVIEW OUTCOMES

Author's name and year	**Major problems discussed**	**Solutions suggested by the researcher in paper**
Ana Tejero-Gonzalez et al. (2021) [17]	Design of DEC pads optimally to increase the performance of cooling.	The optimally designed DEC pads have maximum water-to-air surface contact which favours air saturation, but very less resistance to airflow. A rigid media that achieves total humidification through a high water-to-air contact surface is simple to install, disassemble, clean, and maintain. The recirculated water temperature is considered to be close to air Wet Bulb Temperature, in adiabatic systems, but experimental results can be higher or lower. In adiabatic systems, measuring water temperature helps in understanding the air conditions at the system's outlet and the saturation efficacy.
Anatolijs Borodinecs et	The major problem discussed in this paper is	Nozzles have been designed to spray fluid on the designed

al. (2022) [18]	the insufficient evaporation caused due to the substandard and non-homogeneous distribution of water over the pre-cooling pad.	additional metal mesh cooling pad to improve cooling efficiency. Results show that it increases the mass transfer coefficient by 15–25%, An increment of 20% to 40% of the heat transfer coefficient and an increment of 30% to 40% of the atomization efficiency occurs. The installation of metal pad mesh results in uniform distribution of water.
Sachin Sunil Mothiravally et al. (2021) [19]	Pre-cooled air in the commercial prevailing cooling system can improve its cooling efficiency.	The result analysis shows that implementing the adiabatic cooling pad in commercial HVAC units saves energy by 20% with a good investment return.
G ̈okhan Yıldı.(2022) [20]	Energy consumption worldwide is due to the energy consumed by air conditioning systems in residential and industrial buildings. Evaporative cooling systems are advantageous since it is economical; It has zero pollution, and is easy to maintain, thus reducing the consumption of energy in buildings.	With four different evaporative cooling conditions exergy and cooling efficiency have been analysed. The 3rd case has the highest exergy efficiency at 20.83. In the 2nd case, the highest loss in specific exergy was found to be 100.51 J/kg and in other cases, the loss was calculated as 74J/kg, 81J/kg, and 74J/kg respectively, During the analysis same conditions it was found that values of sustainability match with exergy efficiency. Exergy and cooling efficiency rise at high airspeed under negative pressure but decrease under positive pressure.
Eloy Velasco-Gómez et al. (2020) [21]	Conventional cooling pads are less durable and cooling efficiency degrades with time.	The present work focuses on the design of an alternative evaporative cooling pad using cotton fabric. The cotton fabric used in this particular design performs better. When compared to other materials, its design allows for the maximum wetted surface with the minimal amount of pressure drop.
G. Cortella et al. (2019) [22]	During warm and hot climatic conditions efficiency and operation	Warm and hot climate is responsible for change of pressure of CO_2 and a pre cooled air in

	performance of Carbon di oxide is affected.	condenser can reduced pressure of CO_2 and can improve its efficiency. With the help of subcooling method using evaporative systems in the gas cooler is a best way to minimize coming air's temperature. By this way we can reduce the pressure of CO_2 and it will help to enhance the plants efficiency The implementation of adiabatic cooling results in reduction of 10% in the energy usage.
Ghassem Heidarinejad et al. (2010) [23]	Global warming and depletion of fossil fuels results in climatic change. Artificial energy resources are one of the main causes of global warming and therefore it is very important to replace it with natural resources. Ground cooling is a type of passive cooling technique which is very economical and can be used as pre-cooler in conventional system.	Geothermal energy-based condensers are a fast-growing renewable energy-based condensers. Earth's ground can be used to reject heat and can get subcooled situations of the refrigerant. It is also helpful to get the warmth in winter season with reversed cycle also it can be used in hybrid mode to improve the efficiency of the cooling system.
A Anarbaev et al. (2020) [24]	Wet mats used in evaporative cooling increases the quality as well as its cost which in turn increases the price of cutting flowers during summer season.	Evaporative water cooler has an efficiency(thermal) of 79%. During evaporative cooling operation it was found in the experiment that temperature rises up to 28 and the humidity is 71% in a green house.
Azzeddine Laknizi et al. (2019) [25]	Evaporative cooling pads are quite expensive with less life cycle. Scaling and Rusting is a major problem while using conventional cooling pads. For attractive pads there is need of low-cost material pad.	Evaporative cooling pad made up of tubular pottery rods has been designed and tested. The research output is as follows: The temperature reduces by 10 and the relative humidity increases by 5% The saturation efficiency is found to be between 49% and 66% approximately.
Sarvesh	Approximately 36% of the	The direct and indirect evaporative

Kashyap et al. (2021) [26]	entire population of the world lives in areas where the daily mean temperature exceeds 25 . Increased standards of living, constantly growing population, and regular heat waves have quadrupled energy use for cooling. Currently, there has been a rapid increase in the need for efficient cooling methods.	coolers are clubbed into a single unit. The cooling system (dual mode) comprises of regenerative type heat exchangers. It also consists of extra arrangement (vanes) to stop dry channel flow during direct operations. The greater the ratio of extraction in regenerative mode results in increased effectiveness of the system. But the cooling capacity reduces. The Coefficient of Performance reduces to 53% and the effectiveness increases by 10% during the analysis.
Ahmed Y. Taha Al-Zubaydi et al. (2019) [27]	The WBT efficiency measures Indirect evaporative cooling's (IEC) performance. As a result, the system is restricted to the secondary air's WBT. Therefore, the efficiency of IEC is low and not suitable for large buildings when the secondary air's humidity is high.	In this work, an innovative spraying arrangement was suggested. The system under investigation is an IEC with nozzles internally placed to spray water into the wet channel. With the water spray on cooling pad can increase cooling load by 12.5%.

4. RESULT OF REVIEW

This paper examines the Evaporative cooling process that has been under use in the past and it is very popular cooling method. Few researches have been made regarding the improvement of the effectiveness and how to use it in commercial and residential building as well as other apartments with less energy consumption. The techniques utilized in the adiabatic cooling process are also discussed. The study also discovered that the adiabatic cooler/chiller would operate at low power consumption with higher efficiency and comfort cooling without using any harmful refrigerants. After the review of various research papers, it is suggested that adiabatic cooling systems are good option to achieve proper cooling and ventilation with better energy management for a smart city or other commercial apartments. The improvement of cooling pads has also been discussed as it is a very important part in evaporative cooling. Methods of spraying water by various methods into the cooling pads and using clay to build tubular pads to increase its efficiency has also been a topic of discussion for researchers.

5. Conclusion

The review paper gives a detailed study on how we can reduce emissions of greenhouse gasses and minimize global warming by using evaporative cooling instead of commercial refrigerants for air conditioning. It also provides a cheap process of air conditioning. Energy management being as the top priority for researchers in modern world use of evaporative cooling can be a game changing method in HVAC sector as it doesn't consume or consumes very less amount of electric current thus reducing energy consumption. After the review it has been found that installing higher-efficiency based adiabatic chiller and coolers is the best way to achieve a comfort cooling in buildings apart from traditional air conditioning systems.

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A Matrix Converter Structure for Wireless Vehicle to Vehicle (V2V) Power Transfer

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Abstract

Electric Vehicles (EVs) increasing and gaining popularity day by day due to its less dependency on gasoline and no harmful gases emission in the environment. But charging time and range anxiety issue in a battery technology is affecting slow development growth in EVs. The driver thinks that their EVs run out of charge during journey. This is demonstration of a structure examination on the application of wireless power transmit between in between two vehicle using single phase matrix converter system. By using single phase matrix converter is capable for converting fix to variable AC instead of existing system using converter such as rectifier for AC to DC & Inverter for DC to AC conversion process which make system bulky, more equipment & less efficient. A Single phase Matrix converter is cable as an active power filter to improve power factor & current waveform. It reduces harmonics by using LC Filter. This paper also addressing limited number of charging station available and reduce out of charge during journey. A transmitter and receiver shape of coil is also recommended for wireless V2V charging system with consideration of misalignment and geometrical matching between transmitter and receiver coil.

Keywords Vehicle to Vehicle (V2V) charging, Matrix Converter, Wireless Power Transfer (WPT) Technique.

1. INTRODUCTION

Now a day, the demand of Electric Vehicle rapidly increases due to advance technology, cheap renewable resources and awareness on air pollution for better environment. Automobile industry launching various segments in Electric vehicle field such as pure electric vehicle, hybrid electric vehicle etc. Majorly plug in charging technologies are using which are having several disadvantages such as physically plug and unplug charging cable, carry a charging cable, risk of high

voltage shock and leakage current during charging of EVs, life of charging cable reduce with respect to time and also hazardous situation during rain or bad weather condition [1].
The issues can be overcome by using Wireless Power Transfer (WPT) Technology by inductive charging system. Wireless Power Technology (WPT) is sufficient for both static and dynamic charging methods.
the most popular invention of wireless transmit electricity by Nikola Tesla, so WPT technology is based on wireless electricity transfer without any physical contact through inductive coil [2]. The best solution for wireless power transfer is thorough Electromagnetic Field (EMF) thorough inductive coil for transfer electrical power [3]. Just like a transformer similarly here is no physical contact in this proposed technique for power transfer. The main goal of wireless power transfer (WPT) is to provide new comfort in daily charging for electric vehicle additionally share vehicle to vehicle (V2V) Strategy when there is charging connection is busy with charging other EVs.
The Common vehicle to vehicle (V2V) indirect wireless technology using multiple converter such as rectifier for AC-DC, inverter for DC-AC, matrix converter for fix AC- variable AC & rectifier AC-DC for battery charging as shown in Figure 1.1.

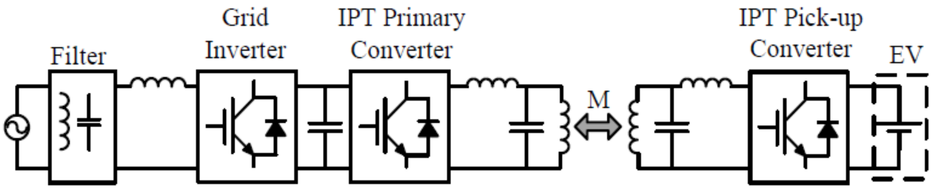


Figure 1.1 Grid inverter based IPT system

It Makes system become more bulky, increase system cost by using more equipment’s, increase system losses and reduce efficiency [4]. By using matrix converter is solution for the existing V2V System.
There are two steps of matrix converter process in which first step voltage switching is involve and in second step current switching is involve for output current [5-6]. The power conversion produce harmonics distortion can be reduce by LC filters [7].

Figure 1.2 represents single phase topology of a matrix converter with four bidirectional switching technique can pass and blocks current in both directions as shown in figure 1.3. A single phase matrix converter is bidirectional switch which act as rectifier (AC-DC) & also act as inverter (DC-AC)

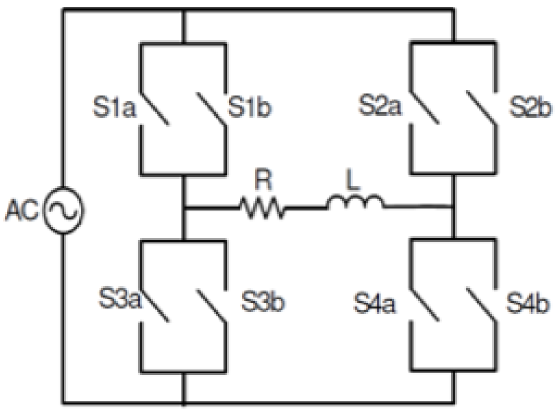


Figure 1.2 Single Phase Matrix Converter (Four bidirectional Switches) Topology

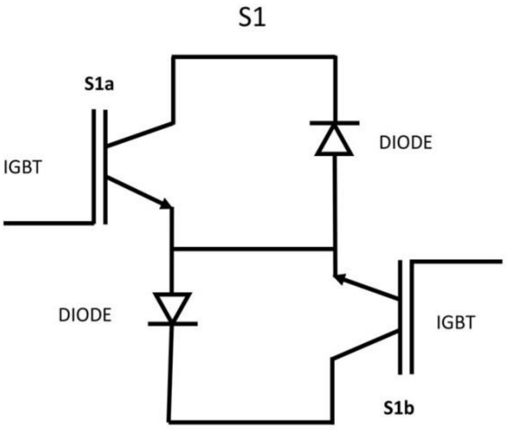


Figure 1.3 Bidirectional Switch contain Two IGBT & Two Diode

2. PROPOSED MATRIX CNVERTER FOR WIRELESS VEHICLE TO VEHICLE (V2V) POWER TRANSFER

Following Fig. 2 shows the recommended block diagram of vehicle to vehicle (V2V) power transfer operation in which there is only two stage power conversion is using due to matrix converter is cable to transfer power on the basis of single stage conversion technologies. Here is power conversion technique is vehicle 1 DC to high frequency AC & then AC to DC for Vehicle 2 via magnetic field. The single phase matrix converter of vehicle 2 is converting high frequency of AC to Dc power for vehicle 2 battery charging.

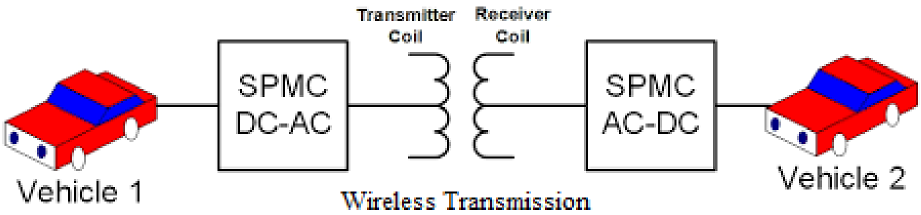
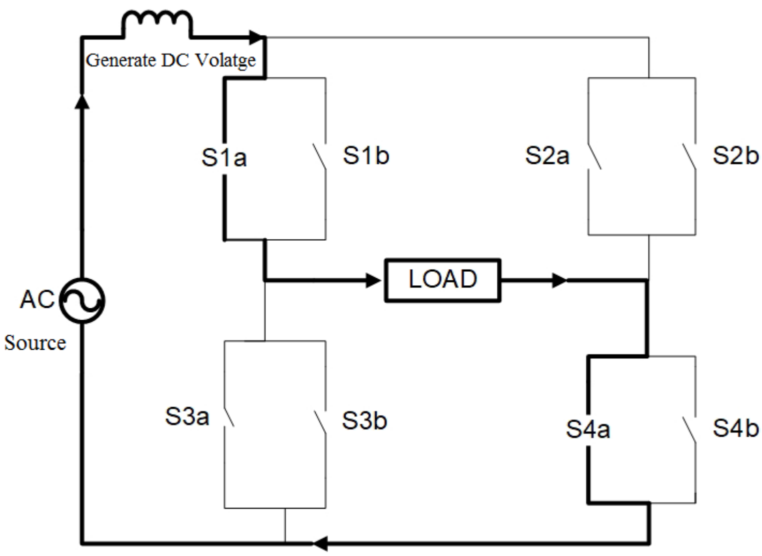


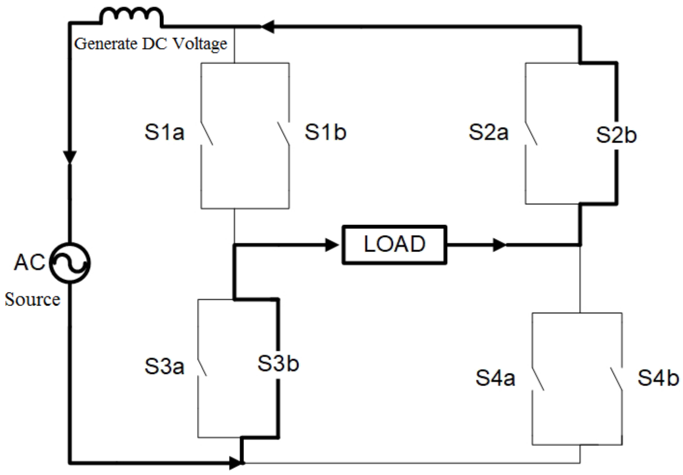
Figure 2 Wireless Vehicle to Vehicle (V2V) Power Transfer

2.1 Single Phase Matrix Converter Rectifier (AC to DC) Mode

Single phase matrix converter on rectifier mode is showing in the fig. 2.1 first input supply positive half cycle, two switches S1a and S4a will be turn ON. As outcomes current flows through the switch S1a to load and Switch S4a to generate DC voltage across the load. During input negative half cycle, a pair of switches S3b and S2b turns ON.As outcomes current flow through the switch S3b to load and S2b to generate DC voltage across the load. That matrix converter is generating DC voltage across the load on both positive and negative cycle.



(a)



(b)

Figure 2.1.Single Phase Matrix Converter as rectifier Mode during (a) half-positive cycle and (b) Half negative cycle of AC voltage.

3. ARRANGEMENT STRUCTURE OF WIRELESS POWER TRANSFER IN VEHICLE TO VEHICLE (V2V)

The recommended technology of power transfer from one vehicle to another vehicle is majorly for two applications; first method is plug in EVs charging and wireless V2V alliance system as shown in figure 3.1. Second method is vehicle to vehicle (V2V) power transfer called by V2V Assistance method as shown in fig. 3.2.

3.1 Plug in Wireless V2V Charging System

Today’s charging station is having limited number of chargers and it require continuous maintenance to ensure that all equipment of charging station working properly. So that problem can be resolve by one to another wireless vehicle charging as shown in fig. 3.1 having frontal coil as a transmitter and rear coil as an receiver are installed. The first car is charge by plug in and simultaneously provides wireless charging to the car behind it without any charging station infrastructure.

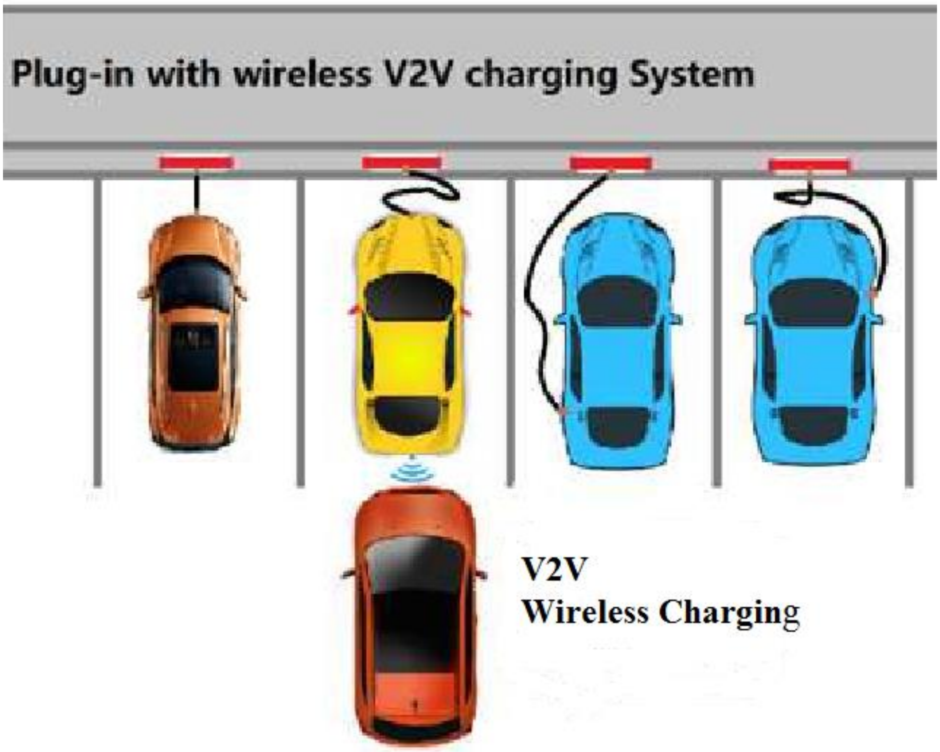


Figure 3.1 charging station with wireless V2V charging system

3.2 Vehicle to Vehicle (V2V) Associate with wireless Charging System

Fig. 3.2 shows the vehicle to vehicle associate with charging system. If the Electric vehicle battery runs low, it can be charge by wireless through other vehicle. In this method various auxiliary system work on it such as vehicle to vehicle communication, GPS, state of charge (SOC) indicator of available charging, depth of discharge (DOD) indicator of used charging and State of Health (SOH) Monitor battery health condition etc. the driver can communicate though smart device to donor vehicle about charging, distance, pricing etc. the concept can reduce range anxiety in EVs. The wireless power technology (WPT) by inductive charging coil as a transmitter and receiver is best suited for this concept.[8-9].

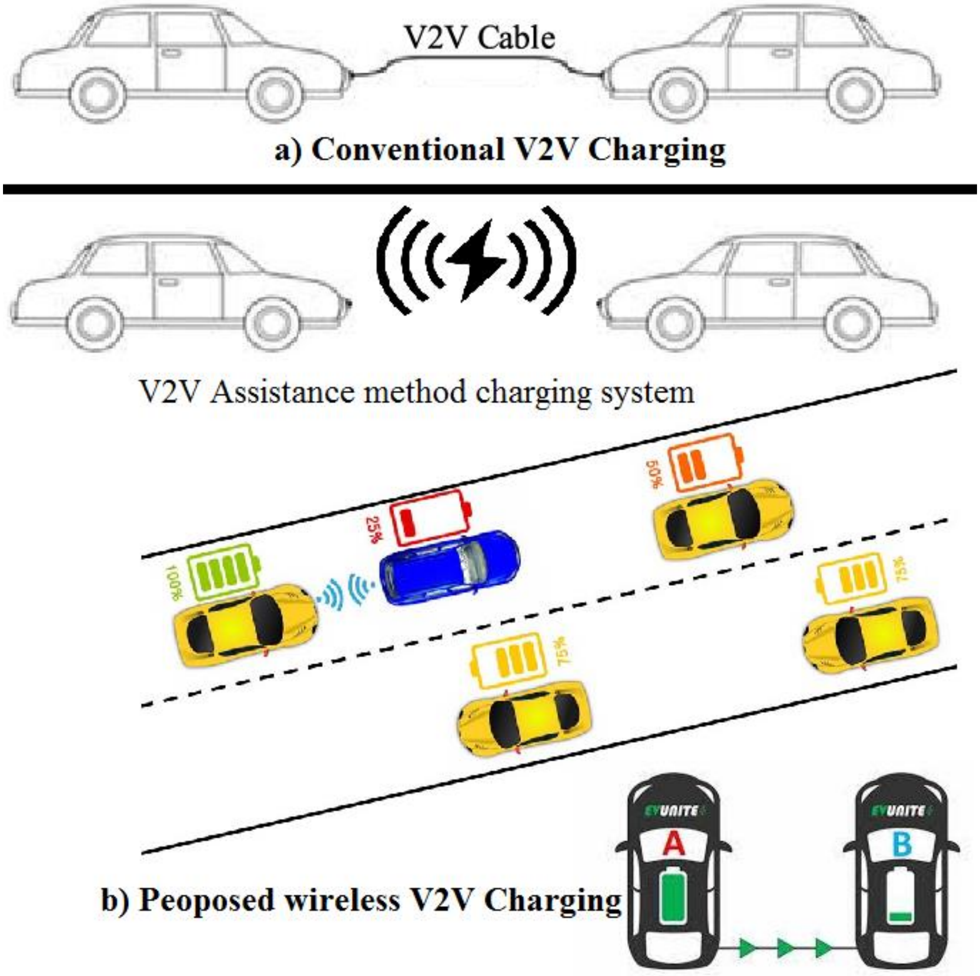


Figure 3.2 V2V Assistance method charging system a) Conventional V2V Charging b) Proposed wireless V2V charging

4. CONCLUSION

This paper proposes new system of vehicle to vehicle (V2V) wireless charging and it can solve the problem of limited number of charging station and also reduces range anxiety problem on highways. By using matrix converter is capable of converting power by single stage conversion process instead of multi stage existing converter. Matrix converter is beneficial for system become less bulky, high efficiency, compact and smooth operation. This paper also present Vehicle to Vehicle (V2V) transmitter and receiver coil designing with consideration of alignment and angular offset. A triangular shape transmitted coil and rectangular shape receiver coil is recommended in this paper for angular misalignment problem. The high power fast charging setup can implement in future for V2V wireless charging. Transmitter coil should be in ground and the receiver coil in vehicle. But wireless V2V system, the transmitter coil is installed at front and receiver coil is installed at rear side of EV. We will also focus on hardware prototype model for this wireless vehicle to vehicle power charging system.

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ANALYSIS OF HYDROGEN FUEL USAGE IN IC ENGINES

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Abstract.

The paper investigates the study and analysis of hydrogen as a fuel to create a new phase in the current technological era for the future by improving the economy, health and environment at its best. The focus of research article is to solve the problems associated with power generation thereby increasing the efficiency of hydrogen fuel based IC engines. The outcome of study reveals to save the environment and use alternative eco-friendly sources as much as possible. The review since last 10 years shows that the technology is already into existence and being used in certain areas of the world. The statistical data reveals how countries like India can move ahead in the era of development of hydrogen as a fuel and make it as a dependable source of energy for future generations.

Keywords. Hydrogen Fuel, IC Engine, Efficiency, Zero emission

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1. INTRODUCTION

Many people are worried about the future of low-carbon and energy-efficient strategies. Today entire world is suffering from the effects of global warming and environmental pollution; Therefore, alternative fuel is considered as an alternative system to protect the environment. And this technology also applies to transportation systems. Primary function of fuels is to store and generate energy, thus it's important that it's readily available in a stable form. Generally, the fossil fuels we are using are quite polluting. And today that fuel is also depleting due to its long term and ubiquitous use. This is why various alternative fuels are being developed to overcome this problem, hydrogen fuel being one of them. This technology is significant as well as in the field of transportation systems. If we consider the internal combustion engine, first it releases harmful gases, secondly fuel combustion of the internal combustion engine is also an issue along with that the efficiency of the engine, after the depletion of fossil fuel, the engine would stop working and fuel consumption is also less. These are some of the problems that are associated with internal combustion engines. [1] Hydrogen is able to store and carry energy through chemical processes. Consequently, hydrogen is a sustainable and low-emission fuel source. In other hand, the main byproduct of burning this fuel in an internal-combustion engine is water., and there is zero production of carbon dioxide.[2] Hydrogen is a high flammable and minimum ignition energy, wide range of flammability limits and high calorific value, these all properties makes hydrogen suitable internal combustion engine.[3]

2. LITERATURE REVIEW

Hot spots in the combustion chamber: deposits and particulates - Bardon and Haycock (2002), MacCarley (1981); the spark plug – Das (2002), Lucas and Morris (1980); residual gas - Das (1996), Lucas and Morris (1980), Berckmülleret al. (2003); exhaust valves - Berckmüller et al. (2003) , Stockhausen et al. (2002), Swain et al. (1988), TÜV Rheinland (1990).[4]Combustion in the piston top land persisting up to inlet valve opening time and igniting the fresh charge - Lucas and Morris (1980), Swain et al. (1996), Koyanagi et al. (1994), Lee et al.(2000)[4] Maro JELIĆ and Neven NINIĆ have discussed the analysis of Internal Combustion Engine Thermodynamic Using the Second Law of thermodynamic. And they found that a powerful tool for optimizing compress and spark ignition engines for lower fuel consumption and fewer emissions was obtained by combining numerical simulations of the system of internal combustion engine which is based on thermodynamics 2nd law.[5] The fundamentals of the combustion sector its whole system has been the subject of Arka Ghosh's research. New designs for combustion chambers are a major focus of their investigation. [5]

2.1. Internal Combustion Engine

More than 2000 years ago, people discovered the method of moving an object with heat, and this concept was first implemented on Aeolipile. After another 2000 years. first steam engine was invented. After this invention people wanted to have more effective engine. In 1679 D. Papin invented the boiler with steam power that hold the steam inside a cylinder. In 1791, John Barber developed the gas turbine. The purpose of this turbine was to make a carriage which can move without any animal power. And for rotating the turbine hot gas generation was necessary, so they used the mixture (fuel and air) in the cylinder and burn those components for produce hot gas. The first internal combustion engine was patented by Robert Street in 1794. But the actual development was happened in 18th century. This development makes a huge revolution in the whole world. In 1876 Nikolaus Otto carried this revolution forward by inventing first four stroke internal combustion engine which was much more effective than other previous engines.

2.2. Hydrogen fuel

A very commonly known element in this planet is Hydrogen. In 1766 British scientist Henry Cavendish proved CO_2 as a fixed type air and another is H_2which is flammable type. Hydrogen is combined with oxygen to produce hydrogen fuel, in this procedure there is no chance to produce carbon. Hydrogen has some special properties; it is the most resourceful alternative to fossil water of the present era. This element is also used in a number of important fields like in industry, automobile sector, power generating sector etc. Due to its many positive aspects, it has been suggested to use it as a fuel of the future. Itis an environmentally benign, quickly depleting type of renewable energy. [6]A minor power of only 0.02 mJ is required for ignition of hydrogen air mixture. Since H_2 has a density of 0.0838 kg/m3, which is lighter than air and may easily diffuse into the atmosphere.[7] The higher compression ratios possible in hydrogen internal combustion engines are due to hydrogen's higher self-ignition temperature of 858 K compared to diesel's 453 K. [8]

2.3. Specifications of useable fuels in IC Engines

	HYDROGEN	GASOLINE	DIESEL
Density (Kg/m3)	42	700-800	830
Energy Content (MJ/Kg)	120	44.0	35.86
Auto Ignition (K)	858	550	483
Cost (Rs/kg)	320-330	96.72	100
Emission of carbon (Kg)	0	2.3	2.7
Efficiency	60%	50%	55%-60%
Flame speed (m/s)	1.85	0.37 - 0.43	1.28

Table 1 -Most usable fuels in IC Engines [9]

3. METHODOLOGY

To control the carbon emission from the vehicles and producing energy from its source. To reduce carbon emissions the energy used in transportation needs to be change.[10] The structure of a H_2 powered engine is nearly similar of a general conventional engine (IC engine). The highest potential power output depends on its ratio of fuel and air in H_2, and fuel injection mechanism. H_2 has a fixed fuel-air ratio of 1:34. H_2 occupies 30% of the combustion chamber with this air fuel ratio, leaving more than 70% for air. Gasoline fuel reduces this mixture's energy content. The output level of gasoline engines is around 85% due to fuel-air mixing and direct injection systems' pre-combustor fuel-air mixing. The highest engine power for direct fuel injection system, that combine the mixture of air and fuel inside the closed intake valve (combustor has full of air), may be 15% greater than for gasoline engines.

3.1. Purpose

The project has some aim for better transportation system for the modern society.

1) To solve the combustion engine’s problems and reducing the carbon emission from it.

2) To reducing the cost from the ongoing electric and other types of vehicles.

3) To improve the fuel consumption than the hybrid and combustion engines.

4. RESULT & ANALYSIS

SN.	AUTHOR/ YEAR	STUDY	RESULT
1.	Das, et al.	Result comes from after using renewable resources in SI engines. [11]	● The present study involves testing clean-burning fuels, such as hydrogen, in engines with modest spark ignition. ● This research contrasts hydrogen fueling with compressed natural gas operation since CNG is currently utilized as an auxiliary fuel source for internal combustion engines.
2.	Verhelst & Sierens.	Behavior of hydrogen engine. [12]	● The promise for sustainable growth, notably in the transportation industry, is offered by hydrogen as an energy carrier. ● The possibilities for a hydrogen-fueled engine emissions from internal combustion engines are far cleaner. ● The rapid propagation speed and wide flammability limitations can improve efficiency. ● By using multipoint injection method the benefits and drawbacks of power regulation via altering the air – fuel ratio and throttle are assessed.
3.	Natkin, et al.	Application of hydrogen IC engine in Ford car.[10]	● When produced from renewable resources, hydrogen is sustainable and clean, making it ideal for use as a transportation fuel. ● To advance the plan for moving away from the petrol economy and toward the hydrogen economy, it is simple to take advantage of the advancement and application of hydrogen Internal combustion engine H2ICE technology.
4.	Manikant,et al	Current position of the hydrogen energy for application. [14]	● The state of hydrogen generation, storage, and application are outlined in current research and active initiatives. ● Analyzed as potential barriers to the commercialization of hydrogen-powered cars in the Indian market are issues with infrastructure development, distribution, regulation, pricing and public acceptance.

5.	Ciniviz & Kose	Use of hydrogen in IC. [7]	• The rapid depletion of non - renewable has accelerated the need for research into practical alternative fuels capable of meeting ecological energy requirements with minimal environmental impact.
6.	Bhaskar, et al.	Performance of H_2fueled in IC engine. [4]	• For IC engines to reach zero output of carbon dioxide we should apply such a fuel which is not produce CO_2 in transportation applications and the fuel will be hydrogen. • The manufacturing, storing, and establishment of the necessary infrastructure are the real downsides of using hydrogen in IC engine.
7.	Faizal, et al	An analysis of behavior of H_2in IC engines. [15]	• The need for alternate fuel sources has increased in order to avoid an energy catastrophe. hydrogen is a modern transport energy source,this fuel is an excellent small-scale energy source for fueling batteries and fuel cells. • The need for hydrogen has led to the development of a number of production, storage, and transportation techniques that make hydrogen as accessible as petroleum while posing less environmental risks.
8.	Verhelst.	The progress of hydrogen fuel for IC engines. [16]	• This study examines the developments in modelling, direct hydrogen injection, in-cylinder heat transfer, and combustion techniques both at the engine and vehicle levels. • Impressive efficiency levels have been achieved as a result of these efforts, both at Peak and half load operating with emissions much below the legal limit establishing reasonable specified power output limitations.
9.	Shadidi, et al.	Hydrogen as a Fuel in IC Engines. [17]	• Hydrogen-powered vehicle research and development wants to increase the efficiency of the new fuel energy(H2) and make a continuity in the transportation sector. • The result comes from adding hydrogen in different types of ignition engines on their gas emissions and performance.
10.	Kanna, et al.	Efficiency enhancer of IC engine using hydrogen. [18]	• The decision to attempt using hydrogen as a kind of alternative power for the automobile due to the escalating expenses of gasoline and diesel fuel. • The aim behind a hydrogen generator is to use hydrogen instead of a portion of the gasoline.

5. CONCLUSION

When using hydrogen as a fuel, the engine cycle does not need to be changed. [24] The energy we use in the future should be safer and more efficient. Hydrogen is the best alternative fuel for lowering or eliminating harmful vehicle emissions and protect the environment from damage. Because hydrogen is just one of several atmospheric components, It's one of the best substitutes for fossil fuels, and it's widely available. Hydrogen can be used to improve the performance of IC engines while also reducing harmful exhaust emissions. Hydrogen is an attractive energy option due to its low negative impact on the environment and long lifespan. [11] The study shows that HCNG is a viable fuel option for IC engines. In CNG, added H_2 as a fuel in spark ignition engines has a noticeable and beneficial effect on efficiency, especially towards the lean limit. Since HCNG allows the engine to be run smoothly, and it also produces less carbon dioxide, hydrocarbon etc. [1]

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Living in anti-pollution Carbon Negative Green building: Mycelium Insulation

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Abstract.

Increase in pollution for whatsoever cause has been a serious issue in recent years. The steep growing curve for the number of vehicles, factories and industries each year probes an immense reason for environmental pollution. Some densely polluted cities has now been a challenge to healthy human lifestyle. Degrading Air Quality Index (AQI) is now observed in many important cities all over the world, leading to increase in diseases, road accidents due to coagulation of pollutants in the environment. Latest method of living to be adapted by humans in order to sustain even in the most polluted zones of the World. Mycelium, a product made from the vegetative part of a type of fungi or mushroom, which can be blended to form mycelium-composite-insulation brick to be used in construction of building. This has shown insane capability of absorbing harmful pollutants like carbon dioxide, purifying air during its lifetime. They feed on agricultural and synthetic wastes, are natural fire retardant among many other useful features hold a strong point for its application in upcoming days. Implementation of mycelium-based product along with solar power systems has shown a positive result in the study.

Keywords: Pollution, lifestyle, Air Quality Index (AQI), mycelium-composite-insulation brick, mycelium.

1. INTRODUCTION

Living in a world packed with advanced features providing a much better facility towards easy and modern lifestyle has always been an area of development and innovation over these recent years. But, with advancement in facilities and technologies, pollution to the environment has been a direct threat due to more industries, factories, vehicles etc. Increase in pollutants in the air has been observed over the recent years containing mainly the oxides of carbon, that cannot be stopped. Newer methods for a healthier lifestyle to be developed to sustain healthy life by neutralizing the pollution from the environment. A naturally grown bio material, mycelium, could be used in construction purposes and as decorating materials like floor mats, facades or wall sheets that absorbs a huge amount of carbonthroughout its lifetime.[1][2][3][8] Solar energy to be used for electric and other power supplies in the building. Implementing solar energy system along with mycelium blended products onto a building that would be self sustainable and anti pollution as a carbon negative, safe and healthy green building would be a challenge to be researched in this study.

1.1 Mycelium

"Mycelium is a bio-material that forms the root systems of fungi", *Pleurotus ostreatus,* which is bio compatible as well as fast growing.[4][5] Synthetic and agricultural wastes and by-products are identified to grow mycelium. This helps the environment from waste decomposing land fills and soil pollution.[3] This material saves energy usage in buildings by providing thermal insulation.[3] Thermal insulators available in the market are generally synthetic or petroleum based, such as glass wool, (Tatematsu et al., 2014), expanded polystyrene (EPS) (Lakatos and Kalmár, 2013), and polyurethane (PU) foam (Kuhn et al., 1992) etc., which provoke carbon footprints during their manufacturing process.[1] Even the content of harmful substances in synthetic and petroleum based products being the major issues for them to be used for building construction applications. Mycelium products are made to be carbon negative sequestering at least 16 tonnes of carbon per month by a sheet of size 1200 X 2400 mm.[3] As mycelium is fire retardant, make buildings somewhat fire resistant when applied. Thermal conductivity of mycelium has been found to be as low as 0.03 W/m.K, outperforming other thermal insulators available in the market. A very good acoustic insulation as high as 75% at 1000 Hz among other features, makes a strong reason for using mycelium based product in green construction.[3]

1.1.1 Features of mycelium

Thermal Capacity

The ability of a material to conduct or transfer heat is referred to as thermal conductivity. Thermal conductivity as low as 0.03 W/m.K has been shown by mycelium blended construction materials, which makes it thermal resistant, meaning it is a bad conductor of heat. When applied in buildings, it works as thermal insulators especially in extreme hot and cold climate zones by regulating alternating heat within the building with respect to the conditions outside the building.[3]

Fire Performance

When exposed to fire, very less heat and smoke is being released from mycelium, unlike other synthetic and petroleum based insulators, which releases much harmful and toxic smoke, making it much healthier and safe. Spread of fire is being prohibited by mycelium products due to its charring behaviour. Thus, much safety to fire is provided by mycelium products in comparison with other insulators, making buildings fire safe to an extent.[3]

Acoustic Performance

Absorption of noise by a material when exposed to an environment is referred as acoustic insulation. It has been concluded from tests that acoustic absorption of at least 75% at 1000Hz(the typical frequency of road traffic noise) is being shown by mycelium products. Thus, mycelium products can be used as both thermal and mycelium insulator, making it advantageous over other insulating construction materials.[3]

Sustainability

Synthetic and organic wastes such as agricultural wastes and by products are being consumed by mycelium to grow into desired shapes to achieve ranges of moisture and mechanical properties. Environment is being helped by consuming the wastes and by-products which would otherwise fo for land fills polluting soil and ecosystems.[3]

Durability

"Research conducted by Munster Chamber of Craftson the long therm in-situ performance of mycelium has demonstrated that they are at least as durable as conventional materials and maintain their insulative properties over the course of their life." When contact with soil, mycelium decomposes slowly over a period of six weeks. Favorable and stable conditions being maintained, lifespan as long as 20 years is being shown by mycelium even when in contact with soil. When exposed to air, mycelium products are made as to last as long as they are intended to be used.[3]

Carbon Negative

This is the most vital role played by mycelium in green building construction. Air is filtered of carbon as carbon dioxide both from outside and inside of the building by mycelium products. The main advantage of mycelium is that it can continue to absorb carbon dioxide over its lifespan.[4]

1.1.2 Limitation

Though mycelium blended materials show a huge revolution in the fields of thermal, fire and acoustic isolation and most importantly carbon absorption, it is being limited in terms of load carrying capacity. Mycelium blended bricks can not be used in construction at places where huge load is to be transferred. They should be used only in the walls where much loads are not transferred. Rather, mycelium should be applied as facades, insulating sheets and mats for more efficient results.[2][5]

1.1.3 Application of mycelium

Mycelium based products such as insulating sheets, mats, bricks, facades and clads can be designed according to desired shapes and sizes. Mycelium based insulating sheets are used on the outside walls of buildings as facades and cladding.[4][9] The insulating mats are used on the floors and walls on the inside of the buildings to provide thermal and acoustic insulation within the building. Though mycelium based bricks show good connection between moisture as Relative Humidity(RH) and its mechanical properties, but they have been limited to carry much loads. Thus they can only be used in construction where huge load is not being driven.[6]

1.2 Green Energy

Implementation of green energy system in a building should be obvious to make it self-sustainable as well as regenerative that would prevent pollution to the environment to a great extent. Solar panels should be installed on the rooftops of buildings to make then self-sustainable and reduce the pollution by limiting the use of fossil fuels. Thin transparent solar panel films to be installed on the outer side of window panes which would increase the amount of energy for the buildings.

2. Research Gap

Earlier researches have dealt with their flexural strength, their physical properties like thermal conductivity, acoustic insulation, fire resistivity and relation of moisture with its mechanical properties. They lacked the implementation of features, capabilities and limitations together to form different mycelium induced or mycelium based products.Integration of all the properties together to bring out the best and most efficient ways of applying mycelium blended products to minimize environmental pollution by taking the limitations into accounts to find a better way of utilizing mycelium based products and installing suitable green energy equipment into a carbon negative self-sustainable green building to make healthy life sustainable even in the most polluted cities in recent future have been the main motive for our research.

3. Observation and Conclusion

The study revealed that mycelium based products showed efficiency in cleaning air from pollutants by absorbing huge amount of carbon dioxide from the air. Use of carbon negative green building has shown great results by reducing pollution and also absorbing huge amount of pollutants from the environment. Mycelium blended bricks to be used in construction purposes only at walls where minimum load is transferred due to its inability of huge load carrying capacity. Other products like floor mats, wall sheets and facades are highly recommended to be used in buildings in recent future. With its brilliant acoustic, thermal and fire insulating features, it could be a revolutionary step towards a cleaner and greener world. Furthermore, proper and suitable solar panels and films to be installed on the rooftops of buildings and window panels respectively to make the building self-sustainable using green energy. With further upgrades in technologies, cost of materials could be lowered and used globally. Besides, some other features like terrace gardening would promote a better way of living in a cleaner, healthier and greener environment.

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BUILDING THERMAL COMFORTS WITH VARIOUS HVAC SYSTEM AND OPTIMUM CONDITION : A REVIEW

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Abstract

Energy-related issues reduced thermal comfort. Emerging economies like India have energy use issues. Researchers discuss buildings with optimal HVAC systems, but HVAC consumes most building energy. Only temperatures can't be used to measure human thermal comfort. It depends on the person and the physical activity. Environment affects thermal comfort. This research seeks the best ways to achieve thermal comfort in smart city buildings. This review examines research papers on building thermal comfort. The research focused on techniques to achieve building thermal comfort. Air-temperature, heat-generating devices, air-quality, moist, garment level, and movement affect building energy usage and thermal comfort. Tests showed that nocturnal ventilation increases diurnal temperature variations, especially for lightweight construction, while high thermal mass and closing exterior blinds reduce them. Deep reinforcement learning controls multi-zone HVAC thermal comfort. Implementation and evaluation of a modern HVAC system that incorporates occupant thermal profiles. The Pareto solution was used to generate optimal building design options (NSGA-II). Designers use thermal comfort assessments. Thermal comfort models are described. Thermal comfort requirements protect human and building health.

Keywords: HVAC, Building, Thermal Comfort, chiller, Air-Conditioning, Energy, Heat, optimisation

1. INTRODUCTION

Thermal comfort is the state of mind that expresses satisfaction within the thermal environment [1, 2]. Thermal comfort can't be measured in degrees or a range. Environmental and energy problems are global [3, 4]. The VRF system cools or heats air-conditioned spaces by controlling refrigerant flow with an inverter-controlled variable speed compressor [4, 6]. Modern compressors, like the twin rotary compressor, can close the metering mechanism to restrict refrigerant flow between indoor and outdoor units [7]. Temperature-priority lists improve HVAC load dispatch to maintain indoor temperatures and load diversity [8]. Realistic intra-hour load balancing signals analyse HVAC load characteristics under varying external and internal temperatures. The ideal zone temperature set-point schedule minimises running costs, CO2 emissions, and occupant thermal discomfort [9]. A comfort-preserving energy-saving approach is more popular and easier to implement [10, 11]. Microencapsulated PCM in wallboards reduced Darwin's cooling demand. Using artificial lighting regression models and artificial neural network (ANN) models with an Energy Plus model database, a meta-model was created to predict building energy performance. [12]This study examines how light shelf affects thermal comfort and energy use in residential buildings. Cooling/heating loads were hand-calculated until the mid-1960s [13].

2. RESEARCH METHODOLOGY

Various research papers find the effect of energy efficiency on thermal comfort. This research used these methods:

Step I: Collected various research papers Scopus, science direct, Google Scholar, and Web of Science were searched for relevant papers published in the past 5 years and new research in the same field.

Step II: Choosing only relevant research relevant physical and human body research papers were filtered, shortlisted, and considered based on their abstract, results, and conclusion.

Step-III: Extracting Data Coziness. The study included 100 research papers on thermal comfort of HVAC system activities in buildings. Methods, Technologies, problems, questionnaire and thermal comfort of HVAC systems in various buildings were reviewed.

Air Temperature	Easily influenced by Mechanical, passive heating and cooling
Mean Radiant Temperature	It defines operative temperature, a key thermal comfort factor.
Humidity	Air moisture. High or low humidity might cause pain.
Air Velocity	Measures room airflow. Rapid air velocity changes may cause draught complaints.
Physical Activity	Human body heat, which affects temperature perception.
Clothing Level	Body insulation. Higher clothing levels reduce skin heat loss and make the region stays cool.

3. OUTCOMES OF PAPER REVIEW

This study compared HVAC and building temperatures. Residential Buildings, offices, hospitals, universities etc. had the most thermal comfort due to convection heat, air velocity, air heat, moist, clothing level, and physical movement. Demand response reduces a building's AC load by 40% and saves 26.8% energy. DR events covered 70% of peak energy [14]. Low occupancy (10%), off-air conditioning, and open windows reduce interior air temperature [15]. Composite PCMs improve thermal properties. Temperature isn't the main factor in regulating thermal comfort in HVAC systems [16, 17]. Personalized cooling, heating, and ventilation with a lower cooling set point (24℃) can save 60% energy [18]. Building sensors in HVAC system helps to measure thermal comfort, visual comfort, indoor air perfection, and future problems for improving building interior environmental quality and energy efficiency with close examination [19, 20]. AI2CC ventilation used less power than ICC and it's energy-intensive. AI2CC was 6.4% more comfortable than ICC but used more humidifier energy [21, 22]. SCHX VRF systems have 8.5% more CPF at equivalent outside temperatures. When SCHX passes 5.27% of refrigerant, evaporator mass flow rate drops [23]. PMV-based control and ASHRAE comfort range management reduce energy consumption by 25.4% and 27.0%, respectively [24]. Nano-insulation reduces cooling and heating energy by 2.85 to 3.6%, they reduce total energy consumption by 5.68 to 6.25%. [25]. A green retrofit design ideally saves 4% energy and improves comfort level [26]. Pipe diameters, length, and EEV control for larger airflow air handlers and a smaller wall unit improves operation and reliability of VRF system. Modern air-conditioning systems are more suitable to achieve desired comfort level with advance features [27].

Author, type of job :: Major part	**Paper summary**
Q. Zhao at al. (2020) [28], Thermal Comfort model's developments, **::** Improve Human thermal comfort and balance.	Earlier sleep thermal models included body part emotions with Overall cool and hot feelings measure thermal comfort and human thermal balance.
S. U. Rehman et al. (2020) [29], predict thermal sensation votes, **::** conventional and deep learning algorithms	According ASHRAE RP-884 Analyses, machine learning and deep learning predict the thermal comfort. Personalized Comfort predicts thermal voting with 85% accuracy, 8% higher than studies.
S. K. Sansaniwal (2020) [30], human thermal comfort **::** Local culture and adaptation.	Study found a weak link between thermal comfort and indoor air quality, which depends on occupant behaviour.
T. Kuczyński et al.(2021) [31] , Night ventilation and window shading effects **::** Effect of night ventilation, window shading and thermal mass	High thermal mass and closing external blinds reduce diurnal indoor temperature variations, with good night ventilation and lightweight construction.
Y. Yao and D. K. Shekhar (2021) [32], review on model predictive control (MPC) **::** MPC design parameters and its uses in HVAC	MPC optimizes plant response using a model, prediction horizon, and optimization tools. After widespread use in industrial process control, MPC is growing in HVAC (HVAC).
L. Xiong et al. (2021) [33] K-nearest-neighbours (KNN) algorithm **::** In contrast to static thermal comfort models	In this study a KNN-based thermal relief model creates based on environmental factors. 34 volunteers will test KNN-based thermal relief. The KNN model with 1000

	training sets achieved 88.31% accuracy.
G. Halhoul Merabet et al.(2021) [34], Intelligent building control systems **::** Artificial Intelligence-based techniques.	Evaluated AI-based building control system outputs, implementations, and energy efficiency. AI technologies for power and comfort relief include identification, recognition, optimization, and predictive control.
Z. Ding et al. (2022) [35], Energy-efficient control **::** Thermal comfort in and SVR-DNN model HVAC	SVR-DNN model is used and results indicating this method can improve thermal comfort by 20.5% in complex HVAC system compared with other models.
S. A. Mansi et al. (2022) [36], human thermal comfort decoding via physiological signals **::** Physiologic signal via decoding of human thermal comfort	Physiological signal can distinguish between cold and warm thermal sensations. Physiologic signal processing identified thermal perception when combined, signals show excessive heat.
H. Fitriani, M. Rifki (2022) [37], Investigation of Energy Saving **::** Network theory models	Thermography Laplace transfer models of HVAC and controls applied. Determining radioactive and convective load transfer functions. Convective heat input increases concrete-floored rooms' first-order time constants by 80%.
B. K. Jeon et al. (2022) [38] White-Model Predictive Control **::** Multi-zone MPC evaluation.	Multi-zone MPC benefited from Energy Plus's thermal comfort and energy savings. The simulation for thermal comfort and power savings optimization showed suggested framework can reduce current TOU fees by over 55%.

4. RESULT

Table summarises literature review results.

Commercial buildings, hospitals etc. are required the highest thermal comfort. Temperature, air quality index, heat-generating devices, humidity and personal characteristics like clothing level and movement affect thermal comfort. Different technology like artificial intelligence-based techniques, machine learning driven models and MPC design parameters are used to achieve the more thermal comfort and energy management in smart cities. Reduced buildings AC load and save 26.8% energy by using demand response management. Energy efficient HVAC system with PMV –based control systems and ASHRAE comfort range management can reduce consumption of energy by 25.4% and 27%. SVR–DNN model improve thermal comfort by 25.5% in complex HVAC system with other models.

5. CONCLUSION

This paper analysed building thermal comfort and HVAC systems. The study found that buildings, offices, hospitals etc. requires maximum thermal comfort. Air heat, mean convector heat, air velocity, moist, clothing level, and physical movement affect thermal comfort and building energy uses. Now a day, HVAC uses most building energy. According to studies, plan orientation and design can improve building energy and temperature issues. Many industries with good job prospects undervalue thermal comfort. We can achieve more thermal comfort and save more energy by using different-different technology. Future research should focus on building and other energy-saving tasks. Future research could focus on small, medium, and large building thermal comforts, optimal conditions, energy consumption, and costs.

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Voltage Stability Analysis Using GVSM

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Abstract

Voltage stability is currently causing a lot of concern. This research presents the evaluation of voltage stability using the global voltage stability margin (GVSM).The system's overall state with regard to voltage stability is evaluated using it. This approach is assessed using the IEEE 14-bus test system. In terms of voltage stability, GVSM is an effective system health indicator. An algorithm to compute GVSM, (V_{crm}) is used. To analyse the voltage stability of any system at any operating point, the π-equivalent model generated by the recommended technique is more accurate than the series equivalent model, according to simulation findings for the IEEE 14-bus system.

Keywords

Global Voltage Stability Margin (GVSM), Voltage Collapse, Critical Voltage.

1. INTRODUCTION

Modern electricity systems have developed in recent years into a sophisticated, linked network. With a variety of utilities of various types at the generating, transmission, and distribution ends. Issues with voltage stability are well-known and significant given the market's dynamic demand pattern. Stability is referred to as perturbation. Stability of voltage is the capacity of a system to sustain adequate voltages at each bus both during standard functioning conditions and after a disruption. After a disturbance, the level of voltage at various points somewhat fluctuates, which is a common characteristic of voltage instability. It could be close to the brink of collapse. As a result, the voltage level alone is not a reliable indication of the system's health. The mismatch between the supply and demand for reactive power is what leads to voltage instability. Voltage collapse results from repeated episodes of voltage instability. Voltage stability research is crucial for locating crucial buses in a power system.

The feasibility of power flow solutions, the singularity of the Jacobian, the bifurcation method, the optimal flow of power, etc. are some of the ways for assessing the voltage stability of power systems along with for recognizing the point of critical voltage stability. For evaluating the voltage stability of key buses in power systems, researchers mostly employed the traditional PV, QV curves, and PQ plane [1, 2]. V-I characteristics were employed by MH Haque et al. [1] to evaluate the voltage stability limit. In this technique, current and recent operating point bus voltage and current data were used. The least squares approach was used to analyse these data and create the V-I characteristics. P. Nagendra et al. [3] In their discussion of the equivalent pi-network construction utilising series and shunt the line in certain places. Separate data on power losses were acquired from operational characteristics of the original OPF solution multiple bus power network. The state of the voltage stability was evaluated by GVSM. A method to simplify the provided power system to a two bus equivalent model is described in [4, 5]. The notion of single line equivalent is used in the references [6–8] to determine the vicinity of voltage collapse. References [4–11] equivalent models that are used for the assessment voltage stability of the system and are created by grouping together all transmission line shunt admittances and series impedances into a single equivalent are reviewed. Voltage stability indices comparison is provided in [12]. This work presents the simulation for weak load bus detection and credentials of global voltage stability based on the magnitude of the Global Voltage Stability Margin Analysis (GVSM) assessed via IEEE-14 bus system. The rest part of the paper is organized as follows: In section 2, technique to evaluate equivalent two-bus pi-network is described. Section 3 formulates the mathematical analysis of GVSM. Algorithm is provided in section 4. The simulation results are given in section 5. Section 6 presents the whole work's conclusion.

2. A TECHNIQUE FOR EVALUATING THE EQUIVALENT TWO-BUS π-NETWORK MODEL

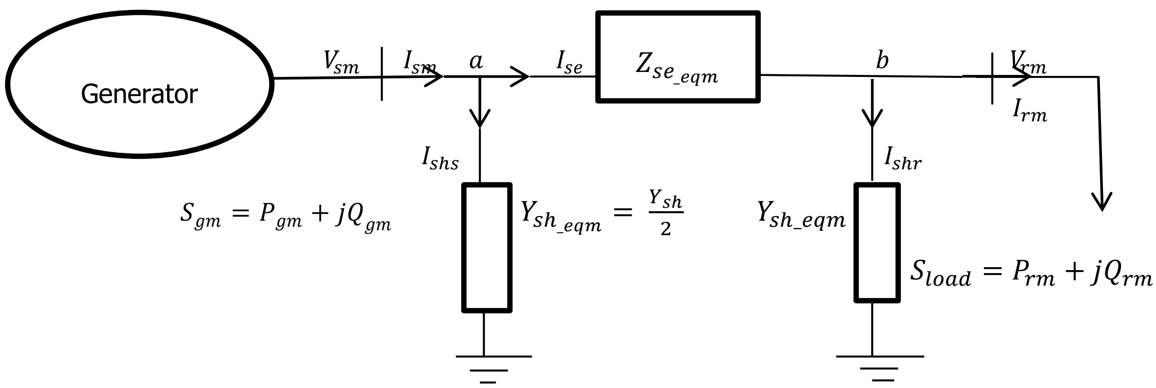

Figure 2.1 Model of the equivalent two-bus π network

$$S_{gm} = P_{gm} + jQ_{gm} = \vec{V}_{sm}\,\vec{I}_{sm^*} = (S_{se} + S_{sh}) + S_{load} \tag{1}$$

Where

$$S_{se} = \left(\overrightarrow{V_{sm}} - \overrightarrow{V_{rm}}\right)\ \vec{I}_{se^*} \tag{2}$$

$$S_{sh} = \vec{V}_{sm}\ \vec{I}_{shs^*} + \vec{V}_{rm}\ \vec{I}_{shr^*} \tag{3}$$

At nodes a and b, apply Kirchoff's current law (KCL).

$$\vec{I}_{se^*} = \frac{S_{gm}}{\overrightarrow{V_{sm}}} - S_{sh}\left(\frac{\vec{V}_{sm^*}}{\left|\vec{V}_{sm}\right|^2 + \left|\vec{V}_{rm}\right|^2}\right) \tag{4}$$

$$\vec{I}_{se^*} = S_{sh}\left(\frac{\vec{V}_{rm^*}}{\left|\vec{V}_{sm}\right|^2 + \left|\vec{V}_{rm}\right|^2}\right) + \frac{S_{load}}{\vec{V}_{rm}} \tag{5}$$

where the voltages and currents at the sending and receiving ends are $V_{sm}, V_{rm}, I_{sm}, I_{rm}$. The current flowing via the equivalent series impedance I_{se}, and at the transmitting and receiving end sides, the shunt branch currents, are denoted by I_{shs}, I_{shr}.

$$S_g\left|\vec{V}_{sm}\right|^2\overrightarrow{V_{rm}} + S_g\left|\vec{V}_{rm}\right|^2\overrightarrow{V_{rm}} - S_{sh}\left|\vec{V}_{sm}\right|^2\vec{V}_{rm} - S_{sh}\left|\vec{V}_{rm}\right|^2\vec{V}_{sm} - S_{load}\left|\vec{V}_{sm}\right|^2\vec{V}_{sm}$$

$$-S_{load}\left|\vec{V}_{rm}\right|^2\vec{V}_{sm} = 0 \tag{6}$$

By assuming transmitting end voltage, eq. (6) equation may be split into real and imaginary portions. $\vec{V}_{sm} = 1\angle 0°$ and receiving end voltage $\vec{V}_{rm} = \left|\vec{V}_{rm}\right|\angle\delta$ and the two equations obtained are as follows:

$$\left|\vec{V}_{rm}\right|^3\left(P_{gm}\cos\delta - Q_{gm}\sin\delta\right) - \left|\vec{V}_{rm}\right|^2(P_{sh} + P_{load}) + \left|\vec{V}_{rm}\right|\big(P_{gm}\cos\delta - Q_{gm}\sin\delta - P_{sh}\cos\delta + Q_{sh}\sin\delta\big) - P_{load} = 0 \tag{7}$$

$$\left|\vec{V}_{rm}\right|^3\left(P_{gm}\sin\delta + Q_{gm}\cos\delta\right) - \left|\vec{V}_{rm}\right|^2(Q_{sh} + Q_{load}) + \left|\vec{V}_{rm}\right|\big(P_{gm}\sin\delta + Q_{gm}\cos\delta - P_{sh}\sin\delta - Q_{sh}\cos\delta\big) - Q_{load} = 0 \tag{8}$$

On solving Eq. (7) & (8) by using Newton – Raphson method.

$$Z_{se\_eqm} = \frac{\left(\vec{V}_{sm} - \vec{V}_{rm}\right)}{\vec{I}_{se}}\ \ and\ \ Y_{sh\_eqm} = \frac{\vec{I}_{shr}}{\vec{V}_{rm}} = \frac{\vec{I}_{shs}}{\vec{V}_{sm}}$$

Where, Z_{se_eqm} and Y_{sh_eqm} are the equivalent series impedance and equivalent shunt admittance respectively. To assess how the actual system behaves, the equivalent two-bus π-network model is obtained.

3. GLOBAL VOLTAGE STABILITY MARGIN (GVSM)

The global network's parameters can be used to create global voltage stability indices. For the two-bus network that corresponds to the transmission line's π-equivalent, the V-I relation is calculated using ABCD parameters and is given by

$$\begin{bmatrix} V_{sm} \\ I_{sm} \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_{rm} \\ I_{rm} \end{bmatrix} \qquad A = D = 1 + \frac{YZ}{2}; B = Z; C = Y\left(1 + \frac{YZ}{4}\right)$$

Assuming $\left[Z_{se\_eqm} = Z \; and \; Y_{sh\_eqm} = \frac{Y}{2}\right]$

Suppose $A = |A|\angle\alpha;\ B = |B|\angle\beta;\ \vec{V}_{sm=}|\vec{V}_{sm}|\angle 0;\ \vec{V}_{rm} = |\vec{V}_{rm}|\angle\delta;\ \delta < \theta$

Receiving end current will be obtained as

$$I_{rm} = \frac{|\vec{V}_{sm}|}{|B|}\angle(\theta - \beta) - \frac{|A||\vec{V}_{rm}|}{|B|}\angle(\alpha - \beta + \delta) \tag{9}$$

Receiving end complex power is given by,

$$S_{rm} = \vec{V}_{rm}\,\vec{I}_{rm^*} = |\vec{V}_{rm}|\angle\delta\left[\frac{|\vec{V}_{sm}|}{|B|}\angle(-\theta + \beta) - \frac{|A||\vec{V}_{rm}|}{|B|}\angle(-\alpha + \beta - \delta)\right] \tag{10}$$

At the receiving end Active power (P_{rm}) and Reactive power (Q_{rm}) are:-

$$P_{rm} = \frac{|\vec{V}_{rm}|}{|B|}\cos(\beta + \delta) - \frac{|A||\vec{V}_{rm}|^2}{|B|}\cos(\beta - \alpha) \tag{11}$$

$$Q_{rm} = \frac{|\vec{V}_{rm}|}{|B|}\sin(\beta + \delta) - \frac{|A||\vec{V}_{rm}|^2}{|B|}\sin(\beta - \alpha) \tag{12}$$

$$J = \begin{bmatrix} \frac{\partial P_{rm}}{\partial \delta} & \frac{\partial P_{rm}}{\partial V_{rm}} \\ \frac{\partial Q_{rm}}{\partial \delta} & \frac{\partial Q_{rm}}{\partial V_{rm}} \end{bmatrix}$$

$$= \frac{1}{|B|}\begin{bmatrix} -|\vec{V}_{rm}|\sin(\beta + \delta) & \cos(\beta + \delta) - 2|A||\vec{V}_{rm}|\cos(\beta - \alpha) \\ |\vec{V}_{rm}|\cos(\beta + \delta) & \sin(\beta + \delta) - 2|A||\vec{V}_{rm}|\sin(\beta - \alpha) \end{bmatrix}$$

The Jacobian matrix's determinant is:

$$\Delta[J] = \frac{1}{|B|^2}\left[2|A|\left|\vec{V}_{rm}\right|^2 \cos(\delta + \alpha) - \left|\vec{V}_{rm}\right|\right] \quad (13)$$

$\Delta[J] = 0$, when voltage stability reaches its critical point.

$$\left|\vec{V}_{rm}\right| = V_{crm} = \frac{1}{2|A|\cos(\delta + \alpha)} \quad (14)$$

Where, V_{crm} stands for the receiving-end voltage stability limits' critical value. A low value for V_{crm} indicates that the system will be able to handle more load while also having a better voltage profile. For maintaining, global voltage stability $\Delta[J]$ should be greater than 0. For achieving the global voltage stability, it can be written as $GVSM\ equals\ to\ \Delta[J]$.On the operating condition's global voltage security status, it shows the GVSM points.

4. ALGORITHM

The following steps describe how to compute GVSM and V_{crm} using the suggested methodology:

a) Execute optimal flow of power, trace the weakest bus, and stipulate the power factor.
b) Maintaining the power factor constant, increase active load, and change reactive load.
c) Execute the optimal power flow algorithm. Stop, the algorithm if it does not converge.
d) Determine the overall generation, load, and losses of the system.
e) Find Z_{se_eq} & Y_{sh_eq}
f) Determine the ABCD parameters of the system.
g) Compute the $GVSM, V_{crm}, V_{rm}$, & Go to step (b)
h) Stop.

5. RESULTS OF SIMULATION

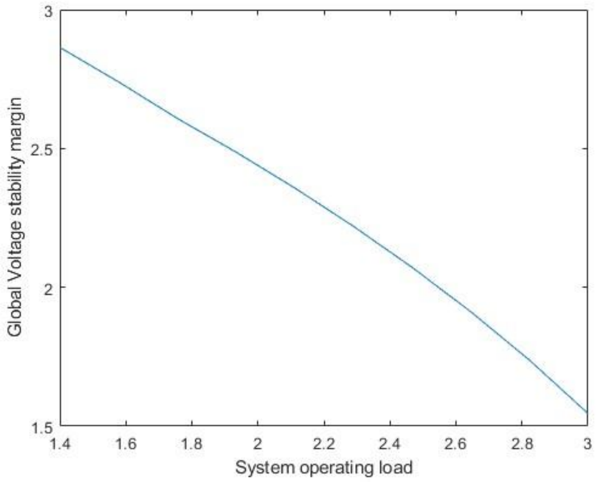

Figure 5.1 GVSM Profile for the IEEE 14-bus system.

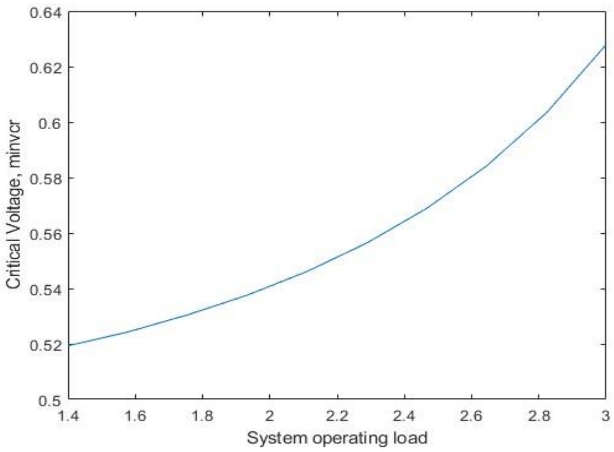

Figure 5.2 Critical Voltage Profile for the IEEE 14-bus system

Using a test system for the IEEE 14-bus, the efficacy of the suggested approach has been shown. There are 14 buses, 5 generators, and 11 loads in the IEEE 14-bus system. A computer programme made in the MATLAB 2022a environment runs the simulations. The parameters of the overall voltage stability margin for the IEEE 14-bus test system with increasing load are displayed in Fig.5.1. As seen in Fig. 5.1, the system is moving closer to voltage instability as the GVSM profile declines.

The parameters of critical voltage with variations in operational load are shown in Fig. 5.2. The V_{crm} is particularly vulnerable to variations in system operating load, it should be highlighted. Voltage collapse can happen even at high voltage magnitudes, V_{crm} increases with load, suggesting a more hazardous operating condition.

6. CONCLUSION

In this study, a novel approach is provided to assess a two-bus equivalent π-network model for a series and shunt characteristics of transmission lines are combined independently into series and shunt equivalents in a multi-bus power system. As opposed to the two-bus series equivalent technique, equivalent network metrics such as GVSM, V_{crm} , global receiving end voltage, etc., are able to sense any form of change in the system with accuracy and efficiency. To evaluate voltage instability, or, to put it another way, to evaluate how far the current system state is from voltage collapse, a novel approach known as GVSM is applied. The IEEE-14 test bus system is used to accomplish the suggested approach. GVSM technique is developed by using the proposed equivalent two-bus π-network model which helps to analyse the proximity of the present system state from global voltage collapse. In Fig. 5.1, when the operational load rises, the global voltage stability margin also declines, causing the system to become unstable. The GVSM is zero at the point of voltage breakdown. The GVSM profile makes the impact of local voltage collapse occurrences in a global context highly dependable. The global critical voltage V_{crm} for a π-equivalent network is shown in Figure 5.2. In the π-equivalent model, V_{crm} increases as system operating load increases, signifying a more critical operating situation.

7. ACKNOWLEDGMENT

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Treatment of collected Rainwater for Household Usage to facilitate Energy Conservation

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Abstract.

Being witnessed by the alarming reduction in groundwater level it is important to store water from various sources like rain, snow, etc. and treat the collected water and purify for household usage and even drinking purpose. So, it will become a necessity in the upcoming future for the conserve and treatment of water from outsources. It can be done by adding simple machineries outside any apartment or any building or home. These machineries include outsourcing water collector attached with solar water heater and condenser unit. This can be governed under smart city management with solar energy. It will serve increasing population and may help to develop the urbanisation. So conserving water from out sources may serve a whole nation significantly and will provide to the construction of smart cities.

Keywords. Groundwater, Solar water heater, Rain water, Condenser, Conserve, Smart city

1. INTRODUCTION

Among all the classic elements in nature, water plays the vital role in human life. Nature is collateral to the chain of hydrology, and by any means any imbalance may lead to lose in fractional management of water [1].70% of earth crust is covered with water-body but still it is difficult to find portable water for household usages. The purest form of water is mainly rain and onto some extent snow can also be used as the form of water. So, to conserve the rain water and to use it, continuous cycle of evaporation, condensation and precipitation is required. Global warming and many more effects have caused significant decrease in water resources, in order to overcome these circumstances, it has been taken in counter to ask take forth many techniques in Rain Water Harvesting (RWH). For increased demand in water RWH is highly accepted and is mostly used as common means of economical conservation of water [2, 3].This paper represents the conservation and treatment of water for house hold usage in duration of natural calamities and to avoid usage of underground water frequently.

2. OBJECTIVES

- To collect rain water from out sourcing.
- Heating the collected water to make it evaporate to stick on the upper wall of the figure 2.
- The evaporated droplets will run down to the condenser chamber.
- Condensation procedure will take part and make the droplets precipitate.
- The precipitate water will be delivered to the house.
- This study aims in portraying the need for adopting RWH as a common practice in day-to-day life [4, 5].

2.1. Collection of Rainwater

A channel will be constructed from the roof of the house to the collector where the rainwater will be collected whenever rain persists. The collected rain on the roof will then be drained through the channel to the collector.

2.2 Work Approach

After the collection of rain water it is heated by the solar water heater in order to make it pure and treated to be used in household works and drinking purpose as shown in the figure 2.This heating procedure will make the collected water to evaporate onto the upper wall of the collector and the lid will open due to vapour pressure and the water droplets will slide down to the other side to the condenser chamber. Where the condensation procedure will take place and the water droplets will be condensed to precipitate. This precipitate will be supplied to the house.

2.3 Set Up Procedure

A collector unit will be set up outside the building or house which will be connected to the roof of the building by a pipe system. The collector will receive rainwater whenever it rains. Solar water heater will be set up at the bottom of the collector as per demand of the building. This solar water heater will heat the collected water to purify, the purified water will be evaporated and collected to the inside wall of the lid as shown in the figure 2, the lid is connected to the collector by hinge instrument and is extended to the condenser unit. After the evaporation process is done, due to the vapour pressure the lid will open and the water droplets will slide to the condenser unit and the condenser will make it cold and it will precipitate. The precipitate will then be supplied to the building with the help of pump.The treated water can be used for various purposes, and further can be purified by RO purifier for drinking purpose [6].

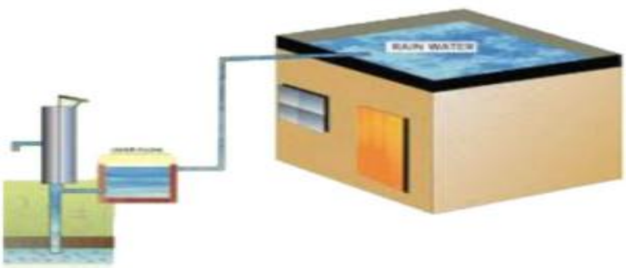

Figure 1 – Roof Top harvesting on open terrace

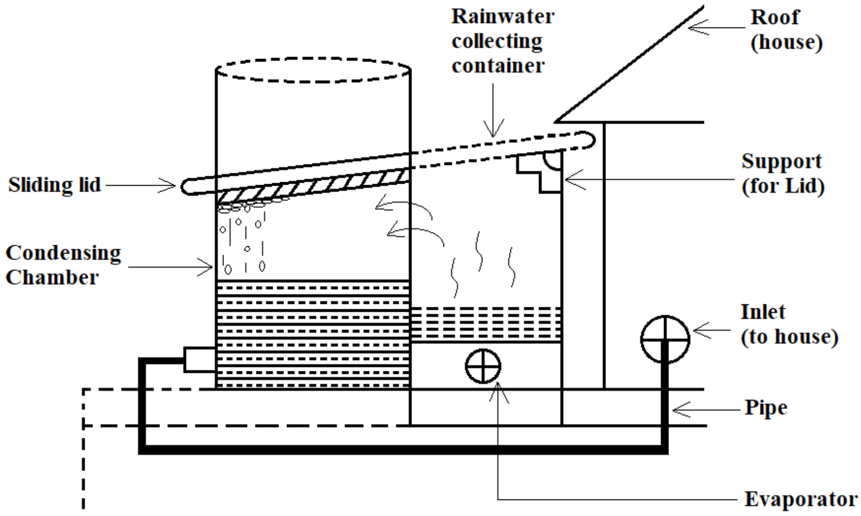

Figure 2- Schematic diagram representing collection of water in unit ‘A' and being heated by solar water heater and is collected in unit ‘B’ and condensed to precipitate and supply to the building by pump for house hold usages.

3. RESULTS AND DISCUSSION

After reviewing and researching many papers and from day-to-day usage of the setup there are consequences with both benefits and drawbacks of the setup. So, user have to take under consideration the drawbacks and make it work or to minimise the drawbacks in order to fulfil the criterions. Table 1 shows the mentioning benefits and drawbacks.

Table 1

Benefits	Drawbacks
• Easy maintenance when needed. • Technology of water collection is simple. • Can serve at the time of drought. • Can also reduce the water bill. • Rise in water table. • Assists reduction in soil erosion leading to the balancing in moisture of soil	• This setup may not work in the areas where there is limited or scarce rainfall. • Installation cost is very high. • Inspite of easy maintenance regular supervision is mandatory. • The reservoirs should be chemical free and the growth of algae and other microbes should be inspected regularly.

4. FUTURE SCOPE

- This feature of collecting and harvesting rain water may lead to increased volume of water and on future it may be an aid to water crisis and establish a crisis free society.
- As INDIA is the second most populated country, it may soon be a water scarce country. So, harvesting and collecting water may endure an increase in demand by 30%, this can be the solution to provide the growing demand.
- Rain water harvesting will act as a sprint mode for generation of revenue with sustained implementation with the increased rainwater reserves, it may also lead to prefatory reforms and taxes can also be imposed [7].

5. CONCLUSION

This paper divulgesan eloquent idea about the methods of harvesting and conservation of water by means of collector and reservoir units. After intense study on the conservation of water the best conclusion is to make major changes in the working modules leading to more emphasised and precise results**.** The last phase of the incarnation of RWH would be ‘‘Natural Resources are meant to be used, conserved and reused just as the hydrological cycle of precipitation and evaporation goes on.” For a developed urbanisation, enlightened future and cosmopolitan society, conservation of water is mandatory and it should be a duty and not a hobby and should be accepted in each and every country to fight in times of scarcity of water.

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