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The correlation between urban energy efficiency technology, global warming, focusing on sustainable power system and electrical supply in India

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Abstract

Population growth and urbanization are closely related, with the effect of urbanization in Ahmednagar's metropolitan region being evident. Energy consumption per capita is a measure of economic progress, but India faces challenges due to its heavy dependence on imported fuels, scarcity of capital, and dearth of natural resources. India's energy supply is a major obstacle, with a massive disparity between the two states' energy needs and supplies. The demand for energy is likely impacted by a large population with low incomes and low per capita consumption levels, as well as the need to accelerate economic development. Grid power supply is unappealing or nonexistent in distant areas due to high costs, political pressure, and a centralized management structure. The increasing number of automobiles is driving up the need for fossil fuels as an energy source. Using nonconventional sources is essential for pollution management and preserving the natural energy cycle equilibrium. The thesis consists of seven chapters, providing an overview of the relationship between urbanization and energy use.

Keywords: Renewable energy, technology, urbanization, kerosene, solar energy

Introduction

The energy intensity of the economy is roughly 2.88 times that of industrialized nations, it was determined by the IEA (2002) [1]. India has been more reliant on foreign energy suppliers in the last forty years. There is a clear inverse relationship between an economy's energy intensity and its growth tendencies, according to global development.

Every sector of the economy relies on energy. Energy resources are essential for the day-to-day operation of every sector of society, including households, businesses, and the tertiary sector. The demand for energy resources is rising at a high rate due to the rapidity of global growth. However, a new obstacle has emerged in the form of the diminishing availability of fossil fuels, which makes it more difficult to maintain both economic expansion and environmental sustainability. This obstacle prevents the developed and developing worlds from making renewable energy compatible and efficient enough for their economies. A new global energy economy is taking shape, according to Lester R. Brown's 2015 [2] book "The stated, Great "As Transitfossion" lfue, air pollution is becoming worse, and worries about climate change are casting a shadow on the future of fossil fuels. The economy that relied on fossil fuels is giving way to one that harnesses the power of the sun and the wind.

Recent years have seen enormous promise for renewable energy generation from wind and solar in nations such as the United States, China, India, and Germany. The possibility has become a beacon of hope for a new age of clean energy in a nation like India, which has a very favorable geographical position for solar power. India has the potential to generate five thousand trillion kilowatts of electricity thanks to its abundant solar energy resources. Solar insolation ranges from 4 to 7 kilowatt hours per square kilometer per day, thanks to its 300 bright days each year. To address the anticipated increase in energy consumption in the years to come, some states have begun to focus on solar power as a possible energy source. Solar power will play a more significant role in the years to come. Therefore, the government is making an effort in this manner via the Jawahar Lal Nehru National Solar Mission. Gujarat and Rajasthan are two states that have begun generating electricity from solar panels because of the promising future of solar power. In 2009, the state of Gujarat became the first

in India to introduce its own solar policy. When asked about the Gujarat Solar Policy, Swami P. *et al*. (2013) [6] noted that it had been in existence for a year prior to the announcement of NSM. At the conclusion of this era, the primary objective is to reach 500 MW of installed capacity. Nodal agencies for the facilitation and implementation of the policy have been established, namely the Gujarat Energy Development Agency (GEDA) and the Gujarat Power Corporation Limited (GPCL). Making power generating a cleaner process is one of the greatest options for lowering carbon emissions.

Renewable Energy

The definition of renewable is "not depleted" when utilized. We have begun to harness energy in the contemporary era from renewable sources such as wind, solar, hydro, and biofuels. Sustainable development and renewable energy go hand in hand. "Affordable and as goal number clean" is already in the UN's Sustainable Development Goals. Increasing the proportion of renewable energy sources in the world's energy mix by the year 2030 is one of energy's primary goals. No. 2. Intended Nationally Determined Contributions (INDCs) were addressed by India in relation to the Third Framework Agreement on Climate Change. Raise the percentage of power generated by sources other than fossil fuels to 40% by the year 2030. Renewable energy presents an opportunity for our world to lessen its carbon footprint, improve air quality, and establish a more sustainable society. Additionally, it presents nations with an opportunity to enhance their energy security and stimulate economic growth. Biomass in its modern form is basically chemical solar energy storage and includes a wide variety of photosynthesis-derived compounds. That 18% of the world's total energy consumption comes from renewable sources. This includes both old-school biomass and big hydropower as well as "new" renewables including small hydro, contemporary biomass, wind, solar, geothermal, and biofuels. About 13% of biomass comes from traditional sources, such as cooking and heating, and this proportion is declining in certain areas due to more efficient biomass use or the rise of other, contemporary energy sources.

New types of energy are proliferating as a result of the world's growing efforts. In terms of cleanliness and future efficiency, they are well on their way. The most important renewable energy sources are:

a) **Hydropower:** Hydropower plants generate electricity from falling water from height. Generally, these plants are situated near dams and waterfalls. There are also small hydro power systems that are known for generating approximately 50MW of power.
b) **Wind Power:** The flow of the air is used to generate energy through wind mills. There are many wind farms all over the world situated at areas with strong winds.
c) **Solar Energy:** This type of energy is harnessed by sunlight. The sun radiates good amount of heat in the form of sunlight. It is converted into energy through appliances like photovoltaic systems, solar thermal heaters, solar cookers etc. Today solar photovoltaic cells are taking revolutionary stand in generating clean energy all over the world. Country like India which is geographically blessed for consistent sunlight has a huge future potential for solar.
d) **Geothermal Energy:** The depth of earth's surface in the form of magma and hot rocks. The steam present in those rocks is used to generate electricity through turbines connected through pipes.
e) **Bio Energy:** This type of energy is generally used in the form of bio-fuels. The bio-fuels are conversion of biomass that can be easily used as an energy source. Bio-fuels are commonly extracted from sugarcane, bamboo and corn etc.

Energy Consumption Pattern in Urban India

Firewood, liquid petroleum gas (LPG), electricity, and kerosene are the most common cooking and lighting fuels in urban India. The 55th national sample survey organization (NSSO) study found that firewood usage went up from 1999–2000 to 2004–2005, with only a little dip in 2009–10. Having said that, compared to 1999–2000, the overall use of firewood in 2009–2010 was greater. The average annual rise in firewood usage was 7.5-8 percent, whereas the average annual increase in electricity consumption was 25-30 percent. There have been small shifts in the use pattern of LPG during the last several years. There are primarily three income brackets represented in urban India: low, middle, and high. Different types have different patterns of energy usage. The next part will provide a sequential discussion of the different energy sources and their consumption patterns in urban India.

Linkage between Energy, Economy and Environment

People in our modern culture, particularly economists, seem to be growth focused-if not obsessed-with growth. For them, economic development is the bee's knees, and any sign of economic contraction or stagnation is news to be feared. People seem to think that a flourishing economy is a sign of a strong society, but progress does not last forever. People require resources so that economies may expand. It is a common misconception that resources are endless or easily replaced. We are destroying Earth's resources at an alarming rate, and soon there will be nothing left. Even while technological advancements have repeatedly postponed growth's limitations, this won't cut it in the long run. We are quickly approaching the point when Earth can no longer support human population growth at our current pace. The only way for individuals to control the population is to follow all the rules and regulations. There were a billion people in the world till 1800 AD, two billion by 1930 AD, and three billion in just another 30 years. This shows that the rate of population expansion is exponential rather than linear. There are almost seven billion people in the globe right now, according to latest estimates.

There is a direct correlation between population growth and increased consumption, which in turn leads to a depletion of energy supplies. Yet, there is a limit to how many resources we may use; many of them are not infinite. Coal, natural gas, and oil are examples of fossil fuels that humans have relied on excessively, but these supplies will soon run out. The Earth's fossil fuel reserves are not uniformly distributed; some areas have large amounts of these resources, while others have very little. A country's ability to maintain a sufficient supply of fossil fuels is contingent upon its extraction, consumption, import, and export rates. Remember that developed-world residents use substantially

more energy than their less-advanced counterparts. Oil accounts for 35% of the world's energy consumption and is thus our most used fuel. Keep in mind that energy is required to create energy. For example, drilling for oil demands a massive infrastructure of roads, trucks, pipelines, all of which we need to utilize energy. Apart from this, it gets harder and harder to extract oil from the ground as time goes by, and for this reason some oil companies are not willing to extract it, because the extraction of oil tends to cost more than what they would receive from selling the oil.

Overview of Urban Energy Technology

Energy is essential for many urban activities, including heating homes during the winter months, lighting, cooking, and pumping water for irrigation and drinking. Most people use electricity to power their lights and other electronic devices that provide us with information, communication, and entertainment, such as televisions, radios, and telephones. Having said that, urban areas still have spotty and limited access to power. The grid power supply is not always a financially feasible option because of certain geographical regions. Consequently, a large number of urban areas lack access to modern energy. This highlights the critical requirement of supplying electricity to urban communities using off-grid energy technology. Having grasped the significance of these technologies, this part provides an outline of urban energy technologies that might enhance urban India's energy supply.

Improved Chulha: The majority of energy utilized by low-income urban households was for cooking. Their cooking stoves, constructed from mud and brick, are inefficient, accounting for just 10-15% of the time. Thus, the first technology for better energy availability in urban India was the upgraded chulha, which can burn firewood's with an average efficiency of 30%.

Thermal Solar Cooking: Thermal solar cooking is an advanced method of using solar energy to prepare food. Solar thermal cookers' efficiency is 30–70% higher than that of conventional burners, and they're also quite inexpensive to make.

Biogas Digesters: The abundance of cattle in urban India makes biogas digesters an attractive technology for improving urban residents' quality of life.

Other uses of Biomass: Potential alternatives to more conventional applications of biomass in India include more recent developments in the field. Sugar bagasse, paddy husk, rice, coffee, and other agricultural byproducts make up the bulk of alternative biomass. However, transporting and handling agricultural waste is a huge hassle due to its low energy per volume, which is the main obstacle to energy generation from this waste.

Solar Photovoltaic: Solar Photovoltaic (PV) Panels is a common solution to serve the necessity of energy supply in fewer privileged places.

Wind Energy: Another potential solution for urban regions' energy supply is wind power. Both residential and utility-scale applications are possible with wind energy systems. More windmills produce more electricity, much like PV installations.

Micro Hydropower: Micro hydropower has a great potential in India for generating micro-grids electricity.

Biomass gasification: Another technology that has great promise for power generation in India is biomass gasification.

Urban energy efficiency technology

Our nation's cities, in particular, have the potential to become self-sufficient if more people become aware of the issue and take action to reduce their energy use, improve their energy efficiency, and generate more energy from renewable sources. Given that most of India's farms are located in urban areas, it stands to reason that farmers there would welcome the opportunity to invest in cutting-edge farming technology that would allow them to meet both their own and the nation's food production needs. Proper supply of electricity or other types of energy is now necessary for the implementation of innovative agricultural technologies. It is an enormous undertaking to construct thermal power plants or grids with vast distribution capacities in a state like Ahmednagar, which is entirely a mountainous territory. Since Ahmednagar is home to a sizable urban population and a number of high-quality agricultural goods, it is crucial that all parts of the city have access to reliable electricity. For their cooking and lighting needs, city dwellers rely on kerosene and firewood. Many health risks, particularly for women, are associated with old energy sources. Because they generate carcinogens, airborne particles, and greenhouse gases, firewood and kerosene pose a significant threat to air pollution. As a rule, women spend much too much time in close proximity to open flames while they cook. Nighttime workers, especially women, must rely on a weak, strobing light. Furthermore, in many rural regions, it is the midwives who go on firewood hunts and carry kerosene.

Literature Review

Jeremy Lagorse *et al*. 2020 [7], From the viewpoint of Multi-Agent Systems (MASs), a decentralized method of administration been suggested by. Under the "bottom- Up" philosophy, this technique ensures a more organic conception and improved system dependability. After reviewing the literature, we show how MAS may be used to control power in a hybrid power source. This is how a simulation model is used to test the system. With this method, centralised Energy Management Systems (EMSs) can respond to the majority of problems.

(Behnke, Rodriguez, and colleagues, 2023) [8], A technique for a microgrid that relies on renewable energy sources and following the recommendations made by the Energy Management System (EMS). A mixed-integer optimization problem is detailed, with a forecasting model providing help for each decision step. In line with a Demand-Side Management (DSM) system, the EMS transmits client signals and online set points to each producing unit. Autonomous microgrids powered by renewable energy sources like solar panels and wind turbines are managed

using this energy management system., a diesel engine, and batteries. A unified mechanism for economic comparisons and prediction information is offered between the RH and the conventional Unit Dedication (UC). Also included is a neural network that can predict power use two days in advance.

Biogas, says Khandelwal (2023) [3], is great news for those living in urban areas. Using it as a cooking fuel is perfect. "Gramme laxmi" is the name given to it in the biogas unit. This has gained global popularity as the biogas plant model from India. The ailments caused by smoke and dust are greatly alleviated by it. Efficient demand management, switching to fluorescent light bulbs from incandescent ones, better chulahs for urban families, and an improved suction and delivery system for irrigation pump sets are all ways to reduce energy use, says Satish Chandran (2014) [11].

Amacher *et al*. (2023) [4] The normal job of urban women and children includes collecting a non-commercial fuel item, which acknowledge. People in urban regions often gather the necessary cooking ingredients-twigs, agricultural waste, cow manure, and fuel wood-from neigh bouring woods or their own gardens.

(T. Praveen Kumar *et al*., 2023) [12]. A hybrid The DG system is an important issue that requires careful consideration. Numerous intricate procedures comprise the control of a fuel cell/battery hybrid system. These include controlling the fuel cell's flow rate in respect to the load request expectation, dividing the power between the two sources to manage the fuel cell's efficiency, and/or charging and discharging the battery. efficiency in an abnormal state, and so on (Hajizadeh *et al*., 2020) [5].

Global Warming and Climate Change

Extensive research has been conducted by scientists on the greenhouse effect, which proposes that, in the next century, substantial climatic changes, including global warming, would be caused by the buildup of greenhouse gases (GHGs) such as carbon dioxide (CO_2) (Nordhaus, 1991) [13]. Future conflicts will pale in comparison to the danger posed by global warming. Global warming is directly or indirectly responsible for a wide range of natural disasters, including glacier melting and water shortages. Even now, this danger is affecting a lot of nations and places. What we know about climate change comes from over two hundred years of research and theory, according to Frankhauser and Stern (2006) [14]. Jean-Baptiste Fourier and John Tyndall proved in the second part of the nineteenth century that the Earth may retain heat due to the presence of gases in the atmosphere that trap heat. This proved the fundamental physics of the greenhouse effect. Investigating the former proved that some obstruction was impeding the energy's departure, while the latter pinpointed the gases responsible. Svante Arrhenius established the connection between emissions from fossil fuels and the natural greenhouse effect around the turn of the twentieth century. He demonstrated that these emissions amplified the impact and offered estimates of its possible size. After quantum theory gained traction in the early 20th century, scientists determined that greenhouse gases' (GHGs') oscillation frequency was interfering with infrared radiation.

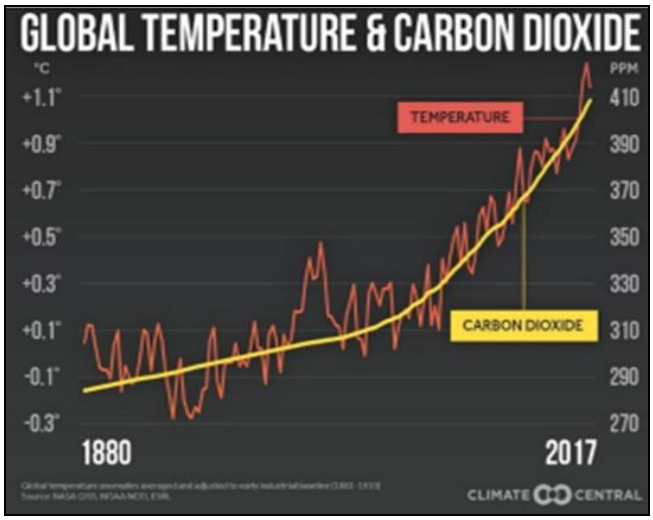

Fig 1: Global Temperature and Carbon Dioxide

The average yearly global temperature has risen by almost 1.5°F (0.8 °C) since 1880, and the concentration of carbon dioxide has also peaked. The red bars in the illustration represent temperatures above the long-term average, while the blue bars represent temperatures below it. The black line represents the concentration of carbon dioxide (CO_2) in parts per million (ppm). Since the 1980s, when industrialization reached a peak and human intervention in the extraction of natural resources became commonplace, the world's temperature has risen steadily, as seen in the figure, with only minor changes in the intervening years.

Power systems and electrical supply in India

Despite having 18% of the global population, India uses only 6% of the world's main energy. With 200 kWh/a compared to around 900 kWh/a globally, India's home consumption falls short of a quarter of the global average (IEA, 2015). Energy consumption has almost kept pace with the doubling of GDP since the year 2000. An ever-increasing human population means an exponential rise in energy demand (IMF, 2016). But there are already major problems that need fixing before we can meet the present electrical demand with consistent power. According to the Government of India (2015), the current energy mix in India consists of 70% thermal power, which includes 61.5% coal and 8.5% gas, 16% hydro, 12% other renewables, and 2% nuclear power. To prevent polluting metropolitan areas, fossil fuel power facilities are often sited far from cities. The cost of transmitting the energy may account for more than 10% of the overall cost (Australian Energy Market Commission, 2016). To generate power, India relies largely on coal imports. It is among the world's top coal importers. Epstein *et al*. (2011) [15] found that customers pay two to three times as much for coal as it really costs, which not only creates an economic imbalance but also drives up the price. This is because of the expenses associated with pollution on people's health and other externalities. The air and water quality in cities is deteriorating, which is harming the quality of life for many animals and humans. Indeed, 6.5 million lives are lost annually due to air pollution globally. There will be many more fatalities from this than from

HIV/AIDS, TB, and traffic accidents put together, says the World Health Organization (WHO) (IEA, 2016b). Therefore, protecting our environment is crucial if we want to ensure a future in which people may still live comfortably. Clean technologies will be used eventually. Over the last 20 years, the price of renewable energy generation has dropped significantly, because to technological advancements, mass production, and financial incentives from the government. Power output from renewable sources like solar and wind has surpassed fossil fuels in many areas, and research has shown that these alternatives are not to blame for the recent spikes in power costs (Sisodia *et al*. 2015) [16].

Conclusion

It should be mentioned right off the bat that the scientific study of the energy situation in the Ahmednagar district of Maharashtra has supported the theories put up for this study. With the forest cover decreasing at an alarming rate, gathering firewood from the forest is becoming an increasingly challenging task. Another thing they came to is that there has to be a public education campaign about the benefits of biogas facilities. Specifically, in order to ensure the scheme's success via the media. According to the research, considerable amounts of energy needs for the commercial sector in the Ahmednagar district urban region are met by wind mills and solar energy. Instead of firewood, crop leftovers are used as fuel in certain urban areas of Ahmednagar district. It is concluded that city dwellers and those in extremely high-income brackets continue to use non-commercial energy sources, despite the obvious drawbacks, due to the ever-increasing daily demand for heat energy to prepare animal feed, food for workers, and themselves. Society cannot function without energy. The availability of electricity at affordable prices is crucial to the growth of many sectors and the well-being of the population. We can increase employment, mass-produce a wide range of goods, and effect positive change in many other areas of society if we have access to sufficient electricity. Traditional energy sources are struggling to keep up in response to the growing need for electricity. Therefore, alternative energy sources that aren't conventional have the potential to significantly impact societal and economic progress.

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