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The Role of Energy Literacy in Advancing Renewable Energy Adoption for India's Sustainable Development Goals

Dr. Jyoti Bajpai[1]
[1]Assistant Professor, Government Degree College Gosaikheda, Unnao, Uttar Pradesh

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Abstract

The energy sector of India is facing the double challenge of rising energy demands and transition from conventional energy resources to sustainable energy systems to align with the SDG 7-affordable and clean energy and SDG 13-climate action. This paper investigates the critical role of energy literacy-energy generation, consumption, misuse, conservation, and clean energy opportunities in bridging the gap between current energy practices and sustainable clean energy solutions. Despite being the world's third energy consumer India is still dependent on conventional energy sources like coal, fuel, oil and natural gas. These sources have accelerated India's economic growth; they also promoted environmental degradation and increased greenhouse gases (GHG) emission. Although India has started promoting renewable energy resources like solar, biomass and wind energy, there is a lack of energy awareness. Energy literacy is an understanding of energy resources, mindful consumption patterns, environmental impacts, sustainable and eco-friendly alternatives, sustainable behavioural changes like adapting clean energy technology and reducing wastage. Many challenges such as limited awareness, educational gaps, and socioeconomic barriers hinder progress. To address these issues, a multi-faceted approach is proposed, including education and awareness campaigns, community engagement, policy support, technological innovation, and behavioural change initiatives. The article suggests that fostering energy literacy is crucial for India to achieve SDG7 and a sustainable energy future. Collective actions like reformed government policies, sustainable business plans and energy educated society is essential for a clean energy transition in India.

Key Words: Energy literacy, sustainable development, renewable energy, environment.

Introduction

Energy is crucial for social and economic growth of a country (UNEP 2023) but excessive use of fossil energy has caused harmful climate changes like global warming, forest fires, floods, heat waves and cyclones with increased intensity and frequency. Energy is a basic requirement for humans to survive and solve many life challenges and necessary to achieve the United Nations agenda for 2030 (UN & UN-Energy, 2022). Energy literacy is understanding energy, its generation, consumption and wastage. It helps to understand carbon footprint and its impact on the environment. Van den Broek (2019) suggested different forms of energy literacy

1. Device Energy Literacy: that explains energy consumption of domestic appliances like refrigerators, washing machines, microwave, dishwasher electronic geysers, induction cooktops, computers and also about star rating of electrical domestic appliances. Persons equipped with device energy literacy adopt low carbon inventions and technologies like roof top solar panels, solar cookers, solar pumps that further have a positive impact on carbon mitigation.

2. Action Energy Literacy: that describes the ability to implement the energy knowledge on energy saving in homes and the impact of day to day activities.

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3. Financial Energy Literacy: One's ability to make financially efficient energy decisions.

4. Multifaceted Energy Literacy: comprises the above three types of energy literacy as well as general energy knowledge, attitudes, values and energy conservation behaviour.

In India there is a lack of widespread awareness on energy supply issues, climate change issues, and the availability of alternative solutions. The Paris Climate Agreement and the United Nations 2030 Agenda for Sustainable Development cannot be achieved without sustainable energy production and consumption. Approximately 755 million people worldwide lack access to electricity at the moment, according to the International Energy Agency. Effective energy education and energy efficiency depend heavily on an understanding of energy literacy and consumption patterns. The goal of the Energy Literacy Training is to teach the general public about energy production and use, as well as how these factors affect the environment, individual, state, and country. Energy literacy training would help people and organizations make well-informed choices about the sources and quantities of energy to consume and make people aware about climate change, sustainable lifestyles, and life sustainability.

India's target to achieve Sustainable development goals (SDG7 and SDG13) is connected to energy transition from conventional energy sources to renewable and clean energy sources. This energy transition needs more energy literate stakeholders and households who play an active role to adopt and switch renewable energy systems. The UN SDG7, 'Affordable and Clean Energy', aims to ensure access to affordable, reliable, sustainable, and modern energy for all and outlines actions needed internationally and nationally.

2. Current Energy Challenges in India

2.1 Energy poverty:

India is facing an energy crisis because of rapidly growing populations since India's energy sector is facing significant challenges like insufficient domestic energy production, substantial energy losses during transmission and distribution, and a heavy reliance on imported fossil fuels, impacting energy security. The country must balance affordability, environmental sustainability, and phasing out coal while meeting its growing energy demands. The rapid expansion of hi-tech industries adds another layer of complexity to these challenges, further emphasizing the need for sustainable and efficient energy solutions.

2.2 Fossil Fuel Dependency

India's fossil fuel subsidies have declined by 59% since 2014—an accomplishment that many other large economies have struggled to achieve. However, the 2022 energy crisis—together with India's growing energy demand—has led the country to support all forms of energy supplies and adopt a mixed approach to fossil fuels and clean energy. According to a report of the Bureau of Energy Efficiency, India installed 203 GW of renewable energy in October 2024 and reduced the emission intensity of its GDP by 33 percent (from 2005-2019); still 75 percent of greenhouse gas (GHG) emissions come from fossil fuels, which currently dominate energy sources. This emphasizes how urgently energy literacy is required to create awareness about energy production and environment friendly consumption habits in order to reach net-zero emissions and successfully lessen the effects of climate change.

2.3 Urbanization and Rising Energy Demand

India is the world's most populated country and it is the third-largest energy consuming country due to improved living standards and rising incomes and being the most populated country creating an energy crisis situation. Growing economy, population and rapid rate of industrialisation has created a large energy demand.

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Urbanisation has increased energy consumption as urban households require more energy than rural. According to the International Energy Agency (IEA) people are moving towards cities and putting more pressure on energy demands. As a result of urbanization Industries developed and they also depend on energy to run. Large amounts of energy are needed to run the machinery and equipment in industries like manufacturing, mining, and agriculture. The demand for energy rises in tandem with the establishment of additional industries in urban areas. The Energy Crisis in India is a serious issue affecting the daily lives of millions and causing significant challenges to economic targets of the country. Despite being the world's third-largest producer of electricity, India struggles with frequent power shortages. In 2020, the country faced an energy deficit of about 0.4%, leading to regular blackouts even in metropolitan cities like Delhi and Mumbai. India has faced some of its worst energy crises ever in recent years, and June 2024 saw the country's largest energy deficit in 14 years. Furthermore, projections indicate that India could face a significant power shortfall beyond 2025. The country's power demand is growing at a rate of 6% annually and will double by 2045. Therefor to handle the energy crisis there is a strong need for energy literacy among housewives, school and college going students and even illiterate persons who are consuming energy on a large scale.

Role of Energy Literacy for Sustainable Development:

Energy literacy builds the foundation for sustainable development by enabling people to make informed choices, reduce energy waste, adopt renewable technologies, and actively contribute to climate change mitigation and resource conservation. Energy literacy encompasses both understanding the science of energy—its origins, flows, and how energy systems operate—and the ability to critically evaluate information, communicate energy issues clearly, and make well-informed energy choices in real-world situations.

The country faces challenges of energy security, affordability, and environmental sustainability, given its heavy dependence on energy imports and rising greenhouse gas emissions. To address these issues India has set an ambitious target of achieving 500 GW of non-fossil fuel-based energy capacity by 2030 and net-zero emissions by 2070, aims to have 50% of its energy needs met by renewable energy sources by 2030 as mentioned in its Nationally Determined Contributions (NDCs) set after the Paris Agreement. The Indian Prime Minister outlined five ambitious targets at the 26th Conference of Parties (COP26) in Glasgow in 2021, which encouraged the execution of "LIFE"—Lifestyle for the Environment (4) by 2030, India wants to reduce its overall anticipated carbon emissions by one billion tons, grow its non-fossil energy capacity to 500 GW, get 50% of its energy from renewable sources, and lower the economy's carbon intensity by less than 45%. Additionally, India will reach the Net-Zero goal by 2070, which entails eliminating the same quantity of carbon dioxide that has been produced. India has also increased its target for installed non-fossil energy capacity to 500 GW by 2030, from 175 GW renewable energy by 2022 aligned with SDG7. India has already achieved a total renewable energy capacity of 203.18 GW as of October 2024 but still to achieve these targets by 2030, the whole population of the nation should be energy literate. In the current period of rapid global energy transition from fossil fuels to green energy the importance of energy literacy can not be underestimated. Energy literacy creates a base on which people can create a greener and more sustainable future.

Despite the growing debate of sustainability and the importance of climate change as an issue of international concern (Stibbe, 2009; Wiek et al., 2011), the development of "energy literacy" has received relatively little attention in the research literature. Energy literate persons will possess the skills to "make informed energy-related choices as they go about their daily life" based on knowledge and understanding about energy, its use and impact on environment and society, their intentions/behaviours promote energy conservation, make thoughtful decisions and advocate change (DeWaters and Powers, 2011). According to

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Van den Broek (2019), an energy literate person knows about the energy consumption of his appliances, which activities and behaviour can save energy in his daily life, how to make energy efficient decisions or knows the relationship between energy consumption and climate change. Understanding Energy and Making Informed Choices

Energy literacy involves grasping both the scientific aspects of energy Energy literacy builds the foundation for sustainable development by enabling people to make informed choices, reduce energy waste, adopt renewable technologies, and actively contribute to climate change mitigation and resource conservation (sources, flows, systems) and the ability to critically assess information, communicate meaningfully, and make informed energy decisions. This foundational concept is outlined by the U.S. Department of Energy.

Energy Literacy Improves Energy Conservation Behaviour

Energy literate persons have awareness of energy sources, energy consumption patterns and their environmental effects they used to avoid energy expensive electronic gadgets and adopt energy efficient and sustainable options for their daily lives. In a sociological analysis of energy literacy among the citizens of Mashhad Sayarkhalaj and Khesal (2022) found that the three components of energy literacy- knowledge, attitudes, and behaviours are interconnected and energy saving attitudes have a significant and direct relationship with the knowledge of energy consumption. Appiah et. al. (2023) also explained that there is a positive relationship between energy literacy and energy saving behaviour of lower middle income country Ghana and suggested that energy literacy translates into practical approaches that further supports achieving sustainable development goals. Teaching of energy issues at school and college level improves energy conservation behaviour. Gill and Lang (2018) also found that energy education is an important method for energy conservation and resource efficiency. Project "Carbon Zero" campaign in Singapore used school children to nudge families toward electricity conservation which reduced 8.5% household energy consumption by delivering personal messages and talks to their families, tracking and auditing electricity uses Agarwal et al. (2016).

Energy literacy promotes adoption of renewable energy

Energy literate populations play a significant role in supporting renewable energy technologies like solar panels, solar powered pumps, electric vehicles which further stimulate renewable projects and green policies. Energy literate persons make investment in renewable green policies like the PM Surya Ghar Muft Bijli Yojana, Solar Park Scheme, and the Roof Top Solar Programme Phase-II, Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM-KUSUM), Pradhan Mantri Ujjwala Yojana (PMUY) and other financial incentives that are designed to make solar energy adoption accessible to households, further empowering citizens to become active participants in clean energy transition. After awareness of energy literacy people adopt sustainable lifestyles and sustainable patterns of consumption and production and their energy utilization becomes mindful and deliberate and not mindless and destructive. Energy literate communities also support government initiatives, advocate for green policies, and invest in sustainable practices, accelerating the country's progress toward its energy targets.

Energy literacy reduces Energy poverty

Energy poverty also known as energy vulnerability, fuel poverty, and energy insecurity is becoming a great problem to states, communities, and households worldwide. Rosie Day and Gordon Walker (12) defined energy vulnerability as, "A situation in which a person or household is unable to achieve sufficient access to affordable and reliable energy services, and as a consequence are in danger of harm to health and/or well-

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being. This open definition makes no specific judgment about which energy services are significant, what constitutes sufficient access, how harm may be involved or how substantial that harm needs to be. The notion of vulnerability also conveys a sense of potentiality or precariousness rather than necessarily a situation of demonstrable and existing harm". As India aims to ensure access to clean electricity to every citizen by 2030 it becomes an urgent need to alleviate energy poverty. Energy literacy can significantly mitigate energy poverty, as the energy conserved by individuals will diminish energy vulnerability of weaker sections of society. Education, employment and culture positively affects reducing energy poverty (Prajapati et al. 2025). Gawusu, (2024) also emphasized that better understanding of targeted renewable strategies can alleviate energy poverty and foster sustainable development, achieving net-zero emissions and SDGs.

Policy Recommendations to strengthen energy literacy for sustainable development

Policy incorporates the rules, regulations and guidelines established by governing bodies to influence societal behavior. Policies related to energy can range from subsidies for renewable energy development to regulations on carbon emissions from power plants. Energy literacy leads to the formation of attitude and effectiveness towards energy saving and energy saving attitude leads to better energy consumption behavior. By incorporating energy education into school curricula we may raise awareness on energy conservation, renewable technologies, and climate change impacts (Sayarkhalaj and Khesal 2022). The relation between government policies and improved energy literacy is crucial because informed decision leads to better policies and which further empower people with sustainable choices. Energy literate people, corporations, and governments are more likely to implement fair, effective, and long-lasting ecofriendly policies whereas energy illiterate people create hindrance against renewable energy facilities likely in case of electric vehicles purchase and installation of solar panels on roof tops. Batool et al. 2023 elucidated the contribution of corporate social responsibility (CSR) to energy poverty alleviation by as assessment of renewable energy resource, feasibility of sustainable energy supply and sustainable energy development. Corporate social responsibility (CSR), a business model that balances three pillars of sustainability i.e. economic, environmental and social needs (Behringer and Szegedi, 2016). Companies following CSR practices can sponsor workshops on efficient energy use in rural areas to address both poverty and sustainability goals. Government policies should promote technologies like battery storage, hydrogen fuel cells, and low-carbon construction materials to complement energy literacy efforts.

The Indian government must implement public awareness campaigns highlighting the economic benefits of renewable energy adoption that can drive behavioural change at scale. In these campaigns people get technical assistance and guidance from experts of sustainable energy companies (Espinoza et. al. 2024). Public awareness campaigns serve as a bridge between the latest renewable technologies, sustainable start-ups and the general public, providing information in an accessible and engaging manner. By raising awareness, these campaigns empower individuals to make informed decisions that contribute to energy efficiency and sustainability. By supporting green initiatives these campaigns help in combating climate change and preserve natural resources for future generations Gupta et al. (2025) assessed that traditional or digital marketing of solar energy adoption is effective, to overcome socioeconomic disparities, and behavioural factors that impact consumer decisions. Consumer awareness was found the strongest factor of the adoption of solar energy, whereby higher levels of awareness was directly linked to higher adoption levels. Digital marketing strategies, especially AI-powered targeted campaigns and social media outreach, were found more convincing than traditional advertisement methods in terms of consumer engagement.

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