International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Energy Security: Global Concern and Local Challenges

Nanse Rana

Student, Law College Dehradun, Uttranchal University, Dehradun – India

Abstract: ***Energy security is the main driver for energy transition around the world. The impact of burning fossil fuels on our environment as well as the rising energy demand is growing into a global concern. Renewable energy plays an important role in the transformation; coupled with low-carbon emission technologies that are now becoming more effective and economical. A lot of electricity regulators decided to embrace small-scale renewable energy called distributed energy resources (DERs) close to demand to enhance the traditional electric power grid all around the world. Various DER solutions with battery storage and demand response have been proposed in a microgrid system to improve electrification and the reliability of power systems called Hybrid DER solutions. The cost of renewable electricity generation has been continuously falling triggering the fast development of the technologies. With the support of efficient policies and regulatory frameworks, renewable energy will be significantly growing to formulate energy security. In the future, the trade of excess solar electricity on consumers' rooftops or electric vehicles with the neighborhood at a market price will be the new way of living. The deployment of virtual power plants, and carbon pricing schemes will be moving forward to drive the uptake of clean energy technologies for the sustainable electricity industry. Energy security aims to increase the efficiency of energy, diversify the sources it's derived from, develop renewable energy, and strengthen the energy infrastructure while also increasing the domestic product for self-consumption.***

Keywords: energy security, distributed energy resources, hybrid microgrids, renewable policy, virtual power plants

1. Introduction

This research paper explores the critical issue of energy security at both global and local levels, seeking to answer the central question: "Why is energy security important?" In the modern world, energy has become fundamental for survival and economic development. Access to affordable and clean energy is not only vital for national functioning but also plays a significant role in a country's political and strategic standing. However, over 85% of global energy is still generated through non-renewable sources such as coal, oil, natural gas, and nuclear energy—resources that take millions of years to replenish. At the current rate of consumption, these sources face rapid depletion. According to the International Energy Agency (IEA), energy security refers to the uninterrupted availability of energy at affordable prices. Yet, over a billion people still lack access to electricity, and nearly 3 billion depend on unsafe fuels like charcoal and animal waste. The energy sector also contributes to two-thirds of global greenhouse gas emissions. The challenges of energy security are no longer purely geopolitical but involve complex issues including policy reforms, economic constraints, affordability, and international trade in energy. There is also ambiguity in how to address energy security effectively, despite clear definitions. The focus must now shift toward sustainable and equitable energy solutions.

What is Energy Security?

Energy security is a complex and multifaceted concept, making it challenging to define in precise terms. However, the International Energy Agency (IEA) describes energy security as the uninterrupted availability of energy sources at an affordable price. This concept encompasses both short-term and long-term dimensions. Short-term energy security relates to a nation's ability to respond quickly to sudden shifts in the supply-demand balance, while long-term energy security involves sustained investments to ensure stable energy supplies that align with economic growth and environmental objectives. Energy insecurity, on the other hand, highlights the vulnerabilities in energy systems, such as physical disruptions due to infrastructure failures, natural disasters, social or political unrest, terrorism, or fluctuating market conditions. It also includes broader consequences like economic instability, price shocks, or health and safety hazards arising from energy crises. Thus, energy security is not merely about having access to energy but ensuring its stable, affordable, and safe supply while anticipating and mitigating potential risks that threaten national and global stability.

Objectives of Energy Security:

Another substantial answer to the question "What is the objective of energy security?" is that it's one of the 4 pillars of the ASEAN Energy Cooperation in achieving Sustainable Development. Along with energy accessibility, affordability, and sustainability, energy security forms a significant part of determining sustainable energy planning.

Whereas availability ensures that there are enough energy supplies available, affordability aims to have these resources available at sufficiently low prices. Accessibility focuses on making sure that all citizens have access to energy, which to some extent entails making sure that a solid infrastructure is in place to ensure a robust supply for the end user. However, in practice, this is typically interpreted as making sure that energy prices are kept low and fuel poverty is kept to a minimum.

Oil is one of the main sources of energy in the world, making the rising reliance on it and the high prices associated with it one of the most significant threats to energy security. The world's oil reserves may not be able to keep up with the rising energy demand. Acceptability addresses this issue by focusing on the detrimental effects of energy, such as pollution and environmental harm, and making sure that these effects are minimized to make the energy acceptable to the client.

Hence, having substitute sources of energy is detrimental to sustaining global consumption. With oil being one of the world's major energy sources, the growing dependence on oil along with the high prices tied with it become one of the most crucial challenges to energy security. The ever-increasing demand for energy might be disproportionate to the amount of oil in the world. Hence, having substitute sources of energy is detrimental to sustaining global consumption.

Significance of Energy Security:

Global industrialization has created two major, interconnected issues that the world is currently dealing with: first, an inadequate and unpredictable energy supply; second, environmental pollution and climate change as a result of excessive energy usage. The effective use of energy is one strategy to lessen the effects of these phenomena and to support sustainable development.

Energy efficiency is the culmination of all efforts taken in all spheres of life to reduce energy consumption, provided that the standard of living and work is either maintained or improved. Efficiency in energy use, rather than energy conservation, promotes higher standards of living, more productive work environments, and increased production competitiveness.

Energy security refers to the availability of energy supplies in terms of cost, physical availability, or the volume of trading necessary to meet demand. Countries with weak energy security may: - Rely on expensive sources, raising electricity costs above what the general public can afford; - Rely on sporadic sources, including wind, solar, or biofuels (if crops fail). The amount of electricity that is steadily provided to the national grid may be low in the country. A developing nation has limited technology to access resources or generate power. Countries are dependent on other nations for energy commerce. There are few resources accessible to generate electricity.

2. Contemporary Challenges and Global Concern: Energy Security

Energy security is no longer a purely geopolitical issue, although it remains at the core of ensuring the availability of internationally traded fuels, particularly oil. India is the third largest energy- consuming country in the world and the electricity demand is growing at 4.7 percent annually. The multifaceted challenges of energy security, which have historically been addressed separately, such as global limits, as well as the role of markets and investments, have recently become increasingly intertwined.

We are very dependent on the oil economy. Although we want to transition to a gas economy, the biggest obstacle is that we do not produce enough to meet domestic demand. The current government must have a unified energy policy where the energy basket must have a balanced mix of energy sources. India faces multiple interlinked challenges in achieving energy security, spanning policy, administrative, economic, and geopolitical dimensions. Despite allowing 100% FDI in petroleum and natural gas exploration through the automatic route, India has struggled to attract significant international investment. The New Exploration Licensing Policy (NELP) failed to generate interest from major global players, highlighting the urgent need for greater investment in both domestic and overseas hydrocarbon assets. Administrative inefficiencies, particularly delays in coal mining approvals due to regulatory and environmental bottlenecks, further strain domestic energy production. Economically, India is heavily dependent on coal, oil, and natural gas, but limited reserves have forced the nation to rely on costly imports. Affordability remains a concern—petrol prices in 2017–18 accounted for 25% of the daily per capita GDP, pushing inflation across sectors. Diesel, a key input in transportation, makes up 60–70% of transport costs, indirectly raising product prices nationwide. India's reliance on energy imports renders it vulnerable to external shocks, including geopolitical tensions. Conflicts involving energy partners like the U.S. and Iran have impacted oil imports. Additionally, China's Belt and Road Initiative poses strategic risks to India's energy access, while stalled regional projects like the $10 billion TAPI pipeline face persistent uncertainty, further complicating India's energy future.

Distinct Countries

Japan: Japan's progress in achieving energy efficiency has been notable but more restrained compared to countries like Denmark. From 1973 to 2005, per capita energy consumption in Japan increased across households and passenger transport. While the Japanese government implemented stringent performance standards for appliances, it only introduced voluntary guidelines for building efficiency and delayed significant financial incentives until the late 1990s. In the transportation sector, Japan enforced mandatory efficiency standards and labeling for vehicles, which contributed to a 12% rise in fuel economy between 1979 and 1985, followed by an additional 8.5% improvement from 1990 to 2000. However, these gains were overshadowed by rising energy use in transportation, largely due to increased car ownership and the growing size of vehicles. Private automobile use grew substantially, rising from 42.5% in 1970 to 55.9% in 1987. Furthermore, the mid-1980s period of low oil prices encouraged greater energy consumption. As a result, Japan's overall energy demand, which had grown modestly at 0.2% per year between 1973 and 1986, surged to an average of 4% annually between 1987 and 1991. This pattern illustrates how technological advancements in efficiency may be undermined by broader social and economic trends, such as consumer behavior and market conditions.

Denmark: Denmark is now the unchallenged world leader in terms of wind energy, exporting $8 billion in wind turbine technology and equipment per year, and Denmark also boasts one of the lowest energy intensities in the European Union (96). Primary energy consumption nationally grew just 4% from 1980 to 2004, even though the economy grew more than 64% in fixed prices. At the same time, more renewable energy replaced fossil fuels, and total CO2 emissions decreased by 16%. Therefore, the CO2 emission intensity, the amount of CO2 emitted per unit of GDP—was 48% lower in 2004 than it was in 1980.

Spain: Spanish energy intensity increased from 1990 to 2000 by 5% while European intensity decreased by 10.4% (94). The Spanish economy continues to be highly dependent on high-carbon fossil fuels such as oil and coal, which accounted for roughly 60% of energy use in 2007. The situation is further compounded by the mismatch between state, territorial, and national energy policy, which has been very sporadic and irregular, with some regions aggressively pursuing renewables, such as wind and solar, whereas other regions have little penetration of renewable power supplies.

In 2022, European nations encountered a severe energy security crisis following Russia's abrupt decision to halt gas supplies to several EU countries. This action created a significant supply shock, driving gas prices to unprecedented levels and causing a parallel spike in electricity prices due to the interdependent structure of the EU energy market. The situation was further aggravated by Russia's military aggression against Ukraine. In response, EU member states adopted relief measures in line with the European Commission's 2021 energy prices toolbox and the temporary crisis framework for state aid. Consequently, energy security has become a central focus in Europe's long-term strategic planning, with emphasis on minimizing political risks and reducing exposure to external supply threats. Meanwhile, the ASEAN+6 group, comprising ASEAN countries along with Australia, China, India, Japan, Korea, and New Zealand, faces distinct yet interconnected energy challenges. These include overdependence on fossil fuel imports, susceptibility to natural disasters, and vulnerability in energy transit routes. Regional cooperation presents an opportunity to address these issues collectively. A gravity model-based study using data from 1995 to 2016 demonstrates that renewable energy expansion, energy efficiency, and regional integration are vital for improving bilateral energy trade. Strengthening these pillars will be critical for achieving energy resilience and sustainability in the region.

India- By 2022, India had pledged to ensure electricity access for every household, with the more ambitious goal of providing round-the-clock power still underway. Initiatives like the Pradhan Mantri Ujjwala Yojana have improved access to clean cooking fuel, but further support is needed. Installing biomass pelletizing units and distributing efficient biomass chulhas could significantly enhance rural energy access. In agriculture, the promotion of solar irrigation pumps requires financial support through NABARD and government subsidies. India must also invest in research and development to make alternative energy sources such as geothermal and tidal energy economically and technologically viable. To strengthen the oil and gas sector, the Hydrocarbon Exploration and Licensing Policy (HELP) promotes transparency, reduces bureaucratic delays, and supports revenue sharing and marketing freedom. A rationalized tax regime for energy imports and sales based on thermal value is vital to enhancing competitiveness. The country must also expand its refining capacity to maintain its position as a key exporter of refined petroleum products. Additionally, 31 companies across 21 states are developing City Gas Distribution (CGD) networks to facilitate the delivery of natural gas to residential, commercial, and industrial users. These integrated efforts have helped India navigate the global energy crisis, reinforcing its energy security strategy.

Diversification of energy supplies

1) Increasing India's Exploration & Production Footprint
2) Alternate energy sources and meet energy transition through a Gas-based economy
3) Green Hydrogen and EVs.

Diversifying Sources of Supplies:

India increased the number of its crude oil suppliers from 27 countries5 in 2006-07 to 39 in 2021- 22, adding new suppliers like Columbia, Russia, Libya, Gabon, Equatorial Guinea, etc. The government is supplementing supplies by setting up compressed biogas (CBG) plants that use animal and Agri Waste to produce gas. While the nation is dependent on imports to meet 85 percent of its oil needs and 50 percent of its natural gas requirements, India is mixing ethanol extracted from sugarcane and other Agri produce in petrol to cut overseas reliance. Ethanol blending has reached a national average of over 8 percent blending currently and is all set to increase to 20 percent by 2025. India is intensifying efforts to boost domestic oil and gas production to reduce reliance on imports and stabilize fuel prices. The government aims to expand exploration acreage to 0.5 million sq. km. by 2025 and 1.0 million sq. km. by 2030, while also planning to double oil refining capacity to 450–500 million tonnes by 2030. This push for self-reliance comes amidst rising global energy costs that directly impact domestic consumers. Simultaneously, India is transitioning toward cleaner energy alternatives. With 40% of its installed electricity capacity now sourced from non-fossil fuels, India ranks as the world's third-largest producer of renewable energy. This diversification includes solar, wind, hydro, nuclear, geothermal, and ocean energy, reflecting a strategic shift toward environmentally sustainable development. In parallel, the government has launched major initiatives to support gas and green hydrogen as key elements of the energy transition. Under the National Green Hydrogen Mission, Rs 19,744 crore has been allocated to position India as a global hydrogen hub. The nation also targets raising natural gas's share in the energy mix to 15% by 2030. Additionally, plans are underway to establish 12 commercial-scale 2G bio-ethanol projects and 5,000 compressed biogas units under schemes like the Pradhan Mantri Ji-VAN Yojana and SATAT.

3. Measures Taken to Enhance Energy Security System

Energy security refers to the ability of a country or region to meet its energy needs reliably and sustainably. It is essential for economic development, social stability, and environmental protection. The energy security system is a complex network of policies, technologies, and institutions that work together to ensure a stable and affordable supply of energy. In this article, we will discuss some measures that can be taken to enhance the energy security system.

1) **Diversify Energy Sources:** Enhancing energy security begins with diversifying energy sources. Relying heavily on a single source increases vulnerability to price shocks and supply disruptions. A balanced energy

portfolio, including renewable energy, nuclear power, coal, and natural gas, ensures stability and resilience in supply chains.

2) **Increase Energy Efficiency:** Improving energy efficiency helps reduce overall energy consumption without compromising output. Efficient use of energy across sectors, through better building designs, smart appliances, and upgraded transportation systems, can lessen dependence on imports and reduce vulnerability to external shocks.
3) **Develop Renewable Energy:** Renewable sources like solar, wind, and hydropower provide sustainable and secure alternatives to fossil fuels. These resources are not subject to global price volatility and are environmentally friendly. Governments can support renewables by offering incentives, funding research, and building necessary infrastructure.
4) **Strengthen Energy Infrastructure:** Reliable infrastructure is critical for secure energy supply. Investments in storage systems, modern transmission grids, and emergency backups ensure uninterrupted power and quick recovery from supply disruptions.
5) **Promote International Cooperation:** Global collaboration can improve energy security through shared technologies, cross-border infrastructure projects, and coordinated energy policies. Diplomatic initiatives and trade agreements help reduce conflict and improve access to energy resources.
6) **Increase Domestic Production:** Exploring domestic oil, gas, and coal reserves helps reduce dependence on imports. However, this must be balanced with environmental protection to avoid long-term ecological harm. Incorporating these six strategic measures allows countries to build a robust, resilient, and sustainable energy security framework.

4. Conclusion

Energy has emerged as one of the most pressing challenges of the twenty-first century, affecting economies across all levels of development. The global recession from 2007 to 2010 significantly reduced energy consumption due to declining economic activity, especially among major energy consumers. Although early signs of recovery appeared by 2011, the broader trend has been a consistent rise in energy consumption, driven by expanding economies, growing populations, and improved living standards. This surge has heightened the importance of energy security as a critical policy objective for nations striving to meet current and future energy demands while remaining resilient to potential disruptions. All countries, regardless of development level, are affected by global energy trends due to their participation in international energy markets. These trends, whether linked to supply chains, pricing, or geopolitical shifts, can have varying impacts, short-, medium-, or long-term, depending on a country's reliance on imported fuels. Energy policies must therefore adapt proactively to these evolving global dynamics.

Acknowledgment

In the successful completion of any mission, only a few faces are seen out at sunset. However, the completion is never without a few unseen hands working their magic behind the scenes. It gives me immense pleasure to acknowledge the contribution of these magical hands in this work, as that is the bare minimum I can do as a mark of respect for all the interest taken by them in helping me reach this end.

First and foremost, there are no proper words to convey my profound gratitude and measureless respect for my dissertation supervisor Prof. Laxmi Priya Vinjamuri. She has inspired me to become an independent researcher and helped me realize the power of critical reasoning and ethical research. I feel extremely lucky to have her as a supervisor who gave me the unbridled freedom to explore and experiment with the topic and at the same time the luminous guidance to recover when my steps faltered. Her unparallel grip on the basic tenets of constitutional law with her inspiring capacity of solving knotty constitutional issues with awe-inspiring deftness helped me a lot in charting a luciferous path throughout the making of this research paper. I feel fortunate to have worked under her tutelage which in turn has helped me to carry out a hassle-free paper. It is with hearty gratitude that I thank her for all his patience, support, and guidance.

I find this opportunity befitting to thank the library staff of the Law College Dehradun faculty of Uttaranchal University for always being supportive and providing all the books required.

It would never have been possible to complete this study without the amaranthine support of my family, especially my mother, father, and brother, for being my never-ending tower of strength throughout. I could not have done it without them.

References

[1] **Definition of Energy Security (IEA):** Int'l Energy Agency, *Energy Security*, https://www.iea.org/topics/energy-security (last visited June 28, 2025).
[2] **Global Dependence on Fossil Fuels and Greenhouse Emissions:** Int'l Energy Agency, *World Energy Outlook 2021*, at 35 (2021), https://www.iea.org/reports/world-energy-outlook-2021.
[3] **Over 1 Billion Without Electricity & 3 Billion Relying on Biomass:** Int'l Energy Agency, *Sustainable Development Goals*, https://www.iea.org/topics/sustainable-development-goals (last visited June 28, 2025).
[4] **Energy Efficiency in Japan:** Diana Farrell et al., *Energy Productivity: Harnessing Energy Efficiency for Profitable Growth*, McKinsey Global Institute (2008).
[5] **Japan Automobile Efficiency Gains:** Int'l Energy Agency, *Energy Policies of IEA Countries: Japan 2003 Review*, at 92–94 (2003).
[6] **Denmark Renewable Energy Leadership:** Danish Energy Agency, *Energy Statistics 2020*, https://ens.dk/en (last visited June 28, 2025).

[7] **Spain Energy Intensity & Regional Disparities:** Int'l Energy Agency, *Energy Policies of IEA Countries: Spain 2009 Review*, at 88 (2009).
[8] **Russia's Energy Crisis Impact on EU (2022):** European Commission, *REPowerEU: Joint European Action for More Affordable, Secure and Sustainable Energy*, COM(2022) 108 final (Mar. 8, 2022).
[9] **EU Energy Prices Toolbox:** European Commission, *Tackling Rising Energy Prices: A Toolbox for Action and Support*, COM (2021) 660 final (Oct. 13, 2021).
[10] **ASEAN+6 Energy Security Challenges:** Asian Development Bank, *Energy Security in Asia and the Pacific*, ADB Working Paper Series No. 296 (2021), https://www.adb.org/publications/energy-security-asia-pacific.
[11] **India's Pradhan Mantri Ujjwala Yojana:** Ministry of Petroleum & Natural Gas, *Pradhan Mantri Ujjwala Yojana*, https://www.pmuy.gov.in (last visited June 28, 2025).
[12] **Solar Pumps & NABARD Subsidy:** NABARD, *Solar Energy Initiatives*, https://www.nabard.org (last visited June 28, 2025).
[13] **HELP Policy India:** Ministry of Petroleum & Natural Gas, *Hydrocarbon Exploration and Licensing Policy (HELP)*, https://mopng.gov.in (last visited June 28, 2025).
[14] **Ethanol Blending in India:** Ministry of Petroleum & Natural Gas, *Ethanol Blended Petrol Programme*, https://petroleum.nic.in (last visited June 28, 2025).
[15] **SATAT and Bio-Gas Plants:** Ministry of Petroleum & Natural Gas, *SATAT Scheme Guidelines*, https://satat.in (last visited June 28, 2025).
[16] **Green Hydrogen Mission:** Ministry of New & Renewable Energy, *National Green Hydrogen Mission*, https://mnre.gov.in (last visited June 28, 2025).
[17] **City Gas Distribution in India:** Petroleum and Natural Gas Regulatory Board, *CGD Infrastructure Data*, https://pngrb.gov.in (last visited June 28, 2025).
[18] **Global Energy Market Trends:** Int'l Energy Agency, *Global Energy Review 2022*, at 20–25 (2022), https://www.iea.org/reports/global-energy-review-2022.
[19] **World Bank on Energy Access & Security:** The World Bank, *State of Access to Modern Energy Cooking Services2020*: https://www.worldbank.org/en/topic/energy/publication/state-of-access-to-modern-energy-cooking-services (last visited June 28, 2025).
[20] **Energy Diversification Importance** Int'l Renewable Energy Agency (IRENA), *Renewable Energy and Energy Security*, IRENA Working Paper (2020), https://www.irena.org/publications.