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Renewables and Rare Earth Elements: A Key to India's Coal Dependent Power System

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Image Source: News18.com

The recent coal shortage in India is an alarm for India's power generation system, which is significantly dependent on coal. It was reported that coal stocks fell short in over 135 thermal power plants due to the increasing power demand, and the early arrival of summer.[1] This is assumed to worsen with the growing supply chain issue under the Russia-Ukraine crisis. It is an alert for India to fasten its clean energy transition and develop the capacity of renewable energy for electricity generation by investing in power infrastructure development, which can reduce its reliance on coal consumption.

India's Power and Electricity System

The energy transition requires a country to move not only 'towards' clean energy but also away from fossil fuels. Despite the devastating impact of the climate crisis and India's commitment to a net-zero economy, coal use is still on the rise in India. As reported by the International Energy Agency (IEA), India's coal consumption is likely to reach 1.8 billion tonnes in 2024, a considerable rise from 931 million tonnes in 2020 to 1.04 billion tonnes in 2021.[2] India is the third-largest producer of electricity in the world, and the largest share of India's coal consumption goes to power generation due to the increasing electricity demand with the growing household electrical system.[3] In their analysis of India's energy capacity, the reports by IEA and NITI Aayog claimed that, "Coal will remain the mainstay source of energy for India and will see 4% growth in demand per year, which will be mainly to match the economic growth and increasing electrification of India."[4] India is seen in the midst of a transition to greater use of coal, not away from it, which is making the transition to renewables neither sustainable nor just. If India wants to meet its target of coal combustion, over 80 per cent of current coal reserves should remain unused till 2050, as claimed by McGlade and Ekins. India's dependency on coal for the power sector can be reduced by installing 175 GW of renewable energy by 2022 and 275 GW by 2027.[5]

Most of India's coal needs is met by importing the black diamond. Coal imports contribute to 75 per cent of India's overall power demands. The main import countries are Indonesia, South Africa, and Australia.[6] India's power requirement is likely to reach 817 GW by 2030, as estimated by the Central Electricity Authority. Thereby, there would be a need to increase its domestic production or increase coal imports from the aforementioned countries, until viable renewable source isn't explored.

Phase-out of Coal: Is it Possible with Renewable Power?

The generation of electric power [7]oes through energy conversion processes characterised by high efficiency and guided by the fundamental laws of thermodynamics. The essential energy supply chain involves power stations that depend primarily on sources like coal, natural gas, and natural

uranium, which then convert them into secondary energy sources or carriers, commonly electricity.[8] India's goal of transitioning towards sustainable energy sources requires it to follow a sustainable path. India should develop its domestic manufacturing of renewable sources that include solar energy, bio-power, wind power and small hydropower plants.

PM Narendra Modi's National Statement, at UNFCCC's COP-26, Glasgow, proposed 'LIFE'- Lifestyle for Environment Campaign- to create an environment-conscious lifestyle. This LIFE campaign quoted 'Panchamrit' or Five Elements to deal with the climate challenge, one of which was the goal to meet the country's energy requirement using renewable energy by 2030.[9]

India's electricity needs

In India's case, the use of coal for electricity generation is 17.49 Terajoule (TJ), while the use of renewable sources is just 11 TJ.[10] In 2021, India ranked third in the renewable energy country attractive index with a total installed capacity of 151.4 Giga Watts (including large Hydro) from 76.37 GW in 2014, which stands at 39% of its total energy capacity. With the fourth largest wind power and fifth-largest solar installed capacity in the world (see figure 1),[11] India could manage to achieve only 75% (151.4 GW) of its target in 2022 (175GW) due to the pandemic impact, logistic issues and financial distress faced by the state retailers.[12],[13].

Rare Earth elements and Renewables

The shift to renewable technologies for electricity generation is not easy for a country, like India, due to two major reasons:

a) High dependence on coal power

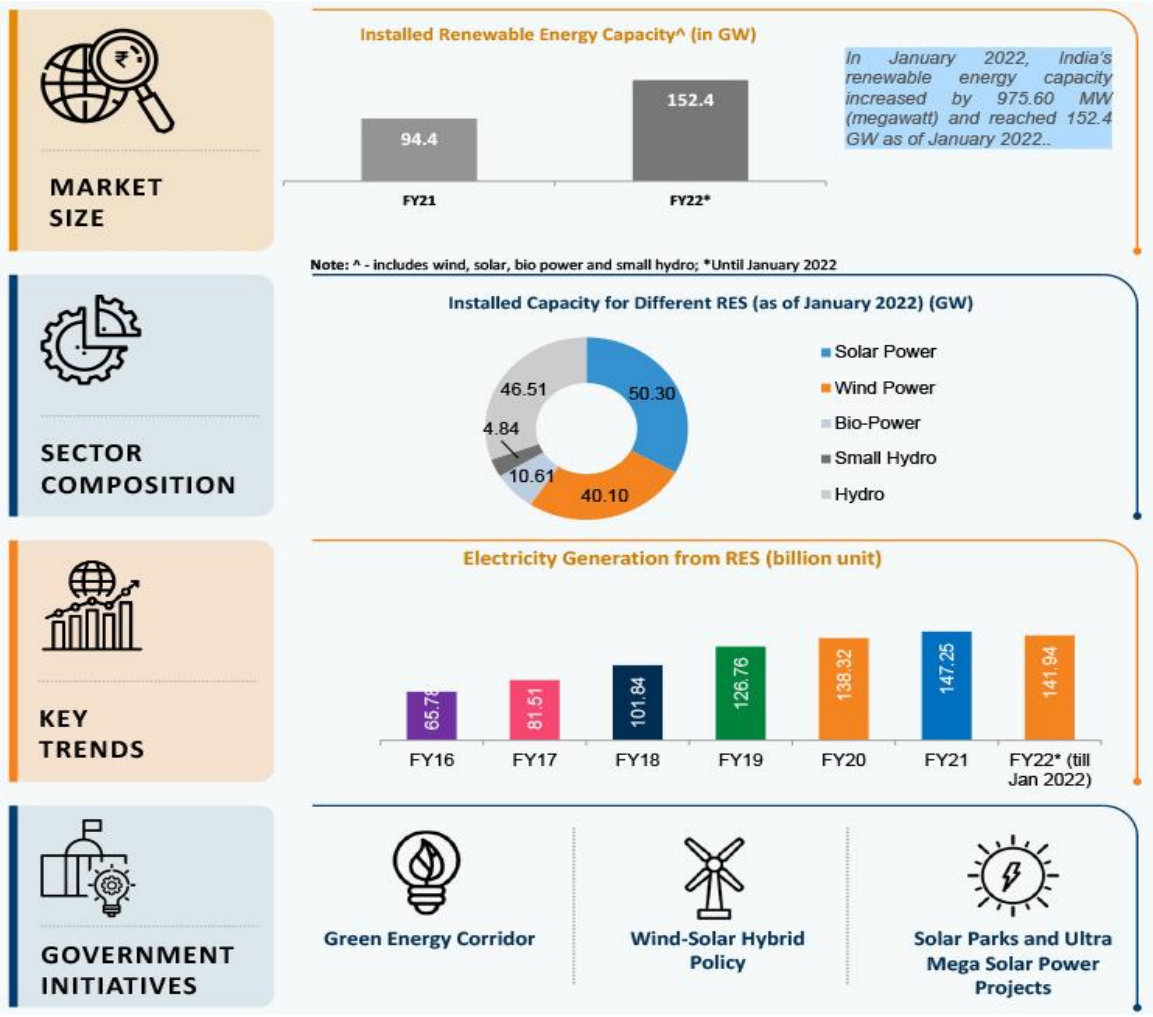
b) Less developed infrastructure for renewable power generation

The utility and the advantage of rare earth elements (REEs) can be understood in this respect. REEs can make the infrastructure development of renewable energy a cheaper process. The 17 REEs have high utility potential to enhance the infrastructure and conductivity of renewables for electricity generation. Among the renewables, only solar and onshore-offshore wind power employs the REEs for their production, most particularly erbium, neodymium, dysprosium, praseodymium, and Yttrium.

Solar energy requires semiconductors for production and energy conversion, which are getting short due to the global semiconductor crisis. The use of REEs can increase the production of inorganic semiconductor photocatalysts that exhibit eco-friendly features, unlike other semiconductors. The presence of REE, most particularly Erbium and Yttrium, dopes the efficiency of the Zinc Oxide (ZnO) materials that further enhance the conductivity of solar cells.[14] The wind

power turbines rely heavily on praseodymium, dysprosium, and neodymium for the production of permanent magnets used in their electric generators. As per the report, the REE content required for the wind turbines using an asynchronous motor is 600 kg per average 3.5 MW turbine to enhance their efficiency.[15] In commercial wind power production, REE contents are required for their direct-drive design system that is used for the installation of wind turbines; their permanent magnets use neodymium rare earth to lower the cost and improve reliability.[16]

Figure 1: Figure 1: Renewable Energy Capacity in India



Source: IBEF, "Growth of Renewable Energy Industry in India", https://www.ibef.org/industry/renewable-energy/infographic. Accessed on 4 June 2022.

Indian Rare Earth Industry

The Indian rare earth industry, although requires to be reformed to match the electricity needs of the renewable industry, has a lot of potential if it is used effectively. India has 6% of the world's rare earth reserves and produces only 2% of the total rare earth oxides globally. The significant rare earth minerals found in India are collectively called coastal sand minerals. Despite having 35% of the total global coastal sand minerals deposits, India has been import-dependent on its REE supplies. All the mining operations are allowed only to public sector undertakings (PSUs),

particularly the Indian Rare Earth Limited (IREL) and Kerala REL, which have been facing financial as well as operational challenges. The reforms in the Indian mining of critical minerals can boost not only its domestic high-tech manufacturing but also its green future goals to move away from its dependence on coal consumption.[17] Thus, the Indian power generation system needs to reform the capacity and effectivity of its sources through investing in the renewables and rare earth industries.

NOTES

[1] "Current power crisis due to sharp fall in generation; not due to non-availability of domestic coal", *Economic Times*, April 24 2022. https://economictimes.indiatimes.com/industry/energy/power/current-power-crisis-due-to-sharp-fall-in-generation-not-due-to-non-availability-of-domestic-coal/articleshow/91048055.cms. Accessed on May 18, 2022.

[2] Sanjay Dutta, "India's Coal Demand to top 1 billion tonne in 2022, push net-zero goals further away", *The Times of India*, December 17 2021, https://timesofindia.indiatimes.com/business/india-business/indias-coal-demand-to-top-1-billion-tonne-in-2022-push-net-zero-goals-further-away/articleshow/88346693.cms. Accessed on May 20, 2022.

[3] *India Energy Statistics*. World Energy Outlook 2021. https://www.iea.org/countries/india.

[4] Shreya Jai, "Coal demand to peak in India by 2030, will back up renewables: NITI report", *Business Standard*, December 21 2021. https://www.business-standard.com/article/economy-policy/coal-demand-to-peak-in-india-by-2030-will-back-up-renewables-niti-report-121122001169_1.html. Accessed on May 20 2022.

[5] Brototi Roy and Anke Schaffartzik, "Talk Renewables, Walk Coal: The Paradox of India's Energy Transition", *Journal of Ecological Economics*, Vol. 180: February 2021. https://www.sciencedirect.com/science/article/pii/S0921800920303232. Accessed on May 21, 2022.

[6] Soutik Biswas, "Coal Shortage and Heatwave spark India's Power Woes", *BBC News*, May 9 2022. https://www.bbc.com/news/world-asia-india-61330302. Accessed on May 22, 2022.

[7] India Brand Equity Foundation (IBEF), "Growth of Renewable Energy Industry in India", May 2022, https://www.ibef.org/industry/renewable-energy/infographic. Accessed on May 21, 2022

[8] W.D. Judge, Z.W. Xiao, G.J. Kipouros. 2017. "Application of Rare Earths for Higher Efficiencies in Energy Conversion." *The Minerals, Metals, & Materials Society*, 37-45. https://www.researchgate.net/publication/313315767_Application_of_Rare_Earths_for_Higher_Efficiencies_in_Energy_Conversion. Accessed on May 22, 2022.

[9] *Ministry of External Affairs*, "National Statement by Prime Minister Shri Narendra Modi at COP26 Summit in Glasgow", November 2 2021, https://www.mea.gov.in/Speeches-Statements.htm?dtl/34466/National+Statement+by+Prime+Minister+Shri+Narendra+Modi+at+COP26+Summit+in+Glasgow. Accessed on May 23, 2022.

[10] *India Energy Statistics*. World Energy Outlook 2021. https://www.iea.org/countries/india.

[11] India Brand Equity Foundation (IBEF), "Indian Renewable Energy Industry Analysis", February 2022, https://www.ibef.org/industry/renewable-energy-presentation. Accessed on May 21, 2022.

[12] Bloomberg, "India set to Miss Modi's ambitious 2022 renewable goals", *The Economic Times*, April 2 2022, https://economictimes.indiatimes.com/industry/renewables/india-set-to-miss-modis-ambitious-2022-renewables-goal/articleshow/90603387.cms . Accessed on May 25, 2022.

[13] India Brand Equity Foundation (IBEF), "Indian Renewable Energy Industry Analysis", February 2022, https://www.ibef.org/industry/renewable-energy-presentation. Accessed on May 21, 2022.

[14] Katarzyna Znajdek, et al., "Luminescent layers based on rare earth elements for thin-film flexible solar cells applications", *International Journal for Light and Electron Optics*, March 2018, https://www.researchgate.net/publication/323927030_Luminescent_layers_based_on_rare_earth_elements_for_thin-film_flexible_solar_cells_applicat. Accessed on May 25, 2022.

[15] Paul Veers, Latha Sethuraman and Jonathan Keller, "Wind-Power Generator Technology Research Aims to Meet Global-Wind Power Ambitions", *Joule Previews*, Vol.4, 2020: 1856-1863.

[16] Jiashuo Li, et al., "Critical Rare-Earth Elements Mismatch Global Wind-Power Ambitions", *One Earth*, Vol. 3, 2020: 116-125. https://www.sciencedirect.com/science/article/pii/S2590332220302980.

[17] Neha Mishra, "India is a rich source of rare earths, but still imports. US collaboration can help change that", *The Print*, April 26 2022. https://theprint.in/opinion/india-rich-source-of-rare-earths-but-still-imports-us-can-help/931113/. Accessed on May 28, 2022.