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INDIA'S FUTURE ENERGY BASKET: A PLACE FOR EVERYTHING

Wg Cdr Rohit Kaura
Research Fellow, CAPS

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India's total installed electrical capacity was just over 329 gigawatts (GWe) as of August 2017.[1] Of this around 219 GWe comprised came from coal, gas and diesel or thermal power sources. India is thus exceedingly dependent on fossil fuels to meet its energy requirements. A substantial percentage of the total installed capacity, around 44 GWe comes from hydroelectric power and around 59 GWe from grid-interactive renewable power—which consists of wind, solar, biomass and small hydro. Nuclear power contributes around 6.78 GWe, a mere 2 percent of the total capacity.[2]

India is the world's fourth largest energy consumer and the fourth largest CO_2 emitting country, following closely behind the European Union, and ahead of the Russian Federation. However, per capita India's CO_2 emissions are much lower than those of most developed countries and China.[3] Its per capita electricity consumption[4] stood at just over 1,000 kilowatt hours (kWh) in 2014-15. In comparison, developed countries average around 15,000 kWh. China has a per capita consumption of around 4,000 kWh.

The link between energy and climate change is significant, especially since the energy sector accounts for at least two-thirds of the global greenhouse gas (GHG) emissions. With fossil fuel diminishing and climate change on the rise, the world has been looking for more environmentally clean energy sources to be the new champions of our energy requirements. In its Intended Nationally Determined Contributions (INDC) under the Paris Agreement, India is committing to reduce the economy's carbon intensity and increasing clean energy capacity to 40 percent of the total installed capacity by 2030.[5] So, which energies will play a key role in the country's future energy mix? Which power source will shape our future? In this article the focus is on solar and nuclear energy.

Solar and Nuclear energy can help reduce reliance on fossil fuels, which we desperately need to do as our net emission of 49.3 gigatonnes of CO_2 per year is wreaking havoc on the planet, causing global warming, extreme weather events, and millions of deaths.[6] While clean energy is a key component of the climate mitigation strategy, it also contributes immensely towards community welfare by offering significant benefits in the areas of education, health, livelihoods, productivity, better quality of life and reduction in poverty.

Land Area: Solar farms require significant land mass to produce energy. Nuclear is more an energy factory; it takes relatively little land mass and materials to produce electricity. Consider Kudankulam Nuclear Power Plant in Koodankulam in the Tirunelveli district of Tamil Nadu. One unit of this nuclear power plant produces 1,000MWe. Industrial estimates reveal that you need around five acres of land to produce 1 MWe of solar energy.[7] For a 1,000MWe plant, you need 5,000 acres. The efficiency of photovoltaic panel is about 11-15% and the efficiency of a nuclear power plant is around 33%. With the current model, one would need a much larger solar plant to generate energy to match the energy generated by a 1,000MW nuclear power plant.

Functionality and cost: Building solar panels has become much more cost-effective in recent years, which has fostered large-scale solar initiatives all over the world. This is primarily possible because of government subsidies in virtually every country. Now, with Tesla's solar roof panels set to provide homeowners with an inexpensive, aesthetically pleasing and convenient way to take advantage of solar on an individual basis, the technology seems more poised than ever before for energy domination. However, is it better than nuclear energy? Is solar energy the future? Right now, solar energy costs more than two times the nuclear energy cost. The efficiency of a nuclear plant is in the region of 33%. A solar plant has an uninspiring 11-15% efficiency. On an average, a nuclear plant has a 60-year lifetime. A solar plant has only 30-40-year lifetime. Nuclear plants are very capital intensive. But running costs are low. Add to this, low maintenance costs of nuclear power plants. Considering all the statistical data, it is much more profitable to produce electricity using a nuclear power plant.

Capacity: While nuclear currently far exceeds solar in terms of energy generation, the International Energy Agency predict solar could be the world's largest source of energy by 2050 due to its falling cost and increasing convenience. As per data from GTM Research, Solar energy has been on the rise and due to its rapid adoption, solar could compete with nuclear energy by end of 2017 in terms of global gigawatt capacity.[8]

Fuel resources: A fraction of uranium produces about the same energy produced by one ton of

coal. It should take hundreds of years for us to exhaust these resources. Nevertheless, this fuel is an exhaustible resource. Nuclear fusion kicks in and all these inconveniences are resolved. This problem is absent in the case of a solar plant. We all know that solar energy is a renewable energy resource.

Safety aspects and pollution: Solar energy is a great way for generating clean energy. But there's merit in the argument that you can't have solar generating enough for all of us.[9] Nuclear power, therefore, provides a viable option. It currently generates *multiple times* more power per unit input mass, and does pretty much as clean as any other source, provided waste disposal is done correctly. Avoid proper care and a nuclear power plant can lead to an environmental disaster. Solar plants cannot cause an ecological disaster. A win over a nuclear power plant but the manufacturing and recycling of PV modules used in solar plants raises many questions regarding scarce commodities, health and environmental issues.

Forthcoming step-ups: Use of Generation IV nuclear reactors would minimize waste. The waste generated is in lesser quantities and is more stable when associated with conventional nuclear waste. Apart from this, nuclear fission with thorium as fuel will be the answer to a much safer nuclear power plants. Sodium-Cooled Fast-Spectrum Reactors are also being researched and developed. They could provide better safety and enhanced efficiency. Waste management is unparalleled and fuel recovery is up to 99.99%. In Solar plants two-sided panels generate up to 10% more electricity. Doping silicon with other semiconductors increase the efficiency up to 40%. However, this is still in experimental phase only. Self-cooling solar panels are also in the works. Nuclear dominates right now and will continue to do so for many years. Solar could catch up with the help of Perovskite and other technologies but Generation IV nuclear reactors are the future. [10]

India faces a daunting challenge to cater for energy requirements at a reasonable cost for its vast and growing population. India's improved economic development combined with rapid urbanisation and improved standards of living for the millions of households, has led to inexorable upward pressure on need for energy. The future of India's energy security lies in integrated energy policy.[11] This must be done by using different fuels and forms of energy, conventional and non-conventional, as well as by diversifying India's portfolio through competitively priced renewable energy sources.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])

Notes

[1] "Monthly All India Installed Generation Capacity Report". Central Electricity Authority.http://www.cea.nic.in/reports/monthly/installe

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[2] Why nuclear power still makes sense for India,http://www.livemint.com/Opinion/6Jnpny7AnuKs29Y9ll2rZN/Why-nuclear-power-still-makes-sense-for-India.html, accessed on October 05, 2017

[3] PBL Netherlands Environmental Assessment Agency. Trends in global CO2 emissions: 2016 Report,http://edgar.jrc.ec.europa.eu/news_docs/jrc-2016-trends-in-global-co2-emissions-2016-report-103425.pdf, accessed on October 05, 2017

[4] Per capita electricity consumption is computed as the ratio of the estimated total electricity consumption during the year to the estimated mid-year population of that year

[5] Why Increasing India's Solar Energy Capacity Won't Work,https://thewire.in/116842/solar-energy-india-capacity, accessed on October 08, 2017

[6] PBL Netherlands Environmental Assessment Agency. Trends in global CO2 emissions: 2017 Report,http://themasites.pbl.nl/publications/pbl-2017-summary-trends-in-global-co2-and-total-greenhouse-gas-emissions-2983.pdf, accessed October 05, 2017.

[7] Frequently asked question,http://seci.gov.in/upload/uploadfiles/files/FAQ.pdf, accessed on October 05, 2017

[8] New data suggests solar energy could rival nuclear energy in terms of global capacity by the end of 2017, https://www.weforum.org/agenda/2017/09/solar-energy-will-surpass-nuclear-by-the-end-of-the-year?, accessed October 06, 2017

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[10] Technology Roadmap Update for Generation IV Nuclear Energy Systems, https://www.gen-4.org/gif/upload/docs/application/pdf/2014-03/gif-tru2014.pdf, accessed on October 09, 2017

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