AN FTI CONSULTING REPORT – PUBLISHED JULY 2024

Going Green Starts with Blue: The Water Impact of India's Energy Sector

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Going Green Starts with Blue: The Water Impact of India's Energy Sector

Water impact from industries and the energy sector is gaining increased visibility due to climate change actions and India's net zero and sustainability aspirations. This paper examines water usage within India's energy sector and three other energy-intensive industries. India, one of the most water-stressed countries globally, holds 18%[1] of the world's population but has only four percent of its fresh water resources.

The European Union (EU) is currently developing a Blue Deal for water, similar to the Green Deal for decarbonising industry, along with an EU Water Framework Directive (WFD) to address increasing water scarcity and environmental imperatives in the green transition.[2] It is about time that we formulate a similar Blue Deal in India, aimed at reducing our water footprint.

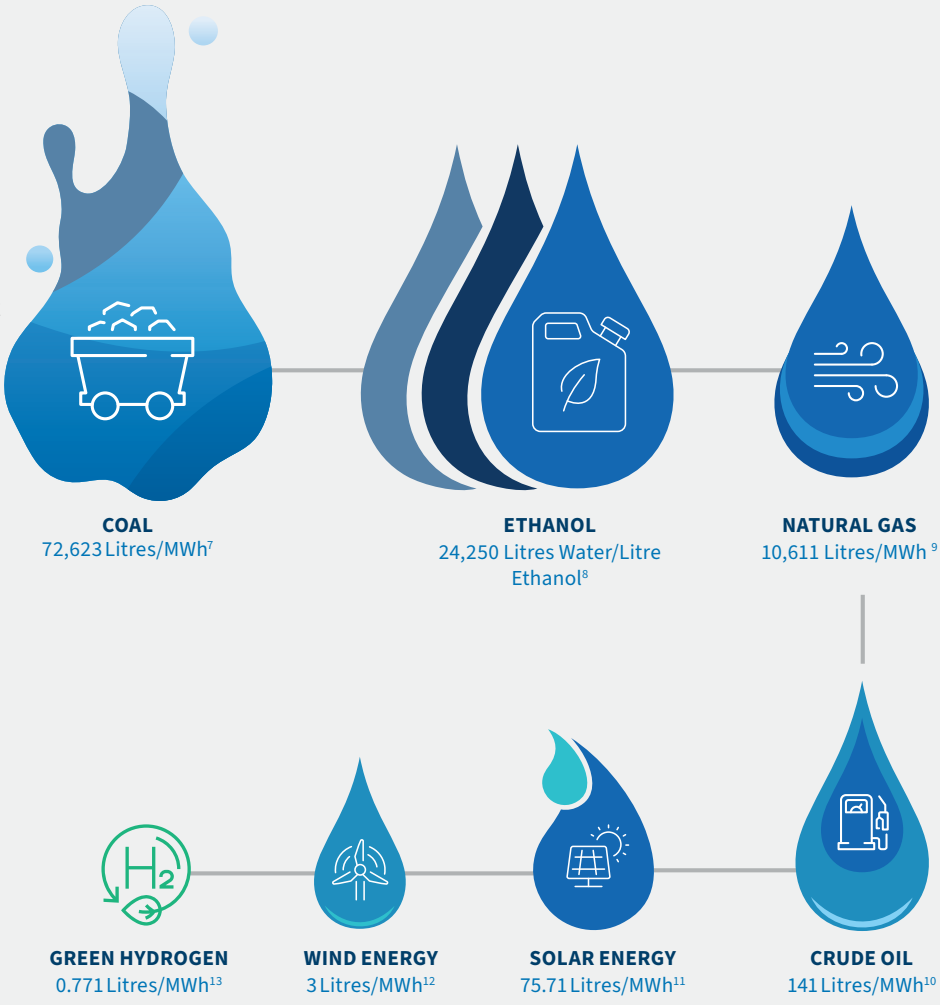
Energy Sector's Increasing Water Demand

According to 2021 data from the International Energy Agency, India's energy sector withdraws roughly 30 billion cubic metres of water (bcm) and consumes almost 6 bcm a year[3] (the amount withdrawn but not returned to a source). By 2030, the energy sector's demand for water is expected to double to over 60 bcm.[4] This includes water requirements for all conventional and new energy production, covering requirement by fossil-powered thermal power, bioenergy, renewables (solar and wind), nuclear, and green hydrogen in the future. (NOTE: Domestic/residential use accounts for 4% and 84%[5] is used in agriculture. Industry accounts for 12% of India's water use.)

Water shortage in the industrial sector have become increasingly problematic, particularly affecting thermal plants. Between 2017 to 2021, insufficient water for cooling these plants resulted in a loss of 8.2 terawatt-hour (TWh) of energy, equivalent to the power supply for 1.5 million households.[6]

Water Intensity in Different Energy Generation Segments

Ethanol has very high water impact due to its reliance on the cultivation of biofuels, followed by coal-fueled thermal power. In contrast, wind power and wind-powered green hydrogen production have the lowest water impact.



Half (48%) of India's existing coal power fleet is located in water-scarce districts like Nagpur and Chandrapur in Maharashtra; Raichur in Karnataka; Korba in Chhattisgarh; Barmer and Baran in Rajasthan; Khammam and Kothagudem in Telangana; and Cuddalore in Tamil Nadu. (CSE, 2021)

Coal-Based Energy

In India, coal-based thermal plants account for about 70% of the industrial water withdrawal i.e., power plants occupy about 22 bcm of the water use,[14] with cooling towers responsible for 80% of input water for the thermal plants. For a plant of 1000 MW capacity, existing specific water consumption (SWC) is around 2.3-3.9 m3/MW.[15] As the plant size and cooling systems change, water requirements can exceed 13,000 cubic meters per hour (m3/hr).[16] According to the US Energy Information Administration, coal-powered plants require about 19,185 gallons of water per megawatt-hour (MWh), equivalent to 72,623 litres per MWh.[17]

Oil and Natural Gas

Unconventional wells require more than 15 million litres of water per year. According to the International Energy Agency, it takes 2 cubic metre of water per tonne of oil equivalent (toe) to generate energy using crude oil.[18] This measurement is only for freshwater and does not include surface/ground water used by this source of energy. The water consumption of natural gas power plants can vary depending on the plant's efficiency, cooling systems

employed, and location. On average, natural gas power plants use around 2,803 gallons of water per MWh (or 10,611 litres/MWh).[19]

Biofuels: Ethanol

In 2003, the government of India launched the Ethanol Blending Program (EBP) to mix ethanol with petrol. Currently, a 10% ethanol blend is in use, with plans to increase this to 20% by 2025. The water impact of India's biofuels programme has not been clearly assessed and requires thorough review.

According to NITI Aayog's report on the sugar sector, most of the country's irrigation facilities are utilised by paddy and sugarcane, depleting water availability for other crops.[20] A litre of ethanol produced from sugarcane requires at least 2,860 litres of water in the process.[21] Beyond sugarcane, maize requires about 1,222 cubic metres/ton of water while rice requires about 1,673 cubic metres/ton.[22]

Renewables: Solar

Cleaning of solar panels, which accounts for 25-35% of the total O&M costs,[23] is a key requirement in solar farms. A modest amount of water (approximately 20 gallons per megawatt hour, or gal/MWh) for cleaning solar collection and reflection surfaces like mirrors, heliostats, and photovoltaic (PV) panels, is used.

The amount of water needed to clean a single solar panel is 3-5 litres per panel in normal areas and 7-8 litres in arid areas. For a 1 MW solar park with about 3,000 panels, up to 24,000 litres of water would be required per wash (which usually happens weekly).[24]

Note: In normal areas, a single solar panel needs about 3-5 litres of water per panel for cleaning; which can double in arid areas.

Renewables: Wind

Wind energy is the least water-intense source of energy. Wind turbines need water only for cooling purposes (generator, transformer, inverter), and occasional blade washing.[25] To produce 1 megawatt hour (MWh) energy, wind turbines consume 0.1% and 14% of the water used by nuclear and coal plants respectively.[26]

Green Hydrogen

While polymer electrolyte membrane (PEM) electrolysis is currently most efficient with the lowest water usage, cooling presents a significant water demand (56% for PEM vs. 14% for grey hydrogen). Efficiency improvements in electrolysers (including upcoming technologies) can significantly reduce water usage (2% reduction per 1% efficiency increase).[27]

Achieving a 5 MMTA green H2 production target by 2030, would require 116 million cubic meters of water annually, representing just 0.4 percent of annual water demand in the energy sector. (Assuming 4:4:2 ratio for PEM:Alkaline: Solid Oxide Electrolyser Cell (SOEC)+ Anion Exchange Membrane (AEM).

A 1 MW solar plant would need to spend at least INR 738,000 (USD 8,850.36) on cleaning in a given year.[28]

Recommendations: Importance of Water Impact in India's Energy Project Developments, Net Zero Plans

Greenfield energy projects and capacity-enhancement at brownfield projects should include an assessment of water impact as part of their project risk assessment. To help reduce the water impact and footprint of energy developers and investors in India, the following three recommendations are proposed.

Water Audits and Central Monitoring: To ensure sustainable and efficient use of water, implementing central oversight is essential. Water audits can be embedded as a part of the new energy project planning to reduce water impact and safeguard this vital resource for future generations.

Water Bonds: Mapping the flow of finance to water security investments can be a crucial strategy to address India's impending water crisis. By identifying the ultimate sources of capital, investment levels, key players, and various channels like green/water bonds, we can streamline funding for water security initiatives. India's NSE Social Stock Exchange offers a unique platform for social enterprises (non-profit organisations and for-profit social enterprises) to raise funds.

Leveraging this exchange can ensure water-friendly solutions are integrated into India's energy projects and industrial decarbonisation efforts, providing a sustainable pathway to alleviate the water crisis. Water bonds can become an effective tool for upcoming projects in the energy sector to allocate capital specifically for addressing water security issues. By issuing water bonds, energy projects can ensure dedicated funding for sustainable water management practices, helping to mitigate the water crisis while advancing industrial development.

Waste Water Recycling & Desalination Plants/Investments: As of 2022,[29] the current overall desalination capacity in India is estimated at over 620 million litres per day (MLD), with 67% (around 418 MLD) share with industries. India will need more private sector investments, public-private partnerships and more water treatment plants to meet its growing demand for industrial water over the next 5-10 years (NOTE: A 100 MLD plant can cost anywhere between INR 387 crore/USD 46.41 mn (Gujarat) to INR 900 crore/USD 107.92 mn (Tamil Nadu) and about five years to be setup).

Annexure: Water Use of Indian Energy Industry[30]

Total water consumption of listed companies in India's energy sector as publicly reported in the annual filings (annual reports/business responsibility and sustainability reports) for FY23. This includes a combination of various sources - surface water, ground water, third-party supply, sea water/desalination, rainwater harvesting, and other sources.

COMPANY	INDUSTRY	TOTAL WATER WITHDRAWAL (KILOLITRES)
Adani Energy Solutions Ltd.	Power	1,842,970
Adani Green Energy Ltd.	Power	447,630
Adani Total Gas Ltd.	Oil Gas & Consumable Fuels	54,055
Aegis Logistics Ltd.	Oil Gas & Consumable Fuels	19,710

COMPANY	INDUSTRY	TOTAL WATER WITHDRAWAL (KILOLITRES)
Bharat Petroleum Corporation Ltd.	Oil Gas & Consumable Fuels	66,220,800
Castrol India Ltd.	Oil Gas & Consumable Fuels	45,846
Coal India Ltd.	Oil Gas & Consumable Fuels	642,061,000
GAIL (India) Ltd.	Oil Gas & Consumable Fuels	17,506,677
Gujarat Gas Ltd.	Oil Gas & Consumable Fuels	75,318
Gujarat State Petronet Ltd.	Oil Gas & Consumable Fuels	35,092
Hindustan Petroleum Corporation Ltd.	Oil Gas & Consumable Fuels	138,753,757
Indian Oil Corporation Ltd.	Oil Gas & Consumable Fuels	108,500,000
Indraprastha Gas Ltd.	Oil Gas & Consumable Fuels	0
Mahanagar Gas Ltd.	Oil Gas & Consumable Fuels	34,187
NTPC Ltd.	Power	56,620,000,000
Oil & Natural Gas Corporation Ltd.	Oil Gas & Consumable Fuels	18,657,369
Oil India Ltd.	Oil Gas & Consumable Fuels	No Data Available for FY23
Petronet LNG Ltd.	Oil Gas & Consumable Fuels	11,203
Power Grid Corporation of India Ltd.	Power	2,777,668
Reliance Industries Ltd.	Oil Gas & Consumable Fuels	200,518,912
Tata Power Co. Ltd.	Power	4,567,484,000
Total		**62,385,046,194**
		62.39 bcm

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