TATA CONSULTING ENGINEERS LIMITED

ENGINEERING A BETTER TOMORROW
SINCE 1962

“SYNERGIZING WATER AND ENERGY : CHALLENGES AND PATHWAYS FORWARD TOWARDS NEUTRALITY AND CIRCULARITY”

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Contents

INTRODUCTION

- **Water Scarcity and Thermal Power Generation**
  Recognize the pressing challenge of water scarcity, particularly in thermal power plants specific water consumption (SCW), as a critical concern amid rising global water demands.

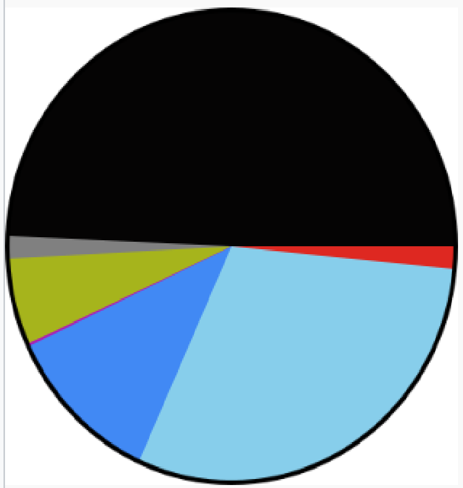
- **Techno-Economic Impacts**
  Understand the trade-offs revealed through techno-economic analysis: decrease in plant efficiency, rise in per-MW capital costs in some solutions, While these solutions may address extreme water scarcity, their economic and operational constraints demand careful assessment and due diligence.

- **Balanced Decision-Making**
  Highlight the importance of a balanced approach, carefully evaluating the interplay between water conservation goals and economic feasibility to ensure sustainable power generation.

- **Innovative Solutions for Sustainability**
  Advocate for innovative strategies to optimize water use in thermal power plants, addressing the dual challenge of water scarcity and sustainable energy production, with an emphasis on long-term benefits for humanity and the environment.

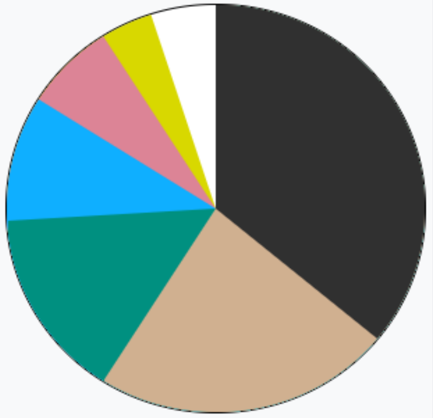
CHALLENGES

Installed capacity by source in the utility sector as on 12 June 2023[48]



Breakdown of Installed Generation Capacity as on 31/03/2023

Source	Installed Capacity (MW)	% of Share in Total
Fossil Fuels (Total)	**237,269**	**57%**
Coal	205,235	49.3%
Lignite	6,620	1.6%
Gas	24,824	6.0%
Diesel	589	0.1%
Non-Fossil Fuels (Total)	**178,790**	**43%**
Hydro	46,850	11.3%
Wind	42,633	10.2%
Solar	66,780	16.1%
Bio Mass Power/Cogen	10,248	2.5%
Waste to Energy	554	0.1%
Small Hydro	4,944	1.2%
Nuclear	6,780	1.6%
Total Installed Capacity	***416,059***	***100%***

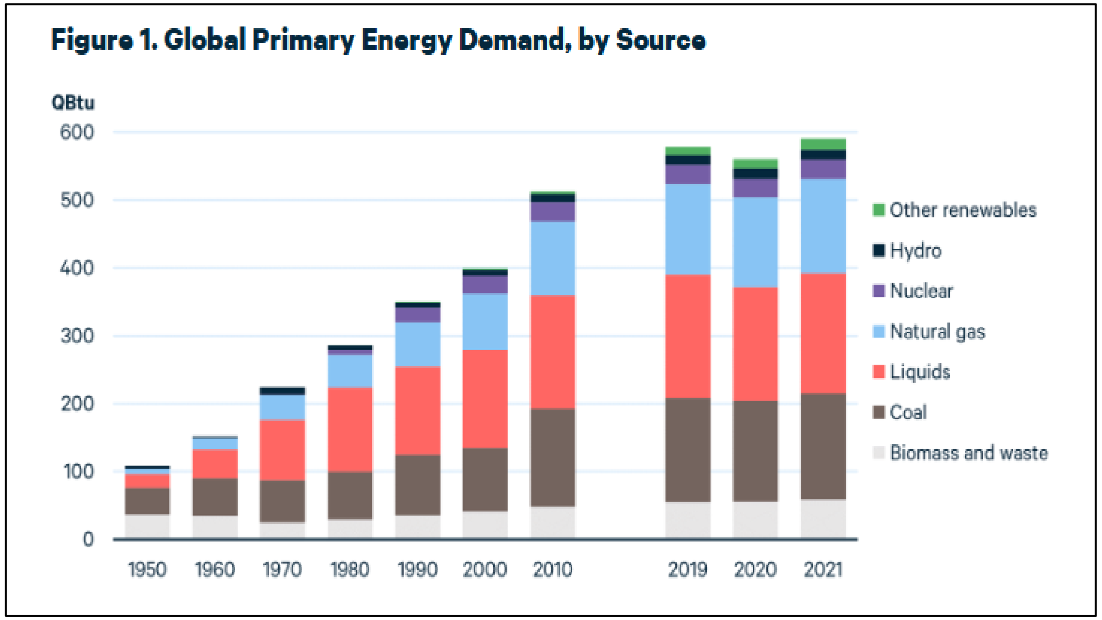


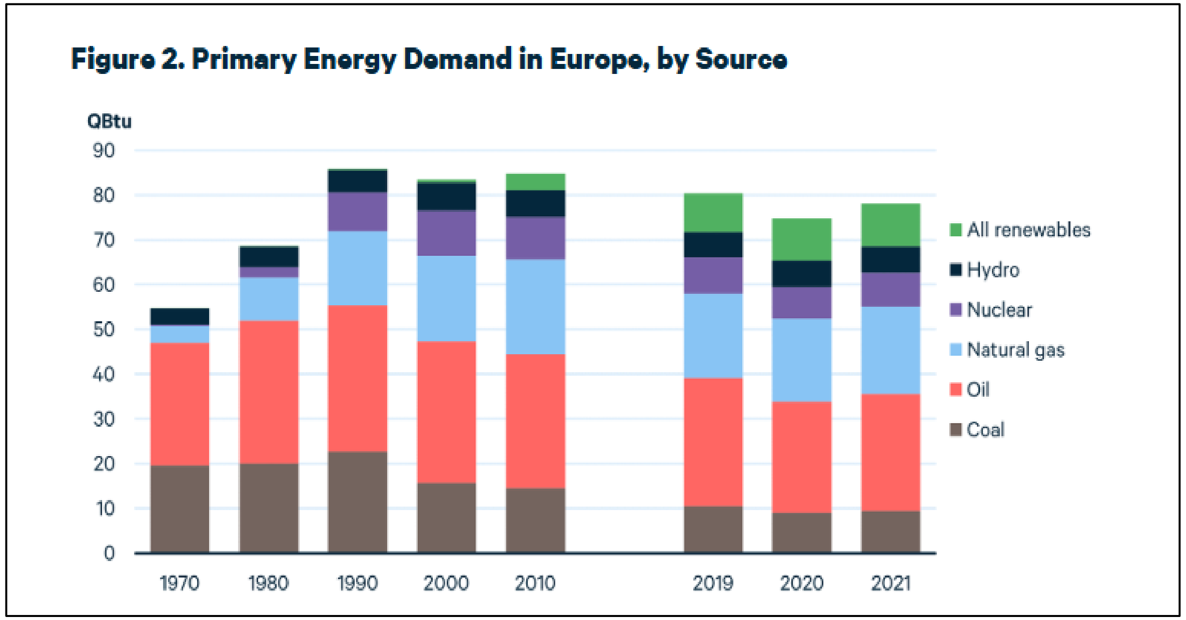
2021 world electricity generation by source. Total generation was 28 petawatt-hours.[10]

Largest primary energy producers (76% of world production) as of 2021, given in million tonnes of oil equivalent per year

	Total (MToe)	Coal	Oil & gas	Renewable	Nuclear
China	2,950	71%	13%	10%	6%
United States	2,210	13%	69%	8%	10%
Russia	1,516	16%	78%	2%	4%
India	615	50%	11%	33%	6%
Saudi Arabia	610	0	100%	0	0
Canada	536	5%	81%	10%	4%
Indonesia	451	69%	17%	14%	0
Australia	423	64%	33%	3%	0
Iran	354	0	99%	0	1%
Brazil	325	1%	55%	42%	2%
Nigeria	249	0	47%	53%	0
United Arab Emirates	218	0	99%	0	1%
Norway	214	0	93%	7%	0
South Africa	151	91%	1%	8%	0
Algeria	150	0	100%	0	0
France	128	0	1%	34%	65%
Germany	102	27%	3%	47%	23%
World	**14800**	**27%**	**53%**	**13%**	**7%**

CHALLENGES Contd.





Despite global pledges from governments and major corporations to adopt clean energy, the world continues to rely heavily on older energy sources.

While some leaders have initiated efforts towards energy transition, more action is urgently needed.

To avert the worst effects of climate change, energy transition must occur at a larger scale and faster pace

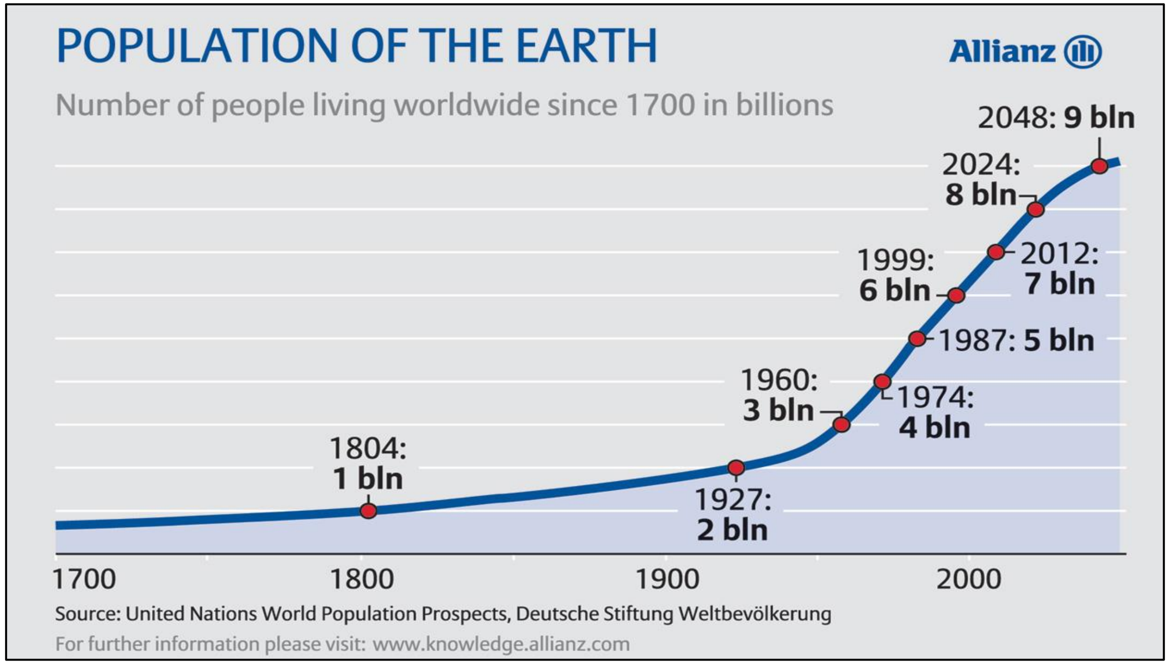
Policymakers and private sector leaders are committing to net-zero emissions, shifting energy systems in developed economies like Europe and North America.

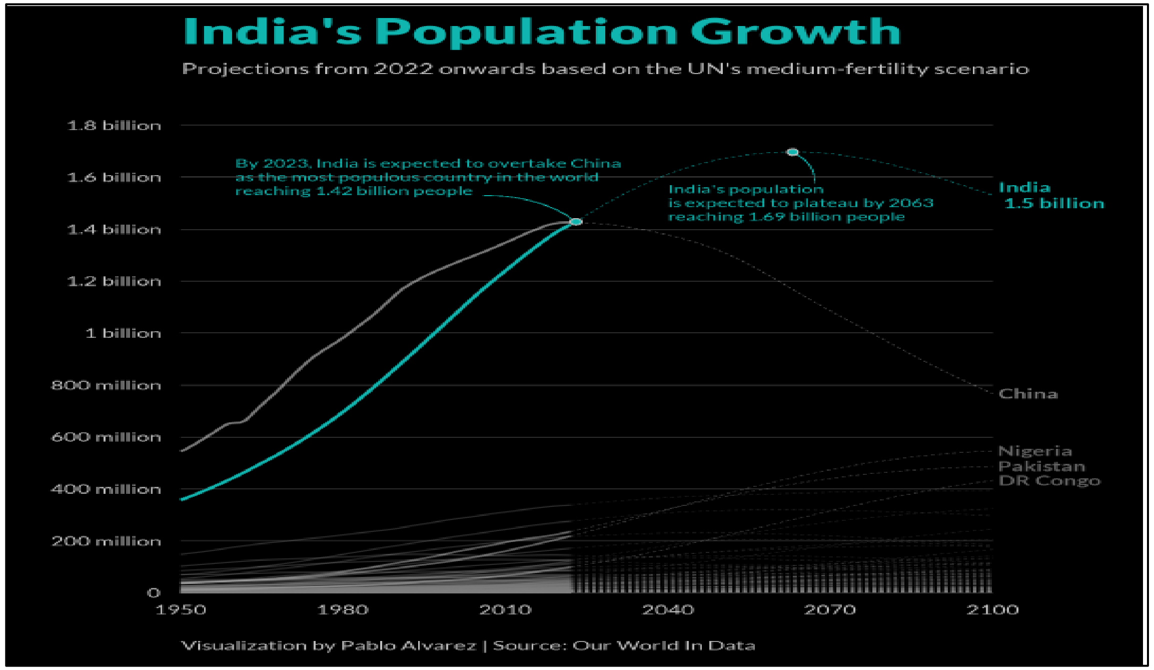
However, experts emphasize the need for concrete actions to meet the target of limiting global warming to 2°C, let alone 1.5°C by the end of the century.

Despite global emissions and fossil fuel consumption remaining high, some regions, especially Europe, are progressing in energy transition, replacing fossil fuels with cleaner technologies.

The energy insecurity caused by Russia’s invasion of Ukraine has accelerated Europe’s move away from fossil fuels.

CHALLENGES





Global Increase Index

•**Global Population Growth**: The global population is expected to reach approximately 9 billion by 2048, marking a significant increase.

•**Population Increase Percentage**: This represents a 12.5% increase in the global population over the period leading up to 2048.

•**Pressure on Resources**: With such an increase in population, there will be greater demand for essential resources, including food, water, energy, and infrastructure.

Implications of Population Growth on Water Demand in India

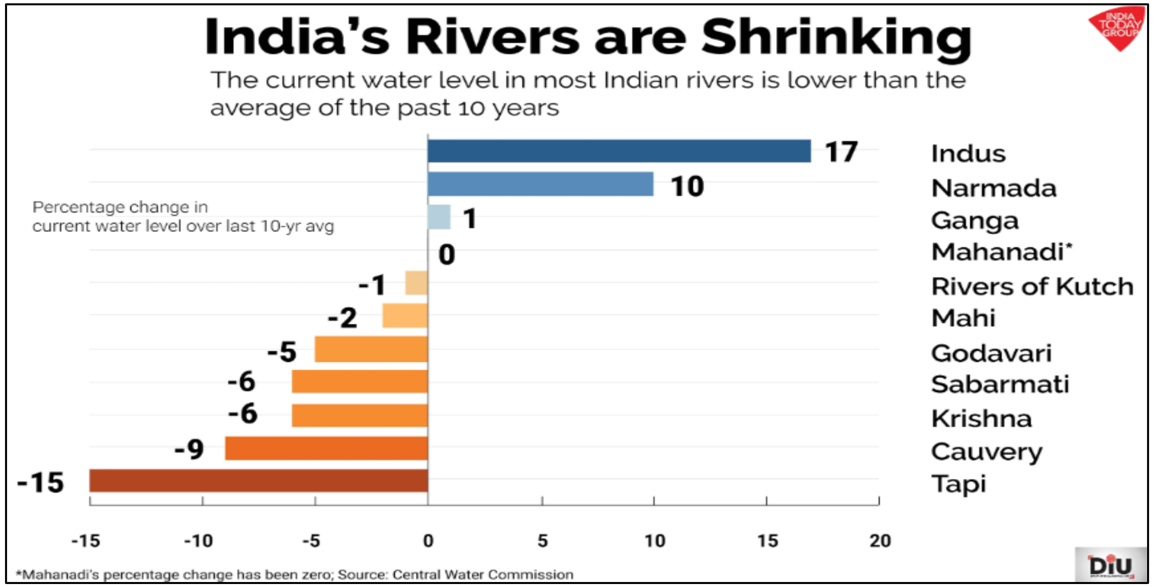
•**India's Population Growth**: By 2048, India's population is projected to reach approximately 1.62 billion, marking a 15% increase in the country's population.

•**Population Growth by 2035**: India's population is expected to grow by 7.5% by 2035, adding an estimated 120 million people.

•**Increased Water Demand**: By 2035, an additional 8.4 million cubic meters of water per day will be required to meet the needs of the growing population.

•**Pressure on Water Resources**: The increase in population will intensify pressure on India's already strained water resources, necessitating enhanced water management and conservation strategies.

CHALLENGES

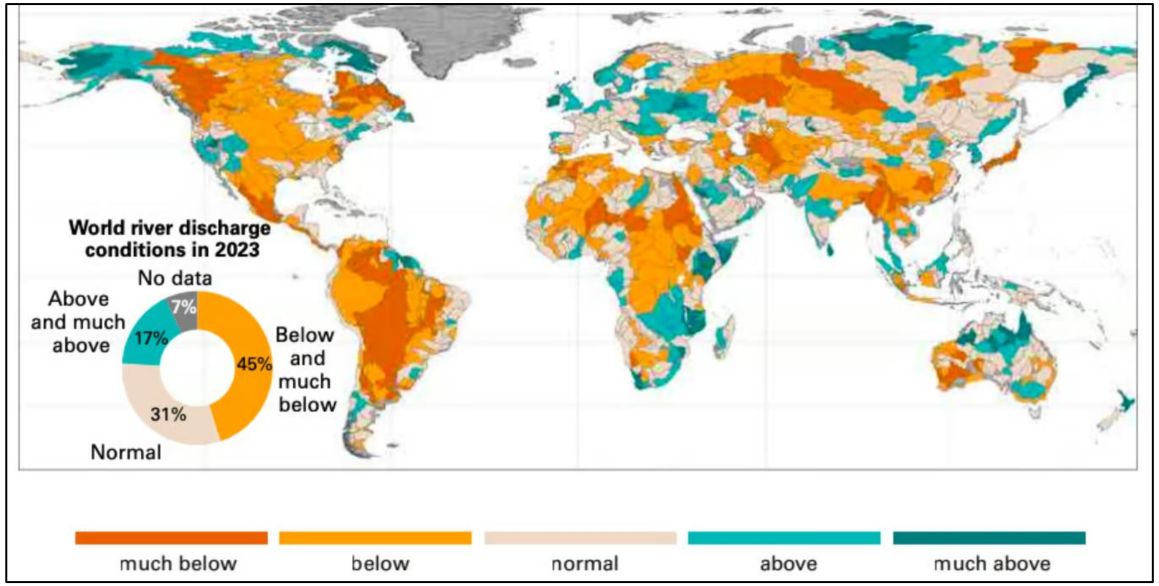


Water for Prosperity and Peace: Ensuring Sustainable Management Amid Global Challenges

- Large river basins such as those of the Ganga and Brahmaputra experienced lower-than-average conditions across almost their entire territories, Other Indian rivers also faces similar shrinking conditions
- In an unstable world where security threats are growing, we must all recognize that ensuring the availability and sustainable management of water and sanitation for all – the aim of Sustainable Development Goal 6 – is essential for global peace and prosperity
- The United Nations World Water Development Report 2024: Water for prosperity and peace highlights the wider significance of water for our lives and livelihoods. It explores water's capacity to unite people and serve as a tool for peace, sustainable development, climate action and regional integration for securing sustainable management amid global challenges

Global Water Resources Under Stress: Alarming Trends Highlighted by WMO Report 2024

- The report highlighted severe stress on global water supplies.
- Increasing temp & widespread dry condition resulted in rivers mostly facing conditions that were drier-than-average to average for river discharge.
- More than half of global catchment areas in 2023 showed deviations from near-average conditions for river discharge, predominantly lower than average
- Between 2015-2021 below- and much-below-average conditions affected North America (except Alaska), Central America and South America unstable management amid global challenges



Source: State of Global Water Resources, 2023

CHALLENGES

As per latest report by Ministry of Power, PIB Delhi, 25 July 2024

•**Projected Electricity Demand**: By 2031-32, India's electricity demand will necessitate significant expansion in power generation capacity.

•**Coal and Lignite Capacity Requirement**: The required coal and lignite-based installed capacity by 2032 is projected to be 283 GW, a substantial increase from the current capacity of 217.5 GW.

•**Planned Capacity Expansion**: To meet this demand, the Government of India plans to set up an additional 80 GW of coal-based power generation capacity by 2031-32.

•**Base Load Dependence**: The expansion is aimed at addressing the base load requirements of the country, ensuring stable and reliable power supply for industrial, commercial, and residential needs.

•**Strategic Planning by CEA**: The Central Electricity Authority (CEA) has conducted detailed generation planning studies to determine the necessary capacity expansion and to guide future investments in the energy sector.

•**Energy Security and Challenges**: While addressing electricity demand, this expansion also highlights the importance of balancing energy security with environmental sustainability and exploring clean coal technologies to reduce emissions.

- 80000MW is to be implemented by 2032-2035.
- Additional water demand for energy & community upto 2035
- Water required for 80000 MW = 80000 MW *2.75 M3/HR/MW*24 = 5280000 M3/day= 5.2 Million M3/day (Source: MOEF 2.5 M3/hour/MW- 3 M3/hour/MW)
- Water required for 12 Cr addiontal population = 12*10^6*70 liter/person/day 8.4 Million M3/day (50 litres to 100 litres) Source WHO
- By 2035 – Total additional water demand for (Additional energy requirement + Indian Population growth) = (Approx) **13.6 Million m3/day.**
- **Almost a tank of size 4.5KM (L) X 0.5KM (W) X 6M (H)**

CHALLENGES

United Nations World Water Development Report 2024

•Energy and freshwater demand will rise significantly, straining resources, especially in developing regions.

•Water and energy are interdependent; decisions in one impact the other.

•Policymakers can bridge gaps with innovative policies for efficient, cost-effective water and energy services.

•Pricing for services should reflect provision costs and socio-environmental impacts while protecting the disadvantaged.

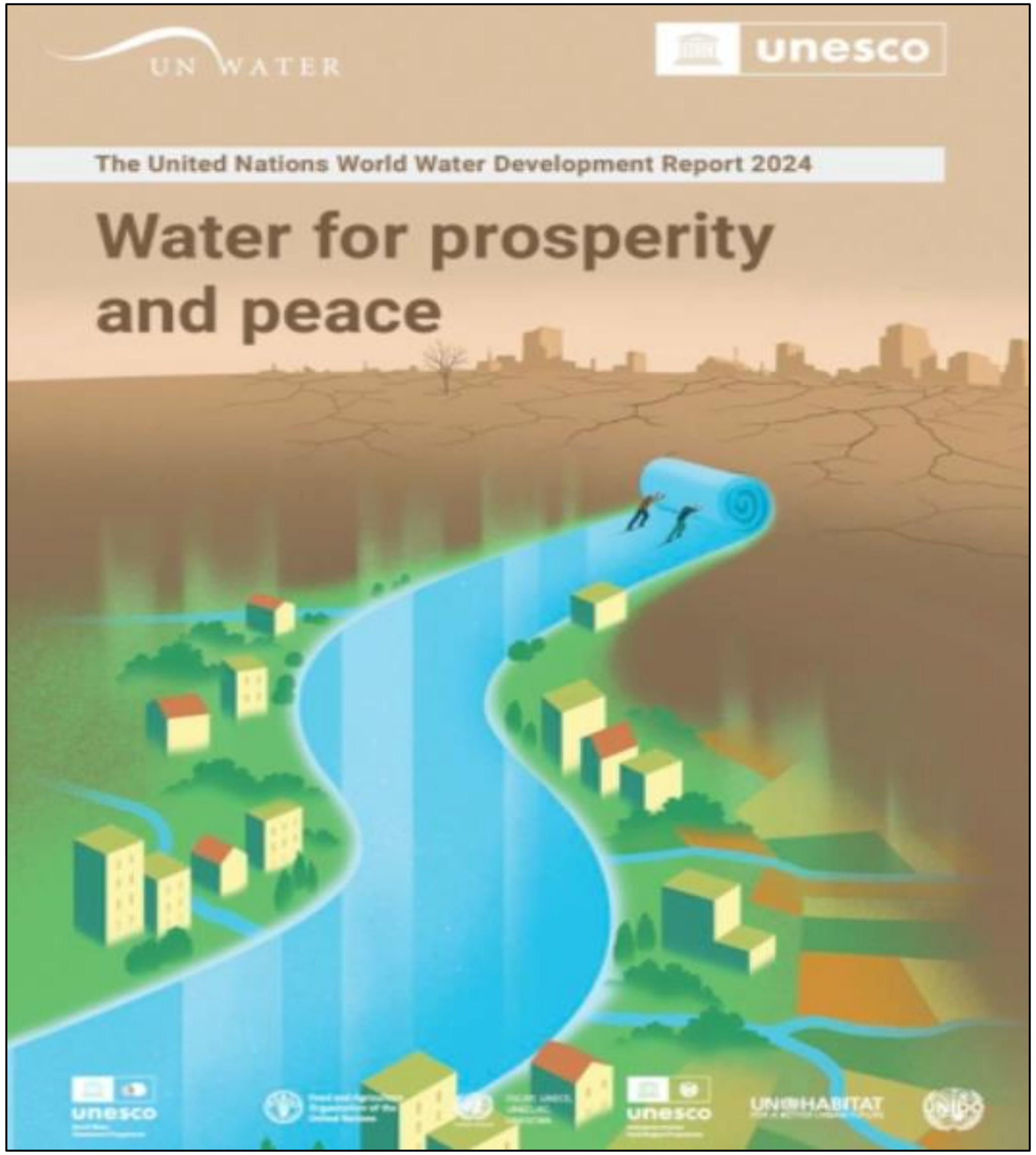
•The private sector can enhance investment, maintenance, and operation of water and energy infrastructure.

•Government and private sector support for R&D is vital for developing renewable and less water-intensive energy sources.

•Water and energy are central to sustainable development and must be prioritized.

•Governance in water and energy must consider social and gender equality implications and be gender-sensitive.

In an unstable world where security threats are growing, we must all recognize that ensuring the availability and sustainable management of water and sanitation for all – the aim of Sustainable Development Goal 6 – is essential for global prosperity and peace..



POWER SCENARIO IN INDIA

Power Sector and Water CEA Guidelines (India)

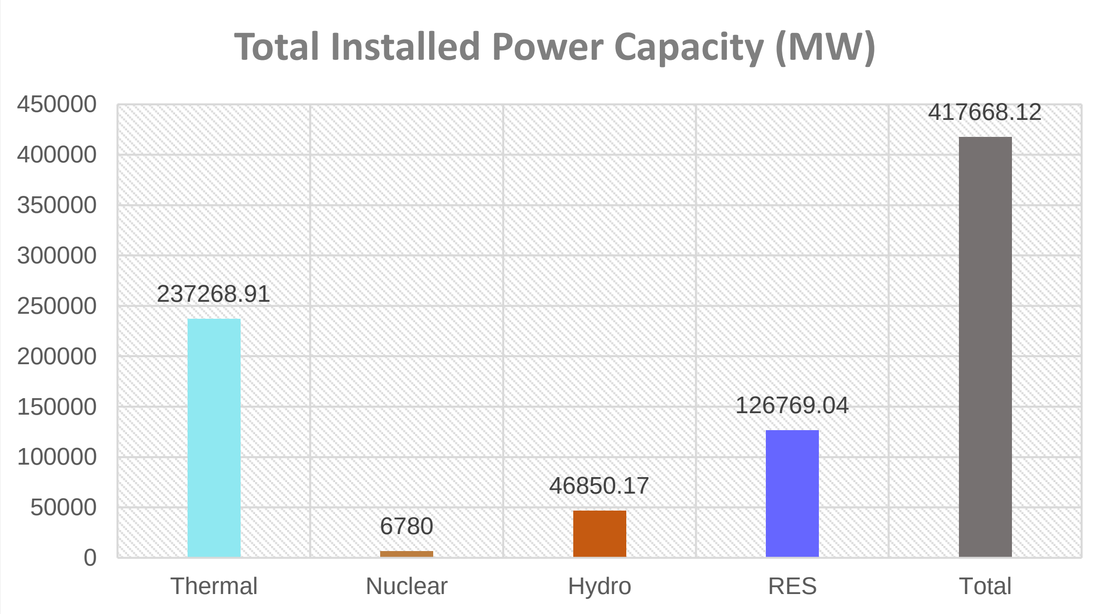
India has a current installed thermal power capacity of 237.46 GW as on Nov-2023. 3.5 to 4 $m^3/h/MW$ of raw water on an average is the consumption pattern

On an average coal based thermal power plants consumes approx. (5500 to 5900) million m3 of fresh water every year.

This makes coal based thermal power plants a major consumer of fresh water in the country and a prime focal point for water conservation measures

Water consumption for Thermal Power Plants: "Specific water consumption shall not exceed 3.0m3/MWh for new plants installed after 1st January 2017 and these plants shall also achieve zero water discharge consumption"
Water consumption norms shall not be applicable to the Thermal Power Plants using Sea water.

In the present study, CW system is considered to be operated at COC of 5.0 with requirement of make up water typically about 2.1 % of CW flow (comprising of 1.7% evaporation loss, 0.05% drift loss and 0.35 % as blow down). The blow down water is considered to be used for disposal of bottom ash, and unutilized blow down, if any, is led to central monitoring basin (CMB) of the plant for further utilization/ treatment/ disposal outside the plant boundary. The quantum of blow down water can be further reduced by increasing the COC of CW system which can be achieved by suitably improving the chemical regime of circulating water, if feasible.

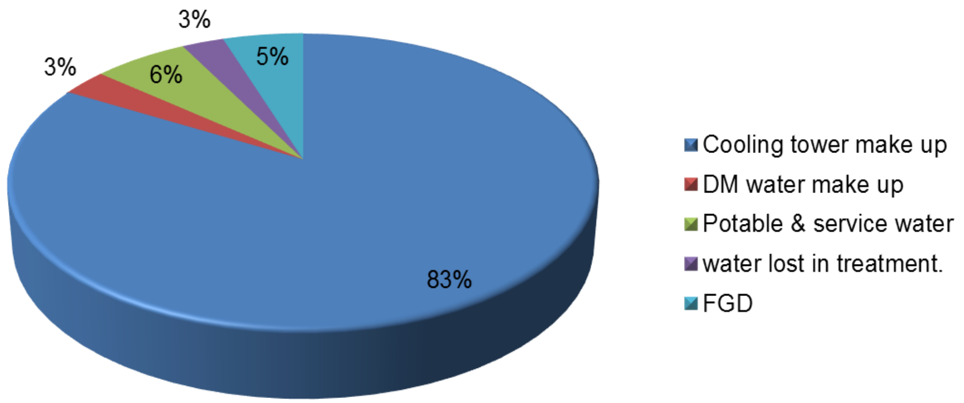


Environmental Norms (CEA)

WATER NORMS**	I. All plants with Once Through Cooling (OTC) shall install Cooling Tower (CT) and achieve specific water consumption of 3.5 m3/MWh within 2 years of notification. II. All existing CT based plants shall reduce specific water consumption up-to maximum of 3.5 m3/MWh within a period of 2 years. III. New plants to be installed after 1.1.2017 shall have to meet specific water consumption of 2.5* m3/ MWh & achieve zero water discharge.

CONVENTIONAL WATER CONSUMPTION PATTERN

Sl. No.	Mode	Major Water requirement areas		Water Consumption range
1	Coal/ Lignite	Condenser cooling System, Auxiliary cooling, Ash handling system, Power cycle, FGD, Service & Potable water		Water consumption of the order of 3-3.5 m^3/MWh
2	Gas	In CCGT- Condenser cooling System, Auxiliary cooling, & Power cycle of steam turbine, Service & Potable water		Lower than Coal TPPs (around 1/3)
3	Diesel	Engine cooling, Service & Potable water only		Little to no water for operations
4	Nuclear	Condenser cooling System, Power cycle, Service & Potable water		Slightly higher than coal based plants
5	Hydro	Service & Potable water only		Little or no water for operations
6	Renewable Energy Sources (RES)	Solar	Cleaning Solar panels/Surfaces, Service & Potable water	Around 0.1- 0.2 m^3 /MWh
		Wind	Service & Potable water only	Little to no water for operations
		Biomass	Similar to Coal TPPs	Same order as Coal based power plants



Currently the TPP's with cooling towers consume (3 to 3.5) m^3/MW without FGD's
With lime based FGD's installed the consumption will be close to 4 m^3/MW.
Make –up to wet cooling water system ranges 1.85% to 2.1% of total circulating water flow with COC 5 to 7.

Condenser Cooling system

Flue gas desulphurization unit

De mineralized water consumers such as

- Power cycle make up
- Condensate polishing Unit (CPU) regeneration
- Demineralization (DM) plant regeneration

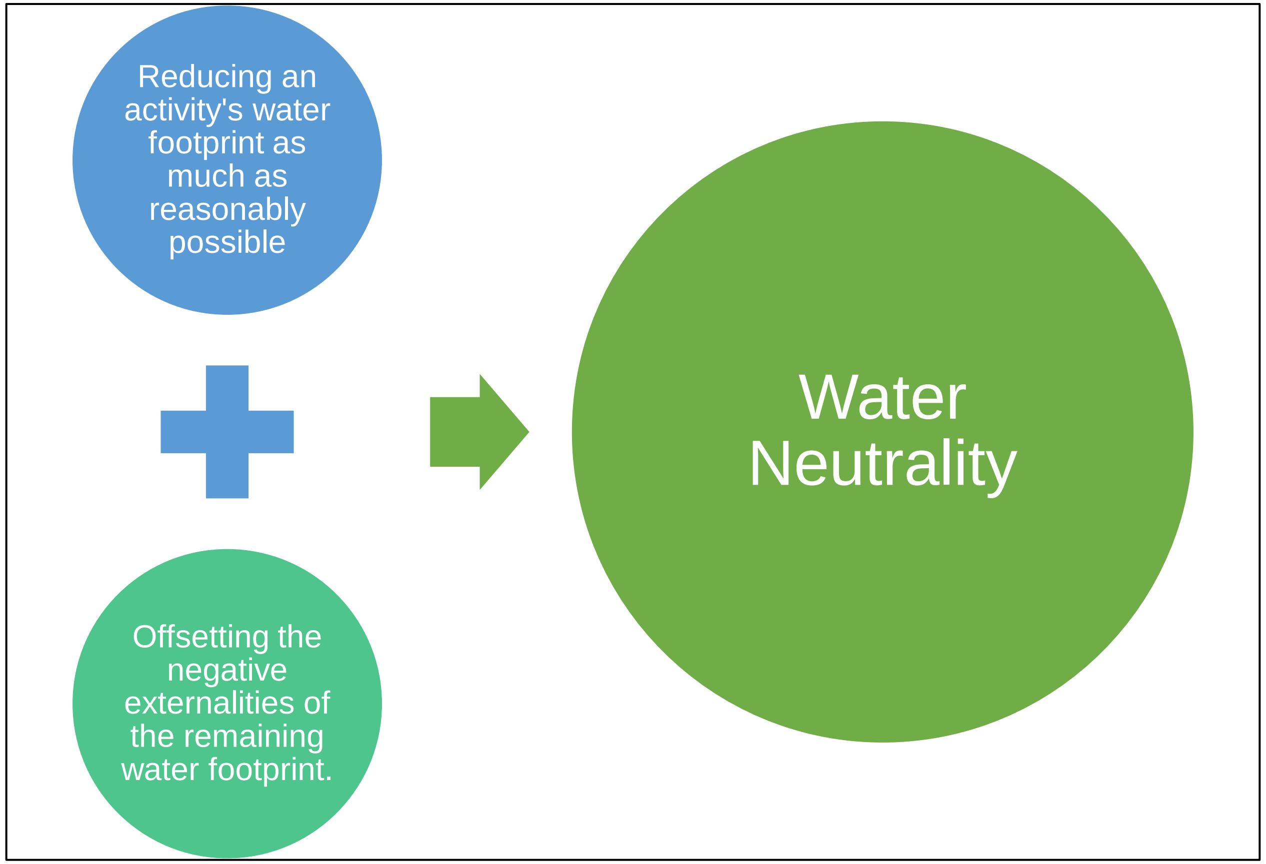
Service water for

- Ash handling system
- Coal handling system
- Miscellaneous requirements

Potable water

WATER NEUTRALITY

WHAT IS MEANT BY WATER NEUTRALITY?



Water neutral is not about nullifying water use, but about water saving where possible and offsetting the negative environmental and social effects of water use

- **Achieving Water Neutrality: A Path to Sustainable Water Management**
- A business achieves water neutrality when it has made every reasonable effort to minimize its water footprint and has implemented actions to compensate for the adverse consequences of its remaining water usage.

- **Water Neutrality: A Parallel to Carbon Neutrality**
- The concept of water neutrality aligns closely with the principles of carbon neutrality, developed to address the challenges of combating climate change

- **Water Neutrality among communities and businesses**
- The water neutral concept offers a great opportunity to transfer water footprint impacts into action to mitigate those impacts within both communities and businesses.

WATER NEUTRALITY

WATER FOOTPRINTS IN THERMAL POWER GENERATION

- **Specific Water Consumption (SWC): A Key Indicator**
  Specific Water Consumption (SWC) quantifies the direct water footprint of electricity generation. It serves as a critical measure to assess the efficiency and sustainability of water use in thermal power plants. Thermal power generation heavily depends on water for cooling, steam production, and other essential processes.

- While water is indispensable for electricity production through thermal processes, achieving reductions in SWC beyond the stipulated limit of average 2.5m3/hr/MW to 3 m^3/hr/MW is technically constrained at present.

- Achieving substantial improvements would require breakthroughs in water-efficient cooling systems and process optimization

- **Future Water Demand Projections**
- Projections indicate that under future growth scenarios, thermal power plants could consume over 1 million m^3 of water every hour.
  This immense demand underscores the critical need for sustainable water management strategies, especially in the light of impending water scarcity challenges.

- **The Water-Energy Nexus: A Growing Challenge**
  Thermal power generation exemplifies the intricate relationship between water and energy, often referred to as the water-energy nexus. The reliance on water for electricity production makes this sector highly vulnerable to water scarcity, climate change, and competing water demands from agriculture, domestic use, and industrial applications. Effective management strategies, supported by innovation & advancement and policy interventions, can pave the way for a more resilient and sustainable energy sector

CONFIDENTIAL

STEPS TO ACHIEVING WATER NEUTRALITY

Water and wastewater management at plant level (with the fence)

+

Water conservation/water use efficiency at watershed scale (Beyond the fence)

+

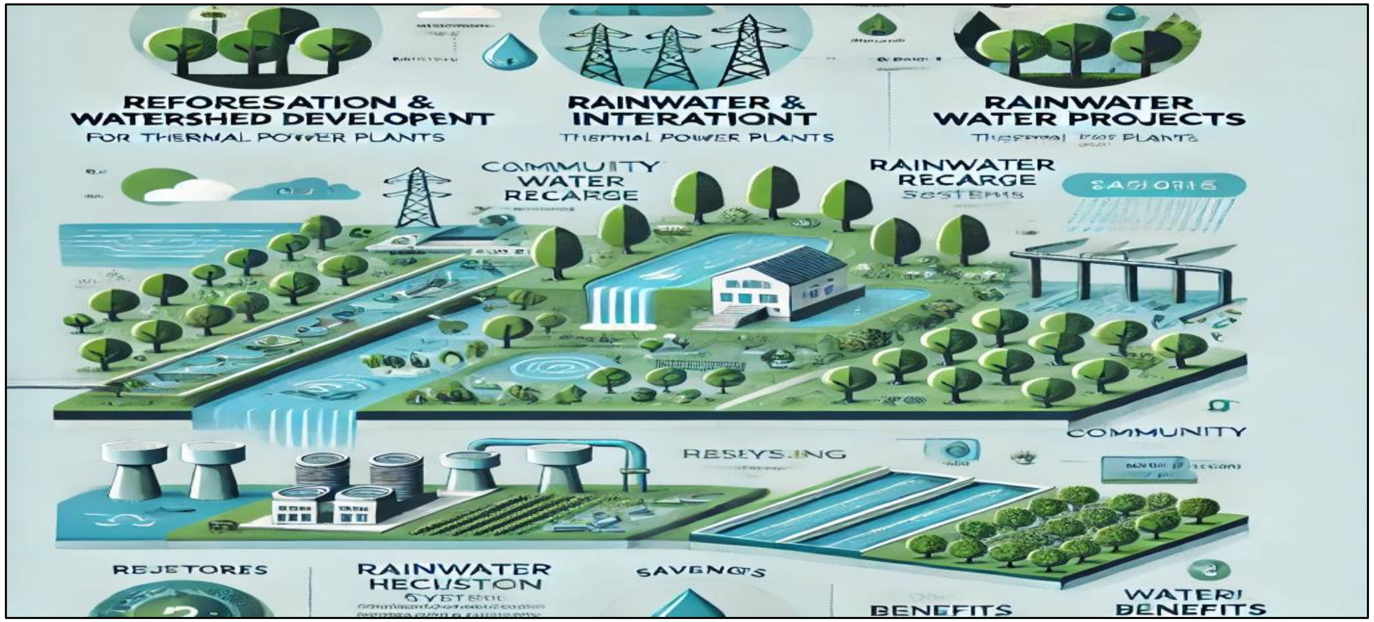
Water conservation/water use efficiency, water and waste water management of Supply chain

=

Total water extraction or consumption measured and/or estimated as sum total of freshwater – all of the sources – Within the fence, Beyond the fence and as part of supply chains

WATER NEUTRALITY HIERARCHY

- REDUCE WATER USE
- WATER REUSE
- OFFSET WATER

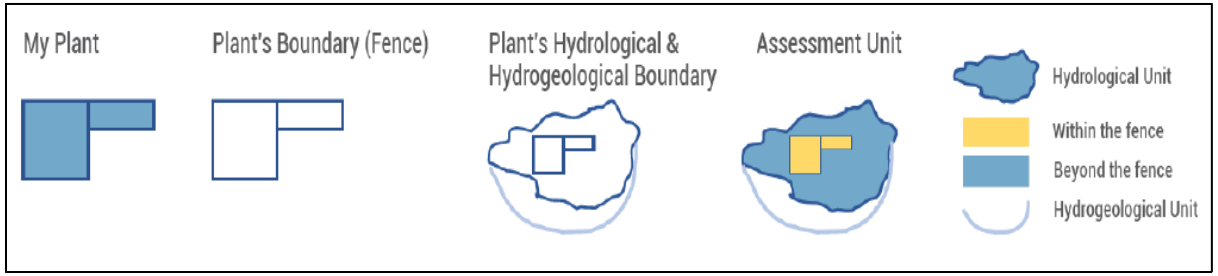


STRATERGIES FOR WATER NEUTRALITY

Water use efficiency through wastewater reuse, recycle and freshwater reduction

Reduction in wastewater should be visible through reduction in freshwater use i.e., optimization of freshwater usage as well as source diversification especially if the freshwater source is groundwater located in a semi critical, critical or overexploited area as per CGWA classification of blocks.

Defining Assessment Unit: (Establishing spatial context)



Assessment unit

Neutralizing impacts in the same watershed

Water depletion or pollution in one watershed/ groundwater system of a watershed cannot be compensated by water saving or pollution control in another watershed. Both plant's watershed and watersheds of water critical supply chains need to be looked at separately and in integrated manner from overall perspective.

STRATERGIES FOR WATER NEUTRALITY

Inside Plant Boundary

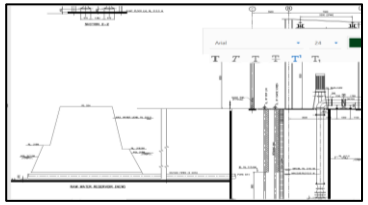
Water use efficiency through various advancements

Innovative Approach -1 : Smart approaches to raw water reservoir utilization

- Transforming Raw Water Reservoirs into Renewable Energy Hubs
- Reducing Evaporation Losses: Innovative Bund Height Strategies
- By harnessing renewable energy optimizing the energy consumptions through fossil fuel.
- Synergy between raw water reservoirs and renewable energy generation allows for energy storage in the form of potential energy, further optimizing energy utilization, promoting sustainability.

One(1) acre of reservoir surface = EV loss 1.2m3/h
Twenty-five (25) Acres surface = 30 m3/h = (typ 2x500MW)

- 2x500MW raw water reservoir requires 20 to 25 acres land.
- One(1) acres of land generate electricity around= 0.3MWh
- Twenty(25) acres will generate approx.= 7.5MWh



Innovative Approach -2 Driving Sustainability: Incentivizing Dry Cooling Systems in Water-Stressed States

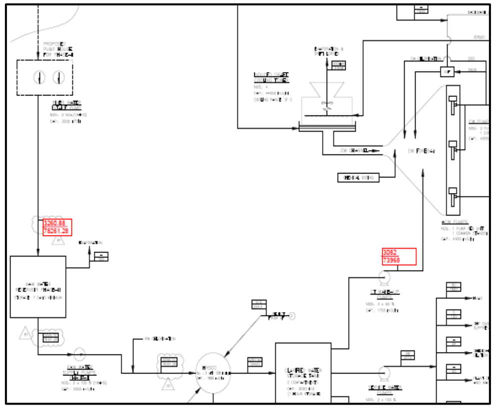
CPPP projected upto 2023 to 2032 = 80000MW
10 states out of 36 states is arid /semi-arid climatic condition.

If 30% of proposed TPP, 24000MW is to be on Arid states,

If Dry Cooling system is implanted in mutual understanding b/w Government and Owners. Through policies /subsidies/Taxation.

It has potential to save 1.1 Million m3 /day…

- States facing severe water scarcity, arid and semi-arid climate such as **Rajasthan, Gujarat, Tamil Nadu, and Maharashtra**, should adopt **dry cooling systems** to ensure sustainable water use in thermal power plants.
- While these systems may lead to reduced power output and higher initial costs, the government must implement supportive policies to address these challenges.
- This includes **compensating power plant owners for operational losses**, along with offering **attractive incentives, subsidies, and tax benefits** to encourage adoption and promote long-term sustainability in water-stressed regions.



Techno-Economic Aspects

	Wet Cooling	Dry Cooling	Remarks
Generation output	500MW	465MW	7% reduction in dry cooling system
Thermal efficiency	38%	35.5%	2.5% reduction In dry cooling system
Coal consumption	less	High	7 % increase Dry cooling System
CO2 emission	0.9 kg/kWh	0.96kg/kWh	7% increase in CO2 emission
Foot print	less	high	10% higher in dry cooling system
Capex	less	high	15% higher in dry cooling system
Tariff	less	high	8% to 9% high for dry cooling system

STRATERGIES FOR WATER NEUTRALITY

CPPP projected upto 2032= 283000 MW
Total approx. water con/day =18.6 Million m3/day

As per TERI report 24% T&D Loss…
If 10% saving will reduce consumption =1.8million m3/day.
As per Ministry of Power press release = project 2023 to2032 =80GW…

Water required for 80GW =5.3 Million m3/day
10% saving = 0.53 million m3/day

Tank size approx. =500M X200MX6M

Inside Plant Boundary

Water use efficiency through various advancements

Innovative Approach – 3: Urgent Call to Address India's High T&D Losses to Safeguard Energy and Water Resources

Approximately 24% transmission and distribution losses (both technical and non-technical) of electricity produced in the country

Probable way forward to Curb High T&D Losses in Electricity Distribution

- **Upgrade Infrastructure** and **Implement Smart Grid Technology** to monitor real-time electricity usage and detect losses effectively
- **Improve Energy Efficiency** by replacing outdated transformers with energy-efficient ones and **Strengthen Legal Frameworks** by enforcing stricter laws and penalties for electricity theft
- **Promote Private Participation** by allowing private investments in electricity distribution infrastructure to accelerate improvements.
- **Subsidies and Incentives for Loss Reduction** and **Develop a Comprehensive Loss Monitoring System** by setting up a centralized loss monitoring and reporting mechanism to track and analyze T&D losses.

Innovative Approach – 4: Integration with Meteorological Data

Harnessing Weather Intelligence: Optimizing Cooling Systems for Sustainable Operations“

By leveraging weather information, this advancement optimizes energy usage and water consumption, leading to enhanced sustainability and operational efficiency.

- Real-time adjustments with metrological data.
- Dynamic control and precise optimization of water and energy usage.
- During periods of lower cooling demand or favorable weather conditions, cooling systems can operate at reduced capacity, conserving both water and energy.
- Conversely, during peak cooling demand or adverse weather conditions, cooling systems can adjust operations.

STRATERGIES FOR WATER NEUTRALITY

Potential impact of water offsetting programs in thermal power plants: Outside Plant Boundary

Reforestation and Watershed development

Tree Plantation Impact:: A mature tree can **intercept up to 15,000 liters of water annually** through rainfall retention and groundwater recharge.

A reforestation project covering **1 hectare** with 1,100 native trees can recharge approximately **3 million liters of groundwater annually** in semi-arid regions

Artificial Wetlands: Artificial wetlands can treat **70-90% of plant wastewater**, significantly reducing freshwater dependency.

Watershed Development: Building check dams and percolation tanks in catchment areas can enhance aquifer recharge by up to **20-30%**.

Community water projects

Rainwater Harvesting Systems: A **100 sq. meter rooftop rainwater harvesting system** can collect approximately **50,000 liters of water annually** in regions with 500 mm annual rainfall.

Reservoir Construction: A mid-sized reservoir (10,000 cubic meters capacity) can store enough water for irrigation and drinking purposes for a village of 1,000 people for **3 months**.

Water Recycling Plants: A single **recycling plant** can treat up to **10 million liters/day** of municipal wastewater, providing reclaimed water for plant cooling and irrigation.

Economic Benefits

Cost of Water Offsetting Programs: Reforestation: **₹50,000/hectare ($600)** including plantation and maintenance.

Rainwater Harvesting: **₹2-3 lakh/system ($2,400-3,600)** for a 10,000-liter capacity structure.

Artificial Wetlands: Construction and operation cost around **₹10-15 lakh/hectare ($12,000-18,000)** but recoverable through reduced water purchases.

Savings: A 500 MW thermal plant implementing water offsetting programs can save up to **₹50 crore ($6 million)** annually through reduced water procurement and regulatory incentives.

WATER CIRCULARITY

• NEED FOR WATER CIRCULARITY

•**Water is circular in nature**, and water cycle is the evidence of nature's circularity. Need to combat the current problem of water scarcity because of a linear approach

•**Water Quality and Human Needs**: Water quality is crucial for satisfying basic human needs, but it is increasingly threatened by industrialization, power plants, urbanization, climate change, and agricultural activities.

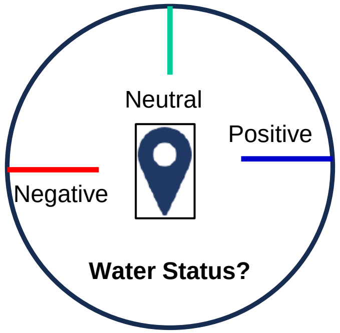
•**Global Water Pollution Crisis**: Around 2 billion people worldwide rely on drinking water sources contaminated with feces, highlighting the urgent need for improved water management and treatment.

•**APPROACHES AND ADVANTAGES OF WATER CIRCULARITY**

•**Circular Economy in Water Management**: The principle of Circular Economy (CE) offers a sustainable solution to combat water scarcity by shifting from a linear approach (take, use, dispose) to a system focused on reducing, reusing, recycling, and recovering water.

•**Economic and Environmental Benefits of CE**: CE increases economic benefits while reducing pressure on natural resources, ensuring that today's goods and water can be transformed into valuable resources for the future.

•**Sustainable Development through CE**: The CE concept works on waste management principles to conserve water resources and enhance sustainability, creating a more resilient water system for tomorrow.



Water Status

Positive implies giving back to the economy More
Neutral implies giving back to the economy same
Negative implies giving back to the economy less

Water than what is expected and consumed in first place

Essential to manage the water and wastewater resources following reduce, reuse, recycle, reclaim, recover, and restore (6Rs) strategies of CE.

Achieving neutral or positive water status is a significant step toward achieving water circularity.

INSIGHTS

TATA

- **Minimize Water Footprint**
  Strive to achieve the lowest water intensity among global power generators by optimizing water use in all processes.
- **Attain Water Neutrality**
  Commit to becoming a water-neutral company by implementing fully circular water management systems across all business units.
- **Adopt Environmentally Sound Technologies**
  Incorporate innovative and sustainable technologies to enhance efficiency, reduce water wastage, increase recycling and reuse, and prevent water pollution.
- **Environmentally Responsible Water Management**
  Develop and manage water resources sustainably, balancing environmental protection with human, social, and economic needs.
- **Risk and Opportunity Proactive Measures**
  Anticipate water-related risks and opportunities to guide strategic business decisions ensuring long-term sustainability.
- **Stakeholder Engagement**
  Collaborate with stakeholders to raise awareness and encourage responsible water use practices across communities and industries.
- **Legal Compliance**
  Ensure strict adherence to all applicable water-related environmental laws and regulations.
- **Periodic Policy Review**
  Regularly review and update water policies, at least once every three years, to align with evolving business and environmental needs.

PATHWAYS FORWARD

- ✓ Taking strong commitment for water conservation and sustainability.
- ✓ Ensure and Strive to achieve water neutrality as a goal.
- ✓ Proactive measures for Zero Liquid Discharge(ZLD).
- ✓ Proactive measure like rainwater harvesting, developing road map to utilize treated water, enhancing water recharge capacity and recycle treated wastewater for gardening purposes, ensuring sustainable water practices.
- ✓ Proactive collaboration among stakeholders, fostering innovation, and adopting a holistic approach to implementation.
- ✓ Prioritize investment in research and development.
- ✓ Incentivizing the adoption of sustainable practices and providing support for the deployment of advanced technologies.
- ✓ Conducting comprehensive feasibility studies, engaging in strategic partnerships with technology providers, and investing in workforce training to ensure successful implementation and long-term sustainability.
- ✓ Moreover, ongoing monitoring, evaluation, and knowledge sharing are essential for identifying opportunities for improvement and scaling up successful initiatives.
- ✓ Embracing these recommendations, industries can realize the full potential of advancements in cooling water system optimization and contribute to a more sustainable future.

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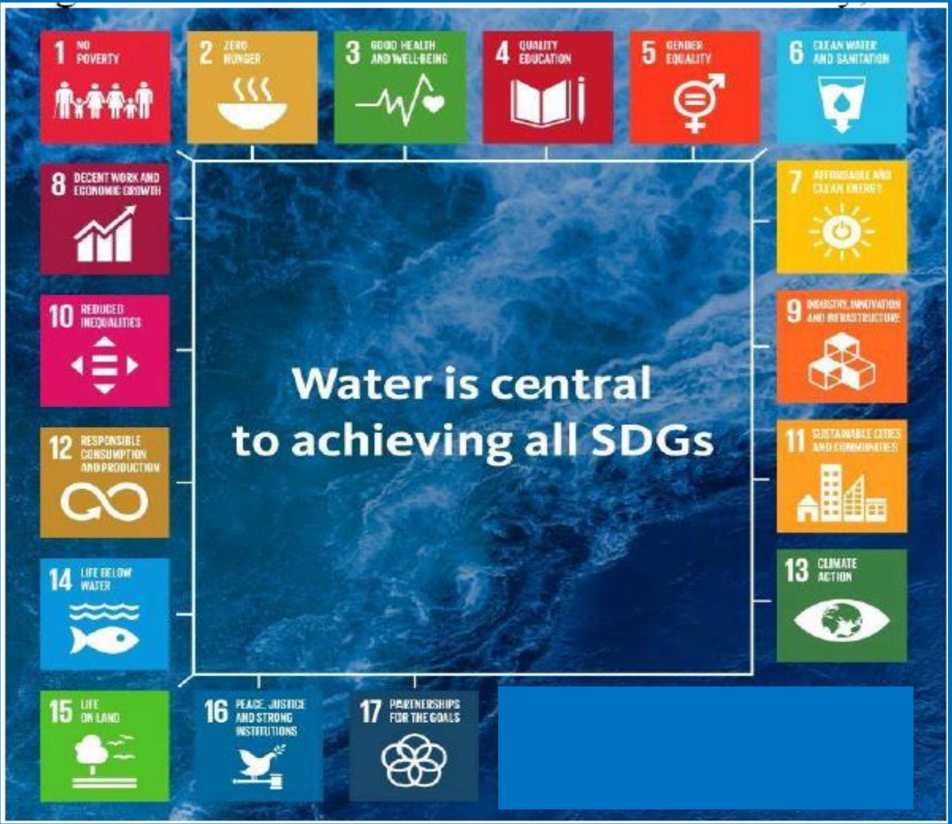

THANK YOU

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" 💧 **Save Water Today for a Thirsty Tomorrow**
🌍 Every Drop Counts—We are Responsible!"