

ACHIEVING COMPLIANCE WITH ZERO LIQUID DISCHARGE NORMS

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Presentation Outline

- Key Levers and Step approach for Water Management in Power plants
- Overview of Zero Liquid Discharge
- Drivers for Recycling Waste Water
- Cooling Water Systems
  - Recycling of Waste Water for Cooling Water Systems
  - Corrosion in Cooling Water Systems & its Effects
  - Scaling in Cooling Water Systems
  - Fouling, Biofouling, MIC in Cooling Water Systems
  - Monitoring in Cooling Water Systems
- Case Studies on Waste Water Recycling
  - Boiler Blow Down for CW System
  - CW Blow Down for Improving Cooling Water Quality
  - Treating Waste Make-up Water for Plant Performance Improvement

Key levers for water management in Thermal power plants

Key Levers

1 Enhanced Monitoring

- Increase in levels of water & wastewater monitoring
  - ↓ to identify water consumption pattern at process level
  - ↓ To achieve water balance chart

2 Asset Management

- Identify old, inefficient equipment accounting for leakages
- Replacement of old pipes to reduce water wastages

3 Augmentation of water resources

- Utilize captive area in plant for rain-water harvesting
- Explore alternative sources of water E.g. Desalination plants

4 Recycling / reuse of water

- Adopt newer (cleaner) technologies to reduce water footprint and recycle wastewater
  - ↓ **Zero Liquid Discharge**
  - ↓ usage of air-cooled condensers instead of water cooled condensers

Source: Tata Strategic Analysis

Step Approach to Implementing of Water management in Thermal power plants

1 Base-lining of Water & Wastewater Footprint

- *Identify "Influence area" (locations / geographies) and establish As-Is Water Balance chart*

2 Risk profiling & Sustainability Assessment

- *Estimate "actual cost" of water*
- *Identify risks to water availability in future scenarios*
- *Identify issues in current patterns of water consumption*
- *Create an "Impact analysis chart" for alternate scenarios*

3 Response Formulation

- *Identify measures to reduce water consumption and develop cost-benefit analysis for these measures*

  E.g. ***Implement Zero Liquid Discharge program***
- *Develop a Water footprint abatement curve and enhanced water monitoring program*

4 Integration into long-term planning

- *Set long-term water targets and develop a water strategy for the future*
- *Integrate water strategy in development of future business planning*

Source: Tata Strategic Analysis

Zero Liquid Discharge (ZLD)

- ZLD - stands for Zero Liquid Discharge – meaning zero discharge of wastewater from Industries.

- A ZLD system involves a range of advanced wastewater treatment technologies to recycle, recovery and re-use of the 'treated' wastewater and thereby ensure there is no discharge of wastewater to the environment.

- A typical ZLD system comprises of the following components:

  - Pre-treatment
  - Reverse Osmosis
  - Evaporator & Crystallizer

Need for Zero Liquid Discharge (ZLD)

- Most polluting industries such as Pharma, Pulp& Paper, Tanneries, Textile Dyeing, Chemicals, Power Plants etc generate wastewater with high salinity/TDS.
- Conventional ‘Physico-chemical-biological’ treatment does not remove salinity in the treated effluent. The TDS content is well above the statutory limit of 2100 mg/l.
- Discharge of saline but treated wastewater pollutes ground and surface waters.
- Several states in India such as Tamilnadu, Rajasthan, etc are water stressed. Competing demands for water from agriculture and domestic use has limited industrial growth.
- Location of industries in ‘Inland areas’ and issues related to sea discharge of ‘treated’ wastewater.
- High cost of water and statutory regulations are prime drivers for ZLD.
- **MAIN MOTIVATORS- Water Scarcity, water economics, regulatory pressure.**

Zero Liquid Discharge (ZLD)

The scarcity of valuable freshwater resources, concerns about the environmental impact of industrial wastewater discharge and increasing regulatory controls make a compelling case for recycling and reuse.

Zero Liquid Discharge (ZLD) is the next generation of wastewater recovery methodology for industrial applications, resulting in significant payback (by enabling businesses to save money, reduce environmental impact and meet legislation for discharge).

The technology used to achieve Zero Liquid Discharge, depends largely on the type of the business. However, the main aim is always the same - to purify the water up to the level that can be reused for every application inside the same Company.

Zero Liquid Discharge (ZLD)

Zero Liquid Discharge is a process that is beneficial to industrial and municipal organizations as well as the environment because money is being saved and no effluent, or discharge, is left over.

ZLD systems employ the most advanced wastewater treatment technologies to purify and recycle virtually all of the wastewater produced.

ZLD systems provide numerous economic and environmental advantages for plant managers—water is recycled and reused, saving on the cost and treatment of raw water.

Since all water is reclaimed, no effluent is discharged from the plant, avoiding the cost of environmental impact. The technology is particularly appropriate in water-short areas.

Drivers for Waste Water Recycling

- National Water Policy
- National Water Mission
- Non-Availability of Quantity & Quality of Water for specific application
- Improving Water Efficiency
- Cost Reduction & Resource Conservation
- Sustained Growth and Environmental Considerations
- Statutory Requirements
- Plant Operational requirements
- Availability of suitable Technologies
- Reducing Energy Consumption in Water Systems

Benefits of Zero Liquid Discharge

- To save costs and reduce the capacity needed, comprehensive water audits are usually performed which also ensure that the system deals only with the most polluting streams. Installing **ZLD** technology is therefore often beneficial for the plant's water management; encouraging close monitoring of water usage, avoiding wastage and promotes recycling by conventional and far less expensive solutions.

- High operating costs can be justified by high recovery of water (>90 - 95%) and recovering of several by products from the salt.

- A more sustainable growth of the industry while meeting most stringent regulatory norms.

- Possibility of use of **sewage** for recovery of water, for Industrial and municipal use, using ZLD technologies.

- Reduction in water demand from the Industry frees up water for Agriculture and Domestic demands.

Challenges in Zero Liquid Discharge

- ZLD results in generation of hazardous solid wastes creating disposal challenges- need to think of Zero Waste Disposal (ZWD) Plants. Generate products/ by-products out of the waste.

- Economic viability- cost and availability of water, regulatory pressure are the real driving force.

- High Carbon foot print- is this environmentally sustainable?

- High Operating cost and financial impact on the industry and its Regional/ National/Global competitiveness.

- Technology shortcomings.

Some of the Industries where ZLD can be adopted

- Power
- Synthetic fuels
- Primary metals processing
- Microelectronics
- Chemical
- Pulp and paper
- Coal mining
- Battery manufacturing
- PVC manufacturing
- Uranium mining
- Petroleum and petrochemical
- Oil refining
- SAGD heavy oil recovery
- Cogeneration
- Fertilizer
- Solid waste (leachate and secondary sewage effluent)
- Coal liquefaction
- Ethanol production

Water Foot Prints

The UN estimates that by 2050, half the World's population will live in nations that are short of Water. Water is needed throughout the energy sector at each step-energy extraction & production, refining & processing, transportation & storage and electric power generation it self. It is estimated that water consumption to generate electricity will more than double over the next 40 Years

Water footprint of an individual - sum of his or her **direct** and **indirect** freshwater use. The **direct water** use is the water used at home, while the **indirect water** use relates to the total volume of freshwater that is used to produce the goods and services consumed.

S.No.	Country/Type	Water Foot Print m^3/yr
1	Average Global	1385
2	USA	2842
3	China	1071
4	India	1089
5	Daily vegetarian diet	1500 lit
6	Daily Non-Vegetarian diet	3400 lit

Water Foot Prints

Research by the Cranfield University calculated the amount of water required to produce various common foods in the United Kingdom:

S.No	Product	Amount of Water Liters
1	1 cup of tea	32.4 l
2	1 imperial pint of beer	160 l
3	1 glass of wine	120 l
4	1 glass of milk	200 l
5	1 kilogram (2.2 lb) of beef	15,000 l
6	1 kilogram (2.2 lb) of poultry	6,000 l
7	250 grams (8.8 oz) packet of M &Ms	1153 l
8	575 grams (20.3 oz) jar of Dolmio pasta sauce	202 l

National Water Policy

Basic principles of draft NWP

Some of the basic principles that govern the draft NWP are as follows:

☐

- The principle of equity and social justice must inform the use and allocation of water.
- A common integrated perspective should govern the planning and management of water resources.
- Such a perspective would consider local, regional and national contexts and have an environmentally sound basis.
- Water needs to be managed as a common pool community resource that is held by the state under the public trust doctrine to ensure equitable and sustainable development for all.
- Water may be treated as an economic good to promote its conservation and efficient use after basic needs such as those of drinking water and sanitation are met.
- The river basin should be considered as the basic hydrological unit for the purpose of this policy.

National Water Policy

Enhancing water available for use

- Rainfall needs to be used directly and inadvertent evaporation of water needs to be avoided.
- Aquifers need to be mapped to know the quantum and quality of ground water resources. Local communities should be involved in this process.
- Declining ground water levels in over-exploited areas need to be arrested by introducing improved technologies of water use and encouraging community based management of aquifers. Additionally, artificial recharging projects should be undertaken so that more water is recharged rather than extracted from aquifers.
- Inter-basin transfers of water from surplus basins to deficit basins/areas need to be encouraged to increase the production of water.
- Integrated watershed development activities with groundwater perspectives need to be undertaken to increase soil moisture, reduce sediment yield, and increase overall land and water productivity. Existing programmes such Mahatma Gandhi National Rural Employment Guarantee Act may be used by farmers to harvest rain water using farm ponds and other soil and water conservation measures.

Demand management and water use efficiency

The draft NWP recommends the following methods to promote and incentivize the efficient use of water: □

National Water Policy

Demand management and water use efficiency

Systems to benchmark water use, such as water footprints (total volume of water used in an area to produce goods and services) and water auditing (assessment of water use), need to be developed. Continuous water balance and water accounting studies need to be conducted to improve the efficiency of water use from irrigation projects and river basins.

- Project appraisals and environment impact assessment for water uses, particularly for industrial projects, should include analyses of water footprints.
- Water needs to be saved during irrigation. Methods to encourage water saving include, aligning cropping pattern with natural resource endowments, micro irrigation (drip, sprinkler, etc.), automated irrigation operation, and evaporation-transpiration reduction. Canal seepage water can also be recycled through conjunctive ground water use.
- Small local level irrigation through small bunds, field ponds, agricultural and engineering methods for watershed development, need to be encouraged.
- Users of water should be involved in monitoring the pattern of water use if it is causing problems like unacceptable depletion or building up of ground water, salinity, alkalinity etc.

Water pricing

For the pre-emptive and high priority uses of water, the principle of differential pricing may have to be retained. Other than these uses, water should be allocated and priced according to economic principles. □

National Water Policy

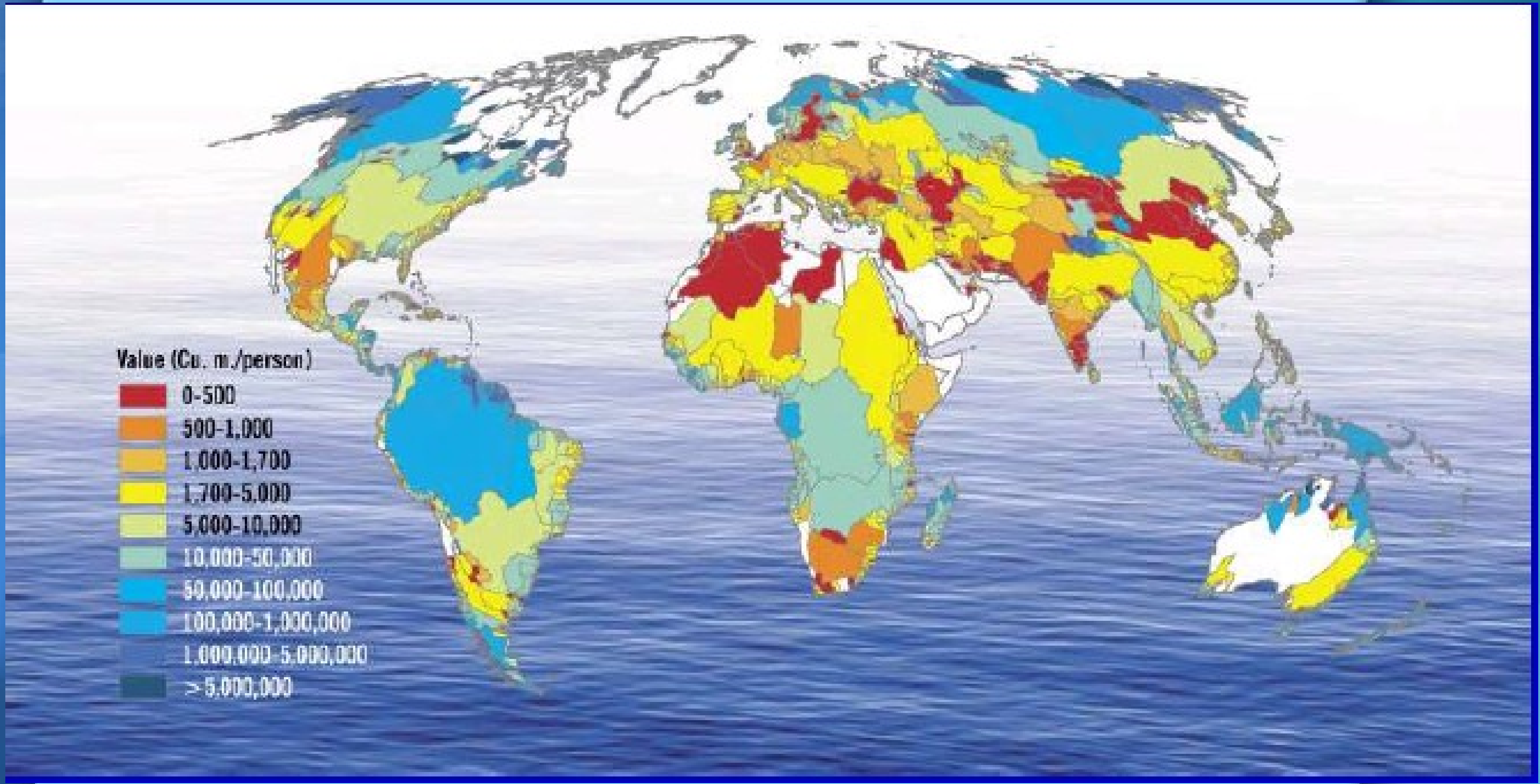
Water pricing

- A Water Regulatory Authority should be established in each state. The authority will be responsible for fixing and regulating the water tariff system and charges to be levied.
- Water charges should be determined on a volumetric basis.
- Recycle and reuse of water should be incentivized through a properly planned tariff system.
- Water Users Associations (WUA) should be given statutory powers to collect and retain a portion of water charges, manage the volumetric quantum of water allotted to them and maintain the distribution system in their jurisdiction.

Conservation of river corridors, water bodies and infrastructure

- Conservation of river corridors, water bodies and infrastructure needs to be undertaken in a regulated and scientifically planned manner through community participation.
- Encroachments and diversion of water bodies and drainage channels must not be allowed. Wherever such diversions have taken place, they should be restored and maintained to the extent feasible. Pollution of sources of water and water bodies should not be allowed. Water bodies should be periodically inspected by a third party and stringent punitive action should be taken against persons responsible for pollution.
- Legally empowered dam safety services need to be ensured in the centre as well as states.
- Appropriate safety measures such as downstream flood management for each dam should be given top priority.

Global Demand for water is fast outstripping supply

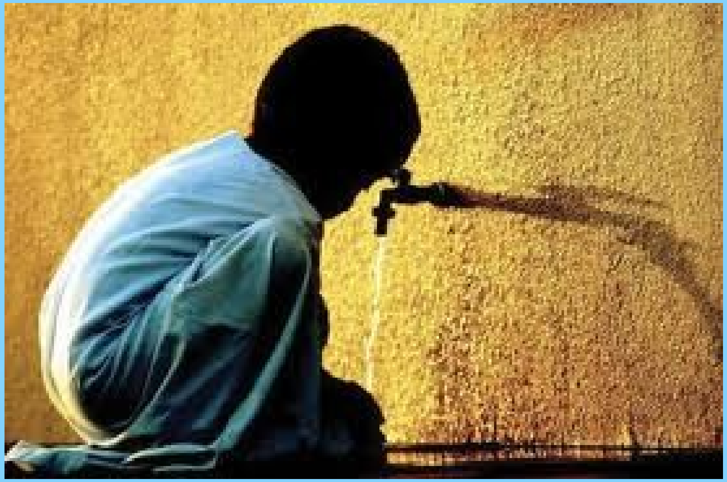


India possesses 5% of the World's fresh water but is home to 16% of global population; water use efficiency for irrigation is approx. 65% and power use efficiency for extracting GW is only 28%

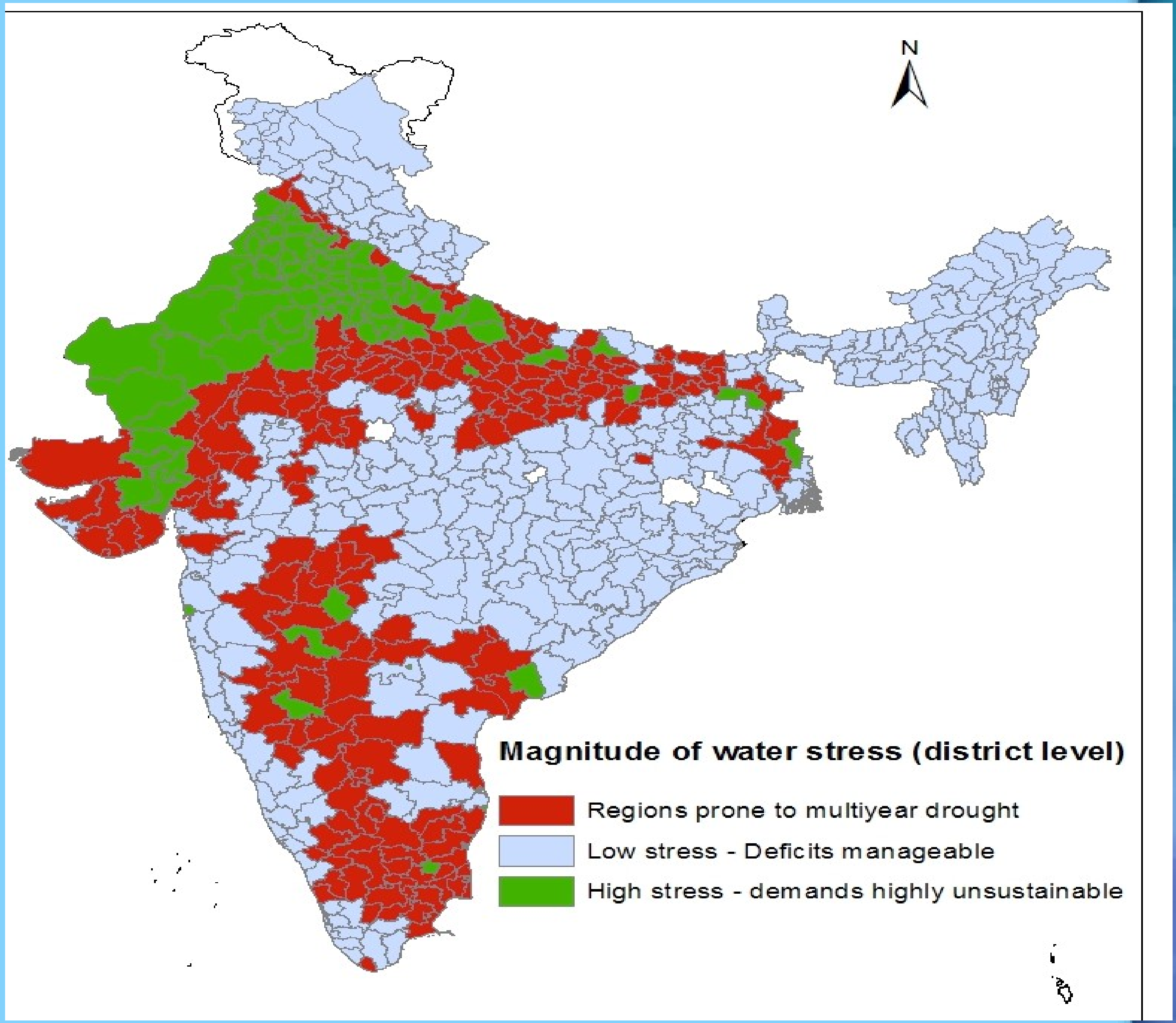
Source DJB

Water Availability & Scarcity

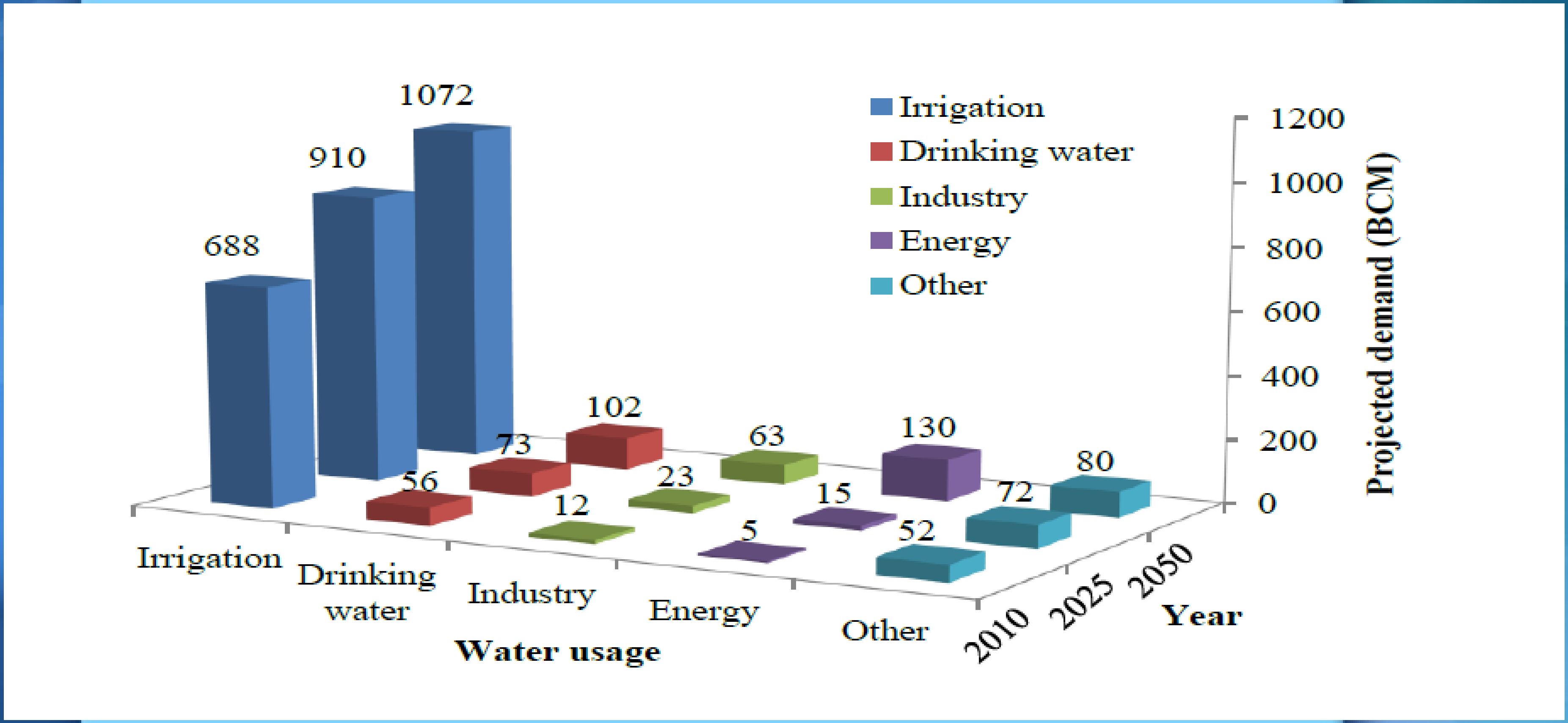
Water Availability & Scarcity



Water Stress Status of India



Water Usage & Demand



Water Availability & Utilization

In India, the total utilizable water resource is assessed as 1123 BCM.

The per capita availability of water at national level has been reduced from about **5177 cubic meters in 1951** to the estimated level of **1,820 cubic meters in 2001** with variation in water availability in different river basins. Given the projected increase in population **by the year 2025**, the per capita availability is likely to drop to below **1,000 cubic meters**, which could be labeled as a situation of **water scarcity**

Water Demand (in BCM) for various Sectors

Sector	Standing Committee of MoWR			NCIWRD		
Year	2010	2025	2050	2010	2025	2050
Irrigation	688	910	1072	557	611	807
Drinking	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	813	1093	1447	710	843	1180

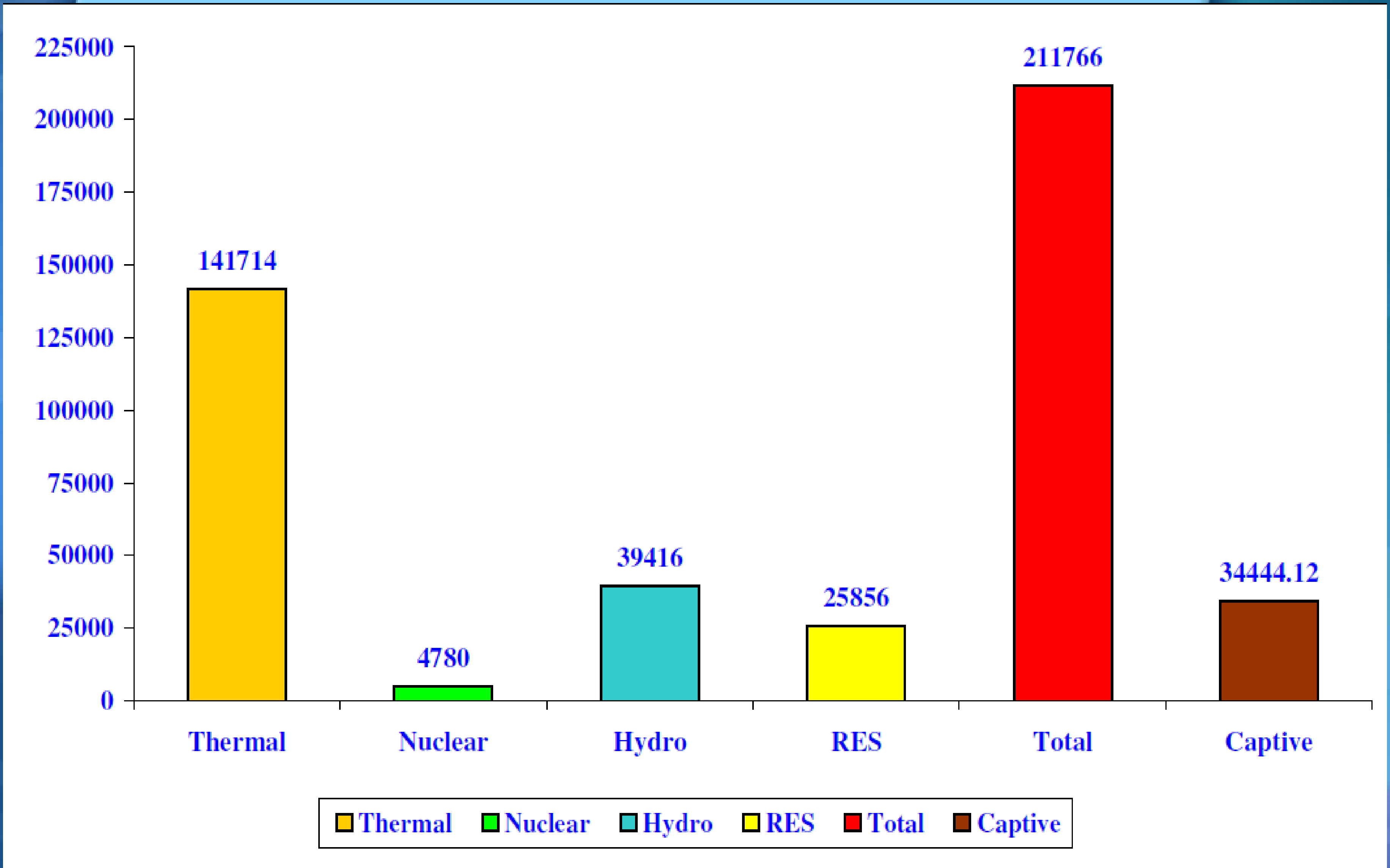
Water Quality Criteria (CPCB)

Designated-Best-use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	**A**	➢ Total Coliforms Organism MPN/100ml shall be 50 or less ➢ pH between 6.5 and 8.5 ➢ Dissolved Oxygen 6mg/l or more ➢ Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	**B**	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less

Water Quality Criteria (CPCB)

Designated-Best-use	Class of Water	Criteria
Propagation of Wild life and Fisheries	**D**	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	**E**	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below E	Not Meeting A, B, C, D & E Criteria

ALL INDIA GENERATING INSTALLED CAPACITY (MW) (As on 31-01-13)



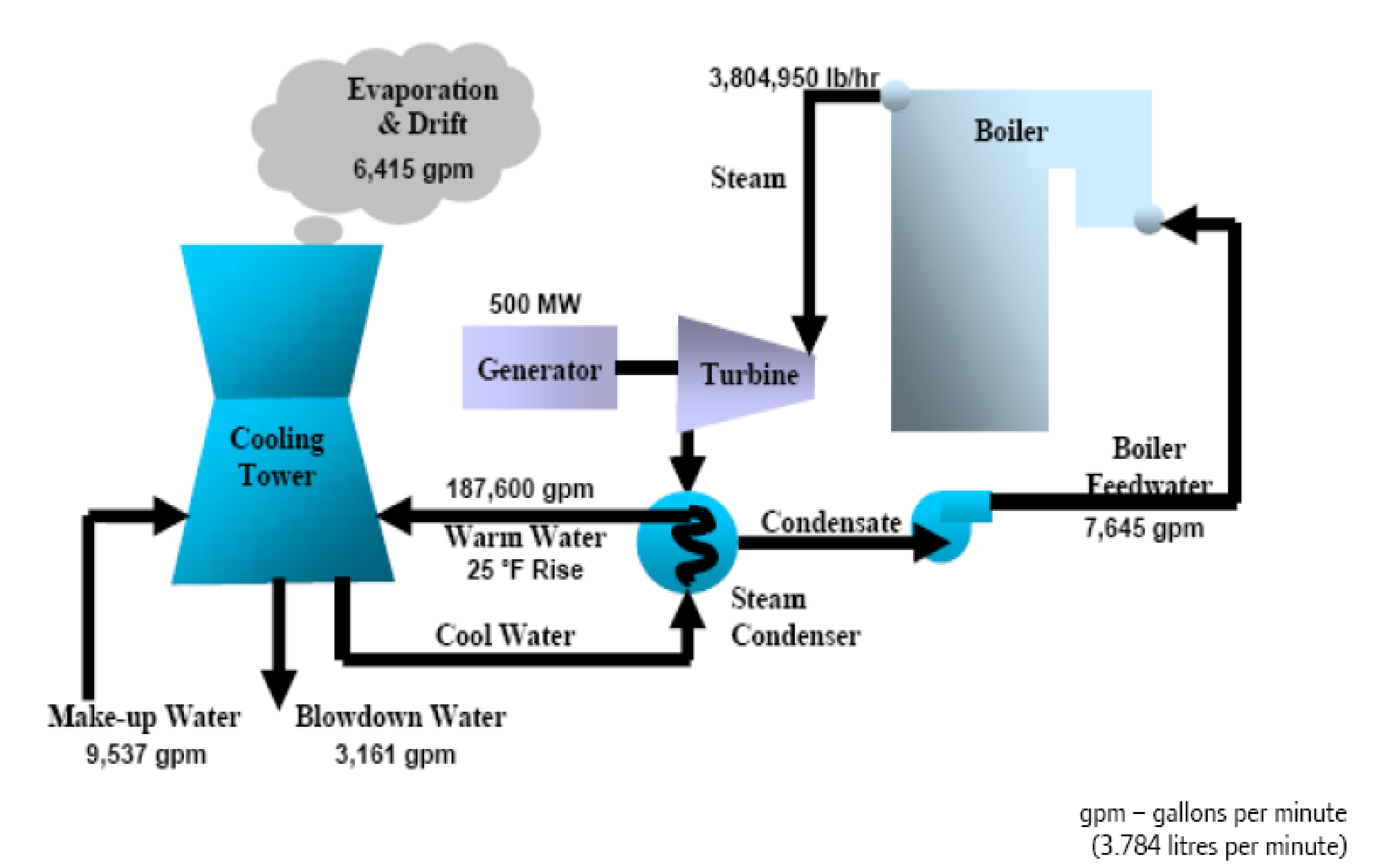
Source CEA

ALL INDIA GENERATING INSTALLED CAPACITY (MW) (As on 31-01-13)

Fuel	MW	%age
Total Thermal	**141713.68**	**66.91**
Coal	121,610.88	57.42
Gas	18,903.05	8.92
Oil	1,199.75	0.56
Hydro (Renewable)	39,416.40	18.61
Nuclear	4,780.00	2.25
RES** (MNRE)	25,856.14	12.20
Total	**2,11,766.22**	**100.00**

Source Mop

Process Flow Schematic for Wet Recirculating Cooling Water System



1 GPM = 0.2271 M3/hour

Water Requirements

Water Requirements for a 500 MW Unit

S.No.	Description	Flow rate GPM	Flow rate M3/Hr
1	Boiler Feed water	7645	1736.18
2	Circulating Water	187600	42603.96
3	Evaporation & Drift	6415	1456.847
4	Make up	9537	2165.853
5	Blow down water	3161	717.8631

Water Requirements for Thermal Power Plants

Power Plant Type	Range m^3/MW
Gas based power plant	1.7 – 2.0
Coal based Plants with total dry ash handling system	3.0 – 3.5
200 MW Coal based Power Plant with once through cooling	3.0 – 3.5
200 MW Coal based Power Plant with cooling towers	4.5 – 5.0
200 MW Coal based Power Plant with ash water recycling	3.5 – 4.0
500 MW Coal based Power Plant with cooling towers	4.0 – 4.5
500 MW Coal based Power Plant with ash water recycling	3.0 – 4.0
110 MW Coal based Power Plant	7.0 – 8.0

Water requirement for different type of Power Plants

Typical Water Requirements of TPS

Area	Quantity m^3/hr with ash water recycling	Consumption m^3/MW	Percentage
Ash Handling	4180	2.0	41.4
Cooling Water	32070	1.5	30.4
DM Water	260	0.13	2.6
Drinking Water (Plant + Colony)	640	0.32	6.3
Coal Handling	130	0.065	1.3
Fire Fighting	476	0.37	4.7
Others	1334	0.66	13.2
Total	**39090**	**5.0**	**100.0**

Water Requirement & Consumption in a 200 MW Coal fired Power Plant

Water Optimization in New Plants

S.No	Description	1 X 500 MW M3/hr	2 X 660 MW M3/hr
1	Evaporation & Drift from CT	1160	2555
2	HVAC System Losses	50	100
3	Potable Water System	70	100
4	Evaporation losses in Ash Dyke	200	570
5	Losses in Cycle make up	42	80
6	Losses in Service Water System	350	300
7	Evaporation Losses in Reservoir	-	100
8	Total Consumptive Water	1872	3805
9	Water for Ash Handling	1410	1650
10	Water recovered in AWRS	1230	1190
11	Additional Make up	180	460
12	Total Water Drawl	33 Cusec (Max)	38 Cusec (Normal) 50 Cusec (Max)

Recycling of Waste Waters

Industrial Water Quality Requirements

There are two water quality drivers that affect the treatment requirements for reclaimed water:

- The regulatory requirements which are typically for the protection of public health and the environment and focus on microbiological parameters.
- The user-specific requirements for the water supply, which in the case of industries is a very specific set of water quality criteria for a given facility.

Existing Standards for Reuse in India

Class	Designated Best Use	Criteria
A	Drinking water source without conventional treatment but after disinfection	Dissolved Oxygen : 6 mg/l or more Biochemical Oxygen Demand : 2 mg/l or less Total Coliform : 50 MPN/100 ml
B	Outdoor bathing (Organised)	Dissolved Oxygen : 5 mg/l or more Biochemical Oxygen Demand : 3 mg/l or less Total Coliform : 500 MPN/100 ml
C	Drinking water source with conventional treatment followed by disinfection	Dissolved Oxygen : 4 mg/l or more Biochemical Oxygen Demand : 3 mg/l or less Total Coliform : 5000 MPN/100 ml
E	Irrigation, industrial cooling and controlled waste disposal	Electrical Conductivity : 2250 mhos/cm Sodium Absorption Ratio: 26 Boron : 2 mg/l

Source DJB

Proposed Water Quality for Reuse

User	Required Water Quality	Indian Standard
Agricultural	Irrigation	E
Domestic	Public access	C
Industrial	Per industry requirements	Negotiate w/ industries
Groundwater recharge	Indirect potable	E
Reservoir Recharge	Indirect potable	C

Source DJB

International Reuse Guidelines

WHO

- 1989 Guidelines for the safe use of wastewater in agriculture and aquaculture
- Guidelines for safe recreational water environments
- Guidelines for drinking-water quality

US EPA

- Reuse Guidelines – 1992, 2004 & 2012
- Safe Drinking Water Act

Recycling of Waste Waters

Regulatory Requirements

In addition to the specific constituent limits established by the Title 22 criteria, which are only for total coliform, there are also best practices that must be employed for specific uses. Title 22 defines the water quality/treatment technology criteria applied to reclaimed water for industrial uses under two general categories:

- Disinfected secondary-23 recycled water (secondary-23 recycled water)
- Disinfected tertiary recycled water (tertiary recycled water)

Recycling of Waste Waters

Regulatory Requirements

(California Water Recycling Criteria, Title 22 California Code of Regulations (Title 22))

Type of Use	Total Coliform Limits	Treatment Required
▪ Cooling water where no mist created ▪ Process water where no worker contact ▪ Boiler feed ▪ Mixing concrete	▪ ≤ 23/100 ml[1] ▪ ≤ 240/100 ml (max in any 30-day period)	▪ Secondary ▪ Disinfection
▪ Cooling water where mist created[2] ▪ Process water where worker contact likely	▪ ≤ 2.2/100 ml[1] ▪ ≤ 23/100 ml (max in any 30-day period)	▪ Secondary ▪ Coagulation[3] ▪ Filtration ▪ Disinfection

Source: Adapted from State of California [2000a].
1 Based on running 7-day median; daily sampling is required.
2 Drift eliminator required; chlorine or other biocide required to treat cooling water to control *Legionella* and other microorganisms.
3 Not required under certain conditions.

Recycling of Waste Waters

User-Specific Requirements

The total coliform limits imposed by the Title 22 regulations are the regulatory criteria assumed for all Minnesota industrial reclaimed water uses. The other water quality criteria that will drive the treatment process selection will vary with the specific use of the water. These use-specific criteria do not need to meet a regulatory permit limit, but would likely be listed as site-specific water quality standards in a user agreement.
Generalized water quality limits for various industrial uses are provided in Table. While this is a limited list, it is the mid-range of quality expected for use by each industry group listed. Industries such as sand and gravel washing operations would have less stringent criteria, while electronics production typically requires much more stringent criteria.

Basis for Water Reuse

- None of the current regulations directly prohibit the use of reclaimed water as power plant cooling water.

U.S. Environmental Protection Agency published "Guidelines for Water Reuse" for the benefit of utilities and regulatory agencies (USEPA, 2004) (updated in 2012). "Guidelines for Water Reuse" provides an overview of (1) types of reuse applications, (2) related technical issues, (3) water reuse regulations/guidelines established by each state, (4) legal and institutional issues, (5) funding water reuse systems, (6) public involvement programs, and (7) water reuse in other countries. For those states having no water reuse regulations/guidelines, the USEPA guideline document provides suggestions about treatment, reclaimed water quality, reclaimed water monitoring, and minimal distance between wastewater source and public area.

Basis for Water Reuse

Summary of reclaimed water quality when used in cooling water system (USEPA, 2004)

System	Treatment	pH	BOD_5	TSS	Fecal Coliform	Cl_2 Residue
Once-through cooling	Secondary, disinfection	6-9 (monitored weekly)	30 mg/l (monitored weekly)	30 mg/l (monitored daily)	•200/100 mL (weekly median, monitored daily) •800/100 mL (max)	1 mg/l (minimum, monitored continuous)
Re-circulating cooling towers	Secondary, disinfection (chemical coagulation and filtration may be needed)	6-9 (variable depends on recirculation ratio)				

Control of Air Emissions

• Aerosols are the major concern for cooling tower emissions

• In National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations," (EPA, 2005), cooling towers are categorized as potential point sources of pollutants emission with volatile organic compounds, PM10, PM2.5, and NH3

• Possible issues with emissions of concentrated metal and chemicals

Blow down Management for Use of Impaired Waters in Cooling Systems

Management of cooling tower blow down is one of the key components of cooling tower operation and requires significant attention due to important economic and environmental implications. Due to fairly low water quality, blow down is typically subjected to some treatment in order to meet local, state or federal discharge requirements that are governed by the final disposal options. Management or disposal options available for cooling tower blow down depend mainly on its quality, local discharge regulations and capabilities of treatment processes under consideration. Typical options for power plant blow down management include:

• Discharge to surface waters. This is the main option for once-through cooling systems that is not feasible for recirculating cooling systems because of the low blow down quality.
• Discharge to wastewater treatment plants (WWTPs): This is probably the most cost effective management alternative but may not be feasible for many plants since the WWTP may not accept the blow down without any pre-treatment due to extremely high solids and presence of other chemicals in the blow down that were added to control corrosion, scaling and biofouling.

Blow down Management for Use of Impaired Waters in Cooling Systems

- Zero liquid discharge (ZLD): Zero liquid discharge means that blow down is treated and used internally in power plant. This alternative involves extensive treatment of blow down to facilitate its reuse combined with some form of volume reduction to minimize or eliminate the need for liquid discharge. Most power plants using reclaimed water for their recirculating cooling systems would choose ZLD as the main blow down management option.

Compared to other discharge options, ZLD is preferred as it helps to decrease environmental impacts of power generation. ZLD typically includes one or more of the following advanced treatment technologies: (1) Lime-soda ash softening; (2) Reverse osmosis (RO); (3) Electrodialysis (ED); and (4) Evaporation.

Waste Water for Cooling Water System

Before making any plans to convert an existing cooling tower water system to recycled water these questions need to be addressed:

1 What is the cost of recycled water versus fresh water?
2 Will the recycled water need further treatment to be acceptable? If so, what costs are involved?
3 What is the cost to bring the recycled water to the cooling tower water system from your "fence" line?
4 Will the water treatment cost of the cooling tower be increased or decreased with recycled water versus current and how much?
5 Are additional water monitoring or feed systems needed and what are their costs?
6 Can you expect equal, poorer, or better protection of the cooling water contacted equipment when on recycled water?
7 Is there any danger to using recycled water such as the potential for pathogens?

EPRI Guidelines for Cooling Waters

Water Quality		EPRI Guidelines	Remarks
Parameter	Units		
Ca	Mg/l CaCO3	900 (max)	
Ca X SO_4	$(Mg/l)^2$	500000	
M Alkalinity	Mg/l CaCO3	30 – 50 220 - 250	Without Scale Inhibitor With Scale Inhibitor
Mg X SiO_2	Mg/l CaCO3 X Mg/l SiO2	35000	
SO_4	Mg/l		
SiO_2	Mg/l	150	
PO_4	Mg/l		
Fe (Total)	Mg/l	< 0.5	
Mn	Mg/l	< 0.5	

Cu	Mg/l	< 0.1	
Al	Mg/l	< 1	
S	Mg/l	5	< 0.25 ppm for Copper Alloys
NH_3	Mg/l	< 2	For copper based alloys present in the system
pH		6.0 – 7.2 7.8 – 8.4	Without Scale Inhibitor With Scale Inhibitor (Higher operating pH is possible with new alkaline treatments)
TDS	Mg/l	70000	
TSS	Mg/l	< 100 < 300	For Film type Fill Splash type Fill
BOD	Mg/l		
COD	Mg/l		
LSI		< 0	
RSI		> 6	
PSI		> 6	

Desirable: BOD < 5 ppm, Turbidity < 2 NTU, Sulphide < 0.1 ppm (for Cu based systems), Chloride < 200 ppm for SS 304 (up to 500 ppm short duration & < 500 ppm for SS 316 (3000 ppm short duration)

CONCLUSIONS

For using recycled waste water as make up to Cooling Tower following needs to considered:

- The recycled water should be at-least treated to the Secondary level, however; in many instances tertiary treatment may be necessary.
- Applicable Environmental Norms for use recycled water and final disposal of blow down water are to be followed.
- The quality of the recycled water needs to be ascertained for use in Cooling Water System so as to avoid Scaling, Fouling, Corrosion & Biofouling in the system and site-specific chemical treatment need to be adopted.
- Materials for handling recycled water need to be properly selected as per recycled water quality.
- Preferably online monitoring of Corrosion, Fouling & Biofouling to be used.

OVERVIEW OF TATA STRATEGIC

- Founded in 1991 as a division of Tata Industries Ltd.
- The largest Indian owned Management Consulting firm
- About **70** member strong Consulting Team
- Supported by a panel of domain experts
- Growing client base outside India
- **500+ engagements, 100+ clients**, across countries, across sectors
- Increasing presence outside the Tata Group & India
  - **50+%** revenue outside Tata Group
  - **20%** revenue outside India

OFFERINGS OF TATA STRATEGIC

Set Direction

Strategy

- Vision
- Market insights
- Growth Strategy/Business Plans
- Scenario Planning
- India Entry
- Alliance & Acquisition Planning
- Strategic due diligence
- Manufacturing Strategy

Drive Strategic Initiatives

Organization Effectiveness

- Organization Structure
- Corporate Center Design
- Roles & Decision rules
- Culture Transformation
- Performance Management
- Capability Assessment
- Talent Management

Marketing & Sales

- Revenue Enhancement
- Product Innovation
- Market Share Growth – Rural/Urban
- Dealer Effectiveness
- Sales Effectiveness

Operations

- Supply Chain Optimization
- Throughput enhancement
- Superior Fulfillment
- Project Excellence
- Procurement Transformation
- Strategic Cost Reduction
- Energy/Water Management

Support Implementation

Implementation

- Implementation Plan
- Program Management
- Refinements/Course Corrections

INDUSTRY DOMAINS AND FUNCTIONAL AREAS OF TATA STRATEGIC

Industry Domains

Auto

Engineering

Infrastructure & EPC

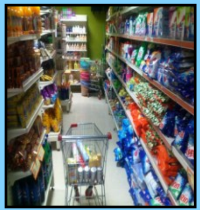
Technology

Education

Healthcare

Durables

FMCG



Retail

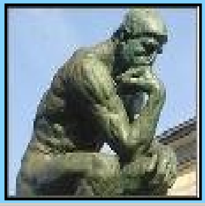
Hospitality & Tourism

Chemicals

Energy

Functional Areas

Strategy



Organizational Effectiveness

Delivery Excellence

Logistics

Sourcing

Sustainability

Conserve Resources

Thank You

Schedule-I: Standards for Emission or Discharge of

Environmental Pollutants from various Industries

Thermal Power Plants

S.No	System	Parameter	Standard
1	Condenser Cooling waters (once through cooling system)	pH	6.5 – 8.5
		Temperature	Not more than 5oC higher than the intake water temperature
		Free available chlorine	0.5 ppm
2	Boiler blow downs	Suspended solids	100 ppm
		Oil and Grease	20 ppm
		Copper (total)	1 ppm
		Iron (total)	1 ppm

Schedule-I: Standards for Emission or Discharge of *Environmental Pollutants from various Industries*

Thermal Power Plants

S.No	System	Parameter	Standard
3	Cooling tower blow down	Free available chlorine	0.5 ppm
		Zinc	1.0 ppm
		Chromium (total)	0.2 ppm
		Phosphtate	5.0 ppm
		Other corrosion inhibiting material	Limit to be established on case by case basis by CPCB in case of Union territories and SPCB in case of States.
4	Ash pond effluent	pH	6.5 – 8.5
		Suspended solids	100 ppm
		Oil and Grease	20 ppm