Water Efficiency in Thermal power Sector:

An Outline of Cooling Technology in India

Speaker: Kalyan Bhattacharya, Vice President – E & BD
Paharpur Cooling Towers Ltd, Kolkata, INDIA

Introduction:

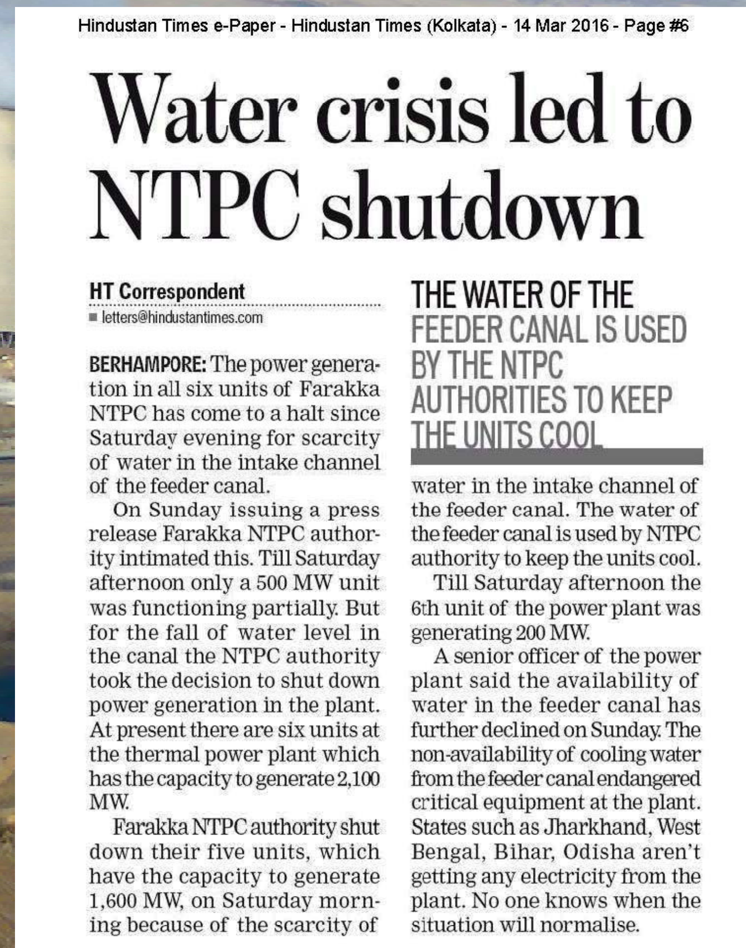
- Water is one of the vital inputs for thermal power generation.
- Water has the **highest specific heat** amongst all materials available in abundance, hence, ideal as cooling fluid. (Sp Heat of Water = 1 Kcal/Kg deg C)
- In addition, water can be used to reject heat by evaporative cooling process. The latent heat of vaporisation of water is approximately 555 Kcal/Kg.
- Process cooling in the **condenser**, **ash disposal**, removal of heat generated in plant **auxiliaries** and various other activities require water.
- Large coal based Power Plants are likely to come up in future.
- Difficulties are already being faced in existing thermal power plants due to **non-availability of water** and expected to be **aggravated in future** with more coal fire TPP coming up.

Water Insufficiency issues of Existing Plants:

NTPC's 2100 MW Farakka STPP in West Bengal has come to a halt due to falling water level in the Feeder Canal. This is in the news and the crisis is continuing.

Effect is being felt in Jharkhand, Orissa, Bihar and West Bengal.

Non-availability of water is encountered in existing Power Plants which are situated in coal bearing states like Orissa, Jharkhand and Chhattisgarh.



Hindustan Times e-Paper - Hindustan Times (Kolkata) - 14 Mar 2016 - Page #6

Water crisis led to NTPC shutdown

HT Correspondent
letters@hindustantimes.com

BERHAMPORE: The power generation in all six units of Farakka NTPC has come to a halt since Saturday evening for scarcity of water in the intake channel of the feeder canal.

On Sunday issuing a press release Farakka NTPC authority intimated this. Till Saturday afternoon only a 500 MW unit was functioning partially. But for the fall of water level in the canal the NTPC authority took the decision to shut down power generation in the plant. At present there are six units at the thermal power plant which has the capacity to generate 2,100 MW.

Farakka NTPC authority shut down their five units, which have the capacity to generate 1,600 MW, on Saturday morning because of the scarcity of water in the intake channel of the feeder canal. The water of the feeder canal is used by NTPC authority to keep the units cool.

Till Saturday afternoon the 6th unit of the power plant was generating 200 MW.

A senior officer of the power plant said the availability of water in the feeder canal has further declined on Sunday. The non-availability of cooling water from the feeder canal endangered critical equipment at the plant. States such as Jharkhand, West Bengal, Bihar, Odisha aren't getting any electricity from the plant. No one knows when the situation will normalise.

THE WATER OF THE FEEDER CANAL IS USED BY THE NTPC AUTHORITIES TO KEEP THE UNITS COOL

Consumption Areas of Water in Power Plant:

Water is used in almost all areas/ facilities of thermal power stations in one way or other. A typical list of plant systems/ applications requiring consumptive water is indicated as below:

- Cooling water system (Condenser & ACW)
- Ash handling system
- Power cycle make up
- Coal dust suppression system
- Service water system
- Potable water system
- Gardening
- Evaporation from raw water reservoir

Typical Water Consumption Figures

Plant water consumption is governed by a number of factors such as :
Quality of raw water, type of condenser cooling system, Quality of coal, Ash utilization, Type of ash disposal system, Waste water management aspects etc.

In the past, power stations were designed with water systems having liberal considerations and high design margins.
The consumptive water requirement for coal based plants with cooling towers used to be about **7 m3/h per MW**

In recent times, plants have been designed with reduced Plant water consumption rate in the range **3.5 - 4 m3/h per MW**

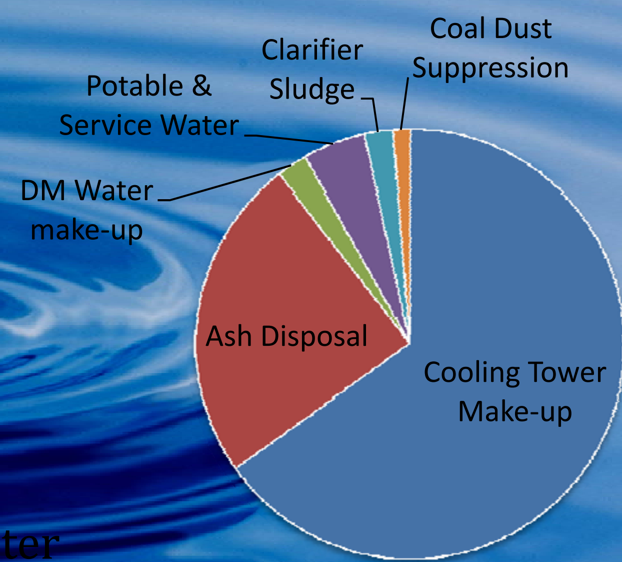
Water consumption of a typical Coal Based TPP

Water consumption of a typical 2x660 MW TPP is given below (As per recent design)

@ 4 m3/h per MW

Cooling tower make up :	4550
Ash disposal :	1700*
DM water make up :	160
Potable & service water :	330
Clarifier sludge etc. :	150
Coal dust suppression :	90
Total :	5280*

*Ash Water to be tapped from CT blow down water



MoEF Notification:

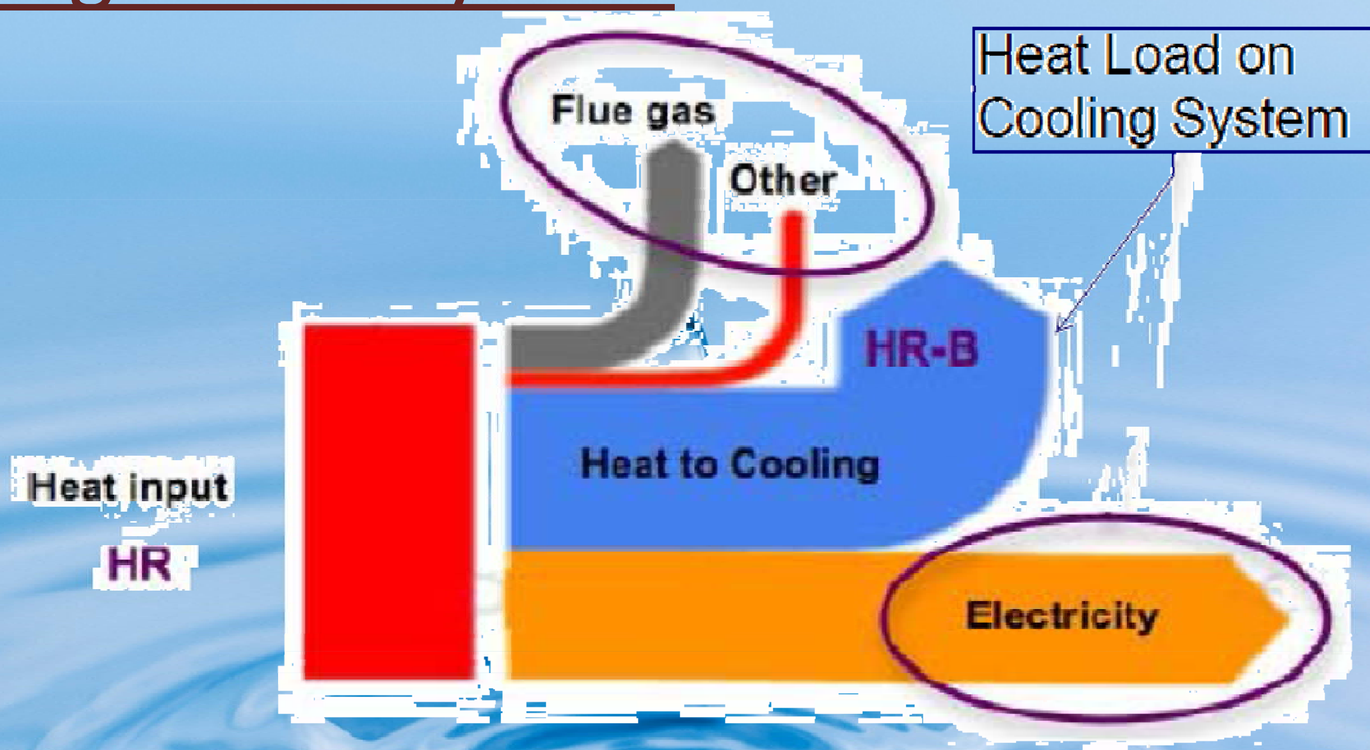
Ministry of Environment, Forest and Climate Change (MoEF) in its recent notification dated December 07, 2015 on **Environment (Protection) Amendment Rules, 2015** have notified the following:

I. All plants with Once Through Cooling (OTC) shall install Cooling Tower (CT) and achieve specific water consumption upto maximum of 3.5m3/MWh within a period of two years from the date of publication of this notification.

II. All existing CT-based plants shall have to reduce specific water consumption upto maximum of 3.5m3/MWh within a period of two years from the date of publication of this notification.

III. New plants to be installed after 1st January, 2017 shall have to meet specific water consumption upto maximum of 2.5 m3/MWh and achieve zero waste water discharged

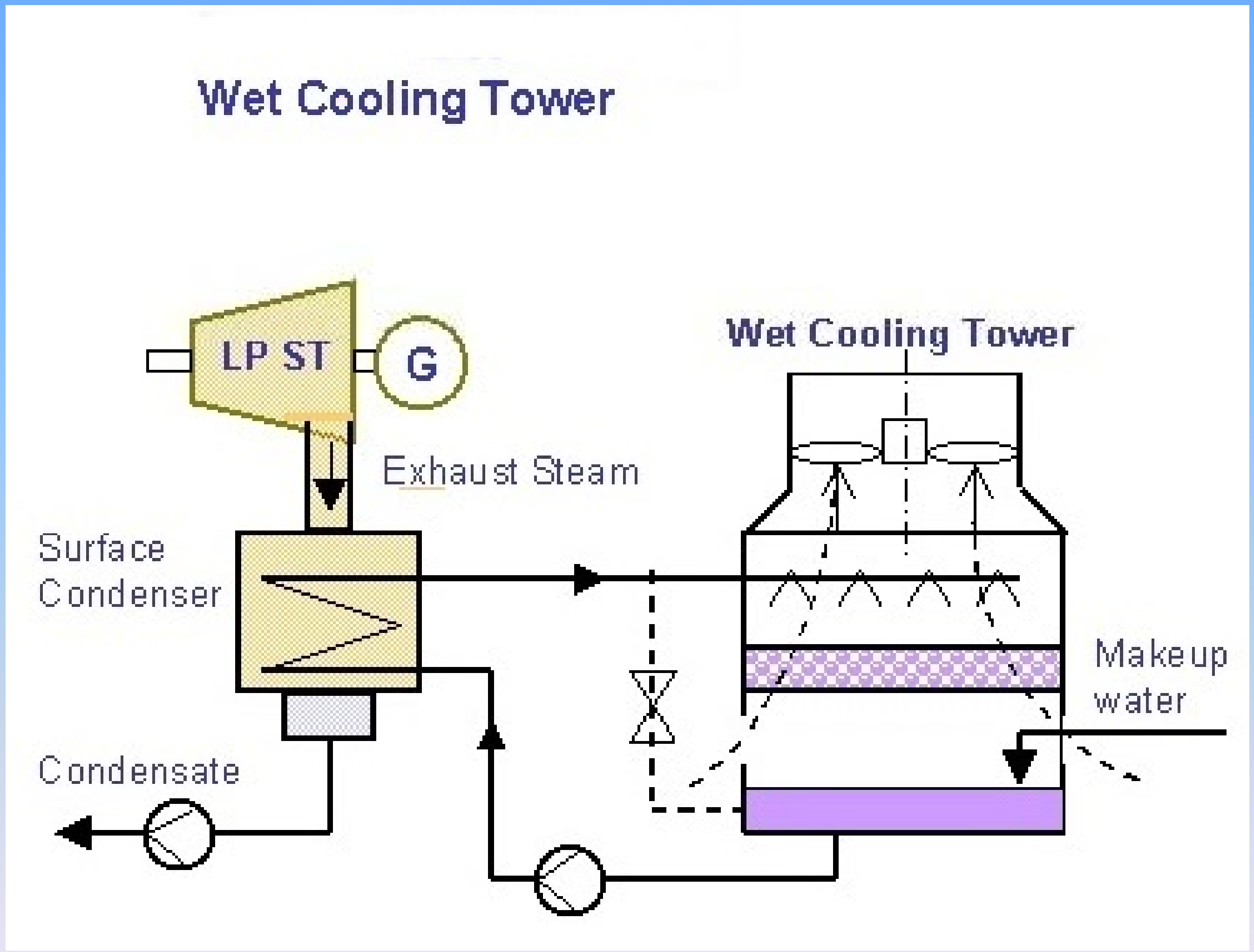
Cooling Water System:



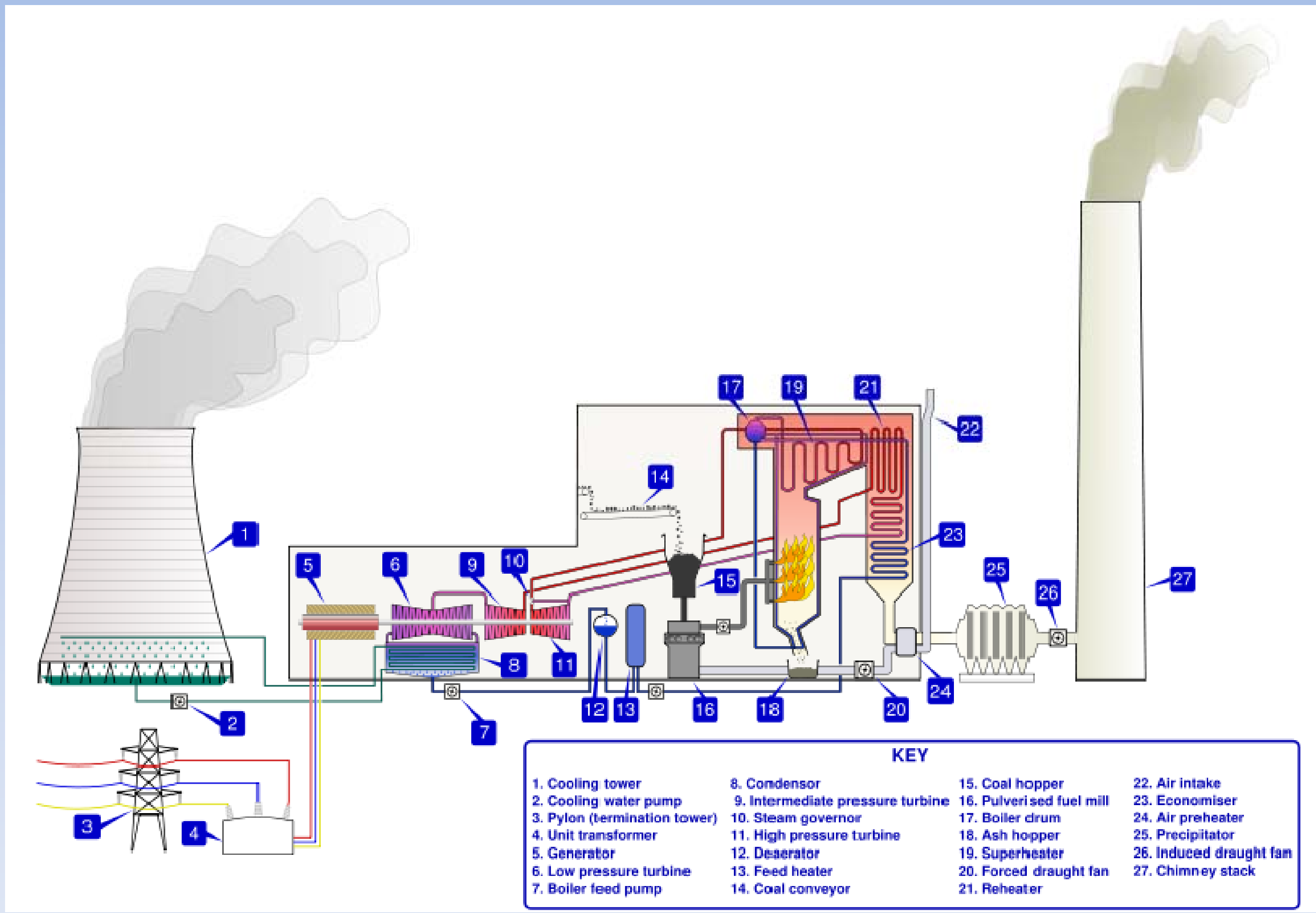
Cooling Systems in Practice in India:

1. Cooling Tower (IDCT / NDCT) – Wet Cooling
2. Air Cooled Condenser – Dry Cooling
3. Once Through Cooling – To be replaced as per Dec 7, 2015 Notification

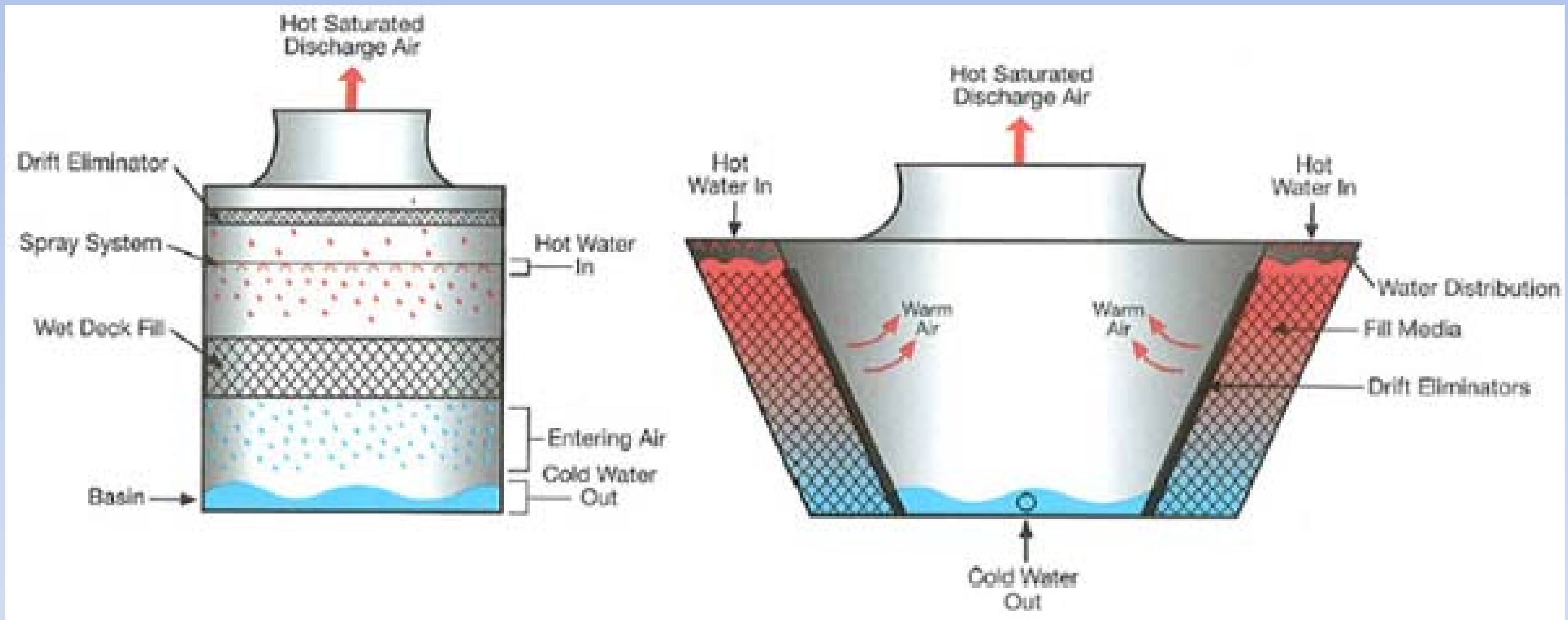
Wet Cooling System:



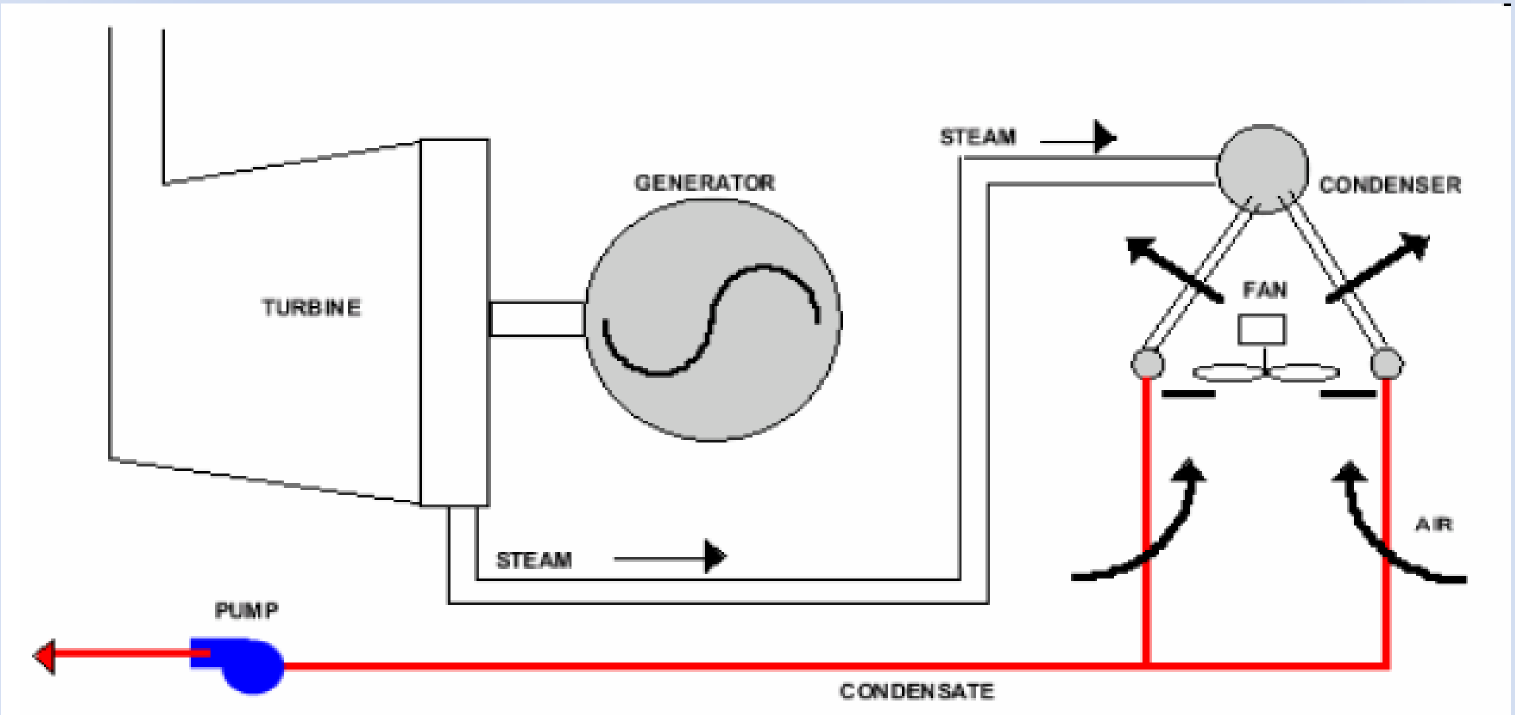
Natural Draught Cooling Tower



Induced Draught Cooling Towers

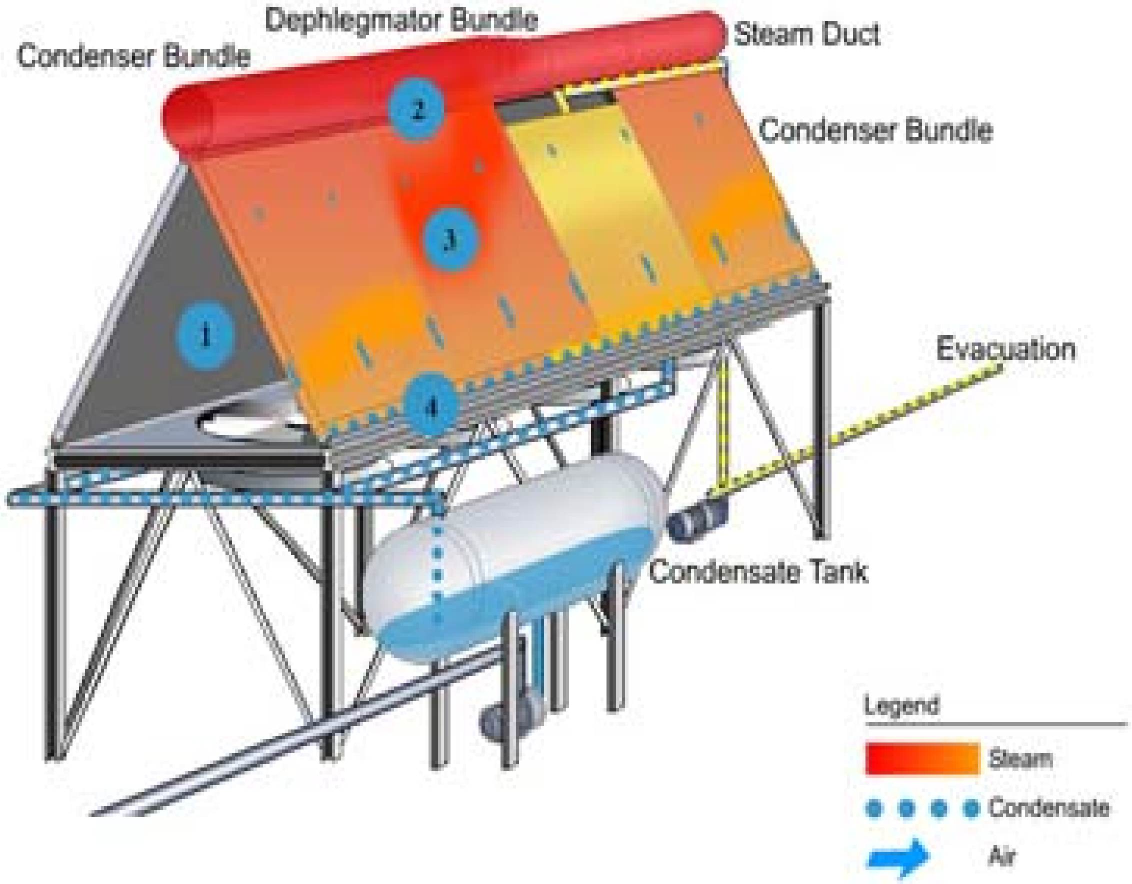


Dry Cooling System

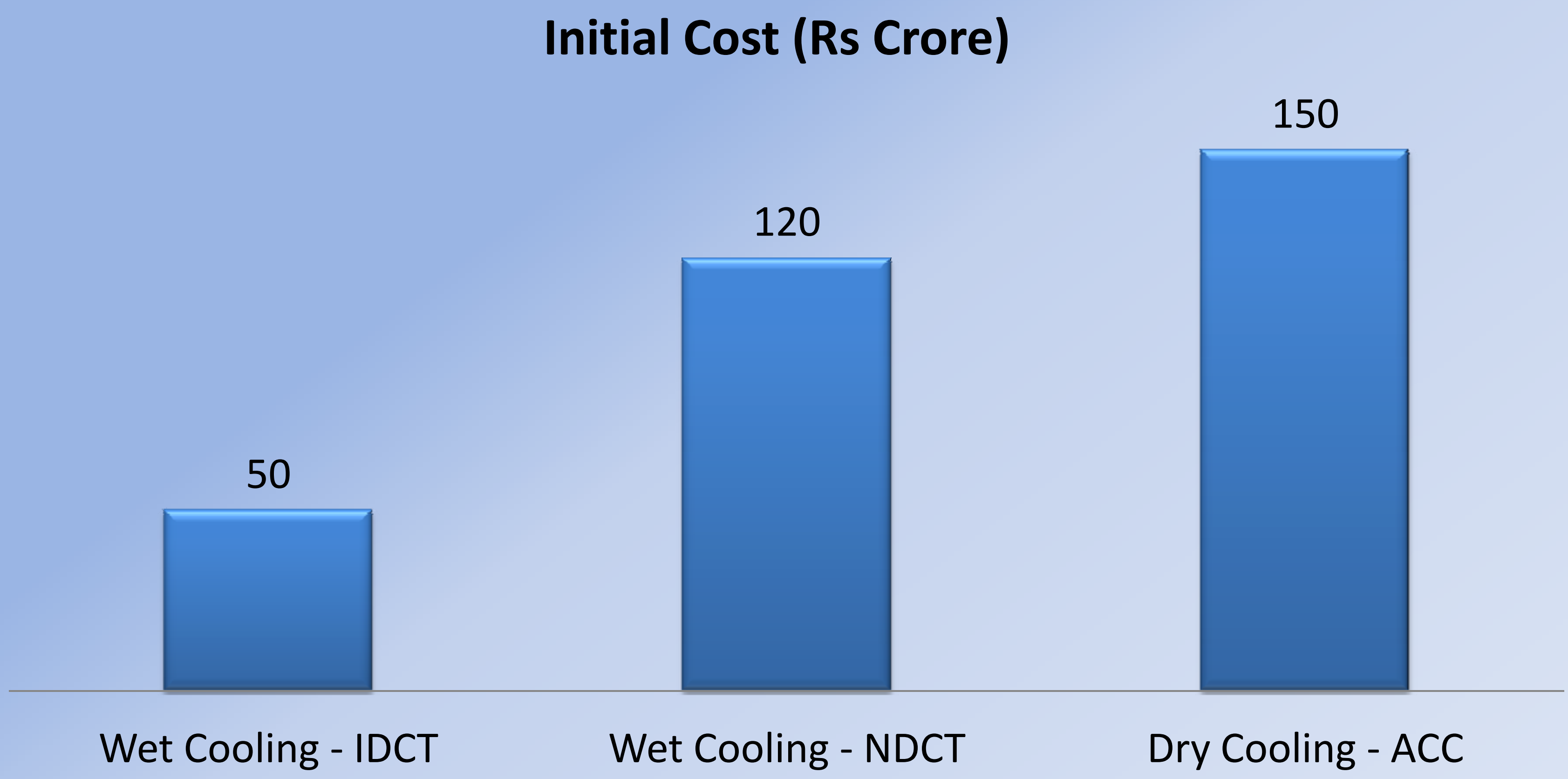


Air Cooled Condenser

Air Cooled Condenser

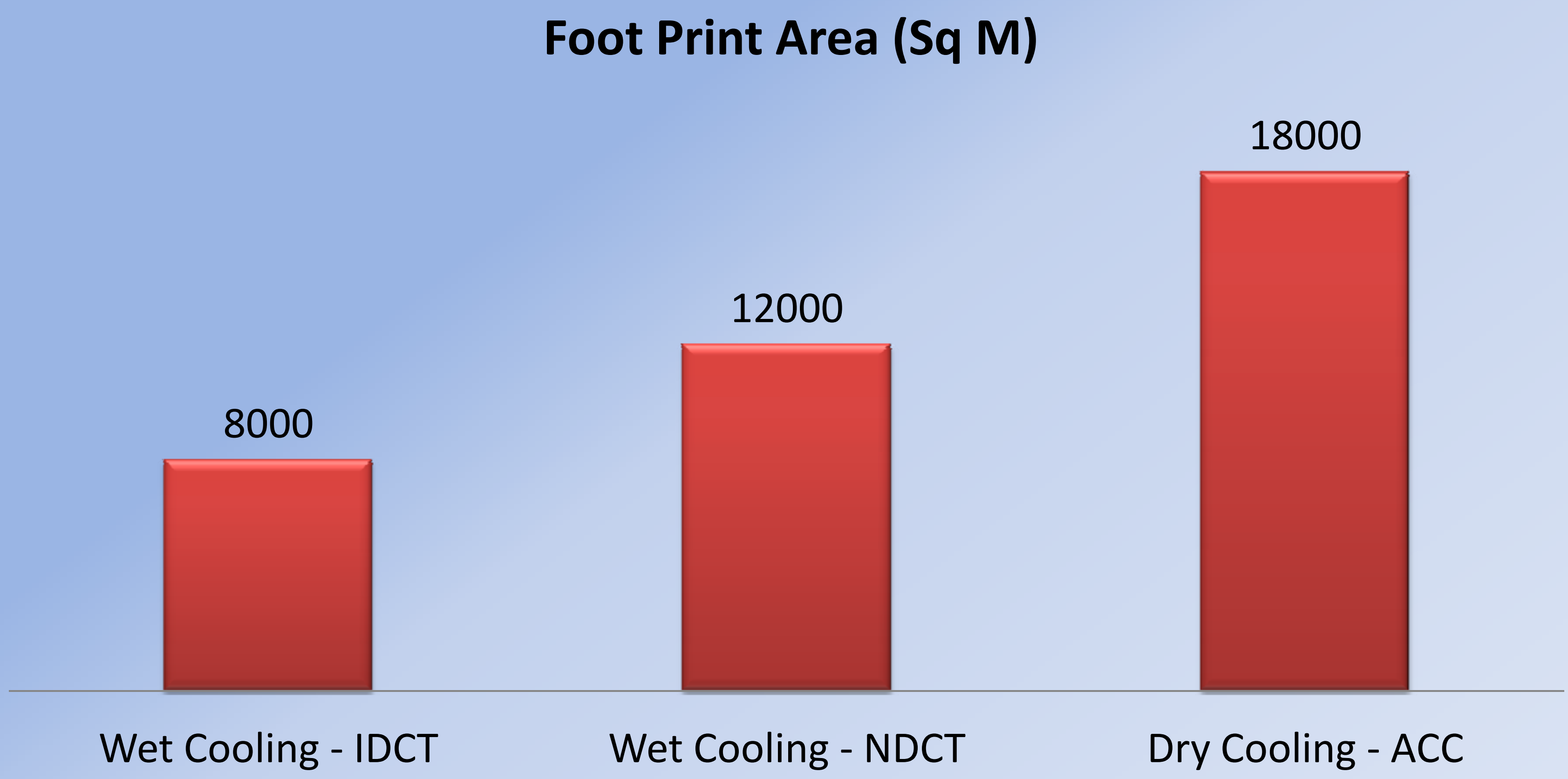


Economics of Dry Cooling vs Wet Cooling System



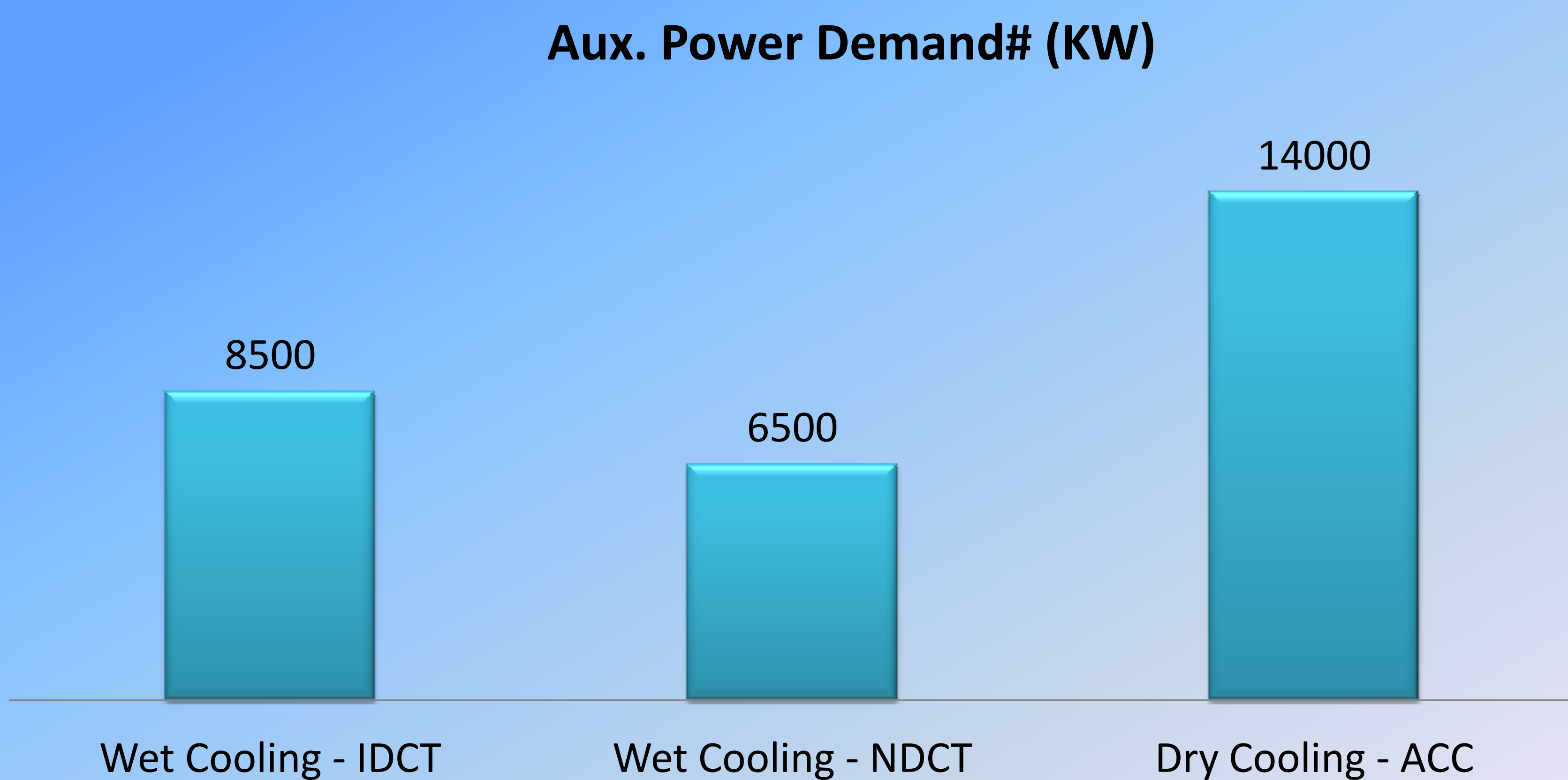
For a typical 660 MW Coal Based TPP

Space Requirement of Dry Cooling vs Wet Cooling System(NDCT & IDCT)



For a typical 660 MW Coal Based TPP

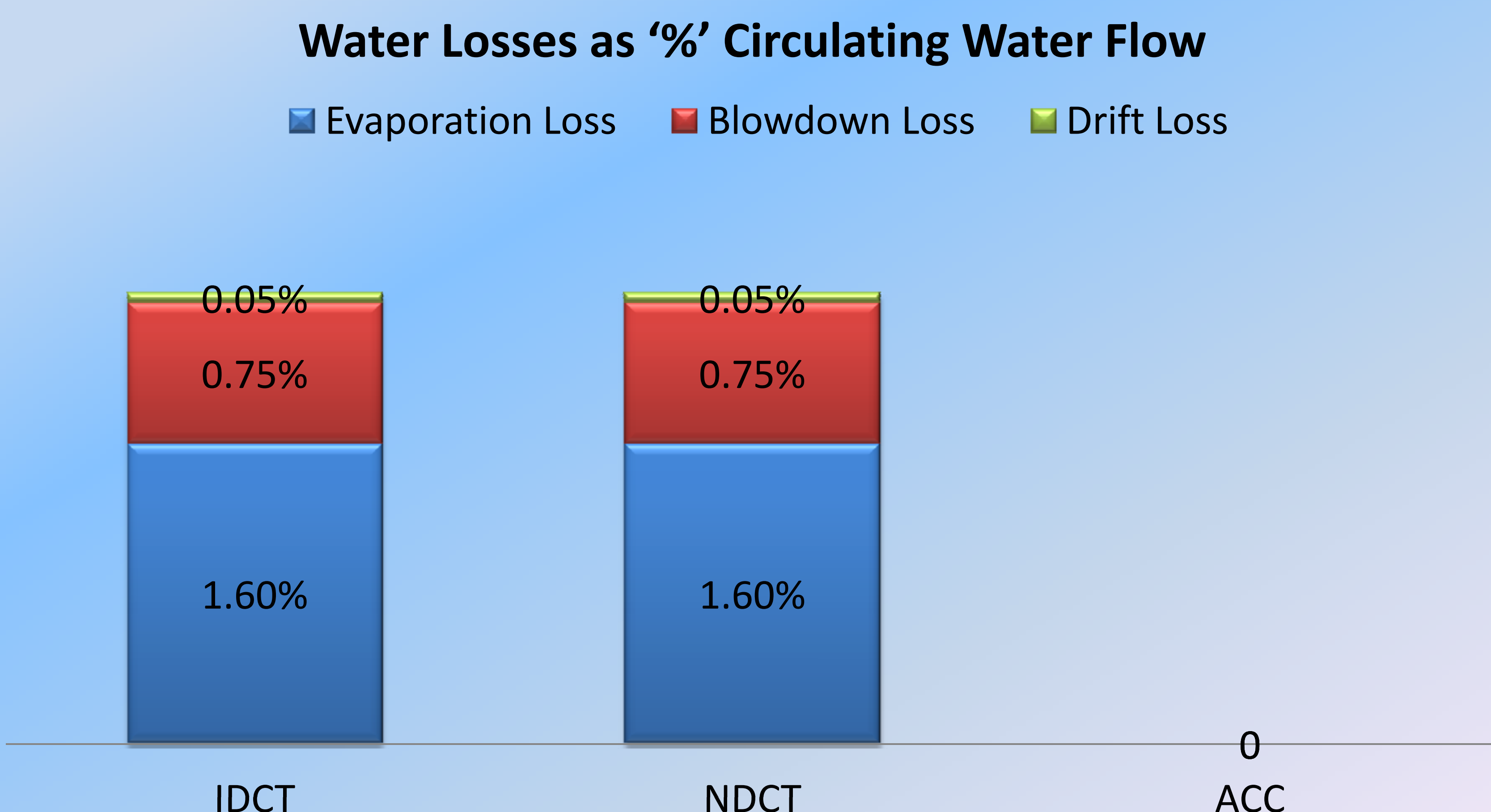
Power Consumption of Dry Cooling vs Wet Cooling System



For a typical 660 MW Coal Based TPP

#CW Pump Power included for IDCT & NDCT.

Water Consumption Comparison of Dry Cooling vs Wet Cooling System



For a typical 660 MW Coal Based TPP

Water Conservation Techniques for CW System

- **Replace Once Through Cooling System with Cooling Towers / Air Cooled Condensers**

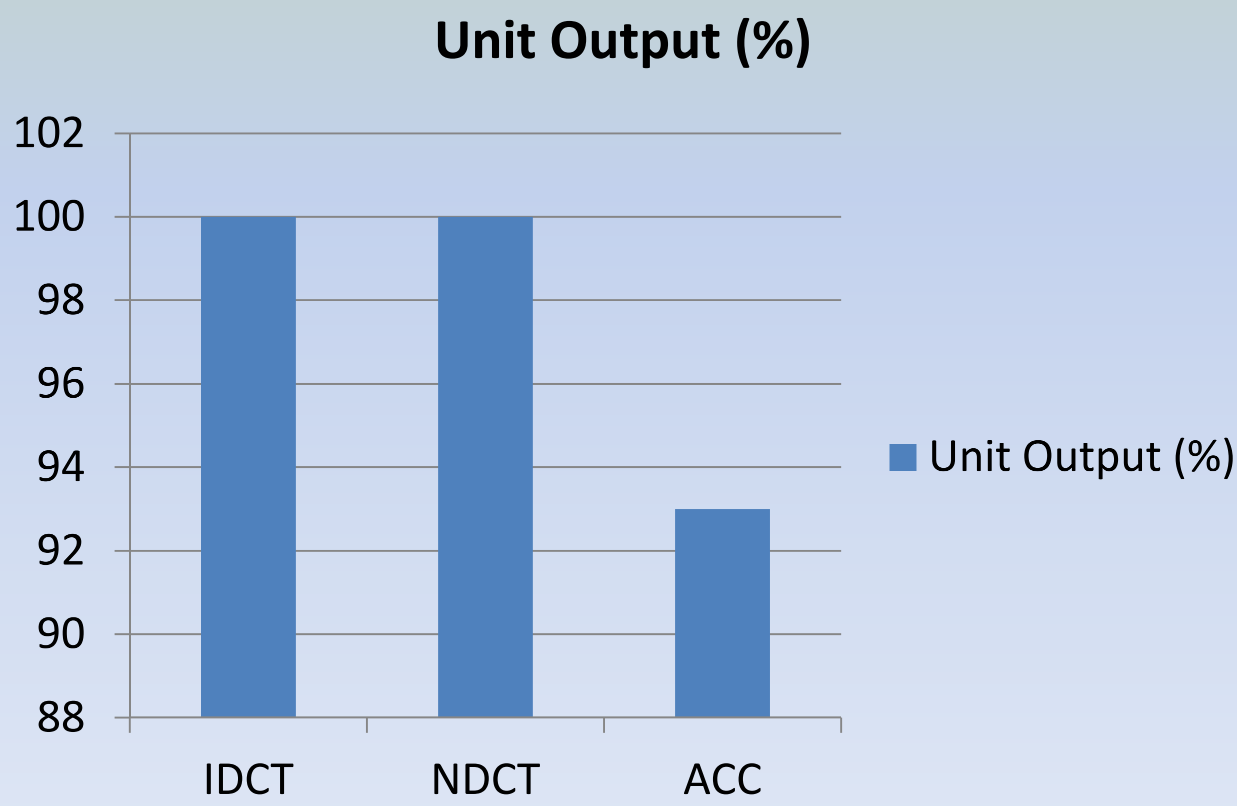
- **Implementation of High operating COC (Cycles of Concentration) to reduce the blow-down loss**

  Increasing COC to 5 from COC=3.0, Blow-down loss will reduce by 50%.

- **Installation of Air Cooled Condensers**

Techno- economics of Dry & Wet Cooling Systems

As compared to wet cooling system, dry condenser cooling system results in reduction of unit output by about 7%



Techno- economics of Dry & Wet Cooling Systems

The heat rate of the unit with dry condenser cooling system is higher by about 7% in accordance with reduced output as indicated.

Heat Rate on ACC ↑ 7%

In terms of efficiency, thermal efficiency of the plant shall reduce by about 2.5 percentage points

Plant Thermal efficiency with dry Cooling system ↓ 2.5%

Techno- economics of Dry & Wet Cooling Systems

Specific coal consumption of the unit shall increase by about 7%.

Specific coal consumption with dry Cooling system

7%

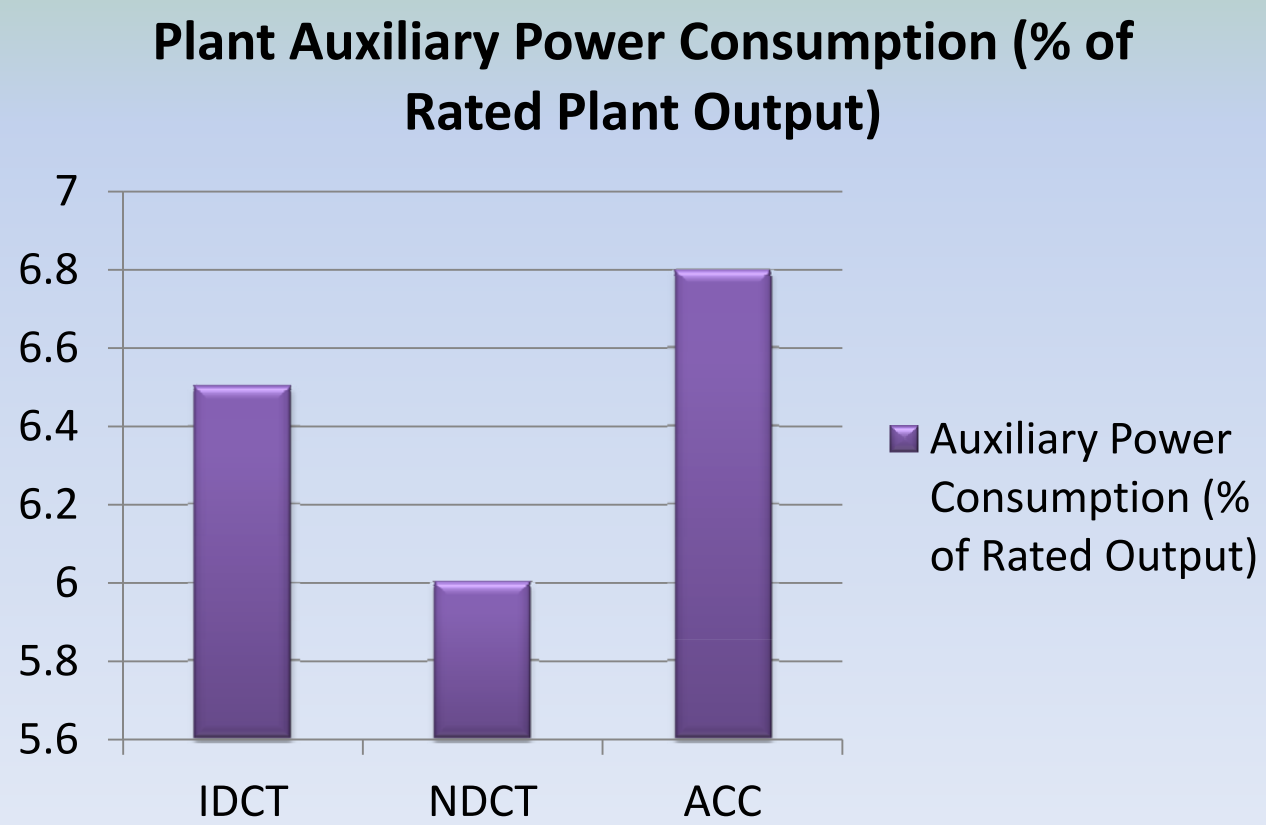
Typical CO_2 emission from the plant shall also increase by about 7% (from 0.9 kg/kWh to 0.96 kg/kWh) with dry cooling system as compared to wet cooling system.

Specific CO_2 emission with dry Cooling system

7%

Techno- economics of Dry & Wet Cooling Systems

For a conventional 660 MW unit, Aux Power Consumption is 6.5 % with IDCT, 6 % with NDCT based CW system and 6.8 % of gross output for plant with direct cooling air cooled condensers



Techno- economics of Dry & Wet Cooling Systems

- Cost for plant with wet cooling system as ` 5 crore/MW, the cost of the plant with dry cooling system would vary from ` 5.5 to 5.7 crore/MW

Cost of Plant with dry Cooling system 10%

- The levelised tariff is expected to increase by about 8- 9% over base levelised tariff for plant with dry Cooling system

Levelised Tariff with dry Cooling system 8-9%

Key Findings

- Dry condenser cooling system can be considered for the sites where availability of water is very scarce. In such case, the requirement of plant consumptive water shall reduce by about 80%.
- However, for typical Indian conditions, dry cooling system shall result in reduction of plant output by about 7% and correspondingly, gross heat rate shall increase by 7%.
- The capital cost per MW of the plant, shall increase by about 10%.

#These are indicative values

Conclusion

Dry cooling systems, as such, are costly technologies and are not comparable to wet cooling system on techno economic considerations.

However, for sites where water availability is scarce or unreliable, dry cooling system using air-cooled steam condenser offers the only solution for power plant installation.

When we are discussing changeover from once-through cooling system to a cooling tower system, there is no point in considering a dry cooling system as the need for this changeover is to reduce the water requirement and not eliminate it completely. And, it is safe to pre-suppose that, if the plant was working on once through system abundant water is available.

Conclusion (Cont.)

In such changeover cases, it is important to tailor the dimensions of the cooling tower to suit the available space as experience shows that the existing power plants are likely to be very tight on open space. It is also important to select cooling towers which can be installed quickly as the time permitted by the Ministry of Environment for the changeover is short (it has to be implemented within 6th December 2017).

To meet these requirements, it is our considered recommendation that you look seriously at cooling towers with pultruded FRP or treated wood structure.


Thank you!