
# ACC User Group Presentation

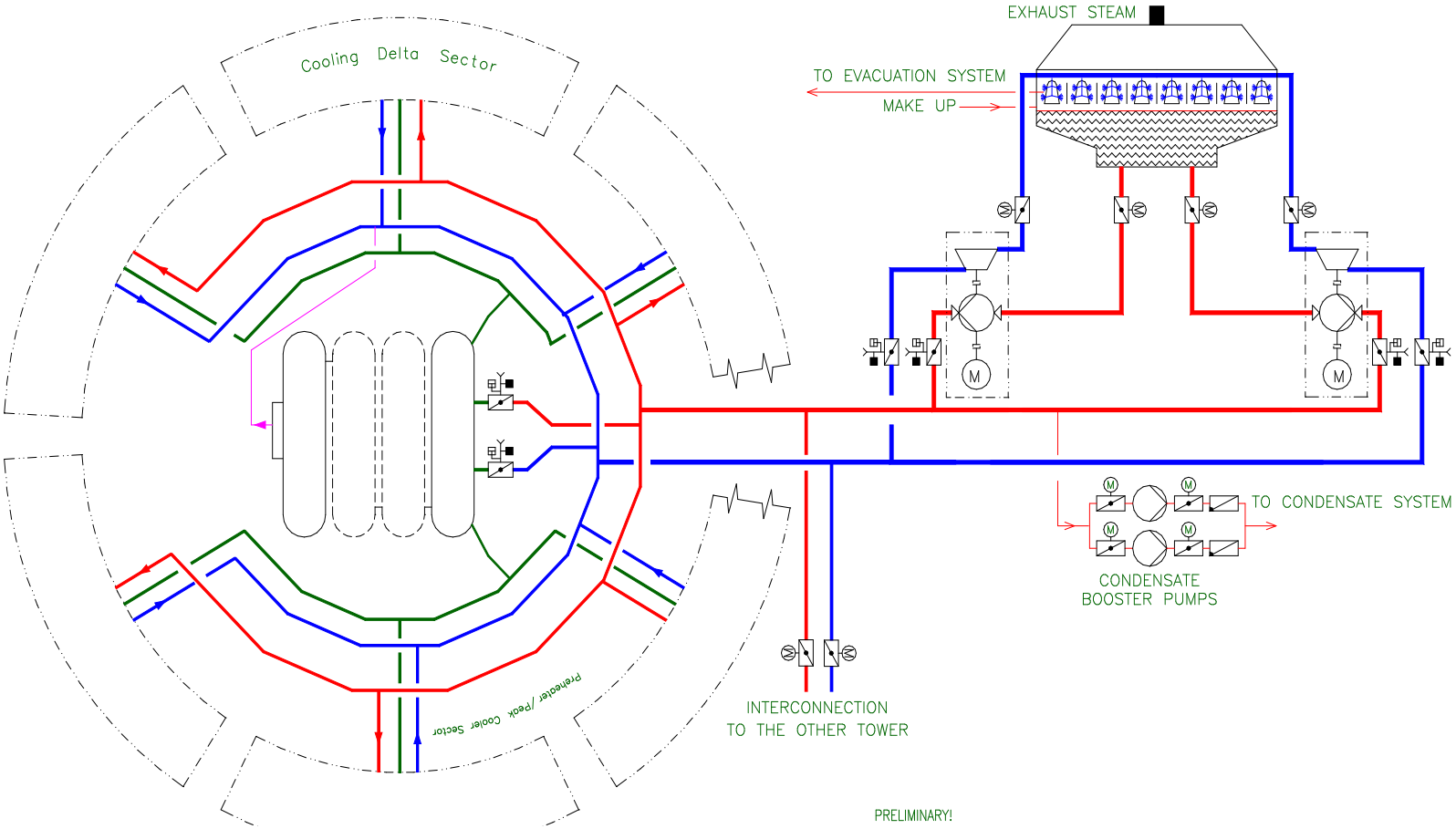
## Direct Air Cooled Condensing vs. Indirect Air Cooled Condensing Comparison Studies

GEA Heat Exchangers

# Topics of Discussion

- Heller Process Diagram
- Major Components of Heller
- Cooling Systems Case Studies

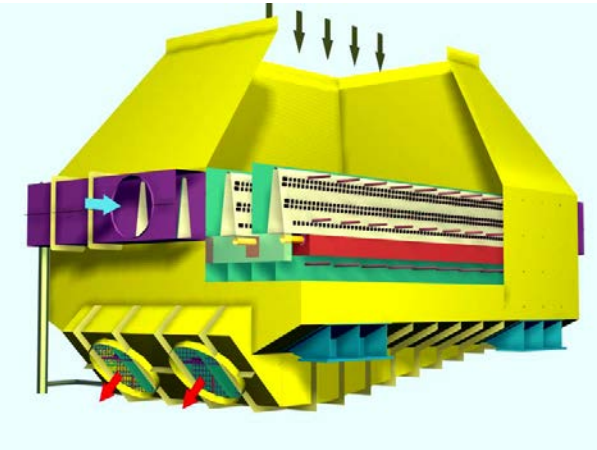
# Flow Diagram



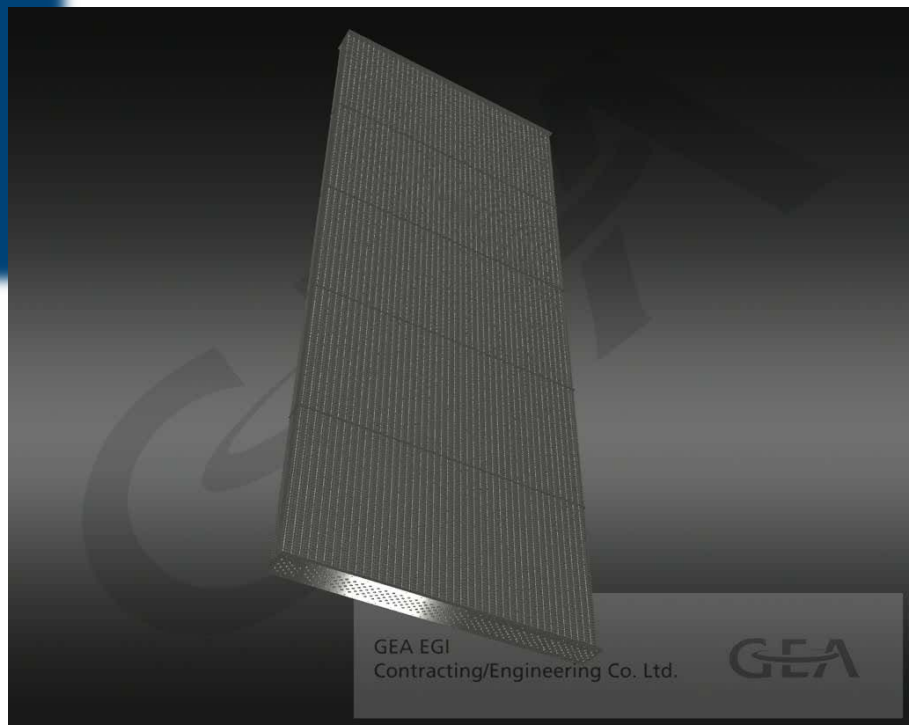
# Topics of Discussion

- Heller Process Diagram
- Major Components of Heller
- Cooling Systems Case Studies

# Direct Contact “DC” Jet Condenser



# Forgó Heat Exchanger



# Heat Exchanger Assembly & Erection

# Air Cooled Heat Exchanger: Natural Draft

- The NDCT can be built either with a conventional reinforced concrete shell or with a steel structure covered by corrugated aluminum clad.

# Air Cooled Heat Exchanger: Mechanical Draft

# Topics of Discussion

- Heller Process Diagram
- Major Components of Heller
- Cooling Systems Case Studies


# Illustrative Case Study 1

## 1. Aux Power Benefit (NDT)
## 2. Cold Condensing

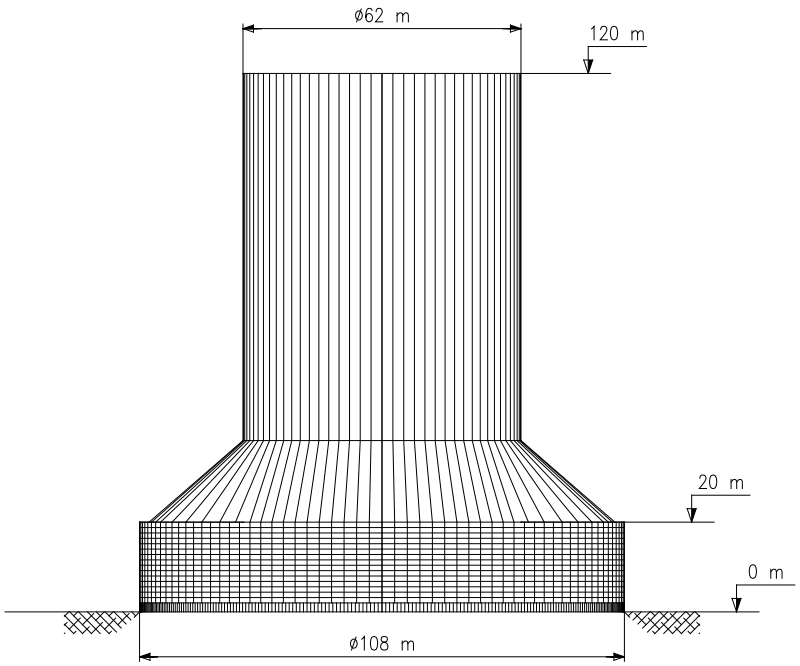
GEA Heat Exchangers

# Comparison of Cooling Systems: Case I

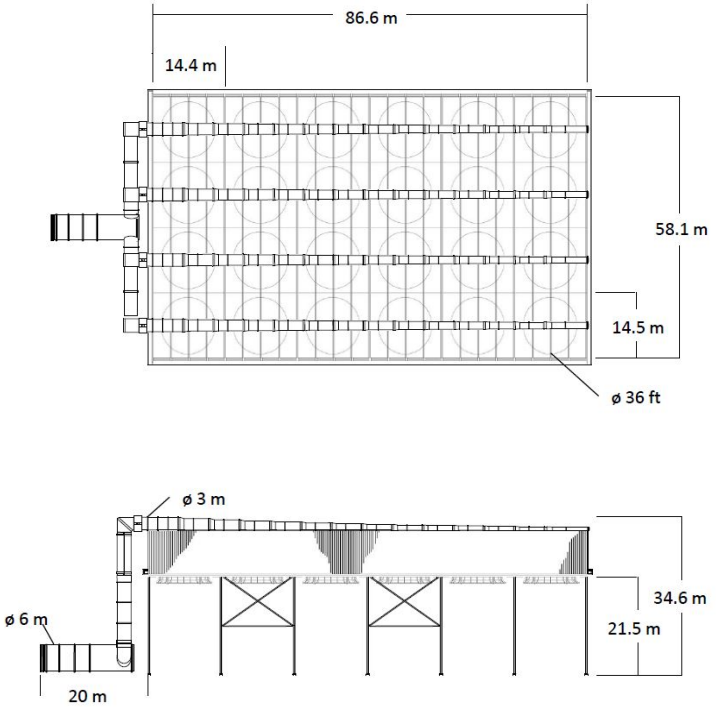
| HELLER SYSTEM | DIRECT ACC |
|---|---|

## OCCUPIED AREA

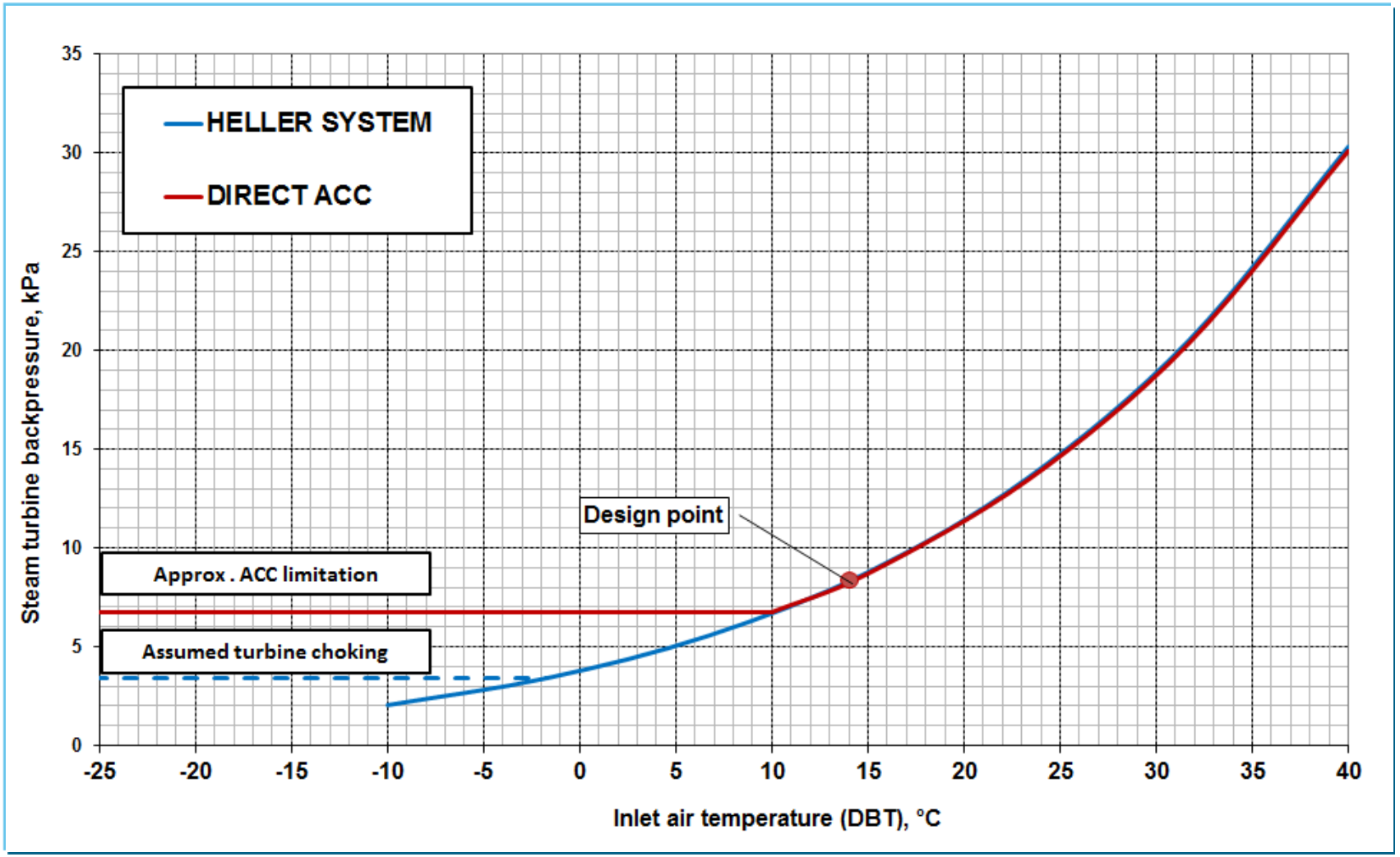
**9130 m²**




**5030 m²**



# Comparison of Cooling Systems: Case I



# Comparison of Cooling Systems: Case I

| Main technical and budgetary price data | HELLER SYSTEM | DIRECT ACC |
|---|---|---|
| Auxiliary power consumption | **1900 kWe** | **3610 kWe*** |
| Minimum backpressure | **<0.035 bar(a)** | **>0.065 bar(a)** |
| Area occupied by limit noise | **60%** | **100% (BASE)** |
| Material & Equipment Price | **0.98** | **0.88** |
| I&C and electrical items related to the cooling system | **0.04** | **0.12** |
| **Cooling system related material & equipment prices together **** | **1.02** | **1.00** |

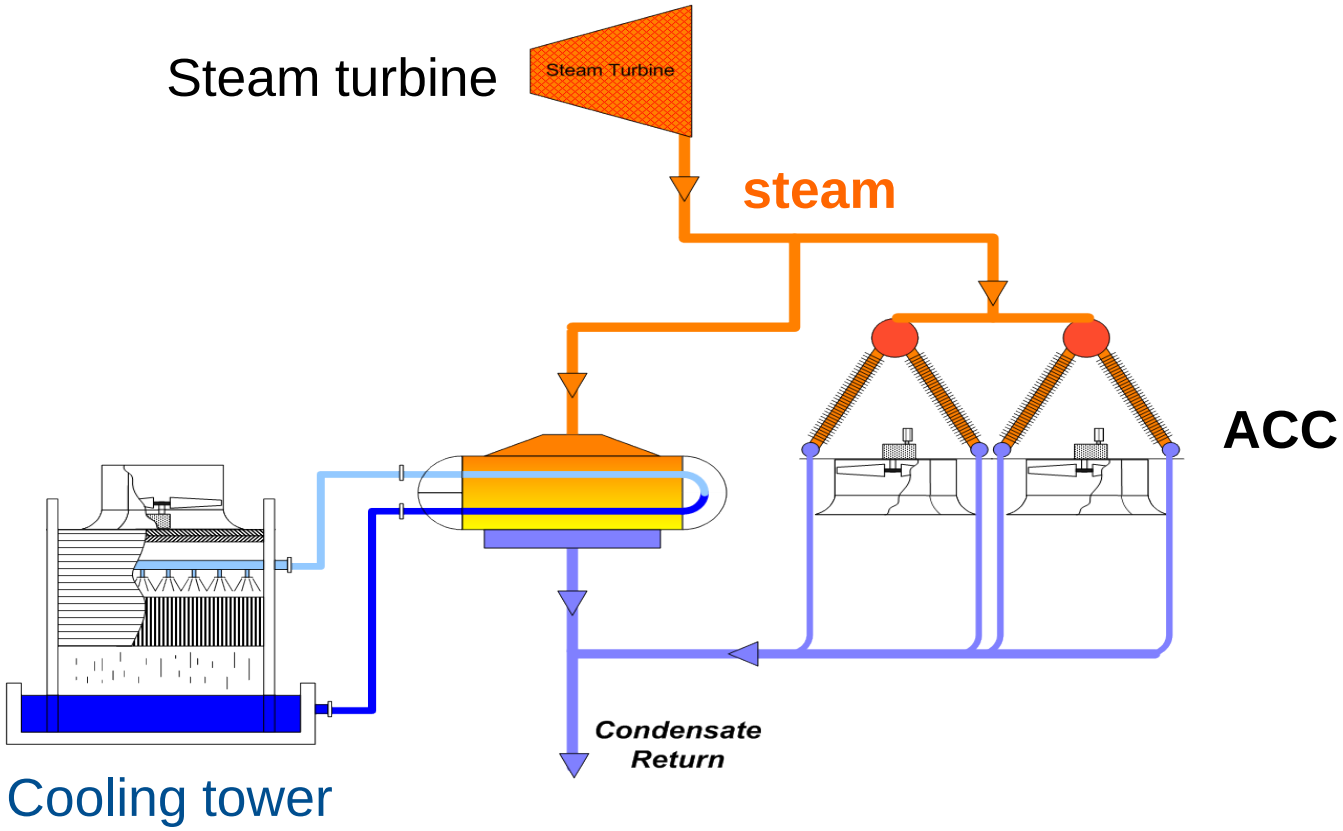
* Does not include aux power requirement for condensate extraction pumps
** Does not include cost impact due to civil works


# Illustrative Case Study 2

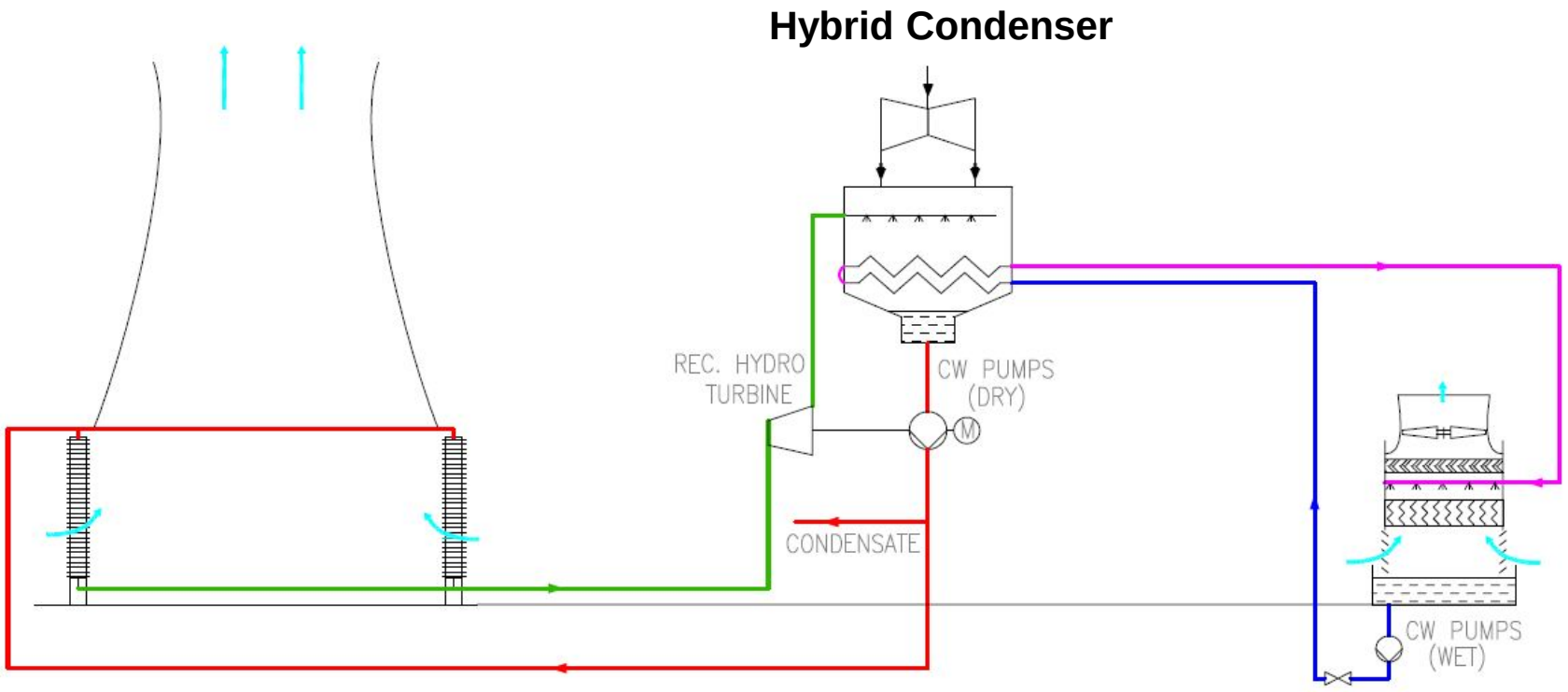
## 1. Aux Power Benefit (NDT)
## 2. Efficient Use of Limited Wet Evaporative Cooling

GEA Heat Exchangers

## SSC & ACC are condensing steam in parallel



# Dry/Wet Separate Circuit For Combination System

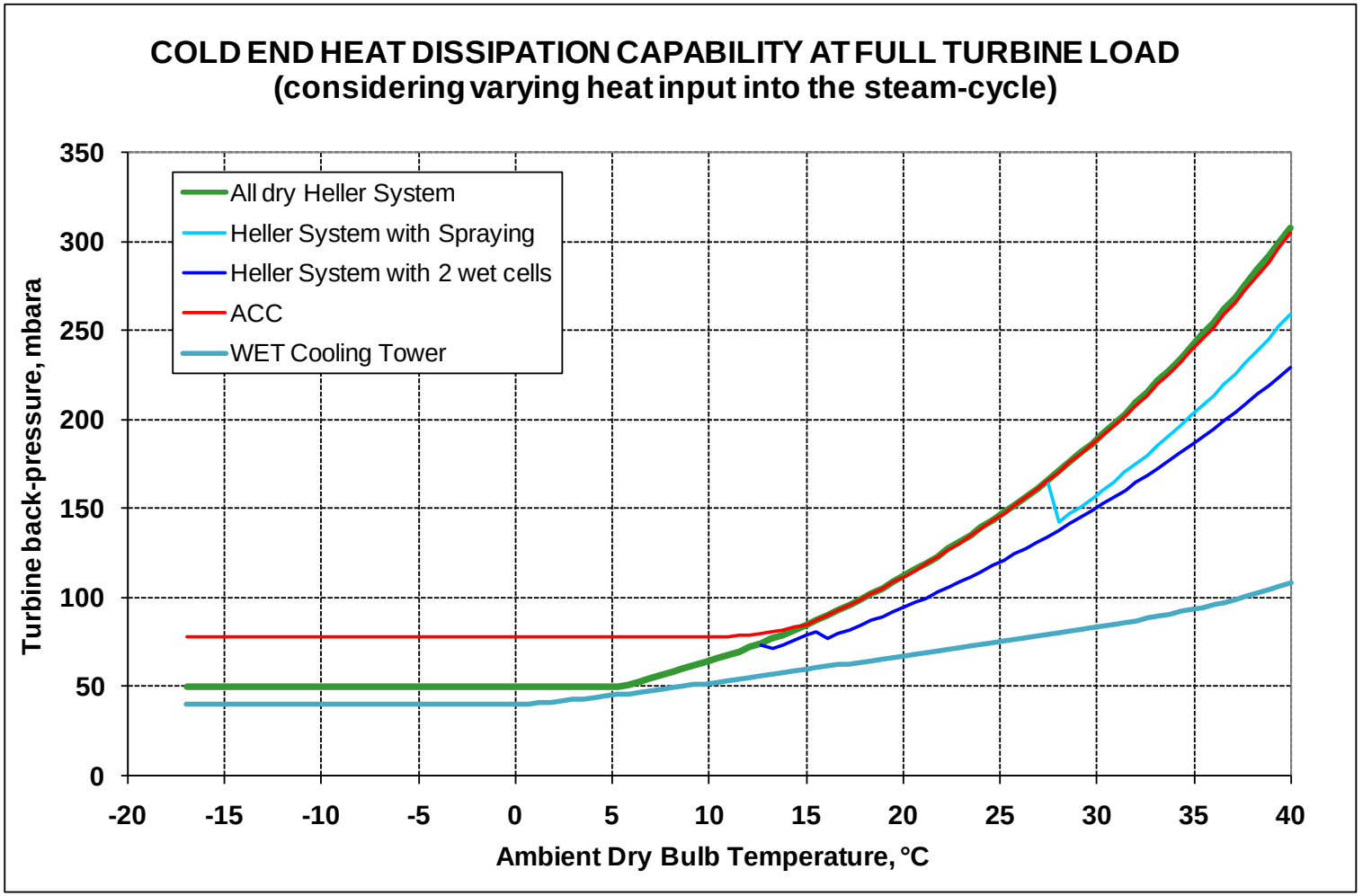



**Dry ACHE Tower**

**(Mechanical Draft or Natural Draft)**

**Wet Cooling Tower**

# Cold Condensing Capability



# Comparison of Cooling Systems: 2 x 7FA Blocks (Combination Wet/Dry System)

| Main technical and budgetary price data | HELLER SYSTEM | DIRECT ACC |
|---|---|---|
| Auxiliary power consumption | **4864 kWe** | **8064 kWe*** |
| Area occupied by limit noise | **60%** | **100% (BASE)** |
| Material & Equipment Price | **0.99** | **0.91** |
| I&C and electrical items related to the cooling system | **0.03** | **0.09** |
| **Cooling system related material & equipment prices together **** | **1.01** | **1.00** |

* Does not include aux power requirement for condensate extraction pumps
** Does not include cost impact due to turbine hall height, and auxiliary equipment for fast start


# Illustrative Case Study 3

## 1. Footprint / Layout Flexibility (MDT)
## 2. Rapid Response

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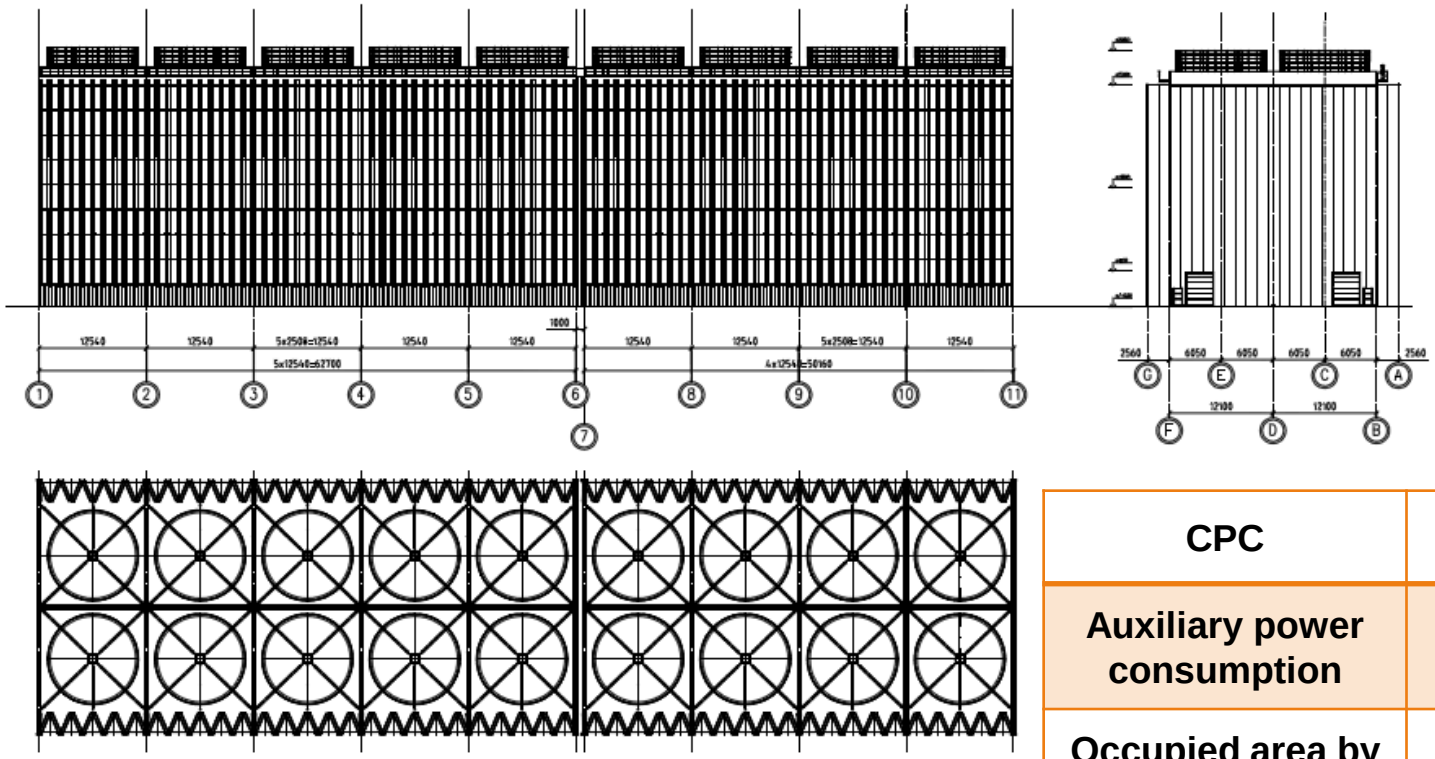
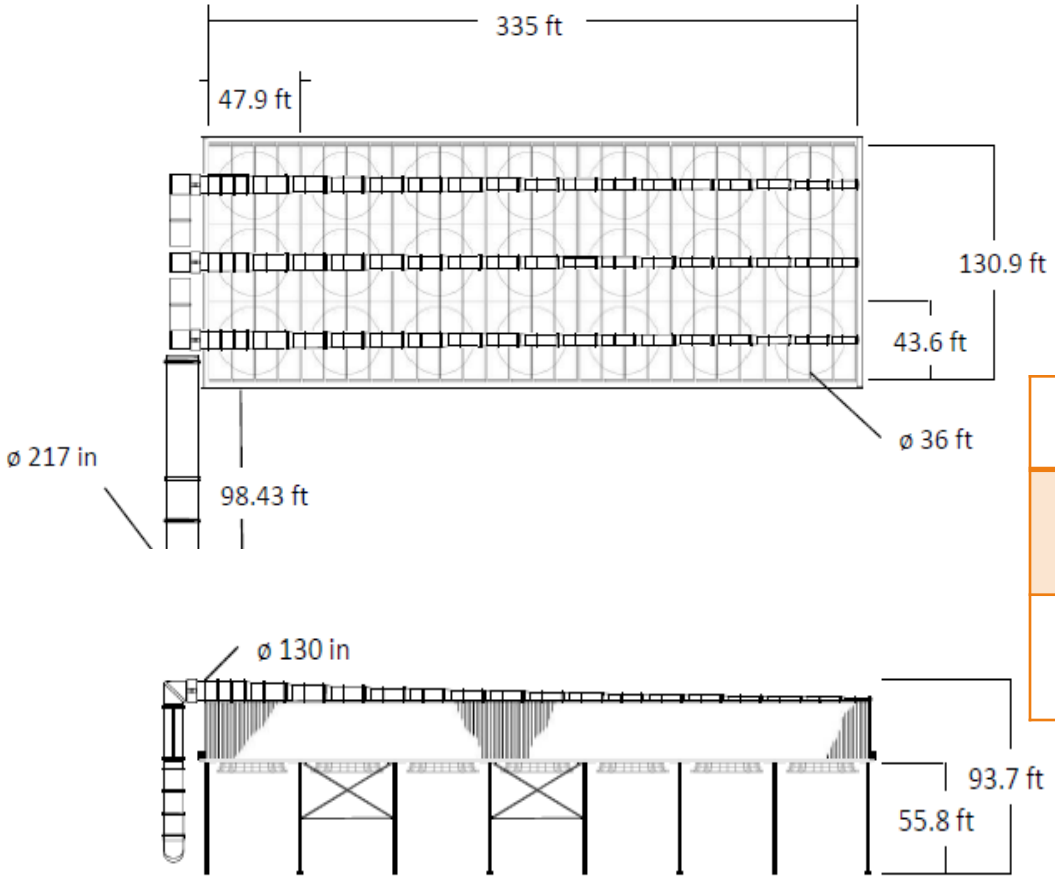
# Rapid Response CCPP Case Study:  Heller Option



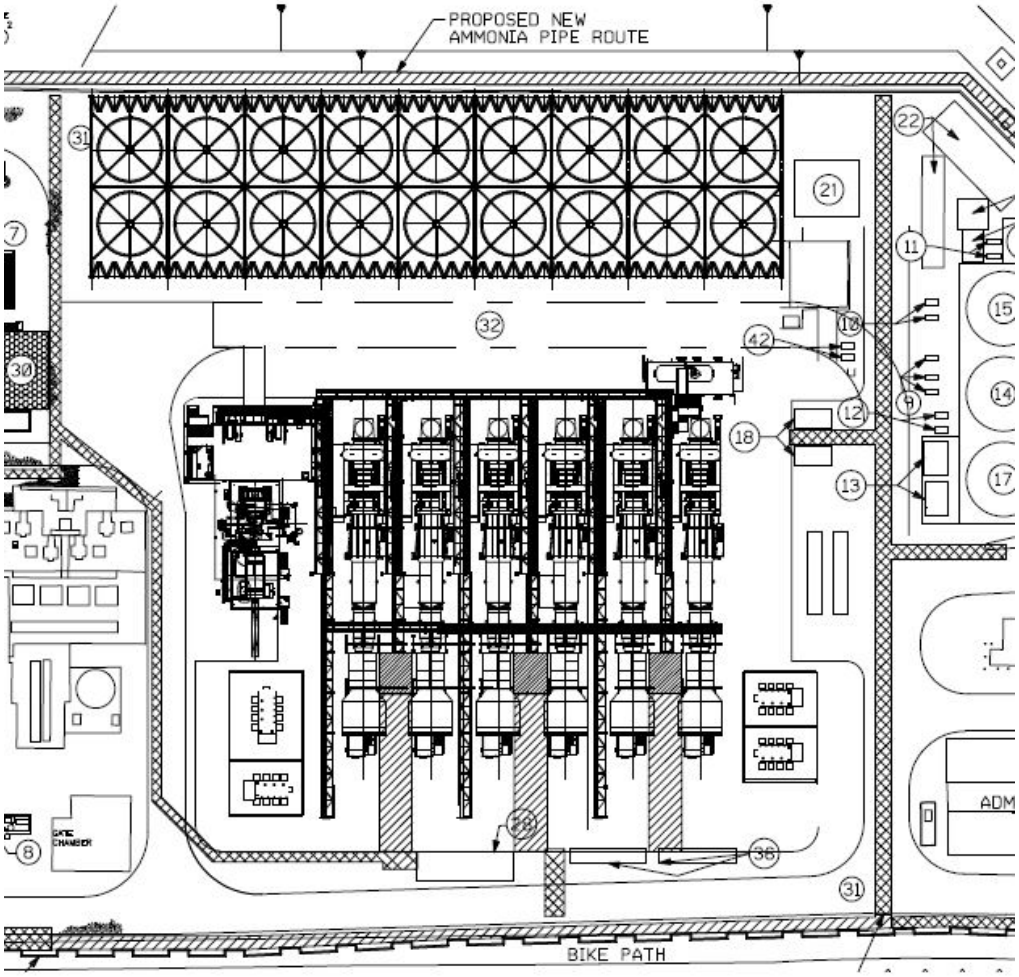
| | |
|---|---|
| CPC | 23.6 MBTU/hr/ºF |
| Auxiliary power consumption | 3660 kWe |
| Occupied area by tower | 36,950 sq-ft |

# Rapid Response CCPP Case Study: ACC Option




| | |
|---|---|
| **CPC** | **23.6 MBTU/hr/°F** |
| **Auxiliary power consumption** | **2910 kWe** |
| **Occupied area by tower** | **43850 sq-ft** |

# Rapid Response Plant Case Study: Layout



# Rapid Response Study: Comparison Cooling System Options

| Main technical and budgetary price data | HELLER SYSTEM | DIRECT ACC |
|---|---|---|
| Auxiliary power consumption | **3660 kWe** | **2910 kWe** |
| Minimum backpressure | **<0.035 bar(a)** | **>0.06 bar(a)** |
| Material & Equipment Price [1] | **0.97** | **1.00** |

1. Does not include: (i) electrical and civil works, and mechanical erection (ACC > Heller), (ii) O&M impact (Heller < ACC)

## Rapid Response Study: Comparison Cooling System Options

- Three Rapid Response Power Plants have been permitted with Heller despite 0.75MW aux power penalty. Why?
  - Unless extreme/expensive measures are taken, an ACC would delay a warm/hot start by 8 minutes
  - To “overcome” an 8 minute delay, a rapid response CCPP would need to run 26 hours.
  - “Super Peak Periods” average 50 minutes in duration

# When Indirect Dry Cooling (Heller) Should Be Considered vs. an ACC

- Large Power Plants where reduction in Parasitic Load / Aux Power Consumption is desired/evaluated
- Life Cycle Evaluation (vs. Installed Costs) is taken into consideration—including efficiency benefits, maintenance costs and increased availability
- Need for Site Arrangement flexibility
- Revenues generated during winter operation are significant
- Power Plant is designed around a Fast-Start concept
- Regions that are vulnerable to wind gusts
- Installation where labor is very expensive or unskilled
- Re-Powering/Retrofits requiring conversions of Wet-Cooled Systems to Dry-Cooled Systems

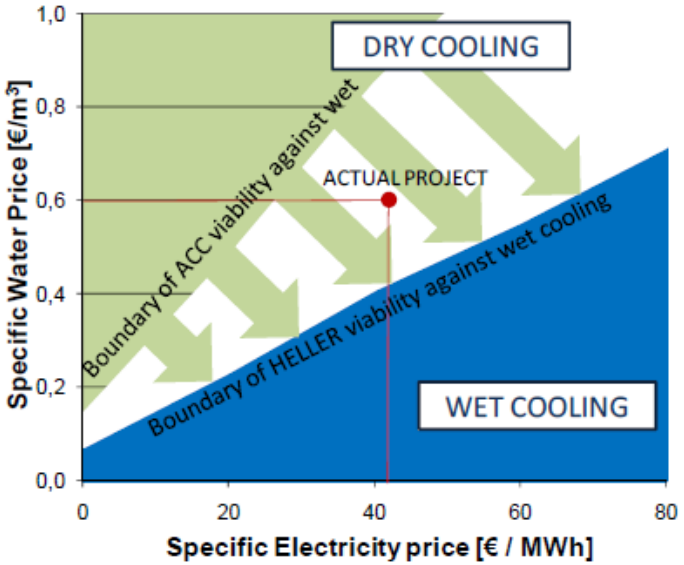
# GEA Cooling System Evaluations/Studies

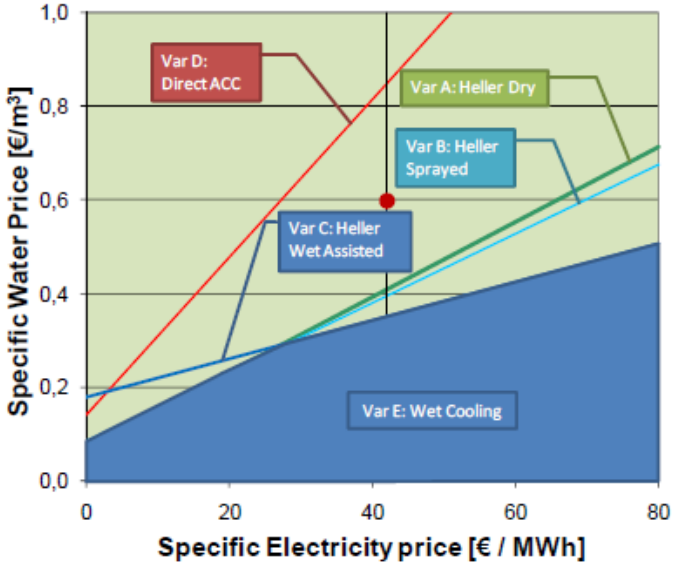
7.1 Results of cooling systems' evaluation serving a 800 $MW_e$ CCPP – cont.

❖ Economical aspects – cont.

**Economic viability envelopes**

*- coordinates of two vital factors: water and electricity prices – helps to judge financial stability of cooling systems relative to wet cooling in view of potential changes of these factors*




➢ The all-dry HELLER System (var. A) is competitive against wet cooling (var. E) - at an assumed water price of 0.6 €/m³ – up to 63.5 €/MWh electricity selling price.

➢ At the same electricity selling price (63.5 €/MWh) the wet assisted HELLER System (var.C) reaches economic equivalence already at 0.46 €/m³ make-up water price.

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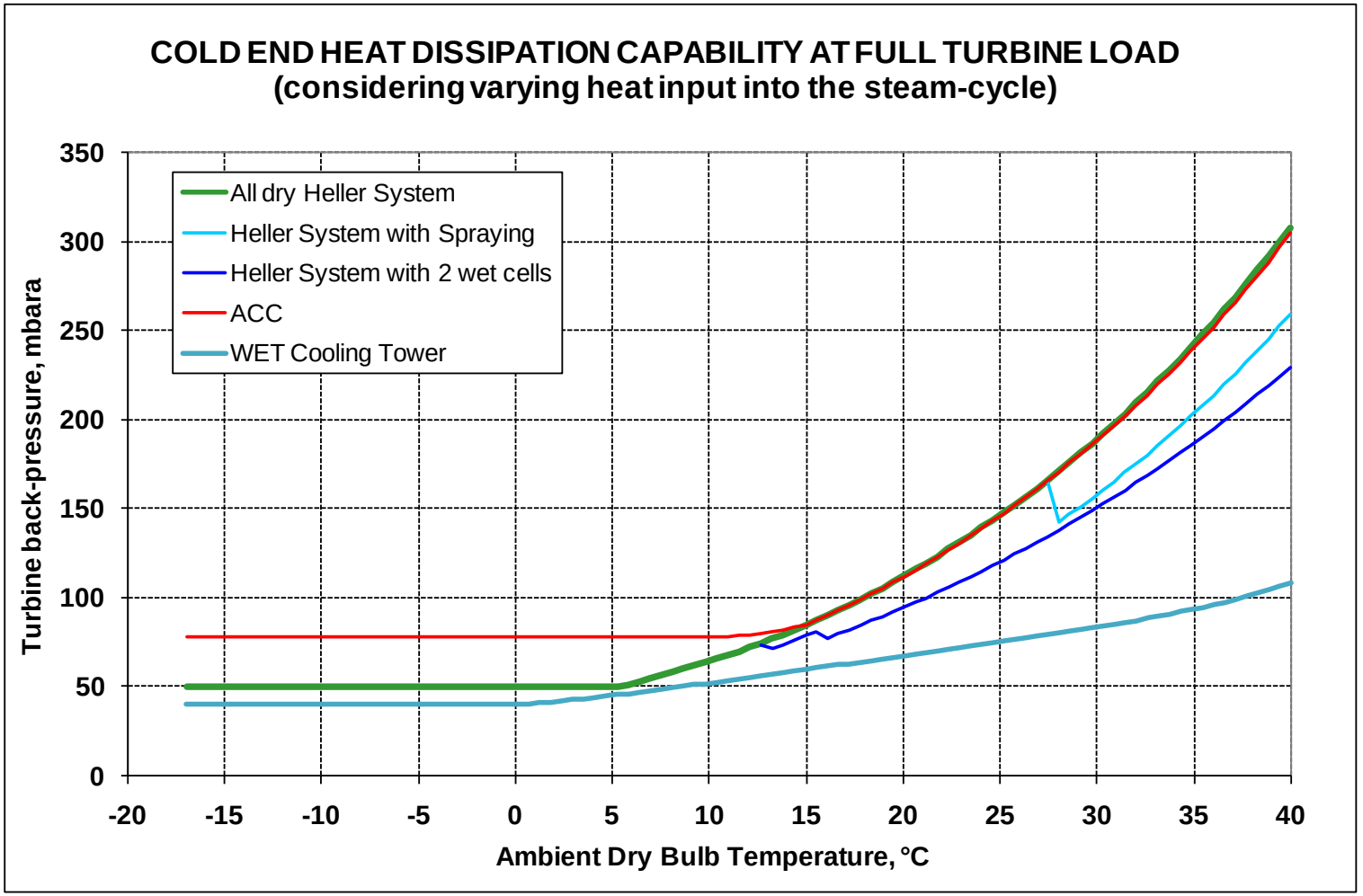
# Appendices, Enclosures, Attachments, etc

# Cold Condensing Capability



# Noise Generation Study

➢ **Impact of cooling systems on noise emmission**

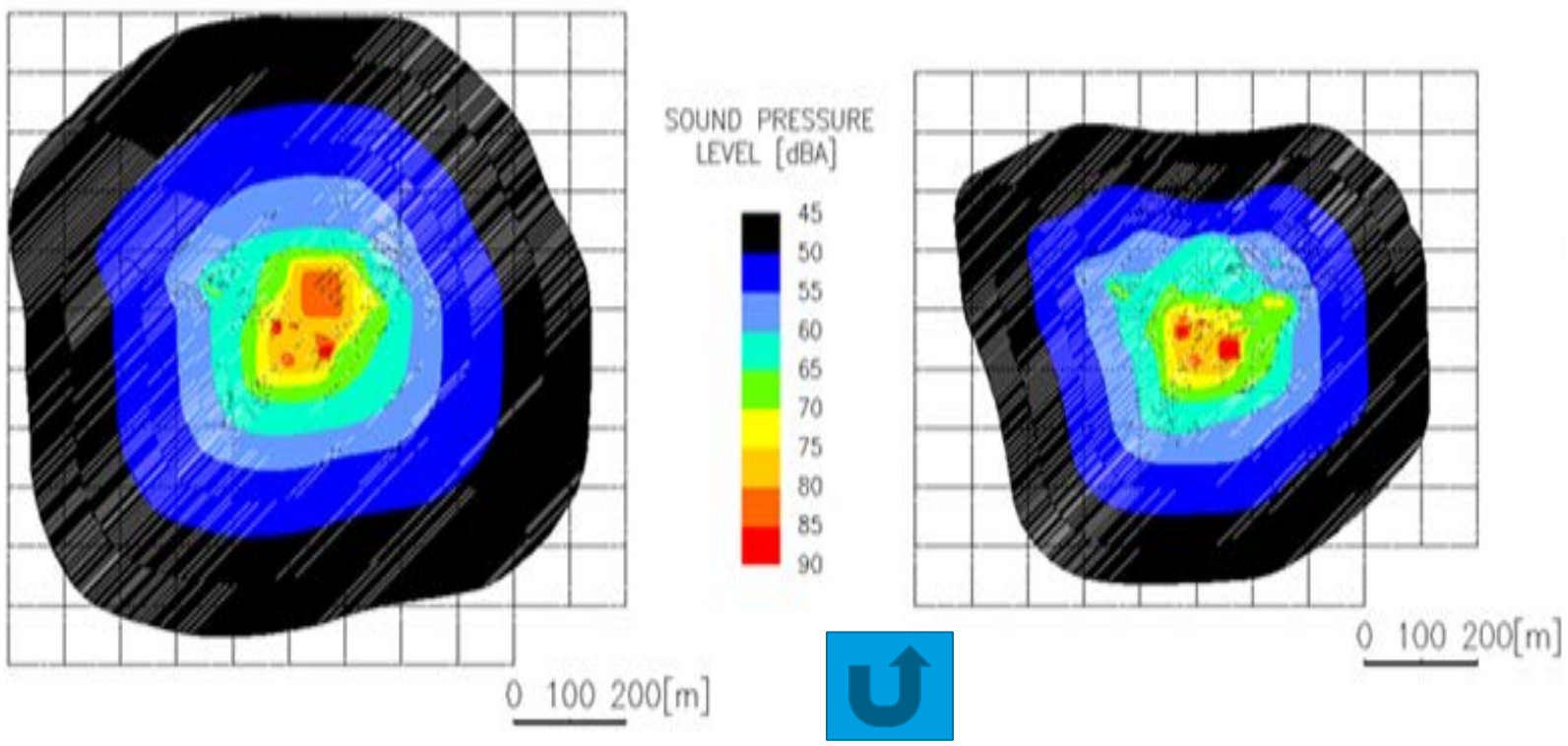
Sound pressure levels around the 800 $MW_e$ CCPP equipped with functionally equivalent dry cooling systems: natural draft HELLER System and mechanical draft direct ACC :

**Direct ACC**

**90 ha occupied by noise > 45 dB(A)**

**HELLER System**

**54 ha occupied by noise > 45 dB(A)**



# Heller Indirect Dry Cooling References

**Intergen (Developer) and Bechtel (EPC)**

**2400 (3×800) MW Gebze & Adapazari CCPP:**

**Largest CCPP with Dry Cooling**

# Select References, Mechanical Draft Heller Systems

800 $MW_e$ Modugno CCPP, Italy (EPC: Alstom, owner: Energia SpA)
Heller System with DC Jet condenser

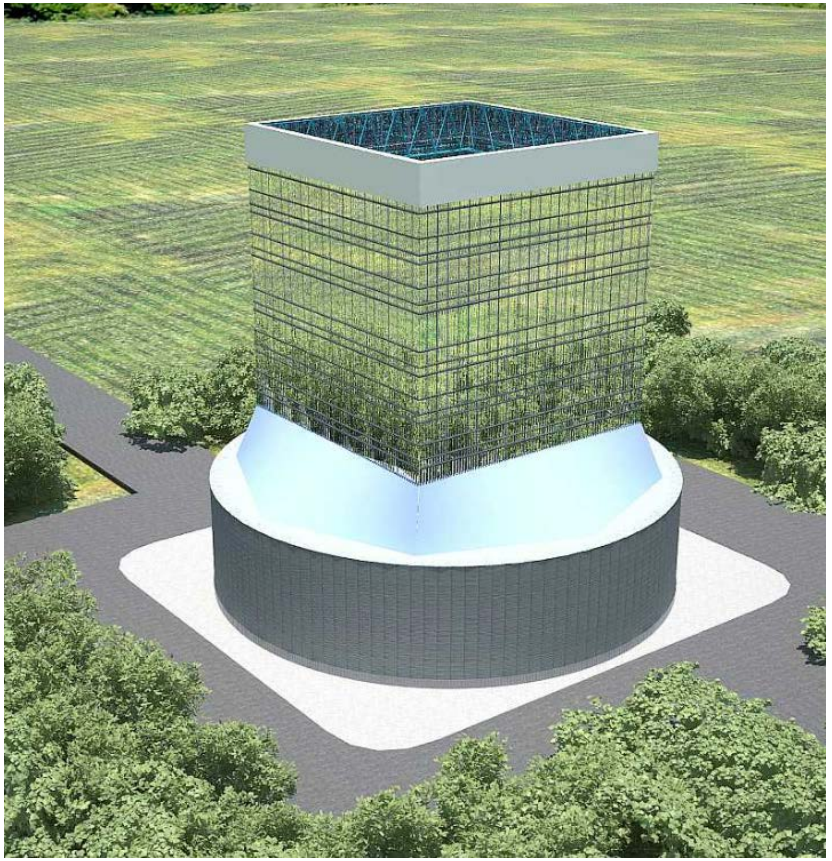
No bypass stack for gas turbines, cooling system supports plant reliability



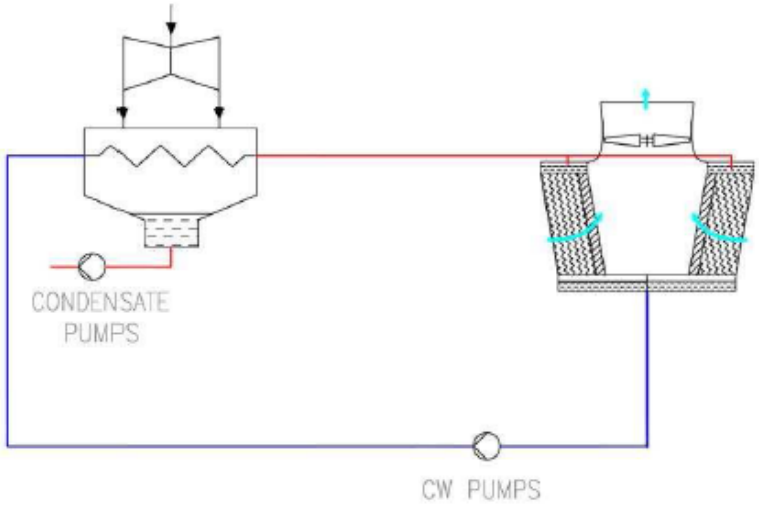
24 main cooler cells with single fan

2 auxiliary cooler cells with four fans each

# Natural Draft Tower Design Flexibility



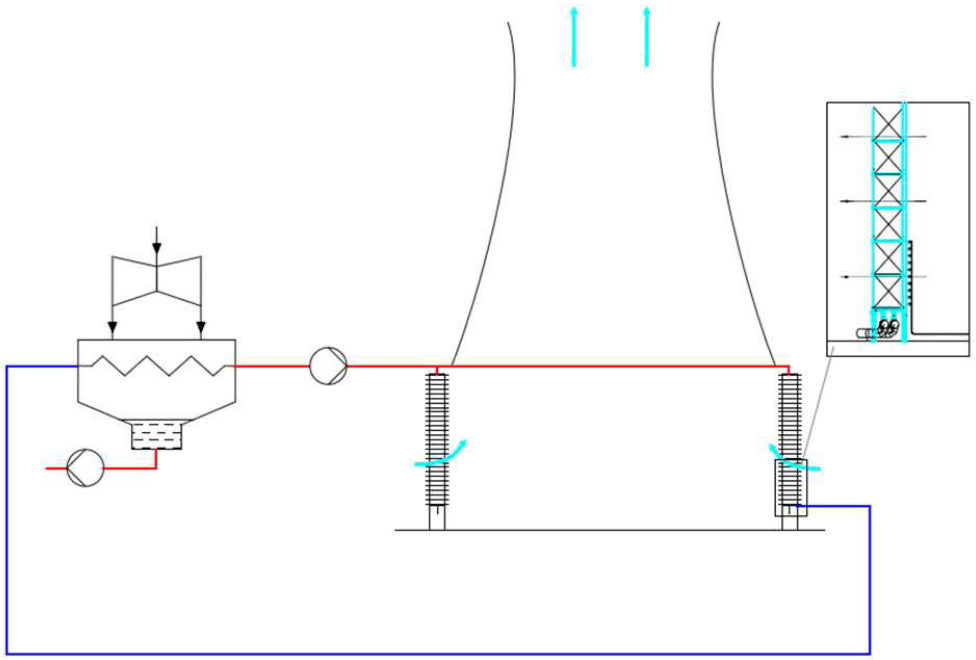
# Wet-to-Dry Conversions




**Pre-Conversion**

Wet Cooling Tower with Surface Condenser

# Wet-to-Dry Conversions

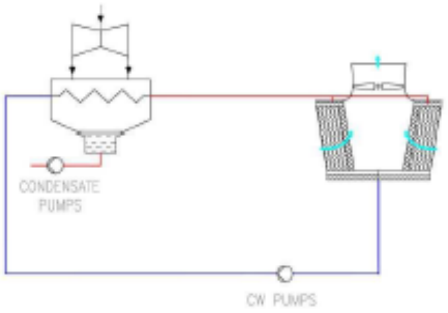


**Post-Conversion**

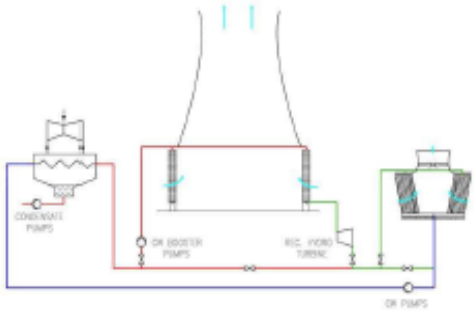
Dry System utilizing existing Surface Condenser and supplement spraying

# Wet-to-Dry Conversions

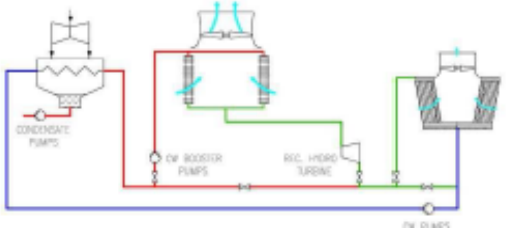
**var. MW**
Existing mechanical draft wet



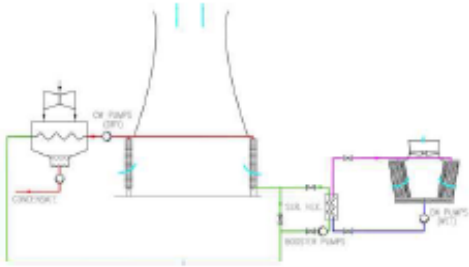

**var. Sing. ND-W**
Single circuit natural draft
serial dry/wet



**var. Sing. MD-W**
Single circuit mechanical draft
serial dry/wet



**var. Sep(X) ND-W**
Separate circ. natural dry/wet
cells inside integrated by
water-water HEX



**var. Sep(X ) MD-W**
Separate circ. natural dry/wet
cells inside integrated by
water-water HEX & divided cond.