MVM EGI

An Introduction to Medium-to-Large Size Hybrid Cooling Solutions

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ABOUT MVM EGI

Profile: Globally active cooling system provider
Consultancy, design, engineering, delivery, after sales

Manufacturing: Fully owned factory in Wuqing, CN

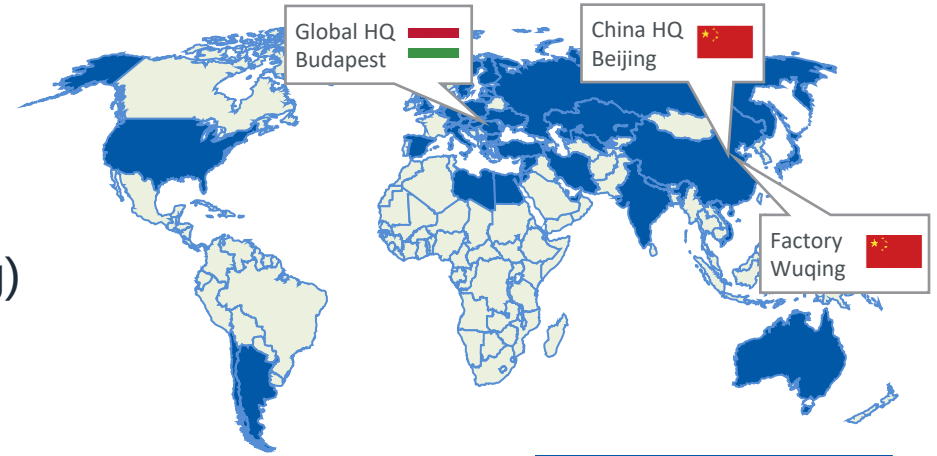
Founded in 1948 as EGI
GEA Group 1992-2014, ENEXIO 2014-2020

Owner: MVM Group *(100% Hungarian state owned)*
The largest power-utility company in CEE region

Headcount (FTE): 125 (68 Budapest, 25 Beijing, 32 Wuqing)
Headquarters: Budapest, Hungary

MVM EGI Factory in Wuqing, China

Global supply track record



MVM EGI

ABOUT MVM EGI

Technology leader with strong Hungarian engineering heritage

Organization milestones

1948 — Foundation of EGI by Prof. Dr László Heller and Dr. László Forgó

1962 — Heat exchanger workshop starts production in Jászberény, Hungary

1984 — Acquisition of EGI by GEA Group *(German Industrial Conglomerate)*

GEA-EGI

1994 — New heat exchanger production site in Wuqing, China

2008 — Acquisition of EGI by Triton Partners *(German Private Investment Fund)*

Triton

2015 — Brand change from EGI to ENEXIO

ENEXIO

2021 — Acquisition of ENEXIO Hungary by MVM Group

group m v m

2023- MVM EGI

Technology milestones

1954 — First pilot-plant scale Heller system

1968 — First mechanical draft indirect cooling tower *Eilenburg Chemical Works, Germany*

1972 — First dry cooled nuclear power plant Mechanical draft indirect cooling towers *Bilibino NPP, Russia*

1992 — First hybrid cooler *Great Isfahan Power Station, Iran*

2008 — First hybrid cooler in the USA *Neil Simpson Power Station, Wyoming, USA*

2014 — Next generation mechanical draft indirect dry cooling tower, *Avtovo PP, Russia*

2021 — ACC for *W2E Plant, Warsaw, Poland*

2023- 7.4GW new build dry cooling *China*

MVM EGI PRODUCT PORTFOLIO

Excellence in engineering and highest quality project execution

		HELLER INDIRECT DRY COOLING	AIR-COOLED CONDENSERS	EVAPORATIVE COOLING TOWERS	HYBRID DRY/WET COOLING TOWERS	DRY COOLING SPECIAL APPLICATIONS	CIRCUMIX ASH HANDLING
POWER PLANTS	COAL FIRED	x	x	x	x	x	x
	COMBINED-CYCLE	x	x	x	x	x	
	NUCLEAR	x		x	x	x	
	BIOMASS & W2E	x	x	x	x	x	
	CONCENTRATED SOLAR	x	x	x	x	x	
	CHEMICAL PLANTS	x		x	x	x	
	INDUSTRIAL APPLICATIONS	x	x	x	x	x	

HYBRID COOLING – THE FACTS

WHAT IS HYBRID COOLING?

Wet cooling

- Wet cooling: dissipation of heat into the atmosphere via evaporation of cooling water in wet cooling tower to provide cold water for the surface condenser
  - Very good performance even in summer (approach towards ambient wet bulb temperature)
  - Low power consumption
  - Limited plot area requirement
  - Low CAPEX
  - Possibility for natural draft tower
  - High water consumption
  - Visible plume in certain conditions
  - Icing of surroundings in cold environments
  - Chemical dosing requirement
  - Increased maintenance costs

HYBRID COOLING – THE FACTS

WHAT IS HYBRID COOLING?

Dry cooling

- Dry cooling: dissipation of heat into the atmosphere via steam-to-air or water-to-air heat exchangers. 2 possible solutions: ACC or IDCT/Heller
  - Limited performance in summer (approach towards ambient dry bulb temperature)
  - Higher power consumption (large air-flow required)
  - Larger plot area requirement
  - Higher CAPEX
  - Possibility for natural draft tower (IDCT/Heller)
  - No water consumption
  - No plume
  - No icing of surroundings in cold environments
  - No chemical dosing requirement
  - Reduced maintenance costs (especially for natural draft towers)

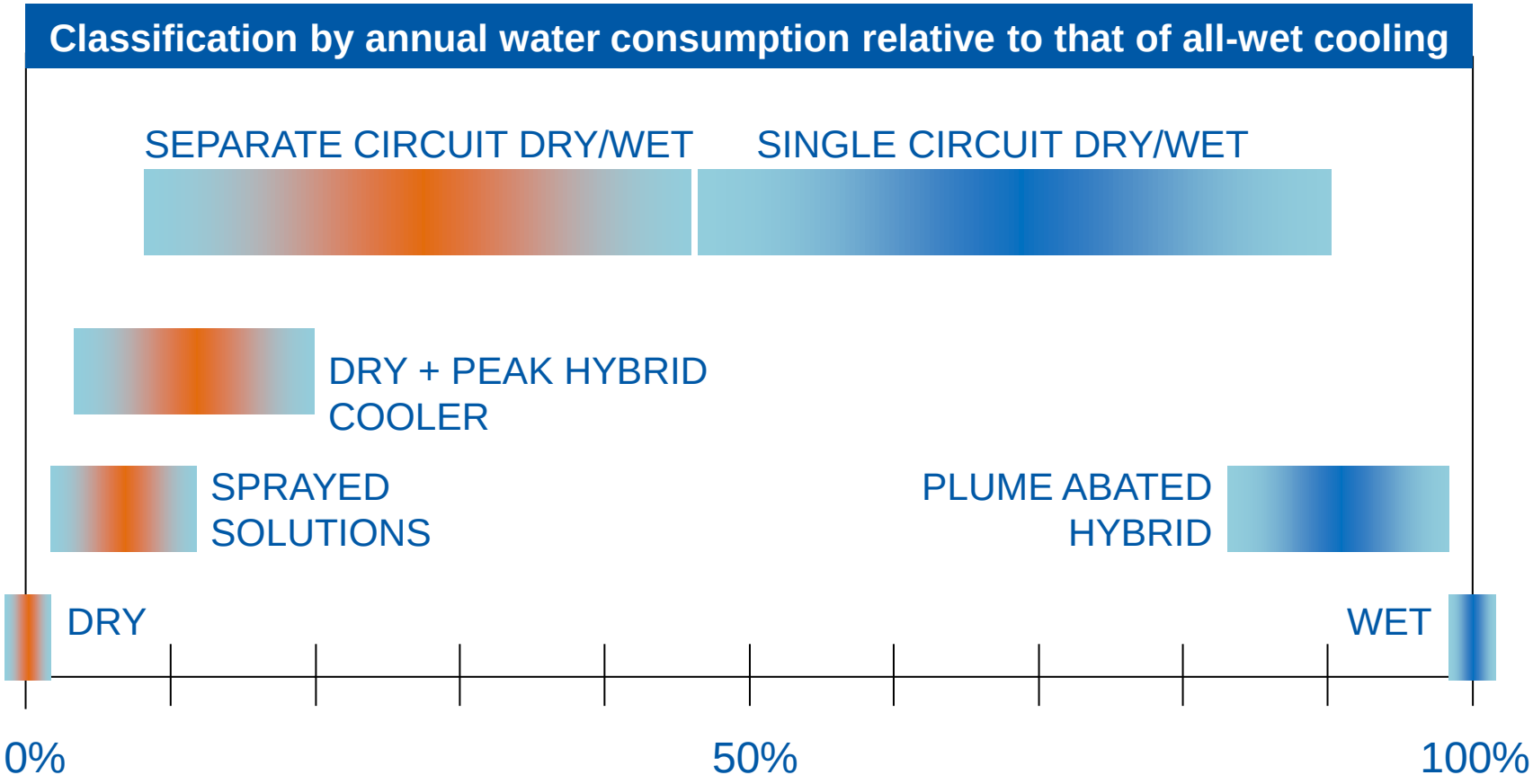
HYBRID COOLING – THE FACTS

WHAT IS HYBRID COOLING?

Wet + dry cooling

- Hybrid cooling = a combination of wet + dry cooling, combining the benefits while reducing/eliminating the disadvantages.
- **Realistic goals (because physics rule):**
  - Very good performance in summer (approach towards ambient wet bulb temperature)
  - Limited power consumption
  - Limited plot area requirement
  - Limited CAPEX
  - Possibility for natural draft tower
  - Limited water consumption
  - No plume
  - No icing of surroundings in cold environments
  - Less or none chemical dosing
  - Reasonable maintenance costs

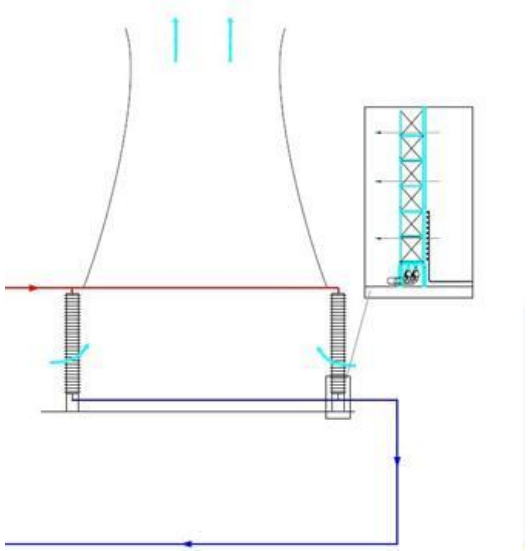
HYBRID COOLING – THE SOLUTIONS
A COMPLETE RANGE FROM DRY TO WET

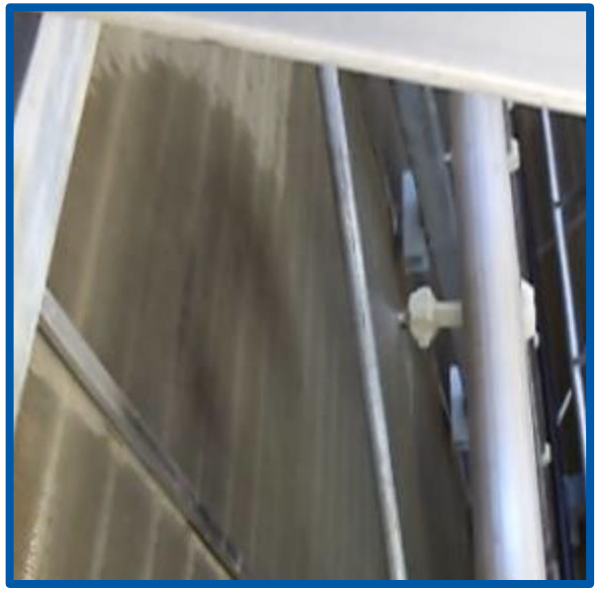


HYBRID COOLING – THE SOLUTIONS
SPRAYED SOLUTIONS

Heller/IDCT with Supplemental Spraying:

- Low water consumption (on annual basis)
- Spraying system requires clean water (20µS/cm conductivity) to avoid deposition on fins of HX bundles
- Water totally evaporates from the surface
- Only part of the total surface is sprayed
- Negligible price adder for spraying system
- Limited annual spraying operation foreseen

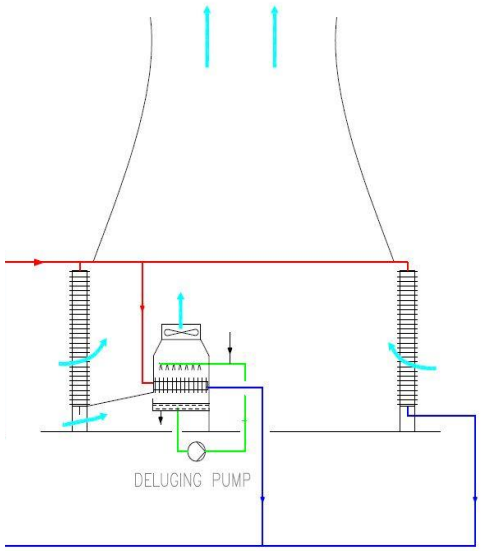




HYBRID COOLING – THE SOLUTIONS
HYBRID PEAK COOLED SOLUTIONS

Heller/IDCT with peak Hybrid Coolers:

- All-Dry base operation of IDCT
- Peak cooling with Hybrid Coolers (HC – finned tubes deluged, pls. see MVM EGI ACC Users Group 2023 presentation for details)
- Low water consumption (on annual basis)
- First-pass RO, ultrafiltered water required for deluging of HC
- Operation regime can be determined by user, Hybrid Coolers can operate for prolonged periods
- Moderate price adder compared to All-Dry solution



HYBRID COOLING – THE SOLUTIONS
HYBRID PEAK COOLED SOLUTIONS

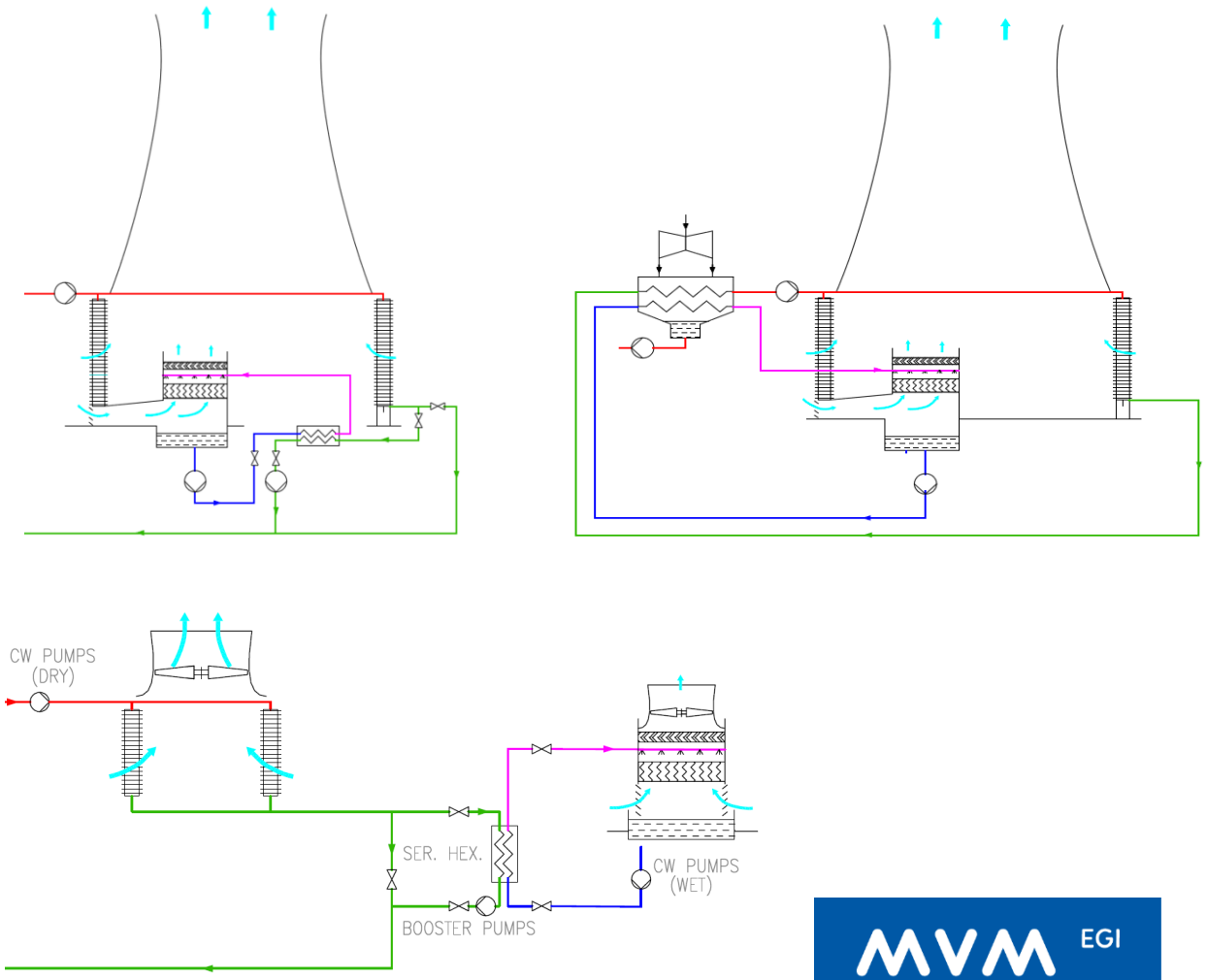
ACC with peak WSAC:

- All-Dry base operation of ACC (multiple row spiral fin HX arranged horizontally, induced draft)
- Peak cooling with Wet-Surface Air-Coolers (WSAC – bare tubes deluged)
- ACC and WSAC connected in parallel (part of the steam is led into the tubes of the WSAC)
- Example: geothermal plant in EU
- Low water consumption (on annual basis)
- Use of well-water for deluging without cleaning
- WSAC completely replaced every 2-3 years due to scale build-up on bare tubes of WSAC
- Moderate price adder compared to All-Dry solution

HYBRID COOLING – THE SOLUTIONS
SEPARATE CIRCUIT DRY/WET SOLUTIONS

Separate Circuit Dry/Wet systems:

- Heat rejection is split between a dry and a wet circuit, which are separated by water-to-water heat exchangers, in order to allow the independent use of the dry circuit, and use of non-stainless-steel dry Forgo HX bundle tube material
- Totally closed dry circuit, separate wet circuit
- Parallel and serial connection of dry and wet circuits both possible
- Forgo HX bundle tube material can be aluminum (low cost), since the dry circuit is totally closed
- Very high flexibility in operation
- Wet part can be located inside the dry tower (natural draft, mechanical draft or fan-assisted natural draft options available)
- Balanced year-round performance (flexibility)
- Requires pumps for separate wet circuit
- High level annual water savings compared to all-wet system



HYBRID COOLING – THE SOLUTIONS
SEPARATE CIRCUIT DRY/WET SOLUTIONS

Hybrid Induced Draft Cooling Tower (HICT)

- Wet cooling tower is located inside the dry cooling tower

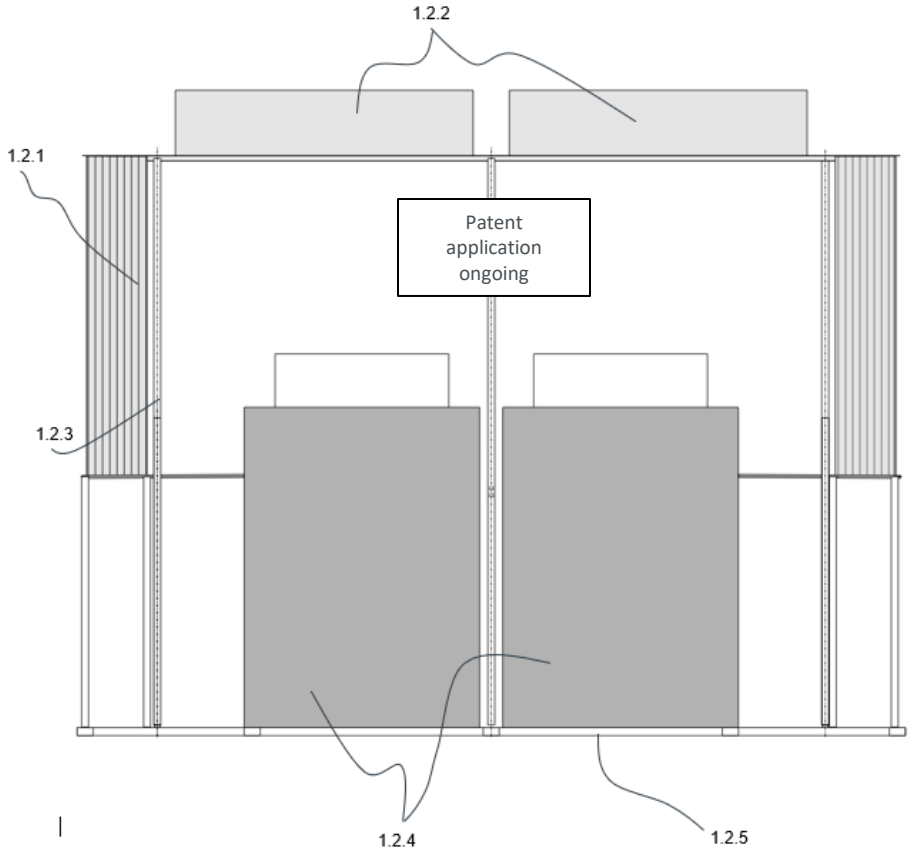
1.2.1 Fluid-to-air heat exchangers in vertically arranged cooling deltas

1.2.2 Fan drive units

1.2.3 Modular HICT cell structure

1.2.4 Complete wet cooling cells

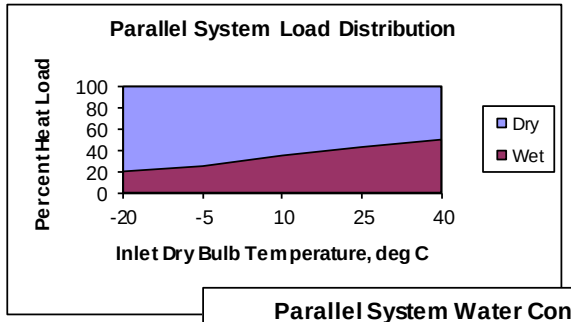
1.2.5 Water basin

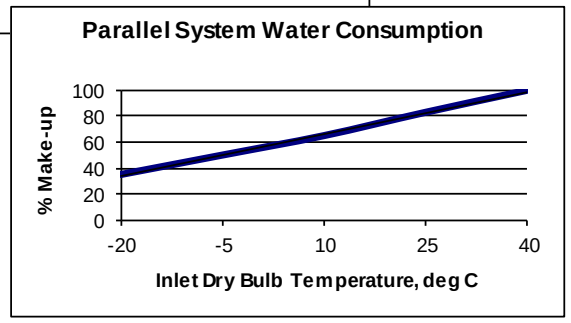


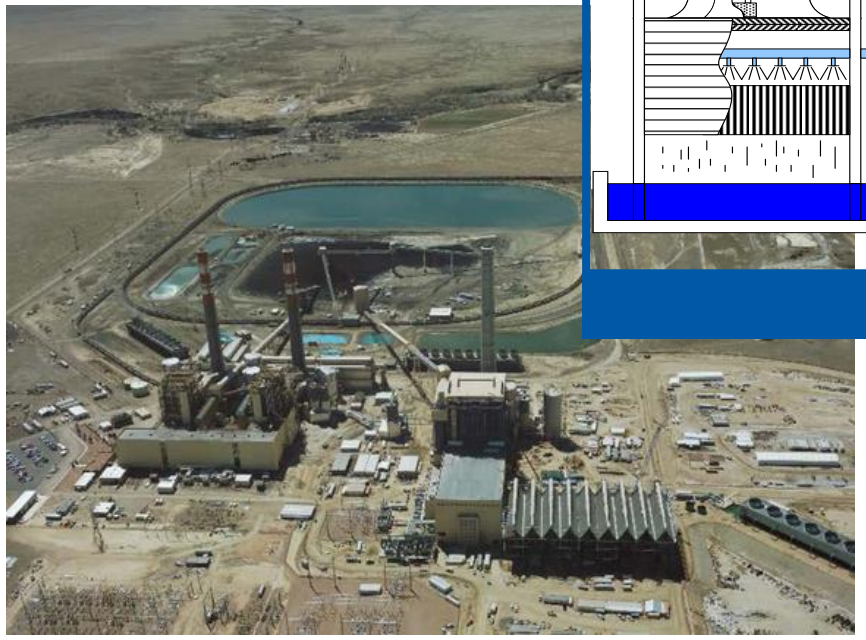
HYBRID COOLING – THE SOLUTIONS
SEPARATE CIRCUIT DRY/WET SOLUTIONS

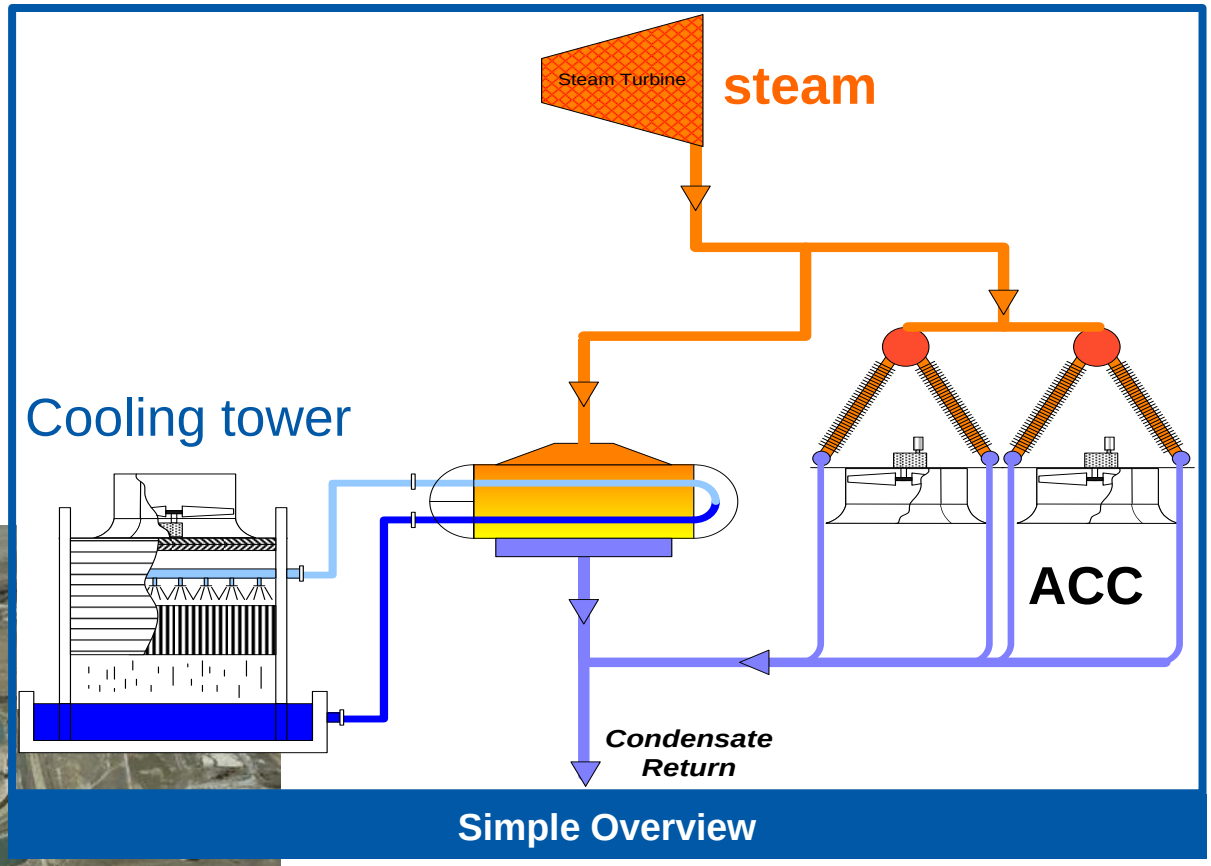
PAC: Combination of Air-Cooled Condenser and wet cooling system

- Reduced water consumption vs 100% wet system
- Reduced capital cost & improved performance vs 100% dry system
- Reduced or eliminated visible plume
- Optimized for performance and available cooling water resources



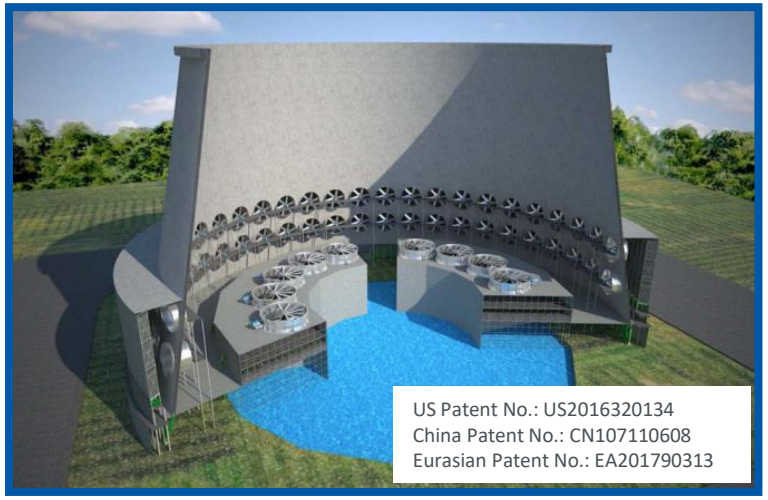




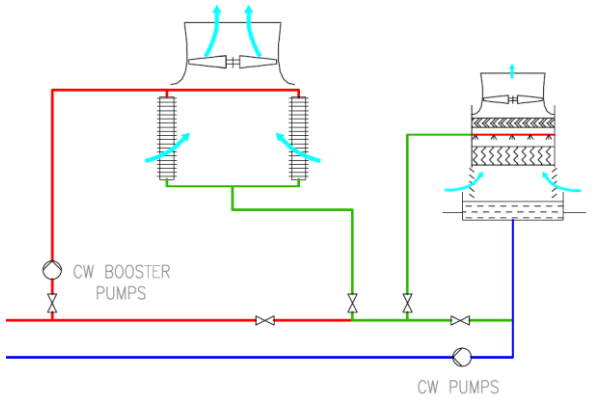


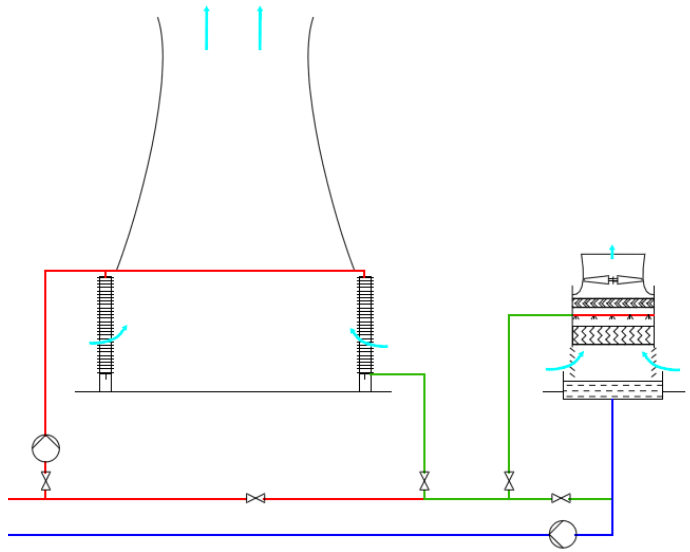
HYBRID COOLING – THE SOLUTIONS
SINGLE CIRCUIT DRY/WET SOLUTIONS

Single Circuit Dry/Wet system



- Warm cooling water is led into a dry cooling tower, in which it cools down via Forgo bundles, then the cooling water is led to wet cooling cells, where the cooling water further cools down – comprising a single cooling water circuit.
- The cooled cooling water collected in the wet cooling tower basin, is recirculated to the surface condenser again, to reject turbine exhaust steam condensation heat.
- All-Dry & All-Wet operation both possible
- Forgo bundle tube material is stainless steel, since the circulating cooling water is in direct contact with ambient air in the wet part
- Very high flexibility in operation
- Wet part can be located inside the dry tower (natural draft, mechanical draft or fan-assisted natural draft options available)
- Balanced year-round performance (flexibility)
- Requires booster pumps for dry part
- Moderate annual water savings compared to all-wet system
- MVM EGI patented solutions for main cooling of 1200MW Nuclear Power Plant in USA & Czech Rep.





HYBRID COOLING – THE SOLUTIONS
SINGLE CIRCUIT DRY/WET SOLUTIONS

Hybrid Dry-Oriented Plume Abated Cooling Tower (HPCT)

- Complete combination of wet and dry cooling towers

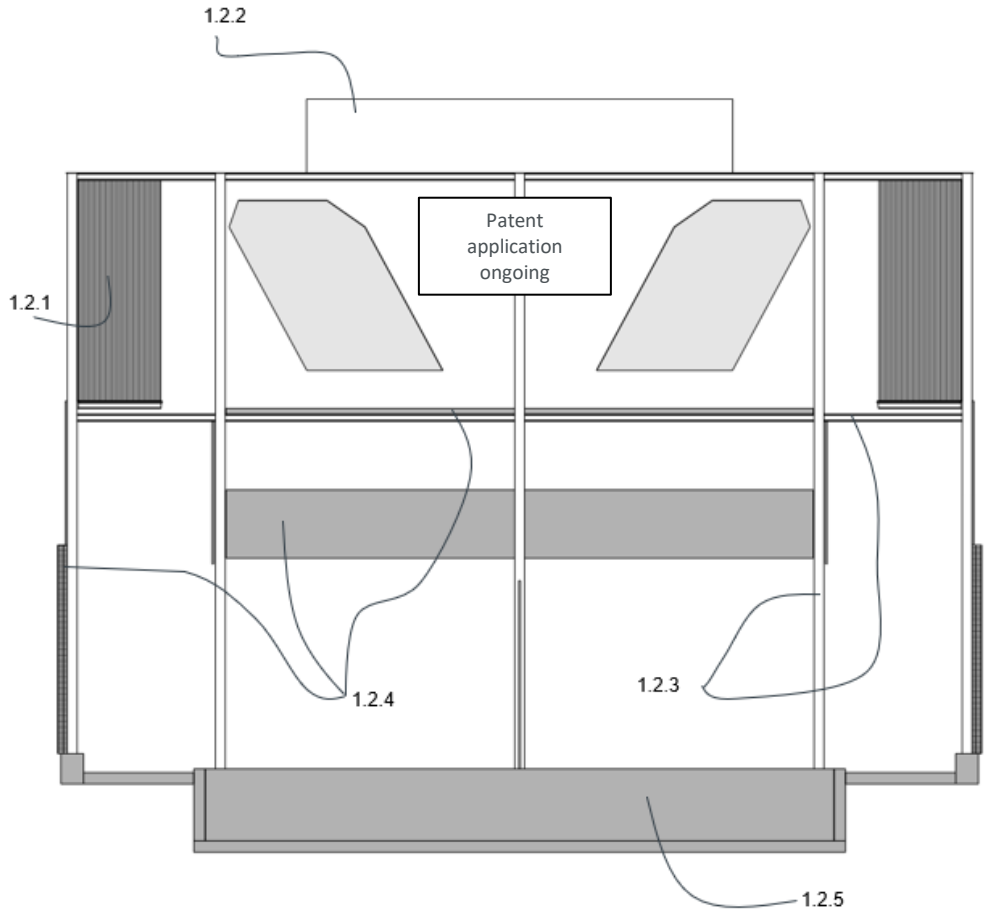
1.2.1 Fluid-to-air heat exchangers in vertically arranged cooling deltas

1.2.2 Fan drive units serving both wet and dry parts

1.2.3 Modular HPCT cell structure

1.2.4 Wet cooling technology (louvers, fills, water distribution piping and prayers, drift eliminators)

1.2.5 Water basin



HYBRID COOLING – THE SOLUTIONS
SINGLE CIRCUIT DRY/WET SOLUTIONS

Hybrid Wet-Oriented Plume Abated Cooling Tower (HCCT)

- The HCCT uses wet cooling technology to dissipate most of the heat into the atmosphere.
- A smaller portion of heat is dissipated into the atmosphere via water-to-air Forgo HX bundles located in the tower.
- Ambient air passing through the Forgo bundles warms-up, and this warmed-up air is mixed with the warm humid air from the wet part, thus abating visible plume emission.
- The cooled cooling water is collected in the wet cooling tower basin
- All-Dry operation not possible
- Small dry part is located above the wet tower
- Mechanical draft cell-type tower design
- Annual water savings smallest amongst dry/wet solutions
- Example shown: Shanghai Fengxian 800MW Power Plant (MVM EGI 2019)

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