Reducing the abstraction of fresh water in Power Plant: Matching H2020 project

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

September 8th ,2016

EXPPERT EUROPE 2016 Conference

KRACOW

Danila Cumbo, Enel

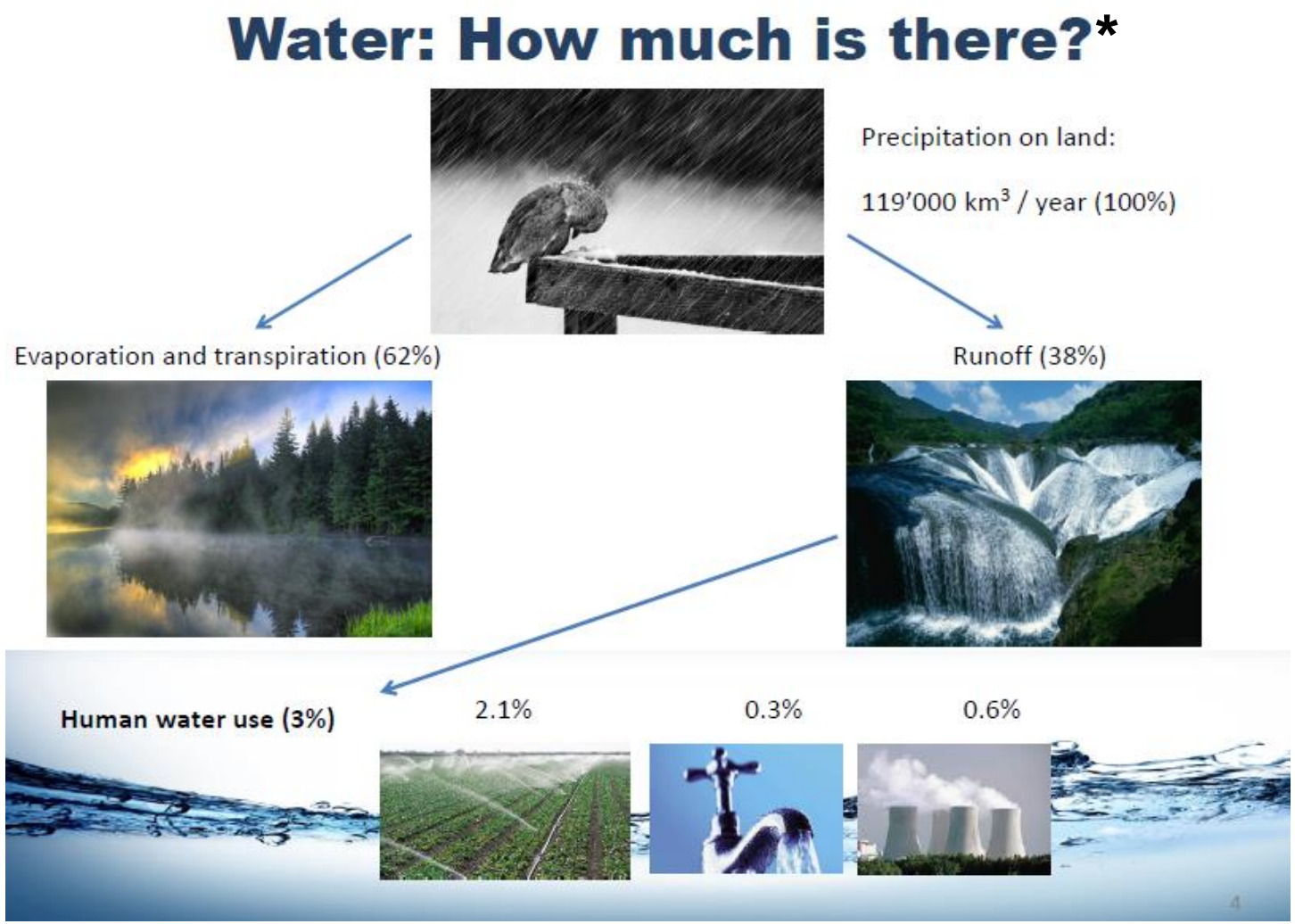
CONTENT

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

- Background and rationale
- The Matching H2020 Project - Overview
- Focus on Water Saving Technologies

Background and Rationale

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS



Human water use is a so small percentage of the total amount of water precipitated on the land…

Then what is the problem ?

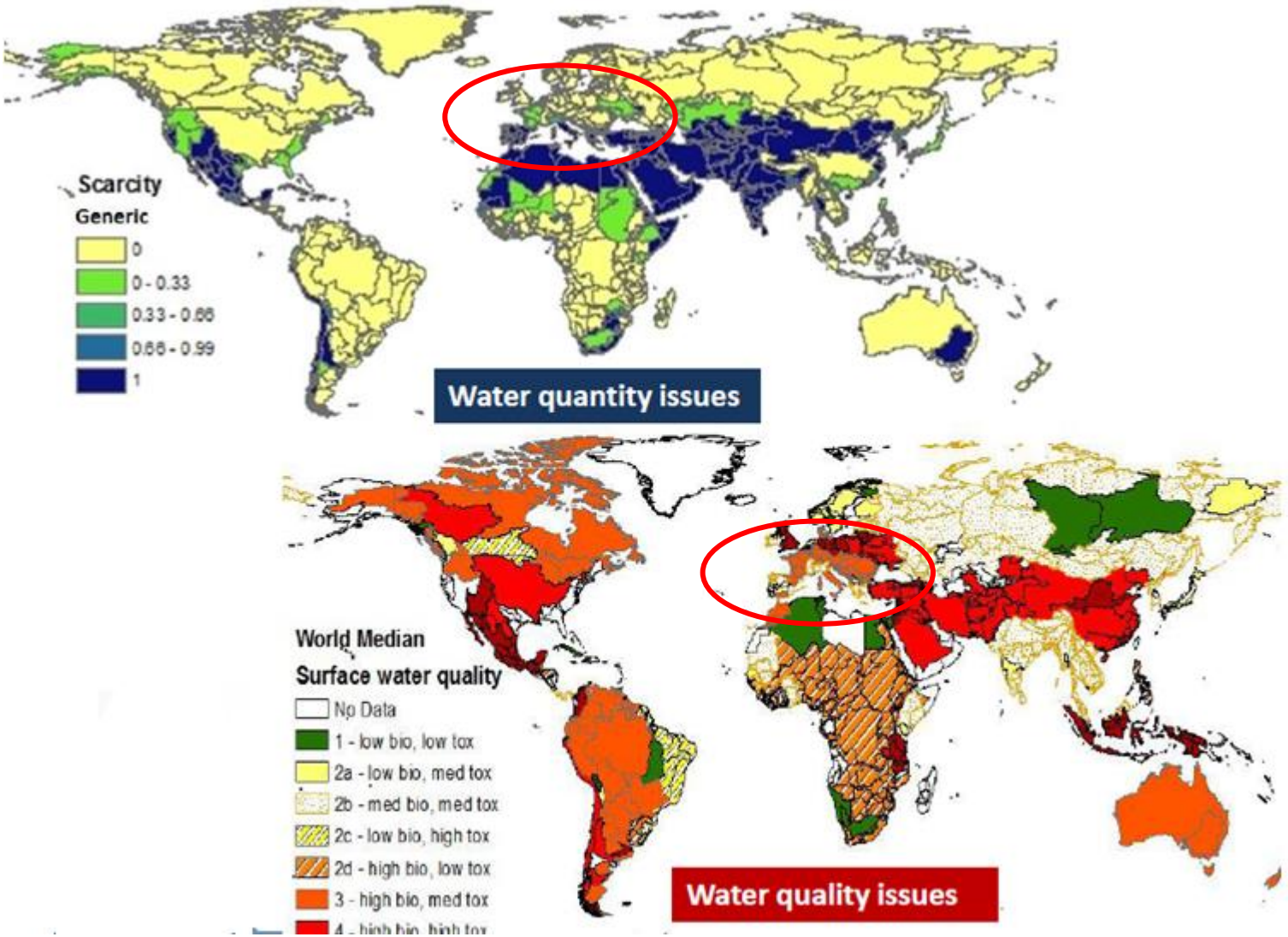
First**: Water is not well distributed in time and space and its quality is deteriorating around the globe: **quality issues

Second:** The quantity represented as accessible, reliable, environmentally sustainable supply is a much smaller quantity than the absolute raw water available in nature and that is the amount that truly matters**:** **quantity issues

✱ ***Source:***
Anne-Marie Boulay, Ph.D. WULCA,
Water footprint training, San Francisco, October 8th, 2014

Background and Rationale

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS



At European level, while water is in general abundant, *water scarcity still affects some regions in particular during summer*.

On the basis of an EEA assessment the good ecological status aimed by the European water framework directive (WFD) was reached only in 53% of the cases.

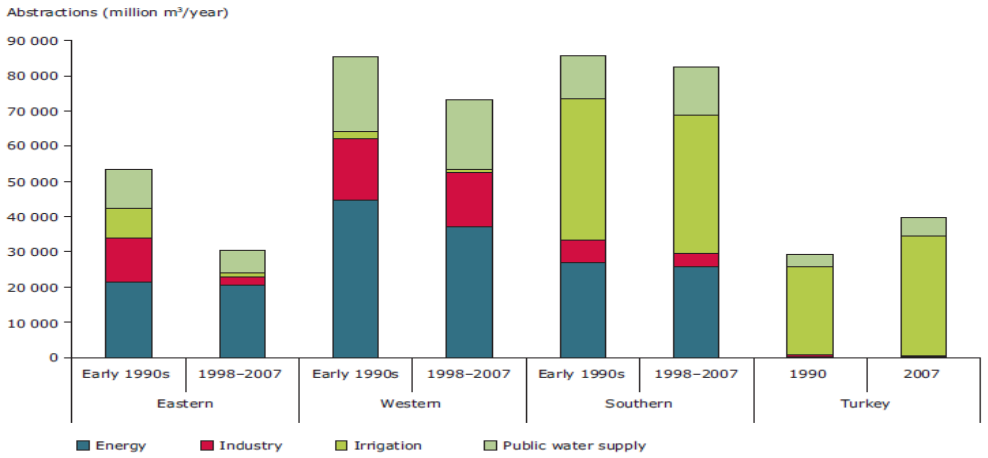
In most cases *"water abstraction" was one of the factors that affected the quality of water bodies.*

Source:
Anne-Marie Boulay, Ph.D. WULCA,
Water footprint training, San Francisco, October 8th, 2014

Background and Rationale

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

EU Water abstraction per sector – EEA 90's vs 2007



Power generation is a sector requiring great amounts of water: Cooling water for energy production accounts in fact, for 43-45% of total water abstraction in European Union

MATChING is a collaborative project, funded by EU H2020 program, which has the aim to reduce the water demand and to improve the energy efficiency of cooling systems in the power generation sector

(1)Roadmap to a Resource Efficient Europe, EC COM (2011) 571 Final (2) The European Environment State and outlook (2010) EEA (3) Charting Out Water Future, 2030 Water Resource Group (2009);(4)Rübbelke and Vögele, 2011

The Consortium

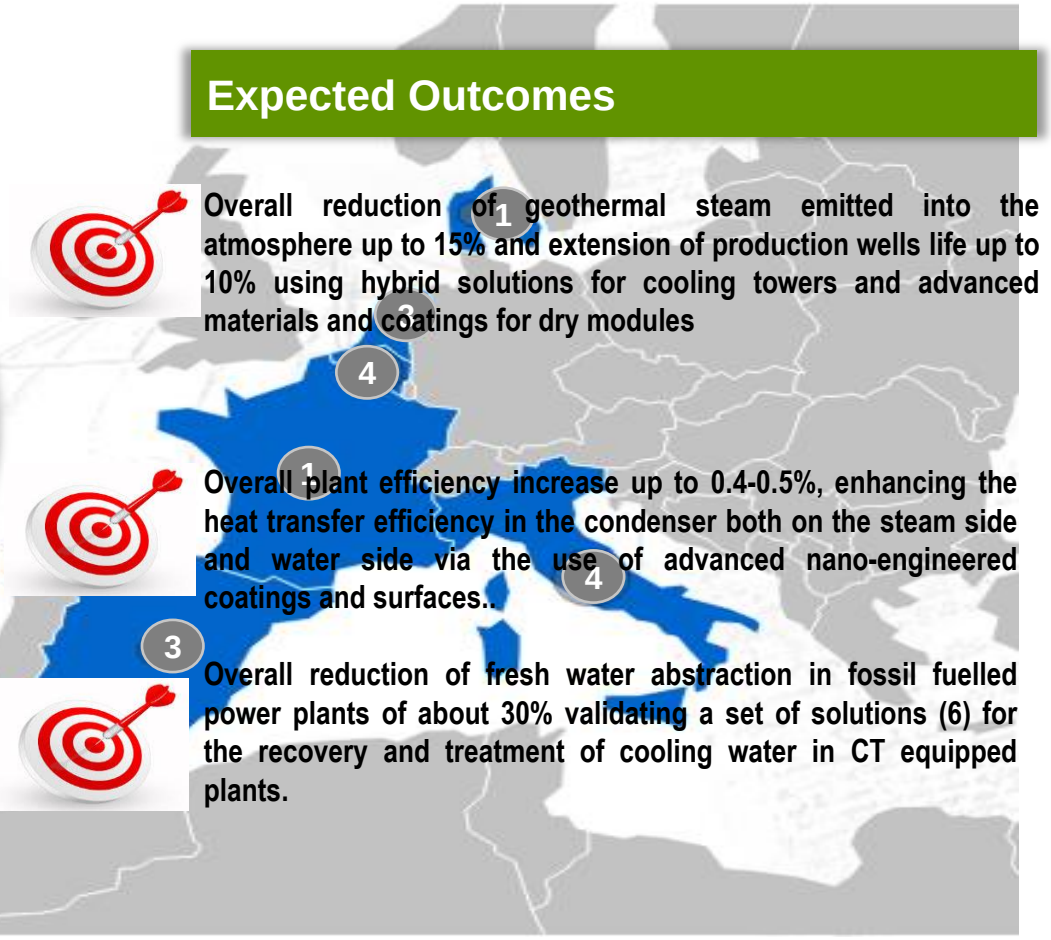
MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

Consortium is made of 4 Utilities, 5 Technology Providers, 6 Research institute and 1Service provider.

Partners are from 6 EU Counties: 4 from Italy, 4 from Belgium,3 from Spain,3 from Netherland and 1 from Denmark

SPIG
Aquastill
enel
eDF
enel Green Power
ionics surface technologies
INTEGASA HEAT EXCHANGERS
endesa
Pathema Innovatief met Water
vito
ITM
SWECO
DANISH TECHNOLOGICAL INSTITUTE
MateriaNova MATERIALS R&D CENTRE
ENGIE Lab
aimen CENTRO TECNOLÓGICO

Expected Outcomes



1 3 4

Overall reduction of geothermal steam emitted into the atmosphere up to 15% and extension of production wells life up to 10% using hybrid solutions for cooling towers and advanced materials and coatings for dry modules

1 4

Overall plant efficiency increase up to 0.4-0.5%, enhancing the heat transfer efficiency in the condenser both on the steam side and water side via the use of advanced nano-engineered coatings and surfaces..

3

Overall reduction of fresh water abstraction in fossil fuelled power plants of about 30% validating a set of solutions (6) for the recovery and treatment of cooling water in CT equipped plants.

MATChING approach and methodology

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

RECOVER EVAPORATION

Water recovery from plume through **membrane condenser** (MC)

EVAPORATION

REDUCE EVAPORATION

Advanced Hybrid Systems

ALTERNATIVE WATER SOURCES

Novel membrane based technologies for intake water pretreatment

Special materials/coatings to handle "dirty" fluids

INTAKE WATER

CONDENSER

ENHANCE HEAT TRANSFER AND EQUIPMENT ROBUSTNESS

Coating to promote drop-wise condensation

Special materials/coatings to handle "dirty" fluids

Recirculating water

RECOVER BLOWDOWN

Novel membrane based technologies for blowdown recovery

BLOWDOWN WATER

REDUCE BLOWDOWN

Special materials/coatings to handle "dirty" fluids in CT and condenser

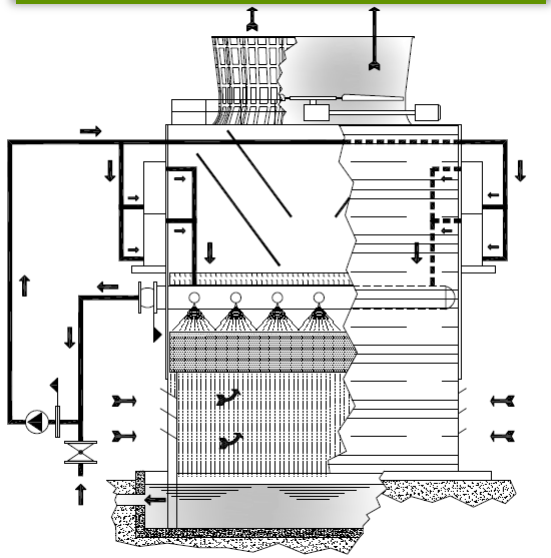
Novel membrane based technologies to enhance intake water quality

Novel Circulating water conditioning systems

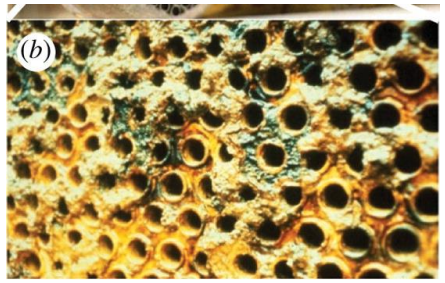
Technologies

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

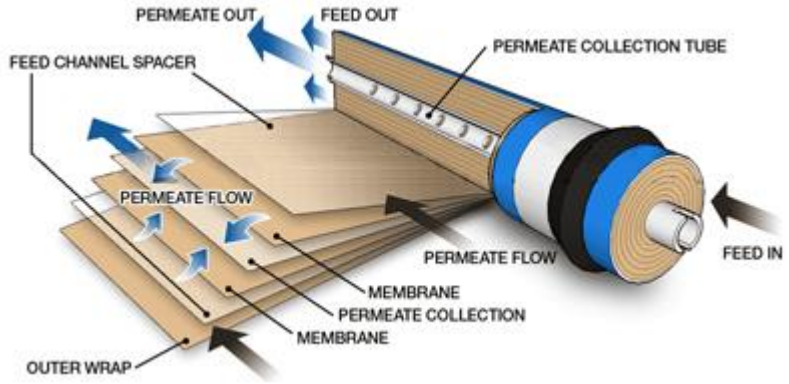
Hybrid CT for Geothermal application



Materials for steam condenser& heat exchangers

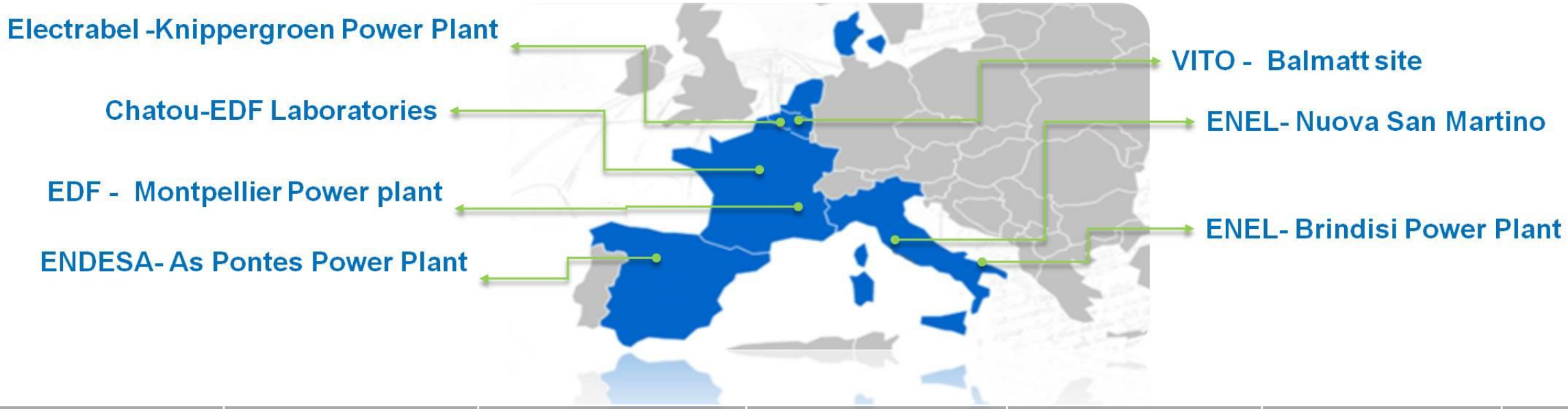


Water treatment systems



Demonstration program

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF IN POWER



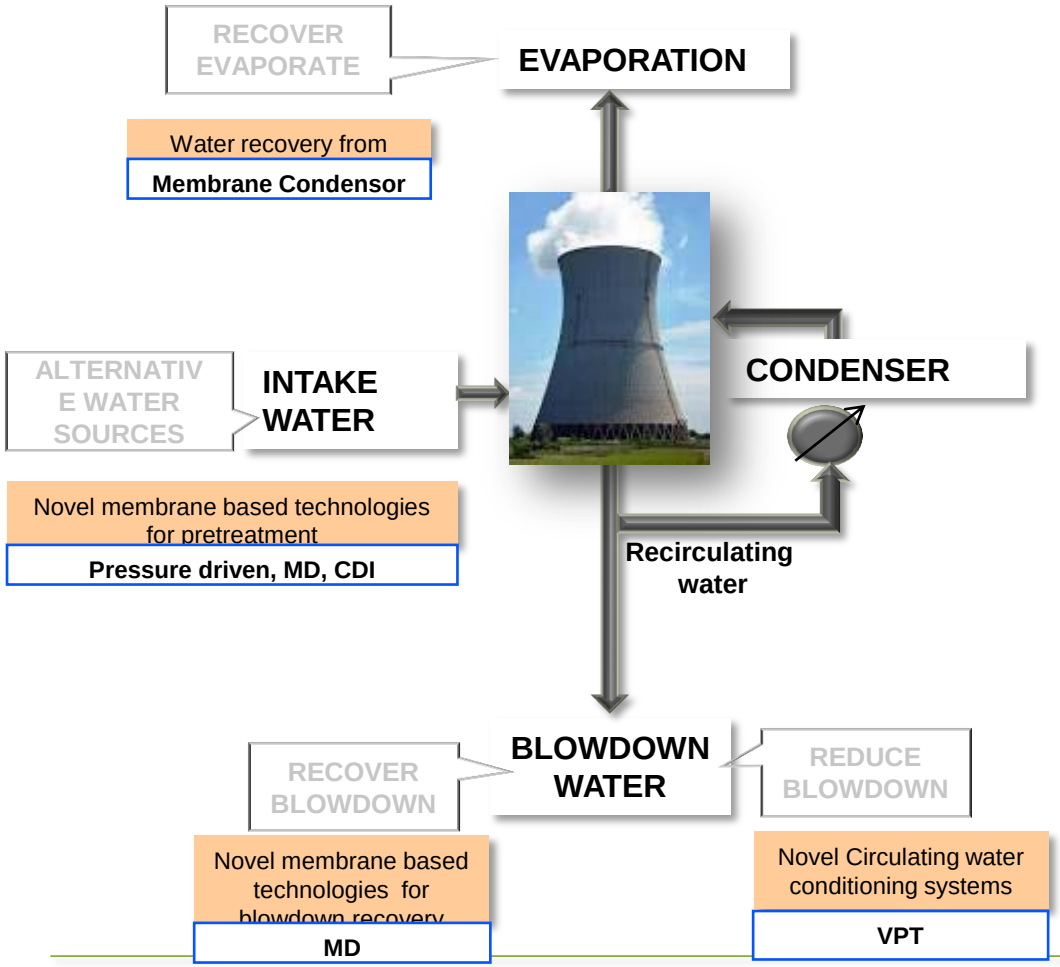
Coatings for geothermal heat exchangers	Membranes for water recovery from FGD	Hybrid CT for geothermal application	Coatings/materials for steam condenser and membranes for cooling water treatment	Coatings/materials for steam condenser	Membrane condensor	Membranes and technologies for cooling water treatment
						
Balmatt in Mol, Belgium	Brindisi Sud, Italy	Nuova San Martino, Italy	As Pontes, Spain	Chatou, France	Montpellier, France	Bruxelles, Belgium

Focus on technologies for water treatment

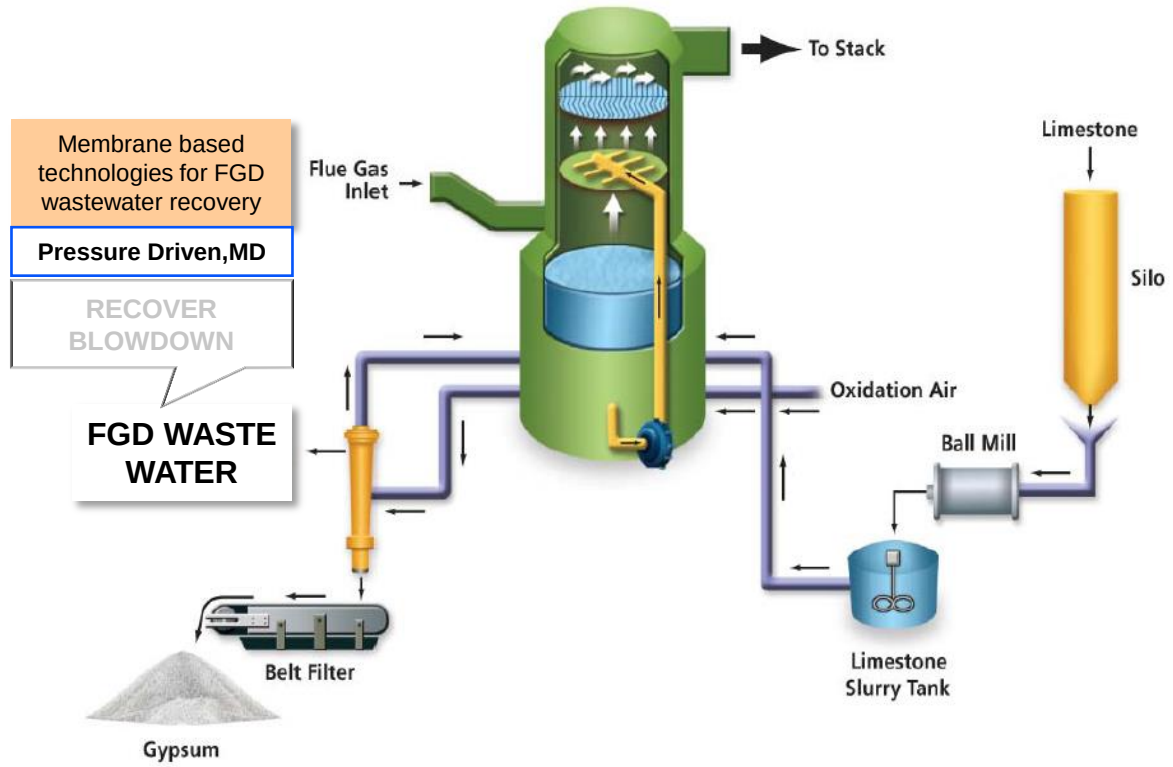
Water saving opportunities: MATChING approach

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

Cooling Section

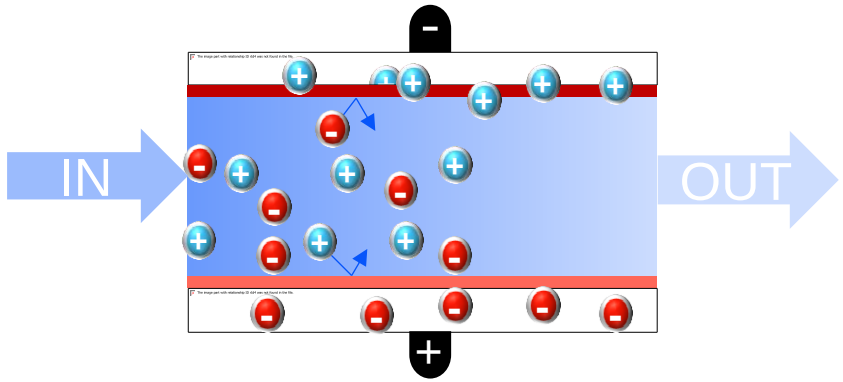
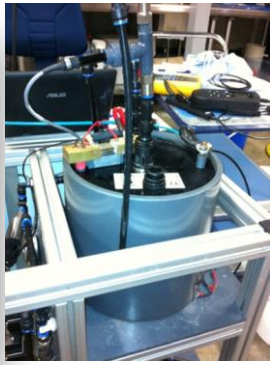


Flue Gas Treatment Section



Water Treatment technologies

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

WATER	SELECTED TECHNOLOGIES	GOAL	LABORATORY	PILOT SCALE
INTAKE WATER	Membrane Capacitive deionization (MCDI)  *Characteristics:* • *Low E (<0,5kWh/m³)* • *Low fouling* • *No chemicals needed* • *Water recovery >90%* • *Able to handle solids* • *Robust*	Increase COC by: ➢ decreasing hardness ➢ decreasing salinity (intake or recirculating water) Determine: ➢ maximal COC for a selected intake water source	**VITO LAB.** Lab-scale tests will be conducted on four different streams: ➢River water with low hardness (<160mg CaCO3/l) ➢River water with high hardness(>160mg CaCO3/l) ➢Brackish water from estuaries/harbours (max 5g TDS/l) ➢Treated municipal waste water.	**Merades Pilot Plant** A pilot scale MCDI unit and module will be built and deployed in combination with the MERADES Facility The pilot unit will consist of one industrial-sized module (approximately 10m² electrode surfaces)  

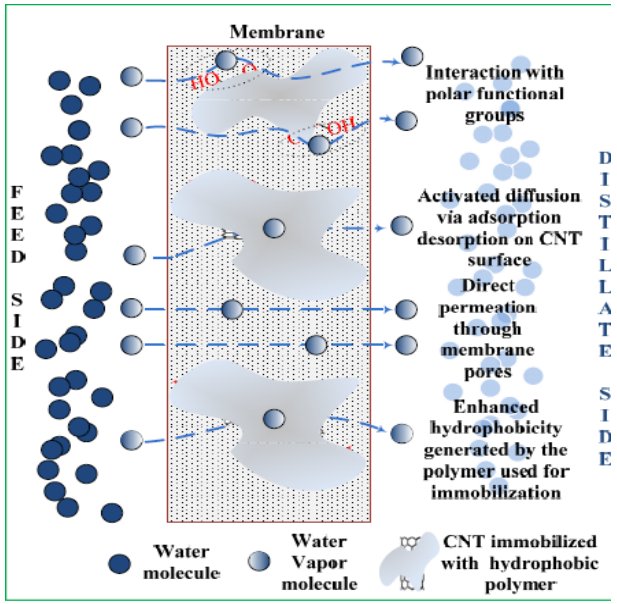
Water Treatment technologies

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

WATER	SELECTED TECHNOLOGIES	GOAL	LABORATORY	PILOT SCALE	DEMO SITE
Circulating Cooling Water	**Vortex degasification technology (VPT)**  **Principle:** Chemical free conditioning of cooling tower circulating water using vortex degasification and calcium precipitation	Increase COC by: ➢ Reducing scaling tendency of water without the need to add chemicals	Small scale vortex test device will be tested at VITO Lab to evaluate: scaling/fouling effects with and without coupling vortex with membrane filtration process	**MERADES PILOT PLANT** VPT will be coupled to the MERADES pilot plant Test duration ~ 3 months 	**ASPONTES POWER PLANT** VPT will be coupled with SWECO TEST RIG and in side-stream configuration to the As Pontes PP Cooling Tower Test duration ~ 2 months 

Water Treatment technologies

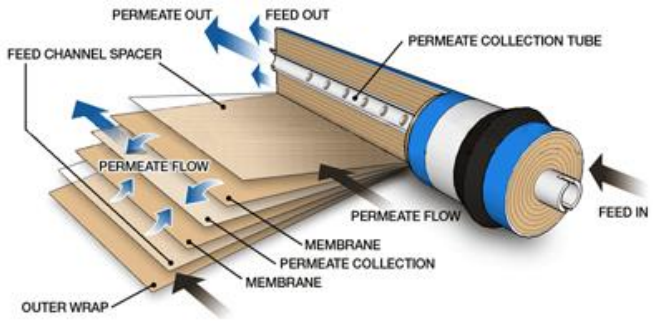
MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

WATER	SELECTED TECHNOLOGIES	GOAL	LABORATORY	PILOT SCALE	DEMO SITE
Cooling Tower Blowdown	**Membrane Distillation**  **Principle:** - Based on the retention of liquid water and the permeation of water vapour. - Process thermally driven.	Reduction and reuse of CT blowdown using MD, combined with pretreatment to tackle scaling/fouling issues.	**VITO LAB.** Preliminary test at VITO lab to define the optimal module parameters and to support the design of the MD modules for demonstration in real conditions.	**MERADES PILOT PLANT** MD pilot module will be coupled to the MERADES pilot Test duration : 3 months 	**AS PONTES POWER PLANT** A larger MD demo module will be installed in side-stream configuration. Test duration : long run demonstration of 12 months 

Aquastill vito ENGIE Lab endesa

Water Treatment technologies

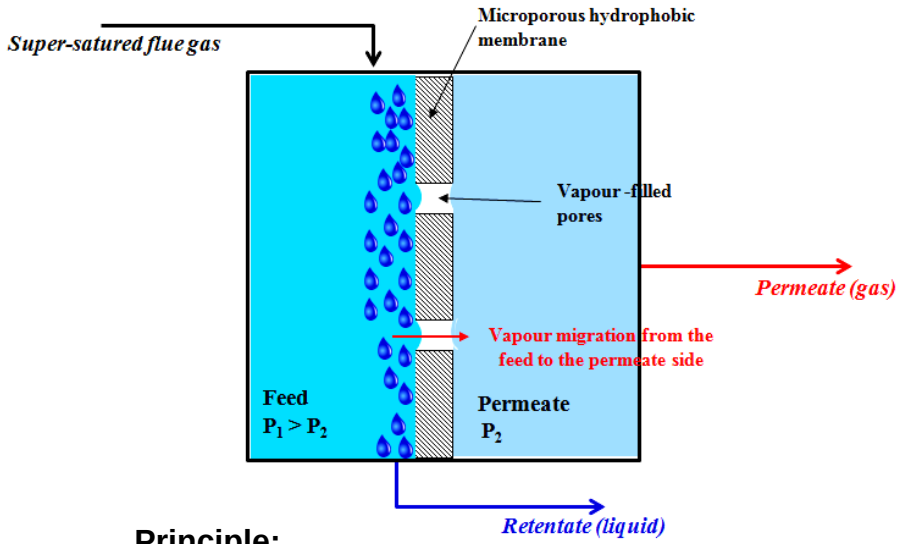
MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

WATER	SELECTED TECHNOLOGIES	GOAL	LABORATORY	PILOT SCALE
FGD WASTE WATER	**Pressure Driven Membranes & MD**  **Principle:** - Use of commercial pressure driven membranes (eventually coupled with thermally driven membranes) in adequate process schemes to treat high salinity waters	Recovery of water from waste streams reusing it for different power plant purposes and avoiding at the same time waste water discharge. Demonstration of treatment schemes based on commercially available pressure driven membranes eventually coupled with specific pre-treatment processes .	**CNR LABORATORIES** Different MF, UF,NF and RO and MD configurations will be characterized to select the best schemes to be applied for the design of pilot unit in Brindisi Sud PP	**BRINDISI SUD POWER PLANT** A pilot unit will be installed In Brindisi Sud to treat FGD waste water in side-stream configuration with the current Brindisi ZLD System 

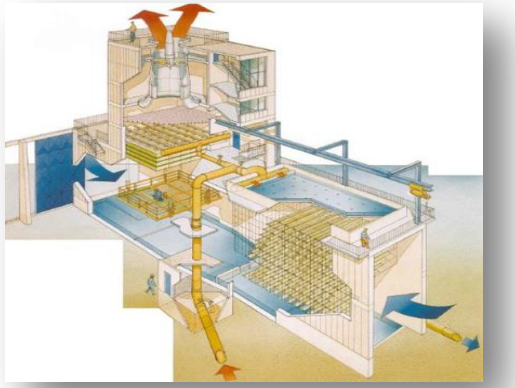
Water Treatment technologies

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

WATER	SELECTED TECHNOLOGIES	GOAL	LABORATORY	PILOT SCALE
Cooling Tower Plume	**Membrane condensers**	Recovery of water vapor from Cooling Tower Plume.	**CNR LABORATORIES** Experiments and modeling will be carried out on selected humidified waste gaseous streams (i.e., plume of the EDF MINSTRAL facility). A test system will be designed and constructed to be integrated in EDF MINSTRAL facility	**EDF MINSTRAL FACILITY** A test system will be integrated in EDF MISTRAL facility. The test will allow the evaluation of: 1) the amount water recovery (Liter /day /m2) in winter or summer condition; 2) the quality of collected water; 3) the associated energy consumption.



Principle:
Microporous hydrophobic membranes for water recovery from the retentate side and the simultaneous transfer of the other gases across the membrane.



Where we are

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

- The project has started on the first of March 2016
- Up to now, for many of the presented technologies, the laboratory test have been already started or will start soon
- Some of the Project Numbers:

Starting Date:	**First of March 2016**
Duration:	**42 months**
Partners:	**16**
Overall Budget	**€ 11.847.291,75**
Grant Amount	**€ 9.706.413,77**

Acknowledgement

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

Thanks to all MATChING Partners and our Stakeholders Community:

Acknowledgement

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

Thanks to all MATChING Partners and our Stakeholders Community:

Follow us on
www.matching-project.eu

MATChING Group on LinkedIn

Main Coordinator Contacts:

enel

danila.cumbo@enel.com;

Thanks for your attention

This project has received funding from the *European Union's Horizon 2020 research and innovation programme under grant agreement N° 686031.*

The content of this presentation reflects the author's view. The *Commission is not responsible for any use that may be made of the information it contains*

Water saving opportunities: Current practice

MATChING
MATERIALS & TECHNOLOGIES FOR PERFORMANCE IMPROVEMENT OF COOLING SYSTEMS IN POWER PLANTS

WATER SAVING OPTIONS FOR CT	PERCENTAGE OF WATER SAVING ACHIEVABLE [%]	CURRENT PRACTICE
Intake water pre-treatment	**~14%:** COC increase from 4 to 8 by means of softening process. **~24%:** blowdown elimination (COC of 4) through intake water demineralization.	**Not applied** *Unless too bad quality of intake water.*
Reuse of other available waste water streams, as make up water.	**Up to 100% fresh water reduction** is possible depending on the amount of available waste water sources.	**Not applied** *Unless site specific conditions are met, i.e. a dry region or huge amount of (municipal) waste water available.*
Reduce blowdown through operation at high COC.	**~ 9%** assuming to increase COC from 4 to 6.	**Commonly applied** *Adoption of cooling water treatment programs; implying use of chemicals to avoid scaling and corrosion problems.*
Recovery of blowdown.	**~24%** assuming to completely recover the blowdown water (starting from a COC of 4.)	**Not applied** unless site specific conditions (dry climates and/or restrictions on waste water discharge).
Reduce the evaporation.	**~15%** assuming to reduce the evaporative losses of 15% (without changing COC) through the installation of dry modules.	**Sometimes adopted:** this option reduce also considerably the plume visibility.
Recover the evaporated water.	**~ 60% - 65%** assuming to recover the 80% of evaporated water.	**Not applied** Dry cooling is adopted alternatively