Integrated Production of Power Cooling and Water

Jürgen Scharfe

Cairo, Nov. 2007

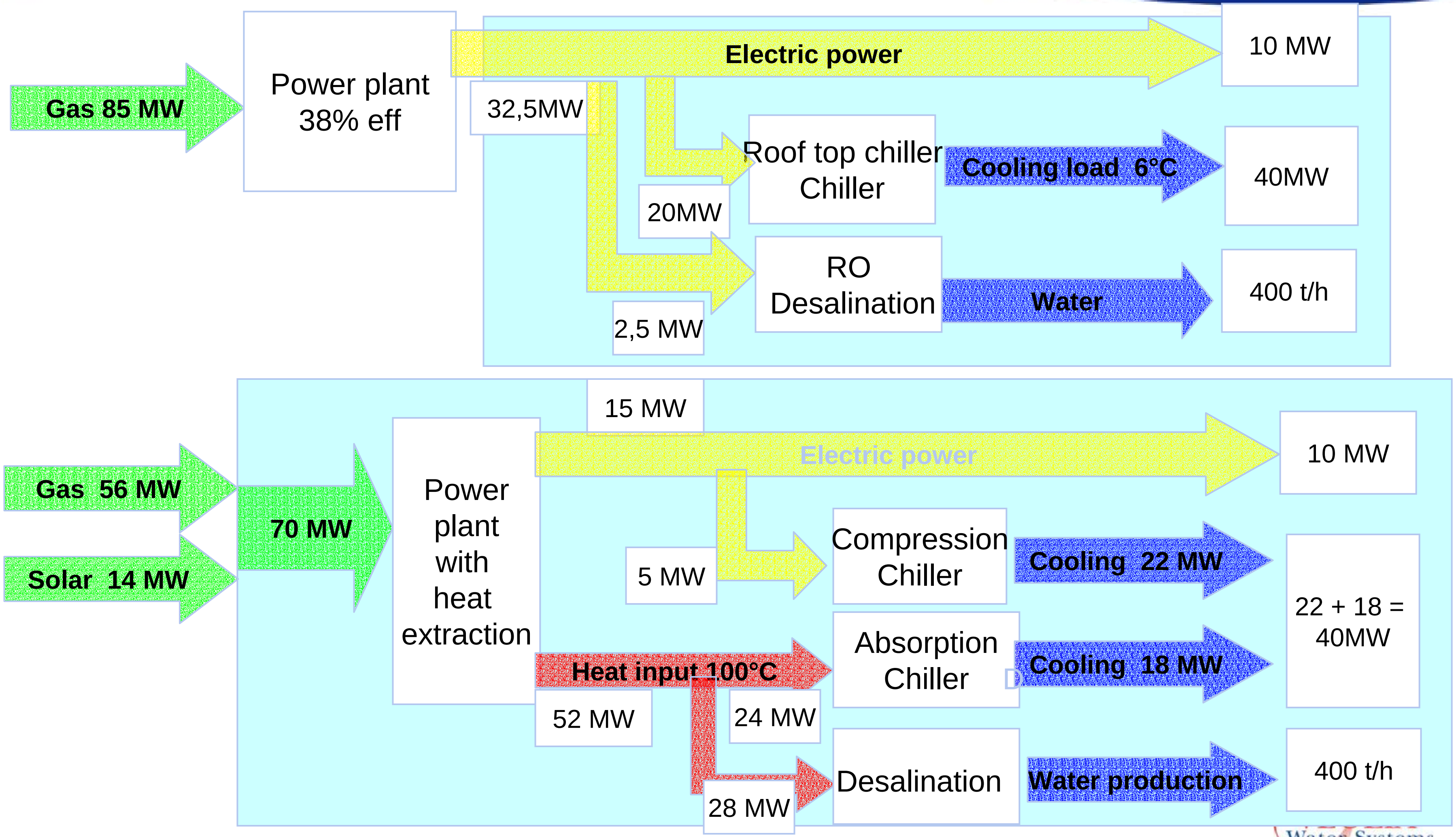
VEOLIA Water

Objective of Integration of Utilities

- Integration is one of the concepts that have the best potential of increasing overall efficiency in the power industry
- Higher efficiency means
  - Less energy consumption
  - Less waste heat rejection to ambient
  - Reduced impact on environment
- Centralized cooling increases comfort for individual users
- Makes renewable energy more economic
- Reduces cost for peak power production facilities

VEOLIA Water Systems

Conventional - Integration



Water Systems

Examples in Trigeneration

> Scandinavia has extensive district cooling systems with absorption and compression systems
  - Stockholm
  - Helsinki
  - Västeras
  - Göteborg

> But only very few installations around the Mediterranean

Power Cooling and Water

- Integration of Desalination adds another product to the plant
- Power and Cooling can be integrated quite easily because there is only one thermal consumer
- Heating and cooling is usually not coincindental
- Water production is mostly coincidental with cooling – much unlike heating and cooling
- Therefore the cooling machinery is competing with the desalination for the available heat
- Desalination has different requirements

VEOLIA Water Systems

Interface Conditions

Consumer	Media to provide	temperature supply / return
space heating	Hot water	70/100°C / 40-60°C
sanitary hot water	Hot water	min. 60°C
kitchens and laundries	steam	4 bar min.
Air conditioning	cold water	5-8°C / 12- 18°C
Absorption Chillers SE	steam	0.8 to 1.5 bar abs.
MED desalination	steam	0.35 bar abs. for
vacuum pumps	steam	min. 3-4 bar
MED with TVC	steam	min. 3 bar .

Competing Heat Consumers

> Cooling and Desaliation compete for the available heat

> The two systems require heat at different temperature levels

> Selection of temperature level is very important

> Using steam at a too high level has a negative impact on the power generation process

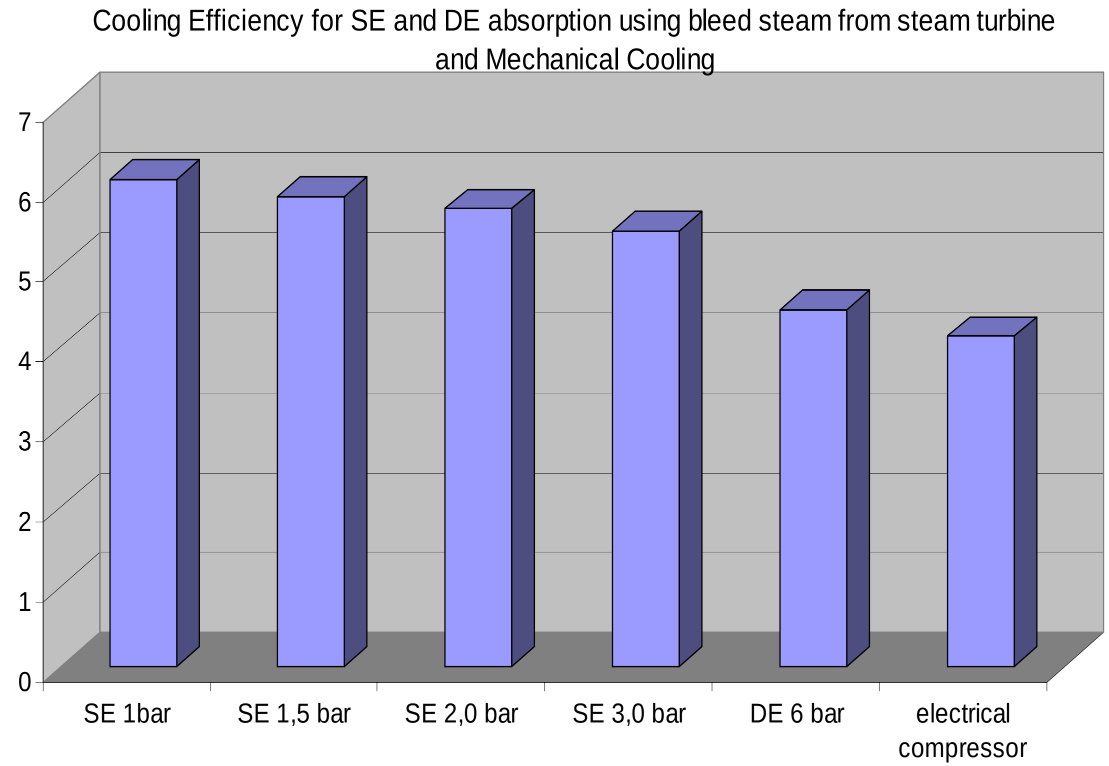
VEOLIA Water Systems

Efficiency of cooling

How to compare systems?
One way is compare the impact on the power generation

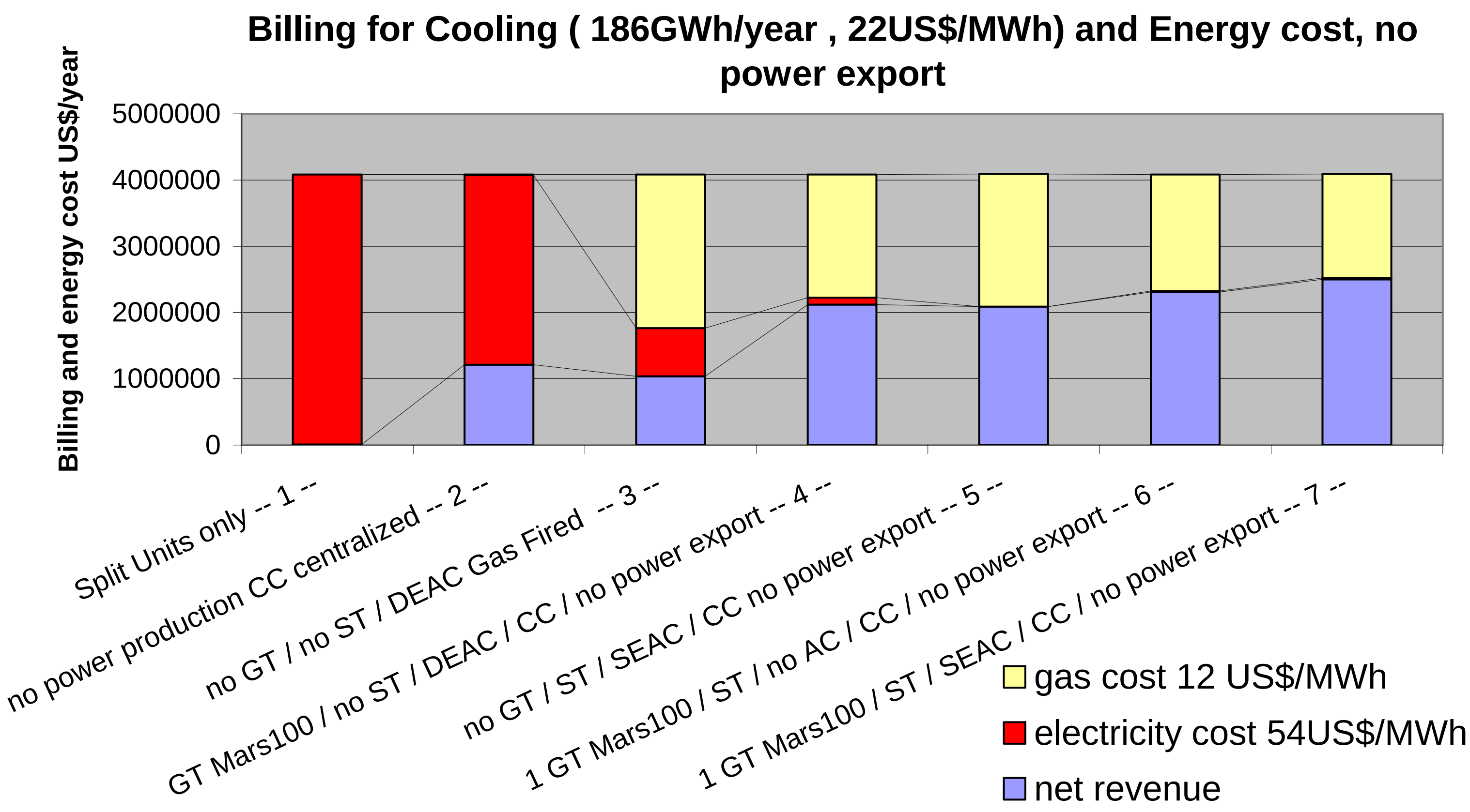
The table includes

- Power consumption of chiller
- Power consumption of cooling water pump
- Loss of electrical power output due to steam extraction
- Values calculated for 34°C/43°C cooling water
- Conventional
  2–2.5 kW cooling /kWel



VEOLIA Water Systems

Which System to select?



Power and Cooling

The simulation has revealed some very interesting results:

> Single effect absorption chiller can outperform other systems when using bleed steam at a properly selected pressure

> Combinations with steam turbine and absorption very competitive

> Gas turbines and heat recovery boilers + double effect chiller are almost as efficient but has higher CAPEX

> Maintenance cost must be considered also

Example

The boundary conditions for all cases are

cooling water 34°C summer / 25°C Winter

condensing turbine stage only for RO-coupled plant

MED coupled unit with back pressure turbine , T sat 85°C winter / 105 °C summer

Back pressure is higher than required by MED because chillers need the temperature

Result

> The processes with MED will show a higher power loss for two reasons:

> Bleed pressure too high for MED

> Efficient absorption chiller must be replaced by compressor due to insufficient steam quantity

VEOLIA Water Systems

Energy blances for the examples

	Cooling GWh	Water Mm3/a	Power GWh	Gas GWh
No water production	302	0	63	441
5000 m³/d RO	302	1,79	63	474
5000 m³/d MED	302	1,79	63	527
5000 m³/d RO	302	1,79	93	575
5000 m³/d MED	302	1,79	93	579

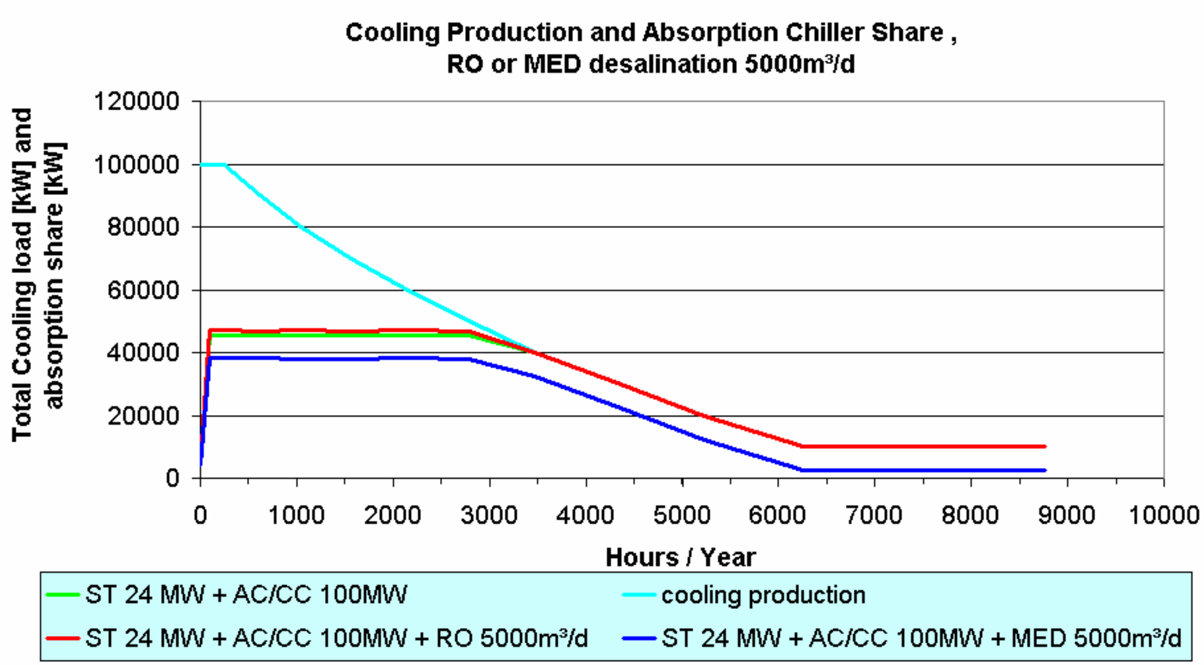
Effect of Competing Heat Consumers

> Improper design can have negative effects

> Desalination plant receives too much heat

> Absorption chillers replaced by compressors

> Reduction in plant efficiency



VEOLIA Water Systems

Summary

- Solar powered thermal desalination use the waste heat at very low temperature (70°C)
- The power process of a dry cooled and cogeneration unit has roughly the same condensing temperature (70°C)
- The dry cooed process has to reject the heat but the combined process uses it for desalination
- Combined plants are more efficient than a remote solar thermal plant using dry condensers and coastal RO
- The key to efficient use of solar energy is optimized thermal process using the condenser for desalination instead dry cooled plants

Summary

- Tri-Generation (Power / Water / Cooling) is the most efficient way to reduce fuel consumption and environmental impact
- If plants are large enough – and 5000m³/d is small ! Steam turbines with dual pressure exhaust are available for optimized performance of MED desalination
- A minimum of 10000 to 15000 m³/d of desalination should be taken into consideration to make plant cost effective
- Properly designed units can reach identical performance provided the absorption units take the majority of the load
- Thermal cogeneration unit can most efficiently use biomass or solar energy as a fuel saver

VEOLIA Water Systems