AIR-COOLING TECHNOLOGY APPLICATION WITHIN ESKOM

Centre for Science and Environment Conference

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- Technology Selection
- RSA Drivers
- Associated impact on Auxiliary/ Efficiency and Water Consumption
- Water Challenges associated to Retrofits e.g. FGD/ CCS

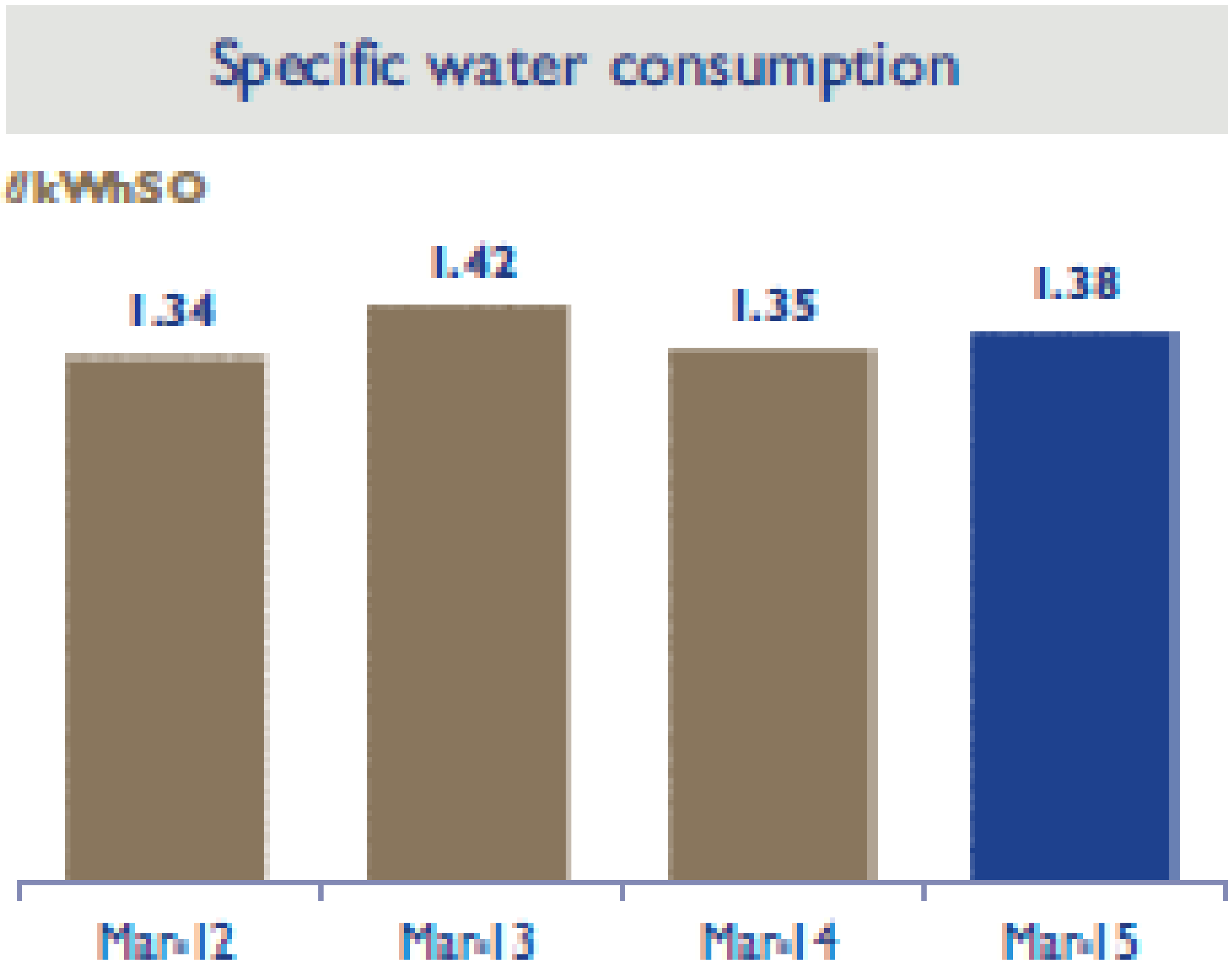
ESKOM'S WATER MANAGEMENT POLICY

Eskom is a large consumer of fresh water in South Africa, accounting for approximately 2-3% of the country's total water consumption annually.

"Reducing fresh water usage and eliminating liquid effluent discharge to avoid impacting water resources through effective water management processes and the use of mine water" is on of Eskom's environmental management strategic objectives.

The water legislation pieces are: The National Water Act *(Act 36 of 1998)* and The Water Services Act *(Act 108 of 1997)*, which strong emphasis on equity, efficiency and affordability. The National Water Resource Strategy (NWRS) classifies Eskom as a Strategic Water User – thus water supplied to Eskom is at a 99.5% assurance level, which implies that the risk of failure to supply water is 1 in 200 years.

ESKOM – CURRENT TECHNICAL STATUS



ESKOM POWER STATIONS – COOLING SYSTEMS

Year Commissioned	Power Station	Unit size (MW_e)	Design Raw Water Consumption (l/kwh)	Cooling Technology
1962 onwards	Komati 1-5 / Komati 6-9	5 x 100 / 4 x 125	2.30	Wet-cooled
1967	Camden	8 x 200	2.80	Wet-cooled
1969	Grootvlei 1-4	4 x 200	-	Wet-cooled
1970	Hendrina	10 x 200	2.15	Wet-cooled
1971	Arnot	6 x 350	2.04	Wet-cooled
1971, 1977	Grootvlei 5-6	2 x 200	2.60	Indirect dry-cooled
1976	Kriel	6 x 500	2.06	Wet-cooled
1979	Matla	6 x 600	1.98	Wet-cooled
1980	Duvha	6 x 600	1.97	Wet-cooled
1981	Koeberg	2 x 965	-	Once-through (ocean)
1985	Lethabo	6 x 618	1.84	Wet-cooled
1985	Tutuka	6 x 609	1.80	Wet-cooled
1987	Matimba	6 x 665	0.12	Direct dry-cooled
1988	Kendal	6 x 686	0.14	Indirect dry-cooled
1991	Majuba 1-3	3 x 657	-	Direct dry-cooled
1998	Majuba 4-6	3 x 712	1.07	Wet-cooled
2014	Medupi 1-6 (FGD)	6 x 800	0.16 (0.25)	Direct dry-cooled
2017	Kusile 1-6 (FGD)	6 x 800	0.3	Direct dry-cooled

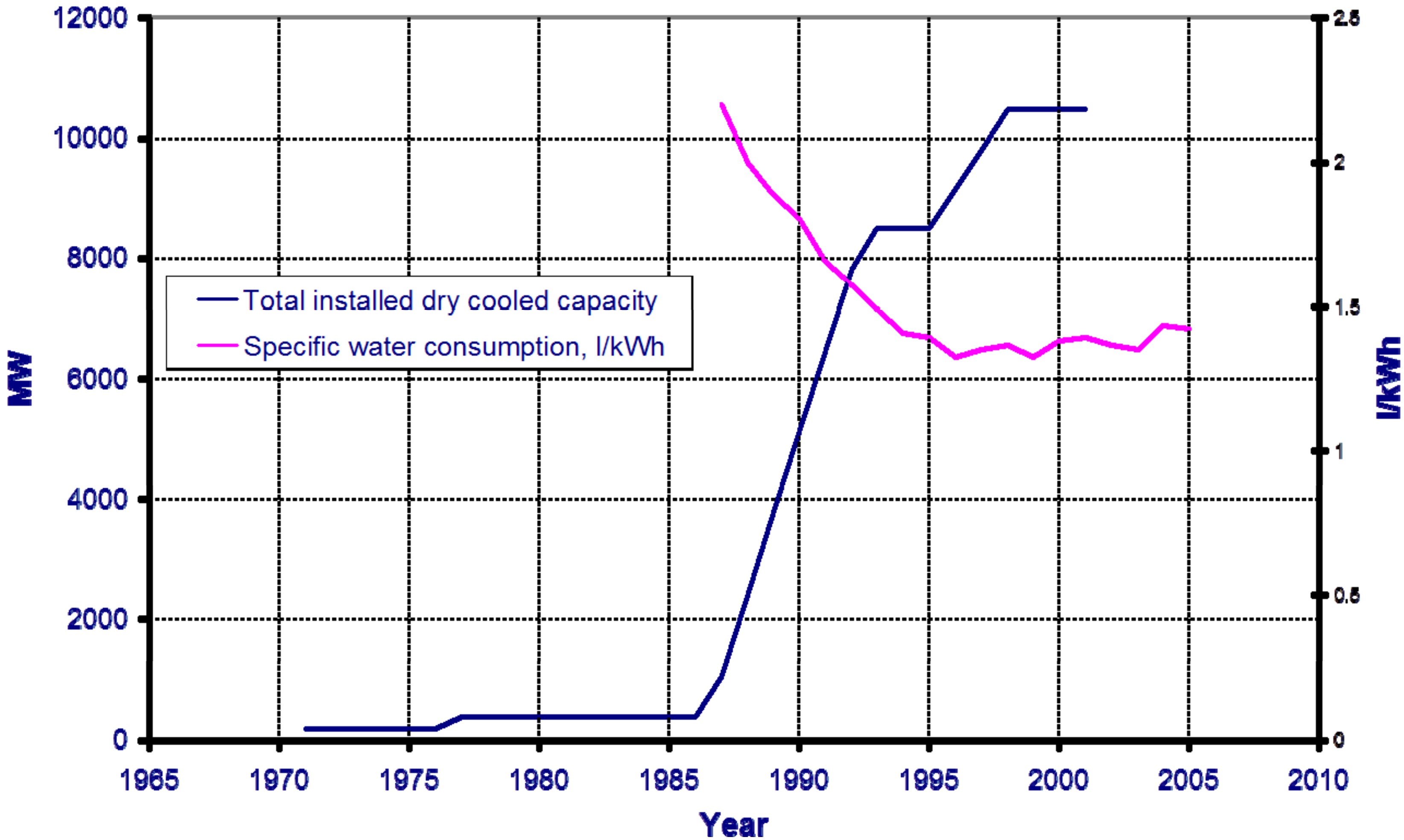
ONCE THROUGH WET COOLING

Eskom: Koeberg Nuclear Power Station

DIRECT DRY-COOLING

Eskom: Matimba Coal-fired Power Station

IMPLICATIONS OF USING DRY-COOLING…POSITIVES



Francois du Preez: Eskom – Corporate Consultant

IMPLICATIONS OF USING DRY-COOLING…NEGATIVES

- Efficiency loss compared to wet-cooling (Assumes same quality of coal burnt)
- Product of efficiency loss – increased greenhouse emissions
- Capital & operating costs greater compared to wet-cooling
- Greater sensitivity to ambient temperature & wind

Francois du Preez: Eskom – Corporate Consultant

INITIAL TEMPERATURE DIFFERENCE (ITD)

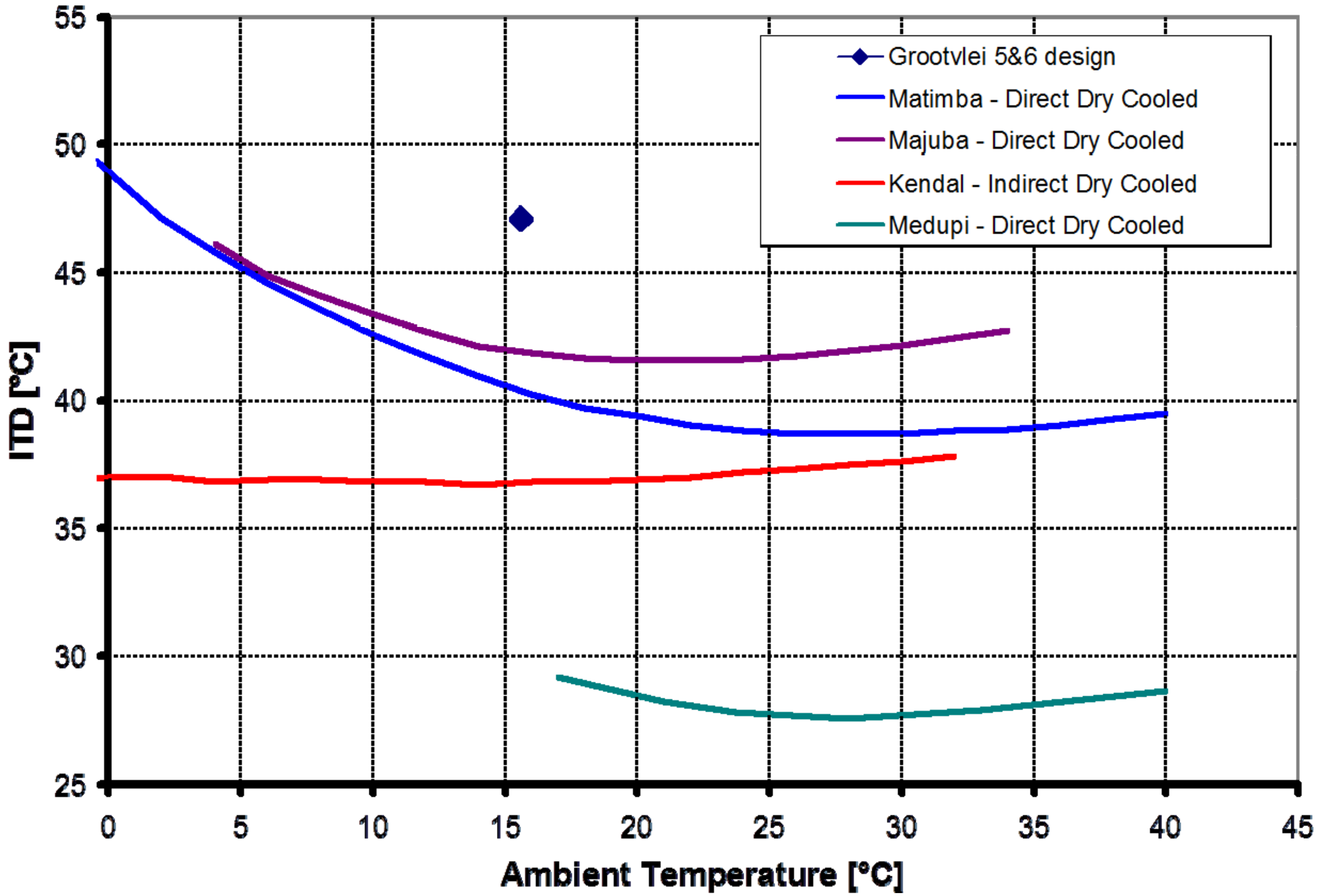
Design point ITD determined by relative size of the ACC

- Large ACC (i.e. large area), small ITD
- Small ACC (i.e. small area), large ITD

- E.g. Medupi design ITD = (T_{steam} – T_{in}) = 52.7 – 23.7 = 29°C
- E.g. Solar ACC design ITD = (T_{steam} – T_{in}) = 51 – 32 = 19°C
  - Comparatively “larger” ACC than Medupi

Francois du Preez: Eskom – Corporate Consultant

ITD TRENDS IN ESKOM



Francois du Preez: Eskom – Corporate Consultant

COLLABORATIONS: LOW WATER FGD – SNO_X

(ENGINEERING PRE-FEASIBILITY ASSESSMENT PHASE BASED ON MAJUBA POWER STATION CASE)

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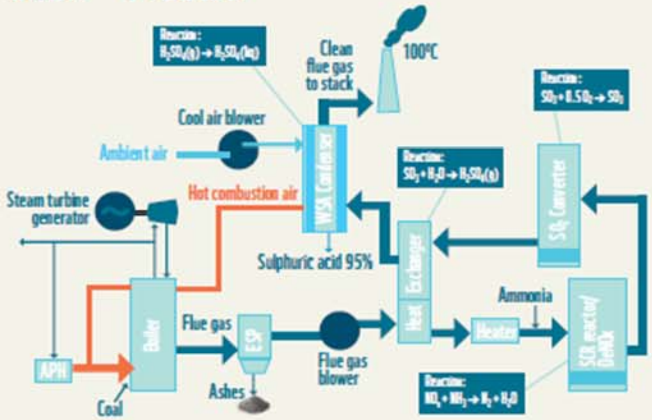
SNOX™ Process



- Starting with an additional filter system, dust and ash is almost completely removed, typically from 20-50 milligrams per cubic metre of flue gas down to 1-2 milligrams per cubic metre.
- A small amount of ammonia is added to the remaining flue gas and, initiated by a catalytic process, the nitrogen oxide (NOx) is converted into harmless water (H2O) and nitrogen (N).
- Sulphur oxide is then passed through another catalytic process which converts SO2 to SO3, followed by a moderated cooling process under which SO3 reacts with a small amount of water vapour already present in the gas to form sulphuric acid (H2SO4) in vapour form.
- Using large air-cooled condensers, the vapour is then condensed – or liquefied – from which the commercial grade sulphuric acid is produced.
- The flue gas leaving the stack is now free from dust and with concentrations of nitrogen oxide and sulphur oxide well below the required limits.

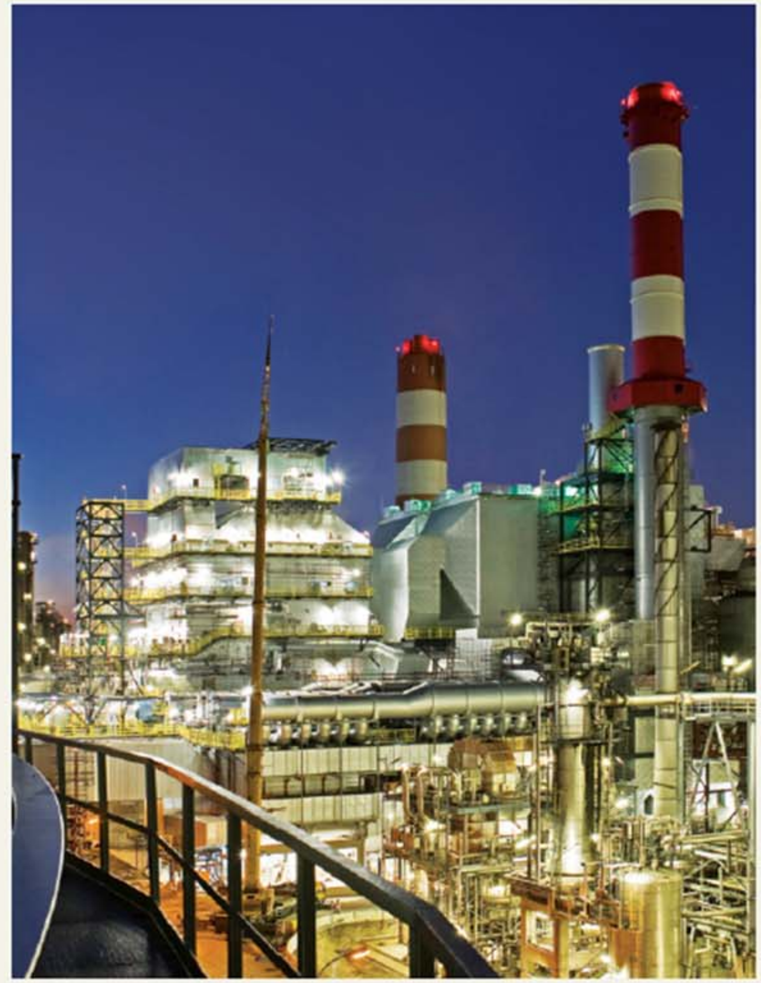
Initial results

"We have been focusing on this study with Eskom since April 2015 and we are completely confident of the technology," says Rosenberg. "It has 20 years of operation behind it, and it is used in plants all over the world, including Denmark, Austria and Brazil. We look forward to the results of the study that will specify the savings for a power station like Majuba."

81%
OF ELECTRICITY COMES FROM COAL-FIRED POWER STATIONS

Guidelines for best practice learned in this project

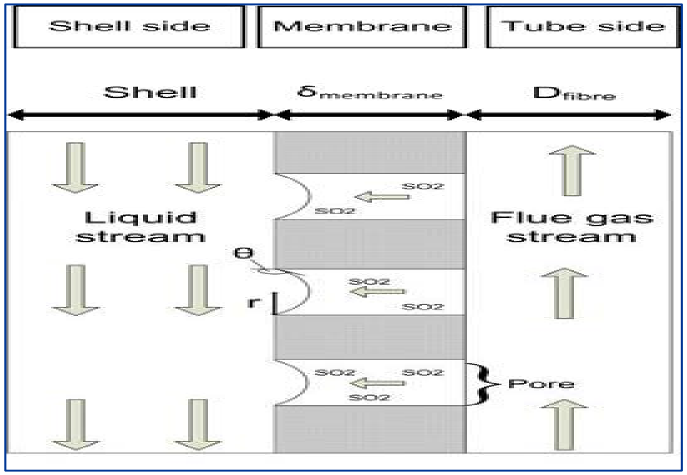
South African partnerships are a key factor – there will be a huge element of local content into possible future SNOX™ projects in South Africa. It is also very important to invest in skills development. Two exceptional South African chemical engineers with whom we have worked are Dr Emma Mokoena and Xolelwa Ntlango.

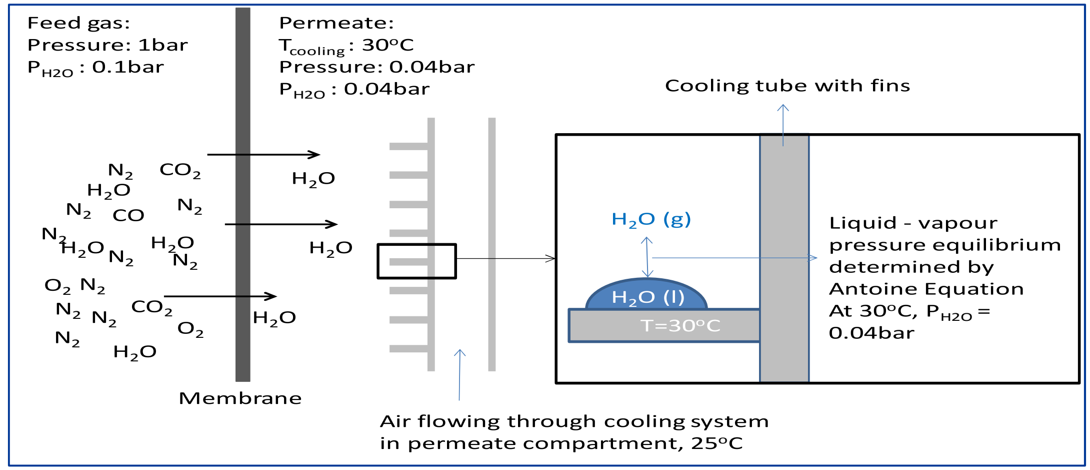


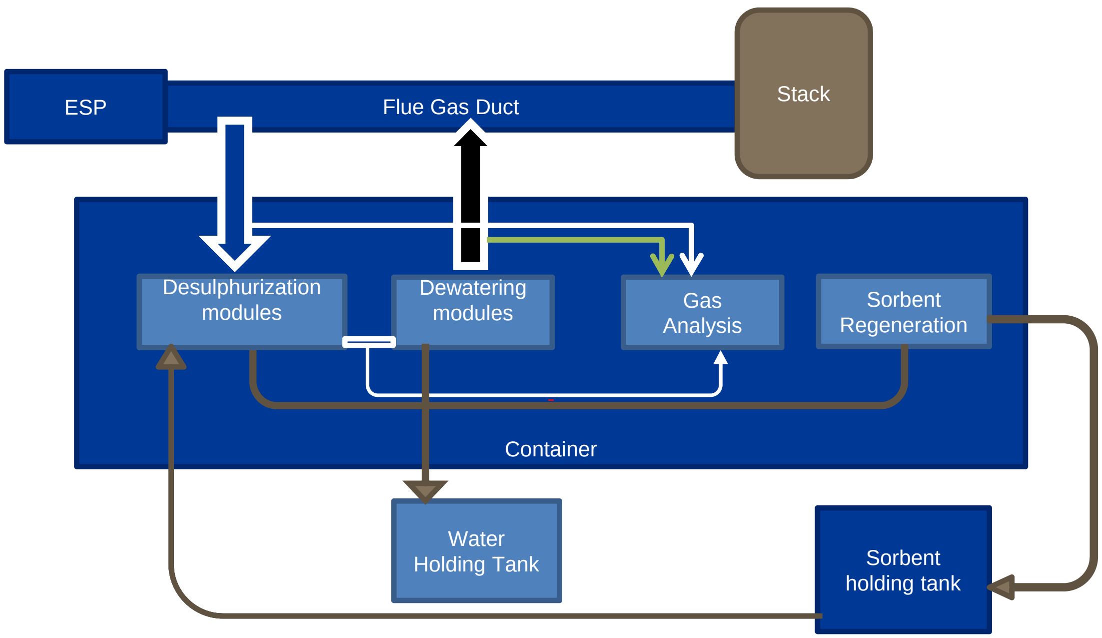
"SNOX™ technology is used in plants all over the world, including this plant in Austria. It is all about the correct technology for the process and this is what Haldor Topsoe is proposing for one of Eskom's largest power stations, Majuba, in South Africa's Mpumalanga province," says Helge Rosenberg.

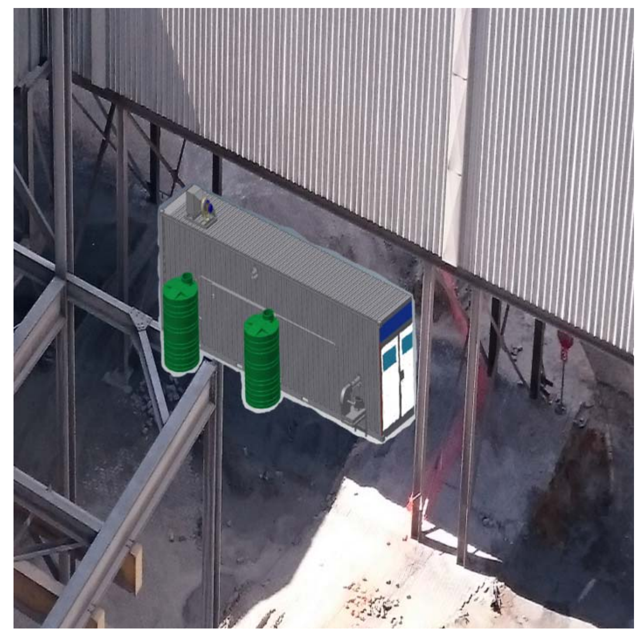
LOW WATER FGD
– FLUE GAS WATER & SO_2 RECOVERY

(ENGINEERING PRE-FEASIBILITY ASSESSMENT PHASE BASED ON LETHABO POWER STATION OPERATING CONDITIONS)









COLLABORATIONS – MATChING

(*Materials & technologies for performance improvement of cooling systems in power plants* **- HORIZON 2020)**

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Background

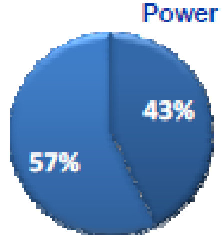
European Commission's Resource Efficient Europe Roadmap 2050, indicates that by 2020 "**Water abstraction should stay below 20% of available renewable water resources**"(1).

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 second behind agriculture (2,4).

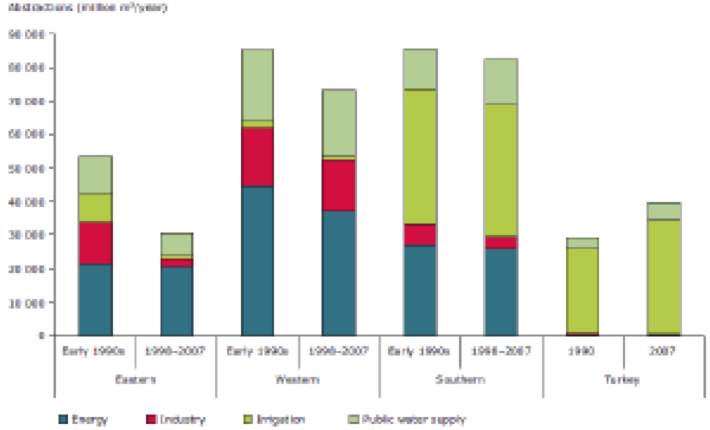
There is currently a gap between water demand and water availability. Following the business as usual approach this gap is expected to increase in the upcoming years (3): to meet EU requirements, **Additional innovation actions are needed.**

MATChING aims to reduce the water demand and improve energy efficiency for cooling systems in the energy sector through the use of advanced and nano-technology based materials and innovative configurations

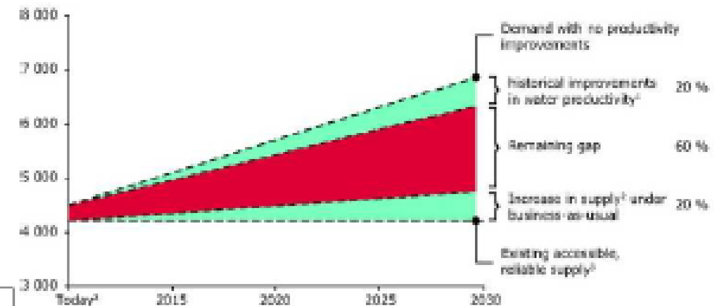
Average EU Water withdrawal 4)



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



World water demand and supply gap (3)



(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)Röbbelke and Vögele, 2011

Courtesy: Enel

Thank you

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