A LCA (LIFE CYCLE ASSESSMENT) OF DESALINATION FOR THE ETHEKWINI MUNICIPALITY

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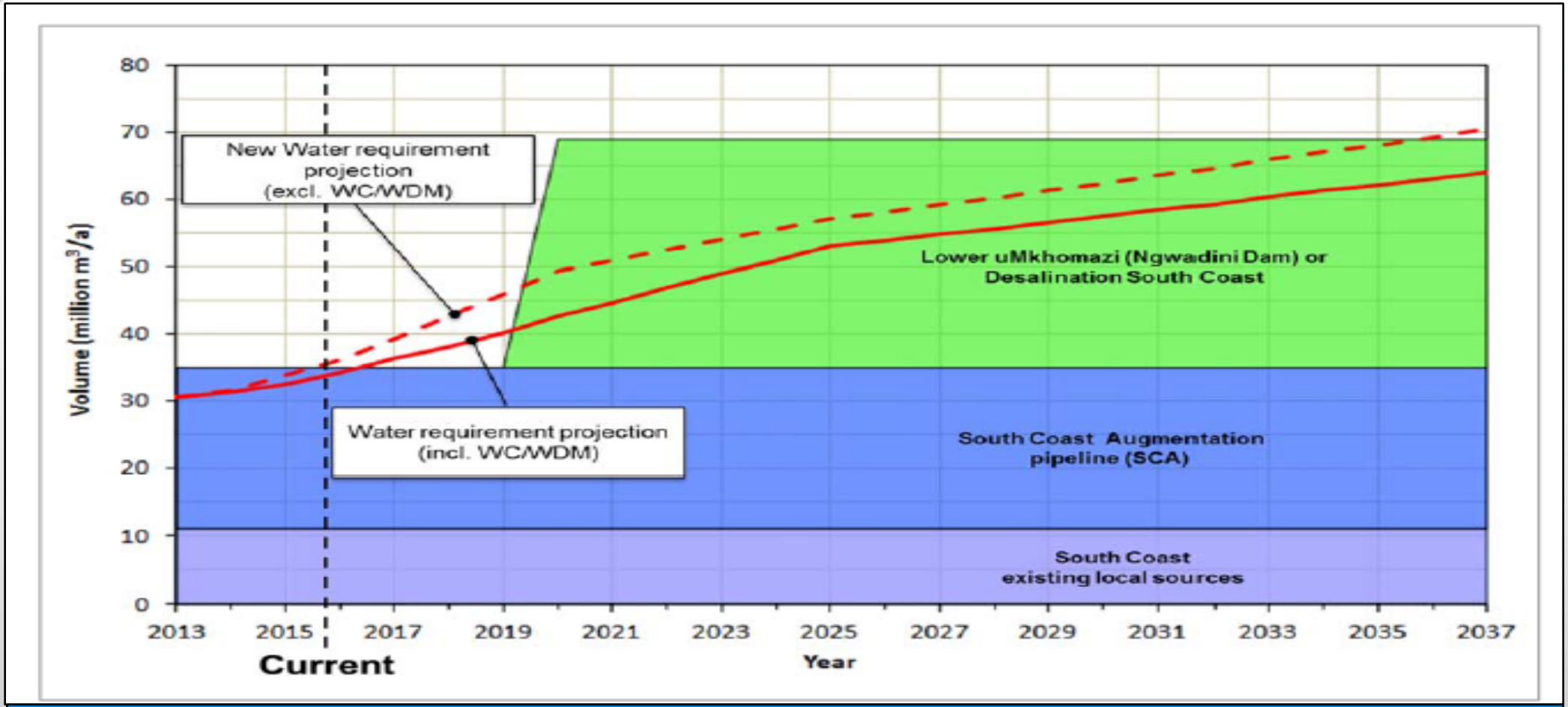
OUTLINE

- Background
- Methodology
- Results
- Summary
- Future Work

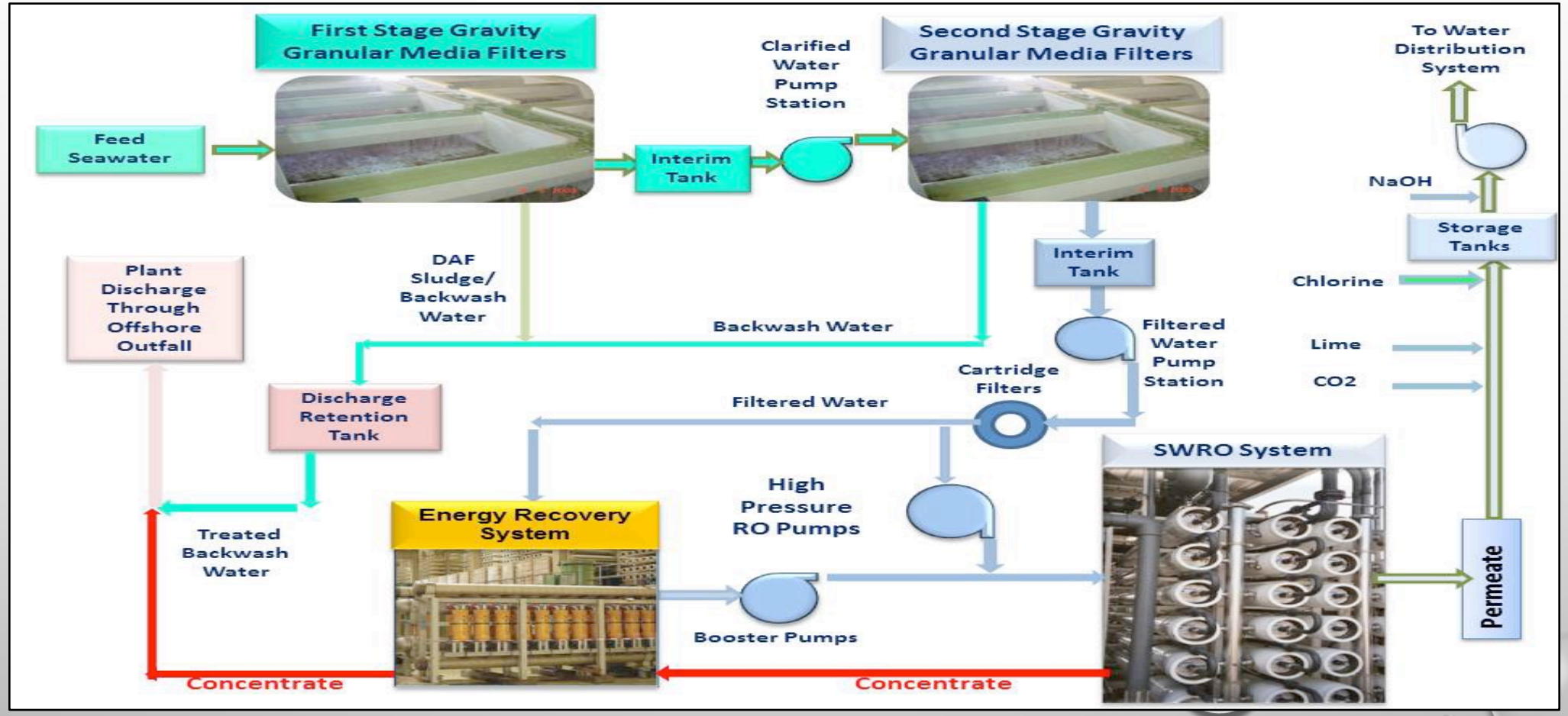
BACKGROUND - MOTIVATION



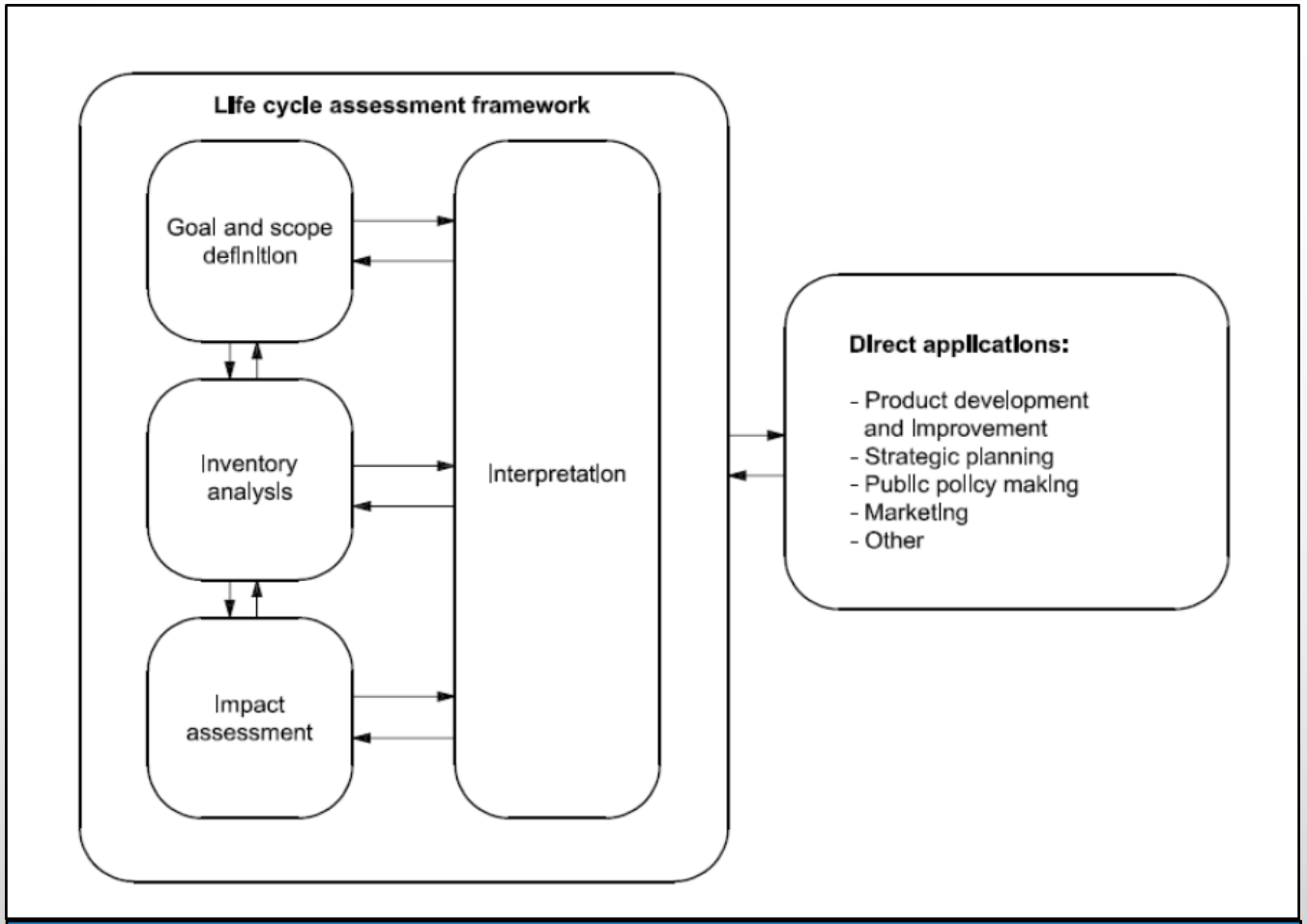
South Coast Water Balance with Support from Mgeni WSS (https://www.dwa.gov.za/Projects)

BACKGROUND – PROBLEM STATEMENT

What are the environmental burdens associated with the desalination process ?
Which of the unit operations within the process account for the highest environmental impact ?



BACKGROUND – LIFE CYCLE ASSESSMENT (LCA)



Life Cycle Assessment Framework - Stages of a LCA

(ISO 14040, 2006)

METHODOLOGY - LCA

GOAL AND SCOPE DEFINITION

Goal : Generate environmental information on life cycle of desalination process

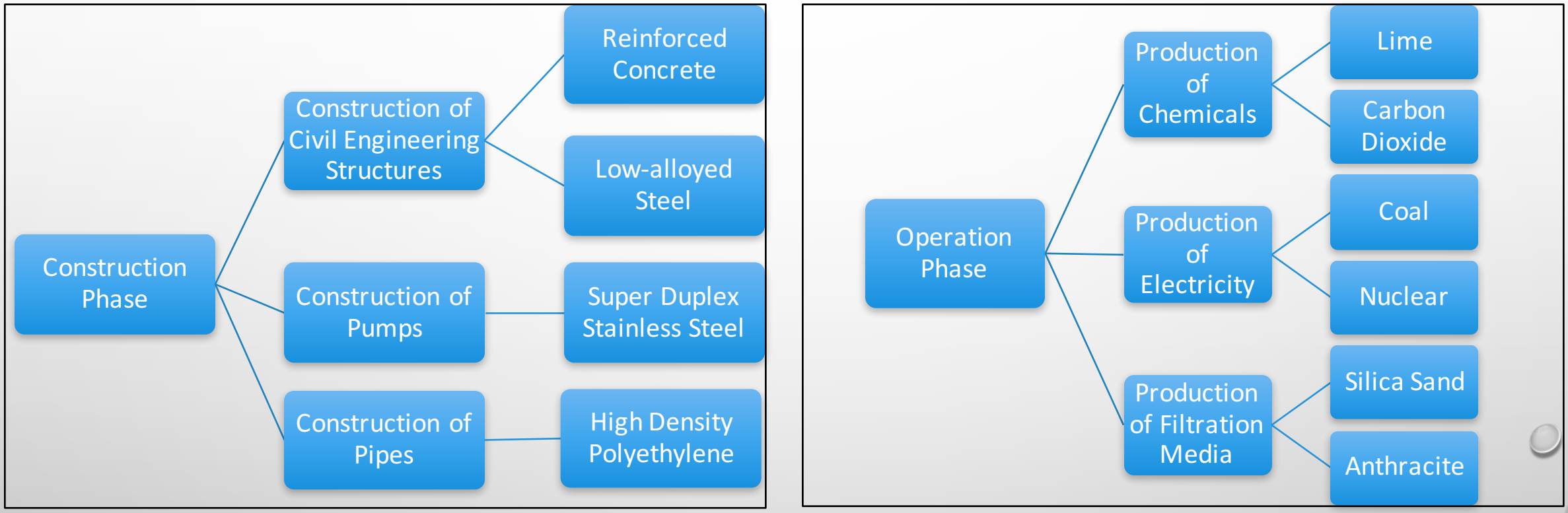
Intended audience : Design engineers, environmental and operational managers

Function : Produce potable water of a certain quality from seawater

Functional Unit: 1 kL (m^3) of water at quality specified by Umgeni Water

METHODOLOGY - LCA

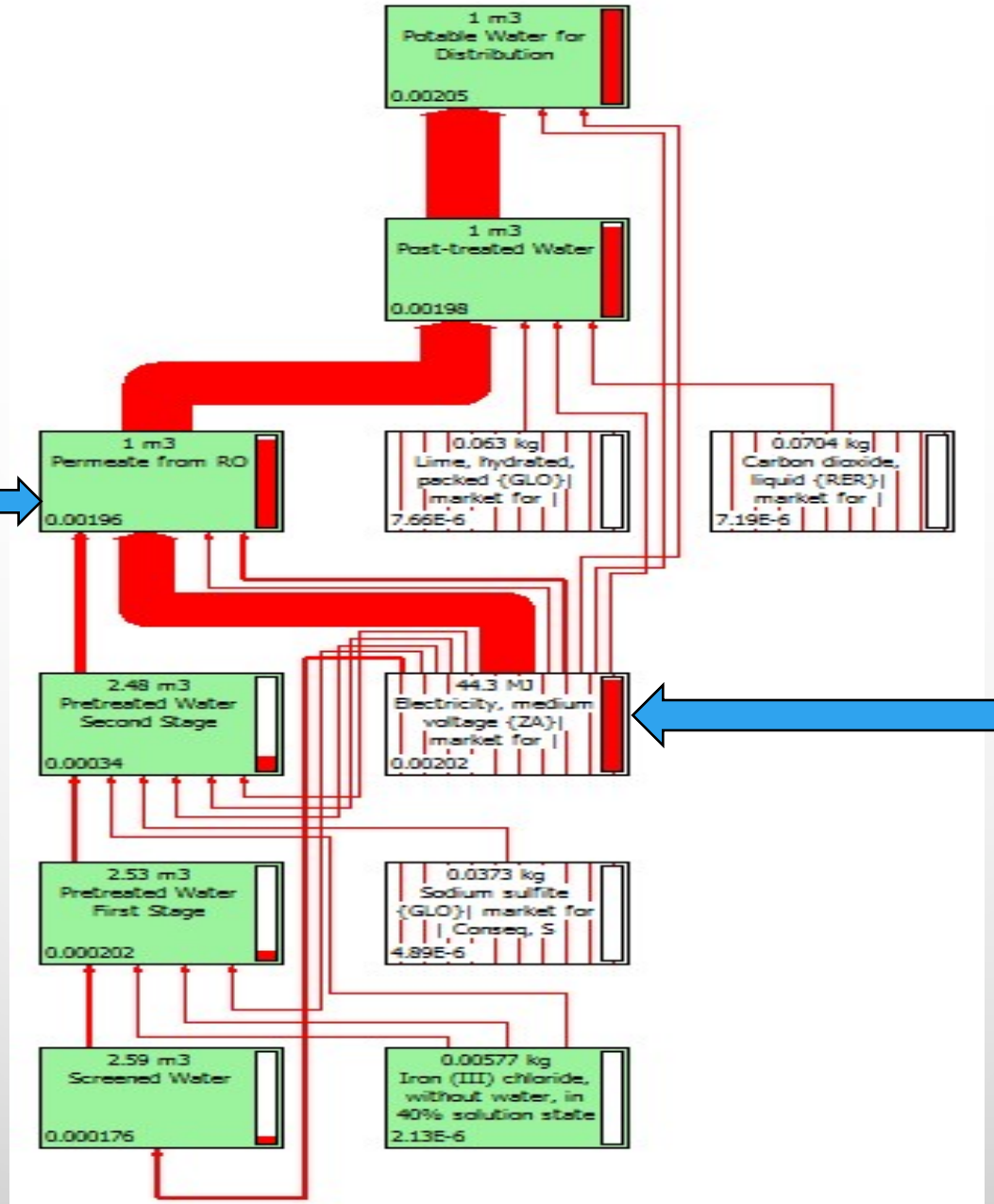
INVENTORY ANALYSIS



Life Stages and Processes involved in the Production of Potable Water

RESULTS

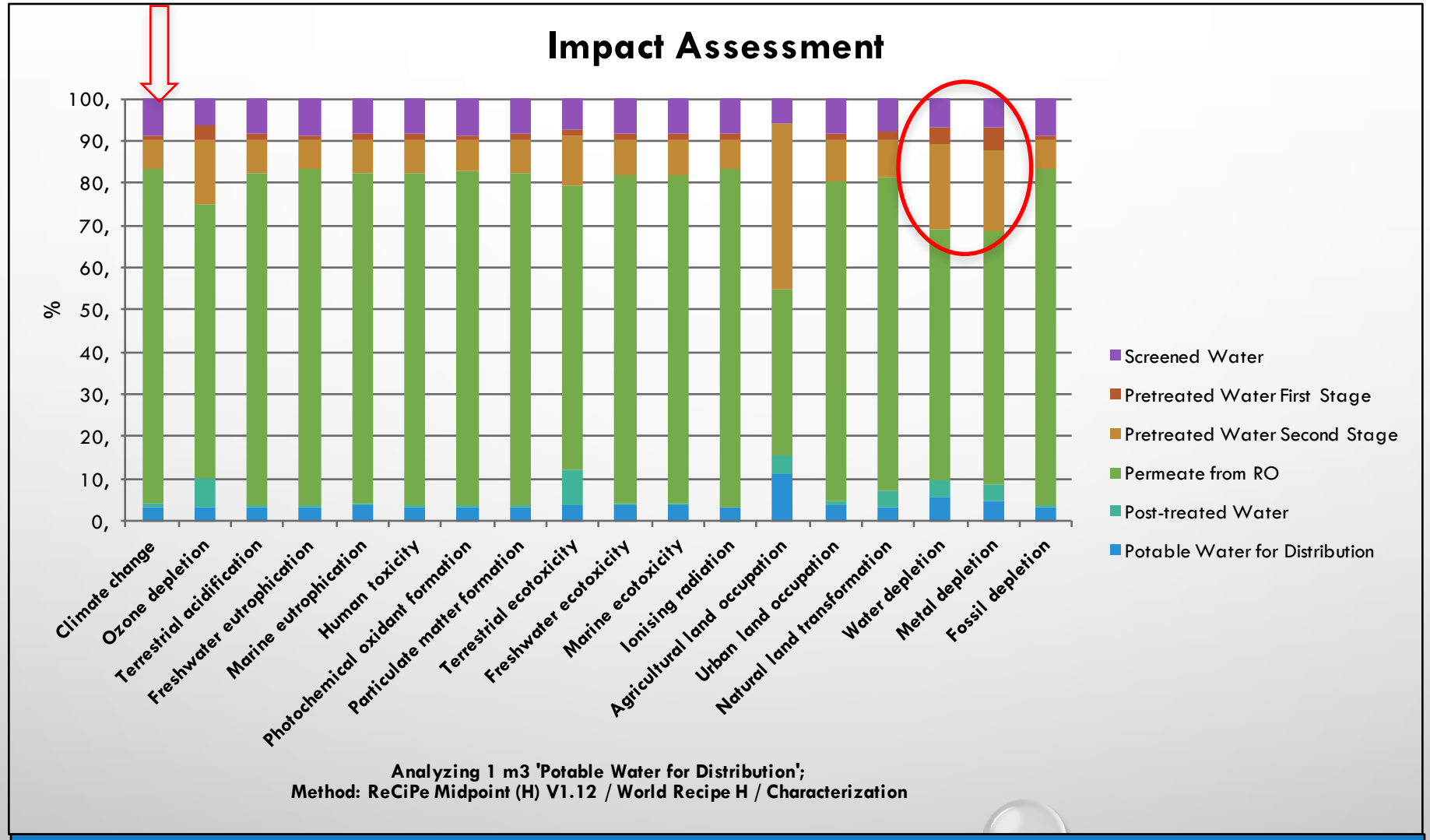
From all processes investigated, Reverse Osmosis carries the highest environmental burden



From all inputs analysed, electricity consumption has the highest environmental impact

Network Diagram generated in SimaPro

RESULTS

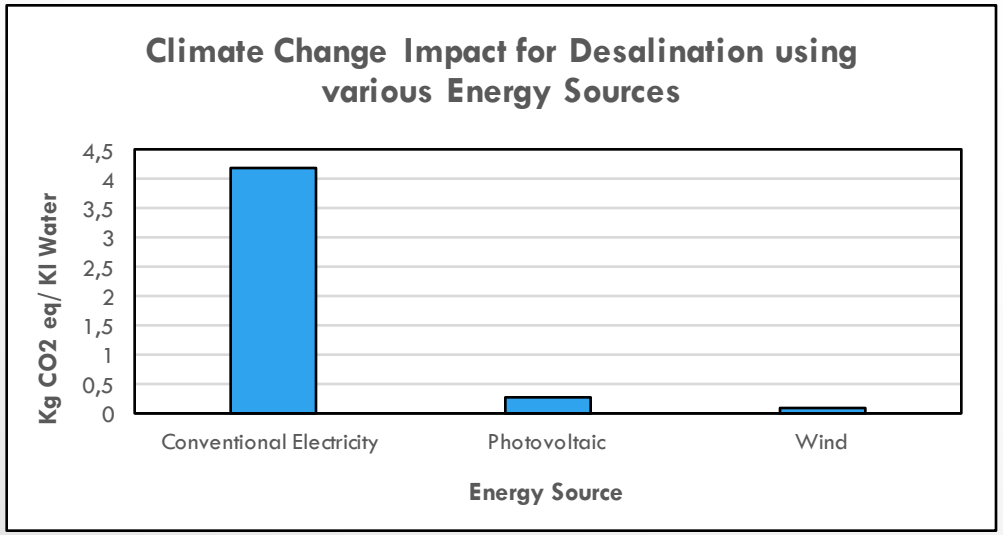


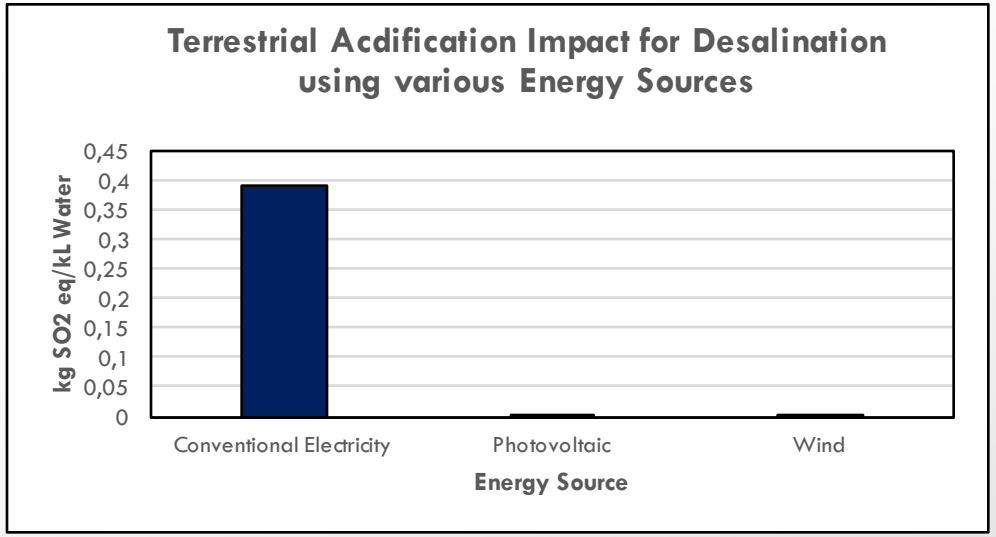
Results of Impact Assessment for stages in desalination process

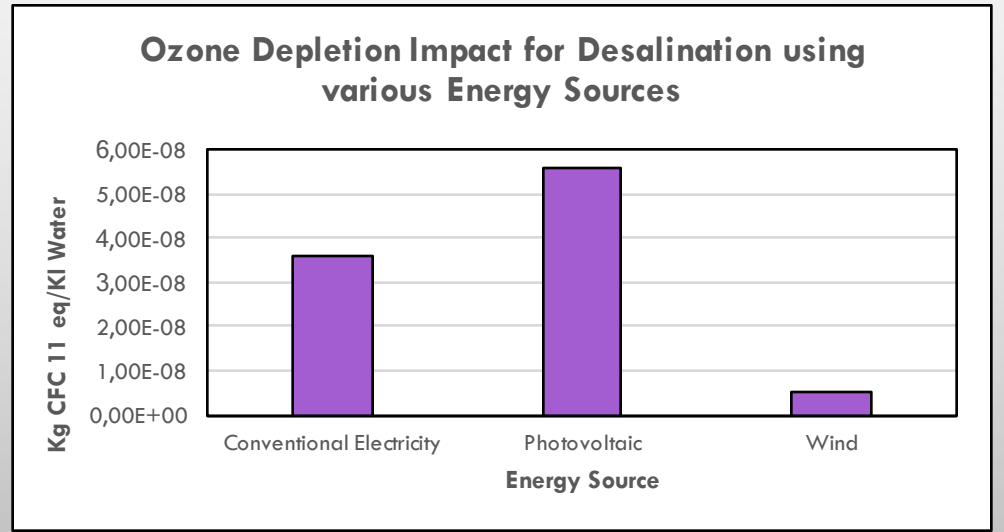
RESULTS

- Energy (3.73 kWh/m^3) for desalination is the highest contributor to the environmental burden of the system.
- Comparison with the literature showed that the above figure is within the acceptable range (3.5 – 4.5 kWh/m^3) for various desalination plants.
- Therefore electricity inputs are quite significant and a series of additional modelling was undertaken.

RESULTS – ALTERNATIVE ENERGY SOURCES INVESTIGATION FOR DESALINATION







RESULTS - COMPARISON WITH CURRENT TREATMENT METHODS USED BY UMGENI WATER

- Comparison with conventional processes in the local context (e.g. Wiggins Wastewater Treatment Works) illustrates that the energy consumption for desalination is much higher – 3.73 vs 0.01 kWh/m^3.
- Thus, the use of alternative energy sources can drastically decrease the environmental impacts.

Effect of Energy Source on Climate Change

Energy Source	Characterization Factors (kg CO_2 eq)	Climate Change (kg CO_2 eq/Kl water)
Conventional Electricity	1.13	4.22
Photovoltaic	0.08	0.30
Wind	0.02	0.08

- From this, we can gauge that desalination using wind and solar power will produce Greenhouse Gas Emissions in the range of 0.08 – 0.3 kg CO_2 eq/Kl Water which is comparable with the current emissions from conventional processes – Wiggins WWTW of 0.11 kg CO_2 eq/Kl Water and Durban Heights of 0.08 kg CO_2 eq/Kl Water.

SUMMARY

- Reverse osmosis carries the highest burden of the desalination process.
- Electricity usage has the highest environmental impact of the reverse osmosis process.
- The use of alternative energy sources in particular wind and solar has the potential to lower the environmental burdens of the desalination plant to the levels of conventional technology.
- Therefore it is recommended that the desalination plant is developed concurrently with solar/wind farms.

FUTURE WORK

- Sensitivity analysis to identify the most vulnerable parameters of the system.
- Undertake Life Cycle Assessments on other water treatment plants using alternative water sources e.g. wastewater reclamation, acid mine water etc.
- Compare the environmental burdens of processes investigated.

ACKNOWLEDGEMENTS

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- The design engineers from Aurecon