Estimating the Upper Limits of U.S. Power Plant Waste Heat Driven Forward Osmosis

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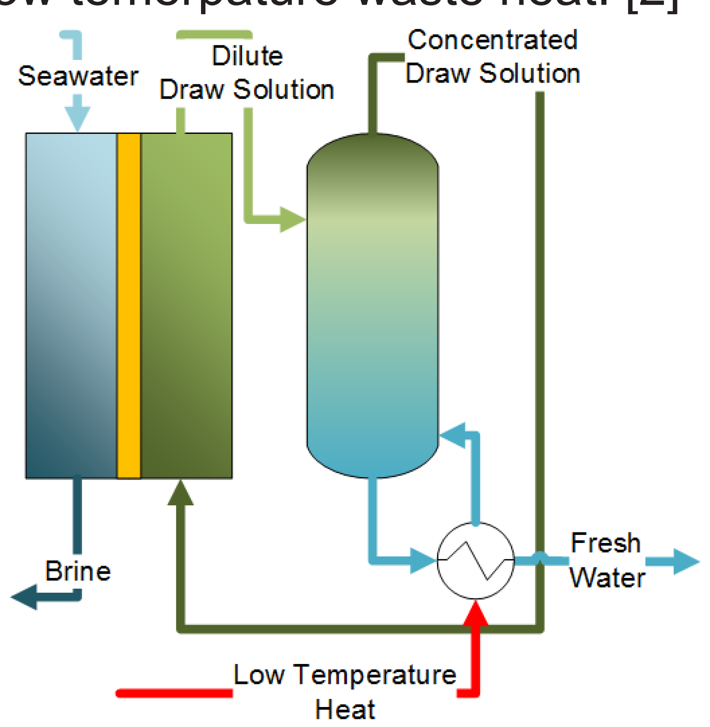
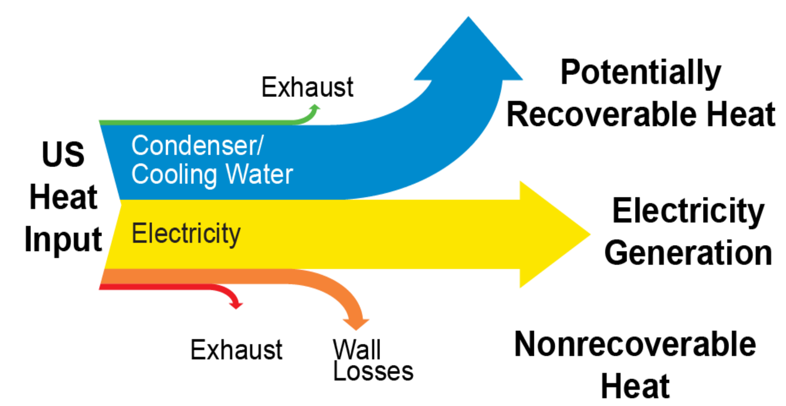
Introduction

- Forward osmosis (FO) that uses a natural osmotic gradient between a feed stream and a more concentrated draw solution to produce clean water. [1]
- If this draw solute is a thermolytic salt the draw solution can be regenerated with low temerpature waste heat. [2]

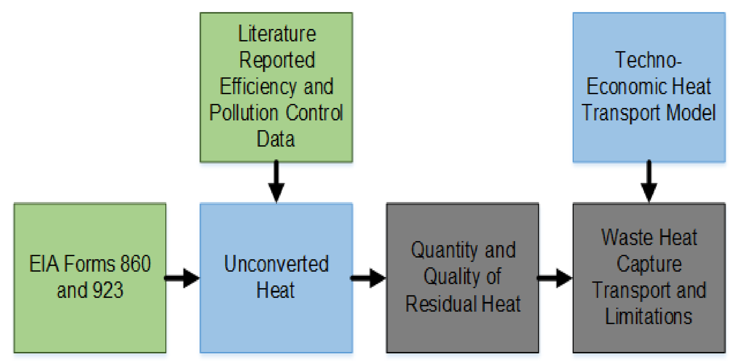


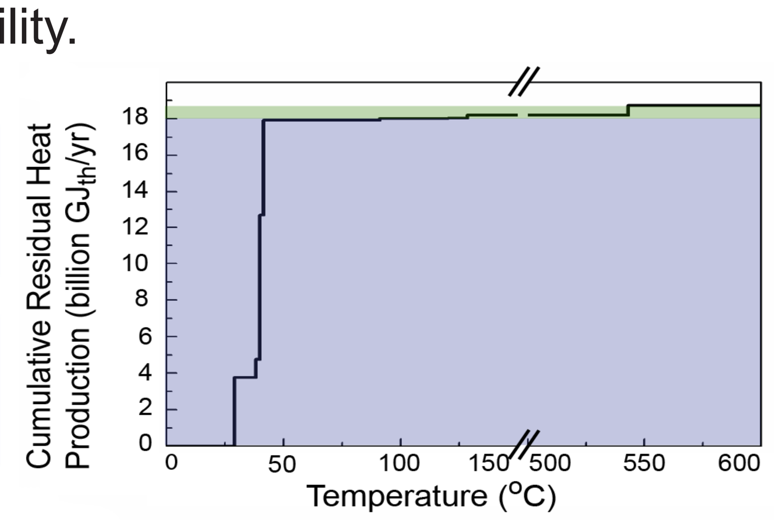
- The abiltiy to use waste heat is what gives FO its advantage. [3, 4]
- To date no one has studied the technical feasibiltiy of this arrangement.

Estimating US Power Plant Waste Heat Production



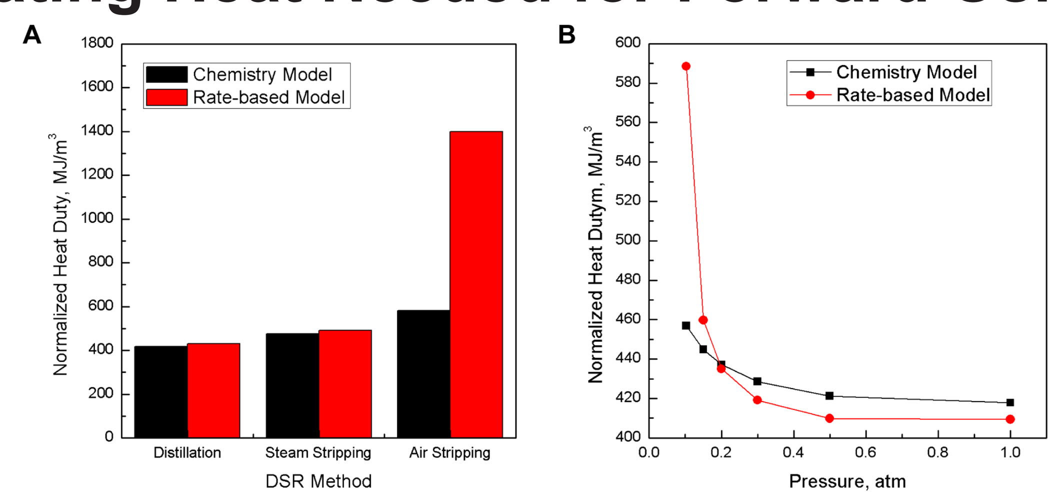
- Power plants are only about 30% efficient at converting heat into electricity, the rest is discharged as waste heat, some of which is recoverable. [5]
- Using publically available data we can estimate how much heat is discharged and at what temperature.
- We can also model heat transport to understand techno-economic limiations on waste heat availability.



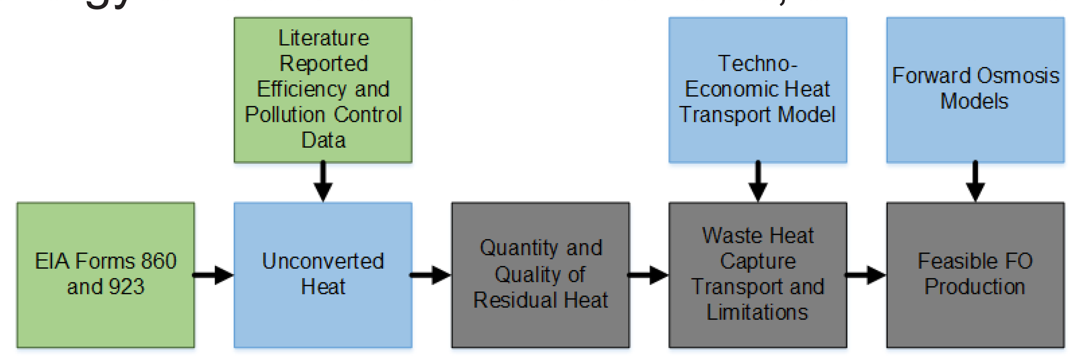


- 19 billion GJ of recoverable heat was discharged in 2012, but only 900 million GJ is potentially useful exhaust heat. [5]

Estimating Heat Needed for Forward Osmosis

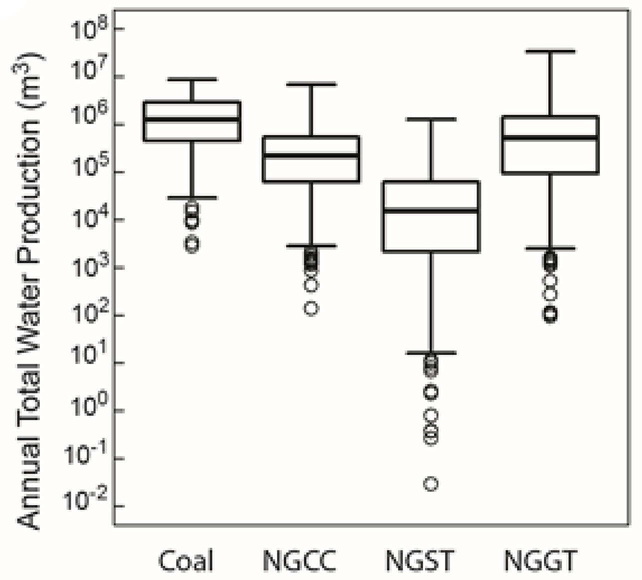


- Previous work [6] found that distillation at atmospheric pressure is the most energy efficient for forward osmosis, at ~ 410 MJ/m^3.

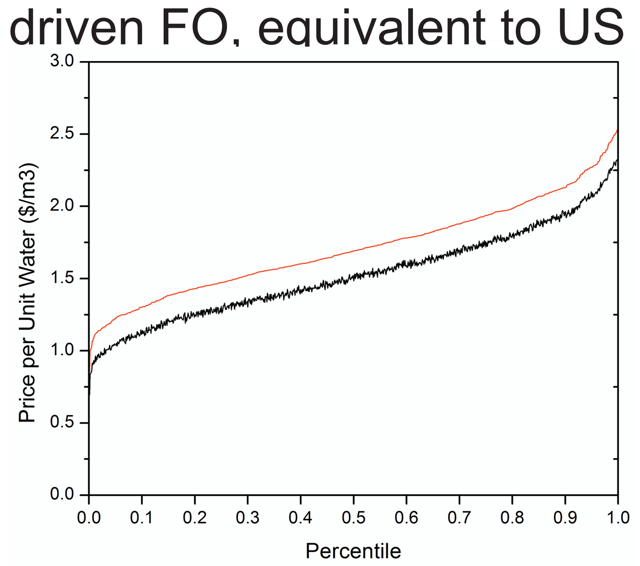


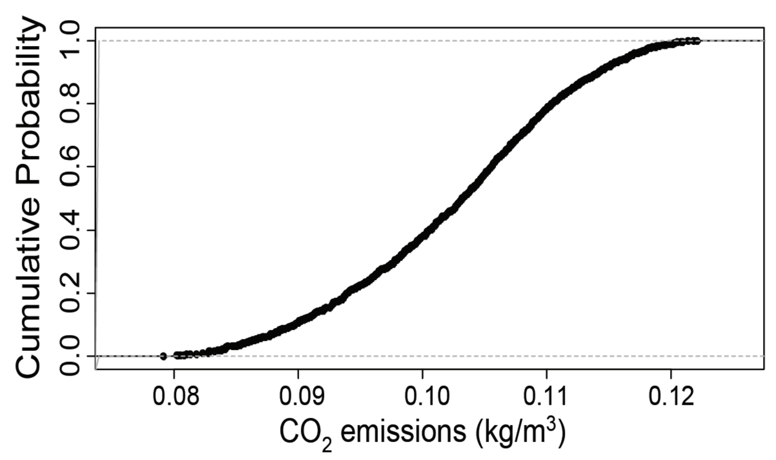
- By combining this with our estimates of waste heat we can calculate FO production

Results



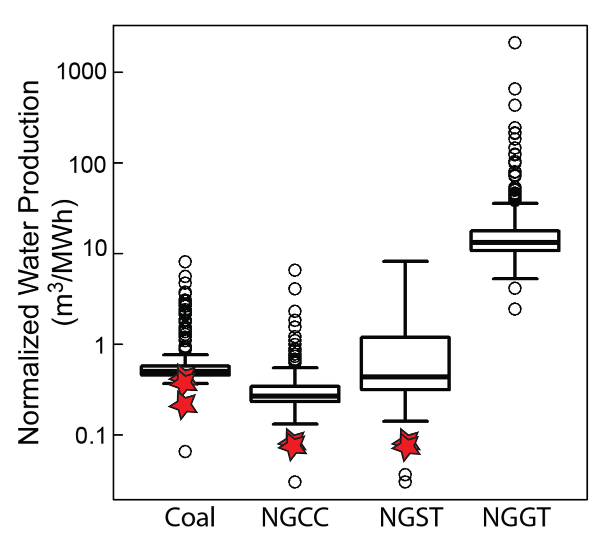
- 1.9 billion cubic meters of water could be produced with waste heat driven FO, equivalent to US household water use for 3 weeks.

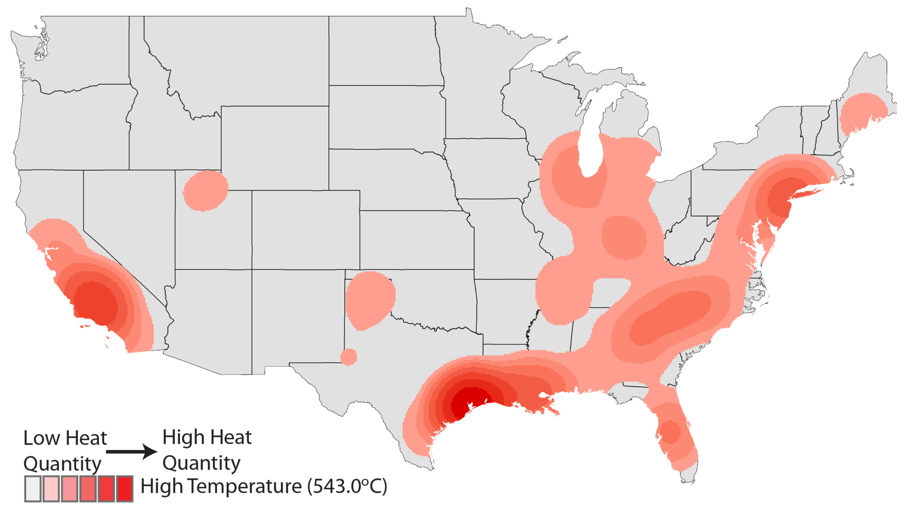




- Most of the costs of FO are capital costs associated with the large membranes required for the process.
- FO also offers around a 90% reduction in carbon emissions compared to reverse osmosis, currently used in these processes.

Conclusions





- Transport limits the produciton of this water to on site for most systems.
- FO is capable of meeting on site high-quality water needs at coal and natural gas plants.
- Natural gas gas turbines with their large transport range are the only feasbile candidates for off-site water produciton

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Disclaimer

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