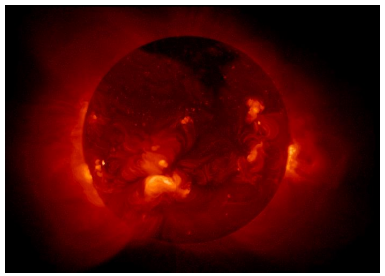
Introduction to Renewable Energy Applications for desalination

Dr. Guizani Mokhtar



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PhD Env. Eng.
Master Hydraulics & Env.
Civil Eng.

Research Interests:

Water reuse & reclamation
Sustainable sanitation
Desalination
Sustainability science education
Revitalization of local economies
(JICA, JBIC, JST…)

Objectives

- Introduction to RE powered desalination
  - Motivations
  - Opportunities / Challenges
  - Potential impacts & alternatives

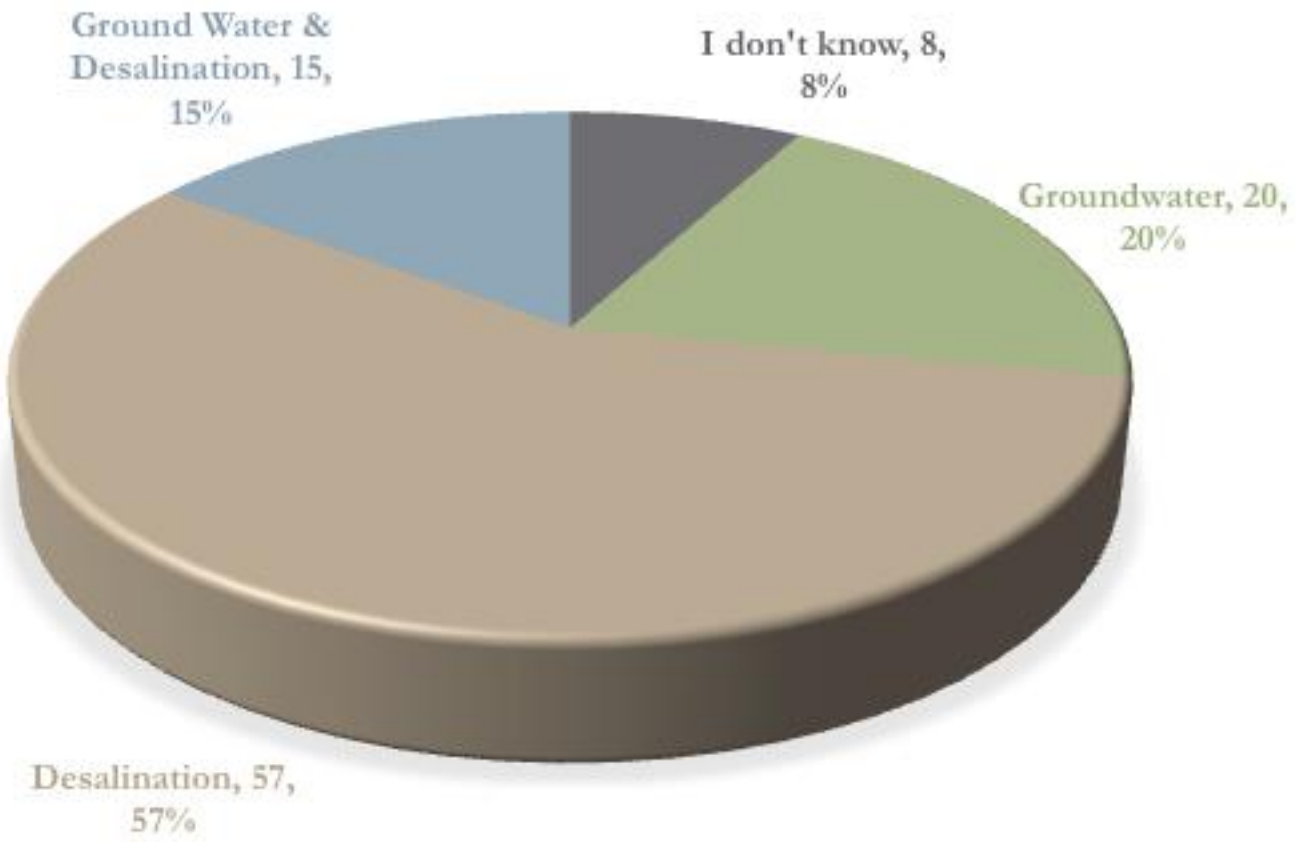
Hypothesis

- If we use RE then we can offset a significant portion of the conventional power requirements of current desalination methods.

MOTIVATIONS

Water Resources in KSA

What are the sources of water in KSA?



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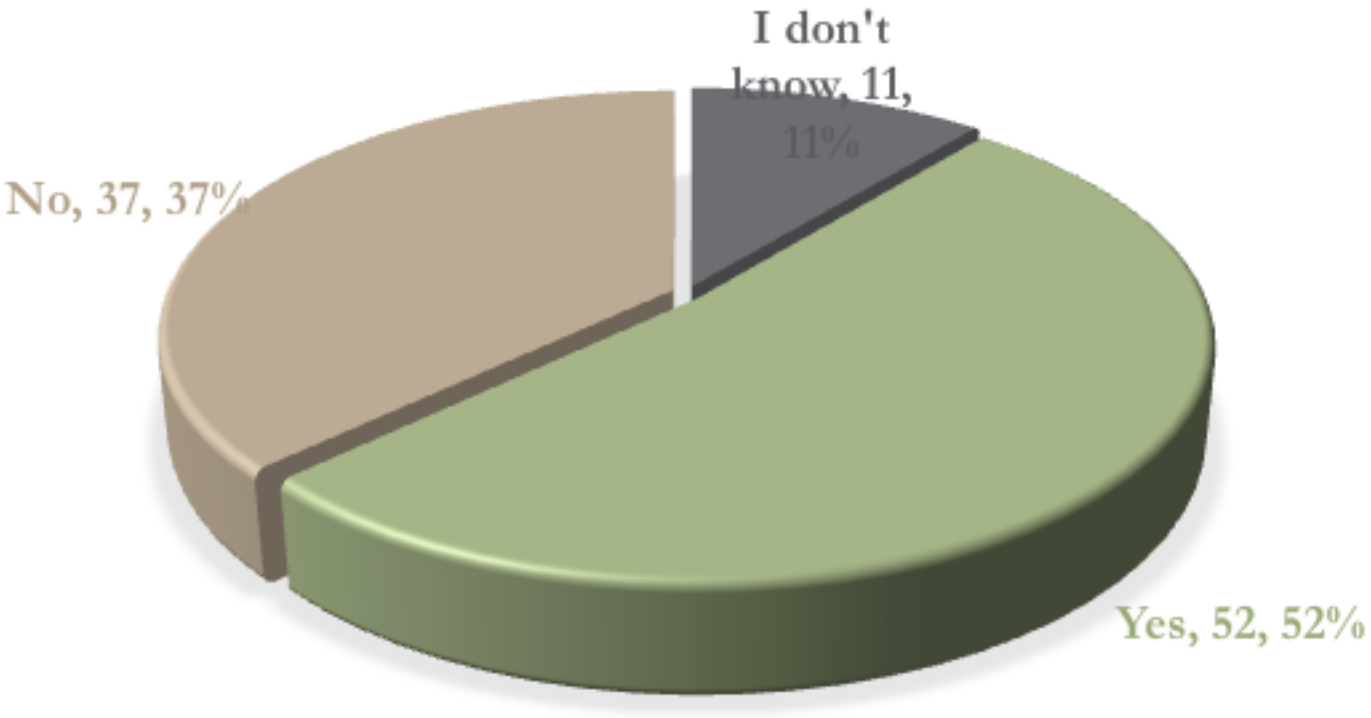
Water Resources in KSA

Do you think KSA has a water shortage problem?



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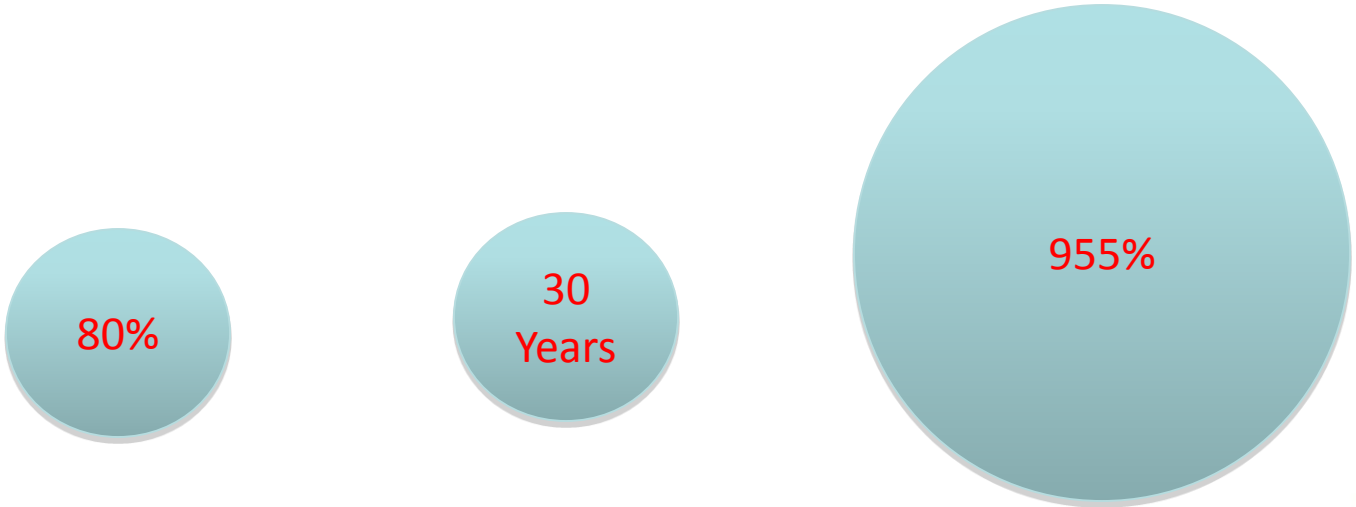
Conventional water sources



Rain water

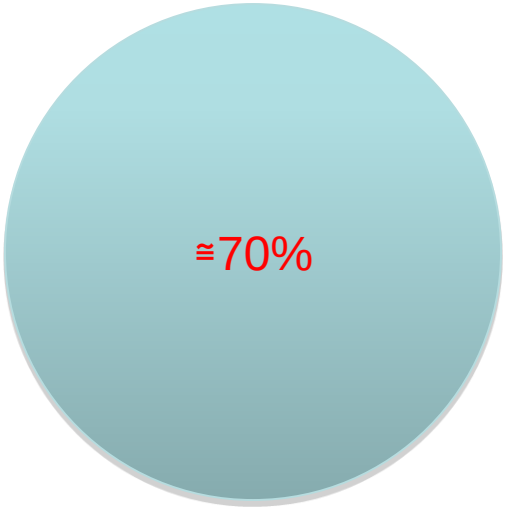
Groundwater

Use rate

Non-Conventional water sources

Water reuse

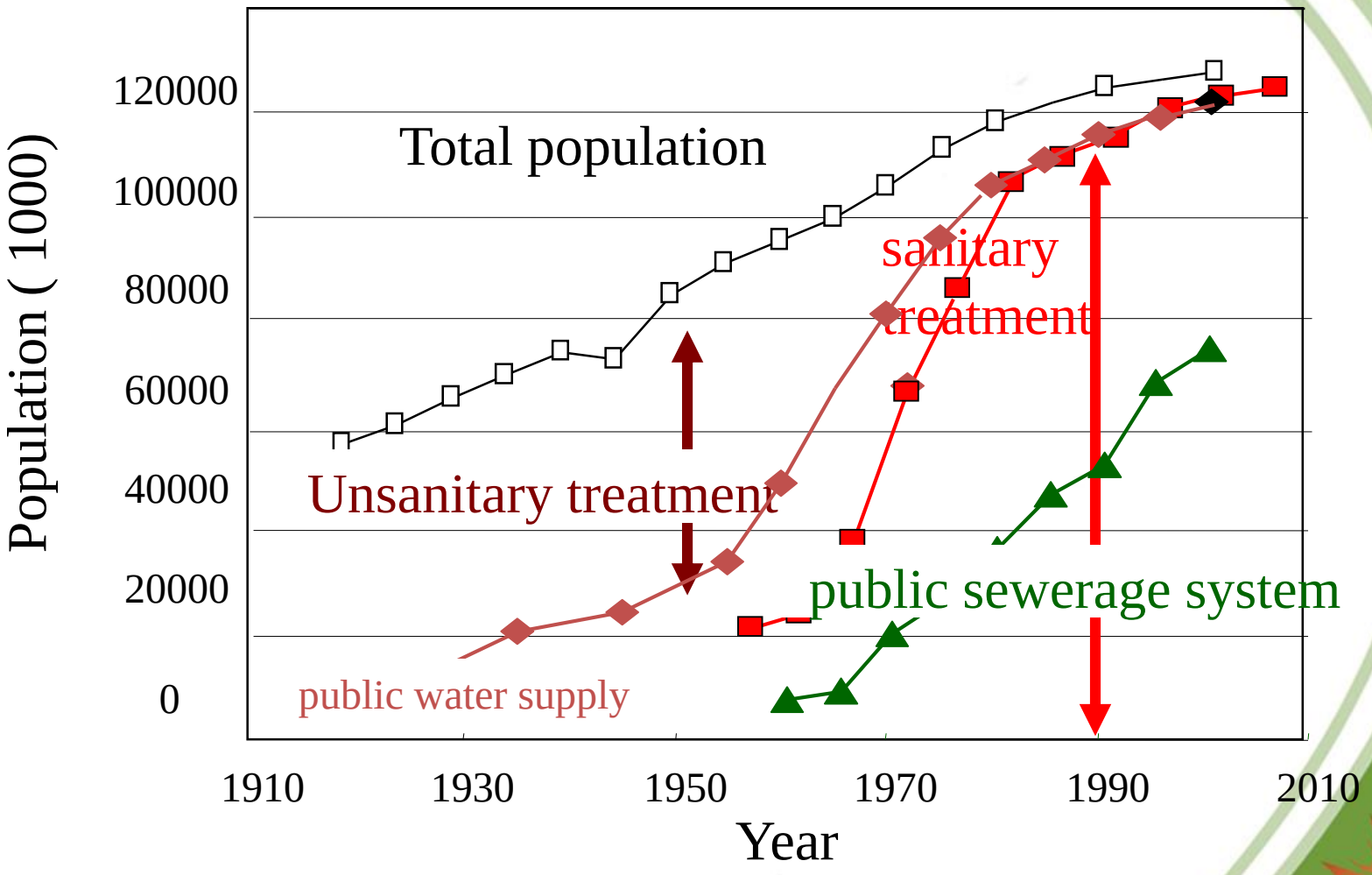
Desalination



RO(14%): 3~10KWh/m3

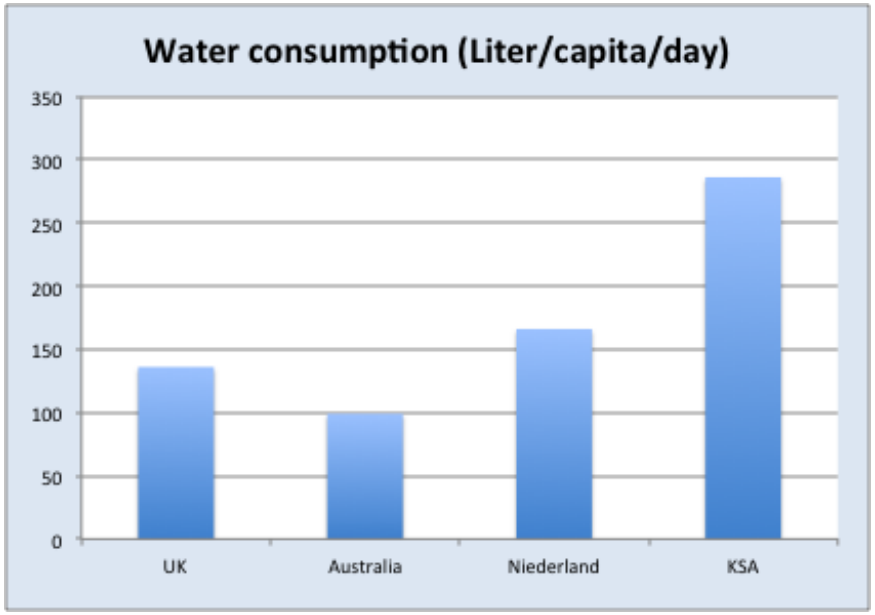
Thermal (86%): 20KWh/m3

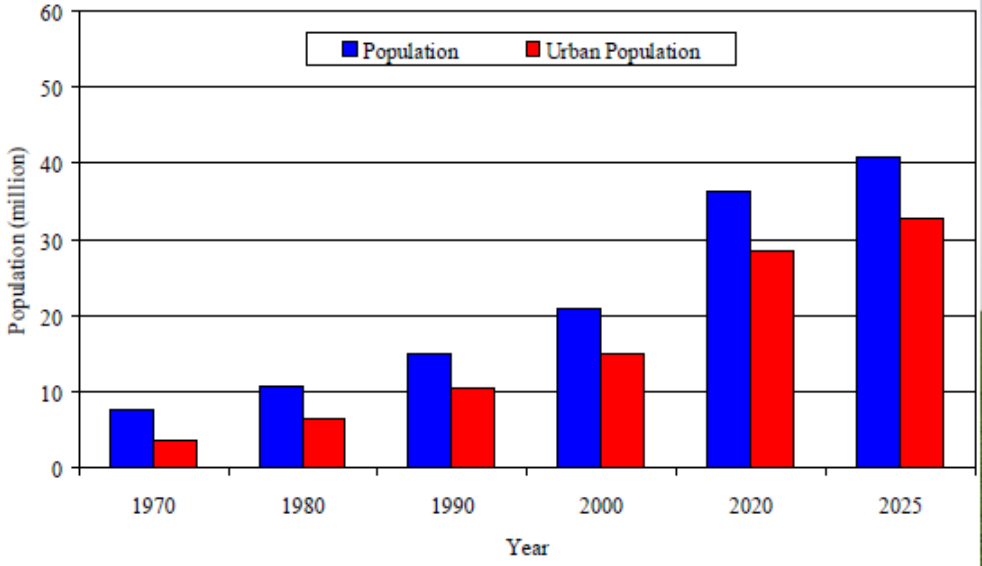
Japan experience with sanitation



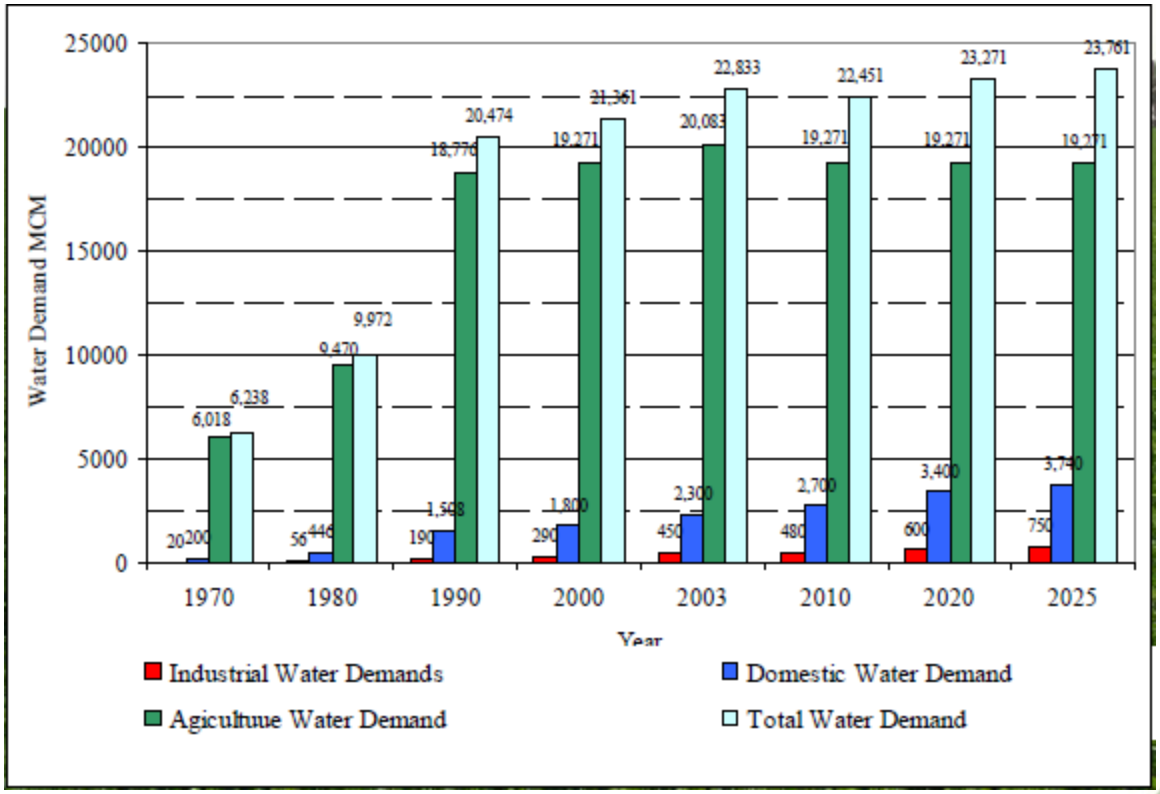
By Prof. Magara

Water Demand and Future trends in KSA





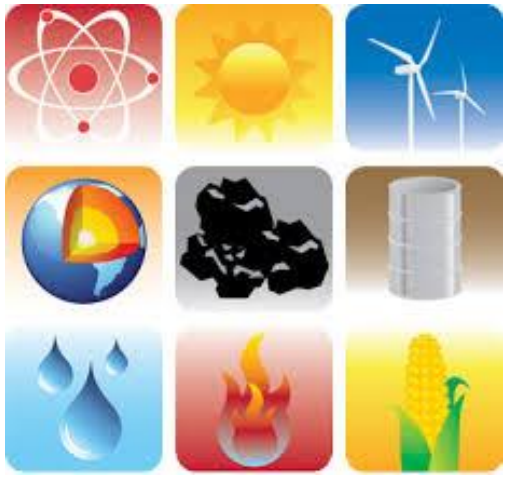
Water Demand and Future trends in KSA (cont.)

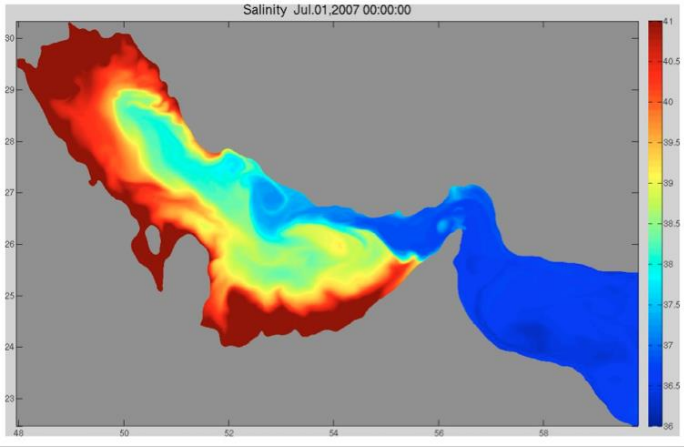


4% Rise in demand

30% Leakage losses

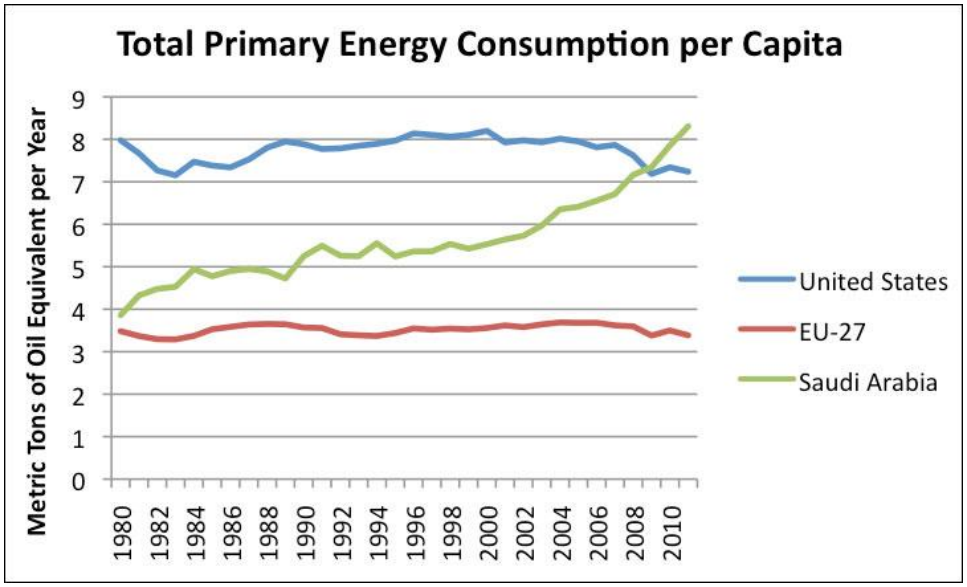
Desalination related problems

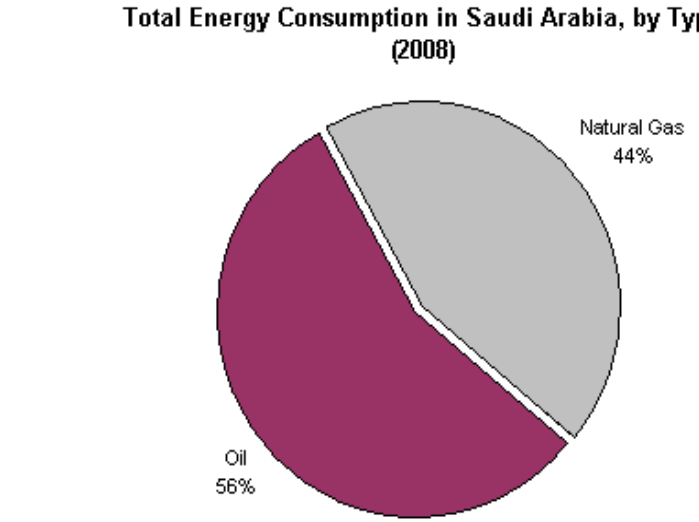




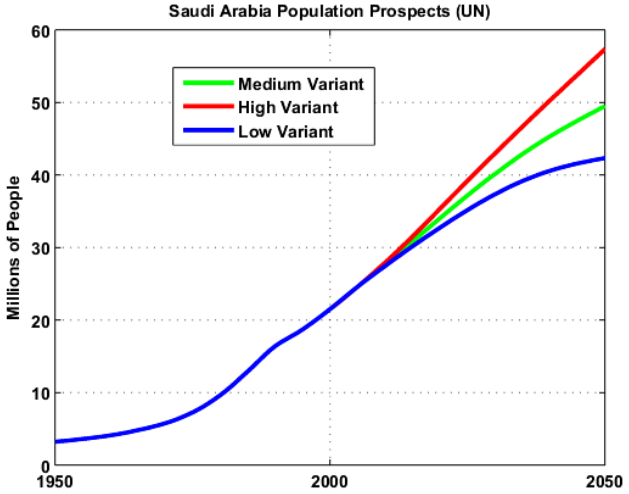
Salinity in Persian Gulf. Source: Allsop & Yao (2010)

Current and future Energy Consumption in KSA





Source: EIA International Energy Statistics 2008



Major energy consumer:

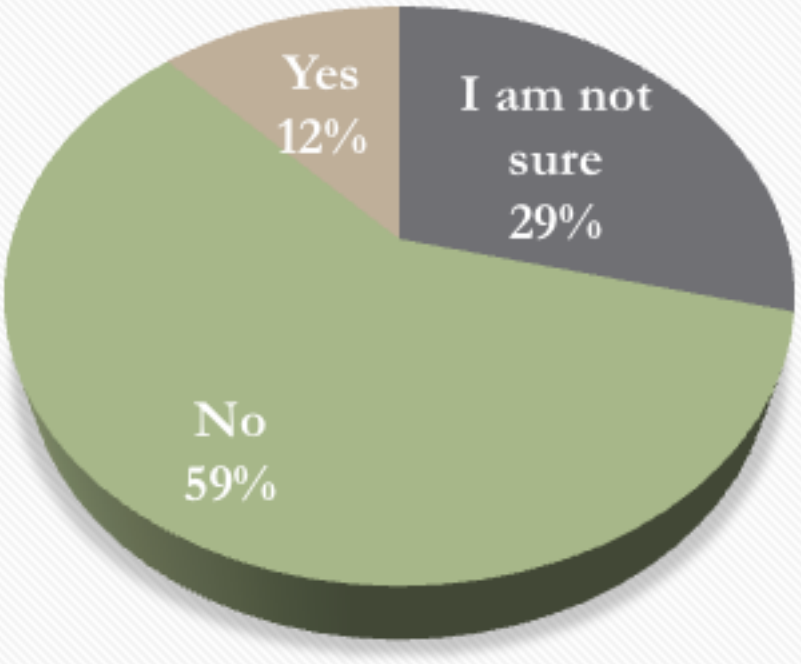
- Cooling
- Transportation
- Water supply

Water-Energy uses: interesting examples

- Energy required annually to pump and treat water IN California exceeds 15,000 GWh, approximately 6.5% of total electricity used in the state per year
- Energy required daily to pump and treat water to Jeddah approaches 6.3 GWh/day, approximately 8% of total electricity used in the city of Jeddah per day.
- Energy required annually to pump and treat water in Riyadh approaches 100,000 GWh, More than 10% of total electricity used in the city of Riyadh per year

Water Resources in KSA

Do you think you pay a lot for water?



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Water Resources in KSA

Cost of cubic meter

Table -1: Price of water (KSA)

Segment	M3/month	Price (SR)
1	1-50	0.10 (5)
2	51-100	0.15 (7)
3	101-200	2.00 (9)
4	201-300	4.00 (12)
5	301+	6.00 (15)

Source: Ministry of Economic and Planning Report, 2009

RE Powered Desalination

- RE: Energy which is renewed at a rate larger than consumption rate

- People need access to fresh and clean drinking water
- Oil prices are fluctuating
- Oil reserves ?
- Go green

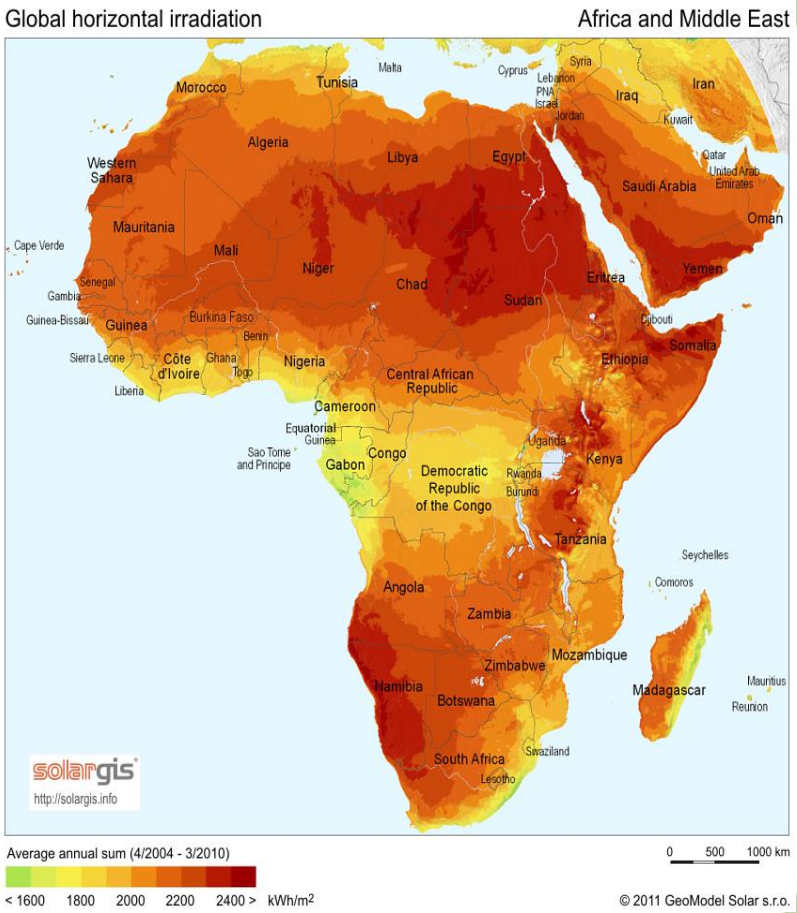
OPPORTUNITIE CHALLAENGES

RE potentials

RE	MED	MSF	RO	ED	MVC
Solar thermal					
Photovoltaic					
Wind					
Geothermal					
Biomass					

Solar Energy for Desalination

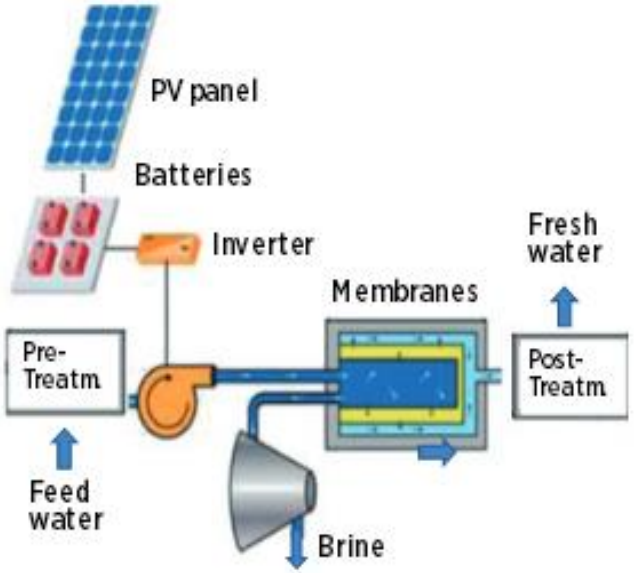
- Availability
- Processes: Thermal, RO, Freezing
- Production Cost
- Maintenance

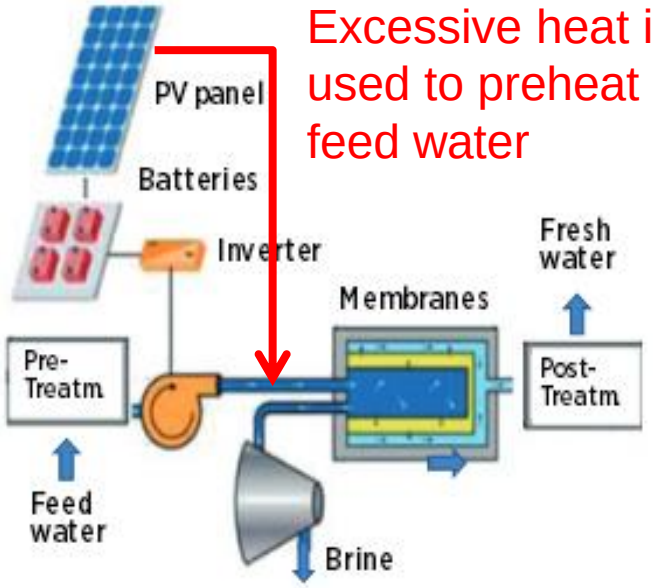


Solar powered desalination Photovoltaic/Thermal

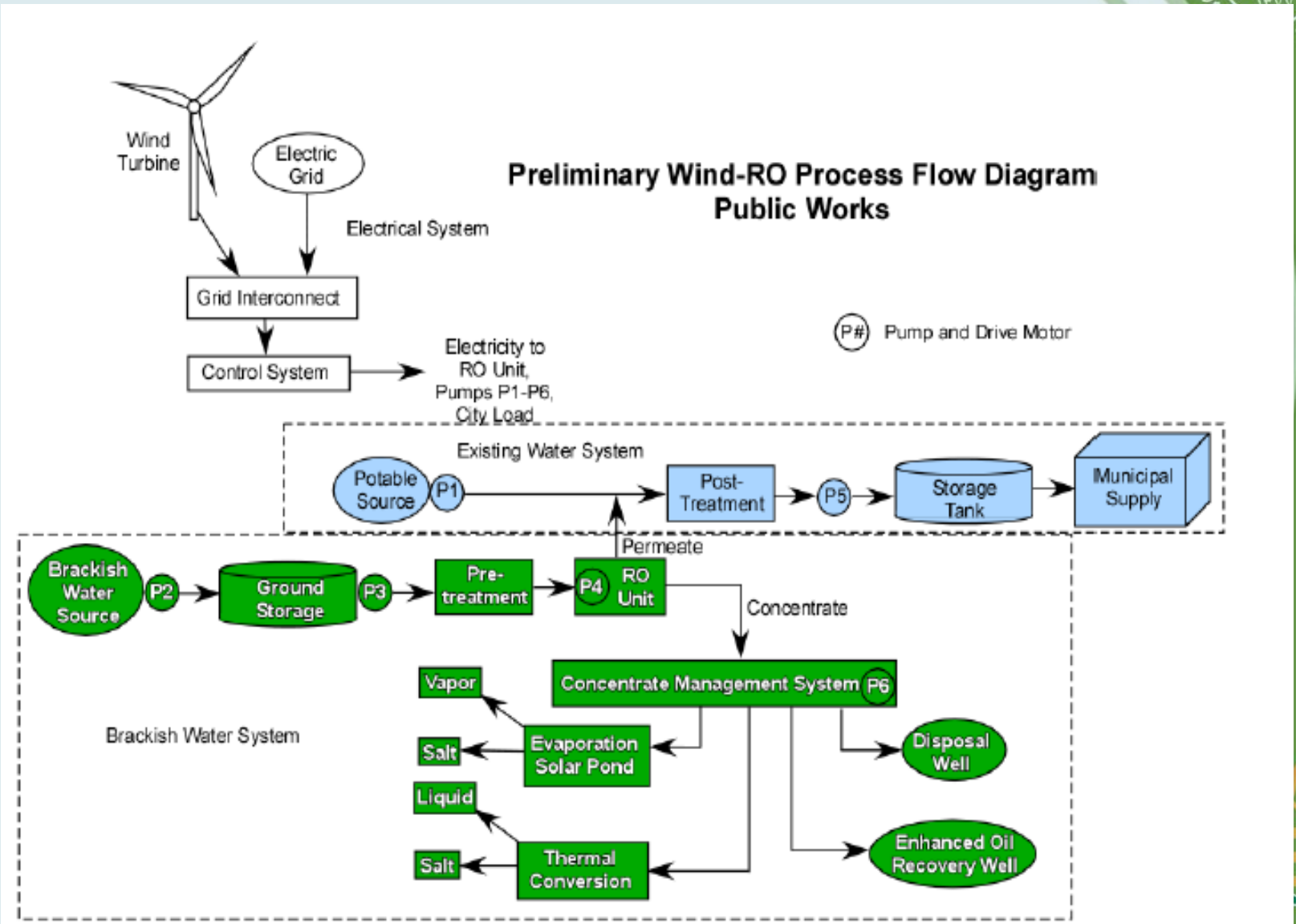
Coupled PV and RO desalination plants

Recommended for remote area, Roofs





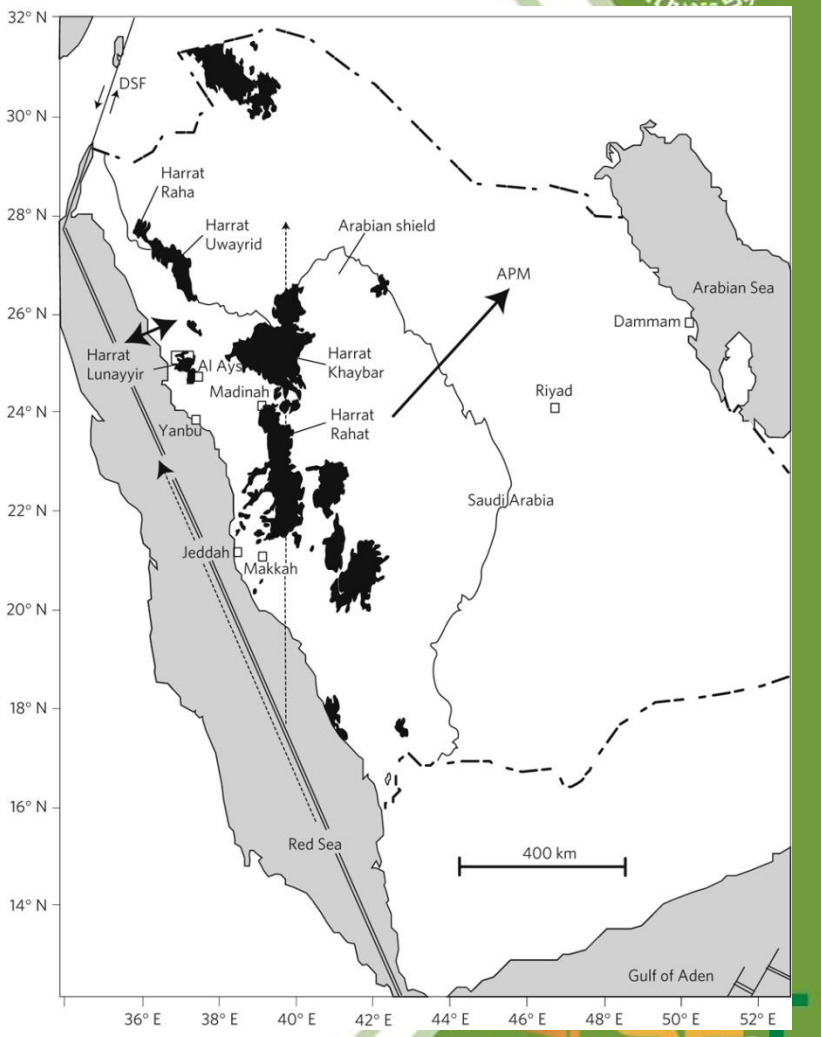
Wind Power for desalination



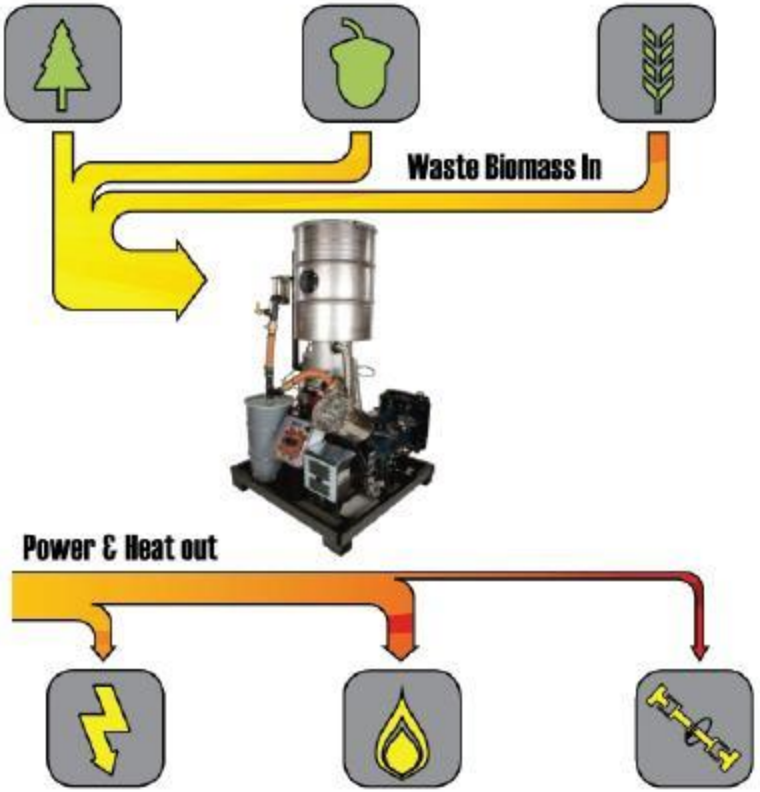
Geothermal powered desalination

Why should geothermal energy be preferred in a desalination process ?

1. Reliable (365 days; 24hours)
2. Technology is mature
3. Yields fresh water of high quality
4. MED desalination technology is also mature
5. Cost effective (<1Euro/m3)
6. Environmental friendly
7. Successful experiences
8. Feasibility of exploiting the low enthalpy geothermal potential

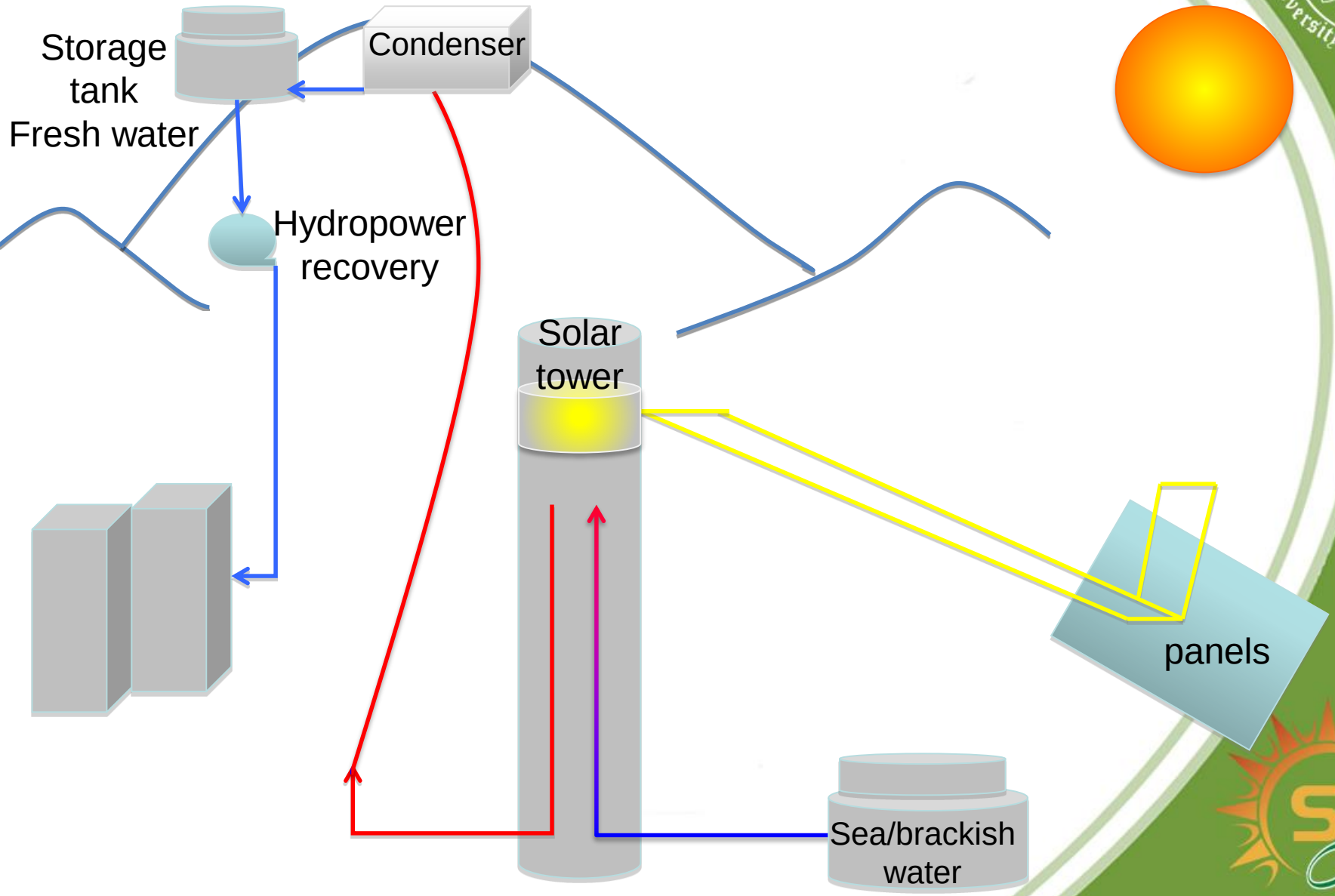


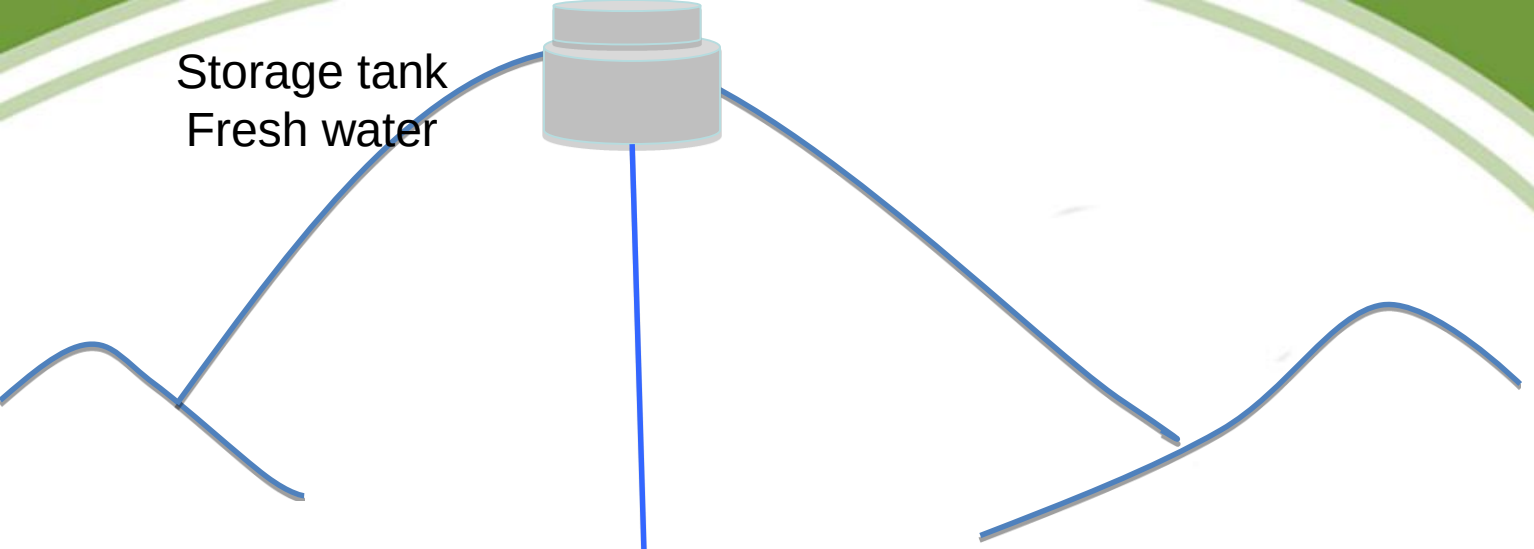
The forgotten Biomass powered desalination



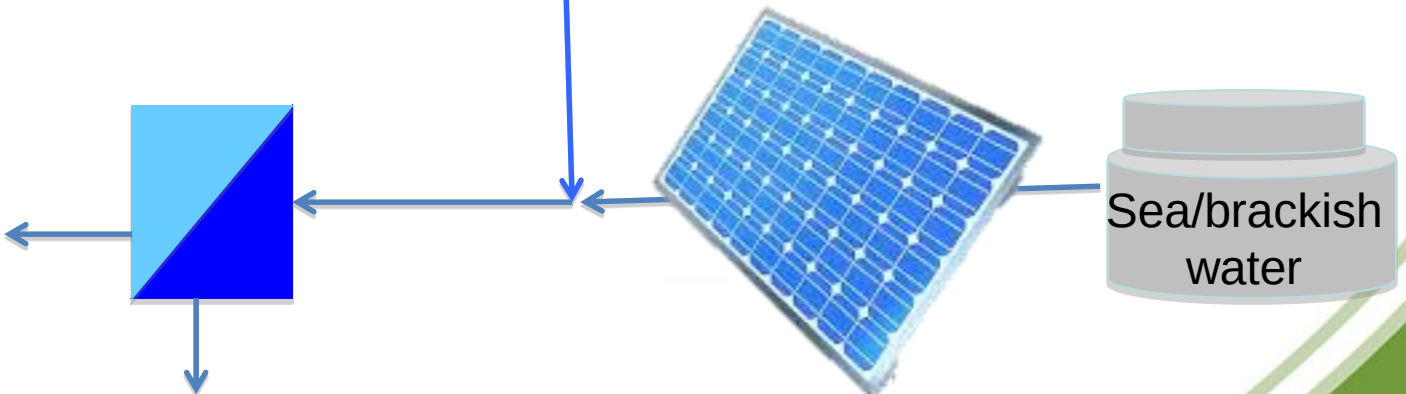
60% less expensive than comparable solar or wind power systems
1.5kg/day/capita municipal solid waste

Innovative designs for better efficiencies
Heat efficiency / Energy recovery





Gravity Force driven desalination (80-90% less expensive)
+ RO and solar pannels efficiency improvement



Research Question

Is it possible to build desalination units (using current methods) with power requirements able to be supplied by RE?

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Corollary Questions

- What are the power requirements associated with various desalination methods?
- What quantity of power can be feasibly supplied by RE?
- What are the potential geographic and temporal limitations?
- At what scale would various desalination methods be compatible with RE while still producing water at a reasonable rate?

POTENTIAL IMPACTS

- Use patterns will continue to increase
- More concentrated salts will be discharge into seawater
- More wastewater will be discharged
- More power plants are required
- Monetary budget?

Solution

- Reduce consumption patterns
- Decentralized waste water Recycling

Current Desalination Research examples at SET

- **Low energy demanding/passive alternatives**
- **Renewable energy source based alternatives**
- **Small scale decentralized desalination units**
- **Household desalination units**

Thank you

The Kingdom needs water but at lower energy cost and Powered by renewable energy options