تحت رعاية معالي رئيس مجلس الوزراء المصري المهندس شريف إسماعيل
مؤتمر تحلية المياه الحادي عشر في البلدان العربية
UNDER THE PATRONAGE OF THE EGYPTIAN PRIME MINISTER ENGINEER SHERIF ISMAIL
11TH WATER DISALINATION CONFERENCE IN THE ARAB COUNTRIES
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DESALINATION SYSTEM DRIVEN BY A HYBRID LOW GRADE WASTE HEAT AND SOLAR ENERGY

Nabil A.S. Elminshawy[1]*, A.M.I. Mohamed[2], Farooq R. Siddiqui[3]
[1,2] Prof. of thermo-fluids, Mechanical Power Engineering Department,
Faculty of Engineering, Port-Said University, Egypt.
[3]Mechanical Eng. Dept., Islamic University, Madinah, Saudi Arabia
*** Corresponding author. Tel.: +201001593131**
E-mail address: profminshawy@gmail.com (Nabil A.S. Elminshawy).

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Waste Heat From Thermal and Industrial systems

- Various Industrial Sectors
- Combined power stations
- R.O. and thermal desalination plants, …ect

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Sea water desalination factory at Jubail (Saudi Arabia). Today, the largest fresh water producers are in the Middle East.

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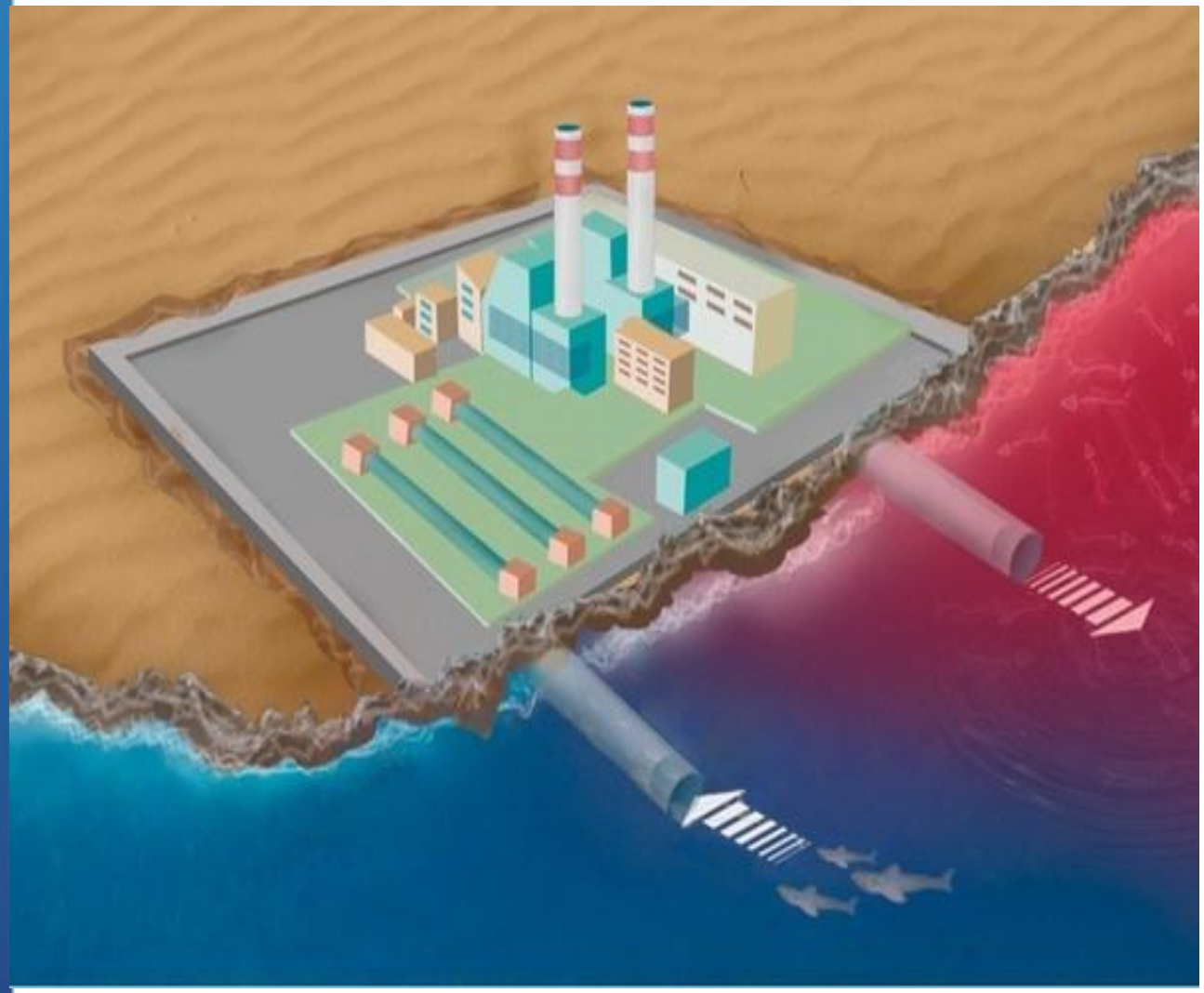
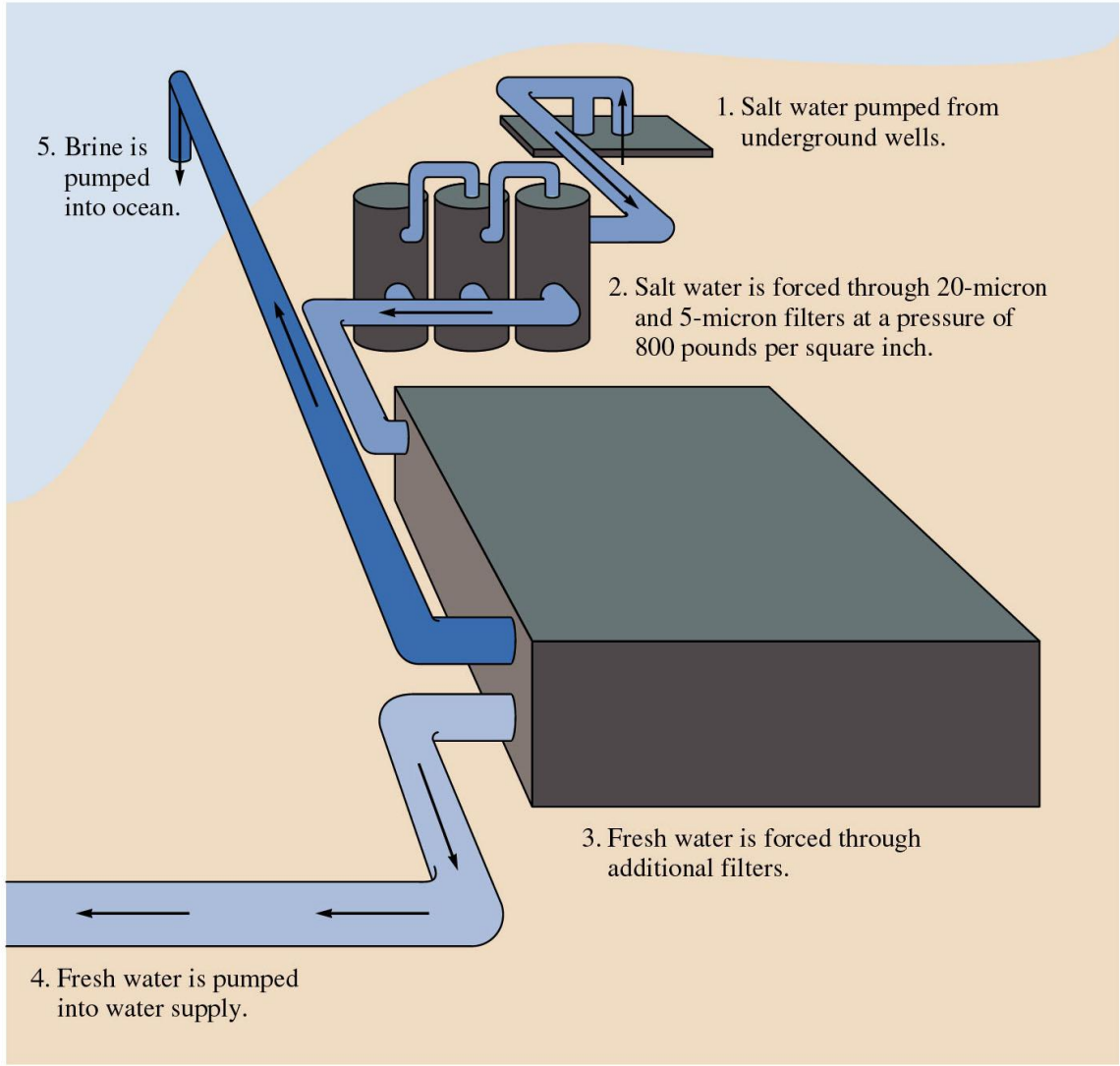
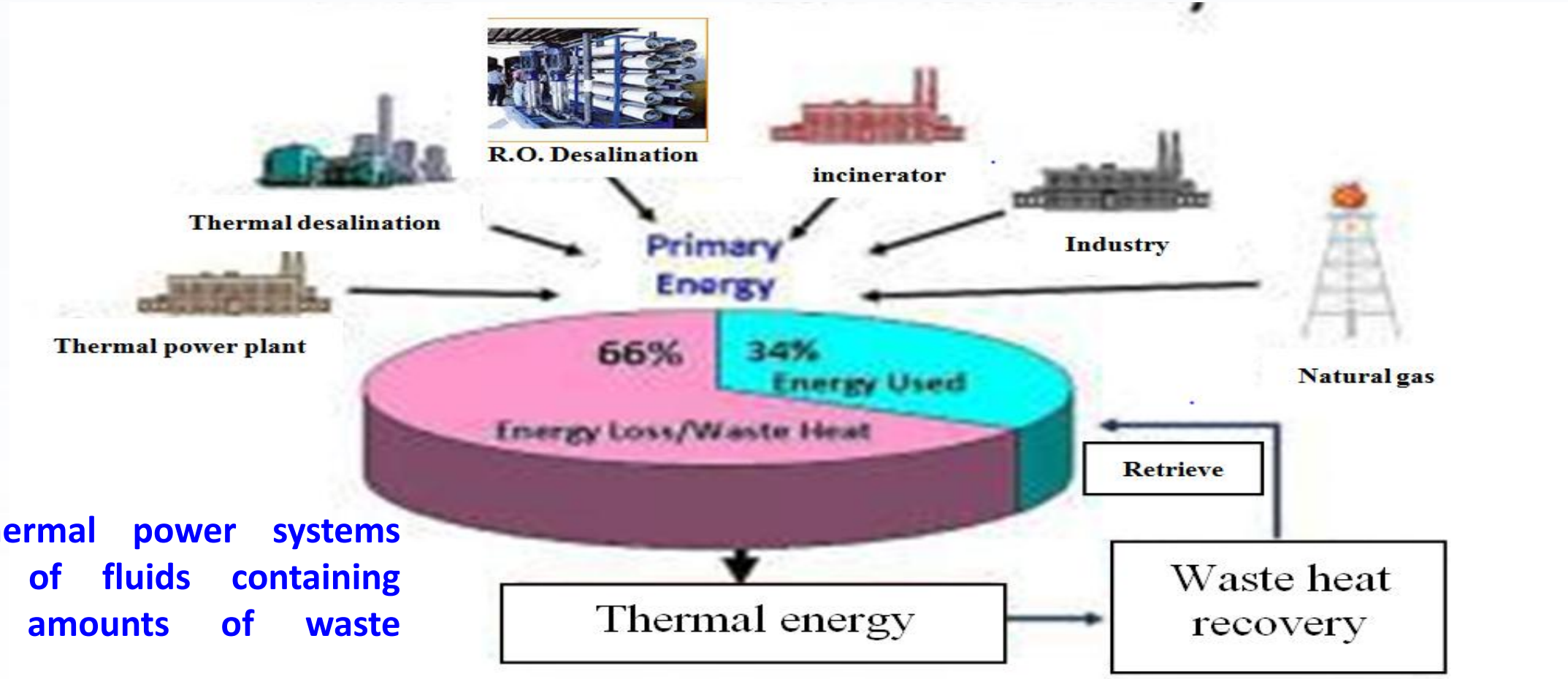




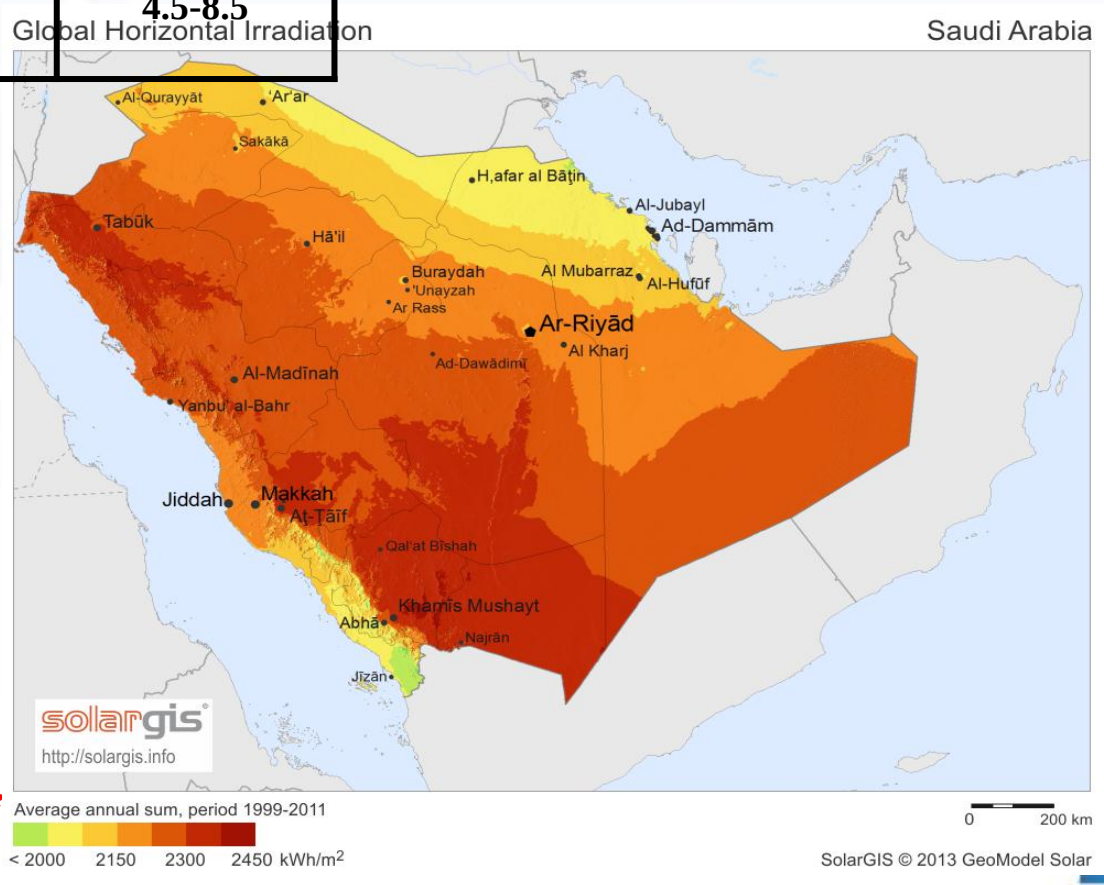
Waste heat retrieve from various thermal systems



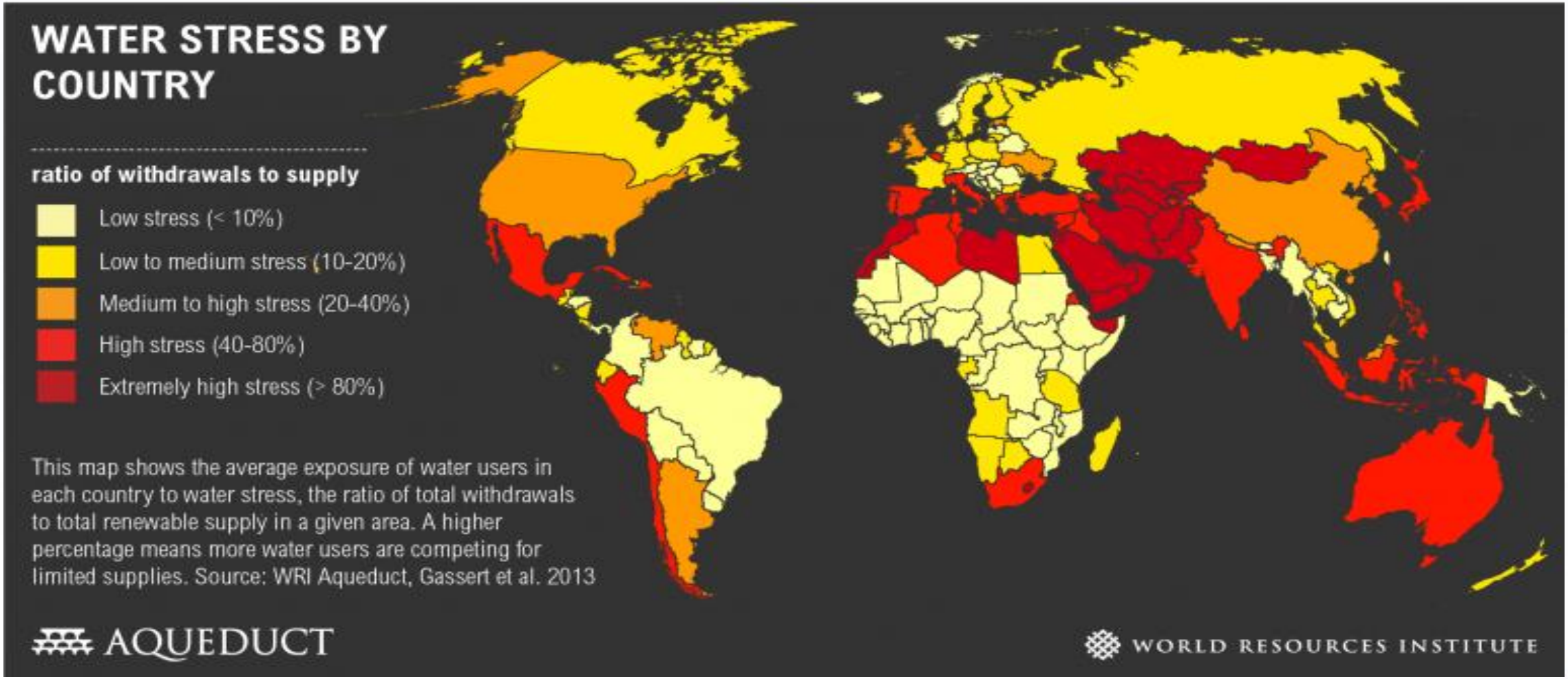
Various thermal power systems emit flue of fluids containing significant amounts of waste energy.

Meteorological Characteristics of Madinah

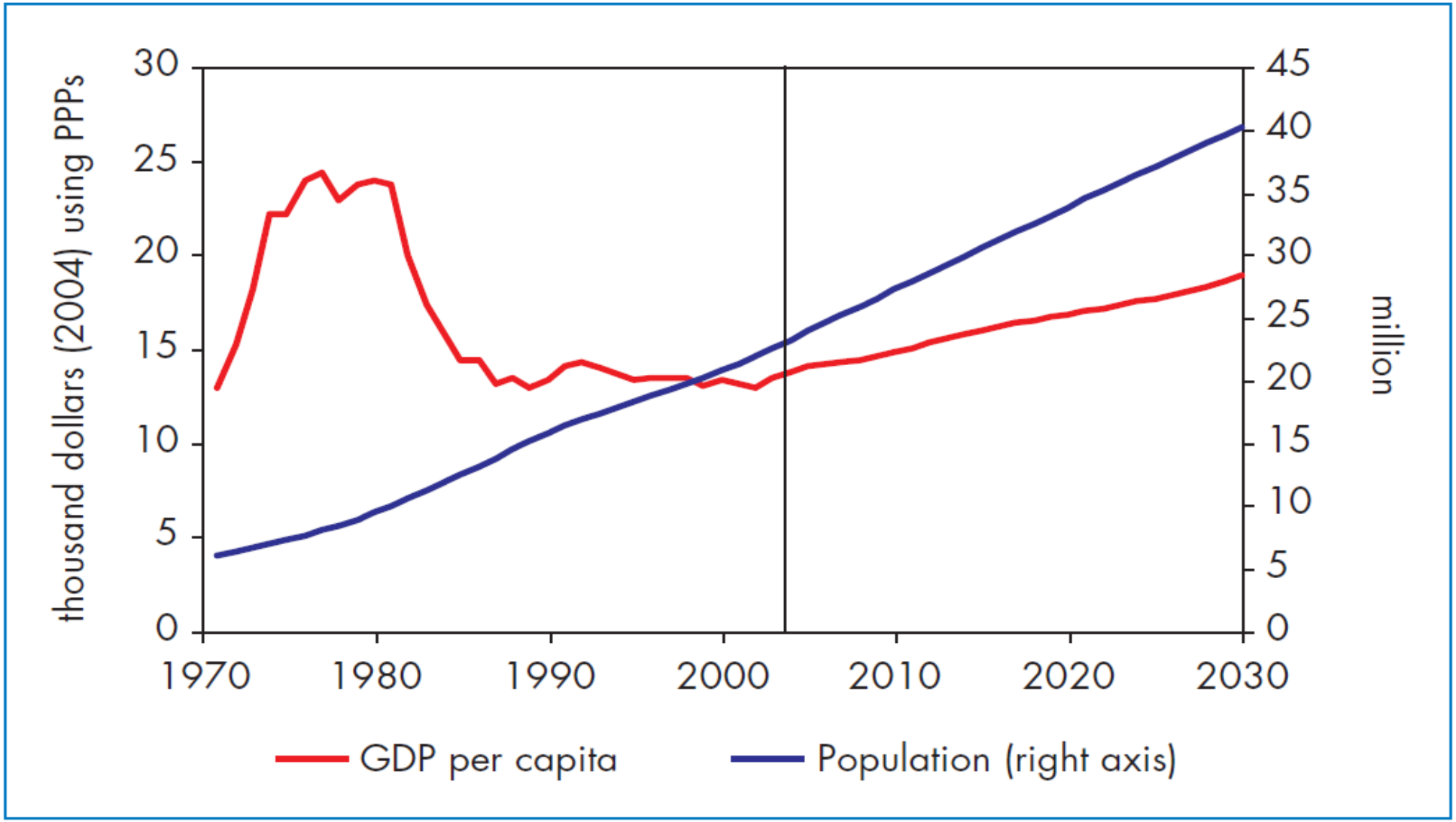
Latitude (°)	Longitude (°)	Altitude (m)	Daylight hours, hr	Average ambient temperature	Yearly irradiance (kW h/m²/day)
24° 55 N	39.70°E	626	10-12	15 °C(January) 48 °C (August)	4.5-8.5



Water scarcity by country with extremely high stress in Saudi Arabia

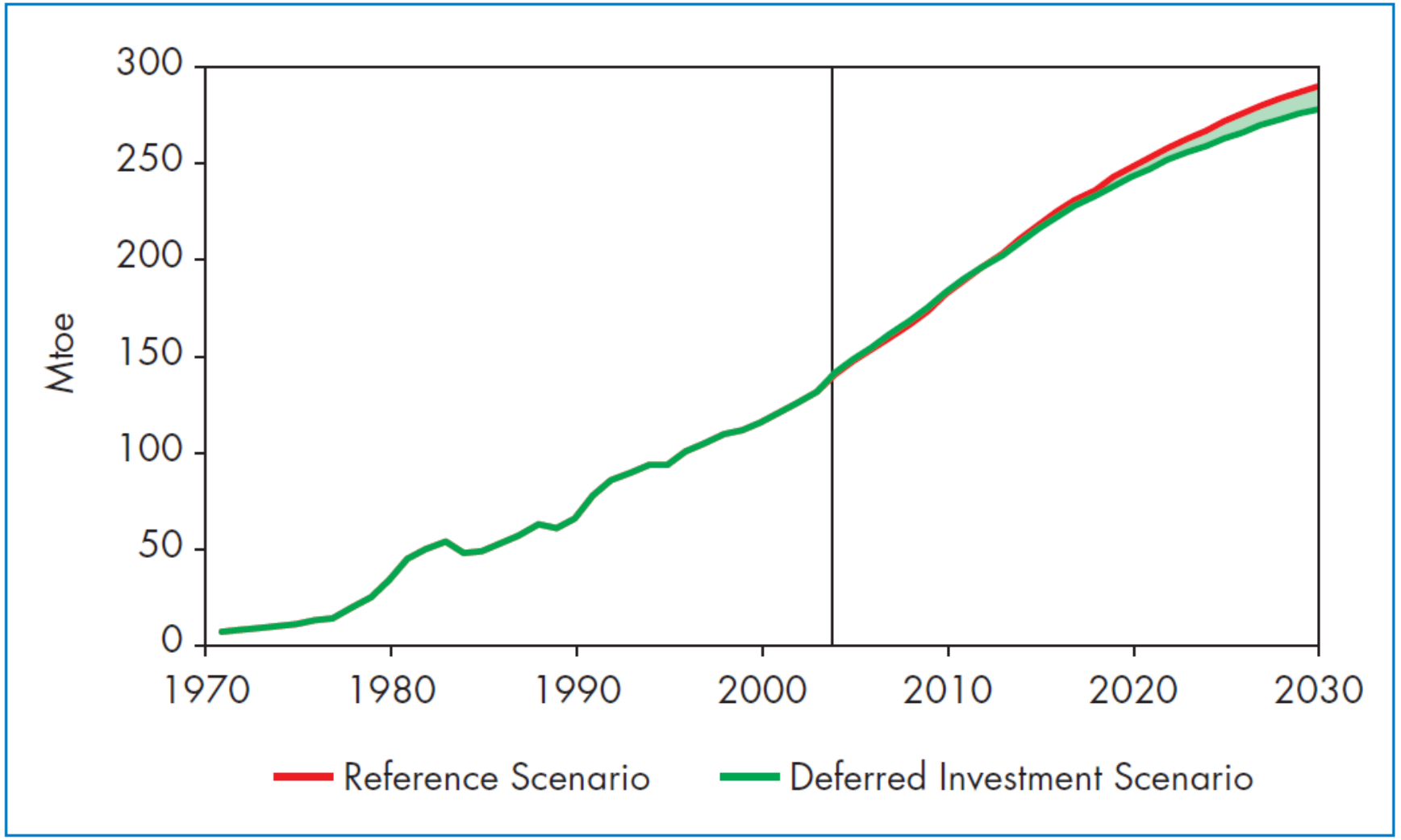


Saudi Arabia's population will reach 40 million by 2030



Energy Demand

Total primary energy demand in Saudi Arabia grows at an average annual rate of 2.8% per year demand reaches 277 Mtoe in 2030



Saudi Arabia's Water Production and future Demands

Saudi Arabia is the largest producer of desalinated water in the world. Desalination is expected to increase rapidly over the coming years.

Fuel requirements for desalination will rise from 11 Mtoe in 2003 to 31 Mtoe in 2030, when they will account for 11% of total primary energy supply.

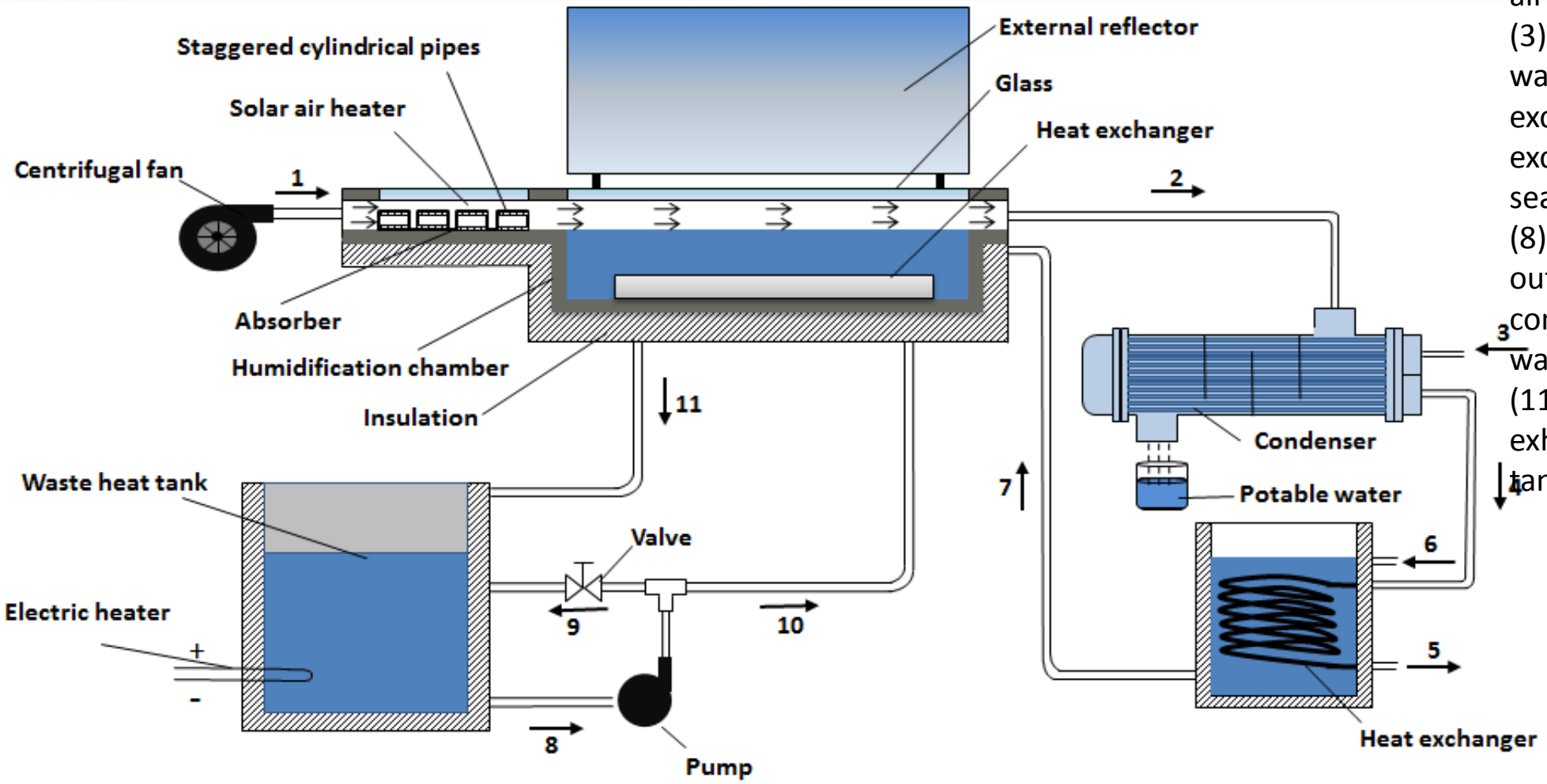
Total water consumption is projected to increase from 22.5 bcm in 2003 to over 25 bcm in 2030, an average annual rate of growth of only 0.5% (Table 16.6).

Table 16.6: **Saudi Arabia's Water Desalination**

	2003	2010	2020	2030
Water consumption (bcm)	22.5	23.1	24.0	25.1
Desalination capacity (bcm)	2.2	3.5	5.6	7.8
Oil and gas use for desalination (Mtoe)	11	17	24	31

Experimental test rig

System schematic diagram

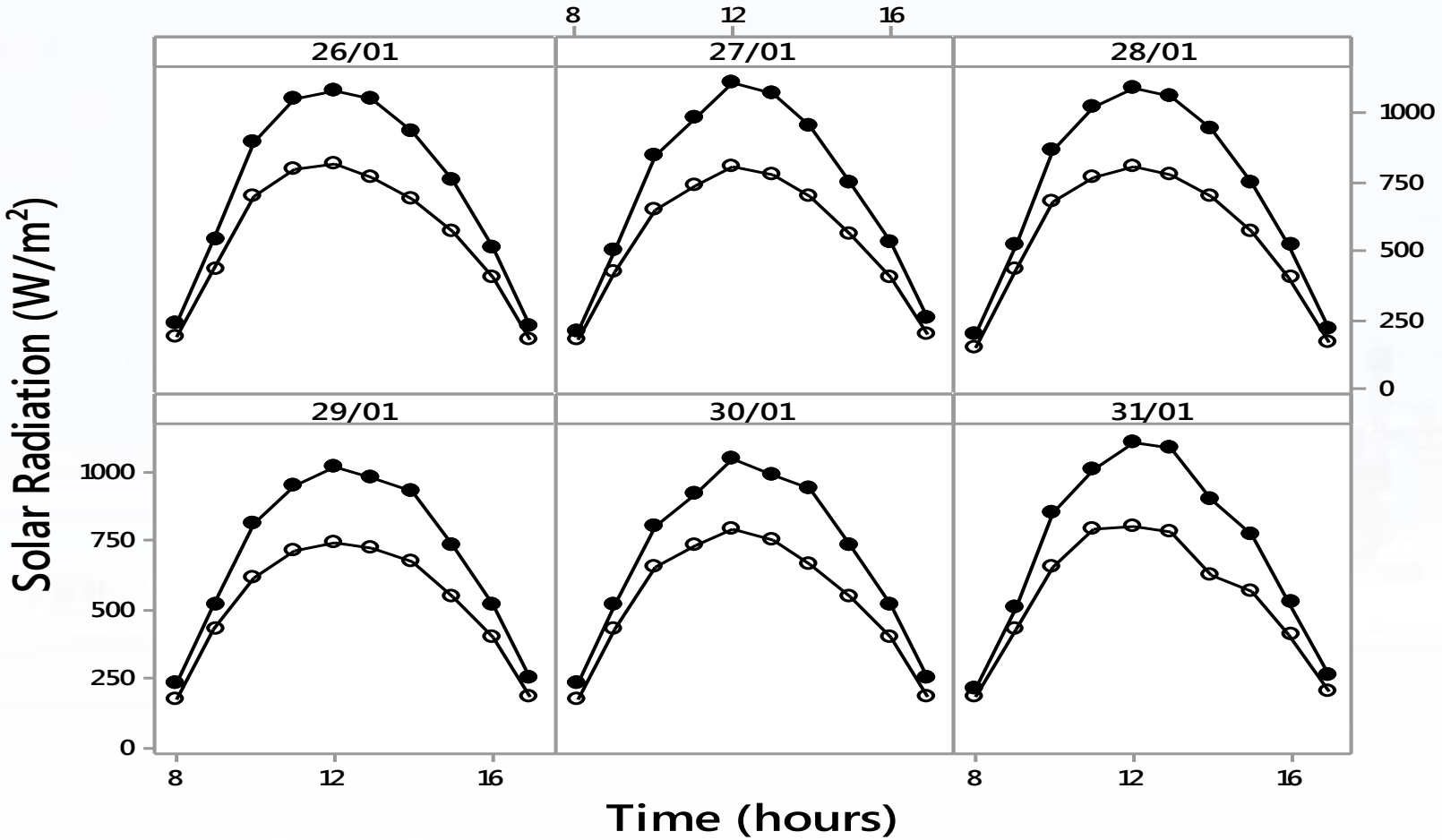


(1) Air blower; (2) moisture air stream to condenser; (3) sea water inlet; (4) sea water outlet; (5) heat exchanger inlet; (6) heat exchanger outlet; (7) hot sea water to the solar still; (8) waste heated water outlet to the still; (9) control by pass valve; (10) waste heat water to still; (11) waste heated water exhausted to waste heat tank

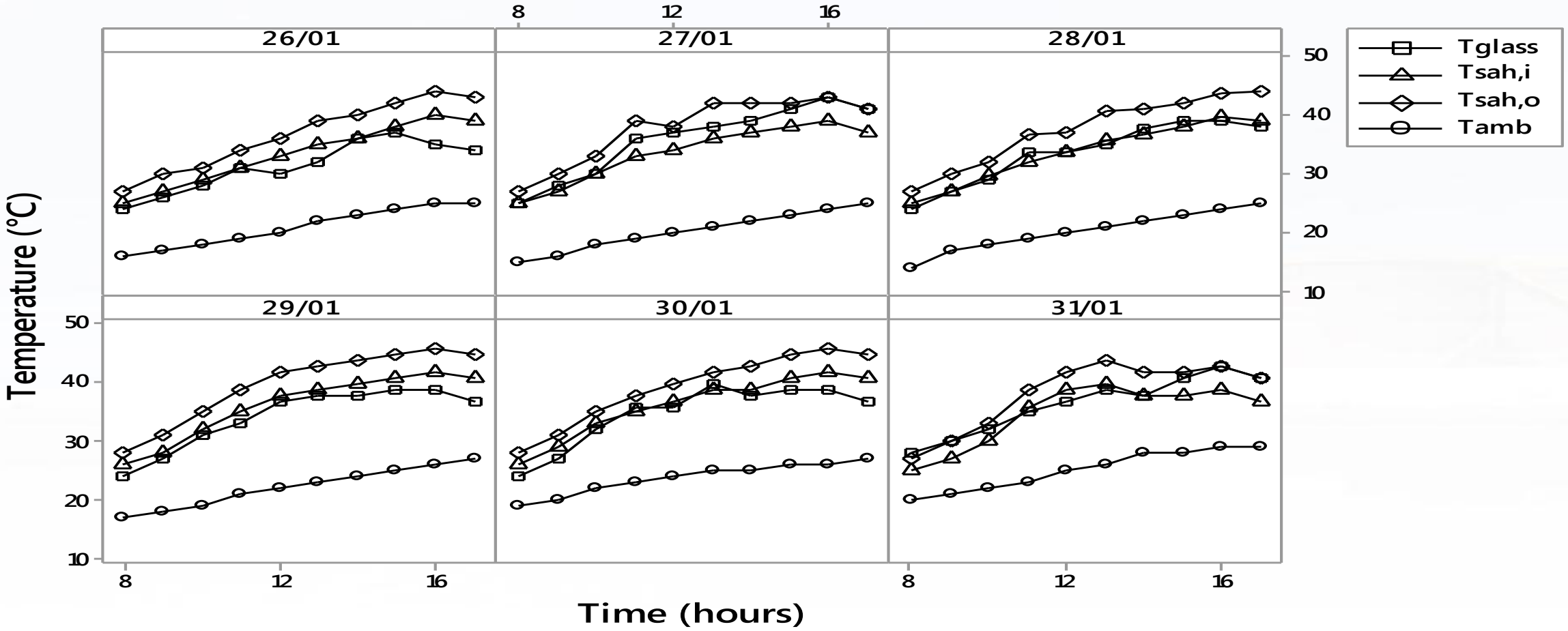
Factorial design of experiments

Factors	Factor Level	Factor values
Waste heated water flow rate, kg/s	4	0.05, 0.1, 0.15, 0.25
Waste heated water temperature, °C	3	60, 70, 80

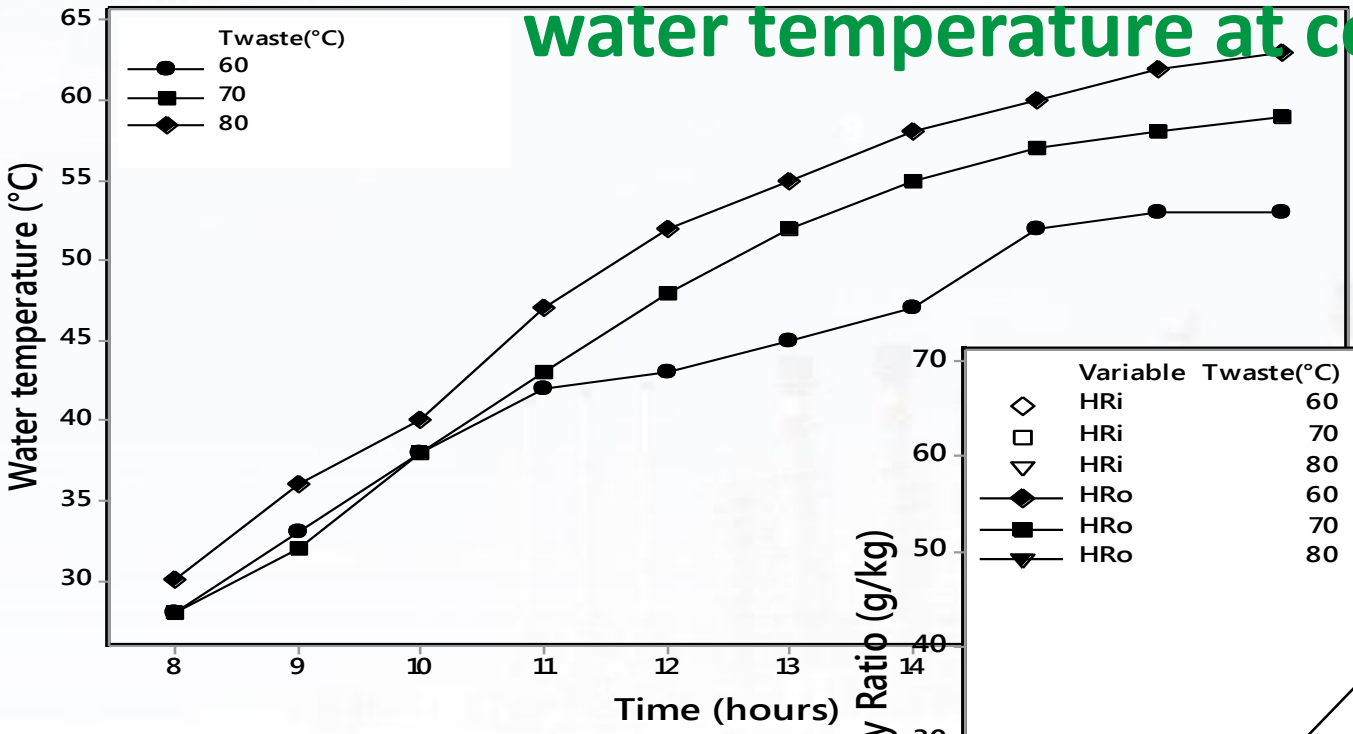
Plots of hourly variation of solar radiation for all the test days

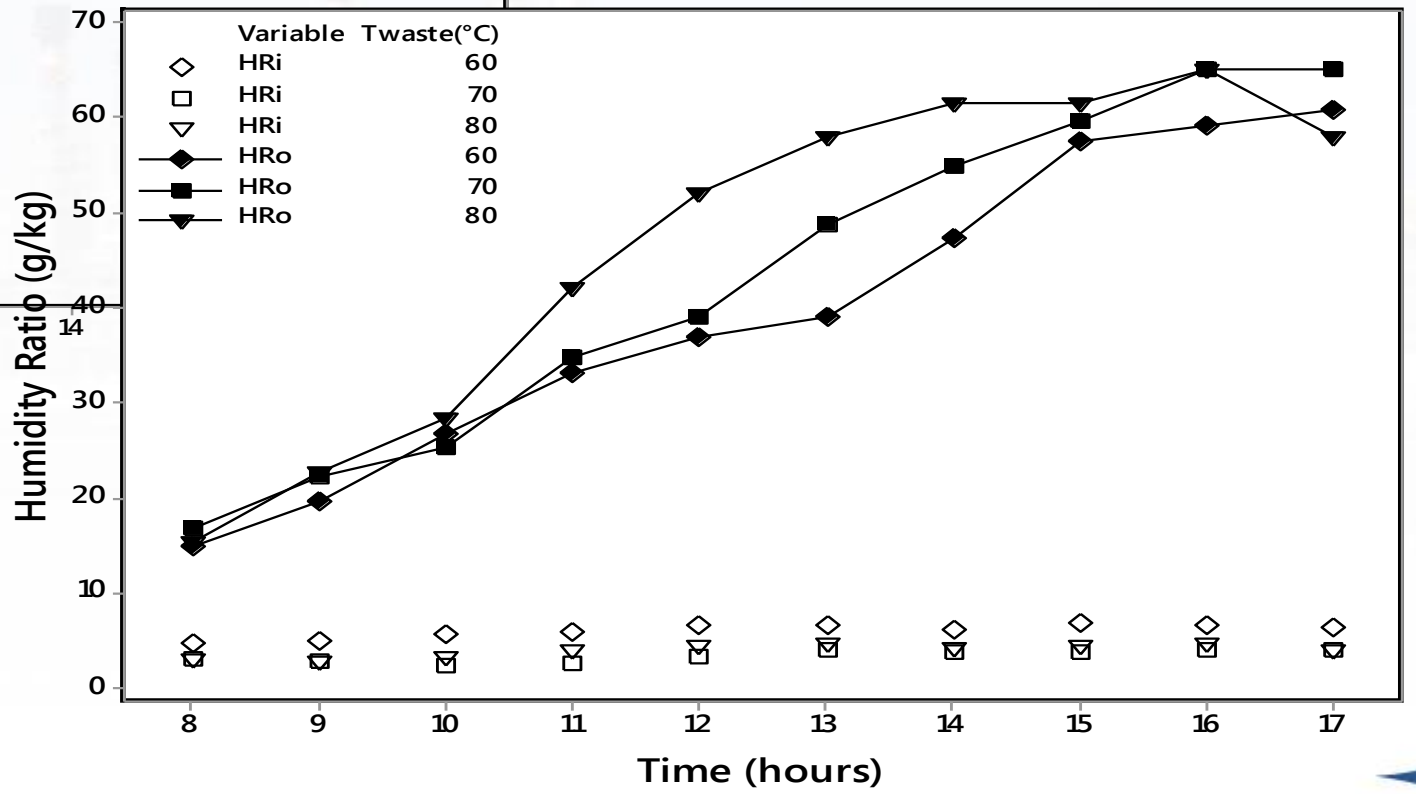


Ambient temperature, glass cover and induced air temperature at solar air heater inlet and outlet



Water temperature and humidity ratio inside the humidification chamber for different waste heated water temperature at constant flow rate 0.15 kg/s





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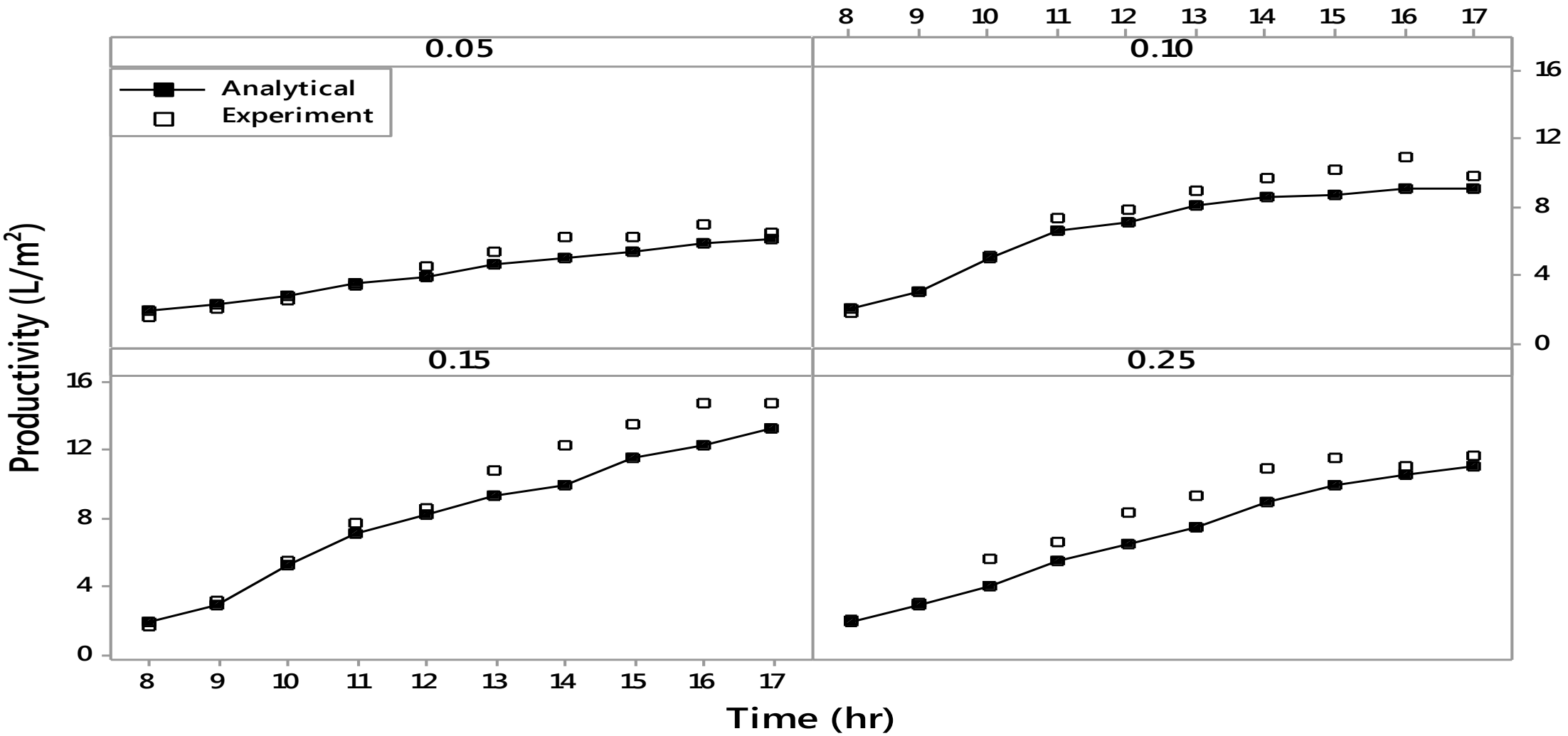
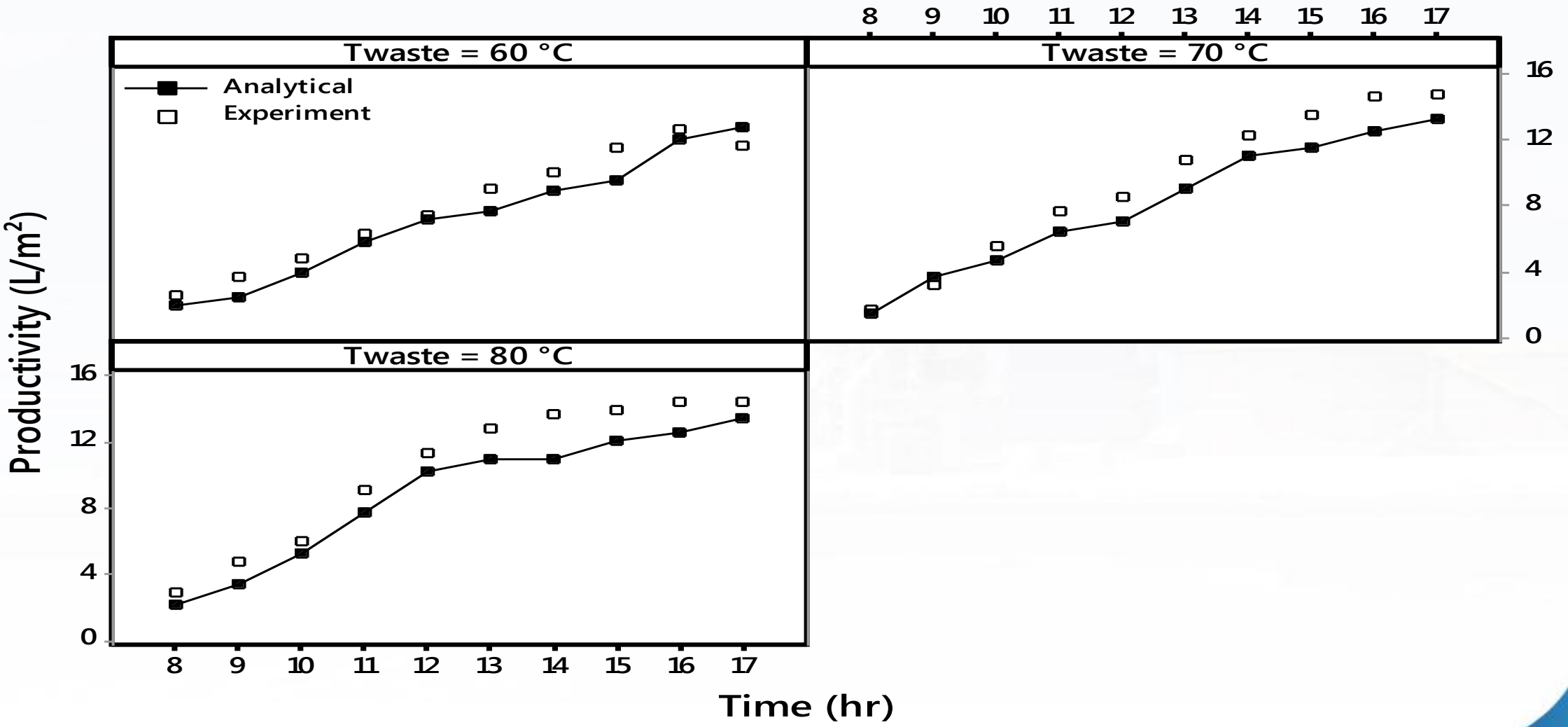
Productivity with time for different waste heated water flow rates at constant waste water temperature 70 °C

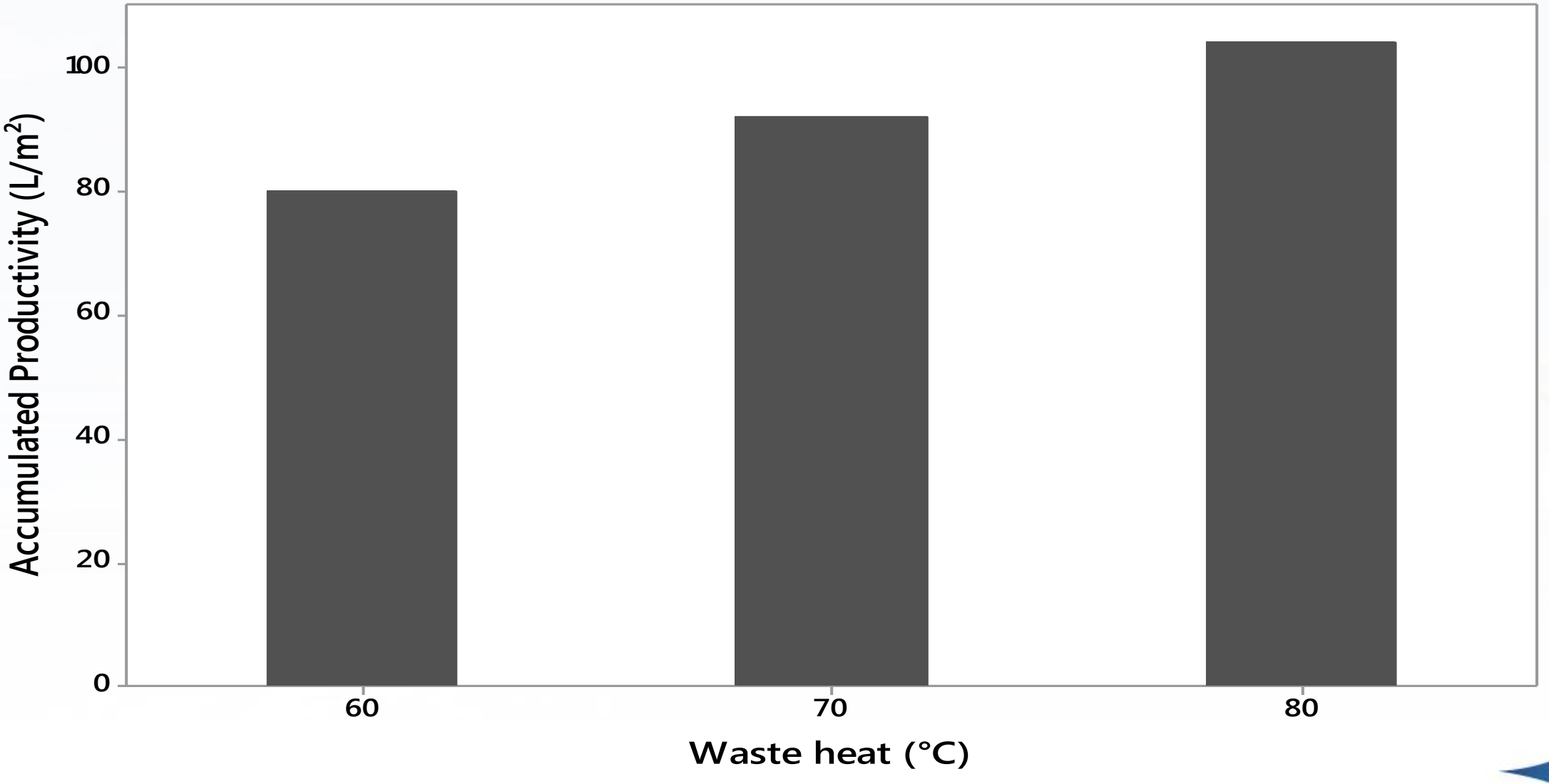


Panel variable: Geotherm water flow rate (kg/s)

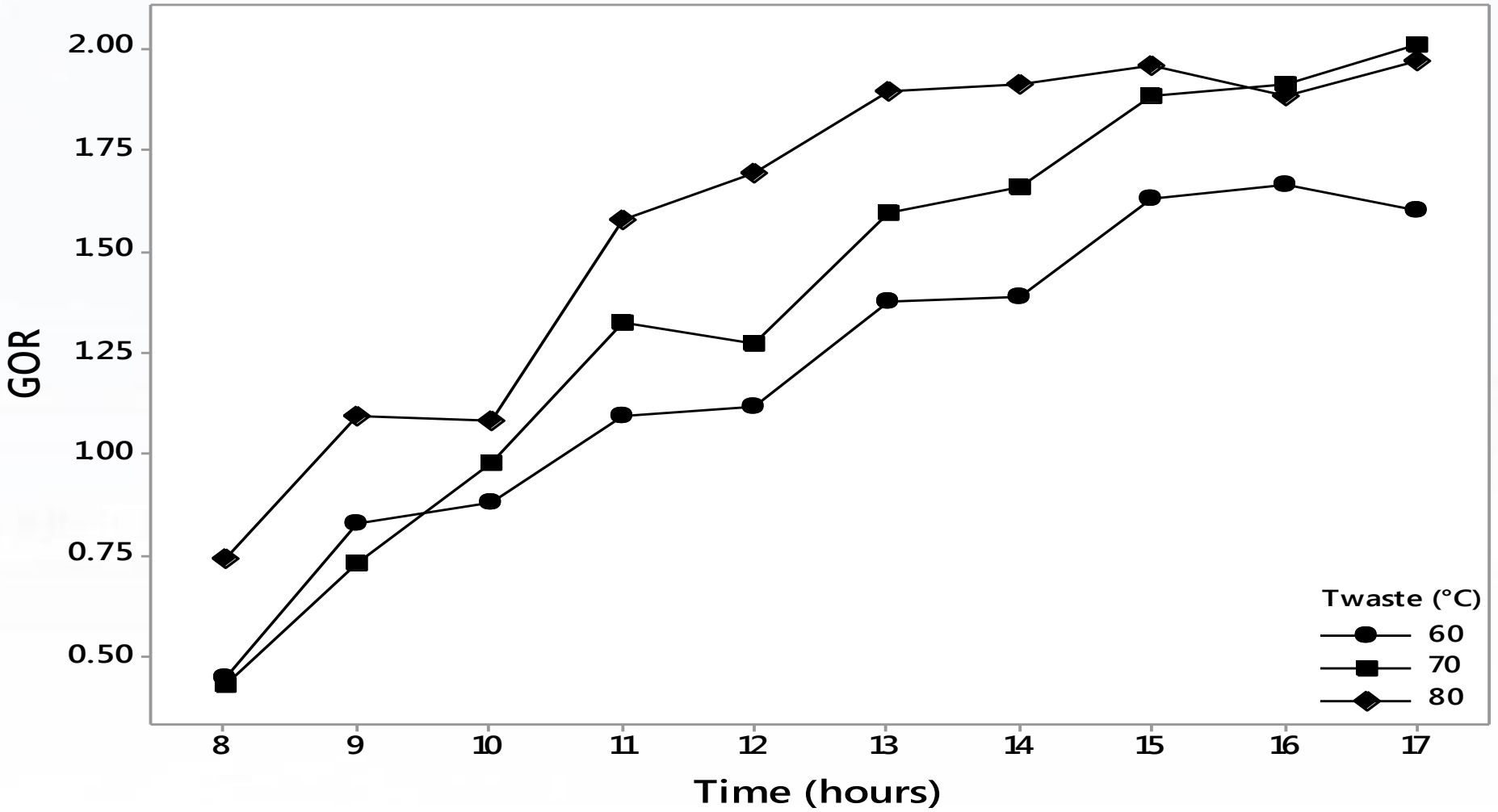
Productivity with time for different waste heated temperatures at constant flow rate 0.15 kg/s



Accumulated productivity for different waste heated water temperatures at constant flow rate 0.15 kg/s



GOR with time for different waste heated temperature at constant flow rate 0.15 kg/s



Conclusions

- Accumulated potable water productivity and GOR both increase with increase in waste heated water flow rate until 0.15 kg/s.
- Accumulated potable water productivity and GOR both increase with increase in waste heated water temperature.
- High instantaneous hourly GOR up to the value 2.12 was observed in the evening hours (4-5 PM).
- Experimental daily (8 AM–5 PM) accumulated productivity up to 103 L/m^2 was achieved using the proposed desalination setup under the considered range of waste heated water temperature and flow rates.
- Fresh potable water can be produced at 0.0094 USD/L using the proposed desalination setup.

THANK YOU

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