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MINISTRY OF CLIMATE CHANGE
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مـؤتـمـر عـجـمـان
الدولي السادس للبيئة
Ajman 6th International
Environment Conference

AC/DC technology is revolutionizing controlled environment agriculture in desert ecosystems

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TOWARDS >>> 2071
SHAPING THE FUTURE
FOR ENVIORMENTAL SUSTAINABILITY

Desert farming system challenges

- Little to no rainfall,
- Poor and sandy soil,
- Extreme temperatures,
- scorching winds,
- Little water catchment potential,
- Almost complete reliance on often non-renewable groundwater.

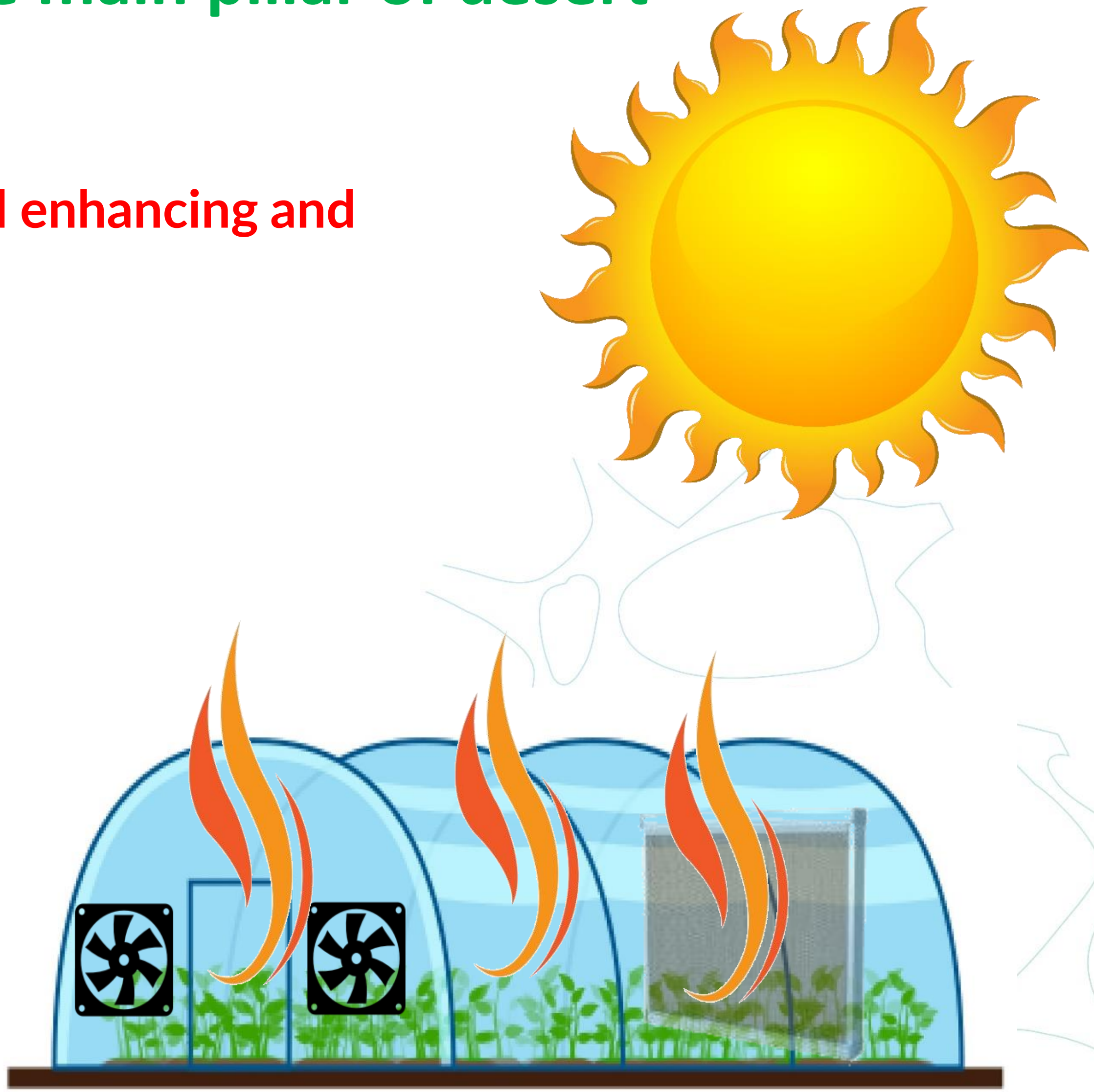
Make up 1/3rd of the land's surface area, deserts are a source of livelihood for millions of people

Control environment agriculture is the main pillar of desert farming

Protecting crops from the harsh environment and enhancing and managing crop production throughout the year.

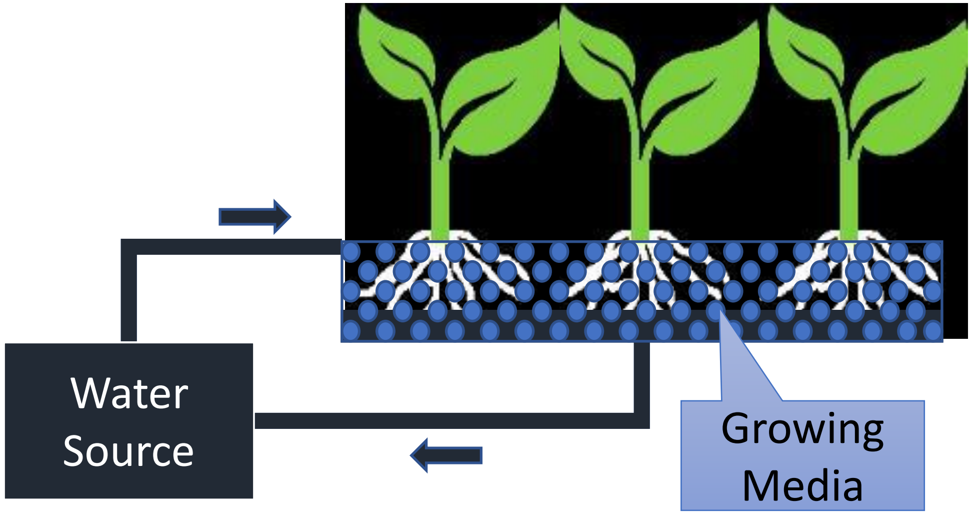
The main technical problem of using conventional greenhouses:

- maintaining the inside air temperatures and relative humidity favorable for plant growth under a desert farming system (Abdel-Ghany & Al-Helal, 2020)
- High water and energy consumption for plant production and cooling system



Simplified Closed Soilless Production System

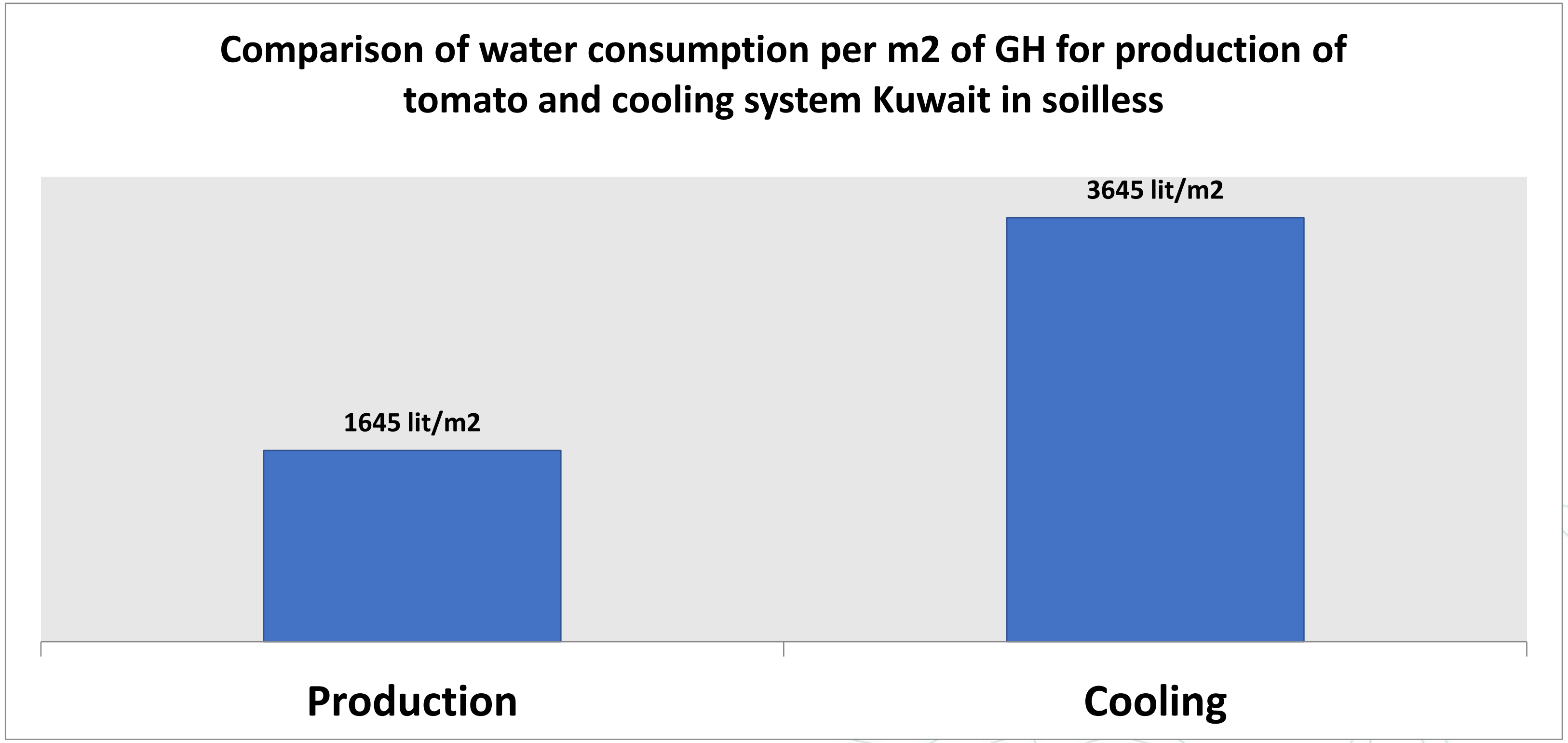
Reduce irrigation water by more than 50%



The evaporation cooling system (pad and fan) is widely using

However

- the efficiency of the cooling systems is low due to high humidity and temperature in desert farming system.
- The critical issue is that the cooling system requires large amounts of water and energy.

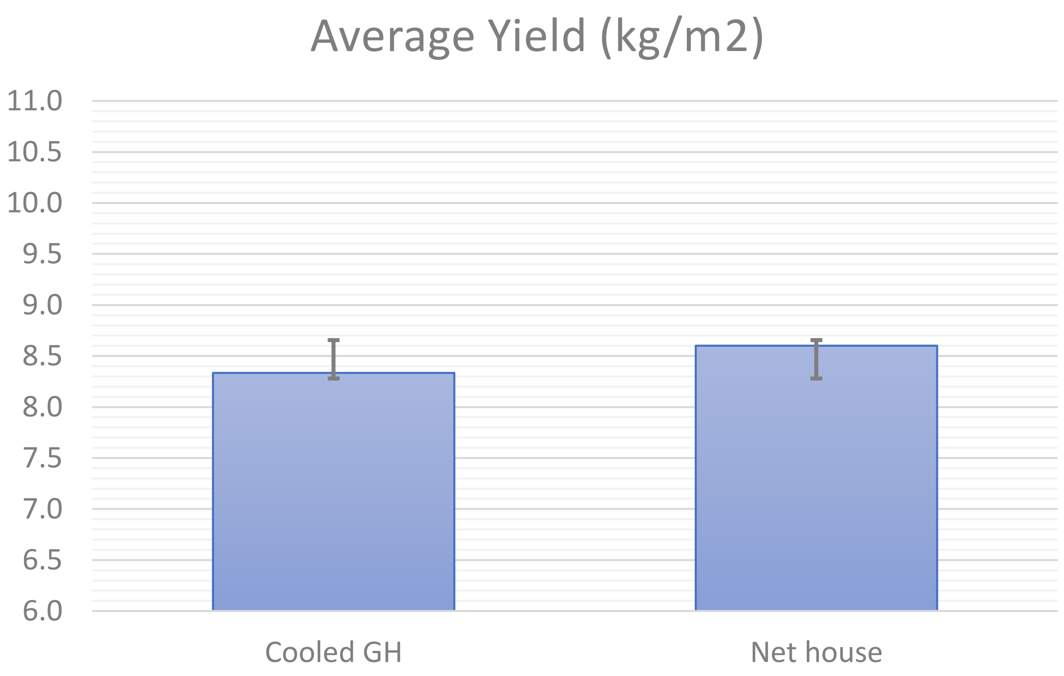


M.S. Albaho, K. Al-Mazidi, 2004. EVALUATION OF SELECTED TOMATO CULTIVARS IN SOILLESS CULTURE IN KUWAIT. ISHS Acta Horticulturae 691: International Conference on Sustainable Greenhouse Systems - Greensys2004

Net-house using insect-proof net

Considering the average monthly temperature, the production of cash crops could be successfully adopted in net-house for 7-8 months/year.

Comparing cucumber production in Net-house VS. Cooled GH in UAE (September to December 2012)



Root zone area cooling (RZAC)

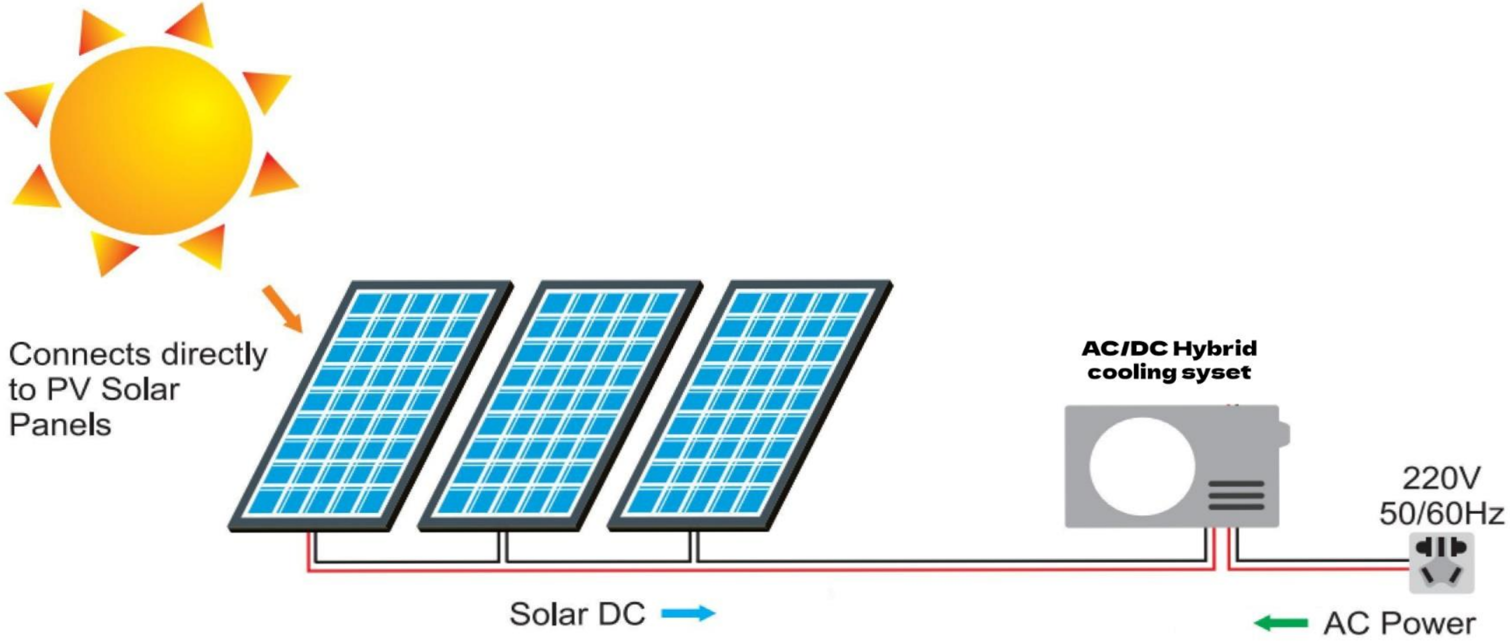
The air temperature inside the greenhouse tends to be very high during the daytime. The root zone cooling system has been used as an energy-efficient cooling system for GH to overcome this problem

- Niam & Suhardiyanto, 2018;
- Lyr & Garbe, 1995;
- Lahti et al., 2005;
- Solfjeld & Johnsen, 2006;
- Dıaz-Perez et al., 2007;
- Nxawe et al., 2009

Ultra-low-energy drip irrigation and Utilizing Hybrid Solar Energy

The new emitters studied through ICARDA-MIT research activities

- Cut pumping energy by 80%,



The AC/DC hybrid solar energy system combines On-Grid and Off-Grid based solar energy systems

- It comes with the advantage of on-Grid energy when the solar panel operates is not at its peak or the system requires extra energy to run.

Combination of Five technology packages

For the first time, this study aimed to combine the five technologies to investigate the possibility of improving productivity and extend the production period of the net house,

- closed soilless production system,
- net house,
- ultra-low pressure irrigation system,
- root zone area cooling,
- and low-cost solar energy,.

Setting up the experiment

- Three (3) similar hydroponics greenhouse structures (8x30m) in the Al-Dhaid research station, were selected.
- Two of the structures were covered with insect-proof net (net-house) and the third one with polycarbonate and pad and fan cooling system.
- The irrigation schedule and fertigation in all three greenhouses has been controlled by an automatic start/stop device
- Irrigation in the net-house with RZAC powered 100% by solar energy
- The irrigation water in the experimental net houses remained constant at 25 degrees using a hybrid solar energy system

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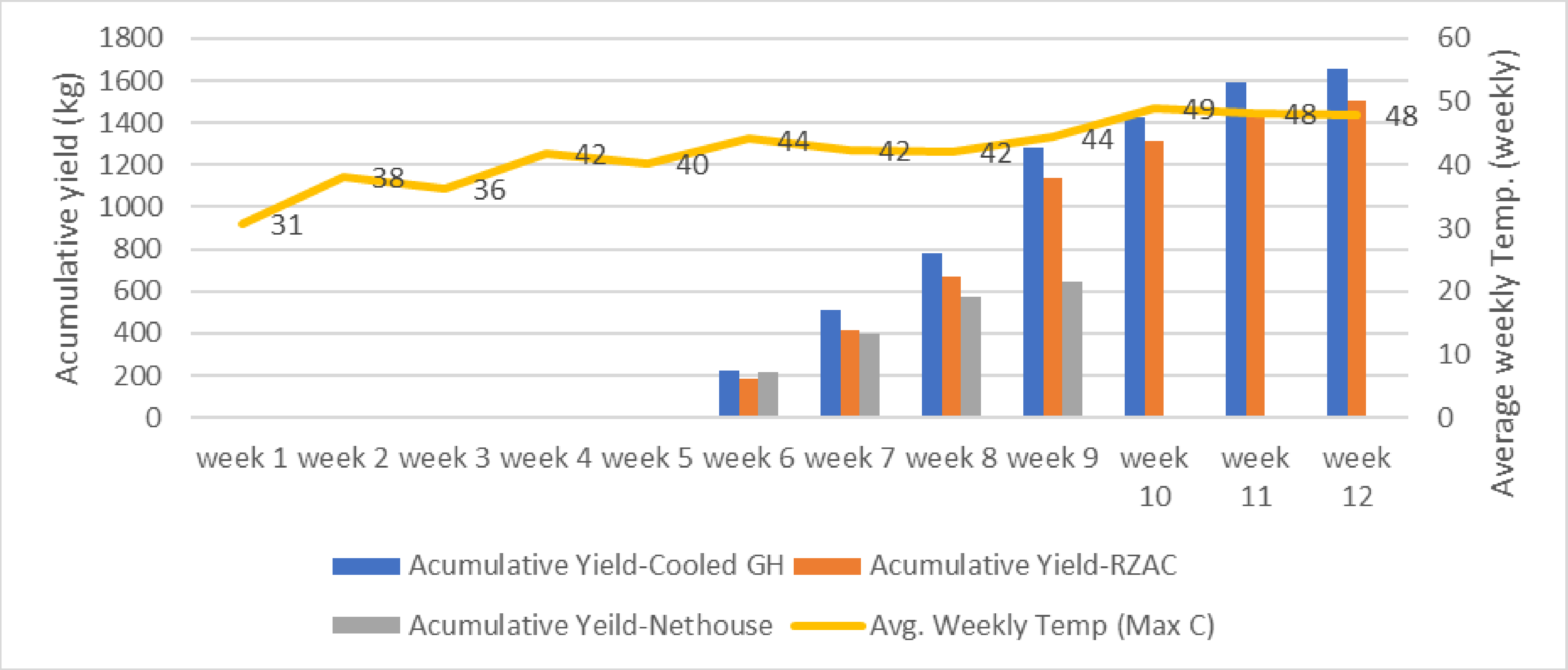
Production period

24 March → 13 June



Comparison of cucumber yield under Net house with RZAC and Cooled GH

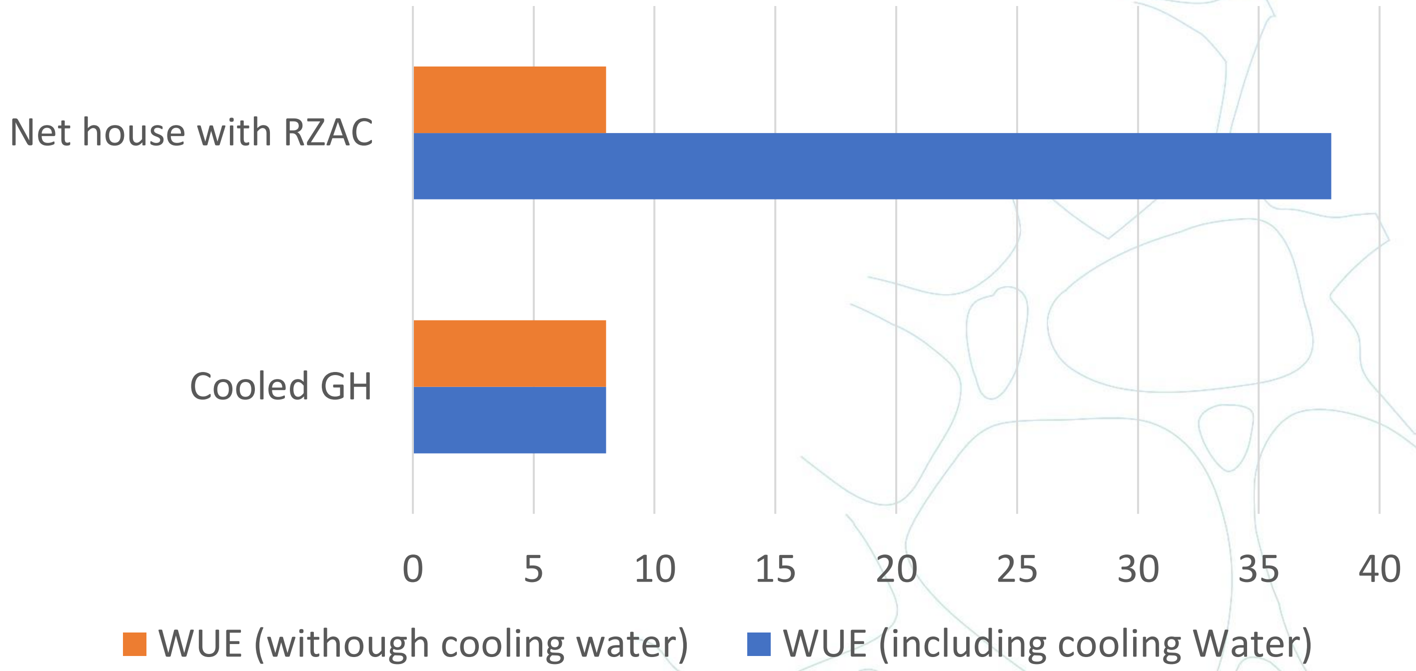
- Each of the structures was divided into seven sections in length.
- Each section had 70 pots and 140 plants.
- The production records of each section were collected separately and used as different samples to compare each structure's average yield and water productivity using independent samples t-test.

	Net-house with RZAC production (kg/m2)	Cooled Greenhouse production (kg/m2)
Section 1	7.13	6.18
Section 2	6.49	7.24
Section 3	6.14	7.94
Section 4	6.07	7.41
Section 5	5.82	7.24
Section 6	6.46	6.42
Section 7	6.14	6.21
Total	**6.32**	**6.95**

The independent two-tail t-test for equal variance proved no significant yield between cooled-GH and NH-RZAC

Water Use Efficiency (kg/m3) in the net house with RZAC and conventional cooled greenhouse

- Both structures used about 40m^3 of water for crop irrigation and fertigation
- The cooled GH consumed an extra 176.85m^3 of water for the cooling system.



Economic analysis

Machinery and depreciation

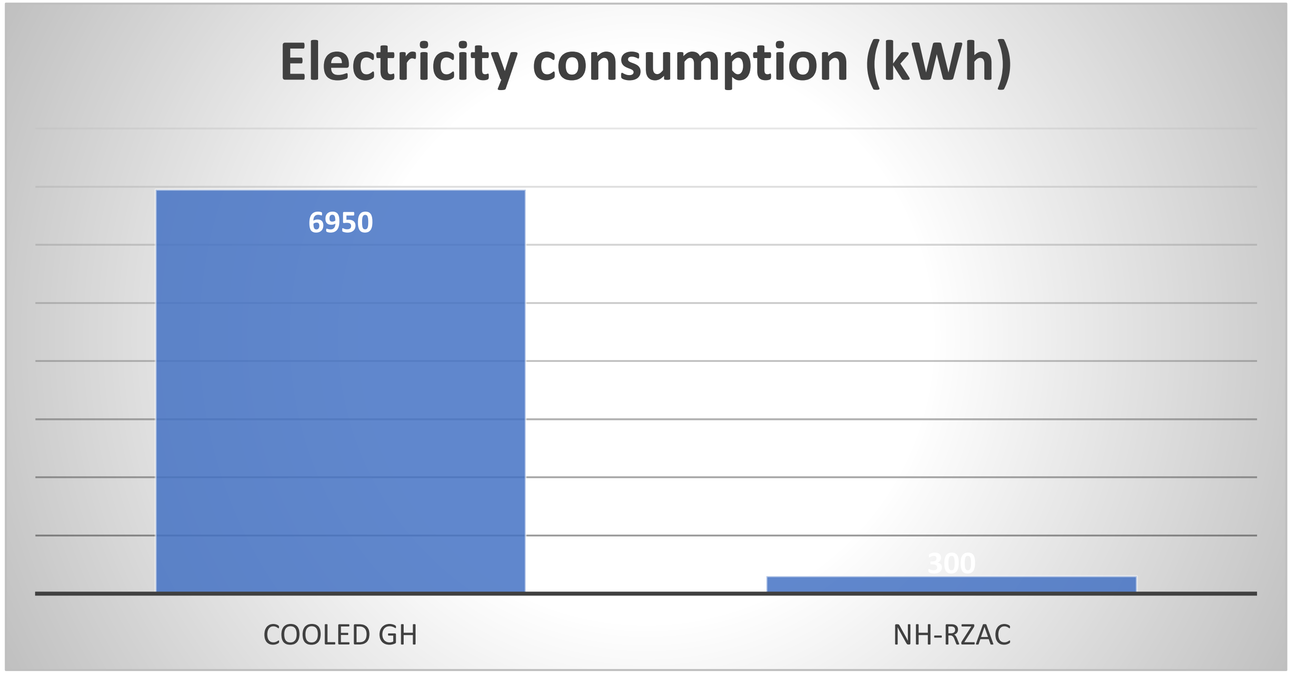
Estimated cost of establishment and equipment

	Establishment cost		Economic life (year)	Annual cost	
	cooled GH	NH-RZAC		cooled GH	NH-RZAC
Greenhouse structure	40000	25000	10	4000	2500
Irrigation system	2930	2015	5	586	403
Root Zone Cooling	0	7000	5	0	1400
cooling system	10000	0	5	2000	0
Hydroponics system	3000	3000	5	600	600
Total	55930	37015		7186	4903
Cost per season (4 seasons for cooled GH and 3 seasons for the net house)				1797	1634

Net house with RZAC and solar energy reduce establishment cost and depreciation with about 10%

Economic analysis

Energy :



- Save 95% of electricity consumption
- Saves annually about 4AED/m2

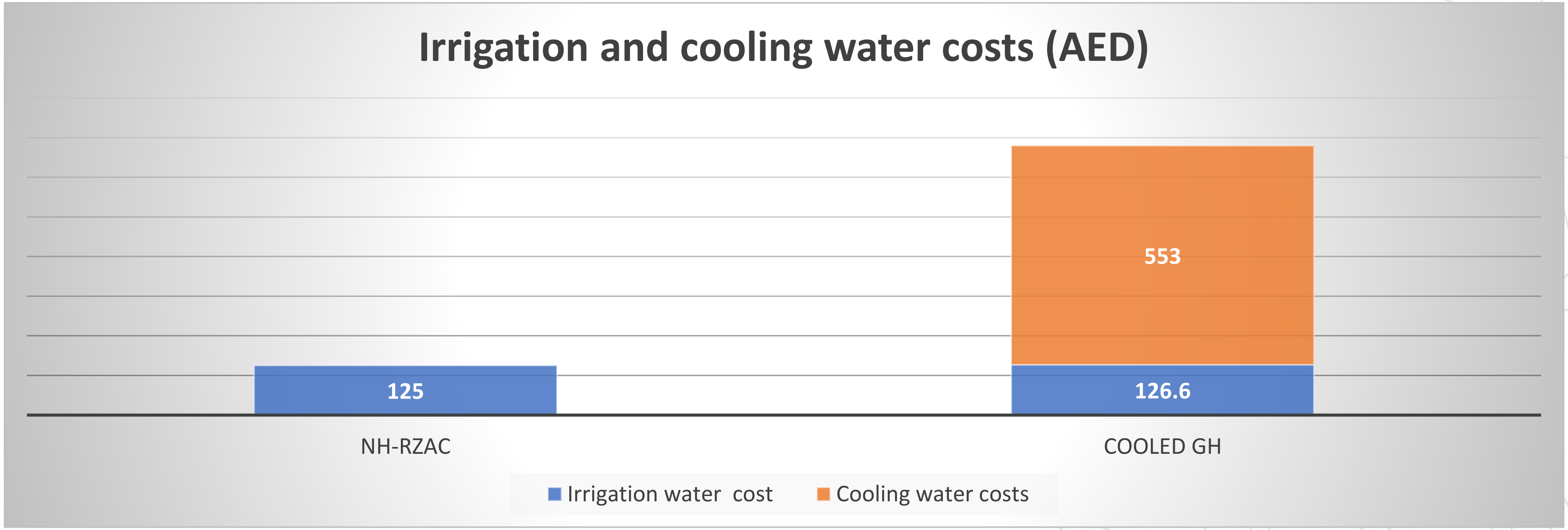
Environment: Less electricity means less carbon footprint.

The 6650-kWh saving is equivalent to 4.7 metric tons of Co2 not emitted to the atmosphere. This is equal to a co2 generated by a small car run for one year (EPA, 2020)

Economic analysis

Water

Overall, the NT-RZAC saved water costs by more than 5 folds.



The Water cost is 3.13 AED/m^3 as agricultural water tariff (Abu Dhabi Distribution Company, 2017).

Partial budget analysis

	Cooled GH	NH-RZAC
Seeds	180	180
Total fertilizer	225	225
Total pesticides	50	50
Labor	500	500
Energy	**302**	**14**
Machinery (including depreciation)	1797	1634
Water	**680**	**126**
Total Cost	3733	2729
Total revenue	6614	6019
Net return	2881	3290

compared to the conventional cooled greenhouse, utilizing net house with RZAC powered by solar energy

- reduced the total cost of production by 27%
- increased net income by about 14%

Conclusion

from this study findings, it can be stated that utilizing the AC\DC hybrid on-grid solar energy combined with four other proven technologies shows promising results for improving the yield, water productivity, and production period of cucumber crop under net house compared to the conventional pad and fan greenhouses in desert farming system.

eliminating the pad and fan cooling system, the combination reduced

- energy consumption by up to 95%
- water by 80%, mainly by.
- No quantitative or qualitative yield penalties were observed.

THANK YOU