NOVEL STANDALONE SOLAR DRIVEN AGRICULTURE GREENHOUSE DESALINATION SYSTEM: Self Sufficient of Energy and Irrigating Water

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Motivation

- ❑Problem definition
- ❑Resources
- ❑Solution

Problem definition:

- Egypt's natural water resources are in a critical limiting range (550 m^3/capita). That situation may get worse after Ethiopian dam construction.
- Agriculture is the most consumable of water (70-80% of water).
- Open field agriculture in such conditions, with mainly dry and hot environment, is not economical with such limited water resource.

Resources:

- About 94 % of Egypt lands are desert (harsh climate and brackish water).
- Egypt has solar radiation much more than the plant needs of photosynthetic process (about twice plant needs).

Motivation

- Problem definition
- Resources
- **Solution**

Solution:

- Therefore, agriculture Greenhouses (GH) presents a suitable alternative solution for different plants growth for Egypt's desert.
- With the available high solar energy in Egypt, integration of solar – GH – desalination systems present a real challenge and is the focus of this paper.

Objective

The target of this research is developing, manufacturing, and pilot testing the system in Egypt and the MENA-GCC region. The new proposed integrated system should, therefore, be (i) standalone and grow its energy and irrigation water demand; i.e. be self-sufficient of energy and irrigating water, (ii) has a suitable microclimatic conditions for different plants in order to be a provider of the basic food needs for small community living in remote areas and (iii) a means of creating jobs and business opportunities.

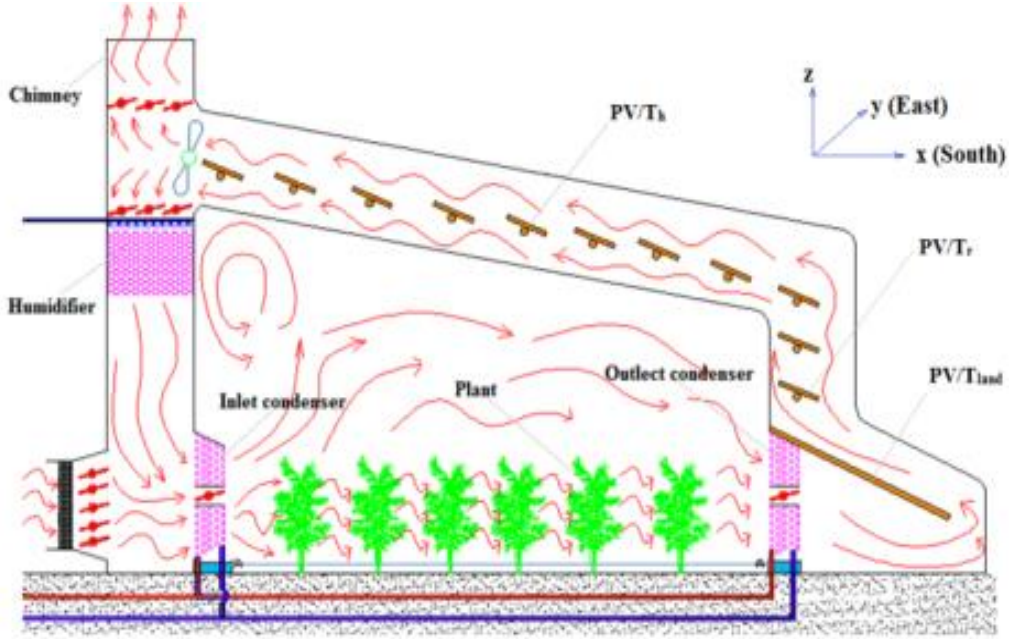
System characteristics

Standalone

The developed Solar – GH Desalination system is standalone as it grows its energy and irrigation water demand.

GH components

- GH cavity (Plants growth area)
- Double layer of transparent material (Circulating ventilation air path)
- Thermal Photovoltaic (PV/T) panels (Electricity generation)
- Condensers (inlet for cooling, outlet for transpiration recovery)
- Service room (RO, Auxiliaries)

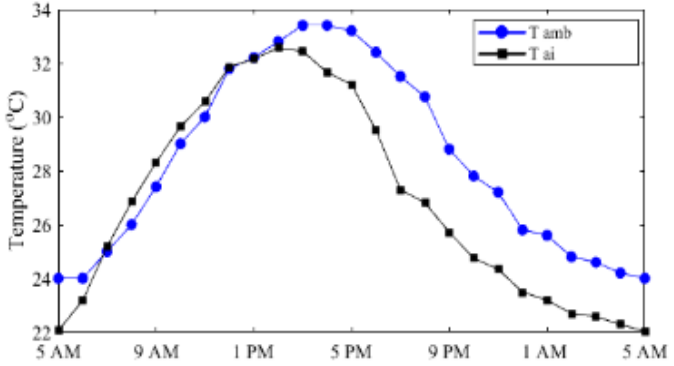


System characteristics

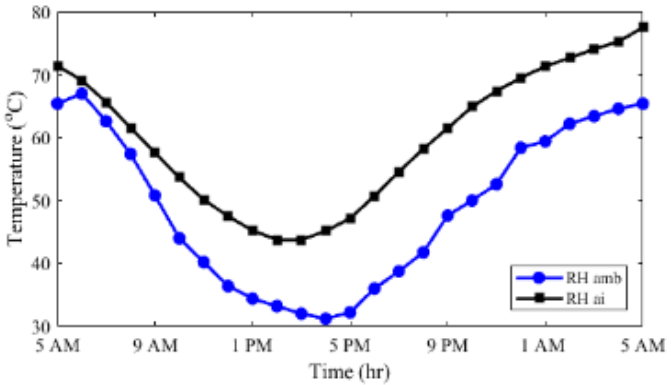
- **Controllable microclimate**

A transient mass and energy balance mathematical model is developed to simulate the system performance for a typical environmental condition in Zagazig city, Egypt.

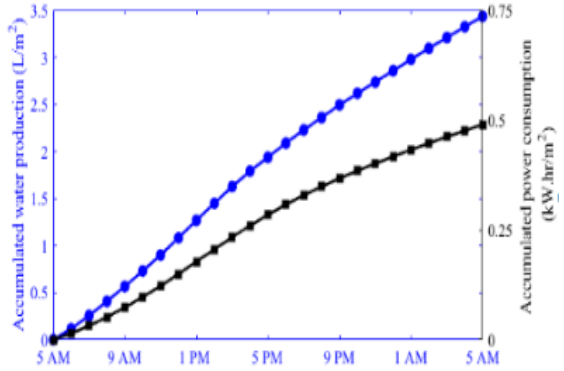
Temp.



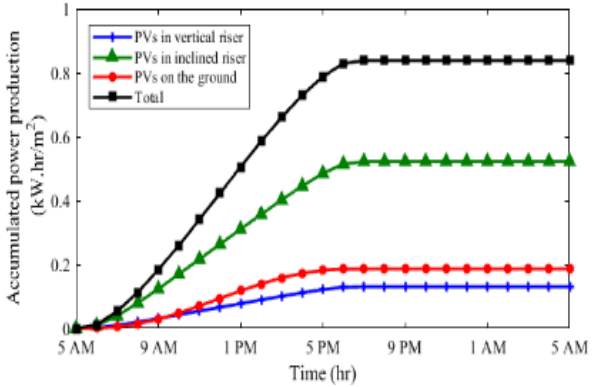
Relative humidity



Transpiration Water production



Electricity generation

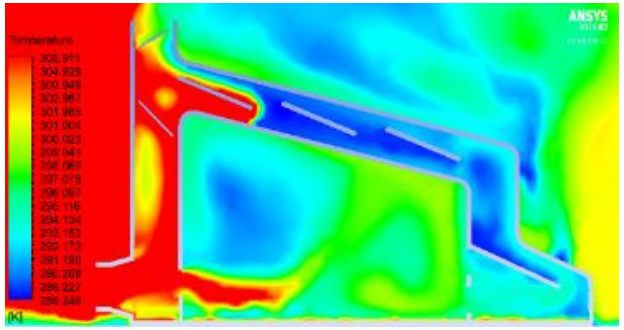


System characteristics

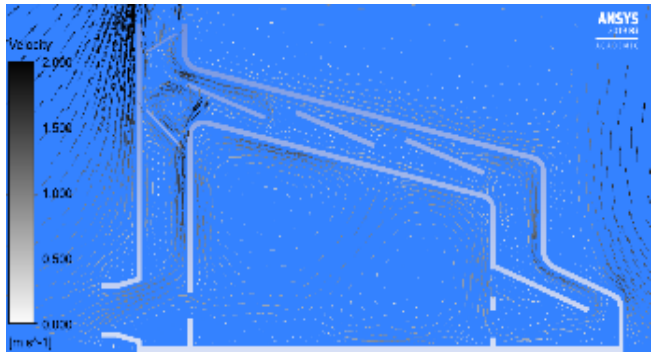
- **Controllable microclimate**

CFD model is used to monitor detailed microclimatic conditions inside the GH.

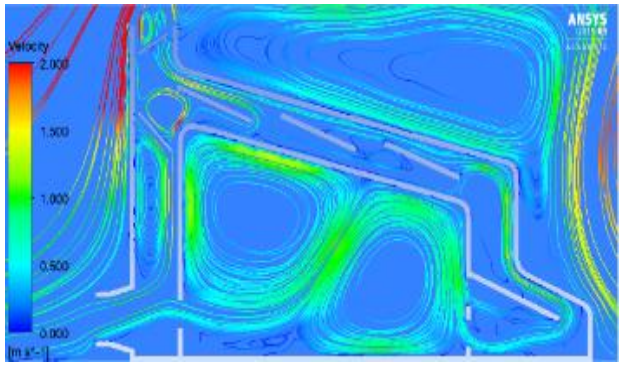
Temperature Contours



Velocity Vectors



Velocity Streamlines



System characteristics

- **Multi-discipline**

The newly developed system is a means of creating jobs and business opportunities and could be a module for a larger integrated complex of water-energy-food nexus to sustain remote communities.

Conclusions

A novel solar driven agriculture GH is developed for arid areas where harsh climate, and saline water is found, to provide suitable environment for plant growth.

The developed system uses the extra solar radiation, above the photosynthetic plants needs, to power the GH and to desalinate water for plants irrigation.

The developed system can provide controllable microclimate conditions in the GH plants. In addition, it recovers transpiration water via dehumidification process.

This system contributes in creating jobs and business opportunities when it applied in commercial scale.

Acknowledgments

This paper is based on work that supported by the British Council (BC) of UK, Grant No. (332435306) and Science, Technology, and Innovation Funding Authority (STIFA) of Egypt, Grant No. (30771), through the project titled “A Novel Standalone Solar-Driven Agriculture Greenhouse-Desalination System: That Grows its Energy and Irrigation Water” via the Newton-Musharafa funding scheme