قافكو
QAFCO
شركة قطر للأسمدة الكيماوية
QATAR FERTILISER COMPANY

Sustainable Food Production Via High-tech Greenhouses In A Desert Environment

A Case Study in Qatar

22.09.2021

01

Why High Tech?

Climate in Qatar

The climate of Qatar is desert, with mild winters, and hot summers. Rainfall occurs during the winter months, and it amounts to less than 100 millimeters per year.

In winter, from December to February, temperatures generally range from lows around 14/17 °C to highs around 22/25 °C.

Summer is very hot with highs around 42/43 °C and lows around 30/32 °C. Daytime temperatures can go up to 45/47 °C.

Relative humidity increases over the summer and the combination of moisture and temperature that is recorded in summer in the Gulf countries is one of the most extreme in the world.

High-tech greenhouses could provide the means to achieve year round sustainable agriculture in Qatar

Water Use Efficiency

300 liters

Open field

150 liters

Greenhouse with desert cooling

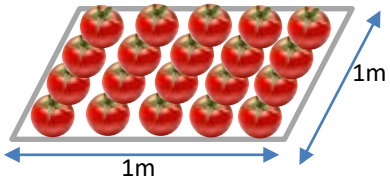
5 liters

High Tech greenhouse

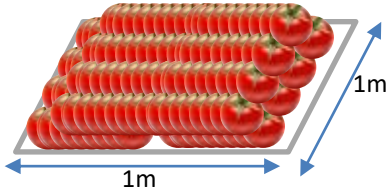
High tech greenhouses are super water savers, it allows deployment of the technology in water scarce countries

Improved Yields

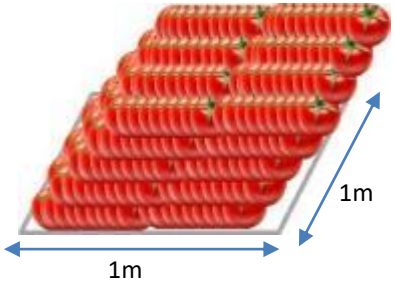
5 kg



40 kg



100 kg



Open field

Greenhouse with desert cooling

High tech greenhouse

High tech greenhouses can produce 10 to 20 times more than open fields

Additional Benefits of High-Tech Greenhouses

- More resilient to climate change because the greenhouse protects the crop from heavy rain, sandstorms and heat waves
- Most wild-life like birds, rodents and large size insects cannot enter the greenhouse easily
- Grow without pesticides and chemical residues using natural enemies and natural repellants and pheromone traps thus minimizing pesticide residues
- Consume and recycle the CO_2 emitted by industries to produce 30% more food
- 90% of fertilizers are recycled and consumed and leaching of fertilizers into water bodies is mitigated
- High tech greenhouses collect and gather tremendous amount of data and thus allow the use of automation, robotics, machine learning and Artificial Intelligence.

02

Why The Desert?

Potential Benefits from Developing Desert Agriculture

- Reduce the pressure on deforestation by exploiting non arable lands
- Reduce the demand arable lands / compensate for the loss of fertile soils (The UN estimates that in 60 years all the fertile lands will be losing their top soil)
- Reduce carbon impact of cooling and shipping food from agricultural countries to the deserts by air, land and sea
- Reduces food wasted during shipping of goods
- Social impact by creating jobs for local communities

Potential Benefits from Developing Desert Agriculture

- By planting in the desert, the potential to provide healthier, fresher food for local communities is created as produce can be harvested ripe full of vitamins and antioxidants.
- Local production contribute to food security
- The best place to use solar panels to energize the greenhouses is where the sun shines: The deserts!
- The amount of radiation in the deserts is optimal for plants photosynthesis
- The sun radiation allows production for 12 months per year

03

An Overview of the Project

The Partners

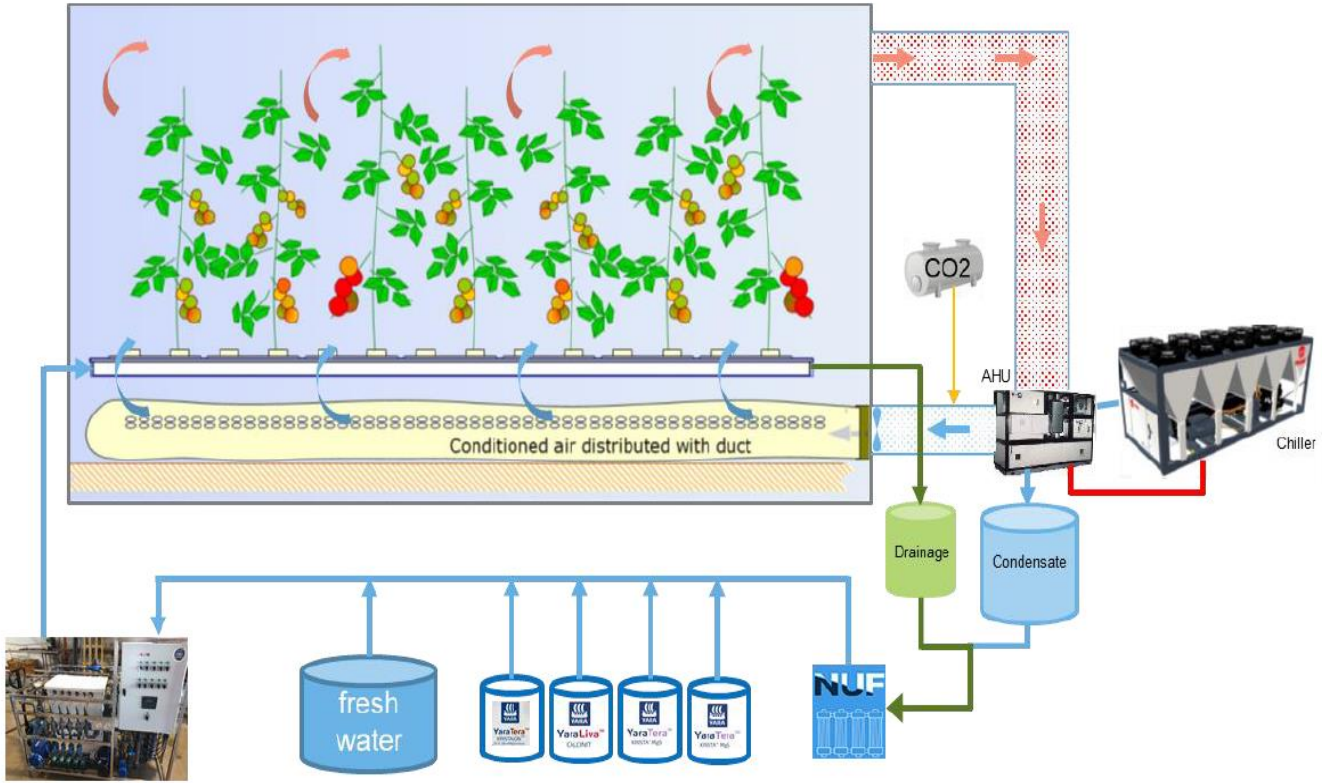
The high-tech greenhouse project was kicked-off as part of a collaboration agreement between Hassad Food, QAFCO and Yara

The Location

An existing Hassad Food Fan & Pad greenhouse was selected for upgrade to high tech

The Concept

The high tech Water saving greenhouse is a first pilot in Qatar to prove best yields all year round and water savings potentials



Construction Timeline

- Climate study: August 2018
- Engineering works: December 2018 to April 2019
- Project Kick Off: May 2019
- Construction started: July 2019
- Construction ended: November 2019
- Budget: 500,000 Euro
- Area: 800 M2

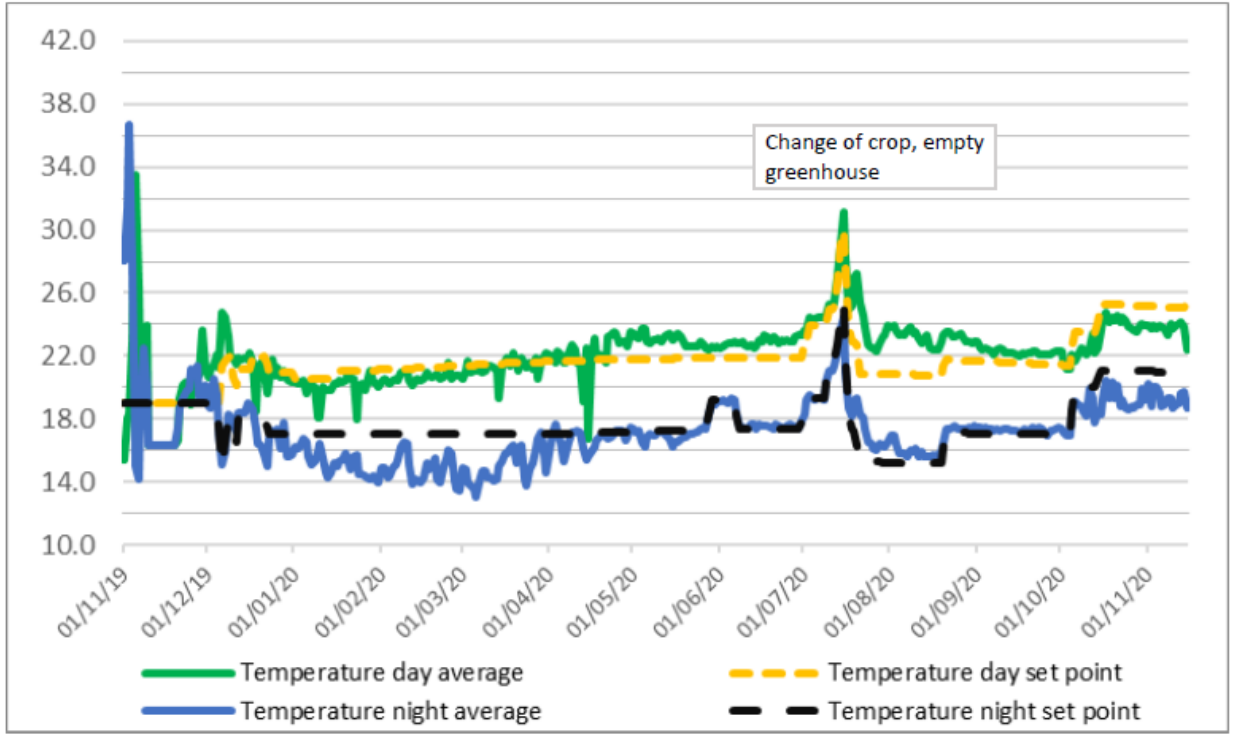
Construction Challenges

- To upgrade the electrical connection to grid to accommodate the power demand
- Coordination between HVAC companies and Greenhouse construction companies
- Adapting the HVAC system to respond to agricultural needs and the balance between cooling, heating and dehumidification
- The challenge of CO_2 enrichment

04

First Year Results

Internal Climate



Optimal climate was achieved and maintained year round

Productivity, Energy and Cost

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Productivity (KG/M2/Month)	3.3	6.2	6.9	9.8	7.3	5.56	2.1	-	0.4	9	6	-	**62.5**

After the first 12 months of the trials conducted on November 2019-November 2020 the following results were obtained.

KPI	Results
Yield	62.5 kg/m2
Total Production	44,570 kg
Water consumption per kg	26 L/kg
Electricity consumption per m2	1100 KWh/m2/year
Cost per kg	3.45QAR/kg
Operating profit margin (before depreciation)	22%

Operational Challenges

- The most critical challenge was adapting the European systems and controls to local conditions
- Training the local community on the use of high tech greenhouse
- Finding the right balance between, cooling, heating, fan speed and shading.
- Manage the high sun radiation especially when it comes to calcium deficiency
- Managing the right PH balance of the rootzone in summer conditions

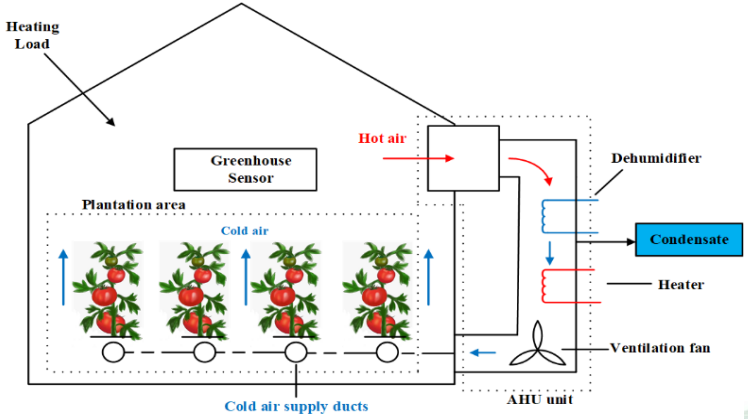
05

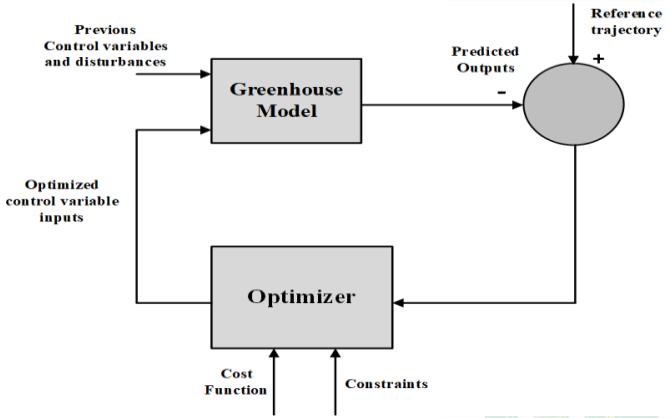
Future Steps

Optimize Energy Consumption

Predictive energy management for greenhouses

- Cooling load prediction, several hours in advance, for optimal microclimate conditions in the greenhouse.
- Comparative studies considering:
  - variabilities between day and night; summer and winter
  - 'Model-predicted' and 'Actual' control for cooling to assess potential energy savings on a yearly basis





Renewable Energy Source

A future enhancement would be to use 100% renewable energy for the greenhouse

Agreement signed for QR1.7bn solar power plant

Prime Minister and Interior Minister, H E Sheikh Abdullah bin Nasser bin Khalifa Al Thani, yesterday attended the agreements signing ceremony of first-of-its-kind 'Al Kharsaah Large-Scale Solar PV Power Plant' project.

Prime Minister and Interior Minister, H E Sheikh Abdullah bin Nasser bin Khalifa Al Thani, and Minister of State for Energy Affairs, who is also the President and CEO of Qatar Petroleum, H E Saad Sherida Al Kaabi, witnessing the signing of agreement for Al Kharsaah Large-Scale Solar PV Power Plant, yesterday.

SANAULLAH ATAULLAH
THE PENINSULA

Prime Minister and Interior Minister, H E Sheikh Abdullah bin Nasser bin Khalifa Al Thani, yesterday attended the agreements signing ceremony of first-of-its-kind 'Al Kharsaah Large-Scale Solar PV Power Plant' project in Qatar which will produce electricity using photovoltaic technology.

With an estimated total cost of QR1.7bn, the Large-Scale Solar PV Power Plant will be constructed at Al Kharsaah area west of Doha on a 10 square kilometre land plot. The total capacity of Al Kharsaah Solar PV Power Plant is 800MW.

During the first phase of the project, 350MW will be connected to the grid by the first quarter of 2021 while the commercial commissioning of the total capacity is expected to start in the first quarter of 2022 in line with strategic objective set in Qatar National Development Strategy 2018 – 2022.

With this project, Kahramaa has managed to avail competitive power generation prices, save significant natural gas quantities used in traditional power generation, reduce carbon and other emissions and preserve the surrounding environment.

During the project's life time, the plant will contribute to reducing 26 million tonnes of CO_2, which aligns with the objectives of the national program for conservation and energy efficiency 'Tarsheed' to reduce one million tonnes of carbon emissions annually until 2022.

The agreements were signed by President of Qatar General Electricity and Water Corporation (Kahramaa), Eng. Essa Hilal Al Kuwari; General Manager and Managing Director of Qatar Electricity and Water Company and Board Member of Siraj Energy, Fahad Hamad Al Muhannadi; President and CEO of Japan's Marubeni Corporation, Masumi Kakinoki; and Chairman and Chief Executive Officer of Total, Patrick Pouyanne in a ceremony held at Sheraton Doha.

Pursuant to the agreements, Kahramaa in its capacity as the Transmission and Distribution System Owner and Operator (TDSOO) in Qatar, will buy electricity from Siraj1, which is owned by Siraj Energy (60%) and a consortium of Japan's Marubeni Corporation and France's Total Solar International (40%). The project follows a build, own, operate, and transfer (BOOT) model and has a term of 25 years, after which the ownership will be transferred to Kahramaa.

Later addressing the press conference, Minister of State for Energy Affairs who is also the President and CEO of Qatar Petroleum H E Saad Sherida Al Kaabi, said: "This project comes in implementation of Qatar's policy to diversify the production of energy and to increase reliance on and the efficiency of renewable energy, which is a basic cornerstone for a sustainable future for the generations to come."

H E the Minister said that this plant is the first of its kind in Qatar with a total capacity of 800MW which equals about 10 percent of Qatar's current peak electricity demand. "The project is also part of our efforts to conserve energy and protect the environment in a manner that strikes a balance between the needs of the current generation and that of the future generations as stipulated by Qatar National Vision 2030," said the Minister.

H E the Minister said that this project also comes as part of the energy sector's contributions towards Qatar's commitment to host the 2022 FIFA World Cup. "It will generate about 8 times the size of the solar energy Qatar had pledged to build, helping the organization of a carbon neutral event," he added.

An Illustrative Example

How much food could be grown with 800 MW of Solar Power?

- Energy Optimization of High-tech greenhouses can reach around 0.6 MWH/m^2/year
- 800 MW of Solar power can generate up to 1,750 GWH/year, thus it could potentially supply power to around 3,000,000 m^2 of greenhouses
- Considering 1 m^2 of greenhouses can produce 50 Kgs of various fresh vegetables
- It is possible to grow 150,000 tons of various vegetables 12 months of the year or 75% of estimated Qatar fresh vegetable consumption in 2021

الاكتفاء الذاتي للنصف الأول لعام 2021

استهداف %	لاكتفاء الذاتي(%)	لاستهلاك (طن)	الواردات (طن)	لإنتاج المحلي (طن)	المنتجات الإستراتيجية
70%	47%	100,708	53,788	46,920	الخضروات الطازجة
100%	99%	117,636	970	116,666	الالبان و مشتقاتها الطازجة
100%	99%	17,103	196	16,907	الدواجن الطازجة
70%	27%	23,817	17,293	6,525	بيض المائدة
90%	74%	12,699	3,353	9,346	الاسماك الطازجة
30%	29%	22,582	16,113	6,469	اللحوم الحمراء الطازجة

To Integrate solar Cells in the roof of High-tech greenhouses

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THANK YOU

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