SAHARA FOREST PROJECT

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Foreword

Deserts are often used as symbols of infertility and lost hope. Many, if not all of the world's deserts, formerly supported vegetation. Were it not for the lack of freshwater, they could still do so.

The initiation of The Sahara Forest Project was based on the recognition that the world is not short of water. The water is just in the wrong place and it is too salty.

The threat of global warming is closely linked to the lack of freshwater, food and energy, while the solutions often target only one specific problem. How can we benefit from a more integrated approach to the great challenges of our time?

By applying design principles from nature, The Sahara Forest Project provides solutions to global water, food and energy challenges without waste streams.

The Sahara Forest Project is a unique combination of proven environmental technologies, such as solar power, modern biomass production and the Seawater Greenhouse. The result is restorative growth: Reforestation and creation of green jobs through profitable production of food, freshwater, biofuels and electricity.

The Sahara Forest Project is a cooperation between Seawater Greenhouse, Exploration Architecture, Max Fordham Consulting Engineers and The Bellona Foundation.

This folder outlines the technologies and potential for The Sahara Forest Project. Now we embark on the quest from concept to realization.

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Exploration Architecture

Bill Watts
Max Fordham

Frederic Hauge
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The Sahara Forest Project

Within recorded history large parts of the Sahara, and other deserts, were vegetated with forests of cedar, cypress and other plants. A long history of highly extractive land use has reduced the amount of vegetation on the planet and threatens to exacerbate climate change, potentially creating a positive feedback that will further accelerate desertification.

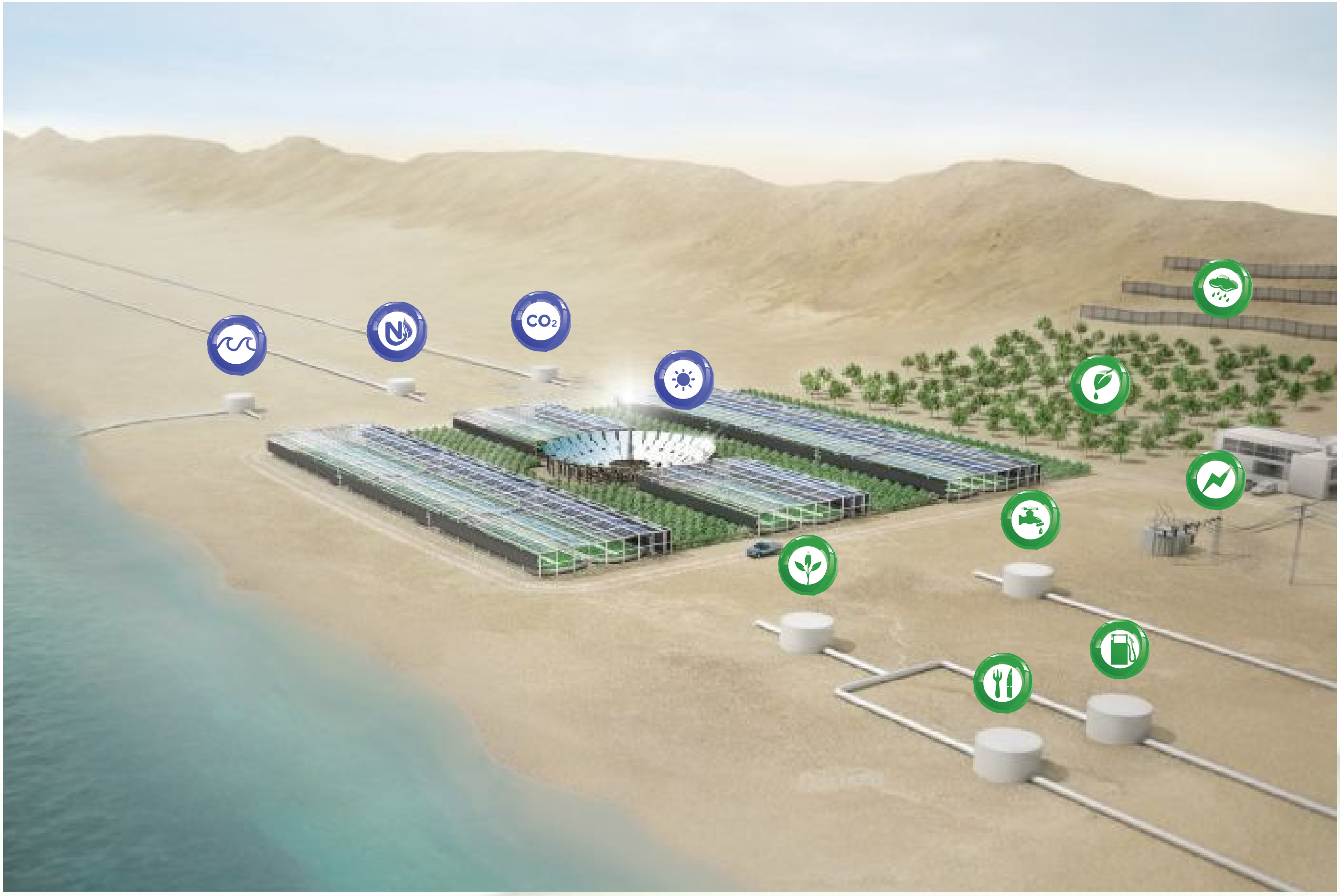
However, deserts represent a big opportunity and have the highest levels of solar energy in the world. Capturing a proportion of this energy and reversing the process of desertification would help humans deal with many current and future challenges.

The Sahara Forest Project is a vision of how the Seawater Greenhouse, solar power technologies and cultivation of traditional as well as new promising crops can be integrated on a large scale to revegetate arid areas and create freshwater, food, electricity and biomass for energy purposes. The project has the potential to restore areas of desert to biological activity and sequester large amounts of carbon in plants and soil. The over-arching aspect is that this development is driven by profitable business enterprise that is restorative, rather than extractive. In so doing, it would create employment opportunities for some of the poorest areas of the world.

The project integrates two proven technologies for the first time in a way that yields highly beneficial synergies. The core technologies are the Seawater Greenhouse and various forms of solar power. The Seawater Greenhouse is an ingenious technology that creates a cool, humid growing environment in hot parts of the world by evaporating seawater from cardboard grilles at the front of the greenhouse and condensing some of this humidity as distilled water at the back. Solar power technologies have the potential to meet a huge part of our future energy needs.

Before the seawater is evaporated, it can be used to grow microalgae, seaweed, shellfish, shrimps and fish. The waste products of these processes can be used as a fertilizer and soil conditioner to further encourage the development of external vegetation.

The scheme also offers the potential for a number of other complimentary profitable enterprises such as extracting useful elements from seawater. The latter could generate substantial quantities of valuable compounds and provide minerals to fertilise desert soils, countering the trend over the past century of a steady loss of minerals from the land. In certain circumstances it is possible to derive hydro power from running seawater into a depression near the sea.



INPUT

Seawater — Nutrients — CO_2 — Sun

OUTPUT

Humid air — Freshwater — Biomass — Electricity

Humid air ↓ New vegetation → Biofuel

Biomass ↙↘ Biofuel, Food

New vegetation — Biofuel — Food

Key technolgies:

The Seawater Greenhouse

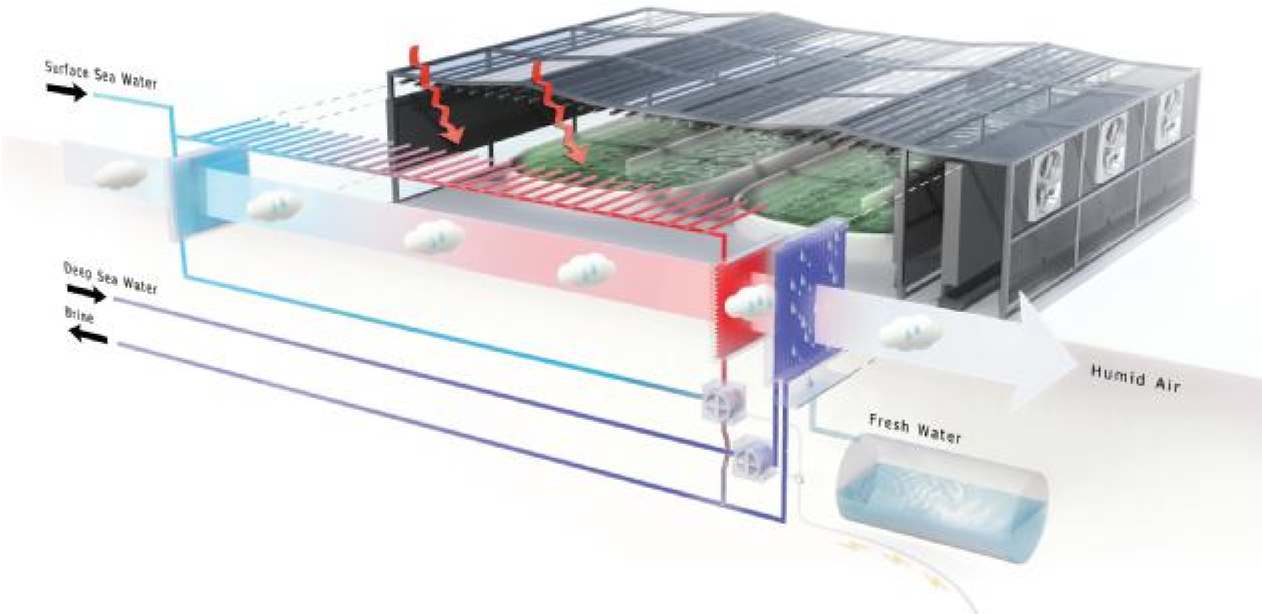
The Seawater Greenhouse represents a simple and low cost solution that enables crops to be grown throughout the year in some of the hottest countries on earth. Many years of modeling and testing has resulted in an integration of technologies, mimicking natural processes, and producing the highest maximum yield.

With Seawater Greenhouse it is possible to grow crops without any supply of freshwater. Seawater is evaporated from grilles at the front of the greenhouse to create cool humid conditions inside. A proportion of the evaporated seawater is then condensed as freshwater that can be used to irrigate the crops.

The diagram illustrates the basics of the process. The air going into the greenhouse is first cooled and humidified by seawater, which trickles over the first evaporator. This provides good climate conditions for the crops. As the air leaves the growing area, it passes through the second evaporator over which seawater is flowing. This seawater has been heated by the sun in a network of black pipes above the growing area. Thus, the air is made much hotter and more humid. It then meets a series of vertical polytene tubes through which cool seawater passes. When the hot humid air meets these cool surfaces, freshwater will condense as droplets that run down to the base where they can be collected.

The cool and humid conditions in the greenhouse enable crops to grow with very little water. When crops are not stressed by excessive transpiration, both the yield and the quality will be higher.

The simplicity of the process mimics the natural hydrological cycle where seawater heated by the sun evaporates, cools down to form clouds, and returns to the earth as rain, fog or dew.



A 1000 m² Seawater Greenhouse has been erected in Oman, evaporating around 5 m³ of seawater a day. That equates to 50 m³ of water a day per hectare of land.

In comparison with conventional greenhouses and conventional desalination facilities, the Seawater Greenhouse uses very little electrical power, as the thermodynamic work of cooling and distillation is performed by energy from the sun and the wind. For example, 1 kW of electrical energy used for pumping seawater can remove 800 kW of heat through evaporation.

The modest demand for electricity enhances the potential for driving the entire process using solar power, yet without the need for batteries, inverters etc., as power is only needed during the hours of daylight. Stand-alone operation will enable food and water self-sufficiency, especially in remote, off-grid regions.

The Seawater Greenhouse evaporates a great deal more water than it condenses back into freshwater. This humid air is `lost´ due to high rates of ventilation to keep the crops cool and supplied with CO_2. The humidity delivered to the outside environment allows for cultivation of crops, or revegetation of the environment downwind of the greenhouse.

The surrounding area of the Seawater Greenhouse at the time of construction.

Two years into operation. Although the picture is taken from another angle, the effect of revegeatation is clearly visible.

Growing cucumbers inside the Seawater Greenhouse in Oman

Key technolgies:

Concentrated solar power

According to legend, Archimedes once used polished shields to concentrate sunlight on the invading Roman fleet and repel them from Syracuse. Today the principle of concentrated solar power (CSP) is applied in the largest solar power plants in the world. In fact, many see CSP as one of the most promising technologies for the production of cheap, renewable energy.

Some systems use mirrors to concentrate the energy from the sun and create very high temperatures which produce superheated steam that can power a conventional steam turbine. As with all thermal power plants the greatest efficiency is achieved by having the hottest steam and the coldest condenser temperature. In the past these systems have used fresh water to provide the necessary cooling, which is not sustainable in an arid environment. Dry air coolers do work, and can reduce the amount of water needed, but at a cost of reduced power production.

There are several arrangements of mirrors that can be utilised to focus the energy to achieve the high temperatures required. Tower systems use a field of mirrors that can be steered in two dimensions to focus the sunlight onto a receiver on top of a tower. Trough systems used curved mirrors formed into parabolas to focus the sun onto a pipe receiver mounted at the focal point. The mirrors are steered in one dimension to follow the elevation of the sun. Finally, Fresnel systems use an array of long flat mirrors mounted horizontally that rotate to focus onto a pipe suspended above the mirrors.

Of the systems discussed above the simplest and cheapest to construct uses Fresnel mirrors. However, the towers produce the greatest level of concentrated solar energy and, consequently, the highest temperatures and efficiencies.

Solar towers like this is the is at the core of CSP installations. In May 2009 the world's largest solar power tower plant made up of more than 1200 mirrored heliostats surrounding a huge 54 story high tower went on line near Seville in Spain, Developed by Spanish engineering company Abengoa, the PS20 plant generates 20 megawatts (MW) of electricity.

The solar radiation falling on a square meter of the earth every year varies from less than 1000 kWh in temperate climates like northern Europe to 2500 kWh in deserts. The efficiency of systems to turn solar energy into electrical power varies from 5 to 15%. As a typical household needs approximately 5,000 kWh of electricity a year, it would take 13 to 40 m2 of desert area to generate this using solar power.

Key technolgies:

Photovoltaic solar power

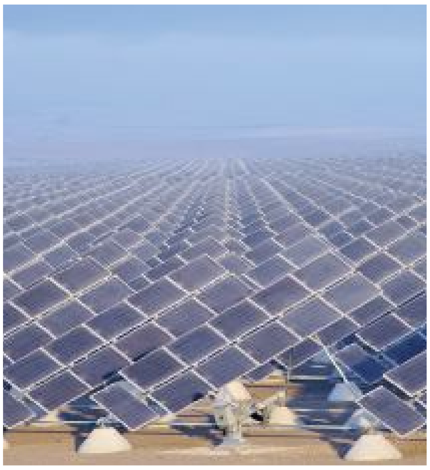
Photovoltaic (PV) panels create electricity directly from light. Simplistically, the photons of the light directly excite the electrons in the PV material that create a voltage and current.

There are a number of different materials and technologies ranging in efficiency and cost that do this. As would be expected, the cheaper systems are less efficient than the expensive systems. PVs function better if they are cool and systems that take the heat out of them are beneficial.

Considerable investment is being made on research to get the unit cost down and the efficiency up. One method of improving efficiency involves a "triple junction" technology which requires higher than ambient light levels. This in turn requires a degree of concentration of sunlight that leads back to the sort of moveable mirror technology needed for the concentrated solar power that produces steam, although the levels of concentration are much less.

All the aforementioned systems are designed to convert solar energy into power. To get the most out of them they must have a plentiful supply of sunlight as a raw energy source, and they are most effective when placed in sunny places. In addition, CSP systems rely on focusing direct sunlight onto a point, or line, in order to achieve the high temperatures required. As such they require clear air and skies. PV systems on the other hand can receive light from any direction and work just as well when the light is a bit diffuse.

PV systems create electricity instantaneously in relation to the light falling on them. The only way of storing this energy is in some other device like a battery, whereas in CSP systems the solar energy can be stored as heat before being converted into power. While CSP only works on a large scale from 10's to 100's of megawatt capacity, PV systems are completely scalable. Dust resting on mirrors or PV panels is a universal problem for solar systems. Planting the area around the collectors with vegetation will help filter the air and reduce the amount of dust.



A PV farm consists of numerous panels that convert solar radiation into direct current electricity. Manufacturing of PV-technology has advanced dramatically in recent years.

Further Opportunities

The project will be a demonstration of how manmade systems can mimic the remarkable efficiencies of natural systems.

Mature ecosystems provide many useful lessons in the way they have evolved, over the course of billions of years of evolutionary development. Such systems are characterized by being completely close-looped in their recycling of resources: All waste from one organism becomes nutrients for another organism.

The Sahara Forest Project team aim to explore further some of the very promising opportunities that have become apparent during the completion of the Feasibility Study. One of the most commercially attractive and environmentally beneficial possibilities is extracting useful elements and compounds from sea water. A number of elements are already extracted from sea water, but the cost of evaporating large quantities of water is financially prohibitive in the case of many elements.

As the Sahara Forest Project will be evaporating vast quantities of sea water for other purposes (principally to create cool, humid growing conditions for plants in arid regions) it makes it far more viable to extract valuable elements and compounds. This will include calcium carbonate which is deposited on the evaporators, sodium chloride which has many industrial applications, magnesium chloride which is a valuable desiccant for low energy cooling systems and lithium which is increasingly demanded for high performance electrical batteries.

Some of the elements extracted from sea water can be used to re-mineralize the desert soil and by doing so help to reverse the loss of minerals from the world's soils into the oceans – a process that increased dramatically with the advent of intensive, industrialized agriculture.

The quality of the soil can be further enhanced by the use of washed seaweed – rapidly growing and mineral-rich algae. Similarly, agricultural waste offers potential for biogas and biochar production; both of which can yield beneficial soil conditioners.

Although technological progress and cost reductions will be necessary, there is a tremendous interest in the possibilities for growing microalgae for energy purposes.

Flue gases from the Niederaussem power station in Germany are fed into an algae production plant to convert the CO_2 from the flue gas into algae biomass. (Source of picture: RWE Power).

Arrangement of photobioreactors in a traditional greenhouse. (Source of picture: RWE Power)

The Sahara Forest Project offers exiting possibilities for overcoming several technological and economical barriers for cultivation of microalgae. In addition to providing a seawater infrastructure and abundant sunlight, the Seawater Greenhouse also ensures an ideal temperature range and filtered air that lowers the risk of contamination.

The construction of a sea pipe offers further possibilities for inland, tank-based, mariculture crops such as fish, brine shrimp and abalone. A number of these crops can in turn be produced in a way that creates interesting synergies that increase productivity and approach zero waste. The cultivated organisms and crops could be used for production of fodder, food, fertilizer and fuel. These added values could benefit both the core activities of the Sahara Forest Project and local communities.

Tomatoes

Algae

Halophytes

Synergies

At the core of The Sahara Forest Project there are a number of synergies arising from the combination of the key technologies in the integrated system. Some are mentioned here.

Avoiding dust and pesticides

The greenhouse evaporators make very efficient dust traps, (as do plants that are growing outside) which benefits the CSP and other forms of solar power since the mirrors and collection surfaces stay cleaner and therefore operate more efficiently. Along the windward edge of the greenhouses an elevated CSP parabolic trough collector would provide added benefits to the seawater greenhouses by acting as wind catchers. The evaporators of the seawater greenhouse are also very effective air scrubbers. This is an advantageous feature, greatly reducing the need for pesticides in crop production.

Maximizing growth

The combination of cooling and a lot of sunlight provide excellent growing conditions for algae and other crops, allowing for maximized growth rates. High growth rates also mean high rates of CO_2 absorption. Part of the algae biomass and crop residues can also be used as fertilizer and soil conditioner for cultivation of the environment outside the greenhouse.

Halophytes

In addition to traditional crops and microalgae, we wish to explore the possibilities for using the supply of saltwater to cultivate halophytes in The Sahara Forest Project. Halophytes are plants tolerant of salty conditions. Some species can grow in an environment with as much as 60 grams of salt per litre of water. Many halophytes are both fast-growing and rich in energy. This makes halophytes promising candidates for future energy crops.

Water and power

Both the seawater greenhouse, and the cultivation of algae and saltwater crops, will need a supply of salt water as well as power. CSP will be an ideal candidate for generating electricity and creating beneficial synergies with the seawater greenhouse. CSP systems need water for cleaning the mirrors, and for the generation of steam to drive the turbines. This will be provided by the seawater greenhouse. With CSP, only about 25 percent of the collected solar energy is converted into electricity. In combination with sea water, another 50 percent of the collected energy, normally released as heat, can be used to evaporate more sea water and extend the area of desert that can support vegetation.

Zero discharge desalination

One of the challenges of conventional approaches to desalination is how to deal with the concentrated brine emitted by the process. The combination of technologies utilised in the Sahara Forest Project make extraction of useful elements from brine for commercial purposes a straightforward process. Approaching "zero discharge" desalination is therefore a realistic prospect and the environmental impacts of brine disposal can be avoided.

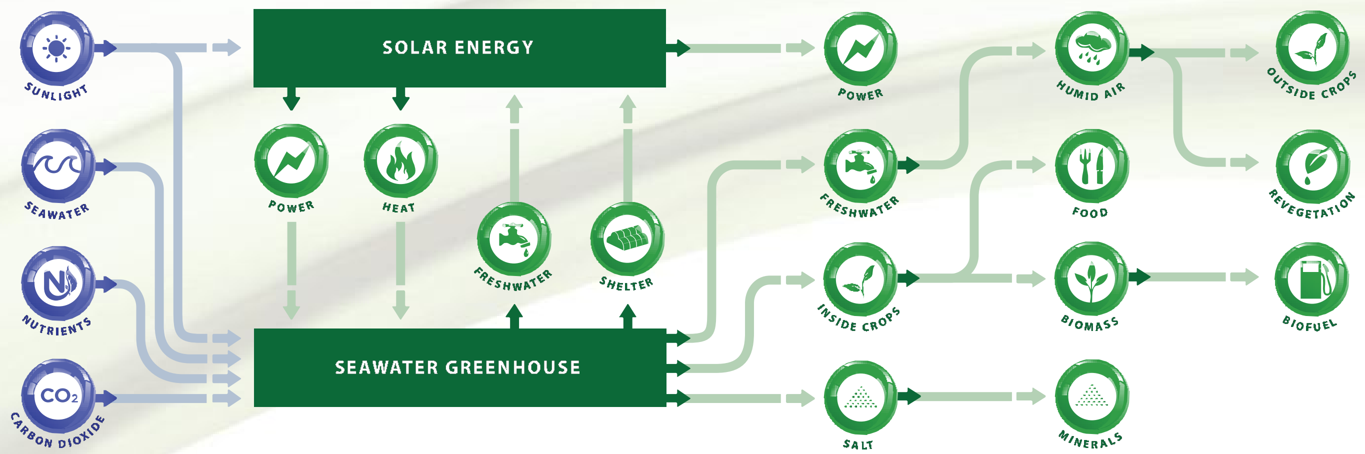
Maximing humidity and creating growth

The seawater greenhouse evaporates large volumes of sea water. A portion of the evaporated water is then condensed as fresh water. When cultivating saltwater microalgae inside the greenhouse, additional fresh water will be available for outside use, since the algae will not need fresh water for growth. Through ventilation the `lost´ humidity from evaporation will provide a micro-climate of cooler and more humid air downwind of the greenhouse, reducing the water demand and enhancing the growing conditions for vegetation.

In addition, the `lost´ humidity will increase the potential for precipitation through dew formation or rainfall. An area covered with greenhouses has a similar effect on the climate as an area covered by forest. The combinations of technologies in the Sahara Forest Project could be located some distance from the coast in a desert region. At a significant scale very large quantities of sea water can be evaporated. The greenhouses can be arranged as a long `hedge´ to provide a windbreak and shelter to outdoor planting, and to maximize the area of evaporation.

At intervals along the `hedge´ of greenhouses CSP arrays would be installed. At locations at or below sea level, pumping costs are minimized or avoided altogether. If the facility were located upwind of higher terrain, then the air carrying this `lost´ humidity would rise and cool contributing to the occurrence of cloud and dew. This precipitation could fall as rain, or be collected using fog-nets thus allowing additional areas of desert to be revegetated. The new plant growth and the soils would sequester significant quantities of carbon from the atmosphere. A forest could grow in the desert.

Flowchart



Realizing The Sahara Forest Project:

Key findings from the feasibility study

The Feasibility Study has been organized under two broad headings: the primary elements of the project and further opportunities created by the project. The former has explored how best to integrate the two main technologies (The Seawater Greenhouse and solar power). The latter has assessed other opportunities and potential benefits.

In order to investigate the optimum integration of technologies, thermodynamic modeling and engineering calculations have been carried out using empirical data (derived from the three Seawater Greenhouses that have been tested), meteorological data and data gathered from a range of sources about CSP, photovoltaic generation and conventional desalination processes.

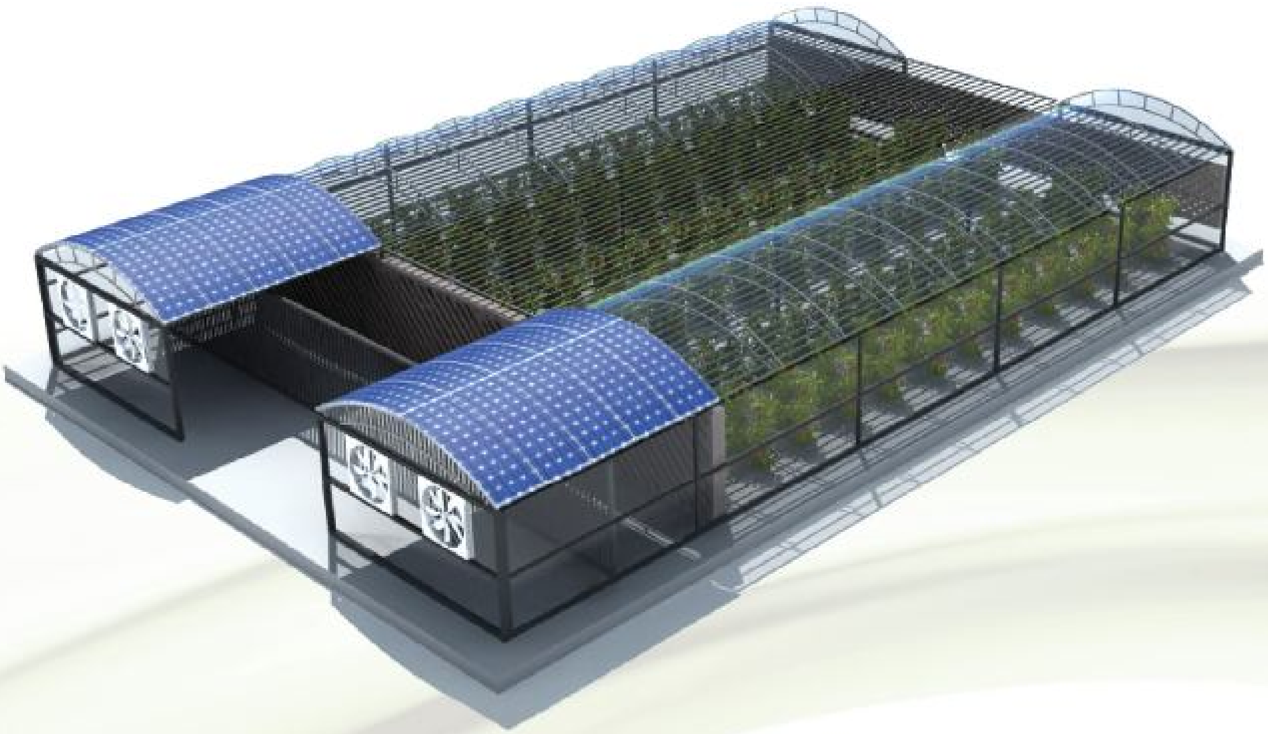
The Seawater Greenhouse can be combined with a number of different solar technologies. At a small scale photovoltaics are likely to be most cost effective; at a large scale, CSP offers substantial benefits. It has been concluded that the balance between the area of Seawater Greenhouses and solar power is not critical to the functioning of the scheme and can therefore be matched to demand.

The economic calculations of capital cost and productivity have concluded that the project is commercially viable and offers high rates of return. The Seawater Greenhouse and its associated infrastructure form the keystone to a range of activities that will derive substantial commercial benefits from their integration. The scheme therefore offers very significant commercial and political advantages to those organizations that are planning large-scale CSP plants.

The study has concluded that in typical desert conditions the Seawater Greenhouse will create good growing conditions for various crops and that the project can be self-sufficient in water. It is estimated that the greenhouses can produce 450-550 tonnes of high value horticultural crops per hectare per year and that the project can sequester 8 tonnes of CO_2 in soils per hectare per year. The Feasibility Study supports the main assumptions of the concept and the findings justify further work towards a full realization of the project.

"The Sahara Forest Project appears to be a very interesting example of the more integrated and holistic kind of thinking that we willl need a lot more of in the future to make our energy, water and industrial systems more sustainable".

- EU Energy Commissioner Andris Piebalgs



Realizing The Sahara Forest Project:

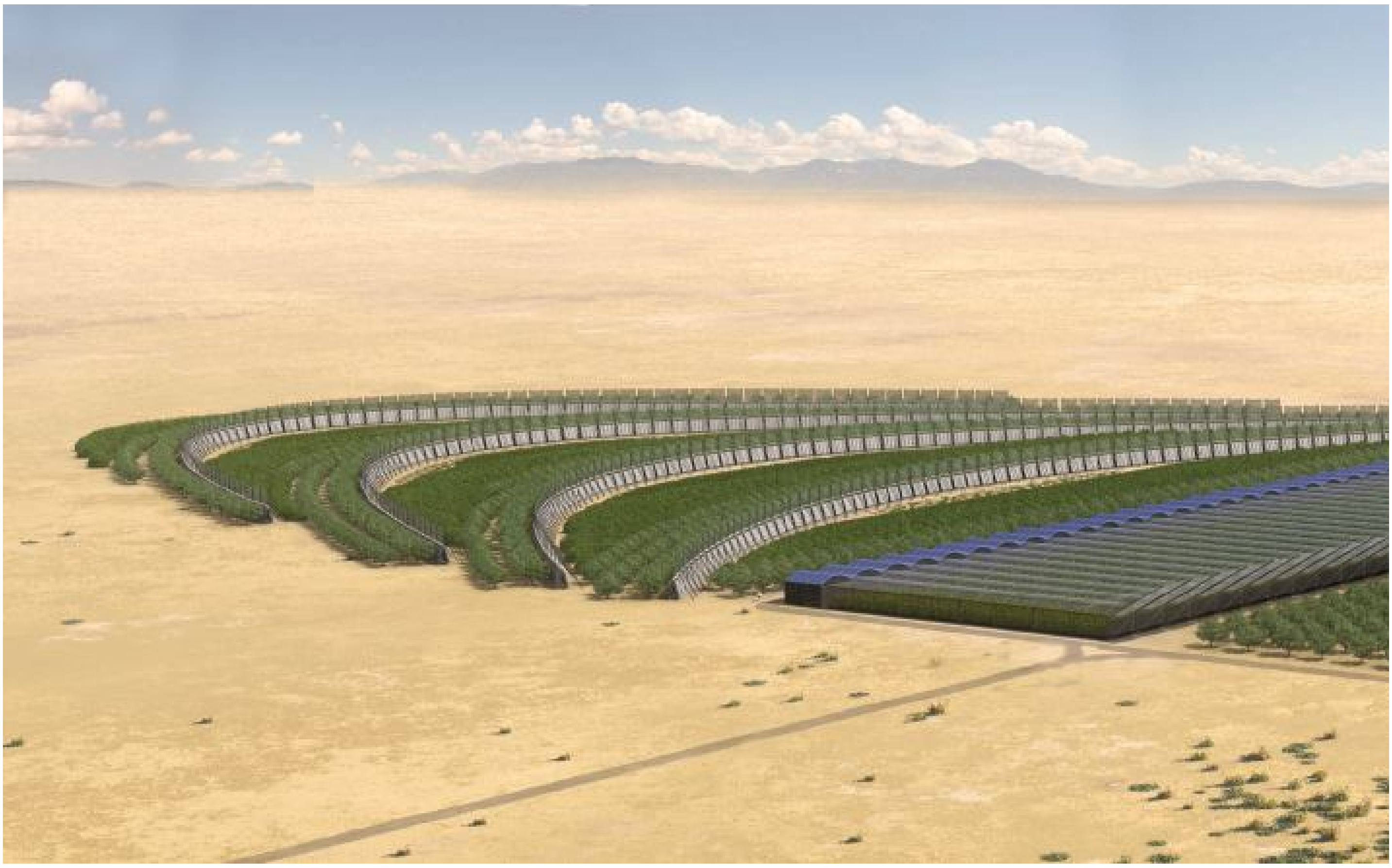
The Sahara Forest Demonstration Centre

The Sahara Forest Project is intended to be a project that continuously evolves and adapts, incorporating new technologies and knowledge. The partners of the project have therefore embarked on a path towards the realization of a Sahara Forest Demonstration Centre.

The centre will function as a cutting-edge environment that demonstrates the synergistic relationship between the main technologies as well as provides data for optimizing future SFP facilities. In addition, the Sahara Forest Demonstration Centre will be a proving ground for testing additional technologies that can be of benefit to the project.

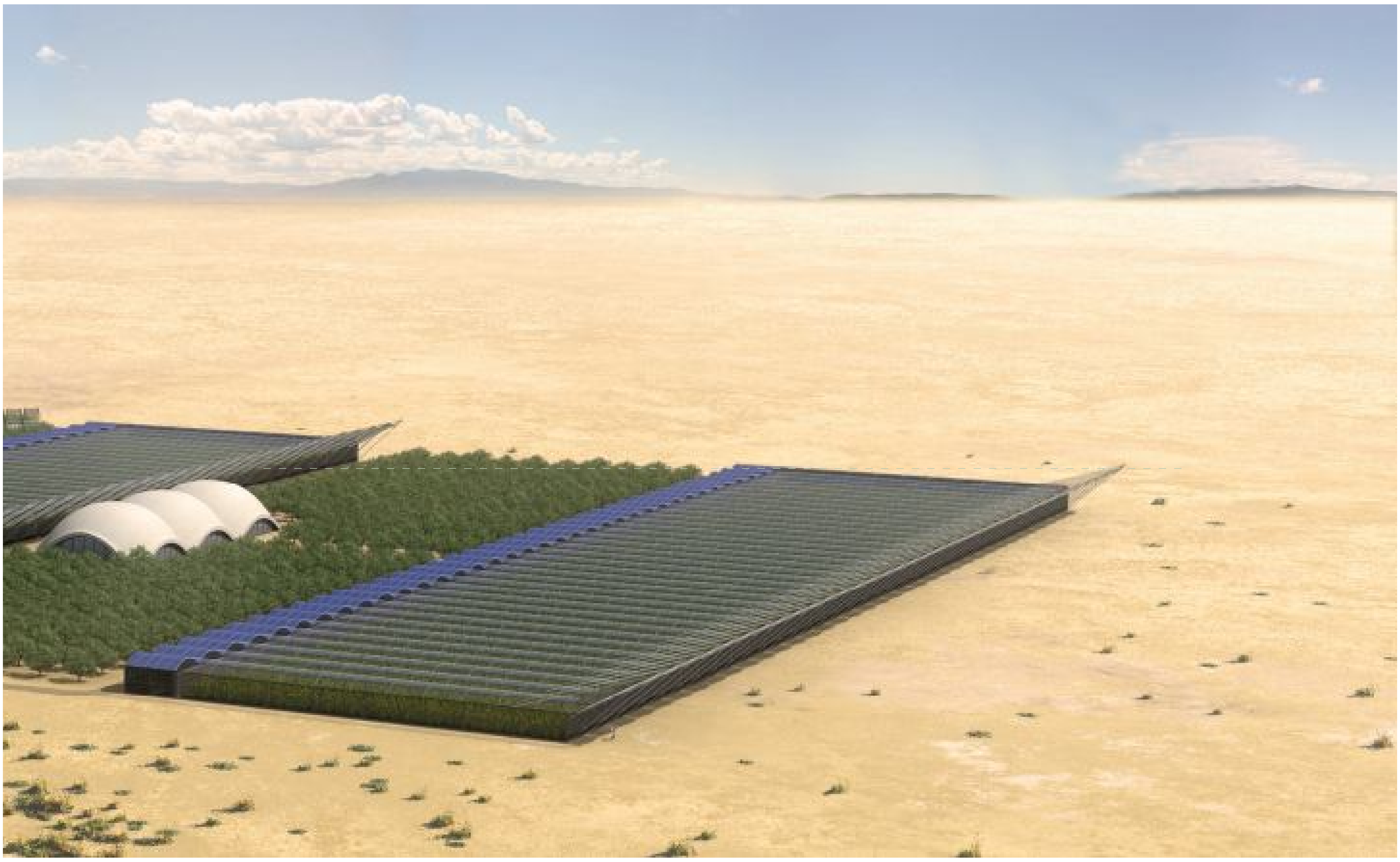
The Sahara Forest Demonstration Centre represents a major effort towards realizing the full potential of the Sahara Forest Project. The partners will team up with scientists, businesses, governments and other organisations that share their vision for incorporating principles and designs from nature into architecture, engineering and the creation of a synergetic technological system.

From the very beginning of The Sahara Forest Project it has been clear that the project should be economically viable. We need to go green by black numbers. The Sahara Forest Demonstration Centre will be approximately 4 hectares in size, large enough for planned research activities and profitable operation.



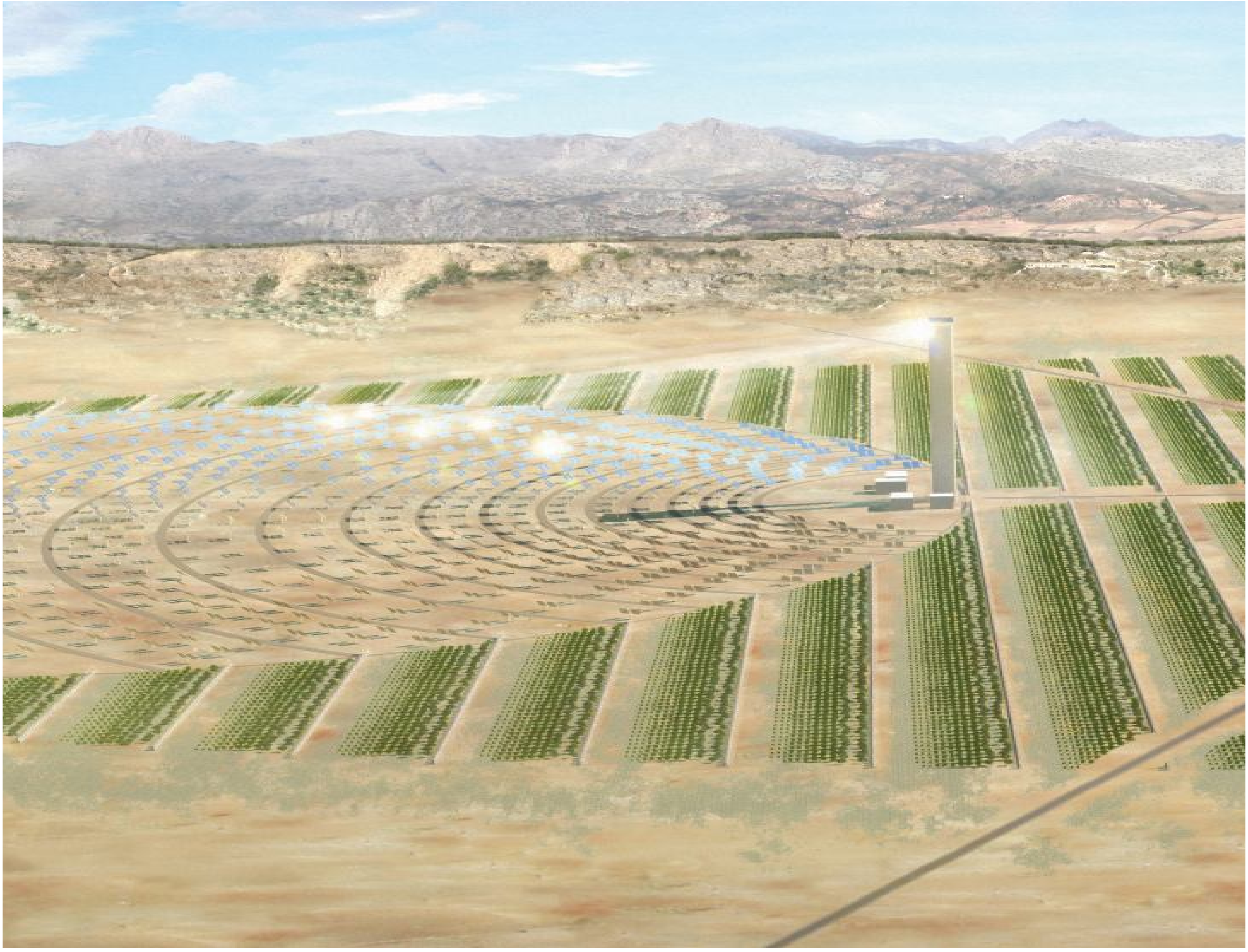
Key aims of the Sahara Forest Demonstration Centre:

- Optimization of synergistic effects of the Seawater Greenhouse and solar power technology.
- Proof of commercial viability of the Sahara Forest Project.
- Optimization of food production and the most suitable crops.
- Testing of promising crops for production in revegetation zones.
- Research on the cultivation of halophytes, algae and other candidates for mariculture.
- Testing of technologies for utilization of seawater minerals.
- Knowledge about how to use the Sahara Forest Project as a driving force for the creation of “green jobs”.



Realizing The Sahara Forest Project:

Large scale deployment



The objective of the Sahara Forest Project is to develop and deploy an integrated, large-scale system for reforestation and create green jobs through the profitable production of food, biofuels and electricity from sunlight, nutrients and seawater. Future Sahara Forest Project facilities will vary in size depending on local conditions.

Here we illustrate a facility with 50 hectare greenhouse that is equipped with 50 MW of concentrated solar power. Estimates suggest that on an annual basis such a facility could produce 34,000 tons of vegetables, employ over 800 people, export 155,000 MWh of electricity and sequester more than 1,500 tons of CO_2.

Key challenges

The following section provides a summary of the key challenges addresed by The Sahara Forest Project.

A cluster of intertwined problems today poses a historic threat towards the stability of our ecosystems and human development.

We have only started to comprehend the gravity of this threat towards our future. However, we know more than enough to realize that failure to respond is simply not an option.

The challenge will be to properly identify the risks we are facing and use this knowledge to rethink how to supply resources for tomorrow's population.

From 6,5 to 9,5 billion people

The global population is expected to increase from 6.5 to 9.5 billion people by 2050. Without a doubt, this will lead to an additional demand for energy. To meet this tremendous challenge we will need a broad spectrum of nonfossil sources of energy. A number of recent reports identify increased use of biomass for energy purposes as one important solution.

However, the additional 3 billion people will not only need energy. They will also need food. In 2009 as many as 800 million people suffer from hunger. It is predicted that we have to double our food production over the next 25 to 30 years to be able to feed a global population of more than 9 billion people in 2050.

A transformation of our agricultural system is needed. This transformation has to be based on sustainable principles. Sustainability was defined by the Brundtland Commission as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This criterion must be at the core of any evaluation of the options we have for securing the future food supply.

Adding to the complexity of the equation are significant predicted increases in water shortage and land degradation, combined with highly uncertain effects of global warming on future biomass production.

Rising greenhouse gas emissions

Global warming is caused by emissions of CO_2 and other greenhouse gases. In 2009 the atmospheric concentrations of CO_2 reached 389 ppm. This is higher than the natural range over the last 650,000 years. Global warming poses a serious threat to human welfare, as well as to the stability of vital ecosystems. If no measures are taken, the global greenhouse gas emissions are expected to nearly double by 2050. This will lead to dangerous global warming. The consequences will be many, and they will be intricate. Despite regional differences, it is stated that the negative impacts of climate change on freshwater systems outweigh the benefits. Higher water temperatures and changes in weather extremes, including floods and droughts, are projected to affect water quality and exacerbate many forms of water pollution.

Rising sea-levels are projected to extend areas of salinization of groundwater and estuaries. The result will be a decrease of freshwater availability in coastal areas.

By 2050, it is predicted that the areas experiencing negative effects on water supplies will be twice as large as the areas positively affected. By 2050, it is predicted that the areas experiencing negative effects on water supplies will be twice as large as the areas positively affected.

Freshwater shortage

Today, 1.2 billion people live in areas with physical water scarcity. An increasing world population will require more water. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be approaching water scarcity. The challenge will be to sustainably produce enough freshwater for production of future food and biomass.

Freshwater is much too often obtained through over-abstraction from ground reserves. Shortage of water will affect the carbon cycle as shrinking forests will reduce the natural rate of carbon capture, and the regulating influence that trees and biomass have on our climate will be disrupted, exacerbating the situation further.

Agriculture accounts for more than 70 percent of the world's current total water use. According to UNEP it will be necessary to double water use by crops by 2050 in order to meet the Millennium Development Goal on hunger.

Transition from fossil-based energy

Sixty-one percent of global GHG emissions are from energyrelated CO_2. The US Department of Energy predicts that world market energy consumption will grow by 50 percent from 2005 to 2030, given no changes in current laws and policies.

The International Energy Agency (IEA) has concluded that "the era of cheap oil is over". The agency has called for an energy revolution, stating: "Current global trends in energy supply and consumption are patently unsustainable -environmentally, economically and socially". The United Nations Framework Convention on Climate Change concludes that current levels of funding will be insufficient to address the future financial flows estimated to be needed for adaptation and mitigation under a strengthened future climate change deal post 2012. UNFCCC further states that particularly in the energy sector, huge investment flows are needed.

Biomass shortage

Biomass in the form of plant material and animal waste has historically been one of the most important sources of energy in the world, and will play a significant role in a global society based on renewable energy. It is predicted that world demand for biomass will increase substantially over the next years.

Biomass for energy purposes is a carbon neutral process. This is due to the fact that the CO_2 emitted during combustion is balanced by the uptake of CO_2 through photosynthesis during biomass growth. In the scenario "How to combat global Warming" The Bellona Foundation concluded that biomass had an important role to play in reducing CO_2 emissions. A number of other studies also identify biomass for production of energy as a key element in future non-fossil energy production.

Production of biomass normally requires arable land, a requirement that is becoming increasingly difficult to fulfill. A large-scale sustainable production of biomass in areas that are now non-arable, could significantly add to the potential of bioenergy as a part of future energy solutions.

Non-sustainable production of food

In 2009 as many as 800 million people suffer from hunger. Thus far, attempts to solve this situation have failed. It is predicted that we have to double our food production over the next 25 to 30 years to be able to feed a global population of more than 9 billion people in 2050.

The Partners

Seawater Greenhouse

Seawater Greenhouse Ltd. is founded by Charlie Paton. Mr. Paton has a highly regarded track record in innovation, research and development. His broad understanding of a range of technologies and the intricate mechanism of photosynthesis led to the concept of the Seawater Greenhouse. He has since been actively engaged in the development of this concept. Charlie Paton has received a number of awards for his work. Recently this includes the `IET´ Institute of Engineering + Technology 2006 Sustainability Award, `Tech Award´ Technology for the benefit of Mankind, Tech Museum of San Jose CA (2006), The St. Andrews Prize for the Environment (2007) and Courvoisier / Observer - The Future 500 Science and Innovation winner (2008).

exploration

Exploration Architecture was established by Michael Pawlyn in 2007 to focus exclusively on environmentally sustainable projects that take their inspiration from nature. From 1997 to 2007 Pawlyn worked with Grimshaw Architects and was instrumental in the design development of the Eden Project. He was responsible for leading the design of the Biomes and proposals for a third major climatic enclosure.

Michael Pawlyn has lectured widely on the subject of sustainable design in the UK and abroad. In 2006, he was appointed to represent Grimshaw as a Founder Member of the UK Green Building Council and in 2007 was elected as a committee member of `The Edge´, a think-tank dedicated to addressing important political, social and professional issues.

maxfordham
ENGINEERING DESIGN ENVIRONMENT

Max Fordham Consulting Engineers are award-winning designers of energy-efficient systems for building services and the wider environment. For over forty years, the success and approach of this British company has brought many awards, including The Queen's Award for Enterprise in Sustainable Development.

Bill Watts joined Max Fordham LLP in 1980 and became a Senior Partner and team leader in 1988. He has worked on the design of a large number of buildings in the housing, office, sport, theatre, museum, health and education sectors. Bill Watts has written on a wide range of subjects including chapters in the "Sustainable Design", "Photovoltaics in Architecture" and the "Pool Water Treatment Advisory Group" guide book. He is a regular speaker on low energy buildings at the Carbon Trust in Northern Ireland. He sits on the RIBA Sustainable Futures Group and the British Property Federation Sustainability Group.

BELLONA

The Bellona Foundation is an international environmental organization based in Norway with offices in Murmansk, St. Petersburg, Brussels and Washington DC. Bellona was founded in 1986 as an independent foundation working for increased ecological understanding and preservation of the environment and health.

Today, Bellona has over 80 highly skilled employees that work on a wide spectrum of environmental issues and cooperates closely with key actors in our society, in particular the business community. Bellona fights to identify and implement sustainable solutions to the world's most pressing environmental problems.

Frederic Hauge is the president and founder of The Bellona Foundation and has received a number of awards including TIME Magazines "Hero of the Environment" Award in 2007.

Restorative growth:

Reforestation and creation of green jobs
through profitable production of
food, freshwater, biofuels and electricity

SAHARA FOREST PROJECT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