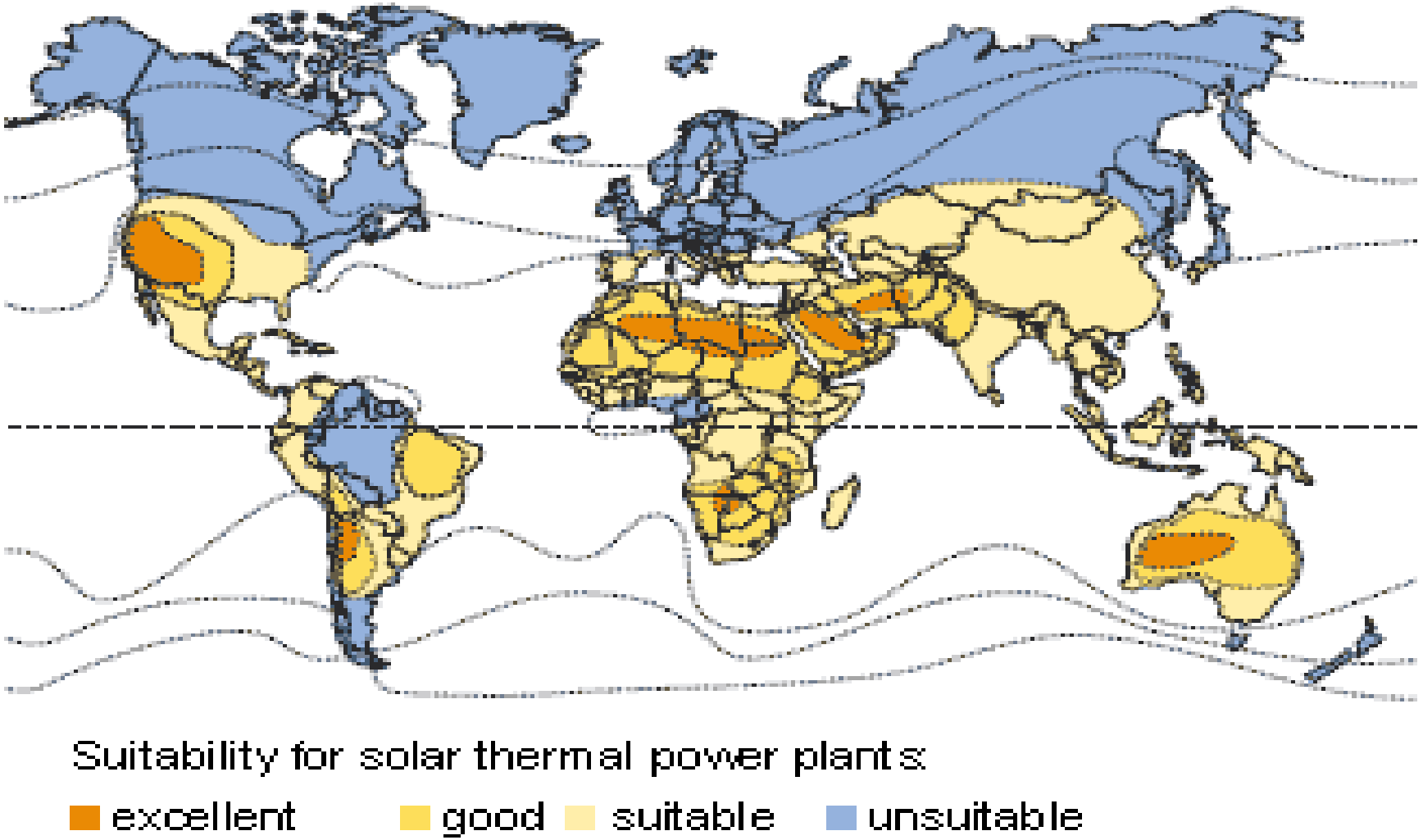
King Abdullah Initiative for Solar Water Desalination

Introduction

- King Abdullah's initiative for Solar Water Desalination announced in a press conference early 2010, with launching of the first phase of the initiative.
- Saudi Arabia is considered one of the countries depending mostly on sea water desalination. It produces more than 4 million cubic meters per day, represents more than 18% of global production.
- Power and desalination plants consume around 1.5 million barrels of oil per day, which has a significant impact on the economy of the Kingdom as well as the environmental.
- Water technology is the first priority of the National Plan for Science, Technology and Innovation (NPSTI).
- KACST has more than 30 years of Experience in Solar Energy Research.
- Saudi Arabia is one of the best regions of the world in terms of the amount of solar radiation

Global Solar Radiation



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The Initiative's Objectives

1. **Desalinate seawater by solar energy at low cost to contribute to the Kingdom’s water security and support the national economy.**
2. **Applying nanotechnologies developed in the field of Photovoltaic and RO membrane systems.**
3. **Build advance industries advocated by the Industrial strategy of the Kingdom.**
4. **Develop clean energy and protect the environment.**

Production Cost (Comparison)

Technology		Energy	Production Cost (SR/m³)
Conventional technologies	Thermal	Gas Diesel	2.5 - 5.5
	Reverse Osmosis	Electricity	2.5 - 4.5
Initiative's Technologies	**Reverse Osmosis**	**Solar** (less than $.08/KWH)	**1.0 -1.5** (Target)

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The Initiative

All Desalination of sea water in the Kingdom to be done completely by Solar Energy in 9 years starting 2010.

Implementation Phases of the Initiative

The Initiative will be implemented in four phases:

Phase I:

Construction of a solar-powered desalination plant at Al-Khafji (30,000 m^3/day).

Phase II:

Construction of a solar-powered desalination plant. (300,000 m^3/day).

Phase III:

Implementation of the initiative throughout the Kingdom.

Al-Khafji Solar Desalination Plant (2010 - 2013)

Building a desalination plant with a capacity of thirty thousand cubic meters per day (30,000m^3/day) to meet the needs of one hundred thousand dweller of Al-Khafji City (Arabian Gulf) and construction of a solar energy station with a capacity of 10 Megawatts.


Existing Thermal Desalination Plant
Proposed New RO desalination Plant
Proposed Site
For Solar farm
KACST
Arabian
Gulf
Al-Khafji
City

Wastewater Treatment Plant- Al-Khafji

The Initiative's Technologies

KACST - IBM Cooperation

Joint Research Cooperation between KACST and IBM through the "**Center of Excellence for Nanotechnology**" has developed many technologies in the field of **Solar Energy and RO Membranes.**

1. **Ultra High Concentrator Photovoltaic (UHCPV).**
2. **Desalination Membrane Module Development (DMMD).**

1- Ultra High Concentrator Photovoltaic

Objectives:

1. Design and installation of a high-concentration solar cells with a capacity of 10 megawatts.
2. The cost of energy production should not exceed 30 halalas (8 US Cent) per kilowatt-hour.
3. Link solar station to the Grid.
4. Power the seawater desalination plant by UHCPV.

UHCPV

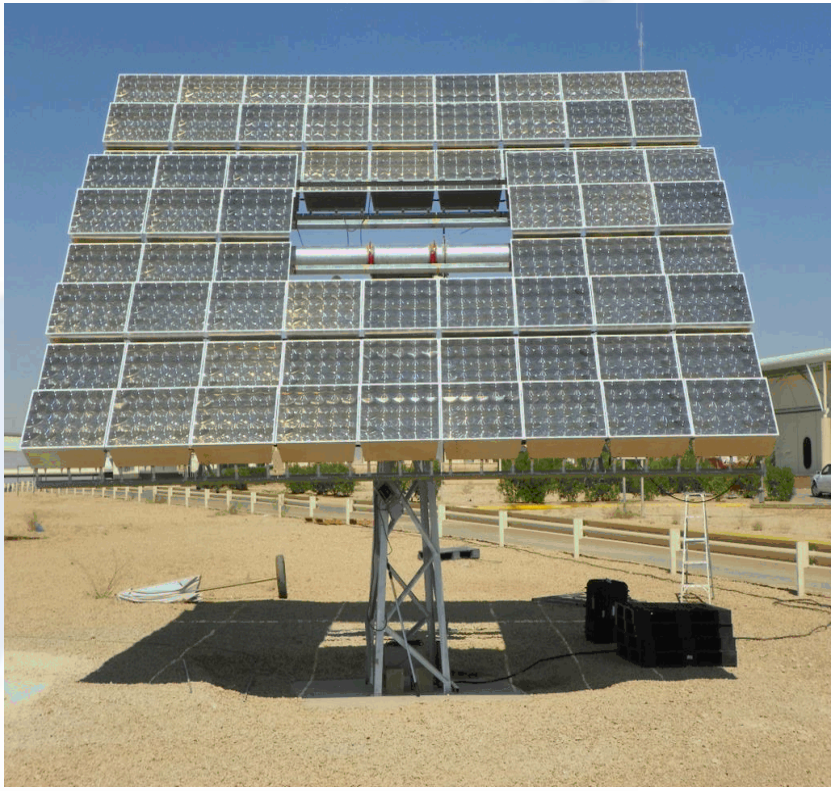
Ultra High Concentrator Photovoltaic (UHCPV) system have been developed to concentrate solar radiation to more than 1600 times resulting in high electric power output.

KACST and IBM jointly developed :

- **Drop and plug techniques**
- **Advanced cooling techniques**
- **Tracking systems for UHCPV system.**

UHCPV

First Module (Solar Village)
~ $ 5.5 / Watt



Second Module(Solar Village)
~ $ 2.00 / Watt

Installation of First Tracker in Al-Khafji

10 Megawatt Solar Farm
81 Modules per tracker

1000 trackers
130 watts each module

UHCPV - Patents

1. **Immersion** solar concentrator system.
2. **Alignment System** for High Performance Solar Concentrators.
3. **Hybrid Metal** Thermal Interface.
4. **Cooling System** for High Power Solar Concentrators.
5. **Interposer connector** for solar concentrators.
6. **Tracking system** for solar concentrators.

2 - Nano-Membrane for desalination

Objectives:

1. **Production** of membrane highly resistance to chlorine, salt blockage and accumulation of bacteria in reverse osmosis membranes .
2. **Development** of advance industrial membranes models.
3. **The establishment** of a desalination plant with a capacity of 30,000 m3/day in Al-Khafji.
4. **Transfer** membrane technology industry in the Kingdom with the participation of private sector.

2 -Desalination Membrane Module Development (DMMD).

The new membrane was named (i-Phobe) for its unique chemical composition of hydrophobic ions which allows it to change radically when used in different conditions transforming it into hydrophilic. The new nanomembrane has been developed to efficiently purify the water from salts and toxic materials at high flux, can resist chlorine, and prevent the accumulation of bacteria

Nanomembrane - Patents

1. Interfacial Polymerization Methods for making Fluoroalcohol-containing Polyamides.
2. Polyamide Membranes with Fluoroalcohol Functionality.
3. Highly Water-Permeable, Anti-Fouling Coatings and Method for its Preparation.
4. Fouling Resistant, Hydrophilic Coating Materials .
5. Fouling Resistant, Interfacially Polymerizable Hydrophilic Coating Materials and Method for its Preparation.
6. New Crosslinked Coatings.

Research Materials to Product Development

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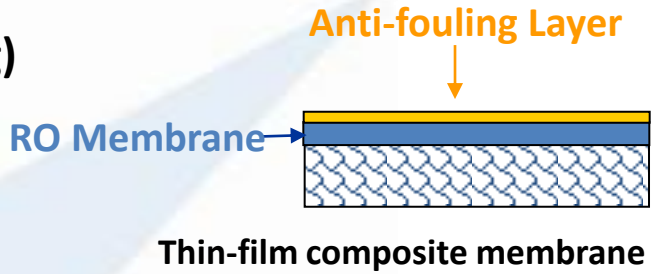
Phase 1

- Optimize materials (both RO layer and antifouling coating)

  (Performance: NaCl rejection ≥ 99. 6 %,
- Integrate film stack (Fouling Resistant, RO Membranes)



Thin-film composite membrane

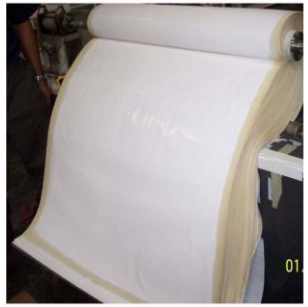
2” diameter,
10” length

Phase 2

- Prototype module phase (rapid cycles of learning)
- Evaluation of prototype modules
- Optimized membrane module (chemistry and process)

Phase 3 (Manufacturing)

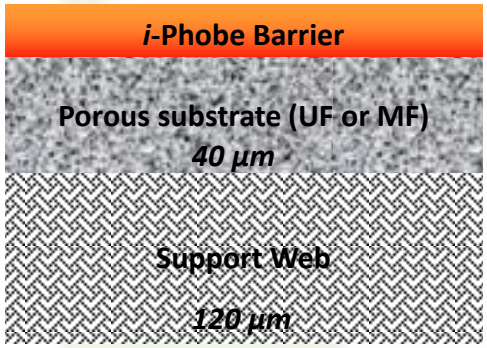
- Technology transfer to Vendor
- Full scale modules for use in UHCPV-driven desalination plant



8”, 16” or 20” diameter,
40” length

i-Phobe 2 Membranes: Performance Improvement

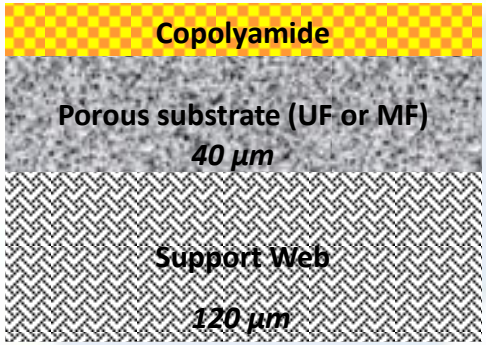
Gen-1



Pure *i-phobe* membrane

Salt rejection: 96. 0 %

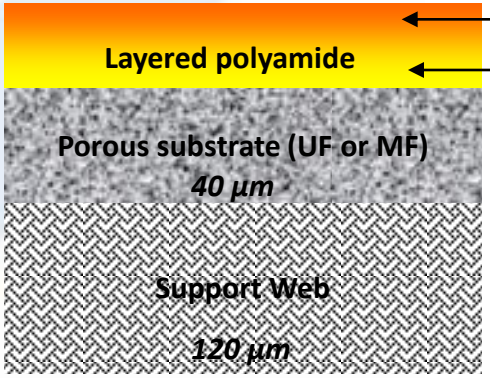
Gen-1.5



Copolyamides

Salt rejection: 98. 7 %

Gen-2

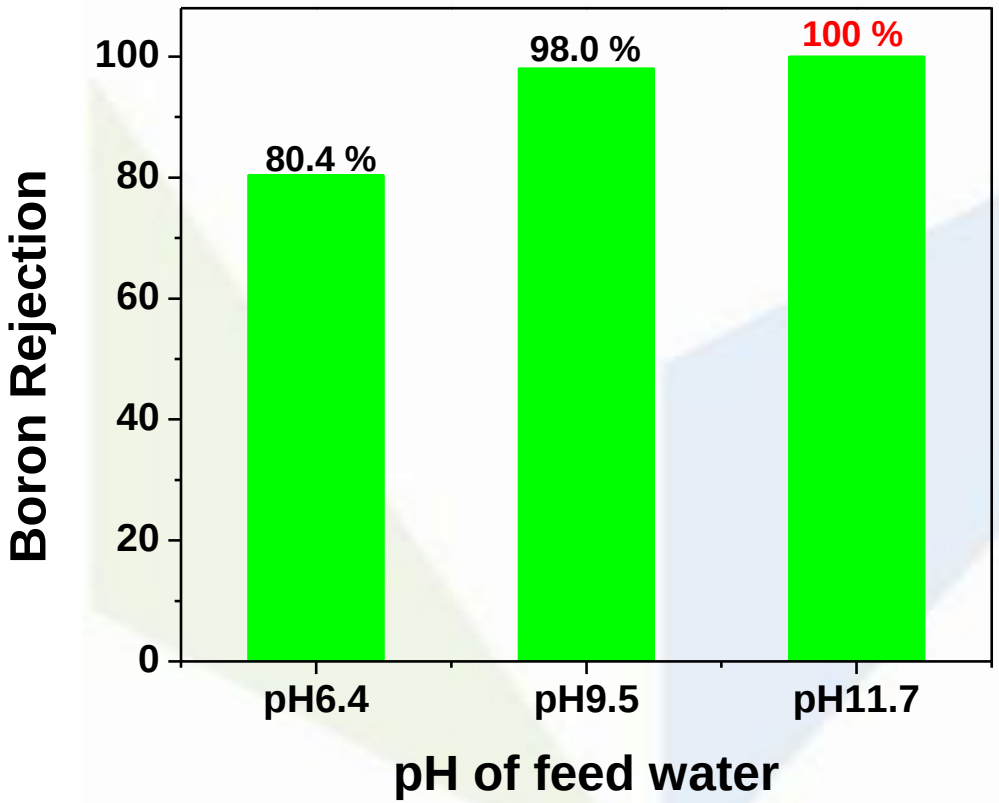


Layered polyamides

Salt rejection: 99. 6 %

Strong Candidate for Module Development!

Boron Rejection of Layered Polyamide Membrane



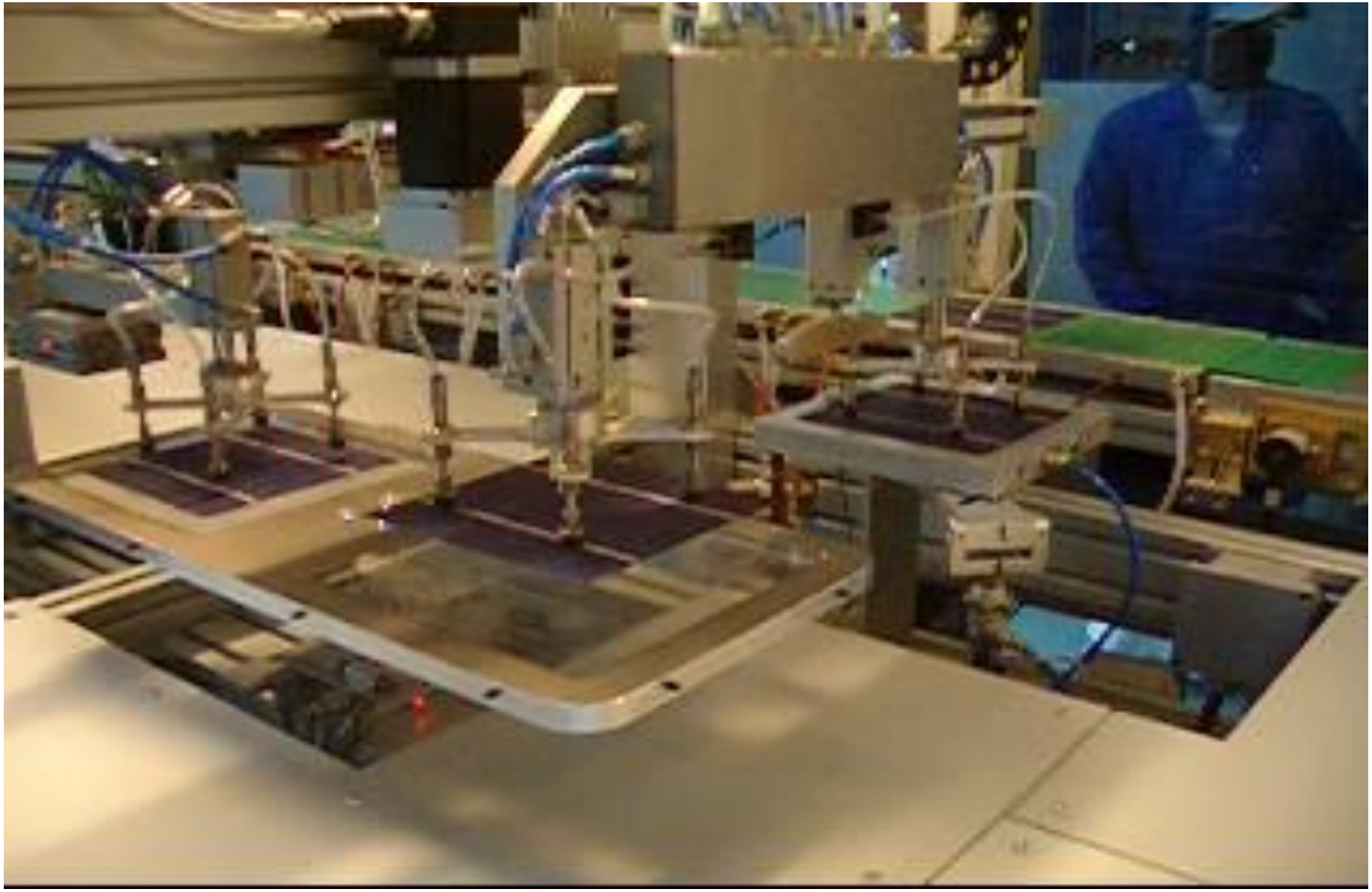
- 2-3X Improved Boron Rejection
- Excellent Combination of Salt Rejection & Water Throughput

"This is a breakthrough" Prof. Benny Freeman (UT-Austin)

3- Photovoltaic Solar Panels Factory (3 mw)

- State of the art PV factory
- On-line production since 2010
- 3 MW production capacity (12000 solar panels per year
- Run 100% by the Saudi engineers and technicians

Assembly line of 3 Megawatt Photovoltaic at Solar Village –Al-Oyaanah – (Video)



Replacement of old CPV panels at Solar Village

350 kw

800 kw

Solar Powered Desalination Plant Timeline

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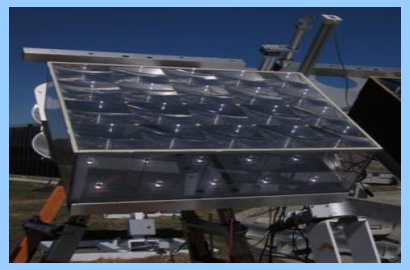

Large-Scale Installation to Power Desalination Plant

First proto-type design and 20 KW system design & build

Lab environment demonstration of high concentration CPV

2008 2009 2010 2011 2012 2013

Incorporation of Membranes in Solar-Powered Desalination Plant in Al Khafji

Initiate DMMD Project to Scale and Commercialize Desalination Membranes

First proto-type Nanomembrane system design & build

Begin Joint Research Into Nanomembrane Materials

Joint Press Release on iPhobe Membranes

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TAQNIA

- **Commercialize the Technology locally, regionally, and internationally.**
- **Create an Industrial Consortium to Implement the Initiative throughout the Kingdom.**
- **Build Photovoltaic Development, Testing and Manufacturing Facilities as well as other solar technologies in the Kingdom.**
- **Build Solar Farms throughout the Kingdom and Worldwide.**
- **Build RO membranes Development, Testing and Manufacturing Facilities as well as other membrane technologies in the Kingdom.**
- **Build Desalination Plants throughout the Kingdom and Worldwide.**

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Thank you