PRODES

Promotion of Renewable Energy for Water production through Desalination

www.prodes-project.org

Deliverable 2.3:

Proceedings of the Strategy Session at the EDS Conference in Baden-Baden/Germany

WP2 – Task 2.6

ProDes is co-financed by the Intelligent Energy for Europe programme

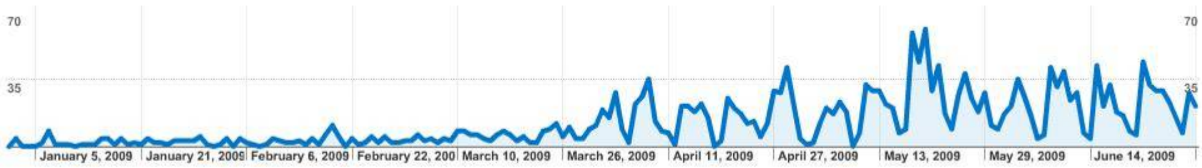
(contract number IEE/07/781/SI2.499059)

Table of Contents

Introduction

On the 18th of May 2009 the ProDes strategy session took place, embedded into the "Desalination and the Environment" conference and Exhibition that was organised by the European Desalination Society (EDS) in the congress centre in Baden-Baden, Germany. The event started with a reception at 18:30, after the completion of the conference programme for the day. At 19:30 there was a 30 minute presentation that was followed by an extensive discussion with the event participants that was completed by 21:00.

The strategy session was very successful as it attracted more than 100 representatives from its main target groups, the industry and the research community. The interest and awareness generated is reflected in the statistics of the website presented below, which show a peak of visitors during the period of the strategy session.



The ProDes reception

As the panel discussion was planned for the evening after the conference, the ProDes event started with a reception organised by the congress house in Baden-Baden. Below are some pictures of the reception which was given in the area where posters relevant to the project were exhibited and outside the hall where the strategy session would follow.

The ProDes panel debate

Presentation

After the participants registered (see Annex II), the strategy session started at 19:30 with the General Secretary of the European Desalination Society, Miriam Balaban, welcoming the audience and introducing the ProDes panel and the event. Then, the project coordinator, Michael Papapetrou (WIP) provided an introduction to the ProDes project.

The main part of the panel contributions included short overview of the main RE-desalination technologies. Hendrick Müller-Holst (Almeco TiNOX) illustrated solar powered thermal desalination, Guillermo Zaragoza (Ciemat) the options of combining Concentrated Solar Power with desalination, Andrea Cipollina (UNIPA) PV and wind combined with Reverse Osmosis and Matt Folley (Aquamarine Power) closed this overview with explaining ocean energy powered desalination.

For initiating the discussion about the RE-desalination roadmap, which is under development within ProDes, Marcel Wieghaus (ISE) presented the structure, focusing on the main non-technological barriers identified by the working group.

The three sections are grouped in a single power point presentation which is available in Annex IV of this document and in the project website for downloading.

Discussion

The discussion with the audience was lively and lasted longer than one hour. The whole event, including the discussion, is available on DVD, where all the points raised can be followed in detail. Here the main issues covered are outlined:

Based on the road-map presentation, the main focus was on the non-technological barriers that RE-desalination. The ProDes consortium wanted to lead the discussion in this direction, because the real barriers faced by the people doing the work in the market should be the starting point of any market strategy. Also ideas on how to deal with these barriers were sought. The following barriers, grouped in four categories, were suggested by the consortium during the presentation to stimulate the discussion:

Technological Barriers

- Intermittent energy supply (discontinuous operations) => this requires hybridization, energy storage or quite sophisticated tailor made control system
- Maintenance, reliable remote monitoring, discharge/brine-solution, robust materials, long-time operational experience
- No standardized configurations (certified systems?)
- Lack of suitable design tools/experts

Economic Barriers

- Relatively high initial investment cost
- Lack of an established market discourages standardisation and mass production that would bring the investment costs down
- No network for the distribution of the consumables and the spare parts => 100% imported systems hinders the market penetration
- Loans and equity financing difficult because investors perceive new technologies as high risk – the lack of financial incentives like feed-in tariffs does not help either (see institutional barriers)

Institutional Barriers

- Socio-political management of energy and water generally unrelated
- RE electricity is strongly subsidized while the desalination of water with renewable energy is not
- No full cost recovery (i.e. Malta 3 times higher costs than prices, Algeria 15 times) but water price is a sensitive socioeconomic issue

- Water authorities are reluctant with RE-desalination because of confidence with current technology and culture of risk avoidance
- There are few institutions to promote, inform and provide training is RE desalination
- The legal framework for independent water production is not clear and permissions for a small systems involve various authorities

Social Barriers

- Desalination plants are generally considered energy intensive and damaging to the environment
- Water consumers and authorities are not aware of the availability and advantages of technologies based on RE desalination
- RE desalination currently is more suitable for isolated locations where users might be reluctant to accept a new technology → also the ability or willingness to pay can be low
- The different quality and value of water for human consumption, for agriculture and for other uses needs to be appreciated

The audience firstly did show high interest on technical issues and the presentation of the possible RE-desalination combinations. The technical issues were addressed, but the panel did focus the discussion on the barriers and the strategy to overcome them.

Regarding the technical barriers, it was suggested to try and work together with other industries that are also active in areas with similar conditions. The example of the gas and oil exploration facilities was given, who do operate in isolated areas and could be a niche market for RE-desalination. Issues about the reliability of the technology were raised and the robustness of small scale systems to operate under hard conditions. It was stressed that in order to enter the niche markets in isolated locations, the products have to: (a) Guarantee the desalinated water is of the highest quality all the time; (b) Ensure long technical life-time and provide comprehensive guarantees; (c) Ensure automatic operation; (d) Facilitate maintenance through development of a network of technicians and spare part distributors

Most of the discussion though was about the economic barriers. There was debate about the water cost from RE-desalination and the best method to calculate it reliably. The real cost of alternative solutions and its future development associated with the fossil fuel prices were discussed. The positive and negative aspects of subsidising where touched upon. The view was expressed that subsidies is a twist of the economy and should be avoided, but it is better to subsidise RE-desalination than unsustainable technologies.

The institutional issues were also of interest. The main concern raised was about the method used by municipalities or other governmental organisations that tender their desalination needs. Very often all they do tender for is the capacity of the desalination plant they are looking for, without detailed technical specifications. The result is to select then the lower cost solution, which does not take into account other framework conditions. The example of the Greek islands was mentioned, where the solutions selected after tenders do use electricity that they purchase from the grid. However, the real cost of the electricity is very high but the price quite low because the diesel transported to the island is heavily subsidised. Similarly there is water transported to the Greek islands, fully subsidised by the Greek government, which was mentioned as the most clear institutional barrier to RE-desalination in an area that would otherwise be one of the prime markets.

Finally, regarding the social barriers, it was mentioned that it is necessary to coordinate the activities for selling the idea of RE-desalination to the general public.

Feedback

A feedback sheet (see Annex III) was distributed, giving the opportunity to the participants to provide their opinion in a few lines for the most important barriers and the elements of a strategy to overcome them. About 40 fully completed sheets were collected.

The main barriers identified by the participants are presented here:

- ✓ Many isolated R&D efforts lead to repetition and slow down progress
- ✓ High energy demand

- ✓ There is a lack of reliable pumps and energy recovery systems in the small scale necessary for most RE-desalination systems
- ✓ There is a lack of suitable energy storage technologies
- ✓ Lack of desalination components designed specifically for RE-desalination an being able to deal with the intermittency problem
- ✓ Lack of technical know-how
- ✓ High investment costs
- ✓ The technology is not viable without subsidies
- ✓ The use of RE is an additional cost with slow recovery of the capital expenditure
- ✓ The low price of conventional fuels
- ✓ Regulatory issues
- ✓ There is a lack of business acumen in the area, in Europe at least
- ✓ Large land requirements
- ✓ Lack of awareness about RE-desalination
- ✓ The general public has a rather conservative approach to new technologies when it comes to electricity and water
- ✓ The RE-desalination technologies sound very complicated for non-technical people
- ✓ Lack of public and political support
- ✓ Politicians have generic and often wrong information on technical issues like desalination and RE
- ✓ The non-technological barriers are not addressed systematically
- ✓ Rather than listing the barriers, a problem tree approach would give better structure
- ✓ There is no transparency of the real costs of the various water supply options
- ✓ There is no explicit demand for RE-desalination; for example all relevant tenders are open regarding the energy source and at that stage it is not possible to compete directly with conventional technologies
- ✓ Lack of decision support systems to help configuring the hybrid RE –desalination systems

- ✓ The barriers are of different nature in every geographical area, however the economic and institutional issues are the strongest
- ✓ The lack of taste of distillate water and the difficulty to develop good remineralization in the small scale
- ✓ The risk of hygienic safety in small devices

Here is a summary of the suggestions for a strategy approach as provided by the participants in the feedback sheets:

- ✓ Encourage technological development
- ✓ Develop dynamic operation modes
- ✓ Develop suitable storage or buffer systems
- ✓ Development of robust prototypes
- ✓ Develop standardised solutions and mass production
- ✓ Patience and focused R&D will lead to the innovation for overcoming any technical barrier
- ✓ Use the know-how of experts in the area of control algorithms to deal with the problem of variable operation
- ✓ Use desalination as a switchable and variable load in electrical grids with high RE penetration – this is a big opportunity especially in island grids that benefit also from feed-in-tariff schemes
- ✓ Develop small mobile systems that can go where there is demand and be rented to people, to reduce the risk of the end-user

- ✓ Bring the equipment manufacturers together
- ✓ Contribute to R&D independent of commercial interests
- ✓ Develop decision support systems based on GIS
- ✓ Develop systems that are optimised to operate at partial load and size them so that they deliver over the medium to long term the average quantity that is needed
- ✓ Develop hybrid systems that power desalination through a combination of RE and grid or conventional systems
- ✓ Give incentives to the industry for focusing on RE-desalination
- ✓ Information campaign targeting the general public
- ✓ Promote RE-desalination through the mass media
- ✓ Include RE-desalination in the education system
- ✓ Work together, communicate better and exchange information on innovative concepts
- ✓ Worldwide R&D cooperation including US, Singapore, Japan, Africa and Middle East
- ✓ Develop connections with social and political networks
- ✓ The worldwide RE-desalination community has to be more organised
- ✓ Make people realise the importance of desalination and renewable energy. This way RE-desalination projects and research will get public and political backing
- ✓ Political lobbying
- ✓ Develop intelligent subsidies
- ✓ existing RE electricity tariffs
- ✓ Bring on board investors from the Middle East where demand for the technology exists to finance the product development
- ✓ Water tariffs should be adapted if the water is produced through RE to match the

Conclusions

The main conclusion of the session was the identification of the need to formalise the RE-desalination community in a body that will represent the sector and will lobby for its interests. Other activities that have been identified as priorities from the discussion and the feedback sheets include the continuation of R&D but in a cooperative way, focusing on topics that can benefit all the community. Education and training activities covering all the field of RE-desalination should be also promoted. The general awareness about the technology should be improved through demonstration plants and a communication campaign. Finally, the companies active in the field need support to enter the promising markets in far away countries.

The recommendations from the discussions and the feedback sheets have been taken into account in the revision of the Road Map and in the further work within ProDes.

Annex I: Invitation

Conference and Exhibition on
Desalination for the Environment
17 – 20 May 2009
Kongresshaus, Baden-Baden, Germany

presents on Monday the 18th of May the panel debate

"Roadmap for the development of desalination powered by renewable energy"

organised by

PRODES

Promotion of Renewable Energy for Water production through Desalination

www.prodes-project.org

Panel:
Miriam Balaban (European Desalination Society)
Andrea Cipollina (University of Palermo)
Matt Folley (Aquamarine Power)
Hendrik Müller-Holst (MAGE Water Management GmbH)
Michael Papapetrou (WIP-Renewable Energies)
Marcel Wieghaus (Fraunhofer ISE)
Guillermo Zaragoza (CIEMAT- Plataforma Solar de Almeria)

supported by:
Intelligent Energy Europe

SCHEDULE:		
18:30 – 19:30	Reception with food and wine	
19:30 – 20:00	RE-desalination roadmap and technology perspectives	Presented by the panel
20:00 – 20:45	Panel Discussion	

Concept

A working group on renewable energy desalination has been developed within the EDS. Its main task is to elaborate the roadmap – a strategy for the market development of desalination powered by renewable energy. In this panel debate the roadmap under development will be presented and the view of the event participants will be discussed. We are particularly interested in the input of:

- the industry producing renewable energy desalination systems
- the industry producing just some of the components (pumps, energy recovery systems, membranes, batteries, chemicals, renewable energy equipment etc)
- utilities and end-users
- the research community

The roadmap will include the following sections:

1) Status of the RE-Desalination technology
2) The perspectives RE-desalination to gain a share of the water supply market
3) Technological, economical, institutional and social barriers
4) A strategy leading the way to a sustainable future
5) Resources and activities needed for the implementation of the strategy

The working group will run a consultation process every two years updating the road map and following-up its implementation.

WIP Renewable Energies
Sylvensteinstr. 2; 81369 Munich; Germany
Tel. +49 89 720 12 723; Fax: +49 89 720 12 791
Email: michael.papapetrou@wip-munich.de

Annex II: Participant List

ProDes Strategy Session Participants				
	Company	**Surname**	**Name**	**Country**
1	ACEC	Al-Sofi	Mohamed	
2	Alkon Holding Inc.	Alexandroou	Emmanuel C.	Greece
3	APL - Aquamarine Power	Folley	Matt	United Kingdom
4	AQUATECH	Millauer	Karl Michael	
5	Arabian Consulting Engineering Centre	Al-Sofi	Mohammed AK.	Kingdom of Saudi Arabia
6	Ariel University Center	Borak	Amitzur	Israel
7	CEDT - Center of Excellence in Desalination Technology	Al-Beirutty	Mohammad H.S.	Kingdom of Saudi Arabia
8	Centre for Research and Technology Hellas	Sotiris	Patsios	Greece
9	Centre of Research Excellence in Renewable Energy	Bores	Hasan	
10	CIEMAT - Plataforma Solar	Zaragoza	Guillermo	Spain
11	CIEMAT Plataforma Solar	Alarcon	Diego	Spain
12	CIRCE Foundation - University of Zaragoza	Rubio Maya	Carlos	Spain
13	CNRST - Centre National pour la Recherche Scientifique et Technique	Zejili	Pr. Driss	Morocco
14	CNRST Marocco	Zogli		Morocco
15	CREST - Loughborough University	Bermudez-Contreras	Alfredo	United Kingdom
16	D&WR - Desalination & Water Reuse	Wiseman	Robin	United Kingdom
17	Dalian University of Technology	Yang	Luo Peng	
18	DHV B.V. Water	van Houwelingen	Gerard	The Netherlands
19	DOW Deutschland AnlagengmbH	Lomax	Ian	Germany
20	DWs PS	Berzley	C.	
21	DWs PS	Casane	A.	

22	Ebro Armaturen	Oberfoell	Bernhard	
23	Ebro Armaturen Gebr. Bröer GmbH	Schneider	Markus	Germany
24	Ebro Valves Middle East FZE	Oberfoell	Bernhard	Kingdom of Saudi Arabia
25	EDS - European Desalination Society	Balaban	Miriam	Italy
26	Enercon	Hensel	Frank	Germany
27	European Desalination Society	Hardiman	Richard	Italy
28	Fichtner	Pakade	Benjamin	Germany
29	Fraunhofer ISE	Went	Joachim	
30	Fraunhofer ISE	Schies	Alexander	
31	German Jordanian University	Muna	Abu-Dalo	Jordan
32	German Jordanian University	Muhaidat	Ahmad	Jordan
33	Glasgow University	Hedgkies	Treuer	
34	IAEA - International Atomic Energy Agency	Khamis	Ibrahim	Austria
35	ILF Beratende Ingenieure GmbH	Trostmann	Andreas	Austria
36	ISE - Fraunhofer Institut	Koschikovski	Joachim	Germany
37	ISE - Fraunhofer Institut	Schies	Alexander	Germany
38	ISE Fraunhofer Institut	Wieghaus	Marcel	Germany
39	Jordan University of Science & Technology	Abu-Arabi	Mousa	Jordan
40	Kema	Daal	Ludwin A.	The Netherlands
41	KEMA - Energy Consulting	Daal	Ludwin	
42	King Abdulaziz	Mohamed	Albeirutty	
43	King Abdulaziz University Jeddah	Albeirutty	Mohammed H.	
44	King Jahd University of Petroleum & Minerals	Baig	Hasan	Kingdom of Saudi Arabia
45	Laborelec	Tai Ngoc Han	Huynh	
46	Lohmeyer International	Schäfer	Arne	Germany
47	Medesa	Silke	F.	Switzerland

48	Medesa Technology GmbH	Sitte	Frank	Germany
49	Mekorot Development & Enterprise Ltd	Anahory	Deborah	Israel
50	Membrana	Selzer	Norbert	Germany
51	Ministry of Electricity & Water	Hashim	Ahmed Hashim	Kingdom of Bahrain
52	Ministry of Electricity & Water	Muneer	Ebrahim Hajjaj	Kingdom of Bahrain
53	Norit Process Technology BV	Broens	Lute	The Netherlands
54	Orchard Public Relations Ltd.	Orchard	Bryan	United Kingdom
55	Pall	Johannsen	Petra	
56	RD-Omnes	De souza	Guillaume	France
57	Renewable minerals	Alex		
58	Research University Karlsruhe	Bleninger	Tobias	Germany
59	Saline Water Conversion Corporation	Gassem	Ahmed H.	Kingdom of Saudi Arabia
60	Saline Water Conversion Corporation	Alshareef	Fehied F	Kingdom of Saudi Arabia
61	Scut International UG	von Löbbecke	Hans-Dither	
62	Sidmar	Payo	Andrés	Spain
63	Sonatrach	Fouzior	Nacer	Algeria
64	Statkraft	Kofod Nielsen	Werner	
65	Student PhD	Bar-Zeer	Edu	
66	Student PhD	Sharma	Gunjana	
67	Sultan Qaboous University	Purnama	Anton	
68	Sulzer Pumps	Camacho	Maria	Spain
69	Sulzer Pumps	Meinl	Kurt	Germany
70	SWCC	Subrahmanyam		
71	Synlift Systems GmbH	Käufler	Joachim	Deutschland

72	Synlift Systems GmbH	Pohl	Robert	Germany
73	Technical University Freiburg	Rieger	André	Germany
74	Technical University of Lodz, Poland	Tomcrar	Elmira	Poland
75	Technological University of Lodz, Poland	Ichminski	W.	Poland
76	The College of Judea & Samaria	Barak	Amitzur z.	Israel
77	ThyssenKrupp Titanium GmbH	Jost	Helmut M.	Germany
78	TiNOX Almeco	Müller-Holst	Hendrik	Germany
79	TU Munich	Hassabou	Abdel Hakim	Germany
80	UNIPA - University of Palermo	Cipollina	Andrea	Italy
81	University Bremen	Glade	Heike	Germany
82	University Bremen	Boeck	Katharina	Germany
83	University Duisburg	Flemming		Germany
84	University Duisburg-Essen	Flemmsury	Hans-Durst	Germany
85	University MMDS	Elmidadui	Azzeddine	
86	Uppsala University	Sharma	Gunjana	Sweden
87	VA Tech WABAG GmbH	Schausberger	Paul	Austria
88	Vito - Flemish Institute for Technological Research (Flemish Government)	Brauns	Etienne	Belgium
89	Water Services Corporation	Vella	Warren	Malta
90	WIP Renewable Energies	Papapetrou	Michael	Germany
91	WIP Renewable Energies	Hiptmair	Marion	Germany
92	WWWS World Wide Water Systems AG	Fischer	Edgar	Germany
93	WWWS World Wide Water Systems AG	Baldes	Hans-Ulrich	Germany
94		Orchard	Bryan	UK
95		Ha	Houng	

96		Golli	Alessandro	
97		Hoang	Ha	
98		Galli	Alessandra	

Annex III: ProDes feedback sheet

PRODES

Feedback sheet

Baden-Baden Conference

ProDes panel debate

Please take a few moments to give some feedback about the ProDes Roadmap

Name:	
Company:	
Webpage:	
Email:	

What do you feel are the main barriers for RE desalination (technological, economical, institutional, social):	
What do you think are the best ways to overcome these barriers:	

Would you like to receive the upcoming ProDes newsletters	☐ Yes, please send them to my e-mail mentioned above ☐ No, I prefer to just check the webpage
Would you like to be included in the working group and be consulted for the roadmap development	☐ Yes, please contact me on my e-mail ☐ No, thank you

Annex IV: ProDes presentation in the Strategy Session

RE-Desalination Road Map and technology perspectives

PRODES

Miriam Balaban (European Desalination Society)
Andrea Cipollina (University of Palermo)
Matt Folley (Aquamarine Power)
Hendrik Müller-Holst (MAGE Water Management)
Michael Papapetrou (WIP-Renewable Energies)
Marcel Wieghaus (Fraunhofer ISE)
Guillermo Zaragoza (CIEMAT- PSA)

Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

ProDes: Main facts

- Co-financed through the “Intelligent Energy for Europe” programme

➢ ***Contract number:*** IEE/07/781/SI2.499059
➢ ***Starting date:*** 1 October 2008
➢ ***Closing date:*** 30 September 2010

➢ 14 partners with a focus on Southern Europe

WIP	INETI	AQUAMARINE POWER	BEFESA
www.wip-munich.de	www.ineti.pt	www.aquamarinepower.com	www.befesa.es
ΚΑΠΕ CRES	aosol	HELLAS ENERGY	Ciemat
www.cres.gr	www.aosol.pt	Greece	www.ciemat.es
Università degli Studi di Palermo	FhG Fraunhofer Gesellschaft	EDS	ALMECO TiNOX
www.unipa.it	www.fraunhofer.de	www.edsoc.com	www.tinox.com
CAPITAL CONNECT	itc Gobierno de Canarias		
www.capitalconnect.gr	www.itccanarias.org		

Objectives and main activities

- ProDes aims to support the market development for RE-desalination, through the following strategy:
  - ✓ Bring together the European players and coordinate their activities
  - ✓ Develop training tools
  - ✓ Identify key players on the local level and connect them with technology providers

  - ✓ Liaising with investors to facilitate product and project development
  - ✓ Working with policy makers to outline a support mechanism
  - ✓ Making the general public aware of the technology

Expected results

- A working group will be established within EDS coordinating the RE-desalination community activities
- Training courses will be implemented enriching the pool of experts on a European level
- The companies will build a network for promoting their products to the niche markets Southern Europe
- The framework conditions in each target country will be improved
- The general public will become familiar with the technology

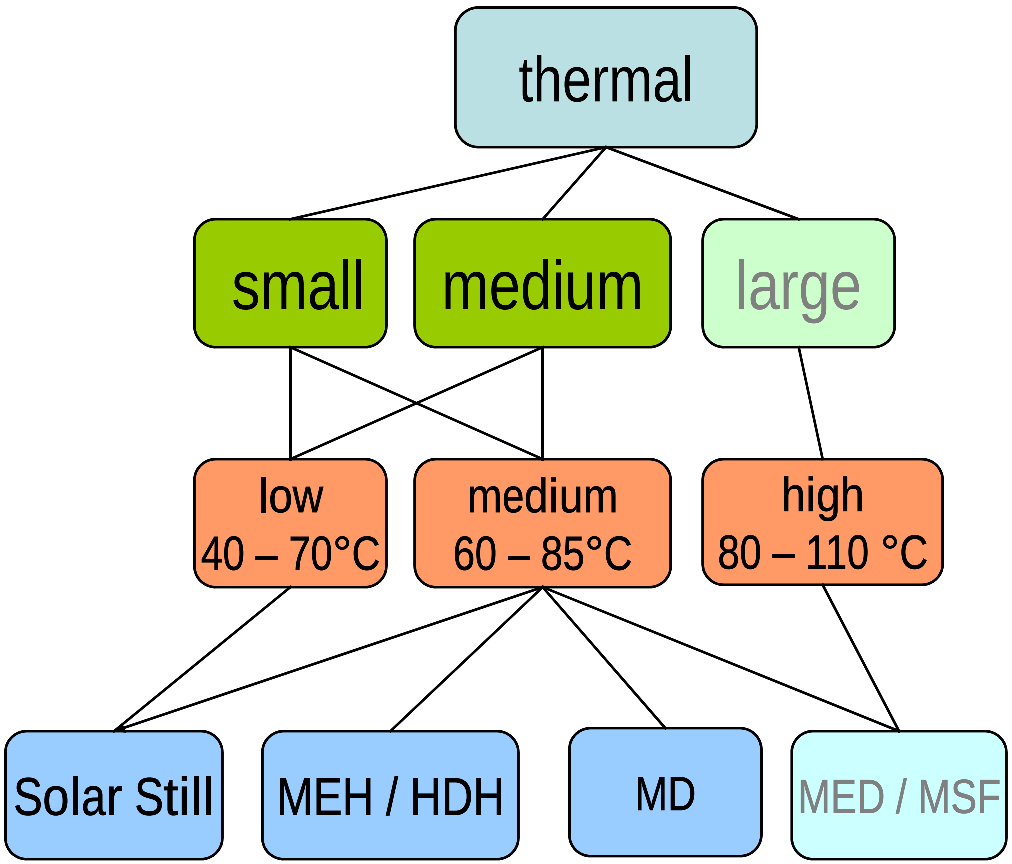

MD by ITC in Canary Islands

Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

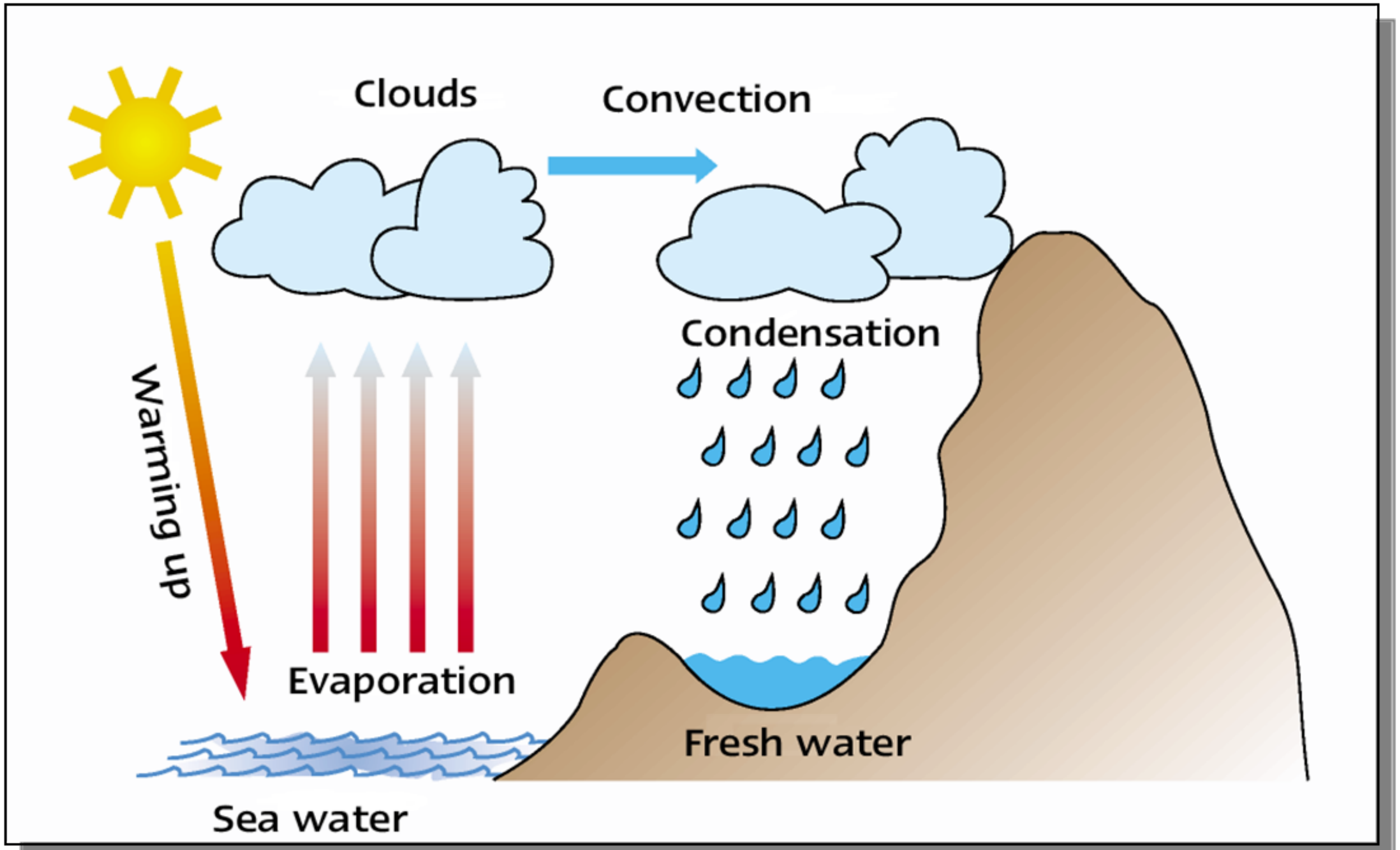
Solar Thermal powered desalination methods

for small and medium scale application



- Multiple Effect Solar Stills
- Membrane Distillation
- Multiple Effect Humidification
- Modified MEH
- MED and MSF

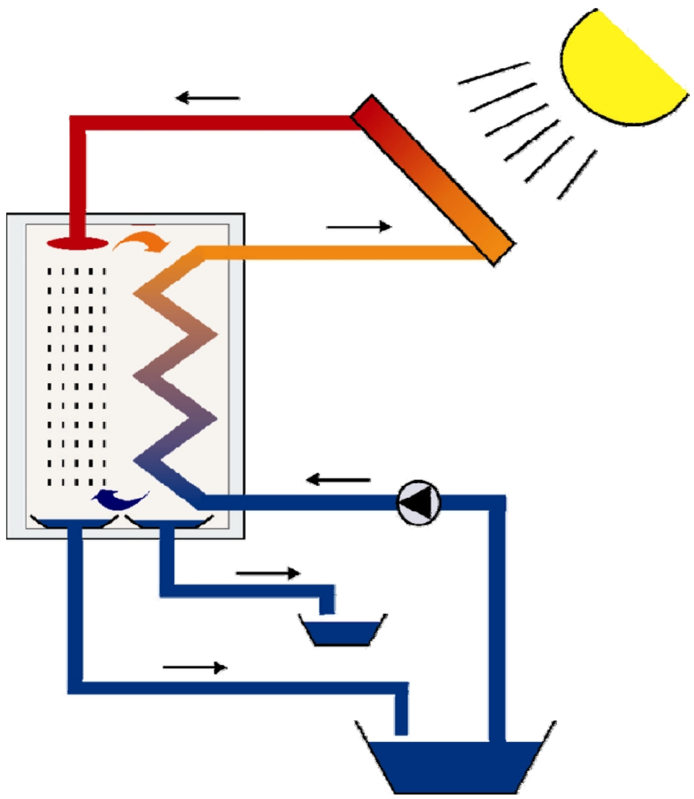
Rebuilt the natural water cycle



Solar Thermal powered desalination

Multiple Effect Humidification (MEH)

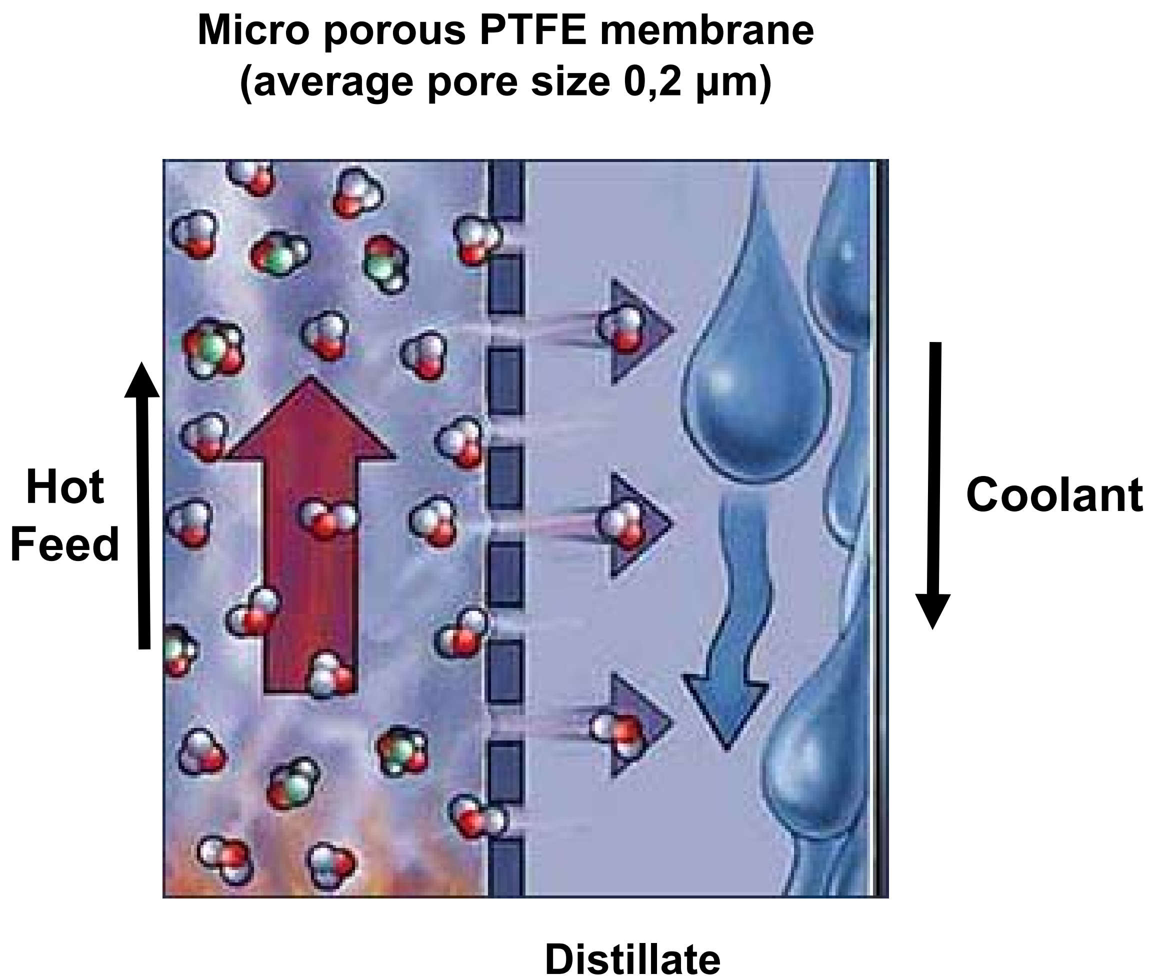
Main Characteristics:

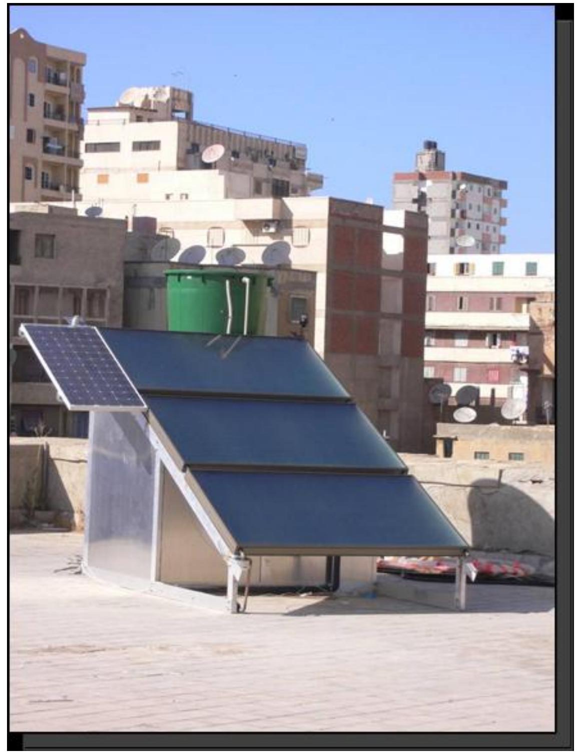


- Thermal energy demand 120 $kWh_{thermal}/m^3$
- Specific water production: 25 l/m² Collector area
- No raw water pre-treatment needed
- Produced water is complying with EU drinking water directive (COUNCIL DIRECTIVE 98/83/EC of 1998 on the quality of water intended for human consumption) and WHO standards
- Self reliable operation
- Very low maintenance demand

Membrane Distillation

Distillation driven by partial pressure difference on the two sides of a hydrophobic membrane which permit the flow of vapour but not of liquid water





Main barriers

- Reatively high initial specific investment
- No standardized configurations
  → difficult to compare conventional and renewable energy driven systems
- Lack of suitable design guidelines and tools
- Low awareness of the technology
- Lack of installation and operation know how

Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

CSP technologies

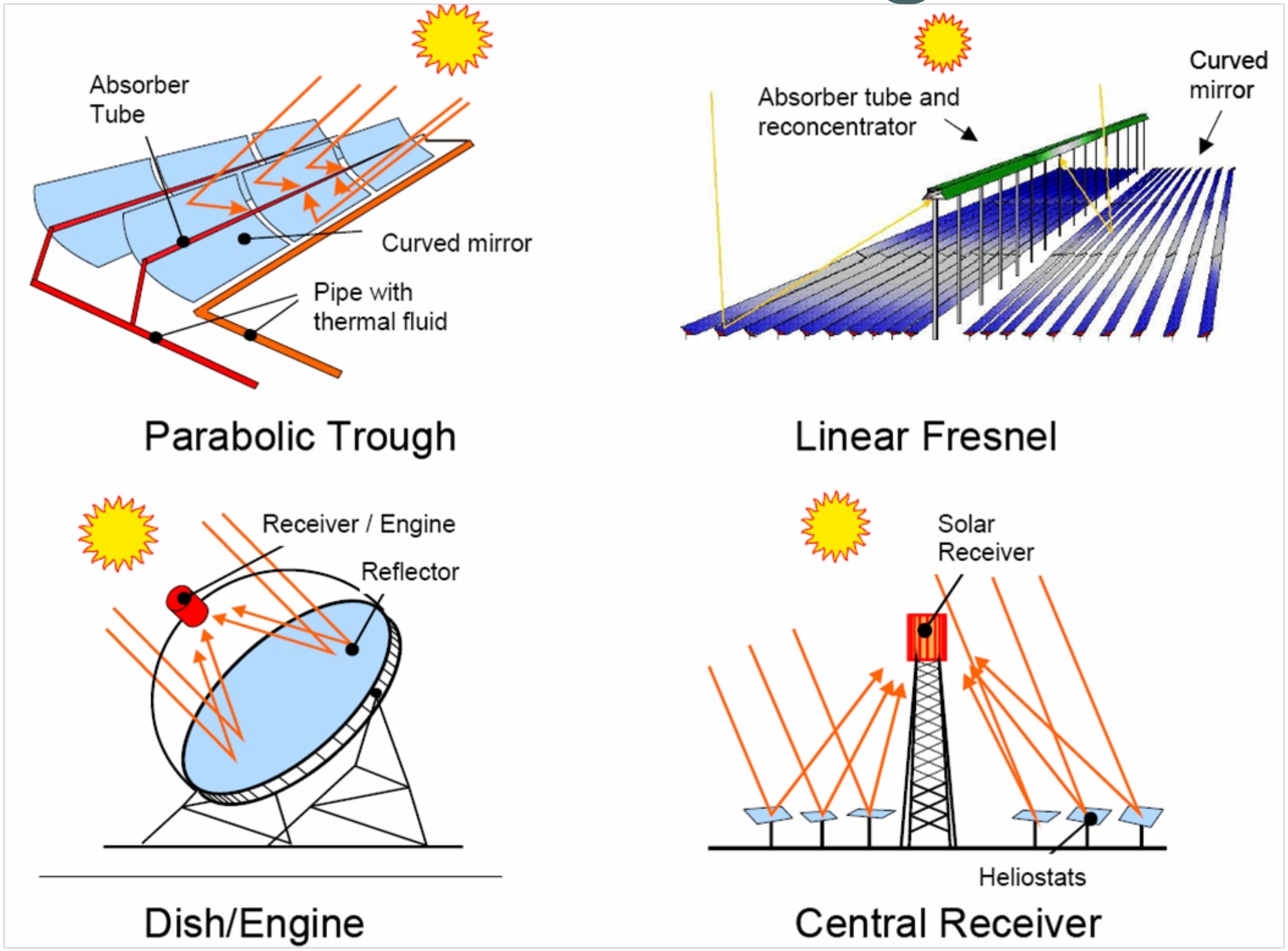
MW scale solar power generation using Concentrating Solar Power (CSP) can be of four types:

- Central receivers
- Parabolic troughs
- Parabolic dishes
- Linear Fresnel systems

Glass mirrors continuously track the position of the Sun to attain desired concentration ratio. Heat from concentrated light is used to generate high-P high-T steam to drive a turbine in a conventional power cycle.

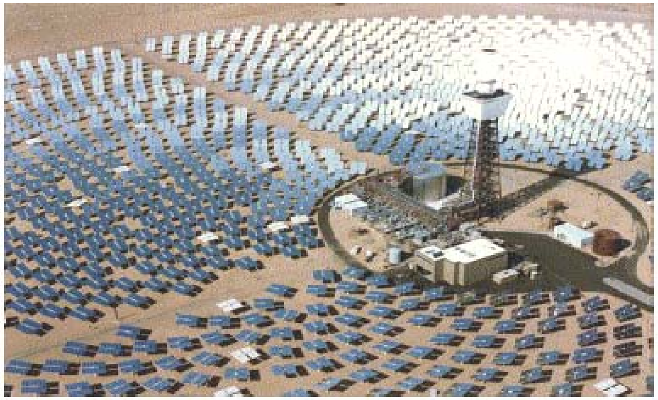
Large amounts of water are required for CSP plants operation

CSP technologies



CSP technologies



CSP+D

Combination of CSP and seawater desalination can be done with several configurations:

- Multi-Stage Flash (MSF) distillation operated with steam extracted from turbines or supplied by boilers
- Low-T Multi-Effect Distillation (MED) using steam extracted from a turbine
- Reverse osmosis (RO) supplied with electricity from steam power plant or combined gas/steam power cycle

CSP+D self-supplies water for the cooling system required for condensation of exhaust steam from the turbine

The integration of a MED unit can replace the conventional water cooling system while producing fresh water

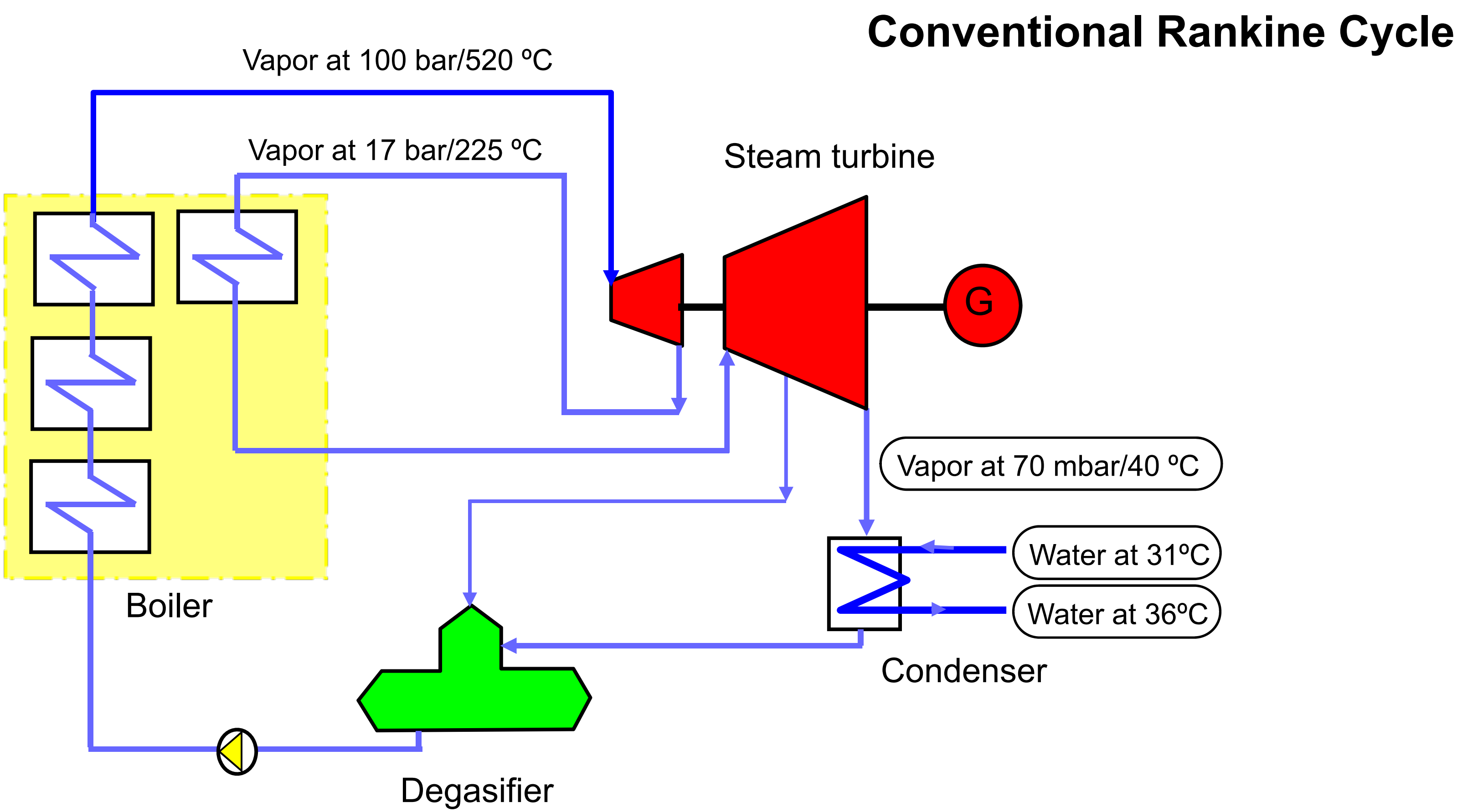
CSP+D

PSA-CIEMAT is currently studying the possible configurations for coupling of a MED plant with a solar thermal power plant.

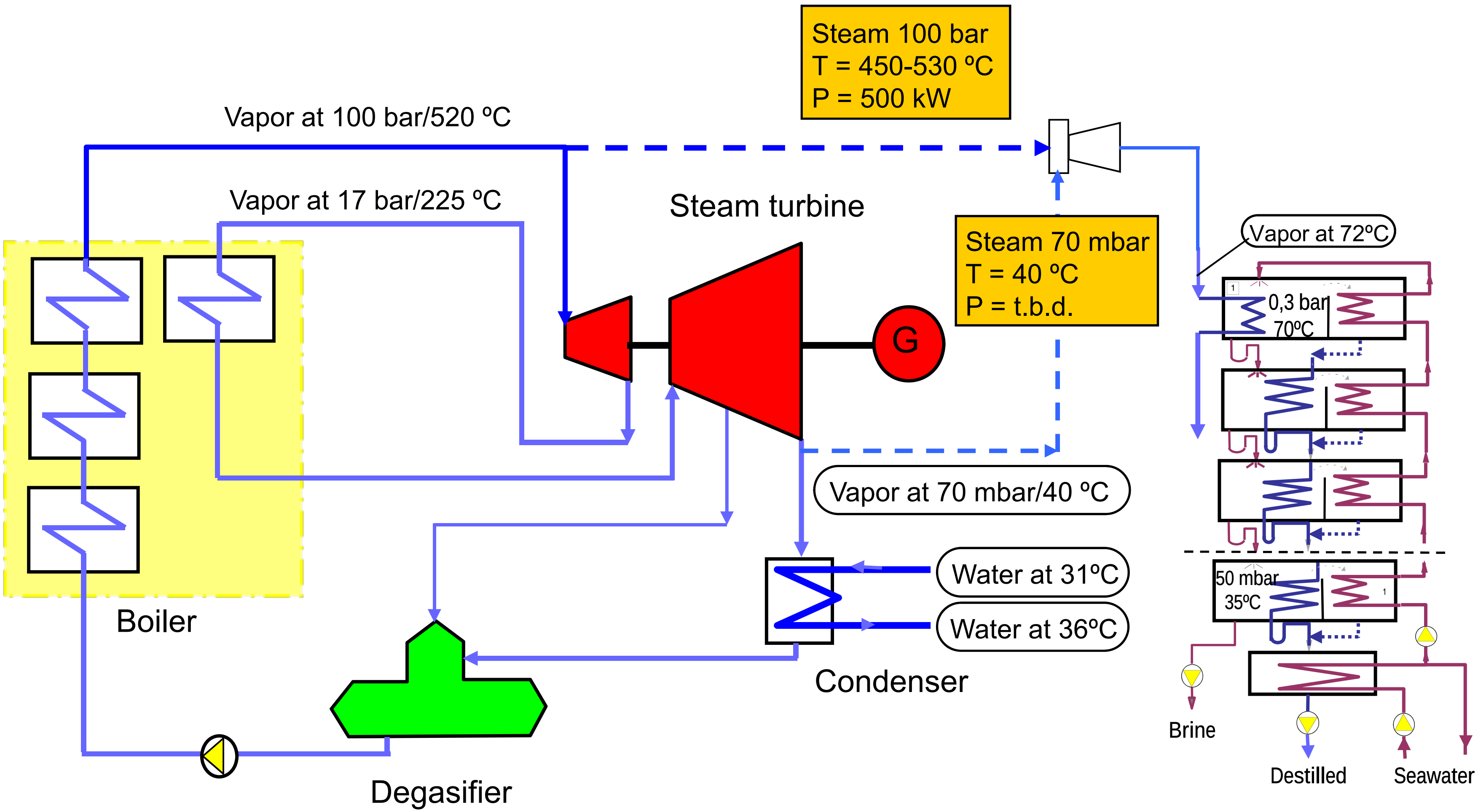
A specific CSP+D test bed is being built with the elements:

- Parabolic trough field
- Thermal oil storage tank
- MED 14 effects plant
- Double Effect Absorption Heat Pump
- Thermo-compressors
- Vapor generation to simulate extractions from turbines

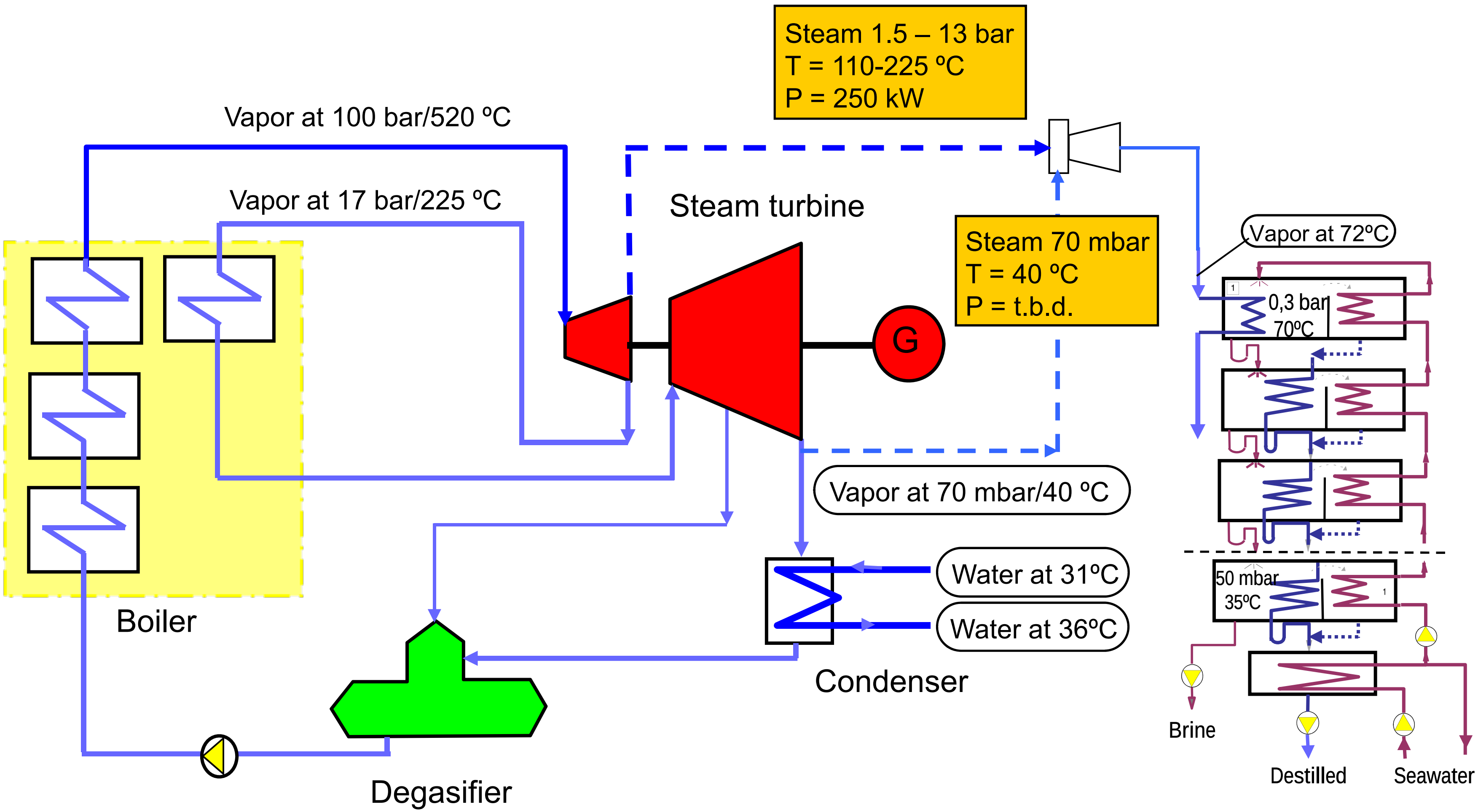
CSP+D test bed



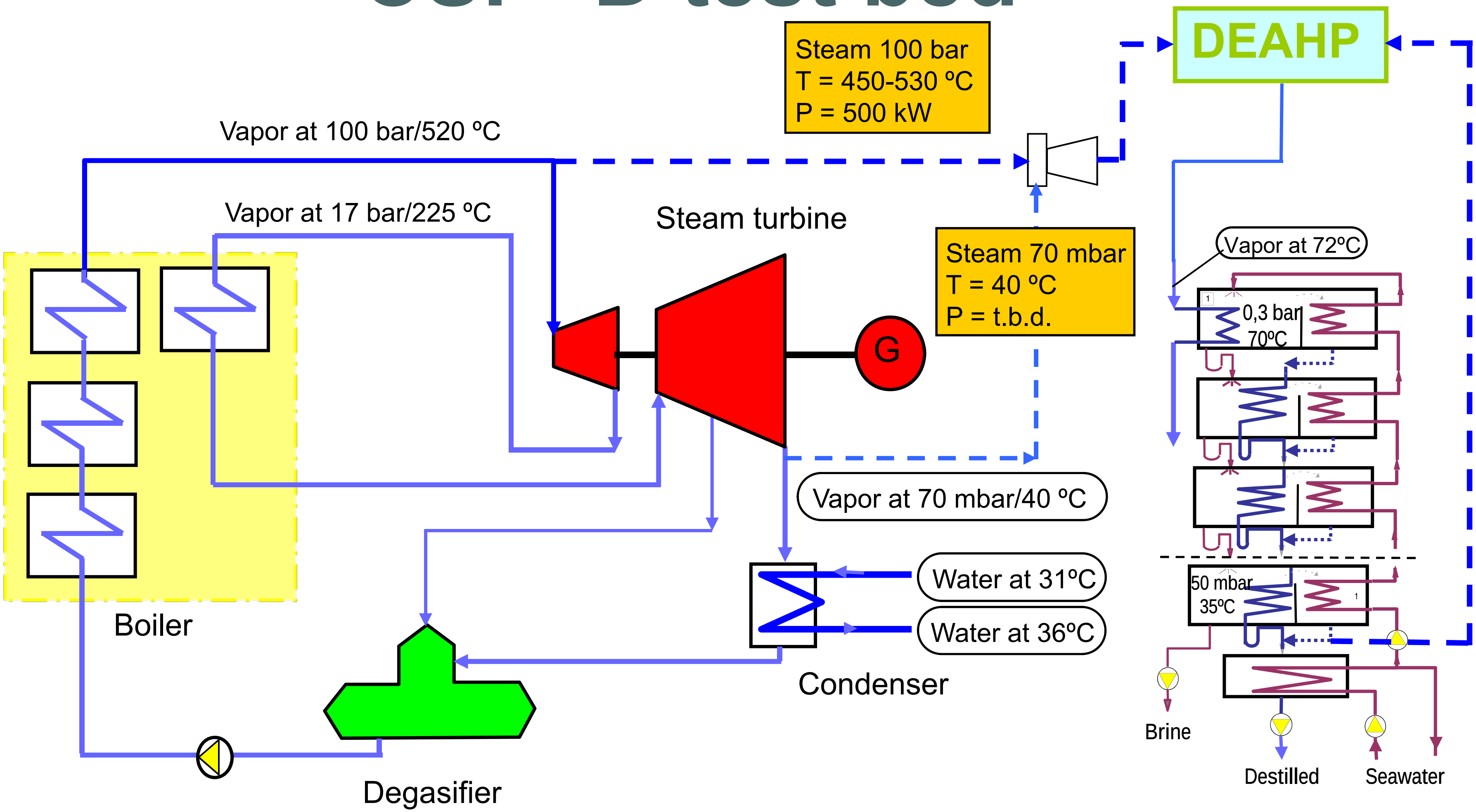
CSP+D test bed



CSP+D test bed



CSP+D test bed



CSP+D

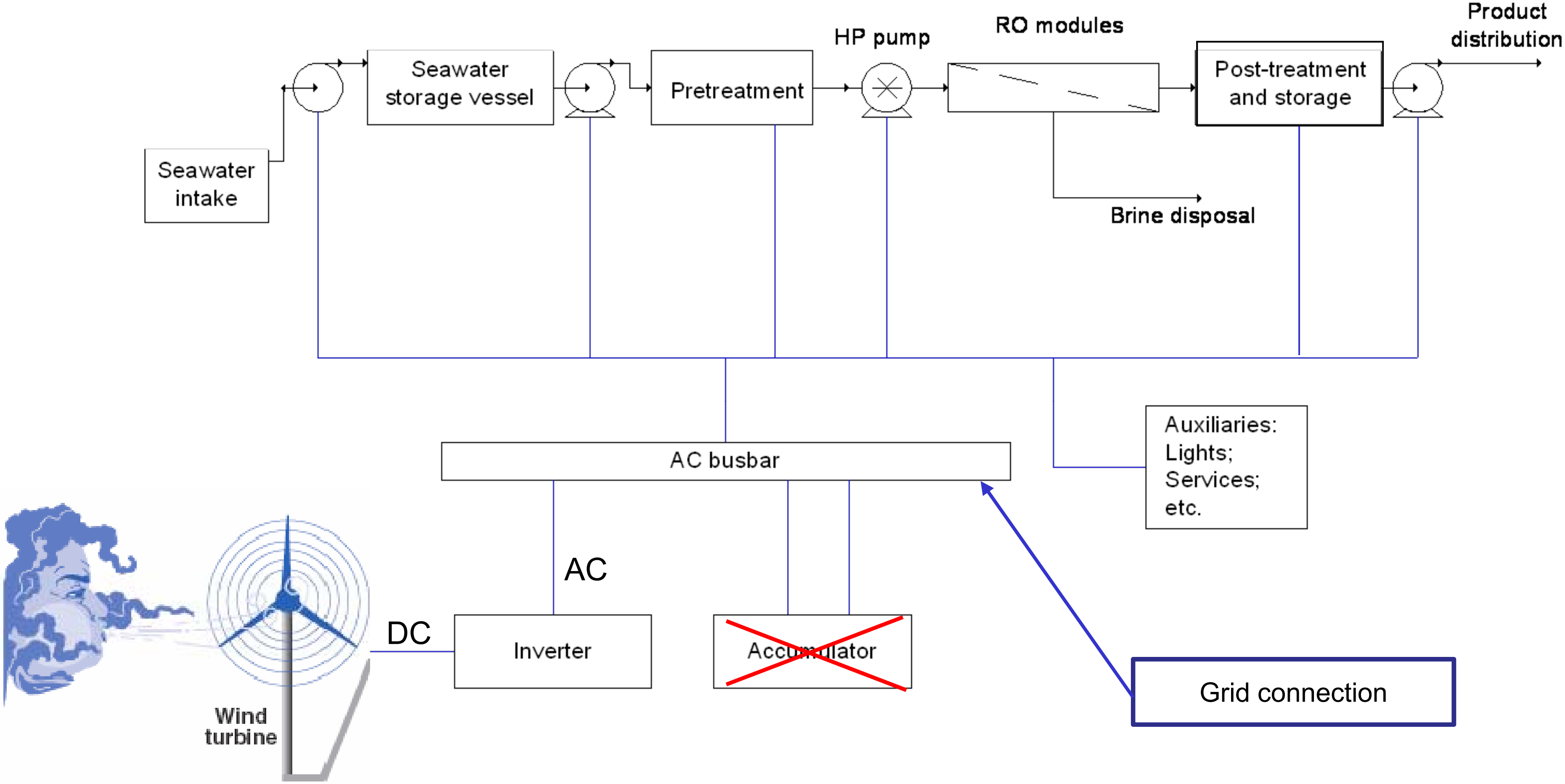
Main barriers:

- Solar power generation must be close to the sea, where land is more expensive and climate less favorable
- Socio-political management of energy and water generally unrelated, which complicates effective penetration of CSP+D in the market (subsidy policies)
- Efficiency of thermal distillation plants needs to be increased (larger potential for MED plants)
- Continuous operation of desalination plants requires hybridization of power plant
- Variability in the energy source and power demand requires flexibility in desalination productivity (in the case of MED, need for adaptive thermo-compressors or absorption heat pumps)

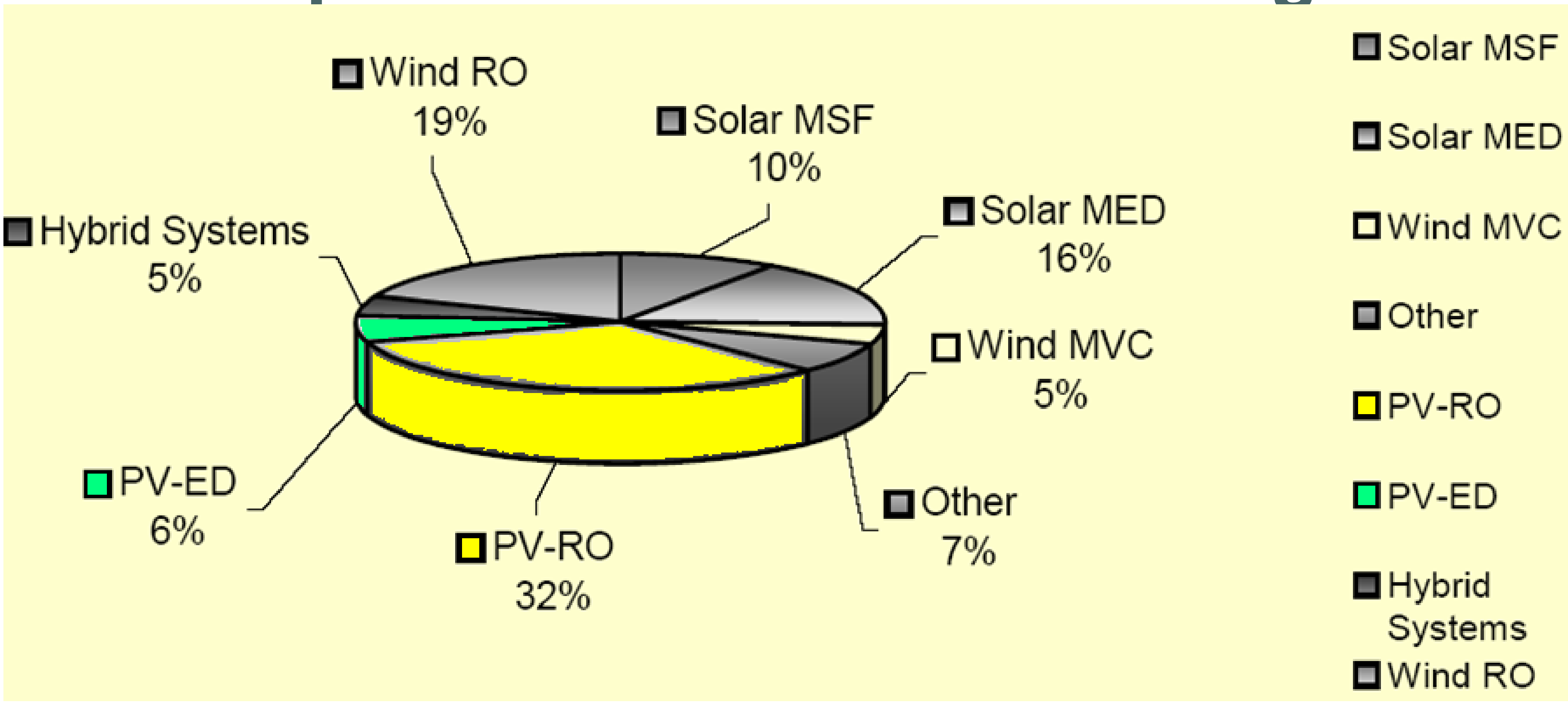
Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

PV/Wind Reverse Osmosis



Comparison between technologies



Very suitable for remote areas and small scales;

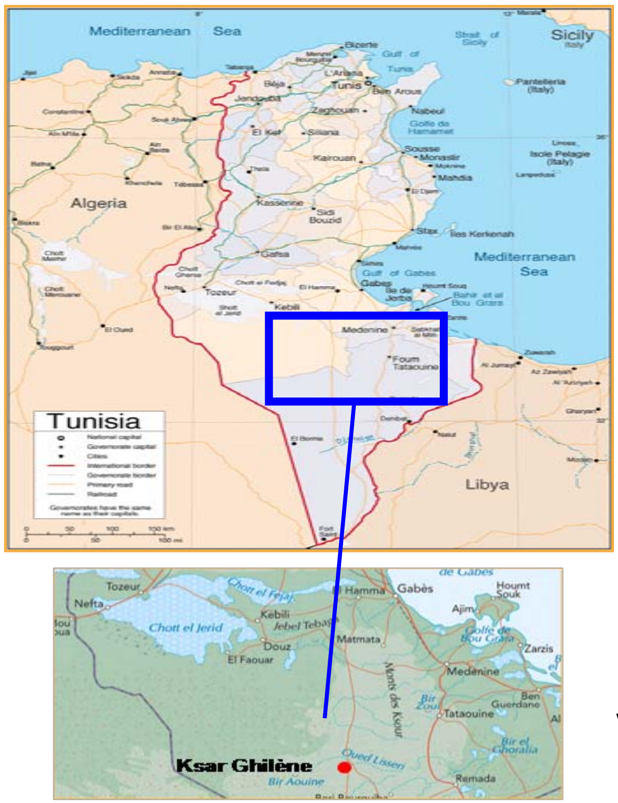
More suitable for larger scales;

PV-RO: CASES OF STUDY. KSAR GHILÈNE

Dessol® (by ITC)

Cooperation project. Autonomous PV-RO unit in Tunisia (since 2006)

- The village of Ksar Ghilène 1st African location with 2 years operating PV-RO system.
- 300 inhabitants with no access to electric grid (nearest at 150 km) or fresh water.



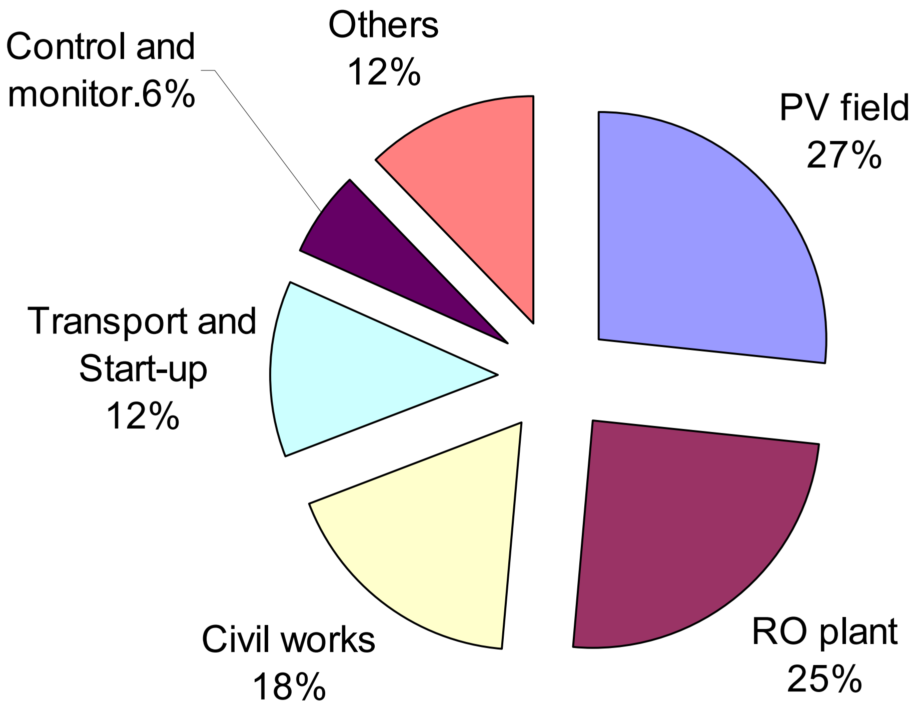
Ambient Temp: 0 – 60 ºC

PV:
power 10.5 kWp (≈80 m^2);
batteries 79,2 KWh;

BWRO:
-capacity 2 m^3/h;
-feed salinity 3500 ppm;
-recovery 70%

Operating more than 3,100 h producing 6,000 m^3 of drinking water in 27 months.

Example of costs break-down for small PV-RO units



Average water prices:
- BW, from 5 to 9 €/m^3
- SW, from 9 to 12 €/m^3

From some PV-RO case studies. Units installed in Morocco, treating Brackish Water (average salinity ≈ 5gr/lt), capacity ≈ 24m^3/d

Pozo Izquierdo, Gran Canaria, seawater, stand-alone
Desalination: **19 m^3/d** RO plant
Power Supply: 15 kW W/T, 190Ah battery bank
Year of installation/operation: 2003/4
Unit Water Cost: **3-5 €/m^3**

Milos island, Greece, seawater, grid connected
Desalination: **2x1000 m^3/day** RO plant
Power Supply: 850 kW W/T
Year of installation/operation: 2007
Unit Water Cost: **1.8 €/m^3**

PV and Wind Desalination barriers

PV for BWRO & SWRO

- High investment cost due to photovoltaic;
- Oscillating availability of the energy source (discontinuous operation)
- Need for large surfaces for PV installation;

Wind/T for BWRO & SWRO

- Difficulty in predicting the energy source availability for no-grid connected systems;
- Site specific energy source (fairly constant and high speed wind required);
- Need for installation sites far enough from houses and villages;

Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

Ocean power and desalination

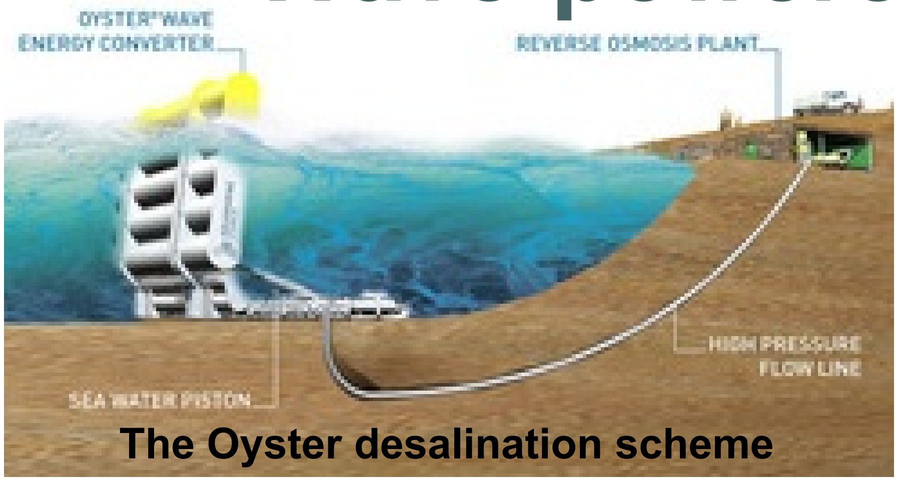
- Marine renewable energy (wave and tidal) is a form of mechanical energy so most suited to membrane desalination processes
- Marine renewable energy could be used to generate electricity to power conventional desalination plant
- Alternatively, marine renewable energy could be used to pressure sea-water directly

  - ✓ significant increase in overall plant efficiency
  - ✓ reduction in plant complexity
  - ✓ reduction in plant flexibility

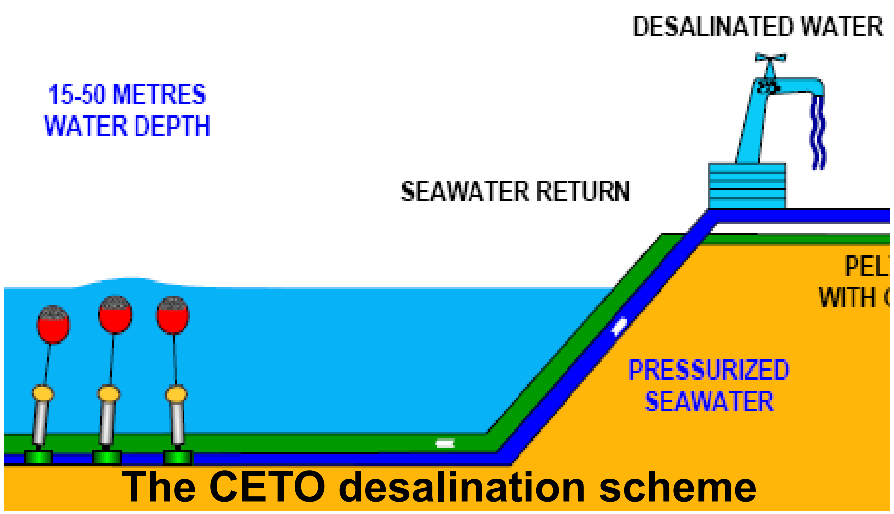
Ocean power and desalination

- High cost of marine operations means that offshore marine energy farms are typically proposed to generate ~ 100 MW+
  - conventional desalination plant size is typical less than 100,000 m^3/day (~10-20 MW)
  - desalination plants powered by renewable energy are typical much smaller
  - Offshore farms most suitable for hybrid-powered or co-generation plants
- Shoreline and nearshore marine energy plant have reduced operational costs and so can be a sized more suitably for coupling to desalination plants

Wave-powered desalination



The Oyster desalination scheme



The CETO desalination scheme

- Wave-driven motion pumps sea-water using linear pistons
- Sea-water transported to shore via pipelines
- Increase is overall of energetic efficiency ~ 40% by elimination of intermediate electricity production
- Estimated specific energy consumption 1.8 – 2.5 kWh/m^3
- Proposed commercialisation 2011-2015

Ocean power and desalination barriers

- Lack of energy recovery technologies suitable for direct coupling with sea-water supply of variable pressure and flow
- Lack of robust RO membranes suitable for operation with sea-water supply of variable pressure and flow
- Lack of pre-treatment hardware suitable for operation supplied with high-pressure sea-water of variable pressure and flow
- Lack of extremely low-maintenance (< 1 visit/year) pre-treatment hardware suitable for deployment and operation offshore

Structure

- The ProDes Project
- Solar powered thermal desalination
- CSP desalination
- PV and/or wind with RO
- Ocean power and desalination
- The RE-desalination roadmap

RE-desalination roadmap

Objective:

- Outline the vision, barriers and strategies to accelerate the development of RE-Desalination so that it can become a significant part of the unconventional water supply market

Structure:

- **Current** status of the technology
- **Perspectives** of RE-desalination
- **Barriers** that hinder the development of the technology
- Outline of the **strategy** to overcome the barriers
- Resources needed for the **implementation** of the strategy

RE-desalination roadmap

Definition of Barriers

- Technological
- Economic
- Institutional
- Social

RE-desalination roadmap

Technological Barriers

- Intermittent energy supply (discontinous operations)
  => this requires hybridization, energy storage or quite sophisticated tailor made control system
- Maintenance, reliable remote monitoring, discharge/brine-solution, robust materials, long-time operational experience
- No standardized configurations (certified systems ?)
- Lack of suitable design tools/experts

RE-desalination roadmap

Economic Barriers

- Relatively high initial investment cost

- Lack of an established market discourages standardisation and mass production that would bring the investment costs down

- No network for the distribution of the consumables and the spare parts => 100% imported systems hinders the market penetration

- Loans and equity financing difficult because investors perceive new technologies as high risk – the lack of financial incentives like feed-in tariffs does not help either (see institutional barriers)

RE-desalination roadmap

Institutional Barriers

- Socio-political management of energy and water generally unrelated
  => RE electricity is strongly subsidized while the desalination of water with renewable energy is not

- No full cost recovery (i.e. Malta 3 times higher costs than prices, Algeria 15 times) but water price is a sensitive socioeconomic issue

- Water authorities are reluctant with RE-desalination because of confidence with current technology and culture of risk avoidance

- There are few institutions to promote, inform and provide training is RE desalination

- The legal framework for independent water production is not clear and permissions for a small systems involve various authorities

RE-desalination roadmap

Social Barriers

- Desalination plants are generally considered energy intensive and damaging to the environment
- Water consumers and authorities are not aware of the availability and advantages of technologies based on RE desalination
- RE desalination currently is more suitable for isolated locations where users might be reluctant to accept a new technology
  → also the ability or willingness to pay can be low
- The different quality and value of water for human consumption, for agriculture and for other uses needs to be appreciated

RE-desalination roadmap

Strategy

The role of industry and of R&D in overcoming the barriers

- R&D needed
- Visions and timetable on market development
- Education of professionals
- Regulatory issues
- price/performance
- Financial support

Implementation

Resources and activities needed for the implementation of the strategy

Consultation

Our consultation process reaches out to all of you to define the view of the RE-desalination community on the perspectives, barriers and visions

- Interested in active participation?
- What do you feel are the main barriers for RE – desalination?
- What do you think are the best ways to overcome these barriers?
- Shall we contact you for further consultation?

PRODES

Feedback sheet
Baden-Baden Conference
ProDes panel debate

Please take a few moments to give some feedback about the ProDes Roadmap

Name:	
Company:	
Webpage:	
Email:	

What do you feel are the main barriers for RE desalination: - technological barriers - economical barriers - institutional barriers - social barriers	
What do you think are the best ways to overcome these barriers:	

Would you like to receive the upcoming ProDes newsletters	☐ Yes, please send them to my e-mail mentioned above ☐ No, I prefer to just check the webpage
Would you like to be included in the working group and be consulted for the roadmap development	☐ Yes, please contact me on my e-mail ☐ No, thank you

Thank you for your attention!

ProDes - Promotion of Renewable Energy for Water Production through Desalination

www.prodes-project.org

Michael Papapetrou
WIP-Renewable Energies
Sylvensteinstr. 2, 81369 Munich, Germany

Phone: +49 89 720 12 792
e-mail: pmp@wip-munich.de
website: www.wip-munich.de