Proceedings of International Seminar

Desalination Systems

Powered by Renewable Energy

Institutional Framework Conditions

in the Mediterranean Region

www.adu-res.org

19 September 2006

Le Royal Hotel, Amman, Jordan

The seminar was hosted as a parallel session to the GC READER conference. Organised from the project ADU-RES with financial support from the 6th Framework Programme of the European Commission (Contract number: INCO-CT-2004-509093)

Programme of the Seminar

14:00	***Welcome***	**Mohammad Saidam**, Royal Scientific Society, *Jordan*
14:10	***Brief Keynote – Middle East Desalination Research Centre***	**H.E Koussai Quteishat,** MEDRC Director, Oman
14:20	***An introduction of the ADU-RES project***	**Christian Epp**, WIP - Renewable Energies, *Germany*
14:40	***Jordan's National Water Master Plan***	**Suzan Taha**, Ministry of Water & Irrigation, *Jordan*
15:00	***The MEDA Water Programme***	**Gert Soer,** Head RMSU MEDA Water**,** *Jordan*
15:20	***Overview of the desalination technologies powered by Renewable Energy***	**Eftihia Tzen**, Centre for Renewable Energy Sources, *Greece*
15:40	***Cost analysis of the various technologies and potential for cost reduction***	**Vicente Subiela Ortin**, Instituto Tecnológico de Canarias, *Spain*
16:00	***Coffee break***	
16:20	***Socio-economic, health and environmental issues***	**Ayman Rabi**, Palestinian Hydrology Group, *Palestinian Authority*
16:40	***Action Plan for Solar and Wind Desalination in Jordan***	**Mohammed Saidam**, Royal Scientific Society, *Jordan*
17:00	***Action Plan for Solar and Wind Desalination in Tunisia***	**Thameur Chaibi**, Institut National de Recherche en Génie Rural, Eaux et Forets, *Tunisia*
17:20	***Action Plan for Solar and Wind Desalination in the European Union***	**Michael Papapetrou**, WIP -Renewable Energies, *Germany*
17:40	***Questions and discussion***	
18:00	***End***	

BRIEF KEYNOTE – MIDDLE EAST DESALINATION RESEARCH CENTRE

H.E Koussai Quteishat, MEDRC Director, Oman

Two main points will be covered in this presentation. The first is the differentiation between desalination using renewable energy as a power source and what we call renewable energy desalination. The second point is the way renewable energy is looked at by the desalination industry at large. When I come to that, I wouldn't be trying to belittle your great and persistent efforts but rather to entice us all to continue our work with even greater diligence in order to put renewable energy desalination on the road map of water resource development.

As you know, not all renewable energy sources apply to all desalination processes. The first step is always to match a renewable energy source with its appropriate desalination process or processes. Renewable energy has both direct and indirect applications.

Example of direct application of renewable energy is the use of solar energy directly to evaporate the saline water and vapor is then condensed. Another example is geothermal energy which can be used to power Multi stage flash (MSF), Multi Effect distillation (MED), or Thermal Vapor Compression (TVC).

In the indirect applications, however, renewable energy is first converted to some other forms of energy, like thermal or shaft work, or electrical energy. This converted form of energy is then used to power the desalination process. Examples are solar energy which can be converted to thermal energy using solar thermal collectors. Thermal energy thus produced can be directly used to power desalination processes like MSF, MED and TVC. Thermal energy can be converted to shaft work and it can power Mechanical Vapor Compression (MVC), and Reverse Osmosis (RO) or the Thermal energy can be converted to Electrical energy in order to power Mechanical Vapor Compression (MVC), Electrodialysis (ED) and Reverse Osmosis (RO). Now solar energy can be converted to electrical energy directly by using photovoltaics. Electrical energy thus generated can power RO, ED and MVC. Wind energy can be converted to shaft work and electrical energy. Shaft work can power MVC and RO and electrical energy for MVC, ED, RO. Geothermal energy can be converted to electrical energy. Electrical energy can then power RO, ED and MVC. Biomass can be converted to thermal energy. Thermal energy can be used to power MSF, MED and TVC. This thermal energy can be converted to electrical energy which can be used to power RO, ED and MVC.

Naturally, in order to industrialize the processes, they need to be economic. At this moment these processes are not economically competitive because in direct applications, such as in the solar stills for example, the energy required to produce desalinated water is high because the latent heat of condensation is not recovered. This leads to large surface area contributing to significant increase in the capital cost of the units. Recently however, there are some experimental/pilot units which are designed to reduce energy consumption by building multistage configuration though there have been limitations to how these stages can be increased.

Direct use of geothermal energy for powering MSF, MED or MVC has witnessed some peculiar scaling problems on the geothermal fluid side of the heat exchanger. This required specific measures that have to be taken contribute to the increase in costs.

In the indirect applications, additional equipment is always required to convert renewable energy to thermal or shaft work or electrical energy. This is done at low conversion efficiencies leading to higher capital costs. In comparison, conversion efficiencies are very high in conventional fossil fuel power plants. This, compounded by the fact that electrical power is subsidized in most countries; the gap in costs is widened further.

The need for additional equipment is also dictated by some renewable energy sources that do not provide continuous supply of power such as Solar and Wind energies. Desalination processes are technically and economically viable if they are operated continuously. The need for additional equipment to store thermal and electrical energy generated by solar and wind energies also contributes to the increase in the costs of desalination.

With these examples and specific cases, I have tried to touch upon the broad reasons for the high costs of renewable energy desalination and to show that there is indeed a difference between desalination using renewable energies and the integration process of renewable energy generation and desalinated water production. Economy will only come through integration.

As for the second point that I want to highlight stems from the current status of renewable desalination in the world. We all know that there are no large scale desalination processes in operation, and we are here to eventually change that.

According to Wangnick's 2004 inventory report of desalination plants in the world whereas total desalination production is over 55 mcm per day, solar desalination capacity in world over was a mere 3330 m3/day; 63% capacity for municipal use, 36% capacity demonstration plants and the rest 1% irrigation. Total number of solar desalination plants is 83, out of which 68 are demonstration plants, 13 are used for municipal water supply and 2 are for irrigation. Solar desalination capacity comprises 48% by RO and 36.5% by MED.

Currently, the cost of desalination using renewable energy is at least 4 times that of conventional desalination. More efforts are directed world wide to reduce the cost of renewable energy desalination. These activities are undertaken by either renewable energy experts or desalination experts. In these efforts, renewable energy experts are trying to learn desalination processes and desalination experts are learning about renewable energy conversions. Very few studies are available in the literature which involves experts from both disciplines.

Let me conclude by the following. In 2000, the World Bank underwent a study on regional desalination in MENA. I had the opportunity to be reviewer of the study. When the final report was disseminated for comments to “desalination proper” experts, a renowned and very notable expert commented on the section about solar desalination, and I quote: “It should be noted that after 125 years of field testing and millions of government and private dollars for research, solar distillation is still not commercially viable.”

It is your efforts that brought you here and the efforts you are pursuing in the future. It is with these efforts and with a close association with the industry, that this stigma can be altered and eventually removed. So keep up the good work.

AN INTRODUCTION OF THE ADU-RES PROJECT

Christian Epp, Senior Project Manager, WIP – Renewable Energies, Germany

Introduction

Many arid regions in Mediterranean countries have a great potential to cover part of their pressing water needs by renewable energy based desalination. However, the wide-scale implementation of this technology faces numerous technical, economic and policy barriers.

These barriers are studied and strategies to overcome them are developed and implemented within the ADU-RES project. The consortium involves partners from 8 Mediterranean Partner Countries (MPC) as well as institutes and SMEs from 5 EU countries specialized in desalination and renewable energy systems. All partners can be seen and contacted through the project website: www.adu-res.org.

Objectives

ADU-RES pushes forward technical and policy developments to boost the implementation of renewable energy based desalination units in the Mediterranean. Therefore the aim of the project is twofold. Firstly an analysis of the current status and recommendations for improvements on the technical side is performed, for mature and cost efficient renewable energy based desalination units. The second field where the efforts of the project are focused is the formulation of political strategies for boosting ADU-RES implementation within the existing policy and legislative frameworks.

For achieving its challenging aim, ADU-RES has defined a set of objectives that will gradually lead to a better understanding and improved framework conditions for the wide-scale implementation of autonomous desalination.

Initially, the project consortium creates a complete survey on recent progress in the field. Thus, the foundations for the next steps are set by collecting past research, development and demonstration activities and identifying key research results, research actors and demonstration sites. A second objective is to develop an understanding of potential user groups in the Mediterranean. The needs and requirements of specific user groups are studied with on-site research in order to guide the technology developers into designs tailored to the needs of the end user. Then, cost reduction strategies are defined. The techno-economic performance of selected technologies is analyzed and potential cost reductions are identified.

The social and environmental impacts of autonomous desalination units and the health and safety performance of existing units are scrutinized and measures for improving them are suggested. A central objective of ADU-RES is to develop recommendations for policy strategies supporting wide scale implementation of autonomous water production systems.

Therefore, first the socio-economic and policy framework conditions are analyzed in some representative countries of the region.

Finally, the consortium disseminates the opportunities and advantages of renewable energy based desalination and raises the awareness for sustainable water supply.

Results

Various research exchange activities between relevant stakeholders will take place for the duration of the project implementation period. One tool that has been developed for this purpose is the “research matrix”. This is an Excel based, easy to use database with recent publications related to autonomous desalination. Furthermore the research matrix provides links to institutes and companies active in the field. The information in this tool is structured under twelve different fields in a matrix format. Upon completion of the project it will be made available to the research community for use and further development.

A comprehensive report has been produced covering the following fields:

- Description of the available combinations of renewable energy systems with desalination technologies introducing the main technological features of each one.
- General guidelines for selecting the appropriate technology combination depending on the framework conditions and requirements of each case
- An overview of selected plants worldwide focusing on the technological and financial performance of the units and the lessons learnt from their operation
- A survey on the relevant software simulation tools
- A review of research projects on the field

A computer model has been developed for use by project planners and decision makers on a local level. The model allows the user to get also information on the water management options of the wider area. Thus, the decentralized solutions, like autonomous desalination units, are put into a general perspective and an assessment is given of their potential role in the integrated water resources management of the region. The software requires some climatic and water data as input and gives information on the general features of the main technologies for desalination based on renewable energy. Additionally, quantified results are given for the production capacity of each technology and the required size of the energy components.

Information has been collected on potential consumers of the fresh water produced from autonomous desalination units. On-site research has been carried out in the five target countries, Morocco, Algeria, Tunisia, Egypt and Palestine. Twenty consumer groups have been analyzed, four from each country. The consumers were selected based on specific predefined characteristics, mainly scarcity of fresh water and access to salty water and renewable energy resources. All results were compiled in one report.

A study of the financing mechanisms that could be used in small desalination projects was also performed. The study includes a description and comparison of the various financing schemes, evaluation of these mechanisms for financing autonomous desalination projects and case studies of renewable energy powered desalination practices, with special focus on Mediterranean Partner Countries. Conclusions and recommendations concerning ADU-RES financing strategies and mechanisms are drawn. Because of the similarity these projects have with the usual renewable energy projects, the research builds on the experiences acquired from the financing of small scale renewable energy projects in the target countries.

The potential for reducing the capital and running costs of installing and running small desalination plants powered by renewable energy has been studied. Two parallel actions took place, first the various components of the desalination unit have been analyzed theoretically and then the process has been simulated in a computer programme. The results of both actions were documented in a report while specific recommendations were summarised in a separate document.

The possible environmental impacts of small desalination units were analyzed. The possible gender, social and health effects have been also studied with on-site and desk based research. The results of these are under review and will be documented in a report.

The energy performance of existing units is closely monitored with the aid of a developed simulation tool. This will allow clear conclusions regarding the potential for improving the designs in this respect. Additional research is being performed to bring together the results from all previous work. All these will be collected and the conclusions will be collected in the “Guidelines for improved design”.

The legislative and institutional framework conditions in Spain, Greece, Morocco, Tunisia, Algeria and Jordan are being analyzed. Based on the results an “Action Plan” will be developed suggesting improvements of the framework conditions that will allow the wide-spread deployment of the technology in question. Additional similar analysis is performed in the level of the EU analyzing the relevant directives and programmes.

Acknowledgements

ADU-RES is supported by the European Commission under contract number INCO-CT-2004-509093. However, the views expressed herein are those of the authors and can therefore in no way be taken to reflect the official opinion of the EC.

NATIONAL WATER MASTER PLAN IN JORDAN

Suzan Taha, National Water Master Plan Director
Ministry of Water & Irrigation, Amman, Jordan

Within the Water Sector Planning Support project funded by the German Technical Cooperation (GTZ), a constellation of digital water balancing tools was designed, and implemented, in order to enable the Ministry of Water and Irrigation to carry out nation wide water balances based on the most recent data and various development scenarios, and therefore support efficient water sector planning.

The tools consist of (a) Eleven interactive modules for the assessment of the present water management situation and projection of water resources and demand; (b) A database for storing projected demand and resources data; and (c) A balancing module to balance the resources and demand for the entire Kingdom or selected parts of it, including a transfer module (to simulate the operation of transfer systems on national scale and assess the effect of transfer from surplus areas to water deficit on water balance) and allocation module to test the various allocation options   The Modules, which run through a GIS application, are linked to the ORACLE[1] water resources and uses databases and thus allow for the regular updating of the NWMP.

The Digital Water Master Planning tools, currently deployed at the MWI are used to assess water resources and demand projections. The National Water Master Plan is the key planning tool for the Jordanian water sector. It encompasses all aspects of Integrated Water Resources Management and aims at balancing water resources and demands temporally and spatially by the year 2020. Jordan’s current water situation is characterized by a big deficit, filled at the expense of an unsustainable use of renewable resources, such as groundwater mining. Use of alternative resources of water, efficiency gains, reallocation of resources between sectors and water transfers are the recommendations to mitigate that situation. These tools therefore assist in evaluating reasonable options and strategies to reverse water imbalances, and in managing and developing Jordan’s water resources.

[1] Relational Database Management System – RDBMS

THE MEDA WATER PROGRAMME

Gert Soer, Head of RMSU MEDA Water, Amman, Jordan

The official name of the MEDA Water programme is Euro-Mediterranean Regional Water Programme for Local Water Management.

The programme is part of the support of the European Union for the development of the water sector in the North African and Middle East (MENA) countries under the *MEDA Regional Indicative Programming.* The available budget for MEDA Water is € 40 million. From this amount, nine different consortia of non-profit organisations (NGOs, Universities and Government Agencies) receive grants up to € 5 million for the implementation of measures related to local water management.

The programme started in 2002 with a call for proposals. Out of more than 40 applications, 9 projects were selected for implementation. Implementation of the first projects started in May 2003 and activities will last until the end of 2008. The EMWIS project, though not financed from the MEDA Water programme but from the general MEDA budget, has important dissemination tasks with respect to the MEDA Water programme and is therefore also included in this brochure.

The programme intents to improve local water management conditions through co-operation of non-profit organisations from EU countries and non-profit organisations in the MENA countries, capacity building, construction of demonstration plants, technology transfer and creation of awareness. It aims mainly at three technical components, (i) water supply and wastewater reuse (in agriculture and in an urban set-up), (ii) irrigation water management and (iii) improvement of decision-making structures in irrigation, rural water supply and sanitation, and drought management.

Encouraging results have been achieved in all sectors mentioned above. Successes can be reported in many fields. Farmers increasingly manage their water resources themselves; villages now plan improvement of water availability and its use, and negotiate their investment needs with local, regional and national authorities; through clear guidelines and pilot projects wastewater reuse is becoming more accepted. North-South academic exchanges have taken place on a large scale on subjects such as drought management, wastewater treatment, wastewater reuse, autonomous desalination, irrigation technology, dissemination technology and others. The capacity of MEDA countries to solve their problems has therefore increased. Due to this, the European Commission now considers to implement a follow-up phase of selected Programme activities.

OVERVIEW OF THE DESALINATION TECHNOLOGIES POWERED BY RENEWABLE ENERGIES (RE)

Eftihia Tzen, CRES, Greece

Purpose and Scope of the report

Most of the Mediterranean countries exhibit significant Renewable Energy Sources (RES) potential. The coupling of renewable energy sources with desalination processes is seen as having the potential to offer a sustainable route for increasing the supplies of potable water. It is unlikely to solve the world's water problem in the immediate future but it does offer the potential of providing a sustainable source of potable water to some communities, particularly those in arid areas where there are no indigenous sources of fossil fuels. Detailed surveys of the already installed plants provide precious data and encourage the researcher to continue working on this field.

Description of the Work

The present work mainly concerns with small autonomous systems of the three most applicable technologies combination (solar thermal distillation, Photovoltaic-Reverse Osmosis, Wind Energy - Reverse Osmosis). Technically mature technologies reviewed are: solar thermal energy and distillation desalination process which include solar collectors coupled with Multiple Effect Distillation (MED) desalination process; photovoltaic and membrane desalination processes: photovoltaic (PV) coupling with Reverse Osmosis (RO); wind energy and membrane desalination process: wind energy conversion coupling with RO process; as well as wind energy and distillation process; wind energy and Mechanical Vapor Compression.

Several installations around the world are examined in detail. Technical characteristics, design data, lessons learnt as well as cost data are also presented.

Figure 1 presents the installations of the several desalination processes in conjunction with renewables, regarding small-scale systems. As it is obvious from the figure, the most popular combination is PV with Reverse Osmosis followed by wind.

Installations that examined were as follows:

- 2 seawater solar Multi Effect Distillation (MED) plants in Abu Dhabi and Almeria of 80 m^3/day and 72 m^3/day, respectively
- 1 seawater Geothermal MED plant of 80 m3/day in Kimolos island, Greece
- 1 seawater wind Mechanical Vapor Compression (MVC) of 50 m3/day in Pozo Izquierdo, Gran Canaria

- 2 seawater PV Reverse Osmosis plants of 120 m3/day and 9.6 m3/day in Lampedusa island, Italy and in Pozo Izquierdo, Gran Canaria respectively
- 2 brackish water PV Reverse Osmosis plants of 6 m3/day and 1.5 m3/day in Brazil and in Nevada, Colorado respectively
- 2 seawater Wind Reverse Osmosis plants of 12 m3/day and 19.2 m3/day in Loughborough Univ., U.K. and in Pozo Izquierdo, Gran Canaria respectively
- 2 hybrid (Wind, PV) RO of around 3 m^3/day for seawater desalination at Lavrio, Greece and for brackish water desalination at Maagan in Israel.

The cost of the several plants under study ranged from 3 to 9 €/m^3.

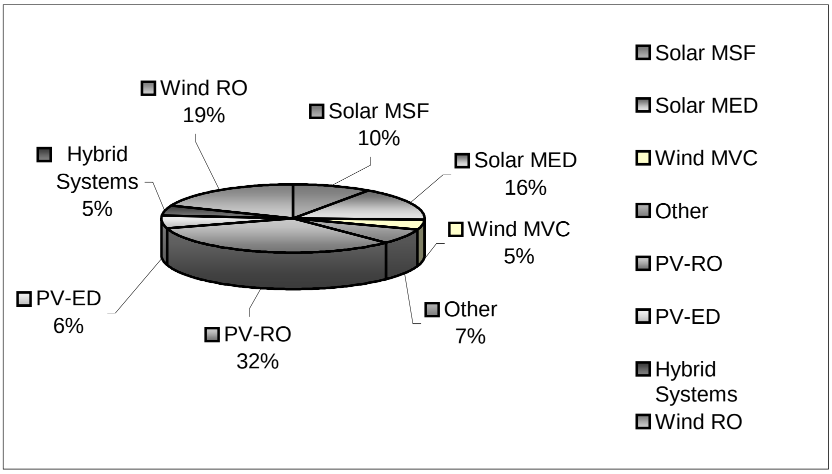

Fig 1. Desalination processes used in conjunction with RES

Most of the above plants have a sufficient operation. The most important issues that still existed are the requirement of the continuous operation of the desalination units and the variability of the RE sources, the use or not of energy storage system, the lack of efficient small energy recovery systems and the high cost of PVs.

The success of an installation has to do with the quantity and the quality of the produced water, the energy consumption and the final unit water cost. Following basic guidelines such as to choose the correct desalination technology for the required size or for the specific feed water quality (brackish or seawater), are the first steps for the success. The next steps have to do with the design of the RES desalination system, the selection of the proper equipments and the design and development of the control system.

Conclusions and Recommendations

As it is concluded there is much room for the improvement of RES desalination systems. What it is required is to accelerate the development of novel water production systems driven by renewables. In particular there is a need for much stronger effort on R&D and real installations in the Mediterranean area, Middle East and Africa; close collaboration between the R&D institutes and the industry as well as provision of reliable compact RES desalination devices by the market at a reasonable cost. Finally, the acceleration of information dissemination, education and training is also of vital importance.

COST ANALYSIS OF THE VARIOUS TECHNOLOGIES AND POTENTIAL FOR COST REDUCTION

Vicente J. Subiela, Water Department, Canary Islands Institute of Technology, Spain

Introduction

The fresh water scarcity is a very known problem, specially in dry and isolated areas. The use of autonomous desalination units (ADU) by renewable energy sources (RES) can be a viable solution at remote areas, where there is no access to the electricity grid, and the most available energy resource is sun and/or wind. Autonomous desalination systems are energetically independent; and have demonstrated their reliability in decentralized operation.

However, a higher penetration of ADU-RES greatly depends on the economic feasibility of these systems. A very relevant potential for cost reduction can be incorporated in future ADU RES systems, and there are many influent factors, as utilization of the appropriate solutions for the main components and proper design and sizing.

This paper presents data from real systems, indications about the most recommended actions for the reduction of costs in ADU RES systems and conclusions for future activities.

Data of ADU RES Systems

The Canary Islands Institute of Technology is a multidisciplinary R&D institution with a long experience in designing, installing, monitoring and testing ADU RES systems. The activity in this field started in 1995, with the installation of one RO unit connected to a wind-diesel system. Subsequently, different combinations of RE and desalination technologies were tested (cases with "*" are currently in operation):

- Wind energy connected to different desalination units:
  - RO: 2 systems (15* and 200 m3/d),
  - EDR (200 m3/d) and VVC (50 m3/d): 1 system
- Solar distillation:
  - Humidification / dehumidification (1 system), 100 L/d
  - Membrane distillation* (2 systems, 100 and 1,200 L/d)
- PV driven RO systems*:
  - 2 systems for seawater (with and without batteries) 400 L/h and 1,500 L/h
  - 1 system for brackish water (50 m3/d).

The next table shows a summary of the most relevant operating systems with the main technical and economic data.

Location	*Operation year*	*Power option*	*Desalination process*	*Water salinity (ppm)*	*Water production Capacity*	*Estimated Cost (€/m^3) (10-year life time)*
Ksar Ghilène (Tunisia)	2006	PV	RO	5,700	50 m3/d	5
Pozo Izquierdo (Spain)[2]	2000	PV	RO	35,000	400 l/h	15
Pozo Izquierdo (Spain)	1999	Wind generator	RO	35,000	15 m3/d	9

After analysing data from the pilot testing projects, some remarks can be made regarding the most influent factors on the cost of ADU RES systems:

- *Quality of feed water:* the level of dissolved solids is especially relevant; the higher salinity, the higher required operation pressure (case of RO) and, consequently, more RE power would be demanded.
- *Availability of RE resources:* The local availability of RE (solar, wind…) will strongly affect to the size of the power supply system; for example, in the case of PV, the less solar peak hours, the larger required area of panels.
- *Local costs:* Specific local circumstances as labour, land or transport costs will affect to the final cost of the system.

Potential for costs reduction

A deep analysis of cost reduction strategies has been carried out within the ADU RES project for the PV-RO option. The concluded most relevant factors can be described as follows:

- Design of the system adapted to the specific local conditions (raw water characteristics, environment…)
- Good selection of components (materials and equipment): high efficiency and selection of the optimal ratio quality/cost
- Use of energy recovery and energy storage systems

Conclusions

The reduction of costs in ADU-RES systems is a key factor for the future development of this technology as a reliable contribution to the water shortage problem in remote areas. Consequently, it is necessary to promote the R&D activities in improving design and operation of these systems, to achieve better final costs and a progressive movement from

[2] Facilities of ITC

pilot to operating systems. Additionally, ADU RES systems can contribute to encourage the joint projects and links between Europe and ME countries.

IMPACT ASSESSMENT: GENDER, ENVIRONMENT, HEALTH AND SAFETY ISSUES

Ayman Rabi, Natasha Carmi and Subha Ghannam[1] and Abdel Karim Saadi[2]
[1] Palestinian Hydrology Group, West Bank
[2] Centre de Développement des Energies Renouvelables, Algeria

"Impact Assessment: Gender, environment, health and safety issues" is the title of work package five within the ADU-RES project; the objective of which is to set out a comprehensive agenda for gender, environmental, public and safety impact issues of ADU-RES technologies, and to encourage holistic ADU-RES plant design.

The main *hypothesis* upon which the work was based was that ADU-RES will generally have a positive impact on most of the sectors to be discussed. A report on social and environmental impact of autonomous desalination units was produced including literature review as well as case studies in selected southern Mediterranean countries characterized by similar arid and semi-arid climate. The literature review included impacts of both general desalination plants and ADU-RES systems. A questionnaire was prepared and randomly distributed in areas with renewable energy resources, brackish and seawater resources, and severe fresh water scarcity problems.

The 151 questionnaires mainly gathered information related to socio-economic conditions, present costs and quality of the water consumed, accessibility to water resources, water borne diseases and willingness to pay for and use desalinated water. Based on the report, the work package provided recommendations that will assist in the further development of integrated plant designs. ADU-RES systems can play an important role in providing fresh water for small communities and hence improve their living conditions providing adequate measures for brine rejection. Solutions for adverse effects need to be investigated locally with the participation of users and local community. In addition, ADU-RES systems need to be designed to meet the specific environmental conditions in which they operate.

Finally, given that application of ADU-RES systems in the southern Mediterranean countries is limited, it is necessary to ensure funding for continuous regional research in relation to a reduction in their operational costs and their adverse affects on the environment.

ACTION PLAN FOR AUTONOMOUS DESALINATION UNITS BASED ON RENEWABLE ENERGY SOURCES (ADU-RES) IN JORDAN

Mohammed Saidam, PhD, Environment Monitoring & Research Central Unit
Royal Scientific Society – Amman, Jordan

Jordan is a water scarce country that is in dire need for augmenting its water resources. Opting for desalination has been slow somehow in Jordan. This is attributed to the high costs entailed for desalination and the low water tariffs in the country. However, this is changing rapidly now as water scarcity is becoming more acute. The construction of 55 MCM surface water desalination plant is a strong indication of how the water sector in Jordan is adapting to this treatment technique. At present, most installed desalination plants are owned and operated by the private sector for irrigation purposes. Experience in Autonomous Desalination Systems (ADS) is at its infancy in the country. Only one desalination unit is operated by photovoltaics in Aqaba.

Jordan imports its energy needs which currently amount to six million tones of oil and is expected to double every 15 years. With soaring oil prices, the country is striving to find alternatives. More emphasis is being made on renewable energy (RE) sources as a potential alternative. Renewable energy sources are given second priority only to energy conservation and demand management. Solar thermal energy has been widespread for decades and other forms are getting increasing attention e.g. wind, biomass and hydropower. Renewable energies are considered indispensable in achieving sustainable development since they are considered as the least long-term cost option for energy and water security. However, it is realized that more actions are needed to achieve that. Prudent policies are needed to create an enabling environment for the expansion of renewable energies. Decision makers, planners, engineers and scientists in the water and energy sectors need to work more closely together.

The objective of this Action Plan is to introduce ADU-RES as an instrument of augmenting water supply through presenting findings on successful set-ups, cost reduction, environmental and socioeconomic aspects and integrated plant designs. An analysis of policy and institutional framework favorable settings that are vital to accelerate the adoption and implementation of ADU-RES is also presented.

ADU-RES can be of great potential for Jordan as water transport and supply expenses are rising. In concept, ADS advocate decentralized management which is conducive to the promotion of subsidiarity and sharing the responsibility. In turn, this can allow for a better participatory approach which can lead to the acceleration of water augmentation and service provision. Such systems are certainly more sustainable and are more environmentally friendly as they use RE sources. This makes them more conducive to water safety and security. Nonetheless, ADS still need to be further developed to render them more robust and less costly.

From a technical perspective most plants constructed to date have been either as research or demonstration projects. Coupling desalination with an RE source is technically feasible, but is complex since desalination processes are best suited to continuous operation but renewable sources are non-continuous.

There is much room for the improvement of renewable energy driven desalination systems and thus there is a need for much stronger efforts on R&D and real installations.

Cost considerations remain the major challenge in adopting ADS. Short-term local cost reduction possibilities include the local manufacturing of components and spare parts required on a regular basis. A more rigorous and detailed analysis of entailed cost should be carried out locally. There are various appropriate integrated designs that exist worldwide. However, the most appropriate set-ups have to be worked out locally.

From an environmental viewpoint ADS constitutes a more sustainable option and better water safety and security compared with conventional desalination. However, brine disposal is likely to need more regulatory and control measures. Socio-economically, although it enhances the participatory approach, the impact of public-private configurations on consumers should be carefully checked.

The importance of desalination as a water augmentation option has not been reflected in Jordan's water policy, especially using renewable energies. Thus the introduction of institutional & policy reforms conducive to promotion of ADU-RES is required. Introducing a water pricing policy especially for rural areas rather than just applying national water tariffs seems to be the better approach. It should also allow for the development of special financial schemes, including supplier credits, leasing and micro-financing arrangements. Other promotional efforts include tax exemptions of renewable energy equipment and encouraging local participation in water planning, development and management.

It is necessary to create a knowledge base through the development of educational and research programs considering technical, socio-economic and environmental aspects. Training of local engineers and technicians and knowledge transfer through workshops and seminars are indispensable in creating the ADU-RES knowledge base. This should in turn help in the adaptation of the appropriate ADU-RES set-ups to suite prevailing local conditions.

Several measures and actions are needed in order to support concrete project implementation: these include the introduction of the legal, regulatory and organizational framework with the participation of pertinent stakeholders and capacity building programs. Easing of administrative procedures, encourage water and energy specialists to work more closely together and creation of public-private partnerships to mobilize funding and investment into ADU-RES. Subsidies should gradually be reduced and vulnerable communities should be protected. An enabling environment should be created whereby small size industries and local workshops can assemble and / or manufacture parts of ADU-RES that are most regularly used.

It is equally important to ensure good practices through acclimatization and further development of ADU-RES. This is in order to address local cost and environmental concerns. It is also necessary to institute procedures to select appropriate types of ADU-RES set-ups. Monitoring and evaluation of the impact of brine disposal are critical to ensure good practice. Also, it is necessary to facilitate access to state funding as a short-term measure, support low-income communities and enhance water demand management programs.

ACTION PLAN FOR SOLAR AND WIND DESALINATION IN TUNISIA

M. T. Chaibi, Institut National de Recherche en Génie Rural, Eaux et Forets, Tunisia

In Tunisia, the potential water resources are of about 4670 $Mm^{3/}$year, of which 550 Mm^3 are not renewable. This potential presents a greater regional disparity as regards quality and quantity aspects. The centre part of the country is considered as the poorest region on water. Tunisia is rapidly approaching full utilization of its available water resources and the scarcity of water resources is even more acute as the possibilities of developing new sources are limited and their costs are increasing.

Regarding Tunisia energy sources, the decline of the production of the hydrocarbons and the rapid growth of the local demand in energy products have moved the energy sources from exceeds of an energy balance to a slight balance deficit position. Henceforth, Tunisia is obliged to import a part of its needs in energy.

Tunisian future plans call for a reduction on reliance on imports and for increased emphasis on conservation and renewable energy as well as water management and new water sources development. The growing need to find solutions to the problems of fresh water supply in arid rural areas of the country has driven the government to seek for the potential for autonomous desalination units based on renewable energy sources (ADU-RES) concepts in alleviating water stress and for issues to incorporate renewable energy sources desalination in water policy and development program

ADU-RES strategy is considered not enough investigated and analyzed to be incorporated in the global scale of water policy as priority is going towards the water saving and catchments management and the intensification of the water demand management The promotion of the potential for desalination using alternate energy sources is in need of major improvements regarding the comprehensive institutional and policy reforms and the creation of knowledge basis areas.

The Tunisian action plan calls for a strong effort to accelerate the opening of renewable energies market for the desalination systems, help rural water consumers to have a choice regarding their water supply, and put in place better systems to deliver and finance ADU-RES systems. This plan intends to base its efforts to provide better access to ADU-RES for rural people on five principles:

- Pricing policy to improve water supply
- Financing and lowing capital and operating cost
- Encouraging investments and investors
- Upgrading institutional aspects
- Create knowledge basis

The continuous updating of Tunisian national ADU-RES water policies, as regard institutional and policy reforms, is highly needed to support the development of ADU-RES systems.

ASSESSMENT OF EU POLICY: IMPLICATIONS FOR THE IMPLEMENTATION OF AUTONOMOUS DESALINATION UNITS POWERED BY RENEWABLE RESOURCES IN THE MEDITERRANEAN REGION

Michael Papapetrou and June Gibbons, WIP – Renewable Energies, Germany

Purpose and Scope of Report

The Mediterranean is a region where water is scarce and unevenly distributed. Access to sufficient fresh water is a factor limiting economic development, while overwhelming demand for existing supplies has negative environmental and social effects. Desalination water treatment is one solution to providing sufficient fresh water to populations in arid areas.

Small-scale autonomous desalination systems (ADS) provide small volumes of freshwater via distillation or membrane technologies in combination with a renewable energy source such as a wind turbine, or photo-voltaic cell array. ADS are therefore ideal for implementation in arid or semi-arid regions like the Mediterranean, especially in remote coastal and inland locations. ADS are now technically feasible but need further impetus to begin commercial scale implementation.

EU legislation and policy is relevant to the commercial implementation of ADS for both member states and non-member states in the Mediterranean region. Relevant policy subjects include: drinking water, environmental and water management, energy, external relations and sustainable development, and financing.

Policies Considered

EU policies that are considered relevant to the implementation of ADS in the Mediterranean include:

- EU Water Framework Directive;
- EU Drinking-water Standards;
- EU Water Initiative including EUWI-MED and EUWI/WFD Joint Process;
- EU Energy Directives and Energy Charter Treaty;
- Euro-Mediterranean Partnership (Barcelona Process) including MEDA and FEMIP finance;
- European Neighbourhood Policy and ENPI finance;
- EU general budget 2007-2013 including 7th Research and Technology Framework and LIFE+ finance.

Discussion

EU policy shows limited direct support for the implementation of ADS as well as more widespread indirect support. Direct support is found in such programmes such as the EU Water Initiative and the Euro-Mediterranean Partnership with explicit objectives to increase non-conventional water supply. Indirect support for ADS can be found in policies such as the Energy Directives, EU Water Framework Directive, and European Neighbourhood Policy where objectives of sustainable development, reduced regional disparity, and enhanced security and trade provide a supportive framework for implementing ADS in the region.

Barriers to ADS implementation are also present in EU policy. Generally this results from not considering ADS technology rather than any outright opposition to ADS. Barriers can be found in the Drinking-water standards, EU Water Framework, and energy policy. Barriers can be reduced by excluding ADS from certain requirements of water policy, or by specifically including it into energy policy.

- The EU budget is under review for the 2007-2013 period. ADS implementation can be financially supported from a number of sources in this new budget. The most important are the new European Neighbourhood and Partnership Instrument (ENPI) and the 7^{th} Research and Technology Framework. The current transition period is an ideal time to ensure that ADS implementation becomes a funding priority in the Mediterranean region for the coming years.

Conclusions

Water scarcity is a high-profile political issue within the Mediterranean region however this is not generally reflected in the wider EU policy framework. The ADS research community needs to become more organised in order to implement this new technology by raising political awareness within the EU; not only for the technology itself but more importantly for the benefits it can bring to isolated water scarce areas. Specific recommendations on what to amend within EU policy are contained within the report, but efficient implementation will require the creation of an industry representative or lobby group.