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Co-ordination action for autonomous desalination units based on renewable energy systems — ADU-RES

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Abstract

Many arid regions in Mediterranean countries have a great potential to cover their water needs with autonomous desalination units powered from renewable energy systems. The Coordination Action ADU-RES develops further integrated designs of renewable energy based desalination units and formulates political strategies for boosting the implementation of such units in the Mediterranean. The highly experienced consortium comprising institutes and organisations from 5 EU and 8 Mediterranean Partner Countries (MPC) will develop guidelines for overcoming remaining technical barriers and will elaborate policy recommendations for improving the framework conditions for sustainable and decentralised water supply. The dissemination strategy will enhance the public awareness with comprehensive documents and Internet portals. Finally, the action outcomes will be compiled in a specific exploitation plan, based on the dialogue between the industry, policy and research community on the scheduled workshops.

Keywords: Decentralized water supply; Autonomous desalination; Mediterranean; Renewable energy; INCO-MPC

1. Introduction

By 2025 water demand for domestic and industrial use is projected to increase by more than 50% [1]. In particular, the southern and eastern Mediterranean countries are anticipated to be consuming more than 50% of their renewable

water resources by that year, with at least 8 of them using all of their renewable resources [2]. This overexploitation causes seawater infiltration into the aquifers and the deterioration of entire ecosystems and thus endangers the livelihood of the entire region. This looming water crisis has boosted the implementation of desalination technologies. Large-scale implementations of various

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technologies already are applied in many arid regions of the world particularly in the oil producing countries of the Middle East. In recent years intense research work has been performed on small-scale systems for decentralised water production.

All desalination systems are highly energy intensive. Decentralised systems require only small amounts of energy for water transportation, the water cleaning process itself however is very energy intensive and might consume more than 10 kWh for every m³ of fresh water [3]. Many arid regions of the world, like the Mediterranean countries, have poor conventional but abundant renewable energy resources. Therefore, autonomous desalination units (ADU) based on renewable energy systems (RES) are a highly feasible solution for these regions.

ADU-RES is a Co-ordination Action, funded by the EU INCO MPC programme. Its consortium involves partners from many Mediterranean Partner Countries (MPC) as well as institutes and SMEs from the EU which are specialised in the desalination and renewable energy systems. The Action started on the 1st of April 2004 and will be completed by October 2006. This paper outlines the objectives of ADU-RES and presents the consortium members. Then, the main ADU-RES activities and the expected results are summarised.

2. Objectives of the co-ordination action ADU-RES

2.1. Further development of R&D

In recent years, the research community worked intensively on coupling desalination systems with renewable energy technologies in robust and cost effective autonomous small-scale desalination units (see for example [4–6]). While both components of these set-ups are mature technologies in themselves, few commercial products in combination of those are available. Additional research and development challenges remain, before large-scale implementation will be

possible in arid regions like the Mediterranean basin. The major requirements are:

- *Radical cost reduction:* Decentralised desalination systems have to drastically reduce costs on investment and maintenance for being able to compete with other non-conventional water sources (e.g. waste water recycling, water imports).
- *Advanced management and control system:* The unsteady power supply from renewable sources must be balanced against the constant energy demand of the desalination unit by an advanced management system
- *Long-term reliability:* The coastal climate conditions, particularly salinity, places high demands on materials. Moreover the systems must be easy to maintain and supported by effective local maintenance services.
- *Energy efficient components:* Most desalination technologies as well as the pre-treatment units are developed for a grid-connected operation. The systems are designed for low overall costs rather than for maximum energy efficiency.
- *Environmental needs:* The systems must be modest in their demand of land, which is particularly precious in coastal regions. Inland desalination requires environmentally sound brine disposal.

ADU-RES, focusing on those challenges, is working to develop further integrated plant designs for mature and cost efficient autonomous desalination units based on renewable energy systems. The action will bring together the existing R&D work and the results of own technical, economic, social and policy research to design and present specific guidelines for ADU-RES plant construction

The scientific and technical objectives of the Coordination Action are summarised in Table 1.

2.2. Formulation of policy initiatives

The implementation of RES based desalination

Table 1
Scientific and technical objectives of ADU-RES

	PV-RO	Wind-RO	Solar distillation
Cost reduction	Use of thin-film amorphous silicon cells	Reliable small wind turbines	Cost effective collector by system and material optimisation
	Minimise energy storage requirement (batteries) Efficient brine-stream energy recovery Development of cost effective hybrid system		
	Chemical pre-treatment minimisation Storage without disinfection Optimisation of efficiency of pumps		
Advanced control and management systems	Efficient maximum power point tracking	Rapid response to wind variation	Use of hybrid heat sources
	Control to achieve optimum use of variable power		
	Simplification of energy storage (e.g. storage of water not of electricity)		
	User-oriented interfaces for effective maintenance		
Long term reliability	Minimisation of membrane scaling and fouling Maximisation of pump service life		Ensuring long term vacuum in vacuum tube collectors by one-piece manufacturing
	Minimisation of maintenance needs		
Environmental needs	Using high-efficiency PV modules to reduce use of land		Reducing land use by highly efficient vacuum tube collectors
	Minimisation of added chemicals in brine		
	Brine disposal for inland applications		

units is partly hindered by unfavourable socio-economic framework conditions: In many regions conventional and environmentally harmful water supply, like groundwater wells, is heavily subsidised while no public support can be found for autonomous desalination units. Further on, questions like capacity building for the system operators and the users, adequate infrastructures for spare parts, acceptable and realisable payment schemes and clear ownership concepts are missing. Moreover, state monopolies on both the water and energy sectors form an unfriendly environment for independent producers.

As a first step, representative Mediterranean regions with high demand for decentralised desalination units will be selected and their socio-economic and political framework conditions will

be analysed in detail. Based on this analysis, a political strategy to boost decentralised renewable energy based desalination units will be developed. At the same time, the relevant EU legislation will be scrutinised, namely all relevant EU Directives like the Water Framework Directive and Action Plans like the “Water for Life” initiative. The simultaneous development of political strategies for representative regions and the analysis of the EU programmes will result in clear and concise recommendations for development of autonomous desalination units.

2.3. Political dialogue and dissemination

The Co-ordination Action intends to reach policy makers and think tanks, providing them

with an invaluable source of expert analysis and recommendations for the promotion of autonomous desalination units. At the same time widespread circulation of reports, papers, methodology and guidelines amongst the research and industry communities will initiate and maintain a fruitful interdisciplinary dialogue on the issue. Additionally, the main objective of ADU-RES is to create widespread public awareness of the co-ordination action's activities.

These dissemination actions in combination with the technical and policy work mentioned above will lead to the creation of international consortia for the exploitation of design concepts and plans developed within ADU-RES.

3. Consortium

All project work is supported by the excellent knowledge basis accomplished by the consortium partners in numerous R&D actions. The consortium consists of specialists in the field of water desalination and autonomous power supply sys-

tems. All relevant research topics are covered by at least one partner from the consortium. Furthermore, the partners have vast experience with field installations, which assures a high degree of dedication of the research work to practical needs and requirements. In Table 2 all the project partners are shortly presented.

4. ADU-RES activities and expected outcomes

1) Knowledge on relevant R&D actions is shattered between institutes and companies in EU and the Mediterranean.

ADU-RES will compile relevant data in comprehensive and well-structured documents and Internet portals.

2) There are basic technical requirements which have to be fulfilled before the commercial implementation of the technique is possible. These requirements are:

- Drastic cost reduction
- Improved reliability
- Advanced control and management systems

Table 2
Project partners

Participant name	Participant short name	Country
Agricultural University of Athens	AUA	Greece
Centre de Développement des Energies Renouvelables	CDER	Algeria
Centre for Renewable Energy Sources	CRES	Greece
Earth Link and Advanced Resources Development	ELARD	Lebanon
EC Joint Research Centre – Institute for Environment and Sustainability	JRC	EU
Egyptian Association for Water and Energy	EWE	Egypt
ETA – Renewable Energies	ETA	Italy
Fondation Marrakech 21	FM 21	Morocco
Fraunhofer-Institut für Solare Energie Systeme ISE	FhG-ISE	Germany
Institut Agronomique et Vétérinaire Hassan II	IAV	Morocco
Instituto Tecnológico de Canarias	ITC	Spain
Loughborough University	CREST	United Kingdom
National Institute of Rural Engineering, Water and Forestry	INRGREF	Tunisia
Palestinian Hydrology Group for Water and Environmental Resources Development	PHG	Palestinian Authority, West Bank
Royal Scientific Society – Environment Monitoring and Research Central Unit	RSS	Jordan
WIP – Renewable Energies	WIP	Germany

ADU-RES will design guidelines with recommendations that will contribute in the progress towards those objectives.

3) Issues related with the environmental and social impacts of any activity are usually neglected causing harm to the environment and opposition of local populations

ADU-RES will focus its research on any potential environmental, gender, health and social aspects of decentralised desalination.

4) The awareness for the technical options and the socio-economic barriers of RES based desalination units is rather limited between stakeholders in utilities, industry and policy

ADU-RES will enhance the awareness for the desalination based on renewable energy sources namely with the organisation of 3 events:

- First one, in parallel to the European Conference on Desalination and the Environment, Morocco, May 2004 which will be dedicated to the presentation of consortium research activities
- A seminar that will take place in Tunisia in April 2005 and will be dedicated to the presentation of ADU-RES related research results
- The third event will take place in Jordan in March 2006 and will be dedicated to political decision makers

5) Practical implementation of autonomous desalination units is hindered by the lack of adequate financial resources

ADU-RES will research and define appropriate financial options and will raise awareness among investors and financial institutions

6) There are no commercially operated demonstration sites for decentralised desalination units in the Mediterranean. Such demonstration sites would raise the trust in the maturity and efficiency of decentralised desalination units.

ADU-RES strives to stimulate the in detail planning of commercial size desalination units based on renewable energies in the Mediterranean.

5. ADU-RES outlook

ADU-RES is an interdisciplinary action with crucial innovative characteristics. Researchers from EU and MPC will come together to revise the state of the art and perform original, targeted research. A well-designed work-plan ensures the optimum exploitation of the synergies between the technical and socio-economic work that will be carried out. The Coordination Action ADU-RES has just started and is inviting all relevant stakeholders to take part in the wide dialogue and contribute in the preparation of concrete implementation plans of pilot desalination units.

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