



A strategy for the introduction of desalination powered by renewable energy in Jordan

Hazim Mohameed Qiblawey^{a*,c}, Michael Papapetrou^b, Fawzi Banat^a

^aDepartment of Chemical Engineering, Qatar University, PO Box 2713, Doha, Qatar

Tel. +974 4 852192; Fax: +974 4 852491; email: hazim@qu.edu.qa

^bWIP, Renewable Energies, Sylvanstr. 2, 81369, Munich, Germany

email: pmp@wip-munich.de

^cDepartment of Chemical Engineering, Jordan University of Science & Technology, PO Box 3030, 22110 Irbid, Jordan

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ABSTRACT

Within the ADIRA project (www.adira.gr) a strategy has been developed facilitating the up-take of desalination powered by renewable energy in Turkey, Morocco, Jordan and Egypt. This strategy has been documented in a central report called the “Master Plan for the Wide Implementation of Autonomous Desalination Systems in Turkey, Morocco, Jordan and Egypt”. In this paper the work and results for Jordan are presented. The work methodology included planning of the process, with definition of five sections for the strategy and the information needed for the assessment of the current situation of the country. A literature review was then conducted to find out what relevant information was already collected and classified by others. In the next stage, research was conducted to identify and gather all relevant information, like legislation, prices, cost figures, administrative procedures etc. Interview with key stakeholders took place after that in order to fill the information gaps and to find out how things work in practice. In the end the information was evaluated and analysed. Recommendations have been developed for action by the Autonomous Desalination Community that will facilitate the improvement of the framework conditions for the implementation of concrete installations.

Keywords: Strategy; Autonomous desalination; Renewable energy; Jordan

1. Introduction

On a per capita basis, Jordan is one of the most water scarce countries in the world. For fulfilling the current needs, the full potential of surface and ground water needs to be tapped to the limit of technical feasibility, respecting the social and environmental constraints.

The objective of this report is to develop clear recommendations for improving the conditions for implementing an Autonomous Desalination System (ADS) in Jordan. The implication of the existing conditions for ADS will be discussed through the following five sections: relevant policy and programs, legislation and administrative issues, water prices and subsidies, institutional framework of the water sector and capacity building. In each section, a presentation of the current situation is given first and then the implications, positive or negative, are analyzed

*Corresponding author.

for the implementation of ADS. Clear recommendations are developed for improving the framework conditions to foster ADS implementation in Jordan. At the end of each chapter the recommendations are presented [1].

2. Relevant policy and programs in Jordan

2.1. Water policy and programs

A World Bank report from 2006 [2] noted that Jordan was one of the best reformers within the region and also in comparison with other middle-income countries. The report emphasized reforms of the energy and water sectors as being particularly strong in creating a modern institutional and regulatory framework.

The Ministry of Water and Irrigation (MWI) has created an action plan in order to address two main goals. The first goal is an efficient administration to ensure that water sector development proceeds in the light of national socioeconomic needs and environmental and sustainability implications. The second goal is legislation allowing private sector participation and compliance with the set national development objectives. This action plan takes into consideration the following policy guidelines [3]:

- Protection of surface and groundwater by very efficient use of resources.
- Efficient management of urban water and all environmental and irrigation aspects relevant to the water sector.
- Development of appropriate institutional capacity building and legislative framework for water management.
- Efficient and sustainable management of utilities by further involvement of the private sector.
- Further enhancement of efficient financial management, accounting and controlling tools in the utilities.
- Intensified donor coordination.
- Introduction of socially acceptable cost recovery tariffs for all types of water use depending on the quality and quantity of water consumed.
- Fostering regional cooperation.

The action plan identifies the major structural and policy reforms required for the sustainable development of the water sector nationwide. The plan also provides an excellent basis for common understanding between the Jordanian Government and the various donor agencies on key issues.

2.2. Energy policy and programs

Energy forms a very difficult challenge for Jordan because of the lack of local energy resources and the great need for energy for social and economic development. In light of this situation and the social and economic

development plan which is being implemented to improve the quality of life for Jordanian citizens, it is expected that the demand for energy will grow to high levels reaching 3% growth annually for energy generally and around 6% growth annually for electric consumption specifically. This situation pushed the energy bill in 2006 to constitute 18.9% of the gross domestic product and around 52.2% of the value exported goods. This is considered by international standards as a heavy burden on the economy in addition to the burden of investing in energy production, refining, transport and distribution [4].

Energy planning and policy is under the Ministry of Energy and Mineral Resources (MEMR). MEMR helps to create national energy policy however most of its work is practical: implementing national policy, overseeing companies in the energy sector, and assisting private sector involvement in projects.

The Government of Jordan developed an overarching energy policy in 2004 called the Energy Master Plan [5]. Although much of it deals with securing supplies of oil and gas, there is a section aimed at developing domestic energy sources which includes renewable energies. The Master Plan also promotes private sector investment in energy supply and markets. It notes that investment opportunities exist in developing wind power and solar energy for power and domestic heating. It is planned that the renewable energy contribution will reach 3% of the overall energy mixture by the year 2015. In order to develop and improve the renewable energy resources, several studies have been launched. One of the most prominent studies is one that involves removal of the impediments facing the renewable energy.

The MEMR 2005 Annual Plan [6] lists a number of programs and initiatives in the renewable energy (RE) sector.

2.2.1. Solar energy

MEMR has helped prepare a study on the economic feasibility for providing remote villages with electrical light by using RE sources in cooperation with the Canadian RSW Company and the Jordanian Rural Electrification Project. Currently funds are being raised to implement a first pilot project. The National Energy Research Centre (NERC) carries out several solar projects like the operation of 22 PV plants for pumping water from desert wells or the installation of a water desalination plant powered by PV within the Aqaba International Industrial City in cooperation with the US Renewable Energy Laboratory.

2.2.2. Wind energy

There are plans to expand the two existing wind power sites, the Hofa and Ibrahimiya plants, which are run by

the Central Electricity Generating Company (CEGCO). Also a study of the wind characteristics at 15 sites in Jordan was undertaken in association with the COWI Company of Denmark. The best two sites will be further investigated for concrete project implementation and used for training local engineers and technicians.

2.3. Implications for the implementation of ADS

In the water sector, the search for non-traditional water resources has reached advanced steps in Jordan. But the search for alternative energy resources in the energy sector is still lagging. Studies about the RE in Jordan are still in the early stages and several years are needed to obtain results in this field.

To foster ADS in the Kingdom, it is important to create a RE framework as there is currently nothing in existence. The studies supervised by the Ministry of Energy (ME) will help as they will create a network for measuring the characteristics of the wind and solar energy in promising areas and drawing detailed climatic maps to assess the solar and wind energy sources. Work is also needed to help with identifying the technical and legislative obstacles facing renewable energy and drawing up a policy for renewable energy along with, eventually, draft legislation for RE.

In Jordan there are many tourist sites around the country. Some of those places are of important historic interest, but they are small in size, and the tourists spend only a short time in such places. Many of these are in the desert area and they are wide distances from each other. Examples include Qasr Al-Hallabat, Qasr Al-Humaima and Um-Alrassas. The operating costs for such small sites are high and providing them with water and electricity increases the cost. An alternative is to use ADS, which will make the preparation of such places more favorable for the government from a cost point of view and it will have a good impression on tourists by supplying both energy and water from an environmentally friendly method.

From our point of view, adopting ADS will be very helpful for Jordan to accelerate the use of RE resources and give the flexibility to explore more non-conventional water resources.

2.4. Recommendations

Current policy trends in the water and energy sectors for private sector involvement should be strengthened and followed-up by ADS operators.

- Energy policy should promote RE resources as an alternative to petroleum and gas.
- Allowing private electricity generation from RE resources will encourage ADS implementation.

- Implementation of ADS sites will help achieve the Energy Master Plan goal of 3% RE by 2015.
- The NERC related to the Ministry of Energy should be supported as it could play an important role in implementation of ADS in the country.
- Small isolated tourist sites are prime candidates for ADS water supply

3. Legislation and administrative issues in Jordan

3.1. Relevant legislation

3.1.1. Supply and quality of drinking water

In accordance with the Water Authority Law No. 18, 1988 and its amendments, the Water Authority of Jordan (WJA) monitors drinking water in order to “ascertain the safety of water and wastewater structures, public and private distribution”. This activity is performed by the Drinking Water Quality Monitoring Department at WAJ laboratories. Water quality is regularly monitored before and after treatment in order to safeguard public health as part of a quality assurance program [7].

As for quality control, the Ministry of Health also monitors drinking water. If any deterioration in quality is observed, the Ministry of Health (MOH) informs WAJ so that the situation is rectified and precautionary measures can be taken to prevent a reoccurrence.

3.1.2. Groundwater drilling legislation (underground By-Law 2002)

The By-Law No. 85 of 2002 Underground Water Control By-Law regulates the conditions for groundwater well and drilling. The license to drill a well is carried out under the supervision of the relevant water authority and a pumping test must be performed. The well production capacity and the water quality are then determined, and an extraction license is issued in which the annual allowed pumping quantity and the rates are defined. Distances between wells must be at least 1 km and more than 3 km from the nearest spring. Wells can be closer to springs than 3 km if a written guarantee is provided that the well will not affect the average output of the spring. If an impact is found, then the license will be cancelled and the well filled in.

The use for the water is specified in the water extraction license, and unless prior written approval is obtained, it is prohibited to irrigate any land other than that specified or to sell the water for irrigation purposes, or to sell the water extracted for drinking purposes.

3.1.3. Brine disposal legislation

Brine disposal comes under the Protection of the Environment Law No. 12 of 1995. This law established an

official environmental agency, the Corporation for the Protection of the Environment (CPE), in order to implement environmental policy in cooperation with other Jordanian agencies (Art. 16). Specifically for water, the CPE must create a set of standards that govern water use and must check water sources for any pollution (Art. 17).

Article 26 of the Protection of the Environment Law prohibits the dumping or disposal of harmful substances close to water sources. Penalties include fines or imprisonment, as well as the rectification of any damage. The Protection of the Environment Law 1995 also sets up the Standards and Specifications Corporation which undertakes all the technical work and sets standards for the CPE. One of the standards related to brine disposal is the Industrial Wastewater Standard Specification, Jordanian Standard, No.202 of 1991, 2nd edition. This defines the quality standards of treated effluents which can be reused or safely disposed. The maximum salinity levels of effluent depend on its final destination:

- to be recharged to wadi with maximum salinity of 3000 ppm
- for reuse in agriculture, industry etc., with maximum salinity of 2000 ppm
- to be used for artificial groundwater recharge with maximum salinity of 1500 ppm

Reclaimed water may be discharged to streams or wadis as long as it meets water quality standards. However, there are limits to this: wadis which drain to the Gulf of Aqaba may not receive reclaimed water; disinfection must take place if it is likely that the public may have direct contact with the reclaimed water, and measures must be taken to prevent any leakage of this water into aquifers.

3.2. Energy sector legislation

The General Electricity Law, No. 64 of 2002, is a “Temporary Law” which regulates the energy sector in Jordan. It set up the Electricity Regulatory Commission which has the following powers:

- To license, regulate, and set tariffs for the generation, transmission, supply, distribution and system operation of the electricity sector in order to provide reliable services in an economic and technologically efficient manner.
- Assist the implementation of environmental standards for electricity generators.

Article 28 prohibits the construction or operation of electricity generation. There are some exceptions however which include: construction or operation of small generators under 1 MW construction or operation of small transmitters under 100 kW peak demand.

3.3. Required licenses

Official permission is required for drilling a well. A short application form is submitted to the Directorate of Well Licensing which is part of the WAJ central office in Amman. Applicants must submit evidence to show that they own the land where the well will be drilled. A fee of 50 JD is paid for a well inspection and report. It takes between one and three weeks to get approval from the WAJ. Following approval, the applicant pays further fees.

Another license is required for trading drinking water from the well. An application form should be completed and submitted to the local WAJ office. There are no fees for this process. The applicant should contact the MOH to complete the process. A separate license from the MOH is required in order to have an outlet for selling the water to the customers. The applicant should present the details of water desalination (purification) process, analysis of the source water and the location of the outlet.

Energy produced from photovoltaic sources needs no license as long as the energy generated is not traded or distributed and used only for the ADS unit. Electricity generation less than 1 MW needs no license. Since most of the electricity generation for ADS will be less than 1 MW, this exemption should prove useful to most ADS units. In the cases where generation is more than 1 MW the ADS will be treated as an industrial unit and should apply for the Ministry of Energy for a special license.

If the water from the ADS is used for irrigation purposes, a drilling license is needed and the water should be used only for irrigation within the specified land area and cannot be traded. Currently more than 21 desalination units are licensed to produce water for irrigation purposes in Jordan. All of them are in the Jordan Valley area and they use RO units but none of them use renewable energy resources. Water produced from the desalination units is mixed with the water from the wells to ensure acceptable salinity levels for irrigation.

3.4. Implications for the implementation of ADS

Currently, there is no specific law or regulation directly addressing ADS applications. This leads to a complex set of license systems that ADS installations must apply for. The fact that no regulation addresses directly ADS is very reasonable as very few ADS installations exist up to date in the country. However, as the market builds up with the technology becoming more robust and affordable, the ADS community in Jordan should work on the development of a draft proposal for a single process and lobby the authorities to review and adopt it.

Assuring the quality of any water resource that has been treated for human consumption is the responsibility of WAJ. Quality control in this case is a public health issue,

which falls under the jurisdiction of MOH. The MOE is involved in trying to maintain water quality. This situation is confusing as there is overlapping authorities. MOE's efforts should therefore concentrate on protecting water quality not in relation to use but as a national resource. Another important issue to note is water quality in wells and springs utilized in rural areas for drinking purposes. These areas should be identified and properly controlled, with proper cooperation between the Ministry of Water and Irrigation (MWI) and MOH.

The current environmental legislation in Jordan lacks any specific legal terms regarding the disposal of brine that is produced from the desalination units. The brine is treated as an industrial waste. Since the nature of ions in the brine, mainly sodium, calcium, etc., are much less dangerous than other ions from industrial plants like mercury, nickel, etc., legislation needs to be changed to take this into account. This will foster the implementation of ADS because this is the only expected negative environmental impact shared with other technologies.

Up to now, all desalination units used for water distributed in the water network are owned by the government and there are no private companies providing drinking water. From our personal contacts with the MWI, there are no specific written procedures that a private investor should follow to get a license for installing an ADS desalination unit and distributing water through the network. This is because there is no legislation that allows a private investor to connect to the water network in the kingdom. Usually, each applied case is treated as individual application and the ministry determined its decision. All the private desalination units are located in the Jordan Valley and are generally used for irrigation purposes. It is unclear what licenses would be required for an ADS unit which was not connected to the reticulated water supply network.

After the fast increase of the oil price in the last 2 years, the different authorities in cooperation with the MOE were talking about the VAT exemption of energy saving equipment. This is to include the energy saving lamps, solar technology used for water heating, and all other relevant production raw materials in this sector. None of this took place till now. Offering ADS in this stage could be a good way to accelerate in achieving the exemption. This is because ADS combines both water and energy, which means that more stakeholders are involved.

3.5. Recommendations

- Clear procedures and outlines should be drafted to issue a license for ADS, particularly for inland applications.
- Research institutes in cooperation with the NERC

should contributor in developing a draft for ADS license procedure.

- Separate standards for brine di-posal should be set out under the relevant industrial discharges regulation.
- Regulations should allow commercialization of desalinated water. This is consistent with the privatization policy adopted in Jordan in the last years.
- Additional incentives like VAT reductions for RE equipment could be introduced as well as for desalination components to be used in ADS.

4. Water prices in Jordan

4.1. Water tariffs and charges

Jordan charges for water according to its purpose and the quantity used. For non-residential uses it is 1.0 JD/m³ plus an additional 0.56 JD/m³ for sanitary discharge for those connected to the sewerage network (1 JD = 0.71 US\$). For residential uses the water tariff follows a tiered structure such that the more the volume of water consumed the higher the price per cubic meter. Water bills are issued on a quarterly basis. According to the MWI, 64% of consumers pay 0.22–0.26 JD/m³, 34% pay up to 0.71 JD/m³ and only 2% pay more than that.

A report for the Heinrich Böll Foundation by Wardam in 2004 [8] found that about 95% of people in Jordan are connected to reticulated water supply; however, because of water rationing since 1988, the supply is unreliable. The report notes that during summer, households only receive water for short periods per week and this causes many households to either invest in private water tanks or to rely on private water sellers. Although the official price of this water should be 2 JD/m³, it is common to pay up to three times this amount.

The Wardam report cites a study of households in east Amman which showed that households spent between 1–2.9% of their income on water on average, usually less than that in winter and more in the summer period. Households in villages in the north of Jordan pay less, between 0.7–1.4% of household income. These are only the official numbers however, and because of the unreliable supply, most households invest in water storage which drives their actual spending on water up to 2.3–4.6% for urban and 1.5–2.3% of rural household income.

Even though many Jordanians rely on private water sellers, the market is still fairly small. It can be segregated into three groups: sellers of bottled water from WAJ-licensed private wells; sellers of distilled mineral water who use municipal water which is distilled using small reverse osmosis machines; and finally private well owners selling water to tankers which provide bulk water supplies. The price for this water has increased in recent years up to 3.0 JD/m³ because of higher oil prices.

4.2. Implications for the implementation of ADS

The total water quantity billed by WAJ is about 50% of the water quantity produced. This has been attributed to “technical and financial losses” caused by the unaccounted for quantities of water. The losses are so high because the water resources are usually far away from the populated cities. ADS could be a good solution to reduce the need for water transportation and the associated losses.

The Jordan Valley Authority (JVA) sold water for irrigation in the Jordan Valley at 0.011–0.012 JD/m³ compared to farmers at high lands at 0.05 JD/m³. This policy by JVA is justifiable since the main mission of JVA is to promote social and economic development in the Jordan Valley. It is targeted to have full cost recovery by 2020. Till that time the gap in cost can be recovered through improvements in operational efficiency and by instituting better integrated investment planning. The implementation of ADS could be of help for the decision makers in the Jordan Valley to promote the social and economic development in the area. The Jordan Valley is the region with the highest solar irradiation in Jordan while there is also brackish water available.

The fact that households are commonly purchasing water from tanks or other private sources at relatively high prices forms positive conditions for the implementation of ADS, either at the household level or from entrepreneurs that will trade the product water. The conditions will gradually become more attractive for ADS as energy and water prices become higher.

4.3. Recommendations

- ADS applications in the Jordan Valley would promote social goals and could be used to maintain low water prices.
- Implementation of the ADS could be a good tool to explore more non-traditional water resources for the farmers as they are most affected by the water shortage.
- Implementation of the ADS will help decentralize water distribution which reduces water losses.
- ADS could be used to gradually replace the various private traders offering alternatives to the unreliable tap water supply.

5. Institutional framework of the water sector in Jordan

5.1. Water sector institutions

The MWI is the official government body which oversees water resources. MWI assumes full responsibility for water and public sewage as well as for the projects pertaining to them. MWI prepares the National Water

Master Plan and water sector programs, formulates water sector policies and participates in the licensing of water abstractions. MWI plans and monitors externally funded projects while the actual project management is carried out by WAJ and JVA.

The WAJ is linked to the MWI but retains financial and administrative independence. It is responsible for public water supply and wastewater treatment. Additionally, it is responsible for regulating wells, surveying and researching water resources, and developing water resources. WAJ's Project Management Unit regulates water and wastewater utilities under private management.

Due to the steps taken by the MWI to partially privatise the water sector, many private sector operators have taken responsibility of water management in different parts of Jordan. The JVA is responsible for social and economic development in the Jordan Rift Valley. This role includes the development, utilization, protection and conservation of water resources. Residents of the Jordan Valley turn to JVA for all issues dealing with water.

The MWI, the WAJ and the JVA are legally responsible for monitoring and planning for water resources. Additionally, the Jordanian Institute of Standards and Metrology is charged with the duty of issuing standard specifications for the water sector in cooperation with representatives of MWI, WAJ, JVA and also representatives of the MOH and the Ministry of the Environment. All health matters of Jordan are under the responsibility of the MOH, which includes monitoring of both wastewater and water systems to ensure compliance with public health standards.

5.2. Energy sector institutions

Energy planning and policy in Jordan is the responsibility of the MEMR. MEMR is governed under the provisions of the General Electricity Law. The CEGCO is responsible for the generation sector in Jordan. Some individual large industrial units produce their own electricity. The National Electric Power Company (NEPCO) is responsible for the transmission of power through 400 and 132 KV networks. NEPCO purchases power from CEGCO and sells it to distribution companies and bulk industries. NEPCO manages the system loads through its national control centre. It is also responsible for the operation and management of interconnection links with Egypt and Syria. The distribution business is handled by the three private distribution companies. They are the Jordan Electric Power Company (JEPSCO), Irbid District Electricity Company (IDECO) and Electricity Distribution Company (EDCO). JEPSCO distributes power to the greater Amman area and central Jordan. IDECO distributes power in the north of Jordan while the EDCO distributes power in the areas outside the concession areas of JEPSCO and IDECO.

5.3. Implications for the implementation of ADS

The institutional framework of the water sector in Jordan is not especially complex. There are only a few governmental agencies involved in water related services, which make the implementation of ADS easier. However, the current institutional set-up is based on traditional, supply oriented, centralized water supply models. This set-up traditionally favours established solutions rather than innovative and decentralized approaches. This is also true for the energy sector in Jordan.

The municipal governments have no major roles in the water and energy sectors. Consumers should deal directly with the distributed directorates of the WAJ or with the private operators like LEMA in the Amman area or Northern Governorates Water Administration in the northern part of Jordan. This is also true for electricity sector where the consumers should deal with the three distribution companies: JEPCO in the greater Amman area and central Jordan, IDECO in the north of Jordan and EDCO outside the concession areas of JEPCO and IDECO.

A centralized water supply has its advantages by maintaining water resources under stringent control and monitoring, but it has the disadvantage of slowing the privatisation process and the decentralized nature of water distribution which is preferred for ADS implementation.

5.4. Recommendations

- More decentralized water management will help implementation of ADS.
- Encouragement of energy auto-production will be of benefit for ADS.

6. Capacity building and awareness raising in Jordan

6.1. Existing capacities and awareness

Research on water issues in Jordan is widespread and at a high level. Most universities provide specialized courses on water and agriculture, engineering, geology or botany. NGOs have also implemented projects such as water harvesting, water reuse and sustainable agriculture. This research has been used, in addition to activities by NGOs to help local communities with water management and raising awareness. A drawback is that independent researchers and the public do not have access to the MWI water information database, and communication consists of occasional published reports or papers [7].

There are more companies working in the water desalination field than in the RE sector in Jordan. All of those companies are working in membrane desalination processes. Although both desalination and RE systems are established and fast growing in Jordan, there are currently no ADS available in the country. Lack of know-how and

technical challenges are the main reasons for hindering the project developers to combine the two technologies.

6.2. Sources of external financing for Jordan

Wardam lists a number of external donors who are active in the water sector in Jordan. The following describe the major donors in Jordan:

1. USAID: By far the biggest donor to the water sector in Jordan. Since 1990 the USAID has built a strategic partnership with the MWI and other institutions in Jordan and invested heavily in developing water demand and supply projects, especially in infrastructure.

2. GTZ: A government-owned company that implements technical assistance projects for the Government of Germany. In Jordan, GTZ has supported projects in the areas of rural development water and institutional support.

3. European Union: At the latest meeting of the Euro-Mediterranean Foreign Ministers a new MEDA financial assistance package for the EUs partners in the Mediterranean was launched. Thereafter, bilateral relations with Jordan were strengthened and new EU grant and loan agreements worth over €200 million were signed. Jordan also benefits from a host of EU-funded regional institutions and relief and rehabilitation programs.

6.3. Implications for the implementation of ADS

With the availability of large number of the funding agencies in the water sector in Jordan, it is probable that the funding for implementation of ADS could be of interest for many of them and should not be a main issue. There are a significant number of companies active in both the desalination and the RE fields in Jordan. This is an important pre-requisite for the ADS market to develop.

Current activities have established networks for distribution of spare parts and maintenance services of the installed systems. As the conditions and the awareness of ADS grow, it is expected that the same companies will cover the demand for ADS offering planning, installation operation and maintenance services. The traditional approach of cooperation with companies abroad that have the know-how and are producing the main parts of the system will be most probably followed.

Awareness of ADS is very low among all relevant actors, from the authorities and the academic community to the companies and the general public. Awareness-raising is a key activity for increased ADS implementation. Each group should be addressed separately with targeted information.

Networking and establishment of contacts among Jordanian companies and international technology producers would accelerate ADS market penetration. The

authorities, especially the municipalities in arid areas, should be also informed about the ADS solution and its benefits. An example in Jordan is the Badia Research and Development Programme, which should be supported and be given more responsibilities to enable it to implement the ADS in the country. In parallel there should be extensive information about the relevant support programs for financing water supply infrastructure from the different external funding agencies mentioned above.

End-users should become more aware of the importance of water quality. Quality of water supplied, particularly for rural sites, is often unsatisfactory.

ADS implementation requires qualified human resources from different disciplines. Autonomous desalination requires specific training in terms of design, operation, maintenance and management of such plants. The existing courses in the engineering and other relevant departments produce scientists with high-qualifications. However, introduction of various ADS related aspects including technical, environmental and economic issues should be included in the curricula of those courses.

ADS specific research is still very limited. Awareness raising among the academic community, especially between the RE and membrane research groups, is required. Together with adequate funding from the government the pre-requisites are there for local products and designs to develop that will lead to regionally adapted and regionally sustainable technologies.

It is important that the governmental institutes, public and private sector, researchers and NGOs develop a common set of priorities in the water supply and RE fields that are in line with the output delivered by the scientific research carried out in the country.

6.4. Recommendations

- Availability of development agencies in water sector could be used for ADS implementation.
- Awareness-raising among the private sector in Jordan about the ADS benefits.
- Targeted information to local government and the end-user about the ADS benefits and the available support programs in Jordan.
- National and local media coverage of ADS pilot and demonstration plants.
- ADS basics including technical, environmental and economic issues should be included in the curricula of relevant university courses.
- Research in Jordan on ADS development and adaptation to the local conditions should be promoted and supported.

7. Conclusions

In Jordan water is very scarce and the sector is closely monitored. Efforts are being made to maximise the efficiency and exploit every resource in the best possible way. Non-conventional resources are a priority for the government and already used, as for example treated waste-water for irrigation. Desalination is also relatively widespread, used by farmers for irrigation water and by entrepreneurs who filter tap water and sell it as drinking water. Renewable energy on the other hand is not very developed, but interest is growing.

The combination of the two technologies is still not popular in the country but ADS could be a suitable option for small communities scattered in the country. Small tourist areas and the natural reserves visited for short time by the people in the country are cases where the ADS can offer an interesting alternative for water and power supply. To support that MWI has to strengthen the decentralisation policy that will encourage ADS implementation when and where the cost becomes competitive. The removal of subsidies that hide the real cost of water can also help the fair treatment of ADS as an alternative. Financial support for demonstration ADS projects shall be sought from the numerous development agencies traditionally active in the water sector of the country.

The government should also support the implementation of ADS which is in line with the national policies. A good start would be the farmers in the Jordan Valley that have desalination units, mainly RO technology, connected to the electricity grid. They should be supported to switch and power their units by PV panels.

Research institutions and universities should play an active role in fostering the ADS implementation in the country by offering relevant courses by including a theoretical part and practical training in the universities curriculum. Research to develop and adapt ADS concepts to the local conditions should be also promoted.

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