ADIRA

Autonomous Desalination System Concepts for Sea and Brackish Water in Rural Areas with Renewable Energies

Deliverable 4.2:

Master Plan for the Wide Implementation of Autonomous Desalination Systems in Turkey, Morocco, Jordan and Egypt

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Executive Summary

Introduction

The ADIRA project (Autonomous Desalination System Concepts for Seawater and Brackish Water in Rural Areas with Renewable Energies) is designed to improve the technology and implementation of small-scale desalination systems powered by autonomous renewable energy (RE) sources such as photovoltaic panels and wind turbines. This autonomous desalination system (ADS) technology is ideal for remote arid areas in either coastal or inland locations and is currently in its final stages of commercialisation and implementation in Mediterranean and North African countries. This report provides an overview of the relevant legal and institutional framework in four countries: Turkey, Morocco, Jordan and Egypt. Each country report provides a case study of both strengths and weaknesses from which the ADS community can learn.

Country Summaries

Turkey has more water resources than its neighbours, which are unevenly distributed in time and space. The available resources per capita are decreasing with the rising population and the climate change effects. A long history of water development in a large and populous country has resulted to a complex and overlapping set of water institutions and laws. The government is now trying to simplify and decentralise planning by enhancing collaboration between water agencies while retaining decision making authority at local levels. It is also considering at least partial deregulation of water supply to allow private investment. Various programmes support rural infrastructure; specific grants for water and RE installations cover up to 75% of the investment costs. Another positive aspect of the framework conditions is that the current legislation provides exemptions for several licences in case of small-scale applications of both water and energy equipment. This makes it easier for developers to plan and install ADS.

Municipalities are responsible to define the water supply rates and often charge below the real costs, event though they do not receive financial support from any source for that. This distorts fair competition between water supply technologies and hinders the opportunities of private sector to install ADS for water supply. However it can also be used for the benefit of ADS if the local authorities of suitable areas get aware of the ADS benefits and redirect the subsidies to it.

Awareness about ADS is very low among all relevant actors; local authorities, the academic community, the companies and the general public. The municipalities in arid areas should be informed about the ADS option and about the support programmes for financing water supply infrastructure. Finally, creating awareness between RE and desalination companies will be a very effective way of accelerating ADS implementation.

Morocco faced severe droughts over the recent years combined with increasing demand for water, mainly for irrigation and tourism purposes. As a result the water stress in the country

was intensified and there is currently clear policy support for the exploitation of non-conventional water resources like desalination. Renewable energy systems are also strongly promoted by the government as a tool to reduce the dependency from imported fuels. These policies create good framework conditions for ADS, but so far no reference has been made to ADS in the official documents or any other concrete project implementation than the ADIRA systems.

Various programmes provide support for water and renewable energy installations in rural areas. For example the PAGER programme may provide up to 85% of the capital costs for water supply works in the form of grants and loans. Such programmes have been a great success and ADS implementation could very much benefit from them. Also the innovative financing mechanisms and the networks of technicians for PV created through these initiatives provide an excellent basis for ADS development.

The procedures involved in setting a drinking water project are time consuming and may involve several public actors. There are exemptions for small projects, but there is still enough room for simplifying the procedures in order to encourage small, efficient projects.

There is already widespread experience in transferring water supply services to entities that are able to carry out that task, and setting tariffs that cover the operation and maintenance costs as well as the recovery of the initial investments. This is exactly what needs to happen with ADS and the fact that the process is already established is an encouraging factor.

Overall, Morocco has favourable conditions and a great need for ADS. What is missing at the moment is widespread awareness for the opportunities this technology has to offer and targeted actions in this direction should be organised. Also the ADS prices have to come down before the technology can be widely applied, even with the existing Moroccan support programmes. The first step would be to lower or eliminate the relevant taxes and then develop know-how to produce some parts and assemble the system in the country.

Jordan is one of the most water scarce countries in the world. It has already developed a national water plan to extend water resources as far as possible, and this includes support for desalination. For the energy sector though very little is done on the renewable energy exploitation. There are some initiatives and studies but the country could benefit very much from the know-how and support schemes implemented elsewhere.

The regulation for water withdrawal, processing and trading is detailed and rather complex but this reflects the necessary intensity of monitoring the efficient use of the restricted resources. However no licences are required for autonomous RE generators under 1MW.

Most of the people are connected to the water supply network but supply can be unreliable and many rely on private water sellers, especially in the summer months. Although the official price of this water is 2JD/m³ it is common to pay up to three times this amount. Even like that, water produced by ADS can be up to twice as expensive at the moment. However, as the oil prices rise, conventional solutions are becoming quickly more expensive. At the same time costs of ADS are going down as the technology develops. This trend should be further supported by governmental measures, for example the VAT reduction suggested in the previous chapter.

The centralised approach is maintained in order to keep the scarce water resources under stringent control and monitoring. But local populations and their authorities should be given some responsibilities and get involved in the water supply for more efficient use and fewer losses from water transmission. Especially for the rural areas this approach should be promoted and it would create the right conditions for the development of ADS in the areas where it most makes sense.

Some of the historic tourist sites around the country are in the desert area long away from other populated communities, like Qasr Al-Hallabat and Um-Alrassas. Providing them with water and electricity is very expensive and the operating costs are high. Such cases are ideal for the first demonstration projects in the country and it will help to raise awareness about the technology.

Egypt is dependent on the Nile River for 95% of its water. For this reason it has a centralised water planning system and a strategic national water policy. Currently the government is adopting an integrated water resources management approach and this is a good opportunity to push for more decentralisation in the water sector administration. Also plans have been made to relocate part of the growing population to areas in the desert, away from the Nile, and ADS could be an important tool to support the challenging water supply requirements that the plan implies.

Egypt has a complex set of licences required for ADS installation, which involves numerous authorities of the central administration. This should be simplified by delegating the relevant powers to the local level and eliminating the need for licences for smaller projects. It is easier for renewable energy systems, where small, stand-alone projects can be implemented without any permission required.

In general water supply in Egypt is provided in low prices, subsidised by the government. This makes it difficult for new innovative solutions like ADS to have a fair opportunity to complete with traditional approaches. On the other hand the fact that resources for subsidising water do exists make it possible for ADS to gain access to some of these funds for supporting the first installations in the country.

There are already ADS companies in the country with local representatives offering solar stills designed in Germany and assembled locally. This example should be replicated, encouraging and supporting local entrepreneurs to form collaborations with international technology providers for offering together suitable products in Egypt.

Conclusions

All four countries share imminent or acute drinking water shortages and strong pressure to increase supply. They have in common arid climates that are suitable for solar or wind energy and their governments have a commitment to use RE. ADS demonstration plants already exist in all four countries and many more suitable sites are available. The existing ADS plants can be used as the basis to increase awareness of the possibilities of ADS for both the public and for water agency officials. Educational courses need to be developed to train engineers and technicians in ADS technology for both installation and maintenance.

One barrier to implementation in the four countries is the variety of licences which are needed to construct and operate an ADS plant. A major recommendation from this report is the creation of a streamlined licence system so that an operator only has to liaise with a single government agency rather than multiple. Even if this idea were scaled down to a standard licensing process this would still benefit operators by reducing complexity.

ADS is a feasible technology providing drinking water to remote areas in arid coastal or inland locations. It is environmentally friendly and becoming more affordable. This report helps clarify legal and institutional support and barriers in four target countries: Turkey, Morocco, Jordan and Egypt. As more systems are installed it will become an established source of water for remote arid areas: a truly sustainable development.

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1 Introduction to Country Reports

Freshwater is a scarce resource around much of the Mediterranean. Providing a reliable supply of potable water to a growing population is a challenge for many Middle East and North Africa (MENA) countries, especially when the supply should be both economically viable and environmentally sensitive. Autonomous Desalination Systems (ADS) is a technology which can provide small scale supplies of drinking water via a distillation or membrane desalination unit powered by a renewable energy source such as solar photovoltaic panels or small wind turbines.

The ADIRA project (Autonomous Desalination System Concepts for Seawater and Brackish Water in Rural Areas with Renewable Energies) is intended to not only improve the technology but also to aid implementation in MENA countries by analysing the role of socio-economic and institutional factors. This report is part of the second aim and gives an overview of the legal and institutional frameworks in four countries: Turkey, Morocco, Jordan and Egypt. Each country report provides a case study of both strengths and weaknesses from which the ADS community can learn.

The report is divided into six chapters: Chapter 1 is a general introduction; Chapters 2, 3, 4 and 5 provide the Country Master Plans of Turkey, Morocco, Jordan and Egypt; and Chapter 6 highlights the similarities and differences between the Country Master Plans and provides general conclusions.

Each Country Master Plan is structure into eight sections. Section 1 is a list of acronyms and abbreviations used in that plan. Section 2 is an introduction. Section 3 covers the general water and energy policy of the country. This is followed by analysis outlining the implications of this policy for ADS. Section 4 provides more detail on relevant legislation and administrative issues such as permits or licences that an ADS installation may require. Again, a conclusion subsection brings together the implications of this for ADS. Section 5 covers the water tariffs and subsidies in the country and what impacts they could have on ADS installations. Section 6 provides an overview of the institutional framework of the water sector and in some cases also the energy sector. It provides a description of the main government agencies and any other relevant groups. Section 7 looks to the future and provides information on general awareness and capacity building for the ADS sector. Section 8 provides a general summary and conclusions for the report. Each section is concluded with a list of recommendations for improving the legal and institutional frameworks of the country to enable easier and quicker implementation of ADS technology.

2 Turkey Country Report

2.1 List of Acronyms and Abbreviations for Turkey

ADIRA	Autonomous Desalination System Concepts for Seawater and Brackish Water in Rural Areas with Renewable Energies
ADS	Autonomous Desalination Systems
ATR	Advanced Tax Ruling
BoP	Bank of Provinces
BOT	Build Operate Transfer
EMRA	Energy Market Regulatory Authority
EPRSD	Electrical Power Resources Survey Development Administration
EU	European Union
GDLA	General Directorate of Local Administrations
IBRD	International Bank of Reconstruction and Development
IWRM	Integrated Water Resource Management
MoEF	Ministry of Environment and Forestry
MoH	Ministry of Health
NGO	Non-Governmental Organisation
PV	Photo Voltaic cell
RES	Renewable Energy Sources
RSU	Rural Service Unit
SHW	State Hydraulic Works
SME	Small Medium sized Enterprise
SPA	Special Provincial Administration
SPO	State Planning Organisation
TIDB	Turkish Industrial Development Bank
VAT	Value Added Tax
WIHC	Directive on Water Intended for Human Consumption
WPPD	Water Pollution Prevention Directive
WWTP	Waste Water Treatment Plants

2.2 Introduction

Water resources across Turkey and the Middle East are far from meeting the demand for fresh water and there is a serious water shortage in the region. Turkey is in a relatively better condition than its neighbours but increasing demand and changing climate are expected to contribute to a worsening of the problem in the near future.

The ADIRA project is studying the potential of Autonomous Desalination Systems (ADS) to provide a small-scale water supply for arid, isolated areas with access to sea or brackish water. ADS is a clean and reliable alternative that for suitable sites has many advantages against traditional centralised solutions.

In a separate report [1] the various actors in the water sector in each country have been identified and the role they could play in the implementation of ADS has been analysed. In addition, entities that have the potential to become operators of ADS have been selected and studied.

The Master Plan builds on that work and provides an overview of the existing situation. The analysis has been structured in five parts that are reflected in the sections of the report:

- Section 2.3: Relevant policy and programmes
- Section 2.4: Legislation and administrative issues
- Section 2.5: Water prices and subsidies
- Section 2.6: Institutional framework of the water sector
- Section 2.7: Capacity building and awareness raising

In each chapter, a presentation of the current situation is given first and then the implications, positive or negative, for the implementation of ADS are analysed. Clear recommendations are developed for improving the framework conditions to foster ADS implementation in Turkey. In the end of each chapter the recommendations are collected again in a text box.

2.3 *Relevant Policy and Programmes in Turkey*

2.3.1 Water and energy policy

Water Policy

Water supply problems in Turkey are mainly related to inefficient or malfunctioning water distribution and sewage systems, seawater intrusion, contamination of water resources, and lack of proper wastewater treatment plants. Another basic problem is that 94% of the irrigational activities cause overexploitation of water and almost half of the water is lost without being used up by the crops. Over-irrigation also causes build-up of salts in the soil, reducing its fertility.

There are also political aspects to rivers running across country borders. A significant portion of Turkey's total water resources is stored in the cross-border water basins primarily in the Euphrates and Tigris river basins. Hence cross-border waters play an important role in Turkey's water policy.

The Turkish water policy aims to provide a framework to help solve these problems. The main principles of the water policy are given below as expressed in the final report of the project *"Acceleration of Collaboration between Responsible Institutions and Organizations in Water Management and Improvement of Integrated Approach in Water Management Planning in Turkey"*[1] and also as referred in the declarations of NGOs [2, 3, 4, 5 and 6]:

- Caring for ultimate public benefit which respects the following generations' rights in all type of interventions to water resources;
- Adopting a demand oriented management approach instead of supply oriented;
- Adopting an integrated watershed/basin management;
- Incorporating the ecological and economical added value obtained from the natural water cycle.

In practice, the need to develop regional water strategies, to adopt decentralized management oriented to the specific requirements of the region, and to take measures to improve water supply and limit water demand is recognized. Water supply for residential areas is given priority. The need for policies and applications for efficient use of water resources in agriculture is also recognised, however the trend is generally towards assigning new water resources to meet demand rather than improving existing applications or developing non-conventional resources.

The European Union (EU) harmonization processes conducted in Turkey in the agricultural and environmental sectors provided a good opportunity for reviewing water policy to achieve a more rational use of the country's water resources. It is planned to continue the ongoing revisions in the current legislation regarding regulation of drinking water and wastewater discharge according to EU regulations and directives.

The government is also working on some policies supporting rural communities to establish their own water infrastructures. The tools are designed to help village communities overcome

[1] Project funded by the Dutch Government (Ministry of Economical Affairs) supporting the Turkish government to implement the study on adoption of the WFD in Turkey

difficulties on their tax liabilities and promote building of water plants and networks to supply healthy drinking water by applying VAT exemption to water supply for village residents. These incentives do not cover commercial activities such as trading bottled spring water or supply of water from water resources managed by commercial enterprises.

Energy Policy

In the energy sector Turkey is trying to develop a long-term energy policy that will decrease the external dependency and diversify the sources by putting emphasis on national resources. As in the case of water policy, Turkey's energy policy is currently based on managing supply instead of controlling demand.

It is broadly accepted that further efforts are needed to provide a competent electricity market. In this respect, the situation of the dominant public trading company and the energy buying agreements will be reviewed. Studies are being conducted regarding:

- *Electricity Market Balancing and Settlement Regulation*, which aims to set principles and procedures regarding the activities carried out by the National Load Dispatch Centre, in order to equalize the system supply and demand of active electricity energy on real-time;
- *Electricity Transmission System Supply Reliability and Quality Regulation*, which aims to set the procedures and principles applicable to the transmission system supply reliability and quality requirements for reliable and low-cost operation;
- *Electricity Demand Forecast*, which aims to set the principles and procedures regarding electricity demand forecasts. These will constitute the basis for preparation of generation capacity projection.

Turkey is also considering removing existing limitations in cross-border electricity trading.

Problems have also been identified in the BOT (Build Operate Transfer) process and the electricity production and distribution agreements. The Energy Market Regulatory Authority (EMRA) [7] will put emphasis on fair and transparent access to the transmission system in order to create the conditions for a free market.

It is planned to develop a renewable energy strategy in order to increase the utilisation of renewable energy resources. In this respect the *Regulation on Exploitation of Renewable Energy Resources for Electricity Production* was prepared and took effect in 2005.

The problem of energy efficiency is also recognized in energy policies. Losses during transmission of electricity add up to almost 20%, which is quite high. Accordingly, administrative and institutional regulations are planned and a regulation on energy efficiency has been drafted.

Further efforts are required to re-structure the sector which will allow more involvement of the private sector and which will create the framework for an open energy market, consistent with EU regulations and directives.

2.3.2 Relevant programmes and initiatives in Turkey

In Turkey, public water and wastewater treatment projects are financed by the Bank of Provinces (BoP), which provides long term credits to the responsible municipality authorities. It is planned to improve the administrative, technical and financial capacity of BoP to help local

administrative units to utilize the EU financial support and other international funding resources available for water projects.

Several programmes to support rural infrastructure development have been formulated in the framework of the EU harmonisation process in order to achieve EU standards in all parts of the country. All these programmes, which are presented below, refer specifically to the problem of water supply and address the need for infrastructure which is in line with the concept of sustainable development.

The State Planning Organisation (SPO) supports projects through grants under the prioritised topics determined by the regional development programmes conducted within the framework of the EU-Turkey Financial Cooperation. The prioritised topics are; (i) Supporting Small to Medium sized Enterprises (SMEs); (ii) Environment and small-scale infrastructures; (iii) Capacity Building in local scale. The preparations and applications regarding the grant programmes are coordinated by the SPO and the tenders are conducted by the Central Finance and Contracts Unit [8, 9 and 10].

The institutions allowed to apply for grants are:

- Local administrations;
- SMEs;
- NGOs and all local initiatives;
- Chambers or organizations of industrial, trading, agricultural, or occupational types, foundations, trade unions, and cooperatives;
- Universities, research institutes and education units.

Calls for project proposals are announced by the SPO and the time allowed for project development and submission is 60 to 90 days. A maximum amount of €100,000 can be granted to projects and SMEs are generally required to co-finance 50% of the project costs from other sources.

There is also the 'Support Program for Rural Development Investments', which is conducted by the General Directorate of Organization and Support under the Ministry of Agriculture and Rural Affairs. The program provides grants for rural infrastructure development within the framework of development plans and programs and the 2006-2010 National Agriculture Strategy. The program includes the promotion and supporting of investments for drinking water plants for villages. The grants will cover 75 % of project costs (turnkey tenders) and the remaining 25% is to be covered by the contractor. The grant amount is up to 300,000 TRY (€165,000). Projects can last for up to 12 months after signing the contract [11].

Another programme called 'Support Program for Rural/Village Infrastructure-KÖYDES' was started in 2005 by the Ministry of Interior. The programme aims to solve problems related to water supply and road access and which have not been included in investment plans via the efficient use of local means and capacities within a short time and at a low cost. The program is led by the governors and officials with support from Local Administrations and Rural Service Units (RSUs). The amount allocated to each province is announced by the Supreme Planning Council which consists of the prime minister, other selected government ministers, and the undersecretary of the SPO. A total of 200 million TRY was allocated for the KÖYDES program for the year 2005 which has beed increased to 2,2 billion TRY for the year 2006. The allocations range from 135,000 TRY to 50 million TRY for different provinces and their villages [12].

The allocated funds are used and distributed within each province by the mediation of RSUs, which are established in each administrative district. In case of central districts, RSUs are lead by the governor, otherwise by an official of the district. Council members include the village heads and members of the provincial council. The distribution of funds among the various RSUs and projects are decided by the Allocation Commission which is led by the governor and includes the head of the provincial council, the assistant governor, the secretary general of the Special Provincial Administration (SPA) and an official of the district. The allocations assigned are approved by the governor and communicated to the General Directorate of Local Administrations (GDLA) within the following 15 days. GDLA prepares the list of RSUs and SPAs to be funded and the amount of funds to be transferred to their accounts. The Ministry of Finance transfers the funds according to these lists. On a local level, the governor is the responsible authority for the evaluation and monitoring of the investment projects. Governors are required to prepare monthly reports to the Ministry of Finance on how the projects are progressing.

Cultural and tourism activities receive a considerable level of governmental support for infrastructure services through tourism specific regulations. According to the Tourism Incentive Law (Date: 16/3/1982, No: 17635), it is compulsory for the relevant public organizations to complete all infrastructures (roads, sewerage, water, electricity and telecommunication) in protected cultural or tourism regions, in developing regions and in tourism centres with priority. Financial allocations for these purposes are also prioritized.

A new regulation issued by Ministry of Culture and Tourism, the Regulation on Application of Support on Energy and Water Price Discount to Cultural Investments and Enterprises, Date: 14.07.2006, No: 26228 also supports tourism investors and entrepreneurs with help for energy and water related costs. In the case of energy, the Ministry will pay 20% of the energy expenses of certificated tourism plants for five years via the Turkish Treasury. For water however, a different mechanism is used. The certificated tourism investors or enterprises can only be charged the lowest tariff for that region. The organizations responsible for water distribution in the region, i.e. the municipalities, are required to process necessary arrangements for the certificated plants. The discount is not subsidised by the Ministry so the extra cost is borne by the municipality.

There are some support mechanisms for investments regarding renewable energy production plants under the “Regulation on Use of Renewable Energy Resources for Electricity Production’ Date: 10.05.2005, No: 5346, which are described as follows:

All lands registered to the State Forestry Department or under the jurisdiction and disposal of the state are permitted to be used for production of electrical energy from renewable energy resources. A 50% discount will be applied for the permission, easement and utilization right charges during the investment period.

Real persons or legal entities who own renewable energy plants up to 1000 kW for own-use, stand-alone or connected to the grid, will not be charged for the compulsory studies and licenses by the State Hydraulic Works (SHW) and the Electrical Power Resources Survey and Development Administration (EPRSD).

Another opportunity to support the investment of a renewable energy installation is the Renewable Energy Loan provided by the International Bank of Reconstruction and Development (IBRD) under the World Bank. IBRD Renewable Energy Loan became operative in July 2004 and provides credit via the Turkish Industrial Development Bank (TIDB). Up to 50% of the total cost of the investment is eligible for financing and the maximum sub-loan per sub-borrower is US$20 million. Maturity is determined according to the feasibility of the project.

2.3.3 Implications for the implementation of ADS and recommendations for Turkey

Turkish policy is evolving and follows international trends. Services and decision making processes are becoming decentralised and the private sector is encouraged to get involved in the energy and water sectors. Renewable energy is actively considered and supporting policies are formulated. Finally rural development is supported and the concept of sustainability appears more frequently in the policy documents. All these facts are very positive, as they will create conditions that favour decentralised solutions which are also environmentally friendly. However lobbying and follow-up actions are needed to ensure that the policy agenda keeps on moving in that direction. Most importantly, work is needed to realise all these policies, to transform them to effective regulations and to reach the targets set.

The main disadvantage of existing water policy with regard to ADS is the failure to explicitly acknowledge and consider non-conventional water resources for areas that are facing water shortages. It is common to simply transfer water from another area, as Turkey has traditionally been a relatively water rich country. However, water is unevenly distributed across space and in time. Climate change may bring the problem that water resources become scarcer and even more unevenly distributed. In response to that, policy needs to consider local and sustainable solutions like water reuse and ADS. The planned application of Integrated Water Resource Management (IWRM) methods at the river basin level will help in this direction. In addition to that, activities are needed which promote non-conventional resources.

We have seen that there is a wide range of support programmes that exist, from which ADS could benefit. This is a very positive characteristic of the policy framework in Turkey. Depending on circumstances, financial support can be secured either for the renewable energy components or for the water supply plant, especially in rural areas. Also technical support from the state organisations may be available. However, most of the programmes only address the municipalities that are responsible for the water supply and not private entrepreneurs. Municipalities tend to be slower in taking up new technologies. It would contribute to the exploitation of non-conventional resources if the programmes were made broader and made funds available for private bodies who were interested to invest in small-scale water supply systems. However, the municipalities are and always will be the main bodies providing water supply, and therefore the available programmes and funds form a very positive start to support the ADS uptake. It is important to combine this with awareness raising and capacity building as we will explain later in the report.

The new incentives which support tourism investors in coastal regions by subsidising their water and electricity costs make it more difficult for ADS to become financially competitive. As stated by relevant authorities, there are many problems faced in the implementation of this regulation. Tourism plants rarely receive payments from the Ministry for the 20% of energy expenses. Municipalities do not apply the lowest tariffs and arrange their tariffs to prevent low rates to be charged to tourism plants. Hence in practice, this regulation provides no incentive to tourism investors yet. The Ministry is still trying to improve the application of this regulation as, in its original form, the regulation is not in line with water and energy policies and not economically sustainable, especially in terms of water supply. The tariffs should encourage the end-users to save water and therefore should reflect at least the real costs of water supply.

A good example of municipalities managing decentralised solutions and covering the costs from the operation of the service is the environmental investment programme. Municipalities all over the country are obliged to complete their Waste Water Treatment Plants (WWTP) within strict deadlines. Credits have been given to the municipalities for this task which they have to pay back in the coming years. In order to repay the credits municipalities will have to bill water

services at higher levels. In that case, alternatives such as ADS will become more attractive in certain cases.

Recommendations:

- The current policy trends for decentralisation of decision making, sustainability and private sector involvement should be strengthened and followed-up.
- Water policy should promote non-conventional water resources as an alternative for water scarce areas.
- The available support programmes for renewable energy and water supply in rural areas should be more actively used for ADS implementation. Opening all support programmes to the private sector would help in this direction.
- The tourism support programme should be redesigned to become better aligned with water and energy policies.

2.4 Legislation and administrative issues in Turkey

2.4.1 Relevant legislation in Turkey

In this chapter the legislation related to ADS installation and operation is briefly presented.

Withdrawal/utilisation of seawater and brackish water

Groundwater Law by State Hydraulic Works clearly states that drilling and/or utilisation of any type of well to obtain fresh water or brackish water must be studied and permitted by the SHW, unless the well is not deeper than 10 m.

Water Pollution Prevention Directive-WPPD by Ministry of Environment and Forestry states that utilisation of wells near the shoreline has to comply with the safe yields criteria for withdrawal of water from the groundwater resources as a measure to prevent saline intrusion. No criteria are included to assess suitability of seawater for production of drinking or irrigational water.

Brine disposal

Current environmental legislation in Turkey lacks any legal terms regarding the disposal of waste brine produced from the desalination of sea or brackish water. However, WPPD defines a sub-group of industrial wastewaters which includes the wastewaters from water softening, demineralization and regeneration, and activated carbon back-wash and regeneration plants and a set of standards are specified for chlorine, sulphate, iron, pH, and fish bio-experiment.

Construction of structures in coastal regions

Coastal Law by Ministry of Public Works and Settlement defines the shoreline as a line extending at least 100 m from the water line. Coastal structures shall only be allowed after 50 m and are limited to tourism infrastructure like camping sites, showers and restaurants, roads, open parking lots and treatment plants.

Supply and quality of drinking water

Directive on Water Intended for Human Consumption-WIHC by Ministry of Health (MoH); classifies water intended for human consumption as “spring water”, “drinking water” or “drinking & usage water” (domestic use washing, cooking, etc.). WIHC provides quality standards for each class, and sets out rules and procedures for licensing, installing, controlling and monitoring water production. Drinking water and spring water can be also used commercially. Desalinated water is categorized as “drinking and usage water”. Commercial use of desalinated water is forbidden according to the Directive (Article 16), where commercial use is described as trading water in labelled bottles. Supply of desalinated water by a municipality is recognized as a public activity.

Plants that supply less than 10 m³ of water per day on average or that serve fewer than 50 persons are exempted from the requirements of WIHC directive. However, since water quality is directly linked with human health, small plants are still required to analyze the parameters set out in the directive, submit the reports to MoH and be monitored at least once every year.

Renewable energy installations

Legislation regarding electricity supply is documented by the Energy Market Regulatory Authority (EMRA).

Electricity Market Licensing Regulation refers to licenses for renewable energy installations

Law of Electricity Market defines relevant licenses for juridical persons operating renewable energy plants parallel to the grid. The licenses cover generation, transmission, distribution, wholesale, retail, retail service, import and export

Law on Utilisation of Renewable Energy Resources for the Purpose of Generating Electrical Energy describes implementation of procedures and principles in the generation of electricity from renewable energy sources.

2.4.2 Relevant administrative procedures and required licenses in Turkey

The required licenses for ADS implementation from water intake to installation, water supply and brine disposal are presented below.

Water intake

Sea water - There are no legal statements applied under the SHW authorization or any other governmental authority for sea water withdrawal. The legislation regarding the coastal waters is limited to the protection of the shores from polluting streams and/or disposals.

Brackish water - A license is required from SHW for permission to drill a well deeper than 10m and to utilise existing wells to obtain fresh water or brackish water, according to *Groundwater Law* Date: 16.12.1960, No: 167. Municipalities commonly interfere with the operation of wells as they try to register the water source and invoice the consumed water since it will end up in the wastewater treatment plants operated by municipalities. The Ministry of Environment and Forestry (MoEF) also intervenes with the operation of wells to prevent negative effects on the environment and try to ensure that suitable technologies are applied to protect the resources.

SHW issues two kind of licences for the use of groundwater: (i) for groundwater exploration; and (ii) for groundwater exploitation. SHW first approves the project proposal that outlines the drill point, design of the well and pumping scheme, which is required to be conducted by a geological engineer or a hydro-geologist. There is a list of firms authorized to conduct such projects. If the well already exists, only the second licence is required for groundwater exploitation. The information required includes the well coordinates, a pumping report, a chemical analysis of the water, and the justification for the need. The average waiting period is one month for the whole licensing process. Licences are issued for one year and must be renewed yearly. SHW does not charge for the licenses issued, however, the firm charges for the well project. The price charged for the project cannot exceed a certain amount which is announced by SHW every year.

Construction of ADS and water supply

As indicated in the WIHC directive on drinking water, ADS plants are not required to obtain licences for plant construction and operation since the water produced cannot be traded. In intensive tourism regions construction periods are limited to off-season months. In most of the Aegean and Mediterranean coastal sites, constructions are allowed only between October and May.

Brine disposal

No licence is legally required for brine disposal. A person or institution asking for a '*discharge license'* for an industrial demineralization discharge has to fill in the application forms provided

by the Water Pollution Prevention Directive communiqué on administrative procedures. The applications for discharge licenses are concluded within maximum two months.

Renewable energy installations

Operators of power production systems are required to obtain licenses from EMRA. The following licenses may be necessary depending on the activities of the producers: Generation license, Auto-producer license, Auto-producer group license, Transmission license, Distribution license, Wholesale license, Retail license.

The following terms are defined:

Generation: The transformation of energy resources into electricity in generation facilities.

Auto-producer: Any legal entity engaged in electricity generation primarily for its own needs.

Auto-producer Group: Any legal entity engaged in electricity generation primarily for the needs of its partners.

Transmission: The transport of electricity through lines higher than 36 kV.

Distribution: The transport of electricity through lines of 36 kV or lower.

Wholesale: The sale of electricity for resale.

Retail: The sale of electricity to consumers.

An exemption to obtain the relevant license is valid for the cases stated article 5 of this regulation as: '*The real persons or legal entities generating electricity for their own needs and those who have facilities or equipment which are not operating in parallel to the transmission and distribution network shall not be required to obtain a license as long as they remain disconnected to the transmission and distribution network and are not engaged in wholesale or retail activities to sell the electricity and/or capacity generated in these facilities*'

In order to be granted the relevant licenses to operate in the market, the legal entities shall apply to EMRA by submitting a list of documents indicated in "*List of Information and Documents to be submitted during License Application*" [7, 13] defined by a Board decision, together with the "*License Application Form*" and the "*Commitment Form*" provided in the annexes of the regulation. All legal entities subject to private law and applying for a license in order to operate in the market, are required to have been established as *joint stock* or *limited liability companies* in accordance with the provisions of the Turkish Commercial Code no. 6762. The license applications are finalised within 60 days following their submission to EMRA. After the positive evaluation, the applying person or entity is asked to submit the signed contract, notarized copies, and document to prove that license fee is paid. After this stage the licence is issued within 90 days. The license fees are announced by EMRA in their website[2].

According to the law (*Law on Utilization of RES for the Purpose of Generating Electrical Energy),* any legal entity holding a generation license shall be granted with a "*Renewable Energy Resource Certificate*" (RES Certificate) by EMRA for the purpose of identification and

[2] http://www.epdk.gov.tr/lisans/elektrik/lisansbedel/lisansbedelleri.htm

monitoring of the resource type in purchasing and sale of the electricity generated from renewable energy resources in domestic and international markets. The Certificate is issued within 30 days after application.

Import taxes and procedures

For products imported from EU countries, payment of VAT along with an ATR (Advanced Tax Ruling) document, which is a goods movement certificate used for preferential treatment of goods moved between the European Community and Turkey, are required to complete the import procedures in Turkey.

At the importing stage the 'Declaration of Entrance to Free Circulation' together with the original invoice, packing list, freight invoice and insurance policy are submitted to the Customs Administration. The procedure is completed within days.

2.4.3 Implications for the implementation of ADS and recommendations for Turkey

Currently, there are no specific laws or regulations directly addressing ADS applications. Regulations and procedures regarding water supply and renewable energy have separate legal frameworks. Hence separate procedures and licences apply for desalination and renewable energy units. This leads to longer waiting times and more complicated procedures to obtain the required licences. The fact that no regulation addresses directly ADS is reasonable as very few ADS installations exist to date in Turkey. However, as the market builds and the technology becomes more robust and affordable, the ADS community in Turkey should work on the development of a draft proposal for a single process and lobby the authorities to review and adopt it.

There are several governmental authorities involved in these procedures, especially in the case of water treatment and supply, which often fail to establish proper coordination in the implementation of intended work. The procedures may become confusing at some stages with overlapping authorities. Especially for water withdrawal licenses SHW as well as the municipality and sometimes the Ministry of Environment may be involved. As a single process for ADS licensing is developed, all the relevant responsibilities should be transferred to the municipalities, which will then be the only interface with the applicant. They should consult with SHW, MoEF or any other body necessary before issuing the license but the applicant will have to deal only with the municipality.

The brine disposal issue is currently not directly addressed by the WPPD. A new paragraph should be added setting standards that will ensure that inland brine discharge from ADS will not endanger the environment. This should then be incorporated into the suggested one-stop ADS application.

The positive aspect of the current legislation is that it provides exemptions for several licences in case of small-scale applications. For example wells with depths less than 10 m, which is the case for many beach wells, do not require licenses from SHW. Also ADS plants do not require construction and operation licences according to the WIHC Directive. However, the same Directive does not allow commercialisation of water produced from ADS plants, for example bottling the water and trading it. In most of the cases this is not within the ADS operator's objectives, however it does restrict the options to raise revenues that would help to pay back the capital and operating costs and thus makes ADS less attractive for investors. The desalination community, including both small and large desalination industries should lobby to

lift this restriction. Then, separate licensing procedures should apply, depending on the size of the plan like in the case of other water supply systems as described below.

Plants that supply water intended for human consumption, with an output less than 10 m³ a day or serving less than 50 persons are exempt from the requirements of the WIHC Directive in the case of individual applications. In the case of public water supply, MoH simply asks for water analysis and monitoring of certain parameters only once a year. Since ADS targets mostly small rural communities, plant capacities are very likely to be below 10 m³/day and could directly be operated without a license from MoH. Tourism facilities who intend to operate small-scale ADS for their own freshwater requirements also do not need to get a license from MoH.

The allowance for installation of treatment plants in coastal regions after 50m distance from the sea line is also a positive factor for ADS implementation in coastal regions which operate with seawater.

The procedures required for renewable energy plants are quite straightforward, and managed by a single authority, which is the EMRA. License applications are simple and finalized within 60 days from the date of application. The major positive aspect of the current legislation on renewables is that RES operators producing electrical energy for their own needs and which are not connected to the grid are exempt from license requirements. Hence, ADS in rural areas which are commonly designed to operate independent from the grid do not require licenses regarding renewable energy utilisation.

Recommendations

- The simple processes and numerous exemptions from licensing procedures should be used more actively for ADS installations
- As the technology develops, a single license procedure should be drafted by the ADS community and presented to the authorities for adoption
- Standards for brine disposal should be set out under the relevant regulation.
- Regulations should allow commercialisation of desalinated water
- Additional incentives like VAT reductions for RE equipment could be introduced as well as for desalination components to be used in ADS

2.5 *Water prices and subsidies in Turkey*

2.5.1 Water prices

There is no fixed water tariff applied across the whole of Turkey. Prices are determined on a municipal basis. Pricing of municipal water supply is managed by the Municipal Assembly of the responsible municipality. Tariffs are decided each year by a majority of votes in the Assembly independent from other governmental organisations.

Water tariffs screened across the country have shown that the prices and the scales in tariffs vary from region to region, from metropolitan cities to towns and also vary according to the intended use of water supplied and available conventional water resources. An idea of the price ranges for the first $10m^3$ of domestic water consumed per month is given in the following table:

	Price range (TRY)	**Price range (Euro)**
Cities	0.7 – 1.64	0.39 – 0.9
Towns	0.4 - 1.2	0.22 – 0.66
Irrigation water	0,12 – 1.1	0.06 – 0.60

In many cases there are exceptions and special treatment. For example in İzmir tourist related businesses are billed at lower prices. The same applies for governmental units like schools and hospitals in Fethiye and Istanbul.

Many municipalities adopt water tariffs lower than the actual cost of water supply mostly due to political reasons. There is no direct support from the central government to cover this extra cost. However, the common practice is to use either shares distributed by the Bank of Provinces which are proportional to the population of the municipality or the taxes applied to real estate.

As discussed earlier there is a regulation that obliges municipalities to charge certified tourist complexes at the lowest rates available.

2.5.2 Implications for the implementation of ADS and recommendations

Charging for municipal water at lower rates than its real cost distorts the fair competition between the various water supply options. Private entities that consider developing their own water supply solutions, and thus would help the municipality to reduce related investment and operation costs, are discouraged because of the low water prices.

However, the fact that municipalities do often subsidise water supply from their own resources can be used to raise some initial support for ADS. In areas where the conditions are favourable, when new water infrastructure is needed, ADS should be promoted by the scientific community and the industry. The high initial costs can be supported from some of the programmes mentioned in Chapter 2, while any additional difference between the running costs and the established tariff can be covered by the municipality as is currently common practice.

The incentives applied to certificated tourism plants on water prices place an extra financial burden on municipalities that decide to provide their citizens with drinking water below its real

costs. Tourist complexes would normally be interested in ADS implementation because they have need for high quality water, with the peak demand coinciding with the maximum availability of solar energy. Therefore the provision of very low priced water to them is a very negative practice for ADS and does not send the right signals to the hotel owners. As suggested already this support scheme should be redesigned.

Recommendations

- The municipalities should charge actual costs for water supply to allow development of alternative solutions where feasible
- Alternatively the municipalities should establish mechanisms to identify themselves the best alternative, which may be ADS. For that, contacts with the academic community and the industry should be developed

2.6 Institutional framework of the water sector in Turkey

2.6.1 Main water actors

Management of water services in Turkey is vested in the public sector. Several governmental institutions play a role in the development, conservation and exploitation of water resources for drinking, irrigation, industrial purposes, and tourism as well as in planning, implementation, monitoring and auditing national water infrastructure and resource protection. These actors operate within their establishment laws and legal frameworks. The main water actors in Turkey can be listed as:

General Directorate of State Hydraulic Works (SHW) under aegis of Ministry of Energy and Natural Resources (MENR): It is the main executive state agency responsible for planning, development and management of all water resources and the main actor in the water sector. It was established in 1954.

Ministry of Agriculture and Rural Services (MARS): It is the responsible state agency for developing policies and providing all necessary infrastructures (roads, water supply, sewerage, electricity) for the development of rural regions, and conducting related research, inventory and planning activities. These were also defined under the responsibilities of the former General Directorate of Rural Services (GDRS) before they were transferred to Provincial Governances on the local level.

Bank of Provinces (BoP): It serves municipalities in financing public works such as water and wastewater treatment plants, water supply systems, etc. The bank itself also has technical capacity to perform construction of such plants on behalf of the municipalities or it may sell or allow municipalities to rent necessary equipment.

General Directorate of Electric Power Resources Survey and Development Administration (EPRSD) under aegis of MENR: It is responsible for performing engineering services to produce electrical energy from water (hydropower) and energy resources (geothermal, renewables, etc). It also assumes a role as an investor.

Ministry of Environment and Forestry (MoEF): MoEF is responsible for developing policies and principles to prevent pollution of water resources and to provide control and auditing services.

Ministry of Health (MoH): MoH is responsible for licensing and monitoring of water intended for human consumption.

Ministry of Foreign Affairs (MoFA): MoFA is responsible for coordination of national and international policy formation and implementation regarding water issues.

State Planning Organization (SPO): SPO is the policy making and coordinating agency of the state. It prepares long-term development plans including distribution of investments among sectors and among governmental institutions such as SHW and BoP. It monitors and coordinates the water sector.

These actors assume different responsibilities generally distinguished by the state of the work, that is, as the planning state or the executive state. Referring to the application in Turkey it is also possible to classify these organizations according to the activities in urban and rural settlements and the population they serve. Ministry of Energy and Natural Resources (MENR) is the main body, which has the overall responsibility and control on the water issues of Turkey.

However, the State Hydraulic Works (SHW), with a legal entity and supplementary budget, is the primary executive state agency of Turkey responsible for the nation's overall water resources planning, managing, execution and operation.

The water supply though is managed on the local level. The actors involved in that process include:

Metropolitan Municipalities and/or municipalities: Municipalities are the basic actors to provide water services in settlement zones. They work very close with SHW as it is the only authority, which is empowered to manage the water resources. Local administrations have to seek permission from SHW to use surface or ground water resources. SHW also may provide services such as construction of transmission lines and necessary pumping stations to local authorities and then transfer operation and maintenance of these to local administrations only if they have adequate staff and facilities.

General Directorate of Rural Services (GDRS): GDRS is responsible for supplying water and making necessary arrangements for satisfactory environmental health conditions in villages, rural districts and military garrisons. The regional directorates of SHW and GDRS both serve the rural settlements for the supply of domestic, industrial and especially irrigation water.

Villages (village councils and the director): Village head 'muhtar' and the selected council coordinate operation and maintenance of irrigation activities in line with governmental authorities. SHW may also transfer the constructed irrigation schemes to the muhtar.

Irrigation Associations (IA): IA, composed of governmental authority representatives, are formed under Municipal Law with support from the World Bank in accordance with the adoption of a privatisation approach after 1993, in order to reduce the financial and administrative burden of SHW and GDRS.

Irrigation Cooperatives (IC): IC are legally formed under the aegis of Cooperation and Maximization Department of MARS at the request of interested farmers, who are to own and operate the IC. Cooperation management is most common among the irrigation schemes developed by GDRS.

The various water sector actors their responsibilities, roles and interactions are analysed in depth in a separate report, project deliverable 4.1 of the ADIRA[3] project [1, 14].

2.6.2 Implications for the implementation of ADS and recommendations

The institutional framework of the water sector in Turkey is rather complex. Many governmental agencies are involved in water related services causing overlapping authority, mainly between the Municipalities, SHW, MoH and MoEF. In the case of water resources planning and utilization SHW is the ultimate authority, however water supply services are mainly delivered and mostly financed by Municipalities. MoH and MoEF intervene with licensing of water intended for human consumption and discharges to receiving bodies.

The current institutional set-up is based on traditional, supply oriented, centralised water supply models. This set-up traditionally favours established solutions rather than innovative and

[3] www.adira.info

decentralised approaches. However, as already mentioned in chapter 2, the there is a general shift towards decentralisation. The Ministries of Health, Culture and Tourism, Environment and Forestry, Agriculture and Rural Services, Energy and Natural Resources, Trade, and Public Works and Settlement, many of which interfere with water issues, are not allowed to establish any local units anymore. Existing units of these ministries within the borders of the municipalities are transferred to the municipalities and others to Provincial Governments.

This reconstruction is expected to simplify things and to encourage the acceptance of local solutions based on the available resources, solutions like ADS. Therefore the full enforcement and implementation of the decentralisation plans should be supported and followed-up by all ADS involved parties.

Currently the private sector is not much involved in water supply except for a few examples of dam managements. The main area where the private sector dominates is the trading of bottled water. The importance of the private sector is already recognized in development plans which are formulated to involve incentives for privatization of water and sewerage plants management and ownership, while municipalities would assume supervisory roles.

Private sector involvement will allow for case specific applications in a more dynamic environment, which in some cases may favour implementation of ADS rather than conventional solutions such as constructing transmission lines to transfer water from far-away basins. However, we have seen that the municipalities in many cases supply water below cost and subsidise this by other activities. The private sector will not be willing to provide subsidies and the prices will increase. Taking into account the relatively high cost of water produced by ADS, this may cause difficulties to consumers to cover the increased expenses for water and this may result in socioeconomic problems. Therefore in arid but socially sensitive areas the introduction of privatisation in the water supply has to be done carefully. In some cases the municipalities may be a more suitable ally for ADS than the private sector.

Recommendations

- The ADS community should ensure that the creation of a more decentralised institutional set-up will be completed and fully enforced.
- The privatisation of water supply services should proceed carefully, ensuring that socio-economic sensitive areas have a smooth transition from the subsidised regime.

2.7 *Capacity building and awareness raising in Turkey*

2.7.1 The existing capacities and awareness

The two main desalination practices are the membrane based systems and distillation technologies. Both are well-established in Turkey and are used in various industrial applications as well as in a wide capacity range of drinking water production systems.

In the renewable energy sector, there are more than 30 companies operating in Turkey. They import and trade products like photovoltaic modules, photovoltaic power systems, solar outdoor lighting systems, batteries and charge controllers. These companies also provide services such as installation, engineering and project development.

Although both desalination and renewable energy systems are established and fast growing in Turkey, there are currently no ADS available "off-the-shelf". Project developers can combine the two technologies but there are technical challenges involved and know-how in the field should be further developed.

Turkish Universities and Technical Institutes provide high-level training of scientists, engineers and technicians. As a result, the private and public sector have well trained personnel that deal very well with established and emerging technologies. However, no higher education courses have yet introduced modules on ADS, neither at undergraduate or post-graduate level.

Awareness about ADS options is very limited in Turkey, similarly to most countries. There are some scientists involved in relevant research and some authorities that host pilot programmes. Apart from that, and sporadic scientific events, no knowledge on the possibilities and benefits of ADS exists in Turkey.

On renewable energy in general the situation is much better. The scientific community is very much aware of the possibilities and very active in further development and international cooperation on the issue. The authorities develop and put in place incentives to promote and help the development of alternative energy systems.

In parallel the general public becomes more aware of renewable energy options and their benefits. In a study conducted in 2003 on '*Understanding level and public perception of the PV Systems in Turkey*' of a wide range of electricity consuming establishments and households the main results were as follows:

- 75% has no knowledge of alternative energy sources;
- 29% would not consider using any form of alternative energy;
- if alternative energy sources were to be used, 28% would prefer PV systems;
- 96% would change the negative answers if adequate subsides were applied.

Results clearly show that there is room for improving public awareness on renewable energy systems.

2.7.2 Relevant research and training activities

Membrane-based separation processes and industrial applications of membranes, like water treatment, recycle and reuse are widely studied in many institutes and companies. The major

universities actively involved in membrane research studies and partnerships with the industry are: Istanbul Technical University (ITU), Bogazici University, Dokuz Eylül University and Istanbul University. These universities offer courses on water and wastewater treatment in their environmental engineering departments. They do not have courses which provide training specifically on desalination technology. The exception is ITU which offers more specific courses i.e:

Istanbul Technical University

Environmental Engineering Department- EED[4]

Related courses offered by the EED are *Theory of Filtration* and *Separation Techniques* (types of processes, types of membranes and their applications in water and wastewater treatment, reverse osmosis, nanofiltration, ultrafiltration).

Department of Chemical Engineering[5]

The department offers undergraduate courses on *Separation Techniques* (Introduction to separation techniques based on phase equilibrium, diffusion and rate processes, analysis and calculations of separation techniques, equilibrium stage and counter current operations, calculations of separation equipment based on sedimentation, filtration, distillation, evaporation and extraction) and also special courses offered for graduate studies on membrane based separation techniques, clean energy and applications

Part of the related graduate level research is dedicated to membrane based desalination. More specifically, theses commonly cover topics such as reverse osmosis and nano-filtration applications for various salinity ranges, membrane compositions, measurement and improvement of membrane stability, mass transfer in membrane processes and organic ion effects.

Research in the field of water also includes development of methods to increase the amount of water supplied such as: cloud seeding, increased use of groundwater, re-use of wastewater, and desalination of sea and brackish water. These have been studied to assess economical viability and technical feasibility to ensure sustainability of such systems.

TUBITAK (Scientific and Technological Research Council of Turkey) is the public agency in charge of promoting, undertaking and coordinating research and development in line with the national targets of economic development and technical progress [15]. TUBITAK acts as an advisory agency to the Turkish Government on science and research issues, and is the secretariat of the Supreme Council of Science and Technology, the highest science and technology policy making body in Turkey. TUBITAK is the executing agency in deployment of international scientific and technological agreements. In this context, it is the national coordinating body of EU Research Framework Programmes.

One of the major interests of the Electric, Electronics and Informatics (EEI) Research Group under TUBITAK is energy. The EEI Group plans, supports, manages and monitors research and development studies, sets priorities, and works to develop services and products from the results of the research studies. EEI evaluated the natural wind energy potential over the country using monthly wind speed and directions from the State Meteorological Institute (SMI).

[4] http://www.ins.itu.edu.tr/cevre

[5] http://www.kimyamuhendisligi.itu.edu.tr/english/index.php

At the second phase, measurements were taken at locations determined to be promising in wind energy. For this purpose, automated wind data acquisition stations have been installed. In addition, the Turkish Wind Energy Association plans to prepare a wind atlas of Turkey jointly with SMI, EPRSD and Bilkent University.

EPRSD is the General Directorate of Electric Power Resources Survey and Development Administration under the MoE. Its solar energy branch has been conducting research, development, awareness-raising, and demonstration studies since 1982 [16]. Since the existing meteorological data was not technically sufficient for the assessment of the solar energy potential, EPRSD has initiated a project in cooperation with the State Meteorological Institute (SMI). The aim of this project is to determine the actual solar potential nation wide. Solar data acquisition systems have been installed in 8 locations and the overall results will be available very soon.

The TUBITAK-Marmara Research Centre is a leader in solar energy research projects. In addition research on PV power systems and applications are carried out in 32 Universities with over 300 researchers and 3 Research Institutes with over 80 researchers. Major universities involved in solar studies are:

Muğla University

Physics Department[6]

The physics department offers undergraduate courses on Semi-conductor materials and Devices (production techniques, physical and material properties, production of semi-conductor devices, p-n joints, metal- semi-conductor joints, solar cells, transistors) and Solar Energy (Sun, light and materials, photo thermal phenomena, flat-plate solar collectors, concentrators, heating and cooling with solar energy, direct conversion of solar energy to electrical energy, solar cells and collectors, photovoltaic applications). The department also offers special courses for graduate studies on theory and application of solar energy.

Clean Energy Resources Research and Development Centre[7]

The Muğla University Clean Energy Research and Development Centre was established in 1996. Currently 3 professors, 5 assistant-professors, 6 MSc and 1 BSc physicists are working for the centre. The major fields of activity are fundamental studies on electrical, optical and structural properties of photovoltaic devices based on crystalline silicon as well as thin film ternary compounds. The centre provides funding and other opportunities for researchers in the field.

Istanbul Technical University

Energy Institute - Renewable Energy Branch (REB)[8]

REB was established under the Energy Institute and it has been offering MSc and PhD programs since 2001. The related courses included in the graduate program are; Active and Passive Solar Energy Systems, Wind Energy and Conversion Technology, Geothermal Energy, Bioenergy Recovery from Organic Wastes, Direct Energy Conversion, Modelling and Design of Renewable Energy systems.

[6] http://fizik.mu.edu.tr/indexe.htm

[7] http://mutek.mu.edu.tr/eindex.html

[8] http://www.energy.itu.edu.tr/EN/index.htm

Faculty of Electrical and Electronic Engineering, Electrical Engineering Department (ElED)9

ElED offers graduate courses on Electrical Systems (Design, Optimisation and Control) including renewable energy systems. The department also conducts projects on renewable energy application projects, as for example the “solar race cars”[10] .

Middle East Technical University

Mechanical Engineering Department[11]

The department offers two related courses in its undergraduate program which are Energy Conversion Systems and Introduction to Solar Energy Utilization. The course includes topics such as: nature of solar radiation, calculation and measurement of insulation on horizontal and tilted planes, transmission of solar radiation through glass and plastics, flat-plate collector, theory and performance of concentrating type collectors, heat storage, use of solar energy for power production, miscellaneous uses such as distillation, cooking, cooling, and laboratory practice on solar radiation. At graduate level, the course “Advanced Solar Energy Utilization” is offered and also special studies on alternative energy systems may be conducted as MSc and PhD thesis.

Physics Department[12]

The undergraduate programme offers two courses. Solar Energy-I which includes measurements and estimations of solar radiation, calculation of solar energy reaching inclined surfaces, fundamentals of heat transfer and applications to renewable energy, projects on low and high temperature renewable energy conversion and on other renewable energy sources. The second course is Solar Energy-II which includes: introduction to physics of materials; material science aspect of photo - thermal solar energy conversion; and projects on renewable energy, like energy efficient windows, smart windows, transparent insulation, principles of photovoltaic conversion, and others.

At graduate level, the course named Physics of Solar Energy describes solar thermal properties, solar materials, and alternative energy sources. There are also opportunities to conduct graduate theses on special topics.

Ege University, Solar Power Research Centre[13]

The institute provides extensive training on solar energy and its applications. Courses offered allow graduate and undergraduate students to reach a competent level of knowledge on related topics through specialised training. The courses include: fundamentals of solar energy, alternative energy sources, solar and other renewable energy sources, system analysis, fundamentals of geothermal energy, biomass energy, fuel cells, principles of wind energy, solar collectors, reactions of photo degradation in industrial water, renewable energy applications, solar energy laboratory, flat-plate collectors, energy storage, automatic control in solar systems, use of renewable energy sources in agriculture, photovoltaic systems, industrial energy management, solar photochemistry and solar photochemical production.

[9] http://www.elk.itu.edu.tr/0index.html

[10] http://www.ariba.itu.edu.tr/ project

[11] http://www.me.metu.edu.tr/

[12] http://www.physics.metu.edu.tr/

[13] http://bornova.ege.edu.tr/~egegunes/

Although research on desalination and on renewable energy is advanced, very few research organisations and researchers are involved in studying the combination of both technologies and the development of ADS. One of the few examples is Istanbul Technical University that has installed 2 PV-powered pilot desalination plants in the Fethiye region to desalinate brackish water at a capacity of 2 m^3/day within the scope of the EU supported MEDA project ADIRA (2003-2008). Within ADIRA, awareness raising activities also took place as well as analysis of the potential of the technology to cover the water needs in arid regions and the market. Some lab-scale research is also being conducted individually by university branches.

2.7.3 Implications for the implementation of ADS and recommendations

There are a significant number of companies active in both the desalination and the renewable energy fields in Turkey. This is an important pre-requisite for the ADS market to develop further. The 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 probably followed.

The conditions on this aspect are very promising for ADS. Still, quicker ADS deployment could be achieved by raising awareness about ADS and its techno-economic characteristics among the appropriate Turkish companies and service providers. Networking and establishing contacts with European and international technology producers would also accelerate ADS market penetration. The research institutes active in the field and the relevant associations are best placed to initiate and organise such events.

In Turkey there is currently no production of solar cells which results in relatively high prices for PV. The development of production facilities would be beneficial for the ADS objectives as well as for the long-term prospects of the Turkish economy in general. Similarly, production facilities of spare parts for the desalination systems would also lead to lower ADS prices. Indigenous production is an important strategic decision, especially in view of the potential market in the wider region. Therefore, the government should encourage and support the establishment of such initiatives.

Awareness about 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. Earlier we referred to the necessary actions for companies in the field.

The authorities, especially the municipalities in arid areas, should be also informed about the ADS solution and its benefits. In parallel there should be extensive information about the relevant support programmes for financing water supply infrastructure, as presented in Chapter 2. Such information should initially be presented in high-profile regional events. When a database of contacts from authorities of particular relevance has been built, updated information can also be provided by targeted personal communication. Training for the technical personnel involved in water services is also crucial; in cases where an ADS is installed the training should be the responsibility of the installing company.

Among the general public, recognition will come at a later stage, most possibly through the companies and authorities when the first round of awareness campaigns has been

successfully completed. Still, the first pilot and demonstration units, as well as the efforts in the research institutes should try to maximise the dissemination of their results, with exposure in the general media, both on national level and on the local level in areas that have a high-potential for ADS implementation. The end-users should also become more familiar with the importance of water quality. Quality of water supplied, particularly for rural sites, is often unsatisfactory. The low income rates of the public also require the service providers to apply low rates, which can result in poor services.

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 do 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 graduate and post-graduate courses. This way there will be higher awareness amongst students and specialists in the future work-force of Turkey who will work in both the private and public sector in technical, managerial or decision making positions.

Although some institutions have been working on renewable energy and its applications for over 20 years, research and development studies on RES has just started to yield positive results. The main problem is the lack of solar and wind data recorded in a way that could be exploited for RES design. As mentioned in the previous paragraph, there are currently studies which will result in a wind atlas and a reliable solar database. Extended research is now going on and the studies of Mugla University on PV applications have proved their feasibility in the region. This is very promising for ADS implementation in the tourism sector of the Aegean and Mediterranean regions.

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

It is important that the governmental institutes, public and private sectors, and researchers and NGOs develop a common set of priorities in water supply and renewable energy utilisation priorities which are in line with the outputs delivered by the scientific research carried out in the country.

Recommendations

- Awareness raising among appropriate Turkish companies. Networking with international technology producers facilitated by the relevant associations.
- Local production of RES and membranes equipment should be encouraged and supported by the government.
- Targeted information to municipalities about ADS benefits and the available support programmes in Turkey.
- National and local media coverage of promising results from pilot and demonstration ADS.
- ADS basics including technical, environmental and economic issues should be included in the curricula of relevant university courses.
- Research in Turkey on ADS development and adaptation to the local conditions should be promoted and supported.

2.8 Conclusions for Turkey

The framework conditions in Turkey overall are relatively favourable and do not pose unnecessary barriers to the implementation of ADS. The policy trends for decentralisation and involvement of the private sector in water supply are expected to favour ADS where it is a suitable option. There are various programmes that offer support for the implementation of water supply and renewable energy projects, especially in the rural areas. This way financing for part of the ADS capital costs can be secured improving the economics of the system. In addition, there are regulations that foresee simplified administrative procedures for small water supply units and renewable energy systems.

On the other hand, there are various facts that hinder quick ADS development. The general water policy and the personnel in the responsible authorities are traditionally oriented towards conventional centralised solutions. Furthermore, a new programme intending to support the development of the tourism industry offers incentives that are counter-productive and not in-line with the water and energy set policy objectives. The governmental awareness about ADS is very low and the research in the field still restricted.

A lot of work has to be done to improve the framework conditions. In this report, concise recommendations have been developed that suggest simple steps for the establishment of ADS in Turkey. These recommendations cover many different fields and have to be realised by coordinated and targeted activities that involve various actors. In order to bring together the critical mass required for these activities, international cooperation is necessary among all parties that have similar objectives; from NGOs that advocate sustainable development to companies that produce the technology and researchers active in the field.

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3 Morocco Country Report

3.1 List of Acronyms and Abbreviations for Morocco

ADS	Autonomous Desalination Systems
ADIRA	Autonomous Desalination System Concepts for Seawater and Brackish Water in Rural Areas with Renewable Energies
BOT	Build Operate Transfer
CBH	Communal Bureau of Hygiene
CDER	Centre for Renewable Energy Development
EIA	Environmental Impact Assessment
EU	European Union
INDH	National Initiative for Human Development
IPP	Independent Power Producers
IWRM	Integrated Water Resource Management
KFW	Kreditanstalt für Wiederaufbau (German Reconstruction Credit Institute)
MATEE	Ministry of Territorial Management, Water and Environment
MEM	Ministry of Energy and mines
MEMWE	Ministry of Energy, Mines, Water and Environment
MEDA	Mediterranean Development Assistance fund
NGO	Non-Governmental Organisation
ONE	National Office of Electricity
ONEP	National Office of Drinking Water
PAGER	Programme for the provision of potable water to rural populations
PERG	Programme for increasing rural electricity access
PNE	National Water Plan
PV	Photo Voltaic cell
RE	Renewable Energy
SHS	Solar Home Systems
SMMD	Membrane and Desalination Society of Morocco
UNDP	United Nations Development Programme
VAT	Value Added Tax

3.2 Introduction to Morocco

Water resources in Morocco are characterized by their large regional variability and increasing scarcity. The situation is worsening in recent years due to reoccurring droughts. Therefore, the efficient exploitation of available water resources (conventional and non-conventional) is becoming more and more important, especially in remote areas. New institutional measures are being anticipated and desalination has emerged as one of the alternatives for fresh water supplies.

This report examines the relevant points of the water and energy sectors in Morocco and their positive and negative impacts on the development and implementation of Autonomous Desalination Systems (ADS).

The points examined include:

- Existing policies and programmes;
- Legislation and administrative issues (procedures, permits, VAT);
- Water prices and subsidies;
- Institutional Framework
- Capacity building and awareness-raising.

Concrete recommendations are formulated in order to strengthen the positive impacts on ADS and to eliminate the negative ones in each case.

3.3 Relevant policy and programmes in Morocco

3.3.1 Water sector

The policy of the country in the water sector is driven by increasing urbanisation, fast development, extension of irrigated land, development of tourist infrastructures (hotels, golf fields, host houses etc), and generalisation of access to drinking water in urban and rural areas. On the other hand the policy has to deal with increasing drought periods, population growth and improvement in the standard of living. Together these factors put severe pressure on water resources and the volume of water that can be mobilised per capita under normal climatic conditions has already reached its maximum. The impact of climate change and the succeeding shortage in rainfall aggravate the situation further. The mobilisation of every water resource is becoming increasingly necessary including non-conventional resources like brackish, sea and waste water, and the rational use of water especially in agriculture.

The strategic orientation of the water policy includes: demand management (including generalisation of access to fresh water supply), evaluation of water resources, development of the participative approach, decentralization of water management and solidarity between various users.

A National Water Plan (PNE) was put forth by the water authority (MATEE) in this regard and is currently subject to national debate as described later. The main points of PNE can be summarised as follows:

- Secure drinking water supplies for urban areas and accelerate the generalisation of access to drinking water for rural areas. For supporting this the PAGER programme has been introduced (see below);
- Mobilize all surface waters by the construction of dams;
- Preserve water resources and water quality by instituting the “user-pays” and the “polluter-pays” principles;
- Resort to non-conventional water resources, like waste water for irrigation and desalination of water for drinking purposes;
- Transfer of water from basins with a surplus of water to others suffering from a deficit;
- Promote demand management and water saving in irrigation. Agriculture consumes more than 80% of the available water resources. Significant progress can be made by introducing modern irrigation techniques as well as the rehabilitation, modernisation and proper maintenance of existing irrigation infrastructure in order to reduce the water losses in the distribution networks;
- Promote rational water resource management and preservation of the quality of water resources;
- Promote financial sustainability of water service providers.

For rural areas and locations at water stress risk **PAGER** has been launched by the government for the provision of fresh water. The “Programme d'Approvisionnement Groupé en Eau Potable des Populations Rurales” (PAGER) started in 1995 with financial support from numerous origins: UNDP, Kuwait Funds, MEDA programme, French Agency for Development (AFD), KFW, Belgian and Japanese Governments and others. It was initiated by the Ministry of Equipment and Transport, but since 2006 the National Office of Drinking Water (ONEP) has been in charge. PAGER mainly supports the provision of public water points, which comprise the construction of wells, pump systems and reservoirs. The percentage of rural population that

has access to water (access rate) has considerably increased from 14% in 1994 to 70% in 2006. The strategic goal of the PAGER programme is to achieve a 90% access by 2010.

The preferred management concept in PAGER is the establishment of a users association which ensures the operation and maintenance of the equipment through the revenues of the water sales. The populations can also delegate management to a manager-guardian. The financial contribution is distributed as follows:

- Governmental contribution (25%);
- Beneficiary communities (15%);
- Funds from the national solidarity act (15%);
- Loans and grants (45%) – usually from international financial institutions.

The "National Initiative for Human Development" (Initiative Nationale pour le Developemnent Humain) **INDH** has been launched in September 2005. INDH is an innovative programme to reduce poverty and social exclusion in Morocco. It aims at consolidating the basic infrastructures and social services in the water, wastewater, education and health services. INDH is a Community-Driven Development (CDD) programme which relies on a participatory approach. The programme is divided in four sub-programmes:

1. Fight against precariousness: this programme is dedicated to selected communes which are in precarious (at risk) conditions;
2. Fight against poverty in rural areas;
3. Fight against social exclusion in urban areas;
4. The transversal programme dedicated to improving access to basic infrastructures, social services, income generating activities, cultural activities and capacity building.

The first three programmes concern targeted communes and neighbourhoods (rural or urban) selected at the national level after regional studies and participatory diagnostics.

Under the fourth programme a call for projects is issued and is open to communes, associations, NGOs, cooperatives and other relevant stakeholders. They can express their interest and prioritise their needs. The selection is done by a regional INDH committee. This process is designed to strengthen local decision making and empower local communities and local governments. NGOs and village associations play an important role in this programme. ADS can benefit from the funds offered by the second and fourth sub-programme in the framework of the access to basic services especially drinking water supply. The criteria used for the selection of the projects include:

- Adequacy of the project with the defined objectives of the programme;
- Feasibility;
- Extent to which the project respond to the local needs of the populations;
- Effectiveness and Sustainability;
- Contribution to the financing either directly or indirectly;

Recently two important national debates were organised by the government; one on Energy policy in October 2006 and the other on Water policy which started in November 2006 and is still going on at the levels of the different river basins. The **national debate on water policy** was first launched on a national level in Rabat in November 2006 by the Prime Minister. Then it

was followed-up by the thematic workshops in December 2006. Regional meetings are planned on the level of the seven main basins (agencies). The debate aims to:

- Share information and discuss the water situation;
- Define and share the objectives of the new water policy;
- Reinforce the participation of all stakeholders;
- Collect at different levels of the country (both geographically and institutionally) the elements to elaborate the National Water Plan (PNE).

3.3.2 Energy Sector

Morocco imports 95 to 97% of its energy because it does not have any major conventional energy resources like oil, natural gas or coal. This energy vulnerability has prompted the government to diversify the energy resources of the country. Major efforts are now devoted to the development and exploitation of renewable energy (RE) sources like wind and solar. This is manifested by different initiatives:

- The recent construction of wind farms in Tetoaun (54MW) and Essaouira (60MW). Others are planned in Tagier, Taza and in the southern cities (e.g. Laayoune, Dakhla, Tarfay);
- The Rural electrification Solar Home systems (SHS) under the PERG programme;
- The provision of fresh water supplies by photo-voltaic (PV) water pumping. It is expected that rural electrification will be widespread by the end of 2007. Renewable energies will contribute about 7% of electricity production. On the other hand, the strategic national energy plan calls for a 10% overall share and 20% of electricity produced from RE by 2012.

The National Energy Policy aims at improving energy supply, particularly in rural areas, and reducing energy dependency. This will be done by:

- Securing and improving the energy supply by encouraging private investments (independent power producers, alternative energy sources, interconnection with Europe);
- Rationalising demand for conventional and wood energy (energy conservation, alternative renewable energy sources, tariff adjustments);
- Generalise access to electricity for the rural population;
- Restructuring the energy sector. The hydrocarbon sector has already been liberalised. The electricity sector is still awaiting liberalisation.

In 1996, a reviewed electrification programme – the Programme pour l'Electrification Rurale Global (PERG) - was launched by the National Office of Electricity (ONE) with the aim of generalising access to electricity in rural areas. An elaborated master plan defined areas and villages which will be supplied by grid extension and renewable energies mainly Solar Home Systems (SHS). Approximately 6,000 villages comprising 200,000 households will be supplied by SHS by the end of 2007.

The PERG programme that started in 2000 tendered the installation, maintenance and service of SHS. ONE now follows the "Fee for Service" approach when providing SHS. Upon a tendering process, private operators supply the PV kits and provide the maintenance for 10 years including the replacement of defective systems and the provision of spare parts. The

service provider receives 55% of the system cost from a ONE subsidy and 45% from the beneficiary who makes a down payment (700 DH for the 50 Wp system) and monthly payments of 65 DH for 10 years. For electrification by grid extension, the financial contribution is divided among ONE (55%), and the balance is provided by the local communes and the beneficiaries. Beneficiaries pay either the whole connection fee (2025 DH) or a monthly payment of 40 DH for 7 years.

To further promote the use of RE, particularly PV and solar water heaters, a training and entrepreneurship programme was launched recently by CDER (Centre for Renewable Energy Development). The programme is called Energy House (Maison d'energie) and it encourages young entrepreneurs to create energy services locally in rural and urban areas. This initiative was supported by UNDP, the government of Andalusia, the Ministry of Energy and Mines, ONE and other national stakeholders. By 2004, 100 small enterprises were created in rural and urban areas and 500 more are underway. In rural areas, these energy houses provide services such as battery charging, installation of PV kits and general maintenance of the systems.

The challenges that the energy sector is facing were defined and discussed by stakeholders in the recent National Debate on Energy. Emphasis was put on the promotion of RE in the energy mix in order to reduce the dependence on foreign energy sources (security of supply) and also to reduce the energy bill which weighs heavily on the budget of the state as a result of subsidies of some energy products (certain fuels, butane for example). Different recommendations were formulated: enactment of legislation regarding RE and energy conservation in buildings, industrial sector, etc; increased grid access; sales tax reduction for renewable energy components from 20 or 14% to 7%[*]; and the need for a strategic energy plan defining the role of the State.

3.3.3 Implications for the implementation of ADS and recommendations

The national policy recognises as priorities both the exploitation of non-conventional water sources and the penetration of renewable energies. This political support is favourable for ADS. At the same time, the sustainable development of rural areas is also high on the policy agenda as well as the decentralisation of water management which can also benefit ADS. However, there is no explicit mention of ADS in the policy documents because water and energy policies are developed independently and because the combination of RE with desalination is relatively new concept in the country. It is the task of scientists and the industry to ask for the inclusion of ADS in policy documents like the National Water Programme (PNE) by explaining how ADS meets the expressed policy objectives. The on-going National Debate on Water Policy in the main river basins is an ideal platform for such awareness-raising. This was done recently by FM21 in the national debate meeting held in Marrakech (2-3 February 2007) for the Tensift basin.

One of the main results of the recent national debate on energy is that sales taxes (VAT) will be reduced to 7% for RE accessories. Such positive measures should be strengthened and extended to sustainable water equipment; especially desalination technologies which can proven that they will be connected to RE for potable water production.

There are many programmes supporting water and RE infrastructure in rural areas, like the INDH programme. Implementation of ADS in remote areas where this is the only economically viable option can benefit from this programme. The concerned communes, village associations

[*] The actual VAT rates are 20% if only RE equipment are purchased and 14% if installation is also included

and NGOs can apply for financial support in the framework of the INDH programme. This is actually the case for two communes where ADIRA pilot plants will be installed. However there are two main awareness issues to be addressed for this potential to be realised. First, the local groups have to be aware about the possibilities INDH and other programmes have to offer. This is partially addressed by the programmes themselves and should be supported by ADS stakeholders. Second, and most important, is that the local communities are not aware of ADS options and benefits. This issue will be analysed in Chapter 6 of this report.

The investment costs of ADS units are still high compared to the very low income of rural population. The innovative financing schemes implemented within PERG combining grants, interest free loans and technical support are good practice for dealing with such problems and have created valuable know-how in rural areas of Morocco as well as in the central administration. A similar scheme should be introduced for ADS, probably within PAGER. However ONEP, which is in charge of the PAGER programme, does not consider ADS for small rural agglomerations as it is a relatively new technology and is not well known. In addition there are so many dispersed water supply problems that ONEP has to establish priorities taking into account economic and social aspects like tourism activities, population density and the cost of the unit of freshwater. Still, the ADS community has to promote selected ADS applications within PAGER in suitable sites. This way the local technological know-how will be improved and more reliable cost data for on-site ADS application will be available which will allow for fair treatment of the ADS option in the future.

As ADS becomes established as a reliable solution, financing mechanisms like social-type connection fees and financing of the ADS unit have to be developed in order to support the effort already done by the INDH programme.

The “Energy House” programme has created an extended network of small enterprises offering maintenance services for PV. This very valuable experience has to be used to design similar courses and initiatives targeted to ADS, parallel to other support programmes. In particular the existing centres can be used if they extend their expertise to cover ADS as well.

Recommendations

- Active participation in the national water debate from all relevant actors to promote ADS consideration in the PNE.
- The VAT reduction for RE should be strengthened and extended to sustainable water equipment.
- Use the positive experiences from PERG and other programmes where innovative financing schemes were implemented to provide financial support for poor communities interested to adopt ADS.
- Multiply pilot actions like those in ADIRA to demonstrate that ADS units could be a good alternative for fresh water supply.
- ADS community should support the effort of programmes like INDH to create awareness about the possibilities ADS offers on the local level.
- Build on the Energy House experience and train targeted technicians in ADS maintenance and operation.

3.4 Legislation and administrative issues in Morocco

3.4.1 Water Sector

The 10-95 Law on Water is the main law directly regulating the water sector. It states that water, independently of its form, is a public property (public hydraulic domain) except when water rights are acquired. The public hydraulic domain includes both natural and artificial waters like dams or wells built either by the government or on its behalf for public use. Any action that may affect the public hydraulic domain needs authorisation from the relevant river basin agency. Seawater however is not a part of the public hydraulic domain but belongs to the public maritime domain and is therefore not managed by the river basin agencies but by the Directorate of Ports and Maritime Public Domain which is part of the Ministry of Equipment and Transport. In addition, the 10-95 Law on Water also provides for:

- Integrated and decentralised water planning and management through the creation of river basin agencies;
- The protection of public health by regulating the exploitation, distribution and trading of water for human consumption. Operators are obliged to comply with Standard NM-03-7001MNW which defines the required physical, chemical and microbiological characteristics of drinking water. The Communal Hygiene Services, part of the Ministry of Health, are responsible to monitor this;
- Regulation of activities which may pollute water resources;
- The regulation of underground water use. Thresholds for the minimum depth and flow rate for each river basin are fixed by decree. For example Decree n° 1556-17 October 2002, Minister of Equipment and Transport, for the Tensift Basin.

The Environmental Protection law (11-03 Law) promulgated by the Dahir (Royal Decree, n° 1-03-59, May 12, 2003) defines the basic rules and general principles of national policy in the field of environmental protection and development:

- to protect the environment against all forms of pollution and degradation of any source;
- to improve the framework and the living conditions of the people;
- to establish the basic orientations of the legislative, technical and financial frameworks concerning environmental protection and management;
- to establish a specific mode of responsibility which guarantees the repair of damages to the environment (polluter-pays) and the compensation of any victims.

The Environmental Impact Assessment Law (12-03) states that all projects carried out by any person or entity, either private or public, are subjected to an environmental impact study if they are likely, because of their nature, their dimension or the site, to have negative impacts on the biophysical and human environment. According to this law, a regional or national committee is formed by the Ministry of Environment which evaluates the EIA following a public investigation and consequently issues a decision of environmental acceptability. The costs of this investigation are charged to the project holder. This EIA decision is one of the documents needed to request an authorisation for the project. ADS are not specifically mentioned in the list of projects requiring such assessment.

The Decree n° 2-04-553 of January 24, 2005 applies Articles 52 and 53 of the Law on Water 10-95. It deals with direct or indirect discharges, flows, and deposits in surface and underground waters that can potentially modify the physical, thermal, chemical, biological and

bacteriological characteristics of water. Again ADS (brine discharge) is not specifically mentioned in this decree.

The Communal Chart which rules the organisation and operation of local governments also sets out their responsibilities for potable water supply, sanitation, and wastewater treatment. The local communes can choose any form of management including the creation of Regies or concession. However, the concession to private operators or to ONEP requires approval of the Ministry of Interior.

3.4.2 Energy sector

The main legislation for the electricity sector is the Decree n° 2-94-503 (September 23, 1994) modifying the Royal decree (Dahir) n° 1-63-226 of August 5, 1963. With these decrees the National Office of Electricity (ONE) was created and is regulated as follows:

- ONE has the monopoly for the production of electricity with power higher than 10 MW; productions equal to or lower than 10 MW must be intended for the exclusive use of the producer (auto-producers);
- ONE is also entitled to make a concession, through a call for tenders, to the private sector (Independent Power Producers, IPP), for the production of electric power higher than 10 MW. However, the production is sold exclusively to ONE.

The electricity market is still regulated and the liberalisation is expected by the end of 2007. Two kinds of markets are envisaged:

- A liberalized (free) market, where eligible clients (medium and high voltage clients) are free to choose their electricity suppliers (IPPs, commercial agencies, imports);
- A regulated market, which is structurally similar to the existing one, where ONE is still the grid operator and unique buyer. This market can also be supplied from the first market.

It is also expected that the power threshold for auto producers will be set at 50MW

No specific legislation exists yet for RE installations. Moroccan standards are prepared for some components of renewable energy systems. The Centre for the Development of Renewable Energies (CDER) certifies components including PV Panels, Batteries, luminaries, charge controllers, ballasts.

3.4.3 Relevant administrative procedures and required licenses

The installation and operating of desalination units will require authorisation in respect to the following procedures:

Borehole and well digging require an authorisation from the river basin agency when their depths exceed a threshold depending on the river basin and the site.

Water withdrawal: this also requires an authorisation when the flow rate exceeds a pre-defined value fixed by ministerial decree for each river basin. The Table 1 below gives the thresholds for the Tensift River Agency, as a case study.

Table 1 Tensift River Agency Water Withdrawal Rates*

	Threshold depth (m)	Threshold withdrawal flow rate (m^3/day)			
		Domestic use	Water supply for agglomerations	Agricultural use	Industrial use
Eastern bank of the river	30	5*	50*	40*	1*
Western bank and to the east of Imintanout river	40				
Left bank of Tensift river, west of axis oued Imintanoute_Oued Chichaoua	20				

* No reference is made to brackish water in the Decree. However, private communications asserted that what counts is that water is being pumped from the aquifer, independently of its nature.

The procedures to obtain these authorisations were specified in the Law on Water and subsequent ministerial decrees. The authorisations can be obtained from the river basin agency whose action zone contains the water point. The fees range between 50 and 2500€ for each one of the authorizations depending on the size of the project and the intended use. A single application form cannot be filed simultaneously both for well digging and water withdrawal as the authorization for water withdrawal requires a copy of the authorization of the well or the borehole.

Brine disposal: Although there are no specific laws regarding this issue, the water law clearly provides for the protection of water resources. Direct or indirect discharges, flows, or deposits in superficial or underground water which have the potential to modify its physical, chemical, biological and bacteriological characteristics, are not allowed without an authorisation granted beforehand following an enquiry by the river basin agency. The authorisation requires a preliminary environmental impact assessment that should be carried out by the water producer.

Renewable energy systems: The installation and operation of small autonomous renewable energy systems does not yet require licensing except construction licenses. Small-scale energy projects (except hydroelectric plants) are not subject to the environmental impact assessment. Systems that are connected to the grid require permits and compliance with national standards regarding power quality, harmonic distortion and frequencies. Certification of the parts of the system (panels, batteries...) can be performed by CDER in Marrakech. Import taxes for renewable energy products have been reduced to a minimum of 2.5% while, as mentioned earlier, the sales taxes will be lowered to a rate of 7% in line with conventional electricity products.

Produced water quality: Drinking water quality monitoring must be ensured permanently by the producer and the distributor of water. For this purpose, water must be analysed by accredited laboratories. In urban areas these analysis are performed daily by ONEP and the distribution companies. In rural areas they are done mainly by the Ministry of Health. The regional Laboratory of Hygiene of the Ministry of Health performs both routine and requested bacteriological analysis of different waters. The sampling must be performed by the qualified hygiene technicians or by the technicians of the Municipal (now Communal) Bureau of Hygiene (CBH) in the concerned provinces. In rural areas, biological and bacteriological contamination of water is the major source of health problems among children and infants. Treatment of the wells two or three times per year by hypochlorite is usually carried out by the CBH. Bacteriologic analysis of the water produced by ADS can be performed by CBH free of charge,

but the chemical analysis done in accredited laboratories usually require additional fees charged to the project holder.

3.4.4 Implications for the implementation of ADS and recommendations

By creating the river basin agencies, the Water Law calls for decentralised water management; this is in favour of solutions like ADS. The environmental laws are advanced and set the framework to protect the environment from adverse affects that may be caused by ADS. However, the criteria that define if projects are subject to EIA have to be more clearly defined. Small ADS on the coast should not be subject to strict EIA, brine discharge regulations and fees that make their implementation more complicated, since their impact is minimal.

The planned liberalisation of the energy market is a positive development. However the regulation of RE generators should be developed to provide incentives and support for investors. This is in line with the national energy policy that calls for increased RE penetration.

The procedures involved in setting a drinking water project are time consuming and may involve several public actors from river basin agencies, local authorities and the Ministries of Health, Agriculture, Interior, and Equipment and Transport. This is especially true when an EIA must be performed, when the thresholds are exceeded or when sea water has to be withdrawn. For example, the authorisation to discharge in the public hydraulic domain (aquifer or surface water) requires an investigation that should not exceed 30 days and which is performed by a regional commission composed of the representatives of all the public actors in the water sector: local authorities; river basin agency; provincial services of water, environment, health services, and agriculture; and president of the communes. Borehole or well drilling authorisation shall be delivered within a maximum of 40 days.

These procedures need to be further simplified. For example there should be a single process to apply for well construction and water withdrawal, reducing associated time and costs for both coastal and inland sites. However, for small ADS the process should be straightforward as there is little chance for harm when such small volumes of sea water are used for desalination.

The reduced import tax applied to renewable energy equipment is an important step. An additional measure should be similar reductions for desalination equipment that will be used in combination with renewable energy.

Recommendations

- The Environmental Impact Assessment regulation should be clarified - small ADS should be exempted from an unnecessary complicated and expensive EIA.
- Legislation should be developed in line with the national policy regulating renewable energy production and setting the framework for incentives and support.
- The procedure for small water supply projects should be simplified as much as possible. The target should be to have a single application to one authority.
- The import tax for desalination equipment should be lowered when they are to be used in combination with renewable energy.

3.5 Water prices and subsidies in Morocco

3.5.1 Water prices

Water tariffs for production (prices for water distributors) and for distribution (for the clients of the regies and ONEP) are fixed by a Decree for each region upon recommendation from an inter-ministerial commission comprising the ministries concerned with water. In the case of private distribution operators (Amendis, Lydec and Redal), the tariffs are fixed via agreements between the communes and the operators. They intend to cover the operation and maintenance costs as well as the recovery of the initial investment. In addition, the Competition and Price Freedom Law states that water tariff changes are subject to controls by the government in order to avoid anti-competitive practices, especially since quasi-monopolies exist in this sector in urban centres (ONEP, Concessions, and regies).

Drinking water tariffs for production (the price paid by the distributors to ONEP) vary from one region to another from 2.19 DH/m^3 in Settat to 4.34 DH/m^3 in Casablanca[*]. Urban water distribution tariffs from Regies or ONEP to consumers differ from one town to another and reflect the differences in production and distribution costs. Four different user groups are defined:

- Residential (domestic), where a variable tariff is used depending on the monthly consumption;
- Preferred (such as public baths and public fountains) for which a fixed tariff is used, usually on the same level as the distribution tariffs;
- Industrial (food industry, hotels): a fixed higher tariff is also used in this case;
- Governmental (schools, hospitals): Depending on the operator, these tariffs may be similar to those of the domestic use.

The tariffs include:

1. A fixed fee: destined to recover fixed costs for connection and the maintenance of the distribution network. This is 6 DH/month for domestic use (increased recently from 2.50 DH/month) and 10 DH/month for preferred (public baths and fountains) industrial and hotels clients (increased recently from 6.16 DH/month).

2. A variable fee: depends on consumption volumes. For industries and hotels only one tariff bloc is used. However, for domestic and administrative usage (governmental institutions) tariff blocks are used which are progressive tariffs depending on the level or consumption:

- *Block 1:* < 6 m^3/month (social bloc). In this case the social tariff is lower than the real cost. The social block was reduced from 8 m^3 to 6 m^3/ month after March 2006;
- *Block 2*: 6 - 20 m^3/month. The tariffs are close to the actual water cost;
- *Block 3:* 20 - 40 m^3/month. The tariffs in this case are high and are used to compensate for the loss incurred in the social block;
- *Block 4:* > 40 m3/month.

[*] €1.00 = 11 DH

3. A PAGER tax: A 5% solidarity tax was introduced in order to improve access of the rural population to drinking water.

Rural areas: Tariffs are usually higher in rural areas than in urban centres due to the reduced number of users and increased infrastructure costs. The tariffs vary between 2.37 DH/m^3 for Block 1 and 11.27 DH/m^3 for Block 4. In the case of rural villages supplied by decentralised systems such as wells and boreholes, water tariffs may range from 4 to 6 DH/m^3. Water users associations are generally in charge of the management of these systems.

Irrigation water: Irrigation water fees are fixed by a joint decree of the Minister of Agriculture, the Minister of Finance Privatisation and the Minister of Land Management, (MATEE). The irrigation tariffs vary between 0.22 and 0.67 DH/m^3 in the irrigated perimeters. When the water is pumped, an additional fee is charged which varies between 0.05 DH/m^3 and 0.5 DH/m^3.

3.5.2 Implications for the implementation of ADS and recommendations

There is already widespread experience in transferring water supply services to entities that are able to carry out that task, and setting tariffs that cover the operation and maintenance costs as well as the recovery of the initial investments. This is exactly what needs to happen with ADS and the fact that the process is already established is an encouraging factor.

However, the average subsidised price of water in the municipalities and in some rural centres (maximum of 3.81 DH/m3 for the Social Block) is much lower than the cost of water produced by ADS which is greater than 25 - 50 DHS/m3 depending on the size of the installation and the quality of the feed water. Therefore, at least for the first years governmental subsidies that will support ADS are needed. Initially the existing programmes discussed in Chapter 2 should be used. Also a special use of the cross-subsidies between the different water tariff blocks should be used to support ADS. Subsidies are also provided for social access and connections to the potable water network in the form of loans with reduced interest rates. Another form of concession is through the PAGER solidarity tax aimed at increasing access to water supply in small town and rural areas. These taxes are paid to ONEP by the customers of Regies and the concessions. If these are not enough to produce affordable water for the local populations, new targeted subsidies should be designed and implemented.

Recommendations

- ADS investors should use the established practice of concessions and agree on tariffs that cover the operation, maintenance and investment recovery costs.
- The gap between these tariffs and the ability of the local consumers to pay for water should be bridged by using existing programmes and redirecting existing subsidies
- If additional subsidies are needed, targeted initiatives should be created that support promising ADS installations until the “learning by doing” principle brings the cost down

3.6 Institutional framework of the water sector in Morocco

3.6.1 Main actors in the water sector

The institutional framework of the water sector is organised on three levels: policy making and supervision, water resource management (river basin agencies) and public service provision (regies, ONEP, concessions, associations). The Ministries concerned with water MATEE, Equipment and Transport, Agriculture, Interior, Health, and Finances also intervene at various stages. The main actors in the water sector at the national level are briefly presented below:

The Higher Council on Water and Climate (CSEC, conseil supérieur de l'eau et du climat) which is chaired by the king and brings together all actors in the water and environment sectors, ministries, NGOs and researchers. By virtue of the 10-95 Law on Water, the CSEC is in charge of formulating the overall orientations of the national water policy, examines the national water plan and develops integrated water planning for water resources such as distribution of water among sectors, water transfer, protection and evaluation of the water resources.

Ministry of Territorial Management, Water and Environment (MATEE)[*]: The mission of MATEE includes, amongst others, planning and management of water resources and the environment. These tasks are carried out by:

- Secretariat of State in charge of Environment (SSCE)
- *Secretariat of State in Charge of Water* (SSCW) which also established the National Water Plan (PNE) in cooperation with CSEC. The mission of SSCW is carried out by:
  - Directorate of the Water Research and Planning (DRPE);
  - Directorate of Hydraulic Installations;
  - Directorate of Hydraulic Works;
  - Directorate of General and Technical Affairs;
- The National Office of Drinking Water (ONEP), which is the main executive body responsible for the supply of drinking water. It is also involved in the distribution of drinking water in some rural areas and small cities;
- River Basin agencies;
- Ministry of Agriculture and Rural Development: irrigation water and irrigated land.

Ministry of Equipment and Transportation: Sets up and executes the policy concerning infrastructures such as dams, roads, ports, pupil equipments and transportation. The ministry also performs, supervises and controls technical studies and technical works for other ministries and public establishments.

Ministry of Public Health: Performs mainly drinking water quality testing and control.

The Ministry of Interior: Includes the General Direction of the Local Communities (DCGL) and the Directorate of the "Régies" and the Conceded Services (DRSC) which supervises the electricity and water distribution companies and autonomous public utilities (Regies).

[*] Following the elections of September 2007 and the appointment of the new government in October 2007, the water sector is now under the auspices of the Ministry of Energy, Mines, Water and Environment (MEMWE). SSCE and SSCW are still kept in this new government.

Ministry of Energy and Mining[*]: The ministry of Energy of Mines (MEM) is in charge of planning and management, monitoring and setting the policy of energy sector as a whole. The ministry sets up strategy and programmes to promote renewable energies in Morocco such as hydroelectric power stations and wind farms.

Ministry for Finances and Privatization:

- elaborates the financial and monetary policy of the country and ensures its execution and follow up in accordance with the laws in place,
- takes an active part in the development, the implementation and the evaluation of the economic and social policies,
- controls the incomes and expenditures of public organisations,

Apart from the actors on the national level, the water supply is generally managed on the **local level**, where the following actors are involved:

River Basin Agencies (RBAs): are public institutions with financial autonomy and the authority to manage surface water (storage and allocation), groundwater, water pollution and water quality control. Their policy and activity programmes are set up periodically through a board of directors, chaired by the minister in charge of water, and composed of national and regional stakeholders. The financial resources of these agencies are built up by loans, subsidies, donations and fees collected from the water users, according to the "user-pays" and the "polluter-pays" principles. RBAs make bulk water resources available to ONEP and ORMVAs (see below) who, in turn, provide retail water supplies to various users. Every river basin agency has a mission to:

- Elaborate on the master plan for an integrated management of the water resources coming under its action zone and to supervises its application;
- Help prevent the pollution of water resources;
- Manage and control the use of mobilised water resources.

Regional Office for Agricultural Development (ORMVA): They are in charge of large irrigated areas. An ORMAV is usually created in an area where large public water mobilisation infrastructures are constructed, such a dam or water transfer canal. It also includes areas where irrigation based on extensive pumping from aquifers exists. Their main mission is the planning, management and development of the irrigated perimeters of their zone of action.

Provincial Directorate for Agriculture (DPA): The DPA are in charge of areas where farming depends mainly on rainfall. Locally known under the name of "Bour", these areas suffer from irregularities of rainfall and scarcity of water. DPA is also in charge of the promotion and management of the small and medium irrigated areas. The latter include foothill sites linked to springs and surface water flows from mountainous areas, along with small and medium size pumping boundaries.

Provincial Water Commissions: These represent the SSCS (Secretariat of State in charge of Environment) at the provincial level.

[*] Following the appointment of the new government in October 2007, the energy and water sectors are put and the auspices of one ministry: the Ministry of Energy, Mining, Water and Environment.

Water distribution entities: In urban areas autonomous entities called "Regies" are created by the local Communes (municipalities) for the water and electricity distribution. The last years the "Regies" are also undertaking the waste water services in the main cities of Morocco.

Water and electricity distribution concessions: Private operators (concessionaires) in charge of water and electricity distribution and sanitation in selected cities including Redal in Rabat, Lydec in Casablanca and Amendis in Tangier and Tetouan.

Users associations: Irrigation water users and village associations which are often responsible for the management, the operation and the maintenance of the water infrastructures at the village level.

3.6.2 Main actors in the energy sector

Ministry of Energy and Mining (MEM): development and application of the national energy policy to the secure energy supplies for Morocco at the best prices.

Ministry of Interior: supervises the Regies which are communal autonomous public utilities companies for water and electricity distribution, including waste water.

National Office of Electricity (ONE): public organisation with financial autonomy under the supervision of MEM. The main mission of ONE is to meet the country's needs in electrical energy production, transport and distribution.

Independent power producers: Private operators have recently been involved in the production of electricity (Power greater than 10 MW) selected by a call for tender and sold exclusively to ONE. At a lower scale, indirect concessions for power production lower than 10MW are introduced mainly in the PV sector for rural electrification. ONE has conceded the installation, the follow up and maintenance of SHS systems to private operators such as Temasol, SPM, BP Solar and Isophoton, in the framework of the PERG programme.

Auto-producers: Private companies producing electricity for their own needs (up to 10MW power). Excess energy can be injected in the grid through an agreement with ONE, as for example in the case of the Lafarge Company 10 MW wind farm. The upper limit of 10 MW will be extended to 50 MW as suggested in the national debate on energy (November 2006). Further, a programme (EnergiePro) was launched recently by ONE offering reduced grid access fees (0.06 DH/kWh) which will further promote decentralised production.

Electricity distributors: Electricity transmission is carried out exclusively by ONE. The distribution on the other hand is performed by various actors:

- ONE in rural areas and in some parts of the urban centres
- Regies such as RAMSA (Agadir), RADEEMA (Marrakech) and RADEEF (Fes).
- Private operators such as LYDEC (Casablanca), REDAL (Rabat) and AMENDIS (Tangier and Tetouan).

CDER: the Centre for the Development of Renewable Energies

Professional associations: Federation of Electricity (FENELC) and Amisole (Association of professionals working in the field of renewable energies).

Research and training institutions: Training and R&D programmes in renewable energies are available in some institutions including Cadi Ayyad University, and CDER.

NGOs: Various NGOs are involved to some extent in rural electrification and water pumping using renewable energies.

The distribution of oil products is carried out by private companies. Oil and mining prospecting are undertaken by the National Office of Mining and Hydrocarbons (Office national des mines et des Hydrocarbures) which resulted from the fusion of two institutions, ONAREP and BRPM, dealing with oil and mining respectively.

3.6.3 Implications for the implementation of ADS and recommendations

There are important responsibilities devolved to the local level to deal with water supply issues. This decentralisation trend can be beneficial for decentralised solutions like ADS. However, since there are still multiple actors involved in the water sector this results in slow and inefficient procedures. This is widely recognised and improving the situation is a main objective of the national water plan. The decentralisation has to be supported and implemented in practice and the ADS community should support and contribute to this effort.

In rural areas, the main actors are ONEP and River Basin Agencies, which are very interested in ADS as a tool to meet their challenging drinking water supply objectives. If they are allowed to be flexible in defining the water supply means and tariffs more efficient decentralised technologies will be adopted faster.

Recommendations

- Accelerate the reform of the institutional framework of the water sector as suggested in the national debate in order to make it more efficient.
- Emphasis should be put on promoting further decentralization of water management on the local level.
- Concentrate all water issues under the authority of the river basin agency since their board of directors includes all the relevant regional actors.
- Accelerate the reform in the energy sector as suggested in the national debate on energy, particularly the regulation of the renewable energy sector.

3.7 Capacity building and awareness raising in Morocco

3.7.1 Relevant research, education and commercial activities in the country

In Morocco substantial experience both in the renewable energy and the desalination fields already exists. CDER offers regular training courses for young entrepreneurs in renewable energies. Until 2004, 100 solar houses were formed offering local energy services to both urban and rural areas such as installation, battery charging, repair, and maintenance. ONE has acquired extensive experience in wind and PV installations as a result of the training programmes accompanying the construction of wind farms and rural electrification by SHS. About 150,000 rural households will be supplied with these systems by the end of 2007.

Academic and research institutions (universities, research centres, engineering schools) have extensive experience in capacity building for renewable energies. In particular the Faculty of Sciences Semlalia (Marrakech) has been the leader in the field by offering degrees in renewable energies and their applications. In addition, the projects developed by the government in the electricity sector and renewable energies (wind, PV, hydro, gas) have significantly contributed to capacity building and awareness-raising.

Various local suppliers for RE and water treatment equipment can be found. However, there are very few companies combining the two and offering complete ADS. Membrane technologies are also widely used in industrial processes throughout the country such as the sugar and milk industry. An association called Société Marocaine de Membranes et de Dessalement, (SMMD) has been recently created gathering together the researchers and users of membrane technologies and particularly desalination.

On the other hand, ONEP has extensive experience in desalination. The cities of Layoune, Boujdour, and Tarfaya, located in the south of the country, are supplied through large scale reverse osmosis desalination plants. These plants have contributed significantly to building the know-how in the country. In recent years regular training courses on desalination have been organised by the National Scientific and Technical Research Centre (CNRST), ONEP, the Centre for the Study and Research on Phosphates (CERPHOS) and SMMD in collaboration with the Middle East Desalination Research Centre (MEDRC).

ONEP is the most suitable operator for ADS since it already has the required scientific, technical and financial capacities. Most importantly in addition to the experience accumulated in operation and maintenance of desalination units, ONEP has extensive experience supplying rural areas with drinking water. PV water-pumping has also been implemented by ONEP in some rural areas.

An efficient alternative operator in the framework of a cooperation agreement between the two entities could be the administrative regions together with companies or research institutes. The region’s financial and administrative capabilities in providing drinking water supplies are then combined with the technical knowledge of companies or institutes in the field of ADS.

3.7.2 Implications for the implementation of ADS and recommendations

Supply and maintenance networks and experience already exist for both desalination and renewable energy in Morocco. This situation is positive for the implementation of ADS. However the coupling of desalination and renewable energies is practically nonexistent. The ADIRA pilot installations are the first ones in the country, although small experimental distillation plants have been tested on the laboratory level.

The lack of public awareness about renewable energies and desalination technologies, particularly for small scale autonomous units, is among the barriers to the development of ADS. Further actions to create public awareness are needed and should be integrated with existing RE and water campaigns. Both the decision makers and the users should be targeted. Separate actions are needed targeting RE and water companies and entrepreneurs in the rural areas. The SMMD can organise and implement such actions in cooperation with relevant actors. The six ADIRA pilot units in Morocco can also play an important role disseminating information about the reliability of this alternative non-conventional water resource.

Nowadays the Moroccan government makes intensive efforts to promote the creation and development of micro-enterprises. This opportunity should be used to enhance the SMEs specialised in ADS as in the case of RE Energy Houses which can provide jobs and also local services to rural populations.

Training programmes are needed to develop a skilled operation and maintenance workforce for these systems. This will also contribute to the sustainability of the installed systems and even to the development of local industries. To ensure sustainability and increase reliability of the ADS, field training of local technicians in the operation and maintenance of such systems has to be developed. Support of local communities with technical assistance has to be provided. Capacity building can be reinforced by:

- The development of curricula to train students in order to provide the skilled workforce needed for future growth and implementation of ADS;
- The creation of new majors or degrees in professional schools or universities which include ADS related curricula in their programmes;
- Encouraging R&D activities in fields related to ADS.

Recommendations

- Exploit the existing industry experience in renewable energy and desalination, especially with targeted awareness raising actions about the benefits of ADS.
- Awareness-raising among the general public and decision makers: promotion of pilot units and best practices via seminars, workshops and field visits.
- Use the government support for SMEs and promote creation of ADS related enterprises on the local level.
- Introduce ADS related training and modules in relevant university courses and support relevant research.

3.8 Conclusions for Morocco

In Morocco the decentralisation of water administration and the opening of the water and energy markets to private entities are already very advanced relative to other countries of the region. There is also clear policy orientation towards non-conventional water resources and renewable energy systems. These facts create favourable framework conditions for ADS implementation and the ADS community has to promote the technology as a tool for achieving the policy objectives. The on-going consultation for the development of the National Water Programme is a good opportunity to do so.

The country is also implementing a number of wide-reaching programmes that demonstrate a commitment to bring basic services, including water and electricity, to the rural populations. In many cases, like the SHS part of the PERG programme, these initiatives are promoting decentralised solutions, rather than conventional approaches. They also involve innovative financing mechanisms; for every small project a combination of grants from the state, grants from international organisations and low-interest rate loans might be provided to match the contribution of the beneficiary that has to be at least 15%. The experience, know-how and cultural evolution these programmes have brought to the rural population of Morocco are another great opportunity for the ADS development.

The administrative procedures involved in developing a drinking water project though are time consuming and may involve several public actors. There are exemptions for small projects, but there is still enough room for simplifying the procedures in order to encourage small, efficient projects. But the fact that it is well established to create a users association that operates and manages the water supply can also be used as a basis for establishing successful decentralised ADS projects.

Overall, Morocco has favourable conditions and a great need for ADS. What is missing at the moment is widespread awareness for the opportunities this technology has to offer. The ADS community has to work much harder to promote the technology among political decision makers at the national, regional and local level, the utilities, the scientific and business communities and the end-users. And the ADS prices have to come down before the technology can be widely applied, even with the existing Moroccan support programmes. The first step would be to lower or eliminate the relevant taxes and then develop know-how to produce some parts and assemble the system in the country.

3.9 References for Morocco

[1] Report on Autonomous Desalination Systems – Main Actors and Operators in Turkey, Morocco, Jordan, Egypt and Cyprus, Part 1: Actors in the Water Sector on National, Regional and Local Level (2004) Deliverable of ADIRA WP 4.1

[2] Ministry of Land Management Water and Environment (MATEE): www.matee.gov.ma

[3] Secretariat of state in charge of water: www.water.gov.ma

[4] 10-95 Law on Water and procedures: www.water.gov.ma/04textes-juridiques/loi-10-95.htm

[5] Ministry of Energy and mines: www.mem.gov.ma

[6] The INDH programme: www.indh.gov.ma

[7] Ministry of Finances and privatisation: http://www.finances.gov.ma/

[8] Ministry of Health: www.sante.gav.ma

[9] Ministry of Agriculture: www.madrpm.gov.ma

[10] National office of Potable Water: www.onep.ma

[11] National office of electricity: www.one.org.ma

[12] Renewable Energy development centre: www.cder.org.ma

[13] Cadi Ayyad University: www.ucam.ac.ma

[14] National Federation of electricity and electronics: www.fenelec.com/

4 Jordan Country Report

4.1 List of Acronyms and Abbreviations for Jordan

ADS	Autonomous Desalination Systems
ADIRA	Autonomous Desalination System Concepts for Seawater and Brackish Water in Rural Areas with Renewable Energies
BRDP	Badia Research and Development Programme
CPE	Corporation for the Protection of the Environment
EU	European Union
GDP	Gross Domestic Product
IWRM	Integrated Water Resource Management
JD	Jordanian Dinar (currency)
JVA	Jordan Valley Authority
MEMR	Ministry of Energy and Mineral Resources
MOH	Ministry of Health
MWI	Ministry of Water and Irrigation
NERC	National Energy Research Centre
NGO	Non-Governmental Organisation
PV	Photo Voltaic cell
RE	Renewable Energy
VAT	Value Added Tax
WAJ	Water Authority Jordan

4.2 Introduction to Jordan

Jordan is one of the most water scarce countries in the world, measured on a per-capita basis. To cover its needs, all the available surface and ground water needs to be tapped to the limit of technical feasibility. However, social and environmental impacts have to be taken also into account to ensure that adequate water quantities are available at affordable prices without compromising the resources of the future generations.

The objective of this report is to develop clear recommendations for improving the conditions for implementing Autonomous Desalination System (ADS) in Jordan. The issues involved will be discussed through the following five chapters:

Chapter 4.3: Relevant policy and programs

Chapter 4.4: Legislation and administrative issues

Chapter 4.5: Water prices and subsidies

Chapter 4.6: Institutional framework of the water sector

Chapter 4.7: Capacity building and awareness raising

In each chapter, a presentation of the current situation is given first and then the implications, positive or negative, are analysed 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 collected again in a text box.

4.3 Relevant Policy and Programmes in Jordan

4.3.1 Water policy and programmes

A World Bank report from 2006 noted that Jordan was one of the best reformers within the region and also in comparison with other middle-income countries. The report emphasised 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 socio-economic needs while respecting the natural environment. The second goal is legislation allowing private sector participation and compliance with the set national development objectives. This action plan has been approved by the Cabinet of Ministers and will be updated periodically. It takes into consideration the following policy guidelines:

- Protection of surface and groundwater by very efficient use of resources.
- Efficient management of urban and irrigation water.
- Development of appropriate institutional capacity building and legislative framework for water management.
- Efficient 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.

4.3.2 Energy policy and programmes

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, have pushed the energy bill to around 1913 million Jordanian Dinars (JD) annually in 2006 constituting 18.9% of the gross domestic product GDP and around 52.2% of the value of 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 which amounts to around 150 million JD annually.

The Ministry of Energy and Mineral Resources (MEMR) is responsible for energy planning. MEMR helps to develop the national energy policy however most of its work is practical: implementing the national policy, supervising 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. 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 barriers that renewable energy development is facing.

The MEMR 2005 Annual Plan lists a number of programs and initiatives in the renewable energy (RE) sector. These are briefly presented below:

Solar Energy

MEMR has helped prepare a study on the economic feasibility for providing remote villages with electricity by using renewable energy sources in cooperation with the Canadian RSW Company, and the Jordanian Rural Electrification Project. The Ministry is now involved in discussion with funding institutions to raise the necessary resources for implementing an experimental project in one of the villages proposed by this study.

The National Energy Research Centre (NERC), which was established in 1998 to focus on developing domestic energy resources including RE, carries out several solar projects, some of which are of interest to ADS:

- Operation and maintenance of 22 plants powered by solar cells for pumping water from desert wells which are affiliated with the Water Authority Jordan.
- Installation and operation of a water desalination plant powered by solar cells within the Aqaba International Industrial City in cooperation with the U.S. RE Laboratory.
- Providing lighting via solar cells for the Al-Harrana Palace. This project is affiliated with the Ministry of Tourism and Antiquities and supported by funds from the Jordanian Rural Electrification Project.
- Designing and accepting two systems of lighting via solar cells on behalf of the Ministry of Tourism and Antiquities, at the visitor centres of Qasr Al-Hallabat and Qasr Al-Humaima in Jordan.
- Extending necessary technical consultations in the field of the solar cells to several authorities in the Kingdom such as the Ministry of Agriculture and the Jordanian Badia Research and Development Centre.
- Signing an agreement of cooperation with the Solar Energy and Hydrogen Research Centre of Germany for the purpose of building computerised forms simulating the renewable energy systems concentrating on the water-pumping and desalination systems by utilizing solar cells.

Wind Energy

The MEMR 2005 Annual Report also contains a list of current wind energy projects. There are plans to expand the two existing wind power sites, the Hofa and Ibrahimiya Plants, which are operated by the Central Electricity Generating Company (CEGCO). The Delenova Company

has received a US$180,000 grant for this purpose from the United Sates Trade and Development Agency (USTDA).

Development of the electricity generation project: “Out of the Wind”. MEMR has applied to external funding agencies such as the Global Environmental Facility (GEF) and the World Bank to further work on this project to develop the wind energy market in Jordan.

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 used as the basis for a project which starting from an economic feasibility study; terms of reference for an Environmental Impact Assessment; an action plan for implementing a commercial scale project; and training programs for local engineers and technicians.

4.3.3 Implications for the implementation of ADS and recommendations

Jordan is very fast adopting the international privatization trends in both the energy and water sectors. This might have a positive effect in fostering the implementation of ADS in Jordan. Privatization in water sector however, is in the water management but not on merchandizing the water, this has its positive effect of terms of controlling the price of water in the country. On the other hand the privatization of management of water in Greater Amman area for example shows a positive experience. This also can be extended for water merchandizing where it may make the prices reasonable for the population. ADS could be a strong candidate for the private sector to implement for selling water.

In the water sector, the search for non-conventional water resources has reached advanced levels in Jordan. But the search for alternative energy resources in the energy sector is still lagging. Studies about the renewable energy in Jordan are in the early stages and several years are needed to obtain results in this field. Here Jordan can benefit from the international experience where a lot of work has been done in the sector. For that though, political support and initiative is needed.

The studies supervised by the Ministry of Energy is a good start 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 identify the technical and administrative obstacles that renewable energy is facing. Based on that and a national policy and eventually legislation that will promote renewable energy should be developed.

Recommendations:

- Privatisation should not only focus to large utilities but also support independent producers, for example RE developers and ADS operators
- Energy policy should promote renewable energy and specific support programmes have to be launched.
- The National Energy Research Centre (NERC) should be encouraged to apply its expertise for supporting ADS implementation.

4.4 Legislation and Administrative Issues in Jordan

4.4.1 Relevant legislation

Drinking water

In accordance with the Water Authority Law No. 18, 1988 and its amendments, WAJ 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.

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

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 drilling of a well should be 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 allowed pumping quantity annually and the rates are defined. Distances between wells must be at least 1km, and more than 3km from the nearest spring. Wells can be closer to springs than 3km if a written guarantee is provided that the well will not affect the average output of the spring. If an affect is found, then the license will be cancelled and the well will be closed down.

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.

A fee must be paid before a license is issued. Details about the relevant fees can be found in Appendix 1: Prices for Water and Water Licenses in Jordan. The water itself must be paid for and the prices are fixed annually depending on the quantity of water extracted and the conditions of the license. These water prices can also be found in Appendix 1.

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 Minister of Municipal, Rural and Environmental Affairs has discretion over the exact distance within which dumping is prohibited, and may also create exemptions for certain substances, if they meet one of the following criteria:

- Substances used to treat pollutants in order to render them harmless and in compliance with regulations;

- Substances used for weed, flies and rodent control and are within approved specifications;
- Substances which are used for approved research purposes.

The Protection of the Environment Law 1995 also set 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, Second 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 to the reclaimed water; and measures must be taken to prevent any leakage of this water into aquifers. There are a range of different quality standards which must be met in order for the reclaimed water to be used for different purposes. These purposes include:

- Artificial recharge of groundwater (although it is prohibited to recharge to aquifers used for drinking water purposes);
- Irrigation where different standards exist depending on the type of crop that will be irrigated (although it is prohibited to use the water to irrigate vegetables which will be eaten raw).

The exact parameters which effluent wastewater from industrial activities must meet are contained in Jordanian Standard, No 202 of 1991. These are contained in Appendix 2: Effluent Wastewater Limits.

Wastewater discharged from private industrial sources is sampled by WAJ and MOE, who coordinate their efforts in order to avoid duplication of sampling. Discharge violations are recorded; the violators are warned or in certain circumstances taken to court. Information about violations is shared between WAJ and MOE.

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 megawatt (MW); construction or operation of small transmitters under 100 kilowatt (kW) peak demand; and construction or operation of auto-generation.

4.4.2 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 which are detailed in the Annex, Section 4.10.3.

Another license is required for trading drinking water from the well. An application form should be filled and submitted to the local WAJ office. There are no fees for this process. The applicant should contact the Ministry of Health (MoH) to complete the process. Samples are taken from the well and sent to the Directorate of Laboratories in WAJ in order to be tested chemically and biologically. A license will be issued based on the chemical and biological results from both the MoH and the Directories of Laboratories in WAJ if they comply with the Jordanian standards. This process takes one month. The details of the two licenses needed from WAJ are shown in the Annex, Section 4.10.4.

A separate licence from the MoH is required in order to have an outlet for selling the water to the customers. The license is issued by the local Directorates of Public Health which are distributed in the country. The applicant should present the details of water desalination (purification) process, analysis of the source water and the location of the outlet. Usually one week is needed to get a decision from MoH.

Energy produced from photovoltaic sources needs no licence as long as the energy generated is not traded or distributed and used only for the ADS unit. Electricity generation less than 1MW needs no licence. Since most of the electricity generation for ADS will be less than 1MW, this exemption should prove useful to most ADS units. In the cases where generation is more than 1MW 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 is powered by renewable energy. Water produced from the desalination units is mixed with the water from the wells to ensure acceptable salinity levels for irrigation.

4.4.3 Implications for the implementation of ADS and recommendations

There is a set of procedures and specifications for the applications needed relevant to the installation and operation of ADS. This has mainly to do with the fact that small-scale desalination is already common practice in Jordan and the only innovation that ADS brings is the autonomous operation and the use of renewable energy. Still, small renewable energy installations, as the ones needed for ADS, do not need a license and this simplifies the procedure. The regulations relevant to water withdrawal, processing and trading are detailed and relatively strict, which may end up confusing potential operators. On the other hand though, the very restricted water resources make it necessary to monitor closely the water use and overall no unnecessary administrative barriers are posed to ADS.

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 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.

After the fast oil price increase over the last two years, the different authorities in cooperation with the Ministry of Energy were considering a VAT exemption for energy saving and renewable energy systems, including relevant raw materials. This has not been realised yet. The ADS community should lobby the authorities together with the relevant energy stakeholders for realising the VAT exemption plans that will help reduce the ADS costs. Together with that a similar VAT reduction for desalination equipment that are used in combination with RE should be demanded.

Recommendations

- Separate standards for brine disposal should be set out under the relevant industrial discharges regulation. This is because the effect of the salts composing the brines like sodium, magnesium, etc. are less harmful to the environment than other ions from other industrial activities like mercury, nickel etc.
- Additional incentives like VAT reductions for RE equipment should be introduced as well as for desalination components to be used in ADS

4.5 Water Prices in Jordan

Jordan charges for water according to the planned end-use and the quantity used. For non-residential uses it is 1.0JD/m^3 plus an additional 0.56JD/m^3 for sanitary discharge for those connected to the sewerage network. For residential uses the water tariff follows a tiered structure, where the more water consumed the higher the price per cubic meter. Water bills are issued on a quarterly basis. Table 2 below shows the charges in 2006. The total charge includes the cost of water, sewerage treatment, a meter fee plus special charges. 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.

Table 2 Residential Water Tariffs in Jordan

Consumption (m^3)	Total amount of water bill excluding Sanitary Discharge Charges (JD)	Cost of Water per m^3 * (JD/ m^3)	Total amount of water bill including Sanitary Discharge Charges (JD)
< 21	4.45	0.22	5.122
30	7.85	0.26	8.970
40	9.25	0.23	10.818
50	15.728	0.31	19.586
60	21.717	0.36	28.288
70	29.018	0.41	38.949
80	37.629	0.47	51.567
90	47.552	0.53	66.145
100	58.786	0.59	82.680
110	71.331	0.65	101.174
120	85.188	0.71	121.627
> 130	n/a	0.85	n/a

Source: Translated form MWI first quarterly water consumer bill, year 2006.
* Calculated

A report for the Heinrich Böll Foundation by Dr Batir Wardam in 2004 found that about 95% of people in Jordan are connected to the water supply network. 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 watertanks, or to rely on private water sellers. Although the official price of this water should be 2JD/m^3 it is common to pay up to three times this amount.

The Wardam report (Wardam, 2004) cites a study of households in east Amman which showed that households spent between 1 and 2.9% of their income on water; closer to the lower end of the range in the winter and closer to the high end in the summer months. Households in

villages in the north of Jordan pay less, between 0.7 and 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 (Wardam, 2004). The price of this water has increased in recent years up to JD 3/m³ because of increases in petroleum prices.

In the last years treated waste water is commonly used for the agricultural and industrial applications in Jordan. Following a decision made by the WAJ and approved by the Prime Minister of Jordan in 1999 a water tariff must be paid for the reuse of treated wastewater for irrigation or industrial purposes. The details of this can be found in Appendix 1.

The total water quantities billed by WAJ are about fifty percent of the water quantity produced. This has been attributed to “technical and financial losses” caused by the unaccounted for quantities of water. While this is for municipal water, water for irrigation in the Jordan Valley is sold by JVA at 0.011-0.012 JD/m3 which is considered rather low as farmers in the highlands put up with a 0.05 JD/m3. The low water tariffs are seen somehow justifiable because JVA main mission is to promote social and economic development in the Jordan Valley. Nonetheless, full cost recovery is targeted for 2020. It is estimated that 30% of the "cost recovery gap" can be achieved through improvements in operational efficiency and a further 30% by the institution of better integrated investment planning.

4.5.1 Implications for the implementation of ADS and recommendations

The rates at which water is sold in Jordan are very low, in general below the real cost. The various subsidies distort competition and do not allow to alternative solutions to have a fair chance in the market. The subsidies are being phased out slowly and it is planned to gradually establish a full cost-recovery system. In addition, already many consumers are forced to buy water from other sources at much higher prices because the supply from the network is unreliable, especially during the summer months. Even like that, water produced by ADS can be up to twice as expensive at the moment. However, as the oil prices rise, conventional solutions are becoming quickly more expensive. At the same time costs of ADS are going down as the technology develops, for example PV costs are expected to costs 50% less within the 20 years. This trend can be further supported by governmental measures, for example the VAT reduction suggested in the previous chapter.

The implementation of ADS could also help the decision makers in the Jordan Valley to promote the social and economic development in the area. The Jordan Valley is the region with highest solar availability in Jordan in addition to the availability of brackish water. Water losses are very high because the water resources are usually far away from the populated cities. ADS could be a good solution to decentralise water distribution and reduce the amount of unaccounted water quantities. Since the water resources are more available in the countryside where there are fewer inhabitants but less available in the cities, the application of ADS will help to solve this distribution problem and reduce the costs of transporting water to the most populated cities over long distances.

Recommendations

- The gap in the cost between water from ADS with that from conventional resources is slowly narrowing. The trend should be reinforced by targeted financial support from public sources
- ADS applications in 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

4.6 Institutional Framework of the Water Sector in Jordan

4.6.1 Main water actors

The major institutions working in water related issues in Jordan are (Wardam, 2004):

- Ministry of Water and Irrigation (MWI)
- Ministry of Environment (MOE)
- Jordan Valley Authority (JVA)
- Water Authority of Jordan (WAJ)
- Ministry of Health (MOH)
- Water and Environment Research Centre - University of Jordan
- Royal Scientific Society (RSS)
- The National Energy Research Centre (NERC)
- Badia Research and Development Programme - the Higher Council for Science and Technology (BRDP)
- Centre for the Study of the Built Environment (CSBE)
- Queen Rania Al-Abdullah Centre For Environmental Sciences & Technology
- Jordanian Environmental Watch Programme (JEWP) – Al Urdun Al-Jadeed Research Centre
- Jordan Environment Society (JES)
- Jordanian Royal Ecological Diving Society (JREDS)
- Jordanian Society for Desertification Control and Badia Development (JSDCBD)
- Royal Society for the Conservation of Nature (RSCN)
- Water Efficiency and Public Information for Action (WEPIA)
- Non-governmental organizations

4.6.2 Water Sector Institutions

The Ministry of Water and Irrigation (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 programmes, 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 Water Authority of Jordan (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 (PMU) 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. When people have problems with water, they usually contact these private operators rather than the

WAJ. LEMA is the private operator which takes the responsibility of water management and distribution in the Great Amman Area. Wastewater management is also performed by LEMA.

The northern part of the country is under the Northern Governorates Water Administration (NGWA) whose responsibility includes extracting water from a local well and distributing it to the local community. The NGWA area is divided into 10 service areas covering the four governorates in the northern part of Jordan. NGWA was created in year 2001.

The rest of the country deals directly with the WAJ through its directorate, which are distributed overall the country.

The Jordan Valley Authority (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 Ministry of Water and Irrigation (MWI), the Water Authority of Jordan (WAJ) and Jordan Valley Authority (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 Ministry of Health and the Ministry of Environment.

The MWI, WAJ and JVA are also legally responsible for collection of water resources data. MWI has established a national water data bank as part of the Water Information System to support planning and decision-making processes. The major internal data source is the water resources monitoring network operated by the Water Resources Directorate of the MWI. Water and wastewater production data as well as wastewater quality data are collected from WAJ and JVA and entered to the MWI database. Surface water quality is monitored by different entities and is not systematically covered by any nationwide monitoring network. Surface water quality is monitored by JVA along the Zarqa River course by the Royal Scientific Society on commission from the WAJ.

The Ministry of the Environment (MOE) was set up in 2003. It guides policy on environmental matters and undertakes environmental monitoring.

All health matters of Jordan are under the responsibility of Ministry of Health (MOH), which includes monitoring of both wastewater and water systems to ensure compliance with public health standards

4.6.3 Energy Sector Institutions

Energy planning and policy in Jordan is the responsibility of the Ministry of Energy and Mineral resources (MEMR). The electricity sector in Jordan is divided into three elements; generation, transmission and distribution.

The Central Generating Company (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 (JEPCO), Irbid District Electricity Company (IDECO) and

Electricity Distribution Company (EDCO). JEPCO distributes power to 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 JEPCO and IDECO.

4.6.4 Implications for the implementation of ADS and recommendations

The institutional framework of the water sector in Jordan is rather straightforward as there are only a few governmental agencies involved in water related services. 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 municipalities and local authorities have no major role in the water and energy supply for their areas. Water consumers should deal directly with the distributed directorates of the WAJ or with the private operators like LEMA in Amman area or NGWA in the northern part of Jordan. Also for electricity, end-users deal with the three distribution companies; JEPCO in Greater Amman Area and central Jordan, IDECO in the north of Jordan and the EDCO outside the concession areas of JEPCO and IDECO.

The centralised approach is maintained in order to keep the scarce water resources under stringent control and monitoring. It is also a small country and there is a degree of decentralisation introduced by subcontracting the services of specific areas to private companies. However, involving the local populations and their authorities in the water supply would bring many benefits for Jordan, including more efficient use and fewer losses from water transmission. The positive examples from other countries in this respect can be used. Especially for the rural areas this approach should be promoted and it would create the right conditions for the development of ADS in the areas where it most makes sense.

Recommendations

- Allocation of water supply related responsibilities to the local authorities could have positive results both for the efficiency of the resource use as well as for the implementation of ADS, especially in the rural areas.

4.7 Capacity Building and Awareness Raising in Jordan

4.7.1 The existing capacities and awareness

Research on water issues in Jordan is widespread and at a high level. Most universities provide specialised courses on water, agriculture, engineering and geology. However, there is no coverage of ADS related information on any of these courses. Among scientists there is a certain activity and awareness of ADS, but there is a lot of room for improvement and collaborations with other researchers in the region and internationally.

NGO's have also implemented important projects such as water harvesting, water reuse and sustainable agriculture. The research results are used by the NGO's in their other activities to support local communities with water management and inform the local population about relevant issues. Within the NGOs awareness about ADS is relatively low, and apart from the ADIRA installation there are no other ADS implemented by NGOs in Jordan that we are aware of.

There are some difficulties in official information dissemination from government sources. Independent researchers and the public do not have access to the MWI water information database, and communication consists of occasional published reports or papers.

More companies are working in the water desalination field than in the renewable energy sector in Jordan. Quite a lot of companies are working with membrane desalination processes. Although both desalination and renewable energy systems are established and fast growing in Jordan, there are currently no ADS available in the country. Lack of the know-how and the technical challenges are the main reason to hinder the project developers to combine the two technologies.

Sources of external financing for Jordan

Wardam lists a number of external donors who are active in the water sector in Jordan (Wardam, 2004). The following paragraphs describe the major donors in Jordan:

- ***European Union:*** The Euro-Mediterranean Foreign Ministers have approved a new MEDA financial assistance package for the EU's partners in the Mediterranean. 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.
- ***World Bank*** is one of the world's largest sources of development assistance. It works in more than 100 developing economies with the primary focus of helping the poorest people and the poorest countries.
- ***KfW*** is a bank, 80% owned by the German government. Jordan is a partner country of German Development Cooperation and is intensively supported by KfW Entwicklungsbank in the establishment of an efficient management of its water resources.
- ***GTZ*** is a government owned company that implements technical assistance projects for the Government of Germany, primarily the Ministry of Economic Cooperation and Development. In Jordan, GTZ has supported projects in the areas of rural development agriculture, water, institutional support and public administration
- ***USAID:*** Since 1990 the USAID has build a strategic partnership with the MWI and other institutions in Jordan and invested heavily in developing water demand and supply projects, especially in infrastructure.

- ***Japanese International Cooperation Agency (JICA):*** The Cooperation Agreement between the Government of Jordan and the Government of Japan was signed in 1985. Assistance funds were provided through the Japanese Embassy. In 1991, JICA office opened in Amman. However, with the rising incomes in Jordan, it is expected that grant aid to Jordan will cease within the coming three years.

4.7.2 Implications for the implementation of ADS and recommendations

ADS implementation requires qualified human resources from different disciplines. The existing courses in the engineering and other relevant departments do 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 graduate and post-graduate courses. This will also enhance the interest and activities of researchers in the Universities for ADS and support the development of local designs and adaptations. Awareness raising among the academic community, especially between the renewable energy and membrane research groups will be also of help. Together with adequate funding from the government the pre-requisites are there to develop local products and designs that will lead to regionally adapted technologies.

The access to MWI water information will facilitate research and should be made easier for any interested party. Similarly, completion of the wind atlas and the solar database should be accelerated and then be made available for free access, as it will help researchers and project developers to plan and implement ADS.

The active NGOs can also help in the ADS development as they have experience in working together with the local populations in implementing projects and informing them about water issues. The ADS community has to strengthen the ties with the NGOs in Jordan and develop common projects and inform the local populations about ADS and its use.

There are many companies in the desalination field and quite a few active with renewable energy. Especially in the water sector a network has been established for distribution of spare parts and maintenance services of the installed systems. The same is expected to happen with renewable energy quite fast as the political support becomes more active. These conditions could be used for the benefit of ADS by informing the relevant Jordanian companies and service providers about the ADS technical characteristics and prospects. Networking and establishment of contacts with European and international technology producers should also be facilitated.

The authorities, especially the municipalities in arid areas, should be also informed about the ADS solution and the relevant support programs for financing water supply infrastructure from the different external funding agencies mentioned above. The Badia Research and Development Programme (BRDP) should also be encouraged and supported to implement ADS in the country.

Some of the historic tourist sites around the country are very small and isolated. Tourists tend to stay only a day and possibly also stay for one night. Typically such sites are in the desert area long away from other populated communities. 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 reduce the costs and will show to the local populations and the tourist the commitment of the government towards environmental friendly applications. The large number of agencies that

traditionally fund water projects in Jordan makes it probable that selected ADS projects in such sites will be considered for financial support.

Recommendations

- 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
- Awareness-raising among relevant companies in Jordan about the opportunities the development of ADS offers through workshops and short courses. This could be done under the umbrella of the Higher Council of Science & Technology
- Targeted information to local government and the end-user about the ADS benefits and the available support programmes in Jordan
- The small isolated tourist sites are prime candidates for ADS water supply.

4.8 Conclusions for Jordan

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.

4.9 References for Jordan

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4.10 Appendices for Jordan

4.10.1 Appendix 1: Prices for Water and Water Licenses in Jordan

Fees to license groundwater wells

Drilling license	JD (1000) one thousand Jordan Dinars
Renewal of drilling license	JD(500) five hundred Jordan Dinars
Water extraction license	JD (100) one hundred Jordan Dinars
Renewal of extraction license	JD (50) fifty Jordan Dinars
Substitute drilling license	JD (750) seven hundred and fifty Jordan Dinars
Well Deepening license	JD (500) five hundred Jordan Dinars.
Well maintenance or cleaning license	JD (300) three hundred Jordan Dinars.
Possession or use of a drilling rig license	JD (500) five hundred Jordan Dinars.
Renewal of Possession or use of a drilling rig license	JD (100) one hundred Jordan Dinars.
Driller license	JD (50) fifty Jordan Dinars.
Renewal of driller license	JD (10) ten Jordan Dinars.

Price of Groundwater from a Well

The prices of the water are subject to the conditions of the water license and the quantities specified for the permitted extraction. The prices for the water extracted annually are fixed as follows:

1- Licensed agricultural wells

Water quantity	**Water price**
Zero-150 thousand cubic meters.	Free
151-200 thousand cubic meters.	0.025 JD per cubic meter*
More than 200 thousand cubic meter	0.06 JD per cubic meter

2- Wells, which belong to Government Departments, official public institutions, public institutions and municipalities:

Use for Water	**Water Price**
Agriculture	0.025 JD per cubic meter of water
Drinking or any other purpose	0.1 JD per cubic meter of water
If the water well was designated for drinking purposes and was partly used for any other purposes	0.1 JD per cubic meter of water
From wells for industry, production, tourism or university	0.25 JD per cubic meter of water
Sale of water extracted from drinking water wells	0.25 JD per cubic meter of water
Sale of water extracted from wells of non-drinkable water	0.1 JD per cubic meter of water

Prices for Reused Wastewater

Based on the Water Authority of Jordan's Board decision number 3 dated 20/6/1999, and approved by the Prime Minister, the tariffs of treated wastewater are determined as follows:

- Treated wastewater tariff is 0.01 JD/m^3 for irrigation purposes.
- Treated wastewater tariff is 0.05 JD/m^3 for industrial use like cooling in power plants

- Treated wastewater is free of charge for research and study purposes, under condition that water quantity does not exceed 200 m^3/day and a copy of the research results are to be submitted to the Water Authority of Jordan.

4.10.2 Appendix 2: Effluent Wastewater Limits

Jordanian Standard, No.202 of 1991 set limits for the properties of effluent waste water from industrial activities, as presented in the table below.

Allowable concentrations of the effluent water from industrial activities:

Properties	The maximum limit allowed - milligram / liter			
	Disposal to streams , rivers, valleys , water gathering		natural feeding for ground water	Reusing water for irrigation purposes
	Allowed	Maximum		
Bio-oxygen demand BOD5	50 M	_	50 (M)	_
chemical oxygen demand COD	150 M	200	150 (M)	_
Dissolved oxygen DO	1*	5*	1*	1*
Total dissolved solids TDS	3000 (1)	_	1500(1)	2000 (2)
Suspended solids TSS	50	_	_	100 (3)
PH	6.5-9.0	5.5-9.0	6.5-9.0	6.5-8.4
color	15	75	15	_
TC	_	4	_	_
FOG	5	10	Absent	5
Phenol	0.002	1	0.002	0.002
MBA	25	_	15	_
NO3_N Nitrate - nitrogen	12(4)	_	12(4)	30
NH3 Ammonia	5	12	5	5
T_N	_	125	_	50
PO4-P phosphate - phosphorous	15	_	_	_
Chloride cl	500	_	500	400
Sulfate So4	500	_	500	400
Florid F	1.5	_	1.5	_
HCO3	_	_	_	500
Sodium Na	_	_	400	_
Magnesium Mg	_	_	_	_
calcium Ca	_	_	_	_
SAR	_	_	_	9
Aluminum Al	5	_	0.3	5
Arsenic As	0.05	0.1	0.05	0.1
Boron B	1	_	1	1 (5)
Chromium Cr	0.1	0.3	0.05	0.1
Copper Cu	2	0.1	2	0.2

Iron Fe	1	2	1	5
Manganese Mn	0.2	0.02	0.05	0.02
Nickel Ni	0.2	0.02	0.1	0.2
Lead Pb	0.1	0.1	0.1	1.0
Selenium Se	0.02	0.02	0.05	0.02
Cadmium Cd	0.01	0.07	0.02	0.01
Zinc Zn	15	_	15	2
Cyanide CN	0.1	1.0	0.1	0.1
Mercury Hg	0.001	0.001	0.001	0.001
TCC MPN/100 ml	_	5000	_	_
TFCC MPN/100 ml	1000 (6)	_	1000 (6)	1000 n(6)
Nematodes	less than 1	_	_	less than 1

(+) Unit is milligram / liter unless otherwise is mentioned

(*) Dissolved oxygen rates are the minimum limit.

(**) This depends on the quality of plants , quantity of production , the irrigation system applied , soil , climate and ground water quality in that area.

(_) Undetermined: it depends in its determination on standard and general stipulations.

(M) Monthly rate.

4.10.3 Appendix 3 Licence to dig a new artesian well

Required Documents:

1. Application to obtain the service.
2. A new registration document to prove ownership.
3. A land plan.
4. A land plate with coordinates.
5. For industrial projects, a trade registration from the Ministry of Industry and Trade.
6. For university projects, a university license.
7. For tourist projects, an approval from the Ministry of Tourism.

Fees:

1. JD 500 license fees.
2. JD 100 for rock sample description.
3. JD 50 for field inspection.
4. JD 500 for supervision of digging the well (if approved) or any other process related to the services of private wells.

Venue for service delivery: The Water Authority Jordan main offices (headquarters)

Average time for service completion: One week to three weeks

Procedure:

1. Request for application

2. The application is considered and the site is inspected prior to issuing the relevant report.
3. The inspection report is considered by the Director of the Unit of Wells and then is referred to the Committee of Wells for consideration and recommendation of either acceptance or rejection.
4. The application file is referred to the Secretary General of the Water Authority to study the subject matter and then is submitted to the Board of Directors of the Water Authority.
5. The application is considered by the Board of Directors who either accept or reject the application.
6. In case of approving an industrial license, the approval of the Ministry of Municipal and Rural Affairs and Environment must be present.
7. Upon paying the stipulated fees, the license is prepared.
8. The license is submitted to the Minister of Water to be signed following the hierarchical sequence.
9. The License is entered into the outgoing mail register and is handed over to the applicant.
10. The applicant submits a request to set the location of the well on site after concluding an agreement with a private digging company to dig the well during the validity period of the license; i.e. one year.
11. The request is registered and referred to the Division of Private Wells.
12. A date is set to implement field inspection and produce a report of delivering the site to the digging company according to the coordinates in the License.

4.10.4 Appendix 4 License to Sell Water from an Artesian Well

Required Documents: An ID document or an official power of attorney from the well owner

Fees and Stamps: None

Venue of Service Delivery: The relevant Governorate Water Department.

Average time for Service Completion: One month

Procedures:

1. Fill in the relevant form - have it registered at the Chief Bureau of the Water Authority Jordan and referred to the competent division for study.
2. Undertake field inspection of the well and produce the required report.
3. Address the Ministry of Health and take the required procedures.
4. Address the Directorate of Laboratories at the Ministry of Water to collect water samples from the well to be tested.
5. Receive the replies of the Ministry of Health and the Directorate of Laboratories.
6. The License is approved if the lab test results comply with requirements and standards.
7. The License is prepared, typed and signed by the Director of the Water Department at the Governorate and then sent to the applicant.

5 Egypt Country Report

5.1 Acronyms and Abbreviations for Egypt

ADIRA	Autonomous Desalination System Concepts for Seawater and Brackish Water in Rural Areas with Renewable Energies
ADS	Autonomous Desalination Systems
BOD	Biological Oxygen Demand
BOOT	Built own operation transfer
CDM	Clean Development Mechanism
CPE	Corporation for the Protection of the Environment
EDR	Electrical Dialysis Reverse
EEAA	Egyptian Environmental Affairs Agency
EU	European Union
GDP	Gross Domestic Product
IEA	International Energy Authority
IWRM	Integrated Water Resource Management
KFW	Kreditanstalt für Wiederaufbau (German Reconstruction Credit Institute)
MALR	Ministry of Agriculture and Land Reclamation
MHUNC	Ministry of Housing, Public Utilities and New Urban Societies
MLD	Ministry of Local Development
MOE	Ministry of Electricity
MOHP	Ministry of Health and Population
MSF	Multi Stage Flash
MWRI	Ministry of Water and Irrigation
NGO	Non-Governmental Organisation
NREA	New and Renewable Energy Authority
NWRC	National Water Research Centre
PV	Photo Voltaic cell
RE	Renewable Energy
RO	Reverse Osmosis
UNDP	United Nations Development Programme
WUA	Water User Association

5.2 Introduction to Egypt

The gap between fresh water supply and demand in arid zones is rapidly widening due to the increase of population and the fixed nature of the available water resources. Non-conventional water resources become increasingly important to bridge that gap in the country.

Non-conventional water resources include desalination of brackish and sea water and reuse of agriculture drainage water and treated domestic waste water. Autonomous Desalination System (ADS) can contribute to the water supply in rural areas but the challenges are great and success depends on the coordinated efforts by the public and the private sector.

Water supply in Egypt comes mainly from the river Nile and the volume of water available is fixed according to an agreement from 1929 and extended in 1959 to 55.5 billion cubic meters per year. The population of Egypt is about 61 million which results in a per capita share of 985 m³/person/year. The population is expected to reach 90 million by 2025 thus the per capita volume will drop to about 600 m³/person/year [11], or even less according to the latest population projections made in 2006.

Egypt is an arid country which covers an area of about 1,000,000 km² but only 4% is occupied by its population. About 99% of the population is concentrated in the Nile Valley and Delta. It will be necessary to redistribute the population over a larger area in order to ensure future development. To reach this objective, Autonomous Desalination Systems (ADS) can be used to provide pure water supply in order to create new communities.

This report examined the framework conditions in the country and suggests possible improvements in order to facilitate faster ADS development. The report is organised in the following chapters:

- Relevant policy and programmes
- Legislation and administrative issues
- Water prices and subsidies
- Institutional framework of the water sector
- Capacity building and awareness raising

5.3 Relevant policy and programmes in Egypt

5.3.1 Water and energy policies

Conventional water resources in Egypt are limited to the Nile River, rainfall, flash floods and deep ground water in the deserts. The Nile River provides the country with more than 95% of its water needs. Egypt is considered an arid country which receives an amount of rainfall that seldom exceeds 200 mm per year along the northern coast and which declines very rapidly to almost nil south of Cairo. Groundwater aquifers in the west desert are generally non-renewable, while such aquifers in Sinai may be partly recharged by the rainfall and flash floods resulting from a short-period of heavy storms.

Egypt has many problems in both the water and wastewater sectors, namely:

- Inefficient water and wastewater networks
- Shortage of proper water and wastewater treatment plants
- Water pollution from different types of wastes
- Erosion in the Delta area due to the sea water and the reduced mud deposition after the erection of the Aswan High Dam
- Pollution of most northern lakes and drains

Egypt's present main irrigation water delivery system was developed over the 19th century with the initiation of barrage construction on the Nile in 1861. 80% of irrigation water delivery comes from the river source, the remainder is nearly all pumped. This leads to another basic problem in that approximately 85% of irrigational activities use too much water and almost half of it is lost without being used by the crops. Over-irrigation causes salts to build up in the soil reducing its fertility.

There are also political aspects of the cross-border running Nile River. A significant portion of Egypt's total water resources (98% of its fresh water) comes from the cross-border water basins primarily in the Nile river basins in Africa, while the other portion is stored in the lake Nasser behind Aswan High Dam in the Upper Egypt. Countries associated with the Nile River play a great role in Egypt's water policy. Also it must be noted the growth of population in these countries is also a problem causing political crises.

Water policy in Egypt

After the completion of the Aswan High Dam, a series of water policies were developed in Egypt to ensure better management of the available water resources. Most of these policies were inflexible and consequently they could not cope with uncertainties such as future changes in technology or in the country's priority issues affecting the behaviour of water users. Since 1975 there are 8 pivotal policies (1975, 1980, 1982 (Master Plan), 1986, 1990, 1993, 1999, 2002 (plan for 2017)). From 1975 to 1999 all policies addressed mainly the agricultural sector which is responsible for more than 80% of the total water demand and employs more than 40% of the workforce. Details of these past policies are given in reference [2].

The National Water Resources Policy 2002

A few years ago the latest water policy document drew attention to water management. At present the Ministry of Water Resources and Irrigation (MWRI) uses an integrated water resources management policy approach to create an efficient blend of all available resources (fresh surface water, ground water, precipitation and drainage water) to meet the demands of

the full range of water users (including agriculture, domestic users, industry and in-stream flows).

The integrated management approach requires much closer coordination between governmental institutions and the active participation of water users in the planning, management and operation of water collection and distribution systems. Also a strong legal basis for water allocation, conservation and protection is needed. To cope with these challenges, the MWRI has developed a national policy with three major pillars:

- Water use efficiency enhancement
- Water quality protection
- Pollution control and water supply augmentation

The planning horizon is the year 2017. The plan aims to optimise supply and control water pollution in the face of the rapidly growing population. The draft plan was completed in March 2004 and also includes an investment plan. It addresses all water related activities and considers the technical, managerial and institutional interventions. Important decisions on allocation of resources and priority setting of interventions are indicated [2].

Traditionally the efforts to improve water supply were focused on the residential areas. The new policies and programmes though for the efficient use of water resources are aiming the agricultural sector as well. Generally attention is given to the development of conventional resources while non-conventional resources are left for decentralised applications.

Energy policy in Egypt

The Egyptian government has recognised that primary energy resources need to be efficiently developed and managed in order to create a sustainable supply for the country. This needs to be matched with expected growth in demand of 6-7% within the next ten years [3]. The Ministry of Electricity and Energy manages national supply and has policies of:

- diversifying energy resources
- improving energy efficiency
- applying energy conservation measures
- promoting renewable energy utilization

The New & Renewable Energy Authority (NREA) was established in 1986 under the Ministry of Electricity and Energy to introduce and promote RE technologies and implement energy conservation measures. Other tasks include [12]:

- RE resource assessment.
- Research, development, demonstration, testing and evaluation of the different RE technologies focusing on wind, solar, and biomass.
- Implementation of RE projects.
- Proposing the Egyptian standard specifications for RE equipment and conducting tests to evaluate their performance under the Egyptian conditions
- Consultancy services in the field of RE.
- Technology transfer and development of local manufacturing of RE equipment.
- Education, training and information dissemination

A renewable energy strategy has an aim of supplying 3% of electricity from renewable sources by 2010. This will mainly be from wind and solar supplies although other sources such as

biomass will also be used [3]. Statistical data which illustrate the RE sector development are given in the annual NREA report 2005-2006 [3].

5.3.2 Relevant programmes and initiatives

Water Programmes

In Egypt, water projects are mainly financed by the government with some support from foreign development agencies and funds like EU programmes, KFW, USAID etc. The required investments to meet the water demand, as outlined in the *National Water Resources Policy*, are high and it will be a challenging task for the government to secure and allocate them.

The water requirements of the agricultural sector represent more than 80% of the total demand, so irrigation improvement programmes are a priority in the Egyptian water policy. The Irrigation Improvement Project (IIP) supported by USAID aims at transforming the irrigation system, especially on the micro-level. The project encourages the participation and involvement of the user in the operation, maintenance, and management of the irrigation system. The framework of IIP includes rehabilitation and renewal of water distribution structures, use of pipe and raised mesqas (the Arabic word of irrigation ditches), use of one-point collective pumping from branch canals into mesqas, and land levelling using modern techniques. It also includes modified designs for field irrigation systems. Most importantly, the formulation of Water User Associations (WUAs), which expresses the new vision for water distribution management processes.

The Ministry of Agriculture and Land Reclamation (MALR) reviewed the horizontal expansion plan and updated it, using intensive surveying to create soil characteristics maps for parts of Western Desert and Sinai and to locate new areas suitable for reclamation. The plan is expected to be completed by 2017 [1]. The Egyptian government has already started the development of three mega projects (North Sinai, Toshka and North-West Delta) to expand the agricultural land by more than 1.5 million feddan in the next decade.

Donor contributions to water resources management in Egypt have been of substantial importance over the past 4 decades. A list of the major international donors in Egypt include the European Commission, USAID, The Word Bank, UN organizations, the Netherlands (particularly in potable water), Japan, Canada, and Germany (particularly in wastewater), Finland (in hazard waste), and Denmark (in RE).[1]

Energy Programmes

In the sphere of renewable energy, Egypt has developed a number of wind farms, with capacities between 80-220MW. These projects have all been implemented with the help of foreign donors. By 2010 a total of 850MW is expected to come from wind energy [3,8].

Wind Atlas for Egypt

A wind atlas for the Suez Gulf area was issued in 1996 in cooperation with the Danish company RISO labs. It found that the area west of the Suez Gulf is one of the best desert regions for wind production and able to produce up to 20,000MW of electricity. The wind atlas has now been extended to cover the whole of Egypt [3].

Solar Atlas

A solar atlas was issues in 1991. Direct solar radiation is observed between 2000-3200 kwh/m²/year from north to south. The sun shine duration ranges from 9 – 11 hrs per day, with

only a few cloudy days per year [3]. A solar thermal power plant is being considered at Kuraymat with a capacity of 150MW and implementation is now on an early stage [3].

5.3.3 Implications for the implementation of ADS and recommendations

Egypt has developed water and energy policies that are pointing to the right direction of water conservation, demand management and development of renewable energy. The implementation of the policies though is done exclusively from the central government and this has proved to be rather slow and inflexible. There is a lot of infrastructure works needed and programmes that will encourage and promote water conservation and investment in renewable energy and decentralised water projects.

The policy objectives would be better served if more power was given to the local level to choose their own water and energy supply solutions and if money was made available for design and implement programmes that call for local projects to support rural development and basic services provision. Then ADS would have an opportunity to compete with other decentralised water supply options on equal terms. The integrated water resources management approach that is currently introduced by the government will be a good opportunity to push for more decentralisation in the water sector administration.

The concept of non-conventional water exploitation is also gaining ground, although traditionally it has been ignored because of the Nile water availability. The fast growing population forces the government to consider use of previously uninhabited areas in the desert and reclamation of the land for agriculture. This provides an excellent opportunity for ADS to provide part of the water needed to implement these plans.

Recommendations*:*

- More programmes that are needed that will support water conservation and investment in renewable energy and decentralised water projects
- The IWRM trend has to be used to promote decentralisation of the water sector administration
- The relocation to new arrears away from the Nile plans is a good opportunity to promote ADS

5.4 Legislation and administrative issues in Egypt

5.4.1 Relevant legislation

Egypt water legislation is divided among a number of governmental sectors and this causes overlap with other sector policies.

The group of laws associated with the water sector is listed below [4, 5]:

- Law 48/1982 for Nile river and water canals protection from pollution
- Law 93/1962 for wastewater drainage conditions and quality
- Law 57/1978 for septic bodies elimination
- Law 27/1978 for drinking water resources management
  - Attachment 301/1995 for law 27/1978 for the intakes of drinking water plants
  - Attachment 108/1995 for law 27/1995 for drinking water quality and specifications
- Law 12/1982 for irrigation and drainage
- Law 213/1994 for farmer participation
- Law 4/1994 Law for the Environment

Law for the Environment 4/1994

Items No. 19, 20, 21, 22, 23, 70, 71, 73 from law 4/1994, specify the procedures required for the environmental impact assessment for all projects and installations [6].

Projects are mainly classified into 3 categories according to their environmental impact and the expected degree of pollution:

- White projects: affecting <1,000 persons
- Grey projects: affecting 1,000 – 1,000,000 persons
- Black projects: affecting >1,000,000 persons

ADS are usually classified as white projects because of their small size and impact. Classification also is defined according to which ministry is responsible for the project:

- Ministry of Electricity MOE
- Egyptian Environmental Affairs Agency (EEAA)
- Ministry of Water Resources and Irrigation MWRI
- Ministry of Housing, Public Utilities and New Urban Societies MHUNC

Documents required from each category are given in details in reference [6].

Brine disposal

The Egyptian Environmental Affairs Agency (EEAA) has issued two laws, 48/1982 and 4/1994, which prohibit the discharge of untreated effluent from desalination plants or the irrigation drainage network into water resources based on the level of total dissolved solids (in mg/l).

Structures in coastal regions

The Ministry of Housing, Public Utilities and New Urban Societies defines the width of the shoreline and which coastal structures are allowed. Generally structures are limited to tourism infrastructure and the height of these buildings is controlled to prevent obstruction of sea views.

In light of prevailing and projected water supplies, demographic, and ecological conditions in Egypt, these laws need to be reviewed. States that utilise wells near the shoreline have to comply with the safe yields for withdrawal of water from the groundwater resources as a measure to prevent saltwater intrusion. No criteria were put to assess suitability of seawater for production of drinking or irrigational water.

Supply and quality of drinking water

The Ministry of Health and Population (MOHP) administers the Attachment 108/1995 of law 27/1995 for drinking water quality and specifications. The law defines the specifications for healthy drinking water intakes, sampling techniques for treated water, well water, vessels water and channel waters.

Renewable energy installations

Renewable energy installation such as wind farms are classified as grey projects, while the only white projects are the extension of power lines with limits 10% and new constructions or extension of operating plants for low voltage less than 130 KV.

Legislation regarding the electrical energy installations is documented by MOE.

Small renewable energy installations in the order of 10 KW which are designed to operate independently from the grid do not require licenses.

Law of Electricity Market:

In order to encourage private power stations, belonging to industries or other major consumers, there are various incentives offer to connect with the electricity grid.

The Clean Development Mechanism (CDM) under the Kyoto Protocol could provide benefits for ADS. Egypt prerequisites for CDM participation include the legal framework for investment in Egypt found in reference [7]. Environmental Protection Fund (EPF) was established in accordance with law 4/1994 to promote the investment in environmental field (in which ADS may be included as a CDM project)

Law 59/1979 for new communities and cities can help also for ADS installations

5.4.2 Relevant administrative procedures and required licenses

The required licenses for ADS implementation from water intake to installation, water supply and brine disposal are presented below:

Water intake

Sea water - There are no legal requirements except what are mentioned in laws 48/1982 and 4/1994 for the case of sea water withdrawal. Legislation regarding the coastal waters is limited to the protection of the shores from polluting streams and disposals and the minimum distance for installations (approximately 100 m) and the minimum wastewater discharge (500 m).

Brackish water - A license is required from MWRI for drilling a well and/or utilization of wells (especially deep wells more than 20 m depth) to obtain fresh or brackish water. The Ministry of Housing, Public Utilities and New Urban Societies (MHUNC) intervenes with the site selection of wells in order to protect the resources.

MWRI issues the licences for the use of groundwater. MWRI first approves the project outlining the drill point, design of well and pumping scheme. There is a list of MWRI sub- firms authorized to conduct such projects. If the well already exists, the Ministry of Health and Population (MOHP) tests such groundwater to permit the license of drinking water. A pumping report, chemical analysis for water and justification for the need shall be submitted to MWRI. Average waiting period is 3-5 weeks for the whole licensing process. The distance between 2 wells must be greater than 100 m.

Construction of ADS and water supply

In Egypt, in the case of non profit organizations, the governorates may offer use of the land required for ADS for free during the total project life, in case the whole project is clearly non-profit. After this period of project application, the land is returned again to the governorate and the equipment will be transferred to the community.

Brine disposal

Environmental management sectors in the governorates deliver the permission for wastewater discharges according to the previously mentioned laws. Industrial installations procedures are more complex; they must be classified at first under three categories (white, grey and black) according to their potential environmental impact. Brine disposal is not allowed to the Nile River and other surface water channels without the proper treatment.

Environmental administration in the new cities may test water samples from time to time to check for compliance with wastewater regulations. The strength of the environmental administrations differs from one governorate to another. The law gives the power to the authority to close down the installations that violate the regulations.

Import taxes and procedures

Payment of customs and sales tax is necessary to import equipment from abroad according to the import regulations in Egypt. Some items used in ADS such as photovoltaic cells are exempt from tax while for others the amount varies from 5-10% according to the approved original invoice, shipping and insurance documents. It takes about two weeks for customs procedures to be completed.

5.4.3 Implications for the implementation of ADS and recommendations

ADS technology is still a new approach and subject to a range of laws and instructions. The process to obtain the necessary licences, including well drilling and use, land use, and water distribution for drinking purposes, is lengthy and complicated and requires interaction with representatives from several ministries and authorities. For example, in the ADS planned in framework of the ADIRA project for the Mattroh governorate, it took nearly one year to obtain all the required licences for a 2 m^3/day system.

It is important to keep a reasonable licensing procedure that will allow good control and monitoring over the scarce water resources of the country. However, the unnecessary bureaucratic complications and involvement of several public actors has to be eliminated and the process to be simplified. As part I the IWRM approach all required licenses at least for small projects should be the responsibility of the relevant water basin authority.

The procedures required to install renewable energy equipment though are quite straightforward, and managed by a single authority, the NREA which is supervised by the MOE. License application for commercial plants is under progress. Small renewable energy

systems in the order of 10 kW which are designed to operate independent from the grid do not require licenses. It would be positive to increase the limit to at least 500 kW for renewable energy installations to allow for larger projects without any risk involved for the government.

There is also no import tax for renewable energy equipment which is an additional incentive, reducing the associated costs. The tax break should be included to desalination equipment, as long as they are intended for use in ADS.

Recommendations

- Simplify the procedures for obtaining the licenses necessary to install ADS and transfer the relevant responsibility to the local level, for example to the local water basin authority
- Increase the limit of renewable energy installations that can be installed without a license from 10 kW to at least 500 kW
- The import tax for desalination equipment should be removed, like in the case of renewable energy systems, as long as they are intended for use in ADS.

5.5 Water prices and subsidies in Egypt

5.5.1 Water Prices

Water tariffs in Egypt depend on:

- Treatment technology.
- Consumption volumes, for example the first 20m³ drinking water consumed per month in cities and towns have socially supported subsidies.
- Use of the water affects the choice of treatment technology; so there can be very different prices of water for drinking, industrial or irrigation purposes
- Source of the raw water for example: rivers, groundwater wells, or sea water.
- Ownership of the water for example government, private or BOOT.
- Location can cause high prices, for example when long distances and arid locations in the desert are involved.

The table below gives an indication of the price range for some characteristic cases.

Table 1 Price range for water in Egypt per cubic meter

Type	Uses	Price (LE/m^3)	Price (€/m^3)	Remarks
Treated water	Houses, cities	0.2	0.03	Partly subsidised
Treated water	Projects, irrigation	0.3 to 1.15	0.04- 0.16	Partly subsidised
Treated water	Social places	Free	Free	Subsidised
Raw water	Irrigation	0.05	0.007	
Treated wastewater	Irrigation	Free	Free	

5.5.2 Implications for the implementation of ADS and recommendations

In general water supply in Egypt is provided in low prices, subsidised by the government. This makes it difficult for new innovative solutions like ADS to have a fair opportunity to complete with traditional approaches. On the other hand the fact that resources for subsidising water do exists make it possible for ADS to gain access to some of these funds for supporting the first installations in the country. Together with funds from development agencies that are active in the country it would be possible to have some demonstration systems providing water at the current prices. Isolated communities in the desert area provide ideal cases for ADS implementation.

The established practice in Egypt has contributed in developing a socio-cultural approach that regards the attachment of a price to the unit of water as unethical. While the affordable access to sufficient quantities of safe water should be a fundamental human right, a price structure is necessary to allow for the collection of funds needed to pay for the investment, operation and maintenance of water infrastructure. The same is the case for ADS, and such systems can only

be implemented if local communities develop an understanding of the role and responsibility they have themselves for solving their water problems. ADS as a simple and decentralised solution can be a good tool to show to people that they have the power to create solutions to the problem.

Recommendations

- Part of the existing water subsidies from the government should be used in combination with donor funds to implement demonstration ADS projects
- Rural areas near the coast are the best sites for commercial ADS installations
- The local communities have to get used to the idea that they need to contribute to the efforts and resources needed for the installation, operation and maintenance of the infrastructure necessary for their water supply

5.6 Institutional framework of the water sector in Egypt

5.6.1 Main water actors

Water Actors on National Level

The Ministry of Water Resources and Irrigation (MWRI)

The Ministry of Water Resources and Irrigation is responsible for all Egyptian water resources and authorises the use of water from the Nile, canals, drains, and groundwater sources. The Ministry also has the control over works built to discharge water into canals, drains, and the Nile. MWRI is authorized to assess penalties if these rules are not obeyed.

The Ministry of Agriculture and Land Reclamation (MALR)

The Ministry of Agriculture and Land Reclamation is in charge of agricultural research and extension, land reclamation and agricultural, fisheries and animal wealth development [2]. Prior to 1992 the Ministry of Agriculture and Land Reclamation decided, in consultation with the Ministry of Industry, which crops were to be grown in which localities. From this exercise, the Ministry requested specific volumes of water to be delivered to each canal and each branch canal. Following the liberalization of the cropping pattern in 1992 however, it is not known precisely how the water allocation takes place.

The Ministry of Health and Population (MOHP)

The Ministry of Health is authorized to close potable water supply works if the water produced does not meet quality standards. MOHP is further responsible for drafting quality standards for various water uses and for discharges of waste water.

Ministry of Housing, Public Utilities and New Urban Societies (MHUNC)

The Ministry is responsible for, and represents the owners of water plants, wastewater treatment plants and pumping stations which service these plants.

Ministry of Local Development (MLD)

The Ministry is responsible for the local coordination and administrative agreements for any new projects which need the agreement from several ministries.

Ministry of Electricity (MOE)

The Ministry is the only body responsible for electricity, and until now, it has sole responsibility for renewable energy projects.

State Ministry for Environmental Affairs

The Ministry has the authority to close the factories which violate Law 4/1994 mainly for the air, water, and land pollution. The Ministry supports clean projects and represents an important link between international donors and environmental projects.

The National Water Research Centre (NWRC)

The NWRC is a unique organization developed in Egypt to conduct research at the highest policy-making level. In this way, Egypt has set an example for other developing countries to follow [13]. The objectives of NWRC include: researching and proposing water management policies for Egypt; investigating technical solutions for water and irrigation resources;

agricultural extension support; environmental studies of irrigation and drainage systems; and strengthening international research ties with the Egyptian water sector.

Water Actors on Local Level

The Alexandria Water General Authority (AWGA) is the utility responsible for providing drinking water and some other water supplies to the Alexandria Governorate in Egypt. Its service extends to Matrouh Governorate 300 km west of Alexandria on the Mediterranean coast [9].

5.6.2 Implications for the implementation of ADS and recommendations

As mentioned also earlier in the report, the administration is centralised in Egypt and the IWRM approach should be used as an opportunity to transfer more responsibilities to the regional and local levels, ideally organised on a water basin level. The example of the Alexandria Water General Authority can be followed also to other areas.

The capacities and influence of the NWRC should be also used for promoting the idea of decentralised and non-conventional water supply solutions like ADS to the decision makers.

Recommendations

- The example of Alexandria Water General Authority should be followed to other areas as well with decentralization of the water sector administration
- The National Water Research Centre should promote ADS to the decision-makers

5.7 Capacity building and awareness raising in Egypt

5.7.1 Current Status

Desalination in Egypt is already present using thermal (MSF) and membrane (RO, EDR) technologies in high capacity drinking water treatment plants. This has contributed in increasing the know-how available in the country, with technicians gaining experience in operation and maintenance, spare parts and consumables being imported and distributed in the country and the general public learning about the possibility of gaining water from the sea.

There are also ADS available already in the Egyptian market, as for example the solar still technology that is used for the ADIRA application. This reflects the severe need for decentralised applications for the supply of safe water.

Membrane-based separation processes and industrial applications of membranes, like water treatment, re-cycle and reuse are studied in many universities in Egypt, like:

- Cairo University
- Alexandria University
- Ain Shams University
- Al-Mansoura University
- Assute University
- Zagazig University

Additionally NREA has established a strategic renewable energy research unit, geographic information system and an information and documentation centre. The most important recommendation resulting from NREA's research strategy is agreement to establish a regional research centre in Egypt which promotes RE utilisation and builds capacity within the Middle East and North Africa region. NREA has the following training programmes:

- Wind Energy
- Solar Radiation
- Solar Thermal Applications
- PV Applications
- Energy Conservation

5.7.2 Implications for ADS implementation and recommendations

The existing know-how from the industrial desalination plants is a good basis for further development. ADS can benefit from the availability of technicians, companies and networks for distribution of spare parts and consumables in the country. Also the existing companies that offer ADS in Egypt offer a great opportunity for further development of the technology in the country.

But prices for ADS have to be reduced in order to become competitive, so the research potential in the Universities has to be motivated to develop local designs and systems that will be produced in the country, reducing the associated investment costs. A first step would be to include modules covering the ADS basics in relevant University courses. Then PhD candidates

and researchers should focus their efforts in the application of ADS in the country and how the performance can be optimised under the specific climatic conditions.

Finally, awareness among the local populations in isolated dry areas and the relevant authorities has to be increased with targeted ADS dissemination activities and educational campaigns.

Recommendations

- The desalination and ADS companies in Egypt should be encouraged to network with renewable energy companies and ADS specialists for collaboration.
- ADS basics should be included in the curricula of relevant university courses.
- Research on ADS development and adaptation to the local conditions in Egypt should be promoted and supported.
- Activities and educational campaigns should be organised to inform the general public and targeted groups about ADS and its prospects

5.8 Conclusions for Egypt

The framework conditions in Egypt for ADS development have a lot of room for improvement. However, the huge and fast growing population and the isolated Bedouine communities in the desert do have a clear need for decentralised water supply solutions. Therefore, the ADS community has the opportunity and the responsibility to push for changes in the conditions and the water administration practices for removing the barriers ADS development is facing.

Currently the government is adopting an integrated water resources management approach and this is a good opportunity to push for more decentralisation in the water sector administration. Also the licenses required for installing ADS could be simplified by delegating the relevant powers to the local level and eliminating the need for licences for smaller projects.

Plans have been made to relocate part of the growing population to areas in the desert, away from the Nile, and ADS could be an important tool to support the challenging water supply requirements that the plan implies.

The ADS community should actively try to secure funds from the existing subsidies and from international development agencies active in the country in order to implement some demonstration plants. These projects together with the few existing systems will be a valuable first step in order to raise awareness and enhance the know-how among the specialists in the country.

5.9 References for Egypt

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6 General Conclusions to Country Reports

The four countries included in this report share many similarities in their climate, geography and culture. However they have also developed many different approaches to dealing with water scarcity and its impact on development. The conclusions below emphasise those similarities and highlight the different actions that the ADS community can take in order to improve market penetration and implementation of ADS technology in the Mediterranean.

6.1 The Role of National Policies and Programmes

ADS is a technology which straddles both the water and energy sectors. It is primarily a solution to the problem of supplying potable water to communities and therefore is most concerned with developments in the water sector. However because the desalination units are powered from RE, it is also affected by developments in the energy sector. Further relevant policies include social or rural development and public health.

There are two complementary trends in water planning in the four countries surveyed. The first trend is to simplify and streamline water policy, gathering all responsibilities within one ministry, clearly defining water objectives and clarifying which agencies are responsible for a given issue or project. Jordan, Egypt and Morocco either have or are developing a water master plan at the national level, while Turkey is moving in this direction with its *'Acceleration of Collaboration between Responsible Institutions and Organizations in Water Management and Improvement of Integrated Approach in Water Management Planning in Turkey'* report. This streamlining trend is beneficial for ADS as it focuses governmental and public attention on water issues and provides clear support for environmentally friendly solutions.

The second trend is decentralisation, where decisions for water supply are made at the local level rather than by regional or national governments. This occurs in Turkey and Morocco which are both larger countries with varied water sources, but less so in smaller Jordan and not at all in Egypt. Decentralisation of decision making is more likely to lead to a decentralised solution which is to the advantage of ADS and the Egyptian stakeholders have to focus their efforts on this direction for efficient local water supply solutions.

Non-conventional water sources, which include desalination technology, are already recognised and targeted in the Jordan and Morocco national water plans. This provides explicit support for ADS installations at a high level. However this is not the case for Turkey and Egypt. The ADS community needs to lobby the Turkish and Egyptian government to consider non-conventional water sources as a realistic water supply option. High level governmental support for non-conventional water resources provides encouragement to invest in ADS.

Turkey and Jordan are both investigating the deregulation of the water supply market and allowing private investment and supply. Morocco has already taken some measures in this direction by allowing limited private water supply concessions in some cities. Egypt does not appear to offer much encouragement to private sector investment in the water supply. Privatisation is not a prerequisite for ADS installation as they could be successfully installed by municipal governments or user groups. However it does provide more investment opportunities and a wider range of financing possibilities to meet ADS installation costs.

On the energy side, the widespread support for renewable sources is positive for ADS. All four countries have explicit policy goals to encourage RE installations. Egypt has a set of detailed atlases showing wind and solar data across the country while Jordan and Turkey are in the process of achieving this. Morocco subsidises and provides technical support for electrification through PV installations for communities not connected to the national electricity grid. The ADS community should target these kinds of programmes to gain funding, or at least to obtain and share information and resources such as training and logistics.

6.2 The Cost and Competitiveness of ADS

All four countries have water tariff systems where households and non-residential users must pay for the volume of water they consume; either instead of, or in addition to, a basic connection charge. All countries also provide some kind of subsidy system to small consumers or for socially beneficial uses. Additionally, Turkey uses water tariff subsidies to encourage tourism in certain areas. The established practice of charging for water will aid the acceptance of ADS in areas where operating and maintenance costs must be covered or a return on investment is required. The Morocco report in particular notes positive experiences in charging tariffs which cover the full construction and provision of water services.

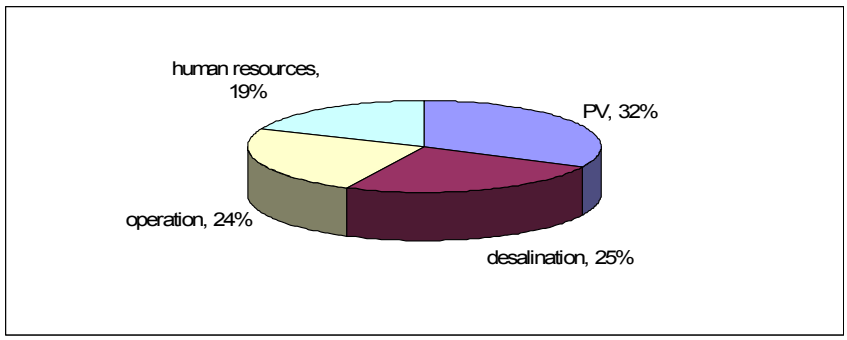
The existing tariffs in all countries do not exceed 1 Euro/m^3 for users connected to the water network. Tariffs close to that are for example charged in rural areas in Morocco to reflect the higher costs of water supply in these areas, or in Jordanian non-residential users. Even higher prices though are paid by users that get their water delivered by trucks or other means because the connection to the water network is unreliable, offers low quality water or simply there is no connection at all. All involved countries show in their statistics that such users are a very low percentage of the overall population, but this is still a large amount of people and the real number of the affected population might be much higher. In Jordan, water supplied by private entities costs between 2-3 Euro/m^3 and in exceptional cases might be charged up to 6 Euro/m^3, especially in the summer months.

The cost of water produced by ADS on the other hand is currently relatively high. The data from the ADIRA installations for example show costs ranging from 5 up to more than 10 Euro/m^3 for the water produced by desalination of brackish water by PV powered reverse osmosis (PV-RO). The cost depends on the specific conditions, like salinity of the water, cost of personnel and accessibility of the site. The size of the installation also affects the cost; for example in one of the ADIRA installations in Morocco that produces daily 6.8 cubic meter of water on average the unit cost is 5.15 Euro/m^3; in Turkey where the capacity is half that size the cost is 6.5 Euro/m^3 while in Jordan where a much smaller unit is installed producing less than 0.5 cubic meter per day on average the cost is close to 15 Euro/m^3.

From the comparison of the current tariffs in the target countries and the water cost from ADS it is confirmed that ADS at the moment are more suitable for niche markets in isolated dry areas where other solutions like water transportation can be similarly expensive. Almost in all these cases the relevant costs are not paid by the end users but are covered by State subsidies. The ADS community should focus its efforts in each country to redirect part of these subsidies for the application of ADS in the areas where it most makes sense. The political process of water supply decentralization and market opening might anyway cause a re-consideration of such subsidies in some of the target countries and ADS community should use the chance to promote ADS as a local, modern and clean solution.

Still, even in rural areas that are connected to the water network we have seen that end-users pay around 2-3 Euro/m^3 for good quality water to be transported to them. It is expected that ADS will fast become competitive in this much larger market. Current practice is to transport

water over long distances with a truck; therefore the cost is closely linked to the oil price which will be rising over the next years and decades. The increasing pressure to the traditional water resources with growing populations and the climate change effects will also add to the rising cost of conventional solutions. ADS, on the other hand, are only at the beginning of their learning curve. As the installations become more common the know-how generated in each country will contribute to the reduction in costs associated with the design, operation and maintenance of the systems. The capital costs for the desalination equipment are also decreasing with the RO industry growing very fast and similarly for PV which are predicted to cost between 50 and 70% less than today within the next 20 years. The effect such developments can have on the price of water produced by ADS become more evident from the figure below that shows the share each aspect has on the cost of one cubic meter of water produced by the ADIRA PV-RO plant in Morocco (Azla):



6.3 *Administrative Issues*

Small scale water and energy installations are generally exempt from many licence requirements. In terms of RE, Turkey provides licence exemptions for RE installations under 1000kW. Morocco currently has an exemption allowing private electricity production not connected to the grid of up to 10MW although this may rise to 50MW soon. Egypt also allows RE production which is not connected to the grid to operate without licences.

These kinds of exemptions are the case for water supply too. Turkey allows plants which supply less than 10m³/day to be exempt from some drinking water quality monitoring requirements and bores which are less than 10m deep do not require drilling or operating licences. Morocco allows small scale projects to be exempt from producing an environmental impact assessment, and provides a varying minimum threshold for bore depth and flow rates before licences are necessary. The small scale of most ADS applications allow them to meet the conditions of these exemptions which can reduce the related costs.

It is possible that the existence of these exemptions may actually lead to a cap on ADS capacities as projects adapt to local regulations. This leads us to the next major recommendation: a ‘one-stop ADS licensing shop’. All four countries maintain separate water and energy policies. This is beneficial from a governmental perspective as it allows separation of responsibilities and clear definition of issues. However, ADS is a technology which involves both renewable energy and drinking water supply. For ADS the result of separating energy and water administrations means that a complex set of laws and regulations must be adhered to, and a variety of different licences must be obtained in order to install an ADS system. Each licence is administered by a different government agency and interagency communication is often poor. A common theme in the country master plans is reducing this complexity and bureaucracy by creating a streamlined licence system, a kind of one-stop shop. The concept is that ADS project managers will communicate with only one agency, for example the agency responsible for drinking water supply. This agency can then contact the other government

organisations if further permits are required. At the minimum a standard licence process needs to be developed with relevant agencies to ensure that licensing proceeds smoothly.

This one-stop licence system would simplify the process for ADS but is only practical from the governmental viewpoint if a threshold number of installations are being considered for that country. The momentum required to initiate these installations will need to begin with awareness-raising for both the general public and more specifically for the water and energy professional community in each country.

6.4 Awareness raising and capacity building

People in the four countries of this report realise that water is scarce and that a reliable supply of potable water is critical. However there is little general public awareness of the possibilities of ADS. Although ADS is a technical solution only suitable for a limited range of situations, the awareness of potential ADS customers needs to be increased. This is particularly the case as decentralised water management becomes more common. Programmes such as the Morocco INDH initiative have funding which groups can access to reduce poverty in their community. Similarly in Turkey the Support Program for Rural Development Investments initiative provides grants which offset the cost of constructing rural water supply infrastructure. Communities need to be aware that ADS technology exists in order for them to consider using it as solution to their water supply problems and subsidise it by the available programmes.

More effort needs to be targeted to educating water and energy industry professionals about ADS. All four countries have a strong engineering and technical educational sector with a focus on water technologies. Experience with both desalination and RE already exists. However there is no formal educational course in any country which targets or includes ADS applications. The ADS community needs to make an effort to encourage and support universities to offer courses or seminars on the topic. At the local level, a network of technicians needs to be available to maintain ADS installations. At least in Morocco this network potentially already exists by training the young entrepreneurs of the Energy House system. A similar network could no doubt be created in other countries.

The best way to promote awareness and trust in a new technology is by showing examples of it in use. Within the ADIRA project, already ADS are in operation in Morocco, Jordan, Egypt, Turkey and Cyprus. This is an important step to build trust in ADS installations. More demonstration sites need to be constructed and existing ADS trials capitalised on to show that ADS is a technology that works.

ADS is a promising technology to supply potable water in places which have few other options. It is environmentally friendly and is becoming more affordable. It needs only continuous support and attention from the ADS community in each country in the areas outlined in this report to achieve good market acceptance in the Mediterranean region. As more systems are installed it will become an established source of water for remote arid areas: a truly sustainable development.