INSTALLATION GUIDE FOR AUTONOMOUS DESALINATION SYSTEM (ADS): TASK BY TASK PLANNING AND IMPLEMENTING - PART I: PLANNING

Hassan E. S. Fath [1], Fatma El-Shall [1] and Vicente J. Subiela [2]

[1] Egyptian Association for Water and Energy (EWE), Alexandria, Egypt
E-mail: h_elbanna_f@yahoo.com, Web Site: www.ada-eg.com
[2] ITC, Canary Island, Spain

ABSTRACT

As a part of ADIRA* project handbook, this paper presents the first of two parts of the installation guide for Autonomous Desalination System (ADS): planning and Implementation. The guide aims to support ADS installation under different local conditions, and draw attention to the important technical, economical and social aspects to be considered as well as the possible problems and solutions and actions to be taken. Part I of this guide presents task by task of the ADS installation planning process, which include; (i) site selection guide, (ii) desalination selection process guide, (iii) ADS economic & financing (cost analysis, decision support tool, and financing mechanisms) , and (iv) social impacts & actors Participation.

Keywords: Autonomous Desalination System (ADS), RE, Desalination, Guide

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1- INTRODUCTION

There is always a need for providing small communities living in remote areas (far from electricity network & fresh water resources) with adequate water supply coupled with environmental concerns. It often happens that the geographical areas where water is needed are well gifted with renewable energy (RE) sources (solar, wind, geothermal, etc). Thus, the obvious way is to combine those renewable energy sources to a desalination plant in a stand alone system named here as; Autonomous Desalination System (ADS)**,** in order to provide water sources as required. A well designed rural water supply project should be:

- ✓ Simple, robust and reliable
- ✓ Relatively labor-intensive
- ✓ low capital cost and little import of foreign material
- ✓ Accepted and supported by the local community with minimum change to social sphere
- ✓ Organized at local level with relatively simple training

Sustainable

The most popular ADS units are PV-RO, although many other combinations have been tried. PV, Fig. (1), is particularly good for small desalination units in sunny areas. For larger units, wind energy may be more attractive as it does not require anything like as much ground.

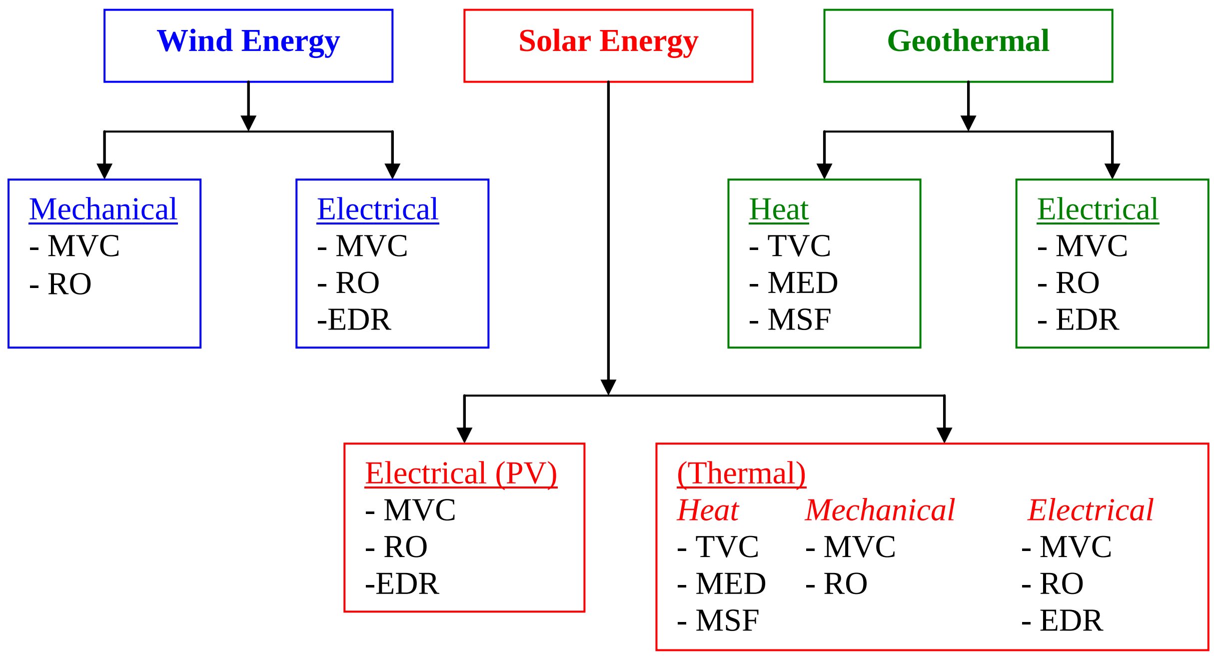

Figure (1) Feasible technology for combination of RE and desalination

A step by step guide for ADS installation planning and Implementation is presented in the coming sections. The guide aim is to support local installation under different local conditions, and will draw attention to the important technical, social and economical aspects to be considered and the possible problems and solutions and actions to be taken.

2- SITE SELECTION GUIDE, [1]

Proper site selection is very important for a successful installation and later operation of ADS. Various aspects are affected by this selection, such as technology to be used, costs, installation time schedule, sustainability, environmental impacts as well as political and social factors. The first step in the site selection process is the candidate sites data collection, followed by the data analysis, then, the selection of the most suitable site among more than one option. Data sources from ministries, universities, research institutes, meteorological stations, utilities, research reports, feasibility studies and maps, and – most of all – on site visits have proven to be very useful. At some sites, it can turn out to be very difficult to obtain some information, perform certain measurements or establish local contacts. Certain problems might arise due to cultural and educational differences, no reliable sources of information or human misunderstandings. This should however not influence objectivity, fair judgment of actual conditions and truthful reporting to the decision makers. It is important to really identify the most suitable site for an installation, best fulfilling the project aims and bringing relief to the local community, rather than selecting one just because it will be easier there.

There are different technical, economical, social and infrastructure factors influences the site selection. The technical factor include; availability and quality of feed water, present water supply situation at a site, existing fresh water sources, RE sources, complete atmospheric data, brine disposal possibilities, topography of the land, seashore information, geology, soils, seism city. The economical factors include; costs of land, labor, transportation, energy, taxes, fees, cost-benefit analysis, water selling price, rules and regulations. The social factors include; Social benefit from planned installation, social situation and willingness of local community to cooperate, quality and quantity of fresh water needed, technical level and skill of local people, local subcontractors, suppliers, employment situation. The infrastructure factors include; existing infrastructure, distance from electricity grid, distance from the users, availability of construction materials. Basic information of these factors should be gathered and analyzed for every candidate site. There might be other factors, not included above, but may have an important influence on final evaluation of the site, or might even suddenly become crucial for it's selection or rejection.

Figure (2) Typical Rural Small Bedouin Communities in need of Fresh Water

At this point it is worth emphasizing the importance of proper identification of beneficiary community's needs, Figure (2). Analysis of many abandoned units of all types (including rural electrification and desalination), indicated the lack of this *social engineering* or technology not properly fitted into local conditions as two most common errors. It is very important to keep the basic principles in the social sciences in mind and try to:

- ✓ communicate well with the beneficiary community,
- ✓ make them aware of the degree in which the installation will change their lives,
- ✓ make sure they really want it and are willing to participate in the project,
- ✓ test their motivation and determination by already giving them some tasks and noticing how they deal with difficulties and tackle problems
- ✓ start creating a feeling among the people that what is supposed to be installed in their village will be for them, will belong to them and whether it will run continuously improving their lives, or will be abandoned after the first major problem is in their own hands.

In case of lack of cooperation or real interest at such an early stage, maybe it's better to turn back to some other candidate site or go through the site selection process again, thus avoiding yet another useless and expensive installation. Those people are obviously not in real need of desalting unit, even if our analytical data says so.

3- DESALINATION PROCESSES SELECTION GUIDE, [2] & [3]

Desalination technology should be implemented only if the renewable water resources have been exhausted and no simpler water purification technology can be applied. When this is the case, we are still left with a number of possible desalination methods and ways of supplying them with necessary energy. A number of basic parameters should be investigated before the desalination process selection. This includes mainly the plant size, RE resources, evaluation of feed water resources (quality and quantity), product water quality and use, technical staff availability, brine disposal, budget constraints, and the cost of water that the users will and could pay.

- ✓ Appropriate technology is that which makes the best use of available resources, such as labor, capital, and natural assets, taking into account operation and maintenance as well. The proper identification of the appropriate technology for a particular rural water supply necessitates the evaluation and comparison of alternative methods, including all costs and benefits. The choice of one process over the other is also very specific site and depends on a number of factors that need to be taken into consideration. Discussion of these factors is given in Appendix (A).

It should be made clear at this point, that there is no straightforward way to select the appropriate RE desalination technology. Rather, an iterative approach is most probable to be followed, involving careful assessment of selected criteria and technical parameters. Furthermore, every candidate process option resulting from the previously described process should be further screened through constraints such as site characteristics (accessibility, land formation, etc.) and financial requirements.

When several alternative ADS schemes are applicable for a specific case, the final decision concerning the most prominent combination should be based, once again, on criteria such as:

- Commercial maturity of technology (an appropriate way to validate this is by examining the performance of similar existing applications).
- Availability of local support (installers, technicians, machine shops, etc.)
- Simplicity of operation and maintenance of the system.

The above factors, in conjunction with available technical information (feed water quality, output water requirements (quality and quantity) as well as the type of RE resource available) provide a starting point for the engineer and the decision maker.

A guidance towards the applicability of each ADS technology option, according to the above mentioned technical factors. It provides an assessment of each technically feasible application. The remarks presented in this table stem directly from the analysis of the various technology options analyzed in Appendix (B), Reference [3].

4- ADS ECONOMICS & FINANCING

4.1 Cost analysis

Cost Analysis of ADS usually aims to estimate the cost of a liter or a cubic meter of fresh water, and calculates the contribution of each cost item to the total cost. This identifies immediately the most significant cost items and attracts the attention to what should first be examined for possible improvement and cost reduction. Unit product cost is mainly affected by:

- ✓ **Unit capacity** – larger units require higher investment, but the product water cost is lower due to higher production.

- ✓ **Quality of feed water** – for RO & ED technologies, for example, the lower the feed water TDS concentration, the smaller the energy consumption and fewer chemicals necessary for pre-treatment. Thermal systems are relatively independent of feed water quality
- ✓ **RE cost** – is closely connected to average wind velocity, solar radiation or availability of other RE sources
- ✓ **Type of technology** – determines requirements for pre- and post-treatment, energy efficiency and costs of equipment and its installation as well as O&M cost.
- ✓ **Site conditions** – existing infrastructure (wells, water distribution network) can decrease the investment costs
- ✓ **Costs of land and labor**
- ✓ **Additional costs** – like taxes, permissions, fees, brine disposal, etc.

It should be however noted, that for a given desalination technology, cost analysis is site-specific and usually cannot be generalized for applications in other situations. As a general rule, the cost of the produced water by ADS is normally higher than conventional electricity sources (fuel energy). However in the remote areas far from fresh water resources as well as areas where the economic driven is tourism, the water price is acceptable. The developments currently underway suggest that the desalination applications are going to become more wide spread. As this happen, price will fall and technology will then become more viable, specially, in the developing countries.

4.2 Decision Support Tool (DST)

To aid the process of cost calculation for a specific desalination technology and situation, a Decision Support Tool (DST) software is being developed within the ADIRA project, for detailed economic analysis of ADS systems, [4]. For analysis, the DST authors, [4], suggest to divide the cost of ADS into following categories, Figure (3):

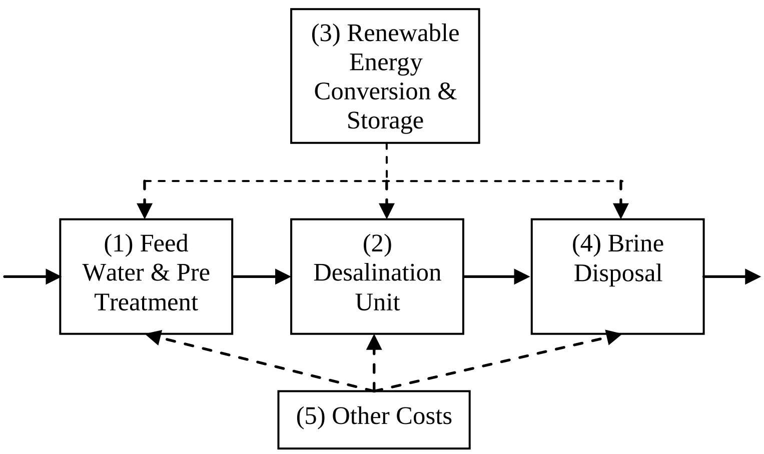

Figure (3) DST Cost Categories, [4]

1. Cost of feed water system and pre-treatment, including all necessary investment and related expenses required for the supply of brackish or sea water to the desalination main system,
2. Cost of desalination unit itself,
3. Cost of supporting RE Source, supplying all the energy needs for the desalination unit, feed water pumps and brine disposal,
4. Cost of Brine water disposal, which could be anything from minimal to very expensive depending upon specific conditions,
5. Other costs.

The usefulness of categorising costs as above allows estimation of each unit costs and facilitates comparisons, such as for example, between using different ADS with the same desalination system, measures the cost of being *autonomous*, increases the scope of sensitivity analyses and helps to optimise system configuration.

Most, if not all, of the above categories have (a) an *investment* and (b) a *running* cost. The first reflects the annual cost of purchasing and installing equipment or other fixed asset, while the second relates to annual expenses and the cost of various consumables which are necessary. The cost per litre or cubic metre of fresh water is estimated by dividing the sum total of all annualised investment plus running costs of all categories by the volume of fresh water produced.

4.3 Financing Mechanisms

ADS project can be considered successful only when all costs are covered. Ensuring financing after the completion of the project can also increase sustainability. Possible financing and water price subsidy schemes by local or international organizations should be carefully examined.

Most of RE projects need considerable investments and cooperative financing. Each project is financed differently, depending on the purpose, country, unit size and other particularities. One can however distinguish several typical ways to finance such projects [2]:

- ✓ Personal savings, assets from users and/or promoters
- ✓ Subsidies or grants to support technological innovations
- ✓ Loans from International Funding Agencies (e.g. World Bank Group, Global Environment Facility, Regional Multilateral Development Banks)
- ✓ National Funding Agencies
- ✓ NGO’s
- ✓ European Commission Programmers (like Europe Aid)
- ✓ Combined projects with strong financial partners - Private Sector Investment

- ✓ Financing of the project with limited guarantees over the future cash flows

According to the previous experiences with the financing of RE, a fee for service is essential for the success of a project. Therefore, an appropriate tariff system for the users should be implemented.

Due to high initial costs of RE powered desalination, a good implementation model is necessary. Some of the possible models are briefly discussed below [2]:

- **Cash sales** – The companies sell their systems to end users directly (possibly via retailers). End users own the system as soon as they have paid.
- **Consumer credit** – Manufacturers (dealers) sell systems directly to end users, but here users can pay for the systems in installments. Hence, the dealer grants credit. Depending on the agreement, users either own the system as soon as they receive it or when payment has been completed.
- **Credit institution -** Companies sell the systems to end users, with a third institution granting credit to the users. Depending on the agreement, the system either becomes the property of the user upon delivery or upon final payment.
- **Lease** – The companies or a financial intermediary lease the system to users, who can purchase it at the end of the leasing period. However, during the leasing period, the lesser retains ownership of the system and is also responsible for maintenance and repairs.
- **Fee for service** – A company or institution (also public water supplier) owns the system and makes it available to users, who in return pay a usage fee. A financial institute (bank, lease company) can be involved to share the risk. The provider retains responsibility for maintenance and repairs, and users never become owners.

Which model (or mix of elements of various models) is best suited for a project depends on the specifics. Thus, the financial concept must be planned exactly at the outset, and local features must be taken into consideration. The model should be selected to fit into the local water and energy markets and suit user’s standard of living. In any of the models it will always be the matter of selling products and services in order to fulfill client’s water (possibly also energy) needs. Table (1) provides an overview of these models, [1]. Note that all of those models assume that the users are paying for water, which not always is the case. The financial actor may fully or partially take on this responsibility, when dealing with poor village communities.

Table (1) Implementation of Financial Models [2]

	Cash sales	**Consumer credit**	**Credit institution**	**Lease**	**Fee for service**
Capital needed by the company	little	medium	low	high	highest
Access for users without means	most difficult	medium	medium to good	medium to good	best
Infrastructure required	little	Medium/high	high	high	high
Political framework	Not necessarily needed, but helpful	Credit generally has to be regulated	Possibly development and water supply aid	Lease contract designs and related tax issues	Concessions to sell water (and energy) helpful
Responsibility for installation and maintenance	Users, in some cases dealer will carry out the installation	Users, possibly installing company	Usually the installing company, possibly users	Initially technicians from installing company	Owner (company, public water supplier)
Risk allocation	End-User, (for dealer until warranty period expires)	Distributed among all parties, highest with the dealer	Distributed among all parties	Distributed among all parties, highest with the lesser	All risk with the owner

5- SOCIAL IMPACTS & ACTORS PARTICIPATION

5.1 Social Impacts, [5] & [6]

Social aspects have received less consideration than techno-economical ones, even though they are of considerable importance to the successful and sustainable operation of any technology, particularly in remote areas. For example, membrane technology is prone to membrane fouling which requires careful management in remote locations. Problems like this can give the technology a poor reputation which does not reflect on the technology itself, but rather the way it has been implemented and is managed. Therefore, and in order to be *socially* sustainable, such technologies must; (i) be accepted by the community, (ii) meet their water needs, and (iii) be within their capacity to operate and maintain. The social aspects of desalination technologies should ideally be considered *before* a new technology is introduced.

A review of the literature relating to small-scale desalination units highlights a number of attributes which have been identified as important contributors to their success and ongoing social sustainability. A review of ADS in remote Australian communities, for example, found that inadequate maintenance support caused by a lack of “effective trained personnel to maintain and service ADS, [5]. This was a major contributor to the failure or sub-optimum operation of such systems. The distance of systems from service centers was also a problem, and a strong influence upon maintenance costs. Responses highlighted that pastoralists tended to be most concerned about the high costs of RE systems, while indigenous communities had concerns about their reliability. Some solutions suggested to these social issues include training programs for maintenance providers and accreditation for system installers, education about energy demand management for consumers, and the development of more reliable systems.

On the other hand, social sustainability for ADS has to be assessed in the selected remote area. This will involve examining ADS compatibility with or ability to be adapted to relevant aspects of the social environment, such as: • water quality and quantity needs, • the human resources available to operate and maintain such a unit, and • the attitudes of community members to a prototype of ADS.

It is worth mentioning here that the concept of appropriate technology has been incorporated in 'sustainable technologies', which are defined as those technologies which are "compatible with or readily adaptable to the natural, economic, technical and social environment". Sustainable technologies are no longer limited to applications in developing countries, and expand the environmental and social focus of appropriate technology to incorporate economic and technical considerations.

Two social science research methodologies can be applied. The first is a case study approach using interviews and site visits. This is considered to be the best methodology for studying in greater detail the social aspects of water use and provision in different types of remote settlements. The second component relates to gathering feedback from community members (community response) about attitudes to ADS via a questionnaire. By gathering responses to such questions, the community response to ADS can be evaluated, which will contribute to a determination of its social sustainability.

5.2 Actors Participation, [1] & [2]

There are different actors (Stakeholders) involved in the ADS installation process, Table (2). Key stakeholders are those individuals or institutions that may (directly or indirectly, positively or negatively) affect or be affected by the outcomes of the project. In addition, the 'Informers', (i.e. ministries, universities, research institutes, consultants, meteorological stations, utilities) are of particularly important in the site selection process, where data collection plays a key role. They should be introduces, pointing out their main interests, influence on the project and possible contributions. A step-by-step Stakeholder analysis scheme should be used to identify them and analyze their role, relation to the project.

Table (2) Stakeholder and their Relation to the Project, [1]

Stakeholder	Interest	Influence on the Project	Potential contributions
Governments, ministries or local authorities	Environmental impacts, costs of water production, wellbeing of the community, employment and regional development, support to R&D	Laws and regulations	Subsidies, reduced import duties, tax and fiscal incentives, awareness raising, promotion campaigns, quality control
The beneficiary community	Availability, costs of product water employment possibilities, regional development, environmental impacts, technical simplicity, sustainability, training	User, acceptance or rejection of the project. CRUICAL for the success of the project	Information about the site, participation in planning, building and maintenance, possibly buying water
Investors, financial partners	Minimizing the site related risks (such as environmental risks), water selling price, life time period	Financing	Supply of capital, Know-how...
Installing companies, subcontractors	Business	Financing	Installation and maintenance of the system
Land owners	earning money, keeping land intact, minimizing environmental impacts, adhering to regulations, ensuring sustainability	Providing of water, need to agree	Know-how of the site, help in maintenance

Contact of local and national authorities for different permits to install the ADS unit is advisable. Permits includes the land allocation for the project, well digging, construction of civil works, use of sea water & intake system, brine disposal to sea or to under ground, possible electrical power connection to net work, …etc. Contacts to ministries of water, environment and energy as well as local city councils, governorate staff, local NGO(s) and local community heads should be carried out.

It will be advisable if the ADS owner sign a protocol of cooperation (or similar agreement with local / national authorities) and get them involved as part of the process. Figure (2) shows a signing a protocol of cooperation between ADIRA –ADS partner and the Head of West Coast Development Authority and the local governorate.

Figure (2) Signing A Protocol of Agreement between ADS Owner & Local Authorities

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Appendix (A)
Factors Affecting Comparison between desalination processes

Factor	Comparison
Feed water type	Thermal and RO processes are used for the desalination of seawater while RO and ED are used for brackish water. Comparing the two membrane processes, at low feed salinity, ED becomes a more attractive alternative for large potable water desalination plants. For higher feed water salinity its main competitor, RO, usually becomes a cheaper option. Feed water treatment for RO is important and can be expensive.
Product water quality	In general, thermal processes produce distillate water with very low TDS, around 10 to 20 ppm. By contrast the TDS of product water from RO and ED is usually around 350-500 ppm (potable). The post-treatment required varies according to the use of the produced water. For potable use, the water produced should be treated according to WHO's standards. With regard the distillate water produced by thermal processes, there are concerns about its desirability for potable use over a long time period, although this question has not been settled conclusively.
Plant capacity	MSF & MED plants are typically available in large unit capacities. VC process which is used in small and medium scale applications. MSF units are best suited to large-scale operation (economy of scale). MED process is used in medium and large-scale applications. Small-scale MED plants have also been developed. Membrane plants can be easily adapted to any plant size and can be found in all capacity ranges. Both technologies, RO and ED are suitable for small and large-scale applications.
Economics of desalination	Cost figures for desalination have always been difficult to obtain. Desalination costs are largely depended on the process, feed water type, product water quality requirements, electricity price, etc. The total cost of water produced by a desalination plant includes the investment cost as well as operating and maintenance cost. In a comparison between seawater and brackish water desalination the cost of the first is about 3 to 5 times the cost of the second one for the same plant size.
Investment cost	Generally, the investment includes equipment, installation, and other civil works. Distillation plants have higher investment costs and lower operational costs than membrane processes. Additionally, land requirements for thermal processes are higher than these for membrane processes.
Operating & maintenance costs	Operating and maintenance costs include energy requirements, labor, and process consumables, including chemicals and membranes replacement (for membrane processes). Operational and maintenance costs are less for thermal processes.
System O&M	The maintenance of a desalination plant includes the feed water pre-treatment, periodic cleaning of the system, replacement of mechanical equipment and control instruments. The most important maintenance

	requirement concerning membrane processes is membrane replacement which constitutes a major cost factor. Scale prevention and corrosion control are important factors particularly with plants operated at high temperatures. Chemical requirements for pre-treatment and post-treatment processes are strongly dependent on the feed water quality. In general, distillation processes require less chemicals for the feed water pre-treatment than membrane processes.
Labor requirements	Generally, the specific cost of labor for a large plant is slightly lower than for a small one. In small plants, labor requirements are slightly lower for distillation processes than for reverse osmosis; however they become equal for larger plants.
Energy requirements	The theoretical absolute minimum energy required for desalination is about 0.8 kWh/m^3 of water produced, depending on the salt content and regardless of the process used. In any desalination process, the energy consumption depends on a variety of factors, such as sea water concentration, temperature of operation for membrane processes, as well as performance ratio, heat losses, temperature difference etc., for thermal processes. Processes that rely on a change in water phase as in thermal processes, usually involve higher energy consumption, [2], than processes that do not require a change of phase. Thus, distillation processes are found mostly in countries with cheap fuel (e.g. Saudi Arabia, U.A.E.). However, thermal processes (MSF, MED) operating with steam supplied by exhaust or bleeding steam from back pressure or extraction steam turbines, are economically attractive and comparable with RO energy cost. For membrane processes the energy required depends on the ions selective transport and is proportional to the salinity of the feed water used and product obtained. For medium and large RO systems an energy recovery system can be used, recovering about 40% of the input energy.
Construction time	In terms of the time of construction, a thermal process requires more time than a membrane process. The construction time for very large MF plants can take from three to five years. Large RO plants can be produced installed and commissioned in periods ranging from 18 to 24 months. Small RO plants can be produced and installed in almost one month.

Appendix (B)

ADS Technology Selection

Evaluation of the various RES - desalination options, [3]

Input (1)	Output (2)	Water Quantity Reqs (3)	Resource availability	RES- Desalination technically feasible Technology	Remarks on technology applicability
Brackish	potable	low	solar	PV - RO	most applicable
				PV - ED	limited experience
		medium		PV - RO PV - ED	because of high cost of PVs only recommended for quantities of output water
		large		PV - RO PV - ED	because of high cost of PVs only recommended for quantities of output water
Brackish	potable	low	wind	Wind - RO Wind - ED	most applicable
		medium		Wind - RO Wind - ED	most applicable
		large		Wind - RO Wind - ED	not recommended because of high storage costs of autonomous wind energy systems
Brackish	distillate	low	solar	Solar Still	most applicable
				Solar thermal - MED	MED not recommended for brackish water desalination, not used for low quantities of output water
				Solar thermal - MSF	MSF not recommended for brackish water desalination, not used for low quantities of output water
		medium		Solar Still	high cost due to large land requirements
				Solar thermal - MED	MED not recommended for brackish water desalination
				Solar thermal - MSF	MSF not recommended for brackish water desalination, not used for low quantities of output water

		large		Solar Still Solar thermal - MED Solar thermal - MSF	significant large land requirements MED not recommended for brackish water desalination MSF not recommended for brackish water desalination
Brackish	distillate	low	wind	Wind - MVC	MVC not used for low quantities of output water, not recommended for brackish water desalination
		medium		Wind - MVC	MVC not recommended for brackish water desalination
		large		Wind - MVC	MVC not recommended for brackish water desalination
Brackish	distillate	low	geothermal	Geothermal - MED Geothermal - MSF	MED, MSF- not used for low quantities of output water, not recommended for brackish water desalination
		medium		Geothermal - MED	MED not recommended for brackish water desalination
				Geothermal MSF	MSF not recommended for brackish water desalination and for low quantities of output water
		large		Geothermal - MED Geothermal - MSF	MED, MSF not recommended for brackish water desalination
Sea water	potable	low	solar	PV - RO	most applicable
				PV - ED	ED not recommended for sea water desalination due to high energy requirements
		medium		PV - RO	because of high cost of PVs only recommended for low quantities of output water
				PV - ED	ED not recommended for sea water desalination due to high energy requirements
		large		PV - RO	because of high cost of PVs only recommended for low quantities of output water
				PV - ED	ED not recommended for sea water desalination due to high energy requirements
Sea water	potable	low	wind	Wind - RO	most applicable
				Wind - ED	ED not recommended for sea water desalination due to high energy requirements
		medium		Wind - RO	most applicable
				Wind - ED	ED not recommended for sea water desalination due to high energy requirements
				Wind - RO	not recommended because of high storage costs of

		large			autonomous wind energy systems
				Wind - ED	not recommended for sea water desalination due to high energy requirements and high storage costs of autonomous wind energy systems
Sea water	distillate	low	solar	Solar Still	most applicable
				Solar thermal - MED	MED not used for low quantities or output water
				Solar thermal MSF	MSF not used for low quantities of output water
		medium		Solar Still	high cost due to large land requirements
				Solar thermal - MED	most applicable
				Solar thermal - MSF	MSF not used for low quantities of output water
		large		Solar Still	high cost due to large land requirements
				Solar thermal - MED Solar thermal - MSF	most applicable
Sea water	distillate	low	wind	Wind - MVC	MVC not used for low quantities of output water
		medium		Wind - MVC	most applicable
		large		Wind - MVC	most applicable
Sea water	distillate	low	geothermal	Geothermal - MED Geothermal - MSF	MED, MSF not used for low quantities of output water
		medium		Geothermal - MED	most applicable
				Geothermal - MSF	MSF not used for low quantities of output water
		large		Geothermal - MED Geothermal - MSF	most applicable

(1) Brackish water: 3000- 11 000 ppm TDS, sea water: 5 000 ppm TDS
(2) Potable: 250- 700 ppm TDS, distillate: < 20 ppm TDS
(3) Low: 1-50 m^3/ d, medium: 50- 250 m^3/d, large: > 250 m^3/d