WATER UTILITIES MANAGEMENT IN THE ARAB REGION

LESSONS LEARNED AND GUIDING PRINCIPLES

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ACWUA
Arab Countries Water Utilities Association

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Foreword

The water sector in the Arab region suffers from chronic problems and faces many challenges in terms of water supply and sanitation services. These challenges are common in most of the Arab countries and are summarized in the following:

- Limited water resources; which lead to a large gap between available resources and increasing demand for water due to the high rate of population growth, rapid urbanization and economic development.
- The impact of political instability in the Arab region (Arab Spring); which lead to internal and external migration in many Arab countries, has dramatically increased the demand for water in the host countries and damaged the infrastructure in the countries of the Arab Spring
- Most water utilities operate under centralized management; especially in the field of planning and determining tariffs, regulations and laws thatregulates the work of water utilities (salary scales, and employment regulations)
- Brain drain from the public sector to the private sector within the same country or from one country to another
- Limited financial allocations in many facilities in the area of training and capacity building, technology transfer and limited financial resources for the implementation of mega projects in water supply and sewage treatment plants
- Many Arab countries have reached lending ceiling, thus cannot take any more loans to implement water projects
- Very limited initiatives from the national private sector to finance strategic projects

Building on these circumstances and to overcome those challenges; the stakeholders in the water sector in the Arab region should go beyond the traditional management. Most of the water utilitiesare being operatedbased on centralizationwith reference to absolute laws and regulations. Thus it is now emergently crucial for utilities and decision-makers to adoptthe effective solutions and the findproper environment to face all these ongoing challenges.

Here arises the role of the Arab Countries Water Utilities Association (ACWUA) and other community-based organizations, in raising awareness at all levels within utilities, especially at the top and middle management levels that have the direct influence over decision makers, in emphasizing the need for development of new policies, and the amendment of existing legislations that would encourage thethe development of utility management approaches and techniques, which in turn will lead to performance improvements and better Water Supply and Sanitation (WSS) services.

According to its mandate, ACWUA is playing a fundamental role in promoting and supporting best practices in managing water utilities in the Arab world. Through the initiation of the (Management of Utilities) Technical Working Group(TWG), ACWUA introduced priority management topics for research and discussion: Cost Recovery, Non-Revenue Water, Energy Efficiency, and Water for the Poor and Asset Management. Throughout the last three years, the Management of Utilities TWG members met many times to share their countries' experiences, exchange knowledge in the form of case studies, and discuss good management practices to be included in a best practice guide or guiding principles and lessons learned. This publication includes the results of these meetings and discussions, where case studies from ten countries were produced in a previous publication, then results of the case studies werethoroughly analyzed and identified good and bad practices when dealing with different management approaches, this synthesis is coming as an end product for the Management of Utilities Technical Working Group titled: "Management of Water Utilities in the Arab Region: Lessons Learned and Guiding Principles". This publication is a milestone in the Arab water sector where it paves the way for better management of utility resources and spot out the hurdles and constraint preventing sound management delivering high level of service and financially viable establishment. The group meetings, publications and all their associated activities were financially supported by the Swedish International Development Cooperation Agency (SIDA) within a three-year support project.

I would like to express my sincere thanks to the authors of this publication, our committed TWG members who showed real dedication to this project and contributed with their expertise to bring out this honorable work.

I would like also to thank the Swedish International Development Cooperation Agency (SIDA) for supporting the production of this publication.

Last but not least, I would like to thank ACWUA Secretariat team and the TWG advisory team from (ECO Consult) for their efforts throughout the two-year working period of the TWG up till the point this publication became available to serve the water and sanitation sector in the region.

Sincerely Yours,

Eng. Khaldon Khashman

Secretary General

Acknowledgement

This publication is based on the knowledge and contributions of ACWUA's Utilities Management Technical Working Group members. It builds strongly on a set of regional case studies presenting regional experience in the topic of utilities management that the Technical Working Group members and supporting consulting team have previously developed. It constitutes the culmination two years worth of effort and hard work that showcases this regional experience as developed and communicated by regional experts for the benefit of regional utilities, drawing on their accumulated knowledge and lessons learned and taking account of common situational, environmental, socio-economic, institutional, financial, technical and operational challenges in the process. This publication and the hard work that led to it would not have been possible without the support of the Swedish people represented by the Swedish International Development Agency. ACWUA would like to acknowledge all those efforts that led to producing this guide.

Many thanks are due to all those who have supported the process—to the Technical Working Group and consulting team members who committedly dedicated their time and effort, and to water experts and practitioners who indirectly contributed to this work by participating in technical discussions and providing technical advice as needed. Thanks are also due to ACWUA member utilities that donated the time and effort of their staff members for the purpose of data compilation, analysis and reporting, and for participation in working sessions, meetings and conferences. In specific we would like to acknowledge the efforts of supporting utility staff members who also supported the compilation of data and information; namely Sid'Ahmed Baba El Houmoud and Abdellahi Hedietti from Mauritania, Aysha Abu Allan from Jordan, and Ahmed El-Sayed Moussa from Egypt. We would like also to thank the supporting staff in ECO Consult and ACWUA Secretariat who worked tirelessly to provide support to all those who participated in this substantial endeavor.

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Acronyms

ACWUA	Arab Countries Water Utilities Association
AMM	Asset and Maintenance Management
AMP	Asset Management Plan
AWC	Aqaba Water Company
BSI	British Standards Institute
CHP	Combined Heat and Power
CIS	Customer Information System
CMMS	Computerized Maintenance Management System
CSO	Civil Society Organization
DAF	Dissolved Air Flotation
DGGREE	General Direction of Rural engineering and Water Exploitation
DMA	District Metered Area
DSS	Decision Support System
EE	Energy Efficiency
EFQM	European Foundation for Quality Management
EIS	Executive Information System
EPC	Energy Performance Contract
ESCo	Energy Service Company
EWA	Electricity and Water Agency
EWRA	Egyptian Water and Wastewater Regulatory Authority
FAVAD	Fixed and Variable Area Discharge
GARWP	General Agency for Rural Water Projects
GCC	Gulf Cooperation Council
GDA	Group for Agricultural Development
GDP	Gross Domestic Product
GHG	Green House Gases
GIC	Group of Collective Interest
GIS	Geographic Information System
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Society for International Cooperation)
HCWW	Holding Company for Water and Wastewater
HHU	Hand Held Units
HR	Human Resources
I/I	Inflow/Infiltration
IIMM	International Infrastructure Management Manual
ILI	Infrastructure Leakage Index
IPCC	Intergovernmental Panel on Climate Change
IPWEA	Institute of Public Works Engineering Australasia
ISO	International Standards Organization
IT	Information Technology
IWA	International Water Association
IWRM	Integrated Water Resources Management
JVA	Jordan Valley Authority
JWU	Jerusalem Water Undertaking
KACE	King Abdullah II Center for Excellence
LCCA	Life Cycle Cost Analysis
LIMS	Laboratory Information Management System
M&E	Monitoring and Evaluation
MCM	Million Cubic Meters
MDG	Millennium Development Goal
MENA	Middle East and North Africa

MEW	Ministry of Environment and Water
MHC	Ministry of Housing and Construction
MNF	Minimum Night Flow
MOEW	Ministry of Energy and Water
MOW	Ministry of Works
NGO	Non-governmental Organization
NRW	Non-revenue Water
NWC	Network for Water Centers of Excellence
NWSA	National Water and Sanitation Authority
O&M	Operation and Maintenance
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
ONAS	National Office for Sanitation
ONEE	National Office of Electricity and Drinking Water Supply
PAS	Publicly Available Standard
PI	Performance Indicator
PMU	Performance Monitoring Unit
PPP	Public Private Partnership
PRV	Pressure Reducing Valve
PV	Photovoltaic
PWA	Palestinian Water Authority
QMS	Quality Management System
R&D	Research and Development
RAS	Return Activated Sludge
RO	Reverse Osmosis
SCADA	Supervisory Control and Data Acquisition
SIDA	Swedish International Development Agency
SNDE	Societe Nationale D'Eau
SONEDE	National Company for Water Exploitation and Distribution
TOR	Terms of Reference
TQM	Total Quality Management
TSM	Technical Sustainable Management
TWG	Technical Working Group
TWh	Terawatt hours
UM	Utility Management
UN	United Nations
USAID	United States Agency for International Development
UV	Ultraviolet
VIP	Ventilated Improved Pit
VSD	Variable Speed Drive
WAJ	Water Authority of Jordan
WBWD	West Bank Water Department
WSS	Water Supply and Sanitation
WSSA	Water Supply and Sewerage Association

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INTRODUCTION

1.1 Introduction

Most of the Arab region is faced with acute water shortages that put tremendous pressure on utilities to develop and sustain adequate water supplies to be able to meet existing and future demand. Climate change, population growth and economic development are at the heart of the ever-increasing gap between water demand and available supplies. Developing additional water supplies from non-traditional water resources such as desalination adds financial burdens on the utilities which subsequently become in need of government support and subsidies. As a means to confront all those challenges, many utilities see the need for performance and efficiency improvements—particularly related to improved services, financial sustainability, and customer satisfaction; for developing water infrastructure responsive to current and emerging needs; and for providing services within an environment conducive to good performance and satisfied customers.

In accordance with its role and mandate of serving its constituency in upgrading their competences by improving their performance in the delivery of water supply and sanitation (WSS) services, the Arab Countries Water Utilities Association (ACWUA) adopted a leading role in the region in presenting and examining approaches to improve the efficiency of the Operation and Maintenance (O&M) systems and standards, to implement reform and restructuring initiatives to improve operational performance, to extend services, to advance management systems, and finally to exchange expertise in developing operation and maintenance procedures and applications.

Accordingly, ACWUA initiated interdisciplinary Technical Working Groups (TWGs) comprising qualified experts from ACWUA member utilities to address specific utility issues in different high priority areas in the water and sanitation sector after conducting a needs assessment exercise for its constituents. To this end, ACWUA obtained the necessary funding to launch and activate the Utilities Management (UM) TWG from the Swedish International Development Cooperation Agency (SIDA).

The UM TWG comprised ten[1] members representing ten different ACWUA utilities and their respective countries working together for a two-year period of engagement in the TWG. The UM TWG relied primarily on its members' technical expertise in utilities management in their respective organizations and countries, and complemented those competencies through information gathering, literature review and stakeholder consultation.

1.2 Overview

During the two-year period of engagement of the TWG, the members met twice to three times annually to design a work plan and schedule; design the outlines for the final deliverables of their work; present their respective experiences in managing utilities and all what comes along with that; exchange knowledge in that respect regionally and highlight related successes and challenges; and present a future outlook that would serve ACWUA in further identifying improvement opportunities in the WSS sector regionally. The TWG members also participated in international and regional conferences presenting their experiences and reaching out to other WSS professionals and experts.

The first deliverable of the UM TWG was a compilation of the regional case studies[2] report, presenting individual experiences in the area of utilities management starting with a country background with focus on water resources, uses and service providers; the institutional and legislative framework governing the sector; specific technical aspects under the headline of utilities management such as Non-revenue Water (NRW), cost recovery, Energy Efficiency (EE), serving the underprivileged, and Asset and Maintenance Management (AMM).

1 The ten Arab countries examined were Mauritania, Morocco, Algeria, Tunisia, Egypt, Yemen, Jordan, Palestine, Syria, and Lebanon.

2 The countries included in the Case Studies report were Mauritania, Morocco, Algeria, Tunisia, Egypt, Yemen, Jordan, Palestine, Lebanon and Syria.

Building on the aforementioned case studies, the publication in hand provides an in-depth analysis of the regional experience in this area, success factors, opportunity for replication and improvement and lessons learned—based on a framework developed by the TWG members. The above mentioned aspects are all compiled in this – the second and final of two – deliverables of ACWUA's current UM TWG based on an outline linked to the analysis framework also developed by the TWG members.

The publication starts with a detailed explanation of the methodology and work plan that the TWG members and supporting advisory team followed to come up with the final output in Section 1 "OVERVIEW". The tools that were used are presented and explained—including the questionnaires and the analytical framework used, and how they translate into this publication. The challenges that were faced during the working period of the TWGs are also highlighted, to be taken into consideration in similar future programs.

This is then followed by an elaborate description of the challenges faced by utilities in the region and the associated conditions, environment and circumstances that the utilities operate in starting with the severe water scarcity conditions in the region, the high costs of developing water resources, the social paradigm governing perceived water value and resulting impacts on the performance of utilities.

The publication then presents attributes of good performing utilities according to universally acknowledged good practices including financial viability, well identified levels of services, technical efficiencies, healthy assets, committed leadership and trained staff, customer satisfaction and sustainable water resources.

Upon the analysis of the case studies and experiences shared, examined and discussed, the main themes of utilities management as relates to regional experience, challenges and opportunities are presented in the next section (Section 2 "BASELINE AND REGIONAL EXPERIENCE"). In specific, the existing characteristics pertaining to utility management as is current within the region along with lessons learned and important notes are presented, including strategic, financial, institutional, and technical aspects to performance and management of utilities. Related regional experience is presented and analyzed with lessons learned. This is followed by a summary that highlights—based on the outcomes of this program and emanating from its findings, the areas where the need exists for further investigation and development, and that constitute core areas that ACWUA will invest in to further support its constituents.

The following Section (Section 3 "GUIDING PRINCIPLES") presents guiding principles in the areas of cost recovery, serving the underprivileged, NRW, EE, and AMM.

1.3 Approach and Methodology

The approach that was adopted throughout the implementation of this program involved ACWUA reaching out to its individual members experiences' in utilities management, and compiling this experience collectively in plenary. This not only presented those various experiences in the region, but it opened the floor to discussions, agreements, disagreements and knowledge exchange.

The whole program was also a platform for participating countries and members to exchange regionally available knowledge—not only in the subject topic of the TWG, but in other related aspects an specific issues born from the various needs and requirements in each of the participating countries. The various levels of knowledge available in this one platform created such a learning opportunity.

The main findings of this program revealed much detail about the Arab experience in the topic of utilities management as will be discussed later in this report, taking into the account the similarities related to regional context, opportunities and challenges. It also relates this experience to universally acknowledged good practices and guiding principles in utilities management, within the limitations and influence of such regional context and challenges. Thus, the outcome of this program is a tool that aims at creating a better understanding of the experience in region in the area of water utilities management, the opportunities and challenges involved, and how this experience can benefit other countries in the region seeking to improve utility performance and efficiency. The methodology applied during the implementation of this program entails primary and secondary research mechanisms:

- Primary research mechanisms were utilized for the collection, presentation and discussions of data/information from each participating TWG member/country. The activities implemented for this purpose included:
    - Developing a detailed Terms of Reference (TOR) and associated work plan for the TWG, explaining the objectives of the program, related activities, expected outcomes, and implementation plan and schedule. The TOR and work plan were developed in a participatory manner involving conducting regional workshops and working sessions that included the TWG members, the consulting team members, and ACWUA.
    - Developing - also in a participatory manner in regional workshops involving the TWG members, the consulting team members, and ACWUA - an outline for case studies and an associated technically based questionnaire consistent with the information/data needed per the case studies outline.
    - Administering the questionnaire and collecting pertinent data/information from each individual member/country. The results were presented in plenary in a regional workshop, setting the stage for discussions and exchange of opinions and experiences in the interim.
    - Developing in a participatory manner in regional workshops involving the TWG members, consulting team members, ACWUA and representation of industry experts, an outline for the utilities management good practices guide and a detailed questionnaire consistent with the information/data needed per the guide's outline.
    - Administering the questionnaire and collecting pertinent data/information from each individual member/country. The results were also presented in plenary in a regional workshop, setting the stage for discussions and exchange of opinions and experiences in the interim.

- Secondary research mechanisms applied by the TWG members and the consulting team members to supplement all the outputs of the primary research activities explained above. Such mechanisms entailed examining available resources, literature, experiences in developed and developing countries, and universally acknowledged good practices in the topic of the TWG, and allowing for comparative analysis of the data/information compiled from all the TWG participating members, and synthesis of the analysis results to be shaped into the final deliverables of the program, highlighting the regional experience and accompanying challenges and opportunities.

1.4 The Water Situation in the Arab Region

The Arab region is one with a diverse profile and characteristics; from low income economically challenged underdeveloped countries to middle income low natural resources developing countries, to extremely well off and economically stable countries abundant with natural resources. However, one agreed upon characteristic of almost the whole region is the very scarce conditions it suffers from in terms of the availability of water resources.

Table 1 below gives an idea about the distribution of population, economic and water resources indicators across the Arab countries. As presented, the distribution of population varies and with it the Gross Domestic Product (GDP) per Capita, exhibiting variable levels of economic prosperity and living standards. The available renewable freshwater resources per capita also provide an idea about the scarcity of water with almost all the Arab countries having a per capita supply of less than 1,000 cubic meters – the water stress threshold according to experts (the chronological trend is depicted in Figure 1 below), whereas the annual freshwater withdrawals[3] provide an idea about the pressure on water resources per country. Water and sanitation services indicators are also presented in alignment with the Millennium Development Goals (MDGs) indicators.

3 Very high values indicate extractions from desalination plants.

Table 1: Selected Demographic, Economic and Water related Indicators for the Arab Region
(Source: World Bank, 2011)

Country	Population	GDP per Capita (USD/Cap)	Improved Water Source[4] (% of population with access)	Improved Sanitation Facilities[5] (% of population with access)	Renewable Internal Freshwater Resources per Capita (cubic meters)	Annual Freshwater Withdrawals, Total (% of internal resources)
Algeria	37,762,962	5,258	83.9	95.1	298	55
Bahrain	1,292,764	18,334[6]	100.0	99.2	3	8,935
Djibouti	846,646	1,464	92.5	61.3	354	6
Egypt	79,392,466	2,973	99.3	95.0	23	3,794
Iraq	31,760,020	5,687	84.9	83.9	1,108	188
Jordan	6,181,000	4,666	96.2	98.1	110	138
Kuwait	3,124,705	56,514	99.0	100.0	--[7]	--
Lebanon	4,382,790	9,148	100.0	--	1,095	27
Libya	6,103,233	10,456[8]	54.4[9]	96.6	115	618
Mauritania	3,702,763	1,154	49.6	26.6	108	400
Morocco	32,059,424	3,044	82.1	69.8	905	43
Oman	3,024,774	23,731	92.3	96.6	463	94
Qatar	1,910,902	90,524	100.0	100.0	29	793
Saudi Arabia	27,761,728	20,778	97.0	100.0	86	986
Sudan	36,430,923	1,539	55.4	24.0	641	124
Syria	21,961,676	2,747[10]	89.9	95.2	325	235
Tunisia	10,673,800	4,350	96.4	89.8	393	68
United Arab Emirates	8,925,096	40,363	99.6	97.5	17	2,665
West Bank and Gaza	3,927,051	1,209[11]	85.0[12]	92[13]	207	51
Yemen	23,304,206	1,361	54.8	53	90	170

Population growth, economic development activities and climate change have placed further pressure on the already strained water resources in the region. Extreme climate variability (increased aridity; shifts in rainfall patterns; reduced groundwater recharging patterns; and more frequent extreme weather events such as floods and droughts) are impacting the availability of water resources and the provision of services. Increasing urbanization is also impacting the distribution of water resources geographically

4 The improved drinking water source includes piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection).

5 Improved sanitation facilities include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

6 2010

7 Data not available

8 2009

9 2001

10 2010

11 2005

12 2010

13 2010

in each country and also sectorally in terms of type of use. Whereas the allocation of water for domestic use is increasing, inherent policies are supporting agricultural activities that counter the increasing urbanization trends – although with a marginal contribution of the sector to the GDP.

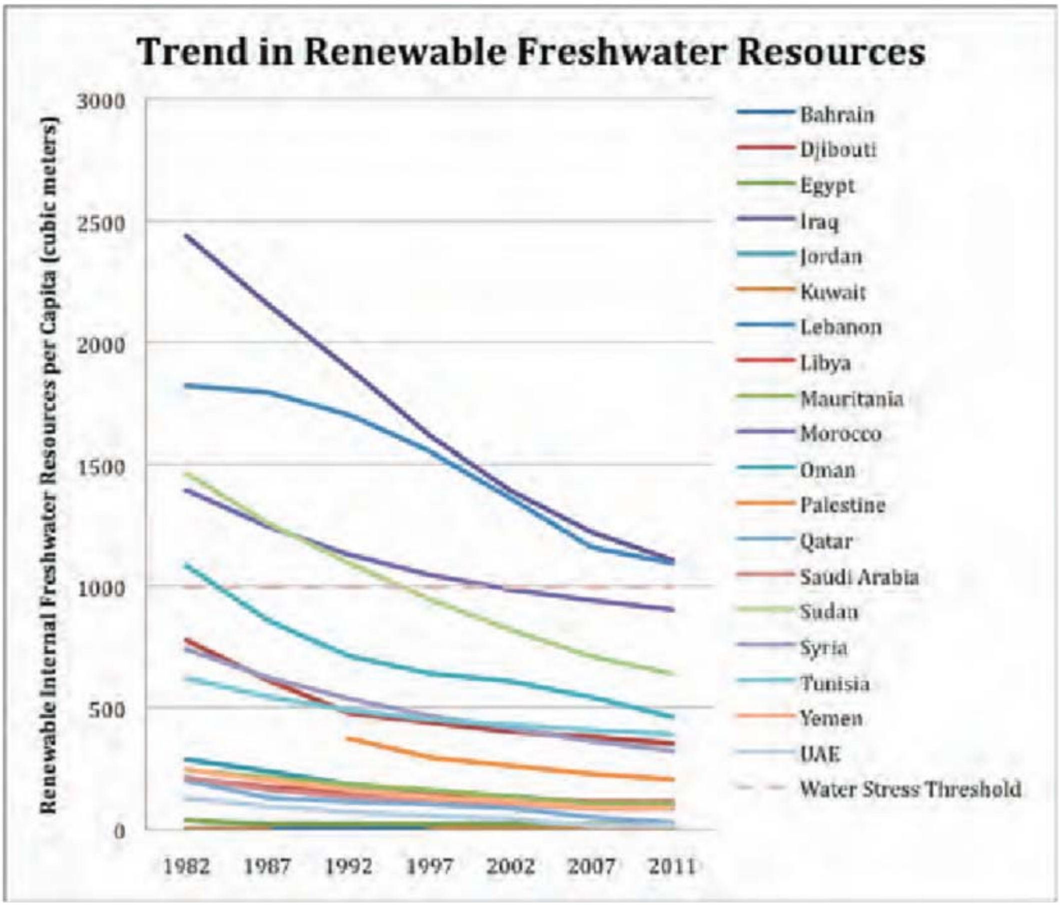

Figure 1: Trend in Renewable Internal Fresh Resources per Capita in the Arab Region
(Source: Calculated from World Bank Databank, 2012)

Adding to the naturally occurring population growth patterns in each country, the volatility of the political situation in the region and of late the Arab spring, have created several crises where displaced individuals are forced to leave their countries and flee to more secure neighboring countries, yet exacerbating the water situation there, and creating emergency conditions that require in some cases non-existent immediate and substantial resources for the displaced population. Specific examples include the Palestinian situation and the refugee camps in Jordan, Syria, and Lebanon, and the Israeli occupation that is controlling water resources in the West Bank and Gaza and preventing the Palestinian population there from basic WSS services. Other conflicts in the region resulted in internal displacement cycles such as the invasion of Iraq that sent Iraqis to Jordan and Syria; the Israeli attack on Lebanon that led to a wave of refugees in Jordan, Syria and the Gulf Cooperation Council (GCC) countries; the Libyan uprising that sent Libyans to Tunisia and Egypt; and the Syrian Civil War that necessitated the construction of refugee camps in Jordan and Lebanon and resulted in a large number of displaced Syrians also in Egypt and the GCC countries.

And where people are not being displaced due to conflicts and wars, managing the trans-boundary water resources is proving to be yet another challenge. An estimated 66% of the surface freshwater available in the region originate from external sources (the Nile river in Egypt; the Tigris and the Euphrates in Iraq; and the Yarmouk river in Jordan), creating another complication to their management, where conflicting interests of countries dictate the nature of relationships between them, and water resource management options. And if this is not enough, trans-boundary issues also exist between countries within the region itself with conflicting priorities and resource management issues.

Whereas in some countries in the region, addressing water scarcity through the development of very costly and energy consuming non-conventional water resources (i.e. desalination plants) is possible and easily achievable, such as in the GCC countries, however, in other countries in the region, such solutions are considered not feasible and difficult to implement due to the unavailability of energy sources required or the lack of available funding for them.

Resulting Challenges Faced by Utilities in the Region

The water situation and adverse conditions that are impacting the available water supply as well as demand, are taking their toll on the utilities that are charged with providing WSS services in each country in the region:

- Dwindling water resources translate into difficulties in providing services to customers continuously in many countries in the region. This is reflected by intermittent water supply (Jordan, Yemen, Palestine, Lebanon, Iraq…), and results in stressful O&M conditions that impact the quantity and quality of water supplied, the level of services provided and consequently customer satisfaction, and also the WSS infrastructure integrity. These stressful O&M conditions and difficulties entail a high level of expenditure the utilities need to undertake, related to capital investment projects for the rehabilitation and replacement of the assets that deteriorate rapidly due to intermittent supply.

- In those cases where governments choose to develop new water resources—conventional and non-conventional, this comes at a very high price that needs to be paid for either by the governments that choose to, such as the oil rich countries in the GCC investing heavily and currently at the forefront of users of the very highly energy intensive desalination technologies, or by private investors who aim at recouping their investments in due course, or by the customers paying for the service.

- The dominant social paradigm that water is not an economic good, rather a public good that needs to be provided to all for free. This does not make provisions for the cost of developing water resources, or the infrastructure constructed, operated and maintained to distribute this water to its end users. Subsequently, and especially nowadays with the Arab Spring and the political volatility in the region, governments are not ready to remove any subsidies they are paying to the cost of services. However, these subsidies are yet another burden that not all countries are able to support, thus leading the utilities into the vicious cycle of deterioration of assets.

- The fact that water is being for the most part perceived as a public good results in governments – local and central – that are not ready to relinquish the reins of WSS completely, albeit at the price of less than optimal performance and humble resources and capabilities. This also results in a multitude of roles played by those governments: owners, operators, regulators… Table 2 below summarizes the institutional setup in selected Arab countries.

Table 2: Institutional Setup of Water Sector in the Arab Region
(Source: Compiled by Author and Co-Authors, 2013)

	Owner	Operator	Regulatory Functions with[14]
Morocco			
Water	• Bulk: mainly ONEE as owner and operator (more than 80%). Other 20% as own production from distributors (Autonomous Agencies) • Distribution: municipalities by law.	• Bulk: mainly ONEE as owner and operator (more than 80%). Other 20% as own production from distributors (Autonomous Agencies). • Distribution: municipalities use four models: 1. Direct management 2. Creating Autonomous Agencies (In 12 large cities). 3. Delegating to ONEE (around 600 small and medium cities). 4. Delegating to private sector (4 concessions in big cities).	1. Ministry of General Affairs and Governance 2. Inter-ministerial committee (Ministry of Interior, Ministry of Energy, Water and Environment, Ministry of Finance). 3. For the private sector there regulation by contract and follow up by a delegating authority.
Sanitation	Municipalities by law	Municipalities use four models: 1. Direct management 2. Creating Autonomous Agencies (In 12 large cities). 3. Delegating to ONEE (around 600 small and medium cities). 4. Delegating to private sector (4 concessions in big cities).	1. Ministry of General Affairs and Governance 2. Inter-ministerial committee (Ministry of Interior, Ministry of Energy, Water and Environment, Ministry of Finance). 3. For the private sector there regulation by contract and follow up by a delegating authority.
Algeria			
Water	• l'Algérienne Des Eaux • Municipalities	1. l'Algérienne Des Eaux in 696 municipalities. 2. The Company for Water and Sanitation of Algiers manages the 57 municipalities in the Wilaya of Algiers. 3. 788 municipalities manage services directly.	1. Ministry of Water Resources (The Directorate of Drinking Water Supply). 2. Hydraulic basin agencies.
Sanitation	l'Office National de l'Assainissement	1. l'Office National de l'Assainissement. 2. The Company for Water and Sanitation of Algiers manages the 57 municipalities in the Wilaya of Algiers 3. 788 municipalities manage services directly.	1. Ministry of Water Resources (The Directorate of Sanitation and Environment Preservation). 2. Hydraulic basin agencies.
Tunisia			
Water	• SONEDE responsible for operation, maintenance and renewal of water production, treatment, transport and distribution facilities (in urban area). • DGGREE responsible for irrigation/drainage, rural infrastructure and water supply for rural populations. • GIC and GDA are the operators for water supply in rural area		Ministry of Agriculture, Hydraulic Resources
Sanitation	ONAS		1. Ministry of Agriculture, Hydraulic Resources. 2. Ministry of Environment and Sustainable Development
Mauritania			
Water	• SONEDE • National Office for Water Supply in Rural Area. • Municipalities.		1. Regulation authority 2. Ministry of Water and Sanitation 3. National Council for Water
Sanitation	• National Office for Sanitation. • Municipalities		1. Regulation authority 2. Ministry of Water and Sanitation 3. National Council for Water

	Owner	Operator	Regulatory Functions with[14]
		Egypt	
Water	HCWW	Affiliated companies in each governorate	EWRA
Sanitation	HCWW	Affiliated companies in each governorate	EWRA
		Yemen	
Water	MEW	1. GARWP. 2. NWSA. 3. Local Corporations.	N/A
Sanitation	MEW	1. NWSA. 2. Local Corporations.	N/A
		Bahrain	
Water	EWA	1. EWA 2. MOW	N/A
Sanitation	EWA	1. EWA 2. MOW	N/A
		Jordan	
Water	• Bulk: JVA, WAJ • Retail: WAJ, some of the water companies owned by WAJ	• Bulk: WAJ, private sector (Disi Production and Conveyance System) • Retail: WAJ, Water Companies owned by WAJ, private sector (service contracts)	PMU or performance based by WAJ
Sanitation	Collection and Treatment: WAJ, some of the water companies owned by WAJ	• Collection: WAJ, Water Companies owned by WAJ • Treatment: WAJ, Water Companies owned by WAJ, private sector	PMU or performance based by WAJ
		Palestine	
Water	• Bulk: WBWD, PWA, municipalities • Retail: JWU, WSSA, municipalities, village councils	• Bulk: WBWD, PWA, municipalities • Retail: JWU, WSSA, municipalities, village councils, joint service councils	PWA
Sanitation	WSSA, municipalities, village councils (where applicable)	JWU, WSSA, municipalities, village councils, joint service councils (where applicable)	PWA
		Syria	
Water	MHC	13 water authorities working across the country under MHC	N/A
Sanitation	MHC	13 water authorities working across the country under MHC	N/A
		Lebanon	
Water	The water establishments	Four regional water establishments	MOEW
Sanitation	The water establishments	Four regional water establishments	MOEW

14 Regulatory functions are included instead of citing a regulator due to the unavailability of an autonomous regulatory body in any of the countries included in the review. Further detailed information about regulation of the sector are presented and discussed in another section of the guide.

1.5 Water and Sanitation Services – Functions and Responsibilities

The functions in a water or wastewater utility are based on the type or nature of services provided, or in other words the value chain linked to this service (Figure 2). In simple terms, a water utility traditionally would be responsible wholly or partly for managing and operating water resources; water supply through the actual production, treatment, transmission, and distribution of water to customers; and water disposal through managing and operation of wastewater collection, treatment and disposal to receiving body.

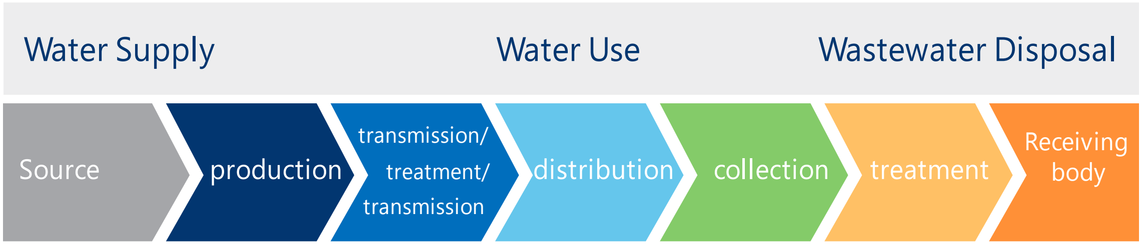

Figure 2: WSS Services Value Chain
(Source: Author, 2013)

On a lower level of detail, the functions and responsibilities of a water and wastewater utilities can be categorized into a number of groups (Figure 3):

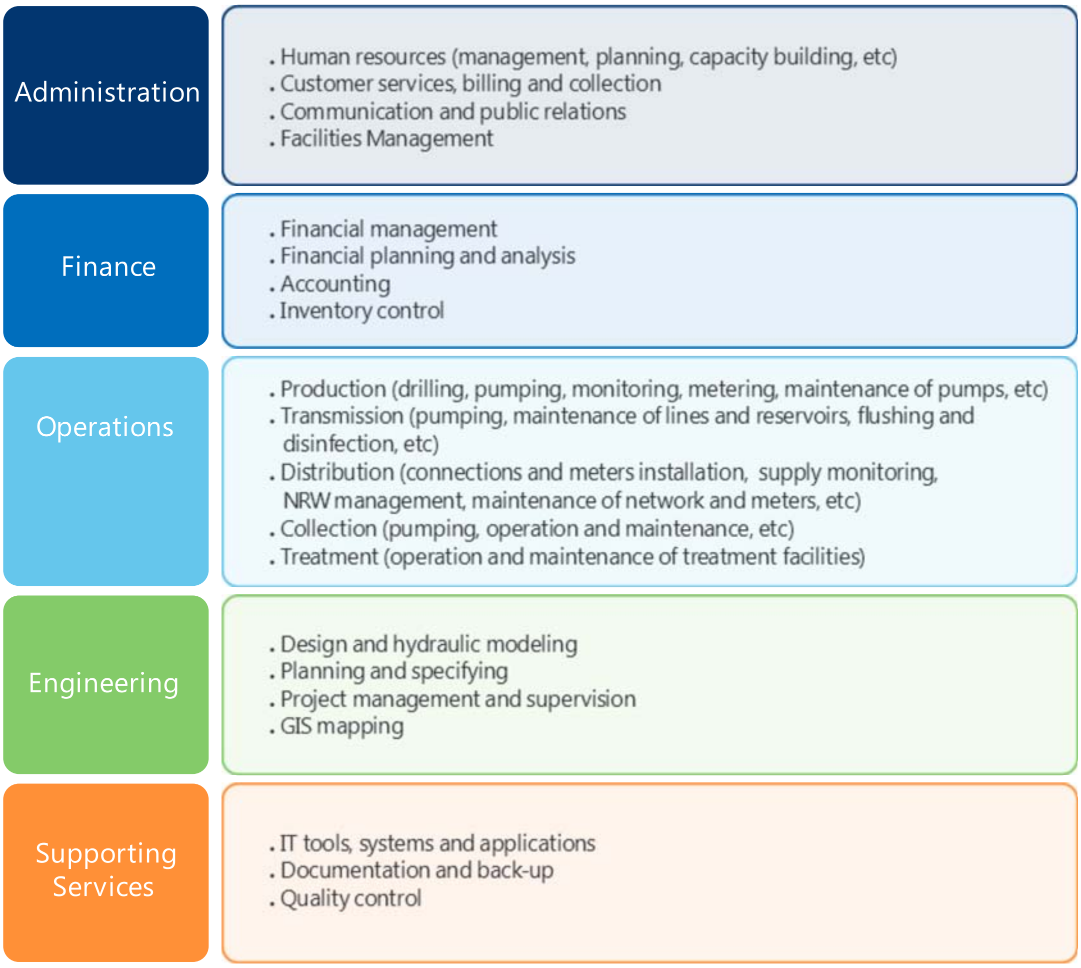

Figure 3: Traditional Functions in WSS Utilities
(Source: Author, 2013)

1. Administrative functions: those functions entail managing the human resources including recruitment, personnel, training management, performance appraisal, succession planning, etc; customer services including complaints management, meter reading, billing and collection, disconnections, etc; communication and public relations including awareness programs, community education, etc; facilities management and health and safety.

2. Financial functions: those functions entail financial management including financial asset management, tariff recommendations, revenue and cost management, cash flow management, investment planning, etc; financial planning and analysis including business planning, auditing, budgeting, forecasting, etc; accounting including book keeping, managing billing and collection records, payroll, assets accounting, cost accounting, etc; inventory control including purchasing, supplies, etc.

3. Operational functions: those functions entail production of water including protection of resources, operating and maintaining and metering pumps, quality control, asset management, etc; transmission of water including pumping, operating and maintaining, metering, asset management, quality control, flushing and disinfecting, etc; water distribution including pumping, asset management, operating and maintaining and monitoring of network and zones, managing water loss and NRW, quality control, new connections, etc; treatment for water and wastewater including operating and maintaining treatment facilities, asset management, flushing and disinfecting, quality control, etc; wastewater collection including pumping, operating and maintaining network, etc.

4. Engineering functions: those functions entail planning for water resources, designing networks and treatment facilities, hydraulic modeling, master planning, etc; project management and supervision including setting specifications and standards for tenders, tendering, contract and project management; supervision and inspection, etc; Geographic Information System (GIS) mapping including surveying and database development and update; asset registering and monitoring; etc.

5. Supporting services functions: those functions entail development, management and support of Information Technology (IT) infrastructure and tools, software and applications used within all functional units; automation including business requirements specifications, technology transfer, training, etc; knowledge management including backup systems, documentation, emergency planning, etc.

The above listed groups of functions are traditionally available within WSS utilities. However, it should be noted that the specific grouping reflected above does not necessarily apply in the same manner or grouping; certain functions can be shifted from one functional group to another, based on political, practical, institutional, regulatory and other factors. Needless to say, no matter what type of functional grouping applies within a utility, leadership and good management will always lead to high levels of performance, success and customer satisfaction; at the end of the day, delivering the service to a happy customer and satisfied regulator is all what counts.

1.6 Understanding the Attributes of Good Performing Utilities

A well functioning utility is one that is conducting its business the right way, and providing its services to its constituents successfully, regardless whether it is state owned, or publicly owned, or privately owned. There are certain functional indications that the business is going well in the WSS industry, and those have to do with the type of services provided, and the functions that need to be carried out that are specific to the industry. Those indications include financial viability and good health; a level of service responsive to the needs of the customers; well maintained assets; technical efficiency and know-how carried out by well trained staff; satisfied customers; and doing all that and accounting for the sustainability of the resources. Noteworthy is that all such indications are interlinked with a substantial amount of interdependency involved.

Financial Viability

Good financial performance is essential for the success of any business, and similarly the business of water and wastewater utilities. Providing services means in general terms sizeable capital costs as investments in assets and infrastructure development, and running expenses for operating and maintaining those assets—all on the demand side. On the supply side, and being a service provider, and to cover all those expenses, the utility has only three sources of revenues according to Peter Borkey's water group at the Organization for Economic Co-operation and Development (OECD), namely: tariffs and other user charges, tax based subsidies, and external transfers such as Official Development Assistance (ODA).

Understanding the full life-cycle cost of the utility and establishing and maintaining an effective balance between long-term debt, asset values, operations and maintenance expenditures, and operating revenues is the key to achieving financial viability. This will also result in identifying tariffs that need to be in place to cover all those costs. Transparency and accountability in running the utility helps make these tariffs as acceptable as possible within the communities once they are properly engaged. They also need to be adequate enough not only to recover cost, but also to provide for reserves, maintain support from bond rating agencies (when and if needed), and plan and invest for future needs.

Well-identiﬁed Levels of Services

In simple terms, the optimal level of service to be provided by a water utility to its customers is the provision of safe water in adequate quantities, sufficient pressure, and quality per applicable standards to its constituents. In a wastewater utility the optimal level of service would be to operate and maintain wastewater collection facilities and treatment in compliance with applicable standards, and consistent with public health, customer, and ecological needs.

On a more specific note, a good performing utility would have each level of service assigned clearly and explicitly according to the prevalent conditions. Usually these levels of services are identified as such in a utility business plan, and also in the associated asset management plan, as each and every one of them will result in specific targets and associated actions that the utility needs to implement in order to achieve those targets. Such actions can be related to capital investment (e.g. expansion of network), or to O&M (e.g. improve pumping efficiency). Working to achieve them impacts the bottom line of the utility based on how they are achieved.

Maintaining such levels of services at all times requires collaborative and proactive efforts by the utility leadership and staff members to identify business risks (legal, regulatory, financial, environmental, safety and disaster related), and to establish tolerance levels and preparedness for those risks in order to manage them effectively and without negative impact.

Technical E ciencies

A successful utility is one that carries out its business and provides services up to the required levels of services at the lowest cost possible and in a timely, reliable, and sustainable fashion, minimizing resource use, loss and impact on every day operations. This entails that the utility possesses the required capacity and resources in terms of proactive leadership, well trained and incentivized staff with technical know-how, and the adequate financial means to implement all activities. Continuous improvement is key to the whole process, and being aware of information and technology developments in order to adopt them in a timely manner in the utility. Examples of these technology developments includes – among others - utilizing modern leak detection tools and mechanisms; using high efficiency pumps; making use of renewable energy sources to operate pumps and equipments where possible; risk-based reliability-centered asset management practices[15]; complete and accurate GIS based asset registry; utilizing remotely readable water meters; integrating the various functional units within the utility in terms of data and information and workflows as needed; and conducting Life Cycle Cost Analysis (LCCA) to minimize expenses.

Of course all these tools and mechanisms come at a substantial cost, and require a fully committed leadership that works hand in hand with utility staff members, and supports their implementation in the utility's every day business. However, on the long run they result in efficient operations and cost savings that can be transferred to more investments in improvement mechanisms, or even in capital improvements.

Healthy Assets

The utility runs its business by means of its assets—human and infrastructure. Maintaining healthy infrastructure means accounting for all of them in a complete and accurate registry; identifying critical assets in terms of the associated risk acceptable and consistent with customer, community and regulator supported levels of services; understanding the conditions of those assets, and the costs associated with operating and maintaining them including all functions involved within the utility to do that; and coordinating with the community for repair, rehabilitation and replacement activities in order to minimize disruptions and nuisances. This is all in line with good asset management practices, which eventually reflects on technical efficiency within the utility, and by extension customer satisfaction and good financial health.

The starting point within the utility as described earlier, is to have a GIS based comprehensive asset registry that includes all assets—fixed and rotating. The registry should include information on age, location, size and/or capacity, original and replacement cost, installation date and expected service life, maintenance and performance history, and construction materials and recommended maintenance strategies. Assets within this registry should be linked to specific cost centers that are defined based on nature of operation in combination with geographic location.

15 Risk-based reliability-centered asset management model entails four phases of implementation to create operational stability and by extension technical efficiency:

1. Classifying assets (establishing an understanding of the process flow and developing a classification hierarchy of the system);
2. Analyzing the criticality of the system components and historical failure events, and identifying a risk ranking for any future failure event for the critical components of the system;
3. Developing maintenance strategies and associated operating procedures (preventive, and predictive) based on asset condition monitoring data; and
4. Setting indicators and metrics for system efficiency to track performance and support the decision making process—optimally using a specialized asset management information system that captures all required data/information from the different functional units within the utility.

Among all the assets within the registry, the utility needs to have their critical[16] assets identified, and condition assessed and monitored to evaluate the risk of failure. This exercise will eventually lead to the successful implementation of risk based and predictive maintenance strategies and choose between the three R's (Repair, Rehabilitate or Replace) and maintaining a minimum life cycle cost in the mean time.

These practices inherently reflect on the quality of water supplied and wastewater effluent, as well as on the integrity of the water distribution/collection system. In a water supply system, this translates into water supplied by required quantities and quality; a reduced number of physical leakage events; lower NRW; optimized system flow and pressure parameters; satisfied customers; regulatory compliance; and a better bottom line for the utility. In a wastewater collection and treatment system, this translates into a reduced number of collection system blockages and/or failures; effluent and sludge in compliance with quality standards; satisfied customers; regulatory compliance; and also a better bottom line for the utility.

Committed Leadership and Well-trained Sta

Any measures that need to be taken to improve performance and enhance efficiencies within a utility will not be effective or even possible without the commitment and dedication of its leadership, hand in hand with the hard work of its well trained, knowledgeable and motivated staff members. The culture within the utility needs to be participatory, collaborative and dedicated to continuous improvement and learning. Technical knowledge needs to be developed, retained and institutionalized within the utility, with provisions for professional development. Training and capacity building should include all working levels at utility (strategic planning for top and middle management, operators' certification for operational and technical levels).

Specific measures indicative of such a culture in a utility are high employee retention rates (low employee turnover rate); employees satisfied on all levels (e.g. work and teamwork, management, compensation and benefits, professional development and advancement opportunities, communication and respect); utilizing job descriptions, clear operational manuals and standards, and employee evaluations; implementing capacity building programs; and implementing succession planning.

Customer Satisfaction

One of the main attributes of a successful utility is customer orientation (Van Ginneken and Kingdom, 2008). A satisfied customer is ample proof that the utility is performing well. It is essential that the utility provides reliable, responsive and affordable service with very clear customer accepted levels of services. A customer-centric approach of carrying on with the utility's every day business entails all levels of interaction with the customers, starting with extension of services and installation of connections and meters; equitable supply management; affordable services; contracts and redress mechanisms; and consumer representation and transparency.

Good management practices of customer satisfaction involve establishing mechanisms for obtaining timely customer feedback, and maintaining responsiveness to valid customer requests and emergencies. Supporting those practices would be engaging the customers in the decision making process through implementing participatory management approaches and public awareness campaigns. Measures indicative of customer satisfaction include number of customer complaints received; time to respond to customer needs; level of improvement on types of complaints; and gauging customer satisfaction upon work order or periodically.

16 Critical assets are those that have a high risk of failing (old, poor condition, etc.) and major consequences if they fail (major expense, system failure, safety concerns, etc.) (The United States Environmental Protection Agency (US EPA)'s "Asset Management: A Best Practices Guide", 2008.

Sustainability of Resources

Natural resources are not as abundant as they were in the past, especially with the growth in population and demand for services. Climate change is another factor further exacerbating the ecological challenges that are impacting the region. In fact, based on estimates from the United Nation (UN)'s latest Intergovernmental Panel on Climate Change (IPCC) assessment, most of the Middle East and North Africa (MENA) region is expected to become hotter and drier. And per IPCC computer modeling, an estimated additional 80 million to 100 million people will be exposed to water stress by 2025, putting more pressure on already depleted groundwater resources. This is in addition to the impacts on the ecological system as a whole. Sources of energy – although abundant in the region – are not readily available in some of the countries, thus leading to high O&M costs in the utilities there.

Subsequently, the sustainability of those resources is becoming at the heart of any type of planning on the sectoral level as well as the policy level, not to mention operational levels within utilities. Sustainability approaches are being applied to decision making in the water sector, and what institutional frameworks need to be in place to support this. Such approaches are put in place to ensure sustainable development of water and wastewater utilities. They aim to manage operations, infrastructure, and investments to protect, restore, and enhance the natural environment and efficiently use water and energy resources, thus promoting economic vitality and overall community improvement. They include a variety of pollution prevention, watershed, and source water protection approaches as part of an overall strategy to maintain and enhance ecological and community sustainability. Examples include examining current and future customer needs through long-term resource supply and demand analysis, conservation, O&M optimization, and public education; resorting to technologies that reduce energy consumption such as gravity flow based networks, developing municipal water reuse systems, utilizing eco-efficient technologies in water and wastewater treatment… etc.

1.7 Operational Challenges facing Utilities in the Region

The above discussed attributes and associated measures, approaches and techniques presented above are all indicative of a well functioning and performing utility. They can be considered as functions of internal factors related to the way the utility is managed and how it conducts its business and every day routines. However, there are numerous challenges that are faced across the region, and that are considered as major obstacles hindering performance improvements and optimization within the Arab water utilities:

- Water scarcity in the Arab region due to increasing demand and dwindling supplies is the most critical challenges utilities are facing these days. Fresh surface water resources are becoming more and more scarce due harsh climatic conditions, low average rainfall, higher temperature and higher evaporation rates. On the other hand, groundwater resources are over-exploited and unsustainable. This situation dictates that utilities often have to deal with the need for non-conventional water resources to meet water demand, including desalination of sea and brackish water, and reuse of treated wastewater as examples. Developing such non-conventional water resources comes at a substantially high cost as well as using modern technology that is not always available in the region and not within the reach of many utilities. This in turn potentially affects the quality of services as well as increases the associated costs. Similarly and with the declining quality of water resources, not all utilities within the region are able to provide their services within required standards and specifications in terms of quality and/or quantity of water delivered. This is also due to challenges related to entailed costs and the unavailability of required knowledge and technologies.

- Also mirroring the importance of financial viability and good health as an attribute of good utility performance, financial viability, performance and sustainability of a utility can be considered a challenge that needs to be confronted and dealt with. In the Arab region, as in other parts of the developing world, tariff setting is a highly politicized matter linked to social objectives, and eventually impacting the performance, efficiency and technical capacity of the utilities, which ultimately dictates reliance on government subsidies and external funding to be able to go about their businesses; the process of setting the tariff is quite "central" and is a matter of policy as opposed to the actual cost of doing business. Tariff setting has been and still is considered a sensitive issue of social and security related aspect, especially with the volatile political conditions and the so called Arab Spring prevailing in the region. Governments are reluctant to come up with decisions that instigate displeasure and associated detrimental results on the side of citizens. This of course is due to the general lack of awareness and knowledge regarding tariff setting and cost of services on the part of customers, due to weak participation and poor transparency on the part of the utilities and responsible authorities. The resulting context is that of deteriorating WSS infrastructures and poor services, dissatisfied customers, detrimental impacts on regional water resources, and private sector that is disincentivized to go into partnerships with public utilities.

- Infrastructure health and viability is yet another challenge that utilities in the region face and have to manage as best as they can. Well designed, operated and maintained infrastructure leads to good services and satisfied customers. However, this is not always attainable within the region due to several reasons:

  - The unavailability, in many cases, of the adequate funds needed to develop WSS infrastructure, and the inability to depend on tariffs to cover investment costs due to the fact that applied tariffs do not cover the cost of service to begin with, let alone account for investment cost.
  - Resorting to shorter or medium term planning to decrease cost, as opposed to the more economically feasible long term infrastructure planning.
  - The lack of accurate and reliable asset registers that include history, age, condition, performance, etc, and the reliance on manual and outdated systems and methodologies to record assets.
  - Resorting to trouble shooting and reactive maintenance approaches of fixing repairs and implementing corrective maintenance, as opposed to the more proactive approaches of preventive or even risk based predictive maintenance.
  - Applying old fashioned (non-systematic, ad-hoc) undocumented operation and maintenance tools and techniques due to lacking capacity and knowledge in modern and technology based methods and techniques.
  - The lack of proper cost accounting mechanisms that analyze specific asset behavior and enable targeted performance improvement interventions and activities.

- Coming back to the issue of scarcity and dwindling water resources, countries in the region are in many cases resorting to intermittent water supply in an attempt to handle the shortage in supply. Needless to say, this comes with unwelcome and costly repercussions to say the least; intermittent supply may seem to be a solution to a water shortage situation in overall terms, however, it causes such deterioration to the network that the amount of water that is supposed to be "saved" ends up being lost, and in greater quantities through increased levels of leakage—mostly undetected, which in fact places an added financial burden on the utility. In addition, intermittent supply leads to quality issues where water contamination becomes a hazard due to back-pressure situations that allow for the infiltration of contaminants into the network. This is in addition to inequitable distribution of water between customers. All this negatively impacts the levels of service and customer satisfaction.

- In most utilities within the region, no O&M optimization can be achieved as organizational units operate as silos without any type of integration between management, engineering, finance and O&M functions and decisions. Consequently, this becomes prohibitive of optimized performance that can be attained through streamlining business processes, better management of capital spending and funding needs, making better decisions, training utility staff, and enhancing facilities to ultimately drive down costs and generate cost savings and greater economic benefits for the utilities. The concept of utility optimization involves finding the most favorable solution to generate cost savings and greater economic benefits for water and wastewater systems, while maintaining desired levels of service and risk management. This is only attainable by fully integrating management and knowledge transfer; engineering and risk management; finance, cost efficiency and sustainability; and O&M decisions, maintenance effectiveness, and service levels, to streamline business processes, manage capital spending and funding needs, make better decisions, train staff, and enhance facilities to ultimately drive down costs.

- The culture of stakeholder engagement in decision making processes is not common in the region, and is often inexistent. This affects the decision making process at all levels; policy making, planning, regulatory, as well as service delivery. In this sense, the absence of the voice of stakeholders leaves the utilities operating in isolation of real identified customer needs and opinions, unilateral decision making, and uninformed stakeholders in what is related to the utility operations, levels of service, challenges faced and cost of service.

The next sections in this guide discuss specific case studies from across the Arab region. They look into the situation within ten Arab countries in terms of water situation and prevailing challenges as discussed above; more specifically, they look closely into technical aspects of every day WSS operational issues that constitute some of the main challenges that utilities face in the region—and those are applied tariffs and cost recovery, serving the underprivileged, NRW management, energy efficiency, and asset management.

2

REGIONAL EXPERIENCES AND CHALLENGES

2.1 Introduction

WSS utilities are industrial facilities providing a unique type of service in terms of its complexity, modes of delivery, management and support. They face significant and common challenges within the region that they have to cope with including a politically influenced sector governance structure; dwindling water resources; increased water demand and emergency response concerns due to growing populations, economic development and political instability and subsequent demobilization of communities; financial constraints; aging infrastructure; climate change; and the difficulty in recruiting and maintaining highly qualified and skilled staff within the current working conditions.

Given that WSS utilities in the region operate within a politically challenging context, with a need for reforming the sector, a successful utility in short is one that is financially viable, good at optimizing efficiency and accountability, and relates to customer needs and satisfaction.

An all encompassing overview of the WSS utilities performance and management practices is provided in this section, highlighting the typical main functions that each utility should be performing, along with indicative performance indicators (PIs), and the operation and management practices that come along with them from financial, institutional and technical viewpoints.

To start with, an overview of the strategic directions the utilities in the region are undertaking is presented followed by a discussion of financial performance and management practices. The institutional aspect of running the utility is also analyzed in terms of organizational development practices. And finally, the main operational aspects of running a WSS utility are discussed and analyzed presenting the main topics of NRW, AMM and EE.

2.2 Strategic Aspects

Several strategic directions that impact the performance and management of utilities are discussed below within the context of the Arab region, the common circumstances and influencing challenges.

Commercial Orientation and Tariff Setting

Whereas there is ample understanding in the region of the importance of commercial orientation in conducting a utility's business in terms of the need to balance revenues and costs for sustainable service delivery—supported by the central governments' decisions in many cases to corporatize WSS utilities and create autonomous entities that operate on commercial basis, however, this is not being practiced in its entirety, and the governments continue – more often than not - to pose considerable constraints on the utilities' ability in actually carrying out their business on a commercial basis. This is all related to applying the principles of good water governance and need for sector reform.

While tariff setting is one of the most important aspects of a utility's ability to provide its services sustainably with the required level of quality, leaving it entirely out of the hands of those who are actually involved in the day-to-day operations and who are aware of the costs entailed and the revenues available, and keeping it in the hands of policy makers whose objectives are entirely different leads to a detrimental effect on the levels of services provided and on the health and integrity of the WSS infrastructure, all the while without the enough funds to maintain those assets and keep up with the required standards of service. This is the case in most Arab WSS utilities today.

A major operational challenge that the utilities are facing in the region is linked to applied tariffs. In the Arab countries, as in other parts of the developing world, tariff setting is a highly politicized matter linked to social objectives and attaining political gains, but eventually impacting the performance, efficiency and technical capacity of the utilities. It is not based on informed decision making that builds on clear identifications of socio-economic studies that look into not only cost of service (with all its elements, including O&M costs, depreciation costs and debt service), but into affordability and willingness to pay. Furthermore, and more frequent than not, tariff changes are not "socialized" among the communities and their representatives prior to applying them formally. The main issue in this case is considering the needs of the poor and their ability to pay for WSS services. This is another issue that will be discussed in this section.

Of course, this ultimately dictates reliance on government subsidies and external funding for the utilities to be able to go about their businesses, as it does not allow for capital investment (expansions of services or rehabilitation/replacement of capital assets). Noteworthy is that tariffs subsidized by the central government are not sustainably so, thus jeopardizing the infrastructure condition and the levels of services provided by utilities.

Pro-poor Perspectives

When asking the question: What are the available policies that cater for the need of the poor and underprivileged, the number answer that came from all subject utilities was: setting the first block within the tariff structure as a social block that applies very low charges that should cater for the needs of the poor.

Although the intention is noble, however the practicality of the solution is not sufficient to actually cater for this underprivileged segment of society. This "social" block in actuality is not really serving the poor; rather it is beneficial to those who are able to manage their consumption of water, especially small numbered families. Of course, this is not the case in most poor families that come in large numbers, or in other cases where two poor families share the same water meter, shifting them to higher blocks and further difficulties in paying the water bills.

It remains that the service is subsidized as opposed to targeting the subsidy to those who are in need. For this to take place, identification of the poor would be required based on agreed upon criteria. This is a country wide pro-poor policy that is so far too expensive to adopt and act upon.

Other pro-poor services that are implemented, although not widely so, are through the differentiation of service to lower costs entailed, such as providing access to safe drinking water through the erection of publicly accessible standpipes such in Mauritania, Morocco and to a lesser extent Egypt. Another that is successfully used in Mauritania, Morocco and Jordan is subsidizing the cost of connecting to the network in rural areas, and giving the poor customers the chance to pay connection fees on installments for up to seven years, which is proving to be an effective policy that is enabling the poor families in accessing WSS services.

Still, more needs to be done in terms of protecting and supporting the poor in their efforts to get access to good quality WSS services.

The Planning Paradigm

Facing the challenges related to WSS sector in the region necessitates that countries carry out the planning function efficiently, identifying those challenges, delineating strategic objectives to be pursued and developing implementation plans that lead to fulfilling those objectives. This function is widely applied in the region as Table 3 below shows. Similarly, capital investment planning is considered an integral part of the planning process that is needed to identify the medium and long term infrastructure development needs. This function is also applied, albeit in a rather un-institutionalized manner that is driven by donor programs and the availability of external technical support in most cases. It is not associated with the implementation of good asset management practices, as the latter are lacking to a large extent in the region.

Table 3: The Availability of WSS Sector Strategies and
Capital Investment Plans in Selected ACWUA Member Countries
(Source: ACWUA UM TWG, 2014)

Country	WSS Sector Strategy	Capital Investment Plan
Mauritania	Available	Available
Morocco	Available	Available, based on master plans
Algeria	Available	Available, based on master plans
Tunisia	Available	Available, based on master plans
Egypt	Available	Available, based on master plans
Yemen	Available	Available, but no updated master plans
Jordan	Available	Available, supported by a wastewater master plan
Palestine	Available	Partly available
Syria	Available	Available
Lebanon	Available	Available

Noteworthy however is that although a sector strategy is usually in place, not all utilities have a supporting business/strategic plan with elaborate action planning, especially when such utilities are a part of a municipal structure, or when they act under centralized management.

Another note is that in many cases, developing the strategy, the capital investment plan and any master plans is not institutionalized, but donor driven and developed under the umbrella of a donor funded technical assistance program. This does not build into the sustainability of the planning process, especially when it is not home-grown. Another fact of life that some countries in the region are dealing with is the difficulty to work around a well established capital investment plan due to emergency conditions continuously evolving with the current political situation in the region. This is manifested in Jordan and Lebanon as an example, where the influx of Syrian refugees requires very quick and implementable solutions on the short term to cope with the largely increasing demand on WSS services.

In other instances, the planning function is fragmented within various institutions with differing priorities. This, along with the mostly arbitrary un-institutionalized prioritization of capital investment needs lead to conflicting messages and final products, affecting the implementation of plans, especially when funding for such plans is to a large extent dependent on the availability of funds, loans or grants from the donor community—which is the case in many of the Arab countries that are facing massive budgetary constraints and with the lack of full cost recovery.

On another note, although a plan is set in place, it is not always followed-up and monitored in terms of PIs, and if it is actually followed up, there would be no serious repercussions to lagging PIs. This is due partly because sometimes the strategy is a very good selling document without having the proper action or implementation plan consistent with it, or because the targets set are not realistic, and are in fact driven by external sources without taking into consideration realistically the challenges to fulfilling them. Also in relation to that, and in relation to the issue of capital investment project, their funding and their implementation, there is a notable weakness in designing and implementing a successfully institutionalized tracking and monitoring process that enables the decision makers to have access to project data in terms of level and timeline of execution and disbursement of funds. This is very important especially when such projects are to a large extent funded by donor agencies that require such information to be available. It is also important to avoid any inaccurate information that could lead to uncareful waste of resources and the reallocation of funds to projects already implemented but not accurately reported.

Another very noteworthy fact is that the functions of policy making and strategizing are not typically supported by the proper research and development activities needed to inform policy and decision makers on the impact of policy and the associated strategy from a social, economic, environmental, political or other perspectives. It is rarely that there is a research and development (R&D) unit that is responsible for such a function within the WSS sector—whether in ministries or in corporatized utilities or other institutions. Most notably is the tariff setting process as mentioned earlier. In this regard, ACWUA has joined the MENA Network for Water Centers of Excellence (MENA NWC) that was founded with the support of the United States Agency for International Development (USAID) as a regional platform that fosters inter-country cooperation in research and development programs that target developing solutions for regional challenges; supporting the exchange of knowledge and experience between the countries in the region in this regard; and involving policy makers and private sector in designing research programs in order to inform the latter when making decisions on policies regarding their impacts, and to work for the sustainability of solutions when involving the private sector.

2.3 Financial Aspects

The overview performed targeted the financial management practices as well as some of the main financial performance indicators in selected WSS utilities in the region. The main areas of focus under the financial management practices were the types of accounting and cost analysis; financial information and reporting. Other areas of focus under the financial performance of utilities include cost recovery and commercial orientation; revenues vs. expenditures and revenue collection; and policy and tariff setting.

Financial Management

Financial management practices are optimally clarified and delineated by a financial policy that tackles the financial targets set for the utility; the implemented accounting and auditing standards; budget preparation; approach set for depreciation; reporting requirements, etc. This document is a prerequisite for consistent financial performance and management that is related to strategic objectives set forth for the utility. Noteworthy is that such a guiding document is not always available in the utilities subject of the review. In some cases they are available and comprehensive, and in others they are available and partially cover the typical contents of such a document. The importance of having the policy is in its provision of clear guidance to how the utility financially operates—a prerequisite for financial sustainability. In public utilities it is more aligned public finance principles, while in corporatized utilities it is more independently articulated, with the exception of certain policy issues that are preset by the central government. This policy is also considered a requirement in any applied total quality management or excellence model, thus is available in countries that adopt such a quality system like Jordan.

Accounting standards used are mostly accrual based, which provides a better idea about the utility's financial situation and health, as it reflects amounts due and amounts owed, not only cash in and cash out.

Budgeting in the most part is more line item budgeting consistent with public finance standards. No clear or identified cost centers as available in the most parts other than considering water as a cost center and wastewater as another. In some cases, cost centers are geographically based and consist of remote stand-alone facilities. In other cases, indirect costs cannot be attributed to line items and are aggregated separately or allocated arbitrarily. Sometimes, even the indirect costs are grouped for all central and decentralized centers. Table 4 below describes cost items and approach to cost accounting. In summary, the utilities in general do not provide for activity based costing, which does not support highlighting potential areas of improvement clearly where efficiency gains can be targeted and achieved.

Table 4: Setting Cost Centers in Selected ACWUA Member Countries
(Source: ACWUA UM TWG 2014)

Country	Cost Centers and Cost Accounting Practices
Mauritania	Some stand-alone facilities are considered as cost centered (geographically based), but not the general setup.
Morocco	Cost centers are available and are based on a combination of several aspects including geography, type of system and facilities. They support the proper costing of services.
Tunisia	Typically geographically based but with indirect costs aggregated for all without allocation.
Egypt	Cost centers are only available in some utilities, and are based on type of operations (i.e. production, distribution, collection, treatment, administration). Enables utilities to estimate cost per cubic meter at each phase of service delivery, and enables them of pinpointing areas in need of improvement and potential efficiency gains. Not available in all subsidiary companies.
Yemen	Dual system of accounting (public and utility specific). Cost centers used in the latter are water, wastewater, Office of the Director General, Financial Management, Administration, Warehouses. However, as the public system is a central government requirement, conformance with the utility specific system is not necessary and not always applied.
Jordan	Cost centers are geographically based for the various water administrations in governorates and water companies, and available for water and wastewater and administration for the WAJ. In water companies, information for activity based costing are available but not easily accessible and require an amount of further data categorization.
Palestine	Cost centers not always available in municipal utilities; in some cases, costs are included in an aggregate cost item for all municipal services. In other cases (the larger municipalities), cost centers are available.
Lebanon	No cost centers are applied.

Financial Performance

In terms of indicators of financial performance, there are several that can be investigated, but we will address cost recovery as one of the most important and representative PIs that reflects the utility's ability to balance expenses with revenues (operational and other). It provides an idea of the utility's health and its ability to sustain its services on the long term, and as it measures the ratio of revenues to costs, it provides an idea of how effective the fees collected are in recovering the costs incurred, and if in fact the collection efficiency needs improvement through the collection efficiency PI which measures the amounts collected to the total amounts billed. It is affected to a great extent by the political decision that is usually governing setting the tariff, and by the operational efficiency of the utility.

As a minimum, utilities should strive to recover O&M costs to continue providing the same service in terms of quality. However, and with the need for expanding the scope of services, and the need to tend to the aging infrastructure, provisions should be make for the tariff to cover capital costs in the form of the depreciation of assets, and any debt service or interests on loans. Table 5 below provides an idea about cost recovery and collection efficiency in utilities in the region.

Table 5: Cost Recovery and Collection Efficiency in Selected ACWUA Member Countries
(Source: ACWUA UM TWG, 2014)

Country	O&M Cost Recovery (%)	Collection Efficiency (%)
Mauritania	52 (2012)	53 (2012)
Morocco	100 (2012)	100 (2012)
Egypt	113 (2010)	84 (2010)
Yemen[17]	65 (2013)	85 (2013)
Jordan[18]	91 (2013)	94 (2013)
Palestine	100 (2012)	70 (2012)
Lebanon	40 – 100 (2013)	30 – 90 (2013)

As evident, most subject utilities do not recover their costs, which places them in a critical area that prevents them from continuing to provide the quality of service aspired for by their constituents, especially when coupled with low fees collection efficiency. It is therefore extremely important to take cost recovery into consideration when setting service tariffs.

The impact of low tariffs is aggravated by not applying good asset management practices, where the efficiency of ageing infrastructure (especially rotating assets such as pumps) decline with time, and where the unavailability of funds to carry out capital improvements eventually leads to deteriorated assets with high energy consumption—leading to an increase in energy costs. This is not to mention the effect of NRW and associated extra costs of production and distribution, which will be discussed later in this section.

Energy cost is yet another very important cost item that utilities in the region are suffering from. Table 6 below presents energy costs for the subject utilities. High energy costs in utilities come as a direct result of the challenges that they face. The central issue of water scarcity and climate change affecting the region drives utilities to developing very costly energy intensive water resources, especially non-conventional ones such as desalination (widely used within the region, especially in the GCC countries), or wastewater treatment (widely used in Tunisia, Jordan and other countries). In some cases the topography of the country poses another challenge that utilities have to deal with when water produced is pumped to communities that located at high elevations thousands of meters above sea level, such as in the case of Yemen. The problem is exacerbated when such situations exist in a non-oil producing country, where energy costs are very high, and especially when the tariff is subsidized and does not reflect the actual cost of service—most prominently energy costs.

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18 In Jordan, by regulation, independent semi-governmental institutions (such as water companies) are not allowed to keep any spare funds that accumulate above their operational needs (by law). This is considered a regulatory obstacle to allowing for a reserve fund that would serve as a capital fund for rehabilitating or replacing capital assets, thus negatively impacting the ability of the utility to cover its costs.

Table 6: Energy Cost Ratio in Selected ACWUA Member Countries
(Source: ACWUA UM TWG, 2014)

Country	Energy to O&M Costs Ratio (%)
Mauritania	12.5 (2012)
Morocco	60 (2012)
Tunisia	15 (2012)
Egypt	21(2012)
Yemen[19]	43 (2013)
Jordan	40 (2013)
Palestine	45 (2012)
Lebanon	30 – 40 (2012)

The impact of energy costs on the utilities' bottom line is now starting to push top management to consider energy efficiency and engage in energy consumption reduction programs, usually funded by donor agencies. This is applicable in the cases of Morocco and Jordan. It can be stated however that the regional capacity and knowledge in this subject is still nascent and requires strengthening.

2.4 Institutional Aspects

The institutional framework that supports the operations and management of WSS utilities is of utmost important to successfully delivering their services. Proper organizational units that cover all the typical functions needed for service delivery should be in place, taking into consideration the institutional and operational challenges that these utilities face in their every day work. Strong leadership and committed and responsible management, coupled with incentivized qualified and skillful staff, are drivers for good performance and satisfied customers. Our overview looks into such important aspects within utilities such as leadership skills and their development; the human capital; and approach to institutionalization such as information and decision support systems, monitoring and evaluation systems, quality systems and means of communication.

Leadership and Human Capital Development

Strong leadership skills are essential to creating an organizational culture and environment that is conducive to good performance and efficient service delivery. Such inherent skills can be developed within the top management of the utilities with the proper tools and facilities, and fortified through leadership training programs. Those programs are not always accessible for top management employees especially with the costs entailed, and are usually left at the end of the scale of priorities, which also applies to training courses provided to utility staff in general. Notable are the programs and courses that provide such types of training through ACWUA, but which are usually funded by international donor agencies such as the German Society for International Cooperation (GIZ).

On a related note, successfully operating and managing utilities in the region entails recruiting the right set of skills, qualifications and competences that are in line with the requirements of utility functions. Utility efficiency is very much related to having these skills in the right number of employees with a balanced workload, achieving the required level of productivity to provide excellent services and attain customer satisfaction within a balanced and comprehensive organizational structure. Such organizational structures are said in many cases to have been manipulated by power plays that are not necessarily always in the best interest of the institution. Table 7 below shows the number of employees per 1,000 connections in the subject utilities. In developing countries, a best practice target is five employees per 1,000 connections in efficient utilities.

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Table 7: Sta ng per 1000 Connections and Hours of Training in Selected ACWUA Member Countries
(Source: ACWUA UM TWG, 2014)

Country	No. of Employees per 1000 connections	Annual No. of Training Hours per Employee
Mauritania	5 (2013)	N/A
Morocco	4.8 (2012)	24 (2011)
Tunisia	2.9 (2012)	6 (2012)
Egypt	6-7(2012)	N/A
Yemen	23 (2013)	N/A
Jordan	6.4 (2012)	39.9 (2012)
Palestine	6	N/A
Lebanon	10 - 18	N/A

The larger than best practice benchmark in many cases is a result of the remnants of the culture of public administration that leads to over-employment with the lack of accountability measures and the culture of reward and punishment. In fact, some of the major issues that utilities in the region suffer from in many cases are the recruitment process that is supposedly linked to qualifications and competence in light of job specifications, however, this is not always the case; "wasta" or favoritism and undue privileges are syndromes that can be found in many of the utilities in the region, as much as it is available in other public administration jobs.

Another constraint to attracting and retaining qualified skills are the mediocre compensation packages when compared to what the private sector is ready to offer. Add to that the unfair mechanisms in some cases of allocating financial incentives, which lack any formal or systematic approach that is linked to performance evaluation, and which depend on the approval – or the lack thereof - of the individual in charge.

Another requirement to building the capacity within WSS utilities is the issue of training programs. Training and capacity building programs are very much needed in utilities in the region, to build the capacity and knowledge of utility staff in their areas of work, as well as enable them to exchange this knowledge and experience with other staff in the region. It is noteworthy that as a general practice, training needs assessments are carried out in the utilities based on actual needs related to the jobs, the qualifications and skills of the employees and the job descriptions and job specifications. However, there is always budgetary constraints that keep the implementation of training programs at the lower end of the scale of priorities in utilities. In fact, training programs are mostly provided by technical assistance and support programs funded by donor agencies. And even then, the enrollment in training programs is sometimes governed by the approval of the individual in charge – irrespective of the actual training needs and job requirements.

The need for training and certification, especially on the technical aspects of service delivery - it must be noted – is one of the most important issues that are currently being evaluated and considered in the region, and through ACWUA in specific. Training and certifying WSS operators and management[20] is become a necessity in light of the current reform initiative in the region, and the advances in technology and know-how that are currently taking place in operating and managing utilities. Such certification programs set the standards on a regional scale for the minimum and more advanced levels of knowledge that workers in the WSS sector need to have in order to efficiently run the utilities and ensure the delivery of services up to the required standards. The importance of having unified

20 ACWUA holds a regulatory membership at the American Association Board of Certification (ABC), and is accredited by the Center of Accreditation and Quality Assurance (CAQA) in Jordan to deliver water operators certification program in the Arab region.

O&M standards in the WSS sector was strongly addressed in ACWUA 6th Best Practices Conference held in December 2013 in Algeria, where all participants from all levels (political and technical) issued the Algeria Declaration[21] which stresses the need for establishing unified O&M standards in WSS systems, thereby becoming one of ACWUA's main goals for the coming period. This declaration was also endorsed by the Arab Water Ministerial Council of the League of Arab States. It is however key for the successful implementation of such certification programs to have an enabling environment with the suitable regulatory and institutional frameworks in place that pushes them into existence as a pre-condition for operators to work in WSS utilities. This requires long term planning and advocacy for a supporting policy, as well as developing the required and suitable resources– knowledge based, skills based and financial resource. Up till now, such certification programs have been developed and implemented in Jordan and Egypt, and are expected to be used as the base for a regional training and certification program to be further developed and implemented by ACWUA in the region.

Information and Decision Support Systems

The WSS sector is one that requires a good amount of data and information to be available due to its complexity and the different types of functions that need to work together in harmony in order to be able to operate a system (financial, technical, institutional, etc). Such information at best should be well documented, easily accessible, reliable, accurate, timely and responsive to the O&M and management needs of the utility. All decisions– small or big– depend on the availability of such information. It is therefore essential that each functional unit within the utility have not only a certain type of information system with the previously stated characteristics, but also in order for the system to be useful, it needs to be properly institutionalized, with a well established data flow with identified sources and access points, and also to be continuously subject to improvements. It should also be integrated with other functional information systems within the utility to act collectively as a decision support system (DSS).

According to the overview in hand, the subject utilities deal with this type of information and data, and have many databases and data warehousing systems in place. However, there are several shortcomings with these systems that are more or less common:

- In many cases, data from the field is reported manually to central operations. In some of these cases, databases are available, but the data input process is inconsistent and unreliable, affecting the integrity of the data itself.
- In some cases reports are also prepared manually, taking too much time and effort, and also compromising the accuracy and integrity of resulting information.
- In many cases certain parameters or measured data have more than one source, that all get reported arbitrarily based on user of information. This results in conflicting, inconsistent and fragmented information.
- Utilities in general have data islands; management information systems that bring together the various data and information from the different sources are not common. The financial department reports separately from the operations department, which also reports separately from the maintenance department, which reports separately from the customer service department, which reports separately from the human resources department, etc. As a general rule, such available reporting systems generally lack the functional integration that is needed to inform the decision making cycle within the utility. They are designed as such to safeguard the interests of each organizational unit on its own, as opposed to acting as one utility.
- In many cases – such as the cases of Egypt, Jordan, Yemen and Lebanon – there are regulatory reports that are submitted to regulatory units to monitor the utilities' performance in comparison to specific identified PIs. Sometimes such reports are prepared manually instead of electronically, which affects the integrity of data and leaves room for changes. In other cases such as Yemen and Lebanon, there is actually an automated system in place that should report directly the PIs on a periodic basis, but

21 http://www.acwua.org/algeria-declaration

both systems are not fully operational without due institutionalization in the utilities. In addition, and in both cases data sourcing of parameters that are used in calculating the PIs are proving to be difficult to measure, and in some cases are not being measured at all. This is also very similar to the Executive Information System (EIS) that was developed and implemented in Jordan by a donor funded program to serve the decision makers within the water sector on various levels, but is still left unused due to difficulties in obtaining the source parameters and in the technical capacity needed to maintain the system. One shiny example would be the case of Tunisia, where decision support dashboards are used to present PIs on a quarterly basis and that are fed data from various other systems in the utility such as Human Resources (HR), financial and inventory control, customer service and billing and collection, and GIS systems—to name a few.

- In general, there seems not to be real interpretation of data/information reported to regulatory units; reports are submitted with no feedback that includes analysis or follow-up actions or similar decisions on the part of the regulatory unit. This is also due to the limited regulatory capacities and functions that such units carry out in the WSS sector in the first place. Such systems can be described as reactive as opposed to proactive in nature.

Quality Management

Applying quality management systems in utilities – as in any other organization – results in improved performance and efficiency of the organization in providing its services to its customers. Applying any type of quality management standards within utilities entails ensuring the quality of all functions that the utility undertakes in order to provide its customers with WSS services to their satisfaction and in compliance with the applicable standards and requirements set forth by the concerned regulatory parties.

The benefits of applying a quality management system in a WSS utility include the following:

- Engaging all levels of staff in how the utility carries out its mandate under a strong and supportive leadership. This supports a culture of cooperation and complementarity and looks beyond isolated interests into the overarching interest of the utility. Such a participatory culture creates the sense of ownership and drives performance improvements.
- Creating and maintaining a customer centric organization that takes into consideration the voices of the customers and their needs in designing their processes and carrying out their everyday business. This result in satisfied customers that are supportive of the utility with a strong level of confidence created between the both of them.
- Creating communication channels internally within the utility and externally with all stakeholders and customers, thus creating ownership on the part of the staff members, and building trust and confidence between the utility and its stakeholders—especially the customers.
- The Utility's work is documented in clear and well established processes that lead to institutionalized systems, good performance, and allows for designing process improvements—all the while keeping the interests of the customers in mind, and taking into consideration the well being of the utility itself in order to continue to be able to provide services at the required standards.

There is actually a number of quality systems applied in a number of the utilities in the region. Examples include:

- In Jordan, the Water Authority of Jordan (WAJ) and the water companies apply the European Foundation for Quality Management (EFQM) quality model, which is supported by the King Abdullah Award for Excellence (KACE) for public and private sector institutions in Jordan. This model focuses on five aspects in each organization (leadership, people, processes, knowledge and finances). Applying this model in effect means that every utility has its own strategic plan (including risk management aspect) and associated Monitoring and Evaluation (M&E) system in place; an empowered organizational culture and staff; good HR planning and management approaches; staff development; identified and documented processes; good knowledge management practices; good financial planning, management and assessment. Noteworthy is that although all such systems and approaches are in place theoretically, but when it comes to actual implementation, there still is a gap there.

- In Egypt, the Technical Sustainable Management (TSM) system is applied in some utilities and some Total Quality Management Standards (TQM) in other utilities. The TSM system focuses on improving the O&M processes in a plant or utility; the quality of water and of wastewater effluent; the health and safety environment in the facility; financial health of the utility or facility by efficient management; and knowledge transfer and sharing between staff members including understanding of applicable standards and processes. A Plan is in place to certify all plants in Egypt in TSM. As for TQM, it is about delivering quality services to satisfy customers through implementing continuous improvements on processes. TQM requires close cooperation of the different functions in the utility to be successful. ACWUA in cooperation with GIZ is implementing a regional TSM initiative on regional basis (TSM-Arab) through a group of experts from Quality Management Systems (QMS) Task Force. TSM-Arab aims to apply a selection of QMS requirements in two pilot countries; namely, Jordan and Tunisia.
- Tunisia applies the International Organization for Standardization (ISO) system; in specific the ISO 9001 (Addresses various aspects of quality management. Applied standards provide guidance and tools that ensure that products and services consistently meet customer's requirements, and that quality is consistently improved), and ISO 14001 (Addresses various aspects of environmental management. Applied standards provide practical tools to identify and control environmental impact and constantly improve environmental performance).

In terms of risk management, and as a general observation (with the exception of Jordan and Egypt), utilities in the region do not have a calculated approach to how to optimally deal with any possible risks or emergencies, or proper risk management plans, and usually react to crises without prior response planning. This leads to severe impacts on utility operations and levels and quality of services, and of course on customer satisfaction and on the financial health of the utility.

In terms of customer service, in some cases such as the cases of the National Company for Water Exploitation and Distribution (SONEDE) in Tunisia and WAJ in Jordan, online or even printed forms and/or manuals that explain all types of services provided by the utilities as well as the prerequisites and steps for applying for them, are available to be used by customers. This practice should be easily replicated in other utilities. Customer service centers are becoming more and more available, and provisions are made to facilitate payment by customers whether in such centers or even in post offices or sometimes banks. Call centers are in most cases available and transfer complaints to maintenance centers – manually or through a virtual link. However, complaints are seldom followed up to monitor performance and responsiveness of the maintenance crews as well as gauge customer satisfaction. Noteworthy is that there are still utilities where no call centers or even hot lines are available to receive complaints from customers, such as some local corporations in Yemen and Mauritania, where the population density is low, making it difficult to provide services to customers that are dispersed on a wide scope.

In terms of customer satisfaction, and with the exception of Jordan and Egypt to a certain extent, so specific approach to measuring customer satisfaction was reported, despite its importance. Noteworthy is that due to the application of quality management systems in both Jordan and Egypt, and as a prerequisite for such systems, customer satisfaction is an important factor that plays into improving the service quality.

2.5 Technical Aspects

The nature of operations in WSS utilities is complex and unique to this industry. Operations are carried out in numerous functional or organizational units within the utility, but should do so in continuous synchronization. In this section we will review two technical areas and supporting systems whose optimization is essential for the utility to be characterized as well performing. Those two areas were chosen having being identified at numerous occasions as challenging, and where capacity development is much needed. They are NRW and AMM.

Asset Management

The concept of asset management in the region as it turns out is more related to how assets are handled in a financial sense as opposed to the technical side of managing assets. When the word asset management is mentioned, all eyes go to the financial people in the utility. This misconception is indicative of the lack of knowledge within utilities of applying best practices in AMM despite the importance of such a topic and the extent of its effect on how the utility can best serve its customers efficiently. Global experience shows that the adoption of AMM and the evolution of its principles and framework for implementation were mostly influenced by the existence of regulatory requirements that utilities need to conform to. This is not the case in the Arab region, where the regulatory function is still immature, and if exists does not step up to address AMM practices.

Briefly, AMM can be described as a planning process that ensures that the most value from each asset is gotten, and that the financial resources needed to rehabilitate and replace them when necessary are available. It also entails developing a plan to reduce costs while increasing the efficiency and the reliability of assets, and using an AMM program for the same purpose. Successful AMM depends on how well a utility knows its system's assets, and on regularly communicating with management and customers about the system's future needs.

The outcomes of applying AMM properly is prolonging the life of system infrastructure through informed assets repair/rehabilitate/replace decisions; complying with regulatory requirements and attaining customer satisfaction and providing the required levels of services sustainably; setting tariffs based on informed operational and financial planning; activity based costing and asset accounting that allows for understanding life cycle costs to improve the efficiency of operations; and improving how the utility responds to emergencies.

Proper AMM requires that a utility has an accurate list of all its assets along with profile (physical description, location, size, age, condition and remaining useful life, replacement cost, etc), criticality, and maintenance history. This requires the development of an updated assets registry that optimally is GIS based. From our overview, such practice is generally lacking in utilities in the region. In some cases such as Tunisia, an asset registry is available and being updated on the GIS, where an organizational unit is available and specialized in this function only. In Greater Cairo Water Company, the exercise of developing a GIS based asset registry is currently underway, and still is incomplete. In Lebanon, donor funded programs enable the registration of some of the assets in some areas in Lebanon, but they are still not completed. In Jordan, in Miyahuna the largest water company, an incomplete asset registry is available that the company is now planning to complete and improve on its accuracy. Similarly in Mauritania.

Another important requirement for proper AMM practices is identifying the probability of an asset failing and the impact of failure. This builds into identifying the criticality of assets to prioritize repair/rehabilitate/replace activities. This action in itself can be performed using specialized software, building on the available information that can be obtained from the various functional units in the utility (asset value and replacement cost and replaced parts and depreciation from the financial and inventory departments; asset location and performance and maintenance history from customer services and Computerized Maintenance Management Systems (CMMSs) and operations, etc).

This type of analysis is also generally lacking in utilities within the region, especially that as previously discussed, the concept of functional integration is very weak and not implemented—organizational units work as silos without the required level of interaction and complementarity and functional or data integration. Despite the commercial availability of modern tools and software for proper asset management and its implementation in WSS utilities, such tools are not applied in most if not all utilities in the region (with the exception of concessions and some autonomous utilities with small systems such as the Aqaba Water Company (AWC)). It is a platform that allows for automated cross-functional integration of the data and information available within the various organizational units based on internal analysis algorithms to inform the decision making process in relation to the assets repair/rehabilitate/ replace decisions.

Another aspect to proper AMM is the ability of the utility to track O&M costs and assets depreciation costs per asset or based also on activities. This requires that supportive cost centers that are either activity based or asset based are established and utilized in cost accounting. As previously discussed, this function is generally not implemented in utilities in the region.

Of course, all AMM practices should be planned in an AMM plan that sets the plan of action annually in relation to the utility's assets. It includes a summary of the condition of assets, what the critical assets are vis-à-vis the levels of services as identified in the utility's business or strategic plan, and based on all the pertinent information collectively provided, a plan for repairing/rehabilitating/replacing assets for the next year. This feeds into the capital investment planning process and the allocation of the required financial, institutional and technical resources for this plan to be carried out.

The overview shows that most if not all the subject utilities do not actually have an asset management plan that they work by. In fact, maintenance is usually reactive – except in very rare situations such as in SONEDE in Tunisia - and is mostly trouble shooting activities to deal with infrastructure failure as it occurs, as opposed to prearranged and well planned preventive and even proactive maintenance activities that do not disrupt service delivery, minimize collateral damage, and cost much less than what corrective maintenance actually costs utilities.

In general, utilizing IT tools and equipments to support maintenance activities in utilities is still limited in scope and in geography; some systems such GIS, CMMS, Supervisory Control and Data Acquisition (SCADA), billing systems, AMM platforms, etc are not commonly used everywhere-some of them exist and are utilized in comparatively large facilities within a utility, and some are not used to their full potential, and if all exist and are used, they are not integrated – functionally or even in terms of IT) in a manner that allows for the information in all of them to be used collectively in supporting the decision making process.

Non-Revenue Water

The Arab countries account for more than 5 per cent of the world's population, but less than 1 per cent of global water resources. Coupled with the effects of climate change on the region, it is facing an even greater water shortage.

The World Bank estimates that in developing countries, water loss through leakage is about 45 Million Cubic Meters (MCM) per day—the highest in the world (Kingdom, Liemberger, & Marin, 2006). The same report estimates the total cost of NRW to utilities worldwide at US$14 billion per year. Reducing by half the current levels of losses in developing countries, where relative losses are highest, could generate an estimated US$ 2.9 billion in cash and serve an additional 90 million people. This is how extensive the aggregate impact of NRW is.

This is how much water is important in the Arab region, and this is how much it is costing water utilities—in terms of quality of services provided and financially as well. The cost of NRW comprises avoidable O&M costs that are expended when water is pumped, treated and distributed but not billed due to leakage, water theft or inaccurate metering. This is compounded by lost revenues that cannot be collected.

Whereas addressing NRW through developing costly water resources is one way of doing things, however, and in light of the stressful water situation in the region, it is essential that utilities work to manage NRW and reduce water losses. Previous studies have shown that efforts toward conservation and NRW reduction can provide water at about one-half to one-third of the cost of water production from new capital plants (World Bank, 1992).

In developing countries, the World Bank recommends that NRW should be "less than 25%". Comparatively, NRW in Arab utilities is relatively high as shown in Table 8 below along with type of supply. High NRW is usually considered a sign of a less than optimally run water utility with shortcomings in governance, autonomy, accountability, and technical and managerial skills necessary to provide reliable services.

Table 8: NRW Indicators in Selected ACWUA Member Countries
(Source: ACWUA UM TWG, 2014)

Country	Type of Supply	NRW (%)	Main Breaks (per Km per year)
Mauritania	Mostly intermittent	47 (2013)	Not available
Morocco	Mostly continuous	28 (2012)	0.1 transmission (2012) 0.5 distribution (2012)
Algeria	Mostly intermittent	50 (2013)	Not Available
Tunisia	Continuous	21 (2012)	0.3 (2012)
Egypt	Mostly intermittent	28 (2010)	0.2 (2010)
Yemen[22]	Intermittent	33 (2010)	2.8 (2010)
Jordan	Mostly intermittent	41 (2012)	3.9 (2012)
Palestine	Intermittent	40 (2013)	1 small utilities (2012) 10 large utilities (2012)
Syria[23]	Mostly intermittent	36 (2010)	Not available
Lebanon	Mostly intermittent	45 (2012)	2 – 12 (2012)

There are several reasons why such high NRW numbers are reported in the region:

- Notably, supply is intermittent in the region, with the objective of managing water scarcity. However, experience has shown that intermittent supply does not reduce water consumption; in fact, increased system input volumes were registered after intermittent supply was used without corresponding increases in customer consumption—signifying an increase in leakage and thereby NRW.
- Low cost recovery and unsuitable water charges – as is the case in utilities in the region - lead to the deterioration of the system components and assets, thereby leading to leaks and more water losses especially with the inability of utilities to carry out the necessary maintenance programs efficiently, and with the budgetary constraints that central governments suffer from that prevent them from providing the necessary subsidy required for capital rehabilitation and replacement projects.

22 2010 data prior to the political unrest that the country witnessed
23 2010 data prior to the political unrest that the country witnessed

- Estimating or calculating exactly what the NRW is through implementing a water balance is not common practice; data and information is not always available to make this possible, and the institutional and technical capacity is lacking in general for this exercise. In addition, there are no really isolated District Metered Areas (DMAs) - with proper input metering and pressure and flow monitoring or control - available as a common practice, making the calculation of water loss all the more challenging, especially when it comes to real losses. It was noted in many cases that although SCADA systems are sometimes in place, but they are either not used to their full potential, or used only for monitoring purposes. The benefits of pressure management are not widely appreciated and there is generally no assessment of the economic level of leakage.
- Determining the division between real (physical leaks) vs. apparent (commercial) losses in order to determine which components of the water balance account more and have a higher degree of impact on NRW cost, is also not common practice in utilities, as the data and information available make it a difficult task to determine this division.
- All the above listed activities are preconditions to developing a sound NRW management strategies and water loss reduction programs. This also has been found to be lacking in utilities in the region, with the exception of specific cases such as Tunisia. Noteworthy is that several pilot activities have taken place in many places in the region such as in Sohag in Egypt, Aqaba in Jordan and other utilities, where specific NRW management programs were implemented and reported very good improvements and results that cannot be sustained without the commitment of utility top management to the continuity of activities, and without the proper financial support that is usually provided by donor agencies, and also without the commitment to implementing good asset management practices in general.
- Still in Lebanon in many cities water is not metered and the tariff is not linked to consumption. This not only does not encourage economizing on water consumption; it also means that commercial losses can only be estimated to a certain degree.
- In most other utilities where consumption is metered, there is not always a meters inspection program in place and many of the meters are either in need of repair, are skewed thus under-reading, or the incorrect meter class is used thus giving inaccurate readings. In addition, there are still instances where consumption is estimated and not measured, also leading to a lesser degree of accuracy in billing information.
- In many cases water theft and illegal use is a major part of NRW that governments and politicians are leaving unaddressed, especially with the volatile political climate in the region and the Arab Spring. In some cases, field staff working on detecting illegal connections or on suspending services for non-paying customers or even service fees collectors (jabis) collecting fees, have reported aggressive reactions on the part of the customers, amounting to be described as risky and dangerous even.

2.6 Findings and Observations

Successfully operating and managing WSS utilities is a multi-faceted process that entails various aspects (strategic, financial, institutional and technical). This should of course be done within a governance system and enabling environment (political, legislative, governance related, and regulatory) conducive of good utility performance on all levels. The question here is where to start and what to target first: performance or policy and governance? There are lessons learned from the experience of Arab countries in managing WSS utilities that are presented in this section:

- **Successful reforming initiatives are those that address both areas of impact (policy regulatory and planning area), and utility performance improvement area synchronously** without giving weight or priority to one over the other and at a prudently planned pace. At the end of the day the goal is to be able to provide sustainable quality WSS services to customers efficiently conforming with applied standards and regulations and at the minimum cost possible.

Experience in the region leads to the realization that focusing on implementing improvement mechanisms, tools and techniques can become useless and non-implementable if the proper enabling factors are not instituted on the policy, legal and strategic levels. Similarly, reforms on the policy and governance level do not automatically result in improved utility performance, as mechanisms, tools and techniques that lead to this type of improvement need to be established and instituted within the utilities.

- **Introducing improved management and operational practices is best effective when it is driven from within the sector as opposed to external pressures and requirements of funding agencies and the donor community.** A regretful reality in the region puts most of the Arab countries (excepting the GCC) in need for external financial aid or loans to carry out infrastructure projects or performance improvement interventions. Obtaining such aid or loans has been in many cases contingent on applying external solutions to "home-grown problems" without looking into their suitability or even applicability in light of local conditions and working environment. These best practices are best customized to fit the local conditions and circumstances by no better than the involved stakeholders. Critical issues are best addressed first with a pragmatic approach accepting what is practically and politically feasible rather than the theoretical best solution.

- **Well designed and targeted applied research is actually essential for informed decision making on policy issues, but it is very much underestimated and ignored in this region.** There is a wide gap between policy related and operational decisions that largely impact the performance and success of WSS utilities, and between understanding the impact of such decision on the customers and on the service providers. This gap is best bridged by supporting the cooperation between scientists and researchers on the one hand, and policy and decision makers on the other. Decisions related to issues such as how best to support the poor, and what would be the optimal tariff system to apply, and what would be an optimal NRW level, need the right level of understanding and investigation and determination of requirements, most suitable approach, socio-economic impact assessment and repercussions, before they are taken and before policies and processes are established and endorsed.

- **Supporting the poor and underprivileged does not mean applying an ascending block tariff with a social first (or first two) block(s).** Understanding the challenges that the poor and underprivileged face in accessing WSS services is necessary before drawing the policies that tackle the situation of the poor. There are a myriad of other approaches that can be applied to that end, and that should be investigated and evaluated informedly.

- **Sustainability of services will only be possible through financial sustainability of the utility and never by government direct support or subsidies.** Experience has proven time and again that government support is never sustained and is never reliable. The definite result of ignoring cost of services and depending on government support is deteriorating infrastructure, low service levels, unhappy customers, and slipping down into the vicious cycle of deterioration. The key to cutting this cycle lies in opening communication channels with stakeholders through effective regulators and implementing awareness programs that engage stakeholders in important decisions linked to services delivered, costs entailed, revenues expected and associated consequences. Of course this will have to be supported and endorsed by the policy makers.

- **Having a quality system in place does not necessarily mean that processes are actually being implemented in an institutionalized manner.** Such systems are being established as preconditions in many cases, but lack institutionalization. The latter is driven by leadership commitment and an enabling organizational environment conducive to staff commitment and institutionalized implementation. Outdated administrative systems applied in public administration, red tape, "wasta" and favoritism are identified as the primary obstacles of improved organizational environment and resulting performance. Utilities in the region – although described as corporatized and adopting commercial principles in most cases, still suffer from such obstacles and will not move on to the next level before they are addressed.

2.7 Moving Forward

Supporting utilities management in the region entails working as previously described to strengthen two areas of impact: the policy and governance area (political, legislative, governance related, and regulatory), and the utility performance related area (technical, financial, commercial, institutional and otherwise). As a regional platform for WSS providers, ACWUA can play the role of catalyst for performance improvement in utilities in alignment with the association's role and mandate of improving WSS services in the region for the benefit of the Arab countries and population.

Given that a large part of successfully operating and managing WSS utilities is associated with improving performance on financial, institutional, and technical levels, ACWUA can facilitate arriving at such improvements by partaking in the creation of regional capacity that enables educated improvement programs and interventions that would positively impact performance and services provided. Accordingly, creating regional competence and developing inherent capacities is where the value lies in this respect. Several capacity development approaches are foreseen and reconfirmed by the UM TWG members for this purpose:

- Developing O&M manuals using unified standards following the international best practices and in accordance with the Algeria Declaration that resulted from ACWUA's 6th Best Practices Conference and that was supported by the Arab Water Ministerial Council of the League of Arab states.

- Regional capacity building, training and certification programs for water sector staff in areas identified as lacking in order to expand the current water operator certification program implemented by ACWUA and creating new priority training topics. The objective of this approach is providing specific training courses in specifically identified topics using adult learning methodologies, thereby increasing the knowledge and supporting the application of this knowledge whenever and wherever possible. The culture of certification would ensure setting operational standards that identify minimum requirements for acceptable performance and services provided. Examples include the utilities O&M certification program that has been – and is being - implemented by ACWUA in the region. Twinning programs among regional utilities on one side, and between regional utilities and other international utilities, taking into consideration similar settings and circumstances on the other side. For this approach a match making exercise will have to take place where strengths and weaknesses are identified and matched. Based on the matches made, twinning programs are developed and undertaken with associated improvement plans in the weaker utilities.

- Implementing situational analyses for the purpose of developing an accurate understanding and evaluation of a specific area under investigation. This will set the stage for the identification of improvement opportunities and planning for their implementation.

- Creating a regional task force that would carry out such a situational analysis, as well as engage utilities and other stakeholders in a participatory and complementary exchange of knowledge and experience, and develop specific action plans to implement improvement plans and activities.

Based on the outcomes and findings of the situational analysis at hand for utilities management in the region, specific areas in need of improvement were identified where specific targeted capacity building programs can be applied for specifically identified areas of intervention. Most notably under the umbrella of utilities management, the following areas/subtopics were identified as being in need of capacity building and strengthening programs in the region:

1. Developing regional capacity in AMM, NRW management and EE[24]. Going over the regional experience in the field of applied AMM, NRW management and EE practices, several shortcomings and mediocre levels of successful implementation can be attributed to lacking understanding of the basic concepts of the above listed topics and the associated best practices, as well as the weak capacity within the relevant institutions and organizations of implementing those best practices and identifying and applying the required resources—financial, institutional and otherwise. Accordingly, and by regional consensus, very well designed and tailored capacity building and training programs are needed to develop such capacity in the three topics.

2. Developing the knowledge in tariff setting and how to account for cost of service. Understanding the implications of setting the tariff vis-à-vis the entailed cost of service through applying proper costing and cost accounting approaches and techniques is very important to identify the revenues needed to sufficiently cover O&M, capital and any other costs that would lead to sustainable quality service delivery. Assessing this practice in the region and comparatively and thoroughly analyzing it in terms of applied approaches and preconditions for good tariff setting techniques would benefit the utilities due to the different levels of cost recovery attained by utilities, and how this impacts their financial health and sustainability. This would be optimally coupled with a program for a regional task force that would work closely with utilities to identify and analyze their costs and develop an informed and recommended tariff that would ensure sustainable service delivery.

3. Exchanging regional experience and applications in the area of billing and collection. This area has been identified as a potential area for exchanging regional experience through a twinning program or through a creating a task force that would look into current practices, and identify specific improvement mechanisms by improving on management and implementation, or through the introduction of tools and equipments such as Hand Held Units (HHUs).

24 ACWUA in cooperation with GIZ formed an EE Task Force that includes regional experts in WSS EE in order to develop EE guidelines/ manual to be used by utility operators and managers, in addition to developing energy audit requirements for water and wastewater utilities in the Arab region. The Task force is also working on developing EE PIs to monitor EE within regional Benchmarking programs that ACWUA is also implementing

3

GUIDING PRINCIPLES

3.1 Cost Recovery

One of the major challenges in maintaining and upgrading sustainable delivery of WSS services is the constraint of financial resources, for both investment and operations and long-term maintenance purposes. At this point in time, funding by governments international development agencies is becoming more and more constrained, thus creating the need to mobilize financial resources from the users through tariffs, consequently improving the prospects of financial sustainability. In addition, recovering costs, financial and economic, is desirable in the context of Integrated Water Resources management (IWRM). It also guides appropriate allocation of water resources and assures appropriate waste water management according to polluter pays principles.

The guiding principles for achieving cost recovery in WSS services can be grouped into five main elements of reform necessary to successfully and sustainably achieve cost recovery and subsequently improved service provision and satisfied customers:

A. The Economic, Policy, Legislative and Institutional Environment

- There should be a good understanding from national statistical information, of average household income per income group to get an evaluation of the level of affordability of WSS charges. In developing countries, the average household water and wastewater bills to average net disposable household income indicators are often quoted in the range of 3-5% (Managing Water for All: An OECD Perspective on Pricing and Financing; OECD; 2009).

- There should be a formal policy statement and related legislation regarding water resources and WSS services, particularly supportive of cost recovery, even if with a futuristic vision due to limitations in capacity and/or institutional setup. Without such commitment, attaining cost recovery will remain to be an elusive goal even if there is an earnest aspiration to implement it.

- There should be a proper institutional setup and clear articulation of responsibilities of the various organizations that impact the decision related to attaining cost recovery. Clear mandates, processes and responsibilities need to be in place in order to identify the responsibilities of all related entities in terms of estimations, calculations, supporting studies, recommendations and approvals.

- Policies, instructions and proper institutional setups for service delivery should also cater for financial viability and operational efficiency as a prerequisite to cost recovery goals. Developing effective and efficient service providers and a viable economic regulator to give independent reviews of cost of service is a critical aspect that is required to get all stakeholders (government, regulator, civil society, advocacy groups and most importantly utility customers) on board with the plans for cost recovery. This will also work to neutralize any political aspect of setting user fees as much as possible.

B. Clear Objectives for Cost Recovery and Services

- There should be two main objectives addressed within utilities to achieve cost recovery; namely (1) controlling costs and making the best use of facilities and manpower, and (2) increasing revenues through tariffs.

- The tariff structure should be prohibitive of high consumption; the approach is to charge on a consumption basis. However, this requires efficient metering operations and minimal illegal connections to the network.

- The tariff system used should deliver a positive return on capital, over and above operational cost and capital maintenance costs. This requires the implementation of accrual based accounting and the economic valuation of assets periodically. It also requires separation of costs on the basis of service provision activities and implementing fixed asset accounting.

- Sanitation services should also attain cost recovery, and sanitation can be directly related to water consumption. An integrated tariff system for both water and sanitation can be used, achieving full cost recovery for both systems.

- There should be an equitable distribution of benefits and access to services, catering for the underprivileged. In this sense, cross-subsidies can be utilized to provide the largest volume of benefits to the most deprived segments of society. Similarly, service differentiation can be used also to ensure full cost recovery while catering for the social objectives of providing services to all. In the end, there should be no sacrifice of financial objectives for the sake of social benefit; subsidies can be targeted directly (or even indirectly through public enterprises) to the poor by central government instead of jeopardizing the goal of full cost recovery in utilities.

- Tariffs should be reflective of service standards as well as operational efficiency. As such, service standards or levels of service and efficiency targets need to be clearly identified for the utility—this could be done by benchmarking against other national or international comparators. Specific indicators include service coverage percent (specifically for the underprivileged); number of hours of water supplied; NRW percent[25]; collection efficiency; staffing ratio (per connection). Building upon those targets, tariffs are set, taking into consideration the cost of service. If tariff required is too high, then revisiting the levels of service should be evaluated.

- Before setting a tariff system, an ability and willingness to pay study needs to be conducted, using a group of alternative levels of service (service differentiation) at different prices (price differentiation). This is especially important to decide on levels of service and reflective prices especially for the underprivileged.

C. Identified Revenue Requirements

- In order to identify revenue requirements, cost of service throughout the life cycle of system assets needs to be identified. WSS services entail three types of costs:

  - O&M costs, including expenditure on labour, power, chemicals, supplies, vehicles, information and communication services; overhead and institutional expenditures; bulk water purchases; and direct support costs such as licenses, and customer involvement costs.
  - Capital maintenance or depreciation costs, including any expenditure on infrastructure replacement or rehabilitation based on serviceability and risk criteria per proper asset management planning that includes having a current reliable and accurate asset registry, economic asset valuation, condition assessment and monitoring for assets and "repair, replace, rehabilitate" plans.
  - Capital costs (debt and equity), including amounts invested in constructing fixed assets such as hydraulic structures; electro-mechanical equipments; pipes, etc. It also includes any debt service involved.

- For sustainable service delivery, the first target would be to cover O&M costs through tariffs.

- It is essential not to discount the importance of depreciation costs in setting the tariff, as they represent the critical spending part to ensure continuous service on the long term. Failure to invest in depreciation leads to a steady degradation in service quality to a point where very high additional costs would be required to finance rehabilitation.

- A depreciation charge should be identified according to current asset management planning practices, and based on the current costs of fixed assets, updated to take inflation into account, and not the original historical costs.

25 Reducing leakage before considering additional capacity might be a priority objective; experience has shown that the additional capacity resulting from reducing water loss is a cost effective source of water which can be used to supply service extensions in low-income areas.

- Capital costs need to be identified along with any associated debt service or interest payments in the case of loans, or even dividends if applicable in the case of equity. This should cover a 20 to 50 year master plan for major infrastructure, with a review period of 5-10 years. Even when capital is provided by central government as a form of subsidy-without the need for dividends, they would best be included in the tariff so that the level of subsidy is transparent to users and civil society.

- Tariffs and subsequent billing and collection should allow for cash flow sufficient to pay for depreciation and meet debt repayment requirements. If those do not balance, utility financeability or cash flow issues will have to be addressed.

- All costs need to be projected into the future for proper revenue requirements identification-especially if current tariffs are not cost reflective, and where tariffs will need to be adjusted gradually. Change in cost over time needs to be catered for before taking into account any possible efficiency gains attained through possible future operational improvements. Customers need to be aware of the idea that tariffs need to increase to match inflation. Experience has shown that when customer resistance results in deferring inflation increases, revenue falls behind costs; capital maintenance is deferred resulting in poorer quality; maintenance is deferred leading to increased leakage; and power costs are not affordable in many cases such that intermittent supply becomes the norm.

- Having identified revenue requirements currently, future revenue requirements will be equal to current revenue in addition to a percent of this current revenue that caters for inflation, extended service coverage (taking into consideration the possibility of additional storage or pumping or increased treatment costs associated with new water sources), environmental quality enhancements, security of supply (storage and leakage reduction), improvements to service levels, and any possible efficiency gains-all in present value.

- Objective and unbiased specification of revenue requirements would involve an autonomous third party body-or even a professional, to determine fair and reasonable tariffs; economic regulators would be such a body, especially in the context of private sector participation. Within the same context, incentive based economic regulation has been used as a tool to guide utilities to the introduction of improvements in management and operations and cut costs, thus attaining efficiency gains.

- Several approaches can be considered to reduce costs, including revisiting service levels and standards, differentiating service standards, using benchmarks and metrics for operational optimization, improving billing and collection techniques, asset management planning, and even outsourcing specific services.

- Any subsidies-direct or indirect should be transparently and clearly specified, targeted and limited. Subsidies should be reflected on bills to educate the customers to the real cost of service, and therefore the value of water.

D. Considerations for Tariff Design

- When setting the tariff, the following key principles need to be addressed:

  - Revenue adequacy for O&M, depreciation and capital costs needed.
  - Equity and social fairness in differentiating between the different customer types or groups, and in recognizing the needs of the poor and underprivileged.
  - Managing water consumption through demand management of water resources and wastewater treatment and return charges based on the "polluter pays" principle.
  - Simplicity and enforceability.

- The main approaches to calculating tariffs are:
  - Fixed fee based on billed amounts;
  - Variable fee based on billed amounts;
  - Fixed fee based on a consumer characteristic such as household connection diameter;
  - Variable fee based on a consumer characteristic such as household connection diameter; and
  - A combination of all or some of the above.

- When there are conflicting principles involved (revenue adequacy, social fairness, water demand management, etc), a form of block tariff is recommended to differentiate between users based on amounts consumed.

- Where water supplies are intermittent and water available for an identified number of hours, metering is not cost effective, and fixed fees can be easily calculated. However, experience has shown that customers are more willing to pay for water bills that are based on metered consumption rather than flat rates. Consequently, wherever reasonable, volumetric user fees should be encouraged although they add to the O&M costs.

- Fixed fees are usually charged to large commercial and industrial users, who pay by metered volumetric use. Alternatively, a decreasing block tariff may be used to reflect reduced O&M costs per cubic meter associated with higher consumption. However, at all cases, provisions for higher future costs of service related to developing water resources need to be included within the tariff. Another approach for large users is using seasonal tariffs. It is however not recommended that such large users pay very high rates that eventually lead to subsidizing all domestic consumers—not just the poor, as this will negatively impact the economic activities of such consumers, and thus economic development in general.

- To cater for the underprivileged and poor segments of society, a "social block" is introduced with low tariff amount of water deemed sufficient to meet the basic needs for water (5 or 6m3 per connection per month) and can be delivered at an affordable price irrespective of cost, ideally with provisions to reflect household size and/or number of households per connection. As a best case scenario, prices for this social block should not be less than O&M costs to maintain the customers' understanding of the true value of water.

- In a large community, it is recommended to have a two-part tariff with a fixed meter fee (to cover customer related costs such as billing and collection and other administrative costs) and a volumetric fee (sometimes it would be a one block tariff in smaller communities). If water demand is an issue, the fixed fee should not exceed 15% of the revenue per customer as a general rule. More complicated multi-block tariffs are only needed when there are issues related to demand management or a mix of customers or difficult planning.

- Connection fees need to be paid by customers to cover – fully or partially - extensions of distribution and/or collection systems. There should be a difference between commercial, industrial, individual and low income connections. Catering for the underprivileged in this respect can be achieved through monthly installments or a two to five year period, as connection charges may prove to be a deterrent for those households to connect to the system.

- In cases on communal water sources that usually serve the poorer segments of society, are considered their only possibility of accessing safe water, consumption should be metered and cost can be shared out between households in the community per family, per individual or per property value. The common practice in utilities is to rent out such water sources to operators as an "individual concession", where operators buys water in bulk from the utility and has full control of the sources and sells water at fixed rates.

- In terms of charging for sanitation services, and where water supply is metered, sanitation service charges are charged for approximately 80% of the amount of water consumed. If water supply is not metered, cost can be calculated per household or in accordance to property characteristics. In terms of sanitation costs, collection, secondary treatment and sludge management, a general assumption is that costs amount to approximately 120% of water costs.

- As a norm, storm water should be the responsibility of the local authority or municipality and should be charged for as part of local taxes or other local fees. Because storm water in many cases mixes with wastewater, provisions for costs entailed should be agreed upon with the related municipal party per an established formula.

- Industrial wastewater and household septic tanks should be dealt with based on the principle of "the polluter pays", where tariffs should reflect the costs of transportation and treatment, which will be based on volume and characteristics and/or strength. As such, those characteristics need to be established for the various forms of wastewater—whether domestic or industrial, and a tariff set accordingly.

- Payment mechanisms need to be "little and often". Utilities should demonstrate flexibility and design an acceptable revenue collection system which allows for special mechanisms for the poor. Pre-paid metering is a mechanism that is based on time or volume. Experience has shown that low income families prefer pre-paid metering as it provides them with the sense of security in terms of amounts they pay for WSS services.

- A clear disconnection policy needs to be in place. Such a policy aims at enabling non-paying customers to return as quickly as possible to being good paying customers. Where there are arrears, the utility needs to allow for gradual re-payment in addition to current fees.

E. Planning for Cost Recovery and Periodic Review of Costs

- A cost recovery plan needs to be developed, based on identified revenue requirements that are based on full cost recovery. Similarly, a financing plan needs to be developed for capital investment needs using any available capital reserves or revenues or loans or any combination thereof. The plan should reflect tariff stability as well as equitable allocation of costs to current and future customers.

- To ensure sustainability of services, and as opposed to government subsidies, there should be within the financing plan - in accordance with applicable policies and regulations - a dedicated reserve fund to ensure that funds are set aside for capital investment in the future.

- Full cost recovery should be a part of the annual budgeting exercise. Accordingly, it should be updated annually to ensure full cost recovery annually. Specific cost assessments should be undertaken periodically to update costs to be recovered and establish procedures to set their levels. Customers should be involved and consulted in such studies and fully informed of any change that would be introduced as a result of such studies.

3.2 Serving the Poor and Underprivileged

WSS utilities are mandated with serving all their constituents, and need to cater most urgently for the needs of the poor and underprivileged. Meeting the MDGs is at the heart of fighting poverty, and in that context, meeting the WSS MDGs means halving the proportion of people worldwide who are without sustainable access to safe drinking water and basic sanitation by 2015. For WSS utilities this requires that they be in an environment conducive to reaching the poor and providing them with better services.

The following guidelines highlight the important elements of serving the poor and underprivileged. They are grouped under three main working areas:

A. Policies, Legislations and Enabling Environment

- It is essential for the success of any reform initiatives in the WSS sector to engage all stakeholders including involved public institutions, civil society, and the consumers. Engaging civil society organizations (CSOs) and consumer associations in specific will ensure that the voice of the poor and underprivileged is heard in planning reform and in developing policies and amending laws and regulations. Civil society stakeholders represent trusted opinion leaders and are considered effective channels to reach the urban poor, and vice versa. Special attention should be given to women in this respect, as they are often the "managers" of household incomes, and also of water consumption within their households. Consumer associations are direct representation from all segments of society, and offer a channel for direct consumer engagement in WSS service improvement. Establishing two-way interactive communication is an approach to create a relationship with those stakeholder using mechanisms for public participation such as forums.

- It is essential for the poor communities and underprivileged to successfully engage in planning and in any effective dialogue with the policy makers and utilities, to be informed and knowledgeable with regards to the applicable policies laws and regulations. For that to take place, educational programs that provide the poor with such types of information and knowledge, as well as skills that they would need to participate as well-informed productive citizens, are necessary for their participation in planning and management of services.

- Attending to the needs of the poor should be addressed within national policy, and specifically in WSS policy statements. Barriers to serving the poor should be investigated and identified, and suggestive strategies to removing them articulated, and explicit reference to the particular needs of the poor and underprivileged should be in place in national policies and supporting laws and regulations, that are clear enough for utilities to act on them. Incentives mechanisms should be established with clear time-bound performance targets set for them that are related to serving the poor, even if in the form of a performance contract.

- Two main policy related issues that impact providing services to the poor on the municipal level are related to (1) unplanned and/or illegal areas where the poor reside, and (2) the lack of proof of land tenure which in many cases prohibits the utilities from providing services. Clear rules should be established that would enable the utilities in delivering services to the poor in such circumstances:

    - In the case of unplanned and/or illegal areas, intermediate solutions that allow for service delivery can be applied, such as agreements that enable utilities to deliver services for a specified period of time while suitable planning time horizons are considered – if not to remove this restriction on services to such places altogether as a form of regularization.
    - In the case of the lack of land tenure, which is considered in many cases as a prerequisite to obtaining WSS and other services due to the commercial risk involved, alternative risk reducing measures can be used such as deposit payment. Another approach would be to allow for alternative documentation such as lease agreements or other "proof of occupancy" documents.

- The institutional arrangements that enable informed policy making should be in place in relevant institutions, where data and information about the poor and their access to WSS services is gathered, documented, analyzed, and used to inform policy making and the amendment of relevant laws and regulations.

- Addressing the needs of the poor in financing strategies is essential to achieving policy objectives and meeting targets for improved services to the poor. Identifying and establishing specific goals and targets related to expanding services in identified poor areas (even if they are informal) will guide the allocation of funding – internal or external – to those areas. Constraining policy, regulatory and legal factors to allocating external funds to such areas need to be highlighted and addressed, or internal funding or funding through non-governmental organizations (NGOs) that work outside the formal administrative framework can be used instead.

- A very important instrument for serving the poor and underprivileged is the WSS services pricing policy, tariff structure and targeting subsidy. It can be used to improve affordability for the poor; subsidize connections and finance on-site sanitation in many cases. It must not however jeopardize cost recovery at any rate as this will eventually lead to deteriorating service standards which primarily affect the poor. Several aspects of pricing policy and tariff structure should be taken into consideration:

    - Pricing policies in place need to ensure that there is no reverse cross-subsidy (i.e. charging the poor more than better-off consumers). In terms of subsidy, direct targeted subsidy to the poor is a better instrument than subsidizing the service itself as this will ensure it reaching the rightful recipient.
    - In terms of service connection fees, it was found that in many cases they are prohibitively high, and as such, if a subsidy is considered, it would be most beneficial when applied to such connections. Alternatively, another solution would be to allow for spreading the cost in installments over two to five years. All such solutions will require a clear identification of the poor through clear criteria that are defined for identifying poor customers.
    - In terms of service fees, a social tariff block is usually used, although it not only serves the poor, but also low level consumers, which is supportive of demand management. However, such social blocks do not serve large poor households or an arrangement where more than one poor family uses the same meter. Ideally, provisions for such cases need to be in place, such as identifying the poor and linking the first block consumption limits to a certain poor household characteristic such as number of family members or household income. In cases of non-metered consumption, care should be taken not to overcharge the poor by billing based on estimates. It would be also necessary to consider the trade-offs between introducing universal metering and defining improved methods of tariff differentiation, based on geographic location or household characteristics.

B. The Regulatory Environment

- To enhance the regulatory and monitoring function of the regulator – no matter where this function actually resides (in a public institution or as a separate regulatory body), proper institutional capacity is required, with access to information that enables effective monitoring and that reflects local circumstances that are needed to set service standards and clear targets and indicators. Information on quality and levels of service in poor areas are also needed by the regulator for monitoring purposes. Where the regulator capacity does not allow for obtaining such information, the assistance of NGOs and consumer or professional associations can be used.

- Appropriate technical standards and service levels and associated targets are a critical element of any strategy to improve service delivery to the poor. Efforts should be made to increase the range of service options available to low-income households in the form of service differentiation (such as using public standpipes), while ensuring that quality is not compromised. Regulatory frameworks must be adapted accordingly and, where appropriate, alternative regulatory arrangements should be linked to consumers and even small scale providers who are working outside the scope of monopoly of the operating utility. In this sense, standards and associated targets should not be restrictive, and they should be supported by incentives such as subsidies or funds for example, to encourage utilities to carry out whatever can be achieved before penalizing them for what can be out of the scope of their control in terms of financing.

- In terms of service quality standards, a solution that can be considered as a sort of service differentiation is adapting quality standards and providing innovative solutions based on cost and benefit analysis, all the while not impacting the welfare of the poor. Examples would be providing water at lower pressures to poor households that are located in an area that allows for lower pressure water to be delivered, and providing them with roof tanks.

- Small scale service providers might be able to cover a service gap that involves the poor, and that utilities cannot cover due the lack of economic feasibility. Such providers can prove to be very beneficial to the poor once they are regulated and legalized, optimally in the form of a professional association such as an association for water vendors for example. Such an association will lead to establishing common rules and procedures in conformance with regulatory requirements; recognizing and protecting small businesses within the regulated framework of operation; and creating a forum for cooperative dialogue between public institutions, the utilities and the small scale service providers eventually in the best interest of all involved parties, in addition to the poor. In all this, proper measures should be taken by the regulators to avoid collaborative action on the parts of such associations that could disadvantage the consumers—most importantly the poor and underprivileged.

- Public-Private Partnerships (PPPs) in WSS sector can be used a tool for serving the poor and underprivileged. To that effect, it is essential that the regulatory arrangements, the bidding process and applicable laws and regulations do not affect service outcomes that target the poor. This can be done by implementing a partnership with arrangements that protect the interests of the poor by carefully designing a contract that does not impact the obligations, ability and financial incentives of the private partners to serve poor households. In that respect, contract objectives that involve delivering services to the poor should be clear and easily measurable. Any policy or regulatory barriers to extending services to the poor should be eliminated, such as service boundaries that exclude poor areas, or the need for proof of land tenure before delivering services, or strict service or quality standards that prohibit delivering services to the poor such as the possibility of service differentiation and price differentiation or other innovative solutions. Financial incentives can be designed in association with service expansion or improvement objectives linked to servicing the poor. Of course a clear identification of the poor through specific criteria should also be included within the contract.

C. Strategies for Service Delivery to the Poor and Underprivileged

- On the institutional level within the utilities themselves, specific corporate policies and business plans should establish pro-poor objectives (e.g. specific service objectives and targets) and approaches to achieving them. Such corporate policies should build on the national pro-poor policy, but also be able to cover any specific gaps within.

- In line with corporate pro-poor policies and strategies within the utilities, developing a specialized unit or skilled team focusing on improving services to the poor and underprivileged has been successful in establishing direct communication channels with the poor and underprivileged and obtaining all necessary data and information for the design of pro-poor policies, strategies and service delivery programs; designing targeted WSS service delivery programs; and monitoring and measuring outputs and impacts of such programs.

- Overexploitation of water resources eventually results in dwindling supplies, and the need to develop new water resources that are costly. This translates to higher costs of service, and consistently the need for higher service prices. To counter this impact, utilities should develop strategies to reduce water loss and encourage the adoption of water saving technologies and low cost sanitation at the household and community levels.

- Where conventional water and sanitation service delivery systems cannot be used in poor areas due to cost or other environmental or location related factors, other alternative technology methods can be used and in fact were successfully used across the globe. Examples include on-site sanitation options; condominial sewerage systems (service is provided to a group of houses using smaller pipes at shallower grades resulting in cost savings); bulk sewerage (a sewerage connection system provided at the boundary of the poor community into which community–managed system is discharged); rainwater collection systems; utilizing large storage tanks in poor communities to increase hours of supply in case of unreliable or intermittent supply; bulk supply to a community tank that provides supply to an internal community distribution system; relaxed standards (e.g. installing pipes and connections above ground); street or block metering for water supply (installing meters at the end of each block or street instead of metering each household) and billing based on average consumption; etc.

- An approach to be considered to encourage the poor to pay for their WSS services is to introduce frequent collection of fees. This can also be facilitated by recruiting the services of community representatives who collect the fees on a periodic agreed upon basis (e.g. weekly, or bi-weekly even) and pay them to the utility on behalf of the poor customers.

3.3 Non-Revenue Water Management

Water scarcity is one of the most important challenges that the MENA region is facing. Ensuring safe, sufficient and affordable water supply is becoming a priority for decision makers. Increasing population, economic development and urbanization with the region is putting more and more pressure on the already dwindling water resources. Governments and utilities are finding more and more difficult and costly to develop new water resources.

Further exacerbating the problem is the high levels of water being lost within delivery systems due to actual leakage, or due to unbilled distributed water-the combination of which is referred to as NRW. In 2006, the World Bank estimated that on average, 40-50% of water produced in developing countries is NRW. This not only puts a huge amount of pressure on water resources; it also results in a heavy financial burden on the shoulders of utilities that are losing income and incurring unnecessary cost with every cubic meter produced and not billed.

The following guidelines highlight the important elements of managing NRW in terms of the enabling environment governing service delivery; institutional and management related factors within the utilities; and last but not least technical aspects of managing NRW:

A. Enabling Environment

- Successfully managing NRW is as much a matter of good governance as it is technical; setting the right framework for autonomy and associated accountability and transparency within the utilities - starting with the head of the organization, and going down the hierarchy to heads of departments – is essential for the proper management of NRW reduction efforts, and for the empowerment of utility staff to do their jobs efficiently with well identified responsibilities and targets.

- Provisions – legal, regulatory or otherwise – should be made so that the decision making power rests with the right group of stakeholders who are involved and rightly aware of the volume of NRW and its impact on the utility's bottom line and its ability to sustainably deliver its services to the satisfaction of its customers. This should off-track political pressures that are driving the decision making process down a path where water theft remains unpunished due to political interests, and where disconnection from the system is not permitted also for political reasons related to power plays and personal interests.

- Stakeholder engagement and awareness is essential to the success of NRW management. Stakeholders targeted should include politicians, government officials, municipalities, community leaders, customer representatives, etc. Awareness programs should be designed and delivered to develop the proper understanding of NRW, its reasons, and its impact on the water resources, on the utility, and subsequently on the levels and quality of services provided to customers. The programs should also educate stakeholders on what their roles can be in reducing water loss, such as reporting leaks and refraining from illegal water use.

- Decision makers in utilities will only have the right incentive to take decisive actions to manage NRW and reduce water loss when they become aware of the size of the problem and its impact not only on the quality of service provided and customer satisfaction of the lack thereof, but also on the costs incurred due to NRW (and accordingly the cost saving potential), as well as the lost revenue due to unbilled water produced due to meter inaccuracies or water theft. It is therefore imperative that NRW is estimated in terms of amounts and money as well (i.e. the cost of NRW = O&M costs incurred for the production of water that is lost + lost revenues due to NRW).

- Engaging the private sector for reducing water loss has been proven to be successful throughout the world, especially in publicly owned water utilities. The most favored applied model of partnership is performance-based contracts. This type of arrangement allows the private sector to carry out a comprehensive NRW reduction program with sufficient incentives and flexibility within a framework of accountability for results. The important issues to consider when designing such a contract would be to provide the private partner with sufficient flexibility in carrying out the required interventions; to set educated and realistic targets that are based on a good understanding of the system baseline, to assign associated suitable incentives; to ensure that knowledge transfer to and capacity building of the utility staff is included within the arrangement; and to carefully allocate the risks involved between the contractor and the contracting authority and introducing a fixed fee component and a performance based component, where the better the available information about the system the higher the performance based component.

B. Institutional and Management Related Issues

- Within the right setup encouraging autonomy, accountability and customer orientation, a framework for incentives needs to be applied for the head of the utility, his management team as well as utility staff members. A well designed incentive scheme linked to well-established and identified performance targets would be a prerequisite for the design and successful implementation of a water loss reduction strategy.

- Knowledge in NRW management and water loss reduction is more based on actual experience in the subject, exchange of knowledge available among peer engineers and technicians and through interaction with practitioners and technology developing entities such as private sector contractors. This knowledge base and capacity is not easily found in utilities in the region. It is therefore a priority to develop capacity building programs (including training materials, methods and institutions as well) for managers, engineers, skilled staff and even technicians on the topic of NRW management and water loss reduction.

- NRW management and water loss reduction is a continuous process that should not start at one point and end at another. It is therefore essential that the utility management and decision makers demonstrate a non-wavering long-term commitment to the implementation of an NRW management initiative or program with all what it takes in terms of institutional capacity, organizational development, technical aspects and financial resources. As a general rule, it is realistic to say that any successful endeavour to address NRW will take a five to seven year program to start with, and then to sustain any positive outcomes from such a program, provision must be make institutionally to committedly and consistently continue on with such a program.

- Being at the core of business of water utilities, NRW management should be high on the board of the utility head as a number one priority. It is essential therefore to dedicate resources to this activity by dedicating qualified staff with proper processes, tools and systems in place. This would be best achieved by establishing a unit specific for the purpose of NRW management with assigned staff and budget. And due to the importance and criticality of the subject of NRW, such a unit should not be lying at the end of the authority ladder under the umbrella of another organizational unit; rather it would best be placed under the direct supervision of the head of the utility or his deputy. Careful estimation of required budget needs to be conducted annually according to a NRW management strategy that needs to be developed and implemented within the utility.

- One of the main reasons for unsuccessful NRW management interventions most often is the tendency for the different functional/organizational units within the utility to operate as silos. This lack of complementarity of objective and integration of functions leads to conflicting priorities and the unavailability of pertinent information when and as needed. Lack of cooperation between the staff members of the different units due to such lack of complementarity is yet another obstacle to successful NRW management. It is therefore essential to design business processes, work and data flows, and management information systems in a way that ensures integration among the different units and unified objectives and assigned targets that take into consideration the type and nature of operations in each unit, and the ensuing challenges that ultimately affect the success of everyone.

- One of the main factors supporting proper NRW management is the implementation of good practices of asset and maintenance management. In summary, asset management means proper mapping and profiling of the system in terms of location, type of asset, material, age, condition, etc in a GIS based asset registry. It also means establishing a history of such assets including leakage events in pipes, faulty metering in meters, valves and fittings, related maintenance activities, etc. Utilizing an asset management platform along with other tools to monitor the performance of the networks enables the use of assets history and monitoring data to identify swiftly areas and causes of commercial or physical water losses within the system. In summary, good asset management practices translate to – among other things – asset condition monitoring, identification of risk associated with failure, and reduced O&M costs, proactive leak detection capabilities, improved meter readings, and reduced NRW levels.

- It is essential for the success of any NRW management strategy to engage the utility staff as well as all stakeholders – and most importantly – the utility constituents by developing a communication and an awareness building campaign whose objective is to educate all stakeholders to the importance of managing NRW, and to the plan activities and components and timeframe for implementation, and highlight the impacts of implementing it on water resources and on the quality of service the utility is providing, and in order to gain support for the important and effort and resource-laden program it is embarking on.

C. Technical Aspects

- The most important prerequisite to successfully managing NRW is acknowledging the existence of NRW and reporting it correctly. Beyond that, solutions are available to address all types of water loss. It is therefore imperative that water utilities actually report NRW as it actually is without dolling up the facts. At this point, it is essential to establish the amounts of water actually lost, and where they are lost. Experience showed that NRW data is very often not reliable because there is no institutionalized way of measuring and reporting this data. Provisions should be taken so that very clearly defined, well established NRW calculation related data are specified—including the financial and economic aspect of it to calculate its cost, and that a process is in place for measuring and reporting them on a periodic basis. Some of the data might prove to be difficult to measure, in which case very clear and documented and institutionalized methods for estimating them should be developed and used.

- As previously mentioned, the first step to any NRW management strategy is identifying how much water is lost. For that, international best practice refers to the International Water Association (IWA)'s standard water balance structure and terminology (Figure 4 below). The Water Balance below includes the system input volume on the one hand, and on the other hand, the types of consumption: authorized—billed (metered and unmetered), and unbilled (metered and unmetered); and all identified types of water losses (apparent and real).

<table>
<tr><td rowspan="9">System Input Volume</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Metering Inaccuracies and Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to Point of Customer Metering</td></tr>
</table>

Figure 4: Standard IWA Water Balance[26]
(Source: IWA Water Loss Task Force)

- Calculating how much water is lost and where requires that each component in the water balance is also calculated. Table 9 below summarizes best practices in calculating the water balance components.

26 See more detailed descriptions of each component and their measurement in the IWA reference manual by Farley, M. and S. Trow, 2003, "Losses in Water Distribution Networks—A Practitioner's Guide to Assessment, Monitoring, and Control" IWA Publishing: ISBN 1 900222 11 6. http://www.iwapublishing.com/template.cfm?name=isbn1900222116.

Table 9: Calculating and/or Estimating Water Balance Components
(Source: IWA Water Loss Task Force)

Component	Calculation/Estimation	Comments
System Input Volume	Measuring system input by meters and verifying using portable flow meters. If no metering of input, using portable flow meters, reservoir drop tests, or analysis of pump curves, pressures and average pumping hours.	Average billing cycle must be factored into NRW calculations to ensure that time period used for the consumption volume measurement matches the production meter volume measurement.
Billed Metered Consumption	Extracting data from utility billing system for all types of consumers (domestic, commercial, industrial, large consumers, etc).	
Billed Unmetered Consumption	Extracting data from utility billing system.	As those are estimated, sample monitoring and temporary metering of consumption is recommended to verify numbers.
Unbilled Unmetered Consumption	Identifying components of unbilled unmetered consumption and individually estimated according to type and frequency and duration of use.	Usually constitutes of amounts used by utility in operations such as flushing, fire fighting, etc.
Unauthorized Consumption	Using estimates that are based on clear assumptions that can be easily checked and modified.	
Metering Inaccuracies and Data Handling Errors	Representative sampling of meters and performing accuracy tests to estimate average inaccuracy values for different user groups.	Composition of sample should reflect the differences in meter brands and meter age groups.
Real Losses (by calculation)	Calculating: NRW – (Unbilled Authorized Consumption + Apparent Losses)	Recommended to verify figures by one of two methods: (1) Component Analysis (top-down assessment); or (2) Minimum Night Flow (MNF) Analysis (bottom-up assessment); or both.

Component	Calculation/Estimation		Comments
Real Losses (by estimation – top-down)	Leakage and Overflows at Utility's Storage Tanks	• In case of overflows, each event is handled by evaluating duration of overflow and estimated flow in and out of the reservoir. • In case of leakage, a level drop test is utilized.	
	Leakage on Transmission and/ or Distribution Mains: three types (refer to in Figure 5 below):	1. Background[27]: Mains: 9.6 Litres per km mains per day per meter pressure. 2. Unreported: number of bursts x average leak flow rate x average leak duration; if average leak flow rate is not measured, then use 240 Liters per hour per meter pressure for mains (IWA Water Loss Task Force). 3. Reported: number of bursts x average leak flow rate x average leak duration; if average leak flow rate is not measured, then use 120 Liters per hour per meter pressure for mains (IWA Water Loss Task Force).	Average pressures should be calculated as a 24-hour value for the system.
	Leakage on Service Connections up to Point of Customer Metering, three types (refer to in Figure 5 below):	1. Background[28]: (1) Service Connection (main to property boundary): 0.6 Litres per service connection per day per meter pressure ; and (2) Service Connection (property boundary to customer meter): 16.0 Litres per km of service connection per day per meter pressure 2. Unreported: number of bursts x average leak flow rate x average leak duration; if average leak flow rate is not measured, then use 32 Liters per hour per meter pressure for service connections (IWA Water Loss Task Force). 3. Reported: number of bursts x average leak flow rate x average leak duration; if average leak flow rate is not measured, then use 32 Liters per hour per meter pressure for service connections (IWA Water Loss Task Force).	Average pressures should be calculated as a 24-hour value for the system.
	Excess Losses	Excesses losses = Real losses (from Water Balance) – Real losses (from top-down analysis)	When Excess losses = 0, then assumptions used in water balance are good enough to provide results consistent with top-down analysis. In case of discrepancy, revisit assumption in water balance and in top-down analysis to improve results.
Real Losses (by estimation – MNF)	24-Hour Flow Measurement	Measure flow rates and pressure (inlet, average pressure points and critical pressure point) for a sample of DMAs or temporarily isolated areas for 24 hours.	Data to be registered along with length of mains, number of service connections, number of households and other consumers. This is to be used to apply the Fixed and Variable Area Discharge (FAVAD) method for day time leakage rates determination.
	MNF Analysis	1. Real loss at MNF = assessed amount of legitimate night consumption in area – MNF measured. 2. For daily losses apply FAVAD[29] principles (Lambert, 2001) and simulate leakage over the full 24 hour period. 3. Compare results to Real Losses from Water Balance and from top-down analysis.	MNF is not recommended for intermittent supply, as supply during night time continues because of the use of roof-top storage tanks.

27 General guidelines developed by IWA Water Loss Task Force
28 General guidelines developed by IWA Water Loss Task Force
29 Leakage Rate L (Volume/unit time) varies with Pressure P (L1/L0 = (P1/P)N1; when N1 is not known, use the value 1 for it.

Figure 5 below depicts the three types of leakage and leak duration phases (gaining awareness of the leakage; locating the leakage; and repairing the leakage) as:

- Background (undetected) losses: small leaks and weeps that cannot be detected and therefore not reported. They continue to exhibit a very low flow rate until they worsen to a point where they become detectable.
- Unreported (detected) leakage: small leaks that are detected due to proactive leak detection efforts on the part of the utility staff.
- Reported leakage: leaks apparent to the public and are reported to the utility for repairing.

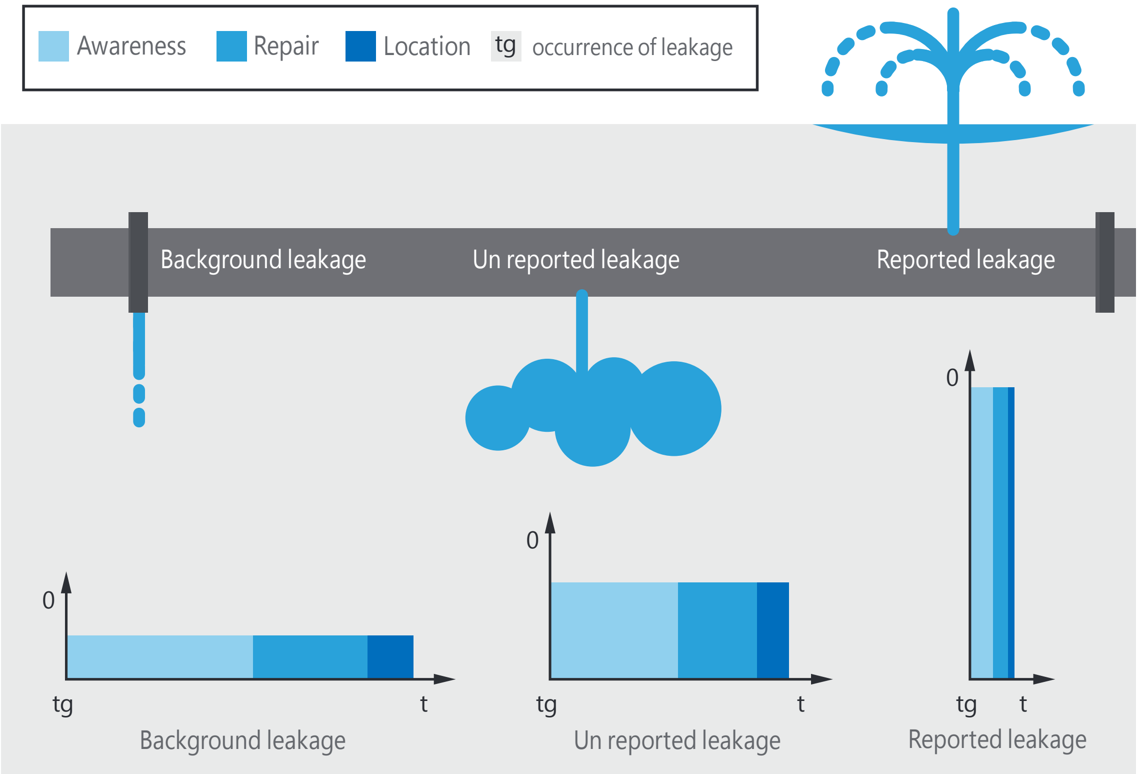


Figure 5: Types of Leakage in Mains and Distribution Networks
(Source: Guidelines for Water Loss Reduction, GIS & VAG)

- The establishment of DMAs is essential for proper management of NRW and for better management of the system as a whole. It is implemented by dividing the system into smaller zones (generally between 1,000 and 2,500 connections are included within each zone) that are hydraulically isolated with well established boundaries and no inter-linkages. Pressure monitoring and control as well as flow measurement is introduced at strategic points, to enable proper monitoring of pressure and flow, and pressure optimization to reduce leakage.
- Although intermittent supply in many cases in the MENA region is used as a solution to water scarcity, but it definitely is a short term solutions that leads to the disruption of service; dissatisfaction of customers; and most importantly the quicker deterioration of mains and distribution network and by consequence a large increase in the number of leaks (detected and undetected). Intermittent supply also leads to substantial damage in the metering and pressure monitoring and control equipments such that proper monitoring of the system becomes more difficult to achieve. In terms of calculating

real losses, MNF is not advisable as it does not represent the normal supply behavior in the network, as with intermittent supply, customers tend to use water tanks (on street level or on the roofs) and this continues night and day as long as the supply is running.

- Experience has shown that intermittent supply does not reduce water consumption; in fact, increased system input volumes were registered after intermittent supply was used without corresponding increases in customer consumption—signifying an increase in leakage. Similarly, the number of reported leakage events increased after intermittent supply. This all leads to increasing the amount of supply, which is not consistent with resorting to intermittent supply in the first place, as well as increased cost and lost revenue. It is therefore not recommended to resort to intermittent supply, and in case it is applied, plan to resort to continuous supply to avert such losses in water resources, in financial resources and in service levels and associated customer satisfaction.

- In cases of introducing continuous supply after intermittent supply, it is recommended to apply the process gradually by establishing a number of DMAs that gradually use continuous supply. Once consumption is stable in these DMAs, input volume will decrease, the utility should implement leak detection activities to reduce water losses to an acceptable level, creating spare supply capacity that can be used in other areas. Once this first group of DMAs is successfully supplied continuously, another group of DMAs is established and gradual conversion to continuous supply in the same manner is implemented.

- NRW is most frequently used as a PI that reports the amount of water supplied as a percentage of the amount of water billed. However, this is not always the most appropriate PI to represent NRW. Various types of NRW are best represented by different PIs and based on the function of the PI as follows in Table 10 below:

Table 10: Non-Revenue Water (NRW) Performance Indicators (PIs)
(Source: IWA Water Loss Task Force)

PI	PI Function	Calculation	Comments
NRW (by volume)	Operational	Volume of NRW (% of system input volume)	Can be calculated by water balance, not reflective of types of losses.
NRW by cost	Financial	Value of NRW (% of annual cost of running system)	Allows different unit costs for NRW components.
Apparent Losses	Operational	m3/service connection/year or m3/km mains/year (only if service connection density is <20/km)	Useful for target setting, not very useful for comparison between systems.
Real Losses	Operational	Liters/service connection/day or Liters/km mains/day (only if service connection density is <20/km) >	Useful for target setting, not very useful for comparison between systems.
	Operational	Liters/service connection/day/m pressure or Liters/km mains/day/m pressure (only if service connection density is <20/km)	Useful for comparison between systems
	Operational	Infrastructure Leakage Index (ILI) (Ratio of current annual real losses to unavoidable[30] annual real losses)	Most powerful indicator for comparisons between systems

- It is essential when embarking on any NRW management program, to set realistic targets taking into consideration the baseline values as well as the cost effectiveness of reducing water loss. The target NRW should not be chosen arbitrarily; it should be based on a comparison of the cost of water lost (O&M cost for real losses plus lost revenues for apparent losses) versus the cost of implementing NRW reduction activities. There will be a certain point in time when the cost of NRW reduction activities exceeds the cost of water lost, at which point, it becomes no longer feasible to undertake activities that would lead to further reductions in NRW. The only reason why further NRW reductions are carried out would be to deal with very scarce water resources, in which case the difference in cost should be funded externally.

- The two main components of water lost are real losses and apparent losses, and developing any NRW management program entails the following strategies as included in Table 11 below:

30 According to the IWA Water Loss Task Force, the Unavoidable annual real losses(liters/day) = (18 x Lm + 0.8 x Nc + 25 x Lp) x P, where Lm = mains length (km); Nc = number of service connections; Lp = total length of private pipe, property boundary to customer meter (km); P = average pressure (m).

Table 11: Types of Water Loss and Related Reduction Strategies
(Source: Compiled by Author, 2014)

Type of Water Loss	Intervention/Reduction Strategy
Real	Pressure management: Pressure and leakage flow are directly proportional, that is why lowering the pressure in the system leads to lesser leakage. This is done by all the below collectively: 1. Establishing properly monitored DMAs. 2. Continuous monitoring of flow and pressure at zone inlet, average zone point, and critical node points. 3. Modeling flow and pressure data to identify the needed control valves, variable speed pump controllers, break pressure tanks, and Pressure Reducing Valves (PRVs), and where to place them, and what would be the optimum pressure applied within the system.
	Active leakage control: This is necessary to monitor water loss and successfully locate detectable and unreported breaks within a monitored DMA. This is done by all the below collectively: 1. Metering the DMA flow, most optimally automatically using SCADA to discern leakage patterns. 2. Pinpointing leaks within the networks by tracking noise of water leaking from pressurized pipes using data loggers, leak noise correlators, ground microphones, sounding sticks, ultrasonic detectors, using tracer gas, etc.
	Proper asset management practices: this leads to accurate and detailed mapping of the system along with pertinent information (e.g. age and condition) using a GIS based asset registry and employing GIS maps, and monitoring assets performance and life cycle costs, which enables risk based decision making in terms of repairing, replacing or rehabilitating assets, thus minimizing associated cost.
	Speed and quality of repairs: by quickly tending to any reported or detected leaks, the duration of leakage is reduced, thereby minimizing the real losses. Quality of repairs is also essential to avoid any recurrence of breaks.
Apparent	Reducing meter errors and under-registration: 1. Monitoring water quality to ensure that no sediments build up in the pipes and meters, causing inaccurate and lower than actual readings. 2. Avoiding intermittent supply and making provisions to go to continuous supply, because intermittent supply negatively impacts the meters due to the sudden pressure variations the system is exposed to, which leads to damage in meters and inaccuracies in readings. 3. Linking and continuously updating information about customers within the CIS with the GIS database, including data about location, land plot identification, meter per account, etc. using a proper identification or classification code that is consistent within the CIS and the GIS. 4. Using the proper meter size, based on consumption levels and patterns. This will ensure that the water flowing is accurately being registered in the meter. 5. Using the suitable class and type of meter, based on water quality parameters, whether the supply is intermittent or continuous and whether roof tanks are used. There are various types of meters, and it is essential that the right type of meter is used to avoid any inaccuracies or under-registration due to using the wrong type of meter. 6. Implementing a proper meter maintenance and replacement plan regularly, where meters are installed above the ground for easy reading. Continuous check-ups of conditions of the meters should take place, and replacements should be done based on condition. 7. Carrying out regular monitoring rounds for meter tampering to avoid errors in readings, and taking corrective actions and implementing penalties in such cases to deter such behavior. 8. Developing a routing system that is based on the information within the GIS and CIS databases that link the customer with the meter installed along with its location and previous history of account and meter readings, etc.
	Controlling illegal water use and water theft: 1. Carrying out and reporting on regulator inspections on meters to check for possible meter bypassing, tampering with the meter seal, etc. This is coupled with a flow balance analysis in such suspected cases. 2. Conducting and reporting on periodic checking rounds on customers, verifying customer information and all registered and unregistered customers. 3. Conducting and reporting on periodic rounds on system zones where any types of illegal activities are suspected and enforcing penalties on those who are caught. 4. Rotating meter readers to different routes on a regular basis to avoid any possibility for collusion between meter readers and customers. This is in addition to intensifying supervision and carrying out spot checks.
	Reducing water accounting errors: 1. Training meter readers to improve their skills in meter reading. 2. Automating the meter reading and billing process as much as possible to avoid related human error. Possible tools include electronic meter reading and bill issuing devices that automatically and wirelessly transfer data to the utility billing software. Other tools that can be used especially with commercially large customers are remotely controlled smart meters. 3. Using billing software that has the capabilities to detect potential data handling error and report such cases.

- Developing a NRW management strategy entails carrying out the water balance and undertaking specific interventions to reduce the water loss and improve billing and collection. It is essential that the data required to implement a water balance (or the suitable assumptions) are made available within a utility, such as system input volume, meters readings, flow rates and pressures within the system, number of service connections, length of pipes, materials of pipes and age and condition of pipes and meters, maintenance history, etc. Using information systems for such data is widely used in utilities, and in fact is an essential part of acquiring and managing all the data that is needed to support the decision making process within the utility. Such systems include a GIS database that includes all assets and their profiles (material, size parameters, age, condition, location, etc); customer information system (CIS) that includes data about customers (meters locations, land plots, etc) and that is linked with the GIS; Hydraulic modeling systems that include DMA data (boundaries, design of system, flow and pressure points, leak detection and repair history, etc). The value of all this data lies in integrating the functionality of all those information systems by consolidating and analyzing them within a single – most optimally GIS-based – decision support system.

- Prioritizing NRW reduction interventions should be based on the results of the water balance and the evaluation of its various components, and taking into consideration the cost-effectiveness of the applied method or intervention. When the primary objective is to attain water savings due to the severe water shortage conditions then reducing water loss would be given priority—provided that the specific planned intervention proves to be cost effective. Alternatively, when the primary objective is improving the utility's financial situation then commercial losses are given priority. Figure 6 below provides the decision makers with general guidelines for prioritizing NRW reduction interventions based on volume and cost.

		Cost		
		High	Medium	Low
Volume	High	Leakage on mains (P) Leakage on service connections (P)	Unauthorized consumption (C)	Unbilled metered consumption (U)
	Medium	Customer meter replacement (C)	Customer metering inaccuracies and data handling errors (C)	Pressure management (P)
	Low	Reservoir leakage (P)	Unbilled unmetered consumption (U)	Reservoir overflows (P)

NRW Type: U=Unbilled authorized consumption; C=Commercial losses; P=Physical losses

Figure 6: Prioritizing NRW Management Activities based on Volume and Cost
(Source: Farley, M. et Al, The Manager's Non-Revenue Water Handbook, 2008, USAID)

3.4 Asset and Maintenance Management

According to British Standards Institute (BSI)'s Publicly Available Standard 55 (PAS 55) for optimized management of physical assets (one of the world's most renowned resources on asset management best practices), asset management is defined as the "systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks, and expenditures over their life cycles for the purposes of achieving its organizational strategic plan".

According to the Institute of Public Works Engineering Australasia (IPWEA)'s International Infrastructure Management Manual (IIMM)—another authority resource on the subject of asset management, it is defined as "The systematic and coordinated activities and practices of an organization to optimally and sustainably deliver on its objectives through the cost-effective life cycle management of assets".

Applying AMM best practices in a WSS utility leads to several benefits on several levels; financial, operational, service levels, etc. Most importantly, AMM improves the ability of utility top management to explain and defend budgets and investments based on information available on asset conditions, risk analysis, consideration of impacts on service levels as well as social and environmental impacts, and in relation to the utility business plan. It helps the top management focus on priorities proactively as opposed to depending for future capital plans on previous system performance. It also improves the ability within the utility to balance between capital and operating expenditures for optimal performance.

Below is a compilation of industry best practice in AMM on two levels:

A. The Institutional Enablers

- Implementing AMM best practices is not an easy mission, and requires the full endorsement of the utility top management as well as the staff members—it is a combination of a top-down and bottom up approach to implementation that is needed for its success. This is achievable when top management fully support this initiative in the utility by committing to it in front of the utility board with a proper orientation to the benefits of implementing AMM—on the utility's bottom line and on customer satisfaction, and on the utility's ability to rationally plan for O&M and capital expenditures on the short, medium and even long terms. This is required along with a complete well studied implementation plan that includes a strong communication strategy for the engagement of utility workers in the process to mitigate any resistance to change, and for educating them on what is AMM, why adopt AMM best practices, how would everyone benefit and how it will be done.

- Setting up a multidisciplinary AMM team or committee or even an organizational unit within the utility to focus on the AMM adoption program facilitates its implementation and directs the focus of the various functional units on AMM and how each unit's role should be. Such a unit would be supported by other smaller multi-disciplinary working groups (also working on team building and creating the supportive organizational culture) and would be responsible for identifying drivers and barriers to implementation, planning for the implementation, performance monitoring and improvement, ensuring that all business processes are revisited to be AMM driven. In many cases, implementing such a program was supported by an external advisor or consultant for the duration of the AMM program implementation.

- Implementing an AMM program is a complex thing and not to be underestimated; it requires knowledge and time. Proper education and training of all staff members on all levels needs to take place, and provisions for gradual implementation of the program also need to be made, starting with the process block by block.

* AMM is not a group of IT systems that are placed in the utility to carry out its operations, and it is not the way the financial unit in a utility handles assets accounts and depreciation; rather it is a culture of inter-functional integration and cooperation in the utility—it is all the business processes in the different functional units of a utility working together in unison for the goal of providing the levels of service required at the minimum cost. As such, applying AMM best practices entails revisiting the business processes within the utility as a whole and establishing the required inter-departmental links in terms of the work undertaken as well as the flow of information.

* Effective information management is critical to the success of AMM. The ability to provide feedback throughout the life cycle of an asset is essential to manage it effectively by taking into consideration life cycle costs, levels of service, and risk. This type of feedback supports the decision making process that relates to maintenance strategies to be implemented, required investments and resources needed. Information should be shared among the various departments within utility for this purpose. Ideally, IT should integrate various systems for this purpose within a utility, including call centers; CMMS; CIS; procurement; warehouses and inventory; finance and human resources; assets inventory management system or database (usually on GIS); capital assets plans; O&M systems such as SCADA and Laboratory Information Management Systems (LIMS); and other applications such as hydraulic models.

B. The AMM Framework

Figure 7 below depicts the AMM system, including the principles of implementing AMM in general according to PAS 55. It requires the development of an asset management policy, which serves as the basis to develop organizational values, functional standards, and requires asset management processes for acquisition, utilization, maintenance and disposal of assets. PAS 55 also requires performance and condition monitoring so that continual improvements can be made to policies and procedures.

As an overview, the asset management policy[31] is developed in alignment with the requirements of the utility's strategic or business plan, and with corporate policy in general and with the legal requirements of other key stakeholders such as regulators, owners, customers, etc. An accompanying asset management strategy[32] and plan[33] are also developed, also in line with the policy, and all responsive to external requirements set forth by owners, regulators, the customers, governmental entities, etc.

The combination of policy, strategy and plan articulate collectively the long term strategic objectives to be realized, and how to realize them in terms of what the utility owns and/or operates in terms of assets and system, and taking into consideration all requirements that are to be met in the meantime. They include a list of all system assets that are managed including types, numbers, condition, performance, criticality, etc, as well as the management practices and approaches that will be adopted in the utility, based on the asset specific information and data that needs to be provided for the purpose and utilizing unified O&M standards and adhering to clear working manuals for all types of maintenance and other activities that are involved (e.g. maintenance activities for facilities, and equipments; operating system components and supporting services; etc). Decisions for repairing/rehabilitating/replacing assets are also presented based decisions to prioritize the process built on the data available about each asset.

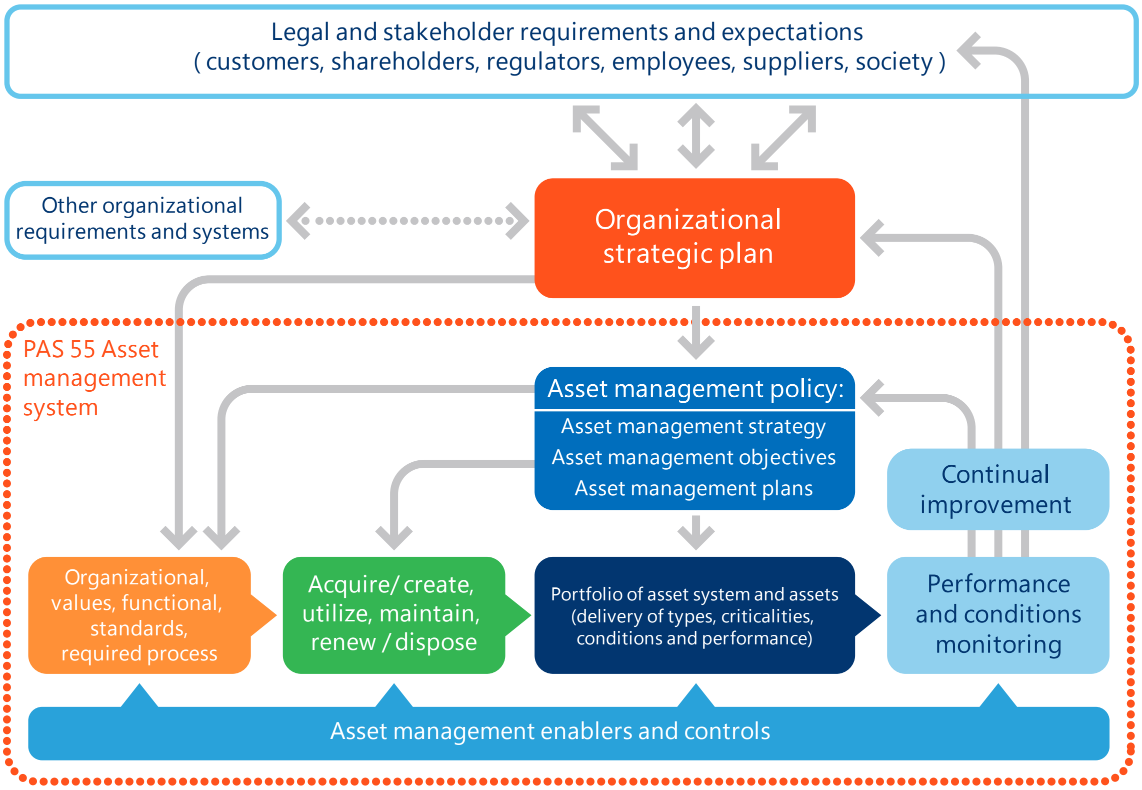
31 An asset management policy articulates the utility's commitment to asset management and provides policy statements to guide utility departments in their responsibilities regarding AMM so that it is integrated within the organization in a cost effective sustainable manner. It defines the levels at which assets will be managed; it identifies required standards and service levels; it identifies requirements for assets inventory; it specifies infrastructure replacement strategies through the use of life cycle costing principles; it sets the requirements for financial planning of maintenance of assets throughout their lifecycle and for long term funding plans for replacing/rehabilitating assets

32 The asset management strategy is one for the implementation and documentation of asset management practices, plans, processes and procedures within an organization. It includes the "vision, the goals and objectives" and describes how, in practical terms, these corporate objectives can be achieved (generally in the longer term). The strategy covers overall themes of activities and leaves the detailed activity planning to the more specific plans.

33 An Asset Management Plan (AMP) is a plan developed for the management of one or more infrastructure asset classes with a view to operating, maintaining and renewing them in the most cost effective manner while providing a specific level of service. It addresses links to the asset management strategy and policy; physical classification and description of assets; asset management practices; service levels; asset valuation and lifecycle costing; future demand and technological changes forecast; forecasts for expenditure and cash flow; and goals, targets and indicators.

The plan for monitoring the performance per the Asset Management Plan (AMP) is also indicated with provisions for continuous improvements on the process as a whole.

Figure 7: PAS 55 AMM System
(Source: The Institute of Asset Management)



C. Implementing the AMM Planning Process

The AMM planning process entails implementing a cyclical group of activities similar to any other planning process, as per Figure 8 below. However, the planning part of it entails a number of activities specific to AMM, as is explained in Table 12 below. Following the process of planning based on AMM best practices, the utility implements this plan, checks on progress, prevailing requirements, conditions and performance of utility against set plan, and revises this plan and by extension the Asset Management Strategy and Policy if needed. This process is repeated annually, and the AMP is updated accordingly.

Figure 8: AMM Planning Process
(Source: Author, 2014)

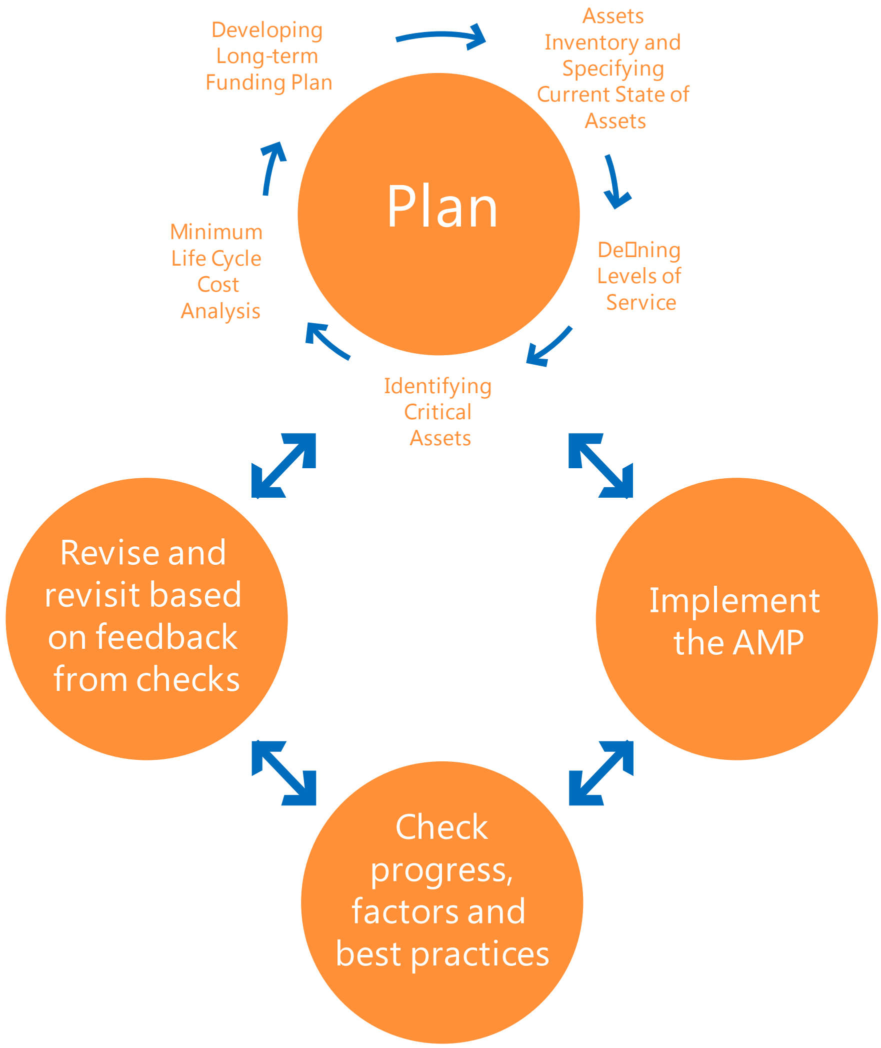


Table 12: AMM Implementation Activities
(Source: Compiled by Author, 2014)

Step in AMM Process	Description	Best Practices
Assets Inventory and Specifying Current State of Assets	This step entails the utility identifying all its assets and their current state. Informed estimations are used when accurate data is not available, but with time, such data will become available and can be used instead.	• Developing a GIS based asset registry that include fields about asset, description, location, type, size/ capacity, material, age, condition, expected useful lifetime, date of installation/ construction, history of O&M, current value, replacement cost. • Introduce ID for the facilities based on the GIS maps and introduce cost centers for every facility on all levels to enable the management to calculate the real cost of maintenance and check feasibility for adequate arrangements (rehabilitation or replacement) • Instituting a condition monitoring system either by inspection when possible (especially for fixed assets) or through using other techniques such as full spectrum vibration or thermal imaging or oil analysis, etc (especially for rotating assets). • Developing a condition assessment and rating system. • Evaluating remaining useful life based on typical asset decay curves and on history of assets.
Defining Levels of Service	Levels of service and system performance goals are applied quality, quantity, reliability and environmental requirements or standards set forth by the utility board, regulators, customers, etc, and also taking into consideration the physical capabilities of the utility system.	• Analyzing demand for and satisfaction with services—current and future. • Understanding regulatory requirements. • Documenting and sharing with customers and other relevant stakeholders written levels of service agreements that describe targets set. • Utilizing PIs related to levels of service for performance monitoring.
Identifying Critical Assets	Risk based AMM entails identifying assets critical to sustainable system performance. Critical assets are those that have a high risk of failing (e.g. old, deteriorated, etc) and major consequences of failure (e.g. costly collateral damage, compromised water quality, substantial disruption in services, etc).	• Based on assets condition, typical asset decay curves, redundancy and expected useful lifetime, developing and implementing a rating system for assets probability of failure and listing them by failure type. • Developing and implementing a rating system for consequence of failure. • Calculating assets criticality based on probability of failure x consequence of failure, and listing assets based on criticality. • Conducting a failure mode analysis for critical assets.
Minimum Life Cycle Cost Analysis	Determining what are the lowest cost options to maintain the required levels of service based on identifying critical assets and prioritizing repair/ rehabilitate/ replace decisions.	• Moving from trouble shooting and reactive maintenance to preventive and even better predictive maintenance based on asset condition monitoring[34] and trend analysis through Predicative Maintenance Modules within CMMSs for rotating assets and through regression analysis and failure mode analysis for fixed assets. • Carrying out a cost-benefit analysis for rehabilitation vs. replacement decisions. • Examining lifecycle costs for critical assets through analyzing lifecycle costs based on performance of assets and activity based costing techniques. • Deploying resources based on asset conditions and minimum lifecycle costing. • Developing response plans based on causes of asset failure.
Developing Long-term Funding Plan	Determining the utility's financial forecast based on an informed estimation of expected revenues vs. costs based on planned capital rehabilitation/replacement needs.	• Revising tariff system to cater for long-term needs. • Funding a capital reserve from current revenues through a capital annuity. • Financing capital works through loans or other financial assistance.

34 For rotating assets such as motors condition monitoring can be done using various approaches such as full spectrum vibration measurement and analysis, tribology and oil analysis, infrared thermography, electrical signals measurements and analysis. For fixed assets such as pipes, condition monitoring can be done by continuously

3.5 Energy Efficiency

Energy is in most cases the number one cost item within all WSS utilities O&M cost items, and a controllable one at that. In addition, it has been reported that the potential for energy savings at WSS utilities in the developing world can reach between 30 – 40%--depending on the baseline situation, and that many EE measures have a pay-back period of less than five years (Feng Liu et al, 2012), which means that investing in them would enable the utility to expand and/or improve its services because of the efficiency gains it is achieving.

But even if monetary benefits are the number one priority for any utility when it considers system improvements, however, reducing energy consumption not only reduces energy costs and operating expenditures, but has a direct impact on reducing Green House Gas (GHG) emissions, and reducing the pressure of adding or sustaining power generation capacity on the national level[35].

Consequently, improving EE in WSS utilities is the right way to save money, extend the life of existing infrastructure, and contribute in environmental sustainability.

There is no one-size-fits-all EE indicator in the WSS industry, as each utility is unique in terms of types of processes and technology it applies; what types of water resources it utilizes and what size are the communities it serves and how dispersed, what are the applicable standards and regulatory requirements, as well as the availability and prices of energy sources. Each utility needs to evaluate its own goals, financial situation and commitment to improving EE. Below is a number of guiding principles for EE and reducing energy consumed per unit water delivered or per unit of wastewater treated, under three main areas of discussion.

A. EE Enabling Environment

- Applying the principles of good governance is at the top of the scale of factors that are preconditions for planning for and implementing EE programs in the WSS sector. It has corporate, institutional, regulatory and financial dimensions that impact the successful implementation of such a program:

    - Ring-fencing utilities is essential for them to become independently accountable and self sustaining, and is also related to their credit worthiness and their ability to secure financing for EE investments. Of course, this comes in parallel with utility management and operations practices and corporate decisions that ensure the sustainability of healthy assets and infrastructure, thereby providing good quality services. This all lies at the heart of good corporatization practices.
    - Applying good tariff setting practices, away from political influence, based on the actual cost of service and on two distinct levels: (1) the level of the utility itself and charging for the actual cost of service without unguaranteed or unsustainable subsidies; and (2) the level of the WSS sector and removing any sector subsidy that reduces or removes incentive to improve EE.
    - Setting EE related and clear performance targets for utility top management and monitoring performance against them, all the time establishing the right set of corporate incentives and accountability measures, gives EE the importance it deserves and pushes towards its improvement.
    - Raising the awareness of stakeholders, including public officials, civil society organizations, customers and others, to the importance of EE in WSS utility operations and engaging them in decisions that are related to its impact on the overall service delivery cycle in terms of current and future costs entailed, levels of service provided, quality of service attained, environmental sustainability and associated costs.

- Applying regulatory requirements that make EE an element of assessing utility performance is considered a good driver for utilities to implement EE measures. This can be done through setting target EE indicators based on informed analysis of potential savings. It can be also achieved through establishing procedural requirements that enhance EE in utility operations as a minimum, such as energy metering, water metering, proof of regular or scheduled maintenance, etc.

35 A recent assessment of utilities in industrialized countries also suggests similar financially viable system-wide energy savings potential (5 to 25 percent). Using the 5 to 25 percent range, the global energy savings of the sector at its current level of operation could be in the range of 34 to 168 TeraWatt hours (TWh) per year. The upper bound is roughly the annual generation of 23 large thermal power plants (1,000 Mega Watt (MW) each) (Feng Liu et al, 2012).

- The existence of institutional capacity within the utility is essential for its ability to implement any EE program successfully. Such capacity is necessary at several levels within the organization:

    - The lack of knowledge in EE and its impact on utility operations among staff members contributes to the lack of interest in supporting EE interventions. Establishing this understanding and educating staff members to the importance of EE and how it links to the overall service delivery cycle is necessary to engage them in any planned interventions.

    - Limited internal capacity and know-how to undertake EE improvement programs prevents utilities form planning such interventions, and undermines their ability to structure feasible EE investment projects. This can be addressed by investing in building institutional capacity through training programs, targeted external technical assistance, supported by the utility itself, or even by external parties such as central government or donor funded programs.

    - Linking organizational performance to EE related targets and goals and setting up the incentive schemes are good drivers towards accomplishing those targets on the level of the utility organizational or functional units, especially when a harmonized framework for sharing and information between the various units is developed and cross-organizational cooperation in this matter is encouraged. One such example is in establishing multi-disciplinary energy management teams or committees with a mandate to control energy cost. Such teams would for example ensure that operating staff are aware of the consumption amounts included in electricity bills that are received and that get paid by financial staff.

- Even when regulatory and corporate or institutional dimensions are conducive to successfully implementing EE programs, those will not be possible if a supporting EE policy and legislative framework is not in place on the national level. This should be inclusive of central government, energy service industry and commercial EE financing sources. This is achievable by engaging development institutions that support and facilitate such efforts by providing technical assistance and access to other demonstrative experiences and implementations.

- Another major factor of successfully implementing EE programs is the availability of necessary funds. As previously mentioned, this is highly impacted by the credit worthiness of the utility, which is influenced by its ability to provide sustainable service based on a solid and cost based tariff system. In the absence of such conditions, it is very difficult to obtain commercial financing for EE investments, and requires long-term reforming actions. However, possible solutions include applying sovereign or sub-sovereign guarantees if possible, or turning to the private sector and structuring a partnership in the form of a PPP contract-of course all with the right set of solution specific prerequisites available.

- Recently, energy performance contracting (EPC) – a PPP model – has been used as a financing approach for implementing EE programs in utilities. In such a model, the contractor bears the capital/initial costs involved, and is repaid through cost savings from energy savings. Energy Service Companies (ESCos) usually engage in such contracts and provide various services including design and specification of new equipments; installation; energy audits; and long term monitoring and verification of energy savings.

B. EE Program Implementation

Setting up an EE program and implementing it successfully entails several steps that utilities should take (Table 13 below).

Table 13: Energy Efficiency Program Implementation
(Source: Compiled by Author, 2014)

Steps	Main Highlights
1. Establishing commitment within the utility for EE and associated cost reductions	• The design, adoption, and implementation of a comprehensive energy management plan requires the full support and buy-in from utility top management, operators and staff, in addition to other stakeholders such as utility board members, municipalities (if associated with WSS services), customers, utility power providers, potential funding agencies. This can be done through implementing awareness campaigns and setting the stage for engaging stakeholders in the planning process as it relates to each prospective stakeholder. • The commitment of the utility is best supported when the utility establishes an "Energy Management" team or committee that is usually interdisciplinary, with a Energy Management Program Manager. All will be appointed to follow up on the planning, implementation and monitoring processes.
2. Implement a comprehensive assessment of baseline and evaluating improvement opportunities	• It is essential to establish a baseline and proper evaluation and understanding of energy use and flow within the utility. This is done through the collection of pertinent information taking the following factors into consideration: • Data related to 75 – 80% of energy use. • Data on key facilities, assets and processes coming from power utility billing records, operational information from SCADA, hydraulic data and network zoning, meter readings, asset inventory information, applied conservation practices. • Data should reflect seasonal variations for the last 2-3 years. • Data should also reflect variations within the 24 hour period in intervals (most importantly presenting peak demand usage, load profiles, and total demand). • Benchmarking data available for other utilities would be beneficial for comparison purposes. • In order to assess energy use and flows within the system, an energy audit should be conducted. The most energy intensive components are identified in terms of facilities, processes and equipments and related energy consumption as a profile (raw water and distribution system pumping, filtration and treatment processes are good examples of energy intensive processes. The approach to implementing the energy audit should provide information that focuses on energy use for a specific process or operation. Possible interventions and energy conservation measures are then recommended in relation, with associated preliminary capital costs involved and if possible anticipated energy savings. Energy audits can be carried out by internal competent and knowledgeable utility staff or through external specialists.
3. Plan for implementation of improvement opportunities through evaluating and quantifying potential savings and prioritizing actions accordingly	• Based on the outcomes of the energy audits, possible interventions are identified with associated capital costs and monetized savings involved, and payback periods. Such interventions can be grouped per type of intervention: • Changes to energy use patterns (i.e. changing time of peak pumping, load shedding, etc.) • Capital investment in or replacement of assets and using hydraulic modeling (if not already in use) for that purpose • Optimization of equipments and/or processes • Installation of meters and controls (e.g. SCADA) • Building improvements • Vehicles related interventions • Renewable energy linked interventions • Water loss reduction related interventions • After listing the possible interventions per type category, a prioritization process is carried out and a shortlist is developed. The prioritization will be based on the data previously prepared for the interventions. It might be useful at the onset of an energy management program to focus on quick wins that can be used to showcase positive impacts and build the confidence of the utility board and other stakeholders before embarking on more complex or capital intensive interventions.

Steps	Main Highlights
4. Implementation of action plan	• Based on the prioritized interventions and action items, an implementation plan is developed including detailed description of intervention and action items involved; associated goals and targets; timeframe for implementation of each intervention and associated action items; responsibility of implementation; resources and requirements to be availed such as revisiting business processes; training and capacity building and/or technical assistance; and associated costs. • The plan is developed with the participation of all related functional units in the utility and is submitted to the utility's top management for endorsement and the necessary approvals.
5. Monitoring, tracking and evaluation of progress	• Plan implementation progress should be monitored along with identifying and also monitoring the expected impacts on operations in terms of anticipated changes on business processes and related schedules and operations. • Based on implemented interventions, changes in energy use and associated costs should be tracked and compared with baseline data over time to document successful implementation. Noteworthy is that impact of interventions can be detected on the short term upon applying interventions (e.g. using energy saving equipments or devices), or it could take some time until it is attained (e.g. operational practices that are to be changed will require that staff are well prepared and trained on doing them before any impact is detected). • The development of a metrics system that tracks specific indicators would be useful for any benchmarking exercises when it comes to comparisons between various facilities and/or systems nationally as well as internationally. Such metrics relate energy consumption to operational characteristics such as total flow, total pumping horsepower, distribution main length, distribution elevation change, etc. • The Program Manager with the engagement of the Energy Management team/committee members should make sure that periodic reviews of data are undertaken to ensure that the program goals are being met. Similarly, and based on how the implementation of the planned interventions progresses, and also on the priorities of the utility itself, prioritized interventions should be periodically reviewed and revised as needed with the aid of periodic energy audits. • The results of implementing the program should be communicated within the utilities as well as to other stakeholders to build the confidence in such programs for future plans, and to reaffirm the need for energy management in WSS utilities.

F. Technical Aspects of EE Program Implementation

As a general rule, the key areas where energy consumption is relatively high in a WSS utility would include pumping from distant or deep water sources; distributing drinking water over wide areas; asset condition and pipe leakage; and treatment of sewage by aeration and pumping raw and treated effluents. Noteworthy is that in a typical WSS utility that provides both water supply and distribution services as well as wastewater collection and treatment services, energy consumption can be divided between the two components at a 45:55 ratio (Brandt M. J. et al, 2010). Of course other utility specific characteristics still influence this ratio such as the availability and quality of resources, the specific types of technologies used, and thus the real costs of services that are associated with the identified levels of services and applied standards and specifications.

Tracking energy use and recommending conservation and optimization approaches would flow along with all components of the water cycle. Table 14 below includes a summary of best practices that are associated with each component, along with associated potential energy savings as a best case scenario when best practice interventions are applied as a package and across a specific timeframe.

Table 14: Guidelines for Energy Efficiency Implementation
(Source: Energy Efficiency in the Water Industry: A Compendium of Best Practices and Case Studies, UKWIR, 2010)

Treatment

Characteristics of Process and Energy Consumption	Guidelines for EE
Process: Mixing / Applicability: Water, wastewater	
Water mixing can either hydraulic (use turbulence created by head loss through a mixing device, so energy needed comes from the pumps) or mechanical (relies on external energy source by an electric motor). Application in wastewater is similar to water.	• Using hydraulic mixers is usually more energy efficient than mechanical mixers. • If using a mechanical mixer, using VSDs on motors allows for variable energy utilization as best suits the operating flow, which is more energy efficient than not using them at all. • Coarse bubble aeration is an alternative means of mixing, also used in aerobic treatment of wastewater, and in mixing sludge in tanks and digesters. Splitting the digesters into zones that are mixed in sequence reduces energy consumption. • Dissolved Air Flotation (DAF) can be used for water and wastewater treatment to remove suspended solids. Energy savings are related to optimization of process design parameters such as recycle rate; recycle booster pump type; and absorber type.
Process: Aeration / Applicability: Water, wastewater	
Aeration is an energy intensive process in the wastewater treatment process, and entails using blowers and compressors in wastewater Activated Sludge Plants (ASPs).	• Can use centrifugal blowers which are suited to larger-scale duties (currently modifications that involve motor and shaft mounted on a single shaft are allowing for increased efficiency) or rotating lobe blowers. EE measures can be applied through considerations related to pumping and system design and engineering, operation, control and maintenance.
Process: Ultra-Violet (UV Treatment) / Applicability: Water, wastewater	
UV is used for disinfection in water treatment plants and wastewater treatment. In the latter, it accounts for about 10% of the energy demand.	• The application of UV should vary with effluent quantity and quality, which would require effluent monitoring. • Quality of inflow should be maintained at high standards to reduce energy consumption.
Process: Sludge thickening and dewatering / Applicability: Wastewater	
Thickening is done in a centrifuge or by filtration. Dewatering is done in a centrifuge or by using a press. Energy is consumed by the feed pumps and by the processes themselves.	• Considering energy efficient equipment to be used within the processes such as drums or belts.
Process: Sludge Digestion / Applicability: Wastewater	
Anaerobic digestion of sludge produces methane which can be used as non-fossil fuel. It entails pumping and mixing and heating. It is energy intensive (consumes up to 10-15% of the treatment process energy demand) but at the same time can generate enough energy to cover the requirements of the process.	• Generating renewable energy through a Combined Heat and Power (CHP) process. • Maximizing the primary sludge content fed to the process. • Optimizing retention time to maximize gas production. • Considering energy efficient mixing technologies. • Match between the digester size and the feed, pumps and engines to maximize sludge used to generate gas.
Process: Sludge Drying / Applicability: Wastewater	
Sludge drying is energy intensive, and is carried out by conveying the dewatered and thickened sludge through a heated chamber.	• Optimizing process control parameters such as conveyance speed and retention time, and chamber temperature. • Utilizing waste heat from other processes to preheat sludge. • Using biogas producing from the digestion process for heating.

Transmission and Distribution

Characteristics of Process and Energy Consumption	Guidelines for EE
Process: Pumping / **Applicability:** Water, wastewater	
Two main aspects of pumping are involved: 1. Layout of mains: the most optimal for energy demand is gravity flow, but taking into consideration any possible layout or operational constraints that require pumping. Optimal layout results from proper hydraulic modeling for the system as well as the zones. 2. The types of pumps used: 80-90% of energy consumption has been reported to be used by pumps, depending on type of pump.	1. To optimize gravity flow: • For existing systems minimize pumping based on data on flow and pressures by using PRVs and monitoring system characteristics. Possibility of enlarging mains should be considered to reduce friction during flow. • For new systems several factors should be taken into consideration when designing the system with the objective of minimizing the need for pumping such as hydraulic layout and gradient; operational supply regime; valve maintenance (air and pressure); storage capacity and structure; etc. 2. In terms of pumps used: • When selecting a pump, a best match with the expected duty should be sought (maximum flow and head within pump's range, normal operating point closest to best efficiency point, protection from overload or underload, etc). These considerations are also valid when pump duty changes and the potential need for a new pump by extension. • If range of conditions the pump is required for is too wide, using more than one pump might be preferable. • Using Variable Speed Drives (VSDs) when a wide pump duty range is involved and two fixed speed pumps are actually costlier. • Considering the type of application within a water system the pump is used for: - For river water abstraction consider using more than one pump or VSDs to cope with water level variations. Also robust pumps are needed, such as split-case centrifugal pumps, to deal with possible debris and silt. - For abstraction from aquifers multi-stage mixed flow submersible borehole pumps are typically used, and two pole motors running at two speeds are often required to generate sufficient head. In addition, aquifer drawdown should be monitored and pump locations adjusted accordingly. - For bulk transfer pumping, it is essential that pumps are always operated at optimum efficiency since volumes, distances and consequently power involved are often quite high. - Booster pumps are used to raise the level of flows in mains or to initiate mixing, dilution or addition of chemicals. When in use for large flows, split case or other centrifugal pumps are used, and multi-stage versions are used for high lifts. For smaller flows, multi-stage mixed flow pumps are common. - For filter backwashing conventional centrifugal pumps are usually used. Sometimes it would be beneficial to maintain a header tank for wash water that gets topped up. - Ultra-filtration or Reverse Osmosis (RO) flows are boosted using membrane boosting pumps with high energy demand, so it is essential to consider how best to raise the pump efficiency . Noteworthy is that modern membranes are reported to require lower operating pressures. - Conventional centrifugal pumps are typically used for water distribution. Factors to be taken into account when selecting the pumps would include demand variations (seasonal and diurnal) and providing for emergencies. Other factors to be taken into consideration during operation is maximizing pumping during low tariff periods, adjusting delivery pressures to match demand variations, and introducing local boosters and lowering overall system pressure. • Considering the type of application within a wastewater system the pump is used for: - For raw sewage pumping it is essential to screen flows in front of pumps. Measuring flows and heads to optimize operation of pumps should yield energy savings. Archimedean screw pumps are typically used, in which case efficiency depends on the suction sump level relative to the first flight centre line, and the fit of the screw periphery to the flume or casing (low suction levels and high clearances lead to energy loss). - Turbine pumps and screw impeller pumps are frequently used as Return Activated Sludge (RAS) pumps to remove it from the bottom of the final settlement tanks of an activated sludge plant. Flow optimization or reduction has been reported to result in energy savings. - Sludge pumping is a very energy intensive process. Centrifugal, screw centrifugal or progressing cavity pumps are typically used depending on sludge thickness and other characteristics. Mechanically reciprocating pumps can also be used for best EE results. Efficiencies can be optimized through paying close attention to fettling castings and careful alignment during assembly, accurate trimming of the impeller, correct assembly of bearings and seals.

Characteristics of Process and Energy Consumption	Guidelines for EE
Process: Inflow/Infiltration (I/I) / Applicability: Wastewater	
I/I into the wastewater collection system from rainwater runoffs and other sources, or infiltration due to leakage from supply pipes means higher volumes of wastewater to be pumped and treated.	• Quantifying I/I to measure the extent of the problem through monitoring flow at various conditions and locations within the system to locate problematic areas and take corrective measures (fixing or replacing damaged or leaky pipes). Smoke and dye testing can be used also to identify sources of I/I. • Upon identification of problematic areas, corrective measures are taken such as pipe repairs/replacements, manhole sealing, source control, etc.

Water Demand Management

Characteristics of Process and Energy Consumption	Guidelines for EE
Process: Leakage Reduction / Applicability: Water	
Leakage reduction leads to energy savings across the water cycle through reduced abstraction, treatment, distribution, wastewater collection, infiltration, wastewater treatment and disposal.	Apply leakage reduction techniques: • Proactively (pressure management, establishing DMAs, targeted detection of unreported leaks, minimizing repair times, etc) • Reactively by responding to complaints and reported leaks and changes in system pressure.
Process: Water Conservation / Applicability: Water	
Similar to leak reduction, any reduction in demand will impact the whole water cycle in terms of energy demand.	Apply conservation measures: • Apply metering. • Optimize tariff structure. • Promote using water conservation devices and fittings. • Carry out public awareness campaigns. • Regulate water use.

Facilities and Buildings

Characteristics of Process and Energy Consumption	Guidelines for EE
Process: Building Services / Applicability: Water, wastewater	
Energy is used in buildings for lighting, air conditioning and ventilation, communications, IT systems, water supply and effluent removal, elevators, etc.	• In terms of lighting using sensors to control light switches, low energy lighting units, and low voltage equipments. • In terms of heating and ventilation, maximizing natural ventilation and restricting air conditioning rooms that are constantly occupied, and installing natural ventilation for rooms housing heat generating equipments as much as possible. • In terms of office equipments and IT tools, switching off all non-essential equipments out of working hours. • In terms of water supply and sewerage, using tap aerators and low capacity toilet flush cisterns, and using time switches on water heaters and cooling equipments. • Utilizing energy generation tools such as solar panels for energy and heating. • In new buildings, using insulation to minimize heat transfer, maximizing natural light, optimizing ventilation to maximize natural convection, using grey water reuse and on-site treatment solutions, etc.

Renewable Energy Production

Characteristics of Process and Energy Consumption	Guidelines for EE
Process: Energy generation / **Applicability:** Water, wastewater	
Various sources of renewable energy can be considered in WSS utilities to balance energy inputs and outputs from utility activities. Noteworthy is that as renewable energy sources are usually dispersed while power demands are concentrated in centers grid connections become essential and also energy storage.	Potential renewable energy sources in WSS utilities include: • Hydro generation is used whenever there is excess hydraulic head. As such, hydro turbines can replace devices such as PRVs, control valves, flow restrictors, etc. • Solar energy captured thermally through circulating fluid (and so can be used for heating purposes), or electrically through photovoltaic (PV) panels (can be cost effective for small power demands). Applications are mostly external to the water cycle, but can also be used within, such as using PV cells to help power tertiary treatment stages. • Wind turbines can be used based on the availability of proper space and wind, public acceptance, and grid connection availability. Wind and solar PV generators can be used for low power requirements such as instruments in place remote from power supplies. • Biogas CHP is becoming more and more cost-effective with rising energy prices and carbon reduction strategies. CHP can run a complete sewage treatment facility on its own.

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السادة / الجمعية العربية لمرافق المياه (أكوا)

تحية طيبة وبعد،

أرجو إعلامكم بأن المصنف بعنوان " Water Utilities Management In The Arab Region Lessons Learned And Guiding Principles"، اعداد: Arab Countries Water Utilities Association (ACWUA)

قد تم منحه رقم إيداع في مركز الإيداع في دائرة المكتبة الوطنية تحت رقم الإيداع المبين أدناه.

يرجى العمل على تثبيت هذا الرقم كما هو مدون أدناه، في أي مكان ظاهر من المصنف، وتسليم مركز الإيداع ثلاث نسخ على سبيل الإيداع وبحيث تكون النسخ المودعة مطابقة للمصنف من جميع الوجوه ومن أجود النسخ المنتجة، وذلك استنادا لأحكام المواد (38، 39، 40، 41) من قانون حماية حق المؤلف رقم (22) لسنة 1992 وتعديلاته، وأحكام نظام إيداع المصنفات رقم (4) لسنة 1994 م.

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