WSC SCADA
A Tool for Efficient Resource Management

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INTRODUCTION

Malta is an archipelago made up three main Islands, namely Malta, Gozo and Comino. Malta, the largest island has a surface area of mere 246km^2 whilst Gozo and Comino together account for 70km^2. The total population in 2014 was 421,364 equating to a population density of 1,333 persons/km^2 making it the 10th most densely populated nation in the World [1]. In addition, Malta has to cope with a tourist influx of around 1.5million visitors each year.

Malta's weather and climate are strongly influenced by the sea and have a very characteristic Mediterranean flavour, similar to that found in southern Italy or southern Greece. The average annual rainfall is about 550mm however it rarely rains between April and August. July and August are Malta's hottest months with daytime temperatures usually above 30˚C and quite often also above 35˚C. [2]

In the last decade over-extraction led to a decrease in freshwater within the aquifer, displacing it with increased amounts of seawater and therefore increasing its salinity. Trends in fertilizing agricultural land have led to excessive nitrates coming into contact with rainwater. Rainwater dissolves these nitrates and carries them down into the aquifers. As a consequence, the water produced by 90% of Malta's aquifers no longer meets the Maltese and EU standards for safe drinking water. [3]

Consumption from various sources far exceeds the availability of groundwater and therefore it has to be supplemented by sea-water desalination. Water from these sources is blended in order to ensure a supply of good quality potable water at the least possible cost in an environmentally sustainable manner. This mode of operation entails pumping water from sources as well as between reservoirs to maintain a sufficient level of reserves throughout the Island, thus making the system totally power dependent. In 2014 the total water production for Malta was 30,472,000m^3**,** of which 54.2% was produced from desalination and 45.8% from groundwater. [4]

BACKGROUND

The Water Services Corporation (WSC) was set up in 1992 to produce and distribute potable water in the Maltese Islands. It currently operates 131 groundwater abstraction boreholes, 13 pumping stations, 25 reservoirs, 3 RO plants and a groundwater polishing plant at Ta’ Cenc, Gozo. The water distribution network operated by the WSC consists of more than 2,500 km of pipework of varying material and sizes. The network includes transfer mains linking sources to reservoirs, intra-reservoir connections and distribution mains with trunk mains and reticulation mains. There are also a further 1,700 km of service pipework serving about 220 000 accounts. [5]

In October 2003, WSC was also entrusted with the national wastewater collection, disposal and treatment facilities. This means that the Corporation is wholly responsible for the complete water cycle from production to its safe disposal.

In the last decade WSC invested heavily in a number of technological projects mainly for monitoring and control purposes, regulatory compliance and to improve efficiency and reduce energy costs. Two significant projects were the SCADA systems for the Water and Wastewater commissioned on 2003 and 2010 respectively. Like the Wastewater SCADA system, the water SCADA comprises GE Cimplicity software running in redundant configuration. The latter covers nearly all the major 42 sources comprising 9 pumping stations, 25 reservoirs and 8 booster stations. Parameters like conductivity, residual chlorine, flow, pressure, level and pump status are being monitored. The Wastewater system covers the entire 100 pumping stations and provides monitoring for specific energy, pump status, inflow and outflow, sump level and pumps current.

CHALLENGES

Like other water utilities, WSC is subject to, and must continuously adapt to, constant economic, societal, governmental and environmental pressures in order to meet its mission. Understanding and analysing these 4 key areas is important for the design of appropriate water management strategies for the islands' water supply. Solutions for the present as well as for the future are required to meet the challenges it is facing.

The three major challenges are:

1) Lack of fresh water resources
2) Reliance on desalinated water which has a substantial carbon footprint thus carrying both environmental and economic consequences at national level, as well as
3) Water Quality

ADDRESSING THE ENERGY EFFICIENCY CHALLENGE

Over the past decade, WSC made numerous investments in the fields of desalination, wastewater treatment and SCADA systems. It is a known fact that desalination is a very intensive and expensive technology but is essential to compensate for the lack of natural water supplies. The table below provides a comparison for the electrical consumption of water production from groundwater sources and reverse osmosis plants between 2004 and 2013. [6] During this period the specific power to produce 1 cubic metre of desalinated water was reduced by a significant 1.1kWh per cubic metre. This can be mainly attributed to the upgrades carried out in 2008 at all the reverse osmosis plants consisting mainly of membrane replacement, introduction of special control algorithms and with the installation of variable speed drives. The upgrade continued in 2009 and resulted in net savings of 20% in electrical consumption. [7]

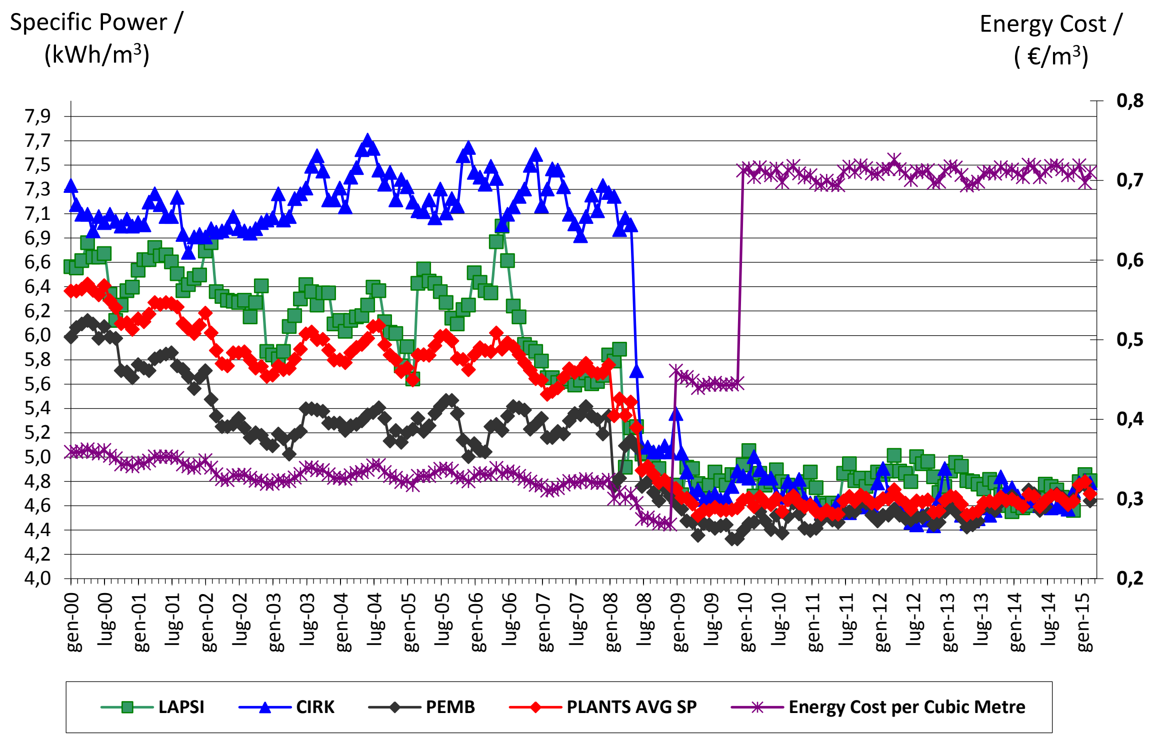
Year	Groundwater			Reverse Osmosis plants		
	Production in m^3	Electricity consumption in kWh	Specific power kWh/m^3	Production in m^3	Electricity consumption in kWh	Specific power kWh/m^3
2004	14,886,796	10,300,306	0.7	17,894,583	101,125,657	5.7
2005	13,994,560	10,558,513	0.8	17,049,042	89,659,759	5.3
2006	13,059,358	10,829,154	0.8	17,469,049	92,808,953	5.3
2007	13,957,572	10,569,217	0.8	17,007,077	86,545,960	5.1
2008	14,075,940	10,534,962	0.7	16,871,911	80,790,899	4.8
2009	12,676,827	10,939,855	0.9	16,653,689	66,685,517	4.0
2010	12,784,120	10,908,805	0.9	16,109,456	65,069,209	4.0
2011	13,060,554	10,737,874	0.8	16,722,082	67,222,315	4.0
2012	13,298,978	10,895,038	0.8	17,646,924	71,276,528	4.0
2013	13,788,433	10,573,869	0.8	16,791,994	67,520,920	4.0
average 2004-2013	*13,558,314*	*10,684,759*	*0.8*	*17,021,581*	*78,870,572*	*4.6*

Source: Water Services Corporation

Note: Electricity consumption data for groundwater sources and wastewater treatment is estimated for 2004-2010.

Table extracted from NSO Malta – News Release 2014

Also, from the above table it can be concluded that the reduction in energy between 2004 and 2013 was equivalent to 1.1% of the national electricity supply.



The above figure [8] shows that in 2008 there was a sharp drop in energy consumption resulting in great energy savings with an annual reduction of CO_2 emissions equivalent to 29,000 tons. At the moment Water Services is planning to reduce further the specific energy down to 3.6 kW/h/m^3.

Coincidentally in 2009 and 2010 the cost of electricity escalated by approximately €0.42 per cubic metre of water.

Reduction in energy was also possible thanks to the strict condition based maintenance adopted by the maintenance personnel. The SCADA system was programmed in such a way that alarms are generated in the event of deviations from the design values so that immediate intervention was possible to maintain the highest possible level of efficiency.

Another investment worth mentioning is the construction of 3 wastewater treatment plants on the Maltese Islands, which are:

a) Gozo STP (Limits of Mgarr), funded through the 2003 EU Pre-Accession Program (51% EU Funds - 49% Local Funds).
b) North STP (Malta – Limits of Mellieha), funded through the 5th Italo-Maltese Financial Protocol.
c) South STP (Malta - Ta' Barkat – Limits of Xghajra), funded from EU 2007-2013 Cohesion Funds Program with a co-financing rate of 85% EU Funding and 15% Local Funding.

For the South STP, the total budgeted infrastructural cost of the plant was €57 million excluding ancillaries. The plant has been specifically designed around a fixed media bed filter treatment process to reduce the footprint of the installation, besides offering additional operational advantages. It is equipped with anaerobic sludge digestion to recover energy from 3 biogas generator sets, each rated 330kW [9]. Maintaining high standards of maintenance is paramount for reliability and top-notch performance of the generator sets. Between October and May, the gas flow is optimised to peak the generators output to 370kW, however, in the summer months these must be de-rated to their rated power due to the high ambient temperature. The philosophy adopted is simple: keep generator breakdowns to a minimum to make better gas utilisation and avoid excess gas burning. Engineers also take advantage of the variable day-night pricing to schedule the generators to operate at peak power during the day when the prices are high.

Through these initiatives, the total bio-gas energy generated in 2014 was 4800MWh, which is 11.6% higher than that produced in 2013, that is 4,300MWh.

CURRENT PROJECTS

To further address the above mentioned challenges, the WSC is working on a number of measures targeted to enhance water conservation and efficiency, optimise the use and quality of groundwater as well as increase the use of alternative sources of water supply. [10] A number of projects were submitted for funding under the Cohesion Policy 2007-2013 Operation Programme I and categorised under ERDF 334 – Carbon footprint reduction project and CF355 – Water Quality and Supply Improvement Project.

The following is a list of some of the projects:

PROJECTS	ESTIMATED COST €
Upgrading of existing traditional Motor Control Panels with variable speed drives and installation of new SCADA outstations	4,108,000.00
Replacement of all sensors and analytic instrumentation.	2,566,000.00
Provision of a new UHF radio SCADA communications equipment	755,000
Replacement of all pumps with new Premium Efficiency IE3 motors	700,000.00

The scope of these projects is to upgrade motor control panels, some of which date back to 1965 with new panels incorporating variable speed drives, energy monitoring devices, protection relays, programmable logic controllers (PLCs) and Human Machine Interfaces (HMIs').

By installing 127 new outstations, of which 119 are boreholes, 5 pumping stations and 3 reservoirs, WSC SCADA system would have all functional outstations connected to its SCADA system. It would be possible to exchange information seamlessly between the variable speed drives, PLCs, Panel HMIs and finally remotely to SCADA servers via a single industrial Ethernet protocol. Other information like sump level, pressure and water quality data such as, hydraulic pressure, conductivity, temperature, pH, turbidity, free chlorine and nitrate level shall also be collected locally by the PLC via serial Modbus communications. In strategic sites such as reservoirs and pumping stations, an automatic chlorine dosing system shall be installed to precisely control the rate of chlorine injection thus enabling only the minimal amount of chlorine to be injected into the system. In three stations, this shall be combined with newly built ultra-filtration plants to improve disinfection control, reduce excess chlorine by-products and minimise chlorine wastage.

Through these projects WSC would be able to monitor continuously all sources and distribution points thereby permitting accurate control over abstraction, blending and part of its distribution network. It is anticipated that these new outstations will increase the amount of SCADA points by over 4.500, with data being collected every 5 minutes. Analysing large volumes of data for effective decision making takes more than simple statistical tools in spreadsheets.


The newly refurbished WSC control Centre – 2012

In such a scenario, there exist hundreds of plausible permutations and combinations on the way water is produced and distributed, however there is only one optimal solution. This combination is applicable only for a relatively short period of time until another combination becomes more feasible given the ever changing demand and quality conditions.

Today, all decisions related to demand management are being taken using experience and rudimental tools built along the course of time. A software tool using genetic algorithms will be developed in-house that will utilise the data from the SCADA system regarding the demand in combination with reserves, water quality and power characteristics of the different sources. This tool shall be based on a GIS package and shall be capable of comparing the actual measured specific energy to the theoretical values and therefore highlighting bottlenecks and anomalies that may produce better results if corrected.

It is a known fact that SCADA systems are no longer isolated but are fully integrated within a Corporate IT infrastructure. A properly designed infrastructure which provides high availability without compromising resiliency and robustness of the communications network is very important in today's world. It is for this reason that WSC intends to upgrade to a more secure and cost-effective IP based private radio network. Currently the two SCADA systems connect to remote outstations via a variety of communication networks such as UHF, ADSL, 3G, Private WIFI and 3rd party radio links. These are classified as follows:

Water SCADA:

Network type	**3G**	**3rd Party Radio links**	**ADSL**	**Private WIFI**	**Radio UHF**
Quantity of RTUs	0	3	7	17	14

Waste Water SCADA:

Network type	**3G**	**3rd Party Radio links**	**ADSL**	**Private WIFI**	**Radio UHF**
Quantity of RTUs	2	6	37	10	47

The associated communication charges in 2014 were as follows:

Technology	Speed	Monthly Subscription	Capital cost for each station
Private 2.4GHz WIFI	Up to 1 Mbps	-	1,350
ADSL	4Mbps/256K	€42	-
3rd party 5GHz WIFI	1Mbit/1Mbit	€25	-
UHF licensed radio	1200bits/s	€4	1200
3G-HSDPA	7.2Mbps	€23.69	146

From the above tables it can be concluded that the monthly charges by service providers amount to €2,120 or 90% of the total cost. New UHF SCADA radio equipment was purchased this year from RACOM to replace these services and reduce the cost to a minimum. The cost of equipment was €755,000 and it is estimated that it will give a return on investment in around 4.5 years. Installation and configuration or the radio network started in April of this year and it is anticipated to be completed by April 2016.

Advantages of the new system over the existing system:

1. All base stations will be fully redundant with a switchover time of less than 2s.
2. Each radio has a data rate of 83kbps at 25kHz channel spacing and 2W RF power.
3. Radio modems are IP native devices and can be accessed and configured remotely via a password-protected access through an https web interface.
4. AES 256 encryption algorithm.
5. Integrated SNMP client for remote monitoring by WSC Engineers.

CONCLUSION

During the last 5 years, WSC intensified further its efforts to unlock the numerous opportunities that exist in bridging data between SCADA, Water Modelling, AMM and other management tools. It has long been realised the tangible and intangible benefits of using intelligent SCADA systems where both hardware and software are tightly integrated leveraging secured protocols and standard programming environments. With the implementation of the above WSC projects it would be possible to leverage the power of real-time data as opposed to relying on expired calibration data. This would create challenges not only from the management point of view but also from the point of view of security and protection of the underlying plants.

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