T1.6.1 - Emerging Solutions Report

GREEN WIN PARTNERSHIP

MAY 2023

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1 Introduction

In the Arcadis Initial Green WIN trial site assessments, the common issues identified for attention by Canal & River trust (CRT), Waterways Ireland (WI) and Voies Navigables de France (VNF) were to;

- Review and optimise pumping station operating regimes to further improve overall efficiency and specific energy
- Improve energy data and metric reporting through improved data analytics software and presentation.

Through Green WIN we have identified several 'emerging' solutions that can help us achieve this. They include;

- Smart Controllers
- Smart Pumps
- Web based 'subscription services'

These are currently being developed by industry and can be used on smaller inland waterways. Organisations can get holistic improvements from such services.

This report aims to highlight the opportunities and benefits for Water Management Organisations (WMO's) from introducing these emerging solutions.

2 Background

2.1 Trends in intelligent asset management: the key to sustainability

Intelligent asset management is set to grow dramatically in the water industry. The larger amounts of data available, provided by infrastructure sensors, will enable companies to ensure environmental sustainability whilst progressing towards more efficient resource management. One of the main challenges is to 'be brave enough' to tackle the technological complexities involved, as smaller organisations often don't have sufficient technical and financial resources to tackle this issue. The support of external partners that combine technology and expertise, is essential if they are to succeed.

WMO's like CRT, WI and VNF, along with large water industry companies, face a similar challenge i.e. the need to incorporate smarter asset management. In recent years, leading water utilities have built intelligent asset management into their processes: deploying sensors on their infrastructure and implementing other technologies such as micro-metering, GIS and SCADA to increase volume of information available on their infrastructure and assets.

The application of technology - based on experience of an asset's performance can help predict the risk of failure and determine when it should be replaced. The lifetime of assets is extended and WMO's can anticipate replacements, adjust maintenance tasks, and prevent outages. In addition, these systems help to pinpoint the most problematic materials, making real preventive maintenance possible and even guiding future investments.

As Green WIN has demonstrated, smarter management of pumps and other operating elements can optimise energy consumption, reduce carbon emissions, and provide a better service overall.

To summarise; Intelligent management can lead to maximised efficiency. More efficient resource management brings significant economic and environmental benefits by reducing costs and energy consumption. It optimises productivity, ensures service availability, and reduces downtimes.

"Today, the water industry is adding intelligent management with the ultimate goal of maximizing efficiency. Although utilities have varying degrees of digital maturity, there is a definite trend towards moving in this direction." Rafael Rubio, Head of IT Operations at Idrica. (1)

2.2 The Internet of Things (IoT)

IOT is a meeting of smart device technology and data generation, processing and accessibility. Within the consumer sector, this has resulted in the rapid creation of the smart home, where users can remotely control multiple household appliances - from lighting and heating to kitchen appliances, security devices and entertainment systems. All via computers, smartphones, and tablets.

In the water industry, operators seeking to improve efficiency and sustainability are increasingly specifying web-enabled pump systems.

Whilst equipment is in operation, IoT systems receive information from pump sensors which are constantly collecting data e.g. cycle status, and vibration monitoring. Using historical and real-time data, users can make informed decisions relating to system performance and perform immediate adjustments e.g. to flow rate, as well as altering pump operating modes such as manual, batch and timed.

IoT technology even allows the performance and status of specific pump components such as bearings, couplings and belts to be assessed. This means that the operator can be alerted immediately should a part be due for replacement.

2.3 Smarter management

IoT-based systems enable users to receive smartphone notifications as soon as faults occur, meaning defects can be identified immediately and remedial action planned to

take place outside normal operating hours when disruption can be minimised. Operators can see big improvements in the efficiency of equipment maintenance, repair and upgrade planning while avoiding costly and inconvenient unplanned downtime. Other cost savings can be found also, as in addition to making instant efficiency improvements, operators are able to budget with greater accuracy and confidence.

Often lone, long-serving operators may possess extensive knowledge of complex older systems that may not be recorded or documented. Retirement, illness, or periods of extended leave can therefore significantly impair system operations. Wasted journeys by technicians - who may travel a considerable distance to assess a pump's condition as part of routine maintenance – can be eliminated, as engineers need only be deployed when required.

2.4 Downsides?

The influence of IoT on the pump industry is extremely positive and as technology advances will only make life easier for operators. However, as with most devices, connecting pump systems to the internet does make them vulnerable to cyber-attacks, and breaches of security can have a potentially devastating impact on safety, cost, and reputation.

3 Green WIN partners perspectives

The following examples of ways partners already, concurrently, or as a result of our work in Green WIN are operating their pumping regimes more efficiently and with fewer carbon emissions.

3.1 Canal & River Trust (CRT)

Highlighting Inefficient Sites

CRT's Annual Pumping Report compares all Pumping Stations in terms of usage and power consumed. The power consumed per volume of water raised (kW/Ml/m) indicates the relative efficiency for each pumping system. This figure provides a tool to focus on poorly performing sites.

Pump System Efficiency

A programme of installing variable speed drives (VSD) has been underway since 2011. This enables variation in the speed of the pump motor and allows adjustment in power consumption to fine tune a pump to its best efficiency point (BEP). By optimising the pump to its duty point (flow) using a drive the minimum amount of power is utilised to achieve the duty flow. Not all pumps or systems are suitable for VSD equipment. Each pumping station enhancement is now considered for VSD installation.

Pumping SCADA Control & Set Points

The installation of SCADA telemetry and level instrumentation on a pumping station allows enhanced control options. The decision to install or upgrade SCADA instrumentation is considered as part of the prioritisation process. Each site has a Water Management Operational Procedure which documents the level reference or datum control point for the SCADA instrumentation. This Operational Procedure defines the optimum control parameters for the operation of the site with SCADA control. SCADA also enables pump use to be monitored, examined and analysed. Pump switch on-off points can be set to water levels or to a clock timer to provide the right pound level to meet water demand and with a bias towards off-peak electricity timing the set points can reduce overall pumping costs.

Overarching SCADA

A series of pumping station operating independently occasionally create imbalances in individual canal pounds leading to a deficiency in pumping or excessive pumping leading to waste. A project of Overarching SCADA is underway which aims to design and implement a system which controls the chain of pumps as a whole. Pumping regimes will be developed to achieve either net transfer of water or lock recirculation as required in all conditions i.e. summer or winter, drought, normal or flood conditions, night time or daytime. Each pumping regime will be designed to be efficient so as to minimise the cost of pumping and eliminate any water that is pumped to waste. A further objective is to contribute to the reduction of CO^2 emissions as part of the Trust's carbon management plan.

Power Grid Demand Balancing

Working with energy providers, the Trust has linked suitable pumps to an energy management system which can under/over speed pumps or alternatively switches pumps on or off allowing the release of energy or absorb excessive energy back to the National Grid to even out its temporary peaks and troughs in demand. This reduces the demand in standby power stations and allows the greater use of green powers sources such as wind and solar. These short-term interventions generate revenue for the Trust and in turn helps to reduce carbon emissions.

3.2 Rijkswaterstaat (RWS)

Reduced use of energy, maximized use of green energy

The use of predictive models, water flow models combined with rainfall models, can reduce pumped volumes and energy use. Other recent developments are to tune pumping operations to the availability of renewable energy (wind, solar). To do this, the steering software has to be adapted and will be combined with an advanced water flow and rainfall model.

Predictive maintenance

Data downloaded from installations, combined with data from operations (e.g. SCADA) can monitor the installations and their deterioration. Available data is therefore extended with data from additional electricity use sensors. By analysing this data, maintenance needs can be predicted.

Energy production

A hybrid pump has been installed at one RWS pumping station. This works two ways; normal pumping and production of energy when water has to be discharged. This technique has potential application in more situations.

3.3 Waterways Ireland (WI)

Importance of data collection

The efficiency of pumps is becoming increasingly important at a national level. New legislation covering abstractions under the EU Water Framework is being prepared at this level in Ireland. WI is working with the Irish Environmental Protection Agency (EPA) to provide abstraction data for their national Qube hydrological model. Canal water requirement data will be an important issue in determining the flow limits in the catchments from which canal supplies are derived. Consequently, the provision of accurate pumping data utilising flow meters etc. needs to and will be employed.

Ultimately, the EPA wishes to undertake a joint and comprehensive water balance measurement exercise over the course of several days. This will benefit both organisations in determining how much water is entering, leaking from and flowing out of the canals at various locations. It is of key importance to measure all elements either concurrently, or over a very short time span to ensure measurements are relevant to each other.

3.4 Voies Navigables de France (VNF)

Climate change and water resource changes

VNF launched a programme to modernise their inland waterway management and optimise the water resource. A new SCADA system was developed (AGHYRE) which provides better supervision and information about water levels and volumes at local, regional, and national levels. The development of monitoring systems to better monitor water uses is also part of the programme.

To modernise the network and make it safer and more efficient, VNF continues to automate works and equipment operated on the inland waterways network: dams, locks, and pumping stations.

VNF is developing renewable energy production in partnership with renewable energy developers and operators and have worked up plans to develop new hydropower plants across the French inland waterways network. They plan to rebuild dams on the Aisne and Meuse rivers, and has developed with its partner four new hydroelectric micro-power plants for a total power capacity of 8.3 MW. Other projects were developed in partnerships to develop three hydropower plants for a total of 18.3 MW capacity.

VNF is working to achieve better preventive maintenance. The aim is to reduce operating costs and to facilitate a better water and energy efficiency of the equipment.

3.5 Vlaamse Landmaatschappij (VLM)

Smarter pumping, reduced energy consumption, costs and ecological impacts

VLM work with LRM - an investment company that develops and stimulates economic growth in Limburg. The company has statutory responsibility for pumping in the Limburg / “Mijn Mangelbeek” / de Wijers area and an obligation to minimize and prevent damage caused by mining subsidence. They are gradually upgrading the area’s pumping stations with real-time flow monitoring and remote control. Some pumps have already been replaced by more energy efficient ones. New pumps are slow start pumps and/or Concertor pumps in which flow is depending on the water level in the underground reservoirs.

They look to reduce energy consumption and thus costs and the ecological impact of pumping. The yearly energy consumption cost varies between €140.000 and €160.000 depending on the yearly precipitation.

They also investigate the re-use of the pumped water (which is actually a combination of ground and surface water) as an alternative for the direct discharge in the Mangelbeek. One of the possible examples is the use of these pumped water volumes as a source to irrigate agricultural lands in dry periods. Solutions like this depend on the water quality, availability, and cost of extra investments to make these alternatives feasible.

4 Green WIN findings / Waterways Ireland case study

Waterways Ireland developed plans for their Green WIN trial sites following tendering from suppliers guided by Arcadis recommendations for individual sites. Xylem’s Flygt

smart control system and pump(s) proposed is a prime example and the plans for Leinster Aqueduct PS were explained in a presentation (see below) given by Xylem at the Dublin partner meeting in May 2023 and later that day at the actual site.

4.1 Flygt MultiSmart iPSM (Intelligent Pump Station Manager)

- Reduces energy consumption
- Eliminates nuisance call outs
- De-skills maintenance
- Provides information for predictive maintenance
- Allows quick retrofit to deliver benefits by scale
- Enables smarter networks

'Out of the box' product

- Specifically for water industry pumping applications up to 6 pumps,
- Designed to simplify water and sewage pumping applications and improve operational efficiencies.
- Provides all pump station control, communications, and data requirements in one box eliminating solution,
- Reduces energy consumption,
- Reduces whole of life costs,
- Future Proof - Implement Smarter Networks

Controls any type of level sensors, pumps; Works with any level device, can control any manufacturers pumps, either directly or via variable speed drives. Pump manufacturers seal and thermal connections can be connected directly into MultiSmart digital inputs.

Easy access to six different set point profiles; Can change set point profiles automatically or manually, locally, or remotely.

Flow Monitoring; Analogue input, pulse input or derived calculation. Inflow, individual pump flow rates, total station volumes, individual pump flow warnings and alarms. Records overflow events, time / volumes.

Phase Voltage Monitoring; Phase voltages displayed & logged. Can hold off pumps during voltage fluctuations - high voltage events, low voltage brown outs etc.

4.2 Xylem Flygt Concertor pump

Uses above controller to bring out the best in each below feature to create the optimal flow:

State-of-the-art technology

- Remote control capability
- Integrated control system
- >IE4 Motor Efficiency
- Intelligent functionalities
- State-of-the-art N-hydraulic efficiency and reliability

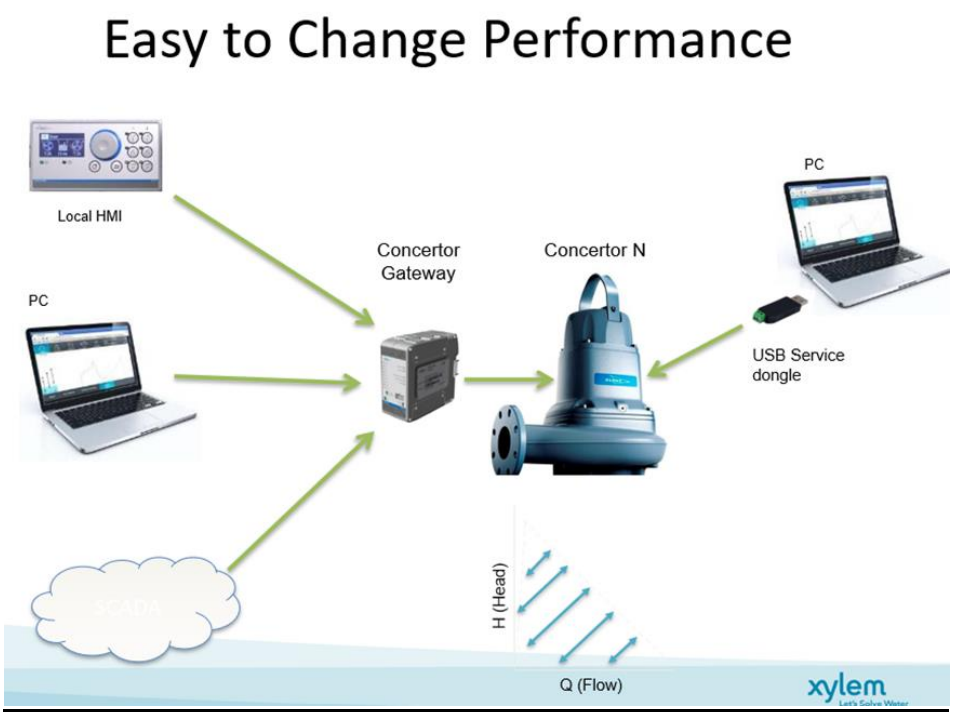
Built-in intelligence

- Self-adaptive energy minimizer function
- Automatic adaption to different duty points
- Built-in self-monitoring functionality
- Self-adjusting pump cleaning function and built-in sump and pipe cleaning
- Performance can be fine-tuned on-site or remotely

Efficient asset management;

Easier product selection & adjustable performance. The need for multiple versions of installed pumps and difficulty to select the right pump is eliminated. One solution fits all and manufacturer's inventories can be reduced by up to 80% hence a reduced need for backup inventory.

Unique axial movement will improve the mechanical self-cleaning ability and increase the reliability of the pump. Ultimately it will lower the total cost of ownership since it will reduce the unplanned maintenance.



Xylem Flygt Concertor pump

The Flygt Concertor control system

Is embedded in the pump; It consists of a processor, software, electronics, 2 x temperature sensors and power electronics. Electronics are potted in plastic, protected against vibration, heat, humidity, dust, dirt, and extreme temperature variations.

Operating inside a pump is beneficial for the power electronics as they are protected from exposure to vibration, heat, dust, dirt and extreme temperature variations. The cooling is compact and stable; the motor leads are as short as they can be to eliminate the risk of electrical disturbances between the in-pump processor(drive) and motor.

The in-pump processor utilises the power electronics feature to achieve variable pump performance, to meet the demand at hand. Instead of having to remove the pump to trim or change an impeller, a different duty point can be met by the touch of a button.

Sensors and software functions are built into the electronics to constantly monitor key electrical parameters and the motor and circuit board temperatures. If for example a loss of cooling happened it would not result in a motor overheating as the power would be reduced to a safe level.

5 References

(1) Trends in intelligent asset management: the key to sustainability SMART WATER MAGAZINE 14 Feb 2022
(2) The future for pumps, IoT and Industry 4.0 SMART WATER MAGAZINE 4 March 2022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North-West Europe
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