Project main outputs achievement

3.01 Number of adopted or applied low carbon technologies

1. **PUMP CONTROL SYSTEMS (STARTS)**
2. **SCADA / AUTOMATION**
3. **SMART PUMP TECHNOLOGY (CONTROLS & PUMPS)**
4. **LIÈGE TESTING AND OVERARCHING OPTIMISATION**
5. **VARIABLE SPEED DRIVES (VSD'S)**
6. **ISO9906 CERTIFICATION**

1. PUMP CONTROL SYSTEMS (STARTS)

Green WIN extended the knowledge organisations have about the various pump start up options available that will deliver significant Co2 emission reductions in their pumping operations.

Green WIN trialled Soft start (digital), USB (digital) and Star delta (hardware / software) which are the three most common options used to start pumps. CRT's control panel, which embeds all three of these was tested in Liege to assess which option was most efficient for the Hidrostal pump they selected to operate at the Calcutt PS trial site. Technicians ran the pump several times on the Variable Speed Drive (VSD) to tune operation and check parameters and perform a test on all three starters.

Ensuring the optimal start up method may appear to achieve only marginal improvements but it is part of wider efficiencies that when aggregated or implemented as part of overall improvements to pumping 'regimes'.

Several reports produced refer to the importance of automated start-ups and the final assessment report sets out the suggested solutions involving this (where applicable) per trial site.

2. SCADA / AUTOMATION

In Green WIN partners were at different 'stages of the journey' regarding use of **S**upervisory **C**ontrol **A**nd **D**ata **Ac**quisition (SCADA). CRT were relatively ahead with this whilst VNF (to an extent) and WI largely lagged behind (but wanted to introduce such technology and processes). The project developed an extended knowledge of the SCADA / Automation options and encouraged partners and other WMO's to begin the roll-out at suitable sites.

Standard technology pump system controls have varying complexity, functionality, and cost. Control systems are typically built and programmed to the end users' specifications and involve multiple devices to enable a complete system, including Programmable logic controllers (PLCs), human machine interfaces (HMI), and SCADA.

SCADA is an interactive system comprised of software and hardware used to control and monitor pumps. Specifically, a SCADA system collects data from microcomputers such as PLCs and displays the information collected to the user through an HMI. The system is centralised and can remotely monitor and control a number of applications, such as a network of distributed pumping stations via telemetry.

PLCs are the most common application of pump control system. They gather system operating performance information and HMIs display it on the control panel or remote terminal.

HMI terminals use a keypad or touchscreen and are available in multiple configurations and sizes. System data is recorded in a database and transmitted in any configuration to provide system performance data and alarms in multiple formats.

3. SMART TECHNOLOGY (CONTROLS & PUMPS)

Green WIN tested the functionality of such systems, and in our reports and through the Greener Pumping Toolkit (GPT) explained the suitability, and opportunities (for smaller inland waterways managers) to install "intelligent" or "smart" pump CONTROL SYSTEMS which are becoming available on the market and that offer full control functionality in one economic, easily programmed unit.

We also explained how SMART CONTROLLERS **"**Intelligent Pump Station Management systems" reduce energy consumption, eliminate call outs, de-skill maintenance, provide information for predictive maintenance, allow quick retrofit to deliver benefits by scale, and enable smarter networks. In short, they provide all pump station control, communications, and data requirements 'in one box'.

They can control any manufacturers pumps, either directly or via VSD's. Can change set point profiles automatically or manually, locally, or remotely and monitor inflow, individual pump flow rates, total station volumes, give individual pump flow warnings and alarms, and records overflow events, time / volumes.

We explained how WMO's could start their journey - using the GPT to select the option(s) from these which suit their budget and ambition and reduce whole of life costs, and future proof (later) implementation of smarter networks (so this also links to *OVERARCHING OPTIMISATION*).

SMART PUMPS use above controllers to create the optimal flow. They feature remote control capability, integrated control system, motor efficiency, and built-in intelligence such as self-adaptive energy minimising functions, automatic adaption to different duty point, self-monitoring functionality, self-adjusting pump, sump, and pipe cleaning increases the reliability of the pump and helps lower the total cost of ownership by reducing unplanned maintenance. 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%.

Most obvious feature / difference is that a pumps processor, software, electronics, temperature sensors and power electronics are embedded in the pump - 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 such impacts and cooling is compact and stable.

The in-pump processor utilises the power electronics feature to achieve variable pump performance, to meet the demand at hand. Sensors and software functions are built into the electronics to constantly monitor key electrical parameters and the motor and circuit board temperatures.

Waterways Ireland developed plans to install smart control system(s) and pump(s) at Leinster Aqueduct and other sites in due course. Lessons from this exercise were built in to reports and will be added as case studies in the GPT.

4. LIÈGE TESTING AND OVERARCHING OPTIMISATION

Green WIN developed and our reports explained the 'intelligent thinking' around wider 'overarching' optimisation of pumping on our smaller inland waterways. The concept of interlinking operations (thus achieving efficiencies) seems obvious – but this has to date not been commonplace - in reality organisations have focused on local needs / solutions and the costs or scale of works needed to introduce this have proved prohibitive.

Liège used the Kennet and Avon Canal (K&A) modelling report and analyses to develop a hybrid modelling approach in Green WIN. The experimental 'test bench' used for calibrating a computational model of the whole system, including the motor, the pump, and the hydraulic setting.

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.

5. VARIABLE SPEED DRIVES (VSD'S)

A suitable tool to evaluate the actual on-site energy efficiency of pumping systems used in waterways was missing. Pump manufacturers generally provide detailed information on a curve of pump efficiency at *nominal* rotation speed only. Little or no information is available concerning off-design pump operation for varying speed, while VSD's enable increased overall efficiency of the pumping system. Precisely what matters for the end-users.

A VSD controls the flow of energy between the electrical supply and the motor by adjusting the frequency and the voltage based on the current process demands, allowing energy savings.

Greener VSD technology has progressed in recent years with improvements in efficiency, harmonic filtration, set up, and smart energy saving functionality. Emerging innovations of applying VSDs with IE5 permanent magnet motors promise greater energy benefits through reduced losses. The correct selection and application of VSDs is important to ensuring reduced energy consumption.

Green WIN showed how organisations can identify the efficiency of VSD's. Our report (1.7.1) setting out what was done in trials calculates and shows the magnitude of the performance of VSD's and how this impacts on the pump's performance. It describes the process and a sketch of the equipment / instrumentation set up used to calculate efficiencies. Some 'in lab' tests were needed to identify any "losses in the chain of transmission" occurring through VSD use. The lab added extra equipment to test the efficiencies of electric currents etc needed / used in VSD drives which is explained in the report.

6. ISO9906 CERTIFICATION

ISO 9906 'characterisation' is something that's only come to the fore recently, but by refining their test regime, Liège give organisations wishing to test pumps / controls the assurance that they offer this additional service.

In Green WIN we demonstrated how (relatively) straightforward it can be for organisations to achieve ISO9906 certification. This standard defines test acceptance grades for pumps and its purpose is to define a technical agreement between the pump user and the manufacturer over the pump specifications.

The pump test bench performance was compared to the requirements specified in the standard. Liège refined the methodology for testing of pumps so that their test plan was (and will continue to be) based on such industry recognised testing standards i.e. ANSI/HI 14.6, 11.6, and / or ISO 9906.

Our T1.8.1 report contains an overview of the standard, its limitations, how the Liège test bench' results compared favourably and how they were equally reliable as 'industry standard' testing carried out to allow certification. It proved our measurements are sound enough to apply to all the lab testing carried out to date - and importantly in future. The report was based mainly on Liège lab 'experience', but we extrapolated data to provide (industry) acceptable results.