SELECTED SCALLOWAY'S ENERGY DATA MONITORING EQUIPMENT

E-Harbours towards sustainable, clean and energetic innovative harbour cities in the North Sea Region

The Interreg IVB North Sea Region Programme
Investing in the future by working together for a sustainable and competitive region

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ACKNOWLEDGEMENT

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GLOSSARY

NSS	Net Service Shetland	CAPEX	CAPital EXpenditure
NSR	North Sea Region		

EXECUTIVE SUMMARY

This report has been carried out as part of a pan European project called **E-Harbours, E-Logistics in NSR Harbour Cities**, awarded by the Interreg IVB North Sea Region Programme.

The report describes the selected monitoring hardware selected for installation at Scalloway harbour. It presents some of the rationale behind the hardware selection and the different data that will be acquired through the monitoring exercise.

The data loggers have been selected on a cost versus data output basis and harbour downtime. In selecting the hardware, special attention was given to future application of the Scalloway energy monitoring strategy (report 6) in other larger North Sea Region (NSR) harbours. As such, CAPital EXpenditure (CAPEX) for acquiring the monitoring hardware was handled with care for Scalloway harbour. In doing so, and when the remote monitoring strategy would be applied in another larger NSR harbour, the cost of the monitoring hardware (CAPEX) would be acceptable to the local harbour community for investing in the strategy.

In addition to the above financial care, it was important not to reduce the quality of the data logged through purchasing of 'low cost' loggers which do not fulfil the energy monitoring requirements. Though cost was the major factor in selecting the monitoring hardware, the main characteristics of the loggers were also taken into consideration. The outcome was simply a good balance between getting the most favourable data loggers with the required output data at the most favourable CAPEX.

Of importance, operation downtime has been identified as a major issue in a harbour. As such all data loggers have been selected with the view of reducing downtime. In some cases, when downtime is not allowed, non-disruptive equipment was acquired.

In summary, the selected energy monitoring data loggers presented in this report allows the widest replicability of the energy monitoring strategy in other harbours. This is accomplished by applying a good balance between acquiring the best value hardware as well as obtaining the required quality data from the logger. This is further accomplished through the acquisition of non-intrusive hardware to reduce downtime in a number of critical applications.

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INTRODUCTION

The analysis of the electricity bills has been described and provided in a previous report (report 7). This has provided an initial understanding of the energy related activities and performance linked to each and every Scalloway harbour's organisation. This initial energy analysis was critical for allowing the selection of a number of key harbour points for monitoring (high energy points). Following a periodic logging of these key monitoring points, a more detailed understanding of what is occurring at a given harbour energy point can be derived. This will then provide a real life energy behavioural analysis of the Scalloway harbour`s organisations.

This report provides a summary of the selected, designed, developed and installed data monitoring systems for the Scalloway Harbour Showcase. The ultimate goal is to document and disseminate the different types of data loggers chosen for installation in the Scalloway harbour so that, in the future, these can be easily applied to other harbours of similar size, but also large scale harbours at European level and beyond.

Therefore this report describes the required hardware and monitoring system to be used at the Scalloway harbour. The different data loggers selected are regrouped in four clusters:

- Energy data loggers with the aim to log current, voltage, frequency and the power factor (cos Φ).
- Weather data which monitor the wind speed, wind direction, solar radiation, ambient temperature, wind chill, humidity and precipitation.
- Indoor room temperature and humidity measurements loggers.
- Thermal imaging equipment for logging buildings thermal activity (in this case the logging equipment is to determine the thermal losses of a given building).

Logging, then analysing and associating all the above data will provide critical information regarding the electrical, weather and thermal performance of the different buildings and process within a harbour. Of key significance, it is anticipated that the weather data logged during this project will lead to very important conclusions about the potential for the installation of renewable energy systems, but also allows clear conclusions to be drawn re-energy requirements during given weather conditions (windy, sunny day, and others).

Two main criteria have been identified as vital for the selection and installation of the monitoring hardware. These are:

- Required installation time: the hardware must be easy to install to reduce downtime so that the harbour's organisations are not affected by the monitoring system.
- Cost and performance: substantial amount of equipment have many features (GPRS, etc.) that are appealing to a monitoring system designer. These features are nice, but in many times not necessary and with a substantial associated cost. Therefore, one must look at the cost escalation that this equipment may have on a project and how it may adversely affect the go ahead decision if used.

The design of the proposed data monitoring system have taken the above two criteria so that the selected data loggers can be used in other harbour set up at minimal costs, with low operation interference and high performance achieved. Of importance, other data loggers can be selected in different circumstances as long as the above criteria are taken into account.

The monitoring equipment proposed for this project are the following:

- Energy meter: Northern Design - *Cube 400IP* System Meter
- FLIR Camera: b60 Flir System
- Weather station: Davis Instruments – Vantage pro 2
- Temperature and humidity sensor: Omega OM-EL-USB-2 Temperature, Relative Humidity, Dew Point data logger with USB Interface

Through this report, harbour masters, harbour owners, harbour policy makers and harbour business organisations will be able to learn and select effective energy data monitoring equipment. This will support them in their chase for identifying and analysing their energy consumption and target with great effectiveness their emissions high consumption spots.

This report is therefore divided into eight (08) sections. The first section of the report provides the aims and objectives. The second section describes the purpose of the energy monitoring equipment. The third section proposes the communication technology for data logging. The fourth section describes the selected energy meter. This is followed by the selected FLIR camera. The sixth section summarises the rationale behind the installation of a weather station and briefly describe the selected station. In the seventhes section, the temperature sensor for NSS is described. This is then followed by a summary of the different monitoring equipment installations.

AIMS

The E-harbours Project as a whole aims to create a lasting change towards sustainable energy logistics for North Sea Region harbour cities. It aims at setting innovative energy standards to create a transformation of the energy network in harbour areas.

This report intends to provide a summary of the selected data logging equipment. Specifically the loggers have been selected for installation, as part of the e-harbour NSR project, one of Shetland Islands' most well know harbour, that is Scalloway Harbour.

The monitoring data logger described can be used in any other, NSR, European harbour and beyond to develop the future harbour's energy profiles, with the aim of reducing energy consumption and increasing renewable energy, smart grid and VPP usage.

The monitoring equipment proposed in this document can be universally applicable to any small, medium and large harbour.

Of key significance, the pieces of monitoring equipment have been selected to support the future installation of data loggers in other NSR harbours. This was achieved by a cost, quality and replicability driven methodology which shall lead to a quick and effective decision-making process for installing monitoring systems.

OBJECTIVES

After reading this report, the reader should be able to:

1. Select and acquire data loggers from the ones described below.
2. Understand the different defining factors that need taking care for selecting a logger.
3. Have a clearer understanding of the data loggers outputs.

PURPOSE OF THE ENERGY DATA LOGGERS'

Energy data loggers are the key hardware equipment for monitoring the energy consumption of any harbour in general and for monitoring Scalloway harbour's energy profile in particular. They can be used to monitor specific processes or buildings of the harbour, collecting and storing electrical data, such as voltage, current, frequency and the power factor. Analysing these data using graphs, curves and schematics can reveal trends, anomalies, sudden increase and decrease in power consumption, hence allowing for modifications and improvements to the energy system in place.

Therefore the below sections present a technical description of the different hardware monitoring equipment proposed for the Scalloway harbour. It describes the different monitoring technologies available, when appropriate provides a comparison and a rational for selecting a given type equipment.

PROPOSED COMMUNICATION TECHNOLOGIES FOR MONITORING ENERGY

Two methods of acquiring and storing the data have been shortlisted. These are: MODBUS and Internet Protocol. MODBUS is a serial communication protocol used in many energy meters to collect and transfer logged data to a local data logger. The term local is important here. In this case, the data acquired in the field is logged on a local hard drive. In most cases the drive is a common hard drive found in a computer. This data is then taken away periodically by local staff for further analysis at a later stage.

Internet Protocol, on the other side, is used to collect data from an energy meter and upload it directly to a remote web server. In essence, any logged data are transferred using communication technologies (Wi-Fi, etc.) to server and saved/stored on that particular server. In this way the monitoring procedure is much more flexible because, a user can access the system from any place using an internet connection.

Table 1 compares the two proposed technologies for acquiring and storing the data. In most harbour cases, very little availability of internet communication technology will be available. Therefore as a worst case scenario, it was important to test and select a technology that can be applied in any possible scenario and it is affordable. Therefore, a MODBUS approach was chosen over the internet type protocol communication to support the data monitoring of the Scalloway harbour.

MODBUS	Internet Protocol

If not selected properly, it may requires software development efforts to store data	Require no software development
Lower cost energy meter	Higher cost energy meter
Requires supporting equipment on site (storage system such laptop or computing tower)	Doesn't require supporting equipment on site if internet connection is available
Requires no internet connection	Requires internet connection close to the installation
Requires a visit to the site to acquire the data	Meter accessible from remote places
If a storage system breaks, then only the data associated with that storage system is lost	If the internet communication is broken, then all data is lost till communication is re-established

Table 1 – MODBUS and Internet protocol

SELECTED ENERGY METER

The energy meter must be able to data log the different electrical power consumptions across the Scalloway harbour. The energy meter shall log:

- Current
- Voltage
- Frequency
- Power factor (cos Φ).

The selected energy data logger is the Cube 400 IP system meter from Northern Design electronics. A picture of this meter is shown in Figure 1.

This meter has been selected for the following reasons: (a) there is no need for developing any software and any communication interfaces to operate the data logger; (b) in field data to be monitored can be logged and saved just after the onsite installation of the meter is finalised (no network issues or configuration setup are required); (c) installation of this data logger is simple; (d) the data logging very reliable; (d) it is a highly affordable meter; (e) the meter is fitted with a standard RJ45 connector which simplify its installation and connection to a local computer; (f) it combines both local and remote features, which allow the meter to be used in a harbour that has a network for remote monitoring and a harbour that does not have access to a network, where the data is saved on a local storing device such as a hard drive.

The main technical characteristics of this meter are as follows:

Network Interface:

- RJ45 Connector, 10 BaseT, Cat5 Cabling

IP Protocols:

- FTP, TFTP & SNTP, MODBUS® TCP, Fixed IP address (User, configured), DHCP & SNMP in development

Web Server:

- HTTP, HTML Format, SVG for dynamic graphics, 8 split Direct, Display Pages, Additional user-configured pages can be added, 'Excel Web Query' Page, Network Configuration Page, Meter &, FTP Data Transmission Configuration, Page

Time:

- A software real time clock is integrated, synchronized to local or global time server using the SNTP protocol

Meter Inputs:

- Voltage: 230/400V Standard, 63/110V, 120/208V & 277/480V Optional
- Current: Standard Meter 5 Amp (or 1 Amp), Retro-fit Meter to suit Split Sensors
- Frequency: Fundamental 45 – 65 Hz, Harmonics to 30th at 50Hz, Individual To 15th
- Aux Supply: Standard 230V ± 15% 50/60Hz, Optional 110Vac; 24, 48 or 110 Vdc

Meter Options:

- Digital Inputs & Outputs: 2 digital Inputs for external pulsing devices or status**,** 2 digital for Alarm or local control

Figure 1 – The ND Cube 400IP System Meter

ENERGY METER ADDITIONAL COMPONENTS

In addition to the above energy data logger, each meter requires some additional components to operate in the field. These are:

- Current clamps to measure the current. The selected clamps are dual clip type, converting 300 Amps to 5 Amps. Selecting a current clamp instead of a hardwired shunt type measuring system allows reducing the installation time and there is no need for shutting off the operation. Though clamps are a little more expensive than current shunts, the cost of interrupting a harbour operation is more expensive than buying the clamp itself. This was taken into account for this showcase and shall be taken into account for other installations. Thus, with a clamp there is no need to connect the meter with a shunt.
- A voltage probe to log the voltage.
- An enclosure for protecting the meter as the meter may operate in a harsh environment and its setup may be modified by visitors (if not enclosed). The enclosure

selected has the following dimensions: 220 x 150 x 150mm.

- A cable to connect the current clamp and the voltage probes with the data logger.
  - Cable glands (in this case 20mm) for data logger's enclosure.
- A laptop with FTP server installed where Internet connection is not available.
- An Ethernet CAT 5 cable to connect to the Ethernet socket of the meter and the laptop for storing the data. If internet is available, then the CAT 5 is to be connected to the server.
- Ethernet crimps
- 240VAC Main power supply for the meter

SELECTED FLIR CAMERA

Thermal imaging (or infrared thermography) is a technology that is now being used to visualise thermal losses of a building. It allows visualising the points where heat escape in a building, hence providing a means to define areas on a particular building where energy efficiency measure are required.

The FLIR (Forward Looking Infra-Red) technology has initially been developed by the US army for military operation. FLIR Systems are well known and is also a brand for thermal imaging cameras. Unfortunately, the cost of a single camera can reach some tenths of thousands pounds. Thus, for the Scalloway showcase, it was chosen to hire a thermal camera instead of purchasing a new one.

Three (03) UK companies were contacted for quotations. It was decided to hire the FLIR Systems B60 model for costings and technical features reasons. This camera is shown in figure 2. The most important characteristics of the B60 camera are (FLIR Systems[1]):

- Digital Camera: 2.3 Megapixels with built-in LED lights provides sharp images regardless of lighting conditions
- Picture in Picture (PiP): Displays resizable IR image super-imposed over a digital image
- Wide Temperature Range: from -20°C to +120°C
- MeterLink™: Wirelessly transmit data from clamp or moisture meter to your infrared camera
- ± 2% Accuracy: Reliable temperature measurement
- Insulation alarm: Shows the insulation performance of the building structure
- Dew point alarm: Alerts you to the areas where there is a risk of condensation
- Annotations: Record voice comments via Bluetooth wireless headset
- Laser Pointer with marker in IR image — Accurate positioning with marker in the IR image
- Micro SD Card: Stores more than 2000 radiometric JPEG images
- Copy to USB: Upload images and measurement findings to USB stick

1 http://www.flir.com/uploadedFiles/Thermography_APAC/Products/Product_Literture/FLIR_b60%20APAC.pdf

Figure 2 - B60 FLIR Systems IR Camera

WHY A WEATHER STATION IS NEEDED FOR SCALLOWAY SHOWCASE?

In order to evaluate the renewable energy potential of Scalloway harbour, it is important to have up to date and accurate weather data.

There are many weather parameters that have to be monitored like wind speed, wind direction, solar radiation and others. In addition, several conclusions on the thermal performance of the building can be drawn by monitoring ambient temperature, precipitation, humidity and wind chill and a correlation between energy consumption and weather data could be drawn.

Analysing weather data in conjunction with energy consumption can support the appropriate sizing of a wind turbine capable to some of the energy supply to many harbour organisations. It can also support the sizing of a PV system for a particular process. In addition, the weather information can be used to calculate the capacity factor of a proposed renewable energy system solution. Therefore, a weather station can help in:

- Sizing a renewable energy solution
- Computing anticipated generation
- Defining the type of renewable energy solution that needs to be installed to support the needs of the harbour at a given season of the year
- Supporting the decision making for a smart grid system

EXISTING WEATHER STATION

At the start of the e-harbour project, Scalloway harbour had an operational weather station. The Pure Energy® Centre collected the station's weather data as far back as 2008. This included wind speed, wind direction, maximum gust and tide height.

The above wind data is enough to devise wind yearly and seasonal patterns. From these, it is possible to conclude on the potential for electrical generation from a wind turbine at the Scalloway harbour site. The issue with the existing data produced with the available weather station was the lack of measurement for irradiance, temperature sensor for the main harbour office, water rain and other data. Also it was found that it was not cost effective to upgrade this station with irradiance, humidity and other sensors. The purchase of a new weather station was almost the same price as to the upgrade. This is why it was decided to install a new weather station.

SELECTED WEATHER STATION

Most harbours near the sea are subjected to salted environments and storms. Salt and strong winds can therefore be serious problems for a Shetland weather system installation, and this was taken into account when selecting a station.

A large variety of weather sensors and weather stations are available on the market, all of them having extra different features to choose from. Two main options were identified for installing a weather station: (a) build a weather station by purchasing several sensors and a data logger; (b) purchasing a complete packaged weather station. Because building a weather station by purchasing many sensors and other parts may lead to uncertainties in the time it takes for manufacturing it, it is decided to purchase an off the shelf weather station.

The weather station selected for Scalloway Harbour Showcase is the Vantage pro 2. This station is shown in figure 3. It is a wireless weather station displaying and recording barometric pressure, temperature, humidity, solar radiation, rainfall and wind speed. It also gives values such as wind chill and dew point. The weather station does come with UV sensor (at extra cost). With this station, it is possible not only to log the data, but also to display all measurements on a World Wide Web (WWW) page.

The most important technical features of the Vantage pro 2 weather station are as follows (Davis Vantage Pro2[2]):

- **Outdoor Unit:** The unit includes the tipping bucket rain collector and the radiation shield for the temperature / humidity sensor. The tipping bucket mechanism records rain every 0.2mm and is chrome plated to reduce loss through evaporation.
- **Wind sensors:** Wind Speed can be displayed in mph, knots, m/s or kph (range: 2 to 150 mph). Wind Direction can be

2 http://www.davisnet.com/weather/products/weather_product.asp?pnum=06152

displayed using a 16 point Compass type system or from a 0° to 360°.

- **Temperature range:** -40°C to +65°C displayed in °C or °F.
- **Relative Humidity range:** 0% to 100%. Rainfall in mm or inches and rate in mm or inches per hour. There are also calculated values for wind chill, dew point and heat index.
- Additional sensors and stations are available for Solar, UV, temperature, humidity, soil moisture, soil temperature and leaf wetness.
- **Dimensions:** 350 x 220 x 360 mm
- **Batteries:** 1 x LR123 lithium back up battery needed. Ordinarily this should last 2-3 years.
- **Power:** Solar powered.
- **Software:** Can be used on a PC and Mac. This will collect time stamped data from the station at intervals from 1 minute to 2 hours.

The weather station includes an indoor unit for real time data display but it was found that this is not an important criterion to be taken into account for Scalloway. Therefore this display was not ordered.

Figure 3 - DI Vantage Pro 2 Weather station

TEMPERATURE SENSOR FOR NET SERVICE SHETLAND (NSS)

Net Service Shetland (NSS) net drying room must be monitored due to its high energy consumption. The temperature and humidity inside the drying room have to be balanced and maintained at the right level so that the process of net drying is deemed successful.

The cost to produce the quality hot air for drying the nets is high. About 5,200 litres of oil consumed per month. The consumed oil is used in an oil boiler.

To reduce the consumption and define a course a course of action, two main points need to be addressed:

- The heat losses of the net room.
- A better consumption and utilisation of the boiler.

The below two sensors will help in investigating and analysing the above two points:

1- Using a FLIR camera described above will reveal potential insulation weak points (losses) around the room and will identify the worse points for heat losses / leakages.
2- A temperature sensor with a data logging system will provide more information regarding room temperature versus time and weather change.

PROPOSED TEMPERATURE SENSOR TECHNOLOGIES

Two main technologies are available for the temperature and humidity sensor:

- A temperature sensor using MODBUS communication technology. This is a sensor which logs and stores temperature data. It uses a MODBUS protocol to transfer the data onto an electronic data storage system (e.g., hard drive or other). This sensor can be used in conjunction with a laptop computer, the computer acting as the storage medium for the data.
- An all in one temperature sensor data logger. In this configuration, the sensor and data logger are manufactured into one single device. This all in one device generally comes into the form of a USB type key.

The sensor can be programmed to make measurements periodically, depending on the needs of the project. It has been estimated that a proper sampling period for temperature is 5 minutes. Using this sampling period the sensor can store temperature data for more than three months. Data can be collected by visiting the NSS and downloading them to a laptop using its USB socket. When download is complete, the data logger is emptied for another three more months of sampling.

It is very important that the USB temperature sensor is powered by a battery so it can be placed anywhere in the room. The battery's life is typically one year so it can easily cover the three month sampling period.

Finally, the low cost of the all in one sensor and its simplicity are the reasons why it has been selected for Scalloway harbour project.

SELECTED TEMPERATURE AND HUMIDITY SENSOR

Omega OM-EL-USB-2 is the sensor selected to monitor the temperature of the NNS net drying room. The sensor has the ability to take measurements for relative humidity and dew point via windows software. The sensor is shown in figure 4. Below are the key features of the sensor (Omega Engineering Limited,[3]):

- **Temperature:** -35 to 80°C (-31 to 176°F), Resolution**:** 0.5°C(1°F), Accuracy**:** ±0.5°C (±1.0°F)
- **Humidity:** 0 to 100% RH, Resolution**:** 0.5% RH, Accuracy at 20 to 80% RH**:** ±3.5% RH
- **Dew Point:** overall error in the calculated dew point for RH measurements from 40 to 100% RH @ 25°C: ±2°C (±4°F)
- **Memory**: 16,000 temperature and 16,000 relative humidity readings
- **Logging Interval**: 10 seconds to 12 hours
- **Operating Temperature Range**: -35 to 80°C (-31 to 176°F)
- **Alarm Thresholds**: High/low alarm thresholds for % RH and temperature, selectable in software
- **Start Date/Time**: Selectable in software
- **Status Indicators (LEDs)**: Red and green
- **Software**: Windows 98/2000/XP/VISTA
- **Power**: 12 AA 3.6 V lithium battery (included)
- **Battery Life**: 1 year typical (depends on sample rate, ambient temperature and use of alarm LEDs)
- **Weight**: 57 g
- **Dimensions**:103mm X 26.4mm

[3] www.omega.com/pptst/OM-EL-USB-1.html

Figure 4 – Selected temperature Sensor

SUMMARY INSTALLATION OF THE SOME OF THE MONITORING EQUIPMENT

The below sections illustrates some of the data logging equipment as installed at Scalloway harbour. The sections focus on SSF, Scalloway harbour office, LHD Ice factory, the weather station and the room temperature at NSS.

SSF ORGANISATION

SSF fish processing plant energy monitoring system contains:

- 1 energy meter.
- 1 laptop which receives and stores files from the energy meter through its Ethernet socket.
- 3 of 800/5 current clamps, one for each current phase.
- One CAT5 cable for the connection between the laptop and the energy meter.
- 2.5mm^2 cables for the sensors connections.

- Three (03) fuses for the voltage sensor protection.

The energy meter sends to the laptop one log file per day. This log file contains 24-hour measurements for 3-phase current, 3-phase voltage, cos Φ and frequency.

SSF has one energy data logger installed. It can be seen as one of the most important data logger because it monitors the fish plant facility which is responsible for the highest electricity consumption in Scalloway Harbour. Figure 5(a) shows the location of the energy data logger system before the installation. Figure 5(b) illustrates the energy data logger box with all the connections ready. In Figure 6(a), the current clamps can be seen installed around the cables. Finally, Figure 6(b) shows the complete system installed.

Figure 5 - a) Available area for energy data logger installation (left). b) Connections inside the energy meter box (right)

Figure 6. a) Current clamps (left). b) Fish Plant complete monitoring system (right).

SCALLOWAY HARBOUR OFFICE

Two energy data loggers have been installed in Scalloway Harbour Office. The first one installed in the fish market refrigeration plant to monitor the refrigeration compressors. The second monitoring system has been installed in the green shed where the shore-power electricity meters are located.

Both of the two monitoring systems are similar to the SSF monitoring system above. The only difference is the current clamps. In Scalloway Harbour Office the current clamps are capable to monitor smaller currents (500/5).

Figure 7(a) shows the available space for the installation of the monitoring equipment in the fish market. Figure 7(b) illustrates the energy meter connected to the electrical network of the refrigeration facility. Figure 8(a) shows the connected current clamp and Figure 8(b) is the complete monitoring system after the installation.

Figure 7. a) Available space for monitoring system (left). b) Fish Market Connection to the Electricity Network and energy meter (right).

Figure 8. a) Current clamp as installed (left). b) Fish market complete monitoring system as installed (right).

LHD ICE FACTORY

LHD Ice Factory organisation is a high electricity consumer due to two ice machines operating within the factory. It was decided to monitor both ice machines separately using two separate energy data loggers.

The LHD monitoring system is slightly different when compared to the aforementioned systems installed at NSS and Scalloway harbour office. The monitoring system first uses two data loggers (one for each ice machine), and then store all data onto one single laptop. In order to store data from both energy meters, and to recognise as well as identify these data at a later date, two different IP addresses for each energy meter have been used. A network switch to connect the two devices to one Ethernet socket has also been used. The LHD has the following equipment installed at their facilities:

- 2 energy meters.
- 1 laptop which receives and stores logged files from the energy meter through its Ethernet socket.
- 6 x 500/5 current clamps, one for each current phase of the two ice machines.
- 3 CAT5 cables for connecting the laptop and the network switch and the energy meters with the network switch.
- 2.5mm^2 cables for the sensors connections.
- 6 fuses for voltage sensors' protection.

Figure 9(a) shows the LHD ice machines' connection to the electricity grid. The single phase voltage is at this point is 400V. Figure 9(b) illustrates the complete data logger during testing. This enclosure includes the energy data logger the network switch and fuses for the voltage sensor. Figure 10 is the LHD Ice Factory monitoring system after the installation is completed.

Figure 9. a) LHD Connection to the Electricity Network – Installed Current Clamps (left). b) Energy Meter Box including the Network Switch (right)

Figure 10. LHD Ice Factory Complete Monitoring System

SCALLOWAY HARBOUR WEATHER STATION INSTALLATION

The weather station has been installed on the roof of Scalloway Harbour Office organisation using a lifting machine as shown in Figure 11(a). The anemometer has been fixed at 1.5 meters above the roof of the building for better measurements and least turbulence. In Figure 11(b) the weather station can be seen, fixed on the left mast.

The weather station includes a web page where the authorities can monitor the weather sensors real time. This can be found at the below link:

http://www.shetland.gov.uk/ports/scalloway/Current_Vantage_Pro_Plus2.htm

Once per day the weather station sends a summary report of the day weather conditions to a local computer within the Scalloway Harbour office. It also generates some graphs / diagrams of the weather conditions for that particular day.

Figure 11. a) Installation of the Weather Station (left) b) Installed Weather Station – left mast (right picture)

The temperature and relative humidity sensor have been installed in the net drying room of NSS organisation. The installation of this sensor is fairly simple as it does not require any integration work with the equipment on site neither any external power supply. It is totally independent and uses only a battery as a power source. The sensor has been set up to measure the temperature and the humidity every 5 minutes. In this way the battery will last for 50 days. Then the data from the sensor have to be downloaded to a laptop using the sensor's software and the battery has to be replaced for further monitoring.

Figure 12. Net Drying room where the temperature datalogger is installed.

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