SMEs Innovating with the Networks

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MD of ASH Wireless

ASH Wireless:
- Electronics design consultancy
- Specialists in wireless, low power and sensors
- Most projects involve condition monitoring, IoT
Celsius ENW NIC project

Awarded: 9th December 2015

- **Go live**: Monitoring installation Mar 2017
- **Monitoring trial**: Mar 2018
- **Thermal ratings tool stage 1**: Oct 2018
- **Retrofit cooling installation**: Jun 2018
- **Cooling trial**: Jun 2019
- **Thermal ratings tool stage 2**: Jan 2020
- **Closedown**: Mar 2020

- **£5.5 million** investment
- **Up to £583m across GB by 2050**

Financial benefits

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- **electricity north west**
- **RICARDO**
- **ASH**
- **Impact Research**
- **UK Power Networks**

Bringing energy to your door
### Partners and roles on ENW project

**Project Lead =**

<table>
<thead>
<tr>
<th>ASH</th>
<th>Ricardo</th>
<th>UK Power Networks</th>
<th>Impact Research</th>
<th>University of Southampton</th>
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</thead>
<tbody>
<tr>
<td>Supply complete retrofit monitoring solution</td>
<td>Analyse trial data: Develop methodologies to understand relationship between asset temperature, load characteristics and surrounding environment. Determine impact of cooling technologies. Develop tool and spec for low cost temperature sensor.</td>
<td>Work with ASH, Ricardo-AEA and Electricity North West to develop retrofit thermal monitoring solution. Participate in evaluation and selection of retrofit cooling techniques.</td>
<td>Facilitate customer focus groups. Develop customer communication materials. Lead the customer survey engagement.</td>
<td>Peer review of the analysis methodology of the retrofit temperature sensor part of the project. An investigative study on the impact of Celsius on the lifetime health of network assets.</td>
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<td>Provide ongoing support throughout installation, commissioning and operation of the retrofit thermal monitoring workstream</td>
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Step 1: Fit thermal monitoring

Asset

Internal temperature

External temperature

Environmental factors

Learning

Thermal coefficient

Deliverable

Thermal Ratings Tool

Benefit

More capacity
Trial Site map
Celsius
- Design Requirements

- Monitoring system can be installed non-invasively;
- All equipment magnetic or cable-tie mounting;
- All equipment battery powered for duration of data gathering project (3.5 years).
- All equipment wireless, only leads are those required to actually take measurements.
- Daily reports to back end. 30 minute measurements of V, I, P, Q, THD, Temperature
How to fit monitoring sensors when...

- No internet connection available
- No mains power available
- Can’t install wiring, mount equipment, etc without intruding on critical operations
- Hostile RF environment for radio connections, indoor, multipath, multiple monitoring points needed
- Need to minimise worker presence for safety reasons
K²LVN

- Substation Monitoring

Single Temperature Sensors

Low Power Radio Network

Hex 1
PMU

Hex 2
Ind. V,I,T

Hub 1

Hub 2
(optional)

Rogowski Coil

Voltage Sensor

Temperature Sensor

GPRS Backhaul

Mobile data link

Back End

Celcius

Sensor 1
Sensor 2
Sensor 3
Sensor 4
Sensor 5

WWW.ASHWIRELESS.COM
## Commissioning app

### CELSIUS: Site List

<table>
<thead>
<tr>
<th>Location</th>
<th>Type</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENE RD</td>
<td>Single</td>
<td>Transformer</td>
</tr>
<tr>
<td>Ash Wireless</td>
<td>Single</td>
<td>Transformer</td>
</tr>
<tr>
<td>TOWNEND FM M6</td>
<td>Hex voltage</td>
<td>LV Board</td>
</tr>
</tbody>
</table>

### Sensor Positions

1. **144409FA9D0E**
   - Component: Transformer
   - Type: Single Temperature Sensor
   - Position: Top Oil Temperature - Face 1

2. **0818D700CF9B**
   - Component: Transformer
   - Type: Single Temperature Sensor
   - Position: Bottom Oil Temperature - Face 1

3. **0F15832CF100:0**
   - Component: LV Board
   - Type: Hex voltage flying lead
   - Position: Voltage Phase 1
Celsius technology

KeLVN Hub

KeLVN Wireless sensor
Celsius technology – trial fit

LV board with three sensors
Celsius technology – trial fit

Transformer

40.0°C
Trial site data

Magda Rd 750kVA Transformer Load and Temperatures

- P1 kW
- P2 kW
- P3 kW
- Top Oil °C
- Inlet °C
- Outlet °C
- Bottom Oil °C

Temperature Degrees C

Real Power kW per Phase

Date and Time:
30/09/2016 00:00 to 02/10/2016 12:00
Battery Life

The Hub is an interesting challenge:

- Lithium D-cell, 10AH
- Over 3.5 years life
- Distribution of where the capacity is used:

  - KeLVN Hub battery usage
  - Daily GPRS data transfer
  - Quiescent: ‘off’
  - Sensor receiver window
Key learning points

The installation and environment defines

- Equipment design (e.g. magnetic mounting)
- Protocol (e.g. multiple hubs allowed)
- Installation procedure (fast, non-invasive)

GPRS modem auto-connect modes are not reliable, process needs detailed design

Alarms

- Not required in Celsius
- Low latency for alarms is managed with a hub software extension, and external power to the hub
Summary

Retrofitting monitoring equipment to legacy assets:

- Ease of installation is primary consideration
- Use of a local wireless sensor network eases installation
- Optimise air interface to manage trade off between latency, data rate, battery life
- Installation tool helpful to make sure equipment in operation/commissioned before team leaves site

Success of the project lay in focusing design & process on installation challenges.
Further development of monitoring solution

Explored with another DNO:
- Adding alarm capability to KeLVN
- Adding additional sensor types
  - Air Flow
  - Flood Level detect
  - Movement/Infrared detection
  - Smoke detection
- Back end limit/alarms
Adding Alarm capability to Logging

**KeLVN RT**

**Normal Operation**

- a) Add snapshot measurement every 30 sec
- 30 sec periodic transmission
- 12 x 30 mins readings
- Listening window of 1 minute every 6 hrs
- b) Retain 6 hour logging window.
- Always on listen for alarms
- Hub 1
- Standard report Once per day

- c) Every 6 hours report logging calls
- Add alarm reports on triggering threshold, command to request snapshot of all telemetry.

**Reverse Channel**

- d) Add settings of alarm thresholds per sensor

- Low Power
- Radio
- Network

- GPRS
- Backhaul
“Hot Substation” scenario

Play out fictional scenario, based loosely on UKPN Castle Square fire brigade call out.

Sequence of events leading to overheated/damaged transformer.

1. Ventilation failure
2. Power step change on major event (ice rink switch on) but in cold weather
3. Power step change following year, but in warm weather
4. Overheat, smoke, damage leading to reduced life
“Hot Substation” scenario