

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**



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



Investment

£5.5 million

Up to £583m across GB by 2050



Financial benefits

Partners and roles on ENW project



Project Lead =



Bringing energy to your door



Supply complete retrofit monitoring solution

Provide ongoing support throughout installation, commissioning and operation of the retrofit thermal monitoring workstream



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

Recommendations

for BAU rollout



Work with ASH, Ricardo-AEA and Electricity North West to develop retrofit thermal monitoring solution

Participate in evaluation and selection of retrofit cooling techniques



Facilitate customer focus groups

Develop customer communication materials

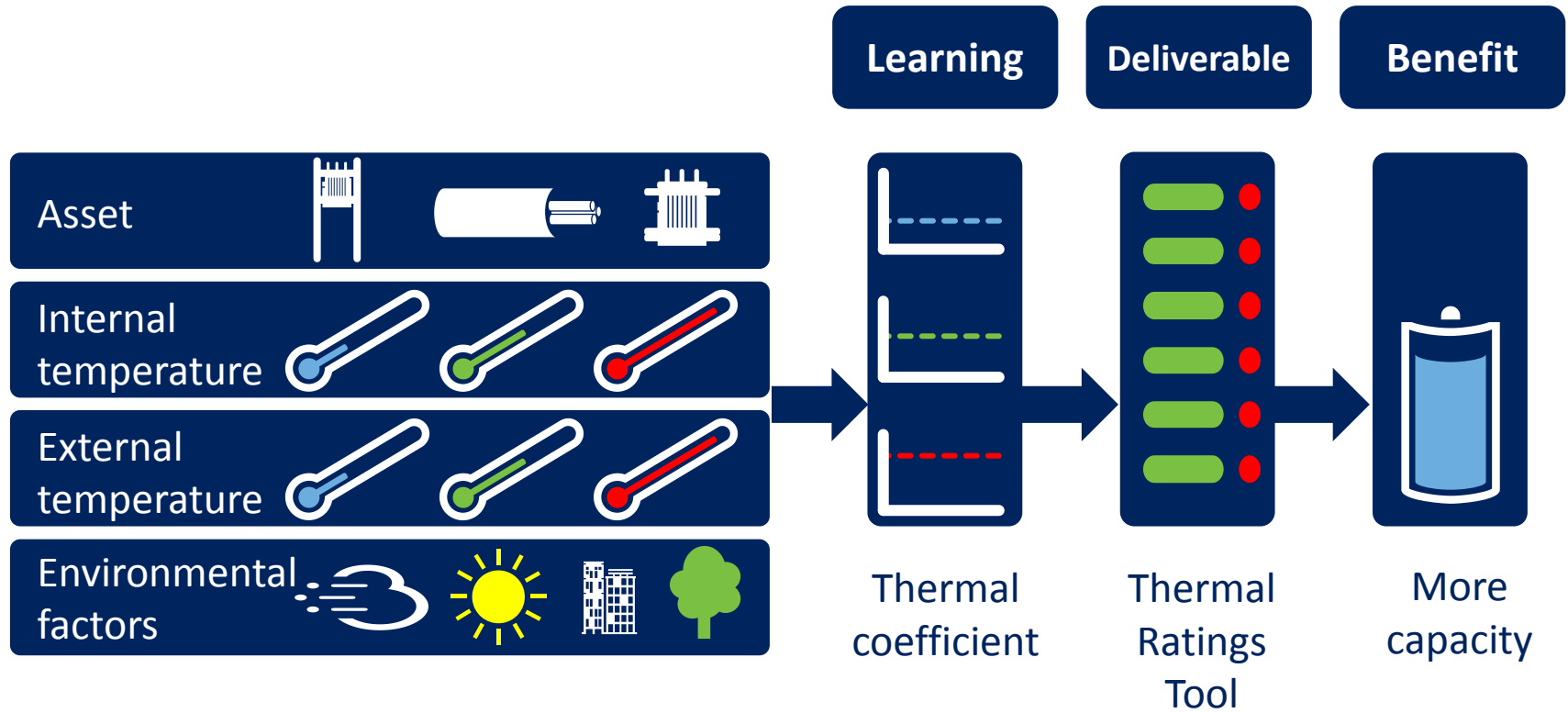
Lead the customer survey engagement



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

Step 1: Fit thermal monitoring



Trial Site map



electricity
north west

Bringing energy to your door



Celsius

- Design Requirements



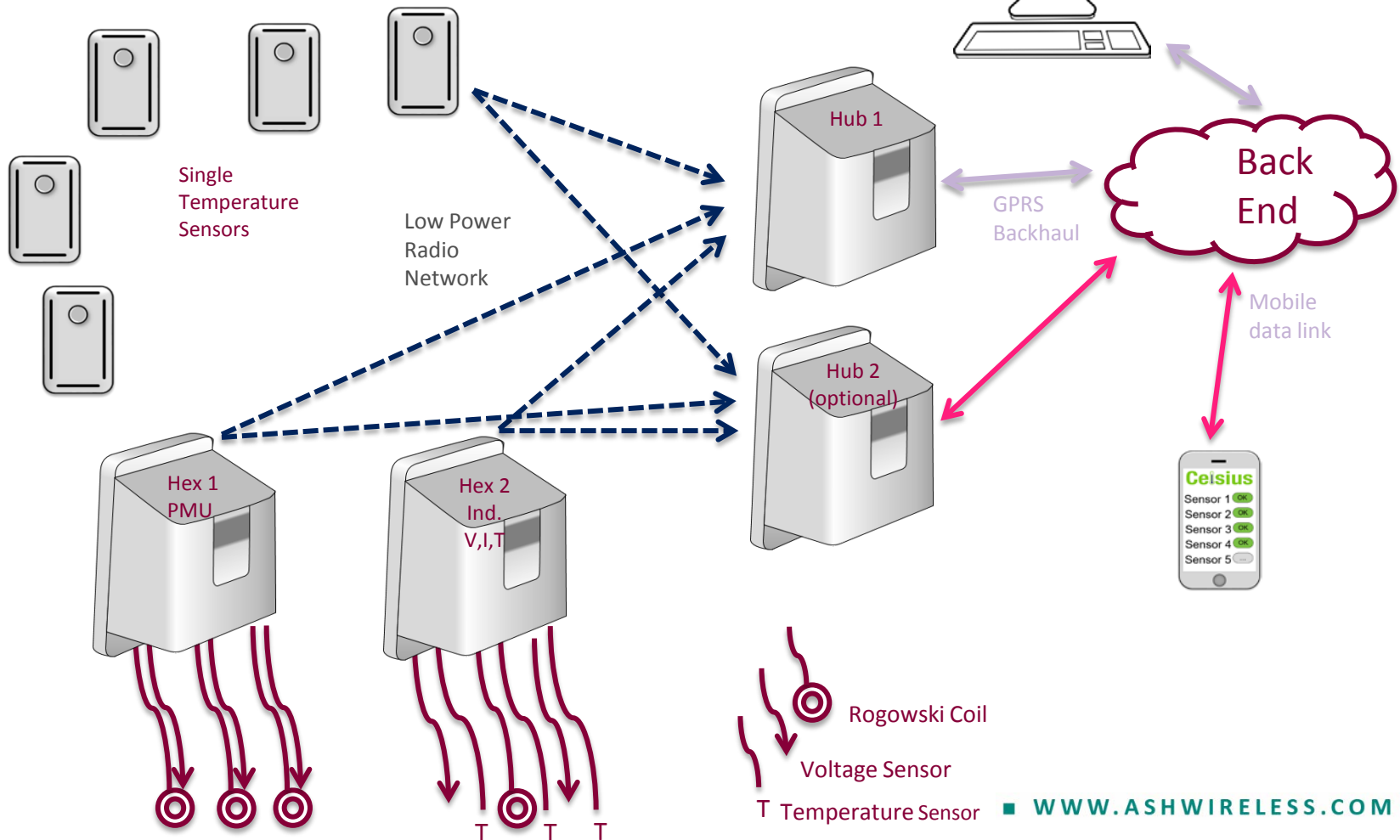
- **Monitoring system can be installed non-invasively;**
- **All equipment magnetic or cable-tie mounting;**
- **All equipment battery powered for duration of data gathering project (3.5 years).**
- **All equipment wireless, only leads are those required to actually take measurements.**
- **Daily reports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



- **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**

K^eLVN

- Substation Monitoring





CELSIUS: Site List Help

IN PROGRESS

DENE RD
ID: 171526
Location: DIDSBURY In progress >
Monitoring: Type 1
Region: Manchester (South)

Ash Wireless
ID: 1
Location: Southampton In progress >
Monitoring: Type 1
Region: Manchester (South)

**TOWNEND FM M6
SUPPLIES_11**
ID: 660360 In progress >
Location: Lowther

< >

CELSIUS: Hubs and Sensors Help

Sensor Positions

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

0818D700CF9B
Component: Transformer
Type: Single Temperature Sensor----- >
Position: Bottom Oil Temperature -
Face 1

0F15832CF100:0
Component: LV Board ----- >
Type: Hex voltage flying lead
Position: Voltage Phase 1

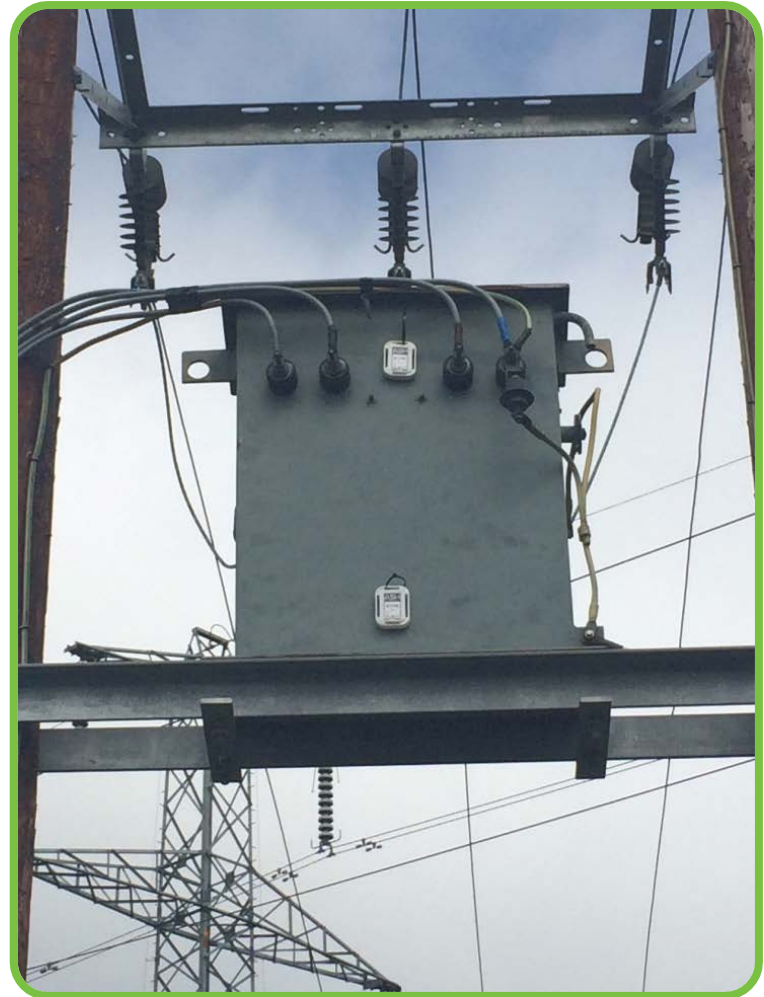
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K^eLVN Hub

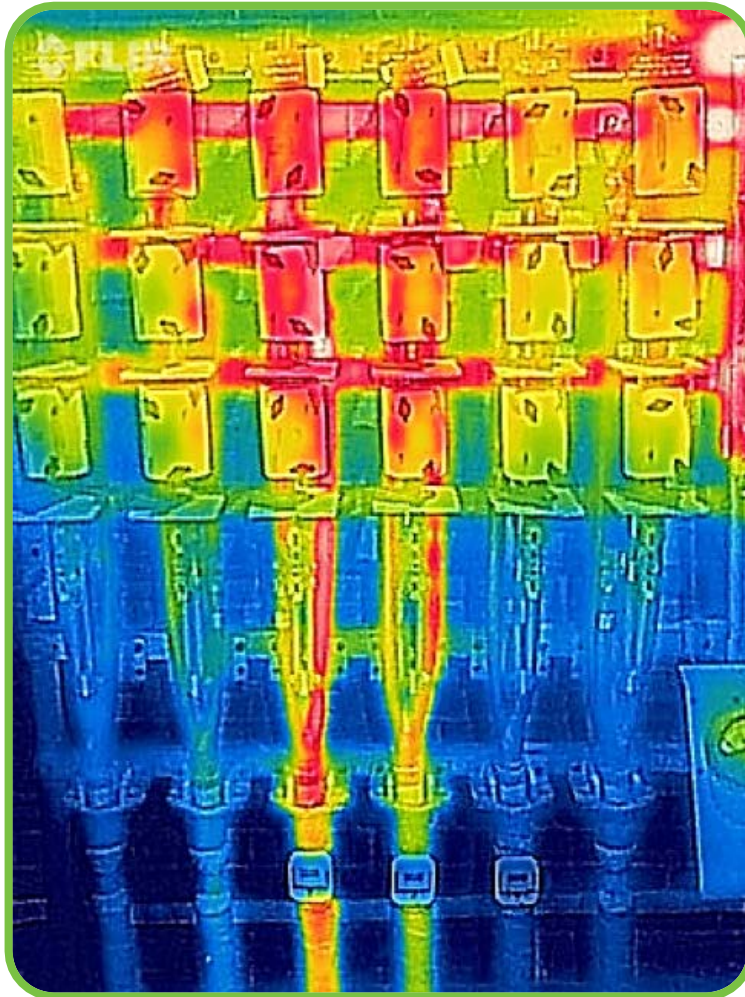


K^eLVN Wireless sensor





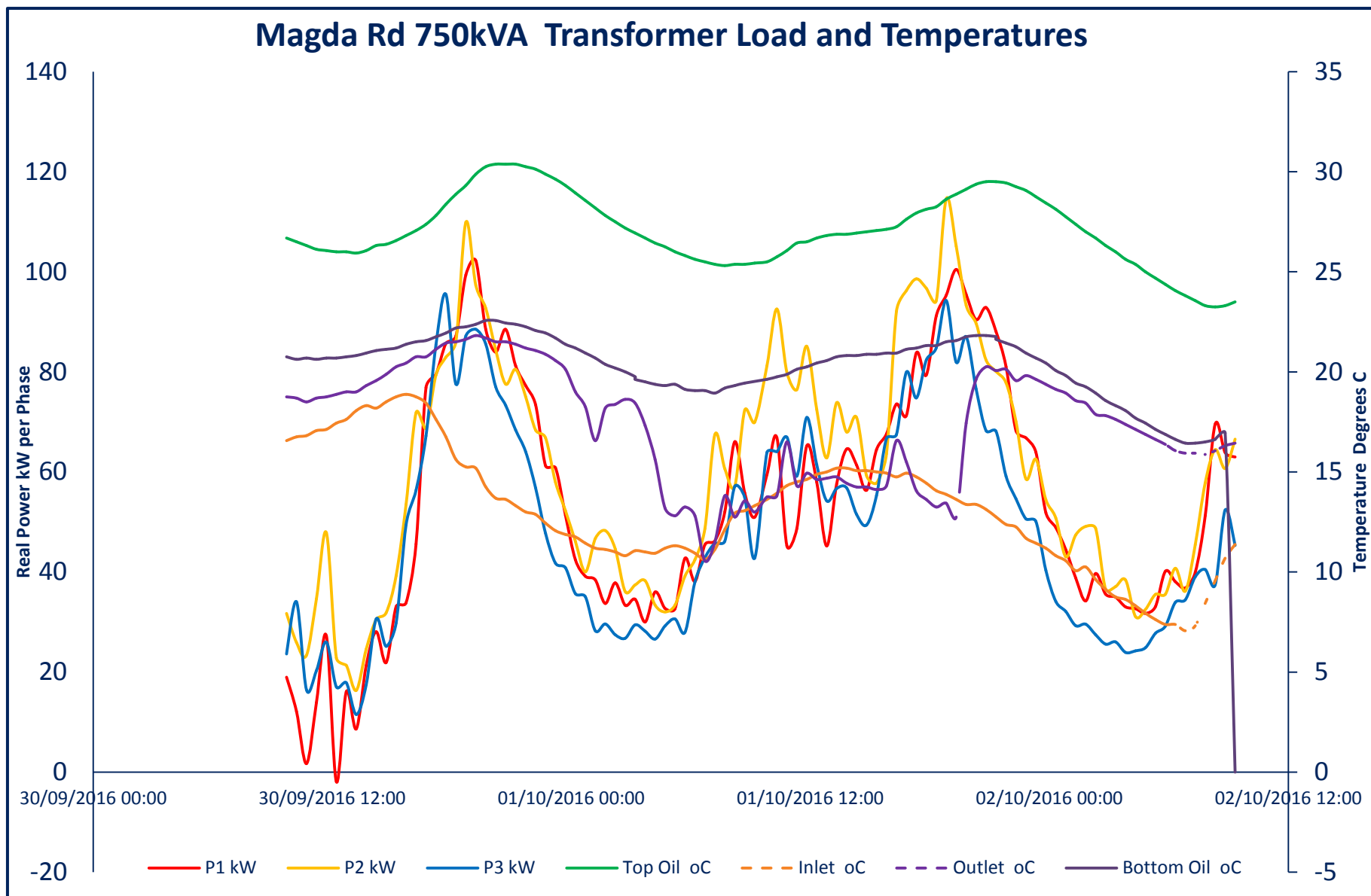
LV board with three sensors





Transformer

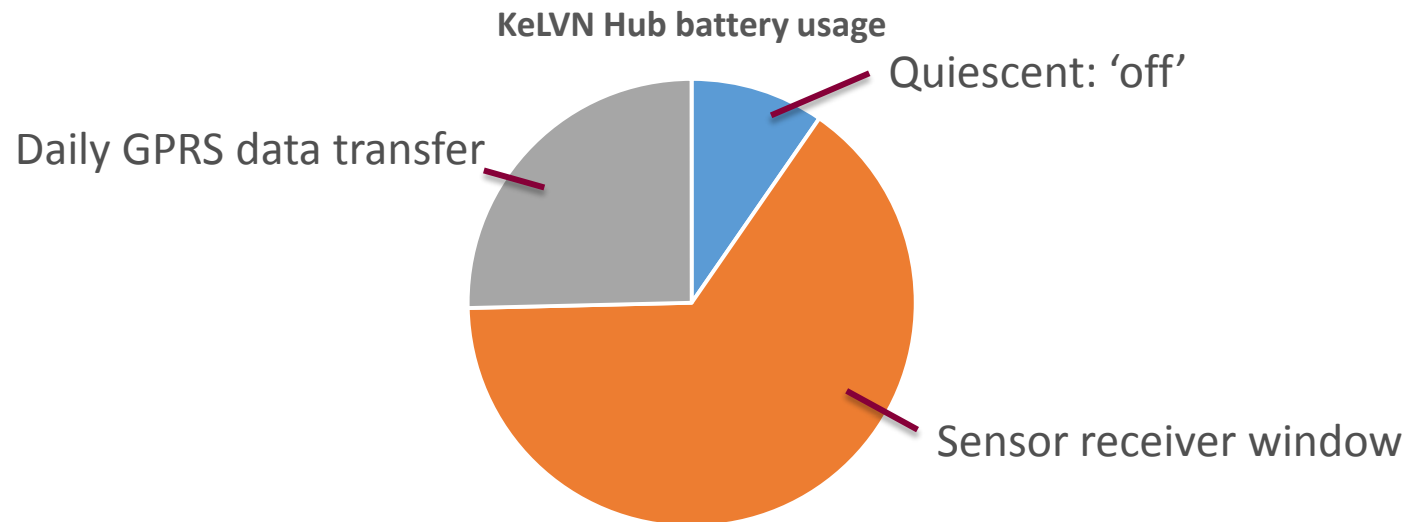




Battery Life

The Hub is an interesting challenge:

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



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

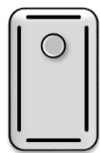
Explored with another DNO:

- 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 K^eLVN^{RT}

Normal Operation

a) Add snapshot measurement every 30 sec

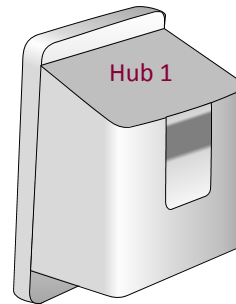


Sensors

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



Standard report
Once per day

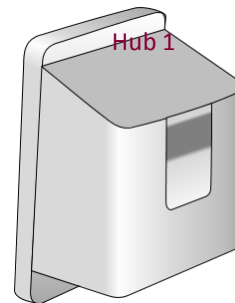


c) Every 6 hours report logging calls
Add alarm reports on triggering threshold,
command to request snapshot of all telemetry.

Reverse Channel



Low Power
Radio
Network



d) Add settings of alarm
Thresholds per sensor



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



KCRZ demonstrator back-end server

K°LVN RT

Alarms:

- Hex alarm of type OVER-VOLTAGE at 16:11:28
- Hex alarm of type TEMPERATURE at 16:11:28
- Hex alarm of type OVER-VOLTAGE at 16:11:58
- Airflow alarm at 16:12:27
- Hex alarm of type TEMPERATURE at 16:12:29
- PIR alarm at 16:12:34
- Smoke alarm at 16:12:52
- Smoke alarm at 16:12:53

Temperature Sensor:

Sensor Name: Temp_1
 Latest Reading: 22.9°C
 Sensor Address: 0c129c855435
 Received Time: 16:12:56

Hex Sensor:

Addr: 2317e50c69d2 Received time: 16:12:29

RMS	THD	Temp.	Type
0	251.0V	3%	Voltage
1	1.5A	3%	I-CT
2		62.2°C	Temperature
3			
4			
5			

Power:

	Real	Reactive
0	374.8W	-3.7W
1		
2		

Thresholds:

- Hex channel 2, alarm type Temperature, limit = 40
- Hex channel 0, alarm type Voltage THD, limit = 4
- Hex channel 0, alarm type Current THD, limit = 10
- Hex channel 0, alarm type Over/Under-voltage, max. = 244, min. = 240
- Hex channel 0, alarm type Over-current, limit = 3
- Hex channel 0, alarm type Power (Real), limit = 137
- Hex channel 0, alarm type Power (Reactive), limit = 50

Temperature alarm Overvoltage alarm
 Airflow alarm Undervoltage alarm
 Smoke alarm Over-current alarm
 PIR alarm Current THD alarm
 Water-level alarm Direct Power alarm
 Reactive Power alarm

MASTER ALARM

Hub COM port: COM1 [Serial] [Open] [Close] [Enable server]

Alarm Threshold Settings

Hex sensor Alarm on: Temperature sensors

Channel 2 TEMPERATURE > 40°C Temp_0 > 40°C

Channel 0 VOLTAGE THD > 4% Temp_1 > 41°C

Channel 1 CURRENT THD > 10%

Channel 0 OVER/UNDER-VOLTAGE > 244V RMS

Channel 0 UNDER-VOLTAGE < 240V RMS

Channel 1 OVER-CURRENT > 3A RMS

Channel 0 POWER (REAL) > 617W

Channel 0 POWER (REACTIVE) > 50W

