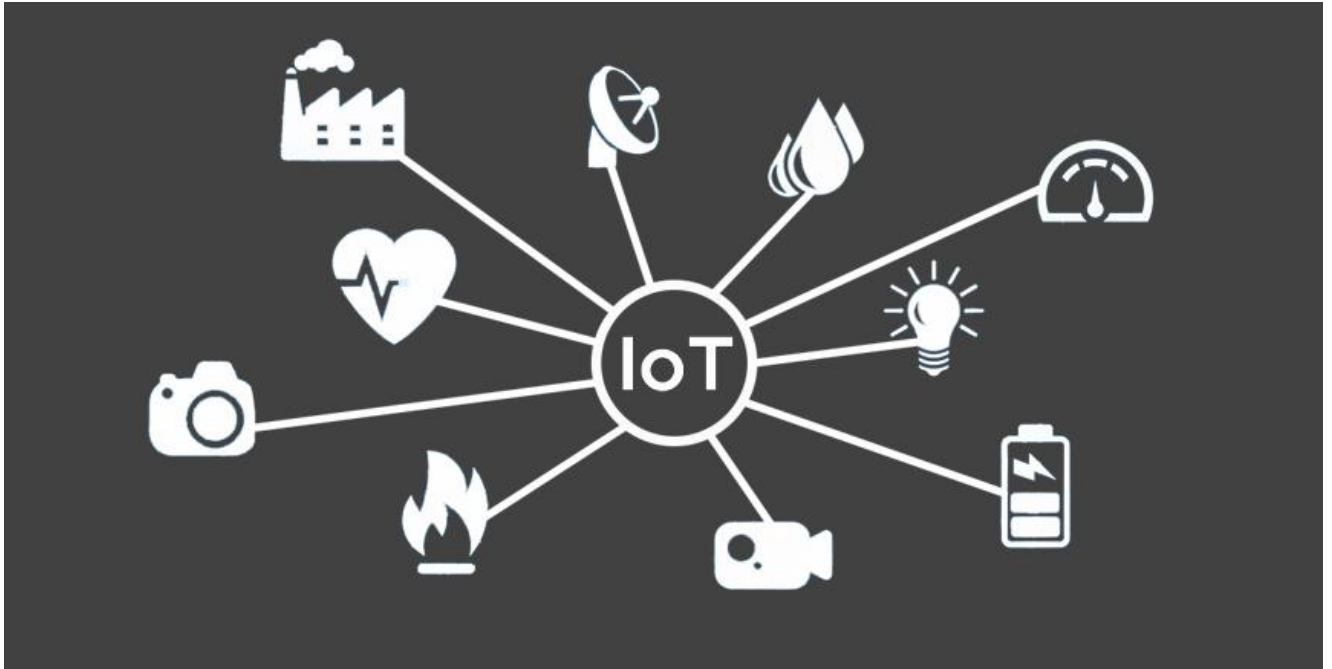


Cardigan Town Internet of Things Pilot

Final Report



March 2023



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Background to Project

Building on the success of Cardigan's efforts to be innovative in its application of technologies for measuring various aspects of the town's activity e.g. footfall, an opportunity to explore a relatively new technology Internet of Things (IoT) Technology called LoRaWAN was provided via the Cynnal Y Cardi Leader fund which includes a focus on piloting new innovations and business support.

To explain about IoT and LoRaWAN, it is a network of low powered devices called sensors, which communicate simple data over a wide area. So a signal from a sensor in say in the north of Cardigan Town can then be picked up by one of a number of internet connected units called Gateways installed across the area (roughly as much as 15 miles away depending on position). The technology could be compared to a low-energy long range wifi network.

A Gateway, like a Wi-Fi hub is set up, and sensors which count and communicate simple data are connected to it, relaying back information to an application the user can develop.

Examples of applications could include

- a healthcare service giving clickers to their elderly clients in the community, which transmit an SOS signal if they fall or to monitor patients in bed with a pressure mat or door sensing for door opening.
- to collect data from devices on CO2 levels or air pollution in a town or in a school class rooms.
- Measure footfall levels in a building and direction of travel
- Provide an alert for Defib access.
- Farm gate sensors to safeguard livestock, water levels, temperature and moisture monitoring and safeguarding agricultural machinery on the yard with vibration sensors.

More info here for Farming examples:

https://businesswales.gov.wales/farmingconnect/sites/farmingconnect/files/documents/Llyfr%20Saesneg%20Lorawan%20A5_1.pdf

Further examples:

[IoT in Wales \(gov.wales\)](#)

Because of the low level of data needed to transmit and therefore low level of power required by the sensors, these devices have a long life and can be run on batteries or solar.

Last year Welsh Government supported the roll out of LoRaWAN Gateways in Ceredigion and other regions of Wales. The local authority installed a number of these devices across Ceredigion on their internet network. This formed the basis for good coverage for sensors to be detected.

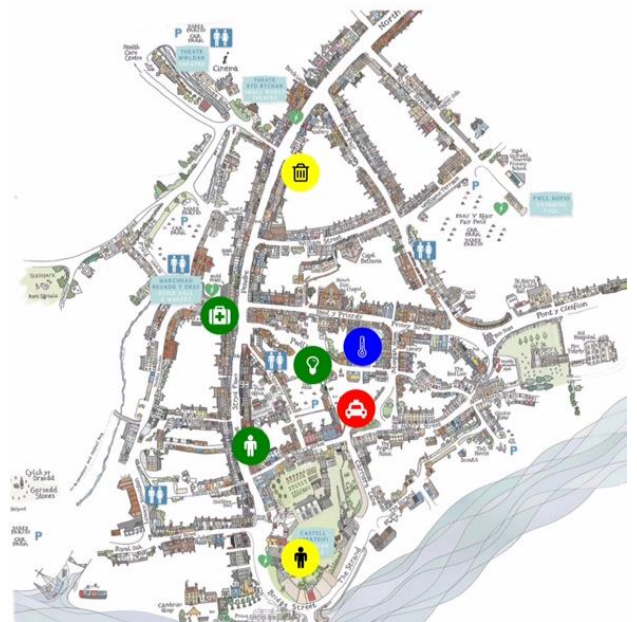


←Current Map of Gateway coverage for use by Internet of Things LoRaWAN in West Wales

Before the Cynnal y Cardi pilot project was developed, local regen social enterprise 4CG Cymru with some sensors provided by Welsh Government carried a small project in Cardigan just like they did with town Wifi back in 2015/16. Sensors were installed in some locations in Cardigan to test the capability and find out what was possible with the new Ceredigion LoRaWAN network.

Experimental Application with sensors applied by 4CG Cymru →

Cardigan Town Sensors



A number of lessons were learnt about the technology range and capability which then fed into the Cynnal Pilot Project for IoT in Cardigan Town, key lessons was partnership working and getting buy in to see what was possible.

The Cardigan IoT project

The aim of the project is to apply Internet of Things sensing technology to a range of pilot applications in and around the Cardigan area. The range would cover applications for Ceredigion Local Government, Cardigan Town Council, Dyfed Powys Police, Cardigan Castle, Ferwig Community

The project was design to happen in phases over 8 months.

Phase 1 : Install remaining Gateway units required. 5 units need to be installed. These across Cardigan and surrounding area and will need co-operation of Ceredigion officers. Property owners have all agreed to host.

Phase 2 : Economic pilot , Install footfall counters and provide display for pilot group of traders.

Phase 3: Environmental Pilot : Install Air Quality on street town centre, CO2 monitor in pilot Café , river level monitor , Parking sensors for denoted loading bay. A single bin sensor to test/build model solution for measuring waste levels.

Phase 4 : Public Safety pilot for alerting , lifebuoys, defib cabinet, work with Dyfed Powys and other organisations on how alerts are processed,

Phase 5 : Learning from previous phases – what is the information showing , patterns, insights. Sharing with stakeholders.

The specific actions in each phase / applications to pilot:

Additional LoRaWAN Gateways to extend coverage : Lack of full coverage in area, with these in place, 100 % coverage likely with element of failsafe from neighbouring units

Parking Sensors in Loading/Disabled bays: Monitor parking bay use, case for enforcement or additional bays. Will need discussions with National Trust and Ceredigion Highways.

Water level monitoring of the river: The Strand, Quay Street Car Park: For alerting on flood defence and readiness. Specific locations to be agreed in light of planned flood defence scheme.

Access alerts for Lifesaving buoys and defibrillators – Cardigan, Mwnt, Llechryd: Anti-social behaviour, alerting local community responsible for units, locating hotspots – times and locations.

Explore– link to emergency services as already achieved with IoT project at Cilgerran Wildlife Park with Dyfed Wildlife and Dyfed Powys Police pilot.

Shop footfall for 4 retail and 1 Café: Granular data set for shop keeper with footfall in shop and town. Able to see income per head value on shop footfall, % against town footfall from Wifi system already established.

Measure Café Co2 levels internal : Pilot selling point on fresh air indoors for café staff to be discreetly alerted on need for better ventilation

Environmental data for Cardigan town centre and Mwnt. Air quality, Co2, NO, NO2, temp, humidity, wind to serve part of the Town Council biodiversity development. Track the impacts of climate change on the town

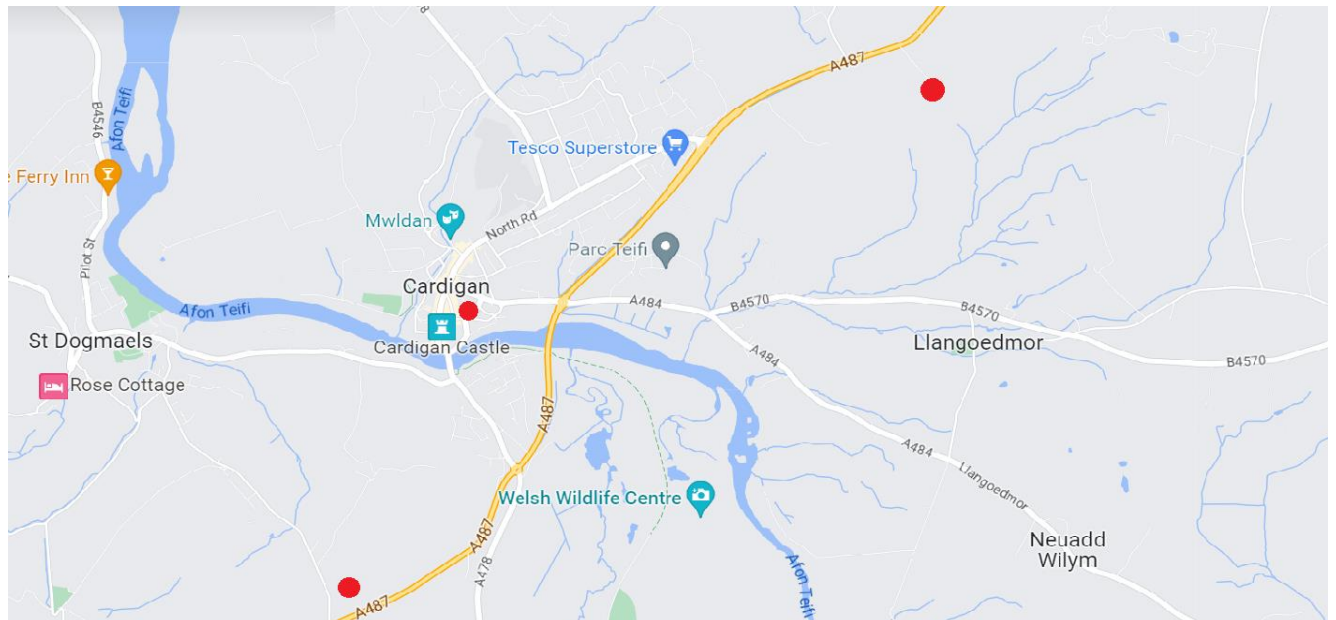
Bin pilot – 1 bin test : Pilot in public bin sensor capability.

To manage the project, 4CG took on this role using the good network of contacts from previous town projects from the Town Centre Partnership and work they did with their own pilot project with LoRaWAN.

Phase 1 – install additional Gateway units.

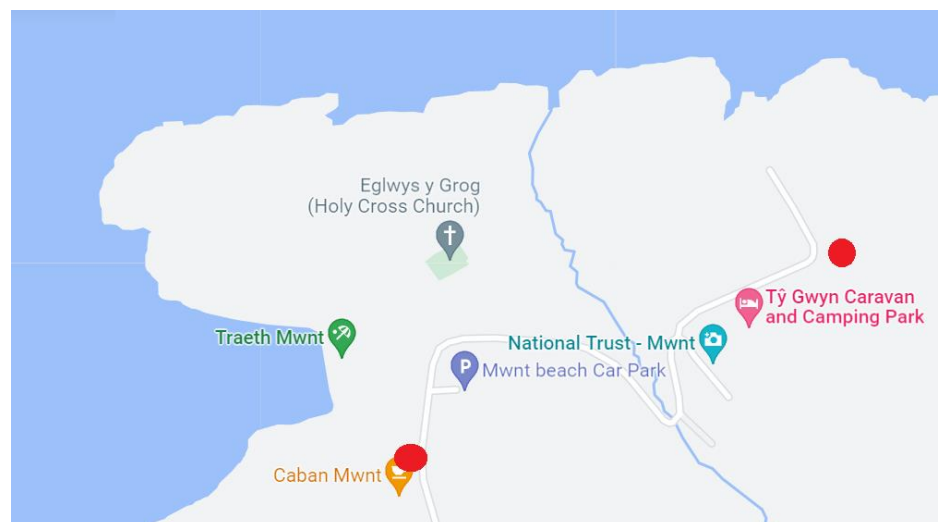
To ensure coverage across Cardigan and wider area, additional sites were required to install Gateways already provided by the Welsh Government via digital officer at the local authority.

Gateways already existed at Penparc, Cardigan and Llechryd School buildings which provided good coverage on the whole. The 3 additional identified sites in Cardigan were to the North overlooking the town at Penlan Farm, In the Centre at 4CG offices and to the South overlooking the Town at Parcypratt. Marked in red in the map below.



For the outlying area, focus fell on Mwnt as secondary site for supporting future sensor installs by the community Council who have established a budget and own applications.

With Mwnts' location being rather remote but with full fibre fire broadband. Two sites identified. One at the caban shop above the beach and looing over the area and coastline Ty Gwyn Caravan park.



So a total of 5 additional gateways needed to be installed. The work was awarded to Telemat ICT. Before the install 4CG contacted the property owners for the 5 locations and setup survey visits. All owners where very happy to support the project and its aims. As part of the survey visit with Telemat , broadband connection and cable/fibre runs where identified, explained to the owner and agreed.

Installation took place over a 6 week period with co-operation of owners, local authority, installer and 4CG.

Images from Phase 1 – installation.

Penlan Farm, Ty Gwyn Caravan Park, Mwnt Caban Shop



4CG , Parc y Pratt



Phase 2 – Economic Pilot

This would be the first of the sensor install phases. For all the sensor installations and application development, the project took on the services of Gary Howell of Morgan Walsh.

Footfall Sensor

A shortlist of shops were identified and a pre-install site meetings carried out to identify the final candidate sites. The factors effecting the decision:

- Suitable location in the shop to install the 2 footfall units (beam breaking)
- Lorawan Signal strength



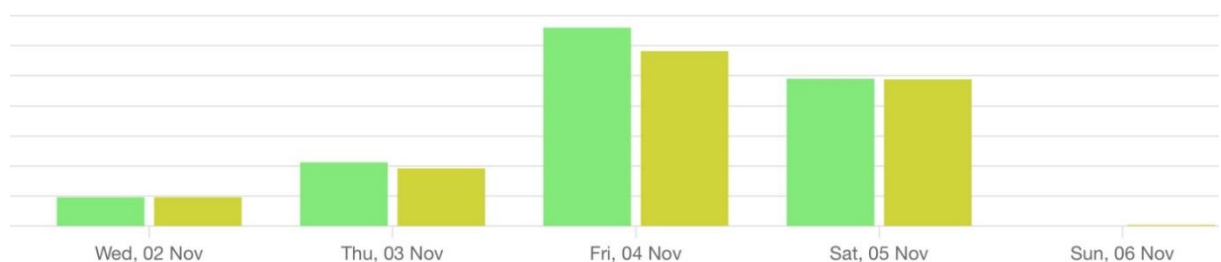
Of the 7 shops visited, the following made the grade for installation. The owners were happy to be part of the pilot and 4CG explained with Gary Howell the technology and how the project would work including the information they would receive.

The shops were:

- Canfas Art Gallery
- Customer House Gifts
- No. 45 Gin Bar
- Stiwdio 3 retail, craft and café

A good cross section of the town retail offer. All the units were installed just before end of October 2022, and so happens that 2 on the above were also venues for the Other Voices Music festival which was a good test to see whether the sensors captured data.

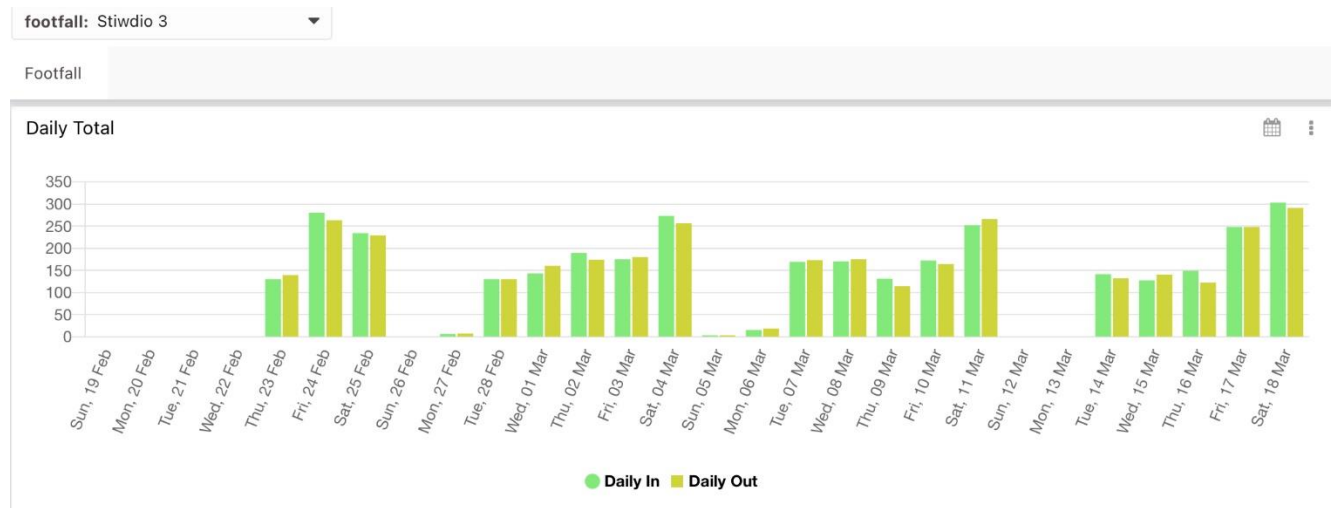
An example is Bar 45, shows the impact of the festival in number entering and leaving.



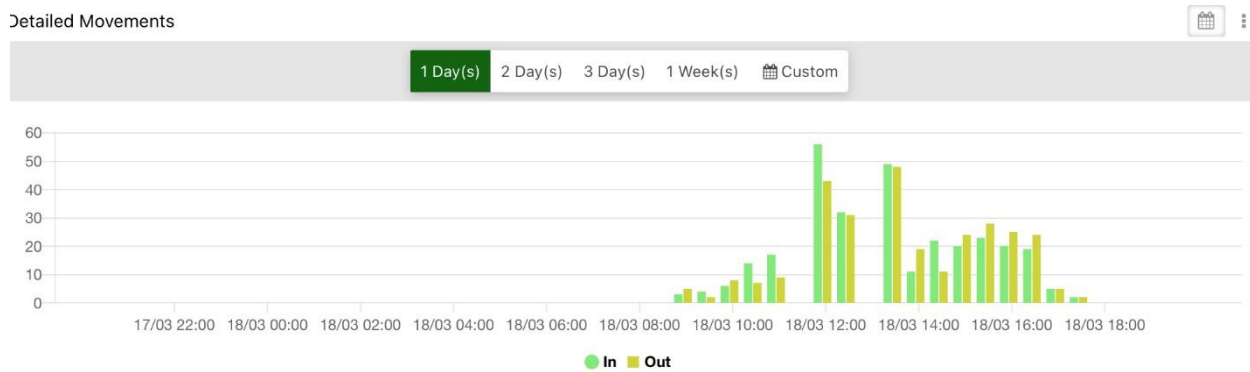
More details hourly chart showed the busy times being from 6pm to 10pm on Friday, at the height of the Music trail in Cardigan. All the shops with the footfall counter have been provided with either a display to show footfall , located next to the till or a link via the developed application called Tago RUN.

Each shop cannot see other subscribers to the project only daily and hourly realtime data for their own footfall counter.

Example Stiwadio 3 - Daily movement

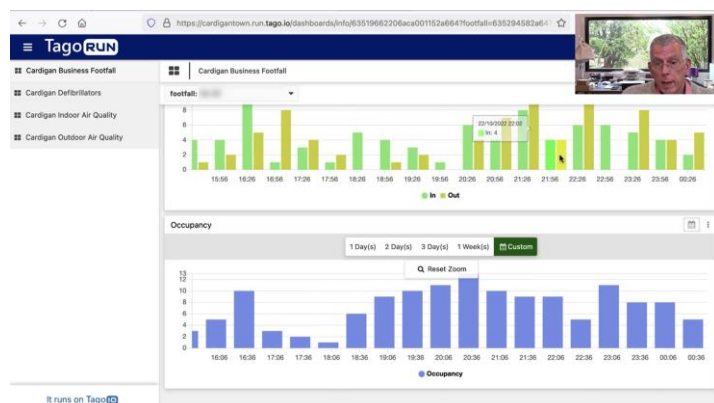


Hourly movements



The only problem identified during this phase was staff sometimes moved objects around and blocked the footfall beam which then caused the counter to read zero. So where the shop had staff apart from the owner we revisited and explained.

To support the business owner, each one was provided access to useful video explaining how to access the data:



Link to video :<https://vimeo.com/765669137/38107af67c>

Phase 3: Environmental Pilot

In this phase, like phase 2 , survey of candidate sites where identified in and around Cardigan for Air Quality on street town centre, CO2 monitor in pilot Café , river level monitor , Parking sensors for denoted loading bay and single bin sensor to test/build model solution for measuring waste levels.

4CG and Gary from Morgan Walsh developed a list of potential locations for each sensor type.

Outdoor Air Quality

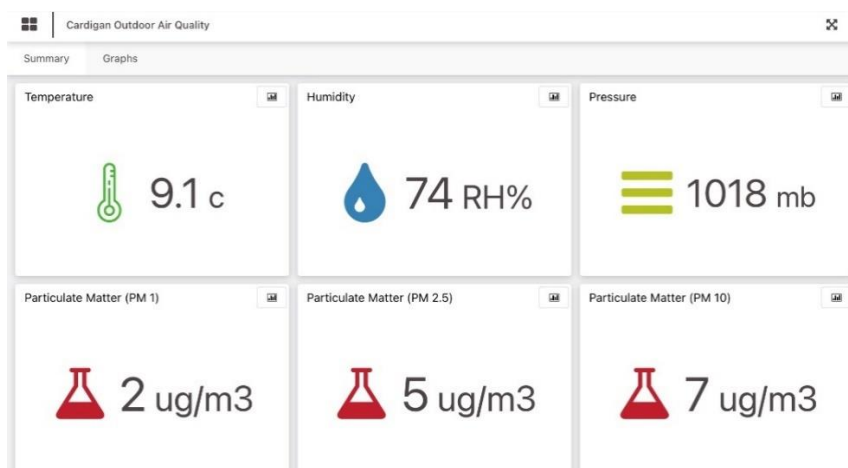
Candidate sites across Cardigan were visited by 4CG and Morgan Walsh. With the outdoor sensor powered by solar and the need to be located on a busy street, the identified location was Pendre. With permission of the building owner the unit was installed at right angles for optimum daylight .

images of sensor installed at Pendre, Cardigan.

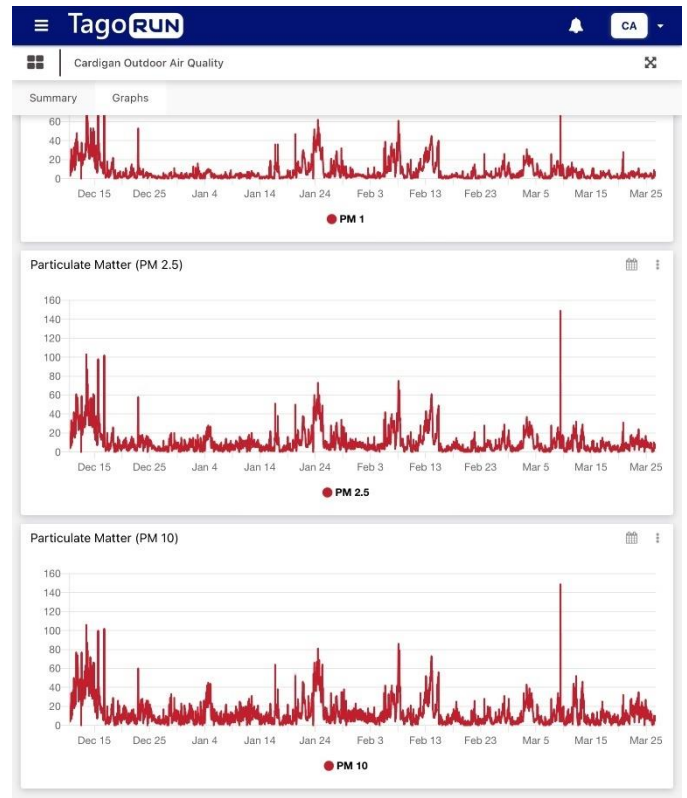
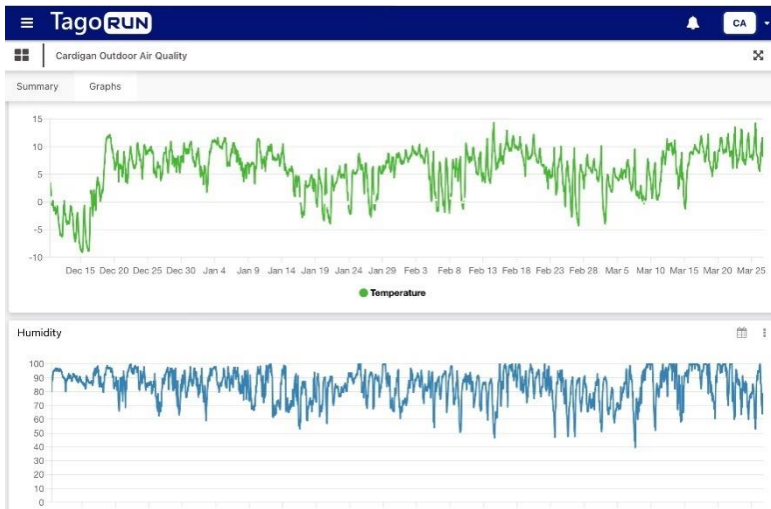


The related sensor dashboard provides Temperature, humidity, air pressure and the key measure of particulate levels. Shown below are images from said dashboard. The system allows a summary screen or more detailed graphs with adjustable timescales.

Summary screen for Outdoor air sensor



More detailed graphs examples



The information is accessible by town Council and interest has been shown by officers of Ceredigion CC to have the data also to compare with the exiting tubed system currently being used in Cardigan. In general, the key measure of PM 10 remains well below 50, it will be interesting going forward how a busy warm summer in Cardigan causes to the levels as this is real time data collected several times a day.

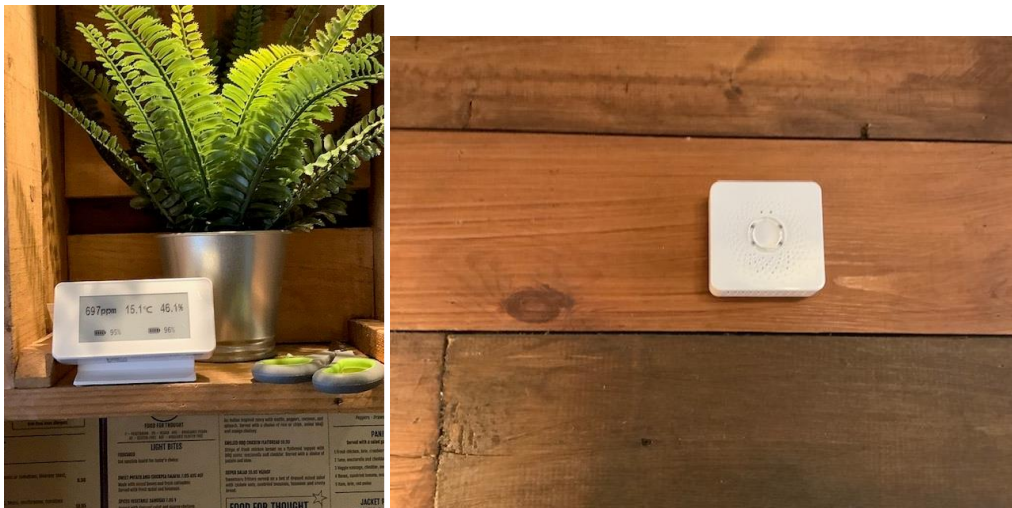
Indoor Air Quality

Like the footfall counters, 4CG contacted candidate hospitality venues. The final list with agreement from the business owners were:

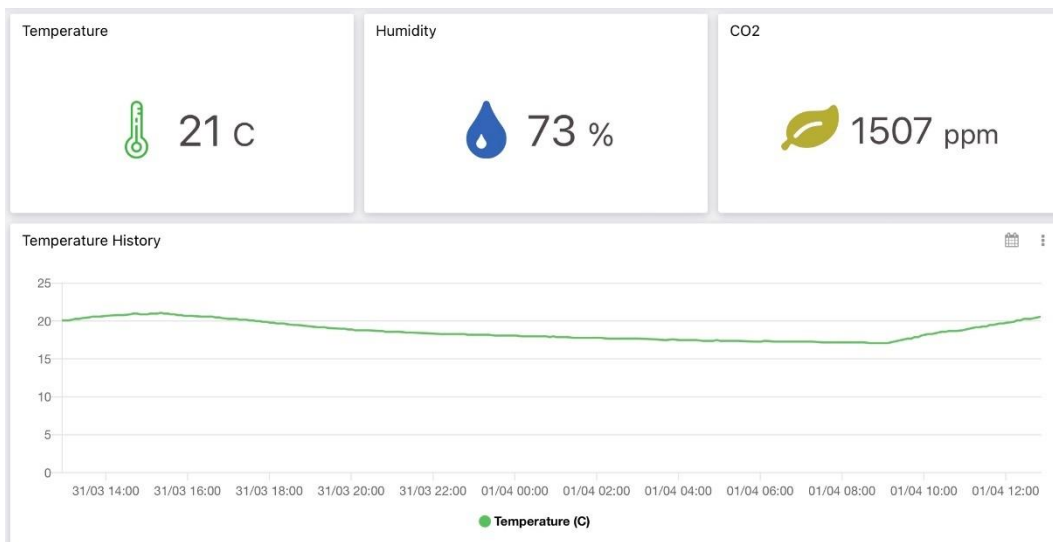
- Stiwdio 3
- Food for Thought
- Crwst

Each food outlet was provided a LED display screen in addition to access to a dashboard of historic and real time data for CO2 and Temperature levels.





Example above shows units installed at Food for Thought. The dashboard reflects data on the display unit.

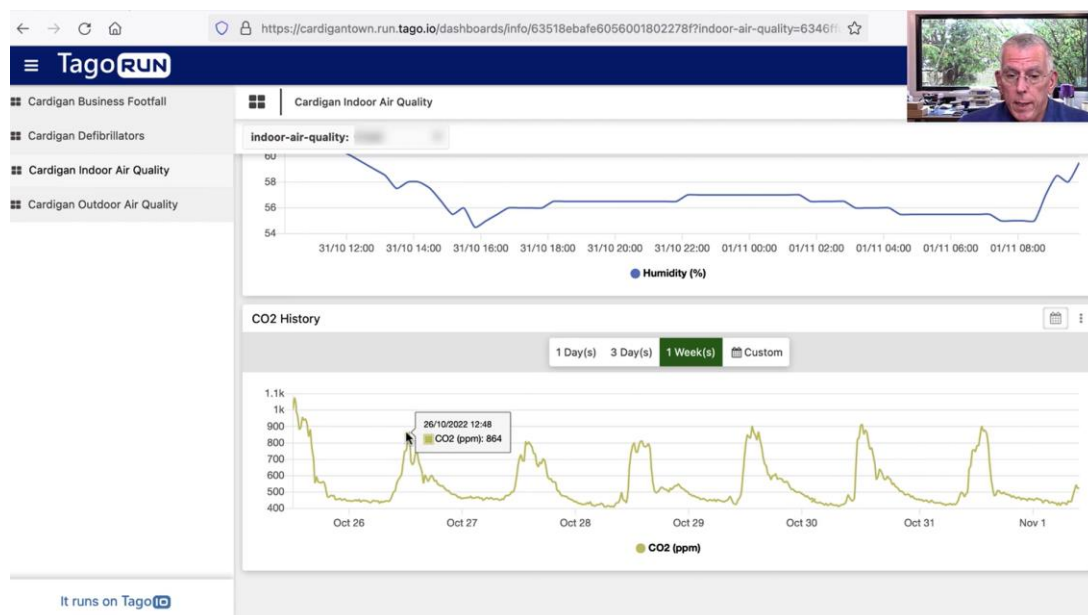


Alert levels have been set on the CO2 for 2000 ppm to inform the business owner. The display units are located by the till for each venue and so staff can monitor levels and open doors/windows as necessary.



Something additional the CO2 revealed is how busy each venue was. The weekly graph in the example above shows the peak lunchtimes and how much busier it is on Saturdays.

To support the business owners a video explaining how the unit works has been created by Gary Howell of Morgan Walsh.

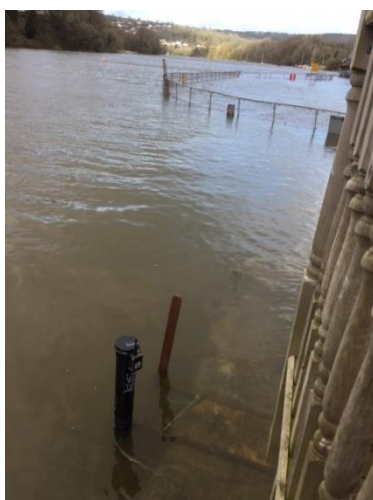


Link to video : [Cardigan IoT - Indoor Air Quality \(vimeo.com\)](https://vimeo.com/708888888)

River Level Sensor

For this sensor we required an accessible river location, few options existed but we managed to get agreement to use a location owned by Richard and Jane Roache of Fishermans Rest located near the Quay Street Car Park, this not only allowed us to measure river levels but also to provide a warning of the Car flooding. Something which in future could be used to switch on a sign at high street level for example.

These images show the river at flood and the tube contains the sensor attached to an existing metal pole/ladder. The second image shows the Car Park in flood with the sensor in frame.



This sensor sends email alerts at set levels to warn ahead for the car park and for the venue.

Example Email with Image of the situation.

-----Original Message-----

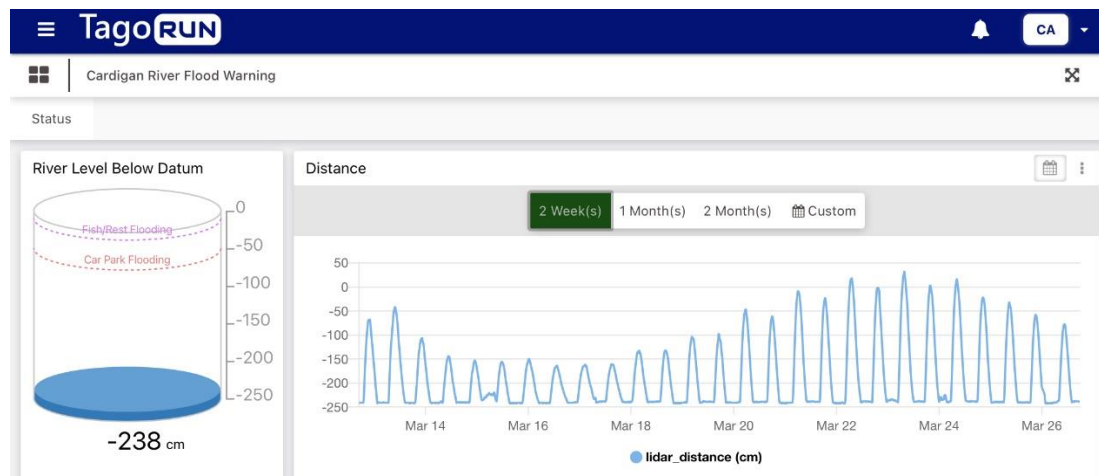
From: Cardigan Smart Town
<ae167@cardigantown.tago.run>
Sent: 24 March 2023 08:27
To: Clive Davies
<Clive.Davies@ceredigion.gov.uk>
Subject: Teifi Flood CRITICAL - Level less than 20cm from Fisherman's Rest Platform

Teifi Flood CRITICAL - Level less than 20cm from Fisherman's Rest Platform (11cm)



The associated dashboard is also available to look at real time and historic data.

The example below taken at low tide



As you can clearly see on the left is the levels influenced by tides and the flood occurrences between March 22nd and 25th in Cardigan.

Parking Sensors

The screenshot shows the TagoRUN interface for Cardigan 4CG Parking. It displays two panels: '4CG Bay 2' (4 days ago) and '4CG Bay 3' (12 hours ago). Bay 2 is marked as 'Occupied' with a blue car icon, and Bay 3 is marked as 'Available' with a green car icon. Below these are detailed tables for each bay.

4CG Bay 2			4CG Bay 3		
Status	Last Occupancy	Date and Time	Status	Last Occupancy	Date and Time
Occupied		23/03/2023 08:06	Available	1.4 hours	25/03/2023 13:53
Available	2.0 hours	22/03/2023 16:11	Occupied		25/03/2023 12:27
Occupied		22/03/2023 14:13	Available	9.1 hours	24/03/2023 17:12
Available	2.4 hours	22/03/2023 14:03	Occupied		24/03/2023 08:08
Occupied		22/03/2023 11:39	Available	8.7 hours	23/03/2023 16:42
Available	1.5 hours	22/03/2023 11:09	Occupied		23/03/2023 08:07

The original plan was to work with the highways department for Ceredigion CC to install in parking bays in the Cardigan town, on the high street to measure use of loading and disabled bays, this was not possible due to the height of the sensor and Ceredigion CC could not take the risk as their insurance didn't cover anything on the road extending 20mm. We then explored other options with Ceredigion CC and concluded that no where was possible due to the insurance issue.

The final solution was to use our own Car Park at 4CG Pwllhai and 2 units were installed purely as proof of concept in 2 bays in the car park. The sensors provide length of occupancy and frequency in the 2 bays.

Bin Sensor

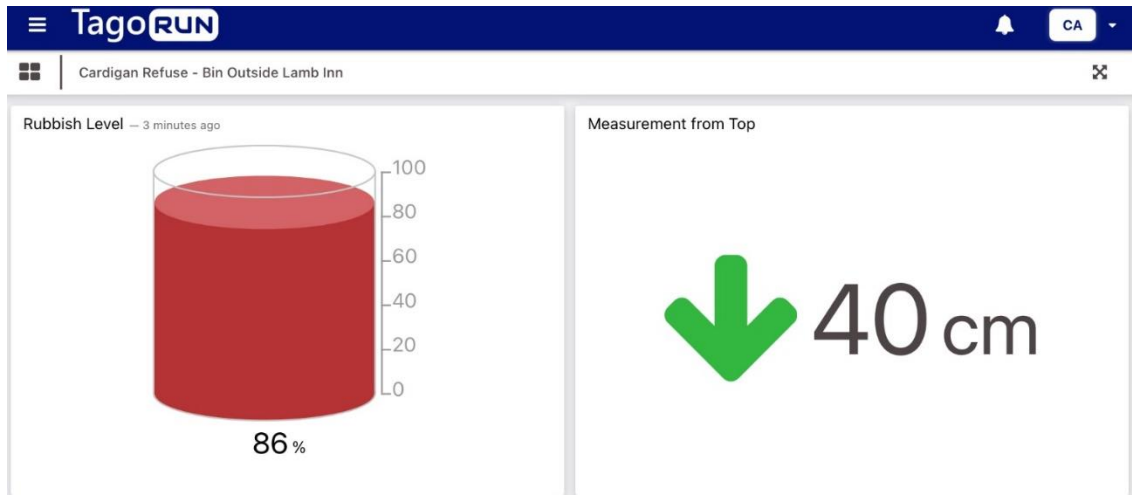
Another proof of concept, using a similar sensor to that used for the river level. With support from Ceredigion Street assets team, permission was given to use a chosen public bin in Cardigan town centre. The Bin chosen was one located at the Bus Station. A cast metal bin, located relatively near a LoRaWAN gateway located on the nearby school, would provide a good signal for receiving sensor data.



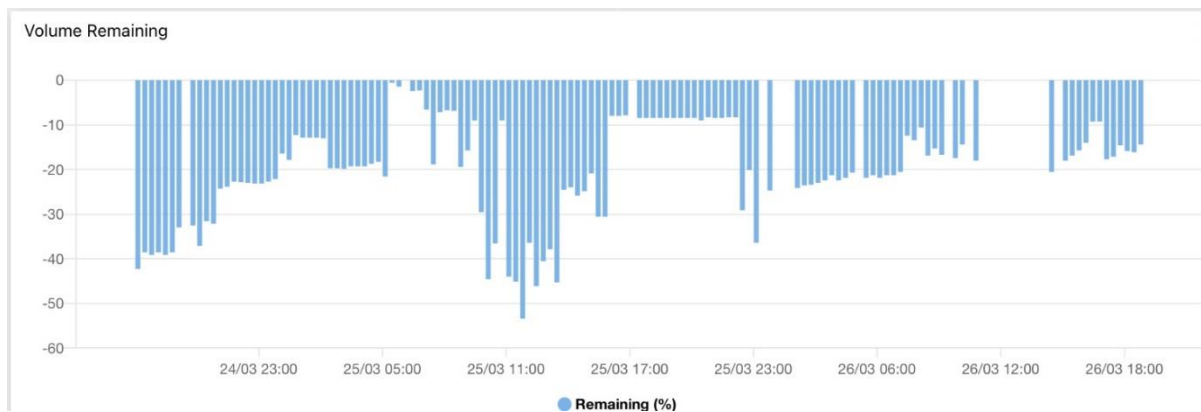
Having installed the sensor, some calibration work was required to reflect the waste levels within the bin in relation to the sensor. This took some repeated visits to take actual waste levels and adjustments to the parameters of the data collection.

The dashboard below shows the data received,

in two parts a live bin level image and



Remaining space in the bin. So it can show how quickly it fill and frequency of removing the waste.



Phase 4 : Public Safety pilot for alerting

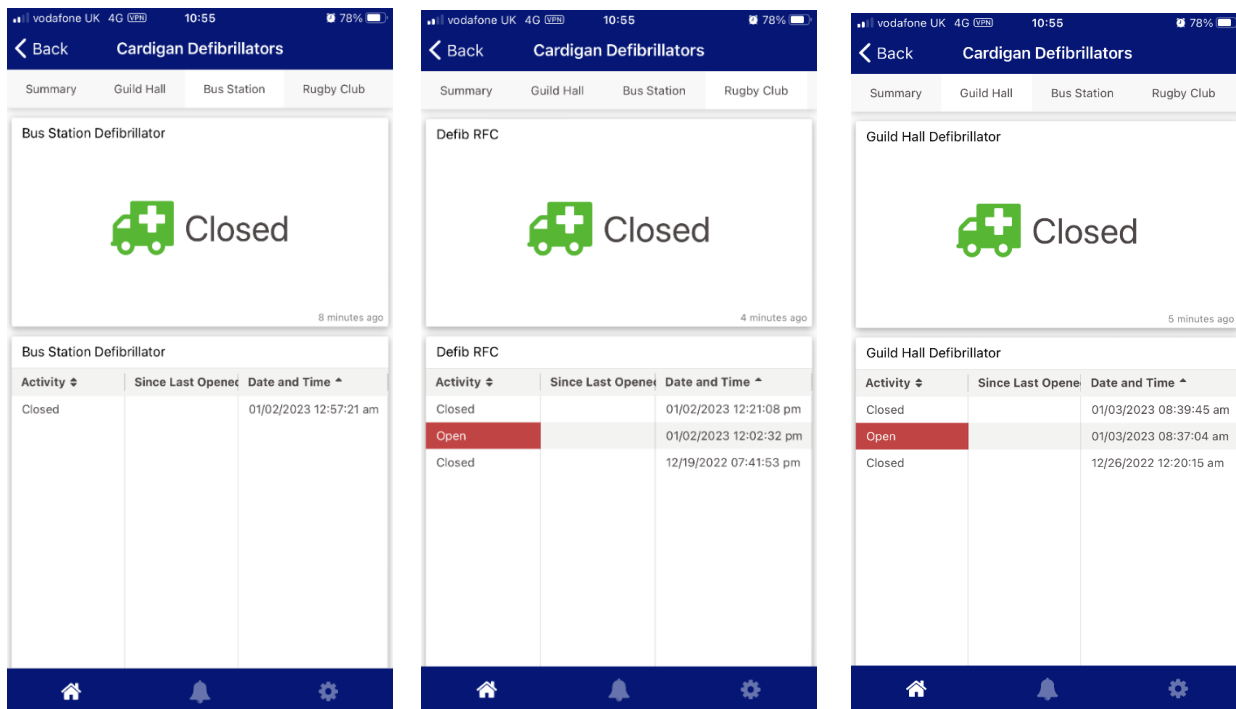
The aim of this phase was to pilot for alerting, lifebuoys, defib cabinets and work with Dyfed Powys Police and other organisations on how alerts are processed.

Lifebuoys

We attempted to install altering sensors for the casing of the current 2 units installed in Cardigan along the riverside. Unfortunately, the material and how the casing door operates didn't allow for positive alerting of the unit being opened.

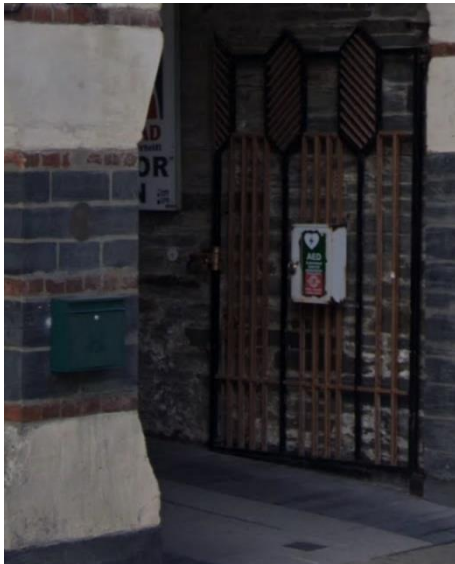
If this is to be something for the future some further thought will be required on how the sensor can be fixed securely and give an accurate alert.

Defibrillator cabinet sensor



The defib boxes were much more straight forward. Installed in 3 locations across Cardigan. With permission of the Town Council and Cardigan Rugby Club staff.

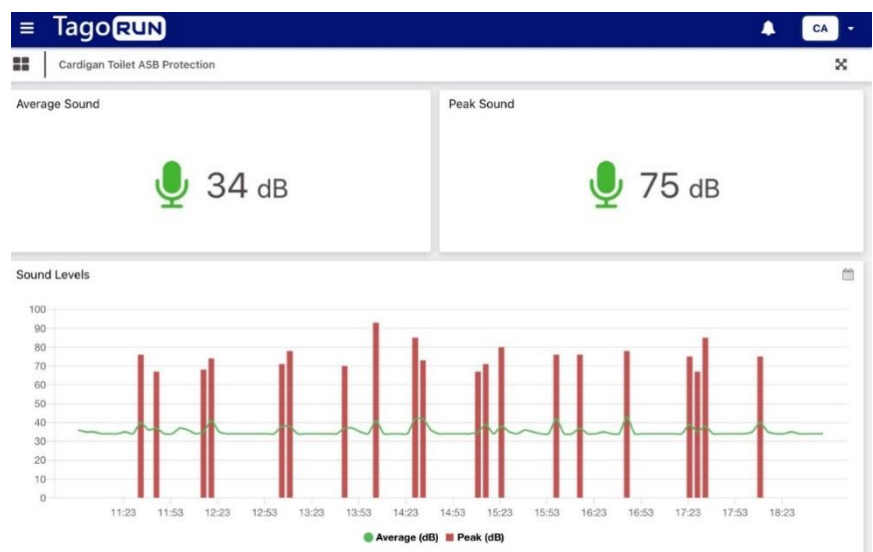
Image below shows the 3 locations. Guildhall, Rugby club and Finch Square bus station.



The sensors alert access to the boxes, so for example alerts recorded when testing and checks are done regularly, these alerts are currently sent to the Town Clerk. The plan is to get a key person for the rugby club to receive the rugby club unit alert, which is located outside the club house.

Anti Social Behaviour

With the remaining budget and building on some work done with Dyfed Wildlife trust and Dyfed Powys Police at the Cilgerran Wildlife Park. We approached the estates team at Ceredigion County Council on piloting the idea of detecting anti-social behaviour in Cardigan public toilets. Permission was granted and with that a sound level sensor was discreetly installed in the public toilets. The image shows average and peak levels. It also shows a timeline. There has not been any incident to verify or help calibrate the alerting levels as of yet.



Should this prove successful as a pilot, there is no reason why similar units could be installed across the other public facilities and a single dashboard made available to the local Police and Ceredigion team.

Phase 5 : Learning from previous phases

Although there has been a very small window for carrying out this project, some 8 months of which all sensors active for about 5 months some learning has been achieved.

- Educating the business owners on access to the data, needs to be more convenient and easier. Owner managers don't have time to go into an app. Altering having a easy to read display is the ideal. Located near the till where possible.
- It is very difficult to engage with the right person in a large organisation like the local authority, luckily county councillor was able to cut through the right people.
- Fully explaining the benefits LoRaWAN can bring helped a lot with sighting the gateway units. Very grateful for these building owners to give their permission to host and use a tiny amount of their bandwidth.
- Once installed, ensuring the business staff all understand the purpose and capability of the sensor and data not just the owner /manager. This may avoid sensors being blocked from working for example.
- Ongoing support is a factor, who will ensure batteries are changed in a few years time. Will the business owner adopt these units and those in the Public realm adopted by Town or County Council.
- A number of the individual projects can now be easily scaled up with the experience and LoRaWAN infrastructure now in place.
- With the project in relatively early stages overall , further work on how Cardigan changes over the year in terms of air quality, footfall into the businesses, comparison of the sensors data and the town wifi data will be something to carry out going forward. This will provide additional information.
- WLGA have shown an interest in the pilot work in Cardigan and a number of Council across Wales are carrying out similar projects, hopefully some of the outcomes from this pilot will help Ceredigion CC determine if there is any value for them in identifying opportunities for efficiencies in the services.

A web page consisting of sensor explanations has been created and in the public realm to help anyone else interested in developing something similar.

Internet of Things for Ceredigion Businesses

Link:

[Internet of Things for Ceredigion Businesses - Morgan Walsh](#)

We are pleased to share our work with Ceredigion County Council and Cardigan Town.

The following videos are designed to help business owners understand some of the benefits of the Internet of Things sensors in their businesses.



The screenshot shows a Vimeo video player interface. The main video area displays a title card for 'THE INTERNET OF THINGS FOR BUSINESS' presented by Gary Howell from Morgan Walsh Consultancy Ltd. To the right, a playlist is visible with five videos:

Video Title	Duration
The Internet of Things	4:39
Footfall Counters	2:36
Air Quality	2:42
Customer Satisfaction	2:33
Regulatory Compliance	2:29

Outputs from project

Indicator	Expected Achievement	Rationale i.e., how have you arrived at the intended figure?
Jobs created through supported projects	Directly 0	Would be piloting new technology with exiting resource. It may lead to indirect creation of jobs through realised opportunity for business.
Number of Feasibility Studies	0	Piloting known technology in primarily an urban area.
Number of Networks established	1	Steering group formed with supplier and those supporting the installation. Police, Town Clerk, County Council contacts, PCSO at Dyfed Powys.
Number of jobs safeguarded through supported projects	0	
Number of pilot activities undertaken/supported	3	Phase 2 : Economic pilot achieved Phase 3 : Environmental pilot achieved Phase 4 : Safety/Alerting Pilot achieved
Number of Community Hubs	1	The community and town council and traders will in a way create a learning hub on IoT and share experience and feedback.
Number of information dissemination actions/ promotional and/or marketing activities to raise awareness of the LDS and/or its projects	6	Case studies (5) for each of the pilots sent out on facebook Sharing of information also via the 120 mailing list, which goes out monthly to town traders and other stakeholders.
Number of stakeholders engaged	12	Consist of : <ul style="list-style-type: none"> • Ceredigion County Council • Cardigan Rugby Club • Cardigan Town Council • 5 x building owners for phase one • 4 x Retail traders • 3 x Hospitality trader • Dyfed Powys Police
Number of participants supported	120	As the pilots go live, some of the general data will be included in the monthly town centre partnership newsletter issued by 4CG. That currently has 120 on the list and incudes majority of shops, councillors in area and Ceredigion officers
Number of communities engaged	3	Ferwig/Penparc, & Cardigan Town
Number of groups engaged	6	Ferwig CC - updates Cardigan TC -updates Cardigan traders – installs and supporting Merched y Wawr – presentation Clybiau Gwawr – presentation Cylch Cinio - presentation

Number of young people participating	0	None unfortunately, down to time. It is something which could be achieved by doing an information session with Coleg Ceredigion.
Number of women participating	9	council clerks, business owners, property owners, stakeholder
Number of Welsh speakers participating	6	clerks, business owners, building owners
Number of elderly participating	0	0
Number of individuals with disabilities participating	0	
Number of projects aimed at environmental enhancement/sustainability	4	Pilot with Bin sensor, CO2 Sensor Air quality Sensor Water level Sensor
Number of consultation exercises	0	
Number of cluster groups / informal networks	1	Steering group