

Welcome

Contents

- [Introduction](#)
- [Technology Guide](#)

Welcome to the HeatHack programme for community buildings. This guide provides the reading materials for the programme. As well as a general introduction to explain what the programme is for and what it will be like, it contains reading materials for each of the sessions that introduce some basic concepts. At the end, we give instructions for how to use the basic thermal monitoring equipment that is supplied as part of the supported phase of the programme. There is a separate guide for the two group facilitators - one, a volunteer engineer, and the other, part of the community around the building - to use in running the small group sessions.

These reading materials are not our last word on the subject - we will be using your experiences to improve them, and in July 2023 we will ensure all of the materials are openly available, including instructions for how to buy thermal monitoring equipment or build it cheaply from electronic components, so that anyone can use them.

This release is a sample containing just the introduction and technology guide, so we can get a sense of whether the format is suitable.

Introduction

Knowing how to manage energy use in community buildings and halls is difficult. Many of us manage the most difficult buildings in our local areas, especially if they are churches or ex-church buildings. We are, for the most part, volunteers who know our buildings well, but have no training that helps us understand how the energy systems in our buildings work and how to change them for the better. Meanwhile, there are few professionals who spend enough of their working lives thinking about community buildings or older premises and able to provide us with confident advice. This means sometimes we are told things that are more appropriate for modern construction, houses, offices, schools, and factories. Even when the professionals have time to think deeply about our needs, sometimes the equipment then can buy is designed with very different buildings in mind. It's understandable, then, that we might not be getting the best service from the energy we put into our buildings.



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Now that energy is expensive and we understand that we need to move to net zero to reduce the harmful impacts of climate change, it is more important than ever not to waste energy. Getting this right will help our buildings and the services provided within them continue to survive, and we hope, even to thrive.

This programme is designed to help you understand energy use in your premises and what net zero means for you. We hope you find the programme useful in your journey, and that together we can build a better future for all of us.

Why take part?

This programme assumes your group needs to understand what a net zero future means for your premises, and in particular, its energy use. For some groups, this need will arise from a deeply felt ethical concern for the planet and its inhabitants. For others, it arises because of pressure from above, for instance, as organisations and governments make policies requiring net zero action plans. For some, volatile and rising energy prices will be foremost in their minds, or the dwindling resources of an aging or declining community. All of these are perfectly valid reasons for taking part.



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This programme is not the place to debate whether climate change exists or whether human behaviour has the power to affect its course for good or ill. It is also not the place to discuss climate change and its effects on the planet, although if that is your main interest, you may wish to consider our sister programmes, Climate Conversations and Conversations for Change. Our programme is about how to get the most benefit out of the energy you put into your buildings and how to have what are difficult discussions about whether that energy use can be supported financially and justified ethically in your place and at this time. It is based loosely on our experiences in running Carbon Conversations, group sessions about how to achieve reductions in the carbon impacts of our personal lives.

Much of the programme isn't technical at all - it's about what your building is for and how it should be used and managed in the future. For this, towards the end, you'll need to engage with others in your local community. After all, it's space that serves them. This kind of conversation will be a new one to many groups, and so the programme is designed to equip you for that, too, by showing you some good ways to engage the people you serve. You should come out of the programme with a plan for your building and evidence that will be useful for securing grant funding if you need it.

1 Further reading

- [Carbon Conversations](#)
- [Climate Conversations](#)
- [Conversations for Change](#)

Why Engineering?

This programme is unusual for ones run in community groups, because it introduces what may be a new kind of specialist to your group: an engineer. Engineers use science to solve problems. They're good at thinking about time and budget constraints, because the whole point of engineering is to make things that work in the real world. They are also used to thinking about Health and Safety and carrying out risk assessments. It can be useful to have an engineer involved when you're thinking about your property just because of the way they are trained to think about problems and potential solutions.





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You should come away from the programme with a new appreciation of engineering and, we hope, able to think a little bit like engineers do.

i Further reading

- [The Royal Academy of Engineering](#)
- [This is Engineering](#)

What you will learn

In the programme, you will learn

- about thermal comfort, where the temperature a thermostat shows is not the whole story, and what this means for deciding how you use your spaces, with different heat strategies for occasional and frequent use.
- the basics of how heating systems work and how to check whether your current heating systems are fit for purpose and working correctly.
- about ventilation, why ventilation is important for the health of the building and its occupants, and the relationship between ventilation and heat loss.
- where the big heat losses in community buildings occur and the measures that can sometimes be taken to reduce them
- about local generation options like solar panels and lower carbon heating options like heat pumps that might be suitable for your buildings
- how to stage changes to move towards lower carbon if you can't afford everything in one go.

Parts of the programme might sound highly technical, but we will keep it simple. We aren't trying to make you into an engineer or heating specialist. The programme is about equipping you with the information about your building and the knowledge that you need to get better outcomes when you engage professionals.

Most of our past experience is with traditionally built, stone buildings, particularly churches. These throw up some particular challenges, so we will spend some time addressing those. If you find some materials do not apply in your case, feel free to skip these parts of the programme.

What we provide

This is not a textbook, but an initial guide based on our past experiences with community buildings in Edinburgh and the surrounding area. We will support you through the programme. For instance, we have in mind helping you compare notes with other, similar groups and letting you ask questions in "Meet the Expert" sessions with some of our advisers, or for us to research and blog. Based on what we learn from you and how you find the programme, we will adapt what we have to make it better. Our goal at the end of the current programme is to put out resources that anyone can use. Towards the end of the programme we will also ask you what we should be doing next.



To help you understand your buildings, we will provide you with a small device you can put in your spaces that will collect regular temperature and relative humidity readings. You do not need to know how they work, but with the aid of your group's engineer, you will learn how to spot some basic problems on the data they provide. We also have a limited amount of specialist equipment available by post for those who need it to look at specific issues. The data our equipment collects, along with other information you will be collecting, will form a profile of your premises and how you use them.

About this programme

This programme has been developed based on experiences within HeatHack, a group of community volunteers and students in Edinburgh that have been helping churches and a few other community groups understand how to heat their buildings better. HeatHack has previously been funded by the John Templeton Foundation via Scientists in Congregations Scotland, with small contributions from the University of Edinburgh Schools of Informatics and Engineering and the University of St Andrews School of Computer Science.

It has been developed and is being run in conjunction with The Surefoot Effect, a Community Interest Company that helps communities, businesses and governments put sustainability and resilience at the heart of what they do, and with support from Engineers without Borders UK to help find engineers for community groups who cannot find them for themselves.

Since 2012, Surefoot has been helping communities, businesses and governments put carbon reduction and care for the environment at the heart of strategy. We work at every level, locally, nationally and internationally to support the essential paradigm shift needed to protect people and the planet. Our continued success lies in the values-based, people and process-led approaches we use and tailor to each project.



Engineers Without Borders UK is working to reach the tipping point to ensure a safe and just future for all. Part of a global movement of over 60 Engineers Without Borders organisations, we inspire, upskill and drive change in the engineering community and together take action to put global responsibility at the heart of engineering.



The programme would not be possible without the generous support of the Royal Academy of Engineering through their Ingenious public engagement programme.

Technology Guide

We will send you devices you can use to collect temperature and relative humidity data for your spaces.

If your venue does not have wifi, you have one box, a sensor unit. You will need to put it somewhere representative of the space and then connect to it every week or two to download and send us the data.

If your venue has wifi then you will have two boxes: a sensor unit and a base station or “hub” that will take readings from the sensor and send them to us automatically. The sensor unit has to be somewhere that reflects how people will feel in a space, but the hub just needs to be plugged in within radio range of the sensor unit.



We built our own cheap devices because it helps to get the readings instantly on line - which we can do for venues with wifi. However, it's perfectly possible to follow along on our materials without our devices, using a commercial logger. They cost around £50 for temperature or £70 for temperature with relative humidity. They just save the data on the device and let you plug them into a computer, usually using USB, to download them. There are sometimes cheaper unknown brands available. We've never tested their accuracy. If you use one it is best to check them against something with known good readings to make sure.

Tip

In the web version of this guide, click on the images to see them bigger. Then use the back button to return to reading. In other formats, you can zoom in and out.

Where to put the sensor unit

You want your sensor unit to reflect the experiences people have in your space, without being affected by local sources of heat. Place it where no one is likely to sit right next to it, away from radiators, and away from direct sunlight. If you can, avoid having it directly next to a window or external wall, especially if the walls are stone. Near the centre of a space is usually best.

💡 Tip

It can be hard to remember where you put the sensor unit - one easy way is to take a picture on your phone. Then if you forget, you'll know exactly where to look.



If you have more than one space you want to monitor, you can move your sensor unit around. Collect representative data from each. You may wish to do this over four seasons even if that is after the programme finishes.

Batteries

The sensor unit uses AA lithium batteries. These are available, for instance, from Energizer. This is the kind of battery used in things like smoke alarms. They are the same size and shape as ordinary alkaline AA batteries, but should last a year. It is possible to use alkaline batteries, but their performance will be variable, lasting something between a week and a month.

⚠️ Safety

- Do not attempt to recharge lithium batteries - these are not the same as the lithium-ion in your phone
- Don't leave them in very hot places
- Don't run battery-operated devices under things where heat can build up

These are the same safety tips as for alkaline batteries, but these batteries store more energy, so it's more important to remember them.

For more information:

- [AA battery guide from RS Online](#)

Instructions for internet-connected version

You have two boxes - a sensor unit and a hub. The sensor unit is usually white and the hub is usually black.

The sensor unit takes the temperature and relative humidity readings and sends them to the hub using a radio link. The hub then uploads the data to the internet. To make this work, you need to tell the hub the password for the guest wifi network in your building.

:TODO: replace picture with one that has the power plug attached



The sensor unit is battery-powered, but the hub has to be plugged using a phone charger. It uses the older style “micro-USB” connectors like for older Android phones. Many people have old chargers from previous phones. If you don't have one with the right connector, but do have one where the cable detaches, micro-USB cables are cheap.

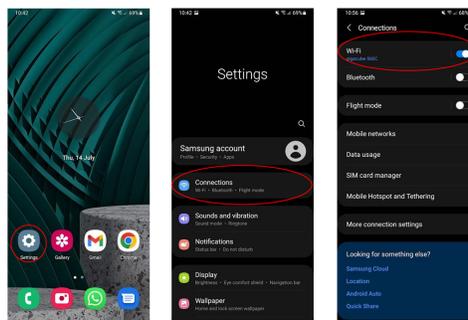


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i Overview for technophiles

1. Plug in the hub
2. Connect your phone/tablet/laptop to the open heathack wifi hotspot
3. Visit 192.168.4.1 using your browser
4. Enter the SSID and password for the venue's guest wifi network
5. Turn on the sensor unit and check for a blue flashing light on the hub showing the radio connection is working
6. Visit your thingspeak.com URL to see data coming in

Connect the hub to the internet

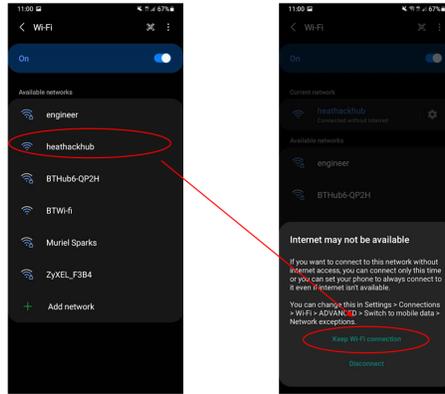


Decide where to place the sensor unit, and plug in the hub not too far away in a socket that people don't need very often. The hub has a blue LED just visible through the case that will flash once in case you need confirmation that the power is working.

On a phone or tablet, then find your wifi settings. You can access them through the settings icon (a gear) on your home screen or by searching.

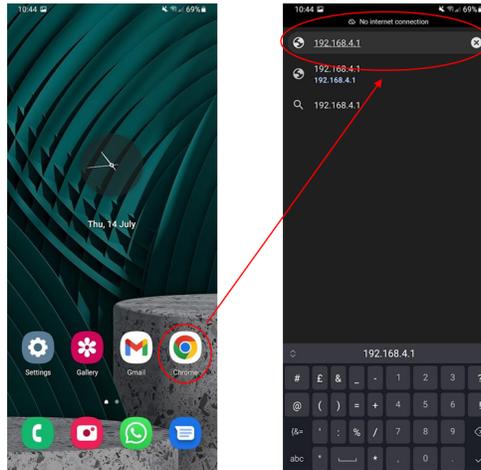
In larger spaces, the radio works best if the arrow on the outside of the sensor unit points towards the hub.

Connect to the wifi hotspot



The heathack network will appear. Connect to it. It is an open network and doesn't require a password. Ignore any warnings about internet not being available - keep the wifi connection to the hub anyway. You will be unable to use the internet while you are connected to the hub.

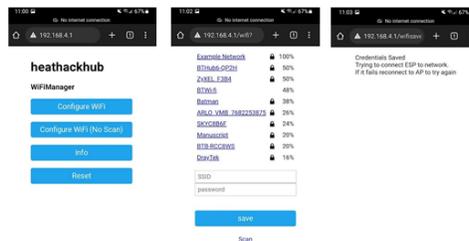
Connect to the hub



Open your web browser and type 192.168.4.1 into the address bar at the top. Chrome, Safari, Firefox, Samsung Internet and Microsoft Edge are all web browsers.

Searching on 192.168.4.1 won't work, but sometimes it's hard to tell when a browser will treat something as an address and when it will treat it as a search term. If you can't figure it out, let us know.

Configure the hub



You should now see the hub's interface. Choose "Configure Wifi", and choose the venue's guest wifi network from the list. If you don't see it, refresh the list by choosing "Scan". Then enter the wifi password and choose "Save".

Some venues deliberately hide the wifi network - in this case you can type in its name (SSID). You may be able to look up the name using a phone you have used on the wifi before or find it on the back of the router.

If after you save the password, heathack disappears from your list of connections, the hub is now successfully connected to the internet. Otherwise you may have entered the wrong password - please try again.

Turn on sensor unit



Now turn on the sensor unit.

The faint blue LED on the hub will flash every time it receives data from the sensor unit. This is useful for checking that the radio on the sensor unit can reach the hub. When the sensor unit is first turned on, it sends data to the hub every 10 seconds for 2 minutes. If you can't see it flash even in low light levels, make sure the arrows on the cases point towards each other and if you have to, move them closer together.

After two minutes, the sensor sends readings less frequently, usually every five minutes.

Check the connection



To check that the hub is working, connect to the guest wifi network and use your browser to go to the thingspeak.com address printed on your box.

You will see three very basic graphs - we will produce better ones later. You should see a recent very low reading (1C and 1%RH). If you don't see this, your hub didn't connect to the internet correctly. You should also see some realistic temperature and relative humidity readings. If you see the low reading and nothing after that, your sensor unit isn't managing to get data to the hub.

You can now leave the sensor unit and hub unattended. If anyone turns them off, they will start working again when you turn them back on. You may wish to leave a note at the power socket, as cleaners often turn hubs off and stick them in the lost and found.

Instructions for standalone version

If your premises don't have wifi, you only have a sensor unit. It saves the data for you to retrieve and email to us for processing. You should do this every week or two, or else its memory will fill up. You'll probably want to use a smartphone to do this, but you could instead use a tablet or laptop. The sensor unit starts recording data again automatically.



Every time you turn the sensor unit on, it starts a temporary wifi hotspot (also called an “access point”) that can be used only to retrieve the data and start the sensor unit running. You connect to it just like any other wifi network, but it can’t be used to reach the internet. When you connect, the sensor unit gets the right time automatically and will let you choose some options like describing where you are putting the unit.

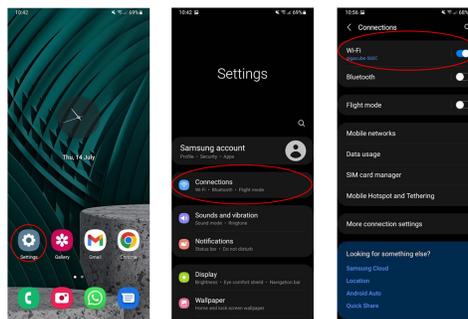
Try connecting to the sensor unit at home first, with these instructions showing on a different phone or laptop if you have one - it will be much easier to follow along and then your phone will remember some of the steps.

i Overview for technophiles

- turn the sensor box off for ten seconds, then on again
- connect to the “engineer” wifi hotspot using the password printed on the box
- visit 192.168.4.1 using your browser
- describe where you are placing the sensor
- download the data (which also starts the device)
- email the data to data@heathack.org

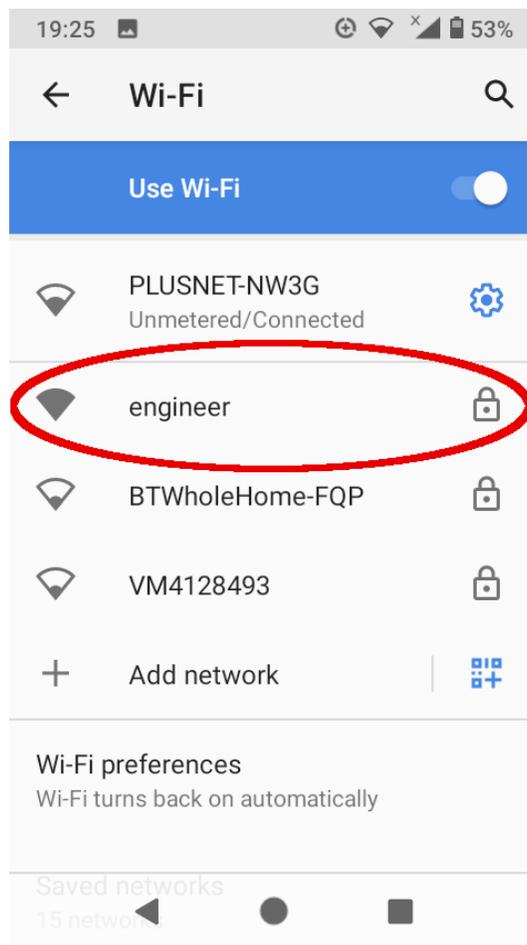
The remaining pages in this section show the full steps to connect. The process is very similar whether you use a phone, tablet, or laptop.

Find your wifi settings



You can access them through the settings icon (a gear) on your home screen or by searching.

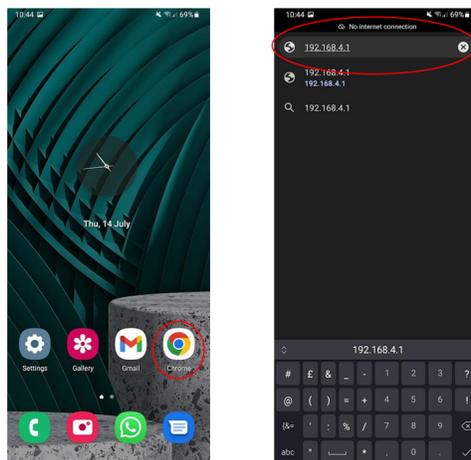
Turn the sensor unit on and connect to the “engineer” wifi hotspot



If the sensor unit is already on, turn it off, wait ten seconds, then turn it on again. A wifi hotspot named “engineer” will appear. Connect to it using the password “heathack”. Ignore any warnings about internet availability - connect to the hotspot anyway.

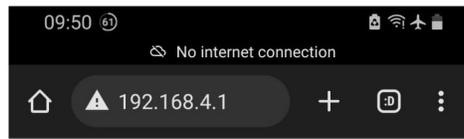
You have around one minute to do this step and the next one but if you take longer, you can start again.

Connect to the sensor unit



Open your web browser and type “192.168.4.1” into the address bar at the top. You might have a separate “search” bar. Using that won’t work. Chrome, Safari, Firefox, Samsung Internet and Microsoft Edge are all web browsers.

Name the location, download the data and restart



SETUP

The sensor will hibernate in 4 minutes if you do nothing.
Please download the data every week or two and send it to data@heathack.org.

This should show reasonable values for temperature, humidity: 21,53

Enter the location

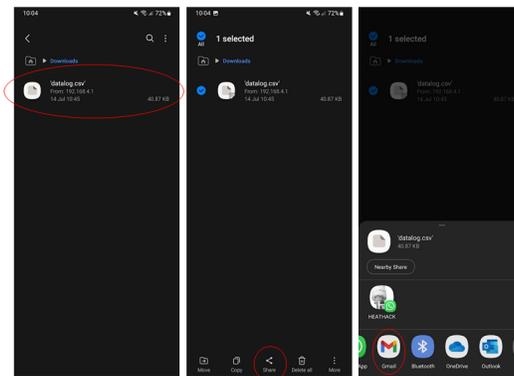
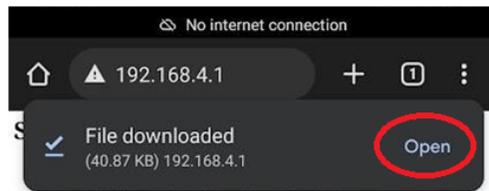
Battery voltage: 3.55v
Save to: Memory
Interval: 5
When no date/time set: Continue
Sensor Type: DHT22
Version: ESP_node_OTA_v6_4_12_13.ino 20:09:43 Jun 17 2022



You should now see the sensor unit's interface. For the location, enter a word or two that will remind you where you've left the unit; for instance "main-hall". You can use hyphens and underscores if you wish, but avoid spaces. Please try to use the same description for the same location every time.

When you press "download data and start", your phone will download a file containing the data and then start logging. You have four minutes to do this but the battery will last longer if you are faster.

Send us the data



You will get a notification that a file has been downloaded. Try to open it. You may see an error message saying the filetype is not supported, but your phone should allow you to open a list of downloaded files.

The correct file is named "datalog.csv", possibly followed by a number if you've downloaded data before. You always want the most recent one. This is usually the one with the highest number. Select the correct file by holding your finger on it, and then choose "Share" and the icon of the email app you want to use. Gmail, Mail, and Outlook are common email apps. This will start composing an email message with the data file already attached. Send the email to data@heathack.org.

If you can't find the option to share the file with us by email, you can open your email, start a message to us, and attach it to the message. The file will be wherever your internet downloads go.

By HeatHack

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