Internet of Things Heating and Energy Use Measuring Project

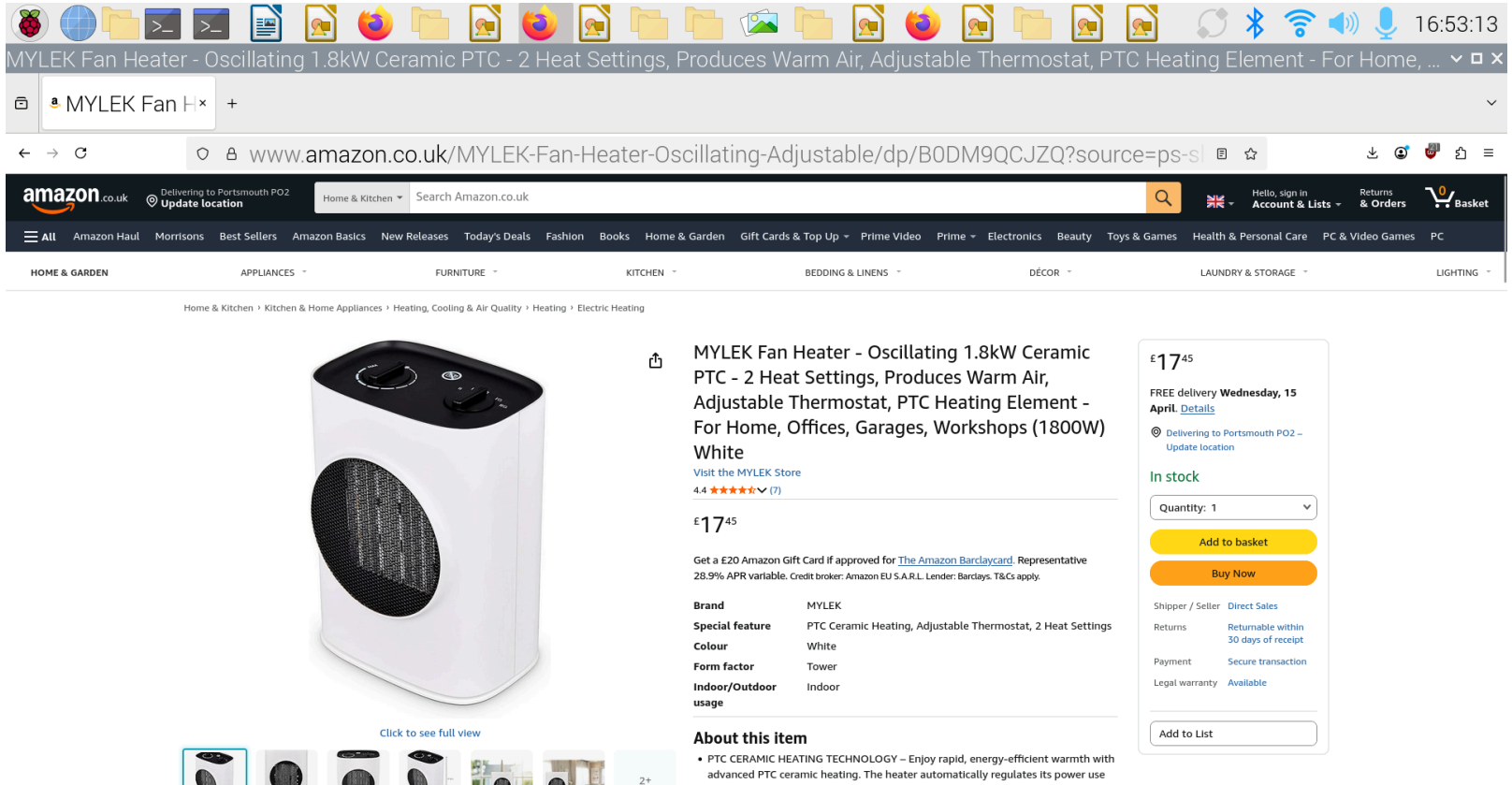
Brief For My Internet of Things Controlled Heating Plugs

My Bills were getting expensive so I set myself a project to create a heating system using Halogen Heaters, Internet of things device and Github Python Libraries + Tons of Coding to Save myself some money and share it with others.

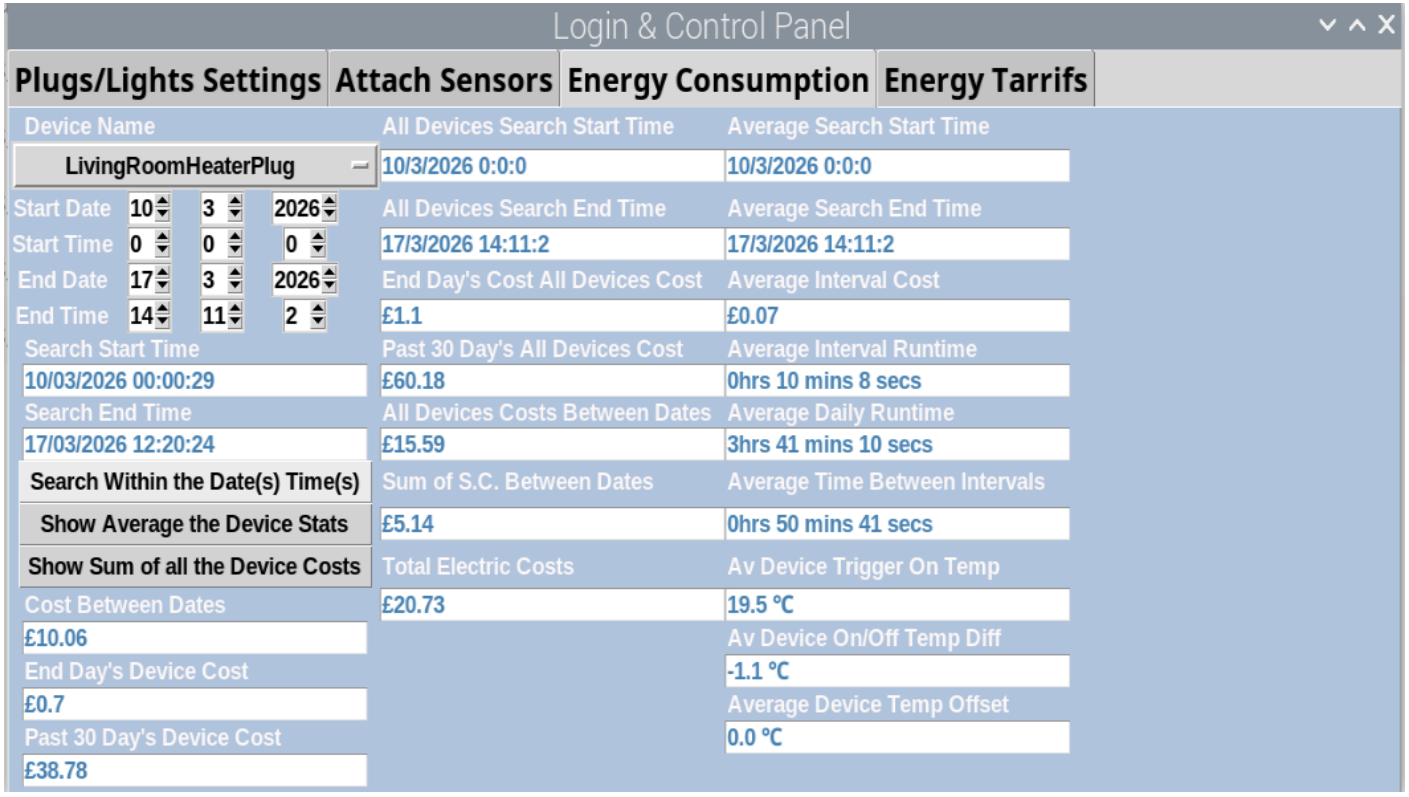
The Data Gathering Page

The following is the Data Collected by My Energy Measurer between the 10th and 17 of March 2026 from a Tapo p110 plug which I used heat my Living Room with a MyLex halogen heater I bought from Robert Dias and would cost 17.99 from amazon its this one:

https://www.amazon.co.uk/MYLEK-Fan-Heater-Oscillating-Adjustable/dp/B0DM9QCJZQ?source=ps-sl-shoppingads-lpcontext&psc=1&smid=A1OY0ON8ILHX86



Energy Consumption Panel



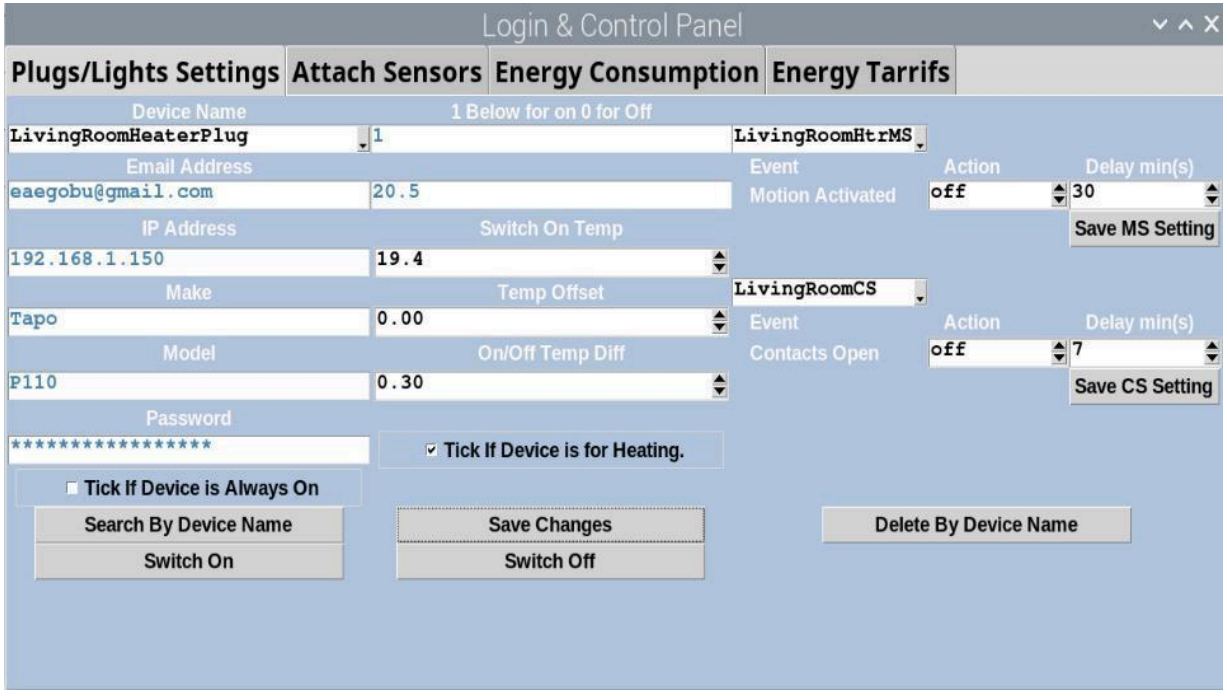
I pressed all the data gathering buttons, including search within date times which tells the heat used by a specific plug between the dates and times including the cost between dates and times the cost of the end of search day and past 30 days cost. The Show sum of all Device Costs is mainly concerned with the middle column. Showing the start end end time of the search similar stats to costs for a single device except for all device costs it also includes the standing charge which is abbreviated to S.C.

The middle button shows the stat on the stats on the last column. There is extra data to look at such as average interval runtime which is the mean time of each heating interval, average daily runtime which is the mean sum of the time the device has been on all day. Average time between intervals, is the time difference between the end of the last heating interval and the beginning of the next heating interval that the heater has been on. It could also be used to measure the average time intervals between using kettles.

Motions sensor. Contact Sensors, Temp sensors and heating

Motions sensors are used to determine if there has been the smallest detectable amount of movement in a room. If there has been motion in this time period and the temp is low the heater is switched on, also a contact sensor determines if the door is open. If the door has been opened for long enough the heater is switched off this saves heat.

Configuring The Plug



The first column is the information the python library needs to loginto the heater which are the device name, email address, ip address, make, model and password. The password is the same for all Tapo Devices on the network.

Configuring The heater

The next column contains some configuration settings for the heater, including: if its on or off. The Switch on Temp is the Temperature the Plug will drop to before it switches of and heats the room.
The On/off Temp Diff is the difference between the switch on and switch off temp. So when the temp is above 19.7 the heater will switch off and drop down to below 19.4 before switching on again.

Motions Sensor and Contact Sensor

The Third column contains settings for the motion sensor and contact sensor. LivingRoomHtrsMS is the name I gave to the Living Room Heaters Motion sensor. If the motion hasnt been activated for a set time it will switch of the LivingRoomHeaterPlug. The setting for LivingRoomCS is a contact sensor I put on the living Room Door.

Summary

It's in the prototype stage at the moment. Tapo equipment is not the best choice because it relies on an internet connection. Need to develop this further, with plugs and sensors that don't rely on a WIFI connection but are internet of things based using; equipment that's meant to be compatible with a Raspberry PI. Such as Zigbee connected plugs and sensors.

Energy Use Between November and March Comparison Between the years 2023 to 2024 and 2025 to 2026.

This was the cost of the overall heating bill while heating only one room. I removed the cost of heating the hallway from the calculation of the final cost. The standing charge was set at that of my current provider which is fuse and is: Electric £0.3598, Gas £0.27. Cost per Kwh is Electric £0.2334 Gas £0.0541.

Type	Start date	End date	Units	Cost of Units	Cost(E)	Type	Units	Cost of Units	Cost(G)	(E+G)*Vat	Daily Cost	Hallway Cost
Elec	06/11/2023	06/12/2023	159.0	£37.11	£47.90	gas	1035.59	56.03	£64.21	£117.72	£3.92	
Elec	06/11/2025	06/12/2025	468.0	£109.23	£120.03	gas	200.44	10.84	£19.03	£114.61	£3.82	£29.90
Elec	06/12/2023	06/01/2024	179.0	£41.78	£52.93	gas	679.26	36.75	£45.20	£103.04	£3.32	
Elec	06/12/2025	06/01/2026	551.0	£128.60	£139.76	gas	200.44	10.84	£19.30	£151.90	£4.90	£14.39

Elec	06/01/2024	06/02/2024	364.0	£84.96	£96.11	gas	1347.39	72.89	£81.35	£186.33	£6.01		
Elec	06/01/2026	01/02/2026	417.9	£97.55	£106.91	gas	156.79	8.48	£15.57	£120.06	£4.62	£8.14	
Elec	06/02/2024	06/03/2024	203.0	£47.38	£57.81	gas	946.51	51.21	£59.12	£122.78	£4.23		
Elec	01/02/2026	01/03/2026	350.0	£81.70	£91.78	gas	154.83	8.38	£16.01	£112.83	£4.03	£0.33	

Cost Comparison

Daily cost figures in green indicate a month when the device was cheaper to run than my previous central heating. Bear in mind this was a prototype and on some weeks it wasn't fully operation so would run overnight.

Temp InfoTemp stats:

- From 6 Nov 2025 to 6 Dec 2025 the average temperature the device switched on at was 19.6 and it went up to 20.1 degrees so the temp was basically no less than 19.6 degrees provided no one was in the room.
- From 6 December 2025 to 6 Jan 2026. The device switched on at 19.3 degrees on average and switched off at 19.9 degrees on average. Between Jan and Feb the device switched on at 19.0 degrees on average and off at 20 degrees on average. It ran for nearly twice as long a day as in December to Jan.
- From 6 Feb 2026 to 6 March 2026 the average temp it switched on at was 19.5 and the average temp it switched of at was 20.7.

Between November and mid Jan I was bug fixing. Between mid Jan and End of march it was running, up to march 17-20. After those dates I'd received a wearable blanket in the post and put it at 18 degrees. It barely went on.
I didn't need to keep fiddling with the thermostat to get it at the right temp. I'd switch it on and leave it to collect data for a month or two. Occasionally you'd have to switch the device on and off again.

Heating a Bedroom at Night

I found it cost 25p to heat a bedroom overnight to 16 degrees, any hotter than this and its too hot and you start dreaming its a summers day and removing blankets.

Overall Costs

If you consider the cost of setting up a central heating system and realise that I used in-efficient halogen heaters for this costing £20 and sensors costing £10-£15 with two or three per room and one raspberry pi costing £45 the cost reason for setting up a central heatings system doesn't make sense. Plugs cost between £8.99 and £12.99 each depending on where you buy them from.

Conclusion

I need one more cold season to test my findings. From November to the end of January the device was under heavy development. From Jan this year I let it run untouched it was a steady prototype. From November to mid Jan I was heating the Hallway as well so deducted this cost from the overall heating cost. It basically works as well as a central heating system for heating a single room. What I also noticed was the temp was more or less steady instead of constantly fiddling with the thermostat.

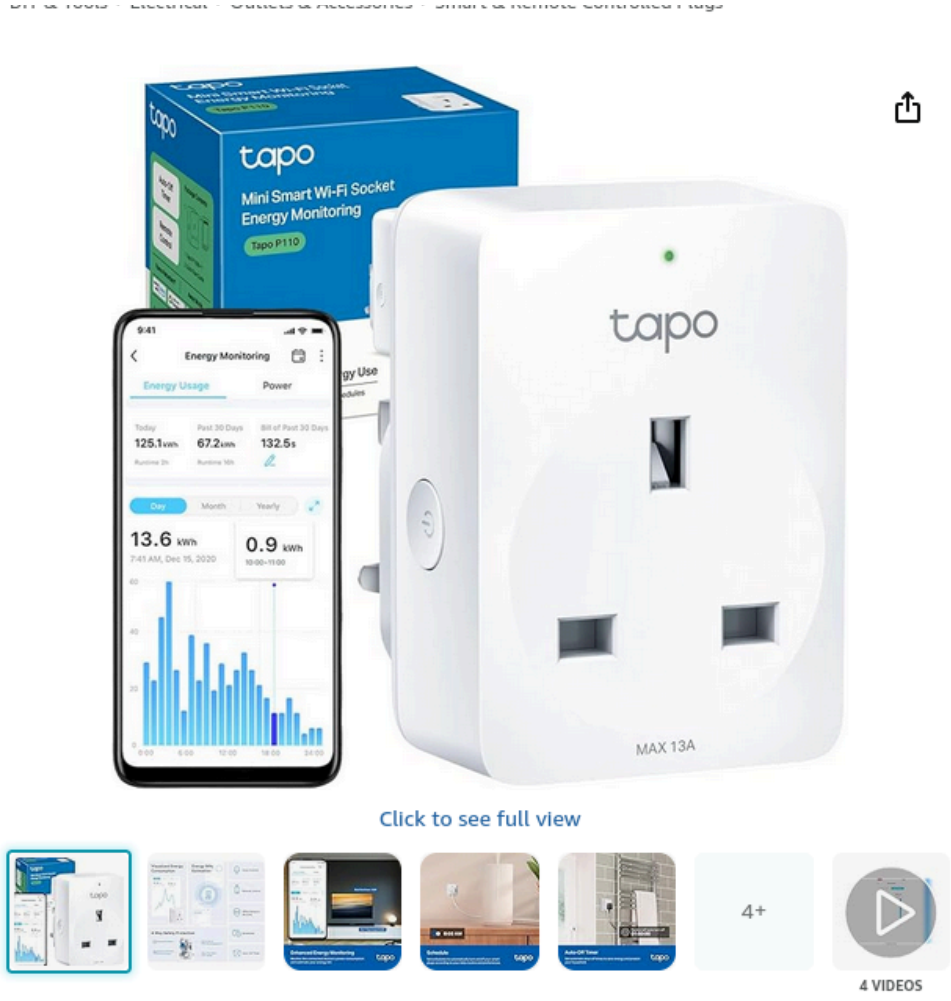
Appendix A Images of Equipment

Raspberry PI 5 4GB and 8GB

This is a photo of my two raspberry Pis in my flat the red and white one is a back-up for storing the energy use data and the black one is the main one which controls the raspberry PI and I also use it for development trial runs as it has a higher ram capacity meaning it runs faster. The program runs for two or three months at time or longer uninterrupted. In case there is an electrical or unpredictable fault in one the data is maintained. There is a backup system that I also built into the data storage meaning, if there is a fault in new data the old data is saved. Its been running for the last two months without any problems.

Tapo P110 Energy Measuring Plug and Heater

The image to the left is of the heater which I should have dusted and the Tapo Plug. The plug is one of these below which is a Tapo P110. It's on and off state depends on sensors including: a heat sensor, motion sensor to tell if someone has been moving in the room less than an hour ago, and contact sensor to tell if the door is open.

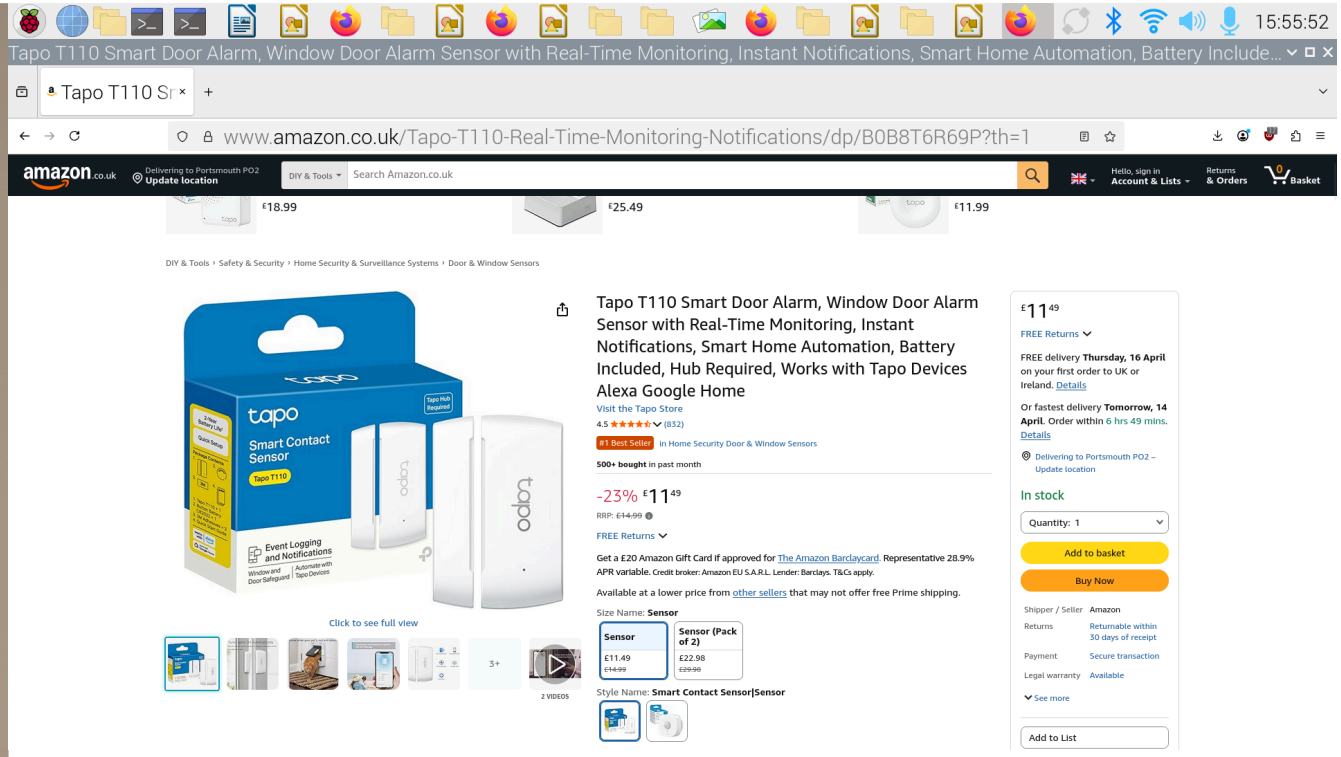


Tapo T310 Heat Sensor (Heater Thermostat).

On the left is a heat sensor its a Tapo T310 heat sensor in my flat. Below is how it appears as amazon listings graphics. Below is what it looks like close up.

Tapo T110 Contact Sensor (Door / Open Close Sensor).

On the left at the top left of the door frame is the t110 contact sensor. If this sensor indicates the door has been left open for x mins the heater is turned off. Below is what it looks like close up.



Tapo T100 Motion Sensors (Acting as Room Presence Detectors)

On the left are two amazon t100 motion sensors. One is to control the heating and the other is to control the lighting the one to control the lighting is at a reduced sensitivity to the one to control the heating this is so you can move slightly while watching a film and although one motion detector attached to the Plug Heater will detect the motion the one attached to the light wont so the light wont come on as you watch the film.
Below is what it look likes close up and on the amazon listing.