

OpenEnergyMonitor

EcoHome Lab: From Monitoring to Control
Using emonPi with integrated MQTT, Node-RED and openHAB

@openenergymon

Glyn Hudson

11th Aug 16

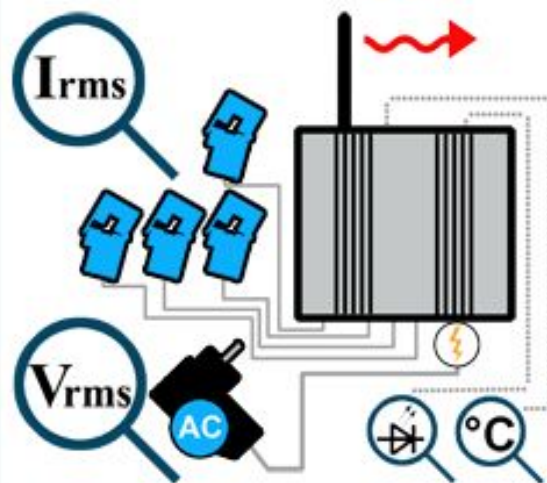
<https://www.meetup.com/Eco-Home-Lab-Manchester/events/230714252/>



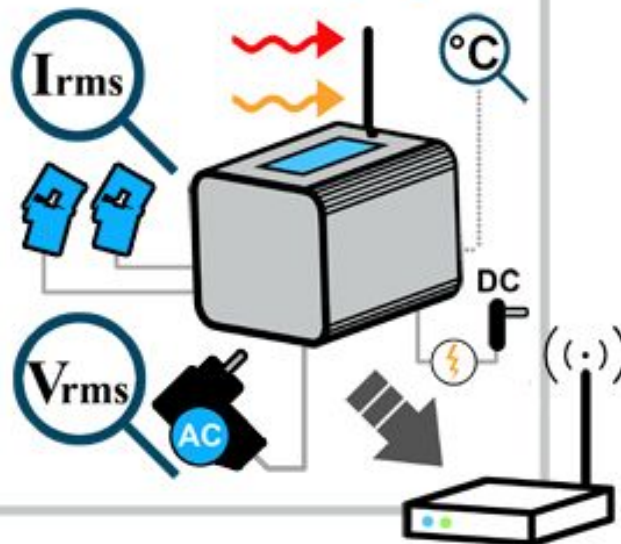
OpenEnergyMonitor is a project to develop open-source tools to help us relate to our use of energy, our energy systems and the challenge of sustainable energy.



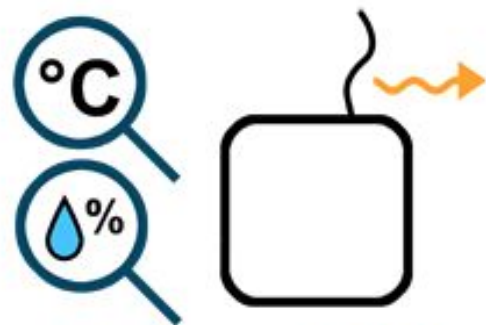
emon**Tx**



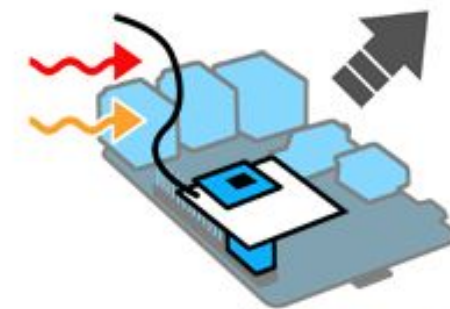
emon**Pi**



emon**CMS**



emon**TH**



emon**Base**

OpenEnergyMonitor Hardware

emonTx

- 4x AC circuits



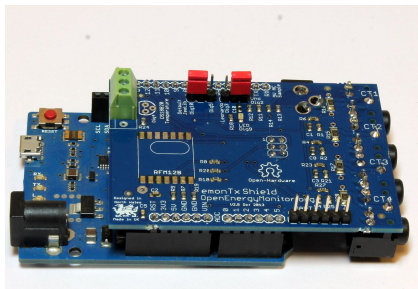
emonTH

Wireless Temperature & Humidity



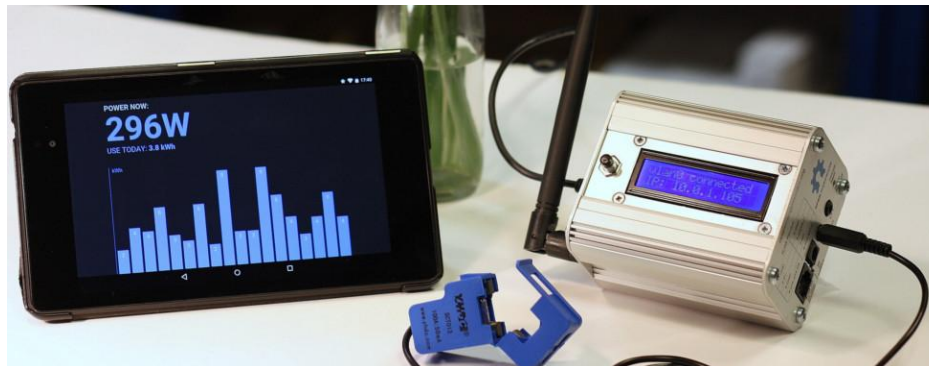
emonTx Shield

- 4x AC circuits
- Arduino shield footprint



emonPi

Raspberry Pi based all-in-one energy monitor
2 x AC Circuits

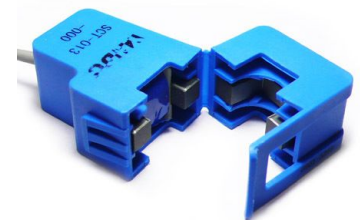


Sensors

- Optical Pulse



- Clip - on CT



emonPi

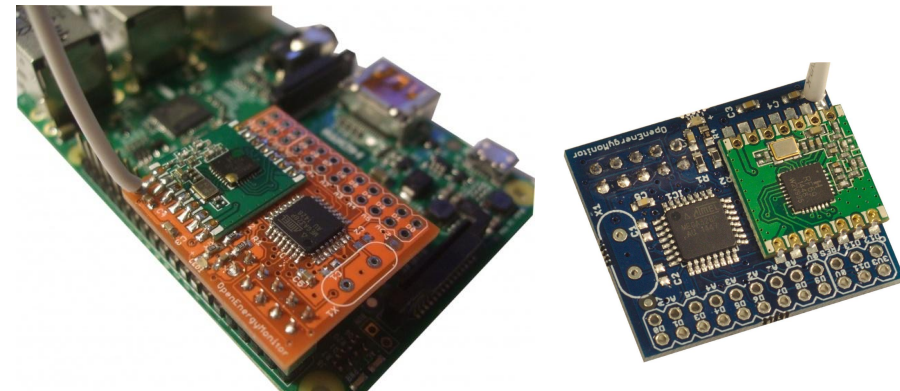
Energy Monitor & web connected base station

Hardware

- 2 x CT channels
- 1 x AC-AC voltage sensor channel
- Optical pulse & multi temperature sensors
- Atmega328p
- RFM69CW RF - (Receive data from other RF nodes e.g. emonTx, emonTH)
- OOK RF (optional) - RF plug control
- Communicate with Raspberry Pi 2 via serial GPIO
- USB WiFi Adapter (optional) / or 3G



emonBase: RasPi + RFM69Pi



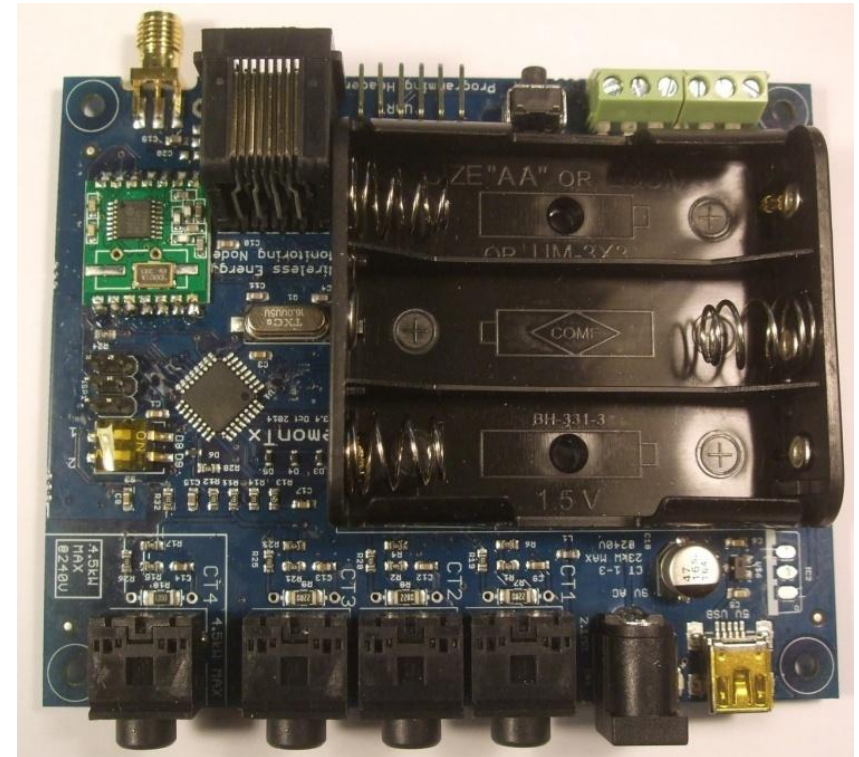
emonTx V3

Remote energy monitoring node

Hardware

- 4 x CT channels
- 1 x AC-AC voltage sensor channel
- Optical pulse & multi temperature sensors
- Atmega328p - Arduino compatible firmware
- RFM69CW
- Powered via AC-AC adapter, 3x AA battery or USB 5V

Transmits power data every 10s via RF to be received with emonPi / emonBase.



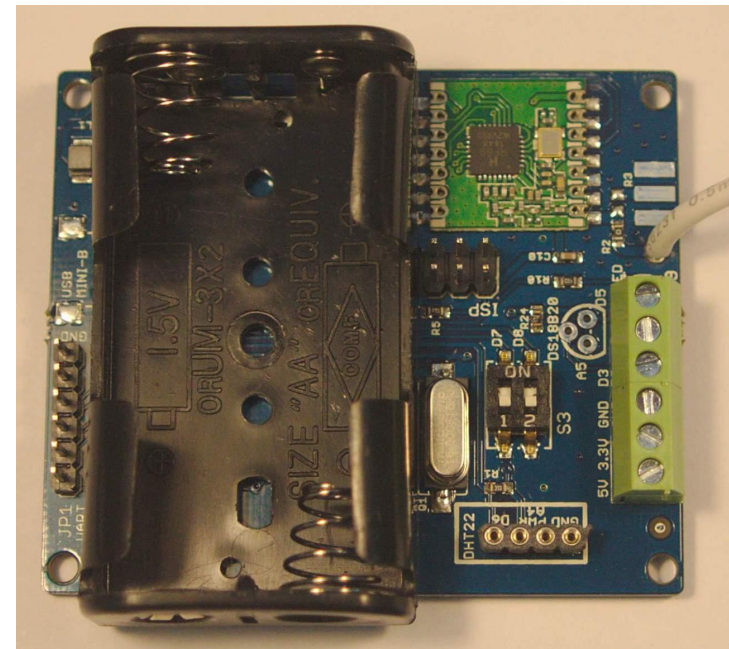
emonTH

Low power remote temperature & humidity room node

Hardware

- ATmega328p
- RFm69CW
- DHT22 / DS18B20 (multiple)
- 2 x AA batteries 7-10 months battery

Transmits temperature data every 60s via RF to be received with emonPi / emonBase.



Emoncms.org

Emoncms is a powerful open-source web-app for processing, logging and visualising energy, temperature and other environmental data.

Part of the [OpenEnergyMonitor.org](https://openenergymonitor.org) project.



Emoncms.org Login

Username:

Password:

☐ Remember me

[Login](#) or [register](#)

[? Forgotten password](#)

Docs

Documentation for how to install, upgrade, use and backup emoncms is available on the emoncms github repository.

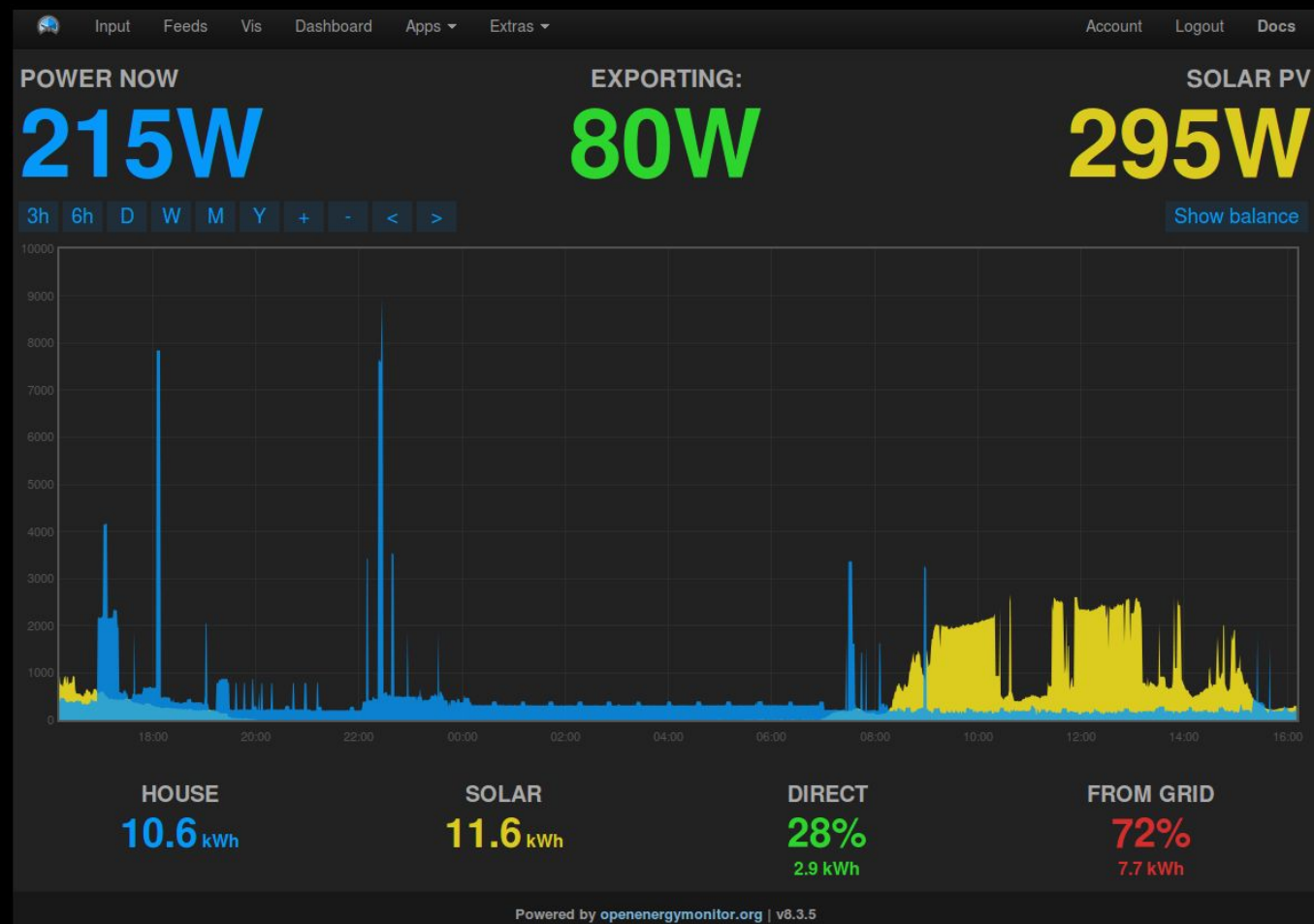
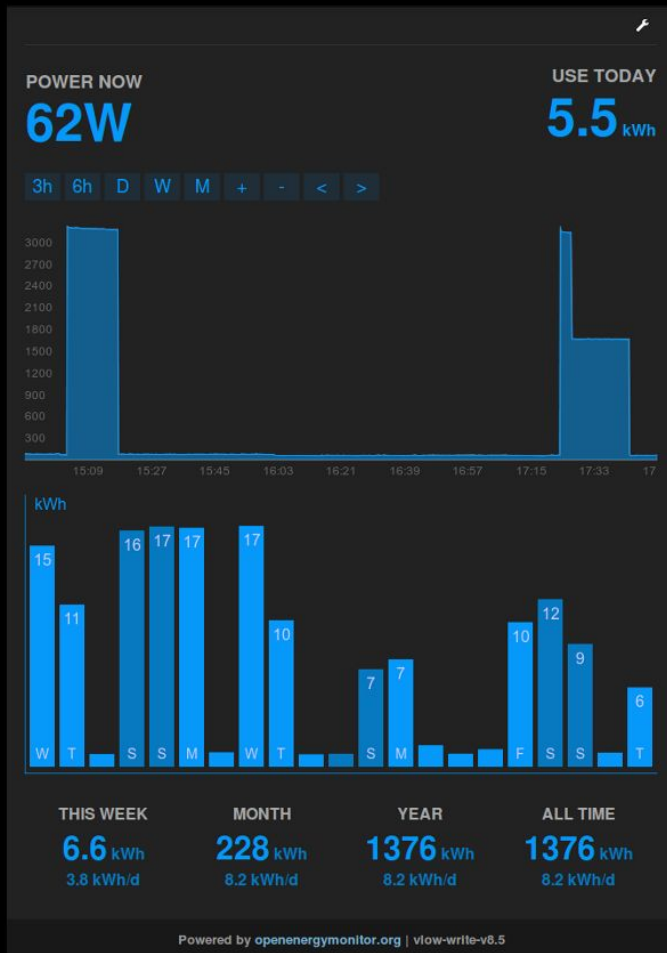
Github

We believe open source is a better way of doing things. Emoncms is available under the GPL Affero licence (AGPL).

Install

Install emoncms on a RaspberryPi, home computer or web server. With emoncms you can have full control of your data.

Emoncms





Emoncms

OpenEnergyMonitor Tools

★★★★★ 19

PEGI 3

This app is compatible with all of your devices.

Installed



Open-source Emoncms dashboard viewer.

View MyElectric Emoncms dashboards from <http://emoncms.org> or any other Emoncms server.

Emoncms is an open-source web application for processing, logging and visualising energy, temperature and other environmental data developed as part of the <http://openenergymonitor.org> project.

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Importing NREL Solar Models in to EmonCMS 4

[csv](#) [pvwatts](#)
[Emoncms](#)


9

122

20m

Dashboards - no data visible after upgrading to 9.7.2 new

[Emoncms](#)


1

18

1h

emonESP firmware development 1

[Labs](#)


9

187

1h

Simple Zoom Not displaying Power new

[emonhub](#) [emoncms](#)
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1

16

2h

Openhab problems connecting through myopenhab with Java 8

[OpenHAB](#)


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3h

Portable air quality monitoring?

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10h

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1d

Diverting Solar to Charge an Electric Car

[evse](#) [electriccar](#)
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1d

Powering custom emonTx board with dual output transformer

[Hardware](#)


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1d

emonTH antenna

[emonTH](#)


1

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1d

Phpfiwa conversion from v8.4.0

[Emoncms](#)


0

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2d

Feeds / Inputs / Process list not working or updating and system fail

[Getting Started](#)


0

31

2d



User Guide

Set up, install and configure an OpenEnergyMonitor system

[Get Started](#)

Home Energy

Understand your energy consumption:

- Monitor in real-time
- Review historic data
- Calculate cost
- Android app

[Learn more »](#)

Solar PV

Make the most of your solar PV:

- Monitor generation and grid import
- Calculate on-site use of solar.
- Real-time & historic performance
- Optimise demand matching

[Learn more »](#)

Integrate

Extend functionality with:

- Emoncms
- MQTT
- NodeRED
- OpenHAB

[Learn more »](#)

System Overview



Sustainable Energy Challenge

New user guide
helps make
getting started
easier

// Connect

[Edit on GitHub](#)[Edit on GitHub Prose](#)[« Previous step: Required Hardware](#)[Next step: Install »](#)

First Boot

Important

This guide assumes you are using an emonPi / emonBase pre-built SD card.

This SD card can be [purchased from the shop](#) or downloaded:

- [Pre-build SD card download & Change Log](#)
- [Instructions to flash image to SD card \(RaspberryPi\)](#)

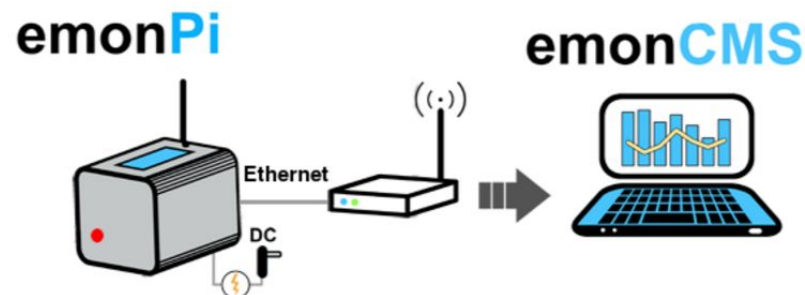
The emonPi runs Emoncms data logging web-app locally from emonPi's internal web sever. Using Emoncms data can be logged locally to the emonPi's SD card and (optionally) posted remotely to the [Emoncms.org](#) cloud server.

Important

Emoncms local: Emoncms instance running locally on the emonPi

Emoncms remote: Emoncms.org cloud server.

1. Connect Ethernet and USB power



Site Map

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- [Add Temperature Nodes](#)
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- [Emoncms API](#)

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- [Solar PV](#)
- [Heatpump](#) ↗

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Support

New user
guide
helps
make
getting
started
easier

Auto Detect

Emoncms setup wizard in development...

2 devices detected:

emonTx v3

Energy Monitoring Node

Select your configuration:

- ☐ Home Energy Monitor
- ☒ Solar PV Monitor

Configure



emonTx v3

Energy Monitoring Node

Select your configuration:

- ☒ Home Energy Monitor
- ☐ Solar PV Monitor

Configure



OpenEnergyMonitor Store

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Featured Products



emonGLCD - LCD Display Unit - Kit

£48.00 (inc VAT)
£40.00 (ex VAT)

[Choose Options](#)



emonTx Arduino Shield SMT

£11.04 (inc VAT)
£9.20 (ex VAT)

[Choose Options](#)



RFM69Pi 433MHz Raspberry Pi Base Station Receiver Board

£18.60 (inc VAT)
£15.50 (ex VAT)

[Pre-Order Now](#)



emonTx V3 - Electricity Monitoring Transmitter Unit - 433MHz

£60.00 (inc VAT)
£50.00 (ex VAT)

[Choose Options](#)



100A max clip-on current sensor CT

£9.60 (inc VAT)
£8.00 (ex VAT)

[Add To Cart](#)



emonBase - web-connected base-station

£56.39 (inc VAT)
£46.99 (ex VAT)

[Choose Options](#)



Optical Utility Meter LED Pulse Sensor

£18.97 (inc VAT)
£15.81 (ex VAT)

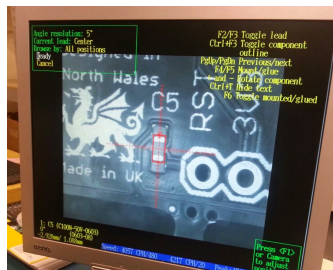
[Add To Cart](#)



emonTH 433MHz - Temperature & Humidity Node

£27.36 (inc VAT)
£22.80 (ex VAT)

[Choose Options](#)



Open Hardware Business (Megni)

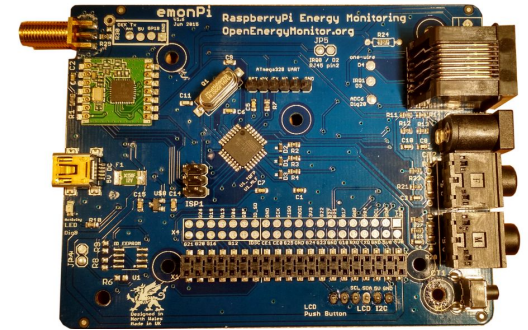
- Local Manufacture: PCB's manufacture in UK, SMT assembly in Bangor, N.Wales.
- Worldwide shipping: Over 10,000 orders to over 70 different countries over past 3 years.
- Open hardware business is an effective model for making and distributing technology, providing employment and supporting open-source development.
- Blurs the traditional lines between “business”, academic research and education.



emonPi Embodied Energy



EmonPi Full



EmonPi Shield only

EmonPi Shield 12.7%
5.1kWh

SMT Crystal? 9.0% 454Wh
SMT Components 2.0% 100Wh

RaspberryPi 25%
10.0 kWh

Integrated
circuits: 4.6%
236Wh

Assembly 32%
1.6 kWh

Connectors
9.4%
475 Wh

EmonPi LCD
Assembly 9.5%
3.8 kWh

EmonPi
Enclosure 25%
10.1 kWh

Sensors and Power
Adapter 27%
10.9 kWh

PCB 43%
2166kWh

**TOTAL
40 kWh**

**TOTAL
5.1 kWh**

Assuming installing in average household, if a 5% reduction in energy can be achieved the emonPi will save the amount of energy used in it's manufacture in 3 months.

<https://blog.openenergymonitor.org/2015/07/open-source-circular-economy-oscedays/>
<https://blog.openenergymonitor.org/2015/06/investigating-embodied-energy-of-emonpi/>



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Extend functionality with:

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- MQTT
- NodeRED
- OpenHAB

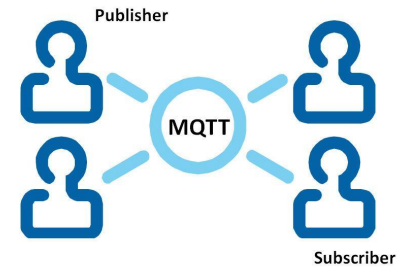
[Learn more »](#)

System Overview



Sustainable Energy Challenge

The glue of Internet of Things...#1



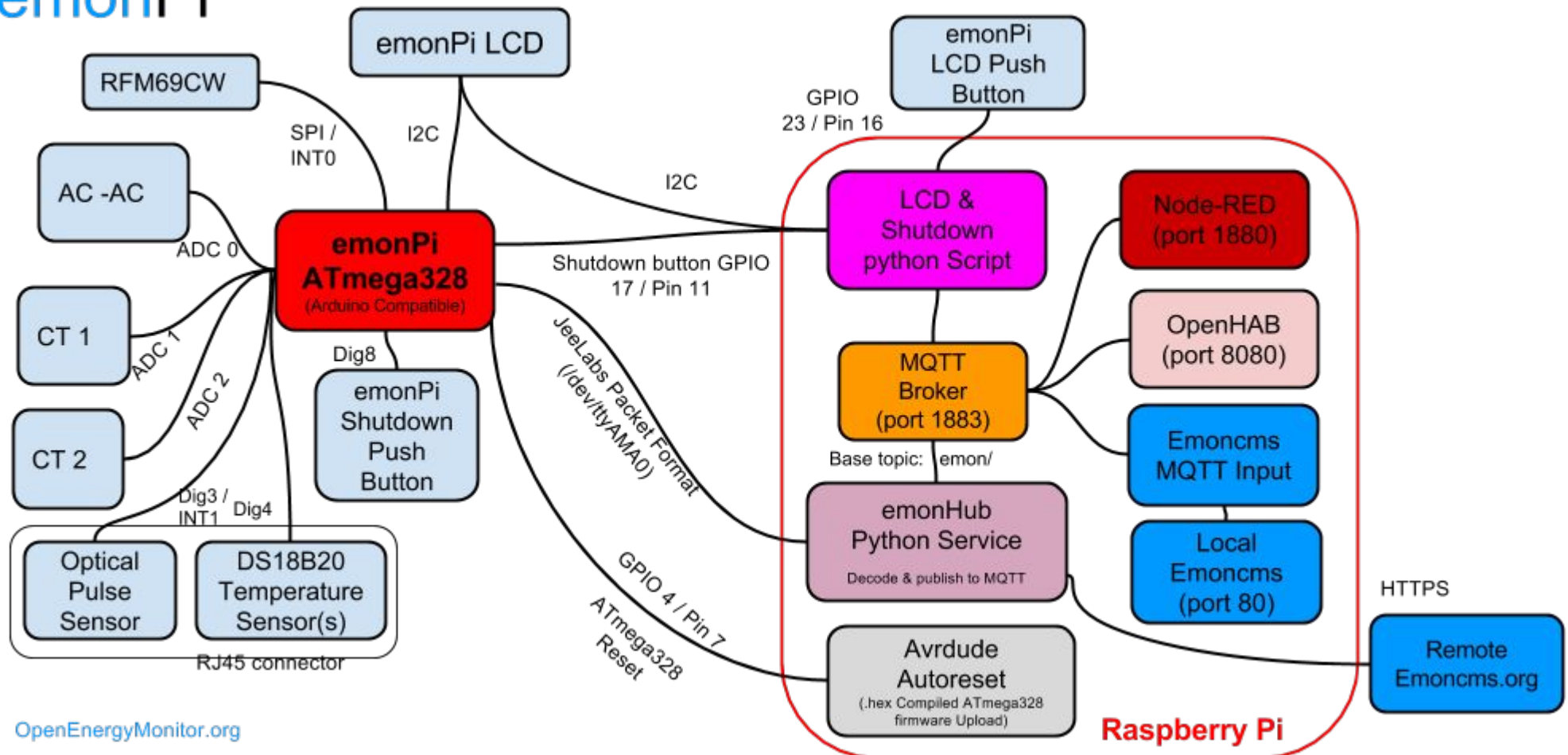
- M2M publish / subscribe message transport protocol
- Runs over TCP/IP
- Lightweight, open, simple and secure
- Used in Facebook messenger, Illy coffee machines and emonPi energy monitor :-)

MQTT topic:

emon/<nodename>/<keyname>

e.g. emon/emontx/power1

emonPi



OpenEnergyMonitor.org

<http://guide.openenergymonitor.org/technical/mqtt/>

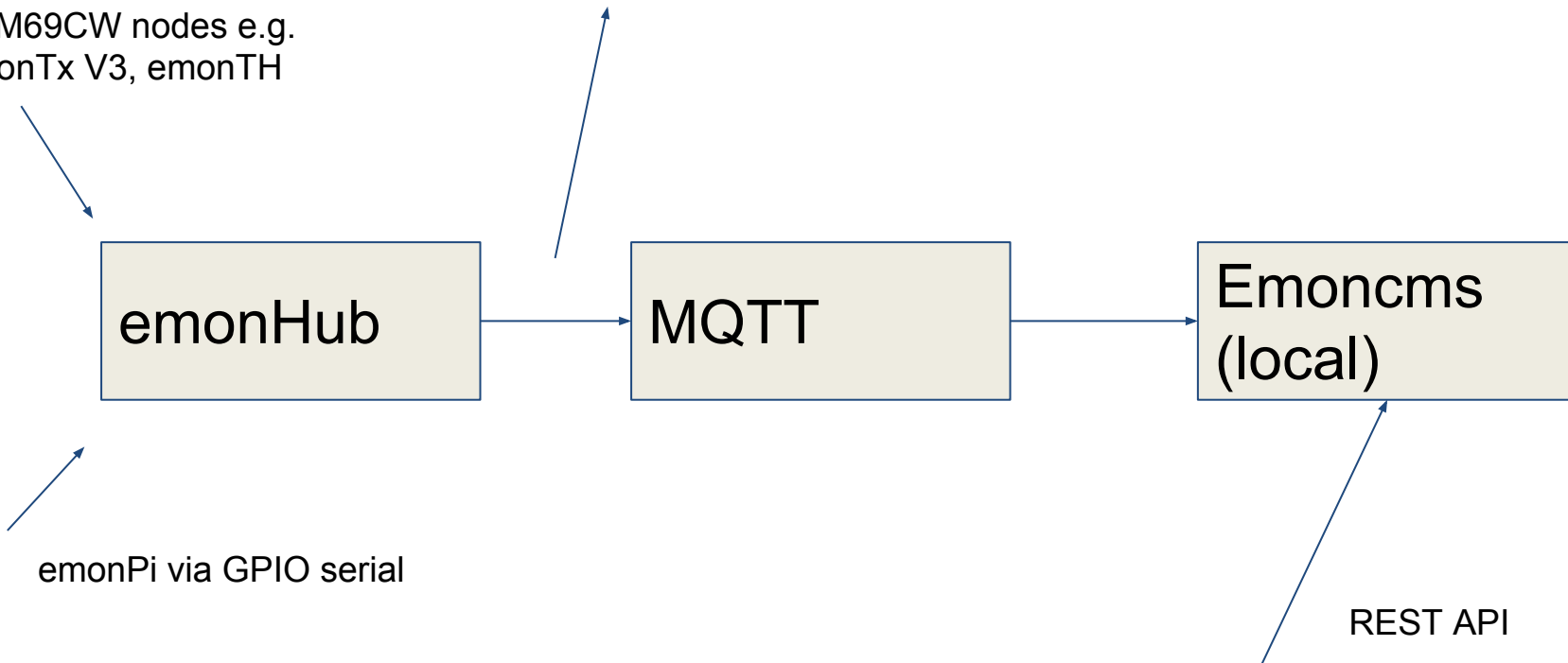
MQTT Interface

emonHub publishes data to MQTT topics:

emon/<nodename>/<keyname>

e.g. emon/emontx/power1

RFM69CW nodes e.g.
emonTx V3, emonTH



Note: Emoncms.org does not yet support MQTT directly

Pre Installed on emonPi

Assuming pre-build SD card image [emonSD-03-May16](#) or later

Node-RED

Node-RED is a tool for wiring together hardware devices, APIs and online services in new and interesting ways. Using NodeRED the emonPi can become a central hub for home automation, control and notification.

OpenHAB

Open Home Automation Bus (OpenHAB) is "a vendor and technology agnostic open source automation software for your home". OpenHAB is java based and can run on an emonPi (Raspberry Pi) and is very flexible and can be configured for just about any home automation task

LightWaveRF Control

LightWaveRF produce a variety of RF plugs and relays which can be controlled via OOK (on-off-keying RF. The LightWaveRF OOK protocol is also compatible with some lower cost un-branded OOK learning receivers relays.

No Installation Required

WiFi MQTT Control Relay Thermostat

Multi-purpose Wifi connected relay control board. Applications include: remote heating an A/C systems control via nodeRED, openHAB and Android Tasker etc.

Installation Required

Home Assistant

Fully open-source python based home automation platform, similar to openHAB but easier to setup with some nice auto-detection. Tested to work on emonPi (requires install)

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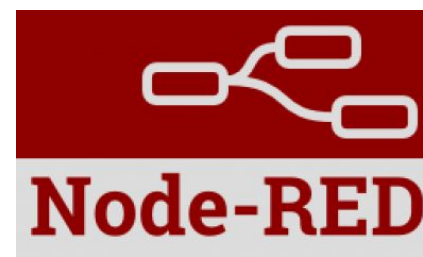
Support

- [Community Forum](#) ↗
- [Contact](#)

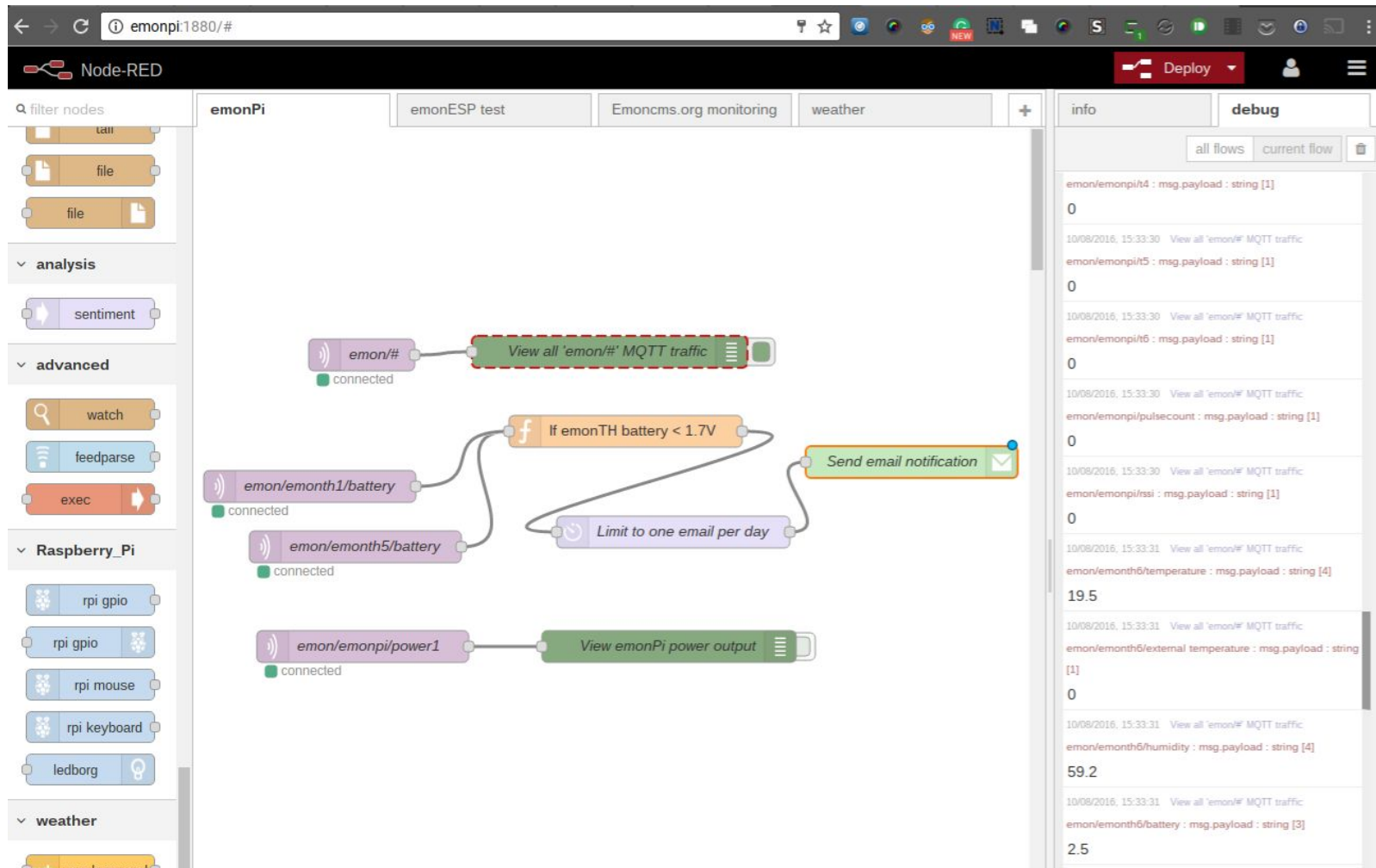
[OpenEnergyMonitor](#) ↗

A project to develop open-source tools to help
...relate to energy...

The glue of Internet of Things... #2

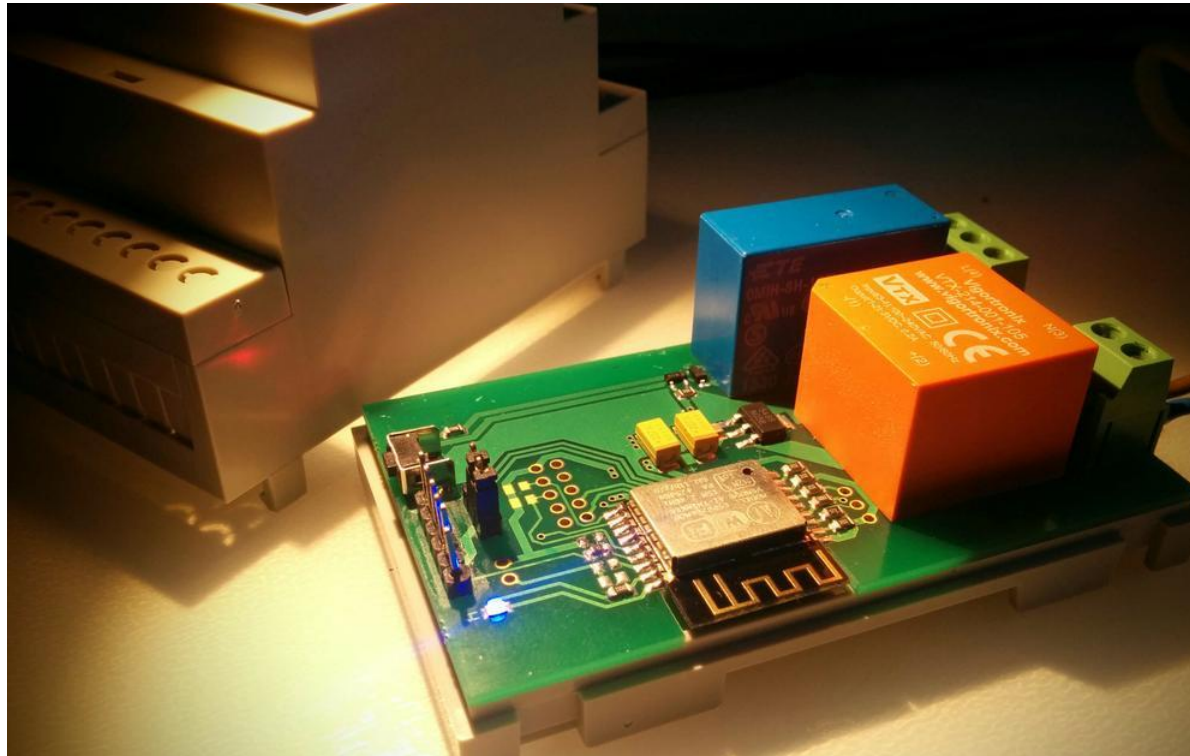


- Tool for wiring together hardware devices, APIs and services in new and interesting ways.
- The emonPi can become central hub for home automation, control and notification.
- Open-source, developed by IBM



<http://guide.openenergymonitor.org/integrations/nodered/>

MQTT ESP8266 WiFi Relay / Thermostat



MQTT Settings

MQTT enabled?: ☒

Host: 192.168.0.12

Port: 1883

Keepalive (sec): 120

Device ID: VE5IV4Z46U

User: emonpi

Password:

Use TLS?: ☐

Subscribe topic: heating/control/#

Publish topic: heating/status/

[Back](#) [Save](#)

WiFi Settings

Current WiFi mode: STA

To connect to a WiFi network, please select one of the detected networks...

☐ TALKTALK-C917B8

☐ Crumble

Current IP: 192.168.0.36

WiFi password:

Mode: Static IP

IP address: 192.168.0.36

IP mask: 255.255.255.0

GW address: 192.168.0.1

[Back](#) [Connect!](#)

192.168.0.36:2015/control/thermostat.html

Heating

[Manual](#) [Schedule](#) [OFF](#)

SET POINT:



19.5°C



Temperature: NaN°C

Schedule

TUE 22:43



[Split](#) [Merge](#) [Move](#)

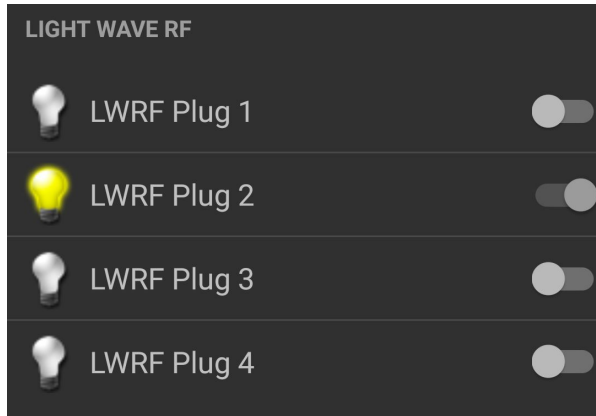
[Heating](#) [Cooling](#)

Relay can be controlled by publishing 1 or 0 to the MQTT control topic, default:

'heating/control/relay/1'

<https://guide.openenergymonitor.org/integrations/mqtt-relay/>

lightwaveRF plug control (OOK RF)



emonPi - Raspberry Pi based energy monitor

OpenHAB
(control interface >
Plug 1 = ON)

Publish

MQTT Server

Suscribe

RF Transmitter
(433Mhz OOK)

LightWaveRF
MQTT Service

“1 1” > “lwrf” topic



RF “ON” Control Signal

LightWaveRF
(Remote Plug)



OpenEnergyMonitor

emonPi

Power 1 153 W

Power 2 0 W

Voltage 242.2 VRMS

emonTH (node 23)

Temperature 14.3°C

Control

LWRF Plug Control >

ESP WiFi Relay >

©2010-2015 openHAB.org

OpenEnergyMonitor

emonPi

Power 1 169 W

Living Room

Temperature 18.3°C

Humidity 69.2 RH

Outdoor

Outdoor Temperature 14.1°C

Heating

Heating Control

Downstairs

All

Projector

Phone Table Lamp

Reading Lamp

Kitchen

Upstairs

Blanket

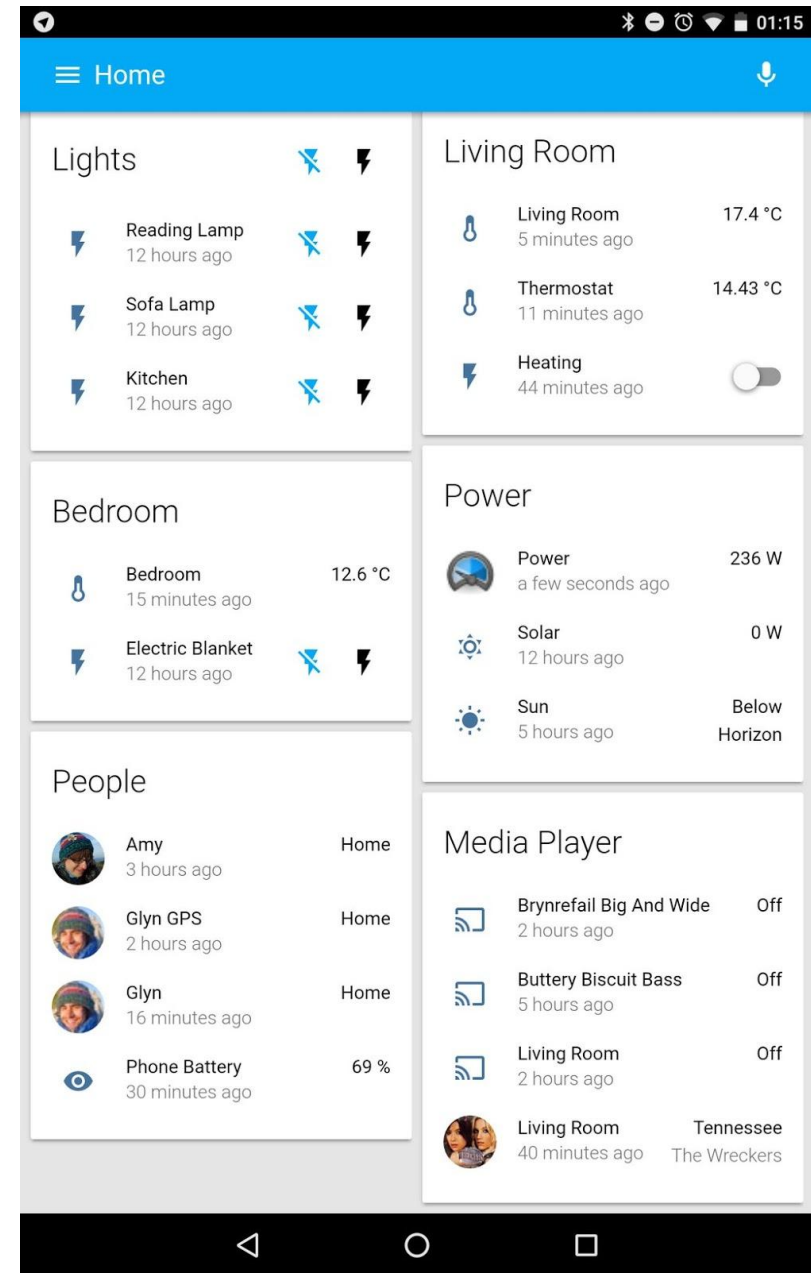
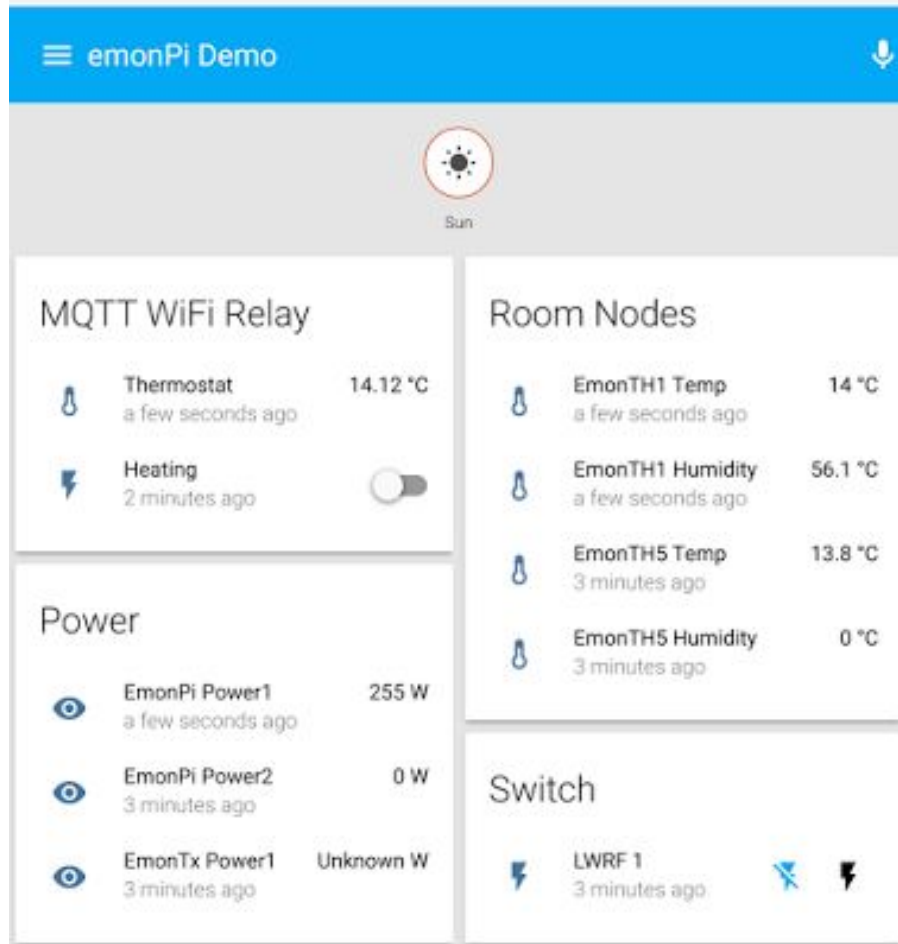
©2010-2015 openHAB.org

<http://www.openhab.org/>

<http://guide.openenergymonitor.org/integrations/openhab/>

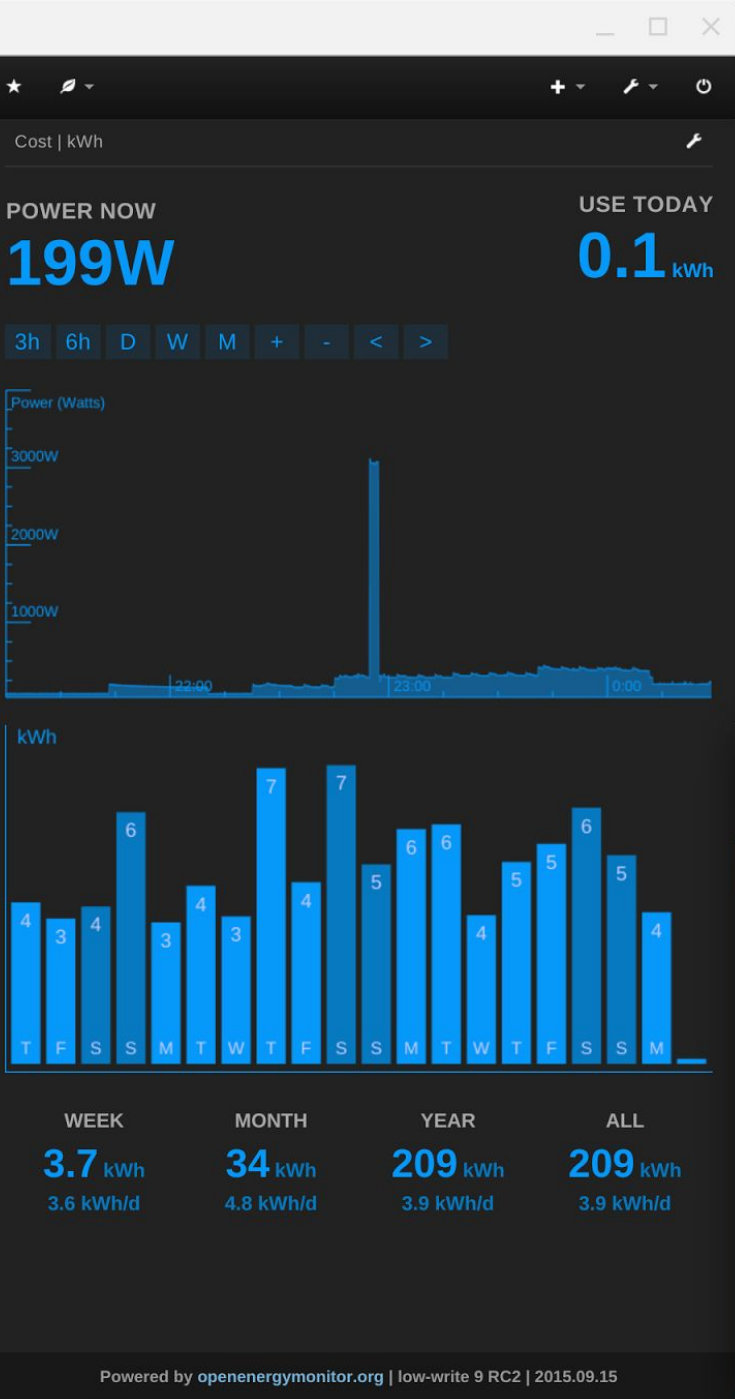


Home Assistant



<https://home-assistant.io>
<http://guide.openenergymonitor.org/integrations/>

LightWave RF MQTT Light Control Demo



IP Webcam

Home Video archive Videochat drivers Other viewing methods

OpenEnergyMonitor

Home LWRF Plug Control

Light Wave RF

- LWRF Plug 1 ☐
- LWRF Plug 2 ☐
- LWRF Plug 3 ☐
- LWRF Plug 4 ☐

©2010-2015 openHAB.org

lwrf 0 - at most once

Publish

Message

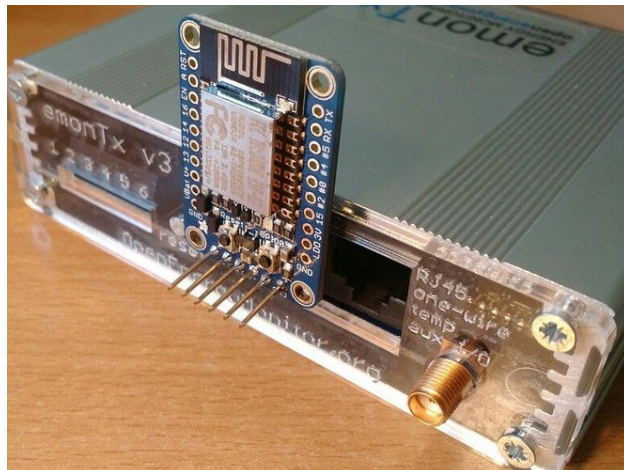
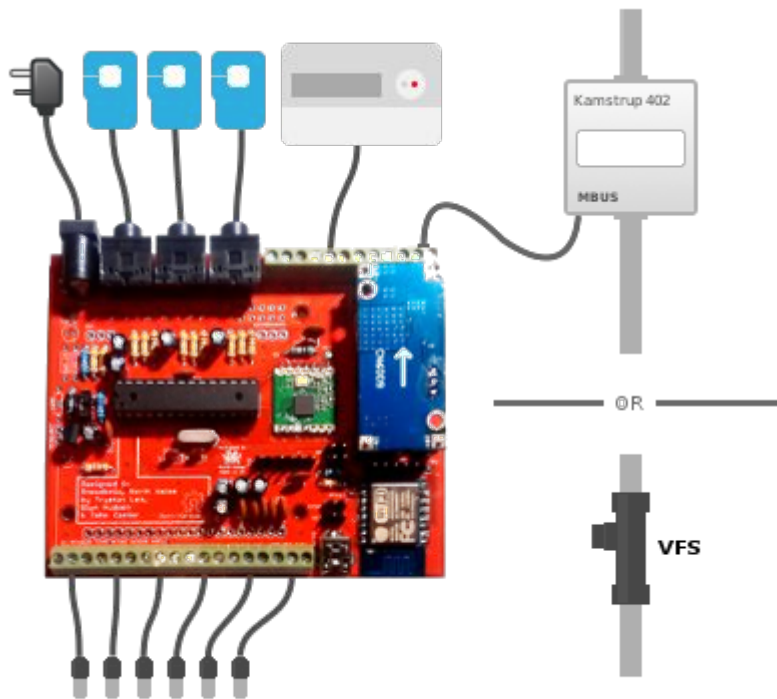
2 0

Subscriptions

Topic: "lwrf2" Showing the last 1 messages Messages: 0/14

#	Time	Topic	QoS
13	12:27:55	lwrf2	0

Message: 2 1



<https://community.openenergymonitor.org/t/using-the-emon-tx-v3-with-the-esp8266-huzzah-wifi-module>

<https://github.com/openenergymonitor/EmonESP>

Wifi

Mode: Client (STA)

Network	RSSI dBm
OpenEnergyMonitor	-62

IP Address:
10.0.1.93

Emoncms

Emoncms Server*:

e.g 'emoncms.org', 'emonpi/emoncms', or '192.168.1.4/emoncms'

Node Name*:

E.g 'emonesp' or 'heatpump'

Write apikey*:

SSL SSH-1 Fingerprint:

HTTPS will be enabled if present e.g:
7D:82:15:BE:D7:BC:72:58:87:7D:8E:40:D4:8D:BA:1A:9F:8B:8D:DA

Connected: Yes

Successful posts: 1 / 1

Firmware

MQTT

MQTT Server*:

e.g 'emonpi', 'test.mosquitto.org', or '192.168.1.4'

MQTT Topic*:

Base topic e.g 'emonesp', 'emon/heatpump'

Username:

Leave blank for no authentication

Password:

Leave blank for no authentication

Connected: Yes

Latest Data

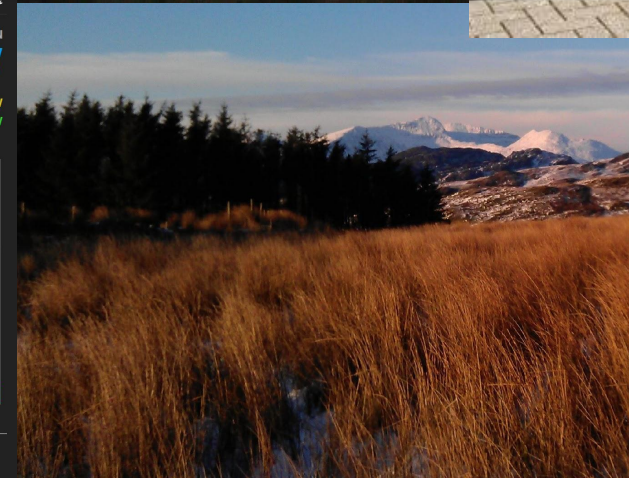
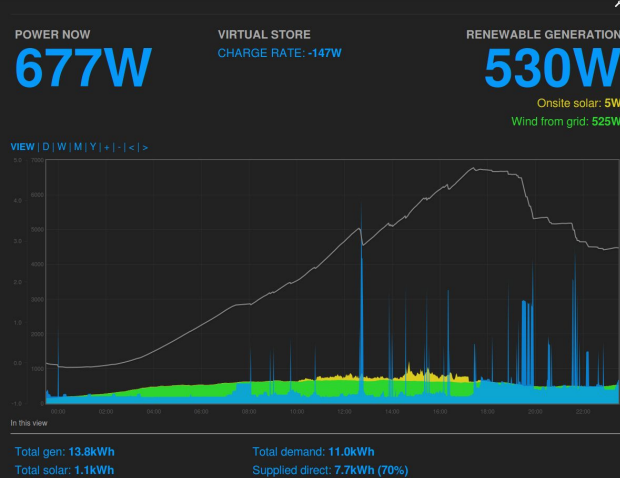
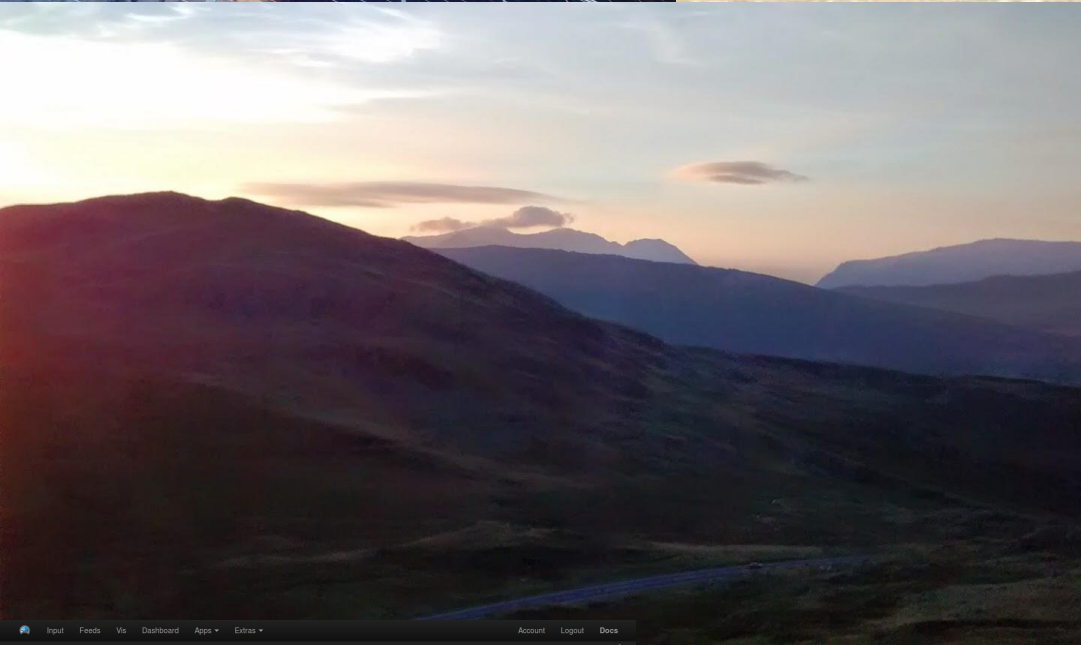
Key	Value
CT1	3935W
CT2	325W
T1	12.5°C
T2	16.9°C
T3	11.2°C
T4	34.7°C

System

Free RAM:
12168B



Thank you



@openenergymon