

# Catch the Flash

## Measuring household power usage

Paul Schulz  
Everything Open  
January 2026

# Contents

Intro

01

The Problem

02

The Device

03

A Bigger  
Problem?

04

What's Next?      Conclusions

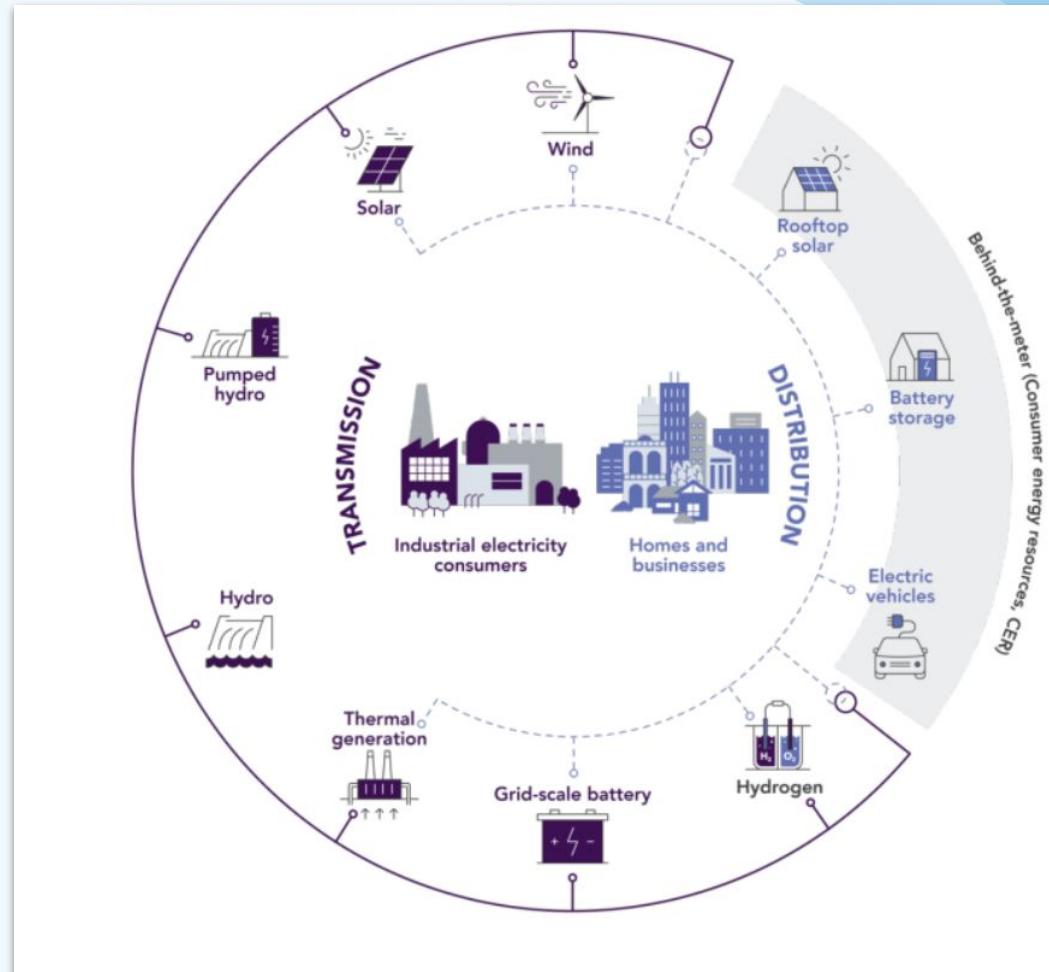
01

What is the problem?

# What is the problem?

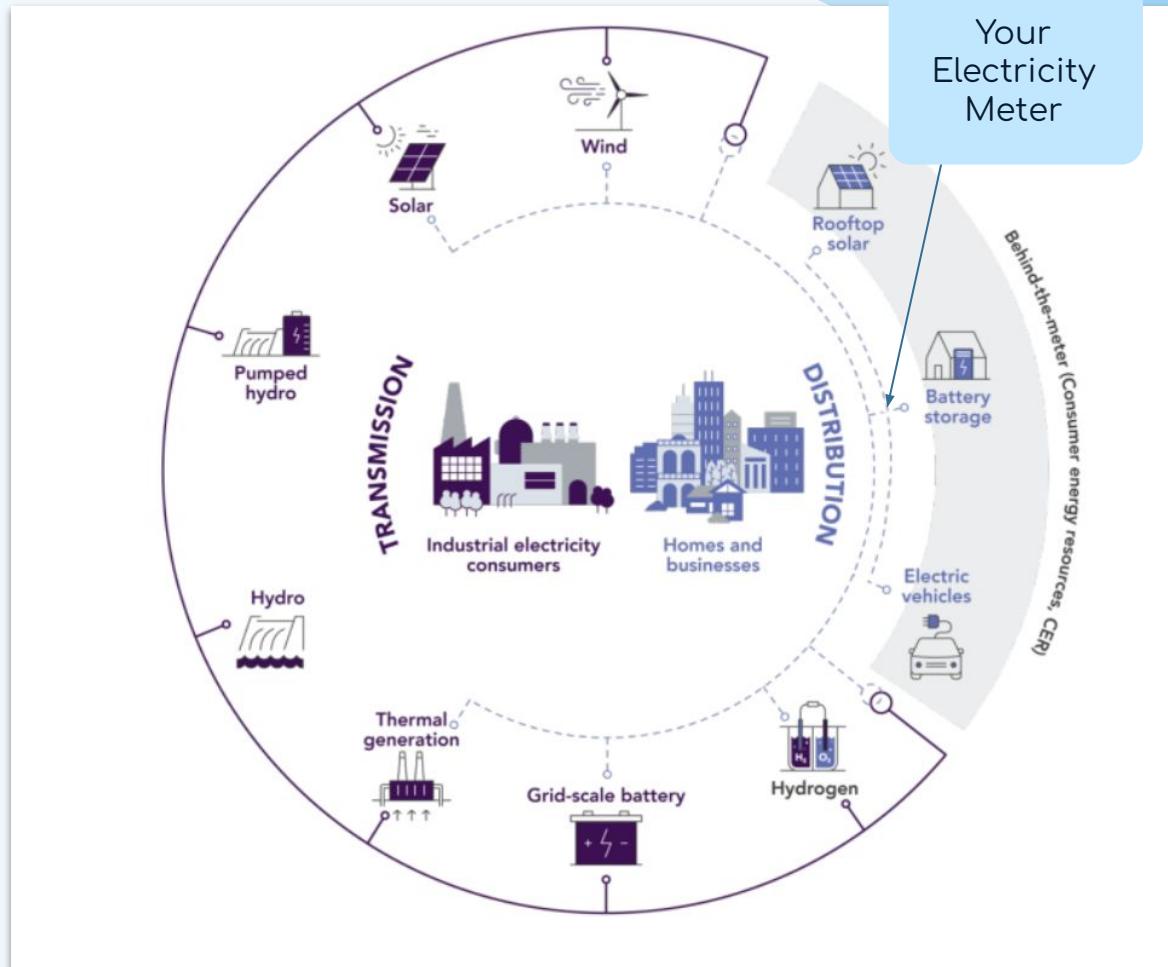
How AEMO sees  
the electricity  
network (NEM)

Diagram from AEMO 2024  
Integrated System Plan (ISP)



# What is the problem?

How the electricity network should be viewed



# Why does this matter?

- Generating and Storing Energy - Who's energy is it?
- Power usage - Who's owns your energy usage data?
- Making the most of your energy - Who controls how you use energy?

If you have energy stored behind your meter, you can...

- Generate Bitcoin
- Train your own AI
- Run your self-hosted network servers
- Run a Neighbourhood First Network
- Create random numbers
- Calculate Pi
- Charge you EV
- ... something else

Real-time energy monitoring is required!

02

## Building the Device Pulse for ESPHome

# How will it work?

Integrating with the Electricity Grid - Options for connecting to the meter\*

- Connecting using a P1 Port
- Connect via Zigbee Energy Profile
- **Reading the Meter via Pulse Counter (eg. Home Assistant Glow)**
- Read meter via IEC62056-21 (Infrared Serial)
- Using (Smart Message Language) interface, (Germany, Infrared Serial)
- Read the meter using an AI-on-the-edge-device (Camera on Data Display)
- CT clamp sensor (Current Transformer)
- Data provided by your energy provider

\* - from "Home Assistant - Integrating your electricity grid"

# Other Examples

Clipsal Cortex[TM] with CX2 Meter

or submeters which support:

PowerPal  
by Amber

CatchPower

eGauge

Tesla Powerwall Gateway

- Modbus (RS485 Serial)
- Modbus (Wifi)
- Bluetooth
- Zigbee
- Wifi

Shelly

Aathom

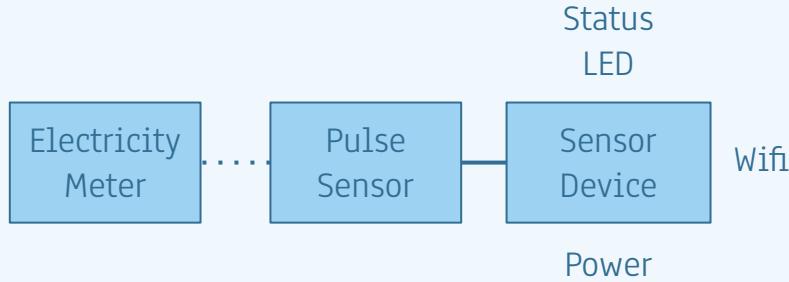
These systems are either:

- Submeters - direct current measurement; or
- Current Transformer(CT) Clamp sensor + Unit

which require an electrician for installation.

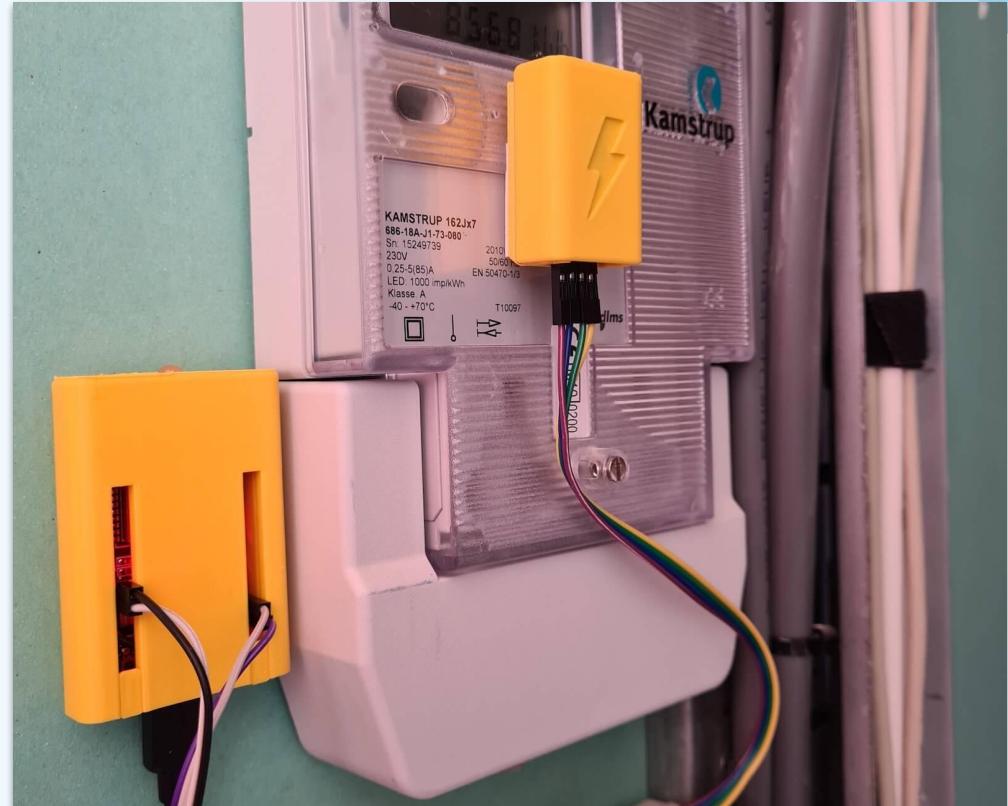
# The Home Assistant Glow

- Easy to obtain parts
- Cheap
- Simple to construct



Based on original ESP32 Dev Board

So why doesn't everyone have one?



# This is great! How can I make it better?

What parts are available? What's cheap? and What's easy?

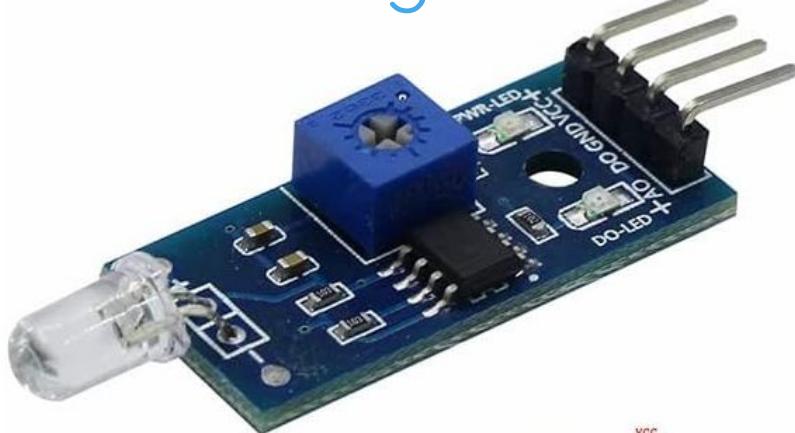
## What should I change or add?

- Newer (cheaper) Processor - ESP32-S3, in the M5Stack's StampS3
- Create a custom PCB, through hole design
- Design and 3D print a new enclosure
- Add a sensor connector and cable

## What should I keep?

- Sensor and Enclosure

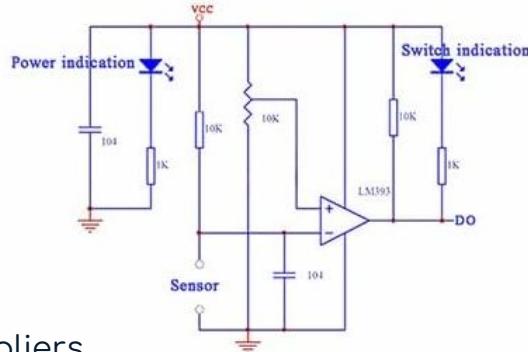
# Photodiode Light Sensor Module



## Uses

- Photodiode, rather than photoresistor
- Based on the LM393 Differential Comparator

Available from multiple online suppliers



Texas Instruments  
LM393

1 OUT	1	8	V <sub>CC</sub>
1 IN-	2	7	2 OUT
1 IN+	3	6	2 IN-
GND	4	5	2 IN+

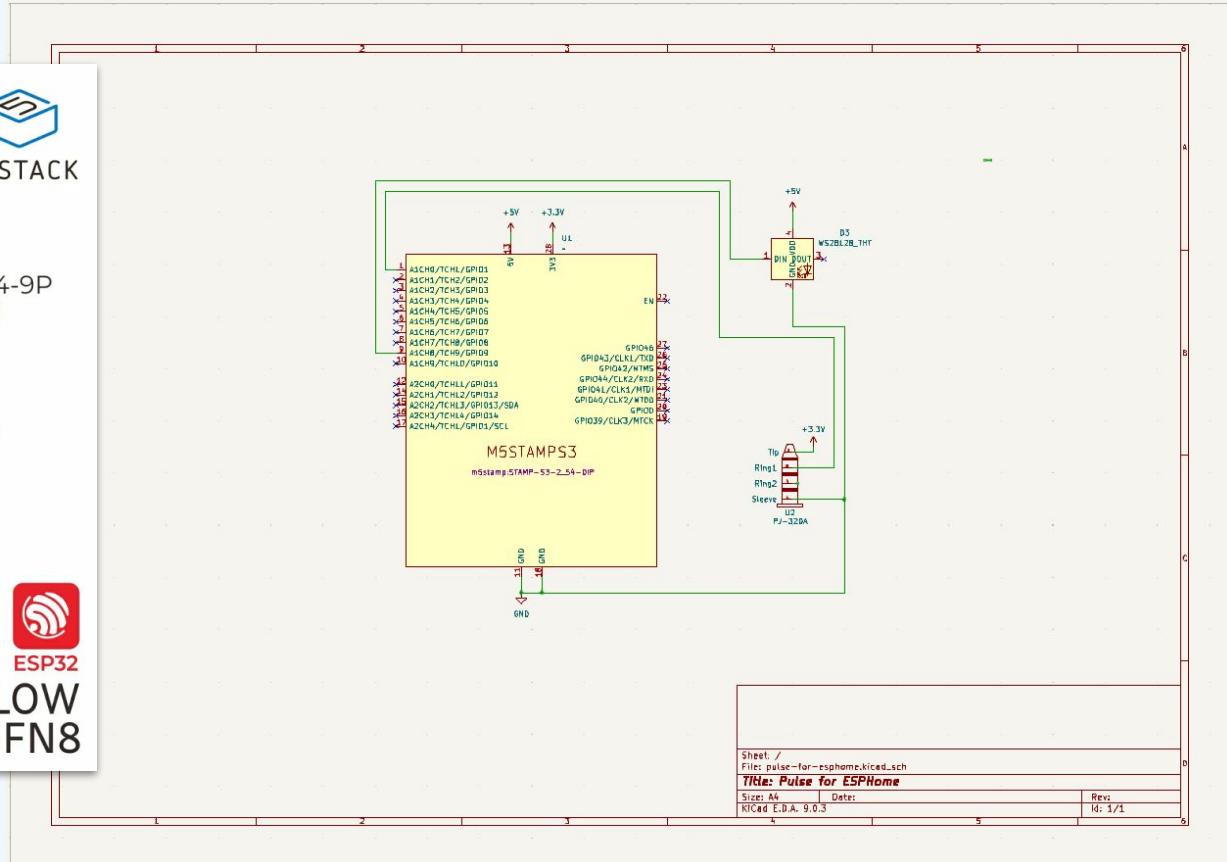


... with a cable and a connector.

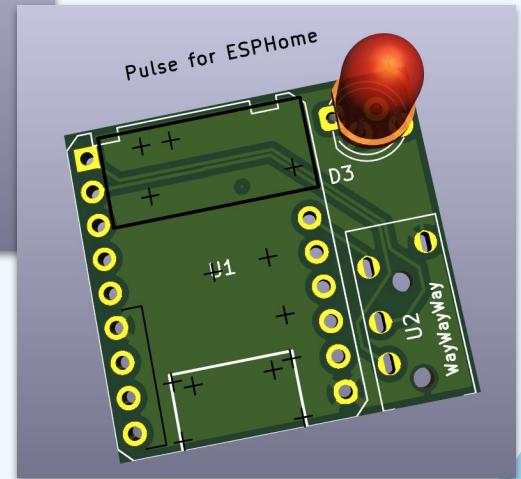
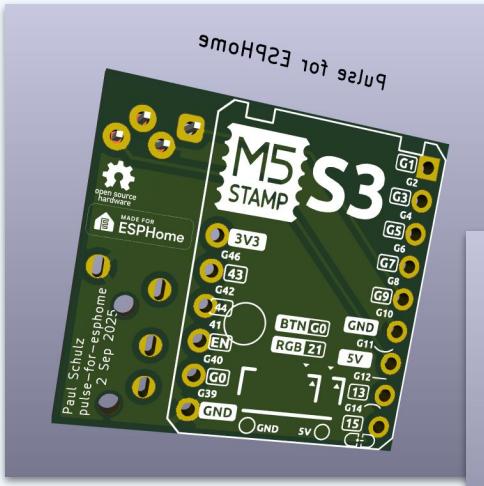
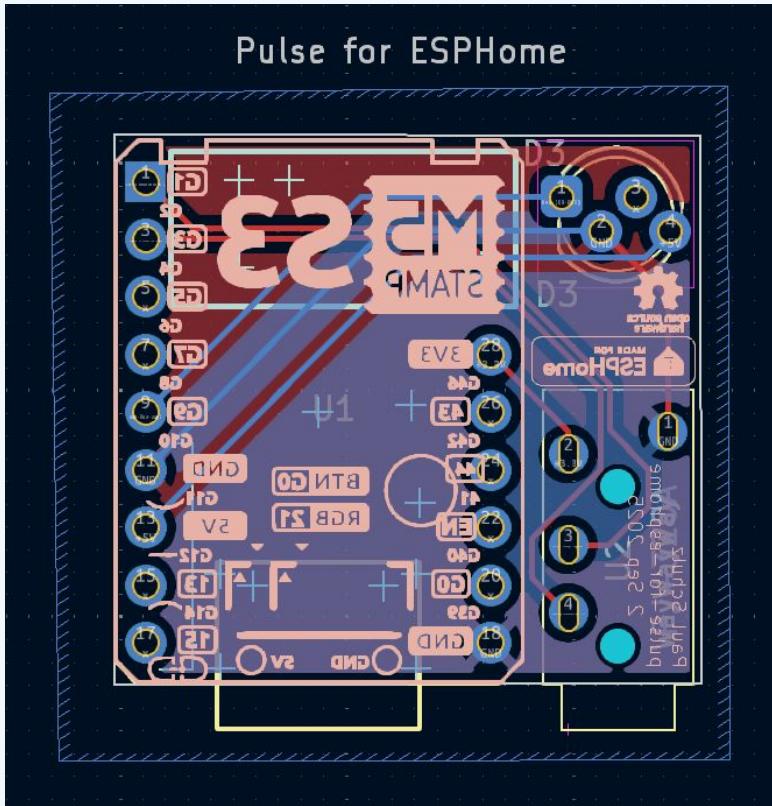
# Pulse Detector



Available from M5Stack  
(KiCAD footprint available)

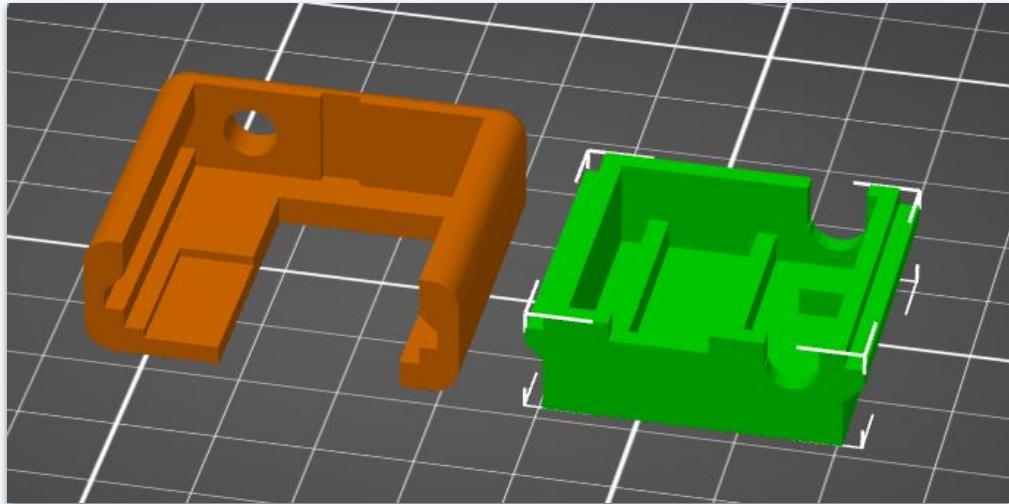


# Pulse Detector Board



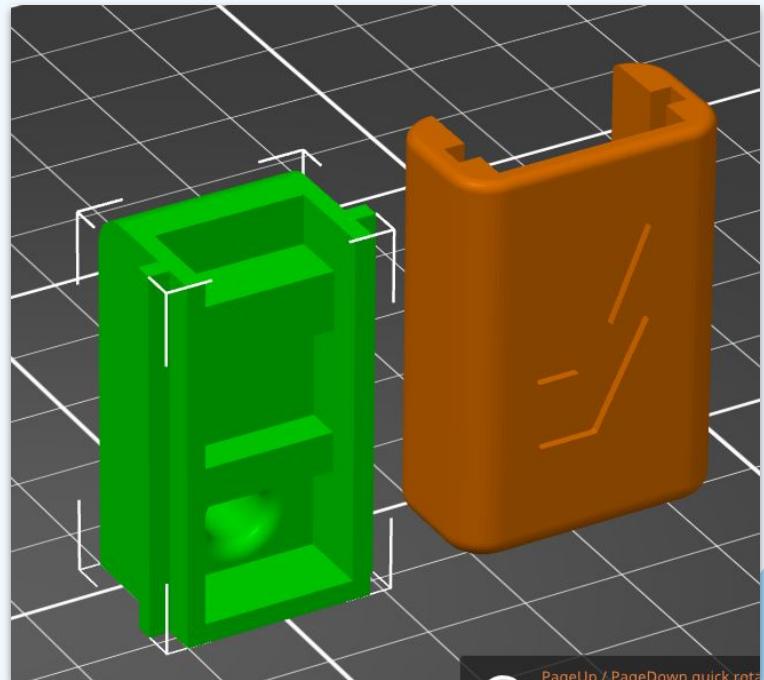
Designed in KiCAD  
Manufactured by PCBWay

# Enclosures



Designed in TinkerCAD  
Printed on Prusa i3 MK3S in PLA

Original design from  
Home Assistant Glow



# Firmware and Programming - ESPHome

```
---
```

```
# Pulse for ESPHome
#
# Read your electricity meter by means of the pulse LED on your
# meter, useful if you do not have a serial port (P1).
#
# Original Project: Home Assistant Glow
#
# © Klaas Schoutte
# Adaptated as "Pulse for ESPHome"
# Paul Schulz

substitutions:
  device_name: pulse-for-esphome
  friendly_name: Pulse for ESPHome
  project_version: "1.0.0"
  device_description: |
    Measure your energy consumption with the pulse LED on your electricity meter.

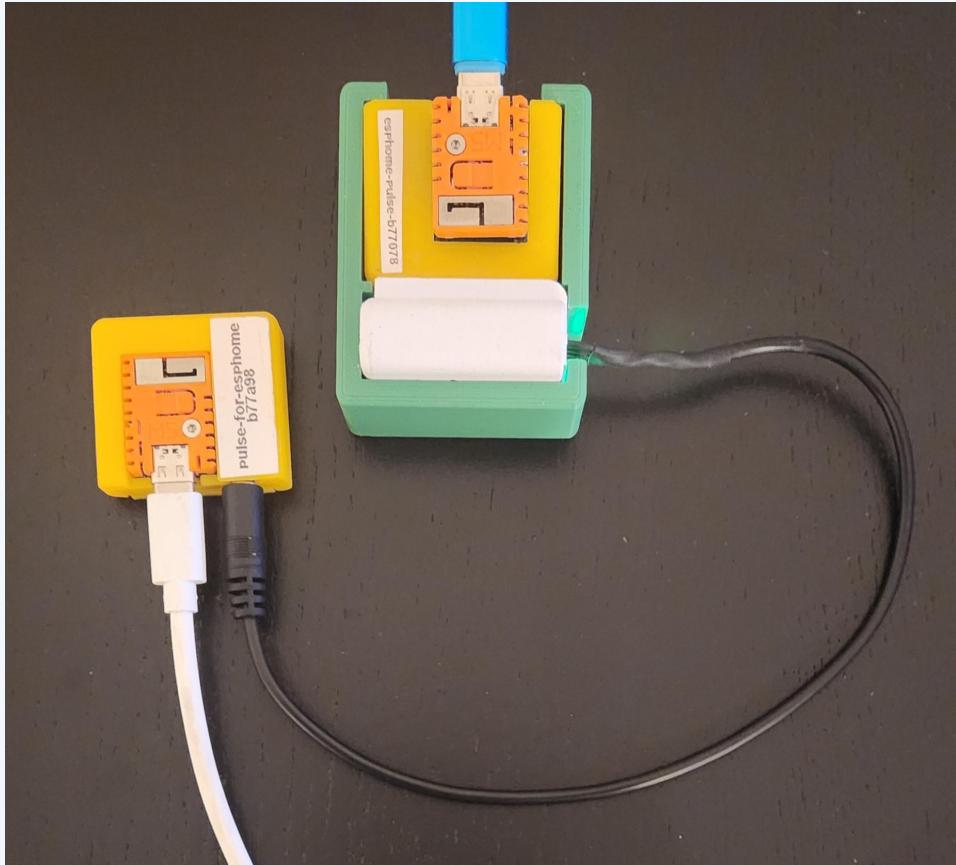
# Define the GPIO pins
pulse_pin: GPIO1
pulse2_pin: GPIO3
pulse3_pin: GPIO5
pulse4_pin: GPIO7
pulse_led: GPIO9
status_led: GPIO21

esphome:
  name: pulse-for-esphome
  name_add_mac_suffix: true
```

```
sensor:
  # Pulse meter
  - platform: pulse_meter
    id: power_consumption
    name: Power Consumption
    unit_of_measurement: W
    state_class: measurement
    device_class: power
    icon: mdi:flash-outline
    accuracy_decimals: 0
    pin:
      number: ${pulse_pin}
      inverted: true
      mode:
        input: true
      internal_filter: 10ms
      internal_filter_mode: pulse
      filters:
        - lambda: return x * ((60.0 / id(select_pulse_rate).state) * 1000.0);
    on_value:
      then:
        - script.execute: pulse

  total:
    id: total_energy
    name: Total Energy
    unit_of_measurement: kWh
    icon: mdi:circle-slice-3
    state_class: total_increasing
    device_class: energy
    accuracy_decimals: 3
    filters:
      - lambda: return x * (1.0 / id(select_pulse_rate).state);
```

# Testing



Tests the sensor and the detector module together.

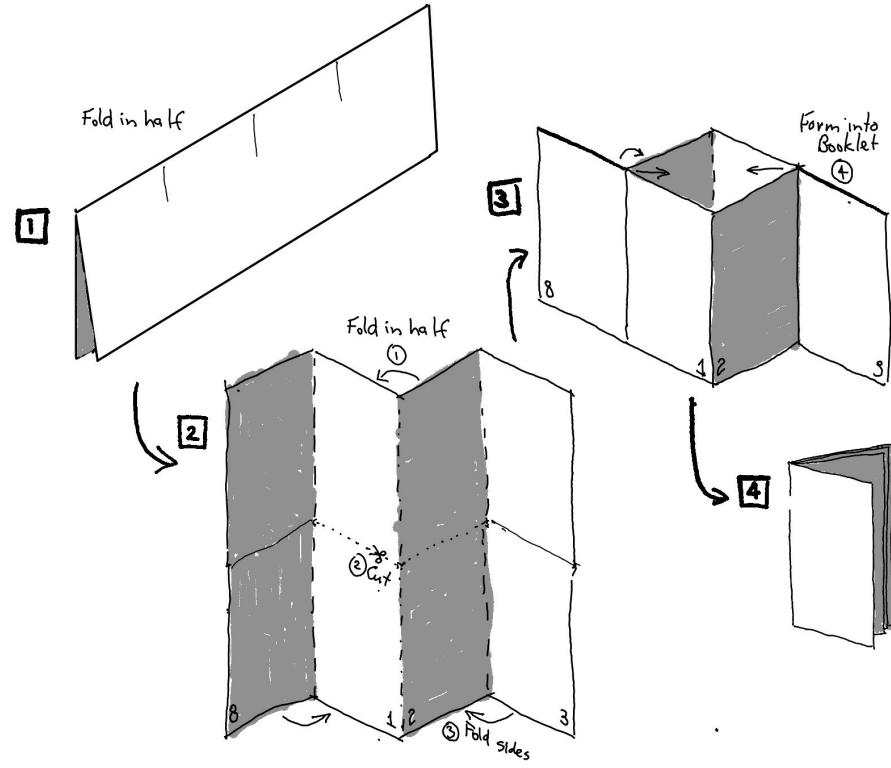
# Wifi Device Configuration - Improv

```
wifi:  
# Allow provisioning Wi-Fi via Serial USB  
improv_serial:  
# Allow provisioning Wi-Fi via BLE  
esp32_improv:  
  authorizer: none  
api:  
ota:  
  - platform: esphome  
  - platform: web_server  
  
web_server:  
  port: 80  
  version: 3  
  local: true
```

<https://improv-wifi.com>



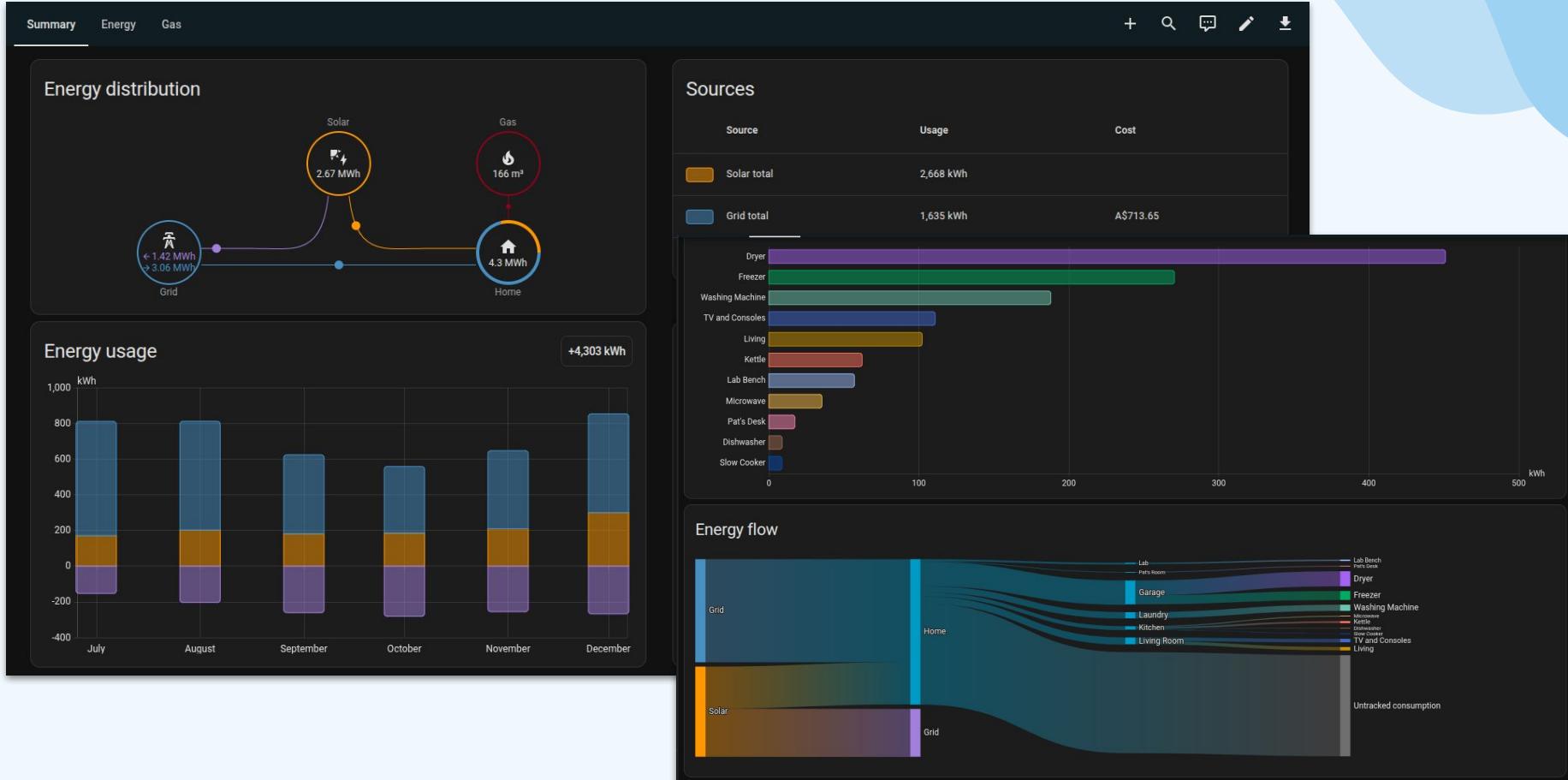
# Instructions and Packaging



# Installation



# Energy Display in Home Assistant



# Problems

Pulse Counts per minute

20 pulses/min = 1200W  
40 pulses/min = 2400W



Pulse sensor graph courtesy of Randel - Port Adelaide Enfield ARIoT Experimenters Group

# Caveats, Provisos, Conditions and Fine Print

Please be aware that...

- A USB-C power supply is required, which may be difficult in an electrical meter box.
- Wifi connectivity may be an issue where the meter box is a long distance from the household Wifi router.
- Single LED sensor works for meters that only report power usage.

Also

- In the units for sale, the enclosure is printed in PLA, which has a lower melting point than ABS.

03

The Renewable Energy Transition  
... and Smart Meters  
or  
What is the real Problem?

# Smart Meters

For Australians on the National Energy Market (QLD, NSW, VIC, TAS and SA)

- Smart Meters are on their way. (If you live in Victoria you probably already have one.)
- Dynamic (Time-of-Use) Electricity Tariffs coming - 3 hours of Free Electricity
- Real-time data for consumers is coming (more about the shortly).
- Network controls for Consumer Energy Resources (CER) are coming, with dynamic import and export envelopes.
- Trials underway for Virtual Power Plants (VPPs) and Community Power Networks (CPN)

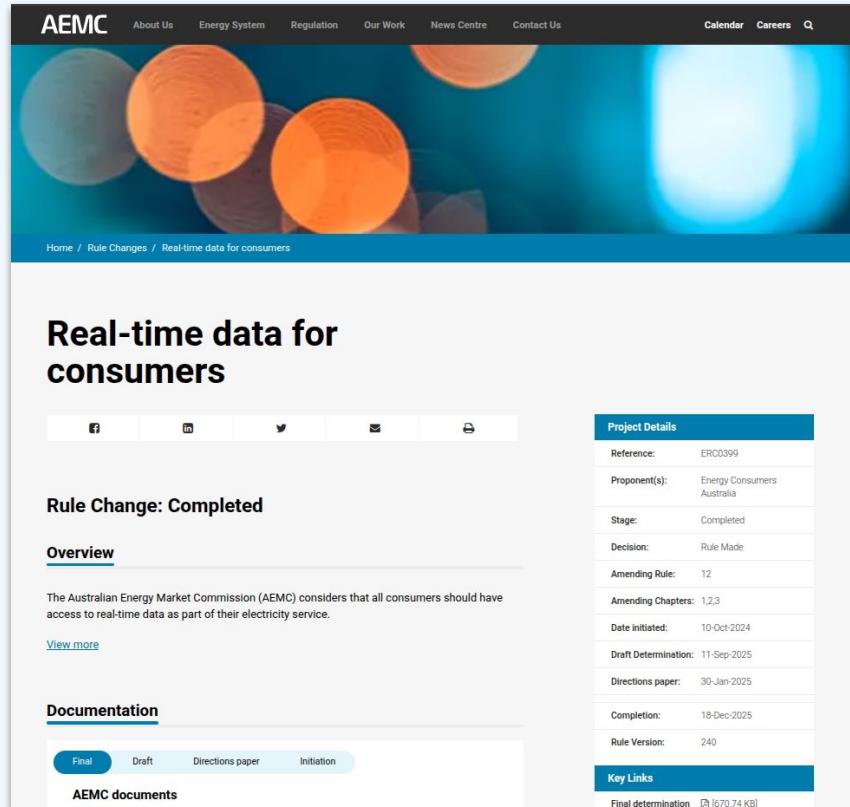
For Western Australia, you will have your own version of this.

For Oversees Guests (including New Zealanders), I would love to know what you are doing.

# AEMC: Real-time data for consumers

Proposed Rule Change request by  
Energy Consumers Australia (ECA)

Initiated: Oct 2024



The screenshot shows the AEMC website with a banner featuring blurred orange and blue circles. The navigation bar includes links for About Us, Energy System, Regulation, Our Work, News Centre, Contact Us, Calendar, Careers, and a search icon. Below the banner, the breadcrumb navigation shows Home / Rule Changes / Real-time data for consumers. The main title is "Real-time data for consumers". To the right is a "Project Details" sidebar with the following information:

Project Details	
Reference:	ERC0399
Proponent(s):	Energy Consumers Australia
Stage:	Completed
Decision:	Rule Made
Amending Rule:	12
Amending Chapters:	1,2,3
Date initiated:	10-Oct-2024
Draft Determination:	11-Sep-2025
Directions paper:	30-Jan-2025
Completion:	18-Dec-2025
Rule Version:	240

The main content area includes sections for "Rule Change: Completed", "Overview", and "Documentation". Under "Documentation", there are buttons for "Final", "Draft", "Directions paper", and "Initiation". At the bottom, it says "AEMC documents".

# Dutch Experience

Feb 2019

## Smart metering in the Netherlands: what, how, and why

Pol Van Aubel<sup>1,\*</sup>, Erik Poll<sup>1</sup>,

*Digital Security group, Institute for Computing and Information Sciences, Radboud University  
Toernooiveld 212, 6525 EC, Nijmegen, the Netherlands*

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### Abstract

This paper describes the functionality and realization of the smart metering infrastructure in the Netherlands, and discusses the changes that have been made in response to privacy and security concerns. We also discuss the rationale for introducing smart meters – which is less clear than one would expect or indeed hope. We consider ongoing developments in the use of smart metering information in local energy community pilots: the design of the Dutch smart meter poses potential security and privacy issues.

*Keywords:* Advanced Metering Infrastructure, Smart Metering, Privacy, Security, Standardisation

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### 1. Introduction

The advent of smart electricity meters sparked a lot of public debate and media attention in the Netherlands in 2008. The debate has involved grid operators, privacy advocates, politicians, security experts, consumer interest groups such as the Dutch consumers' and homeowners'

an organizational point of view. Section 3 then discusses security and privacy issues that were raised and how they were dealt with, as well as some incidents – data leaks – that happened. Section 4 discusses the rationale for smart meters given the current use and Section 5 discusses more intensive use of smart metering information in pilots with microgrids. We draw our main conclusions in Section 6.

# The Neglected Consumer: The Case of the Smart Meter Rollout in the Netherlands

Robin Hoenkamp\*, George B. Huitema\*\* and Adrienne J.C. de Moor-van Vugt\*\*\*

*Smart metering is an important tool in support of the transition to decentralized renewable energy production. However, the introduction of such a new tool requires careful preparation in order to convince people to accept it in their homes. The Dutch experience shows, that smart metering is up for failure when the technical and commercial aspects are considered to be more important than the interests of the end users. This paper examines the procedural and material prerequisites to engineer standards for smart metering in such a way that the interests of all parties involved are reflected in the outcome.*

Published 2011

## 2. Essential Requirements and Principles of Good Governance

As is clear from the Dutch case, making sure the meter benefits the end-user not only serves the interests of the consumer, the rollout also depends on their cooperation. If there is too much resistance the whole process can be delayed. If the involvement of representatives of public interests during the process is complicated or even unfeasible, other solutions must be explored.

The best lesson that can be learned from the Dutch case is that a pre set framework for standardization is needed to guide the process. This lesson was learned the hard way, but eventually this framework was set up to cover the minimum requirements for the meter functions. Not only

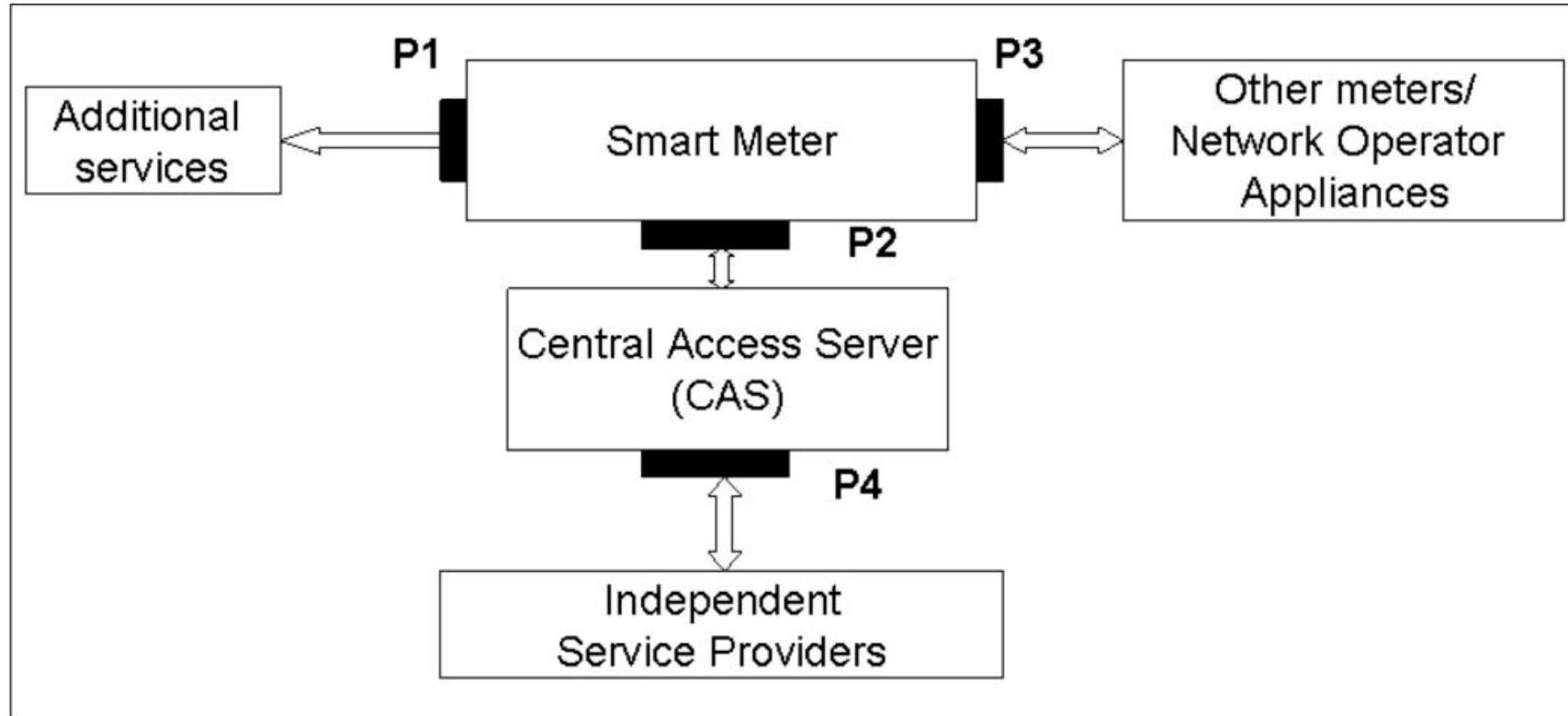


Figure 1: Communication ports of the Smart Meter

Source: Authors.

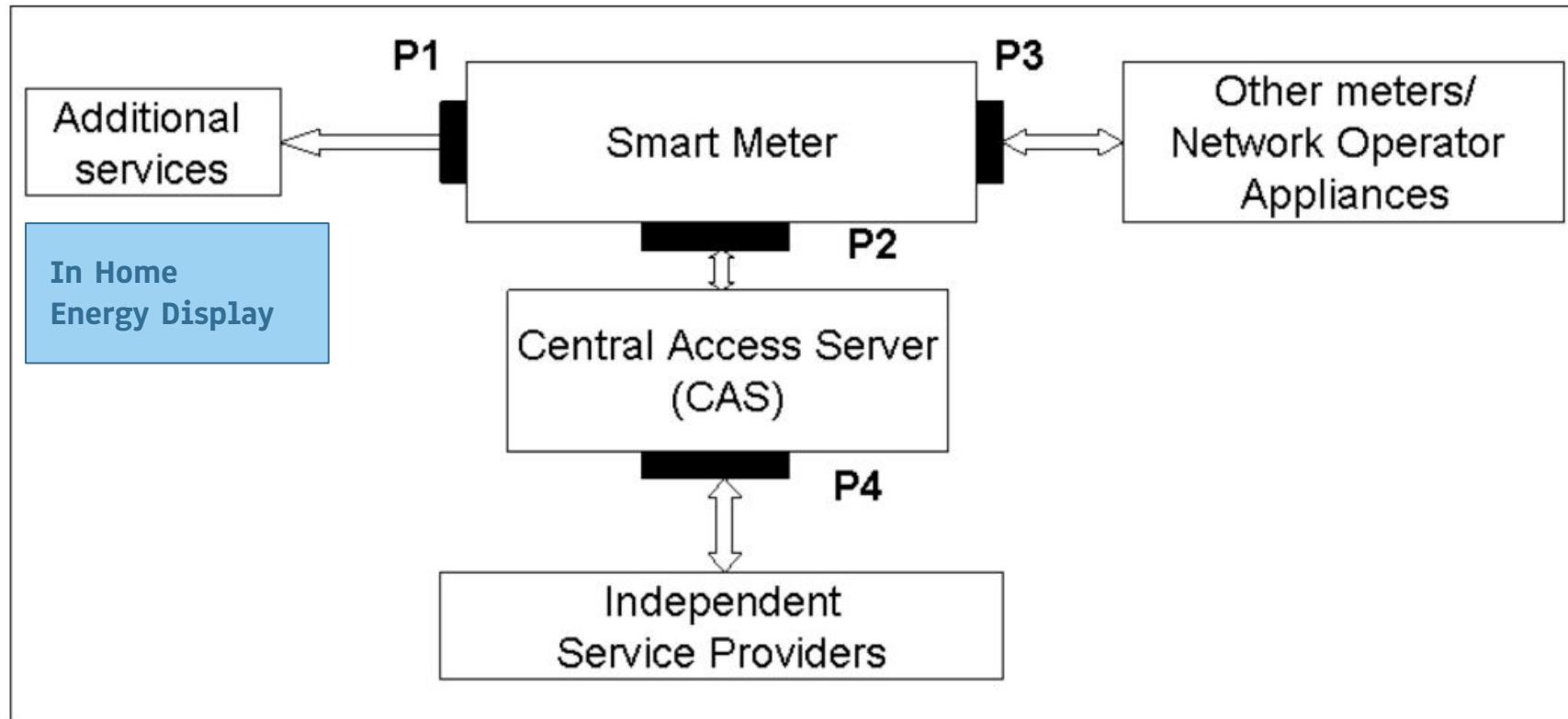


Figure 1: Communication ports of the Smart Meter

Source: Authors.

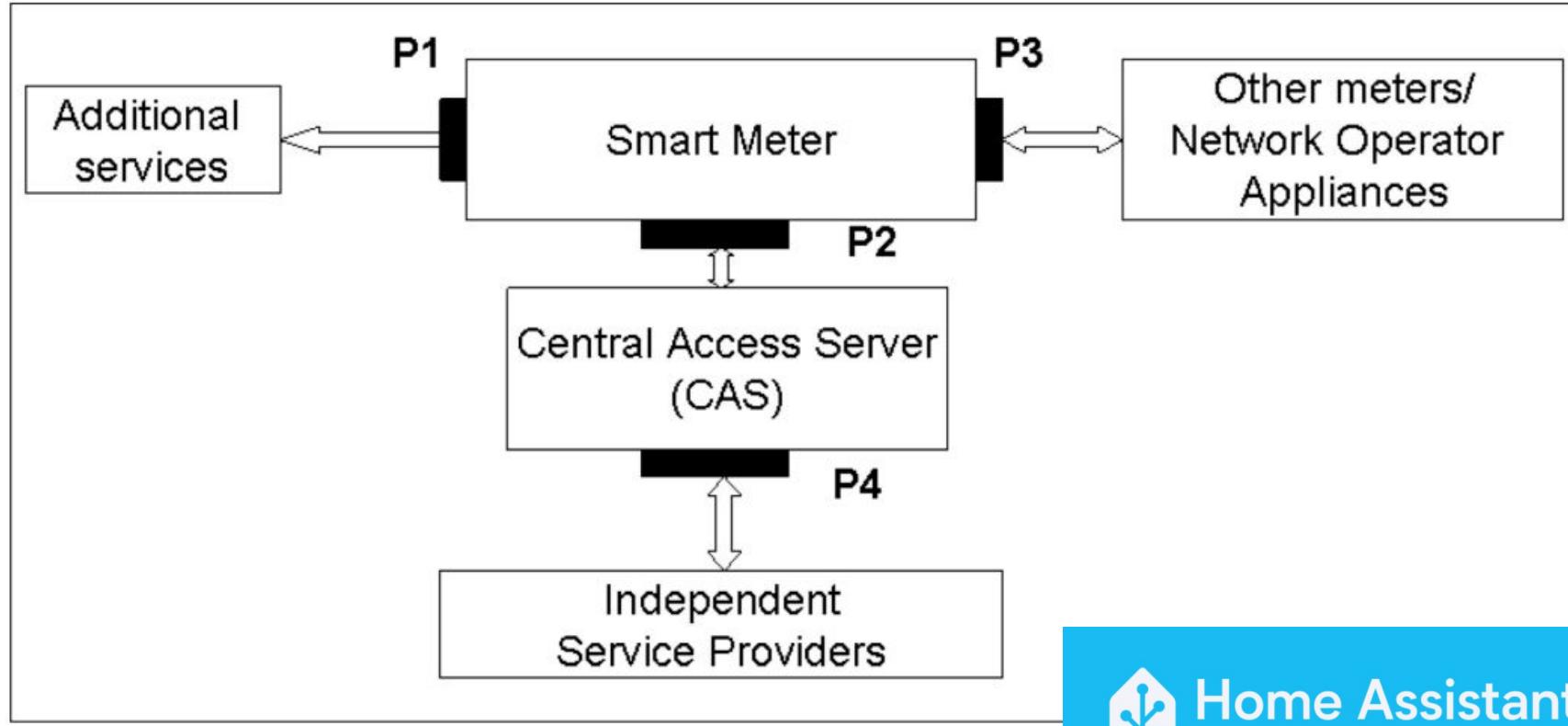


Figure 1: Communication ports of the Smart Meter



Home Assistant

# P1 Data Port

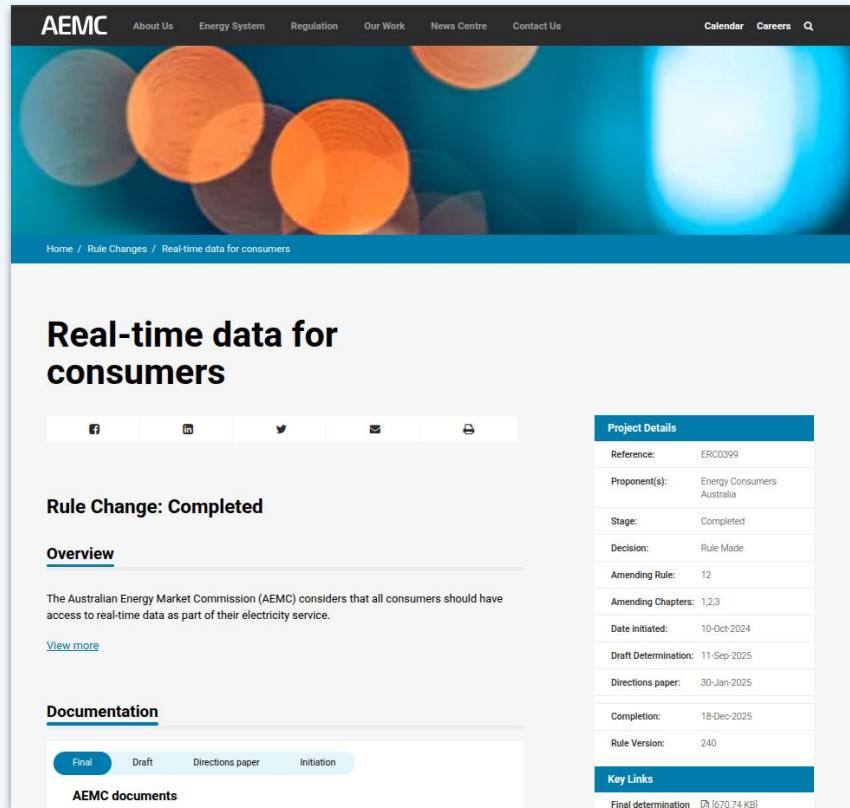


# AEMC: Real-time data for consumers

Proposed Rule Change request by  
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Home / Rule Change

Real-time  
consultation

Rule Change

Overview

The Australian Energy  
access to real-time

View more

Documentation



AEMC doc

### 3.2 AEMO will establish procedures to further specify how real-time data should be communicated to support security and interoperability

As stakeholders suggest, consumers would benefit from standardisation and portability of real-time data communications, which support greater interoperability between devices.<sup>108</sup>

Interoperability means that real-time data can be accessed by multiple different types of devices.

We consider that interoperability is a critical feature of a modern energy system. It is important that the data may be only accessed using proprietary devices does not limit consumer outcomes. An interoperable service encourages the development of technologies that could use real-time data to deliver lower costs and better services for consumers.

Importantly, the definition of real-time data in the rules will not limit interoperability. This is because the data could still be communicated using multiple technologies. We consider that procedures for how real-time data is communicated should be further standardised to ensure



#### Many stakeholders support interoperable real-time data access

Stakeholders indicated their support for interoperable real-time data access in response to our consultation paper,<sup>67</sup> and for an open standards-based approach to interoperability.<sup>68</sup>

Stakeholders also provided a range of views on the:

- **location of the interoperability requirements and standards** – their inclusion in the Rules,<sup>69</sup> AEMO procedures,<sup>70</sup> Australian Standards,<sup>71</sup> or left to industry to decide whether to adopt the standards.<sup>72</sup>
- **changes needed to enable the interoperability** – changes to the minimum services specification in Schedule 7.5 of the NER, metering installation standards in clause 7.8.2 of the NER, metrology procedures and/or other changes would be required.<sup>73</sup>
- **time to develop and implement interoperability standards** – the development and adoption of interoperability standards could take several years to implement.<sup>74</sup>
- **need for a consistent approach across industry** – interoperability standards should be consistent either with the work completed through the CER Roadmap, or with national or international standards.<sup>75</sup>

107 Ibid.

108 Paul Schulz, submission to the draft determination, p. 2.

Directions Paper - Jan 2025

Final Determination - Dec 2025

66 ECA rule change request, pp. 12-13.

67 Submissions to consultation paper: AGL, p. 6; Ausgrid, p. 2; Citipower, Powercor and United Energy, p. 5; Compliance Quarter, p. 3; Endeavour Energy, p. 2; Erne Energy, p. 3; JEC, p. 7; Joint EWOs, p. 6; National Seniors Australia, p. 3; PLUS ES, pp. 4 and 14; Rheem, p. 3; SACOSS, p. 4; SA Power Networks, p. 2; SA Water, p. 4; SMA, p. 8.

68 Submissions to consultation paper: Endeavour Energy, p. 2; JEC, p. 7; PLUS ES, p. 14; Rheem, pp. 14 and 19; SA Power Networks, p. 2; SMA, p. 8.

69 Submissions to consultation paper: Bluecurrent, p. 16; Citipower, Powercor and United Energy, p. 5; Intellihub, p. 18.

70 Submissions to consultation paper: Bluecurrent, p. 16; Intellihub, p. 18; Rheem, p. 13.

71 Intellihub, submission to consultation paper, p. 18.

72 AGL, submission to consultation paper, p. 6.

73 Submissions to consultation paper: Bluecurrent, p. 16; Endeavour Energy, p. 2; Landis & Gyr, p. 4; Paul Schulz, p. 10; PLUS ES, p. 14; Rheem, pp. 17-18; SMA, p. 9; Sense Labs, p. 30.

74 Submissions to consultation paper: Bluecurrent, p. 16; Intellihub, p. 6.

75 Submissions to consultation paper: CEC, p. 6; Energy Queensland, p. 8; Tesla, p. 4.



## Real-time data for consumers

Rule Change: Completed

### Overview

The Australian Energy Market Commission (AEMC) considers access to real-time data as part of their electricity services.

[View more](#)

### Documentation

[Final](#)   [Draft](#)   [Directions paper](#)   [Initiative](#)  
[AEMC documents](#)

Australian Energy Market Commission

Rule determination  
Real-time data  
18 December 2025

### 2.1.4

#### Our final rule is a change from the draft rule

The final rule is consistent with the draft rule in that:

- consumers would still be able to access real-time data from every new meter installed
- all new meters would be required to communicate real-time data wirelessly.

However, as explained in section 2.2 below, we have made the following key changes from the draft rule:

- our final rule does not require all new meters to have an accessible physical communications port.
- our final rule commences on 30 November 2028, instead of 1 January 2028.

Table 2.1 outlines how this chapter is structured.

**Table 2.1: Chapter structure overview**

Sections	Headings
2.2.1	<ul style="list-style-type: none"> <li>• Requiring an accessible port would increase cost, complexity and security risks</li> </ul>

Our draft rule enabled all consumers with a new meter installed from 1 January 2028 to access real-time data free of charge. This means that consumers with new meters would have 15 years to access real-time data, free of charge.

Our draft rule also changed the minimum services specification to require these meters from 1 January 2028 to be able to communicate real-time data wirelessly and through a connection. We considered that changing the minimum services specification would increase market certainty and support interoperability to unlock broader benefits for consumers. However, this would impose the cost of changing the minimum service specifications on all customers. We considered that changing the minimum services specification was in the interest of all consumers because we considered the cost of changing the minimum services specification to be low. This meant that our draft rule would impose the lowest practicable costs on consumers who do not want access to real-time data. We considered the benefits of the draft rule would be greater than the cost and that the draft rule would cost significantly less than the rule change proposal.

We considered that the cost of our draft rule to each consumer would be \$15 spread across the

## 2.2 All new meters from 30 November 2028 must be able to communicate real-time data wirelessly

Meanwhile, in the Netherlands...

## P1 Data Port

since 2008.

EU directive 2019/944 says that consumer is entitled to connect own devices to the smart meter and receive metering information in real-time.

Countries wanting to become a part of the EU need to accept this directive.





Use energy smarter.  
Reduce bills.  
Lower emissions.

[Express your interest](#)

Energy Masters is empowering 500 South Australian households with smart appliances, tools and know-how to take control of their energy use, save on their energy bills and reduce their carbon footprint.

In return, households are participating in research that will strengthen South Australia's position at the front of the global energy transition. It aims to demonstrate a simple, reliable and cost-effective way for all South Australians to become masters of their energy use.

# 04

## Present and Future Plans Pulse for ESPHome

# What next?

- Multi-channel (Import and Export) support
- Dedicated In-Home Display (using ESPNow)
- Alternative Data Logging and Reporting (MeterKloud)
- Integration with NEM Electricity Tariffs and Energy Plans, including Plan Comparison (Energy made Easier)
- Integration with Open Dynamic Exports (CSIP-AUS)

# Status

- Pulse for ESPHome units are available for purchase.
- All original design and manufacturing files are available on GitHub under an Open Hardware License (currently MIT Licence, same as Home Assistant Glow).
- Unique parts (eg. circuit board, 3D Prints) can be ordered themselves, or ordered from other manufacturers using design files.
- Suitable for an entry level DIY or first makerspace project.
- Alternative use and re-use is encouraged (ESP32-S3, 2xGPIO 3.32V, RGB LED, WiFi, Bluetooth)

# Project Mentions

- Glow for Home Assistant
- ESPHome, Home Assistant with Energy Management
- Open Dynamic Export (CSIP-AUS Integration)
- EVerest and LF Energy (Linux Foundation Open Source Energy Projects)

## Tools Used

- KiCAD - Schematic and Circuit Board Layout and Production
- TinkerCAD - Web based 3D Design Tool

## Useful Websites

- ESPHome
- SuperHouseTV - suggested Workshop Tools

# Project Sponsor

V3G - Smart Power Systems

Thanks  
... Questions?

# Thanks

Do you have any questions?

[paul@mawsonlakes.org](mailto:paul@mawsonlakes.org)  
[www.mawsonlakes.org](http://www.mawsonlakes.org)

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TEMPLATE: Simple Watery Shapes Style



