

# Overcoming the chicken-and-egg problem



S2 Standard

**From the battlelines of the S2 energy  
flexibility protocol adoption**



**Seita**

Nicolas Höning & Vlad Iftime  
(Seita Energy Flexibility BV)  
FOSDEM 2025



# Takeaways

Why do open standards matter?  
- Innovation at global scale.

## **Today:**

1. Standards in HEMS
2. The S2 standard for energy flexibility
3. Implementations



**@herosvicentegonzalez7872** 5 months ago

**It's better than perfect, it's standardized!**



4.6K



**Reply**

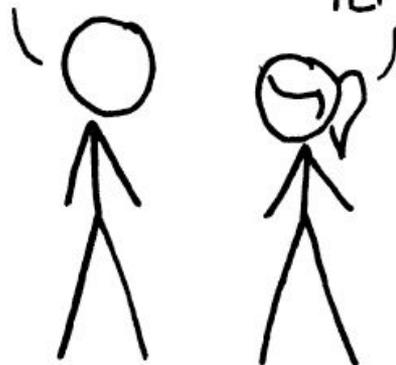
- comment on the video 'The Most Valuable File Format You've Never Heard Of' by Acerola

# HOW STANDARDS PROLIFERATE:

(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)

SITUATION:  
THERE ARE  
14 COMPETING  
STANDARDS.

14?! RIDICULOUS!  
WE NEED TO DEVELOP  
ONE UNIVERSAL STANDARD  
THAT COVERS EVERYONE'S  
USE CASES.



SOON:

SITUATION:  
THERE ARE  
15 COMPETING  
STANDARDS.



I'm the protocol, uniting the home energy management like no other can



## Data Transmission



Bluetooth

Cellular  
(2G, 3G, 4G)

Ethernet

THREAD

LoRaWAN

sigfox

## Application

Home automation and heating & cooling control

Bluetooth

LoRaWAN

sigfox

zigbee



BACnet

KNX

WAVE

THREAD

Energy system services

openADR  
ALLIANCE

S2

FLEXIBLEPOWER  
ALLIANCE NETWORK + TNO

## Cross-cutting integration



matter

Modbus



Cloud APIs

## Asset-specific



OpenTherm



Infrared



Proprietary

Solar PV & battery



(Modbus)

EV & EV chargepoint



IEC 63110 ISO 15118 OSCP  
IEC 61850 CHAdEMO

Smart meter

PLC M-Bus

zigbee



(VTN)



Grid-side

(VEN)  
+  
CEM



EMS



RM



S2 Standard



Building-side

# S2 is at the beginning

- White paper
- Certification (EN 50491-12-2)
- Proof of concepts (PoC) / Pilots
- Open source code



S2 Standard

# Standard adoption

## Criteria of organizations

- Technological superiority
- Relative advantage
- Observability
- Network externalities
- Switching Costs
- Coercive pressures

# Drivers of standard adoption

- Champions
  - Influential people & orgs (e.g. Apple in Podcasting 2.0)
  - Often where standards are born
- Developer uptake
  - **Innovation** (why we are all here)
  - Decisions made at the base (e.g. JSON vs XML)
- Regulation
  - Subsidy (which standards qualify?)
  - Requirements (e.g. Germany: Article 14a)

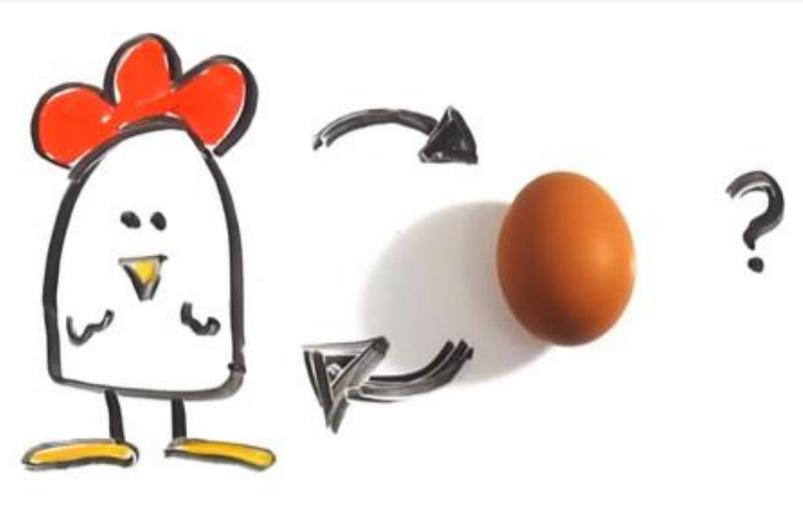
# The Chicken-and-egg problem:

What should come first?

The energy sector is not easy  
(i.e. compared to web):

- Hardware & OEMs play crucial role, EMS need them to scale
- Regulation tighter (safety)
  - & not just one regulation body
  - & different per country
  - grid management changes
- Sectors compete (EVs, HVAC)

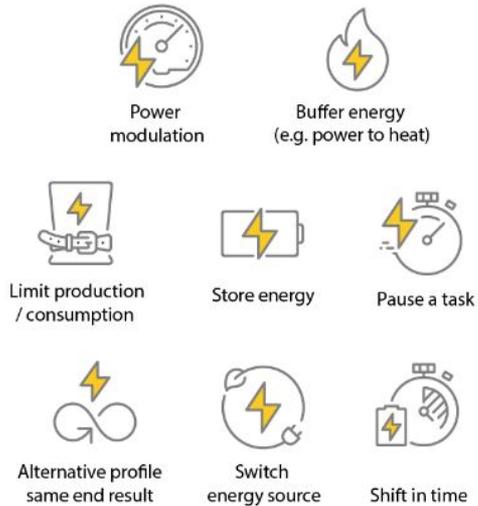
-> Too many pilots, products with partial solutions, potential champions too careful



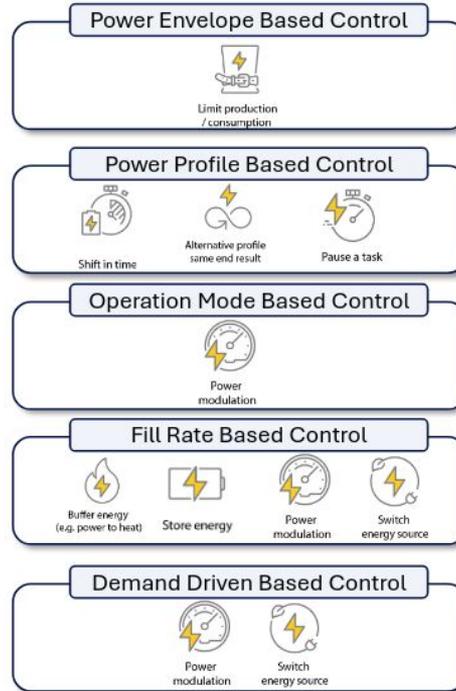


# S2: energy flexibility control types

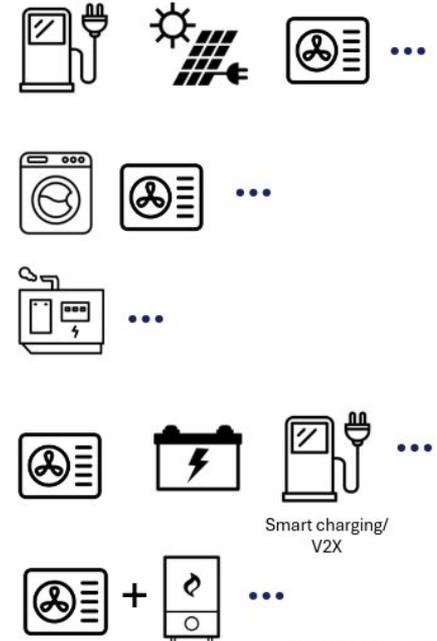
8 generic energy flexibility capabilities ...



... are combined into 5 control types ...



... to manage flexibility of energy smart appliances



# Who is working with S2 right now?



# Insmart project

Prevent grid congestion in neighbourhoods



S2 communication protocol used between devices and central control.

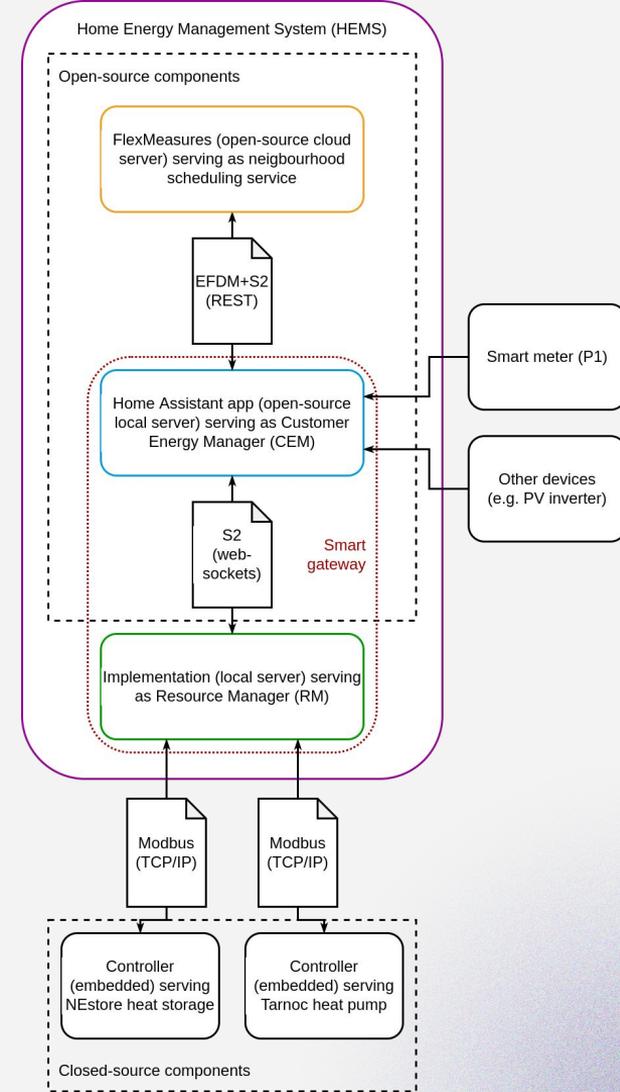


# Tunes project

S2 PoC with heat pump & heat buffer for multiple apartments



Partners:



# Kiflin

Open source HEMS development  
environment with full S2 compability

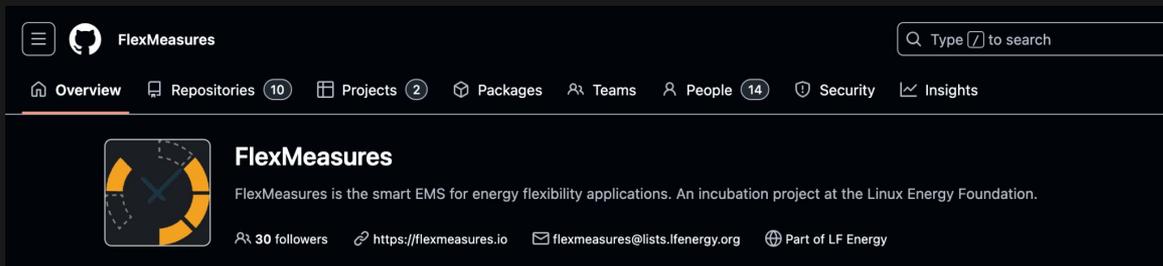
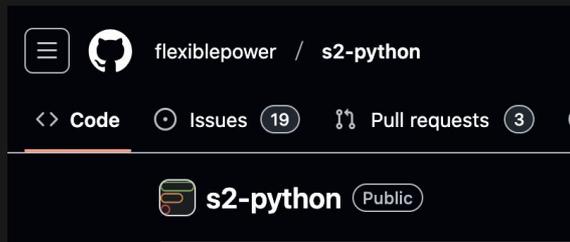
Open-sourcing 'Profile-steering'  
S2 scheduling algorithm

The realisation of a first batch of  
S2-compliant devices

# Open-source: S2, FlexMeasures, etc

<https://flexmeasures.io/get-in-touch/>

- S2-python supports all S2 control types
- FlexMeasures supports CEM side of S2
- FlexMeasures gets a new optimization algorithm specializing on VPPs & S2 flex
- (future) FlexMeasures gets extra tutorial for building an open-source HEMS
- (future) FlexMeasures could support VEN side of OpenADR



Thank you for  
your time!

# Energy management standards

			
What is it?	A standard for device-level energy management. <b>Device-level energy management</b> and building automation	A protocol for <b>automated demand response (DR)</b> . Allows grid controllers to send signals.	A standard focused on <b>in-home energy flexibility</b> and smart meter integration
Use case	Uses <b>peer-to-peer communication</b> between devices and an in-house EMS to enable <b>optimized local energy use</b> .	Focuses on <b>two-way communication</b> between grid operators and demand-side resources, with messages that <b>trigger changes in consumption</b> .	Primarily designed for the <b>in-home environment</b> , linking smart meters with EMS to deliver <b>real-time metering</b> and <b>smart scheduling</b> .

# Viewpoint of organizations

## Key factors

- Technological superiority
- Relative advantage
- Observability
- Network externalities
- Switching Costs
- Coercive pressures

Table 1. Main theories and approaches utilized by researchers studying standards adoption.

Literature stream/ theoretical approach	Category	Factors for standards adoption	Explanation
Network economics [43,44]	Market mechanisms	Network externalities and switching costs	When more firms adopt a certain standard, the value of that standard increases and it becomes more beneficial to choose that standard over other standards.
Neo-institutional theory [48,67]	Pressures	Normative, mimetic, and coercive pressures	A standard is adopted due to pressures that act upon the firm. This pressure can come from the firm or from other actors.
Innovation adoption and diffusion [53,54]	Standards characteristics	Relative advantage and comprehensibility	The choice to adopt a standard depends on its technical characteristics and the extent to which it is compatible with the firm.
Innovation management and standardization [62]	Characteristics of the firm; Standards organization's characteristics and strategies	firm size and standard's price	The choice to adopt a standard depends on the characteristics of the firm that adopts it and the standards organization that offers it (and its strategies).