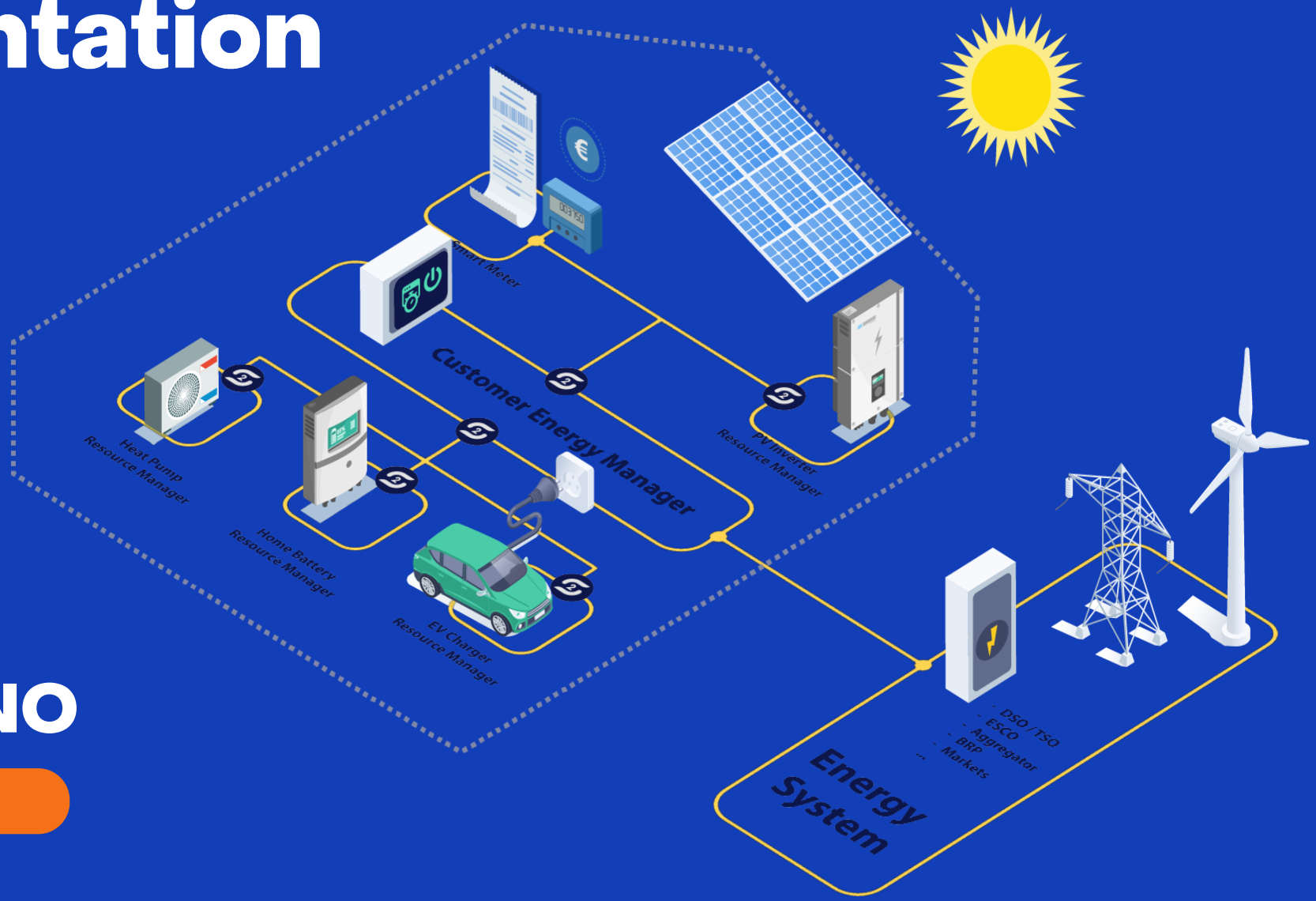
UT Presentation

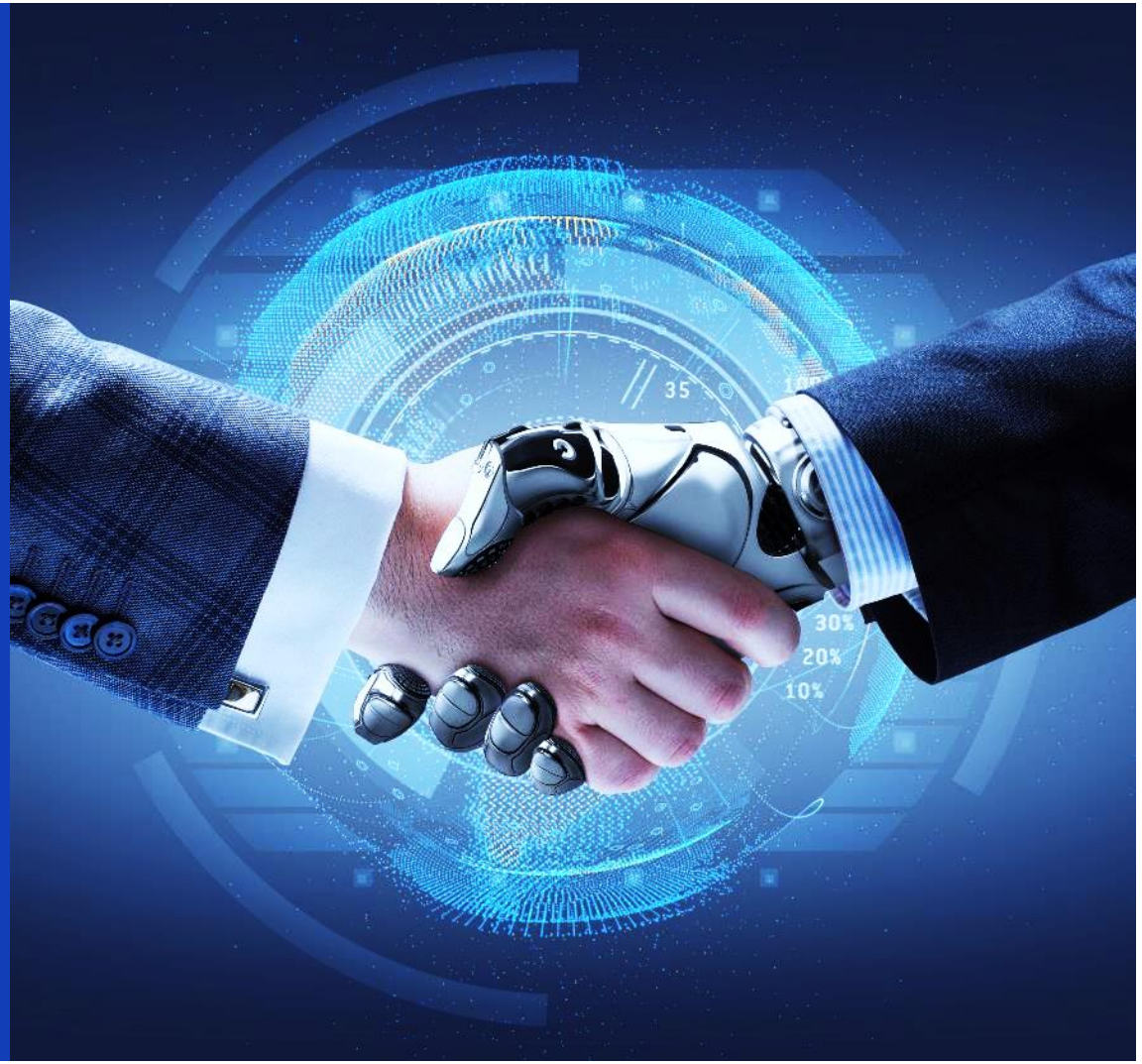


Smart Energy Research @ TNO

Jorrit Nutma

We are TNO

TNO’s mission is to create impactful innovations for the sustainable wellbeing and prosperity of society.



Agenda

- In-home Energy Flexibility (protocols)
- Project examples
  - TUNES
  - KIFLIN
- ~~Simulation tooling~~

Energy flexibility activation mechanism

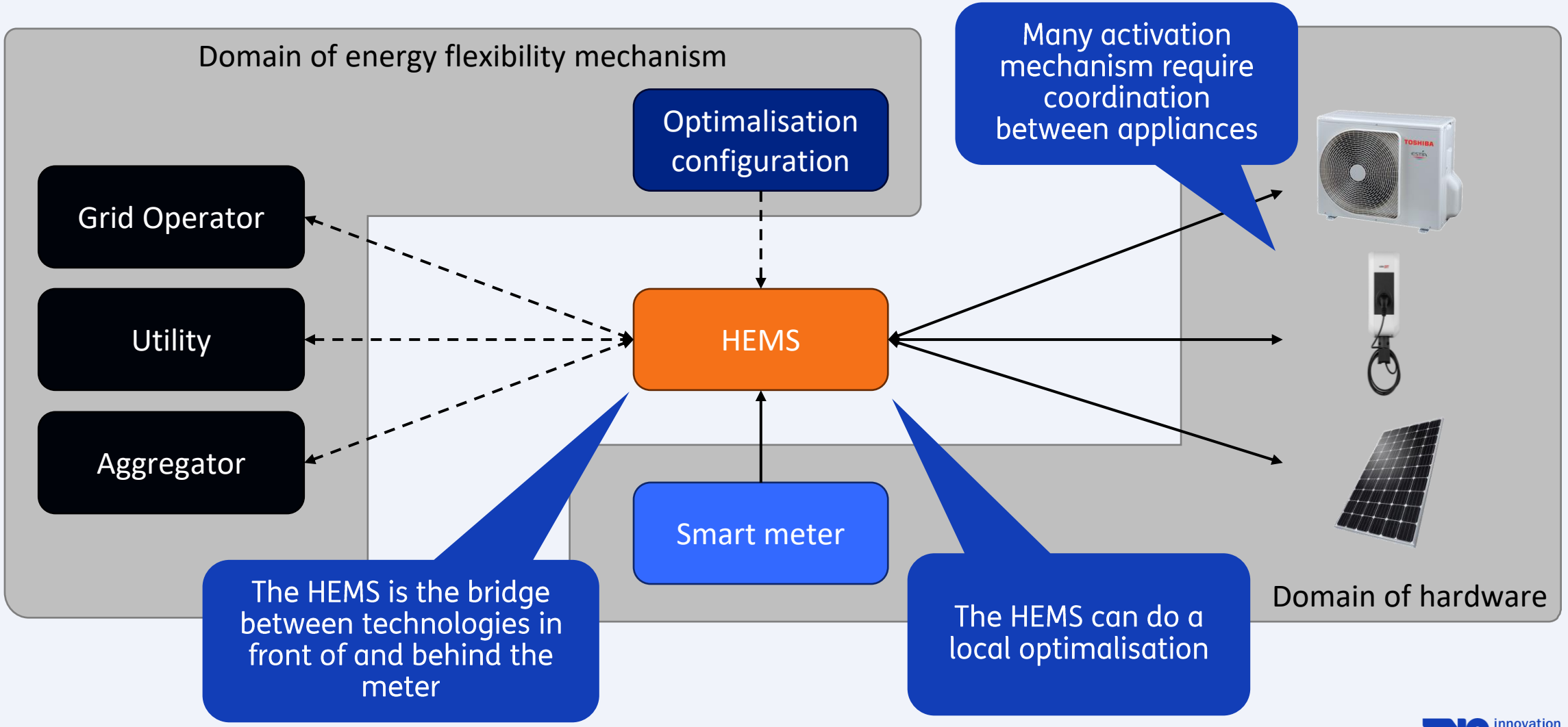
An activation mechanism for energy flexibility:

- Incentive to stimulate devices such that energy flexibility becomes available.
- It is usually a combination of a technical mechanism to indicate whether it is a good or bad time to use electricity and a (financial) reward for good behavior.

Types of activation mechanism

- Direct control
  - E.g., airco peak hour signal
- Static power limitation
  - E.g., during evening peak a reduced connection limit
- Dynamic power limitation
  - Reduce the connection limit in times of congestion
- Static incentive
  - E.g., bandwidth model for grid connection tariffs
- Dynamic incentive
  - E.g., time-of-use energy tariffs
- Coordinated control
  - E.g., virtual power plant

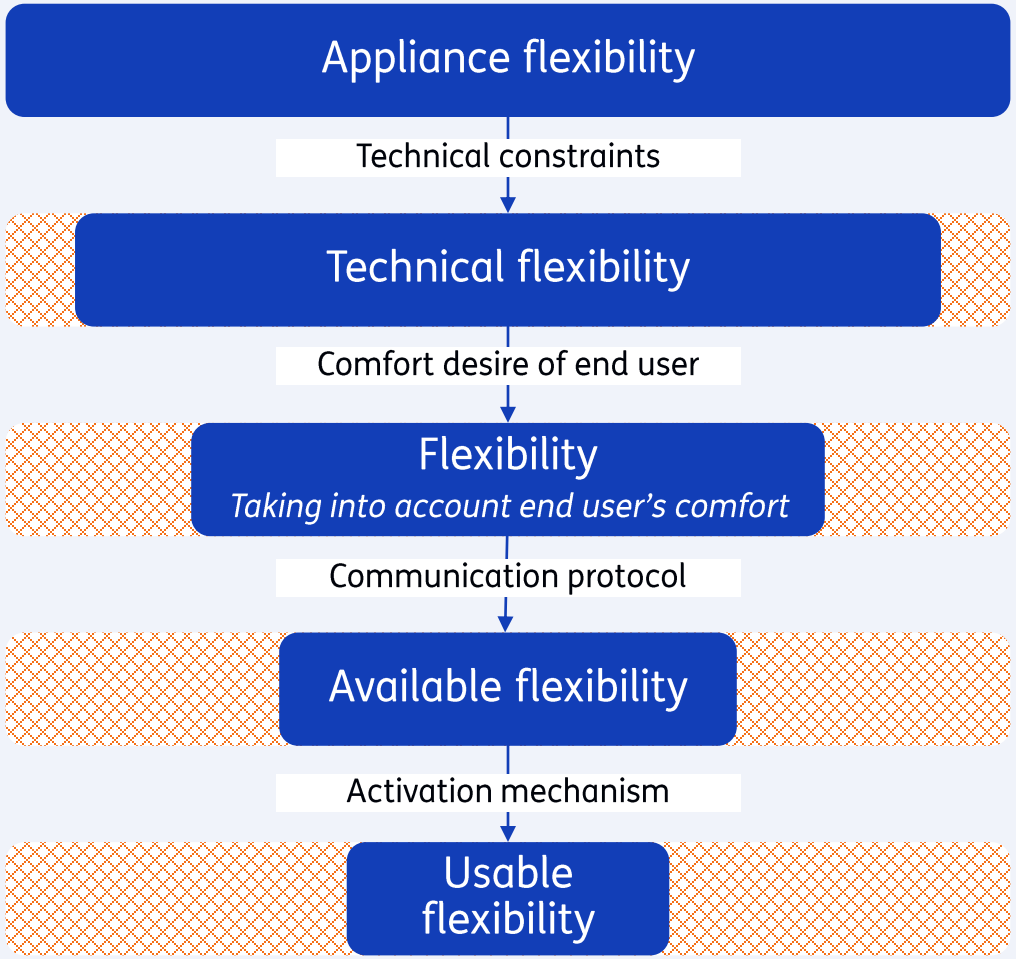
Home Energy Management System (HEMS)



Trends in decentralized energy management

	Appliance based Energy Management	Energy supplier/aggregator-based Energy Management	Independent energy manager
EMS provider	Appliance manufacturer (OEM)	Energy supplier or (commercial) aggregator	A third-party that merely provides an EMS
End-user benefit	Typically includes: • Self-consumption (of PV) • Limit load on grid connection • Time-of-use tariffs	• Reduced energy prices • Using energy on times with much renewable generation	Typically includes: • Self consumption (of PV) • Peak shaving • Time-of-use tariffs
Challenge	• Who is the boss in case there is a combination of devices? • Limited to use-cases supported by OEM	Only works with specific hardware which is selected by energy supplier	EMS provider needs to integrate with many device/manufacturer specific APIs (if present). No guarantees on the energy flexibility capabilities of the APIs

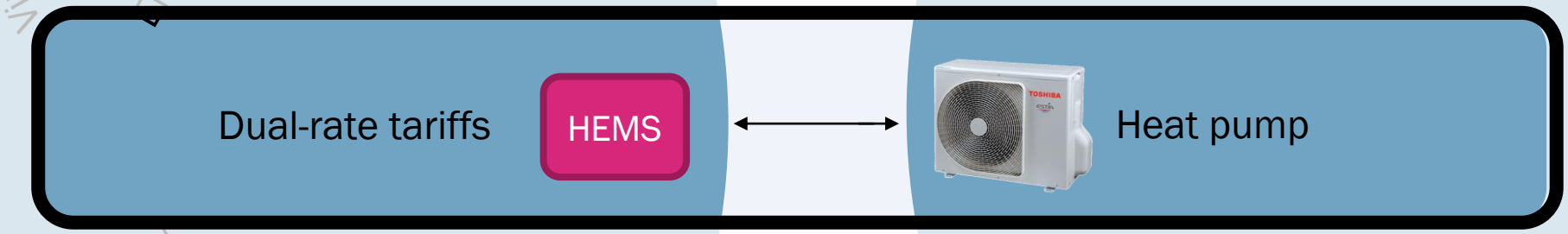
Energy flexibility is scarce!



How to advance?

- Crucial role for the HEMS
- Legislators must improve activation mechanisms
- Create an open ecosystem to maximize usage of flexibiliteit
  - Interoperability
  - Need a future-proof protocol between appliances and HEMS

An open ecosystem



Future proof Energy Management

- **S2: short of European standard EN50491-12-2 (S2)**
- Unique approach:
  - Standardize energy flexibility
  - Clear separation of concerns between appliance and EMS
- Works for example with EV (chargers), heat pumps, hybrid heat pumps, and batteries.

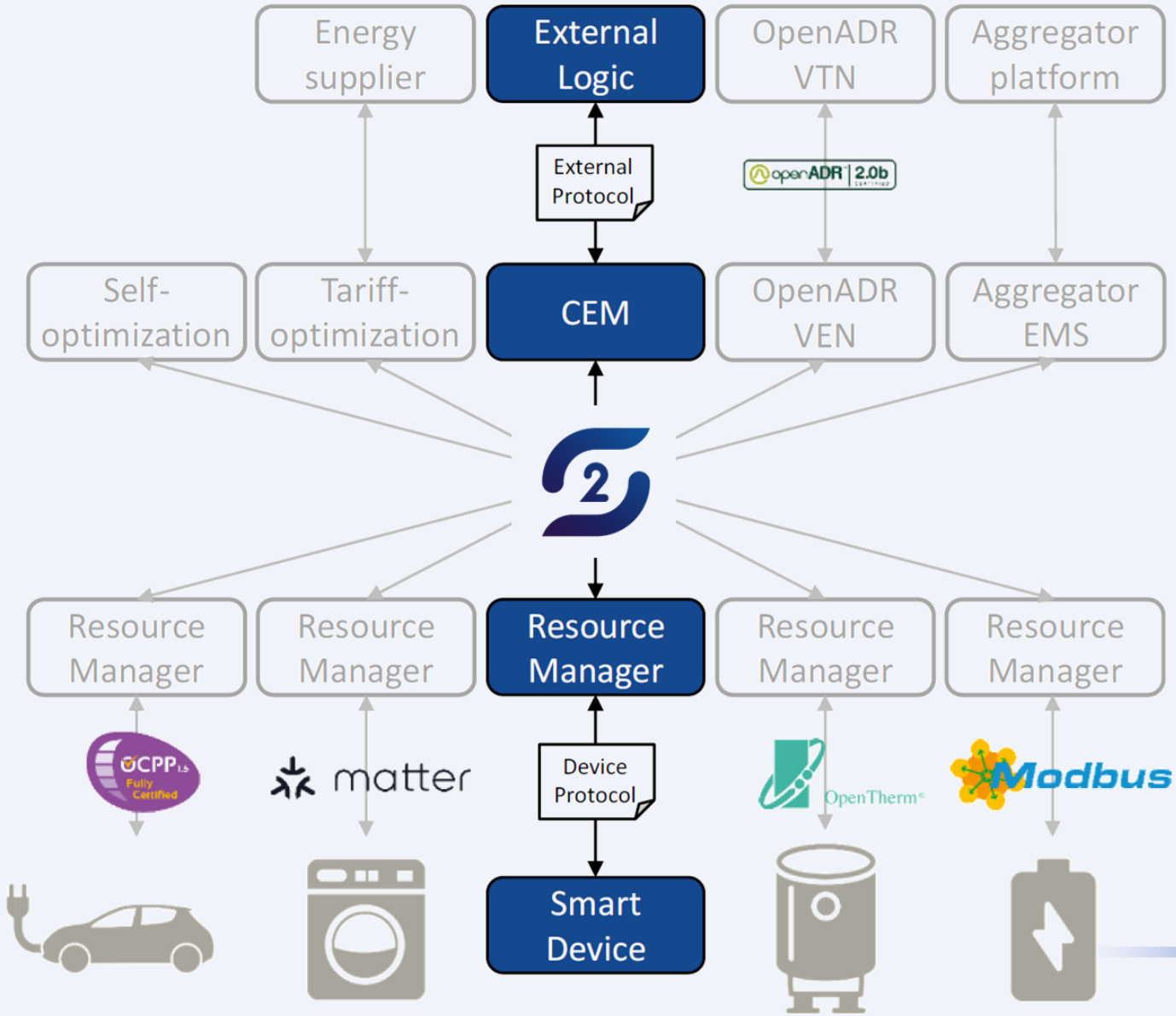
Find more information on s2standard.org

S2 Architecture (1/2)

- Responsibility of aggregator/supplier/...
- Finds the right balance between:
  - Optimization incentives (e.g. tariffs, self optimization, congestion)
  - Flex options for multiple devices
- Sends instructions to the Resource Manager
- End user chooses optimization strategy

- Responsibility of OEM
- Communicates flexibility options from smart device
- Safeguards safety and performance constraints
- End user provides comfort requirements
- Represents a single source of flexibility/device
- Translates device protocol into S2 and vice versa
- Resource Manager enriches flexibility information
  - Using a model or digital twin
  - Using external information, e.g. weather forecast

S2 Architecture (2/2)



S2 Standard

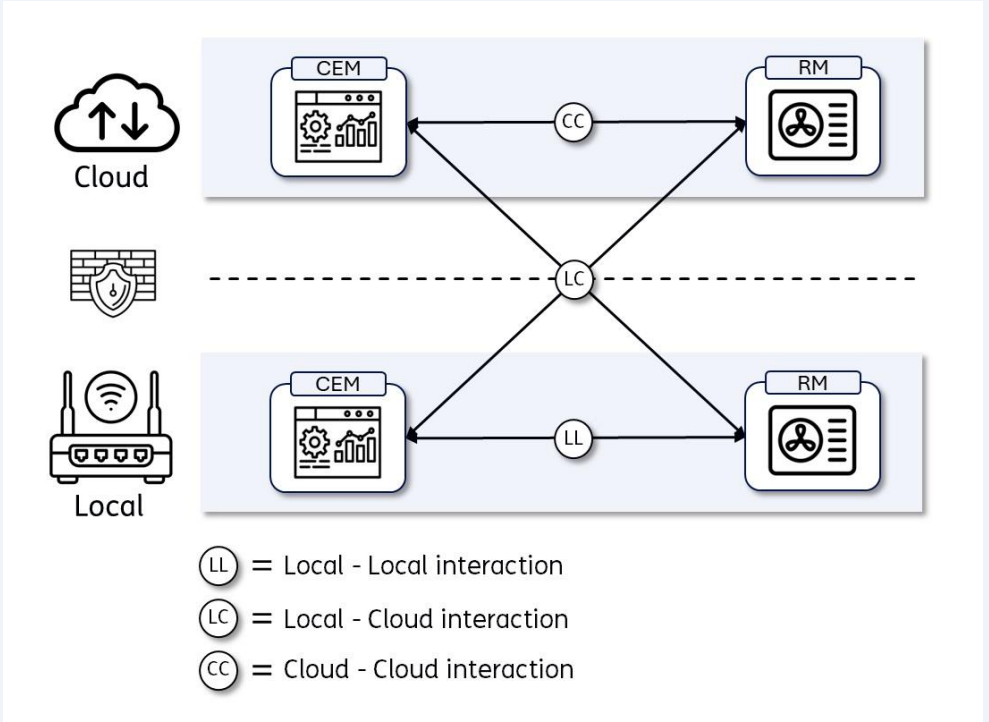
EN 50491-12-2

https://s2standard.org/

Protocol specification

- The S2 standard contains the data model and the specifies interactions between RM and CEM
- It doesn't specify *how* data is exchanged but that is needed for a working and easy implementation
- Therefore, we have an open-source specification of the S2 communication protocol
  - Json as serialization format
  - Websockets as IP-based communication protocol
  - Support four cases: CEM and RM can either run local or in the cloud

- GitHub: [flexiblepower/s2-ws-json: A WebSockets and JSON based protocol specification implementing the EN50491-12-2 "S2" standard for home and building energy management]



Overview of HEMS protocols

Protocol	How it deals with comfort	Local or cloud connectivity?	Optimization done by...	Update needed for new application	Adoption
SG Ready	No guarantees	Local	EMS	EMS	Very high
OCPP	No guarantees	Cloud	EMS	Protocol, appliance, and EMS	High
EEBus	Differs per use case	Local or cloud	Partly EMS, partly appliance	Protocol[1], appliance, and EMS	Low
S2	Device responsible for comfort	Local or cloud	EMS	EMS	Low
OpenADR	Differs per signal	Local or cloud	Partly EMS, partly appliance	Protocol, appliance, and EMS	Low

[1] By means of adding a use case

TUNES

Project goal:

- A Home Energy Management System (HEMS) based on the S2 protocol that controls the heating system to store locally produced green energy, taking into account user comfort and optimize the power flows on neighborhood level

Activities:

- Develop innovative heat pump and heat storage technology
- Apply AI algorithms to learn local heat system parameters

TUNES

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Selflearning Resource Manager

- There are huge differences between households in terms of heating systems and heating demand
- That highly influences the availability of energy flexibility
- We apply AI algorithms to find per local situation accurate values for the heating system parameters

KIFLIN

Goal:

- Kickstart a visible and scalable ecosystem for energy flexibility based on S2

Activities:

- Implementations of Resource Manager and Customer Energy Manager by market parties
- Develop developer tools, documentation and examples for facilitate other implementations

S2 ecosystem development and demonstration

- Heat pump Resource Manager implementation by Itho Daalderop
- Energy manager implementation in FlexMeasures from Seita
- Cloud-cloud deployment setup

- Developer tooling:
  - Improve existing S2 Python library
  - Publish S2 Rust library
  - Create simulation ‘mock’ devices
  - Create dummy energy manager

LF ENERGY FlexMeasures