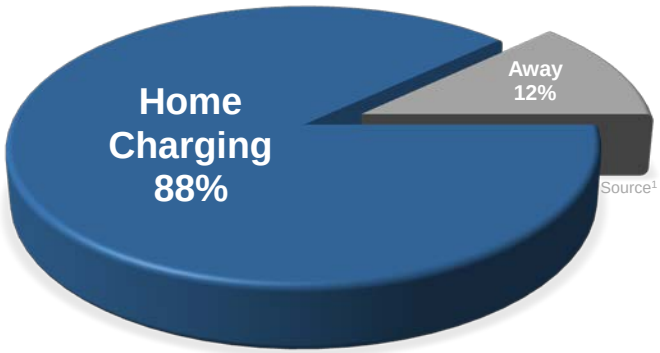

PORSCHE

# Beyond the EVSE

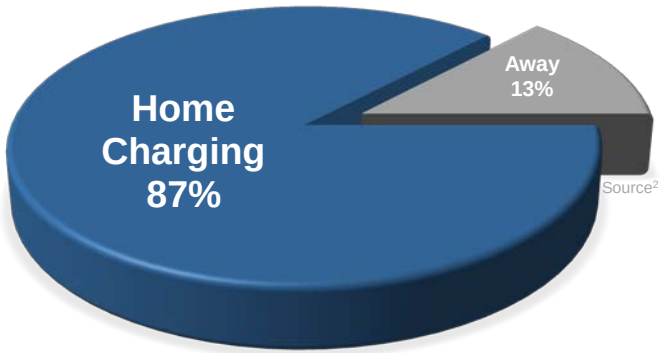
## EV Integration into Energy Management Systems

Barry Sole
Porsche AG

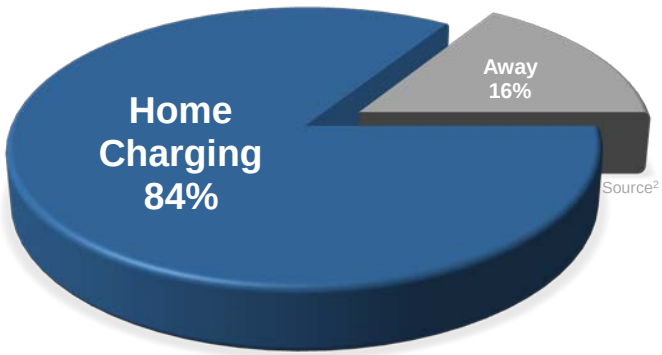
# According to various studies, the majority of EV charging takes place at home regardless of the segment or class of vehicle




Tesla Model S




Chevrolet Volt

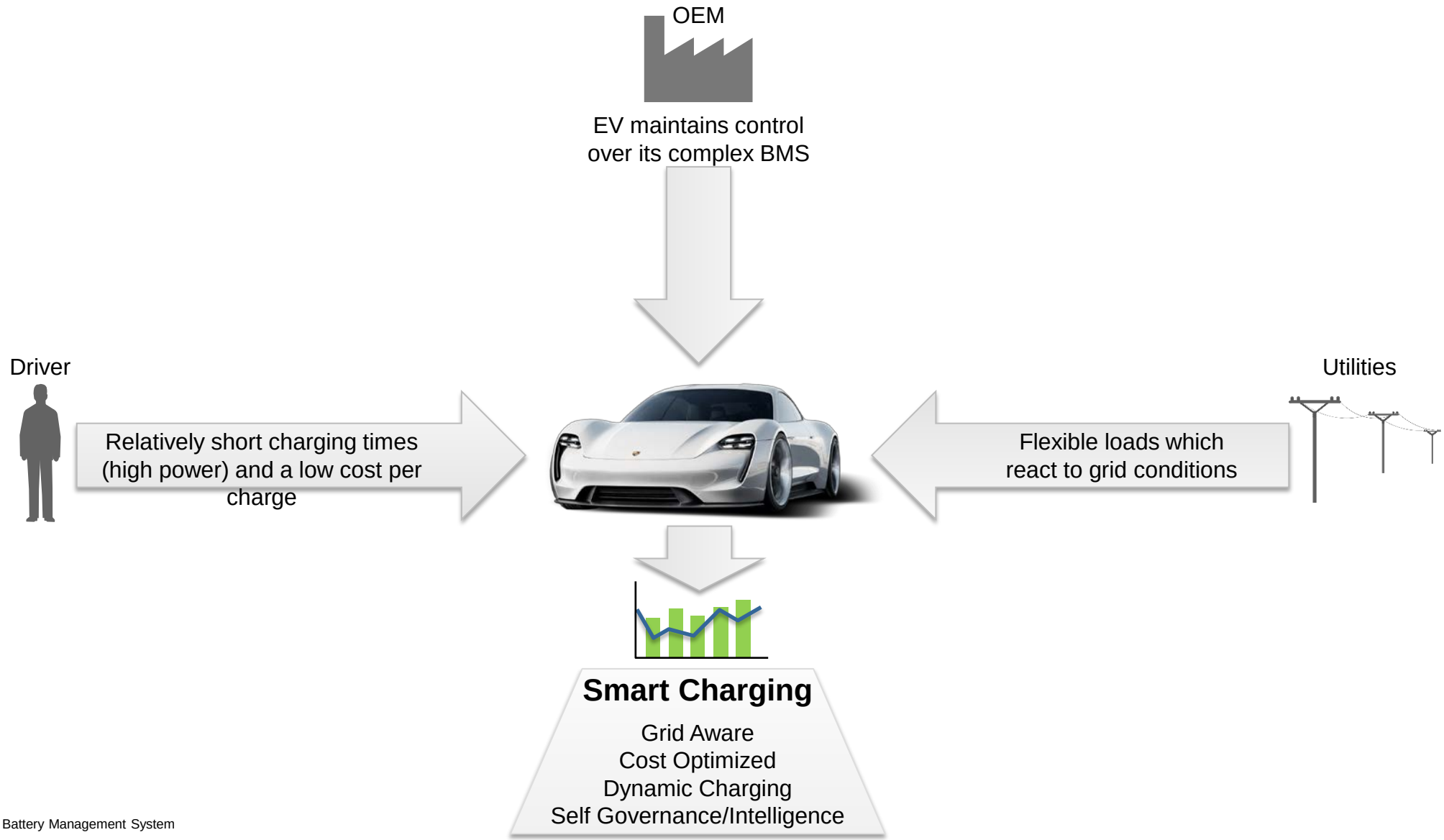



Nissan Leaf

Although these figures may slightly change with the advent of **High Power Charging** infrastructures and **long range BEVs**, the majority of **drivers are expected to continue charging their EVs at home**.

Source¹: http://assets.fiercemarkets.net/public/smartgridnews/PlugInsights_U.S._PEV_CHARGING_STUDY_2013_media_copy.pdf
Source²: https://avt.inl.gov/sites/default/files/pdf/arra/SummaryReport.pdf

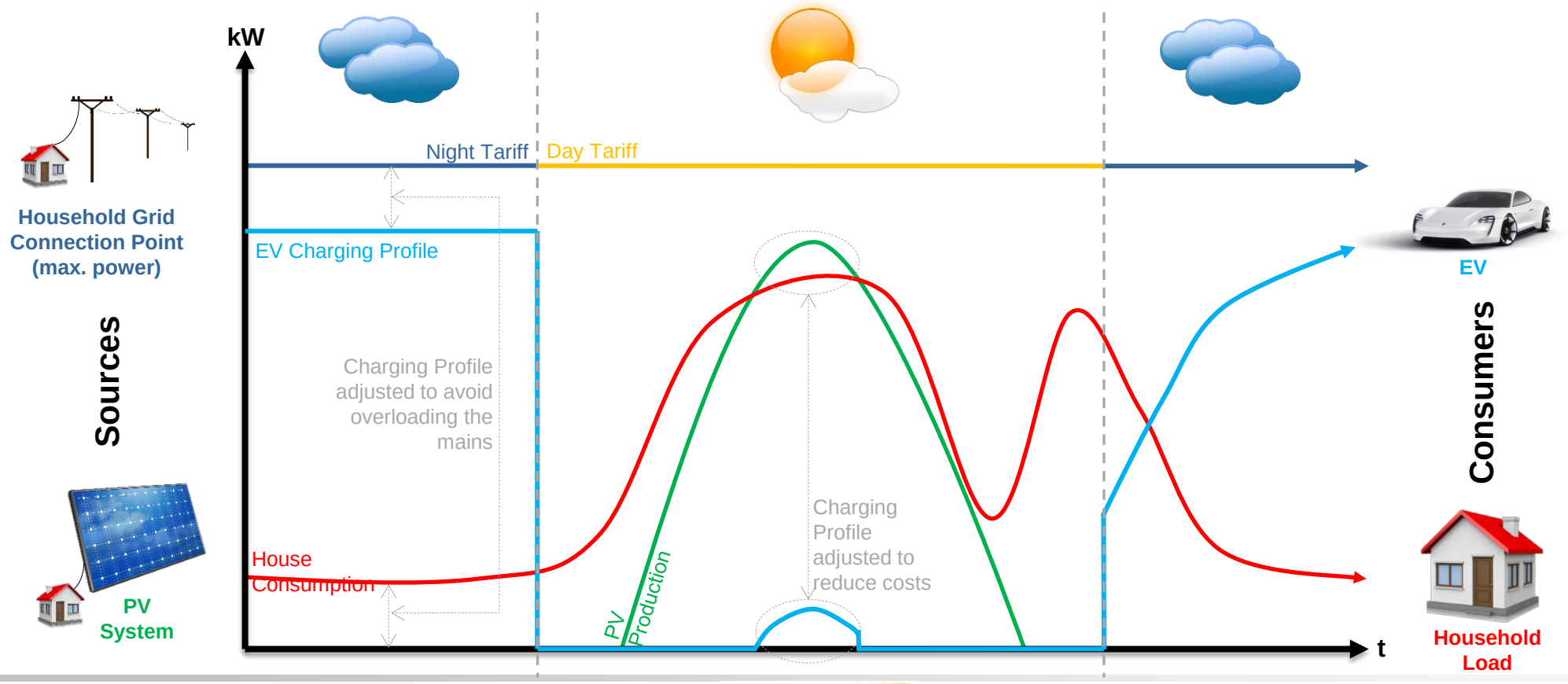
# What's needed for Home Charging?



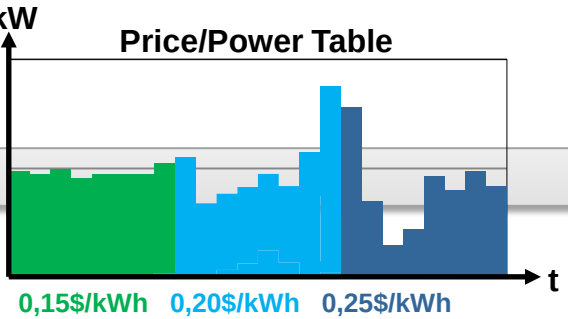

BMS = Battery Management System

# What is Smart Charging?

There is no standard definition for “Smart Charging”, but for simplification we can think of it as **intelligently and dynamically adjusting the EV’s Charging Profile based on various factors** such as grid conditions, financial aspects, and the driver’s needs.



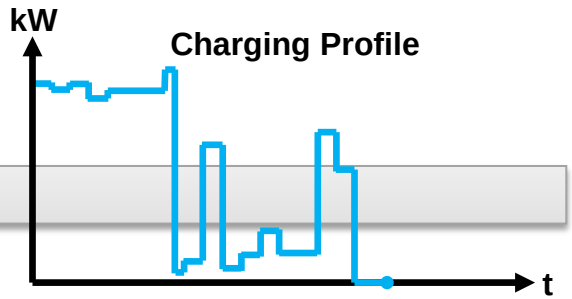
# ISO/IEC 15118 Supports Smart Charging with the use of Price/Power Tables




The EVSE sends a **Price/Power Table** to the EV

Price/Power Tables describe the availability of power and the (relative) cost of energy

The EV creates a **Charging Profile** based on the information in the Price/Power Table, its BMS, and the driver defined settings



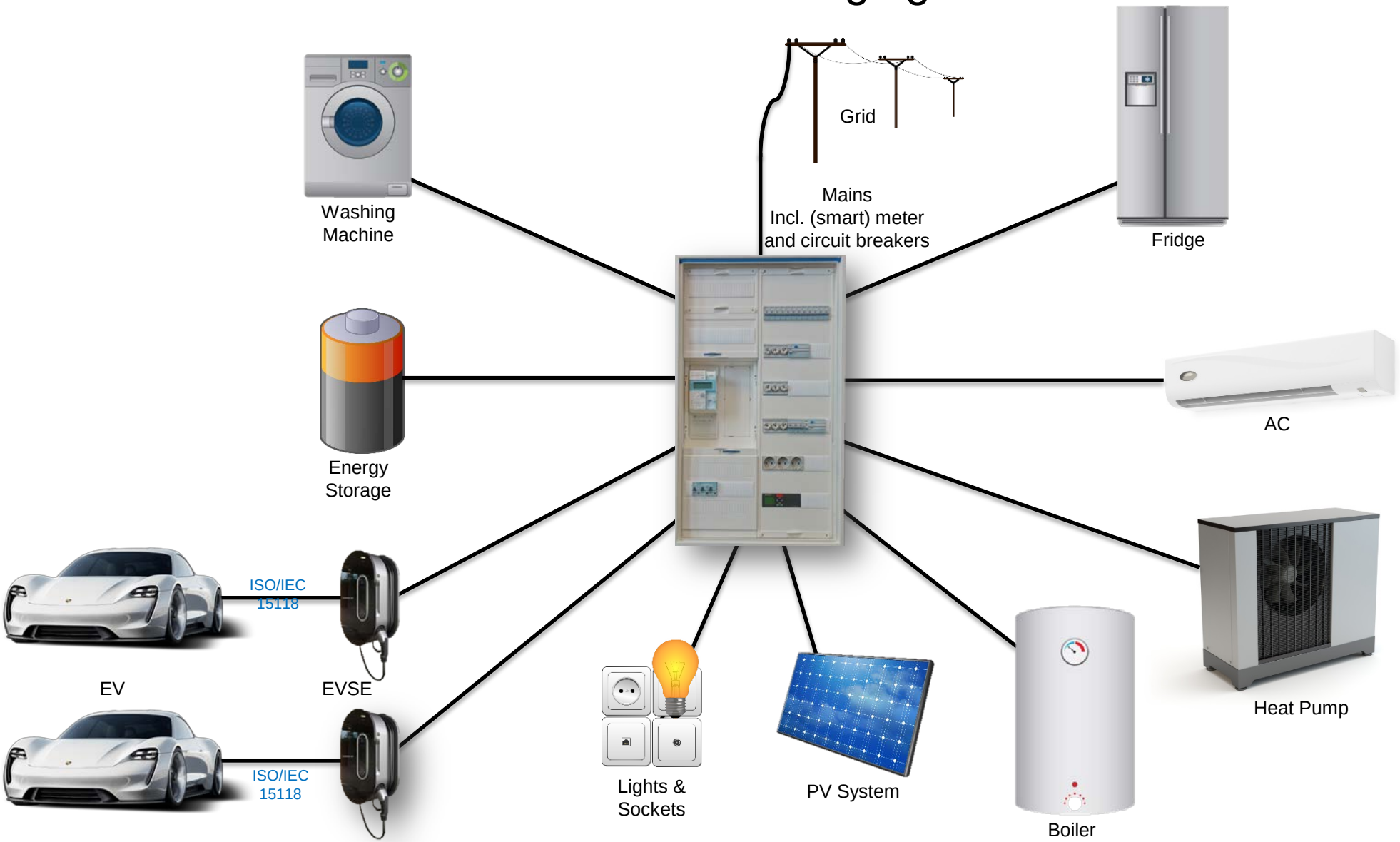

Charging Profiles describe the EV's planned charging power over time

Negotiation

Charge Loop

After this negotiation, the EVSE will **provide power** to the EV allowing the battery to charge

# What's needed for residential Smart Charging?



# What's needed for residential Smart Charging?

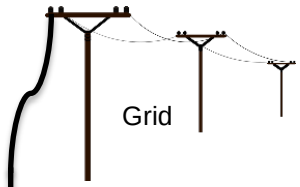
The Problem with Telematics:

- A telematics **link may not always be available**
- **No information** about the building's private network load is available
- **Only considers EVs**
- "Private **Roaming**" is not supported

(I charge at your house! What's your tariff? How much power can I draw and when? …)

OEM Backend

Grid & Tariff Information via Telematics



Grid

Mains
Incl. (smart) meter
and circuit breakers

Fridge

AC

Energy Storage

EV

ISO/IEC 15118

EVSE

ISO/IEC 15118

Lights & Sockets

PV System

Boiler

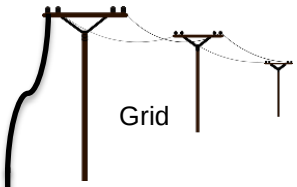
Heat Pump

# What's needed for residential Smart Charging?

Residential **Smart Charging** requires an Energy Management System (**EMS**) which supplies the EVSE with private network information such as tariffs and power availability


Washing Machine

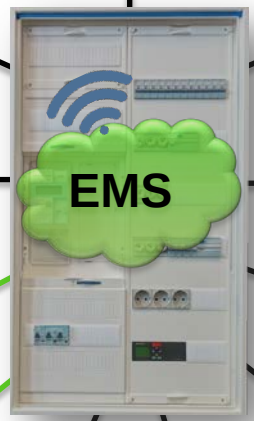

Utility Backend (e.g. Grid & Tariff Information via Smart Meter)



Mains Incl. (smart) meter and circuit breakers


Fridge


Energy Storage





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ISO/IEC 15118


EVSE

Tariff and power information


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Don't forget, **E-Mobility is not the only EMS use-case!!!**


Washing Machine


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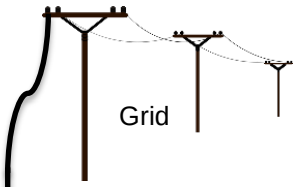

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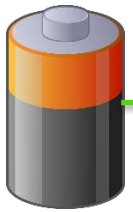
Energy Storage



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EVSE

Tariff and power information


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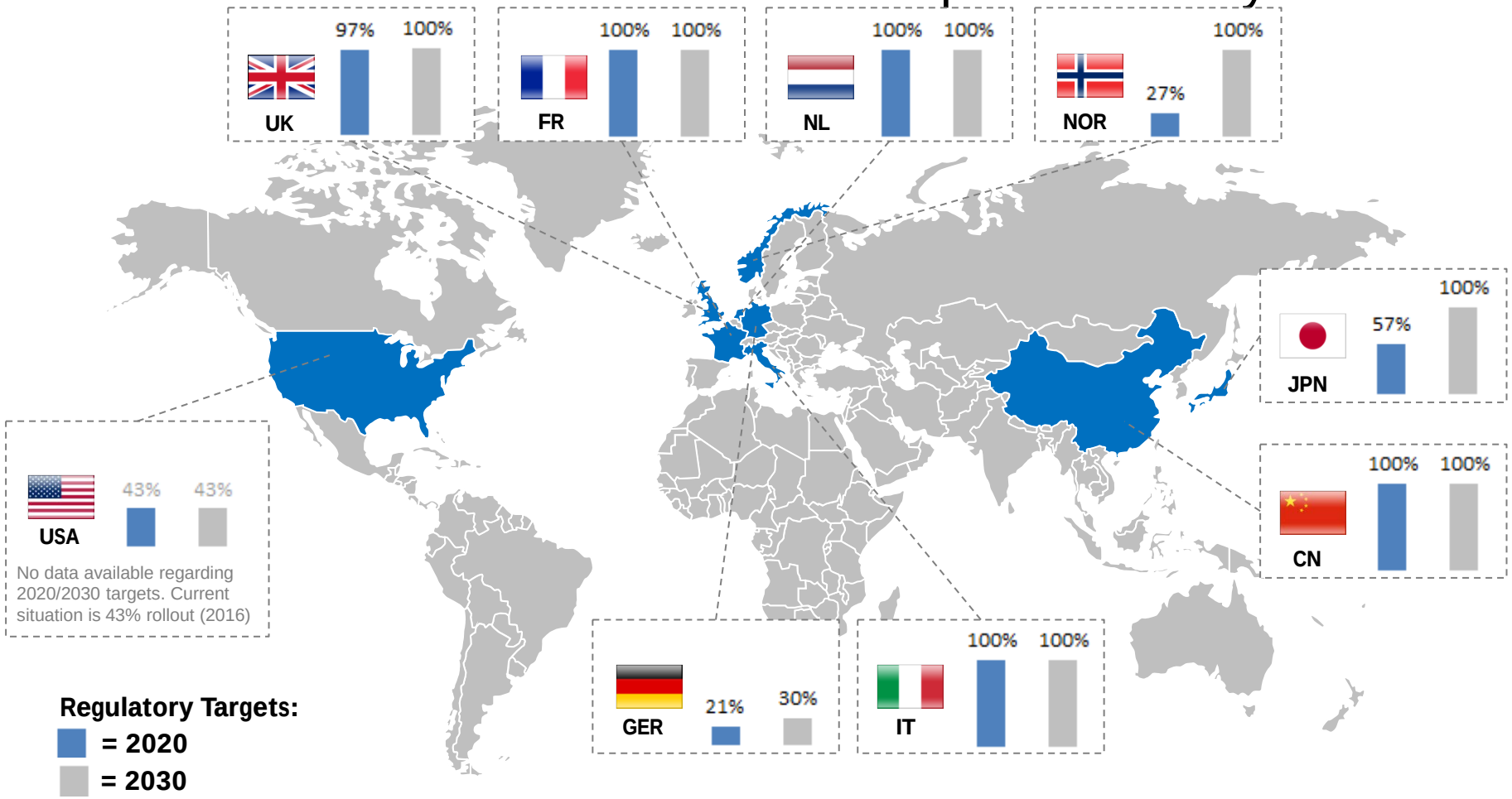
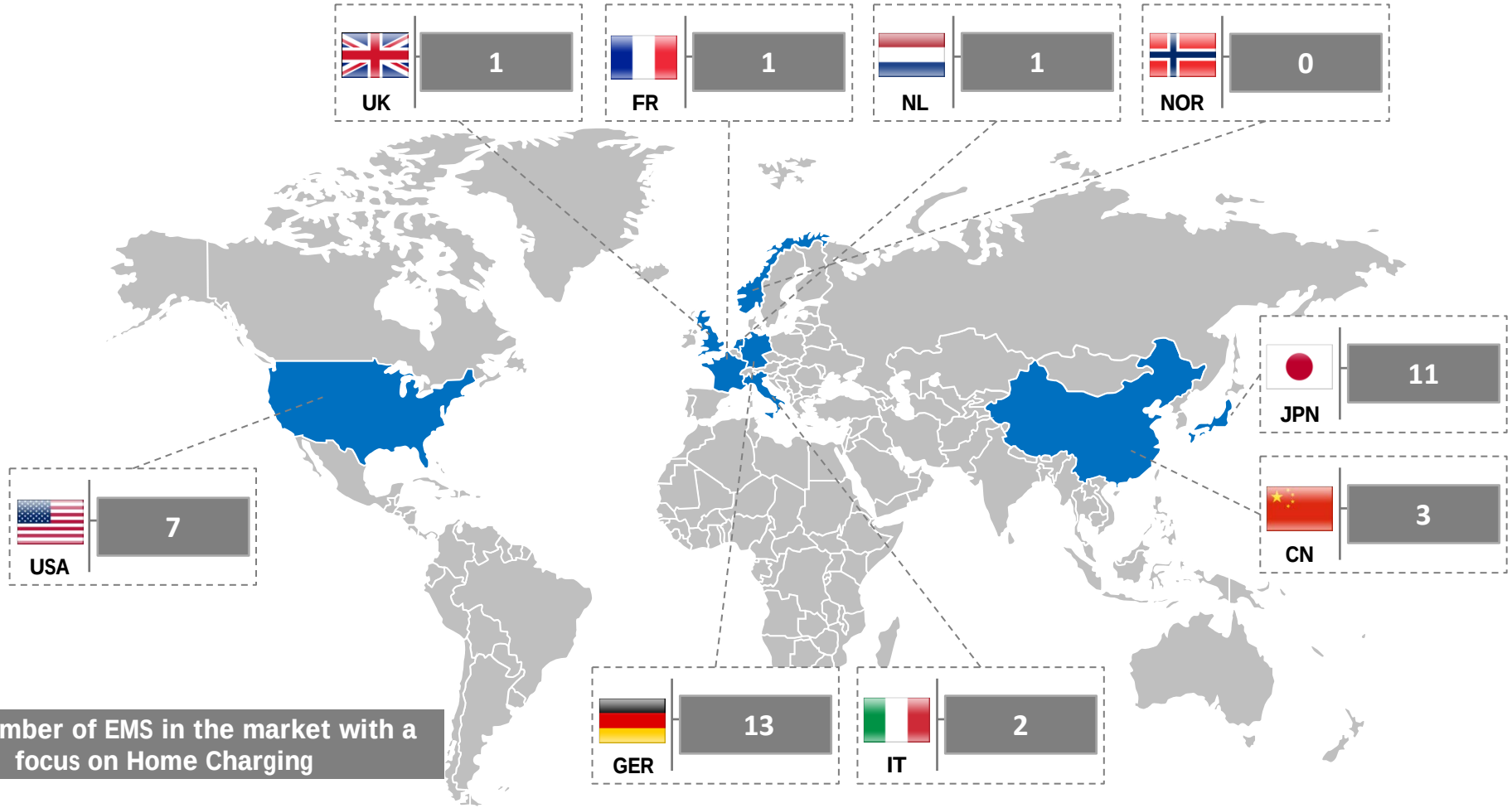
# Let’s take a quick look at the landscape…

# The rollout of residential “2-way” Smart Meters brings with it the possibility of Smart Grid features such as Demand Response and Dynamic Tariffs




Source: P3 Group (2016) | A “2-way” Smart Meter is able to communicate with the utility provider as well as within the home

# EMS availability with Home Charging support is still pretty scarce



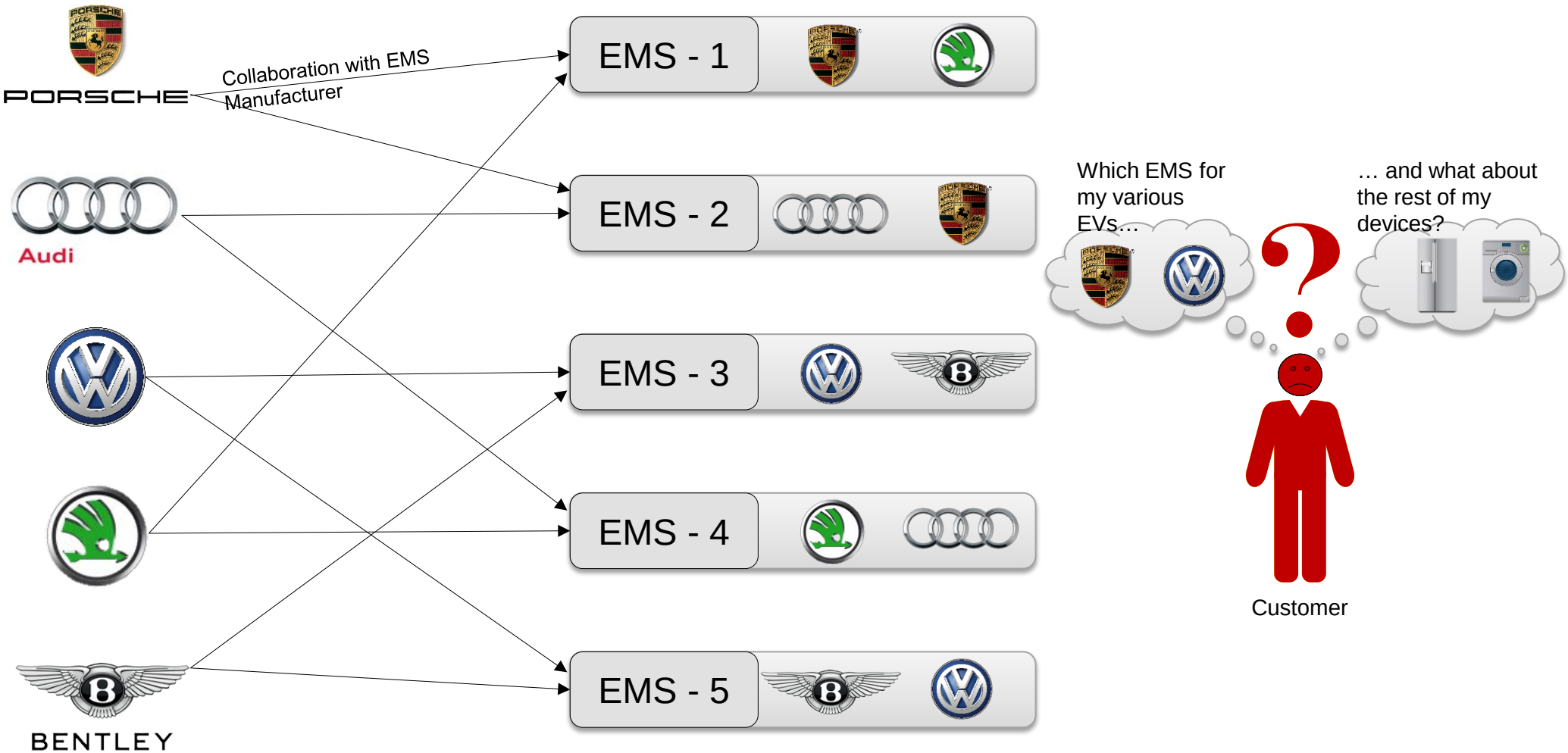

**Legende:**

x = Number of EMS in the market with a focus on Home Charging

**Most, if not all, of these HEMS use proprietary protocols and are not sold worldwide**

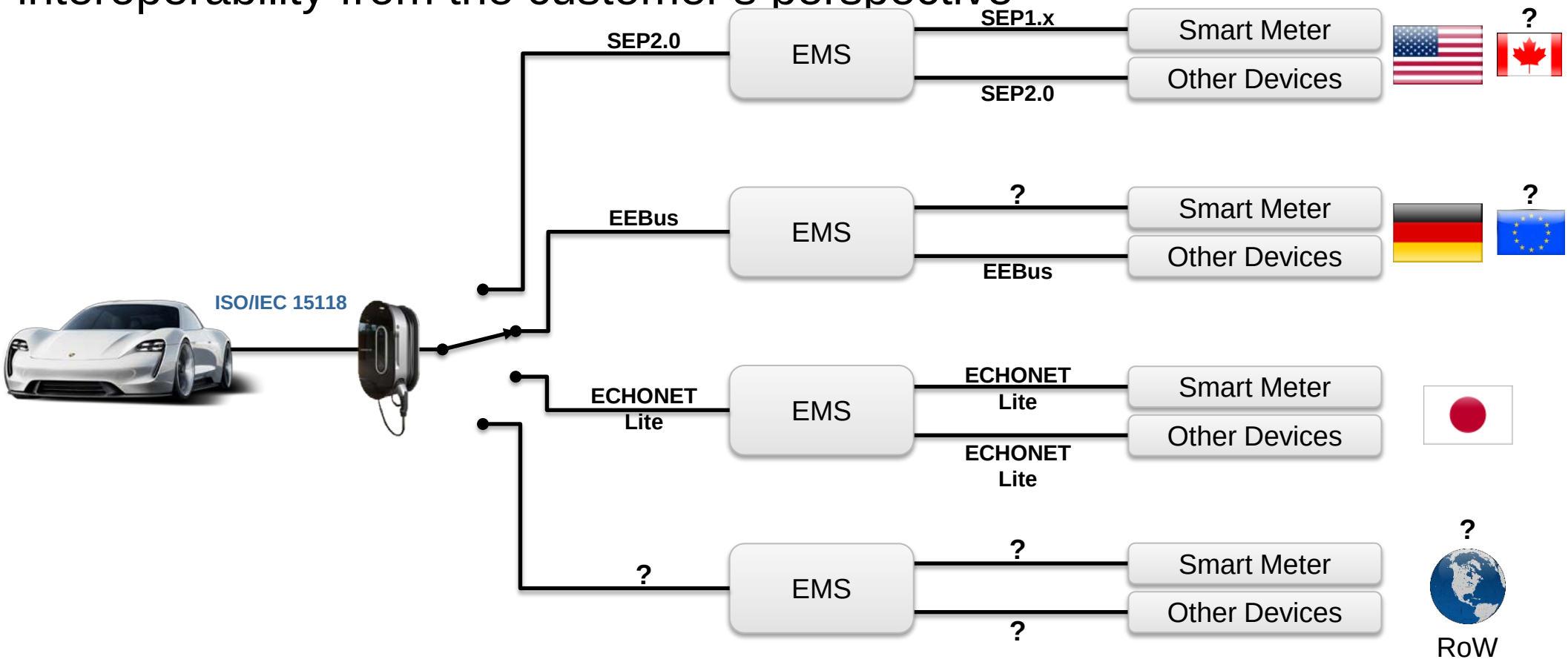
Source: P3 Group (2016)

# Today, most OEMs offer their customers proprietary solutions with very limited interoperability which leads to customer dissatisfaction




EMS = Energy Management System

# Multiple EMS standards already exist which further hinders interoperability from the customer's perspective



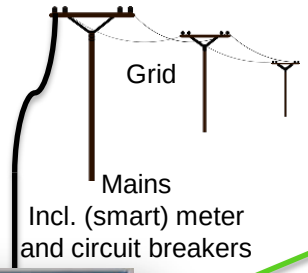

There's **no standard EMS protocol**, however, as we strive towards Smart Homes, Smart Devices and Smart Grids, this will become more paramount. It's doubtful that there ever will be a single EMS protocol, but **limiting the number of protocols will help accelerate the development and adoption of smart EMS technologies.**

# OK, back to the point…

# As we approach the era of Smart Grids, Smart Home and Smart Energy, we expect to see all large energy consumers connected to the home via an EMS

Question:
Who manages everything?


Washing Machine



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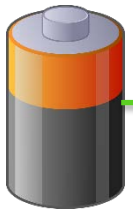
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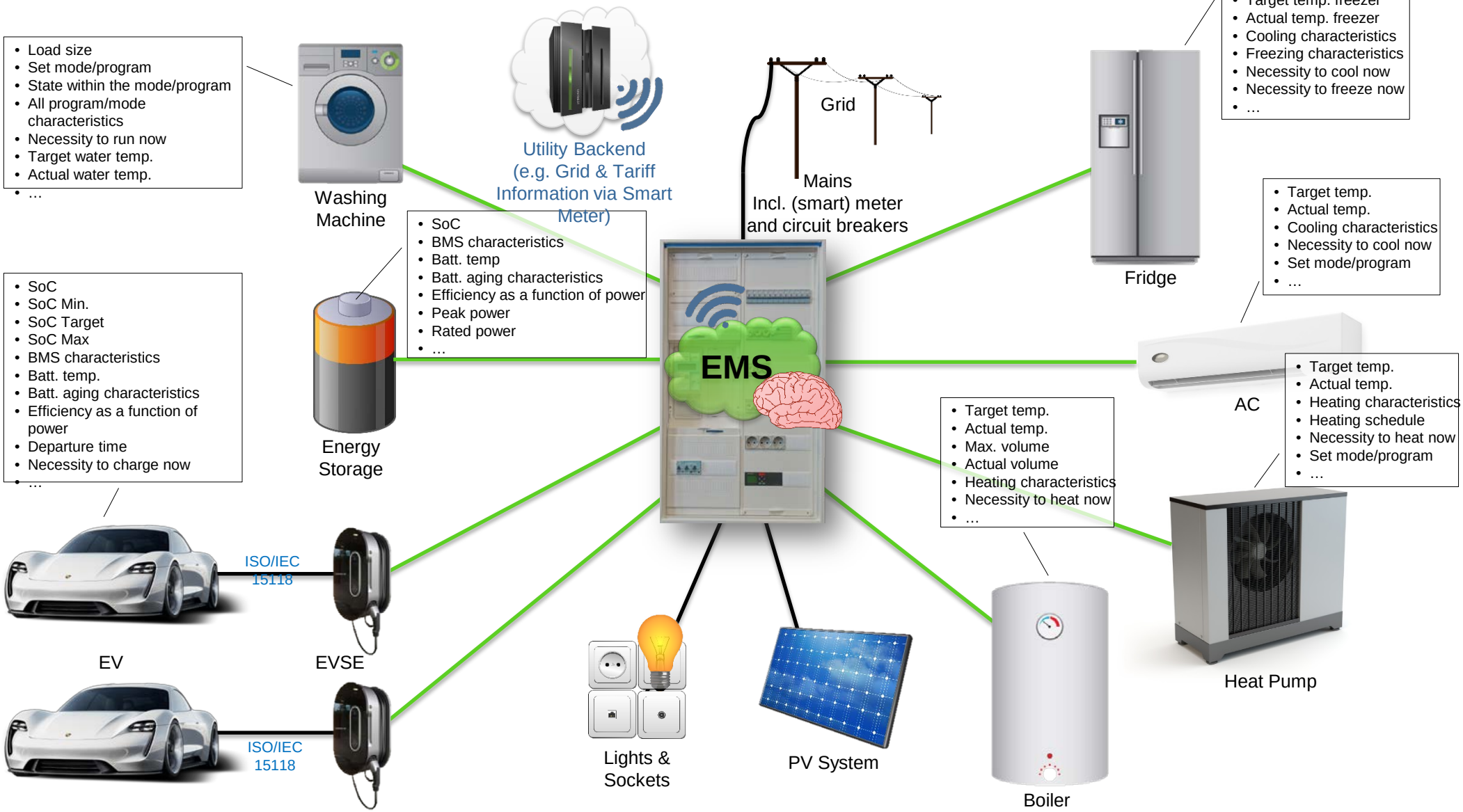
# Option 1: A central intelligence contained within the EMS



# Option 1: A central intelligence contained within the EMS

In order for this this work on a large scale, the EMS needs to know a significant amount of device and domain specific information.

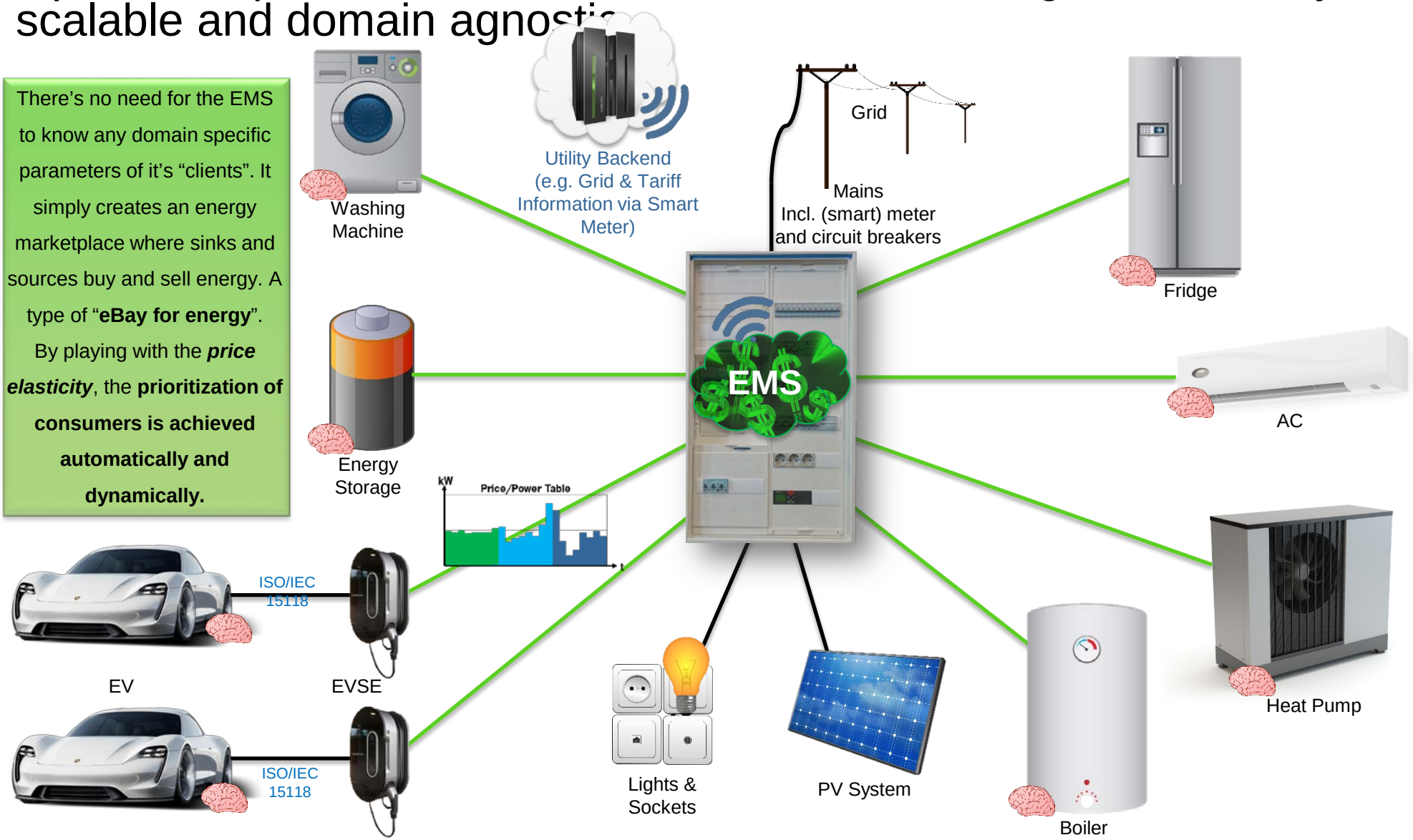
For example:

- What type of device is it?
- What are its electrical characteristics?
- What are its power demands now?
- What will its power demands be later?
- What are the consequences of pausing or delaying the device now?
- What are the consequences of pausing or delaying the device later?
- What program or mode is it currently in?
- At what point in the current program or mode is it?
- …

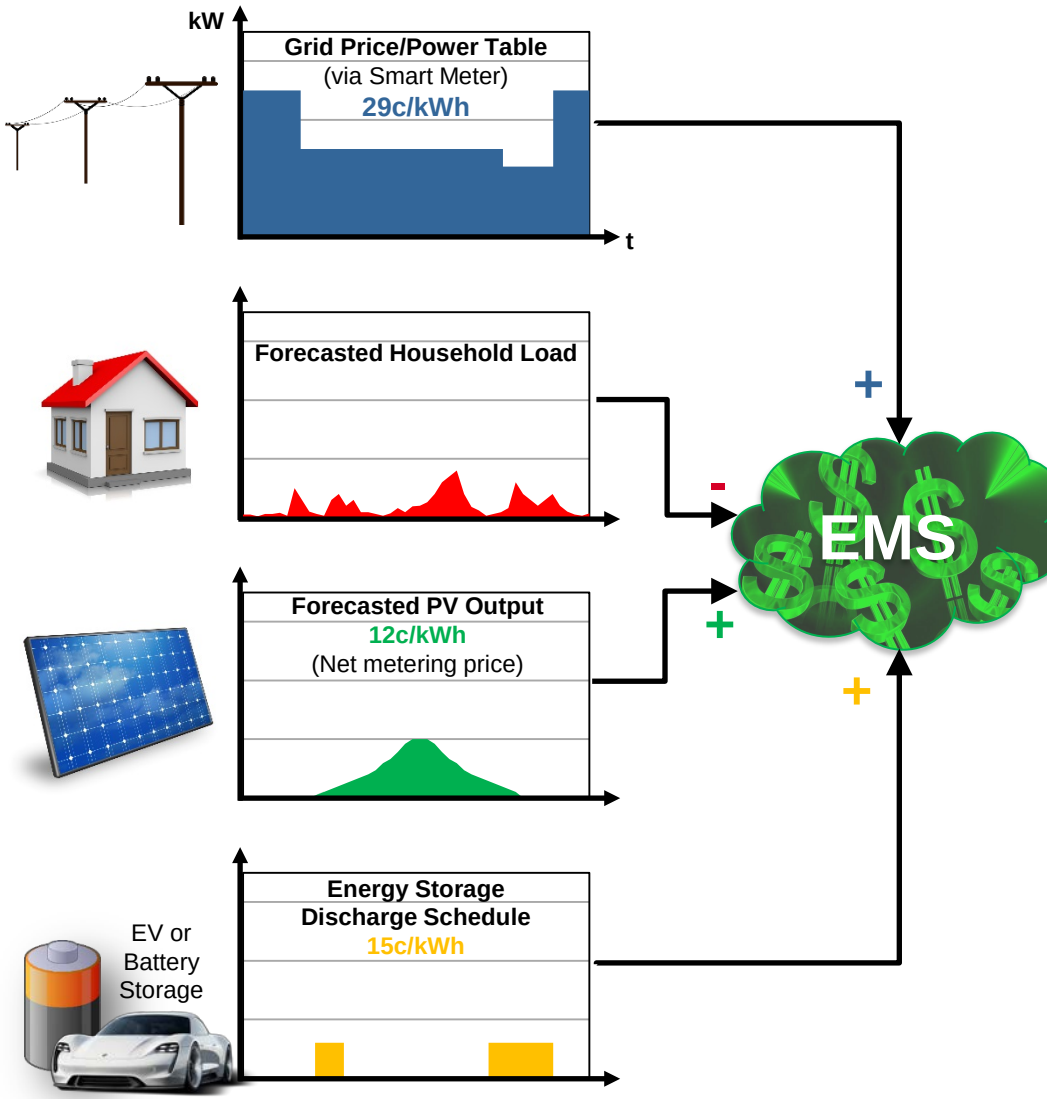
**Additionally, the EMS would need to know all these parameters for all models of all makes of device to ensure interoperability!**

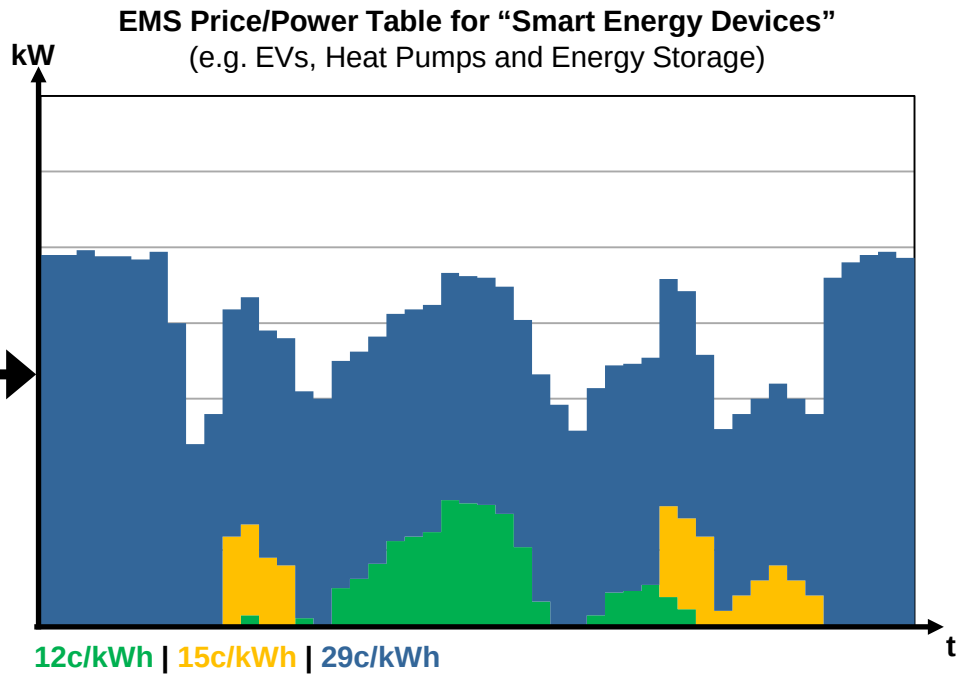
# Option 2: A price based EMS with distributed intelligence is easily scalable and domain agnostic

There's no need for the EMS to know any domain specific parameters of it's "clients". It simply creates an energy marketplace where sinks and sources buy and sell energy. A type of "**eBay for energy**". By playing with the ***price elasticity***, the **prioritization of consumers is achieved automatically and dynamically.**

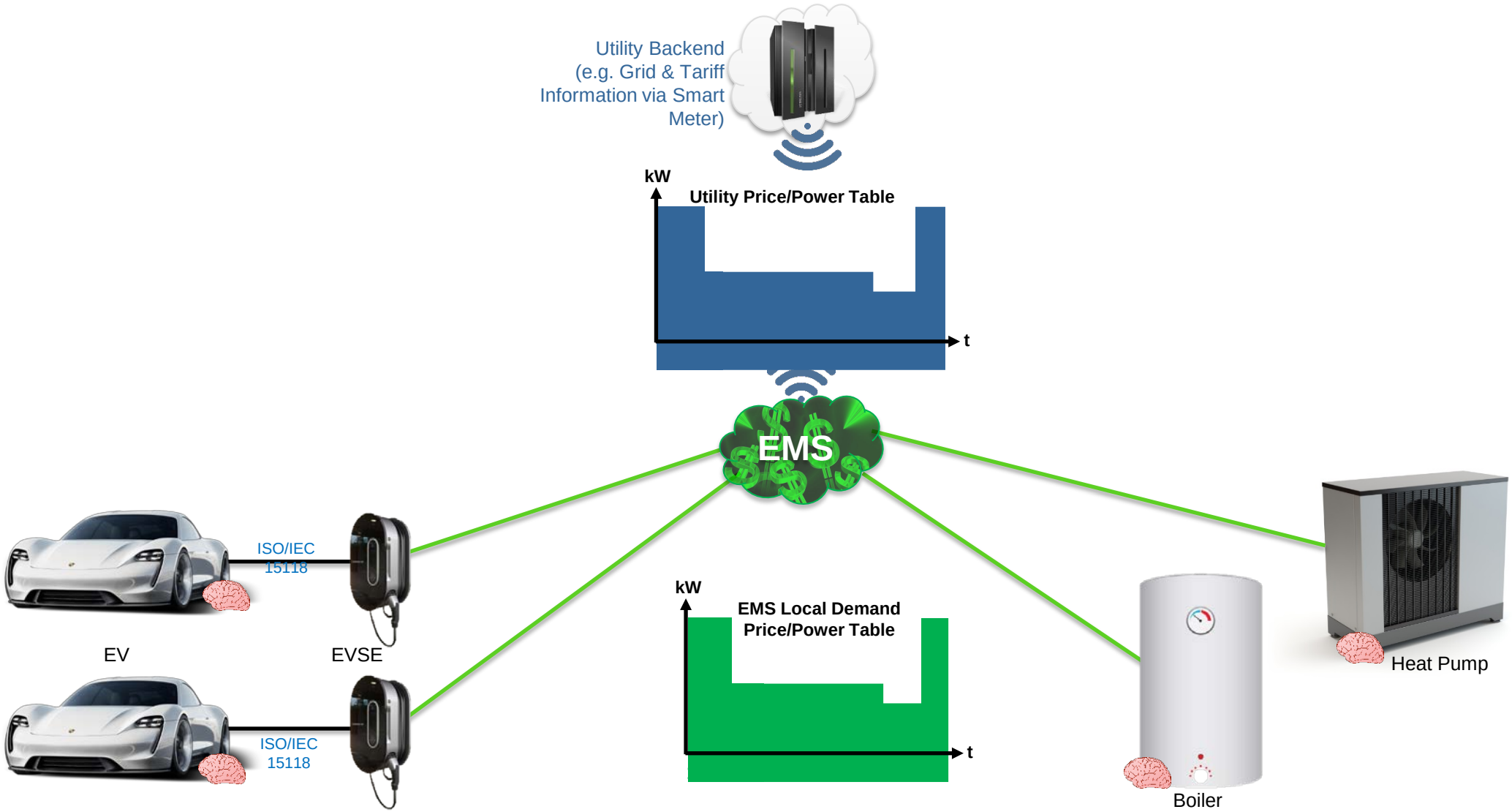


# The EMS acts as a local *Energy Aggregator*. It determines how much power is available for Smart Energy Devices.



# By utilizing the effects of *price elasticity*, the EMS can manipulate the local Price/Power Table to achieve Energy Management



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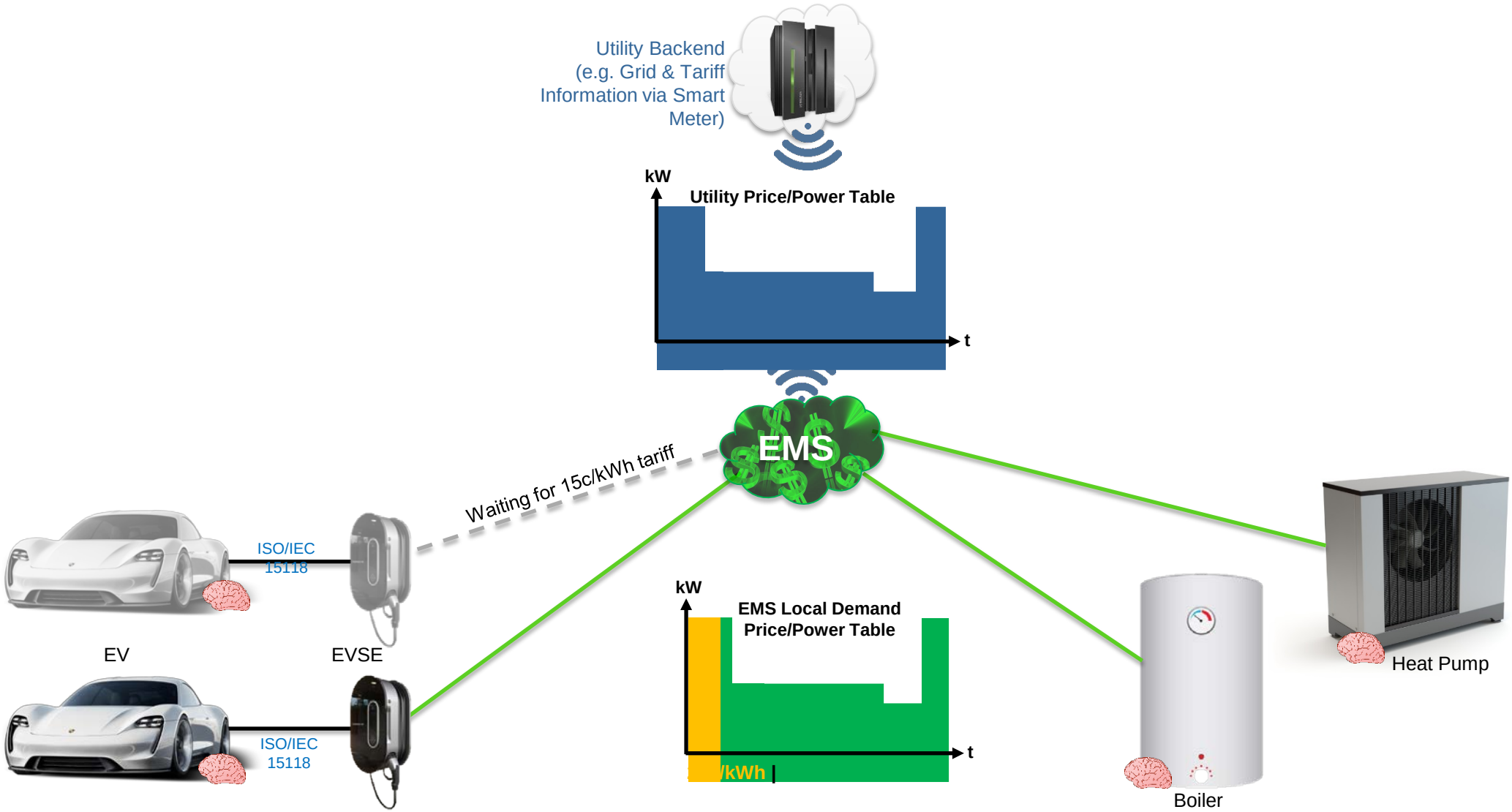

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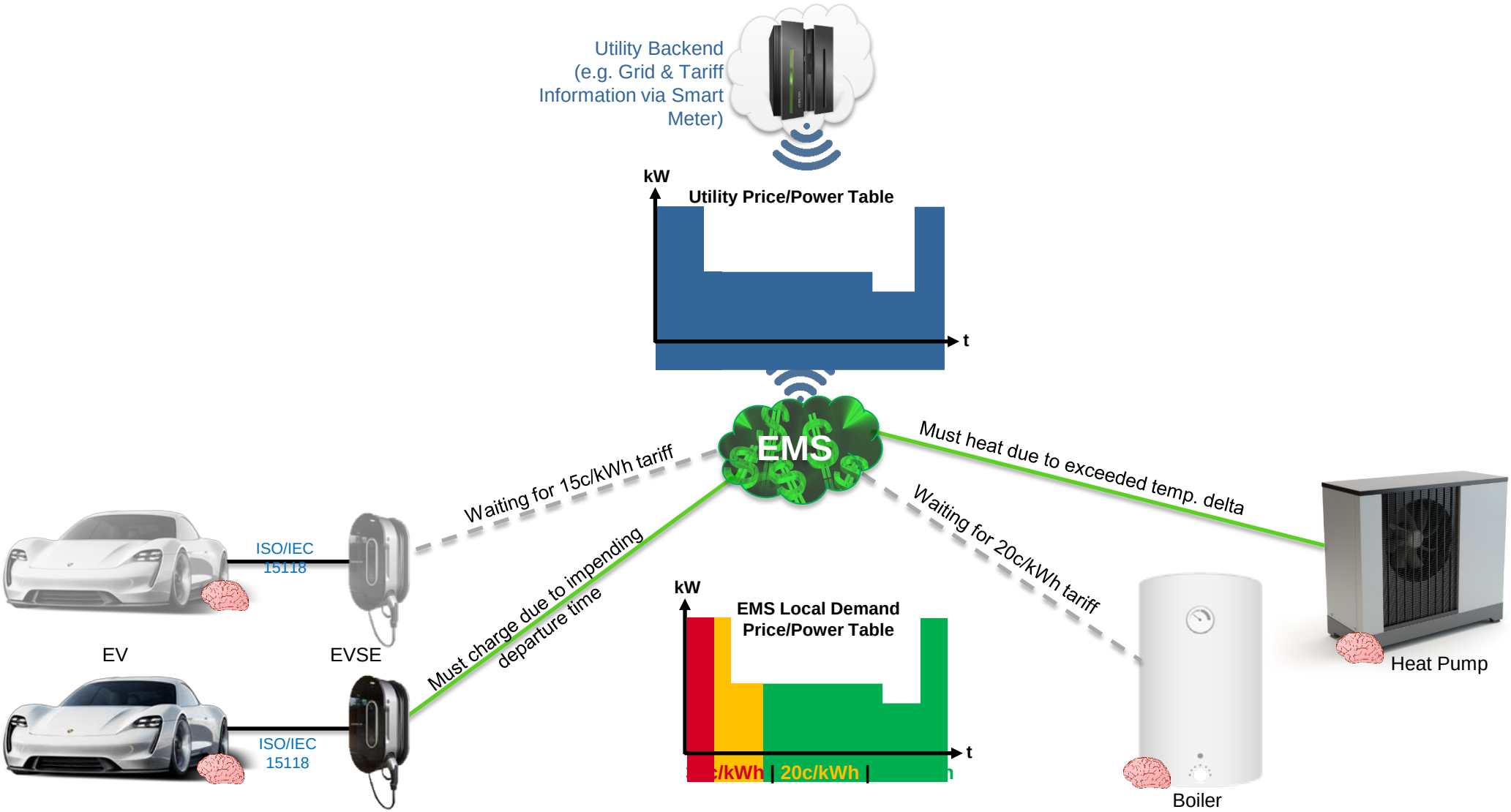


# By utilizing the effects of *price elasticity*, the EMS can manipulate the local Price/Power Table to achieve Energy Management

In its essence, **Energy Management is the art of dynamically prioritizing power distribution** in a way which is harmonized with the user's diverse needs (e.g. heating, mobility, etc.)

By reducing the communication between an EMS and various domain specific devices to the **lowest common denominators (i.e., price, power and time)**, the **effects of price elasticity allow a fully scalable and dynamic energy management ecosystem** to be created.

The question is, **who determines the local demand price and how?**

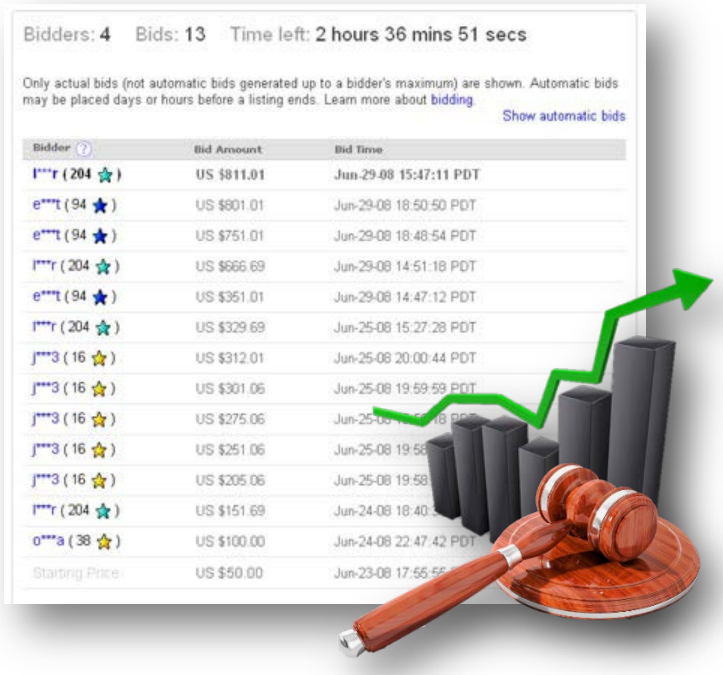
The EMS?


The Devices?

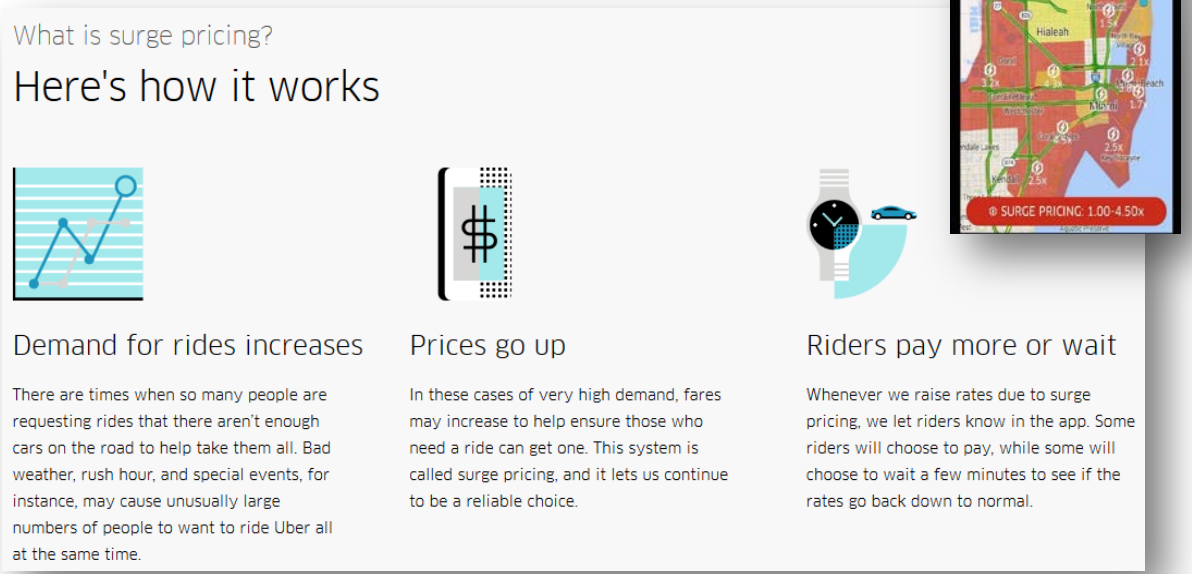
Or some other combination?

# Where else is *price elasticity* successfully used to manage *supply and demand*?

ebay




UBER



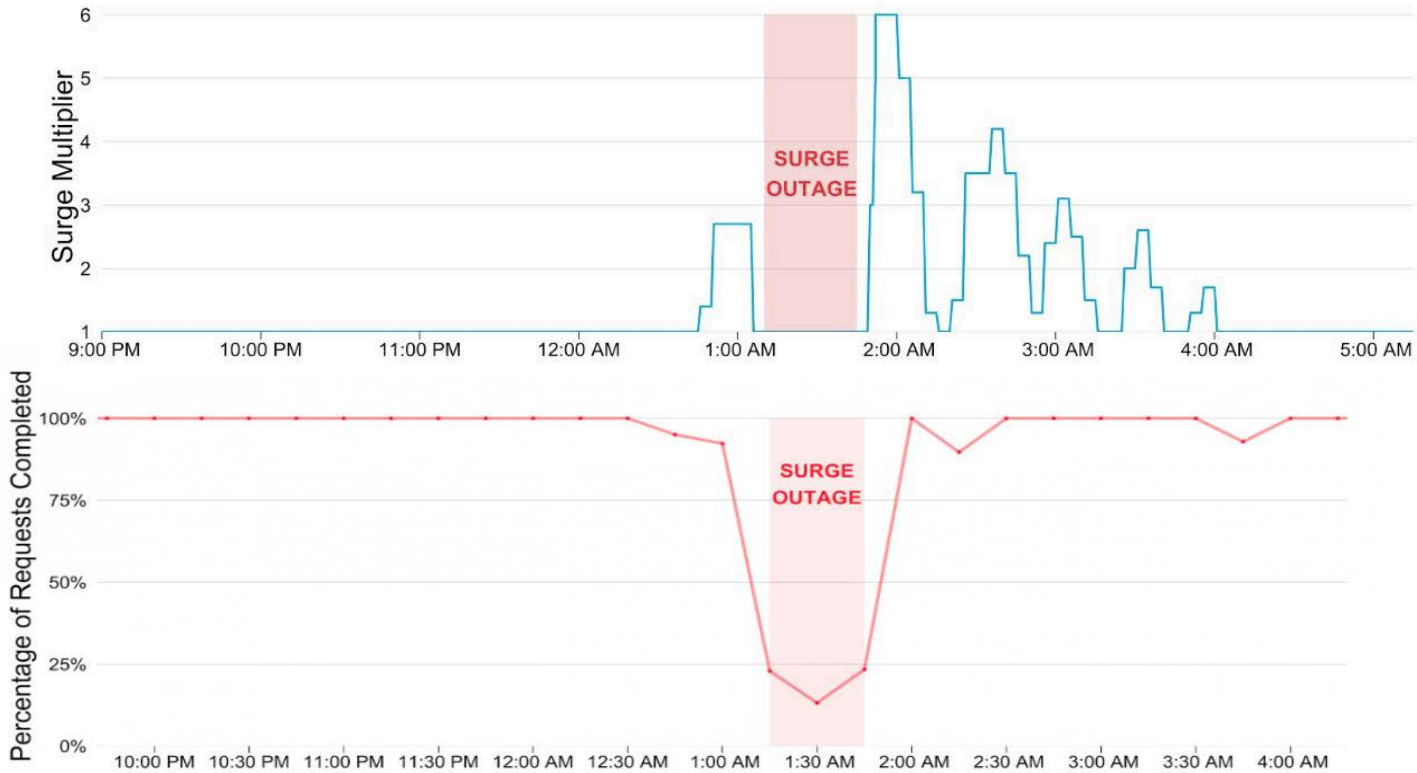

With an ebay **auction**, the price of an article effectively increases with the demand. The **sales price** of the article is **defined by** the **buyer** who most desperately needs the article

Uber uses **"surge pricing"** to manage supply and demand. As the demand for rides in a certain area increases, so does the price. This acts as an **incentive for customers** to wait **as well as for** more **drivers** to head to the high demand areas

Source: https://www.uber.com/de-US/drive/resources/how-surge-works/
Source: https://www.businessinsider.com.au/a-case-study-from-uber-shows-why-surge-pricing-is-actually-a-good-thing-2015-9
Source: http://www.dummies.com/business/online-business/ebay/researching-ebay-bidders-to-win-an-auction/

# Uber’s Surge Pricing is about Quality of Service

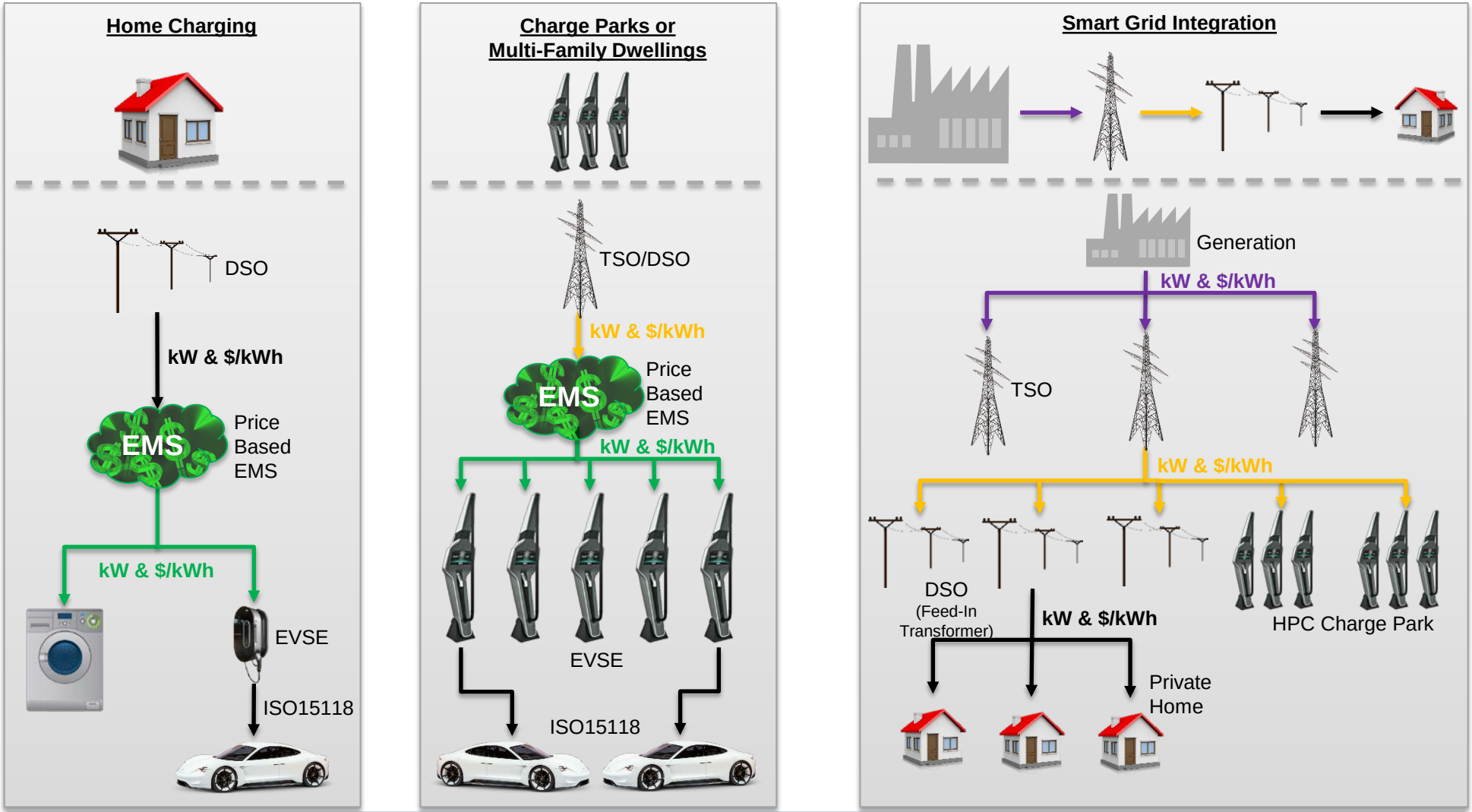
When Uber’s Surge Pricing system crashed for 26 minutes New Year’s EVE 2014 due to a bug, their percentage of completed requests plummeted from 100% to below 20%




This means that while the Surge Pricing system was operating, each request for an Uber was fulfilled because only those really in need of a ride at that moment were prepared to pay the surge price

Source: https://www.businessinsider.com.au/a-case-study-from-uber-shows-why-surge-pricing-is-actually-a-good-thing-2015-9

# … could it scale too?




Using a price based management system, each layer of the grid manages its subsequent layer based on Price/Power Tables

# Thank You

# Questions?