BATTERIES:

Supporting Fast Charging and Vehicle to Home

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Batteries: Grid Support and V2H

1. Fast Charging, Technology
2. Batteries, Grid Support and Business Cases
3. Vehicle to Home

1. Charging: Energy transfer into the vehicle

Burning desire for fast charging
→ Reduction of charging time,
→ Avoiding „charge-boredom“

Grafik 1

Grafik 2

Grafik 3

	Petrochemical	Electrical
Power (Energy/Time)	Refuel power capacity in MW	Charging power in kW
Transport speed	max. 60 km/h	Speed of light
Storage capacity	Fuel als storage device	No energy storage by the Grid

1. Charging: Sensible installation of charging services

		Private	Half private	Half public	Public	Public transport
Today	AC charging (normal) 1~<3.7kW	own garage or parking space	Parking spots in the company	Customer parking spots		
	AC charging (normal) 3~<22kW				Road side, public parking spots, Rest stops	Depots and terminal stops
	AC charging (fast) 3~22-43kW					
	DC charging (fast) 22-150kW					
	Battery charging					
	Standart loading interfaces (Combined Charging System)		Company parking spots	customer parking spots		
Future	Smart charging „Verhicle 2Grid“	Own garage or parking spots				Depots
	Ultra DC charging (very fast) 125-750kW				Highway	Stopovers and terminal stops
	Induktive charging 3-20kW	Own gerage or parking spots	Company parking spots	Customer parking spots	Own garage or parking spots	
	Universal charging „All charge system“					

1. Charging: European Standard for Charging: CCS-Combined Charging System

Typ-2 Connector (AC)

Combo-2 Connector (DC)

- Communication between the vehicle and charging station by Pins „PE“ and „CP“.
- „Low-Level“ via pulse Width Modulation (PWM)
- „High-Level“ via Powerline.
- „PP" measures resistance of connector / Powerline (Limiting (max?) I + El.-Safety)

Role of the connector:
Data- and energy transfer

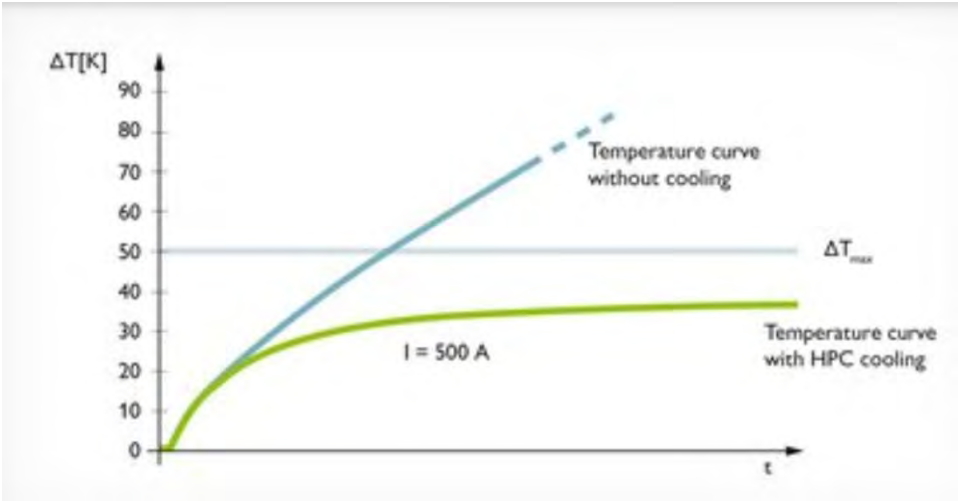
2 ways of data communication:
- Pulse Width Modulation
- Powerline-Communication

Elektrical safety is almost the same for both types.

Powerline-Communication (ISO/IEC 15118)
- Much more complex (and mighty) than PWM
- Fixed protocolls with encoded communication

1. Charging: High Power Charging, Cooling Necessary

500.000 Watt transferred by cooled charging connector



Grafik 4 und 5

During charging process, the connctor und cable could be max. 50 K warmer than the surrounding temperature.

→ Feasible charging power is limited by thermo Management in connector **and** cable.

→ Active chiller for liquid cooling necessary. Preferred location is in the charging stations.

→ Temperature sensors in cable und power contacts of the connector are necessary for temperature control

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2. Batteries: Home Storage Devices, Medium Size Storage

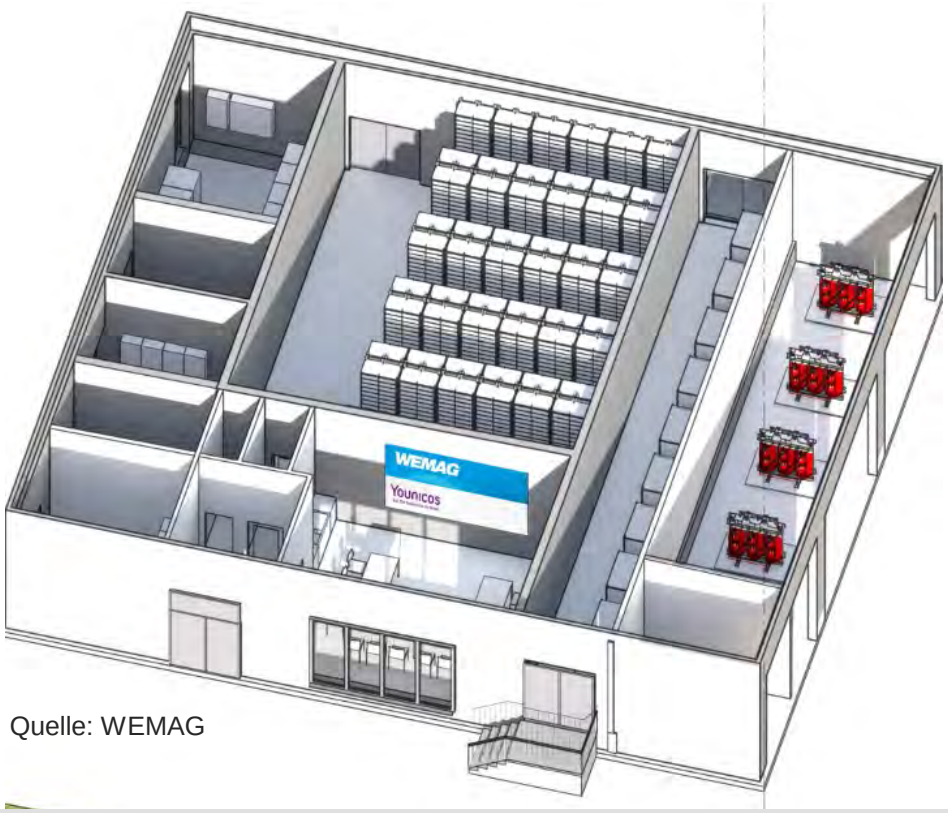
Example:
Storage 10,2 kWh
Fa. Diehl

Images permission from Fa. Lokavis GmbH, Eggenfelden

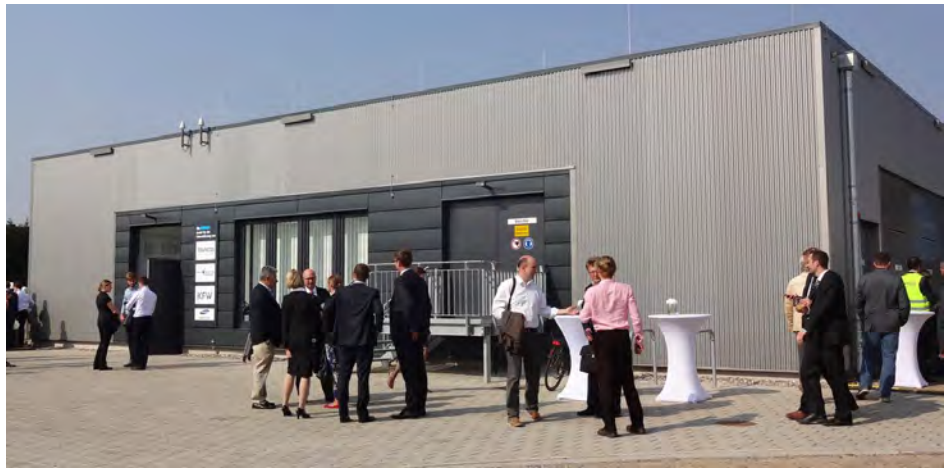
125 kW/150 kWh Lithium-Ironphosphate storage,
UPS- and Buffer-Operation

Bild: Fa. Fenecon

2. Batteries, Large Reservoir in Li-Ionen-Technology



Quelle: WEMAG



5 MWh / as grid buffer with 5 MW Charging- / Discharging power,

Commercial grid buffer.

Operated by WEMAG, Schwerin, Projected by Younicos AG, Berlin

2. Batteries: Large Reservoir in Redox-Flow in Technology

Lighthouse project RedoxWind at Fraunhofer ICT : Buffering fluctuating power in MW

→ Ramping up of 2 MW / 20 MWh
Redox Flow Battery

→ Linking the Battery by a DC circuit with 2 MW Wind generator (100 m Hub Height)

→ Battery efficiency (DC) about 80 %

Bilder mit freundlicher Genehmigung Fraunhofer ICT

2. Batteries: Grid Stabilization

- Increasing Number of Critical Events in the Grid

- Tasks of Batteries for Grid Support
  - Frequency Stability 50 Hz

Within one Week:

Fluctuation -6%/+4% in 10 s-average value

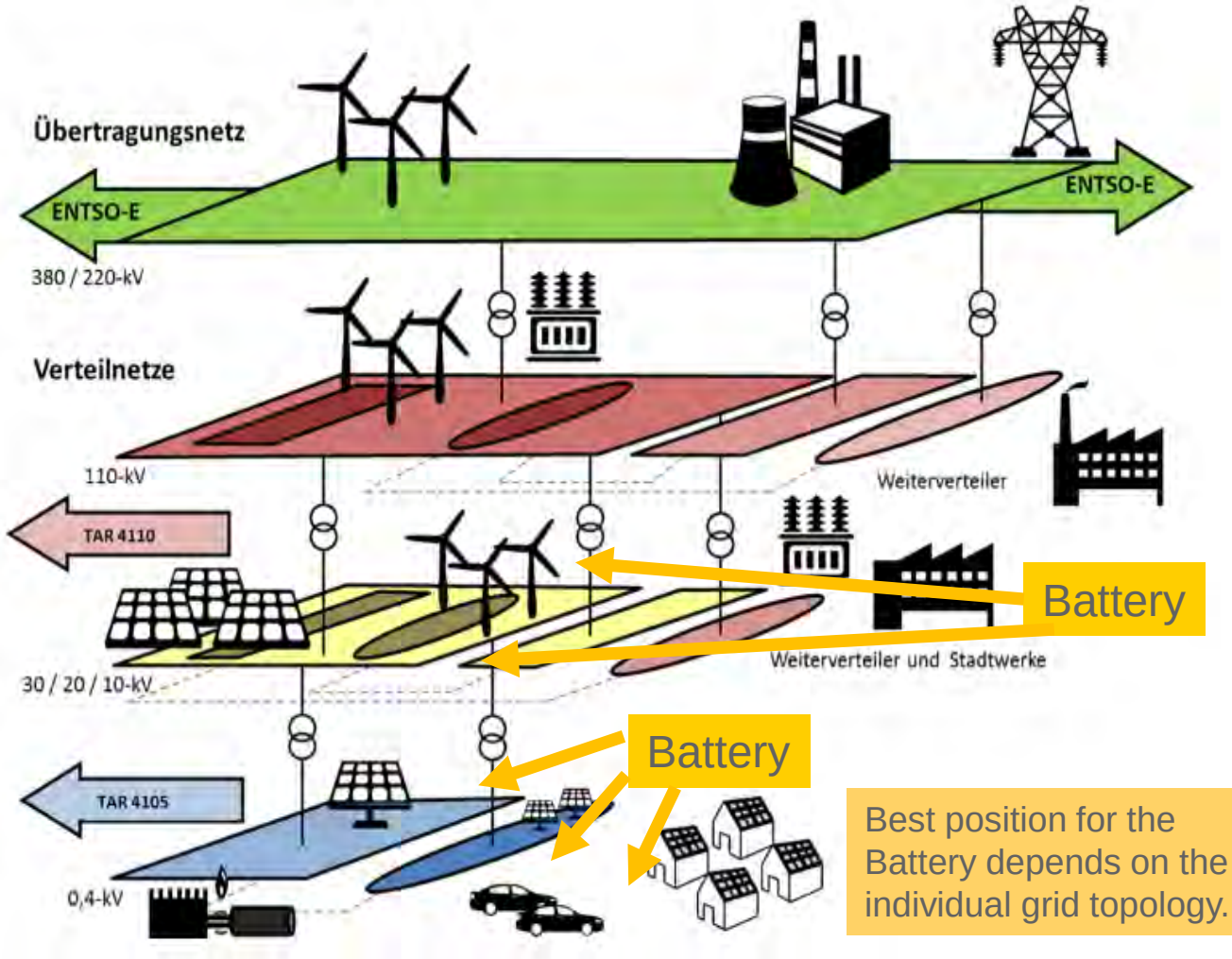
Over the course of one Year:

Fluctuation max. +/- 1% within 99,5 % of the year

  - Voltage Stability 230 V

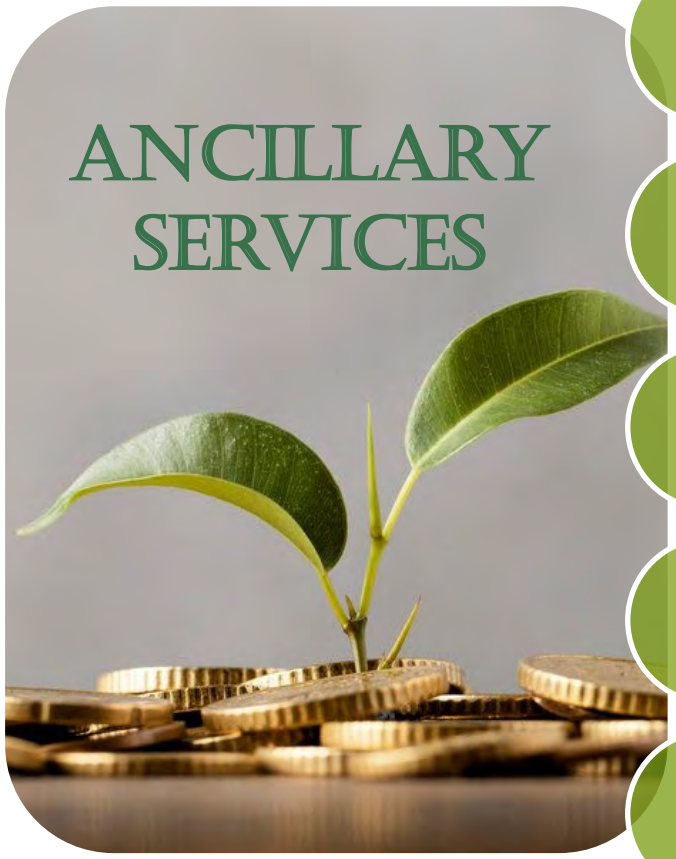
Within one Week:

95 % of all 10 s-average value have to fit Voltage Window +/- 10% ,



Quelle: Dena

2. Batteries: Role of Batteries in EV-Charging



- Energy storage
- Power allocation
- Reactive power Compensation
- Black start availability
- Stabilizing energy supply

Grafik 6

Supporting the Grid

- Battery reduces required power at the connection point between charging devices and grid.

- Battery creates profit in non-charging times.
- The higher charging power, the less workload for charging operations → additional business models can be operated to increase the return on investment.

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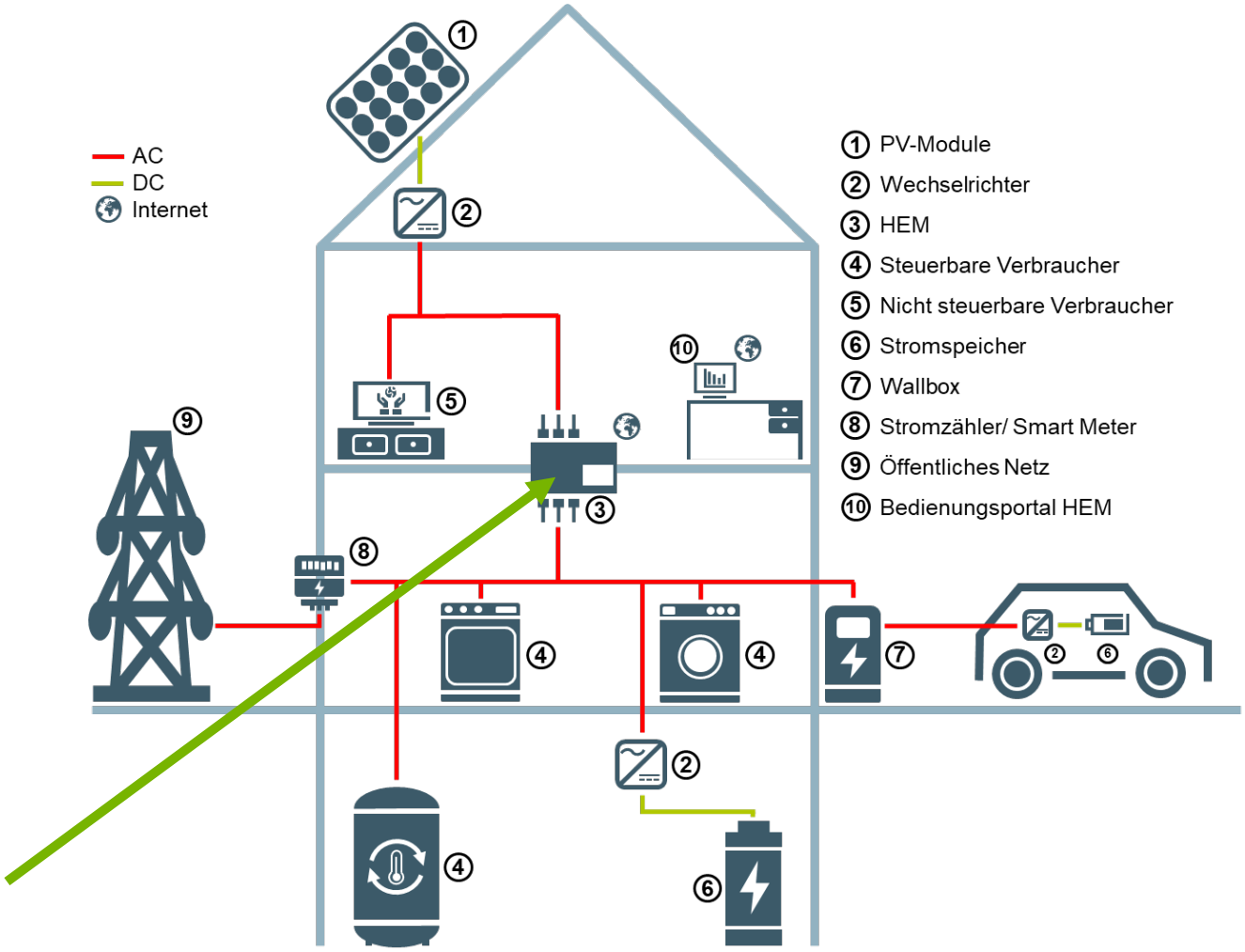
Quelle: EnergyCloud.cz



Home Energy Manager – Brain of the House

3. V2H: Bidirektional Charging

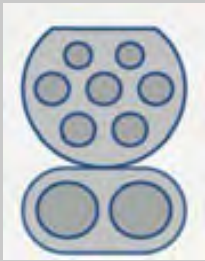
Technical Requirements

- Only DC, since PWM not sufficient and Power devices preferred to be integrated in the charging station.
- Power devices of the Charging Device must be 2Q.
- Vehicle has to be enabled for discharging by OEM-manufacturer.
- Standard ISO 15118-20 (i.a. bidirectional) is still finalized.

Grid Support:

- Complete utilization of the vehicle battery for grid stabilization.
- Reduction of the power demand at grid connection point by balancing charging of multiple vehicles in one unit (e.g. parking lot).
- Potential opportunity to earn addtional money for the vehicle owners.

3. Vehicle to Home, Connector Types to the Vehicle

Types	Type 1	Type 2	CCS	CHAdeMO
				
Connections	AC one-phase Signal-wire Immobilizer Grounding Neutral Conductor	AC one-phase o three-phase Signalline Immobilizer Grounding Neutral Conductor	AC one-phase o three-phase DC Signal-wire Immobilizer Groundimg Neutral Conductor	DC Communication- and Signal-lines
Transferable Power	Up to 7,4 kW AC	3,7 to 43,5 kW AC	3,7 to 43,5 kW AC Up to 170 kW DC	Up to 50 kW DC
Countries	USA and Asia	Europe	Europe	Asia

3. Vehicle to Home: Powermanagement by HEM

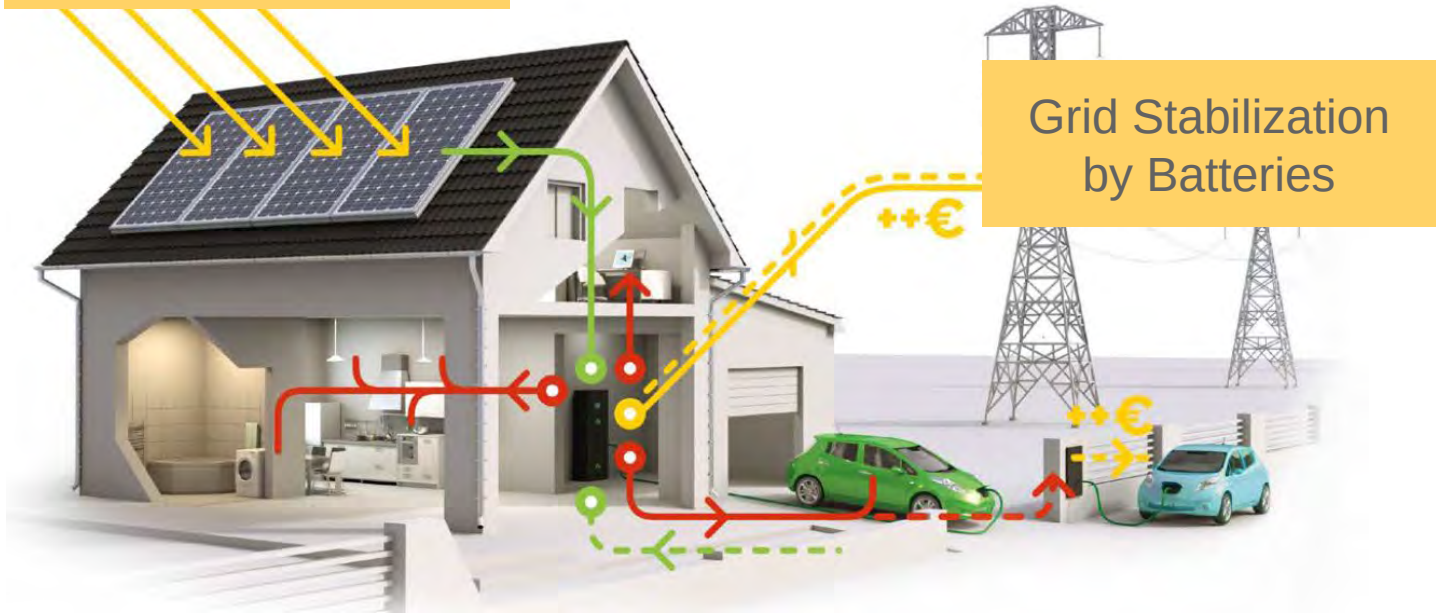
Category	Devices	Operation shiftable?
Periodical Loads	Refridgerator Freezer Pressing Iron	No
Programmable Loads	Dish Washer Dryer Washing Machine	Yes
Arbitrary Loads	Oven Cooker Hobbies	No
Stochastical Loads	Electric Lighting Consumer Electronics	No
Storage Devices	Heatpump/ -buffer Home Stroage Devices Electrical Vehicle	Yes

Customer Requirements for Integration of an EV in Smart Home:

- Smart Charging Functions
- Overload Protection
- Optimized Cost Charging
- Customer-Optimized or Demand-Oriented Charging
- Self Consuption of own PV-Harvest
  - Identification of Charging Equipment
  - Service

V2H: Summary

Utilization of own PV Energy



Grid Stabilization by Batteries

Quelle: EnergyCloud.cz

EV as Battery for Solar-Home

Vision:
Grid Support by V2G

- Allocation and Uptake of Contolling Power
- Allocation and Uptake of Contolling Energy
- Much more power at grid connection than home storage devices
- **Regulatory Hurdles have to be diminished!** E.g. Batteries are currently still treated and taxed by Federal Network Agency as energy producers, not as grid buffers!

Reality:
V2H is realizable currently

Grafikquellen

- Grafik 1: Jahrgang Vektor erstellt von macrovector - de.freepik.com
- Grafik 2: Jahrgang Vektor erstellt von macrovector - de.freepik.com
- Grafik 3: Hintergrund Vektor erstellt von freepik - de.freepik.com
- Grafik 4 and 5: https://www.phoenixcontact.com/de-ch/technologien/high-power-charging
- Grafik 6: Geld Foto erstellt von freepik - de.freepik.com

Thank you for your attention!

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