Future System Services Provided from Electric Vehicles

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Introduction – Perspective & prerequisites

See the whole picture - Different stakeholders of EV charging in the power system

We might be able to handle EV charging by low power charging, but:

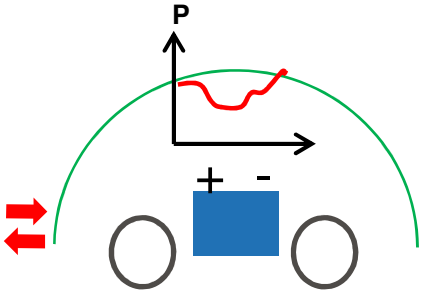
- EV users behaviour might differ…
- There are weak grids…
- Load correlation might not be applicable
- Under voltage might stop charging…

and we are:

- heading into a new energy and power era with different electricity users, new electrical processes and prosumers…
- heading into a new power system (DERs, microgrids, bidirectional electricity flows, etc…)

Introduction – Some statements

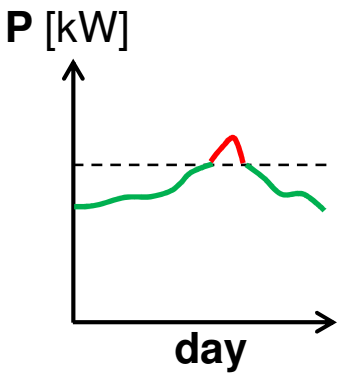
- **EV load potential:** Flexibility as to power level, duration, point of time
- **EVs unique:** G2V, V2G, storage, controllable
- **Interaction** to achieve extended grid/generation benefits and avoid problems, end user conveniency (EV´s and building´s).
- **Local Energy Management System (EMS)** also including power management.

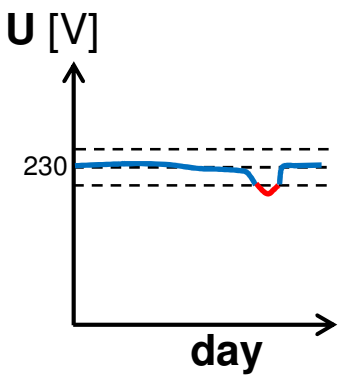


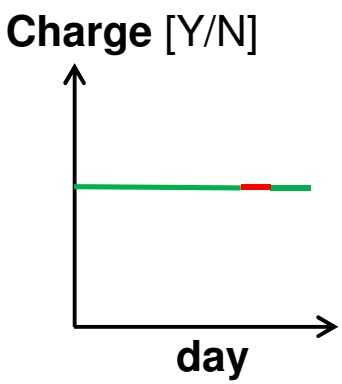
EV charing influence on the power system

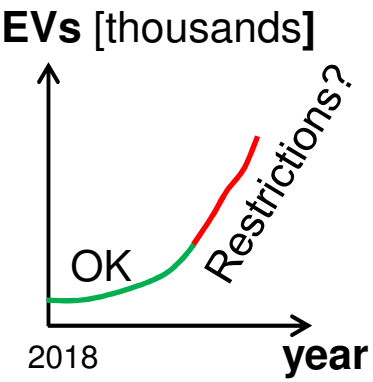
Characteristics	Generation	Distribution	Local installation	EVs
Power need	OL	OL,CR, UV	OL,CR, UV	CR
Simultanious	OL	OL,CR, UV	OL,CR, UV	CR
Asymmetrical loads			OL, CR	CR

OL – Overload CR - Capacity restrictions UV – Under voltage









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Smart charging

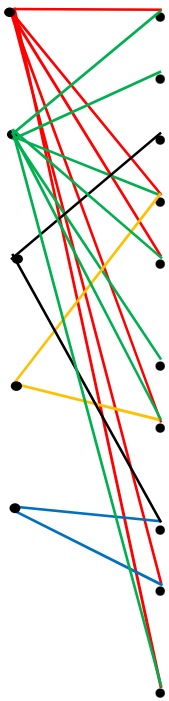
- "**Smart charging** of an EV is when the charging cycle can be altered by external events, allowing for adaptive charging habits, providing the EV with the ability to integrate into the whole power system in a grid- and user-friendly way". Smart charging must facilitate the security (reliability) of supply while meeting the mobility constraints of the user.
- **Different "levels"** of smart charging are possible: starting and stopping the charging according to price signals or signals from the network operator is the simplest form of smart charging. Increasing and decreasing the power (kW) used during the EV charging process is at the next level of "smartness". Some charging points are also able to provide bi-directional charging, which means that for short periods the EV battery could also release electricity and feed it back into the grid, the so-called "Vehicle-to-grid" or (V2G).
- Smart charging has to be regarded as an important aspect of **energy management systems**. These systems manage all significant loads at a metering point, optimising e.g. the EV, the Heat Pump, storage etc.

Source: Smart Charging – Key to unlocking Electro-mobility's potential. A EURELECTRIC statement, September 2017.

Potential benefits by interaction

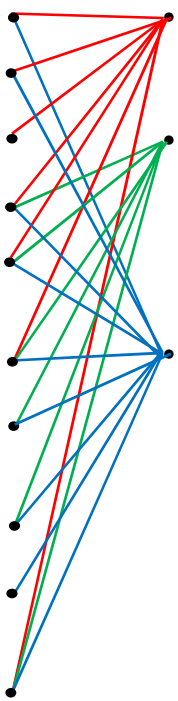
Means by EV & EMS

- Sheduled charging (A)
- Reversed power (B)
- Dynamic control (C)
- Reactive power (D)
- Phase flexibility (E)



Benefits

- Production planning (A, B – 1, 3ab)
- Emergency power (B – 1, 3a)
- Regulation power (C - 1)
- Peak shaving (A, B, D – 1, 2ab, 3a)
- Load shifting (A, B, D - 1, 2ab, 3a)
- Power support (B – 1, 2ab, 3a)
- Voltage support (A, B, D – 2ab, 3ab)
- Phase balancing (C, E – 2b, 3a)
- Confident charging (reliable, quick, fuses, at time) (A, E – 3b)
- Prosumer readieness (A, B – 1, 2ab, 3a)

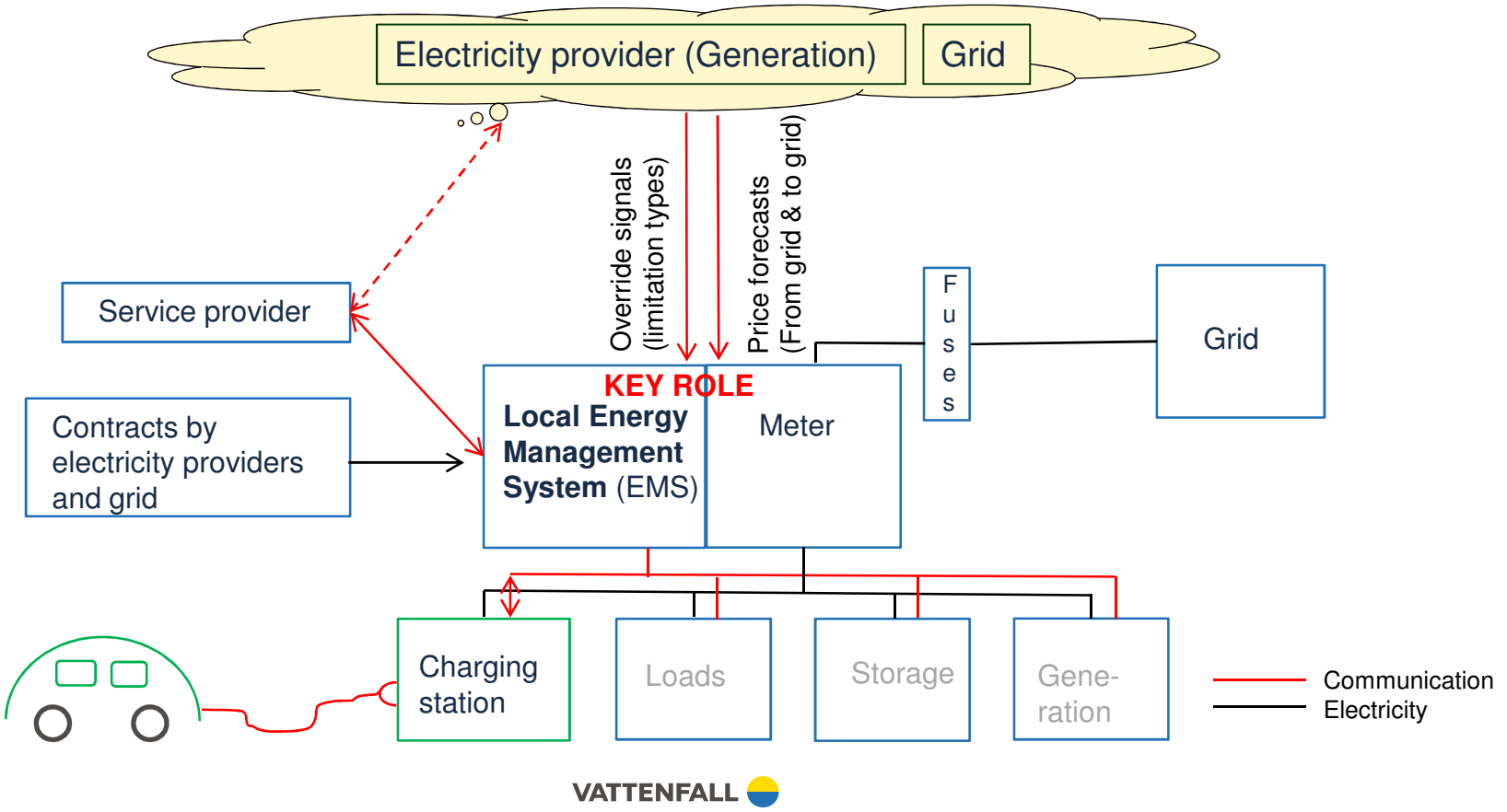


Stakeholders

- (1) Generation
- (2) Grids
  - (a) Regional
  - (b) Distribution
- (3) End users/prosumers*
  - (a) Building
  - (b) EV

* also owners

System topology



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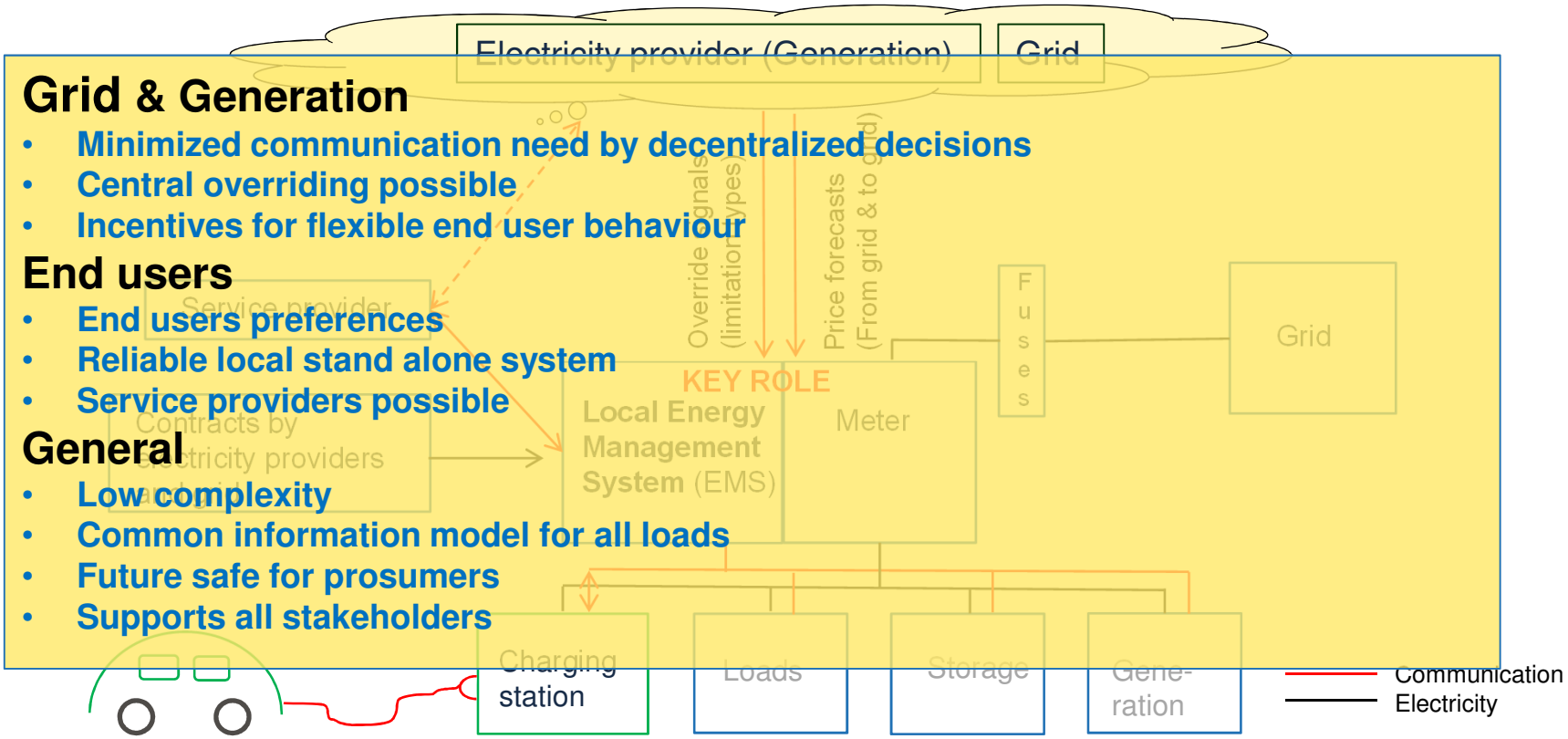
System characteristics



Grid & Generation

- Minimized communication need by decentralized decisions
- Central overriding possible
- Incentives for flexible end user behaviour

End users

- End users preferences
- Reliable local stand alone system
- Service providers possible

General

- Low complexity
- Common information model for all loads
- Future safe for prosumers
- Supports all stakeholders

Turning barriers into solutions…

1. Tariffs with enough incentives for demand-response (grid and electricity provider)
2. Communication standards: Charging station <–> EV (ongoing)
3. Communication standards: Back end services <–> Charging station (ongoing)
4. Communication standards: Grid <–> EMS/meter (real time tariffs & forecasts and control messages)
5. Local Energy & power Management Systems (EMS)
6. Distribution grid control for handling of EVs and other loads
7. Readiness how to handle prosumers
8. Other technical & economical factors

Means placement – at what system level?

SYSTEM LEVEL	Peak shaving	Load shifting	Regulation power	Phase balancing	Power factor correction
Generation	C	C	C		
Grid	C	C	C		(C) (E)
Local installation (EMS, other equipment)	C E	C E	C	C E	C E
Charging station			C	C E	
EV	C E	C E	C E	C E	C E

C = Control equipment (governing), E = Electric equipment (executing)

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Conclusion

- **High charging load might be a problem at all system levels**
- **Interaction makes benefits** for all stake holders within the power system
- **The EV charging has unique control possibilities**, but to get the most out of it, it has to be optimized **together with other local loads/equipment**.
- **The local Energy Management System has an important role in the interaction between the EV and the power system.**
- **Communication is needed** for control by network congestion signals and/or price signals and forecasts.
- **Overriding control signals** might be needed to be sent to specific local areas or end users along feeders to avoid under voltage and guarantee availability for all end users.
- **We are heading into a new energy and power era** with new needs from the end users, new electrical processes and prosumers…



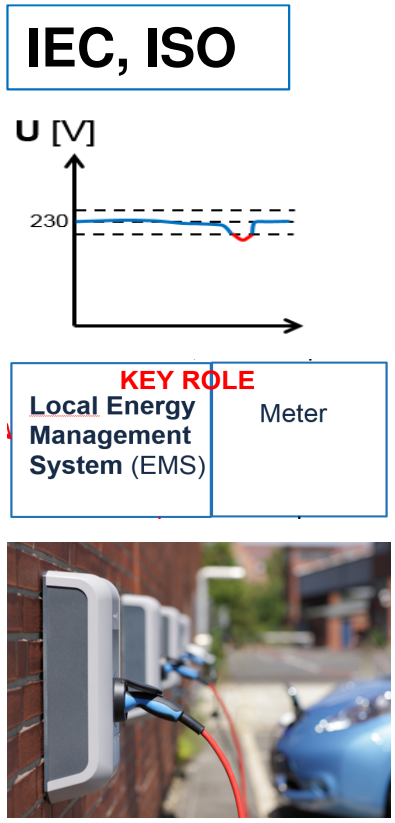


Interaction between Generation, Grids, End users & EV users

WIN, WIN, WIN, WIN

Remarks & future work

- Electricity companies could be more active in international standardisation regarding communication for control of EV charging.
- Need to handle possible voltage drop along a feeder impairing the downstream end users´ possibilities to charge.
- Need for local EMS-systems with interfaces towards connected EVs & other electrical equipment, power system, and service providers.
- Need for communication relevant for interaction between the power system and the local EMS to handle EVs and other electrical equipment together.
- Need for incentives for end users to interact with the power system.



Thank you very much!

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