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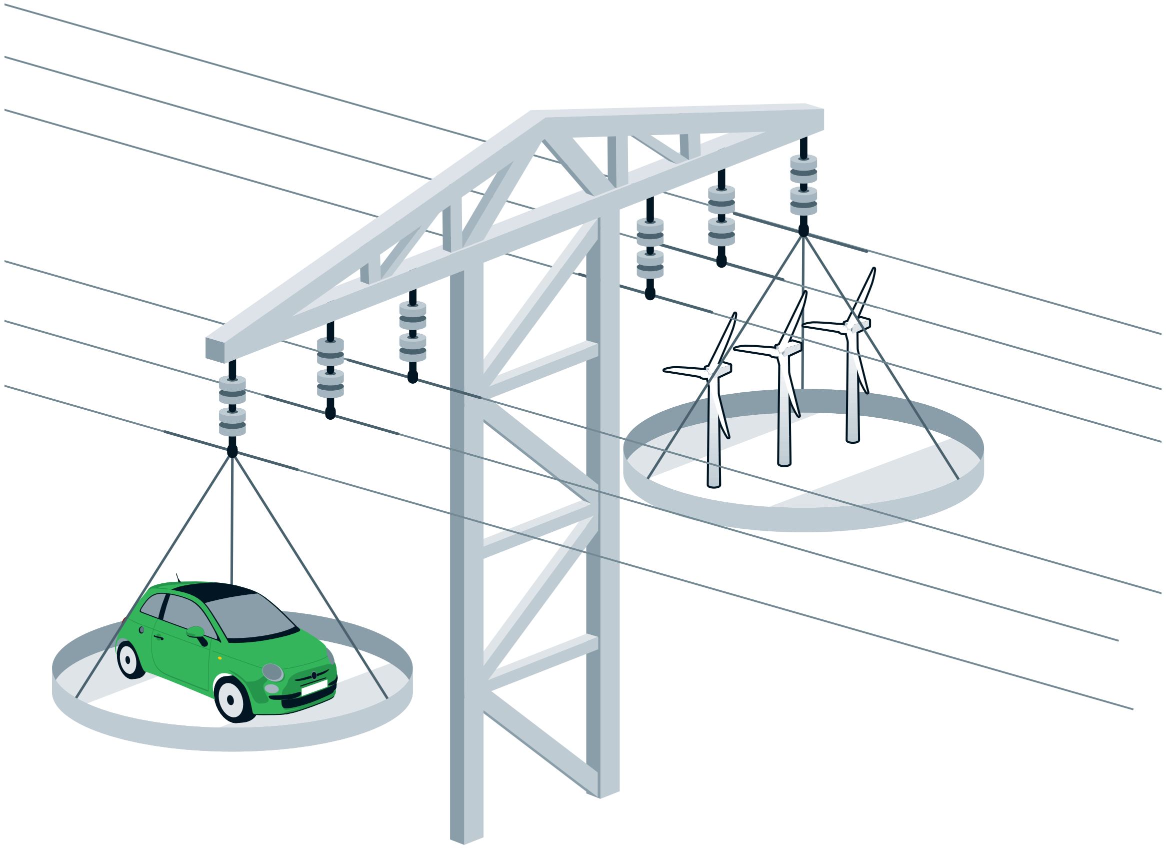
DONG energy DTU EURISCO RESEARCH & DEVELOPMENT IBM ØSTKRAFT energi til gode oplevelser SIEMENS

POWER BALANCING WITH ELECTRIC VEHICLES

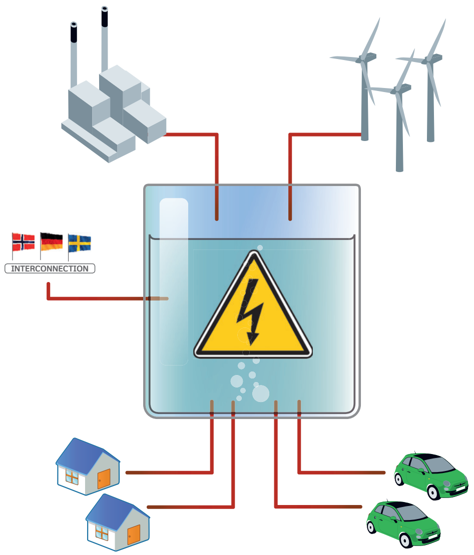


EDISON

Live Demo at SYSLAB

EDISON workshop August 18th 2010
Venue: RISØ DTU

THE BIG PICTURE



"The process of balancing the electrical grid can be illustrated by the water level in a bucket with supply sources and consumption sinks. Water sources are then equivalent to power producing facilities, such as power plant, wind farms, etc., while the water sinks are equivalent to various electrical loads, e.g. households, EV's, plants, etc. The balancing task of keeping the frequency at 50 Hz is then equivalent to a constant water level - i.e. variations in the aggregated consumption must at all times be meet by corresponding control actions of the supply sources in order to keep the water level at a fixed level (alias a fixed frequency at 50 Hz). The electrical grid is coupled to neighboring grids through interconnections. In this way these electrical grids can exchange power with each other."

The potential increase in peak load electricity consumption due to the expected introduction of electric vehicles (EVs) presents some substantial challenges to the electricity grid.

If nothing is done, the distribution companies have to invest heavily in grid reinforcements in order to accommodate the increased peak load. An investment that eventually has to be paid by the consumers.

At the same time, a substantial increase in fluctuating renewable energy sources present the transmission system operator with an equally challenging scenario when balancing production and consumption.

For simplicity, picture the electrical grid as a leaky bucket. Every leak represents an outlet and the water level of the bucket must be held at a fixed level at all times. The sum of everything flowing into the bucket from wind turbines, power stations and other power sources must at every given moment match what is taken from the bucket.

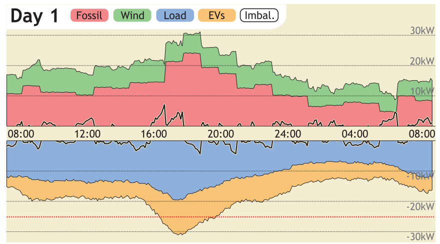
If EVs behave like ordinary appliances, they will increase strain on the system, especially in peak hours which will eventually lead to new peak load power stations.

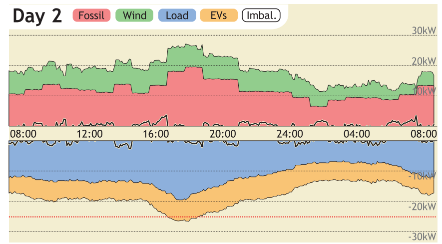
What controllable EVs yield, is a unique possibility to handle the capacity problem and the 'bucket levelling' at the same time. This also offers the opportunity to increase the amount of renewable electricity in the grid and at the same time ensures that investments in grid reinforcement are kept at a minimum.

THE DEMO

The demo shows what the consequences of many EVs without controlled charging are and which possibilities EVs with controlled charging present to the electricity system.

In the demo power consumers in the SYSLAB system are programmed to emulate a typical daily consumption pattern within the five minutes duration of the demonstration. Wind power, EV load and grid exchange are live data from the SYSLAB grid. The typical daily consumption pattern is a 24-hour load distribution from a randomly selected 10kV feeder in eastern Zealand.





Both screenshots shown above are from the demo.

Consequences of EVs without controllable charging

Without controlled charging, EVs will charge as soon as they are plugged into the socket.

This will usually be when people come home from work between 3 and 6 p.m. The charging power of a typically electric car is 2-11kW* depending on whether the EV uses one or three phases. In comparison the typical feeder line in a residential area is dimensioned for 4.8- 7.5kW** per household.

Basically each EV represents at least one additional house that has not been taken into account when the cables were dimensioned. This causes unnecessary high stress on the system and can ultimately lead to grid failure.

Possibilities if EVs have controllable charging

By controlling the EV charging, we can ensure that all EVs are charged sufficiently to ensure consumer satisfaction. This happens with respect to the consumers' needs and to the constraints of the grid.

Where there is surplus flexibility, the Transmission System Operator (TSO) and the Distribution System Operators (DSO) can use the EVs to help balance production and consumption, which is a commodity that both the TSO and the DSOs are willing to pay for. This will lead to a source of income (reduced power cost) for the EV owner. With the future prospect of discharging power back to the grid (V2G), the source of income could increase significantly, while increasing system stability as well.

* 1 or 3 phase @ 16A ** 7-11 A @ 230V 3 phases, Source Dansk Energi