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From PV Systems to Energy Solutions Part II[1]
From the Conecpt to Reality

First operating experience

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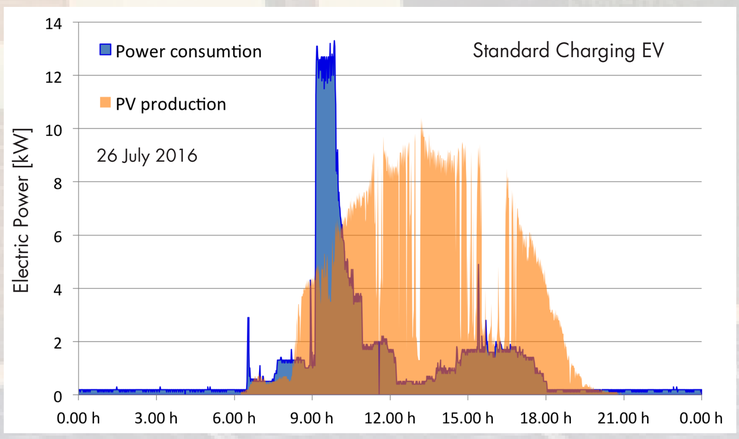
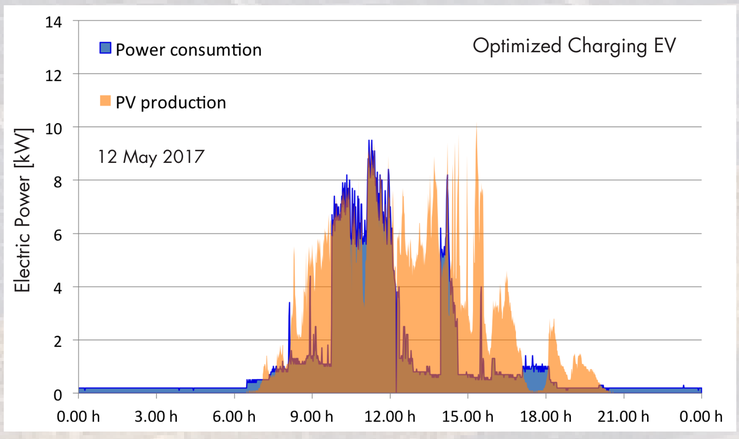
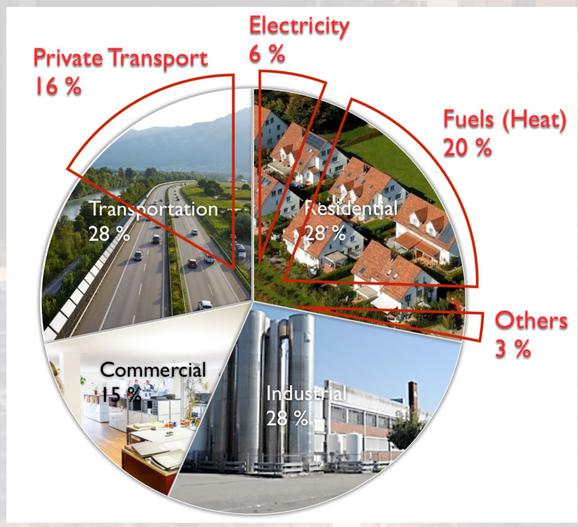
Purpose of this work

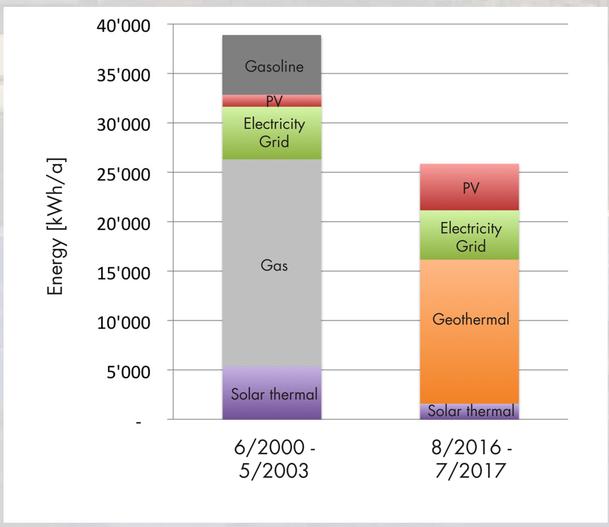
Residential buildings are turning from energy consumers to prosumers using PV. The building as a system combines energy efficiency, PV production, thermal energy management and electric mobility (EV's). Using an electronic „conductor" allows smart energy- and load management. Exploiting existing loads can help reduce the need for additional storage in form of batteries while optimizing self-consumption and grid-services for high penetration rates all while multiplying possible fields of PV deployment by substituting fossil energy with electricity. First operational pilot projects combine different aspects from PV production, energy efficiency, heat generation by heat-pump and electro-mobility. Production and consumption are being monitored and evaluated. First findings include: increased PV self-consumption, individual mobility with PV (solar „gas" station), reduction of energy consumption for heat and general electricity, impact on CO_2 balance of buildings, impacts on grid integration and success of load management.





Under EV standard charge much energy is drawn from the grid even on a sunny day. Most PV energy is fed into the grid. Under PV optimized charge PV production is absorbed precisely by the car battery. Hardly any energy is drawn from the grid.



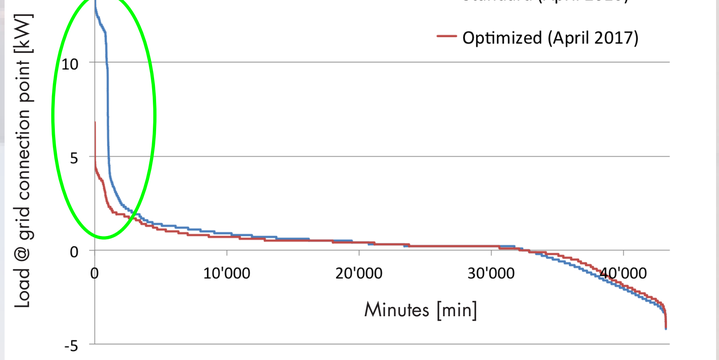


Private households consume ca. 45 % of Germanys final energy demand including indivdual mobility. Thereof the two greatest shares, heating and transport, are almost exclusively generated using fossil fuels. Switching to EVs and heat pumps paves the way to decarbonisation and multiplies overall market potential for PV. Results for a detached house switching to an all electric system powered by renewables are shown on the right side.

Pilot Project 1: PV and Electro-Mobility (EV)

Electrification of Energy System, Decarbonsation, PV Potential

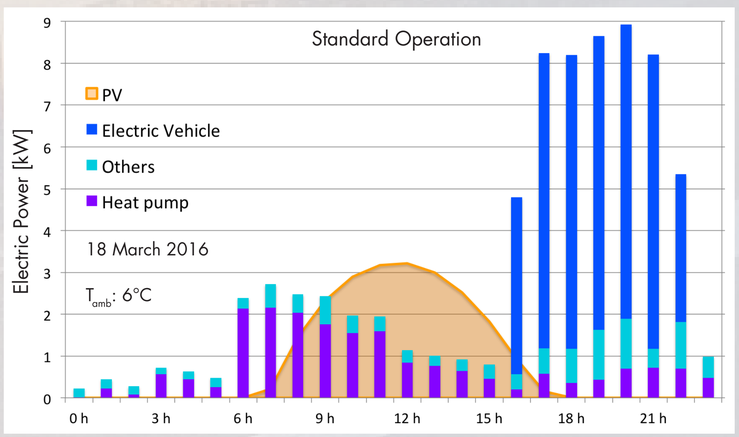
Electronic energy-and load-management with visualisation and operation on mobile devices for energy system house.

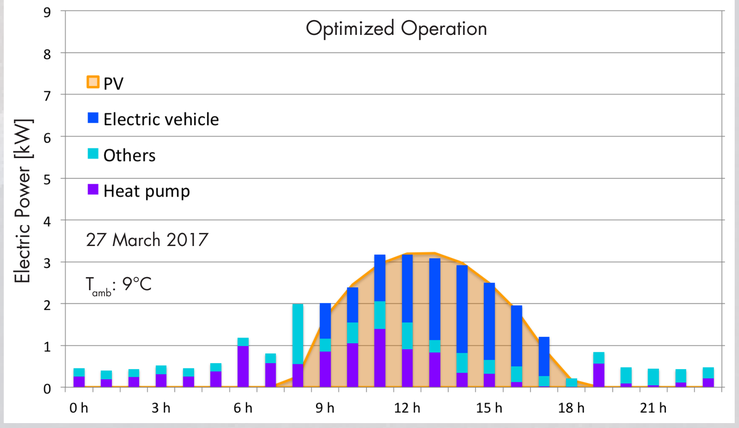


Active load management of heat pump and EV charge for PV optimization not only increases PV self-consumption but reduces strain on the power grid. Especially the high demand peaks of fast EV charge are almost eliminated.

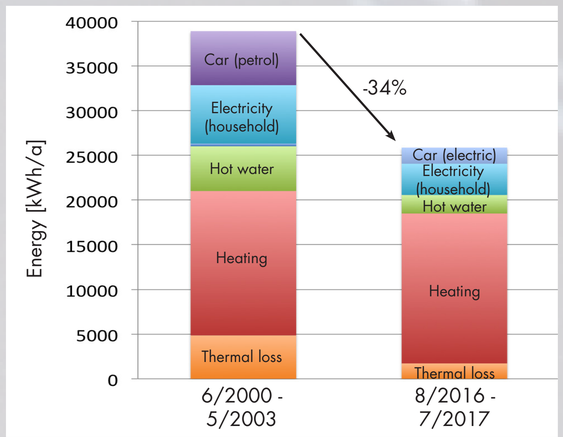
Pilot project 2: PV, Heat-Pump, EV, Efficiency

Grid Services and Integration

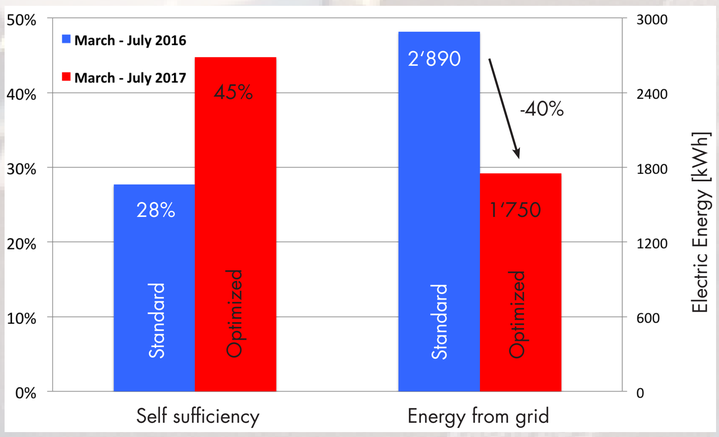




With manufacturers standard settings the heat pump doesn't use PV production optimally. Actively controlling both, EV charge and heat pump operation, PV production is used optimally within the house and less energy is drawn from the grid.



Energy consumption is reduced by 34% realizing various efficiency measures: Reducing thermal losses and standby consumption, exchanging in-efficient appliances, increased efficiency with EV.



PV optimized operation of heat-pump and EV charge increases degree of self-sufficieny from 28 % to 45 % and reduces the amount of energy drawn from the grid by 40 % in the comparative period.

Conclusions

- Two showcased projects demonstrate that decarbonisation is possible by switching to electric mobility and heat pumps from fossil fuels.
- Necessary electric energy can be produced largely local by PV, multiplying targeted market potential for PV. For maximized local consumption optimized EV charge and heat pump operation is sensible and has been demonstrated.
- The presented projects show that controlled EV charge and heat pump operation increase PV self-consumption and reduce grid load significantly, both essential for high PV penetration rates. Energy from grid was reduced by 40% for pilot project.
- Efficiency measures can reduce energy consumption substantially. In the example of a single-family house a reduction by 34 % could be realized and measured.

Outlook

- Further projects on apartment buildings with larger heat pumps and multiple EV charging units are being developed to increase the impact of PV optimized operation of these devices.
- In order to further increase the direct local use of PV production and grid servicesd stationary batteries will be integrated into the energy and load optimization system.
- Control and optimization algorithms are continuously improved. Examples are including the use of weather forecasts and introducing self-learning aspects.
- To increase the number of potential applications the optimization system is further improved regarding compatibility to heat pump types, electric vehicles and batteries.

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[1] From PV Systems to Energy Solutions; EUPVSEC 2013, Paris; TNC Consulting AG