INCREASING RESIDENTIAL SELF-CONSUMPTION OF PV ENERGY BY DSM

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Motivation

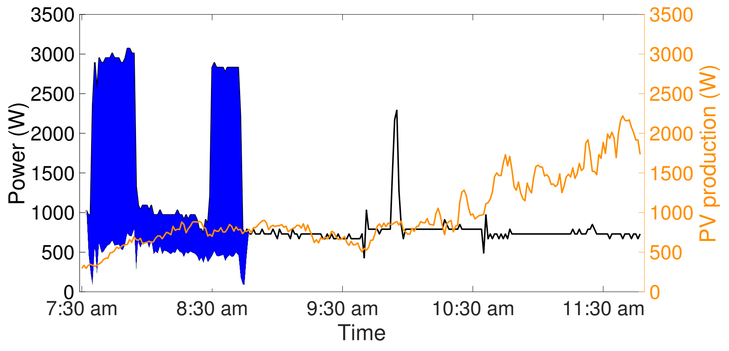
- In 2012, grid parity for photovoltaic (PV) systems in German households has been reached [1].
- Difference between energy costs and feed-in remuneration can be seen as savings.

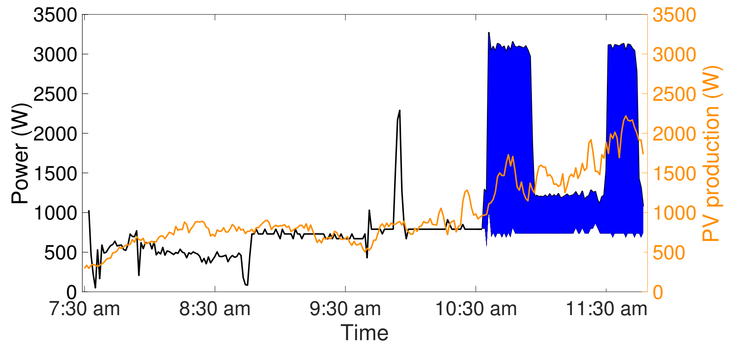
⇒ **Optimization of PV self-consumption is economically viable.**

- Demand Side Management (DSM) of suitable appliances can be a measure to optimize self-consumption.

⇒ **Simulations based on measured time-resolved consumption data allow quantifying possible effects of DSM.**

Methods

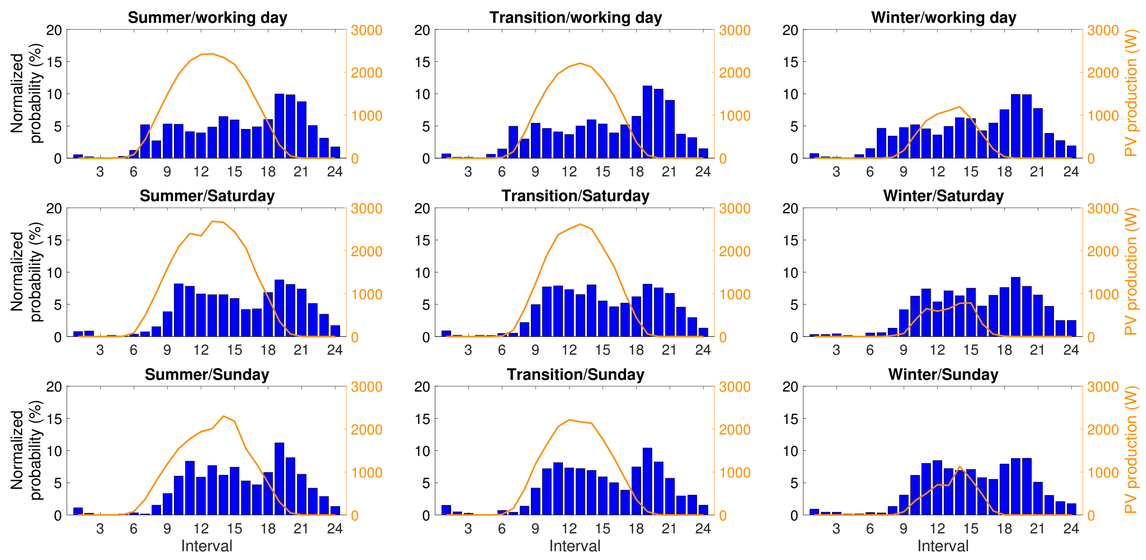


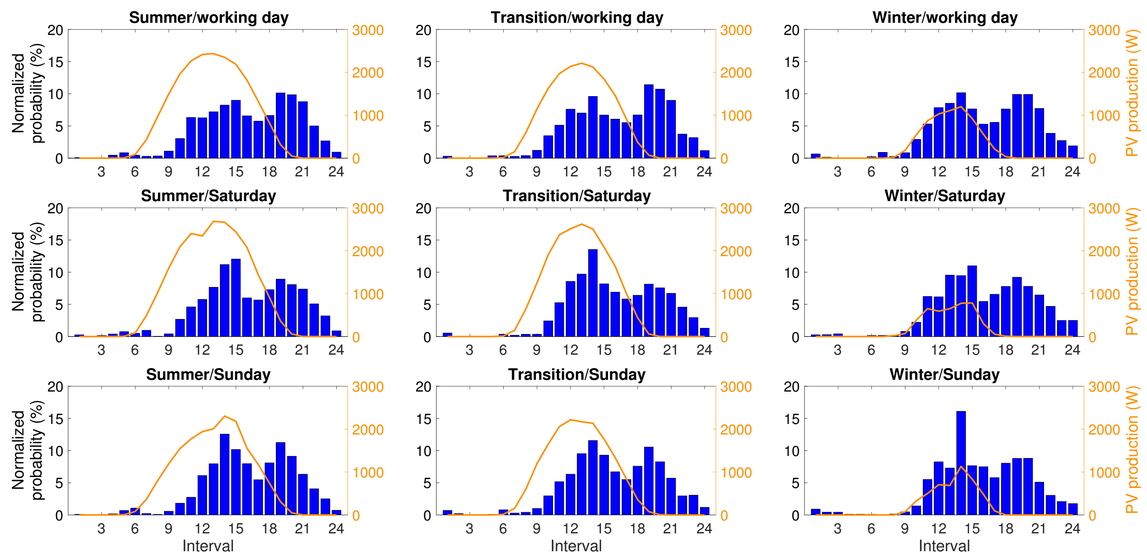


- Load profiles and operation times of relevant appliances (dishwasher, washing machine, dryer) of 565 German households are identified by disaggregation of the total load [2].
- PV generation for the households' location is simulated based on radiation and temperature [3].
- Three different PV system sizes (peak power 3 kW, 5 kW, 7 kW) and shifting intervals (3 h, 5 h, 8 h) are investigated.
- Each recognized device use is shifted to the optimal position regarding self-consumption within the chose shifting interval.

Results

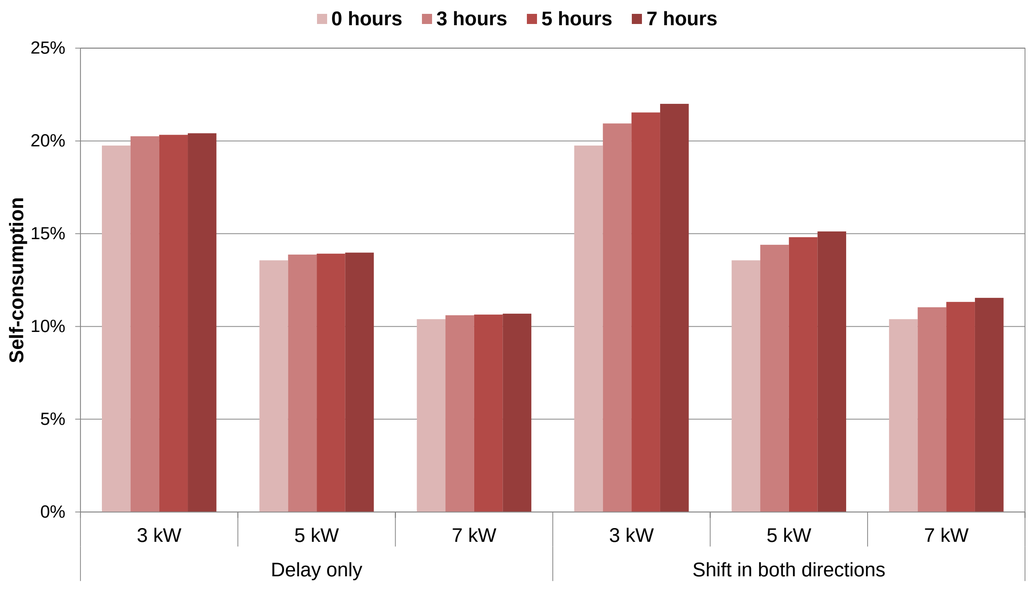
User behavior





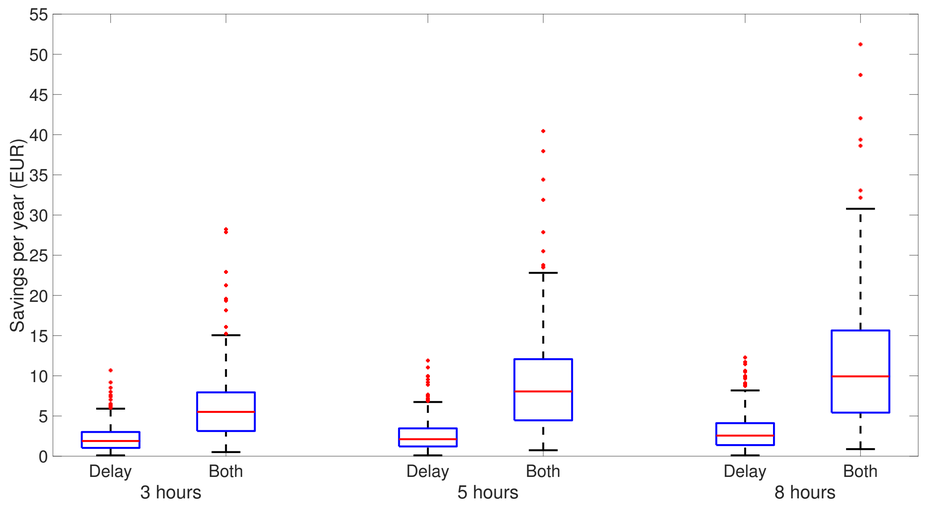
- Normalized usage probability shows the distribution of uses (here: dishwashers) for different types of days and seasons (left figure).
- This probability does not represent the absolute number of uses.
- PV generation for a PV system with a peak power of 5 kW is displayed on the second axis.
- The adjusted user behavior (5 h) according to the described algorithm is depicted in the right figure. The usage pattern for all types of days significantly changed.
- Due to decreasing PV production in the afternoon, this part of the day remains almost unchanged, since postponing does not yield increased self-consumption.
- An extended scenario is investigated which also considers shifts to earlier times.

Self-consumption



- Due to rather low mean consumption, initial values are lower than typical [3].
- Self-consumption rate is smaller for larger peak power, since the amount that can be consumed directly is defined by the household load, and therefore excess production reduces this rate.
- The increase is much higher for shifting in both directions.

Monetary savings



- Assumed difference between energy costs and remuneration is 0.1412 €/kWh.
- Potential yearly savings are given as complete distribution (boxplot) and on average in the following table:

Peak power	3 hours		5 hours		8 hours	
	Delay	Both	Delay	Both	Delay	Both
3 kW	2.12 €	5.11 €	2.49 €	7.64 €	2.83 €	9.70 €
5 kW	2.27 €	6.11 €	2.64 €	9.00 €	3.08 €	11.22 €
7 kW	2.18 €	6.41 €	2.53 €	9.38 €	3.04 €	11.59 €

- Results are in good agreement with literature values [4] of maximum 20 €.

Conclusion

- The economical aspect of PV self-consumption affects the motivation to shift household devices [5].
- Potential of DSM depends on individual load curve.
- Possible savings are rather small (3 % of energy costs).
- Due to constantly decreasing feed-in remuneration, potential savings are going to rise in the future [1].

⇒ **Simulation suitable to assess and forecast effects of PV-driven DSM measures in private households.**

References

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