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MODELLING COMBINED LOAD SHIFTING OF THERMAL SUPPLY SYSTEMS IN SETTLEMENTS

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ISSUE

A combined application of combined load shifting or Demand Side Management (DSM) options is a promising approach to integrate fluctuating Renewable Energy (RE) generation into the grid. Especially shifting loads of thermal supply systems in private dwellings like heat pumps, CHP-units or Night Storage Heaters (NSH) in combination offers several advantages:

- Thermal storages are cheaper than batteries
- Thermal storage systems are already installed
- High theoretical potential now and in the future [1]
- Possibility to use diversified combinations

However, one main barrier to implement DSM lies in the difficulty to estimate and apply its potentials, e.g. due to the variety of boundary conditions and security of supply.

APPROACH AND RESULTS

The introduced model focusses on the calculation of the applied potential of thermal supply systems to integrate RE sources by using optimization tools. First, a representative scenario settlement [2] is chosen consisting of distinctive dwellings, which are described separately by unique one year load profiles for electrical load, heating and warm water. Second, the dwellings are equipped with corresponding thermal supply systems for heating and warm water generation as well as renewable generators. Fig. 1 shows an exemplary scenario for one Single Family House (SFH) equipped with a warm water Boiler and NSH next to a wind turbine.

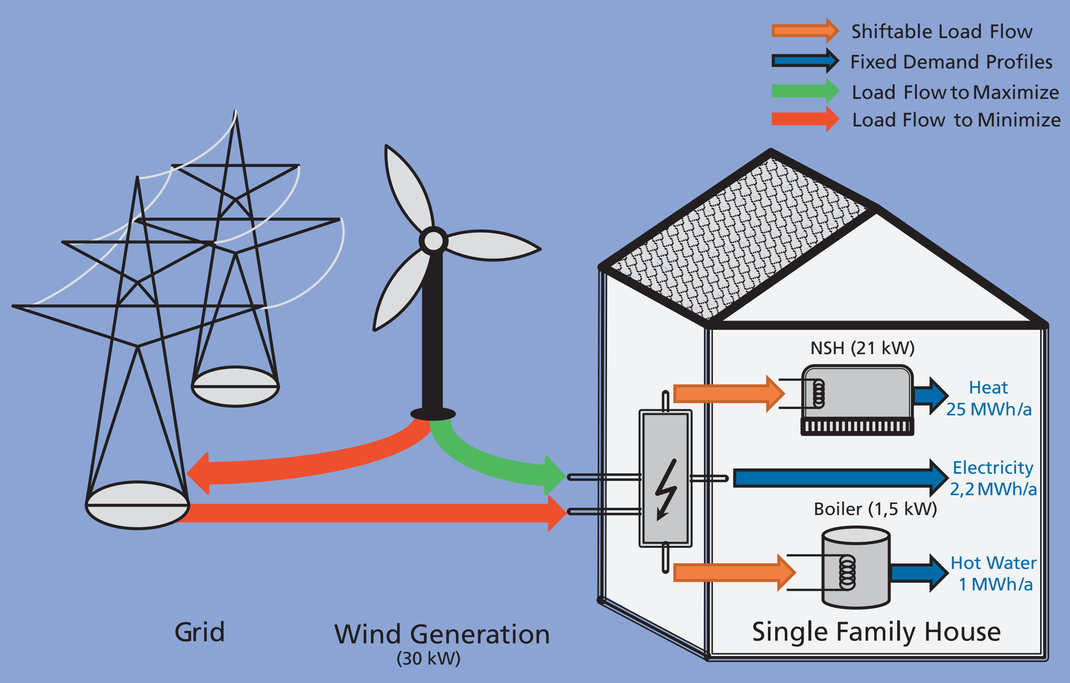

Fig. 1: DSM scenario: exemplary house equipped with thermal DSM options (NSH and Boiler) next to renewable wind generation

In this example the wind energy consumption of the SFH should be maximized [green] while minimizing grid demand and wind power grid feed-in [red] to lower the overall storage demand. Correspondingly the following boundary conditions have to be satisfied:

- Limited foresight for demand and generation
- Thermal storage losses
- System restrictions (On/Off-mechanism, SOC)
- Fulfillment of demand [blue]

As a third step, to draw a proper comparison, the non-optimized standard generation profiles of the Boiler and NSH are calculated using simplified parameters and algorithms for Instrumentation, Control and Automation (ICA) as reference. To finally calculate the corresponding DSM potential an optimization is applied using a curve-fitting algorithm, meaning the Boiler and NSH generation profiles are adapted to an objective curve, in this case wind generation (Fig. 2).

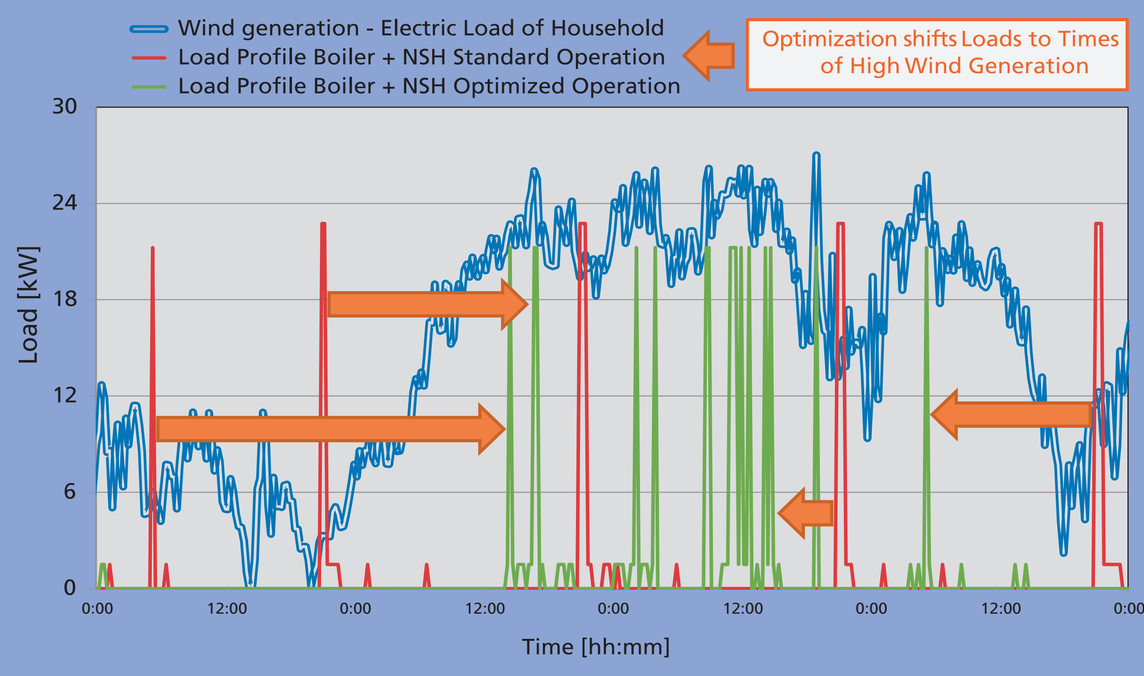

Fig. 2: Four days Boiler and NSH demand profiles with objective load curve (wind generation) before and after optimization using curve-fitting

Doing so in the chosen example the annual share of RE consumption of the SFH with DSM using Boiler and NSH increases from 38 % to 67 % of the annual electricity demand, lowering the residual load of the energy system and as a consequence the overall storage demand in the grid (Fig. 3).

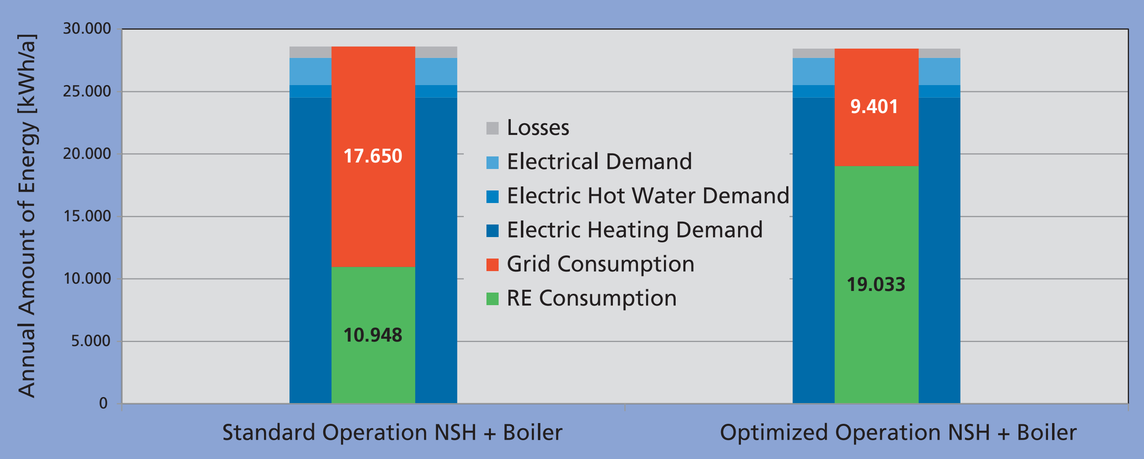

Fig. 3: Comparison of annual RE and grid consumption of the SFH before and after optimization

CONCLUSION AND OUTLOOK

- DSM with thermal supply systems has a high potential to integrate RE into the local power supply. A curve-fitting optimization including several boundary conditions is a valid approach to calculate this potential.
- Recent research is focussed on the implementation of other thermal systems and housing types [3] to model whole settlements and DSM options in combination.

REFERENCES

[1] Stadler, I.: Demand Response, 2006
[2] Jank, R. et al.: Energetische Quartiersplanung, 2010
[3] Loga, T. et al.: Deutsche Gebäudetypologie, 2011