Optimisation of night storage heaters

What is Flexity: Flexity is one of the leading Use Cases within the IO.Energy Ecosystem. Flexity investigates which household assets (EVs, boilers, night storage heaters...) can be technically operated and which value can be offered to the end-consumer in return. Moreover, Flexity investigates how the digital meter can be used to facilitate the settlement of new services on residential level.

Objective of this note: this note summarises Flexity's test results from the optimisation of night storage heaters by tiko and ENGIE.

Approach

A night storage heater (or accumulative heater) is an electrical heater, which stores thermal energy at night when electricity is available at lower cost[1], and releases the heat during the day as required. Since the functioning of an night storage heater is straightforward and the load profile is quite predictable, it makes a promising technology for **participation in the aFRR market**.

Flexity did not optimise night storage heaters in function of day/night price differences as night storage heaters already run exclusively at night. Finally, Flexity investigated the optimization in function of hourly wholesale prices (day-ahead). However, Flexity did not perform physical tests as night storage heaters need 6 hours to heat over a night period of typically 9 hours[2], resulting in little potential to shift load to cheaper moments. Additionally, as variation on wholesale electricity prices at night are low, there was little margin for optimisation.

Results from technical tests

Set-up and scope of the aFRR testing's by tiko and ENGIE

Tiko tested with ENGIE the delivery of aFRR by installing its technology at premises of **14 real households:**

- **First**, a M-box is installed which serves as the communication module between each household and the back-end system of tiko. It communicates with other tiko devices (K-boxes) via your existing in-home electricity network.
- **Secondly**, the K-box is installed to meter and steer different household appliances that are connected to the control panel.

The technical test aimed to review the capability to accurately steer night storage heaters without affecting the comfort levels of the end-consumer. This was done by five different field experiments. Performing the official simulation test for the aFRR product was out of scope, as it typically requires a pool of thousands of night storage heaters.

1. Both the energy retail cost as the distribution grid costs typically tend to be lower at night when compared during the day
2. The night tariff typically runs from 22h in the evening until 07h in the morning

Results of field-test 1 and 2

Objective of testing 1 and 2

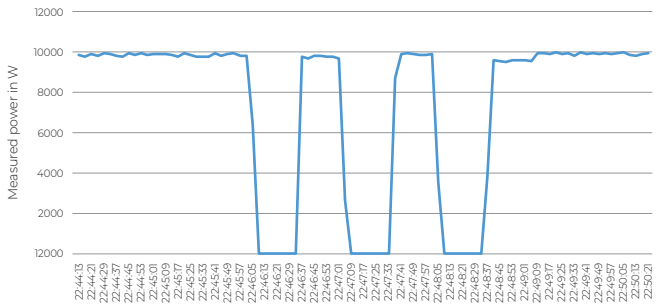
- Test the technical capability to operate night storage heaters via manual jump commands *(= activation request send by a single click on the button)*;
- Test the reaction speed of activations

Results of the testings

- Technically capable to be precisely operated by manual jump commands, incl. consecutive activations
- Fast reaction speed: typical reaction time is 5 sec
- Uncertainty wrt back-on switching is normally mitigated by smart pool management when operating a larger pool

Representation of the test results

Typical jump command on an accumalative heater



Results of field-test 3, 4 and 5

Objective of testing 3,4 and 5

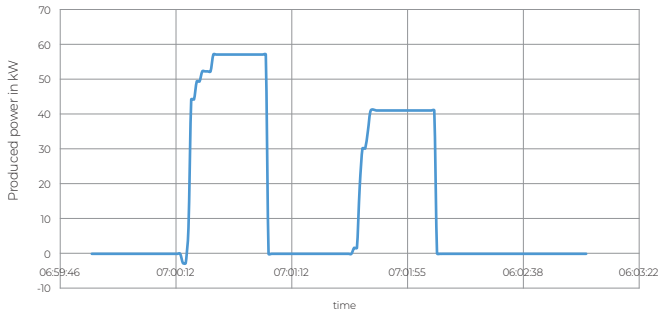
- Test technical capability to operate a pool of residential assets in an automatic coordinated way
- Test reaction speed of pool-based activations

Results of the testings

- During a first activation, the total pool can typically be turned off
- Consecutive activations often face the issue that not 100% of the pool recovered from the first activation and some assets' internal functioning may refrain to turn back off a second time due to a temperature constraint. A big enough pool allows to compensate this effect.
- Fast reaction speed: similar reaction times compared to individual jump commands

Representation of the test results

Pool based activation of night storage heaters



Conclusion and moving forward

Tiko and ENGIE demonstrated that they can technically operate night storage heaters with real households. Consecutive activations on an individual basis, as well as coordinated activations on a pool basis are well managed. However, there is an inevitable probability that some heaters would not turn on after multiple activations of flexibility. Therefore, a sufficiently large pool is needed to mitigate this risk; such a pool should not be limited to night storage heaters but can be reinforced – backed up with heat pumps and electrical boilers.

As the exclusive night mechanism is gradually being phased out ('21 – 24')[3] and dynamic retail price contracts (based on DA-prices) emerge, an optimisation in function of hourly wholesale prices becomes more attractive to the consumer (heat during the day when prices are low or negative). Also, spreading the consumption over time and helping end-consumers to self-consume in function of PV production can help to avoid peak-consumption. Finally, it should be noted that the future purchase of a night storage heater is likely to become less attractive as end-consumers will be incentivised to switch to more energy-efficient heating technology[4].

3. as was recently communicated by VREG together with the introduction of the capacity tariff as from 2022; more information can be found on https://www.vreg.be/nl/nieuws/capaciteitstarief-vanaf-2022-voor-alle-netgebruikers

4. Such as for example heat pumps