

Smappee Load disaggregation

Appliance Detection and Submetering

This document describes the load monitoring options Smappee offers to disaggregate the loads inside an electrical installation (using live submetering of sub circuits and individual appliances and the Smappee Appliance Detection (NILM-Technology)).

Note: When there is a solar present in the installation, solar must also be monitored by the Smappee monitor for the NILM to operate.

Load Monitoring options

Current Transformers (CT) in fuse box [Real Time]: provides real time and accurate measurements of:

- Total Load
- Solar Production
- Battery
- Sub-metering (sub-circuits and/or individual appliances)



Smappee Switch: wireless submetering (*monophase appliances, max. 16A)



NILM (Non Intrusive Load Monitoring): software-matic appliance detection (*residential only)

- Provides insight in appliance consumption: should identify 70% of consumption and events of the detected appliances
- Monthly consumption per identified appliance reporting



Smappee NILM-Technology

General

Smappee NILM-Technology is designed to operate only in residential environments:

- It identifies common residential devices and recognizes the type.
- For successful appliance detection, the 'melody' (consumption profile) of the device must be unique.

The Smappee NILM-Technology has different building blocks that assist the detection of the different types of appliances.

- Auto-labelling: Smappee detects and identifies the appliances automatically and relatively quickly
- Long Running detection: for complex appliances or appliances that consist of multiple electrical components, a longer time period is required to detect these appliances.
- Learn with Smappee Switch: the NILM Technology can be assisted by the use of the Smappee Switch temporarily submeter the appliance and so the NILM algorithm can be learned to detect the appliance automatically in the future.
- Assisted Learning: After a period of time and in some cases, Smappee is able to identify and isolate an appliance but not to label it. For these cases, the end user can activate the Manual Learning model and the mobile app guides the user through the process on how to do it and when it is possible to do so.

The Smappee mobile app guides the user through the processes when there are and can be used. It will report to the end user if specific actions need to be executed or are possible to be executed. Appliances need to be used regularly to be able to be detected. This means that the timeframe when an appliance is detected, labelled or can be learned to the NILM algorithm can vary.

What to expect

For residential environments (houses/apartments), the Smappee NILM algorithm is designed to identify the top **5 energy guzzlers** of which the reporting is available on monthly basis.

The devices that are likely to be detected by the Smappee are: Refrigerator, Freezer, Microwave, Cooking stove, Oven, Vacuum cleaner, Coffeemaker (Senseo, Nespresso,...), Dishwasher, Washing machine, Tumble dryer, Water pump, Lights (> 50W), Car Charger.

Appliances unlikely to be labelled by Smappee automatically are:

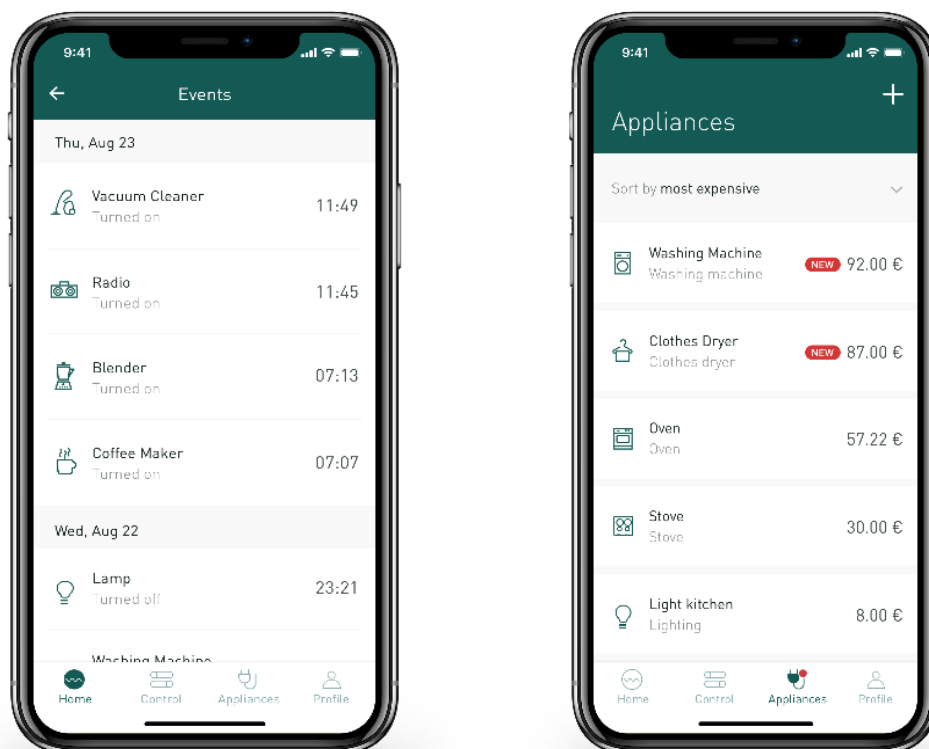
- Appliances with variable loads. Examples: Heat Pumps, Airconditioners, HVAC, Swimming pool pump
- Non-consumer appliances
- Adapter-powered devices (laptop, console, phonecharger,...)

To monitor these appliances, sub-metering needs to be applied (Smappee Switch and/or Smappee Plus or Pro).

Smappee NILM-Technology is not designed to:

- Detect industrial, non-residential appliances
- Work in professional (non-residential) environments, except for small sub-circuits of kitchens in which consumer appliances are present.

For the detected and typed appliances, the Smappee appliance detection identifies approx. 70% of all electricity consumption of the appliances detected, on monthly basis only. Sub-metering circuits or appliances using additional clamps have 1% deviation and monitor directly the consumption of that (sub)metered circuit.



Best-practices (strongly recommended)

The best-practices listed below help to achieve the optimal appliance-detection & consumption reporting:

- The monitoring location needs to be a residential environment and have normal electrical activities (occupied house, apartment, standard consumer appliances to be present).
- Use the Smappee Energy Monitor 2.0 App.
- **Fill in the survey** in the (new) Smappee App:

Tell us more about your home

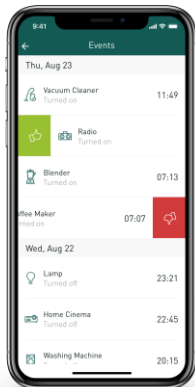
Give me a head start! Complete the survey and I will be able to find your different appliances faster and more precisely. It only takes a few minutes.

Fill in the survey

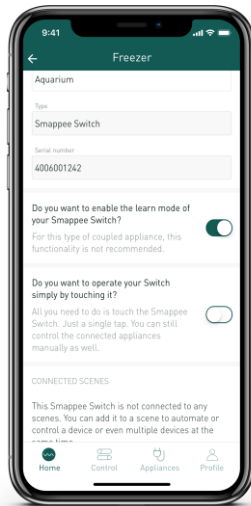
This will help Smappee do identify the appliances in the installation.

Keep this survey always up to date! This can always be accessed through the mobile app.

- In the Events overview, you can **swipe specific events** as correct ones (right) and incorrect (left) to give the Smappee Appliance Detection feedback of the accuracy of the events.



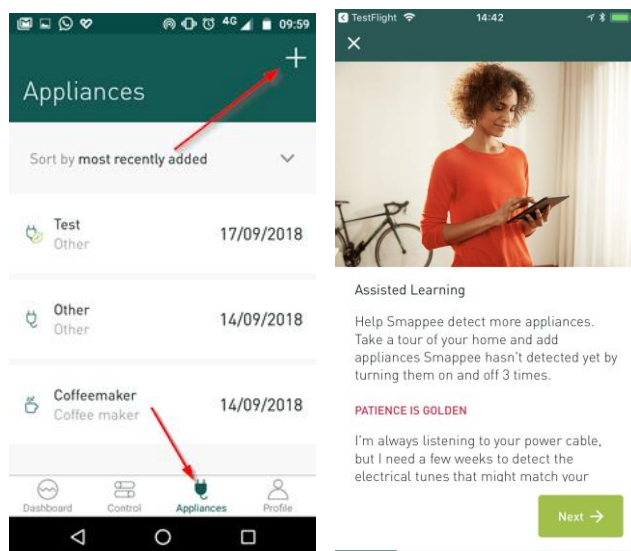
- After a period of 2-3 weeks, the user can help Smappee to learn and detect appliances and have its consumption. If you want to have Smappee specially learn a specific device. **You can mount a Smappee Switch in between and activate the learning mode** so you help the Smappee to learn that appliance so it can be detected by Smappee in the future better. You can have the option to leave the Switch in between or remove it after a period of time. The Smappee App will display if the learn mode for this appliance-type is a possibility (recommended). If it is an appliance-type that is difficult for Smappee to learn or difficult to be detected by our NILM by in the future, the app will display this as not recommended.



(Setting in the Smappee Switch setup)

- After a period of 3 to 4 weeks, you can **activate the Assisted Learning**. With this functionality, you are able to help Smappee label appliances. This functionality is available under Appliances and can be accessed by the '+' mark:

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- Check the Smappee daily to check correct operation & data collection.
- Smappee will identify the frequently used appliances. First appliance is identified 2 days after installation, 70% after 4 to 5 weeks (the more events per appliance, the quicker it will be identified).
- Keep in mind that the update of the Events list in the app could take a few minutes to be updated.

Itemized bill reporting (Pro Dashboard only*)

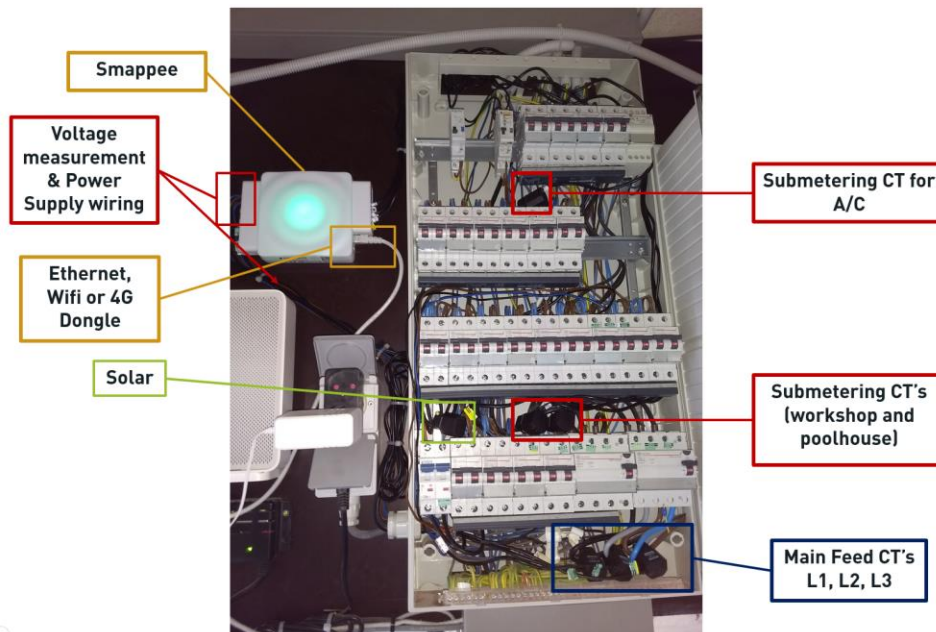
- Visualization: only appliances that are successfully detected and labelled by Smappee are visual and reported in the itemized bill. A common name can be added in order to visualize in a user-friendly and structured way.
- The itemized bill should be used using **Monthly values** to achieve the highest accuracy.

Sub-metering

If use case requires real time and 100% reliable monitoring of installation or subcircuits, sub-metering is the option to use.

Sub-metering possibilities:

1. **Smappee Plus or Pro:** Capture directly the consumption of individual fused appliances or a subcircuits utilizing additional current clamps (CT's).



2. Utilizing the **Smappee Switch**: wireless single phase submeter communicating through RF (max. 16A), compatible will all Smappee Energy monitors.



When to use sub-metering

- Appliances with variable loads are hard or impossible to be detected by NILM.
Examples:
 - Heat Pumps & Airconditioners
 - Large pumps
 - Non-consumer appliances.
- For a correct energy balance elements as PV (solar), battery storage and EV's, these need to be submetered.

On each of the channel inputs of the Smappee Plus and Pro, the NILM appliance detection functionality can be activated. (e.g. main loads, submetering kitchen channel). The same NILM-Appliance detection prerequisites as stated above apply also for the Smappee Plus and Pro.

