# D3.7–List of gaps between user expectation from the technology and satisfaction

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## LEADER: IDC

## DISSEMINATION LEVEL

| | | |
|---|---|---|
| PU | Public | |
| CO | Confidential, only for members of the consortium (including the Commission Services) | |

## HISTORY

| Version | Description | Lead author | Date |
|---|---|---|---|
| V0 | First draft | IDC | |
| V1 | VIL Contribution (1st) | VIL | 09/01/2020 |
| V2 | SON Contribution | SON | 11/1/2020 |
| V3 | reviewers | IDC, DEV, VIL | 23/2/2020 |
| V4 | reviewers | IDC, RINA | 25/02/2020 |
| Final | Final version | IDC, RINA, VIL, SON | 27/02/2020 |

## DISCLAIMER

The work presented in this document has been conducted in the context of the H2020 of the European community project InBetween (n° 768776). The partners in the project are: Rina Consulting S.p.A., Acciona Construcción S.A., AIT Austrian Institute of Technology Gmbh, Develco Products, The Interdisciplinary Center Herzliya, Institute Mihajlo Pupin, Vilogia S.A, Sonnenplatz Großschönau Gmbh. The content of this report does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in the therein lies entirely with the author(s).

## EXECUTIVE SUMMARY

In this report, we have presented the information that we have gathered from the two demo sites in order to receive feedback from the users so that they can influence the design of the InBetween app in line with our user-centric approach. The results presented are preliminary and based on initial interviews with a small number of users. This deliverable will be updated as the project progresses and a revised version will be presented in D3.8 at the project end.

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# 1 INTRODUCTION

The InBetween project applies a user-centric approach for bringing about energy savings from behavioral change. The user-centric approach includes two facets: Overcoming unique behavior related barriers for energy savings and Co-designing of the platform. The co-design process will help us to incorporate users' views and ideas into the platform, to improve its 'tailored' aspects. The project has two demo-sites: Vilogia, in France (hereafter, VIL) with **25** residential users, and Sonnenplatz, in Austria (hereafter SON), with **8** residential and **6** non-residential users. For more details on the demo-sites and the characteristics of the residential and non-residential users, see **D1.1.**

## 1.1 ADDRESSING BARRIERS FOR ENERGY SAVING BEHAVIOR

The project builds on the conceptual model of users' agency and capacity as drivers for behavior change: As discussed in previous reports (D3.2, D3.4) the likelihood of an energy user to take action (in our case change behavior) is associated with the user's level of agency and capacity, where 'agency' refers to consumers' willingness and interest in making their own free choices regarding energy consumption and energy related behavior, and 'capacity' refers to users' ability to perform the choices they have made. When levels of both agency and capacity are high – change is more likely to happen.

In previous reports we identified reasons for low levels of agency and capacity. Accordingly, the platform is designed to improve agency and capacity in various ways, ranging from general advice to specific and personalized notifications and individual actuators (see figure 1). Below are ways in which the platform and app help tackle barriers related to users' levels of agency and capacity. For extended explanation on users' agency and capacity and how these concepts are applied in the inBetween project see D3.4.

Reasons for low levels of user's agency and how the platform can help overcome them:

1. Lack of interest in energy – the app itself does not provide reasons to be interested in energy, however the 'buzz' created around it (in particular if users of the app are satisfied and find it helpful, useful and easy to use) might improve the interest of non-users in energy. In addition, the platform includes non-energy information that could attract users to engage with it, for example weather forecast, as well as health and security alerts. Longer engagement with the platform may be accompanied by a greater exposure to energy features, which in turn could enhance users' interest in energy saving.
2. Lack of economic, environmental or social motivations - the app can provide real-time and general information and advice in terms of money / emissions saved, as well as in comparison to others. In addition, it is recommended that the app send periodical positive reinforcement messages. These are likely to improve the motivation to act. The non-monetary motivation is important in

particular in places where Time of Use (TOU) tariff does not exist, and so does the economic incentive for shifting time of use.

3. A belief that the energy savings potential is exhausted – by providing tailored advice (after learning energy use patterns and preferences), the app can demonstrate to users that there is still energy saving potential.
4. Fear of loss of comfort - the app can provide comfort-based advice, thus improving, rather than harming, the comfort. In addition, automatic control heaters can improve comfort. However, improving comfort (e.g., pre-heating) could result in energy consumption increase, rather than decrease.
5. Fear of unfamiliar technologies and unfamiliar product / service – friendly user interface (visual and operational), the use of non-technical language, simple operation menu (in addition to our friendly app introducers in VIL and SON) are likely to reduce the fear of unfamiliar technology/service. The co-design approach will help us learn what works best for which users and design the features accordingly.
6. Fear of nuisance - as demonstrated in both demo sites, the sensors' installation can cause nuisance to users. The installation phase is an inherent barrier to any technology relying on sensors that need to be installed in homes and is not unique to this specific project. However, in InBetween, the demo sites managers managed to overcome this barrier by being very accessible and attentive to users. The app itself might cause nuisance if notifications are sent too often; or if the same message is repeated over and over; or if people find the notifications irrelevant. This is the main threat to the app success. To overcome this barrier, users are able to select from a menu the type of notifications they want to receive (as detailed above).

Reasons for low levels of users' capacity and how the platform can help overcome them:

1. Daily obligations and family constraints – The preferences can be set by the users, thus take into consideration the specific household obligations and constraints.
2. Technical barriers – the app cannot overcome technical barriers related to the operation of appliances which are not connected to smart plugs/actuators. However, it can provide notifications if some appliances (e.g., boilers, heaters) are malfunctioning. In the future, the app might (a) suggest simple actions that might solve the problem (DIY kind), and (b) recommend professionals who might help solve the problem. Note that such features are currently out of the project scope.
3. Lack of know-how – the app can provide information and advice on specific and timely actions that users can take to save energy.

4. Economic barrier (inability to purchase efficient appliances) – the app cannot overcome this barrier, but if the app itself is free, it can help users better manage their energy use and make the most of the infrastructure they currently have.
5. No ownership (of hh / business) – in cases where users do not themselves pay the energy bill (e.g., workers, pupils), the app can provide non-economic motivations for action, as well as improve users' energy literacy. In cases where lack of ownership prevents users from improving infrastructure or replacing inefficient appliances, see point 4 above.
6. Potential fulfilled – in cases where potential in not fulfilled and further energy could be saved, the app will notify users.
7. Passive personality (prefer automated control) – the various options for automation offered by the platform (e.g., heating, boilers, scheduling), can help passive people who would like to save energy and emissions but do not want to actively act to improve their energy performance and save energy.

## 1.2 CO-DESIGNING THE PLATFORM

The meaning of co-designing in this project is that various inputs and insights from the users are fed back to the developers and incorporated into the platform. The first set of user data, views and aspirations was collected at the beginning of the project, at the initial stage of development and before the installation of the equipment took place (see D3.1, 3.2). We used this information to identify agency and capacity-related barriers for behavior change and to address them (outlined above). The second set of data and inputs is collected in the second stage - after the platform is 'up and running' and users have some experience with it, and therefore can help us improve it.

The InBetween project offers two engagement platforms – a mobile app and a web interface. The web interface is for users who do not own or use Android phones, and for those who prefer a web interface over a mobile app. The web platform contains some similar functionalities to the app in terms of engagement, yet a web interface is somewhat more limited and not as handy as a mobile phone. At the time of writing this report, the web interface has not yet been fully developed. Therefore, while the methodology and methods presented in this report are valid for both engagement options – app and web – this report focuses only on the app.

The following reports focus on data gathered from app users during the second stage, and include both 'hard' and numerical components: engagement with the platforms (discussed in D3.9), and impact on energy consumption (discussed in D3.11), as well as 'soft' and subjective experience and impression of using the platform (discussed in this report). The rational and methodology of the co-design process and the evaluation methods of reports D3.7, D3.9, D3.11 presented in Figure 1.

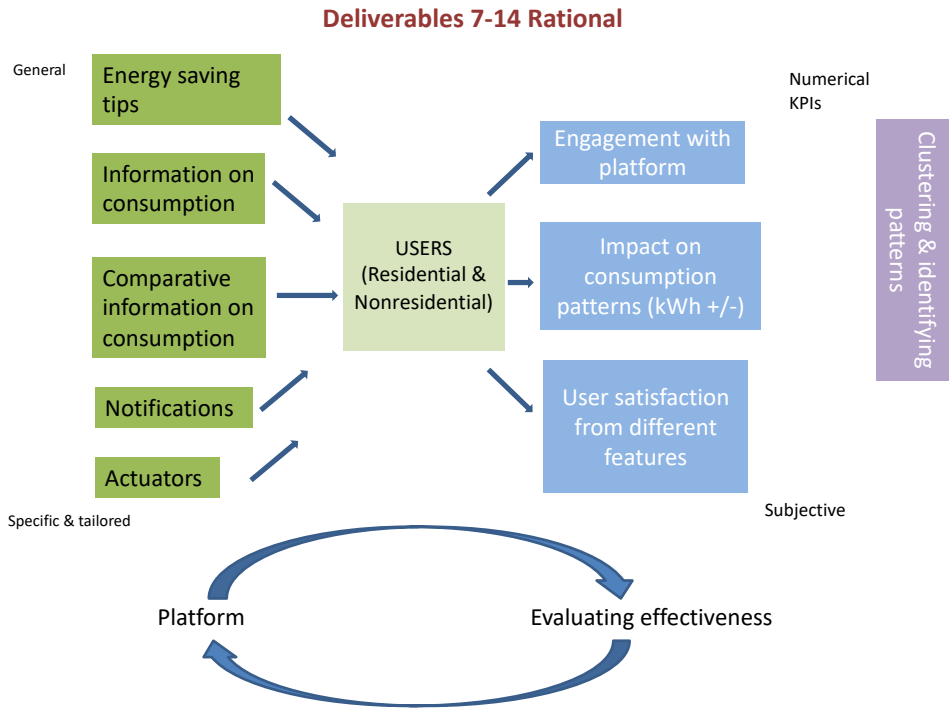
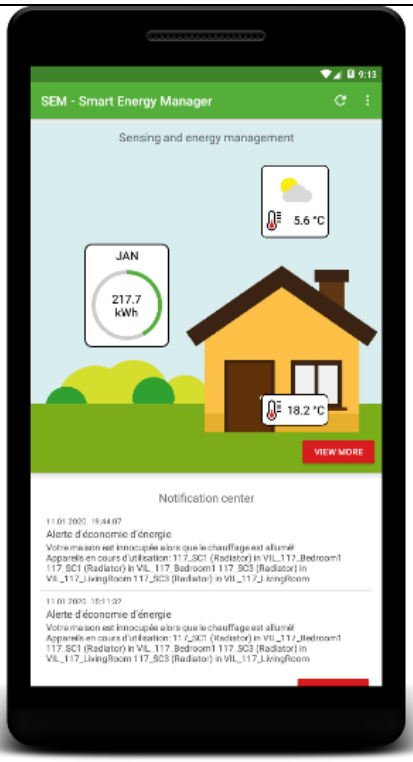
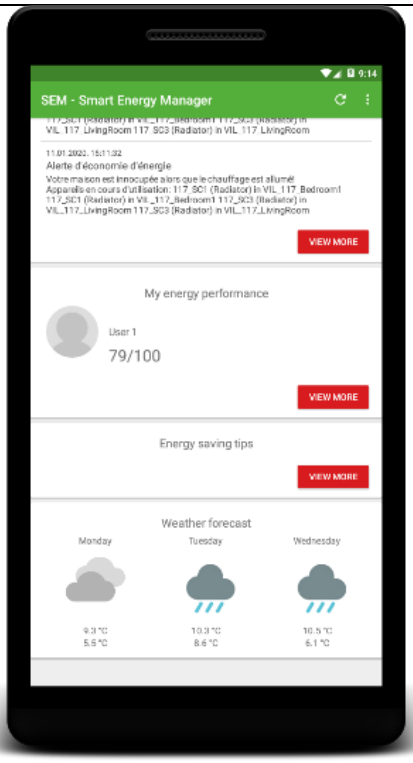


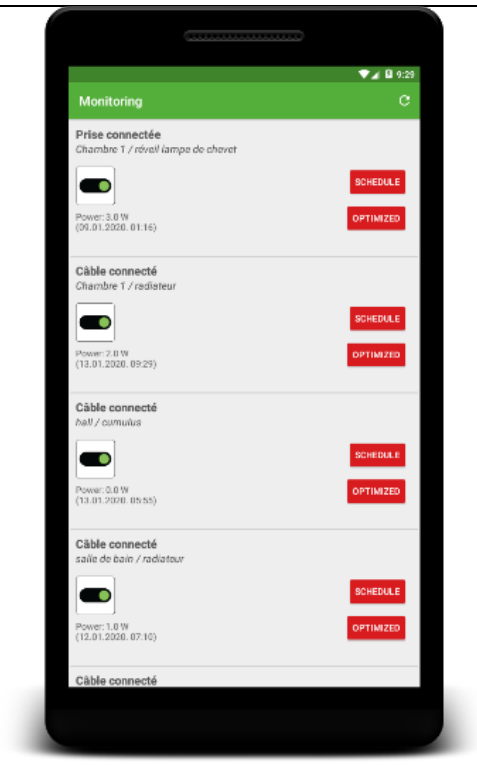
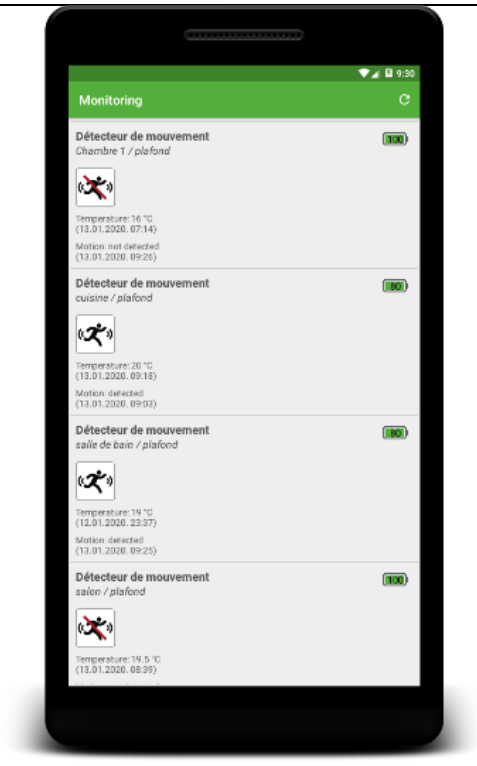

**Figure 1: An overview of the user-centric approach**

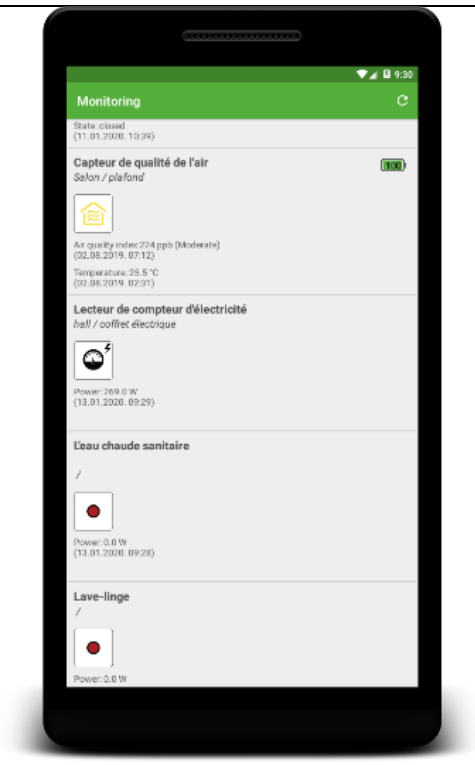
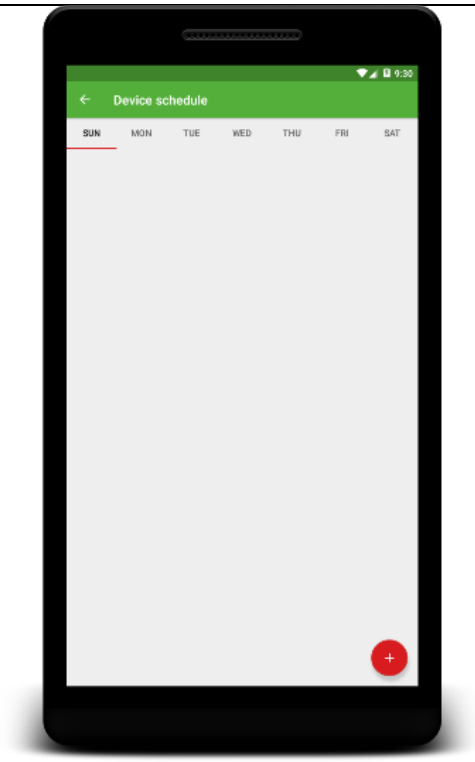
## 2 THE APP

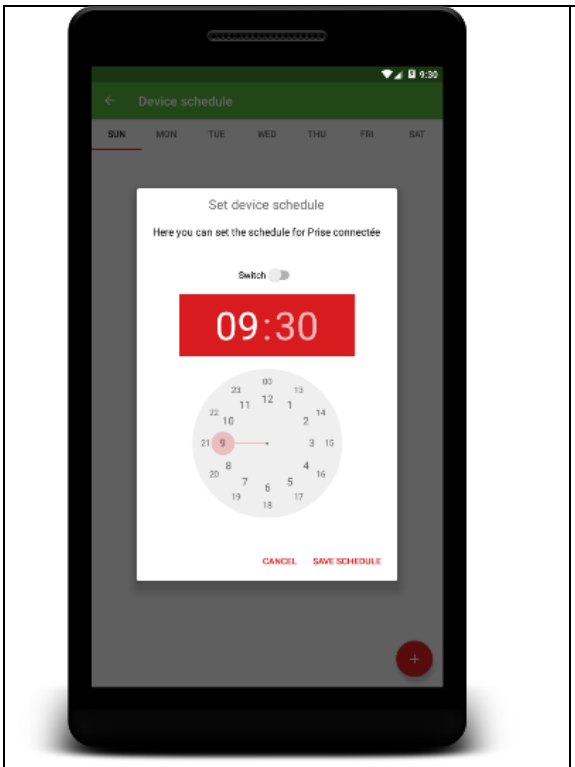
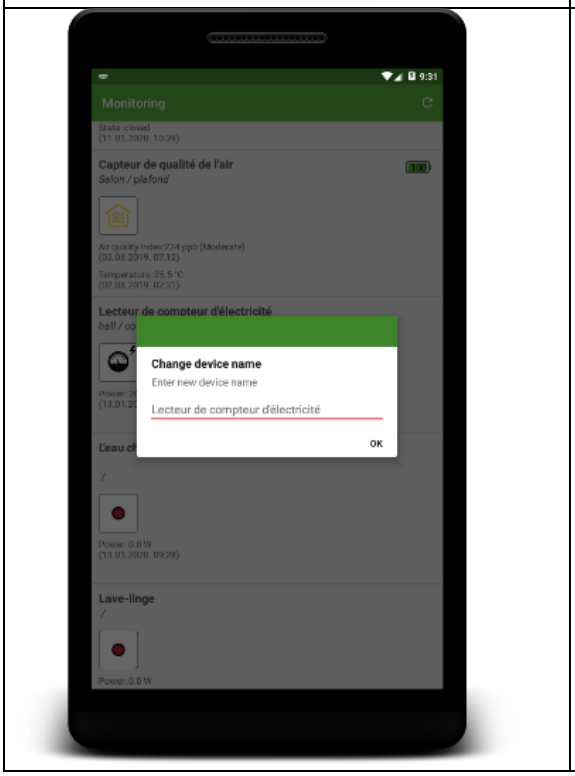
The Graphical User Interface (GUI) intended for the residential end-users, including both occupants from building apartments and private households, has been developed as Android mobile application: SEM – **S**mart **E**nergy **M**anager. The SEM app interface was designed to be easy to use and clear to its users. Table 2 presents screen shots of the app and information on different screens and functionality as seen and experienced by users.

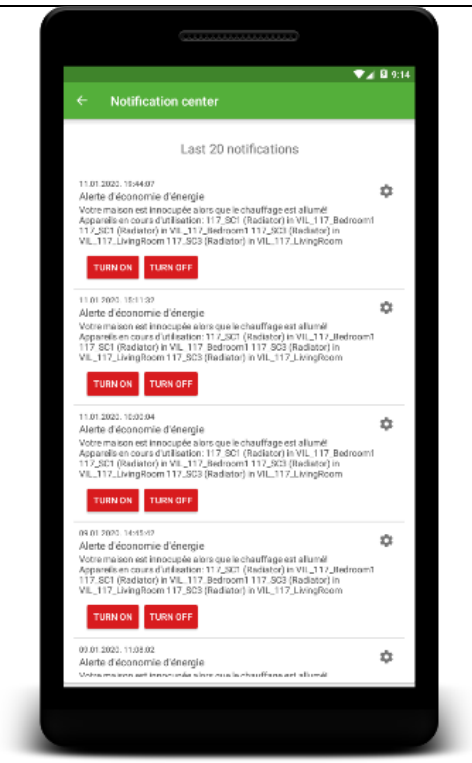
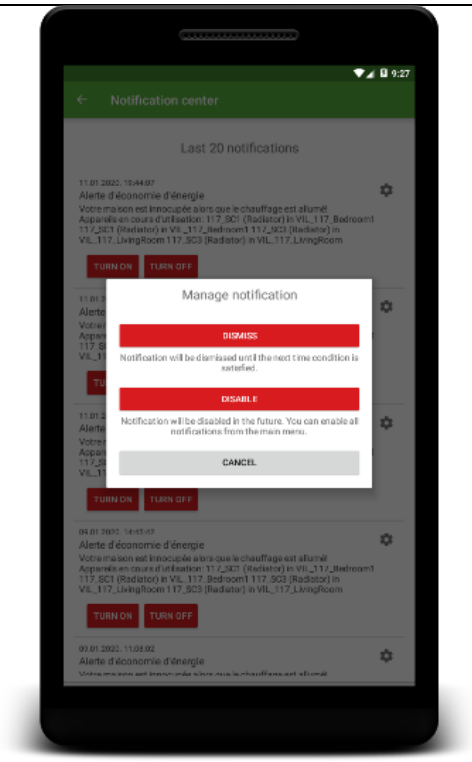
**Table 1: App screen and functionality**

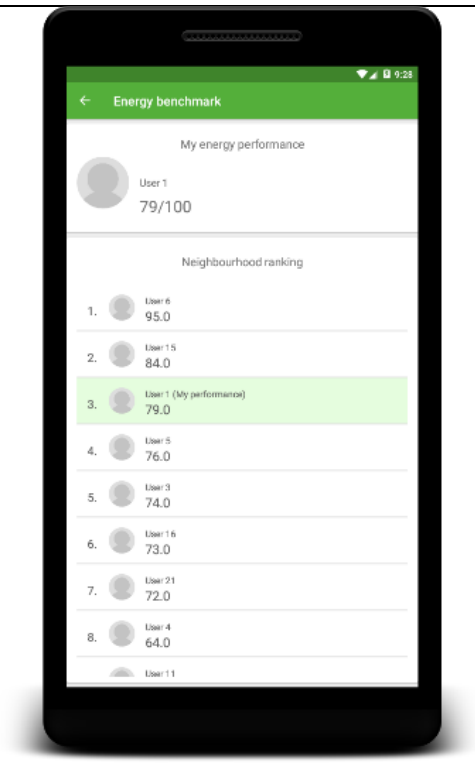
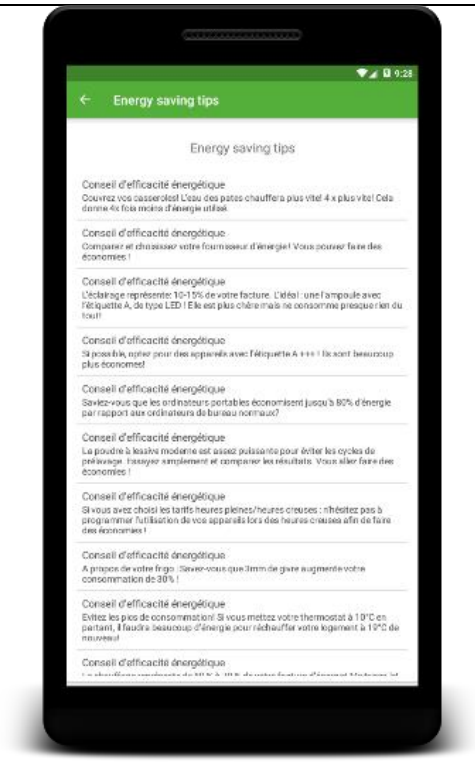
| Application screen | Functionality |
|---|---|
|  | Main dashboard:<br>• Indoor temperature obtained from deployed sensors<br>• Outdoor temperature from weather service<br>• Total energy consumption for the current month<br>• Notification center with most recent notifications |
|  | Main dashboard:<br>• User benchmark<br>• Energy saving tips<br>• Weather forecast |

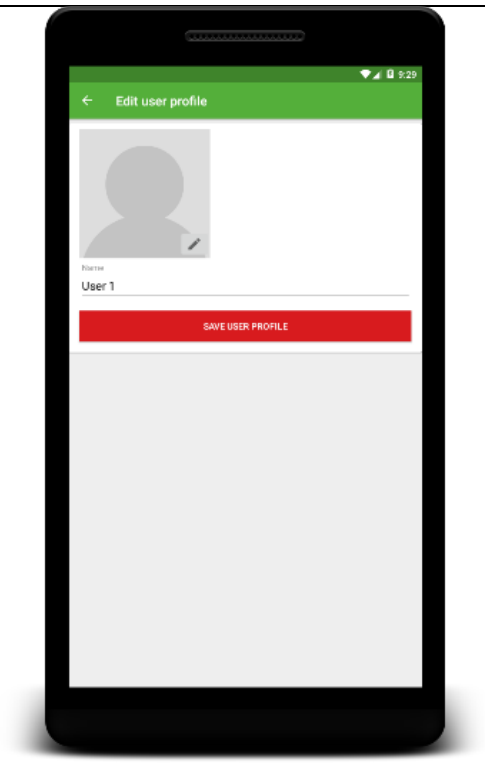
| | |
|---|---|
|  | Monitoring:<br>• List of smart plugs and cables<br>• View current power consumption<br>• Turn on/off the connected appliance |
|  | Monitoring:<br>• Movement detectors |

| | |
|---|---|
|  | Monitoring:<br>• Air quality detector<br>• External meter interface for total energy consumption<br>• Non-Intrusive Load Monitoring (NILM) results |
|  | Device schedule:<br>• Weekly schedule |

| | |
|---|---|
|  | Device schedule:<br>• Add new device schedule |
|  | Device:<br>• Change device name |

| | |
|---|---|
|  | Notification center:<br>• View list of last recommendations<br>• Act on related appliances if applicable |
|  | Manage individual notification:<br>• Dismiss: Notification will be dismissed until the next time condition is satisfied<br>• Disable: Notification will be disabled in the future. User can enable all notifications from the main menu. |

| | |
|---|---|
|  | User energy benchmark:<br>• Current user energy performance<br>• List of all users in the neighbourhood with their respective energy performance |
|  | General energy saving tips:<br>• List of general energy saving tips |

| | |
|---|---|
|  | User profile modification:<br>• Upload new image avatar<br>• Change user name |

# 3 IDENTIFYING GAPS

In order to evaluate the gaps between expectations and actual user experience, users need to be engaged with the app/web interface for at least one month. For gaining a comprehensive understanding of the gap, we planned to use a mixture of methods (face-to-face interview / survey / workshop). However, due to the delay in deployment, only one method – face-to-face in-depth interviews - was applied for the first set of deliverables (D3.7, D3.9, D3.11, D3.13), while the survey and workshop will be applied later, and incorporated to D3.8, D310, D3.12, D3.14.

We recognized in advance possible gaps that we closely examined in the face-to-face interviews and designed our questionnaire accordingly. The questionnaire aims to examine how the tool contributes to users' agency and capacity to save energy, i.e., how it (a) improves their energy understanding and provides motivations to save energy, and (b) enhance their ability to act and change behavior in order to save energy. What changes in the tool could further enhance their agency and capacity?

In addition to the structured interviews, users had various opportunities to talk with team members at the deployment sites and they provided comments and feedback on various aspects of the platform. These comments were incorporated into the second release of the app.

## 3.1 THE QUESTIONNAIRE

The questionnaire was translated to French and German and the interviews in performed by the VIL and SON partners.
In the introduction to the interview, we highlighted that (a) the interview is part of the co-design and user-centric approach of the project, (b) the tool is in its development stage and we are consulting them in order to understand their views, (c) the input they provide will be fed back to developers and used to improve the tool. And finally, we stressed that we need their honest views, and there is no 'right' or 'wrong' questions. We also explained that the information they provide will be used only for these purposes.
The guidelines for interview are presented in Annex 1.

Below are the full versions of the questionnaire:

1. *What interface (tool) do you use?*
    a. *Web*
    b. *App*
    c. *Both*

2. *How long have you been using the tool?*

3. *How did you start using the tool?*
    a. *Did you need help installing it and setting up?*
    b. *Do you understand the tool and the different symbols?*
    c. *If you need help / do not understand, what do you do?*

4. *How intense was your interaction with the tool so far?*
    a. *open the app to check energy consumption?*
        i. *How often?*
    b. *received notifications?*
        i. *Which ones (energy, temperature, security, health messages)?*
        ii. *How often?*
    c. *used actuators to manage/schedule energy use?*
        i. *Which ones?*
        ii. *Did they use the optimize option?*
        iii. *How often?*
    d. *Received general energy saving tips?*
        i. *How often?*
    e. *Check your consumption against other (benchmark)*
        i. *How often?*
    f. *Check weather forecast*
        i. *How often?*
    g. *Check specific appliances consumption*
        i. *How often?*
    h. *Check air quality information?*
        i. *How often?*

5. *Which aspect of the tool you use the most? Can you rank each one (on a scale of 1-10)?*
    a. *Energy*
    b. *Weather*
    c. *Security*
    d. *Health*
    e. *Benchmarking*

6. *How do you find the following features?*
    a. *notifications*

   i. *display clear and easy /unclear and hard to understand (please elaborate on each aspect – energy, security, health)*
   ii. *content useful and helpful – why?*
   iii. *content unclear /not useful / annoying – why?*
   iv. *Intensity of notification – too much/ not enough*
   v. *how could this feature be improved?*
b. *Actuator/energy management*
   i. *display clear and easy /unclear and hard to understand (please elaborate)*
   ii. *content useful and helpful – why?*
   iii. *content unclear / not useful / annoying – why?*
   iv. *how could this feature be improved?*
c. *Consumption information*
   i. *display clear and easy /unclear and hard to understand (please elaborate)*
   ii. *content useful and helpful – why?*
   iii. *content unclear / not useful / annoying – why?*
   iv. *how could this feature be improved?*
d. *Benchmarking information*
   i. *display clear and easy /unclear and hard to understand (please elaborate)*
   ii. *content useful and helpful – why?*
   iii. *content unclear / not useful / annoying – why?*
   iv. *how could this feature be improved?*

7. *Did the tool contributed to your energy / energy saving understanding and perception?*
   a. *In what ways?*
   b. *How could it be done better? (what is missing?)*

8. *Which behaviours and practices (if any) have you changed recently:*
   a. *thermal comfort related*
      i. *which ones and in what way?*
      ii. *has the tool contributed to this change (if yes – elaborate, is it related to notifications, to general information, etc.)*
   b. *energy management (schedule)*
      i. *which ones and in what way?*
      ii. *has the tool contributed to this change (if yes - elaborate, is it related to notifications, to general information, etc.)*
   c. *energy management (remote control via actuators)*
      i. *which ones and in what way?*

*ii. has the tool contributed to this change (if yes - elaborate, is it related to notifications, to general information, etc.)*

*d. daily routine related*

*i. which ones and in what ways?*

*ii. has the tool contributed to this change (if yes - elaborate, is it related to notifications, to general information, etc.)*

*9. Do you think that the tool, as it is, helps you to*

*a. save money*

*i. if yes, how, which features contribute to this?*

*ii. Could you estimate how much money?*

*iii. if no – what is needed to help you save money?*

*b. save energy*

*i. if yes, how, which features contribute to this?*

*ii. if no – what is needed to help them save money*

*c. reduce emissions*

*10. currently, you do not receive notifications between 22:00-08:00 – would you like to receive notification later/ earlier as well?*

*11. We would like to send a summary report once every 2 weeks / month – would you be interested? what sort of information would you like to receive?*

*12. Do you have any other comments / suggestions / insights related to the tool?*

*13. Would you be willing to pay for such tool?*

*a. If yes – why?*

*b. If no – why?*

*We would like to ask you now a few questions regarding the sensors and their installation:*

*14. What did you feel during the installation of the sensors?*

*15. Do you have feedback specifically about the sensors only? Any event to report? Are you satisfied with them?*

*16. Do you remember what is which sensor?*

*17. Are you encountering any problems with them?*

*Any other comments / suggestions / insights that you think we did not cover?*

# 4 FEEDBACK AND COMMENTS

## 4.1 FEEDBACK AND INTERACTION (BEFORE THE INTERVIEWS)

Due to the delays in deployment of sensors and accordingly the delay in the use of the App, we started the more structured collection of user feedback later than planned. However, throughout the whole process, the InBetween contact people in both demo sites were in touch with the users, advised them on the technology and on how to use it. They also collected information and feedback. This, in turn, was reported to the app and platform developers, which made some new features available, as well as changes and improvements.

The sub-chapters below report the feedback from demo sites (SON and VIL) followed by the update-history of the App, from the first availability until now, with a change-log of all the performed enhancements and upgrades.

Note that for this we did not have a structured process with defined stages, but rather performed several updates of the app, every time an issue was identified. The current version is Version 2.04, which includes changes based on User-Feedback or Demo-Site Owner Feedback.

### 4.1.1 Feedback from SON Demosites

As intended in the project-design, the tenants in Austria did not have the app available during the baseline period. On October 4$^{th}$ the first introduction of the functions of SEM was created in German Language, and sent together with the user-credentials to the building owners during the beginning of October. Informal feedback calls took place with non-residential building users at the end of October 2019, beginning of November 2019, in order to receive input regarding the basic functionality of the app, and to forward this to the technical project partners for updating and enhancing.

Below is the feedback from Austrian tenants throughout the various stages of the project:

- At SON-BE and SON-BF an info-letter was designed to inform guests about the project and the functionality of the sensors as guests were afraid that cameras were installed in the rooms. After proactively informing about the project and having this information presented in every room, no further complaints were received.

- At SON-BB a cleaning lady was unplugging a smart plug, as it had the green LED on, and she thought that she will save energy with this action. The device was plugged in again, and the person was informed about the function of the device.
- At SON at all buildings with smart radiator valves, batteries have to be replaced often as the radiator thermostat, chosen for the project, is depleting the batteries faster than anticipated. To help with this issue, SON purchased 200 batteries and is supplying them to the tenants having this issue. Therefore, also a battery level indicator was requested by the users. This function was added to the app by PUP with the December 2019 update.
- At SON-B6 the tenant from time to time unplugs the second gateway.
- At SON-BF the app was not working for some time after an update. The issue was fixed quickly by PUP as soon as it was made aware of the issue.
- At SON-BF one window-sensor was not installed correctly and shows an open window, as there is not enough space to install the sensor properly. This led to notifications, which are incorrect.
- At SON-BE two window-sensors were not installed correctly and show open windows, as there is not enough space to install the sensor properly. This led to notifications, which are incorrect.
- For SON-BA, BB, BC and BD the building caretaker wanted to be able to switch between the buildings in the app. This function was not available in the beginning, but added by PUP with the December 2019 update.
- At SON-BE it was realized that some Android-versions are not supported by the app, especially older Android-versions. This issue was solved by using a more modern device to run the app and was perceived as normal by the user, as waning support for old operating systems is common.
- Until the December 2019 update at the SON-buildings, no notifications were sent, no smart radiator valves were supported and no heat meters were supported. With the December 2019 update changing this, the general usability of the app was of course greatly enhanced.
- At SON-B13 the tenant is waiting for a web-interface, as he only has Apple-iPhones and therefore cannot access the data remotely at the moment.
- By the end of December, training of NILM was started at the Austria demo-site buildings, and visits have been performed in order to help the users plug in chosen devices. As smart plugs are used as pillars of the network (range extenders), they cannot be freely moved so in some cases new smart plugs were used to plug the devices. As of today, training is running, and therefore this function is not available yet for the users in Austria.

In general, the feedback to the Application was positive, with a nice and easy understandable design, and of course functionalities expected for the purpose of the project. Thanks to constant updating and enhancing of the Application during this first stage of its usage, tenants have a feeling that the project is progressing and moving forward. Furthermore, they feel included and valued as potential issues are fixed within a short time.

### 4.1.2 Feedback from VIL Demosites

The tenants of Vilogia demo site were informed in May 2019 of the availability of the mobile app. In respect with the GDPR rules, two ways of communication were used to communicate the ID and passwords to the tenants. Their login was sent by email and the password by mail. During the first months, they were free to install and use it without any energy advices being provided. The communication on the mobile app was followed by some remarks:

- The unavailability of the app for iOS users was a sensitive topic to overcome. People were engaged in the project and expected to use a dedicated and useful tool. The spontaneity provided by a mobile app can't be compared to the environment of a web portal. The phase of deployment of the web platform will be crucial and appointments will be made with end-users of the platform dedicated to help them with the platform.
- A tenant having installed the app from the beginning followed the regular updates from November and noticed the adding of NILM-monitored devices in the sensors list. He found this aspect useful and was particularly impressed by the existence of this functionality.
- One of the tenants regularly used the app to be informed about the consumption of her household and saw that a smart cable was missing. This tool has an important role in providing feedback about the status of sensors, which can help the demo owners to act when an issue is met. It all leans on the reaction of the tenant when such an information is noticed, whether they will warn the demo owner about it or not. This can help to prevent from similar problems, update issues in the ontology, update issues with the gateway, connection issues, etc.
- During the visits, it was noticed that some of the sensors installed barely sent information. This was solved by adding a feature to the app which indicates the level of battery remaining in the sensors.
- Many of the tenants feared to use the app, and have not gotten used to its environment. An explicative sheet with the different menus and features of the app was sent to help them to have hands-on help with the app.
- The alternative to the mobile app will be to use the web platform. Even though the web platform is accessible via a mobile browser, it is primarily dedicated to personal computers. The use of

computer is not perceived as practical by many tenants, mainly the iOS users. In addition, the WITMO web-platform was initially designed for building managers who are usually more tech-oriented than the layperson. Therefore, efforts are made to adapt the web interface to tenants needs, despite the many structural limits.

- An alternative way was also to use the NOX emulator software, which recreates the Android environment on a computer. Unfortunately, two issues were met with this software: its installation was particularly long (between 1h30 and 2h) and its usage not fluid, and it made some computers crash completely. As this solution was not developed by the technical partners from the consortium, it was decided to stop its deployment. Controlling an already-existing solution brought another layer of difficulties since the partners having installed it on their personal computers didn't meet the same issues on their side. The solution was to develop the WITMO web platform and adapt it to the end users.
- Some tenants feared to use the app as they perceived it as a time-consuming feature. They also feared that they would be disturbed by the frequency of notifications. These remarks were considered by the partners and the time delay for sending notifications and the amount of notifications were adapted to the users' preferences.

## 4.2 SMART ENERGY MANAGER (SEM) MOBILE APP – CHANGELOG

The application has been developed in incremental fashion where each new update included the feedback from the end users, as well as project consortium members, with the goal of improving the overall quality of the app, which included the addition of new features and functionalities as well as its ergonomics and usability.
In the sequel we provide the app release change log:

**Table 2: App change log**

| Release date | Application version | Features list |
|---|---|---|
| 1.02 | 04.04.2019. | In order not to impact the user behaviour and interfere with the baselining period, the initial version of the mobile app included only the monitoring capabilities:<br>• Main dashboard total consumption of the household<br>• Current weather and the forecast<br>• List of devices with main measurements |

| | | |
|---|---|---|
| 2.01 | 04.10.2019. | After the validation period has started, a new version of the mobile app has been released. In addition to monitoring capabilities, version 2.01 includes the following functionalities:<br>• Real-time notifications conveying the results of the ECM service<br>• User benchmark which enables the user to compare its energy performance with other users in the neighbourhood<br>• List of all devices with the corresponding measurements and control actions<br>• Schedule smart plugs/cables to turn on/off devices at specific time intervals<br>• Possibility to apply optimal schedule for specific devices |
| 2.02 | 07.10.2019. | Minor bug fixes |
| 2.03 | 21.12.2019. | After receiving further end-user feedback, the application has been updated to enable additional functionalities:<br>• Main dashboard redesign for better information overview<br>• Support for smart thermostat (temperature set-point and schedule)<br>• Support to general energy efficiency tips<br>• Notification centre which allows direct appliance control if applicable (notification related to a specific appliance)<br>• User account management (name and avatar photo)<br>• Battery charge status |
| 2.04 | 10.01.2020. | Minor bug fixes |
| 2.05 | 15.01.2020. | Smart thermostat temperature set-point bug fix |

In addition to the changes in the app, Develco, the equipment provider, received the feedback from SON-BB regarding unplugging the green LED. Develco will examine whether the LED on smart plugs and smart cables could be made less dominant or configurable if the LED is always on or not. This will likely not be within the scope and timeline of the InBetween project. However, such feedback will be considered in future product update considerations.

## 4.3 SUMMARY OF FINDINGS FROM THE INTERVIEWS

To protect the privacy of the participants, we are not enclosing or publishing the full text of the interviews. Rather, we have analyzed them and summarized the findings.

Note: (1) this section is built from interviews with six users in total, and (2) at the time they answered the survey, they had experienced the app for only short period of time (between 1-3 months). This means that the findings are likely to be biased toward early stage of usage (when everything is new) and 'early adopters' (usually more techy people), and the 'margins of error' of our interpretation is likely to be significant.

### 4.3.1 Main findings from SON Demosites

For the first round of formal feedback, it was decided to gather detailed information via face-to-face interviews in order to have as much as possible input regarding potential necessary upgrades as opposed to complete, but only generic, feedback from everybody.

Therefore, at the Austria demo-site, two residential and two non-residential buildings have been chosen and the interview was performed based on the questionnaire above. Each interview lasted about 30-45 minutes and was translated to English language.

#### 4.3.1.1 Findings from the SON Non-residential buildings

In our demo site the non-residential users are building managers (or similar) who are usually more experienced and familiar with energy and energy technologies than the common person. Both users are working in businesses that provide services to other people and are therefore interested in saving money but do not use the energy themselves.

Both users use the app interface (and not the web, as it was not available at that time) and at the time they answered the survey they had experienced the platform for around one month. They use the app about once to twice a week. One user would prefer to have a PC version and not only the Android version. In addition, it was suggested that for some displays, the size of the symbols could be bigger, so that you can recognize them more easily.

As noted before, there are some technical issues related to the compatibility of the app on older Android version. However, these issues did not affect the experience of the specific users of the app.

Only one user received notifications, and it seems that the notifications were sent due to a problem with the sensors' installation (too far from each other, which made the algorithm think the window was open), and not due to a real issue.

Both users do not use the schedule option, due to lack of interest ('old fashion guy') and due to problems with the smart radiator valves (the valves themselves consume a lot of energy). Regarding the smart radiator valves, both mentioned that the batteries are depleting very quickly (less than a year) and this is an issue.

Both users find the energy saving tips too general and not very useful for themselves. However, it is likely that these general tips are known to people who are already familiar with energy saving and could be useful for others.

Both users do not fully understand the benchmark and its meaning, for example, who are the others in the case of a specific business. One suggested that it might be good to add information about how to improve performances.

The weather forecast is nice to have. But one user prefers getting it from the TV.

At the time of the interview, none of the users checked the consumption of appliances, although both said it is interesting.

The air quality feature was checked at least twice a week by one of user. The other is not sure if he has got one.

Both users were asked to rank the aspect which they use the most on the app on a scale on 1 (not at all) -10 (most used). Below is the ranking (separated with ;):

- Energy: 8; 10
- Weather: 1; 9
- Security: 8; 10
- Health: 2; N/A
- Benchmarking: 2; 10

Regarding energy consumption - both users suggested that it would be good to be able to select a time period for the energy consumption, and not having only one value. For example, total value since xx.xx.xxxx and a current consumption: last day or last hour in average, so that one gets a better feeling.

Regarding the Energy Management service - one user suggested to set-up the energy management for chosen meters. In addition, one user suggested to group part of the sensors, so that users don't have to make the same settings for each and every sensor again. Or that user can establish a time-pattern and link it to some of the sensors. 'Otherwise', the user said, 'it is kind of work-intensive to set it up, and therefore I wouldn't set up all of them'.

At the time of the interview, only one user received notifications and was pleased with it. However, this user said the notifications are not intuitive to understand.

Both users indicated that they find the app useful for identifying energy waste (e.g., empty rooms in which heating is running). But both find it hard to estimate the savings (in terms of energy of money).

None of the users interviewed use the remote control via actuators. Not because it is not useful, but rather because they are unsure what is plugged in (the actual energy users, i.e., the guest, might move it to a different socket).

None of the users had changed their consumption habits, but they do engage with the app and check consumption.

As energy managers of the building, they recognize the advantages of the app and think they will be willing to pay for such app. But they are not sure if they would do so as private users.

#### 4.3.1.2 Residential

Two residential users were interviewed.

Both have been using the app for 2-3 months. The installation process was easy in both cases, with no specific problems. However, there seems to be a problem with the energy monitoring of one of the homes, as the energy consumption value provided seems to be wrong.

One user uses the app from time to time and the other uses it daily.

One suggested that the heating information should be at the top of the page as this is the one he finds most interesting. He also suggested adding graphs to make information easily communicated.

None of them received notifications so far, so this aspect was not examined.

Both are interested in the scheduling service and use it daily. However, one user did not manage to save the schedule setting (in cases they want to change it for Christmas for example).

Both looked as the energy saving tips and find them useful, even as a reminder for people who already know them.

While both see the benchmarking when opening the app, but do not find the benchmarking services useful. One said it did not mean much to him, while the other said it is inaccurate as his energy consumption values are incorrect.

Both are interested in checking specific appliances' consumption. One of them indicated that this helped him to better understand his consumption. A summary of usage of appliance would be helpful. i.e., a graph on period of usage.

The air quality sensor is relevant only for one user, and he checked it only in the beginning.

Both users were asked to rank the aspect which they use the most on the app on a scale on 1 (not at all) -10 (most used). Below is the ranking (with ';' between replies) and comments:

a. Energy: 9; 10

b. Weather: 8, in case it can be connected to other functions, e.g. PV; 1-2
c. Security: not needed, I have only one motion sensor, and I don't need this functionality; 10, but we don't have it
d. Health: 2; N/A
e. Benchmarking: 4, it would be sufficient to have it in a sub-menu somewhere, doesn't need to be a prominent feature; 9, interesting, what other people in the surrounding in reality have. You hear or read a lot, but real values would be something reliable and different.

One user uses the energy management option, and finds it easy to use and understand. The other user said he tried it but it did not work. One user is planning to put a solar PV on his roof and is interested in energy management function that will help him to consume energy while the PV generates electricity. The consumption information is clear and easy to understand.
Graph and time period would be useful as well as adding separate data on heating.

Both indicated that the app contributes to their energy understanding and mindset, and that the fact that it is handy is helping them to save energy.

The heating related aspects are seen as the most useful by both users (bearing in mind that the interviews took place during winter time). In particular, the sensors and ability to control the radiator operation more efficiently. The information about how much energy is saved by reducing the thermostat by one degree is useful (and encourages action). One user replaced the Danfoss-App with the SEM and said the SEM is easier to use.

One suggestion is to have the option to set all heaters at once into "holiday-mode", so that they reduce the set-point to a given temperature. Setting each one individually is a lot of work, and then won't be done for only a short leave.

Both users did not yet try the scheduling option.

Both indicated that the option to remotely control appliances is useful and they are pleased with it, in particular heating. Pre-heating rooms is valuable and an important service.

Both think that the app helps them to save energy and to use energy more efficiently while not compromising on comfort – e.g., tailor the energy services (e.g. heating) to their precise need.

Both are interested in receiving a periodic report on their energy consumption, and would like it to be more sophisticated than simply overall consumption.

It would be good to have information about irregular events of the month, as well as a comparison to previous month/year plus information about temperature. A graph that shows the trend of consumption would be good (show improvements).

One issue that came up during the interview is how to add smart plugs to the gateway.

When asked about willingness to pay for such service, one replied that he thinks this service should be sold together with hardware and he was not sure if he will be interested in paying for the software alone. The other replied that if it was simple and well-arranged he might consider paying for this (but this person's profession is related to building services, so this answer might be biased).

As for the installation phase– both encountered some problems, with the heat meter reading, Bluetooth connections with the Danfoss radiator valves and range issues and the need of extender (large houses with two floors, or brick walls that prevent signals).

### 4.3.2 Main findings from VIL Demosites

Two interviews were held in VIL in early Feb. Both users are keen participants and have been using the app for nearly 8 months (although, at the beginning the funcunality of the app was limited).

Both users find the app easy to install and did not need any help. They also find the symbols easy to understand.

Both users engage with the app nearly every day, and use it mainly for checking temperature, heating, and turning off the radiators (even if they are away). Both indicated that they use the actuators / smart plugs but only for turn off heating.

Both indicated that they received (at least once) false notification that the house is unoccupied, while people were at home. This is an indication that the position sensors installed on the ceiling might not be in the right place.

Both tried the optimizer option (once or twice). But it is unclear if they actually used this service or just tried it for the purpose of trying the app. One user suspects that the optimzation might actually lead to energy waste rather than savings.

Regarding the optimzation: One user said he needed to reprogram everything every two weeks (because he is away every other week). While he can manually turn off all the radiators, he cannot just turn off the optimization planning and reactivate it after. He suggests to add an option to disable the planning instead of deleting one by one the planning events.

They did not receive any general energy saving tips.

They both find the benchmark service not very useful. One because he did not provide sufficient data, and the other said that his grade did not change, so he is unsure if this is really working.

Both like the weather forecast service and use it often.

Both users check the consumption of specific appliances. In particular – radiators.

Both check the air quality, but one of them does not understand what the value mean.

Both users were asked to rank the aspect which they use the most on the app on a scale on 1 (not at all) -10 (most used). Below is the ranking (with ';' between replies):

a. Energy: 6; 8
b. Weather: 5; 8
c. Security: 7; 8
d. Health: 8; 8
e. Benchmarking: 5; 3

Both users find the notifications easy to understand and clear

However, they suggest that the name of the appliance in the notification will be the same as the name in the sensor tracking list.

Regarding the security, one user suggested to improve the notification by sending open window alerts as soon as the window is open.

One user said that it would be useful if there was a clearer connection between the radiator thermostat (1-5) and actual temperature.

They find the consumption information useful and clear. However, there are some technical issues (e.g. the NILM device does not correspond to the right device plugged into it).

In addition, one user pointed out that there is no record of previous consumption. Hence, in order to compare, one would have to write them down somewhere, otherwise he loses the information.

Another suggestion is to provide the recommended temperature in a room, e.g. the living room, etc. Both say the app improves their energy understanding and helps them to save energy.

One suggestion is to provide a comparison over months. It would be useful to provide an analysis of the reasons for change in consumption.
Both indicated that due to the information provided by the app they changed their practice of using the radiator (use program 5 rather than 6, turn them down at night rather than turning them off; turning radiators off when opening window) and more generally, save energy.

Only one user uses the scheduling option and there only for heating.
Both used the option for remote control (switching off if left on by mistake, pre-heat the house).
Both cannot estimate the amount of energy and money they saved due to the app.
Both are not bothered if notifications were sent between 22:00 and 08:00. One added that it would be useful to receive notifications about an open window during night time.

They would like to receive periodic information about energy consumption per device over the month; e.g. a recap on air quality with a percentage of deviation from good quality. One user suggested that it would be interesting to see the total consumption in a month, and how much money was wasted due to situations such as open window while the radiator on.
Both indicated that they would be willing to pay a small amount of money (2-3 Euros per month) but some improvements are needed before (e.g., issues with temperature).

They did not encounter any discomfort during the installation of the sensors.

## 5 CLOSING GAPS: USERS SUGGESTIONS TO IMPROVE THE SEM RELEVANCE AND USABILITY

Based on the summary of the information provided above, this section lists the main feedback points and highlights gaps that if filled could improve the usability of the app and its suitability to users' needs.

Overall, all users think that the app is useful, easy to use and that it has improved their energy understanding ('energy literacy'). It helped them to identify energy waste and enabled them to act and save energy.

While the users estimate that the app helped them saving energy and money, they could not estimate by how much.

The behavior that changed the most is related to heating system management (switching off heating) and thermal comfort (reducing the temperature, pre-heating, closing windows).

In addition, the use of the app was not negatively affected users' comfort, and even the contrary – it helped them improve their comfort (e.g., pre-heat space), while allowing them to save energy.

As such, it had improved both their levels of agency and capacity and therefore resulted in behavioral change.

**Technical issues**

1. Smart plugs and gateways can be unplugged easily by uninformed people and this reduces the effectiveness and accurateness of the app. This problem is more likely to happen with people who are not the regular tenants of the buildings (e.g., guest in the guesthouse, cleaners, etc.). As mentioned above, Develco, the equipment provider, will examine whether the LED on smart plugs and smart cables could be made less dominant.

2. Battery fast depletion is a problem. While temporarily solved at the specific site (SON) this is likely to be a recurring problem. The added feature of battery status is useful, but the need for frequent replacement might be a barrier for the usefulness of the app in the future. In another

project, Develco Products is now testing prototypes of a zigbee-based radiator thermostat, which was not available at the time InBetween sensors installation took place. This is already showing much improved installation and is expected also to have longer battery life.

3. Currently the app does not run on older Android-versions or iOS.
4. It is important to provide an easy to use manual or explain to users how to add smart plugs and connect them to the gateway.

**Installation issues:**

1. The installation phase is important and there is a need to develop a clear and easy to understand installation guidelines.
2. Installing sensors and gateway in big houses could be problematic due to Bluetooth connection and range /distance between sensor and gateway. This should be explained to users.
3. Motion sensors should be carefully placed to capture the house real-time occupancy. Otherwise, users might receive false notifications about appliances that are switched on while the house is unoccupied. This, in turn, is likely to reduce users' trust in the platform which will result in withdrawal.

**Appearance issues:**

Overall, the appearance is good and the app is clear and easy to understand.

1. In some displays, the font and symbols are too small and hard to read. This might be a problem for elderly or people with eyesight problems.
2. Because heating is the largest consumer and because the app offers an easy way to manage heating, it was suggested that heating information would appear on the top, separately from the overall consumption.

**The services:**

1. <u>Notifications:</u>

   We cannot evaluate at this point of time because there was not enough experience with them. However, they are being perceived as valuable.

   Wrong notifications were sent several times probably because the motion sensor did not detect people in home and triggered false alerts.

It is recommended that the name of appliance on the notification would be the same as on the sensor tracking list.

2. Consumption:

More sophisticated ways to show information are important. For example, it would be useful to offer options to breakdown consumption information, or to allow users to define a consumption period of time (weekly consumption, rather than monthly, or consumption over the last hour or day).

Graph and time period would be useful as well as adding separate data on heating.

Pointing at irregularity of consumption would be useful.

It would be interesting to add cost information to consumption in specific month, and show how much money was wasted due to situations such as open window while the radiator on.

3. Energy management, scheduling and optimization:

Overall, users find the energy management options useful and easy to understand.
It would be good to set-up the energy management for chosen meters. For example, to have the option to group part of the sensors, so that users do not have to make the same settings for each and every sensor again.
The option to save settings is important. It was suggested to allow saving specific settings and use them when needed.
In a similar manner, it was suggested that in order to make it easier it would be good to allow users to set a time-pattern and link it to some of the sensors at once (rather than do it individually).
Likewise, instead of changing the setting of various appliances separately before going away for a few days, it would be useful to have either a pre-set option or allow users to set themselves a holiday setting that puts all appliances to the same schedule / mode.

4. Appliances energy consumption:

This was perceived by the SON non-residential users as important and interesting (although none of them used it). Residential users who used it find it helpful and easy to manage.

It would be useful to have summary information per appliance – how much it is used, how often etc. Providing the information in a graph would be useful.

The information about how much energy would be saved by reducing the thermostat by one degree is useful and encourages action. Adding this information next to the heating management option might lead to greater savings.

In the same vein, it was suggested to provide a recommended temperature for rooms, e.g., the living room, etc.

5. Benchmarking:

While all users find the benchmarking interesting and they see it every time they use the app, it is evident that they do not know how to interpret it.

In the non-residential case – it is unclear who the others are.

A more detailed (yet simple) explanation should be added to the benchmarking.

It is suggested to associate the benchmark with advice on how to save energy and improve the rank.

6. Energy saving tips:

The tips themselves are general and people who are working within the energy field might be already familiar with them. However, the tips remind users to save energy and keep them engaged. Hence, the notifications are nudges and a means to increase engagement and awareness.

The tips would be more useful if a specific tip is associated with notification or a summary report of usage.

7. Air quality

This service is important and useful.

It would be good to add accessible reference / information that will help them to understand what the levels reported actually mean.

It would be useful to be advised on percentage of deviation from good air quality.

8. Weather forecast:

For some, the weather forecast services improves the app usefulness.

9. PV generation adjusted consumption:

Currently we do not offer this service.

However, managing appliances / consumption in line with PV generation hours would be an important service that SEM could offer. Currently one user mentioned it. However, the number

of household/buildings likely to install solar PV is large (and growing) and this growing segment of society might be interested in SEM.

In addition, while in the winter engagement is high due to heating systems, in the summer, when no heating is required it is likely that people will not be engaged with the app. Adding the PV adjusted consumption is a way to make the app useful in summer (in places when there is no need for cooling).

All users were asked to rank the aspect which they use the most on the app on a scale on 1 (not at all) -10 (most used). A summary of App ranking is presented in Table 3. The table shows the variability of replies. It also highlights the high ranking of the energy aspects as well as the security functions.

**Table 3: App services ranking**

| | SON non-res | SON non-res | SON res | SON res | VIL | VIL |
|---|---|---|---|---|---|---|
| Energy | 8 | 10 | 9 | 10 | 6 | 8 |
| Weather | 1 | 9 | 8 | 2 | 5 | 8 |
| Security | 8 | 10 | n/a | n/a | 7 | 8 |
| Health | 2 | n/a | 2 | n/a | 8 | 8 |
| Benchmarking | 2 | 10 | 4 | 9 | 5 | 3 |

**Willingness to pay for the app**

Users think the app, if and when improved, is useful but either should be sold together with the hardware or be sold for a small monthly fee (single digit).

## 6 CONCLUSIONS

Bearing in mind the short period of time in which the app has been used, the low reply rate, and the fact that the interviewed participants are probably among the most engaged, we conclude that from the feedback gathered informally and in the interviews, the platform and app are useful. In addition, the use of the app has not negatively affected users' comfort, and even the contrary – it helped them

improve their comfort (e.g., pre-heat space), while allowing them to save energy. As such, as outlined above the app can, and actually had improved users' levels of agency and capacity, and therefore resulted in greater energy literacy, and likely behavioral change and energy savings.

In line with the user-centric approach we apply in the InBetween project, we approached users and asked them what is missing and what would make the app and services better tailored to their needs and more useful. The results presented in Section 5 above highlight the need to allow a more detailed energy consumption breakdown, as well as better connecting savings to actions (what was done that affected consumption) and vice versa (what could be done to trigger savings). The general tips would be more useful if a specific tip would be associated with notification or a summary report of usage.

The results also indicate that the app is valuable in the winter for managing thermal comfort and saving energy. An aspect to take under consideration is how to make the app useful during summer days. While the app could work well with air conditioners and apply the same energy saving logic, in both demo sites no space cooling systems are used.
One option to make the app useful in summer times is to use the PV generation forecast and advice users on how to adjust their consumption with local generation.

# 7 ANNEX 1: GUIDELINES FOR THE INTERVIEW

Over all aim: The questionnaire aims to examine how the tool contributes to users' energy-savings related to Agency and Capacity, i.e., how it (a) improves their energy understanding and provides motivations to save energy, and (b) enhances their ability to act and change behavior in order to save energy. What changes in the tool could further enhance their agency and capacity?

While this questionnaire is very detailed, it is also long. For gaining user attention for such a detailed survey, we need to prioritize between questions.
The main aim of the interviews is trying to gather information from users in order to improve the tool (app/web). Therefore, although the questions about the installation are important, I suggest asking them at the end of the interview, as the input about the installation is less relevant to the next deliverables.

In the introduction to the survey we need to highlight that (a) this is part of the co-design and user-centric approach of the project, (b) the tool is in its development stage and we are consulting users in order to understand their views, (c) the input they provide will be fed back to developers and used to improve the tool. And finally, (d) we need their honest views, and there is no 'right' or 'wrong' questions.

The information they provide will be used only for these purposes.

Note that we need to be careful with the way questions are asked. Some of the questions are biased *(e.g., 'have you felt disturbed by…?'*). We need to make sure we are using neutral language rather than leading ones, and only if someone says something negative/positive on the technology/process, keep digging into it.

Please consider the status of the people and elaborate on it in the interview – if they live on their own or live with other family members, etc.