D7.1 PILOT BASELINE AND ACTION PLAN

Definition of the baselines of the pilots and the action plan for community engagement, technical deployment, feedback gathering and KPI validation

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History of changes

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EXECUTIVE SUMMARY

"D.7.1 Pilot baselines and action plans" is specified in the enCOMPASS Description of Action as defining:

"the baselines of the pilots and the action plan for community engagement, technical deployment, feedback gathering and KPI validation".

This deliverable is one of the outputs of the project task "T7.1 User community management, baseline collection, and pilot planning", whose main objective is the development of the strategy and action plans to recruit and activate users in the project pilots, thus providing recruitment campaign coordination, activity planning, and progress monitoring of user recruitment in the project pilots. Recruitment concerns users of the pilots, invited to participate in the trial of the gamified energy-saving apps and the digital-physical game.

For an overall description of the dependencies among the above task T7.1 and the other project tasks and work packages, please refer to section 3.1.2 of the enCOMPASS Description of Action. D7.1 in particular is a main input for the task "T7.2 Baseline refinement and validation methodology" in WP7 (Pilots on behavior change for energy-saving), which will specify the details of the proposed validation methodology as well as the exact selection of indicators and instruments for assessing the KPIs. These outputs of task T7.2 will be discussed in detail in the deliverable D7.2 Validation Methodology and Action Plan. The objective of this deliverable D7.1 is to provide a basic methodological outline for the validation and the action plan for user engagement, technical deployment and feedback gathering in the enCOMPASS pilots.

This document is structured as follows:

- Section 2 describes the goals and motivations of each pilot.
- Section 3 specifies the planning of the pilot validation, the baseline collection (both regarding quantitative electric energy consumption and qualitative energy behavior), the monitoring periods, the definition of control/intervention groups, the monitoring techniques of the KPIs.
- Section 4 details the plan for the technical deployment of the infrastructure required by the pilot trials, e.g. sensors, smart meters, communication networks, smartphone applications.
- Section 5 describes the strategy and action plans to recruit and activate users, also specifying how they will be involved in the different pilot phases.
- Section 6 presents the plan for the validation of the KPIs measuring the impact of enCOMPASS.

1. GOALS AND CHARACTERISTICS OF THE ENCOMPASS PILOTS

The enCOMPASS project will implement and validate a holistic socio-technical system that will stimulate behaviour change of end-consumers by providing innovative visualisation and feedback of their energy consumption data, accompanied by personalised energy saving recommendations and intelligent control.

To validate the suitability and impact of the enCOMPASS system for stimulating behaviour change for energy saving, the developed system will be deployed and evaluated in three real-world pilots in three different climate zones (humid continental, hot-summer Mediterranean, continental subarctic) and three different types of buildings (schools, residential buildings, public office buildings).

To this purpose, three pilot settings with complementary characteristics have been defined:

- **Germany**: town-wide pilot for energy saving in small urban contexts, with smart-metered energy data provided by SHF.
- **Switzerland**: regional pilot for energy-saving in small-scale local contexts, with smarte-metered energy data metered by SES.
- **Greece**: town pilot for energy saving in large urban contexts with smart-metered energy data provided by VWT.

The three pilots are based on holistic approaches for behavioral change, with an original mix of gamified incentives, adaptive energy saving recommendations and smart devices, grounded in a theoretically sound behavioral change methodology expected to have a durable impact on energy consumption in households, public buildings and schools.

To evaluate the energy savings resulting from the use of the enCOMPASS system a before-after comparison will be performed, relying on a comparison of a baseline and a reporting period. The effect on behavioural changes will also be measured by a before-after comparison of theoretically-grounded proxies of behavioural predictors (e.g. awareness, intention to act etc.). In addition, adhering to the eeMEASURE methodology, a control group will be recruited for the residential households, in order to perform a treatment vs. control group comparison regarding the effects of the enCOMPASS system (e.g. on energy consumption and behaviourial predictors). The overall validation design is depicted in Section 3. In the following, we first summarize the main characteristics of the three enCOMPASS pilots and give an overview of the main pilot plan actions.

1.1 German pilot

The German pilot takes place in Hassfurt, a small town between Bamberg and Schweinfurt in Lower Franconia, Bavaria. Hassfurt has 14.000 inhabitants (as of 31.12.16) thus representing a small-scale urban setting.

The effectiveness of the enCOMPASS approach will be assessed in 100 households, Different types of residential buildings and customer profiles (families, one-person households etc.) will be covered, to allow for the evaluation of different scenarios based on different occupation types. Furthermore, the encOMPASS approach will also be assessed in the elementary school “Grundschule Nassachtal” and in the public building “Altes Rathaus” of the Municipality of Hassfurt. This building hosts the citizen contact office (“Bürgeramt”) and is located in downtown Hassfurt which makes it a suitable choice for the public building validation scenario.

In Hassfurt, about 10.000 smart meters have been installed since 2009 to monitor electricity consumption at the house inlet of all buildings. First implementations of two different Smart Home systems are already available in several households, this will be extended for all pilot households. This will allow to monitor internal household comfort via smart sensors (e.g. presence and temperature sensors, door/window sensors, that will be defined in D2.1), as well as to include selectd action controls into the enCOMPASS system and application scenarios.The school and the public building will also be equipped with Smart Home systems for the duration of the pilot.

1.2 Greek pilot

The Greek pilot takes place in two different sites: Thessaloniki and Athens. Thessaloniki is the second largest city in Greece and the capital of Greek Macedonia. It has a population of more than 1.100.000 inhabitants. Athens is the capital and largest city of Greece, with a population of more than 3 million inhabitants. These cities thus represent the large urban setting scenario in enCOMPASS.

WVT will assess the effectiveness of the enCOMPASS approach in households in Thessaloniki. Different types of residential buildings and customer profiles (families, students, one-person occupied flats etc.) will be covered, to allow for the evaluation of different scenarios based on different occupation patterns. All dwellings are part of WVT's portfolio and already with smart meters, allowing for real-time monitoring of consumption, either per residence or per room's power outlets using the company's home automation system, called "smart watt", which utilizes smart plugs. The internal household comfort will be monitored via the "smart watt" sensors, such as presence and temperature sensors, door/window sensors, while action controls would be applied using "smart watt" application scenarios.

The IEK DELTA School in Thessaloniki, a multi-level building, will be involved as a school building. This private institution includes several classrooms, laboratories and offices. The institution is already equipped with a central corporate energy meter. As public buildings, the W+V headquarters (consisting of personnel offices) and the WVT Flagship Retail Store (including personnel offices and a publicly accessible retail store) will be involved.

An additional public building involved in the Greek pilot study is the National Documentation Centre (NDC) in Athens. It consists of an old public building in the heart of Athens, with a 6-storey office building and a big open-scale public library. Two floors (ground & 6th floor) will be included in the pilot area, consisting of offices, meeting rooms and the library with tables equipped with individual lights, used by the library visitors.

1.3 Swiss pilot

The Swiss pilot takes place in Gambarogno, a small district in the Ticino canton. Gambarogno has 5.136 inhabitants (as of 31.12.15) distributed among the fractions of Caviano, Contone, Gerra, Indemini, Magadino, Piazzogna, San Nazzaro, Sant' Abbondio, and Vira Gambarogno.

The fraction of Contone (738 inhabitants) has been selected to assess effectiveness of the enCOMPASS approach in households. This represents the small-scale local setting scenario in enCOMPASS. enCOMPASS will be also tested in the elementary school located in the Quartino-Cadepezzo neighborhood of Gambarogno. Finally, the building of the Municipality of Gambarogno, located in the fraction of Vira, was selected to test the effectiveness of enCOMPASS in public buildings.

In Contone, 614 smart meters were installed by the enCOMPASS partner SES soon after the start of the enCOMPASS project, to monitor electricity consumption at the house inlet. Smart electricity meters are also being installed both in the municipality building in Vira and in the elementary school in Quartino-Cadepezzo, to start collecting baseline energy consumption data. Additional sensors will be installed in the households (e.g. temperature and presence sensor) following the early requirements specification in the deliverable D2.1.

1.4 Overview of the action plan for the pilot trials

The planning of the pilot trials in the enCOMPASS project is a critical activity, a careful interweaving and sequencing of actions, performed by all project partners, and essential to the success of the project.

In

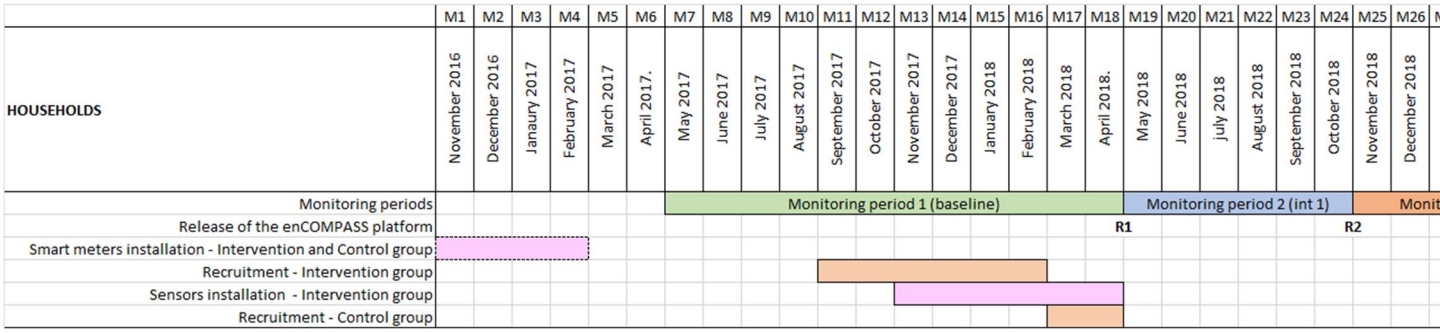

Figure 1,

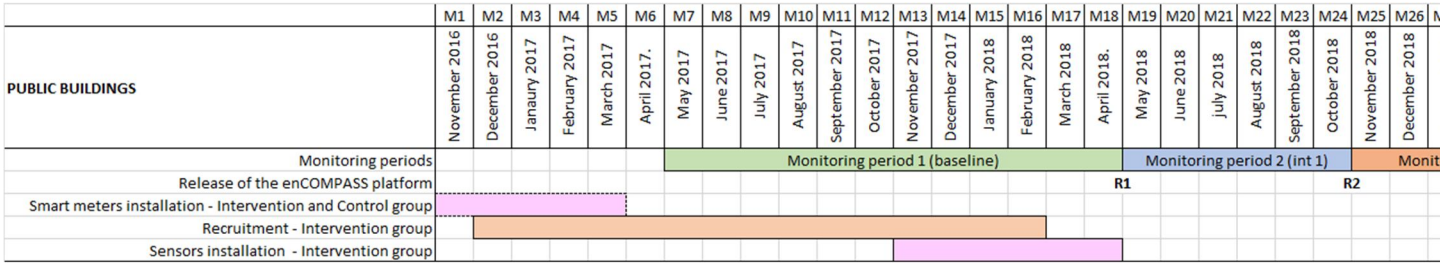

Figure 2 and Figure 3 we detail the timelines of the plans for the trials in the households, in the public buildings and in the schools, respectively. In the following sections, we will detail the specific technical deployment plans for the three pilots. Here we first highlight the overall structure and timing:

- From M1 (November 2016) until M5 (March 2017) the smart meters are being installed in the three pilots, in residential, public and school buildings, where not already available.
- From M7 (May 2017) until M18 (April 2018) included, electrical energy consumption will be recorded, to extend and/or build the reference baseline (where smart meters were newly installed).
- Sensor deployment in the buildings will start in M13 (November 2017) and will be finished by M18 (April 2018). For schools, sensor deployment will be concluded by M21 (July 2018).

- The households taking part in the intervention group will be recruited starting in M11 (September 2017) and are expected to conclude by the end of M16 (February 2018)[1].
- Finally, the control group will be defined in the period spanning M17 (March 2018) and M18 (April 2018).
- For schools and public buildings the recruitment phase of the intervention group has already started due to the time-consuming bureaucratic procedures needed to get in contact with the building managers and staff, and will be concluded the latest by M21 (July 2018).
- For households and public buildings, intervention (trial of the enCOMPASS platform) will take place in the periods M19 (May 2018) - M24 (October 2018), and M25 (November 2018) - M33 (July 2019).
- For schools, intervention will take place in the periods M23 (September 2018) – M27 (January 2019), and M28 (February 2019) – M32 (June 2019).

This plan includes buffer times allowing for contingency planning in the case of unforeseen problems arising, and has been designed to maximize its robustness, as well as to match periods when schools will be available for the trial.

1 Beyond the scope of this deliverable, a small group of user representatives will also be involved in the requirements analysis for the enCOMPASS system in WP2. For this, in WP2 a workshop/focus group with users have been planned to take place in September 2017 to get input on so far defined requirements and mockups of the enCOMPASS system. The description of the requirements analysis process is subject of D2.1. This is an independent activity from the pilot and validation action plan that is reported here.

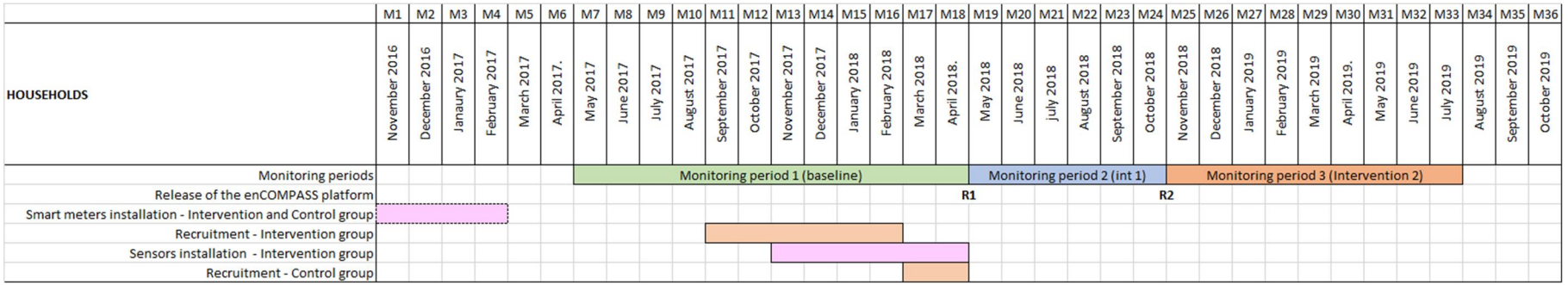

Figure 1: Timeline of the enCOMPASS trial for households

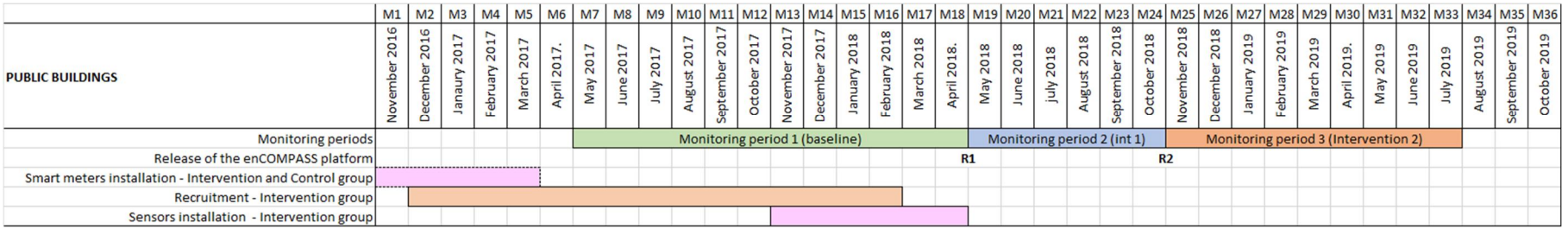

Figure 2: Timeline of the enCOMPASS trial for public buildings

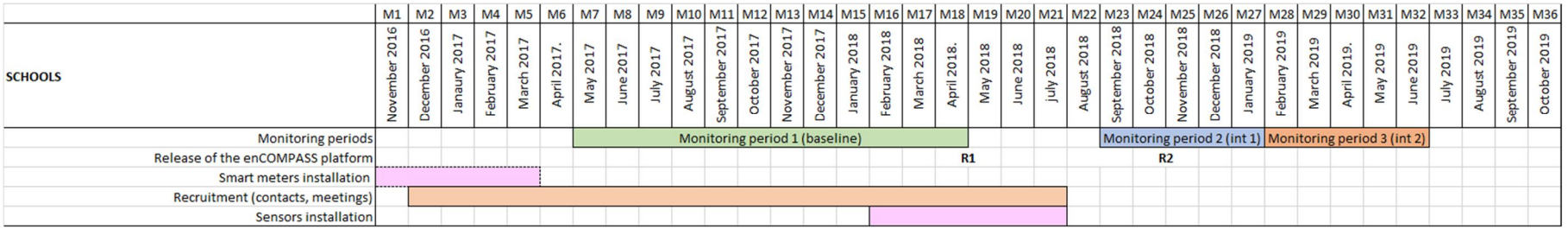

Figure 3: Timeline of the enCOMPASS trial for schools

2. VALIDATION PLAN FOR THE ENCOMPASS PILOT TRIALS

The validation plan for assessing the impact of the various features of the enCOMPASS platform consists of the following steps:

1. Define the time duration of the trial.
2. Define the intervention and control group sample sizes and recruitment strategies.
3. Prepare the data collection infrastructure, making sure data are collected in a reliable and reproducible manner.
4. Perform a statistical analysis on the trial outcomes and compile a report.

The general structure of the pilot trials is summarized in

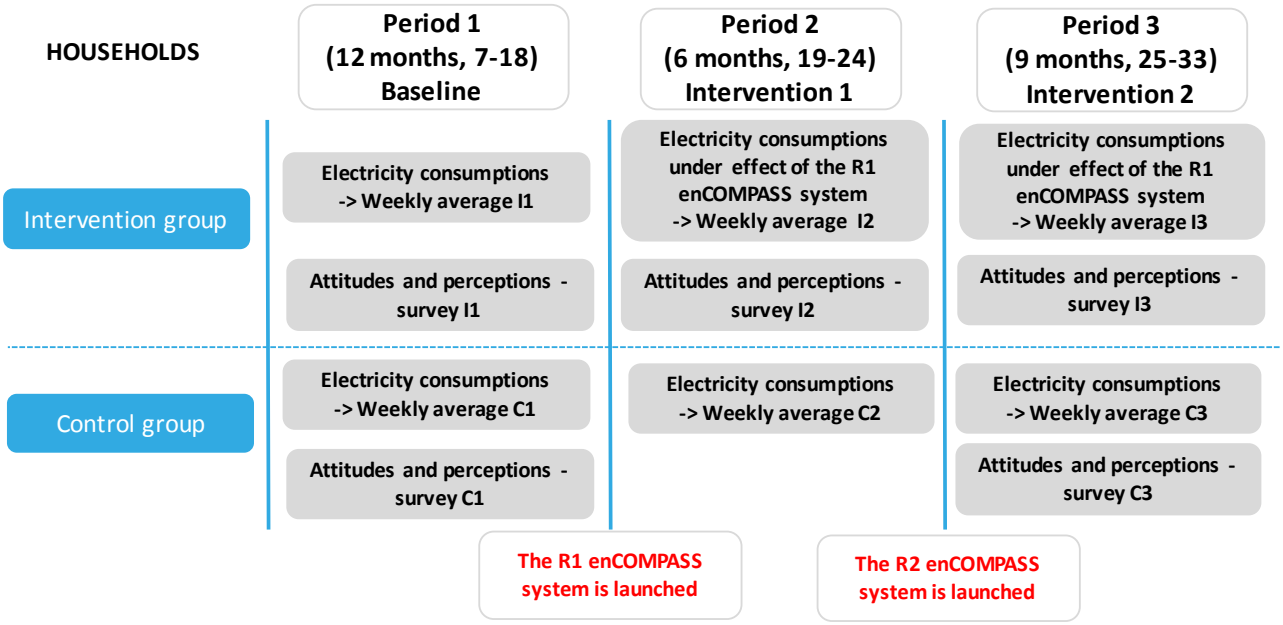

Figure 4, Figure 5 and Figure 6, respectively related to households, public buildings and schools.

For residential users, activities envision three monitoring periods and two sample groups: an intervention and a control group. During the monitoring periods, both energy-consumption data (electricity-consumption data gathered by the smart meters) and behavioural data (proxies for behavioural predictors) will be collected:

- In period 1 baseline electricity consumption and energy behavior data will be collected.
- In period 2 data will again be collected, while:
  - The intervention group will be using the release 1 enCOMPASS platform.
  - The control group will not be influenced by any enCOMPASS tool.
- In period 3 data will again be collected, while:
  - The intervention group will be using the release 2 enCOMPASS platform.
  - The control group will not be influenced by any enCOMPASS tool.

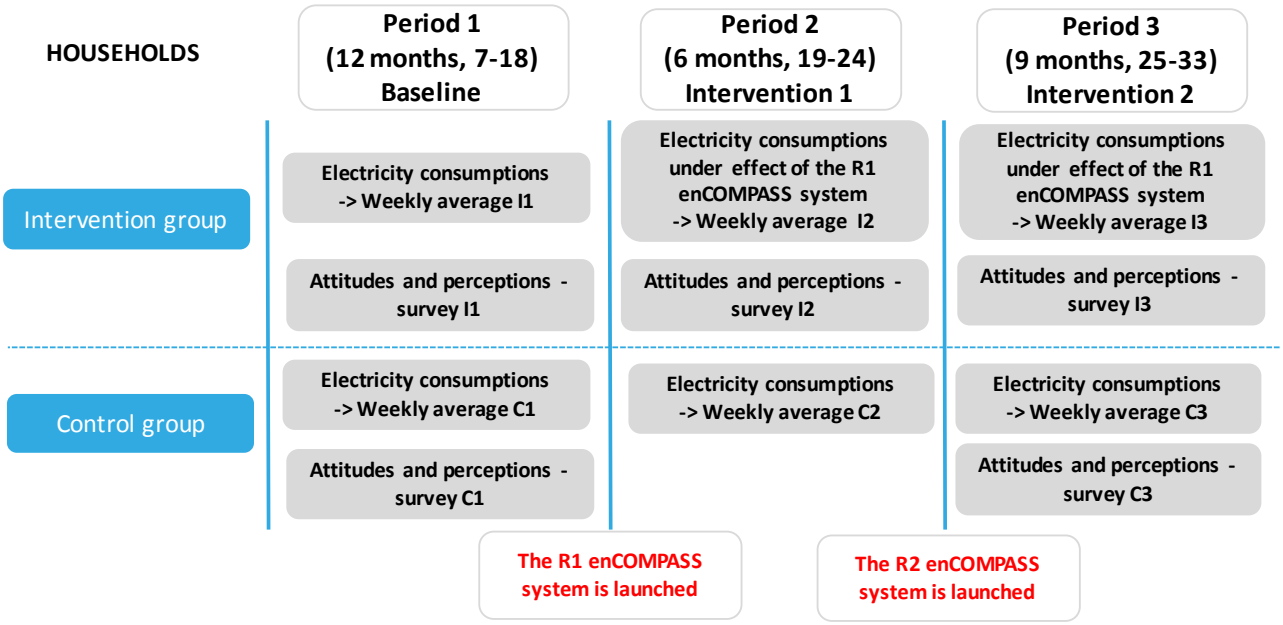

Figure 4: General design of the enCOMPASS pilot trials for households

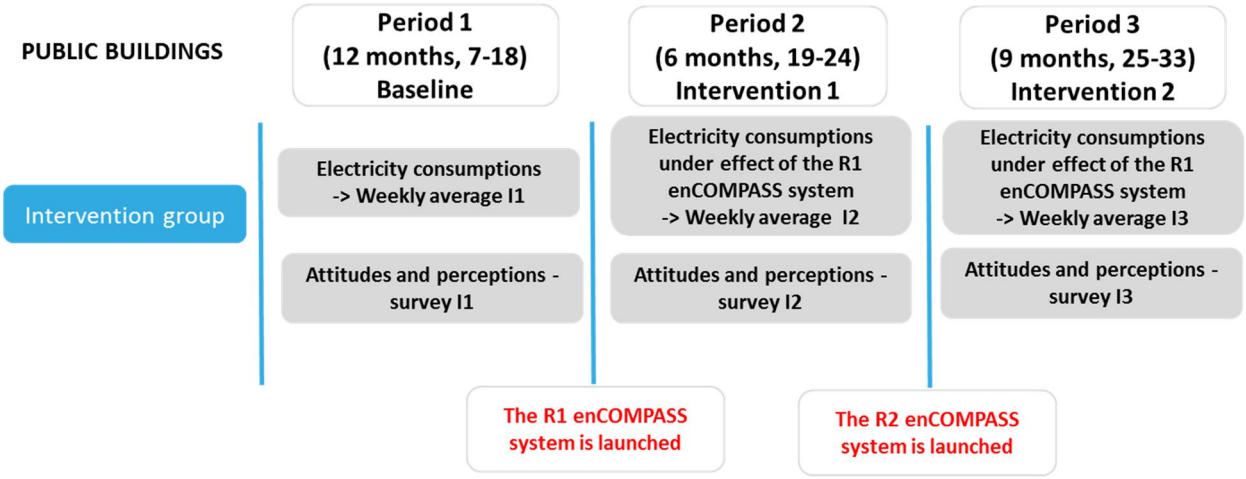

Figure 5: General design of the enCOMPASS trial for public buildings

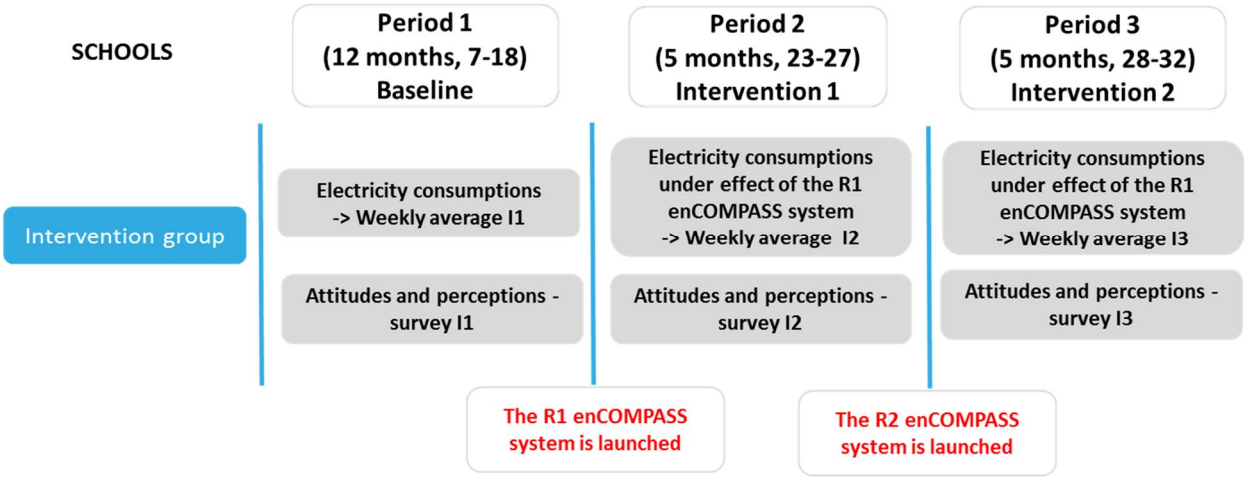

Figure 6: General design of the enCOMPASS trial for schools

The three monitoring periods are run consecutively and, during these periods, data of the involved users will be continuously collected. The third and final release of the enCOMPASS platform (R3, Month 36 – October 2019) simply includes bug fixes and final refinements that were identified as a result of the trials, and therefore does not need to be tested.

Intervention periods are the same for households and public buildings. For schools, instead, we set a slightly different timeline, to adequately account for summer holiday periods, when schools are closed. To avoid holes in the intervention periods, and consequent drops in user engagement levels, the deployment of the enCOMPASS platform in schools will start at M23 (September 2018), as soon as regular school activities restart after the summer break. Also, intervention in schools will stop one month earlier: Intervention period 2 will conclude at M32 (June 2019). Overall, due to holiday periods, pilot activities in schools will be five months shorter than those in households and public buildings.

Quantitative assessment of the effectiveness of the enCOMPASS platform will be performed by means of a "difference in differences approach" (Abadie, 2005), as envisioned by the eeMeasure methodology[2] (Lohmann, Heilmann, Hacke, & Robinson, 2011):

- Electricity consumption and behavioral data will be compared between the monitoring periods, to identify differences between Period 2 and Period 1, and differences between Period 3 and Period 1, both for the intervention group and the control group.
- Such differences will then be compared between the intervention group and the control group.

This will allow to univocally attribute to the enCOMPASS platform the expected positive effects in terms of reduction in electricity consumptions and change in energy behavior (attitudes and perceptions). Note that the eeMeasure methodology will be thoroughly described in deliverable D7.2 Validation Methodology.

2 The ICT PSP Methodology for Energy Saving Measurement, Available at:
http://eemeasure.smartspaces.eu/static/files/eemeasure_residential_methodology.pdf [accessed 22/02/2017]

Smart meters installed in each pilot site will automatically gather electricity consumption data. User perceptions and attitudes will instead be assessed using methods typically employed in user-centered design research and psychological research, such as questionnaires, focus groups or interviews. This will be performed in alignment with the deployment plan (see Figure 5,6 and 7).

As in the case of households, both quantitative electricity consumption and qualitative behavioral data will be collected for schools and public buildings. This will be done in line with the same monitoring periods. But in contrast to the households, samples regarding schools and public buildings will not be backed up by a control group: finding a school for the control group that is comparable to that of the intervention group (in building type, pupil composition etc.) is virtually impossible in small settings in the German and Swiss pilots as is for the private college in the Greek pilot, that is unique in the city of Thessaloniki. However, the effectiveness of enCOMPASS will be assessed by means of the eeMeasure also for the schools, following the specific eeMeasure methodology available for case studies without a control group (which use regression models to estimate the projected energy consumption after the intervention).

We also highlight that the version of the enCOMPASS platform targeting schools and public buildings may be different with respect to the one targeting households, since it will be customized to specific energy-saving needs and opportunities related to collectively used buildings.

Finally, we remark that the different durations of the three monitoring periods, which also run in different periods of the year, will impose the adoption of correction factors, to make electricity consumption data directly comparable. This will be done in line with the eeMeasure methodology.

2.1 Sample size

In each of the three pilot studies, the expected size of the enCOMPASS intervention group sample is set as follows:

- 100 households, corresponding to a total of around 200 participants.
- 1 school.
- 1 public building.

Households of the intervention groups will be stratified by the following parameters:

- Size: Single-person/couple/more than two person households.
- Type of house: Single-family house (including terraced house)/apartment.
- Type of heating: Electricity-fed (heat pump, direct electricity)/oil/gas/wood/other.
- Type of hot water boiler: Electricity-fed/oil/gas/wood/other.

Whenever possible, the same stratification will be applied to households of the same area, and, adopting the same proportions as the Intervention groups, further samples of 100 households will be randomly selected, to create three control groups in line with the eeMeasure methodology. The control groups will thus be totally uninfluenced by any measure or action channelled through the enCOMPASS platform: they will not receive other information on their consumption than the regular yearly energy bills. They will only be asked to take part in a survey/interview/focus group in each monitoring period, to collect the behavioral data, and will be informed that their electricity consumption data will be monitored by the project.

Schools and public buildings have instead already been selected, and they are briefly introduced in the following sections.

The table below summarizes the characteristics of the expected data samples for households in the three case studies, regarding both the intervention and the control groups.

Table 1: Households sample sizes in the three pilot studies

Households	*Installed meters*	*Intervention group provided with the enCOMPASS system*	*Control group*
Gambarogno (CH)	614	100	100
Hassfurt (DE)	10’000	100	100
Thessaloniki (GR)	400	100	100

3. TECHNICAL DEPLOYMENT PLAN

3.1 Electricity consumption data

In the German and Greek pilot deployments, smart meters were already installed at the premises of the users that will be included in the intervention/control groups. Differently, in the Swiss pilot, smart meters were installed during months 1-4 (November 2016 – February 2017) in all the households of Contone, as part of the enCOMPASS activities.

As mentioned in Section 2, baseline electricity consumption measurements of both the intervention group and the control group will be collected during Monitoring period 1 (i.e. from Month 7: May 2017 to Month 18: April 2018, see

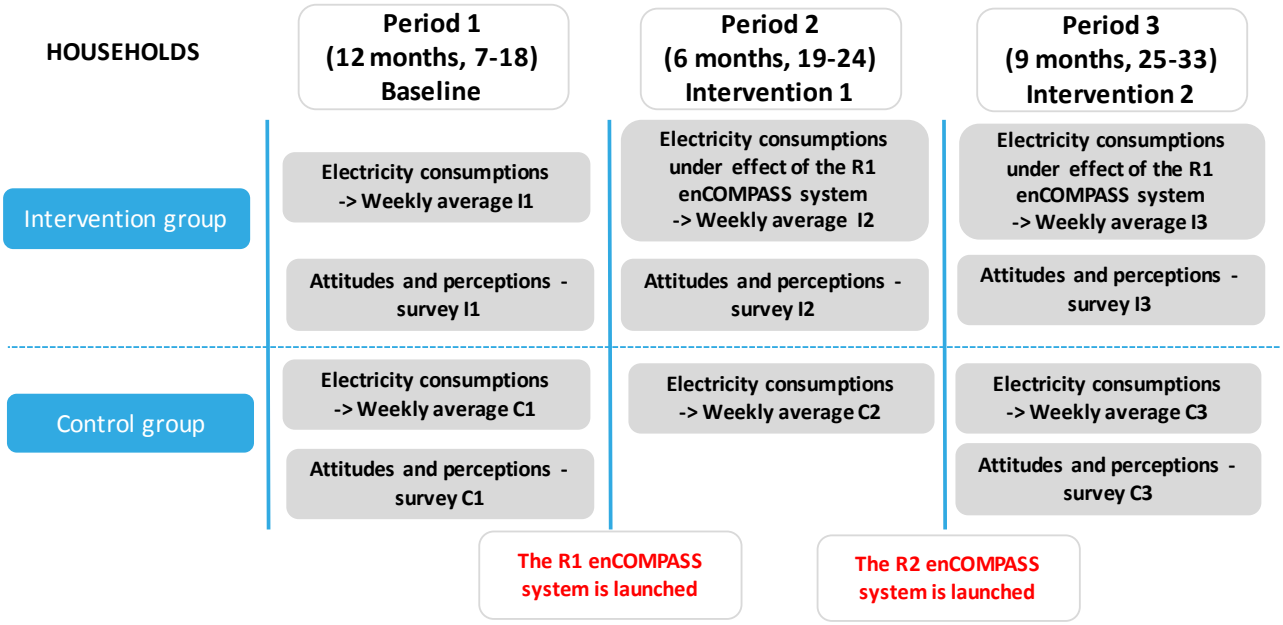

Figure 4). Historical electricity consumption data (i.e. electricity consumption measurements collected before the beginning of the enCOMPASS project) are available for the three pilot deployments: the details of the available information at each site for every building type are summarized in Table 2-Table 4. More detailed data have already been provided in deliverable D3.1.

Table 2: Details on available historical electricity consumption data of residential buildings (households for both the intervention group and the control group)

Households	*Number of monitored users*	*Data granularity*	*Time span covered by historical data*	*Average consumption*	
Gambarogno (CH)	5'200	Monthly	2010-2016	~~5'200 kWh/year~~	12610 kWh/yr
Hassfurt (DE)	10'000	Hourly	2011-2016	~~5'000 kWh/year~~	17000 kWh/yr
Thessaloniki (GR)	400	Monthly	2016	~~8'000 kWh/year~~	7500 kWh/yr

Table 3: Details on available historical electricity consumption data of school buildings

School buildings	*Number of monitored buildings*	*Data granularity*	*Time span covered by historical data*	*Average consumption*

Gambarogno (CH)	1	Yearly	2014-2016	~~30'171~~ kWh/year (for electricity) +200'000 kWh/year (for heating)	63050 kWh/yr
Hassfurt (DE)	1	Hourly	2011-2016	~~13'000 kWh/year~~	22000 kWh/yr + 296000 heating
Thessaloniki (GR)	1	Monthly	2016	360'000 kWh/year	

Table 4: Details on available historical electricity consumption data of public buildings

Public buildings	*Number of monitored buildings*	*Data granularity*	*Time span covered by historical data*	*Average consumption*	
Gambarogno (CH)	1	Yearly	2014-2016	~~124'167 kWh/year~~	100'880 kWh/yr
Hassfurt (DE)	1	Hourly	2011-2016	~~8'000 kWh/year~~	22592 kWh/yr + 155226 heating
Thessaloniki (GR)	1	Monthly	2016	24'000 kWh/year (WVT Flagship Retail Store)	
Athens (GR)	2	Monthly	2016	160'000 kWh/year (W+T Headquarters)	
		Monthly	2016	275'000 kWh/year (NHRF)	

3.2 Sensor data

Besides electricity metering, the enCOMPASS platform will also collect data produced by a variety of sensors, monitoring humidity, indoor temperature, pressure, and presence of people in the room. Table 5 shows the full list of sensors used within enCOMPASS. However, the subset of available sensors will differ across building type and pilot trial. The specific list of sensors for each pilot will be presented in detail in the deliverable D2.1 based on the findings obtained in the requirements analysis process.

Sensors will be installed in all households and public buildings of the intervention group at the latest by the end of M18 (April 2018); in schools, they will be installed by M21 (July 2018). Apart from schools, where activities will start after the 2018 summer holidays, the full metering system for households and public buildings (electricity smart meters and sensors) will therefore be fully operating in Month 19 (May 2018), in occurrence of the release of the R1 enCOMPASS platform.

External temperature data will be retrieved through local meteorological services. In some cases, external temperature sensors will be installed to get more accurate local measures.

Data regarding energy behavior (attitudes and perception) will instead be collected by means of online surveys and/or interviews or focus groups (the exact choice will be made in deliverable D7.2 Validation Methodology), respectively held towards the end of monitoring period 1 (Baseline), monitoring period 2 (Intervention period 1) and monitoring period 3 (Intervention period 2).

Table 5: Independent variables that will be measured and used within enCOMPASS (in households for intervention groups, schools and public buildings)

Variable Name	*Measurement Unit*	*Source of data*
Indoor Temperature	Celsius	Temperature sensors
Indoor/Outdoor Humidity	%	Humidity sensors
Indoor/Outdoor Luminance	Lux	Luminance sensors
Presence	[True/False]	Presence sensors

Door/Window Status	[Open/Close]	Magnetic contact sensors

3.3 Data anonymization

As the enCOMPASS architecture dictates, electricity consumption data are continuously fed into the enCOMPASS database by the energy utilities. This happens thanks to the Smart Meter Data Manager Component, a software component that parses the data files received from the energy utility and feeds the enCOMPASS database.

The enCOMPASS data model (see D3.1 datasets with context data and energy consumption data) can accommodate data measured at different temporal resolutions.

In the enCOMPASS database each smart meter is identified by a unique ID, which is totally anonymous. The geographical information associated with the meter ID is coarse: it will be only possible to know whether the meter is in Switzerland, Germany or Greece. For the Swiss pilot, being the pilot location limited in its dimension, there will be no further information on its location. For the German pilot, there will again be no information on the location of the meter in Hassfurt, although the meters will be located all over the city. For the Greek pilot the meters' location information is the city name.

The meter ID of the SHF, WTV and SES users living in the pilot study areas will be associated with their user ID in the enCOMPASS platform. The association can take place in an anonymous way thanks to a pseudonimisation table maintained by the energy utilities.

Table 6: Meter ID mapping table

Customer ID	*True meter ID*	*enCOMPASS meter ID*
1234	CH_GWF_1234	431242445
5678	SWHYYYY	798465809

The data contained in the pseudonimisation table are managed by the local energy utility. The energy utility knows the "Customer ID" and the true meter ID. Based on this information, the energy utility generates an anonymized "enCOMPASS meter ID", which is uniquely mapped to the "True meter ID" (see Table 6). This "enCOMPASS meter ID" is transmitted to the enCOMPASS platform, together with the meter readings.

During recruitment activities, the energy utilities will communicate with their customers (either by standard mail or by email), inviting them to join the trial phase. In this letter, selected users will receive the enCOMPASS meter ID. This is the only information they need to create an account on the enCOMPASS platform and to associate their newly created account with their own meter readings. From then on, the users will be able to add more data in their profile, for instance regarding the composition of the household, the number of appliances, their type, etc. The data will then be stored in an SQL database, allowing for fast retrieval and processing to compute the key performance indicators defined in Section 5.

4. USER ENGAGEMENT PLAN

In this Section, we present activities envisioned to guarantee appropriate user engagement and effective involvement of households, schools and public buildings.

In all pilot studies participants are identified on a voluntary basis. Countermeasures will be taken to mitigate both a possible selection bias and the risk of participants dropping out before the end of the trial. Such countermeasures could include physical rewards to be awarded at the end of the monitoring periods, virtual rewards (e.g. points for participating in a questionnaire), or randomized draws open to all active participants.

4.1 German pilot

All activities will take place in the city of Hassfurt: households, children attending the local school, civil servants and local decision-makers working at the municipal building “Altes Rathaus”. The presence of such tight relationships between the three levels of the pilot study creates positive synergies and is expected to stimulate higher commitment in the population, to favor active engagement in the project and to reduce drop-out rates over time.

The mayor of Hassfurt guaranteed involvement of the school and the municipal building in December 2016; smart meter electricity consumption data is available since 2009. Contacts have already been established with the school director and responsible for the technical sector to start planing the involvement in the pilots (e.g. for the sensor installation, information and education events for students, civil servants etc).

The involvement of households, the following activities are planned for the intervention group:

- SHF will place articles on the introduction of enCOMPASS into the SHF customer magazine.
- The Hassfurt City council was already informed by SHF (in M4, February 2017).
- If necessary, SHF will also organize a citizen/customer workshop to inform the customers about the pilot.
- SHF will then create lists of typical types of households to be examined and benchmarked, in line with the types of households listed in Section 2.
- Then out of the customer stock and based on the lists and experience out of former projects, SHF will invite up to 250 customers to gain 100 households for the pilot in the end.
- Prizes and rewards to stimulate the signups for participation in the pilots will be offered.
- The action on information campaign and pre-selection of customers is completed by the end of M16 (February 2018).
- Active recruitment activities will however be performed starting from M11 (September 2017).

All the above activities are aimed at selecting the intervention group households. Once such an intervention group is completely recruited, the Municipality of Hassfurt will be asked to provide socio-economic data regarding the participating households and the buildings where they live:

- Number of persons living in the household: single/couple/more than two persons
- Type of the building: flat/other types of building

This will allow us to stratify the sample and to compare it with the other pilot studies. Knowing the households and building types will also allow us to stratify the sample, so that we can then select a

comparable control group, made of the same number of households, with similar proportions regarding number of persons and type of building.

To this purpose, at M17 (March 2018) SHF will invite a set of up to 250 households, whose composition is comparable to the intervention group, inviting them to answer a set of two questionnaires over time, to investigate their energy behavior. They will also be told that, by answering the questionnaires, they agree that their electricity consumption data from M7 (May 2017) to M33 (July 2019) are used within the enCOMPASS project, for research purposes only.

Answers to the first questionnaire are expected to be gathered by the end of M18 (April 2018), to collect baseline behavioral data also for them. Answers will allow to identify the SHF customer number, which would allow us to start monitoring their electricity consumption during monitoring periods 2 and 3 and to gather their consumption during monitoring period 1.

Should more than 100 households answer the questionnaire, a selection among them will be made based on the household and building type, so that the control group is strictly comparable with the intervention group.

4.2 Greek pilot

All activities will take place using WATT+VOLT customer's portfolio in Thessaloniki. WATT+VOLT's Flagship Retail Store opening 20/3/2017 in Thessaloniki city center will be highly involved, engaging new customers to take advantage of the enCOMPASS approach, while the new flagship store customers will be taking advantage of acquiring the "smart watt" gateway and a smart bulb for free.

The Strategic Partnership between IEK DELTA and WATT+VOLT will involve students, parents and teachers gaining the "smart watt" privileges. IEK DELTA school presentations will be settled engaging at least 250 students to the enCOMPASS project and "smart watt" privileges, while it is planned a WATT+VOLT devices and sensors installation laboratory to be introduced, with lectures on the school building.

All the above activities are aimed at selecting the intervention group of households in Thessaloniki. Once such an intervention group will be completely recruited, WATT+VOLT is going to communicate the houses involvement in the enCOMPASS pilot, sending the energy bills with the participation options. The final user group of 100 pilot houses will be selected based on WATT+VOLT's internal processes.

The following steps are envisioned for the selection of the control group households:

- Recruitment will start as soon as the intervention households are selected.
- A group of selected households (between 300 and 400) will be invited to answer a set of two questionnaires over time, to investigate their energy behavior; they will also be told that, by answering the questionnaires, they agree their electricity consumption data from M7 (May 2017) to M33 (July 2019) are used within the enCOMPASS project, for research purposes only.
- Answers to the first questionnaire will be gathered by M18 (April 2018), to collect baseline behavioral data also for them; answers will allow to identify the WVT customer number, which would allow us to start monitoring their electricity consumptions during monitoring periods 2 and 3 and to gather their consumptions during monitoring period 1.
- To stimulate them answering the questionnaire, prizes will be offered. Details are still to be defined; very likely, we will propose a random draw open to all the respondents, offering either discounts on electricity bills or vouchers for department stores or charity donations.

Should more than 100 households answer the questionnaire, we will stratify them based on the household, building and heating type, with the aim of selecting within them a set of at least 100 households that are overall comparable to the intervention group.

4.3 Swiss pilot

All activities will take place in the same community: we will involve households living in Contone (fraction of the Municipality of Gambarogno), children attending the pre-school and primary school in the close-by neighborhood of Cadepezzo, civil servants and local decision-makers working at the municipal building of Gambarogno, and even the household members themselves, in case they visit the municipality building.

The Municipality of Gambarogno, and especially the fraction of Contone, was chosen since SES has just been appointed as the utility company covering this area, after an institutional aggregation between former municipalities. Curiosity towards the new utility company might further favor involvement in the enCOMPASS project and retention during the whole pilot project. The only drawback related to such a choice is that smart meters were not previously available: SES installed them between M1 (November 2016) and M4 (February 2017); by M6 (April 2017) they will become fully operational, and start gathering and storing electricity data, to build the related baseline data. In total, 614 smart meters were installed.

The original plan was to involve the primary school located in the fraction of Contone. However, the building will undergo renovation from the second half of 2017, which would have compromised comparability between the monitoring periods. For this reason, the school in Cadepezzo was selected, which is very close to the Contone residential area.

The involvement of the school and the municipal building was guaranteed by the mayor of Gambarogno in December 2016: Smart meter electricity consumption data will start being gathered from M6 (April 2017) as well and, as planned for the pilot in Hassfurt, contacts will soon be taken with the school director and responsible for the technical sector, to start sensors installation, and plan information and education events.

For the involvement of households of the intervention group, the following activities are envisioned:

- First, enCOMPASS was introduced in a neighborhood assembly held in Contone on February 21st 2017, already organized by the municipality of Gambarogno for other reasons. During the event, the new utility company SES was presented to the population and enCOMPASS was briefly presented. Being mentioned during such an event is strategic for the project, since the assembly is attended by all types of population, not only by the small number of environmentally sensitive ones, who, instead, would have attended the enCOMPASS-only meeting.
- Active recruitment activities will be however performed starting from month M11 (September 2017), since the first activities within the pilot sites are expected to start at month M19 (May 2018), soon after the first release of the enCOMPASS platform.
- On month M11 (September 2017) a descriptive flyer presenting enCOMPASS and its advantages to the population will be sent by SES to all the households in Contone. The flyer will mention prizes, remark that participation is voluntary and invite all the interested households to communicate to SES their willingness to become engaged in the project.
- Since we do not expect to achieve the 100 households target by means of totally spontaneous applications, soon after 200 selected households will be explicitly invited by SES to engage in the

project, by means of direct, written communication. Such communication will highlight benefits associated with participation in enCOMPASS and ask for a confirmation to take part in the project.

- These 200 households will be randomly selected starting from the stratification of households presented in Section 2 (household composition, type of building and type of heating). For the time being, we cannot guarantee availability of all stratification data for all the households in Contone, since we are still waiting for the relevant data, which will be made available by the Municipality of Gambarogno. Should such data prove to be too incomplete, we would at least be able to exclude holiday houses (a piece of information already available in the SES data-base), and then randomly select 200 households between the remaining ones.
- Besides such randomly selected households, participation in the pilot project will be open also to other interested households, in case they are triggered by the above-mentioned flyer.
- To favor positive responses by the 200 pre-selected households and to stimulate self-application by interested households, as indicated above, prizes to stimulate participation are offered (e.g. energy-saving gadgets, bill discounts and/or a prize draw).
- Selection of the participating households will be completed by the end of M16 (February 2018); electricity consumption data will have however been gathered (and stored) by SES for all Contone households since M6 (April 2017), so that the baseline data set will be regularly available from month 6 for the final selection of 10 participating households. As a final step to confirm their subscription to the project, we will ask them to answer the online questionnaire to gather their energy behavior (attitudes and perception) baseline data.
- Installation of sensors will be performed by the end of month M18 (April 2018), so that the full sensors and metering system will be activated in the Intervention group in time to start monitoring period 2 as soon as the R1 enCOMPASS platform is released.

All the above activities are aimed at selecting the intervention group households. For the selection of the control group households, instead, we envision the following steps (similar to the approach adopted for the Greek pilot):

- Recruitment will start as soon as the intervention households are selected (start of M17, March 2018).
- SES will contact all the remaining households in Contone (between 300 and 400 households) and invite them to answer a set of two questionnaires over time, to investigate their energy behavior; they will also be told that, by answering the questionnaires, they agree their electricity consumption data from M7 (May 2017) to M33 (July 2019) are used within the enCOMPASS project, for research purposes only.
- Answers to the first questionnaire will be gathered by M18 (April 2018), to collect baseline behavioral data also for them; answers will allow to identify the SES customer number, which would allow us to start monitoring their electricity consumption during monitoring periods 2 and 3 and to gather their consumption during monitoring period 1.
- To stimulate them answering the questionnaire, prizes will be offered. Details are still to be defined; very likely, we will propose a random draw open to all the respondents, offering either discounts on electricity bills or vouchers for department stores or charity donations.

In case more than 100 households answer the questionnaire, we will stratify them based on the household, building and heating type, with the aim of selecting within them a set of at least 100 households that are overall comparable to the intervention group.

5. KPI VALIDATION PLAN

In the Description of Action, preliminary KPIs have been defined to assess the objectives of the enCOMPASS project. The KPIs will need to be refined based on the outcomes of the requirements analysis and assessment of user needs with respect to energy behavior, whose preliminary results become available in M8 - June 2017 (*D2.1 Use cases and early requirements*) and in their final version in M12 – October 2017 (*D2.2 Final requirements*). Furthermore, the state-of-the-art overview of (psychological) behavioral change research provided in D5.1 *Behavioral change models and determinants for energy consumption* and how such psychological factors can be assessed will be used as input for the details of the validation methodology (D7.2 Validation methodology).

The assessment of the KPIs is done through the three different pilots, following the trial design outlined in Section 2. The refinement of the KPIs with their concrete indicators and measurement instruments will be outlined in *D7.2 Validation methodology and pilot action plan.*

The influx of the outcomes from other work packages into the validation methodology is displayed in Figure *7*.

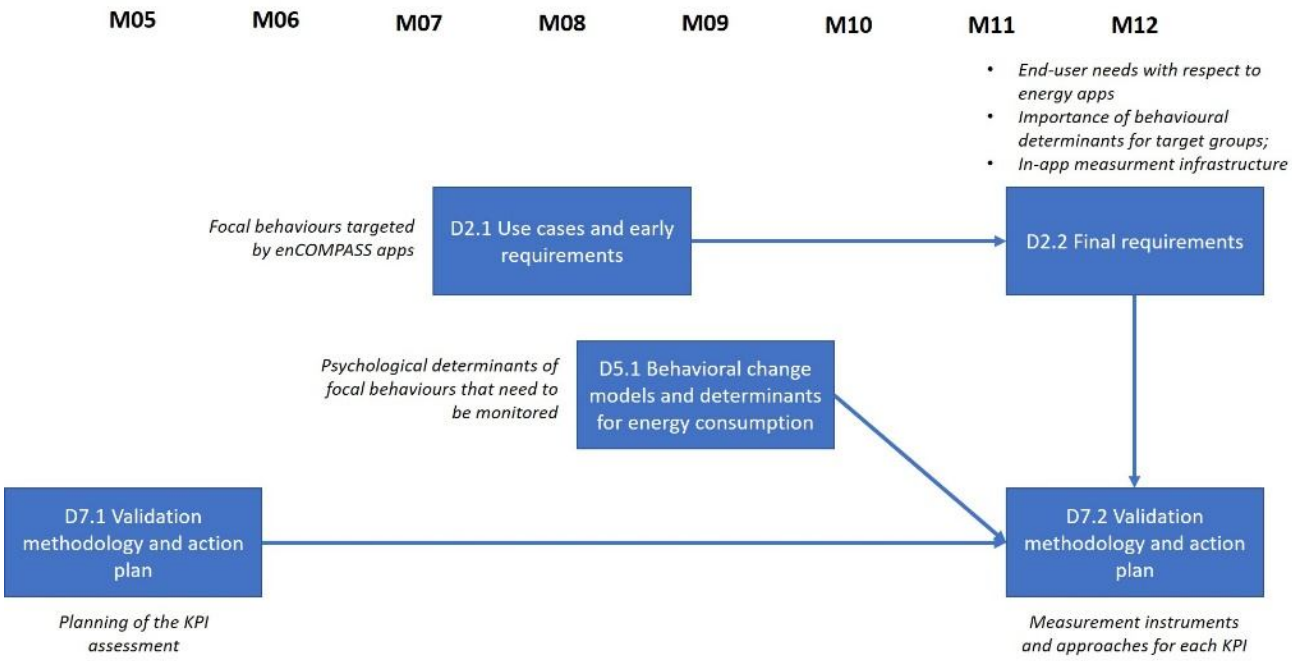

Figure 7. Input from WP2 and WP5 to KPI assessment methodology

KPIs can be distinguished into the following categories. We briefly outline the main approach for their assessment, which will be refined in D7.2:

- *KPIs related to energy consumption*. For these KPIs the eeMeasure methodology is followed. *Energy savings & CO_2 emissions savings achieved through enCOMPASS system: 20-25%*

- *KPIs related to energy consumption awareness, knowledge, and intention to save energy*. Data collection on these KPIs is done by questionnaires at key moments: Before the trial starts (baseline, end of monitoring period 1) and at the end of monitoring periods 2 and 3.

User awareness of energy consumption: 1pt increase on a 5-points Likert scale (+20%)
User knowledge of energy saving actions: 1pt increase on a 5-points Likert scale (i.e. +20%)
Perceived impact of enCOMPASS system on intention to save energy: 1pt on 5-point Likert scale (20%)
Perceived impact of individual elements (energy visualisation / context-based recommendations / adaptive gamification / physical-digital game) on user intention to save energy: 1pt on 5-point Likert scale (20%)

Awareness will be operationalized into key psychological determinants, informed by the state-of-the-art analysis in *D5.1*, as well as the requirements analysis. Starting points are established behavioral change models (Ajzen, 1991; Schwarzer, 1997). The requirements and determinants analyses are not only instrumental to the conceptualization of the enCOMPASS apps, but also support the definition of measurement instruments.

- *KPIs related to usability and comprehension of energy consumption information, comfort level and recommendations for actions.* A mixed-method approach is used, drawing on user behavior data collected from the enCOMPASS apps, and questionnaires that elicit user feedback on technology acceptance of the app (e.g. UTAUT2 framework, Venkatesh et al., 2013), and on individual features, such as the visualizations and recommendations. Logs of user behavior are analyzed to relate the impact of using enCOMPASS features on energy consumption levels. User logs are also analyzed with respect to the acceptance of recommendations for energy saving actions.

  Usability of the energy visualisation for consumers: 4 or higher (on a 5-points Likert scale)
  User experience of the energy visualisation: 4 or higher (on a 5-points Likert scale)
  User awareness of energy consumption: 1pt increase on a 5-points Likert scale (+20%)
  User comprehension of personal energy consumption: 4 or higher (on a 5-points Likert scale).
  User satisfaction with in-door comfort level during usage of enCOMPASS: 4 or higher (on a 5-points Likert scale)
  Perceived usefulness of context-based recommendations for energy saving: 4 or higher (on a 5-points Likert scale)

- *KPIs related to exploitation*. These KPIs will be closely monitored as part of the exploitation work in WP8. Results are documented in the consecutive exploitation plan deliverables (D8.1, D8.4, and D8.6).

  Cost-effectiveness of the enCOMPASS system – ROI <2,5 years (residential: 1-1,5 years, public buildings: 1-2,5 years, schools: <1 years)
  Open APIs for reuse of the enCOMPASS platform by third parties: 2
  No. of third-parties making use of enCOMPASS apps and services during project >=3;
  Number of data sets published as open data: > 5;

As stated above, the final measurements will be defined in the deliverable D7.2 Validation Methodology. That deliverable will also identify practical constraints that influence KPI assessment and propose mitigation measures, such as a incentivization strategy for questionnaires to avoid low response rates.

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