CLEAR2.0

enabling Consumers to Learn about, Engage with and Adopt Renewable energy technologies

WP2 Monitoring Consumptions & Identifying Targeted Solutions

D2.2 Report on the results of the survey on general consumer behaviour and habits of use

Contents

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T2.2 Behavioural survey on changing consumers' sustainable energy behaviour.

1. Introduction.

The main purpose of the T2.3 "Household monitoring of devices to optimize self-consumption" was to gather data regarding the consumption profiles of real families and follow the positive changes resulting from the optimized use of renewable energy equipment and energy efficiency measures. This has been resulted in tailored advice that can fit the specific profiles that were studied. The advices have been, then, disseminated to the remaining population, using the most adequate advices to each profile, and maximizing the potential for energy savings in each profile.

To achieve this goal, the households that have been monitored have been chosen taking into account the most representative energy consumption profiles of each country. And, since the objective was to introduce counselling regarding optimization of energy using equipment, the energy consumption profiles needed to consider specific details, like the type of heating and hot water production systems that are more popular in the countries. Besides this, other elements such as geographic location, number of persons per household, type of energy source used, etc., needed also to have been taken in account. With this report, we explain in detail how each country has proceeded on the monitoring process, since the profiles definition, to the advices adopted for the different families.

In addition, with the monitoring process, the consortium has also looked for checking how a deeper knowledge of energy consumption along with personal advices impact on the energy use of the families.

Even though each country of the consortium is singular, we can see some convergences as a European level in the participating countries, that helps to compare the results, and unify them. The consortium made an effort to find a common approach on the definition of the general profiles (A, B, C and D) in order to facilitate comparisons in the end of the monitoring:

Profile	A	B, C, D
BE	Specific statistics were not available in Belgium. They focused on the profiles selection based on the subscribers (Family A, B, C and D) all of them with PV installation.	
IT	47%	53%
PT	77%	23%
CZ	85%	15%
SL	45%	55%
SP	89%	11%

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The consortium also agreed which would be the metrics, or measurements to be focused, to have, once again, not only comparable results, also for sharing good practices and lessons learnings: electricity, hot water, heating and optimization of renewable installations, principally, self-consumption from PV systems.

2. Executive Summary Monitoring project in each country.

2.1. Belgium.

Scope

The purpose of doing a monitoring program within the CLEAR 2.0 project is to estimate in which extent a detailed feed-back combined with some advice could have an impact on energy consumption.

Therefore, the starting point was first to clarify which energy would be measured and the precision of these measurements and then to target a representative part of the global country population or a specific one.

In Belgium, since energy savings projects and public Authorities programs have already been studied and well develop, we though it could be more useful to explore a more specific part of the population. These existing programs are mainly related to heating consumption and have already pointed out important priorities such as a proper and programmed regulation system for central heating and roof-wall insulation renovation work. However, specific program on electricity consumption and the optimization of PV production use were less known.

To learn more with the monitoring in CLEAR 2.0 from the Belgium perspective we have then decided to focus our program on prosumers for 3 main reasons:

- Net metering support scheme is replaced by a grid fee; the people only realize that they do take electricity from the grid while they are also throwing away a significant part of their production on the grid. Allow these people to have a better understanding and increase as far as they could their self-consumption level was therefore a priority.
- PV owners have a slightly higher electricity consumption compared to the national average (5000 kWh compared to 3500 kWh/year). There must be also opportunities for savings.
- Photovoltaic panels is the most developed renewable technology in Belgium (more than 10% of Belgian housing are equipped).

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Monitoring Market analysis (principles)

We did an overview of the existing monitoring systems available on the market. While doing this assessment we have taken into account different aspects:

- the total price (installation and annual fee)
- the installation process (DIY or installation company needed)
- the user-friendly aspect for the feed-back system
- the channel choices for the feed-back information (via email, a web-based platform, an application on smart phone, combination of these 3 communications).
- after sale service availability
- technical support available at national level (for installation and after installation issues)
- granularity of the data provided (global consumption, solar consumption, each appliances consumption separately…)

We have distinguished two main offers:

- system installed and managed by a company providing passive feed-back on a website.
- system which could be installed by the user

The first kind of offer were actually provided by companies mainly working at B2B level and starting to provide B2C services. Technical support was available but no real user-friendly access to the data has been proposed. The data granularity was very low not allowing us to analyze deeper the family's situation at appliance level for instance. An annual fee was also asked to keep the service on.

Second kind of offer were provided by companies already working at B2C level and providing a device with possibility of DIY installation, free feed-back system web based and or through an app. Data granularity was low except for some companies.

We have selected the Smappee Solar monitoring system because:

- the budget was average
- no annual fee after installation
- user friendly platform and application
- high level of granularity and user-friendly data management (graphs, annual consumption calculation, appliance recognition, message alert in case of consumption changes, costs figures...)
- technical and after sale services available at national level and with no additional costs

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Methodology

We decided to select a monitoring system which could remain after the end of the project and which could give nice consumption data in a user-friendly way.

A general email was sent to many people not targeting any profile and a questionnaire had to be filled in to assess the family situation and the family equipment (PV system, domestic appliances, water heater,….), annual consumption level, family size and composition (adult, children's,..).

An open question allowed also us to see the family motivation and the correct understanding of the project scope.

Since more than 10% of the population has already a photovoltaic system In Belgium and the net metering support scheme is suppressed in 2020, **we wanted to test how advice and behavioral change with no investment could increase the direct use of PV produced electricity.**

30 families were selected among which 26 were followed for one year and a half to follow-up their electricity consumption. Within these families we have selected different profiles (based on presence or not of high consuming items (such as hot water boiler) and delay function on domestic appliances.

After the selection an appointment has been set up to install the monitoring system and explain the project and the methodology.

Basically, after the installation we have had several exchanges with the families to ensure that everything was working fine and that the appliances recognition would be as complete as possible.

After this first step, a full consumption analysis has been done and shared with the families between April until end of May.
This full analysis included some advice in four categories:

- behavioral tip
- very small investment tips
- higher investment recommendation
- specific advice to increase PV production self-consumption

The trial period has been closed after 5 month (June to October) and the families were once a month getting personalized feed-back related to their specific efforts which were chosen among the list of suggested advice included in the first report.

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Technical Difficulties related to monitoring system

First main barrier has been the monitoring device itself and the technical support from the Smappee company (product selected was the Smappee Solar Monitoring).

Installation was supposed and presented in the marketing campaign as very easy and DIY possible. It was not the case at all! We have spent more than 2, sometimes 3 hours for each installation with 2 people. TA expert for the discussion with the family, explanation about the application and the way the system works, one electrician to plug the system and ensure the connectivity.

The main problems we have faced is the electricity network complexity in each housing. Indeed, the network understanding is crucial to allow a proper installation. Secondly the system connectivity was hard to set-up because it worked with WIFI and in each housing the modem is far from the fuse box were the system must be installed.

Even with a systematic call to the technical support service to check live the data flow and the connectivity we've had incorrect set-up which had to be resolved after installation leading to data loss and time waste and also negotiation with the company which was not directly invested to provide an efficient after sale service.

The connectivity has also been a regular problem with the system disconnected time to time and directly related to the WIFI signal strength stability.

The appliance recognition was for us the main asset justifying the Smappee final selection. However, this recognition was not working properly. The main interesting appliances such as tumble dryers, washing machines, fridge, freezers, dishwasher were not fully recognized or sometimes were multiplied detected compared to the reality.

More than this, the algorithm calculating the power and the annual consumption for specific devices were not reliable, showing a power of 55kW for a tumble dryer or an annual consumption of 22kWh for a tumble dryer used once a week with an average cycle consumption around 2kWh as an example.

The connected switch allowed us to circumvented for a part these problems but was not applicable for all the devices because of the switch access of the device itself and the maximum distance required between the connected switch and the monitoring device which was very short (less than 10 meters to ensure a WIFI connection between the smart plug and the monitoring system itself). So, it can be then easily to imagine in a house were the meter is in a garage and the walls are reducing the WIFI signal that it was impossible to use it for the majority of the house's appliances.

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We did then used the feed-back from the families (a list of time of use for each device for one week) and the row data available on the Smappee professional platform to build and calculate the correct data and get a fully detailed consumption profile for each family. These difficulties were not foreseen and has considerably increased the working hours to make sure that the consumption profile would be accurate enough.

Results

We summarized in the table below the main results regarding the feed-back done, for behavioral change, small investment, higher investment and the self-consumption aspect.

Advices	Average savings	Average savings kWh/year	kg CO2/year	Average savings €/year	People has done
ELECTRICITY		**4216**	**1223**	**1,054**	**242**
1. BEHAVIORAL					
COOCKING (cover, appropriate size, less water, switch off before the er	5%	18	5	4	14
WASHING MACHINE (Lower temperature when possible)	40%	28	8	7	26
WASHING MACHINE (use full when possible)	25%	58	17	14	26
FRIDGE (do not put hot food in)	5%	18	5	4	26
DISHWASHER full and no half cycle	25%	75	22	19	26
DISHWASHER ECO mode	22%	66	19	17	26
CENTRAL VENTILATION SYSTEM (set lower speed)	30%	135	39	34	6
2. SMALL INVESTMENT					
LIGHT - replace halogene by led lamp	90%	330	96	83	8
HOT WATER shower head replacement bu eco model	30%	510	148	128	10
BOILER HOT WATER timer (30 euros - see impact on Self consumption se	0%		0	0	
BOILER HOT WATER extra insulation (30 euros)	300%	500	145	125	12
STAND-BY timer and extension cord (automatic switch off TV related ap	75%	112	32	28	52
3. HIGHER INVESTMENT					
FRIDGE replacement by A+++ model	50%	230	67	58	4
FREEZER replacement by A+++ model	50%	250	73	63	3
BOILER replacement by Heat Pump for hot water (3500 euros)	300%	1500	435	375	0
TUMBLE DRYER replacement by Heat Pump Model (A+++)	70%	388	113	97	3
SELF-CONSUMPTION					
BOILER hot water - put timer for PV peak use)	13%	660		106	12
WASHING MACHINE - delay function (PV peak use)	1%	49		8	20
TUMBLE DRYER - delay function (PV peak use)	1%	36		6	22
DISH WASHER - delay function (PV peak use)	1%	41		7	25

Table 1 - Summary of savings obtained by each advice in Brussels

Without surprise the more adopted tips were first behavioral and then regarding small investments.

Just the time for each family to get a better understanding concerning their electricity consumption and to step-back and decide which tips they would like, or they would be able to try out.

Behavioral change

Within the behavioral change the top applied and long-lasting tips were the ones very easy to do and not requiring a lot of effort and leading to substantial consumption reduction and the most important part not leading to any comfort loss.
In this logic use of the **eco-mode for dishwasher and use full cycle for dishwasher and washing machine** were very well appreciated.

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Central ventilation was a surprise. Indeed, recent housing and recently renovated housing are equipped with a central ventilation system for which the flow speed can be regulated. Most of the people hesitate to touch the regulation fearing they would do something wrong while the flow speed could be reduced by 50 or 75% without compromising the building integrity. Knowing that average centralized ventilation system full speed is consuming around 70% more compared to a low speed work mode, it worth it to try to lower the speed in this situation. All the participants equipped did tried the lowest speed mode leading to an average 300 kWh savings per year and indirect heating consumption savings not included here. This shows that EPB regulation sets the flow speed for this kind of equipment way above the real needs.

Small investments

Top small investments were either the one very easy to set up and very cheap either more complex to set up but leading to impressive savings.

Small investment very easy to do was the light replacement by led products (from halogen bulbs, 90% savings) and eco showerhead with an average reduction in hot water consumption around 30%, close to 500kWh a year in the case of hot water produced by an electrical boiler.

The top small investment in terms of energy savings was the **extra insulation layer applied on the hot water electrical boiler**. Indeed, these boilers contain hot water at approximately 60°C and are stored in a basement or a garage which are not heated rooms and were average temperature could remain under 15 to 12°C. Knowing that electrical boiler does not have more than 2 or 3 cm of polyurethane insulation foam the heat loss is very high. If we compare the standard for roof insulation thickness recommended (12 to 15cm) with the same material and the delta in temperature (20-0°C), it becomes obvious that 3 cm to prevent heat loss in a 12-60°C delta is not efficient.

Our participants having a boiler have added this extra insulation layer (15cm rockwool or glass wool) and the savings measured were impressive, **from 350 to 620 kWh per year saved.** In average, families having a fresh storage room for their boiler (average temperature below 15°C) did save 500kWh in a one-year time. If all the boilers owners in Belgium would do the same and save half of this figures (to cover boiler size and room temperature uncertainty) it would lead to a **732 GWh annual savings** without any comfort lose and no rebound effect possible.

Stand-by power has been detected in all families and the easiest to circumvent was the multimedia TV furniture focus point where we also noticed game console, laptop, modem, tv recorder…. All of these items cumulate a significant stand-by consumption and are only used for a short time each day. Connect all these appliances to an electrical cord equipped

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with a switch is one thing, switch it off and on once a day at the appropriate moment is another constraint that we have circumvented using a timer connected to the extension cord with 112 kWh saved annually Timer allowing automatic switch off during 18 hours a day leads to **528 GWh savings every year if all Belgian families would do it.**

Equipment replacement

The detailed consumption feed-back sent to the families allowed us to target high consuming appliances or systems (above 300 kWh/year). Top 3 high consuming appliances were hot water electrical boiler, Fridge and freezers, and old tumble dryer. To be mentioned, electric cooking plate with the induction alternative.

Boiler replaced by a domestic hot water heat pump leads to a 1500 kWh saving annually if we consider an average 2200 kWh yearly consumption and a 2.7 efficiency factor for the heat pump following the laboratory test, we have carried out during CLEAR 1.

Fridge and Freezer replacement would lead to 230 and 250 kWh savings per year respectively.

Tumble dryer (simple model) replacement by heat pump model would lead to 388 kWh savings per year.

In total a family replacing this 3 equipment would then save annually 2368 kWh each year.

Of course, the main barrier is investment with an average price of 3500 euros for the domestic hot water heat pump, 650 euros for a fridge or a freezer showing an energy label A+ to A++, tumble dryer heat pump model 700 euros.

Return on investment were calculated following the precise family consumptions and were therefore very useful as a decision-making information.

Average return on investment time were the following for equipment replacement:

9 years for fridge or freezer
8 years (no support scheme included) for Domestic Hot Water Heat Pump
7 years for tumble dryer

Of course, in some cases were the original consumption is higher, the return on investment is reduced.

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Consumption displacement and self-consumption increase

As mentioned above in the document one of the main monitoring goal was to inform families over their PV production and allow them to move some consumption during the production time and increase therefore the self-consumption rate.
These results are available in the report D2.4 Summary results of optimization of existing Renewable Energy Systems (RES) and optimization use.

Perspectives & recommendation

The monitoring project has established and confirm that provide consumers with clear, reliable and granular information on the energy consumption is key to enable savings and long-lasting effects.

While smart meters will generate huge amount of data, consumption information should be communicated to consumers via an interface of their choice. Information should be clear, visually attractive and granular enough (i.e. per appliance).

Advice services supporting consumers are necessary and complement the information provided to enlighten consumers in their decisions.

2.2. Czech Republic.

Scope

The purpose of doing an audit / consulting program as part of the CLEAR 2.0 project is to estimate the extent in which a thorough household examination with some advice could have an impact on the overall energy consumption.

The program was conducted as a qualitative case-study research with direct quantitative implications regarding real energy consumption levels.

Our goal was to choose as diverse research subject as possible as the Czech Republic has a heterogenous structure of types of housing.

Household analysis

We conducted a large online survey among our subscribers as well as among the public. The survey consisted of questions regarding the type of household, number of people living in the household, location of the household and the type of energy source the household uses.

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Therefore, we conducted a selection of the most representative families – we aimed to select households which would be a good representation of the common households and flats in the Czech Republic – we wanted to include a mix of family houses, flats, families using photovoltaic panels and "regular" electricity means.

We aimed at households located in Prague and surrounding Stredocesky kraj (Central Bohemian Region) as it contains plenty of towns and villages with a wide variety of house types.

Methodology

We decided to combine the household examinations with a set of tips and tricks provided by a professional. He is an experienced engineer who was able to give each selected household counselling with advice of how to lower their power consumption. One of the goals of our professional was to calculate possible savings – which can be further compared with direct measurements in the future.

Our partner visited six households – one flat in an early 20th century villa, one flat in a communist era block of flats, two terrace houses, one single family house, one housing unit in an apartment building. Every examination consisted of the description of the object (house unit), building construction, apartment layout, energy inputs (energy constumption as a whole, ways of usage of electricity, lightning, appliances, stand-by modes, in some cases also PV panels and water heating). Therefore, specific tips specially tailored for each individual household could be assessed and recommended.

We also counted a theoretical energy consumption based on the voltage of appliances, their energy labels etc. and compared them with real energy invoices. This proved to be quite useful when counting theoretical savings based on the tips which were assigned to every single household.

Results

The short table below summarizes the changes conducted by chosen households. As the amount of house units was rather low the overall savings don't seem to be dramatically high. However, the common usage of old bulbs in older households was a bit of a surprise. Therefore, savings made by changing them for LED bulbs resulted in great differences.

Advices	Average savings	Average savings kWh/year	kg CO2/year	Average savings €/year	People has done	Cumulative savings project € / year
ELECTRICITY		**636,35**	**0**	**108**	**8**	**270 €**
Use LED bulbs	90%	399		54	4	216 €
Make smart use of your dishwasher	22%	40		6,2	1	6 €
Do not put hot food in the refrigerator	5%	22		3,4	1	3 €
Renew your fridge	40%	175		28	1	28 €
Avoid stand by on your electronic devices	10%	110		17	1	17 €
HOT WATER		**180**	**0**	28	1	28 €
Install a solar water heater	30%	180		28	1	28 €
HEATING		**84**	**0**	13,2	1	13 €
Insulation keeps your home warm	50%	84		13,2	1	13 €

Table 2 - Summary of savings obtained by each advice in Czech Republic

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2.3. Italy.

Scope

The purpose of doing a monitoring program within the CLEAR 2.0 project is to estimate to which extent a real time and detailed feed-back combined with some advices could have an impact on household energy consumption.

Therefore, the starting point was to clarify which energy would be measured and the precision of these measurements and then to target a representative part of the global country population or a specific one.

In Italy, support schemes to promote energy efficiency through update of domestic appliances, installation of more efficient energy systems and insulation of buildings have been on places for many years but not much has been done to guide consumers in this complex field leading to a slow improvement of households efficiency overall.

At the nation level, the main focus has been put on light efficiency (LED) where it is possible to note a deep penetration nowadays, probably mainly due to the ban of incandescent light bulbs.

While PV plants installation is included in the incentives scheme, specific programs on electricity consumption and the optimization of PV production use are less known.

The energy label scheme has become well known and effective in influencing consumers choices, but with the shift of appliances towards class over the A it has become confusing and less effective.

Due to the highly heterogeneous situation of climate zones and household energy profiles in Italy we decided to sample the profiles of this study in order to be representative of the national situation.

Since the sample is composed by 18 participants spread across the country, the results of this study cannot be considered as statistically meaningful, they should be instead considered as useful quantitative examples.

The focus of this monitoring project was only on electricity consumption and the possible savings achievable with changes in behavior and small investments guided by general advices and a customized feed-back.

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Monitoring Market analysis (principles)

We did an overview of the existing monitoring systems available on the market.

While doing this assessment we have taken into account different aspects:

- the total price (installation and annual fee)
- the installation process (DIY or installation company needed)
- the user-friendly aspect for the feed-back system
- the channel choices for the feed-back information (via email, a web-based platform, an application on smart phone, combination of these 3 communications).
- after sale service availability
- technical support available at national level (for installation and after installation issues)
- granularity of the data provided (global consumption, solar consumption, each appliances consumption separately…)

We have distinguished two main offers:

- system installed and managed by a company providing passive feed-back on a website.
- system which could be installed by the user

The first kind of offer were actually provided by companies mainly working at B2B level and starting to provide B2C services. Technical support was available but no real user-friendly access to the data has been proposed. The data granularity was very low not allowing us to analyze deeper the family's situation at appliance level for instance. An annual fee was also asked to keep the service on.

Second kind of offer were provided by companies already working at B2C level and providing a device with possibility of DIY installation, free feed-back system web based and or through an app. Data granularity was low except for some companies.

We have selected the *Smappee Solar monitoring system* because:

- the budget was average
- no annual fee after installation
- user friendly platform and application
- high level of granularity and user-friendly data management (graphs, annual consumption calculation, appliance recognition, message alert in case of consumption changes, costs figures...)
- technical and after sale services available at national level and with no additional costs

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Methodology

We decided to select a monitoring system which could remain after the end of the project and which could give nice consumption data in a user friendly way. We decided to assume all the costs of the devices and installation not to charge the participants, in this way making the project even more inviting.

A general email was sent to many people not targeting any profile and a questionnaire had to be filled in to assess the family situation and the family equipment (PV system, domestic appliances, water heater,….), annual consumption level, family size and composition (adult, children's,..).

An open question allowed also us to see the family motivation and the correct understanding of the project scope.
The list of applications was then filtered based on reliability and consistency of answers, resulting in almost 200 household profiles, from which 6 main energy profiles were individuated, based on the use of natural gas as primary source for heating/cooking, presence of a PV system and of an energy storage system.

Two more categories were lastly added to take into account special profiles: a household using an electric car, and a household having a storage system (used mainly as UPS) and an electric moped.

Very often the actual household profiles showed mixed systems (use of biomass stoves along with natural gas boilers and/or heat pumps air conditioners etc..) therefore we simplified those profiles based on primary sources.

1- List of profiles, descriptions and percentages on applications

1G	Gas as primary heating system, no PV, no storage	75%
1E	Electric heating system, no PV, no storage	2%
2G	Gas as primary heating system, PV system, no storage	10%
2E	Electric heating system, PV,system, no storage	10%
2GB	Gas as primary heating system, PV and storage system	1%
2EB	Electric heating system, PV and storage system	2%
2GC	Gas as primary heating system, PV system,electric vehicle	1%
2EBC	Electric heating system, PV and storage system, electric vehicle	1%

As it is possible to see, the most common situation is households which uses natural gas as main source for room and water heating and for cooking. Even if the "all electric" profiles with no PV systems were not so abundant in the

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application list, we decided to include them in the sample, since at national level there is a will of shifting the household consumptions in that direction and we foresee an increasing representativeness in the close future.

As anticipated, the final sample of profiles is made up of 18 families, followed during a 10 months span (from May 2019 to February 2020).

The profiles can be further divided by dwelling type:

- 12 detached or semi-detached houses
- 6 apartments.

This numbers don't reflect the average Italian dwelling types distribution (which is more or less 45%-55%) but it is due to the fact that we wanted to put a focus on the study of consumptions of PV owners.

After the selection, an appointment was set up to install the monitoring system with the aid of electrical specialists and the project was explained to the participants.

After the installation we had several exchanges with the families to ensure that everything was working fine and that the appliances recognition would be as complete as possible, and we collected data of electricity and gas consumptions from 2018 and 2019 bills as reference.

The first step after installation was to focus on always-on consumption, a data quite well monitored by the device and relatively simple to modify and track during time with positive influence on electricity bills.

After a transient setup period of approx. 1 month, we delivered a task to the participants, asking to list all the devices and appliances constantly plugged into the household electric grid.

The aim of this task was twofold: to identify possible energy wasters and to engage the participants actively on understanding and reducing their unnecessary consumptions.

Customized tips were delivered along with a rough estimate of possible yearly savings, both in terms of energy and money.

After this first step, a round of general tips was sent to all the sample, including mostly behavioral tips but also small investment tips, higher investment recommendation and specific advices to increase PV production self-consumption for those who has a PV solar system installed.

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Since fridges were quite diffusely recognized by the monitoring system, an in-depth focus on their functioning and how to keep them efficient was sent before summer holidays (beginning of August).

At the end of summer and before wintertime, two separate questionnaires was delivered to the sample in order to gain some feedbacks about the monitoring project as a whole, the use of the monitoring the device and the updated energy bills. Those questionnaires also included behavioral tips related to the seasonal period.

Technical Difficulties related to monitoring system

First main barrier has been the monitoring device itself and the technical support from the Smappee company (product selected was the Smappee Solar Monitoring).

Installation was supposed and presented in the marketing campaign as very easy and DIY possible.

Going down to the facts, installation by participants on their own was not possible and it required authorized technicians which had to be included in the process. This led to delays and to a situation not completely under our control, since every dwelling has its own electrical grid peculiarities and not always we were sure about the correct installation and therefore readings of the devices.

The connectivity has also been a regular problem with the system disconnected time to time and directly related to the WIFI signal strength stability.

Due to the lack of a complete Italian language user interface, we had to tutor the participants on how to use and guide the app in recognizing their electrical appliances but even, so the recognition capabilities were insufficient.

The appliance recognition was for us the main asset justifying the Smappee final selection, however this recognition was not working properly, since most of the common household appliances, which also shows “typical consumption curves” (washing machines, dishwasher and sometimes fridges) were not properly recognized in most of the cases and also they weren’t correctly registered even after the use of user assisted recognition procedures.

Sometimes appliances were detected multiple times and with clearly wrong consumption patterns (washing machines absorbing a maximum power of 60W e.g.).
These issues were not remarkably solved by the use of smart switch, which was tried in some households with no major advantage.

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Comparison between the calculated monthly consumptions and energy bills showed in most cases variable discrepancies ranging from -2% and +1% in the best cases (which are roughly half of the sample) with peaks of -61% and + 27% in the worst ones.

These peaks errors are probably due to long and/or frequent disconnections not detected by the user and to ineffective installation of the monitoring probe leading to inconsistent data (the monitoring clamp is not installed on the total consumption cable).

Thanks to family's feedbacks and calculations made using raw data extracted from the app dashboard some conclusions can be drawn, but these difficulties were not foreseen and has considerably increased the working hours.

Results

We summarized in the table below the main results regarding the monitoring project:

Advices	Average savings	Average savings kWh/year	kg CO2/year	Average savings €/year
ELECTRICITY		**869**	**278**	**174 €**
Avoid stand by on your electronic devices	31%	198	63	40 €
Wash clothes with cold water	24%	47	15	9 €
Renew your old Washing Machine	33%	55	18	11 €
Make smart use of your Dishwasher	39%	157	50	31 €
Renew your old Dishwasher	38%	155	50	31 €
Correct use and maintenance of fridge	10%	43	14	9 €
Renew your fridge	50%	215	69	43 €
HOT WATER		**185**	**59,2**	37 €
Renew your electrical boiler with HP model	65%	185	59	37 €

Table 3 - Summary of savings obtained by each advice in Italy

It's difficult to know to which extent the suggestions have been followed, even though it has been possible to track some positive changes in the stand-by consumption during some part of the year and particularly after tutoring.

It has also been difficult to make general tips that were really effective since the individual situations are very different from one another; more effective tips shall be tailored specifically but this task would be very time consuming, also considering that the results are subjected to the engagement of the users during time.

Lack of engagement was also another drawback of this project, since only about one third of the families in Italy showed active participation in cooperating to exploit as much as possible the opportunities this project made available.

Overall the monitoring project has been perceived as positive and interesting, *Smappee* application has received positive feedback in terms of user-friendliness and ease of use, while it's algorithms of recognition and data in general received bad grades from the families involved.

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Behavioral change

Within the behavioral change category, as we expected, the most appreciated and followed were the ones very easy to do and not requiring a lot of effort and not leading to any appreciable comfort loss.

Correct use and maintenance of fridge tips were generally appreciated, with the clear exception of the tip regarding cleaning of rear heat exchanger, probably since it's a burdensome operation in many cases.

Small investments

The main focus on energy saving with small investment was put on reducing stand-by energy wastes and the entire sample replied with the willingness to afford small investments for stand-by-killers, switched electrical cords and substitution of old small devices with new and more efficient ones; the general perception was that these small investments would pay themselves off in a short time.

Depending on dwelling type, surface and composition of families, we measured different levels of "always on consumption" related to household appliances (not taking into account heating systems when electrical driven).

As expected, on average small apartments showed lower "always on" consumption allowing for minor savings, while big houses showed higher levels allowing for higher energy savings.

In this project, we measured an average of 10W for apartments and 33W for houses as avoidable stand-by powers (on a yearly basis), generally related to a more attentive use and automated setting of entertainment systems (TVs, decoders, game stations, sound systems, laptops, PCs, printers, wi-fi routers etc..) but also other appliances such as air conditioners and coffee machines.

An interesting note is that Smappee itself needs 5W to work, and similar reasoning applies to all home automation systems: it is not a clear-cut conclusion that monitoring household energy consumption leads to energy savings, and home automation is for sure increasing residential consumptions.

Equipment replacement

Unfortunately, there were no possibility to target large energy consumers in all the profiles households, mainly due to monitoring technical difficulties.

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Moreover, the feedbacks related to the substitution of "large" equipment can be summarized in two way of thinking:

- I will replace the existing one with a more efficient one only having energy/money saving estimations;
- I will replace the existing one only when it will be out of service.

However, in few cases we individuated very old appliances and measuring their actual consumption compared to A+++ label alternatives had convinced the two families in replacing them, namely:

- Replacement of an old combined fridge D class with an A+++ one, estimated energy saving ≃ 497 kWh/yr, corresponding to ≃ 100 €/yr.
- Replacement of an old air conditioner with a new heat pump, inverter technology A++ model, leading to an estimated energy saving of ≃ 455 kWh/yr, corresponding to ≃ 91 €/yr.

As an average for the project, a family not having a new fridge and deciding to buy a new one would save approximately 215 kWh each year, more or less 43€.

Other large appliances have been analyzed as much as possible leading to the average results shown in table for renewal of dishwasher and washing machines of the project.

Main barrier is usually the investment cost, which can be overcome with the aid of incentives on energy efficiency (as done in the case of air conditioner) along with a good return on investment, which is not the case for appliances which are not too old.

Perspectives & recommendation

The monitoring project has showed that providing consumers with clear, reliable and granular information on the energy consumption could serve as a starting point to enable savings and long-lasting effects.

The choice of using a device with a user-friendly app interface has been successful, even if this kind of technologies still exclude a big share of elderly household owners.
Advice services supporting consumers are in any case necessary and complement the information provided to enlighten consumers in their decisions.
Real time energy feedback systems of this project proved themselves to be neither sufficient, nor necessary to achieve long lasting energy savings.

Engagement and tutorship were the other necessary ingredients that lead to results.

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Moreover, it should be highlighted that the positive potential of these devices increases with their installation and use complexity and, of course, their price.

Even in terms of long-term savings, the results of this study show that these devices don't pay themselves off without adequate support: these tools are more well suited as a support for pro-active "tech savvy" or to energy managers, especially during the state-of-the-system survey phase.

Without any engagement and proactive commitment by users in modifying their own behavior and upgrade their appliances, the installation and use of these devices could lead to an increase of the consumptions instead of a decrease.

We believe that the promotion of awareness and knowledge of consumers towards energy efficiency through education programs would be more effective from technical, regulatory and financial points of views.

From the experience gained from this project, we believe that communication should be as much as possible tailor made for the recipients, focusing on different situations, needs and languages (retired people, apartment blocks, detached houses etc.).

Our study was not able to take into account the "rebound effect", and we believe that the just the diffusion of the awareness of this dangerous effect could be sufficient to mitigate it.

2.4. Portugal.

Scope

The scope focused on optimizing the use of existing facilities and studying the possibility of replacing some equipment with others that use renewable energy, with guaranteed profitability over a reasonable lifetime.

One of the main stages of this project was to identify the energy used profiles of consumers, to allow for a customization of the solutions to be presented and to be develop tailored advice. For that, we needed the collaboration of Portuguese families, from the North to the South of the country, who wanted to adopt behaviors and systems that improve the way they use energy, translating into a reduction in electricity, LPG and gas bills.

From Portugal's perspective, to get more of the CLEAR 2.0 monitoring project, the main needs of a household including air conditioning (heat-pump), hot water and electricity consumption were our targets. The approaches centered to the Consumer were carried

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out and our focus was based on the Portuguese residential energy consumption profile, through 3 main consumption factors:

- Electrical consumption of equipment, with a strong focus on housing standby and possible replacement of less energy efficient equipment or even analysis of the possibility of installing photovoltaic self-consumption among other equipment with renewable energy sources.
- Sanitary hot water supply equipment. Hot water heaters and gas water heaters have a large share in residential energy consumption.
- Space heating equipment is used in approx. 86% of Portuguese homes. This equipment represents a large fraction of the families' annual energy consumption.

Market Analysis (Principles)

In the beginning, the focus was to identify and differentiate the regions due to the demographic and climatic differences that exist in Portugal. Subsequently, a study was carried out on energy consumption in the household sector, detached by pre-determined regions.

The combination of consumption information and the existing representativeness of domestic consumption equipment was determined and segmented into profiles according to the distribution of equipment in households by geographic area with the highest concentration.

According to the analysis, 4 segmented profiles were defined. Profile A, use of non-renewable energy, characterized by types of heating present in the accommodations and according to the penetration of the appliances and energy source, it is possible to see the representativeness of each profile A segmented in A.1, A.2, A .3 and A.4.

The same structure to identify profiles A, served to identify profiles B, which represents the use of renewable energies, such as fireplaces with heat recovery, heat pump (air conditioning), photovoltaic and / or solar thermal systems.

Profile C presents an optimized system with photovoltaic system (self-consumption) and electric vehicle.

The D profile represents a family with a system optimized with photovoltaic energy with accumulation of electricity in batteries.

During the process of defining the profiles, we made a general survey of the monitoring systems equipment available in the Portuguese market and evaluated their characteristics:

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- The total price
- The installation processes
- Friendly platform for the feedback system
- Channel options for feedback information (via e-mail, a web-based platform, a smartphone application, a combination of these three communications).
- Technical support available at national level (for installation problems and after installation)
- Availability and reliability of the data provided (graphs, diary, week and annual consumption, appliances consumption separately, instantaneous consumption, time by count…)

We selected the Wibeee monitoring system with the support of the brand's official distributor in Portugal, Infocontrol, because:

- The budget was lower/average
- No annual cost after installation
- Friendly user platform and application
- Easy data management and the ability to make them available (graphs, annual consumption calculation, device recognition, message alert in case of consumption change, etc.)
- Availability of up to 3 independent sensors (CLAMPS) for measuring consumption in each device and availability of sockets with the same data storage capacities, allowing the portability and monitoring of independent electrical equipment.
- Availability of a single professional platform showing all devices installed in the homes of participating families.
- Availability of individual platform per family to be able to follow and monitor their housing.
- Technical and after-sales services available at national level and at no additional cost as long as no home visits are required)

Methodology

We started the selection of participants by sending a general email (clear.coaching@deco.proteste.pt), an initial questionnaire, to families that applied to participate in the monitoring project and assessed the situation and the existing equipments of the family (photovoltaic system, appliances, water heater, air conditioning, etc.), level of annual consumption, household and composition (adult, child, ..). This initial questionnaire helped us to find families according to the profile analysis proposed following the market analysis carried out previously.

For each of the families that collaborated in this project, DECO carried out a previous energy audit of the housing and installed (through an accredited entity) the energy

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monitoring system in their homes, which could remain after the end of the project providing good data on consumption in a user-friendly manner. With this system, each family will now be able to view the evolution of their electricity consumption in real time and also check the usage history. With regard to other energy sources, such as propane / butane, heating oil or natural gas, the analysis was based on the family's collaboration in sending the invoices and consumption obtained.

Based on the data collected, the DECO PROTESTE team helped participating families through personalized advice. Thus, for 15 months, these families were accompanied by a technician from DECO PROTESTE who gave instructions on how to optimize the consumption of electricity, gas and water.

The assumptions for families eligible to participate in this project were:

- Be a legitimate occupant of the accommodation in question (owner of the same or tenant, with a lease)
- Have access to energy and water meters (electricity, gas and water).
- Have last year's electricity, gas and water bills available.
- The dwelling in question must be the main residence of the family and, therefore, be occupied for a normal period (with the exception of holidays and vacations)

After installing the Wi-beee equipment, we had several information shares, by email and telephone contact with the representative of each family to ensure that everything was working well.

The complete analysis included some advice in 3 categories per selected profile:

- behavioral tips,
- recommendation for investments in the replacement of household appliances,
- recommendation for use and / or investment in equipment with a source of renewable energy.

The analysis and advice started according to the season and the first steps in space heating were taken. This timeframe has its period between October 2018 and February 2019.

Subsequently and throughout the year, other analyzes of consumption were considered, with a strong focus on electrical consumption and heating of domestic hot water.

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Technical difficulties related to the monitoring system

The first difficulty was to install the chosen monitoring system in the family's homes. The problem has been identified in some internet operators and the solution was the creation of new router configurations (ports and Hz). The router settings had to be made by the network operator at our request. These actions delayed the start of monitoring.

Other problems were verified during the project, namely changes in operators and Wi-Fi Routers by the families. Some families tried to access the equipment which caused the loss of the connection between the equipment and the wi-fi. There were also difficulties in monitoring in some rooms of the house, namely when using the monitoring socket/plug on specific equipment by some areas that were not covered by the wi-fi network and stop working. A significant percentage of dwellings are houses (independent) so that in some rooms due to long distances, the monitoring of some equipment was not possible. The solution found by some families was the installation of a Wi-Fi signal repeater.

In some families with 2 electrical board, was verified the need to install two monitoring equipment with several clamps. This need was necessary for individual monitoring, for example, of the charging of the electric car, photovoltaic self-consumption installations and / or heat pumps. This installation was only possible whenever the Wi-Fi network allowed, having made a previous assessment of the house.

After solving the problems found, it was possible to evaluate different energy consumptions per day of some devices (example: refrigerator, TV cabinet, toaster, etc.), the electricity consumed in space heating in some profiles, especially in the profile where we found more representation in the use portable electrical equipment such as fan heaters. The general standby of the houses and the use of air conditioners were another main focus in which monitoring was possible.

Results

We summarize in the tables below the main results related to the feedback provided, for behavior change, small investments, larger investments and the adoption of self-consumption photovoltaic panels.

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Advices	Average savings kWh/year	kg CO2/year	Average savings €/year	People has done
ELECTRICITY	354	230	129	16
Unplug equipment, do not leave it in standby	309	100	52 €	15
Enhance the use of standby killers				
Installation of PV Panels	400	130	77 €	1
HOT WATER	560	0	41	6
Keep the appliance's temperature regulator in the "Eco" position or as close as possible to the tap temperature.	560	na	41 €	6
Install flow reducers on ANQIP certified taps and shower heads				
Avoid leaks and leaky faucets				
Prefer to use shower instead of soaking bath				
HEATING	282	0	74 €	9
Set equipment thermostat to minimum	494	na	74 €	2
Avoid prolonged use and turn them off when leaving the room				
Install/use air conditioning systems based on renewable energy (air conditioning, pellet stove ...)	1867,5	na	175	5
Choose the right temperature in winter: 20-21ºC	70	22,75	15,75	2

Table 4 - Summary of savings obtained by each advice

Profile		Global saving families (kWh/year) Total by profile (kWh/year)	Total potencial savings (kWh/year)	Potencial saving (€/anos)
Without heating	**A.1**	447,152	**1587**	**124 €**
Eletric portable heating	**A.2**	1649,68	**4642**	**572 €**
Fireplace	**A.3**	743,77	**615**	**142 €**
Central heating boiler	**A.4**	3450,75	**6701**	**625 €**
Fireplace with Heat recover	**B.1**	316,82	**629**	**120 €**
Heat-pump Air Condition	**B.2**	843,26	**2242**	**365 €**
Photovoltaic or solar thermal	**B.3**	999,505	**1159**	**181 €**
Photovoltaic and eletrical car	**C**	406,245	**126**	**78 €**
Photovoltaic + battery + eletric car	**D**	396	**396**	**19 €**
		9253	**18097**	**2 226,10 €**
SAVINGS BALANCE →	**We helped save families participating in the project:**		**18,1**	**MWh / year**
			5882	**kg CO2e / year**
			35	**Trees**
			2226	**€**

Table 5 - Summary of savings obtained by households by profile

The results show that if the families participating in the monitoring project continue with the advising measures according to the study, 18.1 MWh per year can be saved.

The profile that demonstrated the highest savings potential was the central heating profile (A.4). The profiles with referenced equipment that already used renewable energy sources at the beginning of the project, demonstrated a lower but still significant savings potential.

The results indicate that the maximum potential obtained by a family that fulfills the requirements to belong to profile A.1 it can reach 447 kWh / year and a saving of 78€. In contrast, families belonging to the A.4 profile have an annual savings potential of 503€.

Participating families will be able to save up to a total of 2226€ per year if most of the aforementioned advices are still in place.

Unplugging the devices, instead of keeping them in standby mode, is one of the most important pieces of advice for reducing electricity consumption. Consumers tend to underestimate the amount of energy used by devices in standby mode and generally do

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not pay attention to it. The 15 families that implemented this measure achieved an average savings of 309 kWh / year - 160€ per year.

The profile that achieved the greatest savings is related to the change in the use of the gas/diesel central heater to an air conditioning equipment, providing 81% savings in energy expenditure. For hot sanitary waters, the gesture of keeping the device's temperature regulator in the "Eco" position or at the closest possible temperature to the tap, can achieve an average saving of 41€ per year.

Another achievement was the right temperature in winter, at 20 or 21ºC, and disconnecting the air conditioning from the electrical circuit in the months when it is not used. The reduction from 30ºC to 20ºC and the disconnection of the outlet, resulted in 190 kWh / year and savings of 36 euros per year.

Conclusions, perspectives & recommendations

DECO, in terms of energy consumption in the profiles of families in Portugal, identified 77% of homes without any RES technology and 23% of homes with at least one RES equipment. More than 60 families signed up to participate in the monitoring project, and an initial survey was carried out for selection. DECO conducted a study with 24 families selected based on the profiles, with an initial audit to obtain housing typology, family consumption profile, existing appliances and installation of the monitoring system. The study shows that, if all Portuguese families adopted the DECO board, Portugal could achieve 5.5 TWh of energy savings, which represents 29% of Portugal's total residential energy demand (that is, not just the consumption of electricity), electricity in homes, but also gas, natural gas and LPG).

For the families studied, the savings vary between 19 and 503 €/year. In total, they could save 2226€ generating an annual savings potential of 18 MWh.

The profiles of the families that achieved the lowest energy savings were those who already used renewable energy technologies. These results show that the use of technologies based on renewable energy sources can, in itself, result in lower energy bills according to demand.

The CLEAR 2.0 project established and confirms that it provided consumers with clear, reliable and descriptive information on energy consumption followed by personalized advice, allowing for future continuity to obtain energy savings.

Counseling services that have supported consumers are necessary and complement the information provided to inform consumers in their decisions.

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2.5. Slovenia.

Scope

The purpose of monitoring household energy use within the CLEAR 2.0 project was first to gain insight into how households use energy, how economically they behave, and whether they are prepared to do something to use energy more efficiently.

We wanted to find out if people are willing to change their habits about using larger household energy sources, such as using them more often at a lower tariff, when electricity is cheaper, to what extent they are willing to follow simple tips that can reduce power consumption (for example, disconnecting devices when they are not needed, turning off lights when they leave the room ...), if they are willing to replace old energy-consuming devices with new ones, more energy efficient, if they are ready to carry out any other investment that would lead to lower electricity consumption.

Since in Slovenia we have three climate regions (in Central and Eastern Slovenia, there is a temperate continental climate, in the Alpine region a mountain climate and west of the Alpine-Dinar barrier is described as a sub-Mediterranean climate with higher precipitation and lower temperatures compared to the real Mediterranean climate), we wanted to cover the entire territory of Slovenia as much as possible and as evenly as possible.

Therefore, we choose 10 households, evenly across Slovenian regions, average family sizes and different types of homes. Most of these are individual houses, in one case an apartment in a multi-family building. Half of selected households use a heat pump for heating, one even in combination with IR panels, so they also use electricity for heating.

Monitoring Market analysis

We first checked which energy monitoring systems are available on the Slovenian market. We found that quite a few were, but some did not meet our needs, others were too complex for the average user.

While doing the market overview we have taken into account different aspects:

- the total price (installation and annual fee),
- the installation process (DIY or installation company needed),
- the user-friendly aspect for the feed-back system,
- the channel choices for the feed-back information (via email, a web-based platform, an application on smart phone, combination of these 3 communications),

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- after sale service availability,
- technical support available at national level (for installation and after installation issues),
- granularity of the data provided (global consumption, solar consumption, each appliances consumption separately …),

Reasons we decided to select the Smappee monitoring system:

- the budget was average,
- no annual fee after installation,
- user friendly platform and application,
- high level of granularity and user-friendly data management,
- technical support and after sale services available at national level and with no additional costs.

Methodology

We decided to select a monitoring system that effectively collects consumption data and transmits it in a user-friendly format.

We selected 10 households out of 112 that participated in our survey that gave us insight into the attitude towards sustainable energy use among the Slovenes. After the selection an appointment has been set up to install the monitoring system and explain the aim of the project.

After installing the energy monitoring system, we were in regular contact with selected families to ensure that everything was working fine.

We monitored energy consumption in selected households for over a year and a half. For the first three to four months, families did not have access to the data collected, as we wanted them to behave the way they did before the monitoring system was installed - the fact is that people are already subconsciously behaving differently if they know that someone is monitoring them 24/7. If they were given access to the collected energy consumption data from the beginning, they would behave even more rationally in order to reduce their consumption.

After four months a full consumption analysis has been done. We then provided the families with tips to reduce their energy consumption and gave them personalized feed-back on monthly basis related to their specific efforts.

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Technical Difficulties related to monitoring system

We encountered the first problems when installing the devices. Namely, the installation is far from being as simple as promised by the manufacturer, and above all too complicated for the average user.

No one was able to install it by himself. Our expert also needed the assistance of a manufacturer's representative in Slovenia in four cases. The main problems was the electricity network complexity in each housing. The system connectivity was hard to set-up because it worked with WI-FI and in each household the modem is far from the fuse box were the system must be installed.

After initial problems with the installation, six of ten meters have been working without any problems. We had some problems with four of them, mainly related to the connectivity – we noticed that some meters were occasionally unavailable due to specific problems in the domestic WI-FI network, which was related to the WI-FI signal strength stability, but our expert managed to find the solution.

The appliance recognition was one of the main assets justifying the final selection. However, this recognition was not working properly. Namely the Smappee meter does not see the device (such as a washing machine) as a single consumer – it records the individual users in it. It tries to figure out (suggest) which device it is but assembling all the users into one logical device is difficult for users to see. Therefore, spending per device is not very useful, it's better to have a spreadsheet over time, showing the pattern of consumption.

Results

Electricity itself is still relatively cheap in Slovenia, while network charges and other charges that cannot be influenced by the consumer are quite high, therefore the electricity bill is also high. So many consumers think: there is no point in saving.

We would like to emphasize that Slovenians are not too keen on saving energy, if this is not reflected in lower energy consumption costs. On the other hand, most of selected families have a two-tariff connection and they are already accustomed to using large appliances after 10pm when a cheaper tariff enters into force, for example.

Based on the data collected during we did not notice any significant variation in energy consumption by region.

We summarized in the table below the main results regarding the feed-back done for behavioral change.

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Advices	Average savings	Average savings €/year	People has done
ELECTRICITY		495 €	10
Use LED bulbs	90%	60 €	8
Wash clothes with cold water	40%	16 €	4
Turn off the lights when you leave a room	25%	16 €	10
Do not put hot food in the refrigerator	5%	5 €	10
Installation of PV Panels	60%	338 €	1
Avoid stand by on your electronic devices	10%	60 €	10

Table 6 - Summary of savings obtained by each advice in Slovenia

Behavioral change

Based on the data and results collected, we can say that despite initial doubts, people are ready to follow simple tips that can help them use the energy more efficiently. It should be noted that while they are ready to follow the advice and change their habits, they are not ready to give up comfort. The top applied and long lasting tips were the ones very easy to do and not requiring a lot of effort, such as using of the eco-mode for dishwasher and washing machine, turning off lights when leaving the room, avoiding stand-by on electronic devices, not putting hot food in refrigerator, etc.

Perspectives & recommendation

Providing consumers with clear, reliable and precise information on the energy consumption is key to enable savings and long-lasting effects. The use of advanced technologies such as smart meters, however, entails the risk of using such data collected. The consumer, as the owner of the data, has to decide for himself with whom to share his data, when, for what purpose and for how long. The security of this information should be ensured, and the consumer should be able to obtain a copy of their information in a user-friendly format.

2.6. Spain.

Scope

As it has been already mentioned, the main aim of doing a monitoring program within the CLEAR 2.0 project is to estimate the repercussion of well knowing of where the family's consumption energy, alongside personal coaching to improve that waste of resources and energy.

But the objective was more ambitious, not only focus in a determinate number of families or participants, we would like to reach the overall households of the country. And to get results that can be improving to each one from now to the future.

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Thanks to the wide range of smart meter installations in Spain (in June of 2019, 99,14% of the energy meters were already smart meters) the framework of the monitoring in Spain has been different to the other countries.

The smart meters compile thousands of energy information from the families, but these are not able to use this data (in general) to improve their use of energy. OCU want to change it actively, with two different actions. One, comparing the measurements between families in where a monitoring appliance would be installed as in the other countries, with the measurements getting from families that only used the smart meters. On the other hand, comparing also the results of savings between one family and the other.

That information will enable to analyze if in fact the smart meters could be used for saving energy, and in which way, or if the installation of monitoring appliance gets better results.

So, in both cases, the scope focused on optimizing the use of existing facilities and studying the possibility of replacing some equipment with others that use renewable energy, with guaranteed profitability over a reasonable lifetime.

Monitoring Market analysis (principles)

As in the other countries, moreover, taking in account that in a first step we tried to do all together, we did an overview of the existing monitoring systems available on the market.

For doing this assessment we have taken into account different aspects:

- results gotten on our lab test
- the total price (installation and annual fee, in case there is one)
- the installation process (DIY or installation company needed)
- the user-friendly aspect for the feed-back system
- the channel choices for the feed-back information (via email, a web-based platform, an application on smart phone, combination of these 3 communications).
- after sale service availability (preferably near to the households)
- technical support available at national level (for installation and after installation issues)
- granularity of the data provided (global consumption, solar consumption, each appliances consumption separately…)

We ask for several different offers, some of them directly to the manufacturers of the best results on our test (Smappee and Wibee), and others to installers and experts on energy solutions.

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The first kind of offer had the advantage of direct contact with the manufacturer, but there are not going to get any other earn value to the project. In the second case, we can in addition to the application that the monitoring appliance included, have an extra application to manage all the families, compare, the results of each one.

So, we have selected an energy expert company that would supplied Wibee monitoring system because of:

- The budget was average.
- No annual fee after installation.
- User friendly platform and application.
- High level of granularity and user-friendly data management (graphs, annual consumption calculation, appliance recognition, message alert in case of consumption changes, costs figures...).
- Technical and after sale services available at national level and with no additional costs.
- Availability of up to 3 independent sensors (CLAMPS) for measuring consumption in each device and availability of sockets with the same data storage capacities, allowing the portability and monitoring of independent electrical equipment.
- Availability of a single professional platform showing all devices installed in the homes of participating families.
- Availability of individual platform per family to be able to follow and monitor their housing.
- Spanish manufacturer, so the contact and the relationship would be more fluently (indeed it already had been during the tender process).

In the beginning, the focus was to identify and differentiate the regions due to the demographic and climatic differences that exist in Spain. Subsequently, a study was carried out on energy consumption in the household sector, detached by pre-determined regions.

The combination of consumption information and the existing representativeness of domestic consumption equipment was determined and segmented into profiles according to the distribution of equipment in households by geographic area with the highest concentration (as it was explained on the D.2.1. Report on the relevant Energy Consumption Segments in the Residential Sector).

So far, we have described the process followed for selecting the monitoring system, but the process followed for selecting the energy supplier, whose could do the same, was very similar. We needed a supplier that which activities were very transparent, and which objectives with their clients were the same that we had for the participants on the project. After evaluating several options, we contacted with Lucera, who indeed has signed a

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letter of support of the project, so they were very interested in which CLEAR 2.0 were development, and in line with the values of the project.

So, why Lucera was selected:

- they sell the energy a cost price.
- they push their clients to save energy, and money, because they will not earn more money if consumers waste more
- they only sell renewable energy
- they have a platform to monitor the energy that are consuming each client, in where they give them tips of saving (thanks to an algorithm they can identify the consumption of each appliance)
- they will create a special offer for the project, donning free their energy coach for 6 months.

So, we this approach we will be able not only to extend the project to much more people, also to compare the evolution on both different approaches, and being able to concrete better the tips and solutions that could apply each family of the country.

Methodology

We decided to select a monitoring system which could remain after the end of the project and which could give nice consumption data in a user-friendly way.

The first selection of the families was focus in families that were already working with OCU to improve their consumption, as long as they would meet the requirements needed to be eligible to participate in the project, that were:

- Be a legitimate occupant of the accommodation in question (owner of the same or tenant, with a lease).
- Have access to energy and water meters (electricity, gas and water).
- Have last year's electricity, gas and water bills available.
- The dwelling in question must be the main residence of the family and, therefore, be occupied for a normal period (apart from usual holidays).

After the “first batch” of OCU families, the participation was open to the general consumers, from where the selection was focus on accomplish all of the profiles identified.

So, 8 families were selected among the country to be installed the Wibee monitoring system in combination with the clamps, that would be installed in different plugs to measure the performance of specific appliances.

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After the selection, each family received a call from the expert explain a bit more the project, and to arrange a visit, not only to install the monitoring system and explain the project and the methodology, also to do an energy audit to can stablish the base curve of energy consumption, knowing the behavior habits, and the different energy consumption appliance on the house.

After that visit, several exchanges of information have been taking with the families to ensure that everything was working fine and that the appliances recognition would be as complete as possible.

After this first step, a full consumption analysis had been done and shared with the families. This full analysis included some advice in four categories:

- behavioral tip
- very small investment tips
- higher investment recommendation
- specific advice to increase PV production self-consumption, in case they have

All the families were, at least, once a month getting personalized feed-back related to their specific efforts which were chosen among the list of suggested advice.

Each family that collaborated in this project, could remain after the end of the project the monitoring energy system and the clamp that has been using, providing good data on consumption in a user-friendly manner. With this system, each family will now be able to view the evolution of their electricity consumption in real time and check if the improvements have real energy savings.

As already has been said, with only 8 families the success of the project would be moderate, but in Spain we had the advantage of the agreement get with an energy supplier that is able to do exactly the same with the information from the smart meters, and with the collaboration of OCU the savings that the platform will advise will increase. So, OCU launched a campaign "EFICIENCIACLEAR (OCU-LUCERA), how to help consumers to save energy and money with the smart meters, even being an energy supplier https://eficienciaclear.es/"

In where anyone could join the project easily, only changing their energy supplier, something that once they ask, Lucera will do for them.

Thanks to the that agreement, more than 650 families, participated also on the project, receiving an energy coaching for save energy and money.

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Difficulties related to monitoring system (Technical)

The main problems that has been found has taking place, as in the other countries cases, on the installations of the monitoring system part. Basically, the issues can summary as: space needed on the fuse box, the electricity network complexity in each housing, and the WIFI connection, without it the system cannot sent the information to the platform to compilate it.

During the project, in some cases the family changed the internet supplier, so the router was replaced, and the configuration of the system needed to be done again. In other cases, the clamp were installed far away from the router, and the connection suffered interruptions.

Other common "issue" was that some families change the clamp to another plug forgetting informed about it, so if it was supposed to be on the dishwasher, it was really on the fridge.

Nevertheless, the problems were identified and solved rapidly, not having high impact on the results and measurements.

Results

We summarized in the table below the main results regarding the feed-back done, for behavioral change, small investment, higher investment, the self-consumption aspect, and others:

Advices	Average savings	Average savings kWh/year	kg CO2/year	Average savings €/year	People has done
ELECTRICITY		**3326**	**1281**	**860,00 €**	**1204**
1. BEHAVIORAL					
Disconnect the charger when not in use	5%	175	67	16,00 €	70
Check that your refrigerator closes correctly	5%	33	13	16,00 €	66
Choose what you want before opening the fridge or freezer	5%	33	13	16,00 €	54
Keep the refrigerator coil clean	25%	166	64	5,00 €	26
Dry clothes on the clothesline	100%	255	98	62,00 €	19
Check the energy your devices consume	10%	350	135	338,00 €	11
Save energy when cooking	50%	90	35	14,00 €	74
Wash clothes with cold water	40%	102	39	16,00 €	67
Turn off the lights when you leave a room	25%	100	39	16,00 €	127
Make the most of natural lighting	25%	100	39	16,00 €	112
Make smart use of your dishwasher	22%	54	21	9,00 €	49
Iron clothes efficiently	10%	2	1	1,00 €	46
Defrost the refrigerator from time to time	30%	199	76	32,00 €	55
Ready to iron program	25%	64	25	10,00 €	12
Natural defrosting system	2%	37	14	6,00 €	18
Do not put hot food in the refrigerator	5%	31	12	5,00 €	116
2. SMALL INVESTMENT					
Avoid stand by on your electronic devices	10%	375	144	60,00 €	52
Use LED bulbs	90%	375	144	60,00 €	120
Use dimmers	25%	100	39	43,00 €	5
Light colors produce a greater sensation of brightness	25%	100	39	14,00 €	73
3. HIGHER INVESTMENT					
Renew your dryer	70%	388	149	62,00 €	8
Renew your fridge	44%	199	76	43,00 €	24

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HOT WATER		**360**	**139**	**49,00 €**	**13**
Choose the right type of heater	18%	360	139	49,00 €	13
HEATING		**441**	**170**	**187,00 €**	**35**
Insulation keeps your home warm	50%	116	44	135,00 €	16
Heat Insulation	10%	200	77	32,00 €	9
Install thermostatic valve and thermostatic head on the radiator	2%	125	48	20,00 €	10
SELF-CONSUMPTION		**3090**	**1190**	**494,00 €**	**18**
Optimization PV system	10%	375	144	60,00 €	2
Installation of PV Panels	60%	2115	814	338,00 €	10
Install a solar water heater	30%	600	231	96,00 €	6
OTHERS		**0**	**0**	**0,00 €**	**22**
Discuss your goals and recommendations with others			0		11
Check the energy your devices consume			0		11

Table 7 - Summary of savings obtained by each advice in Spain

Without surprise the more adopted tips were first behavioral and then regarding small investments (more than the 90%).

From the 8 families in where the monitoring system were installed, we can conclude that:

- In most of the cases the power contracted is higher than the one they needed, so they have asked for a reduction. This case can be seen only as an economic measure, but it also helps to save energy to the grid system, as far as the power needed to be available will decrease. This measure supposed an average reduction of 60 €/year per family.
- Also we have detected that some old appliances are wasting so much energy, so we have recommend to substitute them for efficiency ones, indeed, for example in the cases of the refrigerator or the fridge, as they are consuming energy 24h per day, and in the case of the dishwasher of tumble-dryer, to use the eco program instead of the standard one.
- As with the energy monitoring and the audit conducted we have all the information needed for a PV system installation study, in the las report sent to the families, we have included it, fitting the dimension of each to the optimize use, and the energy potential production is an average of the 40% of the energy consumption.

The rest of saving energy measures are the same that has been done with the people involved in the project through Lucera, so we are going to explain them together below. That helps us to concluded that the information from the smart meters, if it is has a deeper and good treatment can be used in the same way than a monitoring system installed on the fuse box, so we need to push companies to help consumers to know better their consumption and how to improve them.

The 650 involved in the project through Lucera, has done more than 2,910 recommendations.

The average profile of the families that make up the project coincides with the average profile of Spanish homes, homes between 70 and 90 m^2, consisting of 4 people. So, if all families adopted the 8 simple habits change tips most done for that families, would save

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2,477,465,804 euros a year, a striking figure, ideally possible. A second group of tips are very effective but require a previous expense in the purchase of efficient appliances and appliances. For example, a new refrigerator consumes 40% less than one from 15 years ago, and a new dryer 70% less than an old one. It is worth reflecting on it.

Within the almost 60 tips that we have given these families to start saving, we have detected several, which, although many families have done, or are planning to do, are the ones most families are reluctant to consider. The first two with the most negative votes are the adoption of renewable energy systems, both to produce electricity (photovoltaic installations), and the solar thermal systems to produce domestic hot water (DHW).

It is followed by the advice of renovation of the refrigerator, since it has been identified during the monitoring of consumption that this, which is the element of our house that is continuously connected and spending electricity (it is the appliance that consumes the most in our house about 662 kWh per year, more than 30%), it is consuming much more than necessary, probably because it is near the end of its useful life (12.3 years) (if this is not the case, it will be better to perform a tune-up, cleaning the coil, and defrosting the freezer before deciding on the change to a new one). In relation to the models of fifteen years ago, today's refrigerators consume on average 40% less, or even 60% if they are more efficient models. This translates into a saving of 30 to 35 euros per year, which immediately recovers the money invested in the purchase of the appliance.

These three councils have in common that they require a significant initial investment, hence a large percentage of families do not consider carrying them out. In addition, it is important to point out as another barrier, information. The installation of any renewable energy system is not a decision that can be taken lightly, not only because of the cost it entails, but because its proper operation, and therefore the amortization of the investment depends on the correct sizing of this, of the selection of suitable products, and of course a well-made installation and maintenance.

The following advice has more to do with a change of habits, and it is true that many do not value enough the stand-by consumption that occurs in the appliances that we have plugged in and do not use, and we do not consider unplugging them, but this simple measure can mean an average savings of 10% of our annual consumption, which can be a negligible 60 euros.

The last advice that has not been very well accepted is to discuss with other people the objectives and recommendations of energy saving that they want to carry out, or that have already been made. It is true that it is not a very common type of conversation when we go out for dinner with friends, we should see the “Community” within OCU, where consumers can to exchange this type of experience.

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As for the contracted power, 2% of users have optimized their power, something that also will be rebound on the grid, as we already explain.

Behavioral change and Small investments (5 simple steps to start saving => Tips / habit changes most used and simple to carry out)

In counterpart to the councils with less acceptance, we have the ones that have carried out the most families, which also coincide with the most planned and have the least opposition.

It is not surprising that, in this case, none of them is influenced by the barriers we saw before, in this case it is measures without investment, or minimum investment, and that hardly require effort in changing habits, since they do not influence our "quality of life", simply a change of routine.

The savings we can get by turning off the lights when leaving a room can be 25% of the bill, meanwhile, changing the lighting of the old incandescent bulbs, already missing, to the current LED technology can mean a higher saving 80%, since they are up to 10 times more efficient than these. It is important not to introduce hot food in the freezer, think that each degree of cold is the 5% increase in energy consumption.

And although it seems a very basic advice, the energy that costs less is the one that is not consumed, so making the most of natural light can mean significant savings (imagine how much it can be if just turning off the light when leaving a room, you save 25%).

Regarding the last advice, ventilate the house properly, it is important to keep in mind that the ventilation of the rooms is one of the important factors in the loss of heat and, therefore, in the increase of fuel consumption. Correct ventilation should be used to replace stale air inside the room with fresh new air from the outside. To achieve it effectively, it is enough to open the window and generate air flow with another room. In 10 minutes, all the air in the room will have been renewed by cooling the indoor air but not the walls and furniture, so that when the ventilation is finished, the heating will work only to recover the heat of the ambient air. The ambient temperature will recover quickly, and little energy will be spent.

Consumption displacement and self-consumption increase

As mentioned above in the document one of the main monitoring goal was to inform families over their PV production and allow them to move some consumption during the production time and increase therefore the self-consumption rate, in case they have it (only one of the families with monitoring system has it). In this case, the family need to

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move their consumption to adapt it to the production time, by installing programmers for appliances that can be used anytime.

So, for the others we have done a simulation of what will be the best installation for each one, the energy that they would be able to produce and consume, for have it as much as possible optimize.

Perspectives & recommendation

The monitoring project has established and confirm that provide consumers with clear, reliable and granular information on the energy consumption is key to enable savings and long-lasting effects.

We have checked that the information provided by the smart meters is as good as the one provided by the monitoring system, if it has a previous treatment, and show to consumers in an easy and clear way. So, it is needed that consumers can access to their energy information, but also, with an expert coaching to understanding it. Advice services supporting consumers are necessary and complement the information provided to enlighten consumers in their decisions.

3. General conclusions.

Providing consumers with clear, reliable and precise information on the energy consumption is key to enable savings and long-lasting effects. The use of advanced technologies such as smart meters, however, entails the risk of using such data collected. The consumer, as the owner of the data, has to decide for himself with whom to share his data, when, for what purpose and for how long. The security of this information should be ensured, and the consumer should be able to obtain a copy of their information in a user-friendly format.

As we just said, we have proved that the information provided by the smart meters is as good as the one provided by the monitoring system, if it has a previous treatment, and show to consumers in an easy and clear way.

CLEAR 2.0 has also worked closely to 800 families, monitoring their consumption and supporting in changing behaviour in their day to day life. The consortium was tackling both electricity, heating, water consumptions. As a result, consumers participating in CLEAR 2.0 achieved cumulative savings of 255 MWh/year and managed to directly use 26 MWh/year renewable energy they produced (self-consumption). This means cumulative savings of 97t CO_2/year, which is the equivalent to the CO_2 emissions saved in one year by planting over 16,000 trees.

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Service	Cumulative savings project € / year	Cumulative savings kWh/year (Or kWh green directly used on the case of the Self-consumption)	Cumulative savings kg CO2/year
ELECTRICITY	43.601 €	229.144,59	84.065,51
HOT WATER	1.551 €	11.371,00	2.867,40
HEATING	3.703 €	14.041,00	1.885,73
SELF-CONSUMPTION	4.076 €	25.804,37	9.818,98
	CUMULATIVE INFORMATION FROM PEOPLE REALLY INVOLVED ON THE PROJECT		

As we can see below, the average of energy savings if all the tips will be adopted are so impressive, principally on electricity, as it is the font with more data compilation.

Service	Average savings kWh/year (Or kWh green directly used on the case of the Self-consumption)	kg CO2/year	Average savings €/year	TIPS has done
ELECTRICITY	13146	4598	2.947 €	4604
HOT WATER	1105	198	127 €	685
HEATING	723	170	261 €	44
SELF-CONSUMPTION	3090	1190	494 €	19
	AVERAGE INFORMATION FROM PEOPLE REALLY INVOLVED ON THE PROJECT			5352

But more impressive will be if all the population (56.507.599 households) of the countries involve in the project follow that advices, the yearly savings will be more than 111 TWh/year.

Service	Potential savings (Total households off all the countries)	Potential savings (Total households off all the countries) kWh/year	Potential savings (Total households off all the countries) kWh/year kg CO2/year	Global population
ELECTRICITY	24.253.234.224,13 €	93.448.860.949,30	35.869.723.498,70	56.507.599
HOT WATER	1.161.931.448 €	8.685.663.765,53	3.394.247.241,77	
HEATING	3.803.445.754 €	9.528.997.133,00	3.764.398.734,51	
SELF-CONSUMPTION	8.933.343.848 €	55.885.563.546,15	21.515.941.965,27	
	IN A POSITIVE WAY, IF MOST OF ALL THE POPULATION WILL DO IT			

Lessons learned and recommendations

Putting in common the experiences of all the countries, we have some important lessons learned to take in account for improve our communications and support to consumers and also asking companies and manufacturer to include in their developments. For example, a global feedback is not sufficient to make the change behavior, it is needed a detailed and specific suggestions. Added to that, also is needed, to focus and motivate consumers to have references to compare to what they can reach. Because, people show engagement at the beginning of the projects but lost soon interest and therefore the saving were temporary, probably due to the results are not up to the expectation. Families are not so keen on engaging if it is not visible in the final bills. In some period, we had some saving up to 5-10% but after some months there is raising up, as rebound effect. So, money saving must be shown and be very visible to let consumer continuing their efforts. Environmental sensibility of the family does not appear to have an impact in the willingness to act (at least was not perceived in the monitoring result). We have observed that the main reduction and saving only have an important impact on high consuming appliances (like fridge/freezers and heating systems), for example is interesting the saving get with the isolation of the electrical boiler (heat loss through the boiler) with cut down 70% of the boiler consumption. Another interesting saving point is the stand-by consumption, low technology effort for model and WIFI to reduce the stand-by losses. Those are constant saving that can be maintained because it is automatic, and it does not ask change behavior; one-time effort is much easier, and it has sustainable effects.

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4. ANEX: GLOBAL_MONITORING SAVINGS REPORT (XML FILE).

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