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DELIVERABLE 1.1
Market Research Survey Tool

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Authors List

Leading Author			
First Name	**Last Name**	**Beneficiary**	**Contact e-mail**
George	Tsakirakis	ITML	gtsa@itml.gr

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Executive Summary

This deliverable sets out the first steps for identification and involvement of SIT4Energy end-users in its very early desing stages. End-users identification is the first and foremost important task in effective target groups' engagement. SIT4energy defines target groups as those who are interested in (and have sufficient or little knowledge) improvement of sustainable and efficient energy actions, reduction of energy consumption, wish to address these two issues by means of optimal management of energy consumption and increase of number of so-called prosumers through cross-border cooperation. In this context, SIT4energy aims to interact with stakeholders, researcher users and the community at large in innovative ways that will be based on their proactive direct involvement.

To engage end-users from the early design stages, we conduct SIT4Energy market research survey tool based on initially defined SIT4energy target groups aiming at utilizing it to increase user-awareness on energy consumption using tools/methods required by users themselves.

It should be stressed out that the work performed in the context of Task 1.1, has been planned and executed in a way that the results attained will be directly exploited in the work to be performed in the design and development of the SIT4Energy products and services that will be deployed and demonstrated in the pilot sites.

Additionally, the current document provided valuable inputs for the work to be executed within the Task 1.2; 1.3 and 1.4. Specifically, the performed analysis related to the needs of the main market actors and stakeholders for the SIT4Energy ecosystem will be an essential basis for further SIT4Energy market analysis and business model's definition.

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List of Acronyms and Abbreviations

Term	Description
EE	Energy Efficiency
EMS	Energy Management Service
EU	European Union
DNAS	‘Drivers - Needs - Actions - Systems’
GDPR	General Data Protection Regulation
HUA	Harokopio University of Athens
ICT	Information and Communication Technology
RES	Renewable Energy Source
ToE	Tonne of oil equivalent

1. Introduction

1.1 Scope and objectives of the deliverable

In order to promote green behaviours, increase energy efficiency at buildings and convince end-users in changing their habits an accurate user-awareness and notification system is highly required. User-awareness influences the energy savings at home/workspace and helps users to change their own habits towards green attitudes. ICT-enabled solutions combined with user-friendly consumer interfaces like apps and dashboards enable user-awareness thus enhancing energy and resource savings. These apps can be accessed remotely via smart devices and allow people to respond to changes or problems even if they are miles away. Besides using data analytics for predictive maintenance, real-time monitoring technology can also send notifications to the user’s smart device when an appliance or light is left on or when something is broken and needs replacing. The available data can also be used by urban planners, utilities companies and architects to understand changing demand patterns and respond better, reducing costs to the consumer. Consequently, ICT developers must understand user-awareness as personalization of services delivered to consumers and prosumers. This can be reached by choosing proper data processing and transmission methods, according to needs, desires and requirements stated by end-users.

The purpose of this deliverable is to develop a market research tool. This tool will further be used to reveal the needs and desires of key SIT4Energy market actors and stakeholders (end-users, prosumers/consumers, local utilities, building owners/managers, and academic staff). The tool aims at exploring the needs, preferences, desires and demand for SIT4Energy services, assessing the SIT4Energy solutions acceptance rate. The outcome of the work will be directly exploited in the work to be performed in the design and development of the SIT4Energy products and services that will be deployed and demonstrated in the pilot sites.

1.2 Structure of the deliverable

At first, the general energy efficiency market has been reviewed. Efficient energy market approach could provide multiple benefits ranging from the end-consumers through distribution and transmission network level to societal aspects. In addition to potential benefits from a local market model, the barriers from regulatory, technological, social and economic standpoints are also explored. This is followed by the introduction and description of SIT4Energy target groups considering on a) SIT4Energy pilot cases b) energy services providers/operators and c) any interested energy consumers/prosumers (private/public building managers, residential/household users). Section 4 illustrates the methodology and design of the developed market survey tool followed by the Section 5 where some initial data collected from the survey tool are described.

1.3 Relation to Other Tasks and Deliverables

This work will provide important insights for analysis of energy demand for the different types of SIT4Energy target users (Task 1.2) which will perform a deep analysis of the survey data obtained from the market analysis tool investigated within the scope of the current work, by classifying the users based on personality traits, attitudinal and socioeconomic characteristics. The outcome derived from the developed tool will also help to determine the factors influencing consumer energy consumption behaviour and applicable models of behaviour change (Task 1.4). Furthermore, the users’ needs with respect to energy consumption and production required within the scope of the Task 1.3 will be based on the results of the created tool. The latter will also lead to initial insights of the SIT4Energy product proposition (Task 2.1) and propose a pricing strategy and positioning of the SIT4Energy services and define the value chain. It will also explore the business propositions as to determine their efficiency in creating incentives for the customers to change behaviour and/or becoming more engaged in energy related actions.

2. Energy Efficiency Market Overview

The EU consumes one fifth of the world's energy but has relatively few reserves of its own resulting an enormous impact on its economy. The EU is the largest energy importer in the world, importing 53 % of its energy at an annual cost of around €400 billion.

Total energy demand of dwellings is expected to increase by 0.6% pa in 2000–2030. Given limited population growth, this is mainly due to the rising number of dwellings (+40 million between 2000 and 2030, with 0.68% pa in EU-25), resulting from changes in age structure, lifestyles and dwellings size [1]. Figure 1 represents the residential energy use per capita (cap) while Figure 2 shows the development of total electricity prices for households with consumption between 2500 and 5000 kWh/year (Band DC) from 2008 to 2015. As it is shown the residential energy use per capita (cap) varies widely among European countries being relatively lower in southern EU countries as comparison with most of the Northeast EU countries [65].

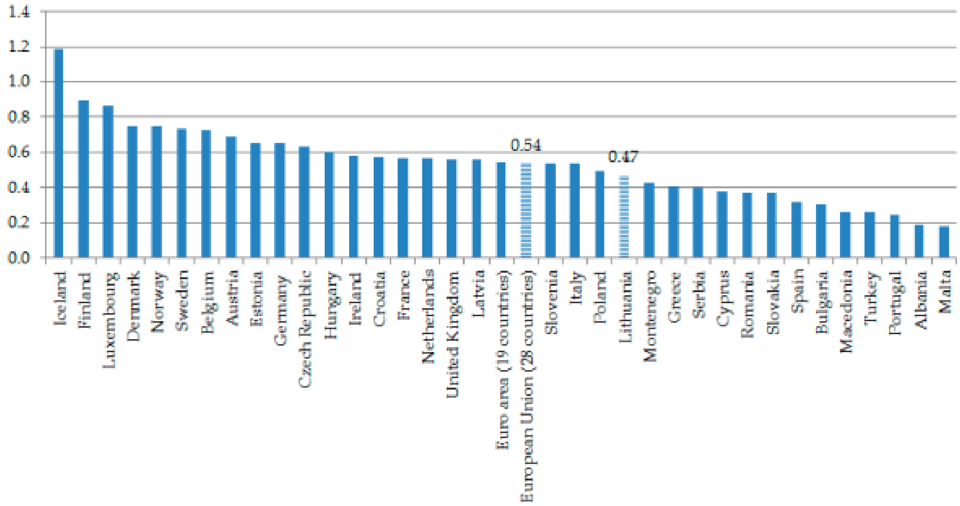

Figure 1. Energy consumption per capita in 2015 (in TOE)

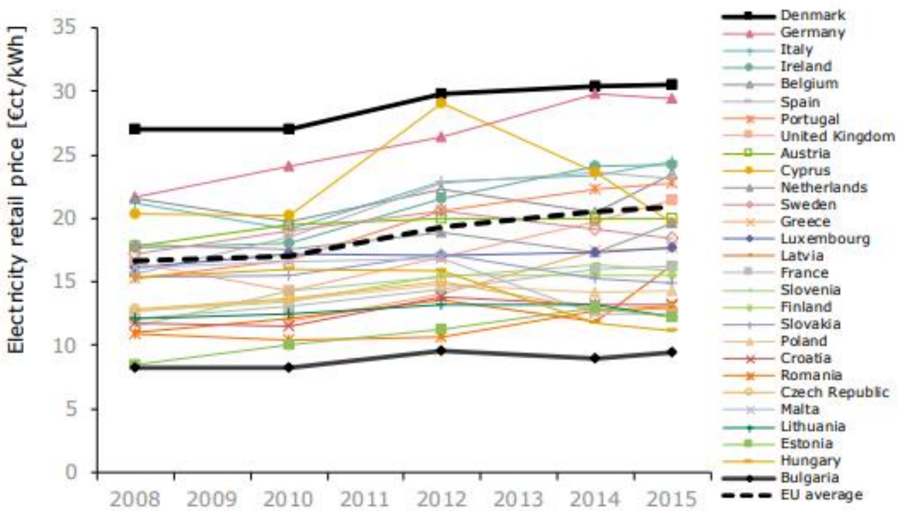

Figure 2. Total electricity price development for households

The EU-28 average of electricity prices increased by approximately 25%, from €16.6 ct/kWh in 2008 to €20.9 ct/kWh in 2015. In all years, Denmark shows the highest prices. On average, households in

Denmark with a consumption between 2500 and 5000 kWh/year paid €30.6 ct/kWh in 2015. With a price of €29.5 ct/kWh in 2015, Germany ranks second highest. The lowest prices can be found in Bulgaria, with a price of €9.4 ct/kWh in 2015. The lowest prices can be found in Bulgaria, with a price of €9.4 ct/kWh in 2015 [2].

The increased energy needs, the growth of prices and also the worldwide environmental issues, request a global trend and demand for energy saving and smart technologies aiming at increasing the efficiency of energy consumption [3]. The European Standard EN 15232 [4] and the Energy Performance of Building Directive 2010/31/EU [5], which is in line with Directive 2009/72/EC as well as the Energy Road Map 2050 [6], promote the adoption of smart technologies to reduce energy usage in the residential sector. Businesses and consumers are increasingly considering the energy efficiency of the products and services they buy and use while industrial production, companies are searching for the most energy-efficient process design solutions [7, 8]. According to Balta-Ozkan et al. [9], the smart technologies can provide control and management of household electricity via connected devices, appliances and sensors that can communicate with each other. Smart metering, appliances and home automation devices are some of the many technologies that can be used to change electricity consumption patterns of households [10] and provide consumers the flexibility of monitoring its electricity consumption and making lifestyle changes to save electricity. It has been noted in [11] that smart technologies does not only provide benefits of efficient energy management, but also provides benefits such as improved lifestyle, security and safety.

The global market for energy management systems (EMS) totaled $1.7 billion in 2012, according to the consulting firm Zpryme [12] and is projected to reach 9.98 billion by 2020. Europe will account for 30% of the global EMS market by 2020 (Figure 3).

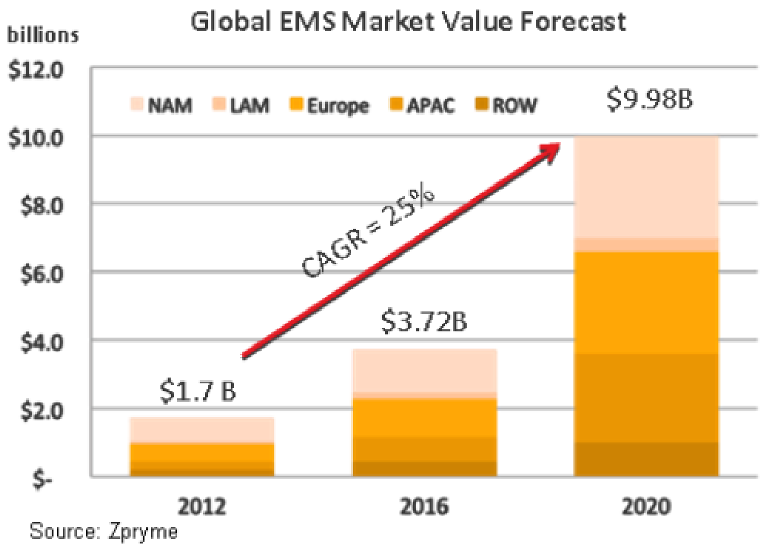

Figure 3. Global EMS Market Size

In this respect, Germany made a policy decision to focus on a sustainable long-term energy supply and adopted its strategy, the Energy Concept, in 2010. The strategy establishes the principles of a long-term and integrated pathway looking towards 2050 with renewable energy its corner stone. The German Government is seeking for Germany to become one of the world’s most energy-efficient and environmentally friendly countries, while maintaining economic prosperity and affordable energy prices. Energy efficiency is a key element of the Energy Package, and Germany set targets to reduce primary energy consumption by 20% by 2020 and 50% by 2050 compared to 2008. Beyond concerns of energy efficiency, as information and communication technology is central to the concept of smart technologies, the Federal Office for Information Security is currently developing a policy for a privacy protection profile for smart meters [13]. Many German companies are in a particularly good starting position to take the lead in the new arena of energy-related completion. Their knowledge and experience in the relevant technologies are advanced, and energy conservation and climate protection have enjoyed high public interest and acceptance in Germany for many years [7].

In case of Greece, the existing Law 3855/2010 “Measures to improve energy efficiency in end use, energy services and other provisions” establishes the framework necessary to promote energy saving measures in the country, and also harmonises Greek law with 2006/32/EC and 2012/27/EU Directives on energy end-use efficiency and energy services. Pursuant to Directive 2012/27/ EU the primary energy consumption in 2020 will amount to 24.7 Mtoe. This target is derived from estimates of the development of both the Greek economy, and the implementation of measures, actions and programmes for improving energy efficiency, penetration of RES and achieving energy savings in final consumption and primary energy production. Greek authorities actively and continuously taking actions to develop perspectives for the use of IT in sustainable buildings which better meet both the needs of users and energy efficiency criteria. Despite the fact that many greek companies [14,15,16https://www.watt-volt.gr/en/services/smart-services/smarteverything-iot-platform/smartenergy/] have already started to supply of reliable, state-of-the-art technology and highly efficient solutions to customers; the energy sector in Greece is considered to be less efficient. In this respect, more intensive efforts should be directed towards an increase of energy consumption efficiency encouraged through the implementation of a package of policy measures for energy saving and the promotion of more efficient appliances, equipment, initiatives and services in all realted sectors.

From a system technology perspective, communication networks represent the largest market segment in 2012, account for 20% of the global market. In 2020, communication networks will account for 18% of the market. By 2020, control systems will be the largest technology segment, accounting for 21% of the global market. In 2012, field equipment, hardware, software and sensors accounted for a total of 46% of the global market. By 2020 these four technologies will account for 44% of the market. Among all the sensors and software technologies are projected to grow the fasted (30% CAR GR).

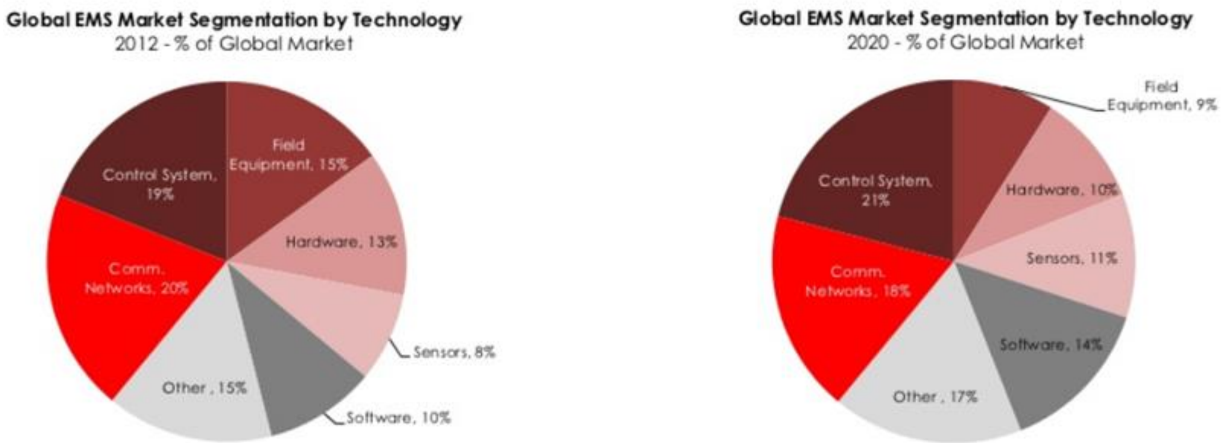

Figure 4. Global Market Segmentation by Technologies

These numbers reveal that the role of smart/new technologies (and the related devices/services) to increase energy efficiencies in households or building facilities is becoming increasingly important. To understand the energy efficiency market, it is crucial to expose and understand factors inhibiting this process, but also factors promoting improvements. Several factors are driving demand for energy management solutions including rising significance of social responsibilities and climate change; focus on increasing demand efficiency and operating cost savings; new products offerings; compliance with energy efficiency regulations, and increased use of renewable energy. The section below presents the main drivers in energy efficient management.

2.1 Energy Efficiency Drivers

Energy saving, and energy security have become major issues in recent years. We are facing energy deficiency which not only impacts economics, society and development of the country, but also results in the global warming [17]. A set of recent developments are about to change this picture and have proposed efficient energy policies. These policies directly or indirectly generate drivers that, from the companys'/customers' perspectives, are considered to be any action which is performed to developed energy efficient mechanism. To assess and judge the desirability, the effectiveness and the acceptability of proposed policy changes, it is of crucial importance to obtain clear empirical insights on how to foster the adoption of energy efficient technologies and practices within the industrial sector. To do that, it is of fundamental importance to come up with a comprehensive taxonomy able to distinguish the drivers. In fact, without a clear understanding of the enterprises' needs, future energy efficiency policies would be abruptly ineffective and inefficient. In addition to that, how these decisions can be influenced by governance strategies, how firms are likely to respond to various possible policies, and how they judge the feasibility and acceptability of these measures, are crucial research issues to be explored.

By designing and developing a DNAS (Drivers, Needs, Actions, Systems) framework for standardization the representation of energy-related occupant behavior in buildings, the authors in [18] have introducted a definition of drivers as follows: Drivers represent the environmental factors from the outside world that stimulate occupants in their inside world to fulfill a physical, physiological or psychological need. A driver prompts a building occupant to perform either an action or in-action with a building system, impacting the energy use of a building. The drivers can include environmental factors, such as indoor air temperature and solar radiation, as well as non-physical factors such the time of day or the season. Another formal definition of energy efficient drivers has been formulated by [19] as follows: "Drivers are factors that force towards the adoption of energy-efficient and cost-effective technologies or practices, influencing a portion of the company or a part of the decision making in order to provide a thrust towards energy efficiency". Hence, it is apparent that drivers do not merely allow to reach an energy efficiency improvement but are also able to reduce any kind of negative environmental impact. In this respect, the drivers for change can be classified as external to the network, like preparing for a low-carbon future by reducing greenhouse gas, as well as internal, like the need for replacement of an ageing infrastructure. In order to provide more robust descriptions of the motivations driving occupants to interact with the building envelope and building systems, in order to bring about desired comfort conditions.

One of the main external drivers is the EU Energy and Climate Package [20], which has set out ambitions targets for year 2030 and beyond as: 40% reduction of greenhouse gas emissions (compared to 1990 levels), 27% of Renewable Energy Sources (RES) in the EU-27 energy mix (today 6.5%) and 27% reduction in the primary energy used (saving 13% compared to 2006 levels) (Figure 5).

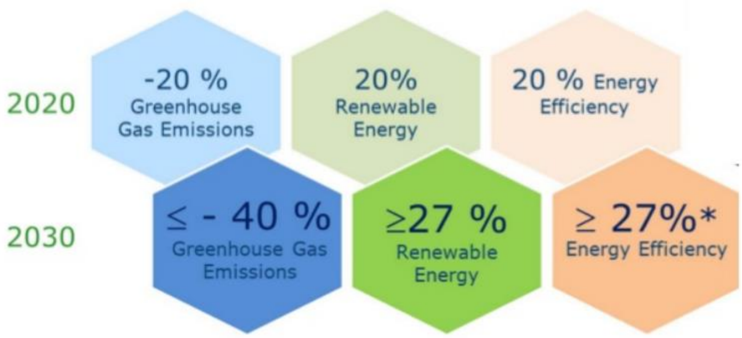

Figure 5. EU's Energy and Climate Triple Package

The EU's triple commitment to reduce CO_2 emissions by 40%, sourcing 27% of its total energy (transport, heating, lighting and electricity) from renewable sources and improving energy efficiency by 27%, all by year 2030, represent a considerable challenge for today's energy sector.

D. Kindström et al. [21] designed a questionnaire to explore barriers and driving forces in the implementation of energy services perceived by local and regional actors in the Swedish energy company market. Figure 6 illustrates the respondents' perceived barriers to energy services.

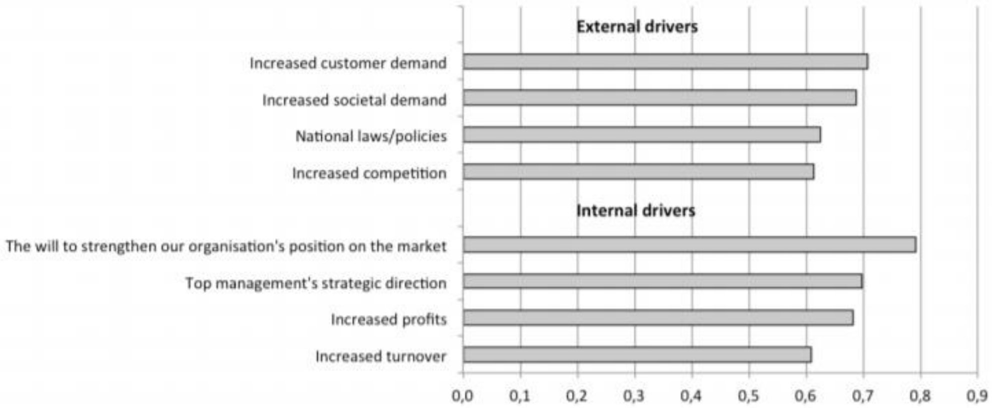

Figure 6. Responses regarding the perceived driving forces of energy services. The driving forces were ranked according to the respondents' answers (based on the Likert scale 1 to 7).

According to the results the highest ranked external driving force, i.e., increased customer demand, indicates that, unsurprisingly, customers play a crucial role in the successful launch of energy services in the market and that stimulating customer demand and interest are key factors. The driving force of societal demand (as perceived by the energy companies) was also relatively highly ranked, i.e., it is not solely economic issues that drive the local and regional energy companies. As many of the included energy companies are municipally owned, the societal aspect becomes important. This is also a consequence of a generally increased awareness of these issues in Swedish society (as in many other societies). The obtained findings also indicate that willingness to strengthen the organization's position in the market is another important driving force of energy services. This is interesting, as it indicates an awareness of the company as an actor in a competitive market in a social context. This could point to increasing environmental awareness, both internally and in the market as a whole, indicating an increased need to provide products and services that contribute to a more sustainable society. The next most important driver was top management's strategic direction. The issue indicates that a lack of strategic direction could be a significant barrier. This means that establishing a clear strategic direction, with, e.g., measurable goals, is a key issue in implementing energy services. Another conclusion from this, and also pertaining to the existence of organizational inertia discussed above, is that a key actor (and a change agent) in implementing energy services will be found in the top management of an energy company.

Internal drivers mean something that the company is able to implement and continue independently to achieve efficiency. In fact, according to [22]: "Internal driving forces are resulted from company's internal motivation (enterprise itself)." Obviously, a growth of awareness and therefore a commitment is required by the organizations. The stimulus to the drivers must derive from policies at a higher level, as noted in the previous sections. The company is therefore able to provide for itself the implementation of drivers as: willingness to compete, cost reduction from lower energy use, long-term energy strategy, staff with real ambition and management with real ambition and commitment, Public investments subsidies, Technical support from technology suppliers [19].

The findings in [21] indicate that indeed the willingness to strengthen the organization's position in the market is the most important internally oriented driving force of energy services (Figure 6). The second most important driver was top management's strategic direction. This indicates that establishing a clear strategic direction, with, e.g., measurable goals, is a key issue in implementing energy services. Another conclusion from this, and also pertaining to the existence of organizational inertia discussed above, is that a key actor (and a change agent) in implementing energy services will be found in the top management of an energy company. Regarding the other internal driving forces, i.e., increased profits (e.g., as services typically have a higher profit margin) and turnover (as in using energy services as a way to increase firm total turnover), these financial driving forces are apparently perceived as somewhat less important and are consistently ranked lower than are the willingness to change and strategic goals. This should likely be interpreted in light of the fact that the participating companies are not privately owned (in the vast majority of cases), meaning that they have not traditionally emphasized profits and turnover to the same extent as more commercial actors. This might in turn also explain why these companies increasingly view environmental considerations as important when promoting energy services. Many municipalities have ambitious sustainability goals that the energy companies must incorporate into their businesses.

Finally, some drivers can either be external or internal. Indeed, programs of education and training can be an internal action arising out of a corporate initiative, but at the same time being also external. In fact, an external body can perform, e.g., training courses regarding how to use raw materials more efficiently. In this way, education and training appears to be a driver has not required an extra effort by the company, and therefore should be accounted as external.

As reported by Marta A.R. Lopes et al. [23] the residential end-users accept smart technologies and support related investments, but are uncertain about their social and individual benefits. Therefore, improving communication to residential end-users on the benefits of smart technologies is a key factor for their deployment. Recent studies also found smart home technologies are adopted or rejected depending not only on their price, savings, and payback, but also on their convenience, ecological footprint, transparency and data privacy, the sense of control they provide, and other design attributes. Factors influencing end-users' enrolment in demand response programmes and dynamic pricing schemes include: end-user's level of electricity literacy (e.g., consumption and electricity market), which may be impaired by the "invisibility" of electricity; the complexity of demand response programmes, dynamic tariffs and contracts; the upfront cost of technologies when compared to savings and financial incentives; the effort required to seek dynamic pricing information and reprogram electric appliances accordingly; end-users' risk aversion; savings expectations and perception of equitable distribution of benefits between the utilities and end-users; and inertia associated with behavioural change, in particular, habits. To this end, to facilitate behavioural adaptations several strategies were recommended, by Marta A.R. Lopes et al. [23] such as improving the energy market regulation, assessing households' behaviours, prioritizing actions already embedded in households daily routines, not interfering with their activities and ensure an override option, and improving energy services, trust and information provided to end-users.

2.2 ICTs Driver

The European Commission has recognized the potential role ICTs can play in improving the energy performance of buildings in several high-level policy documents [24]. ICT and ICT-based innovations may provide one of the potentially most cost-effective means for Member States to achieve the 2020 target and are essential to deliver the fundamental, yet urgent changes required in local and regional communities. ICT provides solutions that enable us to 'see' our energy and emissions in real time and could provide the means for optimising systems and processes to make them more efficient. These solutions for energy management and resources integration should be considered to help designers, stakeholders and users to increase the energy efficiency of those individual systems and the overall efficiency of the European buildings. According to REEB 2010 [28], ICT has been identified as one possible means to design, optimise, regulate and control energy use within existing and future (smart) buildings. Recent studies found that ICT will not only improve energy efficiency and help combat climate change, they will also stimulate the development of a large leading-edge market for ICT enabled energy-efficiency technologies that will foster the competitiveness of European industry and create new business opportunities [24, 25].

Heras and Zarli, [26] identified several areas where there are potential to improve energy efficiency through the use of ICT such as design and simulation tools, interoperability/standards, building automation, smart metering, user awareness and decision support. The last two have been significantly attracted the researchers' attention as many publications [24-27] highlight the importance of ICT in these two fields. The metering infrastructure needs to be coupled with innovative IT services in order to increase energy efficiency by means of rewards, automation and information. Several projects across Europe, USA and other countries show that smart metering is technically feasible and promises many benefits. The consumption awareness over smart metering market is a very active area for technology development. Information and feedback tools using smart meter data, such as displays or energy reporting via internet mobile devices, are already available [28].

In terms of user awareness, it is anticipated that intuitive feedback will be given to users and operators on real time energy consumption and pricing, enabling them to optimise the control of the building and its usage– while at the same time being unobtrusive, and attuned to the user's available attention, taking into account both his/her activity and the urgency of the information that is notified to him/her. Overall, the concept of "user-friendly" environment has to be reinforced, i.e. easy to use (input) and easy to understand (output). New multimodal context aware interfaces and devices will make the in-house network as simple to use as possible, thanks to a right combination of intelligent and interoperable services, relying on new techniques of human-machine interactions. These interfaces could be extended by means to share ambient energy-related information spaces thanks to personal advanced communication devices.

To meet the emerging and evolving needs of their residential and commercial customers, utility companies should begin by working to understand what is driving consumers' needs, expectations, and interests. Utilities/energy providers around the world should realise that the best consumer engagement experience involves meeting customers where they are, which means **online** and **on mobile devices.** Regardless of the nature of the products and services that are developed, companies will need to be better at making customers feel in control and ensuring interaction with them is as **simple** and **easy** as possible. In this respect, energy providers will need to be adept at combining the assurance that comes from being the traditional supplier with the innovation that will be needed to fire customer imagination in an energy transformed world. In Figure 7 it is outlined some key questions that utilities need to address as they develop intelligent energy services for customers [29].

Over the next ten years the utility customer...		Key questions for utilities
Will be digital, connected, and social	• Social media • Mobile connectivity • Smart meter-enabled • Big data	• Are we prepared for the connected, mobile customer? • How do we better engage with our smart meter-enabled customer? • How will we manage and extract insights from an avalanche of data?
Will demand – and receive – greater choice	• Choice of energy supply • New products and services • Payment options • "Green" choices	• What options and choices – energy supply, green solutions, payment options – should we make available to our customers in the fututre? • What new products and services should we offer, and how do we innovate, manage, and build a portfolio of services?
Will be empowered with information and the ability to self-manage energy usage	• Self service • Instant information access • Tools and guidance to manage energy usage	• How will the customer of the future interact with us? • How do we provide instant accesss to information that our future customers will expect and demand? • What tools should we make available to empower our customers?
Will demand a better overall experience	• One-to-one engagement • Customer satisfaction • Customer loyalty/defections	• How do we deliver an experience that is on par with other services our customers enjoy? • How do we improve brand health as our customers' needs change? • As customers have more alternatives, how do we drive loyalty?
Will adopt technologies that will impact the energy infrastructure	• Distributed generation • Net metering • Electric vehicles • Smart devices	• As customers adopt new tchnologies, how do we ensure we can meet demand and maintain service levels? • What is our strategy for smart energy technologies? • What is our play (if any) "behind the meter?"

Figure 7. Customer transformation – key questions for utilities

2.3 Energy Efficiency Market Barriers

The prospect of cost-effective energy technologies looks attractive and the evidence suggests that there is significant potential for cost-effective investment in energy efficiency but still a lot of these technologies are not implemented and the gap between the opportunities for cost-effective energy efficiency investment and the levels actually seen in practice is remaining in high level [19, 30, 31,32]. The explosion of smart technologies – the Internet of Things – enables more efficient use of energy in buildings, it provides a window of equipment operation and monitor performance within the building it identifies ways of potential energy savings. However, these technologies failed to be deployed due to several barriers [33]. The first reason is probably the smart-unreadiness across Europe. No country in Europe is fully ready to take advantage of the benefits of the smart technology revolution as it can be seen also in **Figure 8** [34]. The figure shows that the big difference among countries can be found under the categories efficient and healthy and dynamic operability. It can be explained by the fact that the top countries have more insulated and healthier buildings, better smart infrastructure (smart meters and connectivity) and better-prepared regulatory frameworks (demand response and dynamic pricing). The average score for the categories responsive energy system and renewable energy uptake ranges from low to very low.

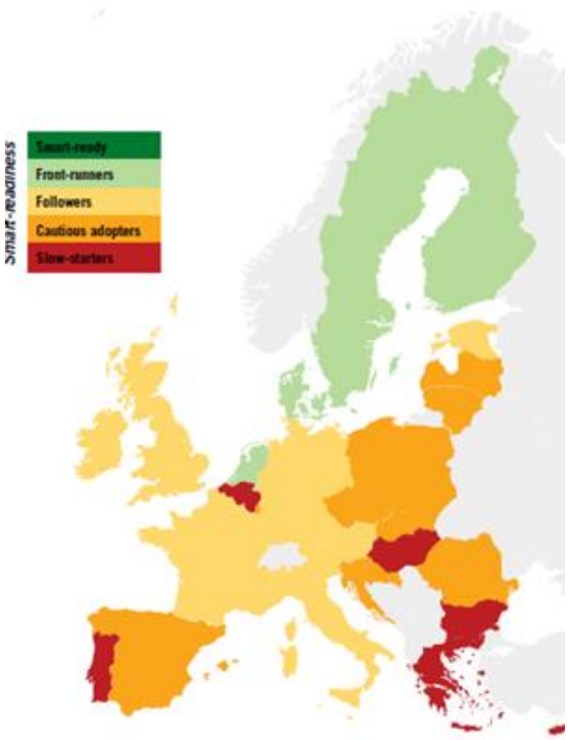

Figure 8. Smart readiness across Europe

The unreadiness to the smart technologies is due to several barriers [35] which can be categorized as Framework barriers, Providers barriers and Customer barriers as illustrated in Figure 9 [36].

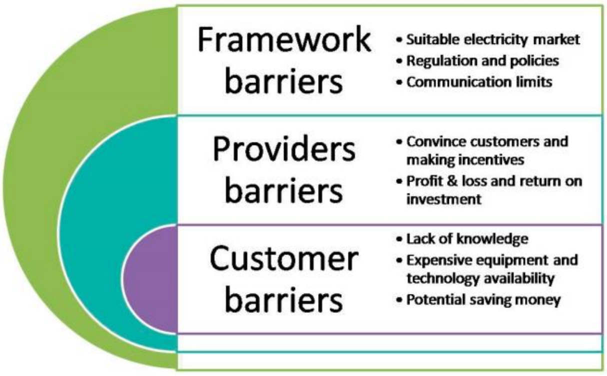

Figure 9. Efficient Energy Market Barriers

2.3.1 *Framework barriers*

Burdensome regulatory environment and the lack of standards are the major barriers to a revolution and a widespread penetration of smart buildings across the European Union. Existing legislation should be revised and future-proofed, in order to support the features of smartness and envisage a future smart building stock in Europe. This means highly energy efficient buildings that drive a faster decarbonisation of the energy system, empower its users and react to their needs in terms of comfort, health, indoor air quality and safety. Despite past efforts to liberalise energy markets, entry barriers still exist and are leading to market concentration. The impact of these barriers is especially severe with regard to new market players, such as 'prosumers' and aggregators [37,38]. *The rejection of modern communications networks* is also holding back the potential of energy management system market. Some issues are related to the lack and trust of information, behaviour barriers that mean energy efficiency is undervalued.

2.3.2 *Providers barriers*

Getting consumers to understand that the *use of energy management systems can empower them to do something about their energy costs* is the biggest barrier for the energy management system market while most companies and customers realize there are means to reduce energy costs, but they lack information about what is happening within their energy systems. Often company manager will have little or no ability to evaluate energy efficiency measures properly and may not appreciate that no-cost/low-cost measures are available that require very little capital to implement. The cost of implementing energy efficiency measures in industry, commercial or residential sectors is also said to be a barrier to effective energy efficiency. For example, energy suppliers may need to invest in upgrading to more efficient electricity generators or transmission lines. In some cases, there are companies that really do not have funds to undertake even modest investments, even though the measures might have very short payback periods. The process of replacing the existing energy services with a smart energy systems will also be a challenge for utility companies. Lack of proper infrastructure for synchronizing this modern technology with the existing ones might interrupt the introduction of smart meters. Integration of the devices becomes even more complicated with an increasing number of customers. Deployment of communication network in some localities might be difficult due to terrestrial difficulties.

Several findings have showed that there is a lack of strategic direction among energy companies when it comes to energy services. Notably, the larger score of internal barriers indicates clearly that energy service development is mostly an issue to be dealt with, within energy companies [21].

In addition to aforementioned aspects, there might be many technical issues that might be considered during the operation of whole energy management systems. The collection and transmission of energy consumption data is a continuous process that is taking place automatically. In this context, a common notion might arise in several customers is that, smart meters they might essentially create some privacy and security risks as the data and signals are being transmitted. Additionally, this data might also reveal the information about presence of people at their residence, when they were present, and what appliances are in use. In view of this, some customers might be unwilling to communicate their energy consumption data with their neighbor's meter. Fundamentally, it would be an issue about the choice of parameters to be transmitted and administrator authentication to access that information [39].

2.3.3 *Customer barriers*

This barrier is the most common problem in almost all countries. Easy access to up-to-date and relevant information is typically lacking even in developed countries. Company managers are frequently observed stating that they have a particular problem that is adversely affecting their energy efficiency, yet the problem has already been solved—sometimes many times—in other countries and indeed in other locations in the same country. The information about energy efficiency measures and programmes is often not well disseminated and the users are simply unaware of energy efficiency measures or their benefits to their homes, company or the country. End-users need to be informed of the availability of efficient equipment and the respective energy cost savings and their positive environmental impacts from proper adoption. Sometimes the information to end-users is incorrectly perceived as being an attempt by government to restrict their energy use or deny them the right to energy, or manipulation on the part of utilities to make higher profits. Industry trade associations could play a positive role in encouraging the sharing of relevant information. Indeed the key and prominent challenge is the device/services cost. The expensive devices, or costs related to upgrading appliances to more efficient one as well as device maintenance issue might also be challenges for energy users. The acceptability of smart homes to users is closely linked to issues of security, privacy and trust as well as practical and ergonomic concerns with user-friendliness. These issues present critical design challenges for how users interact with smart systems [40,41].

Based on June 2015 polling by Deloitte [42] - Figure 10 - the smart-home devices/services aren't exactly an easy sell and responses indicated that high costs were the leading factor holding back interest, cited by 44%; similarly, nearly a quarter of respondents said they couldn't recognize the value of such devices. Data protection and security also emerged as an issue, as well as the opinion that such devices were complicated and limited knowledge about the services.

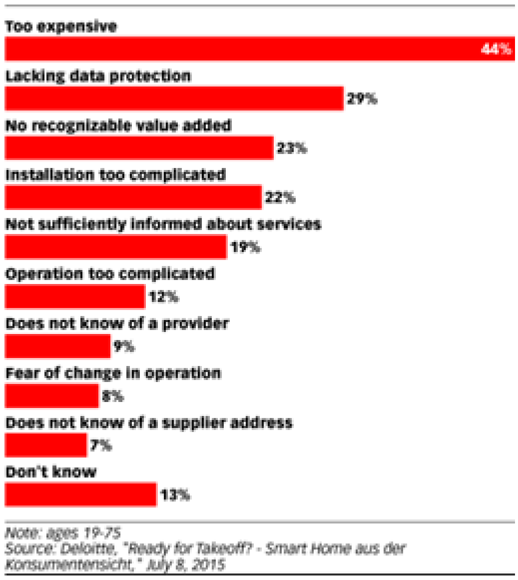

Figure 10. End-users' readiness to accept Smart home devices/services

2.3.4 *Technical barriers*

Besides the above-mentioned barriers and gaps there are various technical challenges associated to the design, installation, and operation of the core component of the whole efficient energy management system. One good example is energy storage system technologies, many of which need more development to be adopted into a wider scale [43].

Smart metering is crucial for energy market operations and flexibility management [44, 45, 46]. A smart meter is an essential tool for successful balancing the demand-offer energy curve. It allows the linking of the consumption and production measurements with the time information and the customer's identity, enabling the substitution of flat-price billing with smarter solutions, such as Time-of-Use or Real-Time Pricing. Smart meter roll out is at different stages in EU-countries. Thus, there is need for development and standardization in metering schemes. For example, in Finland, smart meter implementation is done already but, for example, in Czech Republic implementation is at an early stage (The USmartConsumer Project, 2017). In Greece, a smart meter roll-out plan has been decided. All medium voltage (MV) customer meters have been replaced and since 2005 smart meters are also installed at new low voltage

(LV) connections ≥ 85 kVA [47]. In Germany, the beginning of roll-out plan is considered 2017[48] and the time frame considered for full replacement of old meters reaches up to 2032 [49].
The distribution network “perceives” the microgrid as an individual electrical entity rather than as many DER loads. There are some challenges in the point of common coupling to control bi-directional power flows. Exporting power to the distribution grid can require changes on the medium voltage network protection settings and is not desirable from the networks operators’ point of view [50].

Some problems are associated to communication and control aspects and result mainly from the large variety of communication and control software options, each with different solving algorithms and different functionalities [50]. A related problem is also the abundance of communication protocols in the market. Control systems should be compatible with other components of the microgrid, enabling sufficient operation and therefore standardization, both facilitating microgrid implementation. Because the concept of local energy markets is new and still undergoing development, there are issues and unsolved questions as to how to establish secure and transparent local market trading platforms. For instance, [51] has reviewed how blockchain technology can be used in local/microgrid energy markets. It is mentioned that one of the greatest advantages of blockchain is the transparent, distributed and secure transaction log that allows for a complete and continuous tracing of even the smallest energy transactions. Despite many benefits of blockchain there are also some problems like scalability issues, complexity of technical protocol and implementation with current components.

Significant amounts of data will be collected and exchanged in fully-operating local energy markets. Thus, secure data handling is an essential feature to guarantee in every situation and that can cause some challenges. Energy systems have to be protected from cyber security threats, which have different types and are developing constantly. Based on [52] study, basic security and privacy requirements have been specified that should be considered when designing local energy markets. It is important to use secure user authentication mechanisms to verify that the data is from the right customer and to prevent the possibility of someone trying to manipulate the data. Data includes sensitive information like user identity, contracted suppliers and meter readings, reason why it has to be well defined who has the access to this data. Information exchange between stakeholders is crucial, hence the need for clear definition of responsibility over the maintenance of the information exchange system.

3. SIT4Energy target groups

During the usage phase of a building, there are three main actors involved that can be interested in ICT solutions for energy efficiency: the residents, the building owner and the energy supply company [53]
The residents use energy in order to make everyday life practical, convenient and comfortable. Normally, it is assumed that residents' energy use is based on the convenience and comfort they request, how much time they can save by using electric appliances such as dishwashers, washing machines, etc. and how much money they can afford to spend. The main driving force for **the owner** of a rental building is to attract and retain tenants. To do so the owner needs to offer attractive apartments with modern standards and at the same time low operating costs of the building. Tenants will choose apartments from different aspects such as location, size, rent, energy costs, etc. If the energy price goes up, this factor will affect the choice more than it does today. **The electric companies and third-party providers** want to sell as much energy as possible to the highest possible revenue per kWh. However, it is critical for electric companies to be able to offer value-added, secure and reliable energy services directly to customers and/or in partnership with other companies 24 hours a day, 7 days a week.

SIT4Energy target groups have been defined according to above mentioned three main actors and on SIT4Energy pilots. The next sub sections present the definition and identification of SIT4energy target groups based on a) SIT4Energy pilot cases b) energy services providers/operators and c) any interested energy consumers/prosumers (private/public building managers, residential/household users).

3.1 Identification of SIT4Energy target group based on German pilot case

3.1.1 *Pilot case based on Stadwerk Hassfurt (SHF)*

The German pilot organized and run in the town of Haßfurt, whose energy needs are fully provided for by SHF as its municipal utility. The pilot will include utility employees and a sample of customers (approx. 30 in numbers) served by SHF.

The main goal of the pilot case of Stadtwerk Haßfurt (SHF) is the development and evaluation of IT-enabled services for integrated energy management in prosumer scenarios, that can support customer engagement and the analysis and decision-making for exploiting efficiency potentials in the local energy production and consumption. For the pilot the SIT4Energy system will be deployed in a real-world pilot for novel IT-enabled services by SME energy utilities.
This is of great interest to SHF whose crucial goal is to learn about and obtain novel solutions for effectively analysing and exploiting energy efficiency potentials both on the demand and supply side. Enable and prepare the transfer of developed solutions into the business practice and new commercial offerings of SHF.

On a technical base the distribution grid is predestinated for a pilot case to integrate novel IT-enables services. In 2011 a complete smart meter rollout was done of SHF. Since then every customer has its own smart meter, that provides hourly measurement data to the premises of SHF. So far, this data is mainly used for billing and customer relation management. As additional benefit for the customers SHF is operating a customer service portal, where the measured consumption for all smart meters (electric, gas and water) is visualized. For future IT-services this data can be used for several purposes.
In the German pilot case it is planned to integrate and analyze the consumption data of the participating households with the objective to generate individual recommendations to be shown to the users in energy efficiency matters.

In the context of Task1.1 **TG1 questionnaire** (named as TG1 given in
Table 2) has been developed and distributed via GDPR compliance channels to all utility employees and customer based on Stadwerk Hassfurt (SHF) pilot case. A total 33 completed questionnaires returned back (66% response rate). Some initial results obtained from this questionnaire are already available thus are presented in Section 5

3.2 Identification of SIT4Energy target group based on Greek pilot case

3.2.1 *Pilot case based on HUA*

The Greek pilot in an academic campus aims at validating the SIT4Energy platform within a large building at Harokopio University of Athens (HUA) campus including amphitheaters, offices, and laboratories with approximately 1000m^2 common area.

Figure 11. Harokopio University of Athens (HUA) Campus

The academic campus may be a suitable mean for validation of the SIT4energy platform as it has a substantial experience in contributing and addressing the challenge of creating a sustainable, affordable and efficient energy systems and services. For many years it has been supporting a range of sustainable energy alternatives, smart energy services, their enabling infrastructure, and their effective demonstration and deployment. In the frame of SIT4Energy the role of HUA will be the validation of the platform meanwhile providing accurate and easily accessible information toward the academy members/personnel.

In the context of Task1.1 TG3 questionnaire (TG3 given in
Table 2) has been developed and distributed to all eligible staff and students in HUA Campus in a GDPR compliance manner. A total 30 completed questionnaires returned back (60% response rate). Some initial results obtained from this questionnaire are already available thus are presented in Section 5.

3.3 Identification of SIT4Energy target group based on Greek & German Local/municipal utilities

3.3.1 *Target group based on Greek utilities*

Towards presenting information from the Utility's perspective in the Greek energy market, three large and highly innovative utilities have been approached through GDPR-approved channels, to provide feedback regarding the market needs and their interest to the SIT4Energy solutions. All three companies are not only electricity providers but cover also natural gas supply as well as other energy services for a wide variety of customers, including tertiary and residential consumers and prosumers, which are of interest for the SIT4Energy project.

All three utilities have been approached with the respective questionnaire. To ensure anonymity, the abovementioned utilities will not be named specifically, but their feedback will continue to support the activities of the SIT4Energy tools and services.

3.3.2 *Target group based on German utilities*

Founded in 1898 and transferred into a GmbH in 2000 the corporate concept of Stadtwerke Deggendorf is consistently geared towards strengthening the Deggendorf location in the energy and water sectors around the clock with an efficient and reliable network. With around 70 employees, SWD ensure that more than 20,000 households in Deggendorf and the city districts are supplied safely and reliably with electricity, natural gas and water.

With own plants (Hammermühlbach hydropower plant, 5 photovoltaic plants), SWD generate lectricity locally and at elypso operate a combined heat and power plant that produces electricity and heat decentrally in the process of environmentally friendly combined heat and power. In addition to regional added value, SWD also make important contributions to shaping the energy future. In order to be able to design the smart city of tomorrow, SWD are creating the necessary conditions with the expansion and operation of a fiber-optic network. In addition, SWD will soon set up and operate several charging stations for electric vehicles in the city area.

SWW Wunsiedel GmbH is a municipal, highly innovative utility company and DSO that ensures an affordable, especially environmentally responsible supply of the metropolitan area of Wunsiedel and seven other municipalities. SWW supplies about 20,000 people in the region including various kinds of companies.

For years, SWW and its subordinated service companies have been focussing on the consistent production, use and expansion of renewable energy and sustainable technologies (e.g. solar and wind energy, cogeneration, wood as raw material). In the future, the regionally required energy will largely be generated and consumed on the basis of renewable energy. The main midterm energy goals of the city Wunsiedel and SWW are energy self-sufficiency and supply security by synchronizing and decentralizing energy production and distribution. SWW has developed the roadmap "WUNSiedler Weg – Energie" where a generic smart grid ICT architecture provides load balancing and energy management capabilities by a cellular approach based on self-controlled smart micro-grids.

In the context of Task1.1 TG2 questionnaire (TG2 given in
Table 2) has developed and distributed to Greek and German local utilities through GDPR-approved channels. Some initial results obtained from this questionnaire are available and are presented in Section 5.

3.4 Identification of SIT4Energy target group based on Greek & German private/public building managers

The concept of this questionnaire is to reach to building/ facility managers of SIT4Energy member parties. Below is given the list of the representative building managers of whole SIT4Energy envolved parties. Based on this list the final questionnaire (named as TG4 given in
Table 2) was developed and distributed to the target audience. Some initial results obtained from this questionnaire are available and are presented in Section 5.

HUA Building/Facility Manager(s)	HOST Building/Facility Manager(s)
CERTH Building/Facility Manager(s)	SHF Building/Facility Manager(s)
ITML Building/Facility Manager(s)	Hamβurg Residential Prosumers Building/Facility Manager(s)

4. Survey Design and Methodology

This section presents the design and methodology of the investigated on-line survey. The latter was designed in a way that gives the respondent an impression of SIT4Energy product, but does not include the attributes of SIT4Energy product, in order to avoid confusion and assumption that respondents have already confirmed to desire these systems. In this way the surveys' results will show the willingness to use energy efficient management tools/products thus their general attitude towards SIT4Energy.

The focus was given on the identification of respondents' information, ideas, opinions, and attitudes on efficient energy consumption and production and pointing out which factors influence on their behavior. These behaviors are both complicated and difficult to change: partly because they are shaped by the characteristics of the building and the energy-using appliances, but more importantly because they are influenced by a range of internal and external factors, such as our beliefs, values and attitudes, other people's behaviors, the cultural settings we live in, and various economic incentives and constraints. A specific attention was given also to the identification of users' needs and desires aiming to engage them in the final SIT4Energy product. Questions about the willingness to pay for efficient energy management services were also involved

Four types of web questionnaires with different structures and question contents were designed. The web questionnaires, created via Google forms, were performed in partner countries (Greece and Germany) during July-August 2018. The questionnaires were translated to German and Greek in addition to the English version.

4.1 Survey Methodology

4.1.1 *Domestic buildings*

Domestic sector constitutes an important target group for energy conservation. Residential energy consumption has been studied through questionnaire surveys over the last decades [55-57, 58, 54]. Existing evidence suggests that the factors that influence the efficient energy consumption or environmental concerns of individual (consumers/prosumers/households) can be categorized by the factors such as socio-demographic variables, psychological factors, user awareness. The following subsections provide an in-depth explanation of these factors and their relative importance.

4.1.2 *Socio-demographic variables (individual and household level)*

The socio-demographic variables have been extensively researched however the exact influence of many of these variables is still unclear as results differ greatly among publications [55,56,57]. Therefore, it is difficult to specifically exclude one variable over the other [58]. Among all of them income is quite much studied variable indicated that consumers' income is one of the main constraints that affect purchase of efficient appliances and energy consumption in general. It has been reported [73] that it is more challenging to target high-income households, due to their low interest in energy efficient products and their "fear" of losing social status. Furthermore according to the several studies households with higher income were more likely to be in the category of high consumers of electricity [59, 60, 61, 62, 63]. However, Kavousian et al. [64] found no relationship between income and electricity consumption, and suggest that this might be because the income effect is mediated by appliance ownership which was a separate variable in the analysis. In addition, the authors in [65] have reported that the effect of environmental attitudes is clearly stronger among the households with higher income than among those with lower income. There was an opinion that a low-income consumer can invest only in case the payback period is short, whereas a high-income consumer is able to accept longer payback periods [65].

Household socio-demographic structure obviously has a quite strong effect on energy consumption of households [55]. A larger household size is generally associated with higher electricity use; however, the effect is not necessarily shown to be linear and depends on how the variable is coded. Using household size as continuous predictor showed that a larger household was associated with greater electricity consumption [57]. Halvorsen et al. [66] analysed data from Statistics Norway's annual Survey of Consumer Expenditure and found that electricity consumption rises, among others, with the number of household members**,** however, this relationship is less than proportional. Looking at what factors define being a high electricity user Labandeira et al. [67] found that household composition also affects expenditures on energy for the house [55], meanwhile Jones and Lomas [60] found that households with three or more occupants were more likely to be high consumers than homes with one or two occupants. They also found that households with teenagers were more likely to be high consumers of electricity, as did Brounen et al. [68]. Studies have found that energy demand varies with the age of consumers; however, they do not always agree on the direction of this relationship.

4.1.3 *Psychological Factors*

While socio-demographic factors clearly play an important role in household energy consumption and conservation, a range of person-specific psychological factors may also have powerful effects [69, 70, 71]. Some of the psychological factors most commonly associated with household energy usage include: knowledge and problem awareness (both of environmental and energy issues); beliefs, values and attitudes; motives, intentions and goals; subjective appraisals and perceptions (e.g. cost-benefit trade-offs; perceived behavioral control); personality tendencies (e.g. self-efficacy, locus of control); and personal and social norms [72]. Many studies have focused on social or psychological factors related to energy-saving behavior, by examining the influence of cognitive variables, such as values, beliefs or attitudes towards energy conservation. Some of the general findings to emerge from research exploring the specific psychological and motivational variables that influence patterns of household energy consumption and conservation include the following [72 and references therein]:

- Knowledge, awareness and understanding of environmental issues and energy-related problems does not always lead directly and consistently to pro-environmental behaviour such as energy conservation. Rather, there may often be a “knowledge-action gap”, such that increasing knowledge and awareness does not routinely translate into congruent behavioral change, perhaps due to the influence of various moderating factors that may constrain or facilitate energy-related behavior.
- Likewise, pro-environmental values, beliefs and attitudes do not reliably translate to congruent changes in energy consumption or conservation, with the relationship between values and behaviour ultimately contingent upon various moderating factors, such as knowledge, problem awareness, household technology, socio-demographic constraints, and the like. In the end, there may often be a marked “value-action gap” and/or “attitude-action gap”.
- Likewise, we might reasonably expect that people who are driven by certain goals (e.g. self-transcendence versus self-enhancing goals; hedonic versus gain frames) and motives (e.g. pro-social, altruistic) will be inclined toward energy-saving behavior. But again, the relationship between “good intentions” and actual behaviour depends ultimately on moderating factors. Again, we are often left with a marked “intention-action gap”, with possession of environmentally friendly goals and motives failing to translate—reliably and consistently—into environmentally friendly behavior, such as energy conservation.
- Personal norms (e.g. feeling a strong moral obligation to act in a pro-social, altruistic manner) tend to encourage pro-environmental behaviour such as energy conservation. But this relationship may be contingent on awareness of the consequences of one’s behaviour and ascription of felt responsibility for these behavioral consequences.
- Both economic and behavioral cost-benefit tradeoffs may influence energy consumption and conservation, with people tending (other things being equal) to select courses of action that yield the highest benefit for the lowest cost (in terms of time, effort, money, status/prestige, social approval, comfort, convenience, etc.). However, research in behavioral economics shows that people are also frequently prone to a range of cognitive biases, heuristics and other anomalies in their decision-making and behavioral choices—including around environmental protection, renewable and sustainable technologies, and energy consumption—which cause them to act in seemingly “irrational” ways that diverge markedly from traditional economic models of behavior.
- Personal comfort, particularly the perceived loss of comfort that energy-saving measures may entail, can have a powerful influence on household energy usage. Any decrease in personal comfort, or

reduction in lifestyle quality, may reduce the likelihood of householders engaging in energy conservation behavior.

- Group membership and normative social influence (e.g. the perceived energy-related practices of one's peers or neighbors, and social pressure from family/friends to save energy) can significantly influence household energy use. Much research indicates that people tend to behave in ways similar to those around them (i.e. people desire normalcy and often exhibit conformity). This is largely due to the effects of social norms - those explicit and implicit "rules" or expectations that guide what is deemed normal, common and/or desirable behaviour in society. In terms of pro-environmental actions, injunctive norms (i.e. perceptions of what attitudes and behaviour are approved/desired by a social group with whom one associates or identifies) and descriptive norms (i.e. perceptions of what attitudes and behaviours are normal/common among this social group) can both exercise great influence over behavior.

4.1.4 *Customers' Awareness*

It has been shown, that an effective way to achieve energy saving in that sector, is by providing consumers with information and feedback. This measure increases the consumers' awareness that leads to behavioural changes and could help reduce energy consumption [73]. Most residential consumers only receive feedback on their energy use in the form of a monthly bill from their utility provider. Most utilities give one monthly reading for electricity use, which does not encourage consumers to examine how their electricity use may have changed over the month. However, it is generally recognized that feedback is an important tool for behavioural change and has been implemented and proven to be successful in a variety of fields, such as public health, education, and organizational behaviour [76]. Studies involving informative billing and periodic feedback have realized energy savings between 10 and 20%. It is assumed, based on theory and field research, that if residential consumers had more detailed and/or frequent information about their consumption, they would both better understand their energy use patterns and be able to change them effectively. Many researchers from various fields have studied how feedback on energy use impacts residential consumer understanding and behaviour [74, 75, 76, 43]. Ueno et al. [74] conducted a micro-level study of nine Japanese households. Residents had access to a graphical display of their energy use, broken into different end-uses. The computer displays also included energy prices and historic energy use and past bills. It is assumed, based on theory and field research, that if residential consumers had more detailed and/or frequent information about their consumption, they would both better understand their energy use patterns and be able to change them effectively. The research of energy consumption in the households, characterized by high income levels, showed that money is the main motivating factor to save energy [77]. Hence, appropriate information and feedback increase the awareness of inhabitants, which, in turn, leads to behavioural changes and may help to reduce energy consumption by 15–25% [77].

4.2 Non-domestic buildings

The aforementioned studies and research works show that significant progress has been made in understanding energy use in a domestic setting. Despite to this very little research has yet investigated individual energy use in the office. In fact, non-domestic buildings currently account for around and 20% globally [78]. How much electricity do people use at their workdesks and how prepared are they to change their energy use behaviour? Domestic and non-domestic settings vary on a number of counts, creating very different contexts for behaviour change interventions. The cost of energy use in the workplace is of little relevance to most employees, whilst the sharing of facilities and appliances may create barriers to behaviour change. Some consider this to represent a 'tragedy of the commons' whereby management of a shared resource is delegated to a figure with only limited means of exercising control. Employees can however be a captive audience and are subject to organisational policies, whilst the influence of social and group norms and sense of community may increase motivations to save energy in the workplace. Common to all workplace settings is the relevance of group dynamics and interactions on energy saving, although variation in terms of size and sector also affect the potential for savings.
The role of office management and organisational decision-making was found to be an important for creating opportunities to reduce energy use. Managers and the attitudes that they personally hold are

central to creating opportunities to reduce energy use, and opportunities exist for human resource management to support the idea that managers are the gatekeepers to environmental performance. When it comes to tenanted buildings, building owners can play a role, with an ability to drive sustainability agendas through the requirements that they place on their tenants [78].

Niamh Murtagh et al. [79] in their study have concluded that people use much more electricity in their workdesks than they need and that they are nor very much prepared to change their energy use behaviour at their workspaces thus the behaviour change must be at the center of the overall strategy to reduce energy use and greenhouse gas emissions associated with office buildings. Behavioural interventions may also have a positive spillover effect related to energy efficient technologies: the behaviour of individuals "can strengthen or undermine the effectiveness of technical measures which have been implemented with energy conservation and efficiency considerations in mind" [80]. Authors in [79] also reported that the individual feedback may have some benefit, motivations beyond energy reduction will need to be harnessed to engage people in changing their energy behaviour. Moreover, they pointed out the distinction people make between home and the workplace, in terms of personal pro-environmental behaviours.

4.3 Survey Design

Approaching the end-users directly is the most effective way to unveil their attitude on SIT4Energy product. The current survey is targeted to the main SIT4Energy target groups, e.g. end users (energy consumers and prosumers), building owners/managers and service providers. Four groups are identified as SIT4Energy target groups (Section 0) thus four different questionnaires have been designed including: end users (energy consumers and prosumers), university staff/students as end user at households and at working space, service provider (local/municipal utilities), land or building owner/managers (Figure 12). Households/buildings included in this work are located in both Greece and Germany.

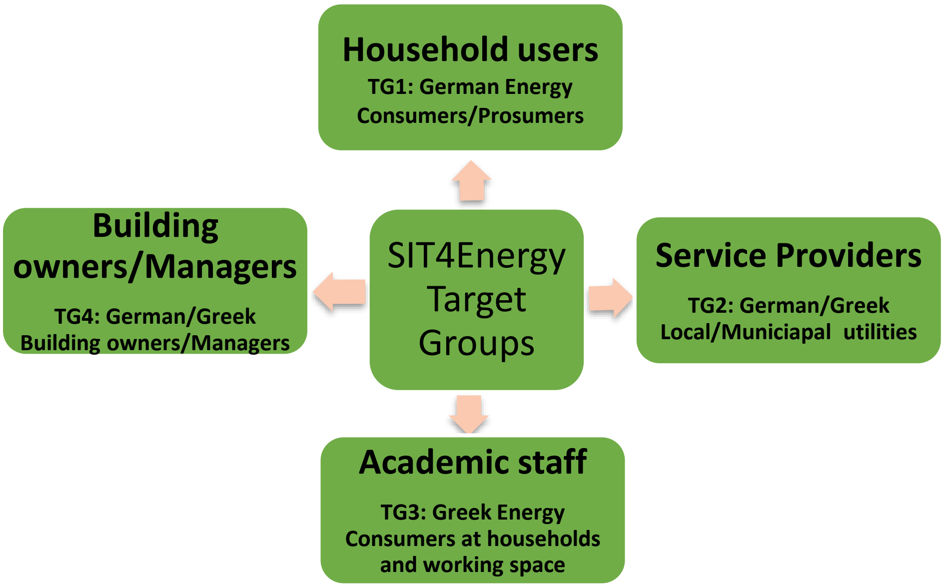

Figure 12. Target grouping of SIT4Energy

When using a questionnaire to obtain information several types of questions can be distinguished [58]. Knowledge-type questions refer to readily available knowledge a participant may or may not have. These questions can be rated as correct or incorrect. Behavior-type questions ask the participants what they have done or are yet to do, and the frequency of such behavior. Attribute-type refer to the socio-demographic characteristics of the participant (i.e. who they are rather than what they are). The last type of questions refers to psychological states of the participant through beliefs, attitudes or opinions. Keeping in mind which questions belong to which type is important as question format can be of great importance to some question types. For example, questions about knowledge and behaviour are more straightforward than questions about attitudes, which have substantial underlying complexity.

Questions related to beliefs and attitudes should therefore be most thoroughly formatted and phrased. Apart from the types of questions the order in which these questions are posed is also of importance. It is the aim of the questionnaire to keep participants interested and involved for the complete duration. Therefore, the simplest questions are to be addressed first and include the socio-demographic and dependent variable related items. The last and most time intensive scale, for the knowledge variable, is located at the very end of the questionnaire as it provides something new to the participants after a multitude of similar perception items. The different scales in between are sorted by how difficult a participant could find such items. For example, items on how people feel towards nature or how certain barriers affect them are put last, while items relating to specific attitudes and motivation are posed first. The questionnaire is designed this way to relieve pressure as the questionnaire is filled out rather than increase it. The surveys can be distinguished also by the form of questions: open-ended and closed ended questions. The work published by Lavrakas [81] describes the advantages and disadvantages between them (presented in Table 1).

Table 1. Critical Analysis on open-ended and Closed-ended questions

	Advantages	Disadvantages
Open-Ended Questions	Respondents are allowed to respond to questions the way they want, and their response is precise.	It consumes time and sometimes responses are ambiguous.
Closed-Ended Questions	It is time efficient and also responses are unambiguous.	Some answer options do not clearly indicate the answer of respondents.

Taking into account the aforementioned type of questions and also the factors mentioned in Section 4.1 and 4.2 the SIT4Energy survey's questions were formulated in order to study the following aspects:

End-users (consumers/prosumers)

- General information (socio-demographic variables): Focused on general information including their ages, degrees of education, monthly salaries, and household energy consumption etc.
- Interests towards energy consumption/production optimization: Focused on respondents' interests, intentions towards more optimized energy production or consumption, the willingness to receive tips/notifications and feedback.
- Attitudes towards environment concerns and efficient energy management: the self-image of respondents with environmentally friendly behavior; their motivation and intentions regarding more efficient energy use and energy saving.

The questions formulated to be directed to electricity services providers/utilities (TG2) involve the following aspects:

Services providers (German/Greek Local/Municipal utilities)

- General information
- Interests towards energy consumption/production optimization: Focused on providers' interests, intentions toward provision of more optimized energy production or consumption, the willingness to receive and further sell tips/notifications and feedback thus automatically minimize energy consumption/production of their consumers.

- Attitudes towards environment concerns and efficient energy management: their motivation and intention of addressing the global environmental issues via provision of energy prosumption services.

In the table below is given the number of questions and online sample of each questionnaire

Table 2. SIT4Energy questionnaires

Target group	Number of questions	Online address
TG1	28	https://goo.gl/forms/9oWRyXnhjCKUW2OE2
TG2	19	https://goo.gl/forms/tAqGLzuFx45Wg5I33
TG3	32	https://goo.gl/forms/1vuZRUSAWztCV3SY2
TG4	26	https://goo.gl/forms/A57RPT64F3jet2Q33

5. Initial Results and discussion

This section primarily focuses on the initial analyses of some raw data received from the surveys undertaken as part of this research. Some initial responses were received for the questionnaire directed to German end users (TG1), German/Greek Utilities (TG2), academic staff at HUA (TG3) and several building managers (TG4). The major analysis was done by the survey engine converting and visualising data into graphs and diagrams. The automatically generated graphs for responses received for each question in the survey give the basic understanding of the types of answers received by the individuals. Also, the online survey engine provides the free and easy distribution and accessibility to the survey questions. The summary of the responses is provided in the sub sections below.

5.1 Survey Analysis obtained from TG1

In the following sections the data obtained from the questionnaire directed to German end-users are summarized and explained via tables and figures aiming at provision of clear representation of the received responses.

5.1.1 *General information (socio-demographic variables)*

The demographic variables are used as an introduction of the respondents of the questionnaire.

Table 3. Socio-demographic variables

Socio-demographic variables	Percent (%)
Gender	
Male	84.8
Female	15.2
Age	
18-25	-
25-35	30.3
35-45	15.2
Over 45	54.5
Highest degree of education?	
Middle school	18.2
High school	9.1
Bachelor	12.1
Master	39.3
Doctorate	21.2
Other	-
Occupation	
unemployed	-
Employee in public sector	51.5
Employee in private sector	30.3
Self-emplyed	12.1
Student	3
Pensioner	3
Numbers of Family	
1	9.1
2	39.4
3	18.2
4	24.2
5	9.1
Over 5	-
Area of your household	
Under 50	3.1
50-80	9.4
80-120	21.9
120-160	37.5
160-200	9.4

Over 200	18.8
Household average yearly income is	
Under 20K	3.2
20K-30K	-
30K-40K	16.1
Over 40K	80.6

Data obtained for monthly energy consumption and production are illustrated in Figure 13 via bar chart. Here one important aspect that should be taken into attention is the 15.2% end-users' are most probably not aware of their energy consumption as they let the box of answer without filling in any answer. In addition around 39% of end users are also energy producers as it is shown in Figure 14.

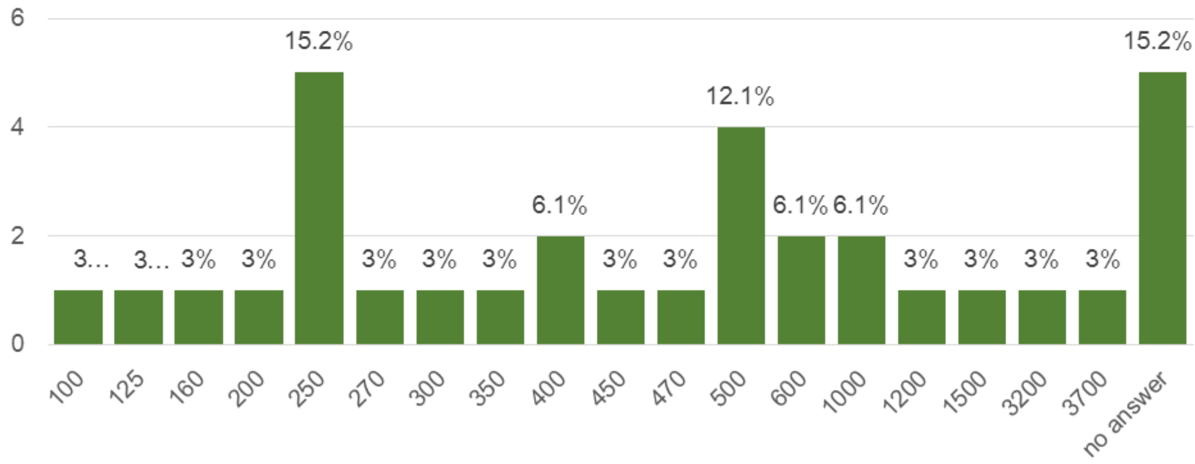

Figure 13. Respondents' monthly energy consumption on average

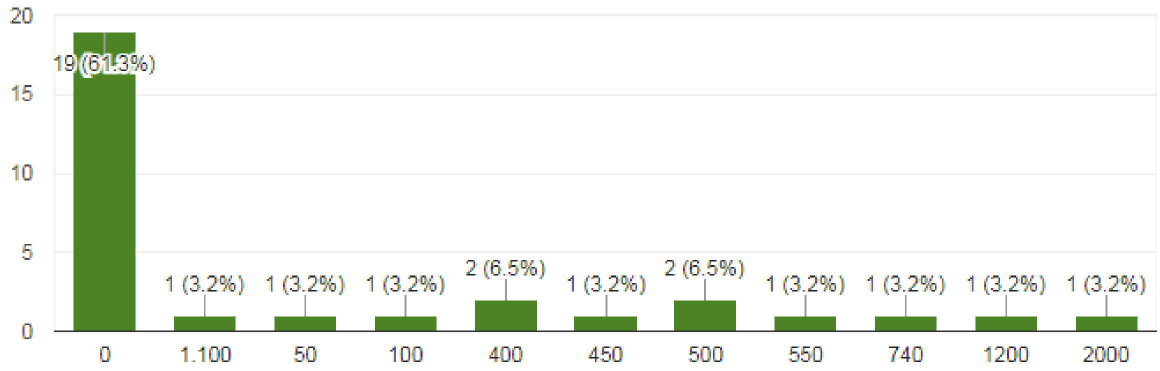

Figure 14. Respondents' monthly energy production on average

The table below shows respondents' awareness of energy management services and willingness to switch off some household's/workspace's appliances during peak hours. The 63.6%, 30.3% and 6.1% of end users answered that they are aware, not aware and are not sure that they are aware of energy management services, respectively. In addition, the majority of the respondents (69.7%) would like to switch off some of their appliances during peak hours at their households' interestingly 18.2% and 12.1% of end-users do not to want and are not sure to switch off some of their appliances during peak hours respectively.

Table 4. Respondents' awareness of energy management services and willingness to switch off some household's appliances during peak hours

Questions	Percent (%)
Awareness of energy management services	
Yes	63.6%
No	30.3%
Not sure	6.1%
Willingness to switch off some of household's appliances during peak hours	
Yes	69.7%
No	18.2%
Not sure	12.1%

Despite the fact that 63.6 % of end-users know about energy management services only 18.8% and 15.2% use applications/services for optimizing their energy consumption and production respectively (shown below)

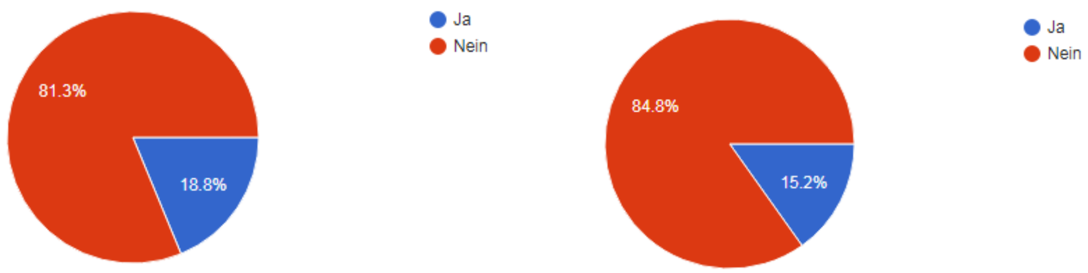

Figure 15. Question: Do you already use some applications for optimizing your energy consumption (on the left side) and production (on the right side)?

Below are given the applications/services that respondents used for optimizing energy their consumption and production.

Table 5. The applications/services that respondents used for optimizing energy consumption and production

The energy consumption optimizing applications that the responders indicated are	The energy production optimizing application that the responders indicated are
SMA Sunny Portal	SMA Sunny Portal
own Excel reports	own Excel reports
Smarthome radiator control	Powerplugs (maybe smart plugs?)
Eco-electricity supplier that prepares balance sheets every quarter of an hour	self developed solution
TP-Link Kasa smarthome solution	

5.1.2 *Interests toward energy consumption/production optimization*

In this section, the focus is to examine whether and to what extent the respondents desire to control and optimize their energy consumption/production via receiving real time consumption feedback or tips and notification about efficient energy consumption. Regarding latter aspect the respondents were free to insert tips that they are desire to receive. The collected data are given in the tables below.

Table 6. Interests toward energy consumption/production optimization and resource sharing

Questions	Percent (%)
How important is to you to receive tips about efficient energy consumption?	
Very unimportant	9.1
Rather unimportant	12.1
Neutral	24.2
Rather important	39.4
Very important	15.2
How important is to you to receive tips about efficient energy production?	
Very unimportant	18.2
Rather unimportant	12.1
Neutral	30.3
Rather important	33.3
Very important	6.1
How important is to you to be able to control your electricity consumption while getting energy real-time consumption feedback on your smartphone	
Very unimportant	18.2
Rather unimportant	12.1
Neutral	33.3
Rather important	27.3
Very important	9.1
How important is to you to be able to control your electricity production while getting energy real-time consumption feedback on your smartphone	
Very unimportant	27.3
Rather unimportant	12.1
Neutral	27.3
Rather important	24.2
Very important	9.1
Are you interested to be part of a community of prosumers and share resources?	
Not interested	30.3
Neutral	30.3
Interested	27.3
Very interested	12.1

Some important tips that respondents desire to receive about energy management are listed in Table 7

Table 7. Tips that respondents are interested to receive

to improve energy consumption in connection with the production of the photovoltaic system
personal tips
Voltage peaks, consumption adjustment to (hourly) electricity price
Saving energy and optimizing the consumption, but without measuring because that doesn't change anything about consumption
Efficient use of heating systems
Notification via Email
Undetected energy wasting devices, general potential savings
No tips, automatic management of production and consumption
Energy savings potential

Possible savings, reduction of peak loads
Simple rules of behaviour, rough overview of a household's base load, subsidies for storage options, information on intelligent management systems
written tips
when to use devices
notifications via app
Saving energy without loss of comfort
Saving electricity without restricting usage habits

The respondents' answers about the suitable timing and regularity for receiving notifications/tips on their smartphone are presented below via two different pie charts. Surprisingly around 43 % of respondents do not like to receive any notifications on their smartphone.

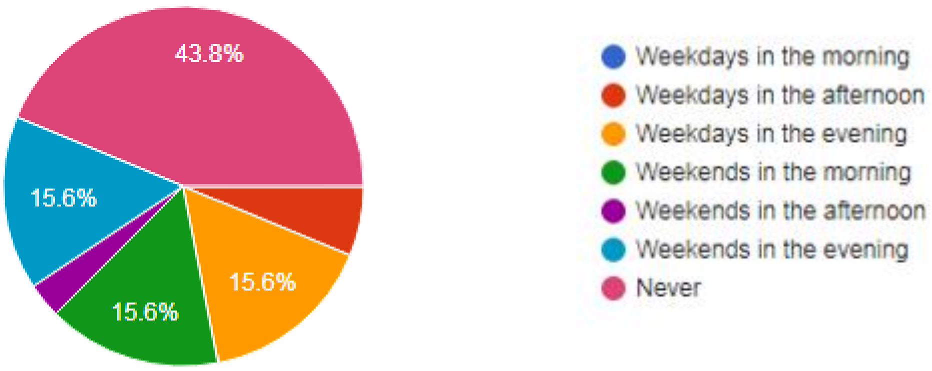

Figure 16. Question: When would you like to receive notifications on your smartphone with tips for optimizing your energy use?

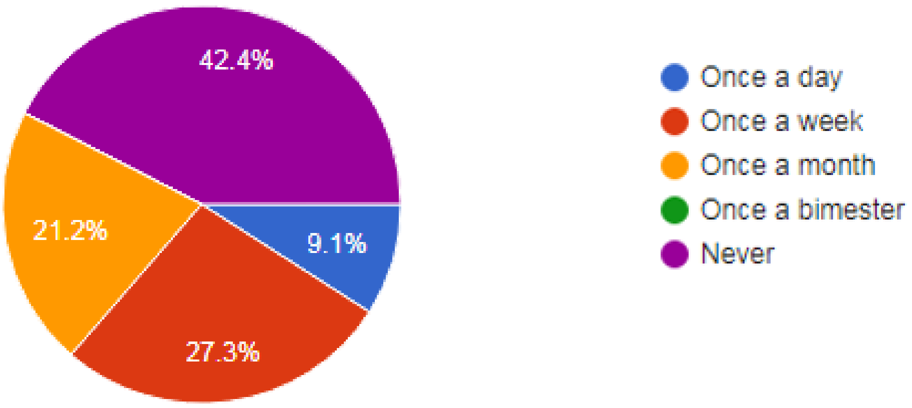

Figure 17. Question: How often would you like to receive notifications on your smartphone with tips for optimizing your energy use?

5.1.3 *Consumer purchasing intention*

To probe the respondents' efficient energy management servicies' purchasing intention two extra questions have been initiated and below are presented the obtained data. 46.7 % of end users voted that it is rather important for them to purchase while 20% respondents indicated that it is very important for them to pay for efficient energy management services.

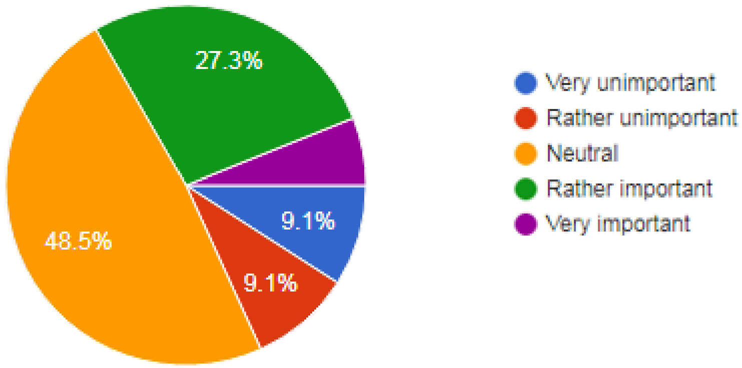

Figure 18. How important is for you to pay for efficient energy management services and thus automatically minimize your energy consumption.

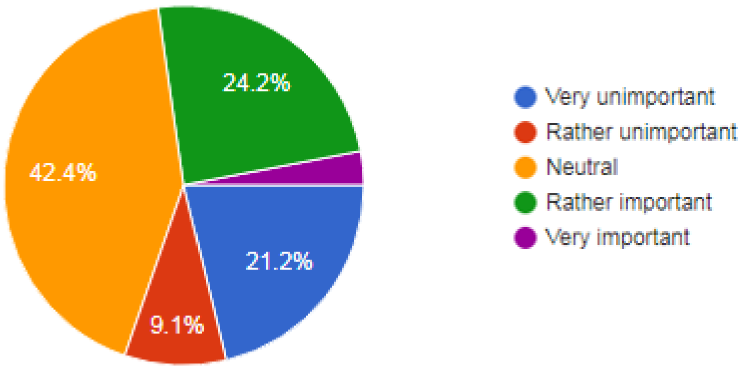

Figure 19. How important is for you to pay for efficient energy management services and thus automatically maximise your energy production

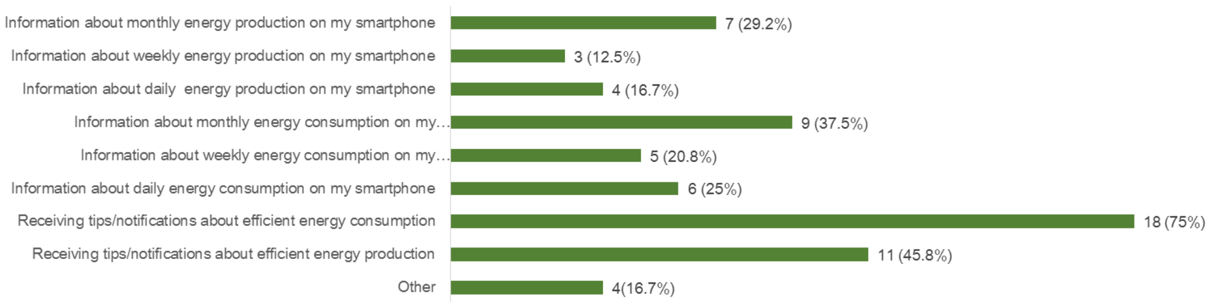

Figure 20. What kind of energy management services would you like to buy (Please, tick as many as you would like)

5.1.4 *Awareness of environment concerns, attitudes towards energy saving*

The following section presents respondents' awareness of renewable energy sources, attitudes towards energy saving and environment concerns motivations towards behaviour changes.

The majority of end users have positive attitude towards energy saving as shown in Figure 21.

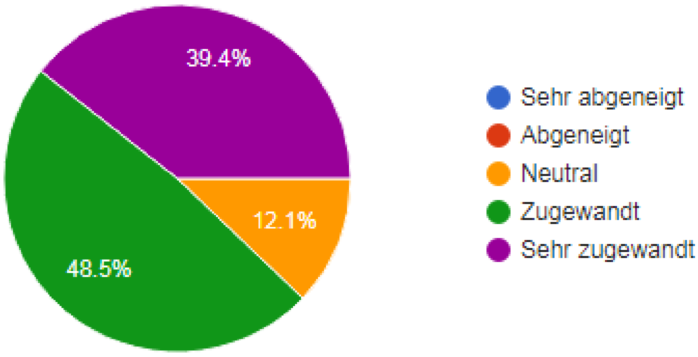

Figure 21. What is your general attitude to energy saving?

Most of the respondents indicate that the protection of environment can motivate them to improve their energy saving behaviour while cost and proper provision of information could also be reason for energy saving.

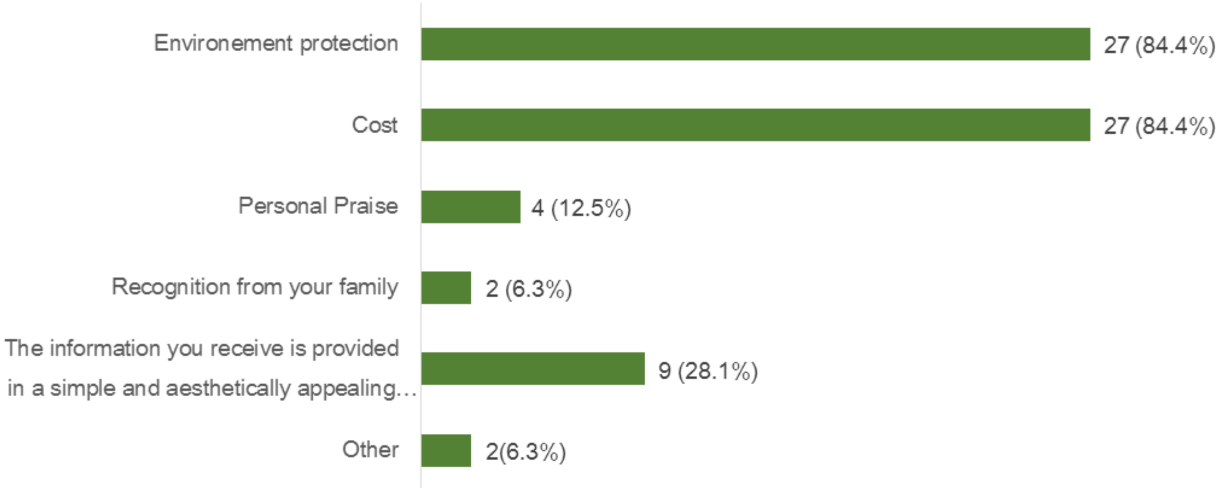

Figure 22.What would motivate you to improve your energy saving behaviour? (Tick as many as are relevant to you)

Finally the responses about the thermal comfortability of end users at their households are shown below:

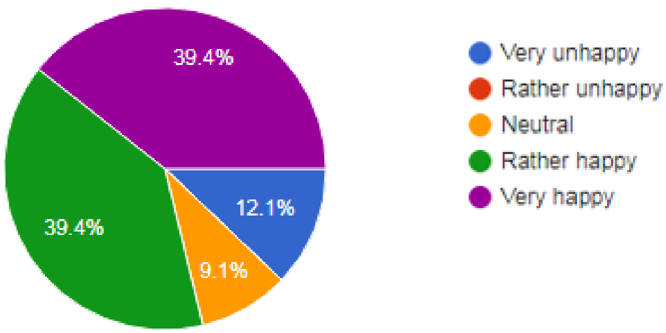

Figure 23. Question: Are you happy with your thermal comfort at your working space

5.2 Survey Analysis obtained from TG2

In the following sections the data obtained from the questionnaire directed to German/Greek local utilities are summarized and explained via tables and figures aiming at provision of clear representation of the received responses.

5.2.1 *General information*

Below is given the utility companies that have contributed to the questionnaire.

Table 8. Customer base of the service providers

Company name	Customer base
Stadtwerke Deggendorf GmbH	Over 5000, lower than 1000
SWW Wunsiedel GmbH	
Stadtwerk Haßfurt GmbH	
WATT+VOLT	

All companies are aware of energy management services and use applications for optimizing the consumers' energy consumption (see table below). The energy consumption optimizing applications that the respondents indicated are: smartwatt, SHF customer portal, (Energy Assistant SHF – new customer portal, solution for utilities).

Table 9. Awareness and application of energy management services

Questions	Percent (%)
Is your company aware of energy management services?	
Yes	100
No	-
Not sure	-
Do you already use some applications for optimizing your consumers' energy consumption?	
Yes	25
No	75

5.2.2 *Importance to retain customers by offering energy consumption/production optimization services*

Herein the focus is to examine to what extent the service providers desire to retain their customers by receiving and further offering energy management and optimization services via real time consumption feedback or tips and notification about efficient energy consumption/production. The collected data are given the tables below.

Table 10. Importance to retain customers by offering energy consumption/production optimization services

Questions	Percent (%)
Would you like to receive more tips and advices about efficient energy systems/services?	
Yes	100
No	-
Not sure	-
How important is to you to retain customers by provision of energy efficiency services	
Very unimportant	-
Rather unimportant	-
Neutral	-
Rather important	25
Very important	75

How important is to your company to improve your consumer service levels by understanding and shaping their energy needs and usage	
Very unimportant	-
Rather unimportant	-
Neutral	-
Rather important	25
Very important	75
Are you interested to deliver more effective (for example mobile recommender based) and user-friendly energy services	
Not interested	-
Neutral	-
Interested	-
Very interested	100
How important is for you to be able to control the electricity consumption of your consumers and deliver real-time energy consumption feedback on their smartphone	
Very unimportant	-
Rather unimportant	-
Neutral	-
Rather important	25
Very important	75
How important is to your company to enable your consumers to make choices about their energy use, change behaviour and ultimately, lower consumption	
Very unimportant	-
Rather unimportant	-
Neutral	25
Rather important	-
Very important	75

As it can be seen in order to empower customers to take control of their energy usage respondents agree to provide rewards, feedback related to energy consumption and discounts on energy efficient solutions.

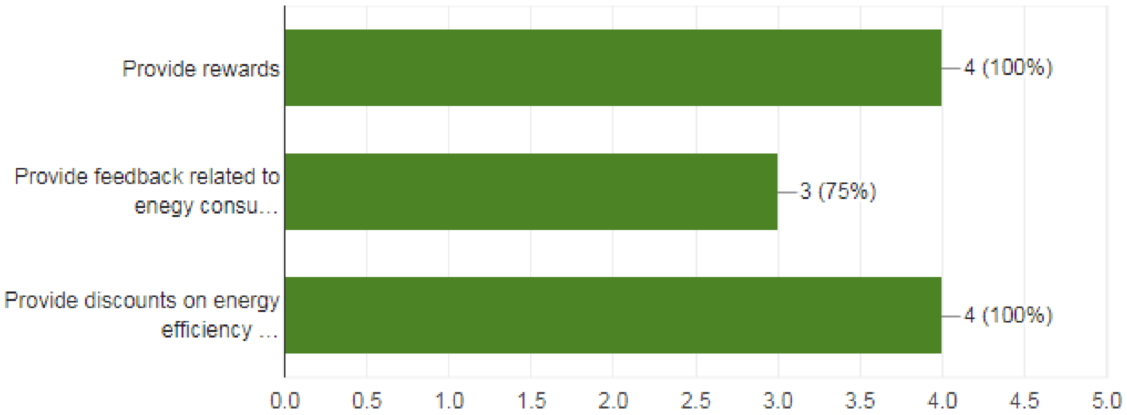

Figure 24. How would you intend to empower customers to take control of their energy usage? (Tick as many as you would like)

The answers about the suitable timing and regularity for delivering notifications/tips on the customers' smartphones are presented below via two different pie charts. The providers wish to send feedbacks mainly in weekends once a day or once a week regularity.

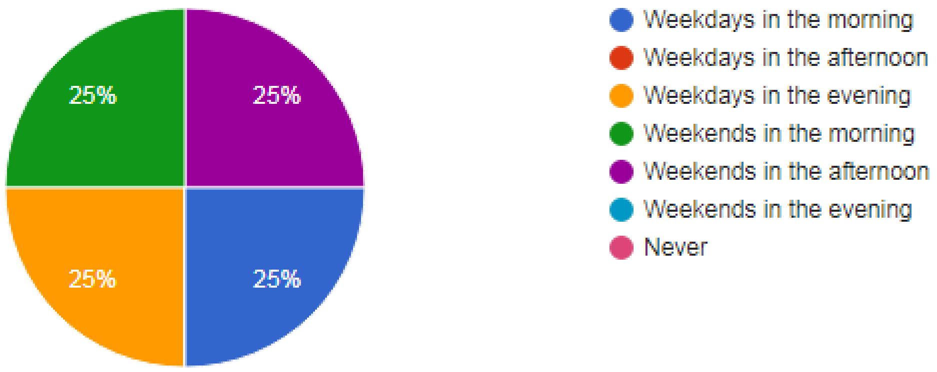

Figure 25. When would you like to deliver real time energy consumption feedback to your consumers on their smartphones?

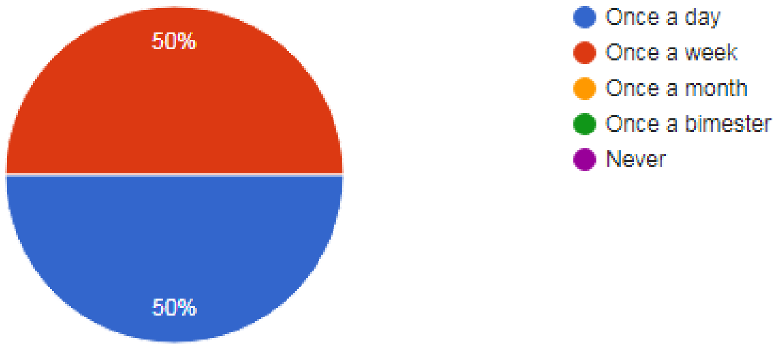

Figure 26. How often would you like to deliver real time energy consumption feedback to your consumers on their smartphones

Service providers indicate the high importance of addressing the global environmental issues via provision of energy prosumption services as it is shown in the chart below.

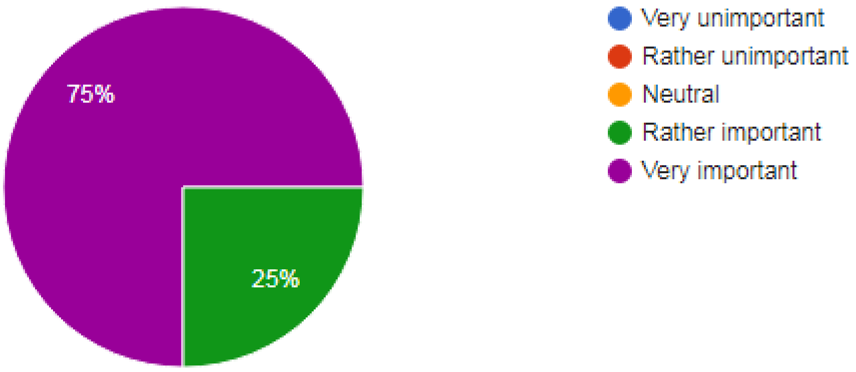

Figure 27. How important is to your company to provide energy prosumption services and address the global environmental issues

It is very important for all companies to sell efficient energy management services so as to automatically minimize energy consumption/production of their consumers. Furthermore, the energy management services that all companies would you like to sell are tips/notifications about efficient energy consumption and tips/notifications about efficient energy production. The respondents desire to sell services like information about weekly/daily/monthly energy consumption and production.

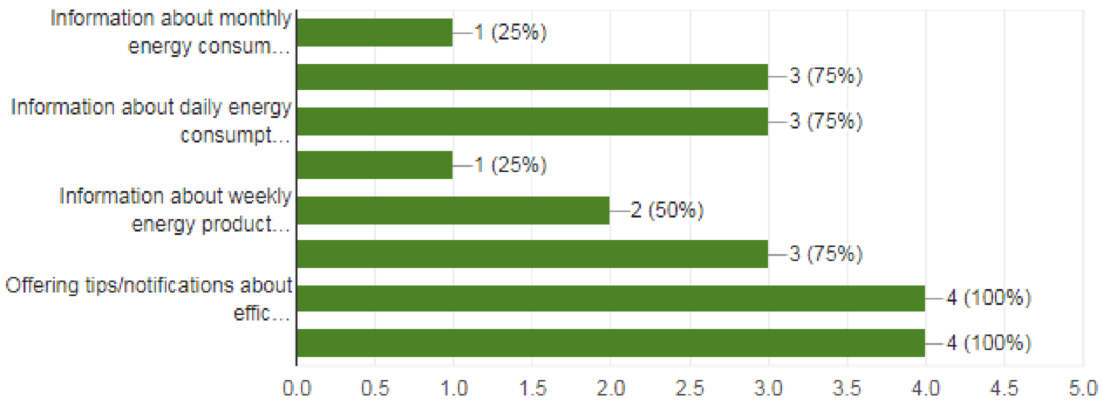

Figure 28. What kind of energy management services would you like to sell?

Lack of consumers' interest in energy efficiency have been selected by all companies as the main barrier of implementing efficient energy management systems as shown in Figure 29. Other barriers like lack of innovative value added services offered, lack of experience and knowledge of smart systems, cyber-insecurity and potential misuse of private data and reluctance of the present players in energy business to change conventional business models have been also indicated by respondents

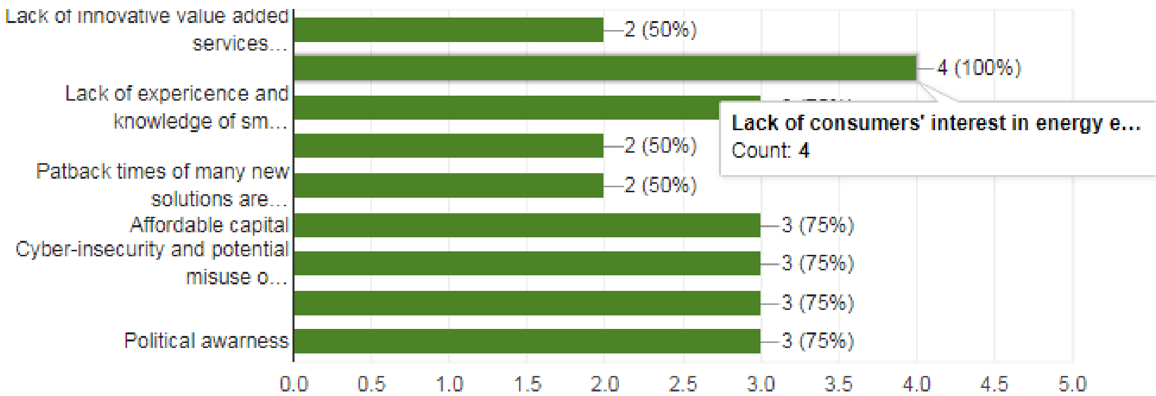

Figure 29. Barriers of implementing efficient energy management systems

Finnaly all responders agree with the following question: Being able to perform actions that improve your consumers' impact on the environment is important to your company.

5.3 Survey Analysis obtained from TG3

In the following sections the data obtained from the questionnaire directed to academic staff at HUA campus Greece are summarized and explained via tables or figures aiming at provision of clear representation of the received responses.

5.3.1 *General information (socio-demographic variables)*

The demographic variables are used as an introduction of the respondents of the questionnaire.

Table 11. General Information (Socio-demographic variables)

Socio-demographic variables	Percent (%)

Gender	
Male	40
Female	50
Age	
18-25	13.3
25-35	46.7
35-45	33.3
Over 45	6.7
Highest degree of education?	
Bachelor	26.7
Master	46.7
Doctorate	26.7
Occupation in university	
Researcher	44.8
Faculty member	6.9
Professor	3.4
Administrative employee	13.8
Student	20.7
Other	10.4
Numbers of Family	
1	16.7
2	40
3	23.3
4	10
5	3.3
Over 5	6.7
Area of your household	
Under 50	30
50-80	40
80-120	23.3
120-160	6.7
160-200	-
Over 200	-
Household average yearly income is	
Under 20K	50
20K-30K	33.3
30K-40K	16.7
Over 40K	-

Data obtained for monthly energy consumption is illustrated in Figure 30 via bar chart. Here one important aspect that should be taken into attention is the 38% end-users' are not aware of their energy consumption as they write "I don't know" answer.

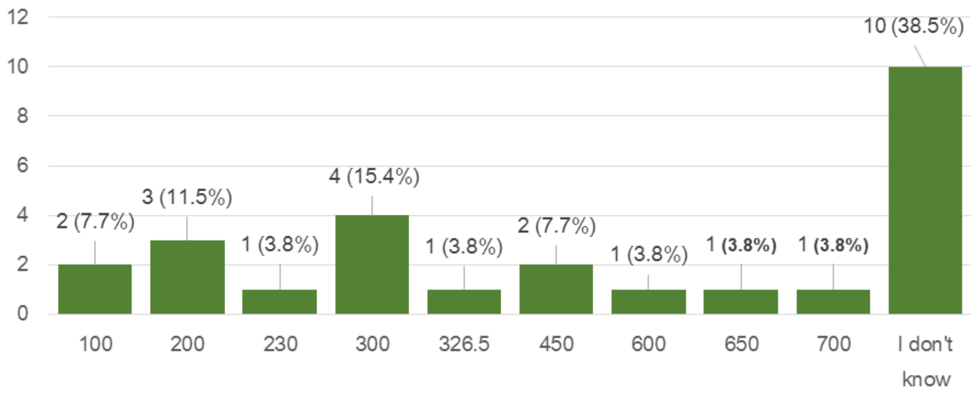

Figure 30. Respondents' monthly energy consumption on average

The table below shows respondents' awareness of energy management services and willingness to switch off some household's/workspace's appliances during peak hours. The 46.7%, 36.7% and 16.7% of end users answered that they are aware, not aware and are not sure that they are aware of energy management services, respectively. In addition, the majority of the respondents (86.7%) would like to switch off some of their appliances during peak hours at their households' interestingly the same question but for workspace's appliances has received 74.1% of positive answer.

Table 12. Respondents' awareness of energy management services and willingness to switch off some household's/workspace's appliances during peak hours

Questions	Percent (%)
Awareness of energy management services	
Yes	46.7
No	36.7
Not sure	16.7
Willingness to switch off some of household's appliances during peak hours	
Yes	86.7
No	-
Not sure	13.3
Willingness to switch off some of workspace's appliances during peak hours	
Yes	74.1
No	7.4
Not sure	18.5

Despite the fact that 46.7 % of end-users know about energy management services only 6.7% and 3.8% use applications/services for optimizing the energy consumption at household and workspace respectively (shown below)

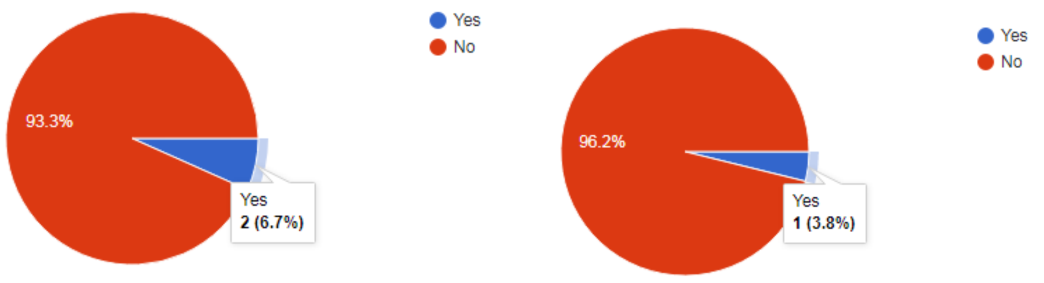

Figure 31. Question: Do you already use some applications for optimizing the energy consumption at your household (on the left side) and workspace (on the right side)?

The external factors that can influence to change energy supplier are shown in Figure 32

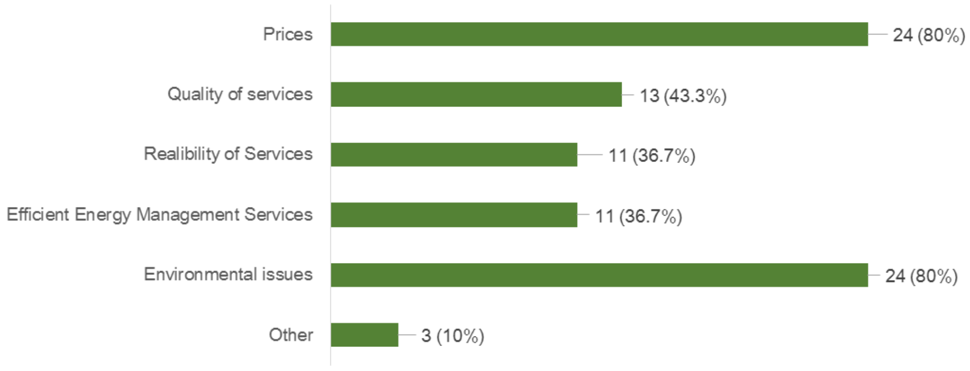

Figure 32. Question: What can influence you to change your energy supply? (Please, tick as many as you would like)

5.3.2 *Interests toward energy consumption/production optimization*

In this section, the focus is to examine whether and to what extent the respondents desire to control and optimize their energy consumption (both in household and working space) via receiving real time consumption feedback or tips and notification about efficient energy consumption. Regarding latter aspect the respondents were free to insert tips that they are desire to receive. The collected data are given in the tables below.

Table 13. Interests toward energy consumption/production optimization

Questions	Percent (%)
How important is to you to receive tips about efficient energy consumption at your workspace?	
Very unimportant	4
Rather unimportant	4
Neutral	20
Rather important	48
Very important	24
How important is to you to receive tips about efficient energy consumption at your household?	
Very unimportant	3.3
Rather unimportant	3.3
Neutral	13.3
Rather important	36.7
Very important	43.3
How important is to you to be able to control your workspace's electricity consumption while getting energy real-time consumption feedback on your smartphone	
Very unimportant	-
Rather unimportant	4.2
Neutral	12.5
Rather important	50
Very important	33.3
How important is to you to be able to control your household's electricity consumption while getting energy real-time consumption feedback on your smartphone	
Very unimportant	-
Rather unimportant	-
Neutral	10
Rather important	46.7
Very important	43.3

Some important tips that respondents desire to receive about energy management are listed in Table 14

Table 14. Tips that respondents are interested to receive

Information for appliances about energy consumption
Tips that can be applied without disrupting my work.
how to save money
seasonal energy consumption
energy consumption, bills vs weather
Tips to save energy and to reduce monthly costs.
to reduce bills
reduced bills
when it is a good time to use energy hungry devices (eg. kitchen), when are the rates lower
pop-up messages
Load consumption profiles of the installed appliances at my house and a suggested day-ahead load scheduling
how much I save when I switch off appliances
Turn on/off this device at a specific time
about the bills
to reduce energy consumption
reduction of electricity consumption, bill
pop-up messages
weather sensitive data
detailed billing information, tips for saving money
saving money
receiving tips/notification about saving money
receiving notifications about energy consumption per appliances
Specific suggestions on how I can reduce my energy consumption

The respondents' answers about the suitable timing and regularity for receiving notifications/tips on their smartphone both for household and working space are presented below via four different pie charts.

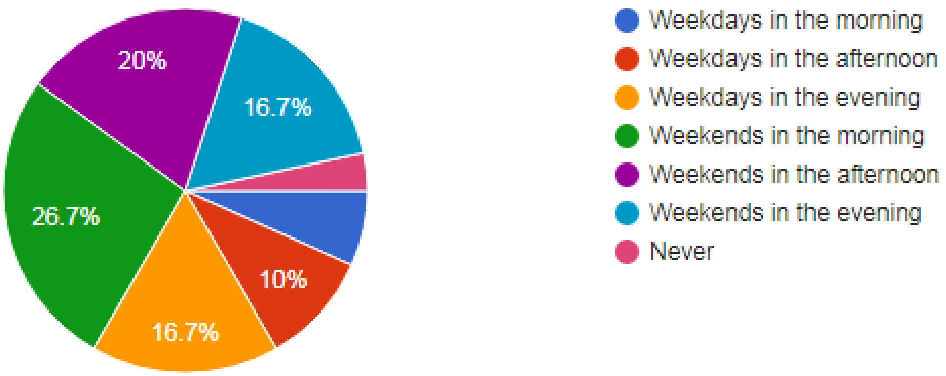

Figure 33. Question: When would you like to receive notifications on your smartphone with tips for optimizing your energy use at your household?

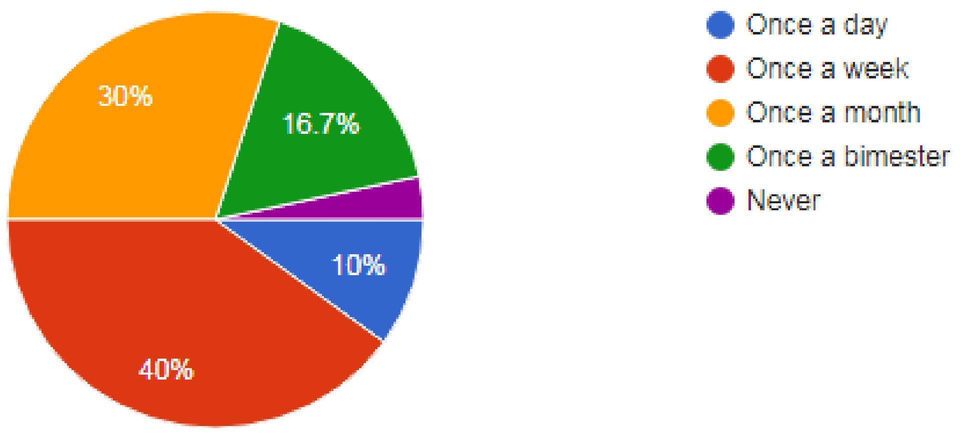

Figure 34. Question: How often would you like to receive notifications on your smartphone with tips for optimizing your energy use at your household?

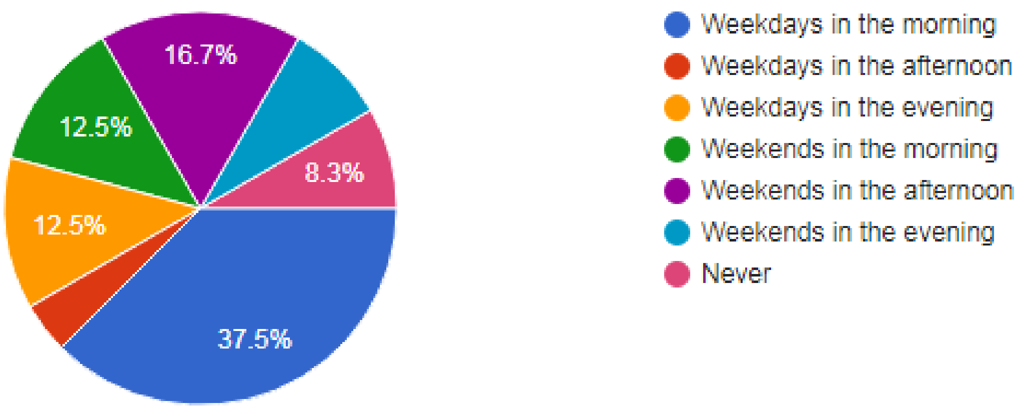

Figure 35.Question: When would you like to receive notifications on your smartphone with tips for optimizing your energy use at your workspace?

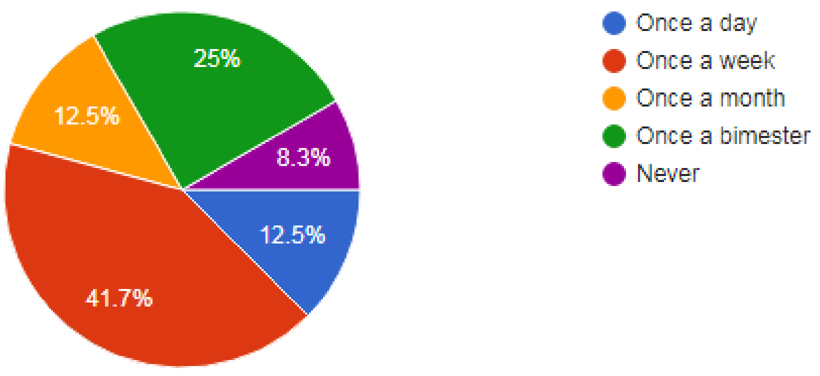

Figure 36. Question: How often would you like to receive notifications on your smartphone with tips for optimizing your energy use at your workspace?

5.3.3 *Consumer purchasing intention*

To probe the respondents' efficient energy management servicies' purchasing intention two extra questions have been initiated and below are presented the obtained data. 46.7 % of end users voted that it is rather important for them to purchase while 20% respondents indicated that it is very important for them to pay for efficient energy management services.

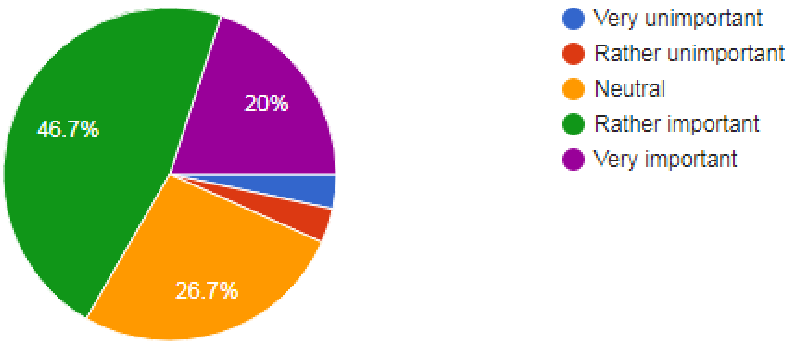

Figure 37. Question: How important is for you to pay for efficient energy management services and thus automatically minimize your energy consumption?

Figure 38 illustrates the willingness of respondents to buy energy management services. Interestingly 20 respondents would like to pay for receiving tips and notifications while around 25 end-users wish to buy services providing information about energy consumption (monthly -12 answers, weekly-8responses, daily-5 responses). Very small percentage of respondents (only 1.3%) does not have willingness to buy such services while other services such as comparative data about my energy consumption (actual versus recent/ past) was also recorded in the 'other' section of this question.

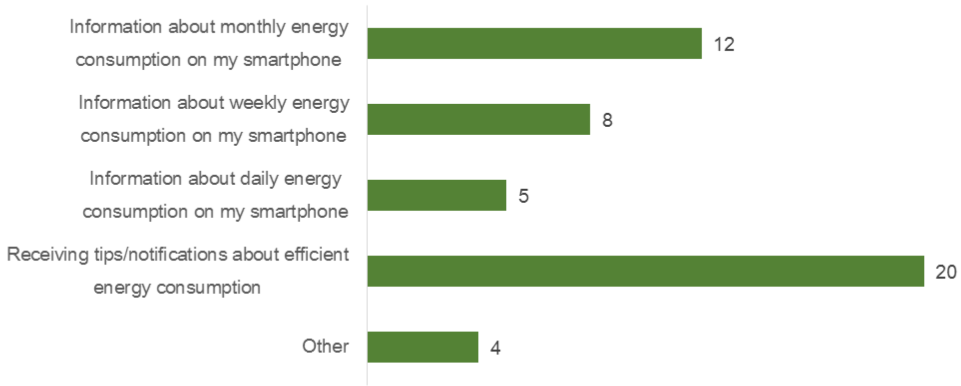

Figure 38. Question: What kind of energy management services would you like to buy (Please, tick as many as you would like)

5.3.4 *Awareness of environment concerns, attitudes towards energy saving*

The following section presents respondents' awareness of renewable energy sources, attitudes towards energy saving and environment concerns motivations towards behaviour changes.

Awareness of renewable energy types is excellent as all respondents know about the term renewable energy source recording 100% positive respond for this question. In Figure 39 is shown the type of renewable energy sources that the end-users are aware of. Solar was the most popular, followed by wind, biomass and geothermal at 17 percent. Few respondents had knowledge of hydropower and wave power and subsequently added these types of energy sources into the ‘other’ section of this question.

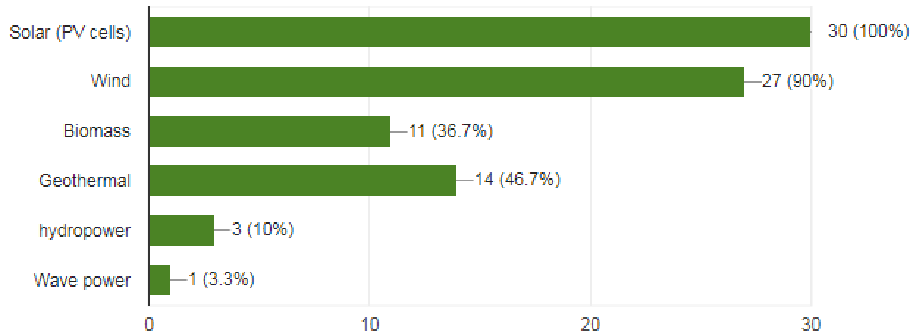

Figure 39.Question: what type of renewable energy sources are you aware of (Please, tick as many as you are aware of)

The respondents are aware of renewable energy sources however none of them use these sources at their households as 100% NO respond was received for the representative question. Despite this fact most of them (as it can be seen in Figure 40) would be consider the renewable energy installation at their households in the future.

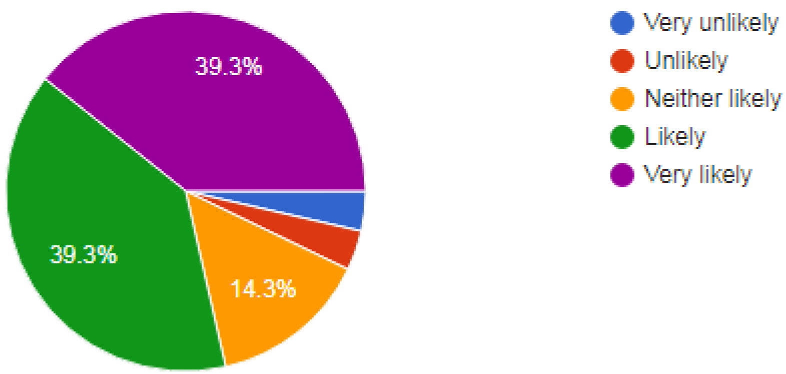

Figure 40. Question: In the future would you consider a renewable energy installation at your household

56.7% of respondents have very positive attitudes about energy saving, in fact none of them have any negative respond (Figure 41)

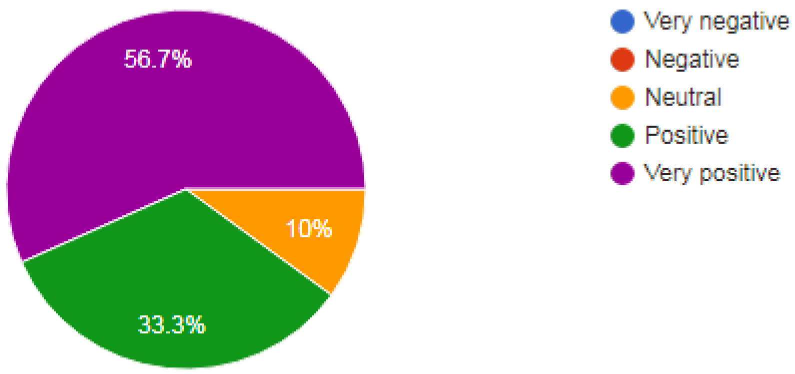

Figure 41. Question: What is your general attitude to energy saving?

Most of the respondents indicate that the protection of environment can motivate them to improve their energy saving behaviour while cost and proper provision of information could also be reason for energy saving (Figure 42).

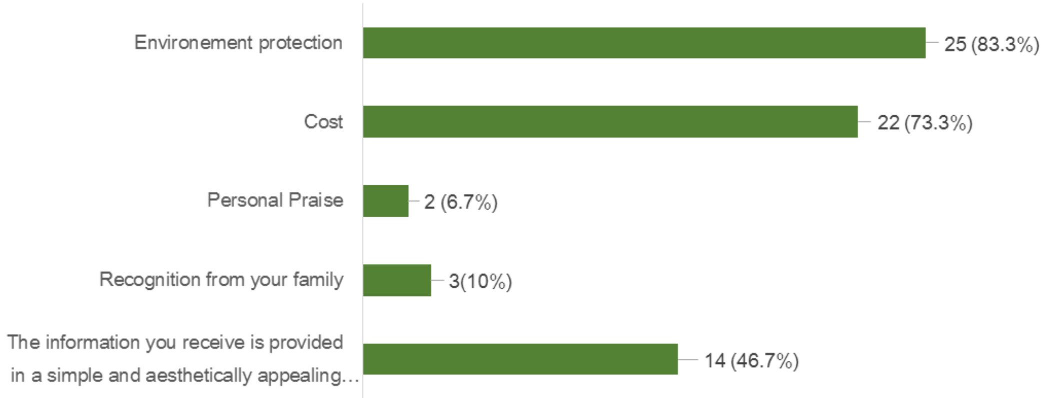

Figure 42. Question: What would motivate you to improve your energy saving behaviour? (Please, tick as many as are relevant to you)

All end users agree that performing actions that improve their footprint on the environment is important for them as it can be seen in Figure 43

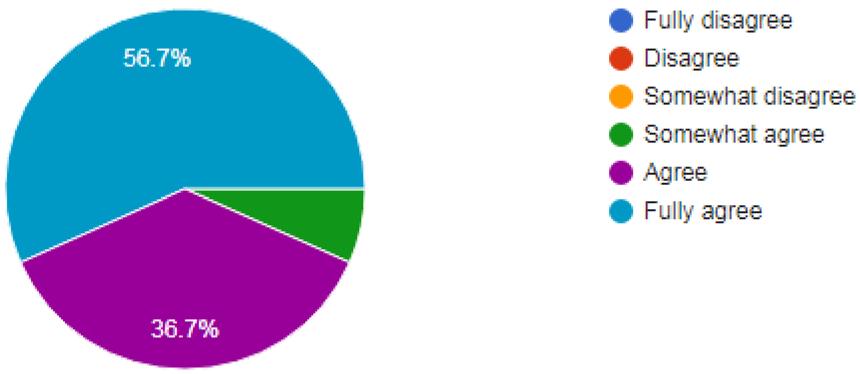

Figure 43. Question: Being able to perform actions that improve my building's impact on the environment is important to me.

Finally, the responses about the thermal comfortability of end users at their households and working space are shown below:

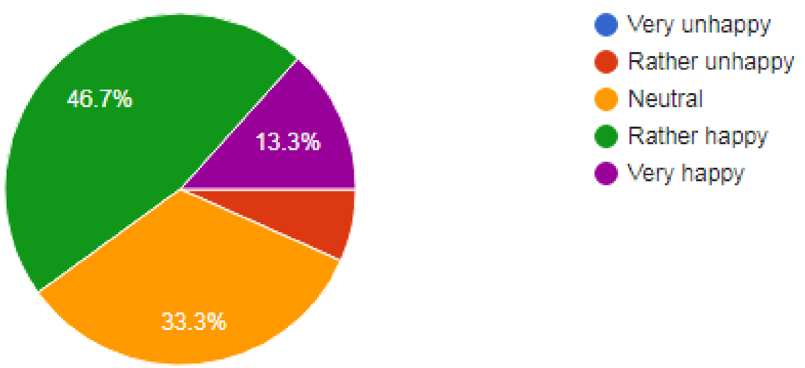

Figure 44. Question: Are you happy with your thermal comfort at your living space

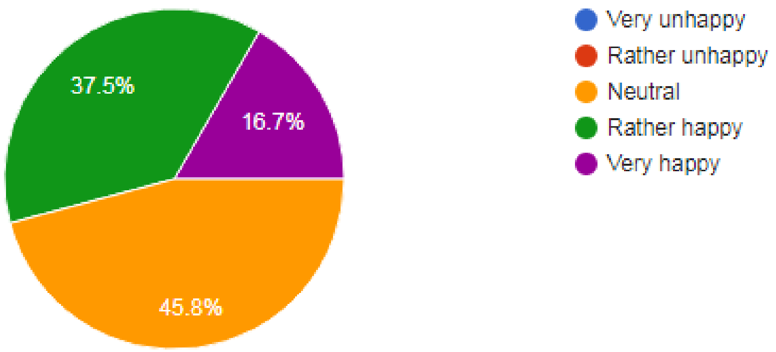

Figure 45. Question: Are you happy with your thermal comfort at your working space

5.4 Survey Analysis obtained from TG4

In the following sections the data obtained from the questionnaire directed to different building managers associated with SIT4Energy consortium members. The initial results are summarized and explained via tables or figures aiming at provision of clear representation of the received responses.

5.4.1 *General information (socio-demographic variables)*

The demographic variables are used as an introduction of the respondents of the questionnaire

Table 15. General Information (Socio-demographic variables)

Socio-demographic variables	Percent (%)
Gender	
Male	33.3
Female	66.7
Age	
18-25	-
25-35	33.3
35-45	33.3
Over 45	33.3
Highest degree of education?	
Bachelor	33.3
Master	33.3

Doctorate	33.3
The location of your building is in (Please indicate country and city)	
Greece, Athens	
Greece, city	
Mecklenburg Vorpommern, Stralsund	
How many people work/live in your building?	
1	-
2	33.3
3	-
4	-
5	
Over 5	66.7
Area of your building is	
Under 50	-
50-80	-
80-120	33.3
120-160	-
160-200	33.3
Over 200	33.3
How much do you spend on electricity bills (monthly) in average	
Under 200 €	33.3
200-400 €	33.3
400-600 €	-
600-800 €	-
Over 800 €	33.3

Two of three responders answered the question related to monthly average energy consumption (the answeres are over 1000and 200 kw/month in avergae).
The table below shows respondents' awareness of energy management services and willingness to switch off some household's/workspace's appliances during peak hours. The majority of the respondents (66.7%), of end users would like to switch off some of their appliances during peak hours at their buildings' and would like to have more control and insight related to their buildings' energy consumption.

Table 16. Respondents' awareness of energy management services and willingness to switch off some appliances of their buildings during peak hours

Questions	Percent (%)
Do you want more control and insight into your building's energy consumption?	
Yes	66.7
No	-
Not sure	33.3
Awareness of energy management services	
Yes	33.3
No	33.3
Not sure	33.3
Willingness to switch off some of building's appliances during peak hours	
Yes	66.7
No	-
Not sure	33.3

Despite the fact that 33.3% of end-users know about energy management services none of them use applications/services for optimizing the energy consumption at their buildings (shown below)

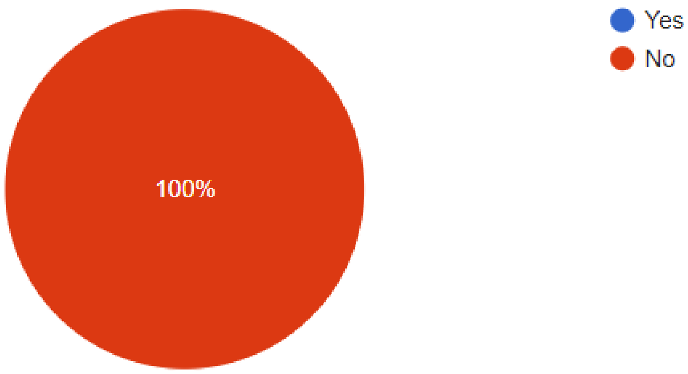

Figure 46. Question: Do you already use some applications for optimizing the energy consumption at your building?

The external factors that can influence to change energy supplier are shown in Figure **47**

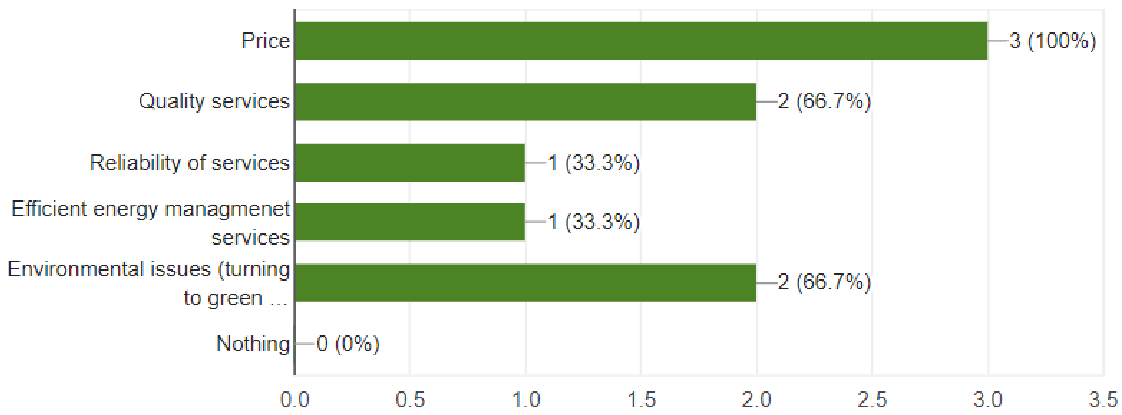

Figure 47. What can influence you to change your energy supply at your building? (Please, tick as many as you would like)

5.4.2 *Interests toward energy consumption/production optimization*

In this section, the focus is to examine whether and to what extent the building managers/owners desire to control and optimize their energy consumption via receiving real time consumption feedback or tips and notification about efficient energy consumption. Regarding latter aspect the respondents were free to insert tips that they are desire to receive. The collected data are given in the tables below.

Table 17. Interests toward energy consumption/production optimization

Questions	Percent (%)
How important is to you to receive tips about efficient energy consumption at your building?	
Very unimportant	-
Rather unimportant	-
Neutral	-
Rather important	66.7
Very important	33.3
How important is to you to be able to control your electricity consumption while getting energy real-time consumption feedback on your smartphone	
Very unimportant	-
Rather unimportant	33.3

Neutral	-
Rather important	33.3
Very important	33.3

Some tips that respondents desire to receive about energy management are as follows:

- Possible economic viable solutions that i could install inisde my apartment
- Saving potential

The respondents' answers about the suitable timing and regularity for receiving notifications/tips on their smartphone are presented below via four different pie charts.

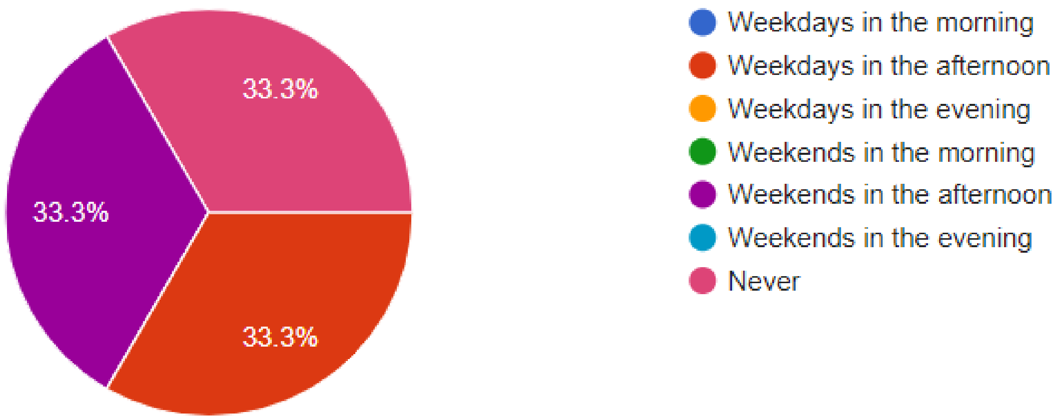

Figure 48. Question: When would you like to receive notifications on your smartphone with tips for optimizing your energy use at your building?

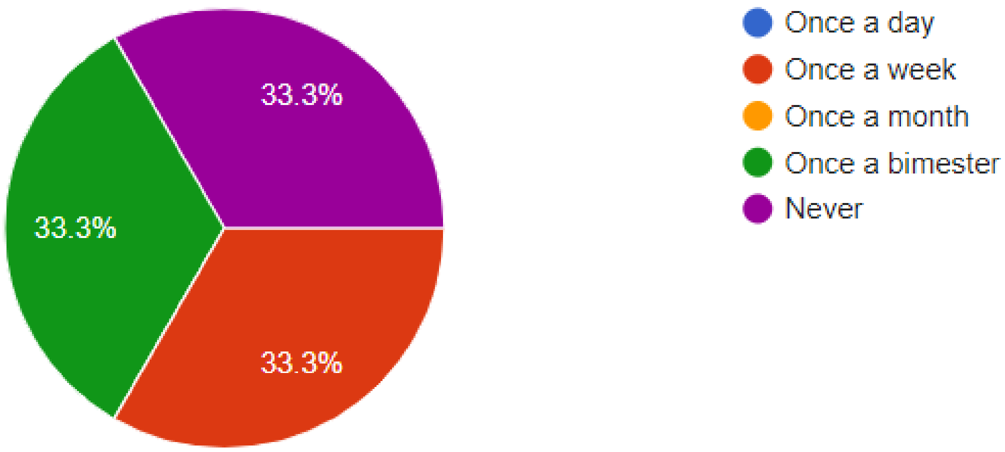

Figure 49. Question: How often would you like to receive notifications on your smartphone with tips for optimizing your energy use at your building?

5.4.3 *Consumer purchasing intention*

To probe the building managers/owners' efficient energy management servicies' purchasing intention two extra questions have been initiated and below are presented the obtained data. 66.7 % voted that it is rather important for them to purchase while 33.3% indicated that it is rather important for them to pay for efficient energy management services.

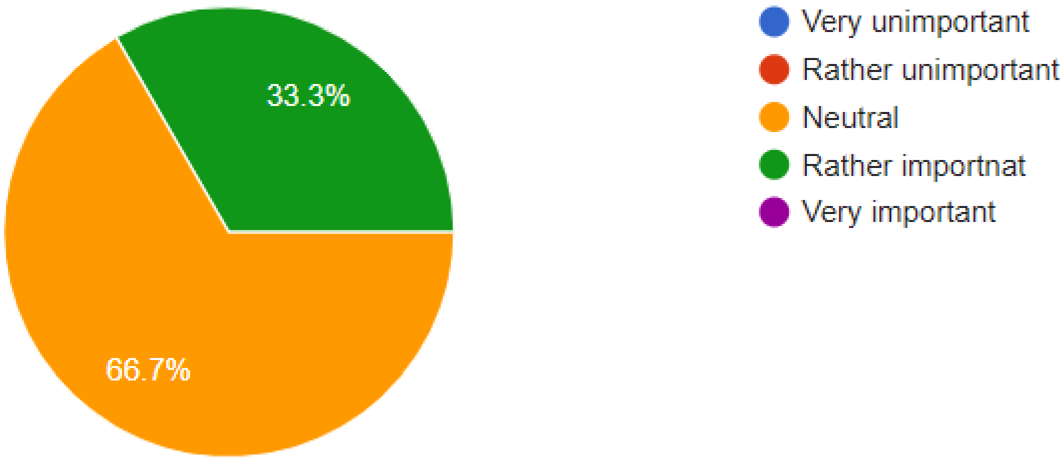

Figure 50. Question: How important is for you to pay for efficient energy management services and thus automatically minimize your energy consumption at your building?

Figure 51 illustrates the willingness of respondents to buy energy management services. Interestingly 66.7% respondents would like to pay for receiving tips and notifications while 33.3% end-users wish to buy services providing weekly and daily information about energy consumption.

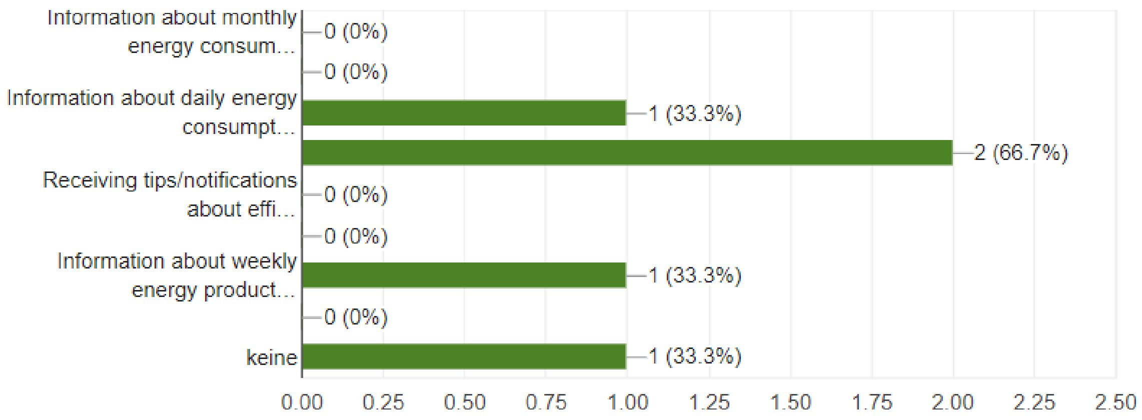

Figure 51. Question: What kind of energy management services would you like to buy (Please, tick as many as you would like)

5.4.4 *Awareness of environment concerns, attitudes towards energy saving*

Awareness of renewable energy types is excellent as all respondents know about the term renewable energy source recording 100% positive respond for this question. In Figure 52 is shown the type of renewable energy sources that the end-users are aware of. Solar and wind power were the most popular, followed by biomass and geothermal at 66.7%. One respondent had knowledge of wave power.

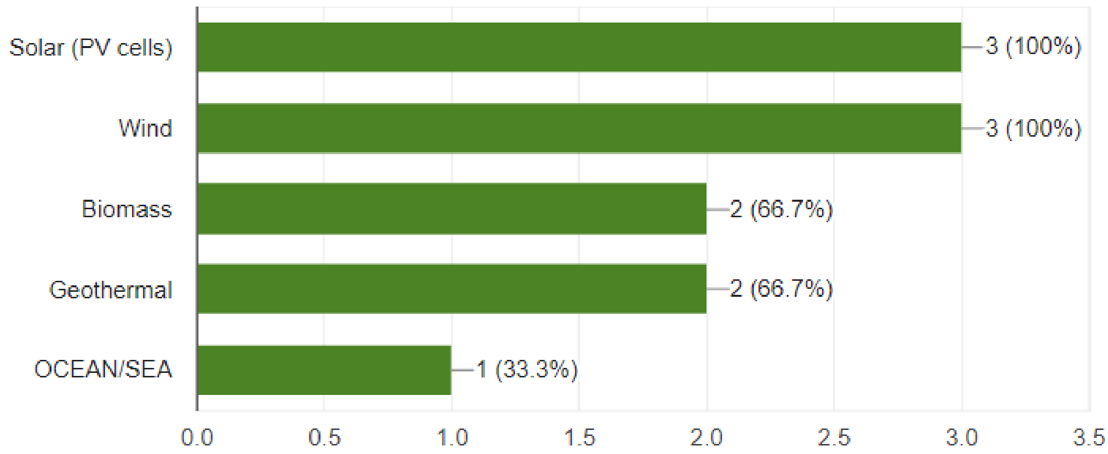

Figure 52. Question: what type of renewable energy sources are you aware of (Please, tick as many as you are aware of)

The respondents are aware of renewable energy sources however none of them use these sources at their households as 100% NO respond was received for the representative question. Despite this fact most of them (as it can be seen in Figure 53) would be consider the renewable energy installation at their buildings in the future.

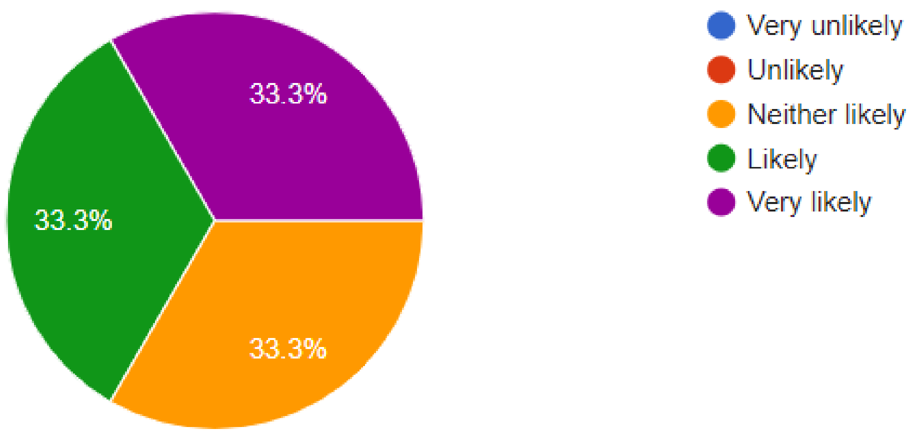

Figure 53. Question: In the future would you consider a renewable energy installation at your building

As it can be seen in Figure 54 all respondents have positive attitudes about energy saving, in fact none of them have any negative respond.

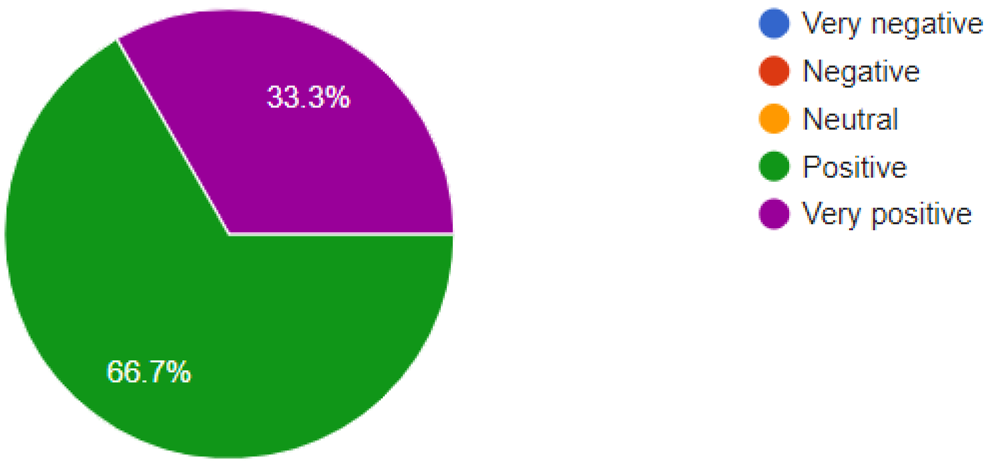

Figure 54. Question: What is your general attitude to energy saving?

For all respondents the cost is the first reason that can motivate them to improve their energy saving behaviour followed by environment issue, personal price, recognition from family and proper provision of information (Figure 55). All responderns are happy with their buildings' thermal comfort and agree that performing actions that improve their footprint on the environment is important for them as it can be seen in Figure 56.

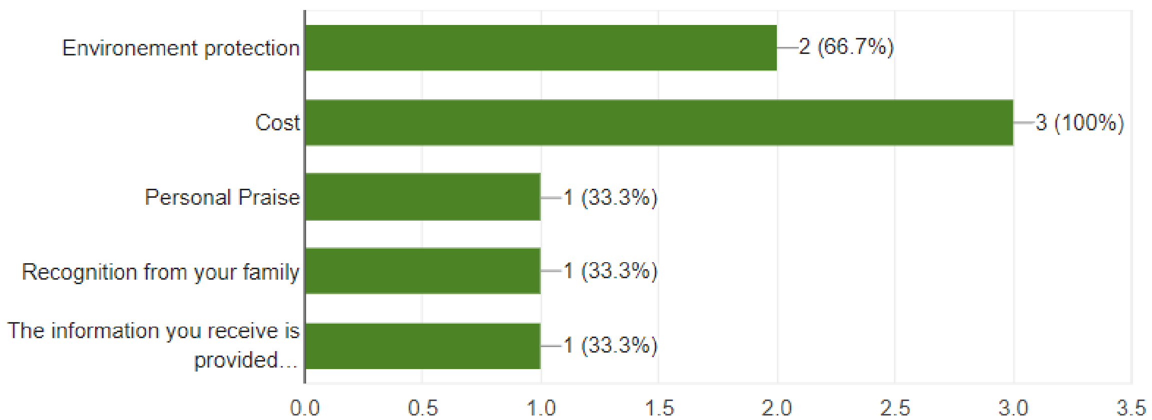

Figure 55. Question: What would motivate you to improve your energy saving behaviour? (Please, tick as many as are relevant to you)

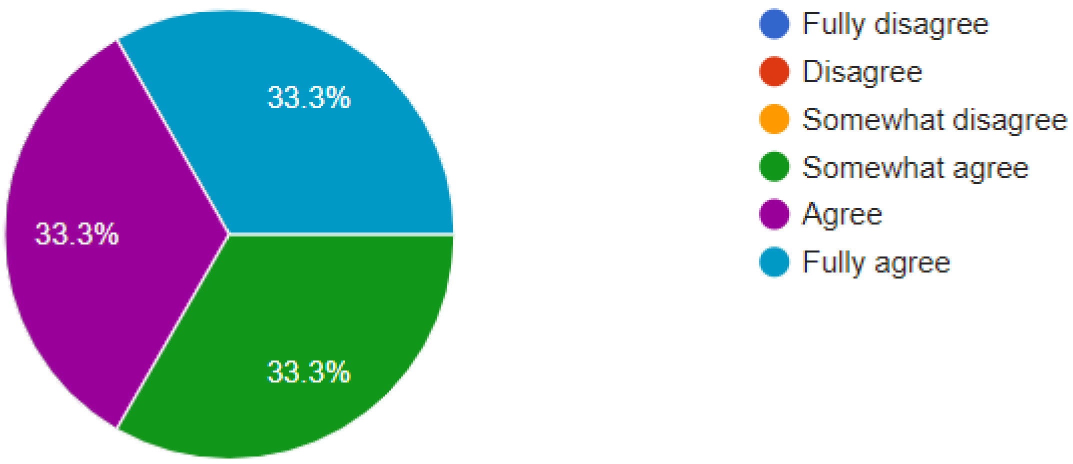

Figure 56. Question: Being able to perform actions that improve my building's impact on the environment is important to me.

6. Conclusion

This deliverable sets out the first stages for identification and involvement of SIT4Energy end-users in its very early desing steps. End-users identification is the first and foremost important task in effective target groups' engagement. SIT4energy defines target groups as those who are interested in (and have sufficient or little knowledge) improvement of sustainable and efficient energy actions, reduction of energy consumption, wish to address these two issues by means of optimal management of energy consumption and increase of number of so-called prosumers through cross-border cooperation. In this context, SIT4energy aims to interact with stakeholders, researcher users and the community at large in innovative ways that will be based on their proactive direct involvement.

In the framework of Task 1.1 a market survey tool composing of four different types of questionnaires with different structures and question contents has been designed. The ready questionnaires were directed to the defined SIT4Energy end-users groups. The latter were defined based on a) SIT4Energy pilot cases b) energy services providers/operators and c) any interested energy consumers/prosumers (private/public building managers, residential/household users).

The focus of survey tool was given on the identification of respondents' information, ideas, opinions, and attitudes on efficient energy consumption and production and pointing out which factors influence on their behavior. These behaviours are both complicated and difficult to change: partly because they are shaped by the characteristics of the building and the energy-using appliances, but more importantly because they are influenced by a range of internal and external factors, such as our beliefs, values and attitudes, other people's behaviours, the cultural settings we live in, and various economic incentives and constraints. Questions about awareness towards adapting new technologies, as well as the role of these technologies in saving energy were also involved. A specific attention was given also to the identification of users' needs and desires aiming to engage them in the final SIT4Energy product. Questions about the willingness to pay for efficient energy management services were also contained.

The web tool has been created via google form in three different languages and was performed in partner countries (Greece and Germany) during July-August 2018. Although the detailed analysis of the designed tool will be conducted within the Task 1.2 and Task1.3 some initial data have been included in the present document.

Some **key evidences** of the survey are:

End-users

- There is a 100% awareness of the term 'renewable energy', of the various renewable energy types (solar, geothermal and biomass) and how they work. The results of this survey show that all respondents have positive attitudes about energy saving and most of the respondents would consider renewable energy installation at their households in the near future.
- Most of the respondents are aware of energy management services and have very strong willingness to switch off some household's/workspace's appliances during the peak hours
- Respondent have very positive energy management services' purchasing intention as around 50% mentioned that it is rather important and 20% that it is very important for them to buy efficient energy management services. Survey respondents are interested to receive tips/notifications mainly in order to reduce energy use and monthly bills.

Utilities

- Service providers indicate the high importance of addressing the global environmental issues via provision of energy prosumption services.
- Service providers agree to provide rewards, feedback related to energy consumption and discounts on energy efficient solutions in order to empower customers to take control of their energy usage
- Respondents desire to retain their customers by receiving and further offering/selling energy management and optimization services via real time consumption feedback or tips and notification about efficient energy consumption/production.
- Lack of innovative value-added services, lack of consumers' interest in energy efficiency and experience and knowledge of smart systems, reluctance of the present players in energy business to change conventional business models and cyber-insecurity have been selected by companies as the main barriers of implementing efficient energy management systems.

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