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Key Performance Indicators for social housing within energy communities

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Public housing is more than just a place to live.
Public housing programs should provide
opportunities to residents and their families.

“Carolyn McCarthy”

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Preface

The research process presented is the culmination of a master thesis investigation which aims to encourage people and institutions (public or private) to take seriously the development of social housing projects knowing the classical necessities and the new ones raised during and after the covid-19 pandemic.

In fact, as you will read, housing is an essential starting point of how society is conformed, while experimenting their daily lives, with its problems, challenges opportunities etc. This approach will be focus on the European context and more over in Italian regulations and case study, however it could be applied in all over the world with it relative changes.

Following an investigation path allow me to identify in each scale (European and Italian) the stakeholders, normative, actions, plans and projects carried on, which will give the possibility to have a broaden vision of the actual situation, giving support to the problematics identified helping the development of the thesis.

The results, and more over the research process, has left me the importance to work side by side with the community, allowing a coherent planning proposal, also it encourage a constantly searching of how as planners can introduce and be a bridge between social, economic, cultural, environmental, and technological developments with urban policies.

Abstract – EN

Social housing projects are still a subject of research, where the basic aim was to provide shelter to all the inhabitants of a city. However, through the years they face challenges such as, affordability, quality, quantity and recently the rise of the right infrastructure to supply the covid 19 necessities.

The thesis therefore aims to define a framework based on key performance indicators as an answer to develop social housing projects within new era necessities (climate change, energy consumption and production), those are linked with the sustainable development goals adopted by the united nations in 2015 as an action plan to ensure people prosperity by 2030, the ones that will be a target of study are: affordability and clean energy, innovation and infrastructure, reduced inequalities, sustainable cities and communities and climate action.

The investigation is going to have to key pillars, the first one is the European and Italian social housing general background and the second one is the energy communities for the European level and passing to the Italian case as a response of actual threats.

Parallel the research thesis investigated which of the key performance indicators from institutions or programs, such as: Interreg MED or ISO37120/2018, are usable, or pilots such as interconnect project or scientific papers which propose indicators could respond to the actual house context.

Understanding the situation between social housing and energy community in Europe and Italy context and selecting the key performances indicators from the institutions, the final step will be testing the selection among the stakeholders, for this it is necessary to contact a community, a developer (profit) and a research institution (non-profit) to confirm their importance (hierarchy) and provide a solid framework.

Key Words: sustainable development goals, Agenda 2030, Adaptation, Affordability, Energy transition.

Abstract – IT

I progetti di edilizia sociale sono ancora oggetto di ricerca, dove l'obiettivo fondamentale era quello di fornire riparo a tutti gli abitanti di una città. Tuttavia, nel corso degli anni, devono affrontare sfide come l'accessibilità, la qualità, la quantità e, di recente, l'aumento delle giuste infrastrutture per soddisfare le necessità del covid 19.

La tesi si propone quindi di definire un framework basato su indicatori chiave di performance come risposta allo sviluppo di progetti di edilizia sociale all'interno delle necessità della nuova era (cambiamenti climatici, consumo energetico e produzione), legate agli obiettivi di sviluppo sostenibile adottati dalle Nazioni Unite nel 2015 come piano d'azione per garantire la prosperità delle persone entro il 2030, quelli che saranno oggetto di studio sono: accessibilità economica ed energia pulita, innovazione e infrastrutture, riduzione delle disuguaglianze, città e comunità sostenibili e azione per il clima.

L'indagine dovrà avere dei pilastri fondamentali, il primo è il contesto generale dell'edilizia sociale europea e italiana e il secondo è le comunità energetiche a livello europeo e passa al caso italiano come risposta a minacce reali.

Parallelamente, la tesi di ricerca ha studiato quali degli indicatori chiave di prestazione di istituzioni o programmi, come: Interreg MED o ISO37120/2018, sono utilizzabili per progetti futuri, o progetti pilota come progetti di interconnessione o articoli scientifici che propongono indicatori basati sul contesto reale della casa.

Comprendendo la situazione tra social housing e comunità energetica nel contesto europeo e italiano e selezionando gli indicatori chiave di performance dalle istituzioni, il passo finale sarà testare la selezione tra gli stakeholder, per questo è necessario contattare una comunità un promotore (profit) e un istituto di ricerca (senza scopo di lucro) per confermare la lora importanza (gerarchia) e fornire una solida struttura.

Parole chiave: obiettivi di sviluppo sostenibile, Agenda 2030, Adattamento, Affordability, Transizione energetica.

List of Acronyms

1. KPI: key performance indicators.
2. SHP: Social Housing Projects.
3. SHN: Smart home network.
4. CRE: Community owned renewable energy.
5. REC: Renewable energy communities.
6. CEC: Citizen energy community.
7. PSH: Permanent supportive housing.
8. PEEP: Area plans for economic social housing.
9. IACP: Autonomous social housing institutes.
10. ATER: Territorial residential construction companies.
11. CBOs: Community-based organizations.
12. Iots: Internet of things.
13. RE: Renewable energy.
14. DSO: Distribution system operation.
15. BESS: Battery energy storage system.
16. UVAC: Virtual units enabled for consumption.
17. UVAP: Enabled virtual production units.
18. UVAM: Mixed enabled virtual units.
19. UPI: Production units integrated with storage systems.
20. UPM: Peripheral Monitoring Unit.
21. POD: point of delivery.
22. ARERA: Autorità di Regolazione per Energia Reti e Ambiente.
23. MISE: Ministerio dello sviluppo económico.

Key concepts

Key performance Indicators:

KPI, or a key performance indicator, are measurable values used to evaluate how successful a Project is at reaching a target.

"A way of measuring the effectiveness of an organization and its progress towards achieving its goals." MACMILLAN DICTIONARY

Energy Communities:

They contribute to increase public acceptance of renewable energy projects and make it easier to attract private investments in the clean energy transition. (Comission, s.f.).

Digital Transformation:

Digital transformation is the integration of digital technology into all areas of a business, fundamentally changing how you operate and deliver value to customers. It's also a cultural change that requires organizations to continually challenge the status quo, experiment, and get comfortable with failure. (Project, 2016).

Equity:

"A situation in which everyone is treated equally". OXFORD DICTIONARY

Smart District:

Typically located in peripheral areas with respect to urban centers, smart districts host from 400 to 1,000 housing units. Smart homes designed so that citizens can manage and communicate with appliances and devices, optimize consumption and benefit from inclusive digital services and social innovation programs. (Idea, s.f.).

Smart Building:

Is a type of building with reasonable investment, efficient energy management, and comfortable and convenient environment, designed by considering the optimized relationship among structure, system, service, and management. (Sinopoli, 2010)

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1. INTRODUCTION

Social housing is a system which provides long-term housing to a group of households specified only by their limited financial resources, by means of a distribution system and subsidies. Those developments are in first instance a responsibility of the state or public districts (through the years the public sector have the support of private entities to accomplish the amount of households required as we will specified in different European countries), meaning this the construction and maintenance, in addition those projects should stablish a rental fee below the market level or using forms of protecting the owners or tenants.

In our current situation we have faced and important challenge, the Covid-19 pandemic, which had represented several changes in our way of living, rising several social problematics that are not new, and reached their critical point during this period, mostly in the neighborhoods or communities with more economic, social, and cultural difficulties. Starting with the problematic of infrastructure that represents our social organization, in this sense the house is conceived as a socio-material assemblage that is constitutive of care.

Secondly a problem of social cohesion and participation is a noted problematic knowing the lack of engagement mostly for the tenants users in decision making, the social integration and cohesion could be achieved through the potential of new technologies, such as smart home networks (SHN), this system will support a community of residents in social housing to enhance the social sphere for residents, neighborhoods, and the city itself. This housing model, SHN will provide direct services to improve mental, physical, and social conditions.

On the other hand, we will understand how communities came together and form different types of relations, starting in a global scale and passing through the European scale and finally in the Italian one. Community cohesions have several situations in which it could take place, geography, peers, age, ethnicity, gender interests among others, in which it prevails a sense of belonging, the community come together to address a particular issue, if the issue or interest is resolve the community will disband. Starting from the Renewable energy communities (REC) an according to the European Union, this initiative can be expressed as a common sharing of both responsibilities and benefits deriving from the activity of energy production. This not excluding the participation of private or public entities in the different stages of the configuration of the REC, being able to be part of the financing construction implementation maintenance and revenues.

Followed by the citizen energy community (CEC) is defined through the directive 944 given by the European union in 2019 in which they define it as a voluntary legal not-for-profit entity

established at a local level for the purpose of energy “generation, distribution, supply, consumption, aggregation, storage”, etc. CEC are a category of cooperation of citizens or local actors that should be subject to recognition and protection under Union law.

At the national level, in this case Italy there is the "Renewable energy self-consumer" as a "final customer” who, operating on their own sites located within defined borders or, if permitted by a Member State, elsewhere, it produces renewable electricity for its own consumption and may store or sell self-produced renewable electricity provided that, for a self-consumption renewable energy consumer household. Such activities do not constitute the main business or professional activity.

As a final part of the research study, it is relevant to investigate the ways in which communities can actively participate in decision-making and actions that may be needed, which is why it has been considered, the extent to which architecture-in-use can enhance social interaction and sense of community, as well as the factors that inhibit interaction and sense of community for people living in permanent supportive housing (PSH) programs. Secondly the “participatory democracy of tenants” this idea derives from the traditional theory of democracy, which assumes that every citizen has a right to express their opinions and have the possibility to be part in decisions – making, in this case, at their local scale. In other words, citizen participation means the activity of parties involved in the preparation of plans and procedures of the implementation of the set policies to create a new, better reality (KWIATKOWSKI 2003, p. 8). Finally, to propose adequate policies for the development of affordable housing, it is essential to understand the role of the parties involved, their interests, demands and needs. In this case, two large groups are identified, the developers and the inhabitants, who later formed a community. Both groups must have tools enabled to be able to exercise the right to take an active part in design, development, and maintenance project decisions.

With the help of key performance indicators (KPIs) and supported by the sustainable development goals the spread of social housing allows us to introduce new tendencies that follows the achievement of high quality of live, make our lives easier, more comfortable, and secure.

To be able to provide a correct analysis of the general situation of social housing within energy communities, there has been developed a unified taxonomy of KPIs were the indicators follow 3 main paths, the perspective under which performance measures are proposed, the rationale,

arguing why an indicator must be defined and a scope must have to be provided to be considered case (Eladio Domíngueza, 2019).

The proposed KPIS framework for social houses in actual situations, will be evaluated in Moneta, Milan social housing project as feedback to prove their relevance and hierarchy between them. Knowing that in Italy about 10% have difficulty paying utility bills, rent or mortgage payments, over 20% live in homes with damaged structures or inadequate heating and almost 60% consider home expenses to be a heavy burden the percentage of these households has increased by almost 7% in less than ten years (group, 2014). To address the inconformity of the 60% of the population regardless to the home expenses we must cover 5 main aspects: the technological regarded to the energy consumption, social, direct on the community participatory approaches, constructive, focus on an adequate infrastructure, economic, regarded to the affordability and environmental answering the actual climate crisis.

As a mechanism of involvement with the Moneta community a 16-question survey was developed to find out the importance of different aspects of a project that let them take the decision to live there or another, in this case the community is changing their main-set, thanks to the interconnect project which is teaching them how to be more active as a community, conscious in their energy consumption and respectful with their environment. This being the starting point to face the key performances indicators considered, another questionary will take place with the perception of a profit organization, in this case the company planet idea srl and later with a non-profit organization, Ricerca Sistema Energetico (RSE).

In this way, the availability to introduce the KPIs framework that should be the projects guideline when it comes to achieve international objectives such as environmental, technology (consumption), social (participation), economic (affordability) and constructive (infrastructure) in the development or management of social housing projects.

1.2 Problem Statement:

Recently the disparity between income and housing prices has continued to widen in the European region, resulting in lower affordability. At the same time, many countries have seen a decline in the role of the state in the housing sector and an increasing reliance on market forces to meet housing demand. As a result, the housing needs of the poor and vulnerable are often overlooked, increased moreover while facing the covid-19 pandemic situation, showing the importance of adequate and enough housing for the well-being of the population. Achieving the problem of the lack of social housing projects in an actual framework should contain in 3 main components, these are: affordable housing, quality-quantity and new necessities raised in the covid-19 pandemic.

For the first challenge referring to the affordable social house projects, quoting the global director Ms. Farha, "The importance of understanding housing as home and as a social good had raised her concern over constantly rising prices of rental housing, especially across the UNECE region and notably in cities". thus, evidencing the lack of adequate housing governance and regulations through the United Nations governments (UNECE, 2020). Also, through the Covid-19 pandemic, exposed several vulnerabilities respect to social housing, stemming from lack of affordable housing deeply rooted in inequalities that have led disproportionate impacts on migrants, the homeless, and those living in urban slums and informal settlements. Becoming the problem to be solved throughout the sustainable development goals (SDGs), specifically in goal number 11 referring to sustainable cities and communities, it will achieve making cities and human settlements inclusive, safe, resilient, and sustainable.

On the other hand, the second challenge focuses on the relation between the offer and demand of the SHP (quantity) and quality leading to the need to improve it, supported by Statista, where 24% of the worldwide population were living in slums and informal settlements in 2018 (UN-HABITAT, 2018) and by the intergenerational foundation in 2020, "the number of new-build homes being developed in Europe are below the 37m2 minimum national space standards for a one-person, one-bedroom home with a shower". These cramped living conditions are unfortunately likely to have a negative impact on people's mental health and wellbeing. This is a major reason why the improvement of living conditions of slum dwellers was identified as a major target area in the Millennium Declaration, also knowing that the new urban agenda for 2030 is searching to Fulfil their social function to progressively achieving the full realization of

the right to adequate housing as a component of the right to an adequate standard of living, without discrimination.

Finally covid-19 pandemic confines people to their homes, disrupting the fragile social fabric of deprived neighborhoods and citizen's participation options, to ensure a socially cohesive society social housing projects must be in the new trends' technology introductions and active social participation, it has been demonstrated that taking advantages of it privates, publics developers, owners and tenants will have tools to have an active participation unfolding as what is define as energy communities and also lead to an environmental control of their services consumption and maintenance in the future. (Perkins, 2022)

A new approach related to the development of social housing has emerged due to the situation experienced during the pandemic in 2020, which, as already evidenced according to Perkins, this is the technological one, where it can be a key factor to overcome the problems set out above, providing the possibility to promote affordable house with the quality they should have and conscious-participatory community.

1.3 Research question:

How can we assess the development of social housing projects within energy communities engaging stakeholders?

1.4 Objectives:

General:

Create a framework for social housing projects within energy communities by selecting key performance indicators (KPIs) which face affordability, quantity, quality, and an active community participation.

Specifics:

1. Investigate the characteristics and problematics of social housing projects in Europe.
2. Identify the typologies of energy communities in a European and Italian framework.
3. Selection of KPIs align to the 17 sustainable development goals.

2. LITERATURE

2.1 Social Housing

Social housing is a system which provides long-term housing to a group of households specified only by their limited financial resources, by means of a distribution system and subsidies (Lundgren, 2018). To justify this definition, it has been stipulated five key criteria to avoid an ambiguous miss understanding, those are target group, the form of tenure, type of provider, subsidies, and public intervention.

Table 1 5 key criteria of social housing, Source: (Lundgren, 2018)

5 key criteria of social Housing in Europe

Form of tenure	owner-occupied housing	commercial-rented housing	social-rented housing	cooperative housing
Type of provider	State management	non-profit organization	Profit Organization	
Subsides or financial support	below-market priced land	debt guarantees	advantageous loans	investment contributions
Public intervention	regulation and/or linkage to public policies	subsidies	direct provision of social housing through public bodies	

The target group understood as Households in need might be specified as vulnerable households in a weak negotiating position having limited financial resources. The form of tenure, in this case social housing does exist in various forms, in Europe actual figures of ownership as Primus list are owner-occupied housing, commercial-rented housing, social-rented housing and cooperative housing. Type of provider in a general understanding point refers to a non-profit organization or state management, however this is not true in all European countries, for example in the Netherlands social housing is provided by housing associations, which are independent from the state, but need approval of their status under the Housing Act and their responsibilities and other operating conditions are regulated in the Social Rental Sector Management Order. The German system allows both, private and public providers of social housing. Subsides or financial support to European social housing providers come in many

different forms, for example debt guarantees, advantageous loans, investment contributions, below-market priced land, etc. (K. Scanlon, 2014) which are provided by public entities, finally public intervention can come in three main forms: regulation and/or linkage to public policies, subsidies, and direct provision of social housing through public bodies or publicly owned companies.

In Italy the public residential building is divided in three branches, the facilitated building (Edilizia agevolata) where the projects are built by private individuals with a state tax, the conventional building (Edilizia convenzioglata) are built by private entities, following a stipulated convention with the municipality, and the subsidized uilding (Edilizia Sovvenzionata) are built directly by public bodies.

Facilitated housing includes non-luxury accommodation with certain characteristics, intended for end users with certain requirements and built by private entities to which the State has granted contributions. As a rule, the construction of "subsidized" housing takes place thanks to subsidized mortgages secured by a mortgage on the housing or area and by a subsidiary guarantee from the state.

The conventional building Housing under contract includes housing intended for certain less well-off individuals, built by private individuals, with whom the Public Administration has entered into an agreement. It is appropriate to identify two legislative strands: the so-called conventions PEEP (or area plans for economic social housing), governed by art. 35 of Law no. 865 of 1971 and the so-called conventions, in the context of the so-called conventions PEEP, it is necessary to distinguish the agreements concerning the assignment of housing in surface rights and those relating to the assignment of full ownership housing.

Subsidized housing construction is the branch of public housing that deals with housing, always intended for subjects in precarious economic conditions, but built by the State or by public bodies, including IACP (autonomous social housing institutes) and ATER (territorial residential construction companies). Depending on the law governing, subsidized housing can be housing directly assigned to the owner, or housing originally leased with a future sale agreement, or leased with the faculty to purchase the property (full ownership of the accommodation itself). The Ministry of Public Works prepared the draft documents made available to the various bodies.

The 3 Italian housing figures face actual challenges for the development of the SHP, those driven by the necessity to boost the dignity and cohesion of the humankind through new programs and tools, one of them and the most relevant is technology, accompanied by the resilience and participation of the community through big changes such as the pandemic, without losing sight the work of years that tend to give warranties to an outstanding house infrastructure.

Table 2 Social housing categories in Italy, Source: Author

Categories	Subsidized housing (edilizia sovvenzionata)	Facilitated - Assisted Housing (edilizia agevolata)	Conventional - Agreed Housing (edilizia convenzionata)
Group Target	• Housing intended for subjects in precarious economic conditions.	• Housing intended for end users with certain requirements.	• housing intended for certain less well-off individuals.
Developer	• Built by the State or by public bodies, including IACP (autonomous social housing institutes) and ATER (territorial residential construction companies).	• Built by private entities to which the State has granted contributions.	• Built by private individuals, with whom the Public Administration has entered into an agreement.
Characteristics	• housing can be directly assigned to the owner, or housing originally leased with a future sale agreement.	• subsidized mortgages secured by a mortgage on the housing or area and by a subsidiary guarantee from the state.	• conventions PEEP (or area plans for economic social housing) • distinguish the agreements concerning the assignment of housing in surface rights and those relating to the assignment of full ownership housing.

2.1.1 Struggles for adequate Infrastructures

Serbia as a south east European country show up challenges regarding to the pandemic situation in the field of infrastructure, revealing a broaden vision of a different but complementary point of view, making emphasis on the failures of the infrastructure and how the care of them thrives across the urban spaces, understanding this through a concept of infra-commoning notion which generates dynamic, social, and economic reproduction patterns of social organization and it is used to explain how commoning occurs in ante-eviction struggles, widen to include struggles to rewire broken care networks between institutions, households, and individuals. The verb "commoning" implies a shift from a reified understanding of commons as entities to a processual understanding of commoning that encompasses specialties, resistance, relations, knowledge, and everyday experience (Trimikliniotis, 2015).

Also putting into a discussion, the redefining concept of infrastructure, this now taking into consideration not just the classical physical elements like roads, water systems, sewage system but also constitutes the creation of health care, education, childcare, and care for the elderly and for people with disabilities. The basic infrastructure that represents our social organization relapse in the housing infrastructure, in this sense the house is conceived as a socio-material assemblage that is constitutive of care. This basic social infrastructure has been changing over the time and categorize in three main branches, the materiality, market, and governance.

In a situation in which social distancing and stay-at-home orders made access to safe, stable, and affordable housing even more imperative, housing has been one of the most visible realms of anti-social policies. This makes collective acts of solidarity and care more essential than ever, even as such acts are repressed or even criminalized in Serbia. reorganization of housing is more akin to punishment than care. Examples of this include erecting extremely small metal containers (14m2), Sharing a small amount of space may be necessary for economic survival, but it became a hotbed of risk during the COVID-19 pandemic and how the effects therefore are unevenly distributed.

Stay at home orders meant that housing becomes the locus of the peoples, however people mobilized to protect their homes and the homes of others as an essential material condition of care, life-making, and the preservation of life, creating temporary care networks closing gaps created by the pandemic. We posit housing as an essential infrastructure of care considering

rapid privatization and financialization, leading to increased levels of eviction, the revisualization of social housing, and the absence of adequate social care for the urban poor, especially racialized minorities.

Serbia as an active country of the European Union since 2009 shows another face of the European social housing policies and practices for high quality and affordable development of the projects, where the people on one hand can´t afford it and have struggles relative to the legal obligations and institutions, on the other the quality of them does not respond to actual necessities. The need to recognize housing as a form of common infrastructure is a response of the communities to the bad and scarce management policies on the country which is struggling parallel of changing their original socialist model to a neo-liberal one, creating and ending in local people to care for both themselves and others even if they do not comply with the vaguely established legal framework.

2.1.2 For more resilient and healthier communities.

Covid-19 had represented several changes in our way of living, rising several social problematics that are not new, and reached their critical point during the pandemic, mostly in the neighborhoods or communities with more economic, social, and cultural difficulties, this can be supported by different sources like morbidity and mortality, rated in some Europeans countries like Spain, United Kingdom, and in America, referring to USA, reflecting unequal experiences of chronic diseases and the social determinants of health (Bambra, 2020), also people in deprived communities in England and Wales are twice as likely to die compared to those living in non-deprived communities (O'Dowd, 2020) and run a higher risk of hospitalization with COVID-19 (Verhagen, 2020). Other Adverse effects from pandemic are containment measures, including financial insecurity, loss of job or livelihood, social isolation, increased risk of gender-based domestic violence (Douglas, 2020).

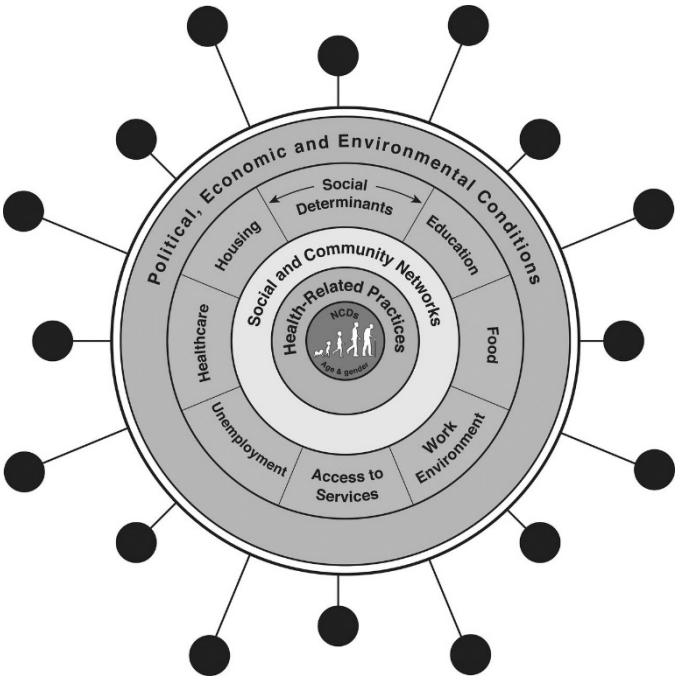

Figure 1 Adverse effects from pandemic, Source: Douglas 2020

This resilient situation or environment are categorize trough the world health organization (Ziglio, 2017) in three levels, individual, community and across a system, and four capacities, adaptive referring to adjust to disturbances and shocks, absorptive as the ability to manage and recover from adverse conditions using available assets, anticipatory also as an ability to reduce disturbance and shocks by proactive action to minimize vulnerability and transformative to develop systems better suited to change uncertain and new conditions (Ziglio, 2017).

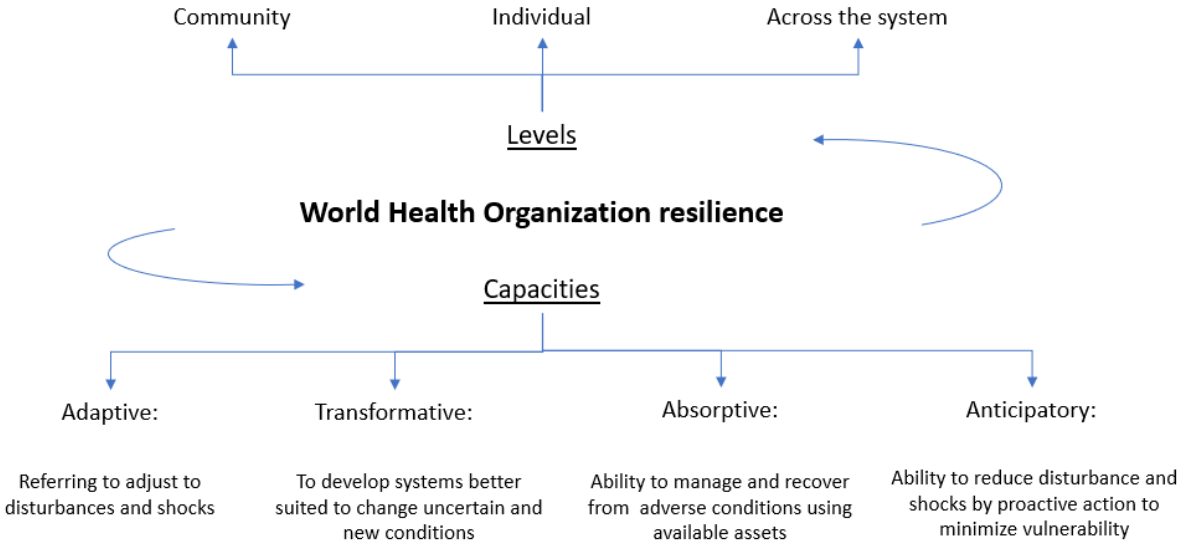

Figure 2 Resilience according to WHO, Source: Ziglio 2017

Communities must improve their ability to face difficulties together, in other words, the active participation of the inhabitants is a key point of getting ahead of what is caused by the pandemic. The active engagement and participation of the community provides access to vulnerable groups, and helps to understand the experiences, assets, needs and problems of the citizens. Lea den broader and her colleagues argue that, to enable a resilient and confident post covid-19 communities, the areas that needs investment encompass a new digital ways of community engagement, transforming and creating initiatives proposed by citizens.

As an example, a study directed towards the populations of Netherlands and UK shows features that indicate how citizens, CBOs (community-based organizations) and formal organizations began to build resilience and community power. The first one is mutualism, there has been an increase in mutual aid groups, where citizens self-organize to support each other and those made vulnerable by the pandemic (UK., 2020). Passing to the neighborhood (physical spaces) which ties being the cornerstone of community action, evolving role of local associations and businesses like bakeries and pubs, those networks also have a function to identify who needs support (Kretzmann, 2018). The central role of CBOs acting as hubs, coordinated volunteers and food supplies (Locality, 2020) changes in patterns of volunteering referring to a significant increase of people interested to be part of. The use of digital media to connect people and to organize activities, leading to a whole new online resource have been created to support collective activities and promote participation and social interaction is healthy in itself (Wageningen, 2020).

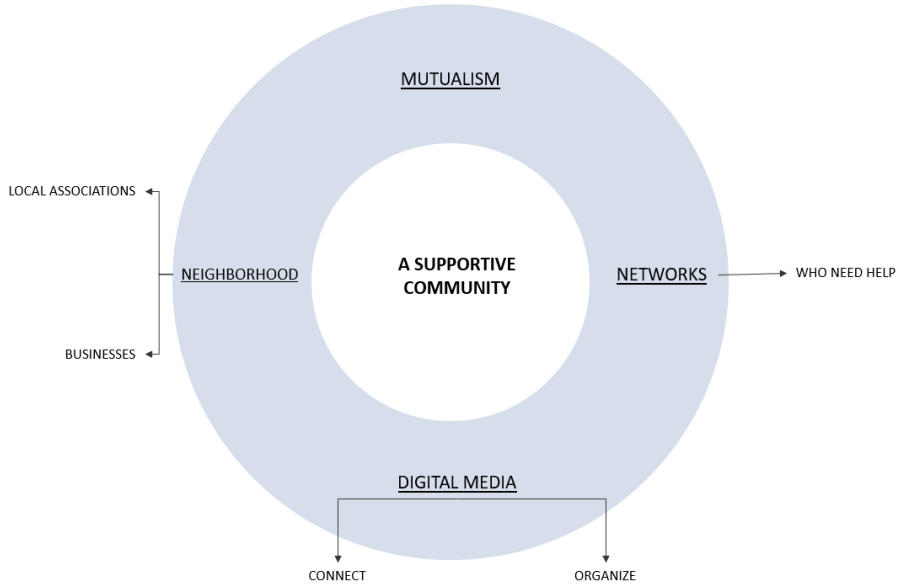

Figure 3 Community based organization (CBOs), Source: UK., Covid-19 Mutual Aid

Based on that, it is reflected on how those community actions can be enabled and supported, particularly in deprived areas where there are major inequalities or where civil society infrastructure is weak, and what is needed for this transformative change to happen. Guaranteeing the forming of long-term partnerships between public services and community-based organizations, giving practical support to volunteers, making sure new digital-ways of connecting are open to everyone, and involving communities in doing research.

2.1.3 A potential to boost the dignity of mankind.

Social integration and cohesion will be achieved through the potential of smart home networks, this system will support a community of residents in social housing to enhance the social sphere for residents, neighborhoods, and the city itself. This housing model solution which will integrate smart home network (SHN) will provide personal services as direct services to improve mental, physical, and social conditions. Personal services where end-users contribute to create the service itself while at the same time facing the problem of vulnerability at urban scale, mainly focusing on resident populations aged between 70 to 80 living alone, single parent families, immigrants and emigrants, non-resident population (students) between 20 and 28.

Until now, technology devices have been mainly driven by the issue of security, while rapid advances in available technologies promise to enable more and more features such as the control of the house services consumptions (electricity, gas).An example in the single dwelling level, there is a technological core device, called the Energy Box (EB) that collects data from the sensor network installed in the home, allowing the control of some devices, and acts as a communication gateway between the home and the aggregator. The end user can interact with the EB via PC or smartphone through appropriate communication interfaces that allow to control and manage the systems inside the home (web-service, app on smartphone).

A project developed by ENEA aims to develop a system of SHN able to monitor energy consumption, the degree of comfort and safety in residential buildings, to be able to transmit them to a higher level where they are analyzed and aggregated to provide a series of feedback to the users. The integration between solutions to solve both, the social aspects and the energy control, by equipping each apartment with a smart sensor system, by providing common areas where concentrate electrical loads (i.e., washing machines, tumble dryers) and finally by

ensuring the provision of innovative services" like common laundries, children's play areas, study areas and a library, to support intergenerational and multicultural approach (Clemente, 2016).

The new approach for technological devices in social houses coming from the post pandemic situation changes the paradigm of the necessity and not the whim of them, since it has been implementing just in security aspects there are not reaching the full potential to actual family's requirements. Thanks to the situation the society went through technological Iots (Internet of things) shown their utility and capacity to build a more fair, equal, and conscious society.

2.2 Energy communities in EU

2.2.1 Community engagement cohesion

Community cohesions have several situations in which it could take place, geography, peers, age, ethnicity, gender interests among others, in which it prevails a sense of belonging, the community come together to address a particular issue, if the issue or interest is resolve the community will disband.

according to the tamarack institute, community engagement is considered as the process of working collaborative with and through groups of people affiliated by geographic proximity, social interest, or similar situations addresses issues affecting the well-being of those involved.

There are several benefits of participating in community engagement such as:

1. Empowering citizens to take responsibilities for the things that are happening in their own community.

2. Encourage community members to address the need that are directly relevant to their neighborhood.

3. Contributes to an enact change in their community rather than passively accepting the circumstances under which they live.

4. Strength community spirit and levels of social inclusion and belonging of its members.

5. Higher quality solutions to community issues are created and more efficient use of the resources.

6. Can inform both policymaking at various levels of government and service planning.

Working with communities represent every time a new challenge, is important to recognize the informal relationships and networks within a local area that determine how residents feel about their community and their neighbors. Therefore, rather than adding additional layers of participation or interaction processes into local civic life, local authorities should seek to map and work with these existing social networks, as well as to provide links, forums, and support to those who do not belong to any such informal networks.

To be efficient and effective the rhetoric that surrounds community cohesion strategies and the working reality of those who deliver these policies on the ground should work together. Often, those who are charged with supporting community cohesion are not the same people who deliver services or public participation activities, and no connection is made between the different strands of work.

Participants saw these divisions between rhetoric, practice, and service delivery as stumbling blocks to progress. There were repeated calls for a more joined-up approach to community cohesion, with cohesion objectives running as a cross-cutting theme through the work of local authorities.

2.2.2 Renewable energy communities

According to the European Union energy community initiative can be expressed as a common sharing of both responsibilities and benefits deriving from the activity of energy production. This not excluding the participation of private or public entities in the different stages of the configuration of the REC, being able to be part of the financing construction implementation maintenance and revenues.

There are two directives that recognizes and categorize this typology of communities, one is the directive 2008/2001, called RED-II which introduces the definition of renewable energy community and the second one the directive 944/2019 which settles the citizen energy

community model. Notwithstanding a wider way of the typologies of REC there is research from Reis Ines FG (Reis, 2021)where it defines 4 main categories for renewable energy communities

Table 3 Categories of REC, Source: (Reis, 2021)

Categories of Renewable energy communities			
non-place-based	Place-based	Single-purpose	Multi-purpose communities
Groups of individuals which: 1. buy into a share of a larger energy project. 2. that is not within the neighborhoods in which they live or work. 3. The ownership of energy equipment and infrastructure is not necessary in such cases.	Members who: 1. gather on a spatial basis in different context dimensions, ranging from condominiums blocks of flats, tower blocks or skyscrapers, to city districts existence 2. of local physical or social peculiarities, and the density of settlement in shared places. 3. recurrent shared ownership of energy infrastructure and equipment “in situ”.	1. Highly specific and limited objectives give form and meaning to the community. 2. Individuals shares system of rules and relationships solely for the purposes of managing energy production and consumption or purchase.	1. Share other types of goods and services. 2. The presence of multiple goals is a factor which implies greater organizational and operational complexity.

The first one corresponds to non-place-based communities, those are groups of individuals which simply buy into a share of a larger energy project that is not within the neighborhoods in which they live or work. The ownership of energy equipment and infrastructure is not necessary in such cases. The non-place-based energy communities have analogies with certain traditional purchase groups That is, non-correlated form a consortium to obtain price advantages for certain goods and services.

The second one Place-based communities made up of members who gather on a spatial basis in different context dimensions, ranging from condominiums blocks of flats, tower blocks or skyscrapers, to city districts existence of local physical or social peculiarities, and the density of settlement in shared places. recurrent shared ownership of energy infrastructure and equipment “in situ”.

The third one Single-purpose communities, highly specific and limited objectives give form and meaning to the community. Individuals shares system of rules and relationships solely for the purposes of managing energy production and consumption or purchase.

Finally, the Multi-purpose communities share other types of goods and services. Clearly, the presence of multiple goals is a factor which implies greater organizational and operational complexity.

Moreover, the design of an energy community in terms of technology, structure and organization constitutes a search or optimization problems that aims to maximize the utility of the energy community while being subject to local technical and framework constraints.

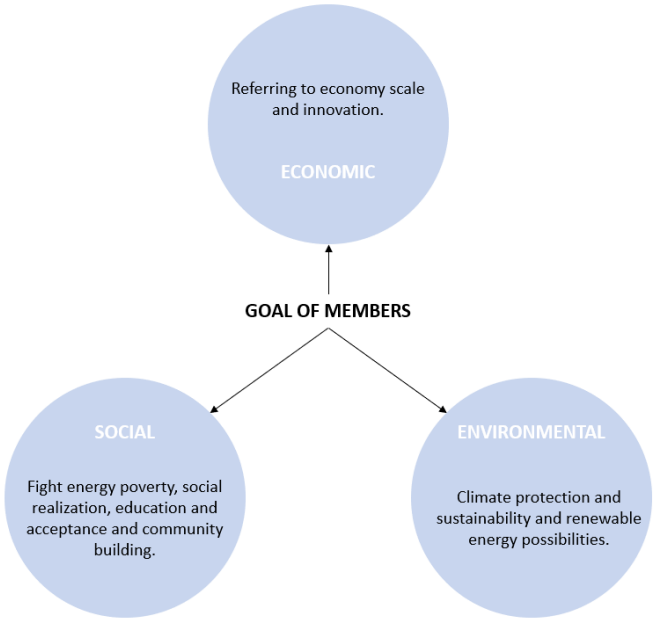

Figure 4 Renewable energy community goals, Source RED II

Resulting in the main goals for each stakeholder, on one hand a wide range of proposal Policy makers, proposal which constitute energy strategies, Policy goals and Economic development, also community members with an economic, environmental, and social approach, Finally, where DSO, supplier and aggregators take advantage of flexibility, could reduce uncertainty, and postpone investments.

On the other hand, in a lower scale the goal of the members is divided in three parts, economic referring to economy scale and innovation, then the environmental approach referring to climate protection and sustainability and renewable energy possibilities and the third one constrains about social issues like fight energy poverty, social realization, education and acceptance and community building.

As a complement, the goals of the external stakeholders are the resolution of conflicts between energy communities and developers (trade-offs), energy security, energy affordability and environmental sustainability.

Regarding to business models for REC will work in 4 main components: power production from the photovoltaic unit, electrical consumption for loads, behavior of BESS (battery energy storage system) storage and exchange of power with the electrical grid.

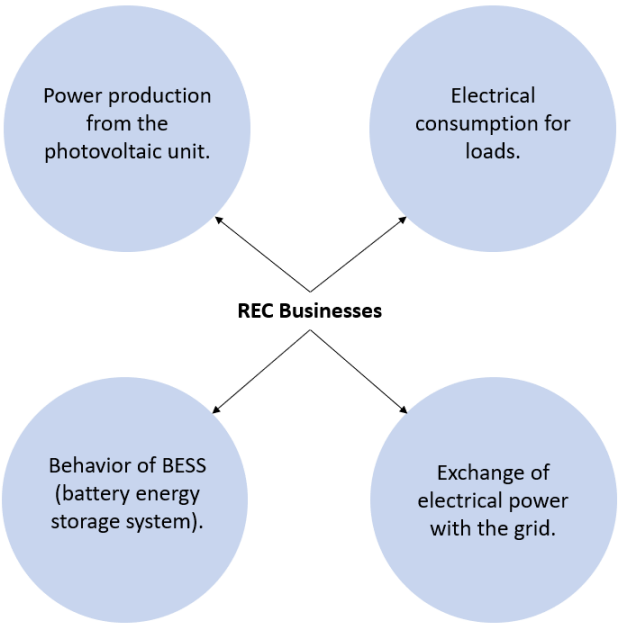

Figure 5 Renewable energy community businesses, Source RED II

With that basis 3 models could take place, in the first scenario the renewable energy community is taking to their self all the capital expenditure for photovoltaic and battery while they assume all the costs of implementation, the second one, an independent company is acting as a technological partner acquiring and managing the assets sharing with the community the revenues and costs and the last one where the company and the community share the costs of the expenditure of the photovoltaic grid and sharing the revenues.

Table 4 Businesses scenarios for REC, source: RED II

Businesses Scenarios		
Community	Company	Hybrid
• the renewable energy community is taking to their self all the capital expenditure for photovoltaic and battery while they assume all the costs of implementation.	• an independent company is acting as a technological partner acquiring and managing the assets sharing with the community the revenues and costs.	• one where the company and the community share the costs of the expenditure of the photovoltaic grid and sharing the revenues.

Incentives for REC are granted from the ministry of economic progress in which the article 42-bis and regulated by area with resolution no. 318/2020 describes the incentive tariff for the remuneration of renewable source plants included in the configurations for collective self-consumption from renewable sources and in renewable energy communities. Some of them are Incentive on shared energy: 110e/Mwah as a feed- in premium if the energy sharing occurs within a REC and granted for 20 years, Tax credit on 50% of the capex (infrastructure for the pv) and Grid cost reimbursement in the measure of 8.22 euros/Mwah again conceded for 20 years.

2.2.2.1 Magliano Alpi, Italy

Magliano Alpi is a commune of 2200 inhabitants in Italy's Piedmont region, where the public administration in 2020 decided to create the first renewable energy community with the help of a guideline document provided by the energy center of the Politecnico di Torino University.

Installing 1 MGW of photovoltaic system meaning a saving of 1,3 million euros, at the same time make this intervention for small and medium interventions will the reduce of cost of energy and reduce of volatility. The energy community is stablished by the city hall and the buildings that surrounds it, all being producers and consumers, meaning this that are connected to the same energy transformation.

Being the first community lead the opportunity to get data and experience on small but active community, enhancing the importance of simulating, working with GIS to understand effect on the medium to long time on making wider renewable energy communities.

Nowadays the intense consumption of energy increase levels of uncertainty and variability in the power system issues to be tackled with new control solutions, these could be expensive if implemented at a high, centralized level, for these reasons decentralize problem of energy volatility, making sure that the demand profile is met as close as possible by generation al a local level.

The community have seen the economic and environmental advantages and have decided to be part of the community, installing photovoltaic panels in their roofs, and become prosumers. (Magliano Alpi, 2020)

2.2.3 Citizen energy Community

Citizen energy community is defined through the directive 944 given by the European union in 2019 in which they define it as a voluntary legal not-for-profit entity established at a local level for the purpose of energy "generation, distribution, supply, consumption, aggregation, storage", etc. CEC are a category of cooperation of citizens or local actors that should be subject to recognition and protection under Union law.

The directive breaks down each of the responsibilities of entities in where the stakeholders are involved, on the hand of the legal entities, understood them as a based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises. They should provide environmental, economic, or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits.

The purpose is the engagement of the community to include renewable sources to an effectively distribution, supply, consumption, aggregation, storage, and efficiency services for electric vehicles or provide other energy services to its members or shareholders.

On the hand of the regulatory framework the members states should ensure the participation of a citizen energy community in an open and voluntary way, with the possibility to leave the community without any struggle, however the shareholders don't lose their obligations as household or active costumers. Also, the ensurement of a fair compensation as assessed by the regulatory authority, relevant distribution system operators cooperate with citizen energy communities to facilitate electricity transfers within citizen energy communities.

Citizen energy communities are treated in a non-discriminatory and proportionate manner about their activities, rights and obligations as final customers, producers, suppliers, distribution system operators or market participants engaged in aggregation. They are financially responsible for the imbalances they cause in the electricity system; to that extent they shall be balance responsible parties or shall delegate their balancing responsibility in accordance with Article 5 of Regulation 943 of the European union of 2019.

The final obligations of the members states is to grant to their citizens the appropriate network charges at the connection points between their network and the distribution network outside the citizen energy community and that such network charges account separately for the electricity fed into the distribution network and the electricity consumed from the distribution

network outside the citizen energy community, including an equal treatment to the customers who wants to be part or not to the network system.

CEC have three main objectives, produce, consume, and sell clean energy through an active participation of the community and public or private entities in which it will stablish the counting, negotiation and communication of the energy produced given at the end social cohesion, where the costumers that are also the producer will be part of a pioneer to a green transition.

2.2.3.1 SOM energy, Spain

Cooperativism helps to generate new opportunities, renewable and citizen energy transition, which is why Som Energia, a non-profit cooperative that produces and provides energy in Spain in a renewable way, is made up of more than 63,000 people around the country is becoming more relevant in the recent years.

Although it is a non-profit figure, it does not mean that it does not have an economic activity from which it benefits, since the profits are reinvested in the cooperative itself.

To be part of the cooperative, a registration of 100 euros is necessary, which is reimbursable if you decide to leave the cooperative, this participation gives you the right to have a voice and a vote. In addition, the possibility of investing in renewable plants is offered, on the one hand, we have the commercialization and on the other the possibility of participating in renewable plants.

Currently, the cooperative has put the photovoltaic plant into operation in Lora del Río Seville, Spain, its cost has exceeded one million euros and it has been financed with the voluntary contributions of 1,600 members. The project has the capacity to supply 1,060 families, which is linked to daily solar production, where it will be higher during the day and will decrease at night.

According to a SOM energy partner, currently in Spain the production of renewable energy has a participation of 42% vs. 48% of production from fossil fuels.

The cooperative provides knowledge to members and families who create connections through courses provided by the cooperative itself where it aims to raise awareness in society to have responsible and reasonable consumption, it is the common denominator of the community because it is a fundamental part of change, where it is not only the change in the production of energy but also the habits of its consumption. (ENERGIA, 2021)

2.2.4 Schemi di autoconsumo collective

Italy as a member of the European Union have to introduce the directive RED-II in their legal framework, the translation and application of the directive is the "collective self-consumption schemes" as a "final customers" who, operating on their own sites located within defined borders or, if permitted by a Member State, elsewhere, it produces renewable electricity for its own consumption and may store or sell self-produced renewable. Such activities do not constitute the main business or professional activity. Therefore, the directive defines renewable energy self-consumers acting collectively as a group of at least two renewable energy self-consumers acting collectively and located in the same building or condominium. This mechanism is introduced by RED II with the aim of increasing efficiency in the production and consumption of energy in households and helping to combat energy poverty by reducing supply rates not only for people who live in single-family homes, but even for who stay in a condominium.

The general characteristics are subdivided in production of renewable energy, including for their own consumption; to store and sell surplus renewable electricity production, including through renewable electricity purchase and sale agreements, electricity providers, and peer-to-peer exchange agreements; The installation and management of electrical energy storage systems combined with renewable electrical energy generation plants for self-consumption will not be a subject to double charging, including network fees for the electrical energy stored that remains available; The public or private entities that provides the electrical service will maintain the rights and obligations of the final consumers and the community will receive remuneration, where appropriate also through support schemes, for self-produced renewable electricity that they inject into the grid, which corresponds to the market value of that electricity and may take into account its long-term value to the grid.

According to the Law 8 of 2020 it allows to a quickly start for some energy experiments, creating new plants powered by renewable sources with modest power but strongly integrated at the urban or territorial level. participants in a Collective Self-consumption scheme are in the same building or condominium, the production plants and intake points belonging to a community are connected to the low-voltage electrical network, through the same MV/LV transformation substation (secondary substation); the production plants, from renewable sources, came into operation after March 1, 2020, and have a total power not exceeding 200 kW.

In accordance with the normative regulation there is the virtual and the physical possibility, on one hand the physical self-consumption scheme, which foresees a direct private connection

between the generation plant(s) and domestic/common users, with a single access point (POD - Point Of Delivery) to the public network, this model allows to the tenants to have an internal network of private condominium with a single connection to the public network through a single fiscal meter, through which is possible to have a single contract of electricity supply for common and domestic users of the condominium.

On the other hand, "Virtual" self-consumption scheme (also called "commercial" or "extended perimeter") that contemplates the use of the public network for the exchange of energy between generation and consumption units, in this case the public network ended at the point of delivery (POD) of individual end users (where a fiscal meter is installed), as a result each end customer is free to choose their own energy provider and opt out of the scheme at any time.

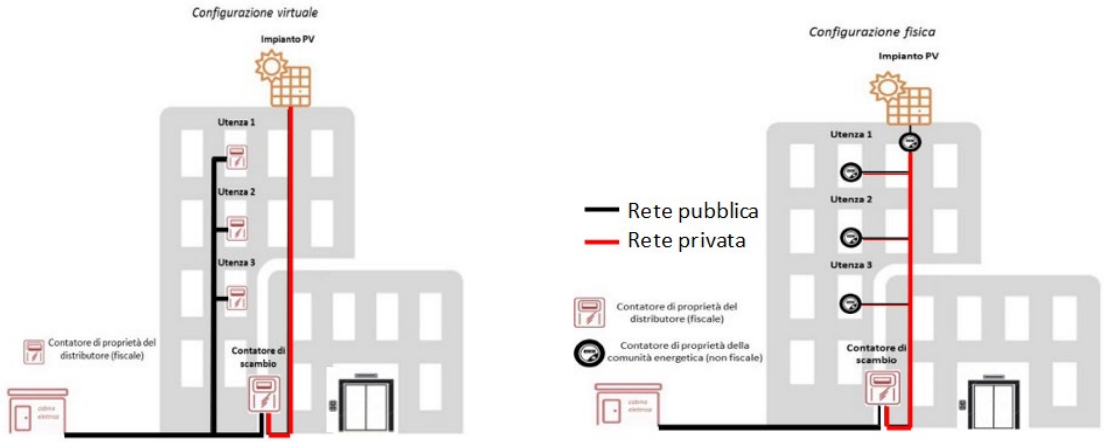

Figure 6 Virtual and physical configurations source: https://dossierse.it/wp-content/uploads/2020/11/Gli-schemi-di-Autoconsumo-Collettivo-e-le-Comunita-dell-Energia.pdf

Picking up again the Law 8 of 2020, the regulation model identified by ARERA (Autorità di Regolazione per Energia Reti e Ambiente), and the incentive system defined by the MISE (ministerio dello sviluppo economico) decree the current tax deduction system, it can be stated that the participants in the Collective Self-consumption schemes and the CERs will be recognized the return of some components previously defined by ARERA according to a logic of use of the reflective network of costs, which amount to approximately €10/MWh for collective self-consumption and €8/MWh for CERs on shared energy, also an incentive for shared energy equal to €100/MWh for collective self-consumption and €110/MWh for CERs and the remuneration of the energy injected into the network at the Hourly Zone Price, which could be assumed to be around €50.

Every electrical system must be able to guarantee instant by instant that the energy required by all consumers (families and companies) is always balanced by the energy produced by power plants.

The regulatory authority for energy networks and the environment expends two resolutions the Resolution 300 of 2017, and the resolution 422 of 2018 which present the regulatory reference point for the experimentation of new resources and new dispatching services, through the establishment of pilot projects. Which are based on the concept of "virtual" unit.

1) Virtual units enabled for consumption (UVAC) characterized by the presence of consumption units only.

2) Enabled virtual production units (UVAP), characterized by the presence of only non-relevant production units, including storage systems.

3) Mixed enabled virtual units (UVAM), characterized by the presence of both non-relevant production units and consumption units.

4) Relevant production units integrated with storage systems (UPI).

The Mixed Enabled Virtual Units (UVAM), which as the definition of the Arera, UVAM is characterized by the presence of production units (significant and not relevant), storage systems and consumption units, also included in dispatching contracts. In Italy can be concretely defined as an aggregate of consumption units, production units and storage systems that are points connected to the network at any voltage level.

The system requires to be equipped with a "Peripheral Monitoring Unit" (UPM) and a meter at least per hour. Furthermore, it must not be qualified for the Capacity Market. It should be noted that the minimum modulation threshold of the UVAM aggregate is equal to 1 MW (lowest threshold at European level).

The incentives referring to the transition or implementation UVAM in communities are two, the ordinary remuneration linked to the activated energy (€ / MWh) and the Remuneration of availability of the resource with a fixed fee, calculated in € / MW.

The perspectives of the UVAM model in Italy according to Terna, in June 2019 more than 120 UVAMs were qualified with a power of about 830 MW. More than 83% enabled with the fixed-term contract that remunerates the availability of the resource.

UVAM is one of the most interesting mechanisms for rebalancing the electricity system in view of the 2030 goals.

The decarbonization of the national energy system and the consequent transition to a mix more based on the contribution of renewable sources, wind and photovoltaic above all, is undoubtedly an important objective from an environmental and economic point of view, as well as being substantially imposed by the directives and by the European.

The increase in the input of energy from renewable sources inevitably reduces the contribution of production from conventional plants, which in recent years have decreased in number (the closure of all coal plants is scheduled for 2025) however, they tend to produce less energy. The challenge relapse in new generation renewable sources is non-programmable, that is, they are unable to generate electricity 24 hours a day.

2.2.4.1 EURIX project, RSE

EURIX has won the first place among 24 proposals, at national level, in the ranking drawn up by RSE SpA, for the implementation of pilot projects of Collective Self-Consumption in Energy Communities.

The target of the project, called “Condomini Torino”, is to implement Collective Self-consumption in an Energy Community. The project aggregates about 50 apartments that virtually consume renewable energy, resulting from the installation of a photovoltaic system on the roof of a condominium in the center of Turin.

Artificial Intelligence algorithms are adopted to optimize the energy distribution in the Community. Moreover, Blockchain infrastructure, based on Ethereum, is used for transaction reporting. The currency trading is the Token ENT EURIX Energy Token, specially coined for the market in the Energy Communities.

The collaboration with RSE has two further aims. On the one hand, it is proposed to identify possible regulatory and administrative obstacles of this intervention; on the other hand, it is intended to replicate this kind of self-consumption community also in other residential complexes and apartment buildings, to achieve significant energy savings and contribute to reducing pollution in cities. (savings, 2022)

Table 5 Comparison between European vs Italian framework, Source: Author

	Stakeholder	Definition	Year	Framework/Law	Objectives	Benefits	Examples
EUROPEAN LEVEL	**Renewable energy communities (REC)**	• Energy community initiative can be expressed as a common sharing of both responsibilities and benefits deriving from the activity of energy production.	• 2018	• directive 2008/2001 called red-II introduces the definition of renewable energy community • 42-bis and regulated by area with resolution no. 318/2020	• Maximize the utility of the energy community while being subject to local technical and framework constraints.	1. Incentive on shared energy: 110e/Mwh as a feed- in premium if the energy sharing occurs within a REC and granted for 20 years 2. Economic value of the energy injected in the grid value at the hourly market price of electrical energy 3. Tax credit on 50% of the capex (infrastructure for the pv). 4. Grid cost reimbursement in the measure of 8.22 euros/Mwh again conceded for 20 years	Magliano Alpi, Italy https://www.youtube.com/watch?v=RkPe9c--T98&ab_channel=EUScienceHub-JointResearchCentre
	Citizen energy community (CEC)	• is a voluntary legal not-for-profit entity established at a local level for the purpose of energy "generation,... distribution, supply, consumption, aggregation, storage", etc.	• 2019	• Directive 944/2019 common rules for the internal market for electricity	• Engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency to provide energy services to its members.		SOM ENERGIA, Spain https://www.youtube.com/watch?v=WksBgQHR-QE&ab_channel=TierrayMar%26EspacioProtegidoCanalSur
ITALIAN LEVEL	**Schemi di autoconsumo collettivo**	• renewable energy self-consumer" as a "**final customer** who, operating on their own sites located within defined borders.	• 2020	• Law 8/2020 allows you to quickly start some experiments, at the urban or territorial level. • 42-bis and regulated by area with resolution no. 318/2020	• Allow the increase of energetic efficiency of the homes and help to fight the energetic poverty through the reduction of the tariffs of consumption and supply.	1. the components to be returned amount to approximately €10/MWh for shared energy for Collective Self-consumption schemes 2. €8/MWh for energy shared internally.	Proposal: RSE/ project by EURIX(is a consulting company whose main business area is dedicated to the application of new technologies to energy and environmental issues. The condominium object of the proposal is spread over five internal staircases (A, B, C, D, E) and over six floors, as well as the ground floor and two underground floors. For each staircase there are two residential units for each floor above ground (in total about fifty apartments

2.3 Examples of social housing projects within energy communities.

2.3.1 Place: Brixton, London, United Kingdom

Brixton Energy has given social tenants in three different buildings on the Loughborough and Roupell Park housing estates in the Brixton area of London the option to buy into a renewable energy project, which uses solar panels placed on the roof of their own building. It is estimated that the Styles Gardens project saves 16 tons of CO2 every year by displacing electricity generated by coal and gas power stations.

EDF Energy's Research & Development department has launched Project 'CommUNITY' with Repowering London and UCL's Energy Institute, which aims to increase residents' consumption of local low-carbon energy while reducing their overall costs. Project 'CommUNITY' will enable Brixton residents at Elmore House to access electricity generated from a solar PV system on the block's roof, store it in a battery and trade with one another (peer-to-peer) using blockchain technology.

The platform, managed via an app, allows residents in urban areas to source their energy from local renewables and either use their own allocation of energy or trade it with their neighbors. Under current regulations, customers cannot buy from, or sell to, other consumers but delivery of the project has been made possible as part of Ofgem's 'Innovation Link', which allows the consortium to work outside the current regulatory framework. (edfenergy, 2021)

Figure 7 Brixton energy project. Source: edf energy

2.3.2 Place: village of Lugaggia, Switzerland

It is a community set-up that aims at onboarding house owners and the kindergarten around them to a smart grid. Will achieve the reduction of grid issues, in terms of unbalances encountered in the distribution grid and the accompanying tariffs and taxes. Grids have been handled by this Lugaggia innovation community (LIC). Starting from creating the self-consumption community (SCC), LIC meets the entire community's pertinent energy needs.

The objectives of this project include:

- checking how acceptable the self-consumption communities would be to the community stakeholders
- making use of blockchain to decentralize the management of bills
- evaluating the needs and requirements of the practical LIC
- accessing the potential for local flexibility
- technically observing the effect of flexibility and how it can be exploited.

LIC's resources consist of homes powered by solar panels and their installations (heat pumps and heaters). They are all first centralized using the OptiFlex-Innosuisse (a product by Optimatik, a Swiss Smart Grid solution provider) solution. This is by integrating all outlets in one grid and making use of a district battery. (power, 2020)

Figure 8 Village of Lugaggia. Source: Hive project

2.3.3 Place: Toulon Provence Méditerranée, France

The project seems to enable consumption shift to better periods for the grid and/or the renewables, while using renewable solar energy (PV) helping flexible consumers to reduce their bill. While optimizing services like heaters and water heaters consumption based on LEC production/dynamic tariff and simulating the impact of flexibility provided to the grid, on top of tariff optimization.

Main goals:

- Maximize the potential of renewable energy.
- Reduce the environmental impact of energy consumption.
- Reduce the energy consumption of the customer.

Until now the project has been working in the installation of the EV charges, the emitter radio linky (ERL) which receive the data from the smart meter in real time, it remains the definition and assign who will take care of the energy community, develop the strategy for recruitment, test continuous data exchange, delivery and installation of appliances and analysis of the results

The risks or challenges are in involving enough participants to conclude on data and finding a legal entity to whom the community will be assigned

Figure 9 French pilot. Source: Interconnect project

2.4 Requirements for an active community participation.

2.4.1 Built-up Sphere

Understanding the basic request for permanent supportive housing (PSH) there is a case study which takes into consideration the construction of housing focusing on the permanent supportive housing, it is a building called the star apartments, its design foster the community through shared spaces, kitchen, garden, and media area. This project tries to understand the extent to which architecture-in-use can enhance social interaction and sense of community, as well as the factors that inhibit interaction and sense of community for people living in PSH programs.

The benefits of PSH starts with savings in health care costs for people who are disabled, sick and mentally ill, also it is an effective intervention for people who suffer poverty and isolation, must of them homeless adults, finally the initiative has shown the reduction of public cost related to the overall care framework, as providing housing and services is cheaper than just provide services. However, the PSH project are not excluded to be well located to general services such as entertainment, food, and health, it still has requirements to be considered a successful project in terms of community acceptance.

In architectural terms what is more relevant are those spaces which people could gather with others, are the ones to give the possibility to create and active community, those common spaces are studied to determine their contribution but also the possibility of detracting it if it is not correctly developed.

The evidenced experience reflected on community that shared spaces can be, in both, positive and negative ways, influenced by how the space is used, how the space is structured and how they identified with the social context. The garden, as an example, manifests a positive interaction, making the inhabitants of the project proud of themselves to be able to produce what they eat, or the satisfaction of creating a pleasant environment for them. It gives value of hard work/ getting dirty, the importance of learn and socialize, creating a sense of a unity home.

Identify how people could have different approach in the way of participation and making community can inform the development of housing projects, the design of activities, and the way case managers or resident coordinators engage and encourage and active and health community. It is possible also to propose and design and active community in the other sense, in which the developers identify the importance of each space an consider them as an opportunity to have encounters with others, classify them in active interaction or passive ones.

2.4.2 Social Sphere – Tenants participation

Recently the position of tenants in their relation to the landlord-manger have been come stronger, until now tenants were marginalized or even excluded to the community or housing activities, concerns, proposals, among others. However, the situation has changed, and they have switch positions, where the tenant is now a customer, the council flat has become a market commodity while the services have become a free market service. These new roles approach has brought improvements in the field of management such as, lower maintenance and renovation costs, an increase in the functionality of a housing area, increased satisfaction of residents, higher care to the cleanliness of the residential units and a reduction of the non-occupied flats as well a shorter time taken to rent them again.

A complementary notion for the social housing management involvement is the social economy, it is related with the "participatory democracy of tenants" this idea derives from the traditional theory of democracy, which assumes that every citizen has a right to express their opinions and have the possibility to be part in de decisions – making, in this case, at their local scale. In other words, citizen participation means the activity of parties involved in the preparation of plans and procedures of the implementation of the set policies to create a new, better reality (KWIATKOWSKI 2003, p. 8).

According to Arnstein participation is a precondition of citizen power, this participation has been divided in eight levels. The first one, called manipulation and the second one identified as therapy, are the section of non-participation, this mean that the population is just inform of the decisions other have taken for basic issues. In the next section defined as tokenism, which contains the level of informing, consulting, and placation, allows people to receive deeper information, have the possibility of consulting projects, listen to others opinion, and expresses their owns, however they don't have full decision-making powers. The final section is citizen

control, containing the levels of partnership, delegation and citizen control, those levels are characterized by have an important influence on the strategic decisions.
The role of tenants in social housing management systems relapse in the better adjustment of services to customers' needs and preferences, and in the improved efficiency of management. According to L. Cairncross there are three types of tenants' participation, been the first one the lower level or the traditional one in which tenant don't get engagement in the management, the second one identified as consumer model in which the tenants are the best source of information about quality of service, tenants are treated as a customer of commercial enterprises and should receive services of required quality. The last one called citizen model is based on the massive and intensive participation in management activity through dialogue and consultation.

If the role of tenants is to be increased, a long-term and multi-layer implementation plan is needed. It should be based on the establishment of: the foundations for the education of civil society, including: the foundations for the education on the joint management of social housing stock, the launch of a system promoting successful examples - models of cooperation in social housing stock management - in the form of, for example, special programs in mass-media, the development of research into models of joint management of social housing stock, and promoting good solutions in this area, developed in economies with advanced social housing systems. (Suszyńska, 2015)

2.4.3 Political Sphere - social Housing Practices

To propose adequate policies for the development of affordable housing, it is essential to understand the role of the parties involved, their interests, demands and needs. In this case, two large groups are identified, the developers and the inhabitants, who later formed a community. Both groups must have tools enabled to be able to exercise the right to take an active part in design, development, and maintenance project decisions.

Involved the community in the creation of the project will avoid the problem of making generic blocks as an answer to be the most efficient, effective, and affordable solution in economic aspects, this solution born in the 60`as an optimistic, utopian, equalitarian and open environment which contribute to the idea of user participation in the design space and decision-making processes by influencing the design. Another similar strategy has been proposed, like

the British architect john turner who introduce the concept that advocated the production of residential settlements for the low-income groups should be left up to the user. (Turner, 1989)

On another hand The Dutch architect and theoretician John Habraken is known for his work on user participation. Habraken notes that user involvement allows the designer to better understand the society; therefore, making their production more effective and dynamic, and allows the architect to master the issue. (Hamdi, 1991)

The support and infill system are defined according to two aspects. The support meant the permanent part of a building or its skeleton that was provided to the occupant by the builder or the architect. The infill part was the parts under the individual control of the occupants, such as partitions, kitchen, and bathrooms, which are defined by the occupants according to their changing requirements or preferences by the cyclical need for technical upgrades or by changes in the building structure. (Moshaver, 2016)

The well-known system recommendations for user participation in low-cost housing design are listed firstly an open building approach or support and infill approach, which is associated with John Habraken, secondly the site-and-services system, which is recommended by the World Bank based on self-help housing discourse that is often associated in the literature with John Turner, and third an incremental housing strategy based on site-and-services/core house projects.

However, the projects have been criticized the standard mass housing that was designed by architects and built by governmental agencies for low-income groups, because they were expensive for these groups and not flexible or adaptable to respond to different living demands and needs, some examples are projects in Latin American countries such as Chile, Peru, and Mexico.

As a response there is a method in which experts had to learn to design with as opposed to or for residents, who themselves had to learn how to be clients being a midpoint of interests, both for the quality of housing and technical and / or development requirements.

3. METHODOLOGY:

Following the general objective, for creation of a general key performance indicator framework, is necessary to pass through 3 main steps, starting from the identification of the problematics, being those old (quantity and quality) or new ones (covid-19),secondly the stakeholders from community to developers, and finally with the support of entities, projects or documents is possible to select key performance indicators that are already measuring efficiency of the projects, for social housing within energy communities we can take those and apply them through two different cases, the first one in a direct way, where it is not necessary to change the scope or another when the indicator could be modify to respond to the specific framework in which we are working on.

The next step is to compare the vision through an involvement tool (questionary) between community, private company (profit) and research entity (non-profit), to provide a clear, concrete, and hierarchical KPIs framework for future projects.

Table 6 Methodology, Source: Author

1 **Formulation**	**steps**	Social housing Typologies	Energy Community Typologies	Examples of SH and EC are together
	methods	Literature review	Literature review	Projects
2 **KPIs selection**	**steps**	Pre-selection	feedback	Final Selection
	methods	SDGS, CESBA, ISO, Interconnect, RSE	Community questionary	Hierarchy between the indicators
3 **Recommendations**	**steps**	Comparison with a research entity And private company		Recommendations
	methods	Questionary		

3.1 Preselection of the Key performance indicators

The pre-selection of the key performance indicators will follow 5 conditions to be take into consideration, such as: relevance, meaning that all indicators should have a significant importance for the evaluation and serve for reach the objectives of the community. Availability referring to the available information (data) for the complete and correct measuring of the indicators. Measurability, All the indicators must be capable of measurement. Reliability, providing a definition and calculation method which should be clear to avoid different interpretations. Last one they must be familiar, easy to be understood by the inhabitants/ community.

On the other hand, the Key performance indicators are dived in 5 main groups which correspond to the sustainable development goals, as key point for the development of social housing projects and energy communities' projects, those are:

Social and cultural which measures metrics that reflect social communities' performance and prove social's ROI for a project. Ensure its social strategy connecting with the target audience and the project while showing the achieving of its objectives. Also tracking KPIs makes a reliable way to prove to internal and external entities that strategies are working.

Technological strategies and devices that are part of a project which helps the developer, community, and stakeholders. On one hand could propose an efficient project and on the other will follow the possibility to track and measures in a precise way (time and quantity) the consumption of services such as the water, light and gas.

Environmental, since the humans' activity have put in risk the availability of naturals resources, including those that are essential to develop infrastructure projects, the necessity to reduce, reuse and recycle is a strategy to improve over the years.

Constructive, considering the projects as a guarantee of confidence, durability, and well-being. Developers have the responsibility to design and built projects which follows a high demand including high-quality conditions live, where they are aware of social, economic, and environmental constrains.

Economic where communities, organizations and institutions that currently exist in a common project will provide an economic expenditure knowing the reliability of each project.

The final consideration is supporting the proposal with 5 different sources of information, those are the sustainable development goals being a plan of action to shift the world onto a sustainable and resilient path (nations, s.f.), CESBA-MED is a program which promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach (fund, 2016), ISO 37120 of 2018 as an independent non-governmental international organization that brings together experts to share knowledge and develop voluntary, consensus-based, market relevant international standards that support innovation and provide solutions to global challenges. Lastly Interconnect project focus on the development and demonstration of advanced solutions for connecting and covering digital homes and buildings with the electricity sector and scientific papers as a supportive source of new tendencies for the social housing projects and renewable energy communities.

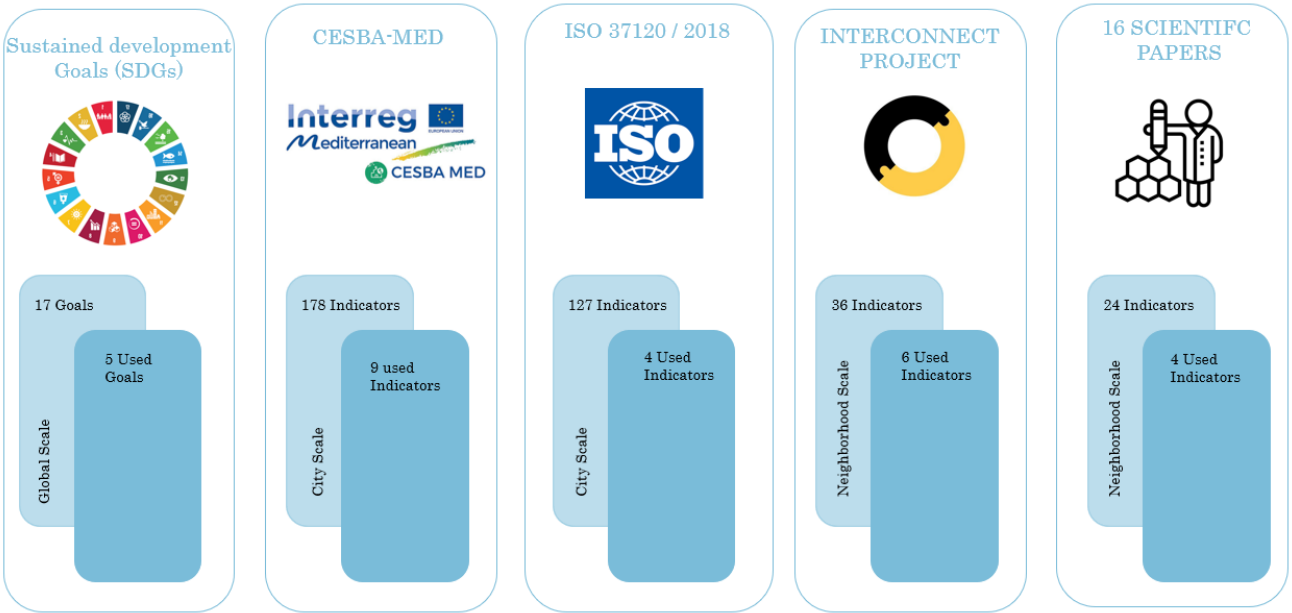

Figure 10 Projects, plans, and papers for KPIs selection, Source: Author

Summing-up the identification of the problematics in the European and Italian context are seven, starting for the old ones, related to the affordability, quality, quantity, inclusive followed by the new ones of the lack of energy efficiency, social distancing and participation options, those problematics are linked with the sustainable development goals plan, more focus on the goals number 7 (affordable and clean energy), 9(industry, innovation and infrastructure), 10 (reduced inequalities), 11 (sustainable cities and communities) and 13 (climate action), likewise are linked to the 5 main categories which classifies the key performance indicators.

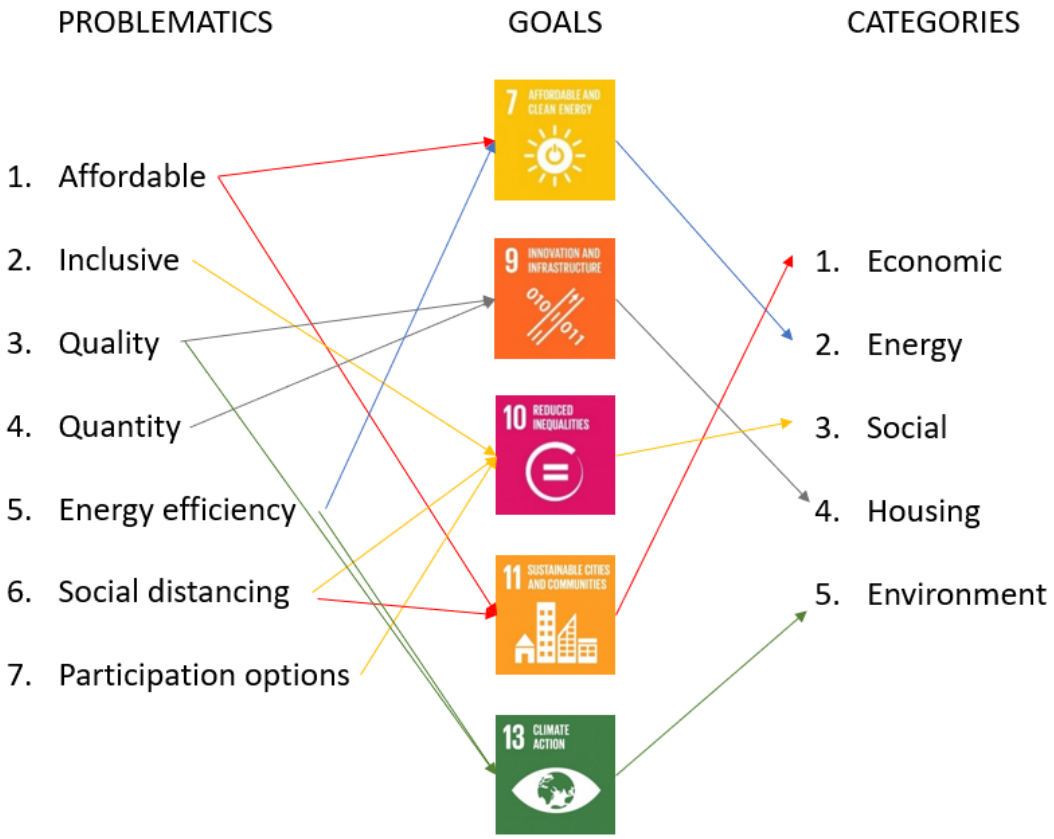

Figure 11 Relations between problems, goals, categories, and indicators, Source: Author

KPI 1

AVERAGE HOUSEHOLD INCOME

INTENT:

Household income measures the combined incomes of the people in a particular household. An average of household income in a city can indicate the monetary well-being of residents within the city.

DATA REQUIREMENT:

Income received in a year/ # of households in the project	UNIT: $

SOURCE:

ISO

CATEGORY:

ECONOMY

KPI 2

AFFORDABILITY OF HOUSING PROPERTY

INTENT

refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.

DATA REQUIREMENT

Residential income measures	UNIT: $

SOURCE

CESBA – OECD

CATEGORY

ECONOMY

KPI 3

AFFORDABILITY OF HOUSING RENTAL

INTENT

refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.

DATA REQUIREMENT

Residential income measures	UNIT: $

SOURCE

CESBA - OECD

CATEGORY

ECONOMY

KPI 4

TOTAL INVESTMENTS

INTENT

The KPI is defined as the number of cumulated payments relevant to the energy aspects of the systems (CAPEX).

DATA REQUIREMENT

Unit prices of all the project development + installation + management/ total floor area of the project.	UNIT: euro/m2, euro (total)

SOURCE

LITERATURE

CATEGORY

ECONOMY

KPI 5

TOTAL ANNUAL COSTS

INTENT

The total annual costs are defined as the sum of capital-related annual costs (interests and repairs caused by the investment), requirement-related costs (power costs), operation-related costs (costs of using the installation) and other costs (insurance).

DATA REQUIREMENT

TAC= CE+Co&m+Cf CE= total annual cost of the system sypplu Co&m= Total annual cost of the operation and maintenance of the facility Cf= total annual financing cost, if applies	UNIT: EURO/YEAR

SOURCE

LITERATURE

CATEGORY

ECONOMY

KPI 6

PAYBACK PERIOD

INTENT:

The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings or set the investment.

DATA REQUIREMENT:

Initial investment / Cash flow per year	UNIT: YEARS

SOURCE

LITERATURE

CATEGORY

ECONOMY

KPI 7

EFFICIENCY BETWEEN RENEWABLE ENERGY PRODUCTION AND RENEWABLE ENERGY CONSUMPTION

INTENT

The indicator measures if the energy produced form renewable energy technologies (RES) is enough for the community energy consumption.

DATA REQUIREMENT

CDE = LPE CDE = Degree of electrical energy self-supply based on RES LPE = Locally produced electrical energy	UNIT: kWh

SOURCE

LITERATURE

CATEGORY

ENERGY

KPI 8

ELECTRIC ENERGY GENERATED FORM RENEWABLE SOURCES THAT IS EXPORTED TO THE LOCAL AREA

INTENT

Aims at the production of the energy demand and at the increase of the share of renewable energy to other neighborhoods.

DATA REQUIREMENT

Ratio between local production of renewable energy/ total energy demand.	kWh

SOURCE

CESBA

CATEGORY

ENERGY

KPI 9

MID-TERM STORAGE OF ELECTRICAL EENRGY

INTENT

the indicator is related with the systems which maximize energy generation from intermittent renewable energy sources. Also maintain power quality, frequency and voltage in times of high demand for electricity. and finally absorb excess power generated locally for example from a rooftop solar panel.

DATA REQUIREMENT:

Energy storage = electrical charge* potential difference/2 (SCIr&i - SCIbaseline/SCI baseline) *100 SCIr&i= SCIbaseline=	UNIT: %

SOURCE

CESBA

CATEGORY

ENERGY

KPI 10

INCREASE OF THE USE OF RES DUE TO LOAD SHIFT IN BUILDINGS

INTENT

This KPI measures the percentual change in local RES penetration enabled by the provision of load shifting capacities in building of the community

DATA REQUIREMENT

%increase_RES = ((∑_RES_energy_with_load_shift/n) - (∑_%RES_energy_without_load_shift /m))/(∑_%RES_energy_without_load_shift_d /m)	UNIT: kWh / %

SOURCE

INTERCONNECT

CATEGORY

ENERGY

KPI 11 PEAK LOAD REDUCTION
INTENT Percentage reduction of monthly peak at grid connection level
DATA REQUIREMENT

peak load reduction= (1-(Ppeak,R&l/PbaU))*100	UNIT: %

SOURCE: INTERCONNECT, LITERATURE
CATEGORY ENERGY

KPI 12 LOCALLY PRODUCED ENERGY TRADED IN THE COMMUNITY
INTENT Percentage of the energy produced locally that is traded in the community
DATA REQUIREMENT

Smart meters for the individual values that lead to kWh demand. Individual meter for the generation of each asset on-site, DSO data for the individual values lead to kWh grid.	UNIT: kWh / %

SOURCE INTERCONNECT
CATEGORY ENERGY

KPI 13 RISE IN COSTUMER ENERGY AWARNESS
INTENT measuring the rise in customer energy awareness, regarding the electrical habits of the community.
DATA REQUIREMENT

Surveys filled by the participants
SOURCE INTERCONNECT
CATEGORY SOCAL

KPI 14 NET PROMOTER SCORE MEASURING CUSTOMER SATISFACTION
INTENT Measure customer satisfaction by comparing the amount of promoters' vs detractors.
DATA REQUIREMENT Surveys filled by the participants
SOURCE INTERCONNECT
CATEGORY SOCIAL

KPI 15 COMMUNITY MANAGEMENT OF COMMUNITY SERVICES AND COMMUNITY SPACES	
INTENT To raise the level of community involvement in planning through the redistribution of power. The assessment is therefore about.	
DATA REQUIREMENT	
Use of the Sherry Arnstein ladder on citizen participation. Rate the level of users' involvement	UNIT: Arnstein Score
SOURCE CESBA	
CATEGORY SOCIAL	

KPI 16

RESIDENTIAL RENTAL DWELLING UNITS AS A PERCENTAGE OF TOTAL DWELLING UNITS

INTENT

provides general insight for local authorities to develop a stronger understanding of the current and future housing supply to better plan and support housing needs.

DATA REQUIREMENT

total number of residential rental dwelling units/ total number of units	UNIT: %

SOURCE

ISO

CATEGORY

HOUSING

KPI 17

RESIDENTIAL DENSITY

INTENT

This indicator means the number of dwelling units per gross acre of residential land area including streets, easements, and open space portions of a development.

DATA REQUIREMENT

# of dwellings/ area of the project	UNIT: %

SOURCE

CESBA

CATEGORY

HOUSING

KPI 18

PERCENTAGE OF REUSED OR RECYCLED MATERIALS USED FOR CONSTRUCTION OR RENNOVATION

INTENT

The criterion measures the number of recycled materials used during the construction or maintenance of the project.

DATA REQUIREMENT

Total re use materials / whole project volume	UNIT: M3 / %

SOURCE

CESBA

CATEGORY

HOUSING

KPI 19

COMPOSTING AND RE-USED ORGQNIC SLUDGE

INTENT

The criterion measures the re-use of organic sludge consumption for services or activities related to gardens or orchards.

DATA REQUIREMENT

Aggregated annual total organic consumption / number of occupants.	UNITS: m3/ occupant/year

SOURCE:

CESBA

CATEGORY:

ENVIRONMENT

KPI 20

RE-USED OF RAINWATER IN RESIDENTIAL BUILDINGS

INTENT

The criterion measures the re-use of water consumption of sanitary fittings/devices and water.

DATA REQUIREMENT

Aggregated annual total water consumption / number of occupants.	UNIT: m3/ occupant/year

SOURCE

CESBA
CATEGORY ENVIRONMENT

KPI 21 GREENHOUSE GAS EMISSIONS
INTENT Reflects the “Biodiversity and Ecosystem Services” and “Economy and sustainable production and consumption” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Preservation and improvement of environment”.
DATA REQUIREMENT Direct emission inside the project/ population of the project. — UNIT: TONS
SOURCE ISO
CATEGORY ENVIRONMENT

KPI 22 CARBON INTENSITY REDUCTION
INTENT Decrease in CO2 intensity of the electricity mix in the pilot due to services implemented in the project.
DATA REQUIREMENT https://app.electricitymap.org/map mCO2 = SUM(Edel,iKdel,i) - SUM (Eexp,ikexp,i) Edel,i= The delivered energy for energy carrier i Eexp,i= The exported energy for energy carrier i Kdel,i= The CO2 coefficient for delivered energy carrier i Kexp,i = The CO2 coefficient for exported energy carrier i
SOURCE INTERCONNECT, LITERATURE
CATEGORY ENVIRONMENT

Table 7 Key performance indicators, Source: Author

NUMBER	INDICATOR	CATEGORY	GOAL	DEIFINTION	UNIT	Measurement	SOURCE
1	Average household income	Economy	Goal 11	Household income measures the combined incomes of the people in a particular household. An average of household income in a city can indicate the monetary well-being of residents within the city.	$	Income received in a year/ # of houselods in the project	ISO
2	Affordability of housing property	Economy	Goal 11	refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.	$	Residential income measures	CESBA - OECD
3	Affordability of housing rental	Economy	Goal 11	refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.	$	Residential income measures	CESBA - OECD
4	Total Investments	Economy	Goal 11	The KPI is defined as the number of cumulated payments relevant to the energy aspects of the systems (CAPEX).	euro/m2, euro (total)	Unit prices of all the project development / installation / managment	PAPERS
5	Total Annual Costs	Economy	Goal 11	The total annual costs are defined as the sum of capital-related annual costs (interests and repairs caused by the investment), requirement-related costs (power costs), operation-related costs (costs of using the installation) and other costs (insurance).	Euro/year	Total Fixed Cost + Average Variable Cost Per Unit * Quantity of Units Produced	PAPERS
6	Payback Period	Economy	Goal 11	The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings o□set the investment.	Years	Initial investment / Cash flow per year	PAPERS
7	Efficiency between renewable energy production and renewable energy consumption	Energy	Goal 7	The idicator measures if the energy produced form renewable energy technologies (RES) is enough for the community energy consumption.	kWh	Fiscal meters/ Chain2 protocol / Bill	PAPERS
8	Electric energy generated from renewable sources that is exported from the local area	Energy	Goal 7	Aims at the production of the energy demand and at the increase of the share of renewable energy to other neighborhoods	Watt	Ratio between local production of renewable energy/ total energy demand.	CESBA
9	Mid-term storage of electrical energy	Energy	Goal 7	the indicator is related with the systems which maximize energy generation from intermittent renewable energy sources. Also maintain power quality, frequency and voltage in times of high demand for electricity. and finally absorb excess power generated locally for example from a rooftop solar panel.	kWh	Energy sotrage = electrical charge* potential difference/2	CESBA
10	Increase in the use of RES due to load shift in buildings	Energy	Goal 7	This KPI measures the percentual change in local RES penetration enabled by the provision of load shifting capacities in building of the community	15 minutes / kWh / %	%increase_RES = ((∑_RES_energy_with_load_shift/n) - (∑_%RES_energy_without_load_shift /m))/(∑_%RES_energy_without_load_shift_d /m)	INTERCONNECT

NUMBER	INDICATOR	CATEGORY	GOAL	DEIFINTION	UNIT	Measurement	SOURCE
11	Peak load reduction	Energy	Goal 7	Percentage reduction of monthly peak at grid connection level	%	Distribution system operation (DSO) power data at feeder level	INTERCONNECT
12	Locally produced energy traded in community	Energy	Goal 7	Percentage of the energy produced locally that is traded in the community	kWh / %	Smart meters for the individual values that leado to kWh demand. Individual meter for the generation of each asset on-site, DSO data for the individual values lead to kWh grid.	INTERCONNECT
13	Rise in customer energy awareness	Social	Goal 10	% measuring the rise in customer energy awareness	%	Surveys filled by the participants	INTERCONNECT
14	Net promoter score measuring customer satisfaction (difference in % between promoters and detractors)	Social	Goal 10	Measure customer satisfaction by comparing the amount of promoters vs detractors	%	Surveys filled by the participants	INTERCONNECT
15	Community management of urban facilities and urban spaces	Social	Goal 10	To raise the level of community involvement in planning through the redistribution of power. The assessment is therefore about:	Arnstein score	Use of the Sherry Arnstein ladder on citizen participation. Rate the level of users' involvement	CESBA
16	Residential rental dwelling units as a percentage of total dwelling units	Housing	Goal 9	provides general insight for local authorities to develop a stronger understanding of the current and future housing supply to better plan and support housing needs.	%	number of residential rental dwelling units/ total number of	ISO
17	Residential density	Housing	Goal 9	This indicator means the number of dwelling units per gross acre of residential land area including streets, easements and open space portions of a development.	U/Area	# of dwellings/ area of the project	CESBA
18	Percent of reused or recycled materiales used for construction or renovation	Housing	Goal 9	The criterion measures the amount of recycled materials used during the construciton or maintenance of the project.	m3/ %	Total re use materials / whole project volume	CESBA
19	Composting and re-use of organic sludge	Environment	Goal 13	The criterion measures the re-use of organic sluge consumption for services or activites realted to gardens or orchards.	m3/ occupant/year	Aggregated annual total organic consumption / number of occupants.	CESBA
20	Re-use of rainwater in RESIDENTIAL buildings	Environment	Goal 13	The criterion measures the re-use of water consumption of sanitary fittings/devices and water.	m3/ occupant/year	Aggregated annual total water consumption / number of occupants.	CESBA
21	Greenhouse gas emissions measured in tonnes per capita	Environment	Goal 13	Reflects the “Biodiversity and Ecosystem Services” and “Economy and sustainable production and consumption” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Preservation and improvement of environment”.	Tonnes	Direct emission inside the project/ population of the project.	ISO
22	Carbon Intensity reduction	Environment	Goal 13	Decrease in CO2 intensity of the electricity mix in the pilot due to services implemented in the project.	gCO2/year	https://app.electricitymap.org/map	INTERCONNECT

3.2 Community feedback Questionary.

The questionnaire is designed to evaluate the relevance of the key performance indicators already selected that are related to the SDGs and social housing problematics by asking to the community of Moneta in Milan. They are being part of a project lead by planet idea srl call interconnect, which is testing punctually the acceptance of the community using Iot devices for a better understanding of their consumption regardless to the energy and water services (washing machine) throughout its duration.

There are 17 questions, each one of them will be an indicator or correspond to a group of indicators to be measured and shows the importance in the project with relation to current demands.

The questions will be divided into 5 groups:

1) Economic group.
2) Technological group.
3) Social group.
4) Constructive group.
5) Environmental group.

The questions are multiple choice, each option have a score according to the Likert scale (methodology used to translate the qualitative answers to a quantitative one):

a) No importance. (Score: 1)
b) Slightly importance (Score: 2).
c) Moderately Important (Score: 3).
d) Important (Score: 4).
e) Very important (Score: 5).

The minimum score is 16 and the maximum score that indicator could have is 80 in the first questionary applied only to the Moneta community, the ranks are:

≥ 16 < 32 No importance.

≥ 32 < Slightly importance.

≥ 48 < Moderately Important.

≥ 64 < Important.

≥ 80 < Very important.

Starting Assumption: WHEN YOU DECIDED TO LIVE IN MONETA, HOW IMPORTANT WERE THE FOLLOWING ASPECTS TO YOU?

ECONOMIC GROUP	
1	COST OF THE HOUSE (PURCHASE PRICE OR MONTHLY RENT)
2	MONTHLY COSTS (maintenance, cleaning...)
3	IF YOU ARE THE OWNER, KNOW IN HOW MANY YEARS YOU WILL BE ABLE TO PAY THE APARTMENT / PAY THE LOAN
TECHNOLOGICAL GROUP	
4	PRESENCE OF RENEWABLE ENERGY PRODUCTION IN THE PROJECT (e.g., presence of solar panels).
5	KNOW THE FLAT'S ENERGY EFFICIENCY
6	POSSIBILITY OF VIEWING ENERGY CONSUMPTION VIA APPLICATION
7	PRESENCE OF TECHNOLOGICAL SOLUTIONS CAPABLE OF OPTIMIZING/REDUCING THE CONSUMPTION OF COMMON AREAS (e.g., smart lighting)
SOCIAL GROUP	
8	PRESENCE OF THE SOCIAL MANAGER IN THE NEIGHBOURHOOD
9	PRESENCE OF COMMUNITY SPACES AND ACTIVITIES
10	PRESENCE OF ACTIVITIES RELATED TO AWARENESS ON REDUCING CONSUMPTION AND SAVING ENERGY
11	PRESENCE OF AN ACTIVE AND ORGANISED GROUP OF RESIDENTS WITHIN THE NEIGHBOURHOOD
12	PRESENCE OF SOCIAL ACTIVITIES INSIDE THE "ENLARGED" NEIGHBOURHOOD (areas adjacent to the housing intervention)
CONSTRUCTIVE GROUP	
13	KNOWING HOW MANY FAMILIES WILL LIVE WITHIN THE NEIGHBOURHOOD
14	KNOWING HOW MANY FLATS WILL BE RENTED/SOLD OUT OF THE TOTAL
15	KNOW THE PERCENTAGE OF REUSED/RECYCLED MATERIALS USED IN THE CONSTRUCTION
ENVIRONMENTAL GROUP	
16	KNOW THE ENVIRONMENTAL IMPACT OF THE INTERVENTION (E.G. RE-USE OF RAINWATER, RE-USE OF ORGANIC MATERIAL, EMISSIONS...)

3.3 Companies questionary.

The questionnaire for the companies will be used also to establish a hierarchy and relevance of the selected indicators based on the needs and challenges of social projects and energy communities, however in this one the vocabulary used is technical, to avoid confusions or wrong interpretations. This will provide a complementary evaluation from a developer company (planet idea) and a research entity (RSE).

ECONOMIC GROUP	
1	Have clear all the costs related to the development of the project (whole investment)
2	Average money that made a house owner (the amount of income produced)
3	Percentage of people that could buy a house (a relation between the price and de services that the project provides, such as renewable energy technologies or a community manager).
4	Percentage of people who are interested in paying a rent considering the services provided versus the value requested.
5	Knowing the annual operational cost of the building (maintenance).
6	Knowing the time will take to recover the investment (the case of developer regarded to the whole development).
TECHNOLOGICAL GROUP	
7	Know the efficiency between renewable energy production (solar panels) vs renewable energy consumption (as overlapping activities).
8	Importance of measuring the amount of electric energy generation from renewable sources that is exported to the neighborhood
9	Measure the capacity to storage renewable energy as a response to the necessities of the community during the night
10	Measure the amount of renewable energy consumption in building due to the load shift. (RES self-consumption optimization)
11	knowing if the consumption of energy from the grid could get to the maximum it could supply to the community without other energy sources.
12	Know the amount of renewable energy traded in the community (building scale).

SOCIAL GROUP	
13	Measure the customer energy literacy (if they are conscious in how to consume and save energy).
14	Measure customer satisfaction by comparing the amount of promoter's vs detractors of the project.
15	Measure the Community engagement related with, urban facilities, urban spaces, and social activities (If they are an active and participatory community).
CONSTRUCTIVE GROUP	
16	Measurement of residential density, related to the amount of residents per square meter
17	Know the number of apartments that are rented vs the total apartments.
18	Knowing the Percent of reused or recycled materials used for construction.
ENVIRONMENTAL GROUP	
19	Compare if there is a decrease in the carbon intensity allowed to the electricity mix consumption
20	Measure the amount of Re-use of organic sludge and composting in the project.
21	Measure the amount of Re-use of rainwater in the project.
22	Knowing the importance of green gas emission.

4. Application and results of the community questionary.

QUESTION 1

Table 8 Have clear all the costs related to the development of the project (whole investment), Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	6	37,5 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max obtained: 5

Sum: 62

Average: 3,87

final score 3.

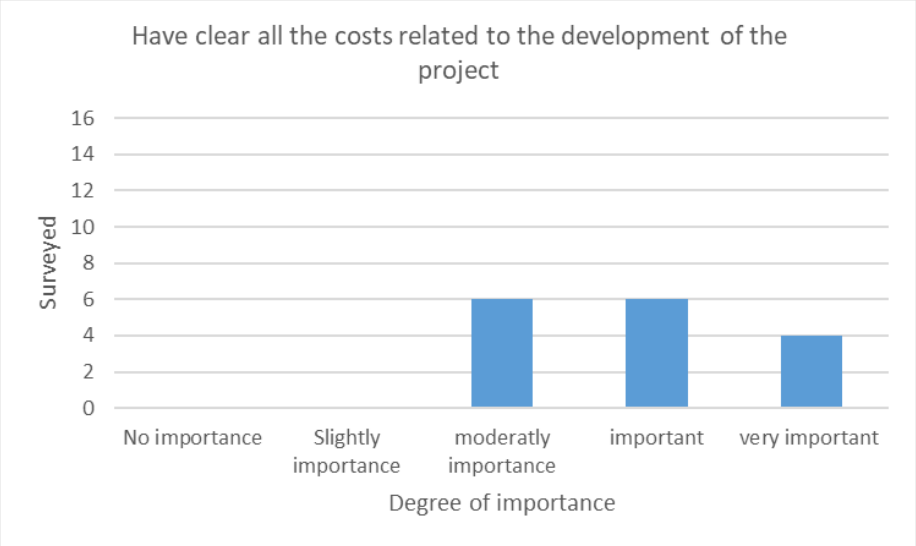

Figure 12 Have clear all the costs related to the development of the project, source: Author

QUESTION 2

Table 9 Average money that made a house owner (the amount of income produced), Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	6	37,5 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 62

Average 3,87

final score 3.

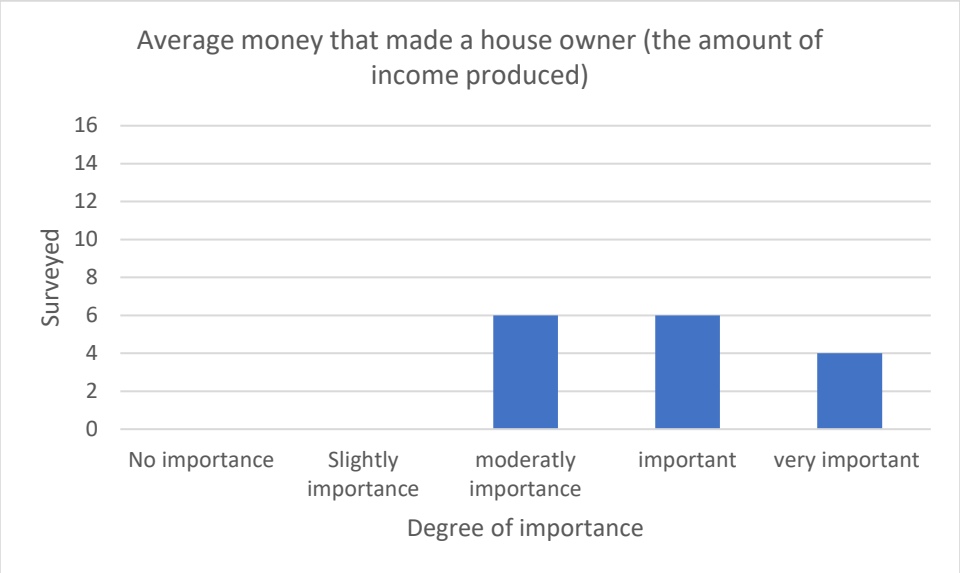

Figure 13 Average money that made a house owner (the amount of income produced)

QUESTION 3

Table 10 Percentage of people that could buy a house (a relation between the price and de services that the project provides, such as renewable energy technologies or a community manager) Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	6	37,5 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 62

Average 3,87

final score 3.

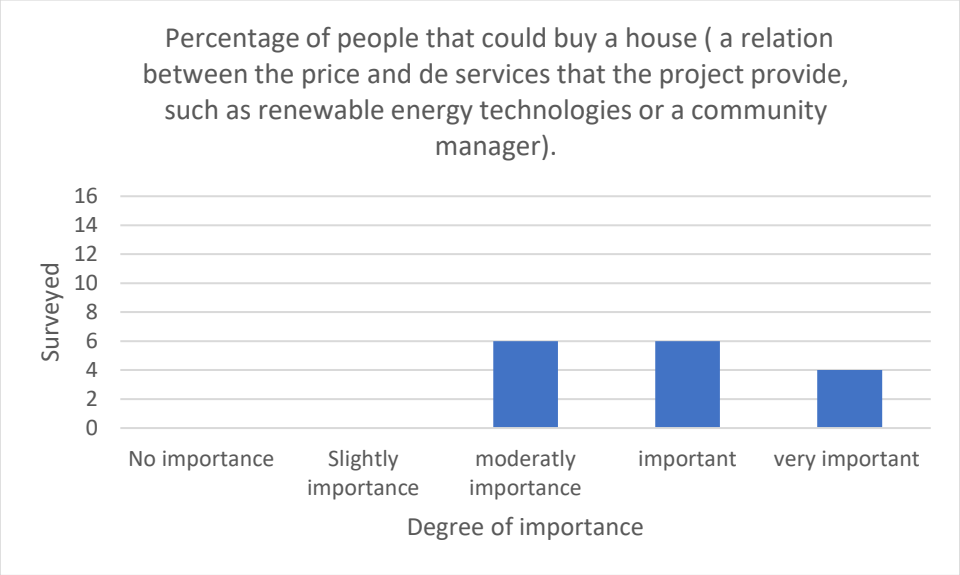

Figure 14 Percentage of people that could buy a house. Source: Author

QUESTION 4

Table 11 Percentage of people who are interested in paying a rent taking into account the services provided versus the value requested. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	6	37,5 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 62

Average 3,87

final score 3.

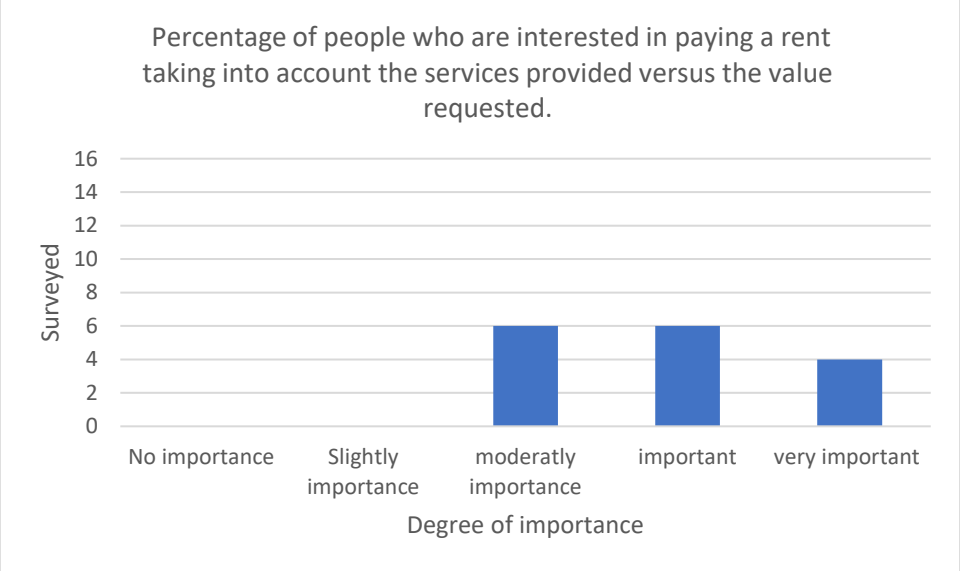

Figure 15 Percentage of people who are interested in paying a rent taking into account the services provided versus the value requested. Source: Author

QUESTION 5

Table 12 Knowing the annual operational cost of the building (maintenance). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	1	6,25 %
Moderately importance	8	50 %
Important	3	18,75 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 58

Average 3,625

final score 3.

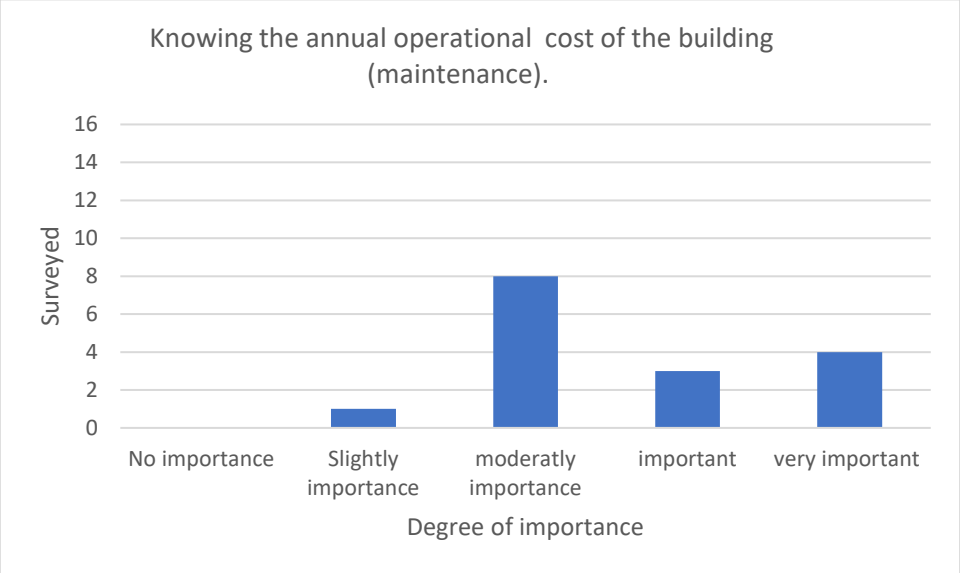

Figure 16 Knowing the annual operational cost of the building (maintenance). Source: Author

QUESTION 6

Table 13 Knowing the time will take to recover the investment (the case of developer regarded to the whole development). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	5	31,25 %
Moderately importance	4	25 %
Important	2	12,5 %
Very Important	5	31,25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 55

Average 3,4375

final score 3.

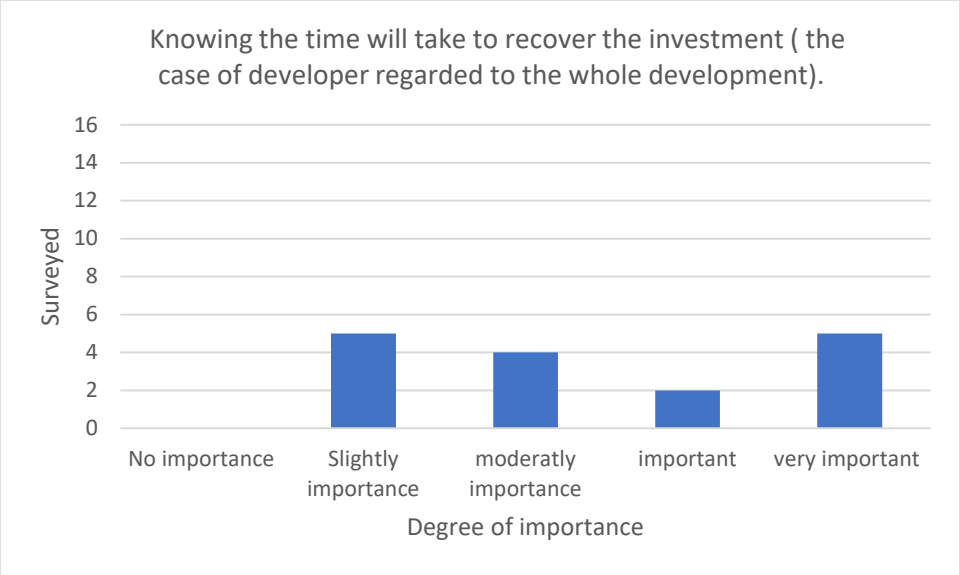

Figure 17 Knowing the time will take to recover the investment. Source: Author

QUESTION 7

Table 14 Know the efficiency between renewable energy production (solar panels) vs renewable energy consumption (as overlapping activities). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	1	6,25 %
Moderately importance	2	12,5 %
Important	7	43,75 %
Very Important	6	37,5 %
Total	16	100 %

Statistics:

Max: 5

Sum: 66

Average 4,125

final score 4.

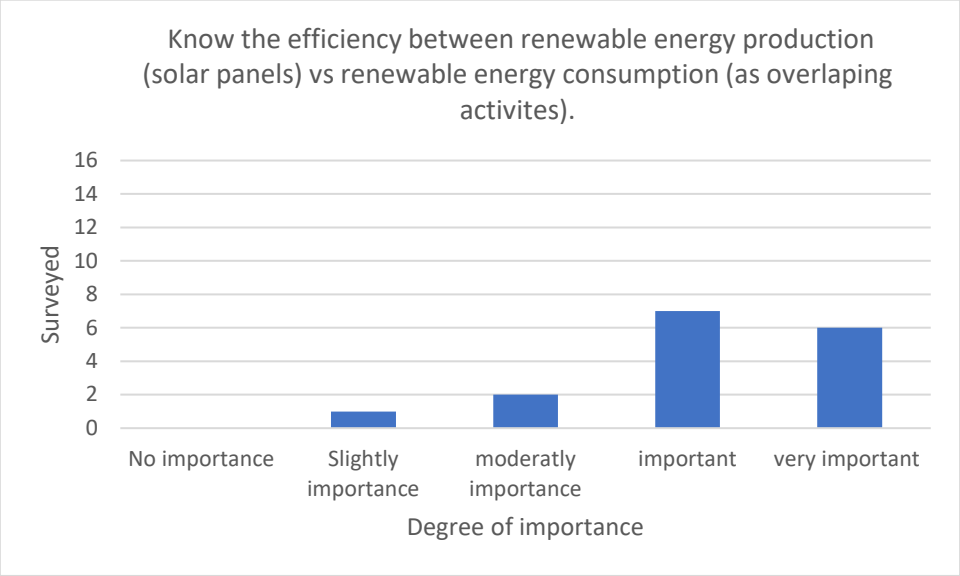

Figure 18 Know the efficiency between renewable energy production vs renewable energy consumption. Source: Author

QUESTION 8

Table 15 Importance of measuring the amount of electric energy generation from renewable sources that is exported to the neighborhood. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	4	25 %
Important	8	50 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 64

Average 4

final score 4.

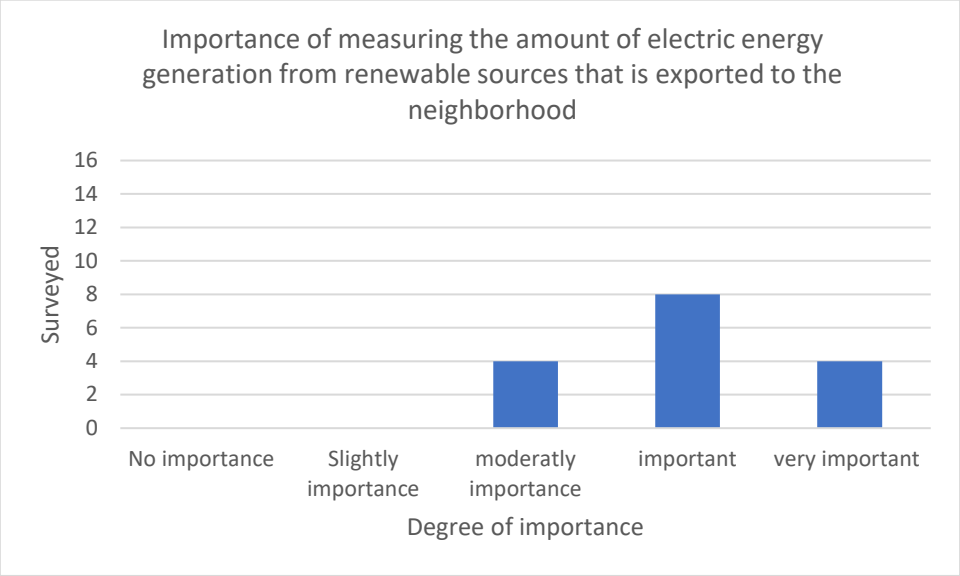

Figure 19 Importance of measuring the amount of electric energy generation from renewable sources that is exported to the neighborhood. Source: Author

QUESTION 9

Table 16 Measure the capacity to storage renewable energy as a response to the necessities of the community during the night. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	4	25 %
Important	7	43,75 %
Very Important	5	31,25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 64

Average 4,06

final score 4.

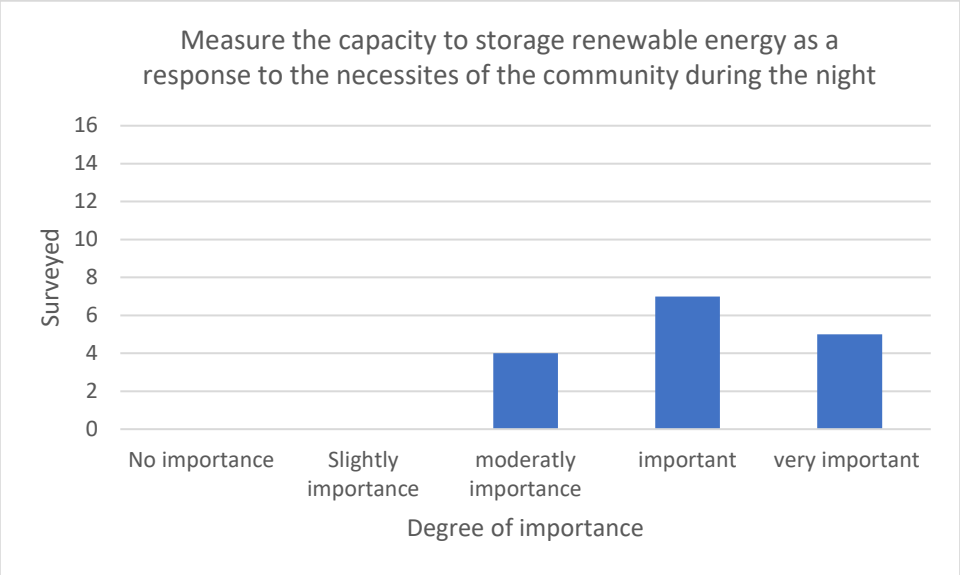

Figure 20 Measure the capacity to storage renewable energy as a response to the necessities of the community during the night. Source: Author

QUESTION 10

Table 17 Measure the amount of renewable energy consumption in building due to the load shift. (RES self-consumption optimization). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	6,25 %
Important	7	43,75 %
Very Important	8	50 %
Total	16	100 %

Statistics:

Max: 5

Sum: 71

Average 4,4375

final score 4.

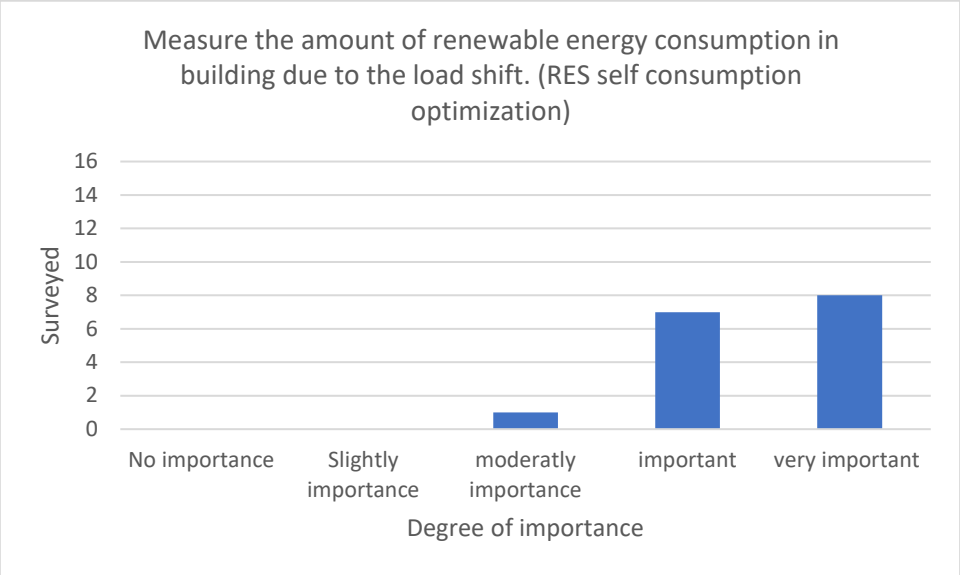

Figure 21 Measure the amount of renewable energy consumption in building due to the load shift. Source: Author

QUESTION 11

Table 18 knowing if the consumption of energy from the grid could get to the maximum it could supply to the community without other energy sources. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	1	6,25 %
Moderately importance	2	12,5 %
Important	6	37,5 %
Very Important	7	43,75 %
Total	16	100 %

Statistics:

Max: 5

Sum: 67

Average 4,1875

final score 4.

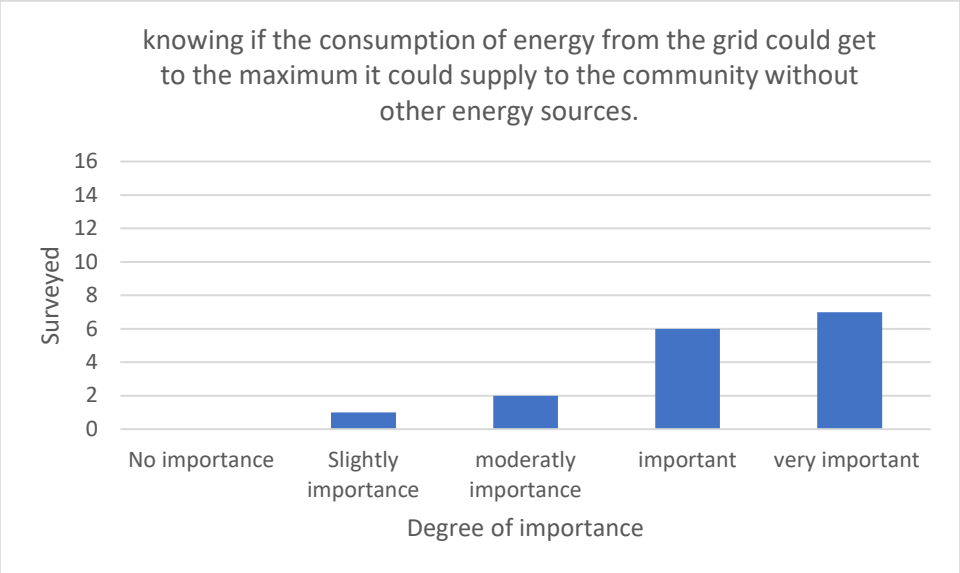

Figure 22 knowing if the consumption of energy from the grid could get to the maximum it could supply to the community without other energy sources. Source: Author

QUESTION 12

Table 19 Know the amount of renewable energy traded in the community (building scale). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	6,25 %
Important	8	50 %
Very Important	7	43,75 %
Total	16	100 %

Statistics:

Max: 5

Sum: 70

Average 4,375

final score 4.

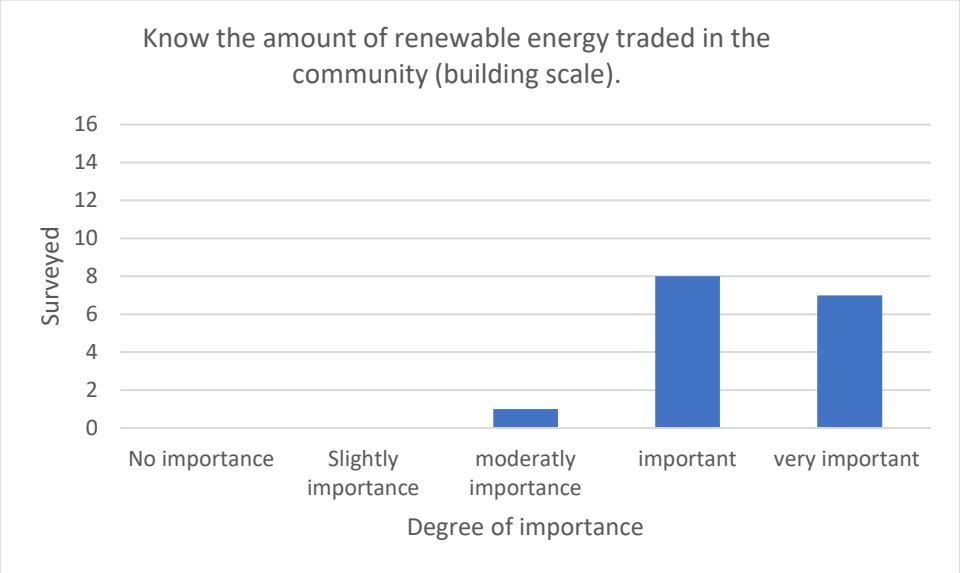

Figure 23 Know the amount of renewable energy traded in the community (building scale). Source: Author

QUESTION 13

Table 20 Measure the customer energy literacy (if they are conscious in how to consume and save energy). Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	0	0 %
Moderately importance	9	56,25 %
Important	1	6,25 %
Very Important	5	31,25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 65

Average 4,0625

final score 4.

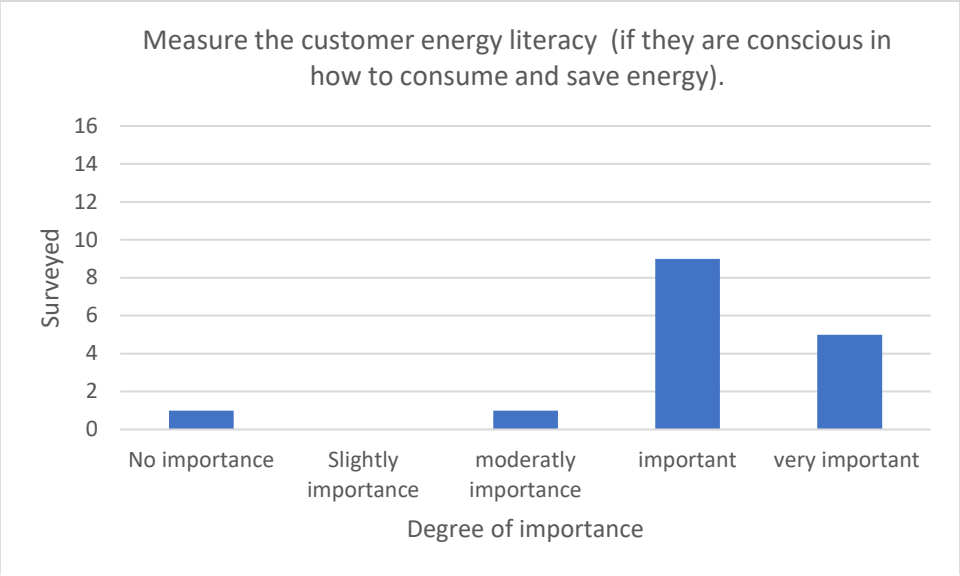

Figure 24 Measure the customer energy literacy. Source: Author

QUESTION 14

Table 21 Measure customer satisfaction by comparing the amount of promoter's vs detractors of the project. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	1	6,25 %
Moderately importance	3	18,75 %
Important	8	50 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 63

Average 3,9375

final score 3.

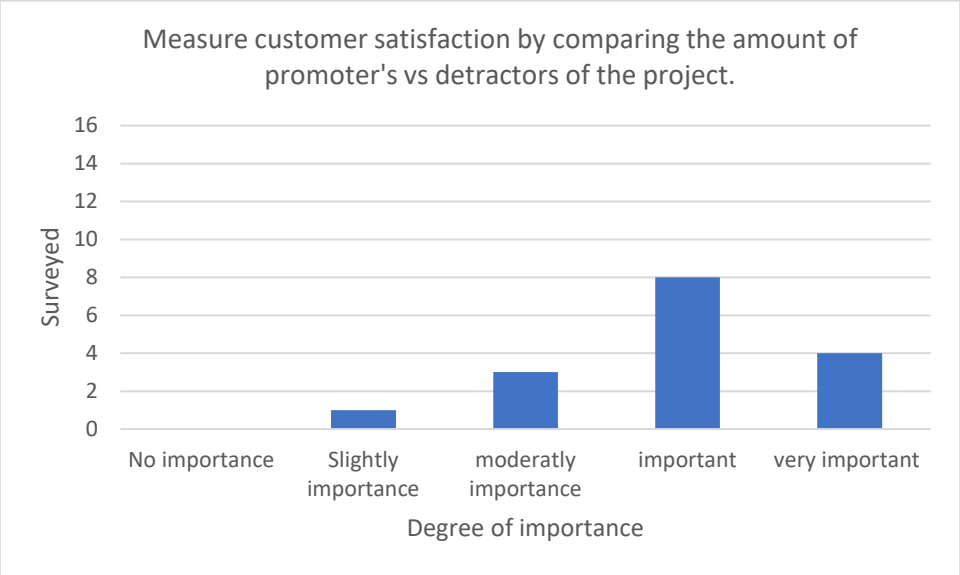

Figure 25 Measure customer satisfaction by comparing the amount of promoter's vs detractors of the project. Source: Author

QUESTION 15

Table 22 Measure the Community engagement related with, urban facilities, urban spaces, and social activities (If they are an active and participatory community). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	2	12,5 %
Moderately importance	3	18,75 %
Important	7	43,75 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 61

Average 3,8125

final score 3.

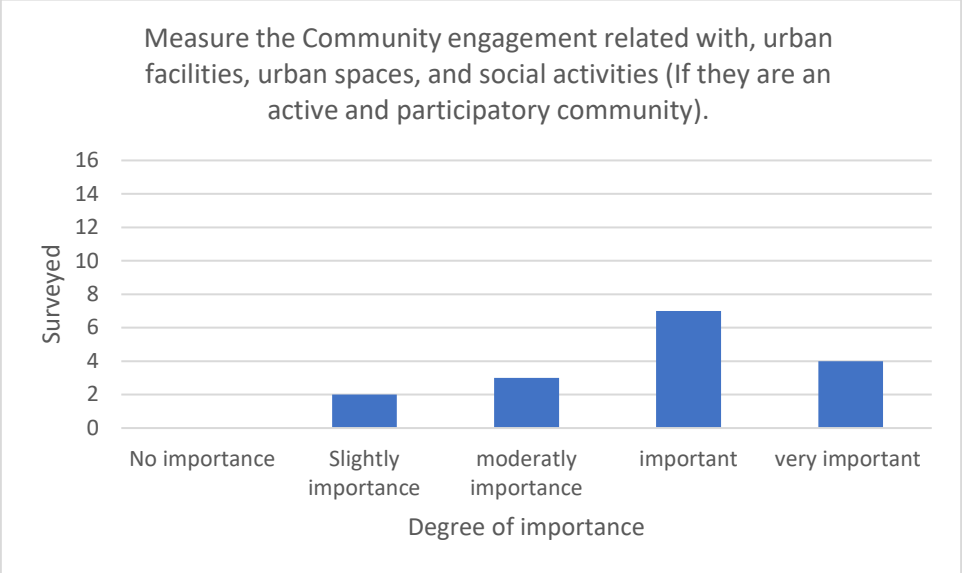

Figure 26 Measure the Community engagement related with, urban facilities, urban spaces, and social activities. Source: Author

QUESTION 16

Table 23Measuemrent of residential density, related to the amount of residents per square meter. Source: Author

Degree of importance	f	%
No importance	1	0 %
Slightly importance	4	25 %
Moderately importance	5	31,25 %
Important	3	18,75 %
Very Important	3	18,75 %
Total	16	100 %

Statistics:

Max: 5

Sum: 51

Average 3,1875

final score 3.

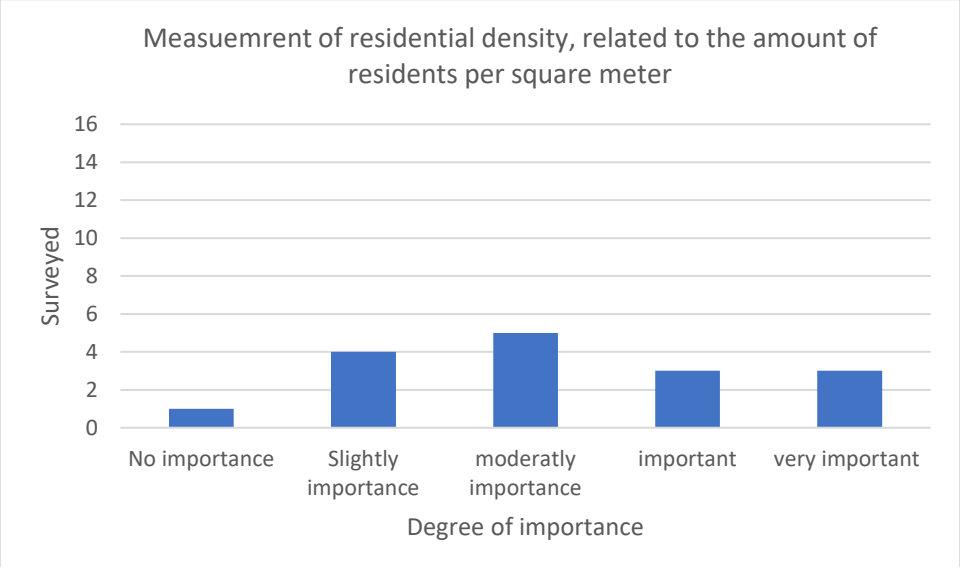

Figure 27 Measurement of residential density, related to the amount of residents per square meter. Source: Author

QUESTION 17

Table 24 Know the number of apartments that are rented vs the total apartments. Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	2	12,5 %
Moderately importance	6	37,5 %
Important	5	31,25 %
Very Important	2	12,5 %
Total	16	100 %

Statistics:

Max: 5

Sum: 53

Average 3,3125

final score 3.

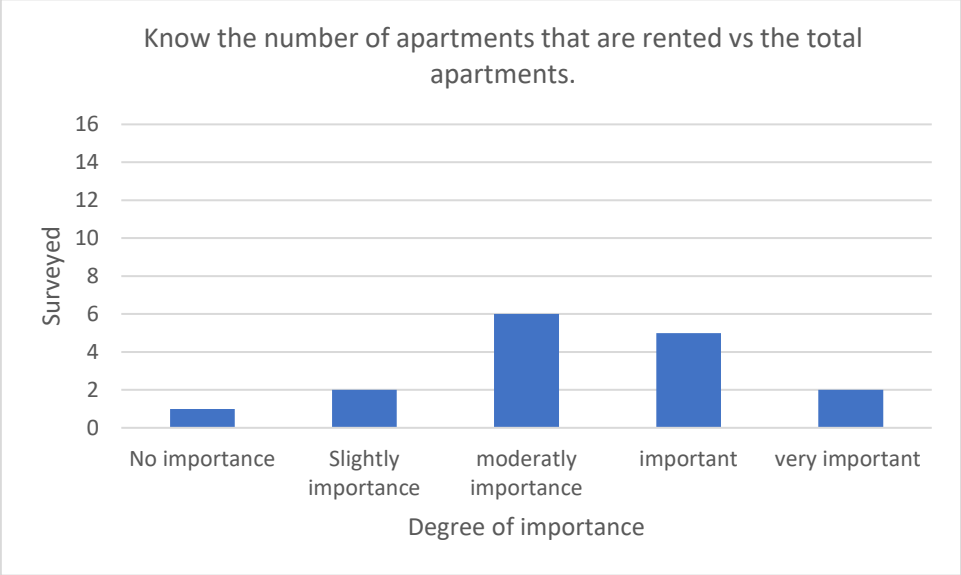

Figure 28 Know the number of apartments that are rented vs the total apartments. Source: Author

QUESTION 18

Table 25 Compare if there is a decrease in the carbon intensity allowed to the electricity mix consumption. Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	0	0 %
Moderately importance	5	31,25 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 60

Average 3,75

final score 3.

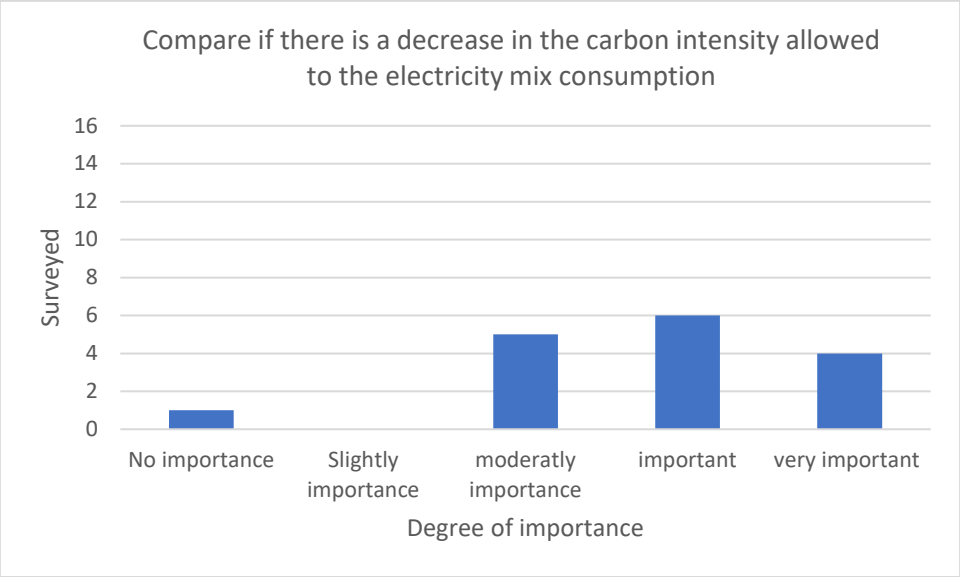

Figure 29Compare if there is a decrease in the carbon intensity allowed to the electricity mix consumption. Source: Author

QUESTION 19

Table 26 Measure the amount of Re-use of organic sludge and composting in the project. Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	0	0 %
Moderately importance	5	31,25 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 60

Average 3,75

final score 3.

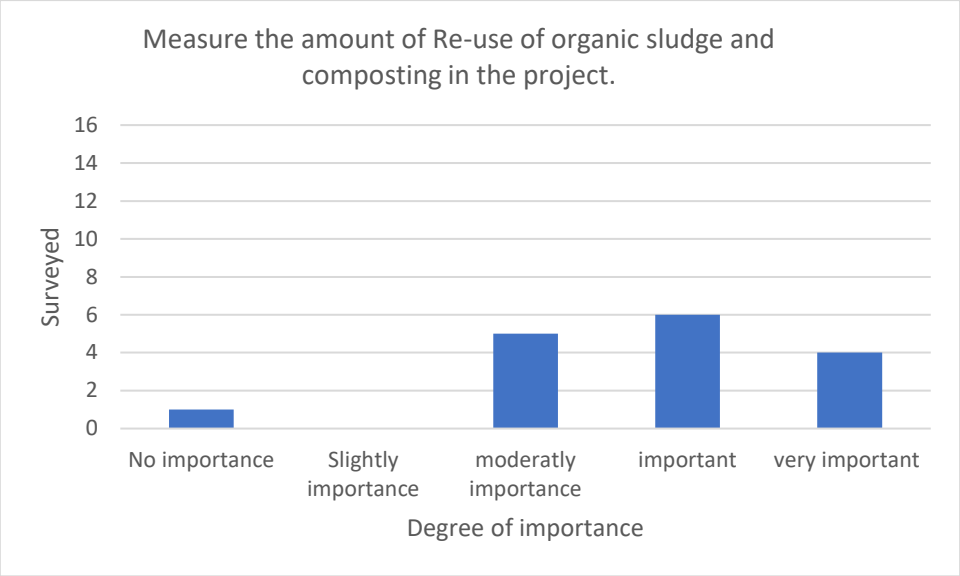

Figure 30 Measure the amount of Re-use of organic sludge and composting in the project. Source: Author

QUESTION 20

Table 27 Measure the amount of Re-use of rainwater in the project. Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	0	0 %
Moderately importance	5	31,25 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 60

Average 3,75

final score 3.

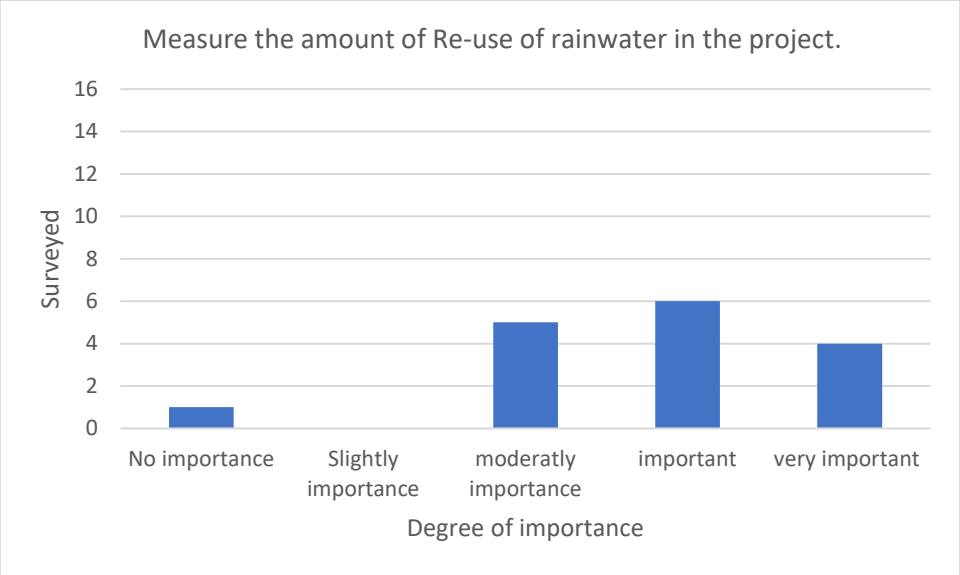

Figure 31 Measure the amount of Re-use of rainwater in the project. Source: Author

QUESTION 21

Table 28 Knowing the importance of green gas emission. Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	0	0 %
Moderately importance	5	31,25 %
Important	6	37,5 %
Very Important	4	25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 60

Average 3,75

final score 3.

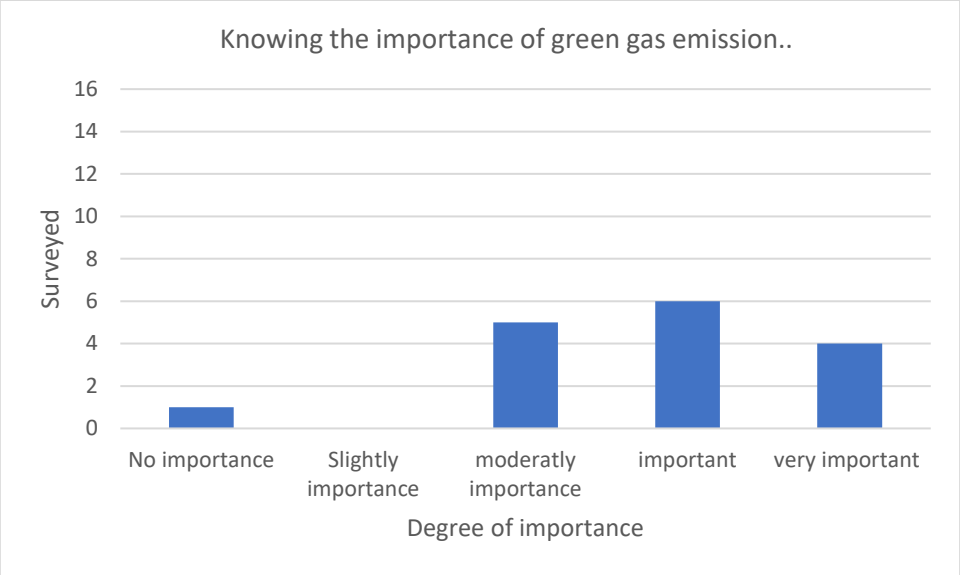

Figure 32 Knowing the importance of green gas emission. Source: Author

QUESTION 22

Table 29 Knowing the Percent of reused or recycled materials used for construction. Source: Author

Degree of importance	f	%
No importance	1	6,25 %
Slightly importance	1	6,25 %
Moderately importance	6	37,5 %
Important	7	43,75 %
Very Important	1	6,25 %
Total	16	100 %

Statistics:

Max: 5

Sum: 54

Average 3,375

final score 3.

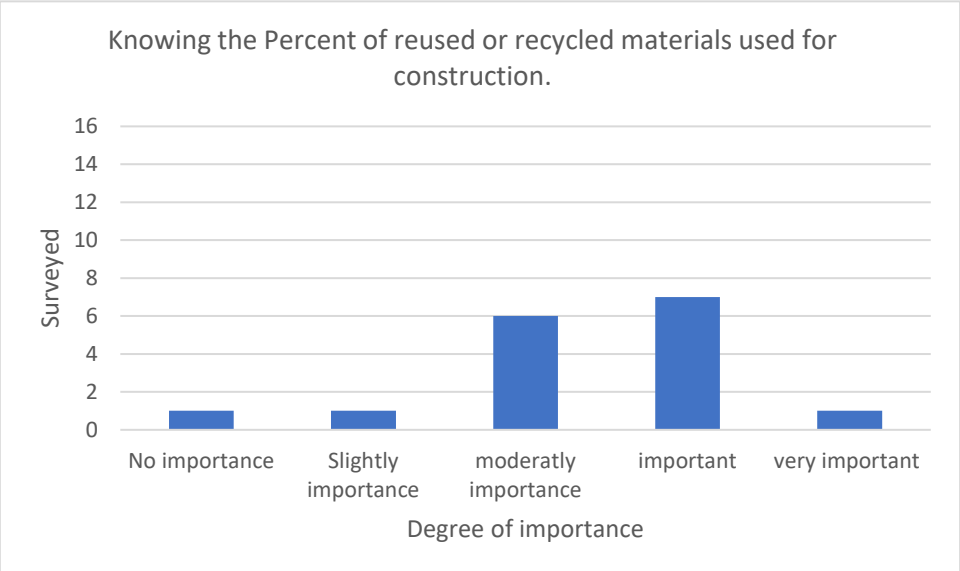

Figure 33 Knowing the Percent of reused or recycled materials used for construction. Source: Author

4.1 Hierarchy of the KPIs according to the community questionary.

Table 30 Final selection of the key performance indicators

NUMBER	INDICATOR	CATEGORY	GOAL	DEIFINTION	UNIT	SOURCE	DEGREE OF IMPORTANCE
16	Residential rental dwelling units as a percentage of total dwelling units	Housing	Goal 9	provides general insight for local authorities to develop a stronger understanding of the current and future housing supply to better plan and support housing needs.	%	ISO	3,18
17	Residential density	Housing	Goal 9	This indicator means the number of dwelling units per gross acre of residential land area including streets, easements and open space portions of a development.	U/Area	CESBA	3,31
22	Carbon Intensity reduction	Environment	Goal 13	Decrease in CO2 intensity of the electricity mix in the pilot due to services implemented in the project.	gCO2/year	INTERCONNECT, PAPERS	3,37
6	Payback Period	Economy	Goal 11	The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings or set the investment.	Years	PAPERS	3,43
5	Total Annual Costs	Economy	Goal 11	The total annual costs are defined as the sum of capital-related annual costs (interests and repairs caused by the investment), requirement-related costs (power costs), operation-related costs (costs of using the installation) and other costs (insurance).	Euro/year	PAPERS	3,62
18	Percent of reused or recycled materiales used for construction or renovation	Housing	Goal 9	The criterion measures the amount of recycled materials used during the construciton or maintenance of the project.	m3/ %	CESBA	3,75
19	Composting and re-use of organic sludge	Environment	Goal 13	The criterion measures the re-use of organic sluge consumption for services or activites realted to gardens or orchards.	m3/ occupant/year	CESBA	3,75
20	Re-use of rainwater in RESIDENTIAL buildings	Environment	Goal 13	The criterion measures the re-use of water consumption of sanitary fittings/devices and water.	m3/ occupant/year	CESBA	3,75
21	Greenhouse gas emissions measured in tonnes per capita	Environment	Goal 13	Reflects the "Biodiversity and Ecosystem Services" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment".	Tonnes	ISO	3,75
15	Community management of urban facilities and urban spaces	Social	Goal 10	To raise the level of community involvement in planning through the redistribution of power. The assessment is therefore about.	Arnstein score	CESBA	3,81

NUMBER	INDICATOR	CATEGORY	GOAL	DEIFINTION	UNIT	SOURCE	DEGREE OF IMPORTANCE
1	Average household income	Economy	Goal 11	Household income measures the combined incomes of the people in a particular household. An average of household income in a city can indicate the monetary well-being of residents within the city.	$	ISO	3,87
2	Affordability of housing property	Economy	Goal 11	refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.	$	CESBA - OECD	3,87
3	Affordability of housing rental	Economy	Goal 11	refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.	$	CESBA - OECD	3,87
4	Total Investments	Economy	Goal 11	The KPI is defined as the number of cumulated payments relevant to the energy aspects of the systems (CAPEX).	euro/m2, euro (total)	PAPERS	3,87
14	Net promoter score measuring customer satisfaction (difference in % between promoters and detractors)	Social	Goal 10	Measure customer satisfaction by comparing the amount of promoters vs detractors	%	INTERCONNECT	3,93
8	Electric energy generated from renewable sources that is exported from the local area	Energy	Goal 7	Aims at the production of the energy demand and at the increase of the share of renewable energy to other neighborhoods	Watt	CESBA	4
9	Mid-term storage of electrical energy	Energy	Goal 7	the indicator is related with the systems which maximize energy generation from intermittent renewable energy sources. Also maintain power quality, frequency and voltage in times of high demand for electricity. and finally absorb excess power generated locally for example from a rooftop solar panel.	%	CESBA	4,06
13	Rise in customer energy awareness	Social	Goal 10	measuring the rise in customer energy awareness	%	INTERCONNECT	4,06
7	Efficiency between renewable energy production and renewable energy consumption	Energy	Goal 7	The idicator measures if the energy produced form renewable energy technologies (RES) is enough for the community energy consumption.	kWh	PAPERS	4,12
11	Peak load reduction	Energy	Goal 7	Percentage reduction of monthly peak at grid connection level	%	INTERCONNECT, PAPERS	4,18
12	Locally produced energy traded in community	Energy	Goal 7	Percentage of the energy produced locally that is traded in the community	kWh / %	INTERCONNECT	4,37
10	Increase in the use of RES due to load shift in buildings	Energy	Goal 7	This KPI measures the percentual change in local RES penetration enabled by the provision of load shifting capacities in building of the community	15 minutes / kWh / %	INTERCONNECT	4,43

4.2 Application and results of the company's questionary.

QUESTION 1

Table 31 Have clear all the costs related to the development of the project (whole investment) Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	2	100 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 8

Average: 4

final score: 4

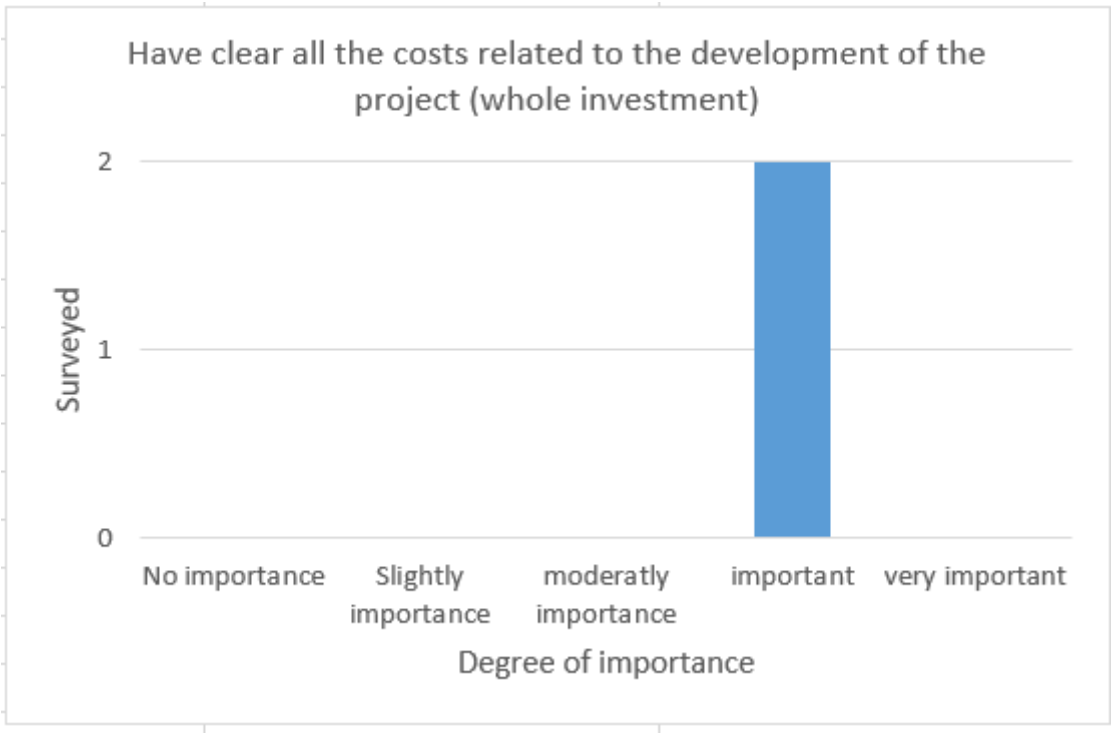

Figure 34 Have clear all the costs related to the development of the project (whole investment) Source: Author

QUESTION 2

Table 32 Average money that made a house owner (the amount of income produced, Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	2	100 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 8

Average: 4

final score: 4

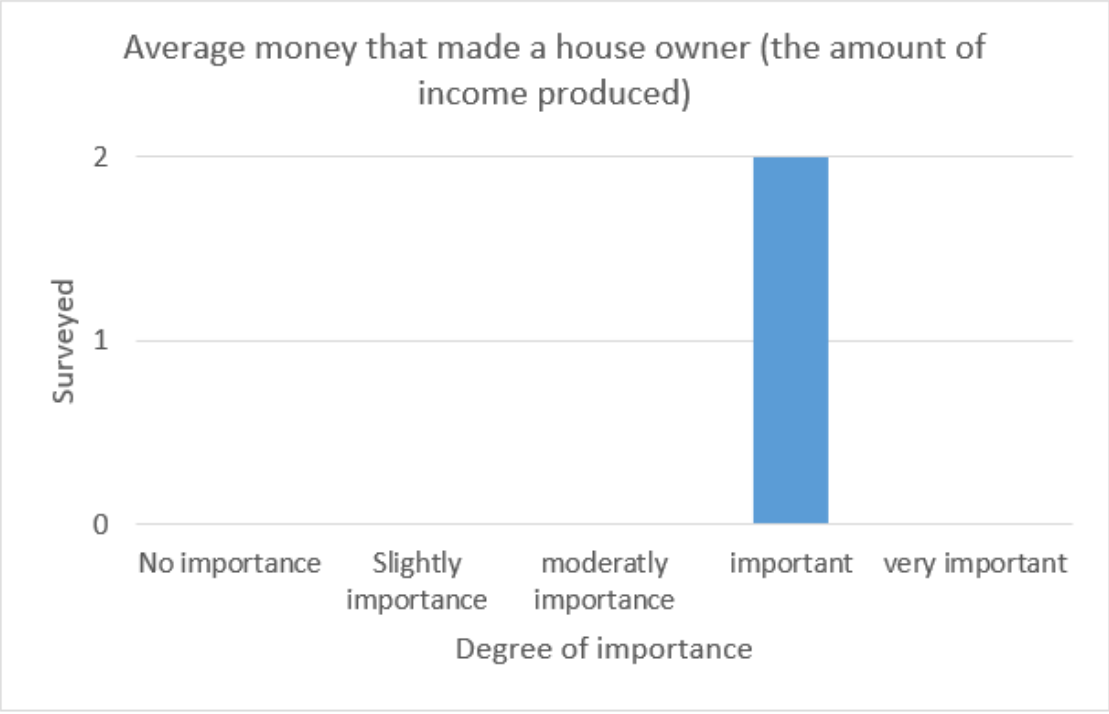

Figure 35 Average money that made a house owner (the amount of income produced), Source: Author

QUESTION 3

Table 33 Percentage of people that could buy a house (a relation between the price and de services that the project provides, such as renewable energy technologies or a community manager). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 8

Average: 4

final score: 4

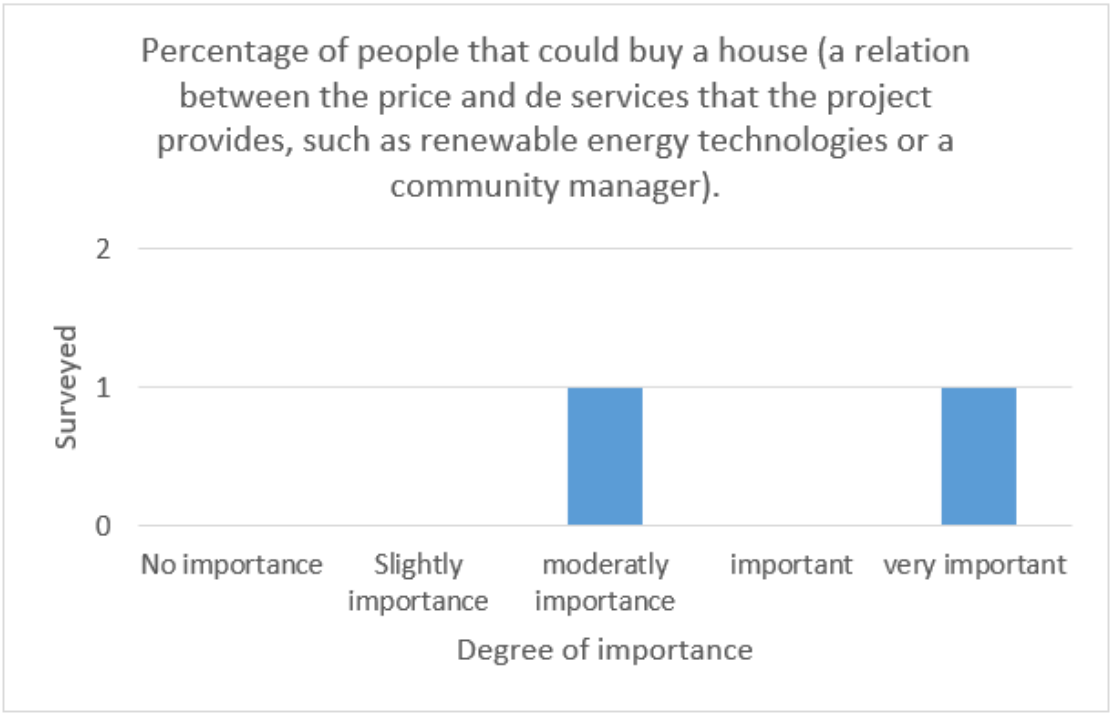

Figure 36 Percentage of people that could buy a house (a relation between the price and de services that the project provides, such as renewable energy technologies or a community manager). Source: Author

QUESTION 4

Table 34 Percentage of people who are interested in paying a rent considering the services provided versus the value requested, Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 8

Average: 4

final score: 4

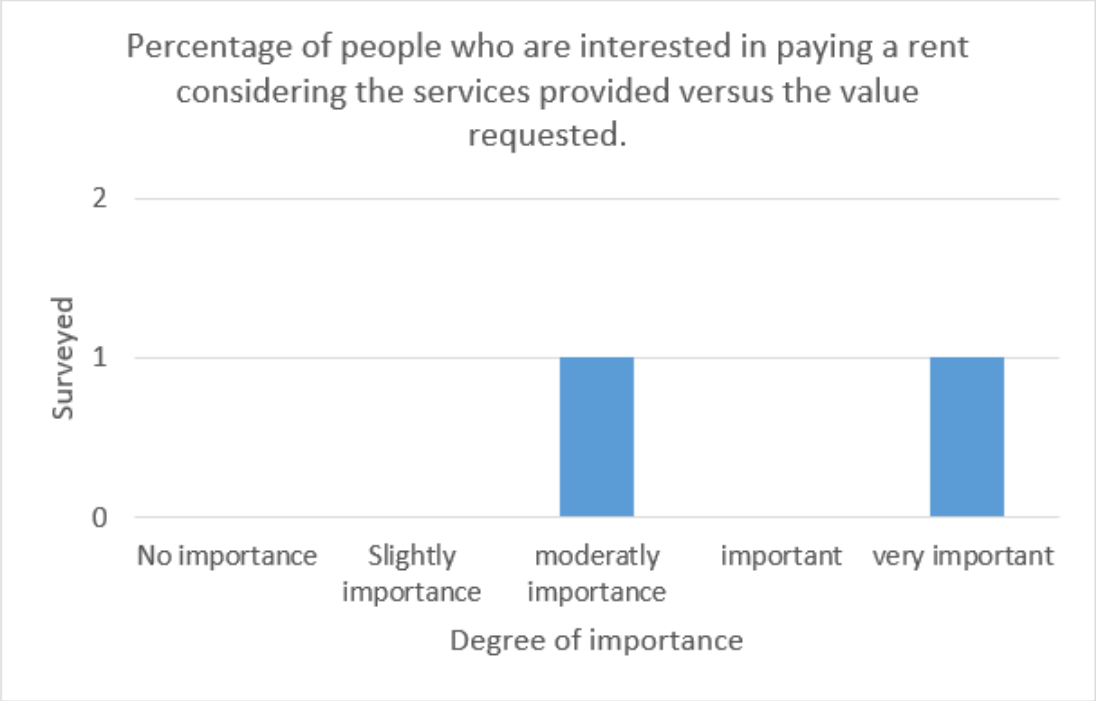

Figure 37 Percentage of people who are interested in paying a rent considering the services provided versus the value requested. Source: Author

QUESTION 5

Table 35 Knowing the annual operational cost of the building (maintenance), Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	2	100 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 8

Average: 4

final score: 4

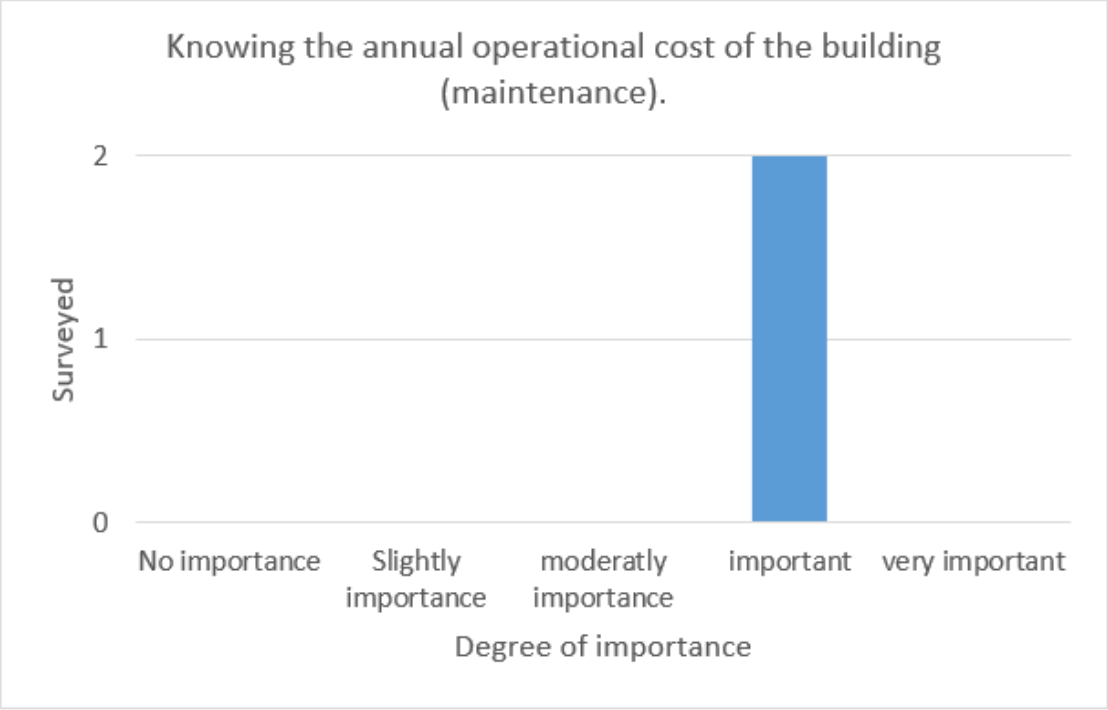

Figure 38 Knowing the annual operational cost of the building (maintenance). Source: Author

QUESTION 6

Table 36 Knowing the time will take to recover the investment (the case of developer regarded to the whole development). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	1	25 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 9

Average: 4,5

final score: 4

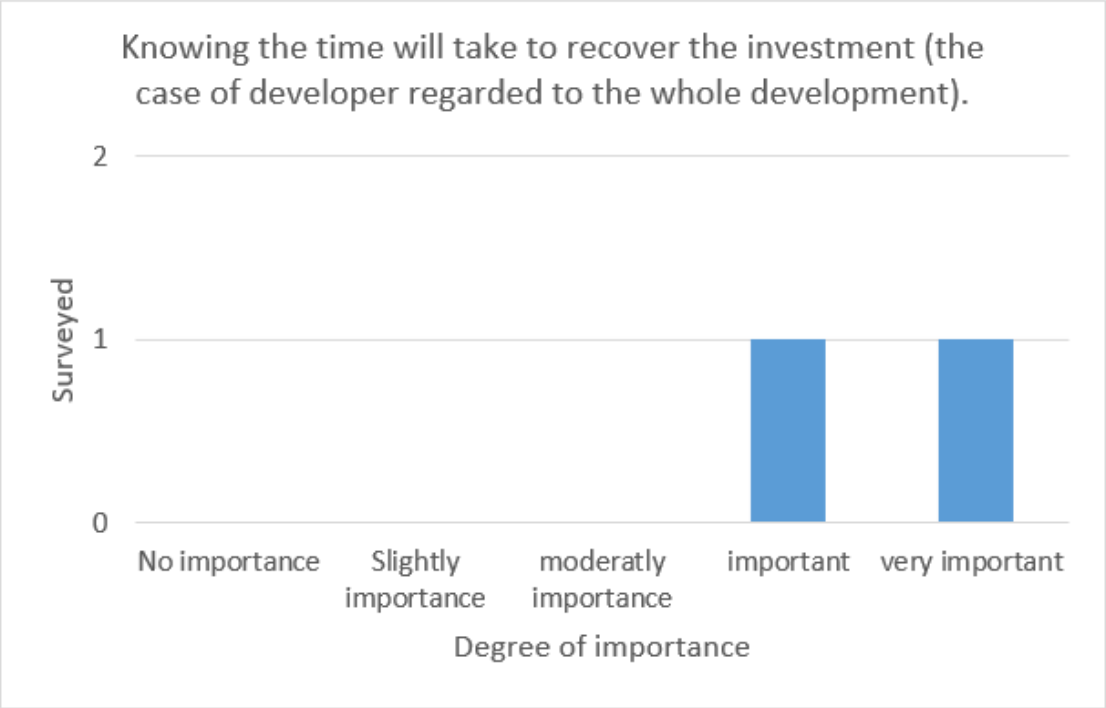

Figure 39 Knowing the time will take to recover the investment (the case of developer regarded to the whole development). Source: Author

QUESTION 7

Table 37 Know the efficiency between renewable energy production (solar panels) vs renewable energy consumption (as overlapping activities). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	1	25 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 9

Average: 4,5

final score: 4

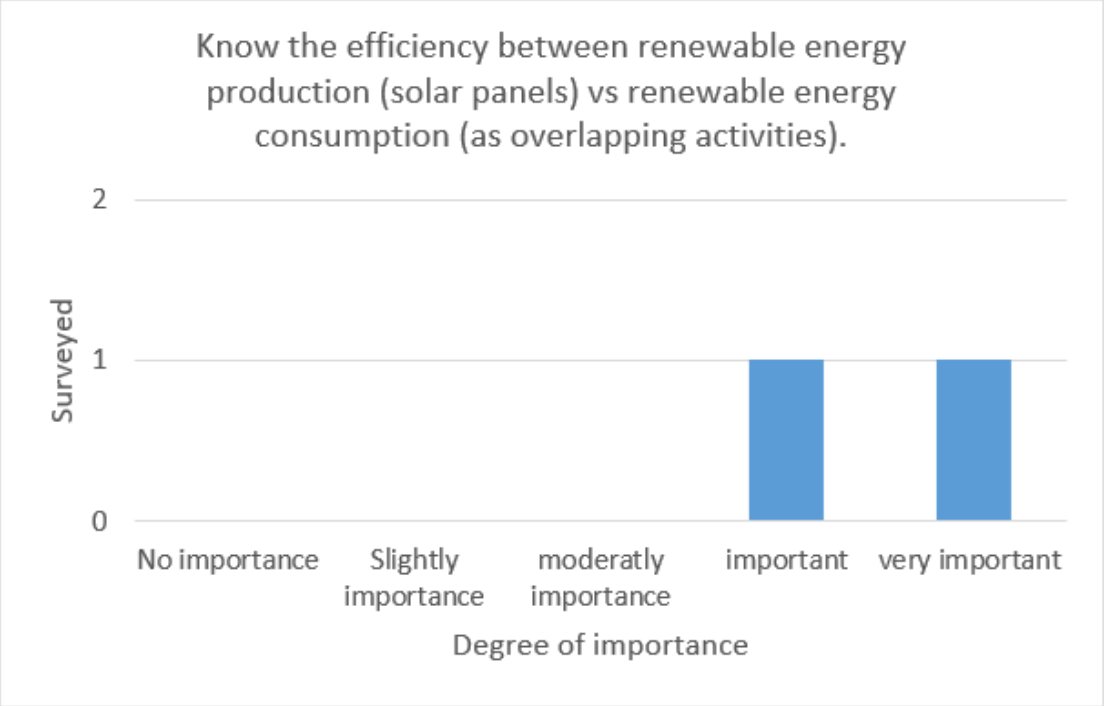

Figure 40 Know the efficiency between renewable energy production (solar panels) vs renewable energy consumption (as overlapping activities). Source: Author

QUESTION 8

Table 38 Importance of measuring the amount of electric energy generation from renewable sources that is exported to the neighborhood, Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	1	25 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 9

Average: 4,5

final score: 4

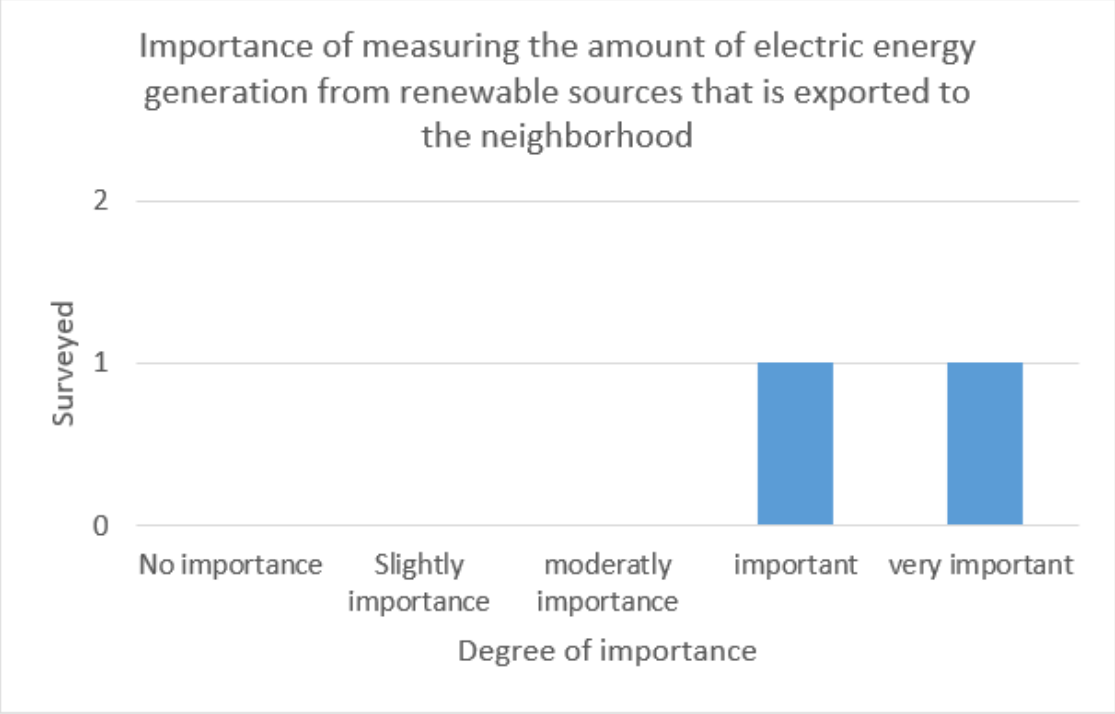

Figure 41 Importance of measuring the amount of electric energy generation from renewable sources that is exported to the neighborhood. Source: Author

QUESTION 9

Table 39 Measure the capacity to storage renewable energy as a response to the necessities of the community during the night, Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	2	100 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 8

Average: 4

final score: 4

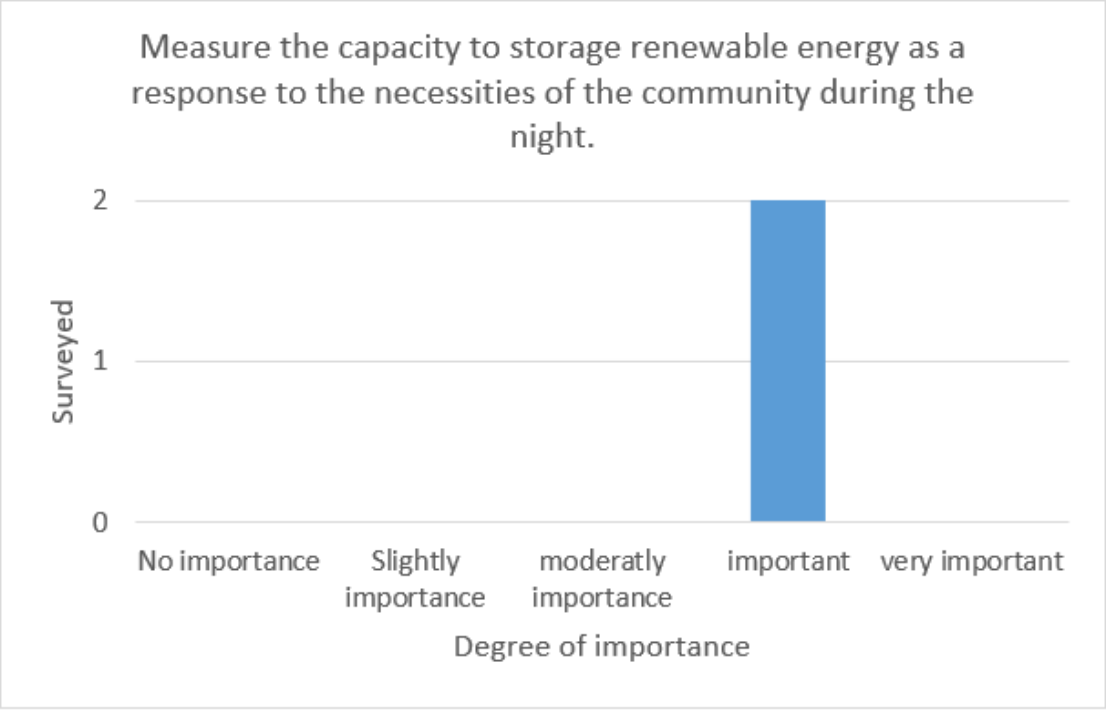

Figure 42 Measure the capacity to storage renewable energy as a response to the necessities of the community during the night, Source: Author

QUESTION 10

Table 40 Measure the amount of renewable energy consumption in building due to the load shift. (RES self-consumption optimization), Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	1	25 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 9

Average: 4,5

final score: 4

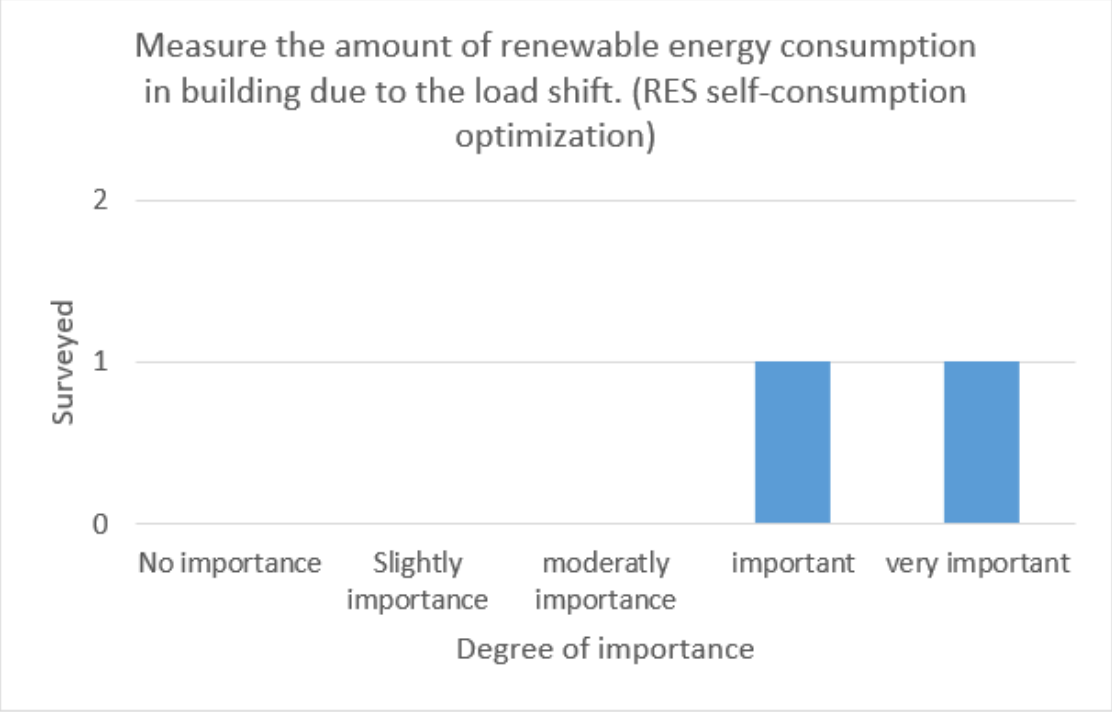

Figure 43 Measure the amount of renewable energy consumption in building due to the load shift. (RES self-consumption optimization), Source: Author

QUESTION 11

Table 41 knowing if the consumption of energy from the grid could get to the maximum it could supply to the community without other energy sources, Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	1	25 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 7

Average: 3,5

final score: 3

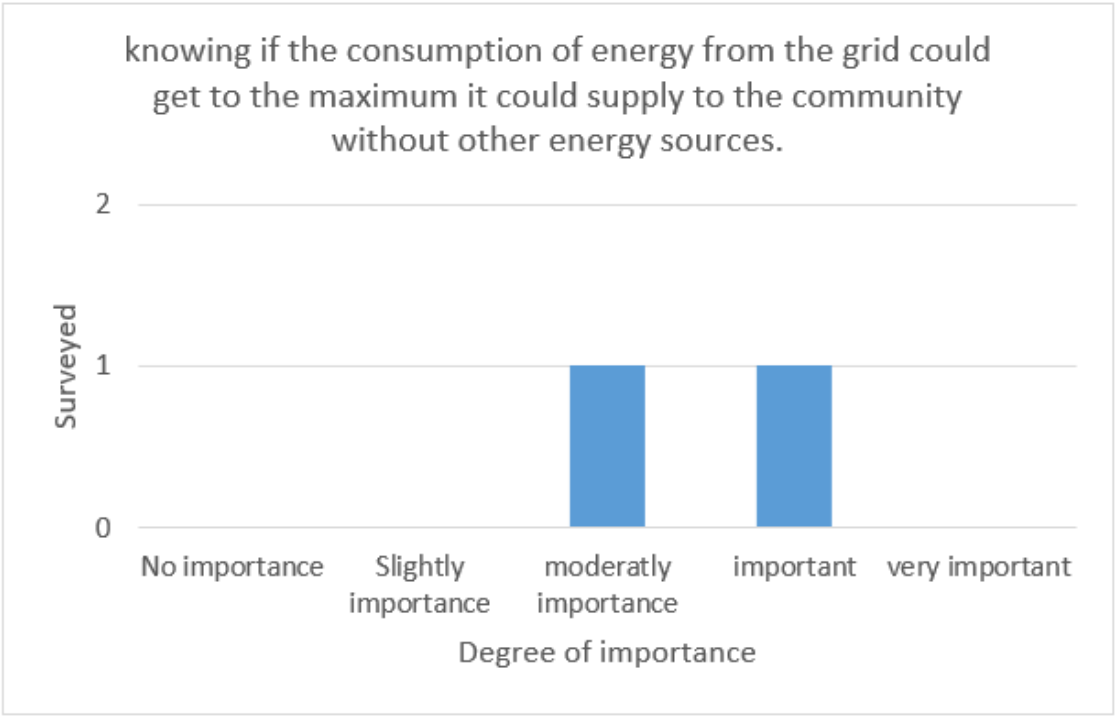

Figure 44 knowing if the consumption of energy from the grid could get to the maximum it could supply to the community without other energy sources. Source: Author

QUESTION 12

Table 42 Know the amount of renewable energy traded in the community (building scale). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 8

Average: 4

final score: 4

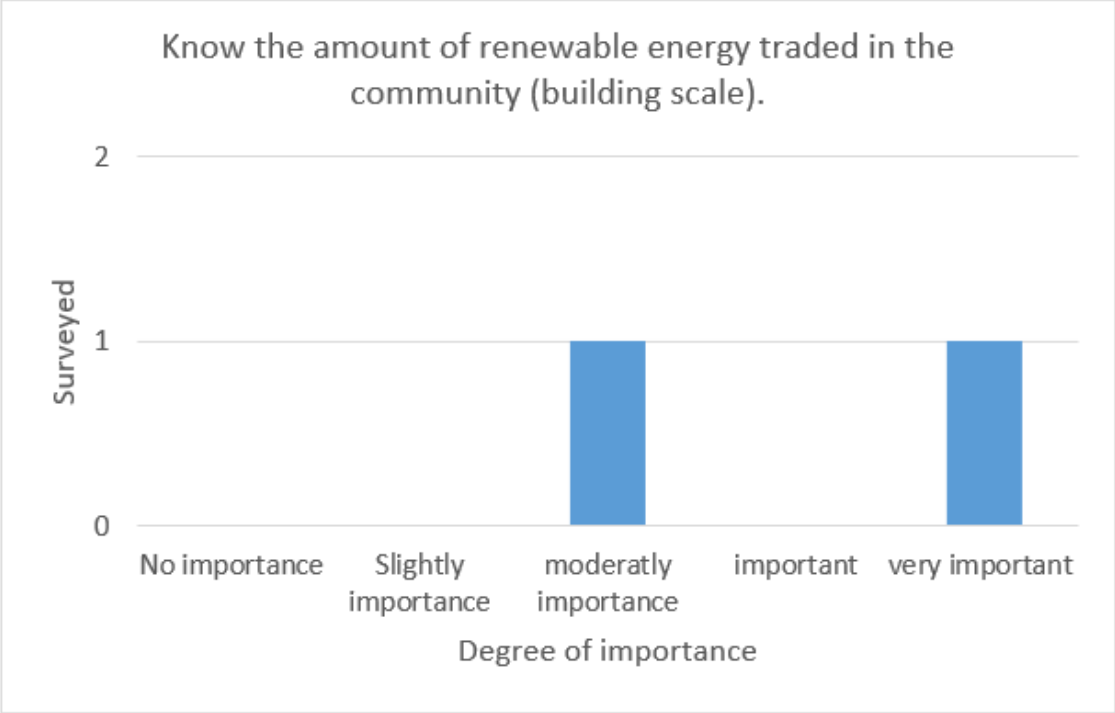

Figure 45 Know the amount of renewable energy traded in the community (building scale). Source: Author

QUESTION 13

Table 43 Measure the customer energy literacy (if they are conscious in how to consume and save energy). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	1	25 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 7

Average: 3,5

final score: 3

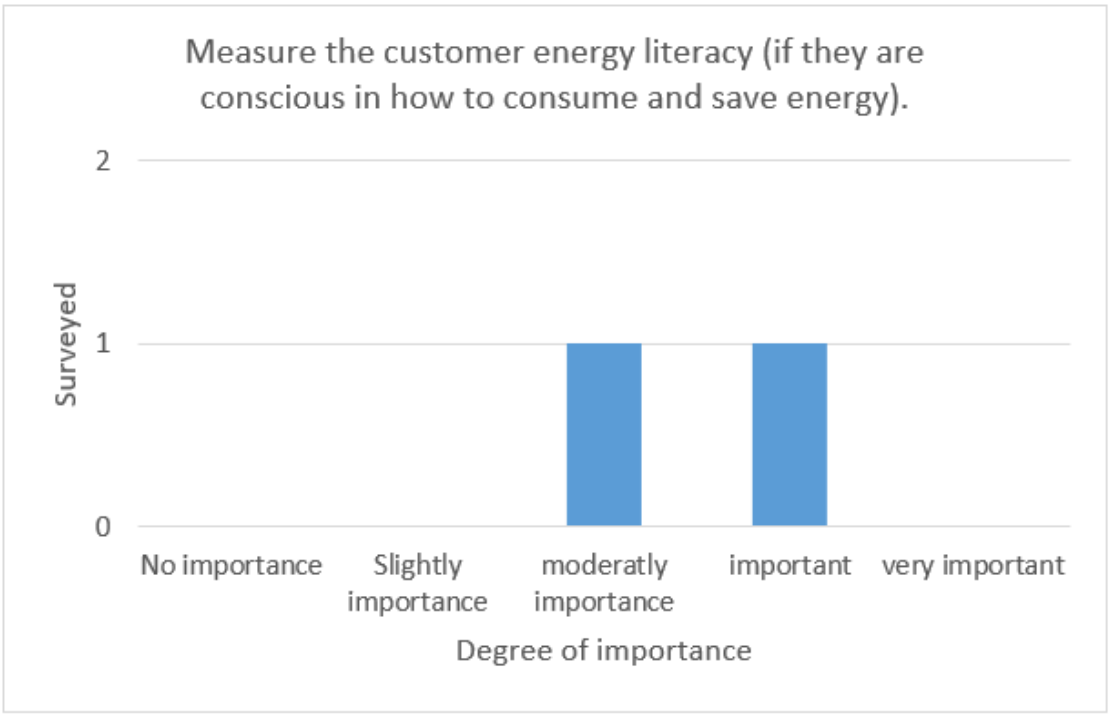

Figure 46 Measure the customer energy literacy (if they are conscious in how to consume and save energy). Source: Author

QUESTION 14

Table 44 Measure customer satisfaction by comparing the amount of promoter's vs detractors of the project, Source: Author

Degree of importance	f	%
No importance	1	25 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 3

Sum: 4

Average: 2

final score: 2

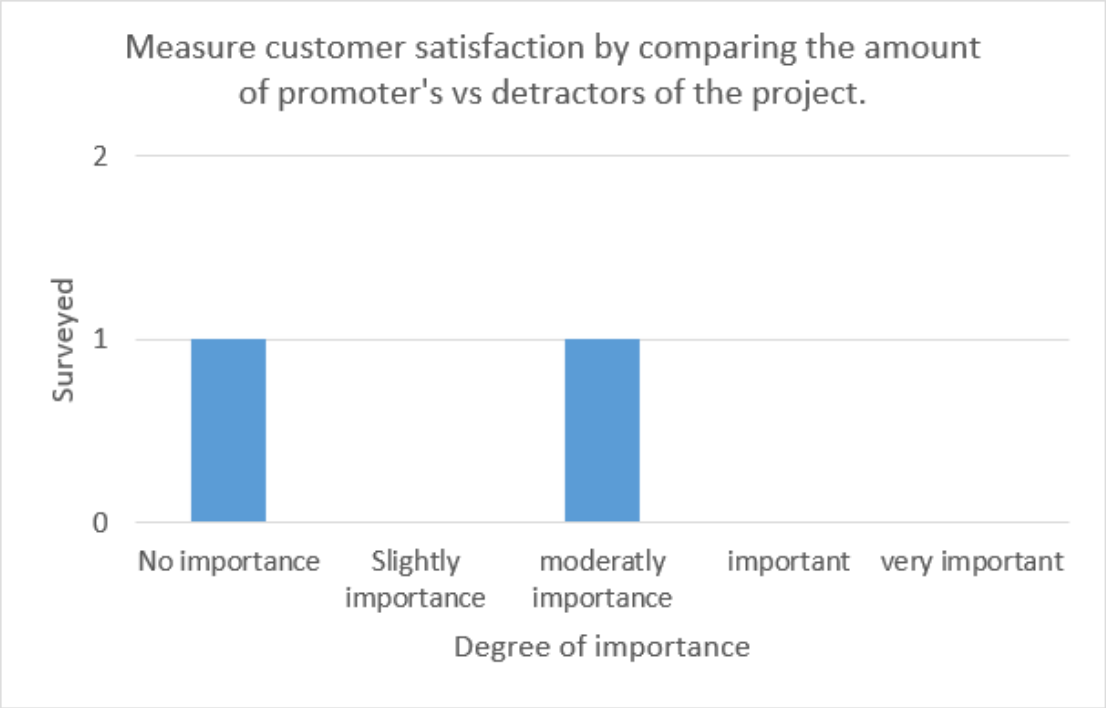

Figure 47 Measure customer satisfaction by comparing the amount of promoter's vs detractors of the project. Source: Author

QUESTION 15

Table 45 Measure the Community engagement related with, urban facilities, urban spaces, and social activities (If they are an active and participatory community). Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	0	0 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 7

Average: 3,5

final score: 3

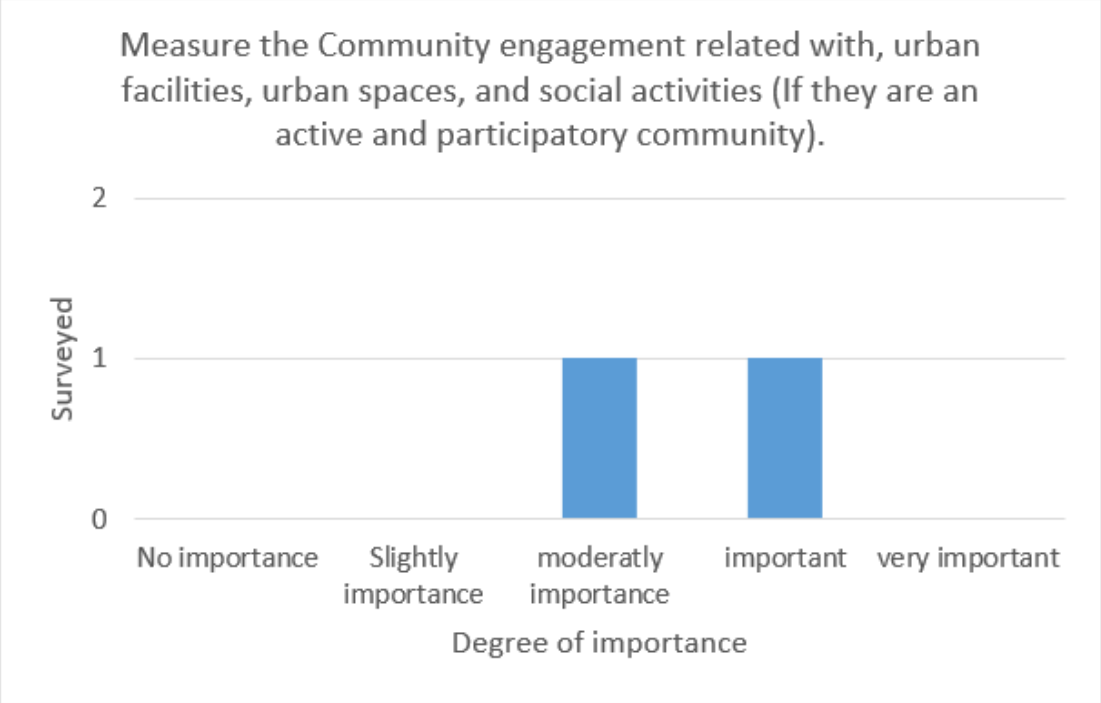

Figure 48 Measure the Community engagement related with, urban facilities, urban spaces, and social activities (If they are an active and participatory community). Source: Author

QUESTION 16

Table 46 Measurement of residential density, related to the amount of residents per square meter. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	1	25 %
Moderately importance	0	0 %
Important	1	25 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 6

Average: 3

final score: 3

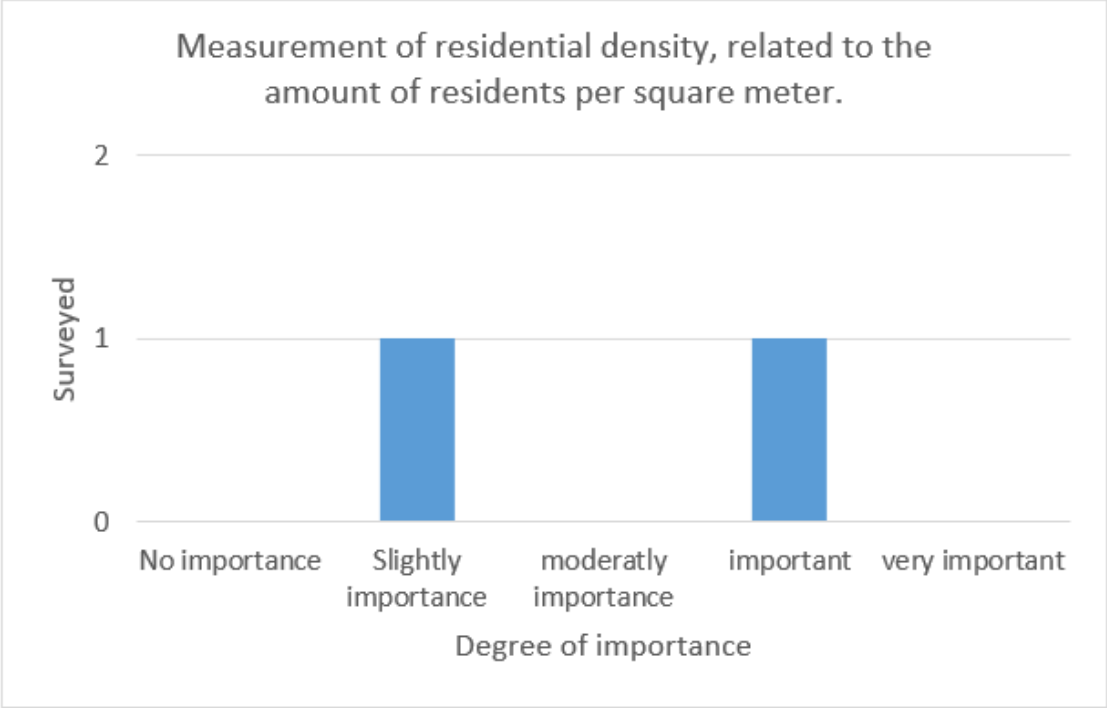

Figure 49 Measurement of residential density, related to the amount of residents per square meter, Source: Author

QUESTION 17

Table 47 Know the number of apartments that are rented vs the total apartments. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	0	0 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 7

Average: 3,5

final score: 3

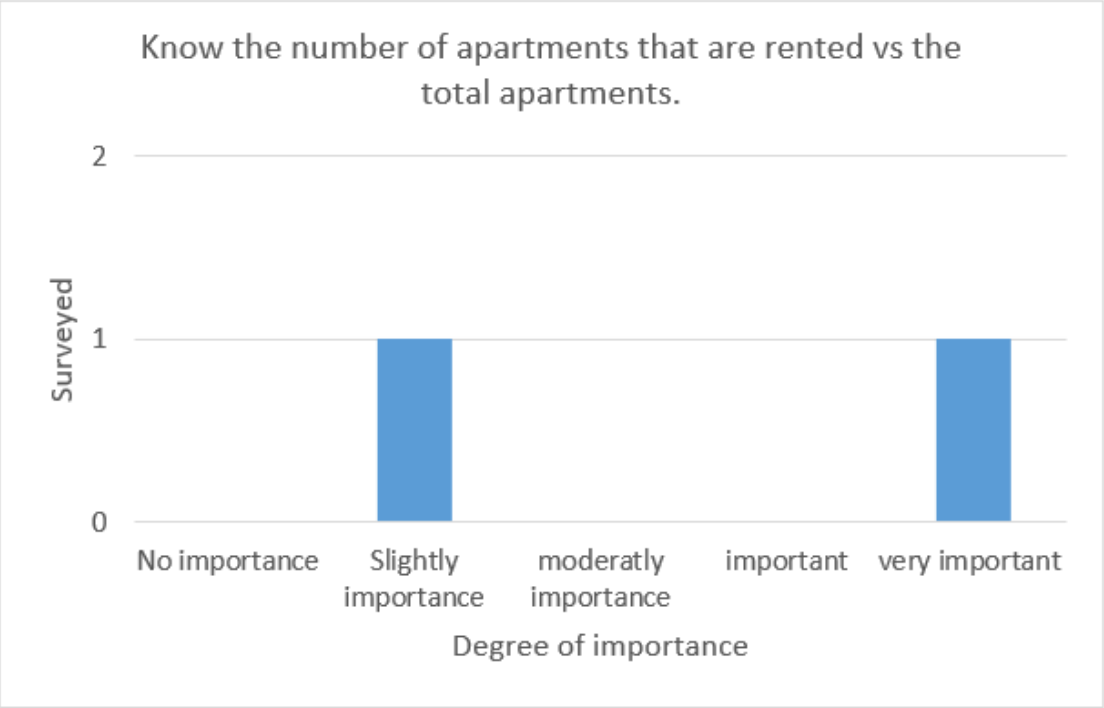

Figure 50 Know the number of apartments that are rented vs the total apartments. Source: Author

QUESTION 18

Table 48 Knowing the Percent of reused or recycled materials used for construction. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	1	25 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 4

Sum: 7

Average: 3,5

final score: 3

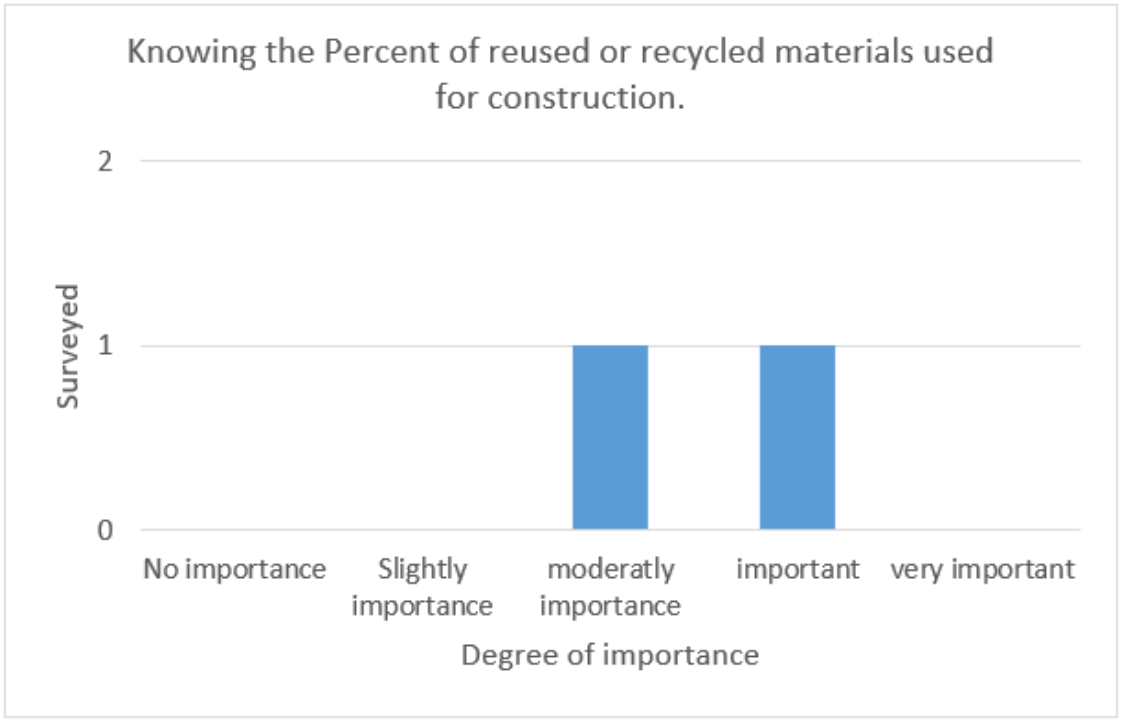

Figure 51 Knowing the Percent of reused or recycled materials used for construction. Source: Author

QUESTION 19

Table 49 Compare if there is a decrease in the carbon intensity allowed to the electricity mix consumption Source: Author

Degree of importance	f	%
No importance	1	25 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 3

Sum: 4

Average: 2

final score: 2

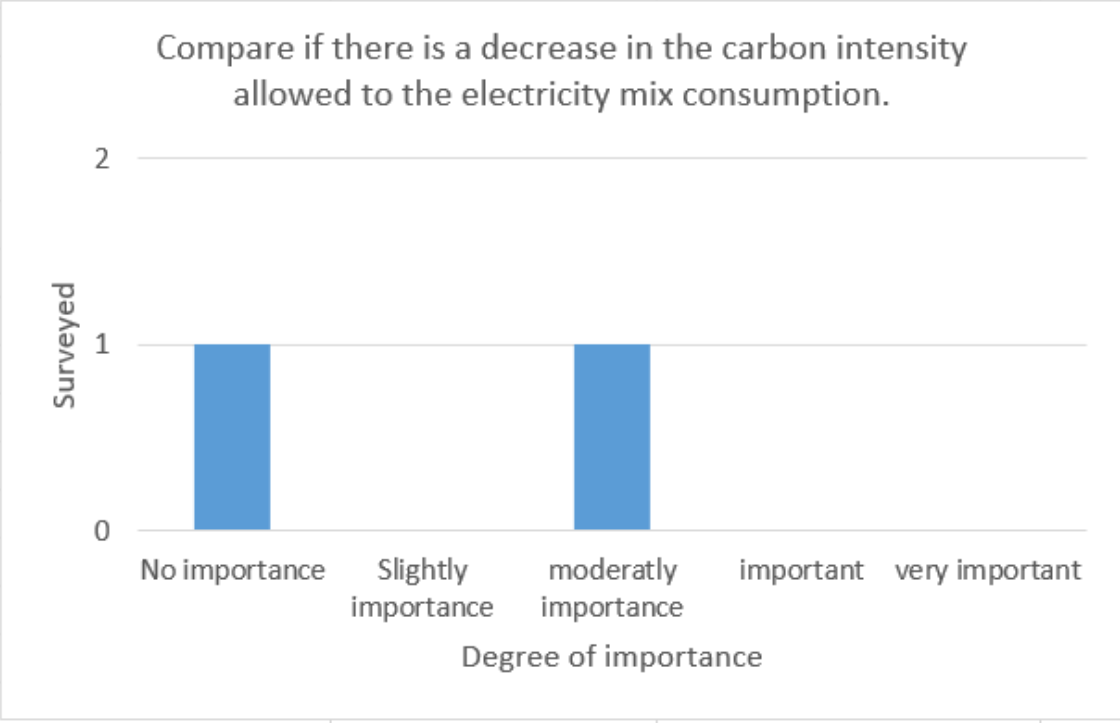

Figure 52 Compare if there is a decrease in the carbon intensity allowed to the electricity mix consumption. Source: Author

QUESTION 20

Table 50 Measure the amount of Re-use of organic sludge and composting in the project. Source: Author

Degree of importance	f	%
No importance	1	25 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	0	0 %
Total	2	100 %

Statistics:

Max obtained: 3

Sum: 4

Average: 2

final score: 2

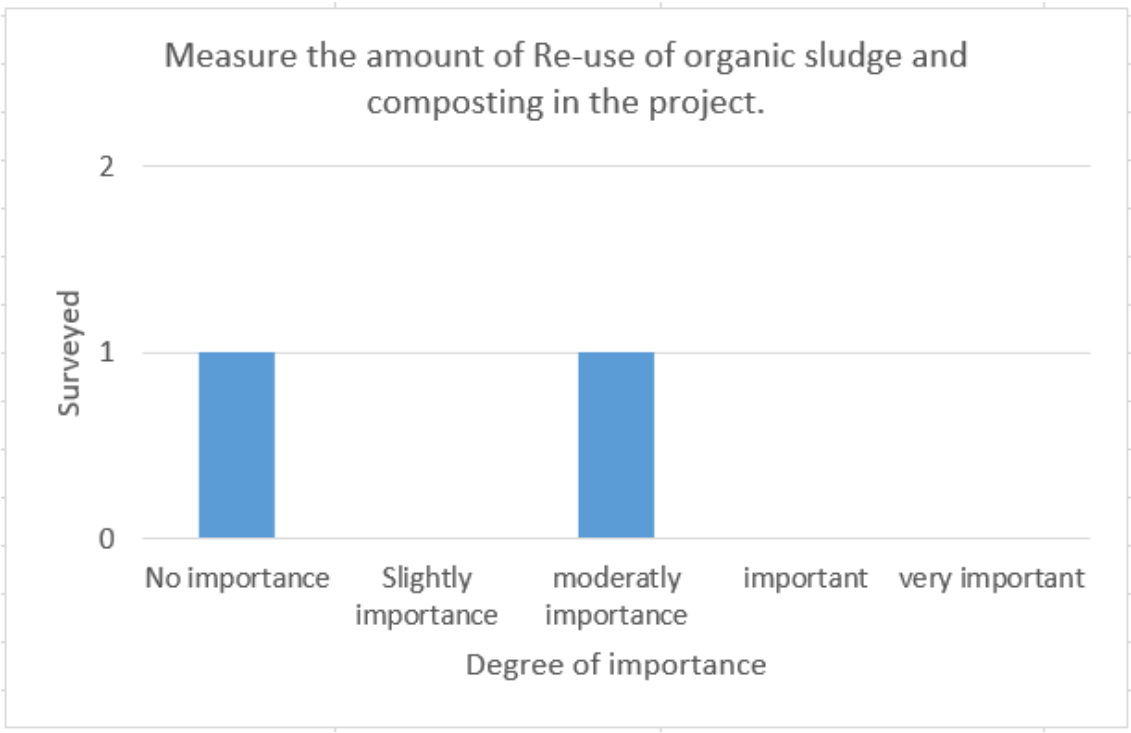

Figure 53 Measure the amount of Re-use of organic sludge and composting in the project. Source: Author

QUESTION 21

Table 51 Measure the amount of Re-use of rainwater in the project. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	0	0 %
Important	1	25 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 9

Average: 4,5

final score: 4

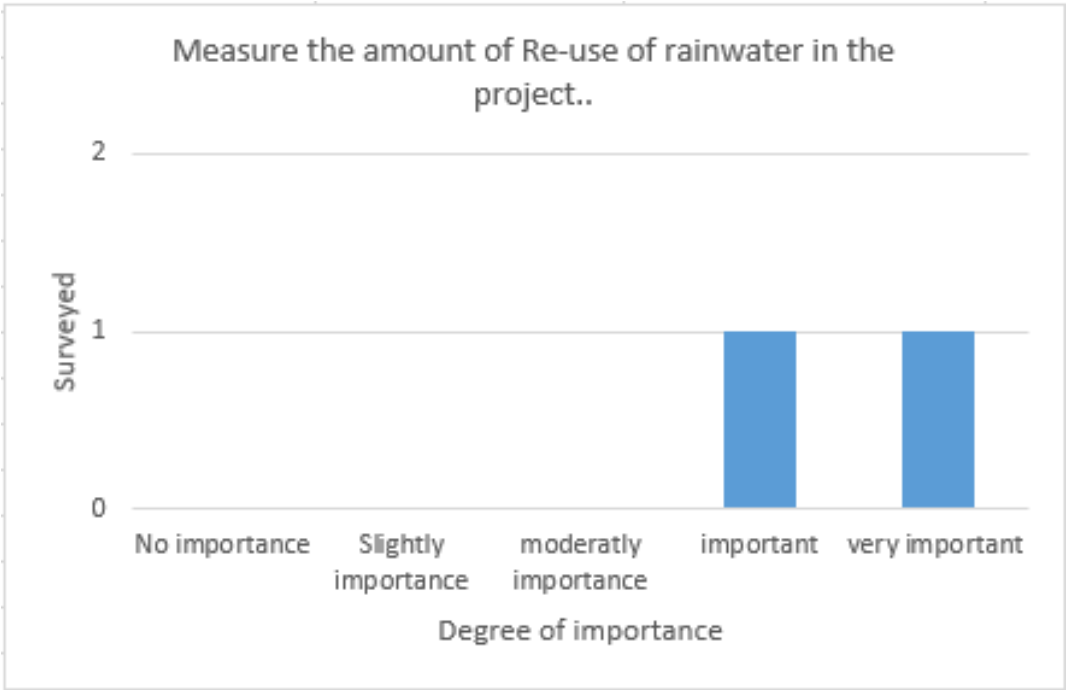

Figure 54 Measure the amount of Re-use of rainwater in the project. Source: Author

QUESTION 22

Table 52 Knowing the importance of green gas emission. Source: Author

Degree of importance	f	%
No importance	0	0 %
Slightly importance	0	0 %
Moderately importance	1	25 %
Important	0	0 %
Very Important	1	25 %
Total	2	100 %

Statistics:

Max obtained: 5

Sum: 8

Average: 4

final score: 4

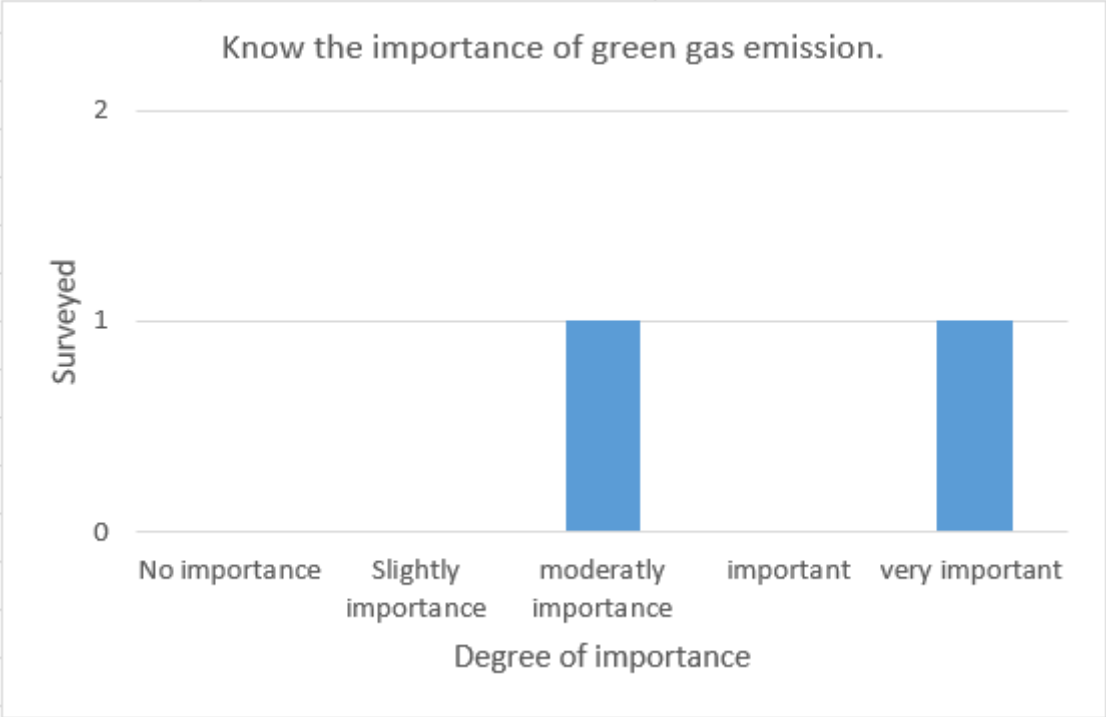

Figure 55 Knowing the importance of green gas emission. Source: Author

4.3 Key performance indicators comparison through profit and non-profit organizations.

Table 53 Key performance indicators comparison through community, profit and non-profit organizations.

NUMBER	INDICATOR	CATEGORY	GOAL	DEIFINTION	UNIT	SOURCE	DEGREE OF IMPORTANCE
14	Net promoter score measuring customer satisfaction (difference in % between promoters and detractors)	Social	Goal 10	Measure customer satisfaction by comparing the amount of promoters vs detractors	%	INTERCONNECT	2,333333333
19	Composting and re-use of organic sludge	Environment	Goal 13	The criterion measures the re-use of organic sluge consumption for services or activites realted to gardens or orchards.	m3/ occupant/year	CESBA	2,333333333
20	Re-use of rainwater in RESIDENTIAL buildings	Environment	Goal 13	The criterion measures the re-use of water consumption of sanitary fittings/devices and water.	m3/ occupant/year	CESBA	2,333333333
16	Residential rental dwelling units as a percentage of total dwelling units	Housing	Goal 9	provides general insight for local authorities to develop a stronger understanding of the current and future housing supply to better plan and support housing needs.	%	ISO	3
17	Residential density	Housing	Goal 9	This indicator means the number of dwelling units per gross acre of residential land area including streets, easements and open space portions of a development.	U/Area	CESBA	3,333333333
18	Percent of reused or recycled materiales used for construction or renovation	Housing	Goal 9	The criterion measures the amount of recycled materials used during the construciton or maintenance of the project.	m3/ %	CESBA	3,333333333
15	Community management of urban facilities and urban spaces	Social	Goal 10	To raise the level of community involvement in planning through the redistribution of power. The assessment is therefore about.	Arnstein score	CESBA	3,333333333
1	Average household income	Economy	Goal 11	Household income measures the combined incomes of the people in a particular household. An average of household income in a city can indicate the monetary well-being of residents within the city.	$	ISO	3,666666667
2	Affordability of housing property	Economy	Goal 11	refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.	$	CESBA - OECD	3,666666667
3	Affordability of housing rental	Economy	Goal 11	refers to the cost of housing services and shelter – both for renters and owner occupiers – relative to a given individual's or household's disposable income.	$	CESBA - OECD	3,666666667
4	Total Investments	Economy	Goal 11	The KPI is defined as the number of cumulated payments relevant to the energy aspects of the systems (CAPEX).	euro/m2, euro (total)	PAPERS	3,666666667
5	Total Annual Costs	Economy	Goal 11	The total annual costs are defined as the sum of capital-related annual costs (interests and repairs caused by the investment), requirement-related costs (power costs), operation-related costs (costs of using the installation) and other costs (insurance).	Euro/year	PAPERS	3,666666667
11	Peak load reduction	Energy	Goal 7	Percentage reduction of monthly peak at grid connection level	%	INTERCONNECT, PAPERS	3,666666667
13	Rise in customer energy awareness	Social	Goal 10	measuring the rise in customer energy awareness	%	INTERCONNECT	3,666666667

NUMBER	INDICATOR	CATEGORY	GOAL	DEIFINTION	UNIT	SOURCE	DEGREE OF IMPORTANCE
22	Carbon Intensity reduction	Environment	Goal 13	Decrease in CO2 intensity of the electricity mix in the pilot due to services implemented in the project.	gCO2/year	INTERCONNECT, PAPERS	3,666666667
6	Payback Period	Economy	Goal 11	The payback period is the time it takes to cover investment costs. It can be calculated from the number of years elapsed between the initial investment and the time at which cumulative savings or set the investment.	Years	PAPERS	4
9	Mid-term storage of electrical energy	Energy	Goal 7	the indicator is related with the systems which maximize energy generation from intermittent renewable energy sources. Also maintain power quality, frequency and voltage in times of high demand for electricity. and finally absorb excess power generated locally for example from a rooftop solar panel.	%	CESBA	4
12	Locally produced energy traded in community	Energy	Goal 7	Percentage of the energy produced locally that is traded in the community	kWh / %	INTERCONNECT	4
21	Greenhouse gas emissions measured in tonnes per capita	Environment	Goal 13	Reflects the "Biodiversity and Ecosystem Services" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment".	Tonnes	ISO	4
7	Efficiency between renewable energy production and renewable energy consumption	Energy	Goal 7	The idicator measures if the energy produced form renewable energy technologies (RES) is enough for the community energy consumption.	kWh	PAPERS	4,333333333
8	Electric energy generated from renewable sources that is exported from the local area	Energy	Goal 7	Aims at the production of the energy demand and at the increase of the share of renewable energy to other neighborhoods	Watt	CESBA	4,333333333
10	Increase in the use of RES due to load shift in buildings	Energy	Goal 7	This KPI measures the percentual change in local RES penetration enabled by the provision of load shifting capacities in building of the community	15 minutes / kWh / %	INTERCONNECT	4,333333333

4.4 Results analysis.

The results obtained reveal the importance of each indicator selected from the 5 different entities/projects which focus their research and application of the correct key performance indicators for projects. The questionary support that every indicator is relevant, being so that no one got a score below 32 points or in the range of no importance, however no one got the maximum score (80 points) and could be situated in the very important position, nevertheless most of the indicators are between “moderately importance” and “important” giving us that on one hand it is necessary to provide more clear and concrete information to the community and on the other one that it is crucial that the private entities balance their interest in the profitability of the project and the quality of it this last referring to social activities and quality of the houses.

The first questionary applied just to the community expose that the most relevant group of indicators are those ones related to energy, this could be on one instance for the constant work of the interconnect project that encourage the community to manage their energy consumption using the energy in periods that don’t overload the electrical network. The second instance could be affected for the actual overprices of the energy, related to the political and economic situation in the European union of 2022.

The next indicator that are also in the range of “importance”, is the number 13 with a score of 4,06 and referring to measure the customer energy literacy (if they are conscious in how to consume and save energy), being the only social indicator in this range, the others two are situated in the middle of the list with a punctuation of 3,93 and 3,81; This show up the interest of the community to have an active role in each stage of the project, having more relevance in the maintenance phase (it is important to have clear that maintenance phase do not only refer to the status of the physical/ technical aspects of the project but also to have a healthy and active community).

The Second big group of the KPIs indicators are the economic ones having a score between 3,43 and 3,87, those are the classic and necessary indicators to know the availability of a project in terms of money, if it needs to be subsidized by the state or privet investors. Also, to the rank the income of the people that would buy or rent the apartments of the project.

It is true that if the community reduced their consumption of services such as light, gas and water it would help the conservation of the environment, however the indicators exclusively of environmental issues don’t have the strong participation that it should have, obtaining and score between 3,35 and 3,75, it is probably that the community need and induction or a course that

explain to them what are the actions the have to introduce to their homes, such as the ones related to the indicator 19 and 20 that wants to increase the re-use of organic sludge and water respectively.

Ending with the housing indicators it evidences that people are not interested in how many inhabitants are in the project or how many inhabitants lives as an owner or a tenant, however if it is not taking into consideration in the design process it would affect negatively the inhabitants of the project. the amount of people will be bigger in comparison with the services that the project could provide, referring for example to the community manager and the spaces for community activities. It is true that those indicators are more relevant for the developer, but the community should also play a relevant role in decision making.

Enery Indicators
Economic Indicators
Social Indicators
Environmental Indicators
Housing Indicators

Position	Indicator	Score	Importance
22	16	51	3,18
21	17	53	3,31
20	22	54	3,37
19	6	55	3,43
18	5	58	3,62
17	18	60	3,75
16	19	60	3,75
15	20	60	3,75
14	21	60	3,75
13	15	61	3,81
12	1	62	3,87
11	2	62	3,87
10	3	62	3,87
9	4	62	3,87
8	14	63	3,93
7	8	64	4
6	9	65	4,06
5	13	65	4,06
4	7	66	4,12
3	11	67	4,18
2	12	70	4,37
1	10	71	4,43

Figure 56 KPIs Hierarchy from community questionary. Source: Author

The second phase of the questionary, the one which compare the point of view between community, private entity, and research entity shows up that the interest of the energy aspects remains obtaining the higher score, between 4 and 4,33.

The changes start to appear in the middle of table where there is a mix between economic (Knowing the time will take to recover the investment), environment (Knowing the Percent of reused or recycled materials used for construction) and social (Measure the customer energy literacy, if they are conscious in how to consume and save energy) indicators, all of them with a score of 3,67, with the same score there is the second big group of indicators referring to economic ones, reinforcing the importance of knowing the availability of the project.

In the case of housing indicators, they obtain a higher position in comparison with the community questionary, this happens because the developer should be aware of the conditions of each habitable space in the project, complying with regulations, making them more relevant, the indicators have a score between 3,00 and 3,33 being lower than the score of the community questionary but obtaining a higher position.

The last group with a score of 2,33 and a grade of importance of “slightly importance” are two of the four indicators referring to environmental aspects and one of social, the environment ones evaluate the amount of Re-use of organic sludge and composting and rainwater in the project, the social one evaluates satisfaction by comparing the amount of promoter's vs detractors of the project, in this case this indicator passes from the position number eight to the last one, revealing that the community consider their participation a key point for projects of social housing with energy communities while the private and public entities don’t recognize them as an important actor. According to the problems studied in the literature, it may be that aspects of overcrowding or poor construction quality are not evident in the Italian context and, in this way, the indicators referring to aspects of housing development are lack importance since the problem is not present in the same intensity.

Position	Indicator	Score
22	14	2,33
21	19	2,33
20	20	2,33
19	16	3,00
18	17	3,33
17	18	3,33
16	15	3,33
15	1	3,67
14	2	3,67
13	3	3,67
12	4	3,67
11	5	3,67
10	11	3,67
9	13	3,67
8	22	3,67
7	6	4,00
6	9	4,00
5	12	4,00
4	21	4,00
3	7	4,33
2	8	4,33
1	10	4,33

Figure 57 KPIs hierarchy mixing community and companies results, Source: Author

5. CONCLUSIONS

Currently, the challenges that social housing has lies in the importance of energy efficiency and community participation to carry out active and efficient consumption practices, in addition to the need to propose a program of activities where, as a result of the pandemic, they have emerged, such is the case of spaces for coexistence and integration, while on the human talent side, the presence of an organizer or manager who understands the needs and interests of those who live in the project is relevant in order to be able to make proper use of the built facilities.

The figure of energy communities in Italy is under development stage, where guidelines are being provided on how they should be configured and act according the implementation of renewable energy sources, as an example of this, the case study that was presented in this thesis, the Moneta community in the city of Milan, although it has not implemented renewable energy sources, meets the objective of understanding how to be aware of energy consumption and how they can actively participate to improve their consumption. The Interconnect project

is a good case study as a prelude to how to empower a community that shows an interest in energy, social, economic, and environmental issues.

The implementation of the figure of energy communities in housing development is a response to meeting the 17 sustainable development goals, representing progress mainly in goals number 7 (guarantee access to affordable, reliable, sustainable, and modern energy for all) where for data from 2017 the rate of improvement in energy efficiency was less than the 3% necessary, in the same way the proportion of renewable energy production in total consumption for the year 2017 was 17%, goal number 11 (make cities and human settlements inclusive, safe, resilient and) where, especially in urban areas where most of the world's population is concentrated, they have to reduce air pollution, which caused 4.2 million premature deaths in 2016 in addition to providing an urban development where the proximity to public spaces and recreation is considered not to exceed 400 meters away in order to provide healthy and inclusive projects, finally objective number 13 (adopt urgent measures to combat climate change and its effects) where it seeks to reduce the increase in temperature since for the year 2019 it was the hottest ever recorded, in addition to investing the investment between fossil fuels and renewable energy.

Social housing developments should incorporate a way in which communities came together. In the cases of energy communities, where a mutual interest will prevail over the years, meaning this that the community will be together and strong without wondering the time. this connection will provide windows to discuss problems, improvements of the generation and management of electrical renewable energy, consumption of resources, re-using organic materials and water.

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