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Master's Degree in Territorial, Urban, Environmental and Landscape Planning

THE MULTIPLE BENEFITS APPROACH IN ENERGY REQUALIFICATION PROJECTS

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SUMMARY

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ABBREVATIONS

ICT	Information and Communication Technologies
PED	Positive Energy District
SCIS	Smart Cities Information System
DUT	Driving Urban Transition
CUE	Circular Urban Economy
JPI	Joint Programming Initiative
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
IEA	International Energy Agency
UNFCCC	United Nations Framework Convention on Climate Change
SDG	Sustainable Development Goal
NEB	New European Bauhaus
EPBD	Energy Performance of the Buildings Directive
PEB	Positive Energy Building
CPCC	Climate Positive Circular Communities
IHRB	Institute for Human Rights and Business
IEBC	Energy in Buildings and Communities Programme
DCE	Discrete Choice Experiment
RUT	Random Utility Theory
BIBD	Balanced Incomplete Block Designs
HB	Hierarchical Bayesian
MNL	Multinomial Logit
ESG	Environmental, Social and Governance

ABSTRACT

Climate change is indisputably one of the greatest global challenges faced by humanity in the 21st century. A great responsibility for this issue must be given to cities (Ranalder et al., 2021); however, we must try to transform them from a problem into an opportunity. According to the World Bank, more than 50% of the global population (United Nations, 2019) lives in cities and as this number is projected to surge further in the upcoming years, it is essential to develop ecologically friendly and sustainable cities. Ensuring that our cities are equipped to deal with the challenges of climate change requires the involvement of all stakeholders, from large corporations and climate lenders to individual citizens. This is a challenge that must be met trying to ensure that no one is left behind.

One approach to meeting this challenge is the recognition, study, and evaluation of multiple benefits of urban and energy requalification projects. Multiple benefits refer to the positive impacts of a project or policy without any ranking prejudice, in contrast to the co-benefits approach, which emphasizes a single main goal (e.g. energy efficiency) although it admits the existence of other "nice to have" benefits.

Even though the concept of multiple benefits has been presented by the International Energy Agency almost a decade ago, in reaction to the recognition of how much potential for investment in the energy efficiency of buildings there was still to be tapped, is still difficult to translate it into evaluation practices, especially when the object of evaluation is a complex one (e.g., an entire neighbourhood instead of a single building).

Moving from this premise, the current thesis addresses the matter of multiple benefits recognition among similar projects and various stakeholder categories, by profiting from two ongoing European urban innovation projects (namely ARV and ProLight) and the global discussion platform IEA-EBC Annex 83 on Positive Energy Districts. Firstly, the expected multiple benefits are hypothesized from the scientific literature review and

analysis of recent smart city and positive energy district projects. Then, they are discussed with stakeholders during interactive workshops in a hybrid mode (in-person and remote interaction), up to eliciting a short list. Finally, experts and project partners, are invited to answer a questionnaire and pick out the most significant benefits for a particular case based on their professional or institutional role. The questionnaire utilized for this purpose is developed using the Best Worst Scaling technique, which requires minimal effort from the respondent while producing reliable results.

The result of the thesis provides insights on which multiple benefits to promote towards each particular stakeholder category and what to expect more from certain types of urban projects, in the attempt to investigate new ways of leveraging investment in the urban energy transition by considering non-financial impacts too.

The Multiple Benefits approach has particular utility in situations where change at the urban level is expected to alter existing social dynamics. This approach can be applied to a wide range of urban projects and policies, and its benefits can be seen across a range of domains, including environmental sustainability, social equity, and economic development. By focusing on the identification of multiple benefits, we can prioritize those policies and projects that are most effective at promoting sustainability and equity, while also mitigating the risks associated with climate change.

Addressing the challenges of climate change requires a multifaceted approach that engages all stakeholders and provides opportunities for constructive dialogue and collaboration. By utilizing the Multiple Benefits methodology, we can create actionable and effective strategies that promote long-term sustainability and resilience, while also ensuring that the interests of all stakeholders are considered. With the ongoing effects of climate change becoming ever more apparent, there has never been a more important time to prioritize sustainability and action.

Ultimately, in order to encourage the energy transition, it is important to adopt a more sustainable organization of the territory, for example by creating smart neighbourhoods and cities. However, both investors and citizens frequently find it challenging to accept such a change. Analysing and sharing the varied advantages anticipated from a project is one approach. Such projects significantly improve community economic, social, and physical well-being in addition to energy efficiency and sustainability. This highlights the need of giving urban regeneration top priority and funding in order to promote sustainable and equitable growth.

Keywords: multiple benefits, positive energy district, climate positive circular community, smart city, experts' elicitation, Best Worst Scaling, non-financial impacts

RIASSUNTO

Il cambiamento climatico è indiscutibilmente una delle più grandi sfide globali affrontate dall'umanità nel 21° secolo. Dato che le città contribuiscono notevolmente ad aggravare questo fenomeno (Ranalder et al., 2021), bisogna cercare di agire cercando di trasformarle da problema ad opportunità. Secondo la Banca mondiale, oltre il 50% della popolazione mondiale (Nazioni Unite, 2019) vive nelle città e poiché si prevede che questo numero aumenterà ulteriormente nei prossimi anni, è essenziale (ri)progettare città in maniera più sostenibile a livello ambientale. Garantire che le nostre città siano pronte per affrontare le sfide del cambiamento climatico richiede il coinvolgimento di tutte le parti interessate, dalle grandi aziende e finanziatori ai singoli cittadini. E' importante, però, considerare i bisogni e le aspettative di più parti interessate, in modo tale da non lasciare indietro nessuno mentre si persegue questo obiettivo.

Un approccio per affrontare questa sfida è il riconoscimento, lo studio e la valutazione dei molteplici benefici dei progetti di riqualificazione urbana ed energetica. I benefici multipli si riferiscono agli impatti positivi di un progetto o di una politica senza nessun tipo di prioritizzazione, in contrasto con l'approccio dei co-benefici, che enfatizza un unico obiettivo principale (ad esempio l'efficienza energetica) sebbene ammetta l'esistenza di altri benefici "aggradabili" .

Nonostante il concetto dei molteplici benefici sia stato introdotto dall'Agenzia Internazionale dell'Energia quasi un decennio fa come risposta al riconoscimento dell'enorme potenziale di investimento ancora inesplorato nell'efficienza energetica degli edifici, risulta ancora arduo implementarlo concretamente nelle procedure di valutazione, soprattutto quando l'oggetto della valutazione è di natura complessa, come ad esempio un intero quartiere anziché un singolo edificio.

La presente tesi individua una metodologia per lo studio dei benefici multipli in relazione a progetti di riqualificazione urbana ed energetica e prendendo in

considerazione varie categorie di stakeholder. Tale metodologia è applicata parzialmente su due progetti europei di innovazione urbana in corso (vale a dire ARV e ProLight) e sulla piattaforma di discussione globale IEA-EBC Annex 83 che si occupa di distretti energetici ad energia positiva (PED). In primo luogo, i benefici multipli attesi sono ipotizzati dalla revisione della letteratura scientifica e dall'analisi dei recenti progetti di smart city e distretti energetici ad energia positiva. Successivamente, si procede con l'organizzazione di workshop interattivi con le parti interessate, adottando una modalità ibrida che prevede sia l'interazione in persona che a distanza. In questo contesto, si arriva a compilare una breve lista di benefici. Successivamente, esperti e partner del progetto vengono invitati a rispondere a un questionario, nel quale sono chiamati a identificare i benefici più significativi in relazione ad un caso studio specifico e in base al loro ruolo professionale o istituzionale. Il questionario, concepito a tal fine, si avvale della tecnica del Best Worst Scaling, la quale richiede uno sforzo minimo da parte dell'intervistato, pur producendo risultati affidabili.

Il risultato della tesi fornisce spunti su quali benefici multipli promuovere nei confronti di ciascuna particolare categoria di stakeholder e cosa aspettarsi maggiormente da alcuni tipi di progetti urbani, nel tentativo di indagare nuovi modi per rendere più proficui gli investimenti nella transizione energetica urbana considerando anche gli impatti.

L'approccio dei benefici multipli ha una particolare utilità in situazioni in cui si prevede che il cambiamento a livello urbano alteri le dinamiche sociali esistenti. Questo approccio può essere applicato a un'ampia gamma di progetti e politiche urbane e i suoi benefici possono essere percepiti a livello di maggiore sostenibilità ambientale, equità sociale e sviluppo economico. Concentrandoci sull'identificazione dei benefici multipli, possiamo dare la priorità a quelle politiche e progetti che sono più efficaci nel promuovere la sostenibilità e l'equità, mitigando anche i rischi associati al cambiamento climatico.

Affrontare le sfide del cambiamento climatico richiede un approccio sfaccettato che coinvolga tutte le parti interessate e offra opportunità di dialogo e collaborazione costruttivi. Utilizzando la metodologia dei benefici multipli, possiamo creare strategie attuabili ed efficaci che promuovono la sostenibilità e la resilienza a lungo termine, garantendo al contempo che gli interessi di tutte le parti interessate siano presi in considerazione. Di fronte all'inequivocabile avanzamento degli effetti del cambiamento climatico, non si è mai avvertita una necessità tanto impellente di dare priorità assoluta alla sostenibilità e di intraprendere azioni concrete.

In definitiva, per favorire la transizione energetica, è importante adottare un'organizzazione più sostenibile del territorio, ad esempio creando quartieri e "città intelligenti". L'analisi e la successiva condivisione dei vantaggi previsti da un progetto rappresenta un valido approccio per favorire l'accettazione di nuovi progetti urbani da parte di cittadini e investitori, che spesso sono riluttanti al cambiamento. Tali progetti migliorano significativamente il benessere economico, sociale e fisico della comunità oltre all'efficienza energetica e alla sostenibilità. Ciò evidenzia la necessità di dare la massima priorità e finanziamenti alla rigenerazione urbana al fine di promuovere una crescita sostenibile ed equa.

Parole chiave: benefici multipli, distretto energetico a energia positiva, comunità circolare positiva per il clima, città intelligente, confronto con esperti, Best Worst Scaling, impatti non finanziari

INTRODUCTION

This thesis was realised after a period of internship at Eurac Research, located in Bolzano (Italy). Eurac Research is a research centre established in 1992 with more than 600 researchers employed. The centre is divided into several institutions and centres that address a wide range of subject areas, including, for instance, engineering, social sciences, and natural and medical sciences. The author was specifically involved in the Urban and Regional Energy Systems group at the Renewable Energy Institute as well as in the Planning and Evaluation sub-group, led by the author's Eurac supervisor, Dr. Adriano Bisello.

During the internship period, the author of the thesis was actively involved in the majority of the projects referenced in this study, namely ARV, ProLight, and IEA-EBC Annex 83, as well as many other European initiatives. The author was asked to give a contribution, especially on the topic of the thesis, gaining expertise and practical experience.

Current challenges

The unmistakable reality of climate change is becoming increasingly apparent in our daily lives, serving as a powerful reminder that humanity's actions have caused this destructive phenomenon. For over a century, our emission of greenhouse gases for energy production, land use, and unsustainable habits have brought us to this point, with potentially detrimental effects on our future (IPCC, 2023). The consequent damages are many, such as the increase in environmental disasters, the loss of biodiversity, reduction of food security, exposure to pandemics, etc. The harmful effects extend beyond the environmental domain and have an impact on the economic and social spheres as well. For instance, it is believed that the scarcity of non-renewable resource reserves may lead to more conflicts (United Nations Interagency Framework

Team for Preventive Action, 2012) and that droughts may result in an increase in the number of people in hunger and living in extreme poverty (Food and Agricultural Organization, 2015).

The negative effects linked to climate change are often even greater within cities. They stand for both the most afflicted areas and the ones that are most responsible for the pollution, which contributes to cause climate change. Over 50 percent of the global population resides in cities, which results in the discharge of roughly 75 percent of the world's energy and 80 percent of the world's greenhouse gas emissions (Short and Farmer, 2021). According to the Sustainable Development Goals Report 2022 (United Nations, 2022), 99% of people living in cities all over the world breathe polluted air.

Moreover, the population in urban areas is expected to increase by up to 70 percent by the year 2050 (International Energy Agency, 2021), which would also result in increased emissions of greenhouse gases if the current energy models and behavioural patterns of society will not change.

Cities, therefore, represent a threat but also a great opportunity to be able to build a better future. The emergence of sustainable solutions for urban settlement can help to limit air pollution. The cities of the future must be sustainable and ecological, to ensure a healthier environment and reduce the impact on natural resources. Among the various solutions for a sustainable city, there are Smart Cities and Positive Energy Districts. Smart Cities use a series of advanced technologies to improve the efficiency of urban services and reduce greenhouse gas emissions while Positive Energy Districts are clusters of buildings that produce more energy than they consume, thanks to the use of innovative technologies such as solar panels, wind turbines, and geothermal systems.

International and European policies

On a global scale, initiatives are being undertaken to put policies against climate change into action. If such an ambitious shared objective is to be realised, cooperation between States is needed. There is still a long way to go, but it is feasible to argue that these regulations have already partially helped to reduce GHG emissions (IPCC, 2023). It is interesting to notice that these agreements and initiatives target various aspects of society and decision-making; they are not only referred to just the environmental concern but seek to improve society in many facets.

Crucial initial measures were implemented through the Kyoto Protocol, a global agreement concerning the environment, released after the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in late 1997. Over 160 States participated in the negotiation of this agreement. The protocol obligated both developed nations and States undergoing economic development to lower gas emissions that could potentially modify the planet's greenhouse effect by at least 5% in comparison to 1990 levels by 2012 (United Nations, 1998). The reduction of emissions has been regulated by the Kyoto Protocol until 2020[1].

Paris Agreement is another important treaty signed between 195 member States of the UNFCCC in 2015. According to this agreement, the increase in global temperature must stay below 2 degrees, and ideally below 1.5, compared to pre-industrial levels to reduce the risk of climate change (United Nations, 2015a). Generally speaking, it consists of a guideline that members must follow to adopt more sustainable behaviours in order to combat climate change. Similar to the Kyoto Protocol, the text is divided into articles dealing with various topics, concerning for example the implementation of mitigation (art. 4) and financing measures (art. 9), the safeguard of the forests and

[1] *https://www.mase.gov.it/pagina/cop-21-laccordo-di-parigi (accessed on 04/05/2023)*

agriculture (art. 5), and indications on how capacity-building should be implemented (art. 11).

Additionally in 2015, the Third UN World Conference in Sendai, Japan, approved the Sendai Framework for Disaster Risk Reduction 2015-2030. By constructing resilient infrastructure and societies, it aims to lessen the frequency of natural disasters and their effects. Enhancing risk governance, making investments in disaster risk reduction for resilience, and enhancing public awareness and education on natural catastrophes are all emphasised in the framework (United Nations, 2015b).

Undoubtedly, the Global Urban Agenda, which was signed in 2016, is a significant step in the landscape of global actions. This agreement aims to transform cities into more sustainable, liveable, and resilient habitats. With an emphasis on resilience to lessen vulnerabilities, it aims to improve the fundamental qualities of cities and revitalise planning. The implementation of the Agenda contributes to the achievement of the Sustainable Development Goals (SDGs) by 2030 (United Nations, 2017). The SDGs are a set of 17 global objectives designed to overcome multiple challenges of our time. For instance, some of them are dedicated to ending poverty, protecting the planet, and ensuring that all people enjoy peace and prosperity. The idea behind the SDGs is to work on economic, social, environmental sustainability, and fair governance spheres in order to leave no one behind (United Nations, 2022). Furthermore, the goals are somehow often connected to each other and therefore it is crucial to try to keep everything under control so that the failure of one does not generate a "cascade effect".

Recently the European Green Deal has also entered the scenario of European initiatives. It sets itself an ambitious goal: to achieve zero GHG emissions by 2050, as well as a more fair, prosperous, and economically growing society (European Commission, 2019).

New European Bauhaus (NEB)[2] is part of the European Green Deal and aims to create a renewed aesthetic and functional approach to the buildings, infrastructures, and objects that surround us, providing innovative and sustainable solutions for the environment. The idea is to integrate architecture, art, science, and technology to create more sustainable designs and improve people's quality of life. The NEB aims to promote the intelligent use of resources and the creation of green spaces, supporting biodiversity and improving the energy efficiency of buildings. An interesting concept that emerges is that following this approach, characteristics like aesthetics of structures and neighbourhoods should be considered on the same level as other elements rather than being treated as a secondary consideration.

For what concerns energy policies, the Energy Performance of the Buildings Directive (EPBD) established long-term renovation strategies in order to have a more energy-efficient and decarbonised energy stock by 2050[3] (Lavikka, 2022). Moreover, by 2030, the EU intends to reach a 32.5% energy efficiency level[4].

The challenges to be faced are highly complex and we must try to consider every aspect of the society to face them and, consequently, every impact that each of our actions has on the territory and the community in order to overcome difficulties.

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[2] *https://new-european-bauhaus.europa.eu/about/about-initiative_ en (accessed on 04/05/2023)*

[3] *Directive (EU) 2018/844 of the European Parliament and of the council of 30 May 2018 amending directive 2010/31/EU on the energy performance of buildings and directive 2012/27/EU on energy efficiency. Available at: https://ec.europa.eu/energy/topics/energy-eff iciency/energy-efficient-buildings/energy-performance-buildings-directive_ en*

[4] *Directive (EU) 2018/2002 of the European Parliament and of the council of 11 December 2018 amending directive 2012/27/EU on energy efficiency. Available at: https://eurlex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2002&from=EN.*

Thesis objectives

The aim of the work is to identify the overall impacts that an urban and energy requalification project has on the community and territory through a holistic approach by developing a new methodology. The multiple benefits analysis is conducted to inform stakeholders and convince potential investors to invest. It is therefore important to show all the positive impacts that will arise from the implementation of the project, always with respect for human rights, as well as the environment.

This thesis brings out a theme often overlooked in the context of urban transformations but of fundamental importance: the actual benefits perceived by all stakeholders. Adequate planning must take into account both the needs of the environment and the community; these are inseparable and to build a fair and sustainable society it is of fundamental importance to be all well aware of the impacts (in this case positive, but it is equally important to consider also the negative ones) that any type of territorial transformation can have on the territory.

The proposed method can be applied to projects in order to understand the priorities of each demo case, build a community that reflects the needs and expectations of the end-users, and communicate to non-experts the overall improvements made by the project. Therefore, it is desirable that the study of multiple benefits does not remain an end in itself but is increasingly introduced within the decision-making process.

Thesis structure

The thesis is articulated into 5 chapters. In the first chapter, the main concepts covered in this thesis will be introduced, such as the Smart City, Positive Energy District, co-benefits, and multiple benefits. Subsequently, the methodology adopted for the research and study of multiple benefits will be explained.

The second chapter will be dedicated to the characterization of the context of the application of the method. The European projects ARV and ProLight will be introduced as well as the committee of experts concerning PEDs called IEA-EBC Annex 83.

The third chapter will introduce Best Worst Scaling, a methodology used to evaluate individual preferences. In particular, the theory behind this approach will be examined, as well as how the Sawtooth programme was used to gather the data, and an example of a study that used the Best Worst Scaling will be discussed.

The application of the multiple benefits relevance study methodology will be extensively addressed in chapter 4, which also contains the related results.

The final chapter is devoted to the findings, the effects of the work done, and its potential future advancements.

CHAPTER 1

This thesis is supported by a number of publications that have been categorised into several areas and this section is aimed at clarifying the meaning of the most important concepts treated here. In order to better understand the fundamental subject and the context of the applicability of Multiple Benefits, a study was first conducted on topics relating to Positive Energy Districts, Smart Cities, and Climate Positive Circular Communities. The notion of co-benefits and the more general concept of Multiple Benefits were then reviewed. After learning the boorish theory behind the aforementioned topics, the multiple benefits present in projects and articles concerning Positive Energy Districts, Smart Cities, and Climate Positive Circular Communities were researched in order to find the most prevalent within these types of urban and energy redevelopment projects, both achieved and foreseen. Later on, the multiple benefits were studied in a more complex way, by analysing them into the phases of the lifecycle of the built environment.

1.1 Overview of the concepts of Smart City, Positive energy District

The objective of building sustainable and liveable urban settings has been the focus of the smart city idea as it has developed over time and given rise to other similar concepts like Positive Energy Districts and Climate Positive Circular Communities. Smart cities are combining Information and Communication Technologies (ICTs) with social and environmental sustainability while the Positive Energy District (PED) concept takes this approach further, aiming to create urban areas that produce more energy than they consume. The Climate Positive Circular Community (CPCC) concept takes this even further, envisioning urban areas that not only produce surplus energy but also use renewable resources, reduce waste, and promote circular economy principles. Due to its strict connection with the European project ARV, the last concept is better explained in the second chapter.

1.1.1 Smart City

The first term that spreads globally between the cited ones is that of Smart city and it was first introduced in the book entitled "The Technopolis Phenomenon" published in 1992 (Gibson et al., 1992). This innovative urban structuring approach has been extensively studied at a theoretical level but also put into practice through many projects, at the European but also international level. However, it has not been possible to provide an unambiguous definition of a smart city, in part because the term is used in relation to various contexts and stakeholders in the current literature (Lai and Cole, 2022). In fact, according to Mosannenzadeh et al. (Mosannenzadeh and Vettorato, 2019), depending on how a person approaches a subject, the word "smart" can indicate a variety of things. It can cover a range of technological characteristics, but also intelligent machines, intelligent-acting products, and finally the term can refer to a development that is correct for all and from many points of view (Smart Growth). In any case, this term is extremely versatile and adaptable to a wide range of circumstances due to its universality.

In general, “Smart city” refers to an urban area that tries to overcome the present issues and improve quality of life thanks to the use of ICTs. The city is therefore supported by technological instruments such as sensors installed in the urban environment, personal devices, cameras, data acquisition systems, systems for monitoring and controlling traffic, etc. (Nam and Pardo, 2011) and considered as a single system composed of interconnected animated and inanimate elements. By concentrating on more than just the environment and lowering pollution inside the city, smart cities aim to improve the quality of life of its residents while also attempting to engage the community in the creation of a comfortable atmosphere for everyday living

(Kourtzanidis *et al.*, 2021). The rapid advance of technologies, therefore, makes this model of the city extremely dynamic and innovative, improving the approach to the city by users on many fronts: social, environmental, cultural, etc.

Attention to this model of city has grown over time, especially as it is potentially useful for contributing to the achievement of the sustainable development goals set by the United Nations to create a better future (Nations, 2015). The term "Smart City" has also been part of the strategies of the European Union for years, which continuously finances projects aimed at creating cities based on this approach, as well as various support initiatives. Consider for example Smart Cities Information System (SCIS)[5], the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) (European Commission, 2017), Covenant of Mayors[6], Eurocities (Commission, 2021). An important project at the European level is certainly CITYkeys (Bosch *et al.*, 2017). Indeed, this aims to develop a holistic framework for measuring the performance of solutions that refer to the umbrella term of "Smart City". This is promoted to encourage and facilitate the deployment of a smart city model. CITYkeys, therefore, give guidelines that can be followed to monitor the improvements made in the area by other projects. According to these authors, a smart city is a city that actively involves citizens and other stakeholders, uses innovative approaches, and takes into consideration and combines different sectors. It also underlines the fact that the same approach can be applied on several different scales: single building, neighbourhood, or city.

[5] EU Smart Cities Information System (SCIS). Available online: https://smartcities-infosystem.eu/ (accessed on 15 April 2023).

[6] Covenant of Mayors for Climate and Energy, Europe. Available online: https://www.covenantofmayors.eu/ (accessed on 15 April 2023).

1.1.2 Positive Energy District

As previously anticipated, the smart city concept has undergone progressive evolution to incorporate newer concepts, such as the Positive Energy District (PED). Although the term Positive Energy District was introduced in the scientific literature only in 2018 (Binda, Bottero and Bisello, 2022), its innovative approach to energy efficiency and flexibility has quickly gained traction with the European Commission as a way to support the energy transition. The PED originates from the Positive Energy Building (PEB), which is an energy requalification model with the same purpose as the PED, but which acts on a single building. The PED approach focuses specifically on the energy sphere, intending to develop urban solutions that generate more energy than it consumes from renewable sources (RES). The excess energy generated can then be distributed and exported to other parts of the city (Moreno *et al.*, 2021). The aim is to create or renovate buildings that not only do not emit greenhouse gas emissions but which instead obtain an annual energy surplus at a local or regional level that can be exported to other buildings in the surrounding. Moreover, "they require integration of different systems and infrastructures and interaction between buildings, the users and the regional energy, mobility and information and communication technology (ICT) systems while securing the energy supply and a good life for all in line with social, economic and environmental sustainability" (JPI-Urban Europe and SET-Plan Action 3.2, 2020).

PED is also considered by the JPI as one of the three pillars of Driving Urban Transition (DUT) together with the 15-Minute City and the Circular Urban Economy (CUE).

This district model has two key elements that may be distinguished from another: sustainability, which includes environmental, economic, and social considerations, and energy security and stability. Both of these facets are essential to the district model's overall performance (Marotta *et al.*, 2021).

Boundaries and energy balance vary amongst PEDs. Buildings may be located inside clearly defined physical limits (geographic boundaries), or they may be located far apart yet connected by a network of pipes for gas, electricity, or heating (functional boundaries). Additionally, if the energy demand is met by a generating unit that is shared with other consumption places and is located outside of the PED's physical boundaries, the literature refers to virtual boundaries (Marotta *et al.*, 2021); (Moreno *et al.*, 2021); (Wyckmans, Karatzoudi and Brigg, 2018).

The interaction with the outside of the PED boundaries determines different sub-models of the same concept. In fact, according to (Salom *et al.*, 2022) and (Wyckmans, Karatzoudi and Brigg, 2018), there are 4 types of categories:

1. Auto-PED (PED autonomous): Energy is produced within the borders and there is no need to import it from outside and instead, it may be exported.
2. Dynamic-PED (PED dynamic): energy self-sufficient within geographical boundaries but with the possibility of exchanges with the external in order to compensate for shortages and surpluses.
3. Virtual-PED (PED virtual): energy self-sufficient within virtual boundaries but with the possibility of exchanges with the external in order to compensate for shortages and surpluses.
4. Candidate-PED (pre-PED): net annual balance is not positive but imported energy is certified green.

In summary, this urban model requires the integration of multiple systems and infrastructures, interdisciplinary collaboration, and broader stakeholder involvement to achieve a fair and equitable society. It is important to keep in mind that a successful PED cannot just concentrate on technological advancements; it also has to include activities that involve end users. In this sense, it is crucial to educate people about the potential benefits of PED while also making an effort to create an environment favourable to establishing social bonds. PEDs offer the potential to support energy transitions and contribute to a more sustainable and resilient energy future.

For implementing a PED, especially with the Italian urban planning tools, the preferred way would be to create a variant to the general master plan (PRG) in order to be able to make the most of a mixed-use. In fact, the creation of a PED could be partially limited by the zoning given by the master plan. Furthermore, if a territorial strategic plan is in force, it would be good to respect the guidelines that the territory wants to undertake.

1.2 Multiple Benefits

1.2.1 Literature review

Any project or policy is expected to deliver some benefits to the community. Moreover, aside from the main ones defined in the design phase, further collateral benefits may derive from the implementation and may strengthen the impacts. All of the effects that a project will have on the neighbourhood must be taken into account while planning an urban project. A study of the real impacts of the project has the dual purpose of not only highlighting negative benefits but also serving as a preventative measure for positive ones that might otherwise go unnoticed. The theory behind the multiplied benefits is based on this premise.

The concept of Multiple benefits is an evolution of the more known concept of co-benefits. Although the definition has changed a little over time, the idea of co-benefits has been present in scientific literature since the 1990s. Davis et al., one of the first ones to address this concept, describe "co-benefit" in a study published in 2000 as a purposeful outcome of GHG reduction strategies (Davis *et al.*, 2000). However, the term was brought up more in detail by the Intergovernmental Panel on Climate Change (IPCC) in the third assessment report in 2001 (IPCC, 2001), where the concept is used to indicate the non-climate benefits of GHG mitigation policies. The report makes a distinction between co-benefits and ancillary benefits, where the latter refers to secondary effects derived from climate change mitigation policies concerning problems that arise after the implementation of a certain policy.

Co-benefits are positive impacts that emerge intentionally or collaterally as a result of the implementation of a project or policy and that exceed the primary objective (Ürge-Vorsatz *et al.*, 2014). The concept of co-benefit is not limited to a particular sphere of society but can refer to that of health and welfare, environmental, economic, social, etc (Bisello *et al.*, 2017).

There are several terms used in research papers that are related to co-benefits (Figure 1), (Ürge-Vorsatz *et al.*, 2014). One of these is the concept of multiple benefits.

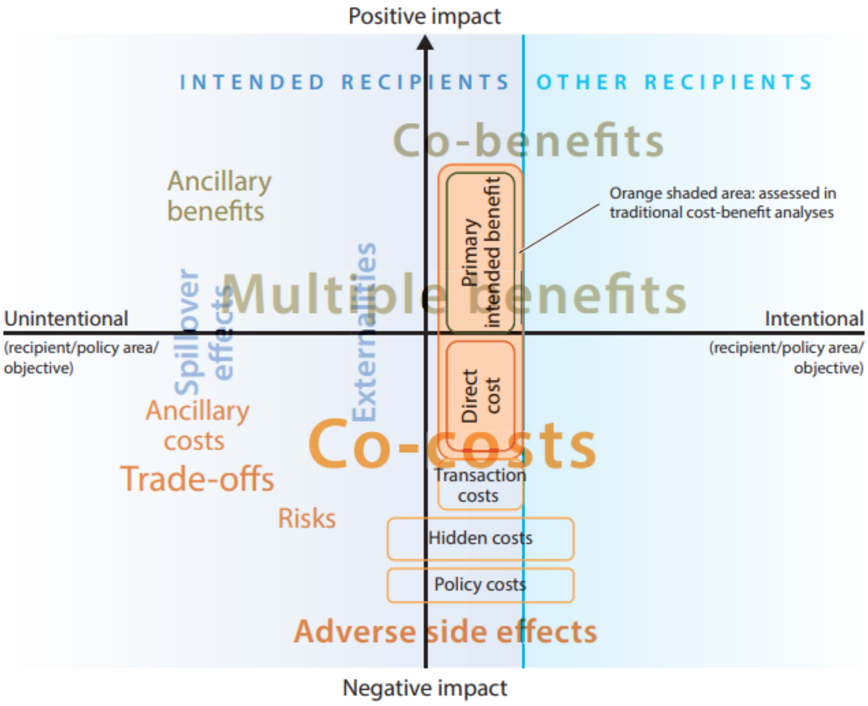

Figure 1 Different terms used in relation to co-benefits. Source: Ürge-Vorsatz, D. et al. (2014).

Despite the fact that the terms "co-benefits" and "multiple benefits" are frequently used interchangeably (International Energy Agency, 2014), more recent literature clearly distinguishes between the two terms.

One of the first significant articles to use the term "multiple benefits" is a study conducted by the International Energy Agency (IEA) in 2014, that details the advantages generated by increased energy efficiency (International Energy Agency, 2014). In that research, the authors investigate benefits that encompass multiple spheres of society and include both intentional benefits, such as saving energy or reducing GHG emissions, and unintentional benefits, such as increasing jobs and improving residents' mental and physical (Figure 2). Since then, research has been advancing energy efficiency interventions by broadening the point of view and attempting to hypothesise, identify, measure, and estimate a large list of potential positive impacts, or benefits. Although IEA does study multiple benefits in relation to energy efficiency, the same approach can be used in any other context.

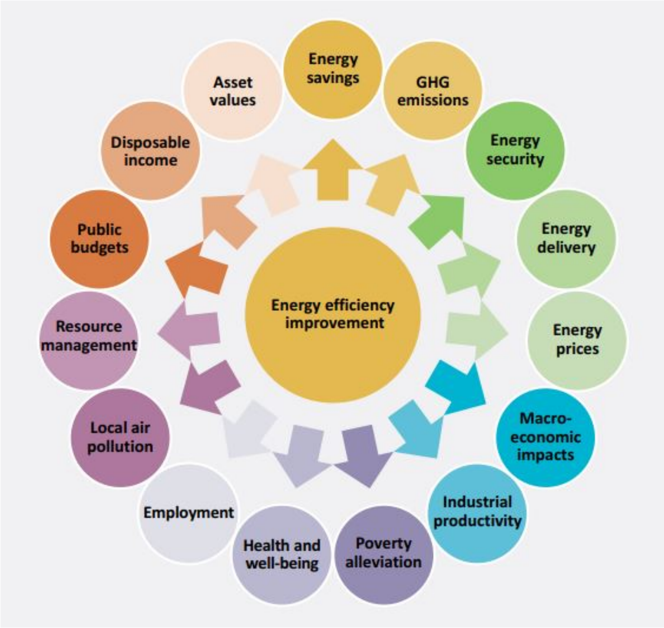

Figure 2 The multiple benefits of energy efficiency. Source: International Energy Agency (2014).

Multiple benefits are, thus, defined as favourable effects that are considered holistically and without regard to any form of priority or bias (Bisello, 2020), including those that are strictly linked to the main goals and those that are not intentionally pursued. Therefore, a key distinction between co-benefits and multiple benefits is the type of hierarchy assigned to the terms: in the first case, it is vertical, while in the second, it is horizontal (Zilio *et al.*, 2022). According to the theory of multiple benefits, the project's co-benefits and primary benefits should not be seen as separate entities, with some benefits being prioritised over others. Instead, each of these benefits should receive the same consideration and attention in order to maximise the project's strengths and minimise its weaknesses.

It is crucial to examine the different benefits in order to fully grasp the project or policy potential through an assessment of all beneficial consequences that result from it. The dissemination of these positive impacts can help raise awareness of the project's relevance and, as a result, gain greater approval from investors, end users, and other stakeholders. In accordance with Sareen *et al.*, 2022, "emerging impacts" may be traded for incentives in order to encourage stakeholder participation. In addition, a study aimed to develop a performance goal for an energy district conducted through a questionnaire revealed that the respondents had a favourable reaction to the inclusion of a multiple-benefit analysis in the cost-optimality calculation process for the district because they recognised it as a key driver for fostering community involvement (Shnapp, Paci and Bertoldi, 2020). The significance of studying multiple benefits is now clearly recognised, not only with the aim of attracting investors but also for including the project's final users (the residents) in the decision-making process and helping them to understand the benefits of the project. This type of approach could be able to attract a greater number of supports considering that the perception of which is the most relevant and interesting benefits change over time based on the various stakeholder perspectives.

1.2.2 Procedure for a multiple benefits analysis

This section outlines the broad technique used to investigate multiple benefits in an energy requalification project. The methodology can be divided into 5 principal steps and the approach follows the one used by (Bisello, 2017) for the investigation of co-benefits in a Smart and Sustainable Energy-District Project (SSEDP). This method is particularly useful for evaluating the total benefits of urban and energy redevelopment projects and has been partially applied to ongoing European projects called ARV and ProLight.

The methodology for conducting a multiple benefits analysis within smart neighbourhoods is crucial for recognizing the advantages that a particular project may bring to the territory. By predicting the expected benefits before implementation and monitoring them over time, project stakeholders can gain insight into the potential return on investment and use this information to promote acceptance among citizens and attract new investors. The proposed approach starts by conducting a literature review and subsequently by gathering feedback from project partners and sector experts in order to identify specific benefits to be considered within each case study. The succeeding creation of a short list of benefits will help streamline the questionnaire that will be released to stakeholders, allowing them to rank the benefits according to their level of importance. Best Worst Scaling, a useful ranking methodology, can be used to analyze feedback from stakeholders to provide valuable insights for future projects. Promoting the use of this methodology within smart neighbourhood projects is necessary for creating a comprehensive approach that benefits all stakeholders involved.

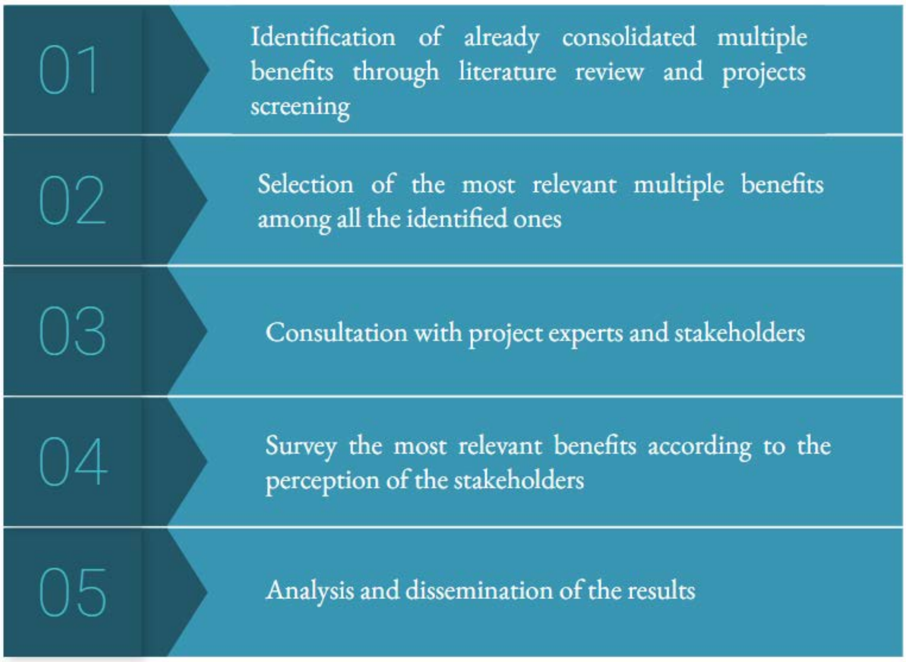

Figure 3 Procedure for a multiple benefits analysis. Source: Author (2023).

Step 1: Identification of already consolidated multiple benefits through literature review and projects screening

In order to understand which are the most cited benefits within energy and urban redevelopment projects such as Smart Cities, Positive Energy Districts and, Climate Positive Circular Communities, 17 projects and 3 articles were consulted.

Identifying multiple benefits within projects similar to the one you are considering is critical to understanding the kind of impact these projects can have or are expected to have. In order to realize this analysis, theoretical articles have been taken into consideration, but above all already completed or ongoing European projects concerning city models such as Smart Cities, Positive Energy Districts and, Climate Positive Circular Communities (CPCC). Regarding the selection of multiple benefits from European projects, for each of them, several deliverables and websites were consulted between October and December 2022. These projects are funded by the European

Union and generally aim to implement new solutions to improve the living conditions of the inhabitants and the environment.

Furthermore, articles not related to a project were also consulted with the specific aim of obtaining multiple benefits in a more theoretic way. The selected articles exclusively concern the concept of Positive Energy District, as the most innovative and all-encompassing concept among those previously mentioned with the greatest number of literary references (the CPCC model, though even more recent, was conceived only within the project ARV, which has not yet been completed).

As regards the search for multiple benefits, the positive impacts that were reported by the texts were considered in the following ways: explicit form, implicit form, and Key Performance Indicators (KPIs).

Since the study of multiple benefits is a relatively new approach, the term "benefit" is not always used, but some papers refer for instance to "objective" (e.g. MAtchUP) or "impact" (e.g. SmartEnCity and SPARCS); in this case, the difficulty lies in the fact that not all impacts mentioned are beneficial.

What emerged from the consultation of the scientific literature is that it is not usual to find a specific section for multiple benefits and therefore it is necessary to carry out an in-depth reading to be able to find them within the text because they are located randomly. The hope is that the analysis of multiple benefits will become more and more frequent.

The following table summarizes the texts and projects consulted to carry out the analysis of multiple benefits from the literature.

Sr. No.	Website	Type	Title	Urban model	Description
1	https://greendeal-arv.eu/	European project	ARV	CPCC	ARV seeks to provide and implement appealing, durable, and practical solutions that greatly speed up extensive energy renovations.
2	https://sparcs.info/en/	European project	SPARCS	PED	SPARCS aims to encourage the participation of residents in the energy market for transforming the urban areas into energy prosumers and involve the community. It seeks to introduce innovative solutions in buildings and mobility.
3	https://pocityf.eu/	European project	POCITYF	PEB and PED	POCITYF aims to demonstrate and replicate solutions for improving the energy system in buildings and districts, favouring renewable energies. It will support the transformation of historical cities into greener, smarter, and more liveable communities while maintaining their cultural heritage.
4	https://triangulum.no/about-triangulum/?lang=en	European project	Triangulum	Smart City	Triangulum aims to show how technologies from the energy, buildings, mobility, and ICT sectors can be used in a single district to significantly reduce energy demand and local GHG emissions while also improving the quality of life and favouring economic growth.
5	https://smart-cities-marketplace.ec.europa.eu/node/3022	European project	SCIS	Smart City	The Smart Cities Information System (SCIS) is a platform for knowledge sharing and collaboration on the development of Smart Cities. The platform provides a guide for Key Performance Indicators (KPIs).
6	https://cityxchange.eu/	European project	+CityxChange	PEB and PED	+CityxChange creates positive energy block solutions that lead to positive energy districts and cities. It employs community engagement strategies and decision-support technologies to empower all community stakeholders to take well-informed decisions. It also implements reduction, flexibility, and energy efficiency measures.
7	http://www.sinfonia-	European project	SINFONIA	Smart City	SINFONIA aims to implement integrated and scalable energy solutions on a large-scale. The target is mid-sized European cities.

	smartcities.eu/				
8	https://smartcity-atelier.eu/	European project	ATELIER	PED	ATELIER aims to create and replicate Positive Energy Districts (PEDs). Reducing obstacles to the adoption of clever solutions on a local level will boost the ecology of local innovation.
9	https://www.synikia.eu/	European project	SYN.IKIA	PED	SYN.IKIA aims to provide a model for sustainable plus-energy buildings and neighbourhoods. The goal is to achieve 100% energy savings, 90% of the energy produced from renewable sources, 100% GHG emission reduction, and 10% life cycle costs reduction, compared to Nearly Zero Energy Building (nZEB) levels.
10	https://smart-beejs.eu/	European project	Smart-BEEjS	PED	Smart-BEEjS aims to train Ph.D. students in policy-making, planning, and business model innovation specialised in the energy and efficiency sectors.
11	https://www.matchup-project.eu/project/	European project	MAtchUP	Smart City	MAtchUP aims to develop and use strategies that can convert urban issues into smart opportunities to create a more liveable urban environment for citizens.
12	https://grow-smarter.eu/home/	European project	GrowSmarter	Smart City	GrowSmarter aims to create smart city solutions which primarily target the issues of energy, infrastructure, and transportation. It is also intended to generate opportunities for replication in other contexts.
13	https://irissmartcities.eu/	European project	IRIS	Smart City	IRIS aims to provide energy and mobility systems creating cheaper, better accessible, reliable, and sustainable cities. The project seeks to incentive citizens to become prosumers and improve their quality of life.
14	https://www.mysmartlife.eu/mysmartlife/	European project	mySMARTLife	Smart City	mySMARTLife aims to increase the use of renewable sources, focusing on creating inclusive cities. The interventions also comprehend mobility and the use of ICT solutions.
15	(Bosch *et al.*, 2017)	European project	CITYkeys	Smart City	CITYkeys seeks to create a set of indicators for the assessment of smart city initiatives. This approach is based on the needs of European cities and citizens and was

					developed with input from 40 other sustainable systems for smart urban performance.
16	http://smartencitynetwork.eu/	European project	smartENCity	Smart City	SmartEnCity seeks to develop sustainable, smart and resource-efficient urban environments. Based on the implementation of measures for increasing energy efficiency and the renewable energy supply.
17	https://www.prolight-project.eu/	European project	ProLight	PED	ProLight aims to lower energy consumption per capita and increase the proportion of renewable energy used in the housing sector. By following the European Bauhaus principles, the six demonstration districts should lead to better quality of life for all targeted end-users.
18	(Marotta *et al.*, 2021)	Article	Environmental sustainability approaches and positive energy districts: A literature review	PED	Analysis of the scientific literature concerning the topic of Positive Energy District, with particular attention to the sphere of environmental sustainability.
19	(Shnapp, Paci and Bertoldi, 2020)	Report	Enabling Positive Energy Districts across Europe: energy efficiency couples renewable energy	PED	Analysis of district-level energy performance objectives. It takes the idea of PED into account from a legal and economical perspective. confirms that the minimum energy performance standards on a district scale may be defined using the cost-benefit calculation technique of the EPBD.
20	(JPI Urban Europe, 2020)	Booklet	Europe Towards Positive Energy Districts	PED	Overview of different European projects based on the concept of the Positive Energy District model.

Step 2: Selection of the most relevant multiple benefits among all the identified ones

The benefits identified during the reading of the scientific literature were collected and a screening operation was carried out in order to group the elements coming from different sources that were conceptually identical. However, given that there is no standardized wording of the benefits, different sources often report the same element with different labels. To overcome this situation, a comparison operation to determine whether it was the same benefit is needed, followed by the assignment of a single name. A further case is the one that refers to benefits that are similar and related to the same concept, but where one can include the other. In this case, the one relating to the broader term must be taken as a reference.

In practice this step can be further divided into three sub-stages:

1. Collection of all benefits divided by article. Following the reading of the articles, the benefits found were reported on an Excel table, regardless of repetitions, and dividing them by reference model (Smart city, PED, and CPCC) and by article. A brief explanation of the benefit has been reported.

2. Grouping of conceptually similar benefits. The benefits collected in the previous stage were compared and those referring to the same concept were merged. Next to the name of each benefit, every author mentioning it has been reported, as well as a description of the benefit, obtained by comparing the different descriptions and combining all of them into one larger definition.

3. Selection of 18 multiple benefits. A further selection was made based on the following criteria: (i) citation by multiple articles, (ii) priority to benefits with broader definitions (for example, "reduced air pollution and GHG emissions savings" was discarded in favor of "Air quality improved"), (iii) importance has been given by the analyst.

The final list is made up of 18 elements as it was considered an adequate number for multiple reasons. Firstly, in order not to create a too long list, which would have been dispersive, and secondly to facilitate the creation of the questionnaire with the Best Worst Scaling method (see Chapter 3).

Table 1 reports the table with the final list of multiple benefits obtained from the scientific literature.

Table 1 List of multiple benefits from the literature review. Source: Author (2023).

ID	BENEFIT	DESCRIPTION	N. OF ARTICLES MENTIONING THE MBs OUT OF 20 ARTICLES
1	Energy savings	Energy efficiency policies guarantee reduced energy waste, which means a decrease in demand and consumption.	12
2	Energy poverty tackled	Cost reductions derived from increased energy efficiency are crucial for those who are struggling financially.	9
3	Energy efficiency increased	The implementation of cutting-edge technologies connected to renewable energy sources leads to greater energy efficiency.	9
4	Local labour market stimulated	New job prospects and market opportunities are anticipated to be produced as a result of project-sponsored interventions and activities.	15
5	Innovation promotion	The project foresees the adoption of novel strategies. Innovations advantage the entire community by advancing the creation of a more sustainable society.	12
6	Citizen involvement	End-user participation in the decision-making process will result in greater fulfilment of community needs.	14
7	Knowledge creation and exchange	The collaboration of researchers and experts in the field leads to a fruitful exchange of knowledge which also favors future developments. It also incentivises capacity-building, training, and awareness-raising opportunities.	7
8	Awareness of environmental and energy issues	The introduction of energy-efficiency solutions, combined with an explanation of how to promote energy sustainability, raises user awareness, which may lead to behavioural changes. Greater information is considered to benefit not only the inhabitants of the project's impacted areas but the community as a whole.	14
9	Quality of life of the inhabitants improved	The living and psychological conditions of inhabitants can be improved by a greater quality of the buildings, indoor thermal comfort, and reduction of environmental, acoustic, and olfactory pollution.	13
10	Indoor comfort increased	A good energy efficiency system leads to the improvement of thermal, humidity, and living comfort.	8

11	Territorial quality and attractiveness increased	An area that is an example of smart and sustainable development might attract tourists who are environmentally conscious as well as institutions, professionals, and researchers.	6
12	Local air quality improved	Utilizing renewable energy sources for energy production and consumption instead of fossil fuels will have a lot of significant positive effects on society and the environment. For instance, it will contribute to reducing the amount of pollutants in the air and the urban heat island effect and, as a consequence, the air quality will increase.	9
13	Fossil fuel dependency and import reduced	Utilizing renewable energy sources for energy production and consumption reduce fossil fuel dependency, contributing to increasing the security of the energy supply.	5
14	Property value increased	Buildings with attractive and innovative features which are also high performing in terms of energy have a property value premium that is greater than the estimated economic benefit of the energy savings.	3
15	Investment prospects and investor confidence increased	The vision of a project that brings benefits to society, also in economic terms, fosters the confidence of investors who will be more inclined to finance future similar interventions; this will create new economic incentives for promoting energy-efficient districts and sustainable mobility actions.	6
16	Economic savings	The redevelopment of the area with more cutting-edge and sustainable solutions makes it possible to reduce the prices for energy and heating buildings. The advantages are found in the reduced initial costs, maintenance, and in general in the entire life cycle of the buildings (in fact, proper management of large-scale interventions allows economies of scale). Moreover, the stakeholders and inhabitants can benefit from the increased economic value of the real estate, higher performances, and additional revenue from delivering specific energy services.	13
17	Neighborhood safety increased	Thanks to the redevelopment of the place in many aspects, it is expected that the neighbourhood will become safer for citizens.	5
18	Overcoming policy/regulatory barriers	Implementing new solutions leads to the determination of regulatory hurdles, legal issues, and data security/protection. It is therefore an opportunity to offer practical suggestions on how to overcome them.	6

Step 3: Consultation with project experts and stakeholders

After analysing various projects and scientific literature to determine the most prevalent benefits of an urban and energy redevelopment project, experts in the field of PED and partners of two European projects (ARV and ProLight) were consulted.

The meaning of this step is to gain a better understanding of the benefits that could be achieved through the implementation of such a project in a specific area.

In all the cases, people were involved through workshops where they received an overview of the main concepts regarding PED and Multiple benefits and where they had the opportunity to report what they could share their knowledge and opinion about multiple benefits within their specific case study (see Chapter 4).

During these workshops new multiple benefits lists were created, this time tailored to the considered case.

Step 4: Survey the most relevant benefits according to the perception of the stakeholders

The list of benefits created following consultation with experts and project partners is intended to consider only the benefits related to the case study in question. The idea is to create a questionnaire to be distributed to project stakeholders in order to understand which are the most relevant benefits for each of them. Indeed, everyone has a different perception of what may be the most important outcomes following the implementation of a project. In this regard, the questionnaire was carried out using the Best Worst Scaling method, as previously anticipated, and aims to obtain a ranking of multiple benefits, based on the perceptions of each stakeholder.

For this thesis, the questionnaire was not submitted to the project stakeholders as it would require more time to deliver it due to formal reasons of the projects. Therefore, it was deemed appropriate to submit it at a later time. However, a simulation was carried out involving some students of the Polytechnic of Turin, that provided their answers after a brief introduction on the main concepts useful for carrying out the questionnaire in the best possible way.

Step 5: Analysis and dissemination of the results

The results of the questionnaire must subsequently be analysed in order to make considerations on the different perceptions of the stakeholders taken into account.

All the analysis is aimed at informing the partners but above all at divulging the objectives and co-benefits resulting from the project to the citizens. In light of this, sharing the findings is a vital component of the process. Within a redevelopment project, the results can be disseminated for instance on the project website, through workshops and participatory tables that include citizens, etc.

1.2.3 Multiple benefits within the lifecycle's phases of the built environment

The multiple benefits analysis discussed in this thesis intends to examine the positive effects of an urban and energy redevelopment project on the area and community as a whole. Why, therefore, not attempt to examine these impacts even more deeply and accurately? Benefits shouldn't be viewed as static and unchanging entities, but rather as dynamic impacts that may be more or less prevalent at a precise moment. It is from this premise that the idea of dividing the project implementation process into discrete stages emerged. Not all benefits can be detected at all stages of the course of a project's execution, but only at certain moments.

The idea is to consider the multiple benefits (and consequently verify their presence) in each phase of the life cycle of the urban project. This type of approach was inspired by the Life Cycle Assessment, which is a technique used to evaluate the environmental impacts of a product considering its entire life cycle (Muralikrishna and Manickam, 2017). Another methodology that considers the entire cycle is the Social-LCA, which focuses on the social impacts of a product on the stakeholders (UNEP, 2009). However, both of these methodologies mainly concern a single or a series of products, not an entire neighbourhood.

In our case, the subdivision of the project into phases was carried out following the one identified by the Institute for Human Rights and Business (IHRB), Raoul Wallenberg Institute of Human Rights and Humanitarian Law, the Australian Human Rights Institute at the University of New South Wales, and the Rafto Foundation for Human Rights. This consortium developed an approach to guarantee respect for human rights and social benefits at the project level (individual or in wider urban development) across each stage of the lifecycle of the built environment (IHRB *et al.*, 2019). The stages identified are land, planning and finance, design, construction, management and use, demolition, and redevelopment. By taking this subdivision as a reference, the focus can be broadened to consider not only social aspects but also other types of benefits. The phases were intended in the following way (Figure 4):

1. Land: It is the first phase of the process, where the area of interest is chosen.
2. Planning and finance: In this phase, the actions and objectives to be achieved during the project are planned. It can evolve and change slightly in the event of the appearance of obstacles or, conversely, facilitations. This phase also includes the search for funding and investors, as well as project cost estimation.
3. Design: After planning the objectives, it is necessary to devise the best way to achieve them through the design phase of the area. In this phase, the decision of how the transformations will take place in practice is taken.

4. Construction: At this point, all of the prior concepts get actualized. Starting from this phase, it is possible to notice the physical impacts that the project has on the territory.

5. Management and use: This phase comprises the inhabitants' actual usage of the renovated areas as well as the management of the city managers and private companies involved.

6. Demolition and redevelopment: This final phase considers the potential disposal of the structures erected in the considered area, as well as the possibility of additional constructions.

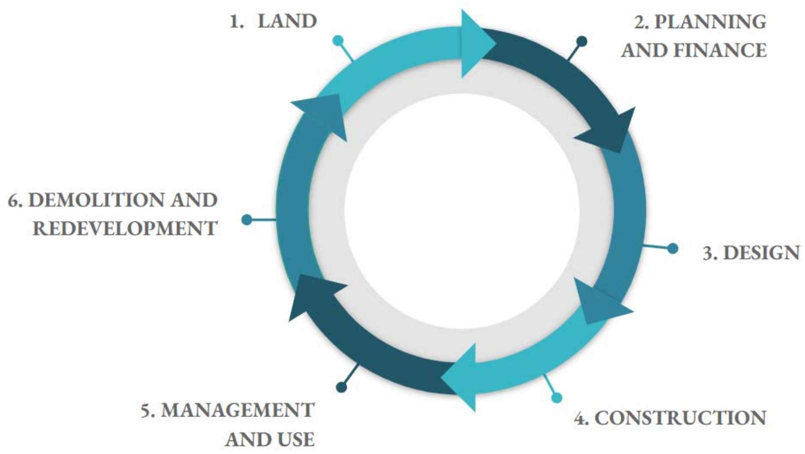

Figure 4 Multiple benefits within the lifecycle's phases of the built environment. Source: Author (2023).

This methodology thus ensures a more in-depth and comprehensive analysis of multiple benefits, which are broken down and analysed here by considering each of their aspects.

The multiple benefits identified following the literature review were therefore divided into the phases of the lifecycle of the built environment (Table 2).
The grey boxes represent the phases in which actions that can induce the corresponding benefit can be carried out, while the ones with the cross represent the phases in which the benefit is identified.

Table 2 Multiple benefits of an energy requalification project divided into phases of the lifecycle of the built environment. Source: Author (2023).

BENEFITS	1. LAND	2. PLANNING AND FINANCE	3. DESIGN	4. CONSTRUCTION	5. MANAGEMENT AND USE	6. DEMOLITION AND REDEVELOPMENT
Energy savings					x	
Energy poverty tackled			x		x	
Energy efficiency increased			x		x	
Local labour market stimulated		x	x		x	x
Innovation promotion		x	x			
Citizen involvement	x	x	x		x	x
Knowledge creation and exchange		x	x		x	
Awareness of environmental and energy issues					x	

Quality of life of the inhabitants improved			x		x	
Indoor comfort increased			x			
Territorial quality and attractiveness increased		x			x	
Local air quality improved		x				
Fossil fuel dependency and import reduced		x				
Property value increased			x			
Investment prospects and investor confidence increased						
Economic savings					x	
Neighborhood safety increased		x				
Overcoming policy/regulatory barriers		x				

CHAPTER 2

The methodology proposed in this thesis for studying multiple benefits is applied to two European projects (ARV and ProLight) and a platform of experts on the topic of PED (IEA-EBC Annex 83). This chapter aims to explain the application context by analysing the case studies one by one.

2.1 ARV

ARV is an H2020 EU-funded project, more specifically under the Green Deal Call LC-GD-4-1-2020, focusing on building and renovating in an energy and resource-efficient manner. It started at the beginning of 2022 and will last until the end of 2025, for a total of 4 years. The project adopts a community-based approach and is coordinated by the Norwegian University of Science and Technology, with the involvement of 35 partners belonging to eight European countries.

The name chosen to represent the project ("ARV") is a word which, in the language of the project coordinator, means "heritage" or “legacy”. Indeed, the project aims to develop solutions to preserve our heritage, which is increasingly threatened by various challenges. One of these is represented, for example, by the need for energy renovation of the existing building stock, which should lead to the reduction of energy poverty and greater environmental sustainability. However, the project does not aim only at applying innovations at a technological level but ensures to create attractive, resilient, and affordable solutions in order to address multiple issues. Another ambitious goal is to make such solutions replicable and scalable so that they may have a far more significant impact rather than just serving as admirable examples.

The project aims to demonstrate over 50 innovations across more than 159,100 m^2 of buildings in six European countries: Czech Republic, Denmark, Italy, the Netherlands, Norway, and Spain (Figure 5).

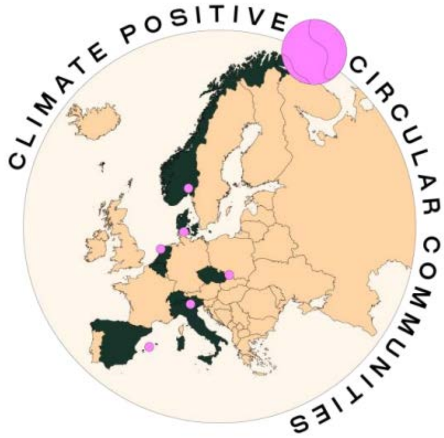

Figure 5 Map of ARV demo projects. Source: https://greendeal-arv.eu/.

The large-scale demonstration projects are overseen by partners from the energy and construction industries as well as a vast network of clusters and innovative companies. These urban transformation/regeneration projects encompass a diverse range of building types, including residential, public, educational, and healthcare facilities. The scope of these projects is extensive, with a total area of 159,100 m^2 being addressed. This includes the renovation of 133,400 m^2 of existing buildings and the construction of 25,700 m^2 of new structures.

The objective of including various building types is to showcase the applicability and benefits of energy requalification processes across different sectors. By addressing a wide range of buildings, the ARV Project aims to demonstrate the potential for energy efficiency improvements and sustainable practices in diverse urban contexts. The renovation component, covering 133,400 m^2, emphasizes the importance of upgrading existing buildings to enhance their energy performance and reduce environmental impacts. This aspect recognizes the significance of retrofitting in achieving energy and climate goals, as existing buildings represent a significant portion of the built environment. Simultaneously, the construction of 25,700 m^2 of new buildings reflects the opportunity to incorporate sustainable design principles from the outset. By integrating energy-efficient technologies and environmentally friendly materials, these new constructions serve as exemplars of best practices for future developments.

Together, these urban transformation/regeneration projects provide a holistic approach to energy requalification, addressing both existing building stock and new construction. Through this comprehensive approach, the ARV Project aims to inspire and guide sustainable practices across different building sectors, contributing to the overall transition towards more energy-efficient and environmentally conscious urban environments.

The demo cases were chosen in order to serve as exemplary models, showcasing outstanding advancements in their respective areas to inspire and guide other initiatives. Moreover, they should complement each other, encompassing all the key aspects outlined in the call and forming a cohesive network of innovation. This approach fosters knowledge sharing, collaboration, and mutual learning among the projects, ultimately contributing to the advancement and dissemination of best practices across the European building sector.

The ARV Project explores the possibility of generating Climate Positive Circular Communities (CPCC). A CPCC is an urban area that strives for net zero greenhouse gas emissions, energy flexibility, circular economy principles, and social sustainability. It emphasizes the integration of new and regenerated buildings, users, and energy systems, facilitated by ICT, to provide attractive, resilient, and affordable solutions for citizens. The CPCC concept aligns with Positive Energy Districts (PED), Sustainable Plus Energy Neighbourhoods (SPEN), Zero Emission Neighbourhoods (ZEN), and EU circular economy principles. The main difference between a CPCC and a PED is that the first one has as key concepts socio-environmental aspects and circularity principles. The project aims to create a CPCC on the base of three conceptual pillars: Integration, Circularity, and Simplicity.

1) Integration: The demo cases aim to take into consideration different aspects altogether. A successful project should not concentrate on the achievement of just one single goal (e.g. energy efficiency in a building) but try to see all the aspects related to the case study in an interconnected way to not overlook any aspect. With this

perspective, ARV considers vital aspects not always taken into consideration by requalification projects: architectural quality, affordability, and people's well-being. In order to achieve these concepts, the focus should be on people, buildings, and community energy systems. Therefore, ARV aims to consider all the stakeholders in the value chain and concentrate especially on the end-users by helping raise awareness, co-creation, and citizen engagement. The integration seeks to involve different stakeholders and expertise along the value chain of the project.

2) Circularity: This aspect is raising importance in the contemporary panorama since the problems linked to excessive consumption were identified and spread. By adopting this strategy, the overall impact of the project should decrease, especially concerning the environmental sphere. Circularity is a fundamental principle that seeks to transform the traditional linear model of production and consumption into a more sustainable and regenerative approach. At its core, circularity emphasizes the importance of giving materials and products a second life, rather than discarding them as waste. In practice, the project seeks to renovate the building stock providing it with more innovative and efficient technologies. Moreover, In addition, the ARV project will actively facilitate the advancement and implementation of digital material banks/logbooks, effectively monitoring the utilization of materials in both existing and new buildings. These comprehensive databases will not only track the materials' usage but also assess their potential for reuse, alongside considering cost and environmental indicators, including embodied energy and emissions.

3) Simplicity: this characteristic is related to the capacity to deliver a project which is based on simple solutions. This approach can bring many advantages: robustness, easy production, low costs, easy understanding, low energy use, and low risks. To address this challenge, the project aims to use intelligence (digitalization), for instance in integrated planning, design, construction, and operation/use.

The ARV Project aims to achieve several key impacts. These include triggering primary energy savings, promoting investments in sustainable energy, demonstrating high energy performance and reduced greenhouse gas emissions, enhancing indoor environmental quality, improving the circularity of materials, and reducing air pollutants. Additionally, the project aims to facilitate replicability, reduce construction/retrofitting time and costs, and increase user satisfaction. More specifically, it seeks to address nine thematic focus areas: 1. Framework for CPCC planning and implementation, 2. Community engagement, environment and well-being, 3. Sustainable building (re)design, 4. Resource-efficient manufacturing and construction workflows, 5. Integrated renewable and storage systems, 6. Efficient energy management and flexibility, 7. Validation by monitoring and evaluation, 8. Business models, financial instruments, policy and exploitation, and 9. Communication, dissemination, and stakeholder outreach.

In conclusion, the project aims to deliver to the territory simple and innovative solutions that have a potential for replication, using an approach based on the circular economy principles.

2.2 ProLight

The ProLight project is acting at a smaller scale compared to the previous project. It deals mostly with single buildings, but always with an eye towards repetition. The acronym ProLight stands for Progressive lighthouse districts serving as green district Gate towards Leadership in Sustainability and is managed by a consortium of 16 European partners from 10 different countries. As well as ARV, also ProLight is a H2020 EU project, funding by the Horizon-CL4-2021-Resilience-02 call. It began in October 2022 and is expected to run for four years.

The project aims to favour energy transition, which requires rethinking building design, construction, and retrofitting practices to reduce embodied emissions and improve energy efficiency. The building sector not only contributes to climate and energy targets but also helps stimulate local investments and mitigate social tensions through innovation. ProLight seeks to renovate and refurbish buildings by emphasizing the importance of creating local urban innovation ecosystems.

In order to enhance collaboration and synergy in achieving ecological, intellectual, and innovative goals, these ecosystems bring together stakeholders from local government, universities/research centres, industry, civil society, and the natural environment. These ecosystems seek to provide win-win scenarios for the economy, society, and policy by using local resources, value chains, and existing assets.

The ProLight project is focused on creating Lighthouse and Pocket (which is smaller) neighbourhoods, which serve as models for creative and ecological living in European cities. The objective is to contribute to the roll out of 100 lighthouse renovation districts that serve as models for replication and highlight cutting-edge housing solutions. Through public-private-people partnerships, these districts will place a priority on liveability, the newest inventions, and the integration of research and innovation processes. The emphasis is on energy efficiency and renewable technology, but also on the social side, with a special focus on disadvantaged households and the eradication of energy poverty. It recognises the gap between the inexpensive owner-occupied sector and the pricey social rented sector and seeks to offer middle-ground, affordable rental, or property alternatives for those with average salaries. Therefore, one of the challenges is to obtain affordable housing while applying innovative and green solutions.

The ProLight project aligns with the principles of the New European Bauhaus, promoting beautiful, sustainable, and inclusive forms of living. This includes creating accessible spaces that foster dialogue between diverse cultures and ages, incorporating innovative and regenerative approaches inspired by natural cycles, and recognizing the importance of creativity, art, and culture in satisfying human needs. By embracing these principles, ProLight aims to create districts that not only address environmental challenges but also enhance the well-being and quality of life for all residents.

The ProLight project aligns with the New European Bauhaus principles, aiming to create sustainable and inclusive living environments. By incorporating principles of good design, ProLight aims to create visually appealing and attractive districts that enhance the quality of life for residents. Both ProLight and the New European Bauhaus recognize the urgent need to address environmental challenges and promote sustainable practices. In this regard, ProLight focuses on energy-efficient buildings, renewable energy integration, and the reduction of carbon emissions. By implementing these sustainable measures, the project aims to contribute to a greener future and mitigate the impact of climate change. Inclusivity is a fundamental common value shared by ProLight and the New European Bauhaus. The project aims to create accessible spaces that are designed to accommodate people of diverse backgrounds, cultures, and ages. This inclusivity promotes social cohesion and encourages dialogue and interaction among community members. By fostering an inclusive environment, the aim is to create districts that are welcoming and meet the needs of all individuals, ensuring that no one is left behind. In this sense, it is crucial to pay close attention to those who are at risk for energy poverty and work to alleviate it.

Inspired by the natural world, ProLight incorporates innovative and regenerative approaches in its design and construction practices. Drawing inspiration from natural cycles and ecosystems, the project seeks to develop solutions that are sustainable, resource-efficient, and resilient. By mimicking nature's processes, ProLight aims to minimize waste, optimize resource use, and create buildings and districts that are in harmony with the environment. Lastly, the ProLight project recognizes the importance of creativity, art, and culture in shaping human experiences and well-being. It acknowledges that aesthetics and cultural expression contribute to a sense of identity and belonging. By integrating art, culture, and creativity into the design and implementation of districts, ProLight aims to enhance the overall experience of residents and create spaces that inspire and enrich their lives.

The project involves six case studies that are spread across Europe (Figure 6), more specifically situated in Vienna (Austria), Kozani (Greece), Matosinhos (Portugal), Rovereto (Italy), Gernika-Lumo (Spain), and Vaasa (Finland). The selected districts reflect the diverse climatic, biogeographic, and settlement conditions across urban, suburban, and rural areas in the EU.

Figure 6 Location of the ProLight project's demonstration cases. Source: https://www.prolight-project.eu/.

They are of modest size and comprehend interventions from one single apartment to a few buildings. For instance, in the Greek situation, the renovation solutions will be realised on one social residential unit, but the plan is that, following this, the same operation will be carried out on the remaining 500 apartments in the area with dwellings for low-income residents.

Photovoltaic panels installed on building roofs, thermal insulations, sensors to track and improve the building's performance, heat pumps, and other similar technologies are the ones that are most frequently employed in these refurbishment actions. Moreover, it will also be created an energy grid between households in order to share the excess energy produced thanks to renewable energy systems. Therefore, these pilot examples will also benefit the surrounding. Some innovative digital tools and services will be adopted within some demonstration cases. For instance, in Rovereto, Planet Idea is developing a mobile phone app that will allow end users to check and monitor the improvements obtained as a result of the implementation of the refurbishment.

Furthermore, the aim is to address questions raised by end-users, such as how to refurbish without causing gentrification or social exclusion, how to maximize the impact of smart concepts in the districts, and how to effectively influence behavioural changes through feedback procedures and energy counselling.

2.3 IEA-EBC Annex 83

Contrary to what has been seen for ARV and ProLight, Annex 83 is not a European project but rather the main platform for scientific debate and research on the topic of Positive Energy Districts. The members were therefore consulted, in this case, only as experts on the subject.

The acronym IEA-EBC Annex 83 stands for the International Energy Agency's Energy in Buildings and Communities Programme (IEA EBC) Annex 83. Established in response to the oil crisis of 1973-1974, the International Energy Agency (IEA) is the global energy authority and was initially created to aid industrialized nations in dealing with significant disruptions in the oil supply. Over time, the goal of the IEA's mission has broadened to encompass a wider range of energy-related concerns, including energy security, economic progress, and the promotion of clean and sustainable energy sources. However, as there are several topics relating to the energy issue, various programmes for their investigation have been developed, among which the Energy in Building and Communities Programme (EBC). The EBC focuses on advancing knowledge and promoting innovation in the field of energy-efficient buildings and sustainable communities. Its primary goal is to support the development and implementation of energy-efficient technologies, strategies, and policies to reduce energy consumption, improve environmental performance, and enhance the quality of life in buildings and communities.

The EBC program brings together researchers, experts, and policymakers from participating countries to collaborate on research projects, share best practices, and exchange knowledge and experiences concerning energy and environmental challenges in the built environment. It covers various aspects related to energy in buildings and communities, including building design, energy efficiency measures, renewable energy integration, building simulation and performance assessment, smart grids, sustainable urban planning, and occupant behaviour. By promoting sustainable building practices and energy-efficient technologies, the EBC program contributes to global efforts toward achieving a more sustainable and low-carbon future[7].

The collaborative research project IEA EBC Annex 83 focuses on addressing the Positive Energy District topic. The goal is to advance knowledge, promote innovation, and provide practical solutions to improve energy and sustainable cities through the Positive Energy District model. The activities developed within this platform involve the exchange of information, data analysis, and the development of best practices, guidelines, and tools to support energy-efficient building design, construction, operation, and retrofitting. Therefore, it is proposed to explore the PED in all their aspects, starting from the common definition of the concept up to defining guidelines concerning both the technical and urban planning aspects.

By fostering international cooperation and knowledge sharing, Annex 83 aims to accelerate the adoption of energy-efficient practices and technologies in the building sector. The research outcomes and findings from Annex 83 contribute to the development of evidence-based policies, guidelines, and standards that support the transition to sustainable and low-energy buildings and communities.

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[7] *https://www.iea-ebc.org/* (accessed on 17.05.2023)

Overall, IEA EBC Annex 83 plays a crucial role in promoting collaboration and advancing research efforts to enhance the energy efficiency, sustainability, and occupant comfort in buildings and communities worldwide.

CHAPTER 3

3.1 Best Worst Scaling Method

The Multiple Benefits analysis inevitably must take into consideration stakeholders to obtain a greater result based on the perception of end users, policy-makers, experts, and so on. The best way to collect as many responses as possible is to submit a questionnaire. Although there are various ways to analyze people's preferences effectively, this thesis will be based on the Best Worst Scaling approach.

Best Worst Scaling (BWS) was developed by Adam Finn and Jordan Louviere in 1987. The methodology is based on the assumption that people are far more adept at evaluating items at their extremes rather than at discriminating between items of medium importance or preference. The choice of the upper and lower object should be more reliable than the ranking of the objects, as required, for example, by the ranking method of conjoint analysis which asks you to sort the alternatives by preference (Bottero *et al.*, 2021). Therefore, the outcome is a rating of the items from "best" to "worst" based on the preferences of the respondents. This method forces the respondent to identify just two items per task: the most and the least important.

This methodology was initially applied to the food industry, where it was used to investigate how and to what extent product safety was intended as a determining factor in customers' purchasing decisions (Finn *et al.*, 1992). However, it was also utilized in several other fields, including marketing, social sciences, and medicine.

BWS is often compared to Discrete Choice Experiments (DCE) as they are similar approaches to preference analysis. DCE asks the respondents to compare and choose between alternatives (Colbourn, 2012). Both of them are based on the Random Utility Theory (RUT), which assumes that individuals have preferences and make choices based on the utility they associate with each alternative. The utility given to each alternative relies on several attributes of each option (Cascetta, 2009).

BWS operates by presenting respondents with a series of tasks or cards, each containing a minimum of three items. The methodology involves finding an appropriate balance between the number of tasks and the number of items per task to ensure effective implementation. Including an adequate number of tasks helps capture a comprehensive assessment of preferences while having multiple items per task ensures meaningful comparisons. The precise balance between these factors may vary depending on the specific research objectives, available resources, and desired statistical robustness. A larger number of tasks increases the precision and reliability of the collected data, allowing for a more accurate estimation of relative preferences. However, including too many tasks can lead to respondent fatigue, diminishing the quality of responses or increasing survey abandonment rates. Furthermore, too many items in an assignment may overwhelm respondents, making it difficult for them to recognise important distinctions. Therefore, researchers must find a compromise between collecting enough data for accurate analysis and maintaining respondent involvement.

Each task requires respondents to evaluate the items based on a specific criterion, such as preference, importance, or quality. The forced-choice approach, which involves asking respondents to rate the "best" and "worst" options, helps in determining the relative preference or ranking of the options within each assignment.

In scientific literature, BWS is often used interchangeably with Maximum Difference (MaxDiff). Nevertheless, (Flynn and Marley, 2007) intend MaxDiff as one of the two variants of Best Worst Scaling (the other one is referred to as “sequential”). According to this article, the sequential approach assumes that each respondent provides the best and worst option in a specific order, while the MaxDiff is known for its assumption of simultaneously selecting a pair of items that maximizes the disparity between them on a latent scale, typically associated with utility.

Best Worst Scaling can be also used to analyse large numbers of items (Louviere *et al.*, 2013), even if the time and effort that a respondent can devote to completing the survey should always be taken into account. The greatest number of items in an academic topic is around 17, although up to 200 items may be found for commercial use. For what concern the number of items per task, 4 or 5 are often the most suitable options, even if for large number of tasks it is possible to end up with 20 or 30.

Best Worst Scaling analysis offers various methods for calculating the results. These methods can be categorized into two groups: simple count-based methods and model-based methods (Chrzan *et al.*, 2019).

In the category of simple count-based methods, one approach involves using the method of simple subtraction (Louviere *et al.*, 2015). This method involves counting the number of times an item is selected as the best option and the number of times it is selected as the worst option. The next step is to subtract the count of worst selections from the count of best selections for each item. This straightforward calculation yields a measure of preference or importance based on the net difference between the number of best and worst selections.

Another method within the simple count-based category is the natural logarithm method. This approach involves dividing the number of times an item is selected as the best option by the number of times it is selected as the worst option. The resulting ratio represents the relative preference or importance of the item. To ensure stability and handle extreme values, the natural logarithm of this ratio is taken. By applying this logarithmic transformation, the resulting scale becomes more interpretable and the data is normalized.

As last method of the simple count-based is the analytical best wost score, which has behind a more complex ratio of counts (Lipovetsky and Conklin, 2014).

On the other hand, model-based methods provide alternative techniques for calculating Best Worst Scaling results: Multinomial Logit (MNL), Latent Class MNL, Hierarchical Bayesian, On-The-Fly Utility Estimation.

Multinomial Logit is a statistical model that identifies a set of utilities that best predict the observed choices made by respondents. It allows for the calculation of MaxDiff utilities for an entire group of respondents using a single aggregate model. Alternatively, separate MNL models can be run for different subgroups of respondents, such as males and females. MNL provides insights into the relative utilities of different items or attributes based on the choices made by respondents.

Latent Class MNL is a method that helps identifying subgroups of respondents who exhibit similar utilities. It is particularly useful when the variables that define group membership, known as "latent" variables, are not present in the dataset. Latent Class MNL simultaneously identifies segments of respondents, determines the sizes of these segments, and estimates utilities for each segment. This approach facilitates segmentation analysis in Best Worst Scaling by uncovering distinct groups of respondents with similar preferences.

Another method is Hierarchical Bayesian (HB) estimation. HB estimation utilizes a statistical modeling technique known as Hierarchical Bayes to estimate preference scores for each item. This method considers individual respondent preferences as well as the overall preferences of the entire population. As a result, HB estimation produces more accurate and reliable estimates of item preferences, especially when there are many items or complicated choice scenarios.

Finally, On-The-Fly Utility Estimation is an approach that estimates utilities in real time during the survey. Quick and less precise utility estimations can be derived while respondents are still completing the survey by displaying each item to them several times (usually 3–4 times). On-The-Fly Utility Estimation allows for gathering immediate insights and can be advantageous in terms of asking more accurate questions to respondents and understanding the reasoning behind their choices. It provides a way to capture preferences dynamically and adapt survey content based on ongoing respondent feedback.

Moreover, each attribute's importance can be also assessed by comparing how frequently it was ranked as the most important to how frequently it was listed as the least essential. The overall participant count is multiplied by the frequency of attribute

X across various datasets and divided the result by the frequency of each item's appearance multiplied by the number of respondents. The computation is performed using the following equation:

$$\text{Average BW score} = \frac{Total\ Best\ X - Total\ Worst\ X}{(N\ set) * n}$$

where

Total Best X = Total number of times in which an item was the most important

Total Worst X = Total number of times in which an item was the least important

N set = Frequency of each item's appearance in the design

n = Number of responders

This formula yields the total score for each characteristic, often known as the Average BW score. This score makes it easy to compare how well each attribute performed over the whole survey (Goodman, Lockshin and Cohen, 2005; Faggion, 2014).

These methods provide different ways to calculate preference or importance scores based on the Best Worst Scaling data. The choice of method depends on the specific research objectives, the characteristics of the data, and the available statistical tools.

3.1.1 Cases of Best Worst Scaling

Best Worst Scaling (BWS) comprehends three cases or variations that are used to gather data and analyse preferences: Object case, Profile case and Multi-profile case. Each case involves different instructions and data collection procedures. BWS may be applied to all three scenarios as a theory of process or a method for gathering data. It is interesting to notice that the sector in which BWS is implemented, typically also influences the case chosen. For instance, marketing and food safety use case 1, while the health sector employs case 2 and marketing industry professionals rely on case 3 (Flynn and Marley, 2007). However, case 2 and case 3 can be conceived as prosecutions of case 1, in which items are presented as multidimensional choice objects (Louviere *et al.*, 2013).

For the execution of this thesis, it was decided to employ case 1.

Case 1: Object case

This first case is the most simple and well-known of the three. Respondents are asked to select the greatest and worst items from a set of elements according to their subjective scale. Case 1 provides measures for each respondent on a different scale with known properties (Marley and Louviere, 2005). It is especially suitable when the researcher is interested in understanding the relative differences between objects rather than obtaining absolute measurements or ratings (Louviere *et al.*, 2013).

In BWS case 1, the items being evaluated do not have different characteristics or attributes. They are treated as separate entities without any variability in their properties. A single regression parameter, referred to as an "alternative-specific constant," is used to represent each item in this case of BWS. This constant contains the object's general preference or assessment. It is a measurement of the object's relative attractiveness or significance in relation to the other items in the set. The regression model parameters are determined by analysing the data and extrapolating the relative preferences or values attributed to the items in the BWS. These variables reflect the relative variations in worth or desirability among the things. The regression model makes it easier to measure and comprehend these variations. The absence of variable characteristics in the objects in case 1 of BWS generally allows the representation of each item by a single regression parameter. The regression model may be used to determine the relative differences between the items in the set (Louviere *et al.*, 2013).

According to (Flynn and Marley, 2007; Aizaki and Fogarty, 2022), case 1 approach can be divided into seven steps: (1) decide the application's goal; (2) choose a statistical/experimental design to construct the comparison sets; (3) prepare the survey; (4) carry out the survey; (5) compile the survey data set and collect the resulting data; (6) integrate the survey data set and the choice sets in order to analyse the data; and (7) measure item preferences.

Many studies regarding case 1 applications use Balanced Incomplete Block Designs (BIBDs) for choice sets. A BIBD is an experimental design in which each item appears the same number of times and appears the same number of times in combination with any other choice (Aizaki and Fogarty, 2022).

Case 2: Profile case

Case 2 of BWS was introduced in 2002 by McIntosh and Louviere in a conference paper. As previously said, case 2 derive directly from case 1, having the items organised into a level and attribute structure, which compose a profile. In this case, the respondent should choose the best and worst within a profile, instead of comparing profiles. There are therefore several profiles, and for each of them the respondent should choose the best and worst attribute levels (Flynn and Marley, 2007).

As well as case 1, also case 2 is divided into seven steps (Flynn and Marley, 2007; Aizaki and Fogarty, 2019): (1) identify the context and define the attributes and their levels, (2) create the profiles using an orthogonal array (OA), (3) get survey questions from the profiles, (4) execute the survey letting the respondents choose the best and worst levels for each profile, (5) compile a raw dataset that includes an answer indicating the best level and a second one indicating the worst level, (6) prepare the raw dataset for the analysis and (7) analyse the data using a counting or modelling approach.

Case 3: Multi-profile case

Case 3 asks the respondents to choose the worst and best profile or alternative in a DCE; in fact, this case is the closest one to traditional DCE. It analyses several options which have different attributes, and the interviewer should select the best and worst options considering the characteristics of each of them. Up until all of the choice sets have been examined, questions of this type are repeated. For this case three common models of analysis are available: the maximum difference (maxdiff), the sequential, and the rank-ordered models (Aizaki and Fogarty, 2022). Compared to a standard DCE, case 3 of BWS provides more preferences information, which constitute a good advantage (Lancsar *et al.*, 2013).

3.1.2 Best Worst Scaling: a non-economic method for stating preferences

Despite being widely used in market research and decision-making processes, BWS is not strictly an economic method in the sense that it does not directly capture concepts like utility maximisation or cost-benefit analysis.

There are many consolidated methodologies that more directly include economic principles in research and economic analysis. These include revealed preference methods (such as the Hedonic Pricing Method or the Travel Cost Method) and designated preference methods (such as Contingent Valuation, Choice Experiments or Quality adjusted Life Year) that aim to quantify economic values, pay-ability, or commitment levels. On the other hand, Best Worst Scaling is considered a non-economic method, together with feedback surveys, health profiles, and satisfactory profiles.

The fact that BWS does not account for the trade-offs people make between various traits or characteristics of the options is one of the reasons it is not regarded as an economic technique. Most economic models of preference make the assumption that people choose depending on the relative importance they set on certain characteristics and the trade-offs they are prepared to make. Contrarily, BWS just records data regarding the best and worst options without taking into account the relative significance of other options or the trade-offs between them.

Additionally, BWS does not offer data on the scope of preference or the intensity of certain preferences. It does not measure how much people like one option over another; it merely lists the best and worst choices. BWS doesn't expressly provide its prices. The price or cost associated with each choice is frequently taken into account in economic research since it is an important consideration in decision-making and resource allocation. BWS might not fully account for the economic consequences of certain decisions.

In economic analysis, discrete choice models are commonly used to estimate consumer preferences and predict market behavior. These models involve estimating utility functions and considering various attributes and trade-offs associated with each option. BWS, on the other hand, is a simpler method that doesn't involve estimating utility functions or accounting for the multidimensional nature of choices. (McFadden, 1981)

3.1.3 Advantages and disadvantages

"The main value of best worst scaling comes from the fact that it generates implicit rank information in multiple ways. With two decisions, rank information is available for five of the six pairwise items in a particular trial of four items" (Hollis and Westbury, 2018).

Numerous authors were able to confirm and establish the greater efficacy of this survey method, which yields more accurate data compared to other research methodologies, for example, the classification of a set of attributes in order of importance, as is the case for techniques that ask you to score one component higher than another (Cohen, 2009).

BWS offers the advantage of identifying the best and worst options without defining those in the centre, which requires less time and effort. Compared to BWS, conventional rating scales have the disadvantage of not discriminating the importance of the items; this makes it impossible to determine which of two highly rated items is the most preferred. BWS also overcomes these approaches' inability to reliably evaluate the significance of the scale values. By conducting random comparisons between each item, BWS finds a solution to the issue while ensuring that each comparison appears an equal number of times (Flynn and Marley, 2014). Another advantage is that, since the method is based on the choice of only two options there is no bias in the rating scale (Goodman, Lockshin, and Cohen, 2005).

However, it is possible to identify some disadvantages and limitations of the method. For instance, the information identified is quite restricted, and it is unknown what order the unselected options are preferred in or how far apart they are from one another (Bottero *et al.*, 2021). Even though BWS can be helpful in some situations, such as finding extreme preferences or doing preliminary exploratory research, it lacks the economic rigor and comprehensiveness required for many applications of preference analysis.

Moreover, although BWS can offer useful insights into relative rankings and preferences, it is vital to keep in mind that economic research frequently necessitates more thorough techniques that take into account the economic backdrop, pricing data, and utility maximisation principles.

By applying BWS in a traditional way is not possible to know if all items are good/bad or whether some of them are good and some bad. This fact can be easily overcome by introducing an anchoring, which let the respondents express somehow their opinion in this concern. There are two types of Anchoring: direct approach and indirect approach. In the direct approach the respondent is invited to tell which of the items are acceptable/relevant and which are not in his/her opinion by selecting “yes” or “no” for each item. For the indirect approach, the respondent should answer to a multiple-choice question after each task with the following options: “all of them are good”, “some are good” or “none are good” (Chrzan et al., 2019).

Despite the fact that BWS can provide valuable information on preferences and classifications, it is important to remember that economic analyses frequently require more thorough methodologies that take the current state of the economy, price information, and maximisation principles into account. BWS is typically used as a supplemental tool to gather qualitative or semi-quantitative data on preferences rather than as an independent method of economic analysis. (McFadden, 1981)

CHAPTER 4

4.1 Application

The technique for the thesis is intended to be applied in urban projects in order to understand and evaluate the benefits that different transformations bring to the territory. As was already indicated in the first chapter, consulting with experts and project decision-makers will help establish a specific list of multiple benefits. Subsequently, stakeholders would define which of them are more and less significant in their opinion according to the specific case they are involved in. However, practically, the survey's final questionnaire was only distributed to a sample composed by Politecnico di Torino students since dealing with the projects' stakeholders required a far more extensive process, which may be applied after the submission of the following study. A theoretical explanation of the application of the methodology will follow and subsequently more practical aspects will be clarified.

4.1.1 Theoretical application

Format of the workshop

In order to gather insights from various sources in regard of multiple benefits suitable for different urban and energy requalification projects, experts, project partners, and decision-makers were consulted through workshops. The workshop format was thoughtfully designed to accommodate the diverse schedules and preferences of all the participants by incorporating multiple modalities: in some cases online, in some in-person and in some others both of them. This hybrid approach allowed for effective collaboration and knowledge sharing among all the attendees.

Three workshops were organized, each dedicated to a different project: ARV, ProLight, and IEA-EBC Annex 83. These individual workshops enabled focused discussions and deliberations specific to each project. The participants in these sessions were all experts and involved in the respective projects.

The purpose of this initial phase was to serve as a preliminary step before engaging other stakeholders in the survey process. The insights and outcomes generated during these workshops would be instrumental in refining the survey materials and aligning them with the perspectives and priorities of the project stakeholders. The feedback received from the initial attendees would inform and enhance the subsequent stages of the research.

Therefore, the methodology seeks to expand the survey distribution to encompass a wider range of stakeholders associated with the projects. However, this particular phase will not be discussed in the current research. It remains a future undertaking that will be executed separately and explored independently from the present study.

In addition to the previous workshops, a parallel survey was conducted involving students from the Polytechnic of Turin (PoliTo). This survey served as an illustrative sample, demonstrating the potential outcomes that could be obtained once the survey is disseminated among all stakeholders involved in real urban projects. The purpose of this survey was to collect more statistically significant data that may offer insightful information from a statistical perspective.

By employing this comprehensive approach, combining workshops, targeted survey distribution, and the parallel student survey, the research team aimed to ensure a robust and holistic understanding of the methodology for the analysis of multiple benefits. The workshops allowed for discussions with selected stakeholders, while the surveys provided broader perspectives and statistical data.

By encouraging active participation and soliciting input from all attendees, the workshop aimed to gather different perspectives and ensure that a wide range of benefits associated with the analyzed projects were captured. This collaborative approach fostered knowledge exchange and allowed for the identification of both common and unique benefits, contributing to a more robust understanding of the multiple benefits derived from the implementation of these projects.

Generally, the workshops started with a brief explanation on key concepts such as Positive Energy Districts, co-benefits, multiple benefits and Best Worst Scaling. This introductory session ensured that all attendees had a common understanding of these fundamental concepts, laying the groundwork for productive discussions and results. Following the explanation of these concepts, the participants were directed to access and engage with a collaborative online platform called Miro. This platform served as a virtual workspace where the workshop activities took place. It was chosen to use Miro since it allows several individuals to write on it and view changes simultaneously. Upon entering the platform, the attendees encountered a board specifically prepared for the workshop.

The Miro board contained several examples of multiple benefits, along with a list derived from the literature review. The purpose of these examples and the list was to inspire and guide the participants in identifying and documenting the benefits associated with the implementation of each analyzed project. The attendees were actively involved in the process by contributing their own insights. The joint exercise/brainstorming consisted in writing down on the board at least ten benefits for each participant deriving from the specific demo case they were working on. If participants were not engaged in a specific demonstration case, they were encouraged to consider the overall project. Moreover, they were requested to include any benefit that had already been mentioned by someone else or which was already included in the list generated by the literature study. This emphasis on capturing all benefits, regardless of repetition, was essential for compiling a concise and comprehensive list. The intention was to derive a final shortlist of benefits that would be based not only on their individual significance but also on the frequency of their occurrence as noted by the participants.

The benefits resulting from the project under consideration required to be listed and categorised into one or more categories. These categories, namely Social, Governance, Economic, and Environmental, were selected to encompass a wide range of societal aspects. The intention was to capture the various dimensions in which the project's benefits could potentially manifest.

In order to visually represent the relationships between these categories, a Four-set Venn diagram was created. This diagram allowed for a graphical representation of how the benefits intersected and overlapped across different categories. Interestingly, it was observed that many benefits were placed within the intersections, indicating that they had implications and positive outcomes that crossed over into multiple categories. This suggests that the project's benefits were multifaceted and had the potential to contribute to different aspects of society simultaneously. Additionally, it was noticed that some similar benefits were placed in different categories. This observation highlights the complexity of the benefits and the fact that they could have diverse impacts and implications across various dimensions. It suggests that a single benefit could positively influence not just one specific aspect of society but multiple facets of it. The understanding that benefits might extend beyond specific categories emphasises how linked and dependent various socioeconomic factors are on one another. It emphasizes that addressing one aspect, such as the environment, can have positive spill-over effects on other areas like social well-being or economic prosperity. This understanding is crucial for comprehensive and holistic decision-making, as it highlights the need to consider the broader impacts and potential synergies that can arise from projects or initiatives.

The benefits were carefully grouped together based on their shared concepts by the researchers, ensuring similar elements were grouped under the same category despite having different labels. This process helped identify the underlying themes within the benefits. From these grouped benefits, a list of 18 relevant benefits was compiled. The selection was based on their perceived importance and impact, which was also based by the number of repetitions of each concept. This list had the function of being used in the survey in order to provide a ranking of the benefits. To conduct the survey and gather data for ranking the benefits, the Sawtooth Software was utilized. This software specializes in tools for conjoint analysis, discrete choice analysis, and MaxDiff exercises.

Therefore, the survey was submitted to the attendees directly during the workshop. After collecting the survey responses, the data was analyzed using the Sawtooth Software. The output of the analysis was a ranking of the benefits, ranging from the most relevant benefit, as indicated by a larger number of participants, to the least important one. This ranking provided a clear understanding of which benefits were considered the most significant and impactful by the workshop attendees.

Each workshop had a total duration of one hour, structured into the following segments: ten minutes for the explanation of the key concepts, ten minutes for the Miro board exercise, ten minutes for a group discussion and preparation of the list and survey, five minutes for the explanation of the Best Worst Scaling method, ten minutes for compiling the questionnaire and, finally, ten minutes for feedbacks and follow up.

After the phase of brainstorming and validation of the list of benefits by partners and experts, the questionnaire can be distributed to all project stakeholders.

During the meetings it was communicated that the same questionnaire should be spread to all the stakeholders of all the demonstration cases and that 150-200 answers were needed. The first idea was to collect all the answers in a short time to incorporate the results in the thesis. Nevertheless, it was realized that this approach would require additional time and coordination to obtain the necessary approvals from multiple parties involved. Therefore, it was decided to leave this data collection phase for future work.

This systematic process allowed for an objective assessment of the benefits and their rankings. It combined thematic grouping, citation analysis, and survey-based ranking to identify the most relevant benefits and their order of importance, providing valuable insights for decision-making and further research in the topic area.

Questionnaire

The Sawtooth Software, notably the MaxDiff tool, was used to create the questionnaire. The survey lasted between five and ten minutes. It started with a brief explanation of the context and goal of the study and the following part can be divided into four macro-sections.

The first section aimed to gather the interviewee's opinion on the importance of energy transition and his/her ability to prioritize and allocate resources among various societal needs within the framework of an urban redevelopment project.

The interviewee was asked to called to express his/her opinion on the importance of the energy transition in relation to the fight against climate change. The purpose of this question was to gauge their perspective and starting to get him/her more involved in the theme of the questionnaire. Additionally, the interviewee was asked to distribute a total of 100 points among four categories: economic, governance, social, and environmental. These categories were intended to encompass the various needs of society as a whole. The respondent was tasked with balancing the allocation of points in order to assign a higher value to aspects (s)he believed more relevant for an urban redevelopment project. By distributing points across the different categories, the interviewee had the opportunity to express his/her priorities and emphasize the areas (s)he believe should receive greater attention and focus in the context of urban redevelopment. This exercise allowed the interviewer to learn more about the interviewee's viewpoint on the interrelationships of the aforementioned categories. This is a preliminary step to understand the sector that the respondent value more within the society.

By understanding these rankings, policymakers and stakeholders can work towards creating integrated strategies that address all macro-categories effectively. This requires finding synergies and aligning goals across economic, environmental, social, and governance dimensions to ensure comprehensive and sustainable outcomes.

The second section of the questionnaire aimed to gather information about the role and involvement of the interviewee within the project and within a specific demonstration case. While the first section was the same for all the four different questionnaires, the second section had some difference.

In the case of the ARV and ProLight questionnaire, there was a specific question concerning his/her involvement within a specific demo case of the project. The goal was to allow the interviewee to concentrate on a single case and provide more specific and focused responses while answering the subsequent questions. This approach ensured that the interviewee's answers were relevant to his/her particular involvement and expertise. Moreover, in the later BWS exercise they could provide answers thinking about the needs of just that single demo case, which could provide more accuracy of the overall questionnaire. Furthermore, the interviewee was asked to indicate their sector of belonging within the project. The options provided were citizen, political/regulatory actor, entrepreneur, socio-cultural actor, academic/researcher, or other. These categories were chosen considering that the final version of the questionnaire would be distributed to all the stakeholders involved in the project. However, at the time of the interview, the questionnaire was only shared with the project partners, which resulted in the inclusion of respondents from a limited number of categories in the results.

For what concern the IEA-EBC Annex 83 questionnaire, the question related to the interviewee were related to the field of study. The options available were social, economic, scientific-technological (math and physics), scientific-technological (engineering, architecture, territorial planning), or other. This question aimed to gather insights into the background and area of interest of each respondent.

Regarding the questionnaire addressed to students, they were asked to select their scientific field of study from the options provided by the Polytechnic of Torino (PoliTo). The options included Urban and Regional Planning, Architecture, Engineering, Design, or other. This question aimed to understand the academic background of the students and how it related to the themes of the interview and the projects being discussed.

The third section included the core of the survey: the MaxDiff analysis. A list of eighteen items was input into the software Sawtooth. It is worth noting that the specific list of items varied depending on the version of the questionnaire administered to different participants referring to different contexts. To ensure an optimal balance between having enough tasks to gather sufficient data and not overwhelming the respondents with too many tasks, it was decided to propose nine MaxDiff tasks in total. Each task consisted of six items that the participants had to evaluate. Having too many tasks could result in respondent fatigue or boredom, leading to decreased attention and potentially lower-quality responses. Moreover, having too many items within each task could make it more challenging for respondents to compare and decide on the best and worst items when faced with a long list of elements.

For a set of eighteen items, it is generally advised to have between nine and fifteen tasks. The recommended number of items per task falls within the range of three to six. By following these guidelines and selecting nine tasks, each consisting of six items, each item appeared approximately three times during the MaxDiff analysis. By ensuring that each item appeared a reasonable number of times, the researchers could gather robust information into the relative preferences and rankings of the eighteen items in the study.

The data are elaborated thanks to the Hierarchical Bayesian method, that incorporates a hierarchical structure that takes into account possible individual differences in preferences, allowing inferences to be made at both the individual and group level. Anyway, the Hierarchical Bayes model which requires a particular and complex computation that will not be covered in this thesis.

In the fourth and final section, questions about respondents' personal information were made. This part was designed to profile the interviewee to possibly make deductions or connections between the type of person and the answers given. All surveys didn't deal with sensitive material and just addressed generic questions. In further detail, the questionnaire included questions on the respondent's gender and age (with the exception of the questionnaire addressed to students, since it was presumed that most respondents were in their twenties or thirties).

Including a diverse age and gender range in the sample would provide a more comprehensive understanding of the attitudes and preferences towards the benefits and goals of the project. It would allow for a more inclusive representation of the population and provide insights into the perspectives of people with different characteristics and backgrounds that might have unique insights or concerns. This can help identify potential gaps in awareness or engagement among specific groups and inform targeted strategies to address those gaps.

4.1.2 Practical application

As already mentioned, the workhops and the relative questionnaires were addressed to different projects and, consequently, different audience. A description of all the sessions follows.

For the ARV, ProLight and Annex 83 cases, the workshops were announced beforehand via email and the attendees were instructed already before the beginning of the meeting to subscribe to Miro, an online collaborative platform, and open the board created specifically for the study of multiple benefits.

The presentation during the workshop was divided between two speakers: the author of the thesis and her supervisor, Adriano Bisello. The latter introduced the concepts of co-benefits and multiple benefits, setting the stage for the workshop. The author then took over and moderated the interactive part of the session. Subsequently, she briefly explained the Best Worst Scaling method and invited the audience to fill out the questionnaire during the remaining time. By giving some space to fill the survey during the workshop, it was possible to obtain more responses since the attendees felt more involved. Moreover, it was useful to answer to questions, doubts or technical issues.

With the exception of two workshops at the Polytechnic of Turin, which were conducted in Italian, all of the workshops were held in English.

Regarding the interactive part, the participants accessed the Miro board through the provided link, which was also shared in the chat of the online meeting for those who hadn't opened it from the email. The attendees were given instructions on how to use Miro and were asked to select pre-prepared post-it notes and place them in the designated scheme. The participants were encouraged to think of approximately 10

Figure 7 Photo of ProLight workshop session in Bilbao. Source: Author (2023).

benefits each and write them on the post-it notes. This exercise aimed to collect as many benefits as possible from diverse perspectives.

ARV

For what concerns the ARV project, the survey was realised on the 29th of March 2023. The workshop was held during the online monthly meeting of the project so that there were many researchers and partners expert in many fields and involved in different aspects of the project. It lasted approximately one hour and it was attended by 31 people. Figure 8 shows what has been elaborated within 10 minutes of workshops, where numerous post-it notes were created on the board and distributed among the proposed categories.

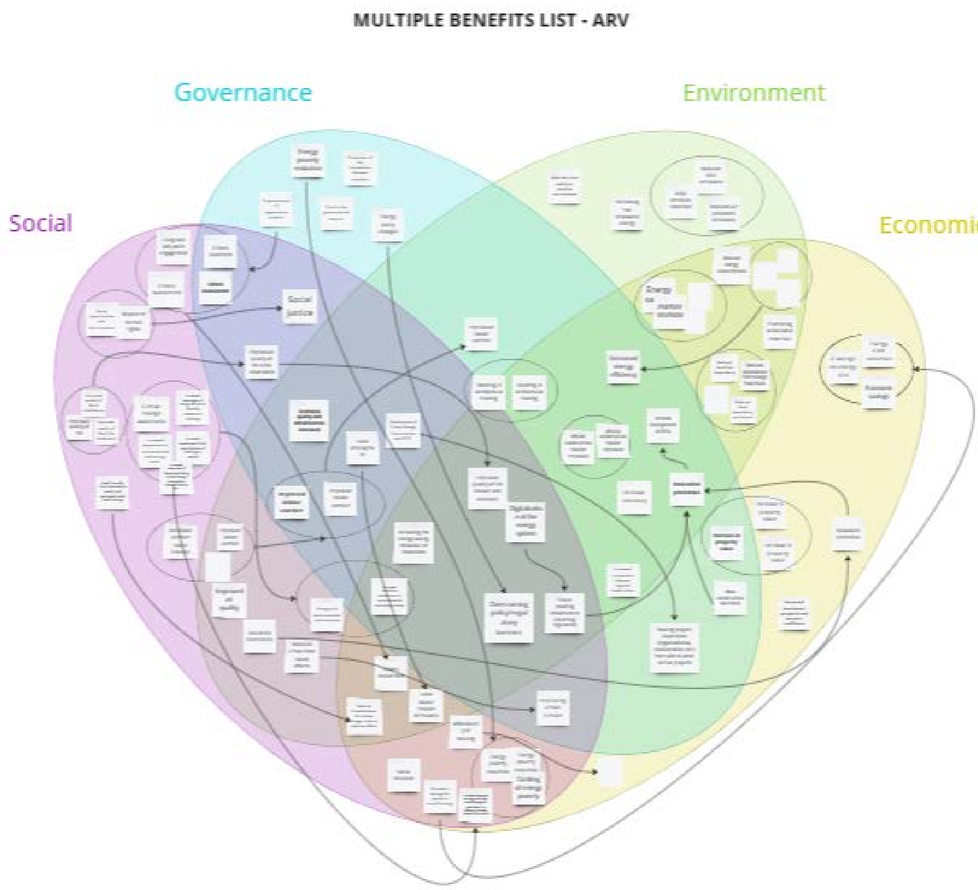

Figure 8 Visual result of the interactive part of the workshop organised for the ARV project. Source: Author (2023).

Although many benefits were identified in the social sphere, there was no significant disproportion compared to the other categories. This observation suggests that benefits were distributed across various spheres, indicating a broad range of impacts and implications associated with the ARV project.

During the workshop, while one collaborator was managing the discussion time, another one focused on listing the benefits identified by the participants. Their goal was to choose the eighteen most relevant and frequently cited benefits from the Miro board. However, due to limited time available for this step, the selection process was not able to accurately capture the most cited benefits. Additionally, some elements on the list were similar, namely "Climate change awareness" and "Energy and environmental consciousness" (later reported under the label of Awareness on environmental and energy issues). Moreover, later on was decided to unite "innovation in governance processes" and "fostering technological innovation" in the broader label "innovation promotion" and the "energy cost reduction" was included in the more general concept of "economic savings". This brought to the conclusion that the questionnaire should be revised before sending it to the stakeholders. As a result, the questionnaire that was initially planned to be sent to the stakeholders was considered only a test phase. It was recognized that improvements were necessary to ensure the clarity and accuracy of the survey. Table 3 shows the benefits identified and listed after the revision. Next to each label is reported the number of repetitions of each benefit within the Miro board. The multiple benefits underlined with a colour are the ones that were included in the questionnaire.

Table 3 List of multiple benefits obtained from the workshop held for the ARV project and after the review. The underlined lines indicate the benefits that were inserted in the questionnaire. Source: Author (2023).

ID	BENEFIT	NUMBER OF REPETITIONS
1	Innovation promotion	7
2	Citizen involvement	6
3	Awareness on environmental and energy issues	6
4	Indoor comfort increased	6
5	Quality of life of the inhabitants improved	5
6	Economic savings	4
7	Energy poverty tackled	4
8	Fossil fuel dependency and import reduced	4
9	Energy efficiency increased	4
10	Energy savings	4
11	Air pollutant emissions reduced	3
12	Property value increased	3
13	Social justice	2
14	Health conditions improved	2
15	Overcoming policy/regulatory barriers	2
16	Local labour market improved	2
17	Affordable housing increased	2

18	Replicability fostered	2
19	Off-site construction market improved	2
20	Investment in architectural training	2
21	Reduced urban heat island effects	2
22	Air quality improved	1
23	Social inclusion	1
24	Investment prospect and investor confidence increased	1
25	Cooperation between regional stakeholders increased	1
26	Resiliency increased	1
27	Sustainable materials promoted	1
28	Energy consumption reduced	1
29	Renewable energies increased	1
30	Noise pollution reduced	1
31	Territorial quality and attractiveness	1
32	Motivate people to adopt environmentally friendly behaviours	1
33	Fair competition between suppliers promoted	1
34	Trust in the government support	1
35	Respect of human rights	1

However, it is worth noting that no negative feedback was received regarding the structure of the survey during the meeting, which led to the assumption that it could still be effective despite the need for revisions.

ProLight

The workshop was held on the 30th of March 2023. The workshop had some differences compared to the ARV one, since it was conducted in a hybrid mode, combining both in-person and online participation. In fact, the workshop was planned taking advantage of the general meeting of the project that was organised in Bilbao, Spain, and at which all of the ProLight project's partners were reunited. Not only the audience, but also some of the presenters were physically present in Bilbao. On the other hand, the author of the workshop, along with two other collaborators, participated remotely.

The hybrid format of the workshop allowed for a combination of in-person interactions and remote participation, enabling both the attendees and presenters to join the event according to their availability and circumstances. This approach facilitated collaboration and knowledge sharing while accommodating the logistical challenges or constraints faced by some participants. Considering both online and face-to-face participation, around twenty-five people joined the workshop, which lasted one hour.

The session progressed similarly to the previous one, but with a few extra challenges brought on by the hybrid modality, which caused some delay.

Anyway, in comparison to the previous workshop, the organizers made some revisions and improvements to the organizational aspects of the event. One notable improvement was the increased emphasis on the use of arrows to link benefits that had the same meaning but were categorized differently. This helped to create clearer connections between related benefits and ensured that they were properly aligned within the workshop's framework.

To facilitate the management of the benefits, a working excel table was introduced. This table served as a central repository for listing and documenting the identified benefits. However, access to this table was restricted only to organizers and collaborators of the workshop. A methodological innovation implemented in this workshop was the use of colours inside the excel table. If a benefit mentioned by an attendee was already cited in the literature review or appeared in the existing list of benefits, it was underlined using the green color. This approach helped to highlight the connections between the ideas and findings from the literature review and the contributions made by the workshop attendees.

Figure 9 provided a visual representation of the distribution of benefits identified by the attendees across different categories.

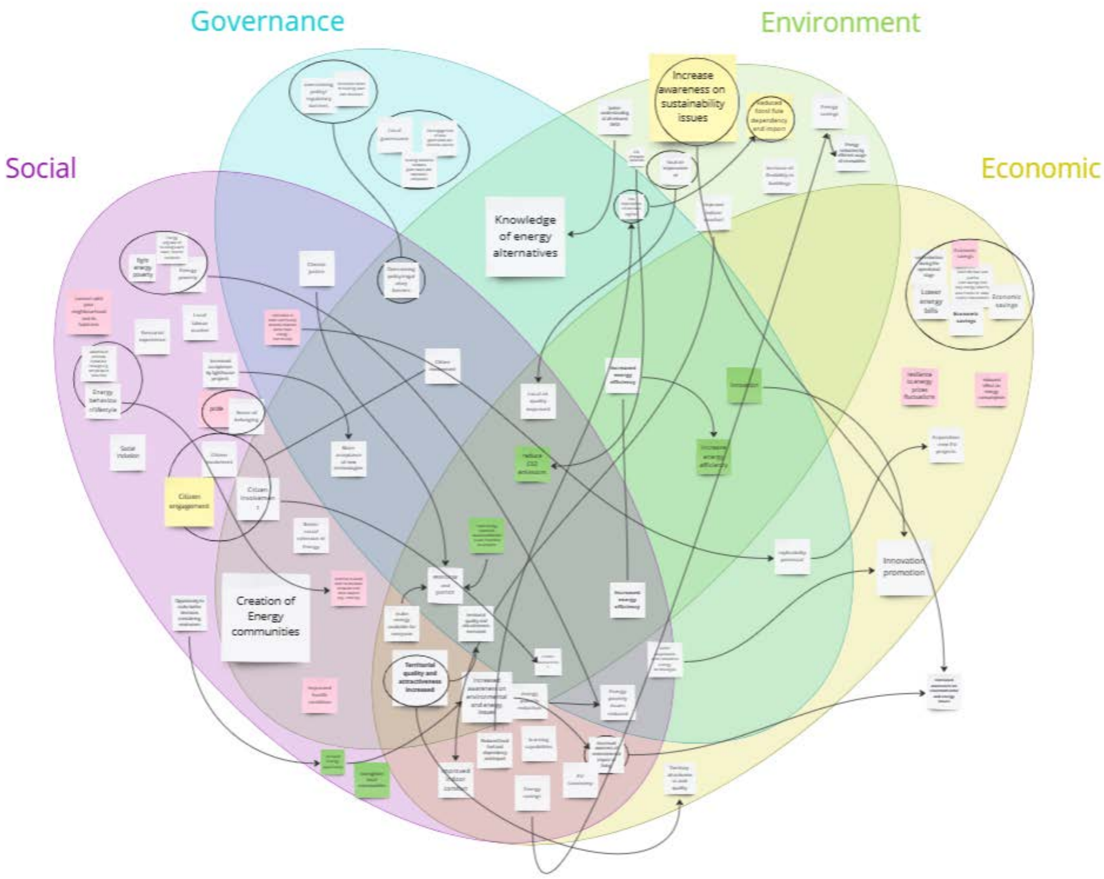

Figure 9 Visual result of the interactive part of the workshop organised for the ProLight project. Source: Author (2023).

The social category is the one that registered the highest number of benefits. This was predictable, since the project is dealing with social housing. This finding was not surprising considering that the project focused on social housing. It highlighted the fact that the attendees of the workshop were actively considering and acknowledging the benefits that could arise from the demonstration cases they were primarily involved in.

However, it is important to note that numerous linkages were identified between the categories. This suggests that the benefits identified during the workshop had the potential to have a positive impact on various aspects of society beyond just the social domain. The attendees' recognition of these linkages further highlights their holistic understanding and consideration of the broader societal implications of the project.

The selection of the benefits to be included in the questionnaire was more accurate compared to the first workshop, but still a better selection would require more time and attention, which cannot be achieved in just ten minutes. After the end of the workshop a revision of the benefits was done, and different priorities were given to the identified benefits. Table 4 shows the completed list of the benefits identified and underlines the ones that were included in the questionnaire addressed to the participants of the workshop.

Table 4 List of multiple benefits obtained from the workshop held for the ProLight project and after the review. Source: Author (2023).

ID	BENEFIT	NUMBER OF REPETITIONS
1	Awareness on energy and environmental issues increased	8
2	Economic savings	6
3	Energy poverty tackled	5
4	Citizen involvement	5
5	Social, environmental and energy justice	4
6	Territorial quality and attractiveness increased	3
7	Fossil fuel dependency and import reduced	3
8	Energy savings	3
9	Innovation promotion	3
10	Energy efficiency increased	3
11	Replicability potential	3
12	Overcoming policy/regulatory barriers	3
13	Local government engagement increased	3
14	Incentive to adopt sustainable behavours	3
15	Acceptance of the project and new technologies increased	2
16	Sense of belonging to a community	2
17	Indoor comfort improved	2

18	Local air quality improved	2
19	CO2 emissions reduced	2
20	Health conditions improved	1
21	Sensorial experience	1
22	Connection with the neighborhood and its inhabitants	1
23	Social inclusion	1
24	Local labour market stimulated	1
25	Social cohesion improved	1
26	Strenghten local communities	1
27	Creation of energy communities	1
28	Learning capabilities	1
29	EU taxonomy	1
30	Flexibility in buildings increased	1
31	Resilience to energy prices fluctuations	1
32	Rebound effect on energy consumption	1

The list of the benefits can be revised before spreading the questionnaire to all the stakeholders. A criterion could be choosing just the first eighteen elements showed in Table 4 since they are the ones mostly cited.

Additionally, there were no unfavourable comments in regards of the survey, thus it was assumed that everything was fully comprehended and that a questionnaire in this format could be distributed to the stakeholders.

IEA-EBC Annex 83

The third workshop was realised on the occasion of the sixth IEA EBC Annex 83 working meeting, held in Palermo (Italy) between April 12th and 14th 2023. The meeting concerned the topic of Positive Energy District and was organised in subtasks (A-D), which treated different important aspects of it. The multiple benefits analysis was included in subtask C, which dealt with the social assessment framework and was held in English.

Since the workshop was realised in the same timeslot of other sessions of the conference, there were not so many attendees. In fact, the participants of the conference had to choose between attending the workshop or other sessions, resulting in a lower turnout. Considering the ones online and in presence, there was a total of twenty participants.

As well as for the ProLight project, the workshop was held in a hybrid mode, and also some collaborators were *in loco* and others online.

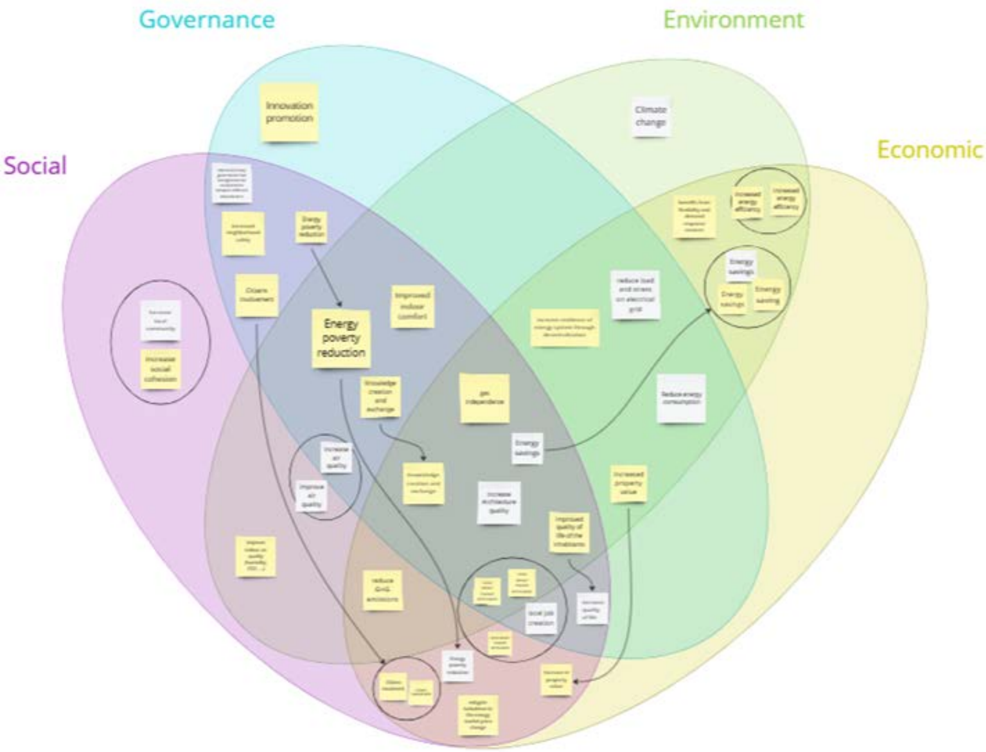

Figure 10 Visual result of the interactive part of the workshop organised for the IEA EBC Annex 83 meeting. Source: Author (2023).

The workshop was not intended for people involved in a specific and practical project, but rather for researchers, PhD students, and experts in Positive Energy Districts (PEDs). By targeting this particular audience, the workshop aimed to provide a platform for knowledge exchange, discussion, and exploration of the broader concept of Positive Energy Districts. Instead of focusing on the benefits and challenges of a specific case or project, the session aimed to delve into the multiple benefits associated with PEDs in general. This was crucial to let participants consider the positive impacts that their topic of interest may truly have on an area or community in a more holistic way.

The identified multiple benefits were fewer in number compared to what was typically observed for the other workshops, it may be due also to the absence of a specific case study to refer to.

As it is possible to notice from Figure 10, there were not many repeated benefits or many linkages between categories. This is probably due to the aforementioned motivations. Almost all the identified elements are in the intersection between categories and, as was also noticed in the other sessions, many benefits intersect with the social sphere. This implies that the benefits identified during the workshop had a strong connection to social aspects, indicating that Positive Energy Districts have possible great potential social implications, such as community engagement, or improved quality of life.

In Table 5 are listed all the identified multiple benefits and the ones that were used in the questionnaire are underlined with light blue. Some benefits were also included in the literature study or other workshops; for instance, “Energy savings”, “citizen involvement” or “energy poverty reduced”.

Table 5 List of multiple benefits obtained from the workshop held for the IEA EBC Annex 83 meeting. Source: Author (2023).

ID	BENEFIT	NUMBER OF REPETITIONS
1	Energy savings	4
2	Local labour market stimulated	4
3	Citizen involvement	3
4	Energy poverty reduced	3
5	Energy efficiency increased	2
6	Property value increased	2
7	Quality of life of the inhabitants improved	2
8	Knowledge creation and exchange	2
9	Social cohesion increased	2
10	Architectural quality increased	1
11	Air quality improved	1
12	Interdisciplinary governance that strengthens the collaboration between different stakeholders	1
13	Neighborhood safety increased	1
14	Indoor comfort improved	1
15	Gas independence improved	1
16	Resilience of energy system through decentralization increased	1
17	Innovation promotion	1

18	Energy consumption reduced	1
19	Load and stress on electrical grid reduced	1
20	GHG emissions reduced	1
21	Indoor air quality improved	1
22	Contribution to the mitigation of climate change	1
23	Turbulence in the energy market price change mitigated	1
24	Benefits from flexibility and demand response services	1

Later on, the questionnaire including the first eighteen benefits identified in Table 5, was submitted to the participants. Again, the lack of unfavourable comments was interpreted as an indication that participants considered the questionnaire as clear, concise, and appropriate for collecting the desired data.

Since this meeting was not linked to any ongoing specific project, the gathering of data was viewed as only a test step for the approach and an opportunity to contact specialists on the subject of PEDs and even let them think about a very crucial analysis related to this model of neighbourhood.

Polytechnic University of Turin

The questionnaire submitted to the Polytechnic Turin students was intended differently compared with the others. It was designed as a testing phase to gather data that had significant statistical relevance. The aim was to understand the priorities that the students from different backgrounds gave to the multiple benefits identified for urban redevelopment projects. The list of the multiple benefits was not created after an interactive session but the eighteen benefits identified after the literature review made by the author were used.

In order to collect the largest number of responses, four workshops were organized for different students belonging to different scientific disciplines. The sessions were held on the following days: April 27th, May 3rd, May 4th, and May 9th. The workshops had the objective to introduce to the students the main concepts and submit the survey to the students. The sessions were led by the author, which was helped by the Ph.D. student Marco Volpatti. They were organised in Turin (Italy), during the lectures of Professor Marta Bottero, who had the possibility to show to the students, through this work, a practical application of an evaluation method. The author participated online while the students were physically in Turin, with the only exception of a class that was only online.

To enhance comprehension of each benefit, an external support file was created, which allows easy access to the meaning of each benefit already defined in the list by associating a clear definition to each benefit. The file was accessible from the part of Best Worst Scaling of the questionnaire. The same procedure is intended to be done for the delivery of the questionnaire of ARV and ProLight to the stakeholders of the projects.

Overall, this questionnaire and workshop approach provided valuable data on student priorities regarding urban redevelopment project benefits. The findings contribute to the broader understanding of urban planning and redevelopment strategies.

4.2 Preliminary results of the questionnaires

In this section, the focus is on analyzing the results obtained from surveys. The analysis begins with a general overview and comparison of the results from four different surveys. This comparison allows for a broader understanding of the trends and patterns observed across the surveys. Although the contexts of application may vary, the underlying subject matter remains the same, which is the Positive Energy District.

Therefore, each context brings its own unique set of considerations which contribute to the increase of knowledge concerning multiple benefits.

After the general overview, the analysis narrows down to focus specifically on the results of the survey that was conducted specifically for the students of the Polytechnic of Turin. This survey is given more detailed attention in order to gain deeper insights into the preferences, opinions, or experiences of this particular group of students.

The sociodemographic data of the respondents will be presented, followed by information in relation to the perception of the respondents on the significance of the examined benefits analysed thanks to the Best Worst Scaling method. Moreover, an analysis on the preferences of the interviews according to their gender and academic field of study will be provided.

4.2.1 Comparisons of the results of the surveys

Since a similar methodology was applied to four different cases of urban and energy requalification projects, it is possible to compare the results, identifying similarities as well as differences.

Interestingly, despite the different methods of benefit identification, the study found that there were many common benefits identified across the workshops and the literature review. These shared benefits highlight the consistency of the positive impacts that urban and energy requalification projects can have. Table 6 provides a visual representation of all the identified benefits, highlighting the overlap and frequency of their occurrence across the four cases. Five benefits were cited in all the three workshops and were also present in the list derived from the literature review. This suggests that these benefits are highly recognized and acknowledged by various stakeholders and experts involved in the urban requalification projects. It indicates a consensus on the importance and value of these benefits in achieving the objectives of projects based on the concept of PED or CPCC. Moreover, six other benefits were cited in three out of the four lists of benefits. This implies that while these benefits were not universally acknowledged across all cases, they still emerged as significant in the majority of the projects mentioned.

Table 6 Presence of all the identified multiple benefits within the four case studies. Source: Author (2023).

BENEFITS	ARV	PROLIGHT	ANNEX 83	POLITO
Energy efficiency increased	X	X	X	X
Energy poverty reduced	X	X	X	X
Citizen involvement	X	X	X	X
Innovation promotion	X	X	X	X
Comfort levels increased	X	X	X	X
Quality of life improved	X		X	X
Awareness on environmental and energy issues improved	X	X		X
Territorial quality and attractiveness increased	X	X		X
Property value increased	X		X	X
Energy savings		X	X	X
Local air quality improved		X	X	X
Economic savings	X			X
Energy fossil fuels reduced	X			X
Social cohesion increased		X	X	
Overcoming policy/regulatory barriers		X		X
Local labor market stimulated			X	X
Knowledge creation and exchange			X	X
Neighborhood safety increased			X	X
Off-site construction market improved	X			
Respect for human rights	X			

Air pollutants reduced	X			
Investing in architectural training	X			
Energy cost reduced	X			
Innovation in governance processes	X			
Adaptation of personal behavior for limiting climate change		X		
CO2 emissions reduced		X		
Energy and social justice increased		X		
Creation of energy communities		X		
Local governance improved		X		
Resilience to energy price fluctuation		X		
Sense of belonging increased		X		
Increase resilience of energy system			X	
Energy consumption reduced			X	
Architectural quality increased			X	
Gas independence			X	
Collaboration between different stakeholders fostered			X	
Investment prospects and investor confidence increased				X

The following figures (Figure 11, Figure 12, Figure 13, Figure 14) display the lists of multiple benefits obtained from each case, as well as the ranking of these benefits based on a survey. The author categorized the identified benefits into four macro-categories: economic, social, environmental, and governance. The distribution of benefits in the categories took place according to the author's perception.

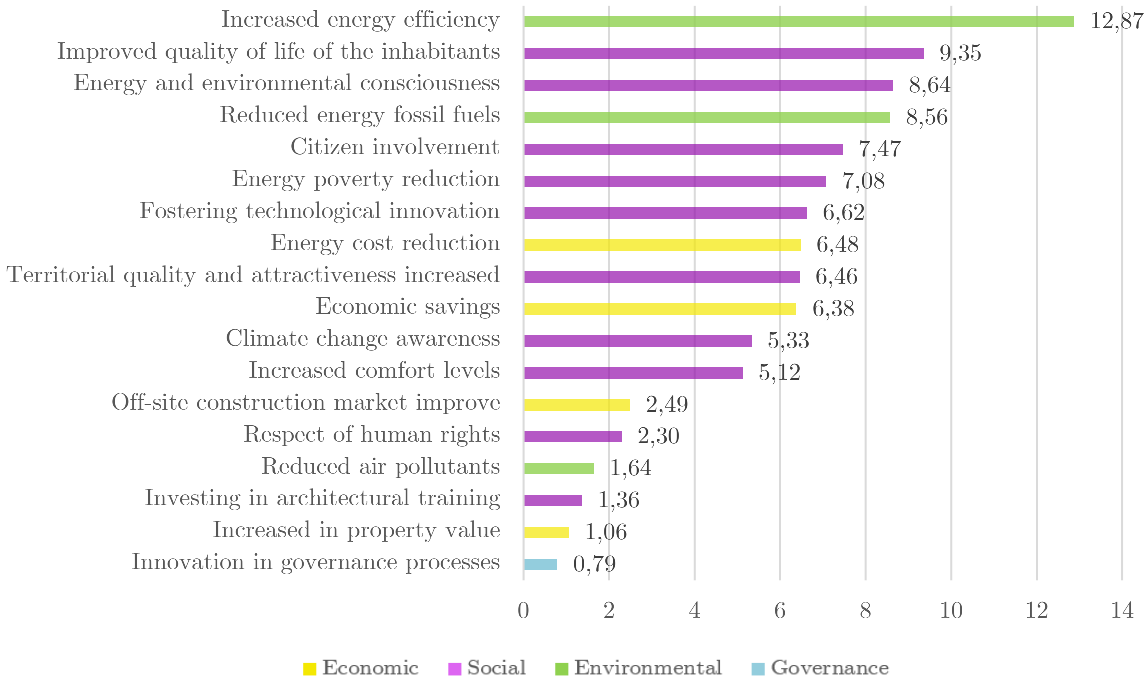

Figure 11 Ranking of multiple benefits according to the perception of ARV respondents. Subdivision in macro-categories. Source: Author (2023).

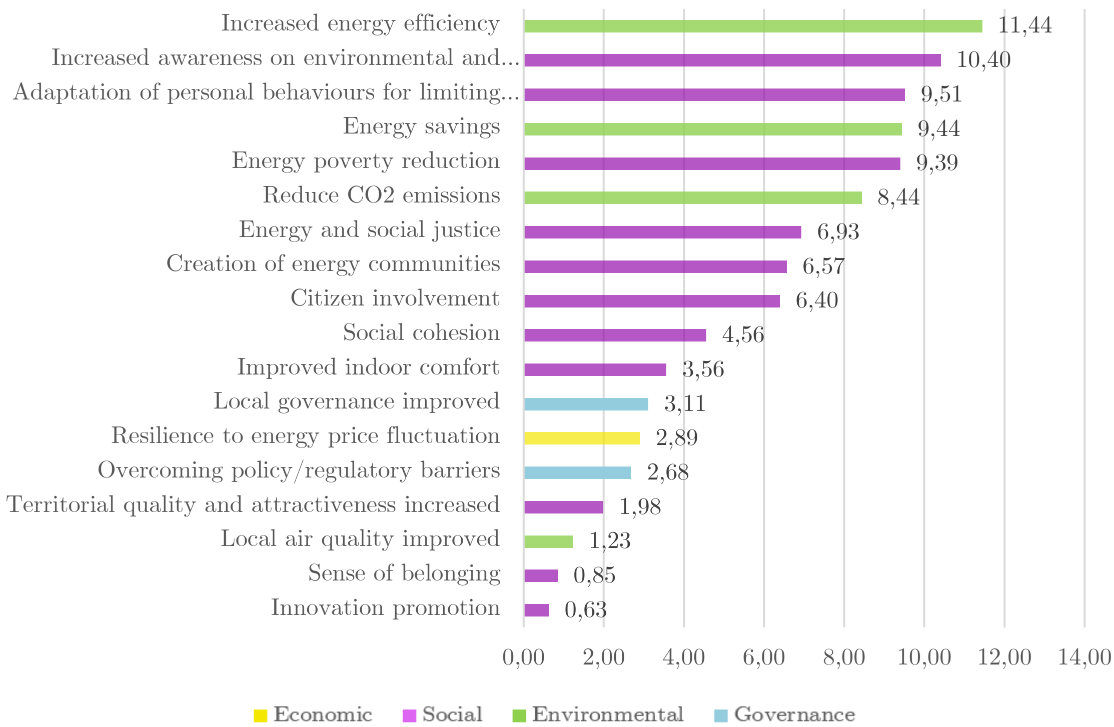

Figure 12 Ranking of multiple benefits according to the perception of ProLight respondents. Subdivision in macro-categories. Source: Author (2023).

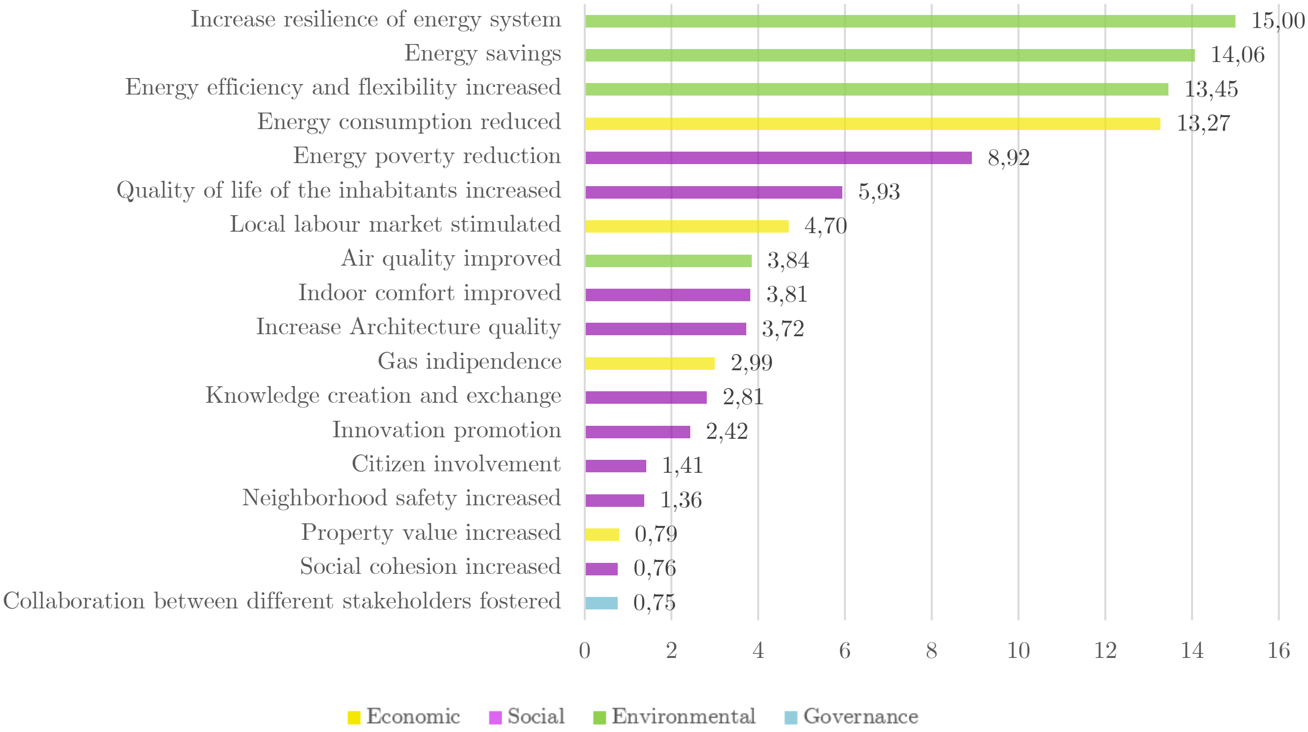

Figure 13 Ranking of multiple benefits according to the perception of Annex 83 respondents. Subdivision in macro-categories. Source: Author (2023).

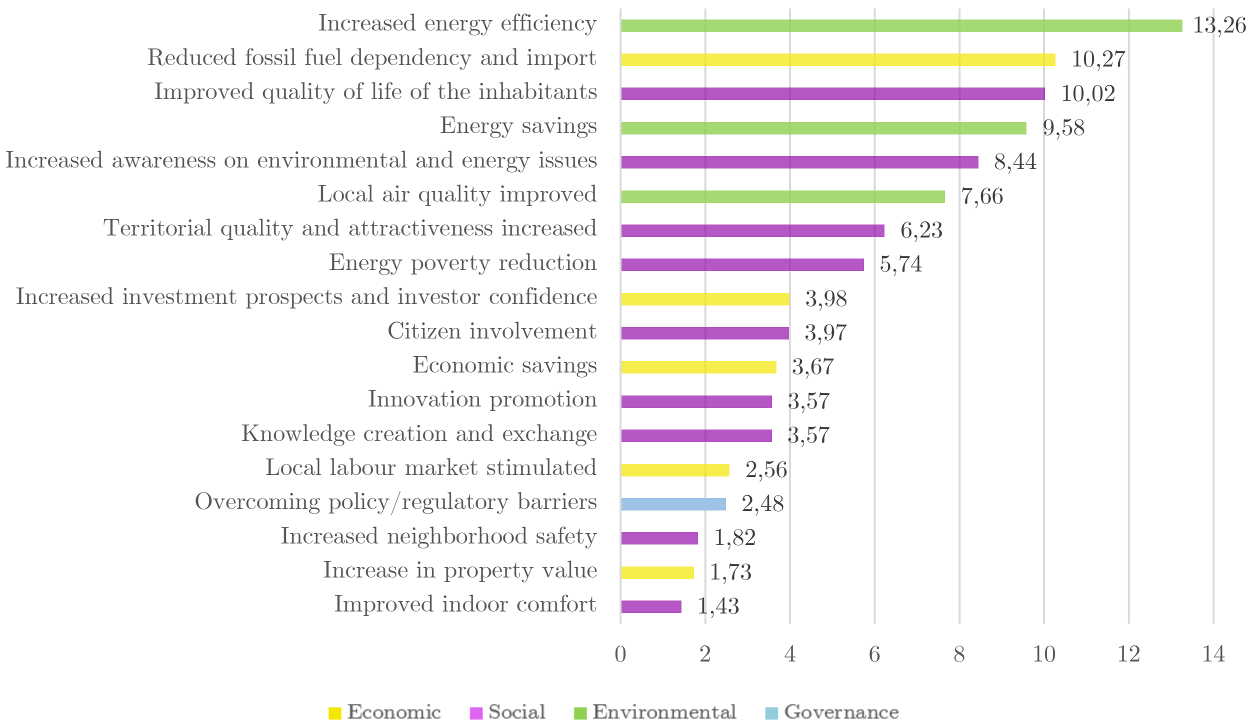

Figure 14 Ranking of multiple benefits according to the perception of the students. Subdivision in macro-categories. Source: Author (2023).

Interestingly, despite the respondents not having access to the benefit lists compiled by others, the lists from the different cases had similar percentages of benefits in each macro-category (Table 7). This suggests a degree of consistency in the perception of benefits across the different projects, irrespective of the specific methodologies used to identify them. This finding is even more valuable considering the outcome of Table 6, since it means the attendees from different sessions considered not only similar benefits in general, but also a similar composition of the list considering the macro-categories.

Table 7 Percentage of each macro-category within the case studies. Source: Author (2023).

CATEGORY	ARV	PROLIGHT	ANNEX 83	POLITO
ECONOMIC	16,67%	5,56%	22,22%	27,78%
SOCIAL	55,56%	61,11%	50,00%	50,00%
ENVIRONMENTAL	22,22%	22,22%	22,22%	16,67%
GOVERNANCE	5,56%	11,11%	5,56%	5,56%

The social category consistently comprised the highest percentage of benefits in all the cases, with this percentage always exceeding 50%. This is likely because social benefits encompass a wide range of aspects, contributing to their higher representation in the lists.

Conversely, the governance category had the lowest representation across the cases. This could be attributed to the perception that governance-related aspects operate in the background and may not be as apparent or tangible as other benefits. In these cases, in comparison to the other categories, the governance category is not just underrepresented but also often at the bottom of the ranking, showing a general disinterest in it. However, governance plays a crucial role in the success of energy requalification projects, even if it is not always considered as relevant or emphasized as much as other benefits and categories.

When examining the rankings of multiple benefits, the first benefit in the ranking across all cases was related to the environmental category, specifically energy efficiency. This indicates that energy efficiency is a consistently recognized and highly valued benefit across the different projects. However, this benefit was not identified in the list compiled from the workshop attended by Annex 83 participants.

Furthermore, benefits associated with the environment tended to be found in the higher part of the rankings, indicating that respondents placed particular importance on environmental benefits. This aligns with the growing emphasis on sustainability and environmental considerations in contemporary energy projects. On the other hand, benefits related to the economy were scattered throughout the rankings, indicating that they may not be as dominant or prioritized compared to other categories.

The survey also explored the respondents' preferences between the macro-categories. This was achieved through a question in the questionnaire where the respondents were asked to rank the four macro-categories (economic, social, environmental, and governance) in terms of their preference or importance (Figure 15).

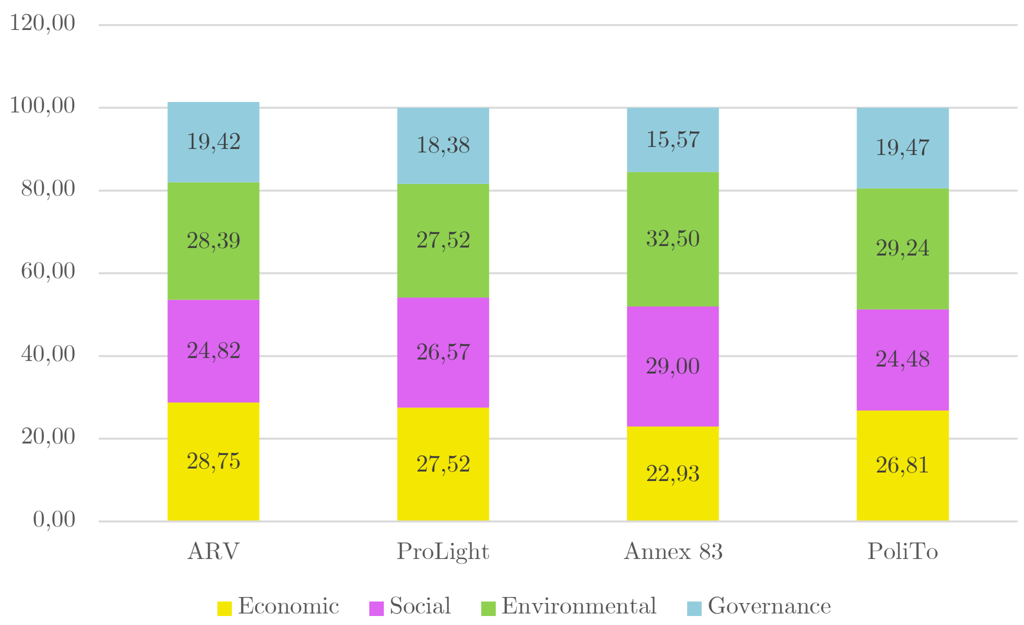

Figure 15 Comparison across projects of respondents' perspectives on the importance of macro-categories. Source: Author (2023).

Contrary to expectations based on the rankings of individual benefits and on the percentages of macro-categories in each list (Table 7), the results of the questionnaire showed that all the categories obtained almost the same score. There was no significant disproportion in favour of any particular category even if governance generally received lower appreciation compared to the other categories. Despite this, the score for governance was not as low as might be expected based on the rankings of individual benefits. This suggests that respondents did not show a clear preference for one macro-category over the others.

This discrepancy between Table 7 and Figure 15 could be attributed to the inherent challenges of self-evaluation and maintaining consistency in judgment, particularly when circumstances or perspectives change. This highlights the complexity of evaluating and comparing macro-categories and the subjective nature of such assessments. The study reveals that while the rankings of individual benefits and the respondents' preferences between macro-categories may not align perfectly, it underscores the challenges of evaluating and prioritizing different dimensions of societal impact. It emphasizes the need for comprehensive assessments that consider multiple perspectives and account for the inherent subjectivity in evaluating macro-categories and their associated benefits.

Generally, a notable finding was the widespread agreement among all the interviewees regarding the importance of energy transition in addressing climate change. As shown in Figure 16, respondents overwhelmingly expressed the view that energy transition is a crucial and significant endeavour.

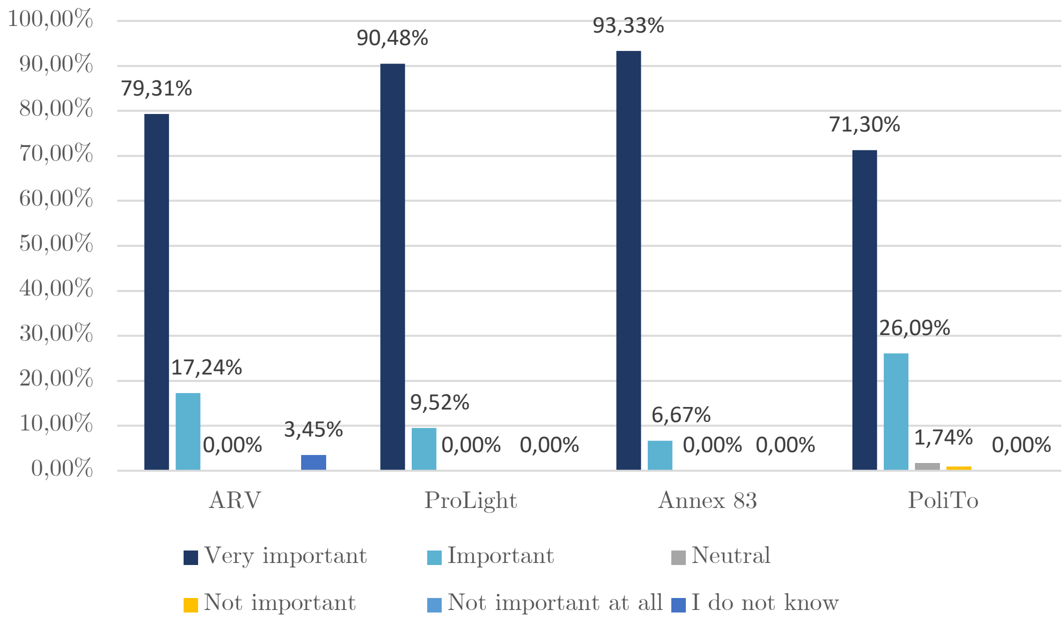

Figure 16 Comparison across projects of respondents' perspectives on the importance of energy transition to contrast climate change. Source: Author (2023).

In response to questions about the importance of energy transition, the majority of the respondents consistently conveyed that it is either "very important" or "important." This indicates a strong consensus among the interviewees regarding the significance of transitioning to sustainable and renewable energy sources as a means to combat climate change.

The recognition of the importance of energy transition aligns with the global consensus and growing awareness of the urgent need to mitigate the impacts of climate change. It reflects a shared understanding that transitioning away from fossil fuels and adopting cleaner and more sustainable energy practices is critical in reducing greenhouse gas emissions and addressing the environmental challenges facing the planet. The recognition of the importance of energy transition serves as a foundation for the research and analysis conducted in the thesis. It validates the significance of investigating energy requalification projects and identifying their multiple benefits across different macro-categories.

4.2.2 Polytechnic of Turin results

The questionnaire addressed to the Polytechnic of Turin students yielded a total of 235 records, even if only 115 of them were considered complete. The difference between the total number of records and the number of completed responses can be attributed to various factors, for instance some participants could have had problems to restart the survey due to technical difficulties. Based on the information provided, it is reasonable to assume that the individuals who accessed the survey were the same people who attended the workshop conducted by the author. This assumption is supported by the fact that the number of participants closely aligns with the completed answers. In other words, the workshop attendees were the target population for the survey.

Given this context, it became crucial to analyse and consider only those records that were completed in their entirety, including the last part of the survey. By focusing on the completed responses, it is possible to ensure comprehensive and reliable data for the analysis.

Therefore, 115 responses were taken into account for the following analysis.

Sociodemographic characteristics of the sample

In terms of the sociodemographic aspects of the survey respondents, the focus was primarily on two variables: field of study and gender. These variables were chosen to gain a basic understanding of the sample composition and provide some insights into the types of participants involved in the survey.

According to Figure 17, the survey achieved a good balance between male and female respondents, with a slight majority of women (52.17%) compared to men (43.48%). It is also worth noting that a small percentage (4.35%) of respondents preferred to not explicitly declare their gender.

This gender balance in the survey sample is considered a positive aspect. It indicates that the interviewees were fairly representative of different genders, allowing for a more inclusive and diverse range of perspectives to be captured. By including a significant number of both men and women, the survey results are more likely to reflect a broader spectrum of opinions, experiences, and viewpoints related to the topic being discussed.

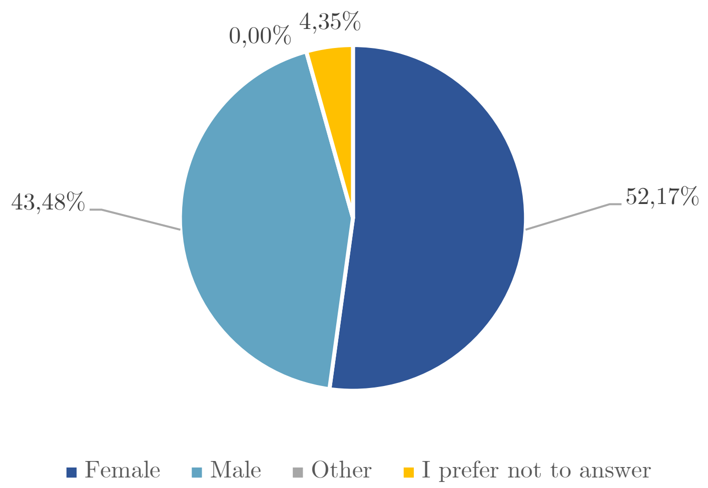

Figure 17 Gender of the respondents from the Polytechnic of Turin. Source: Author (2023).

Having a balanced gender representation is important because it helps to ensure that the voices of both men and women are heard and considered. This inclusivity is crucial in understanding the nuances and potential variations in perspectives based on gender. In fact, different genders may have unique insights, priorities, and experiences that influence their perceptions of the topic.

Regarding the field of study, the survey included categories that encompassed the main branches of study typically offered at the Polytechnic of Turin. These categories likely aligned with the attendees of the subjects taught by Professor Bottero during her lessons, which explains why the questionnaires were specifically targeted toward individuals from these fields. The identified categories included disciplines such as urban and regional planning, architecture, engineering, and design.

However, it is worth noting that the survey also accommodated respondents from other fields of study, albeit to a lesser extent. Participants who did not fall into the predefined categories had the option to select "other" to indicate their field of study. This open-ended option allows for the inclusion of individuals with diverse academic backgrounds, broadening the scope of the sample beyond the primary fields of study typically associated with the Polytechnic of Turin.

The grouping of the interviewers by academic discipline is shown in Figure 18. The findings indicate that the largest portion of respondents (40.87%) were studying urban and regional planning, closely followed by those studying architecture (37.39%). The engineering field accounted for a smaller but still significant portion of respondents. Only a small number of participants (four people) selected the design category.

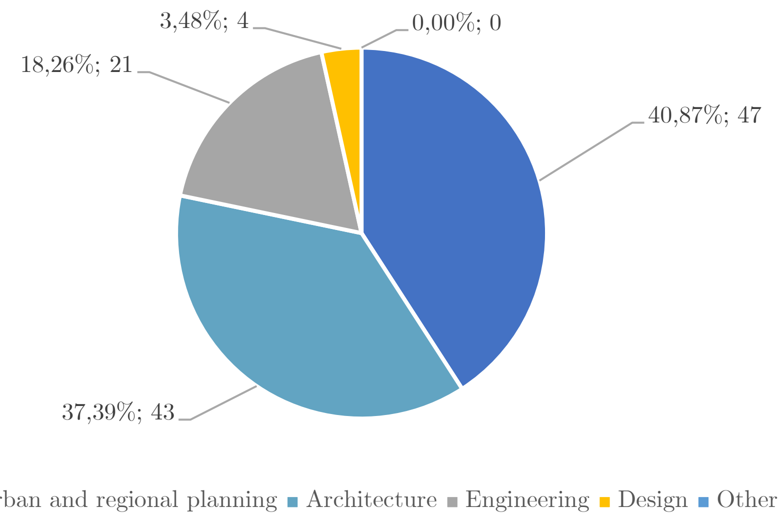

Figure 18 Field of study of the respondents from the Polytechnic of Turin.
Source: Author (2023).

These statistics imply that the perspectives and insights reflected in the survey responses will primarily represent the viewpoints of urban planners and architects, given their majority presence within the sample. The educational backgrounds and formal training received by individuals in these fields can influence their way of thinking, problem-solving approaches, and overall mindset. As a result, the survey responses may be influenced by the specific knowledge, methodologies, and perspectives instilled through their respective disciplines. The responses may lean towards considerations prioritized within these fields, potentially overlooking perspectives or approaches that are more prevalent in other disciplines, such as design.

However, it is worth noting that the survey still captures valuable insights and opinions from individuals across multiple fields of study.

Best Worst Scaling analysis

Thanks to the MaxDiff analysis, it was possible to understand the priorities that the students gave to the multiple benefits analysed.

Figure 19 shows the ranking of possible multiple benefits in a hypothetical PED according to the perspective of the respondents to the survey. The findings underscore the importance of energy consumption optimisation by showing that the panellists chose an improvement in energy efficiency as the top benefit.

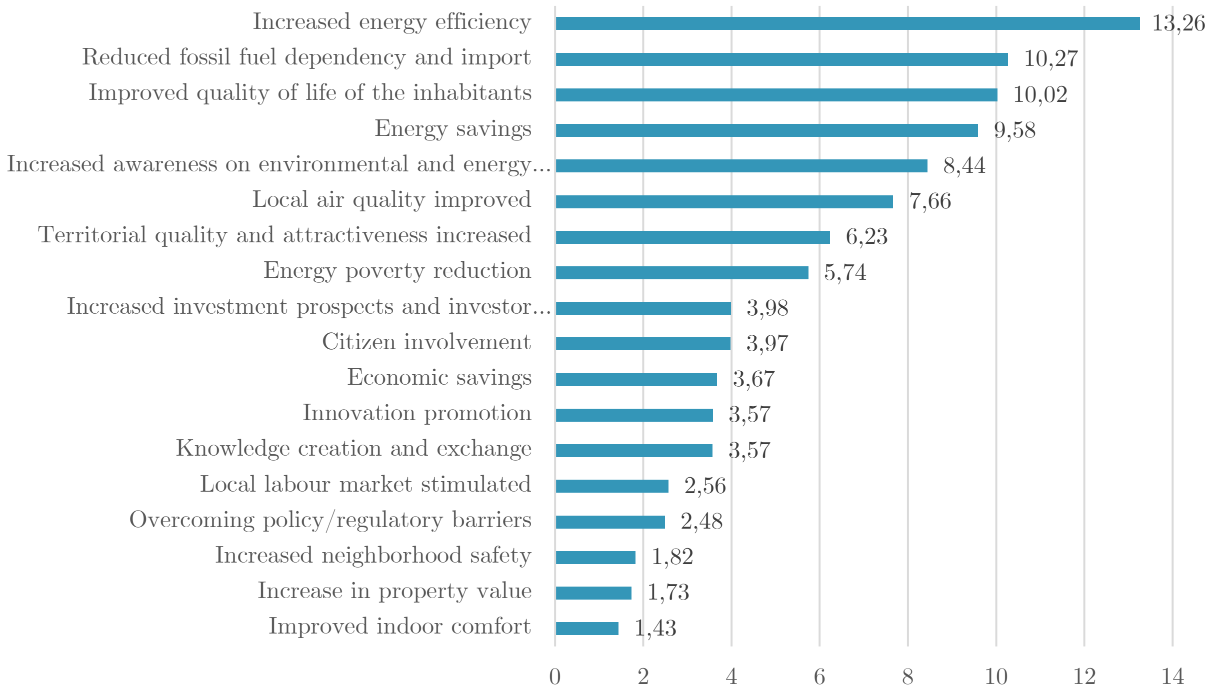

Figure 19 Ranking of multiple benefits according to the perception of the students. Source: Author (2023)

Another significant advantage of a PED project may provide to the local population is decreased reliance on and import of fossil fuels. It is likely also because this beneficial effect will lead to a cascade of other advantages, ranging for instance from increased energy security to improved economic savings.

The third-ranked benefit, "improved quality of life of the inhabitants", underscores the panel's understanding that energy-related initiatives have the potential to positively transform living conditions. This recognition reflects a holistic approach to sustainability, considering not only environmental factors but also the well-being and comfort of individuals and communities. By acknowledging the influence of energy projects on quality of life, the panel demonstrates a good understanding of the interplay between energy systems and human needs. Therefore, human needs have to reconcile with environmental issues, and from this assumption, the respondents highly consider the promotion of energy and environmental consciousness.

Notably, the survey reveals that economic savings, typically considered a prominent benefit in energy-related projects, received a relatively low ranking. This unexpected result can be attributed to the composition of the panel, which comprised academicians and not the end-users. Their focus on overall sustainability rather than short-term economic gains indicates a greater understanding of the long-term benefits and trade-offs associated with energy initiatives even if the economic sphere is also fundamental when considering an urban project. In this concern, an intriguing result is the ranking of the "increase in property value" in the penultimate position. This suggests that many respondents do not intend it as a very significant benefit within the context of the project. While property value appreciation is often considered a positive outcome, the interviewees' lower ranking suggests a prioritization of broader societal and environmental considerations over individual financial gains.

As understandable in Figure 20, each benefit was assessed a total of 345 times, giving respondents the option to select it as the best, worst, or not select it at all. Analysing the figure reveals a ranking of the benefits that effectively mirrors the perspectives of the respondents. Notably, the benefits that consistently claimed the top positions in the ranking were overwhelmingly chosen as the best option by the majority of respondents.

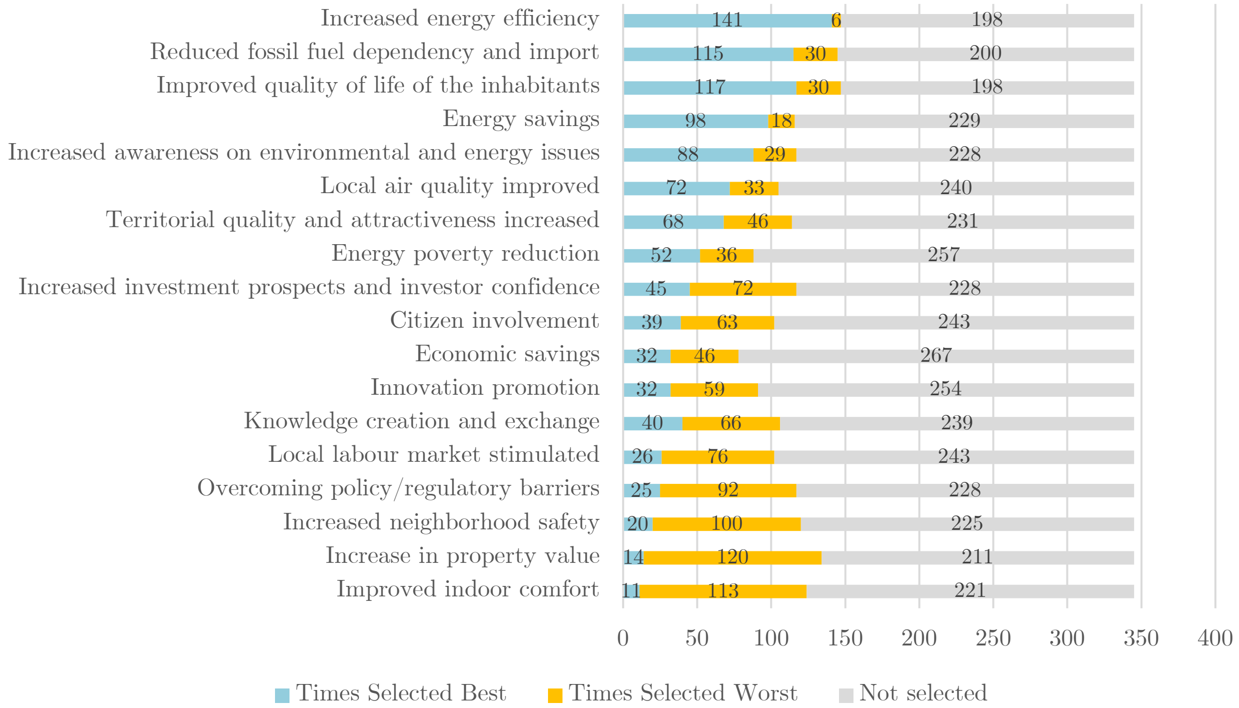

Figure 20 Selection of the benefits by the students. Source: Author (2023).

For instance, the benefit of increased energy efficiency emerged as a standout, with an impressive 95.92% of respondents selecting it as the best option in the times where it was chosen. This substantial preference indicates a strong inclination towards this particular benefit among the respondents, underscoring its perceived importance and desirability.

On the other hand, the benefit of improved indoor comfort is at the bottom of the preference hierarchy. Interestingly, when respondents selected this benefit, it was more frequently designated as the worst option. Approximately 91.13% of the times it was chosen, it was considered the least favorable among the available choices. This notable trend suggests a general sense of perception that this particular benefit is less relevant when compared to the others.

Best Worst Scaling analysis based on the field of study and the gender

The examination of possible correlations between gender groups offers insights into the perspectives of women and men (Figure 21). Since only a small number of respondents chose not to declare their gender, the analysis focuses on comparing the two gender groups: women and men.

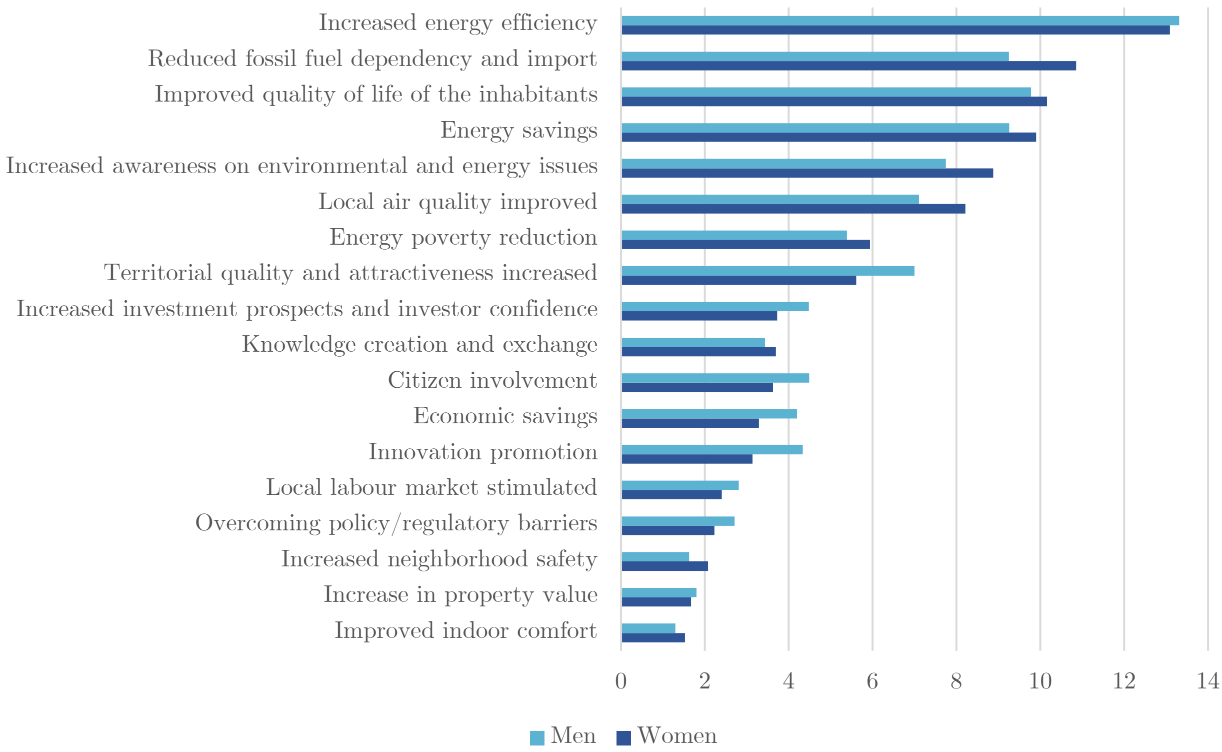

Figure 21 Best Worst Scaling analysis based on the gender of the students. Source: Author (2023).

Interestingly, both women and men agree on the highest-rated benefit, which is the increase in energy efficiency. This consensus suggests that energy efficiency is universally recognized as a fundamental and crucial aspect of PED projects, regardless of gender.

However, there is a slight divergence in the rankings between women and men for the subsequent benefits. Women rank the reduced fossil fuel dependency and import as the second most important benefit, while men prioritize the improvement in the quality of life. Anyway, the difference in scores is not so relevant.

Despite some differences in rankings, the scores assigned to the benefits by both gender groups are generally similar. This indicates a substantial agreement between women and men on the relative importance of the benefits. The fact that the benefits only shift by a few places in the ranking underscores the shared perspectives and priorities across genders. It also suggests that gender is not a discriminant factor when it comes to assessing the relevance of the benefits in PED projects.

The analysis of respondents' preferences according to their field of study provides valuable insights into their perspectives on the benefits of a Positive Energy District project. Figure 22 presents a summary of these preferences, highlighting the order of the benefits in the overall ranking and revealing the contributions of different groups in shaping the rankings.

One notable finding is the consensus among the various disciplines regarding the importance of increased energy efficiency as a crucial benefit of a PED. This consensus suggests a shared understanding of the significance of energy efficiency in achieving sustainability goals and indicates its universal recognition as a key aspect of PED projects.

For what concerns the reduced fossil fuel dependency and import, engineers rated this benefit with a higher value compared to designers who ranked it with the lowest value. This discrepancy in ratings might be attributed to the varying professional perspectives and priorities within the different disciplines. Engineers, with their technical expertise, may have a greater appreciation for the practical implications and engineering challenges associated with reducing fossil fuel dependency. On the other hand, designers, who may be more focused on aesthetic and social aspects, may prioritize other benefits that directly impact quality of life and citizen engagement.

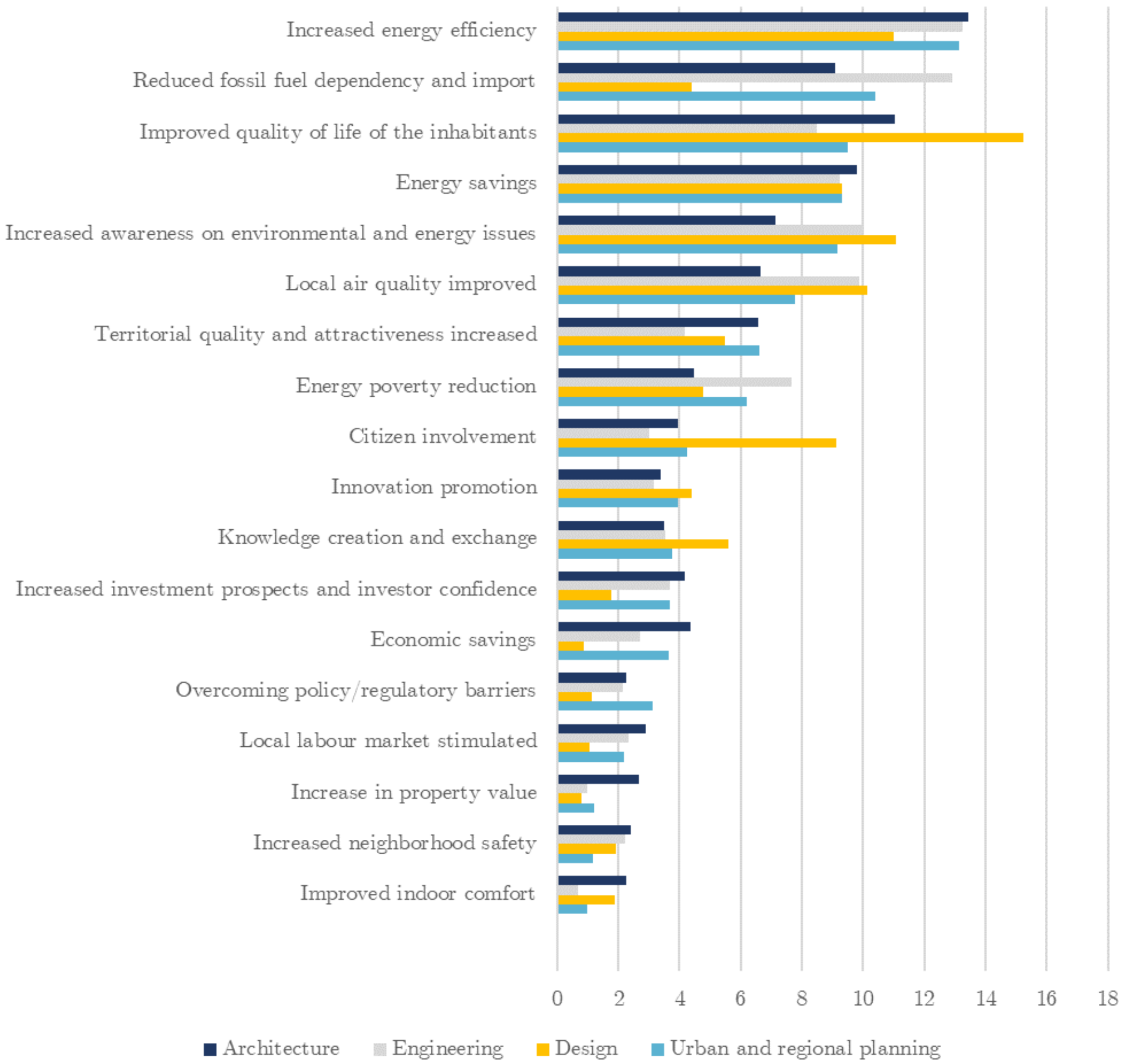

Figure 22 Best Worst Scaling analysis based on the field of study of the students. Source: Author (2023).

Notably, designers displayed a particular interest in social dynamics, as evident from their top-ranked benefits of improving the quality of life of inhabitants and increasing awareness of environmental and energy issues. They also emphasised the importance of citizen involvement, innovation promotion, and knowledge creation and exchange. These findings suggest that designers place greater emphasis on the social and human-centric aspects of PED projects, seeking to create spaces that enhance community well-being and engagement.

Despite some variations in the rankings between disciplines, there is overall agreement on the importance of certain benefits. For instance, the significance of energy savings received high ratings across all groups, ranging from 9.22 (engineering) to 9.80 (architecture). This consensus highlights the universal recognition of energy savings as a fundamental aspect of sustainable development, with potential economic and environmental implications.

In conclusion, while there are differences in the rankings of benefits among different disciplines, there is also a significant level of agreement, indicating shared priorities in PED projects. The variations observed can be attributed also to the distinct approaches, expertise, and perspectives of the disciplines involved.

CHAPTER 5

5.1 Conclusions

The research aims to investigate which are the most important benefits for each category of stakeholders and to better understand the potential of urban and energy requalification projects. The goal is to investigate innovative strategies to leverage investments in the urban energy transition considering the non-financial impacts too.

The multiple benefits approach is particularly useful when implementing urban changes that have an impact on social dynamics within a community. When such changes are proposed or implemented, it is crucial to ensure that the intended benefits are clearly communicated and understood by the end-users, who are the individuals directly affected by the project. In many cases, people may resist or be sceptical of urban changes if they do not perceive any direct advantages or if they do not fully understand the underlying purposes and potential benefits. Therefore, adopting a multiple benefits approach becomes essential to address these concerns and promote acceptance and support for the project. The approach involves identifying and communicating a range of benefits that the urban changes can bring, beyond their primary objectives. These additional benefits may include improvements in quality of life, economic and job opportunities, increased awareness of environmental issues, enhanced the sense of belonging to a community, increased safety and attractiveness of the territory, or increased energy efficiency.

By identifying multiple benefits, it is possible to prioritize policies and projects that promote sustainability, equity, and economic development and mitigate climate change risks. The Multiple Benefits study allows for effective strategies that ensure sustainability and resilience while considering the interests of all stakeholders thanks to a bottom-up approach.

The process involved conducting an extensive literature review to identify the most frequently cited benefits of urban projects such as Positive Energy Districts and Climate Positive Circular Communities. This involved reviewing a wide range of existing research, articles, and publications related to urban projects and their associated benefits. Additionally, experts were consulted to capture additional insights and perspectives that may not have been covered in the literature. These experts were involved in European projects such as ARV, ProLight, and Annex 83, which were dealing with projects regarding the aforementioned urban models. Furthermore, the study also had the purpose to seek and subsequently disseminate to the stakeholders the benefits of such projects. In order to involve the experts, some workshops were organised within each project, to discuss together the benefits they perceived in the context of these types of urban projects. The outcome of each brainstorming was a list of multiple benefits tailored to the project.

To gain a better understanding of the priorities associated with these benefits, a questionnaire using the Best Worst Scaling method was employed. Best Worst Scaling is a survey technique that asks respondents to rate the most and least essential items from a list in order to determine their preferences and priorities. Three different questionnaires were created based on the list of multiple benefits created during each workshop and distributed to the respective group of attendees. This approach provided a structured way to capture the relative importance of different benefits as perceived by the participants.

Later on, a questionnaire was submitted to a group of students from the Polytechnic of Turin, using the list of multiple benefits derived from the literature review. This was intended to be a preliminary test to simulate what it would be like to distribute this kind of survey to a broader group of individuals, in order to later deliver it to the project's stakeholders.

Analysing the various lists of benefits generated during the workshops, as well as the literature review, revealed that there were common benefits that emerged across different projects. This finding suggested that these benefits were not only project-specific but had wider applicability to Positive Energy Districts and Climate Positive Circular Communities. The fact that multiple projects emphasized the same benefits validated their significance in the context of these types of urban development.

Furthermore, the benefits from each list were categorized into four macro-categories: environmental, governance, economic, and social. Interestingly, the percentages of benefits within each category were quite similar across different projects. This implies that there is a general consensus or agreement among the projects regarding the categories of benefits that have the most significant impact on the territory and the community. However, when the interviewees were directly asked which category, they assigned the most weight to, they tended to assign almost equal importance to each category. This suggests that when the interviewees are presented with a more general choice, such as categorizing the benefits into broader groups, they seem to have a rational and similar perspective, while when they are asked to provide specific examples or make concrete choices within those categories, their preferences and priorities vary.

The results derived from the questionnaires indicated that environmental benefits, particularly energy efficiency, were consistently prioritized by the participants. This highlighted the importance placed on sustainable practices and the mitigation of environmental impacts in urban projects. Additionally, social benefits were also considered significant, reflecting for instance the recognition of the importance of citizen engagement, innovation promotion, and quality of life improvements.

In contrast, economic benefits had a relatively marginal relevance in terms of the number of benefits identified and their ranking. This suggests that economic considerations, such as economic savings or an increase in property value, were not the primary drivers behind the implementation of these projects. Similarly, governance-related benefits received even less attention, indicating that considerations related to governance structures, policy frameworks, or decision-making processes were not strongly emphasized.

It is important to acknowledge that the sample used in the analysis consisted mostly of researchers, students, and individuals involved in the organization of the projects. Therefore, the observed patterns and preferences might be influenced by the homogeneity of the sample. To obtain a more comprehensive understanding, it would be valuable to involve a broader range of stakeholders, including residents, policymakers, and industry representatives.

What emerged from the more in-depth analysis of the results of the students of the Polytechnic of Turin is that the preference of the benefits may depend on the interviewee's background. This suggests that factors such as educational background, professional expertise, and personal experiences play a role in shaping one's priorities and perceptions of the benefits associated with urban projects. For this reason, it is expected to obtain a similar consideration also after the submission of the questionnaire to stakeholders of the aforementioned European projects.

These findings provide a foundation for tailoring strategies and interventions that align with the preferences and priorities of the people involved, ultimately increasing the effectiveness and impact of the project on the community and the environment.

5.2 Future developments

The concept of multiple benefits brings up many useful possible future developments.

The next steps of this research involve further exploration and validation of the list of benefits in individual case studies. Discussions with local partners will help identify and evaluate these benefits, considering the predefined Key Performance Indicators (KPIs) from the project and assessing the need for additional ones. Distributing a questionnaire, preferably using a Best Worst Scaling method or a similar approach, among as many local stakeholders as possible will be requested to gather their input.

By advancing the understanding and evaluation of multiple benefits, this thesis aims to contribute to the scientific knowledge of decision-making processes in energy-related projects. The findings will offer guidance to policymakers, researchers, and stakeholders involved in developing sustainable and impactful energy initiatives. The ultimate goal is to enhance the effectiveness and impact of urban projects by prioritizing strategies and interventions that align with the preferences and priorities of stakeholders while ensuring long-term sustainability and resilience.

The aspiration is to give more relevance to the multiple benefits study by making it a matter of general interest and thus creating a standardized methodology at a global or at least European level. By adopting a standardised methodology, it would be easier to integrate the analysis for every new urban projects. For instance, having a predefined list of benefits for each type of urban model, could be a good starting point. To be as more completed as possible should be desirable to have the possibility also to add new multiple benefits according to each case, in order to not overlook any aspect. The presence of a standardised methodology, established by an official organization, would enable comparability among projects, with the option of adding new benefits while maintaining a solid foundation of benefits and a reliable methodology applicable to various urban projects. The inspiration arrives also from the Corporate Sustainability Reporting Directive, which recently obliged to publish sustainability accounting reports apart financial accounting reports. In order to accomplish this, they also have to consider some standardised benefits. Therefore, similarly, a list of multiple benefits can be provided for urban projects.

It is, therefore, envisioned that multiple benefits will be integrated into business models, considering not only financial criteria but also non-financial aspects such as ESG (Environmental, Social and Governance) goals.

Another step forward for the multiple benefits analysis could be to create a standardized methodology that considers both environmental and social benefits throughout the entire life cycle of the built environment. In fact, it is important to assess the importance of benefits at the project's beginning and end, as well as during its progression. These priorities may change over time, as evidenced by previous experiences like the Sinfonia project (Bisello, 2020). The objective is to adapt Social Life Cycle Assessment (LCA) to the neighbourhood scale and integrate the results with those obtained from Environmental LCA (E-LCA) to achieve a comprehensive and reliable analysis of multiple benefits. This approach relies on rigorous research and quantitative data to ensure its robustness. Studying in which stage of the implementation of an urban project a benefit could emerge helps to have a deeper understanding of the significance of it. By understanding the dynamics of benefits throughout the project's lifespan, stakeholders can adapt strategies and interventions, accordingly, ensuring continuous improvement and maximizing positive outcomes.

Moreover, the multiple benefits analysis may be applied to the GBC certification as well. GBC certification has the aim to certify those urban requalification projects or new development areas which respect environmental and human needs. In this regard, this type of certification could first provide in addition to some goals also some multiple benefits that would like to reach. This could help to better evaluate the impacts of the district and could provide a participatory participation already before the implementation of the project.

The thesis underscores the complexity of evaluating benefits, which strongly depend on the composition of the sample and the broader societal and environmental objectives. These insights contribute to the scientific understanding of decision-making processes in energy-related projects and provide guidance for policymakers, researchers, and stakeholders striving for sustainable and impactful energy initiatives.

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APPENDIX I

	ARV	SPARCS	POCITYF	Triangulum	SCIS	+CityxChange	SINFONIA	ATELIER	SYN.IKIA	Smart-BEEjS	MAtchUP	GrowSmarter	IRIS	mySMARTLife	CITYkeys	smartENCity	ProLight	Marotta et al., 2021	Shnapp et al., 2020	JPI Urban Europe, 2021
Energy savings	x	x	x	x	x	x		x		x	x	x	x	x			x			
Energy poverty tackled			x		x		x		x	x	x		x		x		x			
Energy efficiency increased		x	x			x			x	x	x	x		x		x	x			
Local labour market stimulated	x	x	x	x		x	x			x	x	x	x		x	x		x	x	x
Innovation promotion		x	x	x	x		x				x	x	x	x		x				x
Citizen involvement	x	x	x	x		x			x	x	x	x	x	x	x	x	x	x		
Knowledge creation and exchange	x	x		x				x		x	x					x	x			
Awareness of environmental and energy issues	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x			
Quality of life of the inhabitants improved	x	x	x	x			x	x	x		x	x		x	x	x	x	x		
Indoor comfort increased			x					x	x	x		x	x			x	x	x		
Territorial quality and attractiveness increased		x	x				x				x	x								x
Local air quality improved	x	x	x	x		x	x		x		x	x								
Fossil fuel dependency and import reduced		x			x					x		x				x				
Property value increased		x					x											x		
Investment prospects and investor confidence increased		x	x			x				x	x					x				
Economic savings	x	x	x	x	x		x		x	x	x	x	x		x	x	x			
Neighborhood safety increased	x	x									x	x			x					
Overcoming policy/regulatory barriers		x	x			x		x					x			x				

Presence of the identified multiple benefits in the examined projects and articles.

APPENDIX IIa

BENEFITS	1. LAND	2. PLANNING AND FINANCE	3. DESIGN	4. CONSTRUCTION	5. MANAGEMENT AND USE	6. DEMOLITION AND REDEVELOPMENT
Energy savings	The choice of the location of new projects affects energy savings. Factors that contribute are: density, siting (water proximity, sun exposition), mix of functionalities.	Ensure that there are the right conditions to factors that contribute to energy savings, for instance, density, siting, mix of functionality, and include actions that can exploit the mentioned conditions	Measures to limit the energy consumption (adding vegetation, shading systems, enlarge openings, add the largest amount of renewable energy sources, consumption monitorimg system, improve ventilation, smart indoor lightning etc.). The design phase is particularly challenging in redevelopment areas rather then new districts.	Efficient machinery and contruction schedule should avoid unnecessary expenditure of energy.	Adoption of an efficient energy management system and promotion of its correct use. By equipping the house with a home automation system, it is also possible to remotely manage all the appliances in the house via the electrical system and therefore avoid energy waste.	Use of efficient machinery that limits the dispersion of energy. Reuse the materials in other constructions or transform them instead of sending them to the landfill. (however, the decision on the end of life and disposal is usually something defined within the design phase. Also the choice of materials is essential, not all materials are reciclable)
Energy poverty tackled	The choice of the location of new projects affects energy savings and therefore contribute to overcome energy poverty. Factors that contribute: density, siting (water proximity, exposition to the sun...), mix of functionality. The benefit can be fulfilled only if the inhabitants of the chosen are affected by energy poverty	Planning measures that contribute to save energy and make the buildings more efficient.	A step forward in the fight against energy poverty is made possible by the district's design, which should take into consideration the installation of sustainable and technologies as well as effective energy storage systems (PHS, CAES, FES) on new or restored structures. These measures concern all sectors in which energy is required: i.e. heating/cooling, hot water and electricity and therefore refer, for example, to thermal solar panels and photovoltaic panels.		Adoption of an efficient energy management system and promotion of its correct use. By equipping the house with a home automation system, it is also possible to remotely manage all the appliances in the house via the electrical system and therefore avoid energy waste.	
Energy efficiency increased	The choice of the location can help energy efficiency in the district. Factors that contribute: density, siting (water proximity, exposition to the sun...), mix of functionality.	Planning measures that contribute to save energy and make the buildings more efficient; this materializes for instance in greater attention to density and siting.	Renewal and/or insertion of heating systems and large innovative appliances, seek energy independence for example through the use of photovoltaics, insulate the indoor spaces in the best possible way (e.g. replacement of doors and windows, thermal coats, roof insulation).	Use of innovative and efficient machinery.	Adoption of an efficient energy management system and promotion of its correct use. By equipping the house with a home automation system, it is also possible to remotely manage all the appliances in the house via the electrical system and therefore avoid energy waste.	Use of efficient machinery that limits the dispersion of energy.
Local labour market stimulated		The planning of a new project should consider the creation of new job positions that also contribute to a greater gender and social balance.	New job positions for architects, engineers, designers and technological companies.	New job positions for architects, technological companies, construction and engineering firms, and building material manufacturing companies due to the construction/redevelopment of the district.	New job opportunities related to the maintenance of energy systems and the monitoring of building performance trends.	New job positions for architects, construction and engineering firms, and building material manufacturing companies due to the demolition and possible further redevelopment.
Innovation promotion		Innovative decision-making processes that include citizens and end users in the planning phase.	Use of innovative construction material, creation of new systems for indoor comfort, street planning, open space planning etc.	Use of innovative machinery and construction materials.	Adoption of innovative strategies for the management and use of the built environment, for example implementation of intelligent systems and apps for the control of internal comfort, energy expenditure and vehicular traffic.	Use of innovative machinery and construction materials. Devising innovative ways to demolish and rebuild as efficiently and sustainably as possible.
Citizen involvement	Maximum public participation in the site selection process, whether it is a redevelopment or a new construction project, as it will have an impact also on the nearby residents.	Planning and financing of measures for the inclusion of citizens in decision-making moments and dissemination of the project objectives (participation tables, explanatory days with experts, world café method...)	The planning of the environment must be done taking into consideration the needs of the residents themselves, especially if a redevelopment project, where then the inhabitants witness the change of their neighborhood. Being at the forefront of society in terms of technology and resiliency to climate change is essential, but so is creating a pleasant and inclusive atmosphere.		Monitoring of resident satisfaction after implementation of project changes, for example through questionnaires.	The possibility of redeveloping vacant land in a manner that serves to satisfy locally defined requirements should be discussed with local communities and groups to get their feedback. People previously living in those buildings should be relocated or compensated.
Knowledge creation and exchange		Planning a project involves an exchange of ideas, skills and innovative solutions by the stakeholders as a result of comparisons made between individuals with various requirements and backgrounds.	A fruitful exchange of ideas and innovative solutions contributes to the creation of a design, both of the individual building and of the neighborhood, thanks to the development of more sustainable and inclusive solutions. Current Global Change Climate related issues need collaboration with Research centers on best solutions.	Implementing skills development for construction workers to adapt to the green and digital economy.	The quality of life and satisfaction of residents can be raised through the sharing of information about a healthy use of private and community areas. The benefits are numerous, starting with less energy waste due to improper use and the resulting financial savings.	Creation of a demolition and redevelopment system for the area that is as sustainable in social and environmental terms as possible.
Awareness of environmental and energy issues		In the planning phase, the increase in awareness regarding environmental issues due to the planning of sustainable interventions can lead to an increase in funding and investments in renewable energy and other "green" measures.	Design of tools or apps inside the buildings for energy expenses monitoring as well as other issues and therefore increasing awareness on the topic.	While construction is still ongoing, explanatory signs that highlights the changes the project will make to the area in terms of environmental viability can be put up.	Adoption of innovative strategies for the management and use of the built environment, for example implementation of intelligent systems and apps for the control of internal comfort, energy expenditure and vehicular traffic. These tools can help to raise awareness on environmental issues.	
Quality of life of the inhabitants improved		The density of new developments contributes to determine citizens' quality of life. For example an area with high density may have problems linked to the quality of the air, waste, reduced outdoor common places etc.	The design of the built environment contributes to create greater indoor environment thanks to the choice of non-toxic materials, a good ventilation system, pleasant light and solar exposure, control of the quantity of humidity, anti-seismic structure, aesthetically pleasing and ergonomic design etc.	Construction of environmentally resilient and structurally safe buildings.	The quality of life and satisfaction of residents can be raised through the sharing of information about a healthy use of private and community areas. The benefits are numerous, starting with less energy waste due to improper use and the resulting financial savings.	

Explanation of the subdivision in phases of multiple benefits of an energy requalification project within the lifecycle of the built environment.

APPENDIX IIb

BENEFITS	1. LAND	2. PLANNING AND FINANCE	3. DESIGN	4. CONSTRUCTION	5. MANAGEMENT AND USE	6. DEMOLITION AND REDEVELOPMENT
Indoor comfort increased			The design of the built environment contributes to create greater indoor environment thanks to the choice of non-toxic materials, a good ventilation system, pleasant light and solar exposure, control of the quantity of humidity, anti-seismic structure, aesthetically pleasing and ergonomic design etc.			
Territorial quality and attractiveness increased	Choosing to carry out a project in an area with interesting intrinsic characteristics and without distorting but rather enhancing the positive qualities can help make the area more attractive.	Planning for initiatives that encourage residents to enjoy their time in the community, such as creating parks, gardens, and useful gathering spots.	Creating a good exterior and interior design.		Good maintenance and education of locals on how to maintain the area clean and in good condition.	Avoid the creation of urban voids and degra areas.
Local air quality improved		The decisions taken here will affect the air in the area. For instance, the quality of the air will benefit from the installation of parks, gardens and tree-lined avenues. Give priority to investments that favor a reduction in pollution and therefore the improvement of local quality.		Construction with local materials to reduce GHG emissions due to the transportation. Use of efficient and low-polluting machinery.	More responsible consumption by citizens. Use of sustainable choices based on renewable energy for heating systems and appliances by residents.	Use of efficient and low-polluting machiner
Fossil fuel dependency and import reduced		Territorial planning considering technologies that exploit renewable energies, such as the solar panel or solar thermal.	The district's and the building's architecture can increase energy efficiency, encourage the use of technologies that can harness green energy, and therefore lessen reliance on fossil fuels. The placement of solar cells is one possible example of this.		More responsible consumption by citizens. Use of sustainable choices based on renewable energy for heating systems and appliances by residents.	
Property value increased		The planning of buildings with attractive, innovative features and high performances in terms of energy have a property value premium that is greater than the estimated economic benefit of the energy savings.	An attractive design with high quality materials helps increasing property value		Correct maintenance and use of common and private spaces contributes to creating a good image of the area and therefore to the increase of the property value.	
Investment prospects and investor confidence increased		Disseminate the willingness to implement innovative and appealing measures. This may attract investors.	Implementing innovative, more efficient, and appealing measures raises the area's appeal, increasing the probability of attracting new investors and providing rewards for sustainable projects.			Even when its function is going to be altere well-kept area attracts investors more.
Economic savings					Cost savings can be obtained by, for example, reducing energy/water usage, generating renewable energy on-site, or lowering housing expenses.	
Neighborhood safety increased		Avoid planning a city with many dark and isolated areas that could foster fertile ground for criminals. Planning road traffic with measures to ensure the safety of all road users (gymkhanas, cycle paths, speed bumps, pedestrian areas...)	Attractive, functional design that takes into account safety measures. Safety measures refere to proper materials, avoid building blind corners and shady places in neighborhoods, internal preparation of buildings in such a way as to avoid conflicts between appliances.	Arrange the construction site in such a way that it does not affect the safety of the inhabitants.	Enforce safety rules and maintain common areas.	
Overcoming policy/regulatory barriers		Revision of now obsolete laws and regulations in order to build an innovative and sustainable district.				

Explanation of the subdivision in phases of multiple benefits of an energy requalification project within the lifecycle of the built environment.

APPENDIX IIIa

ID	MULTIPLE BENEFITS	N. OF ARTICLES MENTIONING THE MBs OUT OF 20 ARTICLES
1	Reduced air pollution and GHG emission savings	16
2	Fostering circular economy	6
3	Local energy supply chain established	1
4	Energy services developed	1
5	Resilience of energy infrastructure increased	1
6	Energy flexibility, security and reliability	7
7	Energy losses reduced	2
8	Embodied energy reduced	2
9	Self-energy consumption stimulated	3
10	Energy grid failures reduced	1
11	Professional skills developed	2
12	Environmental resources management improved	2
13	Improvement in the transportation system and electromobility development	1
14	New services and revenue streams promoted	1

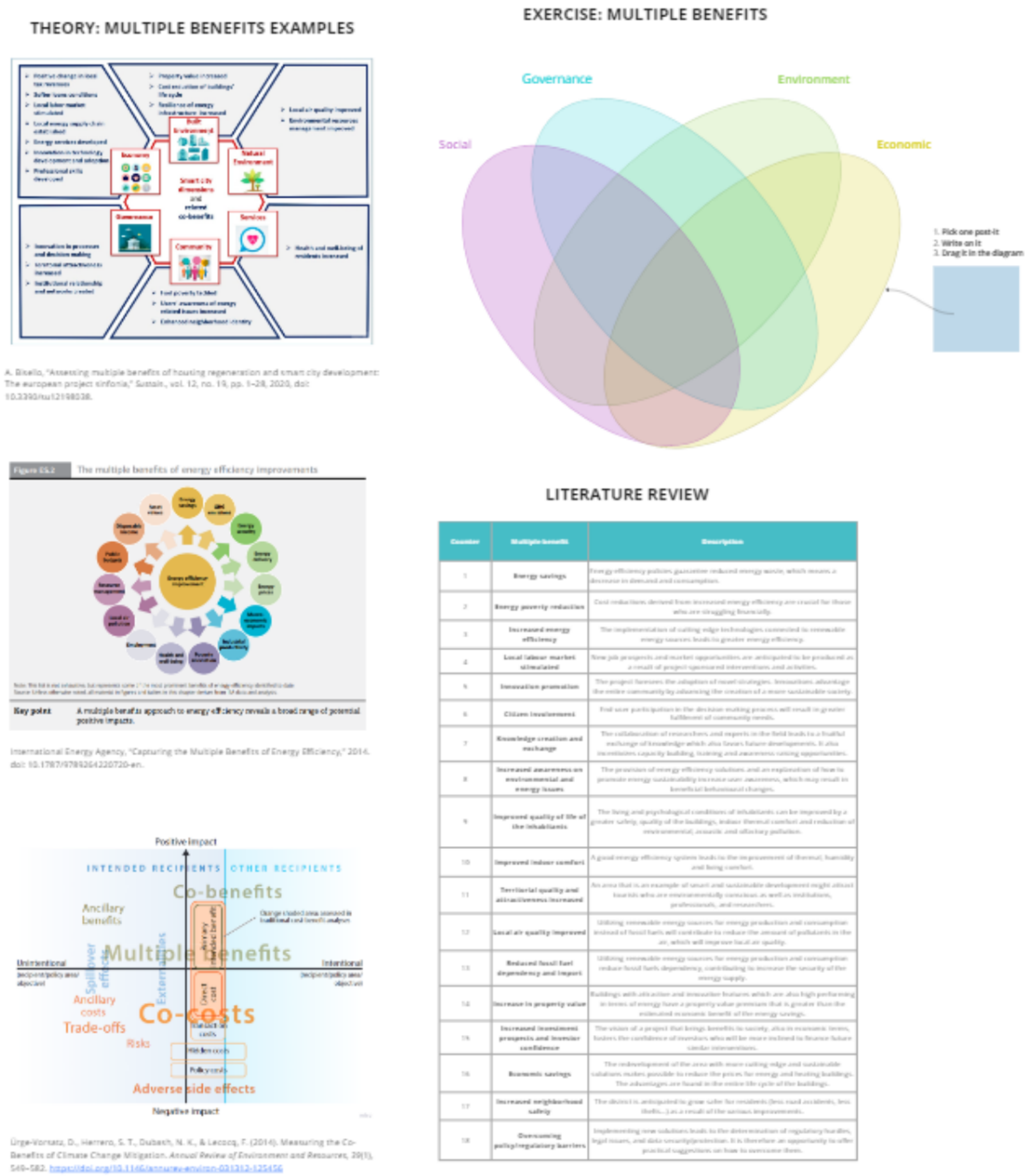
Multiple benefits from the literature and project review that were not included in the list used for PoliTo students' survey.

APPENDIX IIIb

ID	MULTIPLE BENEFITS	N. OF ARTICLES MENTIONING THE MBs OUT OF 20 ARTICLES
15	Replicability potential	3
16	Fostering a well-developed local democracy	1
17	Institutional relationships and networks between stakeholders created	5
18	Design and architectural quality	1
19	Neighborhood identity enhanced	1
20	Reduced noise	5
21	Mobility management improved	1
22	Better loans conditions	1
23	Households' income improved	1
24	Economic incentives for sustainable actions	2
25	Household mobility costs reduced	1
26	Societal costs due to health problems reduced	1
27	Energy grid investments reduced	1
28	Road taxes reduced	1

Multiple benefits from the literature and project review that were not included in the list used for PoliTo students' survey.

APPENDIX IV



General view of the board on Miro concerning the multiple benefits workshops.

APPENDIX Va

Politecnico di Torino

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1 INNOVATION PROMOTION

The project foresees the adoption of novel strategies. Innovations advantage the entire community by advancing the creation of a more sustainable society.

2 CITIZEN INVOLVEMENT

End-user participation in the decision-making process will result in greater fulfillment of community needs.

3 AWARENESS ON ENVIRONMENTAL AND ENERGY ISSUES

The provision of energy-efficiency solutions and an explanation of how to promote energy sustainability increase user awareness, which may result in beneficial behavioural changes.

4 INDOOR COMFORT INCREASED

A good energy efficiency system leads to the improvement of thermal, humidity and living comfort.

5 QUALITY OF LIFE OF THE INHABITANTS IMPROVED

The introduction of measures aimed at improving living comfort and energy efficiency result in an improvement in the quality of life.

6 ECONOMIC SAVINGS

The redevelopment of the area with more cutting-edge and sustainable solutions makes possible to reduce the prices for energy and heating buildings. The advantages are found in the entire life cycle of the buildings.

7 ENERGY POVERTY TACKLED

Cost reductions derived from increased energy efficiency are crucial for those who are struggling financially.

8 FOSSIL FUEL DEPENDENCY AND IMPORT REDUCED

Utilizing renewable energy sources for energy production and consumption reduce fossil fuels dependency, contributing to increase the security of the energy supply.

9 ENERGY EFFICIENCY INCREASED

The project ensures an increase in energy efficiency at the district (and city) scale, maximising the share of renewable energies and their intelligent integration in the energy system.

Description of multiple benefits from the literature review. This description list was presented in the survey submitted to PoliTo students.

APPENDIX Vb

Politecnico di Torino

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ENERGY SAVINGS

10

Energy efficiency policies guarantee reduced energy waste, which means a decrease in demand and consumption.

KNOWLEDGE CREATION AND EXCHANGE

11

The collaboration of researchers and experts in the field leads to a fruitful exchange of knowledge which also favors future developments. It also incentivizes capacity building, training and awareness-raising opportunities.

TERRITORIAL QUALITY AND ATTRACTIVENESS INCREASED

12

An aesthetically pleasing, functional and sustainable area is not only positive for the daily users but can also attract tourists who are environmentally conscious as well as institutions, professionals, and researchers.

INVESTMENT PROSPECTS AND INVESTOR CONFIDENCE INCREASED

13

The vision of a project that brings benefits to society, also in economic terms, fosters the confidence of investors who will be more inclined to finance future similar interventions.

NEIGHBORHOOD SAFETY INCREASED

14

Societal acceptance may be reached through a participatory approach and the improvement of awareness of citizens concerning environmental issues innovative technologies through events, workshops, social media etc.

OVERCOMING POLICY/REGULATORY BARRIERS

15

Implementing new solutions leads to the determination of regulatory hurdles, legal issues, and data security/protection. It is therefore an opportunity to offer practical suggestions on how to overcome them.

PROPERTY VALUE INCREASED

16

The renovated area can improve the neighborhood's perception of itself and its connection with place. This leads to the creation of dense social networks, which eventually bring to positive economic and social consequences. Furthermore, new community gathering places may rise.

LOCAL AIR QUALITY IMPROVED

17

Utilizing renewable energy sources for energy production and consumption instead of fossil fuels will have a lot of significant positive effects on society and environment. For instance, it will contribute to reduce the amount of pollutants in the air and the urban heat island effect and, as a consequence, the air quality will increase.

LOCAL LABOUR MARKET STIMULATED

18

New job prospects and market opportunities are anticipated to be produced as a result of project-sponsored interventions and activities.

Description of multiple benefits from the literature review. This description list was presented in the survey submitted to PoliTo students.

APPENDIX VIa - First section: Interviewee's opinions

The following survey attempts to examine the **Multiple Benefits** that energy redevelopment projects provide to the territories in order to determine which benefits are more significant in the context of the European ARV project for different stakeholders.

Multiple benefits are any **positive impacts** that may derive from a project, including those that are strictly linked to the main goals and those that are not intentionally pursued. They are considered in a holistic approach without ranking prejudice.

The study is part of the **Master Thesis** in Territorial, Urban, Environmental and Landscape Planning at the Polytechnic of Turin, in collaboration with **Eurac Research**.

The information provided will be kept with the highest confidentiality and the questionnaire is entirely anonymous. The following survey takes a few minutes to be completed.

Thank you in advance for your cooperation!

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According to you, how important is the **energy transition** in order to contrast climate change?

- ◯ Very important
- ◯ Important
- ◯ Neutral
- ◯ Not important
- ◯ Not important at all
- ◯ I do not know

Distribute 100 points based on the aspect that you consider most relevant within an urban redevelopment project. You can assign any whole number between 0-100 but the **total must be 100**.

	Economic
	Social
	Environmental
	Governance
0 / 100	Total

Questionnaire submitted to the partners of the ARV project.

APPENDIX VIb - Second section: Involvement in the project

In which of these cities do you live or on which of these case studies do you work? If you are equally involved in more than one, **focus on just one of them** when answering the following questions.

- ◯ Karviná (Czech Republic)
- ◯ Sønderborg (Denmark)
- ◯ Trento (Italy)
- ◯ Utrecht (The Netherlands)
- ◯ Oslo (Norway)
- ◯ Palma de Mallorca (Spain)
- ◯ I am involved in the project, but I do not have a reference demo case

---

Which of these categories best describes **your role** in the previously chosen city or the ARV project?

- ◯ End user/citizen
- ◯ Political/regulatory actor
- ◯ Entrepreneur
- ◯ Socio-cultural actor
- ◯ Academic/researcher
- ◯ Other ________

Are you a member of the ARV project consortium?

- ◯ Yes
- ◯ No

APPENDIX VIc - Third section: MaxDiff analysis

In the next sections of the survey, you will be asked to select **the most and least relevant multiple benefits** among the six suggested ones. You should answer taking into consideration the characteristics of the **demo case** you selected in the previous question. If you are not involved in any case study, think about the benefits that you believe an energy requalification project, such as ARV, can have on the territory.

Below you can find an example of a completed task.

TASK 1/9

More relevant		Less relevant
●	Energy savings	○
○	Citizen involvement	○
○	Fostering innovation	●
○	Energy poverty reduction	○
○	Local labour market stimulated	○
○	Energy efficiency increased	○

Press NEXT to start.

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 1/9

The most relevant		The least relevant
○	Economic savings	○
○	Investing in architectural training	○
○	Citizen involvement	○
○	Reduced air pollutants	○
○	Off-site construction market improve	○
○	Respect of human rights	○

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 2/9

The most relevant		The least relevant
○	Increased comfort levels	○
○	Territorial quality and attractiveness increased	○
○	Increased energy efficiency	○
○	Improved quality of life of the inhabitants	○
○	Climate change awareness	○
○	Energy poverty reduction	○

Questionnaire submitted to the partners of the ARV project.

APPENDIX VId - Third section: MaxDiff analysis

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 3/9

The most relevant		The least relevant
◯	Reduced energy fossil fuels	◯
◯	Energy and environmental consciousness	◯
◯	Innovation in governance processes	◯
◯	Fostering technological innovation	◯
◯	Increased in property value	◯
◯	Investing in architectural training	◯

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 4/9

The most relevant		The least relevant
◯	Fostering technological innovation	◯
◯	Economic savings	◯
◯	Increased comfort levels	◯
◯	Territorial quality and attractiveness increased	◯
◯	Investing in architectural training	◯
◯	Energy cost reduction	◯

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 5/9

The most relevant		The least relevant
◯	Increased in property value	◯
◯	Off-site construction market improve	◯
◯	Energy poverty reduction	◯
◯	Energy and environmental consciousness	◯
◯	Improved quality of life of the inhabitants	◯
◯	Citizen involvement	◯

Questionnaire submitted to the partners of the ARV project.

APPENDIX VIe - Third section: MaxDiff analysis

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 6/9

The most relevant		The least relevant
◯	Respect of human rights	◯
◯	Increased energy efficiency	◯
◯	Reduced air pollutants	◯
◯	Climate change awareness	◯
◯	Innovation in governance processes	◯
◯	Reduced energy fossil fuels	◯

TASK 7/9

The most relevant		The least relevant
◯	Improved quality of life of the inhabitants	◯
◯	Reduced energy fossil fuels	◯
◯	Energy cost reduction	◯
◯	Innovation in governance processes	◯
◯	Energy poverty reduction	◯
◯	Economic savings	◯

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 8/9

The most relevant		The least relevant
◯	Reduced air pollutants	◯
◯	Increased comfort levels	◯
◯	Respect of human rights	◯
◯	Citizen involvement	◯
◯	Territorial quality and attractiveness increased	◯
◯	Increased in property value	◯

Questionnaire submitted to the partners of the ARV project.

APPENDIX VIf - Fourth section: Personal information

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 9/9

The most relevant		The least relevant
◯	Energy cost reduction	◯
◯	Fostering technological innovation	◯
◯	Climate change awareness	◯
◯	Increased energy efficiency	◯
◯	Energy and environmental consciousness	◯
◯	Off-site construction market improve	◯

What is your gender?

- ◯ Female
- ◯ Male
- ◯ Other
- ◯ I prefer not to answer

Which age group do you belong to?

- ◯ 18-24
- ◯ 25-34
- ◯ 35-54
- ◯ 55-64
- ◯ 65-74
- ◯ 75 +

APPENDIX VIIa - First section: Interviewee's opinions

The following survey attempts to examine the **Multiple Benefits** that energy redevelopment projects provide to the territories in order to determine which benefits are more significant in the context of the European ProLight project for different stakeholders.

Multiple benefits are any **positive impacts** that may derive from a project, including those that are strictly linked to the main goals and those that are not intentionally pursued. They are considered in a holistic approach without ranking prejudice.

The study is part of the **Master Thesis** in Territorial, Urban, Environmental and Landscape Planning at the Polytechnic of Turin, in collaboration with **Eurac Research**.

The information provided will be kept with the highest confidentiality and the questionnaire is entirely anonymous. The following survey takes a few minutes to be completed.

Thank you in advance for your cooperation!

ProLight Politecnico di Torino 1859

According to you, how important is the **energy transition** in order to contrast climate change?

- ◯ Not important at all
- ◯ Not important
- ◯ Neutral
- ◯ Important
- ◯ Very important
- ◯ I do not know

Distribute 100 points based on the aspect that you consider most relevant within an urban redevelop-ment project. You can assign any whole number between 0-100 but the **total must be 100**.

	Economic
	Social
	Environmental
	Governance
0 / 100	Total

APPENDIX VIIb - Second section: Involvement in the project

In which of these cities do you live or on which of these case studies do you work? If you are equally involved in more than one, **focus on just one of them** when answering the following questions.

- ◯ Vienna (Austria)
- ◯ Vaasa (Finland)
- ◯ Kozani (Greece)
- ◯ Gernika-Lumo (Spain)
- ◯ Matosinhos (Portugal)
- ◯ Rovereto (Italy)
- ◯ I am involved in the project, but I do not have a reference demo case

---

Which of these categories best describes **your role** in the previously chosen city or the ARV project?

- ◯ End user/citizen
- ◯ Political/regulatory actor
- ◯ Entrepreneur
- ◯ Socio-cultural actor
- ◯ Academic/researcher
- ◯ Other ____

Are you a member of the ARV project consortium?

- ◯ Yes
- ◯ No

APPENDIX VIIc - Third section: MaxDiff analysis

In the next sections of the survey, you will be asked to select **the most and least relevant multiple benefits** among the six suggested ones. You should answer taking into consideration the characteristics of the **demo case** you selected in the previous question. If you are not involved in any demo case, think about the benefits that you believe an energy requalification project, such as ProLight, can have on the territory.

Below you can find an example of a completed task.

TASK 1/9

More relevant		Less relevant
●	Energy savings	○
○	Citizen involvement	○
○	Fostering innovation	●
○	Energy poverty reduction	○
○	Local labour market stimulated	○
○	Energy efficiency increased	○

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 1/9

The most relevant		The least relevant
○	Overcoming policy/regulatory barriers	○
○	resilience to energy price fluctuation	○
○	Local governance improved	○
○	Energy poverty reduction	○
○	Sense of belonging	○
○	Territorial quality and attractiveness increased	○

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 2/9

The most relevant		The least relevant
○	creation of energy communities	○
○	Citizen involvement	○
○	Energy savings	○
○	Energy and social justice	○
○	Increased awareness on environmental and energy issues	○
○	reduce CO2 emissions	○

Questionnaire submitted to the partners of the ProLight project.

APPENDIX VIId - Third section: MaxDiff analysis

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 3/9

The most relevant		The least relevant
◯	Improved indoor comfort	◯
◯	Local air quality improved	◯
◯	Adaptation of personal behaviours for limiting climate change	◯
◯	Increased energy efficiency	◯
◯	Innovation promotion	◯
◯	social choesion	◯

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 4/9

The most relevant		The least relevant
◯	Adaptation of personal behaviours for limiting climate change	◯
◯	Increased energy efficiency	◯
◯	Energy and social justice	◯
◯	creation of energy communities	◯
◯	Territorial quality and attractiveness increased	◯
◯	resilience to energy price fluctuation	◯

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 5/9

The most relevant		The least relevant
◯	Citizen involvement	◯
◯	Energy savings	◯
◯	Overcoming policy/regulatory barriers	◯
◯	Innovation promotion	◯
◯	Local air quality improved	◯
◯	Sense of belonging	◯

APPENDIX VIIe - Third section: MaxDiff analysis

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 6/9

The most relevant		The least relevant
○	Local governance improved	○
○	Energy poverty reduction	○
○	Increased energy efficiency	○
○	social choesion	○
○	reduce CO2 emissions	○
○	Increased awareness on environmental and energy issues	○

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 7/9

The most relevant		The least relevant
○	Sense of belonging	○
○	Overcoming policy/regulatory barriers	○
○	creation of energy communities	○
○	Improved indoor comfort	○
○	social choesion	○
○	Energy and social justice	○

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 8/9

The most relevant		The least relevant
○	Territorial quality and attractiveness increased	○
○	Increased awareness on environmental and energy issues	○
○	Local air quality improved	○
○	reduce CO2 emissions	○
○	resilience to energy price fluctuation	○
○	Innovation promotion	○

APPENDIX VIIf - Fourth section: Personal information

Select the **most** and the **least relevant** benefit among the six suggested ones **based on the demo case** you selected in the previous question.

TASK 9/9

The most relevant		The least relevant
○	Energy poverty reduction	○
○	Local governance improved	○
○	Improved indoor comfort	○
○	Energy savings	○
○	Adaptation of personal behaviours for limiting climate change	○
○	Citizen involvement	○

What is your gender?

- ○ Female
- ○ Male
- ○ Other
- ○ I prefer not to answer

Which age group do you belong to?

- ○ 18-24
- ○ 25-34
- ○ 35-54
- ○ 55-64
- ○ 65-74
- ○ 75 +

Questionnaire submitted to the partners of the ProLight project.

APPENDIX VIIIa - First section: Interviewee's opinions

The following survey attempts to examine the **Multiple Benefits** that energy redevelopment projects provide to the territories in order to determine which benefits are more significant in the context of Positive Energy Districts.

Multiple benefits are any **positive impacts** that may derive from a project, including those that are strictly linked to the main goals and those that are not intentionally pursued. They are considered in a holistic approach without ranking prejudice.

The study is part of the **Master Thesis** in Territorial, Urban, Environmental and Landscape Planning at the Polytechnic of Turin, in collaboration with **Eurac Research**.

The information provided will be kept with the highest confidentiality and the questionnaire is entirely anonymous. The following survey takes a few minutes to be completed.

Thank you in advance for your cooperation!

iea EBC Annex 83 Energy in Buildings and Communities Programme — Politecnico di Torino 1859

According to you, how important is the **energy transition** in order to contrast climate change?

- ◯ Not important at all
- ◯ Not important
- ◯ Neutral
- ◯ Important
- ◯ Very important
- ◯ I do not know

Distribute 100 points based on the aspect that you consider most relevant within an urban redevelopment project. You can assign any whole number between 0-100 but **the total must be 100**.

	Economic
	Social
	Environmental
	Governance
0 / 100	Total

Questionnaire submitted to the partners of the IEA EBC Annex 83 platform.

APPENDIX VIIIb - Second section: MaxDiff analysis

In the next sections of the survey, you will be asked to select **the most and least relevant multiple benefits** among the six suggested ones. You should answer taking into consideration the benefits that you believe a **Positive Energy District** may have on the territory.

Below you can find an example of a completed task.

TASK 1/9

More relevant		Less relevant
◉	Energy savings	○
○	Citizen involvement	○
○	Fostering innovation	◉
○	Energy poverty reduction	○
○	Local labour market stimulated	○
○	Energy efficiency increased	○

Press NEXT to start.

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 1/9

The most relevant		The least relevant
○	Energy poverty reduction	○
○	Innovation promotion	○
○	Local labour market stimulated	○
○	Increase Architecture quality	○
○	Indoor comfort improved	○
○	Property value increased	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 2/9

The most relevant		The least relevant
○	collaboration between different stakeholders fostered	○
○	Energy consumption reduced	○
○	Social cohesion increased	○
○	Citizen involvement	○
○	increase resilience of energy system through decentralization	○
○	Energy efficiency and flexibility increased	○

APPENDIX VIIIc - Second section: MaxDiff analysis

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 3/9

The most relevant		The least relevant
○	Gas indipendence	○
○	Neighborhood safety increased	○
○	Air quality improved	○
○	Quality of life of the inhabitants increased	○
○	Energy savings	○
○	Knowledge creation and exchange	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 4/9

The most relevant		The least relevant
○	Neighborhood safety increased	○
○	Increase Architecture quality	○
○	Knowledge creation and exchange	○
○	Innovation promotion	○
○	Social cohesion increased	○
○	Energy consumption reduced	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 5/9

The most relevant		The least relevant
○	Local labour market stimulated	○
○	Air quality improved	○
○	Energy savings	○
○	Energy poverty reduction	○
○	Energy efficiency and flexibility increased	○
○	Citizen involvement	○

APPENDIX VIIId - Second section: MaxDiff analysis

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 6/9

The most relevant		The least relevant
◯	Property value increased	◯
◯	increase resilience of energy system through decentralization	◯
◯	Gas indipendence	◯
◯	collaboration between different stakeholders fostered	◯
◯	Neighborhood safety increased	◯
◯	Indoor comfort improved	◯

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 7/9

The most relevant		The least relevant
◯	Innovation promotion	◯
◯	Citizen involvement	◯
◯	Quality of life of the inhabitants increased	◯
◯	Energy efficiency and flexibility increased	◯
◯	Increase Architecture quality	◯
◯	Gas indipendence	◯

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 8/9

The most relevant		The least relevant
◯	Energy consumption reduced	◯
◯	Indoor comfort improved	◯
◯	increase resilience of energy system through decentralization	◯
◯	Energy savings	◯
◯	Property value increased	◯
◯	Air quality improved	◯

APPENDIX VIIIe - Third section: Personal information

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

TASK 9/9

The most relevant		The least relevant
◯	Social cohesion increased	◯
◯	Knowledge creation and exchange	◯
◯	Energy poverty reduction	◯
◯	Local labour market stimulated	◯
◯	collaboration between different stakeholders fostered	◯
◯	Quality of life of the inhabitants increased	◯

Which is your **field of study**?

- ◯ Social
- ◯ Economic
- ◯ Scientific-technological (math and physics)
- ◯ Scientific-technological (engineering, architecture, territorial planning)
- ◯ Other

Which age group do you belong to?

- ◯ 18-24
- ◯ 25-34
- ◯ 35-54
- ◯ 55-64
- ◯ 65-74
- ◯ 75 +

What is your gender?

- ◯ Female
- ◯ Male
- ◯ Other
- ◯ I prefer not to answer

APPENDIX IXa - First section: Interviewee's opinions

The following survey attempts to examine the **multiple benefits** that **Positive Energy Districts** provide to the territories.

Multiple benefits are any **positive impacts** that may derive from a project, including those that are strictly linked to the main goals and those that are not intentionally pursued. They are considered in a holistic approach without ranking prejudice.

The study is part of the **Master Thesis** in Territorial, Urban, Environmental and Landscape Planning at the **Polytechnic of Turin**, in collaboration with **Eurac Research**.

The information provided will be kept with the highest confidentiality and the questionnaire is entirely anonymous. The following survey takes about 10 minutes to be completed.

Thank you in advance for your cooperation!

According to you, how important is the **energy transition** in order to contrast climate change?

- ◯ Not important at all
- ◯ Not important
- ◯ Neutral
- ◯ Important
- ◯ Very important
- ◯ I do not know

Distribute 100 points based on the aspect that you consider most relevant within an urban redevelopment project. You can assign any whole number between 0-100 but **the total must be 100**.

	Economic
	Social
	Environmental
	Governance
0 / 100	Total

Questionnaire submitted to Polytechnic of Turin students.

APPENDIX IXb - Second section: MaxDiff analysis

In the next sections of the survey, you will be asked to select **the most and least relevant multiple benefits** among the six suggested ones. You should answer taking into consideration the benefits that you believe a **Positive Energy District** may have on the territory.

Below you can find an example of a completed task.

TASK 1/9

More relevant		Less relevant
◉	Energy savings	○
○	Citizen involvement	○
○	Fostering innovation	◉
○	Energy poverty reduction	○
○	Local labour market stimulated	○
○	Energy efficiency increased	○

Press NEXT to start.

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 1/9

The most relevant		The least relevant
○	Overcoming policy/regulatory barriers	○
○	Energy poverty reduction	○
○	Increased energy efficiency	○
○	Improved quality of life of the inhabitants	○
○	Local labour market stimulated	○
○	Innovation promotion	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 2/9

The most relevant		The least relevant
○	Energy savings	○
○	Improved indoor comfort	○
○	Territorial quality and attractiveness increased	○
○	Increased investment prospects and investor confidence	○
○	Economic savings	○
○	Local air quality improved	○

Questionnaire submitted to Polytechnic of Turin students.

APPENDIX IXc - Second section: MaxDiff analysis

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 3/9

The most relevant		The least relevant
○	Knowledge creation and exchange	○
○	Reduced fossil fuel dependency and import	○
○	Increase in property value	○
○	Increased neighborhood safety	○
○	Increased awareness on environmental and energy issues	○
○	Citizen involvement	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 4/9

The most relevant		The least relevant
○	Increased neighborhood safety	○
○	Economic savings	○
○	Local air quality improved	○
○	Increased energy efficiency	○
○	Energy poverty reduction	○
○	Citizen involvement	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 5/9

The most relevant		The least relevant
○	Increased investment prospects and investor confidence	○
○	Increased awareness on environmental and energy issues	○
○	Overcoming policy/regulatory barriers	○
○	Improved indoor comfort	○
○	Improved quality of life of the inhabitants	○
○	Increase in property value	○

APPENDIX IXd - Second section: MaxDiff analysis

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 6/9

The most relevant		The least relevant
○	Citizen involvement	○
○	Knowledge creation and exchange	○
○	Local labour market stimulated	○
○	Innovation promotion	○
○	Energy savings	○
○	Territorial quality and attractiveness increased	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 7/9

The most relevant		The least relevant
○	Innovation promotion	○
○	Local air quality improved	○
○	Reduced fossil fuel dependency and import	○
○	Economic savings	○
○	Increase in property value	○
○	Overcoming policy/regulatory barriers	○

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 8/9

The most relevant		The least relevant
○	Territorial quality and attractiveness increased	○
○	Increased energy efficiency	○
○	Increased awareness on environmental and energy issues	○
○	Local labour market stimulated	○
○	Increased investment prospects and investor confidence	○
○	Knowledge creation and exchange	○

Questionnaire submitted to Polytechnic of Turin students.

APPENDIX IXe - Second section: MaxDiff analysis

Select the benefit that you consider **the most** and **the least relevant** within a Positive Energy District project among the six suggested ones.

Here the description of each element.

TASK 9/9

The most relevant		The least relevant
○	Improved indoor comfort	○
○	Improved quality of life of the inhabitants	○
○	Energy poverty reduction	○
○	Reduced fossil fuel dependency and import	○
○	Increased neighborhood safety	○
○	Energy savings	○

What is your field of study?

- ○ Urban and regional planning
- ○ Architecture
- ○ Engineering
- ○ Design
- ○ Other

What is your gender?

- ○ Female
- ○ Male
- ○ Other
- ○ I prefer not to answer