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InCUBE
sustainable building innovations

T8.1 – D8.1

How to boost district renovation in Positive Energy Districts

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Executive Summary

The pursuit of sustainable and innovative solutions in the construction and building sector has never been more critical. As the world grapples with climate change and resource depletion, the InCUBE project embarks on a journey to explore, adapt, and create business models that will shape the future of the built environment.

This deliverable delves into the realm of business-as-usual (BAU) business models for energy services, their existing strengths and weaknesses. It also delves into the specific characteristics of the demosites involved in the InCUBE project, ranging from Trento, Zaragoza, to Groningen. These unique features lay the foundation for tailoring business models to the distinct needs and opportunities of each site.

As the InCUBE project aims to revolutionize the construction industry by encouraging sustainable practices, it is imperative to identify potential paths for improvement. The integration of innovative solutions, including blockchain technology, peer-to-peer (P2P) strategies, and public-private partnerships (PPP), holds the key to achieving a more sustainable, efficient, and community-oriented building sector.

This exploration unites insights from existing business models, the characteristics of diverse demosites, tailored strategies, and forward-thinking innovations. The result is a comprehensive understanding of how business-as-usual models can evolve to meet the demands of the future, enriching our communities and safeguarding our planet.

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List of Acronyms and Abbreviations

ESCo	Energy Services Company
BAU	Business-as-usual
EPC	Energy Performance Contracting
ESC	Energy Supply Contracting
IEC	Integrated Energy Contracting
PPP	Public-Private Partnership
P2P	Peer-to-Peer
REC	Renewable Energy Community
BOOT	Build, Own, Operate, Transfer
ETS	Emission Trading System
PNRR	Piano Nazionale Ripresa Resilienza (Italian)
BIPV	Building-Integrated Photovoltaics

1 Introduction

Energy efficiency in construction and renovation is not merely a trend; it is a critical imperative in our quest for sustainability. As the world grapples with escalating energy demands and the urgent need to curb carbon emissions, optimizing the way we design, build, and retrofit buildings becomes paramount. Improved energy efficiency holds the key to reducing environmental impact, enhancing comfort, and curbing operational costs. It is a linchpin in achieving net-zero emissions goals and fostering resilience in the face of climate change. Moreover, energy-efficient construction and renovation spur innovation, create jobs, and bolster economic growth. In this context, exploring innovative business models and financing mechanisms is pivotal to drive transformative change in the construction industry.

The overarching aim of Task 8.1 is to revolutionize the energy landscape within the construction and renovation sectors. By integrating cutting-edge features into existing business models, such as Energy Service Company (ESCO) and Product as a Service (PaaS) approaches, the project seeks to drive energy efficiency and sustainability. It aims to reduce upfront costs, streamline installation processes, enhance operational efficiency, and harness renewable energy sources. Through comprehensive literature reviews, on-site demos, and rigorous analysis, the project aims to identify strengths and weaknesses, paving the way for innovative improvements. Ultimately, this initiative strives to catalyse multi-stakeholder involvement, de-risk energy investments, and promote energy-efficient behaviours while contributing to a greener, more resilient future.

1.1 Aim of the deliverable

The primary aim of the deliverable in this project is to provide a comprehensive and actionable roadmap for transforming the energy efficiency landscape in construction and renovation. Through a literature review, it seeks to distil insights on ESCO models, various business frameworks, and financing models. The description of renovation activities at demo sites, coupled with an examination of existing business models, aims to showcase real-world applications. Additionally, by identifying the strengths and weaknesses of these models and sites, the deliverable aims to chart pathways for improvement. Ultimately, it aspires to guide stakeholders towards more sustainable, innovative, and effective approaches in the construction and renovation industry.

1.2 Dependencies with other tasks

Building on the insights and recommendations derived from this deliverable, D8.2 represents the project's practical implementation phase. Here, the focus shifts toward developing a portfolio of innovative business models (BMs) that can be tailored to various renovation and construction scenarios. These BMs aim not only to enhance energy efficiency but also to promote energy-efficient behaviours among citizens. By leveraging the lessons learned from the analysis in D8.1, this portfolio of BMs can incorporate novel features and approaches. It may include business models that encourage community engagement, innovative financing mechanisms, and solutions that incentivize sustainable practices. The goal is to provide a diverse set of business models that align with actual foreseen interventions (accordingly with D7.1 and demosite owners interviews) and the evolving needs of the construction and renovation industry while fostering a culture of energy-conscious behaviour among stakeholders.

Moreover, the analysis of business models is intrinsically linked to the goals of T8.2, which aims to leverage experiences gained from deploying Renewable Energy Communities (RECs) and insights from district-level Business Models (BMs) in Trento and Zaragoza. By examining various business models and their applications in energy efficiency, T8.2 can generate actionable knowledge for the creation of RECs and seamless integration of building-level systems into the broader energy framework. This includes developing strategies for efficient energy management within solar communities, aggregating demand, optimizing self-consumption, and enhancing the distribution and allocation of energy among neighbours. The analysis of business models informs these strategies, enabling intelligent management of PV and storage installations for maximum efficiency and savings, real-time monitoring, and automation, all of which contribute to the success of T8.2's objectives.

Finally, T8.3 will develop a common framework methodology on the Emission Trading System (ETS) framework, which is a vital element within an array of business models for building renovation. It incentivizes emission reduction through renovation, aligns with financing models like third-party financing (TPF), and contributes to sustainability efforts in the building sector. By assigning market value to carbon emissions, the ETS encourages investments in sustainable improvements, driving innovation and technology adoption. This framework also provides a potential revenue source for funding renovation programs, including those focused on lower-income households.

1.3 Structure of the deliverable

D8.1 is structured to provide a comprehensive understanding of the current state of energy efficiency models in the construction and renovation sector. It begins with a thorough literature review, offering insights into Energy Service Company (ESCO) models and various business frameworks, such as ESC, EPC, IEC, and BOOT. This review establishes a foundation of knowledge to inform subsequent analyses.

The deliverable then shifts its focus to practical implementation by examining ongoing renovation activities at three demo sites in Trento, Groningen, and Zaragoza. This includes a detailed assessment of the renovation processes, building types, and sustainability goals. Concurrently, it investigates the existing business models that support these activities, taking into account financing structures, maintenance contracts, and relationships with stakeholders.

One of the key objectives is to identify strengths and weaknesses in both the business-as-usual models and the demo activities. This critical analysis sets the stage for proposing potential pathways for improvement. By interweaving these elements, D8.1 forms the foundational groundwork upon which the project's innovative strategies for boosting energy-efficient renovation will be built.

2 Business and ESCo models

In the dynamic landscape of energy efficiency and sustainability, the selection of business models plays a central role. This chapter delves into the intricate world of Business and Energy Service Company (ESCO) models, each contributing uniquely to the pursuit of energy efficiency and environmental goals. As we navigate this chapter, we will explore these models in-depth, dissecting their attributes, applications, and the impact they have on various sectors and industries.

2.1 Business-as-usual ESCo models

ESCO models are at the forefront of energy efficiency transformations, offering diverse approaches to achieving sustainability and cost-effective energy consumption. To fully appreciate their significance, let's first understand the origins and evolution of ESCOs, particularly in the European Union (EU).

ESCOs, or Energy Service Companies, are entities dedicated to enhancing energy efficiency and sustainability. They provide a range of services, from energy audits to the design, implementation, and maintenance of energy-saving solutions. ESCOs aim to reduce energy consumption and greenhouse gas emissions while delivering financial benefits to their clients.

The history of ESCOs in the EU dates to the 1970s when energy efficiency gained recognition as a vital component of sustainable development. European countries recognized the potential for ESCOs to drive energy efficiency initiatives. These companies began by offering energy performance contracting (EPC) services, guaranteeing energy savings to their clients.

Over the years, ESCOs in the EU evolved in response to growing environmental concerns and energy efficiency goals. They expanded their services beyond EPC, embracing a broader range of models, such as Integrated Energy Contracting (IEC) and Build, Own, Operate & Transfer (BOOT). This evolution mirrored the EU's commitment to reducing energy consumption, enhancing sustainability, and transitioning toward a greener energy landscape.

Today, ESCOs in the EU play a pivotal role in realizing the ambitious targets set by the European Green Deal and the EU Energy Efficiency Directive. They collaborate with governments, businesses, and institutions to transform energy-consuming facilities into efficient, sustainable, and environmentally friendly assets.

In this section, we delve into the Business-as-Usual (BAU) ESCO models prevalent in the EU, exploring their characteristics, applications, and how they continue to contribute to the EU's sustainable energy future. A critical approach to business models has been employed, thoroughly highlighting both their advantages and disadvantages. Furthermore, we will analyze the key elements of shared and guaranteed savings within these models, shedding light on their roles in achieving energy efficiency and risk mitigation. Through the lens of the EU's ESCO journey, we gain valuable insights into the global transition towards a more sustainable and energy-efficient future.

2.1.1 Energy supply contracting (ESC)

Energy Supply Contracts (ESCs) are a pivotal business model within the Energy Service Company (ESCO) domain, focusing on the direct supply of energy to end-users through efficient technologies. Here is a detailed description of ESCs based on the provided bullet points:

- *Direct Energy Supply*: ESCs involve ESCOs supplying energy directly to their clients by installing and operating new energy-efficient equipment and systems. This often includes technologies like high-efficiency lighting, heating, and cooling systems.
- *Minimizing Energy Consumption*: The primary objective of ESCs is to minimize energy consumption within the client's facilities. ESCOs achieve this by implementing cutting-edge technologies and optimizing energy usage patterns.
- *Risk Mitigation for Final Users*: ESCs are structured to minimize technical and economic risk for the final users or clients. ESCOs take on the responsibility for ensuring that energy supply remains uninterrupted, reliable, and efficient. This includes addressing any technical issues and equipment maintenance.
- *Tariff and Fees Structure*: Final users enter into agreements with ESCOs where they agree to pay an agreed tariff for the energy they consume. This tariff typically encompasses the cost of the supplied energy as well as fees for capital expenditures (CAPEX) and operational expenditures (OPEX). The inclusion of CAPEX and OPEX fees allows ESCOs to recover their investments in energy-efficient equipment and ongoing operational costs.

Energy Supply Contracts are a preferred choice for clients who wish to improve energy efficiency without making substantial upfront investments. By partnering with an ESCO, clients benefit from reduced energy consumption, lower operational costs, and a reliable energy supply, all while avoiding the technical complexities and economic risks associated with energy management.

Aspect	Enablers	Barriers
Energy efficiency	• Minimizes energy consumption. • Reduces energy bills	• Long-term commitment • Potential limited flexibility
Risk mitigation	• ESCOs assume technical and economic risks. • Reliable and efficient energy supply	• Limited control over energy management • Performance risk if savings not achieved
Upfront investment	• Reduced upfront investment. • ESCOs cover equipment and installation costs	• Contractual fees for CAPEX and OPEX can affect cost savings
Operational savings	• Lower operational costs in the long run	• Dependency on market conditions
Environmental impact	• Contributes to sustainability. • Reduces greenhouse gas emissions	

Table 1 - ESC business model enabler and barriers

2.1.2 Energy Performance Contracting (EPC)

Energy Performance Contracting (EPC) is a business model that places ESCOs in charge of implementing energy-saving interventions. It is an attractive option for clients seeking energy savings with minimal upfront costs. Here is a detailed description of EPC based on the provided bullet points:

- *Responsibility for Energy Savings Interventions*: In EPC models, ESCOs take on the role of identifying and implementing energy-saving interventions. This process begins with a comprehensive energy audit to assess existing consumption patterns and identify opportunities for improvement.
- *Costs Covered by Final Users*: Unlike Energy Supply Contracts, the costs associated with energy-saving interventions are covered by the final users or clients. This includes expenses related to equipment upgrades, installations, and other measures aimed at enhancing energy efficiency.
- *Shared Savings Model*: EPCs can operate under two primary financial structures. In the shared savings model, risk and rewards are distributed among various stakeholders, including the ESCO, client, and potentially third-party investors. The ESCO guarantees a certain level of energy savings, and any savings exceeding this level are shared among stakeholders.
- *Guaranteed Savings Model*: In the guaranteed savings model, the ESCO assumes the majority of the risk. They commit to achieving a specific amount of energy savings, and the client is

assured of this amount. If the actual savings fall short of the guarantee, the ESCO is typically responsible for covering the shortfall.

EPCs are highly adaptable and cater to clients looking to enhance energy efficiency while minimizing financial risks. The choice between shared and guaranteed savings models depends on the client's risk tolerance and specific project objectives. These contracts enable clients to realize energy savings without the burden of upfront capital investment, making them an attractive option across various sectors and industries.

Aspect	*Enablers*	*Barriers*
Responsibility for Interventions	• ESCOs identify and implement energy-saving measures. • Comprehensive energy audit to optimize efficiency	• Limited control over project execution
Cost Distribution	• Costs are covered by final users. • No upfront investment for clients	• Financial burden on clients for energy-saving measures
Shared Savings Model	• Risk and rewards shared among stakeholders. • Incentivizes ESCOs to exceed savings targets	• Complex negotiation and distribution of savings
Guaranteed Savings Model	• ESCO assumes most risk. • Clients guaranteed a specific level of savings	• Potential financial liability for ESCO if savings are not met

Table 2 - EPC business model enabler and barriers

2.1.3 Integrated Energy Contracting (IEC)

Integrated Energy Contracting (IEC) represents a versatile and comprehensive approach within the Energy Service Company (ESCO) domain. It combines elements of both Energy Supply Contracts (ESCs) and Energy Performance Contracting (EPC), offering a hybrid model tailored to specific project requirements. Here is a detailed description of IEC based on the provided bullet points:

- *Mixed ESC + EPC Contracting*: IEC, as the name suggests, integrates both ESC and EPC elements. This means that under an IEC agreement, ESCOs not only supply energy but also take on the responsibility for implementing energy-saving interventions.

- *Direct Energy Supply*: Like ESCs, IEC models involve ESCOs supplying energy directly to their clients through the installation and operation of energy-efficient equipment and systems. This ensures a consistent and reliable energy supply.
- *Responsibility for Energy Savings*: IEC extends the responsibility of ESCOs beyond energy supply to include the identification and implementation of energy-saving interventions, like EPC models. This may include conducting energy audits and retrofitting energy-consuming equipment.
- *Cost Structure*: The cost structure in IEC arrangements varies based on the specific project and client preferences. Clients may choose to pay a combined tariff for both energy supply and energy-saving interventions, creating a more holistic and streamlined approach to energy management.

IEC models are particularly valuable for clients seeking a comprehensive energy solution that covers both energy supply and efficiency improvements. By merging ESC and EPC elements, IEC models ensure a holistic approach to energy management, offering the benefits of energy savings and risk mitigation.

Aspect	***Enablers***	***Barriers***
Mixed ESC + EPC Contracting	• Comprehensive approach integrating energy supply and savings. • Single-point accountability for energy services	• Complexity may require careful project management
Direct Energy Supply	• Consistent and reliable energy supply through ESCO • Expertise in energy-efficient equipment and systems	• Limited client control over energy supply
Responsibility for Savings	• ESCOs identify and implement energy-saving measures. • Expertise in conducting energy audits	• Limited client involvement in energy efficiency
Flexible Cost Structure	• Tailored cost structure based on project and client preferences. • Streamlined approach to energy management	• Requires negotiation and agreement on cost-sharing

Table 3 - IEC business model enabler and barriers

2.1.4 Build, Own, Operate & Transfer (BOOT)

Build, Own, Operate & Transfer (BOOT) models represent a distinct ESCO business model designed to facilitate energy efficiency projects by leveraging financing mechanisms. These models focus on the acquisition and operation of energy-efficient equipment and systems. Here is a detailed description of BOOT based on the provided bullet points:

- *Financing for Equipment Purchase and Installation*: In BOOT arrangements, ESCOs secure financing to purchase and install energy-efficient equipment and systems. This financing can come from various sources, including ESCO investments, third-party investors, or financial institutions.
- *Return on Investment through Energy Savings*: The ESCO's return on investment (ROI) is generated through the energy savings achieved by the newly installed equipment and systems. As these systems operate more efficiently, they result in reduced energy consumption and associated costs.
- *Ownership Transfer*: A defining feature of BOOT models is the eventual transfer of ownership. At the end of the contract period, ownership of the energy-efficient equipment and systems is typically transferred from the ESCO to the final users or clients. This ensures that clients benefit from the long-term operation and maintenance of these assets.

BOOT models are instrumental in enabling clients to embark on energy efficiency projects without the need for significant upfront capital investment. ESCOs leverage their expertise to secure financing, implement energy-efficient solutions, and ultimately transfer ownership to clients, who continue to benefit from reduced energy costs and sustainable practices.

Aspect	***Enablers***	***Barriers***
Financing for Equipment Purchase and Installation	• Access to financing without significant upfront costs • Expertise in securing financing for clients	• Potential interest or financing costs
Return on Investment through Energy Savings	• ESCO's return on investment (ROI) through energy savings. • Reduced energy consumption and costs	• Initial financial commitment may be required
Ownership Transfer	• Long-term benefits for clients with asset ownership • Maintenance and operation handed over to clients	• ESCO's control and responsibility diminish over time

Table 4 - BOOT business model enabler and barriers

2.2 Citizen driven BMs

In the European Union (EU) framework, citizen-driven business models have gained prominence as essential tools in advancing energy efficiency, fostering renewable energy adoption, and enabling the inter-exchange of energy resources among citizens and buildings. These models reflect the EU's commitment to promoting sustainable energy practices and empowering citizens to actively engage in the energy transition.

2.2.1 Energy communities

In the pursuit of sustainable and decentralized energy systems, energy communities have emerged as a transformative concept. These communities, comprised of citizens, local businesses, cooperatives, or organizations, collectively engage in the generation, consumption, and sharing of energy resources. Their characteristics and applications reflect a paradigm shift in energy dynamics.

Energy communities are characterized by collective ownership and governance. They represent a departure from the traditional energy model, with a focus on renewable energy generation and local energy production. Collective ownership ensures that decision-making is inclusive and aligns with community interests.

Renewable energy generation is at the core of energy communities. Solar, wind, biomass, and hydropower are harnessed to reduce reliance on centralized energy sources. Local energy production strengthens energy resilience and minimizes carbon footprints. Energy sharing is a hallmark feature. Surplus energy generated is redistributed within the community or fed back into the grid, fostering a sense of shared responsibility and energy solidarity. Efficiency measures, such as energy-efficient technologies and demand-side management, are often integrated to further reduce energy consumption.

Energy communities find diverse applications, from residential neighborhoods to agricultural areas, urban and suburban spaces, remote regions, and industrial parks. Residential communities share energy among households, reducing individual bills. Agricultural communities power farm operations and may sell surplus energy. Urban areas embrace rooftop solar installations and microgrids, while remote communities ensure reliable off-grid energy.

The legal framework supporting energy communities varies but is increasingly recognized and encouraged. In the European Union, directives like the Clean Energy for All Europeans package have legitimized energy communities as market players. They are granted access to the grid, enabling energy sharing and fair compensation.

Aspect	*Enablers*	*Barriers*
Collective Ownership and Energy Sharing	• Inclusive decision-making that aligns with community interests • Fosters a sense of shared responsibility and energy solidarity	• Potential for conflicts in decision-making • Technical challenges in energy redistribution
Renewable Energy Generation and Efficiency	• Reduced reliance on centralized energy sources	• Initial investment costs in renewable energy systems
Diverse Applications	• Reduction in individual bills for residential communities, powering farm operations, urban and remote areas	• Varied challenges and requirements in different application areas
Legal Framework Support	• Legitimization and encouragement through EU directives	• Regulatory complexities and variations in different regions

Table 5 - Energy community business model enabler and barriers

2.2.2 Citizen-driven Demand Response initiatives

Demand response, traditionally associated with utilities and grid operators, is undergoing a transformation as citizen-driven initiatives empower individuals and communities to actively engage in energy management. This approach is reshaping the energy landscape, granting consumers greater control over their electricity usage while contributing to grid reliability and sustainability.

Citizen-driven demand response programs operate on the principles of voluntary engagement and real-time monitoring. Participants, ranging from individuals to entire communities, willingly enroll in these programs. They leverage advanced technology, such as smart meters and energy management systems, to monitor their energy consumption in real-time. When event notifications are received from grid operators or program coordinators, participants respond by adjusting their energy consumption. Adjustment strategies are flexible, allowing participants to tailor their responses to demand response events. They might curtail energy-intensive activities, modify thermostat settings, temporarily reduce appliance usage, or employ energy storage systems to shift consumption to more favorable times. In return for their cooperation, participants receive incentives and rewards, which may include reduced electricity bills, direct payments, or contributions to community projects.

The benefits of citizen-driven demand response are multifaceted. Beyond financial rewards, these initiatives provide valuable support to the grid by reducing peak demand, thus obviating the need for costly infrastructure upgrades, and enhancing grid reliability.

Aspect	Enablers	Barriers
Voluntary Engagement	• Active participation in energy management • Flexibility in response strategies tailored to demand events. • Access to incentives and rewards	• Technical requirements and costs for real-time monitoring • Participants' willingness and ability to respond effectively to demand events
Real-time Monitoring	• Precise tracking of energy consumption. • Informed decisions regarding energy use. • Immediate response to demand events.	• Potential privacy concerns related to data collection. • Initial setup and maintenance costs.
Cost effectiveness	• Reduced electricity bills through demand response. • Potential for direct payments or community contributions.	• Costs associated with implementing monitoring technology.
Grid Support and Reliability	• Reduction in peak demand and avoidance of costly infrastructure upgrades • Enhanced grid reliability	

Table 6 - Demand Response business model enabler and barriers

2.2.3 Peer-to-Peer (P2P) Energy Business Models

P2P energy business models represent a transformative shift in the energy sector. They empower individuals and communities to actively engage in energy production, consumption, and sharing. These models prioritize decentralization, community ownership, and energy sustainability. In P2P energy models, communities invest collectively in local renewable energy sources like solar panels and wind turbines. This decentralized approach reduces reliance on centralized utilities. Community members become energy "prosumers," meaning they not only consume but also generate and share surplus energy.

Blockchain technology plays a pivotal role in P2P energy models. It ensures secure and transparent energy transactions within the community, allowing participants to buy and sell energy directly with one another. This technology also underpins the token rewards system. The token rewards system operates by incentivizing energy producers to generate surplus energy and share it within the community. When energy is shared, tokens are rewarded to the producer. These tokens can then be used for various purposes within the P2P network. For example, participants can use tokens to pay for energy consumed, invest in additional renewable energy infrastructure, or even trade tokens with other community members.

Smart meters provide real-time data on energy production and consumption, enabling participants to make informed decisions about their energy use. This real-time data, combined with blockchain and token rewards, creates a transparent and efficient system where energy transactions are automated and community members are financially incentivized to contribute to the energy supply.

The implications and benefits of P2P energy models are substantial. Individuals gain greater control over their energy consumption, reducing dependence on traditional providers. Communities achieve enhanced energy independence, ensuring a stable energy supply, especially during grid disruptions. The use of renewable energy sources aligns with sustainability goals and reduces greenhouse gas emissions. Financial rewards come in the form of income from selling surplus energy, reduced energy bills, and potential incentives or token-based rewards.

Aspect	***Enablers***	***Barriers***
Decentralization	• Reduced reliance on centralized utilities. • Greater community ownership of energy generation • Enhanced energy independence for communities.	• Initial investment and infrastructure costs for renewable sources. • Ongoing maintenance and operational responsibilities.
Blockchain Technology	• Secure and transparent energy transactions. • Facilitates direct energy trading within the community.	• Learning curve for participants unfamiliar with blockchain.
Token Rewards System	• Incentives for surplus energy generation and sharing. • Flexibility in token usage for various purposes.	• Token value fluctuations and market uncertainties.
Smart Meters	• Real-time data for informed energy consumption decisions. • Automated and efficient energy transactions. • Financial incentives for contributing to the energy supply	• Costs associated with the installation of smart meters. • Potential privacy concerns related to data collection.

Table 7 - P2P business model enabler and barriers

2.2.4 Public-Private Partnership (PPP) Energy Business Models

The Public-Private Partnership (PPP) business model structure represents a collaborative approach where the public sector and private sector come together to plan, finance, build, and operate projects and services that are traditionally within the public domain but can benefit from the efficiency, innovation, and resources offered by private sector involvement.

The process typically starts with a needs assessment conducted by the public sector to identify projects that could benefit from private sector participation, spanning infrastructure development, social services, and public facilities. To initiate the partnership, government authorities often issue a request for proposal (RFP) or conduct a competitive bidding process. Private sector entities then respond with proposals outlining their approach to the project. Following the selection of a private partner, contracts and agreements are established to formalize the partnership, clearly defining roles, responsibilities, risk-sharing, and performance expectations. Financing sources can be diverse, including private sector investments, government grants, loans, bonds, or a combination of these. Private sector investors negotiate agreements detailing the terms, conditions, and returns on their investments. Once the partnership is formed, the private partner takes the lead in designing, constructing, and commissioning the project. They may also be responsible for ongoing maintenance during the operational phase, adhering to established quality, safety, and performance standards. The operational phase is crucial, with private partners working to provide the required service efficiently and at agreed-upon quality levels. In revenue-generating projects, such as toll roads, the private partner may collect user fees, sharing them with the public entity or using them to recoup their investment. The public entity continuously monitors the project's performance, ensuring that contractual obligations are met. Oversight is a fundamental aspect of PPPs, with public authorities retaining the right to intervene if performance falls below agreed-upon standards.

PPP contracts can vary in duration, spanning multiple years, particularly in long-term infrastructure projects. Provisions for early termination are often included in contracts, along with compensation arrangements for the private partner. The PPP business model structure serves to merge the strengths and resources of both the public and private sectors, facilitating the development of a wide array of projects that can benefit society. It allows governments to leverage private sector efficiency, innovation, and financial resources while retaining control over critical public assets and services.

Aspect	*Enablers*	*Barriers*
Collaboration	• Merging of public and private sector strengths and resources for project development. • Efficiency, innovation, and financial resources of the private sector are leveraged.	• Complex partnership initiation involving competitive bidding and agreement formalization. • Potential conflicts over roles, responsibilities, and risk-sharing.
Needs assessment	• Targeted identification of projects benefiting from private sector involvement. • Aligning project selection with societal and public benefits.	• Time-consuming process, especially for the needs assessment.
Financing diversity	• Diverse financing sources, including private sector investments, government grants, loans, and bonds. • Potential for risk-sharing and varied investment returns.	• Extensive negotiation and agreement details required for financing terms and conditions.
Project Phases	• Private partner leads design, construction, and commissioning, ensuring expertise in these phases. • Ongoing maintenance responsibilities met by the private partner, adhering to quality, safety, and performance standards.	• Loss of direct public control over the project's initial phases. • Potential for conflicts related to service quality and standards.
Revenue Generation	• Possible revenue collection, particularly in projects like toll roads, which can recoup private sector investments. • Sharing of collected revenue as outlined in the partnership agreement.	• Public entity reliance on private partner for revenue collection.
Risk Allocation	• Allocation and sharing of risks based on partnership agreements, with mechanisms for risk assessment and mitigation. • Built-in mechanisms for handling unforeseen challenges.	• Complex risk assessment and distribution process.
Oversight and Monitoring	• Continuous monitoring of project performance by public authorities. • Ensuring contractual obligations are consistently met.	• Potential for public authority intervention if performance falls below standards.

Contract Durations	• Contracts can vary in duration, offering flexibility to accommodate different project types. • Provisions for early termination and compensation arrangements often included.	• Extended contract durations may lead to long-term commitments.

Table 8 - PPP business model enabler and barriers

2.3 Business financing

Business financing in energy efficiency represents a dynamic and evolving strategy aimed at allocating financial resources to bolster energy utilization within organizations. The scope of energy efficiency initiatives spans a broad spectrum of projects, encompassing endeavors such as upgrading building systems, implementing energy-efficient technologies, and optimizing industrial processes. This multifaceted approach to energy efficiency is increasingly vital in addressing today's environmental concerns, reducing operational costs, and enhancing organizational sustainability.
At the urban district level, a unique facet of business financing for energy efficiency emerges, marked by distinct characteristics that set it apart from traditional approaches. In this context, business financing takes on a comprehensive and integrated role, fostering innovative solutions that transcend individual buildings or facilities.

The essence of district-level business financing for energy efficiency lies in its *holistic approach*. Unlike isolated projects that target single buildings or specific components, district-level initiatives extend their reach to encompass entire districts or neighborhoods. This approach aims to develop comprehensive solutions that address the energy needs and challenges of an entire community. These solutions can span a diverse range of interventions, including building retrofits, the deployment of renewable energy installations, the establishment of smart grid systems, and the promotion of sustainable transportation systems. By targeting the district, this financing strategy catalyzes synergistic energy efficiency solutions that benefit the entire community.

At the core of district-level energy efficiency financing is the emphasis on *integrated urban planning and design*. Business financing supports projects that consider a multitude of interconnected aspects of urban life. Beyond energy, these projects take into account mobility solutions, waste management strategies, green spaces, and more. The objective is to foster the creation of holistic and sustainable communities where energy efficiency is seamlessly integrated into the fabric of daily life. This integrated approach encourages collaboration among stakeholders, promotes resource efficiency, and enhances the overall quality of life within the district.

District-level financing places a premium on *decentralized energy generation* through renewable sources. Solar panels, wind turbines, and geothermal systems take center stage as localized sources of clean energy. The surplus energy generated by these decentralized systems often surpasses the immediate needs of the district. This excess energy can be strategically channeled back into the larger energy grid, contributing to the district's overall energy balance. Alternatively, surplus energy can be stored for future use, bolstering the district's energy resilience and sustainability. This characteristic marks a departure from conventional centralized energy generation models, offering districts greater control over their energy destiny.

Business financing in district-level energy efficiency fosters a culture of *energy sharing* and collaboration. Inhabitants of the district are encouraged to actively engage in energy sharing and trading. This collaborative energy ecosystem is facilitated through the development of peer-to-peer energy trading platforms. These platforms empower district residents and businesses to exchange surplus energy directly, optimizing energy consumption and reducing waste. By promoting energy sharing, districts unlock the potential for more efficient energy utilization and foster a sense of community engagement in sustainable practices.

The integration of *smart technologies* is fundamental to district-level energy efficiency financing. Advanced monitoring systems, sophisticated control mechanisms, and data analytics platforms are financed to enable real-time energy management. These technologies empower the district to respond dynamically to energy demand, participate in demand response programs, and optimize the utilization of available resources. The implementation of smart grids enables efficient energy distribution and consumption, reducing energy losses and enhancing the reliability of the district's energy infrastructure.

In summary, business financing for energy efficiency at the district level represents a dynamic shift in how we approach urban planning and sustainability. The key characteristics of this financing approach include district-wide solutions, integrated planning, decentralized energy generation, energy sharing, and the incorporation of smart technologies. By aligning with these characteristics, business financing transforms districts into self-sustaining, energy-efficient communities, redefining the way we envision and implement urban development for a more sustainable future.

2.3.1 Risk management of energy efficiency investments

Investing in energy efficiency projects can yield substantial benefits, including reduced operational costs, improved sustainability, and enhanced competitiveness. However, these investments come with inherent risks that can impact project success. Effective risk management is crucial to mitigate these challenges and ensure that energy efficiency initiatives deliver on their intended objectives.

The foundation of risk management in energy efficiency investments lies in *comprehensive due diligence*. This process involves a thorough assessment of all aspects of the proposed project. It includes technical, financial, operational, and regulatory evaluations to identify potential risks and challenges. Technical due diligence examines the feasibility of energy-saving technologies and their compatibility with existing systems. It considers factors like equipment reliability, performance specifications, and potential for technology obsolescence. Financial due diligence involves a meticulous examination of project costs, expected savings, and return on investment (ROI). It considers variables such as energy prices, financing terms, and potential changes in utility rates. Operational due diligence assesses the impact of the energy efficiency project on day-to-day operations. It considers factors like employee training, maintenance requirements, and disruptions to business processes. Regulatory due diligence ensures compliance with relevant laws and regulations. It involves understanding permitting requirements, environmental regulations, and incentives or rebates available for energy efficiency projects.

Performance guarantees are instrumental in managing risks associated with energy efficiency investments. These guarantees are often provided by energy service companies (ESCOs) or technology suppliers and are contractually binding agreements that stipulate specific energy savings or performance outcomes. Performance-based contracts, such as Energy Performance Contracts (EPCs), tie the compensation of ESCOs to the actual energy savings achieved. If the project falls short of the promised savings, the ESCO may be obligated to provide financial compensation to the client. These contracts align the interests of both parties and incentivize ESCOs to deliver on their commitments.

Energy efficiency projects can be insured to protect against unexpected setbacks. *Insurance policies* can cover various risks, including equipment failure, underperformance in energy savings, and property damage. These insurance policies provide financial security and can be tailored to the specific risks associated with the project. Additionally, *risk transfer mechanisms*, such as warranties and guarantees, can shift certain risks from the investor to the technology supplier or ESCO. These contractual arrangements provide assurance that if specific risks materialize, the responsible party will bear the associated costs.

Long-term agreements with energy suppliers and off-takers can help stabilize revenue streams for energy efficiency projects. Power Purchase Agreements (PPAs), for example, lock in energy prices and sales terms over an extended period. These agreements provide predictability, reducing exposure to fluctuating energy prices.

Rigorous *monitoring and maintenance programs* are essential for risk management in energy efficiency projects. These programs help identify and address issues early, preventing potential performance degradation. Advanced analytics and real-time data monitoring provide insights into equipment health and energy consumption patterns, allowing for proactive maintenance.

Energy efficiency investments can be impacted by *market fluctuations and changes in regulations*. To manage these risks, investors should stay informed about energy market trends and policy developments. Diversifying investments across different technologies and geographies can also mitigate risks associated with localized market conditions and regulatory changes.

In conclusion, risk management is integral to the success of energy efficiency investments. It involves thorough due diligence, performance guarantees, insurance, long-term agreements, continuous monitoring, and strategies to address market and regulatory risks. By implementing effective risk management measures, investors can enhance the likelihood of achieving the expected benefits from their energy efficiency projects while safeguarding their investments against potential challenges.

2.3.2 Crowd equity finance models

Crowd equity finance models have emerged as a powerful force in the realm of energy efficiency, driving the green revolution by democratizing investment opportunities in sustainable projects. These innovative financing mechanisms leverage the collective power of a diverse group of investors, ranging from individuals to institutions, to fund energy efficiency initiatives. By enabling broader participation in the transition to cleaner and more sustainable energy practices, crowd equity finance models are reshaping the landscape of energy efficiency investments.

At their core, crowd equity finance models harness the principle of *equity crowdfunding*. Equity crowdfunding allows investors to acquire equity stakes in projects or companies, offering them a share of ownership and potential returns. In the context of energy efficiency, these models are particularly pertinent as they facilitate the flow of capital to projects that aim to reduce energy consumption, improve resource utilization, and mitigate environmental impacts.

Crowd equity finance models cast a wide net, appealing to a *diverse pool of investor*s. This inclusivity encompasses individual backers with modest investments, high-net-worth individuals seeking impactful opportunities, and institutions committed to advancing sustainability. The diversity of participants infuses projects with a breadth of perspectives and capital, enhancing their sustainability and reach.

Equity crowdfunding thrives on *digital platforms*, serving as intermediaries that bridge project developers and potential investors. These online platforms streamline the investment process, making it accessible to a broad spectrum of participants. This virtual marketplace empowers investors to explore and engage with a wide array of energy efficiency projects.

Crowd equity finance models span a *vast spectrum of energy efficiency projects*. They accommodate endeavours of varying scales and scopes, from residential solar installations and building retrofits to industrial process optimizations and the emergence of renewable energy startups. This versatility ensures that a broad range of initiatives can access funding, fostering innovation and adaptability in the energy efficiency sector.

To attract investors, crowd equity finance models often integrate *risk mitigation strategies*. These measures include comprehensive due diligence assessments, financial transparency, and investor protections. Additionally, some models may offer guarantees or insurance options to alleviate potential financial risks. These safeguards instil confidence in investors, reducing apprehensions associated with energy efficiency projects.

Many participants in crowd equity finance models are driven by more than financial returns; they are motivated by the desire to create positive social and environmental impacts. These *investors align with impact investing principles*, seeking projects that generate meaningful societal and ecological benefits in tandem with financial gains. This convergence of interests propels projects that address pressing sustainability challenges.

3 InCUBE demosites

Focus of this chapter is an in-depth exploration of the renovation activities taking place in the demosites. This includes a detailed examination of the specific interventions and technologies being implemented to improve energy efficiency and sustainability. Moreover, the chapter will provide a comprehensive overview of the existing business models that underpin these activities. This encompasses an examination of various financing schemes and the strategies in place for managing the post-renovation phase. This overview will also describe the subsequent management and maintenance contracts. These contracts play a pivotal role in ensuring the ongoing sustainability and efficiency of the sites, warranting a thorough investigation. All the information presented is sourced from questionnaires administered to demosite owners, and these questionnaires can be found in the annex. A critical aspect of this chapter is the evaluation of each demosite's alignment with the business models previously discussed. It is crucial to select the most appropriate model for each building and its specific interventions while considering the stakeholders involved and the long-term sustainability goals.

3.1 Trento

The Trento demosite comprises a multitude of activities spanning various buildings within the district. While the rejuvenation of the B6 building is a central focus, it is important to first explore the broader spectrum of renovation activities within the district.

B1 Building

Once in a state of neglect, the B1 building has been redesigned to host a bar, the Orders of Engineers and Architects, and a youth centre. The comprehensive renovation covers interior remodelling, roof insulation, window and door replacements, and the installation of a new heating system. The funding, secured from the Presidency of the Council of Ministers and the Municipality, amounting to €3,770,000, has completely covered the project expenses. Additionally, the building's external walls have been insulated, further enhancing energy efficiency. Furthermore, photovoltaic installations have been added, entirely funded to ensure sustainable energy production.

B2 Building

This building has already undergone renovation, with the transformation completed in 2021. It now serves as a day care centre, cohousing space, and a day care centre for civic activities. Notably, there are provisions for monitoring energy consumption in this building, an integral part of the energy community framework. The project received funding from the Presidency of the Council of Ministers, amounting to €1,200,000, supplemented by additional contributions from the province.

B3 Building

Partially neglected for years, the B3 building, which previously hosted a care home on its lower floors, is set for a transformation. The planned renovation includes new external and internal walls, the installation of a modern heating system, and the replacement of windows, all financed by €12,500,000 from the Presidency of the Council of Ministers, with supplementary contributions from the PNRR.

B4 Building

Once a historical church, the B4 building is now in the final stages of its renovation. The restoration encompasses renovation of internal walls, external walls and roof, replacement of windows and heating systems. The project received €400,000 from the Presidency of the Council of Ministers and additional funding from the municipality.

B5 Building

What was once an empty space in 2022 is now transformed into two buildings—a tertiary building and 56 residential apartments. Habitat s.r.l. spearheaded this project with their own funding, totalling €23,000,000. The innovative design embraces an A+ energy class, incorporating centralized geothermal heat pumps and photovoltaic systems for sustainability.

B6 Building

The B6 building holds a unique place within the Trento Demosite. With a rich history as a former hospital and university of letters, this aging structure now hosts a diverse array of offices, including those of the municipality, the Film Festival, and Centro Servizi Santa Chiara. However, the building operates at just one-third of its maximum capacity, presenting an opportunity for profound revitalization. The interventions planned for the B6 building are both extensive and intricate. The primary aim is to enhance its energy efficiency, functionality, and sustainability. These encompass:

- *Photovoltaic Installations*: The rooftop of the Palabocchi section will receive photovoltaic panels as part of the InCUBE project. This initiative aims to harness solar energy and reduce the building's dependence on conventional power sources.
- *Roof Insulation*: Roof insulation, funded partially by the InCUBE project, helps conserve energy by minimizing heat loss during the colder months. This intervention contributes to maintaining a comfortable and energy-efficient indoor environment.
- *Window and Internal Partition Upgrades*: Replacing windows and internal partitions is a crucial aspect of the renovation. Modern, energy-efficient windows help prevent heat loss

and create a more comfortable interior. This intervention is partly funded by the PAT (Provincia Autonoma di Trento).

- *Heating System Distribution*: Ensuring efficient heating system distribution throughout the building is vital. The investment in this area, with support from the PAT, seeks to create a warm and welcoming environment in alignment with sustainability goals.
- *Ventilation Systems and Lighting Improvements*: Enhancements to ventilation systems and lighting within the Cuminetti theatre section are funded through the PNRR (National Recovery and Resilience Plan). These improvements aim to create an eco-friendly and pleasant space for cultural events and exhibitions.
- *Geothermal Heat Pump*: The introduction of a geothermal heat pump with a capacity of 500 kW plays a pivotal role in optimizing heating efficiency. This solution uses the Earth's consistent temperature to heat and cool the building, reducing energy consumption and greenhouse gas emissions. Funding is secured through the InCUBE project and the municipality.
- *Monitoring and Energy Community*: The project incorporates a robust monitoring system with the establishment of an energy community. This involves the installation of monitoring sensors in the B6 building, with funding provided by the InCUBE project. It serves to collect data on energy consumption, enabling informed decisions for further energy efficiency improvements.
- *New Heating System for Palabocchi*: The Palabocchi section will receive a new heating system, funded by the PNRR. This intervention is vital for maintaining an optimal indoor climate within the building.

The main information regarding the financing schemes for each intervention in building B6 are summarized in the table below.

Stakeholders involved in the Trento demosite project include:

- *Trento Municipality:* The municipality owns the B6 building, which will be repurposed for public use, housing provincial offices and the Centro Servizi Santa Chiara.
- *ASIS:* This public administration company, "ente funzionale," is the owner of a gym located within the district.
- *Civica di Trento*: As the owner of the B2 and B4 buildings, Civica di Trento actively participates in the project by contributing to the renovation and energy-efficient upgrades of these properties.
- *O&M Managers*: The individuals or companies responsible for the installation and management of various systems are crucial for the project's success. The details of operation and maintenance (O&M) are still under development.

- *HVAC (Geothermal, B1, and B6):* The HVAC systems for B1 and B6 are typically subcontracted to external companies to ensure efficient heating, ventilation, and air conditioning.
- *PV (Photovoltaic):* The management of photovoltaic systems is likely to be handled by ASIS, according to Trento's claims.
- *Real-Time Smart Meters*: EVOLVERE oversees installing real-time smart meters in B1, B2, B3, B5, and B6. These meters enable accurate data collection and monitoring, facilitating energy efficiency.
- *Monitoring Sensors*: TERA is responsible for installing monitoring sensors in the B6 building, enhancing the site's capabilities for tracking, and optimizing energy consumption.

The business model for the Trento demosite, particularly concerning the post-project phase, is currently under development. This phase will determine the operation managers and contracts for energy services, including potential involvement from Energy Service Companies (ESCOs). As the project progresses, the finalization of this business model is essential to ensure the sustained efficiency and success of the renovated buildings.
The Trento demosite project presents a diverse range of renovation activities across various buildings. To align these activities with standard business-as-usual models, we can explore several models to determine the most suitable fit:

- *Energy Performance Contract (EPC)*: The extensive renovation activities, such as improving energy efficiency from class F to A, closely align with the EPC model. EPC contracts would specify the energy savings targets and performance improvements, with the ownership of the installations typically remaining with the building owners. In this approach, an ESCO would invest in, design, and implement energy-efficient solutions, including photovoltaic installations, geothermal heat pumps, and monitoring systems. The ESCO would share the financial risks and returns, often guaranteeing specific energy savings This model offers a structured way to realize the energy efficiency goals in each building, particularly for interventions like roof insulation, window upgrades, and heating system distribution.
- *Public-Private Partnership (PPP)*: The involvement of public institutions, such as the Presidency of the Council of Ministers, the Municipality, and the province, suggests the potential for a PPP model. These public bodies provide funding and support for various renovations, which is a hallmark of PPPs. This model can facilitate comprehensive urban development while sharing risks and benefits between the public and private sectors.
- *Energy Community/P2P energy sharing*: The establishment of an energy community, as mentioned for the B6 building, supports a district-level energy-sharing model. This could involve collective ownership or management of renewable energy assets, optimizing energy use within the community, and even trading surplus energy.

3.2 Zaragoza

Zaragoza demosite activities focus on the reinvigoration of the Valle de Oza community, which includes buildings numbered 1, 3, 5, and 7. This project's particular aspect is the community-driven renovation through a partnership between the local community and the Municipality of Zaragoza.

The scope of renovations within the Valle de Oza community is significant. Specific interventions include the installation of hybrid thermal-solar panels for both thermal energy and photovoltaic electricity generation, and the establishment of rainwater sewage networks and upgraded water supply systems. In addition, thermal envelope improvements will be made to improve the insulation of the building's facades and roof. Moreover, the potential for creating an energy community at the district level is under consideration. This community would facilitate the management of energy resources, promoting efficient consumption and optimizing energy generation.

One notable feature of the Zaragoza Demosite is the plan to deploy hybrid thermal-solar panels. These panels are expected to produce approximately 22 kWh/m^2/year of thermal energy and 39 kWh/m^2/year of photovoltaic electricity, with a total of 40 units deployed across the community. The introduction of these panels not only contributes to sustainable energy generation but also aligns with energy-efficient improvements in the district. The creation of an energy community at the district level is a forward-thinking endeavor. It presents an opportunity for the community to collectively manage energy resources, fostering efficient consumption practices. Energy generation and demand information will be anonymized and shared as open data, promoting transparency and collaboration. This data will be accessible through an open portal, contributing to a global information ecosystem.

Additionally, a solar district is envisioned to be established with two 50 kWp solar installations, each comprising 110 photovoltaic panels with batteries. This initiative reflects a commitment to renewable energy and underscores the potential for the community to be actively engaged in sustainable energy practices.

The approval of a municipal grant specific to the InCUBE Project is a notable development. The grant, amounting to €24,600 per dwelling, has been directly assigned to the owners' communities participating in the project, specifically Valle de Oza 1-3-5-7. This municipal grant reaffirms the Municipality's commitment to the success of the InCUBE Project, offering a guarantee for the viability and timeliness of the funding. Additionally, this grant showcases the strong engagement of the Municipality with the project, emphasizing the shared commitment to sustainable urban development.

In the context of the Zaragoza Demosite, several stakeholders are involved in the project, each with specific roles and responsibilities:

- *Owner Communities*: The owner communities, represented by the residents of Valle de Oza 1-3-5-7, are the primary stakeholders in the Zaragoza Demosite. They are the owners of the residential properties in the district. Their role involves participating in the energy renovation project, allowing the implementation of energy-efficient measures in their respective buildings, and contributing to the success of the project.
- *Zaragoza Vivienda (ZAVI)*: Zaragoza Vivienda, the municipal housing company, plays a central role in managing and overseeing the energy renovation project. They coordinate and administer the project on behalf of the municipality. Additionally, they have successfully secured a specific municipal grant for the InCUBE Project, which will directly benefit the owner communities, demonstrating the municipality's commitment to the project's viability.
- *Municipality of Zaragoza*: The municipality of Zaragoza is a key partner in the project, providing support and resources to facilitate the energy renovation in the Valle de Oza 1-3-5-7 district. Their engagement includes approving grants, coordinating with Zaragoza Vivienda, and ensuring the success of the project.
- *Kover + CIRCE (Modular Facades + energy monitoring + air quality)*: Kover is responsible for the deployment of modular facades, while CIRCE oversees energy and air quality monitoring, and insulation within the project. These interventions aim to improve the energy performance of the buildings, transitioning from EPC class F to A. The ownership of these installations will be retained by the owners of the 40 dwellings. While the operation doesn't require ongoing management, the owners will be responsible for maintenance and can choose to contract an external company if needed after the guarantee period. There are no specific energy communities associated with these interventions.
- *Metro7 + Abora (Hybrid Thermal Solar Panels)*: Metro7 and Abora oversee installing hybrid thermal-solar panels. Ownership of these panels will belong to the owners of the 40 dwellings. Operational management will be handled by the owners, potentially with support from EDP for system management. Maintenance responsibilities will be shouldered by the owners after the guarantee period, and cooperation with EDP may be considered. Energy communities will be managed by the owners to optimize self-owners' consumption.
- *EDP*: EDP is tasked with installing solar districts with PV panels and batteries. The specific location is pending due to political property reasons, with alternative rooftops under consideration. After the project concludes, the ownership of these installations will transition to an energy community. EDP will handle the operational management of the solar districts and their maintenance under a contract with the energy community, potentially employing an ESCO model. The configuration of energy communities will depend on the partners who join the community.

- *CIRCE*: CIRCE will install a wireless dwellings monitoring system that tracks consumption and air quality. It could be considered that the ownership of this system remains with the owners of the 40 dwellings when the InCUBE project ends, but it is not yet defined. Operational management will involve CIRCE. Owners will be responsible for maintenance after the guarantee period, and these monitoring systems are not directly associated with energy communities.
- *Abora*: Abora provides a management system included in hybrid thermal-solar panels. The ownership and responsibility for these panels will be retained by the owners of the 40 dwellings. Operational management will be jointly handled by Abora and an external maintenance company. Maintenance responsibilities will be assumed by the owners through a company of their choice. The configuration of energy communities will depend on the statutes of the owners' community.

These stakeholders play essential roles in the Zaragoza demosite project, contributing to the installation, ownership, operation, and maintenance of the various systems and interventions aimed at improving energy efficiency and sustainability within the district. Their collaborative efforts ensure the long-term success of the project.

Several business-as-usual business models can be considered for Zaragoza demosite interventions, each aligning with specific aspects of the project:

- *Energy Community:* the potential creation of an energy community at the district level is a strong fit for this demosite. This model enables efficient energy management, promotes optimized energy generation and consumption, and aligns well with the collaborative approach of the project. It should be combined with other business models to create a synergy that can be the key to the overall success of the project.
- *Integrated Energy Contract (IEC):* given the integration of various energy systems, an IEC model could be considered with the management potentially assigned to an ESCo. The role of Metro7 and Abora in installing and potentially managing energy-efficient systems, such as solar panels and hybrid thermal-solar panels, aligns with the IEC model. Moreover, the ESCO's involvement in savings guarantees and performance monitoring ensures that energy efficiency targets are met and that the community benefits from reduced energy consumption and cost savings.
- *Public-Private Partnership (PPP)*: The collaboration between the Municipality of Zaragoza, Zaragoza Vivienda, and the owner communities suggests the suitability of a PPP model. This model combines public and private resources, shared responsibilities, and financing support, which reflects the collaborative approach of the project.

- *Peer-to-Peer (P2P) Energy Sharing*: The emphasis on transparent energy data, anonymized open data sharing, and the creation of an open portal for the community aligns with the principles of P2P energy sharing.
- *Demand Response (DR):* While not explicitly mentioned, the project's focus on energy efficiency and community-driven energy management could involve Demand Response strategies. DR programs encourage users to adjust their energy consumption patterns in response to price signals or grid conditions. This can be part of optimizing energy generation and consumption within the community.

3.3 Groningen

The Groningen demosite embodies a remarkable transformation project driven by innovation, sustainability, and community engagement. This chapter takes an in-depth look at the extensive renovation activities, the funding mechanisms in place, and the spectrum of stakeholders contributing to the success of the endeavor. Furthermore, we will assess how well this project aligns with various business-as-usual (BAU) models.

The renovation activities in Groningen are multifaceted, driven by the vision of creating sustainable, energy-efficient, and modern housing solutions. Key activities include:

- *Improved design and expansion*: One of the central innovations involves reimagining the buildings' design. Prefabricated modules and facades have been engineered to facilitate building expansion through the attachment of modules to the longitudinal side of the existing structures. This innovation necessitates the outward movement of the facades, leading to the extension of the floors.
- *Building-Integrated Photovoltaics (BIPV)*: A significant enhancement includes the integration of Building-Integrated Photovoltaics on prefab facades, replacing the existing facades. This integration harnesses solar energy to contribute to the overall energy generation of the buildings.
- *Target energy mix*: The Groningen demosite aims to achieve an energy mix that combines waste heat (from the District Heating Network) with solar power. The target is to produce 126 MWh/year of waste heat and 267 MWh/year of solar energy. Moreover, there is an emphasis on achieving at least 52% self-consumption of renewable energy and elevating the buildings from an EPC Class C to A+++.
- *Monitoring and control system upgrades*: The project includes the installation of upgraded monitoring and control systems. The Specific Required Information (SRI) for these systems

is yet to be determined, but their implementation is integral to tracking and optimizing energy consumption.

The Groningen demosite relies on a range of funding mechanisms to support its comprehensive renovation activities. These include:

- *Public and private collaboration*: The project is partly funded through a Public-Private Partnership (PPP), with the involvement of a Social Housing Company (Lefier) and a private constructor (WV). This collaborative funding model underscores the collective effort in achieving the project's goals.
- *Depreciation and rental income*: The Dutch Social Housing Company business model is pivotal in financing these projects. It involves acquiring housing assets and depreciating them over an extended period, typically 50 years. Rental income from these assets is used to gradually recover the initial investment. Once the book value reaches zero, it signals the need for reinvestment to ensure modernity and sustainability.
- *Fundings for regular interventions*: Funding for regular interventions is provided by Urban Europe (UE) in collaboration with Lefier, the social housing company, indicating a coordinated approach to securing resources for ongoing maintenance and improvements.

Several stakeholders are intricately involved in the Groningen demosite, each playing a vital role in the project's success:

- *Social Housing Company (Lefier)*: Lefier is at the core of the project, representing the housing company that owns and manages the properties. Their commitment and financing model are key drivers for the project's success.
- *Constructor (WV)*: The constructor is responsible for the physical renovation and upgrades, ensuring that the project's vision becomes a reality.
- *Dwelling owners*: Ultimately, the residents of the renovated buildings become the owners, marking a shift towards greater sustainability and comfort in their homes.

The Groningen demosite aligns well with several business-as-usual models, reflecting its adaptability and sustainability:

- *Integrated Energy Contracting (IEC)*: The project's emphasis on energy efficiency, BIPV integration, and the need for a monitoring and control system make it a prime candidate for an IEC model, where energy service providers guarantee energy savings through efficient technologies and practices.
- *PPP (Public-Private Partnership)*: Collaborations between public and private entities, exemplified by the involvement of Lefier (public) and constructor WV (private), resemble a PPP approach.

- *Peer-to-Peer Energy Trading (P2P)*: Given the emphasis on generating solar power and optimizing energy consumption, the Groningen demosite could potentially explore P2P energy trading models to further enhance energy sharing and sustainability within the community.

Here below you can find a table which summarizes the main aspects of the above descriptions of actual demosite business model using the canvas framework.

Aspect	**Trento**	**Zaragoza**	**Groningen**
Customer segments	• Trento municipality • ASIS • Civica di Trento	• Dwelling owners (Community managers)	• Social Housing Company (Lefier) • Constructor (WV) • Dwelling owners (Transition)
Value proposition	• Energy requalification of B6 building • Geothermal HVAC systems • Installation of PV panels • Deployment of smart meters • Monitoring sensor installation in B6	• Solar PV panels installation • Hybrid solar panels • Energy and air quality monitoring • Improved insulation • Creation of energy community	• Improved building design for expansion • Pre-installed BIPV • Renewable energy self-consumption • Waste heat utilization • Upgraded monitoring and control systems
Channels	• Collaboration with HVAC and PV installers • Municipal support	• Communication and coordination through ZAVI • Local community involvement • Municipal support	• Collaboration with constructor and O&M providers • Utility collaboration
Customer Relationships	• Contractual agreements with stakeholders • Collaborative community efforts	• Agreements and contracts with dwelling owners • Community-driven renovation	• Contracts with Lefier, constructor, and dwelling owners
Revenue Streams	• EU funds • Municipal contributions • Savings through energy efficiency	• EU funds • Next Generation district program funds	• EU funds • Rental income (Lefier's business model) • Energy savings and generation

	• Potential energy trading	• Contributions from dwelling owners (income-dependent) • Municipal subsidies • Sustainable energy savings	
Key Resources	• B6 building, Geothermal HVAC systems. • PV panels • Smart meters • Monitoring sensors	• Solar panels • Monitoring systems • Improved insulation	• Prefab modules and facades • BIPV systems • Monitoring and control technology
Key Activities	• Energy system upgrades • Installation of renewable energy systems • Deployment of energy monitoring technology	• Solar panel installation • Energy community setup and management	• Building design improvements • Installation of BIPV • Implementation of monitoring systems • Transition of ownership to dwelling owners
Key Partners	• HVAC system installers • PV system installers	• ZAVI (Municipal company) • EDPS (ESCO)	• Constructor (WV)
Cost Structure	• Renovation costs • O&M expenses (TBD)	• Renovation costs • O&M expenses	• Renovation costs • O&M expenses
Risk and challenges	• Community participation and engagement • Funding availability	• Coordination with local community • Funding uncertainties	• Ensuring energy efficiency • Community collaboration

Table 9 - Demosites' business model canvas

4 Potential paths for improvements

To align the actual renovation plan and funding scheme with suitable business-as-usual models, innovative tailoring will be required. This means adapting traditional business models to the specific context of the demosites. This innovative tailoring involves considering the diverse set of buildings, their purposes, and the integration of various stakeholders. In this upcoming analysis, we will explore how the planned renovations and funding mechanisms fit within these business-as-usual models while also identifying any novel strategies that need to be implemented. By aligning the activities with traditional business models and making innovative adjustments, InCUBE project aims to create a sustainable, efficient, and replicable approach to energy renovation that can serve as a model for other districts and communities.

In the context of the Trento, Zaragoza, and Groningen demosites, it is essential to evaluate the applicability of conventional business-as-usual models and identify areas for innovation that enhance the business aspects. For this purpose, a comprehensive analysis of the strong and weak points within this context drops the basis for a correct tailoring and therefore it will be included in the analysis.

4.1 Trento

The extensive renovation activities, such as improving energy efficiency from class F to A, closely align with the EPC model. EPC contracts would specify the energy savings targets and performance improvements, with the ownership of the installations typically remaining with the building owners. In this approach, an Energy Service Company (ESCO) would invest in, design, and implement energy-efficient solutions, including photovoltaic installations, geothermal heat pumps, and monitoring systems. The ESCO would share the financial risks and returns, often guaranteeing specific energy savings. This model offers a structured way to realize the energy efficiency goals in each building, particularly for interventions like roof insulation, window upgrades, and heating system distribution. However, the coordination of diverse stakeholders within the demand response market, including public buildings and external stakeholders like nearby activities and gyms, may be complex. It requires robust data management and real-time forecasting to participate effectively in the market. The adaptation to EPC may face resistance from stakeholders accustomed to traditional public sector procedures.

The introduction of public buildings as prosumer aggregators is a unique feature that allows integrated data management for forecast purposes, participation in the demand response market, and the sharing of surplus energy with stakeholders. This innovative adjustment enhances the business aspects of EPC, making it more suited to the Trento demosite's goals.

The involvement of public institutions, such as the Presidency of the Council of Ministers, the Municipality, and the province, suggests the potential for a PPP model. These public bodies provide funding and support for various renovations, which is a hallmark of PPPs. This model can facilitate comprehensive urban development while sharing risks and benefits between the public and private sectors. The establishment of a PPP model might require adjustments to accommodate the active participation of public buildings as prosumers and their engagement in the demand response market.

Public-Private Partnerships typically involve long-term contracts, and the integration of public buildings as prosumers could necessitate modifications to the contract structures.

The establishment of an energy community with peer-to-peer energy sharing, as mentioned for the B6 building could involve collective ownership or management of renewable energy assets, optimizing energy use within the community, and even trading surplus energy. The transition to an energy community may require regulatory adjustments to support the sharing of surplus energy with external stakeholders and coordinate energy flows effectively. The adoption of this model might involve a shift in the traditional energy supply and consumption dynamics within the community, necessitating effective communication and management. The integration of public buildings as prosumer aggregators within the energy community is a novel feature. This involves efficient data management for forecast purposes, participation in the demand response market, and sharing surplus energy with stakeholders, including nearby activities and gyms.

In summary, Trento is poised to adapt traditional business models (EPC, PPP, and P2P) to its specific context, introducing innovative features that enhance energy efficiency, support participation in the demand response market, and foster a sustainable and replicable approach to energy renovation. By aligning these innovative adjustments, Trento aims to become a model for other districts and communities.

4.2 Zaragoza

The potential creation of an energy community at the district level is a strong fit for Zaragoza demosite. This model enables efficient energy management, promotes optimized energy generation and consumption, and aligns well with the collaborative approach of the project. The community can collectively manage energy resources, fostering efficient consumption practices. The emphasis on transparent energy data, anonymized open data sharing, and the creation of an open portal for the community aligns also with the principles of P2P energy sharing.

However, the transition to an energy community may require regulatory adjustments to facilitate transparent energy data sharing, anonymized open data sharing, and the creation of an open portal for the community. Effective coordination and management of community managers within the energy community framework will be crucial.
The innovative feature of defining coordination and management of community managers for the energy communities framework enhances the collaborative approach. Another innovative addition to the energy community model is the implementation of blockchain technology for energy transactions. Blockchain can facilitate transparent, secure, and tamper-proof transactions between tenants and nearby buildings. It enables a trustworthy record of energy sharing and financial transactions, enhancing trust among community members.

Given the integration of various energy systems, an IEC model could also be considered with the management potentially assigned to an ESCo. The role of Metro7, Kover, and Abora in installing and potentially managing energy-efficient systems, such as solar panels and hybrid thermal-solar panels, aligns with the IEC model. The ESCO's involvement in savings guarantees and performance monitoring ensures that energy efficiency targets are met and that the community benefits from reduced energy consumption and cost savings. However, the transition to an IEC model might involve complexities in coordinating diverse stakeholders and managing a wide range of energy systems.
To ensure that energy renovation benefits all community members, innovative strategies can be employed to mitigate energy costs for low-income tenants. The IEC model can include specific \guarantees or incentives to help reduce energy expenses for those with limited financial resources. This could involve sliding-scale pricing structures, targeted subsidies, or energy efficiency programs designed to assist low-income households.

The collaboration between the Municipality of Zaragoza, Zaragoza Vivienda, and the owner communities suggests the suitability of a PPP model. This model combines public and private resources, shared responsibilities, and financing support, reflecting the collaborative approach of the project: different partners can contribute to the project's funding, management, and execution, thereby distributing risks and benefits equitably. The transition to a PPP model may require adapting to the unique dynamics of the energy renovation project, including integrating aspects of energy community management.
An innovative aspect of the PPP model can involve flexible financing mechanisms. For example, financing structures can be designed to accommodate the diverse financial capabilities of building owners and residents. This flexibility could include tiered investment options or financing terms that consider the unique circumstances of various stakeholders. To ensure the long-term success and sustainability of the project, performance-based incentives can be introduced within the PPP

model. This means that stakeholders, both public and private, would receive incentives or bonuses for achieving specific energy efficiency targets or sustainability milestones.

While not explicitly mentioned, the project's focus on energy efficiency and community-driven energy management could involve Demand Response strategies. DR programs encourage users to adjust their energy consumption patterns in response to price signals or grid conditions. This can be part of optimizing energy generation and consumption within the community.
Suggestion about blockchain energy transactions between tenants and nearby buildings could enhance the DR model's effectiveness.

In summary, the Zaragoza demosite offers opportunities for innovative adjustments within various business models. These adjustments can enhance energy efficiency, promote transparent energy data sharing, and support a collaborative and sustainable approach to energy renovation within the community. The synergistic combination of suitable business models and innovative features is essential to the overall success of the project.

4.3 Groningen

The extensive renovation activities in the Groningen demosite align closely with the IEC model, which specifies energy savings targets and performance improvements. IEC contracts can guarantee specific energy savings, providing a structured approach for realizing energy efficiency goals in various buildings. The IEC model often involves the Energy Service Company (ESCO) investing in, designing, and implementing energy-efficient solutions. ESCOs share financial risks and returns, which can be attractive for the demosite's comprehensive renovation activities. The IEC model emphasizes performance monitoring, ensuring that energy efficiency targets are met. This aligns well with the need for monitoring and control systems in Groningen.
IEC contracts can be complex and require careful negotiation, which may involve additional legal and administrative efforts. Furthermore, ESCOs usually require an initial capital investment, which may pose challenges in terms of financing the extensive renovations in Groningen.
The IEC model can incorporate performance guarantees, ensuring that energy savings are achieved. To further align with the IEC model, the shared savings achieved through efficient heating practices can be considered an innovative feature. Allocating a portion of these savings to the residents promotes energy conservation and cost reduction. The IEC model in Groningen could introduce custom financing schemes to address the capital investment challenge. Tailoring financial mechanisms specific to the project's needs can provide innovative solutions for funding renovations.

Collaborations between public and private entities in Groningen exemplify a PPP model approach. This model facilitates comprehensive urban development while sharing risks and benefits between the public and private sectors. The involvement of public institutions, such as the Municipality and the Province, suggests the potential for a robust PPP model with essential funding and support. PPP models often include risk-sharing mechanisms, which distribute responsibilities and potential financial burdens between the public and private sectors. This helps mitigate the impact of unforeseen challenges.

Establishing and managing PPPs can involve complex governance structures, necessitating careful management and coordination. PPPs require resource allocation and the negotiation of responsibilities between public and private partners. Securing funds from both the public and private sectors can pose challenges, especially when budget allocations need to be balanced among different elements of the project.

In the context of the Groningen demosite, innovative aspects of the PPP model include the development of custom collaborative financing schemes. These schemes can be tailored to meet the specific budgetary needs of the project, ensuring that both the public and private sectors contribute their resources effectively. Implementing shared data platforms that facilitate transparent financial and operational information exchange can enhance collaboration and streamline financial management.

The combination of an energy community framework and P2P integration can offer efficient energy management for the Groningen demosite. Residents can collectively manage energy resources, fostering efficient consumption practices within the community. The introduction of a digital platform for energy management can facilitate efficient energy sharing. It enables residents to monitor, control, and optimize their energy usage, improving overall sustainability. P2P integration can optimize the use of renewable resources, reducing dependency on traditional grids and enhancing sustainability.

However, implementing an energy community with P2P and shared asset management can be complex. It requires well-coordinated technologies and the participation of all residents. Setting up an effective platform for energy sharing may require initial infrastructure investment. This can be a financial challenge, especially for communities with limited resources.

As an innovative aspect to include in this mode, district heating can be considered as a shared asset within the community, promoting efficient heating practices and cost reduction through the P2P platform. Residents can collectively manage and distribute heat, contributing to sustainability. Furthermore, the integration of blockchain technology for energy transactions ensures transparent and secure exchanges. Residents can track and trade energy seamlessly, enhancing the model's efficiency and trust.

Aspect	Trento	Zaragoza	Groningen
Customer segments	• Public buildings as prosumer aggregators	• Open portal for the community	• Open data sharing portal
Value proposition	• Integrated data management • Demand Response participation • Sharing surplus energy	• Coordination and management of community managers • Blockchain energy transactions	• Performance guarantees, shared savings • Custom financing schemes
Channels	• Demand response participation	• Transparent and secure energy transactions using blockchain technology	• Transparent and secure energy transactions using blockchain technology
Customer Relationships	• None	• Efficient coordination and management of community managers	• None
Revenue Streams	• Revenue from demand response participation	• Revenue from demand response participation	• None
Key Resources	• Data platform • Blockchain transaction infrastructure	• Data platform • Blockchain transaction infrastructure	• District heating used as a shared asset
Key Activities	• None	• None	• None
Key Partners	• ICT partners for innovative data management tools and blockchain technology	• ICT partners for innovative data management tools and blockchain technology	• ICT partners for innovative data management tools and blockchain technology
Cost Structure	• None	• None	• None
Risk and challenges	• None	• None	• None

Table 10 - Business model canvas of innovations in demosites

5 Conclusion

In this comprehensive exploration of three innovative energy renovation demosites—Trento, Zaragoza, and Groningen—we have delved into the intricacies of diverse business models, the strengths and weaknesses of each, and the innovative aspects introduced to align these models with the unique characteristics of their respective projects. The overarching goal of these efforts is to drive sustainability, energy efficiency, and community engagement.

The extensive exploration of innovative business models and incentives within InCUBE has laid the foundation for a comprehensive business plan analysis, which will be developed in D8.2: "New construction/energy business models and inhabitants' centric incentives towards behavioural changes". This upcoming analysis will be defining a detailed business plan considering all the different sources of income and citizen active participation, integrating information gathered in the other WP8 activities.

The lessons and insights derived from T8.2 "Buildings as active nodes of the energy systems" will guide to enhance the efficient management of solar communities and the seamless integration of building-level systems into the wider energy grid. A common framework methodology based on the Emission Trading System (ETS) revenues will be developed in T8.3 “Attracting financing for retrofitting under EU-ETS model”: the aim is to make energy-efficient solutions accessible, especially to lower-income households. The creation of the InCUBE One-Stop-Shop Marketplace in T8.4 opens the doors for third parties to contribute to sustainable solutions. This marketplace will not only offer a platform for the integration of innovative technologies but also serve as a hub for citizen partnership. By providing links for the InCUBE Digital Suite services, it will enable citizens to actively engage in the renovation process and play a pivotal role in optimizing each renovation case. This participatory approach is essential in driving energy-efficient behavioural changes among citizens.

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7 Annex

Example of questionnaire given to the demosite owners for data gathering purposes

INTERVENTION/ INSTALLATION	PROVIDER PARTNER	OWNERSHIP AFTER PROJECT END	OPERATION MANAGEMENT	MAINTENANCE MANAGEMENT	ENERGY COMMUNITIES' FRAMEWORK