D2.4: Report on bankability of the demonstrated innovations

+CityxChange | Work Package 2, Task 2.7

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List of Acronyms

BRP	Balance Responsible Party
DSCR	Debt Service Cover Ratio
DSO	Distribution System Operator
EIAH	European Investment Advisory Hub
EIB	European Investment Bank
ESCO	Energy Service Company
ESG	Environmental Social Governance
FC	Follower City
KPI	Key Performance Indicator
LEM	Local Energy Market
LHC	Lighthouse City
LLCR	Loan Life Cover Ratio
PEB	Positive Energy Block
PED	Positive Energy District
ROI	Return On Investment
SROI	Social Return On Investment
TIF	Tax-increment Financing
TSO	Transmission System Operator
WP	Work Package
NPV	Net Present Value

List of Definitions

Term	Definition/explanation as applied in the project
Bankability	The capacity of a project to attract investment at a given interest rate with a prevailing set of financial conditions and institutions..
CGS	Community Grid System. A "Virtual Grid" that utilises the existing Distribution Grid Infrastructure, to facilitate local Distributed Energy Resources, system balancing, quality management and trading.
CSO Referred to in Ireland as the Energy Community Operator (ECO)	Community System Operator. The operator of the Community Grid that monitors and manages the elements of the community grid, under agreement/license from the regulator and supervision of the DSO. The CSO enables, by Franchise agreement, the formation, and regulation, Franchised Local Energy Communities (FLEC), through, one or more, of the approved, and contracted, Energy Community Utilities (ECUs). The CSO reports directly, and regularly, to the appropriate Energy Regulator (In Ireland the CRU) and through this process it reports monthly (through Appropriate Data Returns), and takes responsibility, and are accountable for the aggregated performance, or non-performance (Errors/Variances) of each, and all , of the Franchised Local Energy Communities (FLEcs), which are operated through the Energy Community Utilities.
Customer	User, buyer of metered electricity energy supplied by licensed retailers through the DSO Operated Consumer Meter Unit which is identified by DSO Allocated Code or Identifier Number (in Ireland MPRN Number).
Prosumer	The Prosumer, in the Local Energy Market, plays the economic role of producer and consumer.
e-mobility platform	A software that support travellers to seamlessly plan their journey across the city based on their time and their convenience and by relying on the best available public, rented, or shared electric vehicles.
Energy product	Flexibility with a time resolution of 1 hour or more which is available in the local PEB market.
Flexibility	Energy, capacity and system services products available for the local market.
Local market	A transparent market for selling and buying flexible resources (energy, capacity and system services) that is available – independent of asset type – within the PEB / CGS*. Connected to wholesale market through one or more DSO connections.
Market Operator	Receive and coordinate bids from power producers, calculate market price and settle contract with customer within the PEB. Operated as an automatic executed algorithm.
Producer	A local energy asset that produce electricity or heat to supply the PEB

Product	A commercial local (within the PEB) traded amount of energy, capacity or faster response in up or down regulation of electricity consumption/production.
Quintuple Helix	Open innovation model, encompassing the five elements, namely: Academia, Industry, Governments, Civil society, Environment.
Retailer	Sell power products to end customers in the global power market
Supplier	Sell power products to end customers in the global power market
System Operator	A control unit with the responsibility to operate the local grid in a way that secure quality and reliability of supply
System service	Electricity services provided as demand/production regulation – up or down - within a period of less than 15 min. A product asked for and purchased by System Operator.
System service product	Flexibility with time resolution less than 5 min which is available as a system service product within the local PEB market.
Trade platform	A software that collects product bids from available flexible resources, calculates market price and sends plan for activation back to accepted PEB bids.

1. Executive Summary

This report details new business and investment models and concepts to create and operate Distributed Positive Energy Blocks (PEBs), with the objective of optimising the bankability of the required investments; it is connected to Task 2.7 "Optimize the bankability of the demonstrated innovations". The content of this report represents the foundation for the further development and implementation of business and investment models, in the Lighthouse cities Limerick (WP4) and Trondheim (WP5) initially and in follower cities afterwards (WP6). The models conceptualised and developed in this work are also the starting point for business-related "Scaling-up, Replication and Exploitation" of the +CityxChange solutions (WP8).
The Deliverable starts with the "classical" description of the Bankability and its translation within the project framework.
Bankability of a (sub-)project is assessed as:

- the project is acceptable to or at a bank;
- the project is guaranteed to bring profit;
- the project future cash flows are acceptable to potential public and private lenders;
- the project assessment shows high probability of being successful after implementation and during its operational life-cycle.

Bankability concepts are then translated in the framework of the PEB establishment and of the operation of Local Energy Markets, assessed from the perspective of different stakeholders involved. Bankability optimisation strategies and procedures are investigated and proposed in terms of:

- investment de-risking, to reduce to a minimum the risk associated with investments required to establish and operate a PEB market;
- stakeholders acceptance and involvement, to maximise acceptance of the proposed solutions and foster ownership of the innovations through engagement and co-design.

The conventional value chain of classic energy markets is reviewed in light of new opportunities, stakeholders, collaborations and technologies, leading to the definition of an innovative value chain for the DPEB implementation and the LEM operation, encompassing Engagement, Implementation, Operation, Delivery and Pricing.
Through support from and interaction with cities and industry partners delivering the innovations, the planned implementation of the proposed business models is investigated and reported. Starting from these exercises, cities-specific investment tasks T4.11 and T5.11 will move towards the optimisation of business practices and consequent optimisation of value creation and capturing. Effectiveness of business model is critical in order to make +CityxChange model profitable and attractive to public and private investors at international, national or local level, as identified in the mapping exercise carried out and reported in detail in the following of the report.

In particular the proposed "integrated investment model", described in section 5 of this report and reported in the following figure, is expected to support +CityxChange in getting access to the necessary funding and financing sources, being them private capital or public funds; customised financing mix and bespoke investment models can be extrapolated from

the integrated model, thus designing sub-models the meet the peculiarities of the different sub-projects as well as national and local scenarios. In each city involved in the project, local and global stakeholders together with new potential players in the local market are expected to share investments and financial risks, in a common effort towards the energy transition to a low-carbon future, considering sustainability aspects and their adaptation to different socio-economic contexts.

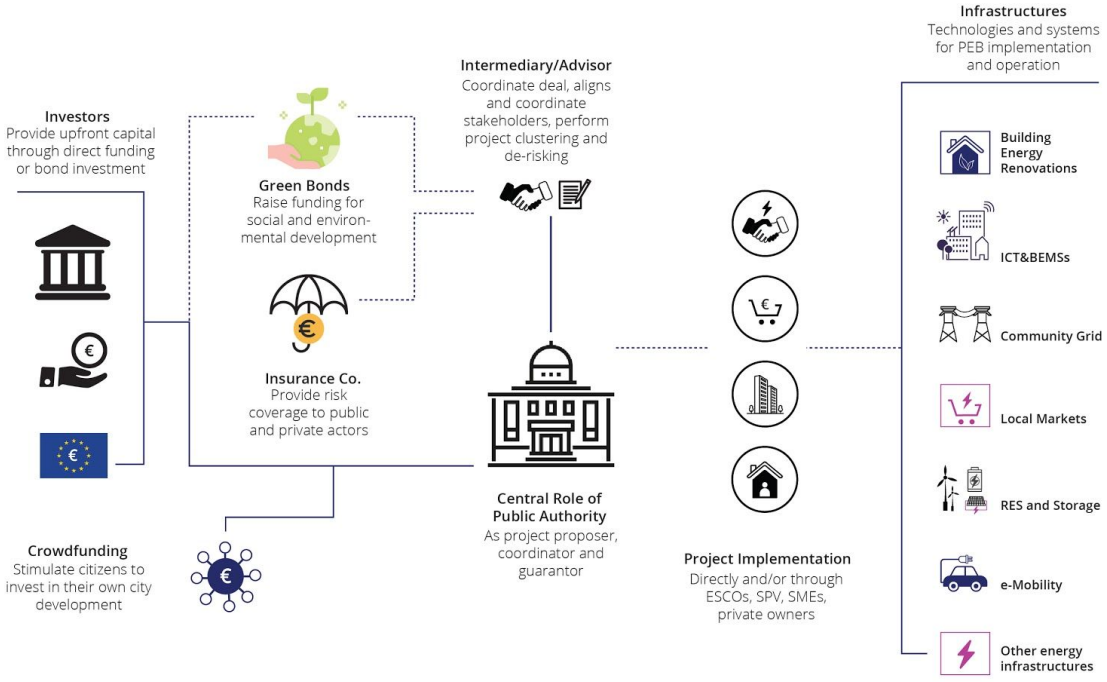

Fig. 1.1: Proposed Integrated investment model.

The model points to support market players in developing and adopting financial solutions to invest in energy infrastructure facilities and services. Public Authorities drive development policies by planning and sharing investments thus increasing social responsibility in all involved stakeholders. The role of the Community is to support and facilitate investments in PEB by the integration of innovative technologies and financial solutions. Main stakeholders that form "the Energy Community" in our integrated business model are:policy makers and public authorities; energy projects executing companies & ESCOs; private investors (real estate companies, banks, insurance institutes); citizens in both individual and associated forms.

The report ends with a Guidelines chapter which identifies seven milestones towards business and investments models implementation, throughout the process of setting up a PEB in lighthouse and follower cities and beyond.

2. Introduction

This report contains proposed business concept and models as well as investment models, developed within Task 2.7 "Bankability of Innovations", that needs to be implemented in order to deliver the Demonstration Projects foreseen by +CityxChange project.
Starting from work carried out in Task 2.1 and Deliverable 2.1 - "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities" - where initial energy-related regulations and markets with initial business concepts have been defined, this task has developed and detailed further business and financial aspects related to the establishment of a number of Positive Energy Blocks (PEBs) or Districts (PEDs).
In D2.1, alongside with the regulatory barriers that need overcoming, enabling technologies and infrastructures required for PEB implementation have been identified.
Establishment of PEBs usually requires high volumes of investments in order to develop, implement, procure, own and operate energy assets and systems that will guarantee the creation of blocks and districts with a positive energy balance; it is clear how the sourcing of such financial resources is critically linked to the successful functioning of implemented business models.
Nowadays, in the conventional energy market, existing business models are not intended to function in local de-centralised contests, being "born and raised within a centralised energy system framework. Therefore in order to meet project's objective of establishing a series of PEBs new concepts and models are required, which involve totally new players working alongside traditional ones and experimenting innovative and fair cooperation models thus generating value in new ways in order to attract investments. Sustainability of PEBs investments depends on the capacity of implemented business models to generate and capture value and from the ability of such models to fairly distribute created value amongst involved stakeholders. Given the de-centralised and inclusive nature of +CityxChange demonstrated innovations, engagement and acceptance plays a critical role in achieving economic and financial objectives; social engagement activities in LHCs and FCs are considered within the work of Task 2.7, with the objective of exploiting such activities in order to contribute to shaping the models and eventually to validating them.
Specific conditions and existing criticalities in each of the involved cities must be investigated and taken into account with the aim of selecting the optimal models to be implemented in each scenario; in this respect Task 2.7 sets the ground and identify the tools that will be utilised in engagement activities throughout the project life. The so called "determinants" identified in this work have to be defined for the cities where DPs will be implemented; assessment of such determinants is intended to define the shape that the local market will take in each PEB/PED, which in turn will influence the applicable investment models.
Guidelines are provided in conclusion of this report, defining an innovative process and indicating roadmaps to be followed for bankability optimisation in LHCs and FCs.

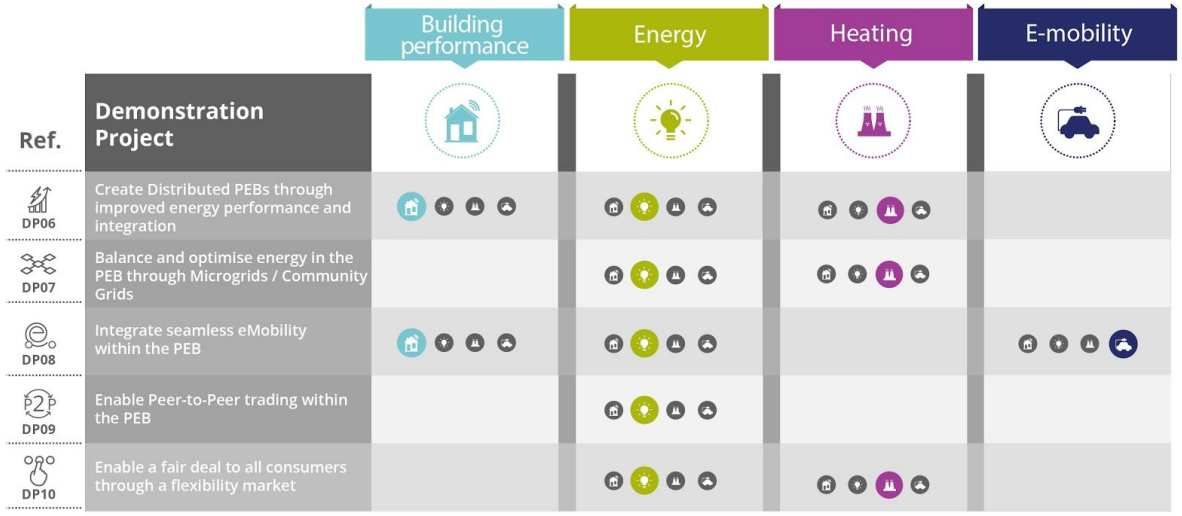

Fig. 2.1: +CityxChange Demonstration Projects concerning PEB implementation and operation of Local Energy Market: Source: +CityxChange, D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities".

The previous figure shows the demonstration projects that will enable the business and investment models for delivery of the innovative consumer-driven decentralised Distributed PEBs through interconnected systems of buildings, Micro/Community Grids and eMaaS.

The integrated investment model proposed in this work, alongside with findings from the mapping exercise of funding and financing sources at European, national and local levels, represents the starting point for delivering the planned innovations in the project Lighthouse and Follower cities and beyond them. The proposed model foresees:

- several public and private financing sources, including fintech solutions like crowdfunding platforms and sustainable finance products such as green bonds, amongst which the customised mix for each sub-project can be selected;
- Technical and financial support institutions, including insurance companies and advisory firms whose role is to contribute to the investment de-risking in terms of, for instance, projects clusterization, projects standardisation, risk covering;
- A central role for the public authority, that is in our case the local municipality, acting as proposer, planner and sponsor of the city transformation action;
- A mix of project executors including, but not limited to, building owners, SMEs, technology providers, ESCOs; for each specific sub-project a different, bespoke mix can be identified;
- A pool of interventions, infrastructures and technologies enabling the establishment and operation of the PEBs, with the potential for scaling up the innovations at district and city level.

To better understand the business and investment scenarios where the demonstrations will be deployed, it is executed an overall mapping of the planned interventions in Norway and Ireland for the Lighthouse Cities. For follower cities in Czech Republic, Estonia, Bulgaria, Romania and Spain interventions are still being planned through feasibility studies;

therefore business and investment models will be selected, amongst the identified ones and suggested for each of the considered interventions once they will be finalised, during replication tasks foreseen in WP6.

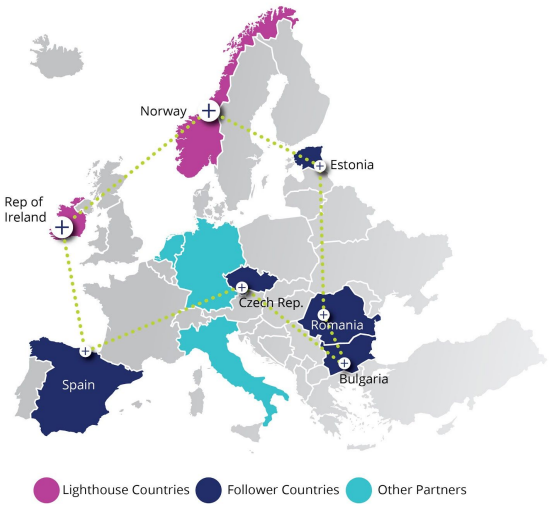

Fig. 2.2: +CityxChange Lighthouse and Follower countries where the demonstrations will be implemented. Ref. www.cityxchange.eu

3. Bankability optimisation

3.1 Definition and Concepts

Today there is no uniform definition for the "bankability" of a project. Commonly, project is considered bankable if investors (citizens, banks, energy communities, companies, energy operators, energy stakeholders) are willing to finance it and project proposers convince third parties to support it: ultimately, the objective is to attract investors.
In the scope of this work we define a project as "bankable" if:

- the project is acceptable to or at a bank;
- the project is guaranteed to bring profit;
- the project future cash flows are acceptable to potential public and private lenders;
- the project assessment shows high probability of being successful after implementation and during its operational life-cycle.

The term "bankability" became of common use in the financial sector in 2008 when the default of some financial institutions made the credit market to shrink consistently. From a pure financial perspective the bankability of a project is measured through a set of indicators, such as the Debt Service Cover Ratio (DSCR) and the Loan Life Cover Ratio (LLCR). It is also contingent on the set of available financial and legal institutions where the loan is ,or is not, to be raised. Thus a project that is bankable in China may or may not be bankable in the EU. These institutional differences matter for the definition of bankability at a high level. However, common key elements to make energy projects bankable and attractive are the assessment and estimation of risks throughout the life cycle of the project.

The DSCR is the instrument that measures the capacity of a company to assess and use the operating incomes to pay back its debt obligations and its related interests (short and long-terms debts)[1]. It is a popular benchmark used in the measurement of an entity's ability to produce enough cash to cover its debt payments. On the other end the LLCR is a financial ratio used to estimate the solvency of a firm, or the ability of the borrowing company to repay an outstanding loan. LLCR is calculated by dividing the net present value (NPV) of the money available for debt repayment by the amount of outstanding debt[2]. The aforementioned indicators can only be calculated once all the investments triggered by the specific project under assessment are known in terms of costs and estimated benefits; moreover the financing sources and the cost of financing must be available in order to calculate DSCR and LLCR. Indicators only tell us how bankable a specific project is, meaning that they are a measure of the capacity of the project to generate enough value to pay for the financing services received for its implementation.
How such bankability can be optimised for complex projects like smart city ones, involving several different technologies and a wide range of stakeholders, in order to facilitate raising funds for the project development and implementation is a totally different matter: it

[1] https://corporatefinanceinstitute.com/resources/knowledge/finance/debt-service-coverage-ratio/
[2] https://www.investopedia.com/terms/l/llcr.asp

concerns innovation in business modelling, stakeholders' identification and involvement including citizens and the wider civil society since the early stage of the initiative, scouting and implementation of innovative financing models sustained through non-conventional KPIs capable to capture and account for non monetary benefits such as social development.

In order to do so, a workshop on bankability of the demonstrated innovation was organised and conducted by OV, in conjunction with R2M for the replication aspects (WP6) during the first consortium meeting of +CityxChange project, in Trondheim on the 9th of November 2018. Discussions during the workshop started from the definition of some concepts[3], proposed to participants by OV, around the wider bankability issue; they are summarised below.

1. The "Long Term Generating" concept: the LTG could be considered as a key enabler concept triggering, around a wide smart city framework, investment projects. According to our experience, 15-to-25 ys is the right lapse able to generate benefits for both financing investors and social welfare.
2. Innovation in KPIs: innovation KPIs is a direct consequence of the Bold City Vision role of the Main Urban Authority and its investment projects.
   According to business literature and forthcoming trends, normal KPIs such as ROI etc, are not well performing the right impact of the Projects. We need to introduce alternative ones, such as SROI, DSCR, etc.
3. Ecosystem Vision: successful case studies underlines the establishment of a well-functioning Ecosystem architecture as a key issue for a real-life city bankable investment plan. Literature is currently focused on the Quintuple Helix engagement, covering all local society involvement.
4. Umbrella concept: our ecosystem is under the Main Public Authority umbrella. They should generate and guarantee the local value chain identification/creation.
   Deploy actions according to EIB Capital requirement especially under the EIAH umbrella, namely the URBIS (new urban investment advisory).
5. Innovation in City enablers' engagement: an emerging case study in the US is the creation of a local Venture Smart Group. A platform built for co-design the local smart city vision, sharing data and information. The objective is to establish a co-thinktank approach involving policy decision making, citizens, technology providers, financial institutions in order to adopt smart city local medium/long term vision (2030, 2050, etc.).
6. Funding and Financing: F&F instruments are the vehicle used to pay for and generate revenue to service costs related to traditional infrastructure development and transitions.
7. Role of Private Equity: according to the latest financial literature "Private Equity is the new black". The biggest firms might become the new banks. They are not linked with deposit and short-term funding, but they raise money from long term investors such as insurance companies or pension funds. Over the last 10 years private credit is the most performing, vice versa Real Estate and Venture Capital are the worst.
8. BM&F customization and packaging process: smart city renovation process in

[3] The same concepts have also been presented at the final conference of the EU-Gugle project, on the 10th of December 2018, about one month after the +CityxChange kick-off meeting, where OV had been invited as an external speaker on the topic of smart city investments. http://eu-gugle.eu/wp-content/uploads/2019/01/05-a-giordano-a-cassisi.pdf

business model will encompass the creation of new types of jobs and a green local value chain, as a baseline milestone of a valuable and bankable platform for innovation. Disruptive business model will be not only on canvas but bankable, having evaluated since the co-design phase the gap analysis, underpinning all the constraints and all the bottlenecks (regulatory, financial, technological and social). The feature is scalable and replicable ready-to-market business model, crossing investors' sentiment, duly highlighting the de-risking of the implemented technologies.

Workshop outcomes relevant to the work carried out in Task 2.7 are summarised below[4]:

- as part of the project output it should be cleared how the results will impact people and what are the cost implications for the implementation;
- financial aspects and implications are key and must be carefully considered;
- the project will have an impact on politicians, owners and occupiers but the general public should be informed as well;
- each stakeholder (politicians, owners, etc.) should be targeted in a different way to highlight how they can benefit from +CityxChange and respond to their needs;
- funds not available
- is the solution affordable and does it have an impact on the single only or on the community?
- top-down design of solutions;
- lack of buy-in, not clear message of the impact to the single/community "what does it bring to me?"
- increasing number of people renting: will tenants be willing to invest? Will building owners invest in a building they don't live in?

The aforementioned concepts are applied throughout the activities carried out in Task 2.7, both in isolation and in conjunction with one another with the additional objective of providing solutions to the issues rosen during the kick-off workshop This is better explained in the following of this report and in particular in the methodology section.

3.2 Methodology

Innovation is key to +CityxChange project and, given the complexity of the actions, there is no standard methodology that can be applied in order to define business related aspects for the demonstration projects being implemented.
A "project-defined, hybrid" methodology is applied, made up of elements borrowed from existing and well established standard methodologies widely used in the business and finance fields, such as the *Value Network Analysis* and the *Solution Space Approach*.
A 4-step methodology is applied:

1. Review of existing value chain and business models in the conventional energy market, in order to define the baseline scenario within which the innovative, consumer-driven local energy market will be developed and implemented.
2. Innovation in business modelling, which includes:

[4] Bankability of demonstrated innovation and replication - 8th November 2018; workshop minutes available on +CityxChange Google Drive.

   a. Definition of stakeholders, players, revenue models in a PEB scenario by applying the "Value Network Analysis" approach. This enables identification of the involved actors and the role they play in the proposed business scenario; it also helps identifying for each of them the intended business strategy, including the value proposition, the revenue structure and the collaboration model with other actors involved.
   b. A Solution Space to define the level of services provided and the infrastructure ownership model for the local market within a PEB. As such market implementation requires high investment volumes in technology and infrastructure it needs to be defined who owns and operate such infrastructures and the related level of offered services, which in turn influence the revenue volumes.
3. Sustainable Investment Modelling: once the infrastructure ownership model is defined and enabling technologies are identified and costed, options for financing the implementation of the PEB are investigated, considering different stakeholders perspectives. This is then applied to specific LHCs scenarios in order to carry out an initial selection of the potential investment models. In dedicated tasks T4.11 (+Limerick) and T5.11 (+Trondheim) such investment models are being developed further and will be tested through local stakeholders involvement.
4. Bankability Optimisation Strategy
   In order to enhance the attractiveness of +CityxChange projects for investors, two critical aspects have driven the development of activities during this task: Investment de-risking and stakeholders acceptance and involvement.
   This has to be done in two ways: implicitly, during the identification and development of business and investment models and explicitly when it comes to implementation of such models into real-world projects.
   As every investment carries risks, and those are even higher in innovative and R&D projects, it is required that the project proposer identify, mitigate and reduce such risks since the early stage of the process, ideally also through involvement of financial stakeholders in the project conceptualisation and design phases. The public authority can play a crucial role in this process, not only as one of the proposers but also due to its potential role of "guarantor" as is detailed in the following of this report.
   Even stakeholders acceptance and involvement can be seen as a form of risk mitigation: involving social actors including citizens, in the project conceptualisation and development, from business perspectives as well, reduces the risk that such actors will not play the expected roles once the project reaches operation phase. Though, social acceptance and involvement goes beyond that, as the overall success of urban transformation projects like +CityxChange is in the citizens' hands: the designed models will function only if citizens take an active part in their operation, for example the local energy market can be profitable only if local residents decide to buy locally generated energy, eMaaS relies on users

decisions to use the e-mobility service provided, energy efficiency requires owners to accept to take part in investments for the energy renovation of their buildings as well as to commit to the necessary behavioural changes that the implementation of energy efficiency measures require. Having social actors involved in the process early on is critical to foster their acceptance and active involvement, this can be utilised as an added value and an assurance for third party investors about the positive outcome of the implemented actions they are asked to fund.

Bankability is then strictly related to risk-management, and for energy efficiency and renewables projects/investments, main banking risks are related to:

Government support:

1. Is the Country risk acceptable? (For example, in developing countries, before providing energy investments it should be prevented any possible political risk such as sovereign default).
2. Does the regulatory framework support or encourage energy investments making them bankable?
3. Are any subsidies or tax expenditures, such as carbon credits, available?

The market & the economic factors:

1. Electricity scarcity or oversupply;
2. Base load costs. (In buildings, base load refers to energy consumption of electricity, gas and water that is not correlated to productive activity);
3. Specific sources (such as hydroelectric or geothermal power) available that make other RES less-bankable;
4. How do specific energy projects compared to other projects of comparable scale.

Other economic factors & applied technologies:

1. Which technologies are applied, and when;
2. Costs per MW (Installation, running and maintenance costs);
3. Any Carbon credits and tax expenditure/subsidies available;
4. Financing options available.

Contracts & agreements:

1. What type of contract/s with third parties are put in place. To provide and finance energy services and interventions, a very common typology of contract in the EU is the Energy Performance contracting (EPC). This contract foresees that a "supplier" (generally an Energy Saving Company, or ESCO) with its own sources or by involving third parties finances integrated services and interventions for the requalification and improvement of an energy system (a plant or a building) owned by another subject (beneficiary), towards a fee correlated to the extent of energy savings[5]. The ESCO designs and develops energy conservation measures and saved costs are used to repay the ESCO for its capital investment. ESCOs also make use of the so-called "chauffage" contract, where the ESCO is responsible for the provision of specific energy services such as ambient heating and cooling,

[5] https://e3p.jrc.ec.europa.eu/articles/energy-performance-contracting

lighting and mechanical power; with this contractual arrangement the client outsources the energy management service rather than the energy supply to provide those services.

Insurance package:

1. Existing product warranties. For example solar panels have performance and equipment guarantee for 25-years (performance guarantee) ensuring, for example, that the panel peak power will remain above the 80% of its rated value for 25 years;
2. Any risk coverage available for equipment;
3. Mortgage possibility on land or other assets.

Third party (sponsor) support:

1. Reliable and experienced sponsor such as policy makers;
2. Private equity investment.

4. Development of business models and concepts

4.1 Conventional value chain model

Electricity does not exist in a usable form in nature, therefore it must be produced through the transformation of primary sources and subsequently injected into the transport network. Electricity is therefore defined as a "secondary" energy source that is released from other sources and then converted.
Before reaching the end users electricity goes through different steps, typically broken down into generation, transmission, distribution and supply, the traditional electricity value chain[6].

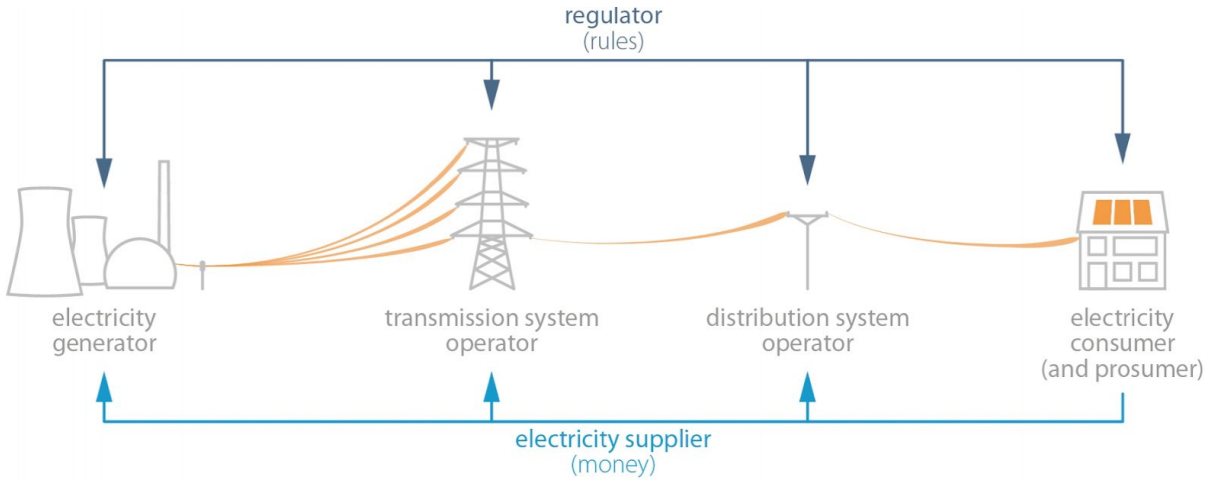

Fig 4.1: Conventional energy market value chain, as defined in D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities". Based on (Erbach, 2016)

Figure 4.1 illustrates the energy market value chain that can be divided into 5 steps[7]:

1. Primary energy is converted into secondary energy in the power plant;
2. High-voltage transmission lines move electricity over large distances from power plants to high-voltage end users and distribution substations;
3. Substations are the link between the transmission system and the distribution system where the voltage is reduced;
4. Transformers reduce further the voltage to levels usable by appliances and machines operated by end users connected to the distribution network;
5. Local distribution wires move low-voltage power to end use locations.

Generation is the first phase of the electricity supply chain and can have different sizes, from small plants with a generation capacity from around 1kW to large plants that can reach several gigawatts capacity[8]. The most common sources of primary energy are[9]:

- Chemical energy - released by burning fossil fuels (coal, oil, natural gas, biomass);

[6] http://www-935.ibm.com/services/us/gbs/bus/html/ibv-electric-utility-innovation.html
[7] https://www.e-education.psu.edu/ebf200/node/151
[8] http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593519/EPRS_BRI(2016)593519_EN.pdf
[9] https://www.e-education.psu.edu/ebf200/node/151

- Nuclear energy - released by nuclear decay of radioactive elements (uranium, plutonium);
- Potential energy - released by forces of gravity pulling something towards earth, generally water;
- Kinetic energy - released by moving particles;
- Solar energy - released by energy radiated from the sun.

Generators are divided into firm-capacity generators that can be switched on and off on demand and variable-capacity generators which can only generate certain amounts at certain times because they are dependent on external factors (e.g. wind and sunshine). Generators can also be classified based on their flexibility: some types of generators produce a stable amount of electricity over a period of time (e.g. nuclear) while others can change production rapidly to meet the variability of the demand side (e.g. hydro-power). Once the electricity is produced, transmission and distribution (second and third steps) have a role to carry electricity from the generation site to the end users whilst managing the functioning, stability, security and reliability of the system[10]. Transmission System Operators (TSOs) are responsible for transmission including the energy grid infrastructure, ensuring the safety and reliability of the transmission system and ensuring the offer/demand balance. As electricity storage is not widely available, the energy produced must correspond to the energy consumed, achieving a balance between demand and supply at all times[11]. In 2016, the European Parliament Research Service the European calculated that the transmission grid in Europe contains more than 300,000 km of power lines with over 355 cross-border lines[12].
Cross border connections enhance european grid resilience and also enable a pan-european energy market; it is considered a strategic goal for the EU[13] and therefore several development projects of common interest are ongoing. Cross-border transmission mainly use high-voltage three-phase alternating current, even though high-voltage direct current connections (HVDC) are becoming more common due to their greater efficiency in very long distances[14].
During transmission, electricity is moved through a national network at high or ultra-high voltage to deliver it to distribution networks. Distribution involves the transfer of high-voltage electricity to the end user through localised distribution network (overhead lines, underground cables and substations) upon reduction of the voltage. The network infrastructure is composed of primary substations (from high voltage to medium voltage), secondary substations (from medium voltage to low voltage) both containing appropriate transformers. The Distribution System Operator (DSO) is responsible for carrying electricity from the TSOs to the consumers[15].

[10]https://eng.gruppohera.it/group/business_activities/business_energy/electricity/electricity_supply_chain/
[11]https://eng.gruppohera.it/group/business_activities/business_energy/electricity/electricity_supply_chain/
[12]http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593519/EPRS_BRI(2016)593519_EN.pdf
[13] "REGULATION (EC) No 714/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL"
[14] Guidance on Energy Transmission Infrastructure and EU nature legislation, European Commission, 2018
[15] Supply Chains, Markets and Power: Managing Buyer and Supplier Power Regimes By Andrew Cox, Paul Ireland, Chris Lonsdale, Joe Sanderson, Glyn Watson

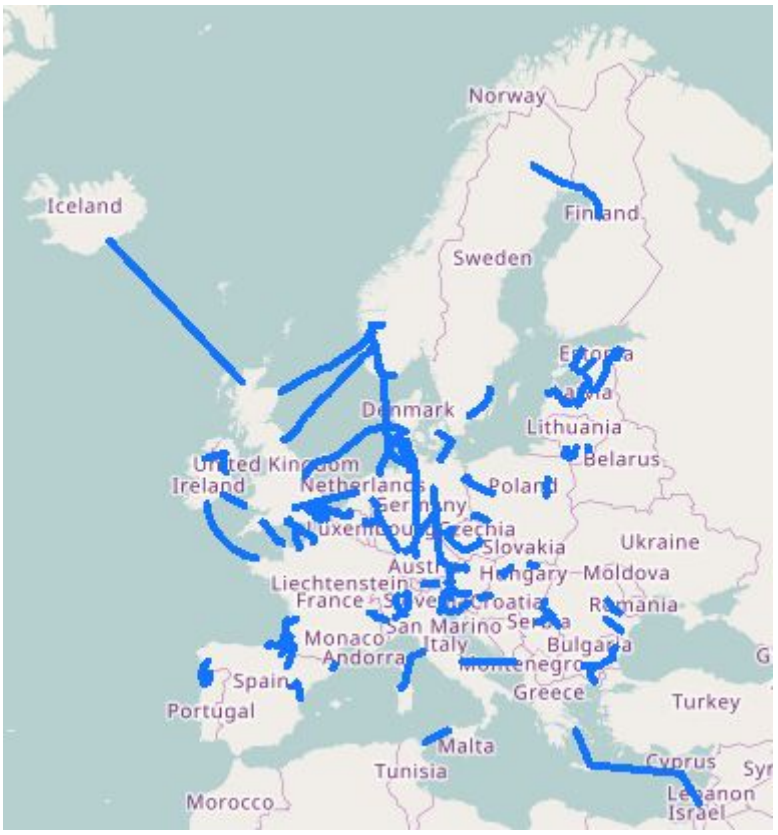

Fig. 4.2 : Map showing main cross-border power connections in Europe, considered "projects of common interest" by the EC.
Source: https://ec.europa.eu/energy/infrastructure/transparency_platform/map-viewer/main.html

The final functional stage of the electricity supply chain is sales, where the suppliers and the end user enters a contract for volume and price for the electricity supplied. The retailing companies responsible for sales purchase power from the generators and retail the power through medium and low voltage distribution managed by the system operators[16]. The final users are charged by the suppliers for the electrical energy utilised, together with costs for energy transmission, distribution, taxes and levies[17].
As presented in the Report on Enabling Regulatory Mechanism to Trial Innovation in Cities (D2.1) the following table presents a summary of the energy market players in Norway and Ireland. Additional details can be found in the mentioned report.

[16] LEONARDO MEEUS, KONRAD PURCHALA, RONNIE BELMANS, Development of the Internal Electricity Market in Europe, The Electricity Journal Volume 18, Issue 6, July 2005, p. 28
[17]http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/593519/EPRS_BRI(2016)593519_EN.pdf

	Trondheim - Norway	Limerick - Ireland
TSO	In Norway there is one state owned TSO called Statnett	In Ireland the in one TSO called EirGrid
DSO	There are 130 distribution grid companies in Norway	ESB Network is the only DSO in Ireland
Supplier	There are several suppliers operating in the Norwegian market, with a wide selection of contracts and moderate switching activity.	There are several suppliers operating in the Irish market. Any person may carry out the retail supply of electricity in Ireland once they have obtained a license from the Commission For Regulation of Utilities (CRU) and agrees to operate within the Single Electricity Market.

Table 4.1: Energy Market Players in the Lighthouse Cities. Source: +CityxChange, D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities".

Retailers stipulate with the generators mid-term bilateral contracts to secure the provision of electricity, fulfill the forecasted base-load demand and prevent price changes due to the fluctuations of the electricity price in the wholesale market. The mid-term bilateral contracted are then integrated with short-term variation based on the transactions that take place in the day-ahead market and in the intraday market[18]. The variation reflects the deviation of the net demand respect to the volumes forecaster in the mid-term contracts. In the traditional electricity supply chain energy flows unidirectionally, from generator to users, and the demand follows cyclical patterns, allowing an almost accurate forecast based on daily, weekly and seasonal demand which is reflected in small adjustment from the day-ahead market[19].
With the growing diffusion of renewable energy sources and distributed generation the classical paradigm is changing, making the demand side more variable and unpredictable. This leads the generators to constantly update the volume of energy offered to the market whilst the retailers need to continuously adjust their purchasing volumes, impacting the day-ahead market variations.

Electricity is provided through a complex network of generators, transmission and distribution, all working with different loads. Traditionally the European electricity sector was dominated by utilities, vertically integrated monopolies, state or privately-owned, responsible for the entirety of the supply chain, from generation to supply[20]. From the traditional structure the market was gradually opened to competition during the 1990s with the aim to accomplish competitive price and establish a unified market with over 500

[18] LEONARDO MEEUS, KONRAD PURCHALA, RONNIE BELMANS, Development of the Internal Electricity Market in Europe, The Electricity Journal Volume 18, Issue 6, July 2005
[19] TERNA RETE ITALIA, Previsione della Domanda Elettrica in Italia e del Fabbisogno di Potenza necessario, 12 November 2013, pp.75
[20] Distribution System Operators observatory 2018 Overview of the electricity distribution system in Europe JRC Science for Policy Report

million users[21]. From an economic perspective it is more convenient to serve a geographical area through a single network and have a single system operator managing the network. This aspect, together with the existing market high barriers to entry and restrictions, made transmission and distribution natural monopoly[22] whilst the market for generation and supply opened for competitiveness. The Directive 2009/72/EC introduced unbundling requirements, requiring Member States to ensure separation of vertically integrated energy companies, opening generation and retail to liberalisation as competitive activities.

Within the electricity market the financial flow moves in the opposite direction of the energy flow [23]:

- users use electricity and pay suppliers via their bills;
- suppliers buy electricity from generators and sell it to users;
- DSOs are paid for delivering electricity to consumers;
- TSOs are paid for the long-distance transport of electricity and for ensuring system stability;
- generators are paid for the energy they produce;
- profitability of the integrated utilities was simply based on the return on invested capital, with different value based on the different steps.

	Supply	*Distribution*	*Transmission*	*Generation*	*Primary fuel*
Typical gross profit margin (ROCE) (%)	1–2	6–8	6–8	18–22	4–6
Typical revenue distribution for 1 MW+ user (%)	6	16	1	47	30
Typical revenue distribution for 100 kW+ user (%)	4	23	5	38	30

Fig. 4.3: Percentage distribution of energy tariffs between operators. Source:Distribution System Operators observatory 2018

As shown in Figure 4.3 the majority of the price paid by the final user goes to the generator with a small profit margin for distribution and transmission and even less for the suppliers. The traditional electricity value model is therefore simple: reliable and universal power is provided to users through a network and different actors (DSO, TSO, supplier) at reasonable rates for which they pay a monthly fee. Subsidised provision is also a feature of the system for low-income households.
By moving towards a local power market, as presented in the "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities", the value chain evolves by reducing the number of roles involved and transforming the role of user in producer and customer at

[21]https://www.politico.eu/sponsored-content/the-eus-electricity-market-the-good-the-bad-and-the-ugly/
[22] INTERNATIONAL ENERGY AGENCY, Secure and Efficient Electricity Supply During the Transition to Low Carbon Power Systems, Paris, 2013
[23] Understanding electricity markets in the EU - Briefing 2016

the same time. This creates a more dynamic market and different parameters for the business model, including new key resources (e.g. local market infrastructure), new value proposition, new relationships and new revenue stream that will be defined as part of WP8 "Scaling Up, Replication and Exploitation" for each +CityxChange solution.

4.2 Innovative value chain model for Local Energy Market

4.2.1 Definition of roles, stakeholders and strategies

In D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities" a simplified value chain model for a LEM is proposed; this is obtained by reducing the 6 roles, identified in conventional energy markets, down to 4 as represented in the diagram below.

It represents the starting point for the work carried out in the task linked to this report: T2.7 "Optimize the bankability of the demonstrated innovations".

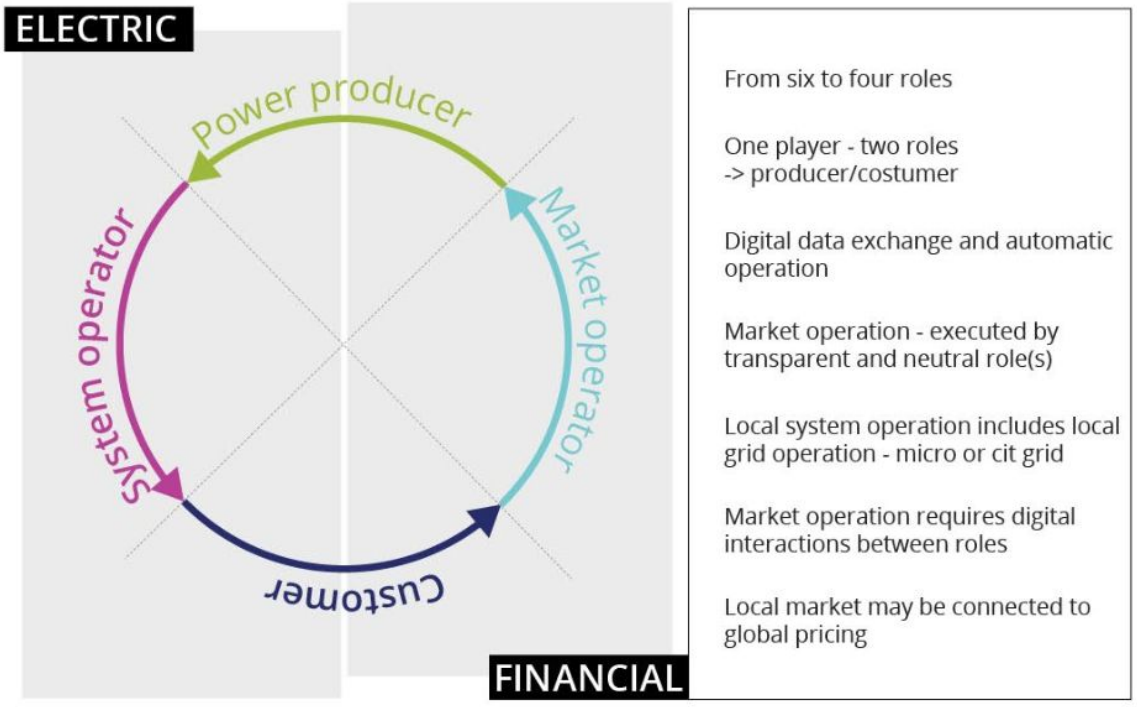

Fig 4.4: The four basic roles within a local power market as operated together with the PEB/PED. Source +CityxChange, D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities".

The above diagram represents the operation of an established local market, though several preliminary activities are required in order to set up the PEB, where the local energy market can be implemented and grow.
In order to define business models for the implementation of a local, consumer-driven, energy services market, we can start from the identification of the innovative value chain that in such scenario exists, given the classic definition of a value chain : "the value chain of

a business is defined as the number of activities to be performed to generate the value proposition offered to the customer". *(Porter, 1985).*

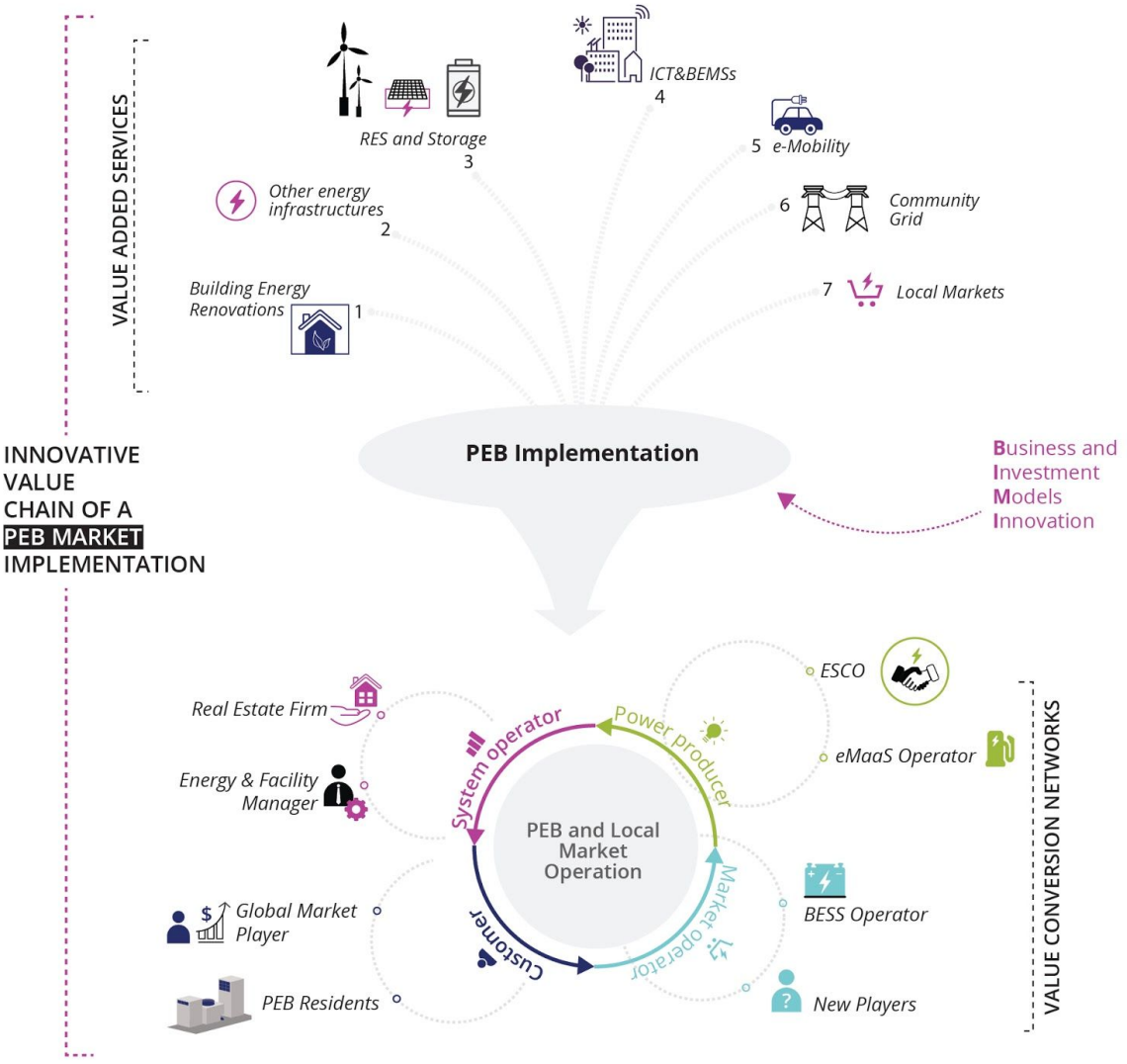

Fig. 4.5: PEB implementation and Operation through Business and Investment Models Innovation

Doing business in a PEB market, including the implementation of all the measures to reach the positive energy balance block or district, means providing energy services with the objectives of guaranteeing the locally-generated energy necessary to meet the local demand. This needs to be done through improvement of energy performance of involved buildings and processes (that is reducing the energy demand), local generation and storage of renewable energy (that is, local production of renewable energy), active management of energy operations by means of automation and ICT technologies, optimised management of internal flexibility, participation in the local energy market. Value-added services can be offered within the PEB/PED that goes beyond the energy services supply, including e-mobility.

At this aim, it is possible to refer to the value chain of a PEB market implementation and operation as it has been identified in previous studies (Facchinetti and Sulzer, 2016); using this as a starting point an innovative value chain is proposed, encompassing all foreseen activities within a PEB synthesised in the five steps describe hereafter.

1. The Engagement: this first activity concerns the set-up of the necessary social and commercial relationships with potential customers and business partners within the block/district. Customers are local consumers and prosumers as well as global market players that can benefit from accessing the local market in order to trade products and services therein (for example DSO trading grid balancing services, power suppliers trading energy for imbalances reduction purposes).
   Business partners are companies that can provide the necessary technologies and infrastructures required to implement and operate the PEB/PED, but also innovation firms seeking to develop and trial new business ideas within a local energy market framework as well as private and public financing institutions that can provide the necessary capital in order to implement the innovations.

2. The Implementation: this activity refers to the procurement of existing and new infrastructure that will enable the delivery of products and services within the PEB/PED. They include, but are not limited to, energy generation plants, energy conversion and grid stability technologies, storage facilities, monitoring and control systems and management of ancillary systems, e-Mobility infrastructure, ICT platforms.

3. The Operation: in this activities technical and economic actors deal with the continuous and constant operation, control and maintenance of the infrastructures utilised. Included in the operation are also the local grid balancing and the assurance of disturbance neutrality toward the external electricity network (and thermal network where this is included within the PEB and the local market).

4. The Delivery: this activity concerns the provision of locally generated products and services to customers, either within and outside the PEB/PED. Products and services include energy, flexibility and grid services traded on the local market but also additional energy efficiency services for residential and commercial customers (such as EPC contracts delivered by ESCOs and energy management services through automatic control systems), e-Mobility services, energy metering.

5. The Pricing: activity that deals with the definition of prices on the local energy and flexibility market which occur via dedicated market platforms. Furthermore additional administrative tasks included in the pricing activity concern communication amongst players, the contracting and billing for the traded goods and services that happen through the IOTA distributed ledger technology (blockchain and smart contracts), as well as the required accounting of cash flows.

The innovative value chain is underpinned by a network of actors and stakeholders performing tasks, where value is created and captured. To such a network the methodology known as "value network analysis" (Allee, 2008) is applied in order to break it down to individual interactions between stakeholders and thus to identify actors, roles and players and the related business models.

Organisations can be seen as purposeful networks, where roles and value interactions exist with the objective of achieving specific tasks or outcomes. Within the network different agents, that are real people, participate by playing particulars roles and fulfilling different functions; whilst doing so they realise the conversion of assets, being them tangible or intangible, creating offerings that are negotiated on a marketplace[24].

In this way, those networks convert values, that is they are value networks: networks of interdependent relationships, where players interact in order to pursue their economic and/or social good.
Networks can be established amongst the elements of an organisation, such as those between company departments, or between internal and external elements, like the ones between the organisation purchase department and suppliers of goods and services.

> "The network is a value conversion mechanism that achieves not only positive goods and outcomes, but nefarious and negatives ones as well, according to the values and intent of those who serve the network. Still, as long as the principles of a healthy value network are followed, the network will be sustained and fulfill its purpose" *(Allee, 2008: 3)*.

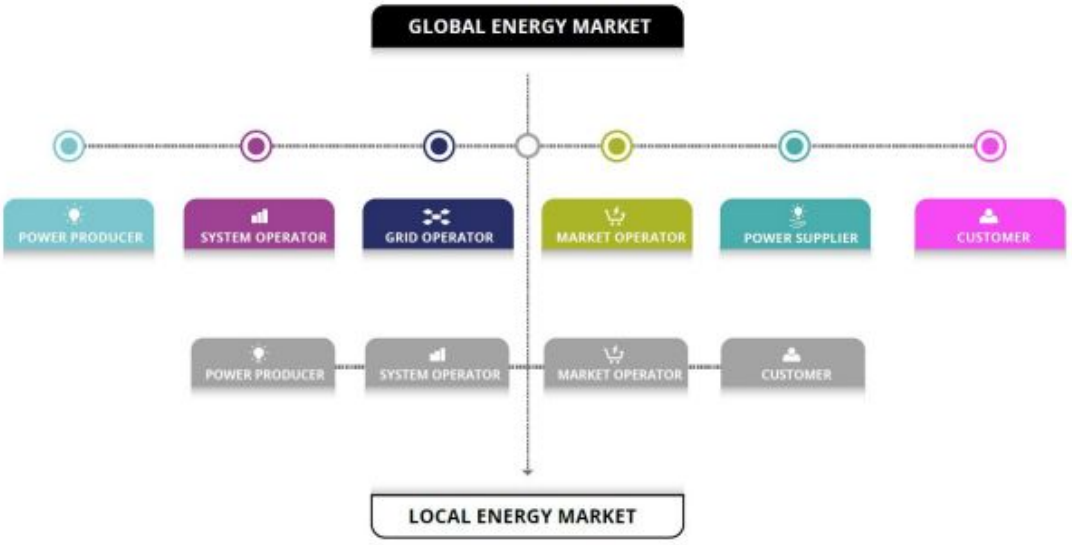

Fig. 4.6: Diagram of roles and interactions in Global and Local energy markets, as defined in deliverable D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities".

[24] Verna Allee, Value Network Analysis and value conversion of tangible and intangible assets. Journal of Intellectual Capital Volume 9, No. 1, pp. 5-24, 2008

Within the framework of Value Network Analysis, the definition of roles and stakeholders belong to the "Ecosystem Level Analysis" stage.
Starting from this assumption, through a literature review and analysis of existing demonstration projects - Brooklyn microgrid[25], Cornwall local market project[26] - potential actors taking place in the LEM dynamics have been identified, as reported in the following table. This is not intended as an exhaustive list, as new business opportunities as well as cooperation models, keep flourishing as long as the LEM operates, expands and attracts more players.

Potential Players taking on the 4 roles in the Local Market			
Customer	Producer	System Operator	Market Operator
Consumer/Prosumer	Consumer	DSO	Energy Cooperative
DSO	Energy Cooperative	CSO	Dedicated company
Energy Supplier	Real Estate firm	Dedicated company	New Player
BRP	New player	Energy cooperative	
Aggregator	e-MaaS provider		
EMaaS provider	BESS company		
BESS company	Aggregator		
Prosumer	Prosumer		

Table 4.2: Local Energy Market Players and Roles.

The table above triggers some considerations:

1. Customer, in the LEM is every economic actor that access the marketplace with the intent of purchasing goods and/or services traded therein; this includes residents and businesses that act as mere energy consumers, as well as players of the Global energy markets such the DSO that can exploit the LEM in order to purchase flexibility services needed to operate the local portion of the Low Voltage Grid.
2. Producer is defined as every economic actor that offers products and services in the local marketplace, including energy producers such as prosumers with excess renewable generation but also service providers such as a battery storage business that can offer balancing services - by offering such service they "produce" a good and sell it on the LEM.
3. PEB residents, both domestic and commercial, can access the market individually or even in associated forms such as "energy cooperative". When in associated form, residents can take advantage of an increased negotiation power and also take over the roles of CSO and Market operator, by owning the related infrastructure or leasing them off respective owners.
4. New players are considered here, even though they're not better specified, in order to take into account future expansions of the business platform and consequent generation of additional business opportunities that cannot be foreseen or clearly

[25] https://www.brooklyn.energy/
[26] https://www.centrica.com/innovation/cornwall-local-energy-market

defined at this point in time - potential new players include Telco, financing institutions, public institutions, etc.

5. Examples of potential new players entering the PEB market business could be BESS operators, renting out their asset to store locally generated energy for later usage by the producer/prosumer in a sort of Hardware-as-a-Service arrangement, or Big Data Company that could build services using the smart city data and reward other layers with an access fee. It is difficult to foresee at this stage all potential new entrants in the local market, communication and engagement activities are paramount in order to attract such players and foster their participation in the emerging marketplace.
6. Meter Operators, responsible for installation and operation of energy metering assets, including the data retrieval, data aggregation and validation as well as provision of metering data to all parties entitled (suppliers, grid operators, customers). Such players exist as third parties in markets where the metering services are deregulated (i.e the UK), otherwise these functions are fulfilled by regulated network operators.
7. Aggregators are considered here as potentially playing the roles of customer (they buy something on the local market, that is the granular flexibility embedded in assets from PEB residents) and producers (they sell something on the local market, i.e. the aggregated flexibility to BRPs). Though the role of aggregators can be redundant in the local market as it is being designed and implemented by +CityxChange project: as it has been discussed during a dedicated workshop in Trondheim in May 2019 with partners Powell, NTNU and Trondheim Kommune in fact, the local market platform will have the ability to provide "implicit" aggregation, thus removing the need for an economic entity providing the aggregation services. The underlying mechanism will be made clearer once the development of the energy and flexibility markets will reach a higher maturity stage, and these aspects will be further investigated in implementation tasks T4.11 and T5.11 for lighthouse cities initially and then in replication tasks for FCs.

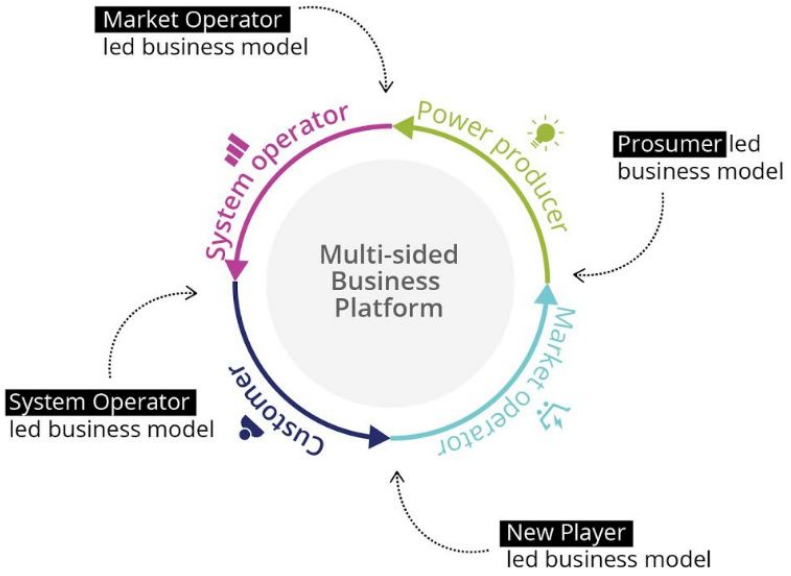

Fig. 4.7: Multi-sided business platform creating the framework for development of innovative business models within the PEB. Source: +CityxChange, D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities".

Business strategies and cooperation models are addressed in the subsequent "Business Model Level Analysis" stage. The analysis starts with the definition of specific objectives and strategies for each stakeholder to meet them - that is defining a high level business strategy. Each business strategy is then investigated further in order to get to the point where for each stakeholder a "mini-business model" is defined; that is the business seen from one side of the multi-sided business platform that has been proposed for the local market in the deliverable D2.1"Enabling Regulatory Mechanism to Trial Innovation in Cities". The table below reports the first part of the analysis, including a comparison between the role that each player assumes in the classic energy market (if any) and in the local innovative market being developed within +CityxChange project. It has been developed in collaboration with partners involved in the development of the local market platforms as well as with LHCs representatives that will firstly trial the innovation, through dedicated meetings and workshops and also continuous exchange during the task activities.

Player	Role in classic energy market	Role(s) in Local Energy Market	Objectives	Business Strategy in LEM
Consumer	Customer - Purchase energy from a power supplier through distribution (transmission) network. Pays a tariff to the supplier that includes energy, DUoS and taxes.	Customer - Can purchase locally generated energy by accessing the LEM. Has always the right to choose a supplier in the global market.	Lower energy bill. Be sustainable and resilient, by increasing self-consumption and being part of a local, independent energy community.	Access the LEM in order to source locally produced energy. In order to still retain its commercial relation with global market supplier the LEM trade has to happen through smart contracts through DLS.
Prosumer	Customer, Power Producer - Same as consumer for the purchase side. Self consumes own generated energy and either stores or sells any surplus back to the grid, via dedicated scheme/contract (PPA, FIT, etc.).	Customer, Producer - Same as consumer for the purchase side. Surplus generation can be sold to the local market for higher rewards compared to global market.	Lower energy bill. Be sustainable and resilient, by increasing self-consumption and being part of a local, independent energy community.	Purchase energy in the LEM when cheaper than from supplier. Sell surplus production to the local market when more convenient than selling to the global market. If prosumer with storage, can use storage to provide flexi services to the local (global) market (through aggregation even implicit).
Energy Cooperative	Consumer - several examples of cooperatives that managed to	Consumer, Producer, System Operator,	Lower energy bills of members, improve PEB	Exploit strengthened negotiation and financial power in order to increase revenues for members by accessing and

	strike convenient deals with suppliers.	Market Operator.	sustainability and optimise LEM operation.	optimizing LEM operations. Utilise LEM in order to put in place plants and energy sharing schemes for members.
Market Operator	Market operator - Operates the energy market acting as a guarantor (sometimes as a broker too) in order to ensure fairness for all involved participants.	Market Operator - Operates the local market both for internal trade and for trade with the global market.	Ensure the smooth market operation and fair remuneration for all participants.	Ensure matching offer and demand in the PEB/PED and provide fair returns for all participants, in exchange of a fee for its services.
System Operator (DSO)	Distribution System Operator - Operates distribution network in order to ensure balancing and infrastructure resilience.	- Community System operator, when the DSO takes on the operation of PEB network. - Customer for LEM products, such as energy, flexibility and capacity.	- Ensure network is operated in reliable and cost effective manner - Guarantee network adaptation/expansion through dedicated investments.	- DSO can access LEM to purchase products in order to maintain proper network operation (energy, flexibility, capacity), thus avoiding network upgrade and managing local criticalities (congestions, curtailments) in a more cost effective way. - DSO/CSO can act as a wholesale market aggregator, buying surplus energy in the PEB and re-selling it within the LEM.
System Operator (TSO)	Operates the transmission network, resolves imbalances on the network.	Customer	Resolve imbalances	Purchase services on the LEM in order to resolve imbalances.
Power Producer	Generates power and feeds it into the grid following agreements with power suppliers.	Producer	- Maximise profit - Minimise imbalances -Expand its customer base	Produce renewable energy locally in order to sell it within the local energy market
Power Supplier	Purchase power from producers and sells it to customers, following bilateral contracts.	Producer, Customer	- Maximise profit - Minimise imbalances - Expand its customer base	Purchase power from producers and sells it to end customers, according to bilateral contracts.In addition to BaU - selling energy to end customer within the PEB - it can source energy locally in order to fulfill demand from own customers.

Real Estate Company	Customer.	Customer, Producer.	- Attract tenants; - Maximise revenue - Expand services portfolio including energy provision; - Increase property portfolio value and revenues.	A RE firm can install RES in the buildings they own in order to: - sell energy to tenants and/or the wider PEB; - lower the building bills and modify tenancy contracts in order to include energy in the rent; - provide EPC to their tenants and use self-generated energy to fulfill them; - increase the property value; - access environmental markets (Green Certificates, etc.) A RE firm can also install BESS in order to: - increase the building self-consumption and boost aforementioned benefits; - provide flexibility/capacity services to the grid; - rent out capacity to the PEB customers.
ESCO	Energy Services Provider.	Customer, Producer.	Increase EE, lower bills, use assets to generate income	Use energy assets of clients to participate in the LEM; expand its offer by including LEM related services.
Aggregator	Flexibility services provider.	Customer, Producer.	Maximise revenues	Access the LEM in order to source and aggregate several small energy assets and utilise them to provide flexi services to players in the global market (who also access the LEM to purchase them).
eMaaS provider	Customer - purchase energy for EV charging.	Customer, Producer.	Buy locally generated cheaper energy; Maximise revenues including from provision of services to the grid	Buy locally generated energy to charge, use assets to generate incomes (V2B, V2G) by providing capacity/balancing services to the grid.
BESS Provider	None - not applicable.	Customer, Producer.	Use battery assets to generate	Use batteries to generate and trade energy, capacity and system services within the LEM.

			income	Rent batteries to other LEM players in a HaaS (hardware as a service) arrangement.
Property Manager	Customer	Customer, Producer.	- Reduce portfolio energy costs; - Increase portfolio sustainability.	Access the local market in order to exploit its property portfolio to trade products and services.
Facility Manager	None - not applicable	Customer, Producer.	Run assets cost-effectively.	Access the local market in order to exploit its managed energy assets to increase efficiency and reduce costs.
Energy Manager	Customer	Customer, Producer.	Ensure energy efficient operation of managed assets; exploit the LEM to increase revenues from assets.	Access the local market to trade products and services in order to increase efficiency and sustainability and reduce costs.

Table 4.3: Ecosystem Level Analysis for PEB establishment and LEM implementation and operation.

The second step in the "Business Model Level Analysis" within the framework of the Value Network Analysis" aims at defining the way each player does business in the local energy market, in terms of their value proposition, the products they offer and the required infrastructures, the revenue models and the type of relations they have with other players.

Player	Value Proposition	Product Offering	Infrastructure	Revenue Model	Relationship type
Consumer	- Reduced energy bill - Reduced energy consumption - Reduced environmental footprint - Status/Image	Locally generated renewable energy	Smart Meter.	Energy cost reduction.	- Ongoing close relationship; - Settlement; - P2P contracts.
Prosumer	- Reduced energy bill - Reduced energy consumption - Reduced environmental footprint	- consumption optimisation - peak reduction - increased self-consumption/local energy consumption	Smart meter, EMS (Energy Management Systems), RES generation, storage.	- Sale of prosumer flexibility/energy to actor within and outside the PEB. - Increased ROI	- Ongoing close relationship; - Settlement; - P2P contracts.

	- Status/Image			for the customer - Sale of added value services.	
Energy Cooperative	- Reduced energy bills, consumption and environmental footprint. -	Through dedicated schemes for members: - Locally generated renewable energy - consumption optimisation - peak reduction - increased self-consumption/local energy consumption	Smart meter, EMS (Energy Management Systems), RES generation, storage.	- Energy cost reduction. - Sale of prosumer flexibility/energy to actor within and outside the PEB. - Increased ROI for the customer - Sale of added value services.	- Ongoing close relationship; - Settlement; - P2P contracts.
Market Operator	Own and operate local energy market platform	Market clearance,	LEM operation platform.	Access fee/transaction fee from market participants.	- B2C contracts; - B2B contracts; - Indefinite delivery contracts.
Distribution System Operator (DSO)	- Reduced grid congestion - Postponed/avoided network upgrade actions	- Locally sourced energy and flexibility products for network operation	- Community grid; - Energy management system.	- Reduced costs for network operation; - Avoided costs for network upgrade	- B2B contracts; - Bilateral contracts.
Transmission System Operator (TSO)	- Reduced grid congestion - Postponed/avoided network upgrade actions - Reduced imbalances costs	- Locally sourced energy and flexibility products for network operation	- Community grid; - Energy management system.	- Reduced costs for network operation; - Avoided costs for network upgrade - Reduced costs for imbalances	- B2B contracts; -Bilateral contracts.
Power Producer	- Reduced imbalances costs - Locally generated renewable	- Locally generated energy and flexibility products	- Smart metering; - RES power plants.	- Reduced costs for imbalances settlement - Reduced generation	- B2B contracts; - Settlement.

	energy - Status/image - Reduced carbon footprint			costs from RES	
Power Supplier	Reduce risk in energy settlement due to inaccurate forecast and/or change of conditions in the day of delivery	Locally sourced products for balancing purposes	- Smart Metering; - Energy Management Systems.	Supplier pays LEM participant for their energy and/or flexibility services in order to achieve balance and avoid imbalance fees on the global market.	- Ongoing close relationship with customers; - B2C contract; - Settlement.
Real Estate Company	- Exploit portfolio for energy market participation - Increase property value - Status, image	- Improved building energy performances and operation - Increased property value and attractiveness	- Energy efficient buildings; - RES and storage.	- Cost savings for energy procurement - Increased revenues from rent	- B2B contracts; - B2C contracts.
ESCO	- Building Energy Efficiency - Energy operations - EPC	- Building energy efficiency measures - Local energy management	- Energy efficient buildings; - Energy Management Systems.	- Sale of energy conservation projects and energy management services; - Trade of energy and flexibility from managed portfolio	- B2B/ B2C - service provision; - EPCs.
Aggregator	- Locally sourced flexibility - Increased customer base and managed portfolio.	- Flexibility products and services	- Energy Management Systems; - Smart metering.	- Trade of flexibility products and services within and outside the PEB.	- B2C Smart contracts; - B2B direct contracts.
eMaaS provider	- Sustainable e-Mobility services	- e-Mobility - Energy and flexibility products	- e-Mobility infrastructure; - Smart metering.	- Service fee; - Reduced costs for energy;	- B2C -service provision; - B2B smart contracts.

				- revenues from V2B/V2G.	
BESS Provider	- Improve local energy generation and consumption through storage and flexibility services.	- Battery storage systems and services (including battery as a service).	- BESS - RES - Smart Metering	- Products and services trade; - service fee for battery capacity access.	- B2C/B2B smart contracts; - B2B/B2C bilateral contracts - system and service provision.
Property Manager	- Reduce energy costs; - Improve efficiency and sustainability.	- Energy and flexibility products.	- Smart energy assets; - Energy Management Systems; - Smart metering.	- Reduced energy bills; -Revenues from the sale of products and services on the local market; - revenues from increased property value.	B2B Smart contracts
Facility Manager	- Reduce energy costs; - Improve efficiency and sustainability.	- Energy and flexibility products.	- Smart energy assets; - Energy Management Systems; - Smart metering.	- Smart energy assets; - Energy Management Systems; - Smart metering.	B2B Smart contracts
Energy Manager	Improved energy efficiency and sustainability.	- Energy and sustainability services; - Energy and flexibility products and services.	- Energy Management Systems; - Smart metering; - Smart Energy assets.	- Service fee; - Reduced costs for energy operation.	- B2B - service provision; - B2B smart contracts.

Table 4.4: Business Model Level Analysis results

4.3 Service level and infrastructure ownership

4.3.1 Infrastructure ownership model and service level analysis

The implementation of PEBs/PEDs and operation of the local market within which the aforementioned business models can flourish, requires deployment of the enabling infrastructure and technologies as identified in the previous section of this report and also in the "enabling technologies" analysis carried out in D2.1 "Enabling Regulatory Mechanism to Trial Innovation in Cities". Several solutions are possible in terms of who is going to own and operate the required infrastructures, as well as which is the level of the services that

will be delivered within the PEB market. The optimum solution for a specific PEB implementation depends on the specific scenario, that can be characterised through a series "determinants" as is better detailed in the following paragraph. Determinants define in which region of the solution space a specific PEB market should position itself in order to maximise business opportunities and to provide fair returns on investments made.

The solution space comes in the form of a matrix where on one axis we find three "procurement of infrastructure" options, while on the other we have three levels of delivered services complexiness. It results in nine alternative positions for the solution identified, even though it is important to say that the resulting solution might end up occupying more than one single position, thus realising the applicative scenario made up of two adjacent cells of the solution space.

Business Model Solution Space				
		Services Provision Level		
		Standard Services (i.e. supply of locally generated energy)	Tailor-made services (flexibility management, eMaaS)	Advanced services (i.e. active real-time energy management)
Infrastructure Ownership	Leasing to customers (rent instead of buying)			
	Shared ownership			
	Customer ownership			

Table 4.5: Business Model Solution Space Matrix. Source: adapted from Facchinetti and Sulzer, 2016.

4.3.2 Definition of determinants

Determinants are intended as the boundary conditions, within which the local energy market is implemented; their identification and investigation is paramount in order to define what's the most suitable structure for both the level of services provided and the ownership model for required infrastructure.
Determinants can be divided into three groups:

- PEB typology;
- Customers;
- External.

PEB typology determinants concern infrastructural, geographical and energy related scenarios within which the PEB and the local market are going to be implemented and operated. For example urban districts with high density of buildings are likely to require less costs for infrastructures and to have higher energy volumes when compared to rural districts, where distances are larger and energy consumption is likely to be lower.

In the same way, a retrofit project for an existing district will cost more than a brand new project where energy efficiency is higher and flexible resources more abundant by design due to recent regulations on buildings standards and RES generation.
In terms of how such determinants affect the business models, customer involvement in the infrastructure ownership and operation is requested when costs are higher, in order to share the investment risks on one end but also to ensure higher commitment towards a profitable involvement in the local market dynamics.
Customer-related determinants are the ones that characterise the existing PEB residents who are the future local market customers: meaning all the economic actors that trade products and services in the local energy market, from economic, financial, energy and sustainability perspectives.
Such determinants will shape the ownership models as well as the necessary level of services provided in order to fulfill customers' needs.
Given the differentiation of products and services available in a PEB market, there exists the potential for diversification of customers, ranging from prosumers to eMobility firms, from Energy Service Companies to Distribution System Operator.
External determinants are related with all aspects that can influence the implementation and operation of a PEB market from the outside; it includes policy at all levels, from international to local, macro-economic aspects as well as the availability and accessibility of financing sources.
The following table reports identified determinants, that will need analysis and evaluation for each of the PEB that is being, or is going to be, implemented in lighthouse and follower cities.

Determinants		
1) Typology	2) Customers	3) External
Characteristics of existing infrastructures and buildings.	Social Demographic aspects.	Energy Efficiency Landscape including Energy Performance of Buildings.
Project Typology: New Project or Retrofitting of an existing district.	Willingness to pay/invest.	Energy policy in support of energy transition, such as feed-in tariffs, tax discounts, grants, etc.
Density of buildings: High density - urban district; medium density - suburban; low density - rural district.	Customer awareness in terms of environmental sustainability.	Macro-economic cycle, such as inflation dynamics, interest rates, etc.
Buildings Typology: Residential, commercial, small industrial, public services.	Building ownership: public building, privately owned, social housing, housing cooperatives.	Private participation in investments of local businesses and building owners.
Energy carriers included and related infrastructures: electric energy, thermal energy, combination of electric and thermal.	Customer segmentation, in terms of engagement level and commitment.	TRL of implemented technologies.
Target energy self sufficiency of the district for	Customer segmentation in terms of customer typology (consumer, corporate, public bodies).	Available and potential sponsorship for the actions to be implemented.

Table 4.6: Definition of Determinants for PEB and LEM. Source: adapted from Facchinetti and Sulzer, 2016.

4.4 PEB Market implementation in LHCs and FCs

This paragraph intends to report planned and ongoing activities in Lighthouse and Follower Cities, in terms of development and implementation of the PEB and the local energy markets.
Information reported here are based on contributions from cities' representatives and industry partners working alongside with them and shows different levels of details depending on how advanced those activities are at this point in time.
As mentioned previously, the development and implementation of the demonstration projects is an ongoing activity that in some cases, mainly in FCs, is still in the planning phase. Accordingly, business and investment modelling will keep evolving alongside with those tasks in order to reach implementation and operation in due course in all involved cities.

4.4.1 +Limerick

Planning and implementation of the Limerick PEB and the associated local market are ongoing as part of WP4 activities; in particular T4.6 "Implementation of the Limerick Positive Energy Blocks" [M10 - M36], T4.7 "Implementation of a community grid within the Limerick PEB" [M10 -M36], T4.9 "Demonstrate the Potential for Energy Trading Market" [M19 - M36], T4.10 "Local Flexibility MArket" [M25 - M36], T4.11 "Sustainable Investment" [M12 - M36]. Moving forward with WP4 activities the necessary business and investment models will be finalised and implemented, starting from the high-level concepts and models developed in this work.

PEB implementation Task	Players	Business Model	Infrastructure Ownership
Energy Renovation	LC&CC; Local Developers	To Be Decided (TBD) according to the table 4.3 and 4.4	Private
RES Generation	MPOWER, GKINETIC, ESBN, CRU	To Be Decided (TBD) according to the table 4.3 and 4.4	Community Cooperative
Storage	MPOWER, ESBN, CRU, Building Owners	To Be Decided (TBD) according to the table 4.3 and 4.4	Community Cooperative & CSO
e-MaaS	AVIS Budget Group Ireland, LC&CC, TBD	To Be Decided (TBD) according to the table 4.3 and 4.4	ABG, LC&CC, TBD
Community Grid	MPOWER, ESBN, Community Cooperative	To Be Decided (TBD) according to the table 4.3 and 4.4	MPOWER, ESBN, Community Cooperative
Local Energy and Flexibility Market	MPOWER, ESBN, Community Cooperative	To Be Decided (TBD) according to the table 4.3 and 4.4	MPOWER, ESBN, Community Cooperative

Table 4.7: PEB implementation in +Limerick - Players and Roles

Local Market Operation Role	Player	Infrastructure Ownership	Business Model
Customer	Building Owners / Tenants	MPOWER, ESBN, ECU, TBD	Retail, Cooperative, TBD
Producer	GKinetic, Building Owners, TBD	GKinetic, Building Owners, TBD	Retail, Cooperative, TBD
Market Operator	ESBN, Eirgrid, ECU	ESBN, ECU, TBD	Retail, Cooperative, TBD
System Operator	MPOWER - New Player	TBD	MPOWER acting as the CSO will provide bills and statements, tariff information to trial customers within the community grid.

Table 4.8: Local Energy Market Operation in +Limerick - Players and Infrastructure

+Limerick Determinants Definition		
1) PEB Typology	2) Customers	3) External
Infrastructures & Building Characteristics: Mixed buildings, many historical ones and in some cases derelicted.	Social Demographic aspects: Mixed.	Energy Efficiency Landscape including Energy Performance of Buildings: Low energy performance for the majority of buildings in the georgian district, though some flagship ones present.
Project Typology: Existing district.	Willingness to pay/invest: Low initially, but growing following first engagement activities in the city.	Energy policy: Ambitious de-carbonisation and sustainability goals set for the country.
Density of buildings: High, city district.	Customer awareness: Low to Medium.	Macro-economy: Limerick city and county are in a positive economic cycle with increased rate of investment in the area.
Buildings Typology: Residential, commercial, public.	Building ownership: Mixed public and private. Private ownership is quite fragmented.	Private participation in investments: Ongoing discussions with private equity fund.

Energy conversion infrastructures: electric, Thermal.	Customer segmentation: To be assessed.	Maturity of technical solutions: Medium (tidal energy) to high.
Self sufficiency level: Positive Block/district.		

Table 4.9: +Limerick Determinants definition

4.4.2 +Trondheim

Lighthouse city of Trondheim is more advanced in the planning and implementation of the local PEBs and the local markets, mainly due to the earlier start of activities in WP5 "+Trondheim". The following tables report the status of the art regarding development and implementation of business and investment models for the city, although the work is still ongoing as part of T5.11 "Sustainable Investment" which will span until month 36 of the project.

PEB Market implementation Task	Players	Business Model	Infrastructure Ownership
Energy Renovation	RK (building owner) Frost Property (building owner, associated partner) Entra Property (building owner, associated partner) ARUP (engineering/ projecting of energy measures) Renewable Energy Cluster Additional consultants for building owners Energy renovation executing company	Building owner: EPC or other Green Rental Contract model with tenants; competence/ capacity building for transfer to other buildings and new development projects (multiplication/volume effect). ARUP: engineering/consulting REC: Non-profit; offer peak energy competence through group of >50 companies Consultants: Assignments for building/energy consultancies Renovation company: products and solutions providing and installations	Building owner: Buildings, BMS, energy management and integration systems for buildings.
RES Generation	ESCO (company X - Sluppen, is ongoing the foundation of a new ESCO) Building owners incl	ESCO: Selling PV el. as a service based on owning PV rigs, renting roof space, and offering (long-term) el. contract	ESCO: PV rigs Building owners: Buildings SV: District heating network; heat pumps

	NTNU) SV (thermal DSO) TE (DSO/CSO), grid owner and operator and market operator. IOTA ABB (Distributed Energy Resource Management System - DERMS for energy assets and systems integration - system: SiteEMS; ABB Ability cloud storage and data integration layer) NTNU property/operation (campus is own DSO for thermal and el.)	with building owners w/guaranteed lower el. price compared to market prices. PV rigs are module based and prefabricated to reduce costs Building owners: Renting out roof space for PV rigs; el. contracts w/ESCO SV: Producing thermal energy from waste heat (computers/servers at local data centre + cooling machines at fruit/vegetable wholesaler). Will sell both heating and cooling. Will create a package out of heat pumps (plexiglass container or similar) which can be a solution to provide or sell other places (product: green thermal energy as a service?) NTNU: Optimize local energy provision/need for within campus (concession area) and/or offer to other community grids	TE: Larger and local el. grid and belonging infrastructure Battery storage(s) - BESS IOTA: Tangle ABB: Site EMS and ABB Ability NTNU (outside being building owner): Local energy system and energy management systems -
Storage	TE (DSO/CSO) Building owners ESCO X ABB	TE: Provide energy, effect/capacity and system services - to themselves and to other players in the LEM Building owners: Rent out space for storage ESCO X: Sell surplus PV el to battery	TE: Larger and local el. grid and belonging infrastructure Battery storage(s) - BESS Building owners: Buildings ABB: Site EMS and ABB Ability
e-MaaS	ABG (eMaaS owner and operator) AtB (adm. company, public transport) Trh City Bike 4C (mob. platform and APP owner/operator) IOTA ABB (2-way EV chargers and DERMS)	Basic model: Offer a one-stop-shop or marketplace for shared/public green mobility. Backend (and APP) highly flexible and scalable for adaptation to any city/place/ at low cost. ABG: Offer shared EVs and E-bikes to any customer (private persons, tourists, and	ABG:EVs and E-Bikes + charging infrastructure AtB: Public transport system Trh City Bike: Shared bikes, racks, and bike stations 4C: Seamless eMobility backend (platform) and APP for booking (integrating micropayment solution at later stage)

		corporate customers) AtB: Part of marketplace to attract customers to the public transport Trh City Bike: Part of marketplace to attract customers to their shared bikes. 4C: Owner and operator of mobility backend and frontend providing services/products to eMaaS actors IOTA: Providing and offering a microtransaction solution for the actors in the marketplace, based on a digital ledger and system to enable low/no cost data and money transactions. Upsides mainly for other players in this ecosystem who are ensured cheap/free of cost transactions	IOTA: Tangle ABB: Site EMS and ABB Ability
Community Grid	TE ABB	TE: Community System Operator - CSO - owning and operating local el grid	TE: Larger and local el. grid and belonging infrastructure Battery storage(s) - BESS ABB: Site EMS and ABB Ability
Local Energy and Flexibility Market (LEM/LFM)	TE POW (trading platform developer and operator) Building owners ESCO X ABG SV IOTA ABB	Basic model: Providing a highly open and integrated P2P/B2B etc local market for energy and energy related products and services. TE: Owner and operator of LFM with low threshold for flexibility providers to participate in (no/low limit for #kW flex a player brings to the market). POW: Developer, provider and operator of Energy Trading Platform (ETP) systems. New ETP is product in itself for other markets ESCO X: Being part of LEM. PV el. produced	TE: Larger and local el. grid and belonging infrastructure Battery storage(s) - BESS IOTA: Tangle ABB: Site EMS and ABB Ability

		over agreed in contract with building owners to be offered in LEM/LFM at prevailing prices. Product not solely being el, but also effect, frequency adjustment etc (and other system services) ABG: Boost economy side of eMaaS by optimizing customer availability of vehicles with charging at favourable el. Prices, and offering EV batteries to local market; product not mainly being el, but more effect and frequency adjustment etc (and other system services) IOTA: "Source" electricity in terms of origin. Can also be used for customers wanting to buy green el. or el. from a specific source/origin. Digital hub and ledger tech (Tangle) to enable and ensure energy and monetary transactions at low/now cost	

Table 4.10: PEB implementation in +Trondheim - Players and Roles

PEB Market Operation Role	Player	Infrastructure Ownership	Business Model
Customer	Building owners TE SV NTNU	Building owners TE SV NTNU	Building owners TE SV NTNU
Producer	Building owners ESCO X TE SV ABG NTNU (as local DSO and CSO of Campus Gløshaugen)	Building owners ESCO X TE SV ABG NTNU	Building owners ESCO X TE SV ABG NTNU
Market Operator	TE POW (trading platform developer and operator)	TE owns and operates flexibility market platform.	Basic model: Providing a highly open and integrated P2P/B2B etc local market for energy

		Powell owns and operates Energy trading platform.	and energy related products and services. TE: Owner and operator of LFM with low threshold for flexibility providers to participate in (no/low limit for #kW flex a player brings to the market). POW: Developer, provider and operator of Energy Trading Platform (ETP) systems. New ETP is product in itself for other markets
System Operator	TE - Trondheim Energi, Local DSO for Sluppen and Brattøra PEBs. NTNU, local DSO for the Campus Gløshaugen PEB.	TE and NTNU both own the portion of the grid which constitutes the community grid in Trondheim PEBs.	Sponsorship:

Table 4.11: Local Energy Market Operation in +Trondheim - Players and Infrastructure

+Trondheim Determinants Definition		
PEB Typology	Customers	External
Infrastructures & Building Characteristics: Mixed buildings	Social Demographic aspects: Mixed demographic	Energy Efficiency Landscape including Energy Performance of Buildings: Medium to high
Project Typology: Existing district.	Willingness to pay/invest: Medium	Energy policy: Regulated
Density of buildings: High, city district.	Customer awareness: low	Macro-economy: taken into account.
Buildings Typology: Residential, commercial.	Building ownership: Kjeldsberg, Entra Frost	Private participation in investments: Yes
Energy conversion infrastructures: electric, Thermal.	Customer segmentation: Mixed	Maturity of technical solutions: high
Self sufficiency level: Positive Block/district.	Customer segmentation: Mixed	Sponsorship: Strong from Municipality and University.

Table 4.12: +Trondheim Determinants definition

4.4.3 +FCs

Follower cities are in the early stage of planning and discussions regarding the development of business and investment models for the local PEBs and the associated local markets have, in the majority of the cases, just started.
Involved partners and stakeholders are being identified, following the methodology and the guidelines developed in this work aiming at optimising the bankability of the required investments.
In the following tables the information available so far are collected, with the intent of bridging the existing gaps moving forward with replication activities. The majority of

information for FCs come from the recent meeting held during the first year consortium meeting in Limerick.

PEB Market implementation Task	Players	Business Model	Infrastructure Ownership
Energy Renovation	Alba Iulia: TBC Pisek: - Municipality of Písek (building owner) -Městské služby Písek (building owner) -Energy renovation consulting and executing companies -ESCO Sestao:TBC Smolyan: Municipality of Smolyan Voru: -Municipality of Voru	Alba Iulia: TBC Pisek: National, european or Norway funds alternative financing scheme – most likely Energy Performance Sestao:TBC Smolyan:TBC Voru: NA/TBD	Alba Iulia: TBC Pisek: -Building owner -ESCO Sestao:TBC Smolyan:TBC Voru: TBC
RES Generation	Alba Iulia: TBC Pisek: -Buildings' owner (Municipality) -ESCO Sestao: Municipality of Sestao Sestao Berri Basque Entity of Energy (EVE) Smolyan:TBC Voru: TBC	Alba Iulia: TBC Pisek: - Biomass powered CHP provides heat and electricity PV - Building owners renting out the roof space to ESCO Sestao: Building owners pay for the consumed heat generated by the biomass district heating Smolyan:TBC Voru: TBC	Alba Iulia: TBC Pisek: - CHP - Co-ownership of city (75% share) - PV - ESCO Sestao: Municipality of Sestao Smolyan:TBC Voru: TBC
Storage	Alba Iulia: TBC Pisek: NONE Sestao: TBC	Alba Iulia: TBC Pisek: NA Sestao: TBC	Alba Iulia: TBC Pisek: NA Sestao: TBC

	Smolyan: None Voru: TBC	Smolyan:TBC Voru: TBC	Smolyan:TBC Voru: TBC
e-MaaS	Alba Iulia: TBC Pisek: -City of Pisek (shared e-bikes, EV charging stations – street lamps) -E.ON, ČEZ (EV charging stations) -Rekola (Shared |e-|bikes) -ČSAD Autobusy České Budějovice (Public bus transport operator) Sestao:TBC Smolyan:TBC Voru: TBC	Alba Iulia: TBC Pisek: -Shared EVs and E-bikes infrastructure -Street lamp charging points -Low or emission free public transport Sestao:TBC Smolyan:TBC Voru: TBC	Alba Iulia: TBC Pisek: -City of Pisek -ESCO -E.ON -ČEZ -Rekola -ČSAD Autobusy České Budějovice Sestao:TBC Smolyan:TBC Voru: TBC
Community Grid	Alba Iulia: TBC Pisek: E.ON -City of Pisek Sestao:TBC Smolyan:TBC Voru: TBC	Alba Iulia: TBC Pisek: -E.ON various tariffs -City of Písek: one tariff Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: -E.ON (electricity and gas) -City of Pisek (heat) Sestao: TBC Smolyan: TBC Voru: TBC
Local Energy and Flexibility Market	Alba Iulia: TBC Pisek: NONE Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: NONE Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: NONE Sestao:TBC Smolyan:TBC Voru: TBC

Table 4.13: PEB implementation in +Followers - Players and Roles

PEB Market Operation Role	Player	Infrastructure Ownership	Business Model
Customer	Alba Iulia: TBC Pisek: -City of Pisek -Building owners Sestao:TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: -City of Pisek -Building owners Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: -same as Community Grid Sestao: TBC Smolyan: TBC Voru: TBC
Producer	Alba Iulia: TBC Pisek: -City of Pisek - ESCO Sestao:TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: -City of Pisek - ESCO Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: -same as Community Grid Sestao: TBC Smolyan: TBC Voru: TBC
Market Operator	Alba Iulia: TBC Pisek: -City of Pisek - ESCO E.ON. Sestao:TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: -City of Pisek - ESCO - E.ON. Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: Local energy/P2P/P2B market Sestao: TBC Smolyan:TBC Voru: TBC
System Operator	Alba Iulia: TBC Pisek: - City of Písek - E.ON. Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: - E.ON with City of Písek Sestao: TBC Smolyan: TBC Voru: TBC	Alba Iulia: TBC Pisek: TBC Sestao: TBC Smolyan: TBC Voru: TBC

Table 4.14: Local Energy Market Operation in +Followers - Players and Infrastructure

+FCs Determinants Definition		
PEB Typology	Customers	External
Infrastructures & Building Characteristics. Alba Iulia: Military area. Pisek: Mixed public buildings and private infrastructure Sestao: TBC Smolyan: Public Buildings, Municipal property in old town centre. Voru: Public Buildings, heritage area. Mostly municipality buildings: culture house, health center, schools, kindergartens.	Social Demographic aspects. Alba Iulia: TBC Pisek: Mixed demographic Sestao: TBC Smolyan: Mixed Voru: Aging population, also due to young people leaving the town.	Energy Efficiency Landscape including Energy Performance of Buildings. Alba Iulia: TBC Pisek: Medium Sestao: TBC Smolyan: TBC Voru: TBC
Project Typology: Existing district. Alba Iulia: Existing district Pisek: Existing district, heritage area Sestao: Existing district Smolyan: Existing district Voru: Existing District, heritage area.	Willingness to pay/invest. Alba Iulia: TBC Pisek: Medium to low Sestao: TBC Smolyan: TBC Voru: NA	Energy policy. Alba Iulia: TBC Pisek: Regulated Sestao: TBC Smolyan: TBC Voru: TBC
Density of buildings: High, city district. Alba Iulia: High Pisek: High – Inner city district Sestao: TBC Smolyan: High, town centre. Voru: Medium, lot of green areas.	Customer awareness. Alba Iulia: TBC Pisek: Low Sestao: TBC Smolyan: Skeptical, quite conservative. Voru: Low, project is completely new to citizens.	Macro-economy. Alba Iulia: TBC Pisek: Considered Sestao: TBC Smolyan: TBC Voru: TBC

Buildings Typology: Residential, commercial, public. Alba Iulia: Mixed Pisek: Mostly Public, but also commercial and residential Sestao: TBC Smolyan: Sport centres. Voru: Public services.	Building ownership. Alba Iulia: Military owned, though municipality trying to take on ownership. Pisek: City of Písek And private Sestao: TBC Smolyan: Public. Voru: Municipality, public.	Private participation in investments. Alba Iulia: TBC Pisek: Yes, partly Sestao: TBC Smolyan: TBC Voru: TBC
Energy conversion infrastructures: electric, Thermal. Alba Iulia: TBC Pisek: Electric, Thermal Sestao: TBC Smolyan: TBC Voru: TBC	Customer segmentation. Alba Iulia: TBC Pisek: Mixed Sestao: TBC Smolyan: TBC Voru: TBC	Maturity of technical solutions. Alba Iulia: TBC Pisek: Medium Sestao: TBC Smolyan: TBC Voru: TBC
Self sufficiency level Alba Iulia: Positive Energy Block Pisek: Positive PEB physical and virtual Sestao: Positive Energy Block Smolyan: Positive Energy Block Voru: Positive Energy Block	Customer segmentation. Alba Iulia: TBC Pisek: Mixed Sestao: TBC Smolyan: TBC Voru: TBC	Sponsorship. Alba Iulia: TBC Pisek: Medium Sestao: TBC Smolyan: TBC Voru: TBC

Table 4.15: +Followers Determinants definition

5. Financing & investment models for +CityxChange

5.1 Integrated investment model

An integrated investment model is proposed for the +CityxChange project and its sub-projects, which aims at connecting the activities and the policies of public authority with the responsibilities of the community: public authority set out the policy of public investments in the local area ,while the responsibility of the community is to facilitate investments' implementation in PEB. The integrated model tries to link the innovations of process and its related strategies by offering specific solutions (financial) and initiatives in different socio-economic contexts. Inside the integrated business model we have identified a mix of "products" as illustrated and described in the figure below and better detailed in the following of this section.
The integrated models contains different investment sub models, which can be "extracted" in order to consider many financial and sustainability aspects and to adapt them to different socio-economic contexts keeping the same strategic perspective. Investing in energy infrastructure facilities and services requires not only direct public management but also social responsibility by all involved stakeholders.

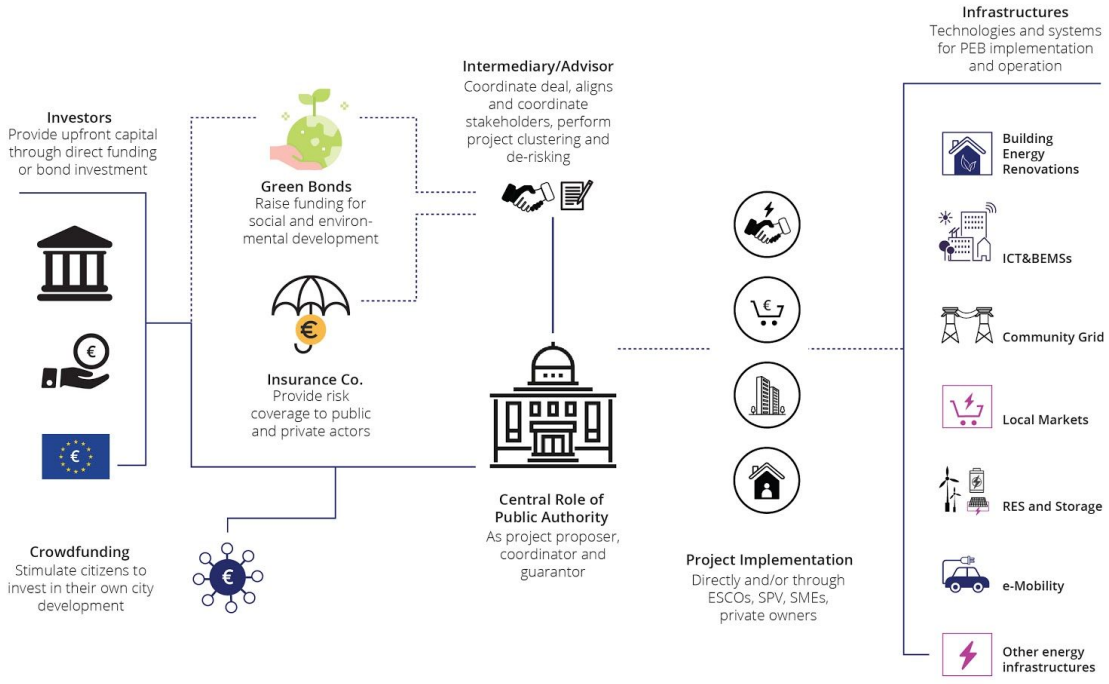

Figure 5.1: Proposed Integrated Investment Model and relevant stakeholders for implementation and operation of PEBs and related Local Energy Markets.

In terms of financing sources, the mix is expected to vary consistently by nationality, given that for example Norway grants, which are a powerful financing tool within the

+CityxChange project, are only available for some European (mainly Eastern) countries; therefore FCs are expected to benefit substantially from these.
On the other end we can expect a higher contribution from citizens driven crowdfunding schemes in "wealthier" countries like Norway.

The investment model shows the central role of Public Authority as project planner and developer, coordinator and guarantor and its related involvement opportunities in energy investments. At the same time, the model aims at strengthening Public Private Partnerships (PPP) as an efficient instrument for implementing public policies and tasks to provide public energy services. By the way, in our integrated investment model, the role of the different stakeholders have to be clarified, such as:

- Policy makers and public authorities;
- energy projects executing companies & ESCOs;
- private investors (banks, insurance institutes);
- citizens.

In many cases, stakeholders use the term of PPP, private investments and crowded funding but they have a very different understanding of it. The simply “philosophy” of our model is that in smart cities and urban development projects public authority involves private investors by citizens’ engagement. Cities of +CityxChange project point to involve private investors in residential buildings and in commercial activities. Public authority gives private investors the opportunity to invest their capital to develop, construct infrastructures taking into consideration urban planning standards. Investments are foreseen with a joint concept the public partner supports the investment and leaves the business to private investors.

The model’s application is driven by development policies (such as Bold City Vision) and considers the cultural and socio-economic frame, the ambition level of the public authority and the medium and long-term investments. The model foresees the role of the intermediary/financial/investments advisor as a player (specialists who coordinates and helps stakeholders to plan financial investments). Financial advisors are key intermediaries for the promotion and distribution of investments’ portfolio, financial products services. Insurance institutes support investments and provide necessary risk coverage, acting as an intermediary among parties to a business investment or negotiation, in order to take decisions shared with stakeholders. In the LEM the methodological approach of our model is to reduce and mitigate investment risks by proposing different financial/product solutions to investors. The aim of the Integrated investment model is to apply an innovative investment process with non-conventional financing instruments that could be used by developers and local governments to invest in +CityxChange and future energy investment projects. The model points to develop smart city projects, in terms of planning and at the same time to identify the most suitable funding sources for foreseen investments.

5.2 Financing options for +CityxChange actions

The present EU scenario with its new economic opportunities aims at increasing energy access by carbon emissions reduction. +CityxChange project consortium is paving the way towards a low-carbon development through establishment of positive energy blocks and

districts in European cities and beyond. The development and the utilization of appropriate financing instruments are ways to overcome the barriers and prevent risks that hold private investments in the energy transition. This chapter illustrates a framework of the main financing instruments at EU level which can be the most appropriate for addressing main barriers and risks. One of the most frequent mistakes by policy makers is the use of financial instruments without assessing which financial instrument would be the most efficient for that socio-economic and environmental context. In selecting and subsequently in the implementation phase, policy makers should point to financial instruments that could bring the highest amount of private financing and minimizing quantities of public funds (maximum leverage of the investments) and this is the approach suggested for +CityxChange investments. Investments represent decisions to acquire assets, grants, equity, debt assets, guarantees, insurance, small-scale project financing.
Whether the acquired assets come in the form of financial products or in the form of capital (either working or fixed), the investment decision reduces to evaluation of how much capital it is required (that is, need t be raised) to fund the planned interventions and/or operations, alongside with the identification of the mix of financial sources applicable.
Capital to be invested can be drawn from the company's cash flows (this is the case of internal capital) or, on the other end, it can be raised on financial markets including commercial banks and markets for equity and bonds; financial markets are the vehicle that "drain" money from people's savings and makes such money available to the institutions, either private or public, that need money to carry out their activities.

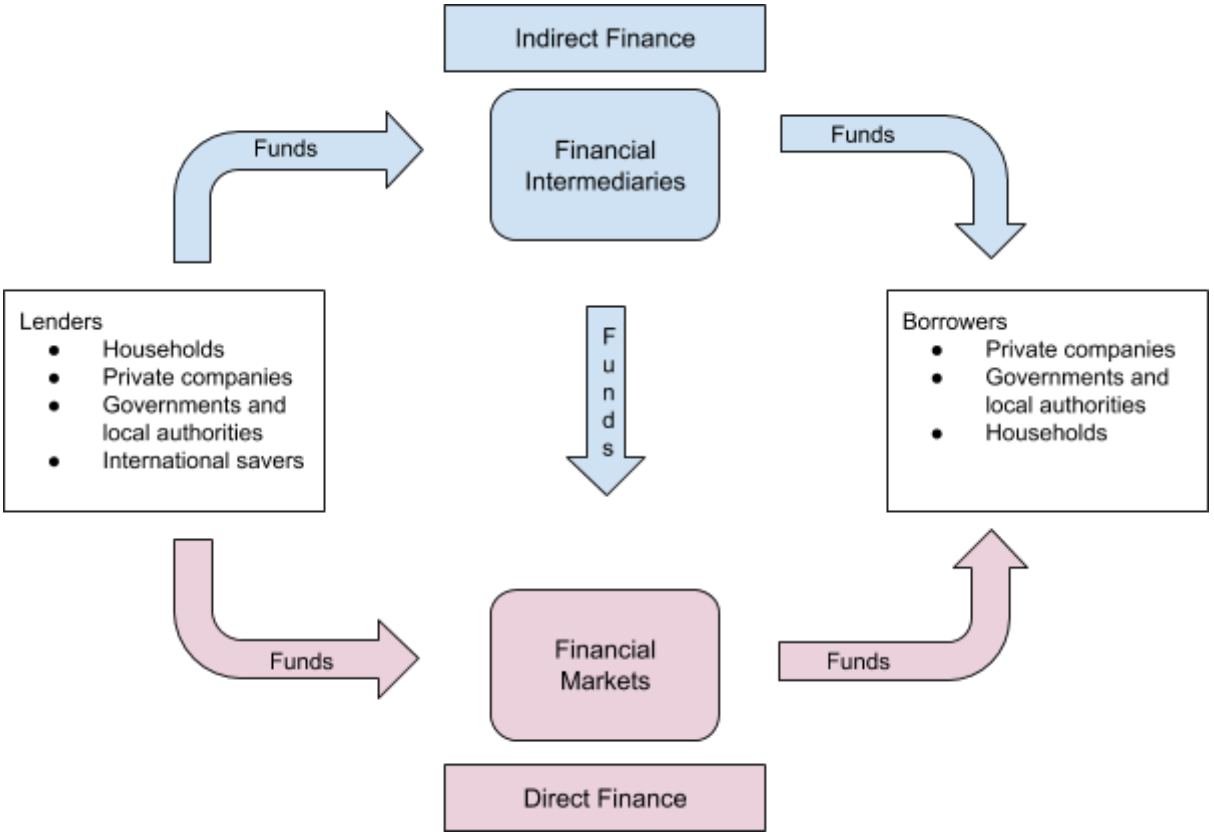

Fig. 5.2: Simplified diagram of the Financial System that can provide funds for Smart City projects. Based on: Hawawini G. & Viallet C. (2007).

The previous figure represents actors and interactions in the financial system, reporting on the right-hand side the actors in need for capital, while on the left-hand side are represented the actors that can provide capital via their "savings". In between there are the actors and the tools that enable the transfer of money, that is the financial system that +CityxChange project need to engage with in order to gain access to funding and financing required for implementations of planned actions.

On a deeper level of analysis, it is possible to split the channels on which the financial systems acts in direct and indirect channels.
Direct financing is realised when money is obtained from the savers without intermediaries, in exchange for a form of security, which is a document specifying under which terms the saver has handed-over the money.
It is, instead, indirect financing the case in which funds are obtained through intermediaries, that in most cases are the commercial banks, insurance firms, private equity funds and venture capital funds which are responsible for the passage of capital from the lenders to the receiver.

+CityxChange project needs to raise capital in order to fund the high-tech and integrated solutions for the energy transition towards positive energy blocks and district in LHs & FCs and beyond.
This needs to happen through close collaboration and continuous interaction with the financial system in order to leverage private investment and requires measures such as:

- New financial schemes;
- Innovation in business modelling
- Standardisation of projects and underlying contracts;
- Reduction of investment risks;
- Projects clustering to increase size and bankability and reduce administrative costs;
- Putting in place mechanisms for investment that falls off the balance sheets via SPV and PPP, as also described in the following of this report.

5.2.1 Mapping of financing opportunities for Smart Cities

In the past public funds from taxation and borrowing have been extensively used to fund European infrastructure for energy and for transport but, due to the consistent reduction in public spending in recent years, there is now the need to better channel the limited public financial resources, in order to leverage private investments required for the smart transformation of EU cities towards digitalisation and energy low carbon transition.
The idea behind +CityxChange financial models being developed is a "shift" from traditional public financial resources, available at national and local level, to other EU funds and contractual models, such as Public Private Partnership (PPP), ESCOs, TIF and others, able to attract private capital. This chapter aims at illustrating main available financial instruments and which risk and barriers these public funds can face.

This idea can be pursued in the smart city arena by creating a governance paradigm encompassing stakeholder engagement at five different levels[27].

- Proposition/Sponsorship, intended as the promotion of smart city transformation programme either at national or local level, which can come from governments, local administrations, technical public agencies or even private firms.
- Implementation and Operation, that is construction of infrastructure, deployment of advanced technologies, system operation and continuous delivery of value services. At this level involved stakeholders are engineering companies, construction firms, technology providers, SMEs, etc.
- Financial, involving entities such as commercial banks, private investors, venture capitalists, financial advisory firms, etc. that have to work together to provide the financial mix of sources and tools for leveraging private investments via public funds (for example PPP, Energy Performance Contracting).
- Certification, that is the level where the "smart plan" is evaluated in terms of potential and expected performances, and also where confidential data and information are properly and lawfully managed. Financial certification firms can participate at this level, alongside with ad-hoc consortium of technical and scientific, private and public entities.
- Guarantees, aiming at providing necessary financial risk mitigation tools for private investors, even through insurance policies subscribed/participated by public authorities for shared public-private investments.

Interaction and collaboration at multiple levels is expected to deliver also:

- Identification of priorities of the cities transformation plans by means of assessment of their feasibility and sustainability;
- Aggregation and standardisation of private investments;
- Bankability assessment via cost-benefits analysis;
- Investment risk management in terms of data certification and bespoke protection schemes.

Thus, the transformation of Cities into Smart Cities requires continuous innovation and investments, that can be secured by accessing the wealth of existing financial and support mechanisms.
Thus it is crucial to be aware of all available funds, financial instruments and dedicated EU programs, focusing the analysis on energy efficiency, RES, research & Innovation, SMEs development, mobility, ICT sectors and respective technical interventions that are supported by EU, all public and private entities, and countries representatives of the smart cities. Some of those financial resources and instruments are summarized in the following table.

27 https://www.uraia.org/documents/109/2013_-_Smart_Cities_Platform_European_Union_-Financing_Models-ENG.pdf

EU funds programmes				Financing Schemes & instruments
Direct funding	Structural funds	EIB Instruments [28]	Financial Institutions Instruments	
Cosme Horizon 2020 Life Interreg Connecting Europe Facility program (CEF)	ROP (Regional Operational Programme), ESF & ERDF Cohesion fund	Loans (for public sector, for private, intermediate loans for SMEs) Equity (venture debt, investments in SME & mid cap, Investments in infrastructure and environmental funds) Guarantees (credit enhancement for project finance, guarantees in support of SMEs, mid-caps and other objectives Advisory services (- InnovFin advisory, EPEC / Public-Private Partnerships (PPPs), JASPERS, ELENA - European Local ENergy Assistance, FELICITY - Sustainable solutions for cities MPSF - Municipal Project Support Facility	European Fund for Strategic Investments (EFSI), also called the Juncker Plan European Energy Efficiency Fund (EEEF) Urban development fund	Green bonds Energy performance contracting Public-private partnership Tax increment financing Alternative financing (crowd-funding, soft loans, guarantees, revolving loan fund, on bill financing, pee-to-peer)

Table 5.1: Funding & Financing schemes for Smart City actions.

EU funds programmes[29] and policies

The European Union finances, by dedicated funds and programmes, policies and actions aimed at developing the entire territory of the Member States, improving the quality of life and thus reducing the economic gap among countries (Cohesion principle). The Cohesion policy, by structural funds, is the instrument that the EU uses to reduce the socio-economico gap and is surrounded by the following principles:

1. 70% of the structural funds are addressed to underdeveloped countries. In +CityxChange some members of the consortium are beneficiary of structural funds. For example, the city of Limerick capital of the Midwest (classified NUTS 3)[30] in the Regional Operational Programme (2014-20)[31] received structural funds for actions

[28] https://www.eib.org/en/products/index.htm
[29] https://ec.europa.eu
[30] NUTS -3 regions with 150,000 to 800,000 inhabitants
[31] https://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/ireland/2014ie16rfop001

and projects regarding some priorities ares like research and innovation, ICT (Information & Communication Technologies), SMEs (linked to innovation), energy policies related to energy efficiency in buildings, low-carbon integrated actions to develop and revitalise urban areas. Last actions and priorities addressed to move towards a low-carbon society are very coherent and linked to +CityxChange project. Also Follower Cities are beneficiaries of structural funds and +CityxChange could be the occasion to start a dialogue with Managing Authorities of each Country to check and analyze any potential investment opportunities.

Structural funds are indirect funds managed by national and regional authorities. Indirect funds are more or less 80% of the EU total budget, with 5 funds that include indeed the European Structural and Investment Funds.
The funds are:

1. ERDF (European Regional Development Fund) – Priorities: infrastructures, SMEs R&D, regional and urban development;
2. ESF (European Social Fund) – Priorities: Human capital, social inclusion and good governance;
3. Cohesion Fund – economic convergence by less-developed regions;
4. European Agricultural Fund for Rural Development;
5. European Maritime and Fisheries Fund.

Beyond indirect funds, EU manages directly some funds by grants and contracts. Grants refer to projects that implement EU policies by calls for proposals (+CityxChange is a project financed by a call for proposal of Horizon 2020). Beneficiaries of grants can be a large variety of subjects like public bodies, business associations, business support providers, consultants, NGOs, etc, that can be eligible to implement EU programmes and policies.
EU issues contracts by Public Tenders to supply services, goods or to recruit human resources for studies, training, conferences, IT equipment and institutional communication.
According to their characteristics, the table summarizes the various instruments into four macro-groups as reported in the following table.

EU funds programmes			
Direct funding	Structural funds	EIB Instruments[32]	Financial Institutions Instruments
Cosme Horizon 2020 Life Interreg Connecting Europe Facility program (CEF)	ROP (Regional Operational Programme), ESF & ERDF Cohesion fund	Loans (for public sector, for private, intermediate loans for SMEs) Equity (venture debt, investments in SME & mid cap, Investments in infrastructure and environmental funds) Guarantees (credit enhancement for project finance, guarantees in support of SMEs, mid-caps and other objectives Advisory services - InnovFin advisory, EPEC / Public-Private Partnerships (PPPs), JASPERS, ELENA - European Local ENergy Assistance, FELICITY - Sustainable solutions for cities MPSF - Municipal Project Support Facility	European Fund for Strategic Investments (EFSI), also called the Juncker Plan European Energy Efficiency Fund (EEEF) Urban development fund

Table 5.2: EU F&F schemes

EIB instruments

The European Investment Bank is the biggest sustainable financing institution in the world, through loans, guarantees, equity investments and consultancy on sustainable projects development. In 2018, € 64.19 billion of funding supported € 230 billion of investments, usually financing 50% of a project trying to constitutes an incentive for the other institutions and private investors to contribute to the financing of projects. EIB Group is shared by the European Bank for investments (EIB) and the European Fund for Investments (EIF)[33]. Here below are listed main EIB financial instruments.

[32] https://www.eib.org/en/products/index.htm
[33] https://www.eib.org/en/products/index.htm

Loans	Equity	Guarantees	Advisory Services	Blending
Loans for the public sector	Venture de	Credit enhancement for project finance	InnovFin advisory	InnovFIN - EU finance for innovations
Framework loans for the public sector	Investments in SME and mid-cap funds	Guarantees in support of SMEs, mid-caps and other objectives	EPEC / Public-Private Partnerships (PPPs)	Donorm partnership
Loans for the private sector	Investments in infrastructure and environmental funds		JASPERS	The European Structural and Investment Funds (ESIF) - Financial Instruments
Intermediated loans for SMEs, mid-caps and other priorities			ELENA - European Local Energy Assistance	Mutual reliance initiative
			FELICITY - Sustainable solutions for cities	Private Finance for Energy Efficiency (PF4EE)
			MPSF - Municipal Project Support Facility	Natural Capital Financing Facility

Table 5.3: EIB F&F tools. Adapted from https://www.eib.org/en/products.

As stated in Article 309 of the Treaty on Functioning of the European Union, the EIB has the objective of supporting and contributing to the development of the European economy, by putting in place schemes to fund projects to support area of the union that are less developed, foster modernisation of the economy and the rise of new markets where these cannot be supported by individual States, facilitate the development in area of common interest of several member states[34]. EIB activities focus on four priority areas: innovation and skills, access to finance for small businesses, climate and environment, and strategic

[34] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:12012E/TXT:EN:PDF

infrastructure[35].The EIB can act in several ways, by providing credit, technical assistance, guarantees or venture capital. In agreement with the EC, EIB provides a set of financial instruments with the aim of encouraging leverage through private investment for projects that, despite having a high socio-economic value, are not attractive to excessive risk profile, time-consuming of the investment or other failures of the market return.

5.2.2 National and Local Financing Instruments

There are several major financing agencies for housing and the built environment in the Irish context. For example, the Housing Finance Agency provides loan finance to local authorities, voluntary housing bodies and higher education institutions for housing and related purposes[36]. There are approved housing bodies, such as Co-Operative Housing Ireland, which work closely with various stakeholders in the housing sector, including Local Authorities, Government, aspiring homeowners, tenants and developers, to provide high quality social-rented and home ownership co-operative homes across the country[37]. Private providers make up the vast bulk of homes built since the 2008 crash, and these are supportively rented through a Housing Assistance Payment to the property owner at a notional 90% of market value, but with post-crash inflationary pressures market rents are being paid across much of the country. Nationally the spend on these support policies is approaching €1 billion with targets in place to add a further 25,000 tenancies nationally by 2021.

+Limerick	
Housing Finance Agency	Loans to local authorities and other quasi-state bodies
Approved Housing bodies	Loans directly to social initiatives to support home building
Housing Assistance and Rental Assistance Support Scheme	Payments by the state directly to landlords to support those in the rental sector.

Table 5.4: Existing Financing Schemes in +Limerick for planned energy renovations.

Norway not being an EU member state, have access to only a limited number of European funding and investment schemes, applicable to local levels and actors (private and corporate). Especially important in this context are lack of access to funding schemes for the built environment, energy efficiency, energy systems, and renewables.

Norway has been blessed with more than 100 years of clean, cheap hydropower from numerous plants around the country, and is now close to fulfilling the 2020 goal of a renewable share of 67.5%. However, this has also had some impacts that influences both view and competence on new renewables, and available funding schemes and actors on the Norwegian scene. Thus, Norway hasn't until fairly recently seen interest from different actors on i.e. windpower, solar cells, energy efficiency measures etc. as well.

[35] https://www.europarl.europa.eu/factsheets/en/sheet/17/the-european-investment-bank
[36] https://www.hfa.ie/hfa/Live/Release/WebSite/HomePage/aboutus.html
[37] https://cooperativehousing.ie/co-operative-housing/

From the Norwegian perspective this can - in this context - be summarized as follows:

- Norwegians have fairly low competence on energy issues, have little interest in and are not good on energy saving and energy efficiency actions;
- The opportunities for funding support for energy measures are rather few;
- Norway has not seen the build-up of players and companies capitalizing on and taking risk shares in the energy sector, such as ESCOs; players also with experience on this within the national/local markets;
- There is low competence on and only limited use of green rental contracts, such as EPC models.

It is still the corporate sector far more than private persons that are concerned with energy issues and energy efficiency in Norway. However can be observed a growing concern and understanding among private persons on this matter in the country. For the +CityxChange project having a highly citizen and user centric approach, this is also important to take into consideration when planning for the citizen interaction part of the work.
All above makes up an important back curtain when describing the challenges on energy issues and actions in Norway for the coming years.

It is primarily the Norwegian State Housing Bank and national funding institution ENOVA that provides funding and opportunities for private persons and households. Still the funding and loans volume is moderate; ENOVA for instance providing €27.5M of funding to households in 2018. ENOVA is the main source and easiest available instrument also for companies. Focus from ENOVA side is now turning funding in the direction of integrated measures and energy assets and systems integration.

+Trondheim		
Norwegian State Housing Bank	Start up loans covering a broad array of topics and opportunities Ground loans Financing schemes for scoping and engineering of smart and green solutions	Ground loans are mainly for upgrading of existing and new private houses and apartments. These loan types also include extra opportunities for innovative and pilot and role model projects including green solutions, energy/renewable measures and projects etc. Financing schemes may also include funding support further than only loans.
Housing association companies (mainly OBOS and TOBB)	A wide variety of funding schemes focusing on climate, environmental, outdoor spaces and energy related interventions and projects	So-called Green Responsibility is a foundation for such companies in Norway. Funding/Financial support goes to housing associations, not private tenants in the associations.
Trondheim Municipality	Funding support scheme for EV charging infrastructure in housing associations Funding scheme for companies investing in freight EVs for their daily	Part funding to housing associations. Supports basic infrastructure and smart systems/ components for the association, not basic charging posts etc to the private tenant.

	operations/business	EV funding scheme provided as risk reduction to companies providing interest support funding for either leasing or buying EVs for professional use.
Storebrand (insurance company)	SPP Green Bond Fund	Invests in companies and projects with a clear positive impact on the environment.
ENOVA	A wide variety of funding schemes for both private persons (per today 10 programmes) and companies (per today 17 larger programmes)	Offers co-financing (highly variable co-funding shares). Programmes focus on energy efficiency, energy consumption reduction and energy systems integration measures and interventions.
Innovation Norway	In this context mainly: Innovation and start-up loans; Funding for commercialization; Funding for innovation contracts (where a public body needs to be one out of three actors); Funding for Environmental Technology; Funding and coordination of innovation partnerships.	Funding and support is for companies. Innovation Norway also offers mentoring and network building opportunities.

Table 5.5: F&F tools available in +Trondheim for planned interventions.

+Follower Cities		
Alba Iulia	Norway funds: EEA Norway Grants	Grants provided from Norway, Iceland and Liechtenstein for reduction of economic and social disparities in the European Economic Area (EEA)[38].
Pisek	Ministry of industry and trade – energy efficiency funding programme EFEKT (focused strictly on energy savings and broadening knowledge including creation of various technical "books"	- Innovation and research funding - Subsidy for public building energy retrofit and RES use (soft costs only) - Street lighting energy retrofit subsidy
	Integrated Regional Operational Program	- Support of alternative and low-/no-emission forms of transportation Residential multifamily housing (except Prague)
	Operational Programme Enterprise and Innovation for Competitiveness (OP PIK), by the Ministry of Industry and Trade[39] (mainly for enterprises)	- Smart grids implementation - subsidy
	Operational Programme Environment (OPŽP) by the Ministry of Environment (for public institutions and organizations)	- Emission reduction of stationary air pollution sources subsidy - Public buildings energy efficiency subsidy - Support to build passive houses
	Nová Zelená úsporám (Green to savings - best practice in EU) by the Ministry of Environment for family houses and residential multifamily housing only in Prague	- energy savings (building envelope and ventilation with heat recuperation) - Efficient RES
	EEA Norway Grants	Grants provided from Norway, Iceland and Liechtenstein for reduction of economic and social disparities in the European Economic Area (EEA).
	EPC/EC	EPC - technological project with payback within 10 years mostly (26 projects in Písek)
	ELENA	Support from EIB provided to regions for soft projects
Sestao	Ente Vasco de Energía (EVE, Basque Entity of Energy)	Grants related to energy efficiency
	Norway funds: EEA Norway Grants	Grants provided from Norway, Iceland

[38] https://eeagrants.org/about-us
[39] https://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/czechia/2014cz16rfop001

		and Liechtenstein for reduction of economic and social disparities in the European Economic Area (EEA).
Smolyan	The OP "Environment" and OP "Regions in growth" fund projects for public authorities.	--
	The Energy Efficiency and Renewable Sources Fund (EERSF)	Facilitates Energy Efficiency Investments; Pursues Substantial Reduction of Greenhouse Gases; Promotes the Development of a Working Energy Efficiency Market in Bulgaria[40]
	The Kozloduy International Decommissioning Support Fund (KIDSF).	--
	Norway funds: EEA Norway Grants	Grants provided from Norway, Iceland and Liechtenstein for reduction of economic and social disparities in the European Economic Area (EEA).
Voru	Norway funds: EEA Norway Grants	Grants provided from Norway, Iceland and Liechtenstein for reduction of economic and social disparities in the European Economic Area (EEA).

Table 5.6: Available F&F tools in +Follower Cities.

5.2.3 Other Financing Schemes and Instruments

This section summarizes the Financial schemes not necessarily connected to the EU but that support the development of Smart city projects in several ways; they are listed as follows:

- Green bonds
- Energy Performance Contracting (EPC) is a mechanism for organising the energy efficiency financing. The EPC involves an Energy Service Company (ESCO) which provides various services, such as finances and guaranteed energy savings
- Public-Private Partnership (PPP) is used for energy efficiency projects, in the form of a business partnership between a public (national or local government or agency) and private businesses.
- Tax Increment Financing (TIF) subsidizes companies by refunding or diverting a portion of their taxes to help finance development projects for a specific area, concerning infrastructure improvements or construction of new ones[41].
- Alternative finance (Crowd-funding, Soft loans, guarantees, Revolving Loan fund, On Bill Financing and Peer-to-Peer).

[40] https://www.bgeef.com/en/about-us/
[41] https://urban-regeneration.worldbank.org/node/17

Alternative Finance

Alternative finance are considered those financial instruments and channels in the market that differ and at the same time derive from the traditional finance system market such as banks/financial institutions and capital markets. Here below are listed not all but some alternative financial instruments.

- Soft loans, loan guarantees and portfolio guarantees. Financial tools where public funds invest in Energy Performance Contracting. Public portfolio covers any potential risk for ESCOs including any delay on payment.
- Revolving funds. Are set-up by either private or public lenders for a specific typology of energy efficiency or environmental sustainability projects; as soon as borrowers start repaying the debt, money are put back in the fund pot and can be lent to new applicants. Such funds can be financed from European Structural and Investment (ESI) funds.
- Cooperatives, Citizen based financing and Crowdfunding platforms. A crowdfunding scheme often uses an internet-based platform to raise funds from a variety of lenders, usually in small to medium amounts, for a specific project; in exchange lenders get equity in the implemented assets or financial guarantees. It can be used in combination with, or in alternative to, cooperative models where citizens get together and self-fund projects with shared ownership of the infrastructure.
- On Bill Financing. Energy suppliers receive their payback on loan by the reduction of energy bills. It makes a leverage effect between a utility and its customers to favour the access to funds for energy investments[42].
- Peer-to-peer (P2P) lending. Through dedicated platforms, citizens can exchange money with no official financial institution involved in the process in order to lend and borrow. It is often used when borrowers need access to financing and they cannot otherwise get. There is a certain degree of risk in such schemes as the lender has no assurance that the borrower will repay the debt. It can be suitable in specific circumstances, particularly small contexts, where trust is ensured between peers due to their geographical or social belonging.

5.3 Innovative and sustainable investments

Innovative, sustainable financing and investment models should drive society towards the achievement of sustainable goals where cooperation among private investors and public entities plays a key role in leading investments, smart advisory services and solutions. To achieve these goals, a commitment among public and private actors is needed in the "Financing chain". "Financing chain" can be defined as a series of business models and financing instruments that link different stakeholders (supplier, buyer, seller, financing institution, public body) to lower investments costs aimed at improving the business efficiency.

Starting from the assumption that "pilot" projects will be implemented in Lighthouse and Follower cities where public bodies play a key role in achieving this result, the first step to plan it's to strengthen cooperation and find common financial solutions among private and public bodies. So, public-private cooperation points to exploit diverse financing products

[42]https://ec.europa.eu/energy/sites/ener/files/documents/Overview%20Financing%20Options%20for%20Cities%20(2).pdf

with the maximum impact mitigating at the same time any risk management. Investment risk can be reduced and mitigated if integrated with digital solutions, digital platforms, crowdfunding and other financial and technological solutions as detailed in the following of this report. Investors (banks, real estate companies, retail market, citizens, etc.) are motivated and feel confident to invest in a mix of financial products if the investment risk is reduced to a minimum. In finance and investment theory, risk refers to the possibility that an outcome or investment actual gains can vary and the expected value or return on the investment can be lower. Definitely, risk can include the possibility of losing partially or entirely the invested capital. In our work and investment model we plan to adopt if necessary a series of mitigation instruments such as contractual arrangements, joint ventures, insurance and guarantees so facilitating the access to debt and equity financing by mitigating and transferring risks from project investors and private lenders to third parties. Risk mitigation instruments are also attractive options to strategically de-risk investments while crowding in private financial resources. In the EU market, banks still finance RES infrastructures, energy efficiency and sustainable actions adopting measures to support both private and public sectors: real estate, SMEs & bigger companies, public bodies, start-up companies, cooperatives and third sector operators.

At the same time, financial institutions are testing and investing in digital technologies trying to match applied technologies with green finance products. In +CityxChange the objective is to model financial products and services towards innovative and more efficient digital technologies thus prepaparing the path to a more flexible and accessible financial market. In +CityxChange potentialities of financial technologies (Fintech), such as crowdfunding applied to a digital platform will be implemented. In fact, for example, the establishment of the digital platform in +CityxChange applied and combined with the identified investment schemes aims at boosting innovation. On the other side, commercial banks are relevant investors in energy market and they are getting more involved in sustainability projects investment, though they are negatively influenced by the long-term returns of sustainable development projects.

Empirically speaking, the credit duration for the majority of environmental sustainability and energy efficiency projects usually falls in the short/medium range, on the contrary, infrastructural investments have long payback period. Green bonds, for example, have a short-medium duration, opposite to long term lenders like private equity funds, pension funds and insurance firms which look for long-term instruments matching their financial responsibilities. Definitely, considering the numerous investments and high financing needs for a public entities (smart city projects like in +CityxChange foresee many interventions), to find financing sources for sustainable development activities different financing channels and schemes are needed, including public and private capitals. The implementation of public policies and the use of public funds is helpful to reduce investment risks and facilitate/determine the involvement of public and private sources to finance sustainable investments.

Financial schemes, in particular “Green finance” investments models will be tested in +CityxChange to contribute to a decisive change towards a low-carbon economic transition for sustainable development. For “Green finance” we consider and include a series of

financial and investment instruments such as equity and debt (most used green financial instruments), green bonds, loans for infrastructural investments in renewable plants installation, buildings conversion and refurbishment. Actions and investments in Lighthouse & Follower cities will showcase and encourage at EU level the development of sustainable investments. Also other financial tools such as investment guarantee (for example for investors that would invest in renewable power production), insurance product or commodity, eco mortgages[43] can be applied. In +CityxChange financial and investment instruments can be released (with a contract) to project lenders in the form of positive externalities, meaning the integration of environmental, social and governance (ESG) with financial aspects, thus increasing accountability. Accountability means a new concept of "governance" where the energy community takes responsibilities for planning and sharing energy investments (in common spaces like citizen observatories). +CityxChange project will drive public entities, financial institutions and investors towards the awareness that ESG factors are fundamental elements for value creation. Actions and investments that jeopardize the environment can determine risks to financial assets.
Financial institutions, capital markets and institutional investors are beginning to take and assess their investment decisions considering environmental and social factors. ESG is not only a momentary tool to use and evaluate investments but a new concept and methodology to allocate capital across the lifespan of the projects and investments. Financial Institutes and companies are designing their investment managers' bonuses also considering the ESG parameters. In our investment models Public finance plays a key role to enable this "change" but also private sectors should invest to empower this shift. At the same time, the goal in +CityxChange is to create the conditions for revenues available to public and private energy projects, such as tariff reduction by reducing the costs of debt and equity.
At EU level, Member States should regulate the financial system to foster and facilitate sustainable investments. New rules to make more "green" the finance sector could help to identify new growth opportunities and new forms to support customers in providing investments. This could contribute to bring financial stability in the market. In Italy, for example, small and medium sized enterprises (SMEs) considering they weight in the economy, need support by financial institutions to facilitate access to credit for investments. In the last few years, the banking system invested large sums of money for renewable energy, above all for solar.[44] Banks are also investing in energy efficiency, in particular in the built environment, where the highest energy saving potential exists. At the same time, for capital markets, innovative instruments are being provided to encourage SMEs to access capital markets and thus boost the transition towards a low carbon economy.

One of these is the "green private equity", a financial instrument that consists of a medium-long term investment for not-listed companies with high potential venture capital (high growth companies). Institutional investors (economic operators like private companies

[43] http://eemap.energyefficientmortgages.eu/wp-content/uploads/2018/04/EeMAP-Technical-Report-on-Green-Finance.pdf
[44] Report of the Italian National Dialogue on Sustainable Finance, United Nations Environment Programme & Italian Ministry for the Environment, Land & Sea - December 2016

and owned by public bodies) use this financial tool with the aim of obtaining a substantial capital gain from the sale of the acquired interest or from the listing on the stock exchange. Private equity is a financial instrument that concerns not only the contribution of risk capital but also some activities (organization, planning, implementation) connected and useful to sustainable business realization. The particularity is that investor brings his professional contribution to the investment and participates to strategic decisions leaving with the executive board the operational management.

Private equity is being largely used at EU and worldwide level in financing development and green projects. Equity for renewable energy projects is also an instrument used by a company/utility that is intended to finance the entire project and also from a developer contributing with a partial equity (usually 20% to 40%) of the investment costs; or it can be provided from other investors such as infrastructure funds, private equity funds and insurance companies[45]. New technologies, human and working capital, new acquisitions can be financed by private equity. Definitely, green technology investments play a fundamental role to drive a "change" and a transition towards a sustainable economy in a Local Energy Market. Another financial instrument to cover debts capital for green projects are green bonds.[46] Green bonds are quite innovative financial instruments (with an extraordinary growth in of 1,5 Billions of Dollars in 2007 and 174 in 2012[47]) whose issues is linked to sustainable projects (energy efficiency, clean sources and sustainable land use). When this instrument was launched into the financial market, they were mainly issued by the World Bank or the EIB (European Investment Bank) but green bonds attracted the interest of other investors like private companies public bodies and municipalities. Some studies[48] revealed empirical difficulties in evaluating the social and environmental impact of green bonds. In +CityxChange the assessment matrix will try to measure the quality and the impacts of the energy projects and related issued green bonds .

Financial tools above described in their mainstream application and implementation face a series of obstacles and barriers that can be listed below:

- limited access to finance for SMEs negatively affects their contribution to the green economy;
- financial decision-making process doesn't look forward towards some long-term challenges such as climate change;
- citizens don't sufficiently participate and they are not informed about environmental aspects and policies.

In 1.0, finance is strictly preferred to sustainable and environmental goals. In 2.0, the total value equation is happy for financial to trade off against environmental and sustainable goals. In 3.0, the situation is the reverse of 1.0.

[45] "The role of institutional investors in financing clean energy" - Kamiinker Ch, Fiona Stewart
[46] Green bonds - Mobilising the debt capital markets for a low carbon transition - OECD
[47] Il Sole 24 Ore, July 2016
[48] Green bond study: Insight Investment (BNY Mellon IM)

Sustainable finance typology	Value created	Ranking of factors	Horizon
Sustainable Finance 1.0	Shareholder value	F > S and E	Short term
Sustainable Finance 2.0	Stakeholder value	T = F + S + E	Medium term
Sustainable Finance 3.0	Common good value	S and E > F	Long term

Source: Bruegel. Note: F = financial value; S = social impact; E = environmental impact; T = total value. At Sustainable Finance 1.0, the maximisation of F is subject to minor S and E constraints.

Fig. 5.3: Sustainable Finance transition in terms of value and horizon. Source: Schoenmaker, 2019.

The transition from sustainable finance 1.0 has already started and some financial institutions are avoiding investing in companies with high environmental risk (i.e. the oil and gas sector), as suggested by several studies and reports. Though, a recent work from Schoenmaker found out the wider financial system is just above Finance 1.0[49]. Nevertheless, +CityxChange objective is to contribute substantially to the transition towards more sustainable investments, by mentoring and leading stakeholders towards the creation of long-term social and economic value for the communities.

What is sustainable finance?

Sustainable finance is an innovative tool that considers and evaluates energy investments integrating financial and economic aspects with wider social and environmental goals. Financial Institutions in evaluating energy investments have not only the scope to reduce environmental impacts of infrastructural investments, minimize waste production and reduce greenhouse gas emissions but also to include social factors such as working conditions, local communities engagement , human rights and governance matters such as taxes. In this "innovative" investment schemes financial institutions are stimulated to inform investors, citizens on the environmental impacts of their investments[50].

EU action

The European Union is leading a change towards a more sustainable and green economy favourating policies and actions that support the financial system in committing to this transition. With the ambition to become a global leader in sustainable finance, the European Commission decided to develop an innovative strategy on sustainable finance. In January 2018, priority recommendations were published creating the ground of the Commission's action plan on sustainable finance approved in March 2018, here below are listed the main objectives:

- to reallocate capital for a sustainable and inclusive growth
- to prevent and foresees financial risks related to environmental and social issues

[49] A framework for sustainable finance, Dirk Schoenmaker, 2019.
[50] Norton Rose Fulbright "Global & EU sustainable finance initiatives" - Publication September 2019

- to encourage circulation of information, transparency and long-terms in financial investments and business[51].

What does the future hold?

Financial institutions and more generally investors in realising their investments want to monitor and assess their "portfolio" and their related financial feasibility. This will be done in +CityxChange investments adding ESG objectives[52].

The innovative and sustainable financing models that will be implemented in +CityxChange should stimulate the following actors and boost financial innovation in priority areas:

1. **SMEs:** existing forms and instruments of finance should be adopted, adapted and experimented in +CityxChange; new forms and schemes should be created and implemented with the objective to match traditional sources of debt finance and more innovative financial instruments thus ensuring that could ensure long-term impacts (financial, environmental and social impacts;
2. **Real Estate**: Central and Local Governments (City Council) could stimulate and encourage significant investments to improve the quality of buildings and make them more energy efficient. Besides, an innovative cooperation could support investments to strengthen the energy performance of residential, commercial and public buildings;
3. **Green Bonds**: the Energy Community of +CityxChange, with the support of financial advisory firms, including private and public bodies could issue green bonds;
4. **Insurance:** Public Authorities in cooperation with Insurance firms can create dedicated schemes to cover risks from investments, in particular for private investments in infrastructures, technologies, commercial and residential properties renovation;
5. **Clean technologies:** Public Authorities, in cooperation with financial institutions, could leverage their role to increase private capitals to discover & develop sustainable technologies, as well as to test and implement them. As an example, the REMOURBAN H2020 project[53] developed an innovative low temperature district heating solution). In the Spanish lighthouse city of Valladolid the solution has been implemented and tested, with private capital invested by Veolia.

In the frame of policies and investments to implement in +CityxChange and beyond the dialogue and cooperation among private subjects (financial institutions) and local and/or central governments it's necessary not simply to implement EU financial tools and regulations but also to take account of the opportunities and risks for the financial sector. +CityxChange to implement sustainable financing & investment models aims at analyzing how financial system can foster sustainable development in the near future. Financial institutions collect and analyze information and finance investments with an appropriate opportunity/risk role.

Moreover, to drive the flow of capital to sustainable business practices, it's also an objective of the "Paris Agreement"[54] on climate change. The starting point could be to promote and

[51] https://ec.europa.eu/info/publications/180308-action-plan-sustainable-growth_en
[52] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance_en
[53] http://www.remourban.eu/
[54] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

facilitate sustainable investments by involving development banks such as KfW - an active financing partner of German municipalities for many years.

In past years, capital infrastructures were financed with public funds and related energy services provided by private firms/companies regulated with procurement contracts. Private Public Partnerships (PPPs) to access finance instruments and thus reducing capital expenditures (used to invest in new projects) become more and more necessary in an historical moment where financial resources are reduced. At this stage, definitely, dialogue is decisive, not simply to implement international and European tools and regulations. To foster sustainable investments, the first step is to gather information on how financial institutions in some countries like (Norway and Ireland) are active in green and sustainable finance and how much they would invest in the sustainable sector. The other point to examine in depth it's to identify and analyze the main challenges and barriers to green and sustainable finance. EU States should operate and follow the European Commission (European Commission's Action Plan on sustainable finance - guidelines[55]).
Following the The European Commission's Action Plan, financial institutions are oriented and they are working to integrate sustainability aspects with consolidated operational processes such as risk management, debt crowdfunding etc.
Elements that represent drivers and barriers to the development of sustainable financing are policies and legal framework.

Moreover, policies and legal framework in most of EU countries are considered a barrier while the markets are not regulated with a uniform sustainable finance taxation. Demand is currently driven mainly by institutional investors, the perception is that demand from private investors (real estate, retail investors) is quite low and that is perceived as a barrier. Some financial institutions presume that's the consequence of lack of financial product offerings. From the other side, other experts believe that demand from institutional investors points to a long-term trend that will spread to other business areas in the near future. Financial institutions are setting up competences to provide advice on sustainable finance so they can approach clients more proactively.

The role of public finance

Public finance gives the opportunity to access to a series of collective and social services [56] that private market alone cannot offer, public actions also foster private investments with incentives, grants and subsidies[57]. in +CityxChange project, public finance could support Lighthouse and Followers Cities, assist them for sustainable investments and development. In +CityxChange, the methodology replicable at EU level, could be to identify and analyze cost-opportunities with high leverage social and environmental impacts. Other actions to foster public finance policies could to overcome market and institutional barriers in the financial system that obstacle green and sustainable investments, thus development.

[55] https://ec.europa.eu/commission/presscorner/detail/en/IP_19_3034
[56] https://ec.europa.eu/info/business-economy-euro/growth-and-investment/investment-funds_it
[57] JOURNAL ARTICLE Review: The Theory of Public Finance Reviewed Work: The Theory of Public Finance: A Study in Public Economy by Richard A. Musgrave

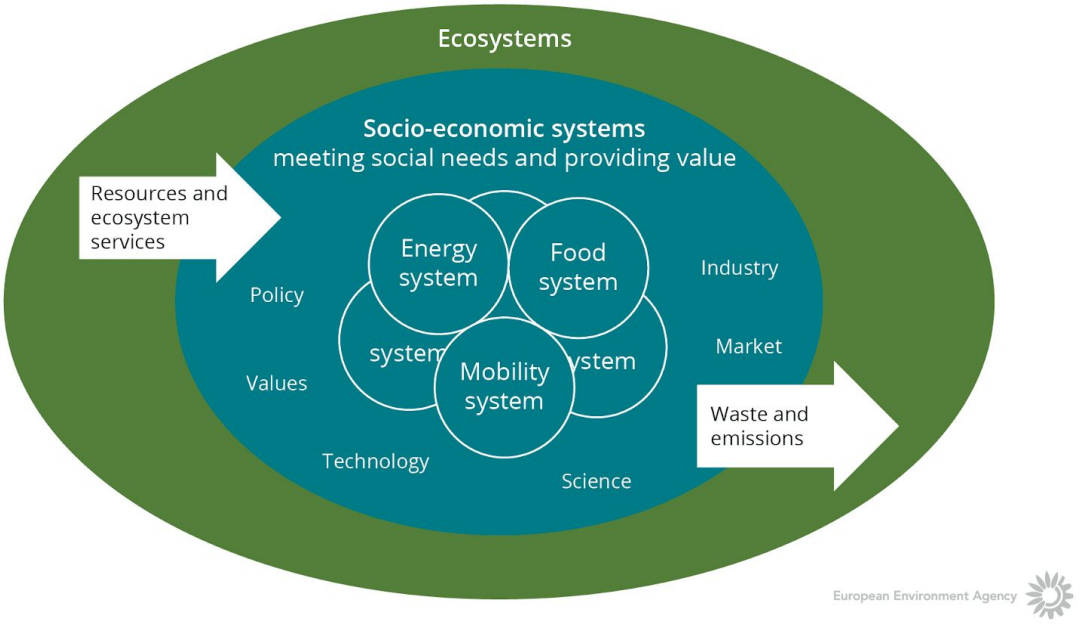

Fig. 5.4: The figure shows the concept and potentialities of 'natural capital' where the environmental system plays a key role for the country's economic growth, outputs and social well-being — providing resources and services, and absorbing emissions and wastes[58]. Source: European Environment Agency.

Other barriers are related to no-efficient incentives, insufficient transparency and poor management. Actions to be implemented to produce effects in sustainable investment models should be addressed to overcome a number of critical financing challenges, including:

- **capital intensity ratio:** it evaluates the capacity of a company to effectively use its assets. The estimation is quite simple while is calculated splitting all the assets of the company by its sales. A company with high capital intensity requires more assets. At the same time, the capital intensity ratio could be higher because a company invests more in capital than in working/human skills and clean technologies. From a financial point of view, this means not only capital costs for investments (buildings, electrical vehicles) but also to optimize life cycle costs. Definitely, to reduce capital cost is challenging. Lower capital ratio is more positive because the company generates more revenues with less assets. In +CityxChange Capital Intensity Ratio could be calculated in a range of a given period which differs from investment to investment; the estimated period to measure the capacity of provided investments is in a range of 5 to 10 financial years (the average period to calculate the profitability of the investment given the longer time-horizon of the project action compared to standard energy investments). In general, given the time range a capital intensity ratio between 1 and 2 can be considered profitable and acceptable.

[58]https://www.eea.europa.eu/soer-2015/europe/natural-capital-and-ecosystem-services/ecosystems-and-socio-economic-systems/view

- **speed and scale**: sustainable finance should be evaluated in a short-medium period to provide investors with "appealing" investment options. To identify short-medium targets is useful to have deadlines and work to a schedule, and motivated to keep moving toward the target as well as measuring how successful it is). Depending on the specific investment/infrastructure, it could be calculated the ROI on 5 to 10 years and considering a minimum amount of investments between 500k€ 1 M€.
- **extending the "Horizon"**: financial investments should be able to postpone and deliver short-term priorities over long-term objectives with a planned investment strategy, in particular for long-lived buildings and infrastructure, but in most cases, financial markets and financial policies don't look so far. The parameter value can vary according to the typology of investments. For building (energy interventions) the time horizon for the ROI could be calculated in 15 to 25 years, for energy generation plants this could be in the range of 7 to 10 years.

Actions in +CityxChange to promote energy investments and mobilize private capitals

In +CityxChange project the goal is to foster and experiment sustainable investments in the local market by the implementation of business models involving stakeholders and actors of the "energy" system. What actions to do and how to achieve this objective? First steps are to improve capacity building of involved stakeholders in local market, to drive them into a new sustainable investment market, raise their awareness and knowledge by the following actions and assessments:

- **investment driven policy recommendations:** a cooperation strategy among public authorities, financial institutions and academia should be established to provide "pilot environmental test investments" also to make recommendations to policy makers by using data and real world experience;
- **public awareness:** public engagement is provided in Living Labs, innovation playgrounds launched by the public bodies like TK and LCCC involving financial bodies (banks, foundations), trading and non-trading companies to illustrate, explain and clarify what environmental and sustainable investments are and how they impact in the market;
- **capacity building**: +CityxChange consortium should increase skills and knowledge concerning geen finance models and investments, also incorporating training programs. Universities and academic bodies could support training on green finance sector.
- **monitor and measuring progress:** +CityxChange project will monitor and measure the results of the financial instruments implemented in the project in line with a sustainable development. The results, the output of this monitoring activity can be a leading guide for orienting other public bodies (like Follower cities) inside the EU. This can also be done by the "+CityxChange observatory" which could give the continuation of the activities and the "pilots" implemented with the project.

The innovative idea could be to build in the implemented platform sharing of information also on threats and opportunities of financial instruments , for example on the following

issues and themes: the green bank system, the green bond market, the green institutional investments, risk analysis and related investments' progress, equity market and public finance.

Fig. 5.5: Key factors of the financial system - banking, capital markets, institutional investors, insurance and how public finance can "crowd" in private capital. Source [59]

What illustrated and shortly described in figure 6.3, defined the "5 Rs" (reallocation, risk management, responsibility, reporting and roadmaps), could be another innovative and useful scheme for evaluating factors that could influence financial investments, better described as follows:

- **Reallocation:** public authorities, to finance a sustainable economy, should re-allocate capital to critical priorities including green finance (e.g. by supporting SMEs with innovative financial schemes), raise capital for infrastructures (e.g. buildings, clean vehicles and urban design), and finance clean technologies.
- **Risk:** sustainable finance investments should take into consideration environmental, social and governance factors, within risk management processes. **Responsibility:** several financial institutions are implementing and sharing policies that integrate ESG factors. At the same time, policy makers need to influence and support the financial system driving theme towards the inclusion of green finance components that support economic growth.
- **Reporting:** financial management actions and investments should ensure information sharing and accountability.
- **Roadmaps:** EU countries have different strategies for sustainable finance so it should be implemented a process to link the different policies and issues in different sectors of the economy, so collecting a cluster of practices and identifying common next steps. The new Irish Climate Action Plan[60] and the National Climate Change Adaptation Strategy[61] are an example of two programmes that could "dialogue" to implement comment environmental strategies and actions.

[59] FINANCING THE FUTURE - Italian Ministry for the Environment, Land and Sea & UN Environment
[60] https://www.dccae.gov.ie/en-ie/climate-action/topics/climate-action-plan/Pages/climate-action.aspx
[61] https://www.minambiente.it/sites/default/files/archivio/allegati/clima/documento_SNAC.pdf

The access to green finance

The access to finance is a crucial point and a barrier to overcome in a positive and sustainable financial system. To guarantee the access to finance should be a priority (above all in Follower Cities) for all EU countries, for individuals and enterprises. SMEs are more and more active in green economy but they find high barriers to finance access. In this perspective, the financial system should foresee the involvement of financial services users and address them towards sustainable financial services.
The designed investment strategy in +CityxChange should drive towards actions that facilitate access to finance for SMEs and include some innovative financial tools like the crowdfunding.

Sustainable finance	Environmental impact	Waste and CO2 emissions	Social factors (working conditions, local communities, conflict and human rights)	Governance matters (executive pay, bribery/corruption, board structure and tax strategy, financial decision-making)
1.0				
2.0				
3.0				

Table 5.7: Sustainable investment assessment matrix

The sustainable investment assessment matrix is an experimental model to assess long-term energy investments in LEM. It measures if investments are sustainable for the Local Energy Market structure and provides information on demand and/or supply of energy services, products and infrastructure by using the following factors and indicators:

- Environmental impact;
- Waste and CO_2 emission;
- Social factors;
- Governance matters.

The matrix proposed here is intended to be further developed during implementation WPs for LH&FCs, by adapting it to specific investments put in place.
The objective of the Matrix is to assess the ESG (Environmental, Social, Governance) key issues of each investment and then identify those that are potentially bankable. The Matrix analysis assesses investments to manage ESG risks and opportunities. In the evaluation of the Governance, the Matrix takes into consideration key issues, such as board structure, remuneration, shareholder ownership & management control. Other key issues are related to carbon footprint or water risk. The model aims at evaluating if the investment is sustainable and respects the integration of environmental, social and governance (ESG) criteria into the analysis. More usual assessment criteria, like risk management, return on investment and cash flow analysis will embrace ESG factors. The matrix incorporates sustainability criteria into every stage of the investment process. One key aspect of the model is to engage a strategic dialogue with policy makers and citizens.

5.4 Required infrastructure and investments

Together with LH and FCs an investigation has been carried out during Task 2.7 in order to identify the planned interventions in the project cities in terms of infrastructure, technologies and systems to be deployed to establish and operate the PEBs and the connected local markets.
Again the level of detail varies quite consistently among cities, being the lighthouse ones more advanced in the planning than the follower cities are.
In the following tables the results of such investigation are reported, being this the starting point for fine-tuning and implementation of financing and financial models, which is ongoing and will be finalised in the dedicated implementation tasks for LH and FCs.

5.4.1 +Limerick

ID	Intervention	Owner/ Leader	Implemented by	Total cost	EU Contribution	In-kind Contribution	3rd Party required contribution
+L01	Tidal energy plant	GKIN	GKIN	€ 3M	€ 514,286		€ 2,485,714
+L02	Energy renovation	LCCC	TBD	€ 50M	€ -		€ 50M
+L03	Community Grid	MPOWER	TBD	€ 250,000	€ 196,000		€ 64,000
+L04	eMobility	ABG	ABG	€ 800,000	€ -		€ 800,000
+L05	LEM	MPOWER	TDB	TDB	€ -	€ -	€ -
+L06	LFM	MPOWER	TBD	TDB	€ -	€ -	€ -
+L07	PV	TBD	TBD	TDB	€ -	€ -	€ -
+L08	Battery Storage	TBD	TBD	TDB	€ -	€ -	€ -

Table 5.8: Planned interventions and required funding for +Limerick

5.4.2 +Trondheim

ID	Intervention	Owner/ Leader	Implemented by	Total cost	EU Contribution	In-kind Contribution	3rd Party required contribution
+T01	Energy renovation corporate buildings Sluppen	RK	ARUP, RK	€ 413,000[62]	€ -	€ 269,000	€ 144,000
+T02	Energy renovation residential building Tempe	Frost Property	ARUP, Frost	€ 63,000	€ -	€ 41,000	€ 22,000
+T03	Energy systems integration	ABB	ABB	€ 10,000	€ 10,000	€ -	€ -
+T04	PV - district level - Sluppen	ESCO X	ESCO X	€ 1,719,100	€ -	€ 1,719,100	€ -
+T05	Battery Electric Storage - Sluppen	TE	TE	€ 260,000	€ -	€ 260,000	€ -
+T06	Heat Pump - Sluppenvegen 10	NHP	SV	€ 444,000	€ 253,714	€ 190,286	€ -
+T07	Heat Pump - Sluppenvegen 17A	SV	SV	€ 444,000	€ 253,714	€ 190,286	€ -
+T08	eMaaS	ABG	ABG	€ 1,484,000	€ -	€ 1,484,000	€ -
+T09	LEM	POW	POW	€ 114,330	€ 29,330	€ 85,000	€ -
+T10	LFM	TE	TE	€ 131,000	€ 131,000	€ -	€ -
+T11	Battery Electric Storage - Brattøra	TE	TE	€ 260,000	€ -	€ 156,000	€ 104,000
+T12	PV - Sluppenvegen 19	RK	RK	€ 230,000	€ -	€ 230,000	€ -
+T13	Heat Pump - Sluppenvegen 19	RK	RK	€ 70,000	TBC	TBC	TBC

Table 5.9: Planned interventions and required funding for +Trondheim.

[62] Energy renovation figures originally based on €8.6/m2 UFA

5.4.3 Follower cities

FC	Intervention	Owner/ Leader	Implemented by	Total cost	EU Contribution	In-kind Contribution	3rd Party required contribution
Alba Iulia	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Pisek	IoT pilot (env., smart metering)	Smart Písek	TCP, Bluematic	€ 17,400	0	€ 8,700	€ 8,700
Pisek	Energy portal	Smart Pisek	ENESA	€ -	€ -	€ -	€ -
Pisek	Energy certificates map	Smart Pisek	Smart Pisek	€ -	€ -	€ -	€ -
Pisek	Heat Vulnerability map	Smart Pisek	Smart Pisek	€ 1,923	€ -	€ 1,923	€ -
Pisek	SECAP+ energy competition in schools	Smart Pisek	E-resources + Smart Pisek	€ 43,294	€ -	€ 8,659	€ 34,635
Pisek	Smart metering	Smart Písek	TBD	€ 17,400	€ -	€ 8,700	€ 8,700
Pisek	Data integration platform	Smart Písek	TBD	€ 11,700	€ -	€ 11,700	€ -
Pisek	OpenData catalogue	Smart Písek	Smart Písek	€ 1,900	€ -	€ 1,900	€ -
Sestao	Biomass district heating	Municipality of Sestao	Giroa-Veolia, Oneka, Tekman	TBD	TBD	TBD	TBD
Smolyan	Energy efficiency measures (insulation, change of windows etc.) in 12 multi residential buildings	Municipality of Smolyan	TBD	€ 2,5M	€ -	€ -	€ 2,5M
Smolyan	Energy efficiency measures in the building of	Municipality of Smolyan	TBD	€ 1,7M	€ -	€ -	€ 1,7M

	the Smolyan Planetarium						
	Measures for the improvement of the quality of the air in the Municipality of Smolyan - heating systems.	Municipality of Smolyan	TBD	€ 4,5M	€ -	€ -	€ 4,5M
Voru	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Table 5.10: Planned interventions and required funding for +Follower Cities.

5.5 Cost of financing, Monetisation of the value chain and Return on investment evaluation for all stakeholders

The task description for T2.7, as per Grant Agreement, requires the evaluation of the cost of financing, the monetisation of the identified value chain as well as the calculation of the ROI for the various stakeholders involved in the PEB implementation and operation.
At this stage of the project, given that the measures to be implemented are not yet completely defined and the market design and the related platforms development are ongoing for both energy and flexibility, it is not possible to carry out the aforementioned duties, as better detailed in the following.

The cost of financing depends strictly on the financing sources selected, and in some cases are subject to negotiation between the project proposer and the financing institutions; it means that it can be defined only once the investment volumes are finalised, the investors have been identified and engaged with.
With regards to LHCs, such activities are ongoing as part of T4.11 "Sustainable Investments" [M12 - M36] for Limerick, and T5.11 "Sustainable Investments" [M6 - M36] for Trondheim, both led by OV and carried out in close collaboration with local partners and financial institutions; T4.11 has been front-started in M8 in order to ensure that all the required funds will be available for the start of the implementation phase.

The monetisation of the value chain is a consequence of the market design and implementation in terms of costs and, especially, revenues that will be generated in the local market for the traded products and services. As the development of the platform for local trade has not (officially) started yet, related information about prices cannot be utilised at this stage in T2.7. In addition, a clear understanding of the local trade operation and of related energy and flexibility prices, will be possible only after the solution is deployed in LHCs. For such reason the monetisation exercise will be carried out in T4.11 and T5.11 for, respectively, the Limerick and Trondheim implementation of the local market.

As a consequence of the aforementioned considerations on cost of financing and monetisation of the value chain, the return of investment calculation needs to be postponed to when the necessary input information will be defined at least for the two lighthouse cities. Again T4.11 and T5.11 will remedy and carry out the foreseen ROI calculations for involved stakeholders.

Future deliverables D4.15 “Limerick Energy Investments Models White Paper” and D5.16 “+Trondheim sustainable investments and business models and concepts” (both due at M36) will report on the aforementioned activities.

6. Guidelines for Bankability Optimisation of PEB investments

These Guidelines are addressed to stakeholders and players in the local market that agree on the relevance and importance to measure the bankability of energy investments. In a more general perspective, stakeholders consider their "slice" of risk and measure their bankality according to their interest and point of view. For example banks focus their attention on the DSCR indicator, that is the capacity of the projected future cash-flows to cover the debt services; on the other end private equity lenders measure the project bankability in terms of return on investment alongside fiscal incentives and how those fit into their overall portfolio strategy. Public Authorities tend to target investments positive impacts on the territory and the genesis of a "political return", while citizens wish a more sustainable urban quality of life. The Deliverable 2.4 gives guidance on technical and economic matters are for all stakeholders, also making energy projects' and investments feasible, respecting regulatory terms. Moreover, a cooperation model that involves all project stakeholders gives the possibility to communicate the right "bankability aspects" of investments to potential investors. The strategy which will be implemented by the actions described in the Deliverable and synthesized in the Guidelines is to co-design business and investment models required to support implementation of the +CityxChange actions, exploiting the wealth and income differences and the diversity of involved stakeholders in order to implement a continuous and effective management of project risks.
These Guidelines summarize and describe the main actions to be taken by stakeholders to move from "Energy Blocks" to "Positive Energy Blocks" reducing the gap and the results from the financial approach, management and technical risks and establish a link between the two.
The +CityxChange definition of a positive energy block is at least three mixed use buildings producing more energy than they consume, annually. A correctly designed and defined pool of flexible resources are crucial to achieve a PEB. The existing resources must be mapped and additional needs for new flexible resources must be analyzed and planned for in the process of setting up the PEB. Incentives regarding cost of investments and benefits from operation must be analyzed and made clear in an early stage of the planning process.

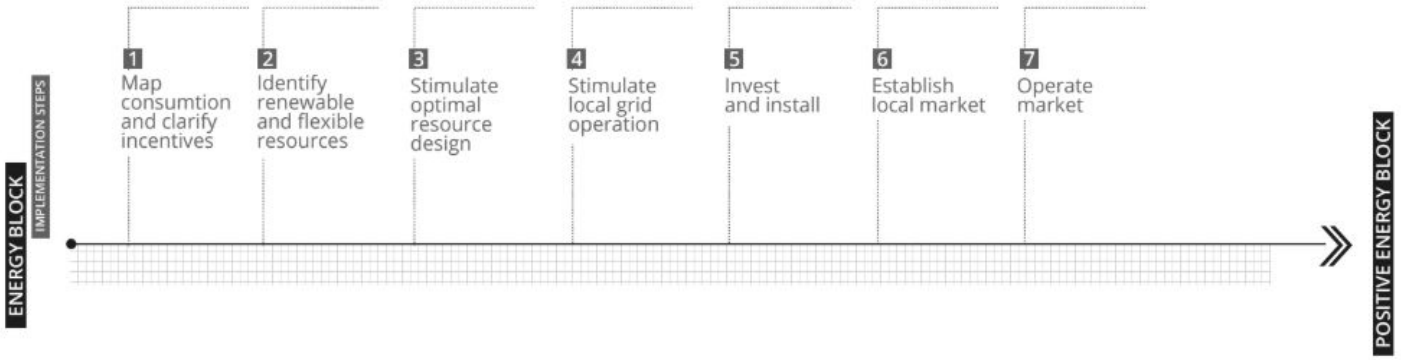

Figure 6.1: The steps from an Energy Block towards a Positive Energy Block with identified actions and their progress. Source +CityxChange, D2.1 "Report on Enabling Regulatory Mechanism to Trial Innovation in Cities".

To establish a PEB it is required to invest in new assets for generation, release more flexibility and to consume energy more efficiently. In figure 6.1 it is given an overview of the milestones in the process of setting up the required resources and flexibility to operate as a PEB.

6.1 A stepwise process for development of PEB business and investments

Although Business and Investments Modelling have been treated separately in this report, they are the two faces of the same coin: making the PEB establishment and operation profitable for all the involved actors, from citizens to local businesses, from prosumers to technology providers, up to institutional investors. Based on the analysis carried out on Task 2.7 and on discussions with involved cities and partners, a set of guidelines is provided in order to optimise business practices and to attract investments for the establishment and operation of a PEB and the associated local market in Lighthouse and Follower Cities within +CityxChange project and beyond.

As emerged during task activities and reported in the previous sections of this document, innovation in business and investment modelling is a key factor for the success of the PEB implementation and the operation of local markets.Such business innovation process requires identification of and engagement with all relevant stakeholders, thus exploiting the ecosystem envisioned by the open-innovation Quintuple Helix Model. Within the ecosystem remains central the role of the public authority, which has to act as proposer, planner and guarantor for the city transformation plan

Physical implementation and operation of a Positive Energy Block/District requires the following activities to be carried out:

- Definition of the PEB boundaries and auditing state-of-art of building energy performances, energy generation and consumption, available flexible assets and related infrastructures;
- Identification of required measures for improvement of energy performances, local RES, storage and management optimisation in order to reach positive energy balance;
- Design of local energy and flexibility markets in order to ensure optimisation of energy operations and value creation within the PEB boundaries.
- Fulfillment of the 4 roles identified for the local energy market in order to provide required energy services with the objective of matching demand, generation and balancing.

Alongside with the physical implementation of the PEB and the Local Market, business and investment models need to be developed and implemented and in order to do so the following steps can be followed:

1. **Define project scope and boundaries, including identification of financing needs:** the first step is to analyze and measure characteristics of the project linked to objectives (feasibility study and SWOT analysis by using the methodologies identified in Deliverable 2.4).

2. **Identification of and engagement with business and financial stakeholders that will participate in the PEB market:** the identification and involvement of business and financial stakeholders is needed to take common decisions regarding engagement on financial options and investments. These actions can be implemented through the creation of a community committee comprising representatives of all stakeholders group to take and share common decisions.
3. **Co-design of business:** co-design foresees a development investment process to ensure that decisions and results meet all stakeholders' needs, including Identification of players, their objectives and strategies to meet them.
4. **Co-design investment models:** the model includes investment risks (identification, characterization, assessment, management and control) and mitigation strategies.
5. **Implementation of business models within the establishing PEB:** the design of an innovative model happens in the planning phase but the real goal is to put it into practice. This phase foresses the actions to test the concrete results and impacts of the business models.
6. **Implementation of investment models**: likewise business models, the implementation of the financial schemes and tools into real world application includes performing necessary tasks to apply for and obtain funds to finance the foreseen actions.
7. **Continuous monitoring of the investments performance**: the community committee monitors funds and portfolios for returns and performance of investments. Through this, the model provides regular commentary on funds as well as on general market and economic conditions and how they may affect investment funds held.

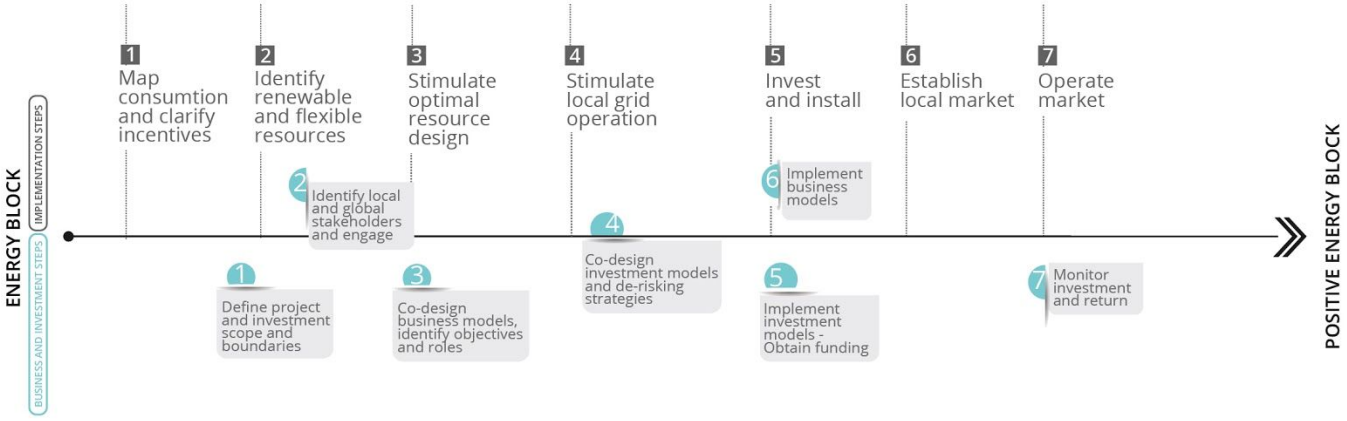

Fig. 6.3: Stepwise process for business and investment implementation in PEBs.

In order to assess the investment-bankability of an energy project, stakeholders evaluate the impacts and the investment risks from different perspectives that are defined by their investment profile, which in turn influence their definition of mitigation measures, being them legal, technical, financial and so on.
Bankability assessment, risk management and mitigation then needs to be informed by produced data, collected information and generated reports looking at the project from

different points of view; therefore it is a collective effort. Here again is central the role of the public authority acting as coordinator of such tasks, with the help and support from technical and financial advisory professionals.

In terms of raising the necessary capital for the implementation of +CityxChange model, potential financial sources and tools have been mapped and reported in previous sections of this report.

In particular, with the support of the EU financing instruments (Elena, Jasper, etc.) one of the priorities of +CityxChange is to obtain funding and financing for many of the planned interventions in LHC&FC, which are actually not funded by H2020, in particular with regard to Energy Efficiency of buildings (as in Limerick Georgian district) and RES (as in all the follower cities). Moreover, in +CityxChange project innovative finance can play a considerable role in raising equity via crowdfunding and participatory budgeting as addressed in WP3, CommunityxChange activities.

The integrated investment model proposed in this report includes such elements of innovative finance, as it aims at matching several different public and private financial sources to enable investments in PEB infrastructure. Green bonds are also included as an option in the model, as this financial tool launched in recent years is expected to continue growing and to play a central role in the European Energy transition [63].

Public financing sources and tools

- Sovereign Funds and Grants (i.e. EEA Norway Grants)
- EIB - European tools of advisory (ELENA, Jaspers, URBIS, ERDF)
- Green bonds, Social Responsibility - expected to grow exponentially in the coming years, should become easier to access

Private investments

- Crowdfunding & Participatory budgeting approach
- Loans
- Tax credit schemes
- ESCo - widely tested for energy refurbishment, could include EPC
- Project Financing
- Vendor financing
- Leasing - rent instead of buying for infrastructures
- Venture Capital
- Cooperative Banking - within the framework of energy cooperatives

Cooperation between private and public subjects

- PPP
- Concession
- ESCo

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https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-green-bond-standard_en.pdf

- Community land trust models
- Co-housing - experiences (as for example those in Germany funded by EIB).

By looking at the financial tools and sourced mapped, another objective of the model emerges: to realise large scale energy efficient investments going beyond the traditional banking system, as commercial banks still expect short term returns on their investments which are often not compatible with the long-term horizon of the expected social returns of the actions implemented within +CityxChange.

Social goals contribute to the sustainability of investments within +CityxChange, which is intended as a broad concept involving, alongside with financial sustainability, environmental, social and governance aspects.

A process for assessing the sustainability of the project investment is proposed in section 6 of this report and is paramount, for reaching the overall sustainability objectives of our investments, that the ESG matrix proposed is shared with and agreed upon by all involved stakeholders, and that the necessary information for its evaluation is produced since the early stage of the process.

As discussed previously in this report, there are two main aspects, worth stressing on, that are key in attracting in designing and implementing successful customised business and financial models:

1. Investment de-risking: by lowering to a minimum and properly mitigating the overall investment risk, +CityxChange project actions will result more attractive to private, public and alternative investors. This can be obtained through:
    a. Setting up a mix of public, private and alternative financial instruments;
    b. Fostering productive interactions between private and public sectors, where the private actors can contribute with experience and professionalism and the public with sponsorship and risk sharing/risk covering tools such as bespoke insurance policies;
    c. The engagement at different levels of the public governance in order to exploit the available financial mechanisms that have been put in place in recent years to support public investments.

2. Stakeholders acceptance and involvement:
   Structured city transformation actions, as the ones foreseen in +CityxChange, concern a wide range of stakeholders, including local government and businesses, non-profit and research organisations like universities, charities and citizens associations, individual citizens and so on. Actions that are expected to affect, even though in positive, their habits and the way they live and do business within the city cannot happen without their active participation and their strong commitment. At these aims, stakeholders and social actors more widely, need to be engaged in the co-design of the actions even in terms of business and investment models. So every stakeholder involved can take ownership of their “slice” of the change being implemented and act towards it.

Stakeholders involvement in +CityxChange is one of the main innovative actions foreseen in the project. The stakeholder involvement methods are expected to be tested in innovative tools developed by and applied throughout the project journey, including the Innovation playground, the Participants playbook and the Innovation Labs. It is therefore through those tools and processes that stakeholders have the occasions to co-design solutions for energy efficiency investments as well as suitable business models and, eventually, they will be involved in making them successful.

7. Conclusions and Next Steps

Activities carried out in Task 2.7 "Optimize the Bankability of the Demonstrated innovations" led to the definition of business and investment models, in terms of roles, players, their objectives and the strategies available to meet those objectives, aiming at optimising the economic and financial operation of the PEBs.
Starting from several high-level concepts around the bankability issue, as they've been presented and discussed in a dedicated workshop held during the project kick-off meeting, a methodology and procedures have been developed and the most relevant outcomes from that workshop have been addressed as reported in the following table.

Kick-off Meeting Workshop outcome	Addressed through
As part of the project output it should be cleared how the results will impact people and what are the cost implications for the implementation.	Stakeholders acceptance and involvement; Co-design of business and investment models.
The financial aspects and implications are key and must be carefully considered.	Dedicated financial models derived from the integrated model presented to be developed in dedicated cities tasks.
The project will have an impact on politicians, owners and occupiers but the general public should be informed as well.	Stakeholders acceptance and involvement; Community engagement activities.
Each stakeholder (politicians, owners, etc.) should be targeted in a different way to highlight how they can benefit from +CityxChange and respond to their needs.	Stakeholders acceptance and involvement; Community engagement activities.
Funds not available	Mapping of financial sources and tools; Integrated Investment Model.
Is the solution affordable and does it have an impact on the single only or on the community?	Sustainability of the investments assessment through ESG matrix.
Top-down design of solutions.	Co-design of business and investment models.
Lack of buy-in, not clear message of the impact to the single/community "what does it bring to me?"	Stakeholders acceptance and involvement; Co-design of business and investment models.
Will tenants be willing to invest? Will building owners invest in a building they don't live in?	Community engagement activities; Co-design of business and investment models.

Table 7.1: Response to Bankability workshop outcomes from kick-off meeting.

Through consultation and interactions with involved cities and partners, the required tasks for PEB implementation and operation have been identified alongside necessary infrastructures and related investment volumes.

The proposed models are intended to set the ground for further development and consequent implementation of business and investments in Lighthouse and Follower cities within the +CityxChange project. In order to do so, activities have already started in LHCs Trondheim and Limerick.

In particular the proposed integrated investment model will be applied to different interventions, by extracting specific path connecting a bespoke mix of financial products to the project implementation party delivering the innovation in the city, through the local authority actions and with support of required financial and technical intermediaries.
An example of how such a model can be utilised is reported in the following figure as highlighted by the red solid lines: public EU funds for energy efficiency of buildings, together with private capital (for example provided by private equity funds) and with the contribution from a crowdfunding platform are raised and made available by the local municipality to private owners and ESCOs in order to deliver buildings energy renovations. In this sub-model the municipality subscribes insurance policies in order to reduce the risks for private investors thus leveraging private capital; also technical and financial advisors participate in the effort for contracts and projects standardisation with the objective to speed-up the implementation and increase the renovation rate, whilst reducing further investment risks.

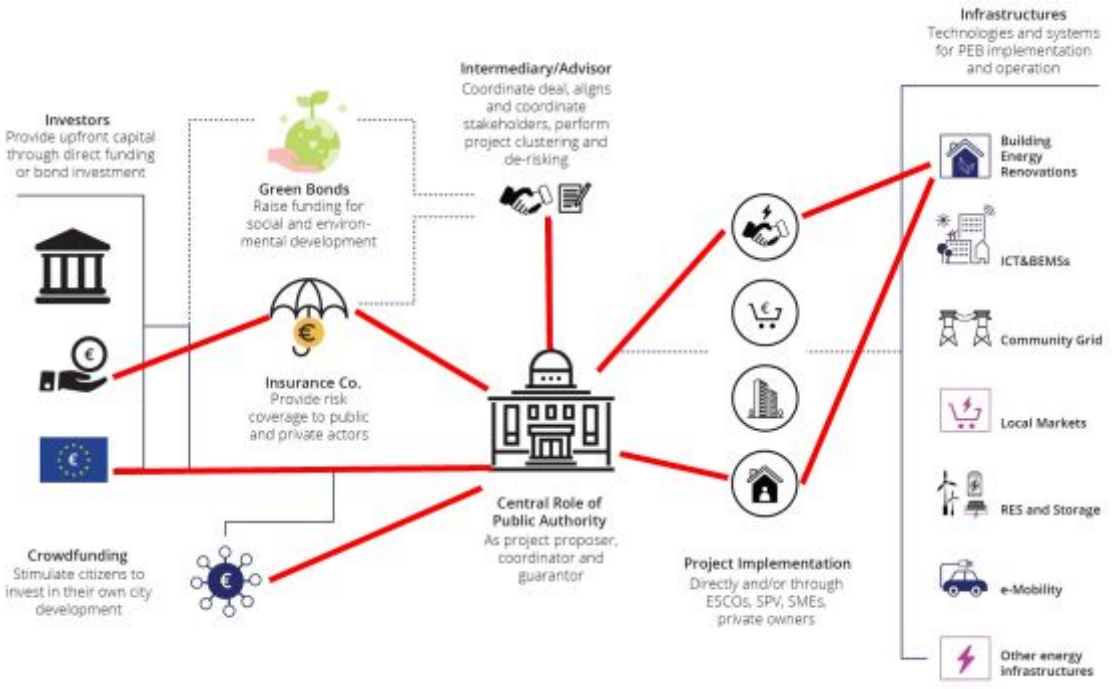

Fig. 7.1: Potential application of the integrated investment model for buildings energy renovation.

The aforementioned sub-model is being evaluated in T4.11 "Sustainable Investments" which is currently focused on investment models for the energy renovation of the Limerick Georgian district. Due to the complexity of that action the mix of financial instruments is being defined, via collaboration with local partners and potential investors, as well as through engagement activities with the city social actors: having the citizens on board is paramount for implementation and operation of the Limerick PEB even because

investment in their own buildings and properties is expected to trigger a strong commitment to the success of the project.
Following on, additional business and investment models will be fine-tuned and implemented in order to deploy all additional necessary infrastructures, technologies and systems to operate the PEB and the local markets, as identified in the dedicated paragraphs of this report.
Task 5.11 instead requires private investments in RES and storage that are not actually funded by the EU. In order to secure such investment the integrated investment model presented in chapter 6 is being adapted to involved stakeholders with the objective of developing a specific "Investment Risk-Sharing Model".
While connection between Task 2.7 and implementation of business and investment models in LHCs is established, for FCs the same will be done later in the project, particularly with regard to Task 6.3 "CommunityxChange" starting in Month 13 and Task 6.5 "Building investment pipelines and novel business models" that is expected to start at Month 37.
For what concerns Task 6.3, the main objectives here are the engagement with local communities and stakeholders in follower cities in order to refine and adapt the identified business and investment models to the specific needs and expectations present in follower cities, and also in order to support deployment of funding frameworks for the innovation playgrounds when the engagement activities will take place.
Starting from the outcomes of Task 2.7 and with contribution from Task 6.3, it will be in Task 6.5 that business and investment models will be customised for the FCs.
Task 2.7 and this deliverable D2.4 are the starting point also for "Scaling up, Replication and Exploitation" addressed in WP8. In particular Task 8.3 "Market and stakeholder analysis to understand exploitation potential of +CityxChange solutions", will move from the outcomes presented in this deliverable and from their implementation in lighthouse cities in order to perform an in-depth market analysis across the different sectors associated with +CityxChange project.
The work done in Task 2.7 and reported in this deliverable, alongside with its development and implementation in cities, is expected to contribute to +CityxChange overall impact as measured by dedicated KPIs in the "Investment" category showed in the figure below.

Fig 7.2: Expected impact related to the "Investment" category. Source: www.cityxchange.eu.

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