D2.1 Report on Enabling Regulatory Mechanism to Trial Innovation in Cities

+CityxChange | Work Package 2, Task 2.1

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List of Definitions

Term	Definition/explanation as applied in the project
Capacity product	Flexibility with a time resolution of 15 min or less which is available in the local PEB market.
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).
Disturbance-neutrality	Disturbance Neutral Electricity Production. The neutralisation of Electrical Disturbance, created by Electricity Production, at the "Grid Edge" (Behind the meter" by appropriate real-time compensatory measures such as "surplus-to-needs" on-site Power Dissipation, Storage or through regulated Disturbance Neutral Power-sharing within a Franchised Local Energy Community (FLEC) by use of regulated collaborative Advanced Digital Trading Control Automation Systems. Grid-connected Disturbance Neutral Electricity Production Systems are designed, and deployed, to eliminate disturbance caused by a specific generator/s in terms of electricity Voltage, Current and Power-factor at the point of sale (the Consumer Meter). Disturbance Neutrality® ensures there is no interference on grid voltage, frequency and power factor. Disturbance Neutrality® is assured by a combination of digital technologies and compliance with power quality rules, regulated by contract.
DSO	Distribution System Operator.
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 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 grid balancing tool	A software that simulates load flow in the local grid with the scope to identify and timestamp possible constraints and need for system services the coming planning period – every hour over a period of not more than 1 week.
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.
Microgrid balancing	Use of flexible products to secure acceptable operation of local grid.

PEB design tool	A software that calculates an optimal diversification of local resources with the scope of creating a PEB. Costs and predicted values of flexibility products are basic inputs for the optimal design.
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.
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 a time resolution less than 5 min which is available as a system service product within the local PEB market.
Tangle	Distributed ledger technology for digitalised information from market transactions of products. Part of IOTA platform.
Trade platform	A software that collect product bids from available flexible resources, calculates market price and sends plan for activation back to accepted PEB bids.

1 Executive Summary

This report investigates and analyses how EU legislations and national regulations influence the process of establishing positive energy blocks (PEBs), positive energy districts (PEDs) and community grid systems (CGSs) - and how they could be processed and operated within the framework of a local energy market. Within the scope of the report, these terms are defined and understood in the following way:

Positive Energy Block (PEB): A compact area including at least three mixed use buildings (> 15.000 sqm) and local production which over a year produce more energy than it consumes. In Ireland the PEB will be referred to as the Community Grid System (CGS) as described below.

Positive Energy District (PED): Mixed-use energy efficient districts that have net zero carbon dioxide emissions and actively manage an annual local surplus production of renewable energy.

Local Energy Market: A transparent market accessible for all appropriately metered assets - independent of size - within a PEB or PED. Could be local production or local consumption. The local market operation includes system operation.

Community Grid System (CGS):
Community Grid System (incorporating smart-grid PEB's) is a group of distribution network connected electrical resources, within a clearly defined boundary in the distribution system, with a single defined logical connection point to the wider grid. Unlike a traditional Microgrid, the Community Grid is a logical rather than a physical connection point in which it is obligated to autonomously maintain disturbance-neutrality at that point. The concept of the Community Grid is that of a virtual "microgrid", where the energy entities (demand customers, generation and energy storage) are connected to the existing DSO network in a similar manner to today.

The project demonstrations will be implemented under actual national regulatory regimes with relevant dispensations. However, an extensive implementation and upscaling of the tested solutions demands compatibility with current and future EU regulations.

The major scope of the project is to identify, describe and support processes that enables positive energy blocks and districts. It is focused on how these rather progressive and innovative processes are challenging established operational routines in the countries of the actual Lighthouse and Follower cities. For the project it is investigated and done through a gap analysis between Norway and Ireland for the Lighthouse Cities of Trondheim and Limerick. It is included an overall comparison with and between the Follower Cities of Pisek in Czech Republic, Võru in Estonia, Alba Iulia in Romania, Smolyan in Bulgaria and Sestao Berri in Spain.

A Positive Energy Block or District is possible where the annual energy production within an area is greater than energy consumed within the same area. To make this possible it is crucial to address all existing and new incentives including how these incentives should be amplified by using new technology and business models. For a basic understanding of all the implications in the process towards this scope, how the power market is operated is addressed – both as an electric and a financial system. Within the EU framework the power market includes the following six roles:

Power producer - generates and sells production through market operator or bilaterally.
Market operator – receives bids and clears the market (neutral).
System operator – ensures that the system is operated electrically correct/optimal.
Grid operator – transports electricity to customer.
Supplier – buys or generates electricity and sells it to a customer.
Customer – buys electricity for consumption.

The roles interact digitally for metering, system services, settlement and payment services. For the local market as demonstrated in the +CityxChange project, these interactions are simplified, and the roles are reduced from six to four due to that the operation is local and partly automated.

The identified incentives for setting up a PEB will be strengthened due to that local energy resources are given a real-time market value. The incentives will vary for the players within the local energy market. The main tasks to be executed within the PEB demonstrations are:

- Generate electricity – as an independent power producer - locally without any upper limits.
- Sell produced electricity to a local market operator or bilateral.
- Third parties allowed to own and operate local storage of electricity and heat.
- Sell storage products either as energy, capacity and system service from battery to local market or local system operator or local grid company.
- Sell surplus energy to the global market through a local market operator.

The gap analysis from Norway and Ireland has identified that to be able to operate a local market including a community grid system special permissions are required. For the Trondheim demonstrations, the Distribution System Operator (DSO) TrønderEnergi will act as the operator of the PEB - the Community System Operator (CSO). The DSO is already granted with the necessary dispensations, thus most likely only a few applications to the regulator is necessary in order to perform the demonstrator. The gap analysis identifies need for changes that are crucial to be able to operate a sustainable PEB within a local power market - after the demonstration period.

The gap analysis for Limerick is more extensive, due to the fact that a new entrant - Community System Operator(CSO) - will operate the local energy market on a pilot basis for the duration of the project, under the supervision of the current DSO. Several dispensations need to be granted to the third party CSO. At the replication level of the project the role of CSO, in many jurisdictions, will conflict with the DSO role under Law.

DSOs are funded under the "Common Good" Principal - in this way freeing up their "Commons" type system for use by producers, system services providers and others. Meantime DSO have, in most jurisdictions, the primary objective of providing the best value possible to all consumers, as determined annually by the Energy Regulator.
DSO-power is not naturally symbiotic, or under regulations, with the strict obligations of CSOs, who must deal with the enabled of ever increasing levels of new Renewable & Recycling Energy Electricity Generators connected under Disturbance Neutral Prosumer Group (Franchised Local Energy Communities - FLEC).

For the Follower Cities, the basic regulatory and policy conditions are mapped, with a focus on replication of the processes and enabling the GAP analyses for the respective countries.

2 Shared Understanding of the Task

Task description

This task will set up a regulatory mechanism to create a regulatory sandbox that will enable and support the demonstration of +CityxChange solutions. It will map actual regulations in each city, perform a gap analysis of the demand for each of the DPs including necessary changes and flexibility in the system, and perform feasibility assessment/state-of-the-art review of existing energy markets and models in Europe (DSO/TSO) linked to EU legislation/regulation. Barriers such as limitations for the technologies being demonstrated and business models will be examined.

Legislation regarding Building energy performance, Integration of renewable energy, Smart grid, and Smart mobility will be investigated. Incentives and tariff for sustainable actions such as feed-in tariffs or incentives for renewable integration of favorable conditions for e-mobility will be addressed. This has particularly to do with the exchange of goods and services among users (e.g., prosumers) and their ability to share. The experiences will be documented and integrated in a guidance package/replication handbook. The work will be further developed and adapted to local conditions in all cities in T4.4, T5.4, and T6.6-6.10.

The objective of the documentation of regulatory mechanism is to secure special dispensation from the relevant national/regional/local authorities for the project duration to implement and demonstrate innovative +CityxChange solutions. Examples of solutions to be trialed are a trade platform for local markets (flexibility included), peer-to-peer trading, integrated energy system balancing between electricity and heat, EV integration and demand response/flexibility. This shall be executed with technology innovated to be scalable and replicable for new markets.

The task will result in regulatory recommendations for how such regulatory sandboxes can be planned, designed, implemented (with feedback from WP4-5), monitored (with WP7) and scaled up in time and space, as input towards replication guidelines in WP8. To ensure success, the Lighthouse cities have already started the process towards the regulatory authorities to ensure the feasibility and the implementation of the DPs. A framework for how this sandbox will be operated will also be created.

Participant Roles: TK is task lead in collaboration with LCCC as the corresponding LHC and from each of the FCs with respect to planning, building control, procurement rules etc. The network operators TE, and ESBN will support with respect to the infrastructure regulations. SV, POW and MPOWER as major solution vendors in the respective Norwegian and Irish markets will also support. OV will perform market review linked to EU legislation and regulation. EAP will share their expertise with respect to the Bulgarian and Eastern European markets.
Innovation Applied to Demonstration Project: DP04

3 Introduction

This report displays the regulatory discoveries and the planned regulatory framework from task 2.1 “Enabling Regulatory Mechanism for delivery of the innovative DPEDs” in the +CityxChange project. A primary objective of the +CityxChange project is to establish a number of Positive Energy Block (PEBs) or Districts. PEDs are (also referred to as DPEDs), underlining the projects ambition to distribute the PEDs in European cities. Presently the energy legislation and regulations framework is developed for a centralized energy generation and distribution system, and is therefore not well suited for local de-centralized energy generation, distribution and storage. Therefore in order to achieve an innovative PEB in each city, it will be necessary to establish a range of regulatory mechanisms either as individual permissions or as an overall Regulatory Sandbox.

A Regulatory Sandbox is a process towards the local, national or European regulatory authorities in order to promote piloting within the demonstration areas. This concerns energy markets, system operations, mobility and building energy performance. This report will describe and evaluate regulatory mechanism required to enable and support the demonstration of the +CityxChange solutions.

The existing regulations are mapped and investigated in line with the actual demonstration projects that will be executed in the +CityxChange project. These demonstration projects are:

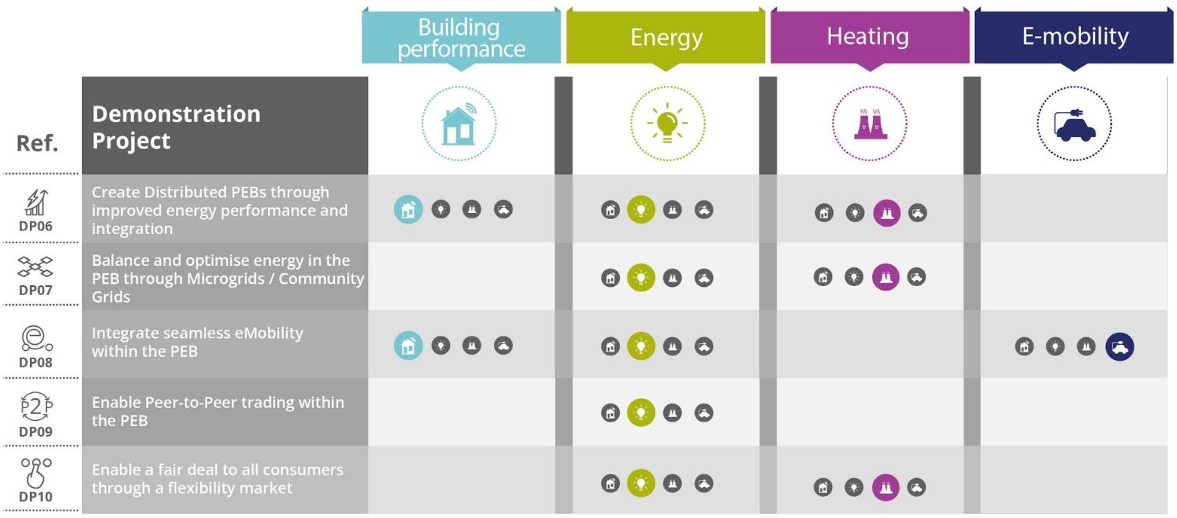

Figure 3.1: Demonstration projects related to building performance, energy, heating and e-mobility.

These are the demonstration projects that will enable the regulatory mechanisms for delivery of the innovative consumer-driven decentralised Distributed PEBs through interconnected systems of buildings, Micro/Community Grids and eMaaS. To fully understand the detailed consequences of how the demonstration projects will “touch” the legal framework, it is executed an overall mapping based on the actual regulatory situation in Norway and Ireland for the Lighthouse Cities and for the Czech Republic, Estonia, Bulgaria, Romania and Spain for the follower cities.

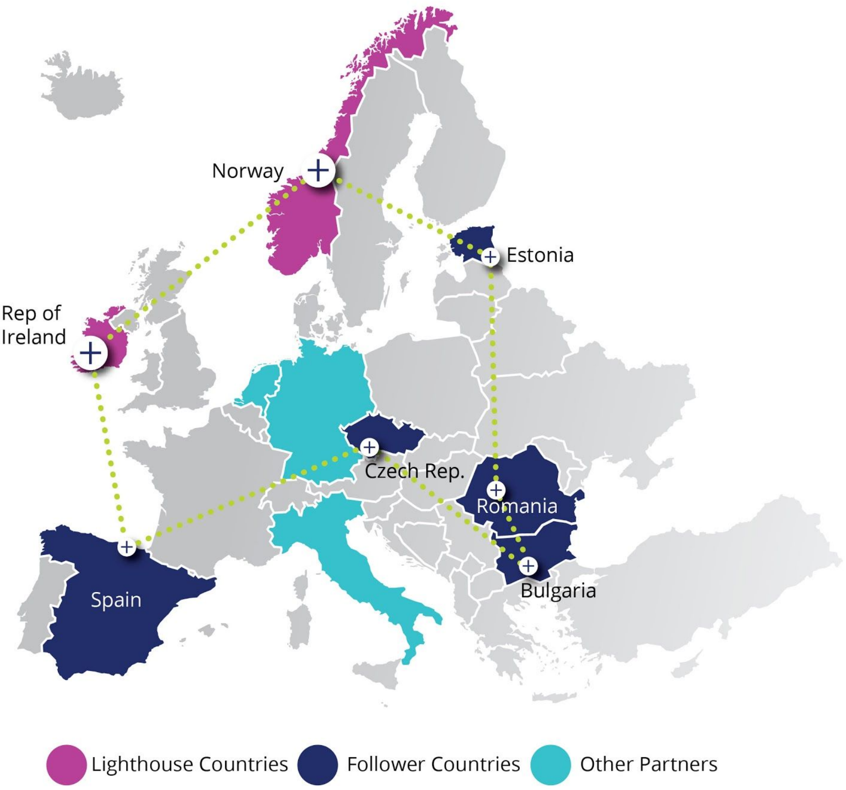

Figure 3.2: Map of the countries involved in the +CityxChange project.

This deliverable will address regulations that influence the process towards positive energy blocks. This includes mapping and gap analysis of energy, mobility and building energy performance. Regulations beyond these themes will be taken into consideration in the respective tasks [appendix 1].

National similarities and the EU overall regulations is not established within the scope of supporting PEBs/PEDs and local energy markets. This is mainly due to the fact that local energy markets as addressed in this project did not represent an actual situation when the framework was presented. It is in the last two-three years that the focus on local energy resources and local system operators has been evolved to become a situation that is significant even in the process of creating a sustainable energy system locally. This report address how existing legislation, technology and market organisation should be evaluated and given an overall new approach in the progress towards PEBs/PEDs and sustainable local energy markets and models.

4 Energy regulatory framework - overview

4.1 EU energy regulations - main principles and status

The goal of the +CityxChange project is to demonstrate easily reproducible PEBs. Drivers for this innovative approach are several, including a rapid development in renewable energy production and ICT. As illustrated in figure 4.1, these technologies are fundamentally changing the electricity markets at the distribution level. While the traditional distribution model focused on a one-way delivery of electricity, new opportunities arising from locally distributed generation and decentralised trade challenge this paradigm.

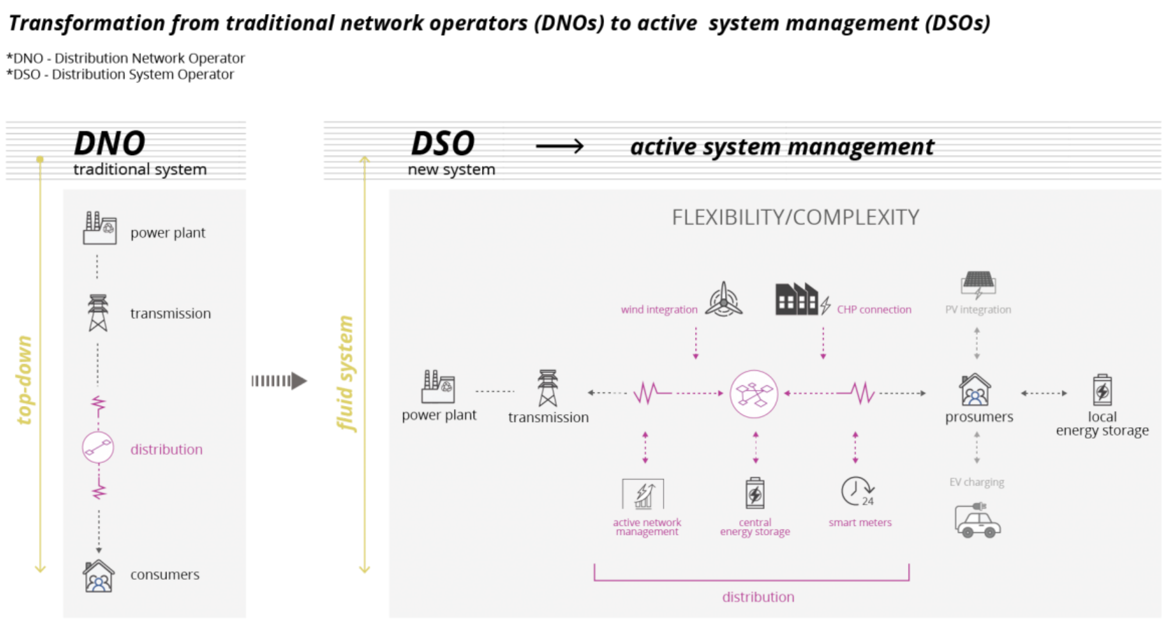

Figure 4.1: Transformation from DNO to DSO.

An important factor to facilitate this transformation is the legal framework, consisting of both national and EU law. Existing EU energy legislation was introduced in 2009. Since then, the marketplace and general energy policy has undergone fundamental changes. In response to the developments, EU has reworked its regulation on several main areas - including energy efficiency, market access, consumer protection and stability. Figure 4.2 shows main principles in the traditional value chain for a centralised power system.

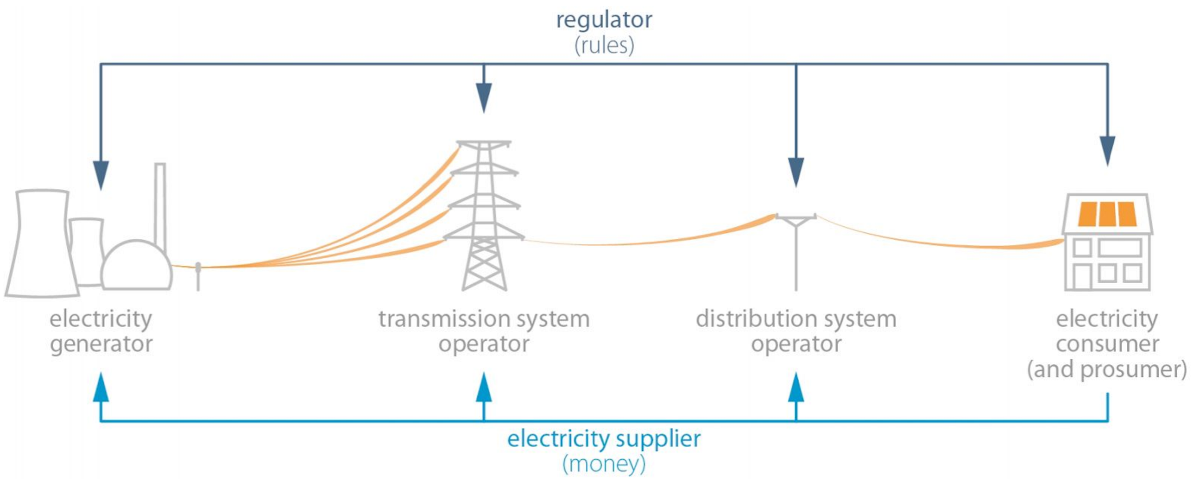

Figure 4.2: A schematic overview of the electricity system as described by EPRS of how EU legislation as of 2009 addresses the different parts of the value chain from generation to consumption (Erbach, 2016).

However, the evolution of energy systems has during the last few years changed this value chain from being mainstream to become "old fashion" without distributed generation and new players on the distribution side. According to the EU commission Winter , future legislation should include more renewables in the market, empower consumers as customers, development of local markets and improved management of energy flows across the EU.

The +CityxChange project will demonstrate how PEBs and PEDs can be established in cities around Europe. Legal frameworks - at EU and national levels - including the market principles, will be a key factor to future replication and development. Some of the solutions drafted in the project may be in conflict with existing rules. The topic of this section is therefore the interaction between current and expected/projected EU legislation, and relevant demonstration projects.

4.2 Future EU energy regulation framework

In December 2018, negotiators reached political agreement on the new Electricity Regulation and Electricity Directive. This agreement marked the finalization of the Clean Energy for All Europeans package, following previous agreements on the Governance proposal, the revised Energy Efficiency Directive, the revised Renewable Energy Directive, the Energy Performance in Buildings Directive and the Regulations on Risk Preparedness and the Agency for the Cooperation of Energy Regulators (ACER) (European Commission, 2018b).

Together, these eight legislative tools aim to introduce a new market design (the E-regulation, the E-Directive and the ACER regulation), align energy consumption with climate and other environmental goals (Renewables Directive and Energy Efficiency Directive), increase risk preparedness (Risk Regulation) and finally enable the Energy Union (Governance Regulation) (European Commission, 2016). Key motivations and intended results of the rework of energy regulation is illustrated by the infographic

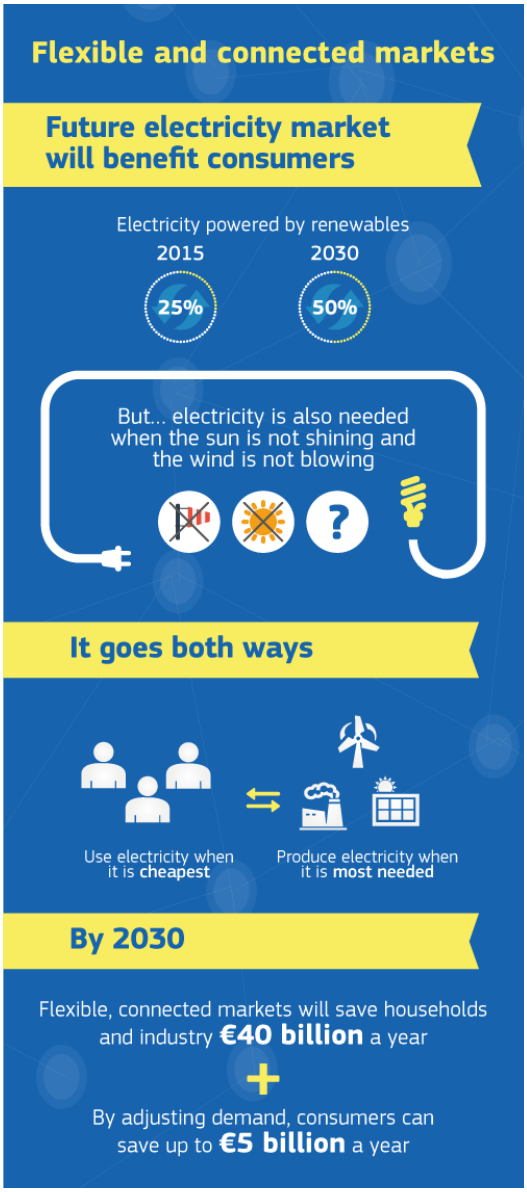

Figure 4.3: The EU Commission ambitions for flexible and connected markets by 2030. Source: https://ec.europa.eu/energy/sites/ener/files/publication/Infographic---Market-Design.png

"Flexible and connected markets" in figure 4.3, by the European commission (European Commission, Directorate-General for Energy, 2015).

Requirements vary regarding national implementation of the different legislative decisions.
For instance, the Energy Performance Building Directive (EPBD) leaves the definition of Nearly Zero-Energy Buildings (NZEBs) to each member state. This leads to large differences in how the common norms are used: Within the EU, the accepted values for primary energy consumption of an NZEB vary with a factor of 4 to 5 (Wolfgang et al., 2018). A factor contributing to such variety is the presumption in the EPBD that requirements should be based on cost optimal levels. Therefore, the key implementation drivers like favorability of investments in renewable solutions will depend a lot on the discount rates used.

The leeway afforded to member states is intentional: While building standards are important, states also need to consider social and more general socio-economic perspectives. Strict regulations could increase housing prices and disparity among the population. While leaving some room for national definitions and other adjustments, recent Directives and Regulations on energy have decreased regulatory maneuverability of member states considerably (Roggenkamp, 2016).

All the while, the following challenges remain for grid development and market design:

- Electrification of the economy (for instance EVs lead to rising electricity demand)
- Wanted increase in distributed and variable renewables (solar, wind) requires increased distribution capacity from generators to customers.
- Increased self-consumption (by 'prosumers') means decreased revenues for grid operators, which in turn might increase network charges for 'regular' customers.
- Smart meters, smart appliances and smart grids, electricity storage, electric vehicles and digitalisation, enable innovation in local electricity markets, for instance give customers an incentive to use less electricity at times of peak demand (adapted from (Erbach, 2016)).

Combined with the Commission's three main goals of the EU energy policy, namely putting energy efficiency first, achieving global leadership in renewable energies and providing a fair deal for consumers/customers, the national freedom to regulate will probably need to accept even further limitations. In addition, other legislative efforts like the Clean Mobility Package may affect the national regulatory situation (European Commission, 2017).

The project demonstrations will be executed under actual national regulatory regimes with relevant dispensations. However, a widespread implementation and upscaling of the tested solutions require compatibility with current and future EU regulations.

In general, the demonstration projects are in line with the intentions of the Winter Package, i.e. the future energy policy of the EU. If successful, the PEBs will provide electric energy from renewable sources in a reliable and efficient way. Similar projects as the EcoGrid EU and the SESP model can be found in the Annex (chapter 12).

5 Energy systems - regulatory similarities and differences

5.1 From global to local energy systems - similarities and differences

The project involves cities from seven European countries. Each of them with different traditions for how to operate and regulate power production, power transport, market operation, system operation and the end customer's rights. All seven countries are involved in EU regulation issues and have stated that they will adapt the principles and most of the details in the coming justifications and changes of their national Energy Acts. However, to be able to execute planned demonstration projects and identify needs for special permissions in existing framework, the project requires a detailed national knowledge and overview of the existing legislative framework. This is done through a mapping separated in one part focusing on Lighthouse Cities in Norway and Ireland, and a separate mapping for the Follower Cities.

To fully understand the capabilities of a local energy market with PEB as the core, it is required to understand the overall power market as it is in principle operated in Europe. The local energy community established and operated in line with market principles and its fundamental roles can easily be described with its uniqueness as a global market spinoff.

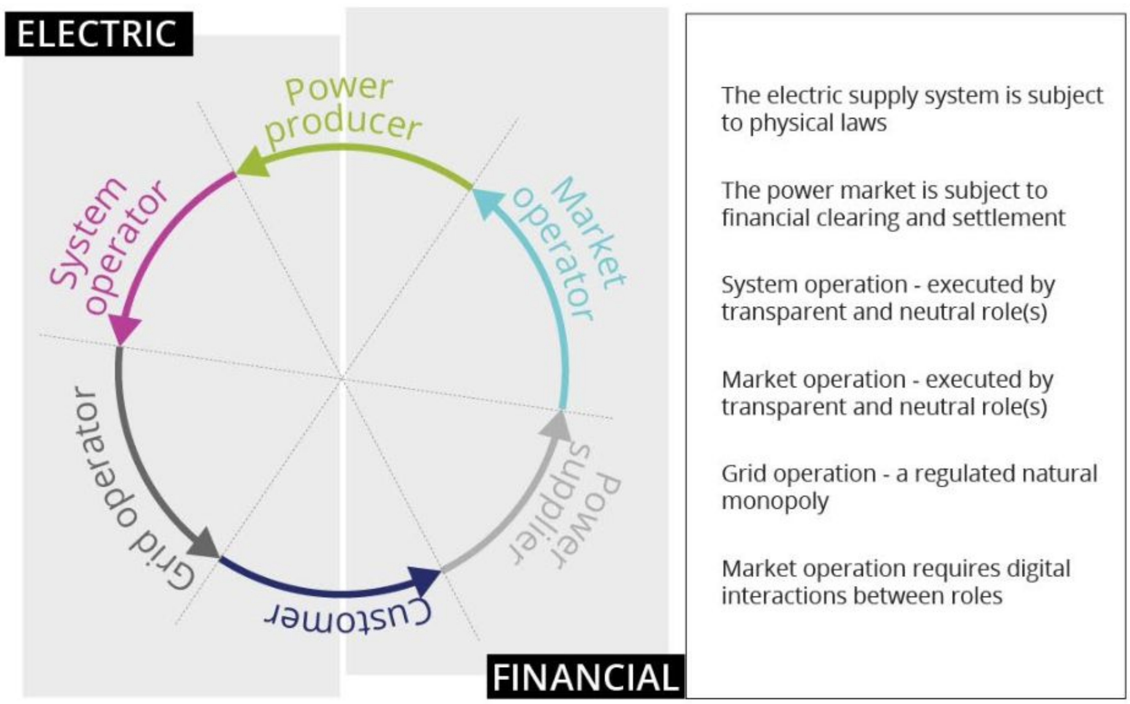

Figure 5.1: Global power market roles and major functions - electric centric and financial - to be operated to achieve an efficient market.

In figure 5.1 the fundamental operative roles in the power market as of 2019 is described. The six roles have well defined and a regulatory mandated way to operate. In total the six roles fulfill both electrical and financial requirements for an operational market. The arrows direction in the figure indicates that electricity is flowing from the producer to the customer - managed by a system operator. After being consumed by the customer, customer pays the invoice to a price cleared by the market operator on behalf of the producer.

However, for a local market it is possible to simplify by using digitalization and automatic execution of trade settlement. The grid and electric system is more easily controlled and operated. In figure 5.2 it is described how the local energy market inside a PEB could be operated and demonstrated in a way that ensure correct use of all flexibility in the available PEB assets. Roles reduced from six to four and system operation includes local grid operation.

The customers in the PEB / PED, Community Grid is to be allowed P2P trading based upon for example IOTA Tangle zero fee micro-/nano-payment protocol and enabled by smart contracts, and select multiple retailers and markets to trade in, including the PEB and wholesale markets.

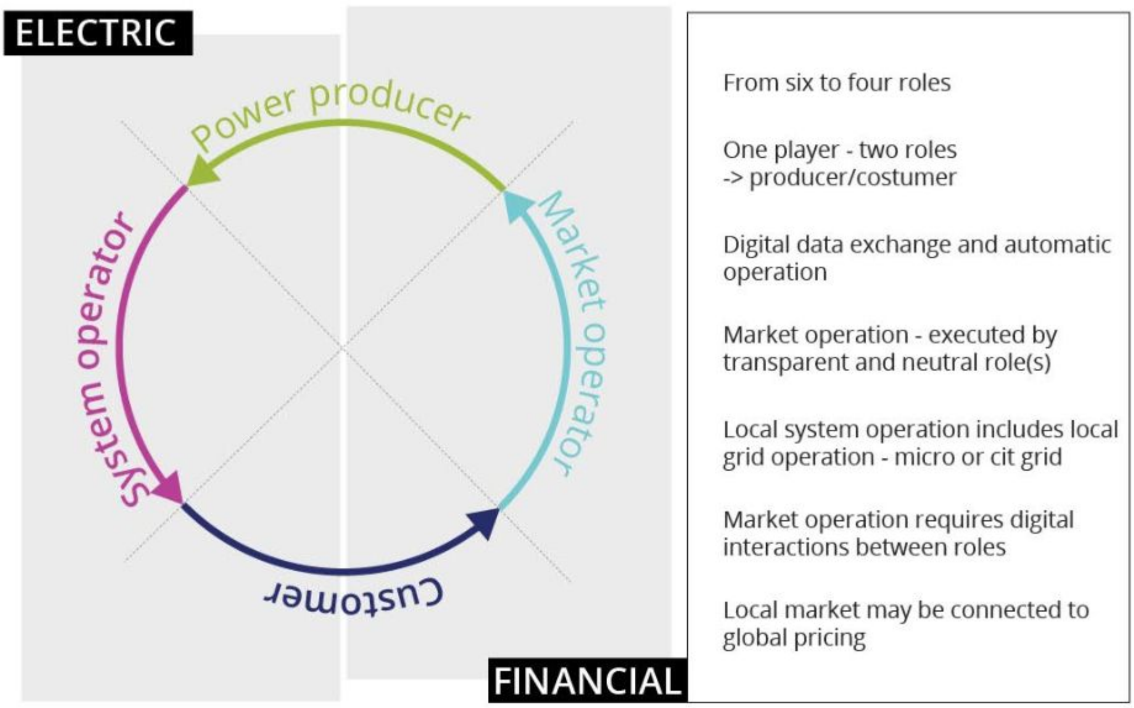

Figure 5.2 The four basic roles within a local power market as operated together with the PEB/PED.

5.2 A local energy system - operated as a PEB market

In the global power market the role as grid operator is a natural monopoly separated from the supply and production businesses. Grid operation is under a precise regulation regime. For the production and supply roles it is also operated in line with precise concessions. Due to a downscaled local market the roles are operated by a digitalised toolkit which secure trustworthy automatic routines for the chain from bidding to settlement and payment.

For the PEB area it will include local resources and assets from customer and producer spread in at least three individual buildings. In a market approach some resources like storage/battery can operate either as producer or customer that consumes power. Consumption may also be operated the same way due to that load/demand is either reduced or in special system situations even increased. While PV panels are producers only.

In figure 5.3 the PEB is exemplified as three buildings each with a regulated meter [M] in addition it is an individual and not regulated meter connected to each local resource/asset. Resource either installed in PEB buildings or as stand-alone resources serving the PEB. The meter MPEB is either a virtual meter or a physical meter that summarise all net consumption inside the PEB for invoicing purposes with the DSO and/or power supplier to the PEB.

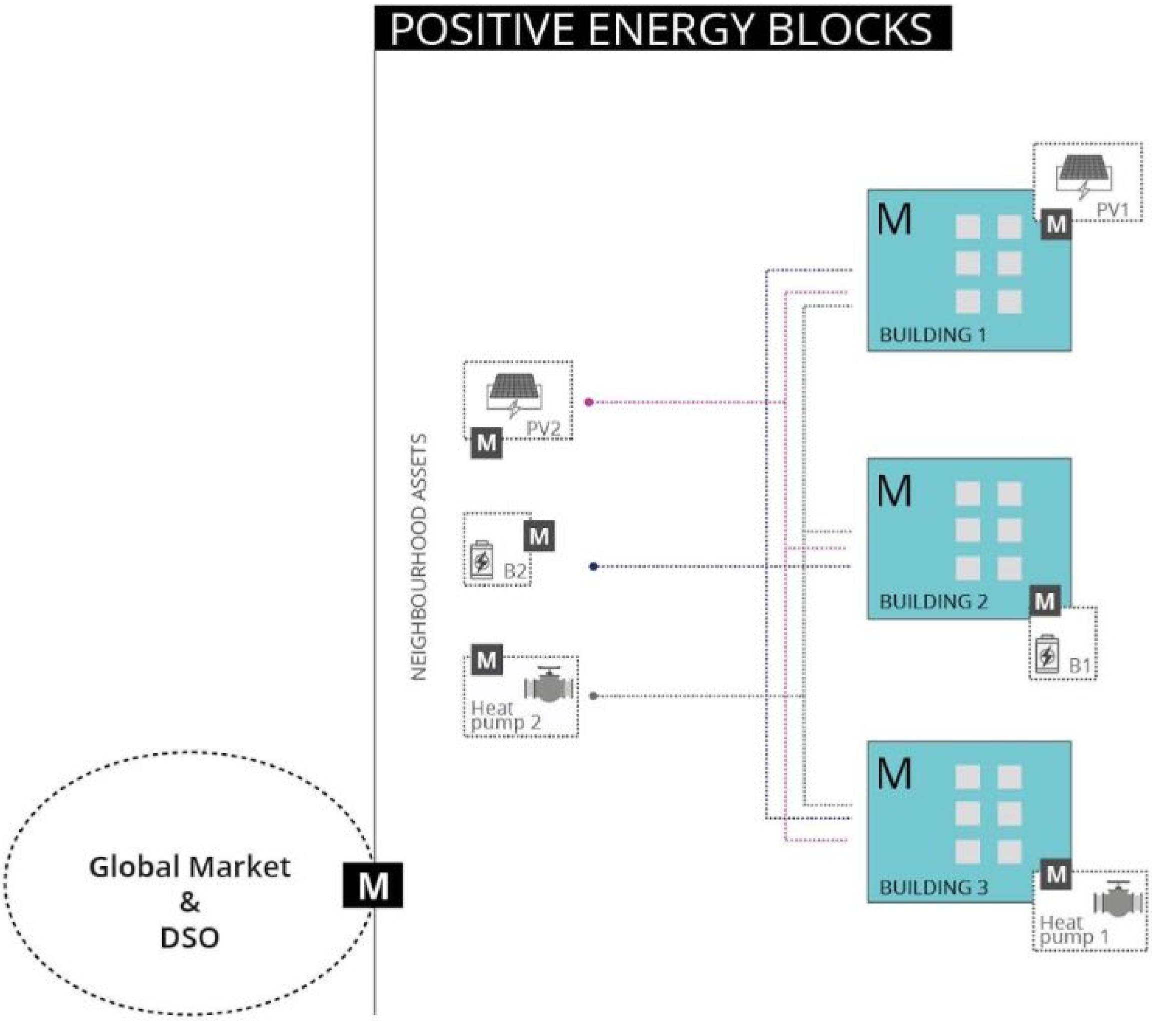

Figure 5.3: PEB resources and metering set-up for local market operation. Three individual buildings with own assets and three neighbourhood assets (PV2, B2 and Heat pump 2).

To document the PEB the main meter in the DSO interface is crucial. This meter is easily replaced with a virtual meter summarising all consumption and production inside the PEB. However, regulatory mechanism as of 2019 will be challenged in an efficient set-up of PEB operation. The customers interface with the DSO is in the meter used for invoicing of the grid tariff. This meter could be for a building, an apartment or another type of consumption. The meter will in the situation of local generation behind the meter also represent the interface for the so called prosumer. DSO has the supply quality responsibility all the way to the meter.

When it comes to supply to customers behind a meter the basic requirement from market regulation is that all customers have a legal right to choose among suppliers in the global market. This principle is taken into consideration in this report. The new dimension which a

PEB introduce is trade between local assets/resources within the PEB (behind the main meter towards the global market). This situation could challenge existing supply concessions and how these are appointed to registered suppliers in the global market. In an ideal PEB setting it is a portfolio of resources traded in a way which gives incentives to achieve a PEB both when it comes to investments and operation.

An example will be when PV2 in figure 5.3 sells its production to Building 1 when at the same time B 2 is selling demand (effect) to Heat pump 2 due to the fact that peak demand in Heat pump 2 at this specific time will be charged to a very high price from DSO due to grid tariff structure. These trades could either be bilateral or made over a market place inside the PEB as earlier described. This will be demonstrated in the Trondheim PEBs and Limerick CGSs.

In the process from a description of the range of flexibility in a PEB to more precisely describe products suitable for being demonstrated within project scope it is chosen to define the following three flexibility products (P1, P2, P3):

P1: Energy product with time resolution of 1 hour or more. A product that will give incentives to invest in and operate energy flexibility resources i.e. between electricity and heat. It will also give incentives to more active use of energy storage resources and focus on the key issue: positive energy block in a one year perspective.

P2: Capacity product with time resolution between 15 min and 1 hour that will reduce peak demand and in addition will efficiently serve active usage of energy storage which also could be used as capacity reserves.

P3: System service product with time resolution less than 15 min and demanded for the purpose of secure local system stability and quality of supply.

The products P1, P2 and P3 shall be established and demonstrated in an open local market situation. To be able to execute this solution several regulatory mechanism must be replaced with exemption or introduction of a Sandbox promoting innovation in the area of local energy communities. The project will face such challenges in both Lighthouse cities and the Follower cities. Lessons from this process is supposed to be valuable in the overall EU scope of scaling up from PEB to hundreds of positive energy districts. For managing the trade of P1, P2 and P3 it will be used a trade platform realized in the project. To establish the flexibility market, deliveries from the project will be applied.

6 National regulations that influence market based operation of PEB

6.1 Lighthouse cities - Norway and Ireland

As a starting point, the regulatory aspects of the Lighthouse cities has been investigated. This gives a good baseline for the following gap analysis in chapter 7 and understanding of the energy system dynamics in the different countries. The main differences between Norway and Ireland is the number of distribution grid companies - Norway has 130 compared to Ireland that has one. The regulators in Norway and Ireland have similar authority - regulating the water and power supply in the respective countries. In Ireland gas represents 30 % of the energy consumption (heating and industry) whereas the district heating in Norway represents 3 % of the energy consumption and 10 % of the residential heating. By february 2019 all electricity consumers in Norway has a smart meter. A similar process in Ireland in ongoing, aiming to be finished by 2025.

Table 6.1 presents an overview of how legislation is addressed to the six basic market roles (System Operator, Market Operator, Grid Operator, Producer, Supplier, Customer) and what is their responsibility in Norway and Ireland where the demonstrations shall be executed.

Issue	Trondheim - Norway	Limerick - Ireland
National regulatory authorities	The Norwegian Water Resources and Energy Directorate (NVE) is a directorate under the Ministry of Petroleum and Energy. Responsible for the management of Norway's water and energy resources. NVE bear the overall responsibility for maintaining national power supplies.	The Energy Act established the Commission for Energy Regulation (CER) to oversee the operation of the sector. The CER changed its name to the CRU in 2017 to better reflect the expanded powers and functions of the organisation. The CRU's mission is to regulate water, energy and energy safety in the public interest. The CRU has a wide range of economic, customer protection and safety responsibilities in energy and water.
Energy market roles	System Operator In Norway there is only one System Operator. That is state owned Statnett which is also the owner of the transmission grid. The System Operator is organized as a Transmission System Operator(TSO). The TSO has the responsibility for the security of supply and is the real-time coordinator of supply/demand in the national power system. TSO offers flexibility and frequency products limited to customers with flexibility >10MW. The balancing service products is divided into primary reserves (FCR), secondary reserves (aFRR) and tertiary reserves (mFRR). FCR and aFRR are activated automatically while mFRR is activated manually. FCR is the fastest, while mFRR is the slowest with a response deadline of 15 minutes. mFRR is activated depending on need and with an hourly price resolution. Gate closure time for bids in the balancing market is 45 minutes before time of production, but since mFRR has a response time of 15 minutes, activation can happen within the production hour. In the Nordics, there is a common market for mFRR	System Operator TSO in Ireland is EirGrid. Any person may carry out the retail supply of electricity in Ireland once they have a license from the Commission For Regulation of Utilities (CRU) and agrees to operate within the Single Electricity Market Section 34 of the Act gives the CRU the regulatory power in respect of connections to the transmission grid. The Act provides that when the TSO receives an application for connection to or to use the transmission grid it must enter into an agreement to permit that use. The CRU can set out the required standard form of transmission connection as well as the approach required of the TSO in facilitating the connection – the establishment of the Group Processing Approach to applications, the approval of the basis of the charges that govern the connection The 1999 Act provides that a licence to own the transmission system may only be issued to E.S.B. (ESB) and that a licence to operate the transmission system may only be issued to EirGrid plc (owned by Irish govt). A Contractual Infrastructure Agreement exists between ESB and EirGrid. In this regard, EirGrid are the certified Transmission System Operator (TSO) in accordance with the requirements of EU Directive 2009/72/EC.

Issue	Trondheim - Norway	Limerick - Ireland
	(common Nordic merit order list). When cross-zonal capacity is available, this enables activation cheaper resources and a more efficient dispatch of balancing resources. Grid Operator Grid companies(including their DSO responsibilities) act as natural monopolies and keep an obligation to connect and supply end customers. They are responsible for determining tariffs within their income cap according to the tariff structure regulation. The price level is set to reflect cost and to stimulate efficient utilization and development of the grid in a way that is non-discriminatory. Tariffs are differentiated based on network related criteria that are objective and verifiable. All tariffs are based on costs referring to the customer"s connection point. An agreement with the grid company for the connection point provides access to the entire network system and the power market. Tariffs consist of a use dependent energy component covering marginal network losses and a fixed annual amount per customer. The fixed component is to cover customer-specific and network costs that are not covered by the use dependent tariff components. There is 130 distribution grid companies in Norway. Market Operator The Market Operator collect bids and coordinates how to calculate price and settlement for actual market products for the actual time-step (period from 1 hour down to minutes). The bids are coming from producers, suppliers, traders and others with the permission to operate on the wholesale power market. The mostly used market operator is NordPool which operates the day-ahead market, the intra-day market and some other markets. In addition it is a market based operation of balance products operated by TSO and imbalance settlement operated by eSett OY in Finland. Market Operator also manages bilateral contracts. Supplier The retail market for electricity is a well-functioning market. There are several suppliers (retailers), a wide selection of contracts and moderate switching activity. NVE's Department of Energy Market Regulation supervises the retail market in accordance with provisions under the Energy Act and adjoining regulations. The regulation is moving from being grid company centric towards a supplier centric model, making suppliers the point of contact for customers. Suppliers has a concession (by NVE) to buy electricity in the market and sell electricity to end use customers. Suppliers have an agreement with a balance responsible party (BRP) which has a Settlement Agreement with eSett and a valid Balance Agreement with the TSO. The BRP may either be the supplier itself - and that acts on behalf of itself either on behalf of third party supplier or producer. Due to that a supplier has an agreement to buy and sell in the retail and wholesale market, it typically act as a market trader either bilaterally or through market operators market place(s). Balance market operated by TSO and settlement of imbalance is within the responsibility of the BRP.	The Energy Act gives the CRU the regulatory power in respect of connections to the transmission grid. The Act provides that when the TSO receives an application for connection to or to use the transmission grid it must enter into an agreement to permit that use. The CRU can set out the required standard form of transmission connection as well as the approach required of the TSO in facilitating the connection – the establishment of the Group Processing Approach to applications, the approval of the basis of the charges that govern the connection. All license holders are subject to a public service obligation to establish Renewable Energy Feed-in Tariffs (Refit). Section 34 of the Act gives the CRU the regulatory power in respect of connections to the transmission grid. The Act provides that when the TSO receives an application for connection to or to use the transmission grid it must enter into an agreement to permit that use. The CRU can set out the required standard form of transmission connection as well as the approach required of the TSO in facilitating the connection – the establishment of the Group Processing Approach to applications, the approval of the basis of the charges that govern the connection Grid Operator There is only one distribution grid company, ESB Networks .All license holders are subject to a public service obligation to establish Renewable Energy Feed-in Tariffs (Refit). A Distribution Use of System (DUoS) is a fee that the DSO charges for the use of the distribution system. In most cases electricity suppliers pass this fee on to customers via their bill. The amount of DUoS that ESB Networks charges a supplier depends on which DUoS Group a customer is classified as, which can be based on several factors including the voltage a premises is connected at, the type of meter installed, or if electricity is exported. ESB Networks seek to ensure that these fees are fair, equitable and are reflective of the customers use of the system. Community Grids could reduce the requirements for DSOs to reinforce the distribution system, and could reduce the costs incurred by TSOs to balance supply and demand. This could be seen therefore to provide a service to the operation of the energy system. A number of models could be used to monetize this. Market Operator The Market Operator in Ireland is SEMO. SEMOpx provides day-ahead and intraday electricity market trading for Ireland and Northern Ireland as part of the Single Electricity Market (SEM). All parties who want to buy or sell energy through SEMO must first register to join the Balancing Market. They then have the option to also join the Capacity Market which ensures ongoing supply. The wholesale electricity price – also known as the system marginal price (SMP) – is heavily dependent on the prices that generators bid into the pool, based on their fuel and other short-run operational costs. Supplier Any person may carry out the retail supply of electricity in Ireland once they have a license from the Commission For Regulation of Utilities (CRU) and agrees to operate within the Single Electricity Market. In Ireland it is several suppliers operating in the retail market. There are nine electric suppliers in Ireland(2019). Most known are Electric Ireland, Airtricity, Bord Gais, Energia, Vayu, Pinergy and PrePayPower.

Issue	Trondheim - Norway	Limerick - Ireland
	Power Producer The power producer has the obligation to produce power and sell it to the market. Either through market operator or p2P or as an OTC contract. The market access may either be directly or through an aggregator or portfolio manager. The number of producers in Norway are more than 70. Customer The Customer purchase electricity in the market from a supplier. This purchase is the retail market where the supplier is selling electricity either traded in the market or bilaterally from a producer. The customer may choose different market products and the customers prices is set by the supplier. The customer is free to choose between more than 50 suppliers operating in the Norwegian power market.	Power Producer Electricity is produced by public and private generators who supply to the gross mandatory market operator of the Single Electricity Market (SEM). All electricity generated on the island of Ireland is sold and purchased through this wholesale market. Customer The Customer may purchase electricity in the market from a supplier. This purchase is the retail market where the supplier is selling electricity either traded in the market or bilaterally from a producer. The customer may choose different market products and the customers prices is set by the supplier.
Metering	All electricity customers have a smart meter (1 hour or less resolution). Customers are given access to near real-time consumption data and new services like DR are about to be developed. Metered data is sent to Elhub daily or more often. The DSOs are responsible for installing and operating the smart meters. Metering cost is covered by the grid tariff.	A requirement of Directive 2009/72/EC is the separation of the ownership and operation of the distribution system. In this regard, the CRU has licenced ESB and in particular ESB Networks as the only licensed operator of the distribution system. Responsibilities include metering of production and consumption. Meter Registration System Operator (MRSO) is a "ringfenced" function within ESB Networks responsible for the Change of Supplier process and the processing/aggregation of meter data required to support Trading & Settlement in the competitive electricity market.
Heating	The licensing scheme for district heating is anchored in the "Law of production, transformation, conversion, turnover, processing and use of energy": District heating license is required when establishing a waterborne heat supply with installed power greater than 10 MW and delivery to at least one external customer. Concession is normally granted for a period of 30 years. In Trondheim, Statkraft varme is granted concession with a plant at Heimdal extracting waste heat from garbage combustion. According to the legal text, any district heating plant may be required to associate with other district heating plants if the plant has a heating system that can be connected. In Trondheim, the connection obligation for total development is carried out larger than 1000 m2. The building owner's responsibility for facilitating the use of district heating follows the building technical regulations (TEK). Energy-flexible systems must cover a minimum of 60% of the normal net heating requirement, calculated according to NS 3031: 2014.The Act sets a price cap for district heating corresponding to the price for electric heating in the relevant supply area. Concessionaire has a duty to negotiate with operators who wish to enter into a third-party supply agreement or third-party access to the district heating plant.	Gas is distributed in Ireland, represents 30 % of the total energy consumption of the country. Gas is utilized for both industrial purposes and private homes. Gas is utilized for space heating, domestic hot water heating and cooking in private homes. The gas retail market in Ireland was opened for competition in July 2007, meaning that any supplier can enter the market. CRU protects the interests of energy customers and maintains the security of supply. CRU is responsible for the economic regulation of gas in Ireland. Gas Networks Ireland (GNI) own, operate, build and maintain the natural gas network in Ireland. They connect all gas consumers to the grid, independently of the gas supplier. The gas network consists of transmission and distribution pipelines in the same matter as electricity. The transmission system distributes larger volumes of gas and distributes gas to the smaller distribution pipelines within the urban areas. Large gas customers e.g. power stations, receive gas from the transmission network.

Table 6.1 An overview and description of regulatory authorities, metering and the six basic power market roles in Norway and Ireland.

6.2 Follower cities - Czech Republic, Estonia, Spain, Bulgaria, Romania

An overall regulatory mapping has also been performed for the follower cities. This gives a good baseline for ensuring replicability when developing the design of the local energy markets within the PEB. Also the mapping is a good starting point for developing the later gap analysis in the respective countries. All follower cities has the same structure of roles in the energy market, and they have all to some extent a liberalized market. All follower cities has some district heating, except Alba Iulia. A more detailed overview about the energy markets in the follower cities can be found in the appendix. Table 6.2 collects and presents information about legislation and execution of the power market operation in the countries where the five follower cities are located.

Description	Písek - Czech Republic	Võru - Estonia	Alba Iulia - Romania	Smolyan - Bulgaria	Sestao - Spain
National regulatory authorities	Energetický regulační úřad (ERU) / Czech Regulation Authority. The Energy Regulatory Office was set up under Act No. 458/2000 of 28 November 2000, on the Conditions of Business and State Administration in Energy Industries and Changes to Certain Laws as an administrative authority responsible for regulation in the energy sector. Important responsibilities are: Price controls and support for competition in the energy industries, supervision over markets, support for the combined heat and power generation and support for decentralized energy production. The Czech Energy Act requires electricity market participants to obtain a licence issued by the ERO in accordance with certain statutory criteria. In the energy sector, the ERO can issue licences for the generation, transmission, distribution and trading of electricity, as well as for market operation.	The Estonian Competition Authority have the regulatory rights and check the financial results of energy and water companies and coordinating, establishing, verifying and repealing the prices of energy and water services sold in the market; - Verification of connection fees. - Imposition of operational and development obligations on the energy or network operator. - Coordination and verification of transmission and distribution service tariffs of the network operator. - Coordination of the conclusion of contracts for the purchase of heat by the network operator. Roles are regulated by the Electricity Market Act where are indicated responsibilities and obligations of market actors, resellers, balance obligations etc. Also connection to grid with capacity above 200 kW is regulated with Network Regulations.	The National Authority for Energy Regulation (ANRE) has the mission to create and implement the appropriate regulatory system for the electricity and natural gas sector and markets. In 2010 ANRE took over the activities of the Romanian Agency for Energy Conservation (ARCE). Now ANRE has the responsibility to monitor and implement energy efficiency measures and promote the use of renewable energy sources to the end user. The market has undergone a profound transformation that continues today, a process based on: - Creating an electricity market based on the principles of transparency, non-discrimination and objectivity. - Introducing competition in the production of electricity and electricity - Introducing a licensing system for new entrants to the electricity market Ensuring free, regulated third party access to electrical networks.	The Energy and Water Regulatory Commission is the national body that regulates the Bulgarian energy market. It defines and revises the energy tariffs, supervises the operation of the energy utilities, and executes and supervises the implementation of the relevant energy acts by the market actors. The national energy company has been split into eight separate companies, the TSO and seven regional distribution companies.	The General administration of the state is responsible to regulate the structure of the charges for regulated costs, the tolls corresponding to the use of transport and distribution networks, to establish the criteria for the granting of guarantees by the appropriate subjects and to fix, where appropriate, the voluntary price for the consumers. Likewise, the Ministry of Industry, Energy and Tourism, shall dictate the necessary provisions for the establishment of: - The prices of access tolls for transport and distribution networks. - The charges necessary to open other costs of the corresponding system activities.

Description	Písek - Czech Republic	Võru - Estonia	Alba Iulia - Romania	Smolyan - Bulgaria	Sestao - Spain
Metering	Distribution System Operator (DSO)- E.ON. An owner of a distribution grid that has the responsibility to distribute electricity from producers to customers. The DSOs have the responsibility to meter production and consumption.	From 2013 all network operators have to measure electricity consumption by the hour and send the data to Elering's central data warehouse.	In Romania, the energy supplier owns the meter. The metering values are collected by the supplier or the consumer, and then checked by the power supplier on fixed intervals.	The values are collected automatically through regular meters or smart meters.The DSOs owns the energy meters. The smart meter roll out has started on initiative by the DSOs in Bulgaria and is an ongoing process.	After the liberalization of the electricity system in Spain, there are the five main distributors responsible to guarantee the supply, reparations, and the data gathering from the meters.
System operation	ČEPS is a member of relevant European international organisations. The Company is responsible for maintaining the balance of electricity supply and demand within the power system in real time (system services) and for organising cross-border power exchanges including transits. CEPS provides transmission System Services with the help of Ancillary Services, that CEPS purchases from producers and dispatching ensures a balance.	For the electricity market to operate, it is necessary for network operators and electricity sellers to exchange information about market participants, and this takes place through the central information exchange platform. Here you can change your supplier, submit meter readings and where all market participants can comply with the requirements of the law and grant the necessary rights to each other. This information exchange platform runs by the TSO, Elering.	For this purpose, Transelectrica SA uses its own resources called functional system services and acquires from the power generators technological system services. Also, for balancing in real time production with consumption, the Company uses the balancing market mechanisms.	The Bulgarian TSO – ESO, is responsible for the transmission of electricity and exploitation and maintenance of the transmission facilities; real-time management of the electricity system and balancing the energy consumption and production; measures, validates and processes the electricity system data.	REE (Red Electrica Española)-Spanish Electricity Network- has the monopoly of transport network being thus the main operator of the electrical system. In December 2018 a new law for self-consumption was approved; and there is a dead-end date in June to establish the regulations between consumers and and Spanish State.
Heating	Písek has a high penetration with district heating network. It supplies more than 600 supply points; 660 thousand GJ / year of 1 million GJ in fuels is consumed in central sources. The plant corresponds to the age and can be operated by 2030, or by regular maintenance and repairs. under the condition of investment in desulphurisation plant by 2023. Transformation losses in heat production amount to 25%. There are 25% of heat losses in the distribution system (50% in steam distribution). The price policy is governed by the municipality as Písek is the majority owner of the company owning the central heating plant.	District heating network management is regulated by District Heating Act. Act governs activities related to the production, distribution and sale of heat by way of district heating networks and connection to district heating networks Municipalities have the right to decide and district heating region. Most operators are private companies. In Võru there is 1 district heating area with 2 networks. In Võru there is one private heating company called Danpower Estonia. 90% of heating material is biomass.	District heating is very limited in Alba Iulia municipality to only a few buildings since almost every household now has 99% gas-based heating. Recently built dwellings of apartments also follow this trend although some social housing buildings were equipped with centralized heating systems at the level of the buildings. Due to this trend the municipality reconverted all of the formed district heating plants into other types of facilities.	The Energy and Water Regulatory Commission SEWRC has granted Licences for heat distribution to over 20 regional heating companies. Other licenses have been issued to thermal power stations with chemical, metallurgical, petrochemical and textile industrial enterprises. All heating companies are private, with the exception of "Toplofikatsia Sofia" EAD (which provides services to over 60% of all consumers of heating energy in the country and is owned by the Sofia municipality). The share of household customers using district heating is 15,6 %. Most of the district heating plants are on biomass/natural gas.	District Heating for heating and hot water in Sestao is in process, due to be finished by November 2019. In line with the European objectives on saving of thermal energy 2020 and with the opportunities offered by the Royal Decree (Real Decreto) 56/2016, by which the Directive 2012/27/EU of energy efficiency is transposed There is a process of a new district heating plant in Sestao, due in november 2019.

Table 6.2 Complete overview of how main tasks which is crucial for operating an open market are executed in the countries of the follower cities.

6.3 EU overall regulation of mobility

E-mobility, or mobility in general, might have to adhere to rules and regulations which might have local, regional (EU) or world-wide coverage. In this chapter, we stay within the context of the +CityxChange project, and we focus on the specific and most relevant regulations relating to the *intelligent transport system* (ITS) side of the matter and the provisioning of mobility-as-a-service - MaaS. I.e., we do not discuss issues relating to *electricity* specifically, nor do we consider regulations relating to the vehicles themselves, like type approval, safety and security, and similar.

Directive 2010/40/EU of 7 July 2010 (ITS Directive, 2010) lays the framework for all deployments of ITS systems in EU/EEA. The directive is often named as "the ITS directive" and was adopted to accelerate deployment of ITS technologies and to address compatibility and interoperability across Europe. The directive is implemented in various ways in the member and EEA states. E.g., in Norway it was implemented as a law in 2015, popularly named as the "ITS law", in which the Department of Transport is given authority to declare further rules and regulations to support the law's intentions (ITS-loven, 2015).

Furthermore, relating to use cases in the context of the +CityxChange project and supporting the ITS directive, EU has issued *Delegated Regulation 2017/1926* which defines to a quite detailed level which types of multimodal travel information any provider of transport (as defined in the regulations) must provide to a "*national access point*" (NAP), and in which format (ITS Regulation, 2017). This directly affects any public and private provider of scheduled (e.g. tram, bus, metro), demand-responsive (e.g. taxis, car-sharing, car-pooling, car-hire, bike-hire) and personal (car, motorcycle, cycle), and also defines from which date this information needs to be made available to the NAP.

In short, this means that any public or private provider of publicly accessible transport services needs to be aware of and adhere to this regulation.

6.4 Energy performance in buildings - international regulations

In all actual countries it is existing regulations that states energy performance variables in buildings. Regulation is applicable to the assessment of overall energy use of a building, by measurement or calculation, and the calculation of energy performance in terms of primary energy or other energy-related metrics. It considers the specific possibilities and limitations for the different applications, such as building design, new buildings 'as built', and existing buildings in the use phase as well as renovation.

The ISO standard "Energy performance of buildings - overarching EPB assessment" ISO 52000-1 was launched in february 2017. The standard was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 371, Energy Performance of Buildings project group, in collaboration with ISO Technical Committees TC 163, Thermal performance and energy use in the built environment, and TC 205, Building Environment Design, in accordance with the Agreement on technical cooperation between ISO and CEN (ISO - International Organization for Standardization, 2017). CEN members are bound to comply with the CEN Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. CEN members are the national standard bodies of the lighthouse cities and the follower cities.

ISO 52000-1:2017 establishes a systematic, comprehensive and modular structure for assessing the energy performance of new and existing buildings (EPB) in a holistic way.

Trondheim - Norway	Limerick - Ireland
The English language version of European Standard EN ISO 52000-1:2017 was adopted as a Norwegian standard NS-EN ISO 52000. This standard supersedes the Norwegian standard NS 3031-2014, NS-EN 15603:2008. Although the standard was formally withdrawn on February 1, 2018, it is still the standard to be used until further notice by checking up against the building regulations TEK 17 (Building Regulations), the Energy Marking Scheme, BREEAM NOR and the passive house standards NS 3700 and NS 3701. TEK17 (Regulations on technical requirements for construction work) draw up the limit for the minimum of properties a building work must have in order to be legally built in Norway.	I.S.EN ISO 52000-1:2017 is the adopted Irish version of the ISO 52000-1:2017. The standard has been drafted so that it can be used in the context of national legal requirements and as such mandatory choices may be given at national level for specific applications. National Standards Authority of Ireland (NSAI) is Ireland's official standards body. Currently this standard is being reviewed by the relevant national authorities after which a decision will be made on the use of the default values. Department of Housing, Planning and Local Government is the lead Department for the implementation of Buildings Directive. The department refers to the Energy performance of buildings directive (EPBD) that is a part of the clean energy for all Europeans package (Fallon, 2016).

Table 6.3 Implementation of standard for regulation of energy performance in buildings (ISO 52000-1:2017) in the lighthouse cities.

2019 Písek	2019 Võru	2019 Alba Iulia	2019 Smolyan	2019 Sestao
The standard was included to the system of Czech Standards in November 2018. There are ongoing legislation changes including implementation of the above mentioned standard.	The Estonian standard EVS-EN ISO 52000-1:2017 consists of the English text of the European standard EN ISO 52000-1:2017. It has been endorsed with a notification published in the official bulletin of the Estonian Centre of Standardisation. The standard is available from the Estonian Centre for Standardisation (Eesti Standardikeskus, 2017).	Romania has an old, republished law in place. According Law No. 372/2005 on the energy performance of buildings, republished –, new buildings, for which the reception at the end of the work is carried out from 31 December 2020, will be buildings whose energy consumption from conventional sources is almost equal to zero; New buildings in the property/administration of public administration authorities to be received after 31 December 2018 will be buildings whose consumption of energy from conventional sources is almost equal to zero. Local Authorities or builders may specify/apply voluntarily or condition the classification in the "ISO 52000-1:2017 Energy Performance of Buildings. The overall assessment of the PEC (Energy Performance of Buildings)", but it cannot at this time represent a legal obligation. As of now, it is a standard "helping" or helpful to be applied by builders who want to approach the near 0 concept anyway. The European directive 844/2014 specifies this standard, but still the Romanian legislation does not make direct references to the annexes/methodological norms.	ISO 52000-1:2017 is not widely used in Bulgaria. In Bulgaria Regulation N E-RD-04-1/22.01.2016 "Energy efficiency auditing, Certification and assessment of the energy savings of buildings" is strictly enforced and ensures the energy performance of new and existing buildings. It is applied by certified energy auditors in the EPC process.	ISO 52000-1:2017 is not used in Spain.. In the Spanish Regulation for energy performance in buildings is R.D.56/2016 In the Basque Country and in Spain in general, the idea of energy saving is becoming more and more widespread. Not only in the acquisition of electric vehicles and/or hybrids, but also in the energy saving in buildings and everyone is aware to make an investment in the future is translated as respect for the environment and energy savings.

Table 6.4: Implementation of standard for regulation of energy performance in buildings (ISO 52000-1:2017) in the follower cities.

7 Identified demands for regulatory exemptions to execute demonstration projects

Through the gap analysis different needs are identified for regulatory exemptions to be able to realize most of the demonstration projects as planned for in the Description of Actions. Especially in the Lighthouse Cities with all demonstrations it is crucial that all are legally planned and executed. The gap analysis is an important tool in the process of mapping the relevant dispensations that are needed in Trondheim and Limerick.

The gap analysis for Limerick is more extensive than the gap analysis for Trondheim. The main reason for this is that Limerick has a third party partner to operate as the CSO in the local market, whereas in Trondheim the DSO will function as the CSO. In figure 7.1 the roles and process which drives the evolution towards a positive energy block (PEB) is described. It is included the most obvious elements of each role value proposition regarding their involvement in this process of operation of a PEB.

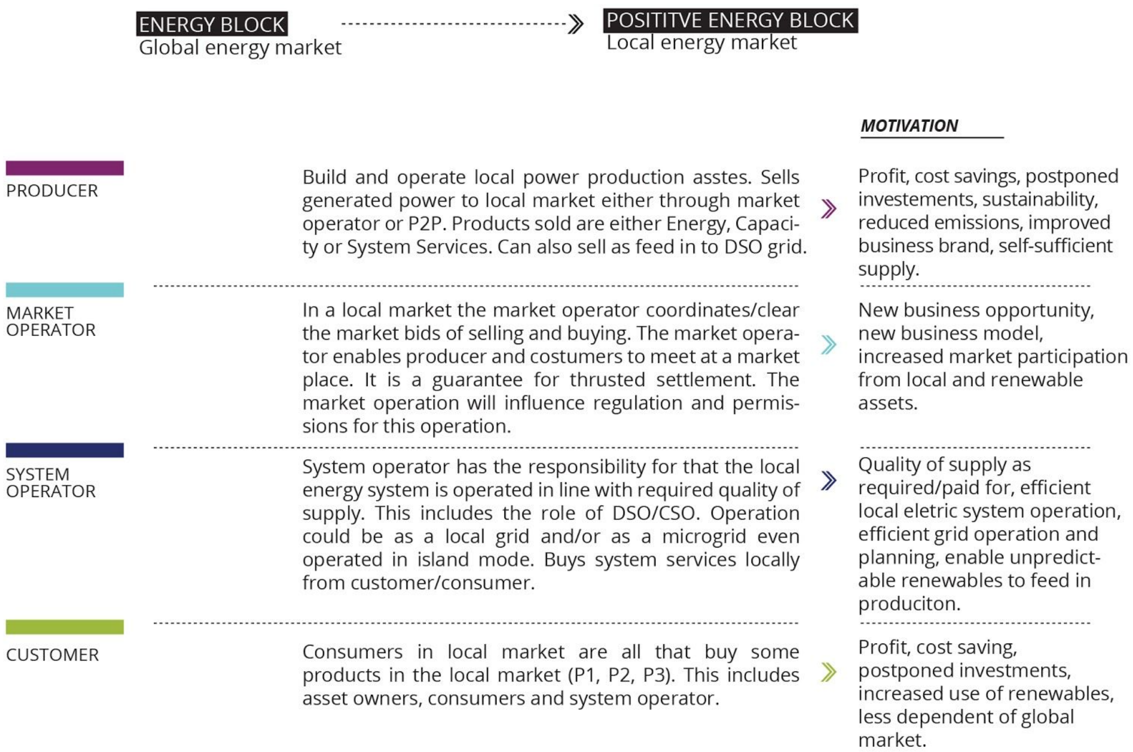

Figure 7.1: Role description and value proposition to operate a PEB in a local market.

The four different local market roles do all have different incentives and value propositions to operate in this new market. The value proposition represents the motivation for them to innovate and take part in the process towards PEB. However the motivation to achieve the best from their value proposition must include both technology and business models. The business models are expected to be the most critical issue to succeed with this goal. Dependent on how the local market is organised, it may be necessary to establish a Community System Operator that will be a similarity to how a DSO operates a distribution system. This is about how to best be organised to release the massive potential of flexibility that communities of prosumers as local market customers represent.

7.1 Trondheim - proposed regulatory change to execute demonstration

Operation / Service	Status Quo	Proposed benefits of a Local Market/Local Flexibility Market Operated by a CSO.	Relevant Policy & Regulation	Regulatory barriers	Possible Solutions to enable a Local Market/Local Flexibility Market Operated by a CSO.
PEB P2P Trading *- IOTA -Licensed Supplier issue*	End-users have exclusive contracts with one retailer to buy or sell all their energy from or to.	Trading P2P, directly between PEBs, and through the wholesale Market Place. Create a new energy market design coupled to consumer-driven innovation and put flexibility at the core of the distributed energy system	Act on the production, transformation, transfer, turnover, distribution and use of energy etc. (Energy Act)	End-users is not allowed to simultaneously trade in multiple Marketplaces. End-users is not allowed to trade P2P	Allow PEB-members, Consumers and Prosumers, enabled by smart contracts, to select multiple retailers and markets to trade in, including the PEB and wholesale markets. Trading P2P based upon IOTA Tangle zero fee micro-/nano-payment protocol.
PEB P2P Trading – *Billing and Settlement*	Billing and settlement has to be through one licensed supplier – which could potentially lead to double counting if issue wasn't addresses.	Trading P2P, directly between PEBs, and through the wholesale Market Place. Create a new energy market design coupled to consumer-driven innovation and put flexibility at the core of the distributed energy system	Act on the production, transformation, transfer, turnover, distribution and use of energy etc. (Energy Act)	Billing and settlement has to be through one licensed supplier	Trading P2P based upon IOTA Tangle zero fee micro-/nano-payment protocol and use this in Elhub to avoid double counting
PEB P2P Trading – *Network Charging*		Introduce a new pass-through tariff?	Act on the production, transformation, transfer, turnover, distribution and use of energy etc. (Energy Act)		
PEB P2P Trading *-Data*	Currently the DSO/Elhub holds all data.	A more granular level of detail will be needed in order to establish what is happening at the customer/ connection level.	Act on the production, transformation, transfer, turnover, distribution and use of energy etc. (Energy Act)		
PEB *-Data Protection*		A more granular level of detail will be needed in order to establish what is happening at the customer/ connection level and throughout the entire PEB. Datasets needed for PEB is currently being held by the DSO and the building owners	The General Data Protection Regulation (GDPR) provides the general legal framework for ensuring privacy and data protection of final consumers in the context of the smart meters' roll-out.	Energy demand, consumption and cost data for local citizens, used by a third party (possibly a co-operative) to trade locally. Data storage.	Work to ensure the protection of personal information during this Pilot project.

			The Commission has also produced guidance on data protection and privacy for data controllers and investors in smart grids (Data Protection Impact Assessment Template supported by Commission Recommendation 2014/724/EU) (European Commission, 2019).		
PEB Environmental Performance Contracts (EPCs)		Implement EPCs for corporate and private tenants to stimulate private, sustainable investments	National Tenancy Act	National Tenancy Act	Implement EPCs for corporate and private tenants to stimulate private, sustainable investments
PEB *Storage.*		Demonstrating the importance of integrating storage devices to the PEB.	The EU "Winter Package" states that DSOs should not be allowed to own, develop, manage or operate storage in order to promote market competition.		Local decentralised energy resources and the PEB cannot fully operate without permission for storage within the PEB.

Table 7.1 GAP analysis of the existing regulations in order to execute the Trondheim demonstration projects.

7.2 Limerick - proposed regulatory change to execute demonstration

Operation /Service	Status Quo	Proposed benefits of a Local Market/Local Flexibility Market Operated by a CSO	Relevant Policy & Regulation	Regulatory barriers	Possible Solutions to enable a Local Market/Local Flexibility Market Operated by a CSO
Electrical Power System Model	Centralised power generation by large commercial plants. Delivery of electricity by TSO & DSO to final customer.	Supply chain moves from being centralised, remote from consumers, to being localised and distributed.	- Directive 2009/72/EC. -EU Renewable Energy Directive (2009/28/EC). -EU Energy Efficiency Directive (2012/27/EU). -EU Clean Energy Package -EU Energy Performance in Buildings Directive - National Renewable Energy Action Plan (NREAP).	PILOT DER. Local / community scale power generation *and* local distribution through a Community Grid are not permitted. The current power model provides a barrier for new trading arrangements within the Community Grid.	Changes are needed to the current power model to enable innovative local trading initiatives such as the Community Grid Model (PILOT DER) to fully participate in providing market solutions.

			-Irish National Energy Efficiency Action Plan (NEEAP). -The Energy white paper – Irelands - The electricity Regulation Act 1999		
Large Commercial (Centralised) Electricity Power Generation	Licensed generators generate commercial electricity centrally. The generators supply their electricity to the "Wholesale Pool".	Community Grid (PILOT DER) should assist the centralised plant in local load management, balancing and flexibility in a disturbance-neutral enabled Energy Market Place.	-Electricity Act, 1999 The CRU may grant a licence to supply electricity under section 14 (1) of the Electricity Regulation Act, 1999. Any person or company who intends to supply electricity to a final customer requires a supply licence from the CRU.	As above: Local / community scale power generation *and* local distribution through a Community Grid are not permitted.	
Transmission	A Contractual Infrastructure Agreement exists between ESB and EirGrid. The CRU sets out the required standard form of transmission connection as well as the approach required of the TSO in facilitating the connection.	A Community Grid Framework (PILOT DER) and model provides balancing and flexibility for the TSO via the DSO.	-EU Directive 2009/72/EC Electricity Act, 1999 1999 Act provides that a licence to own the transmission system may only be issued to ESB -Section 34 of the Act gives the CRU the regulatory power in respect of connections to the transmission grid.	Only large commercial / centralised generation plant will be allowed to connect to the Transmission System (via a Substation with suitable capacity).	Community Grid (PILOT DER) will be a commercial entity operating under a special license to add or remove production on existing or new grid connections in the Distribution System, using only a light-weight connection approval process with the DSO.
Distribution	-CRU has licenced ESB ESBN as the only licenced DSO. Requirement by ESB Networks that Market Participants has security cover in place.	The use of the existing distribution grid by ECU will facilitate the ownership and empowerment of local energy citizens to own and utilise local Distributed Energy Resources. Community Grids reduce the costs for DSOs to strengthen the grid by providing disturbance neutrality. Reduces the cost by TSOs to balance supply and demand therefore provides a service to the DSO.	*Directive 2009/72/EC* is the separation of the ownership and operation of the distribution system. *Electricity Act, 1999*. - Duos Agreement Section 7.3.	Difficult for small generators to connect to the grid. Real power export for generation is currently limited to 6kW for single phase and 11kW for three-phase electricity. Non-gate process intended for smaller generators and experimental technologies is vastly oversubscribed and subject to lengthy delays to connection.	Under SET PLAN 4: Regulatory Innovation Zones for Smart Energy Networks. Community Grid will operate as a live-lab / test bed. Community Grid and operated by ECU registered as a licenced operator in the distribution system. Introduce a new pass-through tariff, the CuOS (Community use Of System).

Table 7.2 GAP analysis of the existing regulations in order to execute the Limerick demonstration projects.

7.3 Limerick - proposed regulatory change to execute community grid demonstration

Community Grid System is established and demonstrated in the Lighthouse city of Limerick. A community grid is defined as a "Virtual Grid" that utilises the existing Distribution Grid Infrastructure, to facilitate local Distributed Energy Resources, system balancing, quality management and trading. The community grid requires special permissions that are not typically is in line with traditional DSO regulations . Based on an extensive mapping of the existing regulatory framework, proposed solutions for how the regulation /internal policies should be justified/changed are described to secure a well functioning community grid system. This is presented in the following table with the most important possible solutions proposed.

Operation / Service	Status Quo	Proposed benefits of a Local Market/Local Flexibility Market Operated by a CSO.	Relevant Policy & Regulation	Regulatory barriers	Possible Solutions to enable a Local Market/Local Flexibility Market Operated by a CSO.
CGS Planning	Planning permission required for Community RES technologies (PV) and additional RES technologies (Tidal Turbine & Solar Farm). Planning permission required for Community Grid Stabiliser (Instalment & deployment).	Provide decentralised energy generation, storage, distribution through deployment of assets.	Planning policy.	Planning required for deployed assets with more complex barriers due to historic Georgian district.	LCCC must be prepared to issue Planning Permission to a set of infrastructures necessary to develop the project (PEB / Community Grid). CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4).
CGS Grid Connections	Community Grid Stabiliser (CGS) needs to connect to the nearest MV Substation to the Community Grid. Tidal Turbine needs to connect to the nearest MV substation to the Community Grid. Solar Farm needs to connect to the nearest MV substation to the Community Grid.	Provide decentralised energy generation, storage, distribution through deployment and connection of assets.	Directive 2009/72/EC Electricity Act, 1999. Duos Agreement - Section 7.3.	Difficult for small generators to connect to the grid. Real power export for generation is currently limited to 6kW for single phase and 11kW for three-phase electricity. Non-gate process intended for smaller generators and experimental technologies is vastly oversubscribed and subject to lengthy delays to connection.	Community Grid Stabiliser – ESBN to give permission with oversight from LCCC and the CRU to connect to the local MV substation nearest the Community Grid. A sandbox would in theory allow for faster grid connections. However, ESB is willingly committed to provide fast connections for RES and additional RES, which is vital to demonstrate that the Community Grid System (CGS) can operate as a MEC 0 site and can be safely considered a single MPRN entity.

CGS Generation	Permitted to operate in a very limited (domestic) scale. Not presently open for new applicants. Obtain a licence to generate electricity from the CRU and authorisation to construct the relevant generating station. A generator with a capacity in excess of 10MW is required to participate as a generator in the ISEM.	Provide decentralised energy generation, storage, distribution and trading at a local (substation) scale. Provide the DSO/TSO with local flexibility opportunities.	CEP (clean energy package) should be adhered to with regard to Community Grids Systems (CGS) generating electricity. Electricity Act, 1999. Energy Act 2016 - peer-to-peer trading enablement laws.	Ensure members of a Community Grid System (CGS) can generate their own RES electricity and use it for their own purposes – as stated in the specific peer-to-peer trading enablement laws contained in the Energy Act 2016. Ensure that the Community Grid Stabiliser (CGS) is not considered a generator under current ESBN policy and is allowed to connect to the nearest MV Substation to the Community Grid System (CGS).	CRU internal policies and licenses need to allow members of a Community Grid System (CGS) to generate electricity. When the Community is proven to be Disturbance Neutral, additional RES should have preferred and a fast route to ESB connections. ESBN recommendation (Additional Renewable Energy Sources dedicated to serving the Community, initially <200KW, moving up to <5MW. ESBN will collaborate with MPOWER to facilitate these connections).
CGS CSO - Electrical Distribution	ESB is the only licensed operator of the distribution system and is the only entity which can charge a Distribution Use of System (DUoS) fee for the use of the distribution system.	Provide decentralised energy generation, storage, distribution and trading at a local(substation) scale. Provide the DSO/TSO with local flexibility opportunities.	Directive 2009/72/EC Electricity Act, 1999. Duos Agreement Section 7.3: PILOT	Local decentralised energy resources cannot operate without permission for a Community Grid. A new (commercial) entity CSO is needed which operates the Community Grid System (CGS) and also ensures disturbance-neutrality.	As part of the regulatory sandbox a Community Systems Operator (CSO) is recognised by the CRU as the operator of the Community Grid System (CGS) within the trial. The Community System Operator (CSO) will engage to establish through a local contract energy prosumer group entity multi-user Maximum Export Capacity Zero Community Grids underpinned by regulation by contract and generator shutdown/isolation controls. (CGS's considered MEC Zero and single MPRN entities).
CGS CSO - Wholesale Market.	The ISEM is a gross mandatory pool market, featuring a single system marginal price (SMP) set on a half-hourly basis by the bids of thermal generators. All parties wanting to buy or sell energy through SEMO must first register to join the Balancing Market	Community Grid operated by the CSO will double as a retailer to provide a local peer-to-peer, but disturbance-neutrality enabled Energy Market Place.	Overseen by the regulatory authorities in Ireland (CRU) and Northern Ireland (UR) through the SEM Committee (SEMC). Trading and Settlement Code: Rules which govern the Single Electricity Market.	The CSO, as a regulated trial entity of the Community Grid System will need to undertake a flexibility market trial process, which will include completion of all registration requirements to qualify as a new market participant in the new I-SEM market. No provision for explicit DSR in the wholesale market. No mechanism for making bids and offers for a customer's potential demand	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4). The SEMO, with the support of the DSO (ESB Networks), and the CRU can assist in the CSO's participation in a flexibility market trial process.

CGS CSO - Retail Market Multiple Suppliers + Smart Contracts.	End-users have exclusive contracts with one retailer. Retailer can become a supplier of electricity in Ireland once they obtain a licence from the CRU.	Enable trade within communities and the wholesale Market Place. The proper execution of all Smart Contracts provides a disturbance-neutral Community Grid.	Electricity Act, 1999 Energy Act 2016 (enabling Peer-to-Peer Trading in Ireland). CRU has a statutory responsibility for protection of energy consumers - through the Electricity and Gas Suppliers' Handbook.	Currently consumers can only have one contract with one retailer under the licensing agreement. As part of a community grid system it would be necessary that consumers have contracts with multiple retailers and have a licensing agreement with the CSO (through Smart Contracts) as well as future retailers in the market. Credit Cover Obligations as outlined in the' Trading and Settlements Code' published by the Commission for	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4). Multiple Retailers: As part of trial consumers will be allowed to have contracts with multiple retailers and therefore have a licensing agreement with the CSO. Smart Contracts - billing and settlement will be through the CSO as a licensed supplier. Market access costs as part of the trial and credit cover obligations as published by the CRU in the "Trading and Settlement Code" will be agreed in advance.
CGS CSO - P2P Trading - *EnerXchange	All transactions must be made through a licensed supplier and customers can only have one licensed supplier. Today customers buy from a retail supplier of choice.	Peer-to-peer trading in a community Grid (Community Grid matches buyers and sellers), as well as in centralised Market Place with a single buyer and / or seller (retailer) for energy not traded in the Community Grid.	Electricity Act, 1999 Energy Act 2016. [No. 12.] PT.4 S.11 "to have regard to the facilitation of consumers to provide, consume and trade electricity that they have generated"	End-users currently cannot trade in multiple Marketplaces.	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4).
CGS CSO - Billing & Settlement + Network Charging.	Currently the system is a one-way system where customers buy from a retail supplier of choice, consumers cannot have multiple suppliers, act as a supplier or trade between themselves.	Producers sell Smart Energy Contracts to consumer in Energy Market Places. Both producers and consumers sell Smart Flexibility Contracts. The proper execution of all Smart Contracts provides a disturbance-neutral Community Grid.	CRU has a statutory responsibility to protection of energy consumers - through the Electricity and Gas Suppliers' Handbook.	Billing and settlement are also through one licensed supplier – which could potentially lead to double counting within the community grid trial if the issue isn't addressed. Network Charging - There is currently no obligation for energy suppliers to pay their customers for the electricity they generate with their solar panels (sometimes known as a 'Feed-in-tariff'). Reduced DUoS charges are not currently available without derogation.	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4). Liaise with CRU & DSO on pricing model as part of the Pilot project. In Sandbox define the pricing model (e.g. CUoS) and evolve to Innovation derogation to test it. The licensed supplier in each trial will continue to fulfil their legal, license and code obligations towards the customers on the trial. The trial partner – MPOWER acting as the CSO will provide bills and statements, tariff information to trial customers within the community grid.

CGS Smart Meters	National Smart Metering Programme: Every single household in Ireland has a mechanical electricity meter. These meters will need to be replaced by 2024. Delivery of 250,000 meters in 2019-2020, and approximately 500,000 meters in each of the four subsequent years.	A uniform sophisticated Smart Meter which is suitable for the Community Grid project would future proof the technology and system.	EU Directives concerning common rules for the internal market for electricity and gas (2009/72/EC and 2009/73/EC) and the EU Directive on energy efficiency (2012/27/EU).	Unknown whether the National Smart Metering Programme will handle more than one supplier per meter point. There are issues with accessing smart meter data – both a DSOs and a P2P platform provider cannot see customer smart meter data due to data protection issues (see data protection below). Sophisticated metering is needed to determine what volume is being sold P2P. There is currently no resolution on who can access smart meter data.	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4). Uniform and sophisticated smart meters and a smart metering system will be provided and deployed by ESBN for the trial Community Grid project. Important to ensure the smart meter can handle more than one supplier per meter point. Ensure sophisticated smart metering is installed in agreement with ESBN which determine what volume is being sold P2P. Allow MPOWER acting as the CSO operating the trial community grid access to the smart meter data in consultation with the data protection commissioner. An overall resolution or memorandum of understanding is needed with regard to who can access smart meter data.
CGS Storage	It is unclear how storage fits within the planning framework. ESB has clear policies with regard to PV devices, generation and storage. Currently storage devices are considered generators in ESB policy and any commercial or residential property with more than 6kW output (including RES device + storage device) is not permitted.	Demonstrating the importance of integrating storage devices to the Community Grid.	The Winter Package states that DSOs should not be allowed to own/ develop/manag e or operate storage to promote market competition. Energy Act 2016. [No. 12.] The use of energy storage.	Important to ensure storage devices are integrated into the Community Grid and not considered as generators (including the Community Grid Stabiliser (CGS) – see next section below). The CGS cannot operate without permission for storage.	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4). Conversations and memorandum of understanding with local planning offices and Limerick County Council with regard to any issues with storage for the trial project.

CGS Grid Stabiliser	No Grid stabilisers are currently permitted to connect to the grid. However, an MPOWER Grid Stabiliser currently operates as part of the Tallaght Community Energy Living Lab'.	A Grid Stabiliser will ensure Disturbance-neutrality.	Electricity Act, 1999 New Regulatory Zones for Sandboxing. SET PLAN 4: Obligations for Energy Regulators. -Enduring Connection Policy Stage 1 (ECP-1)	Currently a Grid Stabiliser is not defined within regulation and is currently not permitted to connect to the grid. A Community Grid Stabiliser cannot operate without connections to the Community Grid MV Substation. A Community Grid Stabiliser requires a license to connect to a substation.	CRU to give permission for Limerick to be accepted as a Regulatory Sandbox or Regulatory Innovation zone (Complying with EU Set-Plan Action No 4). LCCC to validate that the Grid Stabiliser will not require Planning Permission. Grid Stabiliser considered by ESB as a non-generation device (MEC 0) and be allowed fast connection to the nearest MV substation. Application to Commission for Utility Regulation (CRU) with support from DSO – ESB Networks for applicant (MPOWER) to connect to the substation near project site in Limerick. Enduring Connection Policy Stage 1 (ECP-1). {Enduring Connection Policy Stage 1 (ECP-1): ECP-1 is the new process for grid connections, open to all generating and/or storage technologies.}
CGS Data Protection	Currently the DSO and Limerick County Council hold all data needed.	A more granular level of detail will be needed.	In the EU and Ireland, the GDPR provides the legal framework for ensuring privacy and data protection in the smart meters' roll-out. The Commission has also produced guidance on data protection and privacy for data controllers and investors in smart grids (European Commission, 2019).	Access to data from key stakeholders – LCCC and ESBN in order to understand key datasets - Local grid architecture, energy demand, consumption and cost data for local citizens will be necessary to successfully demonstrate the trial project. Data storage will also need to be addressed as part of a Road map for Data Protection.	LCCC to provide a more granular level of data with regard to the buildings and householders involved in the trial. ESBN to provide key data on the local electricity grid system in particular detailed information on the MV Substations and customers per substation. CRU to authorise and guide on a memorandum of understanding with key stakeholders LCCC, ESBN and MPOWER with regard to consumer data.

Table 7.3 GAP analysis for the Limerick CGS

8 Barriers in the process towards a PEB

All over Europe it is ongoing rollout of local renewable energy resources. Some of them are easily connected as a stand-alone asset to the local grid, however it is expected that they in near future must be managed as local energy systems - that should be designed and planned for as in a process towards a PEB. This is capital intensive processes where new technology and business model must be developed and adapted as well. This address several questions and needs for technical, business and regulatory challenges - and opportunities under the umbrella of being named as innovative actions and prototyping.

In the process towards a PEB or PED it is documented a range of barriers that is necessary to overcome. The barriers are challenges mainly related to regulatory framework, available technology, design of local energy market and business models for all players inside the local energy system to be operated.

8.1 Design of local energy market

The European Union has set the ground for the transformation of Europe's energy system, including the redesign of european electricity market in order to ensure that:

- Electricity can freely move towards where it is most needed and valued and it is only dispatched following market signals.
- Consumption is reduced and large shares of RES are integrated at minimum costs.
- Conditions are created for integration of, cost-effective, new type of flexible demand into the market.
- Energy transition is realised by leveraging new enabling technologies and by fostering the development of new products and services.
- Customers are empowered in order to have an active role in the market still retaining their fundamental rights, such as the freedom to choose a power supplier in the free energy market.

PEBs and PEDs have the potential to meet the EU's expectations as long as a fully functional local energy and flexibility market is designed and implemented.

Given the multitude of actors involved and taking into account the four roles model (power producer, customer, system operator, market operator) for a local energy market as shown in figure 8.1, a Multi-Sided business Platform can be utilised to conceptualise a functioning market place taking into account all interdependent relationships, both within the local market and in connection with the existing global energy market.

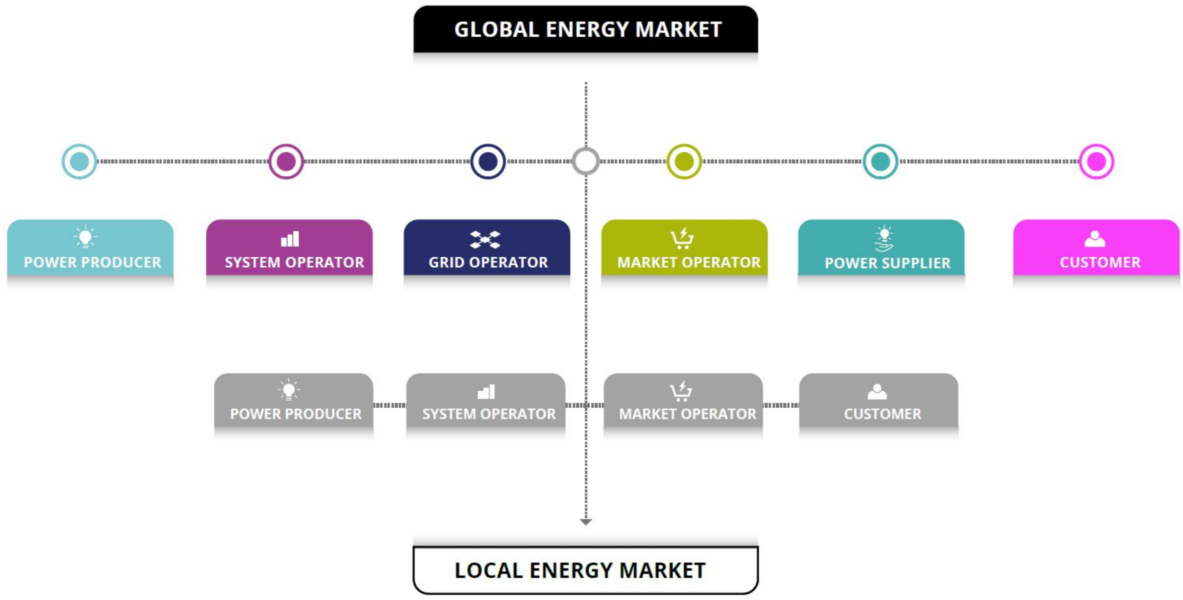

Figure 8.1: Schematic of interactions between local and global markets.

In Figure 8.1 the two following levels are clearly identified:

Local Energy Market; where all the innovative products and services will generated, exchanged and utilised by all actors taking part in such marketplace;

Global Energy Market; which is the traditional energy market place, with which the local energy market can, and must, interact. Innovative products and services created within the local energy market will be exchanged with stakeholders and players operating within the global market, thus creating additional value for all the players involved.

Physical and logical connections between the global and local market places must exist, and they are represented in fig. 8.1 by the dotted line connecting the two. This also represents all the barriers that need to be removed in the process towards a fully functional local energy market.

8.2 Business models for local market players

The methodology known as Value Network Analysis can be applied to the Multi Sided Platform for the local energy and flexibility market in order to understand how and where value is created, how it flows and can be captured in a network of interdependent relationships. Business models are conceptualised and discussed in this paragraph with the intention of further developing and refining them within the scope of Task 2.7 - "Optimise the bankability of demonstrated innovation", including value chain definition and monetisation and innovative finance scheme identification. In order to do so, aligning with +CityxChange and the overall H2020 strategies, Quintuple Helix Model and related methodology will be applied.

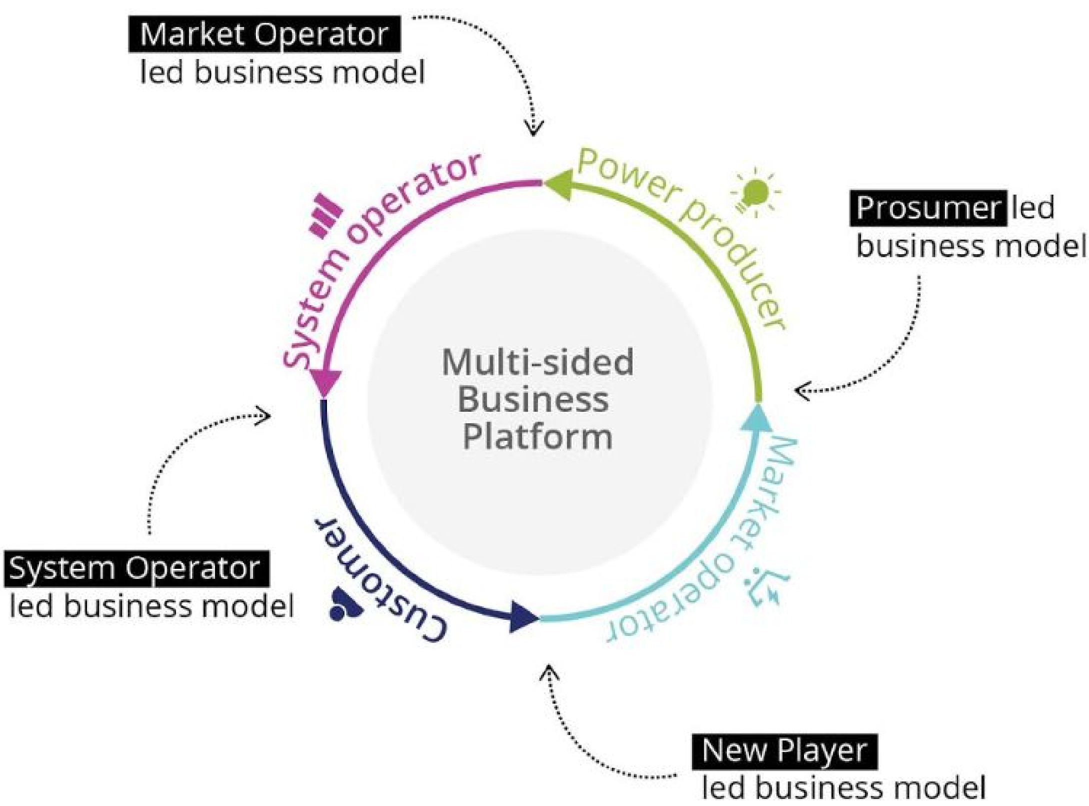

Figure 8.2: Potential business models interactions with the local energy market

Several energy stakeholders can take on one or more of the different roles identified, with various motivations to participate and operate in a local energy and flexibility market. The four roles identified can be performed by players either in combination or individually; for example in the prosumers led business model, the economic actor "prosumer" will play the two roles of Power Producer and Customer, even in associated forms such as a local energy cooperative.

It is worth noting how a prosumer can produce and consume services simultaneously within the local market. For example he can consume energy, which is locally produced in the event of a surplus generation, upon a market signal that comes in the form of a request for capacity; in this case a prosumer consumes energy (for which he pays the settled price) and produces flexibility (for which he gets paid the settled price) for the local energy system simultaneously.

Similarly, a "new player" led business model could concern an energy services company building a rooftop PV power plant within the district, thus accessing the local market with the sole role of Power Producer.

Additional new players can be identified, including for example a battery operator, which could install batteries in the PEB and then sell this storage capacity to other actors which may need it at specific times and in specific situations: a power producer for example may need a battery to store temporarily its surplus generation to be used at a later time. The battery operator could rent out its battery in a sort of "Hardware as a Service" arrangement.

In the framework of a local market, a variety of business models already identified and analyzed in previous EU projects (i.e. http://dominoesproject.eu/), will be assessed considering perspectives, relationships, expected goals, stakeholders involved, investments and many other factors (i.e. (DOMINOES project, 2017)). The same business models will be also adapted to match peculiarities and requirements of the Local Energy Market. The following 6 initial business models are listed and briefly explained:

1. Sharing the exceeding RES generation in the scope of energy communities;
2. Retailer as user of the local market;
3. Energy service provider in enabling / assistive role for local markets and providing energy community service provider capability for retailers, communities or other service providers;
4. Aggregation of small-scale flexible loads as a universal virtual power plant;
5. Aggregated flexibility provision to the Distribution System Operator (DSO) for network management;
6. Using transitive energy for network congestion management.

Table 8.1 synthetically describe main topics of the defined business models and local energy market as organized into who is the provider - what is the service provided and which category of client will gain benefits by purchasing the actual service.

ID	Provider	Service	Client
1	Flexibility service provider (aggregator/ community manager)	Aggregated flexibility as a service. The flexibility service provider will provide the aggregated flexibility as a solution to grid operators and balance responsible parties.	DSO Balance Responsible Party (BRP)/TSO
2	Aggregator	Aggregators offer a new flexibility service to help the DSO solving congestion problems.	DSO
3	DSO	A transactive platform where end-users can make local energy transactions. End-customers receive signals from the DSO to promote local energy transactions. DSO provides incentives to end-users when local transactions contribute to the reduction of penalties caused by congestion situations.	Energy customers
4	Community Manager	The Community Manager (CM) acts as an aggregator. He's the Positive Energy Blocks manager responsible of energy operations and with the objective to provide reduction of bills and green self-consumption in the Community.	End-users of local & global market (i.e., buildings/blocks equipped with PV generation, batteries

			and community members)
5	Local market operator (Flexibility comes from players in the local market).	Use of the local market flexibility to be valued in the wholesale market or to optimize the retailers' portfolio	Retailer
6	Energy service provider (role can be taken by multiple parties)	ICT infrastructure to manage local market that can be used for energy community benefits in and energy community service provider (ECSP) role as well a an ICT tool by other stakeholders for multiple purposes. In addition, the service provider may provide communities with assistance in choosing/sizing generation/storage/control systems in cooperation with technology providers.	Energy communities

Table 8.1: Descriptions of providers and their services and clients in a local energy market with market based flexibility - focusing six actual business models..

8.2.1 Customer perspective

Customers - including prosumers - with own generation and/or consumption will be able to consume self-generated energy by making optimal use of local distributed energy resources (DER), including energy storage (ES) and particularly RES; they become prosumers, who actively manage their energy affairs. This provides them with a higher level of energy independence and control, when compared to the traditional electricity "price-taker consumers", which are essential motivators for their engagement in local energy markets.

They will also be able to trade their energy generation surplus within the boundaries of their local community, such as in a peer-to-peer (p2p) arrangement. This enables the strengthening of the customer's position, i.e. from a passive to an active role, in the energy market/system. With greater involvement, customers also become more energy efficiency-aware, and may take part in innovative demand side management (DSM) and other customer-driven services, including electricity sales to the local or global/wholesale market. Customers can also provide flexibility to DSO/CSO operators through intermediary market products or entities.

By combining the available capacity from multiple customers, players can make offers that comply with minimum capacity requirements, thus enabling the efficient participation of small prosumers that may otherwise not be possible. For these reasons, the connection to broader energy market unlocks various levels of economic benefits to customers, which are not available to self-dependent isolated communities. Local energy markets can also enhance the security of supply if, for instance, these would be structured as microgrids i.e. these could operate isolated from the distribution grid if outages occur. The avoidance of outage costs is thus an additional benefit that customers can leverage in local energy markets.

Local energy markets will connect communities and drive their participant customers into achieving common goals, such as reducing costs of energy, emitting less greenhouse gas emissions, or becoming more energy self-sufficient. This involvement and group-like behavior, alongside a sense of "mission", contributes to a growing perception of transparency and trust in the energy system as a whole, which result in more engagement and commitment.

8.2.2 Local market operators

Even in a local market flexibility products are market based priced. The price is cleared by a market operator which collects all local bids for sales and purchase. This market operator will enable an expanding of the broader energy market to the local level as a significant sectoral change that will drive disruption and innovation, but consequently also competition. The local market operation is in this situation executed as a digitalised algorithm in the trade platform. Competition motivates companies to develop further their services and products in the interest of customers, in terms of both variety and price. More, the continued development of local energy markets will increase pressure over traditional power industry players to adapt their operations towards more customer-oriented approaches.

8.2.3 Local grid operators

The Distributed Energy Resources (DER) generation present in local energy markets will impact the everyday operations of the distribution grid in various ways. It can reduce the network operators' need to make new investments and reinforcements in the distribution grid, not only because of DER capacity additions, but also due to increased flexibility and more efficient overall network operations. These capacity additions at the grid edge also decrease stress in the distribution, due to a decrease in power demand. Network losses reduce as well, since there is less load at both the transmission and distribution levels.

The aggregation of generation and demand capacity from multiple customers can help network operators in more efficiently balancing the grid's supply and demand. Equally, balancing and ancillary services offered by customer-owned DER provide important support to the grid operations. Micro-grids improve the distribution grid reliability by ensuring power supply in case of outages.

Furthermore, the optimized interconnection of multiple micro-grids (when accompanied by effective customer load management) could support the reliability, flexibility, and responsiveness of the overall power system and allow distributed energy resource utilization at larger scale. Power quality at the distribution level can also be improved by the various flexible distributed energy resources and the sophisticated power electronics present in micro-grids. In general, the development of local energy markets opens up new market opportunities driven by new business models geared towards value creation from the network operators' point of view.

If the net local electricity production is larger than local grid capacities, it may cause grid instability and need for grid investments. For this reason it is crucial that the grid operator has a distribution management system which monitor and operate the local grid in line with quality of supply and actual grid codes of practise. Surplus of local production is a potential product that will be traded locally or sold in the "global" power market. Dependent of where the price is best. These options may give new business models and opportunities.

Different forms of value-added and real time services can be provided, as for example real-time energy monitoring and/or billing, DER asset management, customer generation/demand load aggregation, local balancing of supply and demand, distribution network leasing for customer-owned distributed energy resources by DSOs, real-time energy management, etc.

8.2.4 The local market in the perspective of service, technology and energy providers

The local energy markets will rely heavily on digital technologies and on constant product innovation. In this context, opportunities will emerge for market players to reposition their strategies and to develop new products and/or services in line with new customer demands. New market players will emerge due to changes in its models and governing structures. These actors will mostly operate as third-party intermediaries between customers, network and market operators. For example, aggregators are bringing advantages to both customers and operators, and can simultaneously generate profit by providing their core services. Another example are energy services companies (ESCOs), which can drive significant value to customers via reductions in their energy demand. ESCOs offer various types of novel services, most typically by relying on performance contracting schemes for invested capital recovery. In such a model, the ESCO provides investment cost and takes project risk in exchange for realised cost savings over an agreed period of time. ESCOs' revenues link directly to savings achieved for their customers, which is another step towards a more transparent market practices.

Other business opportunities will arise in the domain of active information exchange between stakeholders – a key foundation of the local energy markets. Information and communication technologies (ICTs), the major enablers of a more efficient and flexible operation of the distribution network, will power this exchange. Significant business opportunities to develop and provide related flexibility products and energy management services will drive the entry of new participants in existing local energy markets.

8.2.5 Society aspects in a local energy market perspective

The evolution from a traditional energy model to a new paradigm rooted in decentralized and customer-centric energy production and distribution is a massive undertaking with many positive societal repercussions. Local energy markets not only embrace this paradigm but take it steps further by providing greater market transparency and the promise of more fair distribution of power and more balanced allocation of systemic costs and benefits, which are arguably foundations to advancement of any society. Local energy markets facilitate the growth of clean energy generation, in particular from RES, which leads to lower local and global emission levels. This is in line with the EC's climate objectives and with the Paris climate agreement.

+CityxChange project aims at integrating existing business models and merge different aspects of the energy management in the PEBs.

8.3 Major market regulation needs to be updated

European countries need standardized regulations to adapt and test a model for how to establish and operate a PEB. Countries set various financial incentive schemes and tax regulations for RES avoiding an homogeneous approach for the economic assessment of the energy interventions. For example, in some countries it's not allowed to install and activate battery storage systems or energy generation, in others the distribution network configuration cannot be changed to accommodate distributed energy systems. Definitely, complicated regulations and muddled authorisation procedures create barriers to new investors.

Digitalisation of the economy, including the energy sector, is a trend that continues to march on but at the same time generates legal issues related to privacy and conflict of interests in personal data utilisation. Energy transactions and commercial relationships among end users and public and private stakeholders need regulations to identify and define the responsibilities and obligations of each party.
Peer-to-peer energy trading solutions, energy hub data creating, trading energy on blockchain technology should be relieved (except in some cases) of additional legal and regulatory barriers.

Running policies and regulatory schemes only consider current networks and utilities. The existing energy models boost competition in generation and supply of power but doesn't encourage clean energy supplies. Basically, central Governments implement policies addressed to protect customers/consumers to prevent market exploitation. Recently, policy makers, regulating the liberalized market, are more customer and competition oriented than in the past. New Regulatory models aim at avoiding market abuse and control the return (rates) of the investment.

In the energy market, there are other regulatory barriers not fostering potential demand and flexible energy production while in many cases, the structure of the energy market is disaggregated; in fact, to overcome these barriers, electricity generation, transmission, distribution and sales should be managed by individual companies, as required by EU regulations such as the "unbundling" regulations as per the EU's Third Energy Package, and in particular European Directive 2009/72/EC.

Concerning the demand side management measures, established procedures should be provided with handful separate contracts to connect a single customer to a “pool”. Thanks to the development and the implementation of smart grids and technologies customers are changing their behaviour. Therefore, power generation (not RES) should be reduced when expected demand is overtaken. At the same time, demand side measures should be more deeply classified and analyzed so that suitable capacity for new power generation units can be defined with objective to maximize RES production within the PEB.

8.4 Enabling technologies

8.4.1 Smart Metering

In tariffs to end customers it is normal to include elements that in total covers all grid costs including administration and metering. Cost for power supply – the competitive part to the supplier – is separated – and paid for additionally either as an invoice from supplier or local DSO. To the customer it is presented a cost element structure typically like:

Total Cost [year] =Fixed Cost + Energy Cost [kWh] + Capacity Cost [kW]

The use of the cost elements depends of customer type and smartness in the customers meter. National regulations about tariffs and metering are also influencing the traditional tariff structures. For a customer that participates in a local power market, the meter must include a smartness that makes it possible to meter and account precisely the traded product (P1= Energy, P2= Capacity, P3= System Service).

A smart meter as installed to all customers in Norway includes this possibility. Generally spoken, a smart meter with real-time communication will fulfill these technical requirements and therefore the requirement would shift more on the Advanced Metering Infrastructure (AMI) than on the meter itself.

The Annex I to the Electricity Directive 2009/72/EC requires the EU Member States to roll out electricity smart meters to 80% of consumers by 2020, unless the result of a Cost Benefit Analysis (CBA) is negative. Therefore smart metering as an enabling technology for PEBs/PEDs should be widely available throughout Europe.

The aforementioned smart metering is intended for fiscal use, that is for billing purposes of players within the local energy market. The smart metering of energy assets contributes to the operations of the local energy market even outside the scope of fiscal and billing purposes: availability of granular energy generation and consumption data enable functionalities such as forecasting services and real-time control.

Smart Meters required for such applications do not have to comply with the strict requirements of fiscal ones and therefore can be selected within lower price tiers, although data quality and reliability remains paramount.

In Ireland the Community Grid System deploys high functionality and granularity Digital Electricity Metering along with Single Chip Computer Technology and Machine-to-Machine (M2M) Communications operating between Community Members and the Energy Community Utility + CSO. These are simply titled Smart Link Units (SLU). There is a need to agree the relationship between DSO Metering, Billing (Retailer) and Community Grid Settlement Metrics - this is a key objective of +cityXchange.

8.4.2 Energy Management System

Energy management systems, for building or home applications, consist in a technology platform, including both hardware and software resources, that allows to screen and control building's energy needs, mechanical and electrical components as well as to monitor occupants' energy behaviour. Energy management system is a powerful technology for the management of the energy demand as in a single building as in blocks.

Energy management systems provides:

- Healthy and agreeable indoor climate;
- Safety of the user and the owner;
- Cost-effective and energy efficient running of the building in respect of both plants and personnel.

The application of energy management systems for buildings can significantly improve the energy management and the building's performance with an integrated approach also providing a continuous feedback on building management.
In addition, energy management system has at disposal a large amount of data related to building and occupants that can be made available in order for the PEB to extract knowledge and take advantage of such valuable information with the objective of optimising buildings use of energy and capacity.

Energy management system main characteristics can be described as follows:

- A physical infrastructure of sensors and actuators for monitoring energy consumption, climatic and environmental conditions, human presence and activities performed
- An intermediate ICT services platform that collects data from heterogeneous sources.
- A decision-making system that implements energy saving and energy efficiency policies.

8.4.3 Smart Energy Assets

Smart and local energy assets introduction will enable the creation of PEB and active management of the microgrid at community level, whilst increasing the amount of distributed renewable energy generation within the district boundaries. Smart assets are

intended as components of the local grid, related to energy generation, consumption and storage, that can be remotely monitored and controlled, thus enabling balance and optimisation of grid and market operation, peak shaving, load shifting, increase in the PEB self-consumption, demand response and a reduction in curtailment of RES.
Foreseen smart energy assets at this stage include, but not limited to:

- PV solar systems;
- Mini hydro power plants;
- Micro wind systems;
- Heat recovery systems;
- High efficiency heat pumps;
- Battery energy storage systems;
- Smart appliances;
- EVs and charging infrastructures.

Standardisation of asset interfaces including their integration to the local energy system are paramount to ensure optimum asset operation following market signals. This could be either explicit, by adopting international or "de facto" industry standards, or implicit, meaning that intermediate software and/or hardware layers will be interposed between system components in order to enable integration of and communication to as many products and services as possible.

8.4.4 Forecasting services

Knowledge of forecasted energy consumption and generation within the PEB is required in order to enable local market functionality. Bespoke forecasting algorithms have to be applied, including self-learning features which will make use of the large amount of data made available through meters, energy management systems and smart assets. Different kind of forecast services - included consumption, generation and weather forecasts - are provided from many third parties all over Europe. For the purpose of serving a local energy market it is important that such services are localised and customised for the actual PEB areas.

8.4.5 Trading platform for local energy and flexibility market

A local energy market for flexibility products requires an automated trading platform to make bids and enable trading between local market players and participants.
To enable a demonstration of such local trade at a disaggregated level it is required system integration through a common api for the assets. For settlement and payment services it will as an option also be demonstrated how distributed ledger technologies with a network of computers may be applied for verifying and authenticating of the of traded products. All data related to energy production and consumption within the local grid are recorded and at the same time automated P2P trading will be stored on the ledger. The basic demonstration will show how customers can bid amongst each other in order to sell and purchase locally generated energy products.

9 Handbook for how to establish a PEB within a regulatory framework

Based on the clarifications and information given by involved cities and partners, definitions and proposed requirements in the processes towards positive energy blocks are evaluated and used to set up a handbook for how to establish PEB within a regulatory framework. In this process innovation to several issues is required. This innovation developed in the project to some extent challenges existing regulations and laws. For that reason it is adequate to address the need for a "sandbox" approach where it is allowed to set up and operate the actual tasks required to demonstrate how a PEB could be operated in the Lighthouse and Follower cities.

The sandbox demonstrates the process from establishing communication with the regulator, to applying for dispensations from the regulatory framework and enabling the demonstration project. This is a generic approach that can be utilised for the lighthouse cities, the follower cities and other cities outside the project.

A regulatory sandbox is a framework set up by regulators that allows innovative projects to conduct live experiments in a controlled environment, under a regulator's supervision (European Commission, 2018a). The EU Commission's FinTech Action Plan presents 19 steps in order to secure innovation and business model scale up in the financial system. A blueprint on best practice in regulatory sandboxes is one of these 19 steps. Regulatory sandboxes was first introduced to FinTech in 2015 and has led to a high level of innovation and increased security for the end users in the financial system. The energy-related sandbox setup for +CityxChange is based on the operation model followed by most FinTech sandboxes.

Sandboxes are also called Regulatory Innovation Zones for example in the SET Plan Action 4 (A4-IA0-4) (Temporary Working Group 4, 2018), and is listed as a cross-cutting innovation activity. Topics that will be looked into in the Innovation zones are; Taxation on electricity and energy trade, Energy community / local and regional markets and P2P exchange of energy/flexibility using blockchain.

A report commissioned from NVE (The Norwegian Water Resources and Energy Directorate) on Local Energy Communities also states that NVE should develop a regulatory sandbox solution that provides a clear, standardised process for the granting of temporary dispensations in the form of demonstrations and pilots for the purpose of securing innovation the local energy communities (THEMA Consulting Group & Multiconsult Norge AS, 2019). One of the ambitions of the +CityxChange sandbox is to provide financial and regulatory reports to the regulator advising and informing the regulator on the processes.

9.1 A stepwise process towards a well functioning PEB

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.

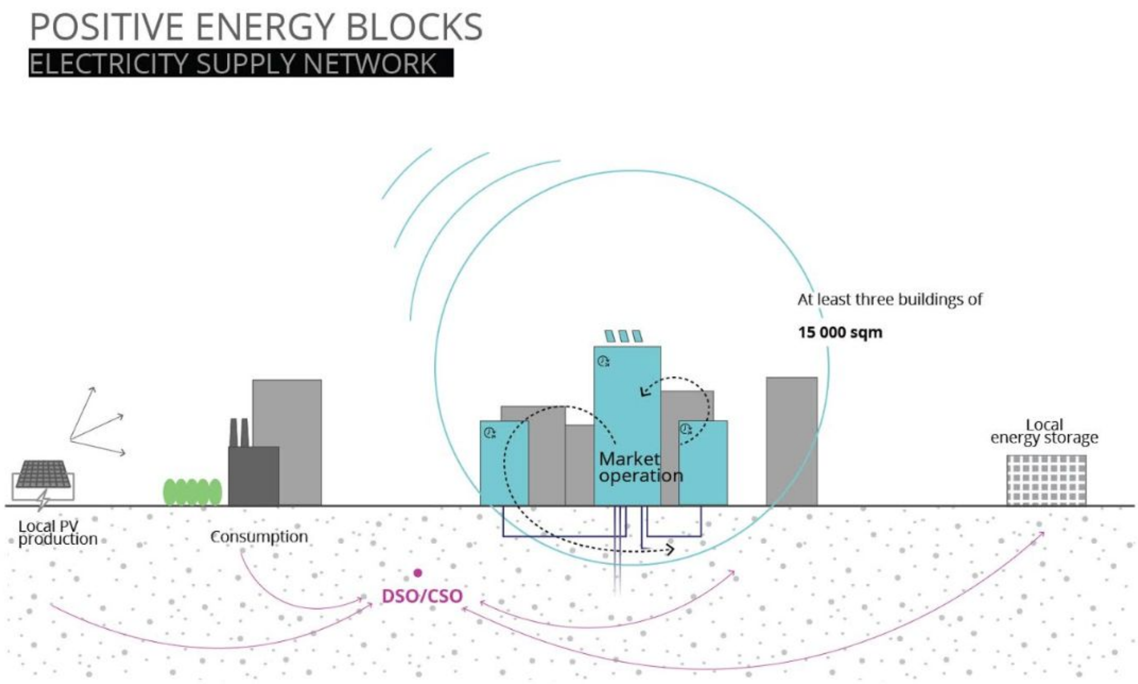

Figure 9.1: The physical and virtual grid of the +CityxChange PEB.

The trade of flexibility assets can be done by utilising the physical grid or the virtual grid. Physically the energy will flow to the closest demanding asset within the PEB, illustrated by the purple line in figure 9.1. Virtually the flexibility assets can be sold to the highest bidding peer within the market, illustrated by the blue lines. The location of the main energy meter of the PEB is important to define and understand its boundaries. In the global power market the role as grid operator is a natural monopoly separated from the supply and production businesses.

Due to a downscaled local market the roles are operated of digitalised toolkit which secure trustworthy automatic routines for the chain from bidding to settlement and payment. In a market approach some resources like storage/battery can operate either as producer or customer that consumes power.

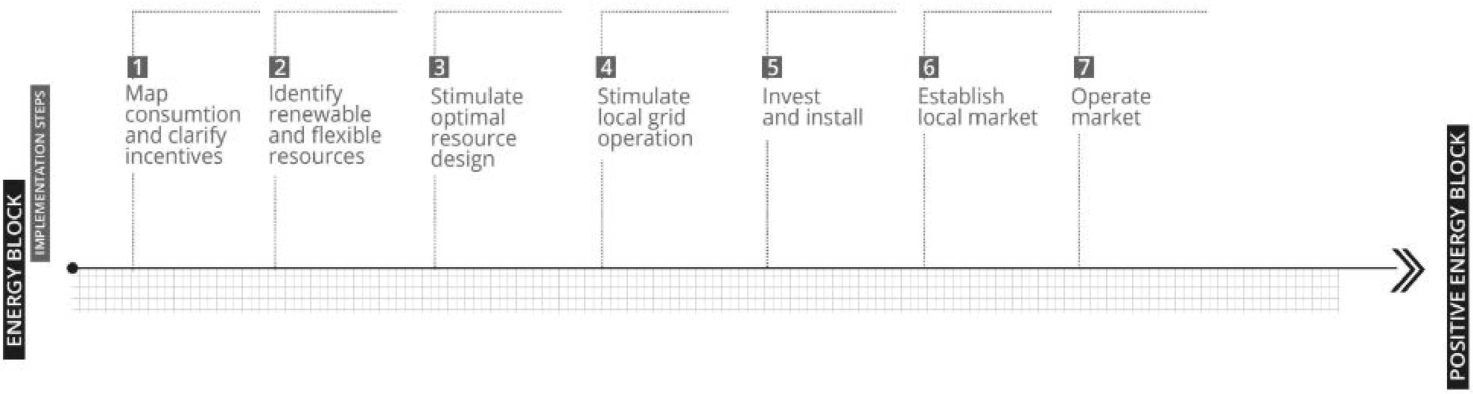

Figure 9.2: The steps from an Energy Block towards a Positive Energy Block with identified actions and their progress.

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 9.2 it is given an overview of the milestones in the process of setting up the required resources and flexibility to operate as a PEB. To be able to execute these solutions, several regulatory changes needs to be done, facing the role of the regulatory authorities within the current country.

9.2 Regulatory Sandbox a tool to promote innovation - the FinTech example

In the area of financial technology, innovation has been crucial to stimulate and test as prototypes and pilots to be able to reach the required evolution of the financial sector. Financial regulations has been the most important obstacle for this innovation. For that reason the regulatory bodies in Europe has set up so called Regulatory Sandboxes to be able to do innovation either internally or by related industries (European Commission 2018a).

The number of firms with financial technology (FinTech) has seen a significant increase over the last four years. The EY FinTech Adoption Index claims that on average one in three digitally active consumers use two or more FinTech services. In 2015 one in seven active consumers were FinTech users. One of the reasons for the massive boost in FinTech, is the collaboration with the regulators in different countries (Ey 2017).

In 2015 the UK's Financial Conduct Authority (FCA) launched the world's first regulatory sandbox for FinTech startups. This allowed innovations to be tested under controlled conditions set and monitored by the regulator. This approach was soon adopted by several Australia, Denmark, the Netherlands, the US and several Asian countries. In figure 9.3 it is described process of how regulatory sandboxes are created and realized for the purpose of innovation and piloting new fintech.

EY presented an operation model for the regulatory sandbox in FinTech. This setup is inspired by the EY operation model for the +CityxChange regulatory sandbox.

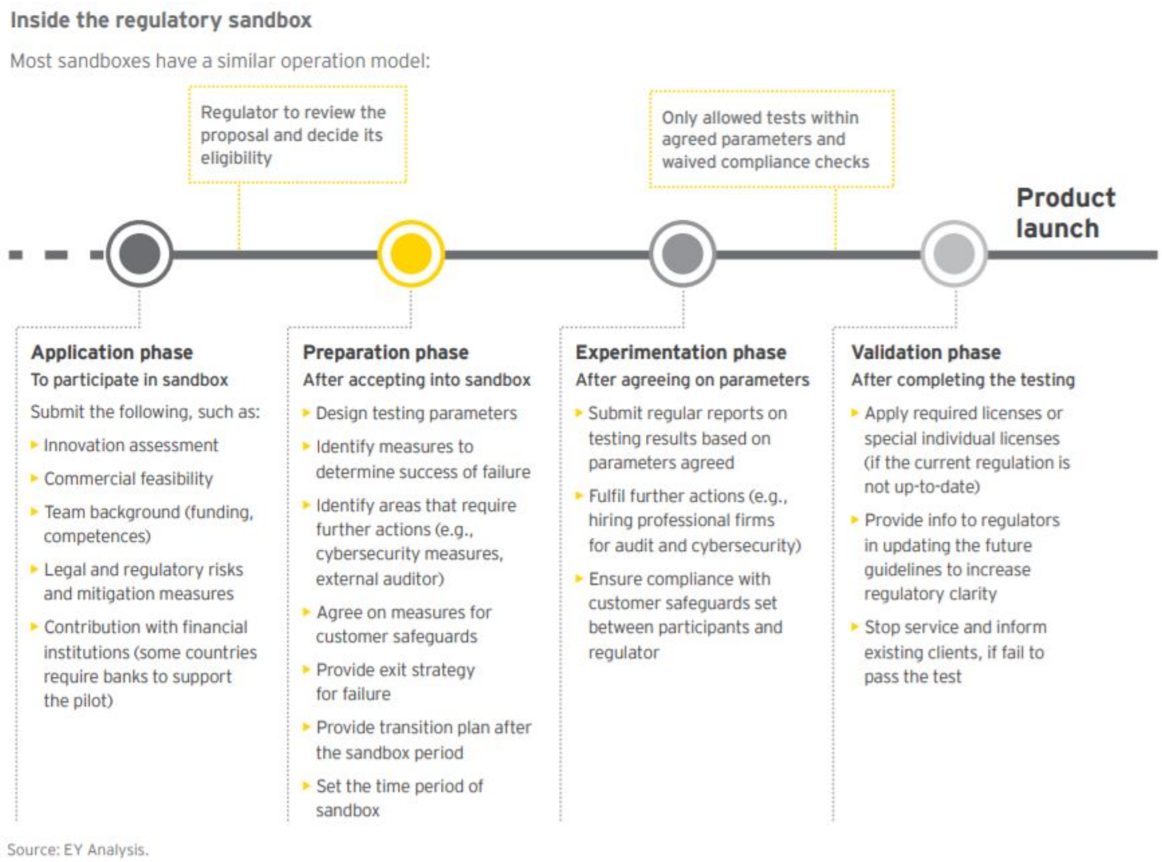

Figure 9.3: Regulatory sandbox from Fintech. Source: (EY, 2017).

9.3 Regulatory Sandbox - a possible tool to demonstrate a PEB

In the process of prototyping local energy markets with PEB it is experienced need for some kind of exemption from existing regulations. Regulatory clarity is highly important when it comes to establishing a local energy market. The agility of the process will clearly depend on the level of bureaucracy of the regulator in each country, and the processing time for the dispensation application will vary from country to country.

The objective for the +CityxChange is to prototype and demonstrate PEBs. The technologies are developing rapidly and the regulations can be seen as a bottleneck in this process. To realize the demonstration of the PEBs, it is necessary to approach the regulator and apply for dispensations. The collaboration between the innovators in the project and regulators is crucial in order to achieve "optimal regulation". A sandbox could aim to create a win/win solution for all participants to reach this in the form of local pilot areas. The regulation

Figure 9.4 shows the setup of the +CityxChange sandbox, showing the relevant milestones in approaching the regulator. As seen in the timeline, the dialogue with the regulator should be established, after the incentives are clear and the available renewable and flexible resources have been identified. This is to secure an early involvement of the regulator, thus potentially increasing the chances for success of the sandbox. After simulating the optimal resource design, necessary dispensations should be mapped (step 2). Step 3 represents applications sent to the regulator. If approval is not received in step 4, it is recommended to discuss with the regulator other possible dispensations for the project. When all assets are installed and the market is established and in operation, status should be reported to the regulator on a frequent basis (step 5). At last, a full report should be submitted to the regulator in order to give an overview of the success of the sandbox. Step 6 represents proposal for changes in the overall regulatory framework, in order to promote innovation in the global energy system.

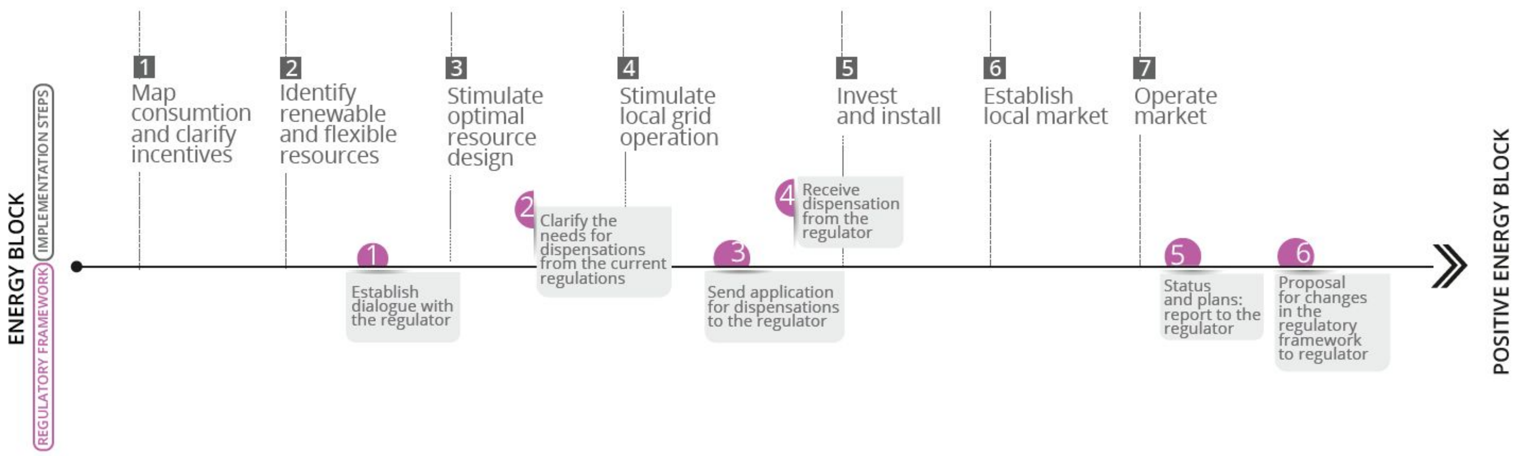

Figure 9.4: The +CityxChange regulatory sandbox approach.

The municipality acts as a neutral coordinator in the sandbox and is responsible to initiate contact with the national authorities. When setting up the regulatory sandbox, it is important to have a common understanding of the different roles. The municipality is also responsible to initiate a project group for the sandbox.

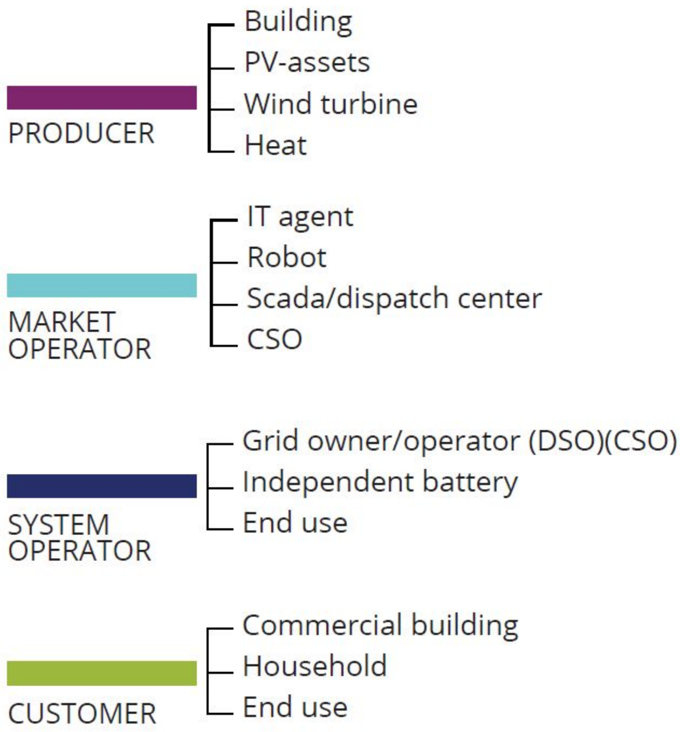

Figure 9.5: Role interface within the local energy market.

In figure 9.5 it is summed up the following four different roles within the local energy market. Each role could be described more in detail like this:

The producer: The producer might be represented by the customer, acting as a producer and a consumer. A third party can also represent the role of the producer.
The market operator: Representing the financial part of the local energy market, the market operator needs to be a part of the process of both designing the local energy market/flexibility market, but also the trading platform within the PEB.
System operator: Depending on the set up of the local energy market the DSO or the CSO will be the participant sending in the dispensation applications. Eventually it might be natural that the DSO or the CSO has the main contact with the regulator.
Customer: Finding the best solutions for the end user is a crucial success criteria for establishing the PEB. The end user as a customer should be a part of the process of when the dispensations being applied for is set, and is also a crucial part of the experimentation phase and validation phase of the sandbox.

In addition to the four roles, the municipality is a crucial participant in setting up the market within the project demonstrations.

9.4 The key for a successful PEB in +CityxChange - The sandbox approach

In establishing procedures of a PEB it is important to understand how the different local market roles have a responsibility and position to take. The actual roles are producer, market operator, system operator and customer - all of them with different motivations and value propositions to operate inside a PEB. This is a generic process that can be utilized disregarded nationality and in figure 9.6 it is indicated how and when the different roles must take actions - and which actions.

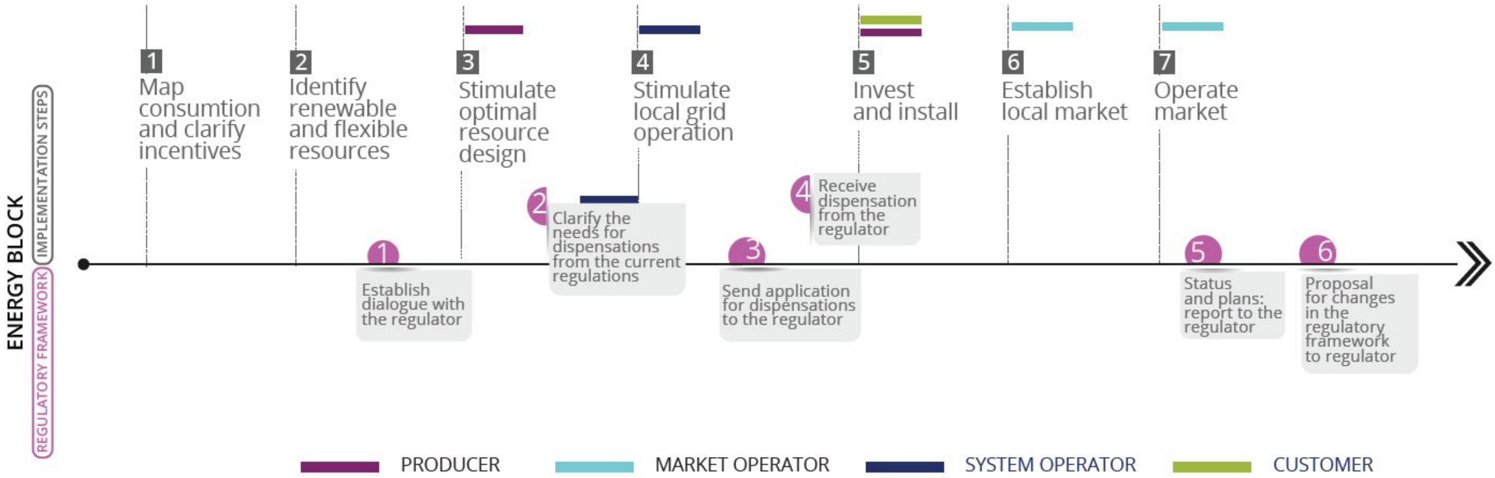

Figure 9.6: The +CityxChange sandbox approach linked to the different roles.

<u>Clarification phase</u>

In the clarification phase all necessary data on the Energy Block is mapped. Available flexibility assets are identified. Due to that, renewable energy sources are flexible resource assets per definition. Figure 9.7 illustrates possible solutions for a peer within the PEB that can be assessed in the clarification phase. A storage of energy and/or capacity is typically flexible and most consumers may turn flexible parts of the consumption up or down depending on their cost and benefit by doing so. The flexible energy and capacity resources inside the energy block could be as presented in chapter 8.4.3.;

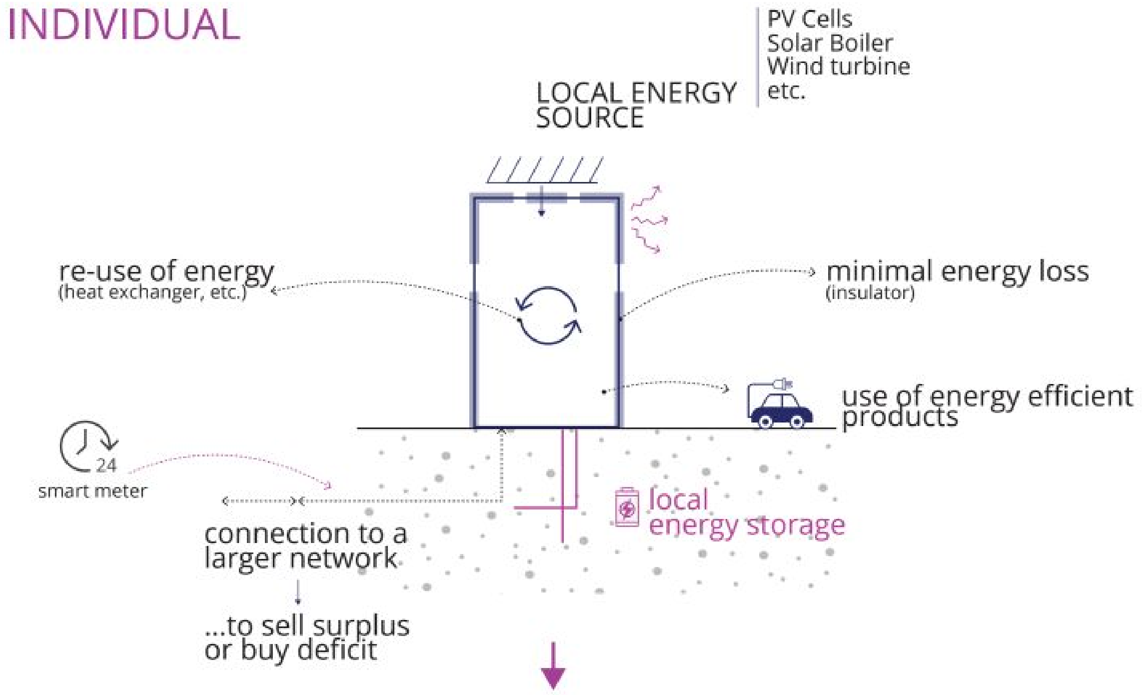

Figure 9.7: Individual PEB assessment for the clarification phase.

<u>Application phase</u>

Prior to the application phase the municipality has organized a project group for the sandbox. A meeting with the regulator should be organized as soon as possible in order to establish a connection point, even if the design of the local energy market is not completely established. This can be done as a parallel process where the technical and financial boundaries can be seen in interaction with existing regulations.

In the application phase, the aim for the project needs to be established. What do the project want to achieve? A GAP-analysis will give insight in the gap from the existing regulations compared to the ambitions of the project. Mapping of the motivation of the different actors within the local market also needs to be identified, as proceeded in figure 9.8.

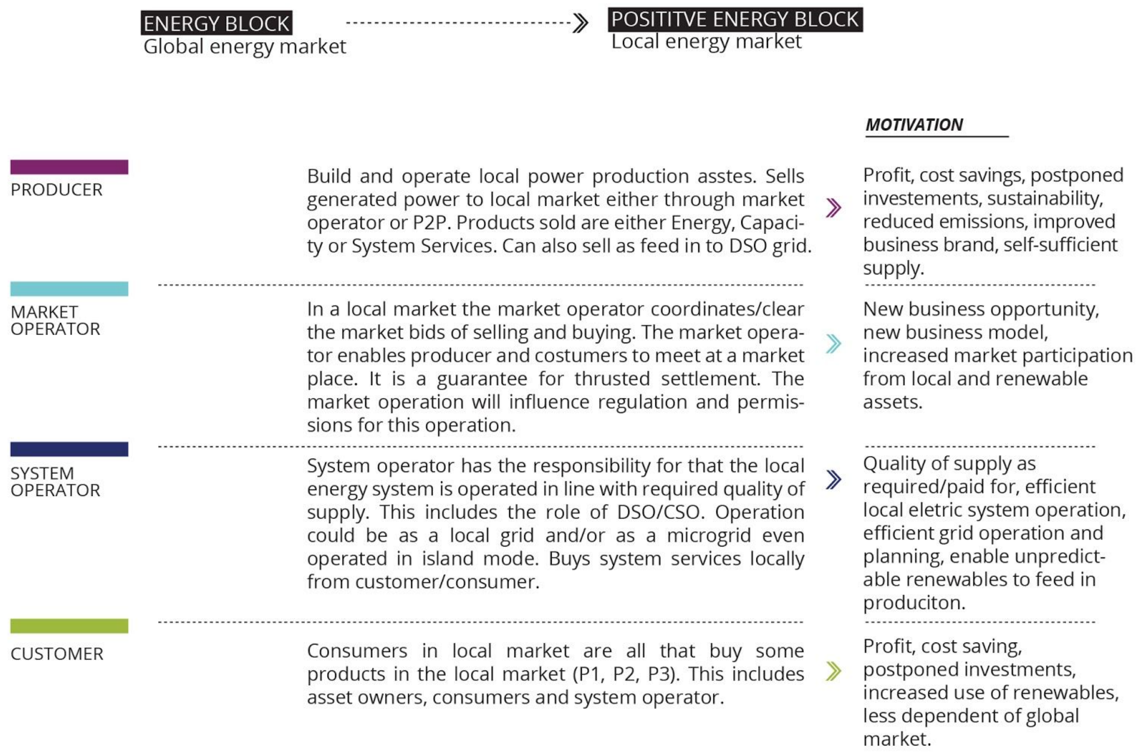

Figure 9.8: Generic approach to a GAP-analysis.

Communication with the regulator will give insight into what possibilities lies within the existing regulations and what dispensations is it possible to apply for.

In the application phase

- Perform GAP-analysis
- Legal and regulatory risks and mitigation measures
- Map socioeconomic intensives
- Map necessary dispensations needed from the regulator
- Contribution of financial institutions
- Apply for necessary dispensations

Report phase

After accepting into sandbox the frame of the sandbox needs to be defined. Together with the regulator, the parameters of interest needs to be set up, il line with the setup of the reports in the piloting phase.

The following steps will be carried out:

- Design testing parameters
- Identify measures to determine success or failure - the regulator might have some demands regarding the business model of the demonstration projects.
- Identify areas that require further actions.
- Agree on measures for customer safeguards
- Provide exit strategy for failure
- Provide transition plan after the sandbox period

- Set the time period of sandbox

Demonstration/piloting phase
In the demonstration/piloting phase all assets and controllers for the local market are in place.

- Submit regular reports on testing results based on parameters agreed
- Fulfil further actions (e.g., hiring professional firms for audit and cybersecurity)
- Ensure compliance with customer safeguards set between participants and regulator

Evaluation phase
Apply required licenses or special individual licenses (if the current regulation is not up-to-date).

- Provide info to regulators in updating the future guidelines to increase regulatory clarity.
- Stop service and inform existing clients, if fail to pass the test.

10 Main findings and next steps

The +CityxChange project will demonstrate how Positive Energy Blocks and Positive Energy Districts can be established in cities around Europe. The demonstrations from the project will be executed under actual national regulatory regimes with relevant dispensations. In general the ambition of the project are in line with the Winter Package and the future energy policy of the EU.

A mapping of the regulations for both the Lighthouse cities and the Follower cities has been carried out. A gap analysis has only been done for the Lighthouse cities. Due to the fact that the DSO in Trondheim will act as a CSO in the local energy market, only a few applications are necessary to enable the PEB. The gap analysis illustrates the regulatory framework that needs to be changed after the demonstration period, these are mostly related to the Energy Act.

The work with the report and gap analysis have resulted in several observations regarding incentives, barriers and regulatory framework which influences the process towards an operative positive energy block (PEB). This is presented as follows:

- There are no existing regulations at national levels that are promoting processes towards establishment and operation of PEBs.
- The regulations are made mainly for power market operation. These regulations are compared with what is expected to be a prerequisite for a local power market - and the conclusion is that existing regulations with permissions and obligations for the actual local power market roles is adaptable for a market based local energy system.
- It is crucial that the roles in a local energy market is clearly defined. These roles are as customer, producer, system operator and market operator.
- It is ongoing digitalisation of energy operation issues - in all four roles, but especially on the production and customer side. This innovation happens fast and gives incentives for new product and services - including the introduction of renewable energy resources.
- The regulatory framework is experienced to develop slowly and actual changes to support the fast introduction of local renewables as market resources is not coordinated.
- If regulation and technology has been more aligned, new business models and new entrants would be introduced to processes related to PEB operations.
- Shorter processes in regulation adaptations will gain to speed up the establishment of PEBs.

To stimulate for innovation in the local energy system domains it is important that demonstrations and piloting is ongoing continuously. This is achievable with specific permissions or regulatory sandboxes as used in the fintech industry.

In order to follow the process of the regulatory sandbox a common understanding of the roles within the local energy market has been set up. Moving from a global energy market to a local energy market, six roles are simplified to four mentioned roles. A first step in the regulatory sandbox is performing a mapping of the regulatory mechanisms within the respective countries and a gap analysis to underline the regulations being affected when developing the PEB.

An understanding of the four roles in the local energy market is a prerequisite to identity and describe the differences in regulations in the respective EU countries as presented in the gap analysis. The main findings are:

- There are the same clear roles in the national energy markets and the markets are operated openly and liberally.
- Smart metering has different grade of implementation in the different countries, but the technology is highly developed. This does not represent a barrier in the process towards a PEB.
- Investment in renewables is mostly performed by the customer.
- The role as a producer is developing fast due to the establishment of renewable assets.
- The intensives for the DSOs participation in the local market varies.
- The local market would be selling and buying flexibility from producers and customers.
- It is required that flexibility must be specified as products possible to manage in a local market. It is defined three flexibility products: p1 - energy, P2-capacity, P3-system services.

The handbook presented in this report illustrates a sandbox process for approaching the regulators in European countries, with the ambition of enabling the regulatory mechanism to trial the PEBs and PEDs in the cities. The handbook being presented in this report shows a step-by-step process to trial innovation in cities. This work builds a platform on how we can proceed with the process to enable next deliverables. Lessons learned is that a dialogue from early stages with regulator is essential to trial innovation in cities.

The work being done in this deliverable is the basis for further work that will be done in the +CityxChange project and will be built on in deliverable 4.4 “Enabling Regulatory Mechanism” led by Limerick City Council and deliverable 5.4 “Enabling Regulatory Mechanism” led by the City of Trondheim, as well. Deliverables 6.6-6.10 which is replication in the follower cities.

In the work with this report it has been contribution from 20 of the project partners representing 9 different countries. This broad contribution has been important to secure valuable information and analysis. It is also important to secure that the report is within project scope and that it as an early project delivery will be valuable for the work to come in +CityXchange project.

This deliverable contributes to the +CityxChange projects overall expected impact (Key Performance Indicators) as presented in figure 10.1.

Figure 10.1: Expected impacts from the project.

Recommendations to the EU and the regulators in the respective countries:
To be able to trial innovation in cities there is a need for making regulatory sandboxes to promote piloting of energy innovations. This is in order to test out new ways in the cities and that the cities take ownership to trial new ideas that other cities can learn from.

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12 Annex

Regulatory issues around Demonstration projects

Demonstration projects	Regulation barriers
DP01 - Model	Addressed in the data management plan [Input from WP1]
DP02 - Vision	Barriers/regulations, if any, will be handled in work package 3
DP03 - Engage	Barriers/regulations, if any, will be handled in work package 3
DP04 - Regulatory zone	Sums up the regulations to be considered in this task
DP05 - Playground	Barriers/regulations, if any, will be handled in work package 4 and 5
DP06 - DPEB	Building energy performance NS-EN ISO 52000-1:2017 - see chapter 6.4 in this report
DP07 - Microgrids	Regulations addressed in this report
DP08 - EMaaS	Regulations addressed in this report The ITS Directive EU Regulations 2017/1926
DP09 - Local trading	Regulations addressed in this report
DP10 - Flexibility market	Regulations addressed in this report
DP11 - Invest	Regulations will be handled in work package 4, 5,6 and 8.

EcoGrid EU (Bornholm)

EcoGrid is an EU project on market-based mechanisms for energy grids.

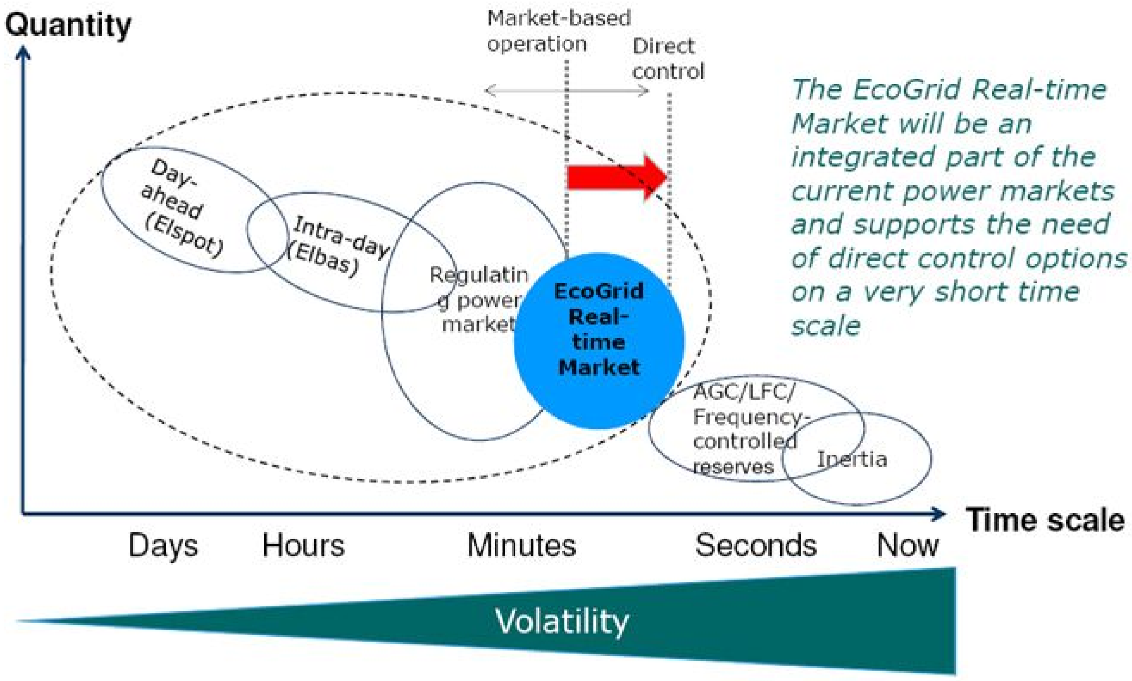

Figure 12.1: Illustration of the EcoGrid Real-time market (EcoGrid EU', 2016).

The overall conclusions of the EcoGrid EU evaluation team are: ('EcoGrid EU', 2016)

- A real-time price signal can be used to activate flexible consumption
- There is a significant peak load reduction potential: The activation of flexible consumption with a five-minute real-time signal reduced the total peak load of the EcoGrid EU participants by approx. 670 kW or 1.2% of the peak load on Bornholm
- The flexible demand response can be forecasted – with some certainty – resulting in overall improved system efficiency
- Households, having equipment that controlled their heating system to respond automatically to price signals, accounted for 87% of the peak load reduction
- Involving the customers is the key to success. Personalised advice works best, but should be kept to a minimum due to the sheer volume in a national roll-out
- Standardised 2nd generation smart grid equipment is necessary

SESP model

The Smart Energy Service Provider (SESP) model is suggested by Olivella-Rosell et al. (2017)

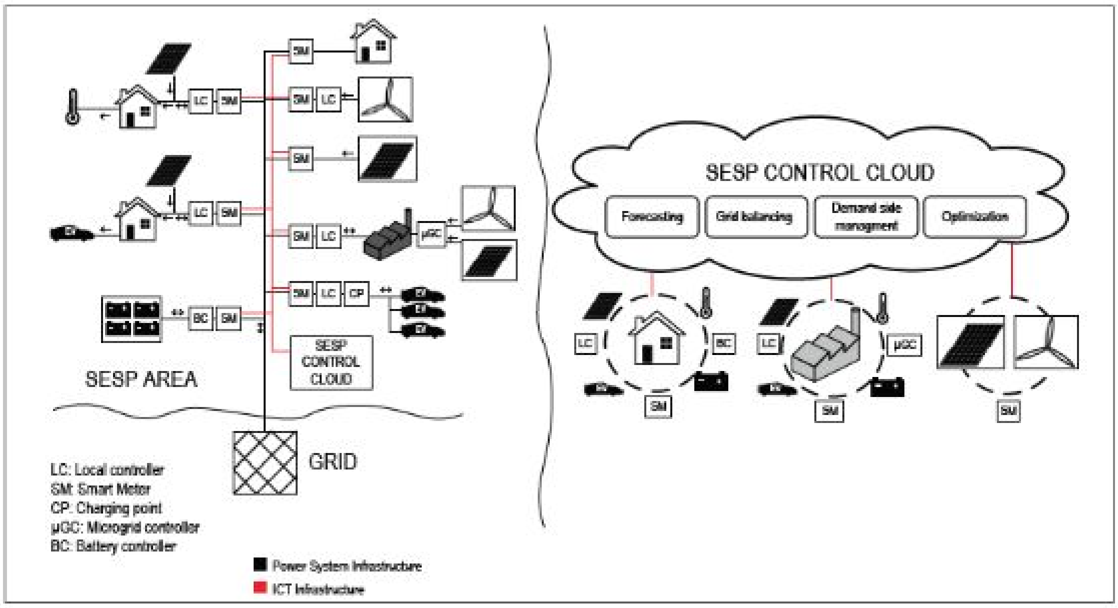

Figure 12.2 SESP local market overview with components and ICT infrastructure (Olivella-Rosell et al. 2017).