atelier
Positive Energy Districts

AmsTErdam BiLbao cItizen drivEn smaRt cities

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Governance, Integrated planning and Law

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Abbreviations and Acronyms

Acronym	Description
aFFR	Automatic Frequency Restoration Reserve
BRP	Balance responsible party
BSP	Balance service provider (aggregator)
CCC	Climate City Contract
CSP	Congestion service provider (aggregator)
DSO	Distribution System Operator
EC	Energy Community
EMS	Energy Management System
ESCO	Energy Service Company
ESG	Energy sharing giver
ESO	Energy sharing organiser
EST	Energy sharing taker
EU	European Union
EV	Electric Vehicle
IA	Innovation Atelier
ICT	Information Communication and Technology
LEM	Local Energy Market
LH	Lighthouse
mFRR	Manual Frequency Restoration Reserve
PED	Positive Energy District
RES	Renewable Energy Resources
SUP	Supplier
TA	Transport Agreement
WP	Work Package

0. Executive Summary

Over the past five years the ATELIER project has worked on the implementation of Positive Energy Districts (PEDs) in both Bilbao and Amsterdam and supported the planning of PED replication in al Fellow Cities. Many cities embrace the PED concept to align the urban development, and transformation plans with the ambition to become energy neutral and/ or net-carbon neutral by 2050. PEDs are being characterised by the fact they generate more Renewable Energy on an annual base than they consume.

Developing a PED presents a range of challenges, including technical, economic, legal, and spatial considerations. To support the development of PEDs, Innovation Ateliers have been organized in Amsterdam, Bilbao as well as all the Fellow Cities. These Innovation Ateliers bringing together relevant stakeholders (from the ecosystem) who are directly or indirectly involved in the development of the PED to collaboratively work on specific topics, challenges, or innovations. The aim of the Innovation Ateliers is to support the development of the particular PED as well as to contribute to the development of PEDs in general.

This report presents the results of the many knowledge sessions, deep dives and workshops that have taken place in the Cities' Innovation Ateliers, within the Innovation Track focusing on *Integrated Planning, Governance, and Law*. Various sessions were held in Bilbao and Amsterdam covering a wide range of subjects, such as energy communities, energy sharing, congestion, and the integration of renewable energy sources in the built environment.

Key questions addressed in these sessions included: What legal frameworks are needed to enable energy sharing, how can we, as a group, enter into sharing or energy contracts with the grid operator, and how do we design our urban neighbourhoods in such a way that we can integrate district heating systems and other renewable energy sources into a flexible energy system?

The sessions were attended by a wide range of participants, including builders and contractors, system operators, local governments, research institutes, companies and citizen representatives. This report summarizes the discussions held during these sessions and provides an overview of the key insights, conclusions, and recommendations for maintaining the impact of the Innovation Ateliers in respect to further replication and upscaling of PEDs in Europe.

1. Introduction

The ATELIER project is dedicated to advancing the development and implementation of Positive Energy Districts (PEDs) as a key strategy for achieving net-carbon-neutral transitions in European cities. A Positive Energy District is an urban area or cluster of interconnected buildings designed to produce more energy than it consumes on an annual basis. This energy surplus is primarily generated through a combination of enhanced energy efficiency, local renewable energy generation, and flexible energy systems that balance supply and demand. Within the scope of the ATELIER project, two PED demonstrators, located in Amsterdam and Bilbao, have been designed, implemented, and tested. Additionally, six partnering (fellow) cities (Bratislava, Budapest, Copenhagen, Cracow, Matosinhos, and Riga) have explored the potential for replicating these PED models, assessing their scalability and adaptation to diverse urban environments.

To ensure the successful development and implementation of Positive Energy Districts (PEDs), the ATELIER project introduced the **Innovation Atelier** framework. This framework facilitates the deployment of PEDs by promoting an innovative public-private collaboration within cities' local innovation ecosystems. Participants of the Innovation Ateliers work together on supporting the implementation of innovations and new solutions in the PED project, by identifying hurdles that need to be encountered, bringing in know-how of other projects or cities, and building on the innovation and learning capacity of individual entities or cities, but also in wider urban networks of cities and via cross city exchange sessions. Throughout the ATELIER project, the Innovation Ateliers played a central role in driving innovation and knowledge-sharing, tailoring smart energy solutions to the specific needs of each city's PED development.

Design of the innovation ateliers

In each of the participating cities, both lighthouse cities and fellow cities, Innovation Ateliers have been established. Depending on the local ecosystem in each city, partners representing the quadruple helix (government, industry, academia, and citizens) have been identified and invited to participate in the activities of the city's PED Innovation Atelier. To drive the required innovation and knowledge creation, the activities are organized into four distinct "Innovation Tracks," each focusing on a specific area of expertise and providing valuable know-how to the local innovation ecosystem.

In Amsterdam and Bilbao, the PED Innovation Ateliers have appointed a specific local track coordinator who serves as the primary point of contact within the network. This role involves identifying specific knowledge needs, challenges, opportunities, or risks within the PED project and or Innovation Track. The track coordinator also plays a key role in advancing these requests, assessing what is needed, selecting partner organizations, and preparing tailored knowledge sessions and/ or workshops. Coordination of international collaboration and alignment across the different Innovation Tracks is managed by a dedicated ATELIER partner.

In the ATELIER project proposal, the four Innovation Tracks were carefully defined based on their critical contribution for realizing the PED ambitions in cities. The co-creation of innovations thus extends beyond the technical realm, integrating innovations in institutional frameworks, financial instruments, data systems, and policy. These four Innovation Tracks, which drive the co-creation of solutions to support the development of PEDs, focus on the following key domains:

Innovation Track #1 > Integrated Smart Energy Systems and Electro-mobility

This track addresses innovations regarding the design and optimization of dedicated measures for reaching energy efficiency goals that are 'beyond existing codes' for buildings, implementation of positive energy systems, deployment of E-mobility solutions and integrated operations and management.

Innovation Track #2 > Governance, Integrated Planning and Law

In track 2 questions related to governance, integrated planning and law are explored.

Innovation Track #3 > New Financial Instruments

Track 3 explores how innovative business models can support different innovations and the concept of PED as a whole. The track also looks into different innovative financing structures.

Innovation Track #4 > Data, Privacy and Data Platforms

Data use and data platforms activities aim to allow collection of local user-data, apply queries and ICT applications for smart energy management, balancing local supply & demand; and ultimately enable automated demand response programs to further increase energy efficiency and impact of PEDs.

In each of the Innovation Tracks, methods and tools have been developed and tested within the cities' Innovation Ateliers. These have been used to identify and explore specific smart (energy) solutions by developing and evaluating new institutional arrangements, innovative forms of cooperation and governance, novel business models, and new financing schemes and funding opportunities that support the technical solutions.[1]

The coordination of knowledge sessions, workshops, and deep dives to address specific knowledge needs or questions has been managed in collaboration with the core team of the LH Innovation Ateliers. The final program for each knowledge session or deep dive was developed in consultation with this team, and included defining the target audience, inviting external practitioners, field experts, or specialists to contribute, and presenting key insights relevant to the topic at hand. All sessions were documented to capture lessons learned, providing valuable knowledge for other cities and PED projects to benefit from.

Purpose of Innovation Track 2

Innovation track 2 has been focused on *Governance, Integrated Planning and Law*. This track includes the exploration of new governance models, supporting the implementation of smart urban solutions in the Cities. For instance, the assessment of the experiments of organisation models to deal with the Energy Community, or how to effectively operate the Local Energy Market. Assessed models have been implemented in the local PED projects and implemented by partners from the Innovation Ateliers. Furthermore, this track will experiment with different options to integrate smart urban solutions and to align or even integrate different planning mechanisms for energy, mobility and urban planning in the cities.

From the legal perspective, the implementation of smart urban solutions and real time experience in PEDs, clearly illustrating in the demonstrator area's where existing legislation and regulations are preventing optimal effect or functioning of the system. This Innovation Track represents dedicated legal expertise and is able to bring in knowledge of parallel projects

[1] EC, ATELIER project Deliverable 3.1: The PED Innovation Atelier Organisation Document, 2020.

or experiments to learn from, and design work arounds of alternative strategies. The inclusion of so-called sand box experiments with temporary exemptions from the relevant laws is a unique opportunity offered in the PED in Amsterdam, to experiment with peer to peer trading, and establishing rules and conditions for trading on the project grid. These lessons have been discussed in much detail in this Innovation Track, and also forwarded to the national regulators and ministry responsible for drafting new regulations and laws, for delivering real time lessons learned and including suggestions for regulatory improvements. one option. Based on the outcomes of these discussions, actions are formulated to improve local, national and even EU legislation, (spatial) planning practices and governance mechanisms in order to effectively support the implementation of PED measures in the cities.

Having these topics as premises Innovation Ateliers in Amsterdam, Bilbao and even the Fellow Cities, prepared and delivered the outcomes that will be further explained in section 3 of this report.

1.1. Purpose and Target Group

The object of this report is to provide an overview of the sessions organised under track 2 on *governance, integrated planning and law* and share the knowledge developed and gained during these sessions. The report also includes reflections on how the outcomes of the sessions were used to support the PED developments and how the insights could support PEDs in general. Finally, the report presents the collective findings of both Bilbao and Amsterdam on the key topics discussed during the meetings. Based on those collective findings, lessons learned, and recommendations for future implementation are formulated.

Outcomes and reflections of these Innovation Track sessions are not only relevant and valuable for the partners of the Amsterdam and Bilbao Innovation Ateliers, not for the invited participants to many of these sessions either, but also for other cities that are planning for PED projects or implementation of some of the technical and non-technical smart urban solutions or cities that are even planning to prepare ground for establishing a local Innovation Atelier themselves. Via cross city events and learnings, the wider network of stakeholders and cities (through EU initiatives like Scalable Cities) have gained access and value from the outcomes and results of many of the Innovation Track activities.

1.2. Contributions of Partners

The following Table 1. depicts the main contributions from project partners in the development of this deliverable.

Partner short name	Contributions
TNO	Overall content to all sections
EVE	Content to section 3.3 and 3.4, plus feedback on section 4
Amsterdam	Review
TEC	Review

Table 1. Contributions of Partners

1.3 Relation with other work packages

There is a direct link between the work carried out in the PED demonstrators Amsterdam and Bilbao that focussed on designing and building a PED project. In both cities creating a positive energy district has faced numerous challenges. Varying from rising energy and material costs due to the Ukraine war, but also congestion issues and challenges around the integration of RES production in densely populated areas. In this context, the Innovation Ateliers played a key role in identifying emerging barriers and offering potential solutions.

The Innovation Ateliers also contributed to shaping the city's long-term vision for 2050 and developing energy transition action plans for 2030. In Bilbao, the Innovation Ateliers provided a framework for organizing a participatory process, engaging both municipal departments and external stakeholders in this strategic visioning process. In Amsterdam the lessons learned from the Atelier project are integrated in the recently submitted Climate City Contract (CCC)

The outcomes and lessons learned from the Innovation Ateliers were shared with the partner (fellow) cities during the Fellow Cities Events. These cities offered valuable insights, enriching the results of the Innovation Ateliers and enabling a comparative analysis of legal frameworks, as well as organizational and governance solutions. Also does the establishment and maturation of Innovation Ateliers in Fellow Cities reflect a successful technology and knowledge transfer across cities, based on the articulation of local ecosystems and their requirements.

2. The Innovation Ateliers

In this chapter the main results of the Innovation Ateliers sessions on integrated planning, governance and law are described. Including a description of how the innovation ateliers were organised, its participants and the planning of the sessions.

2.1 Bilbao

Context description: Planning, participants etc.

Context

In Bilbao, the Basque Energy Cluster organized the Innovation Atelier meetings. This cluster, which brings together over 200 members from across the energy sector (including industry, energy suppliers, grid operators, local government, and research institutions) played a key role in the process. The local coordinator for Track 2, **Ente Vasco de la Energía (EVE)**, the Basque Energy Agency, led the effort. EVE is responsible for developing projects that align with local governmental goals and objectives. Working closely with the core team (see image below), they actively shaped the agenda for the sessions.

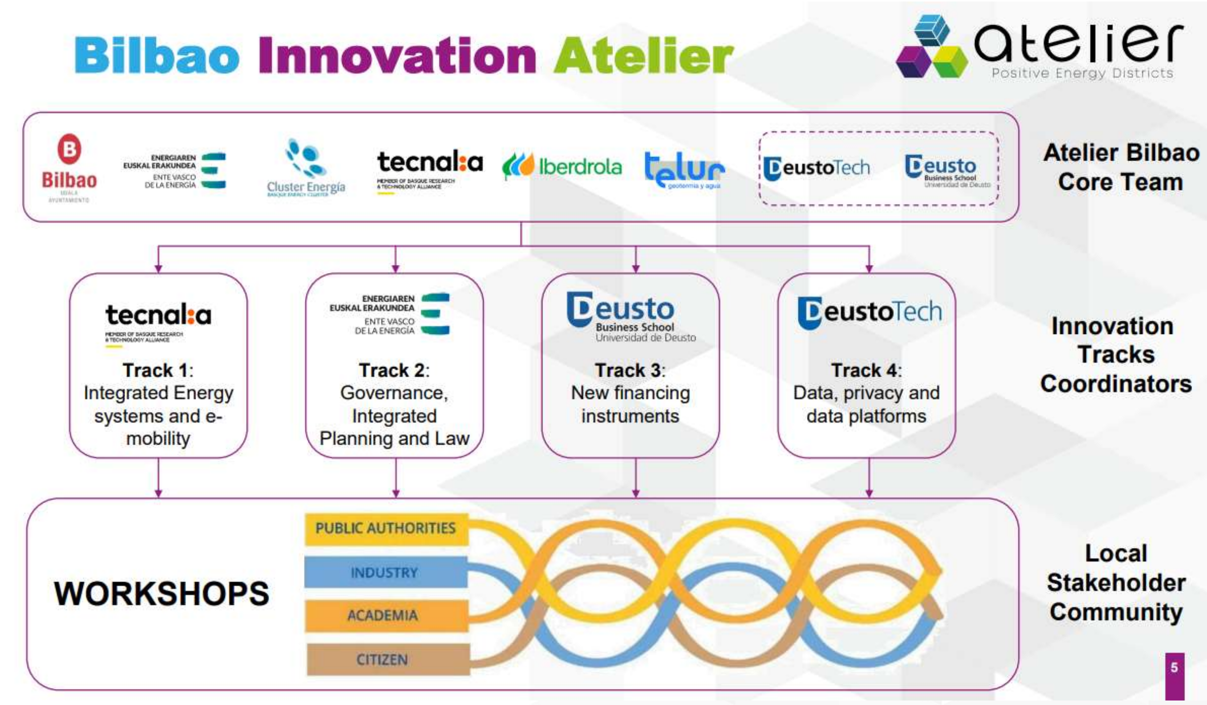

Figure 1 Innovation Atelier governance model Bilbao

Participants

During the project the Bilbao Innovation Atelier organised 3 workshops on governance, integrated planning and law. Two of the sessions were organised in cooperation with other cities or project to exchange lessons learned. The sessions also varied in size, from a small session with three cities to collect specific learnings that could be implemented in Bilbao, to large events with 100 participants.

As the cluster plays a central role in facilitating and organising the meetings, in addition to the project partners, other members of the cluster were often invited to whom the topic could potentially be of interest.

Planning

The workshops took place between November 2022 and October 2023

Activity	Goal	When
Banning the use of natural gas by local governments		18/11/2022
Opportunities for the Energy communities in the framework of the energy transition in Bilbao		17/05/2023
Joint WS with DecarbCityPipes EU project		24/10/2023

Table 2 List of activities in Bilbao

2.2 Outcome of the Innovation Ateliers

Session: Banning the use of natural gas by local governments

The city of Bilbao aims to explore various methods for decarbonizing its building stock. One potential approach is to prohibit the use of natural gas in the built environment. To further investigate this option, an Innovation Atelier session was organized. The concept of banning natural gas is not new; several cities across Europe are already working on this initiative. Bilbao invited representatives from three cities to share their experiences in decarbonizing energy consumption within the built environment: 1. Winterthur, 2. Vienna, and 3. San Sebastián.

Since 2022, Winterthur has banned the use of natural gas, requiring new buildings to utilize CO2-neutral heating sources such as heat pumps and solar thermal energy. The city is also exploring ways to expand its district heating network and identify new production sites.

The focus is not limited to new constructions. Winterthur has implemented a ban on fossil fuel boilers, compelling owners of existing buildings to transition to cleaner heating solutions when replacing their boilers. [2] Citizens can access subsidies to assist in replacing fuel-fired boilers with heat pumps.

Vienna is similarly committed to phasing out natural gas, having banned its use in new buildings. Meanwhile, San Sebastián is concentrating on integrating more solar thermal energy into its energy mix for heating domestic hot water.

Bilbao has developed an energy plan to achieve its decarbonization ambitions. To implement concrete actions in line with this plan, the city is seeking tools and strategies. Phasing out fossil fuels aligns with Bilbao's goals; however, the municipality relies on national government approval to enact such measures. Currently, they lack the authority to make this decision independently and are awaiting legislation from the national government to allow for the ban

[2] Transition roadmap City of Winterthur, 2023

on natural gas. The Energy Performance of Buildings Directive also supports Member States in phasing out fossil fuel-fired boilers.[3]

Session: Opportunities for energy communities in the framework of the energy transition in Bilbao

Energy communities are now officially defined in Spain as legal entities characterized by open and voluntary participation, autonomy, and effective control by partners or members located near renewable energy projects. This definition is part of the regulations concerning electricity self-consumption.[4]

Currently, Bilbao has no energy communities in place. However, the city recognizes their potential value in promoting citizen engagement and contributing to increase investment and production of renewable energy. To explore how local government can support the development of energy communities, Bilbao organized an Innovation Atelier.

The city aims to encourage citizens to take a more active role in installing photovoltaic (PV) panels on rooftops, believing that the concept of energy communities could facilitate this goal. Additionally, they hope that energy communities will not only contribute to electricity generation but also lead to lower energy bills and reduced dependency on traditional energy suppliers for community members and shareholders.

Given the complexity of establishing an energy community, the city is collaborating with so-called "energy community promoters." These companies handle the administrative tasks associated with the community and play a significant role in the design and development phases. The city acknowledges that citizens currently lack sufficient knowledge to manage this process independently. One major barrier to building expertise is the inadequacy of the business case, which has not yet proven attractive enough to justify the time and effort required to establish a community.

Ekiola Energy community

One of these promoters is Ekiola, a company owned by the Basque Energy Agency (EVE) and an engineering firm specializing in renewable energy facilities (KREAN). Ekiola offers a standardized start-up procedure and can assist energy communities throughout various stages of development and with different tasks. Their initial focus is on establishing a legal entity, which is necessary for the community to qualify as an energy community.

A primary challenge in launching an energy community and installing production capacity, is gaining access to the grid. Securing a connection and transport rights is subject to stringent regulations. The promoter typically serves as the initial point of contact for the city when applying for permits and for the grid operator in securing the necessary connection and transport capacity.

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[3] Article 13 and 17 of Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast)

[4] For more information read: Real Decreto 244/2019, de 5 de abril, por el que se regulan las condiciones administrativas, técnicas y económicas del autoconsumo de energía eléctrica. (boe.es)

In addition to organizing the entire process, the promoter also determines the governance models and eligibility for membership. Ekiola prioritizes citizens, but local governments and businesses are also welcome to participate in the development.

The installations are situated in urban areas, with the goal of producing energy close to the consumers. Members can participate only up to their own consumption levels (based on their annual energy use), meaning they cannot invest in more energy than they consume.

Congestion

Integrating more renewable sources poses challenges in the areas where Ekiola and other promoters install photovoltaic (PV) systems. During the workshop, the grid operator explained that the grid requires reinforcement; however, the operator does not see the value in making these investments. This perception is partly due to inadequate compensation for such investments under current tariff regulations, resulting in delays in grid reinforcement.

Participants in the session concluded that a proactive role from municipalities is essential for the successful deployment of energy communities. This includes designating municipal plots or rooftops for community-owned production installations. Additionally, municipal support is crucial in encouraging citizen participation in these projects. Without professional assistance from companies like Ekiola, citizens are currently reluctant to invest collectively in production installations, let alone establish an energy community.

A key question arises regarding whether an energy company designed and operated by a developer of other energy activities can be considered an energy community, such as a citizen energy community or a renewable energy community. This determination heavily depends on the governance of the community: Do the members effectively control the energy community? Do they hire the promoter for services, or does the promoter hold decisive power? To qualify as an energy community, it is essential that the community is based on "voluntary and open participation" and is effectively controlled by members or shareholders who are natural persons, local authorities, including municipalities, or small enterprises. '[5]

Various companies are stepping up to promote energy communities. These can be energy service companies, primarily focused on facilitating self-consumption. There are also examples of promoters that have chosen to become suppliers, thus expanding their business to not only facilitate energy communities but also participate in the market by trading the energy produced. Again, the community is only considered an energy community as defined in the directive if the company does not control or own it, though the community may decide to hire the company for its services.

During the meeting, several follow-up actions were discussed, including the role of the municipality, strategies for communication with citizens, improving collaboration with energy community promoters, and planning a second session to further address the technical support needed by energy communities.

[5] Article 2 (16) directive 2019/944

Session on Energy communities (part II)

The second session focused on the technical developments required to support and facilitate the operation of the energy community. Several companies presented the management platforms they have developed. These platforms cover various functions, including the operation and monitoring of facilities, aggregated supply management (utilizing algorithms), and forecasting.

From a technological perspective, the primary challenge that remains unresolved is aggregation. Currently, there is no framework for independent aggregation, which complicates participation for energy community members in aggregation schemes.

Session on Energy planning for the decarbonization of heating and cooling supply in cities

This Innovation Atelier was organized as a webinar for mayors of municipalities, aimed at raising awareness of various aspects related to planning the supply of heating and cooling in their cities.

First, the Bilbao City Council presented different strategies for decarbonizing the city's buildings, including the development of a heating network. They outlined a comprehensive roadmap that encompasses governance, regulation, social awareness, and training.

Next, the Spanish Heat Networks Association discussed one of their key tasks: creating and updating the Heat Networks Census, which is seen as a catalyst for renewable thermal generation.

Finally, three case studies of heat networks from the municipalities of Barcelona and Vitoria in Spain, as well as Tallaght in Ireland, were presented. All three cases exemplify best practices in the field.

The primary goal of the webinar was to increase awareness of heat networks as an essential tool for the decarbonization of cities, emphasizing their inclusion in future energy plans. The evolution of this technology was also discussed, highlighting its future direction towards the decentralization of heat generation through fifth-generation (5G) heat networks. These fifth-generation networks are low-temperature "exchange" systems capable of integrating low-temperature sources and supporting the incorporation of electrical assets.

2.3 Amsterdam

Context, planning, participants

Context

Throughout the project, the Amsterdam Innovation Atelier organized six meetings focused on governance, integrated planning, and law to support the implementation of smart urban solutions in the Buiksloterham developments. These topics encompass a wide range of issues. Most workshops had a problem-solving orientation, aimed at addressing specific challenges that arose during the project. Topics were selected accordingly.

Given the supportive nature of the workshops, some sessions addressed multiple tracks. Many challenges require a systems perspective, incorporating legal, economic, social, and technical questions.

At the beginning of the project, the emphasis was primarily on technical and planning challenges in Buiksloterham, such as achieving adequate renewable energy generation and managing congestion within the Positive Energy District (PED). As the project evolved, the focus shifted to fostering cohesion among the various buildings and encouraging collaboration among their users. This led to discussions on developing an energy community and designing an energy-sharing system. Establishing cooperation within the neighbourhood proved essential for the design of a successful Positive Energy District.

Planning

The Innovation Ateliers took place between September 2020 and September 2024.

Activity	Track II goal	When
Additional RES session I		10/09/2020
Additional RES session II		24/09/2020
Energy communities		01/07/2021
Congestion		16/11/2022
Energy sharing		5/02/2024
Group contracts		19/09/2024

Table 3 List of activities in Amsterdam

To enhance the report's readability, the sessions are not arranged chronological, but by topic.

Participants

Given the problem-solving approach, attendees were carefully selected for each meeting. An important condition was that various groups from the quadruple helix model were represented. Another key criterion was that the people invited possessed sufficient knowledge of the subject matter, or is directly impacted the topic, or held significant authority regarding the issue at hand.

In addition to the problem-solving meetings aimed at facilitating the implementation of the Positive Energy District (PED), more exploratory meetings were organized. These sessions focused on examining new topics relevant to PED development. One such topic is energy sharing, which is not yet legally supported in the Netherlands but must be implemented by mid-2026, as it could significantly enhance the development of PEDs.

For these exploratory meetings, stakeholders involved in operationalizing the activity were invited, alongside legislators and regulators. This included network operators, energy communities, and energy companies. The core team of the Amsterdam Innovation Atelier and relevant Atelier partners also participated in these discussions.[6]

[6] The Amsterdam core team consist of Municipality of Amsterdam, TNO, Spectral, AMS and Waag

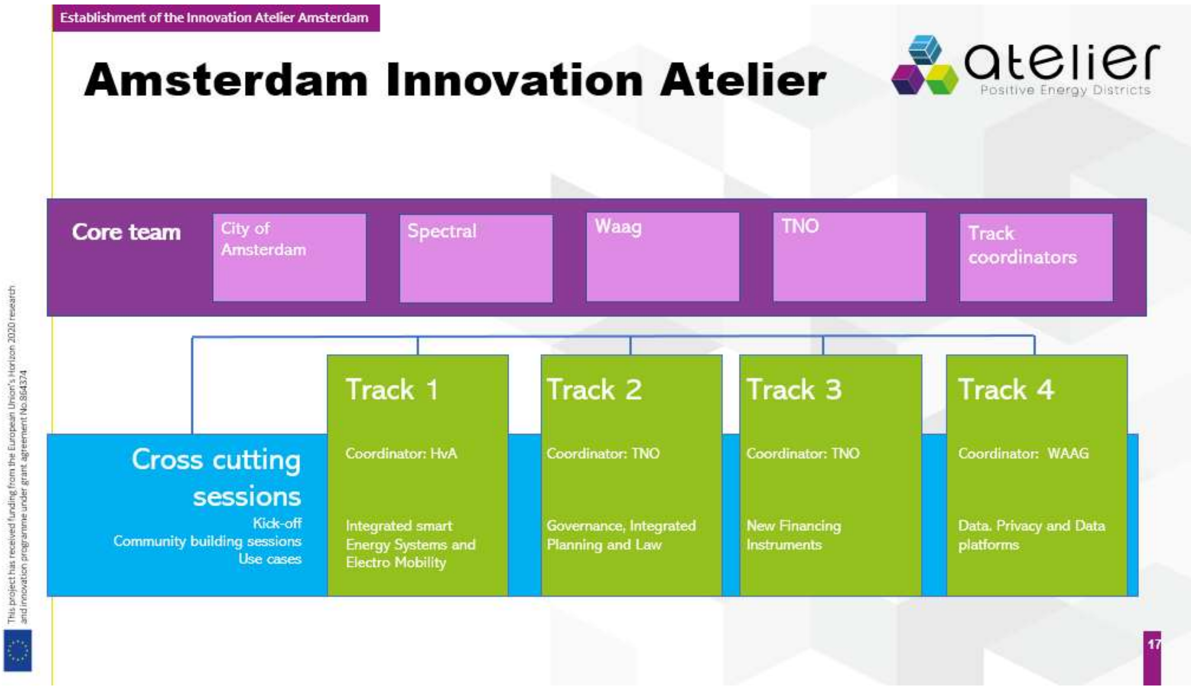


Figure 2 Innovation atelier governance model Amsterdam

2.4 Outcome of the Innovation Ateliers

Session on Energy communities

One of the key interventions in the Atelier project was the Republica energy community. The design and establishment of this energy community ran parallel with the implementation of the Renewable Energy Directive (2018/2001) and the Electricity Market Directive (2019/944), both of which provide definitions for renewable energy communities and citizen energy communities. This new legal framework accelerated discussions and explorations regarding the energy community within Republica and throughout the project as a whole.

Energy community Republica and the regulatory sandbox

The Republica development, located in Buiksloterham, is a mixed-use project that combines residential and commercial units. The development spans 20,000 square meters across six buildings (Figure 3) At the start of the project, the developer applied for a regulatory sandbox available at the time, known as the Experiment's Electricity Act 2015-2018. [7]

[7] Decree on experiments in decentralised renewable electricity generation (Stb. 2015, 99)

Figure 3 Republica development. Drawing by Marc Koehler Architects

One key requirement for obtaining a derogation, as outlined in the act, is the establishment of a cooperative or association representing the connected customers. This requirement is crucial because experimentation can impact certain consumer rights. [8] Therefore, a governance model that ensures effective control by the members is essential. The Republica community utilizes both an owners' association for property owners and a cooperative that includes all connected parties.[9]

The experiment can apply for several derogations, including one that permits the cooperative to build and manage a private network, known as a project net. This derogation is unique because, in the Netherlands, all electricity grids are publicly owned (except from closed distribution systems). In this experiment, all households and offices are connected to a single private network (the project net) and they share one large connection to the public grid.[10]

In addition to the derogation allowing them to connect to a public grid and to build and operate their own private network, the community also receives a derogation from tariff regulations, granting them greater freedom in designing their own tariff structure. However, the tariffs must

[8] explanatory note to the Decree (Stb. 2015, 99)
[9] Zeggenschap in experimenten regeling, RVO, 2021
[10] There is one exception to this; the closed distribution systems, but in principle no households may be connected to such a network

remain reasonable. General principles, such as third-party access, also apply to the customers connected to the project net.

With a single connection to the public grid, the transport capacity on the project net is shared among the connected customers.

Energy communities vs energy companies

In the Innovation Atelier sessions, we explored the concept of an energy community and how it differs from an energy company. We identified several core elements that define an energy community:

1. A governance structure that is open and ensures effective control by members/shareholders.
2. A specific purpose, whether economic, environmental, or social.
3. Engagement in various activities, such as energy sharing, aggregation, supply, and energy efficiency.

The primary distinctions between an energy community and an energy company lie in the first two aspects: governance and purpose. An energy community is fundamentally a means to empower citizens and encourage their participation in energy projects. Therefore, a governance structure that is accessible to all types of households, granting effective control to households and small businesses, is essential. The goals pursued, such as social inclusiveness or specific environmental objectives, largely shape the activities the energy community undertakes and the manner in which they are developed.

These legal definitions of renewable and citizen energy communities have significantly influenced the design of Republica, impacting both the activities they pursue and the supporting technical infrastructure, as well as the governance structure.

Energy community layers

The design of the energy community comprises several layers: technical design, the structuring of energy (market) activities (business), and the internal governance framework. Throughout the Innovation Atelier meetings, these layers were developed and examined.

Technical design

The technical design encompasses infrastructure (both electricity and heat) and different assets, including production, storage, and conversion technologies. To facilitate the integration of these assets and systems, a smart energy management system was implemented, known as the local energy market (LEM). This system optimizes not only the assets connected to the Republica grid but also coordinates interactions between different energy communities in the area. The technical design is influenced by the community's desired activities, affecting the systems they connect to (heat and electricity) and the assets involved.

Activities: what will the community do?

In addition to the technical design, several potential market activities for the Republica energy community were explored. To categorize these activities, TNO developed a framework[11] that

[11] E. Winters & A. van der Veen Energiegemeenschappen in veranderend juridisch landschap Energiegemeenschappen in veranderend juridisch landschap, TNO 2023 R10525

divides them into two main categories and seven subcategories, as illustrated in the image below.

The primary categories distinguish between 1. non-market activities and 2. market activities. Non-market activities occur outside the energy market, whereas market activities involve actual sales, such as electricity or flexibility.

This distinction is crucial because engaging in market activities is often more complex and requires specific licenses or authorizations. It is also important for the party organizing the smart control.

One of the key questions for Spectral, the partner responsible for smart control, revolved around its market role. Spectral sought to determine whether to engage actively in certain energy markets or to continue providing behind-the-meter services and operate as an ESCO. To address this question, Spectral's value proposition was analysed, and recommendations were formulated based on a SWOT analysis. For more information, see textbox on supporting energy communities on energy markets.

Figure 4 Market and non- Market activities[12]

The Republica energy community engages in both non-market and market activities. The community owns a significant part of the assets, including an electricity network, PV panels, PVT panels, an ATES[13], and LV chargers. Additionally, several assets not owned by the energy community are connected to it, providing services that the community collectively purchases. Besides activities around collective ownership and providing services to the energy community, the community also participated in implicit flexibility schemes.

One key activity under implicit flexibility is collective kW-max balancing. Due to congestion, the community faced limitations on its transport capacity (see session on congestion) and therefore needed to engage in collective kW-max balancing to avoid exceeding this limited

[12] Source: De rol van eindafnemers in de energiemarkt: Energiegemeenschappen in veranderend juridisch landschap, March 2023, TNO 2023 R10525
[13] ATES: Aquifer Thermal Energy Storagehttps://www.deltares.nl/en/expertise/areas-of-expertise/energy-transition/aquifer-thermal-energy-storage

capacity. This balancing strategy involved various assets, including a large connected battery, a smartly managed large heat pump, and making use of the connection to the district heating network to minimize electricity demand for heating during peak hours. For more details on the contracts between the DSO and the community, as well as the roles of the flexible assets and the network, read the session on group contracts.

In addition to implicit flexibility activities, the energy community also explored explicit flexibility schemes. Initially, the plan was to utilize the large 1 MW battery, along with other flexible assets, for services such as imbalance management, FCR, and possibly participation in wholesale markets. However, as market prices fluctuated, the strategy for explicit flexibility evolved. Due to grid congestion and limitations, the community faced challenges in marketing the battery's capacity. Towards the end of the project, while the congestion was alleviated and limitations removed, technical issues with the battery hindered its qualification and caused significant delays.

Furthermore, the energy community is responsible for supplying energy to its members, which also falls under market activities. Although they received a derogation from the mandatory supplier's license, the complexities of serving customers as an energy community became evident during the project. Supplying energy involves not only gaining access to markets but also being balance responsible or designating a balance responsible party (BRP). Instead of securing market access themselves, the Republica energy community opted to contract a third party, an energy supplier with the necessary licenses and authorizations, to manage the supply.

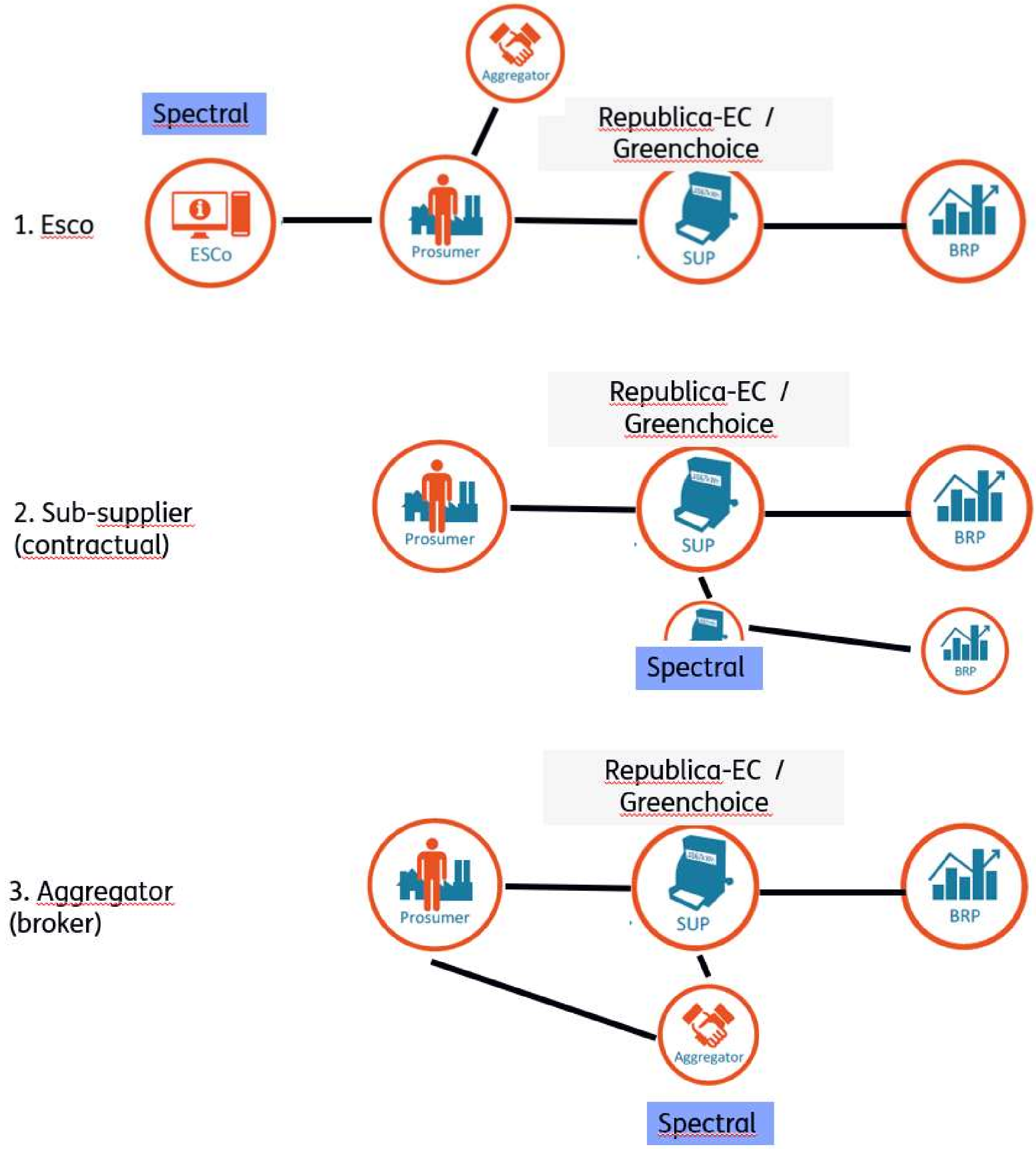
It is important to note that the party responsible for market access differs from the one supporting the community's other activities, such as asset procurement, smart asset control, and implicit steering. The division of responsibilities between the energy service company (ESCO) facilitating all community activities and the energy supplier managing the buying and selling of electricity and flexibility has been an important topic of discussion throughout the project and the innovation ateliers (see textbox below).

Supporting Energy communities in energy market activities

The company responsible for smart control and operating the energy community, including the local grid and assets, is Spectral. At the start of the project, Spectral did not possess the necessary qualifications to participate in various markets. Instead of obtaining the required authorizations to become a supplier, congestion service provider (CSP), balance service provider (BSP), or balance responsible party (BRP), Spectral chose to collaborate closely with existing market participants. A key consideration in this decision was that many of these market parties are also their customers, and Spectral preferred to maintain these relationships rather than compete with them.

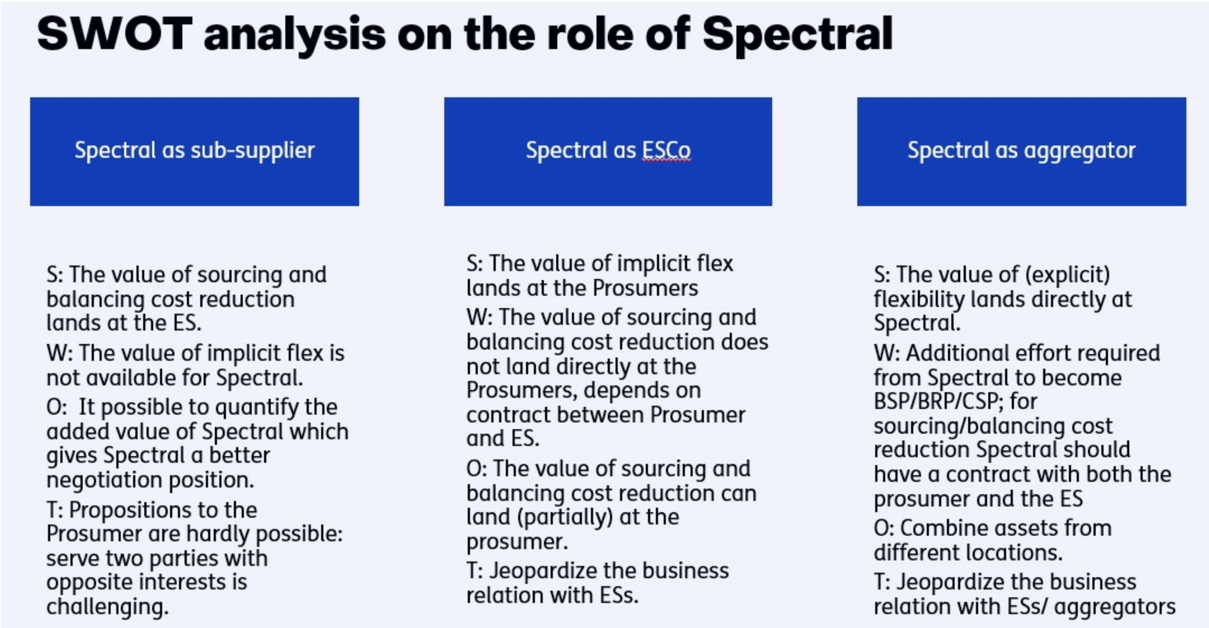
To support Spectral, TNO designed three potential models for spectral:

1. The Esco- model, 2. The sub-supplier-model, 3. The flexibility aggregator-model.



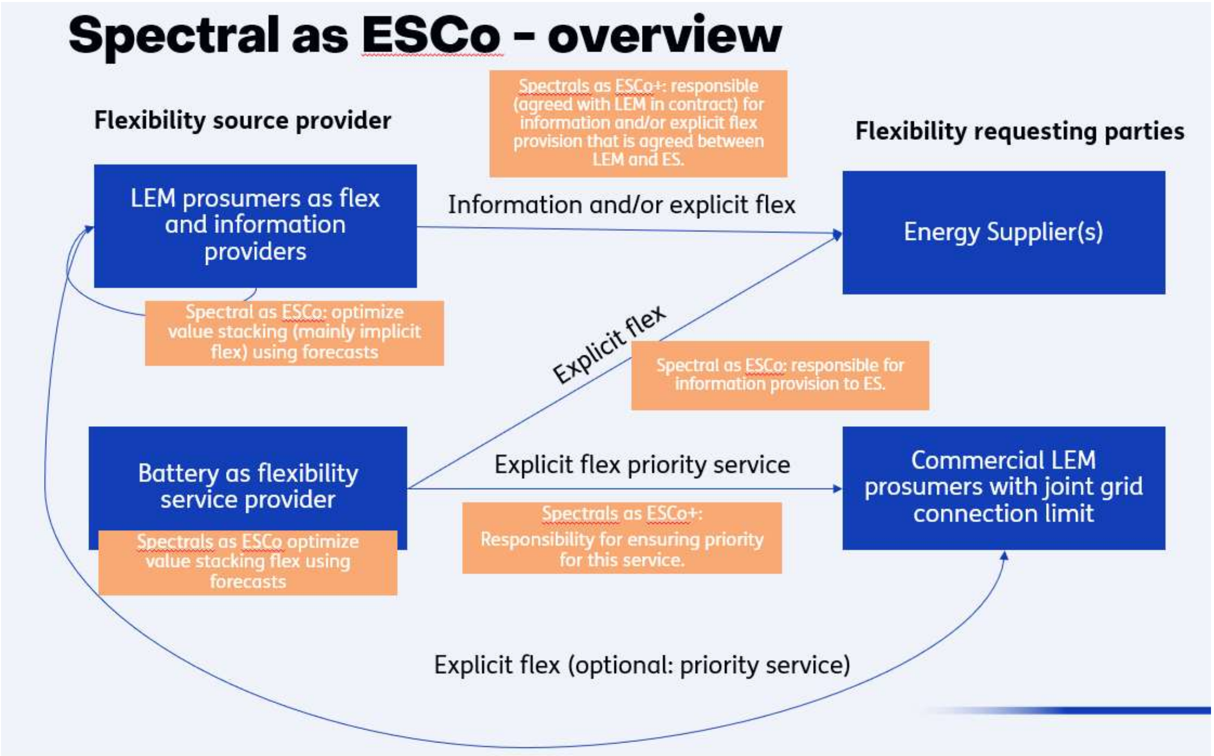
For each model we explored who the paying customer is, if it involves market activities, who was balance responsible and who sends the bill.

In addition, the different services that the Spectral offers, were defined. Initially 10 services were identified. These were quickly narrowed down to 4 products: 1) forecast and flex control towards a connection limit (the non-firm-ATO, see also paragraph on group contracts), 2) forecast and flex control towards low tariff hours, 3) forecast and flex control towards optimizing self-consumption (individual and group level) and 4) providing insights in consumption and costs.



Based on the defined products, the customers of the product and additional preferences of Spectral, each of the three models were analysed. We found that the Esco-model was the best fit. In this model the various services could be developed, while keeping the number of contracts limited. The energy community in this model stays their main customer. However, some of the created value by offering a service, might land with the energy supplier, instead of their customer; the energy community. The energy community should make sure that in the agreement with the energy supplier, the energy community is rewarded for participating in the product.

Spectral as a sub-supplier was rated as a second-best option. In this case the third party is supporting the main supplier and takes over certain tasks. In this model the main supplier becomes their main customer. The combination of delivering services to both the main supplier of the energy community and the energy community directly, was seen as less favourable and might challenge the relation with either one of the customer. The third model; the aggregator-model required a number of authorisations. Spectral would than compete with the energy supplier to deliver certain services to the energy community. This was not a desirable option for Spectral in this project. For an overview of different services see image below.



Internal governance structure

In addition to the technical design and market activities, Republica needed to establish a governance model for the energy community during the project. Since Republica was a new development and the residents (both renters and businesses) were not yet known, the governance model was initially crafted by the developer. To ensure adequate control for household members within the community, a comprehensive governance structure was implemented. This design guarantees that both owners and renters have voting rights, thereby providing them with effective control over the energy community.

More information about the governance structure of the energy community can be found in the report on the Energy community.[14]

Energy communities in new build areas

Designing an energy community from the ground up presents various challenges, particularly when the community aims to engage in advanced activities beyond merely producing renewable energy.

First and foremost, it is crucial that potential buyers are well informed before purchasing a home or commercial property, ensuring they understand their future participation in an energy community. Since future residents are not involved in the design and development phases, it is preferable for the community's design to be flexible, allowing for adjustments as needed.

14 Report on the Republica Energy Community: Amsterdam Innovation Atelier, Amsterdam 2023

When a community is active in flexibility markets or managing assets, multiple market participants are often involved, such as a supplier, balance responsible party (BRP) and an energy service company (Esco). These advanced communities are still relatively rare, and standardized offerings for energy communities are not yet available. Changing service provider later on can be challenging due to reliance on specific IT systems, resulting in a long-term and more intensive collaboration between the energy community and the service provider. Therefore, a clear agreement outlining mutual expectations between the energy community and the contracted Esco or market party, is essential.

While more complex activities present both opportunities and challenges, there are currently no "off-the-shelf" concepts available. This lack of standardization not only increases dependency on facilitating partners (Esco and/or Supplier) but also complicates the comparison of different service offers. Energy communities may face a lack of transparency regarding the fees they pay for services and the rewards they receive for providing flexibility.

Sessions on Additional RES production (Part I)

A positive energy district (PED) is defined as an area that produces more energy than it consumes over the course of a year. The Republica development includes not only residential units but also a hotel, which has a relatively high energy demand. To achieve an energy-positive status for Republica, additional renewable energy production was necessary.

During two Innovation Atelier workshops, we explored how to organize additional renewable energy source (RES) production on-site or within the surrounding area. The central question was: How can Republica become energy positive, and can this be achieved by incorporating photovoltaic (PV) systems in the vicinity?

To address this question, we invited experts from various fields to provide insights on potential solutions. One group focused on spatial planning, another addressed legal aspects, and a third examined the technical possibilities.

Outcomes of the spatial planning expert group

Several options were ruled out: façade-mounted PV systems would not generate enough energy to meet demand, and urban wind solutions are not feasible in this densely populated environment. However, viable alternatives include the roofs of nearby garages, which, although outside the PED area, can be utilized for PV installation. Another possibility is participating in a wind farm development located nearby but also outside the district.

Further exploration is needed to determine whether the PV installations on the garages or the nearby wind farm can be integrated into the PED or if the renewable energy production can be linked to the PED.

Outcomes of the Legal expert group

Republica is generating solar power, and by adding more PV systems, there will be substantial energy production during the summer and daytime, while very little energy will be produced at night and during winter. Therefore, it is preferable to incorporate a source with a different production pattern. The PED should not only focus on the total annual energy generated; it's equally important to consider when the energy is produced. Excess generation during periods of low consumption can lead to increased social costs, such as grid congestion and balancing issues.

In the area, several energy communities will be active. There may be additional energy communities, beyond the Republica energy community, interested in participating in the PV installation.

Several questions were addressed during the meeting:

- Is it possible to tie a production site outside the PED area to the PED development?
- How can we keep the social costs low? For example, by not only finding a solution for this development but taking a more integrated view of additional generation in the district.
- How do we define, taking into account a more integrated approach, a 'good location' for RES production in the city?

Outcomes of the technical expert group

There are numerous technical solutions available. PV installations can be connected both on the facades and in the surrounding area. Regardless of the physical location of the installation, the plant can be integrated into the proposed Local Energy Market (LEM) envisioned in the project. Both PV and wind solutions, or a combination of the two, are possible; however, there are congestion issues in the area that need further exploration. Experts also emphasize the importance of considering energy efficiency measures. By reducing demand, smaller solutions on-site may become feasible.

It became clear that several steps must be taken before experts can provide guidance on how to make Republica energy positive. The following next steps were identified:

- Define the parameters of the PED: How will we demarcate it? Which locations are included or excluded?
- Develop scenarios around: 1. PV installations on the nearby garage, 2. Participation in a wind project.
- Organize a second workshop.

Session on additional RES (Part II)

During the second session the outcomes of the formulated steps were presented, starting with 1. The PED definition and followed by 2. The scenarios.

PED definition

The definition of the PED as described by the EU describes a PED as follows:

'Positive Energy Districts and Neighbourhoods are an integral part of ***comprehensive approaches*** *towards sustainable urbanisation including* ***technology, spatial, regulatory, financial, legal, social and economic perspectives****. They require* ***interaction and integration between buildings, the users and the regional energy, mobility and ICT system****. In this sense, a Positive Energy District is seen as an* ***urban neighbourhood with annual net zero energy import and net zero*** CO_2 ***emissions working towards a surplus production of renewable energy, integrated in an urban and regional energy system****. Active management will allow for* ***balancing and optimisation, peak shaving, load shifting, demand response and reduced curtailment of RES, and district-level self-consumption of electricity and thermal energy****. A Positive Energy District couples built environment, sustainable production and consumption, and mobility to reduce energy use and greenhouse gas emissions and to create added value and incentives for the consumer. Furthermore,*

*implementation has to come with a **high and affordable standard of living** for its inhabitants'*[15]

The definition refers to a neighbourhood but does not specify clear geographical boundaries for the PED. Instead, it emphasizes certain qualities of the neighbourhood, such as liveability, available infrastructure, and the production and consumption of energy within the same area. Given this broad definition, and to ensure that stakeholders in the Buiksloterham district have a voice, the expert group decided to incorporate the preferences of various experts in the discussions regarding the demarcation of the Buiksloterham PED.

				Likert scale				
Discussion matrix PED definition				++	+	o	-	--
				very good/high preference	good	moderate	unfavorable/low priority	not good at all
Different border options versus preference/requirements of different stakeholders								
		On buildings plot	Postcode roos	Local energy according to EPG	Medium Voltage station service	Local energy trading area	None of the previous	Comments
Mun Amsterdam		++	++	+	+	o	--	As local as possible
EU		++	++	++	+	o	--	Little geographical requirements
Alliander		+	o	o	o	o	o	Alliander prefers a societal beneficial solution
Developer Republica								Affordable

*Postcoderoos: limited postal code area

Table 4 Preferences for geographical limitation of the PED

In general, parties preferred a solution as close to the development as possible. However, demarcation to the medium voltage grid, was still rated as moderate and good by the participating partners.

In the discussion, parties indicated that they did not expect congestion to be a problem for connecting more generation in the area. Later in the project, congestion became one of the major challenges. This did involve congestion on take-out and not on the feed-in.

15 Definition base don the call text and FAQ - Frequently Asked Questions Work Programme (WP) 2018 for Horizon2020 Smart Cities and Communities – Lighthouse projects Topic identifier: LC-SC3-SCC-1-2018-2019-202 and Call tekst Building a low-carbon, climate resilient future: secure, clean and energy efficient, Call ID LC-SC3-SCC-1-2018-2019-2020,

Scenario's

During the meeting, 2 main and 2 sub scenarios were discussed:

1. PV would be connected to the *project net* of the Republica development.
2. PV would be connected to the public grid of Liander within 10km from the PED

Different ownerships models for the PV are possible:

a. The PV is owned by the energy cooperative Republica,

b. The PV is owned by a third party.

Scenario 1a: The PV system is connected to the project network and owned by the Republica energy cooperative.

There are suitable rooftops available in the immediate vicinity of Republica. A direct connection must be established between the Republica development and the nearby PV installation, which will involve laying an underground cable across an existing road.

By directly connecting the PV installation to Republica's project network, it will fall under the derogation (regulatory sandbox, paragraph...), providing several advantages. With this derogation, the energy cooperative gains greater flexibility in designing its own grid and electricity fees, allowing for easier management of collective self-consumption.

In this scenario, the energy cooperative can also benefit from the SDE+ and SCE subsidy schemes. Owning the PV plant will give the cooperative decisive control over the installation.

However, this scenario also presents some disadvantages. It requires investment in the cable installation under the existing road, as well as additional costs for the PV plant itself.

Scenario 1b: PV installation connected to project grid with third party ownership

In this scenario, there is again a direct connection between the producer (the owner of the PV plant) and the project grid. However, the PV plant is owned by an external party that is not a member of the cooperative. The fundamental principle within the Regulatory Sandbox is that, on the project network, customers also act as producers, suppliers, and grid operators. This raises the question of whether production units owned by a third party, who is not part of the community, are also covered by the exemptions granted to the cooperative.

In this case, the cooperative does not invest in or own the installation. Instead, they can purchase electricity from the plant's owner, necessitating a power purchase agreement between Republica and the PV plant owner. The attractiveness of this arrangement for a third party is uncertain, as it would leave them dependent on the community. Another consideration is whether connecting to the project network adds value to the community compared to a scenario where the PV is connected to the public grid. The primary benefit would be if the connection to the project network facilitates more efficient grid usage. In this area, congestion primarily occurs on the consumption side rather than on the feed-in side, making a connection to the public grid less problematic.

In this scenario, the owner of the PV plant is likely to apply for subsidies, which could result in a lower kWh price. This price will be determined through negotiations between the energy cooperative, the PV plant owner, and the facilitating supplier (BRP), which could potentially be the same party.

Scenario 2a PV owned by the cooperative and connected to the public grid

In this scenario, the PV installation is connected to the public grid and is owned by the energy cooperative. The advantage of this arrangement is that the cooperative maintains decisive control over the installation without being responsible for the associated cabling. Given the installation's proximity to residents, all available subsidy schemes should apply.

However, since the installation is not part of the project network, the exemptions do not extend to it. This means that a supplier or balance responsible party (BRP) must be selected for the separate connection. The cooperative could opt for the same supplier/BRP they use for the project network. It's essential that the BRP/supplier is willing to facilitate some form of energy sharing (as energy sharing independent of supply is not yet legally supported, see paragraph...) and offer a competitive kWh price during production hours to encourage consumption during those times.

In summary, while the cooperative has fewer responsibilities and the flexibility to choose their own supplier/BRP, the challenge lies in finding a supplier willing to meet the cooperative's needs.

Scenario 2b PV owned by a third party and connected to the public grid

In this scenario, the PV installation is owned by a third party and connected to the public grid. The advantage of this arrangement is that the community is not responsible for the installation or its connection, and it avoids any upfront investment, as this is handled by the third party. However, the downside is that the third party retains control over how and to whom they sell the electricity. Therefore, a power purchase agreement (PPA) between the producer and the energy community is necessary.

Conclusion and recommendation

The description of the Positive Energy District (PED) does not specify concrete requirements for how generation should be connected to the community. However, it is essential to establish a direct connection between renewable energy source (RES) production and the energy community, moving beyond merely purchasing guarantees of origin. To effectively link the PV installation to the community, the community must have some degree of control over the installation, either through ownership or by entering into a long-term commitment, such as a power purchase agreement (PPA). A scenario where at least 50% of the PV installation is owned by the energy community is preferable, as this would allow the community to select a supplier or balance responsible party (BRP) and determine how to integrate the production into the community's overall energy portfolio.

Final outcomes additional RES

The developer tried to reach agreements with several nearby buildings to utilize their roofs for additional PV installations. However, to install PV on another building, a lease agreement for roof use is necessary, and unfortunately, the building owners in the area were reluctant to enter into such agreements.

As a result of discussions in the first session, the developer began exploring the possibility of investing in a wind turbine. However, obtaining a permit for installing a wind turbine in a dense urban area poses significant challenges. Consequently, the developer decided to reach out to an existing wind cooperative in the area, Amsterdam Wind, expressing interest in investing in one of their wind turbines. The timeline for bringing a wind turbine to market is lengthy, and permits have yet to be secured. Ultimately, it will be up to the Republica community to decide whether and how they would like to participate in this wind project in the future.

Session on Congestion in the PED area

Congestion in Amsterdam

In July 2019 the developer applied for connection and the transport capacity of 2 MW. The first request was never processed by the network operator. In May 2022 they submitted a new application. In the period between the first and the second application, the area was then designated as ‘congestion area’ (on demand) under then applicable Netcode[2], resulting in a (partial) rejection of the requested transport capacity. The total requested transport capacity was based on key figures for households and the different types of utilities, including the battery Initially, this total capacity was requested at the DSO. Yet, due to the grid congestion on the demand side, the DSO was unable to provide this and made an alternate offer. In this offer, the non-firm transport capacity agreement, they suggest only one fourth of the demanded capacity during 08.00-21.00 in the winter (November to March). During the remaining hours of the year, 75% of the initial demanded capacity is provided.[3]

The rejection of the requested transport capacities was one of the major challenges of the Republica development and became an important research question in the project.

During one of the Innovation Atelier sessions the following question were discussed:

1. Will Republica (both household and utility buildings) be able to function under these transport capacity limitations?
2. Are there alternatives for the contract offered by the DSO available?

Staying under the group transport capacity

The first question was particularly challenging because Republica was still under construction, leaving no user data available. To address this, one of the project partners, TNO, created a digital twin of the buildings to investigate the flexibility within them, exploring whether it is possible to shift and reduce demand during certain hours (see image x). Another partner, Spectral, examined how to combine the building demand and flexibility calculated by TNO to ensure that all connected customers remain within the transport capacity limitations.

TNO developed the digital twin of the Republica buildings using a model called SirinE. This model incorporates data on the materials used in construction (BIM data from the architect) and weather forecasts (see Figure 2). Additionally, artificial intelligence is employed to model human behaviour (see image). For each function within the Republica development, such as households, the hotel, and the swimming pool, the energy usage is modelled. This digital twin allows for insights into the heat demand throughout the day. Heat is generated by both electric heat pumps and a connection to the district heating system. The heat profile significantly impacts electricity demand and influences the transport capacity required at different times of the day.

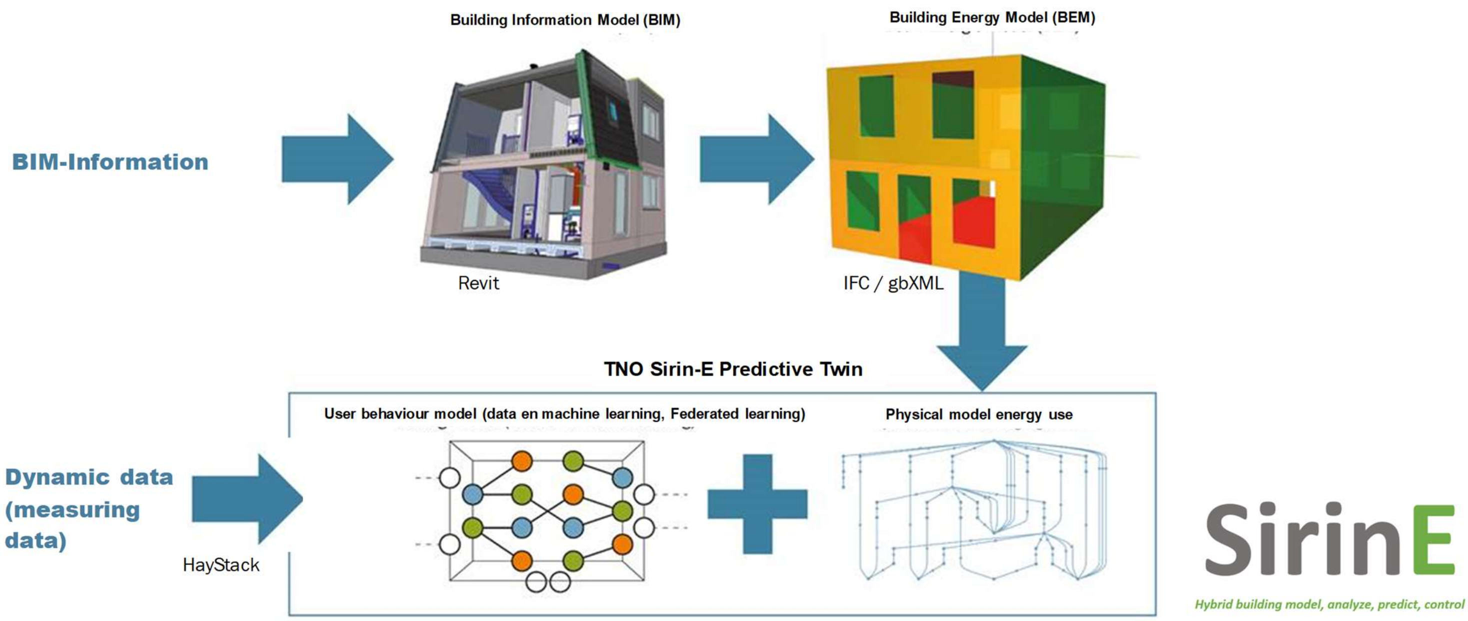


Figure 5 Sirin E model by TNO

Given the investments made in the heat pump the following order of preference is used in the dispatch of the different heat units:

1. Heat pump
2. District heating
3. Hot water buffer

There are several flexible assets connected to the *Project Net* and this makes it possible to, for example, increase the operation of the heat pump in periods of PV production, and so make optimal use of the locally produced electricity and consequently lower the demand on the connection. There is also a 1,4 MW battery on site that has a large flexible potential (discussed below), also the EV charges can be used to increase flexibility.

The model shows that most of the heat demand is during the morning peak. The outcomes also show that the heat pump will deliver most of the heat (Figure 6, Pwp-con-used-collectiveHeating). The figure also shows that District heating (Pstad-used-collectiveHeating) is only used during cold days and the buffer is only used when there is a very high demand (Pbuf-used-collectiveHeating). Through using flex options in the buildings, it is possible to shift the demand and flatten the curve.

Figure 6 Heat demand and production curves, TNO

In summary, given the high energy performance of the buildings and the allowance for one-degree temperature fluctuations, it is feasible to time the activation of the heat pump. This approach enables the electricity demand of the heat pump to be shifted to hours with higher transport capacity availability, thereby avoiding any breaches of the transport limitations agreed upon with the grid operator, Liander.

By calculating the quarterly heat and electricity demand of the buildings and other assets using the digital twin, Republica was able to accept the offered transport capacity, leading to a signed agreement with the DSO.

Congestion significantly affected how the community's various assets could be utilized. Spectral, the ESCO supporting the energy community, analysed the impact of congestion in terms of lost revenues. They modelled the different load profiles of the buildings, utilizing heat forecasts from TNO to estimate total electricity demand throughout the day and year. This analysis provided insights into how transport constraints would affect the development and the business case for individual assets.

In addition to the available flexibility in heat demand, several assets connected to Republica's private network, such as the battery and EV chargers, can also provide flexibility. Based on load profiles for each building (including heat demand, other energy needs, and PV production), Spectral calculated how to remain within transport constraints while meeting the demands of connected customers.

Spectral can send price signals to manage demand effectively. One key finding from the modelling indicated that there might be demand during non-available hours, specifically, times outside the contract with Liander, suggesting that EV charging may need to be limited during certain periods. While the EV chargers are expected to add significant load to the overall profile, the power supplied to them can be easily adjusted. By managing this during critical moments, most risks associated with the limited grid connection can be mitigated. Any remaining issues can be addressed by adjusting the battery's output to stay within net limits. Additionally, the battery can generate extra revenue by responding to wholesale market prices and providing balancing services (FCR).

The first results showed that there was a potential loss based on 2021 tariffs of: on imbalance of 25.200 euro (39.000 for 2022) and FCR 67.800 euro (75.000 for 2022), day ahead 4300 euro (10.500 for 2022).

As such, congestion seemed to have a major impact the business case. Retrospectively, however, that impact appears to be less than initially thought. This has to do with rapidly changing balancing markets. In the past two years, imbalance and FCR have become less profitable.

Alternative transport agreements and congestion management

The second question discussed during the Innovation Atelier focused on the type of contract offered by the DSO to the Republica community. Republica was presented with a non-firm ATO, meaning that the capacity provided was not guaranteed throughout the entire contracted period and could fluctuate both during the day and across different seasons.

Alternative transport agreements: Non-firm group transport capacity agreement avant la letter

Instead of the 2 MW Republica requested, they got an alternative offer; a so-called contract with a time-based constraint due to transport constraints. The grid operator markets it as a product where the applicant is allowed to use more than the committed firm capacity at certain times. In this case Republica was given 536 kW firm and in addition Republica could use 1700 kW during the night between 22.00 at night and 6.59 in the morning and 1700 kW could be used during the summer months from May to November.

For the developer requesting transport capacity, the offer felt like a significant constraint, providing only one-fourth of the requested capacity during the daytime in winter months.

At that time, in mid-2022, such contracts were not yet legally supported, and there was limited experience with non-firm agreements. A standardized format was lacking, which was reflected in the contract's terms and conditions. Exceeding the agreed transport limits with the provider, Liander, incurs a fine of €5,000 for each day they are exceeded (even if only by a minute), and Liander reserves the right to seek full damages. This potential liability raises concerns about whether a community can shoulder such responsibilities.

Another reason why the offer was unique relates to the project net. At that time, small consumer connections were prioritized by the grid operator for connection. [16] In contrast, large connections often faced waiting lists and received full or partial rejections of their applications until new capacity became available. While Republica was technically one large connection, it encompassed a significant number of small household connections. Consequently, the grid operator opted to allocate sufficient capacity to ensure electricity supply for the household customers.[17]

[16] This was practice and is still practice with the regional grid operator. Today housing projects are also on hold due to lack of transmission capacity and congestion affects no longer only large connections, but also small connections. In the meantime, the regulator has been working on a prioritisation framework. Dwellings are also included in this framework and are prioritised through the third category in case of shortages

[17] This was not officially communicated in the agreement.

Having its own project net (private network) in a congested area emerged as one of the most significant innovations of the Atelier project. If all connections had been connected to the public grid, it is likely that only the small connections would have secured transport capacity, while the larger connections would have faced waiting lists. By enabling the sharing of limited capacity, all buildings could be in use immediately, collectively reducing their impact on the grid compared to if they had entered into individual transport agreements with the grid operator.[18]

Congestion management

A group transport agreement is one solution to address a lack of transport capacity, but there are other instruments that can optimize the use of the existing grid. One such instrument is congestion management.

When Republica received an offer for a contract with time-based constraints, the Dutch Electricity Netcode was revised, introducing new congestion management products. [19] One of these products, known as the capacity limiting contract (CLC), shares similarities with the time-based constraint contract but differs in several substantive aspects.

The capacity limiting contract (in Dutch: capaciteit beperkend contract) is an agreement between the DSO and the connected customer(s) in which the connected party agrees to refrain from utilizing the contracted or available transport capacity, up to a specified limit, for an agreed period.[20]

A key condition of the CLC is that the connected party voluntarily waives a "fixed right" or an existing transport right. In return, the connected party receives compensation in the form of a price per MW for the agreed reduction. The contract also specifies how the reduction is to be delivered, either permanently or on demand. Agreements can be established for both short and long terms, making the CLC a more tailored option that allows for negotiation with the DSO.

Another important feature of the Capacity Limiting Contract (CLC) is that it allows not only individual connected customers but also groups of connected customers to enter into agreements with the grid operator. The Electricity Netcode introduced a new role: The Capacity Service Provider (CSP). This party can aggregate the capacity of multiple connections and offer it to the grid operator, effectively representing the connected customers.

The CSP can represent a diverse group of connections that may not otherwise collaborate, but it can also serve as the representative for an energy community or an energy hub.

While this bundling of flexibility into a joint bid is now legally permitted, operational support for such arrangements is still limited. However, this has not posed a challenge for Republica, as their connections are already bundled through the single connection they maintain with the Project net.

[18] Mitigating impact as a group does require some form of behavioural change. This was the case in this project because the flexible assets were used to stay under the available transport capacity

[19] Stcr 2022, 14201: Besluit van de Autoriteit Consument en Markt van 24 mei 2022 kenmerk ACM/UIT/577139 tot wijziging van de voorwaarden als bedoeld in artikel 31 van de Elektriciteitswet 1998 betreffende regels rondom transportschaarste en congestiemanagement

[20] Article 9.1 appendix 12 eerste lid, Netcode Elektriciteit

Unlike users of a Capacity Limiting Contract (CLC), who are rewarded for offering flexibility to the Distribution System Operator (DSO), users of a time-restricted contract receive a discount on their transport agreement. For this reason, the CLC appeared more attractive than the contract initially offered.

A key question was whether the applicant had the right to secure a firm transport agreement with a CLC for the portion that couldn't yet be offered as firm capacity, rather than accepting the contract proposed by the DSO. Several one-on-one meetings were held with the DSO, and representatives from the DSO also participated in the Innovation Atelier sessions. Unfortunately, negotiations did not yield a revised contract, and no further actions were taken.

In spring 2024, the developer reached out to the DSO again to inquire about the timeline for capacity expansion. To everyone's surprise, the DSO informed the developer that congestion was no longer an issue for Republica, and they could now utilize the full capacity.

The reasons for this sudden availability of capacity were not communicated by the DSO. Several possibilities exist: a large consumer may have left the area, or another application higher on the waiting list may have withdrawn its request.

This expansion occurred even before Republica was operating at full capacity, which ultimately meant that it was unnecessary to optimize for the constraints in the original contract. Consequently, the assets can now be repurposed for other uses, such as Frequency Containment Reserves (FCR) and other services.

Session on Group contracts for energy communities and hubs

Having a private network with a joint connection to the public grid is not a prerequisite for sharing transport capacity. However, sharing capacity within a group connected by a project network or a closed distribution system is generally easier, as it involves a clearly defined and organized group with a designated representative. Sharing capacity while connected to the public grid is also possible, and this was the focus of the Deep Dive session on group transport agreements. Specifically, the discussion centred on what insights could be gleaned from the Republica case for other new developments in congested areas.

Projects like Republica have demonstrated the added value of enabling groups to share transport capacity during times of congestion, whether through the public grid or a private network. Such agreements not only facilitate connections for more parties but also promote more efficient use of the existing network, ultimately supporting safer long-term investments.

Currently, such agreements are not yet available. The regulator and regional grid operators have been collaborating for over a year to develop a so-called group transport agreement, which will provide a firm right for a group of connected customers to access a shared transport capacity limit. The first draft is anticipated to be published in November 2024. The regulator aims to complete the amendment process by mid-2025, making these new types of contracts available. In addition to these group contracts, other forms of alternative transport rights are also being introduced. An overview of these contracts can be found in the text box below.

New alternative transport rights

Anyone who requests a connection and transport agreement receives a firm contract, meaning the allocated transport capacity can be utilized throughout the day and week for the entire contract period. This is referred to as a firm transport right. Due to a lack of transport capacity, new types of offers are now available, known as alternative transport rights. These serve as alternatives to firm rights, providing connected customers with either flexible or partially firm rights.

Time-Block-Bound transport right

This contract allows the connected party to transport energy within specific time blocks agreed upon with the DSO. It is available for Low Voltage and Medium Voltage connections. The connected customer receives a firm right of transport during the specified hours. This type of contract can be advantageous for customers with sufficient flexibility. In practice, many parties that are not immediately eligible for a firm transport right due to capacity shortages may accept such contracts.

Time-based transport right

A time-based transport right entitles the connected party to transport up to a quantity equal to the transport capacity contracted at the connection for off-take or for feed-in, during the percentage of the number of hours in a calendar year mentioned in the connection and transport agreement.[21] A connected customer will get 85% of the hours on a yearly basis and can be limited up to 15 % during the year. This contract is only available for connections on the high voltage grid.[22]

Fully variable transport right

A fully variable transport right offers flexibility throughout the contract period, meaning the party can access capacity only if it is available. These rights are last in line, following all other firm and partially firm rights. Each day, the system operator assesses the remaining capacity that can be safely made available, which is then allocated to connected customers with fully variable rights. Since this contract does not guarantee fixed transport capacity, connected customers can always obtain such a right, whether in congested areas or not. [23]

By participating in these agreements, connected customers either pay only for the actual capacity used or receive a discount on the contracted capacity portion of their bill.

The session focused on the added value of projects like Republica for promoting more efficient grid use. Currently, many companies in the Netherlands are waiting to connect or to increase their transport capacity for larger connections. This situation has heightened awareness of the need for local cooperation among businesses, especially as congestion has become a pressing issue. [24] Over 100 business parks are exploring ways to share energy and capacity within communities and hubs, with several of these hubs already operational. This often involves piloting initiatives with the DSO and participating in group contracts, whether as part

[21] Article 7.1c Dutch Electricity Netcode
[22] Article 7.1.c led 3 Dutch Electircity Netcode
[23] Article 7.1 sub 5, Netcode electricity
[24] Routekaart Samenwerken in Energiehubs: de Nulmeting (2024) Samenwerken in energiehubs (rvo.nl)

of a closed distribution system, an experimental project, or through congestion contracts like group capacity-limiting agreements. [25]

Establishing an energy hub is a lengthy and intensive process, often taking more than a year to align all partners in the area. Joining a group also requires sacrificing some degree of independence, as participants must agree to replace their individual rights with collective ones. Regulating this transition has been a major topic of discussion over the past year.

The outcome of many discussions and negotiations is that parties entering a group agreement can leave within three years while retaining their individual rights. Shorter terms can be mutually agreed upon, but after this period, if a company chooses to exit, it may lose some of its initially contracted capacity.

Another significant point of discussion has been the limit on group capacity. Companies prefer to have the total of the contracted capacity of all participating entities, while DSOs advocate for a cap at 70% of the total peak demand (the sum of the peaks of participating companies). So far, the agreement allows companies to access 100% of their peak demand, but not the sum of their contracted capacities.

Additionally, the tariff for such agreements has sparked major debate. The DSO insists that the group should pay the full price, while connected customers argue they deserve a discount on the capacity component of the tariff.

Currently, these group contracts, as well as alternative transport agreements, are only available to large connected customers. Households and small businesses cannot yet participate in group agreements. Engaging households poses a challenge, as they pay a fixed fee for using the grid (capacity tariff), making it difficult to offer them discounts. They are also protected by numerous consumer protection regulations. The right to connect and obtain transport rights is part of the universal service obligation for energy.

Nevertheless, there is a growing demand for group agreements among households and small businesses. Cases like Republica, along with business parks that typically host a mix of small and large connections, illustrate that excluding small connections can negatively impact them.

The conclusion of the Deep Dive on group contracts is that several participants from the workshop will explore the possibilities of making group contracts available to small connected customers.

Session on implementing energy sharing: Exploring different models and stakeholder values

One of the aims of the Republica energy community was to promote collective self-consumption, maximizing the use of energy produced collectively. This was facilitated by the energy service company, and since all households and connected customers started with the same energy supplier, all energy exchanges between the collective and individual households fell under a unified supplier and balance responsible party (BRP) portfolio. This energy exchange can also be described as energy sharing. Each household receives a share of the produced kilowatt-hours (kWh), allowing energy from a neighbour who is not at home to be redistributed to other households.

[25] Contracts for general use are developed by InvestNL together with Kennedy van der Laan in Will be son available on: Juridische gereedschapskist energiehubs (rvo.nl)

Energy sharing presents an intriguing opportunity for other neighbourhoods as well. At the project's inception, energy sharing gained prominence within EU directives, including the Renewable Energy Directive and the Electricity Market Directive, both of which identify energy sharing as a potential activity for energy communities and jointly acting renewable self-consumers. However, at that time, there was a lack of clear explanations on what energy sharing entails and how it differs from peer-to-peer trading and supply. To address this gap, the recently adopted reform of the electricity market design (2024/1711) [5] now includes a definition and a dedicated article on energy sharing.

The obligation to facilitate energy sharing, both among active customers and within the community, has sparked extensive discussion in the Dutch energy sector and within the Atelier project. The underlying assumption is that an effective energy sharing model can help scale up successful energy districts. In the Atelier project, the main focus was on identifying what constitutes a good model for energy sharing.

To tackle this question, TNO conducted research on various energy sharing models. These models were further examined in an Innovation Atelier Deep Dive, attended by a diverse group of representatives from the energy sector, including energy companies, energy service companies (ESCOs), energy cooperatives, and distribution system operators (DSOs), as well as the regulator and the responsible ministry. The aim of the session was to map stakeholder preferences and explore different energy sharing models suitable for the Dutch market.

Several aspects of energy sharing were discussed during the meeting, including the registration process, billing, the freedom to switch to sharing during the contract term, the need for local demarcation, fixed versus dynamic sharing keys, cost allocation for sharing, the necessity for sharing to be financially beneficial, regulatory oversight of the energy sharing organizer, eligibility for low-income households, the inclusion of companies in energy sharing, and the role of the DSO in facilitating these arrangements.

For an overview of the topics discussed during the meeting and whether there was consensus on each issue, please refer to the list in Annex I of this report.

The process of energy sharing

During the workshop, we closely examined the various process steps involved in energy sharing. These steps are as follows:

Contracting: Determining who will share energy with whom.

Validation: Ensuring that the agreement is validated and verified.

Calculation: Calculating the amount of energy to be shared.

Registration: Documenting the outcomes of the calculations.

Settlement: Invoicing and processing payments among the parties involved.

For each step, we discussed the key questions that need to be addressed, including who is responsible for each task and what information and communication technology (ICT) is required to facilitate the process. A significant finding was the emergence of the Energy Sharing Organizer (ESO) as a crucial new role, which could take on various responsibilities throughout these steps. Some of these responsibilities may also be managed by entities such as the Distribution System Operator (DSO). As the ESO assumes more responsibilities, it becomes increasingly important to regulate this role effectively.

Another topic of discussion was how to address the direct and indirect effects of energy sharing on other market participants. The impact on other parties depends on several factors, primarily the registration model used. If energy sharing is integrated into the allocation process, it has a direct effect on other participants active in the connection, such as suppliers and BRPs. For example, Table 5 illustrates how the registration of energy sharing influences the responsibilities of energy suppliers.

Conversely, if a model is adopted where sharing is part of the settlement, there are no direct effects on the BRP or supplier. However, energy sharing may lead to connected customers consuming less energy than anticipated or altering their consumption patterns. In such cases, even in a settlement model, other parties might be indirectly affected. Unlike models with direct effects, indirect effects may not be compensated.

Sharing is registered as part of	Balance responsibility	Collection of grid charges and taxes
Metering process	Yes, the energy sharing leads to a change in volumes that fall under a certain Energy Supplier and so a certain BRP.	If a reduction on grid charges or taxes applies for energy sharing, the Energy Supplier has to take this into account when he invoices his customers involved in sharing arrangements.
Allocation process	Idem.	Idem.
Supply settlement process	No, volumes on the perimeter of the BRP do not change under influence of energy sharing.	Idem. Furthermore, the Energy Supplier might change his procedure to calculate the volumes that apply to grid charges and taxes, since he should also take into account the energy sharing: he cannot take the values registered at the Accounting Points.
Dedicated settlement process	No impact.	No impact. If a reduction of grid charges or taxes applies, this is taken care of in the dedicated settlement process.

Table 5 Energy sharing models

Also, the underlying BRP model impacts how other market participants are affected by activities of other market participants on the connection.[26]

[26] For a more detailed analyses of how the BRP model impacts multi- supply and service models on the connection, read A. van der Veen, E. Winters, G. Trienekes and K. Kok, "Implementing the CEP: Options for Balance Responsibility for Active Consumers in the Netherlands," *2024 20th International Conference on the European Energy Market (EEM)*, Istanbul, Turkiye, 2024, pp. 1-5, doi: 10.1109/EEM60825.2024.10608980.

Conclusion

Energy sharing has the potential to transform the retail market, depending on its implementation. Various registration models can be employed, ranging from cashback models to allocation models. The choice of registration model significantly impacts other market participants involved in the connection.

In addition to selecting a registration model, several other decisions must be made, such as determining who will bear the costs and whether active consumers will receive an integrated bill. Currently, energy sharing has not yet been integrated into the new Energy Law in the Netherlands, and there remains considerable debate about its implementation.

While some market players oppose energy sharing, citizens' interest groups are particularly eager to enable it. Dutch Distribution System Operators (DSOs) express concerns about the potential effects of sharing on congestion management. According to the responsible ministry, more time is needed to develop a suitable model that aligns with the needs of the Dutch market.

3. Lessons learned

3.1 Conclusions

In this chapter, we provide an overview of the key conclusions and recommendations based on the topics discussed during the Innovation Ateliers. These conclusions and recommendations address the common themes in both Bilbao and Amsterdam, while also comparing the specific issues faced in each city. The chapter begins with a comparison of the design and functioning of the Innovation Ateliers in both cities.

The innovation ateliers track 2

The Innovation Ateliers are set up differently in the two cities. In Bilbao, the innovation atelier is embedded within an existing network of government, businesses, and knowledge institutions. In Amsterdam, the Innovation Atelier was built from the ground up. Throughout the project, we observed that for a quick and successful launch, as well as for the continuation of the Innovation Ateliers, it is beneficial to anchor it in an existing network. For this reason, it was decided in Amsterdam to also connect to an existing network in the finalization phase. In Bilbao, this has also allowed for a swift start in organizing sessions.

At the same time, we observe that the knowledge sessions in Bilbao, being organized within the existing network, tend to be more generic and represented strategic level, with topics that are less directly tied to the specific challenges of the PED (Positive Energy District) area in Zorrotzaurre. In contrast, Amsterdam, which lacked such a pre-existing network, had to build the network and innovation atelier methodology from scratch. As a result, the development of the PED (and related partners) became the primary focus for selecting session topics in Amsterdam. These sessions often tackled very specific issues that were encountered throughout the development of the PED projects. For example, one session explored how to integrate more Renewable Energy Sources (RES) into the Republica area. Meanwhile, in Bilbao, the discussions focused on broader, more strategic questions, such as how to phase out fossil fuels in the city, or de-carbonize the entire heat grid of Bilbao.

The sessions organized in Track 2 in Amsterdam have had both direct and indirect impact on the project. For example, various RES solutions were explored through the sessions. Track 2 also supported the decision-making process related to the contract with the grid operator. Additionally, track 2 contributed to more general topics, such as the implementation of energy sharing and provided input for the legislative proposal on energy sharing on the national level in the Netherlands.

In Bilbao, track 2 has played a key role in supporting both the municipality and the track leader EVE in exploring a range of important questions. For instance, the municipality focused on studying how other cities are successfully phasing out fossil fuels in the built environment, while EVE was empowered to experiment with the facilitation of energy communities.

Energy communities

Energy communities have been a key topic during the many events and activities related to the PED Innovation Ateliers. The first reason is that the energy community played an important role in the Amsterdam PED. Secondly, there is an underlying belief amongst project partners that communities can play an important role in creating positive energy districts. Finally, the subject is relatively new; new legislation on energy communities became effective during the course of the project.

In the Netherlands, there is substantial experience with generation energy cooperatives, groups that collectively invest in production facilities such as photovoltaic (PV) systems and/ or wind turbines to generate electricity. Increasingly, these cooperatives are engaging in additional activities, such as optimizing self-consumption and managing transport needs to mitigate congestion. However, energy communities that actively manage demand or resources remain uncommon. The project revealed the complexities energy communities face in expanding their roles beyond energy production. This expansion necessitates an additional ICT layer and increases the need for more complex cooperation among community participants, requiring contracts with service providers for flexible energy management and coordination between multiple service providers.

Currently, the financial viability of many of the above-mentioned additional activities remains unclear. Markets for flexibility services are still evolving, with congestion management often inaccessible for smaller connections or assets. Moreover, an independent aggregation regulatory framework and the implementation on the operational level is not yet in place.

Concurrently, factors such as grid congestion, fluctuating wholesale prices, and changing subsidy schemes are making simply investing in PV and feeding back electricity into regional grid the less financially attractive. As a result, flexibility is expected to gain importance and become more valued in the market. However, the lack of clear frameworks for flexibility activities and energy sharing diminishes the financial incentives for collective investments in for example large batteries or asset management.

In Spain, the number of energy communities has increased during the last two years. Currently, there are 353 energy communities registered. Despite growth, only 12% of these communities currently have operational projects; the rest are at different stages of development due, in part, to administrative obstacles. In the Basque Country and Bilbao, energy communities are scarce. In Bilbao, these communities are typically organized by professional companies that design and implement PV installations with citizen and corporate investments. More complex activities, such as steering towards low prices or more explicit flex schemes, are not yet developed. The challenges that they experience have to do with getting connections and generating interest among residents for PV investments, largely due to unclear business cases.

In addition to technical, regulatory, and financial considerations, establishing a suitable and equitable governance structure was a critical objective in the Republica energy community project. Creating an energy community in a newly constructed environment enabled the development of customized thermal and electrical systems from the beginning. However, technical design decisions also influenced the community's future activities, highlighting the importance of involving residents in these decisions. It is crucial for the governance model to empower residents and the other building owners to take control in the community when they move in, highlighting the need for thoughtful design in advance.

Despite the challenges around designing an energy community in a new build area and without the future habitants involved, energy communities are particularly suitable for new neighbourhoods. New build areas are often built to high energy standards, emphasizing energy efficiency and the use of renewable resource. To optimize the use of these resources and mitigate grid capacity issues, storage solutions or coordination mechanisms can be valuable. Effective coordination, often transcends the individual households, and can be facilitated by the energy community, enabling residents to manage local energy assets and benefit from their assets. Additionally, the community serves as a crucial liaison for various market stakeholders, including grid operators.

Group contracts and congestion

Both Bilbao and Amsterdam face challenges in developing positive energy districts (PEDs) due to limited grid capacity. In Bilbao, congestion on electricity feed-in has caused delays for new photovoltaic (PV) projects due to insufficient available capacity, although the situation is not as serious as in the south of the Basque Country. Additionally, the grid operator is hesitant to invest, as recovering costs for reinforcement under the current tariff structure proves difficult. In Amsterdam, the issue lies more on the take-off capacity; new developments or requests for extending current demand placed on a waiting list.

Positive energy districts often have both: local production and consumption. Depending on their design and management, PEDs can either worsen grid congestion or help alleviate it. Unrestricted connections for PV and wind, without local limits, peak thresholds, or capacity-constrained contracts, have resulted in excessive grid usage at certain times. However, PEDs can also mitigate the impact of demand and production on the grid. The Republica development demonstrated that by intelligently managing flexible assets and utilizing the high efficiency of buildings, along with incorporating storage solutions, the overall transport capacity required could be significantly reduced.

Currently, sharing capacity is not permitted in either the Netherlands or Spain. In the Netherlands, there are pilot projects involving closed distribution systems with a single connection to the public grid. Joint distribution system operators (DSOs) are working on proposals to enable this for large connected customers; however, this does not yet address the needs of households (small connections) and PEDs.

Beyond capacity sharing through group contracts or private networks, other strategies can minimize the impact of PEDs on the grid. For example, implementing implicit or explicit flexibility incentives could help. If households are allowed to share energy and receive rewards for doing so within a specific geographical area, this could contribute to more optimal grid usage. Another potential incentive could involve rewards from the DSO for reducing grid usage during peak hours (explicit flexibility rewards through congestion management).

Overall, the ATELIER project has shown that a positive energy district that incorporates smart control and storage solutions can positively influence efficient grid usage. The project has shown that integrating electricity and heating systems enhances the flexibility and resilience of the development. Additionally, this integration could improve the business case, as the electricity produced can be stored not only in batteries but also in thermal storage systems.

Decarbonizing the heat (energy) demand in cities

Decarbonizing heat demand in cities is an important topic for Bilbao, Amsterdam, and other cities participating in the project. Lessons learned from various cities outside the project have provided valuable inspiration. A key finding is the necessity of national or regional legislation to support local authorities. In Spain, national legislation is not yet in place, which prevents Bilbao from mandating the phase-out of fossil fuels in existing buildings.

In the Netherlands, 90% of homes are heated with natural gas. Over the past decade, Dutch lawmakers have enacted new laws to facilitate the phase-out of natural gas. The first step was to prohibit the use of natural gas in new developments, which must either be connected to district heating or utilize an all-electric solution. Additionally, a law recently passed by parliament (currently under review by the Senate) grants municipalities the authority to designate existing districts that will gradually phase out gas systems over a reasonable timeframe. Municipalities will create heat transition plans and propose alternatives for each neighbourhood, such as district heating or all-electric solutions.

Furthermore, new national standards are being developed to ensure that, starting in 2026, a hybrid or fully electric boiler must be installed when replacing a gas-fired boiler. Finally, new legislation supporting the development of district heating is also in progress. District heating is viewed as an attractive alternative to gas-fired solutions. Most participating cities, including both lighthouse cities and other collaborators, already have district heating systems in place. They are collectively planning and strategizing to expand existing networks and enhance the sustainability of their heat mix by incorporating new renewable sources. For example, Copenhagen is investigating how to lower the temperature of its heating system, allowing more buildings to be served by the same source. Lower temperatures also facilitate the integration of renewable, low-temperature sources.

3.2 Recommendations

Over the past five years, many lessons have been learned within Track 2. These lessons are often not solely on integrated planning, governance and law, but also have an impact on the technical and economic domains. For this reason, the recommendations below will touch multiple domains.

The role of the Innovation Ateliers in developing PEDs

The Innovation Ateliers have supported the successful development of Positive Energy Districts (PEDs) in two key ways. First, the Innovation Ateliers have provided the opportunity to address and explore important topics with a large group of stakeholders. These topics range from broad goals, such as how to reduce CO2 emissions, to more specific issues like how to enable and implement energy sharing functionality. Additionally, in Amsterdam, we have seen that meeting in smaller groups with experts and people directly involved in the development of the district, such as developers, residents, or local government, can also directly support the development of the district. This approach allows specific questions to be addressed by a broader group, helping to overcome obstacles to the project’s progress.

The Innovation Atelier network and methodology can both support and accelerate the development of a Positive Energy District. By building the network, stakeholders are able to connect on specific issues more easily, and can quickly tap into resources when needed. It is recommended that the parties directly involved in a development are also part of the network. This helps ensure that the sessions are not only generic but also address concrete issues.

Positive energy districts

To make a district energy-positive, a significant amount of energy is generated within the neighbourhood. Integrating renewable sources into a district can lead to challenges related to the capacity and management of the grid. This is especially true when large amounts of a single type of energy source is installed, such as solar power. Diversifying sources and employing smart control of both generation assets as well as demand-side management can offer solutions.

During the session on organizing additional sustainable energy generation in the district, we found that the definition of a PED does not always provide enough clarity on how to integrate renewable energy sources (RES) effectively. There is also a lack of clear boundaries/ demarcations for defining the PED. Therefore, we prefer focusing on a more grid-conscious integration of assets and aligning supply with demand, rather than solely increasing the generation capacity.

Energy communities

New governance models

In PEDs, the energy efficiency is high and the energy assets, like production installation and storage, are integrated in the area. Coordination of these local assets and systems is therefor often needed, and sometimes even required. To make decisions about how the system is controlled and assets are managed, governance models are needed too. In Amsterdam, the decision was made to establish an energy community in the form of a cooperative. Through the cooperative, residents have a voice in how they design and manage these facilities together.

The energy community model offers a promising way to involve building owners, residents, and tenants in decision-making. However, the project has also shown that in complex systems like Republica, making such decisions requires considerable effort from the residents themselves. Since this is a new development, residents were only brought into the process at a later stage. The developer, who also manages the cooperative and has been involved throughout, possesses the most knowledge. The challenge is in engaging other residents and encouraging them to take on some of the responsibilities.

For this reason, it is advisable that the energy community seeks support from a professional partner, especially when a community is engaged in more complex activities. In this way, decision-making remains with the community, while they are supported in the day-to-day management of the community.

Incentives for flex

The project has shown that flexibility (flex) is still insufficiently rewarded. While the underlying laws are often in place, such as aggregation and energy sharing, the systems for data exchange and related processes are not yet ready. It is desirable that, particularly at the operational side of these activities, is further developed in the coming years.

There are an increasing number of new offerings in the market, such as dynamic pricing agreements. Additionally, new suppliers and service providers are emerging, specifically targeting energy communities as clients. However, the offerings are still limited. With the implementation of the Clean Energy Package and the rights of communities and active consumers, we hope that the market for serving these types of clients will grow as well.

For example, there are still very few players enabling communities and active consumers to stack activities (value stacking). Clear legal obligations to allow and/or facilitate such activities, along with well-defined operational frameworks, would make it easier for market parties to develop new services, leading to more off-the-shelf smart products and services to support active consumers and energy communities.

Energy sharing

Energy sharing is an interesting activity for both active consumers and energy communities. The models for energy sharing are currently being designed and implemented. In the Netherlands, a model with a fixed allocation key appears to be the chosen approach, with energy sharing becoming part of the allocation process. Additionally, the costs of sharing are, as much as possible, allocated to the sharing parties, and it currently seems that energy sharing does not lead to tax reductions or a different network tariff. The impact of energy sharing within different models on the end-users' energy bills is still unclear and requires further investigation.

There is a desire to make energy sharing accessible for low income and social households too. EU rules on energy sharing also encourage municipalities to reach out to low income and social households. The Innovation Track session revealed that there are still many questions among both governments and energy communities about how to concretely implement this.

Group contracts and congestion

Throughout the course of this project, significant developments have occurred in the area of congestion and congestion management. In a relatively short period, congestion has emerged in various regions due to the integration of renewable energy sources at lower grid levels and shifts in electricity demand patterns. As a result, the grid operator is struggling to meet the increasing demand for transport capacity. To address this, it is essential to optimize the use of the existing grid infrastructure in a more efficient and strategic manner.

In recent years, the Netherlands has introduced a range of new connection and transport contracts for large consumers. These initiatives are designed to mitigate and manage the impact of these connections on the grid. By adopting smarter approaches to grid usage, more stakeholders can gain access to the network and have their energy needs effectively met, contributing to a more sustainable energy system.

Unfortunately, congestion is not limited to large consumption connections. Small consumption connections are also increasingly facing delays in having capacity allocated to them. It is crucial to explore how small consumers can be effectively encouraged to use the grid more efficiently. This requires examining several factors, including their minimum energy needs, the most effective ways for them to collaborate and make agreements, and which incentives (financial, social) would best promote optimal grid usage.

As part of this process, it is important to reconsider grid tariffs and ensure they are aligned with these objectives. Additionally, the right of households to access and utilize the energy system, supported by universal service obligations, should also be a key consideration in shaping future policies.

Decarbonizing the heat (energy) demand in cities

Integration of heat and electricity

Phasing out fossil fuels in heat demand is a challenge for many cities across Europe. There are several promising alternatives. In both Bilbao and Amsterdam, district heating systems are developed in newly planned areas. In Bilbao, this is a low-temperature district heating system. Low-temperature district heating systems are often combined with collective or individual heat pumps. The system provides a stable baseload of heat and can also serve as a buffer. During a number of Innovation Track sessions, it has been emphasized that when planning new infrastructure, it is crucial to consider the electricity system as well.

In the Amsterdam PED, it has been demonstrated that a district heating network can not only reduce the overall demand for transport capacity, but also shift demand to off-peak periods. This approach helps to alleviate congestion and reduces pressure on the electricity grid, contributing to a more balanced and efficient energy system.

To actively phase out fossil fuelled heat use in the build environment, regulations are needed. In Spain, there are currently no regulations that empower municipalities to phase out existing fossil fuel sources, despite a growing need for such measures. In contrast, similar regulations in the Netherlands are awaiting approval by the Senate. In anticipation of these upcoming rules, many municipalities are already taking proactive steps by integrating plans to phase out gas usage in neighbourhoods and urban areas.

Annex I

During the Innovation Atelier Deep Dive on energy sharing various aspects of energy sharing were discussed. The list below shows how the participants felt about the different aspects and shows if there was a consensus on the discussed topics.

Topic	Consensus?	Explanation
Energy sharing should be registered as part of the allocation process	Yes, there is a preference to register sharing as allocation. However, this is seen as a complex model to implement, so an alternative is to start with a model that makes sharing part of the settlement process	In Belgium energy sharing is part of the settlement process. This leads to some indirect effects with the energy supplier (costs). The allocation model is more transparent makes it easier to allocate the induced costs with the right market party
Should the connected consumers receive one bill: supplier + sharing?	yes	All participants agree that this is the preferred option.
Consumers should be free to start sharing whenever they want	No	The suppliers indicate that is undesirable for them if sharing is started during the contractual term. This induces extra costs, due to long term procurement of energy. Other participants point out that limiting consumers to engage in sharing during their contract, is also limiting. Mitigation measures should be explored
Energy sharing should only be allowed in a limited geographical area	No	The DSO's want that sharing is only allowed in a limited geographical area. They fear that sharing can worsen congestion. Other participants mention that the DSO use congestion management for congestion and energy sharing should not necessarily be limited. Other instruments could be used to reward conscious use of the grid
The sharing keys should be static	No	A number of participants (mainly suppliers and DSO's) assume that static sharing keys will lead to more behavioural change. However, other participants doubt whether this is true. There is a discussion on what is static and what is dynamic. Predictability is particularly important; then participants can adjust their behaviour accordingly.

Administrative cost of sharing should not be socialised amongst all system users	Yes	All participants point out that ideally sharing costs are borne by the sharing customers
Energy sharing should always pay off	No	This topic was not discussed in detail during the session. There is not yet a clear picture of how sharing can be made remunerative. For owners' associations, sharing might lead to lower installation costs. The impact of sharing on energy taxes and network tariff, was not discussed
ACM should also regulate the Energy Sharing Organiser (ESO)	yes	If the ESO is also given certain responsibilities and powers, then the ACM, as market regulator, is the most likely body to also regulate the ESO
Low income and energy poor household should have access to energy sharing	Yes	All parties indicate that households with less resources should also have access to energy sharing. This should be taken into account when developing the model
Energy sharing should be easy for the end user	yes	Parties indicate that sharing should be simple, especially for users, but preferably also on the operational side, so as to keep costs down. Exactly how 'simple' should be defined was not discussed.
There is a need to know more about the impact of sharing and choices in implementation	Yes	Parties indicate that they do not yet have sufficient insight into the potential effects of energy sharing. There is a need for more insight into the effects, so this can be included in the decision on the registration model and how to remunerate sharing
Companies should also be able to share	No	Participants indicated that companies are also interested in energy sharing. Whether or not to make energy sharing accessible to businesses was not further discussed in detail and it is not clear whether there is consensus on this.
Commercial parties may take on ESO's role	Yes/no	Participating suppliers and service providers are interested in the ESO role.
DSO's play a role in facilitating energy sharing	Yes	DSO wants to play a role in facilitating energy sharing. However, it is not clear yet what they want to facilitate (validation, registration)