# D3.3

# DEFINITION OF HIGHLY APPLICABLE USE CASES

SUMMARY

This document presents a thorough description of GENTE use cases and their relationship with other aspects of the project necessary for use case development.

Website genteproject.com

Contact hello@genteproject.com

# Impressum

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| **Authors** | 1/9/2023 | Lucas Porto, Laura Zabala, Aitor Perez | R2M |
| **Main contributors** | | Josephine Harris, Chris Young, Ben Bowler | HSLU |
| | | Alexander Nnamdi Ndife | Chalmers |
| **Verification by** | 10/10/2023 | Laura Zabala | R2M |
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# Abstract

The ERA-Net GENTE project aims to develop a distributed governance toolkit for local energy communities (LECs). This toolkit includes advanced digital technologies such as the Internet of Things (IoT), distributed ledger technology (DLT), edge processing and artificial intelligence (AI) for autonomous energy resource management within and across LECs and for flexibility provision to energy networks.

Seven different use cases have been identified as the main outcomes for the energy communities GENTE is targeting to tackle. The use cases are crucial to the development of an effective and useful toolkit during the project. The main use cases to be validated are: grid flexibility provision through self consumption optimization or peak load management, community $CO_2$ emissions reduction, energy efficiency improvement based on energy cost reduction and autarky increase, community federation, and the co-design process for energy communities.

The use cases are characterized by their connections and involvement to technical and non-technical main objectives in the project and by the need owners in charge of developing, promoting and, at the same time, affected by the application of the use cases. Additionally, they are further divided into exploitable results that derive from or are achieved through the fulfillment of the set objectives. Finally, future paths carved through necessities, legislation or main objectives are condensed into six different future scenarios and four different archetypes that fully encompass the development environment for energy communities.

This document presents the interactions between use cases and the characterization of the elements and context required to implement them, as well as their importance in the environment of energy communities' development and future paths. A comprehensive summary is provided to contextualize these use cases within the GENTE project and to facilitate the application of solutions in the project.

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# List of Abbreviations

| | |
|---|---|
| AI | Artificial Intelligence |
| CELL | Collaborative Energy Living Lab |
| $CO_2$ | Carbon dioxide |
| DER | Distributed Energy Resources |
| DLT | Distributed ledger technology |
| DSO | Distribution System Operator |
| EC | Energy community |
| ER | Exploitable Results |
| KER | Key Exploitable Results |
| EV | Electric Vehicle |
| IoT | Internet of Things |
| KPI | Key Performance Indicators |
| LEC | Local Energy Community |
| LL | Living Lab |
| NTO | Non-technical objective |
| PV | Photovoltaics |
| RES | Renewable Energy Sources |
| TO | Technical Objective |
| TRL | Technology Readiness Level |
| UC | Use case |
| V2G | Vehicle to Grid |
| P2P | Peer-to-Peer |
| HG | Hydrogen generation |

# 1. Introduction

The ERA-Net GENTE project aims to develop a distributed governance toolkit for local energy communities (LECs). This toolkit includes advanced digital technologies such as the internet of things (IoT), distributed ledger technology (DLT), edge processing and artificial intelligence (AI) for autonomous energy resource management within and across LECs and for flexibility provisions to energy networks.

The solutions developed within GENTE for the governance of LECs will be validated first at Living Labs and then at real full-scale environments in order to increase technology readiness level (TRL) of the solutions.

Demo sites are suited to assess the state of the art in terms of use case application in the current state of European legislation and as-of-today technological capabilities. The rapid increase of Distributed Energy Resources (DER), the tendency to democratize access to energy management and a higher community involvement within the full energy system implies changes to the relationship between energy communities and the full energy grid scope (maintaining energy balance while providing a stable and resilient energy system). Energy systems will evolve to fulfill both grid and EC participants' requirements.

This deliverable is focused on defining the use cases found to be applicable in the GENTE project, specifically in their relationship with other issues concerning GENTE. Use cases represent the achievement of a certain set of objectives and stakeholder interactions, forming a net of relationships necessary to the full understanding of use case development. Task 3.3 will focus on unraveling this net by linking use cases with all relevant GENTE aspects, including need owners and exploitable results that will be pursued within the project. Use cases will also be linked to the LECs archetypes (developed in Task 4.1: *Characteristics of energy communities and motivations, engagement, and socio-economic profiles of end users*) that best make use of their application and with the future scenarios considered for energy communities depending on the roadmap taken (developed in Task 3.1: *Future Energy Community Scenarios*).

# 2. GENTE use case characterization

This section describes the methodology followed to characterize GENTE use cases within the context of the project and the variables that affect them. This aims to provide a holistic view of how the different aspects in the project coexist and correlate with each other. During this deliverable a thorough analysis has been conducted to link the final use cases to other important parameters that affect the development of energy communities now and during the foreseeable future.

The following steps have been conducted and are represented in Figure 1:

1. Definition of the **GENTE use cases** and links with technical and non-technical objectives.
2. Use case and **need owner correlation.**
3. Use case implementation through GENTE (**key**) **exploitable results linking** which Exploitable Results (ERs) and/or Key Exploitable results (KERs) are involved in the development of the use cases.
4. Use cases applicability in the different energy community **archetypes**.
5. Use case mapping to the future energy community scenarios for best utilization.

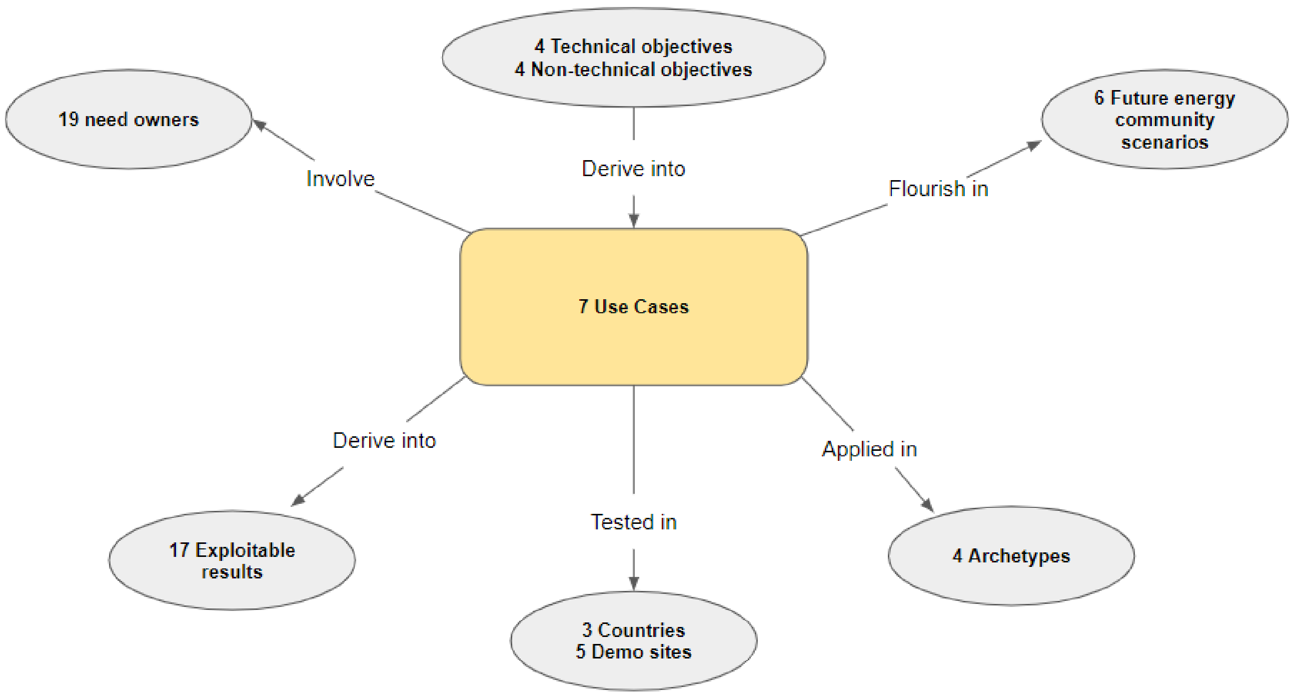


**Figure 1 - Methodology scheme for the use cases definition and characterization**

Final summary tables (Tables 12-18) are provided in Section 2.6 of this document to condense all gathered information within this deliverable.

# 2.1. GENTE use cases

Task 9.1: *Definition of test cases and assessment framework and KPIs for validation* defines the concept of use case (UC) as the materialization into specific issues of the different objectives that a system has to accomplish. This task connects the different technical objectives (TOs) and non-technical objectives (NTOs) to identify a total of five top level use cases to apply in the GENTE project. These use cases are:

- **UC1 - Grid flexibility provision:** Grid flexibility is defined as "the ability of a power system to reliably and cost-effectively manage the variability and uncertainty of demand and supply across all relevant timescales, from ensuring instantaneous stability of the power system to supporting long-term security of supply"[1]. From a wide range of potential flexibility measures, two have been chosen as most relevant to GENTE:
    - **UC1a - Self-consumption optimization:** Refers to maximizing the benefits from the exploitation of an LEC's available renewable energy assets by the usage of correct and optimized energy sharing algorithms, the use of energy storage, and the adjustment of consumption patterns.
    - **UC1b - Peak load management:** Refers to the shifting of grid energy demand requirements in a system with the objective of avoiding large upwards and downwards shifts in energy requirements. [2]
- **UC2 - Community $CO_2$ emissions reduction:** Reduction of greenhouse gas emissions related to the operation of an LEC, either by increased renewable energy integration, self-consumption optimization, or a reduction in consumption patterns.
- **UC3 - Energy efficiency:** Refers to the reduction of the energy used to perform a specific task. This has several implications for an energy community. For the purpose of GENTE, two of these goals are going to be studied:
    - **UC3a - Reduction in community energy costs:** Reduction in the financial requirements to operate the energy community by reducing grid consumption, increasing renewable energy use, and participating in other grid services, if possible.
    - **UC3b - Increase in community autarky:** Refers to the increased independence from the general grid that an LEC can achieve by increasing renewable energy generation and reducing and accommodating community consumption to generation patterns.

[1] Status of Power System Transformation, IEA, May 2019, viewed at https://www.iea.org/reports/status-of-power-system-transformation-2019
[2] D. Darwazeh, J. Duquette, B. Gunay, I. Wilton, S. Shillinglaw, Review of peak load management strategies in commercial buildings, Sustainable Cities and Society, Volume 77, 2022, 10.1016/j.scs.2021.103493

- **UC4 - Community federation:** One of GENTE's main objectives is to facilitate federation between LECs that can accelerate the energy transition and allow for a more optimized management of resources.
- **UC5 - Co-design process for LEC:** GENTE intends to assess a process to increase need owner participation in the development of energy communities. Aimed mainly at tennants, the process' objective is to help to guide in the creation and management of an LEC, not only in social aspects but also in technological implementations.

For the purpose of this deliverable only the use cases applicable to GENTE will be treated. As such, UC1 will be treated as UC1a and UC1b, and UC3 will be treated as UC3a and UC3b.

### 2.1.1. Use cases correlation with technical and non-technical objectives

Use cases in the context of energy communities oscillate between technical and non-technical requirements that influence the development of LECs. Barriers for implementation of the appropriate systems can come from the legal, communication, and physical aspects of the configuration, ranging from the need to instantaneously communicate information from energy sources to optimization platforms to establishing the legal groundwork that will allow multiple LECs to communicate and share energy with one another.

Depending on the level of technicality involved, use cases will be best utilized by different energy communities and their objectives. Specifically, the archetypes in which the use case will be applied will vary depending on whether the end result is energy optimization, community operations or finding new organizational approaches with the objective of decentralizing the energy grid. The GENTE proposal defines four technical objectives and four non-technical objectives, but does not categorize the use cases in a similar manner. This section will assign a loose level of technicality to the use cases, differentiating between mostly technical, mostly non-technical and a similar mix of both aspects.

Figure 2 shows the level of dependency that falls into technical and non-technical aspects of the use cases identified by Task 9.1 (deliverable in which a more extensive definition of these objectives can be found), keeping in mind that all use cases have aspects of both. Color and line style used in the diagram is to facilitate visual understanding of the diagram.

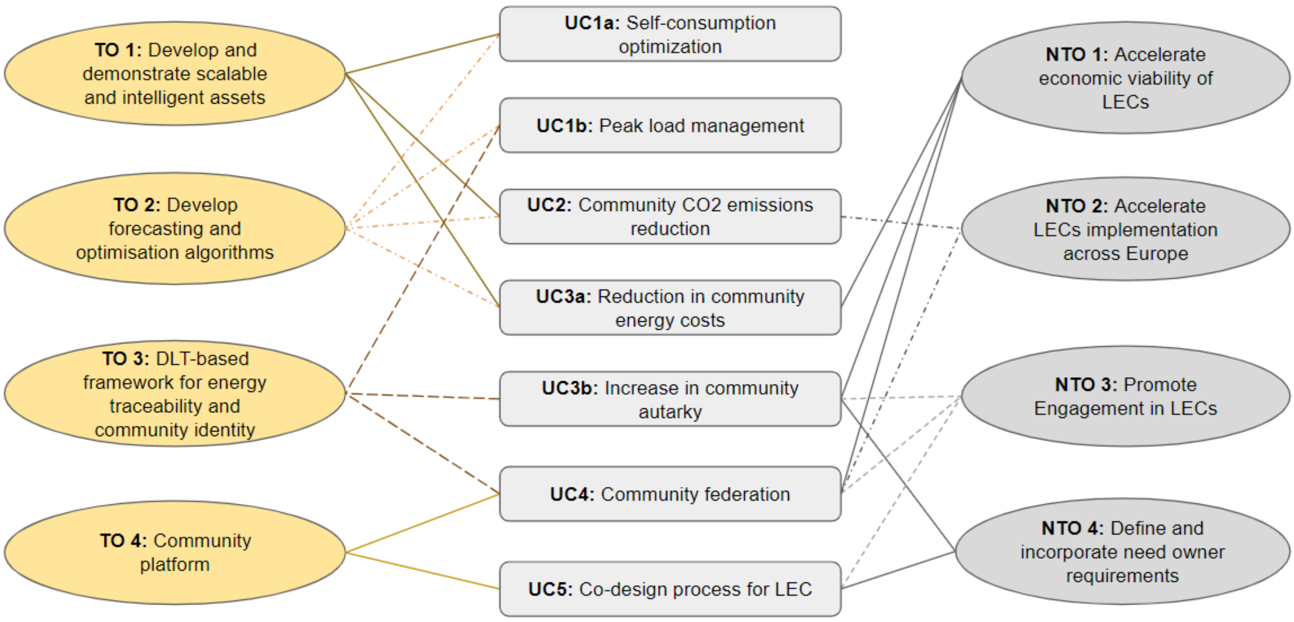


**Figure 2 - Link between use cases and technical and non-technical objectives**

For most cases, arguments could be made to connect all objectives with all use cases. For the purpose of this analysis, only major relationships have been chosen.

What is revealed is that use cases, at least at the current development of LECs in the European context, require a technical foundation (or are purely technical-based), if not for the actual application, at least for the facilitation of the use case. Only two of the use cases (UC1a, UC1b) are purely connected with technical objectives, being the most affected by optimization algorithms, internet of things (IoT) and device implementation. While UC1a: *Self consumption optimization* leads to NTO1: *Accelerate economic viability of LECs*, this connection is made through another use case - UC3a: *Reduction in community energy costs*; to avoid redundancy, UC1a and NTO1 have not been connected. All other use cases are connected, at least partially, with non-technical objectives.

This leads to the categorization of the use cases in the realms of technicality presented in Figure 3, showing that use cases are either technical or a mix between technical and non-technical.

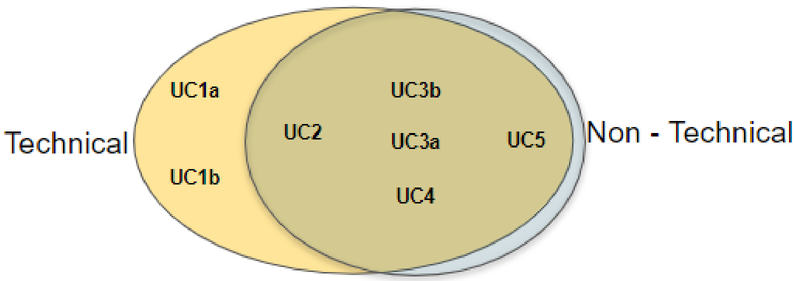


**Figure 3 - Categorisation of use cases based on technical nature**

## 2.2. GENTE use cases and need owner mapping

Need owners, thoroughly defined in Task 3.2: *Specification of stakeholders' needs in local energy systems with high renewables*, have specific roles in each of the use cases, holding responsibility for their advancement either by allowing practices currently not permitted or by partaking in the democratization of access to the energy market. The multi-domain use cases of GENTE involve complex interactions between different users. However, different levels of responsibility can be established to determine who holds the key to the development of the LECs.

GENTE has identified a total of 18 relevant need owners related to the practices, processes, tasks and objectives in the project, which are shown in Table 1.

**Table 1 - GENTE need owners definition**

| Need Owners | | | |
|---|---|---|---|
| LEC | Manufacturers | Municipalities | Advocacy groups |
| DSO (Distribution System Operator) | Technology providers | Energy regulators | NGOs |
| (ESO) Electricity System Operator | Consumers | Regulatory Agencies | Financial Institutions |
| Aggregator | Residential building owner | Energy cooperatives | Research institutions |
| Microgrid Operator | Prosumers | Energy consultants | |

Use case implementation and development success falls on the defined need owners, depending on the relevance of the tasks required. Need for the development and distribution of new materials and devices, the requirement of new legislation and rules to take advantage of the possibilities that an LEC provides to the energy system or the investment required to build new infrastructure will rely on different actors, or, as referred to in GENTE, need owners.

The involvement of these need owners with the use cases will rely on direct participation requirements (e.g. LECs will require the participation of building owners) and the level of technicality required. It has been considered relevant to the understanding of the correlation between need owners and use cases to define the level of technicality of each of the need owners similarly to what has been performed in the previous section. This refers to the separation into three groups: Technical, Non-Technical and Mixed.

The final distribution of need owners between the categories has been performed in terms of both participation and knowledge. It has been considered that regulators require technological inputs in order to correctly set the ground rules in which LECs develop, and thus are a mix between technical and non-technical elements. The classification is presented in Table 2.

**Table 2 - GENTE need owners classification**

| Need Owners | | |
|---|---|---|
| **Technical** | **Mixed** | **Non-Technical** |
| **DSO** | **LECs** | **Residential building owner** |
| **ESO** | **Regulatory authorities** | **Consumers** |
| **Aggregator** | **Research institutions** | **NGOs** |
| **Microgrid operator** | **Energy consultants** | **Financial institutions** |
| **Technology providers** | **Energy cooperatives** | **Advocacy groups** |
| **Manufacturers** | **Prosumers** | **Municipalities** |

As mentioned before, need owner correlation to use cases does not necessarily need to be affected by the technical level but by use case requirements. The final connections considered arise from who influences or is influenced by the specific UC, both directly and indirectly.

Taking everything in consideration, Table 3 depicts the final connections between use cases and need owners.

**Table 3 - GENTE use cases definition and need owner mapping**

| Use case | Type | Need Owners |
|---|---|---|
| **UC1a -** Self consumption optimization | Technical | **DSO, LECs, manufacturers, technology providers, energy consultants, residential building owner, prosumers, consumers** |
| **UC1b -** Peak load management | Technical | **ESO, DSO, aggregator, LECs, residential building owner, energy consultant, prosumers, consumers, manufacturers, technology providers** |
| **UC2 -** Community $CO_2$ emissions reduction | Mixed | **LECs, prosumers ,municipalities, NGOs, technology providers, manufacturers, advocacy groups** |
| **UC3a -** Reduction in community energy cost | Mixed | **LECs, prosumers, residential building owners, manufacturers, technology providers, municipalities** |
| **UC3b -** Increase in community autarky | Mixed | **ESO, DSO, technology providers, manufacturers, LECs, NGOs, regulatory authorities, consumers, prosumers, advocacy groups** |
| **UC4 -** Community federation | Mixed | **LECs, energy cooperatives, ESO, DSO, aggregators, financial institutions, regulatory authorities** |

| Use case | Type | Need Owners |
|---|---|---|
| **UC5 -** Co-design process for LEC | Mixed | **LECs**, **regulatory authorities**, **research institutions**, **energy consultants**, **consumers**, **prosumers**, **residential building owner, municipalities** |

## 2.3. GENTE use cases and key exploitable results

Exploitable results (ER) are defined as "results coming from the project that will have an impact on the economy, environment and/or society as a whole", as explained in Task 4.3: *Market and stakeholder analysis with evaluation and exploitation roadmap*. They are products, applications, processes, valuable information, services or other kinds of results that, while derived from the project, can be utilized (exploited) beyond its scope.

Exploitable results have been identified in the GENTE project by a series of questionnaires meant to "value" said exploitable results in a scale of ***expected impact*** (scaled from low to high) ***vs. innovation risk*** (scaled from high to low) in an *exploration board*. High impact and low risk exploitable results, categorized as "rising stars", are moved into the final exploitation board, while others not deemed worthy are dropped during the project's development phase.

Exploitable results reaching the "rising star" level, which comprises those ERs with maximum scientific, economic, environmental and/or societal impact and minimum innovation risk, are considered a **Key Exploitable Result** or KER. GENTE has identified a total of 17 ERs to test during the project, shown in Table 4, out of which four (in bold) are KERs.

**Table 4 - GENTE exploitable results**

| Exploitable Results for GENTE | | |
|---|---|---|
| 1 - Forecasting heat (Data analytics) | 2 - Data Driven Forecast | 3 - PV optimization |
| 4 - Digital twin for the LEC | **5 - GENTE toolkit** | 6 - Data collection tools, submetering, IoT platform |
| 7 - Sub-metering device | 8 - IoT BEMS including heat pumps | 9 - LEC optimization |
| **10 - DLT-based prosumer platform** | **11 - DLT-based community manager platform** | 12 - Communication between gateway and devices |
| 13 - Edge computation in IoT gateway | 14 - Design, sizing and modeling tools | 15 - Guidelines for community engagement |
| **16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating** | | 17 - Business models for communities, federation managers and aggregators |

These ERs (and KERs) can be considered as the means to develop use cases within the GENTE project, being a section breakdown of the major objectives that are being implemented in the various demo sites. The connection between use cases and exploitable results is presented here, aiming to provide an understanding of which specific actions taken in the project can be extrapolated to achieve objective results beyond the project's scope.

- **UC1a - self-consumption optimization:** Being one of the most technologically dependent use cases, exploitable results related to UC1a carry the need for data-driven energy optimization and the implementation of new monitoring devices. Additionally, it is one of the more general use cases, as any actions taken towards the utilization of more renewable energy within the system can be counted as an action in the realm of self-consumption optimization. Exploitable results connected with UC1a are presented in Table 5.

**Table 5 - GENTE exploitable results involved in UC1a**

| | | |
|---|---|---|
| **UC1a: Self-Consumption optimization** | 1 - Forecasting heat (Data analytics) | 7 - Sub-metering device |
| | 2 - Data Driven Forecast | 8 - IoT BEMS including heat pumps |
| | 3 - PV optimization | 9 - LEC optimization |
| | 5 - GENTE toolkit | 14 - Design, sizing and modeling tools |
| | 6 - Data collection tools, submetering, IoT platform | 16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating |

- **UC1b - Peak-load management:** This use case is very similar to UC1a in terms of requirement, with the difference that peak-load management is not as focused on renewable energy optimization but rather on a specific pattern of energy use, renewable or not. Table 6 includes the exploitable results related to UC1b.

**Table 6 - GENTE exploitable results involved in UC1b**

| | | |
|---|---|---|
| **UC1b: Peak-load management** | 1 - Forecasting heat (Data analytics) | 10 - DLT-based prosumer platform |
| | 2 - Data Driven Forecast | 11 - DLT-based community manager platform |
| | 3 - PV optimization | 12 - Communication between gateway and devices |
| | 5 - GENTE toolkit | 13 - Edge computation in IoT gateway |
| | 6 - Data collection tools, submetering, IoT platform | 15 - Guidelines for community engagement |
| | 7 - Sub-metering device | 16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating |
| | 8 - IoT BEMS including heat pumps | 17 - Business models for communities, federation managers and aggregators |
| | 9 - LEC optimization | |

- **UC2 - $CO_2$ reduction:** Direct actions towards $CO_2$ emission reduction are more renewable energy production and use and less grid energy consumption. Indirect measures include all kinds of forecasting algorithms that facilitate and optimize those tasks. The ER involved in UC2 are shown in Table 7.

- **UC3a - Reduction in community energy costs:** Along with the connection to $CO_2$ reduction with more renewable energy use and less grid energy consumption, a more involved and knowledgeable user base directly translates to lowering costs through taking advantage of time-of-use tariffs, knowledge on generation profiles and other measures. The exploitable results from UC3a are presented in Table 8.

**Table 7 - GENTE exploitable results involved in UC2**

| | | |
|---|---|---|
| **UC2: $CO_2$ emission reduction** | 1 - Forecasting heat (Data analytics) | 7 - Sub-metering device |
| | 2 - Data Driven Forecast | 8 - IoT BEMS including heat pumps |
| | 3 - PV optimization | 9 - LEC optimization |
| | 4 - Digital twin for the LEC | 14 - Design, sizing and modeling tools |
| | 5 - GENTE toolkit | 16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating |

**Table 8 - GENTE exploitable results involved in UC3a**

| | | |
|---|---|---|
| **UC3a: Reduction in community energy costs** | 1 - Forecasting heat (Data analytics) | 7 - Sub-metering device |
| | 2 - Data Driven Forecast | 8 - IoT BEMS including heat pumps |
| | 3 - PV optimization | 9 - LEC optimization |
| | 4 - Digital twin for the LEC | 16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating |
| | 5 - GENTE toolkit | 17 - Business models for communities, federation managers and aggregators |

- **UC3b - Increase in community autarky:** Exploitable results focused on increasing community autarky must focus on reducing grid requirements and trying to "isolate" the system from outside requirements (in energy terms), as is shown in Table 9.

**Table 9 - GENTE exploitable results involved in UC3b**

| | | |
|---|---|---|
| **UC3b: Increase in community autarky** | 1 - Forecasting heat (Data analytics) | 8 - IoT BEMS including heat pumps |
| | 2 - Data Driven Forecast | 9 - LEC optimization |
| | 3 - PV optimization | 15 - Guidelines for community engagement |
| | 5 - GENTE toolkit | 16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating |
| | 6 - Data collection tools, submetering, IoT platform | 17 - Business models for communities, federation managers and aggregators |
| | 7 - Sub-metering device | |

- **UC4 - Community federation:** Community federation requires the ability for communities to communicate effectively internally and externally with other communities, prosumers or businesses that might be open for participation. The exploitable results included in Table 10 are related to this use case.

**Table 10 - GENTE exploitable results involved in UC4**

| | | |
|---|---|---|
| **UC4: Community federation** | 6 - Data collection tools, submetering, IoT platform | 14 - Design, sizing and modeling tools |
| | 7 - Sub-metering devices | 15 - Guidelines for community engagement |
| | 12 - Communication between gateway and devices | 17 - Business models for communities, federation managers and aggregators |
| | 13 - Edge computation in IoT gateway | |

- **UC5 - Co-design process for LEC:** Exploitable results that help with the development of this use case can be attributed to those which help the final users participate in the creation and expansion of energy communities. This is the case for the exploitable results shown in Table 11.

**Table 11 - GENTE exploitable results involved in UC5**

| | |
|---|---|
| **UC5: Co-design process for LEC** | 4 - Digital twin for the LEC |
| | 15 - Guidelines for community engagement |
| | 17 - Business models for communities, federation managers and aggregators |

## 2.4. GENTE use cases and LEC archetypes

LEC archetypes, defined in Task 4.1: *Identification of user types and organizational models*, condense characteristics of energy communities into a useful description of energy communities within the GENTE context. These archetypes are generated by combining the technologies developed or used by GENTE with the European context in which LECs develop or are likely to develop over the coming years.

The objective of this section is to link these archetypes with the UC that will be most advantageous or appropriate for the development of local energy communities within the context of those archetypes. It is considered that LECs have three mandatory characteristics akin to them: *Generation of renewable energy, connection to the public grid* and *legal entity*. This is complemented with a set of dimensions: *Connection type, main activity, revenue model* and *governance structure*, which in turn coalesce into the final four archetypes for GENTE LECs:

- **Archetype 1 - Community-led local optimization community**: characterized by a single connection to the grid, local optimization as the main activity and with governance control widely distributed across the membership. The typical involvement is by small prosumers.
- **Archetype 2 - Virtual community-led local optimization community**: similar to Archetype 1, the main difference being that participants are connected virtually, not physically.
- **Archetype 3 - Business-led service-focused community**: typically organized as a for-profit business, this archetype has a single grid connection and focuses on providing services (e.g. flexibility) to the grid. It can be community or business-led, but will be led by only one or few members.
- **Archetype 4 - Virtual business-led service-focused community**: similar to Archetype 3, the main difference being that participants are connected virtually, not physically.

Use cases will be better adapted to provide services to each of these archetypes depending on the specific requirements or possibilities. Considering the nature of the different archetypes, the analysis will be conducted first for Archetypes 1 and 2 (community-led) and then for Archetypes 3 and 4 (business-led).

## 2.4.1. Community-led archetypes and use cases

The benefits and interests of participating in any LEC can be grouped into social, economical, environmental and political aspects[3]. While participants in the same energy community might be motivated by any or all of these main drivers, it is commonly believed that success, at least at the consumer/prosumer level, is usually pushed by the level of local cohesiveness[4]. Research suggests that while the financial benefits of participating in these projects are important, the main drivers for small participants are community benefits, lower energy costs, environmental concerns, energy independence and the collaboration with local organizations[4].

A particular study performed by the European Commission on the socio-economic drivers of energy communities[5] over 24 case studies found that there were eight main drivers motivating participation in LECs; seven were socio-environmental and only one was financial. Moreover, while financial motivation was the third overall concern, it was always accompanied by social implications like self-sufficiency, social and environmental sustainability and the development of green infrastructure, implying that profit per se was not the main concern. The study concluded that: "The ambition to protect the environment and the desire to be socially, ecologically and economically self-sufficient is particularly prevalent amongst housing communities and bio-villages" [5].

Archetypes 1 and 2 operate within the socio-economic drivers described in that study [5], whether virtual or physically connected, and will continue to do so in the upcoming years. Figure 4 presents the connection between these archetypes and their main use cases. These connections can be "strong", if the use case is a main concern or activity of the archetype, "weak", if it is part of the process but not a requisite, and absent if there is no connection at all.

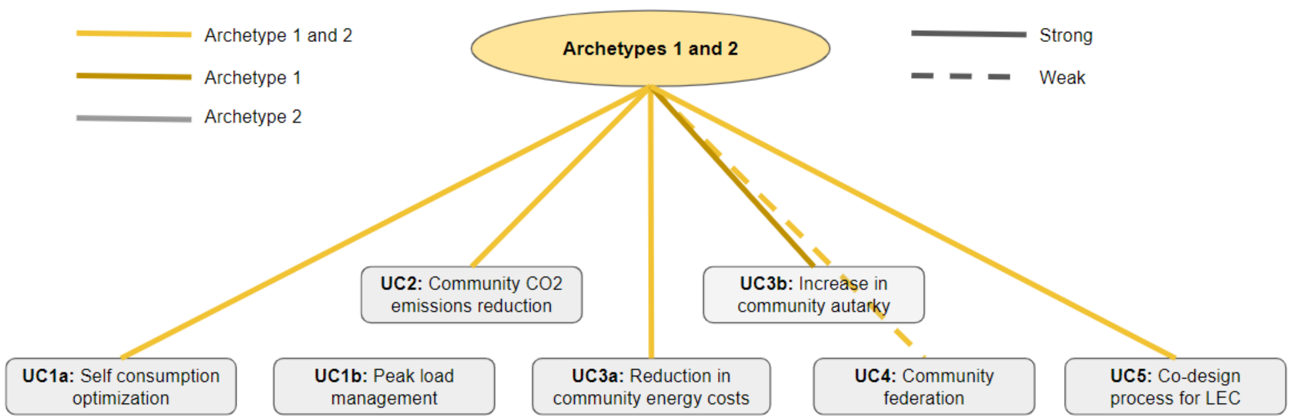


**Figure 4 - Relationship between archetypes 1 and 2 and use cases**

---

[3] B. Van Veelen; D. van der Horst. What is energy democracy? Connecting social science energy research and political theory. Energy Res. Soc. Sci. 2018. https://doi.org/10.1016/j.erss.2018.06.010

[4] D. Wuebben, J. Romero-Luis, M. Gertrudix. Citizen Science and Citizen Energy Communities: A Systematic Review and Potential Alliances for SDGs; Sustainability 2020, 12, 10.3390/su122310096

[5] A. Caramizaru, A. Uihlein. Energy communities: an overview of energy and social innovation. JRC Science for Policy Report, 2020. Viewed at https://publications.jrc.ec.europa.eu/repository/handle/JRC119433

Community-led LECs have connections with almost all use cases, with UC1b - *Peak load management* being the only exception due to the focus on more business-led initiatives. Similarly, it is believed by GENTE that while community federation (UC4) might be a driver for joint social projects, it will be more relevant to large-scale business ventures more akin to Archetypes 3 and 4, and is therefore given a "weak" connection. Finally, UC3b can only be achieved by Archetype 1 (physical LEC) because virtual energy communities require a permanent grid connection and are fully supported by the general grid in terms of energy demand requirements.

## 2.4.2. Business-led archetypes and use cases

While the environmental and social aspects of energy communities are the main driving forces of Archetypes 1 and 2, the business-led archetypes 3 and 4 consist of for-profit ventures that will be enabled by the increasing need of European grids to have access to flexibility assets. These energy communities will use their resources to answer to the needs of an increase in demand-response services, managing flexibility assets, optimizing the use of energy storage and performing coordinated actions with a network of other assets [6, 7].

Archetypes 3 and 4 require the submitting of an LEC's available resources to the needs of the grid. Self-consumption loses importance in the face of load requirements, curtailment and flexibility provisions, which will generally be managed by an aggregator service[8]. Figure 5 illustrates the connections between Archetypes 3 and 4 and the GENTE use cases.

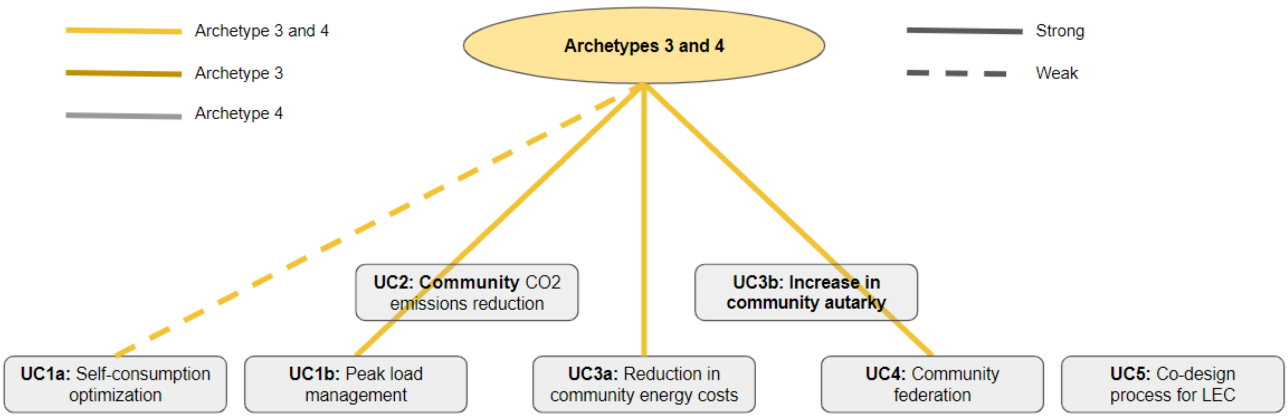


**Figure 5 - Relationship between archetypes 3 and 4 and use cases**

[6] M. Kubli, S. Puranik. A typology of business models for energy communities: Current and emerging design options. Renewable and Sustainable Energy Reviews, Volume 176, April 2023. 10.1016/j.rser.2023.113165
[7] P. Ponnaganti, R. Sinha, J. R. Pillai, B. Bak-Jensen. Flexibility provisions through local energy communities: A review; Next Energy, Volume 1, June 2023. 10.1016/j.nxener.2023.100022
[8] M. Bertolini, G. Morosinotto; Business Models for Energy Community in the Aggregator Perspective: State of the Art and Research Gaps, Energies 16, 2023, 10.3390/en16114487

These connections show that reducing $CO_2$ emissions (UC2) is not a direct objective of the energy communities that fit into Archetypes 3 and 4, even when it is an indirect and extremely important side effect of their operation, as the services provided by these energy communities are paramount for the stability of the grid (UC1b). Similarly, self-consumption optimization (UC1a) is less relevant than general "consumption optimization" in which other practices like demand-side management or peak load management are applied. Another important difference from Archetypes 1 and 2 is that community autarky (UC3b) is completely avoided, as the services provided by business-centric communities require high dependance on grid interactions. Participation in community federation (UC4) could greatly improve the capacity of these ventures by combining assets, effort and services with other communities. Lastly, a reduction in energy community costs (UC3a) increases revenues margin, key for a successful business-led community operation.

It is important to notice that while a physical energy community might make managing the assets easier, the operation of both Archetypes 3 and 4 would probably be similar, and thus there are no differences in the use cases that apply to them.

## 2.5. GENTE use cases and future scenarios for energy communities

Task 3.1: *Specification of future regional scenarios for local systems with high renewables* has determined six future scenarios for energy communities (ECs) depending on different parameters (regulation, feed-in tariffs, level of access to wholesale and flexibility markets, among others). These parameters set a background for the energy community evolution, which in turn will affect how ECs develop over time.

While not completely independent from each other, these future scenarios have a set of baseline characteristics that set them apart from each other and that facilitate the development of different use cases. The six future scenarios are:

- **1 - Generation Community:** Financial support for renewable energy sources (RES) is maintained leading to EC growth continuing as it has in previous growth phases.
- **2 - Local Optimization:** High retail prices makes maximizing self-consumption the most viable strategy for energy communities.
- **3 - Market Access:** Access to the electricity markets is facilitated for ECs, leading to greater community federation, an increase in the importance of aggregator services and the growth of energy community commercialization.
- **4 - DSO Flexibility:** Increased flexibility requirements due to high penetration of distributed energy resources (DERs) on the grid incentivizes using ECs as flexibility providers, focusing on grid balancing and energy storage.
- **5 - Sector Coupling:** Subsidies for photovoltaics (PV) are reduced or removed which leads ECs to adapt through the incorporation of strategies using emerging technologies (which are more

likely to be subsidized) and to seek efficiencies and commercial opportunities across energy vectors by adopting sector coupling.

- **6 - Legal and Regulatory Support:** Legal support for ECs is solidified, broadened and made more supportive, allowing ECs to perform a wider set of innovative actions leading to greater growth potential.

These future scenarios are not exclusive to each other. Facilitating the creation of energy communities is perfectly paired with ease of access to electricity markets; sector coupling pairs particularly well with increasing DSO flexibility; and local optimization with the increase of energy storage that, for example, electric vehicles provide with their batteries[9]. It could be argued that the best possible future for the development of ECs is a combination of the most suitable scenarios to the people and locality of each community as this will lead to a greater chance of ongoing success.

For the purpose of this contextualization of use cases in the context of GENTE parameters, these future scenarios are paired with use cases that best exploit either the development or the achieving of a particular scenario. The connections are included in Figure 6 and explained below (where color coding and line style are only meant to provide clarity in regards to visualizing connections).

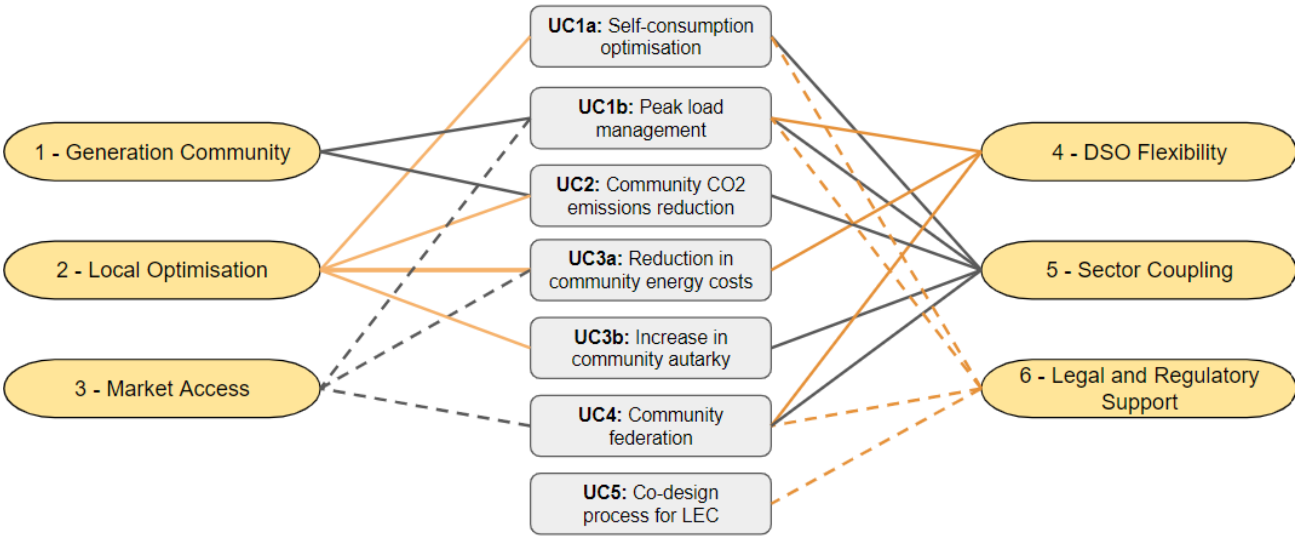


**Figure 6 - Relationship between future scenarios for energy communities and use cases**

- **1 - Generation Community:** Continuation of ECs "as is" will require increased penetration of UC1b: *Peak load management* techniques and technologies to overcome increased differences in day and night time generation levels[10]. This future scenario also implies UC2: *$CO_2$ emissions reduction* as one of the main concerns of participants and relevant authorities.

[9] C. Silva, P. Faria, R. Barreto, Z. Vale; Fair Management of Vehicle-to-Grid and Demand Response Programs in Local Energy Communities; IEEE Access, Volume 11, July 2023; 10.1109/ACCESS.2023.3299500

[10] G. M. Pitra, KS. Sastry Musti. "Duck curve with renewable energies and storage technologies." 2021 13th International conference on computational intelligence and communication networks (CICN). IEEE, 2021. Viewed at https://ieeexplore.ieee.org/document/9574671.

- **2 - Local Optimization:** A future scenario with high retail prices will incentivise ECs to develop UC1a: *Self-consumption optimization* and UC3b: *Community autarky* in an effort to promote UC3a: *Reduction in community energy costs*. UC2: *$CO_2$ emissions reduction* is also affected by this scenario as it is a core goal of the more locally-centric community types (as per Archetypes 1 and 2).

- **3 - Market Access:** Market access for ECs would mean an increase in benefits obtained from the regular operation of the available renewable asset, magnifying UC3a: *Reduction in community energy costs*. At the same time, combined efforts through UC4: *Community federation* would increase their market share and options of inter-community energy exchanges[11]. Access to flexibility markets also enables UC1b: *Peak load management* to become a more attractive revenue stream for ECs.

- **4 - DSO Flexibility:** The use of the flexibility from ECs incentivizes the development of UC1b: *Peak-load management* to increase the flexibility and stability of the grid. At the same time, the service provided to the DSO promotes UC3a: *Reduction in community energy costs*, as providing flexibility turns available flexible assets into a source of income for the community. UC4: *Community federation* is important to maximize the flexibility provided to the system.

- **5 - Sector Coupling:** This future scenario increases the means of an EC to use its resources efficiently[12]. This means the ability to perform UC1a: *Self-consumption optimization* efficiently and perform UC1b: *Peak-load management* using a combination of different technologies to increase consumption / renewable generation as required. Additionally, the combination of different energy sources and technologies promotes UC3b: *Community autarky* by reducing the situations in which the EC is subject to grid requirements (when sector coupling is applied through microgrids). The increased need to manage different energy vectors by UC4: *Community federation* makes this future scenario an ideal development case. Sector coupling also allows ECs to increase their contribution to the wider energy transition, amplifying the impact of UC2: *$CO_2$ emissions reduction*.

- **6 - Legal and Regulatory Support:** While better regulation and legal support facilitates the development of any GENTE use case, there are four use cases that benefit the most in this scenario. UC1a: *Self consumption optimization* mechanisms for ECs have been already addressed by direct regulation in countries like Switzerland[13], and UC1b: *Peak load management* services to the grid requires local / national laws to reflect the ability for smaller energy producers (ie ECs) to connect to the grid and supply/take energy as a paid service. Similarly, this future energy

[11] L. de Almeida, N. Kalusmann, H. Soest, V. Cappelli; Peer-to-Peer Trading and Energy Community in the Electricity Market - Analysing the Literature on Law and Regulation and Looking Ahead to Future Challenges . Robert Schuman Centre for Advanced Studies Research Paper. (March 2021) 10.2139/ssrn.3821689

[12] J. Gea-Bermúdez, I. Græsted, M. Münster, M. Koivisto, J. Gustav, Y. Chen, H. Ravn, The role of sector coupling in the green transition: A least-cost energy system development in Northern-central Europe towards 2050, Applied Energy, Volume 289, 2021, 10.1016/j.apenergy.2021.116685.

[13] P. Mehta, D. Griego, A. Nuñez-Jimenez, A. Schlueter. "The Impact of self-consumption regulation on individual and community solar PV adoption in Switzerland: An agent-based model", Journal of Physics: Conference Series 1343, 2019, https://doi.org/10.1088/1742-6596/1343/1/012143

system scenario is required to allow UC4: *Community federation* to flourish, which would increase the leverage of energy communities in the market and their breadth of revenue possibilities. This scenario also contributes to easing the implementation of UC5: *Co-design process for LEC*, potentially leading to the wider adoption of co-design processes for ECs.

# 2.6. Use case information summary tables

The following section summarizes the information previously gathered into comprehensible and condensed tables, one for each use case, in which the connections and correlations with other parts of GENTE are represented. Additionally, connection between different relevant aspects of the project will be provided through diagrams to facilitate understanding of the interactions involved. These diagrams represent both the necessities and the connections between different parts of the project and the use cases, as well as requirements and tests implemented in the demo sites obtained from Task 9.1: *Definition of test cases and assessment framework and KPIs for validation.*

## 2.6.1. UC1a: Self-consumption optimization

Table 12 collects all the most relevant aspects of UC1a and Figure 7 represents schematically the use case, including the involved exploitable results, need owners and objectives.

**Table 12 - GENTE Use Case 1a: Self-consumption optimization summary**

| UC1a: Self-consumption optimization | | |
|---|---|---|
| **Brief description** | Maximizing the benefits from the exploitation of an LEC's available renewable assets within the LEC itself | |
| **Level of technicality** | Technical | |
| **Objectives correlation** | **TO 1:** Develop and demonstrate scalable and intelligent assets<br>**TO 2:** Develop forecasting and optimization algorithms | |
| **Involved need owners** | DSO, LECs, manufacturers, technology providers, energy consultants, residential building owner, prosumers, consumers | |
| **Related exploitable results** (Key ERs in bold) | 1 - Forecasting heat (Data analytics) | 7 - Sub-metering device |
| | 2 - Data Driven Forecast | 8 - IoT BEMS including heat pumps |
| | 3 - PV optimization | 9 - LEC optimization |
| | **5 - GENTE toolkit** | 14 - Design, sizing and modeling tools |

| | | |
|---|---|---|
| | 6 - Data collection tools, submetering, IoT platform | **16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating** |
| **Archetypes** | **Archetype 1:** Community-led local optimization community<br>**Archetype 2:** Virtual community-led local optimization community<br>**Archetype 3** (weak)**:** Business-led service-focused community<br>**Archetype 4** (weak)**:** Virtual business-led service-focused community | |
| **Future scenarios** | **2:** Local Optimization<br>**5:** Sector Coupling<br>**6**: Legal and Regulatory Support | |
| **Demo sites involved** | **Swedish sites**:<br>- Alingsås<br>**Turkish sites**:<br>- TROYA | |

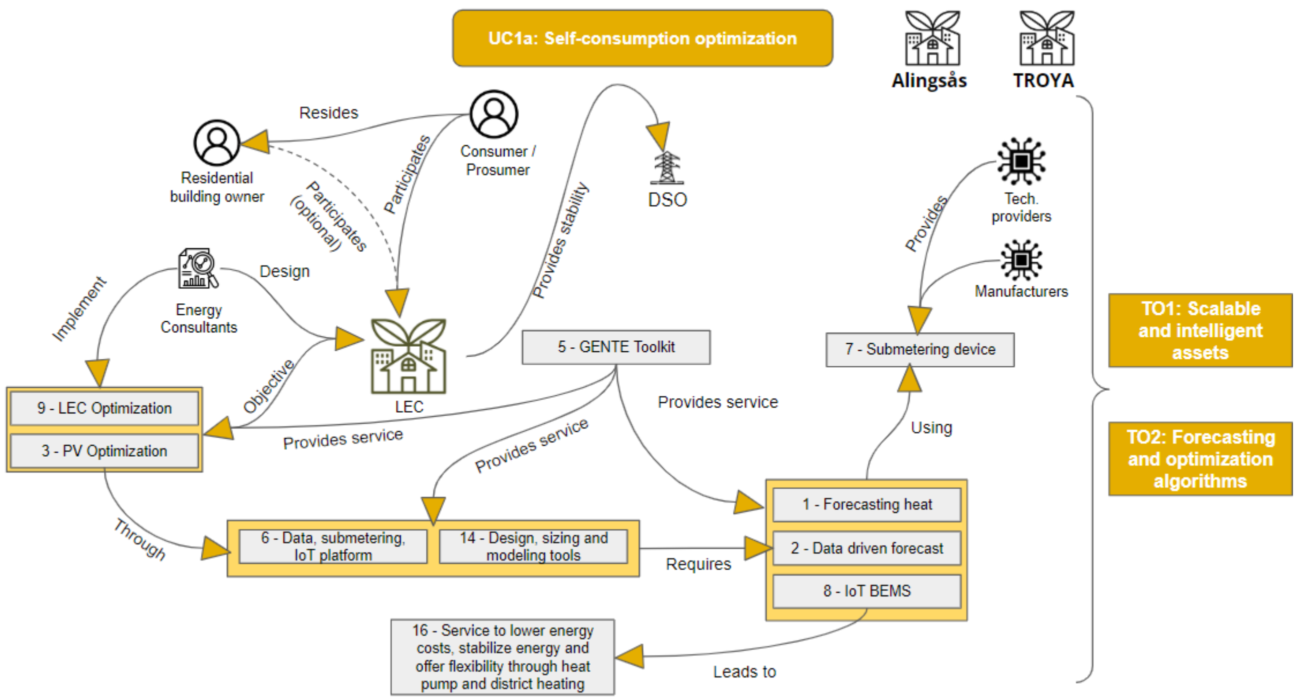


**Figure 7 - Use Case 1a: Self-consumption optimization diagram**

## 2.6.2. UC1b: Peak-load management

Table 13 compiles the most pertinent UC1b characteristics and Figure 8 depicts the use case, including the exploitable outcomes, need owners, and objectives.

**Table 13 - GENTE Use Case 1b: Peak-load management summary**

<table>
<tr><th colspan="3">UC1b: Peak-load management</th></tr>
<tr><td>Brief description</td><td colspan="2">Shifting of grid requirements in a system with the objective of avoiding large upwards and downwards shifts in energy requirements</td></tr>
<tr><td>Level of technicality</td><td colspan="2">Technical</td></tr>
<tr><td>Objectives correlation</td><td colspan="2">TO 2: Develop forecasting and optimization algorithms<br>TO 3: DLT-based framework for energy traceability and community identity</td></tr>
<tr><td>Involved need owners</td><td colspan="2">ESO, DSO, LEC, aggregator, residential building owner, smart grid operator, energy consultant, prosumers, consumers, manufacturers, technology providers</td></tr>
<tr><td rowspan="8">Related exploitable results<br>(Key ERs in bold)</td><td>1 - Forecasting heat (Data analytics)</td><td>10 - DLT-based prosumer platform</td></tr>
<tr><td>2 - Data Driven Forecast</td><td>11 - DLT-based community manager platform</td></tr>
<tr><td>3 - PV optimization</td><td>12 - Communication between gateway and devices</td></tr>
<tr><td>5 - GENTE toolkit</td><td>13 - Edge computation in IoT gateway</td></tr>
<tr><td>6 - Data collection tools, submetering, IoT platform</td><td>15 - Guidelines for community engagement</td></tr>
<tr><td>7 - Sub-metering device</td><td>16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating</td></tr>
<tr><td>8 - IoT BEMS including heat pumps</td><td>17 - Business models for communities, federation managers and aggregators</td></tr>
<tr><td>9 - LEC optimization</td><td></td></tr>
<tr><td>Archetypes</td><td colspan="2">Archetype 3: Business-led service-focused community<br>Archetype 4: Virtual business-led service-focused community</td></tr>
<tr><td>Future scenarios</td><td colspan="2">1: Generation Community<br>3: Market Access<br>4: DSO Flexibility<br>5: Sector Coupling<br>6: Legal and Regulatory Support</td></tr>
</table>

| Demo sites involved | **Swiss sites**:<br>- Am Aawasser<br>**Swedish sites**:<br>- Alingsås<br>**Turkish sites**:<br>- TROYA |
|---|---|

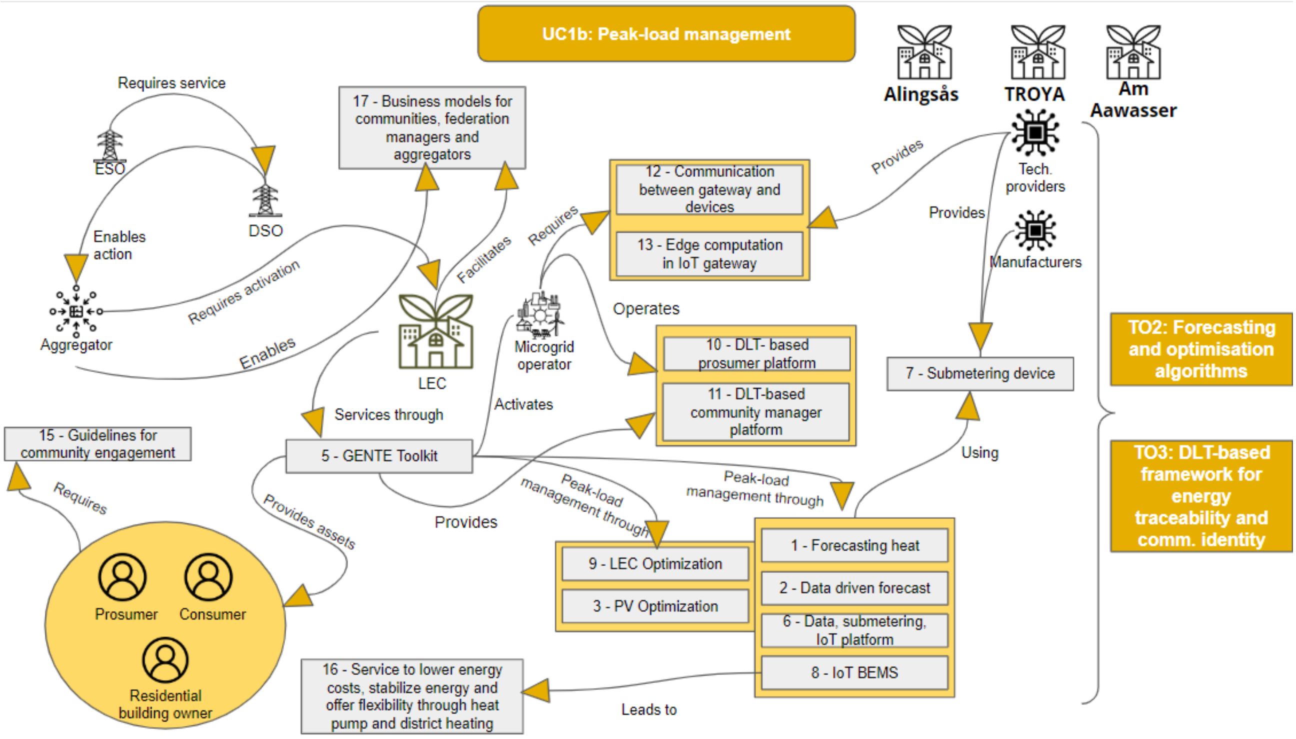


**Figure 8 - Use Case 1b: Peak-load management diagram**

## 2.6.3. UC2: $CO_2$ emission reduction

Table 14 enumerates the most pertinent aspects of UC2. Figure 9 is a schematic representation of the use case, including the exploitable outcomes, need owners, and objectives.

**Table 14 - GENTE Use Case 2: $CO_2$ emissions reduction summary**

| UC2: $CO_2$ emission reduction | |
|---|---|
| **Brief description** | Reduction of greenhouse gas emissions related to the operation of an LEC, either by increased renewable energy integration, self-consumption optimization or a reduction in consumption patterns |
| **Level of technicality** | Mixed technical + non-technical |

| | | |
|---|---|---|
| **Objectives correlation** | **TO 1:** Develop and demonstrate scalable and intelligent assets<br>**TO 2:** Develop forecasting and optimization algorithms<br>**NTO 2:** Accelerate LEC implementation across Europe | |
| **Involved need owners** | LECs, prosumers, municipalities, NGOs, technology providers, manufacturers, advocacy groups | |
| **Related exploitable results**<br>(Key ERs in bold) | 1 - Forecasting heat (Data analytics) | 7 - Sub-metering device |
| | 2 - Data Driven Forecast | 8 - IoT BEMS including heat pumps |
| | 3 - PV optimization | 9 - LEC Optimization |
| | 4 - Digital twin for the LEC | 14 - Design, sizing and modeling tools |
| | **5 - GENTE toolkit** | **16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating** |
| **Archetypes** | **Archetype 1:** Community-led local optimization community<br>**Archetype 2:** Virtual community-led local optimization community | |
| **Future scenarios** | **1:** Generation Community<br>**2:** Local Optimization<br>**5:** Sector Coupling | |
| **Demo sites involved** | **Swiss sites**:<br>- Am Aawasser<br>**Swedish sites**:<br>- HSB Living Lab<br>- Alingsås<br>**Turkish sites**:<br>- TROYA | |

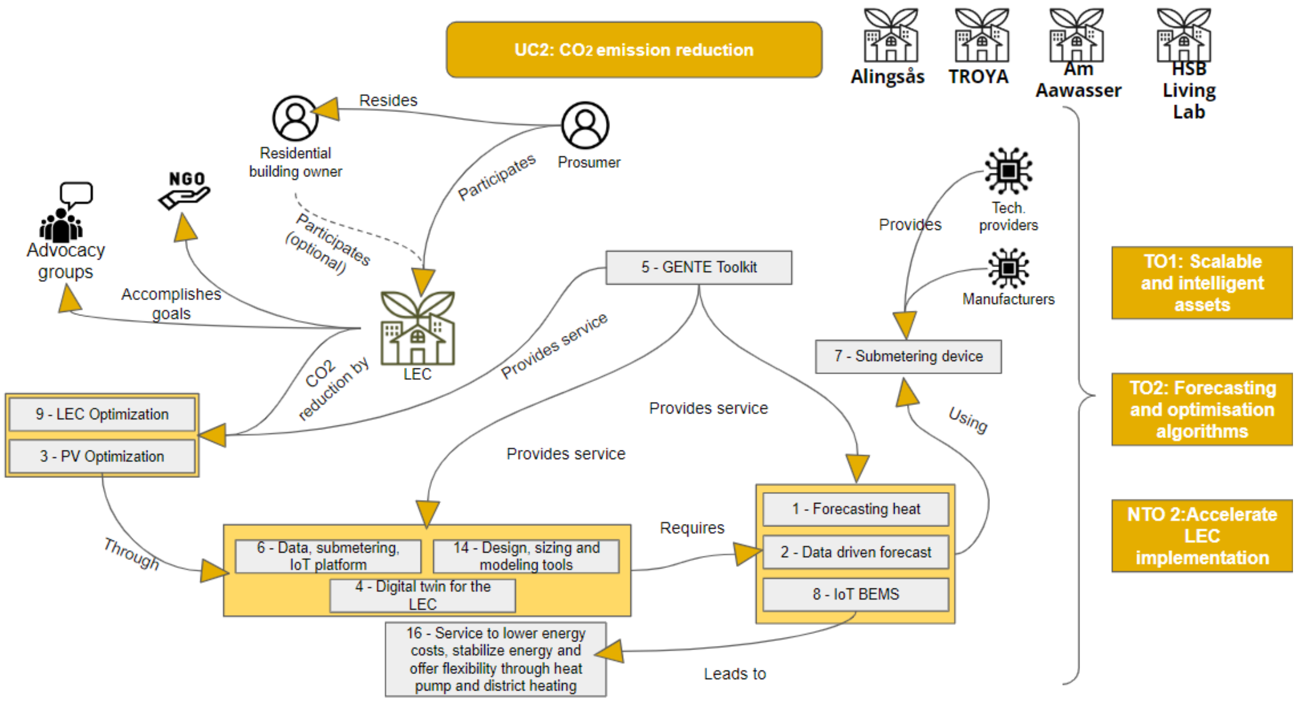


**Figure 9 - Use Case 2: $CO_2$ emissions reduction diagram**

## 2.6.4. UC3a: Reduction in community energy cost

Table 15 summarizes the most relevant aspects of UC3a, and Figure 10 represents the use case, including the related exploitable outcomes, need owners, and objectives.

**Table 15 - GENTE Use Case 3a: Reduction in community energy cost summary**

| UC3a: Reduction in community energy costs | |
|---|---|
| **Brief description** | Reduction in the financial requirements to operate the energy community by reducing grid consumption, increasing renewable energy use and participating in other grid services, if possible. |
| **Level of technicality** | Mixed technical + non-technical |
| **Objectives correlation** | **TO 1:** Develop and demonstrate scalable and intelligent assets<br>**TO 2:** Develop forecasting and optimization algorithms<br>**NTO 1:** Accelerate economic viability of LECs |
| **Involved need owners** | LECs, prosumers, residential building owners, manufacturers, technology providers, municipalities |

| | | |
|---|---|---|
| **Related exploitable results** (Key ERs in bold) | 1 - Forecasting heat (Data analytics) | 7 - Sub-metering device |
| | 2 - Data Driven Forecast | 8 - IoT BEMS including heat pumps |
| | 3 - PV optimization | 9 - LEC optimization |
| | 4 - Digital twin for the LEC | **16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating** |
| | **5 - GENTE toolkit** | 17 - Business models for communities, federation managers and aggregators |
| **Archetypes** | **Archetype 1:** Community-led local optimization community<br>**Archetype 2:** Virtual community-led local optimization community<br>**Archetype 3:** Business-led service-focused community<br>**Archetype 4:** Virtual business-led service-focused community | |
| **Future scenarios** | **2:** Local Optimization<br>**3:** Market Access<br>**4:** DSO Flexibility | |
| **Demo sites involved** | **Swedish sites**:<br>- HSB Living Lab<br>- Alingsås | |

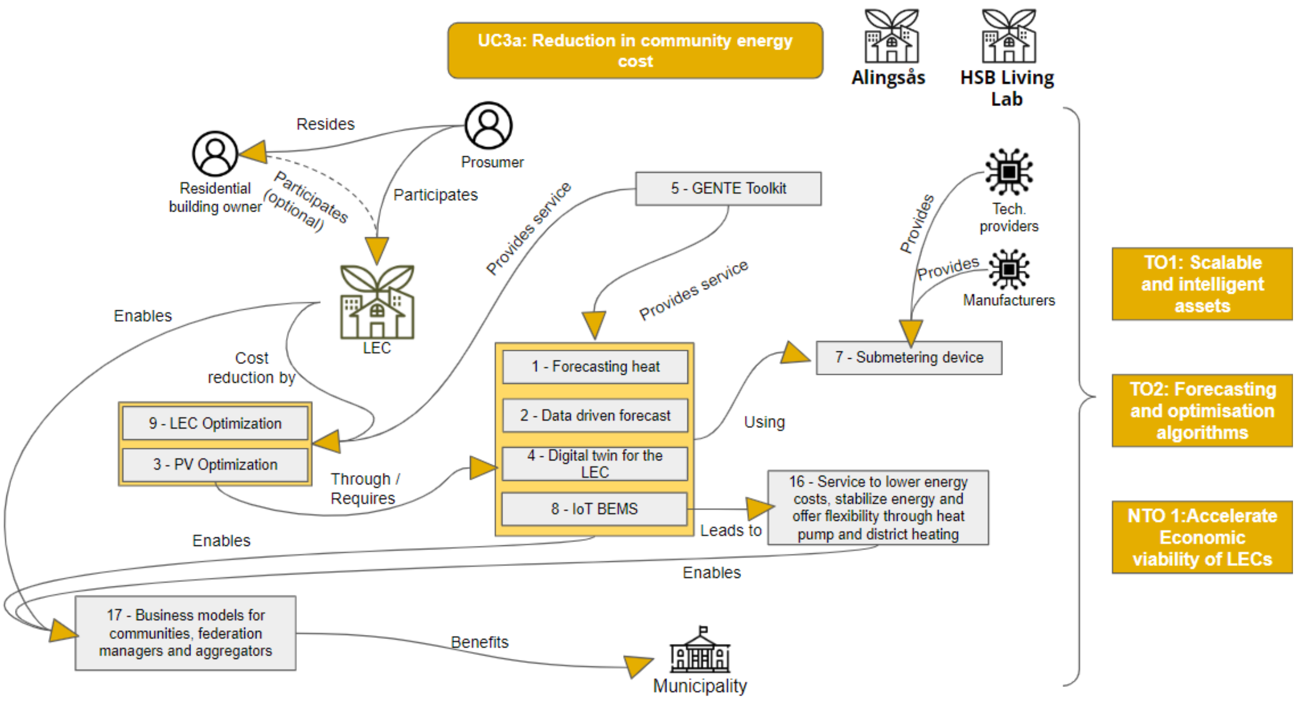


**Figure 10 - Use Case 3a: Reduction in community energy costs diagram**

## 2.6.5. UC3b: Increase in community autarky

Table 16 is a compilation of all of the most pertinent parts of UC3b, and Figure 11 is a schematic representation of the use case that includes the related exploitable results, need owners, and objectives.

**Table 16 - GENTE Use Case 3b: Increase in community autarky summary**

| UC3b: Increase in community autarky | | |
|---|---|---|
| **Brief description** | Refers to the increased independence from the general grid that an LEC can achieve by increasing renewable energy generation and reducing and accommodating community consumption to generation patterns. | |
| **Level of technicality** | Mixed technical + non-technical | |
| **Objectives correlation** | **TO 3:** DLT-based framework for energy traceability and community identity<br>**NTO 1:** Accelerate economic viability of LECs<br>**NTO 3:** Promote engagement in LECs<br>**NTO 4:** Define and incorporate need owner requirements | |
| **Involved need owners** | ESO, DSO, technology providers, manufacturers, LECs, NGOs, regulatory authorities, consumers, prosumers, advocacy groups | |
| **Related exploitable results**<br>(Key ERs in bold) | 1 - Forecasting heat (Data analytics) | 8 - IoT BEMS including heat pumps |
| | 2 - Data Driven Forecast | 9 - LEC optimization |
| | 3 - PV optimization | 15 - Guidelines for community engagement |
| | **5 - GENTE toolkit** | **16 - Service to lower energy costs, contribute to a more stable energy system and offer the utility provider more flexibility by the use of Heat Pump and District Heating** |
| | 6 - Data collection tools, submetering, IoT platform | 17 - Business models for communities, federation managers and aggregators |
| | 7 - Sub-metering device | |
| **Archetypes** | **Archetype 1:** Community-led local optimization community | |
| **Future scenarios** | **2:** Local Optimization<br>**5:** Sector Coupling | |

| | |
|---|---|
| **Demo sites involved** | **Swiss sites**:<br>- Am Aawasser<br>**Swedish sites**:<br>- HSB Living Lab<br>**Turkish sites**:<br>- TROYA |

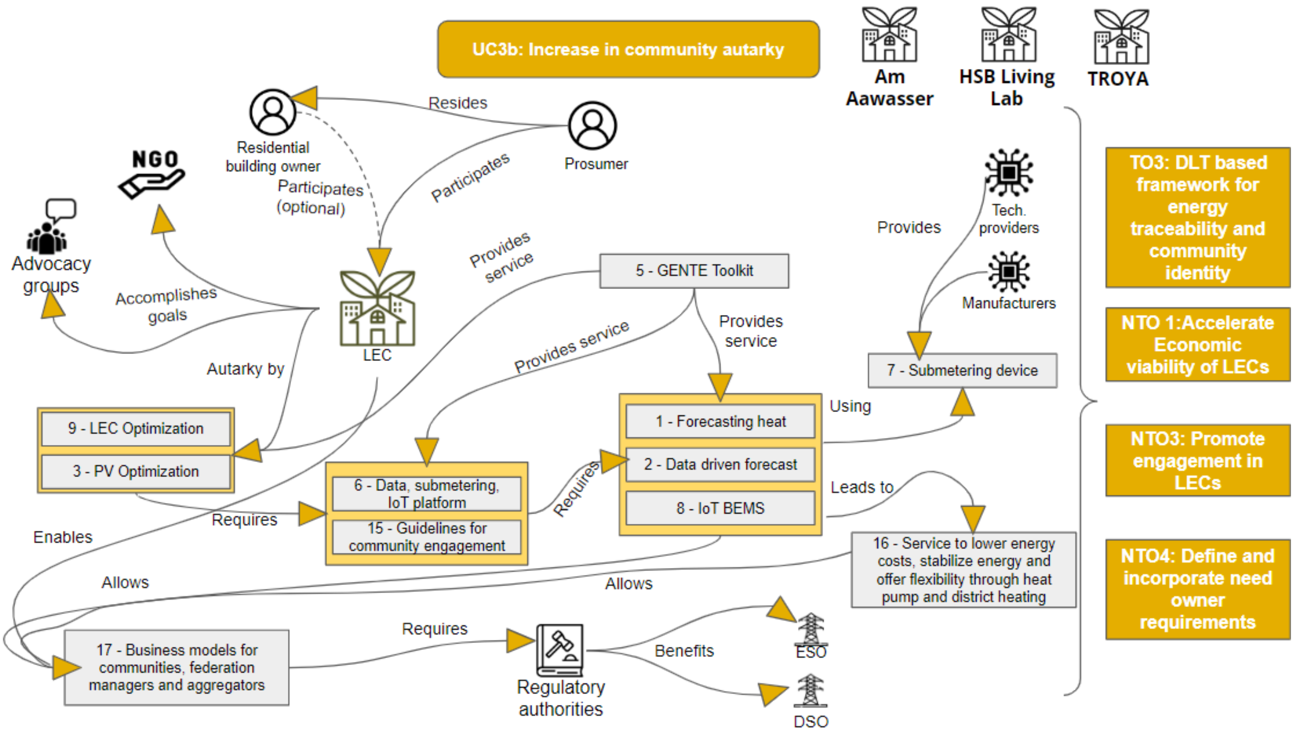


**Figure 11 - Use Case 3b: Increase in community autarky diagram**

## 2.6.6. UC4: Community federation

The most relevant information of UC4 that was analyzed during the deliverable is presented in Table 17, together with a scheme in Figure 12.

**Table 17 - GENTE Use Case 4: Community federation summary**

| **UC4: Community federation** | |
|---|---|
| **Brief description** | Facilitate federation between LECs that can accelerate the energy transition and allow for a more optimized management of resources. |
| **Level of technicality** | Mixed technical + non-technical |

<table>
<tr><td>Objectives correlation</td><td colspan="2">TO 3: DLT-based framework for energy traceability and community identity<br>TO 4: Community platform<br>NTO 1: Accelerate economic viability of LECs<br>NTO 2: Accelerate LEC implementation across Europe<br>NTO 3: Promote engagement in LECs</td></tr>
<tr><td>Involved need owners</td><td colspan="2">LECs, energy cooperatives, ESO, DSO, aggregators, financial institutions, regulatory authorities</td></tr>
<tr><td rowspan="4">Related exploitable results<br>(Key ERs in bold)</td><td>6 - Data collection tools, submetering, IoT platform</td><td>14 - Design, sizing and modeling tools</td></tr>
<tr><td>7 - Sub-metering device</td><td>15 - Guidelines for community engagement</td></tr>
<tr><td>12 - Communication between gateway and devices</td><td>17 - Business models for communities, federation managers and aggregators</td></tr>
<tr><td>13 - Edge computation in IoT gateway</td><td></td></tr>
<tr><td>Archetypes</td><td colspan="2">Archetype 1 (weak): Community-led local optimization community<br>Archetype 2 (weak) : Virtual community-led local optimization community<br>Archetype 3: Business-led service-focused community<br>Archetype 4: Virtual business-led service-focused community</td></tr>
<tr><td>Future scenarios</td><td colspan="2">3: Market Access<br>4: DSO Flexibility<br>5: Sector Coupling<br>6: Legal and Regulatory Support</td></tr>
<tr><td>Demo sites involved</td><td colspan="2">No direct connections with demo sites</td></tr>
</table>

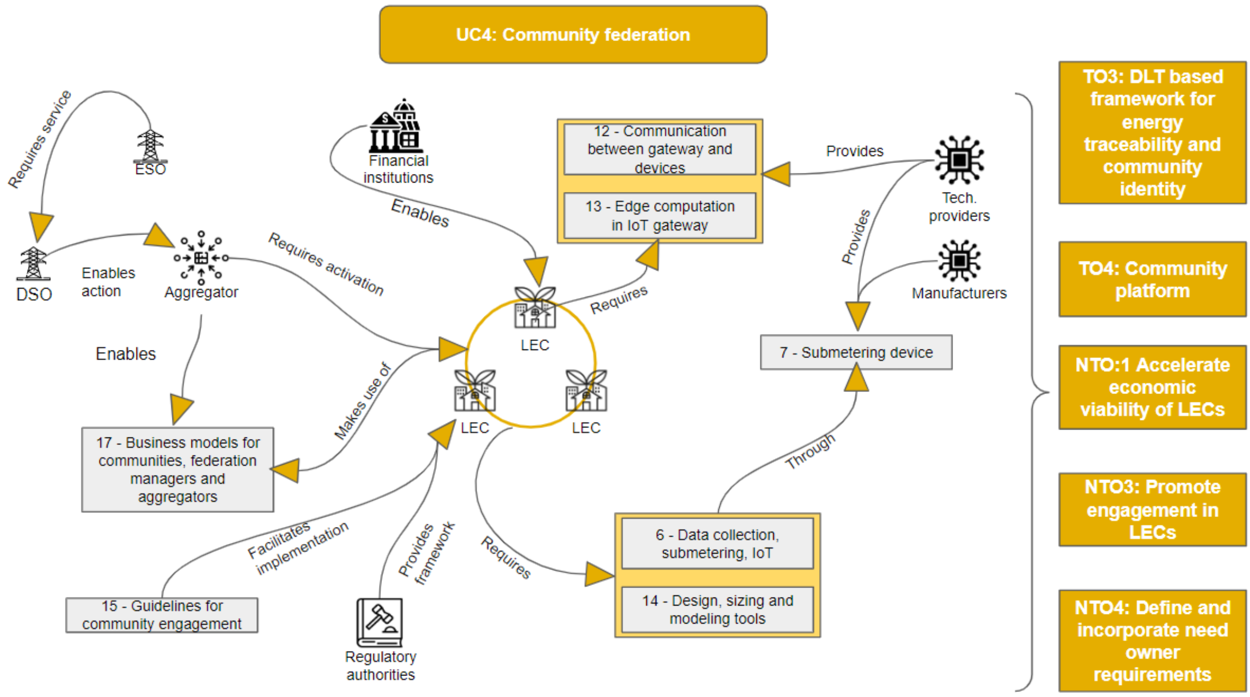


**Figure 12 - Use Case 4: Community federation diagram**

## 2.6.7. UC5: Co-design process for LEC

Table 18 summarizes all the characteristics of the UC5 of the co-design process, which is schematically represented in Figure 13.

**Table 18 - GENTE Use Case 5: Co-design process for LEC summary**

| UC5: Co-design process for LEC | |
|---|---|
| **Brief description** | GENTE intends to assess a process to increase need owner participation in the development of energy communities. Aimed mainly at tennants, the process' objective is to help to guide in the creation and management of an LEC, not only in social aspects but also in technological implementations. |
| **Level of technicality** | Mixed technical + non-technical |
| **Objectives correlation** | **TO 4:** Community platform<br>**NTO 3:** Promote engagement in LECs<br>**NTO 4:** Define and incorporate need owner requirements |
| **Involved need owners** | LECs, regulatory authorities, research institutions, energy consultants, consumers, prosumers, residential building owners, municipalities |

| | |
|---|---|
| **Related exploitable results**<br>(Key ERs in bold) | 4 - Digital twin for the LEC<br>15 - Guidelines for community engagement<br>17 - Business models for communities, federation managers and aggregators |
| **Archetypes** | **Archetype 1:** Community-led local optimization community<br>**Archetype 2:** Virtual community-led local optimization community |
| **Future scenarios** | **6:** Legal and Regulatory Support |
| **Demo sites involved** | **Swiss sites**:<br>- To be confirmed |

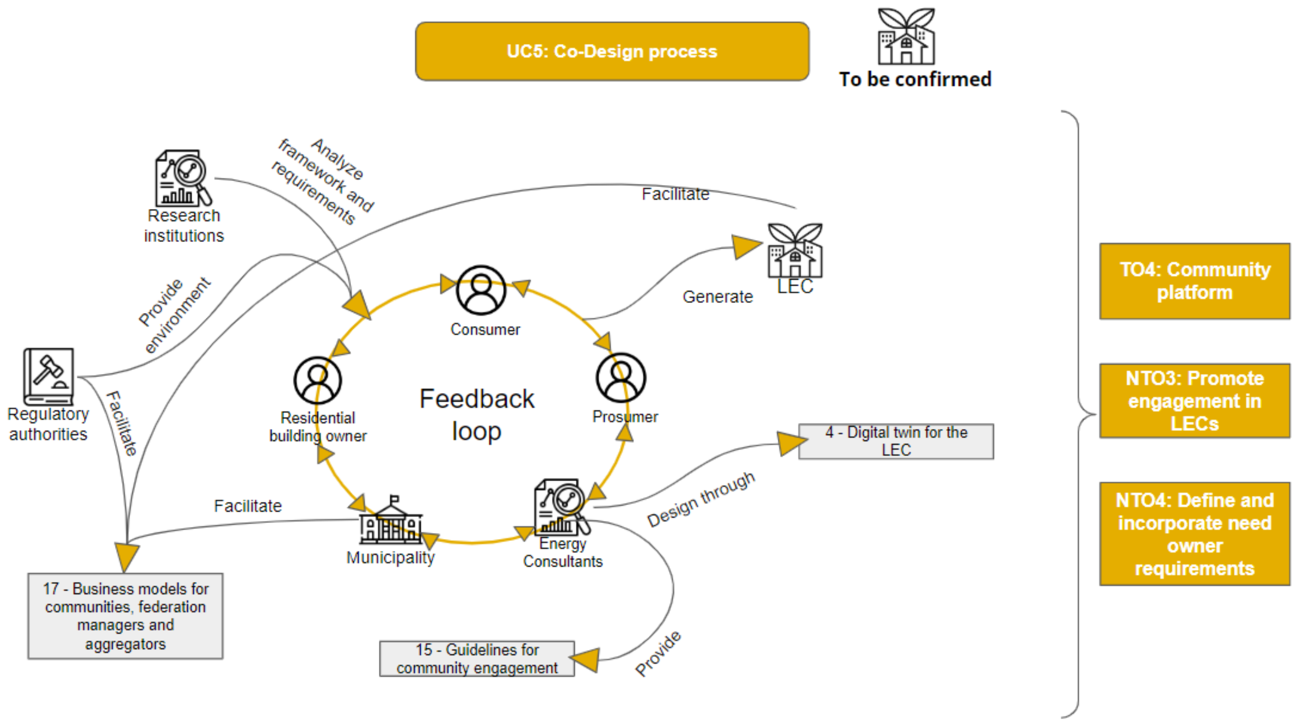


**Figure 13 - Use Case 5: Co-design process diagram**

# 3. Conclusions

This document provides the basic definition for the main use cases applied during the GENTE project and the connections with all relevant aspects of the project. This includes the defined need owners, correlation with technical and non-technical GENTE objectives, the range of exploitable results and the key exploitable results  achieved through the operation of the use cases, the importance of each energy community archetype and the relevance of future energy community scenarios to the use cases.

There are complex interactions between all elements of the project, as well as several use cases closely related to each other through the elements involved in their operation and success. In fact, most use cases would not exist without one another. UC1a: *Self-consumption optimization* and UC3a: *Reduction in community energy cost*, while not following the same principles entirely, are typically achieved through the same means, namely reducing grid energy consumption and increasing renewable energy generation. Adapting both consumption and production curves to follow the same patterns (achieved through UC1b: *Peak load management*) enables reducing emissions throughout the process (UC2: *$CO_2$ emission reduction*) and can lead to a higher independence from the outside grid system (UC3b: *Increase in community autarky*) if desired.

These complex interactions show that the environment in which energy communities develop is very fluid, depending on specific requirements to be pushed, accomplished or accommodated. It is uncertain whether future legislation will allow ECs to adapt into pursuing the GENTE-specific set of use cases, whether some will have to be modified or dropped during the process of GENTE, or if a new set of characteristics will be implemented bringing new use cases to the spotlight.

GENTE is prepared to utilize its demo sites, toolkit and solutions to facilitate the implementation of the use cases defined in this report, having the knowledge and full picture of the elements that are combined to make it possible not only now but in the future.

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