# D3.2 LOCAL ENERGY COMMUNITY ARCHITECTURE DESCRIPTION

VERSION 1.0

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ERA-Net Smart Energy Systems

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Co-creating with partners that help to understand the needs of relevant stakeholders, we team up with intermediaries to provide an innovation eco-system supporting consortia for research, innovation, technical development, piloting and demonstration activities. These co-operations pave the way towards implementation in real-life environments and market introduction.

Beyond that, ERA-Net SES provides a Knowledge Community, involving key demo projects and experts from all over Europe, to facilitate learning between projects and programs from the local level up to the European level.

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| | |
|---|---|
| SGAM | Smart Grid Architecture Model |
| NIST | National Institute of Standards and Technology |
| NIST LRM | NIST Logical Reference Model |
| LECs | Local Energy Communities |
| ICT | Information and Communication Technology |
| CLUE | Concepts, Planning, Demonstration and Replication of Local User-friendly Energy Communities |

# EXECUTIVE SUMMARY

The energy systems landscape is continuously evolving, and over the past decades has seen an acceleration in clean energy alternatives. With the rise in renewable energy and smart electricity grid initiatives, the future energy systems landscape must now be transformed from the traditional methods of generating, transmitting, and distributing electricity.

Local Energy Communities (LECs) will be an essential element of this future energy system and are a concept of enabling communities to be directly involved in the decision-making of how local energy generation, demand and distribution is used within their environment.

Despite efforts to date on LEC's, there are no established tools to manage the system operation across a range of different environments and the development and utilisation of such tools is essential in progressing the establishment of LEC's as part of the future energy system. The ERA Net project CLUE (Concepts, Planning, Demonstration and Replication of Local User-friendly Energy Communities) sets out to acquire knowledge of building such tools on optimized design, planning and operation of Local Energy Communities (LECs). This is executed by leading European research institutes, industry, and local partners, working together in five demo sites in four countries (Austria, Sweden, Germany, and Scotland).

In this deliverable, we have explored two aspects which are required in enabling future interactions in LEC's and the surrounding energy system:

- The development of a local energy community reference ICT architecture (CLUE reference architecture)
- The understanding of the role of stakeholders within local energy communities

In the development of the CLUE reference architecture, we conducted a series of workshops to analyse and understand the required framework for future LEC concepts. This was done through cross collaboration with partners.

A reference architecture based on international standards was developed to provide a common foundation for the CLUE use cases across the different demonstration sites in the project. In order to achieve this, certain steps were taken.

First, a mission statement for the project was derived from the workshops. These statements focused on achieving the high-level objectives of local energy sharing, local grid security, local market/regulation and stakeholder harmonisation.

Next, an architecture methodology was developed. This was done by first understanding the system requirements and then building this on the sound foundations of the NIST Logical Reference Model and the SGAM model. The methodology consisted of two phases: the context identification phase; and the characterisation and goals phase. The context identification phase is the most

critical step of the methodology that identifies and determines the solution for the environment where the system will be working and interacting. This identified the relevant domains within the CLUE project from the NIST Smart Grid Conceptual model and identified relevant actors from the NIST Smart Grid actors (NISTIR 7628). Once the domains had been identified, the characterisation and goals phase classified each of the actors (in NISTIR 7628) according to their roles in SGAM.

Finally, the CLUE reference architecture was developed. This was done through a detailed study conducted through a series of workshops with partners to first identify the context and later extract the requirements for a use case definition. There were five domains identified that were relevant to the solution in the CLUE project (customers, distribution, operations, service providers, and market). Two domains, transmission and generation including distributed energy resources (DER), were identified as not relevant during the analysis. The actors within these domains were further analysed and categorised based on: if they were relevant within the CLUE project: if they were primary secondary or supporting actors: and their ICT and electrical flows.

In understanding the wider role of stakeholders in the energy community, it was necessary to develop a good overview of the relevant stakeholders and a comprehensive understanding of which stakeholders are most crucial in establishing the future of LEC's. A regional stakeholder mapping exercise using the PESTLE analysis was conducted to explore stakeholders based on their political, economic, social, technical, legal and environmental (PESTLE) interests, their awareness of LEC's and if their existing roles need to be strengthened.

In **Austria**, the municipality of Gasen and the region of Southern Burgenland were analysed. In Southern Burgenland, 48 stakeholders were identified with their roles mostly economic (40%), with political (21%) and technological (13%) stakeholders. Most of the stakeholders had a role in a specific sector, district, or area (69%) and some stakeholder roles have to be strengthened (23%); these are the governance stakeholders, the social stakeholders and two technological stakeholders. In Gasen, 25 stakeholders in total were identified with their roles mostly social (60%), economic (16%) and legal (12%) stakeholders. Most of the stakeholders are already aware and active (56%), 32% of the stakeholder roles should be strengthened and there were no stakeholders who are required but not yet active.

In **Sweden**, there were a total of 16 stakeholders identified with their roles mostly technological/energy stakeholders (37%) and spatial-economic stakeholders (25%). The highest number of stakeholders in Sweden have a role in a specific sector and/or in a specific district/area (56%) and have a role on the entire city level/considering large scale or impact (31%).

In **Germany**, a total of 10 stakeholders were identified with the social stakeholders (media and tenants) having a key role in Herne-Shamrockpark. The stakeholders of Germany have different roles, which are mostly technological (33%), social (17%) and other (17%). The findings from the stakeholder mapping is that all the stakeholders in Herne-Shamrockpark are already aware and active.

In **Scotland**, a total of 48 stakeholders were identified with the social stakeholders having a key role. The stakeholders of Scotland hold different roles, who are mostly economic (38%), technological (33%), social (11%) and legal (10%) stakeholders. The role analysis of Scotland shows that most of the stakeholder roles (31%) have to be strengthened. 13 of total 48 stakeholders are already aware and active, and a quarter of the stakeholders are required but not yet active. All in all, about 50% of the Scottish stakeholders have to be strengthened in more than one role.

The regional stakeholder analysis showed that the main role of the stakeholders in each country is different. In all cases social and technological stakeholders are strongly represented and social stakeholders are mainly the "driving" stakeholders, which illustrates their importance in the CLUE project. Most of the stakeholders were shown to be already aware and active, which shows high ambitions of the stakeholders in each country within the CLUE project. Only in the Scottish case, some stakeholders (25%) are required but not yet active. This illustrates that the topic of energy communities still needs further awareness raising and mobilisation of stakeholders.

# 1 INTRODUCTION

Local Energy Communities (LECs) as mentioned in the Clean Energy for All European package of the European Commission will become an important pillar of the new energy system architecture. Until now, LEC planners have not had the sufficient tools to design LEC energy systems and these tools are required to identify the optimal operation of LECs in order to realize their inherent benefits for communities.

The ERA-Net project CLUE (*Concepts, Planning, Demonstration and Replication of Local User-friendly Energy Communities)* was set up to progress the development of these tools for successful replication and upscaling of LECs and aims to acquire knowledge on optimal design, planning and operation.

The project consortium consists of leading European research institutes, industry, and local partners, working together to progress the agenda of local energy communities through cross-country analysis and by validating meaningful proof-of-concepts through pilot demonstration projects. There are five demo sites within the project, two in Austria and three others in Sweden, Germany, and Scotland) working on different technological and market solutions for their respective countries.

The objectives and goals of the project are;

1) To learn from the range of different challenges, prerequisites, and approaches of developing local energy communities (LECs) understanding the potential and flexibilities across the five demonstration sites, their integration into ICT architecture, and the interaction with surrounding energy systems.

2) To develop and validate tools supporting the creation and operation of sustainable local energy systems and to close the gap of missing tools, considering sector coupling, flexibilities, local and coordinating cloud functionalities.

3) To derive tailor-made transition paths for selected groups of LECs through stakeholder interaction in workshops to identify relevant drivers, success factors, and barriers.

This deliverable addresses the areas of developing a reference ICT architecture and understanding the roles of stakeholders within LEC's. This is looks at:

- The development of a reference ICT architecture through a study of grid organisation concepts and concepts for flexible interaction.
- The analysis of CLUE stakeholders within LEC's with relation to understanding the current state of their roles and suggest where these can be improved.

Section 2 details the development of the CLUE reference ICT architecture for the project based on a framework that consolidates the NIST Logical Reference Model (NIST LRM) and Smart Grid Architecture Model (SGAM).

Section 3 shows a stakeholder analysis conducted using the PESTLE methodology to the CLUE explore stakeholders based on their political, economic, social, technical, legal and environmental (PESTLE) interests, their awareness of LEC's and state of their existing in LECs.

## 1.1 Definitions

Use case: A use case defines the relations between the components and users and their interaction within a system to attain particular goals, primarily from a technical/energy (and not from a commercial) perspective.

Actors: NISTIR 7628 Guidelines for Smart Grid Cyber Security is another well-known standard from the NIST. In addition to providing the detailed cyber security mapping and recommendation with the Smart Grid, this standard also provides a list of actors in each of the NIST domains. (See Appendix)

Context: is defined as the environment where the system will be working and interacting. The environment can consist of individuals, systems, sub-systems, processes, documents, etc.

Stakeholders: individuals, groups or organizations that are involved, concerned or affected by the actions or decisions made within the use case. This comprises not only the members (both prosumers and consumers) of the community, but also further parties as the local DSO, energy suppliers, local authorities, municipalities and companies. In the context of business model development for EC, primary stakeholders are all parties for whom value should be created to ensure economic sustainability.

# 2 REFERENCE ARCHITECTURE

A common definition of use cases and business models and the characterisation of the demo sites for the CLUE project have been provided in the previous deliverable No D3.1[1]. This section builds upon previous work in developing a reference architecture.

A reference architecture based on international standards is established to provide a common foundation for the CLUE use cases throughout the project's involved countries and regions. The CLUE reference architectural definition aids in the development of a shared understanding as well as the enhancement of communication with a shared set of actors and interfaces. This will make it easier, for example, to compare the various pilot use cases and identify commonalities and differences.

The mission statement for the project directs the identification of the context[2], the selection of the actors, and their goals. The mission statement is created from the project proposal's inputs and then refined during the consortium's numerous architecture workshops. The following is the finalized mission statement:

*"Generation and consumption of energy, mostly from renewable energy resources, as locally as possible."*

Based on the mission statements above, this is focused on achieving the high-level objectives including:

| S# | Area/Focus | Objective |
|---|---|---|
| **R1** | Local energy sharing | Local loads should be satisfied using local generation |
| **R2** | Local grid security | Specifically using smart grid/control/monitoring to optimally control the grid to eliminate the need for grid reinforcement |
| **R3** | Local market/regulation | Regulations related to all actors involved in the energy community |

[1] D 3.1: High Level Description of Use Cases and Business Models Link

[2] Context is defined as the environment where the system will be working and interacting. The environment can consist of individuals, systems, sub-systems, processes, documents, etc.

| | | |
|---|---|---|
| **R4** | Stakeholder harmonization | Identifying and taking into consideration all the stakeholders when designing and implementing strategies for local energy communities in respective regions and countries |

Numerous European and international Smart Grid roadmaps and reference models give a systematic way to analysing the criteria for defining the boundaries of a solution. Using such standards has the advantage of having a common vocabulary that can enhance communication. NIST Framework and Roadmap for Smart Grid Interoperability Standards 4.0, NISTIR7628 also known as NIST Logical Reference Model (NIST LRM), and Smart Grid Architectural Model (SGAM) are among the standards used for defining a reference architecture for CLUE. Below is a brief description of each of these standards.

## 2.1 NIST Framework and Roadmap for Smart Grid Interoperability Standards 4.0

The NIST Framework and Roadmap for Smart Grid Interoperability Standards [1], Release 4.0, is a comprehensive standard that covers various Smart Grid roadmaps and guidelines. It provides, for example, interoperability suggestions/guidelines as well as a cybersecurity solution for minimizing threats and allowing communication. This is the newest standard released in 2021 as a continuation of the previous such standards including the widely used and accepted Release 3.0 released in 2010.

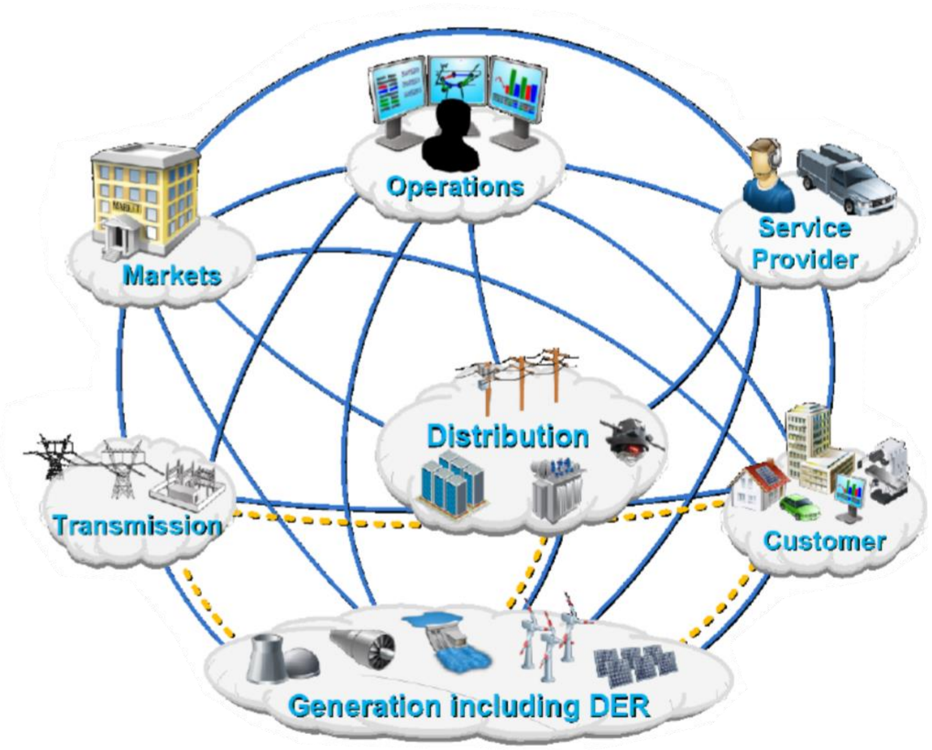


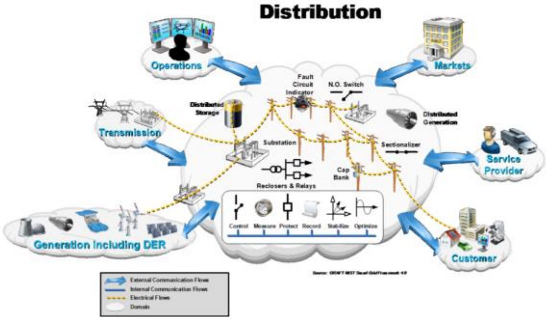

Figure 2-1: NIST Smart Grid Conceptual Model [1]

A variety of models were also covered in this standard. One of these is the Smart Grid Conceptual Model. An overview of this conceptual model is presented in Figure 2-1.

The general structure and implementations of electric grid networks are depicted in this model. This approach is designed to provide a high level of abstraction, providing for a comprehensive view of the Smart Grid. In terms of having a shared interpretation that can be understood, a high-level view like this is often advantageous.

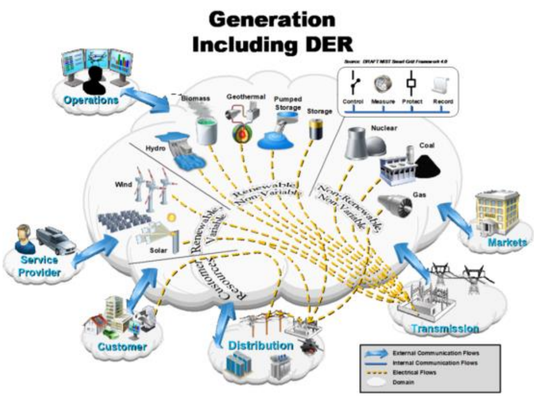
As can be seen, this model provides a high-level view of the whole Smart Grid spectrum dividing it into seven major domains. These domains include:

### 2.1.1 Distribution Domain



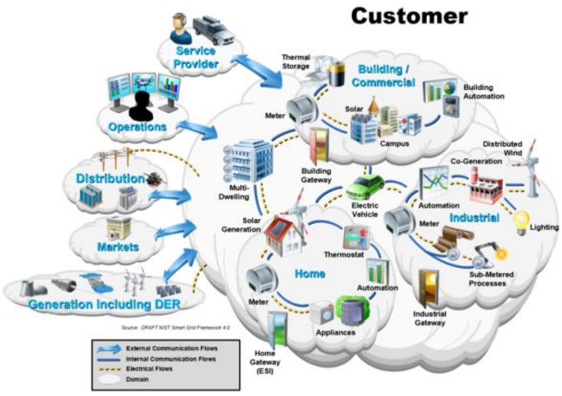

As per the standard, this domain represents the entities that supply and receive electricity from consumers. Some of these entities may be able to store and/or generate electricity as well.

### 2.1.2 Generation including DER Domain




As per the standard, the traditional generation sources, as well as distributed energy resources, are represented by this domain. In general, these sources refer to electricity producers who may also store energy for later distribution. On a logical level, generation refers to larger-scale technologies that are typically connected to the transmission grid, such as classical thermal power, large-scale hydropower, and utility-scale renewable projects. In the customer and distribution sectors, DER is linked to generating, storage, and demand response.

### 2.1.3 Customer Domain

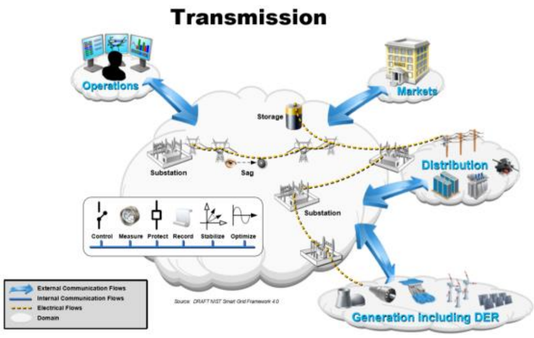



As per the standard, the Customers/consumers of energy are represented by this domain. These consumers can generate, store, and manage energy. Residential, commercial, and industrial customers have historically been separated into three categories, each with its sub-domains.

### 2.1.4 Service Provider Domain

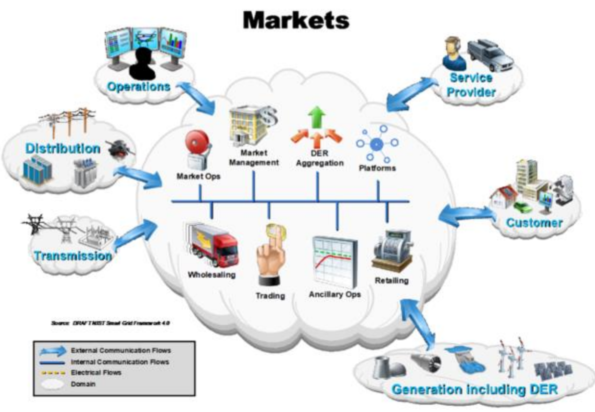

As per the standards, this domain represents the companies/organizations/entities that provide services to electricity consumers, utilities, and/or customers.

### 2.1.5 Transmission Domain



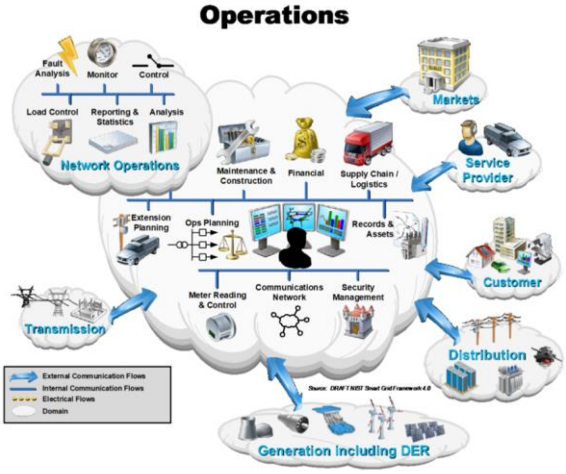

As per the standards, this domain mainly represents the long-distance high-voltage electricity carriers.

### 2.1.6 Markets Domain




As per the standard, this domain represents the facilitators and players in electricity markets and other economic processes that drive behaviour and optimize system outcomes.

### 2.1.7 Operations Domain




As per the standards, this domain represents the process and activities concerning the movement of electricity from generation to consumption.

## 2.2 Smart Grid Architecture Model (SGAM)

The widely used Smart Grid Architecture Model (SGAM) (CEN-CENELEC-ETSI Smart Grid Architecture Model) was chosen as the architecture framework for the development in the CLUE project as shown in Figure 2-2.

In its three-dimensional representation, SGAM groups functions into zones, domains and interoperability levels, with the zones representing the hierarchical management of power grids (Process, Field, Station, Operation, Enterprise, Market). Electricity distribution is divided into different domains (Generation, Transmission, Distribution, Distributed Energy Resources (DER) and Customer). The vertical interoperability layers represent the categories in which interoperability must be ensured (components, communication, information, functionality, and business).

The SGAM model is primarily used to structure and visualise Smart Grid applications. The aim is to be applicable to as many use cases as possible and to serve as a guide for identifying interoperability gaps. It does not contain any information about the technologies or protocols used.

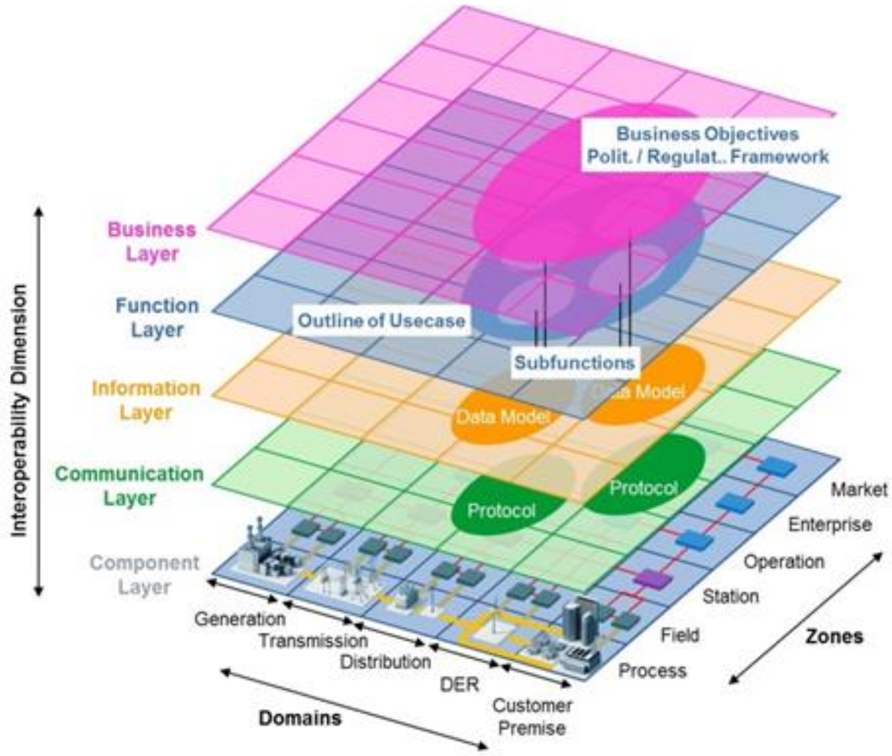



Figure 2-2: Smart Grid Architecture Model (SGAM) [2]

## 2.3 NIST Logical Reference Model (LRM)

The NIST Logical Reference Model (NIST LRM) depicted in Figure 2-3 constitutes a major contribution to the development of Smart Grid reference architectures. It is part of NIST 7628 Guidelines for Smart Grid Cybersecurity [1]. For developing the NIST LRM various use case were analysed and consolidated. Thus, the LRM includes the communication connections required to implement the use cases considered during the development phase. However, in the future new use cases might come up that require additional actors and interfaces.

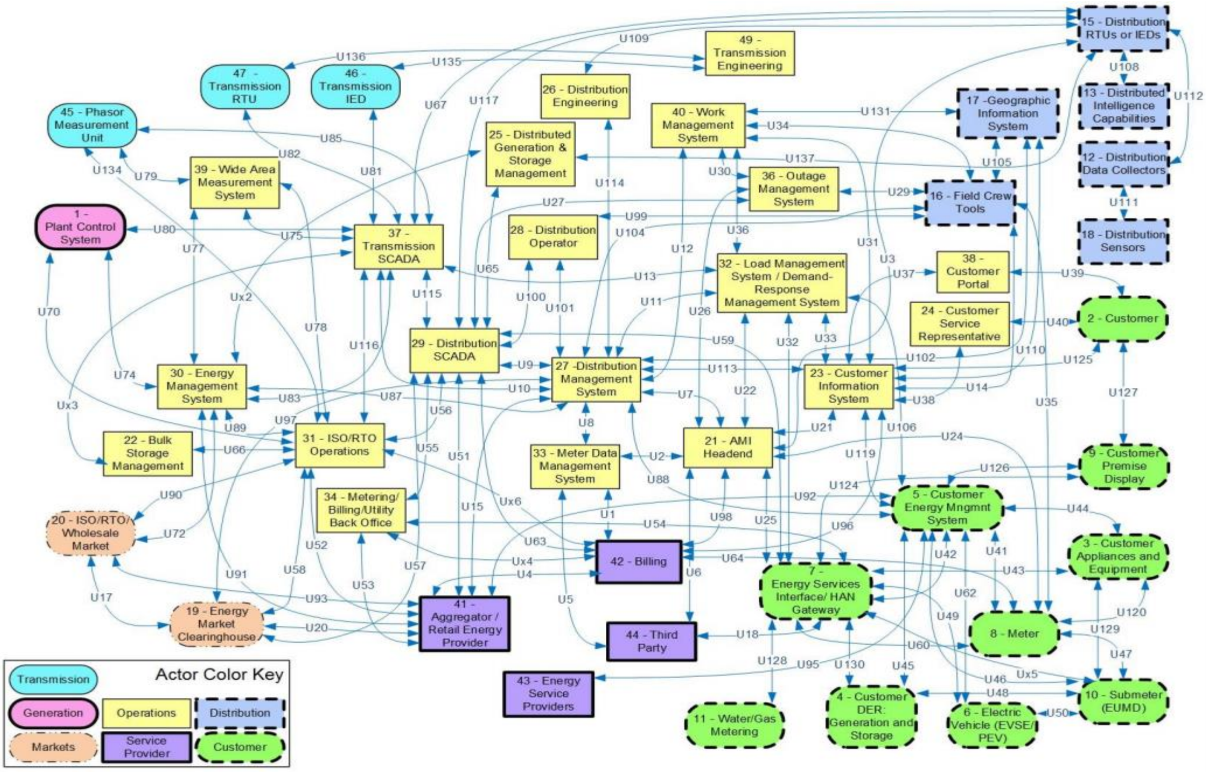



*Figure 2-3: NIST Logical Reference Model [2]*

The NIST LRM includes the smart grid domains, the actors that are part of these domains, and the interfaces between them. Moreover, each interface is assigned a category with a set of associated security requirements.

Like the Smart Grid Architecture Model (SGAM) that will be described in section 2.1, the origin of the NIST LRM is the NIST Domain Model. The individual actors can in principle be easily mapped to SGAM. One exception is the actor Customer Distributed Energy Resources (DER) which is assigned to the customer premises in the NIST LRM.

## 2.4 Architecture Development Methodology

Designing and creating a complex system like CLUE is a difficult endeavour that necessitates establishing and implementing a properly constructed methodology to fulfil the system's objectives. It should also be noted that building any new system necessitates a reasonable understanding of first the system's requirements. Since the requirements exist in a context[3], this comprehension necessitates that significant effort is expended in clearly identifying the context of such a system. As a result, a methodology with two major phases for defining a reference architecture is defined. The methodology is based on NIST Smart Grid Conceptual model, NIST LRM, and SGAM standards. The methodology is practical and based on sound

[3] Context is defined as the environment where the system will be working and interacting. The environment can consist of individuals, systems, sub-systems, processes, documents, etc.

foundations. The NIST Logical Reference Model and the SGAM model have been used already earlier to develop e.g., the Austrian Smart Grid reference architecture [3].

An overview of the methodology is presented in Figure 2-4. As can be seen, the methodology consists of two phases. It should however be noted that the first phase helps in extracting the reference architecture while the second phase is dedicated to extracting the requirements that lead to use case development. Below, a short description of the two phases is presented.


Figure 2-4: An overview of the developed methodology

### 2.4.1 Phase I: Context identification

This is the first and most critical step in the methodology. The objective of this phase is to identify and determine the context of the CLUE solution. The context provides valuable insights into the expected interactions and surrounding entities and helps in defining the solution boundaries. The outcome of this phase is a conceptual model. This phase includes two sub-phases:

1. Identification of the relevant domains from the NIST Smart Grid Conceptual model
2. Identification of the relevant actors from NIST Smart Grid actors (NISTIR 7628) for the selected domains

### 2.4.2 Phase II: Characterisation & Goals

Once the domains and actors have been identified, this phase looks at each of the actors, classifies it according to its role. Later, based on the classification, possible goals are brainstormed to access the requirements for the features and services that would be needed from the CLUE solutions so that the goals can be achieved.

At the use case level, both NIST and SGAM are significant and widely utilized for Smart Grid application planning and analysis. The mapping of the NIST Smart Grid actors, as presented in NISTIR 7628 and used in phase I above, can be mapped to the SGAM plan. One such mapping is presented in [3] and used in this methodology for later development. An overview of this mapping is presented in Figure 2-5. The actors here are identified with their ID, as mentioned in the standard. Seven different colours are used to represent the seven domains.

In the first step, both SGAM and NIST LRM are consolidated. For this purpose, the actors of the NIST model are mapped to the corresponding SGAM zones, domains, and interoperability as shown in Figure 2-5. In order to develop an architecture for a concrete use case, first, the use case needs to be analysed including the identification of relevant actors, diagrams, and requirements. The information about actors as specified in the NIST LRM is in the next step used to define the actual components. Business layer information like business objectives or economic constraints can be derived from the use case analysis. The functional layer represents the different functionalities required for implementing the use. The functionality can also be described using sequence diagrams which can be found in D3.1. The information layer defines the information objects that need to be exchanged between the different actors to realize the use case. On the communication finally, the protocols are defined for supporting the information exchange between actors.

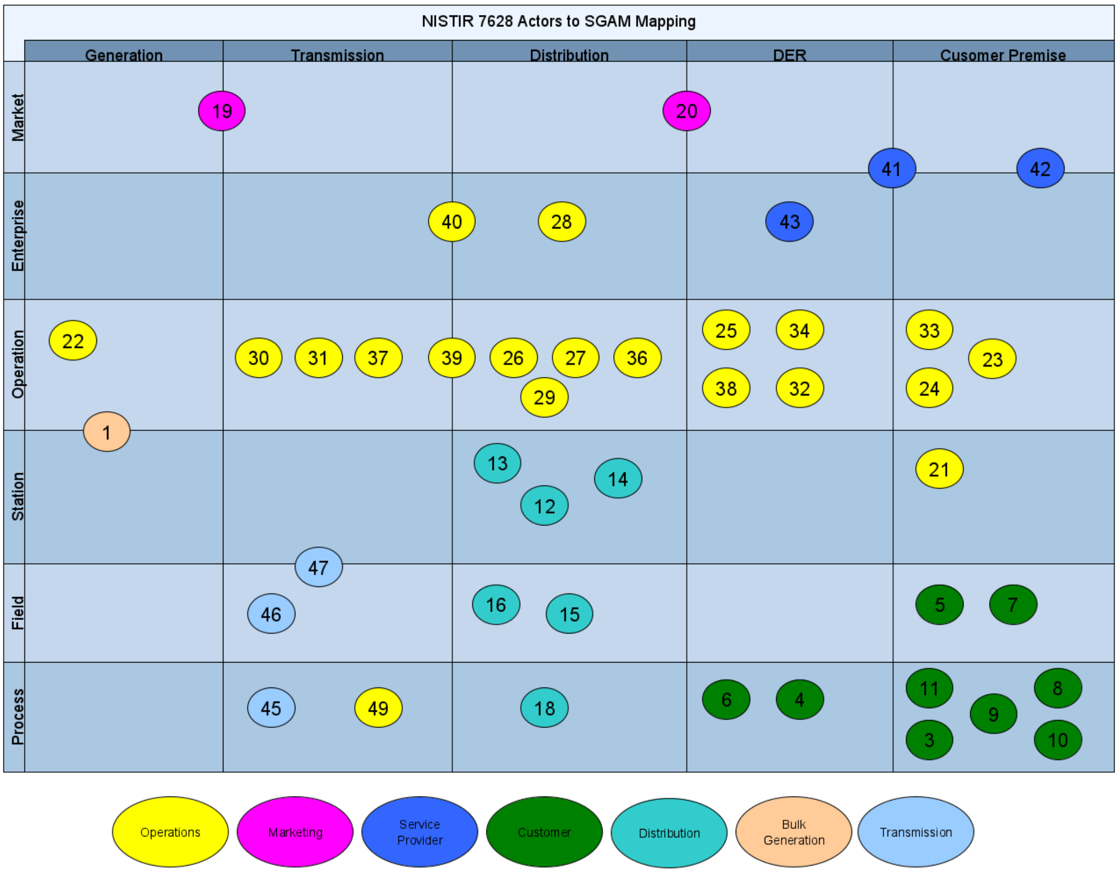



*Figure 2-5: A mapping of NIST Smart Grid Actors to an SGAM Plane [3]*

## 2.5 CLUE Reference Architecture

Following the methodology, briefed in the previous section, a detailed study is conducted to find first the context and later extract the requirements for use case definition. Table 2-1 presents a summary of the outcome from applying the sub-phase 1 of Phase I from the methodology. As can be seen, five out of seven domains from NIST Smart Grid Conceptual domains are identified as relevant for CLUE.

*Table 2-1: Summary of outcome from Phase I.1*

| Domain | Relevance | | | Flow Type | |
|---|---|---|---|---|---|
| | **Direct** | **Indirect** | **N/A** | **Electrical** | **ICT** |
| Customer | ✓ | | | ✓ | ✓ |
| Distribution | ✓ | | | ✓ | ✓ |
| Operations | ✓ | | | ✓ | ✓ |
| Service Provider | ✓ | | | | ✓ |
| Market | ✓ | | | | ✓ |
| Transmission | | | ✓ | | |
| Generation including DER | | | ✓ | | |

A graphical representation of the outcome is shown in Figure 2-6. As evident from the graphic, there are five domains (customers, distribution, operations, service providers, and market) that have direct interaction with the CLUE solution. Two domains; transmission and generation including DER are identified as not relevant during the analysis as these domains do not exist for LEC's in the CLUE project. Both the ICT and electrical flows between the CLUE solution and respective domains are also identified and highlighted with blue and yellow lines.

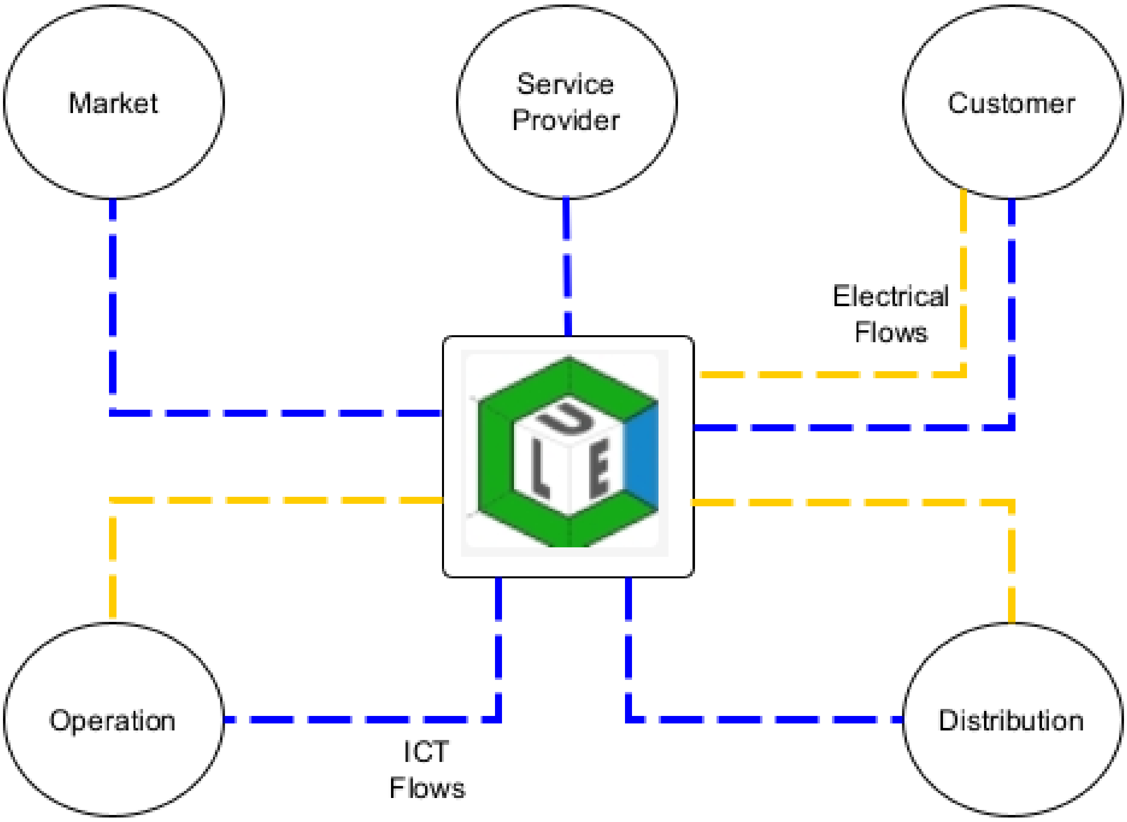



*Figure 2-6: CLUE Reference Architecture.*

Table 2-2 presents the analysis conducted on the NIST Smart Grid Actors. Since the context has already been identified previously, the focus here is only the actor in the five domains. Each actor is identified with a unique ID, the domain it belongs to, and the name is given. A more detailed description of all NIST Smart Grid Actors can be seen in the Appendix[4].

For each of the actors, there are three main categories of questions that are answered. The first of them is a yes/no question about the actor's relevance to CLUE. The answer to this question determines if further analysis is needed or not. The next question tries to find the right classification for the actor under analysis. An actor can take one of the three possible classification types[5]. The third category of questions is about the types of flows that could be envisioned between this actor and the CLUE solution. These flows are divided into two types: electrical and ICT. The electrical flow further classifies if the actor is a consumer or producer of the electricity. While the ICT flow tries to identify if this actor is originating communication being a source or it is a receiver or both.

[4] See Appendix A2

[5] See Appendix A3

*Table 2-2: List of identified NIST Smart Grid Actors*

| ID | Domain | Name | Relevant | Classification | | | Electrical Flow | | ICT Flow | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | Secondary | Supporting | Consumer | Producer | Source | Sink |
| 2 | Customer | Customer | Yes | Yes | | | Yes | Yes | Yes | Yes |
| 3 | Customer | Customer Appliances and Equipment | Yes | | | Yes | Yes | | Yes | Yes |
| 4 | Customer | Customer Distributed Energy Resources: Generation and Storage | Yes | | | Yes | Yes | Yes | Yes | Yes |
| 5 | Customer | Customer Energy Management System | Yes | | Yes | | | | Yes | Yes |
| 6 | Customer | Electric Vehicle Service Element/Plug-in Electric Vehicle | Yes | | | Yes | Yes | | Yes | Yes |
| 7 | Customer | Home Area Network Gateway | Yes | | Yes | | | | Yes | Yes |
| 8 | Customer | Meter | Yes | | | Yes | | | Yes | |
| 9 | Customer | Customer Premise Display | No | | | | | | | |
| 10 | Customer | Sub-Meter – Energy Usage Metering Device | Yes | | | Yes | | | Yes | |
| 11 | Customer | Water/Gas Metering | No | | | | | | | |
| 12 | Distribution | Distribution Data Collector | No | | | | | | | |
| 13 | Distribution | Distribution Intelligence Capabilities | Yes | | | Yes | | | Yes | Yes |
| 14 | Distribution | Distribution Automation Field Devices | No | | | | | | | |



This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme.

| ID | Domain | Name | Relevant | Classification | | | Electrical Flow | | ICT Flow | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | Secondary | Supporting | Consumer | Producer | Source | Sink |
| 15 | Distribution | Distribution Remote Terminal Unit/Intelligent Electronic Device | Yes | | | Yes | | | Yes | Yes |
| 16 | Distribution | Field Crew Tools | No | | | | | | | |
| 17 | Distribution | Geographic Information System | No | | | | | | | |
| 18 | Distribution | Distribution Sensor | No | | | | | | | |
| 19 | Market | Energy Market Clearinghouse | No | | | | | | | |
| | **Market** | **P2P market** | **Yes** | | | **Yes** | | | **Yes** | **Yes** |
| 20 | Market | Independent System Operator/Regional Transmission Organization Wholesale Market | No | | | | | | | |
| 21 | Operations | Advanced Metering Infrastructure Headend | | | | | | | | |
| 22 | Operations | Bulk Storage Management | No | | | | | | | |
| 23 | Operations | Customer Information System | No | | | | | | | |
| 24 | Operations | Customer Service Representative | No | | | | | | | |
| 25 | Operations | Distributed Generation and Storage Management | Yes | | | Yes | Yes | Yes | Yes | Yes |
| 26 | Operations | Distribution Engineering | No | | | | | | | |
| 27 | Operations | Distribution Management Systems | Yes | | | Yes | No | No | Yes | Yes |
| 28 | Operations | Distribution Operator | Yes | Yes | | | Yes | Yes | Yes | Yes |

| ID | Domain | Name | Relevant | Classification | | | Electrical Flow | | ICT Flow | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Primary | Secondary | Supporting | Consumer | Producer | Source | Sink |
| 29 | Operations | Distribution Supervisory Control and Data Acquisition | Yes | | | Yes | No | No | Yes | Yes |
| 30 | Operations | Energy Management System | Yes | | | Yes | No | No | Yes | Yes |
| 31 | Operations | ISO/RTO Operations | No | | | | | | | |
| 32 | Operations | Load Management Systems/Demand Response Management System | Yes | | | Yes | | | Yes | Yes |
| 33 | Operations | Meter Data Management System | Yes | | | Yes | | | Yes | Yes |
| 34 | Operations | Metering/Billing/Utility Back Office | No | | | | | | | |
| 36 | Operations | Outage Management System | No | | | | | | | |
| 37 | Operations | Transmission SCADA | No | | | | | | | |
| 38 | Operations | Customer Portal | Yes | | | Yes | | | Yes | Yes |
| 39 | Operations | Wide Area Measurement System | No | | | | | | | |
| 40 | Operations | Work Management System | No | | | | | | | |
| 41 | Service Provider | Aggregator/Retail Energy Provider | Yes | | | Yes | | | Yes | Yes |
| 42 | Service Provider | Billing | No | | | | | | | |
| 43 | Service Provider | Energy Service Provider | Yes | Yes | | | | Yes | Yes | Yes |
| 44 | Service Provider | Third Party | No | | | | | | | |

# 3 STAKEHOLDER ANALYSIS

Establishing energy communities in an existing energy system is a complex and multifaceted challenge that requires a holistic approach and the consideration of numerous stakeholders with a different set of objectives and priorities [4], [5], [6]. Thus, for setting up an energy community, it is necessary to develop a good overview of the relevant stakeholders and a comprehensive understanding of who is a driving stakeholder for taking decisions and actions, who has the power to influence the set up and running of an energy community and who would have an essential role but is not aware or active yet.

A stakeholder mapping can be an effective approach to reveal the positions, roles, and relationships between relevant stakeholders [5], [7]. This is an important step for identifying potentials and gaps in the stakeholder constellation and for activating and strengthening stakeholders who have a key role but are not active yet or even aware of the possibilities and their role.

## 3.1 Stakeholders and Scope Identification

People, groups, and/or organizations, companies, governments, and legal entities, among others, who may have a positive or negative impact on the project are referred to as project stakeholders. Such entities should be identified, their objectives and expectations analysed, and an effective management and engagement plan designed so that these stakeholders may be engaged in various life cycles of project development and execution is critical to the project's success.



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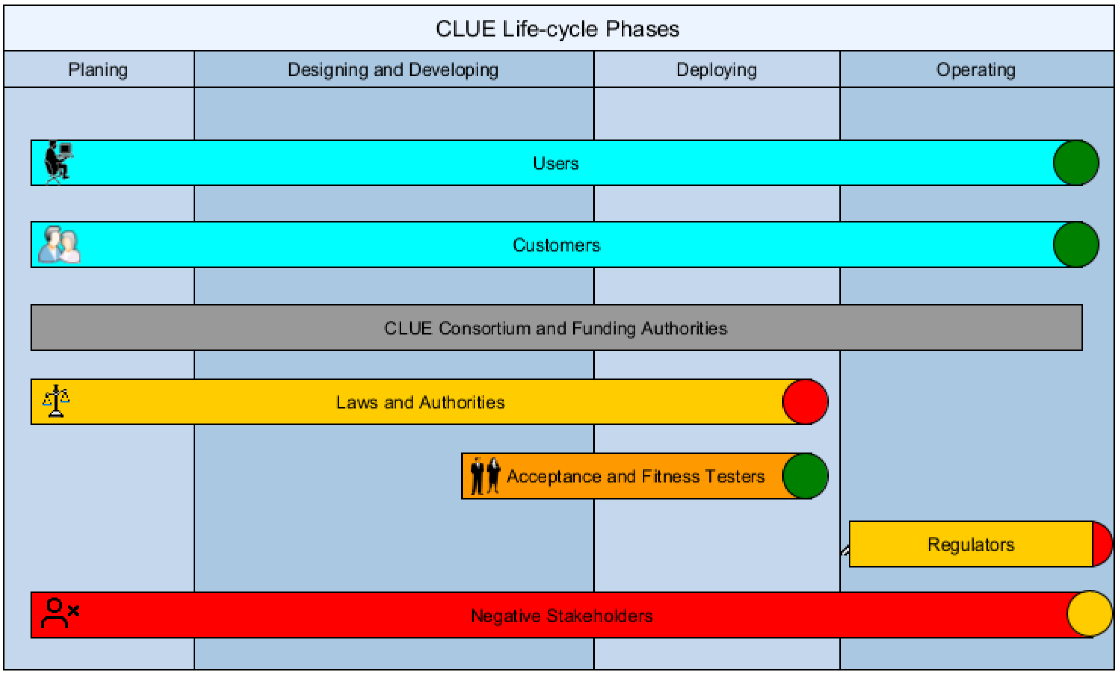


*Figure 3-1-: Overview of CLUE project stakeholders when mapped on various life-cycle phases.*

A simple model for stakeholders' identification is used where first the major life cycle phases are identified. Figure 3-1-: present the populated model with four project life cycle phases and seven classes of stakeholders. Below a brief description of the phase, stakeholders, and scope making is presented.

The chosen life-cycle phases cover the overall project. These phases include:

1. Planning
2. Designing and Development
3. Deploying
4. Operating

Then major classes of stakeholders are identified, that are:

1. **Users**: class of stakeholder that will operate the system
2. **Customer**: class of stakeholder that will use the system
3. **CLUE Consortium and funding agencies (including expected investors) :** a class of stakeholders that would like to invest in the system.
4. **Laws and authorities of the land**: a class of stakeholders that set the laws and have jurisdiction on the land where the system will be used.

5. **Acceptance and fitness testers**: a class of stakeholders that may include the representatives from customer and user as well as regulators that certify that the developed system is as per user requirement and that it also obeys the set regulations for its operations.

6. **Regulators**: a class of stakeholders that govern the laws for operating a system.

7. **Negative stakeholders**: a class of stakeholders that are affected negatively by the system and would not be happy about the change.

A simple stakeholder classification method is introduced with three scope levels:

**Project scope**: these stakeholders and their expectations remain the same throughout the project life cycle and implementation region. The stakeholders in this scope are marked with a green circle.

**Regional scope**: these stakeholders have differing expectations based on the region of implementation. The stakeholders in this scope are marked with a red circle.

**Hybrid (project/region):** these stakeholders may or may not have different expectations based on the region of implementation. The stakeholders in this scope are marked with a yellow circle.

Since CLUE is a multi-national project, there is a possibility that many of these stakeholders may differ on their expectations. Also, there could be a possibility of adopting the different engagement methods. In this task, we decided to focus on understanding political, economic, social, technological, legal and environmental interests of regional stakeholders in the countries involved in the project. The chosen approach was a conducting a stakeholder mapping using PESTLE analysis in order to explore and group the stakeholders into representatives of political, economic, social, technical, legal and environmental (PESTLE) interests.

PESTLE analyses have already been conducted on a range of different energy topics [8], [9], [10] and are particularly useful for exploring issues that are mainly qualitative in nature and for analysing problems holistically [9]. We applied a simplified version of the PESTLE analysis and focusses mainly on the stakeholder setting and their roles. The subsequent sections give an overview of the PESTLE analysis for the different countries involved in the CLUE project.

## 3.2 Austria

In Austria, the municipality of Gasen and the region of Southern Burgenland are part of the CLUE project.

The municipality of Gasen is located in Styria, which is one of the nine provinces in Austria, and has in total about 900 inhabitants. The total area of Gasen is about 34 km² and has about 284 households (Naturparkgemeinde Gasen, s.a.).

The region of the Innovation lab act4.energy is located in the south of Burgenland, which is like Styria one province in eastern Austria. The region of the innovation lab includes 10 municipalities, where the municipality of Oberwart and municipality of Stegersbach have the highest number of inhabitants. All in the region of Southern Burgenland has a total number of inhabitants of about 20,000 and has a total area of about 195 km² (Statistik Austria, 2019).

### 3.2.1 Stakeholder mapping in Southern Burgenland

In the region of Southern Burgenland, there were a total 48 stakeholders identified. Figure 3-2 shows all stakeholders with their roles and position in the CLUE project. The positioning of the stakeholders was determined according to their importance in the project and also according to their spatial scale, whereby those stakeholders with the most decisive role on local scale were positioned in the core (lowest shell) of the bubble.

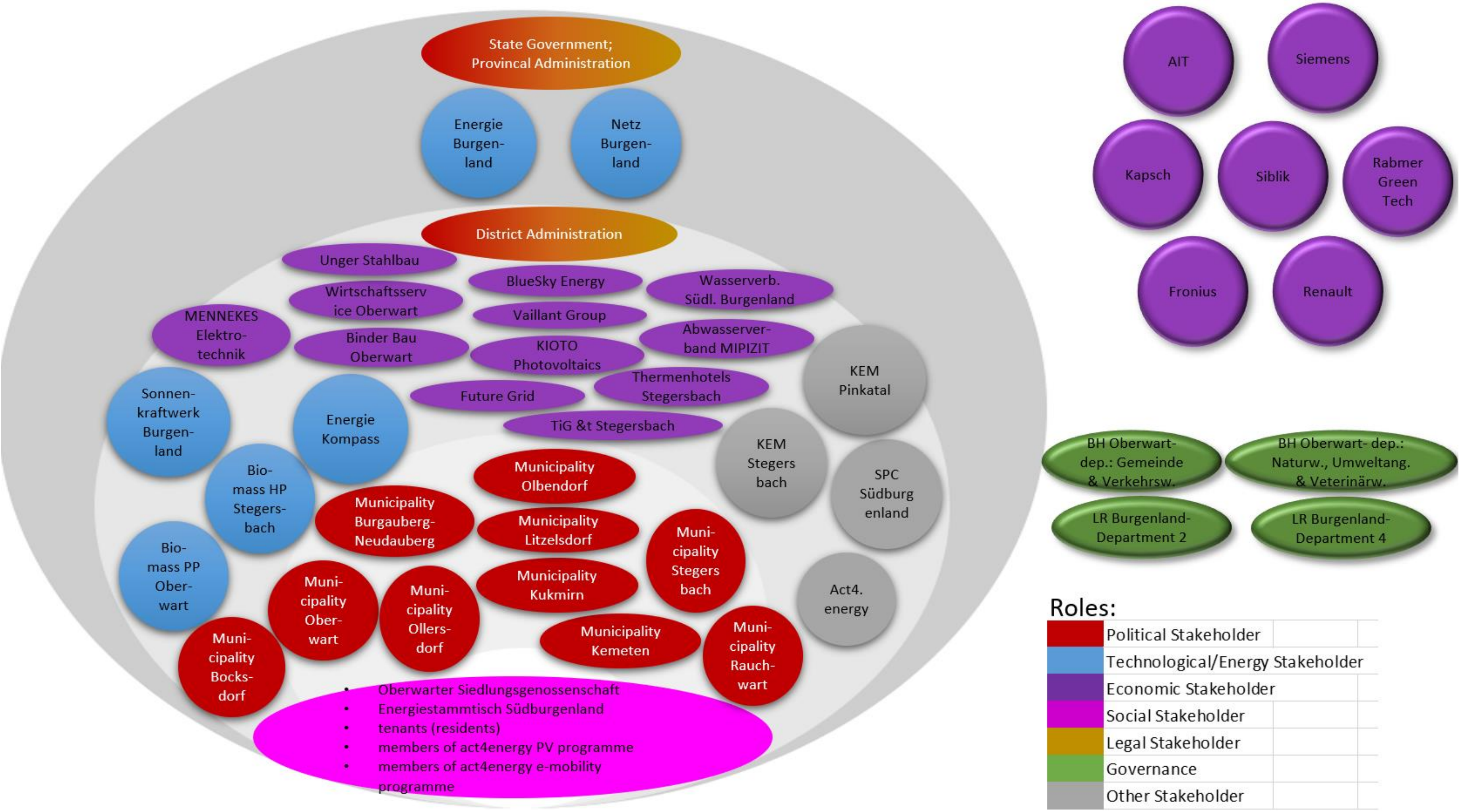


*Figure 3-2: Position and roles of the stakeholders in the region of the Southern Burgenland*



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Smart Energy Systems ERA-Net

As in *Figure 3-2* pictured, the 10 municipalities play a key role in the CLUE-project in the region of Southern Burgenland. Moreover, the stakeholders in the Southern Burgenland have different roles, which are mostly economic (40%), political (21%) and technological (13%) stakeholders (see *Figure 3-3*).

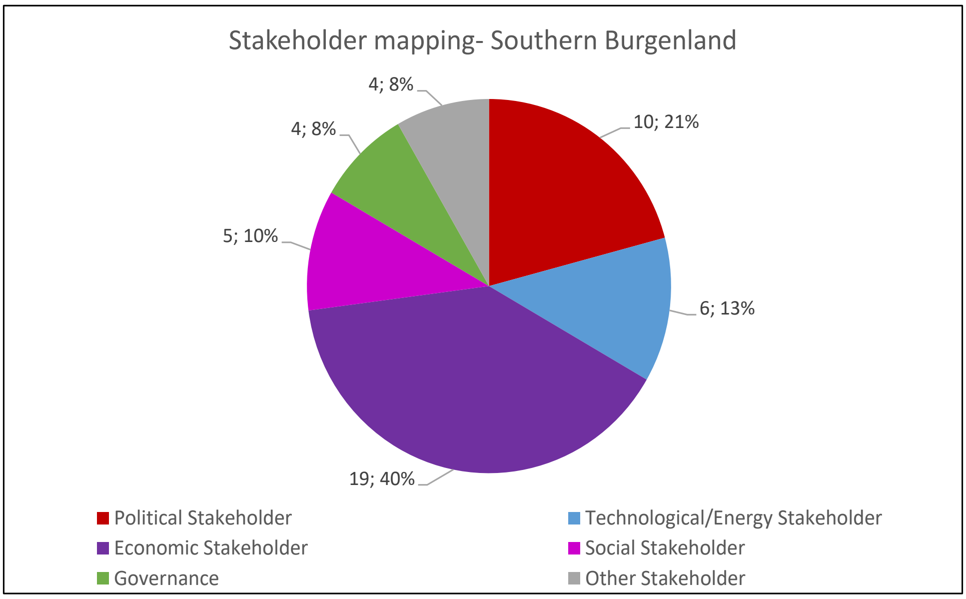


*Figure 3-3: Roles of the stakeholders in the Southern Burgenland*

In case of the Southern Burgenland the 10 municipalities are the political stakeholders. The governance stakeholders include two departments of the governance of the province Burgenland and two departments of the district authority of the municipality of Oberwart.

Furthermore, the stakeholders of Southern Burgenland are mapped in 5 categories based on their roles within the CLUE project:

- Stakeholder 1: role on the entire city level/considering large scale or impact.
- Stakeholder 2: role in a specific sector and/or in a specific district/area
- Stakeholder 3: required in his role/"driving" stakeholder.
- Stakeholder 4: role has to be strengthened. with regards to local energy communities.
- Stakeholder 5: small role



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The results of the stakeholder mapping of the Southern Burgenland in the 5 categories are shown in *Figure 3-4*.

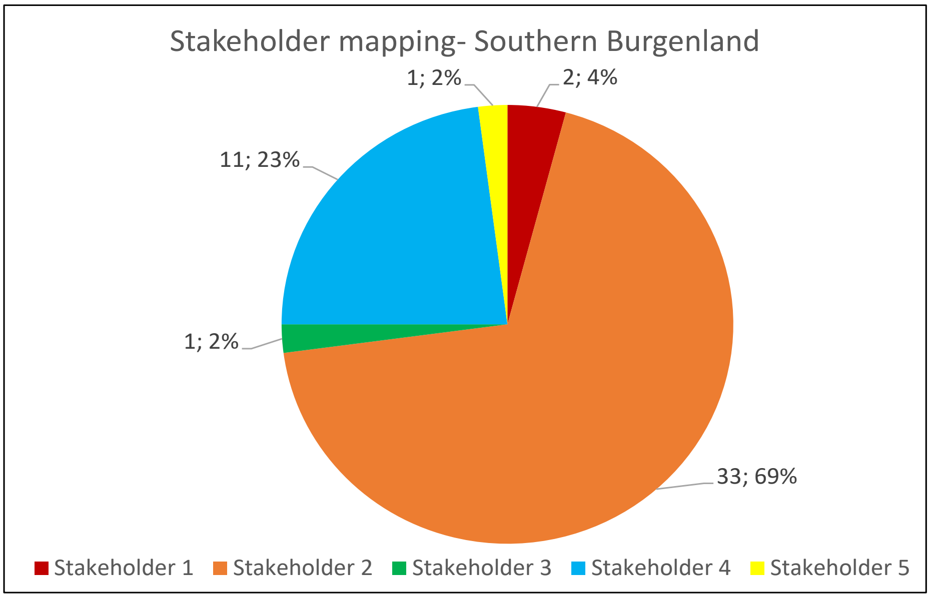


*Figure 3-4: Stakeholder mapping in Southern Burgenland*

The stakeholder mapping (see *Figure 3-4*) illustrates, that most of the stakeholders in the Southern Burgenland have a role in a specific sector, district, or area (69%) and also that some stakeholder roles have to be strengthened (23%). The stakeholders, which mostly have to be strengthened, are the governance stakeholders, the social stakeholders and two technological stakeholders. These stakeholders have to be strengthened in more than 3 roles (e.g.: consultation, decision making, etc.). Although the municipalities need to be strengthened in the role of "awareness building", the municipalities were categorised as stakeholder 2 (role in a specific sector and/or in a specific district/area) due to their predominant role. The "driving" stakeholder (Stakeholder 3) in the region of the Southern Burgenland is "act4.energy".

### 3.2.2 Stakeholder mapping in Gasen

In the municipality of Gasen, 25 stakeholders were identified in total, which hold different roles and positions in the CLUE-project. Like in the stakeholder mapping in Southern Burgenland, the positioning of the stakeholders in Gasen was determined according to their importance in the project (see *Figure 3-5*).

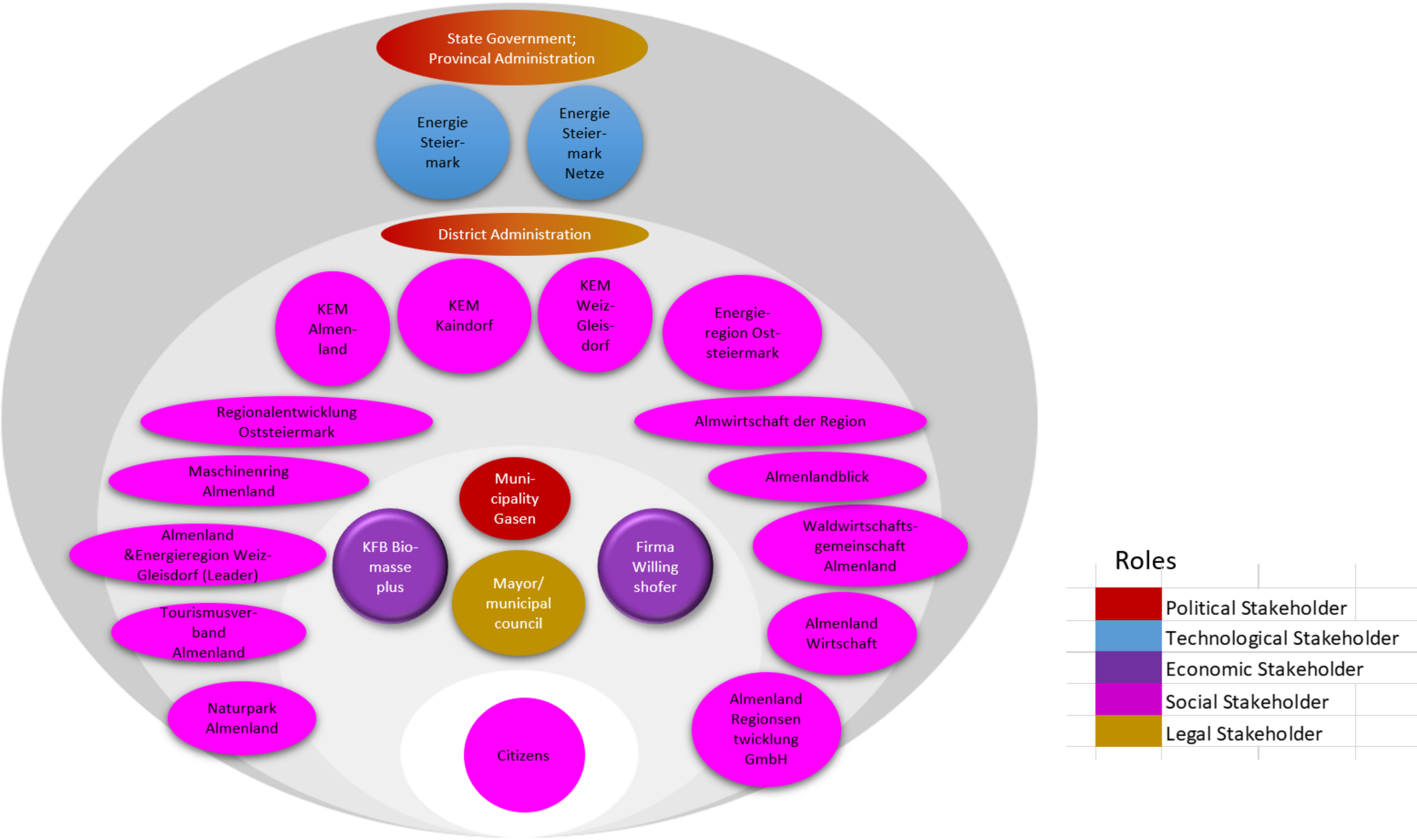


*Figure 3-5: Position and roles of the stakeholders in the municipality of the Gasen*

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*Figure 3-5* shows that the citizens, the economic stakeholders, the municipality of Gasen and the mayor/the municipal council have a key role in the CLUE-project in Gasen. Furthermore, the stakeholders in the municipality of Gasen have different roles, which are mostly social (60%), economic (16%) and legal (12%) stakeholders (see *Figure 3-6*).

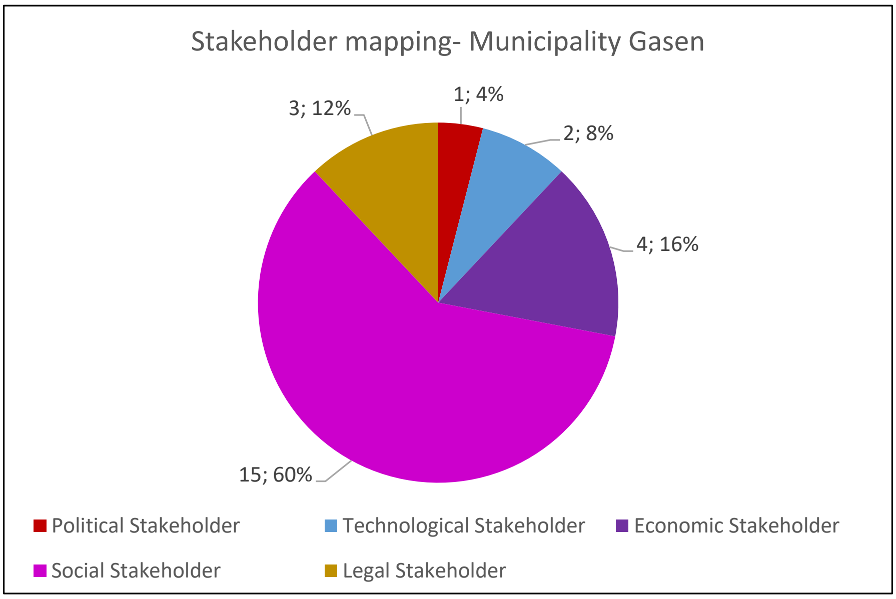


*Figure 3-6: Roles of the stakeholders in the municipality of Gasen*

In case of Gasen, the municipality is the political stakeholder and the mayor/municipal council the legal stakeholder. The economic stakeholders are the two companies "Willingshofer GmbH" and "KFB Biomasse plus GmbH" and the technological stakeholders are the technology and energy infrastructure provider "Energie Steiermark" and "Energie Steiermark Netze".

Furthermore, the stakeholders of Gasen are analysed in 4 categories based on their roles within the CLUE project:

- Stakeholder is already aware and active.
- Stakeholder is required but not yet active.
- Stakeholder's role has to be strengthened with regards to local energy communities.
- Stakeholder is in the moment not relevant.



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In the municipality of Gasen, most of the stakeholders are already aware and active (56%) and that shows high ambitions from them. The high ambitions of Gasen are also proven, that there are no stakeholders, who are required but not yet active. 32% of the stakeholder roles, which are seven social stakeholders and one economic stakeholder, should be strengthened in Gasen. This high number of stakeholders demonstrates, that even in the municipality of Gasen, a support in case of strengthening of the stakeholder roles is necessary. 12% of the stakeholders in the municipality of Gasen are in the moment not relevant. The result of the stakeholder mapping of the municipality of Gasen is shown in *Figure 3-7*.

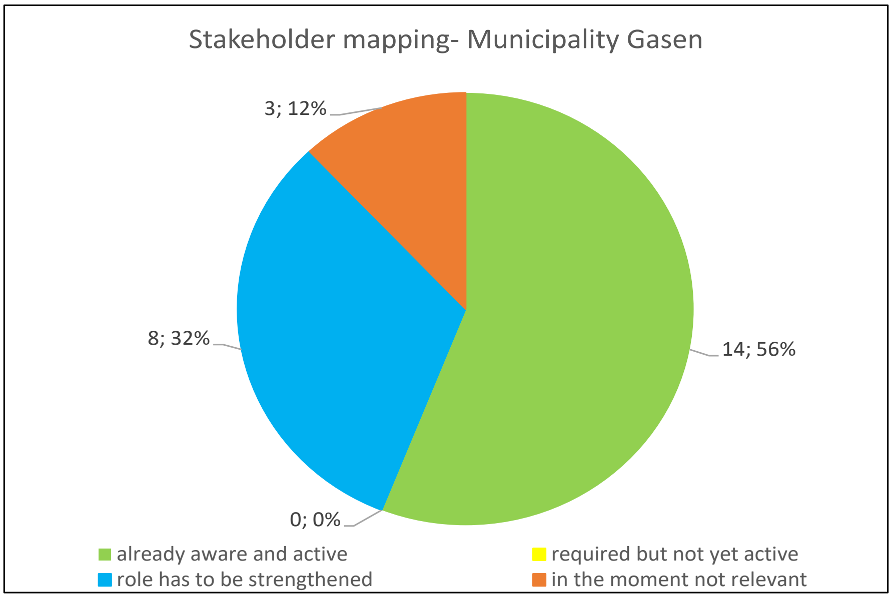


*Figure 3-7: Role analysis of the stakeholders in the municipality of Gasen*

## 3.3 Sweden

In case of Sweden, there are in total 16 stakeholders identified in the CLUE project. *Figure 3-8* shows all stakeholders with their roles and position in the CLUE project. The positioning of the stakeholders was like in the case of Austria determined according to their importance in the project.

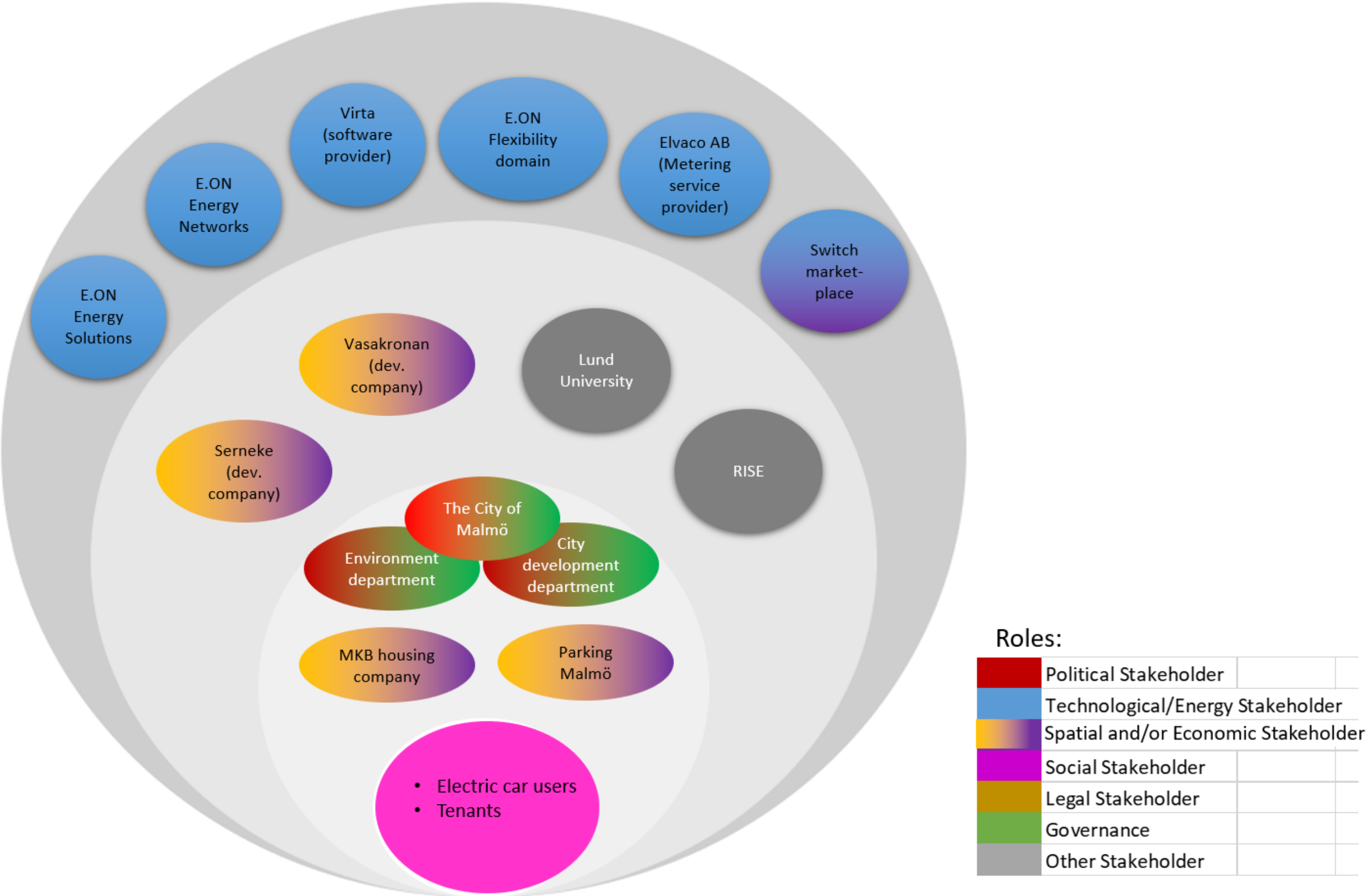


*Figure 3-8: Position and roles of the stakeholders in Sweden*



This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme.

The stakeholders of Sweden are mostly technological/energy stakeholders (37%) and spatial-economic stakeholders (25%). The technological/energy stakeholders provide the energy infrastructure, e.g.: energy solution providers, software provider and software provider. As spatial-economic stakeholders, there are on the one hand municipal companies, who host the demonstration of local balancing and host the demonstration of smart charging. On the other hand, the construction and development company "Serneke Group AB" and the real estate company "Vasakronan AB" were also mapped as spatial-economic stakeholders. In case of Sweden, the governance stakeholders (12%) are two departments (environment and city development department) of the city of Malmö and the other stakeholders are two research institutes. The social stakeholders are the electric car users and the tenants/residents. The mapping of the roles of the stakeholders in Sweden are shown in *Figure 3-9*.

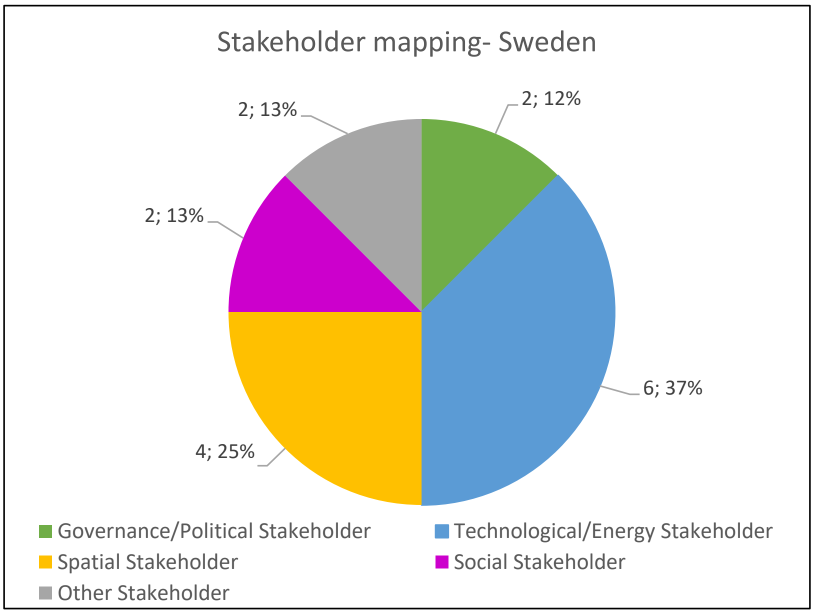


*Figure 3-9: Roles of the stakeholders in Sweden*

Moreover, the stakeholders of Sweden are mapped in 3 categories based on their roles within the CLUE project (see *Figure 3-10*)

- Stakeholder 1: role on the entire city level/considering large scale or impact.
- Stakeholder 2: role in a specific sector and/or in a specific district/area
- Stakeholder 3: small role



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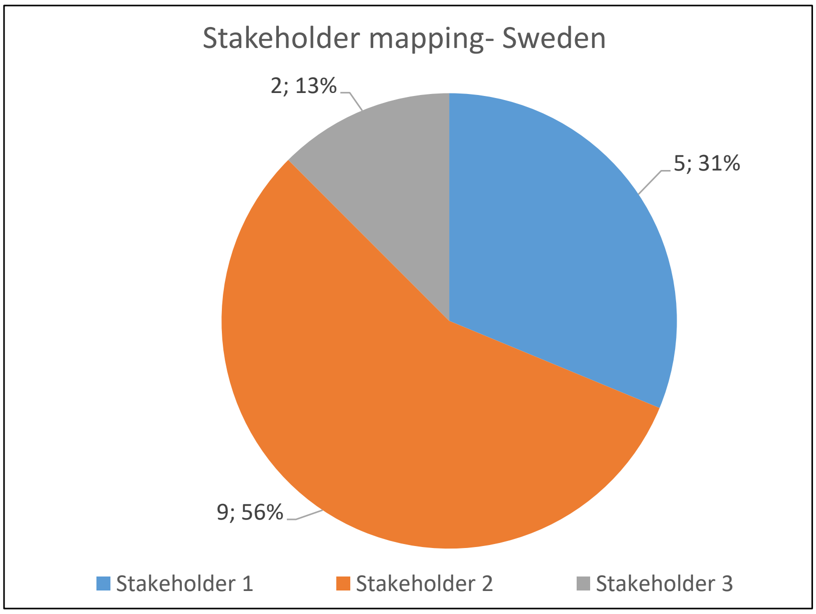


*Figure 3-10: Stakeholder mapping in Sweden*

The highest number of stakeholders in Sweden have a role in a specific sector and/or in a specific district/area (56%) and have a role on the entire city level/considering large scale or impact (31%). The two technological stakeholder "Virta" (software provider) and "Elvaco AB" (Metering service provider) have a small role in the CLUE-project of Sweden.

## 3.4 Germany

In Herne-Shamrockpark (Germany), there are in total 12 stakeholders identified, which hold different roles and positions in the CLUE-project. The positioning of the stakeholders was determined according to their importance in the project and to their spatial scale (state-district-local), whereby those stakeholders with the most decisive role and on local scale were positioned in the core of the bubble (see *Figure 3-11*).

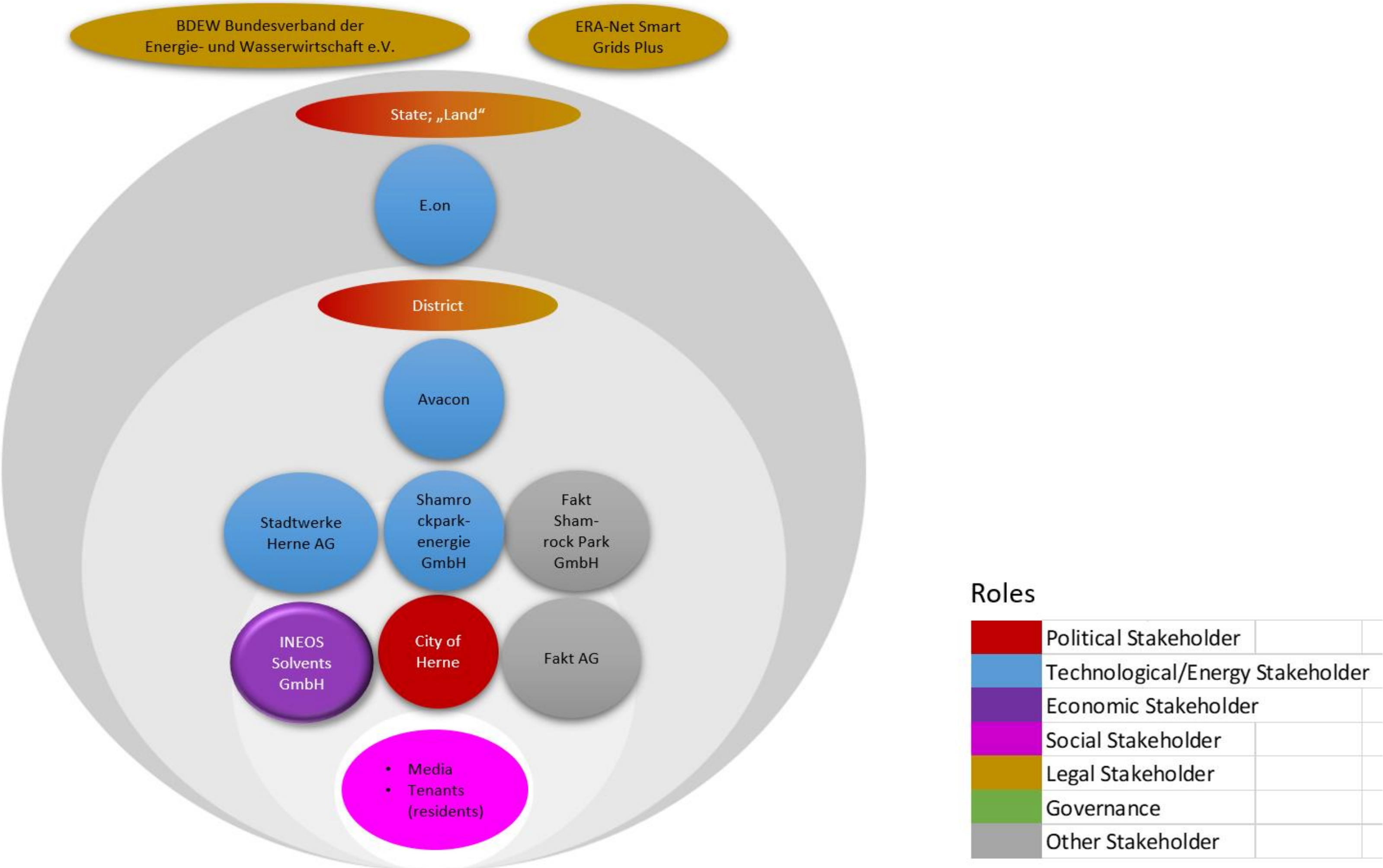


*Figure 3-11: Position and roles of the stakeholders in Herne-Shamrockpark (Germany)*



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*Figure 3-11* shows that the social stakeholders (Media and tenants) have a key role in the CLUE-project in Herne-Shamrockpark. Furthermore, the stakeholders of Germany have different roles, which are mostly technological (33%), social (17%) and other (17%) stakeholders. Additionally, two legal stakeholders (BDEW Bundesverband der Energie- und Wasserwirtschaft e.V. and ERA-Net Smart Grids Plus) were part of the CLUE-project of Herne-Shamrockpark (see *Figure 3-12*).

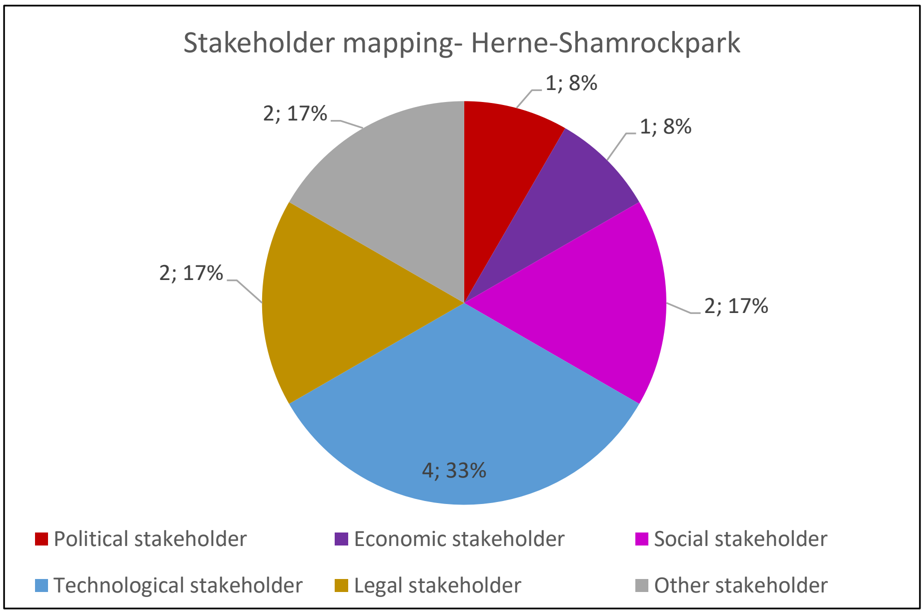


*Figure 3-12: Roles of the stakeholders in Herne-Shamrockpark (Germany)*

Furthermore, the stakeholders of Herne-Shamrockpark are mapped in 4 categories based on their roles within the CLUE project:

- Stakeholder is already aware and active.
- Stakeholder is required but not yet active.
- Stakeholder's role has to be strengthened with regards to local energy communities.
- Stakeholder is in the moment not relevant.

The result of the stakeholder mapping is that all the stakeholders in Herne-Shamrockpark are already aware and active.



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## 3.5 Scotland

In case of Scotland, 48 stakeholders were identified in the CLUE project. *Figure 3-13* shows all stakeholders with their roles and positions in the CLUE project. The positioning of the stakeholders was like in the case of Austria, Sweden and Germany determined according to their importance in the project, at the same time reflecting the spatial scale.

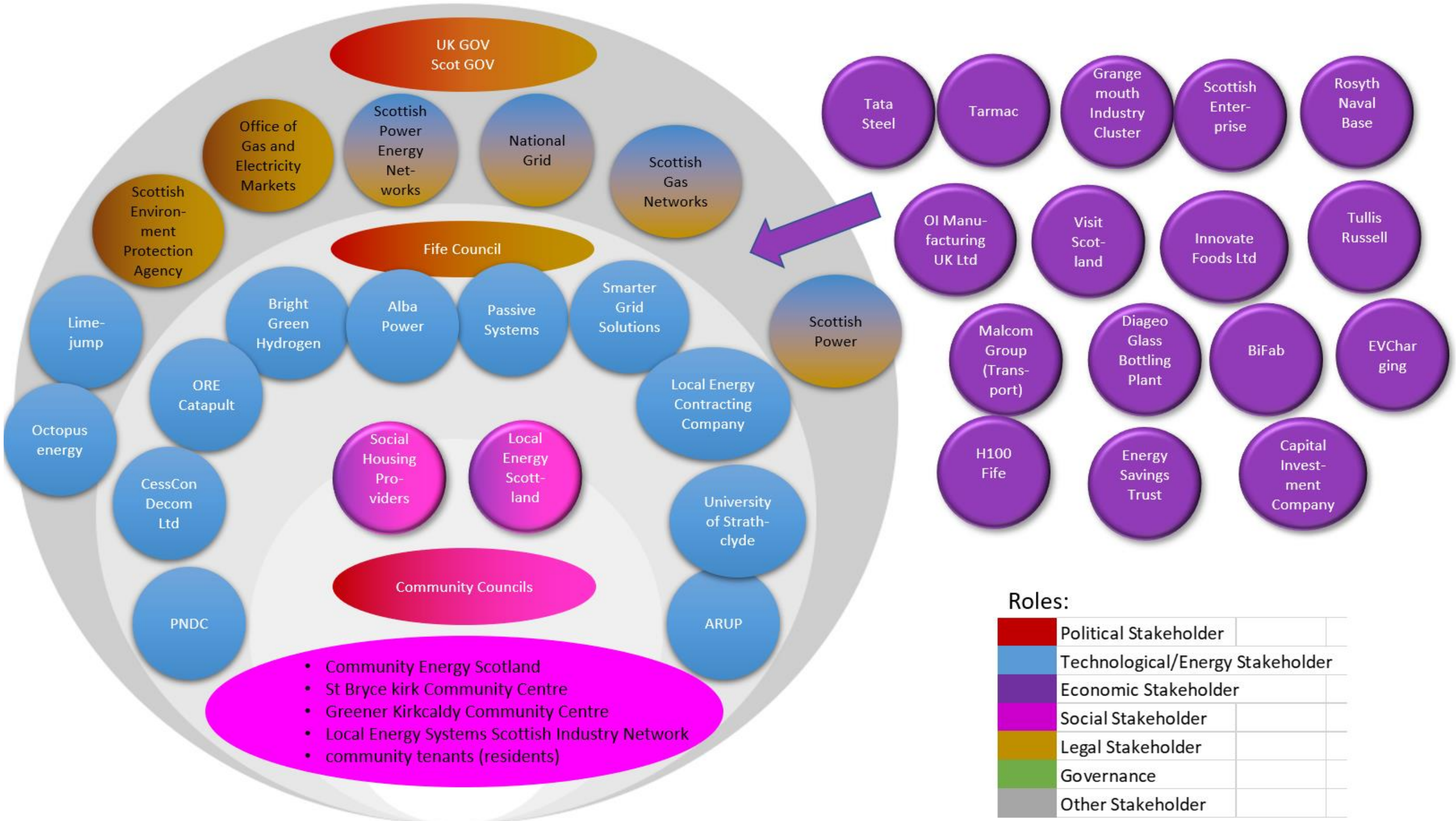


*Figure 3-13: Position and roles of the stakeholders in Scotland*



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*Figure 3-13* illustrates, that the social stakeholders have a key role in the CLUE-project in Scotland. Furthermore, the stakeholders of Scotland hold different roles, who are mostly economic (38%), technological (33%), social (11%) and legal (10%) stakeholders (see *Figure 3-14*).

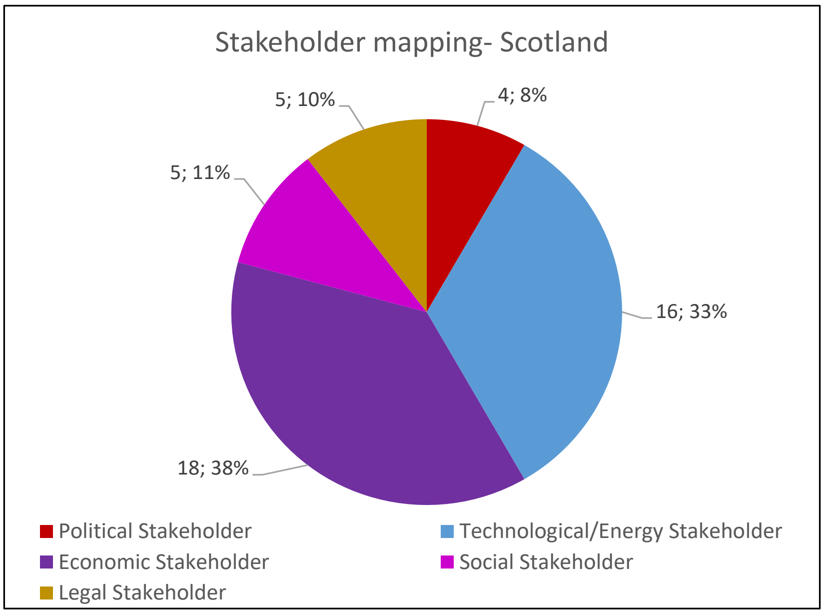


*Figure 3-14: Roles of the stakeholders in Scotland*

The stakeholders of Scotland are mapped in 5 categories (see *Figure 3-15*)

- Stakeholder 1: role on the entire city level/considering large scale or impact.
- Stakeholder 2: role in a specific sector and/or in a specific district/area
- Stakeholder 3: required in his role/"Driving" stakeholder.
- Stakeholder 4: small role
- Stakeholder 5: another role



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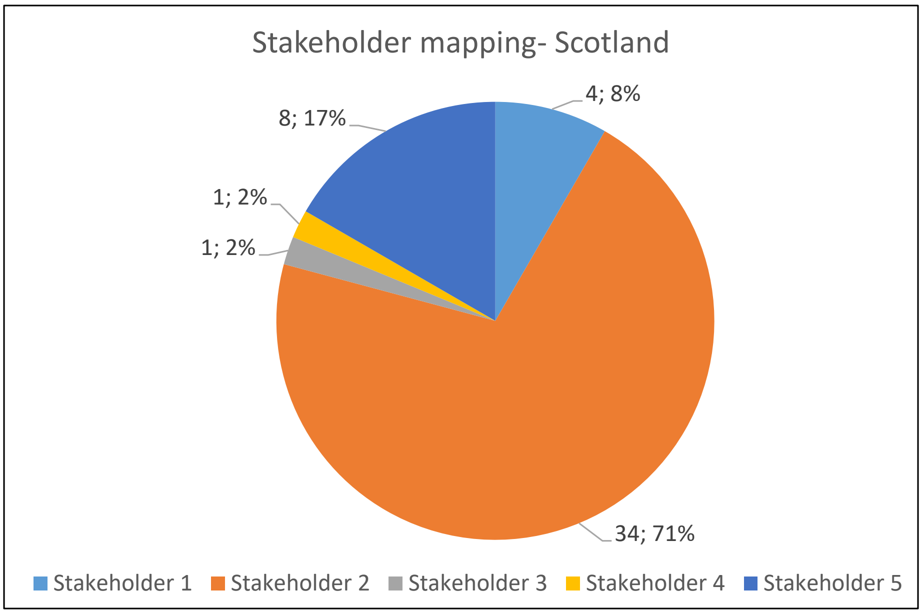


*Figure 3-15: Stakeholder mapping in Scotland*

Furthermore, all of the roles of the stakeholders in Scotland were analysed if they are already active and if their roles should be strengthened (see *Figure 3-16*).

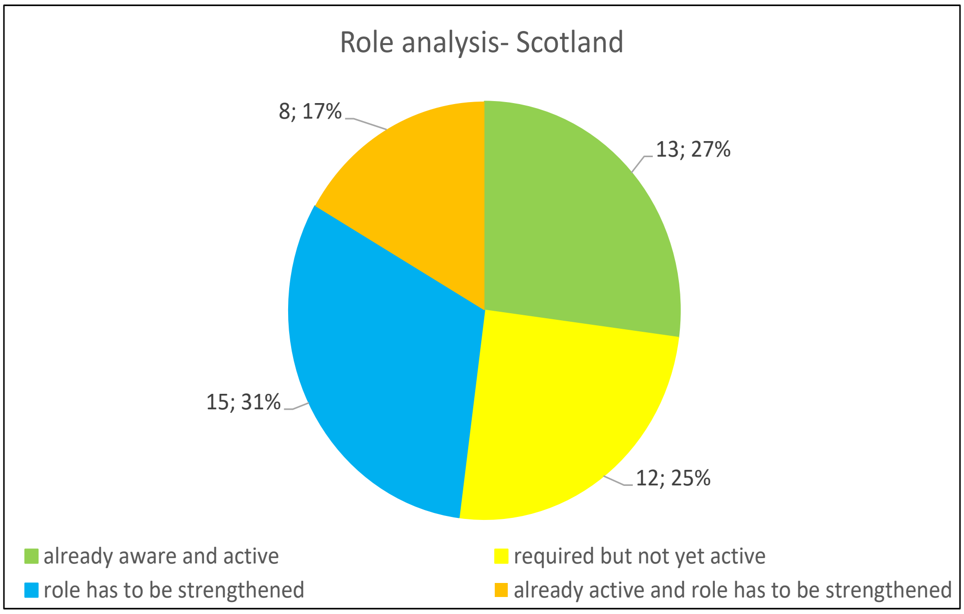


*Figure 3-16: Role analysis of the stakeholders in Scotland*

The role analysis of Scotland illustrates, that most of the stakeholder roles (31%) have to be strengthened. 13 of total 48 stakeholders are already aware and active, and a quarter of the stakeholders are required but not yet active. 17 % of the Scottish stakeholders are already active, but also have to be strengthened in their role. All in all, about 50% of the Scottish stakeholders have to be strengthened in more than one role.

## 3.6 Cross-country comparison

The stakeholders in the countries Austria, Sweden, Germany, and Scotland have different roles and are also mapped in different categories. The cross-country comparison in Table 3-1 highlights the main results of the stakeholder mapping in each country.

*Table 3-1: Cross-country comparison- stakeholder mapping in Austria, Sweden, Germany, and Scotland*

| Result | Austria (S.Burg. /Gasen) | Sweden | Germany | Scotland |
|---|---|---|---|---|
| **Role of the stakeholders** | | | | |
| **Political St./Governance** | 21% / 4% | 12% | 8% | 8% |
| **Technological St.** | 13% / 8% | 37% | 33% | 33% |
| **Economic St.** | 40% / 16% | - | 8% | 38% |
| **Social Stakeholder** | 10% / 60% | 13% | 17% | 11% |
| **Role analysis of the stakeholders** | | | | |
| **St.- role has to be strengthened** | 23% / 32% | n.a. | - | 48% |
| **St.- already aware and active** | n.a. / 56% | n.a. | 100% | 44% |
| **St.- required but not yet active** | n.a./- | n.a. | - | 25% |
| **Mapping categories of the stakeholders** | | | | |
| **St. role on the entire city level** | 4% / n.a. | 31% | n.a. | 8% |
| **St.- role in a specific sector/district/area** | 69% / n.a. | 56% | n.a. | 71% |
| **St.- "Driving" stakeholder** | 2% / n.a. | - | n.a. | 2% |
| **Role of the "Driving" stakeholder** | Social stakeholder | - | - | Social stakeholder |
| **St.- small role** | 2% / n.a. | 13% | n.a. | 2% |

Table 3-1 shows, that the main role of the stakeholders in each country is different. But in all the cases, social and technological stakeholders are strongly represented. Moreover, the social stakeholders are mainly the “driving” stakeholders, which illustrates their importance in the CLUE-project.

Referring to the role analysis of the stakeholders, in each country most of the stakeholder are already aware and active, which shows high ambitions of the stakeholders in each country. Only in the Scottish case, some stakeholders (25 %) are required but not yet active. However, even though there are many stakeholders already aware or active (as in the cases of Austria and Scotland), their role has still to be strengthened, which demonstrates that further support of many stakeholders is necessary.

Moreover, the stakeholder mapping in the countries Austria, Sweden, Germany, and Scotland shows that the stakeholder roles in the CLUE-project are mostly in a specific sector and/or in a specific area/district. It is noticeable, that more than the quarter of the stakeholders in Sweden have a role on the entire city level. Furthermore, with a maximum amount of 2 % of all stakeholders the number of “driving” stakeholders is very low. This illustrates that the topic of energy communities still needs further awareness raising and mobilisation of stakeholders in order to support the small number of “driving” stakeholders or even to increase the number of ambitious front runners

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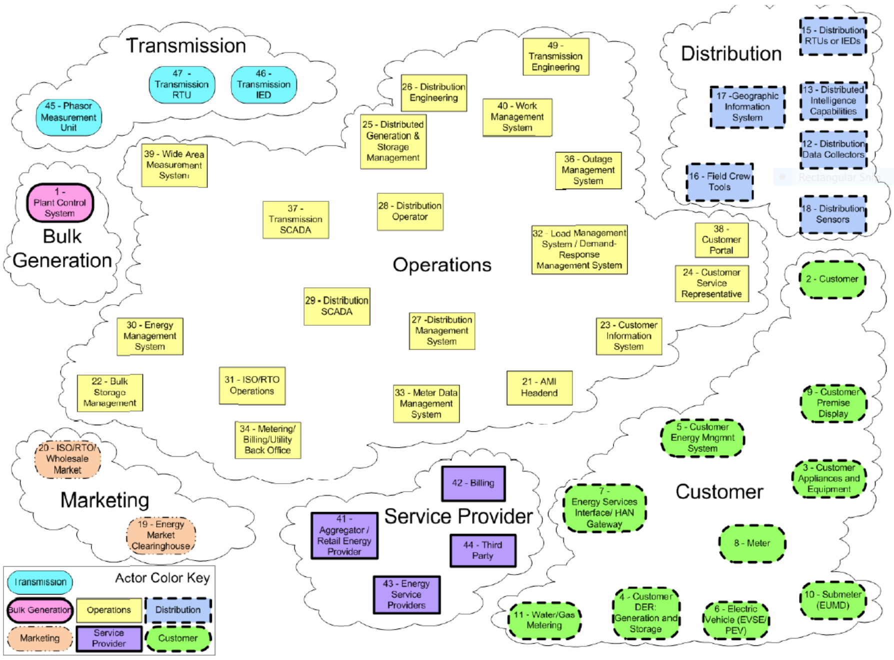
# APPENDIX

## A1: NISTIR 7628 Actors

NISTIR 7628 Guidelines for Smart Grid Cyber Security is another well-known standard from the NIST. In addition to providing the detailed cyber security mapping and recommendation with the Smart Grid, this standard also provides a list of actors in each of the NIST domains. A high-level view of these actors is provided in the figure below while a description of individual actors is presented in the table.




## A2: Description of the Actors in NIST domains

| S# | Actor Number | Domain | Actor | Acronym | Description |
|---|---|---|---|---|---|
| 1 | 1 | Bulk Generation | Plant Control System – Distributed Control System | DCS | A local control system at a bulk generation plant. This is sometimes called a Distributed Control System (DCS). |
| 2 | 2 | Customer | Customer | | An entity that pays for electrical goods or services. A customer of a utility, including customers who provide more power than they consume. |
| 3 | 3 | Customer | Customer Appliances and Equipment | | A device or instrument designed to perform a specific function, especially an electrical device, such as a toaster, for household use. An electric appliance or machinery that |

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| | | | | | may have the ability to be monitored, controlled, and/or displayed. |
| 4 | 4 | Customer | Customer Distributed Energy Resources: Generation and Storage | DER | Energy generation resources, such as solar or wind, used to generate and store energy (located on a customer site) to interface to the controller (HAN/BAN) to perform an energy-related activity. |
| 5 | 5 | Customer | Customer Energy Management System | EMS | An application service or device that communicates with devices in the home. The application service or device may have interfaces to the meter to read usage data or to the operations domain to get pricing or other information to make automated or manual decisions to control energy consumption more efficiently. The EMS may be a utility subscription service, a third party-offered service, a consumer-specified policy, a consumer-owned device, or a manual control by the utility or consumer. |
| 6 | 6 | Customer | Electric Vehicle Service Element/Plug-in Electric Vehicle | EVSE/PEV | A vehicle driven primarily by an electric motor powered by a rechargeable battery that may be recharged by plugging into the grid or by recharging from a gasoline-driven alternator. |
| 7 | 7 | Customer | Home Area Network Gateway | HAN Gateway | An interface between the distribution, operations, service provider, and customer domains and the devices within the customer domain. |
| 8 | 8 | Customer | Meter | | Point of sale device used for the transfer of product and measuring usage from one domain/system to another. |
| 9 | 9 | Customer | Customer Premise Display | | This device will enable customers to view their usage and cost data within their home or business. |
| 10 | 10 | Customer | Sub-Meter – Energy Usage Metering Device | EUMD | A meter connected after the main billing meter. It may or may not be a billing meter and is typically used for information-monitoring purposes. |
| 11 | 11 | Customer | Water/Gas Metering | | Point of sale device used for the transfer of product (water and gas) and measuring usage from one domain/system to another. |
| 12 | 12 | Distribution | Distribution Data Collector | | A data concentrator collecting data from multiple sources and modifying/transforming it into different form factors. |

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| 13 | 13 | Distribution | Distributed Intelligence Capabilities | | Advanced automated/intelligence application that operates in a normally autonomous mode from the centralized control system to increase reliability and responsiveness. |
| 14 | 14 | Distribution | Distribution Automation Field Devices | | Multifeatured installations meeting a broad range of control, operations, measurements for planning, and system performance reports for the utility personnel. |
| 15 | 15 | Distribution | Distribution Remote Terminal Unit/Intelligent Electronic Device | RTUs or IEDs | Receive data from sensors and power equipment, and can issue control commands, such as tripping circuit breakers, if they sense voltage, current, or frequency anomalies, or raise/lower voltage levels in order to maintain the desired level. |
| 16 | 16 | Distribution | Field Crew Tools | | A field engineering and maintenance tool set that includes any mobile computing and handheld devices. |
| 17 | 17 | Distribution | Geographic Information System | GIS | A spatial asset management system that provides utilities with asset information and network connectivity for advanced applications. |
| 18 | 18 | Distribution | Distribution Sensor | | A device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. |
| 18 | 19 | Marketing | Energy Market Clearinghouse | | Wide-area energy market operation system providing high-level market signals for distribution companies (ISO/RTO and Utility Operations). The control is a financial system, not in the sense of SCADA. |
| 20 | 20 | Marketing | Independent System Operator/Regional Transmission Organization Wholesale Market | ISO/RTO | An ISO/RTO control center that participates in the market and does not operate the market. From the Electric Power Supply Association (EPSA) Web site, "The electric wholesale market is open to anyone who, after securing the necessary approvals, can generate power, connect to the grid and find a counterparty willing to buy their output. These include competitive suppliers and marketers that are affiliated with utilities, independent power producers (IPPs) not affiliated with a utility, as well as some excess generation sold by traditional vertically integrated utilities. |

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| | | | | | All these market participants compete with each other on the wholesale market."15 |
| 21 | 21 | Operations | Advanced Metering Infrastructure Headend | AMI | This system manages the information exchanges between third-party systems or systems not considered headend, such as the Meter Data Management System (MDMS) and the AMI network.16 |
| 22 | 22 | Operations | Bulk Storage Management | | Energy storage connected to the bulk power system. |
| 23 | 23 | Operations | Customer Information System | CIS | Enterprise-wide software applications that allow companies to manage aspects of their relationship with a customer. |
| 24 | 24 | Operations | Customer Service Representative | CSR | Customer service provided by a person (e.g., sales and service representative) or by automated means called self-service (e.g., Interactive Voice Response [IVR]). |
| 25 | 25 | Operations | Distributed Generation and Storage Management | | Distributed generation is also referred to as on-site generation, dispersed generation, embedded generation, decentralized generation, decentralized energy, or distributed energy. This process generates electricity from many small energy sources for use or storage on dispersed, small devices or systems. This approach reduces the amount of energy lost in transmitting electricity because the electricity is generated very near where it is used, perhaps even in the same building. |
| 26 | 26 | Operations | Distribution Engineering | | A technical function of planning or managing the design or upgrade of the distribution system. For example:<br>The addition of new customers,<br>The build out for new load,<br>The configuration and/or capital investments for improving system reliability. |
| 27 | 27 | Operations | Distribution Management Systems | DMS | A suite of application software that supports electric system operations. Example applications include topology processor, online three-phase unbalanced distribution power flow, contingency analysis, study mode analysis, switch order management, short-circuit analysis, volt/VAR management, and loss analysis. These applications provide operations staff and engineering |

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| | | | | | personnel additional information and tools to help accomplish their objectives. |
| 28 | 28 | Operations | Distribution Operator | | Person operating the distribution system. |
| 29 | 29 | Operations | Distribution Supervisory Control and Data Acquisition | SCADA | A type of control system that transmits individual device status, manages energy consumption by controlling compliant devices, and allows operators to directly control power system equipment. |
| 30 | 30 | Operations | Energy Management System | EMS | A system of computer-aided tools used by operators of electric utility grids to monitor, controls, and optimize the performance of the generation and/or transmission system. The monitor and control functions are known as SCADA; the optimization packages are often referred to as "advanced applications." (Note: Gas and water could be separate from or integrated within the EMS.) |
| 31 | 31 | Operations | ISO/RTO Operations | | Wide-area power system control center providing high-level load management and security analysis for the transmission grid, typically using an EMS with generation applications and network analysis applications. |
| 32 | 32 | Operations | Load Management Systems/Demand Response Management System | LMS/DRMS | An LMS issues load management commands to appliances or equipment at customer locations in order to decrease load during peak or emergency situations. The DRMS issues pricing or other signals to appliances and equipment at customer locations in order to request customers (or their preprogrammed systems) to decrease or increase their loads in response to the signals. |
| 33 | 33 | Operations | Meter Data Management System | MDMS | System that stores meter data (e.g., energy usage, energy generation, meter logs, meter test results) and makes data available to authorized systems. This system is a component of the customer communication system. This may also be referred to as a 'billing meter.' |
| 34 | 34 | Operations | Metering/Billing/Utility Back Office | | Back office utility systems for metering and billing. |
| 35 | 36 | Operations | Outage Management System | OMS | An OMS is a computer system used by operators of electric distribution |

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| | | | | | systems to assist in outage identification and restoration of power.<br>Major functions usually found in an OMS include:<br>• Listing all customers who have outages.<br>• Prediction of location of fuse or breaker that opened upon failure.<br>• Prioritizing restoration efforts and managing resources based upon criteria such as location of emergency facilities, size of outages, and duration of outages.<br>• Providing information on extent of outages and number of customers impacted to management, media, and regulators.<br>• Estimation of restoration time.<br>• Management of crews assisting in restoration.<br>• Calculation of crews required for restoration. |
| 36 | 37 | Operations | Transmission SCADA | | Transmits individual device status, manages energy consumption by controlling compliant devices, and allowing operators to directly control power system equipment. |
| 37 | 38 | Operations | Customer Portal | | A computer or service that makes available Web pages. Typical services may include customer viewing of their energy and cost information online, enrollment in prepayment electric services, and enablement of third-party monitoring and control of customer equipment. |
| 38 | 39 | Operations | Wide Area Measurement System | WAMS | Communication system that monitors all phase measurements and substation equipment over a large geographical base that can use visual modeling and other techniques to provide system information to power system operators. |
| 39 | 40 | Operations | Work Management System | WMS | A system that provides project details and schedules for work crews to construct and maintain the power system infrastructure. |
| 40 | 41 | Service Provider | Aggregator/Retail Energy Provider | | Any marketer, broker, public agency, city, county, or special district that combines the loads of multiple end-use customers in facilitating the sale and purchase of electric energy, transmission, and |

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| | | | | | other services on behalf of these customers. |
| 41 | 42 | Service Provider | Billing | | Process of generating an invoice to obtain reimbursement from the customer. |
| 42 | 43 | Service Provider | Energy Service Provider | ESP | Provides retail electricity, natural gas, and clean energy options, along with energy efficiency products and services. |
| 43 | 44 | Service Provider | Third Party | | A third party providing a business function outside of the utility. |
| 44 | 45 | Transmission | Phasor Measurement Unit | PMU | Measures the electrical parameters of an electricity grid with respect to universal time (UTC) such as phase angle, amplitude, and frequency to determine the state of the system. |
| 45 | 46 | Transmission | Transmission IED | | IEDs receive data from sensors and power equipment and can issue control commands, such as tripping circuit breakers if they sense voltage, current, or frequency anomalies, or raise/lower voltage levels in order to maintain the desired level. A device that sends data to a data concentrator for potential reformatting. |
| 46 | 47 | Transmission | Transmission RTU | | RTUs pass status and measurement information from a substation or feeder equipment to a SCADA system and transmit control commands from the SCADA system to the field equipment. |
| 47 | 49 | Transmission | Transmission Engineering | | Equipment designed for more than 345,000 volts between conductors. |

## A3: Actor Classification

| Primary | Secondary | Supporting |
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| • **Its goals are directly served by the system**<br>• Its functionality and behavior requirements are the basis for the system's functionally and are addressed in the Use Cases<br>• Can initiate an interaction with the system<br>• Obtains some business value from the system | • **Helps primary actor**<br>• Initiate integration on behalf of primary actor with system<br>• Can not exist on its own without a primary actor | • **Helps system**<br>• Provides support to system in achieving goals for a primary actor |

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