

## THE FUTURE RELATION AND ROLES OF LOCAL ENERGY COOPERATIVES AND DSOs

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### ABSTRACT

*The paper focuses on the future roles and responsibilities of distribution system operators (DSOs) due to the rising number of new stakeholders in the electricity market, such as local services energy cooperatives (LSECs). LSECS are regarded as new drivers to realize the energy transition and may change existing institutions and infrastructures. DSOs manage these infrastructures and, therefore, the paper analyses the visions of LSECs and ways in which DSOs can contribute to their development. Subsequently, it identifies three different organization models of DSOs in order to show the interaction possibilities between DSOs and LSECs. The 'market facilitator' organization model poses little change to the current organization model of DSOs and this paper demonstrates that DSOs are not able to empower the development of LSECs, neither the desired visions by LSECs. Other (market) parties should take this role and the interaction between DSOs and LSECs will, therefore, remain indirect and managed through the market.*

### INTRODUCTION

The Dutch electricity sector has undergone important changes in recent years. The increasing focus on climate change and sustainability has led to more decentralized energy production and electrification of our society, and new stakeholders enter the energy landscape. Overall, the electricity system is transforming towards a more horizontal and bi-directional system dynamic, which also influences roles and responsibilities of both existing and new stakeholders [1]. One of these new stakeholders are local service energy cooperatives (LSECs). These cooperatives desire to develop towards local energy systems, which represents an agglomeration of households and small enterprises within an area, that use and manage their own production and supply of sustainable energy. Successful implementation of these local energy systems cannot be obtained without structural changes to existing industry, institutions and infrastructures [2]. Distribution System Operators (DSOs) currently manage these infrastructures and therefore the emergence of LSECs might influence their operation strategies.

Because of a DSO's monopolistic nature, their responsibilities are limited to legal activities. However, the energy transition seems to pose changes to the

structure of optimal regulatory schemes. For example, sustainability issues cover the responsibilities of several stakeholders and therefore collaboration opportunities might be needed to transform current electricity systems successfully.

Therefore, the aim of this paper is to explore the possible roles of Dutch DSOs in the future energy landscape in relation to local energy cooperatives. These roles should be able to describe the visions of local energy cooperatives and ways in which DSOs can contribute to their development.

The empirical part of the study focuses on local energy cooperatives and DSOs in the Netherlands. Fifteen local energy cooperatives are interviewed about their development process and visions on DSO engagement. In addition, a DSO focus group and three expert interviews as well as relevant policy and regulatory documents are data entries in this research to shed light on the feasibility of these new roles of DSOs. First, the ambitions of LSECs are explained to understand role suggestions for DSOs. Second, the existing interaction between the studied stakeholders and visions on future DSO roles are given. The paper ends with embedding these visions into three local system organization models.

### LSEC AMBITIONS

#### Desired System Configuration

LSECs use self-sufficiency as a guiding principle and have a multi-faceted orientation [3]. LSECs focus on energy user awareness, energy savings, local sustainable generation and energy supply. Sustainability is approached using a user-centric perspective, meaning that a bottom-up approach towards energy neutrality is used and participation of the local community is the main determinant of success. As existing regulations and industry structure are based on a central-system configuration, LSECs opt for integral multi-stakeholder projects with horizontal relations and local system support.

#### Barriers in Development

Because of lacking opportunities and resources, not all desires of LSECs are substantiated by ongoing projects and therefore their development is an ongoing process. For example, LSECs desire to trade electricity between households to reach energy neutrality on the smallest

possible scale. Lacking power and scale of the community organizations as well as existing energy regulations, fragmented stakeholder responsibilities and lacking clarity on development paths towards sustainable energy systems are important barriers encountered by the studied LSECs. Therefore, the engagement of other stakeholders (such as DSOs) is desired in the development of local energy systems.

## LSEC AND THE ROLE OF DSOs

### Current DSO role

Currently, DSOs are involved in LSEC practices in three ways: by connecting collective generating technologies to the distribution grid, giving advice about energy savings and by being involved in the monitoring of energy usage. The first activity fits with the role of the traditional grid manager, which means to deliver reliable and affordable energy to their customers with a high service level. The last two activities, achieving energy savings and creating data insights are not part of DSOs traditional responsibilities and indicate changing practices of DSOs.

### Vision DSO roles by LSECs

According to local energy cooperatives, DSOs could act in the future as grid manager, as energy controller, as political lobbyist, as data translator, as an advisor of infrastructure and of local energy systems, and as service provider. Although local energy cooperatives suggest these different roles, from our results it appears that the visions of local energy cooperatives differs from the current role of DSOs. Only one of the suggested roles matches, which is the role of 'infrastructure advisor' (see Table 1).

Not surprisingly, the focus of DSO visions on the future are broader than only on local energy systems since the development of these local systems does not seem to fit all grid users. In our study, the interviewed DSOs regard LSECs as a small development which not yet imposes changes to network design. Because of lacking insights on the functions and features of local energy systems, it seems to be most important to explore these first before deciding which responsibilities should be given to certain stakeholders.

**Table 1. Vision DSO roles**

Role	Vision LSEC <sup>1</sup> on role DSO	Current role DSO
Grid manager	<ul style="list-style-type: none"> <li>▪ Distributing energy</li> <li>▪ Making possible local transports and matching</li> <li>▪ Developing storage facilities</li> </ul>	<ul style="list-style-type: none"> <li>▪ Developing storage facilities</li> </ul>
Energy controller	<ul style="list-style-type: none"> <li>▪ Keeping frequency stable</li> <li>▪ Coordinating energy flows by managing congestions</li> </ul>	<ul style="list-style-type: none"> <li>▪ <i>No data</i></li> </ul>
Political Lobbyist	<ul style="list-style-type: none"> <li>▪ Active lobby for changes to energy policy and network costs</li> </ul>	<ul style="list-style-type: none"> <li>▪ Support for system changes related to core responsibility</li> </ul>
Data translator	<ul style="list-style-type: none"> <li>▪ Software development</li> <li>▪ Distributing data devices</li> <li>▪ Data insights via graphs and figures</li> </ul>	<ul style="list-style-type: none"> <li>▪ Data insights via graphs and figures</li> </ul>
Advisor infrastructure	<ul style="list-style-type: none"> <li>▪ Sharing knowledge on network for optimal placement of distributed generation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Sharing knowledge on network for optimal placement of distributed generation</li> </ul>
Advisor local energy systems	<ul style="list-style-type: none"> <li>▪ Local energy scenarios</li> </ul>	<ul style="list-style-type: none"> <li>▪ Local energy scenarios</li> <li>▪ Energy regulations and legal issues</li> </ul>
Service provider	<ul style="list-style-type: none"> <li>▪ ESCO concept for energy consumption</li> <li>▪ Flexible payment schemes for connections</li> </ul>	<ul style="list-style-type: none"> <li>▪ Case-specific solutions</li> <li>▪ Administrative services for local matching</li> </ul>

<sup>1</sup> LSEC= Local Service Energy Cooperative

Despite these limitations, two visions appear to be common ground between these two stakeholders. First, more differentiation in energy transportation costs are envisioned as a future development, inducing sustainable behaviour and increasing network efficiency. Second, local matching of energy generation and consumption is a LSEC desire and can decrease network investment as well as transmission losses for DSOs. In local matching, it seems to be sufficient for LSECs to match their total annual energy need with locally generated energy. However, matching has to be done real-time to positively influence the utilization of electricity distribution networks. Therefore, active involvement of DSOs in this matching process is desired for the development of local electricity systems which DSOs can deploy by creating data insights, actively managing power flows within the network to avoid congestions or apply some kind of dynamic network tariff.

The monopolistic nature of DSOs makes it difficult to decide which of the suggested roles must be enabled. The suggested DSO roles include both opportunities and barriers in the regulatory scene (see Table 2). The main barrier in direct LSEC-DSO interaction is the European wide unbundling of the energy sector in which a market-oriented sector organization is promoted. Therefore, capabilities of DSOs cannot be used to a full extend as market parties must carry out these roles.

**Table 2. Regulatory opportunities and barriers**

Role	Opportunities	Barriers
Grid manager	<ul style="list-style-type: none"> <li>▪ Creating local infrastructures</li> </ul>	<ul style="list-style-type: none"> <li>▪ Developing storage facilities as these are seen as production units</li> </ul>
Energy controller		<ul style="list-style-type: none"> <li>▪ Transmission system operators are responsible</li> </ul>
Political Lobbyist	<ul style="list-style-type: none"> <li>▪ Lobbying for dynamic tariffs, Creating transparency in energy regulations</li> </ul>	
Data translator	<ul style="list-style-type: none"> <li>▪ Providing aggregated data insights to the market (e.g. local matching)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Market service</li> <li>▪ Privacy constraints</li> <li>▪ Probably additional ICT needed</li> </ul>
Advisor infrastructure		<ul style="list-style-type: none"> <li>▪ Market service</li> </ul>
Advisor local energy systems	<ul style="list-style-type: none"> <li>▪ Sharing knowledge</li> <li>▪ Open-information platforms to the market</li> </ul>	<ul style="list-style-type: none"> <li>▪ Market service</li> <li>▪ Privacy constraints</li> </ul>
Service provider	<ul style="list-style-type: none"> <li>▪ Providing customer-specific solutions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Standardized network tariffs do now allow case-specific deviations</li> <li>▪ Financing the energy transition is not possible</li> </ul>

**DSO ORGANIZATION MODELS**

Besides the different views from both actors, three organization models for DSO interaction with local energy cooperatives are developed from our analyses: local system shaper, local market facilitator and local grid connector. These organization models include varying levels of control for the involved actors (see Figure 1).

As shown in Figure 1, the developed organization models for DSOs indicate that the interaction between DSOs and local energy cooperatives can be direct or indirect and show varying levels of control on local system practices. DSOs can be actively involved in determining the system configuration, enable the market to fulfill this role or be ‘excluded’ from the local system and merely operate as a local grid connector on a regional or even national level.



Figure 1: Three organization models for DSO interaction with local service energy cooperatives (LSEC); the dot size indicates how much control an actor has on the system configuration.

**Local System Shaper**

In this organization model, DSOs exploit an active role in the creation and development of local energy systems. DSOs use their knowledge of energy infrastructure to consult on local favorable solutions for connections to the grid. DSOs develop and control local infrastructures and facilitate local electricity transports. They invest in storage facilities when necessary for efficient grid management, control local energy flows and actively

coordinate local matching of these flows by managing congestions. The relation between local energy cooperatives and DSOs is direct and collaborative. Furthermore, DSOs become active project participants in managing the projects and assist in mobilizing relevant stakeholders and resources. Providing energy services by means of an Energy Service Company (ESCO) model exploited by DSOs, is also a possibility in this model.

Being a local system shaper, DSOs provide expertise and have great influence on the system configuration. Third parties do not actively influence the system configuration but are still part of the local system in providing products and services.

**Local market facilitator**

In this social organization, shared DSO expertise (data knowledge available under strict privacy conditions) is openly available to the market, so that market parties are responsible for effective translations of energy data. They do this by developing applications and ICT systems creating insights for consumers. As market facilitators, DSOs enable market parties to develop desired local energy systems. Market parties thus mediate the relation between DSOs and local energy cooperatives. DSOs are still responsible for managing the distribution network but have less control over local practices as they do not participate directly in matching generation and demand. As the relation between local energy cooperatives and DSOs is indirect, the market will mainly determine the system configuration in this model.

**Local Grid Connector**

In this organization model, the market for infrastructure development opens up and local energy cooperative organizations are responsible for the construction and management of local infrastructures. Traditional DSOs are thus not part of such local grids. DSOs could become responsible for managing energy flows between local energy systems and therefore DSOs could be seen as back-up manager of the national electricity system.

In this model, local energy cooperatives have developed to professional organizations and controllers of the local system configuration. They manage all functions included in the local system (energy generation, delivery, infrastructure development, transporting energy to households) and determine the strategies for user involvement.

**Current DSO organization model**

The model of local market facilitator mostly fits the current role of DSOs. Within this model, it is possible to adapt existing services to local energy cooperatives developments (such as providing general energy data of local systems to the market). However, market parties are responsible for translating DSO expertise into applications and insights.

Currently, the model of local grid connector seems less likely to happen because local energy cooperatives are not yet able to function as stand-alone systems.

## CONCLUSIONS

Although stipulating DSO roles is difficult because of the dynamic character of LSEC developments and uncertainties about the future and future regulations, two fitting future DSO practices can be derived from the above analysis. First of all, practice with more differentiation in energy (transportation) costs. This differentiation may increase network efficiency by knowing what the right times and places for energy consumption and generation are. Currently, Dutch DSOs actively experiment with different pricing systems in their smart grid pilots. These results provide indications how these tariffs should be set up in order to increase grid efficiency and at the same time induce more sustainable behavior.

Secondly, the development of data insights for both energy consciousness and local matching are opportunities for DSOs. To ensure that local matching positively influences grid management, active engagement of DSOs seems to be necessary. Because of lacking geographical proximity of community members, mismatches in timings of electricity demand and generation, and dependency on central production facilities on peak moments, there is a need for experiments to learn in which ways local matching can be realized and what changes this proposes to infrastructure development and the system configuration.

Relating these findings to the three DSO organization models, the development of privately operated micro-grids includes the most radical change to existing DSO responsibilities. However, the local grid connector model currently seems less likely to happen as the energy systems managed by LSECs are not yet stand-alone systems. The explored regulative trends do not indicate much changes to existing DSO roles and therefore the most likely future DSO organization is that of a 'local market facilitator'. This finding is in line with the conclusions of a research on the future roles of DSOs conducted on behalf of the European Commission [4].

The 'market facilitator' organization model poses little change to the current organization model of DSOs and this paper demonstrates that DSOs are not able to empower the development of local energy systems, neither the desired visions by LSEC organizations. Moreover, the results of our paper indicate that it is not the role of the DSO to stimulate the development of LSECs, but other (market) parties should take this role. To solve the resource issues of LSECs, it is important that other parties, such as independent service providers,

enter local energy systems' development to provide expertise and tools. Although DSOs are not able to empower LSEC developments, there are opportunities to experiment with future network configurations and management. The interaction between DSOs and LSECs will, therefore, remain indirect and managed through the market due to the ongoing European wide unbundling of the energy sector.

### Notification:

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