FLEXPOSTS

FLEXIBLE ENERGY POSITIVITY DISTRICTS

Report:

Working towards a Positive Energy District for Business Park De Zwette, Leeuwarden:

Exploring Stakeholder Perspectives

Kim van Dam, Entrance, Hanze University of Applied Sciences

Project Title	FLEXPOSTS
Project Duration	2022 - 2025
Project Coordinator	Hanze University of Applied Sciences
Report Title	Working towards a Positive Energy District for Business Park De Zwette, Leeuwarden: Exploring Stakeholder Perspectives
Deliverable N°	Part of Deliverable D4.2 Barriers to implementing PEDs in The Netherlands and D4.3 Mapping of existing partnerships and Networks
Work Package N°	4
Dissemination Level	Internal
Lead Organisation	HUAS
Contributing Organisations	HUAS
Publication Date	2025
Author	Kim van Dam
With contributions from	
Information to be use for citation of this report	Van Dam, K.I.M. (2025) Working towards a Positive Energy District for Business Park De Zwette Leeuwarden: Exploring Stakeholder Perspectives. FLEXPOSTS. Vienna: JPI Urban Europe.
Version	06.03.2025
Status	Final

No.	Partner Organizations	Short name	Country
1	Hanze University of Applied Sciences	HUAS	Netherlands
2	Aalborg University	AAU	Denmark
3	Stichting New Energy Coalition	NEC	Netherlands
4	Green Hub Denmark	GHD	Denmark
5	Gemeente Leeuwarden	LWD	Netherlands

Dissemination level

PU	Public	
CO	Confidential	x

Version history

Version	Description	Lead Author	Date
V1	Template	HUAS	July 2024
V2	Draft	HUAS	September 2024
V3	Prefinal	HUAS	Oktober 2024
V4	Draft review	Aalborg University, HUAS	December 2024
V5	Prefinal	Stakeholders	December 2024
V6	Final report	HUAS	February 2025

DISCLAIMER

The FLEXPOSTS project has received funding from National Agencies under the JPI URBAN EUROPE- PED Programme Management, with Project number: 43979516.

CONTENTS

List of Figures

Abbreviations

In the text the abbreviations between brackets refer to specific information that was obtained during the interviews with one of the stakeholders: ML = municipality of Leeuwarden; L = Liander; PF = province of Fryslân; BPA = Business Park Association De Zwette

1 Introduction

This report outlines the results of a stakeholder analysis in the De Zwette case in Leeuwarden that was done as part of the JPI Urban Europe project Flexposts. Central concept in Flexposts is the PED or Positive Energy District that can be defined as an area with a net positive energy balance annually. PEDs can play an important role in the energy transition for urban areas. The aim of the Flexposts project is to provide replicable strategies for improving the process of creating PEDs with a particular emphasis on stakeholder engagement, and to create replicable innovative business models for flexible energy systems. One of the overarching assumptions of Flexposts is that the implementation of PEDs requires the integration of energy planning in urban planning processes, as well as establishing a committed network of stakeholders from public and private stakeholders. Overall, the Flexposts project aims to contribute to finding an interdisciplinary approach for integrating energy and urban planning processes and involving and engaging stakeholders in the implementation of PEDs. In Flexposts, this is done using two case studies in Aalborg, Denmark and Leeuwarden, the Netherlands.

The Leeuwarden case concerns the largest business park/industrial estate of the city: De Zwette. The ambition is to make De Zwette business park 'sustainable'. This includes taking measures directed towards climate adaptation, increasing biodiversity, and reducing CO2 emissions, which is the focus in the Flexposts project. For the De Zwette business park hypothetically, applying the principle of PED, means that businesses on the Zwette on a yearly base must generate more renewable energy collectively than they use. This can be done in multiple ways: through saving energy, the instalment of renewable energy technologies, using and exchanging surplus heat, etc. The ambition to make the business park sustainable is supported by various stakeholders such as the local and regional government, and the parks' business association. However, so far, most efforts to turn De Zwette into a sustainable business park have been seriously limited by the congestion of the electricity grid.

Based on this insight, as part of the Flexposts project, Hanze University of Applied Sciences, together with some of the stakeholders have investigated the techno-economic and legal situation regarding grid congestion, identifying barriers, and exploring possible solutions. In addition to that, we have also conducted a further analysis aimed to gain more insight in stakeholders' perspectives in relation to the issues at stake. In this report we present the findings of this investigation. Three related, overarching topics/angles of the Flexposts project are leading this inquiry:

1) The identification and mapping of relevant stakeholders (the transdisciplinary dimension)

2) Finding out what barriers stakeholders encounter in relation to the PED/sustainability concept, focussing on grid congestion

3) Consider the interaction/alignment between energy planning and urban planning (the inter or multi-disciplinary dimension)

This leads to three related research questions: 1) What are the stakeholders' roles, perspectives and perceived barriers on grid congestion in the context of implementing PED and/or sustainability measures at business park De Zwette? 2) What are the effects of grid congestion on urban planning? 3) and what are the implications of this for the interaction or alignment between energy planning and urban planning, and how can this be improved?

For this research, we interviewed a selection of stakeholders. The interviewees were representatives of the municipality of Leeuwarden, the province of Fryslân, grid operator Liander and the business association of the Zwette. The interviews were directed towards grid congestion and 1) the different roles that these stakeholders have in relation to the topic; 2) the identification of barriers; and ultimately, 3) interviews were aimed towards getting insights to the current state of the interaction between energy planning and urban planning. In addition, we used document analysis and other insights to complement the results.

2 Case description: De Zwette, Leeuwarden[1]

Business park De Zwette

De Zwette is a business and shopping park located on the southwestern side of Leeuwarden, linked to major traffic routes the N31 and A32 (see Figure 1). It is the largest business park in Fryslân with approximately 400 companies facilitating around 6000 jobs. Industrial sectors on de Zwette range from production industry, wholesale, retail and business services to kitchen stores, hardware stores and offices. De Zwette is a spacious business park with plenty of water and greenery.

The De Zwette business park is divided into different zones (De Zwette I to VI). Each zone has its own specifications and conditions. A large part of what is now known as De Zwette has emerged from existing industrial areas (Schenkenschans, later Bedrijventerrein Leeuwarden West), gradually expanding with new areas such as the Newton Parks.[2] In 2012 these areas were brought together in business park De Zwette, the name being based on a waterway that connected Leeuwarden with the town of Sneek. The newer parts of De Zwette are currently being developed, notably Zwette VI, while there are also various locations available on Zwette IV and V (ML). There are currently no companies located at De Zwette VI. Construction on the new site is expected to begin in a few years.[3]

As part of the development of Zwette VI, a special area development project is underway: the WTC area development/transformation with the Eleven Cities Park that accommodates the new stadium of the local soccer team FC Cambuur. The construction of this new stadium creates more dynamics in the area as shops, catering facilities, offices, and indoor activities (leisure) will be added to the development of the stadium. Two new supermarkets have been established and the new Cambuur Stadium also houses educational facilities (ROC Friese Poort).

De Zwette has a sustainability ambition: the park intends to be an energy-neutral and circular business park by 2035. The first steps have been taken. First, since 2019, de Zwette is the location of the Energy Campus. Here, organizations work together on the energy transition through smart cross-pollination between companies, knowledge institutions and government. There are companies that produce sustainable energy, startups for innovations and close collaboration with knowledge institutions. Second, there are a number of renewable energy production facilities on de Zwette. There is currently 4 MW of installed solar PV capacity on the roofs of buildings and some large solar parks are situated close to the Zwette that are connected to the same electricity grid (see Figure 2 and Figure 3). Additionally, there are 2 wind turbines with a capacity of 0,9 MW each linked to the grid.

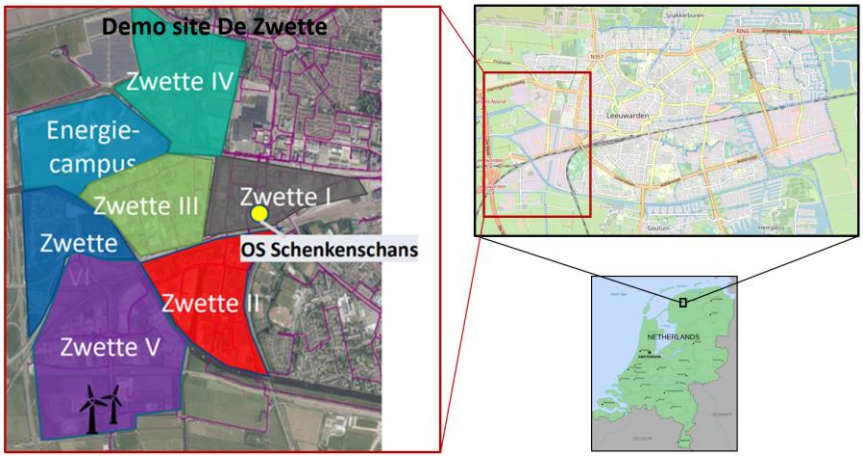


Figure 1: Location of the demo site De Zwette

[1] This is an edited and updated text based on previous documents in the Flexposts project.

[2] The original business association was founded in 1991. See for timeline: https://www.dezwette.nl/vereniging/tijdlijn/

[3] Source: https://ondernemendleeuwarden.nl/locatie/bedrijventerrein-de-zwette/

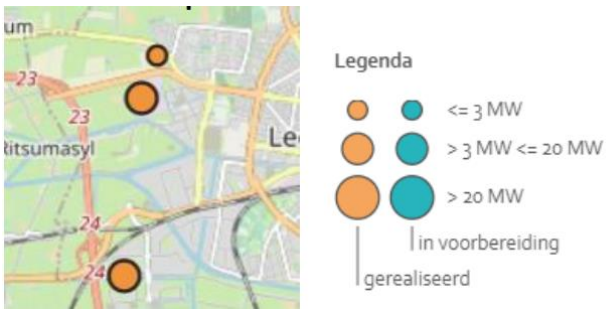


Figure 2: Location of large solar parks at the demo site De Zwette

Grid congestion on de Zwette

In terms of electricity, the Zwette-site consists mainly of light, medium, and heavy industry, with mostly small to medium enterprises and a few large consumers of electricity (connection of >400 kW). For the near future, there are plans to further expand the De Zwette site, creating space for more industrial development and also, new plans for the production of renewable energy are being developed. However, the recent development of the area has resulted in congestion of the electricity grid, such that there is no longer space for adding production, impacting both the existing and newly planned activities.

This congestion relates both to the feed-in of electricity, and to the supply of electricity.[4] The congestion for feed-in is at TenneT level or the high voltage transport connection at the Schenkenschans substation (see Figure 3), one of the two substations in Leeuwarden. This implies that for the time being no additional renewable electricity can be returned to the grid. The congestion for electricity supply is at the DSO Liander or station and substation level. The congestion is caused by overloading of the installations at the Schenkenschans substation (see Figure 3). De Zwette shares this substation with many other users, including households in the western part of the city. The grid is described as a complex grid with many connected loops and branches (ML). Grid expansion will only be available from 2027 onwards, when the construction of new connections at the Leeuwarden substation (the other main substation in the city of Leeuwarden) is ready. So far, there is no congestion in the distribution (mid voltage) network.

Therefore, for the demo site De Zwette, the specific issue that is addressed in the Flexposts project is electricity grid congestion. The (local) electricity grid congestion is partly caused by the large increase of demand, and the non-dispatchable nature coupled with the decentralized production capabilities of solar and wind, which at times give a large surplus in production and congestion on a local level. This can raise issues, such as a limit on the amount of newly distributed intermittent energy resource projects that can be integrated, the number of new consumers/businesses that can be connected to the grid, and/or the ability of existing consumers/businesses to switch from fossil fuel energy to (renewable) electricity sources. As such these local constraints can stifle the energy transition.

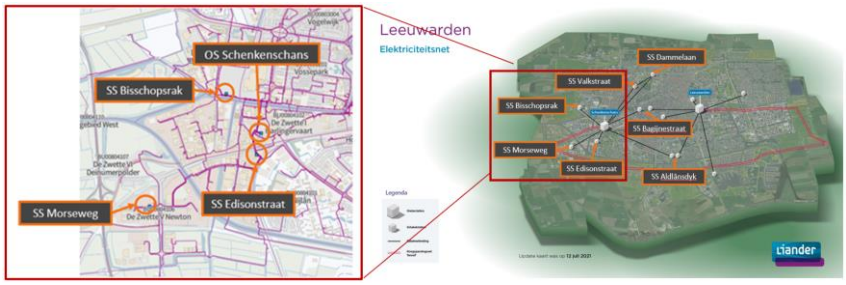


Figure 3: Map of De Zwette area with electricity grid, the main electricity grid transformation and switching stations.

[4] Flexposts methodolgical guide report D3.1_ver 1

3 Stakeholder engagement

Introduction

In Flexposts, most of research focusses on the techno-economic challenges of the Zwette. Traditionally, the intervention by the electricity grid system operator is to reinforce or expand the grid. Although there may be other options such as flexibility and storage, these are historically not studied in depth. The techno-economic research in Flexposts investigates the techno-economic impact of some of these alternative solutions/options that can ameliorate grid congestion, while taking into account regulatory, structural and technical barriers. In addition, we also need to consider the perspectives of stakeholders. After all,

> "The importance of involving the relevant stakeholders in the implementation of PEDs is continuously stressed in the PED literature. In fact, the involvement of stakeholders has been highlighted as one of the biggest success factors for the implementation of PEDs (Bossi et al., 2020). Developing a strategy for engaging (local) stakeholders in the development of a PED in the two demo sites is therefore an important step in the PED implementation process. The (local) stakeholders not only provide important (local) knowledge and different perspectives into the process in accordance with FLEXPOSTS' transdisciplinary approach, but their engagement is also important for developing a local governance capacity, e.g. a public-private partnership, that can take on and promote the PED-agenda in the demo sites beyond FLEXPOSTS' lifespan. In other words, stakeholder engagement is crucial for establishing a permanent network, working towards the sustainable energy transition in the two demo sites. The (local) stakeholders are therefore involved in various phases throughout the FLEXPOSTS project".[5]

How this is done will be further explored in this chapter.

Flexposts' stakeholder engagement methodology

The main stakeholder engagement methodology for Flexposts was developed in an earlier stage of the project (see Figure 4 based on The Carbon Trust, 2018).[6]

Figure 4: Five steps of stakeholder engagement (The Carbon Trust 2018: 7)

Five steps have been distinguished starting with 1) identify the relevant stakeholders in the project; 2) map out the stakeholders to develop an understanding of stakeholders' motivation for engaging; 3) prioritise between the stakeholders in terms of who are the most important stakeholders to engage for

[5] Methodological guide Flexposts report D3.1_ver 1

[6] The initial methodological considerations for stakeholder engagement can be found in the stakeholder section 3.5.1 and 3.5.2. of the methodological guide.

success; 4) prepare and plan a stakeholder engagement strategy; 5) the actual engagement phase. (The Carbon Trust, 2018).

Below is an account on how this was implemented in Flexposts.

Stakeholder identification

The initial identification, mapping, and prioritisation of the stakeholders (step 1,2,3) in the two demo sites has been carried out in the first phase of the project (see also Figures in Methodology Report).

As in De Zwette the main issue is congestion on the electricity grid, stakeholders were identified after mapping the existing congestion in the area. Grid congestion is hindering both economic development as well as achieving sustainability targets such as renewable energy production and electrification of industrial processes. As such, grid congestion also hinders the development of the PED. Therefore, the first step in our stakeholder analysis for De Zwette was focused on mapping the existing congestion in the area.

Based on these insights, the main stakeholders for De Zwette were identified as: the municipality of Leeuwarden; the local grid operator Liander; the businesses located in De Zwette area and the province of Fryslân. The linking pin within this network of stakeholders is the municipality of Leeuwarden, as they are actively engaging the stakeholders, supporting ideas, and coordinating projects. The DSO Liander is collaborating with the FLEXPOSTS partners in the search for solutions to the local grid congestion. The province of Fryslân is not directly involved on the local level of De Zwette; however, they are overseeing issues of grid congestion in the wider context of economic development. Finally, organized in the Business Association De Zwette, the companies of De Zwette are proactively following any development that can help create more room on the electricity grid for companies to grow or new companies to settle in De Zwette. Figure 5 presents a list of the key stakeholders identified in the case of demo site De Zwette, including some key characteristics of these stakeholders in relation to grid congestion.

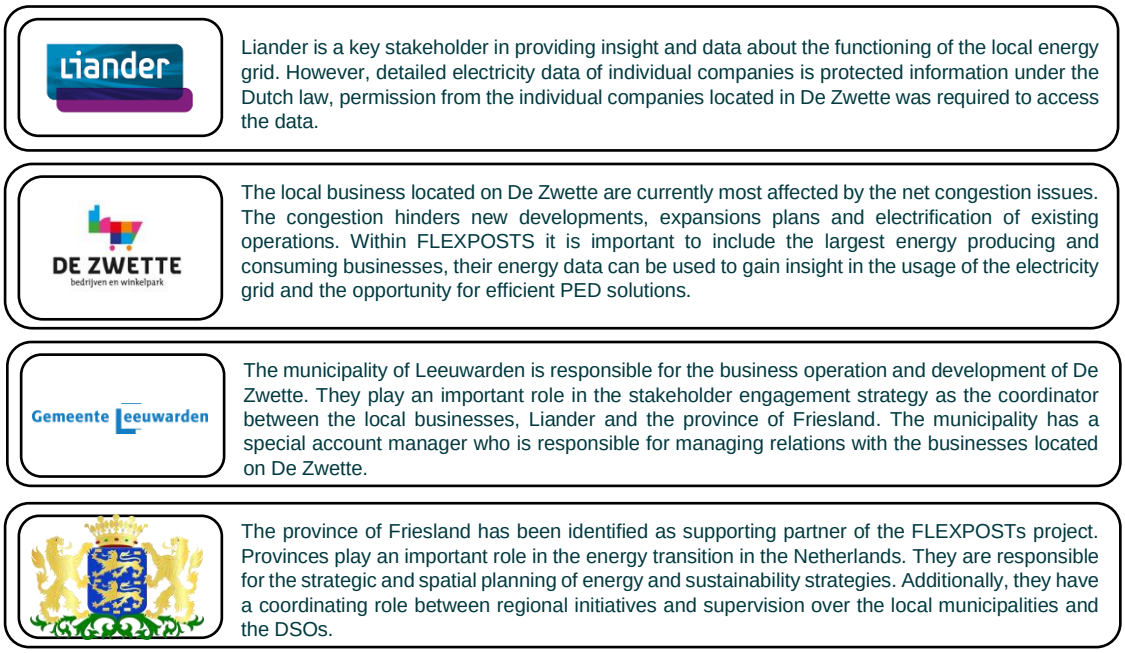


Figure 5: The main stakeholders of the De Zwette demo site.

Mapping of stakeholders

The second step in the stakeholder engagement strategy is the further mapping of the stakeholders. For this, the identified stakeholders were categorised as presented in Table 1 and Figure 6.

Stakeholder	What can they use us for?	How can we use them?
All stakeholders	Give momentum / attention to what is happening (and provide an overview)	Insight in how stakeholders do and work
Liander	Insight in actual congestion situation on the business park Insight in potential scenarios Insight in potential strategies	Understand what they do/ how they work / their strategic approach in relation to congestion (what can be learned from the NL case)
Business Park De Zwette	Insight in actual congestion situation on the business park Work with the experienced barriers Insight in potential scenarios Insight in potential strategies	Understand what they do/ how they work / their strategic approach in relation to congestion (what can be learned from the NL case)
Leeuwarden Municipality (Urban planning Energy planning)	Link between urban and energy planning PED can contribute to their planning, organisation, and thinking across silos	Understand how they work on the issue of congestion Understand their strategic approach (what can be learned from the NL case)
Province of Fryslân	Link between urban and energy planning PED can contribute to their planning, organisation, and thinking across silos	Understand what they do/ how they work / their strategic approach in relation to congestion (what can be learned from the NL case)

Table 1: Categorization of stakeholders

Table 1 presents the stakeholders, including an assessment of the potential benefit the Flexposts project and results may have for them ('what can they use us for?'), and vice versa, the potential benefits the stakeholders' perspective may have for the Flexposts project ('How can we use them?'). From the assessment, we can learn that the project can provide insights in the direct and concrete problem of grid congestion, in particular for the grid operator and the businesses on the Zwette. While this is relevant for the public bodies too, as they are not themselves directly affected by the problems on the grid; their main interest can be found in getting insights on the PED concept and on the interaction between energy and urban planning. From their side, the perspectives of stakeholders provide insight in their operations, and how they strategically approach the issues of congestion.

Figure 6 presents the further mapping, in particular focussing on the links and relations of the stakeholders with the issue at stake (De Zwette as a PED/net congestion) and the other stakeholders. This confirms the relations sketched above.

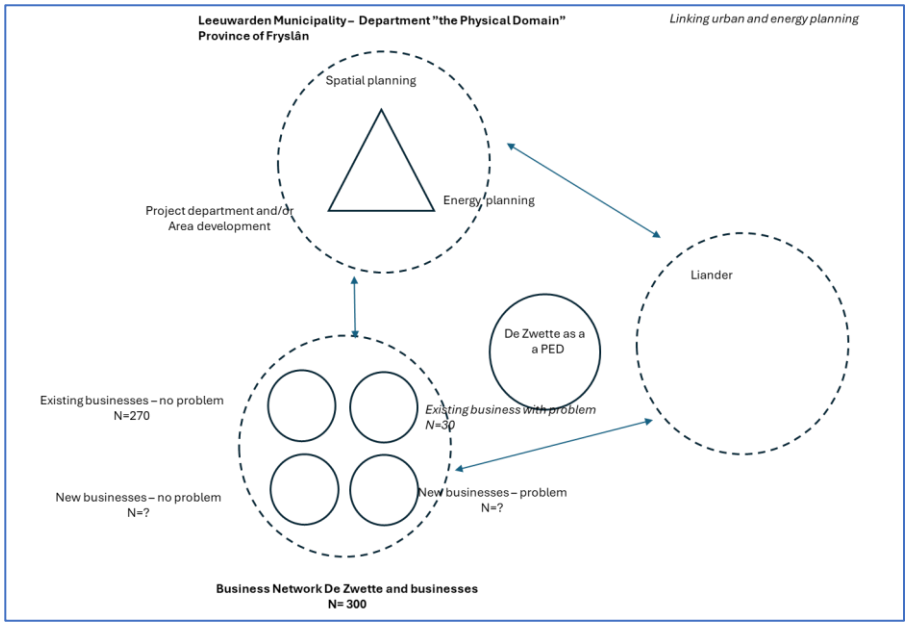


Figure 6: Mapping of stakeholders in De Zwette

Prioritisation

As a third step in the engagement approach, stakeholders were prioritised on forehand based on an assessment on their potential interest in the PED concept, and the importance for them if PED would be implemented (see Figure 7).[7] This may help determine what strategy is relevant to engage them in

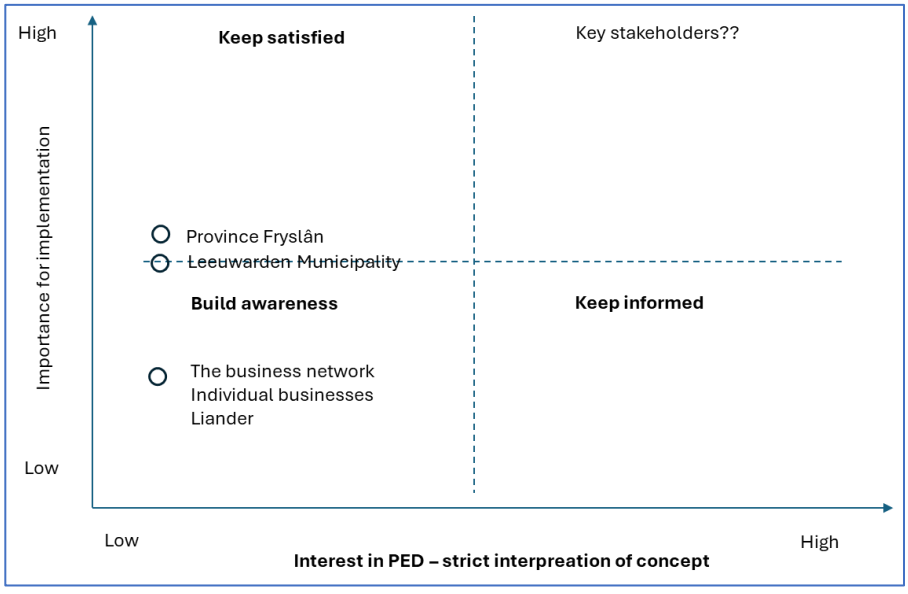


Figure 7: Prioritisation of stakeholders

the Flexposts project. Hypothetically, based on the information that was available at the start of the project, it is assumed here that both the business association (and individual businesses) and Liander score low on both their interest in the PED concept and how important it is for them that a PED is implemented. This implies that building awareness about PED is the strategy for further engagement. The public bodies, while their interest in PED was assessed as being low (x-axes), their potential

[7] Flexposts methodological guide report D3.1_ver 1 (esp. section 3.5. Methodology for local stakeholder engagement and establishing local partnerships and networks to support the establishment of public-private partnerships)

interest in PED as concept was scored higher on the importance of implementation of PED (y-axes), implying that keeping them satisfied is the strategy for further engagement.[8]

On forehand, we assessed that none of the stakeholders scored high on both aspects, i.a. at this stage, none of the stakeholders were identified to be key stakeholders. How this plays out while engaging in the Flexposts project, in particular in relation to stakeholder's attitude towards the PED concept, will be discussed in the next chapter.

Planning and engagement

The next steps (4 and 5) in the methodology are the planning of the engagement strategy and the actual engagement. This is done is two ways.

First, stakeholder engagement activities in the Flexposts project in De Zwette have so far primarily been planned and implemented around two of the four stakeholders, the Municipality and Liander, and as such they have been used to support other tasks in the project. For example, the stakeholders have been involved for the techno-economic analysis, in developing future energy scenarios (T.3.1.2.) and in identifying regulatory, structural and technical barriers for PED implementation (T.3.1.3.). This included developing future scenarios using tools and QGIS, the We Energy Region Tool, the We Energy Game, including the analysis tools used such as Powernodes, Flexnodes, Pandapower and Gridnodes. These tools have been deployed in meetings with the Municipality of Leeuwarden and Liander. The two other stakeholders, the province and business association, were not or less involved in these technical meetings.

Second, in addition to the involvement in the technical part of this project, and in further elaboration of identifying regulatory, structural and technical barriers for PED implementation, additional stakeholder engagement was planned, involving all four stakeholders, by means of interviewing. Specifically, this was done to zoom in on their responses to grid congestion in the PED context, identify the barriers stakeholders are faced with, and to provide a more in-depth consideration of the relation/interaction/alignment of urban and energy planning.

The next chapter presents the results of this.

[8] Open to discussion

4 Stakeholder perspectives

Introduction

In this section the results of the investigation into stakeholder perspectives are presented. For this part of the stakeholder engagement, representatives of the identified stakeholders were interviewed. The aim of these interviews was to get more in-depth insights into the perspectives of the stakeholders on (some of) the issues leading this Flexposts project, and to further engage them in the Flexposts project. Therefore, the interviews that we conducted were directed towards grid congestion and 1) the different roles that these stakeholders have in relation to the topic; 2) the identification of barriers; and ultimately, 3) interviews were aimed towards getting insights to the current state of the interaction between energy planning and urban planning. It is observed that the interviewees mainly represented the energy planning perspective.

We interviewed representatives of the 4 key stakeholders in the Leeuwarden case. As a first step, the contacts of the two most involved organisations (Municipality and Liander) have been approached. In the case of Liander our contact suggested that we interview a colleague. Secondly, as these organisations were less intensely involved in the Flexposts project (Province, Business Park Organisation) existing contacts (Province) or via meetings (Business Park Organisation) were used to get in touch with the Province and the Business Park Association. The representative of the Business Park Association is also an entrepreneur with a business on the Zwette. Not all the interviewees had knowledge of, or were involved in, the Flexposts project before the interview took place.

The method of the semi-structured interview was used to conduct the interviews. This means a topic list was used to support the direction of the conversation, and a checklist was created, to see if all the issues were addressed. Due to the differences of the interviewees in their level of involvement in Flexposts; knowledge on some of the concepts (e.g. PED); and expertise, not all questions were relevant for all the interviewees, so questions were adjusted for the individual interviewees. As they do, these type of interviews follow the rules of normal conversation as much also possible.

All interviewees gave permission to record the interviews. The interviews were transcribed and coded. Given the small number no coding program was used. As part of the interviews, interviewees have been asked if they knew of other persons that would be relevant to interview. All of them indeed have suggested colleagues, however, time and budget did not allow to follow these up. Given the small number (n = 4) and link of the interviewees with the topic at hand, additional interviews are recommended for a more complete picture.

In addition to the interviews, desk research, including document analysis was done to complement the findings.

Below is a further introduction of the stakeholders and the position of the representative that we interviewed. Between brackets the abbreviations that are used in the results section to indicate information, citations or quotations provided by the interviewees.

Municipality of Leeuwarden (ML)

The Municipality of Leeuwarden is the local government. ML has different departments, one of them being the Physical Department that hosts policy areas such as housing, environment, climate, spatial planning, water-management, nature, food, mobility, infrastructure, and spatial-economic development. There are sub-divisions such as 'Ruimtelijke ordening en inrichting' (~Spatial Planning)[9]; Neighbourhood/District; Building Housing and Environment; Area development; Economy and Business Management; and Projects.

The representative we interviewed is employed at the Projectbureau, predominantly involved in Energy. The responsibility of the Projectenbureau is to manage large projects and programmes in the

[9] The Dutch term is: ruimtelijke ordening en inrichting. Spatial planning is not a 100% perfect translation. Strictly speaking, and as a matter of principle, quite fundamentally, ruimtelijke ordening en inrichting is not a sector.

municipality varying from urban renovation projects, housing projects, business parks etc. [web]. In ML approximately 30 people are involved in the field of energy. At present there is no separate department or division for energy, but in the near future this may change.

Liander (L)

Liander is the grid operator in Leeuwarden/Fryslân with a regional office in Leeuwarden (*see* https://www.liander.nl/regio's/friesland).

The representative of Liander that we interviewed is Area Manager for the District or Neighbourhood Approach of Liander. This position is on the strategic and tactical level. The interviewee cooperates with municipalities and residents to implement the district approach. As mentioned, the interviewee had not previously been involved in the Flexposts project.

Province of Fryslân (PF)

The province of Fryslân is the regional government. They are - among other things - responsible for the strategic and spatial planning of energy and sustainability strategies. Additionally, they have a coordinating role between regional initiatives and supervision over the local municipalities and the DSOs.

The representative that we interviewed is coordinating the so-called Mission Wetter, which focusses on aqua-thermal heat & collective heat. In a previous job the interviewee worked at the Zwette. Even though the representative of PF is not directly involved in the Flexposts project and not working on grid congestion per se, this engagement was useful for the broader context, and also for possible alternatives to electricity, to 'counteract' grid congestion.

De Zwette Business Park Association (BPA)

The 'De Zwette Business Association' represents the interests of businesses on De Zwette. There are an estimated 400 companies on De Zwette, of which 165 are members of the Business Association. The board of the organisation are volunteers. In addition to the board, the association also employs two people: a park manager and a transition manager (1 day a week). The transition manager focuses on making the business park more sustainable in the broad sense of the word: besides energy, e.g. climate adaptation is also a point of attention.

The interviewee is the chairman of the BPA, and an entrepreneur with a business in real estate and energy on the De Zwette (Kuub including Energy Factory - Energiefabriek). As mentioned, the interviewee had not previously been involved in the Flexposts project.

In the next section the results of the interviews are presented. The results are organised based on the topics that emerged during the interviews. The texts are largely based on the information given by the interviewees; where they can be ascribed to (one of) the interviewees this is indicated by abbreviation between brackets. The quotations in the text are translated from Dutch by the author.

Grid congestion: a barrier to creating a sustainable business park

The ambition of business park De Zwette is to become a sustainable business park. Both the municipality and province have policies and incentive schemes that support the development of sustainable business parks. This includes broader measures directed towards circularity, climate adaptation, biodiversity and mobility. The stakeholders we interviewed were all focussed on reducing CO2 emissions mainly by increasing the deployment of renewable energy technologies.

As such, De Zwette in Leeuwarden is an example of a business park where this policy was successfully applied. Before, there was no business association for De Zwette so a 'booster' was appointed who established a business association with a number of special working groups. A lot of time was invested (by the municipality) in increasing organisational power and bringing entrepreneurs together.[PF]

The problem of grid congestion

> "Although the number of existing businesses that are affected may seem limited, it does hinder all initiatives to become more sustainable. So companies that want to become sustainable through electrification cannot do so" [ML].

All stakeholders we interviewed recognize that the practical implementation of the sustainability policies for business parks is hindered by the grid congestion problem. Grid congestion is indeed identified by stakeholders as the key barrier to realising a sustainable business park. Grid congestion is a problem for existing companies that want to expand their business; and for the new to be developed parts of the Zwette, as new companies cannot be connected to the grid. It is estimated that currently 30 of the 300-400 businesses located at the Zwette are affected by the congestion.[BPA] These 30 firms are larger firms, or large consumers of electricity, that can either not expand and/or take measures (install solar etc.).[10] The other businesses are stable customers and/or require limited capacity. They are not heavy users of electricity, and at the moment, these companies do not appear to have direct problems with grid congestions.[BPA, ML]

Grid congestion is a relatively new problem that has emerged over the last two years. Actually, according to the Municipality, Leeuwarden was one of the first places in NL where this became a problem.[ML] In this respect, stakeholders expressed critique on grid operator Liander, as they believe Liander could have done more at an earlier stage; they have according to them not anticipated in time. [ML, PF] A series of problems in relation to Liander are mentioned (by other stakeholders): a general lack of skilled staff; high dependence on subcontractors; using the first come first serve principle as mandated by the ACM regulator.[ML] It is also mentioned that Liander is busy in the rest of the country where issues are perceived more urgent and where there is more political pressure.[ML].

Besides the evident technical restrictions of grid capacity, the lack of data of Liander, and linked to that, the limited access to Liander data by others, is identified as one of the critical issues hindering finding quick solutions. "This may be partly due to the fact that Liander took over the grid from Enexis, apparently without good information or data about the grids. In any case the grid is not measured. We are now trying to do that with Hanze, whereby Liander is providing the topology of the grid for the location of cables and transformers etc." [ML] The interviewee of the province was also quite critical towards Liander as "they hold the cards close to their chest" affecting issues that are really in the realm of the public bodies like the province:

> "It is essential – given the importance of this infrastructure – that public bodies, like the province, have sufficient insight in what is happening. That does not always seem to be the case now; too little data is available."[PF]

Potential solutions

General solutions

It is clear that part of the congestion is 'paper or administrative congestion', meaning that it is based on the contracted capacity which is not always used in practice. A number of technical and organisational solutions are mentioned by all stakeholders (congestion management, batteries, etc.), many of which are indeed part of the investigation/research done in the techno-economic part of the Flexposts project.

In terms of concrete (technical) solutions to the current grid congestion problem, extension of the grid capacity on all levels by Liander (and Tennet) is a must. In Fryslân, Liander has introduced the Uitbreidingsproject Netuitbreiding Lelie (NuLelie) project aimed to extend the mid-voltage electricity grid. The NuLelie project, currently facing delays, is an amalgamation of 37 sub-projects in different parts of the province. In total the plan is to extend the grid by 2,100 kilometres of cables and about 300 electricity stations (web). One of the (other) actions of Liander is that they are extending and replacing a total of 700 transformer stations ("trafohuisjes") (low voltage grid/kleinverbruikers). Due to the

[10] These numbers are estimated by the BPA based on the attendance of a meeting that was organised to discuss grid congestion.

(expected future) increase in the use and generation of electricity, the technical requirements for the lv-grid have changed requiring more trafos than previously.[11] For this, Liander has implemented a district approach and foresees the installation of many units in the entire province (this will double the number of trafos) (see Appendix). Although Liander is aware of the potential roll-out of a heat network in some areas, their operation is currently based on an all-electric scenario based on the assumption that all buildings & districts will fully electrify their energy system.

Recently, some of the congestion that was there has been resolved as indeed this turned out to be paper congestion; in reality there was still capacity on the grid (e.g. reserved capacity for the Middelsee, the new housing estate/suburb in Leeuwarden, see below). The capacity has been released by Liander according to the first come first serve principle. For example, the new stadium of Cambuur (soccer team) was connected to the grid. The ML is critical on how Liander handled this, as with setting conditions (e.g. on when the timing of electricity use) it would be possible to increase the number of connections even more. Some may now get full power capacity while that may not be needed.[ML] Similarly for Middelsee: "here at first, they had calculated capacity as if all the 3000 houses would be built at once, while in reality it spans a period of 10 years. This too opened up capacity."[ML] Some other practical solutions were mentioned too; see the textbox below.

Solutions to grid congestion

- Bring buffers in the system: cars, stand-alone batteries in shipping containers
- Behind the meter solutions: use energy at smart times, generation by solar panels, battery etc.
- New grid code: social prioritisation, congestion management with time bound contracts
- Paper congestion, over-capacity

Stakeholders stress that in finding solutions, the role of good data and information is crucial. Grid operators do not really know what is happening on their own grid, nor do they know what is needed. Probably there is much unused excess capacity at many companies/customers but this is unclear [BPA]. Therefore, it is important to map what is actually happening, where the cables are going, and what happens when interventions are made. It may well be that only one company is responsible for the bulk of the congestion. More knowledge and understanding of existing system is much needed. [ML]

PED/Energy hub

Although the PED concept itself is not "on the top of the stakeholders' mind" the ideas behind it are, illustrated for example in the provincial commitment to the "energy hub" concept that emerged in Dutch energy policies recently (PF is supportive of this/the ML representative is less enthusiastic). Although the nature and genesis of the energy hubs concept is quite different from PED, there are some similarities between the two concepts, and it came up in the discussions/interviews. However, there are still a lot of uncertainties and discussion on what an energy hub exactly is. It is criticized by the municipality of Leeuwarden for example as it is used differently by different people, not clear how large these areas are, and what types of companies are involved. At the same time, there are already some initiatives, for example in another part of Leeuwarden where some large companies (Campina and Koopmans) want to electrify their energy system, so they have applied for a 60 MW capacity, which is like a substation. If there are all medium energy consumers with their own production process, the realisation of an energy hub is according to ML less doable. PF clearly sees a role for energy hubs.

What is further noted, is that generally speaking, stakeholders express in one way or the other their preference to generate, store and use electricity on the lowest possible scale. This means they are supportive of solutions and interventions "behind the meter" for individual units or on the district level. Nevertheless, the municipality representative also believes that in order to keep the energy system affordable, an integrated European electricity network is needed with some large strategically

[11] The maximum length for a cable was 1000 meter; now this is 250 meter. Approximately 50 buildings (houses) are connected to one trafo.

positioned central locations, including space for decentralised generation. In any case better integration of the TSOs in the European electricity market is necessary.[ML]

Heat and heat networks

In the context of business parks, it is also interesting to look into other (than electric) options, such as for example heat networks, as this could be an alternative for electrification, thus not affected by grid congestion. Business parks could be important producer/source of heat, also as part of exchanging heat within the business; in Leeuwarden plans for heat networks have been developed.

In particular the interviewee of the province is dealing with heat and heat networks, considering different sources. A heat network may be based on aqua thermal heat (for aqua thermal heat there is a community of practice with 14 heat projects that are considered frontrunners in Friesland); green gas and mono-manure fermentation; and waste heat from industries. The province is currently designing a detailed heat plan based on the potential of Fryslân e.g. locations with the highest heat density and/or sources. Circular Fryslân did a commodity flow analysis to map out which companies are where, what commodities are running, what types of companies are there, and possibly residual heat.[PF]

The Province of Fryslân is currently looking which places could be prioritised for collective heat.[PF] Generally, industrial estates or business parks are considered to be good places to start heat network development. Fryslân has some chemical industry, waste processing industry, and sewage treatment for low-temperature heat. Finding suitable locations for collective heat requires knowledge of the local situations as often more is possible than previously thought.[PF]

The potential for usable residual heat on De Zwette is largely based on a metal processing plant, data centre and biscuit factory. On the level of the Business Park De Zwette, the BPA supports companies that want to use heat as a source. If a company has heat, as residual waste, it can be delivered to other companies. "Your heat is not a waste but a source for your neighbour." This is not so easy to arrange yet because it costs a lot to build the infrastructure and there is a degree of voluntariness.[BPA]

For Leeuwarden, in the original WTV (heat policy) there was a plan for a one heat network for Leeuwarden covering all 22 districts. Now the plan is more decentralised. For example, for the new district Middelsee, in the south of the city, which will be built in 3 years, a collective heat network is being considered. This would save 1 MW of connection capacity.[ML]

As PF mentions, Liander is simultaneously working on trajectory of neighbourhood proposals in which they look at where to expect heat networks, based on national models. According to these models, they expect only a few heat networks in Fryslân. However, the PF has estimates that collective heat may be relevant for 60 to 80% of all built-up areas. So those are opinions that are diametrically opposed.[PF]. Indeed, in their strategy, Liander is anticipating an all-electric scenario:

> "If people chose for e.g. a neighbourhood battery it doesn't affect our neighbourhood approach. Every consumer is free to do what they want behind the meter. Right now, unless e.g. a heat network is organised from the municipality, then fewer stations are placed, we assume all-electric. As long as it is not 100% certain that there will be a heat network, we assume all electric."[L]
>
> And:
>
> "Of course, it's quite an investment but it was chosen to do it like that. In the past when heat network were planned, we would place fewer stations. But I think sometimes the municipality had not realised what the impact is of building a heat network. Then they abandon the plans and ask us to build those extra stations anyway. Therefore, we just built all electric anyway." [L]

This is in contrast with the experience of the interviewee who suggests to municipalities to ignore Liander's models and go ahead with planning heat networks anyway. [PF]

Stakeholder roles

In this section, we discuss the different roles stakeholders have both in general, and in solving the grid congestion problem (see also Figure 5 and Figure 6). As the grid operator, Liander is the main actor that can solve the problem of grid congestion; however, the other stakeholders also have a role to play. In the interviews, we found some reflections on the roles the organisations play themselves, as well as in some instances, on how other stakeholders act or should act.

Different roles and responsibilities

In the case of the business park, the interviewee points out that in essence it is a problem between Liander (supplier) and individual companies (client), as any contract is between these two parties. Therefore, individual companies "…have to deal with the problem themselves". Also suggesting that as a way out, individual firms can or should take matters in their own hand: "if you as a firm have a problem with energy, you solve it. Install a battery". In this perspective, it does not help to "keep moaning about Liander or keep resisting Liander; it is better to look for a "behind the meter" solutions yourself." The interviewee of the BPA aims to generate, store and use energy at the lowest possible level, behind the meter, as he believes self-solving is the only solution at the moment: [BPA]

> "Companies only do something when there is legislation, or because there is money to be made or saved. That is magic word for entrepreneurs. Be concrete and what's in it for me? Make it clear what you gain as a company. It only becomes a real problem when the legislator says: you have to become more sustainable, and the grid operator is in the way. And if that doesn't help. A crisis would help though, only when the power really goes off is there a problem." [BPA]

In the direct client relation between Liander and businesses, the municipality and province do not have a direct role: their role is mainly to use their (political) influence to lobby for the interests of companies. This is exactly what the municipality of Leeuwarden and the province are doing, both in negotiating with Liander but also by bringing the issue to e.g. the national government as the municipality has done. ML is also looking for innovative projects that could solve the problem. The province is only broadly involved with grid congestion. There is no direct role, but they are involved e.g. in the high voltage connection with Tennet. On a more general level however, grid congestion is an important issue for the province.

In addition to that, as mentioned in the introduction, the authorities have an active policy to increase the organisational power of business parks. One of the reasons behind this is that the authorities want to strengthen the collaboration between the companies located at the business parks. Usually there are many actors on a business park that have little interaction with each other. However, to break congestion problems, these entrepreneurs now have to seek cooperation. The core of the incentive policy is that entrepreneurs start talking to each other and start thinking if they can collaborate on energy generation, and exchange energy on the business park level. Ideally, they would make plans themselves. [PF] The municipality in particular supports the business association for De Zwette.

To help the BKA, a transition manager is specifically assigned to making the business park more sustainable. There are e.g. projects on shared cars, advice, motivation, group project on biodiversity [BKA]. In addition, a Green Deal with the municipality and Rabobank is also underway so that companies can have an energy scan and receive targeted advice on how to save energy and possibly generate it with solar panels.[BPA] They have also developed a proposal for a wind turbine. This is a collective solution not with one owner but with a project developer, the community and the municipality, so that is not only for the benefit of the companies but also for the citizens of Leeuwarden. A previous plan to set up a heat network was not successful, as not all the companies wanted to participate. There was too much uncertainty for all parties involved.[BPA]

Reflections on other stakeholders

The different stakeholders reflect on other stakeholders as well. As mentioned, they are quite critical of Liander, in particular the municipality, but also the province is quite critical, and thinks that they can do

more than they currently do; at least show more flexibility and creativity in looking for solutions. According to the interviewee from BPA however…

> "…we should stop whining about the grid operator. The grid manager has clearly let things slip in recent years. That's a given, you can't change that now"[BPA].

BPA is happy with the pioneering role played by the municipality. Despite the fact they are not directly customers of stakeholders in that respect, they can talk with a stronger voice and make more impact than individual companies or a business association. [BPA] Nevertheless, entrepreneurs usually are not very involved with the municipality or province (they only give restrictions and hassle). This changes as soon as things are concrete, including as BPA says, strict rules and regulations, that does help: see for example the recent diesel ban for company cars in relation to the CO2 free city centre.[BPA]

> "That's bad for those companies, but if companies can't install solar panels, who is it a problem for? If it can't be done, then an entrepreneur thinks: never mind."[BPA]

Energy planning and urban planning

> "Until recently energy was not leading developments; it was never a problem. You ask for a connection, and the connection is realised. But it has been increasingly agenda-setting and it is taken up more seriously within the organisation itself" (ML)

In this section, we discuss the present interaction between energy planning and urban planning. Based on observations of the current practice, a number of issues have become apparent, suggesting the interaction between the two fields is far from always optimal. Three different topics will be discussed: first, the existing policies in both fields; second, today's practice; and third, suggestions for more integrated planning.

Analysis of existing policies

Energy planning

The stakeholders in the Leeuwarden case all work in the context of the RES Fryslân (Regional Energy Strategy). This is a national initiated policy, the Dutch National Programme Regional Energy Strategy.[12] In this programme 30 so-called RES regions have established how they will meet the target of the Climate Agreement. In the North of Netherlands these RES regions overlap with the provincial boundaries (this is not the case elsewhere).[13] As a follow up or continuation of the RES, the province, 18 municipalities, Liander and 11 civil society organisations now collaborate in the Friese Energietafel.[14] Recently, the Energietafel has established a Vision for Energy that deals with increasing sustainability and generating own energy. In addition, following a motion in the regional government, there is also an initiative 'Freonen': this is a pooling of civil society organisations (Windunie, energy cooperatives) to see if it is feasible and acceptable to realise energy hubs. This was done in parallel with energy vision. On the municipality level, Leeuwarden's main energy policies are tabled in the RES, the Warmtetransitievisie (Heat Transition) and the Leeuwarder Energieagenda 2021-2024. Leeuwarden has also developed a solar park policy, which is currently being updated).

It should be noted that sustainability/energy is also embedded in other policies. In the PED- sister project Making City, it was assessed what policies and policy areas are linked to energy transition. These are: Work and Income; Economy and Employment; Education; Traffic; Housing; and Quality of

[12] https://www.regionale-energiestrategie.nl/english/default.aspx

[13] Fryslân was one of the pilot regions, so they have been working on and with RES since mid-2010s, longer than other most regions in the Netherlands.

[14] https://www.fryslan.frl/mienskipsinitiatieven

the Living Environment.[15] Examples of these (strategic medium term) policies are the Housing Vision; and the Policy Framework Economic Development.

Spatial & urban planning

As a municipality ML also has strategic, medium-term policies dedicated to and related to spatial planning issues. Of these, in particular the Omgevingsvisie (~Environment and Planning Vision/Strategy) Leeuwarden is a leading document (2021). In addition, there are shorter term operational policies, plans or programmes for specific areas in the city (e.g. the city centre, and the transformation zone near the station). Similarly, as the provincial government, the Province policy is also framed in the Provincial Plan for the Environment and Planning (~Provinciale Omgevingsvisie).

Current practice: a reality check

Indeed, from the (incomplete) account above it may seem that policies in both fields are in place. However, in reality we see that often these policies are quite generic in terms of what can be expected, and what the implications of sustainable energy technologies are on spatial issues and urban planning, and vice versa. As noted, at present the lack of interaction or relation between energy planning and urban planning is highly problematic. Although there are some existing connections between the two fields, the characteristics of renewable energy are such that the role of the energy system has changed. What consequences this has or may have has so far only dimly penetrated both the energy sector itself and other policy fields such as urban planning, for example. In that respect, the grid congestion problem may be seen as an important wakeup call as it exposes some of the underlying problems.

In Leeuwarden and Fryslân, the grid congestion is starting to affect many developments ('opgaven' – policy tasks), in particular related to housing and business park development. The new housing district in Leeuwarden, Middelsee (3200 houses), is affected: the future houses will be connected to the grid, but utilities (shops, schools etc.) will not be connected, meaning that these will not be built as long as this problem is not tackled. This jeopardizes the original urban planning that includes these facilities. From an urban planning perspective this clearly is a highly undesirable situation. Recently Liander announced that the NuLelie project is delayed. One of the implications is that companies and possible housing projects should expect longer waiting time before they get new or heavier connections.[16]

An illustration of the current situation can be found on Liander's website. The website states that all housing projects that have now been announced and planned can go ahead, and all new projects must be submitted to Liander: "Housing projects that have been requested from us and are already in advanced preparation and/or realisation can go ahead. For housing projects where this does not apply, it is unclear whether there is room for this. Therefore, it is essential that developers share plans for new housing developments so that we can indicate whether it fits." [17] With that Liander has great influence over what construction can be realised where. At present in the Netherlands, there are several initiatives and policies (in development) to align urbanisation projects with energy planning[18]; however, how this plays out in practice is a developing story and subject to further investigation.

Similarly, as we have seen, the planned extension of the business park De Zwette is delayed/affected. There is at least on anecdote of a new business/company that decided to relocate to an area without problems on the grid. Like the municipality, the province is concerned that businesses are affected and decide to go elsewhere, as this may hinder future economic development.

> "It is an important issue for the province in particular when the economic component comes into play. In areas like Hallum, De Zwette and Franeker grid congestion is so bad that it is

[15] https://leeuwarden.bestuurlijkeinformatie.nl/Reports/Document/1f51dd81-8091-4679-a83b-98b0558bc75e?documentId=65f910bd-ec56-420d-81de-4b17b0778851

[16] https://www.liander.nl/regio/nulelie

[17] https://www.liander.nl/regio/nulelie

[18] For example, the ministry of Spatial Planning/Interior Affairs is presently investigating this issue. See also: https://www.netbeheernederland.nl/artikelen/nieuws/woontop-afspraak-netbewust-bouwen-meer-woningen-op-dezelfde-kabel

> questionable whether companies will stay there if the situation does not improve. That is when social and economic factors come into play, that is weighty and that is when the province starts to play a role" [PF]

Related to that is the observation that among stakeholders there is a sentiment that due to the (growing) importance of the electricity network to the functioning of society, Liander has unwittingly gained a position or power that normally belongs to the government. For the province and municipality as the public democratically elected government bodies it is important to get more grip on this, if only because they also take other issues into account, both energy related (heat, mobility, etc.) but also other societal aspects (housing, agriculture, etc.). Therefore, it is suggested that integrated planning and programming approaches are needed. This requires integrating energy issues in for example urban planning, and vice versa:

> "There are so many elements at play at the same time that all affect grid congestion. Liander has to monitor the energy network and ensure security of supply. They don't want others to sit down and do calculations, to see in which area something is still possible, but that is the situation you would like to get to, so that you can steer more. Now we come up with assignments and information, they throw it in the hat, and something comes out. You actually want to be in control of that yourself and do the calculations. Also, because you take a broader view: you have to deal with heat, activity requires electricity, heat collectively, individually, mobility issues. Everything affects the energy network, which has become so integral and complex that nobody can say: you press this button and it's done."[PF]

At PF, they see that different developments are piling up: "What is tricky is that Liander is a kind of implementing organisation, but is now actually almost in the lead, determining what happens where, what can and cannot be done. A kind of role reversal, which does complicate things".[PF]

Apart from (spatial-urban) developments that cannot take place due to problems in the energy system (in this case grid congestion), there are also other issues on the interface of energy and urban/spatial planning that are relevant, such as for instance the spatial and landscape implications of the energy infrastructure and technologies. For example, with the large scale NuLelie project and the District Approach (see Appendix) of Liander interventions may be expected that have a considerable spatial-landscape footprint/impact.

In particular in Fryslân, the landscape is highly valued and protected. In the past, this has for example led to a ban on wind turbines in provincial policy. While one of the interviewees acknowledge that this has advantages because the Frisian landscape is quite well preserved, it also causes in his view a delay in the energy targets that where set. [PF] Also, recently the (complex) political situation has meant that not a lot was possible in terms of installing renewable technologies. However, according to the province, in recent years, there has been some thought about how to deal with the landscape, which landscape do we want to preserve, where is space, what carrying capacity do certain types of landscape have in relation to energy developments? How this will work in practice, remains to be seen. [PF] The ML argues that people need to see energy as a necessary facility, so space should be 'created' for that, and people just have to accept that as they do with powerlines.[ML]

The views expressed above are from officials that work in the energy sector. However, it is to be expected that others, e.g. from department of spatial and urban planning or landscape organisations have a different (opposite) argumentation (see e.g. policy documents).

The need for integrated planning

As a possible solution for the non-alignment between energy planning and urban planning, long term integrated planning is suggested, for example by the Province. This refers the integration within the energy sector but also with other policy fields. "In cooperation, you start looking much more for where those things are where we can reinforce each other and how do we prioritise and what decisions do we take based on a certain distribution keys that we use and then eventually you end up with some kind of shared vision or common path that you take. This is not happening at the moment" [PF]

However, in practice integration and working together with other fields is still difficult as can be illustrated by the aqua thermal heating case. At present the interviewee working on this, has little or no contact with colleagues working on for instance spatial issues or the Novex. This is because it is already quite complicated to get the heat network up and running; getting involved with 'others' e.g. spatial planners, may complicate matters.[PF] However, it is recognized that while it is useful in the pilot phase of a project, to be able to think freely, without too many restrictions, there comes a time when you have to engage with others.

Reflections

To conclude this discussion, and in addition to the issues already mentioned, a number of related reflections or observations that emerged during the interviews can be added:

1) If grid congestion continues, power and capacity is increasingly becoming a factor in the location choice of businesses for example, see example of a company that choose another location because of the grid problems in Leeuwarden. If you are constructing new residential areas, it is useful to know what energy technology and infrastructure is going to mean for the construction. If the province or municipality wants to plan a business park and there is no grid capacity, then there is a problem. The availability or unavailability of enough power can play a role in what development takes place where. [BPA]

2) This also may lead to some rethinking about what type of economic development is desirable in Fryslân. For example, in relation to the 380 kV line Eemshaven-Ens that is currently being discussed, the question to ask is whether you need that 380 line to Leeuwarden. Currently there is little intensive industry in Fryslân; in the economic structure of the Province SMEs are more important. Perhaps companies that do need a lot of energy should move to places where energy is readily available. Employment is an issue here. In the end of the day this is a political discussion. [ML]

3) Related to that is the idea to plan (the production of) energy where it makes sense and/or where there is an opportunity. Currently, much energy generation is decentralised to the level of the RES region, each region having their own target. According to the ML interviewee, this is not logical. It would be much better to bring it to the national scale and coordinate with Europe. What still needs to be generated on the local or regional level should be done in locations with little other potentials. That is, in the view of the interviewee, better than scattered generation of energy where every village its own solar farm, that is when you get fragmentation of the landscape.[ML]

4) Simultaneously there is also a tendency to bring the generation and use of energy as close to each other as possible, and to "local use production storage" on the lowest possible scale. On the scale of Leeuwarden this could mean that a city like Leeuwarden should partly have its own generation, conditions for this are good accessibility with substations, enough space and minimal nuisance to residents. Areas have already been designated in Leeuwarden, as much as possible on or near business parks. However, most likely this is not enough year-round. Therefore, the link with largely centralised, at strategic locations, including offshore wind will remain important, preferably operating at the European electricity network.

5) As most of the interviewees were not directly themselves part of the Flexposts project, the PED concept was new to them, with the notable exception for the representative of the municipality of Leeuwarden. Although supportive of the ambition, realising a PED is challenging. In practice the concept is not used, and mostly seen as a theoretical, European concept, difficult to implement and communicate with e.g. companies. The main concern for companies is that there are constrained by grid congestion to reach their sustainability targets. To that, the PED concept doesn't help but doesn't work against it either.[ML]

Conclusion: the stakeholder analysis revisited

Figure 6 was originally designed to identify the stakeholders, for active engagement in the Flexposts project. Based on the last observation in that chapter, it may be concluded that a strict sense, the stakeholders in this project only have limited interest in the PED concept as such. This can – as

mentioned – largely be explained by the fact that most of the stakeholders were not included in the project and thus they were largely unaware of the concept.

However, as mentioned although not worded as such, stakeholders have expressed their interest and concern in some of the underlying principles of the PED concepts. If for example widen the concept to "district-oriented approach" in which the generation and use of energy is kept at the lowest possible level, a different picture emerges (Figure 8). In line with the general trend in the Netherlands, the public stakeholders generally support the idea or principle of using energy and producing/generating this energy as much as possible on the lowest possible scale. They can also be labelled as key stakeholders, as they have big role to play in the implementation of this. For other stakeholders, like the individual businesses in De Zwette and Liander, this is of less interest; for Liander however this it may be important for their policies if this principle is implemented.

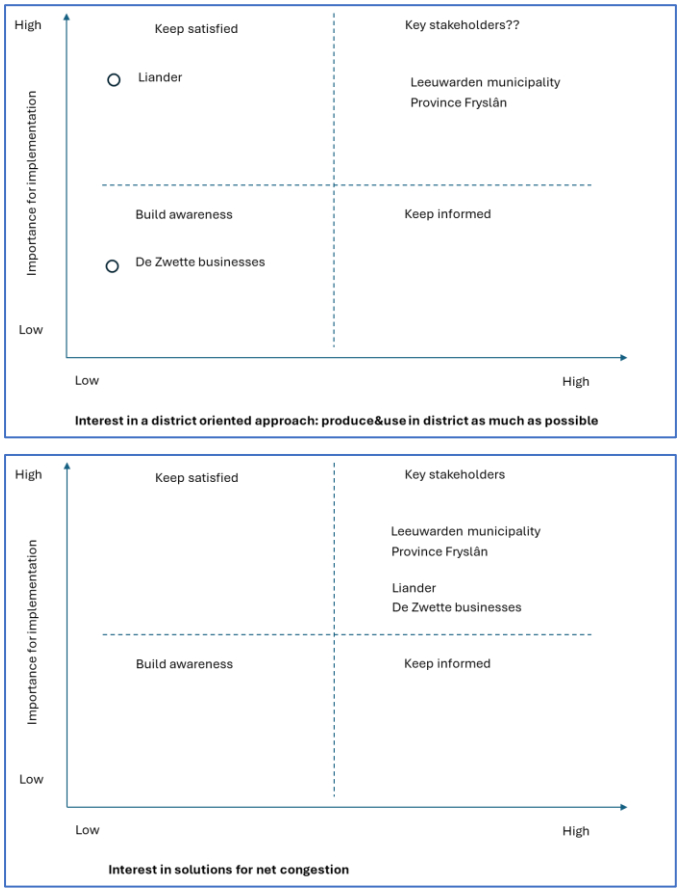


Figure 8: Stakeholder priorisation based on alternatives (on x-axes)

If net congestion is the focus of this figure, all the stakeholders end up in the high right corner of this graph: there is high interest of all stakeholders in solving this issue of net congestion, and for all stakeholders it is important that solutions are implemented to solve the net congestion problem (although arguably, not all the businesses have problems with congestion).

5 Some general reflections on the relation between spatial planning and energy planning

We found that in current practice in the Leeuwarden case there is little alignment between energy planning and urban (spatial) planning. However, it is increasingly recognised that this alignment is crucial. The lack of connection is increasingly causing problems in for e.g. business parks and residential areas as we have seen in the Leeuwarden case. Clearly here, the problems of the energy network hinder the desired spatial development. This goes hand in hand with the observation that the opposite may also be true. After all, until quite recently, urban development project did not consider energy or potential net congestion problems to be relevant for urban planning (see Sijmons et al. 2014).

These observations are not restricted to the case we discussed: the Netherlands is prompted by problems with grid congestion. On a more general level, the (non-)alignment between urban (spatial) planning and energy planning is an issue of growing importance.

In this discussion section, we address this issue with a few additional reflections on the broader issue at stake: the relation between urban (spatial) planning and energy planning.

New relations between (urban) spaces and energy[19]

Overall, until recently, the relationship between spatial planning and energy planning in the Netherlands was only marginal, with energy mainly having a facilitating role in spatial planning and manifesting itself mainly in infrastructure construction. The fact that spatial planning was largely absent did not help. However, after years of absence, spatial planning has officially been reintroduced in the policy and governance arena. This coincided with the increasing consequences of the implementation of the new energy system.[20][21] An important fact here is that renewable energy has a fundamentally different interaction with space and landscape than fossil energy, and thus the impact of energy on spatial planning and design is of a different nature. Renewable energy occupies more (visible) (above-ground) space than fossil energy, and therefore a more (direct) impact on space/land-use, landscape and in the immediate living environment of residents. It is also important to note that energy is not the only function requiring space: there are also other spatial claims, e.g. for living, working, nature, climate adaptation, etc. In a country (NL) where space is generally scarce, considerations on how to allocate that space are increasingly part of the public and political debate. Furthermore, it is increasingly recognised that a sustainable energy system has a strong organizing character, and thus energy is (partly) guiding future developments (see also Top Sector document). In spatial planning, this is relevant for instance with regard to location choices for certain (future) activities and functions (where to develop a residential area, where to develop a business park).

In that context, it is hopeful that the separate worlds of space and energy are growing closer together. From the spatial side, spurred by urgent issues such as the energy transition, housing and agriculture, nationally but also regionally, there is renewed interest in spatial visioning and planning, effected by new policies such as NOVI and NOVEX, Mooi Nederland, Omgevingswet etc. The overall aim of these programmes is to integrally align the interests and spatial claims of various sectors, of which energy system is one. More and more examples of integrated energy and spatial planning are also appearing recently in practice; but it is also clear that there is still much to learn, if only because space and energy have different planning and policy cultures.

From the energy perspective, space and spatial planning are increasingly recognised (e.g. in National Energy Systems Plan (NPE) as one of the conditions for the development of the future energy system, as one of the public, societal values (quality of the living environment) that cannot be expressed directly in monetary terms. In the NPE, the basic principle is to minimise the energy system's use of space, to

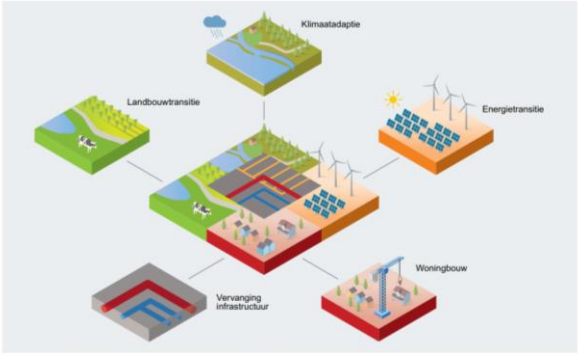
[19] Partly based on Van Dam (2023), Position Paper for UvhN (internal document, not published)

[20] From the Dutch national government, the direction of spatial planning has been brought back. For instance, after 12 years of absence, there is again a minister of VRO and there are now programmes such as NOVEX and Mooi Nederland.

[21] See: Olesen (2023) https://www.tandfonline.com/doi/full/10.1080/09654313.2023.2231500

combine functions, and to fit the various components of the energy system into the living environment (NPE p.13). The preservation and, where possible, improvement of the living environment is named as one of the guiding principles, to which a number of conditions are linked: 1) give greater weight to the impact on the living environment 2) include the effect on the energy system in spatial planning (e.g. for the construction of neighbourhoods, industrial estates) 3) integral programming 4) draw up guidelines to shape and integrate the energy system in spatial programmes (see NPE p. 13). Also elsewhere, there is increasing attention to the changing relationship between energy and space. An illustration of this, for example, is the position paper *Energy and Space: Shaping the sustainable energy system in synergy with other spatial tasks* of the Top Sector Energy.[22]

Figure 9: Changes in the landscape due to integration of the renewable energy system. Source: Topsector Energie 2023.[23]



Figuur 1. Ruimtelijke vormgeving: het slim combineren van gebruiksfuncties.

[22] Topsector Energie (2023), Shaping the sustainable energy system in synergy with other spatial tasks. Topsector Energie Systeemintegratie

[23] Topsector Energie (2023), Shaping the sustainable energy system in synergy with other spatial tasks. Topsector Energie Systeemintegratie

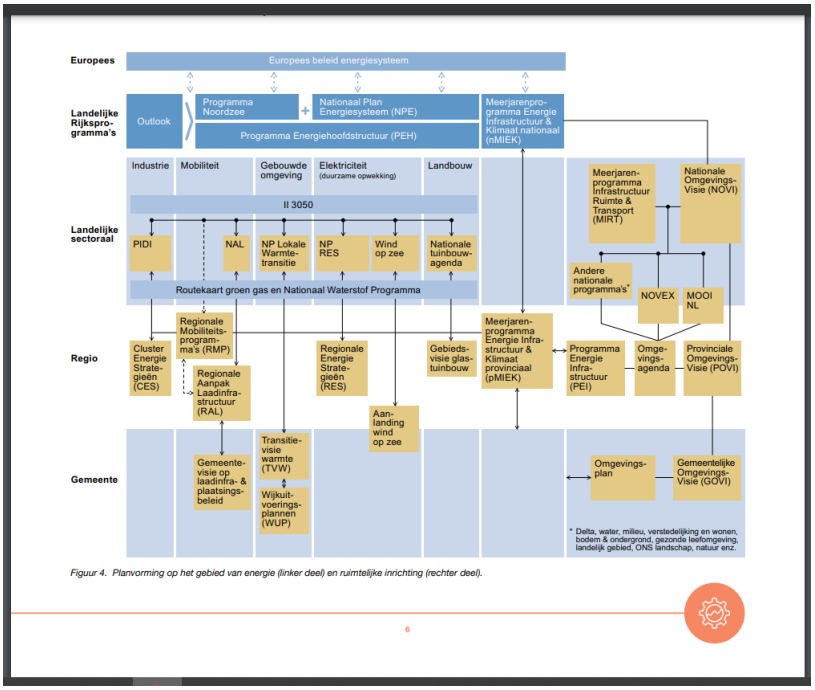


Figure 10: Planning policies in the Netherlands for energy (left) and spatial planning (right). Source: Topsector Energie 2023.[24]

However, despite this growing inclusion of energy in spatial policies and vice versa, many questions still exist about the mutual dependencies between spatial developments and energy facilities in the Northern Netherlands. Grid congestion, for instance, is an issue, but what consequences this has for existing and future spatial policies is still uncertain. This calls for integrated spatial energy planning, involving not only governments but also spatial planning professionals (planners, landscape architects), energy suppliers, managers, companies, etc. Integrated planning also means paying attention to other aspects (housing, agriculture, etc). Both in research and in practice, experience with area-based approaches has recently been gained in various ways in the Northern Netherlands. In addition, existing and new spatial concepts and principles e.g. in urban design and planning can actively contribute to improving sustainability. Examples include multiple use of space or smart zoning. Or organising generation close to where it is used, and vice versa: use where there is or will be generation. This is in line with the assumption in the NPE that energy efficiency and space efficiency are almost the same and thus lead to lower costs, higher social benefits, and more support. In these concepts like the district or neighbourhood approach and Positive Energy District (PED) would well fit.[25]

[24] Topsector Energie (2023), Shaping the sustainable energy system in synergy with other spatial tasks. Topsector Energie Systeemintegratie

[25] See also Making City: www.makingcity.eu

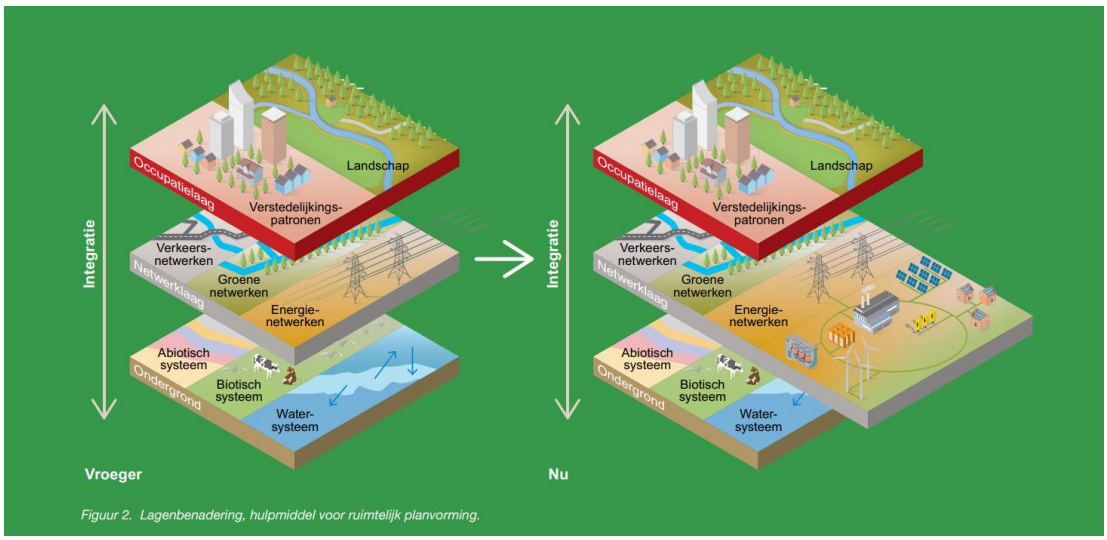
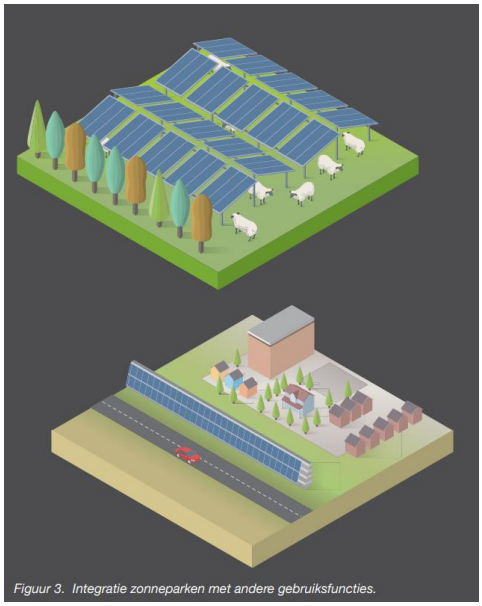


Figure 11: The 'lagen benadering' (layers approach) for spatial planning. Source: Topsector Energie 2023.[26]

Also, a concept used in spatial planning, the so-called layered approach ('lagen benadering') can help to make an integrated (spatial) analysis (see Figure 12 – left side). According to this approach, three layers can be distinguished in the physical space: 1) the fundamental subsurface layer (water, soil, abiotic and biotic system); 2) the network layer (infrastructure, nature network energy network); and 3) the occupation layer (housing, landscapes etc). Energy infrastructure belongs to the second layer, however, due to the current energy transition this layer is "folded out", expanding the impact of this network on both other layers (see Figure 12 – right side). It confirms that the energy system should be taken into account in the development process and in the design of existing and new activities.



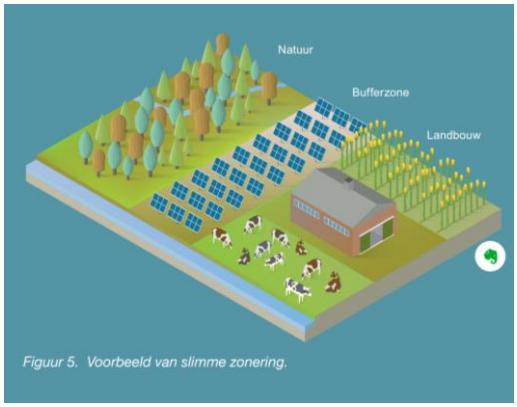


Figure 12: Left, integration of solar parks with other land uses. Right, example of zoning. Source: Topsector Energie 2023.[27]

[26] Topsector Energie (2023), Shaping the sustainable energy system in synergy with other spatial tasks. Topsector Energie Systeemintegratie

[27] Topsector Energie (2023), Shaping the sustainable energy system in synergy with other spatial tasks. Topsector Energie Systeemintegratie

Energy in urbanisation plans

The increasing awareness of this relation can be further illustrated/confirmed by a recent initiative of the Spatial Development Directorate of the Ministry of Interior Affairs. They initiated an investigation on how the current urbanisation plans can be better aligned with the energy transition.[28] A total of 900,000 houses with required facilities are planned. Central issue is the current role of energy in the so-called urbanisation arrangements ('verstedelijksafspraken' in Dutch), housing deals and NOVEX that have been established by national, regional and local governments. This includes the development of approaches needed to better integrate energy in these arrangements/urbanisation tasks. For this several of these urbanisation projects were investigated, representing different perspectives/levels of the planning process: operational, tactical and strategic level, and different parts of the country (with the main focus on cities in Randstad and south-east of the country). Examples include e.g. a short-term project for flex housing in Arnhem; the midterm programming of Metropol region Amsterdam; and long-term plans of the NOVEX in Utrecht, Gelderland and Zuid-Holand. Almere (short term, tactical level) was added due to current net congestion problems.

What was learned was that indeed from the perspective of long-term urban planning energy is generally considered to be a 'manageable' challenge, while grid operators indicate that the limits of what can be managed are in sight (13). At the same time, it was noted that understanding of and control over the energy system as part of urbanisation challenge is generally lacking (and vice versa). Also, there is a lack of connection between the different levels of planning (from strategic via tactical to operational level) which may lead to sub-optimal energy systems; a lack of clear organisation; awareness of what can be done where; knowledge and understanding of the implications that the energy system may have on the urbanisation and vice versa; and the conditions for planning of electricity are not in place (13). Given the current national challenge for urbanisation (add 900,000 houses) the (future) energy system is a prerequisite for the urbanisation task at hand: "on the one hand, to fulfil the sustainability ambitions of living, working and mobility and, on the other, to make the most efficient use of energy infrastructure and balance supply and demand." (13) Given the changes of the future energy system with more decentralised sources, storage and use, and the expected potential impact of future developments on the energy system en vice versa, it is stressed that the two systems need to be better aligned as "the development of the energy system is linked to the choices made regarding urbanisation and economic activities and mobility." (15) The approach suggested is that energy is fully integrated in the urbanisation tasks (15). The current advice is to develop archetypes energy concepts for urbanisation processes.

There are some examples of how this can be taken further such as "grid-aware design" for new housing/construction sites (e.g Merwede, Utrecht).[29] An example of this is: investigating what the implications of the optimal energy concept are on the housing and district design. This includes looking into the consequences of certain choices: central or decentralised energy concept; ground level houses versus or multistorey buildings etc. Another example from Amsterdam engaged in identifying options to realize the urbanisation task with limited grid capacity led to the fictive design of three districts: a post-war district, a public transport hub, and an industrial estate. One of the things that became clear is that building density is the most important parameter for the use of energy, before function and the type of renewable energy that is generated. Also, as the initial design indicates, concepts like building passive houses is not only efficient in terms of energy, but also in spatial terms: they require less space than other types of housing (e.g. because less energy needs to be generated). On the other hand, another observation is that with high density buildings, the spatial footprint of the energy system is significant.

Overall, in all examples used one of the explicit principles leading most concepts is to generate locally, store locally and use energy locally as much as possible. However, it is also noted that trying to arrange everything locally or regional is not optimal from the spatial perspective as usually more space is needed. Therefore, a combination between local and regional solutions with general (supra regional, national, international) solutions is spatially the best option.

[28] Anthea Group 2024

[29] Presented at an expert meeting May 2024/presentations are not publicly available.

6 Conclusion

The findings of this report highlight the complex interplay between energy planning, spatial planning, and stakeholder engagement in establishing a Positive Energy District (PED) at Business Park De Zwette in Leeuwarden, one of the case study areas in the Flexposts project. While the PED concept has not been the primary driver of discussions, related concepts, such as the development of a sustainable business park, have taken precedence. The ambition to create such a business park aligns with broader regional and national energy transition goals; however, this ambition is significantly constrained by the main topic discussed in this report: grid congestion. This congestion, affecting both supply and feed-in capacities, poses critical challenges for businesses seeking to expand, electrify operations, or integrate renewable energy sources.

Given the critical role of stakeholder engagement in addressing these challenges, consultations were held with the Municipality of Leeuwarden, grid operator Liander, the Province of Fryslân, and the Business Park Association. Each of these stakeholders plays a pivotal role in the region's energy transition in general, transition towards a sustainable business park in particular. The analysis indicates that while stakeholders are committed to sustainability goals, their immediate concerns are largely pragmatic, driven or shaped by operational constraints and economic feasibility rather than abstract sustainability frameworks such as PED. This highlights the need for effective communication and the development of actionable, business-oriented models for sustainable energy integration.

This study demonstrates that, while not strictly adhering to the PED framework, incorporating some of its core principles has facilitated strategic thinking—particularly when linked to pressing, tangible challenges faced by businesses. However, a key risk is that an exclusive focus on immediate concerns, while necessary, may detract from long-term ambitions, broader strategic visions, and systemic planning. If the PED, energy hub, or district approach is to be pursued successfully, a strategy that aligns with stakeholders' practical interests while maintaining long-term objectives is essential.

In addition, two key themes have emerged from the analysis. Firstly, there is a growing recognition of the need for innovative solutions beyond traditional grid expansion. While Liander's planned infrastructure upgrades will eventually alleviate/mitigate some congestion issues, these projects are long-term and resource-intensive. In the meantime, flexibility measures such as demand-side management, battery storage, and local energy exchange mechanisms must be explored. The concept of "behind-the-meter" solutions, where individual businesses take greater control over their energy production and consumption, has gained traction among stakeholders, particularly the Business Park Association. However, implementing these solutions requires regulatory support, financial incentives, and technical guidance. In this, the role of data accessibility and transparency cannot be overstated. Several stakeholders expressed concerns over the limited availability of real-time grid data, which hampers informed decision-making. Enhanced collaboration between Liander, local authorities and businesses, coupled with technological advancements in smart grid management, could improve situational awareness and optimise the utilisation of existing grid capacity.

Secondly, the lack of coordinated energy planning in urban development (and vice versa) has led to inefficiencies exacerbating congestion issues. Historically, energy infrastructure was a background utility, available on demand. However, as the transition towards decentralised renewable energy generation accelerates, a more integrated approach is needed. Grid congestion is not only influencing industrial development at the business park but also affecting broader urbanisation strategies, including housing developments such as Middelsee. Without strategic alignment between energy and spatial planning, future economic and residential growth may face significant constraints. Encouragingly, recent developments suggest a growing shift towards better integration of these planning processes.

From a policy perspective, the alignment of energy planning with spatial & economic development strategies at the provincial and municipal levels is crucial. The province of Fryslân has indicated interest in the concept of energy hubs, which, while distinct from PEDs, share a similar objective of fostering local energy autonomy. Such initiatives could provide a structured framework for addressing congestion while promoting business-friendly renewable energy deployment.

To end, this study acknowledges its limitations, notably the small sample size and the focus on a single case study. Further research is needed to deepen insights into stakeholder engagement in the implementation of PEDs or similar concepts and to develop strategies that better align the energy transition with spatial planning and vice versa.

7 Appendix: Main findings & summary

Version: 13.09.2024/kvd (previously distributed internally)

As part of Flexposts, we interviewed a selection of stakeholders. The interviewees were representatives of the municipality of Leeuwarden, the province if Fryslân, grid operator Liander and the business association of the Zwette. The interviews were directed towards grid congestion and 1) the different roles that these stakeholders have in relation to the topic; 2) the identification of barriers; and ultimately, 3) interviews were aimed towards getting insights to the current state of the interaction between energy planning and urban planning. This is a (preliminary) summary of the findings of the interviews.

Introduction

Both the municipality and province have policies to support development sustainable business parks; De Zwette in Leeuwarden is an example of a business park where this policy applies. Although the police also includes measures directed towards climate adaptation and biodiversity, all stakeholders we interviewed are focussed on reducing CO2 emissions mainly by increasing the deployment of renewable energy technologies. It is observed that none of the stakeholders make use the PED concept in their daily considerations. However, the main principles of PED can be traced back in their actions and policies (at least for some).

Grid congestion issues

Currently the practical implementation of the sustainability policies for business parks is hindered by the grid congestion problem. It is estimated that 30 of the 300-400 businesses located at the Zwette are affected by the congestion. These 30 firms are larger firms, that can either not expand and/or take measures (install solar etc.).

Grid congestion is identified by stakeholders as the key barrier to creating a PED, or more generally, realising a sustainable business park. Stakeholders expressed severe critique on grid operator Liander, as they believe Liander could have done more at an earlier stage. Also, in their view, Liander is not always collaborative in trying to solve the issue. It is also clear that part of the congestion is 'paper congestion', meaning that part of the problem can easily be solved as in reality there is enough capacity available. A number of technical and organisational solutions are mentioned by all stakeholders (congestion management, batteries, etc.), many of which are indeed part of the investigation/research done in the techno-economic part of the Flexposts project. Besides the evident technical restrictions of grid capacity, the lack of data of Liander, and linked to that, the limited access to Liander data by others, is identified as one of the critical issues hindering finding quick solutions.

In terms of concrete (technical) solutions to the current grid congestion problem, extension of the grid capacity by Liander (and Tennet) is a must. In Fryslân, Liander has introduced the Uitbreidingsproject Netuitbreiding Lelie (NuLelie) project aimed to extend the electricity grid. The NuLelie project, currently facing delays, is an amalgamation of 37 sub-projects in different parts of the province. In total the plan is to extend the grid by 2,100 kilometres of cables and about 300 electricity stations (web). One of the actions of Liander is that they are extending and replacing transformer stations ("trafohuisjes") (low voltage grid/kleinverbruikers). Due to the (expected future) increase in the use and generation of electricity, the technical requirements for the lv-grid have changed requiring more trafos than previously.[30] For this, Liander has implemented a district approach and foresees the installation of many units in the entire province (this will double the number of trafos). Although Liander is aware of the potential roll-out of a heat network in some areas, their operation is currently based on an all-electric scenario based on the assumption that all buildings & districts will fully electrify their energy system.

Although the PED concept itself is not "on the top of the stakeholders' action list" the ideas behind it are, illustrated for example in the provincial commitment to the "energy hub" concept (province is

[30] The maximum length for a cable was 1000 meter; now this is 250 meter. Approximately 50 buildings (houses) are connected to one trafo.

supportive of this/municipality is less supportive). Generally speaking, stakeholders express in one way or the other their preference to generate, store and use electricity on the lowest possible scale. This means they are supportive of "behind the meter" solutions for individual units or - if that is not possible - to do this on e.g. district level. Nevertheless, the municipality representative also believes that in order to keep the energy system affordable, an integrated European electricity network is needed with some large strategically positioned central locations.

Stakeholder roles

Clearly as the grid operator, Liander is the main actor that can solve the problem of grid congestion; however, the other stakeholders also have a role to play. In the case of the business park, the interviewee points out that in essence it is a problem between Liander (supplier) and individual companies (client), also suggesting that as a way out, individual firms can or should take matters in their own hand: "if you as a firm have problem with energy, you solve it. Install a battery". In this perspective, it does not help to keep moaning about Liander or keep resisting Liander; it is better to look for "behind the meter" solutions yourself.

Obviously, in the direct client relation between Liander and businesses, the municipality and province do not have a direct role: their role is mainly to use their (political) influence to lobby for the interests of companies. This is exactly what the municipality of Leeuwarden and the province are doing, both in negotiating with Liander but also by bringing the issue to e.g. the national government. (more on this)

Relation energy planning and urban planning

At present there the interaction or relation between energy planning and urban planning is highly problematic. Although there are some existing connections between the two fields, the characteristics of renewable energy are such that the role of the energy system in has changed. What consequences this has or may have has so far only dimly penetrated both the energy sector itself and other policy fields such as urban planning, for example. In that respect, the grid congestion problem may be seen as an important wakeup call as it exposes some of the underlying problems.

As an illustration, in Leeuwarden en Fryslân, the grid congestion is starting to affect many developments ('opgaven' – policy tasks), in particular related to housing and business park development. The new housing district in Leeuwarden, Middelsee (3200 houses), is affected: the future houses will be connected to the grid, but utilities (shops, schools etc.) will not be connected, meaning that these will not be built as long as this problem is not tackled. This jeopardizes the original urban planning that includes these facilities. From an urban planning perspective this clearly is a highly undesirable situation. Recently Liander announced that the NuLelie project is delayed. One of the implications is that companies and possible housing projects should expect longer waiting time before the get new or heavier connections (web).

Similarly, the planned extension of the business park De Zwette is delayed/affected. There is at least on anecdote of a new business/company that decided to relocate to an area without problems on the grid. Like the municipality, the province is concerned that businesses are affected and decide to go elsewhere, as this may hinder future economic development.

Related to that is the observation that among stakeholders there is a sentiment that due to the (growing) importance of the electricity network to the functioning of society, Liander has unwittingly gained a position or power that normally belongs to the government. For the province and municipality as the public democratically elected government bodies it is important to get more grip on this, if only because they also take other issues into account, both energy related (heat, mobility, etc.) but also other societal aspects (housing, agriculture, etc.). Therefore, it is suggested that integrated planning and programming approaches are needed. This requires integrating energy issues in for example urban planning, and vice versa.

8 Appendix: Neighbourhood Approach Liander

As the responsible grid operator Liander has, in addition to more general policies, a number of specific measures targeted at Fryslan. In response to congestion problems that emerged end 2010s, Liander's main policy-approach is the NuLely project[31], for the large-scale electricity grid upgrade in Fryslân and Noordoostpolder. This project is currently delayed.[32] Another policy of Liander is the Handreiking elektriciteitsstations Fryslân met Buurtaanpak en Trafotafels/ Guide to electricity stations Fryslân with Neighbourhood Approach and 'Trafo Tables'. This policy/approach is directed towards extending the grid capacity on the level of the transformation stations, in day to day Dutch known as "trafo's or trafo huisjes".

The Neighbourhood/District Approach

The main grid congestion problems are related to large consumers of energy, notably on a business park like De Zwette. Much of this is related to capacity on the mid- and high voltage grid. The majority of the users in Fryslan (and elsewhere) are connected to the low voltage grid, where grid congestion is not a problem (yet). However, the infrastructure for these users also needs to be upgraded. For this, Liander has developed the neighbourhood approach.

To make neighbourhoods or districts future proof Liander is currently rolling out the Neighbourhood Approach, including a process ('the Trafo Table') with stakeholders to determine the design and implementation of the trafos. The approach involves extending the number of stations, and replacing stations, adding cables etc. in the Netherlands, including in the province of Fryslan. Liander has been working with a neighbourhood approach for several years as the previous approach (take action if there is a voltage problem) was too slow to keep up with the energy transition. With the neighbourhood approach the entire neighbourhood is tackled at once to make the district future-proof in one go. Both low-voltage and medium-voltage, so neighbourhoods may in future be off gas, all-electric. This is a long-term action, expected to be finished in 40 years.

In terms of what it entails: new transformer houses are being built. They are bigger than the existing houses. Also, in Liander's service area, the number of houses will double. This is partly due to the fact that the maximum length of a cable between two station has become shorter from 1000 m to 250 metres, due to more (expected) usage of electricity and increase in generation. On average, 50 houses can be connected to a substation. For communities this means that more of these house will be placed in the

[31] https://www.liander.nl/regio's/nulelie

[32] https://www.liander.nl/over-ons/nieuws/2024/vertraging-grootschalige-werkzaamheden-elektriciteitsnet-friesland-en-noordoostpolder

vicinity of public space. For example in Damwoude, 40 to 50 stations will be needed, there are 13 now, some of these are also renewed, some of them new houses. Total just over 24 new locations.

For the planning of these trafos, including the location, Liander seeks collaboration (Trafo Table) with the municipality and other stakeholders to plan where in the neighbourhood to fit this in and whether or not to work with residents. To decide on where these station are located, Liander's network specialists provide a high-over design (circles) within which the station should be located. Fine-tuning for the final location is done with stakeholder organisations, such as the municipality, the water board, SBB, Fryske Gea, housing cooperations or Gausunie etc. From the municipality, relevant disciplines sit around the table and have input on where to put a transformer. [L] Other stakeholders come in when land, pipelines etc of these organisations in involved and/or if permits are required. Whether or not residents are involved in the process depends on the municipality: some organise evenings where residents can provide input; others use communication channels to inform them. In both approaches people may respond negatively to the proposed trafo-location. Liander has noticed on residents' evenings that people have a lot of questions, and sometimes are quite vocal. As some of the plans are non-negotiable, this sometimes leads to difficult situations. On the other hand, there is minimal communication, people are often outraged that there was no consultation. For site selection, residents are usually not consulted, however sometimes it does lead to better locations of the trafos as people in the neighbourhood know the local situation best.

Currently they are prioritising neighbourhoods where there are bottlenecks, but in principle Liander has started to work in all municipalities. Part of this also intends to be demand-driven e.g. based on the requirements of municipalities in terms of spatial development such as newly planned residential areas. The neighbourhood approach works on low-voltage grid and although this can be rolled out now and laid ready, but it depends on the capacity on the higher voltage grid whether or not this capacity becomes available. (So far 15 neighbourhoods are tackled; takes about 2 years between start and finish).

The approach is applied in all neighbourhoods, whether in the larger cities or in small villages. In dense urban areas, e.g in Leeuwarden it is increasingly difficult to find space for the trafos. Usually trafos here are more customised, and architects are sometimes involved to design the transformer buildings. Either to get them out of sight as much as possible or to fit them in. In some case, these trafos can become art objects [L] For more rural areas, it can be difficult as most land is private farm land with little common land, and because of open landscape, it is sometimes difficult to place a station just anywhere. That sometimes takes even longer than a neighbourhood in Leeuwarden. For farms, that 250 metres of cables and transformers also applies. Because of distance between farms, they sometimes work with adjustable transformers and farms, as large consumers, often have a transformer themselves, and so are connected to the low-voltage network.[L]

9 References

Anthea Group (2024), Verstedelijking en energie. Inventarisatie en advies ten behoeve van methodiekontwikkeling. Ministerie van BZK, directie Ruimtelijke Ontwikkeling

Bossi, S., Gollner, C., & Theierling, S. (2020). Towards 100 positive energy districts in Europe: Preliminary data analysis of 61 European cases. Energies, 13(22), 6083.

The Carbon Trust (2018). Stakeholder Engagement in Heat Networks. London: The Carbon Trust.

JPI Urban Europe (2020). Reference Framework for Positive Energy Districts and Neighbourhoods. Vienna: JPI Urban Europe.

Olesen, K. Pierie, F. & Steffansen, R.N. (2023) Developing Methodologies for Implementing PEDs, D3.1, FLEXPOSTS. Vienna: JPI Urban Europe (draft report).

Olesen, K. (2023). Reviving strategic spatial planning for the challenges ahead. *European Planning Studies*, *31*(11), 2318–2326. https://doi.org/10.1080/09654313.2023.2231500

Topsector Energie (2023), Shaping the sustainable energy system in synergy with other spatial tasks. Topsector Energie Systeemintegratie

Van Dam, K.I.M. (2023), Position Paper for University of the North, (internal document, not published, available upon request: k.i.m.van.dam@pl.hanze.nl)

Websites

https://www.dezwette.nl/vereniging/tijdlijn/

https://ondernemendleeuwarden.nl/locatie/bedrijventerrein-de-zwette/

https://www.regionale-energiestrategie.nl/english/default.aspx

https://www.fryslan.frl/mienskipsinitiatieven

https://leeuwarden.bestuurlijkeinformatie.nl/Reports/Document/1f51dd81-8091-4679-a83b-98b0558bc75e?documentId=65f910bd-ec56-420d-81de-4b17b0778851

https://www.liander.nl/regio/nulelie

https://www.liander.nl/over-ons/nieuws/2024/vertraging-grootschalige-werkzaamheden-elektriciteitsnet-friesland-en-noordoostpolder

https://www.netbeheernederland.nl/artikelen/nieuws/woontop-afspraak-netbewust-bouwen-meer-woningen-op-dezelfde-kabel

www.makingcity.eu