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Nr 1/2019

Descriptive study of Local Energy Communities

A report commissioned by NVE

THEMA Consulting Group
Multiconsult Norge AS

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Descriptive study of Local Energy Communities

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Sammendrag: This study provides an overview of Local Energy Communities (LECs) in Norway, identifies their potential costs and benefits, as well as possible barriers to their development, and provides recommendations as to an appropriate regulatory response.

Emneord: Local Energy Community (LEC), regulation, end-user participation, distributed generation, energy storage, distribution system operator (DSO)

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Preface

In Norway, as in other European countries, a growing number of consumers want to take active part in their energy consumption and produce their own electric energy. The Norwegian Water Resources and Energy Directorate (NVE) also sees an increasing interest in so-called Local Energy Communities (LECs) where a neighbourhood collectively owns production and storage units. At the same time, they may perform some of the activities normally undertaken by a distribution system operator (DSO).

DSOs are natural monopolies. Consequently, DSOs are under comprehensive regulation with regard to both costs and quality of the service they provide, as well as what activities they may or may not engage in. Putting a LEC between the DSO and the individual member of the LEC might influence the members' rights and obligations.

For NVE it is important to ensure sufficient consumer protection for all electricity consumers, with regard to grid tariff, quality of supply and access to the energy market. Further, it is important to ensure a reasonable distribution of grid costs between LEC members and all other grid customers. In order to develop a sound regulatory framework for LECs, NVE needs more information about them. Thus, NVE has asked THEMA Consulting Group and Multiconsult Norge AS to identify and describe existing and planned LEC initiatives in Norway, in addition to a selection of European initiatives. Furthermore, the consultants have identified some positive and negative effects of LECs for the society as a whole, pointed out possible barriers to establish and operate LECs in Norway, and suggested a possible regulatory response to the emergence of LEC initiatives.

The content and recommendations contained within this report are those of the consultant, and have neither been accepted nor rejected by NVE.

Oslo, January 2019

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Descriptive study of Local Energy Communities

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About the project

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Brief summary

This study provides an overview of Local Energy Communities (LECs) in Norway, identifies their potential costs and benefits, as well as possible barriers to their development, and provides recommendations as to an appropriate regulatory response. We identify 30 LEC projects, of which the majority are in the concept phase and being led by property developers seeking to create net zero energy consumption developments. There are also a number of DNO-led projects focused on avoiding network reinforcement. The biggest barrier facing these projects is the lack of a well-defined business model, since there are generally no existing markets or other standardised commercial arrangements in place for the services that the LEC can provide. A lack of understanding as to how current regulation applies to these projects may also prevent projects from being realised. In this context, the introduction of a regulatory sandbox regime that provides regulatory advice and time-limited exemptions may be useful, both to enable innovation as LECs seek to develop their business case and to provide a channel for information sharing between NVE and the projects themselves.

About THEMA Consulting Group

Øvre Vollgate 6 0158 Oslo, Norway Company no: NO 895 144 932 www.thema.no	THEMA Consulting Group is a Norwegian consulting firm focused on Nordic and European energy issues, and specialising in market analysis, market design and business strategy.

About Multiconsult

Nedre Skøyen vei 2 0213 Oslo, Norway Company no: NO 918 836 519 www.multiconsult.no	Multiconsult Norge AS is one of the Nordic region's leading engineering and design consultants with expertise that spans a broad range of disciplines. Of the roughly 3000 staff at Multiconsult, more than 270 work specifically in the energy sector.

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SUMMARY AND CONCLUSIONS

This study seeks to provide an overview of the status of Local Energy Communities (LECs)[1] in Norway, consider their implications for the current regulatory regime and provide recommendations as to how NVE should respond.

One of the challenges involved in the work is the nebulous definition of LECs. For the purposes of the study therefore, we've generally sought to identify possible challenges to the current regulatory framework from innovative entrants and then looked to see which of these might conceivably have the characteristics commonly attributed to LEC. When defining the number of LECs in Norway, we've accounted for projects in all stages of development in which several end-users either share locally produced power and/or use it to help limit their wider network requirements.

Our survey of Norwegian LECs shows most of them to be relatively immature. There are no LECs in Norway that involve genuine end-user participation, either through a local market or pricing signals for example, and of the 30 projects identified, only five have been fully or partly implemented. The rest remain early concept studies. In general, the required technology is available but a sustainable business model that could support the LEC has yet to be demonstrated.

Property developers and real estate companies are the driving force behind more than 70% of the projects identified. Their main motivation is attracting tenants and buyers, given experience that zero-energy and zero-emission buildings / areas get a lot of attention in the market. These projects naturally focus on local power production and the self-consumption of locally produced energy. Network capacity and load reduction is a secondary priority, if it is considered at all. The remaining 30% of the projects identified are run by DNOs and are therefore heavily focused on keeping maximum loads and future grid investments down. Given that capacity is expected to be the major driver of future system costs, there is a notable discrepancy therefore between the stated goals of most LECs and the long-term cost drivers of the Norwegian power system.

The expected benefits of these LECs are, to a large degree, quantified only in terms of the energy (kWh) saved or produced locally. Some projects have conducted cost-benefit analyses from the perspective of a participant in the community, but none of the projects investigated had a clear idea of how large the overall economic or financial benefits were expected to be. This is a reflection of the maturity of the projects identified, and the fact that many of them are focused narrowly on exploring the potential for local generation.

Since the projects identified had not attempted a direct comparison their social benefits with the expected costs of the project, it was not possible to draw any conclusions as to their likely economic efficiency.

Looking at examples of international LECs, we found that, while some projects have been realised, these generally either work within existing regulatory structures or are being conducted as part of research projects outside of the standard regulatory model. Specifically, the cases detailed include:

- A generation project operating under the standard regulation for small-scale generators,
- A trading platform nested within a traditional supplier, and
- An experimental network solution operated by the existing DNO.

This suggests that, in general, regulatory innovations in response to LECs have yet to be developed, and that NVE is unlikely to be able to readily apply solutions developed elsewhere.

Given limited international experience of incorporating LECs into the regulatory regime, we've therefore sought to look ahead of current practice and consider the wide variety of potential LECs when looking at their possible costs and benefits and the challenges they might pose to the system. This gives rise to a wide variety of possible costs and benefits ranging from the concrete, such as avoided network investments, to the intangible, such as enhanced social capital.

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[1] Note that the most recent legislative proposal for the Clean Energy for All Europeans package has moved from using the language of Local Energy Communities to instead using Citizens' Energy Communities. We have preserved the use of LECs here since it reflects the actual research question considered.

LECs face a variety of regulatory and commercial barriers to their development, which vary depending on the nature of the specific LEC under consideration. In general, however, the most important barrier in terms of its scale and widespread applicability is the absence of a sustainable and well-specified business case, often due in part to the lack of an existing market for the potential service that a LEC would provide, or else the lack of standard business arrangements to supply the relevant service. There may be a regulatory dimension to this commercial problem, for example where LECs must contract bilaterally with their DNO in order to paid for reducing network costs, rather than receiving payment directly through the network tariff or connection charging regime. However, the most important challenge posed by regulation is likely to be the steep learning curve faced by organisations outside the electricity sector attempting to navigate a licencing regime not obviously designed for a project of their type.

Given the immaturity of existing LEC projects in Norway and the level of uncertainty as to how future projects might develop, it is premature to proactively adapt elements of the general regulatory framework in an attempt to remove the potential regulatory barriers identified. Rather, we recommend that NVE adopt the two-phase approach described below.

In the near-term, NVE should seek to develop a regulatory sandbox solution that provides a clear, standardised process for the granting of temporary regulatory exemptions for the purposes of developing innovative solutions. By improving NVE’s existing exemptions process, NVE should be able to give LECs the support they need in the near-term without incurring the costs and risks associated with more fundamental regulatory reform. Such a solution will also help inform NVE as to whether more general regulatory reform should be considered.

In the longer term, and only if the regulatory sandbox results in the creation of LECs that appear to be of more general benefit to the Norwegian system, NVE can consider broader regulatory reforms to better meet the needs of a power system that incorporates LECs. In doing so, it may wish to make use of Principles Based Regulation as means of opening up the regulatory framework to more diverse models without the creation of a plethora of alternative (and possibly uneven) regulatory standards.

1 OBJECTIVE OF THE REPORT

This report in the culmination of a "Descriptive Study of Local Energy Communities" commissioned by NVE. The work was indirectly motivated by recent proposals in the European Commission's "Clean Energy for All Europeans" package aimed at supporting the participation of LECs in the power system. In particular, these communities appear to challenge the traditional regulatory model by blurring the lines between the archetypal market actors as defined in existing law and may therefore require regulatory reforms to be incorporated efficiently into the existing market arrangements.

Unfortunately, the definition of a Local Energy Community (LEC) is currently so nebulous as to provide little insight into the intended scope or intent of the work. In scoping the work therefore, we have worked backwards, seeking to identify possible challenges to the current regulatory framework from innovative entrants to the power system and then seeing which of these might conceivably have the characteristics commonly attributed to LECs, such as end-user ownership or involvement and a small, bounded geographic scope.

The work itself was divided into two parts and this division is reflected in the structure of the report.

Part 1 explores the current state of LECs. LEC projects, either existing or in development, have been identified and interviewed. Their nature and status, as well as the motivations of the developers, have been examined and summarised to provide an overview of the current state of play. In addition, we have looked at a variety of international cases and summarised a few noteworthy examples of activity internationally to provide a broader perspective on the types of activity that might eventually take place in Norway.

Part 2 considers the issues relevant to the appropriate future regulation of LECs. Specifically, it undertakes a comprehensive review of the potential positive and negative effects that LECs may have. In doing so, it looks both at the effects on scheme members and on the potential contribution that LECs can make to society. It also reviews the current regulatory framework to identify possible barriers to the establishment and effective operation of LECs and considers the trade-offs that need to be considered, in terms of avoiding the introduction of double standards or the removal of appropriate consumer protections. This part concludes with recommendations on an appropriate regulatory response.

Overall, the report seeks to provide some insight into the current state of play of Local Energy Communities in Norway and establish a clear vision for how NVE should respond.

PART 1

2 OVERVIEW OF NORWEGIAN LOCAL ENERGY COMMUNITIES

2.1 What is a Local Energy Community

It is important to have a shared understanding of the expression "energy community" as basis for interpreting the findings and discussion contained in the rest of the report. Definitions clearly vary and this has made it difficult to set an exact boundary. We wish to exclude generic smart homes, or groups of smart houses, but it would also be a mistake to exclude everything that falls short of a full-scale operating energy community, as might exist in the future.

For the purposes of looking at current Norwegian practice, the following criteria have been used as guidelines for whether or not a project is of interest:

- The 'community' should consist of 3 or more different parties;
- There should be the potential for bidirectional power flows;
- There should be some sort of local control or energy management;
- There should be active participation from the end-users in the community; and,
- All assets and participants must be located in a circumscribed geographical area.

It is important to note that these are guidelines and have not been used strictly to exclude projects. Projects and communities that do not fulfil all of these criteria are still considered in the report and we have also considered explicitly the role of trading communities, based around separate means of trading energy among consumers, when considering relevant internal cases and in Part 2 of the report.

To inform our work, a series of separate Norwegian cases have been evaluated to assess their relevance. Of the 30 projects[2] identified as being of interest, given the guidelines above, 15 have been interviewed. Regardless of whether or not these projects are LECs in some sense, we believe they have the potential to challenge existing regulatory boundaries and are therefore included.

Research projects not related to a physical site and initiatives that are more general in nature have not been included.

Figure 1 plots the projects by county on a map of Norway (Trøndelag is regarded as one county, Agder as one, and projects in Akershus and Oslo have been grouped together).

[2] The projects are described in more detail in an appendix.

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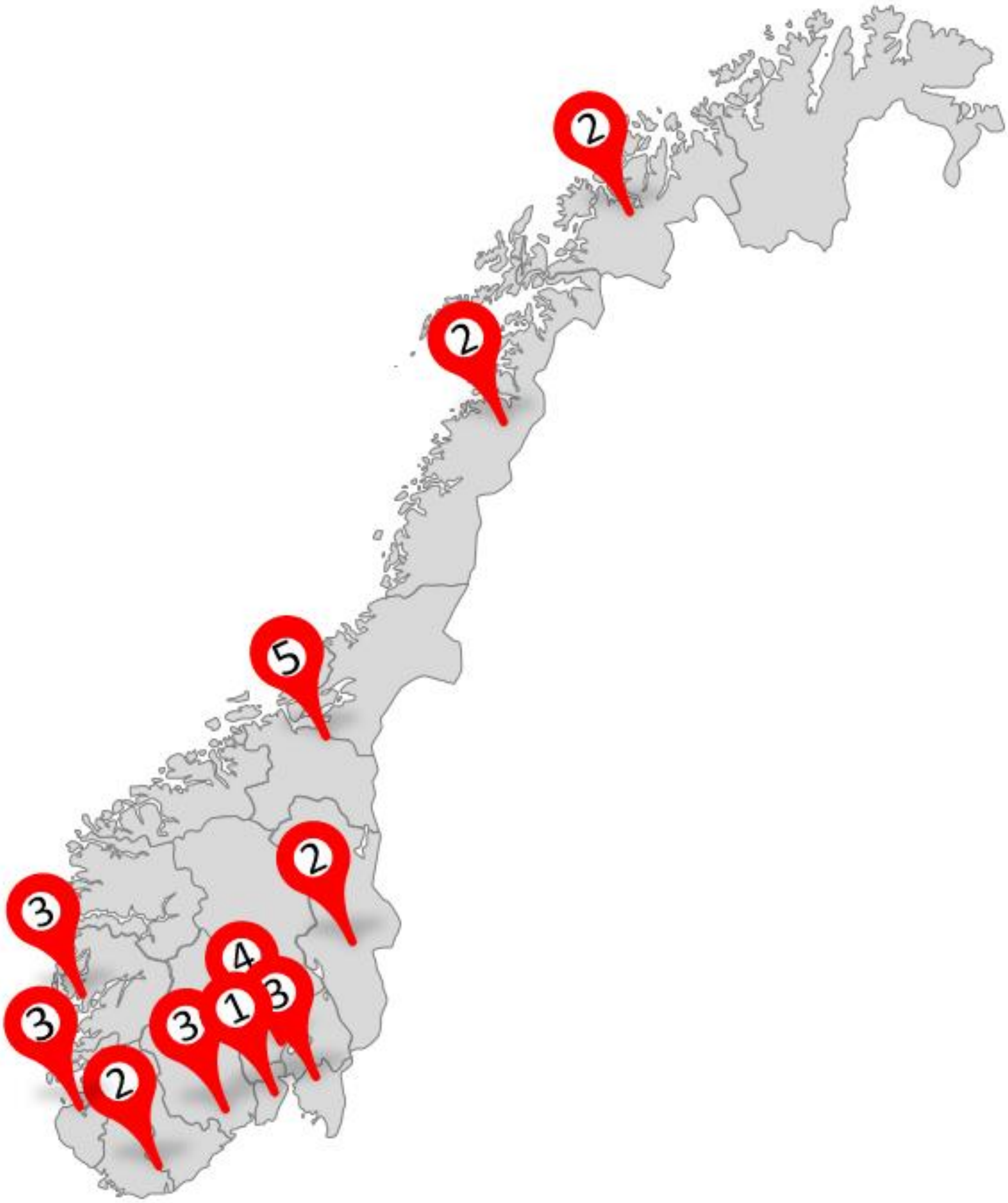
Figure 1 Geographical dispersion of projects by county



2.2 Mapping and assessment of Norwegian energy communities

Numerous projects relating to new buildings, neighbourhoods, business parks and new grid investments have been assessed. Of the more than 50 projects initially assessed, 30 more or less fulfilled the guideline criteria for Local Energy Community mentioned previously. It is a study of these 30 that forms the evidence base the further evaluation and discussion provided below.

The projects involve a variety of different setups regarding the type of project, the prime actor and the motivation behind developing a local energy community.

Typical actors include Distribution Network Operators (DNOs), property developers, and housing communities. Looking at the motivations behind establishing LECs, there are three key motivations:

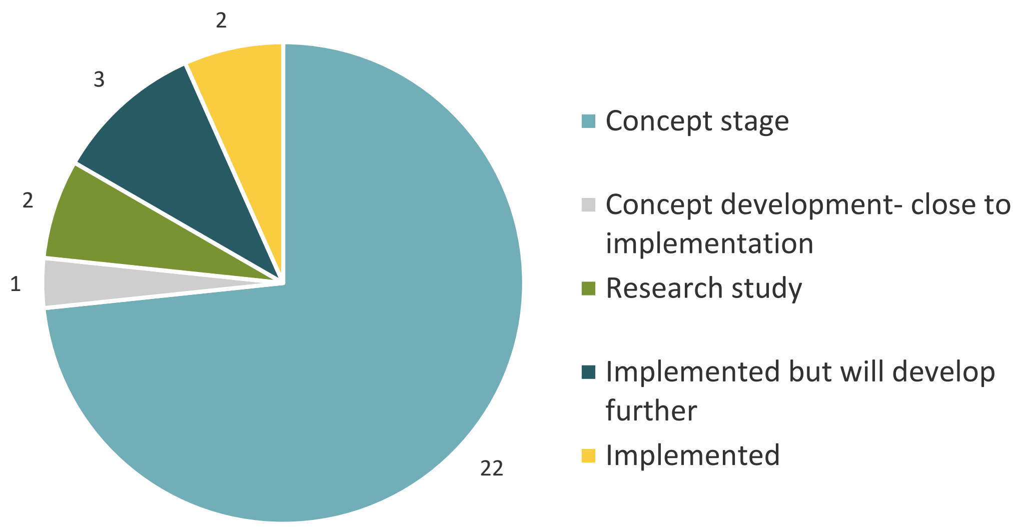
- Postponing grid investments,
- Adding value for property owners / leasees, and
- Research.

It is noteworthy that there are projects reflecting a wide variety of different actors and motivations, but a significant majority of the projects examined are driven principally by property developers looking to add value to properties.

2.2.1 Maturity level

The maturity level of the assessed projects varies greatly. Some are merely concept studies and spoken ambitions, whereas others are pilot trials that have concluded, produced finalised reports and identified clear lessons. Of the 30 projects, only five involve investment that has been realised to some degree, three of which are under further development. The rest of the projects are still in the concept development phase and are relatively immature. Figure 2 depicts the maturity levels of the 30 projects.

Figure 2 Project maturity



2.2.2 The actors

Typically, the primary actor driving the development of the project will be either a DNO or a property developer or owner.

Looking at the DNOs first, they are conscious that the power system and end user technologies are changing and that these changes may bring new challenges and opportunities for their businesses. In general, large new consumer loads are emerging, like electric vehicles (EVs), and new actors are creating smart devices that allow end-users more control over their consumption.

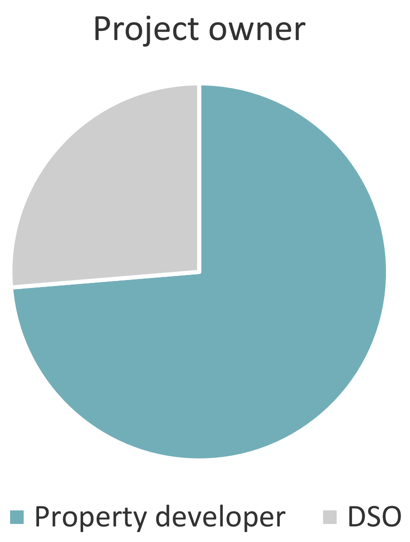
DNOs are looking to adapt to and take advantage of these changes. To do so, some DNOs are seeking to acquire knowledge through research, pilots and other projects related to LECs. These are focused on understanding the potential of LECs in postponing grid investments and how DNOs can secure an attractive position in any revised configuration of market actors brought about by technological development. In particular, DNOs, which already having a close customer relationship with end-users, could seek to provide new services that benefit both them and their customers. Examples of the latter can already be seen, with some DNOs in Norway equipping end-users with smart-house technologies to help lower peak load capacity.

Property owners and developers are driven by the same technological changes as the DNOs, as well as increased end-user awareness of environmental issue and therefore greater value associated with offering environmentally friendly products and services. This change in consumer preferences has helped contribute to the rapid rise in electric vehicles sales in Norway and a growing desire for rooftop PV-panels. It also presents property developers with a new market opportunity – the development of energy neutral buildings or even buildings that are net generators of renewable power. In the assessed cases, energy efficiency and production of energy on site are used to increase the attractiveness of new building complexes, both residential and commercial.

We have also found property owners that want to implement new systems in their existing properties. These are typically cooperatives that want to either allow for higher power consumption and/or make it easier for members to pursue environmentally friendly choices, like owning an EV.

The distribution of projects by the type of project owner is presented graphically in Figure 3.

Figure 3 Distribution of project owners



3 MOTIVATIONS OF LOCAL ENERGY COMMUNITIES

As previously mentioned, the surveyed project developers expressed essentially three key motivations for establishing a LEC:

- Postponing grid investments,
- Adding value for property owners / leases, and
- Research.

Many projects are motivated by more than one of these three. We discuss each in further detail below.

We also briefly summarise the technical objectives of the individual projects for all of the projects considered.

3.1 Postponed grid investment

A lot of Norway's electricity infrastructure is nearing the end of its operational lifespan, and in the years 2016-2025 an expected 140 billion Norwegian kroner is to be invested in new infrastructure. Postponed reinvestment and lifetime extensions for current infrastructure can accumulate into large savings for the grid companies and, in turn, for end-users.

With end-user equipment, such as household appliances, typically becoming more energy efficient but requiring more capacity when active, the maximum capacity outtake, which is the dimensioning factor of transformers and lines, is increasing. This increase in maximum capacity needs to be slowed or eliminated in order to continue using existing congested infrastructure for longer. Indeed, NVE has previously commented on the widening gap between energy and capacity consumption (NVE, 2016).

Therefore, LEC-relevant projects aimed at postponing grid investment often seek to lower peak capacity demand, either by creating a local "market" for capacity and utilising flexible loads, or by installing local production and / or storage capacity.

A typical example would be to control / reduce loads downstream of a congested transformer so as to extend its lifetime. This can be done by creating a local flexibility-market, by encouraging the installation of local energy production, or by using local storage. Instances of each of these mitigating measures are present in Norway today.[3]

One could argue that a form of flexibility markets has existed for a long time, implemented through bilateral agreements between DNOs and large energy consumers in their area, typically heavy industry. What is new is the attempt to incorporate small-scale, end-user flexibility into this market, potentially benefiting DNOs and end-users alike. A lot of work, trials and research has been conducted in this area. One very tangible outcome is the establishment of NODES, which is a flexibility market for DNOs, TSOs and aggregators (NODES, 2018). Other flexibility market models are proposed in different projects, generally defined by the geographical constraints set by local grid infrastructure.

Storage was also mentioned by some as a means to postpone grid investment.[4]

It is usually the DNOs that lead projects intended to postpone grid investment. Understandably, the implied costs and gains are more apparent to them than to other entities. However, because investment cost can be shared with end-users through a connection charge, we are also aware of

[3] It should be noted here that local energy production often includes solar energy, which does little to reduce maximum peaks in winter. Solar energy is however seen by many of the actors as a positive thing, as it reduces the overall energy consumption. Thus, the perceived value many have of solar energy may not match the real added value as seen from a DNO's perspective.

[4] We note that under the current regulatory regime, due to the unbundling requirements, DNOs may not use batteries for purposes other than their monopoly operations. This requirement may become even stricter when new regulations come into force in 2021. As a result, network services reliant on storage may need to be provided by a third party.

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an example in which a housing cooperative sought to use a LEC solution to postpone grid investment.

In this specific example, the housing cooperative wanted to become eco-friendlier, and offer EV-charging to its' residents, along with other measures to reduce energy consumption and their CO_2-footprint. The proposed measures were expected to increase the maximum capacity demand from the local transformers, two of which were already at capacity, and the local DNO did not want to replace them free of charge to allow for increased load.

The housing cooperative essentially had two choices, either pay a connection charge, as regulated by NVE, and thereby contribute to the costs of a new transformer, or implement a local solution to prevent any increase in the peak load.

The concept study conducted to develop a local solution proposes a technical solution for the cooperative that would enable them to install the desired EV chargers and others, without upgrading the transformers. The study does not, however, contrast the cost of the solution with the cost of replacing the transformer.

Looking at all of the assessed projects, a direct comparison of the avoided cost of network investment with the cost of the project is seldom undertaken. As such it is difficult to assess directly the likely economic efficiency of the projects themselves.

3.2 Add value for property owners / leasees

Another key motivation behind making an energy community is to increase the apparent attractiveness of an area by increasing its self- sufficiency in terms of energy production, storage and management.

Most projects that fit into this category are owned by property developers, which are seeking to attract a new customer base and/or take greater social responsibility for their developments.

Although many new projects include energy efficient solutions and even local energy production, these features alone do not constitute an energy community. To qualify as an energy community for the purposes of this study, there had to be something more, like the internal trading of energy or capacity among community member or community-ownership of the resource.

There are some cases going beyond smart houses or low emission neighbourhoods and seeking to establish local energy communities to reduce energy or capacity outtake from the grid, and also to better utilise shared resources, like power production or charging of EVs, between the inhabitants.

To add further value, projects specifically state that sharing energy among more members of a LEC is motivated by increasing the value of locally produced power. Among this group of projects, a common perception is that this power should be transported to the neighbour at no, or very low, grid cost. This will enable the seller to achieve a price for the locally produced power higher than the spot price in the energy market. This is discussed further in section 4.2 below.

The added value to the network of peak shaving is not generally investigated for this group of projects and, in most cases, any network-related assessment will be limited to the possible reduction in grid tariffs as assessed based on the current grid tariff.

3.3 Research projects and pilots

It is important to state that even though 'research' has been defined as its own motivation, the underlying purpose of the research projects examined relates to more tangible outcomes, such as testing business models for local flexibility markets, evaluating the potential benefits of storage at different grid levels, or assessing the reliability of remotely controlled load-shedding.

Energy communities, end-user flexibility, microgrids and flexibility markets are all new developments and consequently relativity immature. The need for research, trials, pilots and testing is being taken seriously by companies, universities, and funding-institutions (such as the European Commission and the Research Council of Norway). Extra funds and flexible regulations to support trialling on these new solutions in the power system have contributed to an exploration of the viability of energy communities through these projects.

Such trials provide useful insight on technological maturity, end-user involvement and interest, and potentially viable solutions in the future. However, the regulatory regime that surrounds the suggested solutions is rarely considered explicitly, and it is thus somewhat challenging to fully understand the obstacles and barriers found in the regulatory regime with regard to these research communities.

In general, research projects have been used to explore the opportunities presented by new technologies and piloting is now being used to test implementation at increasing scales. Prior to the last two years or so, most pilot sites sought to involve 10-100 participants. At this scale, the effects of these projects on the system was negligible, such that unforeseen or undesirable incidents would have little to no consequences for the grid in general.

With small-scale testing now completed and validated, pilot projects are scaling up to cover several hundred to several thousand participants and approaching electrical energies that are sufficiently large to have consequences for the grid in general. Some of the larger ones in terms of the number of end users are Verksbyen in Fredrikstad, Engene Trafo (Agder Energi) and the upcoming large-scale pilots funded through ENOVA. In terms of kW and m^2, Brattøra and Skagerak Energilab are of notable size.

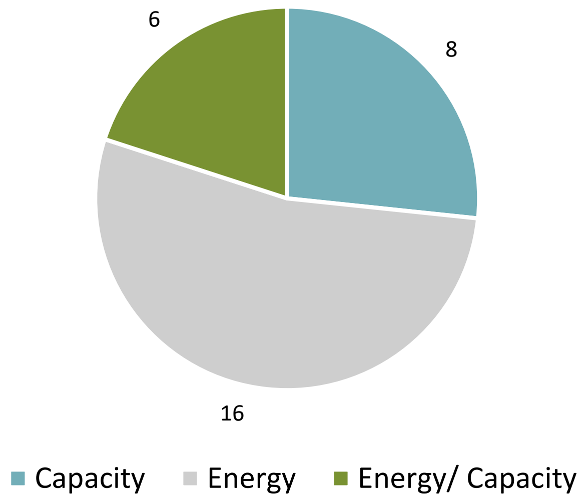
3.4 Technical objectives

Looking at the projects identified, most focus on some combination of energy self-sufficiency and a reduced network capacity requirement. With relatively low energy volumes and low capacities, it is unlikely that these projects could be independent providers of grid services beyond simple energy and capacity control.

Of the 30 identified projects, eight are led by the DNO and focus on reduced grid investment, notably by reducing peak demand. The remaining 22 projects are more energy-oriented, focusing primarily on local generation, greater energy self-sufficiency or net zero consumption. Of these, 14 projects have goals solely related to energy. Of the 30 projects, 18 explicitly mention batteries as possible or necessary as part of the proposed solution.

Looking at Figure 4, it is clear that the majority focus on reductions in energy consumption. Given the expectation that capacity will be the major cost driver in the future, there is a notable discrepancy between the stated goals of LECs and long-term cost drivers for the Norwegian power system.

Figure 4 Distribution of Norwegian LECs by focus (energy and capacity)



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4 OTHER INSIGHTS FROM THE INTERVIEW PROCESS

4.1 Potential benefits and problems with LECs

The benefits of LECs noted by the interviewees were understandably influenced by their own interest area. DNOs noted the potential grid cost reductions. For property developers, the most prominent benefits were the scope to enable greater renewable energy generation and to add value to surplus locally-generated electricity. None of the projects investigated however has a clear idea of how large the economic or financial benefits were expected to be.

Most of the projects initiated by property developers – which included projects with local power generation, the local sharing of surplus electricity generation, and elements of demand side response and/or batteries for peak shaving – have estimated the local utilisation of locally-produced electricity. A few presented the potential financial implications for grid tariffs. However, we found no developer project able to present a cost-benefit analysis of the LEC-solution, either in terms of the business case or the economic benefit for society. More generally, of the interviewed projects initiated by property developers, none has quantified the economic benefits identified. This apparent lack of economic analysis may have several causes:

- For some project leaders, the desire to be a market-leader or an innovator may trump the need for immediate economic returns.
- Presentations on locally-produced energy and end-user flexibility may give the impression that it is always beneficial, creating an expectation that it should be commercially viable.
- The actors interviewed may be reluctant to share the existence of analysis that does in fact exist, and by extension its results, so early in the project's development.

The projects run by DNOs focus on the benefits related to grid costs and security of supply. These benefits are equally difficult to estimate and have been estimated and presented in only a few project descriptions. The few with a clearer picture of the benefits have identified grid congestion as the key motivation behind the project. Others are simply exploring the potentials in demand side management, local production and storage, capacity markets etc. DNOs are also, to varying degrees, involved in several of the projects initiated by property developers. Their involvement helps provide insight into how the energy market thinks and may help prepare the projects for any changes in the sector that could influence the business model.

4.2 Obstacles and opportunities for the establishment of LECs

Technology

There are no apparent technological barriers for creating LECs. Load forecasting is possible, detailed consumption data is provided by new smart meters, household appliances can be remotely switched on and off, and electric vehicles can be charged smartly to adapt to the current state of the grid.

Grid tariffs

The difficulty of introducing a grid tariff that differentiates between the distribution of locally-produced electricity and electricity imported from the transmission system is perceived as an obstacle by some project owners.

From a system costs perspective, it is true that the introduction of sources of generation close to load can reduce the need to flow power over long distances and may allow network reinforcements to be avoided, deferred, or even enable network assets, like transformers, to be replaced with smaller and cheaper equipment in future. As such, there can be genuine costs savings that result from local generation and that are not incentivised through the current network charging regime.

That said, developing tariffs that introduce fully efficient incentives is notoriously difficult. From a theoretical perspective, the introduction of negative connection charges is reasonable, but developing a system for actually doing so is fraught with difficulty. Furthermore, the cost argument expressed above, while valid, does not imply the introduction of sperate tariffs for LEC projects, but rather a general reform of network tariffs to better reflect the potential social costs and benefits they are likely bring, thereby better incentivising their appropriate development. In this regard, it should

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be noted that NVE are considering possible reforms to distribution network tariffs and that new building developments may already benefit from onsite generation through the existing network charging regime to the extent the local generation reduces network connect costs and the associated network connection charge for the development.

Data and IT infrastructure

Another key aspect of operating an energy community raised in the interviews concerned data and the operation of the IT infrastructure used by the LEC. Real-time matching of consumption and production, assessing flexibility requirement, scheduling storage at different time, and arranging billing between entities all relies on the accurate processing of data. However, there are several as yet unresolved operational and regulatory questions that may act as a barrier to the establishment of LECs. Relevant questions regarding the regulation include:

- Who owns the data from the local energy community, each end-user or the community as a whole?
- Who bears commercial responsibility for an IT system failure that, for example, leads to unserved load?

There are also operational questions that need to be resolved, such as:

- What granularity and refresh-rate are needed for this data to be useful to a flexibility market and can current infrastructure deliver against these needs?
- How is responsibility for IT-security divided between the actors involved?

The challenges of stacking multiple revenue sources

Some assets have the potential to provide a variety of services. Batteries are a good example of such, since they can be used for load-shifting, frequency and voltage control, phase balancing, and increased self-consumption for end-users. It can be challenging to sell multiple services simultaneously. Indeed, the case of batteries is discussed in detail in “Batterier i distribusjonsnettet” (DNV GL , 2018). This is a commercial barrier to the use of such solutions and though the solution may not be regulatory in nature, it nevertheless acts as a palpable barrier to deployment of certain assets as part of LECs.

Realising an efficient project scale

A recurring topic for discussion, and an issue raised by some interviewed actors, was how to realise economies of scale from a community-based solution. In order for a small community to develop and share a common renewable resource, grid infrastructure would be needed to distribute the power produced. Many have considered the use of local microgrid but have not determined how this would be owned. If the community itself owns the grid, it would effectively become a local DSO, with all the responsibilities and requirements that brings. This approach is typically unattractive for small communities given the economies of scale associated with network management.

Several actors pointed out the benefits of the “plusskundeordningen” and wanted to see the associated regulation amended to allow for larger net power exports and the sharing of power through real or virtual microgrids.

Interviewees also noted that, to support power trading between LEC members, a licence would be required for the LEC. Small actors believed that the effort and internal costs of obtaining the relevant licence were excessive, given the very small volumes involved.

Immature market

The lack of proven business models able to create and distribute value to both network operators and end-users/ members of an energy community is a major barrier. Current energy market actors have yet to identify a means of trading network capacity. Even though the benefits for the grid might be large, the associated value is spread out across end-users, and the ability to pay each end-user is consequently limited. Furthermore, the risks and benefits involved are not clear to the involved parties.

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A large number of identified projects are looking to identify a viable business model. This is most relevant for those projects trying to trade energy and capacity locally.

4.3 The LEC-DNO interface

We are not aware of any examples in Norway in which a LEC operates as an independent network entity, with its' own interface to the regional DNO. Typically, the LEC, or its members, have a normal end-user relationship with the DNO. The "plusskundeordningen" incorporated in Norwegian regulation technically currently makes it possible for end-users to purchase and sell energy to their DNO. Following the impending implementation of Elhub, the plusskunde's retailer will be responsible for buying the energy injected to the network. However, the plusskunde approach would only apply to a very limited subset of small LECs and would not cover a LEC wishing to own its own licenced assets.

We discuss a variety of international case studies in the next chapter. However, even here, there are no examples of genuinely new regulatory arrangements concerning the interface with the DNO.

In Jühnde (see section 5.4), the LEC is a community-owned power plant and this and similar assets have normal costumer relationships with the local DNO. In Simris (section 5.5), the LEC solution incorporates a variety of different technical solutions, including local production, storage, flexibility and end-user-engagement, as well as interesting grid management dynamics. However, since E.ON is both the pilot owner, facilitator and local DNO, there is no apparent interface. The LEC is effectively integrated into the DNO. This approach probably reflects the 'norm', to the extent one exists, for projects with complicated network effects at this early stage in the development of LECs.

4.4 General observations

Currently, we do not believe there are any genuine Local Energy Communities in Norway. There are several projects which have implemented some kind of smart control technology, that have tested flexibility, or that involve the co-ownership of generation assets. However, if what we imagine is a full-scale energy community with inhabitant involvement and grid congestion management through either a community market or dynamic pricing signals, no such community exists.

ENOVA is currently inviting proposals for '*Large Scale demonstrations of the future energy system'.* One of the participants was interviewed as part of this study and is proposing something more similar to a "real" energy community than projects currently in existence in Norway.

5 INTERNATIONAL CASE STUDIES

In this section, we present some case studies of LEC-like projects that have been implemented in other countries. The examples shown were selected based on an assessment of:

- Their maturity, with projects that had been completed given preference,
- Their likely ability to provide insight into possible regulatory barriers or solutions, and
- The extent to which they exhibited the characteristics typically associated with LECs.

We also sought to pick a sample of cases that would demonstrate the variety of projects that have been completed or that are currently ongoing.

5.1 Cornwall Local Energy Market

5.1.1 Project description

The Cornwall Local Energy Market (LEM) project is a three-year trial (2017-2020) that will create and operate a marketplace for distribution-connected flexibility services in Cornwall in the United Kingdom. The local distribution network has struggled to cope with the connection of considerable solar and onshore wind capacity, necessitating the creation of a waiting list for future connections and the need to curtail existing generation capacity. The trial will both develop a market platform to enable trade in local flexibility services and invest in a variety of technologies that enable existing grid users to provide flexibility services, for example through the installation of onsite storage.

The £19 million project brings together Centrica (which has a distributed energy business), Western Power Distribution (the DNO), National Grid (the TSO), Imperial College London and the University of Exeter. It is largely funded through a £13m grant from the European Regional Development Fund, with most of the remaining funding coming from Centrica.

The market platform is being developed by Western Power Distribution. As part of the market's operation, flexibility providers will be able to specify under what circumstances, and for what price, they are willing to adjust their consumption or generation. The DNO or TSO will then place bids or offers into the nodal market and the distributed flexibility providers will respond automatically based on the parameters set. At present the platform is undergoing initial trials.

The project is also expected to install new technology into over 150 homes and businesses so they can provide flexibility services to the market. The sorts of technologies installed include battery storage, gas Combined Heat and Power (CHP) and solar panels. Centrica will own the associated equipment and lease space from the households and businesses involved.

5.1.2 Objectives and potential impact

The LEM is intended to enable the more efficient operation of the distribution network and thereby to contribute to a number of social benefits that are likely to be captured by the DNO, flexibility services providers, distributed renewable generation owners and developers, and energy consumers in general. Specifically, a LEM is expected to be able to:

- Reduce network investment costs by allowing network infrastructure investment to be avoided or delayed through the use of better network management facilitated through the LEM,
- Reduce the costs of connecting additional renewable generation to the distribution network and thereby enable more renewable generation to be built, and
- Enable greater renewable generation (and therefore lower generation costs), both through the connection of additional capacity and by reducing the need to curtail existing generation capacity.

Potential social challenges involve maintaining adequate coordination between the DNO and TSO, since activity to help manage local grid congestion can, in theory at least, work contrary to the needs of the system as a whole, by worsening system imbalance for example.

For scheme participants, the scheme offers the ability to reduce their net electricity costs, either by selling power or by enabling them to make better use of the power already generated locally. Participation also includes the prospect of revenues from the provision of flexibility services and free installation of the associated equipment. It is also likely that many of the schemes' participants see their participation as means to contribute to a social good by supporting higher renewable generation.

Possible downsides of participation include the hassle costs associated with installation and monitoring, as well as the risk of either equipment failures or the automated provision of flexibility at times when it is not convenient or adequately compensated.

5.1.3 Regulatory issues

A research paper on the policy and regulatory barriers facing Local Energy Markets in Great Britain has been written as part of the project and lists at least 71 potential barriers (Rachel Bray, 2018). A small sample of the more important barriers is listed below:

- The supplier hub model, and the associated metering data arrangements, act as a barrier to the implementation of alternative energy trading arrangements such as peer-to-peer trade, which requires that customers are able to sell their own generation.
- There is considerable regulatory uncertainty as to how and when the role of DNOs will evolve to incorporate more system operation responsibilities.
- Linked to this, it is also not clear what network services DNOs should be seeking to procure through market arrangements, what they will be expected to provide themselves and what legal rights (for example to curtail production) they may have in future.
- The process for coordinating the procurement of network services across the transmission and distribution levels is ambiguous.
- The price control process, despite being Totex-based, is seen as encouraging discrete innovation projects rather than expecting transformation and the use of Non-Wire Alternatives as part of the Business As Usual case.
- The need for a LEM is influenced by regulatory policy on locational network charging signals, which are currently under review.
- The lack of discrete legal treatment for storage leads to variety of problems including ambiguities on how it should be treated with regard to planning and, until recently, the double charging of some network tariffs.

5.2 Wildpoldsried microgrid

5.2.1 Project description

Wildpoldsried is a village in Bavaria, Germany, that since 2010 has been the site of several pilot microgrid projects. Through early adoption of new technology and active public leadership, the village has become the ideal site for testing and researching new grid solutions.

Already in 1997, the mayor and city council of Wildpoldsried decided to reinvent the village based on renewable energy. Since then the village experienced a rapid buildout of locally-owned distributed renewable generation. This development was aided by beneficial local, regional and federal policies, like for instance the federal feed-in tariff, regional investment grants to renewable energy and an active and involved local leadership. The village is powered by wind, solar, and biogas & cogeneration plants, in addition to two backup diesel generators. The citizens of Wildpoldsried have a shareholding in seven wind farms, and rooftop solar panels cover most public buildings and many private households. In total the village produces more than five times its own consumption (Stone, 2014).

Research projects in Wildpoldsried were first initiated by the local distribution network operator AÜW after experiencing issues with maintaining grid stability due to the high volumes of renewable energy fed into the distribution grid. The grid operator was quickly joined by Siemens and several other

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project partners who together created a research consortium called IRENE, funded by the EU and completed in 2014, and then its successor IREN2, funded by the federal government in Germany and completed in 2018. Currently, Wildpoldsried is part of Pebbles, a peer-to-peer energy trading project based on blockchain, initiated by largely the same group of companies and institutions as IREN2 (Pebbles, 2018). The main focus of all these research projects has been how to organise the electricity system in order to facilitate the energy transition.

5.2.2 Objectives and potential impact

In the following paragraphs we summarise the objectives and relevant findings of the research projects Wildpoldsried has been part of.

Wildpoldsried has been part of two completed research projects focusing on different topics within the scope of facilitating energy transition. IRENE aimed at using storage, metering technology and control software to provide a more efficient and stable local distribution grid and thus enable more renewables into the grid. The project also looked at how electric vehicles can be efficiently incorporated. The most important insight IRENE was able to gain is that active distribution grids with real-time measurement and control can significantly save costs for grid extension and can help to increase the grid's capacity for renewable in-feed considerably (IRENE, 2014).

Building on the results of IRENE, the aim of IREN2 was to prove the feasibility of a fully distributed energy supply, focusing on the ability to (1) disconnect from the main grid while keeping a standalone grid stable and (2) use the microgrid as a topological power plant providing ancillary services like a conventional power plant to the upstream supply grid. IREN2 was able to verify that, as topological power plants, microgrids can partially replace today's power plants, contribute to system stability and provide ancillary services through the integration of renewable generators and storage beyond today's levels. Further, it was found that microgrids as island grids can increase the reliability of supply, and that a stable off-grid operation with multiple grid forming generators and zero rotating mass is possible. The work also points to the fact that current regulations concerning the operation of grid-connected microgrids is not adequate and leaves the microgrid without economic incentives for the provision of local ancillary system services. Finally, the need for comprehensive, secure and robust ICT is mentioned as one of the biggest challenges for the development and operation of microgrids (IREN2, 2017).

The current research project, Pebbles, aims to design, develop and field test a digital platform concept for peer-to-peer trading and the exchange of ancillary services, thereby addressing some of the identified issues in its predecessor IREN2. Part of the works looks at how this can be used to help minimise system costs, facilitate active participation, such as prosumption, and support the development of cellular approaches (grid-connected microgrids acting as a cell within the upstream grid) and of energy communities (Pebbles, 2018).

5.2.3 Regulatory issues

As Wildpoldsried has been part of back-to-back research projects since 2010, it is difficult to say how the local energy system would be operated in the absence of these. One of the explicit findings from IREN2 was that current regulations were inadequate for the operation of grid-connected microgrids, suggesting that a similar microgrid could not have been realised, at least to its full potential, in today's regulatory environment in Germany. Based on the insights from IREN2, we speculate that the main regulatory issues arising in a similar microgrid project, outside of a research project, would be the following:

- **Asset ownership/control & consumer rights**: For a local energy community, such as a grid-connected microgrid, to realise the potential benefits of acting as a topological power plant by offering ancillary services to the upstream grid, the community needs a responsible operator able to take operating decisions on behalf of the community as a whole. This operator will necessarily have to exercise a certain degree of control over the production, storage and grid assets within the microgrid. A microgrid operator as envisioned here will not be compliant with the principles regarding both unbundling and consumer rights. It would violate unbundling requirements because a microgrid operator would have to own or at least operate both the grid and generation assets. It would challenge consumer rights regulation because participants of

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such a microgrid, where the operator to a degree controls the assets, would have to resign the ability to choose electricity supplier.

- **Participation in grid-related system operation/balancing markets**: As demonstrated in IREN2, much of the benefit from creating LECs with controllable loads, generation and storage is that they enable a higher penetration of distributed renewables in the electricity system. Specifically, they can help curb the negative effects intermittent generation may have on system operation/grid stability if fed directly in to the distribution network, while at the same time offering a way to contribute positively to system operation/grid stability by providing ancillary grid services. However, it is not clear that there is a process by which LECs can be remunerated for the provision of grid services under the current market and regulatory arrangements.
- **Tariff structure & interface between distribution network operator/local network operator**: The internal network within a LEC could be anywhere on the spectrum between fully owned and operated by the LEC operator to owned and operated by the DNO. If owned by a distinct LEC operator, this would in effect mean adding another grid-level to the electricity grid and raise questions about the appropriate regulation of this network, particularly if it controlled generation assets or was responsible for system operation. Even if the local network were owned by the distribution network, islanded operation also raises questions about who then bears responsibility for the quality of supply within the local network and how is the DNO incentivised to ensure to operate effectively as the local SO. One possibility might be for the DNO to contract away the responsibility of supply to the LEC operator. But would that then make the LEC operator a system operator and again currently regulations are unlikely to be suitable for this case. In conclusion, there are many aspects around the interface between a distribution network operator and a local network operator that would challenge the existing regulatory framework.

5.3 SonnenCommunity

5.3.1 Project description

The sonnenCommunity is an online virtual power platform connecting households producing and storing electricity, enabling them to share electricity produced within the community with each other. It works like an independent virtual power plant (VPP) by optimising its participants' batteries and solar systems to minimise the need for buying electricity on the wholesale market and enable participation in ancillary services markets. This means that if a prosumer in the south of Germany is producing more than she consumes, she will feed this into the community power pool and a community member who does not produce enough to cover own consumption will consume it, regardless of geographical location. From a consumer perspective, this means that the sonnenCommunity effectively becomes your electricity supplier, to which you sell your potential excess electricity and from which you buy electricity, mainly sourced from other community members, when you need it. The sonnenCommunity pools all community members together and if the total production within the community is smaller than consumption they source the remainder on the wholesale market. Similarly, excess generation is sold on the wholesale market if production is higher than consumption.

Within the sonnenCommunity there are various types of electricity tariffs available, depending on the customer's consumption and assets (PV & battery or only battery). One such tariff is sonnenFlat, where the customer pays a fixed monthly fee and consumes 'free' electricity within an allowance. In return, the company behind the sonnenCommunity, Sonnen, retains the right to essentially manage the battery and solar system, deciding when to charge the battery, when to sell electricity and when to sell ancillary services to the grid operator.

sonnen is originally a household battery system provider who has seen the opportunity to create new business models by connecting its prosumers through the sonnenCommunity. The battery systems they provide come with integrated software that enables business models such as the sonnenCommunity to be implemented.

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Any consumer in an area where sonnen operates can theoretically take part in the sonnenCommunity by buying and installing the PV-battery package or only the battery that sonnen offers and becoming a member of the sonnenCommunity.

5.3.2 Objectives and potential impact

The sonnenCommunity claims to be able to provide a clean, fair and affordable energy supply for all. It offers a solution for self-consumption and, if your own supply falls short, electricity from other producers within the community at a lower price than conventional utilities. By digitally pooling the storage systems of their customers, sonnen is also able to equalise fluctuations in the power grid and to provide ancillary services such as frequency response. Aggregating distributed generation and storage and using it to provide ancillary services enables a higher penetration of renewables and eases the integration of more distributed generation.

Some speculate in that sonnen are positioning themselves to profit from intraday "rate arbitrage" (storing energy from the grid when price is low and selling back to the grid when prices are high). A sonnenBattery owner who is not a member of the sonnenCommunity may also benefit from "rate-arbitrage" by charging the battery when price is low and running on battery power when price is high.

The impact of more and more customers choosing to become part of the sonnenCommunity is unclear. Barring incentives to the contrary, it would potentially complicate the task of balancing the grid for the network operators as the physical location of the producer and consumer in the distribution network is irrelevant, as long as they are part of the sonnenCommunity. Sonnen claims to be able to use its "giant pool of batteries" to help stabilise the grid within a matter of seconds by providing ancillary services, but this of course relies on networks being willing and able to pay for this service.

5.3.3 Regulatory issues

Business models such as the sonnenCommunity seek to enable peer-to-peer (P2P) trading that is otherwise precluded under the current regulatory and market model. Specifically, the current metering and settlement arrangements assign one Balancing Responsible Party (BRP) for each meter and do not allow, at least through the current settlement arrangements, for end users to sell a portion of any change in their net consumption or generation directly to other consumers. The sonnenCommunity offers a get-around predicated on the fact it acts as the supplier and BRP for all of the members of the scheme. One regulatory question is whether it would not be better to redesign the trading arrangements to incorporate P2P trading directly.

The sonnenCommunity's minimum contract term is 24 months with a notice period of 3 months (Grey Cells Energy Ltd, 2018). Under such an arrangement the customer effectively resigns his right to choose an electricity provider for the contract period. Extensive minimum contract terms may be argued to weaken the consumer's right to change electricity provider, leaving the consumer locked-in to one provider for too long. This problem might be alleviated by changing the trading arrangements or, alternatively, through specific consumer protections addressing the needs of this type of supplier relationship.

Finally, such trading may exacerbate local network congestion issues in the absence of effective incentives on operators like the sonnenCommunity. Done poorly, uncoordinated dispatch through such a community could increase network costs. This highlights the potential need for procedures through which DNOs can influence the activity of these distributed communities to help meet network needs. Done well however, such a community, could unlike new low-cost tools to help reduce network costs.

5.4 Jühnde Local Energy Community

5.4.1 Project description

The Jühnde Local Energy Community, situated in Germany, was the first village in Germany to produce heat and electricity entirely by means of 100% renewable biomass. The project was initiated as a research project by the University of Göttingen, completed in January 2006, and has run ever since. Jühnde was selected as the pilot site among many competitors and has since proven to be a success story of a complete shift to renewable energy.

To achieve 100% renewable energy production, a 700 kW Combined Heat and Power-plant (CHP) was constructed, with an additional 600 kW boiler that burns wooden pellets to cover extra heating demand in the winter. The CHP-plant gets three quarters of its' fuel from locally produced biomass.

The cost for the new energy system was a total of €5.2m, of which €1.3m came from a research grant, €3.4m from a bank loan and the remaining €0.5m from investing citizens. The buy-in price per citizen was set at a minimum of €1,500, which also provided voting rights in the energy cooperative and covered the investment costs of a district heat connection. About 70% of the inhabitants invested and are part of the cooperative.

Establishing such an energy community should be seen in relation to the German Energiewende, and as a step to achieve the goals of increased renewable electricity and heat production by 2020. Feed-in tariffs and support schemes for demonstration projects were implemented, and these co-founded the energy system in Jühnde. According to different sources, the system more than covers local electricity need, and almost all required heating for the connected houses (IEA Bioenergy, 2018) (EESC, 2013).

The available information suggests the generation assets are set up as a normal local production facility, albeit with a strong local ownership, and it is therefore expected that interaction with the DNO follows the standard regulatory model, with a grid connection and an ordinary tariff.

5.4.2 Objectives and potential impact

The overarching objective for the demonstration is to prove that communities can become sustainable and close to self-sufficient in renewable energy. Based on more than ten years of testing, a further 16 demonstration sites in Germany have been selected for bioenergy projects.

Local anchoring and end-user engagement is highlighted as key to successfully implement and run the energy-cooperative. The social motivations and interest behind the project is thoroughly analysed in Dóci (2017). An important motivator in Jühnde was the mayor, but the project would not be a success were it not for the inhabitants. Important steps to include the community was good communication before, during and after project implementation, efforts to increase local know-how of the system, as well as arranging friendly competitions between community members.

This highlights the importance of understanding the social structures and motivations in the community, and suggests that, in order to be successful, proposed solutions must be tailored, adapted and communicated in an understandable and positive manner to the affected community.

Furthermore, the success of this project shows that local communities can take action and become fully renewable and almost self-sustained with energy, all while cutting a substantial amount of their CO_2-emissions. Such a project strengthens the sense of community and can improve the relationship between local inhabitants.

5.4.3 Regulatory issues

No regulatory barriers or obstacles were presented in the researched material. Judging from the setup and business model, such a system would not be hindered by Norwegian regulation seeing as it operates as a fairly standard generation asset, albeit with local community ownership.

The energy system in Jühnde does not contain any batteries or storage units, which might otherwise have resulted in regulatory complications. Although batteries are often discussed when talking about energy communities, this case shows that they are not always needed and that some successful energy communities would be possible within current regulatory framework.

5.5 Simris grid

5.5.1 Project description

The Simris local energy system is a microgrid located in the south of Sweden and is part of the H2020-project InterFlex (2017-2020). Simris is a pilot site in the project where the interplay between different renewable energy technologies, energy storage and end-user consumption will be investigated. Using local flexibility and smart controls, the share of the local community's energy requirement met through its own generation will be increased. The local DNO, E.ON, is the grid facilitator and is responsible for this project site.

This microgrid is co-financed under the H2020 program, and the investment costs are approximately 35 M SEK, with E.ON covering 50 percent. As E.ON is also the local DNO, systems integration is made easier. The main research objectives of the project relate to the technical and operational aspect of the electricity grid.

The Simris microgrid consists of about 140 households and local power production from 400 kW of PV-panels, 500 kW of wind turbines, and a local battery with 800 kWh of storage. As a whole, the microgrid needs to import energy over the year, and in 2016 imported over 2 GWh, as stated in Ahlgren & Handberg, 2018. It is therefore not a true standalone system, but rather runs in island mode one week every fifth week, with seamless connection and disconnection from the main grid.

As with Jühnde, community participation is important, especially as end-user flexibility is used to realise the full potential of the energy system. Specifically, residents are encouraged to be "smart consumers", controlling flexible loads to match consumption to production. Prosumers with local energy production and storage is also encouraged.

5.5.2 Objectives and potential impact

The objective of the InterFlex project is to make use of local flexibility to increase the share of renewable energy in the distribution grid. In Simris, E.ON demonstrates a fully operating microgrid under real conditions. Furthermore, it is interesting to note that when in island mode, the grid operates exclusively using synthetic inertia[5] to provide ancillary grid services such as frequency and reactive power control. This is a notable technical feat and provides important lessons for the future power system, which will increasingly be comprised of elements that are only capable of providing synthetic inertia, such as PV and wind production.

5.5.3 Regulatory issues

In the researched material for Simris, no regulatory issues are discussed. As this is a pilot-project, and the pilot owner is the local DNO, this is to be expected. However, regulatory issues related to the use of local flexibility and of batteries are likely to be especially relevant.

If this kind of system were to be replicated elsewhere, there are several issues that would need to be taken into account, the most prominent being integration with the DNO and how controlled islanding and reconnection would be executed. Another related question concerns ownership of the LEC and whether the DNO should own and facilitate the local energy community, or whether the LEC should be a separate legal entity that collaborates with the community and the DNO. These issues of integration and legal setup are little explored, and, to our knowledge, there are no projects that provide a template for how to resolve them.

[5] Synthetic inertia is inertia and frequency regulation in the power system provided by power electronic devices, as opposed to physical inertia which is provided by rotating machinery directly coupled to the grid and grid frequency.

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PART 2

6 POSITIVE AND NEGATIVE IMPACTS

In this chapter we present the potential positive and negative impacts that various types of LECs could have on both private individuals and society based on our own independent consideration of LEC concepts. We have drawn inspiration for the sorts of projects that might be possible from the research undertaken for Part 1 and a review of the relevant literature. Importantly, this work is an attempt to comprehensively list all of the potentially credible effects that a LEC could conceivably have. It is not an assessment of the likely or even potential effects of the specific schemes interviewed.

6.1 Different types of Local Energy Communities

Given the wide variety of projects that could conceivably be undertaken as part of LEC, there is an equivalently wide variety of potential impacts for both scheme participants and for society as a whole. To help make the consideration of these impacts more manageable and meaningful, we therefore distinguish between four different possible elements of a LEC project:

1. Generation – The project generates its own electricity
2. Network services – The project either provides its own distribution network, seeks to reduce its use of (or the financial costs of) the DNO's network, or sells ancillary services (such as load or voltage management) to a third-party electricity network
3. Energy efficiency – The project seeks to improve end-user energy efficiency
4. Energy trade – The project seeks to enable alternative energy trading or supply relationships, for example through peer-to-peer trade

Note that any individual project may combine more than one of these elements. Distinguishing between these elements makes it easier to assess the impacts that are likely to be relevant to any given project.

6.2 Comprehensive list of positive and negative impacts

In this section, we provide a comprehensive list of the positive and negative impacts that we think might arise in relation to a LEC, and note which elements of the LEC can, or are most likely to, give rise to the effects discussed. Table 1 summarises our findings, which are described in further detail below.

Generation and emissions

LECs that incorporate generation assets will generate electricity that provides a private benefit for the community's members, either in the form of revenue from power sales, or as a reduction in energy costs due to a reduction in the community's net consumption. However, such projects may also enable social benefits to the extent they allow for lower cost generation, or lower cost low-carbon or renewable generation projects. In this case, they will help to lower the overall costs of decarbonising electricity supply and may help support lower emissions or higher renewable output.

This conclusion is shared by elements of the literature. For example, a report published by the UK's Department of Energy and Climate Change claims that there is evidence that community energy projects can support increased renewable generation capacity in the UK (DECC, 2013). LECs based only on generation, so-called community power projects, are even considered by some authors to be an essential element in Europe's low-carbon energy transition (Roberts, 2014). Certainly, the Wildpoldsried and Simris case studies discussed in chapter 5 support the idea that LECs can help enable specific renewable generation projects.

However, it is not necessarily the case that these LEC-based generation projects are better or lower cost than non-community alternatives and so encouraging such projects, regardless of their cost effectiveness, might actually increase social costs. In particular, if poor regulatory design gives

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community projects a regulatory advantage, for example to limit administrative burdens, it might result in such projects being developed in preference to more cost-effective alternatives. Another potential problem includes the frustration of scale efficiencies, which might be more readily achievable through large-scale commercial deployment than through a multitude of community projects.

Network efficiency

A LEC providing network services to the upstream grid, for example in the form of load management to reduce peak loading, may give its participants either reduced network tariffs or direct revenue from the provision of ancillary services. Socially, LECs providing network services, as described above, may also contribute to more cost-effective grid expansion and reduce network losses, for example by shifting loads and therefore lowering capacity requirements in the network or else by lowering the overall need for the transmission of electricity over long distances (OFGEM, 2017). These are noted as positive social impacts.

There is, however, also a risk that LECs may lead to higher network costs due to the duplication of network assets, for example if the DNO and LEC end up building partly parallel network assets. Other reasons for higher network costs might include coordination failures with the local DNO and again, a loss of scale or specialisation efficiencies due to the relative small scale and focus of the LEC (Eurelectric, 2017).

Energy efficiency LECs may or may not contribute to more efficient network use since a reduced requirement for energy does not necessarily lead to a reduction in required network capacity. In some cases, energy efficiency improvements may actually increase network costs.

Security of supply

LECs that combine generation and network services, and to some degree energy efficiency, may provide greater security of supply to their participants if they are able to run in islanded mode or else provide ancillary services to the wider network. By having the ability to run in islanded mode, a LEC can isolate itself from the upstream grid and maintain power supply using local sources in the event of an outage, thereby increasing local security of supply. By providing ancillary services, as demonstrated by the Wildpoldsried case study, a LEC can support the balancing of the public grid.

However, general security of supply could also be harmed by the presence of many potential electrical islands if their actions are poorly coordinated. In general, effective operation of the wider system requires coordination among the many actors involved. By increasing the number and type of actors that the system operator must liaise with, system operation is made more complex and potentially less predictable, with an associated risk to security of supply.

Consumption efficiency

Pure energy efficiency LECs naturally contribute positively to greater efficiency and therefore reduced energy consumption and emissions by the community's members. This is both a private and a social benefit.

Consumer choice and protection

Based on our case studies, we see that LECs focused on energy trading can provide consumers with greater choice than they enjoy today by providing a platform to buy and sell power from local producers, rather than through a conventional retailer. The importance of this benefit will clearly vary based on how well-functioning the existing retail market is, with the resultant benefit to consumers likely to be smaller in well-functioning markets that already provide for ample consumer choice.

However, LECs need not be universally beneficial for consumers. In particular, if the LEC involves generation, network services or energy efficiency, or even if the trading solution requires the use of an intermediary supplier to facilitate trade, consumers might be faced with lock-ins to a single provider, representing a loss of the consumers' right to freely choose their supplier. Some LEC projects may require members to contractually agree to a waiver of some of their consumer rights. This leaves these consumers vulnerable to abuse by the LEC. Note however that such lock-ins arrangements may be necessary for the LEC to function. For example, a network may only be capable of functioning efficiently if every participant remains involved in the project, and a project with high upfront costs may only be financially viable if it has an enduring customer base over which to recoup the costs. We discuss the potential impact of regulatory changes on consumers further in section 7.1.7.

Community development

Several of the reports and articles that we have reviewed note greater consumer empowerment and trust in the local supplier as examples of the positive impacts that LECs bring to their members. They also highlight enhanced consumer engagement in and awareness of the energy transition as a socially positive impact. One effect of this is that LECs are more likely to accept local community RES projects. In some cases, LECs may contribute to building a sense of community, as well as support the local economy by creating skilled jobs (DECC, 2013) (Roberts, 2014).

In addition to increasing community members' knowledge of the relevant energy systems, the existence of multiple LECs may also spur innovation at a social level, by creating suitable test grounds for new experimental technologies (Hoppe, et al., 2015).

A potential risk associated with LECs is that participants are often exposed to the risk of free-riding within the community, with schemes often reliant on each member "pulling their weight" and on voluntary work.

Other direct costs and possible inefficiencies

LECs may also give rise to a variety of other potential costs and inefficiencies, including the following.

- Financial costs – The capital and operating costs of a project represent an obvious direct cost to participants of scheme membership.
- Hassle costs – Negative private impacts include any extra hassle costs of participation in a community-led LEC, for example due to equipment installation or the need for a more involved and time-consuming relationship a conventional electricity supplier might require.
- Administrative costs – Managing the necessary regulatory regime for LECs may also create additional work for the regulatory authorities which itself has a social cost.
- NIMBY effects – Local assets in the neighbourhood of the community may result in "not in my backyard" type effects, potentially affecting housing prices.
- Risk of lower service quality – LEC members may be reliant on less mature systems and solutions with an associated risk of lower service quality.
- Regulatory risk – Pioneering projects will expose the participants to future regulatory risk, as the benefits they see today in terms of subsidies or other beneficial arrangements may not be there in the future.

Allocation of common network costs

If LECs can obtain lower network tariffs for their participants, without enabling a commensurate reduction in network costs, a cascade effect might develop in which the need for higher network tariffs for the remaining customers incentivises even more widespread use of LEC solutions. This, in turn, might lead to difficulties recovering the cost of operating the distribution network.

These aspects are most relevant for LECs providing network services but are also relevant for generation and energy efficiency LECs on the assumption these projects affect network tariffs or the network's costs.

6.3 Conclusions

Given the very broad range of projects considered in the scope of this work, there is a commensurately wide range of possible private and social costs that might result. We have sought to provide some insight into which of these are likely to be most relevant to each type of LEC in Table 1 below. Those effects marked with a solid circle are considered to be applicable. Open circles demarcate instances where the relevant effects are likely to be relevant is a smaller subset of cases, or to a lesser extent. Blanks imply that we don't expect the effect to be applicable to a LEC of the relevant type. Where effects are shown in brackets, they, or broadly similar impacts, are shown as both potential costs and benefits. The brackets therefore denote that the relevant effect could in general be net beneficial or costly and will ultimately depend on the specifics of the project.

While it is difficult to generalise across all cases, it's worth noting that the nature of the costs and benefits varies from the very concrete, such the avoidance of network investment, to the intangible, such as the creation of social capital. This is not to dismiss the value of the latter, but to highlight the likely difficulty of accounting for all of these effects, and to trade them off, when it comes to assessing individual projects.

It is also worth noting that many of the social costs and benefits identified are not new, but already the focus of existing regulation. For example, protecting consumers from monopoly providers, and ensuring service quality and security or supply are already goals covered by the existing regulatory framework. In the next chapter, we consider that framework at a high-level, the potential barriers it imposes to LECs, and the validity of these barriers in relation to achieving overall efficiency.

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Table 1 Summary of positive and negative impacts

Positive		Negative		LEC elements			
Private	Social	Private	Social	Generation	Network services	Energy efficiency	Energy trade
Revenue from generation / reduced net consumption	(Lower cost generation/capacity as more distributed generation is enabled)	(Loss of scale or specialisation efficiencies, or poor regulatory design results in bad projects being developed)		●			
	Reduced emissions or higher RES generation for same reason			●		○	
Reduced network tariffs / revenue from network services	(More efficient network use leading to lower capex, opex or losses)	(Higher network costs owing to duplication, coordination failures, loss of scale or specialisation efficiencies)		○	●	○	
(Greater security of supply)		(Security of supply could also be harmed by more network islanding and greater scope for coordination failures)		●	●	○	
Greater efficiency / lower energy consumption	Greater efficiency					●	
(Greater consumer choice / competition)		(Some projects might restrict choice / competition)		○	○	○	●
		Risk of lost consumer rights	Weaker consumer protection		●	○	●
Greater empowerment / trust in provider	Enhanced consumer engagement			●	●	○	●
(Builds community / social capital)		(Risk of free-riding)		●	●	●	●
Supports local economy / jobs				●	●	●	●
Knowledge building	Enhanced consumer knowledge and innovation			●	●	●	●
		Financial – capex and opex		●	●	●	○
		Volunteering and hassle costs	Increased regulatory / governance costs	●	●	●	○
		Not In My Backyard		●	●	●	
		Risk of lower service quality		●	●	●	●
		Exposure to future regulatory risk for pioneering projects		●	●	●	●
			Unfair allocation of common network / decarbonisation costs, cross subsidies	○	●		

7 BARRIERS TO ESTABLISHING AND OPERATING LOCAL ENERGY COMMUNITIES

In this section we consider a variety of possible barriers to establishing and operating local energy communities, with each section considering a different set of potential barriers. Section 7.4 concludes.

7.1 Regulatory barriers

In this section we first provide an overview of the relevant regulation before discussing where this regulation may constitute a barrier to establishing and operating a LEC. We consider two sets of regulation:

1. the Energy Act and its underlying secondary legislation, and
2. the general Consumer Protection legislation.

The regulation relevant to any particular LEC will depend on the sorts of activities that it carries out. We therefore look at the different types of LEC separately. We use the same categorisation of LECs as in previous chapters except that we further distinguish between LECs that own what amounts to distribution grids and LECs that operate a single network asset and have no connected end-users. As noted in the previous chapter, some regulation of LECs is likely to be appropriate to mitigate against the potential costs identified, or indeed to enhance their potential benefits. We conclude this section with a discussion of where regulation might constitute an unjustified barrier and where regulation is potentially warranted to protect consumer interests.

The list of regulatory conditions that may apply, provided below, is not meant to be comprehensive. Rather we have sought to highlight what we consider to be the regulations that are most likely to pose a barrier to LECs and/or secure the rights of consumers.

7.1.1 LECs that operate distribution grids

We first consider LECs that effectively operate distribution grids at voltage levels of 22 kV or below, in which the local end-users are customers of the LEC. These LECs would be broadly similar to the smaller network companies already in existence in the Norwegian grid, which have only a few hundred customers. There are two types of licences that would apply to such a LEC under the current legislation and regulation:

1. Area licence
2. Trading licence

A LEC with grid assets can also function as a seller of electricity to the connected end-users and provide market access for local generation. The regulatory obligations of the LEC as seller of electricity are described in section 7.1.3 below.

Consumer protection legislation will also apply.

Area licence

Unless otherwise stated, the paragraphs referred to are in *«Forskrift om produksjon, omforming, overføring, omsetning, fordeling og bruk av energi m.m. (energilovforskriften)».*

A requirement for an area licence (§3-3) applies to DNOs and effectively gives them a monopoly on network assets from 230 V up to and including 22 kV in a designated geographical area (up to 132 kV is possible for certain assets in city-like areas). Separate asset licences for network components are not required within an area licence. A LEC that owns and operates grid assets in an area below 22 kV and supplies end-users will require an area licence under the current regulation.

Normally, all distribution network assets up to the customer connection point must be covered by an area licence (or, in theory, a separate asset licence, although this is not practiced much at lower

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voltage levels). However, assets may be exempted on a case-by-case basis if: a licence is considered “obviously unnecessary”, the assets are considered to be part of customer-specific installation or the assets are built to supply local production to customers where the main fuse capacity is below 200 A three phase and 230 V. These technical limits would be sufficient to supply around three households. Only in very specific cases would a licence be considered “obviously unnecessary”.

An area licence is a general licence for electrical distribution network installations in a specified area. The interface between a LEC with network assets and a current area licence holder requires closer investigation. Presumably the relevant area in which the LEC operated would need to be carved out of any existing area licence and granted instead to the LEC.

We are not aware that NVE has done such carveouts in the past, but it would seem to be necessary if a LEC with a de facto distribution grid is established.

Defining the boundary and interface between LECs and the existing area licence holder would be a critical part of this process, so as to provide clear responsibilities for future connections.

Holding an area licence imposes an obligation to supply all customers within the licenced area (§ 3-3 Energiloven: Leveringsplikt). This means that the area licence holder is obliged to connect and supply physical electricity to all consumers within the area.

There is also an obligation to connect any new production customers in their vicinity if their licenced network asset is the most economically rational point of connection (§3-4). The LEC will also have to bear the associated costs of grid investment exceeding that recovered through any connection charge (“*anleggsbidrag*”). The connection requirement is an obligation that comes with the issue of a licence for electrical network installations and would therefore normally apply to any LEC with an area licence.

It is possible to apply for an exemption from some of the obligations that normally follow with an area licence. Since the introduction of the Energy Act, several exemptions from the area licence obligations have been granted. Most of these have been in the form of an exemption from the obligation to reinvest in network assets supplying areas without permanent residents where the reinvestment costs have been considered excessive relative to the number of customers. Otherwise, few exemptions are granted.

In accordance with the Energy Act, exemptions from the requirements placed on the owners of licenced distribution assets are granted only if the applicant can prove that it is economically irrational to fulfil the requirements of the regulation according to the stated procedure. Obtaining an exemption given this burden of proof will often be difficult and time consuming.

Trading licence

A LEC that operates a distribution grid is required to have a trading licence as a *network operator* (§ 4-2 Omsetningskonsesjon). Unless otherwise stated the paragraphs mentioned are found in *«Forskrift om produksjon, omforming, overføring, omsetning, fordeling og bruk av energi m.m. (energilovforskriften)».* A trading licence for a network operator places several obligations on the LEC:

- *Economic and technical reporting.* The LEC must report economic and technical network data separately to NVE. All trading licence holders are required to report data to NVE, but the reporting requirements for network activities are more detailed. Costs related to competitive activities should not be allocated to the network activity.
- *Revenue cap.* The total revenues of the LEC as a network operator will be subject to a cap set by NVE, currently set as a weighted average of historical costs and a cost norm based on benchmarking. While the current regulation does allow for the special treatment of network operators subject to certain criteria, exemption from the regulation itself is not possible as long as the operator has connected customers.

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- *Network tariffs.* A company that owns network assets will, according to § 4-4, be able to set grid tariffs to recover the cost of providing grid services. Tariffs can only be differentiated according to objective and verifiable criteria based on network-related characteristics. The main tariff principles are regulated by NVE through the Control Regulation ("Forskrift om økonomisk og teknisk rapportering, inntektsramme for nettvirksomheten og tariffer"). From 2019, network companies will be obliged to levy a connection charge on all new connections or capacity increases that are caused by a specific customer (or group of customers).
- *Quality of supply.* "*Forskrift om leveringskvalitet i kraftsystemet"* details the minimum requirements for the quality of supply from any supplier of electricity connected to the Norwegian power system. A network services LEC with an area licence would be subject to many of the requirements and responsibilities detailed in this piece of regulation. However, since the regulation explicitly defines its scope as being electrical equipment connected to "*the Norwegian power system*", islanded LECs may not be covered at all. The regulation states that private agreements concerning quality of supply are permitted, thereby providing LECs with the option of entering into their own service agreements with their participants that deviate from the general conditions in the Quality of Supply Regulation. The network company is obliged to describe the consequences of the agreement in detail to the customer.
- *Unbundling.* A LEC with network assets will have to comply with the unbundling rules in the Energy Act. From 2021, a network operator with a revenue cap cannot have any activities other than network ownership and operation. This precludes a LEC with a distribution grid and the respective area and trading licences from owning or carrying out the purchase or sale of electricity, district heating activities or any other commercial activities. Commercial activities of a LEC would then need to be organised in separate subsidiaries. In the unlikely event that the LEC supplies more than 30 000 customers, it would also be subject to a functional unbundling requirement, which places limitations on appointments to the board and management of the network company.
- *Metering, billing and settlement.* The network company is responsible for metering, including the physical installation and operation of meters, as well as the collection of metering data. From 1 January 2019, all customers should have automatic (smart) meters installed. From February 2019, all metering data will be sent to Elhub. The network company is also required to implement a supplier switches. LECs would have to carry out the same responsibilities as a DNO with respect to the end-user market and must comply with the same data reporting requirements to Elhub. Note also that under the current regulation, DNOs are required to offer combined billing of network services and deliveries of electricity to all suppliers in the area if the DNO offers this to one individual supplier (for instance a retailer within the same group or integrated with the DNO).
- *Neutrality.* Network companies are required to act in a neutral manner. The key objective of the regulation is to ensure a level playing field between suppliers and to prevent suppliers within the same company from gaining an undue competitive advantage within the licence area. *«Forskrift om måling, avregning og samordnet opptreden ved kraftomsetning og fakturering av nettjenester (avregningsforskriften) (FOR 1999-03-11 nr 301)»,* hereafter referred to as the settlement regulation, details in § 8-1 how any company operating as a DNO must provide equal access to its connected customers and their data for all electricity suppliers, as well as a requirement to provide certain information to its customers. This effectively means that a LEC acting as a DNO for its participants must give third-party suppliers access to its grid if any of the LEC's participants wishes to be supplied by a supplier other than the LEC. It is unclear how this neutrality requirement could be implemented in the case of a LEC that sometimes or always operates in islanded mode.
- *System responsibility.* The regulation on system responsibility ("Forskrift om systemansvaret i kraftsystemet") details the obligations of a DNO towards the TSO. It

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states that any DNO shall report any change in production capacity within their area to the TSO. The DNO is also obliged to prepare plans for forced load shedding, and in general adhere to any decisions made by the system operator that affect the DNO's licence area.

Consumer protection

Most of the previously mentioned regulation is developed to protect consumers and make sure that monopoly actors don't abuse their status. Examples of this are the regulation concerning revenue caps and neutrality. In addition to this, there are well-established standard procedures for handling conflicts and complaints between a DNO and consumers. If a LEC effectively acts as a DNO and is regulated like a DNO, its participants would also be covered by these standards and the LEC would have to resolve potential conflicts through the same procedures and abide by their outcome. This means that a LEC cannot rely solely on the goodwill of the participants if conflict arises but will have to follow the standard procedures set out in the relevant regulations.

7.1.2 LECs with single network assets

The licencing requirement for electrical installations applies to any electrical installation with a voltage above 1000 V AC and 1500 V DC (§3-1). This includes any network asset that is not part of an area licence. A LEC that operates a single network asset will therefore need a licence if it meets the voltage requirement. The requirements on single asset licensees are, to a large extent, similar to the area licence requirements, with some differences.

A key difference is that an asset licence holder has an obligation to connect customers but not a full supply obligation. The connection requirement (§ 3-4) is an obligation that comes with the issue of a licence for electrical network installations. Under the regulation, the asset licence holder would be required to connect any new production or consumption customers in their vicinity if their licenced network asset is the most economically rational point of connection. The licensee will also have to bear the associated costs of grid investment exceeding those recovered through any connection charge ("*anleggsbidrag*").

The relevant regulation currently allows for NVE to grant exemptions from the connection requirement upon application from the licence holder if it is considered to be irrational for society as a whole to connect new generation, typically based on an assessment of economic costs and benefits. For consumption, exemptions can only be granted in extraordinary circumstances (a negative cost-benefit is not sufficient).

In the proposed new regulation, "*Forskrift om nettregulering og energimarkedet"*, which is currently out for consultation from the Ministry of Petroleum and Energy, the rules concerning connection requirements are somewhat changed (OED, 2018). The key difference in the proposal is that network asset licence holders would be able to enter into agreements with new production capacity that allow the licence holders to curtail production at certain times if securing an uninterruptible connection involves an unreasonable network expansion costs. This grants a partial exemption from the connection requirement and means that the network asset owner may be able to avoid over dimensioning its network assets to handle situations that may only arise a few hours of every year. However, it still requires agreement between the network owner and the generator and does not constitute an absolute right on the part of the network.

7.1.3 LECs that trade or sell electricity

Trading licence

A LEC that trades or sells electricity would require a trading licence for companies that carry out the sale or generation of electricity. Some key requirements of the licence are:

- *Metering, settlement and billing.* As part of the supplier-centric model, it is expected that mandatory combined billing of energy and network tariffs will be introduced, with retailers responsible for producing a combined bill, including any consumption-related taxes. There

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are also several requirements related to invoicing, including the frequency of invoicing, the information on the invoices and the extent to which customers can be billed in advance.

- *Balancing Responsible Parties (BRP).* Retailers are responsible for settling imbalances in the balancing power market on behalf of their customers. In the current regulatory arrangements, one metering point can only have one supplier. A retailer can, however, outsource its balancing responsibility to a BRP that can handle multiple counterparties.
- *Information exchange.* The regulation defines the processes and technical formats and exchange protocols that all retailers (and network companies) must adhere to. This applies both to the billing and settlement processes and to processes such as switching suppliers.

Other licences

Market place licence (Markedsplasskonsesjon § 4-7)*:* This regulation could apply to LECs providing local market platforms.

7.1.4 LECs with generation assets

A LEC with generation assets will in general be required to have an asset licence for each individual generation unit, provided that the voltage exceeds 1000 V AC/1500 V DC. Onshore wind power plants with a capacity of less than 1 MW are exempt from the licence requirement, unless the plant consists of 5 or more turbines.

A generator is also required to have a trading licence. The relevant type of trading licence covers companies that carry out the sale or generation of electricity. The requirements stemming from this licence include requirements to complete economic and technical reporting to NVE and several obligations under the system responsibility regulation, where the latter also includes technical requirements for generators set by the system operator.

7.1.5 LECs that promote energy efficiency

For a LEC that promotes energy efficiency we assume that licencing according to the Energy Act will not be relevant. The consumer protection rules may however be relevant to the extent that the LEC sells products or services to end customers.

7.1.6 Discussion of regulatory barriers for LECs

The regulatory requirements noted above are clearly intended to support the efficient development of the electricity system and prevent the abuse of customers, notably by monopoly providers of network services. In this this section, we highlight how some of these regulatory requirements might act as barriers to the development of LECs. In some instances, the regulation may ultimately be justified by the benefits it provides, for example, by the protections afforded to customers, and discussed further in the next section. In others, the requirements may reflect the fact that the current regulatory regime has not yet been modified to better integrate alternative types of market actor.

- Administrative burden – Almost all of the licencing requirements will impose an administrative cost on LECs. In some cases, these will be limited to an initial application. In others, the regulation imposes an ongoing administrative burden, notably where there are reporting requirements. These costs are an unintended consequence of the process, but the associated administrative burden may still be deemed significant when assessed by small projects dependent on volunteer support for their ongoing administration.
- Obligations to connect and supply – The obligations placed on network LECs are especially demanding and stem from the natural monopoly characteristics of these assets. Although these obligations may be seen as imposing a regulatory risk on LECs, they are likely justified by the need to prevent the inefficient development of duplicate networks.
- Regulated income – The setting of regulated income is designed to protect customers from exploitation by a monopoly provider and may be appropriate for some network LECs.

However, the setting of allowable revenues through regulatory benchmarking is probably excessive for a micro-network that is end-user owned and operated, and where the network and end-users' incentives are very closely aligned as a result. Processes still need to be in place to protect such customers, notably from mismanagement or internal disputes, but it may be sufficient to require such networks to have minimum internal disclosure, governance and dispute resolution arrangements, instead of adopting procedures designed to protect customers served by large third-party network providers.

- Unbundling requirements – The requirements are already less demanding for smaller providers and removing them entirely would risk creating a problematic double standard. For this reason, a continued policy of proportionate treatment seems appropriate.
- Settlement arrangements – The current settlement arrangements do not directly support end-user trading, since each end-user metering point must be handled by a single balancing responsible party. To fully implement direct P2P trading, end-users would likely have to take over settlement responsibility for their own meters under the settlement arrangements. It is possible, under the current arrangements, for an end-user to partner with a balancing responsible party that then facilitates end-user trading, essentially establishing separate settlement arrangements between the end-user and the balancing responsible party. This is similar to the arrangements discussed for the SonnenCommunity in section 5.3, in which end-users select a retailer that facilitates trade. This probably represents a sensible solution given the maturity of this market.
- Market place licence – The fixed administrative burden involved in obtaining this licence will add to the costs of independently developing small trade trading solutions. However, trading platforms would probably be developed centrally anyway, even if used by several separate LECs, in order to realise economies of scale related to the IT development process. In this context, obtaining a market place licence is unlikely to make much difference to the market's development.
- Retail market access for end-users – The optimal operation of certain types of LEC, for example those that wish to have the option of islanding the local network, may require that participants: (temporarily) resign their right to freely choose supplier, buy electricity mainly from within the LEC or else accept an extended lock-in period. This effectively re-creates (on a smaller scale) a supplier monopoly similar to the situation before electricity market liberalisation in the '90s. In these cases, it will be difficult for the LEC to meet the standards expected of companies designed to operate in a national market for electricity.

Overall, the regulatory requirements placed on potential LECs are most demanding for LECs with network assets. While most of these are likely to be justified, there may be some, in relation to regulatory reporting and regulated income that may be disproportionate, given the additional consumer protection they provide.

Possibilities do exist to provide exemptions for the regulation. In general, LECs will fail to qualify under the exclusion criteria and an outright exemption may go too far in any case. In particular:

- LECs are unlikely to fall under the definition of a small consumer in the distribution grid who owns generation not subject to a licence requirement ("plusskunde"), which would enable them to sell their electricity outside of the wholesale market;
- The exemption criteria for an area licence is unlikely to cover networks serving more than three household customers; and,
- An exemption from the obligation to supply is very difficult to obtain in practice, and not really intended to cover LECs.

7.1.7 Impact of reducing or removing barriers on customers

When considering the appropriateness of changing the regulations, it is important to recognise the potential costs involved for customers. Some of the important considerations to bear in mind when considering potential changes include the following:

- Revenue regulation can only be removed where there are sufficient alternative incentives in place to control costs, such as end-user ownership. Otherwise, consumers may be harmed by higher prices.
- Networks have the ability to distort competition in other markets through discriminatory tariffs or network access arrangements and so all networks, regardless of their size, need to be subject to principles of non-discriminatory pricing and access.
- Similarly, unbundling requirements prevent the distortion of competition through cross-subsidisation from monopoly business areas. Preventing such distortion is likely to require unbundling requirements of some form at all levels.
- The Elhub data reporting requirements are necessary, from an operational perspective, to enable end-user participation in the retail energy market. Removing them would therefore have serious consequences for the affected consumers' ability to benefit from retail competition.
- The current regulations provide a regulatory process for conflict resolution. An exemption would only be appropriate where it could be demonstrated that an alternative process was in place that could effectively resolve such conflicts to the satisfaction of all parties.

7.2 Commercial barriers

As noted in Part 1 of the report, those LEC projects that do exist are still in the process of developing sustainable business cases. In many cases, the absence of pre-existing business models or markets for the benefits provided by the LEC represents the most significant barrier to the LEC's development. We discuss some of the relevant commercial issues below.

7.2.1 Absence of existing market or templates for commercial contracting

Potentially one of the greatest contributions that LECs can provide is the ability to more efficiently manage loads on the transmission and distribution networks, so as to minimise the cost of the electricity network itself. LECs might even be able to provide controllable loads and storage capacity to local DNOs for the purposes of active network management, again unlocking potential efficiencies.

However, while these technical possibilities have been demonstrated by pilot projects, the commercial arrangements needed to exploit them more widely have not. There is no well-established market for load control that LECs could readily sell into and where DNOs do contract bilaterally with third parties, for example to provide interruptible contracts, these commercial arrangements are not readily applicable to the sorts of services that a LEC might supply.

The absence of pre-existing commercial arrangements is a major barrier to the development of LECs aiming to provide services to DNOs, since they would need to incur the costs and risks associated with developing these arrangements themselves, likely in partnership with the relevant DNO. Given these challenges, it is perhaps unsurprising that most of the current work being done to explore commercial arrangements is being led by the DNOs themselves, which have a good understanding of the underlying value provided and can more readily support the cost associated with developing the commercial 'infrastructure' needed to support third-party load management and storage services.

7.2.2 Wholesale market access and aggregators

For those LECs wishing to generate their own energy, there is an established market for power. However, even here, LECs' comparatively small size may make it hard to establish a sustainable business model.

The wholesale electricity market was designed to cater for larger generators and is therefore not particularly well adapted many LEC schemes. Hourly time resolution means that the flexibility of LECs and the demand profiles of members are not easily accounted for. Similarly, high minimum bids (0.1 MW) and the fixed costs associated with market entry all work to preclude commercially viable entry by small LECs.

These issues explain why separate arrangements were made to support generation by plusskunder. However, the associated regulation is unlikely to apply to LECs and therefore may result in them falling between the two sets of commercial arrangements.

Aggregators may form a sensible solution to these challenges by pooling LEC assets to achieve a commercially viable scale. We note that Statnett has already taken steps to try and allow aggregators to tender for ancillary services. However, the aggregator market is also immature in Norway, such that LECs don't readily have aggregator partners with which to work.

Ultimately, there is something of a chicken and egg problem, in that LECs may require the support of aggregators to realise the commercial value of their generation and storage assets, but aggregators will not themselves be viable until there exists a customer base looking for the services of an aggregator.

7.2.3 Network tariffs

We also need to consider the appropriateness of the price signals contained in the network tariffs themselves. This is of particular relevance to LECs that generate their own electricity and/or promote energy efficiency. From the commercial perspective of these LECs, the tariffs payable to the network company are a major driver for the commercial profitability of the LEC.

The interviewees in Part 1 noted that current distribution network tariffs result in the extensive socialisation of network costs. In general, the socialisation of costs weakens the incentives facing end users to take actions that reduce costs, since any increase in cost, or similarly any cost saving, is distributed widely rather than being by borne in full by the responsible party. In the absence of appropriate price signals, LECs may face little to no incentive to exploit opportunities to relieve local network congestion through schemes to manage their load. The lack of financial reward provided to LEC concepts through the tariff regime is therefore seen as a barrier by some of the surveyed Norwegian LECs interviewed.

Conversely, we note that the tariff regime could theoretically encourage LECs that do not support the network, but which do reduce network tariff exposure. Such schemes could be designed to pay less "*fastledd*" or take advantage of the statistical averaging of loads to reduce exposure to peak consumption-based tariffs. This sort of tariff avoidance behaviour could prevent LECs from making a fair contribution to the common costs of network provision and thereby force higher charges on other network users.

The structure of network tariffs and the incentives created by the tariff regime need to be considered carefully in this context, since LECs will likely be more responsive to these incentives than typical end-users.

NVE is already aware of the incentive effects of network tariffs. For example, it has proposed changes designed to limit energy-based network tariffs so that they are more reflective of the marginal network cost implications of changes in consumption. There is always a balance to be struck when designing tariffs between the need to provide efficient incentives and other objectives, such as transparency and simplicity.

In theory, different tariffs could be applied to different groups to achieve more efficient outcomes and better reflect the group's ability to respond to tariff signals. However, tariff reform is fraught with difficulty and would be made all the more difficult if the regime were to include a variety of tariff types for different types of network user.

7.3 Other barriers

Anecdotally, one of the challenges facing would-be LECs is a lack of understanding as to the regulatory environment. Relative to many other sectors, the electricity sector is accompanied by a relatively complex regulatory environment, and the majority of the LEC project leads seen in Norway are not predominantly electricity sector organisations. Many LEC developers are therefore faced with a steep learning curve when they work through the practicalities of their projects, which imposes a practical barrier to their realisation.

This is likely to be a feature of LECs internationally. As we note below when discussing Ofgem's experience with regulatory sandboxes to support innovation, many of the projects entering the process did not really need regulatory exemptions, but merely regulatory guidance.

Clearly a lack of regulatory understanding is not always an issue – many LECs are led by DNOs that are therefore experienced operating in the sector. However, one should not underestimate the challenge facing a small community of end-users that does not have experience beyond that of a "plusskunde" and that wishes to establish a LEC.

7.4 Summary

There are a variety of potential barriers facing LECs, with the nature and importance of these barriers differing depending on the nature of the LEC's intended role. Of these potential barriers however, probably the largest and most widely applicable is the absence of a sustainable business case, due either to the absence of a market for the LEC's intended benefit, or else the absence of existing business models that can readily be copied. There may be regulatory aspects to these commercial issues. For example, the limits of the financial incentives available to LECs through the network tariff or connection charging regime for projects explicitly designed to replace the need for network investments mean that such projects are left needing to develop separate commercial arrangements with the affected DNO. However, the largest barrier related to the regulation is likely to be the learning curve facing would-be LECs when confronted with the need to independently assess the applicability of the existing regulatory framework to their project and navigate the licencing regime. As we discuss further in the next chapter therefore, the appropriate regulatory response is unlikely to be specific changes to existing regulation, but rather the creation of processes that enable LECs to develop their business cases supported by better information exchange and greater regulatory flexibility during the start-up period.

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8 REGULATORY RECOMMENDATIONS

In considering the appropriate regulatory response, we have taken as our starting point the overarching goal of the governing legislation, “energiloven”, namely ensuring the economic efficiency of the power system. We have also been conscious of the fact that, while it is important that regulatory burdens are proportionate, differences in the regulatory treatment of different actors should not give rise to an unlevel playing field that distorts competition and risks undermining the efficiency of the power system.

As is obvious from our survey of current Norwegian projects, most Norwegian LECs are currently in an early phase of their development, with considerable uncertainty as to their future structure and operation. These projects are also operating in an environment of rapid technological development, in which the most effective solutions are often not obvious and may be subject to change.

Although we have identified areas of the current regulatory framework that may act as barriers to the development of these and other LECs, we do not believe it is appropriate to proactively adapt elements of the general regulatory framework to remove these barriers in this context.

Rather we consider a proportionate regulatory response, given the immaturity of LECs and the current uncertainty as to their future role and make-up, would be to adopt the two-phase approach described below.

1. Regulatory sandbox – In the near-term, NVE should seek to develop a better regulatory sandbox solution that provides a clear, standardised process for the granting of temporary regulatory exemptions for the purposes of developing innovative solutions. By improving NVE’s existing exemptions process, NVE should be able to give LECs the support they need in the near-term without incurring the costs and risks associated with more fundamental regulatory reform.
2. Principles Based Regulation (PBR) – In the longer term, and only if the regulatory sandbox results in the creation of LECs that appear to be of more general benefit to the Norwegian system, NVE can consider broader regulatory reforms to better meet the needs of a power system that incorporates LECs. Importantly, by waiting until there are more examples of functional LECs, this reform process should be armed with a more detailed understanding of what is needed and supported by a more developed and informed group of stakeholders. One potentially useful means of adapting the regulatory framework to allow for more diverse market participants, while nevertheless ensuring a level playing field, would be the use of so-called Principles Based Regulation.

We describe both in further detail below.

8.1 Regulatory sandbox

A regulatory sandbox, as described by OFGEM, is a scheme that: “ […] *allows innovators to trial new products, services and business models in a real-world environment without some of the usual rules applying*” (OFGEM, 2018c). The concept derives from the world of software development where new code can be tested in a ring-fenced setting, without affecting the operations and safety of the wider system. Each trial has a defined timeframe and limited number of customers. The trials are also expected to have explicit learning objectives to test the viability of the proposed business model. At the end of the trial period, all rules apply as normal, and the innovator is required to report what it has learnt. It is important to mention that a regulatory sandbox is not a means to change regulation on a permanent basis, but rather a way to provide evidence to help understand whether regulation should change permanently (OFGEM, 2018c).

In the face of new business models in the electricity system, NVE’s toolbox for allowing the trialling of experimental ideas that may have problems complying with current regulation is limited to granting an exemption. However, historically, exemptions have been rare, and involved a time-consuming and demanding application procedure. Such exemptions have also not been time-limited, judged against the potential value of innovation or structured in order to encourage it. It may therefore be worth considering adopting an approach similar to the regulatory sandbox implemented by OFGEM in the UK.

The regulatory sandbox scheme implemented by OFGEM is run by a specific department within OFGEM called Innovation Link, which is a “one stop shop” that offers support on energy regulation to businesses looking to introduce innovative or significantly different propositions to the energy sector. Since launching the regulatory sandbox scheme in December 2016, OFGEM has run two regulatory sandbox windows in which they publicly request expressions of interest from energy innovators. These are clearly defined periods during which OFGEM takes applications, evaluates them against published criteria and provides fast, frank feedback to all of them. Finally, it grants sandboxes to innovators who meet the requirements. The specific contents of each sandbox, i.e. the specific exemptions, are then established in partnership with the innovator (OFGEM, 2018c).

In the first windows, OFGEM received 30 expressions of interest and assessed them against their published criteria. They provided feedback to 22 innovators to help them understand how their business model could operate within the existing regulatory arrangements and offered three innovators a sandbox. Two of the projects explore peer-to-peer trading and the other offers an innovative tariff. The second window received 37 expressions of interest. Of these, four were granted a sandbox. In the majority of cases in window two, the innovators simply needed support to better understand the rules of the energy sector and were able to go ahead without a sandbox after receiving feedback from OFGEM (OFGEM, 2018a). Three of the sandboxes granted in the second window involved some form of a LEC and one was related to market access for prosumers.

Adopting a similar approach to OFGEM would allow innovators to explore which setups are likely to viable and beneficial in a Norwegian context in close collaboration with NVE. Acceptance would still be granted on a case-by-case basis, according to published requirements, and the specific content of each sandbox would need to be worked out in partnership with the innovator.

8.2 Principles Based Regulation

A natural next step, albeit a longer-term project, would be to consider transforming existing elements of regulation into Principle Based Regulation (PBR), so as to create a level but widely applicable regulatory framework. PBR is an approach for developing regulations that are future-proof and provide room for innovation. It generally refers to applying broad-based standards in preference to detailed rules and relies on the use of principles drafted at a high level of generality that impose overarching requirements that can be applied flexibly. These standards are qualitative (not quantitative), purposive (expressing the reason behind the rule) and have a broad application to a diverse range of circumstances. By its nature, PBR puts greater responsibility on the regulated companies to understand and deliver on the principles expressed in the regulation in the most effective way for their business model. (Black, 2007).

Black (2007) describes the potential benefits of using PBR as the following: “*… they provide flexibility, are more likely to produce behaviour which fulfils the regulatory objectives, and are easier to comply with. Detailed rules, it is often claimed, provide certainty, a clear standard of behaviour and are easier to apply consistently and without retrospectivity. However, they can lead to gaps, inconsistencies, rigidity and are prone to “creative compliance”, to the need for constant adjustment to new situations and to the ratchet syndrome, as more rules are created to address new problems or close new gaps, creating more gaps and so on.”*

OFGEM adopted a more principle-based approach to regulation in 2015 and claims considerable success in their implementation of overarching principles as a replacement for detailed prescriptive rules. The application of PBR has focused on domestic gas and electricity supply markets, where several long, complicated and detailed rulebooks have been successfully replaced with overarching enforceable principles. Importantly, the principles allow greater room for suppliers to innovate in their service offerings than the previously prescriptive rules that could stand in the way of new products or technologies (Gray, 2017). OFGEM does however stress that this move is not the end of prescriptive rules, and that some areas will be more suitable for PBR than others (OFGEM, 2018b)

As noted, implementing PBR is more of a long-term strategy than a quick fix. However, it may be an appropriate long-term response to alleviating some of the current barriers identified for LECs. In particular, the difficulty of interpreting detailed regulation in new and unfamiliar contexts and the presence of disproportionate burdens placed on small actors might both be alleviated through the effective use of PBR. The immaturity of LECs also means that alternative detailed regulatory solutions are not obvious and are liable change in the future.

Where NVE deems it appropriate to alter regulation to accommodate LECs following the trialling described above, we would therefore recommend consideration of PBR. This approach will, we believe, be more likely to support ongoing innovation and prove more resilient to further changes to the technical and commercial environment.

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ANONYMISED TABLE OF NORWEGIAN LOCAL ENERGY COMMUNITIES

ID	Driving force/ initiator	Partners	Motivation	Challenges	Business-model	Number of participants	Stage	Local generation	Local storage	Capacity market	Energy market	Main focus area	Energy-production (capacity/ exported)	Power (storage capacity/ flexibility or export)
1	Property developer	Energy retailer, DNO, district heating, smart house technology provider	Flexibility market	Utilisation of real-time data. Ownership of batteries and full utilisation. V2H and V2G.	Postpone grid investments. Synergies between different energy systems. Willingness to pay premium for apartments in a green neighbourhood .	Very large (>1000)	Concept stage	Yes	Yes	Yes		Capacity	N/A	N/A
2	Property developer	Energy retailer, DNO, district heating, smart house technology provider	Environmentally friendly "plus-houses" - for elevated market value	Jointly owned PV-system and utilisation of production. Local energy market.	Self-consumption of solar power and elevated property value due to "green" energy system and low energy consumption	Small (<10)	Concept development- close to implementation	Yes	Yes	N/A	Yes	Energy	N/A	N/A
3	DNO	Energy retailer, research institute.	Test of local energy market and end-user flexibility	Ownership and control of battery. Aggregator and utilisation of end-user flexibility.	Tapping into the value of end-user flexibility and batteries as an alternative to grid investments.	Small (< 10)	Research study	Yes	Yes	N/A	Yes	Capacity		
4	Property developer	Energy retailer, research institute.	Add value to the inhabitants through local energy production and sale of flexibility to DNO.			Large (100-1000)	Concept stage	Yes	N/A	N/A	N/A	Energy	N/A	N/A
5	DNO	Research institute, technology developer.	IT systems to integrate flexibility systems, energy storage technologies and EV chargers to facilitate new business models in the energy industry.			Small (<10)	Research study	Yes	Yes	N/A	Yes	Capacity		

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ID	Driving force/ initiator	Partners	Motivation	Challenges	Business-model	Number of participants	Stage	Local generation	Local storage	Capacity market	Energy market	Main focus area	Energy-production (capacity/ exported)	Power (storage capacity/ flexibility or export)
6	Property developer	Infrastructure owners	Local energy production (solar), electrical mobility and reduced grid costs.		Local energy production - low energy cost and reduced grid costs.	Medium (10-100) Large consumers	Concept stage	Yes	N/A	N/A	N/A	Energy/ Capacity	N/A	N/A
7	Property developer	Mobility partners	Local energy production (solar and wind), electrical mobility and reduced grid costs.		Local energy production- low energy cost and reduced grid costs.	Small (<10)	Concept stage	Yes	Yes	N/A	N/A	Energy/ Capacity		
8	DNO					Small (< 10)	Concept stage	Yes	N/A	N/A	N/A	Energy/ Capacity		
9	DNO		Identified constraints in existing grid.	Lack of market place for flexibility.	Postpone grid investments.	Medium (10-100)	Implemented but will develop further	Yes	Yes	Yes	N/A	Capacity	0/0	0/1 MW
10	DNO		Evaluation of plus-houses, capacity tariffs and batteries for LECs.	Ownership and control of neighbourhood batteries. Interface Aggregator <--> DNO. End-user, aggregator, DNO --> who makes money and how?	Improved grid utilisation and prolonged components life expectancies. End-user saves on grid tariff.	Small (< 10)	Implemented	Yes	N/A	N/A	N/A	Energy	36 kWp (35000 kWh)/0	0
11	Property developer	Municipality, DNO, technology developer	Exchange of energy between the buildings and a common energy central with solar energy and wastewater heat as energy sources			Small (<10)	Concept stage	Yes	N/A	N/A	N/A	Energy	N/A	N/A
12	Property developer		Security of supply. Energy efficiency. Reduce load. Increase self-produced energy. (photovoltaics, CHP, grid, storage) and heat.	None apparent. Unclear how participants share benefit of storage and local production energy and capacity.	--> stable power supply (secondary effect)	Small (<10)	Implemented but will develop further	Yes	Yes	N/A	N/A	Energy	CHP 40 kWel 100 kWth: solar cells 70 kWp (59 MWh)/0	0

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ID	Driving force/ initiator	Partners	Motivation	Challenges	Business-model	Number of participants	Stage	Local generation	Local storage	Capacity market	Energy market	Main focus area	Energy-production (capacity/ exported)	Power (storage capacity/ flexibility or export)
13	Property developer	Municipality, local private developers, a transportation agency, DNO, district heating and waste management.	Minimising the demand for energy and basing energy production on local sources, CHP and solar. Energy storage to be explored.		Plus-houses for a paying market.	Large (100-1000)	Concept stage	Yes	Yes	N/A	N/A	Energy	7 GWh/n.a.	
14	Property developer	Municipality, research	The environmental goals are to minimise the neighbourhood energy demand and greenhouse gas emissions.			Large (100-1000)	Concept stage	yes	N/A	N/A	N/A	Energy	N/A	N/A
15	Property developer	Municipality	Integrated energy strategy with the aim of testing smart solutions for power management, storage and exchange of energy between buildings. Local renewable energy production that is designed to keep import and export of energy as low as possible.			Medium (10-100)	Concept stage	Yes	Yes		Yes	Energy	N/A	N/A
16	Property developer		Net zero and sustainability			Small (<10)	Concept stage	Yes	N/A	N/A	N/A	Energy	N/A	N/A
17	Property developer	DNO, municipality	Energy efficiency	Trading licence and area licence.	Explore CSO (community system operator), Microgrid,	Small (<10)	Concept stage	Yes	Yes	Yes	yes	Energy	1,57 GWh/0	
18	Property developer	DNO, municipality	High ambition on energy efficiency and local production.		To be explored with several partners.	Medium (10-100)	Concept stage	Yes	N/A	N/A	N/A	Energy		

ID	Driving force/ initiator	Partners	Motivation	Challenges	Business-model	Number of participants	Stage	Local generation	Local storage	Capacity market	Energy market	Main focus area	Energy-production (capacity/ exported)	Power (storage capacity/ flexibility or export)
19	DNO	Property developer, municipality	End-user flexibility utilised to reduce grid investments.	To estimate the correct and real value of peak-shaving/ demand side response.	Reduced investments.	Medium (10-100)	Concept stage	N/A	N/A	N/A	N/A	Capacity		
20	DNO	Power producer, end-user	End-user flexibility utilised to reduce grid investments. Local capacity market	Local energy market and capacity market, aggregator role, battery storage. Stacking battery services.	Reduced grid investments and back-up capacity. Reduced energy bill for consumers with production and storage.	Medium (10-100)	Implemented	Yes	Yes	Yes	N/A	Capacity	660 000 kWh/yr (700-800 kW)/ n.a.	800 kW(1000 kWh)/81 kW
21	Property developer	DNO, municipality	Energy efficiency	Local micro grid and energy market. DNO-grid only as back-up. "Readiness-charge" not possible at the moment.	Ownership models to be explored are cooperative, ltd, etc. LEC owning distribution assets.	Very large (>1000)	Concept stage	Yes	No	Yes	Yes	Energy/ Capacity	15-19 GWh solar/ 2,7 GWh	n.a./11 MW
22	Property developer		Energy efficiency. Mentions batteries and end- user flexibility as interesting, pending market development.			Small (<10)	Concept stage	Yes	Yes	N/A	N/A	Energy		
23	Property developer		Energy efficiency	Distribution of benefits among co-owners of solar facility.	No evident business plan beyond reduced energy demand and "plusskunde-ordningen"	Medium (10-100)	Implemented but will develop further	Yes	No	No	N/A	Energy		
24	Property developer		Energy efficiency			Medium (10-100)	Concept stage	Yes	Yes	N/A	N/A	Energy	2,7 GWh/?	n.a./n.a.

ID	Driving force/ initiator	Partners	Motivation	Challenges	Business-model	Number of participants	Stage	Local generation	Local storage	Capacity market	Energy market	Main focus area	Energy-production (capacity/ exported)	Power (storage capacity/ flexibility or export)
25	Property developer		Energy efficiency. CHP and solar and batteries to boost self-sufficiency on energy.			Large (100-1000)	Concept stage	Yes	Yes	No	N/A	Energy	N/A	N/A
26	Property developer		Avoid connection fee due to new demand in existing housing cooperative (EV charging).		Reduced grid cost	Large (100-1000)	Concept stage	Yes	Yes	No	No	Capacity	400 kWp (300 00 kWh)/n.a.	60 kW(230kWh)/ 320 - 340 kW
27	Property developer	Construction company, DNO, power company, district heating company, mobility company, technology developer, research institutes	Utilisation of local electricity production from large rooftop solar energy systems. Elevate the value of surplus solar energy	See issues on trading licence, area licences for building, owning and operating electrical assets.	Elevate the value of surplus solar energy in one building by offering it at a low (or zero) grid cost to neighbouring buildings. Searching for a low-cost solution to share energy locally. E.g. establishing a (CSO) Community System Operator.	Small (<10)	Concept stage	Yes	Yes	N/A	Yes	Energy	631.000 kWh/yr produced locally, 0-350.000 kWh shared locally or exported	0- 500 kW (0-30000 kWh)/0
28	DNO		New capacity demand met by capacity control and local production.		Reduced investments.	Medium (10-100)	Concept stage	Yes	N/A	Yes	N/A	Capacity	N/A	N/A
29	Property developer		Energy efficiency			Medium (10-100)	Concept stage	Yes	Yes	N/A	N/A	Energy/ Capacity	N/A	N/A
30	County as property developer	DNO, district heating company, property developer, research institutes	Energy efficiency, system interplay and storage			Small (<10)	Concept stage	Yes	Yes	N/A	N/A	Energy/ Capacity	N/A	N/A

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