Local energy innovators

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LIGHTENING THE WORK: THE HETEROGENEOUS DEVELOPMENT OF THE DUTCH COOPERATIVE ELECTRIFICATION NICHE IN TERMS OF SPATIALITY AND PACE

Abstract

The cooperative energy movement has been defined as a socio-technical innovation. Socio-technical innovation implies a process of simultaneous change of the structure of the energy system and relationships among the actors in the system, which affect its technical as well as societal and behavioural dimensions. However, framing energy cooperatives and their interaction with the energy system as socio-technical novelty prompts the question: have cooperatives played a role in energy transitions before, and if so, how? This study brings a nearly forgotten, and largely unknown part of the early history of Dutch cooperative electricity back from the margins of historical work on electrification: the emergence of electricity cooperatives in the early 20th century. By using the concept proto-regime from the Multi-level perspective on socio-technical transitions, we explore their role in the development of electricity from niche market to a regime with its own actor constellations, rules, and material and technical elements. Through this analysis we would like to contribute to an understanding of niches as heterogeneous innovation environments where diffusion and embedding of niche technologies can take place at different paces and in distinctive ways across localities. From the analysis, we also conclude that energy cooperatives can still have a transformative role in an energy transition without becoming a dominant player in the regime. The electrification cooperatives did not only inform learning in the proto-regime as experiments, but also improved accessibility of a novel development that not only literally but also figuratively lightened the work in rural areas.

Keywords: multi-level perspective, electrification, local energy, historical, proto-regime, niche heterogeneity.

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Gij, lichtbron van den nieuwen tijd,
Door ons met zooveel vreugd verbeid,
Blink ons uw schijnsel tegen,
Verhelder d'arbeid, noeste vlijt,
Verlicht om 't dagelijksch brood den strijd,
Gemeente en dorp ten zegen.

Thou, light source of the new time,
Awaited by us with so much joy,
Shine your glow on us,
Brighten the work, unremitting diligence,
Lighten the struggle for the daily bread,
Blessing for municipality and village.

~ Festive song composed for the opening of the cooperative energy plant in Bergum.

5.1. Introduction

Today, local civic initiatives are playing a growing role in national energy transitions. Especially in north-western European countries such as the Netherlands, the UK, Denmark, Germany and Belgium, such energy initiatives have been establishing themselves as a community energy sector with their own rules and actor-networks [1], [2]. The sector is expanding its activities, professionalizing, and creating regional, national and even supra-national institutional structures. In some cases, initiatives are enrolling incumbent energy regime actors such as distribution system operators and energy companies in their networks[3], and even creating hybrid business models[4], [5].

The precise growth of local energy initiatives has been country specific and far from linear, with phases of waxing and waning. The latest take-off of community energy in many north-western European countries was during the last 10 to 15 years, and the number of European energy cooperatives already exceeds 1500 [6]. This development has mainly been facilitated by a combination of the liberalization and privatization of the energy markets, dropped prices of solar panels due to rapid technological development, introduction or extension of financial policies for renewable energy, and a societal wish to accelerate the transition to renewables. Especially, a fit with the regulatory framework and supportive financial policy turned out to be important for their growth [7], [8]. Periods with less favourable conditions in those respects had a slower growth pace, which has been seen in Denmark, the UK and Germany [7], [8].

Due to this recent growth of community energy in north-western European countries, community energy has largely been perceived as a novel phenomenon, even described as a socio-technical niche innovation [9]–[14]. However, collective, civic action in the energy sector is not as new as it may seem. For countries with an established community sector today, the roots of the collective local initiative goes back much further than the last 15 years. A few country-based studies provide a wider historical perspective on community energy[7], [15]–[17]. These studies describe how from the 1970s and 1980s, community energy sprouted from a combination of social, political, institutional and environmental factors.

Yet, we found even earlier community energy initiatives in the Netherlands. We discovered that similar to for instance North-America and Germany[18], [19], the Netherlands had a wave of cooperative energy provision much earlier on, at the start of the 20th century. Just like today's initiatives, these cooperatives were part of an energy transition. This study focuses on how a niche market formed for cooperative energy and how it developed in relation

to a changing energy regime. Such information provides a background that can be used for later work involving systematic comparison with today's community energy sector.

Thus, interested in what role electrification cooperatives played in the historical energy transition towards electricity, we focus on the following main questions:

How did electrification cooperatives develop and why did they disappear? What was their role during the Dutch electrification?

We explore these questions through a historical analysis based on archive study and secondary data. As framework for analysis we have chosen concepts from the literature on the multi-level perspective (MLP) on socio-technical transitions. This framework has been used for analysing systems interactions in contemporary and historical transitions. The MLP highlights co-evolution and multi-dimensional interactions between various involved actors, amongst others industry, technology, markets, policy, culture and civil society[20]. We characterise the electrification cooperatives as part of the electrification niche, and describe what role these initiatives played during the shift of electricity from niche market to part of the energy regime.

By doing so, we aim to contribute to an understanding of niches as heterogeneous innovation environments where the development, diffusion and embedding of niche technologies can take place by different actors, at different paces, and in different ways across different localities[21]. This contrasts to MLP studies on contemporary local energy that have given a snapshot of the role of community energy in the national energy system at a certain point in time[2], [10], [11] or analysed local case studies [12], [22]. These studies tend to either aggregate the data and describe the local energy niche from a country-level perspective, or focus on specific cases. As a result, they do not show nor explain the regional differences that can co-exist within a niche.

Hence, we want to show how concepts from the MLP body of literature can be used to show regional diversity. In this paper, we explore and explain the heterogeneity of development pace and the regional diversity of cooperative electrification.

5.2. Theoretical framework

The MLP has been used for understanding contemporary and historical transitions to new socio-technical systems, and has been helpful in furthering the understanding of the dynamics of system innovation. In MLP, transitions are defined as changes from one socio-technical system to another through the co-evolution of technology and society[23]. Historical MLP transition studies have, for instance, been done on the transition from cesspools to integrated sewerage systems [24], from horse-drawn carriages to automobiles[25], from manual to mechanized unloading of ships in the port of Rotterdam[26], and on the co-evolution of water supply and personal hygiene[23].

The MLP's analytical framework to analyse transitions is constructed around the core concepts niche, regime and landscape (see figure 5.1). When innovations emerge at the lowest level in niches [27], rule structures are not yet in place and actors improvise and experiment to come to grips with what their (prospective) target group needs. Networks around the innovation are at this stage rather small and precarious, and the innovation does not threaten the existing regime.

If an innovation catches on, it will get used in small niches of the market, resulting in more interaction with users and other regime actors, providing resources to further develop and specialise the technology. In this second stage, the innovation starts to develop its own trajectory and the rules and actor constellations are getting increasingly stable. The structure of the niche develops increasingly in the direction of that of a regime, and forms an early stage regime like proto-regime[28].

Either the innovation remains a niche product, or it enters a breakthrough phase in which the technology starts to compete with and make changes to the established regime. Both internal niche dynamics, and external regime and landscape developments are earmarked as important for replacement of existing regime structures[27]. This will be accompanied by creative destruction: the collapse of some incumbent actors, and introduction of new actors from the support network of the innovation. Finally, once a transition has taken place via a crooked process of acceleration and slowing down[23], the new constellation settles to a state of dynamic stability and reproduction, forming a regime with a new balance and structure.

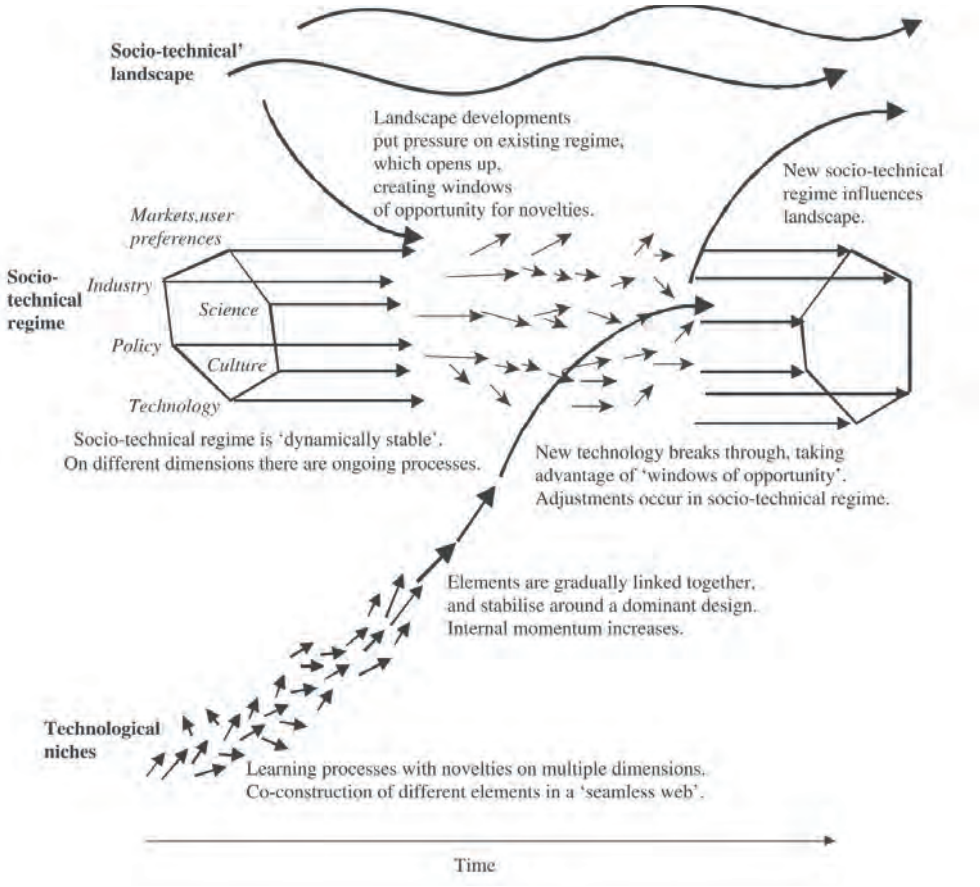

Figure 5.1: The multi-level perspective on socio-technical transitions [27].

In this study, the focus is on the development of the electrification niche to a regime within the wider energy sector (including e.g. gas, petroleum, and candles), and the role of the Dutch electrification cooperatives as a subniche during this development. To analyse the development of electricity from a niche into a regime, we need further operationalisation of the development of a niche into a regime, and for this we use the earlier mentioned concept proto-regime.

Niches have been described to be similar in structure to regimes, but less stable and operating on a lower scale [29]. As a niche matures, it evolves towards a proto-regime that has a similar structure to a regime [30]. The proto-regime comes slowly into being when rule structures and actor-networks start to take shape during niche development [28] (see figure 5.2 for a schematic overview of steps).

Smith and Raven propose five steps for the development of a proto-regime [28]. First, regimes and landscape inform experimentation, and shape the conditions for innovations to arise (T1). Second, a variety of local experiments arises and gets supported by local networks, generating locally applicable lessons. Third, these local lessons are negotiated and translated and some get selected and start to act as rules in the entire niche. Fourth, there is retention of knowledge, and the developing actor-network and the new rules become useful resources for new experiments. Finally, it starts to change prevailing regimes or becomes a viable competitor (T2).

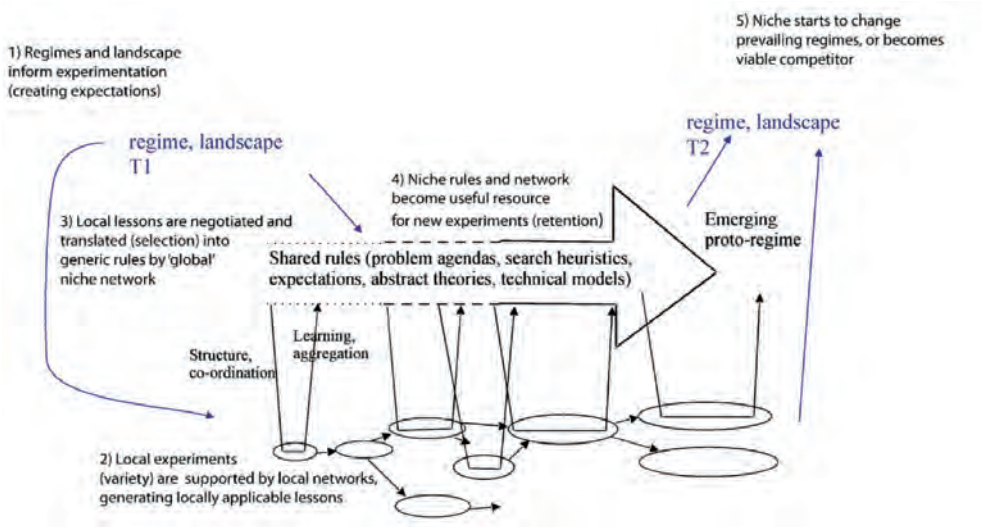

Figure 5.2: Emergence of a proto-regime [28].

Since a niche is in structure similar to a regime, we can use the three interlinked elements of the regime proposed by Verbong and Geels [32] to analyse the increasingly stabilising electricity niche and the role of the electricity cooperatives in it:

- Actors: a network of actors and social groups, which develops over time;
- Rules: regulations that guide the activities of the actors who reproduce and maintain the elements of the energy system;
- Material and technical elements: the tangible elements such as infrastructures and technologies.

After analysis of the emerging electricity regime, we study the cooperative electricity niche in more detail. We focus on the spatial and temporal trends of emergence.

5.3. Methodology

This historical research uses a mixed methods approach and combines qualitative and quantitative data.

For establishing an overview of the electrification cooperatives, we used the yearly supplements of the *Staatscourant (*the Netherlands Government Gazette*)* with an overview of the all cooperative associations founded in that specific year. The supplements include a list of the founded cooperatives, and memoranda and articles of association. These supplements are available from 1904 onwards, and we have searched the period 1904-1935. The delineation of the search era was data-driven and was an iterative process. We set the search limit to 1935 as in the five previous years no new cooperatives were found.

The data sheet we created by using this source includes the names of the cooperatives, their year of foundation, the location (place name and the province), and whether they were started as a distribution or generation and distribution cooperative. Are mark that needs to be made about the reliability of the data of foundation from the Staatscourant is that for a few Frisian cooperatives, this source gave a later year than Jansma [33]. Hence, the cooperatives may not always have incorporated in the year they started operating. However, we expect that the trends in the data will not be affected much by this.

Furthermore, a methodological limitation to this research is that the dates of dissolution of the cooperatives could not be retrieved. It was not yet required to register dissolution of a cooperative. This information is incomplete and scattered over regional archives. In the Drenthe archive information about only 4 of the at least 26 cooperatives could be found, and therefore, we have concluded it was not possible to trace this information for each cooperative individually. However, some global data on the decrease of cooperative energy could be found in provision overviews from governmental organisations and encyclopaedias covering the history of electrification and utilities.

To obtain qualitative data for interpreting and explaining these trends, we used various approaches. We used historical search engine Delpher to search for newspaper articles featuring electricity cooperatives. In addition, we searched via archieven.nl, which is a collaboration of 87 organisations and more than 51.000 archives. We also used a regular web search to

find content from for instance local historical associations to triangulate the data from the Staatscourant.

Furthermore, two contrasting types of cooperatives have been portrayed in more detail as historical cases, and to give a more in-depth understanding of the functioning of these differently motivated electrification cooperatives.

5.4. The developing electricity regime

In this section, the conditions under which electrification cooperatives developed will be sketched. The focus is on how the actors and network, rules, and technologies and material elements changed between 1900 and 1950 while electricity developed from a niche to a regime, and became an increasingly stable part of the lighting and power sector.

5.4.1. Technologies and material elements

After the International electricity exhibition in Paris in 1881, European engineers started to experiment with electricity. The first practical application was lighting, which meant competition for the gas factories.

In 1907, the Netherlands had 131 gas factories, of which 108 municipally-owned companies[34]. The gas was produced out of coal and transported via pipelines. As gas was more expensive than petroleum and candles, it was only affordable for the societal upper class. Initially, owners of gas factories did not perceive electricity to be a threat as they thought it would be only suitable for lighting large public spaces and would stimulate the demand for lighting. Gas light had just gotten an impulse in the 1890s and 1900s because of the invention of the Auer von Welsbach gas mantle, which used less gas and did not require a very specific gas quality[34]. Furthermore, gas was less expensive than electricity. With time gas became more accessible to lower- and middle-class households because of the introduction of coin meters which avoided an unexpectedly high bill at payment time. However, because of the high costs of the development of a gas grid and techno-economic limitations of transport over larger distances, gas remained for use in more densely populated areas, and grid expansion was limited.

While gas was still generally more attractive than electricity, an early niche market for electricity of self-generating factories using electricity for their production processes formed[34]. These factories possessed already a steam engine that could be connected

to an electricity generator. The advantage for these factories was that they did not require a central drive shaft because of the possibility to use electricity cables. However, the gas engine improved during this time as well, increasing the attractiveness of gas, and was still attractive for small- and medium-sized companies for which a steam engine was too expensive.

Although gas had its advantages from about 1905 onward, the gas engine started to lose its competitive advantage to the maturing electro-engine that was smaller and more versatile than the steam engine, and had lower purchase and maintenance costs, easier installation, smaller size, and was cleaner than the gas engine[34].

Especially when the price of electricity went down due to upscaling that was enabled by technological developments electricity started to prevail over gas for lighting and propulsion purposes. An important technological development was connection in parallel of alternating current generators. This enabled extension of production of alternating current that could be transported with high voltages for minimal losses through thinner, and therefore, more economical electricity cables[35]. Until about 1910, the number of gas engines still increased in smaller cities, but because of the quick expansion of electricity these were soon replaced by electric equivalents[34].

However, despite their success, electricity plants were barely making a profit. This was a result of the quick technological advancements, and of the constant need for investments and high depreciation[35]. The electricity providers started experiments with attractive tariff systems to stimulate the demand. However, the success of the plants was determined by a combination of the potential for labour, capital, used technology, the extent of industrialisation, population size, and bargaining power[35]. The population size and the market composition were the most important.

By about 1914, upscaling meant lower production costs, and therefore, bigger plants turned out to be more successful [35]. Between 1883 and 1914, 19 plants already closed again, of which most were smaller, private, direct current plants. Eleven of these were located in localities with fewer than 10.000 inhabitants[35].

In sum, due to progress in electricity technology and market dynamics, gas started to lose its competitive advantage to electricity from about 1905. An important development was connection in parallel of alternating current generators, which enabled extension of production of alternating current that could be transported with high voltages. A decade later, economies of scale could be realised with bigger plants, which led to centralisation of production. This made it harder for cooperatives to remain competitive as around this time rules changed and their institutional space became limited to one municipality only.

5.4.2. Policies and regulations

At the start of the electrification period, rules and regulations for electricity technologies and infrastructures regarding e.g. safety, durability, and organisation of the emerging electricity system were largely absent. Until 1912, the municipal government could decide whether or not to give a concession and allow a private electricity company or to start a municipal company[36]. The prospective concession holder only needed to ask the national government (ministry of water works) permission if the electricity grid came near to telegraph or telephone cables or along waterworks or railroads[36]. In 1912 (Groningen) and 1913 (Noord-Brabant) provincial regulation that obliged prospective electricity companies to get a provincial concession was approved per Crown Decree[36], [37], and soon after this most other provinces applied for this right and started a provincial electricity company.

National policy and regulations developed slowly. It was only in 1938 that the first Electricity Act was passed, whereas the first policy preparations by installing various state commissions started already more than 35 years earlier[38]. In 1903, the Commission Tidemann explored safety and measurement standards. In 1910, the Commission IJsselstein was installed to look into promotion of the electrification of the country side. It recommended to divide the country into districts and to give out concessions based on this classification. The concession system did not yet find its way into regulation, but the provinces North-Brabant and Groningen still successfully applied for a provision concession for their province, which was soon followed by most of the other provinces. An advice of Commission IJsselstein that did make it into law (i.e. to the Belemmeringswet) was expropriation of unbuilt properties for electricity infrastructure, if for the common good. In 1919, Commission Lely made a plan to bring the electricity provision in the hands of the national government. However, parliament downvoted this, after which the proposal was withdrawn. In 1921, Commission Graaf van Lijnden van Sandenburg was installed, which brought out an advice report in 1925 that was used to create a first draft of the first Electricity Act. This proposal did not make it, but led to the installation of an Electricity Council that would advise the ministry of Water works on electricity matters. In 1937, another draft of the first Electricity Act was presented, which was accepted by parliament in 1938. At this point, the importance of coupling the network at the national level to improve security of supply overrode the doubts about the desirability of government intervention and the negative effects of forced collaboration between the electricity companies.

This Electricity Act provided a legal basis for the arrangement of the electricity provision via a state concession system. Concessions that had been given out prior, by e.g. the

municipalities, were not ended but needed to be harmonized with the new regulations to be turned into state concessions. The only exception were municipalities that only serviced their own territory, which could continue as before. Furthermore, the Electricity Act provided a legal ground for the Electricity council. Hence, it mainly consolidated ongoing practices, and added the possibility to later prescribe conditions for effectiveness, safety, and solidity of electrical installations per executive decree[38].

Before the Electricity Act the only regulation in the energy sector was self-regulation of the quality of electric installations and devices via the in 1927 founded Inspectorate for Electrotechnical Materials (KEMA). This organisation secured a high standard in terms of solidity and safety of electronics.

In conclusion, when electricity technology was introduced, no regulations other than concession rules of the local government applied. Only in 1938 national legislation was passed to provide a legal framework and enshrine in law what had become common practice. However, this Electricity Act confirmed what had been reality for nearly two decades: the provincial concession system meant the end of the institutional space for energy cooperatives.

5.4.3. Actors and networks

The first actors in the Dutch electrification niche were small-sized private companies[38], which were mostly self-generating factories (often already in possession of a steam machine) and so-called block centrals that serviced a continuous housing block and did not cross streets. The first example of an electricity plant servicing private users in an area larger than a housing block was the Electrische centrale Kinderdijk that became operational in 1886 and had 350 connections (every lamp counted as a connection).

The municipal government was initially only involved in granting concessions. It did not become active on the developing electricity market as it was not yet confident about the future of electricity. Furthermore, in localities that had been connected to a gas grid, it feared competition for the (municipal) gas factories[39].

However, soon when electricity technology matured and demand grew, the local government became gradually more interested, and in 1895 Rotterdam first started a municipal electricity company. Between 1900 and 1910, nearly all larger cities started a municipal electricity company. From this time on, the number of municipalitie energy companies grew and municipalities became the main player on the electricity market. Yet, between 1895 and 1914, most electricity companies were actually established in small cities under 10.000

inhabitants. Main reasons for this twofold development were that an electricity grid was more viable for vast municipalities, but smaller municipalities more often did not have a gas factory, which constrained concession possibilities and created competition as gas was still cheaper.

Among these smaller municipalities were some where the first electrification cooperatives were established. This development electrification cooperatives was part of a wider reaction between 1880 and 1920 to Liberalism and the strong market economy that dominated in Europe at landscape level [40]. Cooperatives, and other types of collective action initiatives such as cultural and sports associations and trade unions, witnessed a steep rise due to discontent with the power of capitalistic producers and resultant inequality[40].

In the period with municipal electrification, few common interests existed among electricity companies. However, when the electricity provision became more widespread a need developed to organise collectively and explore aspects important to future of the energy system in committees. To this end, the Association of Directors of Electricity Companies in the Netherlands was founded in 1913. Its members were the directors of the larger electricity companies. Small electricity companies such as first electrification cooperatives were no member of this association and functioned relatively isolated within their territory.

The take-off of use and the rapid advancement of electricity technologies stimulated upscaling and concentration of energy production[39]. This led to the development of regional grids that were fed by a central larger-scale production facility. At this point, the provision of electricity started to shift from municipal (private company, cooperative, municipally-owned) to provincial companies.

Between 1914 and 1925, all provinces except Drenthe and Zuid-Holland established a provincial energy company[39]. Drenthe was serviced partly from Overijssel and partly from Groningen. In Zuid-Holland, several large municipalities collaborated and set up regional provision. North-Holland, Friesland, and Groningen had provincially owned companies. In Overijssel, the two most important facilities were in the hands of the Province and a few municipalities. In the remaining provinces, a private company (N.V.) was set up, of which the shares were held by the provinces.

As a result of the increased activity of provincial governments in the energy sector, the number of municipal energy companies and private and cooperative initiatives decreased. The private companies, such as the cooperatives, were increasingly sold to a governmental energy company or their concession did not get extended when the local government wished to start their own electricity company. Table 5.1 shows the development of the distribution of

municipal electricity providers between 1922 and 1949, and shows how private and cooperative initiatives declined when regional energy provision by the provinces became more common.

Table 5.1: Overview of energy suppliers (adapted from [38]).

Year	Total number of municipalities	Municipalities where the municipality supplies (and % that outsources technical or administrative work)	Municipalities where the provincial government holds the concession	Municipalities where a private company or cooperative holds the concession	Municipalities without supply of electricity
1922	1073	588 (42%)	96	52	337
1931	1077	464 (38%)	629	17	27
1940	1050	285 (26%)	743	16	6
1949	1014	242 (30%)	756	11	5

At the end of the 1920s, the actor constellation was expanding as the urge to regulate electric power grew. To secure the quality of electric installations and devices, in 1927 the Inspectorate for Electrotechnical Materials (KEMA) was founded[39] by the VDEN. Furthermore, in 1933, the electricity council was installed by the minister of Water works and was tasked with advising the ministry about electricity provision[38].

In the early 1940s, the upscaling slowed down and the focus shifted to coupling regional grids into a national grid. In 1948, the organisation Collaborating Electricity Production Companies (SEP) was established to promote a national interconnection network[39].

All in all, electrification started as the effort of relatively locally operating actors such as cooperatives, private companies and municipalities. Over time the electrification niche went beyond local experiments and when electricity became a viable competitor the actor-network expanded. Enabled by national legislation provincially-owned companies increasingly pushed the local players out of the market. When electricity became a viable competitor on the energy market, the part of the emerging proto-regime with municipal level actors, such as the cooperatives, ceased to exist.

5.5. The cooperative electrification niche

Established for the electrification of their locality, many of the cooperatives had names such as “cooperative association electricity plant (place name)”, or “cooperative association for electric lighting”, “cooperative association for the provision of electricity in (place name) and its surroundings”, or “cooperative association electricity plant for lighting in (place name)”.

Many of the cooperatives’ names underline that the electricity they provided was initially, primarily used for electric lighting of their members’ properties. The members of these cooperatives were mainly households and sometimes also local businesses. Therefore, these cooperatives can be defined as consumer cooperatives, which are enterprises owned by consumers and managed democratically, aiming at fulfilling the needs and aspirations of their members. The ones that produced electricity for use by their members can be described as prosumer cooperatives.

We found that, between 1905 and 1929 at least 83 electrification cooperatives were established, mainly concentrated in the provinces Friesland and Drenthe. The temporal and geographic trends of the development of this part of the electrification niche are discussed in the remainder of this section.

5.5.1. The emergence of electrification cooperatives (1905-1929)

In this study, we found that between 1905 and 1929 at least 83 electrification cooperatives were established (see figure 5.3). Their names, year of foundation, and location are listed in appendix D. The development of these cooperatives was part of a wider reaction between 1880 and 1920 to Liberalism and the strong market economy that dominated in Europe at landscape level [36]. Cooperatives, and other types of collective action initiatives such as cultural and sports associations and trade unions, witnessed a steep rise due to discontent with the power of capitalistic producers and resultant inequality[36].

The majority of these were founded between 1910 and 1920 (see figure 5.4). The small dip between 1915 and 1917 was likely due to the political and economic unrest at landscape level caused by World War I, in which the Netherlands remained neutral. In 1918, at the end of the war, the number of cooperatives boomed with 32 newly founded cooperatives. A possible explanation for this boom is that the preparations for these cooperatives had been taken in the previous years, or they were possibly already operational, and the cooperatives were incorporated after stability improved when the war ended. After 1929, no new electricity cooperatives were founded.

Figure 5.3: Spatial distribution of Dutch electrification cooperatives.

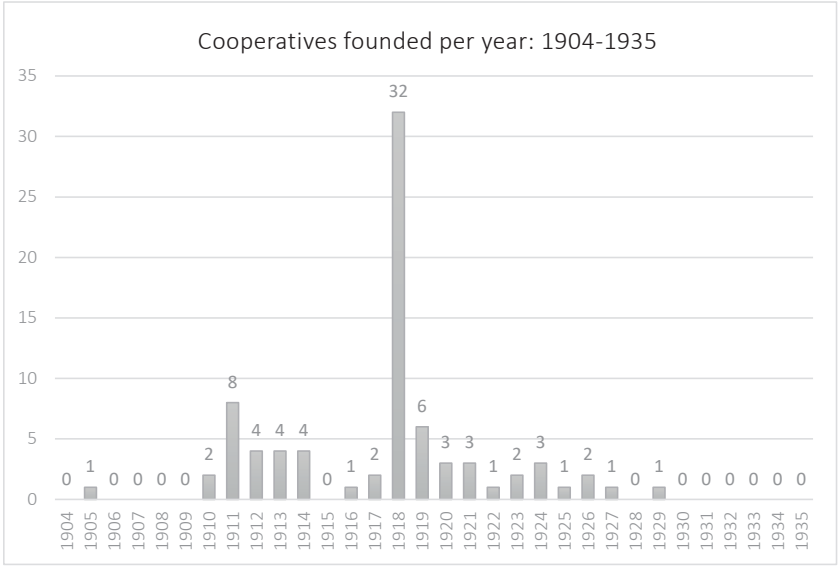

Figure 5.4: Emergence of electrification cooperatives.

A distinction can be made between cooperatives that both generated energy and distributed it, and the ones that only did distribution[1] (see figure 5.5). Based on the statutes of the cooperatives, at least 68% of the cooperatives established an energy production installation and a distribution grid. These cooperatives were founded by collectives of wealthy farmers, peat extractors and the local middle and upperclassmen such as craftsmen, hotel owners, publishers, directors of factories, salesmen, teachers, bakers, doctors, and mayors. Another 27% functioned only as distribution company and bought electricity from another company. These cooperatives either had a contract with a designated electricity plant (cooperative or private) or with a factory. The other cooperatives had a contract with a (cooperative) factory that dimensioned its system to provide electricity for own use as well as for broader electrification of the locality. The distribution cooperatives were often established by larger groups of villagers, also including gardeners and workers, as they needed to guarantee a certain use from the start. Of the last 5% we cannot be sure whether their activities encompassed both production and distribution, or distribution only (based on their memorandum and articles of association).

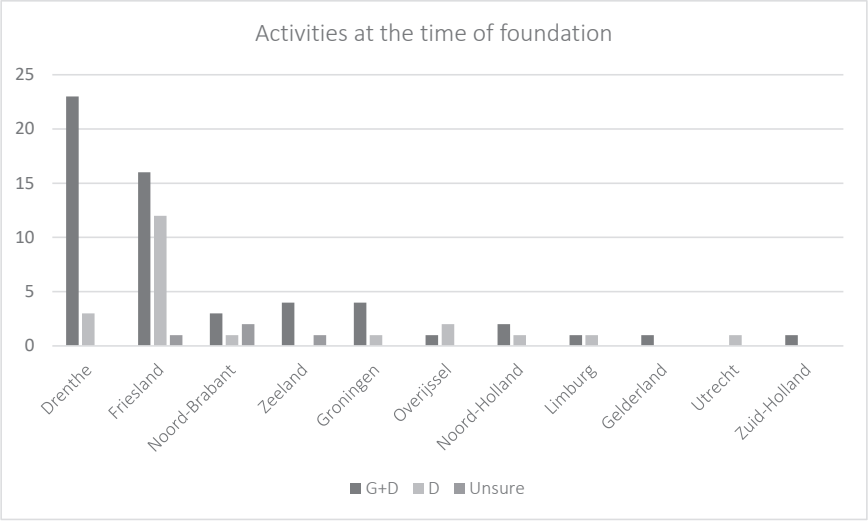

Figure 5.5: Activities of the electrification cooperatives at the time of foundation, as found in the memoranda of association.

Interestingly, the electricity cooperatives were not evenly spread over the Netherlands (see figure 5.6). Of the then eleven provinces, Friesland (29) and Drenthe (26) had by far the most

[1] Some of the generation and distribution cooperatives stopped generation at some moment, but kept operating the distribution grid for a longer period of time (see section 5.5.1.2). This development is not included in this graph as no complete data is available on which cooperatives made this change and when they made this change.

electrification cooperatives. Followed by Noord-Brabant (6), Zeeland (5), and Groningen (5).

Why electrification cooperatives developed mainly in Friesland and Drenthe is discussed in detail in section 5.5.1.1 and 5.5.1.2. In the other provinces, early electrification was mainly carried by the municipalities and, in a few instances, by private companies other than cooperatives. Later, the Provinces became the main electricity provider due to regulatory and technical developments in the developing proto-regime (as discussed in section 5.4.3)

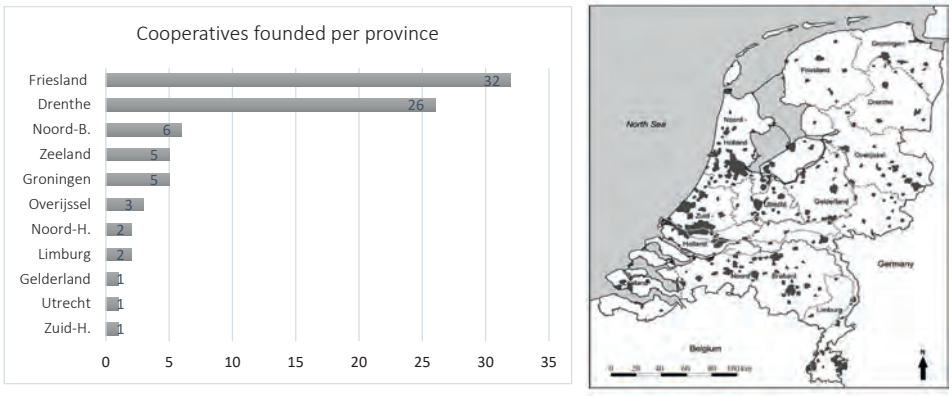

Figure 5.6: Distribution of cooperatives over the Dutch provinces (left), and map of Dutch provinces (right)[41, p. 570].

Between the five provinces with most cooperatives also slight differences in period of emergence of the cooperatives can be seen (see figure 5.7). Over half of the cooperatives in Friesland (62%) was founded before 1915, whereas only 12% of the cooperatives in Drenthe was founded before that year. In Noord-Brabant and Zeeland, the emergence of cooperatives was later still, and took place from 1918 on. Groningen had the first electricity cooperative with the "Cooperatieve verlichtingsfabriek Helpman" (*In English: cooperative lighting factory Helpman*). In appendix E, a small in-depth history of this first electrification cooperative can be found. Groningen's second and third cooperatives were founded five years later, and the province did not experience the emergence of a comparable number of cooperatives as Drenthe and Friesland, the other two northern provinces.

In Zeeland and Groningen, no cooperatives were founded anymore after 1918. In the 3 provinces with the most cooperatives, the emergence of cooperatives continued up to over a decade longer. Noord-Brabant's last cooperative was founded in 1927, and Friesland's in 1925. The last electricity cooperative from this era was founded in Drenthe's Dalerveen in 1929.

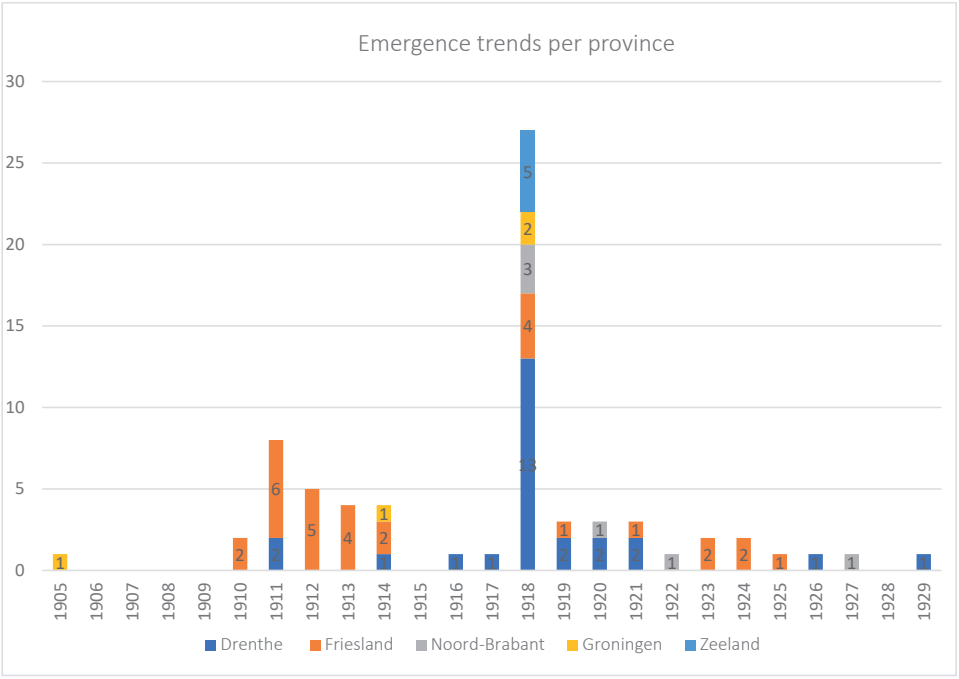

Figure 5.7: Number of cooperatives founded per year in the five provinces with most cooperatives.

Below, we will describe and discuss the dynamics in the two provinces with most cooperatives, Friesland and Drenthe, by placing it in a regional context of grid expansion and other relevant socio-economic, technical and legal developments.

5.5.1.1. Friesland

In Friesland, the first municipal-level, electrification initiatives were cooperatives. Their development sprouted from an anarchistic regional culture. Furthermore, a wish for modernisation of the energy system played an important role, especially in villages that did not have gas yet. Later, distribution cooperatives were founded, which bought electricity from the provincially owned company.

Two cooperative, direct current energy plants were founded in 1910 (Oosterwolde and Kimswerd). Both cooperatives' installations were supplied by the engineering company Doyer & Co. from Rotterdam (after 1910 N.V. Electriciteits Maatschappij Electrostroom), which would later also supply installations to cooperatives in Makkum and Bergum[33].

It started with Oosterwolde. Doyer & Co. wanting to expand its market and had come into contact with a progressive resident of Oosterwolde via touristic promotion this resident did for the local tourist information centre. Furthermore, Oosterwolde had an enthusiastic mayor who was not satisfied with the petroleum lighting in the village. A lighting committee was installed and it was swiftly agreed upon that Doyer & Co. would build the energy plant and get a monopoly position for electricity supply to a designated cooperative that guaranteed a minimal use. After ten years, the Oosterwolde cooperative would get the opportunity to take over the energy supply. When the production started on the 12th of February 1910, the residents of Oosterwolde were so positive about the quality of the light that Oosterwolde provided a boost for the electrification of Friesland[33].

In the next year, six more cooperatives were founded, of which three operated three-phase current plants [42]. One of these was the plant in Bergum, which was described in the local newspaper as 'a wonderful expression of private initiative, because till today only a few rural municipalities are privileged to have a board, enabled by the government to execute this common goods issue' [33, p. 61]. That electricity production was perceived as a privilege was not only due to the novelty of the energy source, but also to the limited possibilities for electrification in municipalities with gas production. Many of the early pioneers were among the municipalities without a gas factory, because private gas factories often had a permit that excluded competition with other energy factories for a certain time and municipally-owned gas factories were reluctant because they did not want to compromise municipal income[33].

In 1912, the municipality of Leeuwarden (Friesland's provincial capital) started generating electricity, and soon started a collaboration for grid extension with the municipal governments of some neighbouring rural villages and the distribution cooperative Noorderlicht from Oudebildtzijl[42].

Around this same time, Friesland got under the spell of electrification. Electrification cooperatives and committees were sprouting in various villages. However, not everybody was pleased with this private initiative. A deputy of the provincial government perceived the proliferation of small plants as a threat to profitable operation due to the limited size of the plants[33]. While a kWh costed 18 cents in Leeuwarden, it cost 44 cents in Oosterwolde. Research commissioned by the provincial government confirmed that it was better to coordinate the electrification. A district-level approach was advised, because a central plant for the entire province was not technically feasible. Still it was estimated that over the coming 6 years 425.000 fl needed to be made available to

offset the losses and settle the accounts. Hence, the anarchistic Frisian culture which enabled the rapid spread of electricity in Friesland did not come without a price tag[33].

In 1916, a provincial electricity company was founded and took over from the municipal company of Leeuwarden. In the same year, the provincial government decided that the province would preferably generate electricity and develop and operate a high-voltage transmission grid, and that the municipalities would take on the distribution and install local grids[42]. Hence, in general, from this time on, electrification was done by municipalities and cooperative electrification became more of an exception.

In 1918, the cooperative association for electric lighting of Witmarsum, Pingjum, Arum, and Achlum decided to connect to the provincial grid, stopped its own generation and only continued distribution. Due to the connection, a grid extension was necessary, which provided Tzum with the opportunity to connect. For this, a distribution cooperative was established. In the same year, the cooperatives in Kollum and Kollumerpomp also switched to the provincial electricity company, and stopped the generation in Kollum. Shortly thereafter, they transferred the distribution companies to the municipality. As the Groningen provincial grid was closer than the Frisian, an agreement was made between the two provincial companies to connect these cooperatives to the Groningen grid.

From 1920 until 1922, the provincial high-voltage transmission grid was extended rapidly. The electricity production capacity of the provincial electricity plant was at the time 6500kW. In 1923, it slowed down due to the lack of financial means of municipalities because of the economic downturn caused by the German hyperinflation crisis (landscape development). By the end of 1924, the electrification by municipalities speeded up again.

All in all, the largest and strongest municipalities were connected first, and when the connection movement slowed down, only parts of villages were connected. The exploitation of the distribution grids was not easy at the countryside. The dispersed living residents created a need for vast networks that were expensive in maintenance and operation. The actual use was initially low, and therefore, the fixed costs of interest and depreciation made up a large share of the kWh price, and led to high electricity prices.

At times, the provincial energy company took the administrative and technical responsibility (after an agreement with the concerning municipality) for the distribution grids. However, the provincial electricity company generally only took on the exploitation of distribution grids after the municipality or a specifically for this purpose established cooperative guaranteed a certain minimum use, that guaranteed the profitability[33].

5.5.1.2. Drenthe

In the province of Drenthe, the first energy companies were also cooperative initiatives. Other than in Friesland, electrification progressed rather slowly compared to the rest of the Netherlands. The Province was not interested in having its own electricity company, which resulted in electrification from other provinces. As this process took some time, cooperatives were well positioned to supply electricity in the meantime.

The first two cooperatives were in founded in 1911 in Beilen and Dalen[43], [44]. In the provincial capital, Assen, some companies and institutions already had their own electrical installations[45], but the cooperatives were the first suppliers that serviced a small municipal market of households and local businesses. From 1901, there had been requests to build an electric plant in Assen, but these were turned down by the municipality that feared competition with the municipal gas factory.

The province of Drenthe was not interested in a concession from the national government. Therefore, its territory was split among two concession holders[46]. In 1913, the province of Groningen received a concession for Groningen based on the condition that the sparsely populated part of the northern part of Drenthe and the eastern part of Friesland would also be electrified where profitable. This happened through a distribution grid company to which all municipalities in the concession area, save a few exceptions, outsourced the electrification. The provinces initially financed the infrastructure and later offered loans to the municipalities. The municipalities only needed to finance the operation of these distribution grids and carry the risks. Due to this attractive construction and the impossibility to establish electricity companies without a permit of the Province of Groningen from 1913 onwards, only few electricity cooperatives were established in the north of Drenthe.

Only five years later, in 1918, the N.V. Electriciteits-Maatschappij Ijsselcentrale from Overijssel, was bound to expand its concession area with the south of Drenthe when its national concession from 1914 for the province of Overijssel expired and had to be renewed[46]. In the same year, the Province of Drenthe became shareholder of this company. The company initially only slowly expanded its grid in the direction of Drenthe, because the disappointing financial results that prohibited extension.

Because of the long wait for connection, quite a few cooperatives were established in the north of the concession area in the relatively wealthy peat colonial area[37]. The step to cooperative electricity in this area was not a large one due to the history of cooperative enterprising. This area had a group of well-organised, wealthy farmers who could collectively get

loans for financing cooperative factories of considerable size due to their land possession[47].

Many of these cooperative companies ended production when they were connected to the regional grid[46]. Some even had this condition specifically in their memorandum of association. The cooperative in Dalen was one of the exceptions that remained operational for a longer time, and functioned as distribution cooperative until 1959 and profited of the economic advantages of owning the local distribution grid. Appendix E contains a short history of this cooperative as it must have been one of the longest surviving cooperatives: We cannot be sure it was the last operational electrification cooperative as we do not have dissolution dates for most cooperatives. We do know only 11 cooperatives/private companies were still in charge of municipal energy provision by 1949 [38]).

Thus, the cooperative electrification niche in the Netherlands was not a homogenous part of the wider electrification niche. Motivations to form a cooperative differed from early enthusiasm, to a wish to be connected sooner than the regional grid would reach the locality, and guaranteeing minimal demand to be connected to the provincial grid. Furthermore, the cooperative electrification niche also developed very heterogeneously in terms of temporal and geographical patterns depending on a combination of, amongst others, local enthusiasm for electricity, pre-existing local collective action capacity, regional familiarity with the cooperative model, demand for electricity (based on socio-economic status of residents as well as the presence of electrifiable economic activities), presence of a competing gas factory, interest of the respective provincial governments to become involved in electricity production, direction and pace of first municipal and later provincial grid extension.

5.6. Conclusions and discussion

The electrification cooperatives were central actors within the electrification niche during its development to regime. We analysed how their emergence and decline was related to the dynamics in the forming proto-regime regarding rules, actor constellations and technologies. We focused on the time period 1900-50 as during this period electricity technology evolved from newly commercially available to matured and well-embedded in an own regime within the energy sector. Here we conclude on how the cooperative electrification niche developed and how it disappeared, as well as its role during the Dutch electrification. Furthermore, we reflect on the theoretical implications of the study for the MLP literature.

5.6.1. Emergence and decline of electrification cooperatives

Among the 83 energy cooperatives founded between 1905 and 1929, we found distribution cooperatives and integrated production and distribution cooperatives. The cooperatives were established by the societal upper and middle class. The distribution only cooperatives were often founded by more diverse groups of villagers, also including gardeners and workers, as they needed to guarantee a certain use from the start.

Large regional diversity existed in the cooperative electrification niche as the cooperatives predominantly emerged in the northern provinces Friesland and Drenthe. In the other provinces, early electrification was mainly carried out in this period by the municipalities or, in a few instances, by other private companies. From about 1914 onward, the Provinces or provincially-owned companies were increasingly in the lead.

The emergence of the cooperatives in Friesland took off rather early in the electrification of the Netherlands in a regulatory vacuum. From 1910-1916, only the permission of the municipal government was required for a permit. Cooperative electricity was orchestrated by villagers used to undertake collective action in the province's remote rural communities. Many of early electrifying villages did not have a private or municipal gas factory yet, and therefore, were not inhibited by competition restriction clauses or the threat of municipal income loss. The cooperatives founded after 1916 were mainly distribution cooperatives that formed to guarantee enough demand to connect these localities to the expanding provincial grid. In Drenthe, cooperative energy development was a way to realise electrification despite a lack of initiative of local and provincial governments, and the slow connection to the regional grids of the neighbouring provinces. Initiative took mainly place in the wealthy peat extraction area. Farmers in this area had a history with cooperative enterprising in the agricultural sector, and were able to collectively secure loans for significant factories processing agricultural produce. The familiarity with the cooperative model in agriculture in both provinces will have made the step to cooperative electricity smaller.

The electrification cooperatives started to disappear when the advantages of upscaling became larger and the regulation put the mandate for energy provision with the provincial government. By about 1914, production by larger energy plants became more economical and reliable due to technological development of electricity technology[35]. Due to the exclusive right of provision the provinces got via national government concessions, it was impossible for the electrification cooperatives to remain competitive by upscaling their production capacity and supply beyond their own municipality. Hence, when their permits ended, or earlier,

they stopped their activities and sold or handed over their infrastructures to a provincial company. Some still functioned as a distribution cooperative for a period of time before being dissolved, and could negotiate better tariffs due to their own grid. By the 1930s, nearly all energy cooperatives had ended their operations for these reasons[38]. The cooperative in Dalen was one of the exceptions that remained operational for a longer time, and functioned as distribution cooperative until 1959 and profited of the economic advantages of owning the local distribution grid.

5.6.2. Role of energy cooperatives during the electrification

The electrification cooperatives mainly played a role in the dispersion of electricity systems during the development of commercially usable electricity from a niche market to a more stabilized regime with wider networks, more regulation and matured technologies. In Friesland, the pioneering energy cooperatives from before 1916 enabled rather early accessibility of electricity for small villages. The later Frisian distribution cooperatives functioned to shift risk of installation and operation of a distribution grid to the users by requiring minimum use. The cooperatives in Drenthe also helped the dispersion of electricity within this rural area, and resulted in earlier provision of electricity than if had been waited for grid extension of the regional grid from the neighbouring provinces.

Whereas these cooperatives were not involved in technological advancement of the technologies, they were very much experimenting with the domestication, the embedding of this new source of energy in the daily life. Electricity changed many existing production and household routines, and enabled many new practices for its users who previously used petroleum, candles or gas. For instance, time was saved to light a lamp, less frequent cleaning was needed, and household activities such as ironing became simpler. On the other hand, reliability of provision was not always high, availability of electricity especially in the evening limited, so limiting use was highly encouraged and sometimes some applications were even forbidden during certain hours. Furthermore, like with other energy sources electricity needed to be handled safely and also new practices for this needed to be developed by its users.

Thus, the electrification cooperatives mainly helped the dispersion of electricity technology, improved the accessibility of electricity in rural areas, and helped the familiarization with this new energy source.

5.6.3. Theoretical contribution and reflection on proto-regime concept

From our study, we can conclude that niches can function as heterogeneous innovation environments where the development, diffusion and embedding of niche technologies can take place by different actors, at different paces, and in different ways across different localities.

The concept proto-regime that we operationalised as consisting of the three interlinked elements rules, actors and technologies was useful to study the development of electricity from niche market to a regime. It showed how the niche for electrification was characterised by a lack of regulations that provided institutional space, technologies that were suitable for the local level without potential for economies of scale. Resultantly, actors were at first local players such as the cooperatives, and private and municipal companies. By mapping out the development of the proto-regime it became apparent why the number of electrification cooperatives began to decrease. Mapping showed how due to the provincial concession system that was enshrined in national legislation the provinces became the designated actor for energy provision. Also, the rapid technological developments made it difficult for energy cooperatives to remain competitive as production at a larger scale started to equal lower energy prices. Hence with this operationalisation, the proto-regime concept is useful to explain the emergence, development and decline of niche phenomena.

When reflecting on the development of the cooperative electrification niche in relation to proto-regime development as described by Smith et al. in figure 5.2[28], we can furthermore conclude that the electrification cooperatives played an important part in the first two steps: the start of experimentation by the regime and landscape and local experimentation supported by local networks. However, when local lessons got translated into generic rules, these rules did soon not favour small-scale systems anymore but stimulated provincially sized companies and centralized production. So, when these newly developed rules such as the provincial concession system informed new experiments, the niche developed in another direction, leading to the downturn of cooperatives.

An important theoretical insight that can be derived from this observation is that local experimentation energy cooperatives still played an important role in the historical energy transition towards electricity. Hence, without becoming a dominant player in the regime, energy cooperatives can still have a transformative role in an energy transition. As aforementioned, the electrification cooperatives did not only inform learning in the proto-regime as experiments,

but, thereby, also improved the accessibility in rural areas of an innovation that not only literally but also figuratively lightened the work.

Appendix D. Overview of electrification cooperatives

Table D1 presents an overview of the year of foundation, location, province, and activities of the identified Dutch electrification cooperatives.

Table D1: Overview of electrification cooperatives

#	Year	Name	Location	Province	Activity (generation/ distribution /unknown)
1	1911	Coöp. ver., „Electr. Centr. Beilen”	Beilen	Drenthe	G
2	1911	Coöp. Ver. Electr. Centr. Dalen	Dalen	Drenthe	G
3	1914	Coöp. Ver. voor Electr. Centr. Verl. van het dorp Emmen en omgeving	Emmen	Drenthe	G
4	1916	Coöp. Ver. Electra te Emmercompascuum	Emmer-Compascuum	Drenthe	G
5	1917	Coöp. ver. Electr. Centrale Sleen	Sleen	Drenthe	G
6	1918	Coöp. Electrische Centrale	Borger	Drenthe	D
7	1918	Coöperatieve Vereniging Electrische Centrale voor Klazienaveen en Omstreken	Klazienaveen	Drenthe	G
8	1918	Coöp. Ver. voor Electr. Centrale verlichting van de omgeving derde Kruismond Nieuw-Weerdinge	Nieuw-Weerdinge	Drenthe	G
9	1918	Coöp. Ver. Electr. Centrale “Noordbarge”	Noordbarge	Drenthe	G
10	1918	Coöp. Ver. Electrisch Licht gem. Norg	Norg	Drenthe	G
11	1918	Coöp. Electrische Centrale Odoorn	Odoorn	Drenthe	G
12	1918	Coöp. Vereeniging ,,Electrisehe Centrale Oosterhesselen”	Oosterhesselen	Drenthe	G
13	1918	Cooperatieve electrische centrale voor de gemeente Schoonebeek	Schoonebeek	Drenthe	G
14	1918	Coöp. Electr. Centrale Valthe	Valthe	Drenthe	G
15	1918	Coöperatieve Vereniging Electrische Centrale te Valthermond en omstreken	Valthermond	Drenthe	G
16	1918	Coöp. ver. Electr. centrale Weerdinge	Weerdinge	Drenthe	G
17	1918	Coöp. Ver. voor Electrische Centrale verlichting ,,De Eersteling’” van het dorp Weerdingerveen	Weerdingerveen	Drenthe	G
18	1918	Coöp. Ver. Electr. Centrale Westerbork	Westerbork	Drenthe	D
19	1919	Coöperatieve vereniging electrische centrale Koekange	Koekange	Drenthe	G
20	1919	Coöp. Ver. Electrisch Licht gem. Smilde	Smilde	Drenthe	G
21	1920	Coöp. Ver. „Electrische Centrale Nieuw-Weerdinge Een”	Nieuw-Weerdinge	Drenthe	G
22	1920	Coöp. Ver. voor Electrische Centrale Verlichting Van het dorp Westenesch	Westenesch	Drenthe	G

#	Year	Name	Location	Province	Activity (generation/ distribution /unknown)
23	1921	Coöp. Ver. Electr. Centrale „Eerste Kruisdiep en Omgeving" te Nieuw-Weerdinge	Nieuw-Weerdinge	Drenthe	G
24	1918	Coöp. Ver. voor Electr. Centrale Verlichting van het dorp Roswinkel	Roswinkel	Drenthe	G
25	1918	Coöp. Ver. Electrische Centrale Wachtum W.A.	Wachtum	Drenthe	G
26	1929	Coöp. Electriciteits-Maatsch. „Dalerveen en Omstreken" G. A.	Dalerveen	Drenthe	D
27	1910	Coöp. Ver. voor Electr. Centr. Verlichting	Kimswerd	Friesland	G
28	1910	Coöp. Ver. voor Electr. Centr. Verlichting	Makkum	Friesland	G
29	1911	Coöp. Ver. voor Electr. Centr. Verlichting	Kollum	Friesland	G
30	1911	De Coöp. Electrische Centrale „Bergum"	Bergum	Friesland	G
31	1911	Coöp. ver. voor electrische centrale verlichting „Witmarsum Pingjum Arum"	Witmarsum	Friesland	G
32	1911	Coöp. Ver. voor Electr. Centr. Verlichting	Luinjeberd	Friesland	G
33	1911	Coöp. ver. voor electr. verl. te Ee en Engwierum en omstreken	Ee	Friesland	G
34	1911	Electra, coöp. ver. tot levering en gebruik van electr. stroom	Rauwerd	Friesland	G
35	1912	Coöp. zuivelfabriek	Langweer	Friesland	G
36	1912	Coöp. Ver. voor electr. verlichting, te Kollumerpomp, Warfstermolen, Burum, Munnekezijl en omstr.	Kollumerpomp	Friesland	D
37	1912	Coöp. Ver. ,,het Noorderlicht"	Oudebildtzijl	Friesland	D
38	1912	Coöp. Vereeniging ,,Electra"	Ijlst	Friesland	?
39	1912	Coöp. Electrische centrale Woudsend	Woudsend	Friesland	G
40	1913	Coöp. ver. voor het leveren van Electr. stroom voor verlichting en voor krachtwerktuigen in het dorp Heeg	Heeg	Friesland	G
41	1913	Coöp. Ver. voor Electr. Centr. Verlichting	Boornbergum	Friesland	G
42	1913	Coöp. electr. centr. Oosterwolde	Oosterwolde	Friesland	G
43	1913	Coöp. Ver. voor Electr. Centr. Verlichting de drie dorpen	Terwispel	Friesland	G
44	1914	Coöp. Ver. voor Electr. Verlichting te Buitenpost, Twijzel, Kooten en omstr.	Buitenpost	Friesland	D
45	1914	Coöp. Ver. ,,Electra" ter verkrijging en verdere expl. van electr. stroom	Scharsterbrug onder Nijega	Friesland	D
46	1918	Coöp. ver. tot expl. van Electriciteitsvoorz.	Oosterlittens	Friesland	G
47	1918	Coöp. ver. voor Electrische Verlichting Tzum	Tzum	Friesland	D
48	1918	Coöp. ver. voor electrische verlichting te Anjum en omstr.	Anjum	Friesland	D
49	1918	De Coöp. werkende Ver. tot levering van Electriciteit	Koudum	Friesland	G

#	Year	Name	Location	Province	Activity (generation/ distribution /unknown)
50	1919	Coöperatieve Vereniging tot Electrische Verlichting te Ameland	Nes	Friesland	G
51	1921	Coöp. Ver. ,,Electra"	Barradeel	Friesland	D
52	1923	Coöp. Ver. voor Electriciteitsvoorziening van het dorp Oldeberkoop en omgeving	Oldeberkoop	Friesland	D
53	1923	Coöp. Ver. voor de Electriciteitsvoorziening in den Kring Oranjewoud	Oranjewoud	Friesland	D
54	1924	Coöp. Ver. voor de Electriciteitsvoorziening te Beneden- en Bovenknijpe en 't Meer	De Knijpe	Friesland	D
55	1924	De Coöp. Electrieiteitsvoorziening in het dorp Akkrum	Akkrum	Friesland	D
56	1925	De coöperatief werkende vereeniging. Licht en Kracht, W.A.	Hemelum	Friesland	D
57	1918	Coöp. Ver. Electriciteitsvoorziening	Oldebroek	Gelderland	G
58	1905	Coöp. verlichtingsfabriek, Helpman	Haren	Groningen	G
59	1914	Electr. Centrale Ter Apel	Ter Apel	Groningen	G
60	1918	Cooperatieve vereeniging electrische centrale Barnflair	Barnflair	Groningen	G
61	1918	De coöp. ver. voor electrische centrale verlichting	Holwierde	Groningen	D
62	1918	Coöp. Ver. Electrische Centrale Vlagtwedde	Vlagtwedde	Groningen	G
63	1919	Coöp. Electr. Distributie Centrale	Baarlo	Limburg	D
64	1919	Coöp. Ver. Electrisch licht	Roggel	Limburg	G
65	1918	Coöp. Electrische Centrale	Baarle	Noord-Brabant	G
66	1918	Coöp. Electr. Noodverlichting	Drimmelen	Noord-Brabant	G
67	1918	Coöp. Ver. tot verschaffing van electrisch licht te Wouw	Wouw	Noord-Brabant	G
68	1920	Coöp. Ver. tot verschaffing van electr. licht	Chaam	Noord-Brabant	?
69	1922	Coöp. Electrische Stroomvoorziening	Zevenbergschenhoek	Noord-Brabant	D
70	1927	Coöp. Ver. tot Electrificatie van Den Hout (G. A.)	Den Hout	Noord-Brabant	?
71	1917	,,Electra", Coöp. ver. ter voorziening in de electrische verlichting van Edam	Edam	Noord-Holland	D
72	1918	Coöperatieve Vereniging Electrische Centrale Verlichting	Oosterend	Friesland	G
73	1918	Coöp. Ver. tot stichting en instandh. eener Electr. Centrale te Hippolytushoef op Wieringen	Wieringen	Noord-Holland	G
74	1918	Coöp.Ver.voorelectrischeverlichting	Ambt-Vollenhove	Overijssel	G
75	1919	Coöp. Ver. Electriciteitsbedrijf	Tubbergen	Overijssel	D
76	1924	Coöp. Electriciteits-Onderneming „Gramsbergen en Omstreken"	Gramsbergen	Overijssel	D
77	1918	Coöp. ver. „Electra" voor Kockengen en Laag-nieuwkoop	Kockengen	Utrecht	D

#	Year	Name	Location	Province	Activity (generation/ distribution /unknown)
78	1918	Coöp. Ver. voor Electr. Centrale Verlichting te Nieuwedorp en omgeving	Nieuwedorp	Zeeland	G
79	1918	Coöp. Electriciteits-Bedrijf voor Kapelle	Kapelle	Zeeland	?
80	1918	Coöp. Electriciteeitsmaatsch. Scherpenisse	Scherpenisse	Zeeland	G
81	1918	Coöperatieve Electriciteits Maatschappij	Sint Maartensdijk	Zeeland	G
82	1918	Coöp. Electriciteitsmaatsch. St.-Pliilipsland	Sint-Philipsland	Zeeland	G
83	1926	Coöp.Electrische Centrale W.A	Stellendam	Zuid-Holland	G

Appendix E. Two detailed examples of electrification cooperatives

In this appendix, we provide a detailed description of the development of two forerunners from our sample of cooperatives on which detailed information is available. By providing short histories of these cases, we would like to provide a better understanding of the functioning of the Dutch electrification cooperatives. The first case is the earliest electrification cooperative located in Helpman, and the second one of the longest operational cooperatives located in Dalen.

1. A risky novel product: Cooperative lighting factory Helpman

The first electrification cooperative "lighting factory Helpman" is an example from the early stage of electrification when electricity was still a high-cost and rather unreliable good, because the electricity technology was still in its infancy. Yet, at the same time, electricity had already acquired the status of a luxury good. It was perceived as a beacon of progress and modernity, because it was cleaner and safer than petroleum and candle lighting which were more common at the time.

The cooperative lighting factory Helpman was established on the 21st of April 1905 [48]. The initiative was founded because the municipality energy company of Groningen (the province of Groningen's eponymous capital) did not want to supply energy to Helpman, fearing that it would encourage commuting [42]. The initiators of the cooperative were Jan Evert Scholten, owner of the agro-industrial Scholten-group, and Willem Albert Penaat, chief executive officer of the Sikkens paint factory. Their ambition was to electrify 1000 villas and houses of the bourgeois in Helpman, among which the houses of the initiators themselves. Hence, the target group were the most affluent residents of Helpman, at the time part of the village Haren. Friends and business acquaintances of the initiators were enthused to buy shares of 100 f, which translates to about €1.267,84[3] [48].

They requested a building permit at municipality of Haren to build an electricity plant nearby in the Emmastraat [48]. A complaint was filed by a resident living nearby, because the plant would disturb the peace in the neighbourhood and might increase the chance of lightning strikes. The labour inspection declared the complaint ungrounded, and the municipal government provided a concession for electricity supply for 10 years.

The total of the starting costs for the electricity plant were f 42.000,-, or about € 532.

493,74 euro [48]. With this capital, two piston engines of 28 HP were bought to power two Swiss generators with a joint capacity of 54 kWh. Furthermore, a room with accumulators and a dynamo for storage of the electricity was built.

In 1906, supply started to many of the monumental villas and an inn, which together represented 55 connections [48]. The electricity net then had a length of about 1200 m, and could hardly be extended because the concession specified that the voltage could not be higher than 110V. At 110V thicker cables are necessary to avoid energy loss, which is expensive.

The supply was not that reliable, and especially in the winter months, the users were regularly left in the dark, and needed to return to candle and petroleum lighting. Thus, many users who needed a new connection turned to the municipal electricity company of Groningen when it became possible, because the municipal electricity company had a higher performance reliability[48].

Not only did the cooperative lighting factory have a competitor early on, but it faced other obstacles as well [48]. Due to the rapid developments in the field of electricity technology, the factory soon got outdated. Furthermore, it could not compete with the municipal, and from 1914 also the provincial, electricity company. Finally, in 1915 Helpman had become part of the municipality of Groningen, and the chance of renewal of the concession was therefore very low.

All these factors led to the decision to sell the grid and the then 68 connections, meters, and street lighting to the Groningen municipal electricity company for f 10.000,- [48]. A share in the electricity cooperative was by then worth only f 17,50,, in contrast to the f 100,- at its start. After the public sales of the factory in café-restaurant De Passage, the machines and the inventory, the shareholders celebrated that a part of the industrial revolution had become history over a festive meal.

2. A rural location: Cooperative association electric plant “Dalen”

The cooperative association electric plant “Dalen” (in Dutch: Cooperatieve vereniging electrische centrale “Dalen” W.A.) is an example of a cooperative that was established in a locality that was deemed too unprofitable for private investors. Dalen was at the time a small, agricultural village (3900 inhabitants in 1925[49]).

The cooperative association electric plant “Dalen” was established on the 9th of August 1911[44]. According to its statutes, the aim of the cooperative was realising lighting

in- and outside the house, and supplying electricity to power units in the village of Dalen. It had permission to function for 30 years, to be extended if desired by the cooperative[44].

The cooperative association in Dalen had been founded by its first board that consisted of an alderman of the municipality, the director of the local, cooperative dairy factory, a farmer, a baker/shop holder, and a carpenter/contractor, who was also electrician and installer. At its start it had 41 members, who were mostly local shop holders and craftsmen [50].

The electricity was generated in the engine room of the local diary factory. The already present steam engine powered a dynamo. Furthermore, there was an accumulator to store energy for night-time use. To distribute the energy, the cooperative constructed an above-ground grid, for which a permit was granted by the ministry of Water management. Furthermore, the cooperative was responsible for installing the meters and checking the usage, but the infrastructure at the properties of the users such as power lines came at the users' expense. The infrastructure the cooperative owned was financed through a loan of f 18.000 [50].

The opening of the plant took place on the 22th of December 1911 in a hotel with a festive, yet modest celebration with the mayor and the city council, the minister of the church, and the board of the steam diary factory. After this, the electric street lights were put on and the board of the cooperative went around in the village and destroyed the old petroleum lights with stones [50].

Over the years the number of members grew steadily. An annual report describes how after 20 years the cooperative had 263 members to whom it supplied electricity for light, and 7 users to which it supplied power for electrified production processes (such as threshing, baking, and forging)[51].

To reduce the cost of the electricity and make it possible to extend the grid, several technological improvements were implemented [50]. To improve the ratio coal used to energy generated, the chimney of the factory was enlarged. In 1918, the voltage was increased to 220V, which enabled grid extension at a lower price because less cables with a smaller diameter could be used for transmission. In the same year, a switch was made to a gas-fed piston engine, because the price of coal increased and thereby the electricity price. In 1923, the accumulator-battery was replaced.

In the 1920s, there had been several discussions with the large plant IJsselcentrale in the neighbouring province Overijssel to buy their electricity instead of keeping generation in their own hands [50]. The advantages of this would be better light and more reliable provision

of three-phase electric power. The costs of the extension of the cable needed to be borne by the cooperative, so the cooperative considered it more attractive to continue generating. However, at the end of the 1920s, due to the bad condition of the battery which would require costly repairs, moving generation to the IJsselcentrale was reconsidered. In 1930, the members of the cooperative voted to buy electricity from the IJsselcentrale and pay the estimated costs for the required grid extension and infrastructural adjustments of f 21.000,-. This was also the moment that the switch to alternating current was made.

The cooperative was from then on solely a distribution cooperative. The transition had been successful and Dalen had an exceptionally low electricity tariff for that time. For instance, light was 25ct per kWh, threshing power 8ct per kWh, and power for the diary factory 5ct per kWh [50].

The cooperative led a quiet life, and only returned to generating electricity for a few months during the second world war [50]. At this time, the transmission losses were very high due to the copper action of the occupier[4]. However, after the war, the cooperative prospered again. It was fully debt-free in 1948 and could extend the grid a few times in the next years.

However, in 1949 disagreement with the municipality arose over the distribution of the costs for a grid extension outside the village [50]. The municipality did not want to pay for the cables and the cooperative appealed to the terms in the concession that did not specify that the municipality could dictate extension. The municipality wanted to solve the problem by selling the distribution grid to the IJsselcentrale.

It became a long-winded affair that was resolved only by the end of 1959 by the sale of the grid and further infrastructure to the IJsselcentrale [50]. In line with the statutes, the profit of the sale was distributed equally among the members. After 48 years, the cooperative the distribution of electricity by the cooperative to its members ended on the 31st of December 1959 by midnight.

[4] During World War II, the German occupier confiscated metal objects for production of weaponry.

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