Tangled transitions: exploring the emergence of local electricity exchange in France, Switzerland and Great Britain

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Tangled transitions: Exploring the emergence of local electricity exchange in France, Switzerland and Great Britain

Abstract: Local electricity exchange is often praised for its ability to empower consumers and benefit communities. In this paper, we investigate and compare the development of local electricity exchange practices in three European countries: France, Switzerland, and Great Britain. We ask: how do local electricity exchange practices and markets vary across national contexts? What are their dynamics of ownership and consolidation, if any? What areas of contestation or disagreement emerge? To answer these questions, we first define and conceptualize local electricity exchange and its categories before explicating our mixed methods research design consisting of document analysis, 40 original expert interviews, and observational data. The comparative cases reveal that (i) approaches to local electricity exchange vary considerably across national contexts and are strongly linked with institutional frameworks and policy regimes; (ii) local electricity exchange has as much potential to cement conventional actors and power relations in the sector as it does to support new actors or transform power relations; and (iii) the future merits of local electricity exchange are prone to great uncertainty and contestation.

Keywords: local electricity exchange; peer-to-peer electricity trading; collective self-consumption; community energy; energy democracy
1. Introduction

Major trends associated with digitization, decentralization, decarbonization and democratization are being portended by many as revolutionizing the energy and electricity sectors. The consulting firm Ernst & Young (2019) recently proclaimed that “digitization and decentralization are accelerating the countdown to a new energy world faster than expected.” The International Renewable Energy Agency echoed this sentiment when they noted that “A digitalized, decentralized future is around the corner” (IRENA, 2018). Another industry group (Grid Beyond, 2019) exclaimed that “decarbonization, decentralization and digitalization are the pillars to creating the green energy economy of the future.” A related notion of energy democracy has emerged and solidified into a global social movement prioritizing the potential of redistributing power and energy production to the people through renewable energy (Stephens, 2019; Szulecki and Overland, 2020). Some scholars even purport that such trends in decentralization could be central to development in regions across the globe where energy poverty is a primary challenge, as is the case in large parts of Sub-Saharan Africa (Zalengera et al., 2020), and could be critical to new modes of energy governance (Brisbois, 2020).

These statements and actions all inherently presume that decentralization and digitization empower consumers and benefit communities. But how have they been occurring in practice? In this paper, we ask: how do local electricity exchange practices and markets vary across national contexts? What are their dynamics of ownership and consolidation, if any? What areas of contestation or disagreement emerge? To answer these questions, we investigate the development of local electricity exchange (LEE) in three European countries. Our sociotechnical approach (Hess and Sovacool, 2020; Sovacool et al., 2020) investigates not only technologies and policies but also discourses and consumer activities derived from the production, consumption, distribution and trading of renewable energy locally. The local electricity exchange concept is particularly interesting from a sociotechnical angle because it intersects with three compelling dynamics: ongoing digitization of energy infrastructure, emerging business models around revenue sharing and trading, and interest in regaining control and community ownership coupled with shifts towards localism and self-sufficiency.

We study this phenomenon in France, Switzerland and Great Britain.¹ In doing so the study discusses different forms of LEE and offers insights into not only changes around practices of renewable energy production and consumption but also changing roles and power shifts, consumer and community involvement, and evolving energy markets instigated by energy transitions, decarbonization and decentralization of the energy system. An exploration of LEE captures innovative approaches that aim to match local renewable energy generation with local consumption resulting in new business models and new forms of collaborations that also allow engaging citizens in energy transitions. Moreover, an additional novelty to our study is that it investigates current practices (not only pilot projects or emerging concepts) in different countries and critically discusses what these various forms of LEE mean, what change they bring, and what they reinforce.

¹ In this paper we discuss Great Britain (England, Wales and Scotland) rather than the UK. This is due to the framework for electricity grid in the country. The term ‘UK’ is still used in the paper where applicable, e.g. for discussion of policy-related issues and electricity market trends.
There are obvious overlaps and similarities between LEE and other concepts in the literature such as community energy, local energy, prosuming, distributed generation, peer-to-peer trading and sharing economy more broadly. This literature helps explaining particular forms and elements of LEE as However, we see LEE as a distinct concept, and our focus on LEE allows taking a dispassionately positioned stand to critically discuss the impact of various forms of LEE that have elements of community energy, local energy, or P2P trading, and might have different value propositions.

One of the core themes we explore in our paper are controversies related to local electricity exchange. Controversies and social opposition to low-carbon transitions generally can occur because local groups perceive a form of renewable or community energy as unfair or unjust (Pesch et al. 2017). Local actors may contest the sustainability of some options, even renewable options that may not be truly renewable or sustainable, e.g. due to impacts on water, land, non-human life, etc. (Behrsin 2020). The disputes can affect local actors but also cascade into larger national and even regional controversies, at times amplified by social media (Borch et al. 2020). Cuppen et al. (2020) even note that controversies can serve instrumental ends in allowing civil society, community, or political groups to strategically control national agendas; Jørgensen et al. (2017) write about how controversies can create “arenas” where important debates about energy can occur that challenge dominant sociotechnical systems. But in the context of local electricity exchange, studies actively examining existing or potential controversies are rare. Notable exceptions are Pressmair et al.’s (2021) examination of controversies about the definition of local scope for local electricity markets and possible market operators, or Murillo et al.’s (2017) critique of the sharing economy leading to suboptimal outcomes on markets, governments, workers, consumers, and the environment. But deeper, more systematic, comparative assessments do not yet exist.

We proceed as follows. We first define and conceptualize LEE and main archetypes positioning the phenomenon in relation to related concepts and recent literature before explicating our mixed methods research design consisting of document analysis, 40 original expert interviews, and observational data from seven meetings and events. The empirical observations stemming from the three countries reveal the complexity and variation of LEE practices and markets and related policy/regulation frameworks across our three national contexts, how such acts of decentralization in turn (and perhaps unpredictably) consolidate power among incumbent actors, and how these are prone to significant contestation and disagreement.

2. Conceptualizing local electricity exchange and reviewing the recent literature

As this section illustrates, LEE is an adaptive, exciting area of energy policy and an activity that involves multi-actor collectives that experiment with and implement novel financial, institutional, technical (digital) and business model innovations to enable grid-connected local/regional renewable energy exchange, which includes production, consumption, distribution and sometimes trading of energy. The aims of initiatives and other activities related to LEE are often to achieve a greater penetration of renewable energy into current energy systems, to reform an electricity market, which has been a field often monopolized by big industry players, and to empower local actors to influence energy decisions and benefit from positive externalities. Although the very concept of local energy (local generation/supply/consumption) is not new, the interest in LEE has
been growing in recent years in the context of decentralization, digitization and decarbonization trends. As a result, new propositions for local/regional production, distribution and trading of electricity are being discussed, tested and in some cases implemented, involving both, traditional energy players (e.g. Distribution Network Operators (DNOs) or Distribution System Operators (DSOs), energy suppliers) and newcomers (e.g. technology companies – providers of digital platforms, prosumers).

Our focus on local electricity exchange sits within a growing body of evidence discussing the merits, risks and drawbacks of community energy, prosuming, local energy, distributed generation, microgrids, and peer-to-peer trading. Given that almost all of these phenomenon are very recent trends, literature on them is still emergent. Nevertheless, some core characteristics and trends are evident, and we would like to point to their relevance to LEE.

The most relevant concepts that represent two modes of implementing decentralized energy are local energy and community energy. While the term “local” is frequently used by energy actors, the concept of “local” is ambiguous and there is no universally accepted definition of local energy. Behind the term “local” there is a notion of geographical location and scale as local refers to arrangements that operate at a scale smaller than the traditional centralized models. However, different actors in the energy sector interpret what makes energy “local” differently. As explained by Open Utility/Piclo, a provider of digital services for electricity retail, “to some people, local means their neighborhood, village, town or county. To the energy industry, it can mean the distance from the generation site or connections on the same network” (Open Utility, 2016). “Local” is also used in relation to energy activities that set out to maximize social benefits in a specific geographical area or community. As such, there are overlaps between “local energy” and “community energy” (Ofgem, 2017; Vernay and Sebi, 2020; Devine-Wright, 2019).

According to the guide produced by Department for Business, Energy & Industrial Strategy (2013/2015), community energy ‘covers aspects of collective action to reduce, purchase, manage and generate energy.’ It also describes community energy projects as having ‘an emphasis on local engagement, local leadership and control and the local community benefiting collectively from the outcomes.’ In literature community energy is seen as a rather ambiguous concept. It can range from ‘strong’ to ‘weak’, e.g. involve bottom-up energy initiatives with strong citizen participation, local ownership and collective benefit sharing, but also decentralized energy provision with relatively little public participation or sharing of benefit with local residents (Devine-Wright, 2019). One can also find two common types: ‘communities of place’ (based on geographical/locality principle) and ‘communities of interest’ (formed around particular project/activity and not necessarily of local residents). Energy communities can also be “single-purpose” (i.e. take shape solely for energy purposes) and “multi-purpose” communities (with a range of objectives including goals encompassing shared management of energy systems) (Moroni et al., 2019).

Devine-Wright (2019) aptly notes that community energy and local energy are not always the same, although they represent two modes of implementing decentralized energy with a focus on place-based system of provisions. As Table 1 overviews, community energy may focus more on individuals and households, with communities of locality and interest, with multiple and at times disparate goals. Local energy by contrast may focus more on institutions and public private
partnerships, with networks of organizations that span spatial scales, with economic growth as a prime objective.

Table 1: Differentiating community energy from local energy

<table>
<thead>
<tr>
<th>Participating actors</th>
<th>Community energy</th>
<th>Local energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals acting collectively, encompassing voluntary actions and financial participation through shareholding</td>
<td>Institutions working in partnership across sectors, with a strong focus on private investment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Positioning of individuals</th>
<th>Community energy</th>
<th>Local energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active citizens led by a range of motivations including social, environmental and economic issues</td>
<td>Active consumers or prosumers of energy technologies, products or services that aim to maximize personal utility and choice</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spatial focus</th>
<th>Community energy</th>
<th>Local energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predominantly communities of locality, yet also communities of interest</td>
<td>Networks of organizations spanning local and non-local areas</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goals</th>
<th>Community energy</th>
<th>Local energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple, including addressing local social, economic and environmental needs as well as contributing to broader environmental challenges</td>
<td>Economic growth and prosperity, specifically job creation and skills training, delivered by investments in ‘clean’ energy systems and technologies</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Orientation to change</th>
<th>Community energy</th>
<th>Local energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predominantly a local focus to address specific needs and requirements</td>
<td>Predominantly identifying locally beneficial solutions that are replicable elsewhere</td>
<td></td>
</tr>
</tbody>
</table>

Source: Devine-Wright (2019).

Connections within the literature sometimes occur between community energy or local energy and more distributed forms of generation such as microgrids. A microgrid can be used for e.g. a multiple occupancy buildings or housing estates. It is consistent in the literature that this usually occurs ‘behind an electricity meter’ (by shifting the Meter Point Administration Number to the
perimeter of the site), so the actual low voltage physical infrastructure is owned privately by a local private network operator (could be community owned), therefore no distribution network operator’s responsibility; may also form a virtual energy company, responsible for billing customers for the energy they consume within the private network (Hall et al., 2020). The microgrid model is ‘less regulatory oversight’; although many early microgrids were ‘islanded’ (e.g. as a solution for remote areas), now these models usually have a grid connection (Brown et al., 2020), e.g. residents get their energy from on-site generation, topping up from the grid when needed, and exporting any excess energy back to the grid. Microgrids are still seen as a viable model to enable generation and self-consumption of community owned renewable energy, particularly in combination with other elements of energy system, e.g. energy efficiency measures, heat pumps, and energy storage, e.g. for new housing developments where the provisions for a private network can be incorporated into the project.

The majority of community energy, local energy, and microgrid schemes exist on public networks and therefore have to use an intermediary – a licensed electricity supplier to make payments on both generation and export from eligible installations. One of the options for a community renewable organization is to become an energy supplier (a local area can create its own supply company and they can either be licensed or exempt i.e. does not have to abide by the balancing and settlement codes). The established models of community renewable energy generation, distribution and (shared) consumption, particularly microgrids, can be seen as a form of local electricity exchange rooted in prosumer business models. However, they are often very limited in terms of electricity exchange and actual transactions between residents (and use of market mechanisms).

Two other concepts relevant to LEE – prosuming and peer-to-peer trading – imply more active citizens’ engagement. They refer to when households or citizens more actively generate either own sources of energy and potentially trade it, rather than merely consume it. In peer-to-peer (P2P) electricity trading, two equal market participants, in most cases prosumers, execute a bilateral contract for the trade of household electricity (van Soest, 2018). P2P schemes are often framed in the literature as a pathway to consumer empowerment, especially when households trade electricity with each other rather than with a distant utility. Pumphrey et al. (2020) evaluated several trials of P2P trading and found that while it holds significant promise, interviews with users revealed some barriers, including lack of engagement with the process of receiving energy and high perceived costs. Pena-Bello et al. (2021) suggest that enabling energy trading for prosumers can lead to higher community autarky compared with when they merely aim to maximize their self-consumption. Among benefits of P2P energy trading based on human decision-making are potential financial benefits and reduced stress for the grid (ibid.).

Prosuming and P2P trading can often be coupled to other innovations, including demand response (shifting demand to accrue utility-scale or community benefits), rooftop solar PV (which can generate electricity used to be graded), or energy storage via batteries (which can store surplus energy and sell it back to the grid at more attractive times) (Parrish et al. 2020). Such couplings can complicate the value proposition and business model environment for P2P trading and local electricity as well, creating savings based or revenue based business models and also operating at the scale of households or also community groups and utilities (Karneyeva et al., 2017). For these and other reasons, Judson et al. (2020) argue that local electricity exchange and decentralization
can shape not only new technology trends across households and energy suppliers, but also broader governance mechanisms, institutional dynamics, and even forms of control and social power.

In this study we adopted a view on LEE as activities that aim to match local renewable energy generation and/or supply with local consumption (i.e. electricity is used close to its point of generation) in form of electricity sharing or trading between actors involved. Our inherently sociotechnical lens goes beyond contract/financial exchange between participants and can also mean practices of asset use optimization e.g. like in collective self-consumption. We specifically focus on the approaches that stipulate a connection to the national grid (i.e. excluding isolated ‘islanded’ projects) and concern first and foremost domestic users.

In our study, projects labelled as LEE exhibit a diverse range of characteristics. Based on the aforementioned definition and empirical observations, here we explore the models that fall into one of the three broad categories: local electricity supply, collective or shared self-consumption, and transactive energy markets.²

| Table 2: Three categories of local electricity exchange (modified from Ofgem (2017)) |
|---------------------------------|---------------------------------|---------------------------------|
| Category                        | Description                                  | Value proposition                                   |
| Local electricity supply         | Aimed at supplying customers, e.g. local communities, with locally generated renewable energy. Achieved through Power Purchase Agreements (PPAs) ³ | Local consumers benefit from locally generated ‘green’ electricity. |
| Collective/shared/community self-consumption | Aimed at facilitating collective production and (self)-consumption of renewable electricity, based on prosumer model. ⁴ Achieved through microgrids (decentralized grids which operate in parallel to the national grid), virtual networks; often try to balance local production and consumption. | A strong focus on community benefits, e.g. cheaper (or free) electricity; often includes collective/shared ownership of electricity generation assets. As a secondary aim can provide network services to grid operators. |
| Transactive (local) energy markets | Take form of virtual networks, operate on the public distribution network, typically offsetting generation and demand (local balancing) through commercial arrangements. Range from very localized peer-to-peer | The focus is often on electricity system benefits, such as integration of distributed energy resources and balancing demand and supply (at the local level); P2P electricity trading for domestic consumers can be part of bigger schemes. |

² Some schemes may cut across categories/archetypes.
³ PPA is a contractual agreement between electricity generators and buyers.
⁴ These models can include prosumers as well as consumers as part of one scheme.
The first two categories of LEE prevail and were observed in all three countries. Here the value proposition has an emphasis on consumers/prosumers, although not excluding system benefits (“bi-directional value propositions where benefits to the energy system are synergistic to prosumer benefit” (Brown et al., 2019)). The third category is more ambiguous as transactive energy markets are less developed, more complex and less aligned with current market and regulatory arrangements; often not sanctioned in the existing regulation taking form of experimental projects. Generally, the markets are not necessarily local and/or have electricity exchange that would involve domestic consumers as part of the arrangements, in contrast to collective self-consumption (CSC) which is of a smaller scale and often bound to a specific local area (Adams et al., 2021).

The means to LEE can vary from simple contractual arrangements on the existing public grid and additional physical infrastructure (e.g. a microgrid/private wire connected to the national grid) to more complex technological solutions such as digital platforms and distributed ledger technology (e.g. blockchain) which are used in some virtual network models in category 2 and 3. The most innovative and controversial are peer-to-peer (P2P) trading\(^5\) and smart energy community schemes as primarily horizontal modes of transacting energy that “defy the traditional hierarchies based on vertical agreements between energy providers at the retail level and consumers” (De Almeida et al., 2021). There are no established P2P electricity trading models and P2P markets in any of the three countries involving domestic consumers. However, our results did depict some trials and experiments.

We posit that LEE can be seen as innovative, socially and technologically, because it brings electricity production closer to consumers and holds a potential to better align electricity production capacities to local electricity needs. As Table 2 also indicated, in some cases LEE models can germinate network benefits, e.g. through reducing losses and therefore costs. Moreover, LEE can reinvent people’s relations with electricity, creating an emotional bond with the electricity they produce and a sense of proprietary (e.g. for domestic customers in case of collective self-consumption or local authorities and community energy generation and supply). This is also linked to the issue of trust and consumer dissatisfaction with large energy utilities and for some a desire for greater control over their energy. Finally, LEE can enable other coupled technologies, it can open electricity markets to new actors with novel degrees of involvement and also for new digital technologies and platforms.

3. Comparative and mixed methods research design

To explore the evolution of LEE in Europe, we relied on a comparative case study approach. Our empirical analysis centers on Western Europe, which was connected particularly to our funding scheme (see acknowledgments). We chose a mix of countries which differ in terms of energy

\(^5\) Sometimes the participants used the terms P2P electricity exchange/trading and LEE interchangeably, however we see P2P as a distinct category.
markets (dominated by nuclear, gas, or renewables) and energy system configurations. We ended up with:

- **France**: large population, large GDP, large energy supply (more than 150 million tons of oil equivalent), large electricity market, reliance on nuclear energy, low carbon intensity, centralized energy decision-making, quasi-monopolistic; grid owned by municipalities.
- **Switzerland**: small population, moderate GDP, small total energy supply (less than 100 million tons of oil equivalent), moderately sized electricity market, reliance on hydroelectricity and nuclear power, very low carbon intensity, decentralized energy decision-making, partly liberalized market.
- **United Kingdom**: large population, large GDP, large total energy supply (more than 150 million tons of oil equivalent), large electricity market, reliance on natural gas, carbon intensive.

Table 3 offers a high-level overview of some key indicators for each of these three countries. Our case study selection also had the benefit of drawing from authors from the project in each of the selected countries, which was a notable strength.

**Table 3: Core sociodemographic, energy and climate change data for our three selected countries**

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>Switzerland</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (millions of people), 2019</td>
<td>67.46</td>
<td>8.58</td>
<td>66.83</td>
</tr>
<tr>
<td>Gross Domestic Product (GDP, adjusted to purchasing power parity, millions of USS), 2019</td>
<td>2,606</td>
<td>730</td>
<td>3,255</td>
</tr>
<tr>
<td>Total primary energy supply (million tons of oil equivalent), 2019</td>
<td>246.35</td>
<td>23.83</td>
<td>175.21</td>
</tr>
<tr>
<td>Electricity final consumption (Terawatt-hours), 2020</td>
<td>480.37</td>
<td>63.29</td>
<td>325.93</td>
</tr>
<tr>
<td>Total greenhouse gas emissions (million tons of carbon dioxide equivalent), 2020</td>
<td>499.1</td>
<td>54.1</td>
<td>585.8</td>
</tr>
</tbody>
</table>

Source: Authors, based on most recent data from the World Bank (2020) and International Energy Agency (2021).

We selected France because it offers an excellent example of a country committed to centralized electricity supply though nuclear power. In 2020, 67.1% of electricity generated in France came from nuclear power plants, 13% from hydropower, 7.5% from fossil energy coal and the rest from other renewable energy source (RTE, 2021). French electricity market was liberalised in 2007. Consumers could then choose to remain with EDF and benefit from regulated tariffs or prefer an alternative supplier and their tariffs are decided by market forces. Since 2015, regulated tariffs were abandoned for large and medium consumers but still exist for residential consumers. The market is currently concentrated in the hands of incumbent state-owned EDF, and alternative energy suppliers only have 21% of market shares (Ministère de la transition écologique, 2021). 41 alternative energy suppliers exist in France, the two largest being owned by multinationals Engie and Total Energies (Selectra, 2021). We selected Switzerland because it has one of the lowest carbon footprints of any European grid. Swiss electricity production is close to carbon free, where
59.9% of electricity is generated from hydropower, 33.5% from nuclear power, and 2.3% from other conventional non-renewable sources like thermal power (EDA, 2019). Following the efforts of the European Union and its member states to open their electricity markets in the 1990s, the Swiss government also pursued the goal of liberalizing the Swiss electricity system and linking it to the European market (Sager, 2014). In 2007, the new Electricity Supply Act foresaw a gradual opening and provided that from 2009 onwards large consumers (annual consumption of more than 100 MWh) could choose their electricity supplier. Small consumers remain in the territorial monopolies of individual energy suppliers and thus cannot switch to another supplier of their choice. The complete opening of the market, including for small consumers, has been repeatedly postponed and is unlikely to take place in the near future due to rising energy prices. We selected Great Britain because it remains focused on natural gas but is trying to diversify into renewables, especially offshore wind; it also features a unique privatized energy system with a great number of private sector actors. As the Britain’s electricity system is undergoing a period of significant change (a transition from a large-scale conventional fossil fuel dominated generation mix to intermittent renewable generation), there has been a marked increase in output from wind and solar farms over the past few years. According to the latest data about electricity generation mix from the Department for Business, Energy & Industrial Strategy (BEIS), in Q2 2021 renewables share of electricity generation was 37.3%, with onshore and offshore wind comprising 8.6% and 7.3% respectively (BEIS, 2021). As of June 2021, there were 49 active suppliers in the domestic gas and electricity retail markets. This consisted of 40 suppliers active in both gas and electricity, 5 in gas and 4 in electricity only (Ofgem, 2021). However, the UK electricity supply market is dominated by the ‘Big Six’6 major suppliers; the supply market structure is operated at a national level, and the licenses and industry codes mandate fully licensed suppliers to be party to the national Balancing and Settlement Code (BSC), and to offer services to all customers regardless of geography (Hall and Roelich, 2016).

With our three countries selected, we then executed a mixed-methods research design consisting of three distinct methods of data collection which ran in parallel. Firstly, we executed an extended document and literature review. For this, we used Nexis lexis, Google, Google scholar and Science Direct. Search queries included: “local electricity exchange,” “peer to peer trading,” “local electricity exchange/trading,” “electricity market,” “local energy,” and “smart energy communities.” This review covered different types of documents: research papers, projects reports, policy documents, official regulator’s documentation, company reports, press/media, news releases. Much of the historical narrative of the field derived from studying and analyzing the numerous websites (e.g. UK Government, Ofgem, French regulator CRE, various cantons in Switzerland, ZEV regulations and guideline reports, specific energy project websites). The review of the recent academic social science energy literature helped better understand the key terms, the underlying mechanisms of LEE and P2P trading and the features of particular models/initiatives.

Secondly, we conducted 40 original semi-structured expert interviews during the period of January, 2020 to June, 2021. A list of our interviewees is offered in Table 4. Interviews lasted generally between 60 to 90 minutes and involved a robust mix of different stakeholder types.

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6 Britain’s largest energy suppliers are known collectively as the 'Big Six'; they are also the UK’s longest running private energy suppliers, having all formed during the 1990s following the passing of the 1989 Electricity Act, which paved the way for the privatisation of the energy sector. https://www.ukpower.co.uk/the-big-six-energy-companies (British Gas, EDF Energy, Eon, Npower, Scottish Power and Scottish and Southern Energy)
Table 4: List of original semi-structured research interviews, 2020

<table>
<thead>
<tr>
<th>Country</th>
<th>Code interview</th>
<th>Empirical description of case</th>
<th>Date of interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Britain</td>
<td>GB01</td>
<td>Researcher and co-director of community energy organization</td>
<td>11.09.20</td>
</tr>
<tr>
<td></td>
<td>GB02</td>
<td>DNO</td>
<td>17.09.20</td>
</tr>
<tr>
<td></td>
<td>GB03*</td>
<td>Researcher</td>
<td>23.09.20</td>
</tr>
<tr>
<td></td>
<td>GB04*</td>
<td>Researcher</td>
<td>23.09.20</td>
</tr>
<tr>
<td></td>
<td>GB05</td>
<td>Ofgem</td>
<td>24.09.20</td>
</tr>
<tr>
<td></td>
<td>GB06</td>
<td>Energy company</td>
<td>29.09.20</td>
</tr>
<tr>
<td></td>
<td>GB07</td>
<td>Lead engineer and research manager (Centrica); Founder of non-profit organization</td>
<td>30.09.20</td>
</tr>
<tr>
<td></td>
<td>GB08</td>
<td>Researcher</td>
<td>1.10.20</td>
</tr>
<tr>
<td></td>
<td>GB09</td>
<td>Community Energy South</td>
<td>2.10.20</td>
</tr>
<tr>
<td></td>
<td>GB10</td>
<td>Researcher</td>
<td>6.10.20</td>
</tr>
<tr>
<td></td>
<td>GB11</td>
<td>Community energy company</td>
<td>7.10.20</td>
</tr>
<tr>
<td></td>
<td>GB12</td>
<td>Coop Community Energy</td>
<td>15.10.20</td>
</tr>
<tr>
<td></td>
<td>GB13</td>
<td>Climate Change campaigning organisation</td>
<td>2.10.20</td>
</tr>
<tr>
<td></td>
<td>GB14</td>
<td>Community Energy England</td>
<td>20.10.20</td>
</tr>
<tr>
<td></td>
<td>GB15</td>
<td>Community organization/registered charity</td>
<td>02.11.20</td>
</tr>
<tr>
<td></td>
<td>GB16</td>
<td>Bristol Energy company</td>
<td>28.09.20</td>
</tr>
<tr>
<td>Switzerland</td>
<td>CH1</td>
<td>Blockstrom</td>
<td>28.06.20</td>
</tr>
<tr>
<td></td>
<td>CH2</td>
<td>Quartierstrom</td>
<td>28.08.20</td>
</tr>
<tr>
<td></td>
<td>CH3</td>
<td>Energiegenossenschaft.ch</td>
<td>03.01.20</td>
</tr>
<tr>
<td></td>
<td>CH4</td>
<td>Erlenmatt Project / ADEV</td>
<td>22.10.20</td>
</tr>
<tr>
<td></td>
<td>CH5</td>
<td>Swiss federal office of energy</td>
<td>09.11.20</td>
</tr>
<tr>
<td></td>
<td>CH6</td>
<td>Housing cooperative Rossfeld Bern</td>
<td>22.07.20</td>
</tr>
<tr>
<td></td>
<td>CH7</td>
<td>Association of Independent Energy Producers VSE / EWG Basel</td>
<td>23.07.20</td>
</tr>
<tr>
<td></td>
<td>CH8</td>
<td>ADEV cooperative</td>
<td>28.07.20</td>
</tr>
<tr>
<td></td>
<td>CH9</td>
<td>Association of Swiss Electricity Companies VSE VSE</td>
<td>29.07.20</td>
</tr>
<tr>
<td></td>
<td>CH10</td>
<td>Association of Independent Energy Producers VSE / EWG Basel</td>
<td>10.07.20</td>
</tr>
<tr>
<td>France</td>
<td>FR1</td>
<td>Lobby organisation</td>
<td>02/07/2020</td>
</tr>
<tr>
<td></td>
<td>FR2</td>
<td>Consultancy firm</td>
<td>02/07/2020</td>
</tr>
<tr>
<td></td>
<td>FR3</td>
<td>DSO</td>
<td>30/07/2020</td>
</tr>
<tr>
<td></td>
<td>FR4</td>
<td>Regulator</td>
<td>21/07/2020</td>
</tr>
<tr>
<td></td>
<td>FR5</td>
<td>Consultancy firm</td>
<td>02/10/2020</td>
</tr>
<tr>
<td></td>
<td>FR6</td>
<td>Parliamentarian</td>
<td>20/10/2020</td>
</tr>
<tr>
<td></td>
<td>FR7</td>
<td>Energy supplier</td>
<td>27/11/2020</td>
</tr>
</tbody>
</table>
In terms of analysis and validation, interviews were fully transcribed, analyzed and coded. To be clear, the empirical data derived from the interviews was initially collected in three languages and analyzed by dedicated research teams in each of the three countries using NVivo software. However, this was an iterative process, with the author teams switching back and forth between ‘deductive’ codes based on our insights from the literature and expert knowledge and the ‘inductive’ findings from the interviews. Codes were recursively refined and molded around the data, and vice versa. Some of these core themes included: various definitions proposed by interviewees for LEE; key events and whether these events supported or constrained the diffusion of LEE; projects/initiatives and their objectives, scope, value proposition; historical development of LEE efforts as well as major policy changes; actors that participated in LEE, enabled or constrained LEE; main controversies in the field; and characteristics of the electricity system. When we finalized our themes and specific interview quotes, we then validated these further with respondents. Interviewees were asked to review the relevant aspects of our analysis and their quotes in order to validate the assumptions and findings. In some instances, interviewees were asked for specific feedback on a paragraph or the key insights. Feedback was incorporated and used for our final analysis.

Thirdly, for context and as a supplemental method, we attended relevant observational data from meetings and events. To supplement the document analysis and interviews, the authors also attended seven events from 2019 to 2020. These events were searched and found on the Internet and through other channels (e.g. recommendations by interviewees), and chosen because they were fairly large (a minimum of 10 participants and a full program), high level (often attended by senior policymakers or intermediaries present), open to wide range of participants (with representatives from energy and equipment suppliers, regulators, civil society, etc.) and verifiable (most had full transcripts, background materials and a briefing booklet). The events are shown in Table 5. The observational evidence collected from these events is useful for aiding the understanding of contextual conditions and deeper dimensions difficult to collect in static sources such as written texts (Yin, 2003). Such participant observation data offers real-time, contextual data to complement the systematic review, and it also improves data triangulation and validity.
### Table 5: List of observational meetings and events attended, 2020

<table>
<thead>
<tr>
<th>Country</th>
<th>Event name</th>
<th>Event organizer (name or description)</th>
<th>Type of event</th>
<th>Date of event</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>Open Networks</td>
<td>Flexibility Consultation Webinar 1</td>
<td>Intermediary organization /Energy Network Association</td>
<td>Online webinar</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Fighting for Local Power: how a UK Bill seeks to support local energy producers</td>
<td>Intermediary organization</td>
<td>Online webinar</td>
<td>15.09.2020</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Erlenmatt Ost project meeting</td>
<td>ADEV</td>
<td>Project meeting, work shops</td>
<td>Various</td>
</tr>
<tr>
<td>France</td>
<td>Webinar Autoconsommation collective</td>
<td>Gresi21 - Renewable energy cooperative</td>
<td>Online webinar</td>
<td>04.06.2020</td>
</tr>
<tr>
<td>France</td>
<td>Energy communities for collective self-consumption: frameworks, practices and tools</td>
<td>Université Grenoble Alpes</td>
<td>Online webinar</td>
<td>15.06.2020</td>
</tr>
<tr>
<td>France</td>
<td>Energy communities for collective self-consumption: frameworks, practices and tools</td>
<td>Université Grenoble Alpes</td>
<td>Online webinar</td>
<td>23.06.2020</td>
</tr>
<tr>
<td>France</td>
<td>Circuits Courts de l’énergie et nouvelles solidarités énergétiques</td>
<td>Greenflex and LLC et Associés</td>
<td>Online workshop</td>
<td>21.07.2020</td>
</tr>
</tbody>
</table>

In the sections below we present some interview findings directly (direct quotes) but we also interpret from the interview data generally (paraphrasing) to contextualize broader findings and themes, especially in Section 5.
Despite the efforts at triangulation (across mixed methods) and validation, our study does have some limitations. Firstly, the depth and breadth of the field (local electricity exchange, decentralization) proved difficult to capture within the length limits for our paper. Therefore, only a selection of relevant narratives could be explored and thus, the case study focuses on specifically chosen LEE dynamics. Additionally, the Covid-19 pandemic posed a challenge by limiting the amount of participant observation that could be collected. Participant observations (online) were mainly used to learn more about the topic of LEE.

4. Results: Comparing the development of local electricity exchange in three countries

This section presents our initial findings organized as a chronological narrative of how LEE emerged and changed in each of our case study countries. We will offer a more thematic discussion of each case in Section 5, after we summarize the chronology of our three cases.

4.1 France: The “Circuit Court de l’énergie”

During the birth of the French electricity system, LEE in the form of local electricity supply were the norm, not the exception. Electricity networks in France were developed and managed by hundreds of local actors (private firms, cooperatives and municipalities) (Defeuilley, 2001). After the second world war, a large wave of nationalization was initiated in 1946 that led to the creation of French national champion EDF (Electricité de France). This did not fully put an end to LEE as some municipalities often located on the edge of the national grid chose to create DNN (non-nationalized distributors) in order to maintain local control on energy related decision-making. In 2007, there were still 157 DNNs distributing 5% of French electricity, the remaining 95% being controlled by EDF (Allemand, 2007).

While the creation of EDF has played a central role in providing French people access to affordable and reliable electricity, it also took away the responsibility over energy issue from local actors. Moreover, French energy policy has long been based on an industrial policy aiming at strengthening the national energy champion, EDF (Andriopoulos and Silvestre, 2017). The French electricity sector is for this reason extremely centralized with citizens being excluded from energy decision-making (Bauby and Boual, 1994).

However, two legal changes have initiated the resurgence of LEE in France. First, after 2012, the government started to rationalize the support for renewable energy by decreasing Feed-in Tariff. This created incentives for renewable energy producers and project developers to find alternative solutions for selling their power (F16). Second, the ratification of the Energy Transition Law for Green Growth (LTECV) in 2015 made it possible for citizens and local authorities to jointly invest in local renewable energy production projects (Peullemeulle and Duval, 2017). Sebi and Vernay (2020) show that many community energy projects were initiated after this law was passed. Moreover, the law also stipulated the need to create a regulatory framework for collective self-consumption (Lormeteau and Molinero, 2018).

7 Local energy flows/cycle (eng.)
8 LTECV – Loi de transition énergétique pour la croissance verte (fr).
The first legal definition of collective self-consumption was published in July 2016 (ordonnance n°2016-1019). It specified that a project has to be organized around one legal entity, the Personne Morale Organisatrice (PMO – fr.). This PMO would not have to meet all the constraints normally applying to an electricity supplier (e.g. the obligation to allow people to terminate their contract anytime without having to pay a fee) (FR3; FR4). It also stipulated that participants should all be connected to the same low-voltage station (i.e. meaning that project would take place on a single multi-story building). The first pioneering projects of collective self-consumption such as Premian (EnergyStream, 2019) and Partagelec (Morbihan Energies, 2018) were realized in the framework of dedicated experimental projects supported by public subsidies (FR2; FR5, FR13).

The legal constraints for collective self-consumption slightly loosened after a working group call “Place au soleil” initiated by the ministry of ecological and inclusive transition recommended in June 2018 to increase the perimeter of collective self-consumption to allow the development of eco-district and a better optimization of production and consumption patterns (Ministère de la transition écologique et solidaire, 2018). In November 2019, a decree stipulated that collective self-consumption projects could take place within a perimeter of 2km between producers-consumers. The decree also specified that a project should have a maximum capacity of 3MW. This followed a recommendation of Energy Regulation Commission (Commission de Régulation de l’énergie (CRE)) arguing that because consumers are not well protected when they participate in collective self-consumption, projects remained of modest size (Commission de Régulation de l’Energie, 2019). In the meantime, CRE worked on proposing a specific TURPE (Tariff for the Use of Public Electricity Networks) for collective self-consumption projects.

Nevertheless, despite this legal foundation, the pace of collective self-consumption development in France is still very slow. The projects emerge in a complex and constraining regulatory framework (FR1; FR2, FR5, FR7, FR12). As expressed by FR7, “it is a blessing for lawyers”. Interviews also revealed that the perimeter and limited capacity of projects make it difficult to make a viable business case (FR1, FR2, FR11, FR12). Further changes may be expected; for instance, since October 2020 it is possible for initiators of collective self-consumption projects in rural areas to ask for a derogation and enlarge the perimeter from 2km to 20 km (Légifrance, 2020). As of December 2021, 68 projects are operational (Enedis, 2021c); most of them being initiated by municipalities, social housing corporations and more recently some energy suppliers (Enedis 2021a). In total, these projects bring together 699 consumers and 116 producers (Enedis, 2021c). First projects (like aforementioned projects in Premian and Partagelec) were very small and on average brought together 2 producers and 12 consumers (Enedis 2021a). In the past months, projects of larger scale have been realized such as that in SerenyCalas. Initiated by the municipality, this project inaugurated in November 2021 brings together 4 producers and 120 consumers (Tecsol, 2021).

New forms of local electricity supply that rely on a direct contract or Power Purchase Agreement started to be initiated in 2019, usually by energy producers and project developers (FR15, FR17). Their objectives are to secure the financial sustainability of either existing assets (e.g. small hydro power plants) or facilitate the realization of new assets (e.g. solar parks) (FR7, FR15, FR17). In 2021, beyond DNN, a handful of small energy suppliers sell power to customers living in the vicinity of the power plants (see for instance PlanèteOui, 2021 or VoltFase, 2021).
In parallel with development of local electricity supply and collective self-consumption, various experimentations (including those framed as ‘local’) supported by large public programs have been conducted to test the potential of smart grid technologies (Commission de Régulation de l’Energie, 2020). Conducted by a consortium of public and private actors, Smart Grid Vendée resulted in experiments related to decreasing grid connection costs, synchronizing period of maintenance to maximize injection of renewables in the grid and better controlling transmission and distribution grids (Sydev, 2021). Moreover, in 2015, the LTECV also made it possible for local authorities to experiment with local flexibility services as part of the regulatory sandbox. In 2019, Enedis initiated a concertation that resulted in the identification of six areas where local flexibility services could be experimented with, and in the summer of 2020 a call for a project was launched for five of these areas (Enedis, 2020, Enedis, 2021b). In November 2020, Enedis signed a contract with SEM les cîmes du Mercantour and EAS Industrie, two local actors that responded to this call for one of the area called Flex mountain (located in the south east of France). Together these actors committed to provide up to 3.6 MW of flexibility during 2 hours to Enedis (Enedis, 2020). No other actors responded to Enedis’ call for a project. A new call was launched in the autumn 2021, results of which are not known yet (Enedis 2021d).

4.2 Switzerland: Community energy for collective self-consumption

Switzerland is unique from other cases because it has a semi-private system of electricity providers. In this system, each county (canton) or city in Switzerland has its own power distributor, with private companies competing to supply them with electricity (Sager, 2014).

In Switzerland, the prerequisites of LEE can be traced back to 2009 when a system of "Feed-in remuneration at cost", known as Kostendeckende Einspeisevergütung or KEV, was implemented. This scheme along with further measures guaranteed renewable energy facility operators fixed remuneration for electricity fed into the grid over a period of 20 years, based on the production costs of a reference plant. The KEV scheme accelerated the diffusion of decentral renewables, and photovoltaic plants became the main technology for decentral local energy production (Verhoog and Finger, 2016). On the business side, so-called aggregator business models emerged which attempted to bundle decentral production facilities in virtual power plants in order to organize and sell energy and flexibility (e.g. tiko Energy⁹ or fleco power¹⁰) (Brown et al., 2019). From the civil society end, actors tried to accelerate the energy transition by experimenting with new types of community energy projects (Lowitzsch et al., 2019).

Due to limited financial resources and a long waiting list for the KEV scheme, the scheme was changed and one-off investment grants were instead adopted as part of a reform of the Energy Act in 2014. In addition, the reform explicitly changed the regulations on self-consumption, which can be summarized as follows (Probst et al., 2019; CH3; CH9; CH10):

- self-consumption is permitted and has to be taken into account in the billing between grid and plant operators;

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⁹ https://tiko.ch/page/home/
¹⁰ https://flecopower.ch/
• self-consumption only takes place when the DSO’s grid is not used between the production plant and consumption;
• self-consumption is also assumed if electricity is generated with solar modules on a rented property; in this case, self-consumption exists though the electricity actually consumed by the tenants.

Due to these changes, solar photovoltaics became the leading local renewable energy production technology in Switzerland, and different initiatives emerged, testing and developing new schemes for local distribution and trading in a partly liberalized energy market (CH3, CH5).

Controversies between new actors and incumbents and persisting regulatory gaps led to further regulative changes, in line with the intended move away from the KEV system towards direct marketing. A key development for LEE in Switzerland was the institutionalization of “self-consumption consortiums” – ZEVs (Zusammenschluss zum Eigenverbrauch) as an organizational model and a legal entity responsible for a self-consumption community (Energie Zukunft Schweiz, 2015). Locally produced electricity can be locally consumed by ZEVs or sold to the grid. Such consortiums can be organized by the residents themselves or by an external service provider and allow energy sharing/trading among the residents (Frieden et al., 2020). As ZEVs became well established, most of the identified LEE initiatives apply this model in various settings (CH1, CH2, CH4, CH6).

By interconnecting several buildings on adjacent properties, the amount of self-consumed electricity can be further increased and thus the profitability of solar plants improved (Gmeiner et al., 2018). ZEVs on broader sites such as districts are therefore also relevant for the activation of new potentials for solar energy, especially for bigger solar plants (CH5, CH7, CH8).

In recent years, mainstream actors such as real estate companies, insurances or pension funds began to actively engage with LEE (Probst et al., 2019). Sustainability goals in terms of requirements for awarding property land from the state and requirements in terms of current building standards forced these actors into pursuing such projects. Companies such as blockstrom11 and ADEV12 became service providers for self-consumption and local electricity supply projects in Switzerland and now take the role of general energy providers in many multi-party buildings and districts in Switzerland (CH1, CH8).

Currently, developments in LEE in Switzerland are mainly driven by the digitalization and the contestation of the boundaries and regulation of ZEVs. This happens through: (1) the introduction of new digital solutions in standard projects; (2) through testing technological innovations in sandbox pilot projects (P2P/local electricity markets e.g. Quartierstrom13), coupled with lobbying activities for potential regulative changes (CH1, CH2, CH4).

11 https://www.blockstrom.com/
12 https://www.adev.ch/
4.3 Great Britain: “Local energy” and smart energy systems

Since privatization in the late 1980s the GB electricity retail market operates on a ‘supplier hub’ model. This means that electricity suppliers are the primary interface between electricity consumers and the electricity system (Ofgem, 2020a). The current market arrangements have evolved around this principle, and the supplier’s role is now entrenched in regulatory frameworks, including licensing arrangements and industry codes (Judson, et al. 2020).

The period 2010-2015 was characterized by the rise of the community energy in the UK, which was largely associated with government support for renewable energy installations, mainly through Feed-in-Tariff (FIT), a subsidy-based mechanism, introduced in 2010 (for England, Wales and Scotland). The FIT scheme intended to encourage the installation of small-scale renewable and low carbon technologies up to 5MW capacity. After the introduction of FIT and especially the Community Energy Strategy 2014, there was a noticeable growth in community renewable energy projects across the country (generation of renewable energy but also generation coupled with community self-consumption). Up to 2015-2016 much of the focus for community energy groups was on setting up their own generation projects (Stephens Scown & Regen SW, 2016); this created grounds for local supply of electricity through a rise of decentralized renewable energy generation.

Before 2015 there was already interest in some forms of local energy and local supply with few examples, such as local electricity tariffs offered by some energy companies (e.g. Good Energy14, OVO Energy15). Around 2015, the supply market saw a number of new entrants, including municipal energy companies and the community energy sector. The new entrants to the electricity supply market were seeking to challenge the way electricity is bought, sold and distributed (Stephens Scown & Regen SW, 2016). Few municipally-owned energy companies were established at that time: Fairerpower (set up by Cheshire East Council) as a ‘White Label’ supplier;16 Robin Hood Energy (Nottingham City Council) and Bristol Energy (Bristol city council) as fully-licensed energy suppliers.17 In contrast with some other European countries, municipally owned energy companies with a full supply license have to operate nation-wide, i.e. be open to customers across the UK, and have to compete in markets with other players. As a way to avoid the complexities associated with a full supply license, a new form of license was introduced in 2009, License Lite (allows to contract with a third party license supplier to avoid adhering to complex and costly market codes). The Greater London Authorities became the first authority in the country to go operational with a new type of electricity license which was granted by Ofgem in 2017 (Element Energy, 2019).

The community energy actors have been experimenting with different LEE models, too. The novel models advocated and implemented by community energy groups usually try to match local electricity supply and demand and deliver benefits for consumers in terms of electricity price (e.g. Energy Local,18 SMART Fintry19). LEE projects that exist on the public network still involve a

14 https://blueandgreentomorrow.com/features/good-energy-local-tariff/
16 In order to supply energy local authorities had to partner with a licenced energy supplier, OVO Energy; the partnership ended in June 2019.
17 Robin Hood Energy and Bristol Energy were sold off in 2020.
18 https://energylocal.org.uk/
19 http://smartfintry.org.uk/
One of the most controversial LEE models is P2P electricity trading that involves the use of digital platforms and blockchain technology. It became a ‘serious consideration’ in the electricity market in the last four years (GB05). Community actors are also involved in few P2P experimental projects (led by industrial partners and tech companies) through the Ofgem’s regulatory ‘sandbox’ mechanism launched in 2017, which grants exemption from current electricity market rules (Ofgem, 2020b). At the time of the data collection, there were three running live sandbox trials, and the fourth was on its way (GB05). Two trials are based in London in tower blocks, both involve fuel poor vulnerable consumers and have solar PV on their roofs. The first P2P electricity trading trial is delivered by Verv, Repowering London and British Gas/Centrica (Ofgem, 2018); it was followed by a similar project, CommUNITY, conducted by EDF Energy working with Repowering and UCL (Bellini, 2019). The third trial was about creating a marketplace for P2P trading (across GB), and was developed in collaboration with BP and Tonik Energy (GB05, Ofgem, 2018).

During the period 2015-2020 one could observe a shift in the policy discourse from community energy to local energy, with the focus turned towards local authorities and local enterprise partnerships (LEPs) (Devine-Wright, 2019). These changes represent “an ideological shift in how decentralized energy transitions should take place”: moving from a “communitarian ideology” to a “neoliberal ideology” (ibid.). In 2017 the Department for Business, Energy and Industrial Strategy (BEIS) Local Energy programme was set up to support the development of local energy projects. Since the UK Industrial Strategy was published in 2017, local energy evolved into support for “smart local energy systems” (SLES) characterized by a “holistic approach” to energy (heat, power generation, distribution, storage and consumption, and transport/electric vehicles) (Devine-Wright, 2019). The £102.5 million Prospering From the Energy Revolution programme, funded through the UK Industrial Strategy as part of Industrial Strategy Challenge Fund, seeks to develop, test and scale up SLES that deliver cleaner, cheaper and more resilient energy.

A related (and sometimes overlapping) concept of Local Energy Markets (LEM) was also emerging in the UK during this period as a potential solution to coordinate an increasingly complex decentralized energy system. The term LEM is used “to describe initiatives that aim to establish a marketplace to coordinate the generation, supply, storage, transport, and consumption of energy from decentralized energy resources (e.g. renewable energy generators, storage and demand-side response providers) within a confined geographical area” (Energy Systems Catapult, 2019). The concept is still in early stages of development, and the value, costs and benefits of LEM are yet to be tested and evaluated.

Despite of the changing policy discourse and some support for the development of SLES and LEMs, the regulatory environment (particularly, the electricity market rules) in the UK is seen as an impeding factor for LEE. A potential novelty that would have a significant impact on local electricity exchange was Multiple suppliers proposition (P379), which was withdrawn in March 2021 due to high implementation costs (Elexon, 2021). The proposed changes for the regulatory framework would allow customers to buy energy from more than one supplier, creating opportunities for more local electricity exchange schemes to come to market. Another proposal,
which is also controversial and contested by some, is the Local Electricity Bill[^20] brought forward by the Community Energy Revolution campaign and introduced in the UK parliament (Power for People, 2021).

5. Discussion: Complexity, ownership, consolidation, and contestation in local electricity exchange

In this section, we build inductively from our chronological case study results to discuss four core themes arising from our data: complexity and variation across national contexts, dynamics of centralization and ownership patterns of consolidation and incumbency, and contestations around local electricity exchange.

5.1 Complexity and variation across national contexts

Our three national cases of LEE reveal that what constitutes these phenomena, what models are labelled as LEE in each country and what is qualified as “local” in electricity exchange is subject to interpretations, and largely depend on the energy system and its institutional context in each country.

For example, returning to our typologies of LEE discussed in Section 2, in all three countries there are numerous examples that fall into category one – local electricity supply, in which local consumers and communities benefit from locally generated ‘green’ electricity (see Table 2). Local electricity supply is relatively well-established and can take different forms, depending on country context. Direct contracts or PPAs are common in all three countries. The second category of LEE, collective/shared/community self-consumption (see Table 2), is more standardized in Switzerland and France and more diverse in Great Britain. Transactive (local) energy markets take form of virtual networks that operate on the public distribution network, typically offsetting generation and demand (local balancing) through commercial arrangements (see Table 2). These projects are less aligned with current regulation systems; Great Britain seems most advanced in experimenting with transactive energy.

In France we observe three types of local electricity supply, all emerging within existing regulatory framework. First, as explained in section 4, it can take place in one of the non-nationalized distributors (DNN). Second, it can be initiated by small electricity producers, DNN or community energy actors to supply renewable energy produced in the vicinity of consumers and secure long-term sustainability of existing renewable energy assets (usually small hydro power plants) via direct contracts or PPAs (e.g. Energie d’Ici) (FR7, FR16). Third, it can be initiated by project developers or electricity suppliers to supply renewable energy securing local acceptability and financial profitability of newly built renewable energy assets (e.g. Enercoop, Terre et Lac, planète Oui, Enargia, LLUM) (FR15; FR17). These last two models have emerged rather recently following changes in regulations, decreasing costs of renewable energy technologies and increasing interest of consumers in local products. Authors expect more of these types of local

electricity supply to emerge in the coming years, especially those that will help develop newly built renewable energy assets.

We have observed a single type of collective self-consumption operating within the existing legal framework (including experiments with microgrids e.g. Pegasus project). The experiments with P2P exchanges in France take place within projects of collective self-consumption (e.g. Premian) (Tecsol, 2018). The definition and support mechanisms for these projects are very strictly regulated and have to fulfil legal and technical requirements (FR3, FR4). While authors expect the number of collective self-consumption projects to develop further, it will remain limited as long as these projects continue to have a very small return on investment (FR1, FR2, FR12).

Finally, no local energy/electricity markets exist in France but there are few experimental smart grid projects that use digital technologies to provide (local) flexibility for the grid, e.g. Smartgrid vendee (Sydev, 2021) tries to optimize the use of the distribution grid and facilitate introduction of RE. The lack of interest in local energy markets may be explained by the fact that French electricity grid does not suffer from important congestion problems (neither at the transmission nor at the distribution level) (FR3, FR18). Interviewees pointed that the French grid has been well dimensioned when first built (FR3, FR11, FR18, FR19). The strong reliance on nuclear power and low penetration of intermittent renewable energy technologies further explains this. As such, TSOs and DSOs do not (yet) have to look for solutions to increase the network’s flexibility. The situation may evolve as the electricity mix changes in the next decade.

In Switzerland, local supply is a common approach (i.e. local utilities) – each county/canton or city has its own power distributor, with private companies competing to supply them with electricity, including renewable energy (CH7, CH9, CH10). Another form of local supply emerged in the self-consumption regulation which take the role of a general supplier towards several multi-party buildings and districts by using decentral technologies (Swissolar, 2019). PPAs are also common.

In Switzerland, shared self-consumption is the dominant type of LEE, and of that almost exclusively related to solar energy. The concept of a self-consumption community (in Switzerland called Eigenverbrauchsgemeinschaften – EVG) emerged as an umbrella term for shared solar power in 2014 (SFOE, 2014). The scale of such communities vary from multi-party buildings to whole districts. There are three types of collective/shared self-consumption mentioned in the interviews and literature (Probst et al., 2019):

(1) Local distribution grid access for LEE (a version of local supply): the grids of the DSOs could be used to connect the individual buildings of the ZEV for the transmission of the self-produced electricity.

(2) ‘Virtual’ self-consumption: The idea is to compare the load profile, or consumption of electricity, with the amount of solar power produced. The consumer is only charged for consumption which cannot be covered by simultaneous solar production. The advantage of virtual self-consumption is that the DSO’s grid could continue to be used at no additional cost. This possibility would reduce the metering costs and would facilitate the selling of electricity locally.

(3) ZEVs of whole areas of municipalities: different concept and feasibility studies have been developed by various actors. Examples include ideas of better coordination between prosumers
and consumers within a municipality (e.g. project Change 38 in Basel) towards compressive approaches of fully developed local markets and energy trading. Under this model, as long as the grid of the DSO is not used, landlords and tenants can organize themselves in self-consumption communities (EVGs).

Transactive markets are currently not possible within existing regulations but sandbox experimental projects are testing the technical feasibility of using blockchain technology for real-time transactions, e.g. “Quartierstrom” in Walenstadt (local electricity market allowing the 37 participating households to buy and sell locally produced solar electricity in their neighborhood) (CH1, CH2).

All three categories of LEE are represented in Great Britain. Here the local electricity supply takes forms of (1) direct supply (licensed and exempt), including PPAs; or (2) retail/commercial models (white label, ‘sleeving’, local tariffs). The examples of initiatives in this category are Robin Hood Energy, a national supplier owned by Nottingham City Council, that offered local discounted tariffs; white label tariffs provided through local authorities; Good Energy local tariff.

The second category, collective/shared community self-consumption, is represented by microgrids of different scale, including virtual microgrids (e.g. Energy Local, some P2P sandbox trials). Although many early microgrids were ‘islanded’ (e.g. as a solution for remote areas), in recent years these models usually have a grid connection (Brown et al., 2020), e.g. residents could get their energy from on-site generation, topping up from the grid when needed, and exporting any excess energy back to the grid. The third category, transactive (local) energy markets, is represented by several examples, e.g. Cornwall Local Energy Market project,21 Local Energy Oxfordshire.22

Overall, in Britain we observe a variety of LEE models/approaches driven by different types of actors, who arguably have slightly different aims (e.g. communities, tech companies, energy suppliers). The GB electricity system is undergoing a period of significant change – a transition from a large-scale conventional fossil fuel dominated generation mix to intermittent renewable generation; liberalization of the electricity system. These changes lead to “a renewed interest in the local context” and an understanding that there is a need for local solutions for the electricity system which is becoming more distributed and decentralized (Van Soest, 2018). The regulator of the electricity market, Ofgem, has adopted a rather flexible approach which relies on “learning over time”, suggesting that the regulatory framework based on principles and outcomes would enable the emergence of business models that are in the long-run interests of consumers (Ofgem, 2017).

As a result of this, new propositions for local/regional production, distribution and trading of electricity are being developed. For P2P trading initiatives there is still a need to have a contract with a licensed supplier who provides balancing and settlement services, however the complexity of the billing is “so off putting” for energy companies that many are not willing to engage in P2P projects; the transaction costs are too high for the amount of electricity that is being traded (GB01). The complexity of some forms of LEE is also seen as a burden for customers, e.g. using of local

21 https://www.centrica.com/innovation/cornwall-local-energy-market
22 https://project-leo.co.uk/
tariffs: “If the answer is that to get the local energy from one of the models is you have to be at home at 3 o'clock to turn on your dishwasher or a washing machine or otherwise you need to get the cheap benefit, then I don't think it will work longer term” (GB12). Even the models that are considered as successful have limits in terms of number of people participating in those schemes.

The diversity of approaches can partly be explained by the early stage of developing community energy projects in new policy and institutional context, but also by the fact that local communities and projects can be quite different (“That's the whole point about community energy, is that every community is so different and that's why every community energy project is so different” (GB12)). This also can create an issue for replicability and wider disseminations of those models.

5.2 Dynamics of centralization and ownership

Further variation across our cases relates to the specific theme of centralization as well as shifting patterns of ownership which have a significant impact on the evolution of LEE.

France, perhaps unsurprisingly, typifies centralized ownership and electricity delivery with strong state involvement. The emphasis is on a controlled development of LEE projects so they do not endanger an already well-functioning electricity system (FR1, FR4, FR6). This degree of state control explains why LEE in general faces a lot of barriers.

The French experience contrasts markedly with trends in Switzerland, which is very decentralized. The focus on community energy there explains why it seems easier to initiate and organize collective self-consumption and also why development really depends on the stance of local decision makers (local DSOs) which can make it easier or harder to organize collective self-consumption. A factor for development of self-consumption is the strong and collaborative housing organizations, supported by the central government and local governments (cantons and cities) (CH4, CH5, CH6, CH8).

Great Britain occupies a middle ground between centralization and decentralization, relying on fairly rigid structures for grid delivery (backed by National Grid and a network of DNO/DSOs) but also enabling a surprising degree of experimentation and innovation. Although Great Britain has generally pursued a centralized approach to energy for many decades, there is an intention to develop decentralized energy and storage systems and replace significant volumes of large, transmission-connected fossil-fuel power stations by smaller, often distribution-network-connected, renewable generation technologies such as wind and solar. This fundamental shift will have implications for how the system is operated. Moreover, some enabling technologies (e.g. smart meters) have opened up the possibility for the creation of new business models (Van Soest, 2018).

Ownership models also differ across the three countries with different impacts on LEE. In France, municipalities own the grid and delegate Enedis to provide this public service; tariff equalization is an important guiding principle in French electricity network, and the regulator is preventing initiatives that would compromise this principle. In Switzerland, local utility companies, which are partially public and partially private, own the grid. Britain operates a fairly conventional grid
ownership and business models of DSOs who deliver electricity to commercial, industrial, and residential consumers.

Consequently, local authorities embrace their role very differently: in Switzerland their role seems very strong, in France – really marginal as they leave it to state-owned EDF, in GB some local authorities tried to become involved in local supply and production but not very successful.

5.3 Patterns of consolidation and incumbency

The new arrangements for LEE have a potential for changing the power relations between actors in the electricity market. What is being witnessed, however, is a concentration of power in the hands of technology companies (providers of trading platforms) and large players (e.g. DSOs). This also raises a question of governance for an emerging phenomenon embedded in a highly regulated field.

The analysis shows that current power balances are clearly in favor of established actors/incumbents and protecting status quo, explaining the slow emergence of LEE in France. Technical elites support the centralized productivist model based on large-scale nuclear energy production (FR1, FR2, FR5). Energy decision-making in France is strongly influenced by established actors, and LEE actors lack countervailing power to obtain further simplifications of the legal framework. Incumbent actors rely on the support of a regulator, CRE, to constrain and slow down experimentation around LEE. The policy is designed to control the development of LEE and make sure that their disruptive potential would be reduced to give established actors enough time to adapt. As explained by the deputy who supported this institutional change, “we need to prove that we are capable of finding a business model that is complementary to that of Enedis [DSO]” (FR 6).

At the same time, we have observed an unstable policy framework as the definition of what can be considered collective self-consumption were changing, e.g. the definition of a perimeter had been one of the ‘battle horses’ of actors interested in experimenting with collective self-consumption (FR1, FR2, FR6, FR12). Interestingly, preventing PMOs (collective self-consumption organizations) to gain too much power is one of the reasons why CRE prefers limiting the size of LEE. PMOs are free from some of the constraints that normally apply to energy suppliers and are able to exert more power over individual consumers than normal energy suppliers. CRE uses this to argue that there is a need to limit the size of those projects in order to protect customers (Commission de Régulation de l’Energie, 2019).

New LEE models reliant on digital technology can potentially contribute to consolidation of the position of big players such as Enedis who has the opportunity to invest in digital infrastructure and smart metering. It is more difficult for small DSOs to be able to facilitate such projects (FR14). The power to influence LEE initiatives also lies with energy suppliers. The supplier as balance responsible can decide to take or to refuse a project e.g. by agreeing to take on the surplus produced by the PV installation (e.g. in la Motte-Servolex EDF first refused to take on the surplus generated by the collective self-consumption project (FR13)).
In Switzerland, DSOs have a lot of power over the grid infrastructure and management of electricity bills, with little incentive for them to cooperate in LEE. This leads to uneven power relations between pioneers trying to build self-consumption communities and DSOs which impeded development.

“There definitely wasn’t much interest from [the DSO’s] perspective. Here we’re talking about the governing sphere. They’re just used to how things are. We’re technically seen as customers but really, we’re just ‘takers’. We come to them and have no chance of doing things differently. They can do what they want, and we have to accept it. At this monopoly area, there’s not a lot of interest in change. It’s rather seen as a disruptive factor” (CH06)

The relations between incumbents, such as utilities and DSOs, and the new actors, such as energy contracting, metering and billing companies, have changed over time. While in the beginning it was rather cooperative and some DSOs worked together with new actors in testing new forms of LEE, the relationship later became more diverse, including some DSOs defending the formation of ZEVs and others developing new services for these customer groups (CH2, CH4, CH6, CH8). Later, a division of labor occurred where DSOs focused on providing solutions for ZEVs on the existing building stock, and new actors focused on providing solutions for new established housing projects or districts (Konersmann and Meier, 2015; Swissolar, 2019). However, contestation between actors might continue to focus on areas such as the regulations of the distribution grid (access, use, financing mechanism) as well as the transfer of grid infrastructural elements towards ZEVs. Power to mobilize resources for LEE has generally been limited based on the regulative frameworks in place.

The Swiss case shows how by a combination of new regulative opportunities (change of KEV), entry of entrepreneurial actors (cooperatives, new services providers) and strong support by federal agencies and established associations (e.g. crafting guideline reports, shaping code of conduct for project realizations) various LEE solutions emerged. There is still an open question whether this path leads to a full functional market of decentralized energy production and LEE. In ZEV organizations tenants get locked-in, as they can only leave ZEVs under specific circumstances, e.g. if a ZEV organization is not able to supply energy or if tariffs are too high. However, a full market liberalization would have an enormous influence on this path, as tenants would be able to leave ZEVs. Therefore, it was not conclusive in the interviews if the evolving path of the LEE turns out to be a success story or leads to a dead-end.

Development of LEE in Great Britain, particularly related to transactive energy, often leads to consolidation of power among incumbent actors, such as energy suppliers and DNO/DSOs. As energy systems are evolving to include more distributed sources of electricity generation, more power is being connected at the distribution level. Besides, green energy is intermittent; adding more renewables to the grid means the grid needs to be even more flexible; more balanced and flexible grid requires more control over energy demand to better match it with supply. This means a growing role of DNOs and a shift from Distribution Network Operator (DNO) to Distribution System Operator (DSO) (Ofgem, 2019), which is enabled by new smart technologies, e.g. platforms for flexibility trading. DNOs play a very active role in ongoing experimentations with local energy markets: Western Power Distribution is a partner for Cornwall local energy market (to create a local marketplace for flexible demand, generation and storage); Scottish and Southern
Electricity Networks leads Local Energy Oxfordshire project (to create a local energy marketplace to enable virtual aggregation of electricity loads, their flexible dispatch and local P2P trading).

In the UK, the majority of interest in local supply market innovation comes from new actors in the supply space, including community groups, social enterprises and municipalities/local authorities (LAs), which can be referred to as ‘local actors’ (Hall and Roelich, 2016). Some local authorities are exploring options for LEE as part of a wider local energy market concept in partnership with various actors. These often come as part of bigger net zero carbon strategies developed by local authorities who declared climate emergency (e.g. Bristol City Leap programme or Norwich Net Zero Strategy). Entering highly risky and competitive electricity markets means that local authorities and community actors must compete with established and resourceful players. Their involvement in big commercial projects, which are beyond traditional area of expertise of local authorities, can be a high risk undertaking. There is a view that P2P electricity trading is driven by technology companies that want to have a share of the emerging (platform) markets. Our expert interview participants suggested that this goes against the common ethos of community organizations that would like to apply technology for not-for-profit objectives. At the moment the technology developers are seen as gatekeepers and as being “quite cagey” about what they can and cannot do making it unclear what actually works (feasible/viable technology solutions) (GB10).

The adoption of P2P electricity trading would require a fundamental revisit of system management and a better understanding of consumer protection, the different roles and responsibilities in this model.

5.4 Contestation and community disagreement

Contestation and disagreements around LEE that we observed in three countries are essentially about an optimal regulatory framework, cost-benefits of LEE and the impact of its development on the electricity systems.

First, we observed some contestations related to issues of fairness and the interests of local consumers. In all three countries actors promoting LEE highlight their aim to empower local communities to decide about energy issues and to generate positive externalities from renewable energy capacities locally, such as strengthening community cohesion, reducing fossil fuel consumption, helping fight energy poverty or creating local jobs. At the same time, participation in LEE might not be accessible to all consumers. Referring, for instance, to P2P electricity exchange, one interviewee explained that P2P platforms are more suitable for ‘the more experienced participants who understand about energy system, have solar panels, more middle-class type residents or it’s more businesses’ (GB14).

The tensions around interests of local communities benefitting from LEE vs other consumers crystalize in the debates about the use of public grid and fair network charges for LEE schemes. Some actors advocate for charging consumers only the marginal impact of their activities (FR1, FR2, FR5); others believe that support for LEE should not create additional burden for consumers that do (or can) not participate in LEE (FR3, FR4, FR10), especially less well-off consumers. These issues are especially prominent in France and Britain. In France for instance, incumbents published tribute where they used very strong words arguing that LEE are ‘communitarian’, ‘self-
centered’, and working to break the solidarity principle of tariff equalization that ensures that all French consumers pay the same network charges (Carenco, 2017). One interviewee linked to community energy also said that participants of collective self-consumption are ‘selfish’ and that “flattering consumers on their small desires (to be autonomous) is not necessarily a good idea” (FR10). Similarly, what should be a fair grid price for LEE is subject to contestation. CRE introduced a specific tariff that, they argue, reflects cost incurred to the grid. Proponents of collective self-consumption on the contrary judge that this tariff “penalizes the virtuous consumer” (Enerplan, 2018). In Great Britain, we observe similar tensions as illustrated in the following quote: “Some advocates of local trading and P2P schemes make the case that they only use a very small, localized proportion of the public network and shouldn’t be required to contribute to other network costs. While we can understand anyone’s desire to minimize their costs, this shouldn’t be at the detriment of other people; as such, local trading and P2P schemes are treated like other arrangements using the public network and should pay their fair share of network costs.” (GB05). The discussions around the Local Electricity Bill illustrate these tensions too as the Bill is trying to address the problem of ‘unfair’ regulations and that are arguably blocking the potential for community renewable energy to benefit local economies suggesting proportional charges.

In Switzerland the debates on whether LEE initiatives should pay grid fees for the locally self-consumed energy also took place: on the one hand, locally consumed energy leads to lower grid costs in general, on the other – LEE structures if not contributing to grid financing are seen as ‘non-solidary’ and could lead to a ‘death spiral’ if more and more people are organized in self-consumption communities (CH5, CH10). However, a political consensus has been achieved that in the absence of FIT there should be some incentives for investors and solar PV can be supported by indirect subsidies i.e. local consumers have a benefit from paying less grid fees (Probst et al., 2019).

The empirical observations reveal intense contestations about the impact that LEE could have on the electricity system as a whole. In France, established actors have framed collective self-consumption as “the tsunami that would overturn the French electrical system” (FR1). They argue that consumers participating in collective self-consumption are less protected. These arguments have been used to restrain the development of collective self-consumption and resulted in a legal definition that is extremely constraining (FR4). The supporters of LEE respond that it is far too early to prevent experimentations that are needed in order to evaluate the potential benefit of such projects (FR1, FR2, FR5, FR12).

Similarly in Britain, the wide adoption of some forms of LEE such as P2P electricity trading would require a fundamental revisit of system management and understanding consumer protections. Importantly, it would require redefining roles and responsibilities and defining who would take over functions such as balancing that are traditionally performed by energy suppliers (“they actively manage that mismatch between what is largely intermittent generation that doesn’t always align with when people want to consume power” (GB05)).

In Switzerland, the relationship between actors have been evolving – from cooperative to more controversial to a ‘division of labor’ with some controversies in terms of which actors took which role and boundaries for selling and distributing locally produced electricity in a partly liberalized market (Energie Zukunft Schweiz, 2015; Konersmann and Meier, 2015). There are still some
contestations around regulation for the distribution grid (access, financing mechanisms, transfer of grid infrastructural elements to ZEVs). As new ideas for organizing local electricity markets have evolved with blockchain and new P2P trading schemes, the boundaries of established forms of LEE like ZEVs are being contested (CH1, CH2). In theory, ZEV organizations and P2P trading solutions have the potential to accelerate the diffusion of decentralized renewable energy in the housing sector. It is accepted that LEE solutions serve the political aim of increasing renewable energy production in Switzerland, however there are also some societal costs (e.g. hidden subsidies) and uncertainty in terms of full market liberalization in Switzerland which would have a serious impact on LEE (e.g. tenants would be able to leave ZEVs) (Verhoog and Finger, 2016; Cuppen et al. 2020).

Finally, the complexity of LEE models was pointed out in the interviews. Some forms of LEE require important digital (e.g. to trace exchanges/transactions) and juridical innovations (e.g. when specific legal entities have to be created to organize LEE or changing regulations to allow customers to buy energy from more than one supplier). Some interviewees argued that LEE involve ‘an additional layer of complexity’ that surpasses its potential benefits (FR13; FR17, FR16). This topic was especially present in France and in Great Britain. Even though few experimentations with P2P trading have been realized, many interviewees were quite skeptical about this model: “it requires a profusion of means for approximate results” (FR16). In Britain, few interviewees shared a similar skepticism. Some pointed that the P2P trading model may not bring substantial benefits: ‘In terms of the amount of benefits that you can get at the moment or the amount of electricity that has traders, the complexity just appears to be excessive relative to the benefits.’ (GB01). As such, P2P electricity trading is not perceived as particularly important, and there are other forms of LEE (e.g. PPAs) that are probably easier to implement and that can deliver more benefit (GB12). Some interviewees also question the potential of LEE schemes based on digital solutions to engage in behavior change. This critique was for instance put forward by Community Energy England who argues that if the process is automated, it would simply be a technological transaction that would be more about financial benefits (“saving a bit of money”) for those participating in the scheme (GB14).

In sum, local electricity exchange remains contested and germinates into controversies across multiple levels of the energy system; the areas of contestation are shown in Table 6.

Table 6: Controversies over local electricity exchange in three countries
### Key areas of controversies

<table>
<thead>
<tr>
<th>Examples of most contested issues in three countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulatory framework for LEE</strong>&lt;br&gt;Legal definitions and (project) boundaries</td>
</tr>
<tr>
<td><strong>How the future electricity system should be organized</strong></td>
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<tr>
<td><strong>Relations between actors involved in LEE</strong></td>
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<tr>
<td><strong>Use of distribution grid</strong></td>
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<tr>
<td><strong>Consumer protection</strong></td>
</tr>
<tr>
<td><strong>Complexity (particularly of P2P models)</strong></td>
</tr>
<tr>
<td><strong>Potential beneficiaries of LEE</strong></td>
</tr>
</tbody>
</table>

Source: Authors

### 6. Conclusion

Local electricity exchange and peer-to-peer trading have been heralded (by some) as harbingers of community empowerment, and even social change, for their ability to push non-traditional actors in the electricity market such as local authorities, community groups and citizens/prosumers. However, our study finds that the results of such actions are often unclear and tangled with concerns over complexity, patterns of incumbency, and substantial areas of contestation. The emergence of new (multi-actor) alliances as a result of increased collaboration involving the public, private and community angles is certainly occurring. But the boundaries of the field are being actively negotiated and re-drawn as new actors entering the scene and forming partnerships with more traditional players (e.g. DNOs/DSOs, utilities or local authorities) and newcomers (technology companies such as digital platform providers). As a result, new propositions for local/regional production, distribution and trading of electricity are being discussed, tested and in some cases implemented. With this in mind, we offer three conclusions.

First, LEE has as much potential to cement conventional actors and power relations in the sector as it does to support new actors or transform power relations. Although LEE, local energy markets and P2P trading rely on multi-actor collaborations, they must work closely with incumbents. For
most community actors and local authorities partnerships with energy supply companies and DSOs would be essential for implementing LEE which is idealistically valuable in smaller self-consumption communities and economically viable for larger districts and the ‘newcomer’ actors from the housing and insurance sectors for example. Many self-consumption communities tend to be cooperatives, which can rather be seen as a way of countervailing power for participants. Great Britain offers a more fluid environment prone to structural constraints but also open to experimentation (driven by both incumbents and new actors). Interestingly, there are also dynamics pushing LEE to only recreate new forms of centralized power. The digital platforms needed for LEE demand economies of scale and push for consolidation. As much as power over self-supply is distributed to new actors, power is only entrenched in other aspects of the system, i.e. among incumbent DSOs, technology providers, and digital platforms. P2P electricity trading in particular represents the level of complexity that can surpass its potential benefits and may be too complex for ordinary consumers. P2P electricity trading is likely to be a 'niche' solution, at least in the nearest future; it can be part of large developments/projects such as local energy markets. These features all partially blunt the transformative potential of local electricity exchange.

Second, LEE varies considerably across national contexts and is strongly linked with institutional frameworks and policy regimes. At times, these frameworks themselves can constrain, making it very difficult for projects to be financially sustainable, and collective self-consumption initiatives often depend on subsidies to be realized, making them so constraining that it is difficult to fully experiment and learn from operational projects; and they are unstable, with legal frameworks constantly being negotiated and challenged by different configurations of actors. The capacity of LEE to impact the energy transition is questioned, particularly in France and Britain. Here the most important issues discussed are related to energy justice, empowerment of consumers, changing roles and responsibilities of key players.

Thirdly, the future merits of LEE are thereby prone to great uncertainty and contestation. Reforms in market arrangements (e.g. the development of DSOs and new flexibility markets) may create an environment more conducive to LEE and potentially P2P solutions (although P2P models will have to compete alongside other solutions to DSO system/network management). There could be potential in developing e.g. P2P business models that would work at a very distributed level, where commercial enterprises do not see any way of engaging or any profit margins that would be large enough for them to engage with. Nevertheless, the viability of LEE, particularly the transactive energy models, is yet to be proven and investments are needed for realization of the projects. The complexities of government policy can be a serious obstacle particularly for LEE projects that are often being developed by community organizations which rely on volunteers and have some social goals, e.g. reducing fossil fuel consumption or elevating fuel poverty in their community. In such contexts, the promise of LEE may be elusive – and it may unfold unevenly, unpredictably, and uncertainly.
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