UNIVERSITY OF EXETER
Energy Policy Group

Unlocking Local Energy Markets

Rachel Bray & Bridget Woodman

Contact: Rachel Bray r.bray@exeter.ac.uk

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1. Overview - consumers at the heart of the energy system?

Historically electricity markets and network operation in GB have been designed to reflect the centralised top down configuration of the system; with generation flowing from large scale power stations and fed through the arteries of the transmission network down through to the distribution network. Within this, consumers have had a passive role in how the energy system actually operates. This traditional model of system design and operation, however, has already begun to change and further change can be expected, potentially creating a wider role for consumers (BEIS and Ofgem, 2017; IRENA, 2018).

The need to decarbonise generation to meet the targets within the Climate Change Act 2008 (HM Government, 2008); the falling costs and increasingly competitive state of renewable technologies and leaps in IT capabilities, provides GB with a huge opportunity to revolutionise the way in which electricity is generated and traded (Ramos *et al.*, 2016). This has the potential to change the energy system from a top-down system in which power flows one-way to a much more complex decentralised system with multiple power flows. Such a system would have much lower carbon emissions through the deployment of small-scale renewable technologies and storage at the local level. Such a system would potentially provide consumers with more opportunity to participate, and allow them to access greater reward in respect to the services they could receive or provide to the system (Ofgem, 2016; IGov, 2018).

One route to enabling greater consumer involvement is through a Local Energy Market (LEM) approach. The authors are currently researching the Cornwall Local Energy Market project, which is a three year trial from 2017 to 2020, jointly funded through the European Regional Development Fund and Centrica. The project is led by Centrica in association with project partners Western Power Distribution, National Grid, the University of Exeter and Imperial College London. The content of this paper however is applicable to any emerging LEM within GB and is not a reflection of the Cornwall LEM project, although this obviously provides context.

2. What is a LEM?

A LEM creates a local marketplace, typically via an online platform, which can draw together a community of renewable energy and low carbon generators, storage and demand side response (DSR) providers at both the domestic and non-domestic level. The online platform allows participants in the local market options to trade energy and flexibility; entering both traditional and new market services, either as a collective or individually, in order to get additional value from their supply or system services.

The LEM-model is about giving consumers choice about how they buy and sell electricity. LEM participants will be able to choose who to sell to and who to buy from. The online marketplace allows LEM participants to be fully informed of the prices for both buying and selling in different markets, thus enabling them to make more informed choices. Effectively, the transparency of the platform allows a more informed proposition to the consumer.

In respect to consumers within a LEM context, these could include individuals and community groups in the domestic sector and also non-domestic entities such as commercial and industrial sites; companies and organisations. Therefore, LEM participants will be consumers, prosumers, storage providers, DSR providers and small-scale generators. LEM participants are local people, groups, businesses and organisations who are no longer passive recipients in the energy system; the LEM offers them the opportunity to become more active participants in the system.

Choices to be made by generators will include whether to sell generation within their locality only; trade into balancing markets at the distribution or transmission level; or demand-match with nearby consumers; or indeed develop partnerships with local charities, social housing schemes etc.

Choices to be made by consumers could include which types of generation they prefer to purchase; the locality of that generation; who they wish to purchase from and when they wish to purchase.

An LEM marketplace can also provide an easy route for participants to aggregate the delivery of various demand-side management options at the local level. New market services provided by an LEM through the peer-to-platform approach could in future include any of the following:

- Balancing services provided to the Transmission System Operator (TSO) and Distribution Network Operators (DNOs) to assist in overcoming system balancing issues. These could include demand turn-up; load curtailment; battery charge / discharge and solar curtailment; as well as reactive power services and frequency response.
- Peer-to-peer (P2P) local energy trading between participants (including domestic participants); alongside the development of demand-generation coupling solutions with large demand-side consumers such as local manufacturing sites.
- Optimisation with suppliers to improve their imbalance position; and
- Trading in the Wholesale Market through aggregation of generation resources.

The Cornwall LEM project covers the whole of the county, which falls within Western Power Distribution's south west network. However, LEMs can be more specifically place based, such as at a town or city level. Whilst various LEM models could arise over the next few years, it is assumed that all LEMs will utilise distributed energy resources (DER) which are connected at the distribution network level.

3. Key Drivers of LEMs

There are several current drivers for the emergence of LEMs in GB. Many commentators describe these drivers in terms of the 3Ds:

- decarbonisation - and the need to reduce greenhouse gas emissions by at least 80 per cent from 1990 levels by 2050 (HM Government, 2016);
- decentralisation - considering the impact which distributed generation will have on the traditional one-way energy system; and
- digitisation - opening up new ways to design and operate the energy system across all levels through advances made in IT capabilities and the emergence of new technologies in generation, demand and control systems (Shakoor *et al.*, 2017).

However, some commentators have proposed the analogy of the 4Ds – which includes an additional D for democratisation - with consumers having a greater role to play in the energy future (Hoggett, 2018). The LEM model incorporates all of the 4Ds within its scope, bringing low carbon DER solutions to local consumers via the LEM marketplace.

The amount of generation in GB that is connected at the distribution level has doubled over the last five years (Ofgem, 2017b) and now represents around 30% of total GB installed capacity, at 30,838 MW as of December 2017 (ONS, 2018). However, distribution networks were not originally designed to accommodate generation and this increase in distributed generation has impacted on them in several ways, creating multiple challenges for the DNOs (Ramos *et al.*, 2016). The DNOs claim that this

abundance of renewable energy generation has at peak times put the local networks under severe strain (WPD, 2017a), leading to distributed renewable generation being curtailed during times of system stress.

LEMs however may be able to help overcome congestion and system balancing issues through more intelligent management of demand, generation and storage on the networks. Indeed, the presence of a flexibility market, such as a LEM, operating at the distribution network level, may also enable additional renewable generators to connect to the network in locations which were previously considered to be constrained.

Research undertaken by Navigant suggests that by 2030 distribution grids will have completely changed their operations to incorporate this rise in DER. Navigant suggest that this will include the incorporation of advanced distribution management systems and pricing signals to overcome issues related to additional activity on the grid. This could lead to DNOs becoming more service-based in their operations (rather than mainly supply-based as at present) and enabling competitive new market places for customers to trade their self-generated power (Ravens and Lawrence, 2017).

In addition, analysis undertaken by Imperial College (Shakoor *et al.*, 2017) suggests that reduced system operation costs of between 25% and 40% could be achieved through the deployment of new, cheaper, flexibility sources connected at the distribution level rather than from conventional generation on the transmission network. The National Infrastructure Commission has also produced models which show that delivering a low carbon electricity system, powered mainly by renewables, is a cost competitive option to investing in new nuclear power stations (NIC, 2018).

Therefore, local distributed generation could be exploited to establish a more efficient, cleaner and cheaper electricity system given the right regulatory environment; as well as giving consumers more choice in buying and selling electricity and flexing demand.

4. Regulatory and Policy Barriers to LEMs

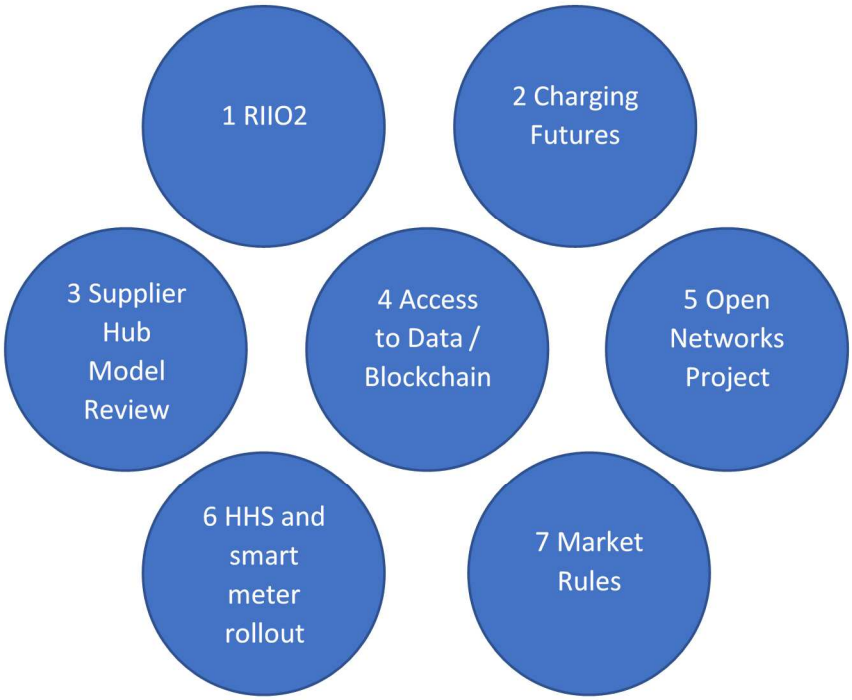
Despite the key drivers and benefits that LEMs could play within the electricity system, their development currently faces a number of policy and regulatory barriers as set out in our recent report 'Policy and Regulatory Barriers to LEMs in Great Britain' (Bray, Woodman and Connor, 2018).

Markets and network operation have historically been designed to reflect the 'conventional' centralised configuration of the system: unidirectional, with consumers as takers of power and price, rather than supporting smaller scale, more active local participation and despite some changes, this remains the case. This regulatory architecture rules out some options for more effective energy management by individual householders and businesses, and thus prevents them from offering systemic benefits. Policies and regulations in place at the moment therefore can act as barriers to the development of a model which allows more local trading of power and flexibility and which fails to maximise utility and consumer choice. By default, it seems likely that this also limits decarbonisation, since a key outcome is often to cause limits to be placed on generation from renewables.

In GB, whilst BEIS and Ofgem claim they want a 'smart, flexible energy system' (BEIS and Ofgem, 2017) they are currently taking an uncoordinated approach to achieving one. Several programmes are being progressed by BEIS, Ofgem, National Grid, Elexon and the Energy Networks Association which will have far reaching consequences for the development of LEMs (see Figure 1). However, many of these appear to be happening in a piecemeal fashion, instead of being coordinated beneath a strategic overarching umbrella. If left uncoordinated they run the risk of realising unintended consequences or

working against each other. Whilst also supporting incumbent system actors at the expense of more innovative ones, including LEMs.

Figure 1 Programmes currently being undertaken which impact LEMs



Note: For individual programmes use following references:- 1: (Ofgem, 2018e) 2: (National Grid, 2018) 3: (Ofgem, 2017a, 2018a) 4: (Ofgem, 2017c) 5: (ENA, 2017b) 6: (Ofgem, 2018c) and (Ofgem, 2018f) 7: (Ofgem, 2018d)

Uncoordinated decision-making has resulted in a situation where much of the change occurring at the network and market levels at present is reactive rather than proactive. For instance, the RIIO2 guidance provided by Ofgem sets the next round of price controls for transmission and distribution networks (from 2021 for transmission and 2023 for distribution) but offers no discussion on the change in operation expected from the TSO and DNOs (who it should be noted are regulated monopolies) during this period. Instead, this has been left entirely to these regulated monopolies themselves to define through the Open Networks Project as will be discussed further in Section 5.

Meanwhile, the Charging Futures programme, whilst encompassing consultations from Ofgem on reforming network access rights and charges for electricity network users, relies on National Grid as Lead Secretariat to coordinate. The Charging Futures Programme would be expected to take into account how BEIS / Ofgem want the networks to be used in future, and then set the according access rights and charges to encourage the required change in consumer behaviour. However without overarching guidance on what behaviour is to be encouraged this has not happened and the present consultation (Ofgem, 2018b) suggests that those consumers who do change their behaviour to help meet carbon targets may be financially penalised for doing so i.e. consumers who have installed heat pumps or who charge EVs at home, may have to pay a higher network access charge than those who rely on fossil fuels.

In addition, the Supplier Hub Model review, led by Ofgem, is currently discussing changes to market arrangements for trading electricity (as discussed in Section 5) whilst most of the market rules, set through Industry Codes, are being led by incumbent market actors (who may be resistant to any change which affects the current status quo) rather than being determined through Government strategy (Lockwood *et al.*, 2017).

The outcomes of all of these programmes need to complement each other if they are to achieve a whole-system energy transformation. However, by consulting different (though overlapping) sets of stakeholders separately, carrying this out through different agencies, working to different timelines and by applying different regulatory standards there seems likely to be little scope for joined-up thinking. Therefore, we suggest that the only way to bring all these elements together is for Government to commit to an overarching strategy which informs the direction of all subsequent policy decision-making.

5. How can LEMs be enabled?

To enable the development of LEMs within the GB energy system all the programmes identified in Figure 1 need to be considered holistically to ensure they work towards the same goals. To provide more insight on some of the complexities involved in doing that, this paper considers in more detail two of these programmes with particular pertinence to the future development of LEMs: the DNO to DSO transition (the Open Networks Project) and the Supplier Hub Model Review.

We argue that both initiatives need to work towards the goals of enabling local trading and balancing markets; providing consumers with choice in how they interact with these markets; and which realise environmental, system and cost benefits. In this respect the DNO to DSO transition should be the market enabler, whilst the Supplier Hub Model Review should provide the mechanism for consumers to engage with the market.

1) DNO to DSO transition (Open Networks Project)

One of the key enablers to unlocking LEMs is the anticipated transition of DNOs to become Distribution System Operators (DSOs). The rationale for this transition is that with the increasing amount of generation connected at the network level, rather than at the transmission level; and with the further emergence of new technologies, heat pumps and EVs at the domestic level; the DNO will increasingly have a greater need to forecast and actively manage energy flows across the network. This could lead to the DSO replicating at the distribution level the system balancing functions which the TSO currently undertakes at the transmission level (Nolan, 2015).

It seems likely that a DSO will be expected to match generation and supply locally, and to facilitate competitive local trading markets as part of enabling this (ENA, 2017a; WPD, 2017b). The emergent and evolving DSO role can therefore be seen as one of the most critical factors in determining whether, and how, LEM participants are able to access new revenue streams and localised markets.

Several of the DNOs envision an active role for LEMs within their future DSO operation (Northern Powergrid, 2017; UKPN, 2017; WPD, 2017b), whilst three of them: Western Power Distribution, UK Power Networks and Scottish and Southern Electricity Networks have commenced trialling of online platforms to procure local flexibility in conjunction with companies such as Centrica and Open Utility (Centrica, 2018; Open Utility, 2018; Pratt, 2018).

However, the transition to DSO status is not an inevitability as BEIS have been relatively silent regarding their expectations. Although BEIS and Ofgem set out in their joint 'Smart Systems and Flexibility Plan' (BEIS and Ofgem, 2017) that they expect to 'see the DNOs operating as DSOs' they have left all transition decisions to be made by the incumbent network operators themselves, coordinated by the Energy Networks Association (ENA) through the Open Networks Project (ENA, 2017c) rather than setting a long-term strategic vision for future network development and operation.

Their role in developing the Open Networks Project has allowed the network operators to set their own timescales for transition and to decide for themselves what can and can't be achieved on individual networks. Therefore, if the DNOs continue to be left rudderless there could be a tendency for them to adapt to a form of the DSO function which best suits their own business operations; regardless of whether this is in the long-term best interests of the customer.

The uncertainty surrounding the DNO/DSO transition also provides uncertainty for LEMs and related stakeholders, particularly in relation to what services the DSO will be procuring from the market and what activities they will be managing themselves as the operator. For example, through current implementation of active network management the DNO/DSOs are able to curtail generation themselves, rather than procure demand turn-down from the market. This leads to uncertainty for generators both in terms of operability and finance, undermining the potential value of market-based solutions provided by LEMs to overcoming system constraints.

BEIS therefore needs to provide clarity on expected DSO role and function as well as provide a strategic view of what needs to happen, and by when, in order to allow innovative market solutions, such as LEMs, to be enabled at the local level. The authors suggest that BEIS should provide this direction before the end of RIIO ED-1 (2023) with an aim for all DNOs to be procuring DSO market services from the commencement of RIIO ED-2 (2023-2028).

2) Supplier Hub Model Review

When the energy industry was privatised in the late 1980s, the market was designed with suppliers as the core intermediary between customers and the energy system, in what is known as the 'supplier hub model'.

Ofgem themselves highlighted through a call for evidence in November 2017 (Ofgem, 2017a) and the subsequent response letter in July 2018 (Ofgem, 2018a) that the current supplier hub arrangements are no longer fit for purpose in light of the desire to bring innovative changes to the electricity markets. For instance, the P2P model (where prosumers can trade their excess generation to a neighbour) is currently inaccessible due to the market design which necessitates that all transactions must be made through a third-party licensed supplier and that customers can only have one licensed supplier at any given time. It is therefore not possible at present for a domestic prosumer to sell any excess generation to anyone else – excess generation can currently only be stored on site or sold back to the grid via the supplier. On the other hand, it is also not possible for a customer to buy electricity from anyone other than their sole contracted supplier. In a world where households can purchase many different products from many different companies, this supplier hub model frustrates greater market interaction, denies opportunities for monetization and potentially constrains low carbon generation to the detriment of investors and decarbonisation targets.

However by allowing consumers and prosumers to have more than one energy supplier at any one time; allowing them to trade their excess generation between themselves without transacting through a licensed supplier; and allowing them to sell their excess generation to whomever they choose, would open up a wider array of choices for market services, one of which would be the enablement of new localised markets.

To this effect Ofgem are currently assisting several developers to trial new P2P models via their Regulatory Sandbox scheme (Ofgem, 2017d). The Sandbox allows innovators to test these models without adhering to the full regulatory requirements for the duration of the trial period. However, the Sandbox approach is not a guarantee that a particular model will be able to continue operation after the end of the agreed period. This is due in part because any change away from the supplier hub model will have far reaching impacts across the whole energy governance spectrum, necessitating changes to several industry codes including the Balancing and Settlement Code, Distribution Use of System charges, Transmission Network Use of System charges and the Master Registration Agreement, all of which will take several years to implement (Elexon, 2017).

Elexon thus subsequently launched a White Paper in April 2018 (Elexon, 2018) explaining how current modifications that are already in progress within the Balancing and Settlement Code could help to support some modest scale of reform within a shorter timeframe (i.e. possibly by 2020) ahead of Ofgem's future proposals for replacing or revising the supplier hub model. Elexon's proposals would enable customers to use multiple suppliers at any one time; which could help with the incorporation of community energy schemes, EV service propositions and rapid switching. However, their proposal could not facilitate transactions completely independent of suppliers' i.e. true P2P transactions which should be independent of any third party involvement.

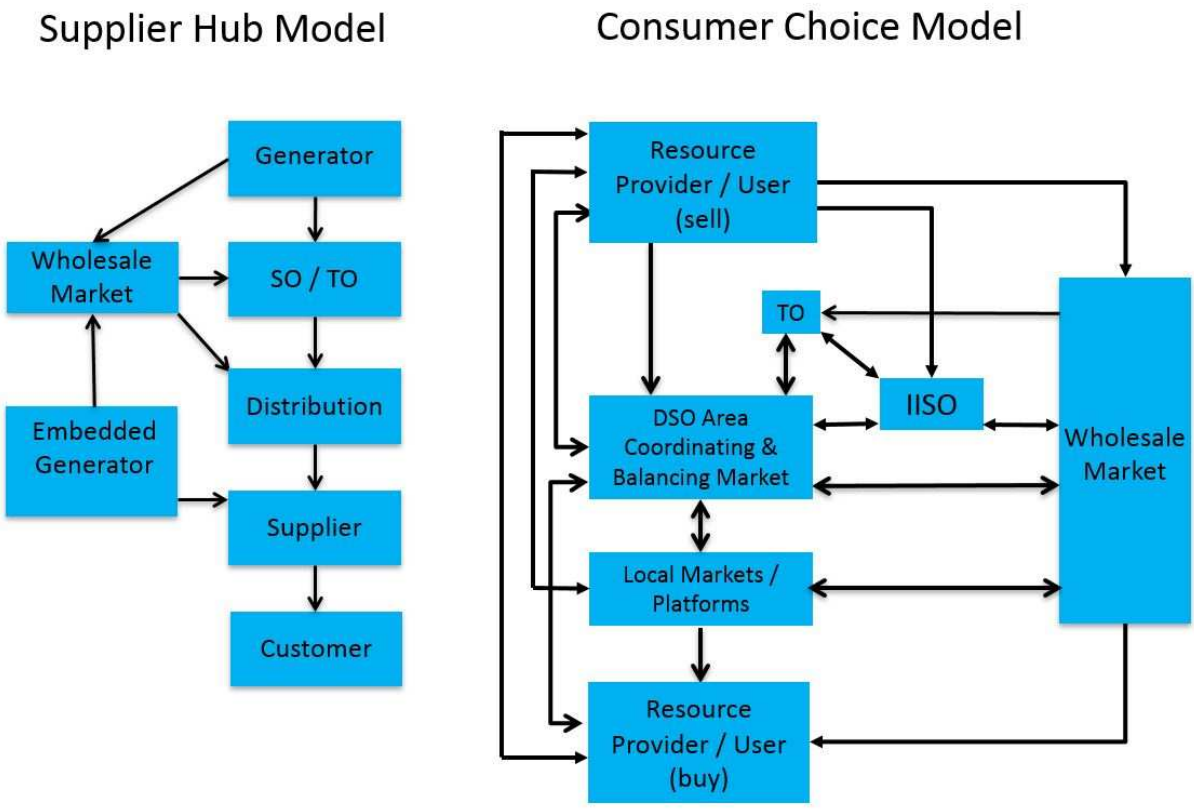
For a more wide-ranging LEM to be realised therefore, one which holds the needs of consumers at a premium and which allows them to maximise utility from their investment, the authors argue that Ofgem need to design a new model which allows customers to transact through new intermediaries, multiple intermediaries or through no intermediaries, depending on how each customer wishes to engage with the market.

The authors thus propose an approach which could be both a key enabler to unlocking LEMs and potentially other market services; by replacing the existing supplier hub model with a new Consumer Choice Model.

6. Developing a Consumer Choice Model

So, what could a consumer choice model look like and how does it differ from the traditional supplier hub approach? The model provided in Figure 2 is adapted from a wider model designed by the Energy Policy Group at the University of Exeter and offers one such concept (Mitchell, 2018b)

Figure 2 Supplier Hub Model v Consumer Choice Model



Note: Diagram adapted from original model constructed by C Mitchell, R Hoggett, R Bray, & B Woodman, University of Exeter, 2018 (Mitchell, 2018b)

As can be seen in Figure 2, the traditional supplier hub model places the customer at the end of the line in the energy system, with all direct contact taking place through a supplier, and with no immediate interaction with what is happening further up in the system. The exception to this is the customer who is also an embedded generator; but again most transactions would be through a supplier, either in the form of a Feed in Tariff (for generation under 250KW) or a Power Purchase Agreement (for the purchase of generation over 250KW) (Bray, Woodman and Connor, 2018).

In contrast, the Consumer Choice Model proposes a more circular approach to system delivery with the new DSO function being crucial to the operation of the system. Indeed, it can be argued that in this model distribution rather than consumers sits at the heart of the system. However, by focusing on local distribution and balancing markets, powered by local renewable assets, and by enabling trading in localised energy markets we have brought the energy system much closer to consumers. Our model therefore offers consumers more choice at potentially less cost (Mitchell, 2018b).

In the Consumer Choice Model customers have direct access to several markets in their roles as either sellers or buyers of generation as well as being able to buy and sell directly between each other. The

LEM approach is fully operational within this model; although it is only one of several new ways in which participants can access trading markets, depending on individual consumer choice.

The model also highlights how the Supplier Hub Model Review and the DSO transition need to be considered holistically if they are to work towards a defined end goal of a smart flexible energy system. Indeed, all the initiatives shown in Figure 1 are interlinked and should be seen as complementary in achieving this goal. For example the Charging Futures Programme (National Grid, 2018) should direct and encourage consumer behaviour through tariff-setting; whilst RIIO2 (Ofgem, 2018e) should be clearer on future DSO expectations rather than relying on 'innovation' as a somewhat abstract pathway of getting there.

However, if Government provided an overarching strategy, clearly explaining what the energy transition needs to achieve, and by when, all further programmes could dovetail under this, working towards the same conclusions, and potentially saving time and money in producing ad hoc consultations that seem to independently address separate issues.

7. Conclusion

The LEM model provides consumers with more opportunity and choice to participate in the energy system at potentially less cost as well as many benefits to the emerging energy system. Market opportunities are signalled via the online platform and these can include traditional services, such as balancing services to the TSO/DSO, or if regulation evolves to allow it, could also include more innovative local services such as P2P and local demand matching. This would enable DER providers to access wider market opportunities than they have access to at present.

LEMs can help to overcome system congestion issues through more intelligent management of demand, generation and storage on the networks; potentially enabling additional renewable connections to be made in previously constrained areas. LEMs can therefore play an important role in establishing a more efficient, cleaner and cheaper system.

However, this model of electricity trading differs significantly from the way in which the electricity system currently operates. For LEMs to be realised the current regulatory environment must be changed, and commitment is needed from BEIS to adopting a 'whole systems approach' to managing the energy transformation.

Although Government has ambitious policies for a smart, flexible energy system; it provides too little direction to Ofgem on its desired outcomes, which Ofgem are then expected to execute (Mitchell, 2018a). Therefore, although key market actors are advancing several programmes to aid the energy transition there is no clear directive as to what needs to be achieved and by when. Indeed, with programmes being led by different actors, there is a risk that any outcomes may not complement each other and further, they could be steered to reflect the desires of the incumbent lead partners, rather than the long-term best interests of either the customer or the electricity system.

It currently seems that the government and regulator are working on an assumption that the energy system will simply transfer to being decarbonised, smart and flexible simply as a matter of course (Mitchell, 2017). However, it is clear that innovation and new entrants can only achieve a certain amount of change before getting stalled in the complexity of the current regulatory regime (Sandys, Hardy and Green, 2017).Therefore, a different market structure and set of regulations will be needed for an industry that transforms from a top-down one-way system to one which fully enables distributed generation and local energy trading.

We have looked in more detail at two of these programmes, the DNO to DSO transition (led by the ENA) and the Supplier Hub Model review (led by Ofgem). We have demonstrated how the outcomes of both programmes will impact, either positively or negatively, on the development of the LEM model. However, as desired outcomes are not as yet fully prescribed by policymakers, LEM developers are left with uncertainty into the foreseeable future.

We therefore ask Government to provide an Energy Transition Strategy and Implementation Roadmap; to guide future decision making by the regulator and then other stakeholders in a coherent manner; rather than delegating responsibility for unclear pathways to those whose role it is to either regulate or implement strategy. This would enable innovators to have clarity over where best to invest, and how to proceed, in providing a smart and flexible energy system.

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