GREATER MANCHESTER LOCAL ENERGY MARKET

DOING THINGS DIFFERENTLY FOR THE ENVIRONMENT

Greater Manchester Local Energy Market

Final report

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Executive Summary

The UK energy system is changing. As we progress towards a net zero carbon future, more of the energy we use in our homes, businesses and transportation will come from low carbon sources of electricity, and the amount of electricity we are consuming will rise rapidly. In Greater Manchester, the Energy System Catapult forecasts that in a scenario with primarily electrified heat, electricity demand will increase by 57% on the 2021 level by 2038.[1]

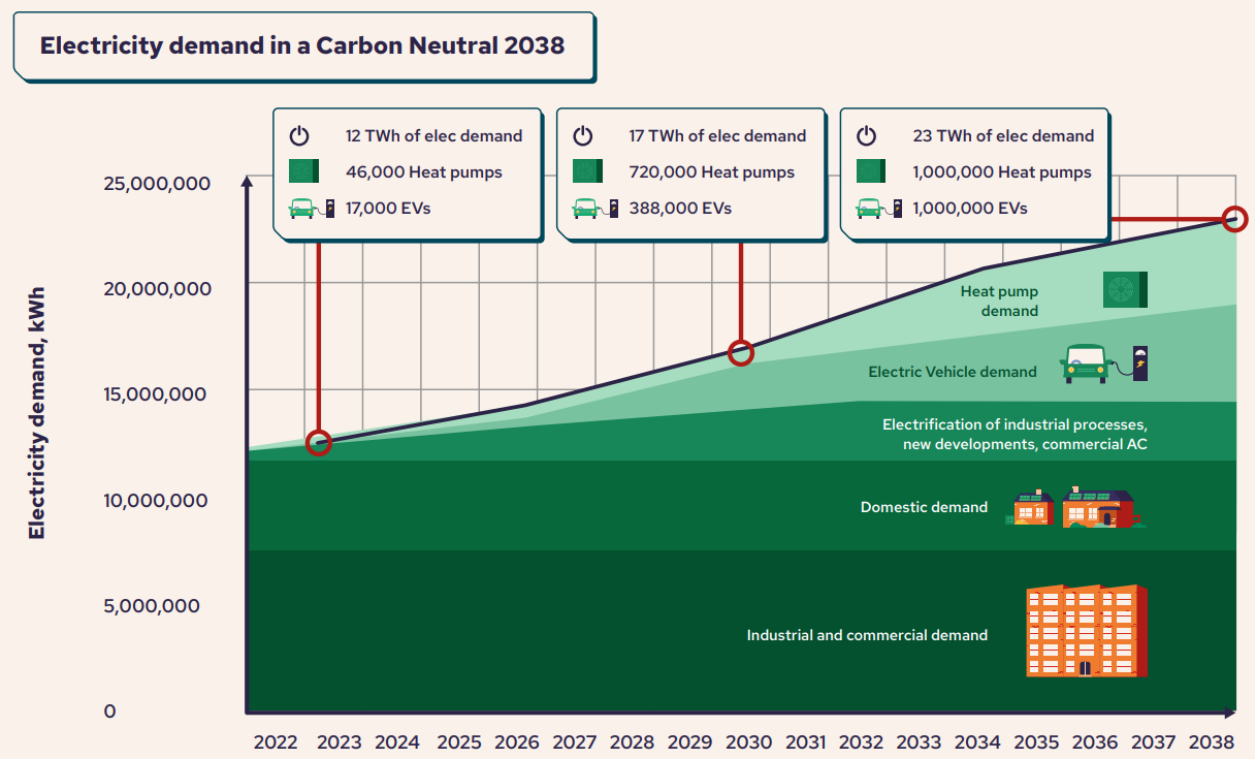


Figure 1: Electricity demand in a carbon neutral GM by 2038

We have much of the technology and tools to make that happen, deploying technologies like heat pumps, electric vehicle charging infrastructure, and solar PV. But there is still a challenge to address: how do we accommodate all these new assets on our electricity network in time to meet the targets, whilst keeping investment as efficient as possible?

[1] See Appendix 1 for the Greater Manchester Local Area Energy Plan summary

The GM LEM 2 project (Greater Manchester Local Energy Market 2), an Innovate UK funded project from the Prospering from the Energy Revolution (PfER) programme, has spent two years looking at the detailed design of a *local* energy market and how that might play a role in facilitating a low carbon energy system.

What could a local approach do?

The UK energy system already has national mechanisms for dealing with fluctuating demand and varying amounts of supply, notably the wholesale energy market and the balancing mechanism. When there are periods of low demand, energy becomes cheaper. Likewise, when there is a sunny, windy day there can be a glut of energy generation, making it cheaper to buy. As we move into a high renewables and high demand future, the wholesale market is likely to become more volatile with faster and more extreme swings in pricing, making it harder for energy suppliers to forecast their costs. But wholesale energy costs are only part of the story, as the energy network themselves, the wires, substations, pipes and pumps will all need huge investment to accommodate the increase in demand. This has implications for us all in what we pay for our energy.

So could there be a role for more regional matching of supply and demand, helping reduce how much energy must be transported around the country and making it easier for suppliers to balance their portfolio with less of the (more expensive) balancing mechanism ‘top-up’? Could a local approach improve our energy system?

A recent report by PwC and Innovate UK[2] concluded that undertaking £3.2bn of investment in energy related place-specific interventions in Greater Manchester would lead to £5bn in savings on energy bills by 2035 and £59bn in wider social benefits. There is clear evidence that place-based action and solutions are not only critical in delivering our carbon neutral targets on time, but have huge additional benefits to local people and the environment. The work undertaken in this project shows that a Local Energy Market could be instrumental in that journey.

[2] Accelerating Net Zero Delivery, March 2022

Some of the value found in the PwC report arises from keeping network investment lower than might be expected for such an increase in system use, but this is not the only source of value. Patterns of energy use have major implications for the environment, for regional economic development, for people's health, for community resilience, and many other features of modern society. A regional energy market could help make these factors more visible in the decisions we make about energy, and engage people more actively in these decisions. This is likely to be an important factor in achieving the citizen buy-in and behavioural change needed to achieve national net zero targets.

What we found

A Local Energy Market, or LEM, in Greater Manchester could make a material difference to how the region generates and consumes energy, with the potential for helping limit future energy bill cost rises. Specifically, the GM LEM could by 2038:

- Be instrumental in bringing over £40mn/year in value to the local energy system by using the existing network more efficiently and avoiding reinforcement costs.
- Support the local matching of 1.5GW of local low carbon generation to local demand, enough for 34,000 homes and 1.2TWh of commercial energy.
- Support the investment of up to £4.6bn of new low carbon, LEM enabled assets, through encouraging uptake with innovative tariffs and business models, some of which have been explored by GM LEM2 project partners Bruntwood, Northwoods housing and Ovo.
- Provided there is a comprehensive effort to address energy efficiency needs in the region, offer potential energy bill savings for typical domestic customers from using energy tariffs aligned to the LEM of over £30/yr; more if there is action on policy and regulation that will enable more advanced features of the LEM.

The LEM could provide even more value to the region as more assets connect. With a network of interconnected energy assets, and visibility of the data they generate, it could be possible to trade energy directly with your neighbours, or for the local authority to identify where EV charging infrastructure should be delivered. A LEM could be instrumental in unlocking how GM works in near real time, and inform better decision making in the future.

Many of the concepts and ideas behind the LEM were tested by project partners with members of the public, through engagement sessions, surveys and one-to-one

interviews. There was strong support from the public for the LEM and what it is trying to achieve and some clear evidence of how it should be achieving them:

- **Domestic customers value convenience over control**
- **Businesses value control, options and quantification of 'green'**
- **Many people expect a LEM tariff to be the cheaper option**
- **People expect LEM tariffs to be as simple as standard tariffs**
- **Transparency and accountability are important**
- **The LEM could be an empathetic initiative that supports community energy and energy efficiency deployment**

This report shows that a market maker platform at the heart of a LEM in GM could be viable with an investment of around £2.7m over 7 years, and would be generating nearly £1m/yr in revenue surplus by 2033, provided the minimum number of assets connect. This revenue comes from four value streams, with the lion's share coming from 'Embedded flexibility'; essentially avoided reinforcement costs.

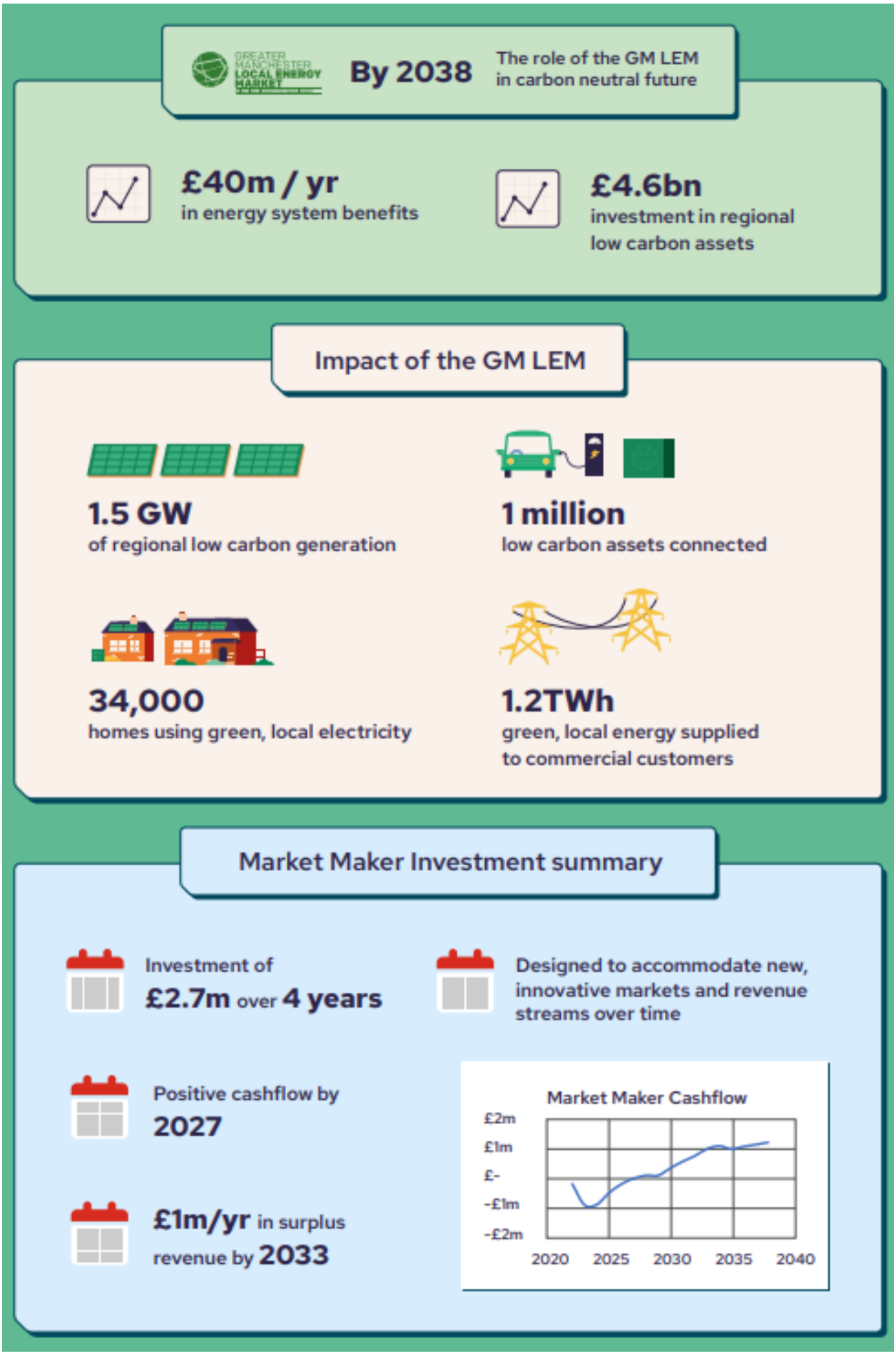


Figure 2: Headline benefits of GM LEM

What is the LEM?

The core of the LEM is a digital platform marketplace called the ‘market maker’ that enables customers with demand to buy from local generators with supply. This has been tried before, but what is innovative about the GM LEM is that it doesn’t seek to balance anything itself. It is a marketplace where participants can see what other local participants are offering and buy/sell based on a variety of attributes including cost, carbon intensity and crucially, location. (Other criteria can be added over time depending on what participants find valuable, for example whether the generation is community owned.) The participants transact directly with each other, using the LEM to see what bids and offers there are for different types of energy service (energy demand, flexibility, network capacity and queue position). The LEM provides a ‘shop window’ for the market participants connected to it, matches bids and offers, and when a transaction is made the LEM takes a small fee from the supplier side. To start with, the participants on the LEM would be energy suppliers, generators, the local network operator and aggregators. Later on, this could be expanded to include some national markets too.

What this means for customers is that their flexible demand assets such as EV chargers and heat pumps must be ‘LEM enabled’ i.e. able to send data about their status to the market maker platform, and receive instructions about when to turn up or down demand. This will typically be done via an intermediary, such as a supplier or an "aggregator". The LEM creates a facility for these parties to trade local energy services more efficiently. Some consumers may also wish to trade directly, in a peer-to-peer manner, and the LEM will also accommodate this over time, if sufficient demand for it materialises. The LEM is essentially an exchange that can be open to everyone who has the capabilities to use it.

How the assets are controlled will be dependent on the particular energy tariff or commercial arrangement. It is expected that the main users of the market maker will be energy suppliers, aggregators or agents, transacting with each other and producing new products and services for their customers. As such, many customers will benefit from the LEM without directly engaging with it themselves.

The GM LEM project has explored two value sharing propositions (VSP) for customers to engage with the LEM that, in time, would form part of a much wider ecosystem of products and offers. The VSPs explored were:

1. A ‘type of use’ tariff trialled by OVO in homes owned by registered provider Northwoods Housing
2. Commercial arrangements including ‘Heat as a Service (HaaS)’ and ‘Vehicle to Grid (V2G)’ by Bruntwood Ltd

Research from both of these routes, known in the project as ‘value sharing propositions’ show huge promise in helping to onboard assets to the LEM and to save customers money on their energy bills.

The GM LEM project has developed a series of animations exploring different aspects of the GM LEM:

- Video 1: Local Energy Markets
- Video 1.1: Local Area Energy Plans
- Video 1.2: Innovative Energy Tariffs
- Video 1.3: Optimisation
- Video 2: Software

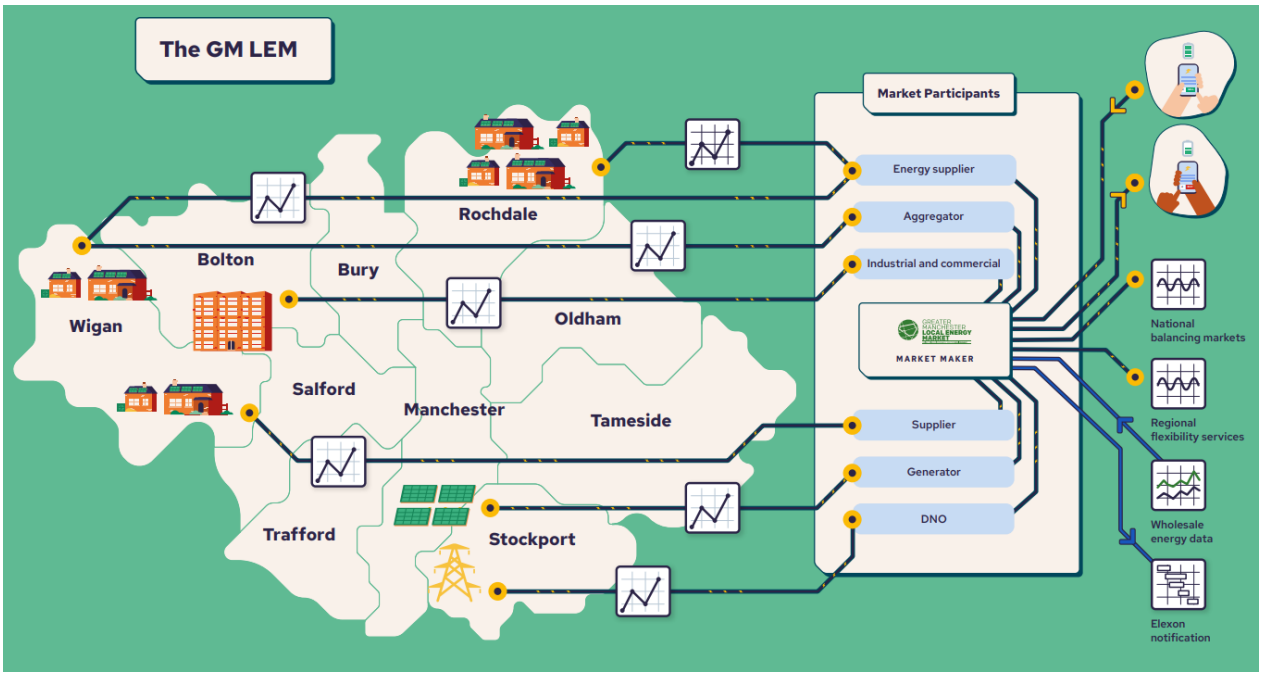


Figure 3: Overview of the GM LEM

Where does the value come from?

There are four main ways the LEM delivers value to the energy system. The LEM itself is an ecosystem of interconnected assets and data, so over time more benefits and value sharing propositions are likely to emerge. Our project, however, considered these four in detail:

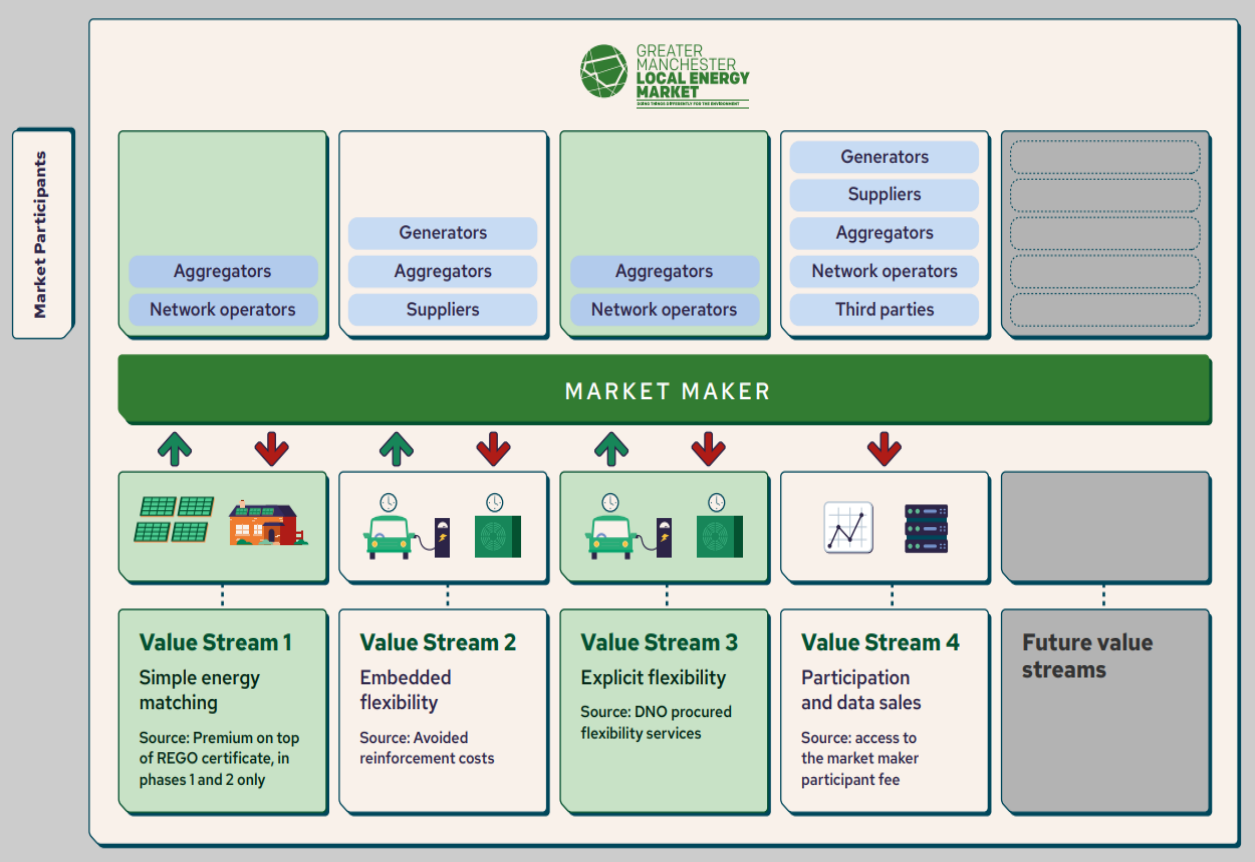
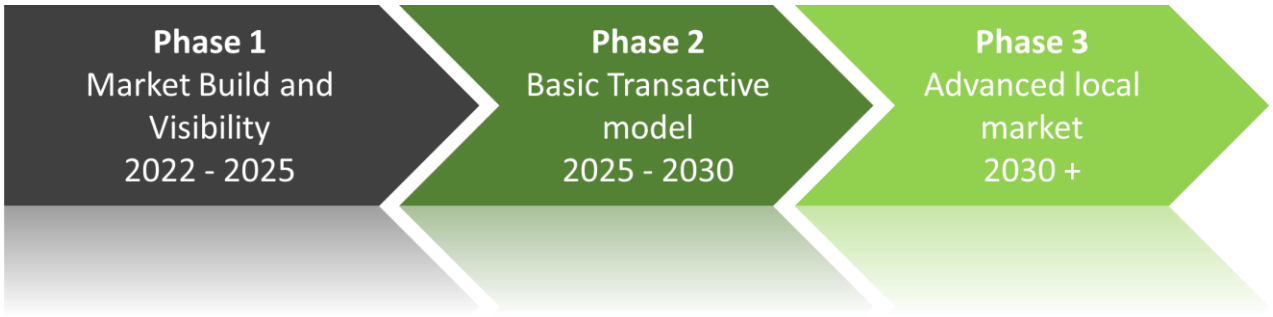


Figure 4: GM LEM primary revenue streams

The most significant revenue stream for the local energy market arises from 'Embedded flexibility'; the concept that shifting demand away from peak times has not just the benefit of cheaper wholesale electricity, but also reduces future investment requirements on the network. These two elements, wholesale arbitrage and network benefits stack together to form the Embedded Flexibility value stream.

The LEM Roadmap

The LEM has been designed to function at a basic level almost immediately, within the rules and regulations of our current energy system, collecting data from anchor participants to 'test and learn', whilst still trading in traditional markets. But, it is also expected to increase its functionality over time, playing a central role in new markets and arrangements as they come forward. The network investment plans for the period up to 2028 have already been outlined by network operators, but it is likely there will be many changes to how our energy system and markets function by the late 2020s and early 2030s. The project has undertaken detailed research into how some of the ideas regarding future system operation would impact the operation of the LEM.



Over time, the LEM will expand in two ways:

1. With the number of flexible assets connected to it, approaching 1 million EVs and heat pumps by 2038 - approximately half of what is forecast by the Local Area Energy Plans for the region.
2. With the range of markets and services it interfaces with, eventually becoming capable of delivering a greater range of services, including peer-to-peer trading.

Who would own and operate the LEM?

The LEM is a term that describes the ecosystem of connected assets, services and value streams that benefit the region. The LEM will be run and managed by an operating organisation, known as the LEMO (LEM operator).

There are two important aspects to the setup and operation of the LEMO:

1. **Commercial:** What are the sources of investment, how will risk be managed and specialist expertise is required?
2. **Societal:** How can GMCA citizens benefit from the LEM and how can it be operated in a transparent and accountable way?

Several project partners undertook public engagement to test the concept of the LEM, how it should be owned and what would be important to them as potential customers or users. There were some clear outcomes as a result of this engagement. Specifically, there was:

- strong support for public ownership over private profit
- a feeling that the LEM operator (LEMO) should return profits to local causes or initiatives
- support for a collaborative environment, where specialist private expertise could and should be used to ensure the LEM runs effectively

- strong support for social responsibility and transparency.

It is clear from public engagement and the regional nature of the LEM that some sort of public body involvement - most likely the combined authority - will be important to its success. In fact, GMCA is already putting in key initiatives and schemes that will ensure the LEM gets off to a flying start, such as the Go Neutral Smart Energy programme[3], which aims to accelerate delivery of 85MW of solar PV on public land.

The project has explored several potential LEMO structures that would give it the necessary power and connections to operate, without requiring expensive and lengthy licences. (See Appendix 5 for more details).

In essence, regardless of the final corporate and governance structure, the LEM will have to adhere to the following principles of trading:

1) **Responsible.** The LEM operates in an open and responsible manner at all times, and requires those party to the LEM to do so.
2) **Fair (Equitable).** The LEM, its partners and participants share the value, costs and risks of all parties appropriately (fairly) based on their specific roles, needs, scale, and activity within the LEM and the wider system.
3) **Evolving (innovative).** The LEM will evolve over time to improve, and support new and different products and services relevant to the parties within the LEM and as the wider energy market changes.

Policy and regulation recommendations for enabling and empowering the GM LEM

Whilst the GM LEM is able to start realising value in today's existing political and regulatory environment, unlocking the more advanced features and benefits requires action from government and the regulator, Ofgem.

[3] Go Neutral Smart Green Energy

There are five key recommendations for realising the full benefits of the GM LEM by 2038:

1) **GMCA to be the competent body to deliver LAEP.** The LAEPs produced in support of this project provide clear evidence for what activity should be undertaken where. This lowers risk for many stakeholders, but it needs a competent, accountable body with appropriate powers to implement them.
2) **Establish Innovation Zones in GMCA.** Innovation zones will provide a mechanism for the exploration of a wider range of energy-related tools including the potential reallocation of policy costs or exploration of alternative routes to deliver ECO.
3) **Energy data access and regulation.** To support the data facilitation, the LEM could trial an innovative approach to customer data access, such as opting in for parties to have visibility of data and therefore be able to access innovative tariffs.
4) **Investigate and pursue opportunities for avoiding network reinforcement and other flexibility services that the LEM can participate in.** There is unquestionably value in matching and dispatching energy assets locally, but how those benefits flow to customers is not yet clear and needs further work and innovation funding.
5) **Capacity trading.** Capacity trading provides for effective utilisation of the local network through reallocating capacity to those that value it most. The GMCA area could be used as a trial zone for capacity trading, using the thinking exploring this in the Access SCR.

Greater Manchester Local Energy Market

Introduction

The scale of the challenge

Greater Manchester Combined Authority has set a target of becoming Carbon Neutral by 2038.

In 2018, the Tyndall Centre provided the Manchester Climate Change Agency (MCCA), the body responsible for championing progress on climate change in the region, with a Carbon budget[4] aligned with GM playing its part in keeping global warming to 2°C. This report set out a clear carbon budget for the region, amounting to about 13% reduction in emissions year on year and three core goals:

- Hold cumulative dioxide emissions from homes, workplaces, and ground transport (direct emissions) at under 15 million tonnes for 2018-2100
- Deliver an annual average of 13% cuts in emissions.
- Reduce emissions from Land use, land use change and forestry (LULUCF) to zero by 2038.

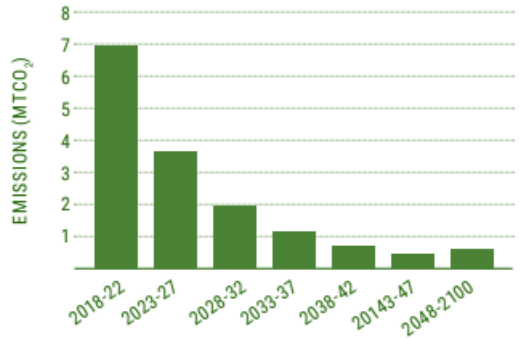


Figure 5: GM emissions budget (Tyndall Centre)

[4] Manchester Carbon Budget (PDF)

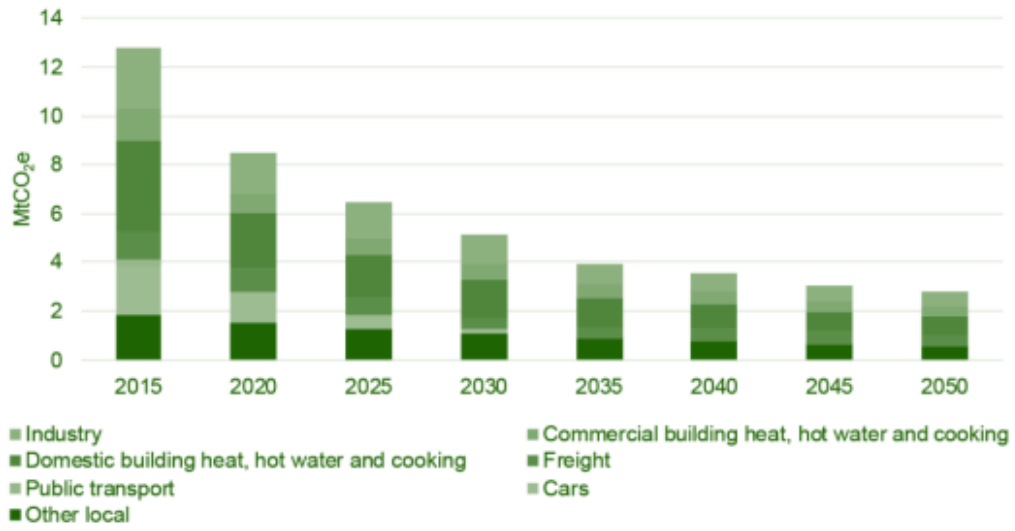


Figure 6: GM emissions reductions by sector

Energy is one of the biggest sources of carbon emissions in the region, as it is in the rest of the UK, and emissions from energy generation and use in Greater Manchester must be dramatically reduced over the coming years to achieve carbon neutrality by 2038.

In response to this demand for lower carbon energy, our energy system is changing. The Energy Systems Catapult has undertaken detailed analysis of all ten boroughs of Greater Manchester, examining how its energy system could be made carbon neutral by 2038. This forecasts a 57% increase in electricity demand, attributed mainly to electric vehicles and heat pumps which will rapidly replace fossil fuelled transport and heating (see Appendix 1 for more details). This correlates strongly to similar analysis on future electricity demand undertaken by Electricity North West Ltd (ENWL), the Distribution Network Operator (DNO) that maintains and operates the distribution network in Greater Manchester. This forecasting work is known as Distributed Future Energy Scenarios (DFES).[5]

The Energy Systems Catapult (ESC) modelled two potential scenarios for replacing fossil fuels: a high electrification scenario (Primary) and a high Hydrogen scenario (Secondary).

[55] Distribution future electricity scenarios

Under the primary scenario, in total by 2038 there are expected to be nearly 2 million heat pumps and electric vehicles in Greater Manchester, contributing to an additional demand for 8.8 TWh of electricity a year.

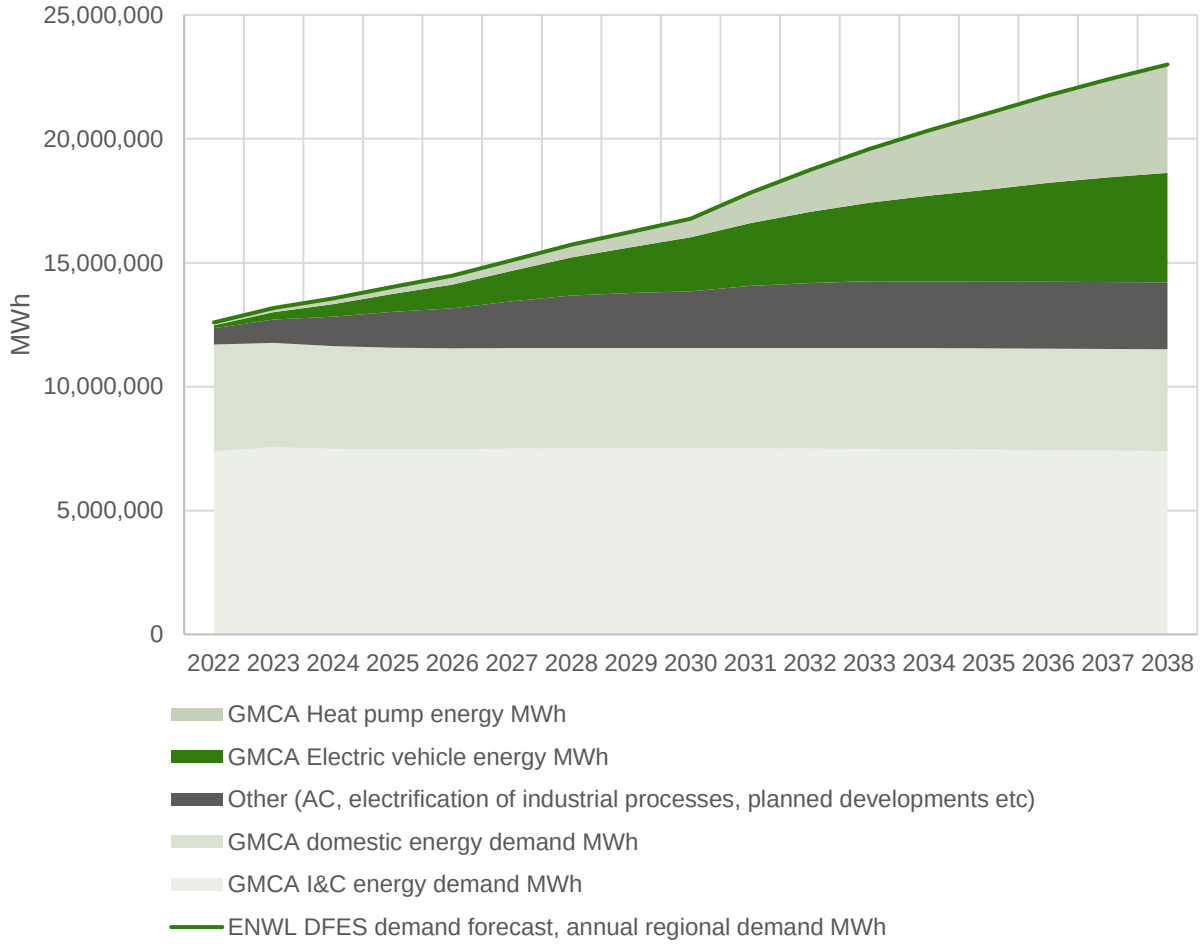


Figure 7: GM electricity demand forecast

Clearly, this dramatic increase in demand will require additional infrastructure and management of the energy networks. Each DNO must submit plans for a five-year price period, in which they forecast the expected changes to use of their network, and associated investment plans. The next ‘price control period’ as they are known will be 2023-2028. However, most of these plans assume decarbonisation by 2050 in line with UK targets, over a decade behind the ambition of Greater Manchester.

Could a place-based, local approach to optimising the networks be a route to supporting the rapid decarbonisation of the energy system and connection of new low carbon assets, without dramatically increasing customers’ energy bills?

Value of ‘local’

The UK electricity system has evolved over decades with a single overriding aim: to keep the lights on at the lowest possible cost to the customer. This approach has led to a system which is now a complex web of markets with an array of participants, balancing responsible parties, generators, suppliers, aggregators and network operators. National markets provide the core price of wholesale energy and there are nationally procured services providing critical services such as balancing, reactive power control, ‘black start’ capability, and more.

But, increasingly, there is interest in how local optimisation of energy networks could supplement these national markets. A recent report by PwC[6] concluded that in Greater Manchester alone, taking a place-based approach to decarbonisation could result in a reduction on energy bills of £5bn by 2050, and wider social benefits of £59bn by 2050, from an investment of £3.2bn.

These benefits arise because place-based approaches to infrastructure and markets can make best use of their own specific resources, knowledge, local supply chains and infrastructure, making strategic decisions that fit the specific needs of that local area. This flexibility to target and leverage investment locally leads to more tailored options for decision makers, and better outcomes for customers and society.

Purpose of the GM LEM2 project

The GM LEM2 project has been a two year, Innovate UK funded project under the ‘Prospering from the energy revolution’ (PFER) programme, building on a previous PfER funded feasibility study, LEM1. This current £100m PFER programme round has funded three demonstrator and ten city and region scale projects, researching innovative smart local energy systems and how they could deliver real impact on our journey to net zero as quickly as possible, match funded by project participants

The GM LEM2 project is a ‘detailed design’ project, focused on how a local energy market could function in Greater Manchester. The Greater Manchester Local Energy Market (GMLEM) aims to change the way the market currently works by developing a

[6] Accelerating Net Zero Delivery (PDF)

platform that increases visibility of energy activity and transactions, suitable for the challenges of the mid-2020s. The project is based on an ambitious whole-system vision for how energy is generated, traded, transported, supplied and used across the city region. It envisions localising energy systems, reducing the distance energy travels to its point of use and optimising consumption. This requires a unique new platform, enabling a local energy market maker to integrate smart technologies across heat, power and transport and link together local demand with supply via local distribution and national transmission.

Project partners:

Supporting partners:

What is a LEM?

A local energy market or LEM is a way of facilitating the movement of energy, capacity or demand to customers close by, with the aim of:

- Reducing the use of infrastructure, to lower costs
- Optimising the use of local supply and demand to reduce import and export out of the region
- Improving visibility of energy flows to help inform strategic decision making about network investment and other place-based services including health, public transport etc.
- Improving visibility of the choices people make and the value they ascribe to attributes of energy such as locality, greenness, ownership. By enabling suppliers and intermediaries to offer “enhanced” products (based on more than lowest price) to the consumer segments that value these attributes, the LEM aims to increase the overall size of the prize that can be addressed by suppliers and innovative intermediaries, and to increase the perceived value of the products available to consumers.

There is no set definition of how a LEM should be setup, or go about achieving these aims but the ESC describes a LEM as: “the term used to describe initiatives to establish a marketplace to coordinate the generation, supply, storage, transport, and consumption of energy from decentralised energy resources (e.g. renewable energy generators, storage and demand-side response providers) within a confined geographical area.”[7]

[7] The policy and regulatory context for new Local Energy Markets

Purpose of this report

This is the final report outlining the detailed design of the GM LEM. The project was divided into ten work packages that tackled different aspects of the LEM design. Each work package lead produced a final report, included here as appendices. The investment summary, final output of Work Package 8, is presented as an Excel workbook (Appendix 6).

The GM LEM

The GM LEM detailed design project has focused on:

- **Optimisation of (local) energy and network usage** to drive down costs and enable decarbonisation (more renewables/storage and electrification) in the local area (fostering investment and local jobs)
- **Improving end customer (consumer and business) benefit** – enabling a competitive LEM with access for all through value sharing propositions
- **Ensuring social inclusion**

After a series of workshops and identification of use cases, the consortium agreed on a functioning exchange or **'market maker'** to trade and optimise energy, flexibility and network capacity at a local level. As it does this, it will make attributes such as location and carbon (possibly others such as air quality, community ownership, etc) visible, allowing people to account for these in their valuation of / preference for service.

This model was selected as it filled a gap that an independent body is well placed to fill, did not directly compete with current market participants (suppliers, aggregators, etc), and could add value with current market regulations, but could also grow and expand in scope as the energy market and regulations developed.

The market maker

The market maker sits at the heart of the LEM, providing that shop window and visibility of many, if not all, the markets and opportunities of the local and national energy system. Specifically;

- Trading parties can:
    - identify suitable counterparties
    - make a contract
    - exercise flexibility contracts

- The LEM operator can clear and settle trades (potentially, from phase 2, as this is currently subject to national arrangements on settlement etc.)
- The GM LEM can be used by parties connected to the electricity system within the LEM's geographic boundaries to trade:
    - (electrical) energy
    - flexibility
    - network capacity
- The GM LEM enables parties to express, within their bids/offers, preferences with respect to attributes other than price, e.g. carbon content of electricity and locality.

All of these functions are intended to supplement the existing markets that participants are already using. Appendix 5 provides more detail on how the LEM fits with national markets and structures.

Phased approach

The GM LEM has been designed to begin operating within the current markets and regulatory framework, and build up functionality over time.

The three core phases are:

Key features of each phase:

Phase 1: 2022 – 2025

- Market maker provides visibility of 'bids and offers'
- Market maker gathers data about connected assets

Phase 2: 2025 – 2030

- All of the Phase 1 features
- Facilitate choice of service level through network charging reform

Phase 3: 2030 onwards

- All of the Phase 1 and 2 features
- Provision of market function alongside existing markets (Federation of energy markets), including Peer to Peer trading

How does the GM LEM create shared value?

The LEM is an ecosystem which can connect suppliers and customers together in a way which delivers mutual value and value to the energy system overall.

To start with, the core users of the LEM in phases 1 and 2 will be market participants who already participate in other, national markets. This includes:

- Energy suppliers
- Aggregators
- Network operators
- Energy generators
- Third parties that are not looking to transact, but value data generated by the LEM

In phase 1, the Market Maker is effectively 'seeding' the market with activity from sophisticated market participants. Thus, while end customers may not interact directly with the market maker, the value sharing propositions designed for the LEM will ensure there are opportunities for end customers to gain the benefits ensuring social inclusion.

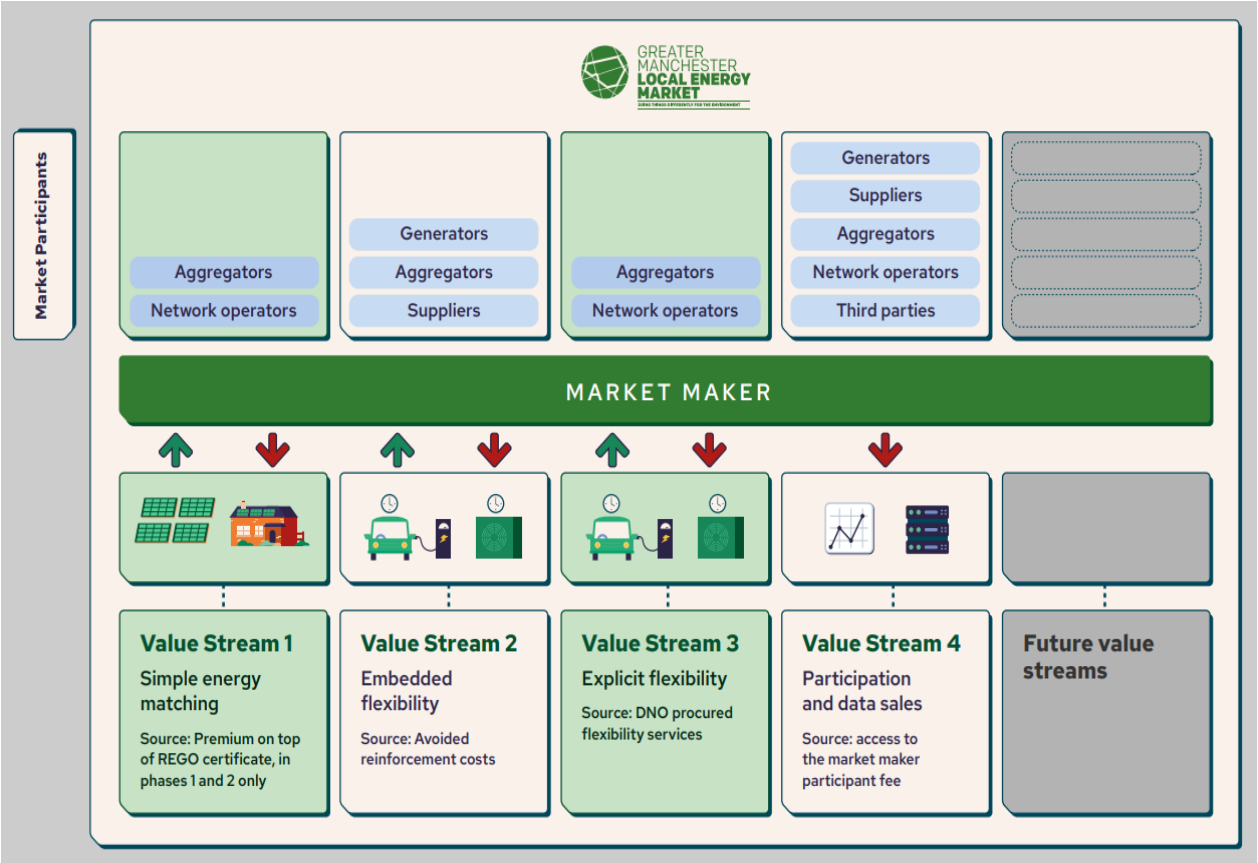


Figure 8: GM LEM primary revenue streams

There are four main activities that are facilitated by the Market Maker in the forecasted investment summary out to 2038:

1. Simple energy matching
2. Embedded flexibility
3. Explicit flexibility
4. LEM participation and data sales

The core value of the LEM is in providing visibility of energy system markets and opportunities to LEM participants, and in later phases having a functional role itself in some of those markets. This means the LEM can be a ‘one-stop-shop’ for market participants who might want to sell their generation or demand into more than one market, at the most opportune time. The core functionality that underpins this is the ability to transact at high granularity, at least half-hourly.

It is this granularity that enables participants to mix and match their profiles to customers, using price, location and carbon intensity signals to drive transactions. The better the profiles are matched and reflect the *cost* of using the network (particularly at peak times), the more efficiently the network can be used, lowering peak usage and the requirement to reinforce.

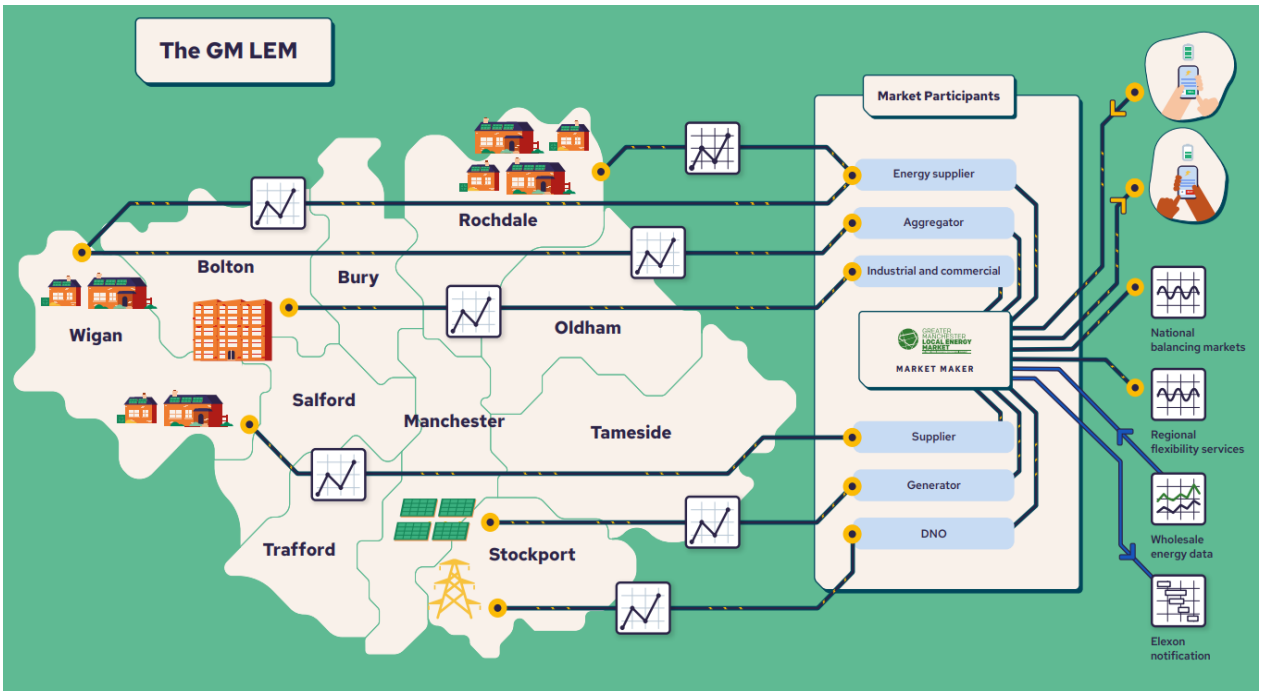


Figure 9: Overview of the GM LEM

Value stream modelling approach

A key part of the GM LEM project has been the commissioning of 10 Local Area Energy Plans (LAEPs) for each of the boroughs in Greater Manchester, culminating in a single, overarching summary plan for the combined authority area. These have been delivered by the ESC. These detailed, address-level plans provide insight into how low carbon assets might be deployed across GM out to 2038, in pursuit of the carbon neutrality target.

Two scenarios were modelled: a high electrification pathway and a high Hydrogen pathway. (See Appendix 1 for the summary LAEP).

The LAEPs provide critical data on the spatial and temporal deployment of low carbon assets such as solar PV, electric vehicles, heat pumps and energy efficiency measures, as well as the forecast impact on energy networks.

It is the data contained in these LAEPs, along with similar forecasting undertaken by ENWL as part of its annual Distributed Future Energy Scenarios (DFES) process which provides the core data for modelling the LEM.

Simple energy matching

Using data from the LAEPs, it is clear that the ESC model forecasts a huge amount of solar PV to be deployed rapidly, topping out at just under 10GW by 2038. Whilst this may be necessary for their primary scenario, it assumes a significant increase in

daytime energy use, energy storage and network reinforcement. For the purposes of the revenue stream modelling, a moderate deployment rate was selected, which delivers just over 4GW of new solar PV capacity by 2038, just under ENWL's current headroom forecast for the region.

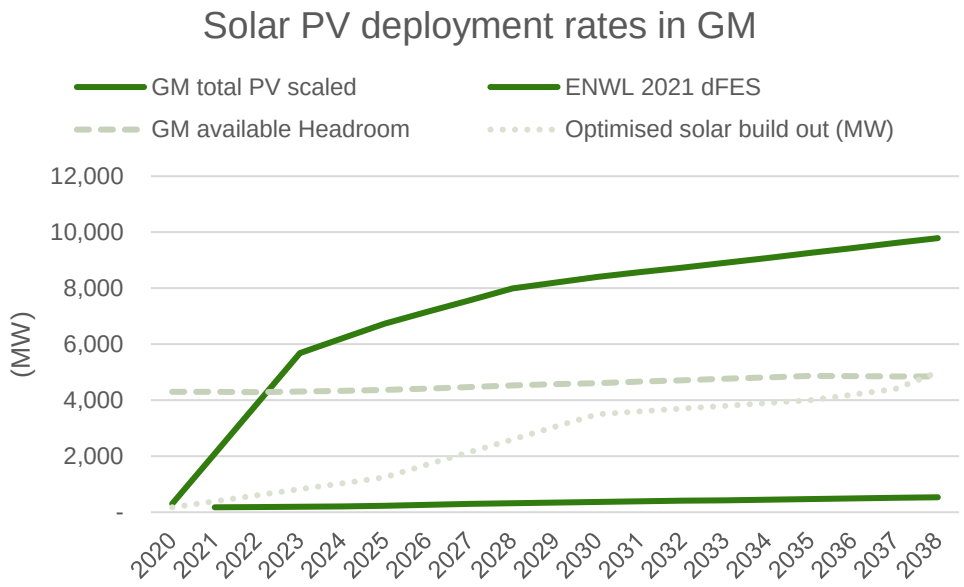


Figure 10: GM solar PV deployment forecast

Using this optimised deployment curve, and a factor for how much of that solar might be available for 'matching' via the market maker (50%), this provided the maximum GWh/yr of local, green electricity that is available for suppliers to buy and sell on to customers through a variety of new tariffs.

Simple matching value sharing proposition

Energy suppliers will be able to use the LEM to develop new tariffs that meet the needs of domestic and commercial customers. One such tariff might be ‘green and local’, which matches every annual kWh of demand to a specific kWh of low carbon generation from local sources. Such a tariff would be limited by the amount of low carbon generation available to buy on an annual basis, but would likely carry a price premium, similar to other premium green tariffs on the market now.

Indications are that 1-2% of the domestic population would want to support local low carbon generation in this way, and many businesses would value such a tariff in pursuit of their Corporate Social Responsibility (CSR) requirements. In addition, some businesses could be offered more advanced tariffs during daylight hours that match on a half-hourly basis, for a higher fee. These fees would be in addition to any Renewable Energy Guarantee of Origin (REGO) certificate market cost.

Embedded Flexibility

The idea of ‘embedded flexibility’ is core to the LEM’s ability to deliver value to the system. The concept of embedded flexibility arises from the difference between:

- **A low flex scenario**. Assumes very low levels of time shifting of demand. Many users (commercial and domestic) will want to use low carbon energy assets, such as heat pumps and electric vehicle charging at similar times. The existing market proves limited at encouraging ‘smoothing’ of demand throughout the day. This is broadly the assumption of the ESC LAEP modelling approach
- **A high flex scenario**. Assumes higher levels of flex than the ESC approach, with the energy system providing mechanisms that encourage demand shift away from peak times. That could be achieved through new time or type of use tariffs, peer-to-peer trading, or demand turn down. This is the approach adopted by ENWL in their 2021 DFES modelling.

The difference between these two forecasts for any given day (see Figure 11 for an example of two typical cold days) is essentially the amount of ‘embedded flex’ that must be found to bring demand in line with the ENWL forecast and therefore their investment profile. This difference clearly has a value, as without it, the network operator would need to accommodate this demand with either reinforcement or significant increases in explicit (procured) flexibility services.

The value of avoiding these levels of reinforcement in the GM region is known as ‘system benefit’ and is one of the key benefits that a LEM could help deliver.

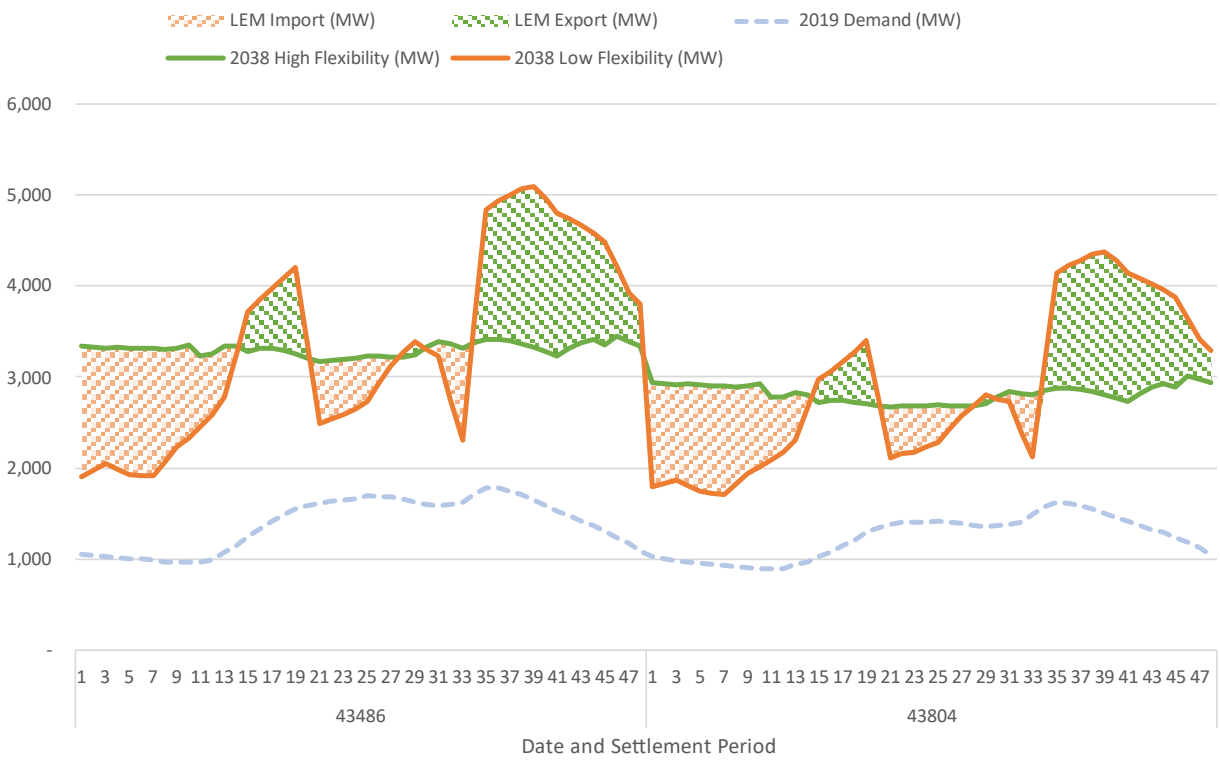


Figure 11: GM electricity profile, two cold days

Whilst there is still significant uncertainty about how much embedded flexibility is going to be needed by the energy system by 2038, it is clear that the wholesale market alone will not produce the time shift in demand needed to mitigate the increase in local peak load. Even with the medium flexibility scenario, there will need to be significant network investment and upgrades to manage the increased energy flows arising from low carbon technologies.

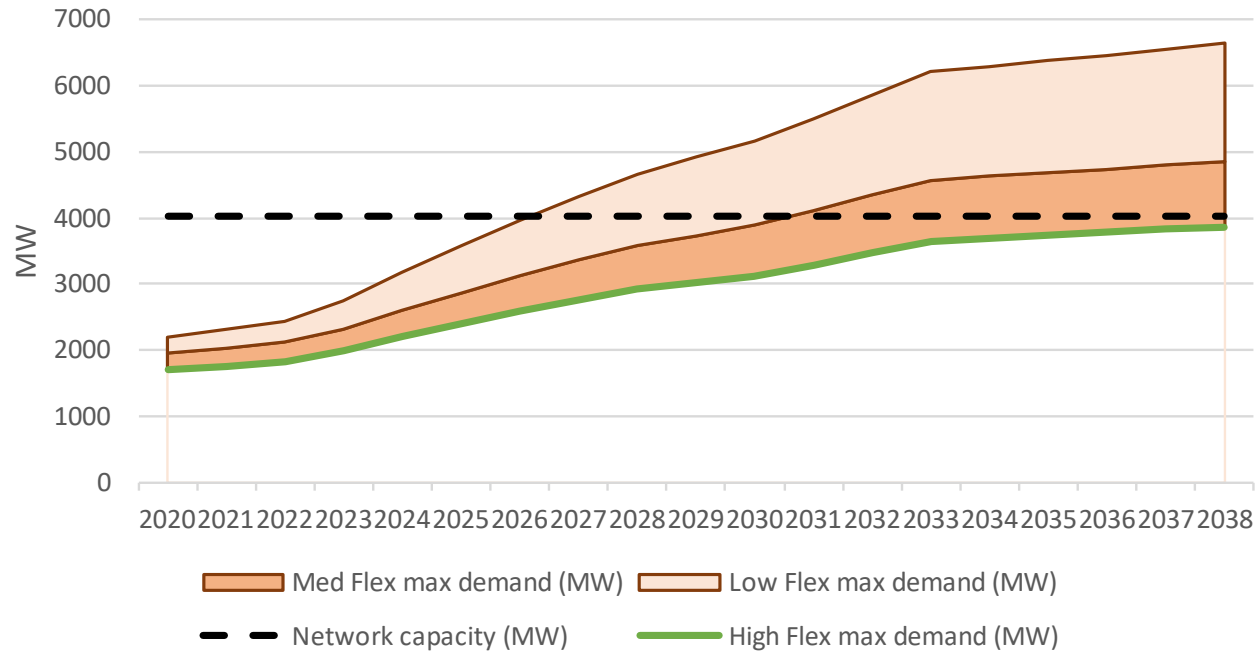


Figure 12: GM maximum electricity demand

It is currently not clear how that system benefit value might be realised as it arises from reducing future spend. A 'low flex' scenario would certainly add additional cost to network operations by 2038 and therefore increase DUoS and potentially TNUoS costs (which currently represent about 20-30% of the typical domestic electricity bill), impacting everyone's electricity bill in the region.[8] [9] A high flex scenario would make better use of the network, but how those savings could be passed through the system needs further investigation.

Note that, since September 2021 and the commencement of the "energy crisis", this typical breakdown has been skewed significantly towards the wholesale element of the bill. In the past 12 months, wholesale costs have represented 66% or more of total electricity costs, although we have retained the typical breakdown to show the cost breakdown in a more "typical" environment aligned with the long-term historic average.

The high flexibility scenario modelled for the LEM minimum viable proposition (see Appendix 6 for more details) enables peak demand to remain under the expected network capacity forecast by ENWL for 2038. The LEM could play a critical role in providing that high level of embedded flexibility.

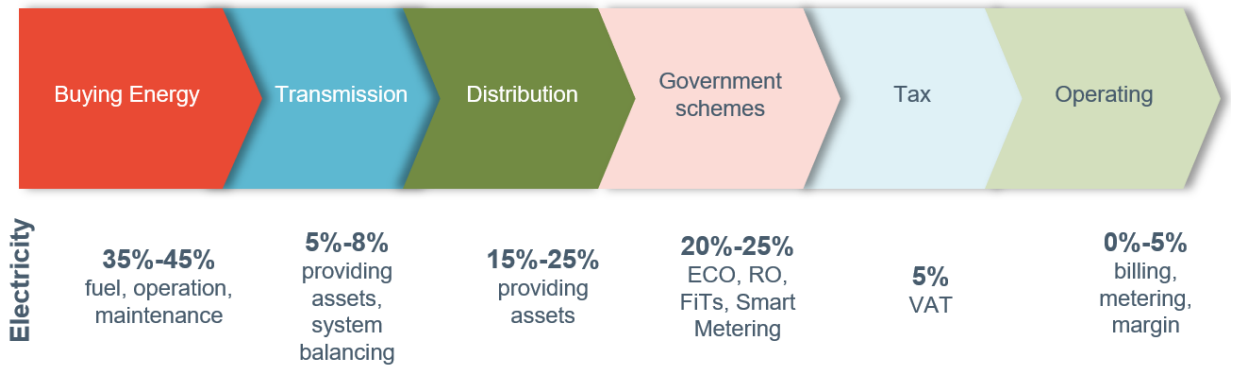


Figure 13: Typical electricity cost split

According to the modelling undertaken by the project, the system benefit that could be passed back to domestic customers for providing small levels of flex could start at around £15/yr per low carbon asset (heat pump or electric vehicle charge).

[8] Current charging information

[9] Costs in your energy bill

Explicit Flexibility

'Explicit flexibility', for the purposes of this report, refers to the flexibility auctions run by all distribution network operators (DNOs) in Great Britain. These are open procurements for market participants to contract with DNOs, providing services in specific zones during specific time windows. The purpose of these 'flexibility services' is to manage times of system stress, paying market participants for their ability to modify their electricity demand. This can be in response to network faults, or times when the network exceeds safe operating capacity. DNOs are encouraged by their regulator, Ofgem, to follow a 'flexibility first' approach to operating their network, only reinforcing when using flexibility becomes less economically beneficial for customers.

These markets have existed for some time and are well understood, with DNOs forecasting their expected spend on flexibility services in their investment period plans.

Phase 2 of the GM LEM will provide visibility of ENWL flexibility requirements in addition to the market participants, allowing aggregators and high demand customers to participate directly in flexibility services auctions. This improves diversity of supply to the DNO buying the flex, and spreads the benefit of providing small amounts of flex to more participants. It also enables other flex buyers to participate in these markets, e.g. for secondary trading amongst aggregators and other flex providers, or for balance responsible parties (BRPs) to buy flex to manage their imbalance positions. In later phases, the LEM also offers a route to integrate all sources of network flexibility (e.g. Active Network Management - ANM) into a single marketplace, improving market liquidity and optimising the value earned by and derived from flex.

ENWL have forecast that flexibility services will increase significantly on current levels by 2038, but this remains a relatively small revenue stream for the market maker, compared to embedded flexibility. [10]

LEM participation and data sales

LEM participants will have access to a range of data streams generated and hosted by the LEM. This data will be at the level of granularity achieved by the LEM, starting off at

[10] ENWL DFES

half-hourly and progressing toward sub-minute by 2038. These data streams are hugely valuable and give the LEM an opportunity to curate data packages for different types of user. For example, public authorities might have free or low-cost access to data streams on the LEM that will aid place-based decision making and inform investment decisions. Private corporate entities may be charged for similar access (e.g. to support their own investment decisions, or to enable development of LEM-enabled products that fully capture the value that people ascribe to attributes such as locality of generation), helping fund the operation of the LEM. It could even be possible for the LEM to provide free visualisation of certain data streams to improve transparency and accountability of the system to the public, and be tied into other things like energy efficiency advice, planning processes and healthcare. Digitisation of energy data is proving a huge opportunity for innovation in the UK, with Innovate UK, Ofgem and others undertaking major programmes of work in this space. [11]

LEM investment and minimum viable proposition

Project partner Regen has undertaken high level analysis of how the GM LEM might function financially in the existing energy market, and what the minimum viable proposition (MVP) might be. This summary was heavily informed by work undertaken by Green Longbow Consulting for Bruntwood as part of the LEM technical design. (See the investment summary workbook in Appendix 6 for more information).

Key assumptions that underpinned this MVP approach are:

- All the assets required for the ESC LAEP primary scenario to achieve carbon neutrality by 2038 were deployed, with a ‘market share’ of those connecting to the LEM via new tariffs or innovative approaches
- An optimised amount of solar PV is deployed and built, which is more than the ENWL forecast but lower than the ESC LAEP forecast
- Energy system value (mostly embedded flexibility value) can be realised as avoided reinforcement costs, and made available to market participants
- 1-2% of domestic bill payers would want to buy local and green energy, matched on an annual basis

[11] MEDApps, REFERENCES

- Some commercial customers would want to buy local and green energy, matched on an annual basis
- The market maker would have 25 market participants (suppliers, generators, network operators, aggregators etc) by 2030
- The LEM takes a transaction fee for each kWh that is bought and sold through the market maker

Overall investment summary

Using the assumptions outline above, the market maker at its minimum viable proposition provides a viable business case.

With two million low carbon assets such as heat pumps and electric vehicles due to be deployed by 2038[12], if half of those connect to the LEM via innovative tariffs or approaches developed by energy suppliers and aggregators, it is possible to use their inherent flexibility to achieve £40 million in system benefit by 2038.

[12] ESC GM LAEP, 2022

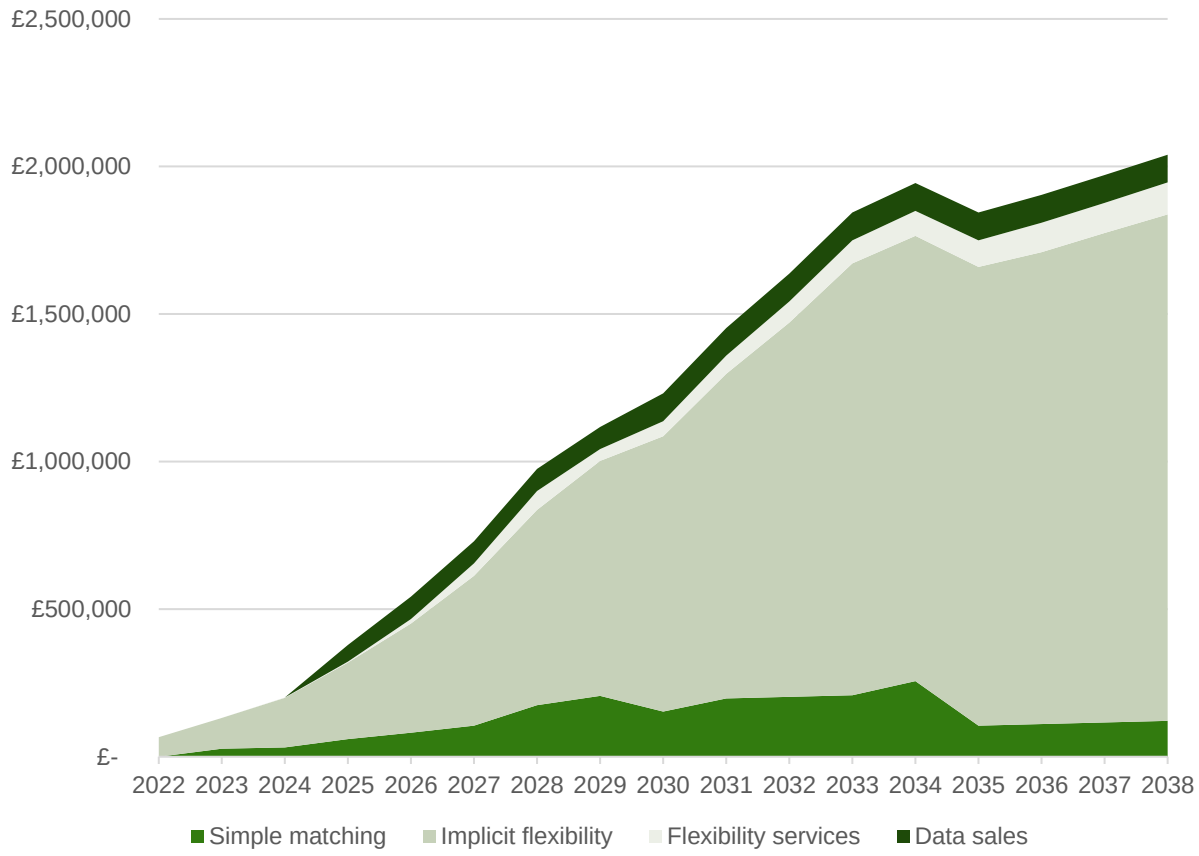


Figure 14: Revenue stream values - income to the Market Maker

The revenue streams modelled for the MVP provide sufficient income to run the LEM and generate a small surplus year on year by 2038.

	2025	2030	2035	2038
Capital expenditure (CAPEX)	£302,000	£151,000	£125,000	£105,000
Operational expenditure (OPEX)	£577,724	£764,724	£764,724	£764,724
Income	£378,760	£1,231,179	£1,843,797	£2,039,833
Cashflow	-£500,964	£315,455	£954,073	£1,170,109
Cumulative cashflow	-£2,487,143	-£2,255,286	£1,964,691	£5,270,290

By 2033, the LEMO pays back its initial investment of £2.7m.

The biggest risk to the LEM generating enough revenue to operate is that the energy market is not able to value alternatives to reinforcement or explicit flexibility.

Most of this revenue comes from transactions which are keeping peak demand below the network capacity and avoiding reinforcement; ‘embedded flexibility’. Of this embedded flexibility, there are two ways that value is realised:

1. **Network benefit** i.e. avoided reinforcement to meet peak demand (and generation export)
2. **Wholesale arbitrage** i.e. making more use of non-peak electricity, which is cheaper.

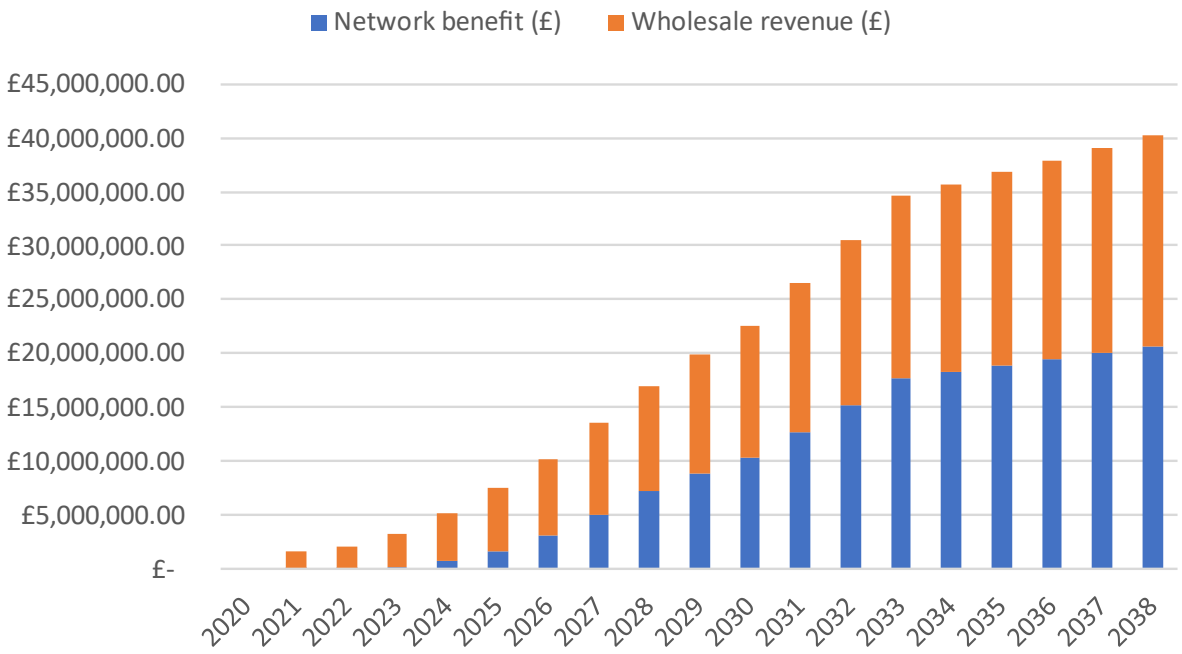


Figure 15: Embedded flexibility value streams

The LEM takes fees for each kWh that is matched between supplier and customer, whether that is generators selling electricity to suppliers, or network operators buying demand turn down at times of network stress.

Embedded flexibility from all installed HPs and EV chargers

Market share	Wholesale fee	Network fee	Solar fee (£/MWh)
50%	6.0%	10.0%	£2.5

After initial investment to recruit staff and setup the platform, the LEMO makes a positive cashflow after 5 years.

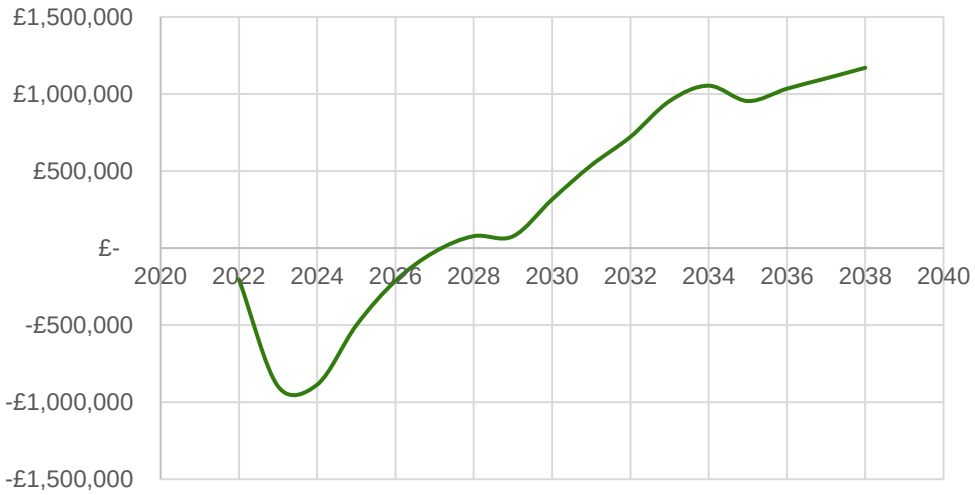


Figure 16: Market Maker cashflow

What does the LEM mean for customers?

The initial phase of the LEM focuses on providing visibility of local and national energy markets to market participants like energy suppliers, generators and aggregators. As the GM LEM will not be an active 'Balancing Responsible Party' (BRP) in phases 1 or 2, it will not be setting up a domestic public facing brand. For this reason, engagement with the LEM may be different for domestic customers and commercial customers.

Domestic Value Sharing Propositions (VSPs)

The GM LEM facilitates demand shifting and granular transactions between market participants. This will make it easier for energy suppliers and aggregators to find demand and generation profiles that could be used for innovative new tariffs, such as a 'green and local' tariffs, or 'Heat Pump Pro +', which could be an evolution of the Heat Pump Pro tariff being trialled by Ovo as part of this project. For domestic customers, once the LEM is running, they should see a greater number of more flexible, locally focused tariffs that give them more choice about where their electricity comes from and potentially savings arising from their flexible assets.

Modelling undertaken by Bruntwood and Ovo indicate that a domestic heat pump or EV could yield around at least £15/yr each from embedded flexibility provision, without playing an active role in asset management. These figures could become substantially higher if peak demand continues to rise and flexibility services become more valuable.

Appendix 3 describes in detail the domestic VSPs.

Commercial VSPs

Some commercial organisations may engage with the LEM directly, especially if they have significant flexible assets (such as industrial fridges, or large heat pumps) or onsite generation that they sometimes export. By allowing the LEM to collect data about their energy use, generation and ability to shift demand, this profile can be available to 'sell' to customers. For example, as part of this project, Bruntwood, a commercial property owner, investigated two models for helping decarbonise their own operations and provide improved service to their customers:

- Heat as a Service (HaaS - see box 4)
- Optimised electric vehicle parking and charging, including Vehicle to Grid (V2G)

Both these models would benefit from connection to the GM LEM, as each would have visibility of a wide and decentralised range of assets that could be used to meet needs elsewhere in the region, whilst being responsive to pricing signals.

Appendix 2 describes in detail the non-domestic VSPs.

How does the LEM work?

The GM LEM has been designed to be an energy marketplace that complements the existing national energy markets (managed by National Grid ESO) and the regional market for flexibility, (managed by the DNO, ENWL). The LEM is a trading platform that provides visibility of markets and market participants, and over time will add more functionality and granularity. Market participants must connect assets such as solar PV or heat pumps to the LEM so their data can be shared. (See Appendix 5 for more details on proposed contractual arrangements to do this).

Specific features include:

- Market participants can:
    - identify suitable counterparties
    - enter into a contract
    - exercise flexibility contracts
- The LEMO can clear and settle trades, subject to national settlement arrangements
- The GM LEM can be used by parties connected to the electricity system within the LEM's geographic boundaries to trade:
    - (electrical) energy
    - flexibility
    - network capacity
- The GM LEM enables parties to express, within their bids/offers, preferences with respect to attributes other than price, e.g. carbon content of electricity and locality

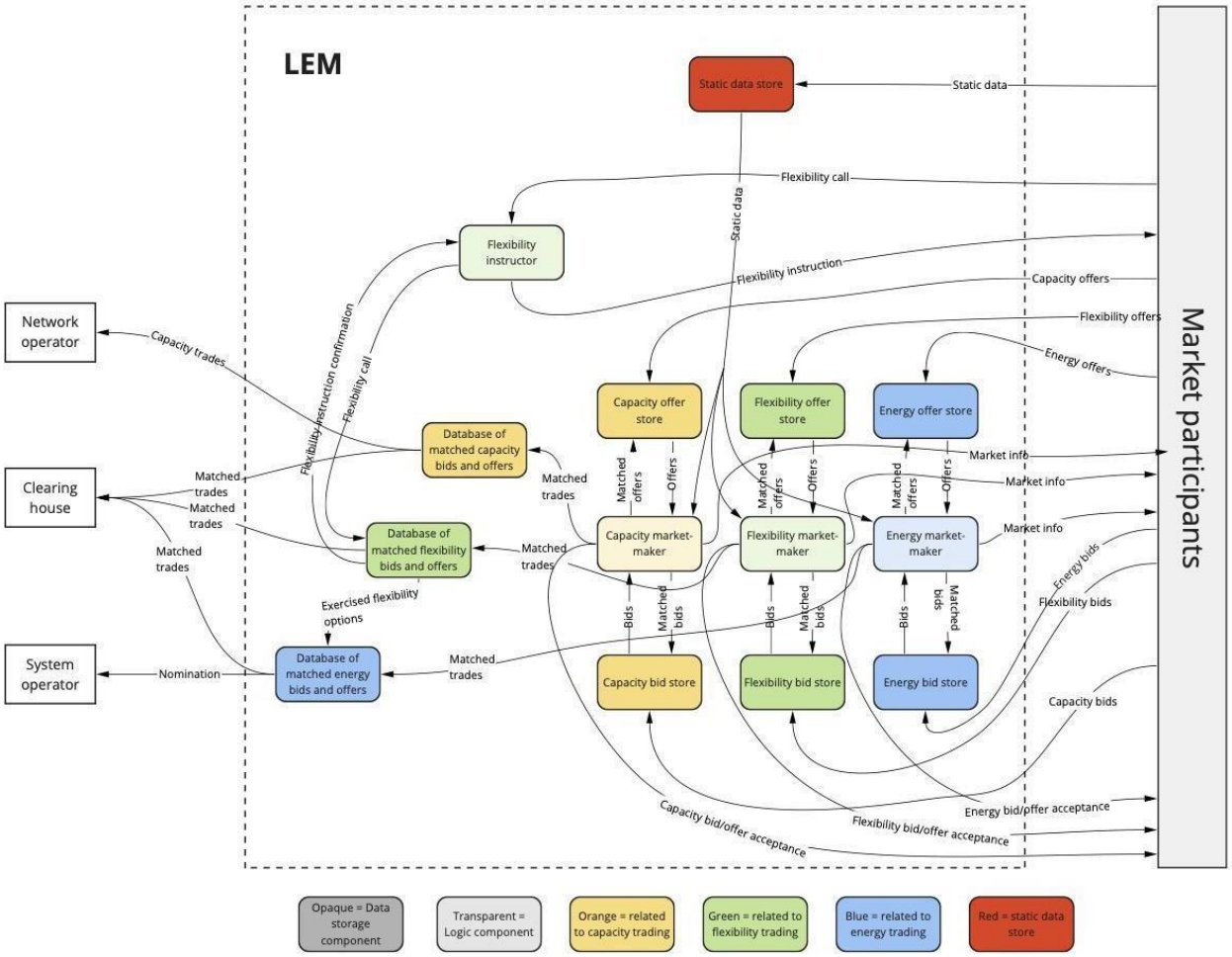


Figure 17: Function map of the GM LEM (phase 1)

The project team contracted KrakenFlex to develop a prototype of the Market Maker platform to demonstrate how bids and offers would be submitted and matched within the prototype. This was shared with the Innovate UK team. Since the demonstration, further work has continued to refine the use cases and improve the user experience of the platform to further demonstrate how it could work.

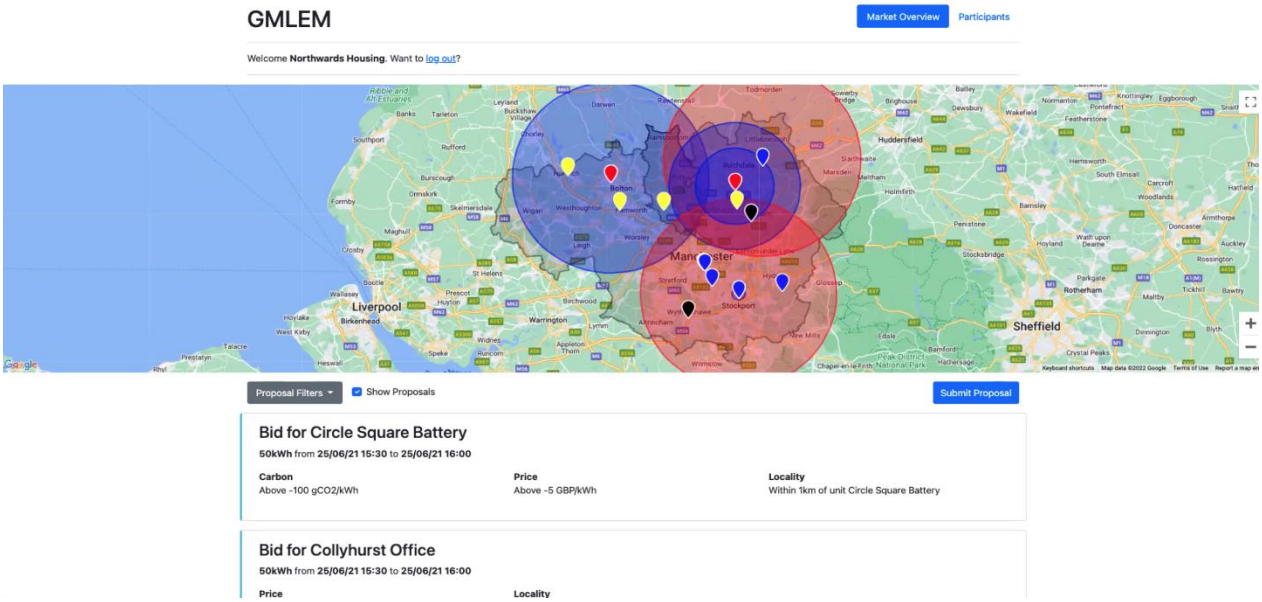


Figure 18: Illustration of the GM LEM Market Maker interface

KrakenFlex have also onboarded a number of assets within the project that can be dispatched according to the bid and offers submitted and matched within the Market Maker, testing the architecture of the LEM. See Appendix 5 for more information.

More advanced LEM features: Heat as a Service

GM LEM project partner Bruntwood, one of the largest commercial landlords in the UK, has explored how heating systems in their tenanted buildings could be switched to lower carbon sources. 'Heat as a Service' (HaaS) where tenants pay a charge for delivery of either heat or 'comfort' has been widely attempted over the years, but has faced challenges in implementation. As part of the GM LEM project, Bruntwood has undertaken detailed research and modelling into HaaS and how it could be used to lower carbon emissions in multi-tenanted buildings. (See Appendix 2 for details). Much of the challenge has been in finding an approach that delivers the following for customers:

1. Being evidentially green
2. Managing unpredictable energy costs
3. Being comfortable

HaaS has the potential to provide real fixed cost energy contracts (which many consumers would prefer from a budgeting perspective). The volatility inherent in the relationship is managed by an energy supplier, who is better placed to manage it, and can do so at a lower cost and risk. In return, the supplier receives an increased margin, and the potential to further optimise the offering over time.

Ultimately, the greatest challenge to creating a viable HaaS offer is management of risk around energy price volatility and changes to patterns of demand related to weather, climate and building occupancy. Work undertaken as part of this project found that there is a viable approach to quantifying and pricing this risk, with the following observations:

- monthly demand for a whole building was a good proxy for hourly data to calculate the risk premium required.
- high quality long duration demand datasets allowed the potential to critically analyse and remove outliers from the historic data, which produced more accurate regression coefficients.
- a reasonably modest increase in heating cost to the tenant of ~1% to provide a fixed cost product was expected to be attractive in order to offset a likely average 5-10% swing in cost (which most tenants are likely to perceive to be a higher risk), especially if bundled into an overall tenancy agreement for a number of years.
- the value to Bruntwood is expected to be materially profitable over time; however, the likely cash flow impacts are likely to be material year on year due to fluctuations in energy volumes and market prices.
- Less energy efficient buildings have a greater temperature dependent volume volatility and therefore require a higher HaaS premium. This is also the case for sites with lower quality historic demand data.

An additional important factor to the proposition is the potential future interaction with the LEM or flexibility marketplaces. HaaS can significantly increase the opportunities to flex load through a proposition such as HaaS which can optimise control and timing of heat without sacrificing comfort and reducing overall input costs which could be shared between energy supplier and consumer.

What would be the benefits of a GM LEM?

Why bother with a Local Energy Market at all? The UK is a relatively small island with good distribution and transmission networks and coverage. How does a more place-based approach to optimising bits of the energy system help unlock more low carbon generation or lower bills?

- First and foremost, the LEM can directly connect generation sites with demand sites, permitting customers to buy their energy not just based on price, but considering carbon intensity, location and other factors. There is clear consumer support for this level of choice and to potentially pay a premium for 'local and green'. Even if this only represents 2% of the energy bill payers in GM, this provides a strong signal to low carbon generation developers to invest in the region and it provides businesses with evidence of strong Corporate Social Responsibility (CSR) and evidence of commitment to place-making. This may be especially important for smaller (<10MW) generators, as it gives them a route to market with fewer overheads than national markets, which were inherently designed for larger facilities. These smaller generators are well suited to many of sites available within GM.
- Secondly, the LEM can help deliver the 'high flex' environment forecast by ENWL; i.e high levels of demand shift within the distribution network. The LEM can achieve this because it will have high numbers of commercial (and later on, domestic) assets connected to it providing data on their demand profiles, as well as equivalent data from local generators. The LEM can enable this demand shift in enough quantity to influence (and reduce) network reinforcement investment, saving money on energy bills.
- Thirdly, the data being produced by the LEM is valuable. The energy system touches on many other aspects of society, including health, transportation, green spaces, air quality etc. Gathering data about patterns of use, responses to network events and pricing can help inform decision makers and lead to better outcomes.
- Lastly, the LEM can be an open and transparent innovation ecosystem for new models, products and services that need to make use of this data. Having a system that already brings together many valuable data streams in the region can provide a powerful launchpad for the businesses of the future, leading to increased prosperity and better outcomes.

What does the public think about the GM LEM?

Three of the project participants (Carbon Coop, Ovo and ESC) undertook public engagement as part of their work on GM LEM, testing the ideas and approaches being generated by the project team through surveys, high-street interaction and a citizens' jury[13].

The engagement approach explained the link between energy, costs, and climate change. 2021 saw the UK enter an energy crisis with steep increases in gas and electricity bills and over 20 energy firms going bust. Notably, the country also experienced a brief crisis in petrol supplies in September 2021. Most recently the devastating war in the Ukraine has also exacerbated the UK's cost of living crisis, with the threat of energy bills heading toward £3000/yr by the end of 2022.

Energy and transport fuel costs are the major contributing factor to the current cost of living crisis, focusing public attention on the way in which we consume and pay for energy. This led to a very active response from the public in the engagement activities of the project.

Figure 19: Public engagement activity (Carbon Coop)

[13] Greater Manchester Local Energy Market (GMLEM) Citizens' Jury

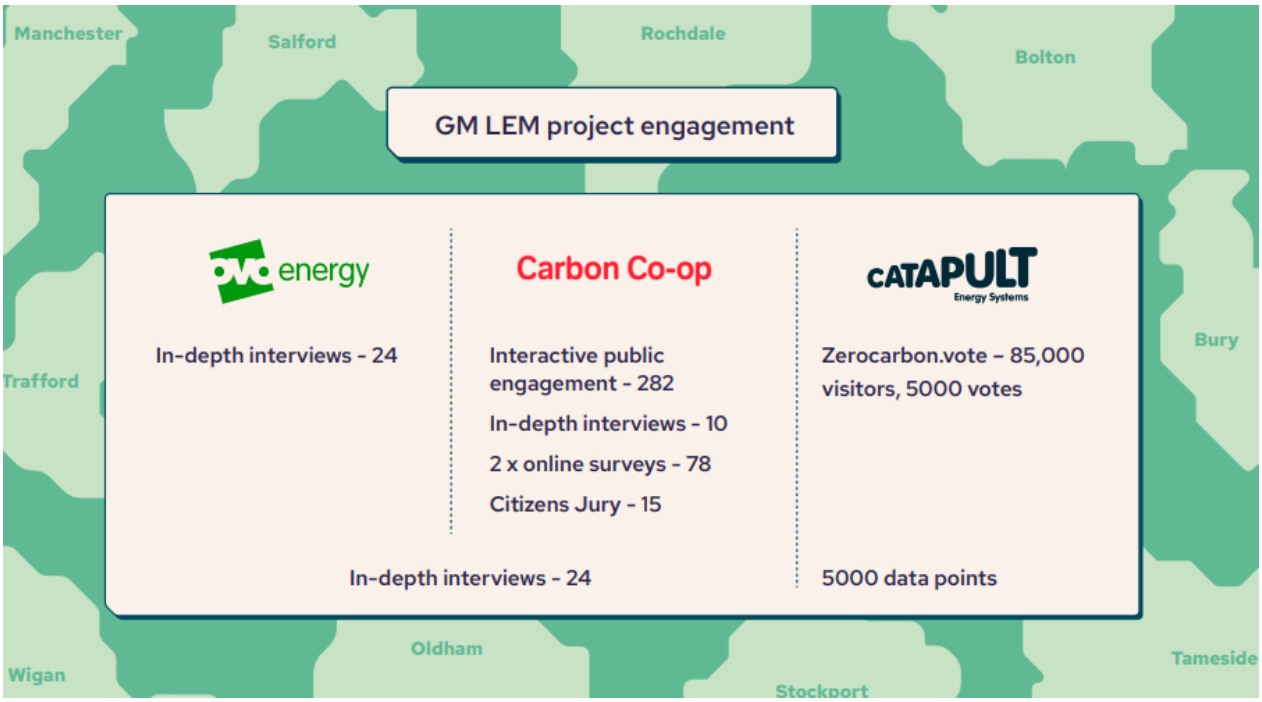


Figure 20: Stakeholder engagement exploring the GM LEM concept

GM LEM project partner Carbon Coop carried out engagement with the public during this project, to not only share plans for Greater Manchester's Local Energy Market, but principally to involve citizens in decision making around the development of the local energy market business model. They used this approach to platform the views and experiences of local people for the project partnership to hear and help inform decision making about market design and consumer priorities. (See Appendix 4 for more information).

Key findings from public engagement

- Citizens in Greater Manchester believe that the local energy market will support the region to reduce carbon emissions.
- People want to see the local energy market providing economic benefit to the region and call for an ownership and governance model that would ensure that happens.
- GM LEM has potential to be an empathetic initiative that could facilitate increased investment into community support schemes including energy efficiency schemes and the purchasing of low carbon technology.
- High levels of transparency and scrutiny were important to people because they lacked trust in the existing energy market. GM LEM should empower people to have a meaningful say in how the local energy market is run.
- People value convenience higher than control.

- Many people expect an LEM tariff to be the cheaper option.
- People expect LEM tariffs to be as simple as standard tariffs.

In addition to detailed public engagement about the *concept* of the GM LEM, Project partner Ovo explored whether a domestic type of use tariff might be attractive to customers and play a role in time shifting demand.

Ovo 'Heat Pump Pro' type of use tariff

GM LEM project partner Ovo led a work package exploring how best to share LEM value propositions for domestic customers. (See Appendix 3 for details).

Based on research outcomes and proposed benefits to the whole system in terms of optimisation potential for a heat pump specific 'Type of Use Tariff', Ovo decided on a Heat Proposition (HVSP). This allows them to charge a lower rate on the consumption related to the heat pump only, made possible by an integration with the Daikin heat pumps that already existed within some Northwoods Housing homes.

The new tariff, 'OVO Heat Pump Pro' is the energy proposition for heat pump users who share their data with OVO / Kaluza. Technically, this covers all Daikin customers with connected heat pumps capable of sharing consumption data. For the purposes of this trial, this tariff was made available for all eligible Northward Housing residents.

The basis for this tariff - which can be extrapolated to a LEM - is that heat pumps operate out-of-peak when compared with standard household consumption, allowing an energy supplier to achieve a lower average cost of energy for the heat pump. Unlocking this value allows Ovo to pass through a cost saving for heat pump consumption. In a LEM where supply & demand can be matched locally, this same principle could apply to deliver a low running cost to consumers. Compared to Ovo's standard tariff, customers on Heat Pump Pro might expect to save around £33/yr on their energy bill.

From Kaluza's perspective, LEM could be an important tool in facilitating faster and more efficient small-scale flex entry into DNO flex markets. Flexibility aggregators like Kaluza are obliged to seek the best value opportunities for participating users. As such, to become a market of choice, LEMs will need to be able to compete in £ / kW terms with other national markets. In terms of value, Ovo estimate this could bring up to £37 of additional value per device per year for customers with EVs or heat pumps.

Ovo and Kaluza have modelled that through wholesale price arbitrage and selling flexibility to DNOs, there could be per-customer benefits of between £25 and £55 / yr.

LEM operating and ownership models

The GM LEM project undertook significant public engagement to find out what citizens of Greater Manchester thought about a LEM, and if it was to go ahead who should own or run it.

Whilst it is challenging to identify all the expertise needed to setup a new energy market in such a highly regulated landscape, it was certainly clear from public engagement feedback that the LEM must be accountable and run in a transparent way, with any surplus revenue benefiting the local area.

Clearly, this indicates strong public involvement, but a new market such as the GM LEM would have to be a partnership approach, incorporating private and third sector expertise, all operating under the requirements of Ofgem licence conditions.

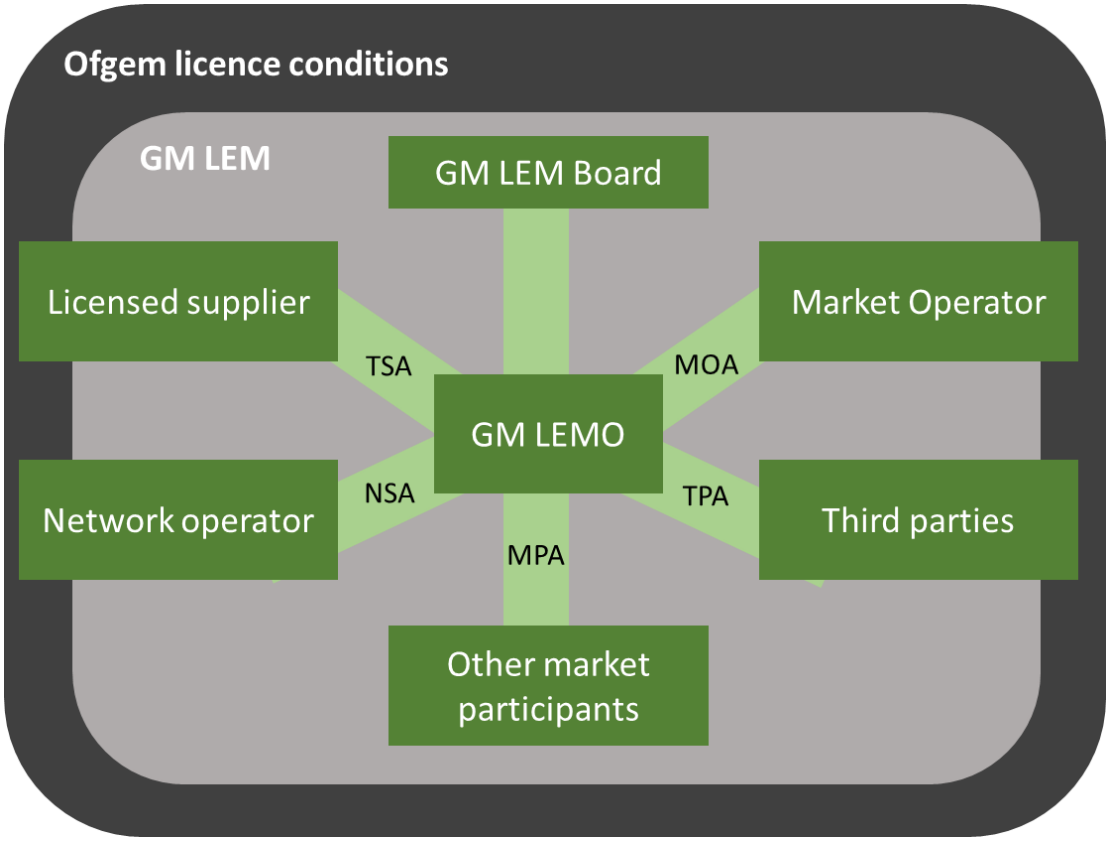


Figure 21: Example GM LEMO structure

It is widely accepted that innovation is a critical element of transforming the energy system to a net zero future. Innovation funding from BEIS has seen significant increases

in recent years, and is fully compliant with the ‘grow back greener’ agenda from government in post-COVID recovery.[14]

However, it is also clear that to develop, test and replicate innovative approaches to something as highly regulated as the energy system, there needs to be spaces where the ‘normal’ way of doing things can be adapted with the minimum level of risk.

An Innovation Zone in a defined geographic area of GM would be valuable tool in testing the more advanced features of the LEM. Led by local government, an IZ could be used to tackle some of the main barriers to innovation (see section below). Innovation, in this case, is not so much around new technology, but in new ways of handling data and joining systems to optimise the infrastructure that already exists.

The GM LEM is by definition a regional market that will limit its activity to a defined space, but the model is certainly replicable around the UK, helping optimise significant parts of the energy network. Given the regulatory amendments and network charging intervention needed for a LEM to run its more advanced features, a certain level of scale and support is required. A regional approach is well suited to developing and testing a LEM, and an IZ would be a powerful route to giving the local authority the tools it needs to pursue it.

Recommendations for enabling the GM LEM

There are some core challenges to realising the full benefits of the LEM within the current regulatory framework:

1) Limited levers to maximise commercial value in the short-term. Current flexibility markets are still uncertain and require multiple ‘revenue stacking’ to generate sufficient value
2) There are numerous ongoing and charging regime reviews already in train. The GB energy market has complex arrangements and multiple parties and stakeholders

[14] BEIS research and development (R&D): UK Research and Innovation allocation 2022-2023 to 2024-2025

3) The energy ‘trilemma’ – tensions between cost, carbon and security of supply remain a challenge, e.g. the pressure to reduce costs while achieving massive transformation while providing incentives for end users and generators to use local energy.
4) There is currently no extra value for locally-sourced energy (bar a behind the meter/ private wire/ network model) so we need to request policy and/ or regulatory change to deliver suitable commercial structures.
5) Attracting customer and asset rollout – in order to be commercially viable, the LEM will need scale and support from local actors.

So how can the regulatory and policy landscape be improved to unlock the benefits of local energy markets, not just in Greater Manchester but around the country?

Specific regulatory intervention

GM LEM project partner Cornwall Insight has already begun detailed engagement with the energy regulator Ofgem to examine the opportunities and barriers to market innovation, like LEMs. Many of the issues have been under discussion for several years.

Specifically, Cornwall Insight have been exploring with Ofgem the following remedies to regulatory barriers, which are potential enablers to project aims:

What	With who	Rationale	Route for exploration
Capacity trading	Ofgem	Capacity trading provides for effective utilisation of the local network through reallocating capacity to those that value it most.	Use the GMCA area as a trial zone for capacity trading, using the thinking exploring this in the Access Significant Code Review (SCR). Support required from ENWL. Derogations needed from existing capacity allocation rules (DCUSA/ Distribution code derogations).
Innovation Zones (IZ)	BEIS	Provides for the exploration of a wider range of energy-related tools including the potential reallocation of policy costs or exploration of alternative routes to deliver Energy Company Obligations (ECO).	The *Energy* Innovation Zone (EIZ) final report, once complete, is expected to outline how EIZs can be applied for and approved. However, the broader term 'Innovation Zones' which could apply different mechanisms to different parts of the region might be a more flexible approach, creating greater impact across sectors.
Local settlement	Ofgem/ BEIS/ Elexon	Should the project lead and partners decide that the LEMO leading and delivering local settlement is an essential objective of the LEM, then engagement will need to occur with Elexon, Ofgem and BEIS.	This would at the very least require changes to BSC Section A – Parties and Participation, BSC Section C – BSCCo and its Subsidiaries, BSC Section D – BSC Cost Recovery and Participation Charges and BSC Section E – BSC Agents. The simplest route might be for the LEMO to become a regionally limited BSC party with a number of devolved functions of BSC Agents, or a more complex route could see if become a partner to Elexon for local settlement.
Energy data access and regulations	Ofgem	The ambition of the LEM is centred on being an independent informational platform and energy exchange facility. To support the data facilitation, the LEM could trial an innovative approach to customer data access, such as opting in for parties to have visibility of data and therefore be able to offer innovative tariffs.	BSC sandbox to facilitate the sharing of data with the LEM platform, and then extra-market rules to engage with customers in the area to understand willingness to share their data. It may be desirable to ask customers to share data on an opt-in basis for suppliers/ aggregators (and commercial products) and an opt-out basis for the LEM and local DNO network (for system management/ planning).

However, the GM LEM project team acknowledge that many of these interventions may require derogations from the national rules, and that attempting to test them in an area the size of Manchester may exceed the scope of the normal derogation regime. While this may limit the project in achieving its aims, we recognise that consumer protection is vitally important and that Ofgem, GMCA and all project partners have a vested interest in ensuring any trials are successful and do not lead to consumer detriment.

GM LEM preferred regulatory approach

Given the LEM's ambitions to be a completely independent market for local generation and demand assets to trade with one another, and to facilitate its use by both suppliers and VLPs/ aggregators, the preferred approach for delivery of the platform does not include the LEMO becoming an active market participant. Instead, the approach taken focuses much more on developing an informational exchange that project partners and local energy system users can use to facilitate trades in the locality.

Phase 1: The LEMO obtains live settlement data from the Data Collectors, with the express consent of participating consumers and their suppliers. The LEMO would use this to match demand to asset generation and thereby prove the connection between generation and consumption within the local area. We understand this could be achieved through customer approval of the sharing of their data on a bespoke basis, or on a temporary enduring basis through a relatively simple derogation and BSC modification. In addition, the LEMO can approach the Granular Energy consortia or develop its own competitor platform for the matching of generation and demand to support the viability of local low-carbon generation production and consumption.

Settlements would necessarily need to be linked to the national settlement process in this stage.

Phase 2: The LEMO develops an energy and flexibility exchange to support local identification of and matching of local generation, flexibility and demand. As per the requirements for existing exchange platforms, the exchange would be required to integrate with the existing settlement system operated by Elexon. Such a move would need to be permitted through change in regulations, and innovation derogation from Ofgem, or the establishment of an EIZ.

The LEMO is unlikely to run the local settlement of the system on the basis that the customer portfolio of generation and supply in the locality is likely to be incomplete; this would be an unprecedented measure that would require changes to codes and legislation; and the establishment of multiple settlement systems is unlikely to be

politically or regulatory desirable. We have, therefore, assumed that the LEM needs to operate under the existing energy settlement system rules and requirements, including a 30 minute settlement period.

As the market is not functionally separately, generators and consumers would retain the option of purchasing and selling power into the local and national market. This provides optionality for both generators and consumers, but potentially damages local system management and works against the ambitions of the project – during times of high renewable output generators would likely look to sell their power on the national market, and during periods of low local renewable output consumers would likely want to procure power from the national market. Therefore, for the best outcomes, the markets would likely need to be mutually exclusive.

Phase 3: There are a range of options that could provide the most suitable option for phase 3 depending on the market, regulatory and policy developments that occur between the present and 2030, as well as the interim options chosen for delivery of the LEM.

- The first is for a new role to be created for the LEM to take on the roles of an exchange/ trading platform, matching and verifying local demand and generation, supporting complex site netting arrangements, and supporting entry of flexibility into local flexibility requirements. It also effectively acts as a flex platform for the local DSO. All trading and procurement for the GM area will take place through this one platform to maximise engagement. This is **Option 3.4**.

  This is a potential approach for the LEM to take, but will likely require legislative/ regulatory change to mandate the use of a single platform in a local area. In fact, the use of a single platform may be in direct conflict with the concept of open and competitive markets. However, if the platform integrates energy, flexibility, and potentially capacity trading in the locality, it becomes an excellent resource to manage the use of the local network. One could also argue that the market itself is no less competitive, with a range of suppliers and generators (and possibly speculators) buying and selling energy, but for the LEM to have a regional remit would require the creation of a new licensed entity (likely price-controlled to simulate competitive pressures).

  An alternative approach would be for the platform to be one of many routes to market for generators and consumers in the local area. This aligns more closely with the concept of an open and competitive market, but clearly has a detrimental

impact on the viability of the platform as a “one-stop shop” for managing the local system.

- The second is for the LEMO to work in partnership with Elexon in order to become a form of devolved local settlement body. In this case, we also envisage strong integration with ENWL to deliver flexibility services as part of the DSO function. This would again require significant reform, not just of Elexon's role but also of ENWL's. The timescale would also likely be several years, requiring commitment by 2025 and buy-in from ENWL for incorporation into its RIIO-3 business plan. This is **Option 3.3.**

  This approach, perhaps, steps back slightly from market facilitation to settlement facilitation. It is the view of the project partners that market facilitation (rather than settlement facilitation) should be the primary aim of the LEM, and therefore this option may not deliver all the desired functions or capabilities for the LEM.

- The least ambitious of the three preferred options provides for the LEMO to become an exchange to facilitate trading, and a Supplier Volume Allocation Agent (SVAA) if there is not one already to facilitate the entity in matching local demand and generation, as well as entering the data into wider national settlements. This enables local power trading in a transparent market, as well as giving LEMO first-hand access to all required data. However, it does not explicitly support the range of wider functions that the LEM would also prefer to have, and therefore this remains the last choice of the options to be adopted in Phase 3 provided a low level of regulatory and market change in the interim. This is **Option 3.1**.

In all options across phases, there are three core themes that will be underpin the running of the LEM;

4) **Responsible.** The LEM operates in an open and responsible manner at all times, and requires those party to the LEM to do so.

5) **Fair (Equitable).** The LEM, its partners and participants share the value, costs and risks of all parties appropriately (fairly) based on their specific roles, needs, scale, and activity within the LEM and the wider system.

6) **Evolving (innovative).** The LEM will evolve over time to improve, and support new and different products and services relevant to the parties within the LEM and as the wider energy market changes.

Policy and regulation recommendations for enabling and empowering the GM LEM

Whilst the GM LEM is able to start realising value in today's existing political and regulatory environment, unlocking the more advanced features and benefits requires action from government and the regulator, Ofgem.

Some of this action is specific, for example:

- investigating and pursuing how system benefit (i.e. the £40m/yr identified in this work) from optimising use of networks and reducing peak electricity flows could be shared by market participants
- widening the access to, and use of, energy data to more market participants
- permitting a wider landscape of capacity trading.

But, aside from specific regulator interventions or changes, there is clearly a need for more joined up approaches to delivering the energy strategies at the core of the local energy market: in the case of GM LEM, that is the local area energy plans.

There must be sufficient powers held by a competent body to take detailed energy plans and begin delivery in a transparent accountable way. Without this strategic, managed delivery of large numbers of low carbon technology assets, there can be no local energy market in the form detailed by this project.

One of the key interventions that such a competent body could make would be to introduce Innovation Zones, that in turn could road test and explore the *specific* regulatory changes outlined in this report, unlocking not just rapid rollout of low carbon technologies through the use of new tariffs and potentially network charging regimes, but support for supply chain development and innovative new products and services. Through the LEM2 programme, we have set out a detailed design for a local energy market that could realise value for the local energy system and end consumers.

The key area of value is about effectively aligning incentives around embedded flexibility. Much of the existing market thinking around flexibility has been explicit flex procured through flexibility markets, which is only a small fraction of what the market is going to require as we electrify our heating and transport. The consortium believe full value of flexibility can only be realised when it is seen within an overall context of wholesale energy markets and the broader picture in a market such as the GM LEM that brings these markets together. We do, however, recognise there is yet to be a pricing mechanism to reflect this value and the LEM would require regulatory and policy support

enable to realise this value and align incentives between energy consumers, network operators and market participants.

The project partners are also aware an innovation gap remains from a detailed design to full scale commercial rollout given the policy uncertainty around capturing this value.

In line with the roadmap for phase 1 of the GM LEM, we recommend a demonstration project that would provide further evidence of the ability for a LEM to optimise use of local energy, flexibility and explore further opportunities to seed the market to support GM decarbonisation aims while creating the opportunity to attract commercial investors.

There are five key recommendations for realising the full benefits of the GM LEM by 2038:

1) **GMCA to be the competent body to deliver LAEP.** The LAEPs produced in support of this project provide clear evidence for what activity should be undertaken where. This lowers risk for many stakeholders, but it needs a competent, accountable body with appropriate powers to implement them.
2) **Establish Innovation Zones in GMCA.** Innovation zones will provide a mechanism for the exploration of a wider range of energy-related tools including the potential reallocation of policy costs or exploration of alternative routes to deliver ECO.
3) **Energy data access and regulation.** To support the data facilitation, the LEM could trial an innovative approach to customer data access, such as opting in for parties to have visibility of data and therefore be able to access innovative tariffs.
4) **Investigate and pursue opportunities for avoiding network reinforcement and other flexibility services that the LEM can participate in.** There is unquestionably value in matching and dispatching energy assets locally, but how those benefits flow to customers is not yet clear and needs further work and innovation funding.
5) **Capacity trading.** Capacity trading provides for effective utilisation of the local network through reallocating capacity to those that value it most. The GMCA area could be used as a trial zone for capacity trading, using the thinking exploring this in the Access SCR.

Abbreviations, units and acronyms

- **Access SCR:** Access and Forward looking charges Significant Code Review
- **BSC:** Balancing and Settlement Code
- **BRP:** Balancing Responsible Party
- **CAPEX:** Capital expenditure
- **CSR:** Corporate Social Responsibility
- **DFES:** Distributed Future Electricity Scenarios
- **DNO:** Distribution Network Operator
- **DSO:** Distribution System Operation
- **DUoS:** Distribution Use of System
- **ECO:** Energy Company Obligation
- **EIZ:** Energy Innovation Zone
- **ENWL:** Electricity North West Ltd
- **ESC:** Energy Systems Catapult
- **EV:** Electric Vehicle
- **GM:** Greater Manchester
- **GMCA:** Greater Manchester Combined Authority
- **GM LEM:** Greater Manchester Local Energy Market
- **GW:** Gigawatt
- **HaaS:** Heat as a Service
- **HP:** Heat Pump
- **kW:** Kilowatt
- **kWh:** Kilowatt Hour
- **LAEP:** Local Area Energy Plan
- **LEM:** Local Energy Market
- **LEMO:** Local Energy Market Operator
- **LULUCF:** Land use, land use change and forestry
- **MCCA:** Manchester Climate Change Agency
- **MVP:** Minimum Viable Proposition
- **MW:** Mega Watt
- **MWh:** Megawatt hour
- **NG:** National Grid
- **NG ESO:** National Grid Electricity System Operator
- **Ofgem:** Office of gas and electricity markets
- **OPEX:** Operating expenditure
- **PfER:** Prospering from the energy revolution (programme)
- **PV:** Photovoltaic
- **REGO:** Renewable Energy Guarantee of Origin
- **TNuOS:** Transmission Network Use of Service
- **TWh:** Terawatt hour
- **V2G:** Vehicle to Grid
- **VLP:** Virtual Lead Party
- **VSP:** Value Sharing Proposition

Appendices

Appendix	Title	Primary Author
Appendix 1	Summary Local Area Energy Plan for GM (WP2)	Energy Systems Catapult
Appendix 2	Non-domestic value sharing propositions (WP3)	Bruntwood and Hitachi Europe
Appendix 3	Domestic value sharing propositions (WP4)	Ovo Energy
Appendix 4	User engagement (WP5)	Carbon Co-op
Appendix 5	GM LEM Technical design (WP6&7)	Bruntwood
Appendix 6	Investment summary (WP8)	Regen
Appendix 7	Policy and regulation (WP9)	Cornwall Insight

- Video 1: Local Energy Markets
- Video 1.1: Local Area Energy Plans
- Video 1.2: Innovative Energy Tariffs
- Video 1.3: Optimisation
- Video 2: Software