DELTA-EE

Whitepaper: Microgrid as a Service

Supporting the growth of low carbon housing and energy communities

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Delta-EE is a leading European research and consultancy company providing insight into the energy transition. Our focussed research services include Connected Home, Electrification of Heat, Electric Vehicles, New Energy Business Models, Digital Customer Engagement and Local Energy Systems. We also provide consultancy for clients including networking companies and policymakers. Delta-EE's mission is to help our clients successfully navigate the change from 'old energy' to new energy.

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Executive Summary

The UK housing market is expected to grow to around 300,000 homes annually by 2030. In order to deliver this level of growth whilst simultaneously meeting our net zero targets, we will need to apply a wide range of technology and business model innovations. Energy Communities are seen as an integral part of this transition.

- Microgrid as a Service (MaaS) propositions address a number of key obstacles to meeting this challenge and offer significant benefits to developers, network operators, communities, and society at large.
- Although all three parties could benefit significantly from MaaS, none has the necessary expertise to deliver such solutions. There is therefore a clear role for innovative companies to fulfil this role.
- The MaaS market is at an early stage today. However, specialist companies are already emerging across Europe, offering MaaS propositions including fully integrated and optimised technology packages.
- We expect that the uptake of these models will increase strongly over the 2020s. Increasing build rates and stricter building regulations driving the rate of electrification could grow the overall market opportunity further by 2030.
- Sales of electrically driven heating systems in new build housing could exceed 90,000 installations per year by 2026 and further accelerate thereafter as gas is phased out in new build.
- Electrification of heat and mobility presents significant technical and economic challenges to the overall energy system, distribution networks

and consumers. These challenges are substantially addressed by MaaS solutions, which simultaneously create additional value.

- The Community Energy new build market (which includes MaaS propositions), might grow from near-zero today to ~32,000 in 2026, with a potential market size of £350 million.
- Policy at both a European and UK government level will further encourage the development of energy communities by 2030.
- We expect key market barriers, such as lack of awareness among housing developers, risk-aversion and business model uncertainty to lessen in the next five years.
- The main obstacles to accelerated MaaS deployment lie in the existing regulatory framework which needs updating and simplification to ensure that values are allocated appropriately and do not unfairly burden any part of society.

Introduction

National greenhouse gas targets will require major transformations across the energy system. At the same time we need significant numbers of new homes to meet our housing needs. The housing and energy sectors need to work closely in delivering this.

The UK Government has passed legislation requiring a reduction in net emissions of greenhouse gases of 100% by 2050. Similar targets have been introduced in other European countries as part of their Climate Change goals.

At the same time, the UK housing market is expected to grow to around 300,000 homes annually by 2030. In order to deliver this level of growth whilst simultaneously meeting our net zero targets, we will need to apply a wide range of technology and business model innovations in the new house building sector.

Significant transformations across the energy system, and the economy as a whole, are needed to achieve these targets. A common framework used to understand this transformation is the four pillars of decarbonisation, decentralisation, digitalisation and democratisation.

Energy Communities are increasingly seen as a key component to deliver democratised, low carbon, sustainable energy systems. However, the majority of energy communities are virtual, operating over public networks, and thus subject to use of system charges, taxes and levies, eroding much of the value from energy transactions.

Physical Energy Communities, by contrast, operating over private wire networks, offer the potential for significantly higher value, but also present new challenges in technology integration, commercial complexity and regulatory constraints.

Microgrid as a Service (MaaS) is a packaged solution starting to be offered to energy communities and housing developers in order to deliver physical energy communities in new build housing.

So what is the problem?

Building large numbers of affordable homes is already a significant challenge. The demand for those homes to perform better in both environmental and economic terms presents additional challenges which developers, network operators and regulatory authorities are not well equipped to resolve. However, new homes do present an opportunity to get it right at the outset avoiding many of the constraints of upgrading existing homes.

In a previous paper[1] we explored the specific difficulties facing housebuilders in obtaining economically viable and timely electricity connections for new housing developments.

But that is just one of the challenges to delivering significant numbers of new, low carbon housing. Housing developers are very conservative and are heavily dependent on existing supply chains, processes and construction technologies and find difficulty in changing their established business models even when superior methods are demonstrably available. The slow adoption of off-site construction methods which overcome skills shortages, provide better quality control addressing the performance gap, improved cash flow and significantly better thermal performance is a clear demonstration of this.

Against this background of existing challenges, developers are faced with the further challenge of providing low carbon homes with much improved thermal performance and additional, complex heating and other energy systems.

With regard to the DNO, there is little financial incentive to implementing innovative solutions such as smart energy communities, although many of them are actively exploring how they might support their development. However, they lack experience of smart systems at the household level.

From a regulatory perspective, there has so far been little activity to encourage private wire networks which would offer significant additional economic benefits such as permitting cost free P2P transactions within a physical energy community. Instead the focus has been on ensuring that all consumers are able to access a choice of suppliers which may often result in less innovative and higher carbon and cost solutions.

It will be interesting to see how this position, based on a somewhat simplistic approach to competition, will evolve as the clear societal benefits of energy communities are more widely demonstrated. The current energy price hiatus across Europe will no doubt lead to a review of this approach.

[1] White Paper: Facilitating electricity network connections for new build housing 2021

What is an energy community?

Energy communities can be either physical or virtual. That is, there are those that operate using the existing public distribution grid to transact energy between their members, and those which operate within bounded networks which might be privately owned, possibly even by the community members.

Although energy communities have a precise legal definition in European Law, we use a broader definition in this paper. That is a '*group of members who own and share generation assets with one another'*.

This may be a single large communal asset such as a wind farm or anaerobic gas digester providing heat and power, or it may be a number of individually owned assets such as solar PV on the roofs of their homes. The important component is that of deeper consumer engagement with their energy supply,

Both the EU definitions and that used in this paper recognise the three primary drivers for energy communities:

1. Flexibility is seen as a key requirement of an energy system dependent on intermittent renewable generation. Individual households with their own generation, energy storage and controllable loads could, when aggregated, provide significant levels of flexibility within the low voltage network.
2. Engagement with the energy system. One of the major barriers to renewable energy projects, that of NIMBYism is largely due to a perception that someone is imposing a solution on communities. It is believed that communities might be more receptive to local generation if they were direct beneficiaries.
3. Funding. Given the scale of investment required to transform the energy system and the level of public debt post-covid, any new source of funding is welcome. The degree of public support and willingness to invest in energy communities is high according to customer research undertaken by Delta-EE in a number of European markets[2].

[2] Delta-EE LES subscriber report: Customer Research Report 2020/21

Private versus public networks

There are those who argue that private networks expose customers to monopolistic business models and remove the potential for competition. Others argue that the current competitive market framework has failed and that other, more innovative models might deliver lower costs and better performance for consumers.

It is for this first reason that, in some European markets bounded private wire networks are not permitted. In other markets it is permitted only up to a certain size and in most cases still requires the private wire network to permit individual consumers to obtain their energy from their choice of supplier using the private network under regulated conditions.

In general, the numerical potential for virtual energy communities, being based on the entire existing housing stock, is significantly larger than that for physical energy communities. However, the regulatory challenges around use of system charges and the complexities of fairly treating socialised costs, both makes this a very challenging proposition and erodes the bulk of the value created.

In contrast, physical energy communities, based on new build housing developments are constrained to the number of new homes being constructed annually, typically around 1% of the existing housing stock. However, the potential for technology optimisation and value capture is significantly higher and can already be profitably implemented in many markets without any need for subsidies or special conditions.

Some commentators have suggested the development of new parallel networks to allow existing homes to capture some of the benefits of private wire networks. Indeed, this approach is often used when connecting large generation assets to nearby demand centres such as connecting a solar park to an industrial facility. In some cases, significant cost savings are achieved, such as the CHP heat network developed in Woking by Thameswey to serve some of the municipal buildings.

However, it is widely recognised that this approach of duplicating existing network assets is sub-optimal and will ultimately result in additional socialised costs being imposed on those not included in the scheme.

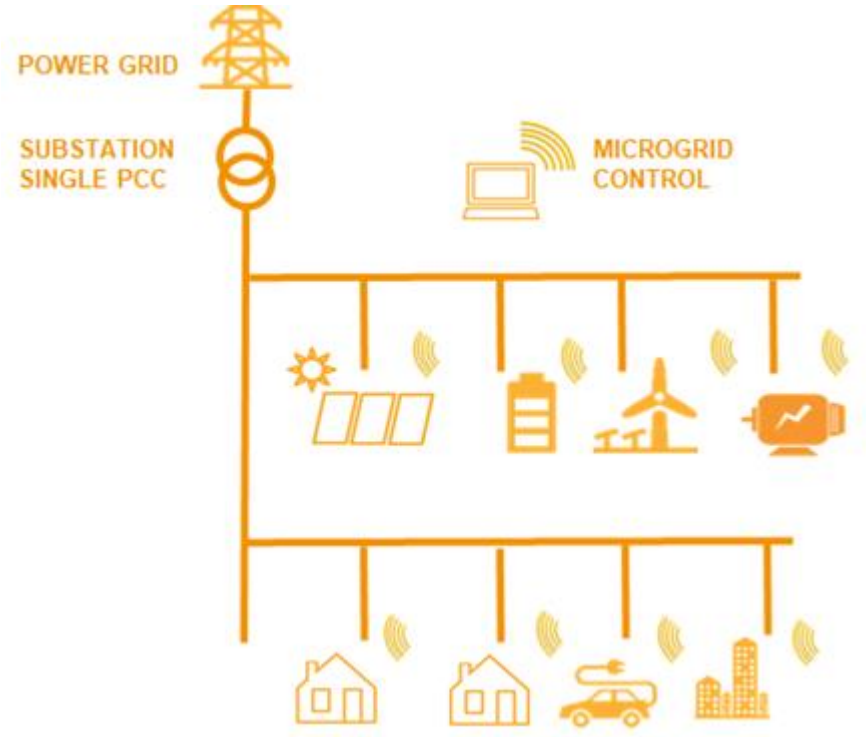
The situation is quite different for new build schemes where there is no pre-existing network at risk of becoming a stranded asset. Indeed, quite the opposite is true. Not only can the microgrid minimise any impact in constrained areas, but it can also provide services to the DNO to support the existing infrastructure.

Physical energy communities

There are clear technical, economic and societal benefits arising from the physical energy community. This physical energy community concept we define as a bounded, private wire configuration, often referred to as a microgrid[3].

Definition of a microgrid

A microgrid is a system of interconnected energy loads and distributed energy resources (DER) within a clearly defined boundary, and with a single point of coupling to the wider electricity distribution grid (or macro grid). Although normally operating in parallel with the grid, a true microgrid is when necessary, able to operate in island mode, disconnected from the main grid.



Here we include all bounded systems, even those which are not capable of operating in island mode. Although such systems are not able to provide the same level of resilience as a

[3] The full definition of a microgrid and an explanation of the different types of microgrid found worldwide is available in the Delta-EE report Opportunities for Microgrids in Europe 2020

true microgrid, they are in all other significant respects the same. Both operate behind a single point of connection and are thus equally able to provide grid services and capture additional value for their customers.

The implementation of these kind of microgrids for energy communities addresses the challenges of the three main participants, the developer, the distribution network operator and the consumer:

For the consumer:

- Although customer research has shown a significant interest in energy communities, it is clearly beyond the ability of individual consumers to establish them. There is therefore a key role for MaaS providers in providing this service.
- Assuming the community owns the generation and demand assets as well as the network itself, members are free to transact energy amongst themselves with a real time match between prosumer and consumer without incurring any additional use of system charges. That is, having invested in the community assets, their ongoing transactions can be used to optimise utilisation of energy within the community, adding value and making best use of those assets.
- Having made their investment in renewable energy production, communities should benefit both from lower energy costs than those available from the grid, and with long term price stability, largely isolated from the volatility of the wholesale market. This will become increasingly important in the energy transition as we encounter unforeseen challenges such as the extreme electricity prices currently being experienced across Europe.
- If the true microgrid option is selected, the community will also benefit from a more resilient energy supply[4], something which is becoming increasingly important as we become ever more dependent on intermittent renewable generation to match our move to electrification

For the developer:

- MaaS overcomes the issues of complexity and scalability.
- The MaaS provider presents the housing developer with a packaged solution which will ensure they meet their emissions compliance targets without needing to develop in-house expertise.
- The significant upfront investment even in a conventional energy solution can also be substantially mitigated and if required, passed through to the energy community, potentially with external funding.

For the distribution network operator:

- An optimised energy system such as a microgrid can be configured to minimise the size of the connection to the main grid. Indeed, it is a characteristic of a true microgrid that they are able to operate in island mode, completely disconnected from the grid if required. This can deliver significant cost savings and facilitate the development of sites where there is little or no available capacity for new connections[5].

4 This topic is explored in the subscriber report, *How microgrids provide resilience*

5 This issue is explored in greater detail in our white paper on facilitating new connections for housing developments

- Finally, rather than presenting a challenge to the DNO to accommodate new connections, the microgrid can actually support the local distribution network at times of stress by delivering flexibility services. There is much discussion as to the role of the DNO as it transitions to DSO; the arrangement presented here offers a solution to the DNO in supporting the transition to a more dynamic, flexible and better optimised one which makes greater use of existing assets and consequently enhances profitability.

Of course, whilst these physical energy community characteristics seem rather attractive in terms of the value they provide to consumers, DNO and the housing developer, their implementation is relatively complex.

Few companies exist which have the combination of technical and commercial competence to deliver them. Neither the developer nor the DNO has the necessary competence even though both are motivated to establish such an arrangement. There is thus a clear opportunity for innovative companies to offer the service linking the three parties in an arrangement such as MaaS.

What is Microgrid as a Service (MaaS)?

MaaS is sometimes used interchangeably with Energy as a Service (EaaS) in that customers contract with a solution provider to supply energy, usually electricity, for a fixed payment based on the amount of energy delivered. However, in EaaS business models, the client takes no ownership of any assets and simply pays for the energy.

On the other hand, MaaS whilst also able to offer energy supply involves the delivery of an infrastructure solution of a microgrid comprising generation and storage as well as the distribution network. There are many variants of this offering. In some cases, the microgrid is delivered to the housing developer, who then passes the assets to a third party which operates the microgrid on behalf of the householders. In other cases, the householders become shared owners of the microgrid and may pay some kind of service fee to the third party but receive the energy at a preferential cost.

Essentially there are three components to the service.

1. The **establishment and operation of an energy community** involving shared use (and in some cases ownership) by the members. There are some companies who specialise in providing this service alone, often as a virtual community.
2. The **construction of the microgrid including the design and optimisation** of the overall asset portfolio (generation, storage, control, cables etc.).
3. The **maintenance and operation** of the microgrid including essential operations such as metering and billing as well as additional value streams such as trading flexibility and other services to the grid.

So who is providing this service?

For many years now, energy suppliers and others have offered packaged energy solutions to housing developers. Recognising that low carbon energy solutions represent a significant challenge to developers which is outside their core competence, major energy suppliers such as E.ON and Engie, for example, have established framework agreements with developers to provide low carbon heat networks based on CHP technology, supplying heat to households and selling the electricity to commercial customers. This is particularly successful in large mixed developments where the diversified loads of housing and commercial buildings enhance the potential for optimised operation and asset utilisation. Examples such as the E.ON development at Cranbrook near Exeter in the UK demonstrate such an approach.

In this case the households are tied to a heat supply contract and it is usual for customers to be connected as E.ON electricity customers in the first instance, although it is possible for them to switch electricity supplier at a later date.

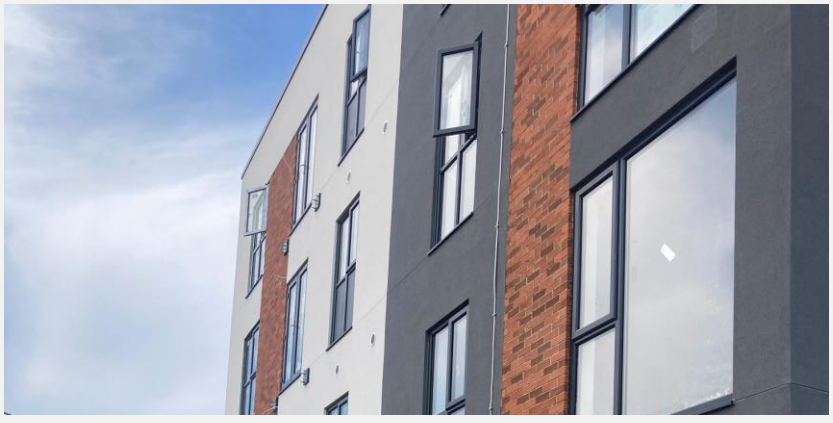
However, a number of innovative companies such as CEPRO and SNRG in the UK[6] are building on this approach to create more value from capturing additional revenue streams from, for example, establishing an energy community in which both heat and electricity production become permanent features of the package.

SNRG Priors Hall Park, Corby

Etopia Homes is currently completing a small apartment block (Solus Apartments) as part of the wider 5000 home development at Corby in the UK. The 16 apartments have high standards of fabric energy efficiency so that the very low annual space heating demand can be met by direct electric resistance heating. The near elimination of space heating demand is a key benefit in terms of minimising the seasonal mismatch between generation and demand which represents such a challenge to many renewables-based energy systems. Domestic Hot Water is provided by exhaust air heat pumps.

Although roof-mounted, the 53kWp solar PV asset is communally owned, as is the 20kW battery. All generation and loads are behind a single boundary meter so that energy produced and stored by the system can be shared within the community according to demand, minimising any excess being exported to the grid. Any deficit is provided by a conventional energy supplier at the boundary meter.

SNRG operates the system using its smart optimisation platform which also facilitates billing and payments. Residents are expected to save 30% compared to conventional arrangements and will receive 100% renewable electricity, further protecting them from volatile energy prices based on fossil generation.



[6] We discuss MaaS both in UK and Netherlands in the Delta-EE podcast on this subject here. Also for subscribers to the Delta-EE LES Research Service there is a detailed report available in October 2021.

As noted above there are any number of variants on the basic MaaS business model, each with its own strengths and weaknesses. The box above illustrates one such scheme nearing completion by SNRG.

This Microgrids-as-a-service offering is a proposition to new build housing developers which allows them to provide an optimised, low carbon energy system to house buyers. It revolves around the formation of an energy community, owned by the householders. It comprises electricity generation and storage assets, as well as a control platform which integrates the generation and storage potential to optimise the utilisation of energy within the community using electrically driven heating and domestic hot water appliances. This then allows the community to maximise benefits from lower cost generation, further enhanced by the sale of flexibility and related future services. Benefits are typically lower and less volatile household bills, as well as a less carbon intensive energy supply.

We have seen recently across Europe the dangers associated with dependence on electricity supply which is vulnerable to the vagaries of fossil fuel supply, in this case natural gas.

Challenges and opportunities

The opportunities for Microgrid as a Service in supporting energy communities are considerable, with substantial growth anticipated in the near future. The main challenges are commercial and regulatory not technology related.

Technical challenges

It is often said that a microgrid is simply a microcosm of a normal grid-based energy system. So, when constituted as an energy community, it includes all of the same components, namely generation, demand, storage and controls.

All these technologies exist, and the demand, generation and storage components are often used in stand-alone systems. However, the critical aspect when applying these to a microgrid is that of system integration.

According to many in the industry, this is really something of a non-issue.

In absolute terms there is nothing which makes the provision of integrated energy packages excessively difficult. Even islandable systems such as microgrids have overcome the technical challenges of operating in both island mode, completely isolated from the grid and operating in parallel to the grid providing services and trading across it. Equally importantly they manage the transition between the two operating models without difficulty as is demonstrated by the thousands of microgrids at various scales, using various DER resources across the world.

However, the technical challenge is beyond the competence of the principal existing players, that is developers, DNO and obviously consumers. There is clearly a role here for specialist solutions providers (such as MaaS) to overcome this challenge and act as an intermediary between the energy community, network operator and housing developer.

Commercial and regulatory challenges and opportunities

It is arguable that the main challenges to the implementation lie, not in the technology, but in the regulatory and commercial uncertainty and complexity. Even the most basic concerns of an energy community around asset ownership, energy supply licencing and so on, present a burdensome obstacle that many prefer to avoid. It is perhaps for this reason that many of the energy communities currently being developed fail to capture much of the potential value stack comprising energy supply margins and flexibility service provision. Consequently, they are much less economically attractive than they might otherwise be.

And it is the issue of economic benefits which is really the crux of the matter. No matter how attractive in environmental terms, there needs to be a tangible economic advantage either in short term cost savings or longer-term price stability to incentivise the implementation of MaaS.

Existing regulatory frameworks also present unnecessary complexity. If we are to achieve the necessary levels of growth in low carbon housing developments and to facilitate the deployment of microgrid based energy communities, there is a need to clarify and simplify arrangements. Considerations such as licence exemption for energy supply at this scale, network charging and business separation all play a significant role in the complexity and ultimately economic viability of energy communities.

For example, the ability of energy communities to provide themselves with an optimised, vertically integrated (but monopolistic) energy supply free from the restrictive conditions which pertain today. Experience with voluntary industry standards on heat networks, (overseen by Heat Trust) should give some degree of confidence that monopoly service provision can be fair to all parties. This should be even more true if the monopoly service provider is owned, or at least overseen, by the members of the community it serves.

Despite the potential complexities of low carbon energy communities, there are clear economic benefits to such an arrangement. But housing developers are not, and arguably should not have to be, well equipped for this task.

On the other hand, the emergence of MaaS solutions providers is one way for energy communities, developers and network operator to avoid involving themselves in such complexities. whilst still delivering the benefits.

What next for MaaS and energy communities?

Community Energy Systems are expected to play an increasingly important role in the transition to new energy; MaaS offerings are clearly one means of delivering them in new build housing. Although the current CES market is in its infancy, we expect it to grow strongly in the next few years, supported by EU legislation and decarbonisation through electrification.

Microgrid as a Service propositions address a number of key obstacles to meeting the challenge of delivering large numbers of sustainable, low carbon homes and offer significant benefits to developers, communities, innovators and society at large. They appear to offer a credible solution to overcoming the complexities of implementing energy communities in the new build sector.

Although the MaaS market is at a very early stage today, already specialist companies, such as SNRG in the UK are emerging, offering MaaS solutions. The market for these solutions is expected to grow from the current level of a few tens of homes to an annual market of £70 million by 2026[7].

As electrification of heat becomes effectively mandatory for new homes in the UK after this date, we would expect to see an even more rapid growth in integrated electrical systems incorporating heat, generation and storage. MaaS will thus become an increasingly attractive proposition by 2030 and we would expect to see rapid growth in this sector.

Similar developments are expected in other markets. A study by TU Delft indicated a potential for as much as 50% of residential electricity demands being produced by households by 2050, supported in EU legislation.

This is likely to be further accelerated as our increasing dependence on electrification of heat and mobility imposes additional strains on an energy system dependent on intermittent renewable generation. Challenges to system resilience will therefore stimulate further interest in microgrids as a technical solution and with it, a greater opportunity for MaaS service providers[8].

The main obstacles to accelerated MaaS deployment lie in regulatory constraints. There is a need to simplify and adapt regulatory frameworks to ensure that energy communities fulfil their economic, societal and economic potential without unfairly burdening any other part of society.

[7] Delta-EE MaaS report 2021

[8] ibid