ZERO CARBON RUGELEY
WP2-D1: LOCAL ENERGY SYSTEMS INSIGHTS REPORT — A REVIEW OF INNOVATIVE BUSINESS MODELS AND ENERGY POLICY FOR ZERO CARBON RUGELEY

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Local Energy Systems Insights Report

A review of innovative business models and energy policy for Zero Carbon Rugeley

Chris O'Connor (30/06/2020)

Executive Summary

As part of Innovate UK's Prospering from the Energy Revolution program, an ENGIE-led consortium is designing a Smart Local Energy System for the Staffordshire town of Rugeley. Through the deployment of disruptive solutions, underpinned by innovative business models, the consortium will aim to demonstrate that local energy can be used as a national solution. This report provides an overview of innovative business models and energy policy for Zero Carbon Rugeley, with the aim of informing the consortium and stimulating debate.

With its fully liberalised and privatised energy system, there are numerous opportunities to capture value from the UK Energy System, resulting in a large number of established and emerging business models. To aid the discussion, the business models have been grouped into three Patterns, identified by Emanuele Facchinetti and Sabine Sulzer. The business models are critiqued individually, and regulatory barriers are highlighted. Opportunities to adapt and combine these models are presented before the trends associated with each Pattern are identified.

Pattern I models represent the **decentralisation** of traditional business models and are likely to appeal to typical consumers. These business models, such as white label energy supply companies, can support local initiatives whilst helping to fulfil the core requirements of an energy system.

Pattern II business models accelerate the **democratisation** of energy by empowering residents to invest in their community. These schemes, such as community owned electric vehicle charging points and renewables, provide innovative funding structures and represent true community energy solutions.

Pattern III business models reflect the ambition of a Smart Local Energy System and attempt to unlock value in a post-subsidy environment. These business models are enabled by **digitisation** and typically provide a service to the customer. The monetisation of flexibility and disruptive mobility solutions are examples of Pattern III business models.

A Smart Local Energy System is likely to draw on complementary features from multiple business models and is the recommended approach to support rapid **decarbonisation** and the delivery of Zero Carbon Rugeley.

Contents

1 Introduction

Although its roots lie in agriculture, Rugeley's local economy has been closely tied to the energy industry for the last sixty years. In 1960, the Lea Hall Colliery began extracting coal, in 1963 the Rugeley A Power Station began generating electricity and in 1972 Rugeley B was completed. Fast forward 60 years and the situation is now vastly different; the pits have closed, both power stations have ceased operations and Cannock Chase County Council has declared a climate emergency, with a vision to reach carbon neutrality by 2030 at the latest.

The Rugeley B cooling towers, which have dominated the skyline for the past 50 years, are set for demolition and ENGIE is regenerating the area into a new sustainable community. As the towers fall, there is an ambition for Rugeley to prosper from the energy revolution through the development of a Zero Carbon Smart Local Energy System.

This report will outline the context for Smart Local Energy Systems in the UK and examine the business models and energy policies that govern local energy innovation. These established and emerging business models will be categorised and their ability to deliver *local value* will be discussed. Finally, their relevance to Rugeley will be examined and the most promising principles highlighted, laying the foundations for Rugeley's road to zero.

2 Local Energy as a national solution

In 2019, the UK Government passed legislation amending the 2008 Climate Change Act and creating a legally binding target for the UK to achieve Net-Zero emissions by 2050. This commitment to decarbonisation has been amplified at a local level with nearly 70% of local authorities in England and Wales declaring a climate emergency in 2019, including Cannock Chase District Council. [1]

One of the major challenges in meeting these targets is the decarbonisation of heat, which currently accounts for 37% of UK emissions. [2] To date, little progress has been made in this area with the Committee of Climate Change (CCC) commenting that there is still *no serious plan for decarbonising UK heating systems.* [3] Although a roadmap is yet to be announced, there is some evidence that decentralised systems could provide a national solution. Following the Local Area Energy Planning pilots in Newcastle, Bridgend and Bury the Energy Systems Catapult (ESC) identified that *the blend of options is highly specific to local conditions and that no single mix of options could be applied nationwide,* although trends between local areas may begin to develop. [4]

Heat is just one vector requiring consideration and Smart Local Energy Systems seek to accelerate the Decentralisation, Decarbonisation, Democratisation and Digitisation of the UK energy system as a whole. These 'Four Ds' are often cited as the drivers and enablers of the energy transition and can be defined as follows:

- **Decentralisation**: The deployment of smaller local solutions with less reliance on large transmission connected generators.
- **Decarbonisation:** The reduction in the carbon intensity of the energy system through the use of low carbon technologies.
- **Democratisation:** Increased participation and influence of consumers in the energy system.
- **Digitalisation:** The use of digital technologies to drive efficiencies and unlock new business models.

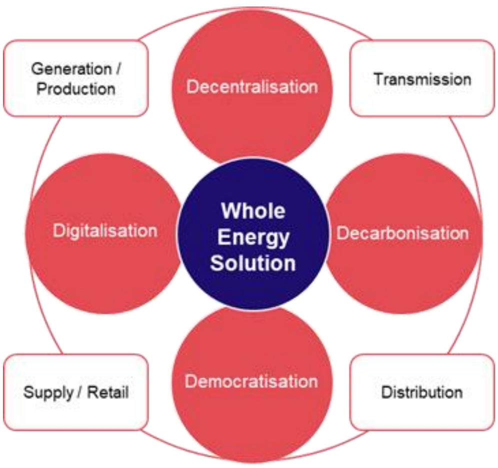

Figure 1 The 'Four Ds' of the energy transition

If deployed successfully, Smart Local Energy Systems have the ability to reduce abatement costs while still meeting the requirements of a functional energy system.

2.1 The function of our energy system

The World Energy Council calculates energy system sustainability from three metrics; energy security, energy equity and environmental sustainability. These categories are often used to measure the performance of an energy system and the UK ranked 4th in the 2019 Trilemma Index. [5] In a liberalised energy system, such as the UK, it is the role of energy policy to stimulate business models that can support growth in these areas.

2.1.1 Energy Security

Energy security *reflects a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks, with minimal disruption to supplies.* [5] The UK currently has a complex energy system to ensure security of supply during the seasonal peaks, with 70% of household gas and 54% of household electricity being consumed between October and March. [6] This includes natural gas storage, electricity interconnectors with Europe and The Capacity Market, which aims to ensure there is sufficient capacity on the electricity network.

Security of supply is not just a national issue and there can be constraints on a local distribution network. In Rugeley, there is only one 132 11kV Sub-Station to supply electricity to the town and surrounding areas. This substation has been identified by Western Power Distribution (WPD), the local Distribution Network Operator (DNO), as requiring flexibility services to meet the morning and evening peaks over the winter months, illustrated in Figure 2. [7] As the energy system continues to decarbonise, the increasing requirement for local flexibility could lead to new business models to support these energy market participants. These emerging business models will be further discussed in Section 4.

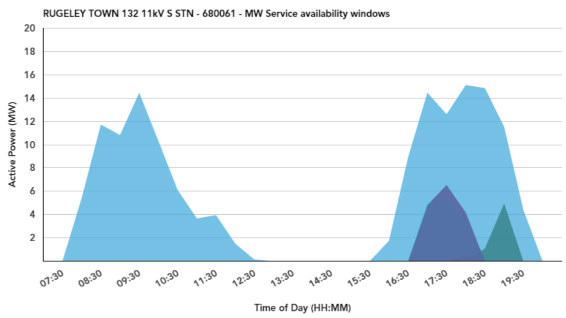

Figure 2 WPD have identified that demand turn down and/or generation turn up would benefit this area on Monday, Tuesday, Wednesday and Thursday from November – March [7]

2.1.2 Energy Equity

Energy equity *assesses a country's ability to provide universal access to affordable, fairly priced and abundant energy for domestic and commercial use.* [5]

Although the World Energy Council grades the UK as 'A' in this category, fuel poverty is still a pressing issue in the UK. The 2020 annual fuel poverty statistics indicate that England currently has 2.40 million households living in fuel poverty. [8] This disparity is more pronounced on a regional level with 12.1% of households in the North West living in fuel poverty compared to 7.9% in the South East, as shown in Figure 3. With the fuel poverty gap strongly correlated to the property characteristics, [8] energy equity clearly is not equal throughout the UK. This is evident within Rugeley with the percentage of households living in fuel poverty ranging between 8.1% (LSOA[1] E01029368) and 12.8% (LSOA E01029404) in 2018. [9]

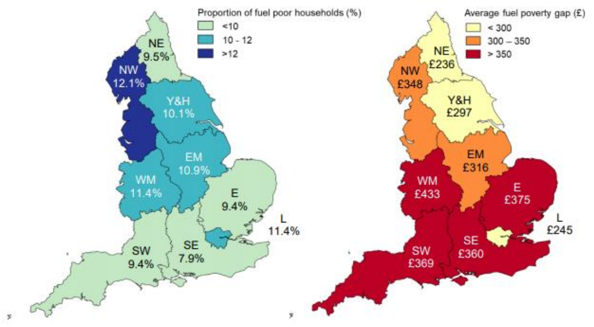

Figure 3 Percentage of fuel poor households and average fuel poverty gap for the regions in England (2018) [8]

An objective of Zero Carbon Rugeley is to decrease energy bills by 25%. Section 4 of this report will examine how and where innovative business models have sought to reduce consumer costs.

2.1.3 Environmental Sustainability

The final function of the Energy Trilemma is Environmental Sustainability; the *transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts* [5]

The UK has made strong progress in this area, with the 2nd largest percentage improvement globally in low carbon generation between 2013 and 2017. [5] Recently, the UK recorded its cleanest day on record with the grid carbon intensity averaging 61gCO2/kWh

[1] LSOA: Lower Super Output Area

on 23rd May 2020. Furthermore, the average day-ahead wholesale electricity price on 22nd May 2020 was negative, averaging -£9.92/MWh. [10]

Although there is still a vast amount of work that needs to be done to decarbonise the UK Energy System, this increased price volatility, amongst other stimuli, could support the development of new business models capable of accelerating the zero carbon transition.

Environmental sustainability is not just a national challenge, with air and water quality issues highly localised, demonstrated by the fact that Cannock Chase District Council has declared three Air Quality Management Areas (AMQAs) for Nitrogen Dioxide. [11] An objective of ZCR is to reduce carbon emissions for the locality in line with the 5th Carbon Budget and present a credible action to plan to reach carbon neutrality.

In a liberalised energy market, the system is also judged on its ability to deliver economic growth and, in a local energy system, provide additional value. This will be further discussed in Section **Error! Reference source not found.**.

2.2 The political and regulatory context

The liberalisation and privatisation of the UK energy market formally began with The Energy Act 1983 which allowed private producers to sell to the area boards. This preceded even greater reforms in the latter half of the decade with The Gas Act 1986 and The Electricity Act 1989, setting the framework for the privatisation of British Gas and the Central Electricity Generating Board respectively. [12] Three decades on, the market is fully liberalised and privatised, but its regulatory emphasis is still largely supportive of a centralised system. As the system decentralises, replacing transmission connected thermal generation assets with distributed renewable generators, this poses a challenge for the existing regulatory structures. [13]

Furthermore, stakeholders in the UK energy market are increasingly calling for a whole-systems approach to energy policy. [14] This term is used to describe solutions that consider the interdependence of the energy system; the fact that solutions will have repercussions elsewhere in the energy system. It reduces the likelihood of double counting and enables new business models to emerge, that otherwise wouldn't be viable. In the UK, the ministerial department responsible for energy is the Department for Business, Energy & Industrial Strategy (BEIS). However, when a whole systems approach is employed, it is evident that other departments are intrinsically involved with the energy transition. For example, the Department for Transport (DfT) lead on policy and consultations related to electric vehicle charging in the UK. At a local level, this complexity is amplified, and designing local energy markets (LEMs), within this context can be challenging. Section 2.2.1 will examine the current and near-term policy and how regulation can support the development of these markets.

2.2.1 Local Energy Markets Policy Overview

The UK electricity sector *operates under a competitive wholesale and retail market, combined with a framework of regulated price controls for network companies*. [13] The market environment is largely driven by policy that seeks to support the three functions of the energy system outlined in Section 2.1. As a regulated sector, there are licences that govern electricity supply, generation, distribution and transmission network ownership, and interconnections which are overseen by the market regulator; Ofgem.

Ofgem's principal duty is to *protect the interests of existing and future consumers* [15] and as such there are a number of regulations that impact the development of LEMs. The regulations affecting LEMs are baked into the licence conditions and industry codes, which are tabulated in Table 3 in the Appendix.

As mentioned, the policy is still skewed towards centralised generation and large assets, however there are some opportunities for smaller distributed assets to participate in the national markets. Currently these are fairly limited due to technical constraints and the administrative and commercial requirements. [13] A table outlining the existing market arrangements and opportunities for small scale assets can be found in Table 4 in the Appendix.

A Smart Local Energy System, such as Zero Carbon Rugeley, will centre around these smaller assets, and as such it's important to understand the expected direction of policy reform. Significant changes are expected through the next Electricity Distribution price controls (RIIO-ED2) which come into effect from April 2023 and from Ofgem's ongoing Electricity Network Access and Forward-Looking Charging Review. The

Energy Systems Catapult have summarised the following policy and regulatory developments that could support the development of Local Energy Markets. [13]

Distribution Network Operators (DNO) to Distribution System Operator (DSO). The responsibilities of DNOs is likely to change, modifying their interactions at a transmission and distribution level. This is expected to have a positive impact on LEM development by creating a new market and demand for local flexibility.

Half-hourly market settlement reform. This reform is intended to create more accurate pricing and could support LEM by maximising the use of local energy resources for local balancing services.

Review of retail supply and the supplier hub model. This could allow local market to participate in areas of the electricity market that are currently attributed to a single licenced party.

Changes in network charging. Large changes in the calculation and allocation of network charges are forecast. This could create complexity in forecasting price signals but may also create new markets for network capacity.

Future governmental support for energy investment. Following the closure of the Feed-in-Tariff (FiT), there is uncertainty in future policy to support small scale generation and local DSR activities

Although there are policy reforms planned, clearly there are some uncertainties and regulatory hurdles that need to be cleared for the deployment of new local energy business models. Section 4 will examine established and emerging local energy business models and how they work within, or would clash with, current policy and regulation.

2.2.2 Transportation

Akin to The Gas Act and The Electricity Act, The Transport Act of 1985 brought about privatisation within this sector. The route licencing system was abolished, allowing private firms to enter the market and charge the fares that they deem appropriate. [16]

The success of this policy is hotly debated with Labour pledging to municipalise Britain's network in their 2019 manifesto. [17] That said, as it stands, private firms are able to operate public bus services, leading to some business models that will be discussed in Section 4.

2.3 Business models

A business model describes the benefits an organisation will bring to its customers, how it will achieve this and how it will retain a proportion of this value. [18] Using a business model canvas approach, a business model can be split into nine categories; key partners, key activities, key resources, customer value proposition, customer relationships, channels, customer segments, cost structure and revenue streams. [19] A categorisation methodology that draws upon this approach will be presented in Section 3.

A subset of business models that are particularly relevant for local energy systems are **community energy business models**. The UK Energy Research Centre has defined community energy as *a solution owned or controlled by a community or third sector body, and/or that involves a significant degree of direct citizen participation and control*. [21] Business models that don't meet these criteria will still be considered, however this democratisation can help realise additional local benefits and ensure the solution is relevant for Rugeley.

2.4 Embracing local variations

As eluded to above, there are some business models that won't be relevant for Rugeley, despite them being applicable in other geographies. This is a core principle of local energy planning; the ability to embrace geographic variations and deliver *local value*.

When discussed at a national level, discourse surrounding the value created by an energy system mainly focusses on its financial metrics. Furthermore, traditional business models that operate within the wholesale and retail markets have a clear quantitative measure of their value, i.e. the revenue and subsequent margin that they achieve.

In Smart Local Energy Systems, value is often considered to include additional societal benefits that the system can bring. As shown in Figure 4, effective business models can generate value that is social, economic and environmental; improving quality of life indicators within an area.

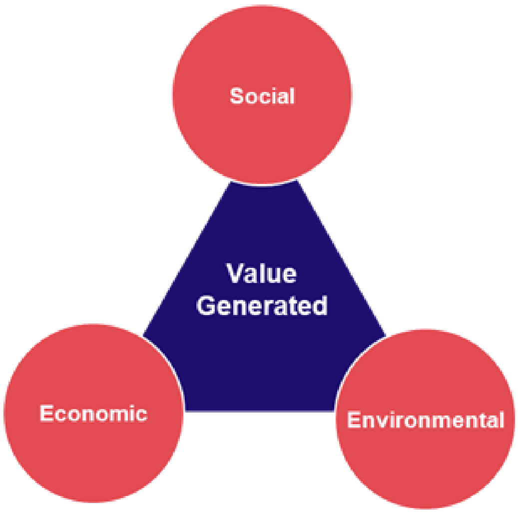

Figure 4 Value generated can comprise of social, environmental and economic benefits and does not have to be directly energy related

EnergyREV have outlined seven areas where a smart local energy system can bring additional value to an area: [20]

Effective provision of energy services. Ability to reduce user costs and improve comfort through a more effective and efficient system. This captures the requirement of a SLES to improve consumer wellbeing.

Enhancing environmental eco-system benefits. Wider environmental benefits aside from carbon savings. An understanding that carbon emissions are just one measure of environmental impact.

Maximising local sufficiency and independence. Local balancing of generation and demand and reduced reliance on the national grid.

Enabling flexibility within and across vectors. Greater system integration and the ability to switch between energy vectors to provide services.

Improved resilience and ability to cope with failure. Improved security of supply through digitisation.

Social justice and energy equity. Improved energy equity and engagement with local stakeholders. Democratisation and empowerment of the community.

Meets fundamental needs in context specific way. Wider benefits to the community on particular issues facing the locality. For example, it is an objective of ZCR to bring more jobs to the area.

As the above can all be seen to bring local value to the community it is important, if possible, to include them in the customer value proposition of a business model. However, as it is often hard to assign financial metrics to some of these benefits, traditionally they have been hard to include.

2.5 System boundaries for Zero Carbon Rugeley

As previously mentioned, a whole systems approach will be employed for Zero Carbon Rugeley (ZCR) and, as such, the production, distribution and consumption of electricity, heating, cooling and passenger transportation are considered in scope. All sectors that contribute to these demands within the ZCR boundaries, shown in Figure 5, will be considered.

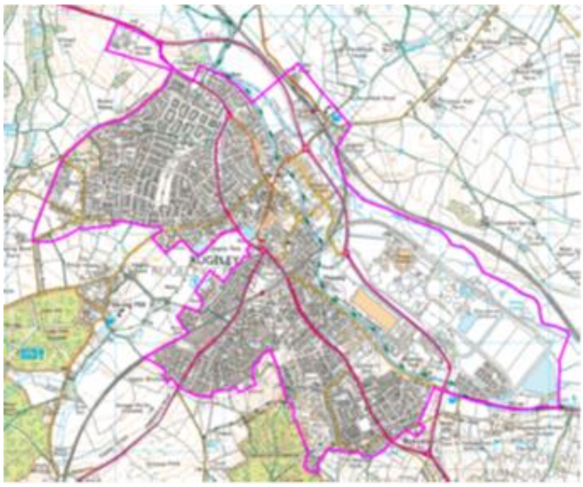

Figure 5 The proposed geographic boundaries for ZCR

Section 4 will explore how innovative business models can transcend multiple parts of an energy system, providing practical examples of a whole-systems approach.

2.5.1 Local energy system participants

The Energy Systems Catapult has identified the roles that exist within the UK Electricity & Gas Sector, as shown below in Table 1. [13] The relevant bodies for Rugeley are also tabulated.

Table 1 Electricity/Gas System Roles and participants within Rugeley

Role	Rugeley Participant(s)
Sector regulator	Ofgem (National)
Setting policy direction	UK Government (National)
Transmission Owners	National Grid (National)

Distribution Network Operators	Western Power Distribution (Elec), Cadent (Gas)
Systems Operator	National Grid ESO (National)
Retailer/suppliers	Multiple (small, medium and large-scale licenced companies)
Electricity generators	Multiple (prosumers[2], small, medium and large-scale companies)
Electricity Balancing and Settlement Code Administrator	Elexon (National)

When a whole systems approach is employed, additional roles can also be identified as shown in Table 2:

Table 2 Additional roles and participants within Rugeley's local energy system

Role	Rugeley Participant(s)
Customers	Residents, Industrial & Commercial
Public services	CCDC, Severn Trent (Water Sewage), South Staffordshire Water
Land development	Multiple (small, medium and large-scale companies)
Local authority	School buildings, theatre, community/ leisure, Housing association assets/council housing
Canal owner	Canal river trust
Mine owners	Mine authority
Transport providers	Ariva (majority) & 30 others
Large businesses	TESCO, Amazon, JCB

It should be noted that participants can fulfil multiple functions within a local energy system. For example, whilst Seven Trent are providing a water sewage public service, they are also a customer to an energy retailer(s) for their electricity and gas supply and may also be an electricity generator if they have embedded generation.

The roles, and participants, can be mapped against the business model canvas described in Section 2.3, forming the basis for the following business model categorisation methodology.

3 Categorisation methodology for local energy business models

This section will propose a methodology that can be used to categorise different business models that could be considered for Smart Local Energy Systems. It will achieve this by drawing on the work of Emanuele Facchinetti and Sabine Sulzer who have defined a solution space where *Energy Hubs*[3] business models tend to operate. [21] Firstly, the relevant activities within the value chain require definition. For Zero Carbon Rugeley, these are identified as: [21]

- **Acquisition/Loyalty:** Establishing relationships with customers and business partners. In the case of ZCR, the customers could be consumers or prosumers of energy services. Partners are the other energy system participants mentioned in Section 2.5.1
- **Procurement of infrastructure:** Exploiting infrastructures for the production, storage, conversion, and delivery of energy services. ICT and ancillary systems are also required.
- **Operation and control of infrastructures:** The operation, control, and maintenance of local infrastructure. This includes local balancing services and engagement for grid operators for ancillary services.
- **Delivery of energy services:** The secure delivery of energy to customers. Delivery of complementary services going beyond energy supply, e.g., domestic services and mobility solutions, is also part of this activity. Furthermore, this activity includes the metering intended as the accounting of the energy exchanged.
- **Pricing**: Administrative tasks such as, the establishment of prices, the communication with the customers and the partners, the contracting, the billing, and the account of trading costs and revenues

Clearly, business models can address multiple activities within this value chain, and thus, theoretically, a vast number of Patterns could be identified. That said, in 2014 Glassman et al. analysed the majority of commercially successful business models across all sectors. Using the business model canvas as a

[2] Prosumer: A producer and consumer of electricity

[3] The definition of Energy Hubs is consistent with SLES

foundation, they found that 90% of these business models were derived from 55 core ideas. [22]

Taking these 55 business model ideas as the base, Emanuele Facchinetti and Sabine Sulzer adopted a heuristic methodology to define a solution space relevant for local energy markets, as illustrated in Figure 6. [21]

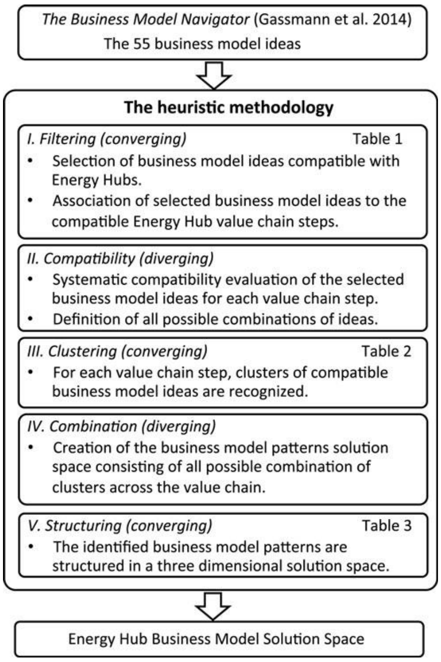

Figure 6 The heuristic methodology for the categorisation of relevant business model for local energy systems [21]

This process involved five sequential steps of converging/diverging decisions, as illustrated above. From this a three-dimensional solution space was contrived showing the possible combinations of clusters across the value chain.

From an analysis of Energy Hub solutions, Emanuele and Sabine identified three business model Patterns within the solution space. These Patterns are illustrated in Figure 13 in the Appendix and are defined as follows. [21]

3.1 Pattern I definition

Pattern I is based on the cluster Orchestrator associated with the Procurement and control of infrastructures value chain activities and on the cluster No Frills associated with the activity Delivery of energy services. Selected Pricing options are the clusters Pay per use and Subscription. Bottom line of this business model is to run the Energy Hub focusing on the operation and control and outsourcing the procurement of infrastructures. The Energy Hub's investment costs are low. The services offered to the customers focus on the essential. The related cost savings can be shared with the customers, which can benefit from low prices. [21]

3.2 Pattern II definition

Pattern II is based on the cluster Fractional Ownership associated with the Procurement and control of infrastructures value chain activities, and on the cluster User Designed associated with the activity Delivery of energy services. All Pricing options are available: Add-on, Pay per use, and Subscription. Within this Pattern, the Energy Hub shares the ownership of the infrastructures with one or multiple customers and offers the possibility of tailored energy services. The Energy Hub benefits from the infrastructure availability and from reduced investment costs and risks, which are partly or fully taken over by the customers. The customers can benefit from the possible valorisation of their partly owned infrastructure while having access to complementary energy services provided by the Energy Hub. [21]

3.3 Pattern III definition

Pattern III is based on the cluster Rent instead of buying associated with the Procurement and control of infrastructures value chain activities, and on the cluster Experience Selling associated with the activity Delivery of energy services. Selected Pricing options are the clusters Pay per use and Subscription. Within this business model Pattern, the Energy Hub offers to the customer the possibility to lease all-inclusive turnkey solutions. The customers benefit from avoiding investments in the required infrastructure and from a complete and high quality customer experience. The Energy Hub is exposed to high investment costs that are met by the potentially high margins expected from the offered high quality services. [21]

Emanuele and Sabine developed this solution space with the objective of supporting the development of innovative business model solutions for Energy Hubs. In Section 4, some established and emerging business models for local energy systems will be examined against this framework.

4 Established and emerging business models

The following Section will review some established and emerging business models which have been categorised based on the methodology outlined above. Clearly not all SLES business models will fit perfectly into these Patterns, or necessarily directly within the solution space. However, when this occurs, they tend to be a secondary service that can be attributable to a core business model that broadly aligns with a Pattern. If they adopt attributes from multiple Patterns then they will be grouped based on their procurement method, but with commentary on how the service delivery differs from the Pattern. To be considered in scope, the business model must involve a transaction with a consumer and therefore secondary markets, such as the ownership of distribution infrastructure, will not be discussed.

4.1 Pattern I

Pattern I business models fulfil the basic needs of consumers. These business models are typically commodity based and focus on a single energy vector. In general, they represent the decentralisation of traditional business models.

4.1.1 White Label Energy Supply Companies

Matchmaking between customers and utilities for energy supply is an attractive part of the energy value chain with Price Comparison Websites (PCWs) in the domestic sector (B2C) and Third Party Intermediaries (TPIs) in the business sector realising significant value. PCWs typically charge a utility £20-£30/fuel for an acquisition, resulting in a clear value attributable to customer acquisition.

Some local authorities and community groups have established white label energy supply companies to try and capture some of this value. A white label energy provider is an organisation that does not hold a supply licence but provides energy through a partnership with a licenced supplier. The branding is in that of the white label supplier, however the delivery is handled by the licenced supplier. Under this arrangement, the white label organisation uses its reach to attract new customers for the partner, and in return is paid the referral fee that would typically go to a PCW. A proportion of this referral fee is also invested in local community projects. This approach has been adopted by a number of local authorities in recent years, two examples being Qwest Energy (Chester) and London Power (London), both in partnership with Octopus Energy.

Although these white label energy supply companies can offer a community-orientated value proposition that the national utilities cannot, in general these models have struggled to attract customers. In the Pattern I solution space, the critical customer driver is price and as such the success of these companies is highly dependent on the competitiveness of the licenced supplier. Furthermore, as the referral commission is paid to the white label energy company, they are unable to be featured on PCWs. In 2017, it was estimated that between 41% and 50% of energy switches were initiated through a PCW. [23] With other companies aggressively acquiring customers through referral incentives, the target customer base for these white label energy companies is limited. Finally, the sustainability of these operations should be questioned with Octopus Energy recording a £34m operating loss for 2018/2019, largely caused by their aggressive acquisition (+327%) strategy. [24]

That said, with the risk largely sat at the licensed supplier, a white label supply company could be a relevant model for ZCR. Alongside the reinvestment of profits in community initiatives, they can provide a route to market for local community generation projects.[4] An example of this is Co-Op Energy; another white label supplier who have partnered with Octopus Energy. [25] They have recently launched a community power tariff that purchases renewable electricity directly from community energy projects via a Power Purchase Agreement (PPA). This tariff costs approximately £5/month more than a standard tariff, with the hope that consumers are willing to pay extra to support community projects. Co-Op Energy are a national brand and are purchasing their electricity from community schemes from across the country, as depicted in Figure 7. However, there is little reason this could not be replicated on a local level for ZCR, with the formation of a local white label company like those mentioned above.

[4] Renewable generation projects that are owned by the community. These are a Pattern II business model that will be discussed in Section 4.2.1

Figure 7 Over 80 community generators are now involved with the scheme [25]

Following on from this approach, the white label energy company could own the infrastructure and cannibalise more of the value chain. With the potential to offer locally sourced renewable energy tariffs, this could form part of a credible decarbonisation strategy.

4.1.2 Local Licenced Energy Supply Companies

Rather than partnering with a licenced supplier to supply local energy, two local authorities have acquired their own supply licenses; Robin Hood Energy of Nottingham and Bristol Energy.

These businesses offer a similar value proposition to the white label providers; namely supporting community development and improving access to affordable energy within the region. That said the core offering is a Pattern I no-frills energy supply contract.

In the highly competitive world of energy supply it is now notoriously hard for challenger supply companies to make a profit. Unfortunately, both of these ventures have been demonstrable failures. Robin Hood Energy announced a £23.1m loss in 2018/2019 [26] and Bristol Energy a loss of £10.1m over the same period. Bristol City council have now announced their intentions to sell the entity. [27]

Based on this precedent, establishing a new licenced supply company would be a highly risky venture for ZCR and is not recommended.

4.1.3 Prosumers

A prosumer is the epitome of decentralised generation and the emergence of this model was largely driven by the Feed in Tariff (FiT) in the UK. The FiT was a government programme *designed to promote the uptake of renewable and low-carbon electricity generation technologies.* [28] The scheme ran between April 2010 and April 2019 and provided generators with payments for each kWh of renewable electricity generated and for each kWh of electricity exported[5] to the grid, guaranteed for 15 – 25 years depending on the technology. The vast majority of installations were Solar PV and upon closure of the scheme there were 857,882 FiT accredited Solar PV installations in the UK. [29]

In general, FiT installations followed a Pattern I business model, with the orchestrator (the customer) paying upfront for the installation and achieving their return on investment through subsidy payments and reduced energy bills. This basic prosumer business model is illustrated below in Figure 8. [30]

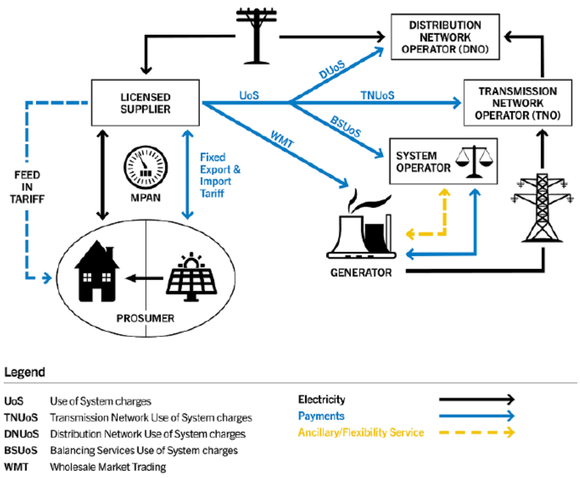

Figure 8 A basic FiT based Prosumer business model [30]

Following the closure of the FiT, the business case for prosumers has been far more challenging with profitability largely dependent on the levels of self-consumption of the electricity. This has led to a requirement for smarter systems, or innovative funding models, to share the CAPEX burden and/or maximise the percentage of self-consumption. The basic operating model seen during the FiT era, are unlikely to be relevant for ZCR, however more comprehensive

[5] For the majority of installations there was no metering requirement so export was deemed rather than actual

prosumer based business models will be discussed later in this section.

4.1.4 Public Electric Vehicle Charging Networks

Smart Local Energy Systems must develop business models that aim to decarbonise sectors other than power, with transport being especially important.

Wide adoption of Electric Vehicles (EVs) in the UK has often been likened to a chicken and egg scenario, with consumers anxious to purchase EVs until there are a suitable number of charging points, (EVCPs) and companies tentative to install EVCPs until there are a suitable number of EVs.

However, a combination of regulation, technical advancements and consumer led evolution has accelerated the deployment of EVs with nearly 270,000 ultra-low emitting vehicles (ULEVs) now registered in the UK [31] and over 18,000 public EVCPs. [32]

In a basic public EVCP business model, a licenced supplier will charge a fee for each charging session. Rates vary but this is often combination of the electricity consumed, (£/kWh) the length of the charging sessions (£/min) and any overstay fees. The CAPEX is normally covered by the owner, although different ownership models have been explored at strategically useful locations.

Despite there only being 279 ULEVs currently registered in Cannock Chase, further penetration of EVs will form an integral part of the decarbonisation strategy. As such, more EVCPs will inevitably need to be installed. Alongside the basic EVCP model is presented here, some attention should be paid to potential future business models, which will be discussed later in this section.

4.2 Pattern II

Pattern II represents the solution space for more developed business models that explore alternative funding mechanisms. The solutions become more comprehensive and are designed with the user in mind, although they still tend to focus on one energy vector.

4.2.1 Community Owned Renewable Generation

Community owned renewable generation is an obvious example of a community energy business model. It is thought to be where the term originated from in the UK, with the establishment of the Baywind Cooperative in the late 1990s. [33] In 1997 the Baywind Cooperative raised £2m in shares amongst its 1217 members. The cooperative owned 6 wind turbines, with the profits distributed to community funds, such as sustainable energy educational activities in the area along with share interest to the members. [34] The Baywind Cooperative is now part of Energy4All, an organisation owned by the cooperatives that it supports. Energy4All has 3 Hydro, 11 Wind, 1 Biomass and 7 Solar farms and claims that its cooperatives pay an annual share interest of about 5% to 10% to their members. [35] The most recent investment opportunity was for the High Winds Energy Society Limited which sought to raise £5.7m with 5-year loan notes at 4% and ordinary shares with a projected return of 4.5% to 5% per annum. [36]

This business model can be seen to clearly align with Pattern II identified earlier and has been shown to be a replicable way of financing renewable energy generation projects. With an increasing social awareness around environmental responsibility, these crowdfunded projects could increase in popularity. That said, these aforementioned projects, although community owned, do not provide electricity directly to the community.

4.2.1.1 *Ripple Energy*

Another interesting business model associated with crowdfunded renewable generation is Ripple Energy. Ripple Energy are the customer facing entity involved in a project that allows customers to purchase shares in a wind farm *after* they have switched supply to a Co-Op (Octopus) tariff. [25] The shares will cover the costs of the construction and operation and maintenance of the Graig Fatha Wind Turbine. The returns are then passed back to the customer as a reduction from the electricity proportion of a customer's energy bill, as illustrated below.

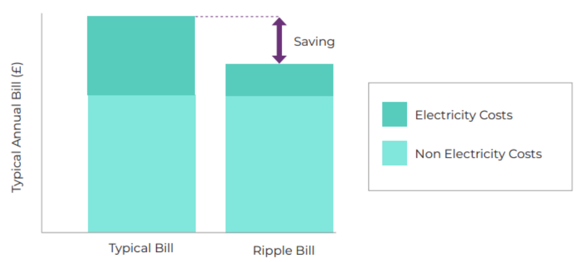

Figure 9 Ripples financial customer value proposition [37]

This business model is interesting as it aims to derive value from the customer acquisition and retention, passing the savings back to the customer through their energy bill. It is unclear what happens if a customer switches supplier during the term of the contract.

Ripple claim to be *the co-op's managing agent. They take care of everything from facilitating the purchase of shares, managing the contractual interfaces between the co-op and the wind farm's construction and operations and maintenance contractors, setting up arrangement with the energy supplier, and managing communications with co-op members*. [37] Ripple's arrangement fee is £206,000.

The share offer closes in July 2020 and with customer breakeven estimated to be between 11 and 20 years, the proposition is likely to only appeal to a niche audience. If the customer base is dissected further by applying a local requirement, it would be even harder to find a suitable number of investors, potentially making replicability for ZCR challenging. That said, the physical ownership of renewable generation infrastructure may appeal to consumers and is worth investigating as part of the user centric design portion of ZCR.

4.2.1.2 Chase Community Solar

Back when FiT payments were attainable, local community funded projects had a stronger business case. Local community funded renewable generation schemes emerged, such as Chase Community Solar; a community benefit society local to Rugeley.

In 2015, Chase Community Solar (CCS) raised over £1 million through a community share offer and loan to install Solar PV on 314 council bungalows within Cannock Chase District Council. [38] CCS consists of circa 200 members who share the FiT payments as well as revenues for excess solar generation.

36 of these homes are currently involved in an additional trial, in partnership with Green Energy Networks (GEN), SmartKlub and SIG. The trial involves retrofitting battery storage to the homes alongside SIG's digital technology that is able to switch customers' electricity supply between local solar, battery storage and the grid. GEN and SmartKlub have established an Energy Services Company, in partnership with a licensed supplier, to provide consolidated billing services to the participants. *The project aims to automate time-of-use-tariff selection, balancing community solar and storage and lowering costs by prioritising how and when power is imported from, or exported to, the grid. By partnering with an aggregator, the ESCO is also seeking to sell local residential balancing and flexibility services to National Grid and the Distribution Network Operator.* [39]

The trial is operating within Ofgem's regulatory sandbox service which was launched in February 2017. These trials allow innovators to trial new products, services and business models without some of the usual rules applying. The consumers can opt-out at any time and are guaranteed to pay no more for their energy than if they had not participated. [39]

With Chase Community Solar part of the ZCR project, special attention should be focussed on their business models and how it may be replicable within larger portions of Rugeley. Furthermore, the Government have recently announced that Pot 1 technologies, including Onshore Wind and Solar, will be eligible for the upcoming Contracts for Difference (CfD) Allocation Round 4. The CfD scheme gives generators a consistent revenue for 15 years at a contracted strike price and could potentially be used to underpin community renewables. Alternatively, the aforementioned Co-Op Energy PPA model could be used to provide certainty to an investment.

4.2.2 Community Owned Electric Vehicle Charging Points

A similar model to community owned renewable generation is starting to be explored for EVCPs. Charge my Street is a community energy society that installs and operates community EVCPs, raising money through community shares. Charge my Street allows customers to nominate locations where they would like EVCPs installed and then pay for these through a community share offer. They have demonstrated the proof-of-concept by installing charge points at two locations in Lancaster and in two Cumbrian villages. [40]

In May 2020 they successfully raised £130,000 through a community share offer, attracting around 130 investors. This money will be used to extend its network of community owned EVCPs across Cumbria and Lancashire, installing at an additional 100 sites. They expect to pay investors 2% interest from 2023 rising to 5% from 2025. [41]

This proposition has clearly resonated with consumers, evidenced by its fully subscribed share offer. Furthermore, the business model could easily be combined with community owned renewable generation to create an interesting customer proposition.

4.3 Pattern III

Pattern III business models are more specialist and are designed to incorporate as many revenue streams as possible. They allow the consumer to rent services and, as such, 'As a Service' models would generally fall into this solutions space. The majority of these business models are reliant on further digitisation to unlock revenue streams which would have not been historically accessible.

4.3.1 Collective Prosumers

Microgrids or Private Wires are well-established in the UK and have historically been used to provide power to remote communities, often from a diesel generator. Recently attention has shifted towards using this concept to support community energy schemes and collective prosumers; where self-generation and consumption is judged at a community, rather than individual, level. Rather than self-consumption being measured at an individual level, it is recorded at the microgrid/community boundary. In these schemes, a local energy company can be established to handle the billing of consumers within the microgrid. It can also offer more competitive supply/export tariffs owing to the privately owned infrastructure and incentivise load shifting through Time of Use (ToU) tariffs. Providing the energy company is managing a system of <2.5MW it qualifies as a license exempt supplier and does not have to abide by the balancing and settlement codes. The electricity, payments and services are illustrated below in Figure 10. [30]

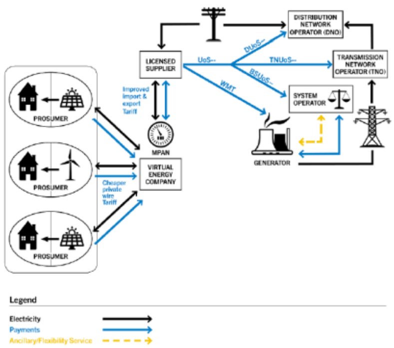

Figure 10 A microgrid/private wire business model for the UK [30]

With higher self-consumption, lower Use of System charges and the potential to reinvest the supplier margin in the community, microgrids have the potential to offer significant benefits to the community. [42] However, consumers are not obligated to remain with the new supplier and the 2.5MW limit reduces scalability and relevance for ZCR.

4.3.1.1 Energy Local & Octopus Energy

An innovative research project that aims to demonstrate the collective prosumer model on a public network is the Energy Local & Octopus Energy partnership. [43]

Energy Local & Octopus Energy are attempting to balance renewable generation and demand at a substation level. To achieve this, they agree a PPA with a local renewable generator and record its half hourly export. They also record the half hourly electricity consumption of consumers who are connected to the same substation. This allows them to calculate the amount of electricity the consumers received from the renewable generator and the amount from the substation during each half hourly period. In aggregate, they are able to determine the total import and export from/to the grid in each half hour and settle using the summation of this value. This can result in circa 50% less electricity costs by avoiding some distribution and transmission charges.

Octopus acknowledge that *Energy Local in some ways 'hacks' the grid by settling scores of generation and consumption off the grid before giving a final, "aggregated" settlement*. [43] However, the project has received funding from BEIS via the Smart Energy Savings competition and could demonstrate how collective prosumer business models are possible on a public network. Although this trial is focussing on a larger generator with a PPA, the concept is perfectly replicable for prosumers and, in theory, Peer to Peer trading.

4.3.1.2 Peer to Peer Trading

A Peer to Peer (P2P) model works by reducing or negating the requirement for a licenced supplier by allowing the direct trading of electricity between energy system participants. Theoretically, participants can negotiate power prices amongst themselves and potentially achieve higher prices for the generation and lower prices for their supply. This would be facilitated by a third party platform, with the most well-known example currently being the Brooklyn Microgrid trial powered by Exergy. [44] With a licensed supplier in the middle of each transaction it is not a true P2P, but rather aims to demonstrate the concept. A schematic for a P2P model is illustrated below in Figure 11. [30]

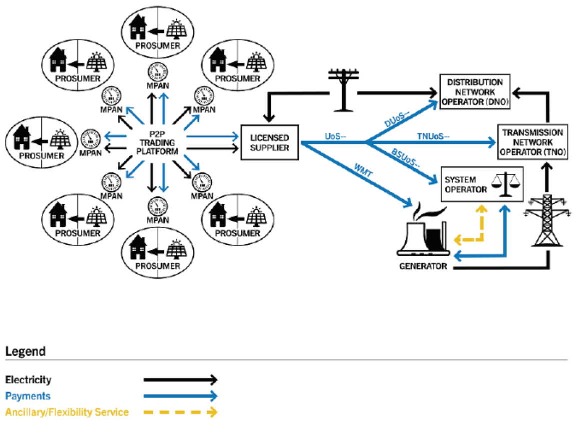

Figure 11 An illustration of how a P2P marketplace could look [30]

Currently, P2P is not scalable in the UK as it is not possible on public networks. That said, a couple of trials are underway as part of the Ofgem regulatory sandbox.

Repowering London are a community benefit society who have installed PV panels to the roof of Banister House in Hackney, providing electricity to communal areas, but not residents. Through the Ofgem regulatory sandbox mechanism, Verv are testing a P2P platform that allows residents to trade renewable energy via a distributed ledger platform. British Gas are the licenced supplier and the objective of the trial is to test the practical applications of Verv technology as well as consumer appetite towards P2P trading.

Given the currently regulatory framework, it would be challenging to deploy an immediate P2P business model for ZCR and it would only be possible on a private wire solutions. However, if ZCR results in a higher number of prosumers in the area, a P2P system could provide a credible solution in the medium-long term.

4.3.2 Business Models for Ancillary Services

As mentioned in Section 2.1.1, WPD have identified Rugeley as an area with local network constraints. This means that there is scope to provide services to the DNO, at the substation level, to help with the local grid constraints. However, this form of flexibility is just one of the value pools that can be accessed by flexible assets. Increasingly, business models are arising that seek to capture value by providing ancillary services, such as: [30]

- **Flexibility Services:** Flexibility providers can help utilities balance their position prior to gate closure[6] by increasing or reducing their demand.
- **Balancing Services:** Balancing services are provided to the ESO after gate closes to balance the volume of electricity purchased and supplied by retailers. These services tend to involve large volumes of electricity for longer periods.
- **Frequency Response:** Small system fluctuations need to be managed by the energy system operator, with demand turned up or down within seconds.
- **Capacity Markets:** The system operator can buy capacity on the market rather than investing in additional infrastructure in the future or extending the life of large power plants.
- **Local Network Management:** Rather than local network reinforcement, flexible assets can be used to manage the load on low voltage networks

For local energy systems and distributed energy resources the markets associated with Energy Arbitrage, Frequency Response and Local Network Management are deemed to be of most importance, as the other revenue streams have less local sensitivity and are better suited to larger assets. In particular, a number of operating models are emerging that aim to capture value from providing ancillary services.

4.3.2.1 Aggregators

To participate in the above markets, there is often a minimum size requirement, which has traditionally excluded smaller participants. However, in some cases this can be overcome through aggregation. An aggregator combines multiple smaller-loads into a 'Virtual Power Plant' and, through coordinated dispatch, is able to participate in some of the aforementioned markets. With conversion technologies such as Heat Pumps, Water Heaters and Electric Vehicles having the potential to be aggregated,

[6] Gate closure refers to the time when the energy trading market closes and the energy system operator takes over. Typically, 30 minutes prior to consumption.

this solution embraces a whole systems approach by encouraging flexibility across different demand vectors. An example schematic of an aggregator business model, which provides services to the ESO, can be seen in Figure 12.

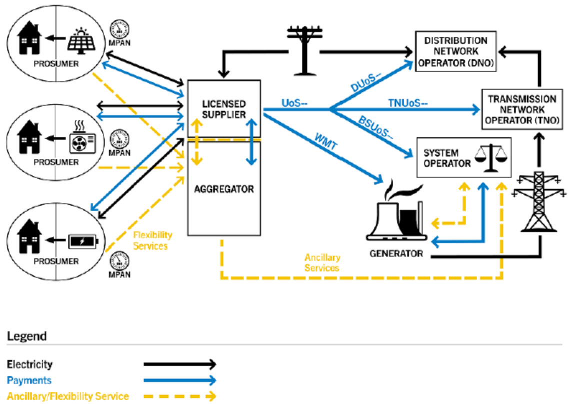

Figure 12 Multiple prosumers can be aggregated to provide ancillary services [30]

Tiko are an example of an aggregator who offer energy management services to more than 7000 connected households. By partnering with Sonnen Batterie, Tiko have been aiming to demonstrate that additional ancillary revenues can be realised without impacting self-consumption levels. [45] Without the FiT payments, this ability to stack different revenue streams is a crucial part of small prosumer business models.

Harnessing domestic and cross vector flexibility is generally considered a core requirement of the zero carbon transition and as such business models that draw on Ancillary Services revenues are likely to be part of the ZCR solution. That said, caution should be employed when considering these largely merchant and generally untested business models. The financials are challenging, and although they are expected to improve in the coming years, the immediate opportunity is less clear.

4.3.3 Energiesprong

With access to some of the ancillary revenue schemes, increasingly complicated housing retrofit business models are being proposed. An example of this is Energiesprong which describes a novel funding approach combined with a whole house refurbishment or new build construction standard. [46]

An Energiesprong retrofit is a modular approach which aims to reduce costs, increase efficiency and improve construction quality whilst simultaneously reducing the resident disruption by minimising the time on site . The cost of the retrofit is nil to the resident with the return achieved through term energy performance contracts. These business models are not currently commercially viable and are reliant on grant funding. For example, in 2019 ENGIE and Moat Homes launched a 5 property demonstrator in Maldon.

The decarbonisation of existing housing stock will be a key challenge for ZCR and innovative business models will be needed to address this challenge. The Energiesprong approach is unlikely to make financial sense until it can reach suitable scale, making deployment for ZCR challenging. That said, some of the principles could be implemented in a slightly less holistic proposition.

4.3.4 Heat as a Service

Heat as a Service (HaaS) is term used to describe business models that allow customers to pay for warm hours rather than kWh. Although the concept has been discussed for a while, it has only recently been trialled. As part of the innovation trials in the ESC Living Lab, Baxi Heating and Bristol Energy trialled two different operating models for HaaS. [47]

Baxi Heating UK sold a Heat Plan that bundled a new heating system, servicing, maintenance and energy for a fixed monthly price. The solution aimed to remove the upfront CAPEX barrier associated with installing a new efficient boiler. The trial cohort was too small to have significantly significant result but was adopted by the sole participant who required a new boiler.

Bristol Energy became the first energy supplier in the UK to trial selling HaaS, selling both fixed price and Pay-As-You-Go Heat Plans to domestic customers. The proposition was offered to 85 participants with an unspecified subset opting in. Some positive feedback included that the service provided higher levels of comfort that traditional models.

Although both trials were considered successful, caution must be employed before deploying these solutions for ZCR. Both trials were conducted on the ESC Living Labs households who already had smart heating controls and were familiar with the concept of HaaS. There is still a question around how less engaged consumers will respond to the proposition. Furthermore, when most homes do not already have the necessary smart heating controls, adding additional CAPEX. That said, service based business models can remove a lot of the entry barriers and potentially accelerate the decarbonisation of heat.

4.3.5 Privately Owned Public Transport

Following on from The Transport Act of 1985, private organisations that can develop business models that profit from providing bus services. The most recent (2016) data from the Department for Transport estimates that there to be 30 different bus operators in Staffordshire, with Ariva holding 53.4% of the market share. [48]

Despite passenger journeys outside London consistently falling over the past 10 years, [17] public transport has the potential to help decarbonise the UK and is clearly possible within the current policy framework.

If ZCR can identify consumer travel Patterns, and appetite, that supports the provision of new bus routes, a simple bus operating business model could prove profitable and valuable to local residents.

Due to the private investment and ‘as a Service’ delivery model, this business model has been categorised as Pattern III. However, the delivery of energy services is user designed rather than experience selling, meaning it doesn’t fit within the Pattern III solution space. That said, some other mobility business models are emerging which seek to provide a more comprehensive user experience.

4.3.6 Community Car Sharing

According the RAC, the average car is parked for 96% of the time. [49] With 45-75% of the life-cycle emissions of Battery Electric Vehicles produced during its manufacture, [50] large environmental benefits can be realised by reducing people’s reliance on personal vehicles. One method of achieving this is through community car clubs, specifically clubs that offer Electric Vehicles. Rather than consumers owning their vehicle, a Pattern I business model, EV car clubs allow consumers to pay for the vehicle based on the duration they require it for and the distance they travel. They typically operate under three models, defined below: [51]

- **Back to Base:** A consumer books the car, drives it and then returns it to the same location.
- **Peer to Peer:** People with underused vehicles can offer them for rent to their neighbours and other members of the local area. A service provider arranges the insurance and takes a small commission.
- **One Way:** Members are able to pick up a car from within a pre-defined zone and drop it off anywhere else within the zone.

Although most car clubs have a fleet of internal combustion engines as well as EVs, a community EV car sharing scheme could form an interesting proposition for Rugeley. Furthermore, this proposition could be nicely combined with the aforementioned Pattern II community ownership models to further increase democratisation.

4.3.7 Micromobility

Micro-Mobility is another alternative to the current car-centric consumer ownership model, whereby urban mobility is facilitated through a suite of different vehicles, which can be sourced from convenient locations for short periods. Such solutions increasingly include e-kickscooters, e-bikes, e-scooters and micro-cars, although the UK market is less advanced with push bikes still dominating. This bike share market is fairly established in the UK, with over 650,000 users across 26 schemes. [52] That said, if micromobility solutions are going to scale in the UK then a range of transport options will be needed to cater for different user preferences and journey types.

Despite micromobility companies attracting $7bn of venture capital in 2019, [53] these companies have struggled to make their business models work with significant losses recorded across the board. With theft and vandalism of vehicles still prevalent and e-kickscooters currently illegal[7] in the UK, there are a number of socio-political challenges to micromobility solutions. Furthermore, high population density and asset usage is needed to overcome CAPEX investment,

[7] A question on whether to legalise e-kickscooters is a question in The Future of transport regulatory review (consultation closing 03/07/20)

so ZCR will need to assess if Rugeley is suitable for such a solution.

That said, when micromobility solutions have been deployed in partnerships with local government, they have had greater success. If ZCR is able to identify an operating model that addresses the challenges above, an offering could deliver significant local value to Rugeley.

4.3.8 Mobility as a Service

Mobility as a Service (MaaS) is a term used to describe the digitisation of transportation via a system that integrates the planning, booking and paying for travel. [54] Ideally, it can support multi-modal transport and allow consumers to adopt a subscription based approach to transport.

An example of a MaaS provider is Citymapper, who are now live in 39 cities globally, including London, Manchester and Birmingham in the UK. [55] Citymapper have recently launched the Citymapper Pass which provides Londoners with access to a range of public transport and private transport solutions for a fixed monthly fee. Their operating model works by providing the users with a pre-paid card that can be used for transportation, with the subscription fee less than the weekly Oyster Card Cap. This means that Citymapper will lose money for each customer who reaches the weekly cap. It is believed they aim to become profitable once they've scaled by exploiting their greater negotiating power and increasing their number of private partnerships. [56]

To date, Citymapper has focussed on deploying its platform in large global cities, and therefore Rugeley is unlikely to be their next target destination. Furthermore, a comprehensive contactless public transport payment system is needed to deliver the service, which Rugeley does not currently have. A MaaS solution is therefore unlikely to be deliverable in the short term despite its potential to deliver significant local value. That said, the concept of using a subscriptions service to underpin investment is valid as demonstrated by the large number of Pattern III business models.

5 Rugeley's road to zero

There are clearly a large number of business models that can be deployed to support Rugeley's road to zero. With varying levels of complexity and replicability, there is no one answer on how to commercially develop a smart local energy system. However, some interesting conclusions can be drawn, and the above Patterns can be used as a framework to guide future debate.

Pattern I business models fulfil the fundamental requirements of an energy system, providing basic no-frills solutions at a local level. The business models are not flashy and are unlikely to capture the imagination of the media, but they do serve a strong purpose. A lot of consumers are disengaged with the energy sector and are unlikely to desire more than a simple cheap offering. These business models facilitate that and should not be overlooked.

Pattern II business models could be implemented to help democratise energy, with these grass roots models educating and empowering the community. They have proved to be popular, with oversubscribed share offers, and have been replicated in numerous settings. With the value proposition appealing to consumers despite the low rates of return, they could also provide a funding route for some economically challenging projects. There is also the potential to bundle more solutions within one proposition, such as an EV car sharing scheme with its own EVCPs and renewable generating assets.

Pattern III business models are likely to be the business models that drive the zero carbon transition due to their high potential impact despite the fact that the majority are not yet ready for commercialisation, either due to regulatory barriers or the underlying economics. These business models should not be thought of as an immediate solution, but rather as a roadmap, and solutions that align with their principles should be developed. Greater digitisation is a key enabler of these business models and should be high on the agenda.

Finally, it is important to note that the aforementioned business models are not mutually exclusive and there are significant opportunities for them to complement each other. For example, a PPA from a white label supply company (Pattern I) could underpin community owned renewables and storage (Pattern II) which could then be used to provide ancillary services (Pattern III). The combination of different business models during the design phase has the potential to abate investment risk and unlock new revenue streams, paving the way for Rugeley's road to zero.

6 Appendix

Table 3 The industry codes that underpin the electricity and gas wholesale and retail markets [57]

Code	Type	Code Administrator	Website
Balancing and Settlement Code (BSC)	Electricity	Elexon	www.elexon.co.uk
Connection Use of System Code (CUSC)	Electricity	National Grid	https://www.nationalgrideso.com/industry-information/codes
Distribution Use of System Agreement (DCUSA)	Electricity	Electralink	www.dcusa.co.uk
Master Registration Agreement	Electricity	Gemserv	www.mrasco.com
Grid Code	Electricity	National Grid	https://www.nationalgrideso.com/industry-information/codes
Distribution Code	Electricity	Energy Networks Association	www.dcode.org.uk
System Operator - Transmission Operator Code (STC)	Electricity	National Grid	https://www.nationalgrideso.com/industry-information/codes
Uniform Network Code (UNC)	Gas	Joint Office of Gas Transporters	www.gasgovernance.co.uk
Independent Gas Transporter UNC (iGT UNC)	Gas	Gemserv	www.igt-unc.co.uk
Supply Point Administration Agreement (SPAA)	Gas	Electralink	www.spaa.co.uk
Smart Energy Code (SEC)	Gas and Electricity	SECAS	www.smartenergycodecompany.co.uk
Retail Energy Code (REC)	Gas and Electricity	REC	https://www.retailenergycode.co.uk/

Table 4 Energy Systems Catapult summary of existing market arrangements for small-scale generation, storage and DSR sources and key directions [13]

<table>
<tr><th></th><th>Market/Service type</th><th>Demand side reduction/ load shifting</th><th>Energy storage</th><th>Distributed generation</th><th>Direction of policy change</th></tr>
<tr><td>Wholesale market</td><td>Bilateral trading</td><td>-</td><td colspan="2">There are no direct barriers to bilateral trade agreements</td><td>Market-wide halfhourly settlement</td></tr>
</table>

	Power exchange trading		Subject to minimum bid size requirements – e.g. 0.1MW (EPEX Spot, NordPool).	reform in progress, enabling more accurate price signals to reach end users.
Ancillary service	**Short term operating reserve (STOR)** Active power from generation or demand reduction. Three tender rounds per year. Seasonal contracts; up to 2 years in length	**Minimum 3 MW**; can be aggregated. Response requirement – within max 240 minutes (20 mins preferable). Sustain requirement – sustain for min 120 minutes; recovery period not more than 1200 minutes.		Transition smaller scale (non-BM) STOR providers to a new IT system to enable efficient dispatch.
	Fast reserve Active power from generation or demand reduction. Procured through monthly tenders.	**Minimum 25 MW** (from March 2019) Delivery must start within 2 mins of dispatch instruction. Response – delivery rate in excess of 25 MW/min. Sustain – reserve energy sustained for min 15 mins; able to deliver min 25 MW		New IT systems for dispatching smaller-scale (nonBM) Fast Reserve providers.
	Demand Turn Up Large energy users and generators at times of high renewables output and low demand.	**Minimum 1 MW; can be aggregated from sites of at least 0.1 MW** Average response time and duration - average notice period (2017) - 6 hours 40 minutes. Average length of delivery - 3 hours 34 minutes. Equipment - minute by minute or half hourly metering required.		Designed for nearterm (not viewed as lasting “negative” reserve solution) All reserve services to be reviewed in 2019 as part of National Grid ESO’s work to reform Balancing Services
	Firm Frequency Response (FFR) Generation and demand; Monthly tenders.	**Minimum 1 MW (single unit or aggregated)** Response – within 2–30 seconds (depending on service time). Dynamic frequency – continuous (via operation in frequency sensitive mode). Static frequency – upon instruction (via automatic relay). Dispatch – single point of dispatch or method to provide monitoring for ESO needed.		Trialling weekly auctions

Balancing Mechanism	Operated by National Grid to balance the electricity network after gate closure	**Minimum 1MW (single unit or aggregated)** Following implementation of Project TERRE, aggregators will be able to bid units without needing a supply licence. **DSR** is currently engaged through bilateral contracts with National Grid, following testing and verification.			Widening access; Project TERRE National Grid's Distributed Resource Desk.
Capacity market	Capacity auctions focused on security of supply. Open to new and existing generation and DSR, with different contract lengths.	Able to participate; subject to verification procedures.	De-rating factors depending on type of asset (e.g. battery duration and capacity).	Open for participation for DER, except renewables in receipt of other governmental support (i.e. CfD, FiTs or Renewable Obligations (ROs)).	Currently suspended De-rating methodology allowing renewables developed to allow participation following end of other support contracts.

		Delivery of energy services		
		No frills	**User designed**	**Experience selling**
Procurement of infrastructure/operation and control	**Rent instead of buying**			*Pattern III* Pay per use Subscription
	Fractional ownership		*Pattern II* Pay per use Subscription Add on	
	Orchestrator	*Pattern I* Pay per use Subscription		

Figure 13 The business model Patterns solution space and three reference Patterns [21]

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