ZERO CARBON RUGELEY
WP3-D1: DEFINING MARKET STRUCTURES FOR THE RUGELEY LOCAL ENERGY MARKET

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Defining Market Structures for the Rugeley Local Energy Market

Prepared for:
Zero Carbon Rugeley
http://www.rugeleypower.com/zero-carbon-rugeley-project/

Version 1

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Contents

EXECUTIVE SUMMARY

Decentralised energy is emerging as a critical player in the delivery of global targets to limit climate change as well as facilitating the drive towards increased decarbonised, decentralised, democratised and digitised energy.

Decentralised energy will support the democratic restructuring of energy systems, increasing civic participation in governance, and fundamentally delivering and creation of new business models and roles for energy citizens in relation to the wider energy system of which they are part. This ultimately leads to a socio-technical energy transition.

These trends and transition in the United Kingdom (UK) is reflected in government strategy with a push toward a low carbon, smart, local energy system (SLES).

The emergence of Local Market Platforms

Covering a wide range of technologies that do not rely directly on the high-voltage electricity transmission network or gas grid, decentralised energy brings a range of business benefits, including:

- increased conversion efficiency (capture and use of heat generated, reduced transmission losses)
- increased use of renewable, carbon-neutral and low-carbon sources of fuel
- more flexibility for energy generation to match local demand patterns for electricity and heat
- greater energy security for businesses that control their own generation
- greater awareness of energy issues through community-based energy systems, driving a change in social attitudes and more efficient use of our energy resources

In addition to improving the use of networks, the growing market introduction of decentralised energy resources is creating new local market platforms for justified and transactive two-way energy and information trading. The transition of sustainable energy systems takes advantage of digital technologies, such as platform organisations. It increases the potential for interaction between consumers, enabling both areas to learn from each other and open up new paths for researchers from different areas.

New developments in the energy marketplace and business models are to be created to benefit from surplus capacities. Load aggregators and utilities are going to have the ability to benefit from fresh electricity for different clients in real-time, even when their distribution and general demand change.

Application in Zero Carbon Rugeley

The Zero Carbon Rugeley SLES project will focus on the design of a local market platform that will

- facilitate the procurement of flexibility services
- allowing customers and energy suppliers to trade

- determine total system value based on a combination of bulk system components, distribution system components, and an evaluation of system conditions

This local market platform will go beyond signposting needs and simply coordinating buyers and sellers. It will include a comprehensive end to end view of the viability of the system and its operation. By placing system and customer needs at the heart of the design of the local market platform will ensure not only economics and technical viability of the market, but also creating the appropriate investment signals, and will remove barriers of entry for local energy participants.

This report focuses on the local market creation and its function as part of the various steps necessary to reach the goal of the Net Zero in Rugeley. Specifically, this report will outline the reasons behind the energy market creation, the initial requirements, its components and their roles along with the tool that will allow the market simulations.

What are the initial expected social, environmental and economic benefits of a local energy market and their impact in Rugeley? The definition of the market structures, financial models and test cases for Rugeley as gathered through interactive workshops with the Rugeley Project Consortium.

This report is organised into four chapters; these chapters cover the following aspects:

Chapter 1: Local Energy Market Design: This section details the Energy Market Objective, Energy Market Service, Market Timing, Contract Structure, Market Actors, Peer-peer and Non-electrical participants.

Chapter 2: Market Structure for Rugeley: This section will focus on the market structure that will be assessed during the project, such as carbon reduction and cost savings. From this information, several market structures were designed to focus on key divers, and main objectives, which are described below with their market goal and the expected results.

Chapter 3: Test Cases: This section will highlight the configuration of the market structure and simulation to test the hypothesis of each market structure.

Chapter 4: Next Steps: This section will highlight the next tasks and activities in the project.

LOCAL ENERGY MARKET DESIGN

Energy markets are commodity markets that deal specifically with the trade and supply of energy. According to the British Institute of Energy Economics, the concept of local energy market (LEM) is to establish a marketplace which draws together a community of renewable energy and low carbon generators, storage and demand-side response providers at both the domestic and non-domestic level. Through the marketplace, these providers can then participate in energy trading, entering both traditional and new market services.

According to Energy UK, supplying electricity to homes involves three key elements: making electricity through generation, transporting electricity and selling it to the customer. Energy companies can work in any of these different areas, and some operate in all three of them. The electricity market in the UK is privatised. This means that private companies make sure we have the energy that we need. It also means that customers can choose which companies supply their power.

Electricity can be generated at large power stations, connected to the national transmission network, and in smaller-scale power stations which are connected to the regional distribution networks. The number and type of power station built is the decision of each individual company based on market signals and government policy on issues such as the environment. There are many companies in the electricity generation sector, from large multinationals to small, family-owned businesses running a single site.

The integration of distributed resources such as wind power, solar power, electric vehicles and demand response, the local energy market can respond providing flexibility to be the benefit of local systems enabling the participation of all the participants in the market.

According to Energy Systems Catapult, Local Energy Markets (LEM) concepts are still in initial stages of development and vary significantly in their design and functionality, including the attribute being traded, the market participants involved and the role they play. The value of different arrangements is also yet to be tested and evaluated.

In the context of these broader system developments, further considerations that should be considered by all local energy market projects, include:

- Cybersecurity, data privacy and data protection risk mitigation and management
- Balancing and settlement processes within LEMs and how the LEMs would interact with system-wide processes and requirements
- Revenue stacking opportunities and potential for LEM participants to access multiple revenue streams, including outside the individual local energy market

- Impacts of future network charges and access arrangements on price signals for consumers and how they will interact will LEM design and decisions for asset owners
- Serving as a point of contact to customers and potential future access for multiple suppliers to a single user
- Impact of existing and future renewable energy incentives on LEM market liquidity and participation
- Impacts of smart meter roll-out, flexible energy tariffs and future data access and communication requirements
- Ensuring system stability and incorporation of system needs in the assessment of the market needs

Individually, for Rugeley, the above considerations are considered to categorise the initial market members. These are being differentiated between Market Participants, following the traditional definition of these, and Market Contributors, essential other roles for the energy market to function.

Energy Market Objectives

The energy market design will focus on achieving many crucial objectives for Rugeley.

1. Achievement of cost efficiency through the identification of cheaper alternatives to higher electrical costs from traditional reinforcement expenses.
2. System reliability by providing more power balancing options.
3. In longer timeframes, markets could be used to support planned outage management, while shorter timeframe markets can support unplanned outage management.
4. Facilitating peer-peer transactions while maintaining system stability and security of supply

Market rules can be adjusted to emphasise other objectives such as stimulating new connections, new technology uptake (such as electric vehicles), achieving carbon-neutral goals, and facilitating a competitive marketplace. Variations to payment structures, penalties, enrolment rules, or procurement periods can favour certain flexibility providers and technologies.

Energy Market Services

An energy market service is a transaction that is being offered and compensated for between two market actors. At a fundamental level, this relates to either the trading of energy or the trading of capacity (the potential to require energy). This can be achieved through an increase of loading, a decrease of loading, increase of generation, or decreasing of generation. In the UK, there is an understanding that electricity demand will continue to grow as the country targets the achievement of its carbon-neutral goals with technologies such as electric vehicles and PVs. Energy transactions at a distribution level can help alleviate the need for capital and infrastructure investments, such as expensive transformer and substation upgrades.

These traditional upgrades are usually passed onto homeowners through their electricity rates, so reinforcement deferral helps maintain low electricity costs for the community. Additionally, in regions where there is high electrical demand, energy market services can provide reliability and consistency in the form of alternative sources of generation other than the energy retailer.

Figure 1 below shows an example of a market transaction where a resource named PV1 dispatches and causes a lower net loading. In this example, a flexibility service at 9pm could mitigate the peak system loading by either producing generation or reducing demand.

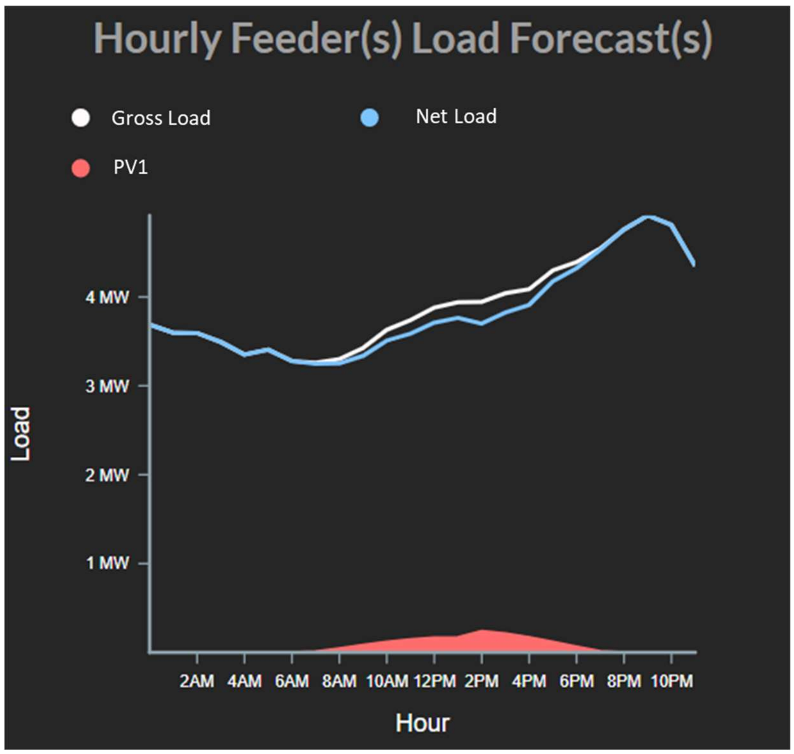

Figure 1: GridOS market simulation Loading graph

To ensure alignment with flexibility market developments in the UK, the project will evaluate the applicability of a number of services for their applicability within the local market platform.

There are three categories, comprising of five services: DSO flexibility services, ESO-DSO coordination services, and Peer to Peer (P2P) services.

- DSO flexibility services (constraint management and peak management) are procured for the DSO to manage their system.
- ESO-DSO coordination services (short term operating reserve) are procured to realise energy balance between the ESO and DSO.

- P2P services (import and export capacity trading and offsetting) are procured and transacted between market actors.

For the markets workshop, simulations will be run the peak management and offsetting services. There is additional complexity with modelling and performing live trials with the other services, and the two selected services cover the general functionality.

DSO Flexibility Services:

Constraint Management

Constraint management is a DSO service. Flexibility in the form of reduced demand, increased generation, or dispatched storage will mitigate the impact of a network constraint. This constraint could be due to a planned outage. Reactive power services can also be procured to reduce losses, improve power factor quality, or manage voltage levels.

Peak Management

Peak management is a DSO service. Flexibility in the form of reduced demand, increased generation, or dispatched storage will mitigate the impact of a period of peak demand on a particular asset on the network. Reactive power services can also be procured to reduce losses or improve power factor quality.

ESO-DSO Coordination Service:

Short Term Operating Reserve

Short Term Operating Reserve is a type of ESO-DSO coordination service. Flexibility will be procured for the ESO as demand reducing or generation producing services when there is forecasted system imbalance. Specifically, the procured services could cause conflicts for the DSO if proper mitigation is not planned.

P2P Service:

Import and Export Capacity Trading

Import and export capacity trading is a type of P2P service. One market actor agrees to limit their import or export to enable increased import or export by another market actor on the network.

Offsetting

Offsetting is a type of P2P service. Flexibility will be procured at one part of the network, either increase generation or increase demand, to enable increased demand or increased generation at another part of the network. This service also includes the charging or discharging of electric vehicles to enable increased generation or increased demand. This service supports both constrained and unconstrained networks.

Market Timings

Depending on the market objectives, services can be procured at various frequencies with different lead times. In support of long term planning, a long term market that procures services from months to a year in advance can be used. In the short term for balancing services or depending on forecasting capabilities, markets procuring for sub-hourly to a day ahead can be used. In Project Rugeley, GridOS Market Simulation Tool (MST) will process and simulate market transactions on a shorter timeline.

Day-Ahead Market

Services will be procured in hourly intervals, 24 intervals in a day. The market for the next day will open at a specified hour of the current day and will close at a particular hour near the end of the business day.

For example, the 24 hourly market intervals for July 1 may open at 12:00 pm on June 30 and close at 8:00 pm on June 30.

Intra-Day Market

Services will be procured in sub-hourly intervals (5, 15, or 30 minutes), at many intervals (288, 96, or 48) in a day. The market for an upcoming period will be open for a short duration beforehand (depending on the market interval, this could be 15 minutes to an hour), and will close approximately 15 minutes ahead.

For example, the market interval for July 1 from 10:00 to 10:15 am may open at 9:00 am and close at 9:45 am.

Participation in the intra-day market allows market participants to refine or change commitments made in the day-ahead market. Given any demand or generation changes in the system, intra-day market procurement can be used to correct any imbalances.

Contract Structure

There are typically three main methods of payments structures associated with a flexibility service contract for market enrolment: availability, arming and utilisation payments. Availability payments serve as a retainer payment for the flexibility services in the energy market. Arming payments are paid to flexibility services to place them in a state of readiness for a period. Utilisation payments compensate flexibility services for their procured services.

In Project Rugeley, the market simulations will consider utilisation payments to investigate the impacts of varying market and loading scenarios on procurement processes. Availability and arming payments are investigated and tested through contract negotiations, while utilisation payments will follow a market-clearing evaluation and mechanism.

Market Actors

The market actors within an energy market are defined as entities or individuals who are highly relevant to the functioning of the energy system or have a high degree of influence to bring about change in it. For example, buyers and sellers are two common types of agents in partial equilibrium models of a single market. In Rugeley, the energy market, specifically the electricity market, will gather the different actors, classified as participants and contributors depending on their decision-making capabilities to enter a transaction to buy or sell within the electricity market. For example, the sellers or generators will decide when to sell responding to the planned demand.

The initial participants and contributors have been identified as any energy producers or sellers, consumers and prosumers, aggregators, traders, National System Operator (National Grid), Public institutions, Data privacy compliance roles and the market operator itself. This list is not exclusive, and there can be other actors in the market in the future as market functions, and structures mature.

The market operator is a role that must be independent of any market participant and resource owners (suppliers). The focus of market operator is to address two essential market needs: (1) to operate the market fairly and impartially and (2) to facilitate market transactions while managing the security of the power system in real-time.

MARKET PARTICIPANTS are those buyers and sellers transacting business in the principal market for an asset or liability. These participants are not related parties, have a reasonable understanding of the asset or liability, can enter a transaction to buy or sell the item, and are motivated to do so.

MARKET CONTRIBUTORS, in the Local Energy Market (LEMs) scenario, are defined as the other active members of the market that are not the traditional participants; however, they are still essential for the market's optimal operation.

Type	Description	Examples in Rugeley (current & future)
	Market Participants	
Producer/Sellers	Local energy generators, energy retailers, and energy distributors	Western Power Distribution (WPD) Engie Aggregated Domestic Houses with PV Fleet Manager of Electric Vehicles
Consumers & Prosumers	Buyers of energy with or without the capacity of selling self-generated power. - Commercial Retailer, Industry (from small to large) - Domestic - Public Institutions, inc Transportation	Commercial: Amazon Warehouse, Tesco Domestic: Cannock Chase Community PV Future: Domestic EV fleet, etc.
Aggregator	Facilitator of communities such as domestic customers. - Energy suppliers could be involved as an aggregator	
Trader - Import / Export	Power trading refers to purchasing and selling power between participants in the energy industry. Various forms of power trading are possible depending on the market design, ranging from short-term trading to long-term power purchase agreements. Traders can take the buyer or seller role depending on the market and trader decisions.	Energy retailers e.g. Engie Generation Owners

Type	Description	Examples in Rugeley (current & future)
	Market Contributors	
Market operator - ***Role to be defined***	Balancing power supplies as well as new roles such as prompting so-called smart solutions to manage increasingly complex energy flows. - Neutral market facilitation (NMF)	Electricity System Operator (ESO)
National Grid	The transmission system is run by National Grid, which is responsible for balancing the system and making sure that the supply of electricity meets the demand on a second-by-second basis.	
Key Roles defined by GDPR	GDPR outlines clear roles and responsibilities for the entities involved in the collection, storage, and processing of personal data.	Data Protection Officer (DPO), Data Processor & Data Controller.
Public Organisations	Such as government authorities, regulators, customers, etc.	Ofgem, HM Government (Department for Transport), Education Institutions

Table 1: Rugeley Market Actors

Figure 2 below shows a visual representation of these actors in the Rugeley area.

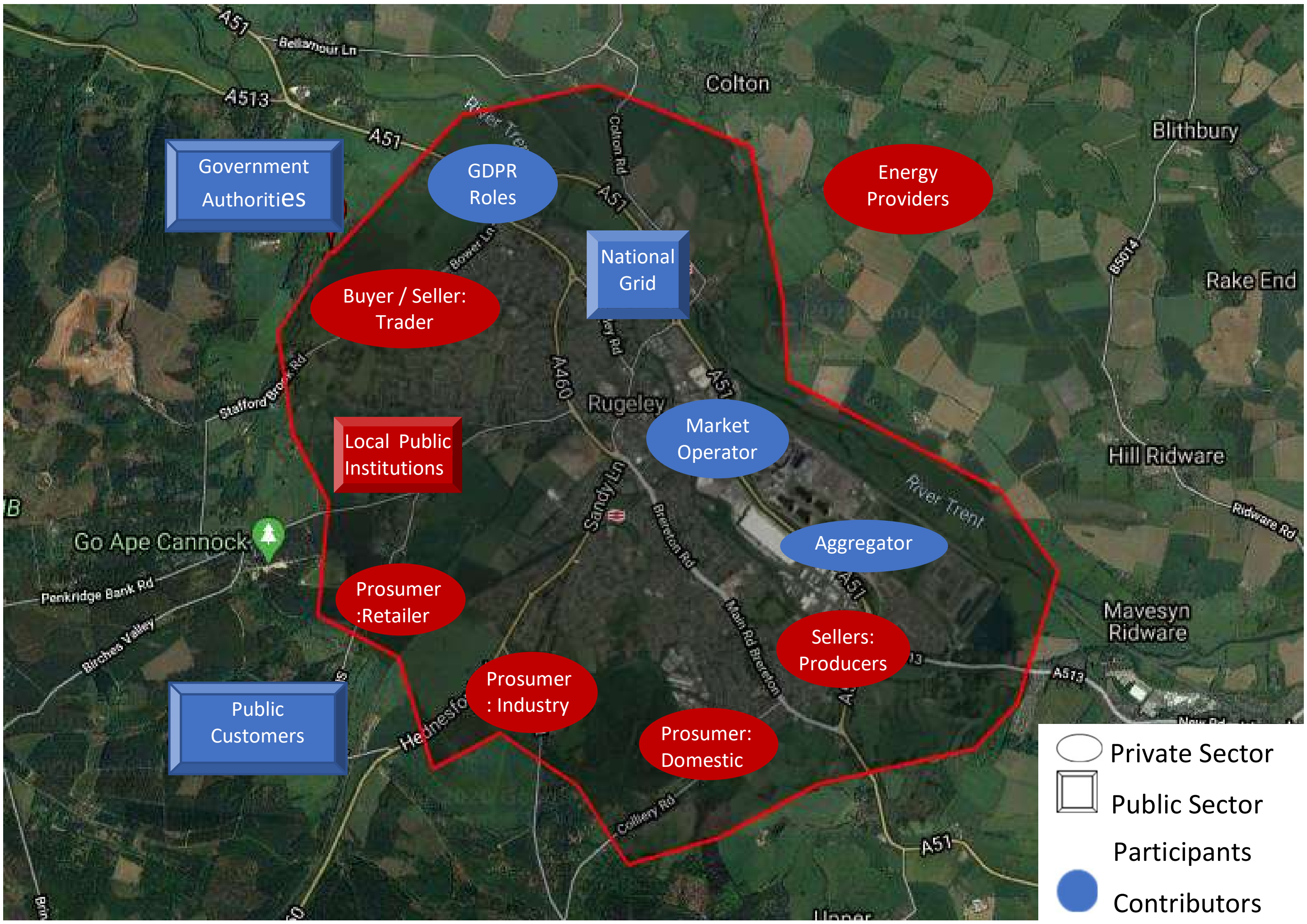

Figure 2: Visualisation disclosing the Market Participants and Contributors withing and outside Rugeley and categorised by Private or Public Sector

Figure 3 below shows a sample network model visualisation in GridOS that captures the network topology and available flexibility services. The lines and dots represent electrical cables and nodes that comprise a sample electrical distribution system. The green bars represent the forecasted power to be delivered by each respected resource on the network for a specific market interval. In the example below, the aggregated household PV will support the substation in providing energy for the entire network. In this market interval, the community battery will not be consuming or producing energy, potentially because it did not clear the market and its services were too expensive.

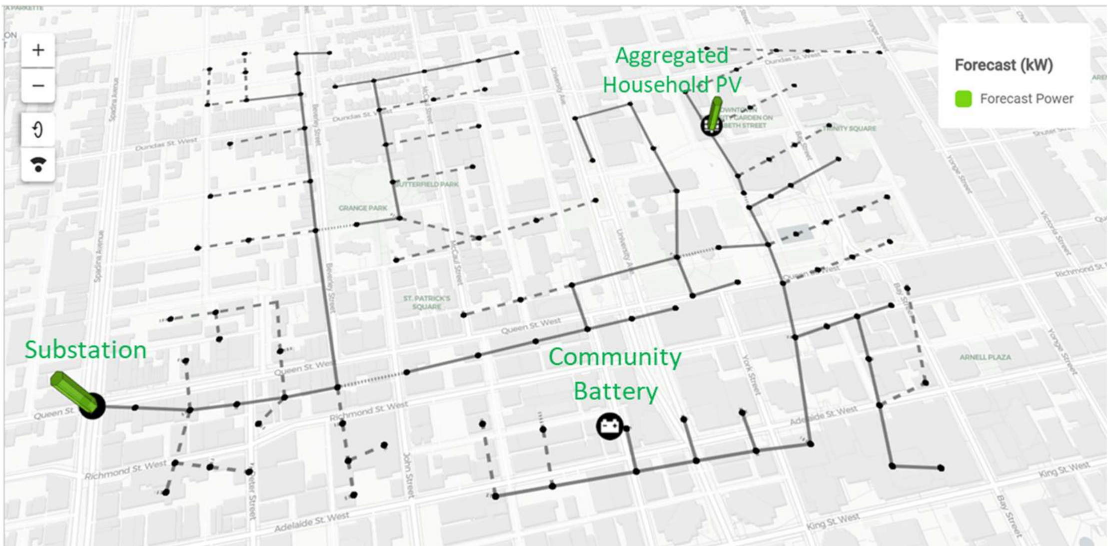

Figure 3: GridOS GIS network model representation

Market participants can submit bids and offers to indicate their desired participation in the market. For every one of their resources, market participants can state their maximum price for purchasing energy and minimum price for selling energy. Figure 4 below shows the configurations available in GridOS for a market participant who owns a battery, PV, and synchronous machine.

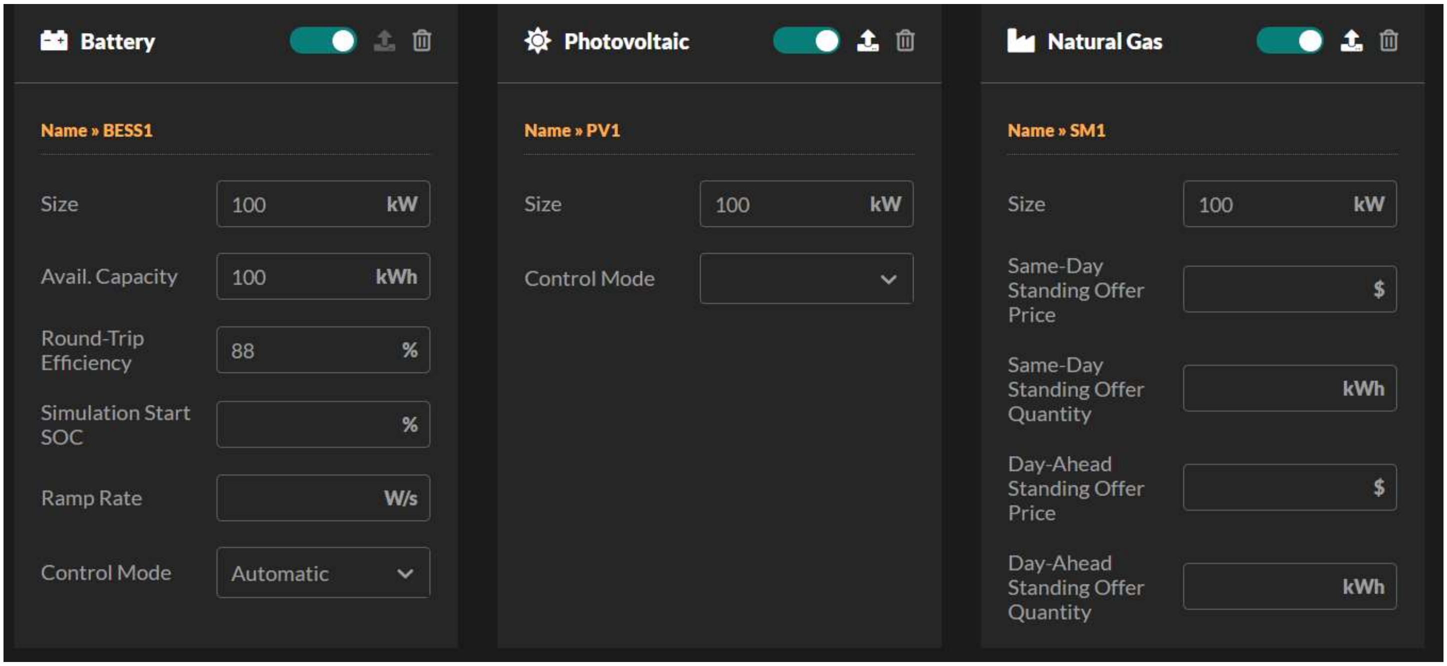

Figure 4: Sample configurations for distributed energy resources

Peer-peer

Peer to peer services decentralise the energy market from the standard model where market participants make transactions with only the retailer. In this project, actors will be able to buy energy, sell energy, buy capacity, or sell capacity with other actors. Any actor can participate in peer to peer services, given their resources are capable of the required energy or capacity requirements. There are two main peer to peer services that will be available for actors: offsetting and trading import/export capacity. As an example, a commercial site can acquire more capacity for a specific duration by acquiring the unused capacity of an aggregator's resource portfolio.

Due to the nature of electricity, it will always travel along the path of lowest resistance. As a result, it is difficult to definitively determine if one prosumer's energy directly supplies a consumer. Instead, sufficient measurement data will identify if the net effects of the transactions were correct. Measured energy generation and usage at both prosumer and consumer sites will provide proof for a completed transaction. Actors will be required to have the ability to produce measurement results in order to enrol in the market. The overall net effects of the transactions will be documented and careful accounting will determine whether the commitment was met.

Every actor will submit their bids and offers, indicating the type of service they wish to fulfil. The GridOS Market Simulation Tool will consider these actors' inputs and then optimally and securely balance the network and clear the market based on a cost-minimisation objective.

Non-electrical participants

Hydrogen, natural gas, and other fuel processes can be converted in order to be represented in the market. A British Thermal Unit (BTU) conversion rate will be used to convert any fuel costs into electrical energy (MWh). The electrical energy generated or consumed by the chemical process can be represented in the market as a transaction.

MARKET STRUCTURES FOR RUGELEY

Through community and stakeholder focused workshop and survey consultation with the Rugeley consortium, the market structures below have been identified as the key areas of focus for this project such as carbon reduction and cost savings. From this information, a number of market structures were designed to focus on key divers and main objectives, which are described below with their market goal and the expect results. The outputs of every market structure will be measured and evaluated by the same metrics and it is expected that different results will be achieved depending on the core objective of the market

Market Structure 1: Carbon reduction

In this market structure, the goal of the market is to reduce the amount of carbon emissions in the Rugeley area as much as possible. This will be achieved by modifying the flexibility service valuation mechanism to prioritise carbon emissions.

Input assumptions and scenario configurations:

- Load scenario captures the representative load growth
- Flexibility growth on network model is modelled through bids and offers
- Cost-minimising optimal power flow analysis is run
- Flexibility services will be valuated for their carbon reduction contributions
- Penalties may be implemented for carbon flexibility services

Expected result:

- Carbon neutral services are procured
- Lowest CO_2 emissions, environmental benefits are valuated

Market Structure 2: Cost savings

The goal of this market structure is to encourage and achieve the lowest possible system and energy costs. These energy costs are passed onto the retailer and homeowners in the Rugeley area. This will be achieved by prioritising cheaper flexibility services.

Input assumptions and scenario configurations:

- Load scenario captures the representative load growth
- Flexibility growth on network model is modelled through bids and offers
- Cost-minimising optimal power flow analysis is run
- Flexibility services will be compensated with a pay as bid methodology, TBD
- Potentially incorporate long term planning strategies and cost of upgrades as avoided costs into flexibility services financial model

Expected result:

- Cost effective services are procured
- Lowest cost of energy to homeowners

Market Structure 3: Low barrier to entry

The goal of this market structure is to encourage participation in the Rugeley area. This will be done by minimising restrictions, penalties, and deterrents for participation.

Input assumptions and scenario configurations:

- Load scenario captures the representative load growth
- Flexibility growth on network model is modelled through bids and offers
- Network model is updated with very small flexibility service
- Cost-minimising optimal power flow analysis is run
- Flexibility services will be compensated with a pay as bid methodology, TBD
- No minimum flexibility service size
- No or minimal penalties for failing to meet commitments
- Potentially emphasis on a long term market
- Potentially more peer to peer services enabled

Expected result:

- Cost effective services are procured
- Highest number of procured services

Market Structure 4: Supply security

The goal of this market structure is to securely minimise risk for the distribution system in the Rugeley area. This will be done by prioritising flexibility service providers of better reputation and having flexibility readily available.

Input assumptions and scenario configurations:

- Load scenario captures the representative load growth
- Constraints are present in the load scenario
- Flexibility growth on network model is modelled through bids and offers
- Cost-minimising optimal power flow analysis is run
- Flexibility services will be compensated with a pay as cleared methodology, TBD
- Constraints are priced extremely high
- Consider a reliability factor or rating for flexibility service providers
- Penalties are severe for failing to meet flexibility service commitments

Expected result:

- Relatively expensive services are procured to avoid very expensive constraints
- Lowest number of constraints
- Flexibility services may be procured with short lead times or paid to be on standby for resiliency

TEST CASES

A test case is the configuration of the market structure and simulation in order to test the hypothesis of each market structure. The test case setup includes tuning the inputs and methodolgy type for each analysis. The goal of the test cases is to evaluate the four market structures with the GridOS Market Simulation Tool. There are some varying datasets that will create different metrics for comparison of each market structure.

Inputs

1. Demand growth will be modelled over several years (i.e. 2021, 2026, 2031) by using a representative 24h load series for the same type of day in each year. This represents the change in the Rugeley area over the years and allows for a long term analysis. Longer duration or more granular loading scenarios can be modelled than one day per year.

Timestamp	Loading
00:00 to 23:59 June 1, 2021	15 MW
00:00 to 23:59 June 1, 2026	20 MW
00:00 to 23:59 June 1, 2031	25 MW

2. Flexibility services growth will be modelled over several years by modelling the largest and final flexibility service provider size but restricting flexibility services participation in earlier years through bids and offers.

Year	Bid and Offer Limit
2021	10 kW
2026	100 kW
2031	1 MW

3. The market rules will be defined and varied as necessary between market structures to influence the results. Market timings for Day-Ahead and Intra-Day participation will likely stay the same amongst all market types. The pricing mechanisms for valuing flexibility services will change between market structures to demonstrate how different structures value different objectives.

Outputs

1. The key measurements and metrics for comparison between the market structures are:
   - Weight of CO_2 emissions (environmental)
   - Cost of energy to homeowners (cost effectiveness)
   - Cost of flexibility service procurement
   - Number of outages or violations (system reliability)
   - Number of procured services (market openness)

Market Simulation Implementation

During the market simulation workshop, the project team will use the GridOS Market Simulation Tool to evaluate the different market structures and test cases. Consortium team members will represent different roles within the Rugeley area such as residential and commercial consumers, prosumers, and aggregators. Opus One will facilitate the role of the market operator and configure the market settings for a particular first market structure.

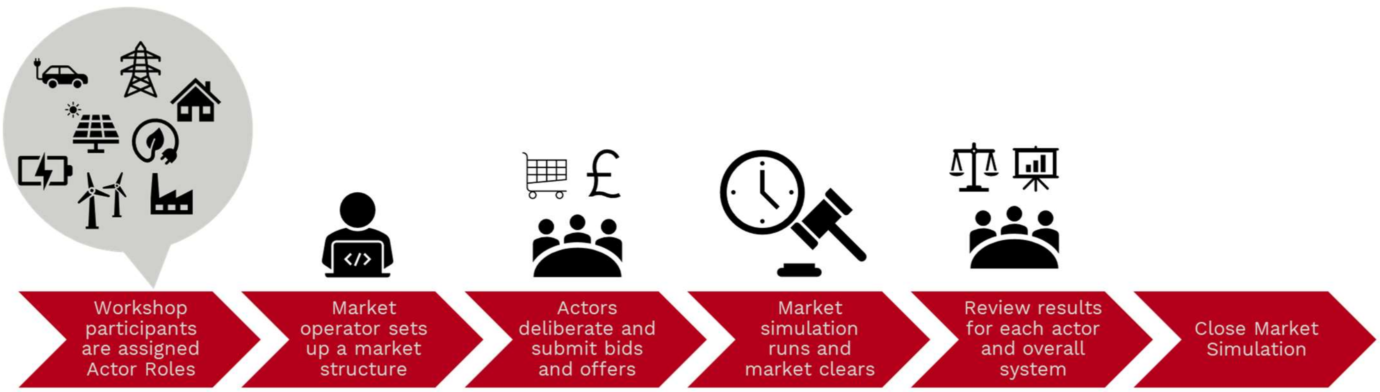

Figure 5: Planned workshop flow

1. Workshop participants are assigned Actor Roles
   All actors will be briefed on their asset portfolio.

2. Market operator sets up a market structure and explains the market context
   All actors will be briefed on the market scenario: market timings, rules, and clearing mechanism.

3. Actors deliberate and submit bids and offers
   These bids and offers can be datetime specific or standing (always applied at all market intervals). These services increase or decrease their real or reactive power impact on the network, and can be peer-to-DSO or peer-to-peer in nature. Actors will then submit their bids and offers to the market operator in the GridOS platform.

4. Market simulation runs and market clears
   The market simulation will clear the market and all particpants will have a chance to review the results of the selected services.

5. Review results for each actor and overall system
   The test cases and metrics will identify whether the market operator and individual actors were able to meet their objectives.

6. Close Market simulation and repeat for next market structure

Other considerations for market workshop include the ability for actors to engage in negotiations and create their own bilateral contracts to be represented in the simulation. This could be in the form of allowing other actors to participate in the market with their assets on their behalf.

NEXT STEPS

- With all market structures defined, the project team will design and implement the valuation metrics for each market structure
- The user interface will be re-evaluated to consider aggregators' interactions with support from Conigital.
- In collaboration with Work Package 7, the project team will identify all market participants and evaluate different methods of outreach

Glossary

Term	Description
1. Aggregator	An aggregator is a new type of energy service provider which can increase or moderate the electricity consumption of a group of consumers according to total electricity demand on the grid. For example an EV Fleet manager could operate as an aggregator.
2. Ancillary Services	Services necessary to support the transmission of electric power from generators to consumers given the obligations of control areas and transmitting utilities within those control areas to maintain reliable operations of the interconnected transmission system. These services can include frequency or voltage regulation.
3. Constraint Violation	A place where the network has a network violation due to the load being too high or generation for the electrical equipment rating. Violations are also caused when the current has exceeded the line's limit (also called a thermal constraint) or when the voltage is outside of a typical operating range.
4. DER	Distributed Energy Resources are a source of decentralised, community-generated energy. Examples can include wind, solar, batteries, diesel generators etc. Also referred to as an Asset.
5. DNO/DSO	Distribution Network/System Operator, securely owns/operates and develops an active distribution system comprising networks, demand, generation and other flexible distributed energy resources (DER). As the UK moves towards the DSO paradigm, the DNO is usually defined as the entity that own the equipment while the DSO is the entity that operates the equipment.
6. Electrical Measurements a. Current b. Power c. Power System Load d. Reactive Power e. Real Power f. Voltage	a. Rate of flow of electric charge past a point or region. b. Measure of the rate of energy transfer and relates to the current and voltage. c. The total electric power consumed by all users connected to the distribution network of a system, and the power used to compensate for losses in all parts of the network (transformers, converters, and transmission lines). d. The power which flows back and forth, meaning it moves in both the directions in the circuit or reacts upon itself (measured in KVAr). e. The power which is actually consumed or utilised in an AC circuit is called True power or Active power or Real power. It is measured in kilowatt (kW) or MW. f. The volume of electrical charge in a point.

7. ESO	The Electricity System Operator is responsible for ensuring the stable and secure operation of the electricity transmission system. Some examples include National Grid in the UK or IESO in North America.
8. EV	Electric Vehicle
9. Generator	Device that converts motive power (mechanical energy) into electrical power for use in an external circuit.
10. Network – Distribution	The system of overhead lines and underground cables that distribute electricity to homes and businesses. This can range for different jurisdictions but is typically around 11 to 33kV.
11. Network – Low Voltage (LV)	230V / 440 V network (typically household level and where EVs are charged).
12. Network – Transmission	High-voltage system for the transfer of electric power. It consists of transmission lines, substations and switching substations. This can range for different jurisdictions but is typically over 100kV.
13. Participant	Also called a Market Participant, an entity or person who participates in the energy market, offering their energy services. A Participant may own and operate multiple DERs.
14. Powerflow	An electrical analysis run on the network calculating the electrical metrics (Real and Reactive Power, Current, and Voltage) on the network and will identify if there are constraints.
15. Transactive Energy / Flexibility Market	The economic and control techniques used to manage the flow or exchange of energy within an existing electric power system regarding economic and market based standard values of energy.
16. TSO	Transmission System Operator, a natural or legal entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.

Rugeley Project Overview

Zero Carbon Rugeley is a project to produce an innovative design for a town-wide Smart Local Energy System (SLES) including the former Rugeley Power Station site. This is one of just a dozen such pioneering programmes in the UK and will demonstrate how carbon emissions and energy costs can be reduced whilst also providing a boost for local regeneration.

In designing the SLES, the project partners will take full advantage of the latest renewable energy technologies and smart control systems to deliver clean, affordable energy for residents. As such, the innovative Rugeley SLES will create a scalable energy solution that can be replicated in other areas in support of the UK's transition to a zero-carbon future.

The project aims to deliver an energy system design for the area which is sustainable, low carbon, and that drives the regeneration of the town and local energy infrastructure. To find out more about the project please visit www.rugeleypower.com/.

Opus One Solutions

Opus One is a software engineering company that brings real-time energy management to the smart grid. Through its leading edge offering GridOS™, Opus One delivers a new level of visibility and control to electricity distribution through sophisticated engineering analytics designed to solve and optimise complex power flows. Seamlessly integrating with utility data systems, GridOS™ provides powerful grid management capabilities and unlocks greater potential for distributed energy resources including renewable generation, energy storage and responsive demand. GridOS™ further facilitates the implementation and management of microgrids from homes to communities for unparalleled grid resiliency and value to the electricity customer. To learn more about Opus One Solutions please visit www.opusonesolutions.com.

Ben Ullman – Manager of Markets and Transactions worked previously as an Economist for Federal Energy Regulatory Commission in the United states where he led investigations into allegations of energy market manipulation within the framework of Commission rules and market tariffs focused on physical and financial electricity and gas trading. Currently, he is leading the Transactive Energy Market Development with National Grid as part of NY State's Reforming the Energy Vision program.	**Jenson Lam – Solution Specialist** has experience in asset management and strategic planning with Toronto Hydro's Long Term Strategy and Planning department. His focus is on projects which support the transition from DNO to DSO through flexibility planning and design for Flexibility Markets. He holds a Bachelors in Applied Sciences with a major in Energy Systems Engineering from the University of Toronto.

Gemma Marina – European Business Development Manager is Opus One Solutions' first UK hire and is the beginning of its UK and European Growth Strategy. She has experience working in energy sector and other tech disrupted sectors as international financial senior management. She has led the business transformation of tech disruptive companies, Gemma has pivoted her focus to the energy section and recently got an MSc in Artificial Intelligence by the University of St Andrews to focus on tech and businesses development.	**Hisham Omara – VP of strategic growth** is a strategy development and transformation leader involved in many business and strategic planning projects for firms competing in the electric power business. He has worked in the energy sector (Innovation, System Operation, Transmission and Distribution, DSR, and Market Policy Development) for the last 10 years in the United Kingdom, Europe, Canada, and Middle East. He has expertise in strategy development, change management, advanced technology for electricity systems and the design and operation of ancillary service markets.
Paula Meehan – Project Manager has experience managing software and solutions delivery projects in the telecoms and energy sectors over the past 5 years. She is currently responsible for managing a number projects delivering the GridOS suite to utilities across Europe and North America. Paula has a PhD in Energy Engineering from Dublin City University analysing the electrical signals of domestic appliances for identification and energy monitoring.	**Raina Kang – Project Manager** has worked as a project manager for over 6 years previously in Solar Energy Industry and now with Opus One Solutions delivering GridOS solutions and managing microgrid construction projects. Raina holds a Bachelor's degree in Electrical and Electronics engineering and had worked in other SW companies as a technical expert for over 3 years before joining energy sector.