Work Package 4:

Future Scenarios for Flexibility Markets in which the RaaS Battery System can be Optimised

(E4.1)

Handed over by: E.ON Business Solutions GmbH

Prepared by: Sofia Rahman, Product Manager E.ON Flexibility Markets

Checked by: Christian Bucher (E.ON), Sarah Rigby (SSEN), David Jackson (Costain), Robert Middleton (Costain)

Status: Final

Confidentiality: For Publication

Version: V1.0

Date: 21/11/2020

I. Content

II. List of abbreviations

DER Distributed Energy Resources

DNO Distribution Network Operator

ENA Energy Networks Association

NGESO National Grid Electricity System Operator

NIC Network Innovation Competition

Ofgem Office of Gas and Electricity Markets

RaaS Resilience as a Service

ROI Return on Investment

SSEN Scottish and Southern Electricity Networks

TSO Transmission system operator

WP Work Package

FEED Front End Engineering Design

1. Executive Summary

This report describes the product features and product design scenarios developed for commercial assessment of the RaaS service. During a 'flexibility scenarios' workshop held in September 2020, the three RaaS project partners SSEN, Costain and E.ON, together with E.ON's WP4 consultant Cornwall Insight, identified and agreed on five product features of the RaaS service: *Service Window, Service Requirement Notification Period, Duration of Service, Average Load, and Number of Utilisations*. These features are variable in a time or quantitative dimension and will have an impact on the revenues achievable from other flexibility markets alongside RaaS.

Based on the definition of the RaaS product features, three main product design scenarios were defined. By creating different product design scenarios, the balance between reserving sufficient capacity to provide network resilience and having spare capacity for commercial optimisation (i.e. participating in further flexibility market channels next to RaaS) can be analysed.

The scenarios were designed to understand the boundaries of "what's possible" within a frame of realistic assumptions on the resilience requirements of a DNO. Generally, it may be expected that a lower proportion of spare 'flexible capacity' from the battery will lead to lower revenues from other flexibility products and vice versa. Scenario 1 represents the least complexity for the DNO but is likely to have the least room for investor commercial optimisation. Scenario 2 builds on scenario 1 with further tailoring of requirements which may provide more scope for a RaaS service provider to participate in other flexibility markets and reduce overall RaaS costs to a DNO. Scenario 3 would require more complex and sophisticated management by a DNO but may have the greatest room for investor commercial optimisation. Scenario 3 will also give the DNO the option to dynamically change the required capacity during the contract period, for example to adapt to changing demand profiles and/or decrease overall costs.

In addition to describing the product features and product design scenarios, the report introduces potential flexibility markets and products that could be suitable to stack with the RaaS service and thus enhance commercial optimisation of the battery asset. A range of flexibility revenue sources are currently available to battery storage operators in Great Britain, representing three market channels: the wholesale market, the Capacity Market and flexibility services for DNOs/National Grid Electricity System Operator (NGESO) according to location. The diversity of revenue streams means that market participants may not be reliant on any one source, and there is commercial value in using an asset to participate in various market channels.

Lastly, the report highlights learnings and conclusions from the scenario development. These relate to such things as penalties for non-delivery, the remuneration of the RaaS service regarding differentiation of availability and utilization payment, the value of increasing operational complexity for DNOs with regard to RaaS, and implications for the technical design of a RaaS battery system, which should take into account the minimum bid-sizes of flexibility products as well as the risk for non-delivery during peak demand hours.

Following this report, WP4 will assess the optimisation of the RaaS battery asset across the flexibility products identified based on the product design scenario.

2. Introduction & purpose of report

a. Background

The Resilience as a Service (RaaS) project is funded by the Network Innovation Competition (NIC) of the UK's Office of Gas and Electricity Markets (Ofgem). It is delivered by three partners – Scottish and Southern Electricity Networks (SSEN), E.ON and Costain. SSEN are the distribution network operator (DNO) for the project, E.ON are an energy solutions provider who are leading the technical and commercial development and delivery of the project, and Costain are a management consultancy acting as programme managers while also providing input to the market design assessment. The project has a budget of £10.2m.

The aim of the project is to investigate the technical application and commercial opportunities associated with the provision of a new flexibility service that could be offered to DNOs to improve network resilience in remote or rural areas. This service would use a battery energy storage system (BESS) together with local distributed energy resources (DER) to supply customers in the event of a fault on the network.

The project will determine how network resilience can be improved in a cost-effective manner for network areas who experience an untypically high frequency of outages. This can be achieved by a DNO procuring RaaS from a third-party service provider who can stack revenues gained through participation in other flexibility markets. The RaaS project seeks to evaluate the financial case from a DNO perspective while giving insights to RaaS service providers on the investment business case as well as the optimal flexibility markets to operate the battery.

In the first phase, the project focuses on site selection, system design for the RaaS application based on the demonstration site, and refinement of the business case for RaaS. This stage will validate whether the concept is technically feasible and financially viable to inform a decision to be made in 2021 on whether to proceed with the deployment and operation of a RaaS system at the chosen site for a trial period of up to two years.

Phase two of the project comprises the delivery, commissioning and operation of the system in a test phase. This will involve monitoring and evaluation of the system's performance as well as examining different combinations of flexibility services.

In addition to developing the technical solution for RaaS, developing the commercial solution and optimization from both the DNO and investor perspectives is a key goal of the project. These are addressed through the two work packages: WP4: 'Operational Optimization' and WP5: 'Business Model'. The purpose of WP4 is to develop the best strategy for a commercial optimization of a RaaS battery. This includes developing scenarios of the RaaS product which will form the basis for a commercial optimisation.

b. Report Purpose

The objective of this report is to describe different scenarios of the RaaS product design based on identified product features with the hypothesis that they will influence the commercial optimisation. Furthermore, additional flexibility products will be introduced and discussed with regards to their stackability with RaaS, and expectations of revenue streams from those products to enhance commercial optimisation.

The next step within WP4, following this report, will be to evaluate optimisation of the battery asset across additional flexibility products alongside RaaS based on the product design scenarios which will be defined in this report. This will be the basis to create operational schedules for the demonstration site. These results will be summarised in the deliverables E4.2 'Optimized operational schedule for the battery for the defined product scenarios' and E4.3 'Optimized operational scheduled for the demonstration site'.

Additionally, the revenue forecast will feed into analysis for deliverable E5.3 'Investor Business Case' to support development of the RaaS business model from an investor perspective. The findings from this will then be compared with the potential DNO business case to assess the market potential and end-customer benefits ahead of the Stage Gate decision.

c. Deviations from initial scope of the deliverable

The initial plan for deliverable E4.1 was that the RaaS scenarios would be defined based on stacking different combinations of flexibility market channels. Following a review of information from the ENA's Open Networks project and its methodology for flexibility service design (see Appendix 1 for reference) it was concluded that a consideration of RaaS product design scenarios will be more valuable and informative than consideration of flexibility product scenarios. This report therefore defines the scenarios based on different design features of the RaaS service, accordingly the scenarios are termed "product design scenarios".

The different product designs across the chosen scenarios will result in varying battery capacity available for participating in other flexibility market channels at different points in time. The optimisation work that will be carried out using the product design scenarios will then show whether the available capacity will be used to participate in the same flexibility market channels and products across all scenarios, or if the different product designs will open up or close the possibility to participate in certain flexibility products.

The definition of scenarios based on stacking flexibility products was also planned to consider different risk profiles of investors. As the scenarios are now defined as product design scenarios, the investor risk profile will be addressed within the commercial optimisation assessment for each scenario, e.g. by considering different wholesale power market trading strategies which can vary in the risk-return expectations. Additionally, the investor business model developed in WP5 will allow sensitivity analysis to be undertaken to assess the impact of changes in factors such as RaaS contract duration on investor risk.

3. RaaS product design scenarios

a. RaaS product features as a basis for scenario development

In order to develop the RaaS product design scenarios, two general assumptions have been made which reflect the interests of both the DNO and the investor in the provision of the RaaS service. Firstly, the battery needs to reserve a certain capacity at any point in time to provide the RaaS service in response to a network fault. Secondly, a non-availability of the battery for the RaaS services due to the battery delivering other flexibility services is not an option as the battery would fail to fulfil its core purpose to provide network resilience.

These assumptions are made to reflect and limit the conflict of interests between DNOs and investors. This conflict of interest is inherent in services like RaaS where DNOs want to cost effectively enhance security of supply in the network area through high availability of the RaaS service, and where investors want to maximise their Return On Investment (ROI) for the capital invested in a RaaS solution. The different perspectives of DNOs and investors are reflected in Table 1 below and have been incorporated into the scenario development work.

Table 1: Risk perspectives of DNOs and Investors

Reserved capacity for RaaS	Available capacity for other flexibility products	Attractiveness to the DNO	Attractiveness to the investor
high	low	high	low
medium	medium	medium	medium
low	high	low	high

The subsequent commercial optimisation within WP4 will seek to establish the right balance between RaaS availability for the DNO and ROI for the investor.

Following a review of information from the ENA's Open Networks project and its methodology for flexibility service design (see Appendix 1 for reference) it was concluded that a consideration of different product design variations is the most valuable approach to create scenarios to be used as the basis for a commercial optimisation of the RaaS asset (i.e. optimising the asset across different flexibility market channels and products).

In order to create variation between the product design scenarios, a suite of product features have been defined. It is acknowledged that some product features of a RaaS service are fixed due to technical requirements (e.g. reaction time in the event of a fault). Hence, the scenarios only consider features that are variable in time or quantitative dimensions and have an impact on the commercial optimisation (i.e. potential flexibility revenue streams).

During a 'flexibility scenarios' workshop held in September 2020, the three RaaS project partners SSEN, Costain and E.ON, together with E.ON's WP4 consultant Cornwall Insight, identified and agreed the five RaaS product features which should be used to form the basis for developing the product design scenarios. These are set out in Table 2 below and reflect the ENA's methodology for defining flexibility products.

Table 2: Product Design Features

Time-dependent product features				*Network-dependent product features*
1 Service window	**2 Service requirement notification period**	**3 Service Level**		**6 Number of utilisations per year**
		4 Duration of service in hours	**5 Average Load in MW**	
4 seasons	Contractually fixed	4-9	Site-specific Input	5-20
4-hourly blocks	Dynamic			
Working days/ non- working day	Two weeks for extra support during network maintenance			

1 Service window refers to the time period that a given *Service Level* is defined for. For the RaaS scenarios this has been structured with four seasons within a year (influenced by factors like weather or tourism, depending on the site), working days and non-working days, and four-hourly blocks within a day.

2 Service requirement notification period is the point in time at which the DNO will inform the RaaS provider about the required *Average Load* and *Duration of Service* for each *Service Window*; these may either be fixed within a contract (values announced before bidding = no notification period) or dynamic (can be changed during the contract period with a defined notification period).

3 Service Level is the combination of *Duration of Service* and *Average Load*, which each individually depend on various factors, as further explained below.

4 Duration of Service is the time period that a RaaS service is expected to be required to cover a RaaS event. The range of four to nine hours reflects the amount of time that may be required to resolve a technical issue on the higher voltage level and/or to transport a diesel generator to the site to support the RaaS asset.

5 Average Load in MW is the average load on the network, to be defined as the highest of the average values from each possible *Duration of Service* block in a certain *Service Window* that a RaaS service must be able to cover if a network fault occurs.[1]

6 Number of utilisations is the number of times a RaaS service is expected to be called. The range of five to twenty times per year reflects the indicative number of outages per year at the shortlist of sites identified through the RaaS site selection process described in deliverable E2a.1.

In addition to the five product features identified above, battery degradation was discussed as a potentially relevant factor. However, the acceptable degradation of the battery was ruled out as this is a risk the investor needs to factor in and would not be a consideration in the product design. Battery

[1] Example 1: if a Service Window is defined as weekdays in summer and the Duration of Service is defined as 4 hours, the Average Load would be calculated for each 4-hour block within all working weeks in summer (e.g. 3 months x 4 weeks x 5 workdays x 24 hours – 3 hours at the end of the Service Period = 1,337 hours where a Duration of Service could start). The maximum Average Load from these 1,337 time blocks will then be used as the Average Load to define the Service Level for this Service Window.
Example 2: if a Service Window is defined as 4-hour blocks on workdays in summer and the Duration of Service is defined as 4 hours, the Average Load would be calculated for each 4-hour block within each working day in summer (e.g. for Service Window *Workday 7 am – 11 am:* 3 months x 4 weeks = 12 hours where a Duration of Service could start). The maximum Average Load from these 12 time blocks will then be used as the Average Load to define the Service Level for this Service Window.

degradation will therefore be further considered in the investor risk evaluation and business case development within WP5.

Two further differentiating variables have also been identified: price forecasts for flexibility markets and trading strategies. However, these are optimisation-specific variables rather than product design features. They will be considered further through the WP4 optimisation analysis to gauge the impact of price variations on the RaaS investor business case and evaluate different trading approaches of investors with different risk profiles.

b. Definition of product design scenarios

Following the definition of product features of the RaaS service the project partners discussed and decided on three main products scenarios which are detailed in this section of the report.

The purpose of creating different product design scenarios is to evaluate the balance between reserving enough capacity to respond to resilience events on the grid and having spare capacity which can be used for commercial optimisation (i.e. participating in further flexibility market channels in addition to RaaS). Furthermore, scenarios will allow sensitivity analysis to be undertaken on the individual product features. This will enable the project team to understand which product features have the highest impact on investor return expectations.

The product features specified for each scenario were therefore chosen in a way which should allow the results of the commercial optimization to indicate low and high levels of achievable flexibility revenues. This was done with the intention to understand the boundaries of "what's possible" within a frame of realistic assumptions on the resilience requirements of a DNO.

Within the scenarios, some features have been defined as ranges which the project team believes reflect the typical types of situations in which a RaaS service would be called upon. These product features are either not controllable but still relevant for commercial assessment (e.g. number of utilizations), or they represent a site specific but fixed requirement from the DNO, which is also key for commercial assessment (e.g. maximum duration of service).

The model-specific variables will be added to the product design scenarios within the modelling work of the total achievable flexibility revenues (coming from the RaaS service and from participation in further flexibility market channels). The revenue modelling will be done based on the selected demonstration site, as well as a more generic evaluation for a Great Britain wide evaluation. The revenue modelling work per scenario will be the next step within WP4 and the results will be published in the subsequent reports E4.2 'Optimized operational schedule for the battery for the defined product scenarios' and E4.3 'Optimized operational scheduled for the demonstration site'.

Table 3 below provides an overview on the product features that have been chosen by the project team to form the three product design scenarios.

Table 3: Product Design Scenarios

	RaaS-specific product features					Optimisation model-specific variables	
	Service window	**Notification period**	**Duration of service**	**Average load**	**Number of utilisations**	**Wholesale prices**	**Trading approach**
Scenario 1: Min. flexible capacity[2]	4 seasons + working days/non-working days	Contractually fixed	4 – 9 h	Site-specific input	5 - 20 p.a.	Low vs. high price assumptions	Risk-averse vs. risky trading strategies
Scenario 2: Med. flexible capacity	4 seasons + working days/non-working days + 4-h blocks	Contractually fixed	4 – 9 h	Site-specific input	5 - 20 p.a.		
Scenario 3: Max. flexible capacity	4 seasons + working days/non-working days + 4-h blocks	Dynamic	4 – 9 h	Site-specific input	5 - 20 p.a.		

It can be assumed that a small share of flexible capacity of the total battery capacity will lead to low revenues from other flexibility products. Conversely, a high share of flexible capacity of the total battery capacity is believed to lead to high revenues from other flexibility products. Accordingly:

Scenario 1 represents the least room for investor commercial optimisation but has the least complexity for the DNO. Within Scenario 1 a DNO would define the RaaS service requirements for a specific site across four seasons (influenced by factors like weather or tourism). Different requirements would also be specified for working days and non-working days, reflecting differing demand profiles at weekends and holidays. As the required Service Level for each Service Window is defined by the expected maximum across all Average Loads Service Window (see footnote on Page 7), the reserved capacity would be higher than the optimal reserved capacity for some Service Windows.

Within this scenario a DNO would evaluate their load and duration requirements of the RaaS service before a tender process takes place, and these would be contractually fixed, with no further notifications during the duration of the RaaS contract.

Scenario 2 builds on Scenario 1, with the Service Window further defined with six 4-hour blocks for each day. As the notification period is still tied to the tender process, the requirements would remain fixed over the duration of the contract. Whilst this would require enhanced analysis and forecasting by a DNO, the recognition of different demand levels at different times of day (including peak periods) allows further tailoring of the required Service Levels to match capacity requirements to demand. This would potentially provide more scope for a RaaS service provider to participate in other flexibility markets and reducing overall RaaS costs to a DNO.

Scenario 3 would have the greatest room for investor commercial optimisation, whilst giving the DNO the option to change the required reserved capacity dynamically during the contract period and thus adapt to changing demand profiles and/or decrease cost.

---

[2] Flexible Capacity refers to the total battery capacity less the capacity reserved for a potential RaaS utilisation, i.e. the amount of capacity that can be used to freely participate in other flexibility products alongside to RaaS. This amount of free capacity is expected to vary within the different Service Windows, giving the investor room for commercial optimization.

Scenario 3 uses the same structure for defining RaaS requirements as Scenario 2, however the requirements can be specified and varied at different points in time over the duration of the contract. As the requirements per Service Window are dynamically adjustable, there would need to be operational processes put into place by a DNO to review requirements on a regular basis, and to notify the RaaS provider of requirements for an upcoming time period. Whilst this would require more complex and sophisticated management, a benefit of this scenario is that the DNO would be able to respond to changing circumstances, such as weather patterns or local cultural events, and make risk based commercial decisions to reduce the overall cost of the service. Correspondingly, the RaaS provider would have more opportunity to participate in other flexibility markets to generate additional revenues.

These product design scenarios will be used for modelling work within WP4 to assess the total achievable flexibility revenues (from both the RaaS service and participation in further flexibility market channels). Further, as noted above, within the subsequent optimisation work the product design scenarios will be complemented with optimisation-specific variables relating to price forecasts for flexibility markets and trading strategies reflecting the risk profiles of different investor types. Results will be published in the subsequent reports E4.2 'Optimized operational schedule for the battery for the defined product scenarios' and E4.3 'Optimized operational scheduled for the demonstration site'.

The next chapter of this report will introduce relevant flexibility market channels and products that can be stacked with the RaaS service to optimise the total achievable flexibility revenues.

4. Outlook on potential flexibility marketing channels and products stackable with RaaS

The preparatory work for this report included an analysis of the UK flexibility market which was carried out by E. ON's WP4 consultant Cornwall Insight. Based on the findings of Cornwall Insight's report, this chapter will provide an overview of potential flexibility market channels and products that could commercially and technically be suitable to stack with the RaaS service. Conclusions on the flexibility products suitable for revenue stacking will be developed as part of the commercial optimisation analysis within WP4 that will follow this report.

A range of revenue sources are available to battery storage operators in Great Britain, however some reflect location specific requirements. The potential diversity of revenue streams means that market participants may not be reliant on any one source of income, however there is complexity associated with identifying the right combination of products. Further, Aggregators or Virtual Power Plant Operators may be contracted to participate in flexibility markets on behalf of the asset owners. Participants must be able to consider the ranges of market opportunities available and seek to 'stack' revenues.

The project team have identified four key market channels that a RaaS service could be stacked with at present, as follows:

1. **Wholesale market**: the trading of electricity within the British electricity wholesale market to ensure supply meets demand - flexibility services can support participants by avoiding or capitalising on imbalance charges or engaging in arbitrage across time or geographical location, including the Balancing Mechanism which allows NGESO to procure capacity in close to real time
2. **Capacity Market:** introduced by the UK Government and designed to support investment in new generation capacity or demand side response to ensure the ongoing balance of supply & demand by providing long term contracts for availability
3. **Flexibility services for DNOs:** the growing market for DNOs to address specific network issues through the use of flexible solutions which represent cost effective alternatives to traditional measures, e.g. network reinforcement, or provide optionality value as more is learnt about how demand patterns are changing through time due to e.g. Electric Vehicle uptake or the electrification of heating
4. **Flexibility services market for NGESO:** services procured by NGESO to support management of the transmission system

The ability to earn revenues from these markets will depend on the asset technology and size, as well as commercial and operational considerations, including any minimum bid size requirements for participation (e.g. the minimum bid size for the CM is 1 MW). Stacking revenues will also involve trade-offs regarding which market to participate in at which point in time. For example, it may not be possible to commit to a defined block of MW capacity into more than one market over any given time period, so it is expected that some consideration of optimisation will be required for many third party owned flexibility assets. Likewise, there is a requirement to consider potential conflicts of interest between the requirements of individual market participants and the wider public interest (societal, environmental, etc.). On these points, the project team will also take learning from the ENA Open Networks project and conclusions from its Work Stream 1A 'Flexibility Services'.

The Open Networks project has also developed proposal for different DSO market models, through Work Stream 3 'DSO Transition'. To explore how these models could be implemented to establish functioning markets for flexibility and allow the DNO/DSO to act as a Neutral Market Facilitator (NMF) with a wide range of market participants, SSEN's TRANSITION[3] innovation project will trial the proposed market models in the city of Oxford, UK. As RaaS and TRANSITION provide different, but complimentary, perspectives on the future DSO model and context for flexibility services, the RaaS project team have established ongoing links with the TRANSITION team to share learning that will be used to inform both projects' activities.

5. Input received from stakeholder engagement

The work for this report was supported by the RaaS project partner Costain, who carried out interviews with electricity network stakeholders to understand external perspectives on the current flexibility markets and the potential for RaaS. This chapter will highlight the findings relevant to this scenario development. The full report from Costain will be published as the combined deliverables C4.1 & C5.1 'DNO/ESO views of flexibility markets and alignment of RaaS to these markets'.

Interviews were conducted with the ENA, the six GB DNO groups and NG ESO. Difference were evident in the way different DNOs currently approach flexibility, ranging from the services procured, the methods used for procurement, and the types of people/organisations services tend to be procured from. One of the biggest challenges shared by the DNOs at present is the capability for flexibility requirements in a given location to be met by suitable market participants/customers, due to the nascent nature of this market.

Regarding RaaS, all participants felt that the investor business case would be very limited based on resilience alone, but that it should be possible and desirable to stack revenues to help develop a stronger business case for investment in an asset, thereby supporting growth in the market for provision of RaaS and other flexibility service to DNOs. Furthermore, it was suggested that DNOs may be able to procure RaaS as part of a tender process for a number of locational flexibility services, potentially with each contract offered to individual suppliers then covering the suite of services to be provided.

The report draws a number of conclusions which support or will inform the approaches to be taken when developing the RaaS service. Firstly, the RaaS service definition and commercial approach in WP4 and WP5 must reflect the scope for RaaS to be stackable with other flexibility services wherever feasible. Secondly, interviewees agree that it is currently sensible to progress with RaaS as an 'anchor' revenue stream supporting a new battery on a longer contract, to which other potential revenue streams could be added by the service provider. Thirdly, routes for procurement should include Flexible Power and other intermediary platforms, to help reach beyond the traditional utilities markets, and maximise the potential supplier base for RaaS. Then fourthly, stakeholder engagement and dissemination must ensure that attitudes to risk are well understood across all potential market participants.

6. Learning implications, conclusions and recommendations for DNOs and RaaS providers

So far, this report has defined and described different product features and designs of how a DNO's RaaS service could look like. Adding to that, the last chapter of this report will illustrate the learning

[3] https://ssen-transition.com

and conclusions drawn from the development of this report. These observations relate to the RaaS contract structure and penalties for non-delivery, the remuneration of the RaaS service, the operational requirements for DNOs and implications for the technical design of a RaaS battery. Recommendations are made regarding further addressing these points within the wider project.

RaaS contract structures and penalties for non-delivery: As an investor's return requirements are unlikely to be covered by revenues from the RaaS service only, there is a risk for the DNO that RaaS providers decide to commercially optimize operation of the asset against the RaaS contract. Although such a situation has been ruled out for definition of scenarios for this project, two points should be considered to ensure that the RaaS service is available to the DNO when required: Firstly, a RaaS contract should specify each of the five product features identified above to give sufficient information to RaaS providers to allow them to assess opportunities for commercial optimisation to meet their return requirements. Secondly, penalties for non-delivery within the contract should be designed to provide a sufficient incentive for the RaaS service provider to ensure the availability of RaaS (and prevent optimisation which prioritises participation in other flexibility products). WP5 will address these points during development of the Heads of Terms for the RaaS Service.

RaaS service payment structures: The RaaS provider would need to reserve a certain share of the battery capacity to provide resilience services for the majority of the time due to the unpredictability of a network fault occurring. However, the utilisation of the RaaS service in response to a fault, or for planned maintenance, would only occur a limited number of times a year. This should be reflected in the payment structure for the RaaS service, for example using the market proven approach of splitting the DNO remuneration to RaaS providers into an availability payment and a utilisation payment. Accordingly, a fixed availability payment for a share of reserved capacity (i.e. £/MW) could be based on the Service Level requirements defined in the RaaS contract for each Service Window. A utilization payment for each RaaS event could be based on the level of value added from the RaaS asset (i.e. £/MWh delivered). WP5 will investigate possible payment structures for a RaaS service, and stakeholder engagement within WP6 will look to ensure that any payment structures defined within the project is acceptable to DNOs and to different investor types.

Operational complexity for DNOs: The three RaaS product design scenarios defined in this report have different implications for the operational processes of a DNO, as DNOs would have to analyse and forecast their RaaS requirements with differing levels of complexity and sophistication, and at different frequencies. In Scenarios 1 and 2 there would need to be a one-time analysis of the grid requirements, with Scenario 1 requiring granularity of requirements for different seasons and working days/non-working days, and with Scenario 2 requiring the additional granularity of six 4-hourly blocks within a day. In Scenario 3 a regular or event-based analysis of grid requirements would be required to provide more dynamic definition of the requirements, with granularity associated with different points of time within the four seasons, working days/non-working days and 4-hourly blocks. This could incorporate forecasting regarding the likelihood of requiring a RaaS response over the short-term (e.g. week ahead) based on weather forecasts, or changes in capacity requirements due to expected events.

These approaches may create new operational processes for a DNO, however could result in the application of a solution which tailors the Service Levels to better match capacity requirements to demand, potentially reducing overall RaaS costs to a DNO and provide more scope for a RaaS service provider to participate in other flexibility markets.

The commercial value of the increased complexity for DNOs and RaaS providers will be evaluated as part of the optimisation modelling work in WP4. Additionally, it is recommended that the stakeholder engagement work within WP6 looks to explore DNO perspectives on the potential scope and appetite for adopting the approaches represented in the different product design scenarios.

Technical design of a RaaS battery: While the sizing of a battery to provide a RaaS service is mainly dependent on the technical requirements of the network demand patterns at a particular site (as will be discussed in the future WP2 deliverable E2a.2 'Front End Engineering Design (FEED)'), an investor must consider a range of additional factors relating to participation in other flexibility markets, and understand their implications on battery sizing with regard to commercial optimisation. In addition to evaluating different potential markets, this must also take into consideration that, as described in chapter four, some flexibility products require a minimum bid size for participation (e.g. the minimum bid size for the CM is 1 MW), and that this could be achieved by aggregating assets or by sizing an individual asset accordingly. Furthermore, the risk of non-delivery should be considered for battery sizing, considering both the average and peak demand levels at a site. Further consideration to the optimal balance between battery size, cost and risk of non-delivery during peak times will be given in the FEED work in WP2.

III. Appendix

Appendix 1: ENA Open Networks template for flexibility product definition

	Scheduled Constraint Management	**Pre-fault Constraint**		**Post-Fault Constraint Management**	**Restoration Support**
		Manual	**Automatic**		
Branding	**Sustain**	**Secure**		**Dynamic**	**Restore**
Minimum / maximum bid size	100kW minimum capacity (can aggregate within area); no maximum				
Minimum / maximum duration	0.5hr minimum; longer is more valuable				3hr minimum; longer is more valuable
Definition of congestion point (identification of the congested area)	Infrastructure-dependent, although will tend to be 'below' the congested asset(s) in terms of voltage. Will be more clearly articulated articulated as part of procurement exercise.				
Bidding period (time granted to the market parties to offer bids)	Months ahead				
Selection period (time required by the DSO to select the bids which will be activated)	Months ahead				
Activation period (time before activation signal and ramp up period)	Months ahead	Closer to real time (depends on driver) - e.g. day-ahead; week-ahead	Real time (pre-fault; time TBC)	Real time (post-fault; time TBC)	Real time (post-fault; time TBC)
Maximum ramping period	Scheduled, so not an issue…		Of the order of minutes (i.e. 'fast', with link to short-term ratings; time TBC)		N/A
Minimum full activation period	2 hours	30 minutes (link with granularity of metering)			At least 3hours
Mode of activation	Scheduled	Manual	Automatic (or manual, depending on post-fault distribution asset capability)	Automatic (triggered by signal from DSO)	Manual
Availability windows	Defined at procurement according to requirement (e.g. could be winter weekday evening peaks)				N/A - 'as required'…

Maximum number of activations (per day, per x)	Scheduled - most likely on a 'one call per day/ basis	Defined at procurement according to requirement	TBD
Recovery time: minimum time between activations	Scheduled - most likely on a 'one call per day/ basis	Defined at procurement according to requirement	N/A
Baseline methodology (basis upon which availability is assessed / delivered)	TBC (likely to vary both by product and by technology of provider)		
Measurement requirements	Minute-by-minute metering		
Aggregation allowed	Yes (within appropriate geographical area)		
Penalty for non-delivery (fixed or dependent on the bid size and/or duration, €10.000, €1.000, …)	Loss of revenue; impact on future procurement/utilisation, and potential for termination of contract Consideration needs to be given to how to ensure the protection of the network - for example whether we need to establish a back-stop tripping capability		N/A

	Scheduled Constraint Management	**Pre-fault Constraint**		**Post-Fault Constraint Management**	**Restoration Support**
		Manual	**Automatic**		
Branding	**Sustain**	**Secure**		**Dynamic**	**Restore**
Minimum / maximum duration	0.5hr minimum; longer is more valuable				3hr minimum; longer is more valuable
Definition of congestion point (identification of the congested area)	Infrastructure-dependent, although will tend to be 'below' the congested asset(s) in terms of voltage. Will be more clearly articulated as part of procurement exercise.				
Bidding period (time granted to the market parties to offer bids)	Months ahead				
Selection period (time required by the DSO to select the bids which will be activated)	Months ahead				

Activation period (time before activation signal and ramp up period)	Months ahead	Closer to real time (depends on driver) - e.g. day-ahead; week-ahead	Real time (pre-fault; time TBC)	Real time (post-fault; time TBC)	Real time (post-fault; time TBC)
Maximum ramping period	Scheduled, so not an issue…		Of the order of minutes (i.e. 'fast', with link to short-term ratings; time TBC)		N/A
Minimum full activation period	2 hours	30 minutes (link with granularity of metering)			At least 3hours
Mode of activation	Scheduled	Manual	Automatic (or manual, depending on post-fault distribution asset capability)	Automatic (triggered by signal from DSO)	Manual
Availability windows	Defined at procurement according to requirement (e.g. could be winter weekday evening peaks)				N/A - 'as required'…
Maximum number of activations (per day, per x)	Scheduled - most likely on a 'one call per day/ basis	Defined at procurement according to requirement			TBD
Recovery time: minimum time between activations	Scheduled - most likely on a 'one call per day/ basis	Defined at procurement according to requirement			N/A
Penalty for non-delivery (fixed or dependent on the bid size and/or duration, €10.000, €1.000, …)	Loss of revenue; impact on future procurement/utilisation, and potential for termination of contract Consideration needs to be given to how to ensure the protection of the network - for example whether we need to establish a back-stop tripping capability				N/A