Issue 02

Enhanced Frequency Control Capability (EFCC)

Progress Report July – December 2015

Contents

Executive summary

One of the key changes resulting from the move towards decarbonisation of the electricity sector and decommissioning of thermal power plants is the increase in the levels of new technologies such as wind and solar photovoltaic (PV) on the system. National Grid presents a number of challenges to the power system associated with this change in the System Operability Framework (SOF). Amongst those challenges is the control of system frequency as system inertia will be reduced because of fewer thermal power stations running on the system.

The EFCC project is collaboratively working with industry and academia to provide greater clarity to the industry on new ways of controlling the system frequency, necessary commercial incentives and products, and how new technologies such as solar PV, Demand Side Response (DSR), wind, HVDC interconnectors, and different modes of operation of Combined Cycle Gas Turbines (CCGT) can provide the solutions to operate the grid in the most economic and efficient way.

Summary of progress (July 2015 – December 2015)

In this reporting period, the focus has been on the ongoing design of the new control system algorithms for the fast detection of the frequency events and how to achieve a proportionate frequency response that doesn't cause instability on the power system. In summary:

- Across the work packages, the project has made steady progress against the objectives of work package 1. The resource algorithm which was due for delivery and forms an important part of this project was developed in August 2015. The full optimisation of allocating resources (e.g. solar PV, DSR etc) will be further refined to include availability and power output characteristics over a period of time, not only speed of response
- Progress has also been made against the objectives of work package 2 namely:
  - Shortlisting of potential DSR participants in the 3 targeted areas of static Rate of Change of Frequency (RoCoF) (e.g. data, communications sites); real inertia (e.g. generation with more than one synchronous generator); controlled response (e.g. demand controlled using variable speed drives)
  - Evaluation of how CCGT plant can deliver faster frequency response using computer based simulations
- The project team has also continued to disseminate knowledge through the submission of academic papers, uploading of documentation on to the project website **(http://www.nationalgridconnecting.com/The_balance_of_power/)** and attendance at events, notably the Low Carbon Networks Innovation (LCNI) conference in November 2015.

There have been some key challenges during this reporting period particularly around the justification of investment for battery storage in the project and finalisation of test schedule for participation of Lincs Wind Farm in the project. In summary:

- A Battery Storage Investigation Report evaluating existing battery units for fast frequency response was completed. The report recommended investment in a new 1 MW battery that could be combined with a solar PV plant to demonstrate how both technologies can be optimised and provide learning for the development of the commercial framework. Further cost benefit analysis was required by Ofgem to outline potential deployment of battery storage with solar PV
- National Grid has continued to liaise with DONG Energy, Siemens and Centrica regarding possible options for wind farm trials. Progress has been made with participation agreed in principle within the project and discussions on the scope of test scenarios are underway. It is anticipated that a detailed schedule of work will be outlined during the next reporting period.

The project team is looking forward to the next phase of the project which will see hardware production incorporating the models developed to detect system events in advance of trialling the capability at the various partner locations.

Project background and business case

In order to meet carbon reduction targets, the UK needs to significantly increase the volume of low carbon energy technologies that are connected to the GB transmission system. The overall impact of increasing these types of technology will be a reduction in system inertia.

System inertia is a characteristic of an electrical transmission system that provides system robustness against any frequency disturbances and is a result of the energy stored in the rotating mass of electrical machines (i.e. generators and motors).

As more renewable energy technologies such as wind, solar PV and other converter based technologies (e.g. interconnectors) are connected to the transmission system, there will be a corresponding reduction in inertia since these technologies do not contribute to natural mechanical inertia.

In the UK, the transmission system frequency is nominally 50 Hz and the System Operator caters for various imbalances caused by changes in demand or generation to maintain the frequency in accordance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS). However, the lower the system inertia, the more susceptible a transmission system is to a higher RoCoF in the event of the loss of a significant volume of generation or demand and requires an increase in the speed and volume of frequency response.

The EFCC project full submission provided cost benefit analysis to show that, under existing mechanisms to control frequency response used by National Grid, the future increase in response requirement to control frequency is anticipated to be £200 million–£250 million per annum by 2020, based on the Gone Green Future Energy Scenario as published by National Grid in 2014. The 2015 System Operability Framework (SOF) published on 30 November still shows future operability challenges arising from an increase in RoCoF to 0.3 Hz/s by 2020.

The objective of this project is to develop and demonstrate an innovative new wide area monitoring and control system which will obtain accurate frequency data at a regional level, calculate the required rate and volume of very fast response and then enable the initiation of this required response. This system will then also be used to demonstrate the viability of obtaining rapid response from new technologies such as solar PV, storage and wind farms. The new system will also demonstrate the coordination of fast response from demand side resources (DSR), and the fast start up of thermal power plants.

Utilising the output of this trial, a fully optimised and coordinated model will be developed that ensures the appropriate mix of response is utilised. This will support the development of an appropriate commercial framework prior to full roll-out after project completion (March 2018).

The outcome of EFCC will demonstrate that the GB transmission system will remain operable by reducing the overall level of frequency response held. Assuming some frequency response holding cost for thermal power plant , the successful development and implementation of this project may result in a predicted saving to the end consumer of £150 million–£200 million per annum.

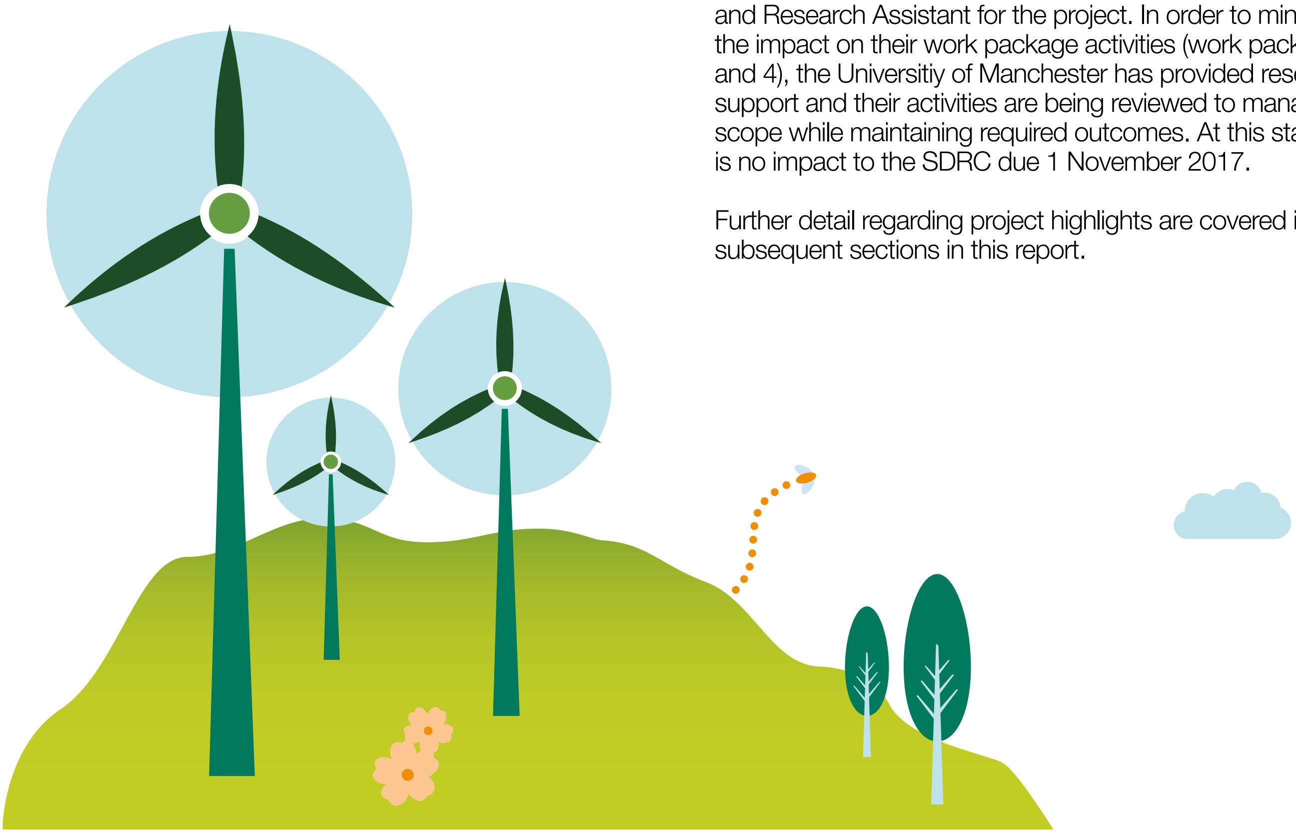
The reduction in system inertia is already a problem experienced by many Network Licencees. Even a moderate future uptake of renewables will impact the costs of managing the system significantly.

http://www.nationalgridconnecting.com/The_balance_of_power/

The project received formal approval and the Project Direction in December 2014. This is the second project progress report covering the period from July – December 2015.

During this period of the project, the main activities undertaken have been the development of the control system philosophy; submission of the Battery Storage Investigation Report as mandated in the Project Direction to allow Ofgem to assess the requested investment for solar PV and battery storage trials and outlining the scope of trials for demand side participants and and assessment of thermal generation plant for faster frequency response.

As highlighted in the previous progress report, the participation of Lincs Wind Farm within the project had not been confirmed. Some progress has been achieved in this aspect of the project during this reporting period. Lincs Wind Farm is a joint venture between Centrica, DONG Energy and Siemens. All parties have agreed in principle for the participation of wind turbine trials in the project, but further discussion is required to finalise trial scenarios and produce a detailed work schedule. Due to these ongoing discussions, it has not been possible for Grid Solutions (a GE and Alstom joint venture) to develop a control system hardware communications interface with the wind turbine. The project schedule catered for a decision point to finalise this design development between all project partners by 11 December 2015. In this respect, the project is exploring other options to demonstrate fast frequency response initiated by RoCoF with the joint venture partners. Further detail is described in the Business Case Update section in this report.



The Battery Storage Investigation Report was submitted in accordance with the SDRC on 30 June 2015 outlining the costs of using three existing battery storage units that were shortlisted (Smarter Network Solutions project at Leighton Buzzard, Rise Carr and Willenhall) and recommends specific investment for this project to trial a combined battery storage and solar PV installation that can be provided by Belectric. Subsequent discussions took place between National Grid and Ofgem on the outcomes proposed and further work was agreed to be undertaken before a final decision from the Authority. This is described in the SDRC section in this report.

The January – June 2015 progress report highlighted that there was a significant delay in the signing of the formal multi-party contract. There has been some impact on the progression of the projects, however, despite this delay, the resource algorithm specification still achieved the SDRC target of August 2015. In order to achieve this milestone the Steering Group collaborated closely and agreed to review the documentation within a shorter period of time. This enabled Grid Solutions to develop the algorithm and specification within the required timescales.

Some areas of evaluation and analysis have not progressed as planned. This is because commercially sensitive control system algorithms and concepts provided by Grid Solutions during the first reporting period could not be shared with all the partners until the contract was signed. This meant that the project partners were not able to evaluate these concepts, and in the case of the academic partners, understand the elements and results to be validated (work package 4).

Furthermore, due to the delayed signing of the contract, the University of Manchester was not able to recruit a PhD student and Research Assistant for the project. In order to minimise the impact on their work package activities (work packages 3 and 4), the Universitiy of Manchester has provided research support and their activities are being reviewed to manage scope while maintaining required outcomes. At this stage there is no impact to the SDRC due 1 November 2017.

Further detail regarding project highlights are covered in the subsequent sections in this report.

Project Steering Committee

The Steering Committee is accountable for developing and undertaking project activities, completing deliverables, raising, evaluating and mitigating identified risks and authorising changes to the project plan.

In this period National Grid has appointed Nick Martin to the Steering Committee to assist the Technical Project manager (Charlotte Grant) to manage interdependencies, risks and track progress against particular project elements. Allowance for additional National Grid resource was considered and included as part of the full project submission in October 2014 and no other changes to the project hierarchy have been made since the last reporting period.

Project Steering Committee meetings

The Steering Committee continues to hold monthly teleconference meetings in order to discuss progress of the project, to enable risks to be highlighted and mitigated and to agree actions. A quarterly face-to-face meeting was held on 2 September 2015 at University of Manchester to discuss the key outcomes during the reporting period and agree the coordination and development of work streams between all parties. The location of future regular face-to-face meetings will be rotated between the various partner sites to facilitate wide engagement.

Contract signing and impact to the project

As previously reported, the project faced several challenges with agreeing terms of a multi-party agreement. This took a longer time than was originally anticipated in the EFCC Submission. As a consequence, some areas of development have been impacted, however, the project scope and high level timescales remain the same.

- Monitoring and control scheme philosophy understanding
  The specifications developed by Grid Solutions at the end of April 2015, describing the detail of the control system elements such as the detection of RoCoF and the concepts to locally control resource providers, could not be shared with project partners until the contract was signed in July 2015. This meant that discussions within the project to understand and interrogate the developing concepts were delayed and, consequently, the start of the optimisation and validation stages being undertaken by the universities (work packages 3 and 4). Sufficient time has been allocated within these work packages, although activities are being reviewed to maintain required objectives. At this stage there is no impact to the SDRC.
- University of Manchester resourcing
  The University of Manchester was unable to commence recruitment for a dedicated Research Associate and PhD student for the project until after July 2015. This process is well underway and it is expected both will join the Project Steering Group in January 2016. To mitigate the impact to the project, the University of Manchester has provided research support to the project so far and has made some progress within work package 3 (Optimisation) with systems analysis to demonstrate the risks of not having coordinated frequency response. Some contingency was built into the schedule of activities at the submission stage and the project is continuing to monitor and develop targeted analysis scenarios to fulfil the scope of the work package. Activities are being reviewed to manage scope while maintaining required outcomes.

Despite these issues, the Project Steering Group closely collaborated to focus efforts in reduced timescales to cross-examine the working approach with how wide area and distributed control of response providers could be used for rapid frequency response. This has resulted in minimal impact on the project.

Further detail on these and other results of the project to date are described in the Learning Outcomes section of this report.

Project progress against SDRC milestones

Project progress is shown in Table 1 below against milestone SDRC activities for this period.

Further detail on these activities during this reporting period is provided in the SDRC section below.

Description	Due Date	Status
Submission of Battery Storage Investigation Report	30/06/2015	Achieved 30/06/2015
Completion of Resource Algorithm Specification	31/08/2015	Achieved 31/08/2015

Table 1
SDRC summary

Project risks

Through the project structure and governance process any potential issues or significant changes that affect project delivery can be identified and mitigating actions put in place for resolution. To ensure effective risk management, risk review meetings have been held at regular intervals.

The Table contained in the appendices provides an updated view of the Project Risk Register and key risks for this reporting period can be found later in this report.

Project knowledge sharing and dissemination

Project lessons learned will be captured throughout the project lifecycle and reviewed by the collaboration partners and the wider project team through ongoing reviews and project meetings. Furthermore, project outcomes and learning will be shared through conferences and university demonstration events.

Project reports such as Event Detection and Control Platform specifications describing control system concepts as part of the intellectual property developed within this project have been uploaded onto the project website.

During this reporting period, the following events were attended and publications submitted.

Event/Publication	Date	Organisation	Contribution
"Assessing the Smart Frequency Control Resources in the Future GB Power System"	07/10/2015	University of Manchester, National Grid, Grid Solutions, University of Strathclyde	Power Systems Computation Conference (PSCC) paper submission for conference, May 2016. Outline of project objectives to deliver faster frequency response in low inertia systems.
LCNI Conference	26/11/2015	National Grid, Grid Solutions	Presentation and panel discussion about the project and inclusion on the NGET stand.
System Operability Framework Launch	30/11/2015	National Grid	Presentation of project and its objectives to representatives from generation, distribution, regulation, manufacturer, trade association and academia backgrounds.

Table 2
Knowledge sharing events July – December 2015

Forecast for next reporting period

The project activities to be undertaken during the next reporting period are shown in Table 3 below.

Work Package	Description	Partner	Comments	Status	Timescale
1	Monitoring & Control Scheme	Grid Solutions	Optimisation algorithm (how resources are prioritised for a proportionate response)	Green	Aug 2015 – Jan 2016
1	Monitoring & Control Scheme	Grid Solutions	Testing of functional algorithms	Green	Jan 2016 – April 2016
2.1	DSR	Flexitricity	Finalisation of list of specific customers for participation in EFCC. Commence site visits to outline technical modifications required for trials. Agree commercial terms with participants	Green	July 2015 – June 2016
2.2	Large Scale Generation	Centrica	Review of performance criteria against each existing operational management system. Verification of operational mode changes and impact on plant	Green	Oct 2015 – June 2016
2.3	PV Power Plant	Belectric	Site preparation and installation of inverter for ramp up and curtailment characteristics for frequency response	Green	Oct 2015 – March 2016
3	Opitimisation	University of Manchester	System studies on representative GB transmission network to assess proportionate responses from service providers using Grid Solutions's event detection algorithm[1]	Amber	July 2015 – March 2017
4	Validation	Universities of Manchester & Strathclyde	Validation of monitoring and control scheme using representative GB network for real time simulations and PNDC	Green	June 2015 – Sept 2017
6	Commercial	National Grid	Commence assessment of economic value of new rapid frequency service	Green	July 2015 – March 2018
7	IS Communications	National Grid	Continue review of Visualisation of Real Time System Dynamics using Enhanced Monitoring (VISOR) project and monitor progress of data gathered from existing phasor measurement units. Commence outline of compliance process for service providers	Green	Jan 2015 – Dec 2017

1. This activity has been deemed amber due to the delays with recruiting research assistance

Business case update

Lincs Windfarm trials

In the previous progress report, it was advised that in order to finalise the test schedule for Lincs Wind Farm as proposed in the EFCC full submission, National Grid was in discussion with Centrica and the other wind farm joint venture partners (DONG Energy and Siemens).

During this reporting period, National Grid has continued to liaise with DONG Energy regarding possible options for wind farm trials. A meeting was held on 2 December 2015 between National Grid, DONG Energy and Siemens. Agreement in principle has been reached for the inclusion of wind turbine trials, however, detailed options and scenarios are to be confirmed. The range of possible options to demonstrate a RoCoF initiated frequency response include Siemens' own simulations of frequency signal injection as well as simulations that integrate GE control system functions.

These ongoing negotiations with wind farm joint venture partners have meant that the design and development of Grid Solutions's resource allocation and control system protocol interfacing with Lincs has not taken place to enable complete product design in advance of testing (April – August 2016). The project schedule catered for a decision point to finalise this design development between all project partners by 11 December 2015. Grid Solutions has informed the project that due to delays with confirming the wind farm within the project there will be an impact on cost and timescales on any future incorporation of their hardware for wind farm trials.
In this respect, once a contract has been signed with DONG Energy and Siemens, a full assessment will be carried out to ascertain the impact of developing another hardware unit.

Table 4 below shows the high level activities for this work package that will be reviewed.

Work Package	Comments	Timescale
2.5.1	Initial engineering assessments and scope definition; produce outline technical requirements	Oct 2015 – March 2016
2.5.2	Initiate formal Engineering Change Process; initial evaluation of technical proposal	March 2016 – March 2016
2.5.3	Concept Design Review; verification of concept, operational parameters and impact on plant	March 2016 – June 2016
2.5.4	Finalise specification for engineering design	June 2016 – July 2016
2.5.5	Detailed engineeering design	July 2016 – Sept 2016
2.5.6 – 2.5.8	Final review and approval, operational planning	Oct 2016 – May 2017
2.5.9	Implementation and demonstration of capability	March 2017 – June 2017
2.5.10 – 2.5.13	Further testing and monitoring of performance if required; review and finalise documentation	June 2017 – March 2018

Table 4
Work package 2.5 wind farm activities

Enhanced frequency response – National Grid issues expression of interest

On 22 September 2015, the Commercial Services team in National Grid issued an invitation for expressions of Interest to industry providers for the provision of an enhanced frequency response service. One of the selection criteria for tender prequalification was that the potential project providing the service can be operational by July 2017 and able to deliver active power within 500 milliseconds and achieve full output in 1 second from the detection of either a pre or post system fault frequency deviation. Full capability characteristics including deadband and other details can be found here **http://www2.nationalgrid.com/Enhanced-Frequency-Response.aspx**. However, the provision of this service will be based on an absolute value of system frequency and will provide dynamic frequency response. The submission deadline for industry providers was 23 October 2015.

There is an overlap with the speed of provision of this service and the objectives of the EFCC project. However, the EFCC project aims to not only demonstrate speed of response from providers but to also develop a GB wide control system that will detect RoCoF and coordinate a proportionate post system fault response from providers on a targeted regional level. In this way EFCC will initiate a response based on RoCoF in order to contain system frequency more quickly, rather than waiting for the frequency to reach a certain value.

This investigation has brought forward providers who have the capability to provide a faster frequency response and, at time of writing, National Grid is developing a tender process and engaging with developers and DNOs to resolve any technical issues in delivering this service. The EFCC project is working closely with the Commercial Services team to share any learning about the specification of technical capabilities of an enhanced service to encourage wider participation from suppliers, as well as market intelligence of valuing an enhanced frequency product (work package 6). This learning will enable any service developed for EFCC to be better defined and facilitate quicker uptake at the end of the project.

Bank account

Bank statements have been provided to Ofgem. Due to the confidential nature of the project bank statements, redacted versions have been included in the appendices of this report.

Progress against budget

Project expenditure is within the budget defined in the Project Direction. The Table on the following page details the project expenditure to date and highlights any variances against the budget.

Project budget

Budget period: January to December 2015

Cost Category	Actual	Budget	Variance
Labour	£282,579	£546,838	£264,259
Equipment			
Contractors	£146,615	£178,505	£31,890
IT			
IPR Costs			
Travel & Expenses			
Payments to Users			
Contingency	£0	£66,154	£66,154
Decommissioning			
Other			
2015 TOTAL	**£429,194**	**£791,497**	**£362,303**

Table 5
Project budget: January – December 2015

During the second half of 2015, additional National Grid resource has been assigned which has resulted in National Grid labour costs being more closely aligned to those stated in the project proposal. The variance between budget and actual labour costs reflects the National Grid savings made over the first year, particularly in the first six months. The project continues to be managed effectively utilising the current resource levels.

The variance between the contractor proposed and actual costs is a timing issue rather than underspend. The £32k variance relates to a delay in work package 2.4 as a decision is still to be made on the battery storage element of the project and these costs will be shown in the next progress report.

Reallocation of budget between work packages

A budget re-distribution has been requested between work packages 1 (Monitoring and Control) and 3 (Optimisation). The objective of the budget reallocation is to allow Grid Solutions to provide additional functionality and added value in terms of product/algorithm optimisation into work packages 1 deliverables. The proposal is to spend 30 man days earlier in the project lifecycle therefore these hours will be moved from work packages 3 budget and timelines.

This will support the design, development and product testing of the resource allocation function (i.e. optimisation of the different power output characteristics to produce the appropriate frequency response) for the next SDRC on 30 April 2016.

A breakdown of the budget proposal has been included below:

Original split	New split
WP1 = 36 man days	WP1 = 66 man days
WP3 = 50 man days	WP3 = 20 man days
Total 86 man days	**Total 86 man days**

This budget reallocation will not increase the cost for the work packages and the payment schedules will remain the same. This request was approved by the Steering Board via the EFCC NIC project change control process in November.

Successful delivery reward criteria (SDRC)

Battery storage investigation report: work package 2.4

In the EFCC submission, National Grid requested funding to generate knowledge in combining solar PV with battery storage to explore the benefits of a combined service that could increase with the anticipated rapid and significant growth of renewables that will be connected to the transmission system. At the start of this reporting period National Grid submitted an investigation report comparing the costs and capabilities of existing battery storage units for rapid frequency response. Ofgem requested that analysis be carried out in advance of committing to funding an additional battery unit within the EFCC project. This report was submitted on 30 June 2015 in accordance with SDRC requirements. Background to the work undertaken is outlined in the first progress report (January – June 2015).

The outcome of the investigation resulted in three sites as potential candidates for the EFCC project. Table 6 summarises these sites.

Battery Site	DNO	Power, Capacity	Battery Technology	Comments
Leighton Buzzard	UK Power Networks	6 MW, 10 MWh	Li-NMC	LCNF funded project investigating battery storage capabilities for ancilliary services provision completing December 2016.
Darlington (Rise Carr)	Northen Power Grid	2.5 MW, 5 MWh	Li-Ion	Currently evaluating options for future research and/or trials for ancilliary services provision.
Willenhall	Western Power Distribution	2 MW, 1 MWh	Li-Ti	EPSRC funded project to explore advantages of energy storage. End of demonstration phase of project due March 2017.

Table 6
Existing battery storage project status summary

Subsequently an updated report was submitted to Ofgem on 6 November 2015 that included further cost benefit analysis and incorporated the potential benefit of future deployment of the hybrid solar PV plus battery storage unit.

The original EFCC project schedule for this work package made an allowance for an investment decision point from the Authority by August 2015 with some contingency provision built in to cater for equipment lead times and planning activities. In practice, the time in completing a detailed cost benefit analysis and subsequent discussion with the Authority have been sufficient to materially change the original project schedule.

Work Package	Description	Existing Start Date	Existing End Date	Proposed Start Date	Proposed End Date
2.4.1	Site preparation	April 2016	Sep 2016	May 2016	Oct 2016
2.4.2	Install equipment	July 2016	Dec 2016	Aug 2016	Jan 2017
2.4.3	Establish and modify relevant IT systems	Jan 2016	March 2016	Feb 2016	April 2016
2.4.4	Establish and test communication	Oct 2016	Dec 2016	Nov 2016	Jan 2017
2.4.5	Test and demonstrate response capability	Jan 2017	Sep 2017	Feb 2017	Nov 2017

Table 7
Revised timescales for WP2.4 activities

Although there is a delay of one month for the proposed start date of site preparation – to ensure there is sufficient flexibility to achieve the subsequent activities – this has extended the overall timescales for the work package.

As a consequence of these changes to activity dates, there will be an impact on the SDRC detailed in the Project Direction. A new date to deliver this work is proposed in Table 8 below.

Work Package SDRC	Description	Existing SDRC Date	Proposed SDRC Date
2.4.5	Complete demonstration of storage response to frequency events and their capability to respond in proportion to rate of change of frequency.	1 Oct 2017	1 Dec 2017

Table 8
Revised SDRC for WP2.4.5

At time of writing, the project is awaiting a final decision from Ofgem on the proposed investment for battery storage. If investment in the Belectric battery storage unit is approved by the Authority and the project can progress with a hybrid solar PV and battery storage trial, then National Grid will formally request an amendment to the Project Direction to change this SDRC.

Resource allocation algorithm: work package 1

Grid Solutions will develop the algorithms for the resource allocation to be deployed on the monitoring and control system platform. The controllable resources for the provision of rapid response are wind farms, DSR, gas turbines, solar PV and battery storage. Technologies have different response characteristics and the resource algorithm will allocate and accurately coordinate the responses to deliver a targeted, controlled and proportionate response to alleviate frequency deviations. A specification was produced containing a description of the principle of the application, the algorithm functionality and a description of simulation tests undertaken.

This document is covered by Grid Solutions's background intellectual property rights and as such not all information can be published via the knowledge sharing e-hub. An edited version will be produced for publication showing the intellectual property developed within the project.

Successful delivery reward criteria for the next reporting period

There are five SDRCs due within the next reporting period January – June 2016.

Description	Due Date	Status	Comments
Complete Optimisation Algorithm (work package 1)	31 Jan 2016	Green	
Annual Knowledge Dissemination Event	31 March 2016	Green	The project will carry out this event on 25 Feb 2016.
Complete Control Platform Algorithm (work package 1)	30 April 2016	Green	
Complete Product Testing (work package 1)	30 April 2016	Green	
Complete Product Development (work package 1)	30 April 2016	Green	

Table 9
Next reporting period's SDRCs

Key

Status	Description
Red	Unlikely to complete by due date
Amber	Minor issues but expected to complete by due date
Green	On track and will complete by due date

Future SDRC

As mentioned above, on receiving a final determination from the Authority regarding the Belectric battery storage unit, National Grid may request an amendment to the Project Direction to change the SDRC associated with Work Package 2.4.

Learning outcomes

This section describes the learning that has been developed within the project for the current reporting period.

Work package 1: monitoring and control system (resource allocation)

Development of frequency event detection (wide area and local/regional) and the methodology showing how the proportionate response will be achieved.

Resource allocation is a functional element within the whole control system that is responsible for gathering all resource information from providers and managing resources to calculate and deliver a targeted proportionate response. Depending on the regional response requirement, an assessment of how much is required to contribute to meet that requirement is made. Each of the resources will then receive a signal from their connected controllers on their requested response. The requested change in power output from a particular resource will move in a single direction during response to a system event, i.e. in an under frequency event, there will only be an increase in power response initiated. This is to reduce the risk of the control system contributing to instability from 'hunting', i.e. continuously increasing and decreasing power following frequency oscillations which could negatively impact upon system damping. Further, the response will be sustained (if resource allows) unless an additional increase in power is requested. The aim of the scheme is to maintain the deployed response level until such time as conventional frequency response can take over, such as conventional governor response or redispatch of generation. The controllers will start to decrease the requested power as they hand over to the longer term conventional responses.

Outline priorities (e.g. speed of response) have been discussed while recognising that DSRs will be initiated within longer timescales and their priority for use during a system event will depend on the specific site operation.

The full optimisation of allocating resource will be defined in collaboration with work also being undertaken by the University of Manchester. This work will encompass resource availability and the power output characteristics over time for each resource to ensure an overall proportionate response.

Grid Solutions has circulated an early draft of the Optimisation Functional Design Specification which has been reviewed by the University of Manchester and National Grid. This document outlines the key functions to be developed by Grid Solutions in the WP1 optimisation deliverable.

Work package 2.1: DSR

Flexitricity has a selection of potential participants within their existing customer base of the 3 targeted areas that were initially set out in the project submission.The expectation is that these sites will be approached in order to sign contracts to carry out trials for the project. The three targeted areas are:

- Static RoCoF e.g. data, communications and banking sites
- Real inertia e.g. embedded generation with more than one synchronous generator
- Controlled response (dynamic RoCoF); e.g. loads controlled using variable speed drives.

Work package 2.2: large scale generation

Centrica has started its review of the performance criteria of the generators at South Humber Bank and Langage power stations against their existing operational management systems. The benefit of trialling both stations is that they are located in different parts of the transmission system enabling frequency response for differing system inertias. At this time priority has been focused on detailed options for initiating a faster response from South Humber Bank. This is on the basis that the control system with South Humber's governor system is less complex than the governor system at Langage as only the gas turbines are involved with modifying their output to provide response. In this way, integration of Grid Solutions's control system at South Humber will be simpler and enable the project to gain experience and learning when developing designs for Langage.

Simulations have been carried out using representative gas turbine parameters to ascertain how frequency response can be achieved utilising a RoCoF signal and under what circumstances response can be delivered more rapidly. Two options have been proposed that integrate new frequency compensation methods into existing frequency response control loops, namely:

- A control function that modulates the response required in proportion to the RoCoF for under frequency events. The total overall power output from the gas turbine is a combination of proportional frequency response (in relation to the absolute frequency value) plus the additional modulated response
- Control functions as above, but only utilising the maximum points to provide response at maximum loading instead of delivering proportionately as frequency changes.

The second option could be more advantageous for fast response, and current simulations show that (depending on the specific scenario and without breaching any future capability limits) it could be possible to deliver a response quicker than 10 seconds.

In both cases, coordination of the use of existing proportionate frequency response must be considered. Further work in reviewing and developing these scenarios will continue into the next reporting period.

Work package 3: optimisation

University of Manchester: system analysis – non-supervisory control

The University of Manchester has carried out some system studies on a representative GB transmission network to assess the frequency response requirements for a number of scenarios with different system inertias. Further work is required to assess future energy scenario possibilities without the use of a coordinated approach of various response providers to contain system frequency and investigate how regional inertia can be considered.

Work package 6: commercial

As outlined in the Business Case section of this report, National Grid is currently preparing a tender for the provision of a pre and post fault enhanced frequency response service. Those response providers that met the initial critieria have given the project insight into the types of technologies that are capable of delivering an enhanced frequency response service that could participate in a future EFCC service product.

The outcome of the tender will allow the EFCC project to gain knowledge about any future cost of a RoCoF service that can be incorporated into the commercial modelling that will be developed as part of this work package. Further aspects of enhanced frequency response provision are discussed in the Business Case Update section earlier in this report.

Work package 7: IS communications

The project has started to evaluate the requirements for the communications infrastructure that will support Grid Solutions's control system. The Wide Area Monitoring System (WAMS) being developed by the VISOR (Visualisation of Real Time System Dynamics using Enhanced Monitoring) project is a critical input into the EFCC project providing infrastructure and system parameter data. However, since VISOR is for monitoring purposes only, a key challenge is ensuring communications reliability and robustness for EFCC to facilitate the control of response providers and prevent system instability. Options for EFCC interoperability with VISOR communications platform have been outlined and discussed between the respective project teams.

One option is to have parallel phasor data concentrators specifically for EFCC purposes to ensure rapid response times can be achieved. Ultimately during work package 4 (Validation), the demonstrations at University of Manchester and Strathclyde PNDC (Power Networks Demonstration Centre) will investigate communcations latency and the capabilities of fast round-trip control of the scheme.

Intellectual property rights

In accordance with the requirements to publish intellectual property (IP) developed within this project, Grid Solutions has made available versions of the Event Detection and Control Platform specifications. Project progression has not been hindered as full versions of these specifications were made available to the project partners when the multi-party contract was signed. Publicly available versions of these have been uploaded to the knowledge sharing website.

Furthermore, during this reporting period, Grid Solutions has developed the Resource Allocation Functional Specification that will be published on the knowledge sharing website.

A similar approach regarding the review and publication of background and foreground IP will be taken with all documents produced throughout this project.

Current risks

Project risks are being monitored and reviewed on a regular basis by the project partners. Key risks for this reporting period with an amber or red status have been included below and a full risk register can be found in the appendices of this report.

Risk No.	Workstream	Risk Summary	Risk Owner	RAG Status
10	General	Academic service providers are unable to recruit appropriate staff to work on the project	Universities	9
34	WP2.1 – DSR	Flexitricity is unable to provide participants for planned trials	Flexitricity	12
35	WP2.1 – DSR	DSR recruitment: industrial and commercial electricity customers unwilling to participate	Flexitricity	12
50	WP1 – Control System	Number of interface protocols impacts development and testing effort requiring extra design, development and testing effort with impact on project delivery timelines	Grid Solutions	8
51	WP2.4 – Storage	Ofgem decision required on storage element of project	Belectric	12
52	WP2.5 – wind	All joint ventures partners need to agree with use of Lincs, Lynn or Inner Dowsing	National Grid	12
56	General	New contract negotiations required to include wind farm element within project	National Grid	12
58	WP2.4 – Storage	Technical difficulties if Ofgem declines usage of Belectric storage. The project may be delayed or working package 2.4 might not be rolled out to full extent (limited response capability)	Belectric	16

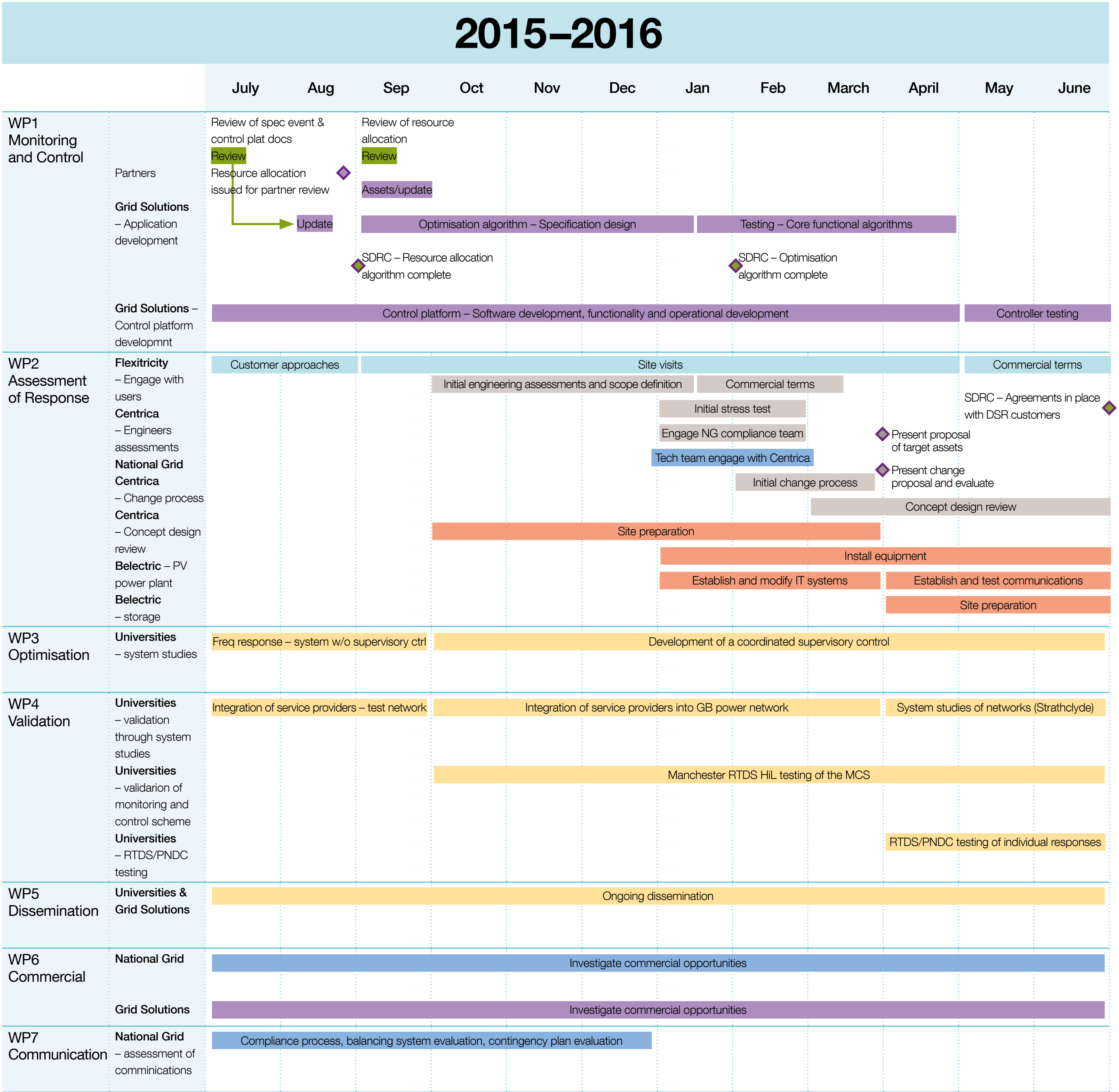
Table 10
Key risks identified

Assurance statement

This report has been produced in accordance with the overall project hierarchy. The report has been written by the EFCC (NIC) Technical Project manager (Charlotte Grant), reviewed by the EFCC (NIC) Project Steering Group, recommended by the EFCC (NIC) Project Director (Vandad Hamidi) and approved by John West (Electricity Policy and Performance Manager) on behalf of the Project Sponsor (Richard Smith).

Every effort has been made to ensure all information contained within this report is accurate.

Appendix A: EFCC NIC project year ahead 2015–2016



Appendix C: Project risk register, risk management and contingency plans

Risk No.	Workstreams/ Area	Risk Description	Cause	Consequence	Risk Owner	Likelihood (1–5)	Financial impact (1–5)	Reputational impact (1–5)	RAG	Escalate To	Action Plan	Control Opinion
2	General	Partners leave project before completion.	Decision is taken by partner to leave the project. Reason could be commercial, operational, etc.	Work is lost or unable to commence and the usefulness of the results of project are reduced or project is delayed.	Project manager	2	2	3	6	Steering Group	Ensure thorough contracts in place. Procurement processes have considered ongoing size and reliability of partners. Replacement partners have been considered and could be approached if required.	Effective
3	General	Estimated costs are substantially different to actual costs.	Full scope of work is not understood. Cost estimates are not validated. Project is not managed closely.	Potential project funding gap. Alternative funding is required or the project scope is reduced.	Project manager	1	3	2	3	Steering Group	Ensure cost estimates are thorough, realistic and reflect full scope of work. Estimates validated based on tenders and market knowledge. Contingency included.	Effective
4	General	Material costs increase.	The cost of materials rises for unforeseen circumstances.	Potential project funding gap. Alternative funding is required or the project scope is reduced.	Project manager	3	2	3	9	Steering Group	Define cost risk owner.	Effective
5	General	Significant changes to the GB electricity system during the life of the project.	Priorities or strategies for planning and managing the GB system may change.	Solution may no longer be suitable. Assumptions may no longer be accurate or appropriate.	Project manager	1	3	4	4	Steering Group	We have fully considered future developments and scenarios. We have ensured usefulness of solution matches planning of system.	Effective
6	General	Critical staff leave National Grid or our project partners during project lifecycle.	Usual and unavoidable staff turnover results in key staff leaving National Grid or our project partners.	Progress of the project is delayed. The expertise to deliver the project is no longer within the project team.	Project manager	2	2	3	6	Steering Group	Knowledge of, and responsibility for, project should not be reliant on one person. Ensure documentation and guidance exist to assist anyone joining project team. Thorough handover processes to be in place.	Effective
7	General	Quality of technology is insufficient - the monitoring and control system and/or equipment installed at response sites.	Least cost option taken ahead of quality and reliability considerations; quality control insufficient at suppliers.	The solution offered is not reliable and commercial opportunities will be reduced. Costs are incurred through delays and replacements.	Suppliers	4	2	3	12	Project manager	All partners have been assessed based on reputation, track record and responses to National Grid tender. Ensure that price is not the prioritised criteria. Ensure quality control procedures are in place and followed throughout project.	Effective
8	General	Technology cannot be easily upgraded.	Monitoring and control technology and/or response equipment is designed without full consideration for future developments.	Technology is less useful in the future as the electricity system continues to develop. Required upgrades are costly or not possible.	Suppliers	4	2	3	12	Project manager	Future requirements considered and built into specification. Flexibility has been built in.	Effective
9	General	Cost of solution over lifetime are high.	Full cost of solution is not considered and/ or understood.	Future usefulness and commercial opportunities of solution are restricted.	Project manager	3	3	3	9	Steering Group	Full long-term cost of solution have been considered as part of detailed Cost Benefit Analysis calculations.	Effective
10	General	Academic service providers are unable to recruit appropriate staff to work on the project.	Lack of suitable candidates or interest in the project.	Trials are limited or unable to take place. The suitability and performance of the technology is not established.	Academic project manager	3	3	3	9	Project manager	Academics have a large internal candidate base of experienced Post Doctoral Research Assistants. Reputation and facilities of partners will attract high-calibre candidates. Process for advertising for suitable candidates is progressing. For UoM, a PhD student has been assigned. The expected RA is due to start in January, subject to visa approval. Student already recruited for UoS.	Effective
11	General	Component failure during project.	Equipment will be run in new ways and therefore may experience problems or failures.	The equipment may require repair or replacement. The tests may be delayed.	Suppliers	3	3	3	9	Project manager	Thorough checks before tests. Clear understanding of equipment capabilities. Particular stress points identified. Spare parts and repairs lined up.	Effective

Score	RAG
1–6	Green
7–14	Amber
15–25	Red

Risk No.	Workstreams/ Area	Risk Description	Cause	Consequence	Risk Owner	Likelihood (1–5)	Financial impact (1–5)	Reputational impact (1–5)	RAG	Escalate To	Action Plan	Control Opinion
12	General	Strategic Spares Policy.	Spares Policy for new technology may not be suitable when taking all risks into account.	If suitable spares are not identified and available, the risks of losing the PMU/controller in the network may reduce effectiveness of project.	National Grid	3	3	2	9	Project manager	Contingency plans will be drawn up to include potential alternative monitoring locations which could be used in the event of equipment and/or communications failure for continued operation. Off-the-shelf products that are readily replaceable are used. The proposed structure will contain a number of PMUs in each zone which should allow continued supervisory actions with the loss of a device. For the controller, redundancy will be planned for to ensure the loss of the controller is suitably backed-up.	Effective
13	General	Maintenance requirements.	Manufacturer recommends intensive and regular maintenance activities which do not fit with project owner's expectations.	Regular intensive maintenance requires additional resource of field staff and potentially affects the network operation thus reducing power transfer levels and potential constraint costs.	National Grid	3	3	3	9	Project manager	Seek to work with the manufacturers to understand maintenance requirements and the impact on the design or selection of components. Remote VPN access to controller for remote logging and maintenance, especially for beta release stages.	Effective
14	General	Loss of telecom-munications.	Technical fault leads to loss of telecommunications between systems.	Reduced availability and performance.	National Grid	3	3	3	9	Project manager	Design scheme for continued operation or graceful degredation in the event of a loss of telecommunications.	Effective
15	General	Inefficient operation of MCS.	MCS not configured correctly which results in spurious tripping or excessive amounts of control initiation commands.	Over-response from resources reducing stability, excessive set-point changes in generators reducing asset lifetime.	National Grid	3	3	4	12	Project manager	The scheme will be extensively tested in a laboratory environment before any network deployment. The system will also be evaluated using recorded measurements from the GB systems allowing tuning and configuration in a safe environment. Academic partners will also provide suitable facilities to test response on generators to reduce risk to assets after deployment.	Effective
16	General	High operation and maintenance costs.	Cost for inspection, maintenance, repairs, spares etc. are higher than expected.	Excessive OPEX costs compared to current alternatives.	National Grid	2	1	1	2	Project manager	Maintenance requirements and spares etc. identified during tender evaluation.	Effective
17	General	Installation.	Supplier of TO/TSO delay on Base Install. Delays in implementing control scheme platforms and comms routes to PMUs/ controllers/controllable resources. Coordination of National Grid and supplier staff availability.	Delays in key control scheme component will push back the trialling period and thus reduce the available time for reports, tuning dissemination.	National Grid	3	1	3	9	Project manager	Select vendor with track record of commercial WAMS installations. Supplier must have experience of deploying in utility environment. Direct support by supplier via VPN for diagnosis. Comprehensive training by supplier for IT personnel in all 3 partners in IT requirements of WAMS project.	Effective
18	General	Communications.	Communication infrastructure is not fit for purpose.	The existing communication infrastructure may inhibit the speed of response of a control reducing scheme's effectiveness.	National Grid	2	1	2	4	Project manager	Work closely with National Grid and partners to ensure that new comms links not critical to project success. Ensure that the communications infrastructure is well understood and the chosen control scheme can best work with available infrastructure.	Effective
19	General	Outage required for commissioning.	Inability to obtain the relevant outages for commissioning.	Possible delays to commissioning programme, or cost of outage.	National Grid	2	1	3	6	Project manager	Outages identified and incorporated in Scheme Requirement Document.	Effective
20	General	Commissioning.	Commissioning procedures encounter problems.	Delays in commissioning the project.	National Grid	2	1	3	6	Project manager	Identify and agree all the commissioning procedures with the supplier for the new technology, and the problems that might be encountered.	Effective
21	General	Capital costs.	Costs higher than anticipated.	Project budget exceeded.	National Grid	2	1	2	4	Project manager	FIDIC contract, contractor takes risk.	Effective

Risk No.	Workstreams/ Area	Risk Description	Cause	Consequence	Risk Owner	Likelihood (1–5)	Financial impact (1–5)	Reputational impact (1–5)	RAG	Escalate To	Action Plan	Control Opinion
22	Health, Safety & Environmental	New equipment.	Lack of experience and knowledge regarding new pieces of equipment.	Health and safety risks present as a result of lack of experience. Inefficient working could result. Note that controller is low voltage equipment and actions are taken through existing standard protection and control equipment.	Project manager	2	1	4	8	Steering Group	Specialist tools and training required for maintenance activity. Procedures to be developed. Controller to go through rigorous testing.	Effective
23	WP1 - Control System	Technology partner fails to deliver suitable product on time.	Problems with design and build.	Project is delayed.	Grid Solutions	1	2	2	2	Project manager	Contracts to be put in place to penalise delays. Clear specification requirements in place. Development of technology to be closely managed to identify and resolve potential problems.	Effective
24	WP1 - Control System	Technical specification lacks the clarity required to deliver the technology, or contains errors.	Requirements not fully understood. Quality control processes insufficient.	The technology developed may not match requirements or be suitable.	Grid Solutions	2	2	2	4	Project manager	Care to be taken over technical specification, with input from all relevant partners. Review process in place and then regular communication with Grid Solutions and other partners to identify and resolve issues quickly.	Effective
25	WP1 - Control System	Flexible embedded real-time controller not commercially available.	A controller with the flexibility to employ the required algorithm is not currently available and will require significant development effort. Resources must be in place for a timely start to the platform development.	Delays in sourcing suitable resources may extend the development period and delay deployment and trialling of the project.	Grid Solutions	2	1	2	4	Project manager	Source suitable development resources in advance of project start date to ensure that timely start can be made to project.	Effective
26	WP1 - Control System	Event detection and response algorithms not available on embedded real-time controller.	The controller will use custom functions which are not currently available on the embedded control platform for determining of appropriate reaction. These functions will require development and testing before deployment. New control approaches need to be developed.	Extension required for the development period which adds delays to all consecutive elements of the project.	Grid Solutions	2	1	2	4	Project manager	Staged approach to application development with simple initial target in first year. Allow sufficient resources for all stages of algorithm development to ensure that sufficient effort is dedicated to the project at an early stage to avoid any delays and allow for sufficient resource for modification based on the outcomes of the early testing.	Effective
27	WP1 - Control System	Resource interoperability.	Using distributed resources for frequency response is untested in the UK and the availability of resources when called upon is critical. There must exist a sufficient information exchange between the controller and the individual resources so that resources can be called upon in a timely manner.	Lack of comms path or interoperability issues between the controller and the resources may lead to delayed initiation of response and reduced ability of the central control scheme to halt frequency excursions.	Grid Solutions	2	2	2	4	Project manager	Agree common standards and offer a simple input and output for all controllable components through standard interface protocols which will be agreed upon by all controllable resources.	Effective

Risk No.	Workstreams/ Area	Risk Description	Cause	Consequence	Risk Owner	Likelihood (1–5)	Financial impact (1–5)	Reputational impact (1–5)	RAG	Escalate To	Action Plan	Control Opinion
28	WP1 - Control System	Resource flexibility.	Resources do not offer enough flexibility for control under proposed control scheme, either offering response which is difficult to quantify or response which is difficult to tune.	May require redesign of the control scheme adding delays to deployment.	Grid Solutions	3	2	2	6	Project manager	Collaborate closely with project partners through all stages to ensure that control scheme is designed according to limits of operation of various resource types. Especially, collaboration between Grid Solutions and academic partners on Optimisation.	Effective
29	WP1 - Control System	Control scheme trial outcome.	Due to the innovative nature of the project, the selected control scheme when trialled may yield negative results, or introduce additional problems.	The selected control scheme will be unable to effectively deploy resources to arrest a frequency excursion.	Grid Solutions	3	2	2	6	Project manager	The risk is mitigated by using a number of candidate solutions which will be based on wide-area control, local-control and a hybrid-approach using both. If any problems arise from one candidate solution, other solutions will be readily available.	Effective
30	WP1 - Control System	Controller scalability for roll-out.	The controller will be developed for trial locations using a limited number of sites and corresponding PMU measurments. The control platform may see reduced performance due to increased amounts of measurement and resource data with larger-scale roll-out. An additional risk stems from exceeding the computational capacity of the controller with complex algorithms and increased inputs, e.g. more resources to optimise.	Timely roll-out of the scheme could be put at risk adding significant delays to full effectiveness of the scheme and putting the learning from the project into action. The risk for this stage of the project is minimal.	Grid Solutions	3	4	2	12	Project manager	Laboratory testing will allow scalability testing which can be used to test the control platform with a greater number of inputs than will be utilised in trialling. This will both allow the limits of the control platform to be found and define new methods by which to overcome these limits.	Effective
31	WP1 - Control System	Additional testing and tuning.	The controller may require additional tests and fine tuning based on real system measurements ifrom the UK network to ensure robust operation. Data will need to be gathered over a sufficient period to determine the control scheme performance.	The selected control scheme will be unable to effectively deploy resources to arrest a frequency excursion.	Grid Solutions	2	2	1	4	Project manager	Information gathered from VISOR can provide an extended period of system measurements. This data can be replayed in the laboratory environment to test the control scheme with real measurements from the UK system to validate the behaviour while also allowing a longer capture period for sufficient disturbances.	Effective
32	WP1 - Control System	Data Quality.	Inadequate data quality from PMUs due to problems with communications infrastructure, incompatible PMUs or from existing PMUs where experience has shown poor quality data.	Controller application value and performance reduced.	Grid Solutions	4	1	1	4	Project manager	Require proof of prior installations with good data availability. Use PMUs that have evidence of acceptable practical performance, and standards compliance where possible. Applications to be robust to data packet loss.	Effective
33	WP1 - Control System	RoCoF trip risk.	Controllable resources which are called upon to arrest frequency excursion may be conflicted by own Loss of Mains RoCoF settings and trip. Also, risk of fast response rolling off at df/dt=0 when it should be sustained.	Loss of effectiveness of resources - unavailable for frequency support or prematurely returned to normal service.	Grid Solutions	2	1	2	4	Project manager	For trial purposes, RoCoF should be sufficiently low to avoid conflicts of LoM detection, however studies will be carried out to assess the problem for future roll-out. Project will provide learning outcome which can be used to inform future grid codes. Also, coordination of control to ensure smooth transitions between stages of response.	Effective
34	WP2.1 - DSR	Flexitricity is unable to provide participants for planned trials.	Timing, risk and commercial terms makes it difficult to recruit DSR participants.	Trials are limited or unable to take place. The suitability and performance of the technology is not established.	Flexitricity	4	3	3	12	Project manager	Flexitricity to identify and start negotiations with potential participants as a matter of priority.	Effective
35	WP2.1 - DSR	DSR recruitment: industrial and commercial electricity customers unwilling to participate.	I&C energy managers' workloads, comprehension of the proposition, duration of trials, uncertainty of long-term commercial service, opportunity cost.	Ability of DSR to deliver EFCC not proven.	Flexitricity	3	2	4	12	Project manager	Use Flexitricity's extensive existing customer base and contracting process for recruitment.	Effective

Risk No.	Workstreams/ Area	Risk Description	Cause	Consequence	Risk Owner	Likelihood (1–5)	Financial impact (1–5)	Reputational impact (1–5)	RAG	Escalate To	Action Plan	Control Opinion
36	WP2.1 - DSR	DSR trials prove infeasible.	Complex technical interaction with existing commercial site processes.	Ability of DSR to deliver EFCC not proven.	Flexitricity	2	4	4	8	Project manager	Pursue three separate technical approaches to spread risk (RoCoF, real inertia, simulated inertia).	Effective
37	WP2.1 - DSR	Total delay between detection and action too long for distributed resources including DSR.	Long signalling chain including communicating with remote sites.	Cannot dispatch certain resources fast enough.	Flexitricity	2	3	3	6	Project manager	Include at least one fast-acting technical approach (RoCoF) for DSR, to compensate for other possible signalling delays.	Effective
38	WP2.1 - DSR	Cost of DSR too high for large-scale roll-out.	Control modifications (especially RoCoF and simulated inertia)	Project does not result in economic source of EFCC from DSR.	Flexitricity	2	3	4	8	Project manager	Pursue three separate technical approaches to spread risk (RoCoF, real inertia, simulated inertia).	Effective
39	WP2.1 - DSR	DSR deployment lead time too long.	Normal delays in dealing with industrial and commercial energy users.	Unable to operate trial for sufficient time; some customers are ready too late for trial.	Flexitricity	3	3	3	9	Project manager	Commence EP recruitment during phase 1; show flexibility on trial dates and durations.	Effective
40	WP2.2 - Large-scale generation	CCGT operators struggle to get relevant technical input from OEM.	Lack of communication or timely response from OEM.	The project is delayed.	Centrica	2	2	2	6	Project manager	Draw up "heads ot terms" with OEM. Pay OEM (from funding) for relevent technical input.	Partially Effective
41	WP2.3 - PV power plant	Bad weather (low irradiation).	Poor weather conditions will mean that trials cannot take place.	Insufficient test conditions will lead to delays in testing.	Belectric	3	1	1	3	Project manager	Plan tests in summer.	Effective
42	WP2.4 - Storage	Delayed installation and commissioning due to local problems.	Issues around grid connection and accessibility cause delays.	The project is delayed.	Belectric	3	2	3	9	Project manager	Careful and detailed up-front planning; project plan not too tight.	Effective
44	WP3 - Optimisation	Detailed models of the various technology types are not made available to academic partners for system studies.	Poor communication and project management. Possible restrictions on data.	Without detailed technology models, any optimised control scheme will be based on generic assumptions about technology capabilities which may not be accurate. As such, true performance will not align with simulated performance.	Universities	2	2	3	6	Project manager	Discussion with GE (WP1) has started.	Effective
45	WP4 - Validation	Unable to model the UK network with sufficient detail using the RTDS facilities in order to thoroughly validate proposed control solutions.	Lack of required data. Lack of expertise on project.	Wide scale roll-out may be severely impacted by issues not flagged during the validation phase.	Universities	2	3	3	6	Project manager	Academic team contains expert knowledge. All data to be provided in timely manner. Problems to be escalated to project manager.	Effective
46	WP5 - Dissemination	Knowledge gained from project is not adequately shared with industry and other interested parties.	Lack of resources dedicated to dissemination. Failure to deliver events, website, etc.	A major benefit of, and reason for, the project is lost. Performance of solution and lessons learned are not shared.	Universities	1	2	3	3	Project manager	Ensure knowledge sharing is a priority of project. Establish formal processes to disseminate results, reports, etc. Use working group, internet, academic partners to facilitate sharing.	Effective
47	WP6 - Commercial	Market for EFCC not taken up by possible resource providers.	Knowledge not disseminated, meaning providers unable to prepare. Commercial arrangements not attractive.	The successful roll-out of the solution will be delayed.	Project manager	2	4	4	8	Steering Group	Ensure that knowledge is shared. Establish clear communication channels with interested parties. Develop commercial terms thoroughly prior to roll-out.	Effective
48	WP1 - Control System	Demonstration partner fails to install and configure demonstration setup on time for SAT.	Challenges encountered during installation and configuration or lack of understanding/training.	Demonstration is delayed with likely impact on other activities.	Grid Solutions	3	1	1	3	Project manager	Grid Solutions wil provide PMU/ MCS training during Demonstration 1 timeframe (combined with FAT). Grid Solutions support effort during installation has been quantified for the different demonstration phases. Scope of works, functional design specification and system design specification will be produced as input to partner installation activities.	Effective
49	WP1 - Control System	PMU/MCS hardware delivery delayed.	Late delivery of PMUs and/or MCS controllers.	Demonstration is delayed with likely impact on other activities.	Grid Solutions	2	1	1	2	Project manager	Ensure early engagement with suppliers and project stakeholders to ensure delivery and installation as per project schedule.	Effective

Risk No.	Workstreams/ Area	Risk Description	Cause	Consequence	Risk Owner	Likelihood (1–5)	Financial impact (1–5)	Reputational impact (1–5)	RAG	Escalate To	Action Plan	Control Opinion
51	WP2.4 - Storage	Ofgem needing to accept storage in "Smarter Frequency Control".	Insufficient argumentation in front of Ofgem.	Storage combined with PV not part of "Smart Frequency Control".	National Grid/ Belectric	3	4	5	12	Project manager	Prepare justification for battery storage to Ofgem.	Effective
52	WP2.5 wind	EFCC project needs to agree with all joint venture partners for use of Lincs, Lynn or Inner Dowsing.	Delay in agreeing use of wind farm.	Delays to project.	Project manager	4	3	3	12	Steering Group	Communication taking place with DONG Energy and Siemens.	Effective
55	WP1 - Control System	Number of Phasor controller applications.	Concept design frequency control has identified potential for the following controller applications: - Local Phasor controller for system aggregation, fault detection, event detection and resource allocation - Regional controller for regional aggregation and fault detection - Central Phasor controller for management and distribution of configuration data (settings, thresholds, parameters).	Depending on demonstration schemes envisioned, extra hardware may be required. Extra effort may be required for development, configuration and testing of extra controller units.	Grid Solutions	3	2	4	6	Project manager	Grid Solutions will further develop controller concepts & schemes. ALSTOM will work with project partners to establish suitable demonstration setups. Impact assessment will be conducted to assess potential extra requirements in terms of hardware and/or effort.	Effective
56	General	New contractual negotiations to include wind farm within the project.	Delay in agreeing use of wind farm.	Delays to project.	National Grid	4	3	3	12	Steering Group	Contractual discussions taking place early in process.	Effective
57	WP1 - Control System	Number of Phasor controller applications.	Concept design frequency control has identified potential for the following controller applications: - Local Phasor controller for system aggregation, fault detection, event detection and resource allocation - Regional controller for regional aggregation and fault detection - Central Phasor controller for management and distribution of configuration data (settings, thresholds, parameters).	Depending on demonstration schemes envisioned, extra hardware may be required. Extra effort may be required for development, configuration and testing of extra controller units.	Grid Solutions	3	2	2	6	Project manager	Grid Solutions will further develop controller concepts & schemes. ALSTOM will work with project partners to establish suitable demonstration setups. Impact assessment will be conducted to assess potential extra requirements in terms of hardware and/or effort. Project partners to confirm/ justify number of controllers with National Grid. Grid Solutions to plan procurement internally.	Effective
58	WP1 - Control System	4-20mA interface	4-20mA currently not part of TPSA Product Roadmap due to other priorities.	Full 4-20mA interface not ready for demonstration testing.	Grid Solutions	4	3	2	12	Project manager	Communicate proposal for inclusion of Advantech ADAM 6024 Convertor Modbus to 4-20mA. Implementation of the same.	Effective
59	WP1 - Control System	Digital interface	Capabilities of digital interface are limited. Alternative hardware solution required if more than 6 digitals required. Product enhancement required within TPSA Product Roadmap.	Full digital interface not ready for demonstration testing if more than 6 digitals required.	Grid Solutions	4	3	2	12	Project manager	Communicate proposal for inclusion of Advantech ADAM 6024 Convertor Modbus to digital for setups requiring more than 6 digitals. Implementation of the same.	Effective

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