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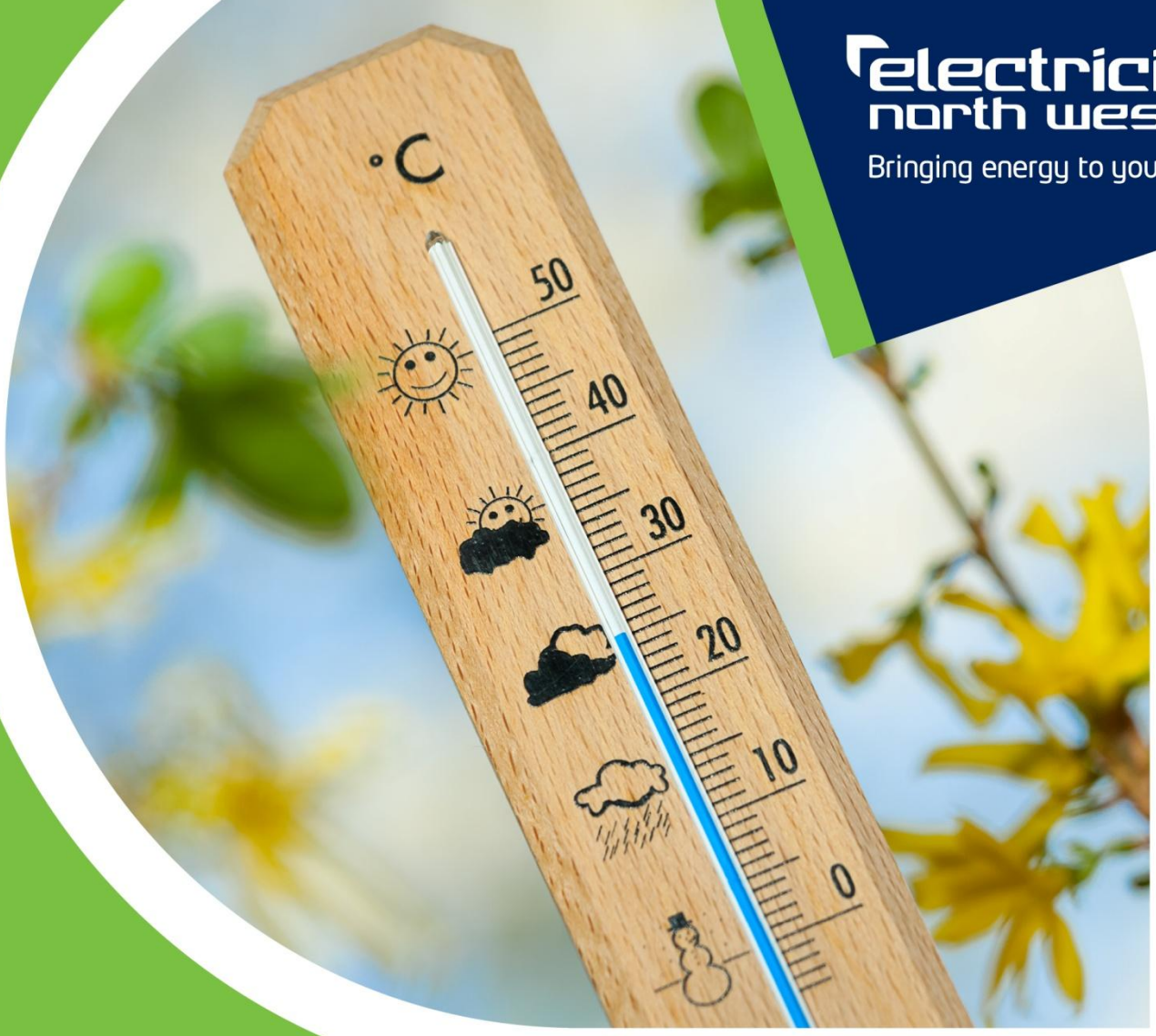

Celsius

Project Progress Report

7 June 2019

VERSION HISTORY

Version	Date	Author	Status	Comments
V0.1	23 May 2019	Delroy Ainsworth	Draft	First draft
V0.2	28 May 2019	Tracey Kennelly	First issue	For review
V0.3	29 May 2019	Delroy Ainsworth	Second issue	Final review
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REVIEW

Name	Role	Date
Paul Turner	Innovation Manager	6 June 2019
Jonathan Goodman	Finance Manager	6 June 2019

APPROVAL

Name	Role	Date
Steve Cox	Engineering and Technical Director	7 June 2019

GLOSSARY OF TERMS

Term	Description
Active cooling	Cooling produced by the installation of fans and control equipment which produces forced air flows to cool the distribution substation equipment
Ambient temperature	Temperature of the air surrounding a component
BAU	Business as usual policies and procedures
Cable	An underground conductor used to distribute electrical power, typically buried directly in the ground or installed in ducts or troughs
Capacity	The amount of power that can be delivered by an asset
CBA	Cost benefit analysis
CCC	Electricity North West's customer contact centre
CNAIM	Common Network Asset Indices Methodology
Current	The movement of electrons through a conductor, measured in amperes, milliamperes and microamperes
Demand	The amount of electrical energy that is being consumed at any given time
Distribution substation	A substation which contains high voltage (HV) switchgear, an HV/LV transformer, LV switchgear and short length of LV cable(s) and can be either pole- or ground-mounted
Distribution network operator (DNO)	The owner and/or operator of an electricity distribution system and associated assets
Energy Networks Association (ENA)	The industry body funded by British electricity transmission and distribution licence holders and gas transporter licence holders. It lobbies on common issues in the operating environment, at domestic and European levels, and provides technical services for the benefit of its members
GRP	Glass reinforced plastic
High voltage (HV)	Voltages over 1kV up to, but not including, 22kV
Hot spot temperature	The peak temperature reached at a point or position in a transformer winding which will determine the maximum load the transformer can carry
Low Carbon Networks Fund (LCN Fund)	Funding to encourage DNOs to innovate to deliver the networks needed for a low carbon economy
Low carbon technology (LCT)	A type of technology which operates with substantially fewer carbon emissions than traditional equivalents
MDI	Maximum demand indicator
NIC	Network Innovation Competition

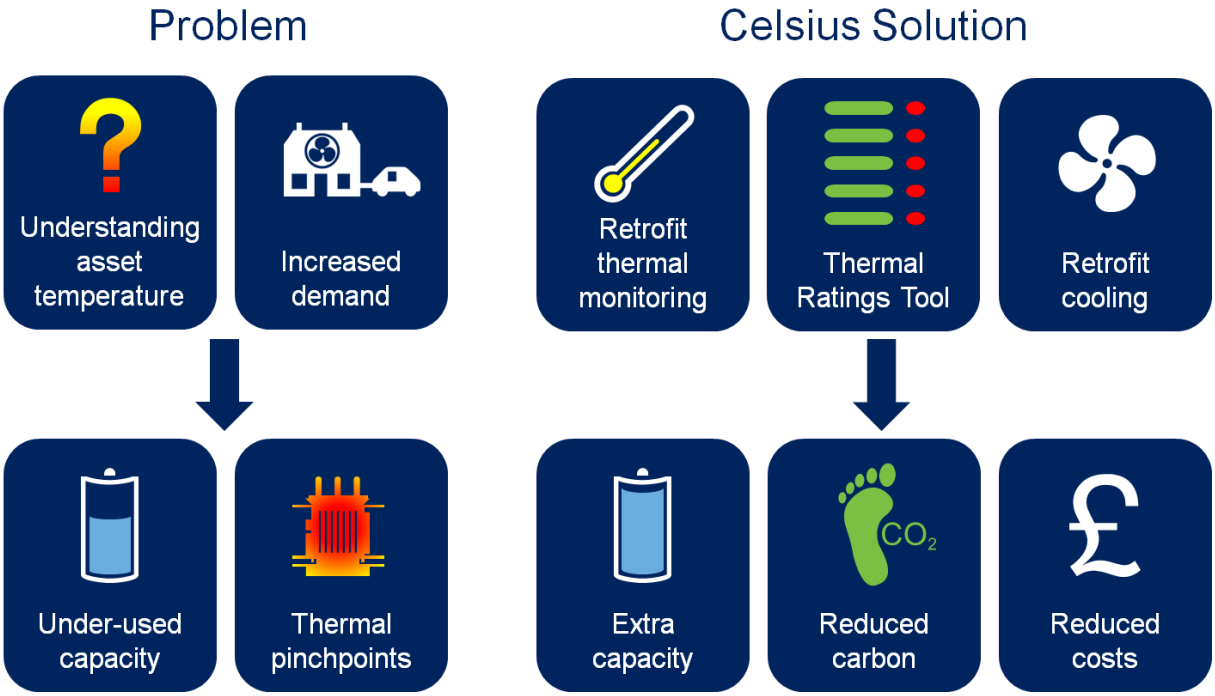
Passive cooling	Cooling produced by the introduction of means of cooling electrical equipment via natural means eg reflective paint, shading from sunlight and the installation of ventilation grills in substation walls and doors
Retrofit cooling	Techniques that can be applied to existing assets to reduce operating temperature
SDRC	Successful delivery reward criteria
Thermal coefficient	The constant by which the external temperature needs to be multiplied to ascertain the hot spot temperature
Thermal constraint	The restriction of an electrical asset's capacity due to the operating temperature
Thermal headroom	The amount of capacity available for use
Thermal Ratings Tool	Software/Microsoft Excel-based solution which will calculate the available capacity at a site, based on inputs of temperature, substation environment and asset type

1 EXECUTIVE SUMMARY

1.1 The Celsius project

Celsius is funded via Ofgem's Network Innovation Competition (NIC) funding mechanism. The project was authorised to commence in December 2015 and is expected to be complete by March 2020.

Celsius explores innovative, cost-effective approaches to managing potentially excessive temperatures at distribution substations, which could otherwise constrain the connection of low carbon technologies (LCTs).



Celsius first seeks to identify potential thermal issues by establishing how different distribution substations in differing environments behave thermally under a variety of load and environmental conditions. Celsius will develop the following methodologies to better understand the real thermal ratings of distribution substation assets to unlock capacity:

- **Retrofit thermal monitoring**: By using improved technology to measure asset and ambient temperatures, and relating these to a range of environmental, load and seasonal factors, Celsius will enable understanding of real thermal ratings of assets, rather than the nominal ratings that are used today. This will allow improved understanding of the amount of latent capacity which could be accessed without further intervention.

- **Thermal Ratings Tool**: the learning from the retrofit thermal monitoring trials and analysis will be formalised and transferred into a simple tool that can be used by operations and planning employees at any network operator, to better understand the capacity of the existing or planned network.

Celsius will then identify, evaluate and demonstrate a range of retrofit cooling technologies that can be used to directly manage the temperature of assets. By managing temperature in this way, Celsius will deliver additional capacity release. Customer surveys will establish customer perception of retrofit cooling techniques and whether the application of these techniques is as acceptable to them as traditional reinforcement.

1.2 Project progress

This is the seventh six-monthly project progress report (PPR) for the Celsius project. This report covers the period from December 2018 to May 2019.

Cooling technology installations

During the last reporting period we have continued to assess the following retrofit cooling techniques/technologies:

- Five outdoor transformers equipped with shades to prevent solar gain
- Ten outdoor transformers painted with anti-solar paint to prevent solar gain
- 20 glass reinforced plastic (GRP) constructed substations fitted with extra passive cooling vents, of which ten also had roofs painted with anti-solar paint to prevent solar gain
- 19 brick-built substations fitted with extra passive cooling vents
- Two unusual brick-built substations fitted with extra passive cooling vents
- Cables at four substations equipped with cable temperature monitoring will be backfilled with thermal backfill in early summer, now that sufficient data has been captured
- Active cooling is installed in 40 substations, 20 positive pressure systems and 20 negative pressure systems.

We have started to analyse the data obtained from these sites. While it is too early to give a full understanding of the effects of the cooling techniques/technology, early analysis has provided some useful information and allowed us to improve our data quality. The analysis highlighted some data gaps and unusual readings which allowed us to investigate and rectify the issues in a timely manner. This provides greater confidence that our data is as complete and accurate as possible, especially before the upcoming warmer months where we expect the cooling to be most effective.

In addition to the cooling techniques applied to the ground-mounted sites, the pole-mounted transformer and buried cable sites were also analysed to check the data quality. This yielded a number of sites where further investigation was required and highlighted issues that needed rectifying.

ASH Wireless – site visit

The data analysis carried out by Ricardo revealed a number of anomalies. Some of these were attributed to faulty equipment that was swiftly replaced on site, but other issues have proved more difficult to rectify. Therefore ASH wireless, the project partner and provider of the measurement equipment, has been asked to investigate and provide an explanation and resolution. This issue affects only a relatively small number of sites, but the investigation should provide useful insight and negate erroneous data capture going forward.

Generation sites

The data analysis also found some unusual results in terms of the power data. Our investigations revealed that some of these sites had distributed generation connected to them, which we need to factor into our analysis. This insight should not have any detrimental impact on the work already carried out, but could provide some useful learning in terms of demand and load profiling.

Thermal Ratings Tool

Further analysis of the calculations and data that feed into the Thermal Ratings Tool has been carried out by Ricardo, with assistance from the University of Southampton. This has produced some significant changes to the tool. This development and validation work is ongoing but it will result in a revision of the temperature behaviour report, which was published in August last year. The revised report will detail all the changes from the initial report.

Business as usual

Consultation with the main business regarding implementation of Celsius techniques into business as usual (BAU) is progressing well. This consultation will establish where Celsius techniques align and support existing processes, ie asset replacement/reinforcement, and ensure that the techniques can be integrated with minimal disruption. It also allows us to identify any potential issues early and take steps to rectify them. All relevant areas of the business have been involved in this consultation, including asset management, design, policy & standards and connections (Energy Solutions). This activity has been supported by our project partner, Ricardo Energy and Environment.

Transition to BAU would likely require changes to the Common Network Asset Indices Methodology (CNAIM), which is a common framework of definitions, principles and calculation methodologies, adopted across all GB distribution network operators (DNO), for the assessment, forecasting and regulatory reporting of asset risk. With this in mind UK Power Networks (a project partner) has been involved in the BAU discussions. This collaboration will ensure that any proposals would be acceptable to other DNOs and are transferable across GB networks.

The broad nature of this consultation has generated useful feedback which is expected to make the transition to BAU easier and more efficient, should the project prove successful.

In addition to considering the integration of Celsius techniques into BAU, we are also generating some interesting learning that will be useful to other areas of the business, such as new substation design (which is expected to benefit from our thermal flow study and ventilation work).

The possibility of obtaining remote maximum demand indicator (MDI) readings from any site with Celsius monitoring equipment fitted, is also being explored. The ability to remotely obtain MDI data would save the time and expense of site visits to check loading, and also provide greater visibility to assess backfeed viability.

Cost benefit analysis

Now that all the costs for the various cooling technology installations are finalised (with the exception of cable backfill) we have started to consider the cost benefit analysis (CBA) for each type of cooling technology/technique. This assessment will be extremely important in the determination of cooling technology selection and viability for BAU. The CBA will cover the cost of the equipment, installation and expected maintenance costs, and will be compared against traditional reinforcement methods. Consideration will also be given to the speed, ease of deployment and the avoidance of customer interruption/inconvenience associated with Celsius techniques.

Passcomm

As a result of noise level associated with this active cooling technology (as reported in the previous project progress report), Passcomm has proposed a re-design of its cooling system, with a smaller, quieter and more efficient unit, which is still able to provide the same level of cooling. This is a positive development which has occurred as a direct consequence of the knowledge attained during this project. The more compact unit should be suitable for installation in more substation scenarios and is less likely to cause noise disturbance to our customers. Manufacture of this unit is under way and will be fitted to suitable substations on

completion. Its cooling effect and acoustic measurements will be compared with those of the original design at the end of the project.

As knowledge of the project is disseminated throughout the business, various departments have contacted the innovation team on discovery of 'hot substations', which might be useful to the project. A number of these have had monitoring equipment fitted (additional to the original project scope) and the most suitable (and most likely to benefit) will be selected to test the new, compact Passcomm unit.

In the last project progress report, it was noted that one of the Passcomm units was re-positioned in a GRP substation with the aim of improving its performance. Since then, we have received a report that a customer has experienced noise disturbance from this site. This issue was identified during the 'test' survey from a customer residing approximately 80 metres away from the substation where the unit is installed. This was unexpected, not only because of the distance, but also because the substation is located next to a main road and on the site of an industrial property (a commercial laundry). This means that the ambient noise in this vicinity is already higher than usual. We have now taken action by changing the fan settings to reduce the noise and the customer has confirmed that this has significantly improved the situation (refer to Section 2.4). However, this has highlighted that noise generated by the laundry itself appears to be in excess of permissible limits, and noise emitting apparatus has been running outside the laundry's stated operation hours. This matter is unrelated to the project and is being investigated by Environmental Health.

Ekkosense

The Ekkosense controller issue highlighted in the last report (risk R023) has now been rectified at all sites. The original temperature control units have been replaced with a different type, which has resolved the issue. In light of the previous fault and the potential for overheating at these sites, the replacement controllers were checked after 30 days to ensure they were still performing correctly before the final payment was made to the manufacturer.

Ricardo Energy and Environment

Ricardo Energy and Environment has been heavily involved in the BAU consultation process. The company has continued to work on the data analysis and has produced a Celsius data summary report, which has been published on the Celsius website.

Financial

The project actual cost-to-date is £4,039,000 and the estimated at-completion cost is £4,953,000 of a planned budget of £5,338,000 (including contingency).

The project is on track to meet its aims, objectives and all SDRC as per the project plan.

1.3 Risks

Project risks are monitored on a continuous basis, including the potential risks that were documented in the full submission. A review of risks is contained in Section 10 and the status of all risks is contained in Appendix A.

There have been a number of changes to the risk log since the last reporting period. This includes one new risk (R025 which concerns potential quality issues with monitoring data), full details of which can be found in Section 10 of this report.

1.4 Learning and dissemination

Details of all learning and dissemination activities conducted in this reporting period are summarised below and included in the communications register in Appendix F.

- Customer contact centre (CCC) briefing to ensure enquiries generated by the test survey were captured and handled appropriately, in accordance with the customer engagement strategy, January 2019.

- Latest Celsius findings were reported to internal and external stakeholders via the Innovation Update newsletter, March 2019.

2 PROJECT MANAGER'S REPORT

2.1 Project background

Celsius will continue to develop an understanding of the operating temperatures of distribution substation assets, including transformers and cables, within a range of substation environments. The project will also deliver alternative, innovative ways to optimise thermal capacity, leading to faster, cheaper responses to the connection of low carbon technologies.

2.2 General

This is the seventh reporting period, mainly focusing on data analysis, investigation and rectification of issues/faults. We have also been working closely with the main business to develop processes for transitioning Celsius into BAU, should it prove a success.

There were two SDRC deliverables in this reporting period which have been successfully completed:

- Publicise Celsius within Electricity North West via the Volt intranet site, email bulletin and/or Newswire company magazine, March 2019.

- Issue project progress report in accordance with Ofgem's December production cycle, June 2019.

The key project management activities undertaken during the reporting period are summarised below:

- **Project monitoring and control:** The monitoring and control of the delivery of the Celsius project is ongoing.

- **Regular engagement with project partners:** The Celsius project team hold a weekly progress update meeting with the project partners to review project actions, risks and issues. Additionally, annual project steering groups are held with key stakeholders.

- **Cooling technology plan/installations:** The installation plan was fully implemented for the active and passive cooling technology contractors. All the cooling technologies have been installed and retrofit cooling data is being monitored (with the exception of the cable backfill which will be completed in the next reporting period). The issue with the temperature control units on Ekkosense installations has now been rectified. These were set at a constant 100% fan speed while the issue was resolved, but they are now operating to their correct temperature profiles. This allows the fan unit to run at different speeds, determined by the temperature of the transformer. The controllers will turn off the fan if the temperature is sufficiently cool. This ensures optimum efficiency of the system and reduces the risk of noise disturbance to local customers.

2.3 Technology, trials and analysis workstreams

The key activities that were undertaken by the technology, trials and analysis workstream during the reporting period December to May 2019 are summarised below:

Retrofit cooling data is now being collected to evaluate the cooling technology.

Data is monitored at all Celsius sites including the cooling sites. This evaluation is in its early stages and the initial assessment of the data collected so far has the following limitations:

- Data was only considered where sites reached 60% utilisation or above. This is because the daily rating calculations are not intended for use below this level. However, further analysis will include this data with stated caution.
- There is no attempt to normalise the data for environmental factors such as ambient temperature or other weather effects. This will form an important part of the full analysis, but has not yet been implemented.
- Additional data will to be collected over the remaining duration of the trials, which will provide further insight into the performance of the technologies in the summer months. This will be included in the ongoing analysis.
- This initial evaluation was conducted to check the accuracy of the data and highlight anomalies.

While it is too early to draw any firm conclusions about the effectiveness of any of the cooling technologies at this stage, the following provides a brief summary of early findings associated with each technology type:

- Ten outdoor distribution transformers were painted with solar reflective paint. The white paint appears to be improving transformer capacity, but we will be able to make a more solid conclusion after examining the data gathered this summer.
- Five outdoor distribution transformers had sun shades erected over them. Shades appear to make some improvement but there is not enough data to draw a solid conclusion. Two of the three remaining sites (after the 60% utilisation filter) appear lightly loaded overall, reducing the amount of data available now and for the future.
- 19 brick-built substations had ventilation improved by the installation of additional vents. Data suggests an improvement in capacity, but not enough time has passed since the installations to draw solid conclusions. We will be able to draw better conclusions later in the year.
- 20 GRP constructed substations had additional vents installed. Data currently presents a mixed picture about effectiveness. Again, there is not enough data to draw firm conclusions but our understanding will be enhanced by the summer data.
- 11 of these sites also had the roofs painted with solar reflective paint. Data currently presents a mixed picture about effectiveness, but there is not enough data at the moment to draw solid conclusions. As above, we anticipate more informed conclusions after the summer data has been analysed.
- Two ‘unusual’ type substations had additional ventilation installed. These substations are older, brick-built constructions with oddly shaped and larger rooms, where ventilation is more complicated. The technology appears to have made some improvement at the one site that was analysed. A better conclusion will be drawn later in the year.
- Four cable backfill sites are planned to be backfilled with a thermally improved backfill. This has been held up due to data quality issues. These issues have now been resolved and the sites will be completed during the next reporting period.

- 20 Passcomm units – positive pressure system. This form of active cooling appears to be improving transformer capacity, but a more solid conclusion will be made after this summer.

- 20 Ekkosense units – negative pressure system. This active cooling technology also appears to be improving capacity, but a more solid conclusion will be made after this summer.

The Celsius asset temperature behaviour report produced by Ricardo Energy and Environment, published on the project website in August 2018, will be updated with the findings arising from the ongoing analysis and the continued consultation with The University of Southampton.

Phase 1 develops a detailed understanding of the operating temperature of assets. This aims to estimate the impact of a range of asset environment factors on the asset rating, which is limited by the operating temperature. The report contains three studies:

- **Transformer hot spot estimation study** – a method was developed to estimate transformer hot spot temperature, the warmest point within the transformer, which is a vital input to later analysis stages but cannot be practically measured directly.

- **Daily thermal ratings study** – in order to compare the thermal behaviour of the wide variety of sites and environmental factors, a daily thermal rating was calculated for each site. This was used as an input into the temperature factors study.

- **Temperature factors study** – a significant number of asset environment and loading factors were assessed to understand their impact on the thermal rating of the transformer. This detailed analysis investigated the relative influence and interaction between factors, as well as their impact on the rating.

This report was influential in the development of the Thermal Ratings Tool. This tool combines input data from the monitoring and cooling trials that can be interpreted in a simple, user-friendly way. The tool enables the thermal ratings of distribution equipment, subject to a range of environments and network conditions, to be evaluated.

This study developed three methods to calculate a more informed thermal rating for low voltage distribution transformers:

- **The simplified Celsius rating** – a simplified way of estimating the daily rating from only nominal rating. This should be used as a first estimate only.

- **The full Celsius rating** – takes into account more temperature factor variables, including transformer characteristics and environment, but no measurement data. It is closer to the full estimated rating, but should not be used as the final estimate to make decisions.

- **The Celsius daily rating** – based on temperature and load data from site, this is a more accurate predictor of ratings. It will vary from day to day, so should be calculated over a number of days to understand thermal behaviour over an extended period.

This tool is functional but is undergoing further development and validation work with assistance from the University of Southampton. Initial findings suggest obtaining a revised rating based on site information only (no physical measurement on site) yields a very low confidence level, as the on-site variables affect the potential rating significantly. Therefore development of the tool is focusing on optimising the accuracy of measured site data. More detail around this will be included in the revised report.

The Celsius cooling data summary report by Ricardo Energy and Environment has been published on the project website. The purpose of this document is to report on the changes made to the data handling system intended to support and accommodate the retrofit cooling technology trial. This includes:

- Update of data collection and back-end data management system
- Changes to data monitoring approach to support retrofit cooling technology trial
- Documentation of the issues encountered, and solutions developed.

Transition to business as usual

Ongoing discussions with the main business regarding the transition of Celsius into BAU have included an evaluation of existing policies and processes, to establish where and how Celsius can be integrated. This exercise has provided very useful insight and learning, which is detailed in the learning outcomes section of this report.

2.4 Customer workstream

The key activities undertaken by the customer workstream, during the reporting period December to May 2019, are summarised below:

- CCC briefed on Celsius prior to commencing 'test survey' fieldwork
- Test customer survey fieldwork conducted
- Adjustment to test survey quotas
- Three further Celsius-related enquiries resolved
- Provisional analysis of Celsius test customer survey (including the investigation of three observations of change, reported in the test survey).

Further customer contact centre briefing (prior to test survey fieldwork)

The customer workstream has continued to work closely with the CCC to ensure that complaints or enquiries associated with any aspect of Celsius are identified. A briefing was issued in January 2019, which was cascaded to all contact centre agents, before the start of 'test survey' fieldwork. This was considered best practice, as it was recognised that direct face-to-face engagement with customers living and working in the immediate vicinity of Celsius intervention sites might highlight previously unreported concerns. The test survey was specifically designed to draw attention to the cooling technique deployed at the substation nearest to each respondent, to ensure that any observation of change or impact was captured. As such, it was important that a robust mechanism was in place to capture and record enquiries generated by the survey, to ensure these were promptly referred to the project team for investigation.

Test customer survey fieldwork conducted

In addition to the strategy outlined above, a separate process was implemented to ensure that our research project partner, Impact Research, immediately informed the project delivery team of any concerns about any aspect of Celsius, raised by survey participants, during the interviews. To comply with the General Data Protection Regulation (GDPR) and the Data Protection Act 2018, Impact Research shared the personal details of these customers, only after obtaining their explicit consent to do so.

As a failsafe, to ensure that respondents had the opportunity and means of directly contacting Electricity North West's project team with any questions, each was provided with a

copy of the Celsius general awareness leaflet. This provided an overview of the project and contact details. This leaflet was handed to every survey participant at the end of their interview, regardless of whether they were part of the educated or uneducated sample.

The 'test' survey began in January 2019. These face-to-face, 'door step' customer interviews sometimes involved revising intervention sites, to secure a sufficient number of interviews with customers who were willing to participate and lived or worked in very close proximity to an intervention substation. This ensured that the views of those likely to be most directly impacted, were captured.

As reported in the previous project progress report, this phase of research was conducted slightly later than originally estimated, due to slippage in the passive retrofit installation programme. This delay had no detrimental impact on the test survey and as previously reported, the delayed fieldwork also ensured that the cooling techniques (specifically the active interventions) had been applied for a reasonable period of time (ie at the settings that would be expected if operating under BAU conditions). This approach gives confidence that customer feedback obtained during this phase of the research is reflective of the actual impact of the cooling techniques.

The customer survey report will be published in September 2019 and will focus on the primary customer workstream hypothesis, that '*customers in the trial areas, who reside or operate businesses in close proximity to the distribution substations, will find the installation of retrofit cooling techniques as acceptable as traditional reinforcement'.* In addition to quantifying acceptability of the various retrofit cooling techniques, the report will include an evaluation of the change in views (if any) associated with the education of customers, to address the secondary hypothesis that *'customers who are educated about the problem that Celsius is seeking to resolve and the benefit of the method, are significantly more likely to find it acceptable'*.

Adjustment to test survey quotas

To test the second customer workstream hypothesis, the aspiration was to re-interview 150 of the 300 included in the 'educated' sample that took part in the baseline survey.

While mitigation was built into the research for attrition, the dropout rate was higher than anticipated and therefore, the test survey involved educating a new sample of customers to provide sufficient numbers to test this hypothesis (discussed further in Section 8 of this report). However, this challenge provided an opportunity to increase the quota size of customers located near to active cooling sites, to maximise the learning from this phase of engagement. This project has demonstrated that domestic customers, residing in close proximity to active cooling sites, are far more likely to notice a change than customers living near to passive intervention sites. Furthermore, these impacts are likely to be far more disruptive. Adjusting the quotas will provide a better and broader understanding of customer perceptions associated with the most disruptive techniques. This revised strategy was also adopted to help shed light on why customers do not appear to be equally impacted by certain interventions.

Customer enquiries/complaints investigated and resolved

Three additional customer enquiries were received about Celsius during this reporting period, which were generated as a direct result of the 'test survey'. These increase the total number of project-related customer enquiries to eight. Each of these was investigated and managed centrally by designated members of the project team. As with previous enquiries, early intervention and appropriate remedial action ensured these were resolved to the customers' satisfaction.

Two of these enquiries were from customers concerned about the authenticity of the research, after being approached to take part in the survey, with the offer of a monetary incentive to do so. These customers were reassured, once the project team had explained

the genuine nature of the research. Conducting on-site surveys was considered the most appropriate research approach for Celsius because it ensured that those most likely to be impacted by the cooling techniques were consulted. It also avoided complications associated with GDPR. However, face-to-face surveys of this nature can raise concerns or suspicion about the authenticity of research, particularly when an approach is made to a potentially vulnerable customer. Refer to learning outcomes in Section 8.

The third enquiry highlighted by the test survey was a noise disturbance issue, which was reported by a customer living approximately 80m away from a substation where a Passcomm unit has been installed. This issue was unexpected considering the substation is located next to a busy main road and on the site of a commercial property (laundry), which operates industrial, noise emitting apparatus including fans and extractors.

The complainant was not initially approached to participate in the survey because interviewers instructed to focus on properties in the immediate vicinity of intervention substations. However, a number of survey participants suggested that it might be prudent to consult this customer, who had previously approached them to establish the source of noise disturbance and ascertain the extent to which other residents were affected. In response to this information, interviewers approached the customer, who then agreed to take part in the survey.

Section 1.2 explains that the Passcomm unit was retrofitted at this site in June 2018 but was relocated to an alternate position inside the substation in August 2018, to improve the airflow across the transformer and the cooling performance of the equipment.

The substation serves a commercial laundry which runs at consistently high load levels on weekdays from 6am to 11pm, resulting in high transformer temperatures.

In response to this complaint, we have made several changes to alter the behaviour of the cooling by modifying various fan settings. These modifications should not significantly affect the daytime running profile of the fans; however, this is not an issue for the customer, as the busy main road and the laundry generate substantially more noise than the Passcomm unit during the day. The customer's primary concern relates to disturbance during the evening and overnight after the laundry closes, when fan noise from the Passcomm system becomes prominent against background ambient levels. The adjusted fan profile means it will only be in operation at high speed for a relatively short time after the laundry is closed and the system will then run at a significantly reduced level throughout the night. These modifications should not detrimentally affect the overall cooling performance at this site and the complainant is now satisfied that the issue of overnight noise disturbance has been resolved.

This situation has highlighted that noise generated by the laundry itself is in breach of statutory limits and extends beyond the company's stated operational hours. This issue is unrelated to the project and the customer is pursuing the matter with the appropriate authorities.

This complaint is unusual in so far as three other survey respondents, who reside nearer to the substation, reported no change or disturbance from the site. This may in part be the result of different levels of tolerance and sensitivity to low frequency noise. It is also possible that respondents who reported no change have a higher threshold, having normalised the 'higher than average' ambient noise associated with the busy main road and the laundry. Our previous investigations into noise associated with the Passcomm units at other sites, suggests that the position of substation vents may also be an influential factor in the way noise is dissipated.

Learning outcomes arising from these issues are documented separately in Section 8 of this report.

Provisional analysis of Celsius test customer survey

Early analysis of the test survey has now begun and the overall findings will be published in the customer survey report in September 2019. These results will be assessed against the outputs of the baseline survey, which was undertaken before the installation of retrofit cooling techniques to provide a comparative measure.

As part of this process we have investigated the following observations of change, highlighted by survey participants:

- During the test survey a customer residing in close proximity to an active cooling (Ekkosense) site reported having previously noticed a continual buzzing noise from the substation, which had now completely stopped. This report has been attributed to the fault with Ekkosense controllers, which has now been resolved. To mitigate this risk of overheating, the controllers had been bypassed to provide maximum cooling, permanently at 100% fan speed. All units have now had the fix applied meaning that the controllers actively adjust fan settings in response to specific temperature profiles.

- A residential customer reported 'an increase in noise and vibrations' from a passive intervention site during the survey. This was unusual because field teams had been unable to secure survey responses from customers adjacent to this site and as such, had extended the survey to include this customer, who resides 60 meters from the site, on the basis that they might have observed changes associated with the additional vents or the painted substation roof. The customer had not supplied a telephone number and the email address provided was erroneous. We attended site but there was no noise apparent at either the substation or in the vicinity of the customer's property. As we have been unable to speak to the customer directly about this matter, we have sent a letter with our contact details to give the customer the opportunity to discuss their concerns with the project team directly. However, we are confident that this issue is unrelated to the Celsius project or the substation in general.

- Finally one survey participant was aware that additional vents had been installed at a passive site. These had no detrimental impact on the customer's perception of the site; however, they requested action to discourage youths from climbing on the structure. This is unrelated to the project and the matter was referred to the appropriate department for assessment.

2.5 Learning and dissemination workstream

The Celsius project team has participated in learning and dissemination events in this reporting period; the key events are:

- Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine, March 2019

- Issue project progress report in accordance with Ofgem's December production cycle, June 2019.

Throughout each reporting period the project team engage with Electricity North West colleagues through various channels including newsletters, company intranet and site briefings.

In the next reporting period, the learning and dissemination workstream will undertake the following activities:

- Publish customer survey report quantifying the acceptability of innovative retrofit cooling techniques on the Celsius website, September 2019

- Publish additional customer survey analysis evaluating the change, if any, in the acceptability of innovative retrofit cooling techniques by educating customers, on the Celsius website, September 2019
- Publish low cost monitoring solution specification on the Celsius website, September 2019
- Publish advertorials annually, October 2019
- Develop and validate Thermal Ratings Tool using retrofit cooling trial data, and publish on Celsius website, November 2019
- Hold annual knowledge sharing events. Provide one-to-one briefing sessions, December 2019
- Publish the cost benefit analysis and carbon impact assessment reports, Celsius business case and buy order of retrofit cooling techniques on Celsius website, December 2019
- Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website, December 2019.

The Celsius communications register that details communications for the current reporting period is detailed in Appendix F.

3 BUSINESS CASE UPDATE

The project team are not aware of any developments that have taken place since the issue of the Celsius project direction that affects the business case for the project.

4 PROGRESS AGAINST PLAN

The project plan is monitored, reviewed and updated on a continuous basis. This process takes into consideration potential risks that were documented in the full submission and any change to these risks. The process also considers newly identified risks and issues that are highlighted during the project lifecycle.

5 PROGRESS AGAINST BUDGET

The project budget as defined in the project direction is shown in Appendix C.

Actual spend to date compared to project budget is summarised in Figure 5.1 below. The report includes expenditure up to and including 31 May 2019. It is noted that the project is currently performing favourably relative to budget. Project expenditure as at the end of May 2019 was £4,039,000 compared to a cost baseline of £4,953,000 including contingency.

In the previous reporting period the variance minus contingency was £406,000. This has now decreased to £258,000; this is for the most part due to the phased payments to project partners (contractors).

Figure 5.1: Summary of project expenditure

Summary Ofgem Cost Category (excluding partner funding)	Spend to date (£'000s)			Total Project		
	Actual	Budget	Variance	Forecast	Budget	Variance
Labour	902	997	95	1,222	1,203	(19)
Equipment	1,287	1,333	46	1,335	1,333	(2)
Contractors	1,438	1,499	61	1,815	1,765	(50)
IT	191	203	12	209	209	0
IPR costs	0	0	0	0	0	0
Travel & expenses	0	0	0	0	0	0
Payments to users	31	31	0	31	31	0
Contingency	77	537	461	77	537	461
Decommissioning	0	0	0	29	29	0
Other	114	158	45	235	230	(5)
Total costs	**4,039**	**4,759**	**719**	**4,953**	**5,338**	**385**

Detailed expenditure is shown in Appendix D at project activity level.

6 BANK ACCOUNT

The Celsius project bank statement is shown in Appendix E. The statement contains all receipts and payments associated with the project up to the end of May 2019.

7 SUCCESSFUL DELIVERY REWARD CRITERIA (SDRC)

There were two SDRCs due in this reporting period, both of which were delivered according to plan; these are shown in Figure 7.1 below.

Figure 7.1: Celsius SDRC due in this reporting period

SDRC evidence	Planned date	Forecast date
LDW.2 – Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine by March 2019	Mar 2019	Delivered
LDW6.7 – Issue project progress reports in accordance with Ofgem's December production cycle and publish on Celsius website	Jun 2019	Delivered

The status of the evidence for all Celsius SDRC is shown in Appendix B. Progress against the SDRC and the project plan will continue to be monitored.

8 LEARNING OUTCOMES

Project application

A lot of the focus for this project has been around the deferral or delay of distribution transformers that may become overloaded or overheat without any intervention. With this in mind, consideration of asset replacement policies and procedures is the natural place to focus our efforts.

While the above is true, there is also a potential for this project to affect the connections (Energy Solutions) part of our business. Should a customer apply for a new connection which takes the existing transformer above its maximum nameplate rating, then a new, higher capacity transformer will be required. The customer will have to pay for a percentage of that new transformer to accommodate their connection.

If the additional load rating can be achieved by applying Celsius techniques to the existing transformer, then the cost of the work would be greatly reduced and the percentage reinforcement payment required from the customer would also be less.

The project was presented to our Energy Solutions colleagues, to explain the process and to highlight any potential issues that might arise from deploying Celsius technology in this way.

The project was well received but some issues were highlighted:

- This department have to quote for work that they are often not awarded. If Celsius is transitioned into BAU, it will necessitate sensors/measurement equipment being installed at the substation and subsequent analysis to assess the viability of cooling techniques. This would be required regardless of whether the work was awarded or not, which would be an additional cost to the company.

- Fitting measurement equipment and carrying out the analysis would take longer than the regulated timescale for issuing quotations, as it currently stands. This is seen as the most challenging barrier as it would require fundamental changes to the regulatory framework governing quotation timescales. The customer could be given the option to wait longer for a quote which could yield a potential saving, or stick to the existing timescales and accept current costs. Current LV connections quotations are subject to the terms of the Guaranteed Standards of Performance, set out in our licence conditions, and have a set timescale of between five and 25 working days depending on the type of connection required, which must be met.

Work will continue with our Energy Solutions colleagues to investigate what changes might be required to the current framework, to transition Celsius into BAU connections processes.

Noise

The noise issue associated with the Passcomm unit situated in the GRP, mentioned above, has presented some interesting learning. The customer who made the complaint lives approximately 80 metres away from the unit, in an area with a high level of ambient noise (next to a main road and opposite a large commercial unit). A number of customers were surveyed that live much closer to the unit and reported no noise disturbance from the site. This highlights the subjectivity of noise disturbance and what causes disturbance to some, goes completely unnoticed by others who may be less sensitive to certain frequencies.

Thermal Ratings Tool

As outlined earlier in the report, the Thermal Ratings Tool was initially intended to be in three different formats. Two of these require information already available (the ‘simplified Celsius rating’ and the ‘full Celsius rating’) and one that requires measurement equipment to be fitted on site (the Celsius ‘daily rating’). From the analysis conducted so far, we have concluded

that the two non-measurement types yield too low a confidence level to be comfortably used. This is due to the on-site variables which cannot be accurately estimated.

While this was initially disappointing, it does mean that the measurement equipment, which has been installed at all Celsius sites, could potentially be used to provide other useful information, such as:

- Remote MDI readings – this would save time and the expense of visiting site to view/reset the current MDIs. Further investigation of this possibility is ongoing
- Remote backfeed viability – similar to the MDI reading, this would enable an engineer to assess the load/capacity on a transformer to check its backfeed viability without having to visit site and fit extra measurement equipment
- Accurate load profiling – load profiles for each site can be analysed
- Demand changes – increases in demand can be seen in near real time. This could provide greater visibility of the LV network, highlight potential overloaded transformers, and, as a consequence, provide more accurate and efficient planning for asset replacement.

Cooling performance

The initial evaluation of thermal data indicates that the vast majority of the cooling sites are showing a reduction in the temperature of the transformer, but with varying levels of success. Unsurprisingly the active cooling sites are showing the greatest reduction in temperature. The highest temperature reduction is at the substation where both a Passcomm unit and an Ekkosense unit are installed (Portland Grove), which proves the theory that they can work together effectively. The plan for this site is to switch each of the units for a period of time, so that the transformer is cooled solely by each of the two systems for a similar period. This exercise will provide a direct comparison in the same substation.

This positive, early finding suggests there may be benefit in deploying both systems in certain substations, to provide even greater capacity release. The scenarios where this would be beneficial from a financial perspective may be rare; however, some substations are situated in places that make the logistics of changing the transformer very difficult and expensive. In these circumstances, this approach could potentially be a better, more cost effective option.

More learning will be obtained over the coming months as more data is captured and the analysis continues.

Data issues

The initial data analysis highlighted a number of issues (missing or incorrect data) that had not previously been identified. Should these anomalies go unnoticed for long periods, it could prove detrimental to the analysis and ultimately the project. As a result of this insight, Ricardo Energy and Environment has been asked to manually check that all the cooling data sites are getting good data every month, to ensure any issues are identified and rectified swiftly. ASH Wireless has also been asked to carry out some on-site investigations, to identify if there is an issue with any of the installations.

Active cooling installations

All of the Celsius sites are fitted with a notice to ensure visitors are aware that Celsius equipment is installed at the substation. In certain circumstances, to accommodate business needs, there may be a requirement to remove Celsius equipment (either temporarily or permanently, depending on the situation). In the vast majority of cases this has not been an issue and operational colleagues have informed the innovation team of any conflicting requirements. However, there has been one occasion where equipment at one of the active

cooling sites was switched off. This was only discovered when a high temperature alert was recorded by the project data handling system.

The Celsius database has the facility to see if the active cooling is running, but there are many occasions when the temperature is sufficiently cool that the unit should not be running. Therefore, simply setting up an alert to flag when the unit is not running would not be sufficient. As mentioned in the data issues section above, Ricardo Energy and Environment will be conducting manual monthly data checks to ensure that all units are running when the temperature warrants it.

Celsius test survey

Background: To test the second customer workstream hypothesis that *'those who are educated about the problem that Celsius is seeking to resolve and the benefit of the method, are significantly more likely to find it acceptable'* the approach was to re-interview 150 of the 300 'educated' customers who took part in the baseline survey. This rationale was expected to provide a sufficient sample of pre-educated customers for the analysis.

Lesson learned: It was expected that there would be a level of attrition between the baseline and test survey and therefore, mitigation was factored into the method. In the event, despite a slightly higher incentive payment (originally £20 in the baseline, increasing to £25 in the test survey, for domestic respondents), it was only possible to re-engage a small number of the original sample because the majority were unable, unwilling or ineligible to participate in the second survey (ie some had moved). In order to achieve the target of 150 'educated' test surveys to test the hypothesis, the sample was increased using a two-phased approach. Firstly, some of the respondents, who participated in the baseline as part of the uneducated sample, were re-contacted and educated about Celsius; secondly, an entirely new sample of customers, with no prior knowledge of the project, were recruited and educated, enabling them to provide informed responses.

Future projects, which require repeated engagement, should consider the approach adopted in Electricity North West's Second Tier LCN project, CLASS, which had a much lower rate of attrition. This was likely to have been influenced by higher incentivisation, again weighted with increasingly higher value payments offered as the research progressed. This was combined with an effective communication strategy, which was maintained throughout the trial period, via regular newsletters and website updates.

Background: To assess customer perceptions of the impact of the Celsius techniques, it was necessary to recruit customers residing or working in the immediate vicinity of the intervention sites. To comply with GDPR and negate issues concerning data sharing, these surveys were conducted face-to face, on the doorstep.

Lesson learned: Fieldwork researchers, conducting the interviews on behalf of Electricity North West, 'cold-called' customers from properties close to substations where cooling techniques had been applied. They first introduced the research and provided potential participants with a letter of introduction which contained the project team's contact details, should the customer require more information or reassurance that the research was genuine. While the research was conducted in strict compliance with the Market Research Code of Conduct, we were contacted by a relative of an elderly customer who was concerned that personal data had been requested in exchange for a financial incentive. This complaint was amicably resolved when the complainant was informed about the nature of the research and the professional standards followed by the interviewers. However, it does introduce questions about the appropriateness of this type of research approach, when engaging elderly or vulnerable customers who may not necessarily fully understand or be in a position to provide informed consent.

9 INTELLECTUAL PROPERTY RIGHTS (IPR)

Electricity North West is following the default IPR arrangements. No IPR have been generated or registered during the reporting period. The IPR implications of forthcoming project deliverables are currently being considered, and will be reported in the next project progress report.

10 RISK MANAGEMENT

Electricity North West employs recognised tested and audited risk management systems and processes as part of its day-to-day operations. Celsius benefits from this approach, which is further refined to fully accommodate the requirements of Celsius and to incorporate learning from previous experience in the delivery of LCN Fund and NIC projects. This approach considers risks and issues that are business as usual and those specifically related to Celsius, all of which are documented in a common format.

The project risks identified in the Celsius bid document have been migrated into the Celsius delivery risk register, reviewed and are still valid. Risks are monitored on a continuous basis, including the potential risks that were documented in the full submission. Project risks are described in detail in Appendix A.

Changes since the last reporting period:

R019: LV loading of cables

There is a risk that the LV loading of cables and transformers to improve data quality will be delayed due to lack of operational resource.

The risk to the project is to be mitigated by using Electricity North West operational teams whenever possible to carry out the operational procedures necessary.

Update: The risk is closed. LV loading was successfully carried out by Electricity North West operational teams.

R022: Grid Key maps

There is a risk that there will be a delay in receiving load data because the iHost server in Electricity North West's control centre is not configured to receive data from the cables in the substations.

All commissioning sheets of the Grid Key units have been re-sent to the appropriate IT engineers so that reconfiguration can be carried out. Some additional site work is being conducted to further validate the data being sent.

Update: The risk is closed. Configuration has been completed successfully.

R023: Ekkosense control equipment problematic

There is a risk that the retrofit cooling plan will be delayed since the Ekkosense control equipment will not perform to its specification.

Ekkosense is in consultation with the suppliers of the control units. The fault is proving to be difficult to rectify due to its intermittent nature. Ekkosense is actively working to resolve the issue.

Update: The risk is closed. Ekkosense has replaced the temperature control units at all sites for a different type which is performing as required.

NEW RISKS IDENTIFIED

R025: Potential data quality issues with monitoring data

There is a risk that cooling data could be missing/inaccurate.

Analysis of cooling data has highlighted a few data issues which have required intervention/ site visits to rectify.

Ricardo will now manually check the data monthly to ensure any further issues are identified and fixed in a timely manner.

ASH Wireless has been requested to visit some of the problem sites with Electricity North West to ensure there are no underlying issues going forward.

11 CONSISTENCY WITH FULL SUBMISSION

At the end of this reporting period, it can be confirmed that the Celsius project is being undertaken in accordance with the full submission.

12 ACCURACY ASSURANCE STATEMENT

This document has been reviewed by a number of key business stakeholders. The project team and select members of the Celsius project steering group, including the lead member of the bid development team, have reviewed the report to ensure its accuracy. The narrative has also been peer-reviewed by the Electricity North West engineering and technical director.

The financial information has been produced by the Celsius project manager and the project's finance representative who review all financial postings to the project each month to ensure postings are correctly allocated to the appropriate project activity. The financial information has also been peer-reviewed by the Electricity North West finance manager.

The engineering and technical director has approved issue of this document.

13 APPENDICES

Appendix A: Status of all risks

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
R001	Project partner mobilisation	Mobilisation	There is a risk that the project partners are not able to mobilise their resources in time because of other commitments leading to a delay in achieving potential milestones, which could have a project reputation and financial repercussion.	0	0	Suitable partnership agreements that ensure collaborative working, value for customers' money and achievement of learning objectives in a timely manner have been identified for all partners. A project initiation document will be issued to the project partners to ensure that all parties are ready. Contingency: Electricity North West will seek new partners should existing partners fail to mobilise. Risk closed December 2016 following successful mobilisation.	0	0	Closed
R002	Thermal sensor lead time	Technology	There is a risk that the lead-time for delivery, installation and/or configuration of the thermal monitoring sensors may lead to a delayed start on the monitoring trial.	0	0	Project plan specifies that a purchase order will be raised to procure the sensors allowing the partner to begin manufacture. Regular meetings/reports to track progress against plan. Commitment to additional operational resource should any delays occur to the installation, testing and commissioning programme. Contingency: Flexibility is built into the installation programme; phased installation plan starts in autumn 2016 to be completed by spring 2017.	0	0	Closed

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
						A full year's data for comparison with the cooling trial could be gained by overlapping these tasks more than planned. Risk closed October 2016 when installation commenced.			
R003	Inadequate existing load monitoring	Technology	There is a risk that sites with existing load monitoring may not be suitable or the existing monitoring units may require a software/ hardware update for the sites to be included in the Celsius project.	0	0	Allowance in budget and plans to move some existing load monitors if necessary. Communications with manufacturers of existing equipment to identify solutions early. Allowance in budget and plans to carry out updates. Contingency: New power monitoring units, supplied by project partner Ash Wireless will be installed where this is deemed most cost-effective. Risk closed December 2016 – existing load monitoring units were found to be unsuitable and planned contingency was initiated.	0	0	Closed
R004	Monitoring equipment reliability	Technology	There is a risk of monitoring equipment failure leading to a requirement for additional resource to attend site to fix or replace.	2	4	Phased rollout of equipment to ensure systems are working properly before all sites are installed. Some remote monitoring and diagnostics will be possible, for example of performance of the communications and through data validation. Contingency: Budget for additional resource. Update: Impact reduced to moderate due to large amount of trial data successfully gathered	2	3	Open

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
R005	Project installation impact on BAU	Technology	There is a risk that internal transformer monitoring or retrofit cooling methods (and their installation) may have an impact on the network as a whole leading to disruption or outage. Probability is low (1) due to successful testing and rollout.	1	5	The technical and installation issues and requirements will be assessed before any installation is carried out, which should identify any risk at an early stage to allow this to be mitigated, or for the technology to be discounted from the trial. Contingency: If any issues occur, then the technology will be removed and made good at the earliest signs.	1	5	Open
R006	Poor communi-cations signal coverage	Technology	There is a risk that there is inadequate signal at sites and communication outages or battery life issues could prevent data being sent to data management system for the duration leading to gaps in data sets.	2	2	The data communications will use 'roaming' SIM cards, the signal will be checked prior to installation, if required an aerial will be installed. If inadequate signal the site will be excluded from the trial. Data will be sent once a day, any failures to send data will be identified automatically and corrected. Data being received will be continuously validated to identify missing or unrealistic data, so issues will be identified quickly. Battery life requirements have been defined and agreed at an early stage. Contingency: Select sites without signal issues. Where gaps in data occur, analysis can be carried out on the remaining data; where necessary, missing data will be simulated. Sensors that are still required will be replaced.	2	2	Open

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
R007	Availability of technology providers	Technology	There is a risk that a lack of suitable retrofit cooling technologies and vendors may result in a poor response to invitations to tenders, leading to reduced competitiveness of quotes and reduced value for money. Impact set to moderate (3) due to good response from call for innovation**.**	2	3	A call for innovation in Celsius development showed that products are available from a number of vendors. A thorough market search will identify as many options as possible. Contingency: Early vendor engagement. If there is significant difficulty in identifying enough suitable technology vendors, then the cooling trial can be implemented with fewer technology types. Risk now closed – Invitations to tender led to sufficient providers being selected to install suitable cooling technologies.	2	3	Closed
R008	Installation delay of cooling technologies	Technology	There is a risk that the lead-time for the retrofit cooling techniques may lead to a delay in the installation of this technology and delay the start of the monitoring trial.	3	4	During technology selection, each technology will be assessed based on a number of characteristics, including readiness and deployment issues. This will reveal early potential issues. Contingency: Flexibility is built into the installation programme with a phased installation plan starting in winter 2018 to be completed by summer 2018. If delays are unavoidable, then technology analysis could be carried out using less than one year's data. The limitations to the assessment caused by this will be identified. Retrofit cooling technology companies appointed and scheduled for installation to be complete to plan.	3	4	Closed

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
R009	Customer impact of retro fit technology	Customer	There is a risk that customers on trial networks might notice a visual or audible affect from a local retrofit intervention, or be inconvenienced during the installation of the technology. This risk might result in a breakdown in customer relationship and reputation.	3	4	To ensure that there is no public or reputation damage to Electricity North West; Celsius will embed a process to quickly and appropriately manage any customer impacts. Contingency: Customer impact will be carefully considered during site selection. This will mitigate against deploying specific interventions on certain networks where the risk of an adverse customer impact, specific to the customer/network/asset/ environment type, from a particular technique, is considered excessively high.	3	4	Open
R010	Attendance at project events	Learning dissemination	There is a risk that attendance at events may be low due to the number of projects and knowledge dissemination events already taking place. Learning may be inhibited due to stakeholders having different interests and learning styles	2	3	Electricity North West will try where possible to merge dissemination events and choose dissemination channels optimised to achieve maximum reach and coverage. Dissemination will be carried out through multiple communication channels including 121 briefings Contingency: Interested parties are able to contact the project team for any queries and request additional information.	2	3	Open
R011	Governance changes	Closedown	There is a risk that new obligations and guidance will be released on key deliverables, such as the closedown report (eg the need	3	3	Communication channels from Ofgem will be monitored and any updates to such requirements identified as early as possible. Contingency: Additional time is allowed for closedown reporting and a	3	3	Open

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
			to get it peer-reviewed) leading to a longer preparation and review period required.			DNO partner embedded in the project to provide ongoing review and challenge throughout project delivery.			
R012	Project progress report	Project Management	There is a risk that the financial reporting contained in the six-monthly project progress report (PPR) may be inaccurate due to the requirement to submit the document on the 9th of each reporting month. Electricity North West's finance system compiles project costs on the fifth working day of the subsequent month. This results in a small window for internal approval before release to Ofgem.	3	4	The risk has been highlighted to the Electricity North West finance team and the approval managers, and a delivery plan is agreed for each reporting period however there is still a risk that all finances are not up to date for the last month of the reporting period. This has been brought to the attention of Ofgem. Several reports have now been issued with the financial information up-to-date.	3	4	Open
R013	Retrofit monitoring resource	Project Management	There is a risk that there is limited resource available to deliver the installation of retrofit monitoring. This may lead to a prolonged installation plan or to	4	4	Two teams have been acquired for the installation period and we are seeking a third team. The installation plan is based upon two installation teams, working normal hours. If a third team is sourced this will reduce the likelihood of this risk. Also if there is any delay to the plan there is the option for premium time working to	4	4	Closed

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
			increased cost due to premium time working.			increase outputs and catch up with the plan. Update: Closed due to completion of monitoring installation. Risk closed.			
R014	Monitoring equipment firmware updates	Technology	There is a risk that the monitoring equipment software will need updating due to unforeseen bugs arising during the monitoring trial.	3	4	To reduce the impact of this risk, project partners ASH increased the functionality of the HUB monitoring device to allow for over the air (OTA) software upgrades. This has been tried and tested successfully.	2	4	Open
R015	Cooling technology effectiveness	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that some of the cooling technologies deployed will have little impact, resulting in reduced learning.	2	4	Electricity North West is working with Ricardo to test a number of the cooling technologies in a lab environment prior to deploying onto the network. Ricardo will produce a test report with recommendations for deployment. A report documenting the findings and passive cooling technologies recommendations (dated 24 January 2018) is published on the Celsius website.	2	4	Open
R016	Availability of operational resources.	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that operational resources may not be available to supervise the cooling installation contractors working in live substations. This would have the effect of delaying the retrofit active cooling	2	4	By negotiating a new contract with an outside agency and agreeing the programme of work this risk should be mitigated. The contract has now been negotiated and operational resource is now available. The risk remains open until the work is complete.	1	4	Closed

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
			work beyond the intended deadline of June 2018.			The work is now complete and risk has been mitigated. Risk closed.			
R017	Completion of the thermal flow study by NPL	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the National Physical Laboratory will not complete the thermal flow study step 2 ('Thermal Flow Modelling Work phase 2') by end-May 2018. This has the effect of potentially delaying the retrofit passive cooling work at 20 substations beyond the intended deadline of end of June 2018.	4	2	By issuing a section of the work earlier and by making use of additional resources to implement the passive cooling work this risk should be mitigated. NPL has now issued the final report on the 31 May 2018. Risk closed.	4	2	Closed
R018	Temperature factors report data will not provide sufficient understanding of thermal behaviour.	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the Secondary Network Asset Temperature Factors Report will not provide a detailed understanding of the thermal behaviour of substation assets (in particular LV cables and transformers) under different asset environment conditions.	4	4	This risk to the project is the subject of ongoing discussions between Electricity North West and Ricardo so that strategies may be developed to overcome this problem. The Temperature Factors Report has been issued and reviewed. It meets with our requirements. Risk closed.	4	4	Closed
R019	LV loading of cables and	Technology / Trials &	There is a risk that the LV loading of	3	3	The risk to the project will be mitigated by using Electricity North	2	2	Closed

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
	transformers will be delayed due to lack of operational resource	Analysis /Learning & Dissemination	cables and transformers to improve data quality will be delayed due to lack of operational resource			West operational teams whenever possible, to carry out the operational procedures necessary. 50% of the loadings were carried out during June and July to increase the loading of smart transformers in particular, to ensure that enough quality data was available to enable the hot spot temperature report to be published. Other loading is continuing. Loading requirements completed by Electricity North West operational teams. Risk closed.			
R020	Two UKPN sites delayed	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the two UK Power Networks cooling sites will not be completed in time to be properly assessed.	3	3	Electricity North West solicitor to engage further with the UK Power Networks' solicitor to encourage a timely solution. UK Power Networks has indicated that it cannot complete the legal requirements in a timely manner therefore the units have been installed in Electricity North West's region. Risk closed.	3	3	Closed
R021	Cooling fan failure	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that if the forced cooling fans fail, the substation temperatures may become excessive. This is further exacerbated by the fact that some existing passive vents need to be	2	2	Utilising the Electrotech NX12 RTU as a method of remotely sending a cooling fail alarm is being designed to mitigate the problem.	2	2	Open

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
			blocked off to allow optimal airflow for the active cooling unit.						
R022	Grid Key maps	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that there will be a delay in receiving load (amps) data because the iHost server located in Electricity North West's control centre is not configured to receive data from the cables in the substations.	3	3	All commissioning sheets of the Grid Key units have been resent to the appropriate IT engineers to ensure that reconfiguration can be carried out and site data also being validated. Configuration completed successfully. Risk closed.	3	3	Closed
R023	Ekkosense control equipment instability	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the retrofit cooling plan will be delayed since the Ekkosense control equipment will not perform to its specification.	3	3	Ekkosense is in consultation with the suppliers of the control units. Suspect induced voltages between the mains supply and control cables. The Ekkosense units have however been set to 100% fan speed in the interim – which will provide good cooling data short term. Contingency: The sum of £69,300 has been withheld from Ekkosense until this matter is remedied Temperature control units have been replaced at all sites with a different type of unit which is functioning correctly. Risk closed.	2	2	Closed
R024	Installation of cooling	Technology / Trials &	There is a risk that the monitoring data	3	3	In some instances the position of Passcomm units is being changed to	3	3	Closed

Risk register ID	Risk title	Project phase/ workstream	Description	Probability score	Impact score	Mitigating action/contingency action	Revised probability score	Revised impact score	Status
	equipment not effective	Analysis /Learning & Dissemination	will be inconsistent as some of the retrofit cooling equipment was not installed in the optimal position due to substation configuration restraints.			more effectively cool the transformer. In some instances the Ekkosense venting hoses are being reinstalled to more effectively cool the transformer and in three instances sub-optimal Ekkosense installations are being modified. The necessary adjustments have now been made to make the installations as effective as possible. Risk closed.			
R025	Potential data quality issues with monitoring data	Technology	There is a risk that cooling data could be missing/ inaccurate. Analysis of cooling data has highlighted a few data issues which have required intervention/site visits to rectify.	2	3	Ricardo will now manually check the data fortnightly to ensure any further issues are identified and fixed in a timely manner. ASH Wireless has been requested to visit some of the problem sites with Electricity North West to ensure there are no underlying issues going forward.	1	3	Open

Appendix B: Summary of project SDRC

SDRC evidence	Planned date	Status
CW.1 – Send customer engagement plan and data privacy statement to Ofgem by June 2016	Jun-16	Delivered
LDW.2.1 – Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine by June 2016, March 2017, March 2018, March 2019 and March 2020	Jun-16	Delivered
LDW.6.1 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Jun-16	Delivered
LDW.1 – Launch Celsius project website by July 2016	Jul-16	Delivered
LDW.5.1 – Hold annual knowledge sharing events in September 2016, 2017, 2018 and December 2019. Provide one-to-one briefing sessions	Sep-16	Delivered
LDW.3.1 – Publish advertorials annually by October 2016, October 2017, October 2018 and October 2019	Oct-16	Delivered
LDW.4.1 – Participate at four annual LCNI conferences from 2016 to 2019	Nov-16	Delivered
CI.3.1 – ENA workshop with DNOs held by November 2016 (to agree areas of changes to Engineering Recommendations P15 and P17)	Nov-16	Delivered
LDW.6.2 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Dec-16	Delivered
CI.3.2 – Publish any areas for change identified at the ENA workshop and publish change proposal options to ER P15 and ENA ER P17 on Celsius website by February 2017	Feb-17	Delivered
LDW.2.2 – Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine by June 2016, March 2017, March 2018, March 2019 and March 2020	Mar-17	Delivered
TW.2.1 – Hold retrofit cooling workshop by May 2017	May-17	Delivered
LDW.6.3 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Jun-17	Delivered
TW.2.2 – Review of highest scoring technologies, circulate workshop outcomes to DNOs and publish on the Celsius website by July 2017	Jul-17	Delivered
CW.2.1 – Deliver customer focus group workshop by July 2017	Jul-17	Delivered
TW.1 – Publish equipment specifications and installation reports by September 2017	Sep-17	Delivered
LDW.5.2 – Hold annual knowledge sharing events in September 2016, 2017, 2018 and December 2019. Provide one-to-one briefing sessions	Sep-17	Delivered

SDRC evidence	Planned date	Status
LDW.3.2 – Publish advertorials annually by October 2016, October 2017, October 2018 and October 2019	Oct-17	Delivered
TAW.2 – Publish thermal flow study report and initial recommendations for substation design on Celsius website by November 2017	Nov-17	Delivered
LDW.4.2 – Participate at four annual LCNI conferences from 2016 to 2019	Nov-17	Delivered
CW.2.2 – Publish lessons learned from testing customer communication materials on Celsius website by December 2017	Dec-17	Delivered
LDW.6.4 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Dec-17	Delivered
LDW.2.3 – Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine by June 2016, March 2017, March 2018, March 2019 and March 2020	Mar-18	Delivered
LDW.6.5 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Jun-18	Delivered
TAW.1.1 – Raw temperature monitoring data to be available from July 2017; and retrofit cooling monitoring data to be available from September 2018	Sep-18	Delivered
TAW.1.2 – Publish asset temperature behaviour analysis report on Celsius website by September 2018	Sep-18	Delivered
LDW.5.3 – Hold annual knowledge sharing events in September 2016, 2017, 2018 and December 2019. Provide one-to-one briefing sessions	Sep-18	Delivered
TAW.4.1 – Develop Thermal Ratings Tool using monitoring data to evaluate site capacity on Celsius substations by October 2018	Oct-18	Delivered
TAW.6 – Publish asset health study report on Celsius website by October 2018	Oct-18	Delivered
LDW.3.3 – Publish advertorials annually by October 2016, October 2017, October 2018 and October 2019	Oct-18	Delivered
TW.3 – Publish cooling equipment specifications and installation reports by November 2018	Nov-18	Delivered
LDW.4.3 – Participate at four annual LCNI conferences from 2016 to 2019	Nov-18	Delivered
LDW.6.6 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Dec-18	Delivered
LDW.2.4 – Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine by June 2016, March 2017, March 2018, March 2019 and March 2020	Mar-19	Delivered

SDRC evidence	Planned date	Status
LDW.6.7 – Issue project progress reports in accordance with Ofgem's June and December production cycle and publish on the Celsius website	Jun-19	Delivered
CW.3.1 – Publish customer survey report quantifying the acceptability of innovative retrofit cooling techniques on the Celsius website by September 2019	Sep-19	On track
CW.3.2 – Publish additional customer survey analysis evaluating the change, if any, in the acceptability of innovative retrofit cooling techniques by educating customers, on the Celsius website by September 2019	Sep-19	On track
TAW.3 – Publish low cost monitoring solution specification on the Celsius website by September 2019	Sep-19	On track
LDW.3.4 – Publish advertorials annually by October 2016, October 2017, October 2018 and October 2019	Oct-19	On track
TAW.4.2 – Develop and validate Thermal Ratings Tool using retrofit cooling trial data, and publish on Celsius website by November 2019	Nov-19	On track
LDW.4.4 – Participate at four annual LCNI conferences from 2016 to 2019	Nov-19	On track
TAW.5 – Publish the cost benefit analysis and carbon impact assessment reports, Celsius business case and buy order of retrofit cooling techniques on Celsius website by December 2019	Dec-19	On track
LDW.5.4 – Hold annual knowledge sharing events in September 2016, 2017, 2018 and December 2019. Provide one-to-one briefing sessions	Dec-19	On track
TAW.4.3 – Develop and validate Thermal Ratings Tool, combining input data from the monitoring and cooling trials, and publish user guide on Celsius website by January 2020	Jan-20	On track
CI.1.1 – Produce Celsius closedown report by January 2020	Jan-20	On track
CI.3.3 – Incorporate relevant Celsius outputs into change proposal options for ER P15 and ER P17 and hold workshop with DNOs by January 2020	Jan-20	On track
LDW.2.5 – Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine by June 2016, March 2017, March 2018, March 2019 and March 2020	Mar-20	On track
CI.1.2 – Complete and publish peer review of Celsius closedown report by March 2020	Mar-20	On track
CI.2 – Publish Electricity North West's approach to managing thermal constraints at distribution substations on the Celsius website by March 2020 and train planners/operational engineers on new codes of practice	Mar-20	On track
CI.3.4 – Submit proposals for changing ER P15 and ER P17 to ENFG by March 2020	Mar-20	On track

Appendix C: Project direction budget

Project direction ref: ENWL / Celsius / 9 December 2015, Annex 1: Project budget

Cost Category	Cost (£)
Labour	1,203,362.07
Equipment	1,333,237.01
Contractors	1,764,545.12
IT	209,136.13
IPR Costs	0
Travel & Expenses	0
Payments to users	30,815.94
Contingency	537,250.86
Decommissioning	29,357.76
Other	230,089.50
Total	**5,337,794.39**

£000's Excluding Partner Funding Ofgem Cost Category	
Labour	**1,203**
Labour - project management	469
Labour - general	288
Labour - installation/commissioning	446
Equipment	**1,333**
Equipment - Materials	349
Equipment - General	-
Equipment - Monitoring Equipment	984
Contractors	**1,765**
Contractor - Project management	74
Contractor - Close Out	25
Contractor - Technology	663
Contractor - Trials & Analysis	515
Contractor - Thermal Flow Study	97
Contractor - BAU Process & Tool	165
Contractor - Customer Survey	116
Contractor - Customer Engagement Activities	53
Contractor - Cost Benefit Analysis	32
Contractor - Dissemination Activities	24
IT	**209**
IT - Hardware	-
IT - Software	209
IPR costs	**-**
IPR costs	-
Travel & Expenses	**-**
Travel & Expenses	-
Payments to users	**31**
Payments to users - Customer Survey	31
Contingency	**537**
Contingency	537
Decommissioning	**29**
Decommissioning	29
Other	**230**
Other - Rent	57
Other - Dissemination Activities	149
Other - Other	-
Other - DNO Workshop	24
Total Project to date	**5,338**

Appendix D: Detailed project expenditure

£'000s Excluding Partner Funding Ofgem Cost Category	Spend to date			Total Project		
	Actual	Plan	Variance	Forecast	Plan	Variance
Labour	**902**	**997**	**95**	**1,222**	**1,203**	**(19)**
Labour - project management	299	368	68	468	469	1
Labour - general	138	198	61	289	288	(1)
Labour - installation/commissioning	464	431	(34)	465	446	(19)
Equipment	**1,287**	**1,333**	**46**	**1,335**	**1,333**	**(2)**
Equipment - Materials	302	349	47	350	349	(1)
Equipment - General	0	0	0	0	0	0
Equipment - Monitoring Equipment	986	984	(1)	986	984	(1)
Contractors	**1,438**	**1,499**	**61**	**1,815**	**1,765**	**(50)**
Contractor - Project management	42	53	12	77	74	(3)
Contractor - Close Out	0	2	2	25	25	0
Contractor - Technology	767	660	(107)	693	663	(30)
Contractor - Trials & Analysis	333	461	128	531	515	(16)
Contractor - Thermal Flow Study	91	97	6	91	97	6
Contractor - BAU Process & Tool	73	66	(7)	165	165	(0)
Contractor - Customer Survey	85	91	6	121	116	(5)
Contractor - Customer Engagement Activities	33	45	12	55	53	(2)
Contractor - Cost Benefit Analysis	0	3	3	32	32	0
Contractor - Dissemination Activities	14	20	6	24	24	(0)
IT	**191**	**203**	**12**	**209**	**209**	**0**
IT - Hardware	0	0	0	0	0	0
IT - Software	191	203	12	209	209	0
IPR costs	**0**	**0**	**0**	**0**	**0**	**0**
IPR costs	0	0	0	0	0	0
Travel & Expenses	**0**	**0**	**0**	**0**	**0**	**0**
Travel & Expenses	0	0	0	0	0	0
Payments to users	**31**	**31**	**0**	**31**	**31**	**0**
Payments to users - Customer Survey	31	31	0	31	31	0
Contingency	**77**	**537**	**461**	**77**	**537**	**461**
Contingency	77	537	461	77	537	461
Decommissioning	**0**	**0**	**0**	**29**	**29**	**0**
Decommissioning	0	0	0	29	29	0
Other	**114**	**158**	**45**	**235**	**230**	**(5)**
Other - Rent	15	23	8	57	57	(0)
Other - Dissemination Activities	91	119	28	153	149	(4)
Other - Other	0	0	0	0	0	0
Other - DNO Workshop	8	16	8	24	24	0
Total	**4,039**	**4,759**	**719**	**4,953**	**5,338**	**385**

£'000s Excluding Partner Funding Ofgem Cost Category	Spend to date			Total Project		
	Actual	Plan	Variance	Forecast	Plan	Variance
Labour	902	997	95	1,222	1,203	(19)
Equipment	1,287	1,333	46	1,335	1,333	(2)
Contractors	1,438	1,499	61	1,815	1,765	(50)
IT	191	203	12	209	209	0
IPR Costs	0	0	0	0	0	0
Travel & Expenses	0	0	0	0	0	0
Payments to Users	31	31	0	31	31	0
Contingency	77	537	461	77	537	461
Decommissioning	0	0	0	29	29	0
Other	114	158	45	235	230	(5)
Total	**4,039**	**4,759**	**719**	**4,953**	**5,338**	**385**

Appendix E: Project bank account

The bank statement below details all transactions relevant to the project in this reporting period. This includes all receipts and payments associated with the project effective up to the May 2019 month-end reporting period.

Date	Type	Narrative	Value Date	Payments	Receipts	Balance
03DEC18		Opening Ledger Balance				2,247,569.04 Cr
05DEC18	DR	TO A/C TFR 02749020 300002		157,238.49		2,090,330.55 Cr
05DEC18	DR	TO A/C TFR 02749020 300002		84,287.25		2,006,043.30 Cr
05DEC18	DR	TO A/C TFR 02749020 300002		119,913.80		1,886,129.50 Cr
05DEC18	DR	TO A/C TFR 02749020 300002		128,727.52		1,757,401.98 Cr
05DEC18	DR	TO A/C TFR 02749020 300002		37,118.03		1,720,283.95 Cr
05DEC18	DR	TO A/C TFR 02749020 300002		24,498.98		1,695,784.97 Cr
10DEC18	CR	INTEREST (GROSS)			1,272.73	1,697,057.70 Cr
09JAN19	CR	INTEREST (GROSS)			976.39	1,698,034.09 Cr
11FEB19	CR	INTEREST (GROSS)			1,074.65	1,699,108.74 Cr
11MAR19	CR	INTEREST (GROSS)			912.40	1,700,021.14 Cr
09APR19	CR	INTEREST (GROSS)			945.49	1,700,966.63 Cr
09MAY19	CR	INTEREST (GROSS)			978.64	1,701,945.27 Cr
16MAY19	DR	TO A/C TFR 02749020 300002		145,072.38		1,556,872.89 Cr
16MAY19	DR	TO A/C TFR 02749020 300002		8,301.44		1,548,571.45 Cr
16MAY19	DR	TO A/C TFR 02749020 300002		45,547.89		1,503,023.56 Cr
16MAY19	DR	TO A/C TFR 02749020 300002		70,669.07		1,432,354.49 Cr
04JUN19	DR	TO A/C TFR 02749020 300002		65,540.67		1,366,813.82 Cr
04JUN19	DR	TO A/C TFR 02749020 300002		97,562.22		1,269,251.60 Cr
04JUN19		Value of Credits (6)			6,160.30	
04JUN19		Value of Debits (12)		984,477.74		
04JUN19		Closing Ledger Balance				1,269,251.60 Cr
04JUN19		Closing Cleared Balance				1,269,251.60 Cr

Appendix F: Celsius communications register

The below updates have been added to the Celsius communications register for the reporting period up to May 2019.

Date	Activity	Audience	Evidence
Jan 2019	Customer contact centre briefing	Contact centre colleagues	*Evidence on file*
Mar 2019	Industry newsletter	All stakeholders	Newsletter page
Mar 2019	Article in Connect bulletin	All employees	

Connect
The weekly bulletin for our people
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ISSUE 245 22 March 2019

LATEST NEWS

Celsius project hots up

We're only part-way through our pioneering Celsius project, but it's already 'business as usual' for one of our new cooling techniques.

As part the project we've installed a range of techniques at a hundred substations across the region which will help prepare our network for renewable energy and keep costs down for customers. Techniques such as improved ventilation, heat extraction fans and alternative kinds of backfill material for underground cables are helping to cool down substations and maximise the use of our assets.

Project manager Delroy Ainsworth said: "As well as the Celsius trial sites, we've installed one of our 'Passcomm' units at a substation in Manchester to help cool down a transformer which was starting to over-heat. We're now working to identify another site to install a redesigned Passcomm unit which is smaller and more efficient but still provides the same cooling effect.

"We're only part-way through the trials, but we're already able to demonstrate that the cooling techniques can be used effectively – which is great news. We're now starting to incorporate Celsius techniques into our business as usual processes."

Throughout the trials we're gathering data from the trial substations to understand which of the different techniques are most effective and how the environment and temperature affect our electrical equipment.

At the same time we're also carrying out a series of surveys to find out what customers living or working near to the substations think of the new techniques. The final phase of this research is under way which will help us to decide which of the Celsius techniques are most suitable under different network and environmental conditions.

Find out more on our website or if you have an idea for an innovation project please contact us.