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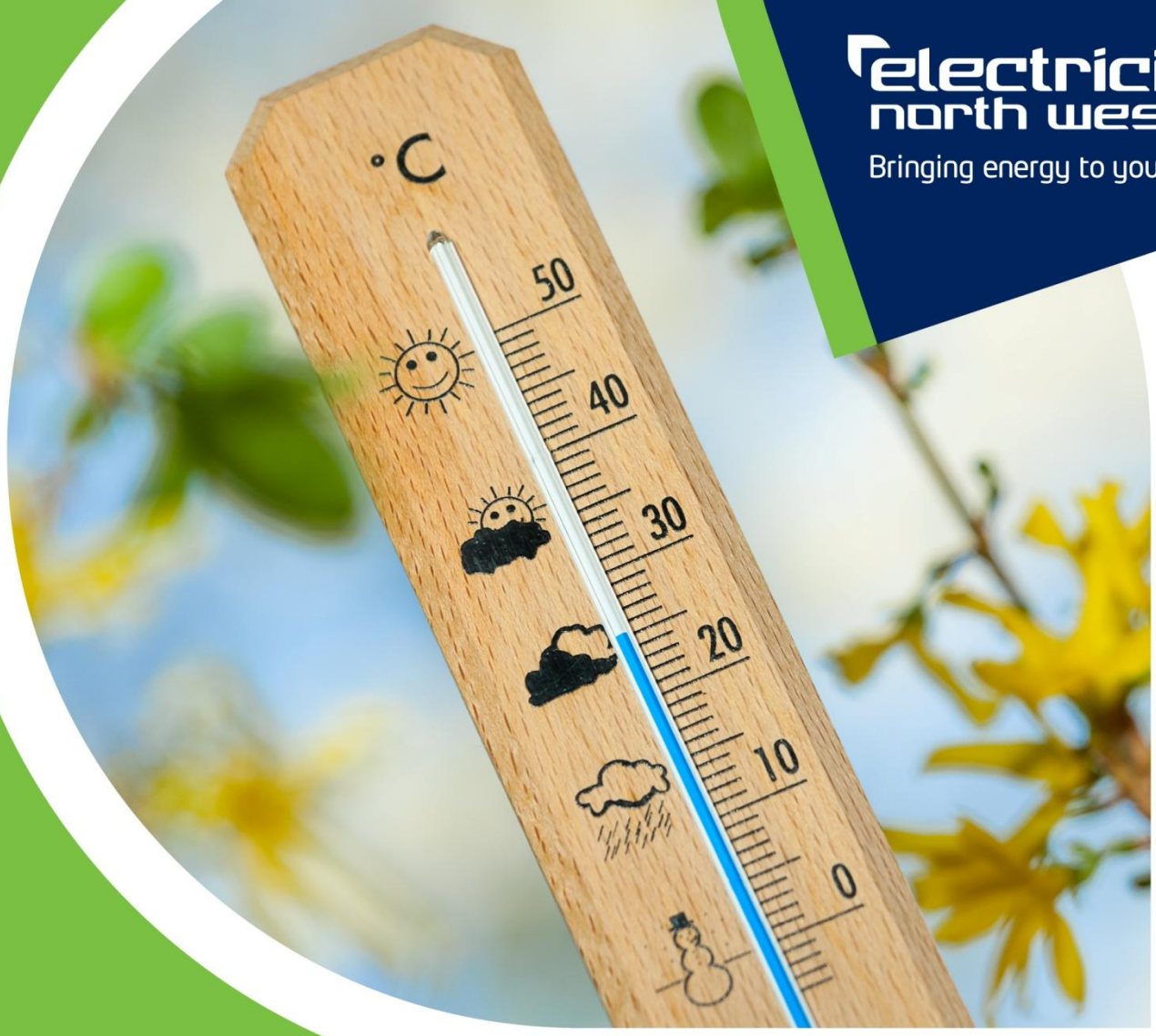


Celsius

Project Progress Report

6 December 2018

VERSION HISTORY

Version	Date	Author	Status	Comments
V0.1	27 Nov 2018	Delroy Ainsworth	Draft	First draft
V0.2	30 Nov 2018	Tracey Kennelly	First Issue	For review
V0.3	3 Dec 2018	Delroy Ainsworth	Second Issue	Final review
V1.0	4 Dec 2018	Paul Turner	Final	

REVIEW

Name	Role	Date
Paul Turner	Innovation Programme Manager	4 December 2018
Sarah Barrett	Finance Manager	5 December 2018

APPROVAL

Name	Role	Date
Steve Cox	Engineering and Technical Director	6 December 2018

CONTENTS

GLOSSARY OF TERMS

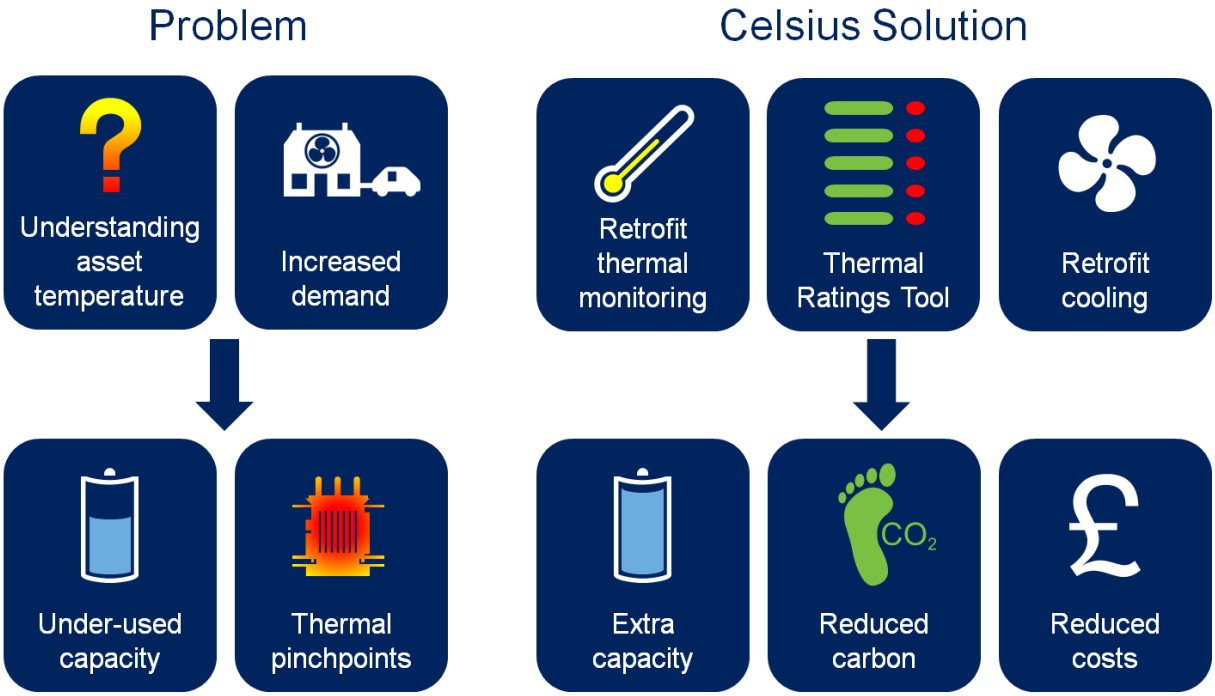
Term	Description
Ambient temperature	Temperature of the air surrounding a component
Cable	An underground conductor used to distribute electrical power, typically buried directly in the ground or installed in ducts or troughs
Capacity	The amount of power that can be delivered by an asset
Current	The movement 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
High voltage (HV)	Voltages over 1kV up to, but not including, 22kV
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
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 hotspot 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
Active cooling	Cooling produced by the installation of fans and control equipment which produces forced air flows to cool the distribution substation equipment
Passive cooling	Cooling produced by the introduction of means of cooling electrical equipment via natural means e.g. reflective paint, shading from sunlight and the installation of ventilation grills in substation walls and doors.
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.

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 sixth six-monthly project progress report (PPR) for the Celsius project. This report covers the period from July 2018 to December 2018.

During this period the active and passive cooling techniques were applied to 100 substations. Installation of all active retrofit technologies was completed at 40 sites. Passive techniques were installed at 56 of the 60 selected sites. The remaining four cable backfill sites were delayed due to data mapping issues and suitable cable loadings. See risk R022 in Appendix A.

It was originally agreed that project partner, UK Power Networks (UKPN), would trial active cooling units in two suitable distribution substations in its region. This was expected to contribute to the overall learning outcomes of the project. Unfortunately because of protracted legal problems, this was not possible. As a consequence these units were installed in Electricity North West's region.

The retrofit cooling techniques/technologies deployed are summarised below:

- Five outdoor transformers equipped with shades to prevent solar gain.
- Ten outdoor transformers painted with anti solar paint to prevent solar gain.
- Twenty 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.
- Nineteen 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 are planned to be backfilled with thermal backfill when sufficient data has been captured.
- Active cooling is installed in forty substations.

Initial evaluation of the effectiveness of retrofit cooling technologies, which included inspections and data analysis, was carried out to ensure the best results were being obtained. This led to additional snagging and improvement works:

- One Passcomm unit was trialled in a GRP constructed substation but was found to have had little effect. After consultation with the site owner, the unit was repositioned to an alternative external position with the aim of achieving more effective cooling of the distribution transformer. Ongoing monitoring will determine if this has been effective
- One Passcomm unit was removed a Celsius substation and re-located to another site due to a noise complaint. Section 2.4 of this report documents the steps taken to resolve this issue by reducing the fan speed. When this failed to resolve the issue, the unit was turned off completely. Further investigations into the issued revealed the source of the complaint was the "hum" of the transformer itself. Whilst installation of the active cooling was not directly responsible for the complaint; the overall increase in noise levels from the unit undoubtedly increased sensitivity to a pre-existing situation. Measures to reduce noise from the transformer are being taken by the main business.
- One Ekkosense unit had to be re-located into an alternative substation. This was due to the distribution transformer developing a severe oil leak, requiring its replacement.
- Three Ekkosense units needed additional ducting/exit vent modifications to make them more effective and minor adjustments were required on six others, predominantly to ensure that the air flow exits were not impaired.
- A problem has been identified with the Ekkosense controllers which are currently proving unreliable. To mitigate this risk the controllers for all units have been bypassed to produce cooling permanently at 100% fan speed. This is providing maximum cooling, and enabling the cooling trial to continue while a permanent solution to the controller fault is achieved. It is expected that this fix will allow various cooling profiles to be selected to suit specific site requirements. The sum of £69,300 has been withheld from Ekkosense until this matter has been remedied. See risk R023 in Appendix A.
- Further technical intervention and customer engagement was conducted at all three sites where customers have been troubled by noise from the Passcomm cooling units. This included decommissioning one unit (outlined above), installing soundproofing and repositioning externally sited units to inside substations. An effective engagement strategy has positively contributed to learning outcomes, as affected customers were

willing to work with the project team to provide constructive feedback during the trial of different adjustments. This has resulted in optimum cooling at these sites with the minimum customer impact. Please refer to Section 8 (customer impact and complaint resolution).

- Ongoing temperature monitoring and analysis identified that Passcomm units failed to operate if the external air temperature was higher that the internal substation ambient temperature. This finding was revealed over summer 2018 when external temperatures were often over 25 degrees Celsius. To rectify this issue, the internal substation ambient temperature sensor that the Passcomm unit uses, was moved to the top oil position. This ensures that the unit will continue to operate when external air temperatures are high.
- Ricardo Energy and Environment started a cooling technology performance analysis.
- Ricardo Energy and Environment have commenced the retrofit cooling trial (phase 2) and are recording the ongoing temperatures reported from the test sites.
- ***SDRC TAW1.1*** - The Raw temperature retrofit cooling monitoring data from September 2018 is now available on the Celsius website.
- ***SDRC TAW1.2*** - Ricardo Energy and Environment produced and published an asset temperature behaviour analysis report.
- ***SDRC TAW4.1*** - Ricardo Energy and Environment developed a thermal ratings tool using monitoring data to evaluate site capacity on Celsius substations. This tool is functional, but is currently undergoing further development and validation with assistance from the University of Southampton.
- Ricardo Energy and Environment are currently undertaking an assessment of cooling technology costs.
- ***SDRC TAW6 -*** The University of Southampton have completed an asset health study explaining how the adaptation of the Celsius principles will affect the condition and life expectancy of electrical distribution assets, particularly distribution transformers.
- ***SDRC TW3*** - Cooling equipment specifications and installation reports published.
- Full liaison has been maintained with the external active cooling technology manufacturers/providers regarding installation set up work, snagging process to ensure maximum cooling efficiency and fault rectification.
- The project actual cost-to-date is £3,606,000 and the estimated at-completion cost is £4,895,000 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;

Three risks have been closed and six new risks have been added; these are outlined in Section 10 and have been added to Appendix A.

1.4 Learning and dissemination

The Celsius project manager held a one-day project steering group meeting with the following objectives:

- To review project progress to date
- To discuss the next six months deliverables and plan
- For partners to share learning and progress.

Of particular note was:

- A project manager update, mainly focusing on the retrofit cooling progress

- A customer engagement update, including actions/resolutions to noise complaints and the customer survey plan
- A presentation on the temperature behaviours report by Ricardo Energy and Environment
- A presentation on the asset health study by the University of Southampton.

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

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 sixth reporting period, during which, we have been busy installing and developing the active cooling technology and the passive cooling technology installations.

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 bi-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). Much work has been carried out with active cooling snagging/development and modification works have been undertaken to address customer satisfaction issues, particularly with respect to noise.

2.3 Technology, trials and analysis work streams

The key activities that were undertaken by the technology, trials and analysis work stream during the reporting period July to December 2018 are summarised below:

Passive and active cooling technology installations

Sixty passive cooling techniques were installed and initial monitoring data collected. These are as follows:

- Ten outdoor distribution transformers were painted with solar reflective paint.
- Five outdoor distribution transformers had sun shades erected over them.
- Nineteen brick built substations had their ventilation improved by the installation of additional vents.
- Twenty GRP constructed substations had additional vents installed. Ten of these sites also had the roofs painted with solar reflective paint.
- Two 'Unusual' type brick substations had additional ventilation installed. 'Unusual' substations are older brick built substations with many and larger rooms where ventilation is more complicated.

- Four cable backfill sites are planned to be backfilled with a thermally improved backfill, but this is awaiting more pre-backfill temperature data.
- Forty active cooling technologies were deployed and initial monitoring data collected. Much work was completed in snagging the installations:
- 20 Passcomm units – positive pressure system
- 20 Ekkosense units – negative pressure system

It was important to ensure that the two active cooling technologies were able to be compared directly to understand which proved to be more effective. Due to the variation and bespoke nature of many of our distribution substations a direct comparison in the exact same conditions was difficult to achieve. Therefore, the following actions were taken:

- At Portland Grove substation, both Ekkosense and Passcomm units were installed to cool the same transformer. This allows for experimentation of the two systems, switching one unit off for a period of time and vice versa to establish which single unit is most effective. Having both units on at the same time can also establish whether a balanced system is more effective than just a negative or positive pressure system alone.
- At Clarendon Rd substation there are two identical transformers in two separate rooms; therefore, a Passcomm unit was fitted to one and an Ekkosense unit fitted to the other. Again, this should provide valuable learning as to the effectiveness of the different active cooling systems.

Slippage of the passive installation programme

Some of the brick built substations required the manufacture of bespoke ventilation louvers. In addition, the internal wall of some double skin brick substations had to be core drilled to maintain the structural integrity of the building and prevent the time and cost of installing new lintels.

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

The technical work stream is considering if additional work is required after the retrofitting has been completed, to assess the validity of the models used.

***SDRC TAW1.1* – Make available raw temperature retrofit cooling monitoring data**

Retrofit cooling monitoring data from September 2018 is published on the Electricity North West website.

***SDRC TAW 1.2* – Publish asset temperature behaviour analysis report**

The Celsius asset temperature behaviour report produced by Ricardo Energy and Environment has been considered and published on the project website. This report details the results of phase 1 of the Celsius project

Phase 1 develops a detailed understanding of the operating temperature of assets with the aim of estimating the impact of a range of asset environment factors in asset rating, which is limited by the operating temperature. The report contains three studies:

- **Transformer hotspot estimation study** – A method was developed to estimate transformer hotspot 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.

***SDRC TAW 4.3* – Publish thermal ratings tool**

This tool combines input data from the monitoring and cooling trials in a user friendly way to enable the thermal ratings of distribution equipment to be evaluated.

The methods included in this tool were developed as part of the temperature factors study, which is described in detail in the above document (Celsius asset temperature behaviour report). This study developed three methods to calculate a more informed thermal rating for low voltage distribution transformers:

- **The simplified Celsius rating**, which is 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**, which 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**, which is based on temperature and load data from site, 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

***SDRC TAW6* – Publish asset health study report**

The Celsius asset health study report produced by the University of Southampton has been considered and published on the project website. This report presents a review of asset health implications arising from the deployment of Celsius techniques, including the use of the Celsius daily rating. This report primarily considers 11/0.4kV distribution transformers. Further work will be conducted to assess the implication for cables when the data is available.

***SDRC TW3* - Publish cooling equipment specifications and installation reports**

The Celsius cooling equipment specification and installation report detailing the retrofit interventions applied at each of the 100 selected sites has been published on the project website.

Transition to business as usual

Discussions with the main business regarding the integration of Celsius into BAU have started to fully understand the existing policies and processes and establish where and how Celsius can be integrated.

2.4 Customer work stream

The key activities undertaken by the customer workstream, during the reporting period July to December 2018, are summarised below:

- Results of the baseline customer survey analysed
- Further customer contact centre briefings on Celsius delivered
- Two further Celsius-related complaints/enquiries received and amicably resolved
- Test customer survey instrument produced in anticipation of fieldwork in January 2019.

Further customer contact centre (CCC) briefings

The customer workstream has continued to work closely with the CCC and four further briefing sessions were delivered in this reporting period, as part of wider innovation training, to explain the nature and objectives of the Celsius project. Maintaining this relationship ensures that all complaints or enquiries associated with any aspect of Celsius are identified, captured, recorded and appropriately handled.

Two additional customer enquiries were received about Celsius this reporting period, increasing the total number of individual enquiries to five. Each of these was managed centrally by designated members of the project team. Early intervention and appropriate remedial action has ensured each was resolved to the customers' satisfaction.

Celsius baseline customer survey analysis

Analysis of the 600 benchmarking interviews with customers living or working in close proximity to trial substations was conducted this reporting period. This baseline survey was undertaken prior to the retrofit of cooling techniques to provide a comparative measure for the test surveys. A summary of the key learning outcomes from the baseline research is provided in Section 8 of this report.

A 'test' survey instrument and associated materials have been developed to facilitate customer interviews that will commence in early 2019. This phase of research will be conducted slightly later than originally estimated, due to slippage in the passive retrofit installation programme and technical snagging issues with active technologies, as outlined above. This delay will have no detrimental impact of the main customer survey. This rationale also ensures that cooling techniques (specifically the active interventions) will have operated, for a reasonable period of time, at the settings that might be expected if applied under 'business as usual' conditions. This logic ensures that customer feedback is reflective of the actual impact of the technique. The outputs of the test survey will be compared with the baseline results and published in September 2019.

Customer enquiries/complaint resolved

In this reporting period two further customer enquiries were received that are directly associated with the Celsius project, increasing the total number of enquiries for this project to five. Details of the three previous enquiries are recorded in the project progress report dated June 2018.

Both of the enquiries reported in this period were associated with noise disturbance, following the installation of Passcomm cooling systems. These two issues increase the total number of complaints associated with this particular active cooling technique to three.

The original complaint associated with Passcomm technology (as reported in the June 2018 progress report) was addressed by adjusting the unit's fan settings and set points (which determine the time and temperature at which the fans are activated). The technical workstream identified that by reducing settings to 40%, it was possible to eliminate the customer noise disturbance issue; however, whilst the reduced settings maintains an observable cooling effect, it is not possible to achieve optimum cooling at these levels.

To provide a solution that was acceptable to the customer but which also met the technical requirements, an acoustic buffer was installed by the manufacturer and noise levels were then tested across a range of fan speeds and settings. This exercise identified that because of the specific environment and the location of the cooling system, the buffer was largely ineffective.

As such, further technical modifications were made to enhance the learning outcomes and aid evaluation of the effectiveness/appropriateness of this type of cooling solution, when deployed in densely populated areas, in close proximity to domestic dwellings. This involved

relocating the Passcomm unit from its external position, on the rear elevation of the substation, to an internal position. The rationale was that the brick built construction of the substation would baffle the majority of noise emitted from the unit, allowing greater headroom for higher fan speeds and wider set points, thereby facilitating optimum cooling of the transformer.

Relocating the Passcomm unit inside the substation failed to completely eliminate noise disturbance but has enabled fan settings and set points to be slightly extended beyond those deemed acceptable to the customer when the unit was externally sited.

This learning will be influential if this or a similar system is deployed at large scale in the future as a 'business as usual' tool; however, the significant variations in the size, construction type and layout of substations means that an internal installation option may not be appropriate in all cases.

The project team maintained dialog with the customer during this period to ensure they were made aware of the actions being taken and the reasons for them. Building a positive customer relationship has generated a significant amount of learning and assisted the project team in understanding actual customer impacts of installing particular interventions in specific locations.

In this reporting period two further customer complaints associated with noise from two separate Passcomm units were received. One complaint was resolved by simply reducing the fan setting and the set points. However, this issue also heightened customer sensitivity to the general condition of the substation and prompted him to lodge a complaint about the poor condition of the building, specifically the roof, fascias and bargeboards. To remedy the wider complaint to the customer's satisfaction, the substation roof has been replaced in its entirety.

Resolution of the other noise complaint arising from the installation of a Passcomm system (also in very close proximity to a customer's home) involved relocating the externally sited unit to inside the building. This was conducted in conjunction with a reduction in the fan settings. As with the original Passcomm noise complaint (outlined above), this action significantly reduced noise levels; however, the disturbance caused when the unit was first installed appears to have heightened customer sensitivity to a pre-existing issue with background noise from the transformer.

Investigations confirmed that there was a constant, resonant hum from the transformer and the tone outside the building changed relative to the position that measurements were taken. It was also noted that the substation's vent had a notable impact on acoustic levels at different points around the site. Some of the ventilation was covered as part of the Passcomm installation, which could potentially have had a negative effect on the original acoustics. This boarding was removed to eliminate it as a potential contributing factor.

This had little effect and as such, the Passcomm unit was switched off. A detailed acoustic survey was then conducted at the site, which confirmed that the transformer noise exceeded ENA guidelines and arrangements are now in place to replace it.

The customer confirmed that they had noticed a constant noise from the substation before installation of the cooling unit; however, this had been perceived as acceptable before application of the intervention. The increase in noise from the Passcomm unit appears to have significantly heightened sensitivity to the pre-existing issue and even after the cooling unit was switched off, transformer noise was perceived to be much louder than prior to installation of the retrofit cooling. In light of ongoing issues outside the scope of this project, the Passcomm unit was removed and this site aborted from the active cooling trial. The main business is currently planning a permanent solution to the transformer noise problem.

The customer workstream has remained in contact with all individuals impacted by the active interventions. These customers are monitoring noise levels and will report any deterioration that might warrant further remedial measures. The project team have committed to

permanently disconnecting any active cooling interventions, to resolve a customer complaint, when all other reasonable remedial measures have been exhausted. This commitment has been demonstrated by the action taken to abort the site where transformer noise was identified as an issue, even though this situation is not directly related to the Celsius project.

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

Customer information card

The technology workstream and colleagues have continued to distribute customer information cards when installing cooling interventions at trial substations. As outlined in the previous reporting period, it is recognised this could have a bearing on the hypothesis that *'Customers who are educated about the need for and benefits of Celsius are significantly more likely to find it acceptable'* because delivering the information card provides a basic level of education and reduces the pool of respondents in the completely uneducated sample.

In light of the above, the test survey will explore whether customers are aware not only of any changes to the substation, but also activities at the substation and whether those in close proximity are able to recall receipt of the card and if it was read.

2.5 Learning and dissemination work stream

The Celsius project team has participated in a number of learning and dissemination events in this reporting period, the key events are:

- ***SDRC LDW 5.3*** - Hold annual knowledge sharing event, July 2018
- ***SDRC LDW 4.3*** - Attend the LCNI annual conference, October 2018
- ***SDRC LDW 3.3*** - Publicise Celsius progress and learning in advertorial 3, July 2018
- Publicise Celsius within Electricity North West via the Volt intranet site, email bulletins and/or Newswire company magazine
- ***SDRC LDW 6*** - Issue project progress report in accordance with Ofgem's December production cycle.

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:

- 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.

The Celsius communications register that details all communications to date 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 30 November 2018. It is noted that the project is currently performing favourably relative to budget. Project expenditure as at the end of November 2018 was £3,606,000 compared to a cost baseline of £4,473,000 including contingency.

In the previous reporting period the variance minus contingency was £544,000. This has now decreased to £406,000; this is for the most part due to the phased payments to project partners (contractors). The variance in contractor payments has now decreased from £267,000 in May 2018 to £146,000. The overall contractor forecast is still within the 5% tolerance; however, we are currently forecasting a £12,000 overspend by the end of the project compared to budget.

Since the last reporting period the contractor under-spend has decreased from £267,000 to £146,000 which is a clear indicator that the project costs are aligning with the budget.

The labour under-spend variance has decreased from £95,000 to £88,000, this is due to costs aligning after the cooling technology installation phase,

Equipment variance decreased from £230,000 to £127,000; this is largely due to the completion of the cooling technology installation; however, costs associated with the Ekkosense kit are being withheld (£69,300) due to problems with the control system and will be released once these issues have been rectified.

As reported in the previous reporting period, IT costs associated with the development of the data management system and user interface have been completed ahead of plan, therefore milestone payments have been paid ahead of the budget plan these costs are expected to align after installation of the cooling technologies has been completed this time next year.

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	799	886	88	1,208	1,203	(4)
Equipment	1,206	1,333	127	1,335	1,333	(2)
Contractors	1,239	1,385	146	1,776	1,765	(12)
IT	191	167	(24)	209	209	0
IPR costs	0	0	0	0	0	0
Travel & expenses	0	0	0	0	0	0
Payments to users	15	31	15	31	31	0
Contingency	77	537	461	77	537	461
Decommissioning	0	0	0	29	29	0
Other	79	134	55	230	230	0
Total costs	**3,606**	**4,473**	**867**	**4,895**	**5,338**	**443**

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 November 2018.

7 SUCCESSFUL DELIVERY REWARD CRITERIA (SDRC)

There were nine SDRCs due in this reporting period, all 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
TAW1.1 – Retrofit cooling monitoring data to be available.	Sept -18	Delivered
TAW1.2 – Publish asset temperature behaviour analysis report on Celsius website	Sept-18	Delivered
LDW5.3. Hold annual knowledge sharing events. Provide one to one briefing sessions. (July 18)	Sept 18	Delivered
LDW3.3 Publish advertorials annually	Oct 18	Delivered
TAW4.1 – Develop Thermal ratings tool using monitoring data to evaluate site capacity on Celsius substations	Oct 18	Delivered
TAW6 – Publish Asset Health Study report on Celsius website.	Oct 18	Delivered
TW3 – Publish cooling equipment specifications and installation reports	Nov 18	Delivered
LDW 4.3 – Participate at four annual LCNI conferences from 2016 to 2019.	Nov 18	Delivered
LDW6.6 - Issue Project progress reports in accordance with Ofgem's December production cycle and publish on Celsius website.	Dec 18	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

This reporting period was initially dominated by the completion/snagging of the retrofit cooling technologies; subsequent installation issues. There have been many learning points which are explained below.

Site surveys

Surveying all the retrofit cooling sites with the chosen contractors and technology providers was invaluable. Whilst most sites met the criteria for active cooling some installations would have been difficult and therefore, the most appropriate type of cooling was selected dependent upon the substation's construction. Some building types did not lend themselves to the installation of active cooling, in particular large volume substations. These would not have benefited greatly from active cooling installations because the volume of air within the building is considerable. Minor building work could have been conducted to compensate for this; however, a cost benefit analysis would need to be completed if this was to be carried out. Most sites were suitable for a passive cooling technique; however, the amount of work required varied.
The surveys took account of how customers might be impacted and other factors that could affect the validity of the installations. Specific note was made of the possible effects of noise created by the cooling fans, a consideration which became a primary consideration during the installations. The position of air inlets and outlets was considered when a customer

premise was in the immediate vicinity of the substation. Similar considerations were made before installing extra passive vents in substation walls and when either painting equipment with reflective paint or installing sun shades over outdoor equipment.

Safety

All the installations were carried out in full compliance of Electricity North West's health and safety directive and each was completed without incident, again demonstrating the value of a pre-survey, enabling completion of any necessary safety works prior to commencing the actual installation. In many instances live low voltage equipment was physically screened off by constructing insulated screens to prevent any accidental contact.

UK Power Networks

The original plan was to install two active cooling units on UKPN's network. Due to legal delays and complications, this aspiration was abandoned and these units have now been installed on Electricity North West's network instead. This is referenced in Appendix A - R020.

Passcomm installations

To provide cooling, the Passcomm unit draws air from outside and blows it into the substation. This increases the volume of air in the internal space, thereby creating "positive pressure." The air is drawn through the filtration system as it passes through the unit, removing dust and potential contaminants. Outside air is generally cooler than the air inside the substation, generating the cooling effect. Due to the positive pressure created within the room, warm air coming from the transformer is forced outside the substation through high level vents.

The Passcomm system has a wall mounted control unit that can be used to programme it with different temperature profiles depending on the specific needs of the substation.

It should be noted that in exceptionally hot weather conditions, such as those experienced over summer 2018, the outside air temperature can exceed the ambient air inside the substation building. In these conditions, the fan within the Passcomm unit, which is controlled by the internal Passcomm temperature sensor, will not operate, even when the internal temperature is high. To overcome this issue extra long lead sensors were installed to provide a transformer top oil temperature as a substitute for the Passcomm ambient temperature. This action ensured the units would continue operating when required to cool the transformer.

To maximise the effectiveness of the Passcomm system, its installation involves blocking off some existing vents, with the exception of a high level outlet vent. This presents a risk that should the unit fail, there is little natural ventilation to cool the transformer.

Distribution substations are generally situated in close proximity to customer premises. Therefore, any noise created by the outside fan can present a problem. This has been realised during the trial, with a small number of Passcomm installations resulting in noise complaints. Care needs to be taken when considering which active cooling method should be used in which circumstances. The trial has identified that a Passcomm unit can be installed inside a substation providing there is sufficient space.

The positioning of the unit was considered on a site by site basis, taking into account the restrictions of the substation and its environment. This assessment considered the position of the unit from the perspective of customer, the operational impact and also the efficiency of cooling. The purpose of retrofitting the Passcomm system is to cool the transformer, not necessarily the internal substation space, although this is an additional effect. The unit should therefore be positioned close to the transformer, to force air directly onto and across it. As such it should ideally be installed on the wall adjacent the transformer. Warm air then

exits the building via a vent located at the opposite side of the substation, installed in a high position. Existing side vents tend to divert air flow sideways, away from the transformer, resulting in less efficient cooling. For this reason, these vents have been blocked off during installation.

However, there needs to be some compromise in the initial assessment. For example, the optimal cooling may be achieved by installing the unit close to a customer's property; however, operating the system at 100% in this location could create noise disturbance. However it may be determined that this remains the most appropriate position; but the maximum fan speed would need to be reduced to 80%.

The Passcomm system provides relative flexibility in terms of installation, and can be mounted internally or externally. It can also be mounted onto substation doors. This adaptability means that for most substation layouts, a suitable position can be found.

The Passcomm unit was originally designed to keep server rooms cool, where air quality is very important and for this reason, the units have G4 filtration system. However, for our application this is not required and following complaints of low frequency noise omitted from some installations, Passcomm have re-designed the unit to provide G2 filtration. The new design, developed on the basis of Electricity North West's requirements, has resulted in a smaller, lighter and quieter unit, which provides the same cooling effect.

Ekkosense installations

Ekkosense installations produce a negative pressure inside a curtained area around the transformer. The hot air rising from the transformer is extracted by fans via a fabric vent tube to a substation exit vent. The installation involves fitting double fans mounted directly above the transformer with a fabric trunking to an exit vent cut into an external facing wall. The installation process is more involved than the other active cooling method deployed. The effectiveness of negative pressure cooling should theoretically be higher than other methods and this will be determined from monitoring data collected over the remainder of the trial period.

As with the Passcomm sites, there has been a requirement to block off existing passive cooling vents, to ensure optimal airflow.

The Ekkosense unit can be programmed with different temperature profiles, via a dedicated laptop loaded with Ekkosense software. There have been some issues with the temperature profiles and control units, resulting in the failure of the fans to operate, as intended. This initially provided inconsistent cooling and data. Ekkosense have carried out extensive testing and are confident that they can provide a working solution in a timely manner. In the meantime, the controllers have been bypassed to provide a 100% fan speed, so that the installations provide continuous cooling of transformers and the project team in able to assess the cooling effect. See Risk R023 in Appendix A

An alarm function was developed by Ricardo Energy and Environment/Ash Wireless within their database outputs and the alarms generated were investigated. These alarms report high temperatures only and are available at all 100 retrofit cooling sites. These alarms are not issued in real time but are reported once every 24 hours. This is acceptable for indication purposes in the trial environment but it is recognised this is unacceptable when extremely high temperatures require immediate attention. This is not currently an issue for the trial as our estimates provide confidence that the loading and temperatures at the intervention sites should not become high enough to cause any problems.

If active cooling technology is deployed as a BAU tool to maintain the transformer below its maximum hotspot temperature, then a real time alarm would be a necessity. Critically, in the event of the failure of a cooling intervention, the transformer temperature could exceed that which it would have reached before active cooling was installed. This is because the transformer is likely to be running at greater load, on the basis that cooling is providing

greater thermal headroom. In addition some existing passive vents may have been blocked, to provide more efficient airflow. In the case of Ekkosense units, the transformer has a curtain around it, which would act as insulation, heating the air around the transformer. For this reason a cool fail alarm is being developed. This is expected to integrate with Electricity North West's network management system to provide real time information about a cooling technology failure, allowing immediate action.

Passive cooling

All the sixty passive cooling technologies were completed (with the exception of the four cable backfill sites as previously referenced).

Some of the brick built substations required the manufacture of bespoke ventilation louvers. These substations are of either:

- Large multi room brick constructions or
- Distribution substations situated in large multi-room primary substations.

These required additional planning to ensure sensitive buildings were not compromised.

Two were located in substations contained in buildings owned by others and work on these required the consents of the owners. These consents required a considerable amount of time consuming planning to satisfy building owners.

Of the nine substations identified as 'unusual', five were assessed, surveyed and rejected for inclusion in the trial. These included grade 2 listed buildings and mall type shopping precincts where complex planning permissions would have proven prohibitive, in light of the requirement to comply with building fire precautions. Each unusual site was inspected and requirements discussed with Electricity North West's legal/wayleaves department. They fully examined and assessed the process required in each instance. In most cases the advice was that consents would take six months or more. This complication would have resulted in too much of a delay to meet project timelines.

Where it has been possible to improve ventilation in unusual buildings, our wayleaves department contacted the owners directly, produced the necessary planning documents and obtained the appropriate permissions. The learning from this process has highlighted that whilst retrofit cooling can theoretically be installed in most situations, the reality is that the technique and design needs to be carefully planned with the relevant authorities and if deployed as a BAU solution, a cost benefit analysis would need to be completed on a case by case basis.

Asset temperature behaviour report

This report highlighted the many factors that can affect a transformers' thermal behaviour and overall ratings. Historically, the nominal nameplate rating is used for all transformers in all environments. This report demonstrates how the rating of a transformer can vary depending on a number of other factors such as specification, environment, harmonics, ambient temperature etc.

Transformer asset health study

This report explored if there were any detrimental effects of operating a transformer above its nominal rating, providing that cooling was applied to keep the maximum hot-spot temperature within limits. The study has determined that as temperature is the primary concern in terms of paper winding insulation degradation, maintaining the temperature of the hot-spot to within specified limits prevents premature aging of the asset, even when load is higher than the nameplate rating, validating the Celsius method.

Celsius baseline survey

Background: The following summarises the main lessons learned from the baseline customer survey:

- The majority of customers surveyed were able to identify a range of ground mounted substations but only around 50% could identify a pole mounted substation. Around 20% of respondents were confused about the difference between substations and cubicles housing other utility equipment.
- Half of the 600 customers surveyed were presented with high level educational materials explaining the challenges for DNOs of transitioning to a low carbon economy and thermal constraints that Celsius is seeking to address. The majority of these respondents felt Celsius represents a credible solution to the problem, with SME customers responding more positively than domestic customers. Of those educated:
- 83% believe that network operators need to find new solutions to meet future electricity demand and keep bills low
- 81% felt Celsius will help to meet greater demand for electricity by making better use of existing substation equipment
- 74% believe the projections that we will all use more electricity in the future and that electric vehicles and solar panels will become commonplace.
- All 600 respondents received information about what traditional reinforcement, to meet additional demand and address network constraints entails. They were then asked how acceptable they would find this solution if the work was carried out near to their home or place of work. Most were ambivalent but around half reported that it would be acceptable (scoring 9 or 10 on a scale where 10 is completely acceptable). However, customers that can see/or live in close proximity to a substation indicated they were less likely to be accepting of traditional reinforcement. In the SME segment, educated customers reported they would find traditional reinforcement less acceptable than those hadn't had sight of the educational materials.
- From a total sample of 600 interviews, 519 respondents knew the location of their nearest substation and around 95% believed its location and size was acceptable; 94% were accepting of its overall appearance and 97% reported that existing noise level are acceptable. However, there was a notable decline in aesthetic acceptability amongst the customers who are able to see the substation from their home or business premise.
- As a baseline measure, only 8% of customers claimed to have noticed any recent change to the most local substation but the majority believe they would notice any future visual or audible changes, particularly if the work causes localised disruption.

The survey included questions about the acceptability of potential changes to substations associated with a range of passive and active Celsius cooling interventions. These were accompanied with information outlining the theoretical impact of specific techniques. All were regarded as acceptable to most customers. However, SMEs are least likely to be accepting of any changes that might cause disruption such as road closures or planned supply interruptions.

Customer impact and complaint resolution

Background: Unforeseen detrimental impacts arising from the deployment of new technology or techniques can necessitate lengthy and costly remedial action by the main business.

Lesson learned: The two noise complaints received in this reporting period (increasing the total number to date, to three) highlight the ripple effect that can emanate from adverse impacts associated with new techniques. Not only has the project team incurred technical redesign works to eliminate noise emissions; but the main business has also picked up significant costs in rectifying issues that might otherwise not have been regarded, by customers, as problematic. This is particularly apparent in the case which has resulted in work to remedy a noisy transformer. A number of proposals are currently under consideration; however, the permanent solution could entail expensive reinforcement to

replace the transformer. In this instance, the customer confirmed they had been aware of constant background noise from the substation before installation of the Passcomm unit; however, the noise level had been perceived as acceptable before deployment of the cooling intervention. The increase in noise from the Passcomm unit appears to have significantly heightened sensitivity to the pre-existing issue and even after the fan was switched off, transformer noise was perceived to be much louder than prior to installation of retrofit cooling. Background acoustic measurements were conducted before deploying the Passcomm unit to ensure installation would not result in exceedance of decibel limits. This case highlights the need for much more detailed acoustic surveys prior to installing active techniques at substations in close proximity to domestic properties.

Background: To ensure that any customer enquiries are addressed quickly, efficiently and sensitively, an enquiry/complaints process was been embedded to support the CCC. Any queries or concerns that cannot be addressed immediately by a CCC agent are referred to a designated member of the Celsius customer workstream.

Lessons learned: Learning from previous innovation projects, most notably Smart Street, had demonstrated that this proactive customer strategy provides the most effective means of ensuring that issues are addressed quickly, appropriately and consistently. This maintains good customer relationships with individuals who are most directly impacted by new technologies and the associated installation work. It was essential that the CCC was made fully aware of the project and the correct process, to avoid any handling delays or the delivery of inconsistent information, which might result in greater customer dissatisfaction and ultimately decreases the chances of reaching a satisfactory resolution. However, learning attained in this reporting period demonstrates the value of having a designated customer expert within the project team, empowered to make appropriate decisions, to attain a swift, mutually agreeable, appropriate and amicable resolution to disputes.

Background: The retrofit cooling installations will have no impact on power quality for customers on trial networks. However, it was originally thought that a small number of customers might have been impacted by brief, planned supply interruptions to install certain cooling technologies.

Lessons learned: To ensure that customers were made aware of all potential impacts, this possibility was referenced in the leaflet, handed to the educated sample of customers taking part in the baseline survey. This resulted in a complaint, demonstrating that customers struggle to accept planned supply interruptions unless the long-term benefit of even a short planned interruption is fully understood. It was possible to install all Celsius cooling techniques/technologies without the need to interrupt any supplies. As a consequence of the complaint, all customers subsequently taking part in the survey were verbally reassured that the project, and in particular the deployment of cooling interventions, would have no impact on supplies. Educational material for future projects should be designed with this sensitivity in mind.

Background: A small number of customers, with properties in close proximity to substations where retrofit cooling techniques have been deployed could potentially be impacted by a visual or audible effect. Surveys will elicit perceived audible and/or visual changes, as will the capture of any associated customer enquiries from individuals whose views may or may not have been recorded in the survey.

The project team received a report of noise disturbance from a property adjacent to a substation where this technology had been deployed. A project engineer immediately attended and extended the night mode settings on the main control unit in addition to reducing the day and night time fan speeds. The situation was monitored over the subsequent days and the action taken was confirmed to have been effective in reducing noise levels, but had not fully resolved the problem. As such, an acoustic foam buffer was installed to further reduce noise emissions. The project team is continuing to monitor the situation and has maintained dialogue with the customer affected, who has been reassured that further remedial measures will be undertaken to resolve the situation if necessary.

Lessons learned: As a result of this enquiry the project team conducted further investigations to understand the correlation between fan settings and noise emission. It is notable that simple decibel measurements alone fail to adequately determine the potential noise impact on customers in the vicinity. Different frequency noises are absorbed differently by the environments in which they are placed. The customer's perception of sound can be different and time of day also affects how easily customers perceive the sounds created by the cooling equipment eg at night time there is little ambient background noise. The technical team are experimenting with sound-absorbing measures and different fan speeds at different times of the day.

This learning demonstrates that while active cooling technology is likely to provide an effective solution to cooling assets, it may not necessarily be appropriate to install such systems in close proximity to domestic dwellings, without deploying additional mitigation against noise disturbance. This could involve:

- Mounting the unit internally; however, this may not be possible or appropriate at all sites
- Use of acoustic foam inside the cooling unit to act as a baffle
- Noise insulation measures inside a substation building
- Reduction of fan speeds and settings – while this option could yield the required reduction in noise output to satisfy local customers, it could also affect the overall effectiveness of the system and its cooling performance
- Utilising different settings of the equipment at different times of the day.

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 will be 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:

R016: Availability of operational resources for the retrofit cooling.

There is a risk that operational resources may not be available to supervise the cooling installation contractors working in live substations.

Update: The risk is closed – Electricity North West was able to provide supervision of the installation of retrofit cooling, which was conducted by specialist external contractors.

R018: Temperature factors report

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. This risk to the project is the subject of ongoing discussions between Electricity North West and Ricardo Energy and Environment so that strategies may be developed to overcome this problem.

Update: The risk is closed and the temperature factors report has been delivered and internally reviewed. It meets with Electricity North West requirements and is now published on the project website.

NEW RISKS IDENTIFIED

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 personnel whenever possible to carry out the operational procedures necessary.

R0 20: UKPN cooling sites.

There is a risk that the two UKPN cooling sites will not be completed in time to be properly assessed

Update: The risk is closed and this element of the trial has been abandoned. UKPN have confirmed that the legal agreements necessary would be lengthy to negotiate and have therefore declined the opportunity of taking part in the trial of active cooling technologies in two substations within its region.

R021: Risk of cooling failure

There is a risk that if the forced cooling fans fail, the substation temperatures may become excessive. This risk is further exacerbated as a result of blocking off some existing vents to allow optimal airflow for the active cooling unit.

Ekkosense extraction fan settings have been overridden and are currently providing 100% cooling at these sites. A long term solution is being developed utilising the Electrotech NX12 RTU as a method to remotely send a cooling fail alarm, to mitigate the risk.

R022: Grid Key Maps

There is a risk that there will be a delay in receiving load (amps) 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 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.

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

R024: Retrofit cooling monitoring data.

There is a risk that the monitoring data will be inconsistent as some of the retrofit cooling equipment was not installed in the optimal position due to substation configuration restraints.

In some instances the position of Passcomm and Ekkosense units are being altered with the aim of more effectively cooling the transformer, but we hope to get some interesting learning points from this to see how much of an effect this has to the cooling performance.

Update: The risk has been closed as the necessary adjustments have now been made to make the installations as effective as possible.

There are currently no uncontrolled risks that could impede the achievement of any of the SDRC outlined in the project direction, or which could cause the project to deviate from the full submission.

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	Risk closed Dec 16 following successful 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.*	0	0	Closed
R002	Thermal sensor lead time	Technology	Risk closed October 2016 – commenced installation 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.	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
						Contingency: Flexibility is built into the installation programme; phased installation plan starts in autumn 2016 to be completed by spring 2017. *A full year's data for comparison with the cooling trial could be gained by overlapping these tasks more than planned.*			
R003	Inadequate existing load monitoring	Technology	Risk closed Dec 16 – existing load monitoring units were found to be unsuitable and planned contingency was initiated 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.*	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. **Update: Impact reduced to moderate due to large amount of trial data**	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	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
			successfully gathered			through data validation. *Contingency: Budget for additional resource.*			
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 roll out**.**	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 communicatio ns 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	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
						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, and where necessary, missing data will be simulated.* *Sensors that are still required will be replaced.*			
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	Technology	There is a risk that the lead-time for the retrofit cooling	3	4	During technology selection, each technology will be	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
	cooling technologies		techniques may lead to a delay in the installation of this technology and delay the start of the monitoring trial.			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 and 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.*			
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*	3	4	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
						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.			
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 to get it peer-reviewed) leading to a longer preparation and review period required.	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 DNO partner embedded in the project to provide ongoing review and challenge throughout project delivery.*	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
R012	Project progress report	Project Management	There is a risk that the financial reporting contained in the 6 monthly Project Progress Report (PPR) may be inaccurate due to the requirement to submit the document on the 9th of each reporting month. ENWL'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 ENWL 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 increased cost due to premium time working.	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 increase outputs and catch up with the plan. Update: Closed due to completion of monitoring installation. Risk closed	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
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 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 work beyond the intended deadline of June 2018	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
						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 twenty 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 have 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 ENWL and Ricardo so that strategies may be developed to overcome this problem. The Temperature Factors Report has been issued and reviewed. It meets with ENWL requirements. Risk closed.	4	4	Closed
R019	LV loading of cables and transformers will be delayed due to lack of operational	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the LV loading of cables and transformers to improve data quality will be delayed due to lack of operational	3	3	The risk to the project will be mitigated by using ENWL operational personnel whenever possible, to carry out the operational	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
	resource		resource			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.			
R020	Two UKPN sites delayed	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the two UKPN cooling sites will not be completed in time to be properly assessed.	3	3	ENWL solicitor to engage further with the UKPN solicitor to encourage a timely solution. UKPN have indicated that they cannot complete the legal requirements in a timely manner therefore the units have been installed in ENWLs 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 blocked off to allow optimal airflow for the active cooling unit.	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
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 host 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 resent to the appropriate IT engineers To ensure that reconfiguration can be carried out, site data also being validated.	3	3	Open
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 are 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*	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
R024	Installation of cooling equipment not effective	Technology / Trials & Analysis /Learning & Dissemination	There is a risk that the monitoring data will be inconsistent as some of the retrofit cooling equipment was not installed in the optimal position due to substation configuration restraints.	3	3	In some instances the position of Passcomm units is being changed to 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. 02.10.2018 The necessary adjustments have now been made to make the installations as effective as possible. Risk closed.	3	3	Closed

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	On track

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	On track
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 Actual	Plan	Variance	Total Project Forecast	Plan	Variance	Comments
Labour	**799**	**886**	**88**	**1,208**	**1,203**	**(4)**	
Labour - project management	252	309	57	469	469	0	
Labour - general	127	168	41	288	288	0	
Labour - installation/commissioning	420	409	(11)	451	446	(5)	
Equipment	**1,206**	**1,333**	**127**	**1,335**	**1,333**	**(2)**	
Equipment - Materials	221	349	128	350	349	(1)	
Equipment - General	0	0	0	0	0	0	
Equipment - Monitoring Equipment	986	984	(1)	986	984	(1)	
Contractors	**1,239**	**1,385**	**146**	**1,776**	**1,765**	**(12)**	
Contractor - Project management	42	39	(2)	74	74	0	
Contractor - Close Out	0	2	2	25	25	0	
Contractor - Technology	676	643	(33)	681	663	(18)	
Contractor - Trials & Analysis	246	423	176	515	515	0	
Contractor - Thermal Flow Study	91	97	6	91	97	6	
Contractor - BAU Process & Tool	73	28	(45)	165	165	(0)	
Contractor - Customer Survey	65	87	22	116	116	(0)	
Contractor - Customer Engagement Activities	31	45	14	53	53	0	
Contractor - Cost Benefit Analysis	0	3	3	32	32	0	
Contractor - Dissemination Activities	14	17	3	24	24	(0)	
IT	**191**	**167**	**-24**	**209**	**209**	**0**	
IT - Hardware	0	0	0	0	0	0	
IT - Software	191	167	(24)	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	**15**	**31**	**15**	**31**	**31**	**0**	
Payments to users - Customer Survey	15	31	15	31	31	0	
Contingency	**77**	**537**	**461**	**77**	**537**	**461**	
Contingency	77	537	461	77	537	461	No changes to contingency spending since last reporting window.
Decommissioning	**0**	**0**	**0**	**29**	**29**	**0**	
Decommissioning	0	0	0	29	29	0	
Other	**79**	**134**	**55**	**230**	**230**	**0**	
Other - Rent	5	3	(2)	57	57	(0)	
Other - Dissemination Activities	66	115	49	149	149	0	
Other - Other	0	0	0	0	0	0	
Other - DNO Workshop	8	16	8	24	24	0	
Total	**3,606**	**4,473**	**867**	**4,895**	**5,338**	**443**	

£'000s Excluding Partner Funding Ofgem Cost Category	Spend to date Actual	Plan	Variance	Total Project Forecast	Plan	Variance
Labour	799	886	88	1,208	1,203	(4)
Equipment	1,206	1,333	127	1,335	1,333	(2)
Contractors	1,239	1,385	146	1,776	1,765	(12)
IT	191	167	(24)	209	209	0
IPR Costs	0	0	0	0	0	0
Travel & Expenses	0	0	0	0	0	0
Payments to Users	15	31	15	31	31	0
Contingency	77	537	461	77	537	461
Decommissioning	0	0	0	29	29	0
Other	79	134	55	230	230	0
Total	**3,606**	**4,473**	**867**	**4,895**	**5,338**	**443**

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 November 2018 month end reporting period.

Lloyds Bank
Statements and Balances

Yesterday's Statement **N398611**

308012-13292060
ELECTRICITY NWL NO.15 (CELSIUS) (GBP)

Date	Type	Narrative	Value Date	Payments	Receipts	Balance
01MAY18		Opening Ledger Balance				2,802,571.01 Cr
09MAY18	CR	INTEREST (GROSS)			1,036.57	2,803,607.58 Cr
07JUN18	CR	FROM A/C TFR 01676933 300002			395.55	2,804,003.13 Cr
07JUN18	DR	TO A/C TFR 02749020 300002		163,275.25		2,640,727.88 Cr
07JUN18	DR	TO A/C TFR 02749020 300002		40,739.38		2,599,988.50 Cr
07JUN18	DR	TO A/C TFR 02749020 300002		109,196.24		2,490,792.26 Cr
07JUN18	DR	TO A/C TFR 02749020 300002		28,674.04		2,462,118.22 Cr
07JUN18	DR	TO A/C TFR 02749020 300002		67,099.52		2,395,018.70 Cr
07JUN18	DR	TO A/C TFR 02749020 300002		154,270.42		2,240,748.28 Cr
11JUN18	CR	INTEREST (GROSS)			1,105.95	2,241,854.23 Cr
09JUL18	CR	INTEREST (GROSS)			773.90	2,242,628.13 Cr
09AUG18	CR	INTEREST (GROSS)			980.00	2,243,608.13 Cr
10SEP18	CR	INTEREST (GROSS)			1,376.90	2,244,985.03 Cr
09OCT18	CR	INTEREST (GROSS)			1,248.58	2,246,233.61 Cr
09NOV18	CR	INTEREST (GROSS)			1,335.43	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
05DEC18		Value of Credits (8)			8,252.88	
05DEC18		Value of Debits (12)		1,115,038.92		
05DEC18		Closing Ledger Balance				1,695,784.97 Cr
05DEC18		Closing Cleared Balance				1,695,784.97 Cr

*** End of Report ***

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Appendix F: Celsius communications register

The below updates have been added to the Celsius communications register for the reporting period up to November 2018.

Date	Activity	Audience	Evidence
Jul 2018	Innovation learning event on Twitter	All stakeholders	
Jul 2018	Innovation learning event	All stakeholders	Slide presentation
Jul 2018	Learning event in internal Connect bullet	All employees	
Aug 2018	Industry newsletter	All stakeholders	Newsletter page
Aug 2018	Media release	All stakeholders	Media release

Date	Activity	Audience	Evidence
Aug 2018	Celsius on Twitter	All stakeholders	
Aug 2018	Celsius in local media	All stakeholders	LANCASTER GUARDIAN **£5.3m project aim is to keep costs down**  Electricity North West Celsius substation cooling. **Electricity North West is trialling a range of cooling techniques at 100 substations across the region, including two in Morecambe and one in Lancaster, to prepare the electricity network for renewable energy and keep costs down for customers.** The trial is all part of a £5.3 million pioneering project called Celsius, which is the first of its kind in Great Britain. Techniques such as improved ventilation, heat extraction fans and alternative kinds of material for filling cable trenches, will cool down substations and help get more out of the substation equipment.
Sep 2018	Advertorial	All stakeholders	Advertorial
Oct 2018	Industry newsletter	All stakeholders	Newsletter page
Oct 2018	LCNI conference	Industry stakeholders	Slide presentation