nortech

Running Cool NIA Project

Work Package 3.2 – Network Use Cases & Study

March 2024

Contents

Version History

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Glossary

Access SCR	Access Significant Code Review
ANM	Active Network Management
DER	Distributed Energy Resource
DNO	Distribution Network Operator
DSO	Distribution System Operator
ENA	Energy Networks Association
LIFO	Last-In First-Out
NGED	National Grid Electricity Distribution
NIA	Network Innovation Allowance
Ofgem	Office of Gas and Electricity Markets
OHL	Overhead Line
PV	Photovoltaic
SN2.0	Smart Navigator 2.0
STPFR	Short-Term Post-Fault Rating

Executive summary

This report presents the methodology and results for the assessment of network use cases and the quantified benefits realised by the application of short-term post-fault ratings (STPFRs) both in isolation and when integrated with active network management (ANM).

The STPFR method considers the adiabatic heating of the conductor to derive a maximum current rating suitable for use over short (10-minute) periods, designing out the need to monitor prevailing weather conditions.

There is a finite limit to the available capacity across the higher voltage distribution circuits, and several regions across the distribution licence areas are already operating towards the capacity limits. To accommodate further connections to the distribution network, without the significant costs of reinforcement, the distribution network operator (DNO)[1] currently offers alternative managed solutions to new connections. However, this can result in a significant volume of curtailment throughout the year, impacting the customer's business case, and deterring often 'clean' generators from connecting to the distribution system.

Results produced at the time of writing indicate that circuits rated at 50°C using 175 mm^2 Lynx conductor have demonstrated the potential yearly uplift in capacity of overhead line (OHL) distribution circuits using a STPFR to be approximately 6,842 MWh on average when compared to the static post-fault rating. Similarly, circuits rated at 75°C using a 175 mm^2 Lynx conductor can offer 2,961 MWh of capacity uplift on average. Using an NGED curtailment analysis tool, results have shown that STPFRs present a reduction in curtailment of approximately 1% over the static post-fault rating.

While the difference in curtailment reduction appears small between the static post-fault rating and the STPFR, the DNOs exposure to risk is preserved when considering the exceedance and potential for conductor temperature excursions above the maximum design temperature. On this basis, STPFRs represent a solution for the DNO to unlock significant latent capacity headroom without a change to the DNOs risk posture when compared to static post-fault ratings which have a 9% exceedance value. The deterministic nature of STPFRs and the 10-minute interval for ANM response does not increase any currently accepted risk of exceedance. However, the preserved level of risk exceedance relies on the ANM system's ability to react within the 10-minute STPFR window.

Currently, ANM systems have limited capabilities to take post-event action due to a delayed reaction time. A 10-minute time interval has been selected to allow the ANM system to apply post-event curtailment measures, which reduces pre-event curtailment measures, and consequently, the overall level of curtailment applied to the circuit.

When combined with ANM or flexibility systems, STPFRs have the potential to greatly reduce curtailment or load shedding for customers connected under curtailable or flexible terms. Subsequently, it may lead to network reinforcement deferral, resulting in a net-positive business case for distributed energy resources (DER) to connect to the distribution system. Moreover, reduced customer curtailment benefits DNOs by potentially reducing flexibility service procurement that is used to defer capital expenditure (due to higher cost-effectiveness), further prolonging the period over which flexibility service procurement is more cost-beneficial over capital expenditure.

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[1] For the purpose of this report, it is assumed the DNO will make use of STPFRs. However, there are also STPFR applications relevant to the distribution system operator (DSO).

Project Background

‘Running Cool’ is a National Grid Electricity Distribution (NGED) [2] project which is funded through the Office for Gas and Electricity Markets (Ofgem) Network Innovation Allowance (NIA) mechanism. This project aims to evaluate and integrate dynamic OHL post-fault rating capability into ANM systems.

‘Running Cool’ builds upon the learnings and successes of a previous NGED NIA project, ‘Overhead Line Power Pointer’ [3], where OHL smart sensors capable of self-powered operation, capture real-time current, conductor temperature, and directional power flow. OHL Power Pointer recorded data in 120 trial locations spanning 11kV, 33kV, 66kV and 132kV overhead circuits. Data captured during the trial has been used to assess OHL network operation more accurately, and more effectively determine the location of faults.

This report presents the methodology and results of conductor temperature monitoring field trials where STPFRs have been implemented. The application of STPFRs has been developed and demonstrated as seen in ‘Realising the Benefit of Short-Term Post-Fault Ratings Using OHL Smart Sensors for Increased DER Integration’ [4]. This method further investigates and quantifies the benefits obtained by the implementation of STPFRs in reducing the level of curtailment for new and existing connections on the network and increasing the available capacity on a circuit.

ANM systems are used to manage and curtail customers that connect in areas where multiple complex constraints affect customers over an extended period. Depending on the network operating conditions (for example system intact or n-1 contingency), OHL ratings are either pre-fault or post-fault, meaning that a significant number of these connections can be curtailed on a precautionary basis under intact network conditions, in anticipation of the next ‘worst circuit’ fault to keep assets within defined ratings. This arrangement leads to customers being curtailed despite the absence of faults. Moreover, the increased level of curtailment can lead to generators being unable to justify the business case, resulting in a reduced volume of new generation.

Under previous regulatory arrangements, generators triggering network reinforcement in the upstream, higher voltage level would be required to contribute to the cost on a pro-rata basis depending on the (static) capacity utilised. However, a reform to access rights in April 2023, implemented by Ofgem through the Access Significant Code Review (Access SCR) means that generators are only required to contribute towards reinforcement at the same voltage level as the point of connection, with the removal of the charge for wider network reinforcement being subject to the High Cost Project Threshold of £200/kW. Instead, any compulsory reinforcement at the voltage level above will be borne by the DNO. It will be the responsibility of the DNO to ensure that there is sufficient capacity for all generation connection applications.

As UK distribution networks evolve to incorporate more DER, DNOs must ensure sufficient network capacity is available to accommodate more DER connections. In turn, this will aid in the reduction of the overall carbon intensity of energy delivered to customers and help to further the transition of the UK energy system to net zero [5].

Details of Work Conducted

This section defines the methodology for the assessment of network use cases and the quantified benefits realised by the application of STPFRs both in isolation and when integrated with ANM. Building on the work completed during the OHL Power Pointer project, the analysis methodology will focus on assessing the improved headroom, energy capacity, and avoided curtailment when using real-time temperature data from Smart Navigator 2.0s (SN2.0) installed during OHL Power Pointer and Running Cool.

1. Methodology

1.1 Calculating the Short-Term Post-Fault Rating

The STPFR of an OHL exploits the thermal capacity of the conductor material (such as aluminium, aluminium alloy or copper). The calculation of the adiabatic rating, based on CIGRE Technical Brochure 601, is not dependent on the measurements of other heat transfer mechanisms (such as convective cooling, solar heating, and radiative heating/cooling). The conductor temperature measurement is the only parameter required to be monitored in real-time to provide a rating to cover short-term (up to 10 minutes) post-fault generation curtailment events.

A 10-minute rating was selected to allow ANM systems to take “post-event” actions since ANM reaction and enaction times have been shown to be as long as 10 minutes.

CIGRE Working Group B2.43 published Technical Brochure 601 (TB 601) “Guide for Thermal Rating Calculations of Overhead Lines” in December 2014 [6]. TB 601 is referenced in the Energy Networks Association (ENA) Engineering Recommendation (ER P27) [7] with consideration given to the thermal rating calculation model and an associated software program.

TB 601 offers a model for calculating the thermal rating of OHLs. It provides typical input parameters used in the thermal model, including wind speed, wind direction, ambient temperature, solar radiation, and conductor resistance. TB 601 Annex E.3 details an example of a temperature tracking calculation, it describes a method to continuously calculate the conductor temperature, considering the weather and current data are provided in 10-minute time intervals. The method derives an estimated final conductor temperature based on the starting conditions, a given set of weather conditions and fixed current loading for the 10-minute period.

NGED’s temperature-based post-fault rating is an adaptation of the TB 601 temperature tracking calculation [6]. It has been implemented on the basis that the starting temperature of the conductor is known, the final temperature of the conductor is known (design temperature rating), and the current carrying capacity is to be determined from the capacity of the conductor to heat to the design temperature over the 10 minutes, assuming adiabatic conditions. For further information, see Work Package 2 (Short-Term Post Fault Rating Technical Specification and Risk Assessment) available from the NGED Innovation Team.

1.2 Capacity and Rating Uplift

Data gathered from SN2.0 locations on K-Line, a 132kV circuit in Cornwall/ Devon, and from Running Cool sites has been used to analyse the increase in available energy capacity when a STPFR is implemented. In doing so, the increase in available capacity can be assessed across all seasons compared to the static seasonal ratings. Data from circuits with multiple SN2.0s installed has been aggregated based on the lowest calculated STPFR value at each timestamp. Where circuits consist of multiple conductor constructions, the static seasonal ratings of the constraining conductor construction have been used as the lower limit of the STPFR in instances where the STPFR is below the static post-fault rating.

For this study, “static seasonal pre-fault” refers to the variable pre-fault rating which applies to intact networks where loads have a degree of variability. The variable pre-fault rating has a small risk of exceedance which is balanced by the relatively low likelihood of the exceeding load occurring due to its variability throughout the measured period. For networks where a load with limited variability is expected, the sustained load pre-fault rating is used. This is a more conservative rating which considers continuous load close to or at the rating as “safe” given the minimal risk of exceedance due to limited load variability.

“Static post-fault” ratings are typically applied to networks where faults may be more prevalent. Therefore, the rating caters for contingency loads that appear on the remaining intact circuits following a fault outage of another circuit on the network. Loads close to or at the post-fault rating have a higher risk of exceedance compared to the variable pre-fault rating but are again balanced by the exceptionally low likelihood of such a load occurring.

1.3 Curtailment Analysis for New Connections

A selection of SN2.0 sites that are subject to or considered for ANM have undergone a curtailment analysis to quantify the reduction in curtailment to new customers when using an STPFR compared to the static seasonal ratings. Additionally, the analysis has assessed the difference in available capacity between a constraining circuit that is lightly loaded, and a constraining circuit that is heavily loaded. Due to the constant analysis performed by the ANM system, it is possible for a circuit to be constraining during intact network conditions or when lightly loaded, as the system looks to ensure network security during an n-1 scenario.

Methodology

A dataset of recorded half-hourly STPFR and load values was produced and input into an NGED constraint analysis tool that contains Last-In-First-Out stack data, which takes into account applied for and accepted connections, and generator profiles for the chosen circuit during the selected period. This data was used to assess the scaled output capacity of a new connection when the maximum capacity of the circuit was adjusted between the static seasonal post-fault rating and STPFR. An ANM capacity factor was generated that quantifies the percent of available capacity and the reduction in curtailment for a new connection.

2. Project Locations

Each SN2.0 installation location was selected based on the circuit being subject to or considered for ANM curtailment. The location selection can be found in **Error! Reference source not found.**. Currently, all 132kV SN2.0 installation sites use the 175mm^2 Lynx conductor. 132kV circuits were selected based on their propensity to be amongst the most thermally constrained on the network. Moreover, the higher conductor rating temperature for 132kV constructions enables them to reap the most benefits when using an STPFR.

Table 1: Project SN2.0 Installation Locations

Site/ Circuit	License Area	Number of Installations	Conductor Type
Staythorpe	East Midlands	2	175 mm^2 Lynx, ACSR
Melton Mowbray	East Midlands	2	175 mm^2 Lynx, ACSR
SPEN Boundary	South Wales	4	175 mm^2 Lynx, ACSR
Pembroke	South Wales	1	175 mm^2 Lynx, ACSR
Rame	South West	2	175 mm^2 Lynx, ACSR
Totnes	South West	1	175 mm^2 Lynx, ACSR

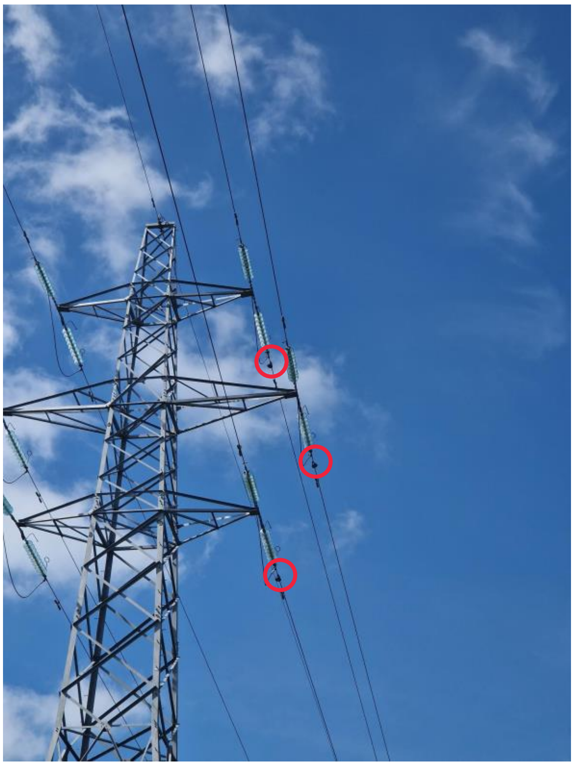


Image 1: Melton Mowbray Installation

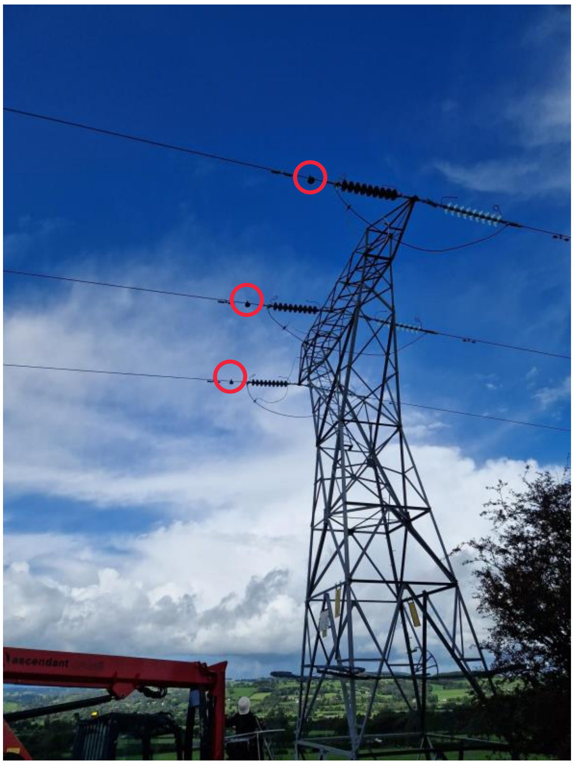


Image 2: SPEN Boundary Installation

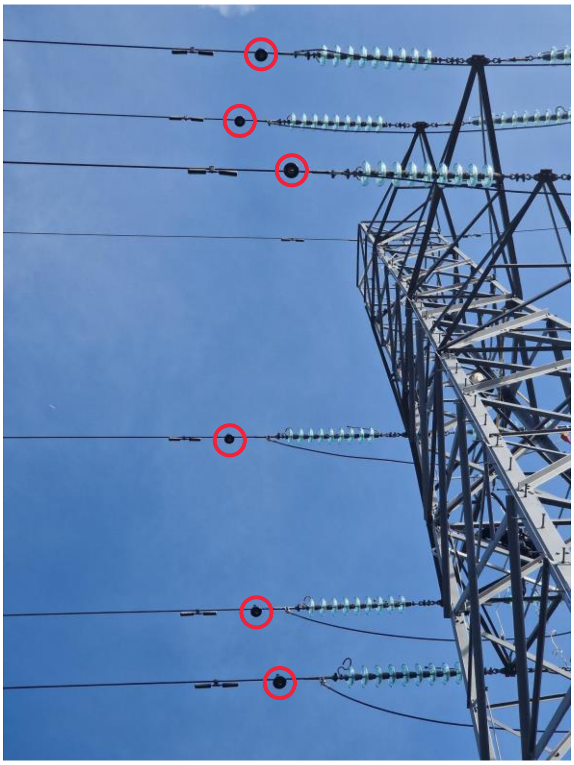


Image 3: Staythorpe 1 & 2 Installation

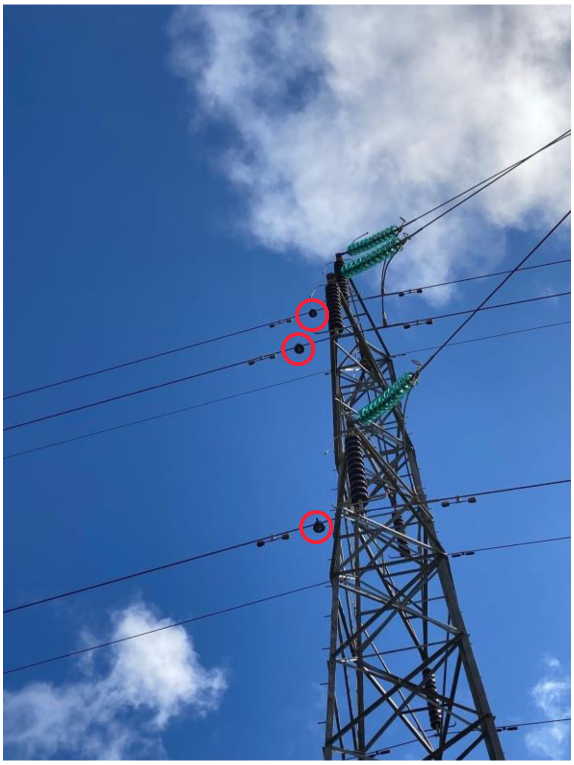


Image 4: Pembroke Installation

Results

1. Rating Uplift

1.1 Running Cool Installations

Analysis

Data collected for the units installed during this project ranges from January 2023 to December 2024. The dataset provides a representative example of the possible uplift across a variety of circuits.

Table 2 summarises the scaled potential annual uplift in MWh for several sites during the project. On average, a potential uplift of 6,842 MWh is expected for circuits rated at 50°C using a 175 mm^2 Lynx conductor. Melton Mowbray 2 shows the highest capacity uplift of all sites at 10,648 MWh against the static post-fault rating. A common trend amongst all sites is that the greatest uplift is produced during the cooler months of the year which can be seen in Appendix 2. This is a result of lower ambient temperatures cooling the conductor while it operates at an equivalent load. Table 6 in the Appendix 1 further breaks down the minimum, maximum, and average uplift for all the circuits studied during this project.

Table 2: Scaled Yearly Uplift (MWh) Running Cool Installations

Site/ Circuit	Scaled STPFR Uplift over Static Post-Fault Rating (MWh)
Melton Mowbray 1	10,043
Melton Mowbray 2	10,648
Pembroke	5,681
Rame 1	3,209
Rame 2	2,923
SPEN NN	8,615
SPEN CC	9,412
Totnes	4,206

1.2 K-Line

Locations

Located in the South-West License area, K-Line is a thermally constrained 132kV circuit of high interest due to the large volume of applications in Cornwall. During the forerunning project 'OHL Power Pointer,' ten sets of SN2.0s were installed between Alverdiscott and Northmoor Solar Park on two separate circuit sections.

Analysis

A historic analysis of two circuit sections on K-Line, ALVE 305 (NOMO), and ALVE 205 (GALS), between January 2021 to December 2023 highlights the potential uplift of a heavily loaded, constraining circuit. The chosen circuit sections use a 175 mm^2 Lynx ACSR conductor, with a rated temperature of 75°C. Across the two years, the average scaled annual uplift over the post-fault rating is 2,961 MWh.

Results have shown that in circuits with limited available capacity, operating at the static seasonal rating, and consequently higher temperatures, the implementation of STPFRs will not produce a significant potential uplift. For circuits where this is the case, the implementation of an STPFR must be assessed further.

Table 3: Scaled Yearly Uplift (MWh) K-Line

Site/ Circuit	Scaled STPFR Uplift over Static Post-Fault Rating (MWh)
K-Line - ALVE 305 (NOMO)	2,508
K-Line - ALVE 205 (GALS)	3,413

2. Curtailment Analysis

A curtailment analysis has been performed on both K-Line circuit sections and a site outside of the Rame substation installed during this project. The analysis of K-Line sites uses historic curtailment data to quantify the ANM capacity factor for a new connection retrospectively. In contrast, the Rame site uses a representative data set combined with measured load and STPFR values from the SN2.0.

The analysis method quantifies the change in ANM curtailment signals and available capacity when a STPFR is used compared to the static post-fault rating. Due to the constant analysis performed by the ANM system, it is possible for a circuit to be constraining during intact network conditions or when lightly loaded, as the system looks to ensure network security during an n-1 scenario. During intact network conditions, the circuit is constrained to the static sustained pre-fault rating which is established in anticipation of the next 'worst circuit' fault to ensure network stability.

When operating at the static post-fault rating, a new connection to K-Line ALVE 305 (NOMO) with a connection capacity of 5MVA will have an ANM capacity factor of ≈ 51%, where the capacity factor is equivalent to the percent of unconstrained generation during the measured date range. This signifies that ≈ 49% of total potential generation output is curtailed at all times. From Table 4 it is evident that the reduction in curtailment between the static post-fault rating and the STPFR is low at under 1%. The high load present on the K-Line circuit results in the conductor operating at a relatively high temperature, which reduces the potential benefit gained by the implementation of a STPFR.

Looking at a new 5MVA connection to Rame 1, the ANM capacity factor when operating under post-fault conditions is ≈ 59%. While the conductor temperature delta is greater for this site, the capacity of connected generation is high, which results in over 40% curtailment across a year.

Table 4: ANM Capacity Factor for New Connections

Site/ Circuit	Post-Fault Rating	STPFR
K-Line - ALVE 305 (NOMO)	51.08	51.86
K-Line - ALVE 205 (GALS)	99.78	99.78
Rame 1	59.19	59.24

Using the NGED constraint analysis tool and STPFR data, the STPFR uplift over the static post-fault rating has been plotted against the constraint overload. The constraint overload on the circuit is calculated by subtracting the scaled pre-event limit (STPFR) from the constraint load on the circuit before a new connection is added when the constraint load is greater than the pre-event limit. Each data point has been plotted by its corresponding hour of the day to demonstrate the daily overload profile of the circuit. As shown in Figures 1-3, the overload has a bell-shaped profile which peaks after mid-day. Moreover, the figures demonstrate how there is a constant uplift throughout the day that can limit and potentially avoid overload and subsequent curtailment when implemented.

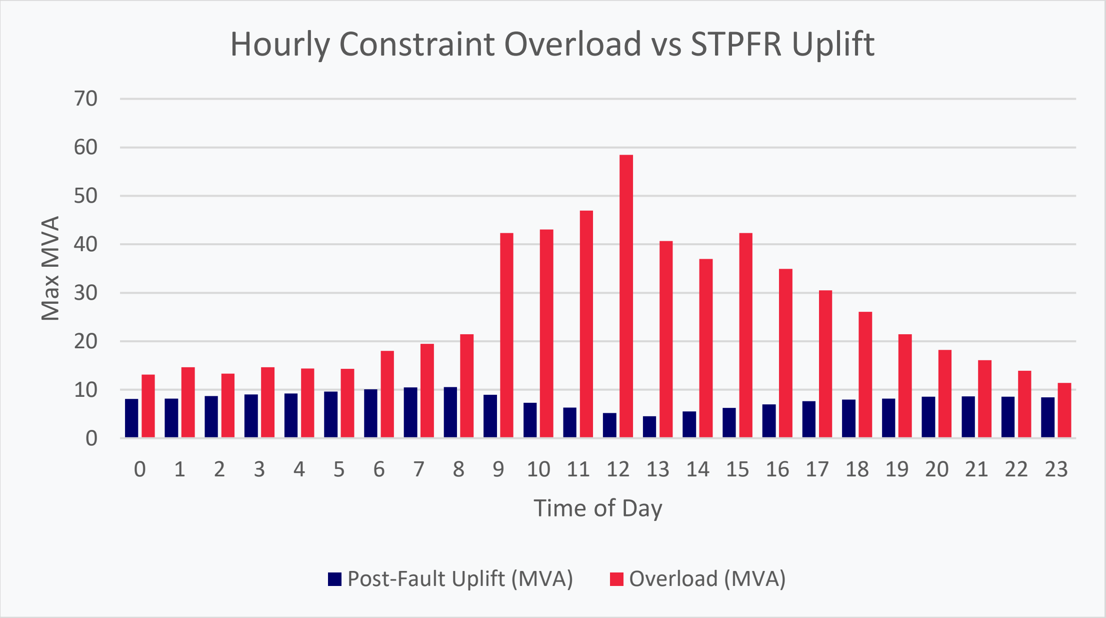


Figure 1: K-Line ALVE 305 (NOMO) Hourly Post-Fault Constraint Overload vs STPFR Uplift

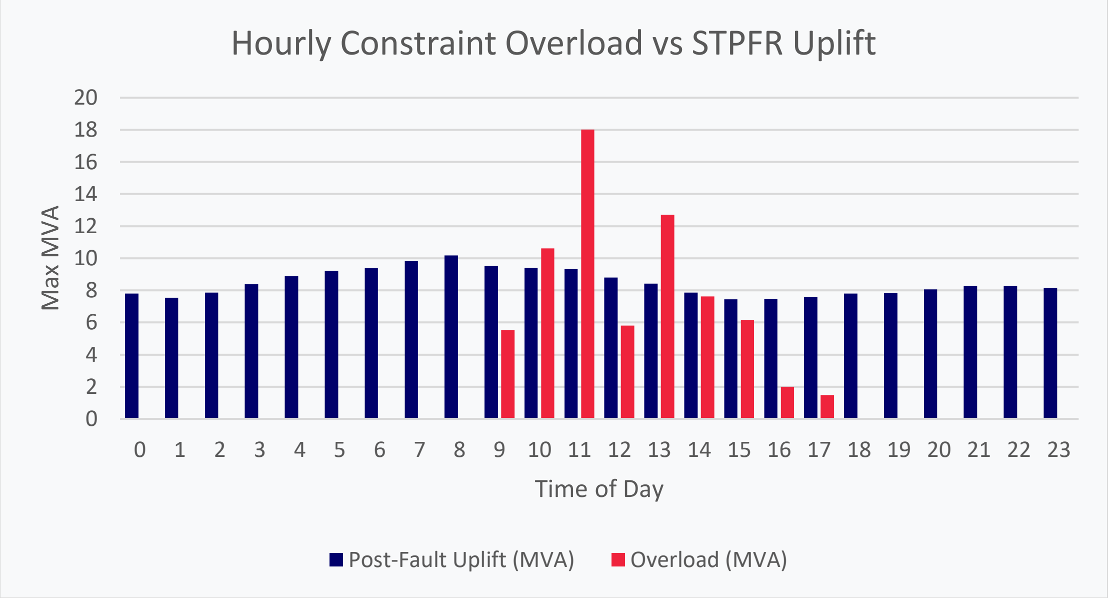


Figure 2: K-Line ALVE 205 (GALS) Hourly Post-Fault Constraint Overload vs STPFR Uplift

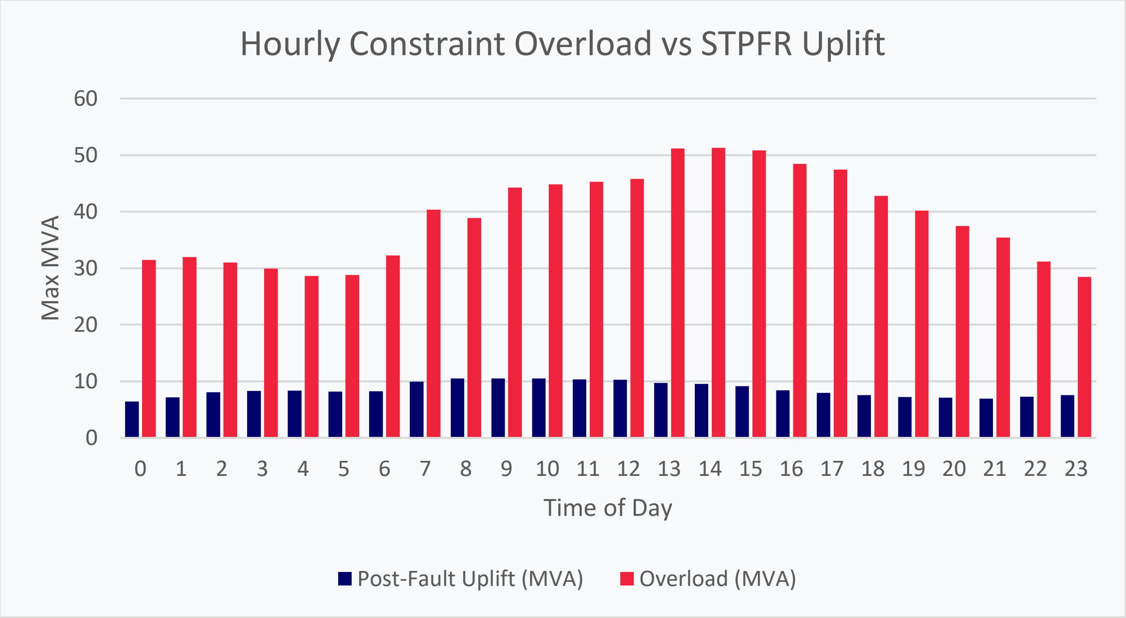


Figure 3: Rame 1 Hourly Post-Fault Constraint Overload vs STPFR Uplift

3. Discussion

Table 4 provides an indication of the potential reduction in curtailment that can be obtained with the implementation of a STPFR. Despite small improvements in curtailment reduction over the static post-fault rating, STPFRs represent a solution for the DNO to unlock significant latent capacity headroom without a change to the DNOs risk posture when compared to static post-fault ratings which have a 9% exceedance value. Exceedance, expressed as a percentage, represents the risk of a conductor exceeding its rated temperature when the full, rated current is applied to it and results in potential temperature excursions, are documented as per Table B2 in SD8/A. The deterministic nature of STPFRs and the 10-minute interval for ANM response does not increase any currently accepted risk of exceedance. However, the preserved level of risk exceedance relies on the ANM system’s ability to react within the 10-minute STPFR window.

STPFRs are especially beneficial on large circuit sections that are made up of differing conductor constructions or that cover differing terrain which results in numerous differences in environmental conditions.

Figures 1, 2, and 3 illustrate the distinct hourly uplift profile that is comparable across three different sites, with the lowest uplift during peak sunlight hours. This uplift profile signifies that STPFRs are more beneficial to circuits with substantial amounts of battery and wind connections which are constantly supplying power. The hourly ambient temperature bears a bell curve profile which drives the base conductor temperature. Because the STPFR rating is calculated using an adiabatic methodology, the baseline is dominated by the ambient temperature and conductor load. Unlike wind and battery power, PV connections generate the largest output during the middle of the day, which limits the benefit of STPFRs during those hours. However, based on the results presented above, the implementation of STPFRs offers a “little but often” benefit with significant aggregate energy volume.

Conclusion

This report has presented the methodology and results for the assessment of network use cases and the quantified benefits realised by the application of STPFRs both in isolation and when integrated with ANM.

The results presented above have shown that on average, a potential uplift of 6,842 MWh is expected on average for circuits rated at 50°C using a 175 mm^2 Lynx conductor. The greatest uplift is produced during the cooler months of the year as a result of lower ambient temperatures cooling the conductor while it operates at an equivalent load. Connection curtailment results have shown that STPFRs present a reduction in curtailment of approximately 1% over the static post-fault rating.

STPFRs represent a solution for the DNO to unlock significant latent capacity headroom without a change to the DNOs risk posture when compared to static post-fault ratings which have a 9% exceedance value. The deterministic nature of STPFRs and the 10-minute interval for ANM response does not increase any currently accepted risk of exceedance. However, the preserved level of risk exceedance relies on the ANM system's ability to react within the 10-minute STPFR window.

A common hourly uplift profile was identified by this study amongst all sites which produces the minimum uplift during peak sunlight hours and the bulk of the uplift during the evenings and mornings. This uplift profile benefits generators that have a constant energy output irrespective of meteorological conditions. This is a result of the adiabatic methodology used to obtain the STPFR which is dominated by ambient temperature, which has a bell curve profile, and conductor load. Generators such as PV connections that have an output profile similar to the ambient temperature profile will not be capable of reaping the full benefits of STPFRs. However, based on the results presented above, the implementation of STPFRs offers a "little but often" benefit with significant aggregate energy volume that will further unlock latent capacity within the distribution network, enabling NGED to consider accommodating more distributed energy resource connections, which would lead to a reduction in the overall carbon intensity of energy delivered to customers. This, in turn, will help to deliver 'Decarbonisation and Net Zero' – a priority area in NGED's Innovation Strategy [5], facilitating the UK's transition to a net-zero energy system.

Next Steps

The next steps in the project are outlined below.

- Upcoming work packages will produce a cost-benefit analysis (WP 5.1) and a review of existing policies for the implementation of SN2.0s will be completed (WP 5.2).

References

[1] S. Hoffmann, “STANDARD TECHNIQUE: SD8A/3,” Western Power Distribution, 2020.

[2] National Grid, “Running Cool,” 2023. [Available on Request].

[3] National Grid, “Overhead Line Power Pointer,” January 2022. [Online]. Available: https://www.nationalgrid.co.uk/innovation/projects/ohl-power-pointer. [Accessed 24 01 2023].

[4] S. Jupe, L. Troshka, S. Casallas Ramirez and S. Hoffmann, “REALISING THE BENEFIT OF SHORT-TERM POST-FAULT RATINGS USING OHL SMART SENSORS FOR INCREASED DER INTEGRATION,” in *27th International Conference on Electricity Distribution (CIRED)*, Rome, 2023 (Accepted).

[5] National Grid, “Innovation Strategy,” 2022. [Online]. Available: https://www.nationalgrid.co.uk/innovation/innovation-strategy. [Accessed 24 01 2023].

[6] CIGRE Working Group B2.43, “Technical Brochure 601: Guide for Thermal Rating Calculations of Overhead Lines,” in *CIGRE Paris*, Paris, 2014.

[7] Energy Networks Association, “EREC P27 (Issue 2) - Current rating guide for high voltage overhead lines operating in the UK distribution system,” Energy Networks Association, 2020.

Appendices

Appendix 1 – Post-Fault Uplift Comparison Tables

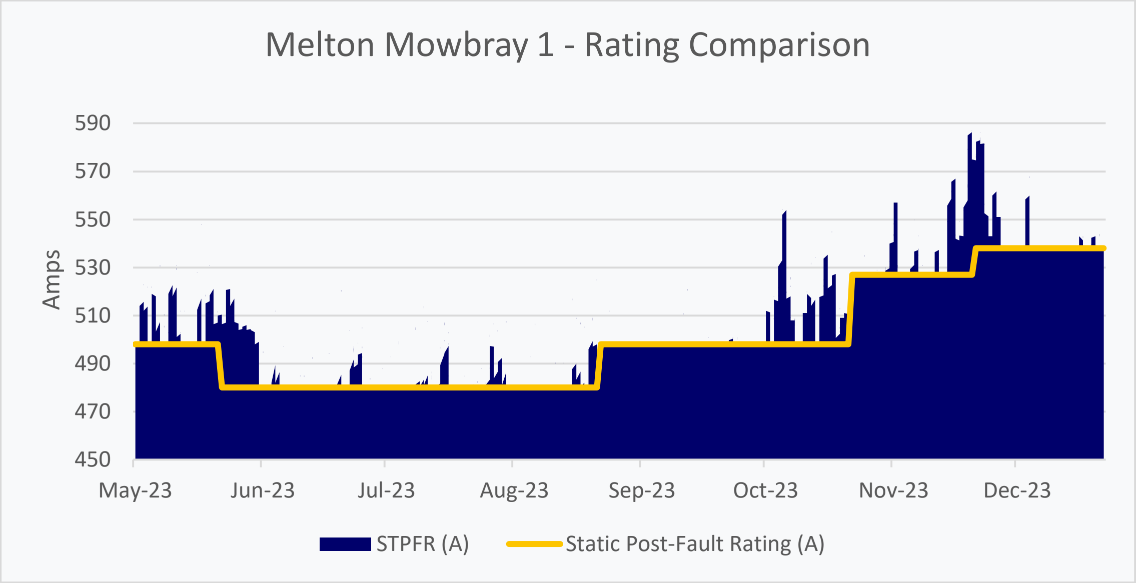
Table 5: 50°C Lynx Conductor Uplift (Mixed Length Datasets)

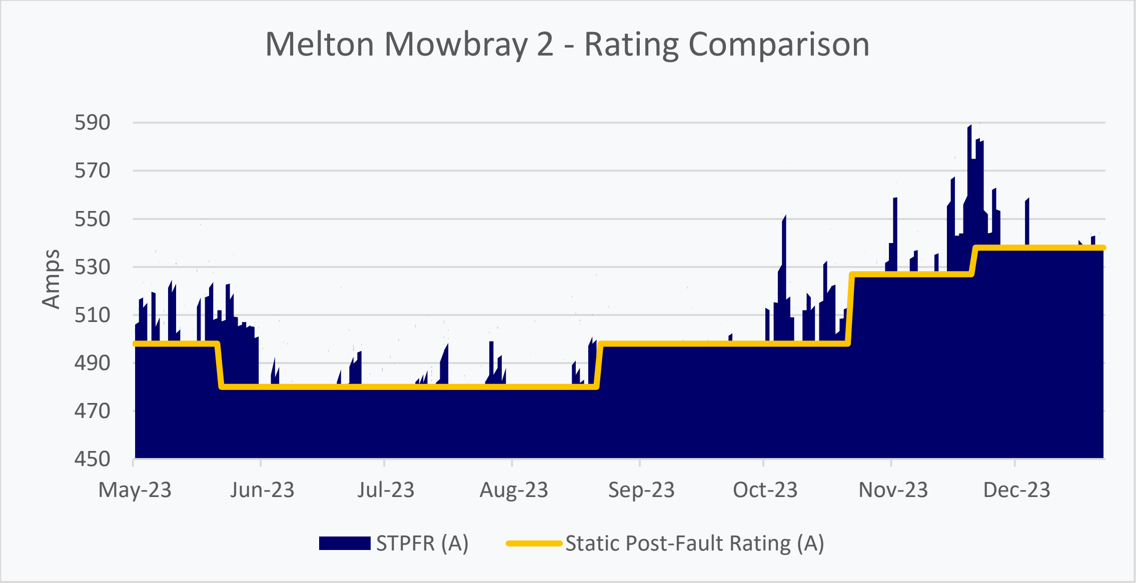
Site/ Circuit	Measurand	Amps	Percent (%)
Melton Mowbray 1	Maximum Uplift	76.00	15.26
	Average Uplift	5.01	1.00
Melton Mowbray 2	Maximum Uplift	76.00	15.26
	Average Uplift	5.32	1.06
Pembroke	Maximum Uplift	119.00	22.58
	Average Uplift	2.84	0.55
Rame 1	Maximum Uplift	47.00	8.92
	Average Uplift	1.60	0.32
Rame 2	Maximum Uplift	45.00	8.36
	Average Uplift	1.46	0.29
Totnes	Maximum Uplift	53.00	10.24
	Average Uplift	2.10	0.42
SPEN Boundary NN	Maximum Uplift	58.00	11.01
	Average Uplift	4.30	0.85
SPEN Boundary CC	Maximum Uplift	64.00	12.14
	Average Uplift	4.70	0.91

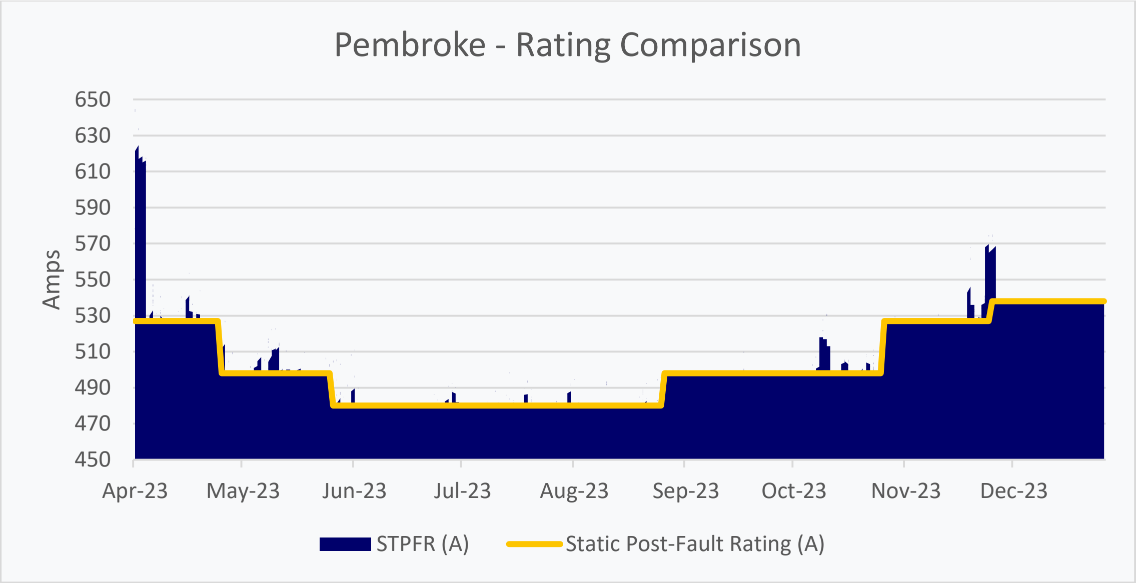
Table 6: 75°C Lynx Conductor Uplift (Two-Year Time Period)

Site/ Circuit	Measurand	Amps	Percent (%)
K-Line - ALVE 305 (NOMO)	Maximum Uplift	53.00	10.24
	Average Uplift	2.10	0.42
K-Line - ALVE 205 (GALS)	Maximum Uplift	45.55	0.07
	Average Uplift	1.25	0.002

Appendix 2 – Rating Comparison Charts






Pembroke - Rating Comparison
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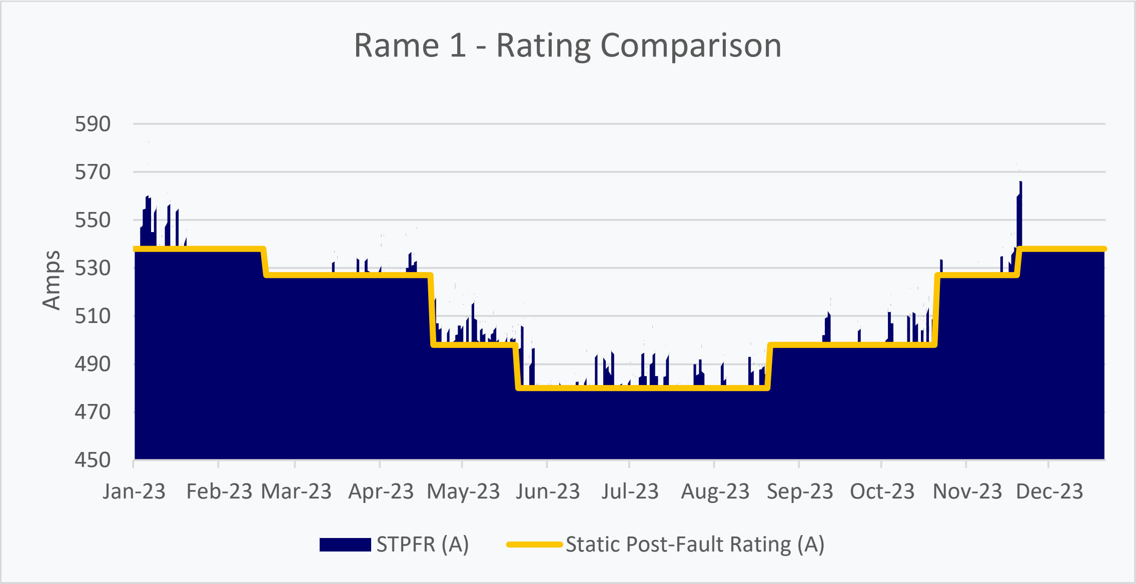
STPFR (A)
Static Post-Fault Rating (A)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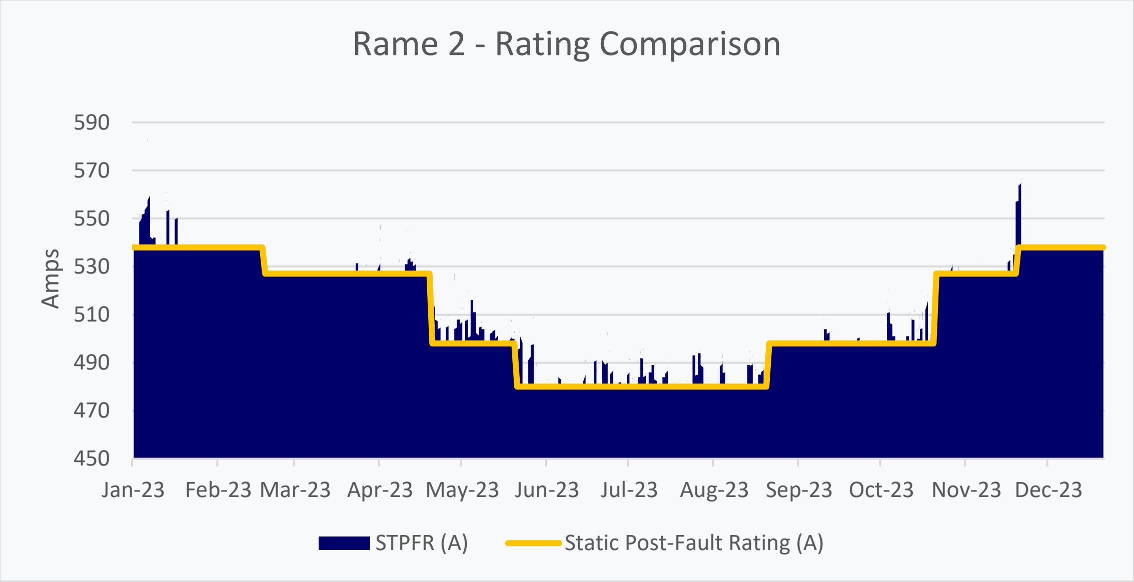
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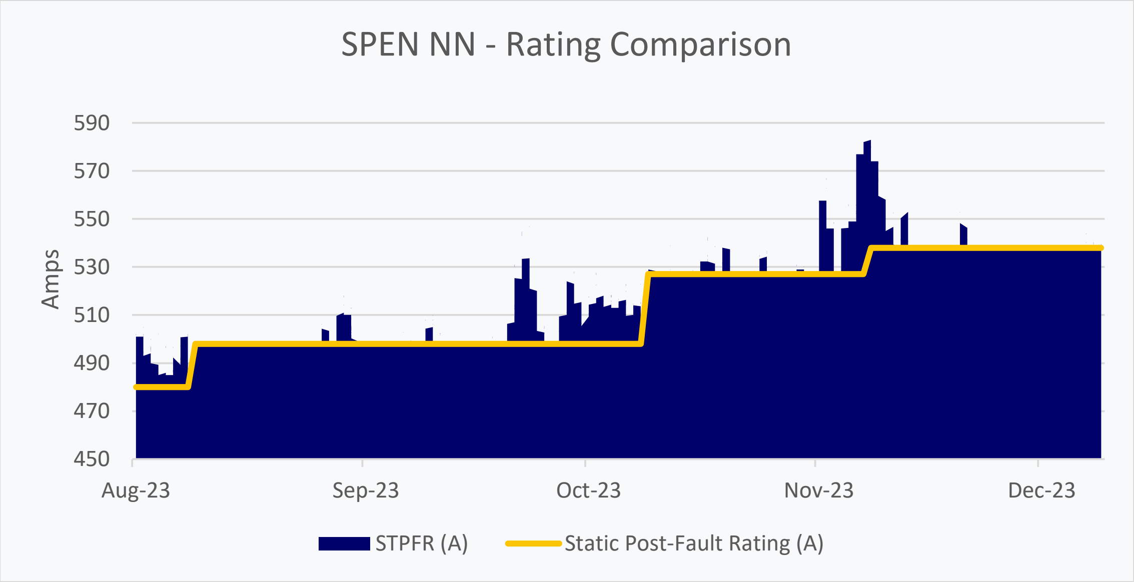
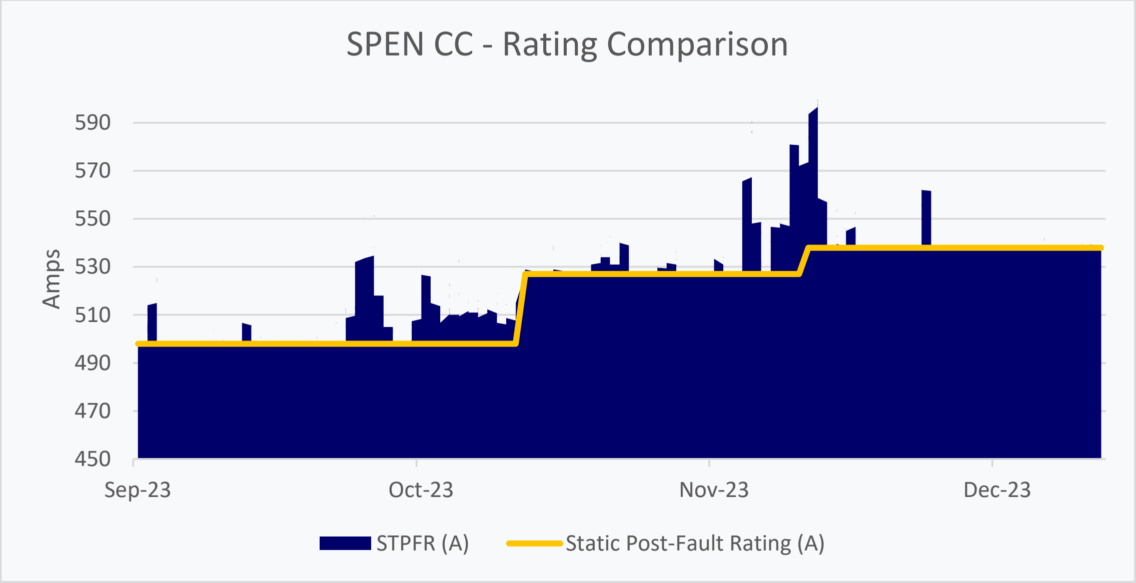
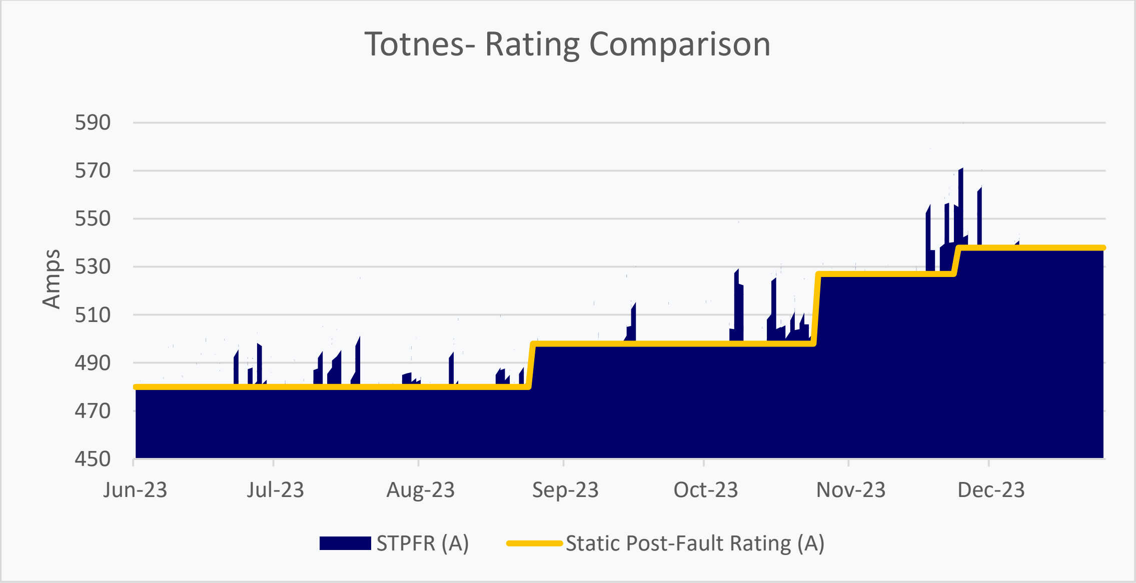
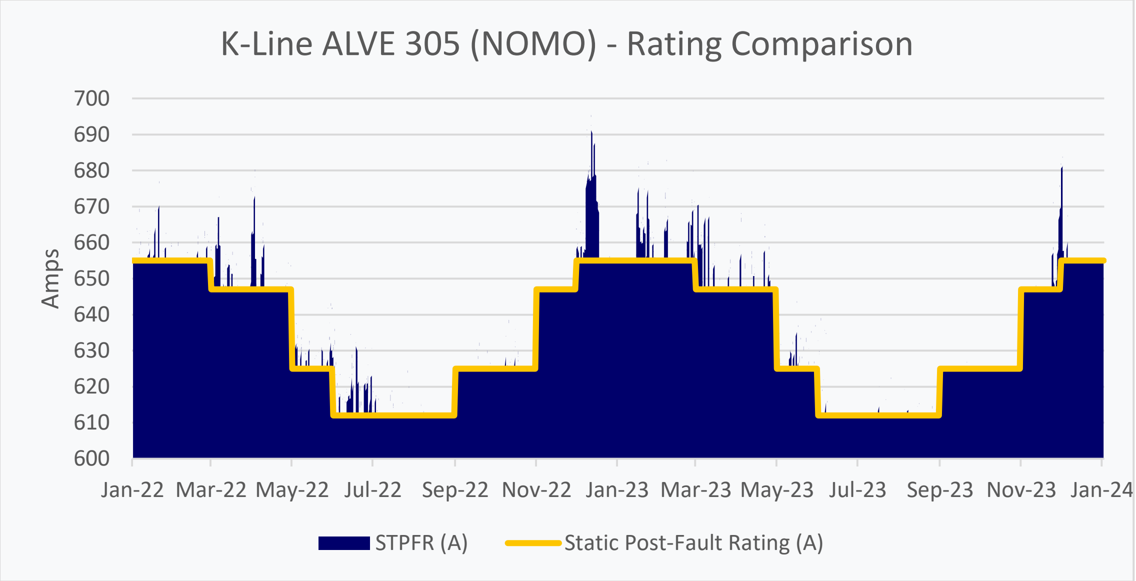
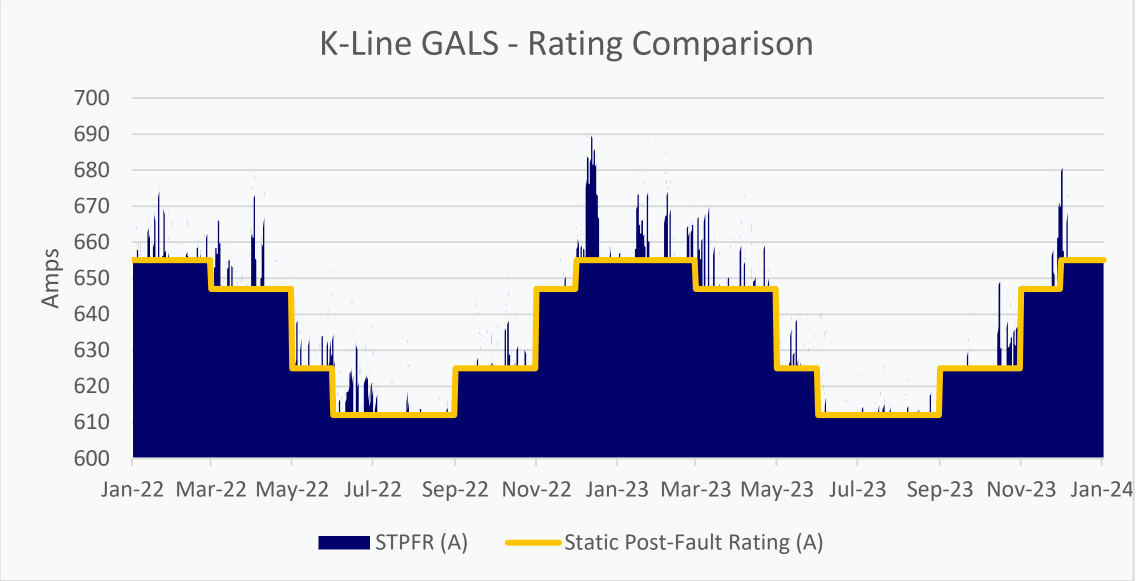
STPFR (A)
Static Post-Fault Rating (A)


SPEN NN - Rating Comparison
Amps
590
570
550
530
510
490
470
450
Aug-23
Sep-23
Oct-23
Nov-23
Dec-23
STPFR (A)
Static Post-Fault Rating (A)


SPEN CC - Rating Comparison
590
570
550
530
510
490
470
450
Amps
Sep-23
Oct-23
Nov-23
Dec-23
STPFR (A)
Static Post-Fault Rating (A)


Totnes- Rating Comparison
590
570
550
530
510
490
470
450
Amps
Jun-23
Jul-23
Aug-23
Sep-23
Oct-23
Nov-23
Dec-23
STPFR (A)
Static Post-Fault Rating (A)


K-Line ALVE 305 (NOMO) - Rating Comparison
Amps
700
690
680
670
660
650
640
630
620
610
600
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
STPFR (A)
Static Post-Fault Rating (A)


K-Line GALS - Rating Comparison
Amps
700
690
680
670
660
650
640
630
620
610
600
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23
Sep-23
Nov-23
Jan-24
STPFR (A)
Static Post-Fault Rating (A)

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