Validation report

Brill Power

15.08.2023

Validation ID: MB2307

Impact Forecast

Impact Insights & additionality

Contents

Details of the validation process

Timestamps and results:
The validation documented in this report was delivered with the following time stamps and results:

Brill Power	Validation request	First review	Feedback call	Hand-in revisions	Final review	Wrap-up call
Date	11/08/23 18h51	15/08/23 11h00	25/08/23 10h00	04/09/23 10h54	22/09/23 17h00	26/09/23 10h00
Result	Plausible, positive and significant			Valid, positive and significant		

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Introduction to CIF Validation

To determine the validity of self-assessed climate impact forecasts we provide CIF Validation, which is a third party verification of the calculation of the climate and environmental impact of an innovation, in order to conclude if the Climate Impact Forecast is valid, positive and significant.

Problem solved

There are areas of LCA expertise that can not be covered in the Climate Impact Forecast workshops or CIF Training, for example where domain knowledge and experience are required. With self-assessments there is also a risk of optimism bias. Validation assures that forecasts do not contain gaps, scoping errors, unsupported assumptions or inappropriate data sources. CIF Validations are made on the request of the project team, and possibly commissioned by an impact organisation. The results are used by teams and organisations to compare and communicate the climate impact of projects.

A validation process performed by an impartial impact expert, who has read about the innovation, seen the forecast and used a checklist to assess its validity. The validator provides detailed written feedback and offers the opportunity for a revision. The goal of this process is twofold: increase the quality of a forecast and to conclude if the forecast is suitable to draw conclusions about the positive climate impact of the innovation. This Validation report documents the results of that process.

Definitions of key terminology

Climate Impact Forecast (CIF)	A Climate Impact Forecast or CIF is an LCA based calculation of the GHG reduction or climate adaptation potential of a project. Using our CIF tool, the project team found the net climate impact of the key differences between business as usual and their innovative solution.
CIF Validation process	A review process delivered by a validator and guided by a structured check of the information entered into a CIF, a sensitivity analysis and the write-up of an Impact story. This process usually takes two weeks and includes a first review, a first feedback call between the team and validator, time for revisions if needed, a final review and a final results call.
Validator	Validations are delivered by Validators; CIF trainers with LCA expertise who are trained to perform this process in a uniform and objective way. Other than providing this service, Validators have no relationship with or obligations to the company or supporting organisation requesting the validation, assuring an impartial third party review.
Validation result	The CIF Validation result consists of three independent outcomes, which in the best case are valid, positive and significant. These qualifications and the alternative outcomes are explained on the next page.

The CIF Validation result consists of three independent outcomes

Validity of the forecast

A CIF is valid if it is representative of the project, using appropriate data and well-justified assumptions. Therefore, the CIF and its results are representative of the potential for the project to mitigate, enable or adapt to climate change.

Detailed requirements for validity are specified on www.impact-forecast.com/ CIF-validations. A CIF can be:

Valid	Plausible	Improbable	Invalid

Reduction potential

A CIF is positive when it shows that the project has a lower climate impact than business as usual, or improved climate resilience in the case of adaptation. A positive mitigation or enabler CIF file shows the avoided GHG emissions in $-tCO_2eq$.

This outcome depends on a sensitivity assessment. CIF results can be:

Positive	Positive within limits	Unclear	Sensitive	Negative

Impact threshold

A CIF is significant when the project has a climate impact (positive or negative) greater than 5 tonnes of CO_2eq per year. This is roughly the global average annual CO_2 emissions per person and the mass of a male African Elephant.

The threshold for significant impact can be set to a higher amount for a particular organisation or occasion. The result can be:

Significant	Marginal

Brill Power CIF Validation

This validation consists of the following sections

Impact story	An impact story is a summary of how a project makes a positive climate impact. It is written by the validating impact expert and contains the key impact data from the Climate Impact Forecast.
Climate Impact Forecast and Validation result	The Climate Impact Forecast shows the scope and parameters of the impact calculation. This includes the resources used and saved by the innovation, their amount and climate impact, the climate impact per unit of user, and the total climate and environmental impact for all units or users in the timeframe. Validator feedback is included on strong and weak points of the forecast as a whole, as well as the conclusion from the sensitivity assessment and the approval status of individual parameters. The conclusion of the validation process is noted in the Validation result.
Sources and assumptions	The differences (resources used and reduced by the innovation, compared to the baseline solution) and quantities (of materials, energy etc.) in the forecast are based on sources and assumptions specified in this section.
Impact projection	The Impact projection multiplies the climate impact per unit with the amount of units planned in the next five years, for a view of the innovation's climate impact at its future scale. This section also includes a look into expected development of baseline emissions.

Battery intelligence platform to make batteries perform better and live longer

Brill Power provides a battery management system for stationary energy storage batteries that acts as a full end-to-end solution consisting of both hardware and software. This battery intelligence platform uses active loading technology to increase the performance and lifetime of the batteries in stationary energy storage applications. In this way it will avoid the need for augmentation of storage batteries in systems with passive balancing and therefore have positive climate impact.

How does Brill Power make a positive climate impact? Compared to which baseline?

The battery management system (BMS) from Brill Power for stationary storage battery systems optimises the working conditions of the different battery cells by actively loading the different cells. Compared to stationary energy storage battery systems that currently use a BMS with passive balancing, Brill Power's innovation extends the lifetime and increases the performance of the battery. While a BMS with passive balancing needs augmentation over time to keep the same capacity by adding new battery cells to the system, the same system with Brill Power's BMS can keep the performance without augmentation over the same lifetime by actively loading the cells. The production of new battery cells has currently a very high climate impact because of the mining of the critical raw materials and processing steps of those materials into a battery cell. The avoidance of the production of these new cells to be implemented in the augmentation steps give the main positive impact for Brill Power's innovation. At the same time, also the avoided transport when installing these extra cells increases this positive impact but these numbers are negligible compared to the other positive impact.

Finally in terms of electronics, the BMS with active loading from Brill Power needs more electronics than a traditional BMS with passive balancing. At the same time, these electronics allow the system to be used for DC applications alongside solar panels, while traditional BMS's would need an extra DC/DC converter. Both of these effects more or less cancel each other out in terms of climate impact with overall a slightly negative impact for the higher amount of electronics compared to the gains of the avoided extra DC/DC converters.

How much impact, and what does it depend on?

For an average stationary storage battery system of 100 kWh, Brill Power is expected to have a positive impact of 27 757 t CO_2eq compared to the baseline solution. For a total of 1215 storage systems that Brill Power expects to serve next year, this adds up to 34 kt CO_2eq. The main climate impact depends on the avoidance of installing the new cells over time to keep the same capacity of the storage system. In this way, the climate impact of Brill Power depends mostly on the current climate impact of the production of new battery cells and also on the fact that augmentation of energy storage battery systems is the current state of the art. If over time the production of new battery cell generations has a much lower climate impact, the positive climate impact of Brill Power will also become much smaller. Similarly, if over time the augmentation of storage systems will become less than 37,5% or even become obsolete because of e.g. more reliable and harmonised battery cell performance that doesn't need augmentation over time, the impact will have to be recalculated based on the new state of the art. However, these kinds of innovations are still not expected in the near future so the realistic changes we might expect over time is that the positive climate impact of Brill Pow

Validity

The forecast is valid, positive and significant. Positive as the forecast is expected to stay positive, even after making the final changes. Significant as the current yearly climate impact is expected to be more than 5t CO_2eq.

Climate Impact Forecast and Validation result

Brill Power provides Battery Management System (BMS) with BrillCore product - BESA BP62X1 (which avoids all augmentation requirements in a system lifetime) instead of a conventional BMS (passive balancing). The difference in impact is calculated per year and the total impact of Brill Power per year is calculated for 1215 times 50kW stationary storage battery system.

Validation	By: Maarten Buysse, Started: Tue Aug 15 2023 18:05:37 CET, Completed: Tue Aug 15 2023 18:38:24 CET
Strong points	Clear scope with well defined baseline, innovation and functional unit. Key differences are clear. Correct impact categories are chosen and it is well explained why they are chosen and how numbers are calculated.
Weak points	The numbers of the main assumption on the augmentation seem to come from a blogpost, would be better to find some more sources confirming these percentages. Other small questions remain on functional unit, total number of FUs, some details in calculations.

Production

−	Lithium-ion LiFePO4 battery (118 Wh per kg	94.11 per kg	288,38	kg	-27140
+	PCB = Printed Circuit Board (including ICs)	475 per kg	18,87	kg	8964
−	PCB = Printed Circuit Board (including ICs)	475 per kg	14,25	kg	-6769

Transport

−	Train, freight diesel (tkm)	0.01986 per tkm	340	tkm	-6.753
−	Container ship (min weight/volume ratio 0	0.00478 per tkm	5536	tkm	-26.44
−	Truck+container, 28 tons net (min weight/	0.07758 per tkm	63,84	tkm	-4.953

Brill Power's total impact per year

- eco-costs of human health euro
- eco-costs of eco-toxicity euro
- eco-costs of resource depletion
- eco-costs of carbon footprint

	Carbon footprint CO_2eq.
Impact per 50kW stationary storage battery system	-24984 kg
Impact of 1215 times 50kW stationary storage battery system	-30Kt

Validation quality mark

Validation ID: MB2307
Date: 15-08-2023

Brill Power
Mitigation project

Impact reduction potential -34 $KtCO_2$eq./year

Validity of the forecast	Valid
Reduction potential	Postive
Impact threshold	Significant

Sources and assumptions

The differences and quantities in the forecast are based on the following sources and assumptions:

Production

There are two types of materials saved or increased/saved in this comparison: Battery cells, and battery electronics. The BrillCore product will avoid three system augmentations (of 12.5% each time) of a system's lifetime. See chart on Battery System Capacity here: https://blog.burnsmcd.com/battery-energy-storage-augmentation-key-project-considerations This means that the battery cells and PCBs needed for these augmentations are avoided. Material cell savings are calculated as follows: An estimate of the weight of LFP cells in a 50kW system is: Assume 50kW system is a 2 hour system so 100kWh. Using an average cell density of 130Wh/Kg (Eco Tree Lithium https://ecotreelithium.co.uk/news/lifepo4-vs-lithium-ion-batteries/), this means that there are 169kg of cells in each 50kW rack. 50kW x 2 hours x 1000W/Kw / 130Wh/kg = 769kg. Three augmentations of 12.5% each time is an extra 288.38kg of cells over a pack's lifetime. PCB material savings are calculated based on the number of battery management systems and their weight. The product used for comparison in the baseline scenario is the Lithium Balance s-BMS (https://lithiumbalance.com/products/s-bms). The BrillCore BMS system will have higher PCB weight. Using the number of PCBs needed and their weight, the baseline product saves 18.87kg of PCBs in each product (since our solution includes power electronics). Separate to this, half of the baseline products will need a dc/dc converter, meaning and additional savings in material. A dc/dc converter weighs 28.5kg (https://www.zekalabs.com/products/non-isolated-high-power-converters/dc-dc-converter-50kw-750v), but would only be needed an estimated half of our product sales, so a total of 14.25kg has been included to represent the average. PCB material has been used to represent the materials of a dc/dc converter..

Use

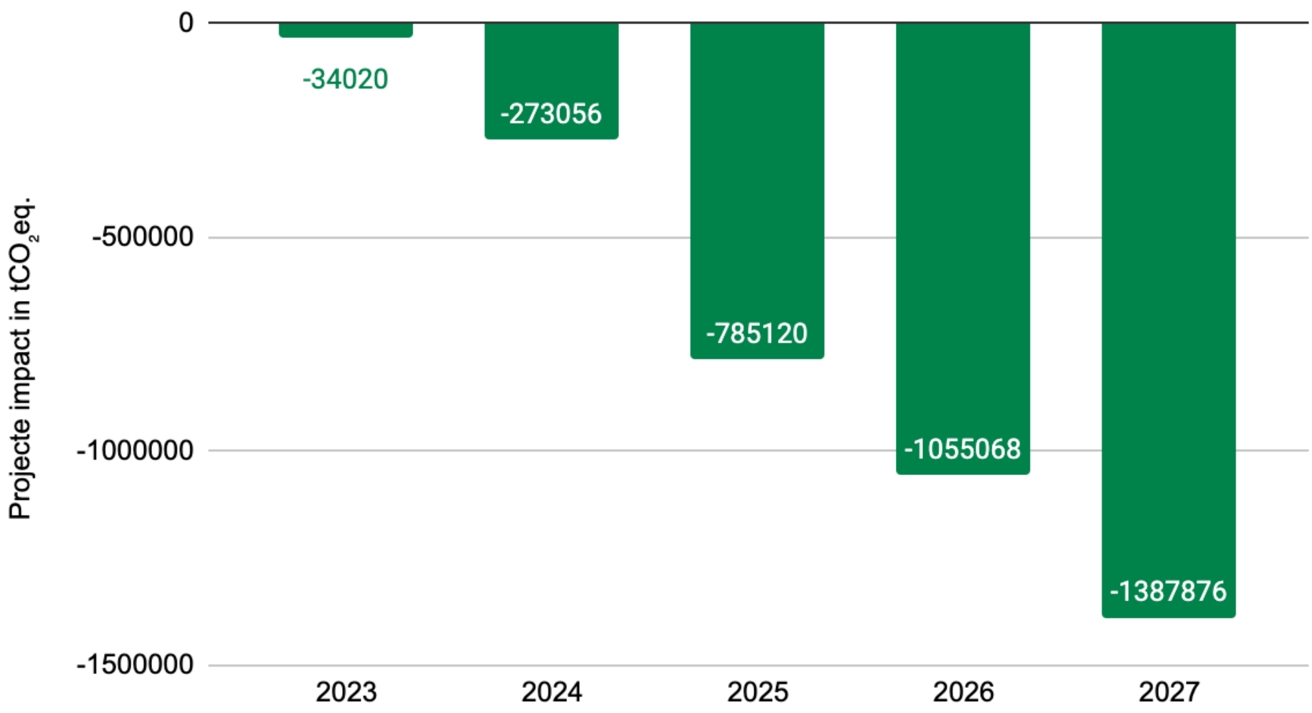
By avoiding three augentations during the life of the battery system, our technology will be avoiding the transportation associated with these three movements of materials. The total weight of those materials has been calculated in the production step (283.76kg). The majority of the materials in this sytem will be manufactured in China and delivered to customers in the UK. An average route has been determined between these points to account for the weight of the material differences calculated in the production step (283.76kg). The distances travelled (with our technology, saved) are based on: BYD factory in Shaanxi China to Qingdao Port in China (1200km). Sea freight from Qingdao China to Southampton (19,511km). Road freight Southampton to Coventry (225km).

Impact Projection

The impact of Brill Power is projected over the coming years following the expected market growth of stationary storage battery systems. This projection is made for the estimated number of stationary storage battery systems of 100 kWh (50kW) that Brill Power hopes to serve over the years. Turning the expected aggressive growth into numbers, Brill Power expects to reach almost 50 000 units of 100kWh storage systems in 5 years. This translates to an impact of 3 535 140 t CO2eq by 2027. To put this in perspective, this is equal to keeping 790 000 gasoline powered vehicles off the road for a full year. It is important to note that the impact is accounted for in the year the system is installed, but happens over the lifetime of the battery storage system. This means that all the impact accounted for in e.g. 2027 actually happens over the lifetime of the installed systems that year.

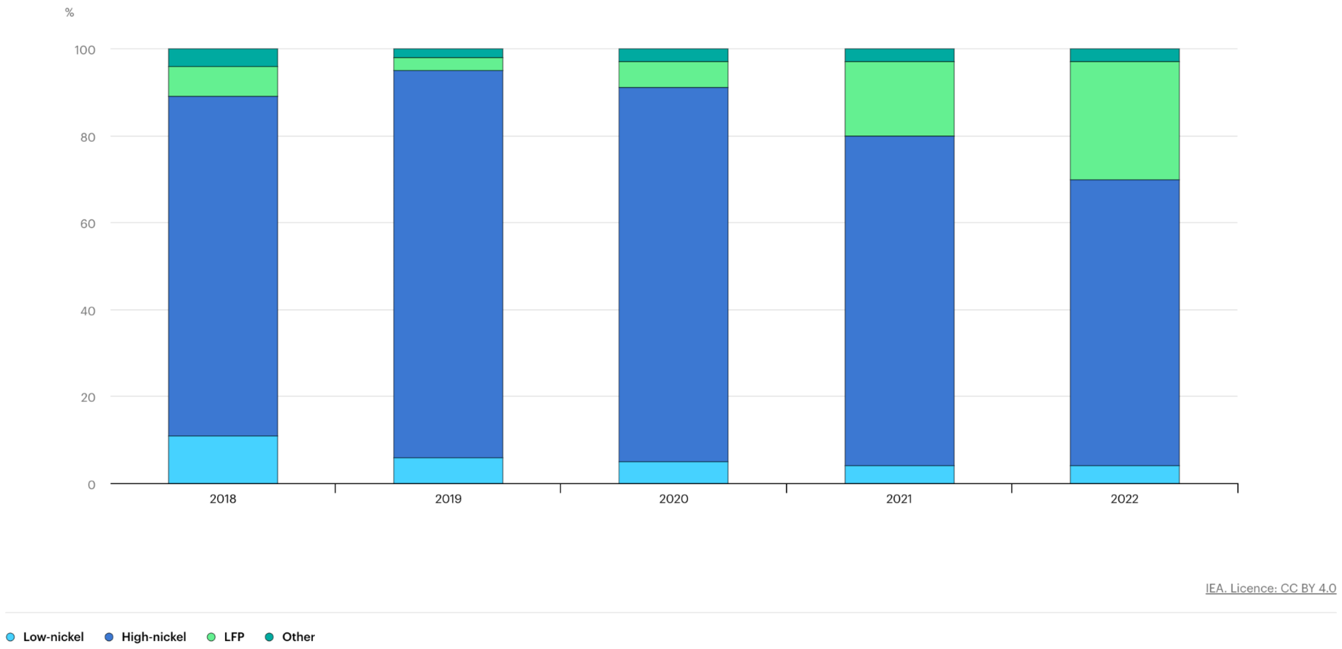
Brill Power	2023	2024	2025	2026	2027
100kWh (50kW) stationary storage battery system	1215	9752	28040	37681	49567
Impact in ktCO_2eq.	-34020	-273056	-785120	-1055068	-1387876
Cumulative ktCO_2eq.	-34020	-307076	-1092196	-2147264	-3535140

Projected Impact In tCO_2eq, Brill Power



Evolution of baseline impacts

The baseline is defined as a battery with a traditional BMS with passive balancing. The efficiency of such BMS is not expected to change a lot as most advancements are focused on active loading BMS. That is why we have to look one level deeper into the climate impact of the battery to understand how the climate impact of the baseline is expected to change over time. On the one hand, changes in the battery cell chemistry will affect the climate impact of the battery.

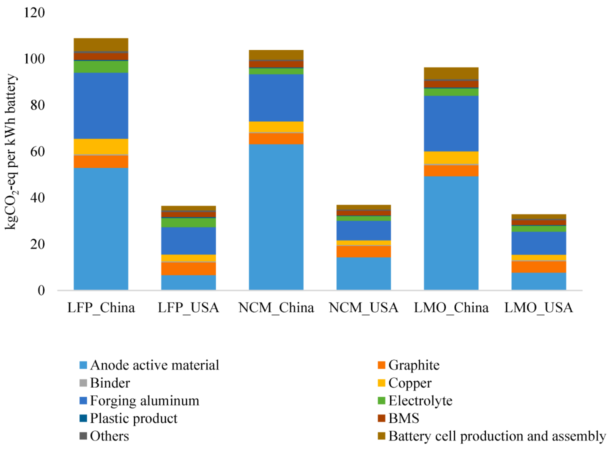


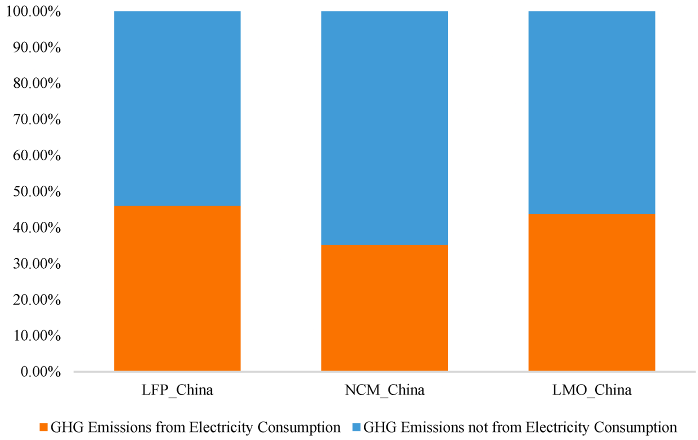
Looking into the above figure[1], we see that LFP has gained popularity over the last years while also NMC with lower levels of Cobalt is being increasingly adopted. It is hard to make predictions on which cell chemistries will be dominant in the future but we can expect the current chemistries to stay dominant while solid state batteries will start appearing in 5-10 years.

Looking at their climate impact, LFP and NMC batteries have a similar (high) impact. However, the bulk of these batteries are produced in China and when we look at the climate impact on the figures on the next page[2], we see that there is a strong geographical dependency. For similar batteries produced in the US, the climate impact is significantly lower, mainly due to cleaner energy use during the production. This means that there is a lot of potential for emission reduction in the energy use for the batteries produced in China, from 30% for NMC until 45% for LFP. Therefore we can expect that, following the clean energy trend, LFP and NMC battery production will slowly but steadily lower their carbon footprint.

[1] Source: https://www.iea.org/data-and-statistics/charts/electric-ldv-battery-capacity-by-chemistry-2018-2022

[2] Source: Hao, H.; Mu, Z.; Jiang, S.; Liu, Z.; Zhao, F. GHG Emissions from the Production of Lithium-Ion Batteries for Electric Vehicles in China. Sustainability 2017, 9, 504. https://doi.org/10.3390/su9040504



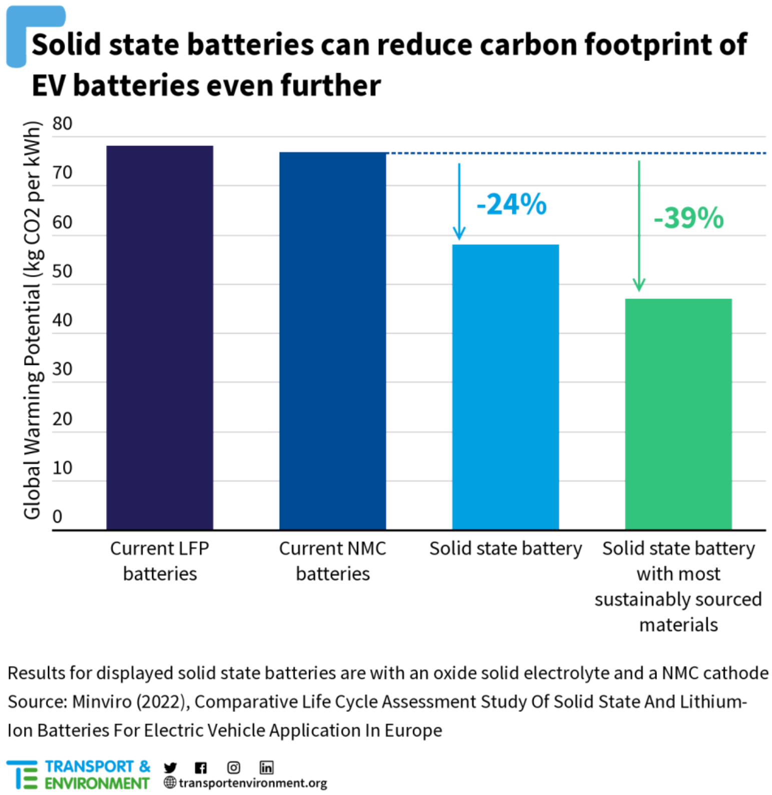


Looking at the next big innovation in battery types, solid state batteries, we see that a further reduction in climate impact is expected.

Apart from expected changes in climate impact related to battery chemistry, the recently approved battery regulation demands to have a higher share of recycled materials into future batteries which is also expected to lower their climate impact. The EC envisions a mandatory minimum level of recycled content for lithium (4%), cobalt (12%), nickel (4%), and lead (85%) by 2030 and increasing these minimum levels by 2035.

The lower (or higher) the climate impact of the battery, the smaller (or bigger) the impact will be of Brill Power as the main driver of Brill Power's climate impact is the avoidance of new battery cells.

We can conclude that both of the trends discussed above are decreasing the climate impact of batteries over time so we can expect Brill Power's climate impact per functional unit to decrease over time. However, the climate impact of new batteries, while being reduced, is expected to stay on a significant level in the next 10 years so we can ensure that Brill Power's climate impact will as well stay on a significant positive level. Finally, the passive balancing BMS will also slowly fade out and be replaced by active loading BMS like the solution from Brill Power. That is why in the future, Brill Power could make the exercise to compare them to other active loading BMS solutions and calculate their impact in this way.



More information

For more information about this validation, and Climate Impact Forecast Validation in general, reach out to Impact Forecast.

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