OPERATO
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SUMO DLR
Litgrid Case Study: The Power of Wind

HOW DLR PAVES THE WAY FOR **RENEWABLE ENERGY,** UNCOVERING THE **UNTAPPED POTENTIAL OF TRANSMISSION LINE CAPACITY**

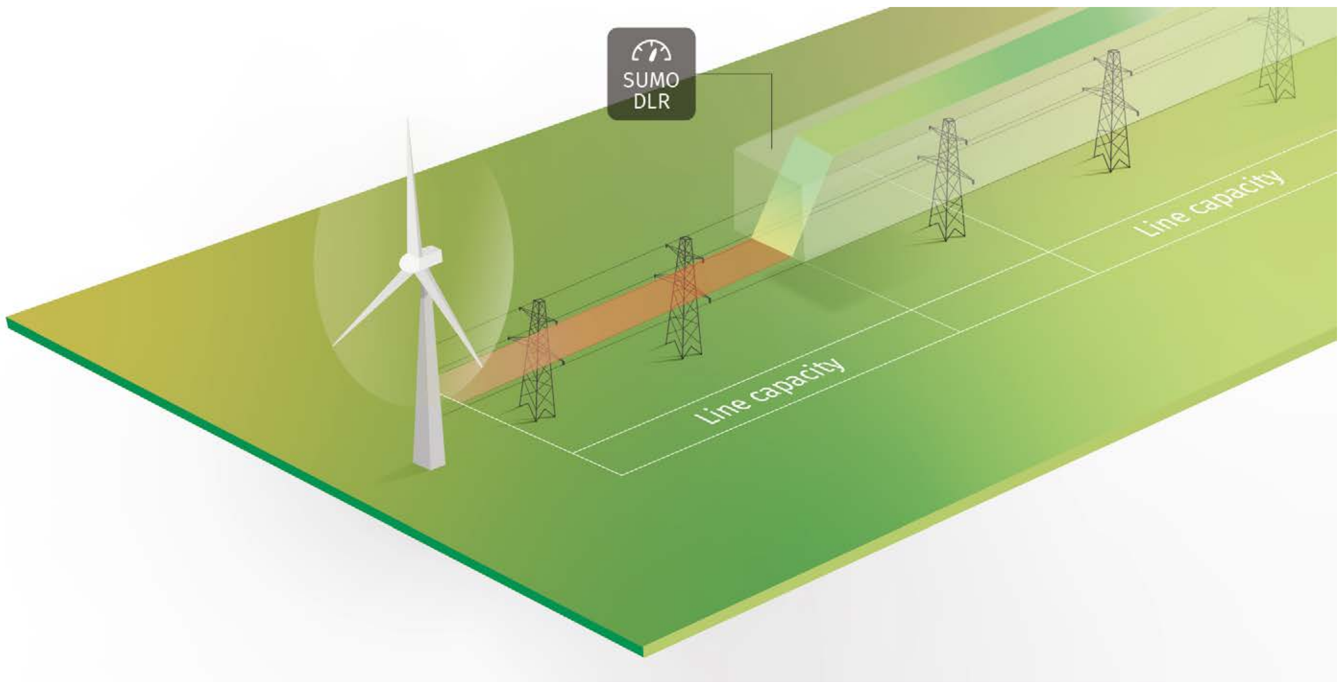
For **Operators.**
From **Operato.**

Partnering with Litgrid for Enhanced Transmission Efficiency

Litgrid, Lithuania, is a forward-thinking transmission system operator (TSO), committed to driving innovation and reliability in power transmission. To accommodate seamless integration of wind energy into a smarter, more resilient power grid, additional transmission capacities have to be facilitated by the construction of new power lines, or even better, by utilising the existing infrastructure. The latter is exactly what Operato's core mission is, enabled by our SUMO Dynamic Line Rating (DLR). By pragmatically discovering additional capacity in existing power lines, we can deffer or even avoid the higher costs and longer timelines associated with the traditional approach of building new ones. SUMO DLR was deployed on the Palanga – Vėjas overhead line that contains 36 towers and is located in the windy north-west part of the Lithuanian coastline.

Boosting the integration capacity of wind energy sources into the power grid

Operato's SUMO DLR redefines power grid efficiency by transcending the constraints of traditional static line ratings. Unlike static assessments, which offer a fixed capacity limit, DLR continuously adapts to real environmental conditions, ensuring a more accurate and responsive evaluation of transmission line capabilities. The SUMO dynamic approach not only enhances safety but also maximizes infrastructure potential, allowing for increased power transfer without compromising reliability. The flow of electric current through a conductor generates heat, posing the risk of overheating and potential violating the safety clearances of the overhead line during high load times. To prevent damage, the static limit was set as a conservative estimate, most of the time underutilizing the line's full capacity due to a lack of real insights into its condition. This conservative approach results in substantial periods where the line operates well below its potential, particularly during favourable weather conditions. This is especially true for areas with consistent wind, as it's the primary weather factor determining the cooling rate of a line. Operato's SUMO DLR capitalizes on this inherent thermal exchange, taking into account the real-time and future weather conditions, with wind playing a pivotal role in the calculation of the dynamic line rating.



Static limit

The static thermal limit expressed in [A] represents the continuous allowed current a power line can carry without breaching the designed maximal conductor temperature or violating safety clearances in any span. It is calculated according to the standards (e.g., EN50341) taken into account along with national normative aspects regarding climatology. Worst-case weather conditions are usually the basis for calculating the static limit for a given conductor type.

However, operating power lines on static limit assumptions is not always without risk. Insights gathered from in-the-field operations indicate that the static limit frequently fails to be a viable solution, especially during periods of intense heat and minimal wind.

Dynamic limit

SUMO DLR calculates the dynamic thermal rating based on weather conditions along the power line, also expressed in [A]. If the weather conditions allow for good heat dissipation, the dynamic limit may be significantly higher than the static one. SUMO calculates the dynamic rating for each line span, and the line-span with the most unfavourable weather conditions determines the ampacity for the whole line.

DYNAMIC LINE RATING

This is where the SUMO DLR principle comes into play. It takes into account various environmental factors, including wind speed, which can cool down the power lines and increase their capacity to carry current without overheating.

In high wind conditions, the cooling effect of the wind on the power lines can significantly increase their capacity to carry current. This means that even though the power lines heat up more due to the increased power output from the wind farm, the cooling effect of the wind prevents them from overheating and causing thermal damage.

In essence, the wind serves a dual purpose in this scenario. On one hand, it enables the generation of more power from the wind farm. On the other hand, it also facilitates the transport of this increased power output by cooling down the power lines and increasing their current-carrying capacity. This synergy between wind power generation and power line cooling is a perfect example of how nature and technology can work together to create efficient and sustainable energy solutions.

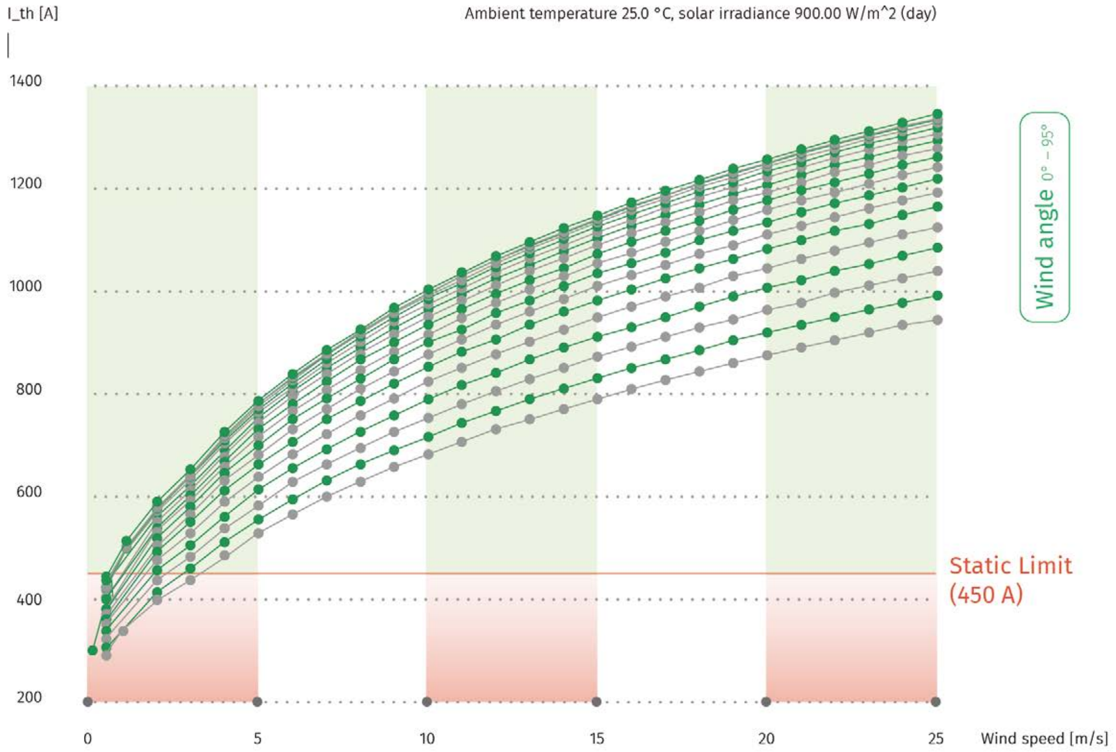
The result and lessons learned

Upon project completion, the impact of Operato's SUMO DLR solution exceeded expectations, demonstrating a significant enhancement in the flexibility of line operation. The capacity gains provided increased 'operator headroom', allowing for more efficient management of the power line. In this specific case, a positive correlation was observed between line cooling and the load on the line from nearby wind farms. This correlation means that the increased capacity can be utilized on a daily basis, thereby optimizing the use of the power line. This not only increases the efficiency of electricity transportation but also ensures that Litgrid's power line operates closer to its full potential more consistently throughout the year.

Building on this, the unique capability of SUMO DLR to measure the wind direction for every line span emerges as a significant advantage. Especially when contrasted with solutions that rely solely on temperature sensors, the superiority of our approach becomes evident due to two major limitations of sensor-only solutions. Firstly, the economic feasibility of installing a multitude of sensors on every single line span or even tensioning section is questionable. Secondly, sensors lack the ability to 'look into the future' and support forecasting. Thus, our SUMO solution, by overcoming these challenges, offers a more practical and forward-thinking approach, ensuring a seamless and efficient operation of power lines.

It’s crucial to highlight that the integration of wind farms, in particular, aligns seamlessly with DLR. This is due to wind being the most significant factor contributing to conductor cooling. A wind turbine’s cut-in wind speed typically begins at speeds greater than 3 m/s and reaches its full power output at around 15 m/s. Transmission lines, which are usually lower than wind turbines and subject to the wind shear effect, can thus still count on a significant cooling effect. As well as transmission lines that are nearby - especially on flat terrain. So, we can count on a significant increase in ampacity for wind speeds exceeding 10 m/s, even at the most unfavourable wind direction, 0°.

DYNAMIC LINE RATING



Our comprehensive approach ensures that our solution not only increases the efficiency of electricity transportation but also enhances the reliability of the power line operation. By using conservative weather estimates in the predictions, we were able to circumvent the non-negligible error margin in predicting wind speed, thereby achieving a minimum of 25% increase in transmission capacity on average.

Final thought

IS THE STATIC LIMIT AN OUTDATED ASSUMPTION?

In the evolving energy landscape, regulators across the globe are reevaluating the applicability of static limits. The USA is at the forefront of this change, with the Federal Energy Regulatory Commission (FERC) order 881 (page 5) highlighting the risks associated with exceeding the current static limit assumption. It states that such a scenario could lead to “potential reliability and safety problems” for the TSOs. [2]

This finding raises an important issue, which is that the static line rating is not truly the most accurate theoretical estimate of the real-life TSO reality. Given this fact, we wanted to quantify the amount of time where the static limit is overestimating the transmission line capability. Upon the completion of the project and analysing all the data, we made a significant discovery: our calculated DLR values fell below the static limit for 3% of the time.

The reason behind this is that the static limits, particularly in Europe, are usually based on the assumption of a 0.6m/s perpendicular wind speed. However, this assumption often leads to an overestimation of the transmission line capability, especially in worst-case scenarios. For instance, when power lines traverse through a forest in a valley, the actual wind speed can be significantly lower than the assumed 0.6m/s. This discrepancy between the assumed and actual conditions highlights the need for a more dynamic and accurate approach to line rating, such as the one provided by our SUMO DLR solution.

Currently, TSOs have limited visibility into the actual conditions of power lines in the field, with their capacity planning often relying on traditional static assumptions that may not fully reflect daily realities.. This discovery emphasizes the necessity of adopting a dynamic approach to ensure grid safety and reliability, and moreover, to truly understand the unique characteristics of each line span. Just as every story is different, so is every line span. This diversity underscores the need for a granular dynamic approach, which can accurately capture and respond to these variations, ensuring optimal operation of the power grid.

Embark on the journey towards a smarter, more transparent power grid by taking a practical first step: request a DLR feasibility study on your historical line data to evaluate the potential benefits of SUMO DLR for your specific power lines.

[1] Kaasik, M. and Mirme, S.: Wind: generating power and cooling the power lines, Adv. Sci. Res., 17, 105–108, https://doi.org/10.5194/asr-17-105-2020, 2020.

[2] USA FERC Order 881, “FERC Rule to Improve Transmission Line Ratings Will Help Lower Transmission Costs”, https://www.ferc.gov/news-events/news/ferc-rule-improve-transmission-line-ratings-will-help-lower-transmission-costs

Book your case study today

Operato

Barvarska ulica 7,
2000 Maribor, Slovenia

E: info@operato.eu
W: www.operato.eu