Overhead line ratings

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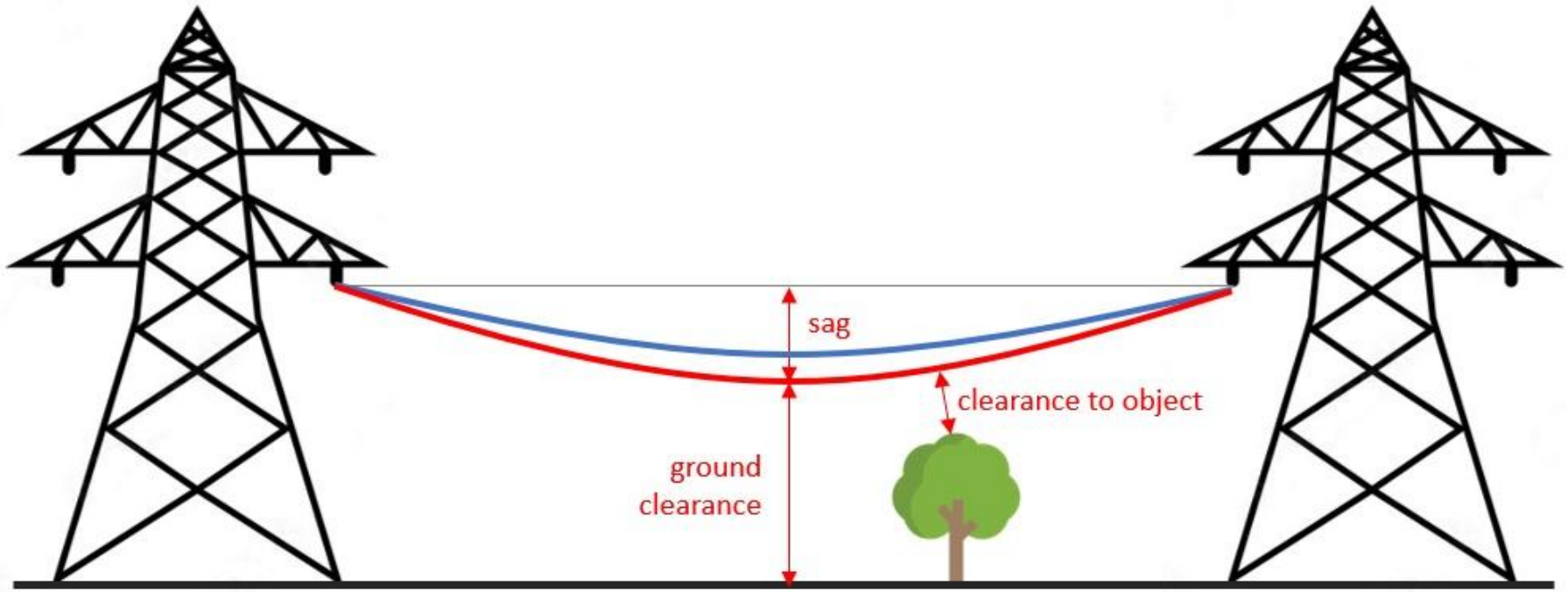
Line rating?

Overhead lines should be safely operated. The clearance to ground and objects shall be sufficiently large.

Current heats up the conductors, causing them to sag.

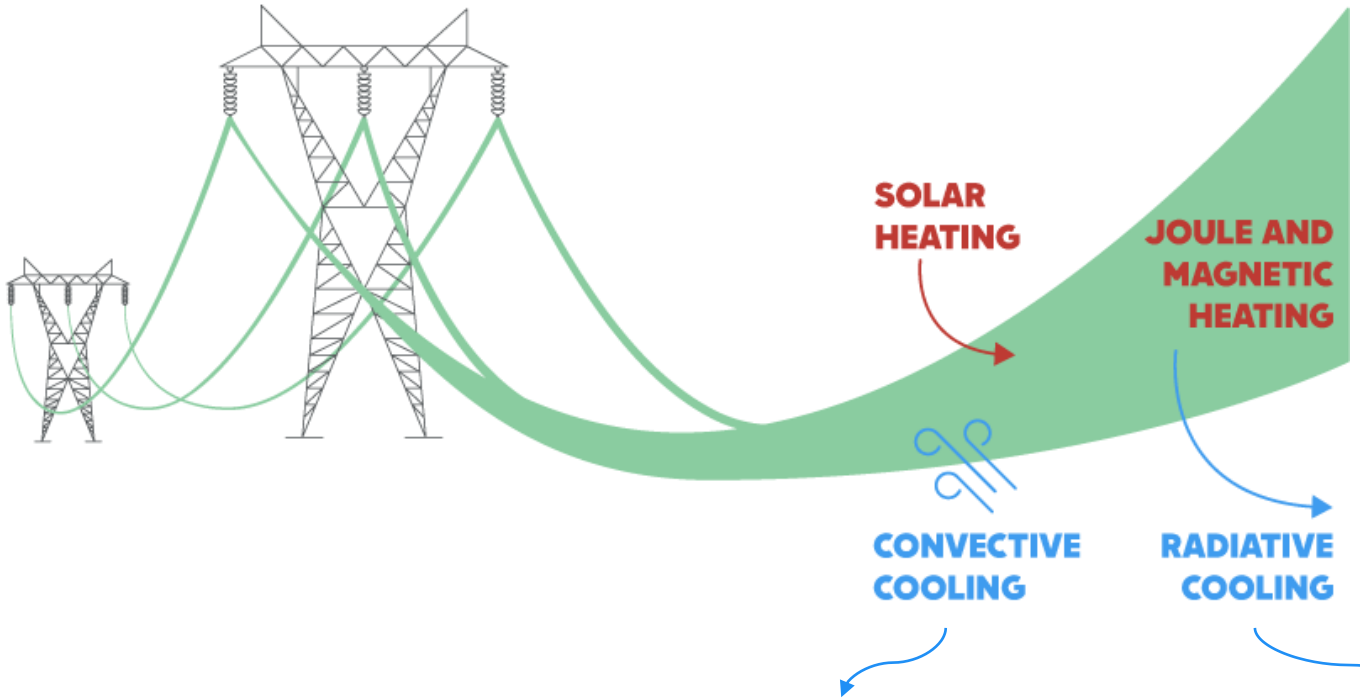
Which other aspects influence the sag over time?



Line rating?

Which factor for cooling is dominant?

The main influences are shown in the figure below.

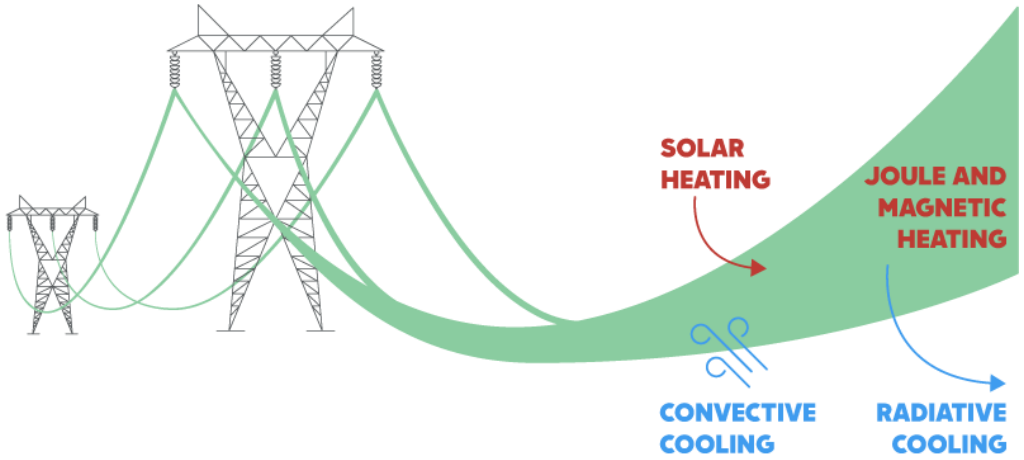


Ambient temperature
Conductor temperature
Wind speed
Wind angle

Ambient temperature
Conductor temperature
Conductor radius
Conductor emissivity

Content of presentation

- Different types of line rating
- Applied types of rating
- Currents in the system
- Dynamic line rating process
- What is there to improve?
  - Understand the current process
  - Year Rating Curve - for planning
  - Sensorless DLR - for operation
- Why don’t we increase all the line rating values?



Different types of line rating
Options

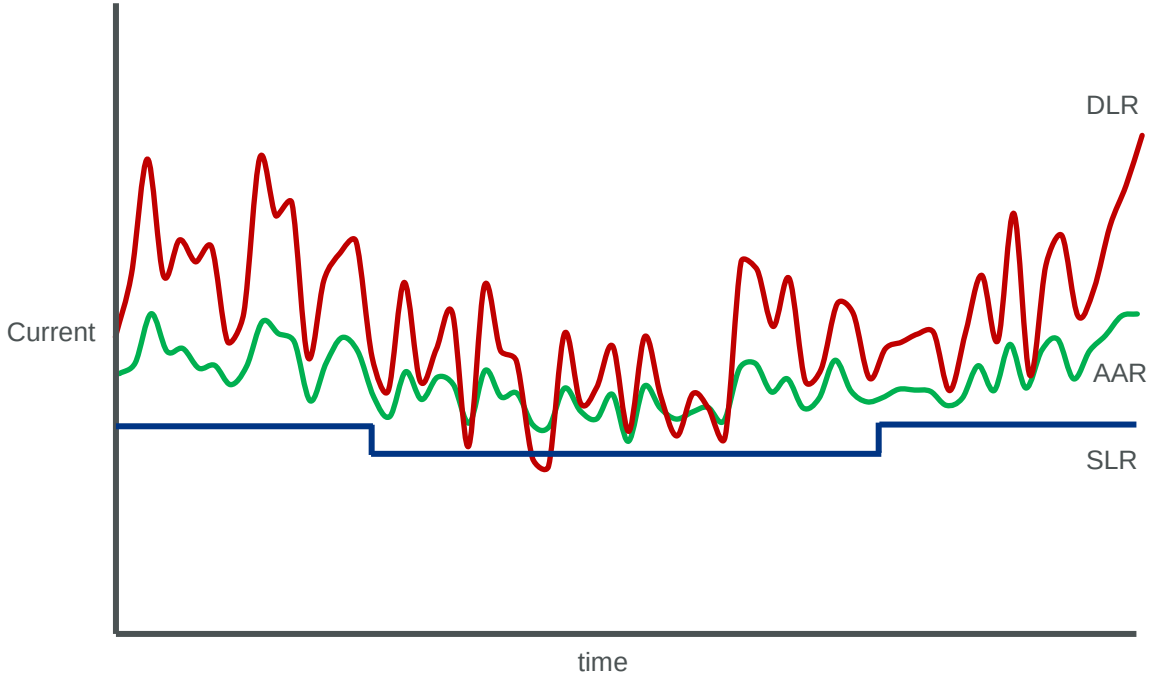
There are different ways to determine the line rating

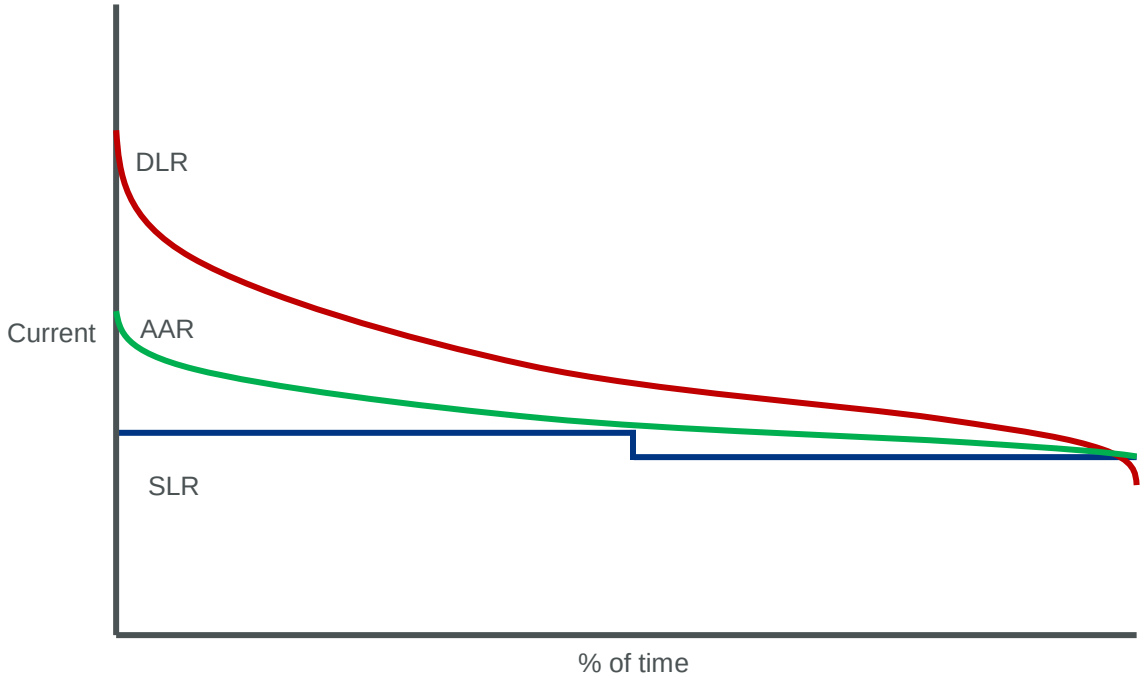
- Static line rating (SLR)
  - Year round value — acc. to IEC 50341-2-15, one value for a line ← Currently applied
  - Seasonal values (summer-winter) — acc. to netcode ← Currently applied
  - Seasonal values (quarterly value) — found at other TSOs
- Ambient adjusted rating (AAR) — variable T_{amb}, static V_{wind} and solar irr.
- Dynamic line rating (DLR) — variable T_{amb}, V_{wind} and solar irr. ← Currently applied

Different types of line rating

Values sorted

How do the different types of rating relate to each other:





Applied types of line rating
Overview

Currently applied for long term planning (congestion) and short-term operation (redispatch):

Based on conservative values; V_{wind} was recently reviewed (1.0m/s instead of 0.6m/s)

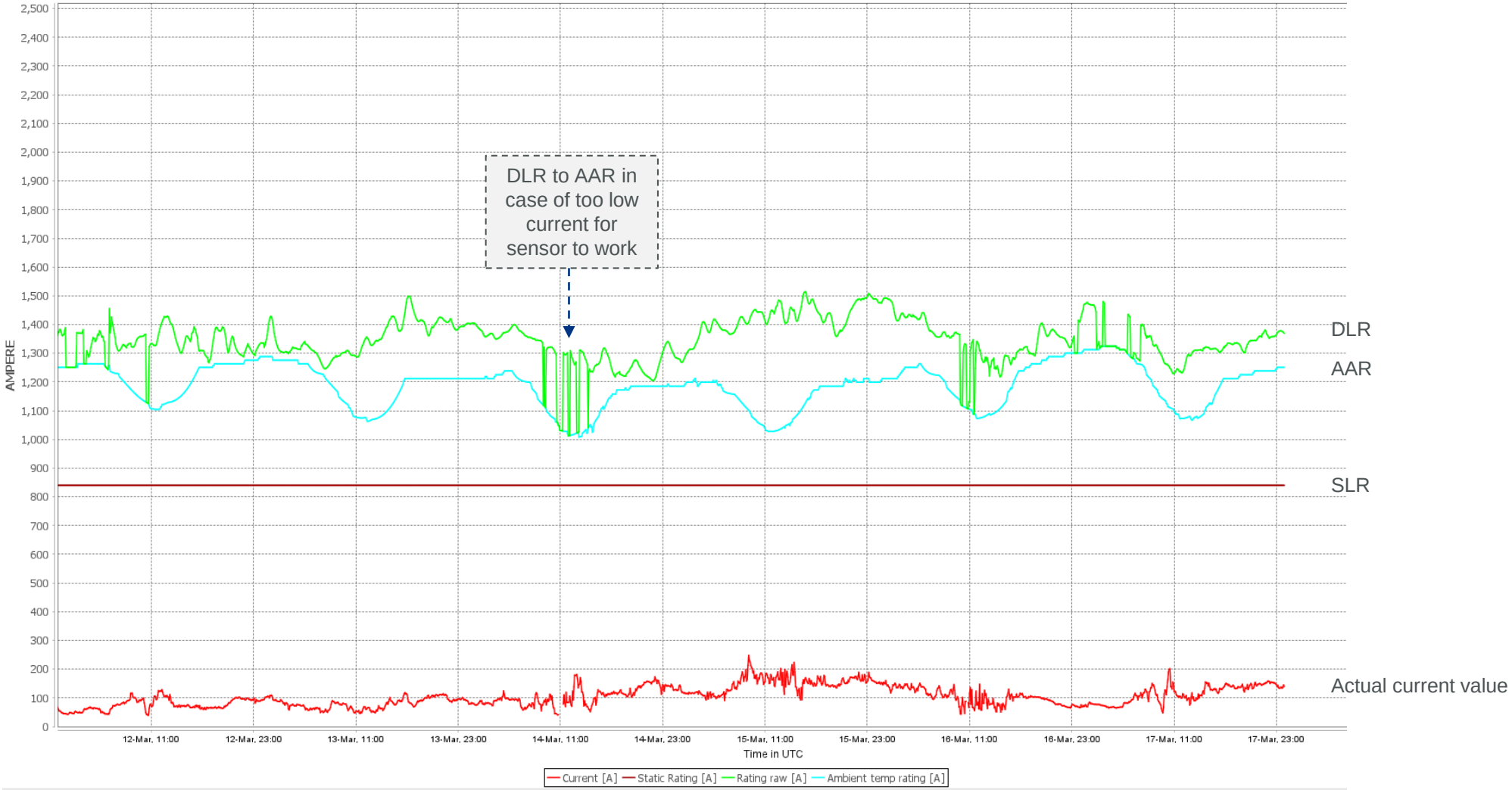
Former Essent also had 4 season-rating

	Design	Planning / Congestion	Operation / Redispatch
SLR	Summer value	Summer + winter value	
AAR	N/A	N/A	N/A
DLR	N/A	N/A	Weather dependent rating

Ampacity determined based on weather data. Calibrated using sensors

Currents in the system

Example graph 1

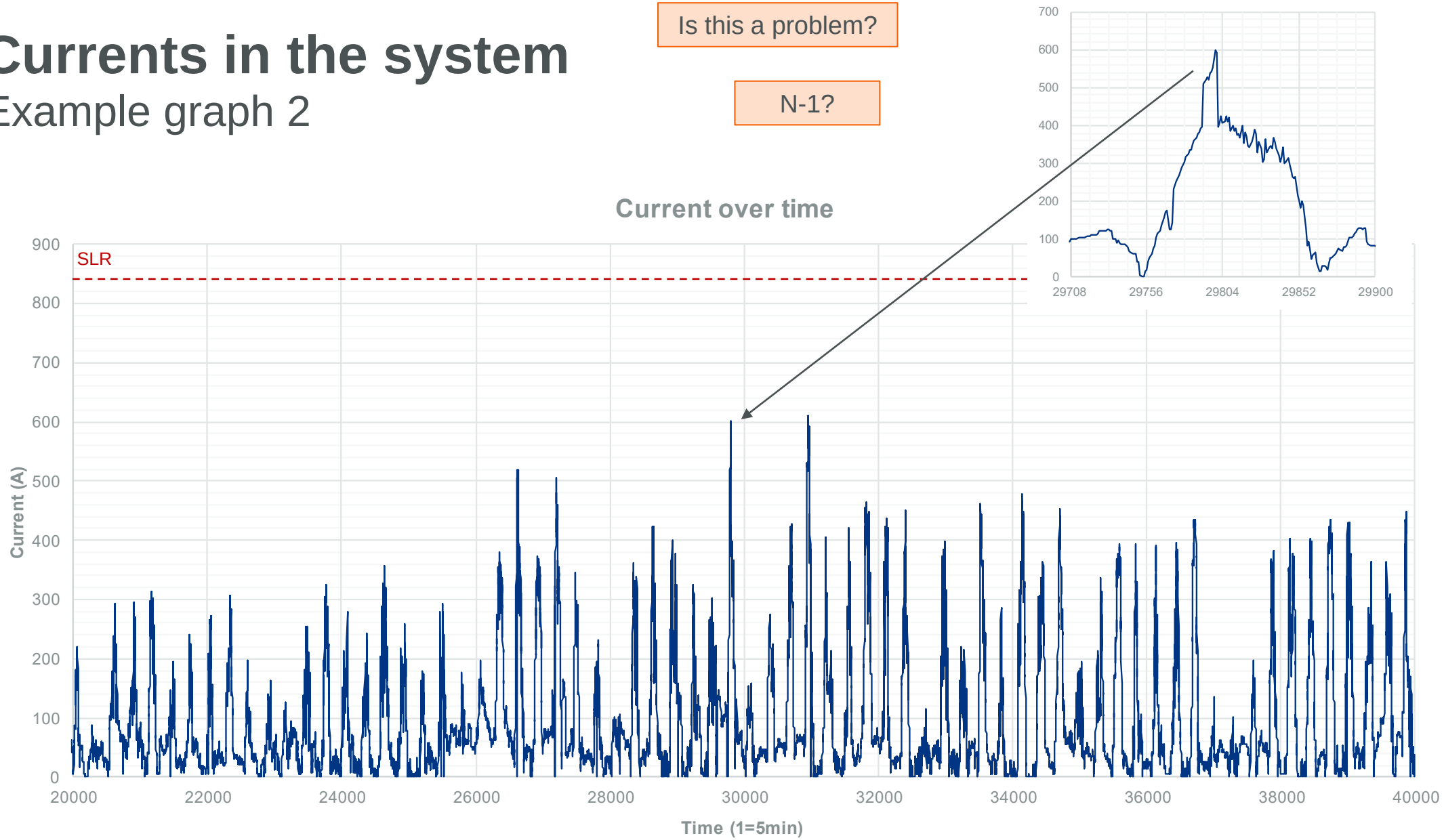


Currents in the system

Example graph 2

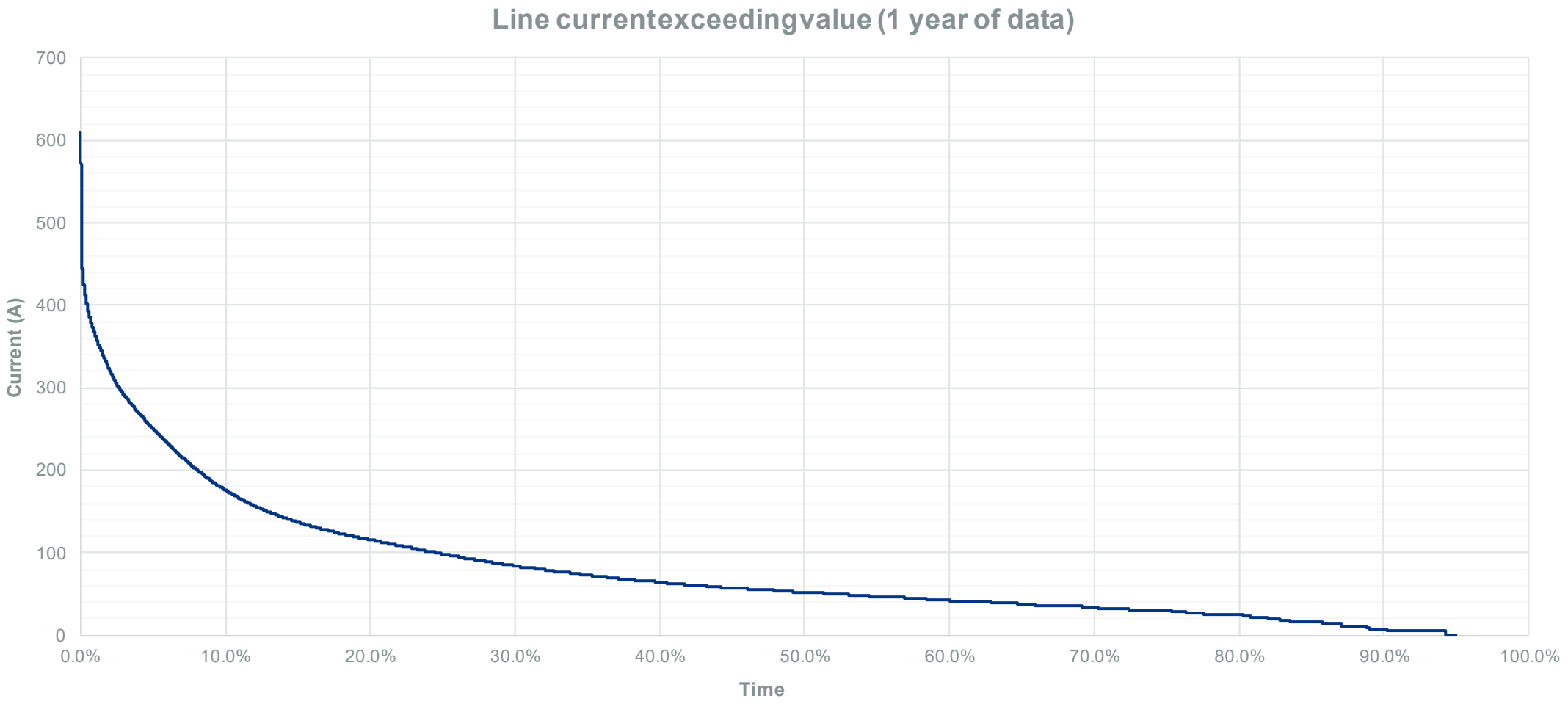
Is this a problem?

N-1?



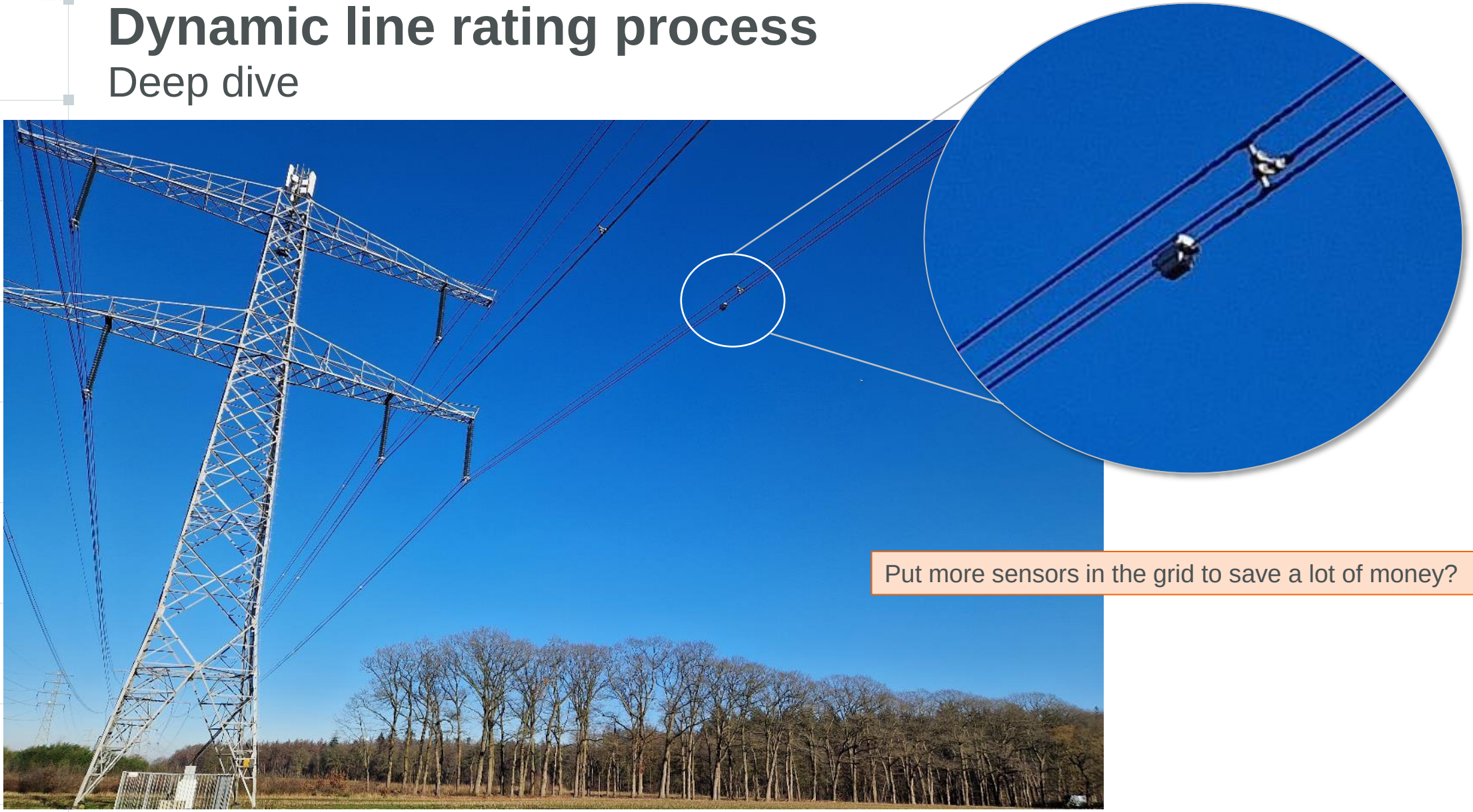
Currents in the system

Values sorted



Dynamic line rating process

Deep dive



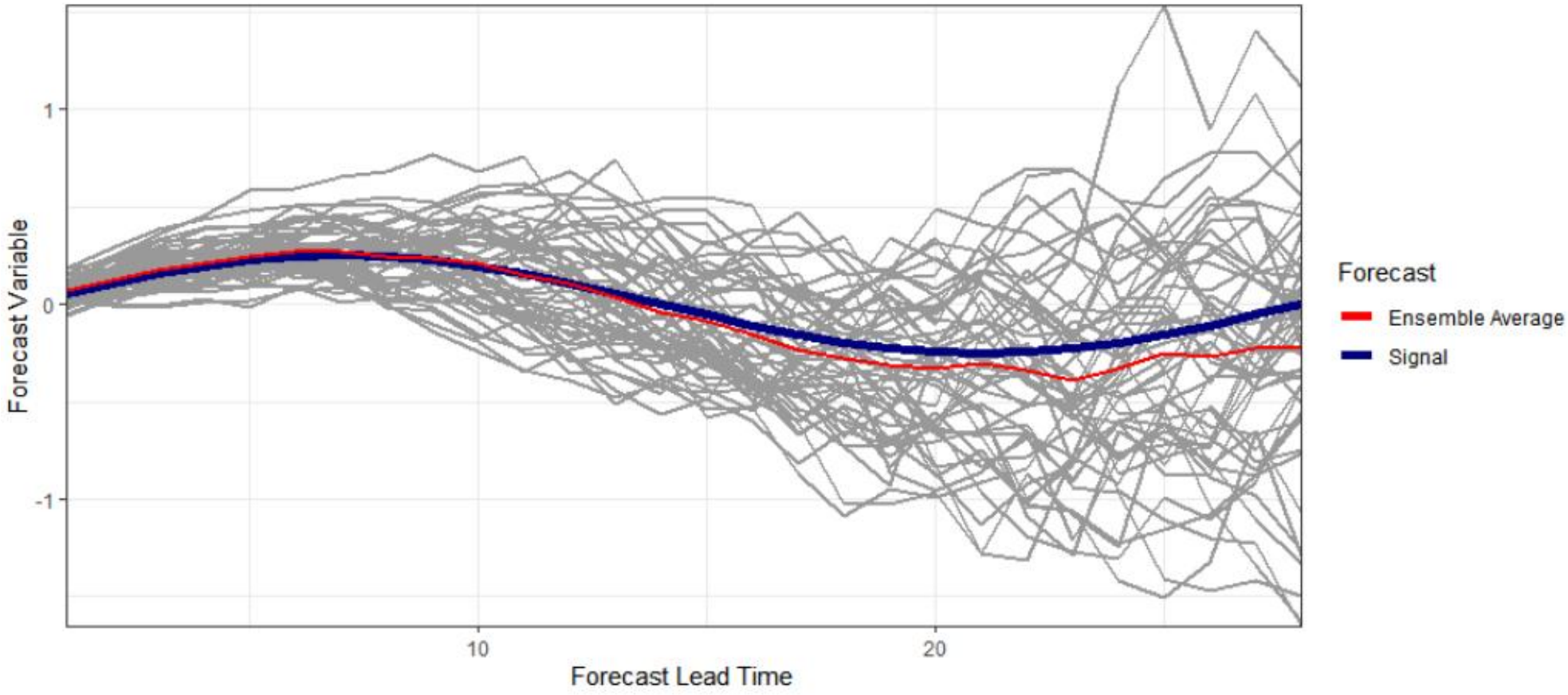
Put more sensors in the grid to save a lot of money?

Dynamic line rating process

Deep dive

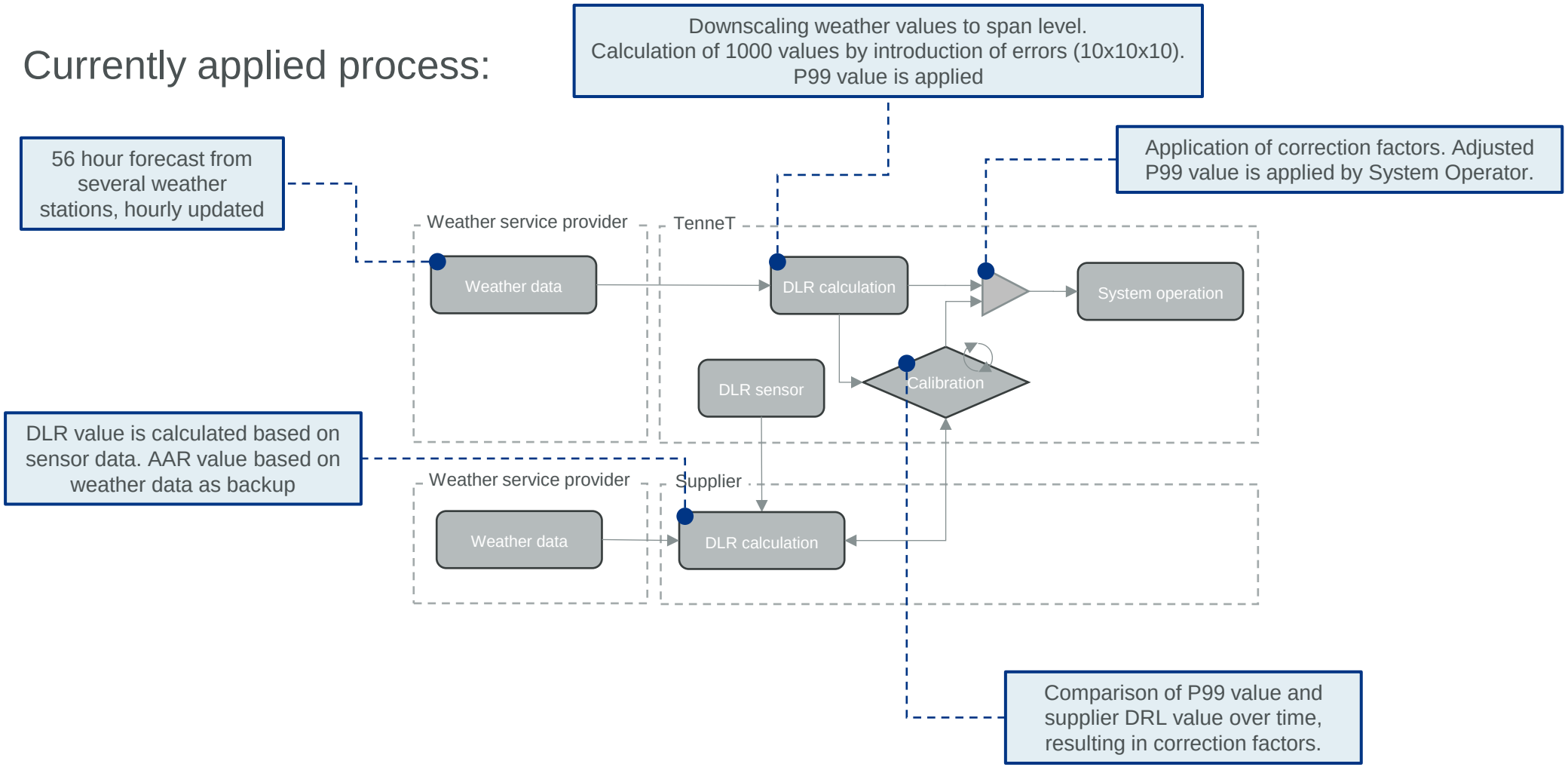
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	…	…	53	54	55	56

Hours ahead



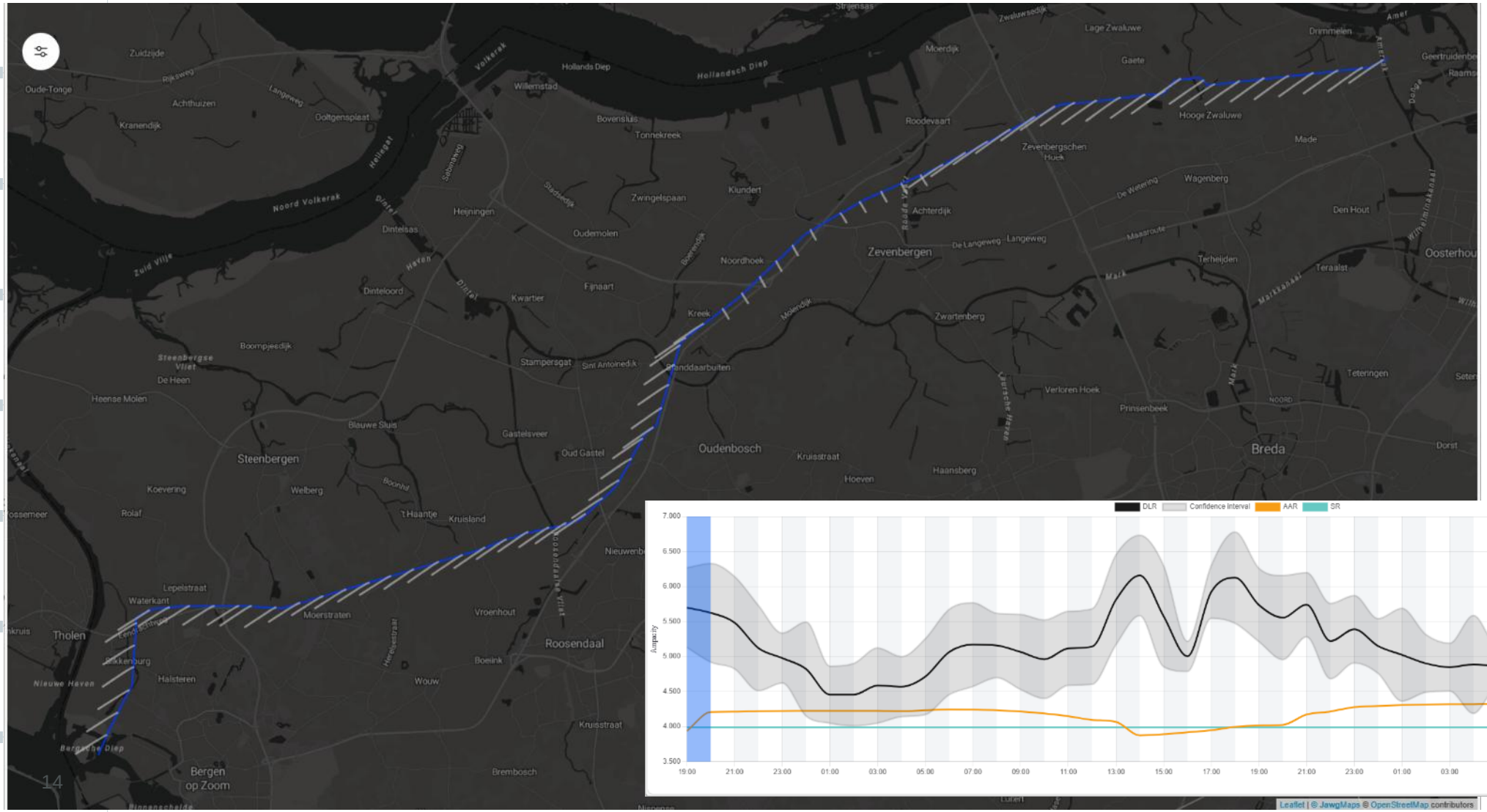
Dynamic line rating process
In TenneT NL

Currently applied process:



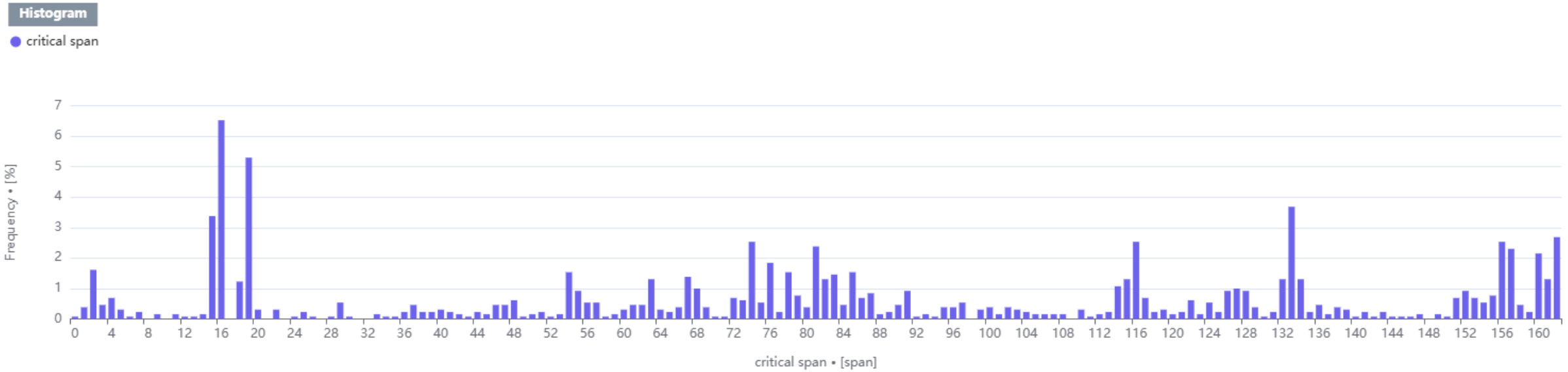
What is there to improve?

Understanding the current process



What is there to improve?

Understanding the current process



Where to put the sensors?

What is there to improve?

Year rating curve and sensorless DLR

Two possible new options to increase the ampacity for overhead lines:

	Design	Planning / Congestion	Operation / Redispatch
Static	Summer value	Summer + winter value	
Dynamic (no sensor)	N/A	*Year Rating Curve*	Based on weather forecast; conservative approach
Dynamic (with sensor)	N/A	N/A	Based on weather forecast; check with sensor

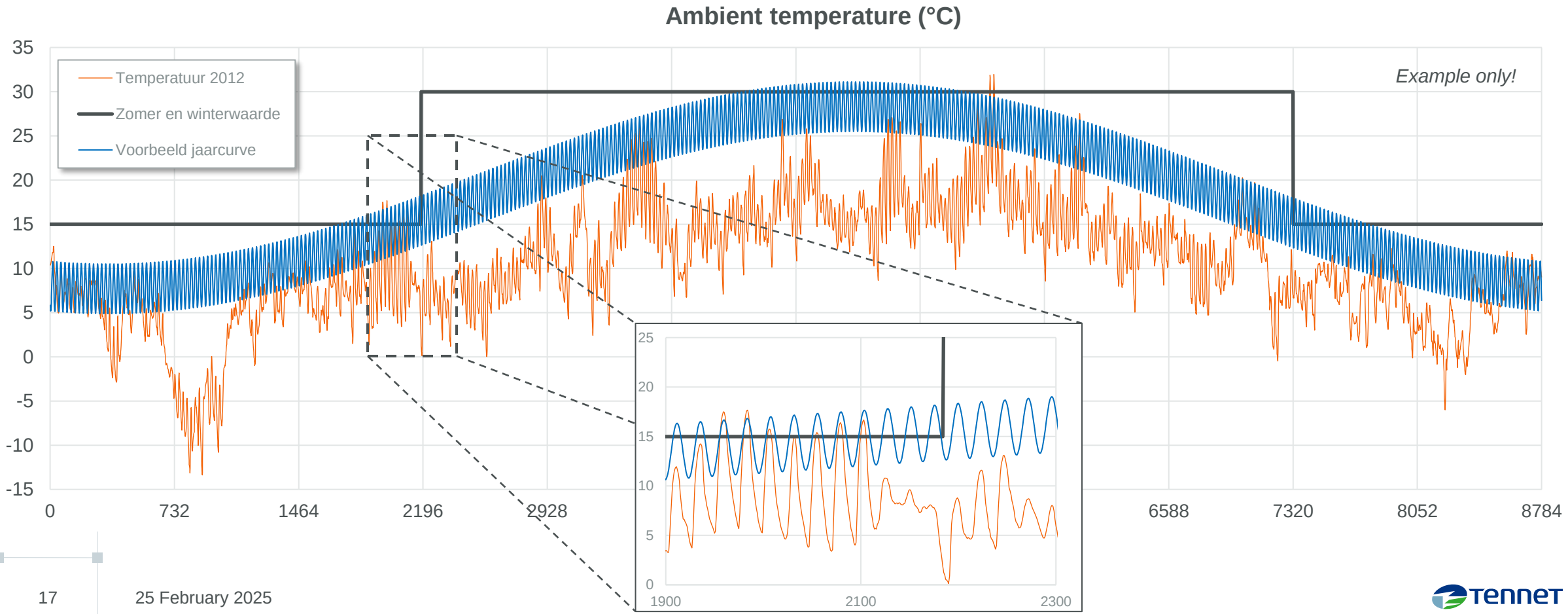
1 Using weather patterns, based on historical data and climatological trends

2 Investigate what the reliability is of DLR, only using weather forecast, but without sensor for calibration

Increase ampacity of overhead lines

Year rating curve 1/4

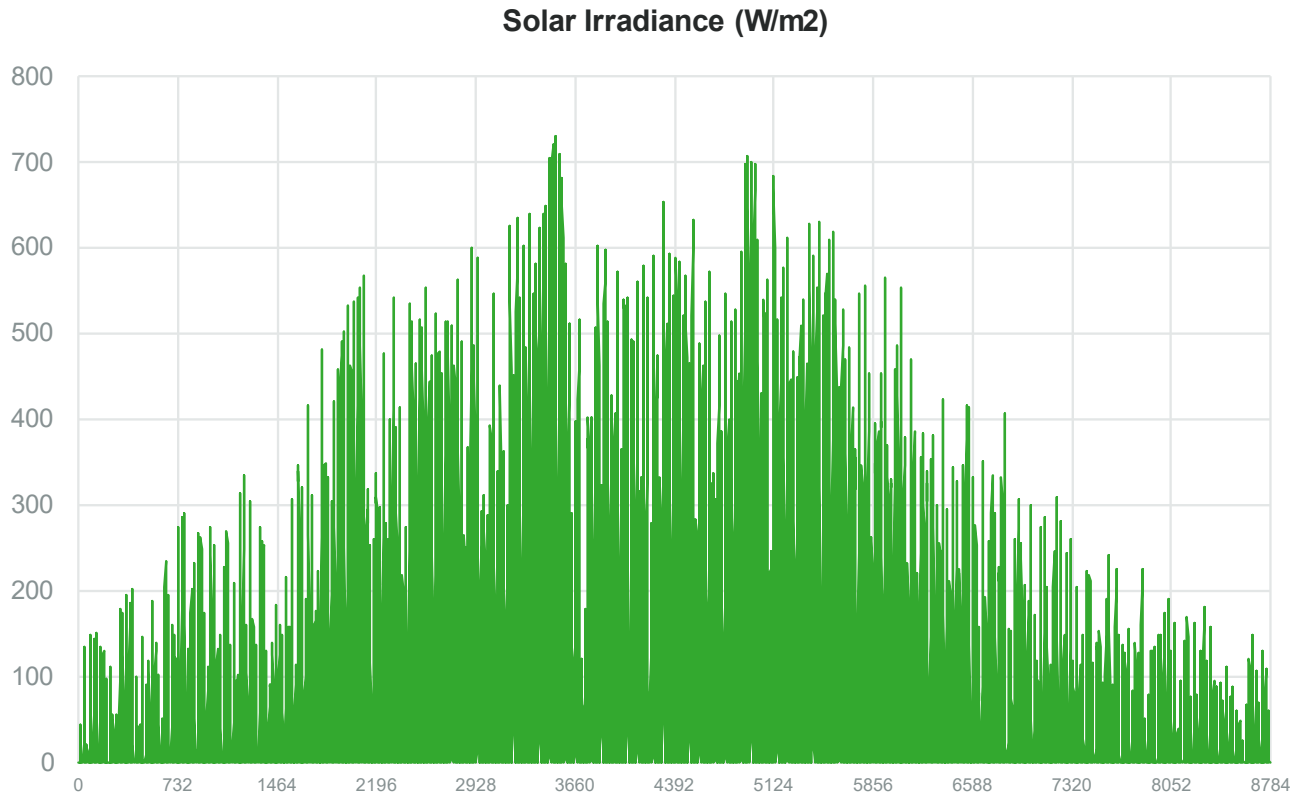
For example: year curve for variation of temperature:



Increase ampacity of overhead lines

Year rating curve 2/4

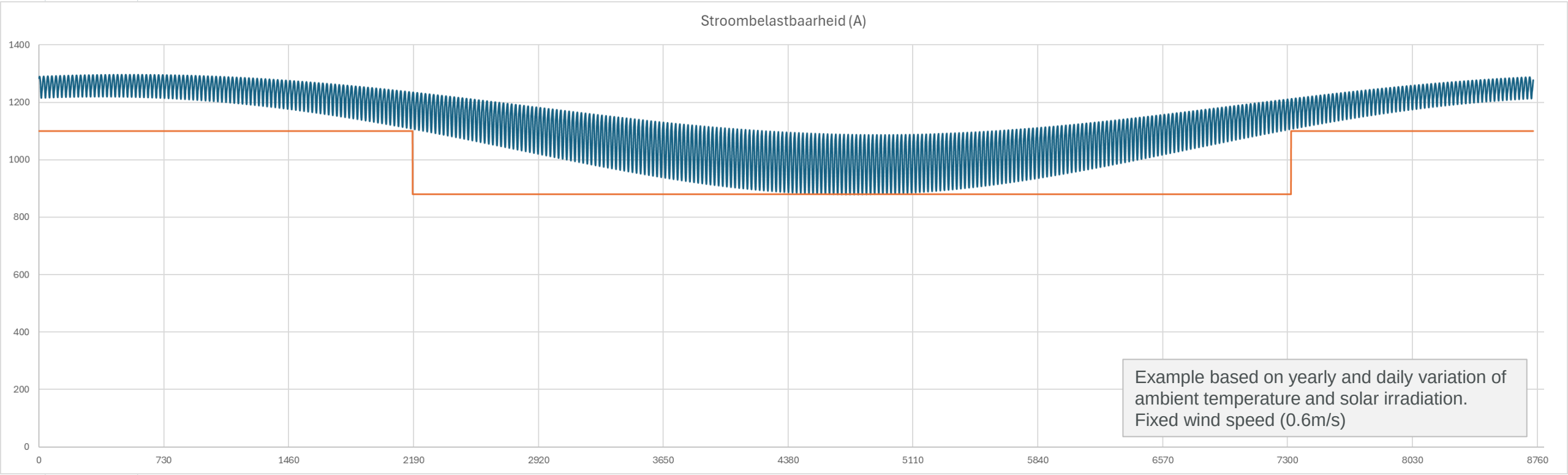
- The same can be done for solar irradiation.



What about wind?

Increase ampacity of overhead lines

Year rating curve 3/4

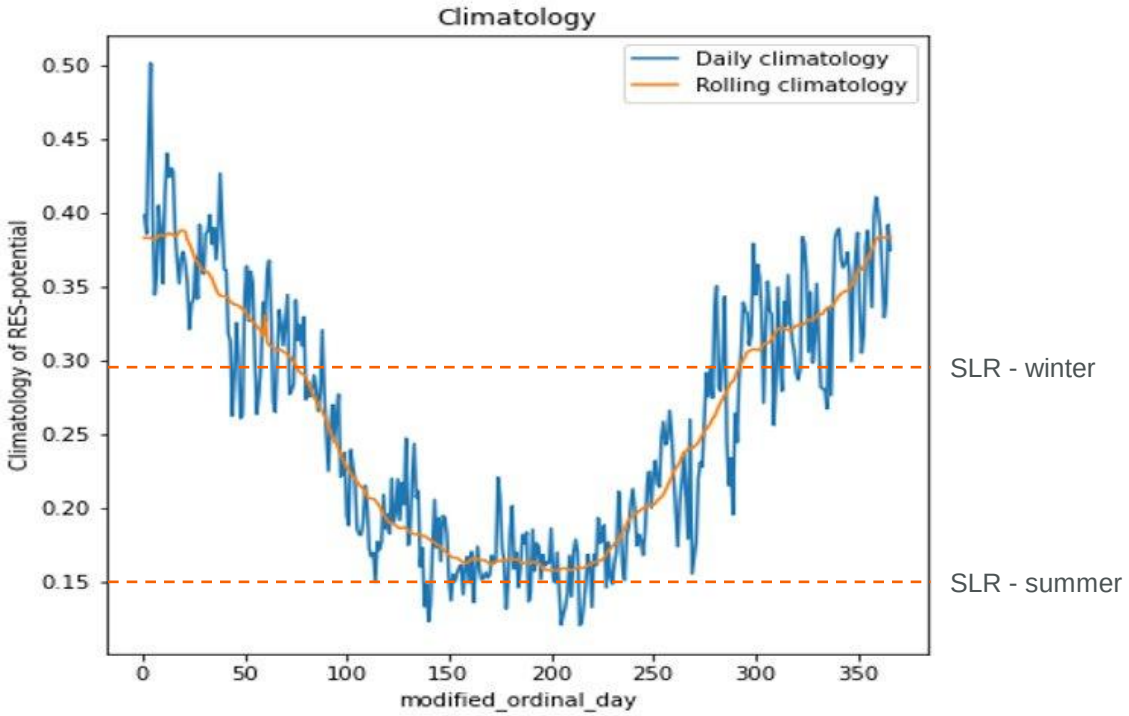


Minima = equal
Avg. extra = 17.2%
Max. extra = 40%

Increase ampacity of overhead lines

Year rating curve 4/4

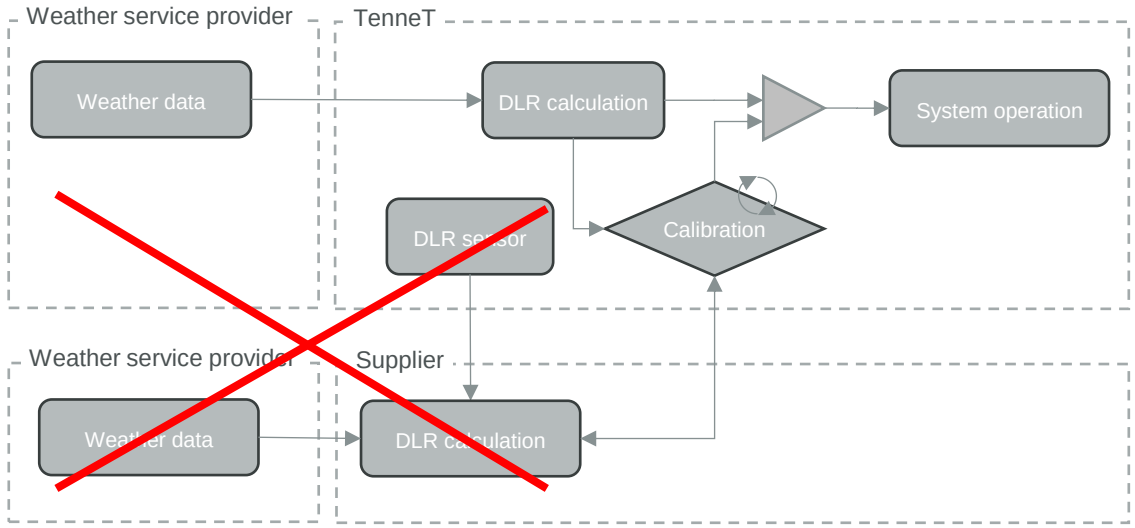
More sophisticated: year curve rating based on statistical evaluation of historical weather data.



Increase ampacity of overhead lines

Sensorless DLR 1/2

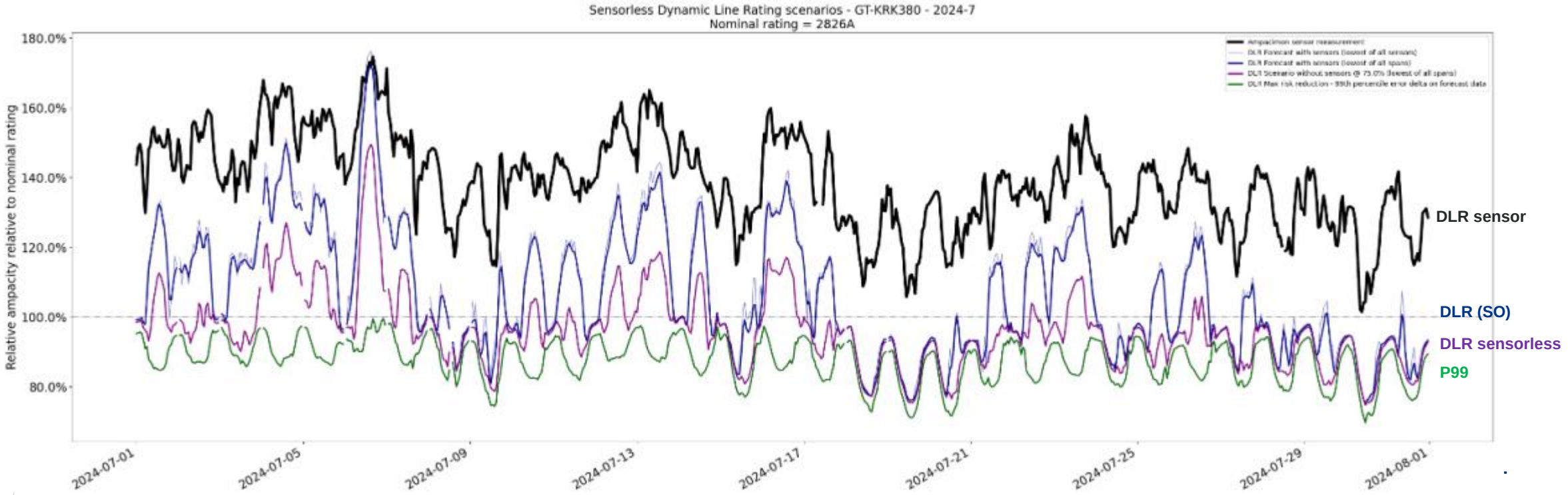
Existing policy is to apply sensors for calibration of DLR. The application of sensorless DLR is possible to speed up the process, using a (conservative) approach based on weather data only and calculate the ampacity for 2-days ahead, 1-day ahead and real-time.



Increase ampacity of overhead lines

Sensorless DLR 2/2

A method for sensorless DLR is currently being investigated. With a predefined risk level, a value (‘*DLR sensorless*’) can be calculated that is more conservative than the actual values (‘*DLR sensor*’ and ‘*DLR SO*’) but results in higher capacity that the SLR (100%) and P99.



Why don’t we increase all the line rating values?
Rating issues

Some checks need to be performed:

a) Safety checks (no existing clearance violations shall be present)

b) Protection settings

c) Data quality check: team working on checking +100.000 asset values

There are some other limitations for currents. To list a few:

1. Grid stability
2. Permits
3. EMC (e.g. inductive influencing)

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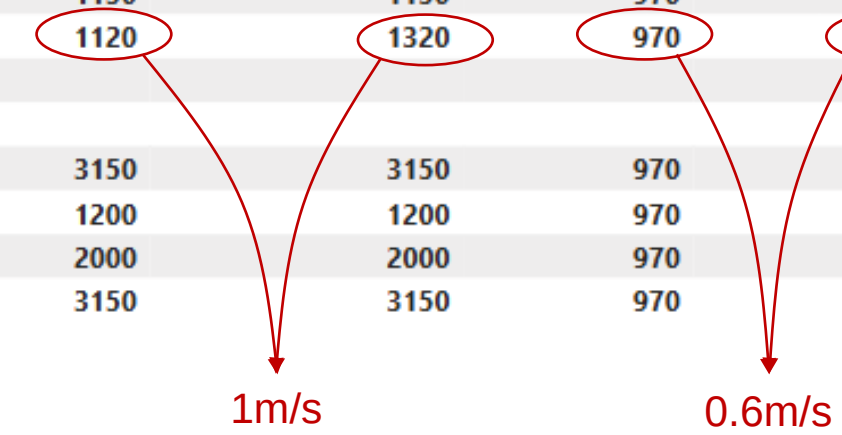
Additional slides

Overview data per connection

BMR_NETSCHAKELID	CALC_ZOMERWAARDE	CALC_WINTERWAARDE	ZOMERWAARDE	WINTERWAARDE	EM_WAARDE	EMC_WAARDE
APD-WHS150 W						
APD150						
APD150						
Scheider	2000	2000	970	1147		1147
Stroomtransformator	1200	1200	970	1147		1147
Veldverbinding	1200	1200	970	1147		1147
Vermogensschakelaar	3150	3150	970	1147		1147
APD-WHS150						
HSkabeldeel	1150	1150	970	1147		1147
HSleidingdeel	1120	1320	970	1147	955	1147
WHS150						
WHS150						
Scheider	3150	3150	970	1147		1147
Stroomtransformator	1200	1200	970	1147		1147
Veldverbinding	2000	2000	970	1147		1147
Vermogensschakelaar	3150	3150	970	1147		1147

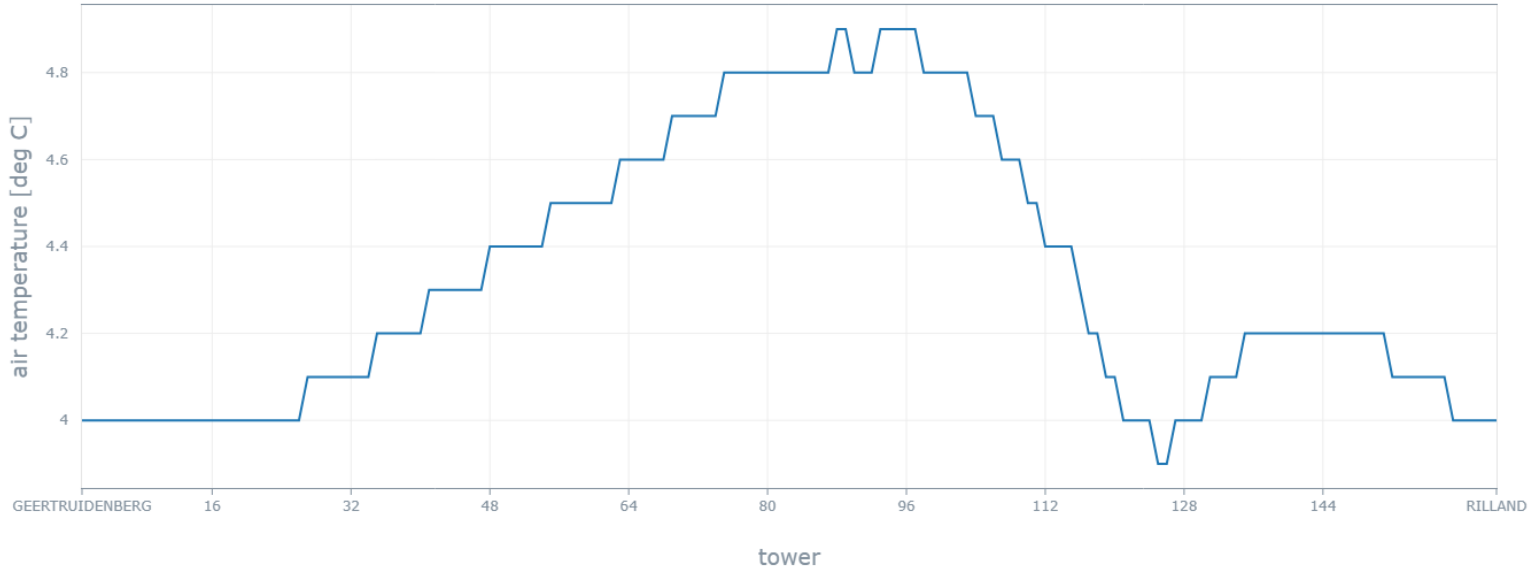


Static wind increase results in +15% higher rating
Cable new limit in winter

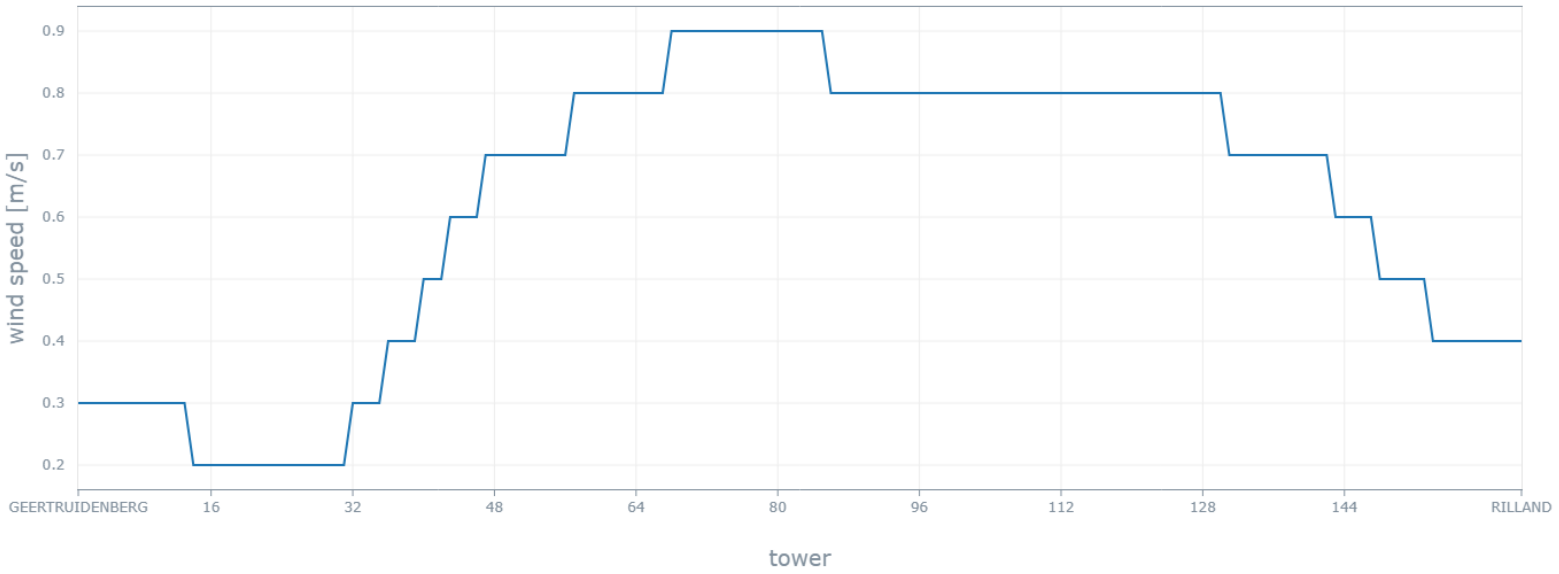
Additional slides

DLR analysis of line

Not much variation



Significant variation



Additional slides

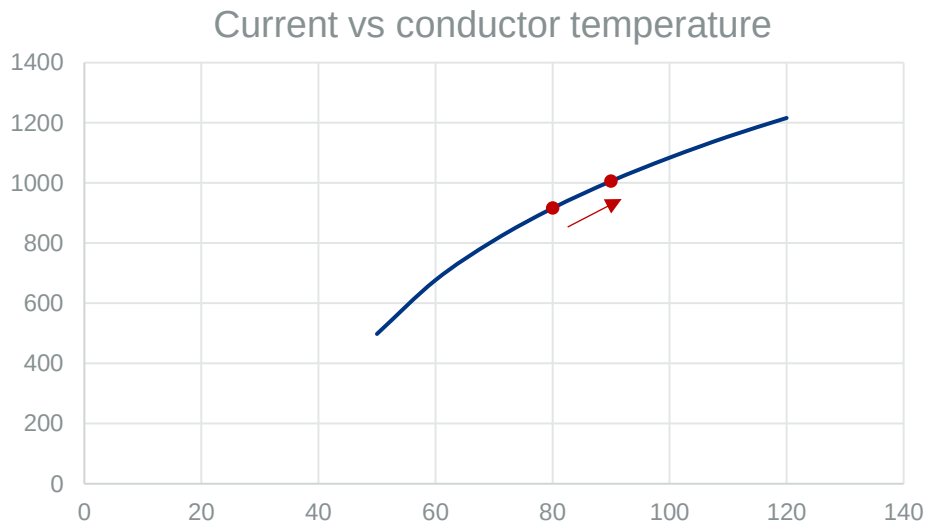
DLR analysis of line

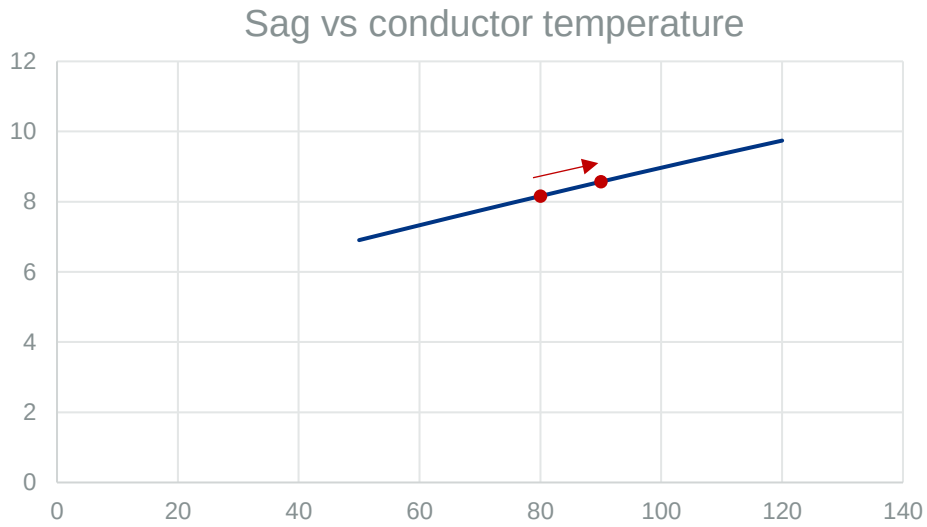
Large variation

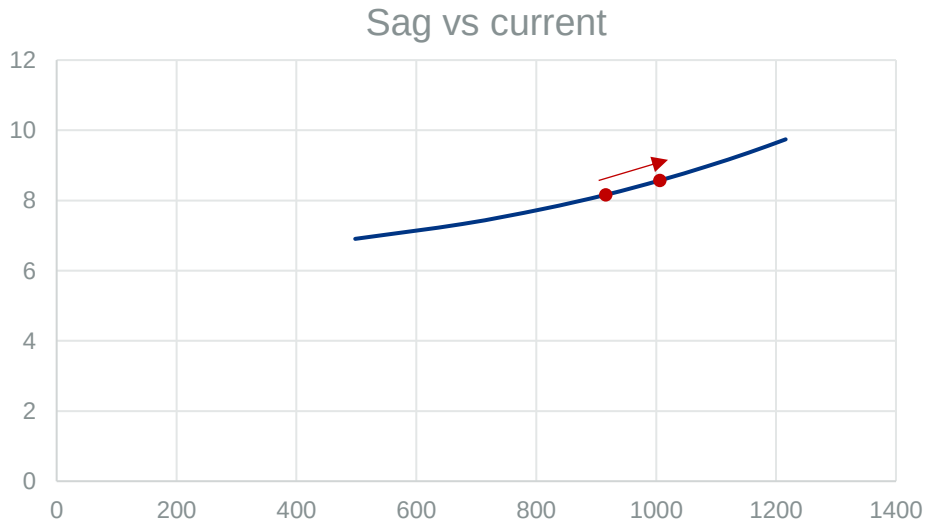
Rating defined by bottleneck(s)

Additional slides

Current, conductor temperature and sag







Conductor temperature	Current rating	Sag
80 ℃	916 A	8.16 m
90 ℃	1006 A	8.57 m
	+10%	+0.41m

Additional slides
Short time overload