Innovative solution for Dynamic Line Rating

Direct sag determination based on conductor vibrations measurement

Connect more renewable energy
Increase capacity in congested areas
Avoid all clearance violation

Ampacimon
Overhead Line Monitoring
Towards a greener society

The energy sector is at the center of the global change towards a greener society. Reaching the CO2 reduction targets across the world has already induced substantial changes to the energy sector and this will continue at even greater pace in the years to come.

The EU’s 20-20-20 plan is a good example: by 2020 Europe has set itself the objective to increase energy efficiency by 20%, reduce CO2 and other greenhouse gases by 20% and increase the percentage of Renewable Energy Sources to 20% of total energy production.

The impact on the energy sector is profound and most so for the transmission and distribution grids which will have to cope with complex, changing and difficultly predictable power flows.

In particular the grids need to be reengineered to:

• Allow new generation to connect
• Increase cross-border energy exchanges
• Cope with increase in consumption
• Handle modified power flows

Grid capacity is the bottleneck

One look at the development plans of the grid operators across the world is enough to understand that grid capacity is the key bottleneck to build the energy system of tomorrow.

Considering the substantial cost and the difficulty to build new lines in many areas of the world, it will be impossible to create the required extra grid capacity using traditional means.

Therefore to reach its target the grid has no choice but to evolve and become smart and dynamic.

Dynamic Line Rating (DLR) is a promising solution to the above challenges. It increases the usable capacity of existing lines while keeping the operation totally safe.

296 GW of new grid capacities needed in Europe by 2020.

T. Ackermann

Smart grids are much more than technology...

Ronnie Belmans, KUL
Dynamic Line Rating, part of the solution!

“The Ampacity of a conductor is that current which will meet the design, security and safety criteria of a particular line on which the conductor is used”.
CIGRE, Guide for Application of Direct Real-Time Monitoring Systems

Sagging, the main safety criteria, is due to thermal expansion of the line, a complex function of air temperature, solar radiation, local wind and actual current.

Due to the intrinsic difficulty in accurately measuring those parameters, a static line rating is traditionally determined based on worst case weather assumption for operation. Per definition, real-time Ampacity is higher than this static rating most of the time.

An accurate real-time Ampacity monitoring system will allow you to exploit the full capabilities of existing lines. Experience shows that an average of 50% extra capacity can be safely exploited in favorable locations.

What can Ampacimon help TSOs with?

✓ Renewable Energy
Connect more renewable energy and minimize curtailing of production on undersized (rural) networks.

✓ Clearances
Monitor your lines to avoid all clearance violation and prove it.

✓ Congestion
Increase capacity in congested areas of your network. Monitor real line overload and avoid costly dispatch changes.

✓ A quickly applicable solution at a reasonable cost
The answer offered to the above challenges is implemented in a matter of months and at a very reasonable cost.

Extra capacity for 98% of the time
How does Ampacimon’s DLR solution work?

Key features

✓ Safe
Sag/clearance measurement in real-time.

✓ Accurate
Less than 20 cm accuracy.
No external parameters.
No point measurement. Frequency “image” of the complete span.

✓ Practical
Real-Time measured and reliable.
1h/4h forecasted max allowable current.

✓ Easy
Live-Line installation anywhere on the span.
No maintenance. Self-powered.
No laborious on field calibration required.

Ampacimon is an innovative and patented technology package that continuously analyses the 3D vibrations of transmission overhead lines using accelerometers. The measurement modules can be installed in any position along the span of single conductors or bundle conductors, either when out of service or on live lines.

The originality of Ampacimon is to extract real-time sag data directly out of the vibration frequency spectrum. The Sag is directly and simply deduced from the fundamental frequency (f0)/sag relationship which requires no external data (line current, topology, conductor data, etc.) and no calibration. This unique physical approach allows Ampacimon to monitor the sag of critical spans with absolute reliability while being very simple to install and operate.

Once sag has been determined, Ampacimon software then calculates in real-time the maximum allowable current for the line using the IEEE thermal model where rating is a function of line loading, conductor constants, mean conductor temperature and ambient conditions.

Thanks to its independent sag determination, Ampacimon is able to tune these measured ambient weather conditions to bring them in line with the actual behaviour of the line, increasing reliability of Ampacity data supplied to TSOs.
And how do I use it in operation?

The system is made of Ampacimon modules, directly clipped on the overhead lines and an Ampacimon server directly linked with the operator’s scada system. The data recorded by the sensors is sent via GSM/GPRS to the Ampacimon server. The server determines sag and Ampacity and provides the data to the scada/EMS system and/or a dedicated web interface.

The calculated data can be used for multiple purposes:

- As an input into the flow simulator of the EMS system to determine the real contingencies avoiding unnecessary and costly redispatch or curtailing.
- As an input into the network planning tools to allow more (renewable) production to be connected to the existing grid in a safe, fast and economic way.

Intra-day predictions (up to 4h) are also available and can be used to:

- Increase capacity available to the market and avoid congestion related price-peaks.
- Give early warning to the grid operators to allow enough time to find the most economic contingency measures.

**Unlike other determination methods, Ampacimon does not need any line nor any environmental data to determine sag.**

Janos Toth, BC Hydro, Canada

**Opportunities of Dynamic Rating**

- **Input into the EMS Flow simulator**
  Determination of the real contingencies, suppression of unnecessary and costly redispatch and curtailing.
- **Input into the network planning tools**
  New connection criteria for more (renewable) production connected to the existing grid.
- **Intra-day Ampacity predictions**
  Less congestion related price-peaks. Early warnings for the operators to find the most economic contingency measures. Up to 4 hours prediction, >95% reliability.
Ampacimon, a proven technology!

Thanks to its innovative approach, Ampacimon has been able to provide the energy sector with a simple and reliable Dynamic Line Rating technology.

With its solution patented in 2006, Ampacimon staff has since be happy to help TSOs deal with congestion, safety and renewable energy production issues.

After more than 4 years of extensive tests, certifications and pilot operations, Ampacimon’s solution is now used by leading grid operators.

Monitors have been installed worldwide on a wide variety of single, dual and quad conductors with a strong focus on the European and American markets.

Direct sag determination of critical spans up to 1.6 km long has shown unseen level of data reliability.

“At 50 Hertz we needed to find a solution to rapidly and safely increase the capacity of our network due to the significant increase in connected offshore windpower. We decided to try out Ampacimon’s product because of its innovative approach.”

Thomas Dockhorn, 50 Hertz, Germany

“Ampacimon can be located anywhere on the span and is installed live-line in a few minutes.”

Linesman, RTE, France
Elia, the Belgian TSO, has been requested to connect significant amounts of wind-power to its 70kV network in south-east Belgium. The connection capacity of the existing network, calculated the traditional way, is already fully utilized and it has become impossible to connect new wind power plants. Extending the capacity of the grid in this area is not possible in a reasonable timeframe and budget and refusing the connection of new wind farms in this location was not an option either, therefore it was chosen to implement an ANM (Active Network Management) solution and connect the plants with the right for the TSO to curtail the output as needed to guarantee safe network operations at all times. Curtailment provides the desired solution but destroys economic value for the operator of the wind power plant and reduces the amount of wind-energy in the energy-mix. To minimize the curtailments required to the very strict minimum, Elia decided to implement Ampacimon’s Dynamic Line Rating solution to maximize the use of the existing 70kV network and at the same time minimize the total cost towards the energy consumers.

Instead of the maximum allowed installed capacity determined on a (static) deterministic N-1 calculation, the injection limit of wind farms is thus calculated for the N-situation.

The goal is in a first step to minimize the amount of curtailment of existing wind power plants in real-time operation and in a second step to increase the available connection capacity for new (wind) power plants.

Location and Line type

A section of line was selected to install an Ampacimon sag measurement module to validate the concept on the 70kV network. Further modules will be installed at a later stage to equip all critical spans. The equipped line is of the type AMS95 and has a 12.5 mm diameter. The static rating of the line is 370 A in winter and 320 A in summer.

Connecting wind farm to the grid is a key issue for the growth of this promising sector

The Solution

Elia decided to apply Ampacimon technology to enhance their ANM solution with the following architecture:
1. The Ampacimon Module(s)
2. The Ampacimon DLR application
3. The EMS and optimal flow simulator

The data is transferred by GSM/GPRS from the module to the Ampacimon server, which computes the DLR based on the various inputs (including line loading from the EMS system) and transfers the result to the EMS and the OPF (=Optimal Power Flow). The EMS system will determine if there is an overload and trigger the OPF to calculate the required curtailment to solve this overload. The OPF will then determine the new set points for the wind farms solving the issue in 15 minutes maximum.

Combining Ampacimon’s DLR solution with our ANM definitely makes sense. The increased capacity is there when needed. It is a real win-win solution: quicker connection, lower investment cost and negligible losses due to curtailment.

J-J Lambin, Belgium
Ampacimon specifications

Position of monitors
in span (critical sections)

Measured value
direct sag – no calibration

Sensing principle
span vibration frequencies

Sensitivity / frequency range
100 μG / 0 – 100 Hz

Sag measurement accuracy (to topography)
typ: < 10 cm (max < 20 cm)

Environment
full weatherproof

Conductor temperature range
-40 °C to + 200 °C

Real-Time Ampacity
CIGRE/IEEE dynamic thermal model

4 hour Ampacity prediction
AMPACIMON algorithm

Power supply
autonomous

Minimum operating line current
80 A

HV compatibility
certified for 400 kV, corona free
lightning (1475 KV peak with cutted wave)
short circuit (63 kA rms, 150 kA peak)

Position on the conductor
not critical, flexible allowing easiest access

Weight
8 kg

Dimensions
440 x 180 x 270 mm

Installation time
typically less than 1h on site

Line outage needed
no

Maintenance
no

Span length
any (has been installed on spans up to 1.6 km)

Conductor diameter range
standard: 6.5 to 52 mm
with armor rod: 6.5 to 33.5 mm

Span configurations
any (anchoring, suspension, single or bundle conductors, incl. unlevelled spans)

Monitor telecommunication
standard: GSM 900 and 1800 MHz
(SIM card provided by TSO)

Server / EMS communication protocols
TASE2 / DNP3 / IEC61850 using VPN
other on request