BUSINESS NETWORK INNOVATION

Questions and Answers
"Smart grid world of innovations: Dynamic Line Rating"

	Question	Answer
1.	How does DLR works for underground networks? If parameters would be different than wind, solar etc? thank you!	Underground power cables are quite different in thermal behaviour and surrounding conditions. In general, the weather does not influence the ampacity of the cable directly, but there will be a difference in ampacity due to seasonal effects (soil temperature, moisture). the large thermal capacitance of the soil makes dynamic rating very interesting for underground cables since the load can be increased significantly for a number of days or even weeks without reaching the thermal limits of the cables. For overhead lines, the overload time is much shorter.
2.	For the slide on comparison of different technologies for DLR, the options are compared based on capacity gains as well as security/risk. I wanted to know what is meant by security/ risk?	the risk to go beyond safety limits (max sag, or max operation temperature of the conductor): if the modelling, or the measurement of the conductor and weather parameters are not done properly (not accurate enough), you could end up overstating the rating, and infringing safety limits. Using sensors that measure sag, you have a "feedback" loop that

		allows you to ensure that you never infringe those limits: risk is reduced
3.	How is the DLR results implemented in the modelling studies while doing day-ahead or 2 days ahead dispatch assessment. Is there any such data available in public domain?	I can send you some. plse contact me for details
4.	Question on DCR: I would expect that the deployment potential of DCR is significantly lower (than DLR) because you can basically not “retrofit”). Moreover, when installing new cables, you will probably select a rating which is high enough. Am I right?	The best option to implement DCR is in combination with fibre optic, which is available in most cables which are less than 10-20 years old. DCR is also used to determine the actual ampacity of the cable, since this can only be known when measuring the cable temperature response. For new wind farms, they use DCR in combination with a smaller cable size to reduce costs, since the wind is not always there for 100% of the time
5.	Question to Elia and Ampacimon: the gain can be easily calculated. What about the risk? As long as nothing happens (fortunately this is the case for most of the time), the assessment is very difficult. Have you made some analyses on planning (where / how much... sensors) to investigate this? Very local effects (on temperature and above all - as you mentioned- wind) might result in a strong increase of risk which is not considered as long as you can’t observe the conditions everywhere. Am I right?	reducing risk is precisely the point of using sensors mounted directly on the conductor: they give you a "feedback loop", to detect any potential infringement...it actually REDUCES risk vs "static rating", because "static rating" also has lots of implied assumptions (often "forgotten" by grid operators) which can be infringed. in fact, in most of our deployments, we see some (short) period of times when the capacity needs to be REDUCED below static rating.
6.	Besides thermal capacity/ span limits, how would you deal with electromagnetic compatibility limits?	You have to verify that you are allowed to increase the current of your line (permitting, notably for magnetic influence)
7.	@Victor le Maire: Is there a similar rule for cables like the "30% rule" for overhead lines?	At elia, we also have DLR for cables and there we do not impose this 30% limit. Indeed the inertia of a cable is so much higher that related risks are lower
8.	What is the deployment status of DLR among TSOs in Europe?	to my knowledge, several pilots in a dozen grids in Europe since close to 10 years. Deployed fully on all congested lines in Belgium. Currently several public tenders for grid-wide deployments in several countries. we have hundreds of sensors in operation around the world

9.	Slide on DLR capacity/gain is over 2 months. Would there be a yearly assessment of DLR capacity available?	no, it's over 2 years.
10.	How much does it cost to introduce the DLR. The cost of sensor device, software and set-up fee etc..	a few hundreds thousands euros per line, depending on line lenght. Plse contact me directly for details
11.	Sensors are installed only at some "critical" parts of the line. Who is taking over the risk if survey missed the correct location? What if you have hot part of the line and you even don't know?	we run software-based simulations to identify those critical spans and recommend which ones to equip, and always take "safe side" assumptions to monitor more than what's required
12.	Why are all TSOs not implementing this technology on all cross-border lines? If the static limit is conservative, capacity increase is close to certain thus bringing more capacity to day-ahead markets.	TSOs need to assess risk very carefully, certainly with a technology bring so much extra capacity. This requires reliability, robustenss of the all DLR system (IT, communication, measurements etc.). TSOs will always proceed carefully and this technology is relatively recent and innovative. You will see how we did implement step by step DLR for Elia in my presentation.
13.	Since the TSO ussualy does not operate its lines at max temperature, the max temperatures are limiting only in terms of N-1 assessments. This means that understanding how the line would heat up in a N-1 scenario is much more important than the measurement of the current sag and/or line temperature. The TSO does not need the current line temperature, but rather how much more amps can that line carry. Are the algorithms for calculating this evolving and being tested?	Ampacimon is giving the permanent maximum current that the line migth see with the current weather conditions. This is the permanent capacity, so the pre-loadind is not relevant. Ampacimon is also proposing another product, the temporary limit (acceptable for 15min for example)for which the pre-loadind is necessary
14.	Question for Ampacimon and/or Elia: in the slides I understood that you advocate as the best technology the sag-monitors with wind sensors. However, I guess these cannot work well without a detailed weather model and also short term weather predictions. Are you using those?	the point is precisely that this type of sensor DO measure the wind speed, exacltly as "seen" by the conductor (which a model would never be able to do): so for real time monitoring, we don't need a model. For day ahead forecasting, we do use forecasts, which we correlate with our sensors reading
15.	Do the limiting spans of the powerline stay the same through time? Is a limiting span always a limiting span?	Yes, if you make a good assessement of the topography, wind exposure etc. You should be able to identify all limiting spans in all conditions

16.	When do you know if the assessment is good?	By looking at the detailed plan along the all line. For all spans with a potential limitation you install a sensor. You also go on site and measure the real sagging in real-time and compare it with the instantaneous flows on it for those different spans to ensure that your estimation of the limiting spans are correct
17.	115% gain 90% of the time - what is in the other 10%? from the figure it can be seen that the dynamic line capacity is lower than the static - what do you suggest to the users in those situations?	It might happen indeed that the static rating is not enough conservative in extreme weather conditions (high temperature for seasonal reference). This is then a way to measure and ensure that you are not overestimating a capacity of your line and so, as a TSO, reduce the risk you are potentially taking. In Elia experience, we had pratically never had to reduce the static rating and when it happens this is by a very low amount
18.	How does the solution with sensors fare in powerlines traversing geographically diverse landscape? Would there be a need to insall a lot more sensors?	Yes the number of sensors per kilometer depends on each line. For Elia case it is typically one sensor per 5km
19.	question for ampacimon: how do you establish/prove, that the line rating that is calculated by your system is actually the right line rating?	by measuring (physically) the sag of the line (measurement done from the ground, by a topographer), which should match what the sensor and model computation says at this point in time. We've conducted such surveys many times on many different types of lines/conductors, and find a very good match (sag accurate to approximatly 20cm, on sags typically of 10-15m)
20.	So, if I understand, you measured the sag at the actual maximum load that was calculated?	at any load, as long as we know what it is (we get that info from the TSO), at the time when we make the measurement.
21.	if all main XB lines (and the internal CBCOs in DE) installed your systems, how much coudl we expect the FB domain to increase (roughly)? (for Ampacimon)	difficult to say, we don't have grid-wide studies showing that. What we know and can rely upon is what Elia did on their interconnectors (and critical lines). Our systems can typically release 10% most of the time...but as Victor explained, that's not the only limit that should be taken into account (because of other substation limits for example)

22.	for DC cables (question for energy solutions): if the cable is so much under the ground/ sea: is the T pretty constant there? beside the load of the cable, what could change it?	For DC cables, a hotspot can also occur due to movement of the soil in the seabed adding a lot of soil on top of the cable insulating it. With DCR you can detect this and take measures.
23.	Is there any sort of cost estimate for different DLR methods?	I can't speak for all technologies, but generally, the order of magnitude is a few hundred thousands Euros per line, ...obviously more for longer lines;
24.	Do you have a case where the DLR capacity decreased the capacity of the line?	Not at Elia. But if you have such effect, this would meen that the installed assets are not those you thought were installed. Historical error in the plans of something and this would be very improbable. Anyway, if you see such values, this is good to see it to avoid this risk you were taking,yes, it can happen occasionnaly for lines that are already very close to their limit, in very hot days typcially. Sensors would allow to detect it and decide on proper action to take
25.	What is effect of precipitation and snow on overhead conductors?	experience shows that rain has a fairly marginal (small) positive effect. we ignore it to be safe. Snow/ice would increase the sag, therefore reducing the capacity. But our sensors can detect it and warn the operator
26.	Is there any difference in DLR improvements with different types of conductors such as ACSR?	yes. plse contact me for further details, too long to provide a full answer here; but the type of capacity increases I mentioned would apply too
27.	Regarding costs, you indicated CAPEX of the physical DLR equipment. What about OPEX (of the DLR equipment)? What about the operational costs related to the extra-losses?	in our case, it's very low: no maintenance at all. only communication costs (GSM)
28.	is it possible to asses for dlr for a transmission line without installing any additional equipment or sensors on transmission line. can it be done just by feeding weather data of the area in which line is located and software installed at control room end can correlate that for assessing dlr.	yes, we actually have software modelling products that allow us to do that, and help customers decide which lines to equip (and which spans to equip with sensors). plse don't hesitate to contact me for more info on this
29.	whether internet availability is must all along the lines.	no, we use GSM (cellular), satelite is also available on some products

30.	whether one sensor is sufficient for a double ckt line for assessing dlr for both lines.	we don't recommend it. each line has its own behaviour and characteristcs
31.	is the cost of dlr assessment model depends on weather conditions of transmission lines	no
32.	IS there Installed in India as on data?	yes, at MSETCL for the time being. plse contact me for more details
33.	Is Sag is mearsured by sensors or devired qunatity . pls inform	measured by the sensors
34.	What is heighest line length of installation for Amp	No limitation of length but you will just need more modules
35.	Would wind direction also be of influence?	Yes wind direction has a big impact on the cooling with similar figures has showed by Frederic for the wind speed
36.	Do you have problems when the line goes past a forest, mountains or city, and there have less wind speed as opposed to line in open field.	Indeed, an overhead line witness different weather conditions over its length. This is important to identify the limiting spans (those with a forest or other obstacles) and to equip those spans with a sensor
37.	Would you use a different cable (like larger diameter) when the cable goes though a hotspot in the J-tube?	Yes, this is sometimes done when the J-tube is the critical part in the connection