

# Senja Leivo

**Senior Industry Expert**  
at Vaisala Oyj

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Interview with **Senja Leivo**

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# VAISALA

## DGA Monitoring on End-of-life Transformers



In this interview with Senja Leivo of Vaisala, we discuss several topics that are both timely and relevant to the safety and reliability of all electrical system assets, particularly transformers. We have focused primarily on DGA monitoring because we believe it is arguably one of the most important tools that you can use if you're looking at the condition of a transformer.



Senja Leivo and Riku Rantala installing the monitor at a utility in Latin America

Senja is a thought leader who brings not only her technical insights, but also a grasp of the marketplace and the changes going on in it.

**Alan Ross:** We are delighted to welcome in this interview Senja Leivo from Vaisala, a Senior Industry Expert and a brilliant leader of the technical and development part of Vaisala.

**Senja Leivo:** Thank you for having me here.

**AR** I would like us to talk about something that has been quite intriguing, and a very much talked about topic in the industry - DGA. DGA technology is probably one of the most important tools that you can use if you are looking at the condition of a transformer, and probably the most important non-invasive condition monitoring technique. But what we see as almost a phenomenon happening is, what we would call, end-of-life monitoring. A lot of people think, "Well, it's the end of life, I'm just going to replace the unit". And they begin doing their end-of-life capital planning to replace it. But one of our partners who does market research in this area recently told us that the global lead time for power transformers - including anything from a distribution transformer all the way up to a GSU - has gone from about two years and two months to three and a half years, which is almost 50% longer.

So, the end of life has become critically important. With that in mind, why would it be important to continue to monitor end-of-life power transformers in the utility industry?

**SL** Obviously, it depends a lot on the policies of utilities, and on what grounds they get a replacement, whether the decision is based on age only or on condition as well. I guess it's more and more coming that the decisions are based on the condition of the transformers rather than transformer age just because it is such a huge capital cost for replacing big power transformers. At the end-of-life phase, the probability of getting failures increases and the longer you go, the longer you postpone the time of replacement, the more likely it is that there will be issues. And like you said, DGA is the way to see those evolving or developing issues inside the transformer.

**AR** As a reliability expert, I love the bathtub curves and they have recently been showing us that that end-of-life stage has been extended. People are taking better care of their transformers. But as you said, if it's just age you are looking at, you're going to probably make bad decisions. If you are also looking at the condition, you will make much better decisions about capital planning. There is a group out of Southern California Edison that did some research and they applied machine learning on the difference between replacing distribution transformers based on age and based on condition and they focused on the

seven conditions around a substation. Once they started taking condition into account, they saved \$21 million when they first back-tested it in 2017. They then back-tested it again in 2018, and it went up to \$40 something million. And given the lead times we've mentioned, that could even now be in the hundreds of millions of dollars for utilities. But there are some specific other things that matter here. Let's say that you have an older transformer, and you already know there is a fault. Why would you put a monitor on that transformer?

**Placing a DGA monitor on a transformer that already developed a fault is one of the biggest benefits of online monitoring at the end-of-life phase. It gives you time to react and prevent the fault developing into something severe or catastrophic.**

**SL** Because that fault you have there may develop further and become more serious. And I think that's really one of the biggest benefits of online monitoring at the end-of-life phase. You have the fault there already, and it's possible and many times even likely that it will develop for the worse. By having online real-time DGA monitoring there, you can see if the gas build-up is accelerating. And if it is, it means that the fault is developing into something further and more serious. This gives us time to react, even though the lead times are so long. Of course, you don't have the replacement for the next morning, but at least you are able to take that transformer offline before something really severe or catastrophic happens.

**AR** And the costs of a catastrophic failure are significantly higher. Number one is getting a crew in to replace it. And here we have to talk about safety. In the U.S., OSHA - Occupational Safety and Health Administration, the government agency that tracks injuries and workplace injuries, now has the power to fine and prosecute through civil and even criminal penalties. If a company is not doing a good job at preventing injury, you are ten times more likely to die from a catastrophic failure of a piece of equipment in the electrical world than you are in the mechanical world. That ought to scare us into realizing that we cannot let it come to a catastrophic failure.

Could you talk a little bit about your perception of why the monitors give us an extra measure of safety in the whole process, given what I just said about injuries and fatalities?

**SL** Yes, I've discussed this topic with a couple of utilities here in Europe. They have internal policies in place for such cases. If they have what they call "suspicious transformers" that are in the end-of-life phase and are showing a tendency towards gas, instead of performing more frequent oil samplings, they fence that transformer off so that people don't get too close to it. And they have online monitoring instead to show if the faults are developing. So that is the safety measure for personnel. No need to go close to a suspicious transformer.

**AR** You once mentioned in a presentation that I listened to that when you use

monitoring, it allows you to do end-of-life or do whatever you're doing in a controlled manner. What does "in a controlled manner" mean?

**SL** For example, we have had a couple of cases recently where the utility company had already made plans to replace a transformer and had foreseen a certain number of months until the ordered transformer would arrive, and the replacement would take place. Meanwhile, they had online monitoring to be sure that they could use the old transformer to the end just before the replacement. In both of those cases I'm talking about, they couldn't wait that long because the gassing was increasing and towards the end even accelerated until they just had to shut it off. Thanks to the remote monitoring they could plan the transfer of that load to the other transformers and do everything in a controlled manner so that there was no disruption in the actual operations.

**The end-of-life phase monitoring is most crucial for transformers with pre-existing gassing issues.**



Senja Leivo, Riku Rantala and Toni Mellin installing the monitor at a utility in Asia





**We have had a couple of cases where the utility that had made plans to replace a transformer, used online monitoring during the lead time to be sure that they could use the old transformer until the time of the replacement. In both of those cases, the transformers couldn't operate that long because the gassing was accelerating so they had to shut them off. Thanks to the remote monitoring they could plan the transfer of that load to the other transformers and do everything in a controlled manner so that there was no disruption in the actual operations.**

**AR** It's interesting. Years ago, there was a trip-down, if I'm not mistaken, in Argentina. And that one trip caused an overload because it was unplanned, and it almost shut the entire grid of Argentina down. In fact, there were areas that were shut down and it was because of that uncontrolled manner of a fault causing a problem that exacerbated it. In Europe and in the United States, so many utilities now have created relay systems that enable that load transfer. And it's so much easier to route it around when you know it's going to happen.

With everything we have just said, there is no reason for a utility not to put a DGA monitor on an older transformer. Are there any other reasons why they ought to do it? Because that's the case we're making today.

**SL** Concerning the end-of-life, I think those are the ones that have occurred to me, and where I have the most experience. There was also one case where a transformer had a thermal issue for years. It was producing some gases and they followed it and added cooling systems to it and so on. But again, towards the end, it was clearly developing and by having the online monitor, they could react to that early enough because they had installed alarms in their systems. There was, of course, some extra work because they had to replace that transformer earlier than they initially anticipated. But everything happened in a controlled manner so that the electricity production was not interrupted at all. The way I see it, online DGA monitoring at the end-of-life phase is most crucial for transformers with pre-existing gassing issues, and they obviously know that based on their manual DGA samples.

**AR** So last time we spoke, we made a case for putting DGA monitors at the beginning of life on newer transformers in service and now we've made a case for putting monitors on transformers that are at the end of life. You've made a great case for that. Thank you so much for joining us today.

**SL** Thank you, it was my pleasure.