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Interview with Janne Wallenius,
CTO, Blykalla AB

Prof. Dr. Janne Wallenius
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Prof. Dr. Janne Wallenius is Chief Technology Officer at Blykalla (LeadCold Reactors) and Professor of Reactor Physics at the KTH Royal Institute of Technology in Stockholm. For more than two decades, he has been driving the development of innovative lead-cooled fast reactor concepts designed for enhanced safety, cost efficiency, and sustainability. Wallenius holds a PhD in Quantum Chemistry from Uppsala University and is recognized as one of the leading experts in materials and neutron physics for compact reactor systems.

You are the Chief Technical Officer of Blykalla and also Professor at the Royal Institute of Technology.
Yes, that's right. So, I am still working one day per week at the Royal Institute of Technology, where I am teaching courses in the Nuclear Energy Engineering Masters program.

What are the origins of the SEALER project, what is the history of Blykalla?
When I was working as a professor in reactive physics at the Royal Institute of Technology from 2008, we had a government funded project developing materials and fuels for lead cooled reactors. That project was quite successful in the respect that we were able to develop novel aluminum alloyed steels that are totally corrosion tolerant in liquid lead. And this was a breakthrough. It was a scientific and technological breakthrough. Now we had hopes to apply these steels in the construction of a research reactor at KTH, but following Fukushima funding for nuclear research disappeared in Sweden. So, I lost as a professor about half my research funding very quickly, both from industry and from the government. Which meant we were sort of in a desperate situation, and we thought, how can we manage now? So, I asked my colleague, how about forming a private company to exploit the outcome of the research that we had succeeded in doing. And Peter Szakalos, my co-founder, agreed to do that.

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And so, in 2013, we founded Blykalla with the intent to commercialize small lead-cooled reactors, using these new alumina-forming steels for corrosion protection. So, that is how the company came about. In the beginning we didn't have much funding. We got some from the government to do market research and we spent a substantial amount of time in Canada, looking into opportunities of deploying our reactors in the Canadian Arctic for remote villages and remote mining operations. That was an interesting time. We learnt a lot, but in the end, we realized we had to get funding to demonstrate our technology elsewhere. And then we had a hiccup, a serious hiccup because we signed an investment agreement with a, let's say a non-serious investor in Dubai. So, in early 2017 we signed an investment agreement for 200 million U.S. dollars. Which never materialised. So that was kind of a shock for everybody involved and very difficult times. So, lessons learned one needs to be careful with checking the background, including by a third party of your prospective investors, if you try to do this. So, for a while the company was hibernating, but then we got the grants from the UK government to investigate the deployment of a lead cooled reactor on the UK grid and we came up with the SEALER 55 reactor solution, which is an optimised version which is a little smaller. The reactor is optimized for long life operation of the fuel, which means that it operates on uranium nitride fuel with 12 % enriched uranium. So that was a good outcome of the British projects which we later brought to Sweden and at that time the prospects for building nuclear power had improved dramatically in Sweden.

So, we started discussions with the Swedish nuclear power plant operator Uniper and the Oskarshamn nuclear power plant to build small lead-cool reactors for deployment in Sweden.

Due to re-industrialisation policy and IT growth, it was understood that the prospective need for new power had increased a lot. That means a doubling or tripling of the foreseen electricity consumption would happen. So, we started discussions with the Swedish nuclear power plant operator Uniper and the Oskarshamn nuclear power plant to build, actually develop and build small lead-cool reactors for deployment in Sweden.

Without governmental support it would have been much more complicated to attract venture capital

That means you also did profit from the turnaround in Swedish politics towards new nuclear and new nuclear development in the meantime. What have you achieved so far in this new political era, so to speak?
Now, this meant that it was possible to attract investors, serious investors this time into investing in a company that would have as its focus to deploy SMRs in Sweden. And that was partially due to the change in governmental policy, which made Sweden very attractive for venture capital investments in a company developing SMRs. So, of course, without governmental support it would have been much more complicated to attract venture capital.

And in terms of the agenda, the timeline, when do you think to have a SEALER operational and ready for deployment?
Yes, our near-term schedule is to submit a request for permission to build a nuclear reactor on a specific site. So, we are going to request the site permit and in the new legislation that will come into place in Sweden this spring this is the first step in an application. So, we will not yet submit anything to the Radiation Safety Authority, which is the nuclear regulator, but we will submit a site permit application to the government. This will happen in spring 2026.

Following that, if we get a positive response from the government, we will approximately a year later apply for permission from the Radiation Safety Authority to build our nuclear power plant on that site. So that application will then be filed in 2027. After that it will depend on how quickly or slowly the regulator will provide its feedback on our application.

Historically, Swedish regulators were doing this in five years. Now we hope that this can become much, much faster, but in the ideal case, they can maybe respond within two years so that we can start building in 2029. Yes. Then of course it depends on how skilled we are in constructing our first reactor. Historically we know large power plants take maybe 7 to 15 years to build, but the whole idea with SMR is that it should be quicker to build and historically the quickest nuclear power plant projects were built within two years. If we can replicate the most successful historic projects, we would have our first demonstration unit in operation in the early 2030s.

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An ambitious target. Do you think that European regulation could enable to be quicker for new reactor concepts or doesn't that play any role?
It is our understanding that national regulators have their own special views on certain aspects which makes it quite difficult to agree on a common European regulation. So, we are currently not foreseeing that we will be assisted by a common European regulation, unfortunately.

Which are the advantages of lead-cooled fast reactors among the different Gen IV advanced reactor concepts in your opinion?
Well, the first advantage is that this is a non-pressurized reactor system, which means that the reactor vessel can be made much thinner. We speak about

40 millimetres for a lead-cooled reactor vessel instead of 150 millimetres for a pressurized water reactor. This immediately translates into a strongly reduced time for making the vessel. A pressurized water reactor vessel takes three years to make by forging. We can build our vessel probably in three months. This is one of the reasons why you can actually build the reactor much more quickly than you can with the current technology. Another advantage which is specific to lead, if we compare it to sodium, is its very high boiling point. Lead has a boiling temperature of 1740 degrees C.

We speak about 40 millimetres for a lead cooled reactor vessel instead of 150 millimetres for a pressurized water reactor

The risk of losing the coolant by boiling is, for practical purposes, eliminated. Which means it is easier to come up with a credible safety case. And in particular – since lead offers a good buoyancy head – it‘s a heavy, a very high-density coolant. It has therefore a much higher buoyancy head.

Then, for cooling you can design a passively safe system relying on natural convection of liquid lead, making it shorter in height. This also contributes to making a lead-cooled reactor much more compact than any other reactors. Actually, lead-cooled reactors are the most compact reactors in general, and that is important because if it's more compact, you can build it more quickly.

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And then you need a smaller reactor building so you can reduce the time you have to pay for interest during construction, and you can save on the cost of the reactor building. Finally, there are some other aspects that also are an advantage. Lead is the definition of radiation shielding. So, we don‘t need to have a biological shielding in our reactor which also makes the reactor more compact.

You already mentioned some safety features. Are there other specific safety features of SEALER that will work during normal operation or in potential severe accident conditions?

Yes. We have designed the sealer reactor explicitly to be able to manage a so-called station blackout event. This is the type of accident that happened in Fukushima where you lose external power, and we are limiting the power of the reactor to 55 megawatts electric. So that in the case of a station blackout accident where we‘ve also failed to shut down the reactor, we will be able to remove the residual heat in the fuel by natural convection of liquid lead and by natural convection of air.

We would like to state that this is the reactor that allows you to spend the least amount of volume on your ship for your propulsion system

Which means we are not dependent on the availability of water for emergency cooling. And this is a lesson learned from Fukushima, obviously. Now other reactor concepts with higher power than us, they need to have an inventory of water on the site. To manage station blackout events, we are independent of this and that makes our safety case more robust and easier to show that it‘s going to work during an actual accident.

Blykalla is developing for the decarbonization of large ships, a hard to abate sector in global decarbonization. What are the specific advantages of SEALER for the maritime sector?

Yes, because our reactor is the most compact reactor, it is especially well suited for marine applications where you have a limited volume available. So, therefore it is probable in our opinion being the vendors of this concept. We would like to state that this is the reactor that allows you to spend the least amount of volume on your ship for your propulsion system.

We will be able to remove the residual heat in the fuel by natural convection of liquid lead and by natural convection of air

What other fields of application are you envisaging as a future market?

We are currently looking into the future. Right now, we‘re focusing on power production, but you can imagine also providing high temperature heat to the chemical services industry. For instance, to make biofuel from biomass, you typically would need steam at 510 degrees Celsius, which is exactly what we provide. We will investigate such applications when we can identify industrial stakeholders that are in direct need of steam at 500 degrees Celsius.

Blykalla recently concluded a cooperation with Oklo Inc. which is developing a sodium-cooled system. What are the aims of this cooperation?

We have a joint interest in fuel fabrication because the Oklo develops a fast reactor too which means that we can use the same types of fuel, and we could save money by building a joint fuel factory. Even though we use different kinds of fuel, Oklo is using metallic alloy fuel, and we have fuel using uranium nitride. Certain aspects of the fuel fabrication chain can be shared among the companies and that would be beneficial for both of us.

How many nuclear engineers and experts in related and other fields do you expect to hire for the project in the coming years? The homepage of Blykalla at least indicates a lot of recruitment activity.

Well, that's a good question. I mean, we always must find a balance between recruiting of the skilled people that we need and the fact that we are a venture capital funded company. So, we cover and do not have revenues. We really must make sure that we find a sustainable balance. Between those matters right now we are going to hire a few tens of engineers over the near term and during the design phase we probably don't need much more engineers.

> Our reactor, because it's a fast neutron reactor is producing much less waste from the spent fuel making it much more suitable for recycling

We are reaching what we need now, but then when you start to actually build a nuclear power plant we will need to increase our staff by an order of magnitude and at that time we will probably need thousands of engineers, but at the moment it's sufficient with the order of magnitude of 100 engineers.

Thank you very much. That was a very interesting interview and interesting to talk with you. Do you have something to add?

Yes, possibly we can add that our reactor because it's a fast neutron reactor is producing much less waste from the spent fuel making it much more suitable for recycling than the spent fuel from light water reactors. Our intent is to recycle our spent fuel and to reuse it as fuel in a future generation of SEALER reactors, which means that we will have a much smaller impact on our spent fuel disposal site in terms both of time and volume. We expect that the waste from our spent fuel after reprocessing only needs to be stored for much less than 1000 years and that the volume needed to store it will be reduced by a factor of 5 to 6.

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