29: From Ancient Organism to Methane Generating Superhero - With Doris Hafenbradl, CTO of Electrochaea

Updated: Feb 16

As a young student, Doris was fascinated by the unique diversity of ancient organisms such as the archaea. She dedicated her PHD, at Archaea Center of the University of Regensburg, to the study of hyperthermophilic archaea and the amazing properties they possess. Since 2014, she has been working with Electrochaea to explore how archaea organisms can be utilized in developing synthetic bio-fuels.

Before embarking on her work with Electrochaea, Doris enjoyed a successful career as a scientist and corporate executive in the biotech and pharmaceutical industries in both Europe and the US. She previously worked at Axxam, a leading company in the field of discovery services for life science industries. Prior to Axxam she held several roles in leading pharmaceutical companies including BioFocus, Proteros, GPC Biotech, and the Genomics Institute of the Novartis Research Foundation.

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What are Archaea?

Archaea are one of the oldest organisms on the face of the earth! They vary in shape and size and are often found living in extreme environments from boiling geysers to the Arctic Ocean. A special type of archaea known as methanogens is capable of producing bio-methane as a by-product by consuming carbon dioxide and hydrogen. They do this in similar ways to how humans produce CO_2 when they breathe in oxygen: this is known as metabolism! (https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/archaea.html)

What is the aim of Electrochaea?

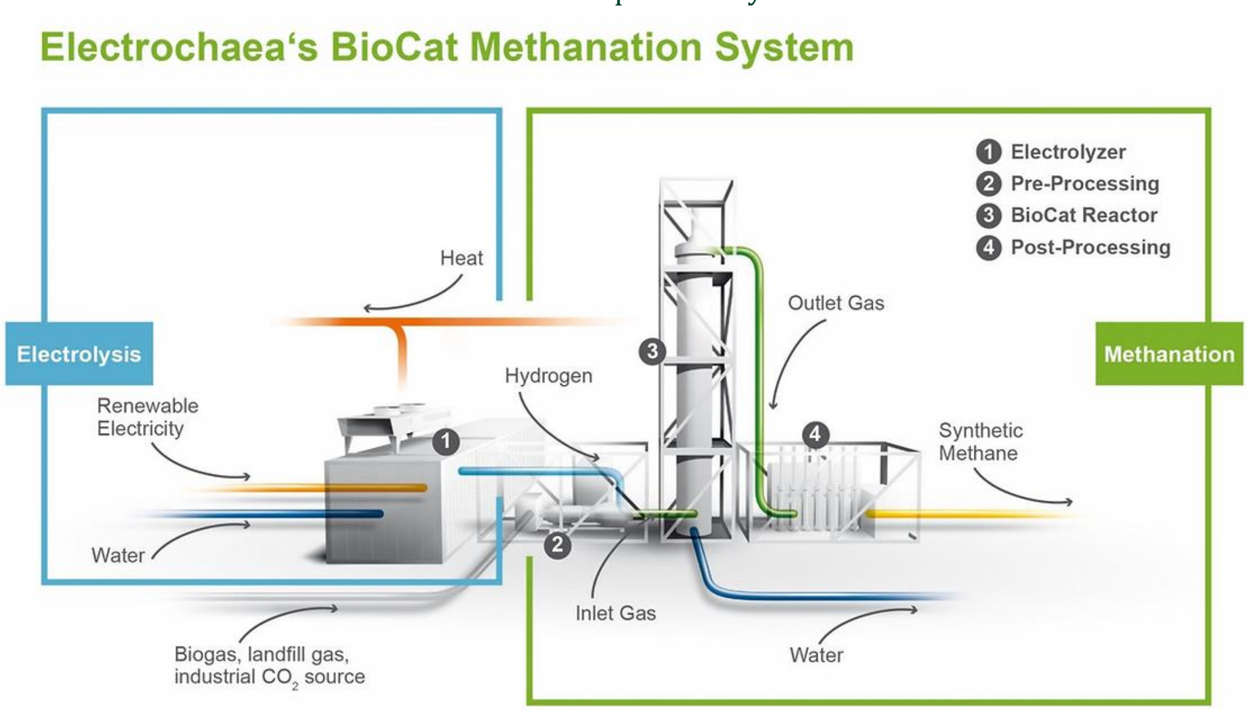
Electrochaea uses the power of methanogenic archaea as a biocatalyst to convert renewable energy and carbon dioxide into grid quality synthetic methane. This methane is safe for storage and distribution and can be used by the current gas grids in place. The aim is to reduce carbon dioxide that could otherwise be harmful to the environment, while simultaneously producing a necessary energy product. The carbon dioxide is recycled from current energy plants and other sources such as landfills, dairy farms, fermentation facilities, and industrial processes. (https://www.electrochaea.com/about/)

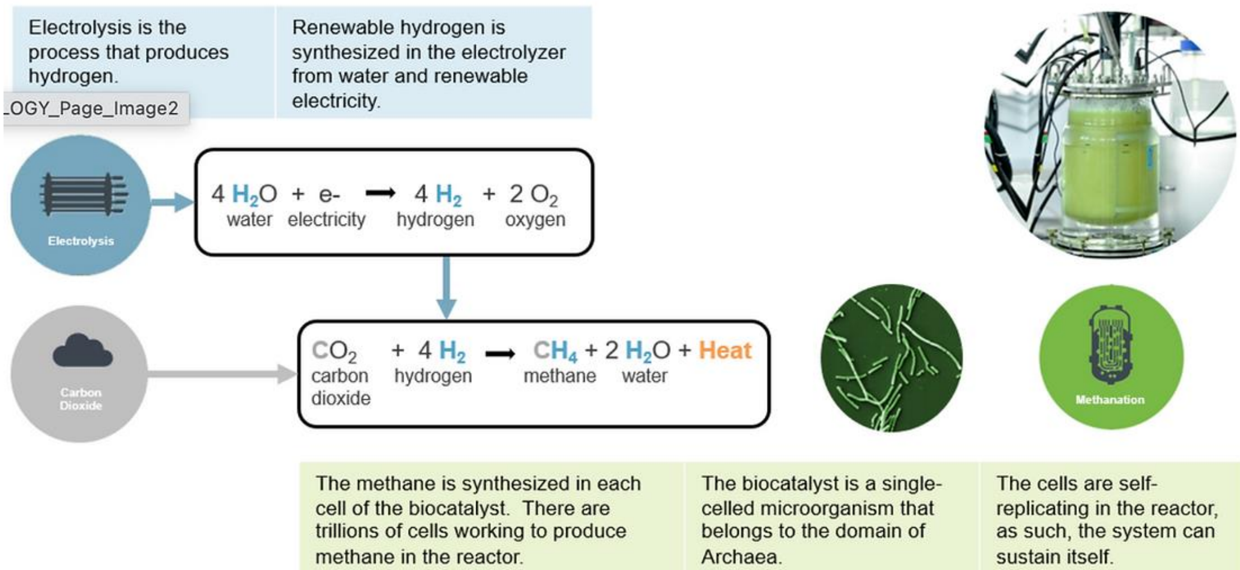
Currently, they are completing several feasibility studies and commercial scale-up projects in Denmark USA and Canada, with plans to expand further.

How does this work?

This technology operates through two steps: (https://www.electrochaea.com/technology/)

1. Electrolysis: This step uses renewable wind and solar energy to produce green hydrogen.
2. **Methanation:** The green hydrogen is now combined with the CO2 collected from the current source (landfill, farm offgas, industry, other energy processes). The hydrogen and CO2 are fed into the bioreactor, where the archaea live. Here the archaea metabolise the materials and produce synthetic methane.





The energy crisis:

Currently we are facing a global energy crisis due to the limited availability of nonrenewable energy sources, and the even more limited availability of renewable energy solutions. Moving towards renewable energy sources is an important step in overcoming the current crisis, and securing a stable future.

Learn more about the energy crisis and current energy status in Switzerland here: https://energiedashboard.ch/dashboard

In this episode we address the following questions:

- Tell us about Electrochaea 3:51
- What problem does Electrochaea solve? 4:23
- Can this replace fossil fuel use? 8:26
- How does Electrochaea utilize carbon capture? 10:27
- Where would Electrochaea plants be located? 11:55
- How many pilot plants do you have installed? 13:55
- What are the steps of the Electrochaea process? 18:25
- Does the CO2 need to be purified? 21:10
- What is the output of the plant? 23:19
- How much can this power? 25:00
- How much energy is needed t create the synthetic methane? 26:15
- How does the cost compare to natural gas use? 29:00
- What are the costs of integrating this to current plants? 34:00

- What are the biggest challenges with upscaling? 35:00
- What does your next 24 months look like? 37:30
- Where do you see Electrochaea in 10 years? 41:00
- How big is the natural gas market in Europe? 42:00
- What made you join this company? 43:00
- If you look back on this year, what is the biggest lesson you learned and what was the biggest surprise? 45:00
- How can people contact you? 46:46
- What makes you confident that we can solve the climate crisis? 47:30

Memorable quotes from the episode by Doris:

"We really try to utilize all the bits and pieces to make it an all over sustainable production."

"The archaea just do their thing, they work day and night, they don't take holidays, they just make methane all the time."

"The implementation of such a new technology, even when it works and you have great support with investors, is really difficult when the market is not yet defined."

"We have a lot of great technologies available, but we need different technologies. We need to get away from oil and gas, and get into renewable energies which already exist."

Electrochaea

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Transcript based on AI and beta- status:

Narrator : 0:01

You are listening to Sustain Now. In this podcast, you will learn from successful entrepreneurs and scientists about the newest climate change solutions to address the climate crisis, from food and agri-tech over energy material innovation to circular economy. This nonprofit podcast is hosted by Frederica. She is a tech entrepreneur and climate enthusiast. You can find show notes and background information on wwwSustainNowch. Enjoy the show.

Friederike: 0:36

Hello everyone. We are back from a longer winter break after an exciting year in 2023. The Sustain Now team is thrilled about the incredible growth of the last 12 months. We've more than doubled our listeners across all platforms and now 20% of our audience comes from the US or outside of the EU. Our commitment remains in 2024 the same we will continue interviewing founders and scientists in the climate tech space to promote both existing and new ideas in the ongoing fight against the climate crisis. Today, I'm joined by Doris Hafenbradl, cto and Managing Director of ElectroKer, a company trying to replace natural gas with renewable synthetic methane. Doris brings a wealth of experience from her successful career as a scientist and corporate executive in the biotech and pharma industry across the US and Europe, joining ElectroKer from AXAM, where she led the company's discovery service activities. So what's the buzz at ElectroKer? Imagine tapping into renewable energy from solar and wind, coupled with a transforming industrial waste carbon dioxide into synthetic methane. Their goal To replace natural gas as an energy source and storage solution. How? By leveraging AQIA, an ancient microorganism that has thrived in extreme conditions for centuries. In May 2021, the International Energy Agency released its roadmap to help the world to get to net zero by 2050. Net zero recommends a baseline target of 10% of synthetic methane in a natural gas flow by 2050. That's the market ElectroKer is targeting. Established in 2014 by Dr Lawrence Metz, a professor at the University of Chicago, and Mick Hain, electroker has grown, with three operational pilot plants. Right now they are raising a new round to further expand their operations. In our conversation, we dive into the power to gas principle and the technology behind it. This episode is a gem for those interested in renewable energy, carbon capture and utilization and the circular economy of carbon dioxide. Happy listening, hello Doris. Welcome to Sustain Now podcast.

Doris: 3:00

Thank you very much. Thanks for inviting me. I'm extremely excited to be here today.

Friederike: 3:06

It took a while we had some back and forth, back and forth to actually manage it, but I'm following your company quite some time. You're based in Munich and I think it's great what you're actually creating. We will talk today about a renewable energy source. Please bear with me if I'm saying that wrong. What are you actually doing? It's about synthetic methane. Electroker this is your company creates synthetic methane from green hydrogen and carbon dioxide using a bio catalyst. In this bio catalyst, you evolve a strain of a very old I think billions old single called micro organism archaea. Did that summarize that?

Doris: 3:49

correctly, more or less. So maybe I give some more background on the micro organism. So our bio catalyst is a really, really old organism called an archaea. It's about 3.5 billion years old and it has been making methane since then from hydrogen and CO2, and that's the bio catalyst that we are using, and we are utilizing this capability of this little organism to make very large volumes of synthetic methane.

Friederike: 4:20

Fantastic. Thank you so much. Before we really dive into that, how are you actually doing it? To step a little back, what kind of problem are you actually solving?

Doris: 4:29

We are solving two types, general types of problems with just one technology there is, on the one side, we have the need for a very large and long term energy storage possibilities. Batteries are great, but they are more suitable for shorter term energy storage and we all know that. It's the implementation of more wind and PV parks. We do need longer term and also fast reacting storage possibilities, and that's where we contribute. We utilize renewable electricity. We are avoiding the curtailment first of all, for example, a wind park, because we can utilize the energy that is maybe normally not even made because the windmill is turned out of the wind. We utilize that energy, turn it into hydrogen and then feed our little archaea, combine it also with CO2, and let them make methane when there is actually surplus electricity available or, if it's, whenever it's cheap enough to actually harvest that electricity, and the molecule that we are making is methane and that can be stored directly into the existing gas grid infrastructure. So we don't need a storage that needs to be built, but we can utilize existing infrastructure and the gas grid is quite abundant and is quite well known, since actually last year where we were all concerned, in particular in Germany, that there could be a gas shortage, so the storage is already available. That's one possibility of utilizing our technology really to use it as a long term storage, because we can storage over the season. So whenever we are producing maybe in summertime there's extra renewable electricity available. We can store that in form of methane gas until wintertime, when we may need it. There's also an dependency from where the electricity, the renewable electricity, is being generated and where the gas molecule is being utilized, so we also make it independent from generation and the utilization. So that's one upside, and the other one is that the CO2 molecule that we need to generate actually methane molecules are waste molecules. So rather than emitting CO2, we are utilizing that is known under the term carbon capture utilization. So wherever that CO2 molecule may come from from a biogas plant, from fermentations, from carbon capture technology, even from air capture any of those CO2 molecules can be converted into a renewable methane molecule. And we can do that with our technology and contribute to the reuse of CO2 molecules that would otherwise be emitted into the atmosphere. And the fact is that we are recycling CO2 molecules and we are avoiding to utilize more fossil methane that we overall want to avoid altogether.

Friederike: 7:30

Okay, fantastic. So just to summarize it and if I understood it correctly so the problem you're solving is and it has been along a lot of discussions is that if you have solar and wind, you have, of course, these peaks of production of energy, and if you don't need it, where do you store it? Like, how do you store it? And that's kind of the power to gas what you're talking about, so that you can actually store that power in a form of a liquid gas, that energy. That's what understood. And, as well, you can use the existing grid system. Instead of, like natural gas which comes out of the ground, you can use methane gas as well. Is that correct? What I understood? Like we can replace that.

Doris: 8:08

It's, in fact, the same molecule, so the fossil gas molecule is also a methane molecule and we can replace that with synthetic methane molecule that originates from CO_2 and hydrogen and is based on the conversion of our little microorganisms, the bio catalyst that generates this methane. And synthetic methane is chemically the same molecule as the fossil gas that we are using today, as gas or liquefied gas, depending on what it is actually being utilized for and the storage. The gas grid, the existing gas grid is the same one, so it's a drop in fuel. We can literally replace the fossil gas in our existing gas grid with the synthetic gas that we are making with our technology.

Friederike: 8:56

Okay, fantastic. When we speak about natural gas, what does, I think, more known? You would actually say you're replacing that natural gas with a synthetic methane, which has the same chemical components, so it actually can be used for the same things.

Doris: 9:10

Exactly. It's the same, exact same use, so is direct replacement. The gas has the same quality, or else we wouldn't be allowed to inject our gas into the gas grid, which, by the way, we have done in Denmark as well as in Switzerland already With our pilot installations. And, of course, we get the same requests from the gas grid operators in terms of the gas quality that we have to provide, or else we would not be allowed to inject into the gas grid. That makes the gas grid operators make sure that we are providing the high quality gas, which is what we can do, not the problem, and it's not a challenge from the technology perspective.

Friederike: 9:50

Okay, fantastic. Last one is the CO_2, capturing CO_2, which is often the waste products in industrial heat or any other production processes. You capture them. We can talk a little bit more about the process, how that actually all works, a little later on. But you use that captured CO_2, which is probably liquefied I guess when it comes to you Is gas typically Okay and then you are in that bio catalyst process. You're actually using a CO_2 to create that synthetic method, so you actually recycle CO_2.

Doris: 10:23

That's correct. Yes, and the CO_2 can really come from any process. I mentioned before a biogas plant, for example. It is known to produce biogas, which is also the same biomethane molecule. Basically it's another type of methane. They can also replace fossil gas, but the resources all the biological waste material are limited, so there's a limitation in how much biomethane can actually be generated by biogas plants. And it's important to know that the biogas plant generates about 50% methane and 50% CO_2. So to get almost twice as much methane out of a biogas plant, you can use our technology to upgrade the CO_2, to turn the CO_2. They would otherwise be emitted into the atmosphere and turn that into a biomethane molecule or a synthetic methane molecule as well. So you get twice as much gas output from the same substrate source. That is an example, but there's other CO_2 sources and they can be from the brewing process, for example. It's a fermentation process that generates a lot of CO_2. But also cement industry, for example, steel industry and so on. They are heavy emitters, obviously, of CO_2. Would you then?

Friederike: 11:46

put a plant. What you're going to talk about it is would you put that plant next to a biogas plant then, or is it somewhere where you have it centralized and you need to transport that CO_2 to it, Like what makes the most sense or what you're targeting here?

Doris: 12:02
So the ideal setting and it's actually not uncommon is a biogas plant that already injects its gas, its methane gas, into the gas grid. So there's already a gas injection station, for example, and in many locations it's co-located with windparks nearby. As an example and we have beautiful example for that with our first commercial project, which will be in Denmark, in Northern Jutland, at a place called Roslef, and in Roslef our partner is a farmer who participates in a windpark basically behind his farm. He has a biogas installation. He already injects gas into the grid and we will help him to reduce his CO2 emissions significantly by turning that CO2 into methane as well and increasing the amount of methane that he can actually inject into the gas grid. So that would be an ideal setup. If there is one of those things missing, for example, electricity may need to be brought to a site as electricity. Or we are talking nowadays about hydrogen pipelines. If something like that is nearby, co2 pipelines also may play a role in the future, but for now we are mostly looking for sites where CO2 and electricity, generally speaking, would be available, because that is the easier way to implement our technology. But there will be many solutions available, in particular with additional pipeline systems for hydrogen and CO2 that we may see or that are planned for the future. It's not today, but looking outward. In 10, 20 years, the infrastructure will be improved significantly and will support our technology even more than today. How?
Friederike: 13:52
many pilot plants do you have already installed?
Doris: 13:56
So we have a total of three pilot plants. The very first one was located near Copenhagen in Denmark, and it was integrated into a wastewater treatment plant where we really utilized, or tried to utilize, all the bits and pieces to really make it a sustainable recycling operation. This means that we have utilized the raw biogas, brought the raw biogas into our bioreactor and goes to hydrogen that came from an electrolyzer and then we injected the biogas into the gas grid at the site. We also generate heat at the temperature of about 65 degrees Celsius. That's the best temperature for our bio catalyst. It likes it hot, so the heat has good value because it's green heat and this is an important product for the Danish energy market. And there is also oxygen from the electrolyzer that could be utilized in the overall setting of a wastewater treatment plant. It was not implemented in the end because it was a funded project and there's often limitations in the budget, but just to give you an idea how we are recycling and utilizing really all the value streams that come from the technology. The second plant was located in Switzerland, in Solotun. There we used CO2 from a pipeline that came from a wastewater treatment plant was already upgraded, meaning the biogas were separated into the methane component and the CO2 component, and the CO2 was then brought to the site where we were located, which was the place where there was already an electrolyzer installed and hydrogen generation was already ongoing, also as a pilot project. Basically and this was a project where we were compared to other methanation technologies one in Germany and one located in Italy was a funded project. The name of the project was Storing Go, and we were able to demonstrate two upsides so far with those two pilot plants One in the context of the Danish one, that we can utilize raw biogas, and that we can actually we don't need to purify that gas from hydrogen sulfide and other potential contaminants. And the other piece that we were able to really demonstrate in Switzerland in that case was that we can follow variable loads of electricity

availability, meaning that we were asked to follow exactly a profile that could have come from a windpark, as an example, and we were following that load directly while keeping the gas quality of our product gas the same. So, no matter how much hydrogen is actually available, because there may not be the wind, may not be blowing full speed, there may be a little bit of electricity available, we can still run our system at lower capacity and we went down to about 10% of the total capacity and we were demonstrating how we can actually go from 100% down to zero and back up in very rapid cycles. So it's an ideal connector with renewable electricity. And then the third pilot plant is actually located in the US. It's a bit smaller than the European installations. It's located at NREL, the National Renewables Energy Laboratory, and the installation there was meant to really de-risk and to demonstrate the technology for the American market. It is now, with funding from the Department of Energy, being relocated to Maine, where it will be integrated into the biogas infrastructure for dairy farm. Also, they are to demonstrate how the mass and energy flows are working, how the gas then can be certified for the market. So we will also support that project in the US going forward.

Friederike: 17:56

Exciting. I think now it's a good point to actually go through each of the steps, how you actually create that synthetic methane like from the electrolysis to the methanasium. Maybe you can. You already touched a few points of it with water hydrogen process etc. But it would be great if you could make step-by-step through for someone. Maybe he's not coming back on the scientists background, it would be great.

Doris: 18:21

The first starting point is the generation of hydrogen, and for that we typically use an electrolyzer. That's not our core technology. We use whatever is available in the market. There's other experts that are working on those technologies to bring down the price and increase efficiencies, and so on. So electrolyzer is utilized for splitting water into oxygen and hydrogen. The oxygen can be utilized if there is a need for that. I mentioned already wastewater treatment plant, but there's also the food and beverage industry who has a need for oxygen sometimes. So we use the hydrogen. The hydrogen, as a gas, is being fed into our bioreactor, which is basically a tube that's standing upright filled with water. How high.

Friederike: 19:12

Just to get a feeling for it, like what's the size?

Doris: 19:15

For a one megawatt installation, which is our pilot size. One megawatt on the electrolyzer side, that means 200 normal cubic meters per hour of hydrogen will be produced. For that we designed a reactor that is nine meters tall. In fact the total installation is 12 meters tall, but a reactor is nine meters tall. It's filled with water and some salt to simulate the environment. For these Ikea the bio catalyst and we introduced the gas, the hydrogen, as well as the CO2 or the raw biogas at the bottom of that reactor. So we blow in those gases. There's a mixer inside and the mixer makes sure that the gases are distributed first of all, but that we are creating very small bubbles, meaning we need to get the gas into the liquid phase of that reactor so that the gases hydrogen and CO2, are accessible to our bio catalyst. So that mass transfer from being a gas and to make that gas accessible to our bio catalyst takes a little bit of energy because the mixer is important for that. But the use of the mixer increases the volumetric productivity, meaning how much water column do you actually

need to generate a certain amount of renewable methane and we want to keep that as small as possible and we have a unique design for that. That allows a really high volumetric productivity. As the gas travels up in the column, more and more of the hydrogen and CO2 are being converted, and when it reaches the top of the liquid column we are basically at 100% methane and that gas easily comes out of the liquid column. We don't really have to do anything, and that gas then needs to be dried a little bit and maybe may have to be polished it depends a little bit and then it can be injected directly into the gas grid. So that's basically all there is, and we operate at 65 degrees Celsius, because that's, as I said, the optimum temperature for our little creatures, ikea, and we operate at 10 bar pressure. That also helps a little bit to get more hydrogen into the liquid phase and to inject the gas into the gas grid. You also have to come basically at a certain level of pressure. It depends on the gas grid that you want to inject into. So our 10 bar pressure operating pressure is very useful for also then going directly into the gas grid.
Friederike: 21:52
The CO2,. Does it need to be purified? Like CO2, if you burn it or if it's like a waste product from an industrial, it's usually not totally pure, that's correct. Does it need to be purified before you put it in, or is it working? Wherever it comes to you, you can work with it.
Doris: 22:07
There is situations where it needs to be purified, but there is a number of gas sources that we can use directly. In particular, the raw biogas that contains hydrogen sulfide may contain ammonia, merecaptains and other things. Those we don't need a purification. We can use that directly. And things like hydrogen sulfide are actually an upside for us because that's the sulfur source for our little microbes and they love it. They need to eat it in any case. So that is for us a reduction of our feeding cost because we don't have to feed a separate sulfur source. Landfill gas is another example that we could use directly. Flu gases, for example, we couldn't use typically directly. There's a couple of reasons for that. There is too much oxygen typically included, which means that's not compatible with our microorganisms. They don't like oxygen. That's so far the only thing that they don't like. But the redox potential when you have oxygen around does not allow the mesonation reaction to actually happen within these organisms. So oxygen needs to be avoided or needs to be removed. Otherwise there is no minimum concentration of CO2 that we would actually require. But often it makes sense to have maybe a higher concentration than just 5% or 10% of CO2, because then the other gases that are contained in this feed gas would show up typically in the product gas and that would not be allowed then to be injected into the gas grid. As an example, if you have a high concentration of nitrogen from a flu gas, for example, that will go through as an inert gas. It doesn't bother our IKEA, but then you also will find it in the product gas and you have to have a certain typically a certain concentration of meson it's typically about 97% meson and some other requirements, and you could not meet these standards so you would have to extract the nitrogen at some point in any case.
Friederike: 24:12
You said the output of this plan is round about 1 megawatt.
Doris: 24:16
It's the input, the electrical input for the electrolyzer. So I mentioned the 200 normal cubic meters per hour of hydrogen. That needs to be paired in a 4 to 1 ratio, so four volumes of hydrogen, one volume of CO2 gas, meaning 50, 50 normal cubic meters per hour of CO2, or

an equivalent of biogas or something else, and that will produce 50 normal cubic meters of synthetic meson.
Friederike: 24:46
And that is roundabout, like for if you think about powering households or if you use, can you make a correlation to that I need to see if I have some numbers here, but it's.
Doris: 24:58
I think the production capacity of our Swiss plant, which was roundabout one megawatt input, is about 300 to 400 households. That's just an approximation. It depends on how exactly the fuel will be utilized. And that's all pilot size. So what we've done in the meantime, since the pilots, was that we have scaled up 10-fold and 75-fold from our pilot plant size, so to really make an impact and to really make an effort on replacing today's use of fossil, the fossil gas that is being utilized at the moment.
Friederike: 25:36
And you spoke about that. You need hydrogen, which is also very energy intensive, and you say you take it from solar and wind, but the electrolysis itself I think it ticks, as my knowledge is a lot of energy. How do you compare that, how much energy you actually need to create then an output for the 300, 400 household, et cetera. Do you need more energy actually for that hydrogen right now? What's the conversion of and how much energy you need to use, whereas this energy you create through that synthetic method as an output?
Doris: 26:14
Yeah, so it's not so easy to compare in numbers the energy levels. And certainly the conversion of the electron into the chemical molecule of methane requires some energy. The main energy input is for the electrolyzer, for the water splitting, but that's the upside that we want to utilize. When we think now about this energy storage idea, that's what we want to do. We want to use all this energy that otherwise will either not be produced or that no one wants, or that actually is generating an issue in the electricity grid. There's already those three points. We would not utilize energy that someone else would need. We use it when there is much of it. So you only use the peaks over production. Yeah, it may not necessarily be only the peaks, it could also be a base load, because the grid may have to have availability of energy to a certain capacity at certain times. We can totally accommodate that, because we can switch off our technology from one second to the other, so we wouldn't mind being taken off so that someone else can actually utilize that electricity. So there could also be opportunities like that, but we would not have to curtail any electricity when we are implementing our technology as an example. So the energy is energy intense, yes, but the energy is what we are converting into the methane molecule, our technology itself. The plant does not actually require a lot of extra electricity it's about between 3% and 5% of what the electrolyzer needs. But the concept is to turn the energy from the electron over into a chemical molecule, which then can be stored and can be utilized Whenever it is needed. It can even be utilized for the generation of electricity again. You're going one cycle around. Of course you're losing energy on the way, but that's not what. That's the lower concern here, when you actually have a need of electricity, and in particular grain electricity, because you can utilize the grain methane or the synthetic methane it's the same thing, just a different route for it to make electricity, to make grain electricity again. So you are covering the gap that you have at night, when there is no wind. Okay understood.

Friederike: 28:46
So if you would compare that to natural gas, because that's kind of the competition or the comparison how much cost would that be compared to producing natural cost? Have you ever done a comparison how much it costs to create natural gas versus the synthetic methane you're using? Is there a possibility to?
Doris: 29:08
compare that. Of course that's what we are being compared against, but it's important to understand what we are creating. There is on the one side the thermal value of the methane molecule, which is a very low cost molecule. It was very expensive for a while, in particular in Germany or in Europe overall, where when we thought there would be quite a shortage, then the price actually went up quite significantly. Typically it is a relatively low price molecule for the thermal value of the molecule. That is the same thermal value in those two molecules, no matter if it's fossil origin or if it is generated with our technology. But you are generating the value in terms of the carbon intensity of the molecule, and that is the upside and that is the value generation. Of course it costs money to generate that molecule and that depends very much on what your electricity price is. So if you're thinking we are only using low cost electricity or maybe negatively priced electricity, then your molecule that you are generating is also not very expensive. Nowadays electricity costs are still relatively high. We know for sure that those prices are coming down as we are installing more and more renewable electricity, which is a must. We cannot stop that and there will be more and more need for technologies like ours to take away the peaks and the extras. That will increase significantly as we are implementing more, and that value that we are generating needs to be considered for that molecule when it is being sold and traded in the market.
Friederike: 30:51
It's just interesting to know the green premium, how much more investment you need to do to have synthetic methane versus natural gas, and how to close long-term that gap in between it. It's just what's interesting for me to know how far we still have to go to provide synthetic methane at a cost of natural gas. Or will it never be possible because just natural gas is so subsidized and it's so cheap.
Doris: 31:22
You're bringing up exactly the point. If you keep subsidizing the fossil gas use, the price will stay low and the intention is not necessarily to bring the cost of our molecule down to that same price. I mean that would be fantastic. The value that we are generating is that we are actually generating something in a recycling process. We are reusing CO2, we are capturing the molecule, bringing it back into use and we are generating a lower carbon intensity production process. For example, when you think about the hard to abate sectors like cement or steel industry, they will have to use these types of molecules because overall their production will keep generating CO2. When you think about cement industry capturing their CO2 and then bringing it back into their energy cycle, they will bring down the CO2 footprint of that entire installation, of that entire plant. There is a value being created because it comes with a cost, but the cost of the generation will significantly go down. It's always like that. First of its kind installations are always rather expensive, need subsidies and then the prices come down. But the value of the molecule is also going up because the markets are recognizing the molecules Now, the shipping industry, for example. They have quite strict requests now that they have to utilize renewable fuels.

Friederike: 32:55
Can you use your synthetic method as well for ships?
Doris: 32:58
Okay, we can liquefy that gas and then it is also a direct replacement for the so-called LNG. We are building terminals at the moment everywhere, and LNG can be of fossil origin or it can be of synthetic origin. That would be our gas that would be liquefied. It's an additional step After you generate that gas, you also liquefy it and then you can use it as a replacement fuel also for the shipping industry, and they will have to do that as a mandate already. They will have to utilize this kind of fuel that we are generating, same for transportation road transport in the United States, but also in Europe. The so-called RFNBO regulations that have been implemented will have to be implemented in the member states to generate more clarity. But we know how those gases and how these fuels are now defined and what is mandatory for certain producers or users of fuels. It creates a market for our product.
Friederike: 34:02
If I would be an energy provider. Let's say I'm a biogas plant and I would like to integrate you in my process. How much would that cost me Roundabout from two? How much would that cost to actually say, hey, I would like to use your technology and integrate it into my existing?
Doris: 34:20
plant. It very much depends on how large the installation is. The larger the cheaper per megawatt, that's very clear. But we are aiming, like the rest of the industry, for something like half a million or then in the future, for very large installations, something like 350,000 euros per megawatt installed capacity. That's comparable to what electrolyzer industry is also aiming for. We expect that our installations are going to be cheaper than electrolyzers, but in the same ballpark, more or less.
Friederike: 34:56
What are you right now the biggest inhibitors for you to scale? What makes it for you difficult to scale that technology and to get as many plants as possible out there?
Doris: 35:06
I would say the technology is ready. We have, as I mentioned before, we have scaled it to 75-fold or 100-fold. We can just add another module of the size of our pilot plant. We have done all the de-risking activities together, actually with our strategic partner and investor, baker Hughes, who do that kind of process all the time. We were very happy to have Baker Hughes looking over our shoulder and doing this work together with us. We are confident on the scaling of the technology. What's the holdup Is a bit the market situation. We need voluntary markets to pay a little higher prices at the beginning, because that's the nature of these first-of-its-kind installations, this transition period where it's a bit unclear who's going to be really mandated to become an offtaker of these types of gases or how exactly the member state rules in Europe will look like. There's a lot of incentives already implemented. In North America, for example, last year has been actually quite I would say. The doors have opened. The markets are there, are clear, what will be the first markets? There's a couple of voluntary markets, but also now the implementation of these rules and regulatory guidelines will help to generate longer-term clarity and insecurity on the offtake side, which is what the investors need. There is certainly a lot of money available for renewable energy installations, but how can we make sure, or how can our clients make sure, that there's really a long-term revenue secured? That is a mix of maybe some

subsidies that are not yet clarified and the actual value of the molecule. The holdup, or maybe the slowness of what we still see, is the uncertainty about the regulatory side. But we are involved in commercial projects I mentioned. The Danish project is 12 megawatt installation, so already 12 times bigger than our pilot installations. We also are working on two projects in Canadian market at the moment.

Friederike: 37:25

What does your next 24 months look like?

Doris: 37:28

Yeah, I think we have a lot to do. The market is opening. There is really a big need for synthetic methane. That has become clear. Also, the oil and gas industry knows that they have to get involved with renewable fuels to actually generate power and to stay in business long term. So we are getting ready for the rollout of our technology in the key markets I mentioned. We have a commercial project in Denmark where we have received actually a hydrogen subsidy from the Danish Energy Ministry. So we are going full force on that project to implement that to get that commission still in 2006. We have the Canadian projects that we are working on. So hopefully those will turn very quickly into actual projects. It's in feasibility stage for those two. And then we are addressing the key markets which you have heard me talk about Europe already, in North America, canada. We are also betting on US or Europe On both. So it's very important what's more complicated, europe or US? Europe is more complicated because you have to deal with all the different member states and each one will in the end have different specific rules and regulations. That makes it more complicated for us. But we already see where the key markets are. Finland, for example, is a really interesting market due to the price of electricity, the need for renewable fuels. So you find single countries actually. So Europe as a whole is a bit hard to grasp, I would say, but those are the main markets. We are a relatively small company, still with 50 people at the moment we cannot address all markets, so we will be focusing on a few and we are also in fundraising mode. So we are raising money for two things for our company, for electric care, to grow and to really work on those commercial projects that are coming, and on the other side to develop those project opportunities where it's clear that we as a company are also contributing to them. And we need enough financial background to actually do that. To help these projects to get off the ground, especially the initial phase is the most risky one and that's where we are mostly needed for contributions as well, and it needs resources to get these projects off the ground, because it's all new technology and we've talked about electricity, co2, gas, grid injection, operation of the facilities. So to bring all of these bits and pieces together, also from a contractual point of view, it does need our input at the moment until we have educated enough strategic partners so that they can actually multiply our technology in the market as well, which is part of what we are doing at the moment with Baker Hughes, with Storenji, an entity of NG, for example, and we are currently evaluating also additional partners that we will use in strategic market approaches, mostly or for certain size products and things like that.

Friederike: 40:45

How do you see yourself in five years or in 10 years? What's the long-term?

Doris: 40:51

vision, the long-term vision and the hope for us is that we will, with our technology, generate significant amounts of synthetic meshing to really work on this replacement of the fossil sources, to become more independent, also because it's a recycling process. You can make it from the CO_2 emissions. That, yeah, we want to reduce CO_2 emissions, but some of them will continue. There's no way around it. We can utilize that CO_2 and really make an impact and help also the renewable electricity installations to be installed more quickly, because a lot of them are blocked due to not enough energy storage capacity. That they will bring to the table and we can be a solution for them as well. How big is the natural gas market in Europe? It's very large. I don't really have the number with me today, unfortunately, but we can use the CO_2 that is available. We can generate actually more than what the current gas great capacities are. So there are no limitations on that. But of course it's stepwise the planning, the permitting phase, the planning and the installation of these plants and to make them, to scale them. Them to gigawatt scale, which is definitely a topic already on the electrolyser side. To get to that level it takes a couple of years, but we need to start the installations now so that we have in 2030, in 2050, where the goals are very clear on no use of renewable fossil energy sources. We need to be at a point where we have both decarbonized one, the electricity grade, but also the gas grade, because there's no way that we are replacing the utilization of gas altogether. There's not going to be enough electricity and power generation will rely on the gas in any case. We need to generate enough gas from renewable sources so that we have that source of energy as well.

Friederike: 42:57

What made you join this company around eight years ago?

Doris: 43:01

Well, I joined when it first got financed with the Series A financing. I was employee number three. Actually, here in Germany, we are located in Munich, which is outside Munich. The company originally was founded as a spinout from the University of Chicago. That's where our scientific founder, professor Lorri Metz, is the company. The early de-risking of the technology was actually done with seed money from a small investment group that was started by our CEO and two partners. They did all the early de-risking activities use of raw biogas, scaling in a non-optimized reactor system, but just to demonstrate that technology can be used in larger scale. At the time, in 2013-2014, they could not find any investors in the US for the technology going forward because gas was so cheap due to all the fracking exercises that they never think that there would be a need for renewable methane molecules. That has changed significantly and the need in North America is actually higher than in Europe, or the most immediate need at least. But Mechai, now a CEO, came to Europe, in particular to Denmark and Germany, where there is the majority, or was at the time the majority of the renewable electricity installations and where people were already looking for storage possibilities. They decided to stay here in Munich to build the company in Munich because Munich Venture Partners was the lead investors at the time and we profited a lot from having our investors around us Munich Venture Partners, but also B2B Energi, 360 degrees in Zurich and a couple of other investors. We built the company from basically the three people to the now about 50 member team that we have.

Friederike: 45:01

If you look back on this one year, so the last year, what did you learn the most and why, and what surprised you the most?

Doris: 45:10

My biggest surprise I start with that is that we could not actually kill our biocatalysts, despite some effort intentional ones or intentional ones they just do their thing, they work day and night, they don't take any holidays and they just make messing all the time. So they have turned out to be super robust and really never been a worry, despite. You know, we threatened them quite a bit with piloting, which is, of course, also the purpose to make mistakes here. So that has been my biggest surprise, because I come you know, my know-how about IKEA comes from my academic background where we were working with very new, newly discovered, extremophilic IKEA which were very difficult to grow, and I did not expect that there would be IKEA around that you can handle so easily and so robustly. Basically, what was your biggest learning? My biggest learning, I think, is that the implementation of such a new technology as we have it, despite the fact it works and we have really good supporters amongst our investors and strategic partners, is very difficult if the market isn't defined, and to really enter this new technology into the market, despite the fact that everyone says this is great, this is going to be very useful and we want it to really roll this out into a new market is quite challenging and it actually takes longer than I would have expected.

Friederike: 46:43

Thank you so much for being part of my podcast today. I think I could have talked way longer about your technology, but you're actually raising in your future. How can people?

Doris: 46:53

contact you. We are here located in our headquarters in outside Munich, so you can send an email at info at electrokeacom. You will be routed in the right direction. That can be your landing point. We have business development colleagues in the US also, but just contact us via email, then we will get back with the information that you need. We will be happy to discuss any project investment opportunities for both our company as well as for projects One last question what makes you confident that you will solve the climate crisis in one sentence? I personally think we have a lot of great technologies available and we need different technologies. We need to get away from thinking about oil and gas but utilize renewable energy technologies, and we have them ready. We just need to have this push now to actually get them applied and to have them work as a very broad portfolio. We are there, we have super technologies and I think we're going to make it, because the awareness level has gone up significantly over the last one or two years and the markets are developing, so I think we can make it Great.

Friederike: 48:13

Thank you so much for participating at my podcast. I wish you and your company all the best for the future.

Doris: 48:21

Thank you very much for having me. It was great fun. Thanks so much.

Friederike: 48:28

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