Global Energy Solutions

For Prosperity and Climate Neutrality

Herewith you receive the newsletter of Global Energy Solutions for the month of May 2021.

Our topics:

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- **Technology openness for CO_2-neutral drive technology**
- **Franz Josef Radermacher: Germany's climate nationalism will not help the world**

The energy transition needs not only electrical but also material energy sources

By Bert Beyers

Professor Robert Schlögl is, among other positions, Director at the Max Planck Institute for Chemical Energy Conversion in Mülheim an der Ruhr. He has been working on molecular energy sources for years. For him, a forest is a biological system that produces wood - from CO_2, light and water. Schlögl's concept The Modern Forest works on the same principle. However, the product is not wood, but methanol. Very much in the spirit of Global Energy Solutions. In the interview, Schlögl talks about how an energy transition with green fuels could come about and what framework conditions he would like to see for it.

Bert Beyers: What are green fuels?

Robert Schlögl: There are two types of green fuels. Firstly, those that basically contain no carbon. You can burn them. Then, only water is produced. For example, hydrogen per se is such a green fuel. But you can also use other substances, for example ammonia. This gives you nitrogen as another product. Secondly, you can of course also use carbon. But then you have to keep the carbon in a cycle. That means you have to capture the CO_2 that is produced during combustion and feed it back into the production of the green fuel. Then you have a carbon cycle. And that is how Mother Nature does it. The cycle with respiration and photosynthesis works exactly according to this principle.

What do you need green fuels for? One could also say: "The energy transition will be carried out entirely with electricity?

Unfortunately, that's not possible. Because you have to collect electricity from all parts of the world and distribute it. So that on the one hand we can meet the energy needs all over the world, and on the other hand we can compensate for the problem of volatility of renewable energy. That means that the sun doesn't always shine and the wind doesn't always blow when we want to use energy. It is unfortunately the case that only a few people live in the places on earth where a lot of solar energy can be converted into electricity. This has something to do with each other. Either it's hot there or there's a storm - and not so many people want to live there. That's why we need a way to transport large amounts of this energy around the world. And the only way to do that is through molecular energy carriers. That's another word for fuels.

Prof. Robert Schlögl, Max Planck Institute for Chemical Energy Conversion

In your view, green fuels are also chemical stores?

Yes, I would equate that.

What types of chemical storage are there?

There are gaseous ones as well as liquid and solid ones. We should pick the storage molecules that have similar properties to our fossil fuels today. So that we can continue to use the technologies that we use today to transport oil and gas. So ideally gases that then replace natural gas and liquids that replace oil. Or the products that are made from the oil. This has the great advantage of minimising the cost of replacing black fuels with green fuels.

Specifically, what would be the best solutions?

The first solution is always hydrogen. There is no other chemical way. You can transport hydrogen in pipelines to a certain extent and store it well in caverns, but if you want to cover long distances, you need ships. And loading hydrogen into ships is a difficult matter.

You can liquefy hydrogen, but it's not done beyond rocket fuels. Simply because it is technologically very complex. So I suspect that hydrogen for global transport will be converted mainly into so-called derivative molecules. That is, the hydrogen is converted with nitrogen or carbon dioxide and thus contains substances that can be transported much more easily. Synthetic natural gas would be one possibility. Methanol would be a second possibility. Ammonia would be a third possibility. And we could make the list considerably longer. There are perhaps ten different candidate molecules, all of which can be used to transport hydrogen.

What is your favourite?

That depends on the application. There is no single favourite. And that's because you have to consider the reconversion. And if you want to use the transport material right away, then I wouldn't convert the hydrogen back here. If I have to convert back to hydrogen because I want the H_2 molecule, I would always use ammonia. That way you don't have to do any real recirculation. Because then nitrogen is produced and there is enough of that in the atmosphere. That closes the circle by itself. But if I need a high-energy application with a liquid fuel, then I would start from methanol and possibly derivatise it further. But I think methanol can be used for many fuel applications. And then I need to collect the CO_2 again and put the liquid CO_2 back where I made the hydrogen, preferably.

What is the difference between defossilisation and decarbonisation?

Defossilisation means you only take the fossil carbon out of the system. And decarbonisation means you take all carbon out of the system. That means you exclude a carbon cycle. And you can't do that in principle, because our energy system contains not only energy, but also material energy carriers. So in the simple case, all that is produced by the chemical industry. And that doesn't work without carbon. And that is why there must always be a carbon cycle. The question is how big it is. Today, the carbon cycle is heading towards 100 per cent of our energy system. Only nuclear energy and renewables are not part of it. But the carbon cycle is not closed because the CO_2 is simply pumped into the atmosphere. And if we were to close the cycle now, then theoretically we could continue like this. But it is not very practical to close the cycle on this scale. Because it is costly to collect and transport the CO_2. This process should be kept as small as possible. But from my point of view, you can't make it zero.

You have co-developed a project called The Moderne Forrest. According to the motto: everything in one place. First, green electricity is produced in the sunny deserts of the earth. You use the electricity to produce hydrogen. Then you take CO_2 from the air and produce methanol. How far is that from reality?

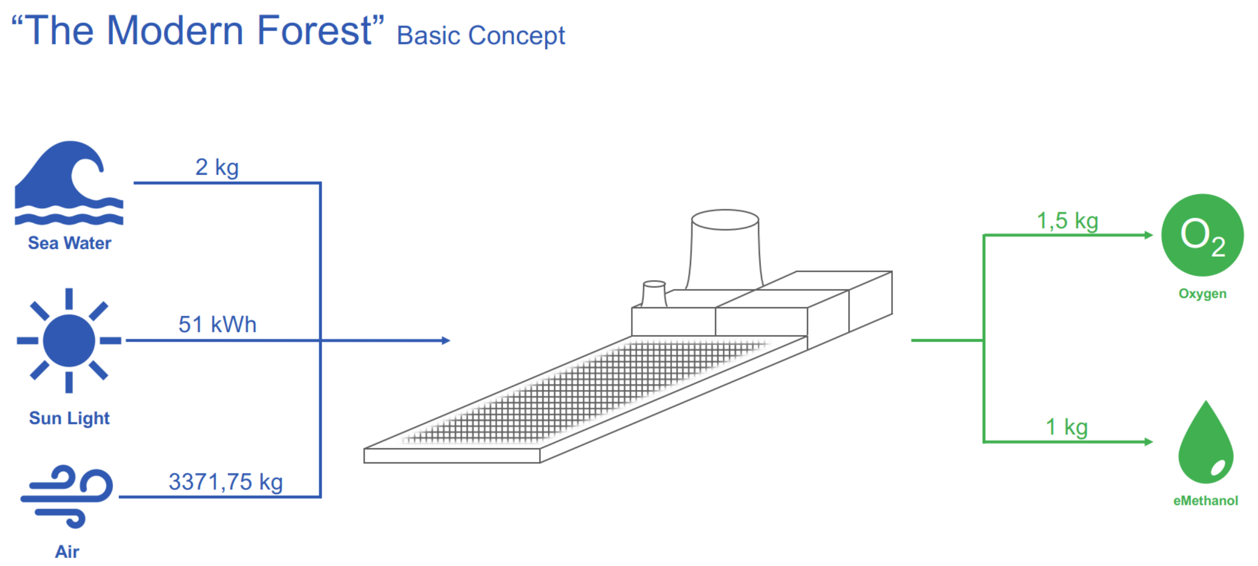
Every single one of the steps you list already exists today. None of it needs to be invented. But we have two difficulties. One is the scale. The whole thing only works, of course, if you do it on a very large scale. And none of the technologies are ready today to be really applicable on the large scale. Whether these are just money issues or whether these are also technological issues, we just don't know yet. And for me, the most critical part is the collection of CO_2 from the air, i.e. Direct Air Capture. This is always propagated, but the physical background is very complicated.

Critics of direct air capture say: The CO_2 in the atmosphere is present in very low concentrations, namely around 400 ppm. And the compression power alone could be quite expensive. How do you see that?

Yes, we don't really know. Compression alone is not enough. There has to be selective separation. And that can only be done by chemical adsorption. There are companies that claim to have produced such adsorption materials. And I can't say that's all fake, I don't know that. But I do know that this has never been tried on a scale where you have filtered millions of tonnes of CO_2 out of the air. Other than that, you have to think of it kind of like an aircraft turbine. So you take electrical energy and you drive a turbine with it. The turbine sucks in the air, passes it over the adsorber material and exhausts the air out the back. The material is loaded with CO_2. With the waste heat from this turbine, the process is reversed and the CO_2 is dissolved back down from this adsorber material. And in principle, something like this has already been demonstrated, but on small scales.

Why is it called The Modern Forest?

Because a natural forest does exactly the same thing. A forest is a biological system that uses CO_2, light and water to produce biomass. And what is methanol in the Modern Forest is wood and leaves in the natural forest. The processes behind this are similar in their functions, although chemically extremely complex. The plant also has such adsorber materials. It respires the air, takes out the CO_2 in the process and collects it in a certain molecule. Then it is reacted with high-energy building blocks. And from this, in the end, through a very lengthy process, what we call wood is created. We wouldn't use wood, of course, because it's too time-consuming. For example, there is too much oxygen in it. That's why we would rather use methanol.



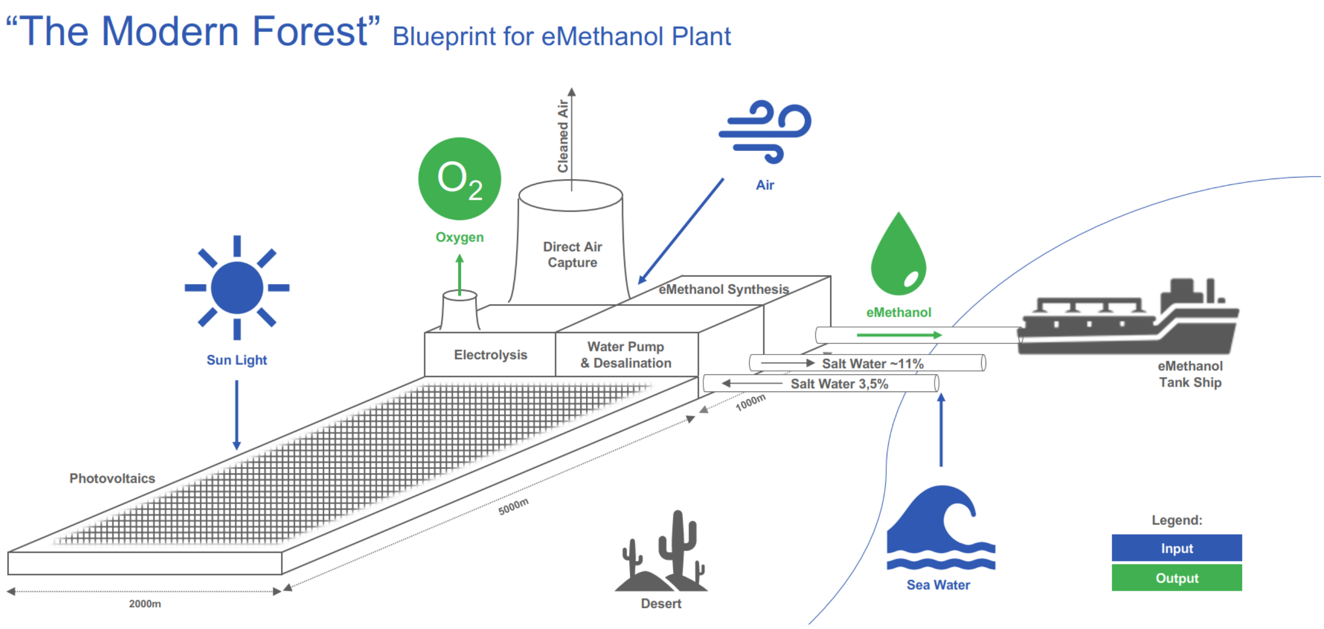
Source: Obrist Group
[Read more about Obrist Group]

The Modern Forest - we are talking about a lot of money.

Every energy transition is expensive. The global energy transition costs about one world gross national product. You always have to invest that. Of course, the artificial forest needs a lot of investment. Theoretically, however, there are considerable advantages. Above all, you can do it in places on the planet where you don't get into trouble with the natural biology. You don't have to chop down forests. You don't have to give up agricultural land. The artificial forest is created in the desert where there is nothing going on anyway. I know a little bit about chemical technology and to build a plant with new technology that reaches the scale of a million tonnes a year, that usually takes 15 to 20 years. But now we don't need one plant, we need thousands. And that would be ramped up gradually. I would say that this is a vision that I see in 20 to 30 years.

Have you ever calculated this?

Basically, you have to stop believing that a sustainable energy system will reach the same price level as today. Simply because the costs of energy sources are basically about two or two and a half times higher compared to the costs of energy sources today. It is impossible to say how this will be reflected in the price. Also because we don't know which market models are behind it and how much tax is on it. In terms of scale, we can say that it will definitely not be cheaper than today. I don't dare say how much more expensive it will be. But I always say, assume a factor of two, then you're on the safe side. That's not too bad. If you consider that today's energy system, at least in Europe, contains more than 50 percent taxes and levies, you will say: if the state were to forego its share, the user would not notice. I know from the chemical industry that estimates can be quite wrong. A tonne of methanol costs about 400 euros or dollars today. And I would say between 400 and 600 euros per tonne will cost the same in the future.



Source: Obrist Group

Green methanol?

Yes.

Who is going to pay for that?

The customer will have to pay it, just like today. It makes no sense for the state to pay for it.

And who is going to push the big plants?

If you look at a refinery or an oil rig, that also has to be made first. It's the same process.

What steps do you see on the way to an artificial forest?

There has to be a carbon cycle. And the first thing to consider is whether that can be driven with biomass or concentrated sources, or whether you can use direct air capture on a large scale. We don't know that yet. And it will take a while before we can really assess that. In parallel, the other sub-processes must be further developed. First of all, electrolysis. We're already relatively far along there. And I am confident that we will have a stable technology on a global scale in the next ten years. It's already working quite well today, but it can still be improved. I reckon that the costs of the electrolyser will be perhaps a quarter of today's costs in terms of order of magnitude. And then there is chemical conversion. Today we control an order of magnitude of about 100 million tonnes per year. In the long term, we will need 20 times that amount. But there is not much left to get out of that. Then there are questions of regulation, control, gas purification and how to run the whole process. Investigations are already underway. But they have to be accelerated. There are so-called CCU projects (Red: Carbon Capture and Usage). I myself am involved in such a project, where we will reach the 100,000-tonne dimension in a few years. But you have to move into the multi-million tonne dimension. And that simply takes time.

What process are you thinking of?

You take CO_2 and green hydrogen. And the simplest reaction the chemist can do with it is methanol synthesis. That's why methanol is believed to be an important platform molecule. Because it is by far the simplest thing we can do.

What are your political demands?

I'm not saying more money for research, but more freedom. At the moment, at least in Germany, we have reached the point where the regulatory framework prevents, for example, investments from being made by the private sector without any problems. We first need a regulatory framework that offers the freedoms to try things out on a scale that is relevant without burning all the money. Because of course the state can use taxpayers' money to fund the test facilities. But if they work, one would want them to continue for decades. And that is not possible at the moment for legal reasons. I would also like to see the electricity system run properly. Because the basis of everything is the energy transition in the electricity sector. At the moment, there is a very narrow framework, which is determined by the Renewable Energy Sources Act. And that, I believe, is not a good basis for development. The most important thing for me is a proper market design for renewable electricity in Europe, not only in Germany, that is not enough. The second thing I would like to see is a regulatory framework in Europe along the lines of the Green Deal that allows private investment in research facilities, and in a way that you get your money back. And the third thing I would expect is the design of an infrastructure in Europe so that hydrogen and its derivatives can be distributed and exchanged across borders to some extent, just like electricity. These are the three main priorities that would have to be created in the next five years.

When you think of infrastructure, you think of gas pipelines...

...yes, and caverns and ports. You have to imagine that this will reach enormous dimensions if you really do it. As much as gas and oil today. And if you take a look at the port of Rotterdam or the oil port of Hamburg, these facilities were not built in a year either.

What do you personally hope to see from this?

Well, I hope that people realise that the energy transition requires not only electrical but also material energy sources. I hope to see the beginnings of a hydrogen infrastructure in my lifetime. I'm pretty sure I'll also see green fuels to get back to where we started. For example, in the form of e-kerosene, possibly also to power ships and for construction machinery where people can't cope with electric mobility. And I fervently hope that I will see a better regulatory framework. To the interview...

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Synthetic fuels as an admixture to regular petrol

With this proposal, Global Energy Solutions is currently targeting the ongoing coalition negotiations in Baden-Württemberg. At the same time, we would also like to address the entire political community in Europe as well as the relevant business associations. Our appeal in the wording:

The Research Institute for Applied Knowledge Processing (FAW/n) and Global Energy Solutions e. V. strongly recommend that politicians set a blending quota for fossil-fuelled synthetic fuels (reFuels) in the RED II directive for fossil-fuelled vehicles (cars / trucks), which is to be finalised by the end of June. In the long term, this is about the climate neutrality of the vehicle fleet, but also about technology openness for vehicles with non-fossil combustion engines in addition to battery-electric vehicles. A blending quota of 10 % by 2030 would make it possible to save about 15 million tonnes of CO_2 per year in Germany at that time. This would be a considerable volume, also in addition to the potential from the ongoing ramp-up of the e-vehicle fleet. By 2040, the entire (remaining) existing fleet (cars, trucks) in Germany could be made climate-neutral through a further increase in the blending rate. Potentially, this would mean more than 100 million tonnes of CO2 per year. The issue of the blending quota is of enormous importance for Germany in terms of industrial policy. For the world, it is a key issue on the question of whether or not the 2° target can be met. For what is at stake is a climate-neutral solution for the existing fleet of 1.3 billion vehicles and thus about 5 billion tonnes of CO_2 annually that could be avoided by using synthetic fuels.

CO_2-neutral drive technology for passenger cars and commercial vehicles

The Scientific Society for Automotive and Engine Technology (WKM) has presented a position paper on the diversity of CO_2-neutral drive technology and in particular on the potential of synthetic fuels. In it, it pleads for technological openness in drive technology "in order to be able to reduce CO_2 emissions from fossil energy sources worldwide and quickly". Only a suitable mix of technologies, depending on the application, would lead to the desired results. Leaders in the field of vehicle and engine technology certainly advocate battery-electric mobility in cities. Europe should not be left behind in fuel cell technology. But it is also important to further develop the combustion engine in combination with CO_2-neutral fuels. WKM emphasises that it is ultimately also a matter of enabling people with low incomes to have affordable CO_2-free mobility for long distances in the future. In terms of technology openness, WKM takes the same position as *Global Energy Solutions*. Read more...

Radermacher: Germany's climate nationalism will not help the world

Germany focuses too much on national goals and measures in the fight against climate change. However, these are hardly relevant in the global context. This is the opinion of Franz Josef Rademacher, board member of Global Energy Solutions. German and European climate policy hardly takes note of influential global developments, such as population trends. By 2050, about 2.5 billion people will be added to the world's population, once every year in Germany. The role of China, by far the largest emitter of CO_2, is also hardly acknowledged. In Focus-Online, Radermacher calls for a rethink. Read more...

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