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**„double-green“ methanol /**

**„double-green“ synthetic fuels**

## **Abstract**

*Methanol is an "anchor substance" for a climate neutral world. Methanol and its derivatives (synthetic climate-neutral fuels) open up the possibility, among other things, to make the entire traffic, including the dominant number of existing vehicles with combustion engines, climate-neutral. The same applies to individual heating and cooling solutions. In the area of mobility, neither the vehicles nor the infrastructure needs to be changed. In the area of heating/cooling systems, the extremely costly energetic renovation of existing buildings can be abandoned. Such approaches are already possible today (including current taxes) for less than 2 Euro per liter of fuel / heating oil, if only sufficient quantities of green hydrogen were available at affordable prices.*

*Another aspect is at least as important for the outstanding role of methanol: Since methanol is produced by combining green hydrogen with CO<sub>2</sub>, methanol creates an option that is missing from all other energy alternatives discussed today: For the first time, methanol opens up a business case for the capture of extremely large amounts of CO<sub>2</sub> via Carbon Capture and Usage (CCU) from industrial and chemical processes. For the first time, this opens up the opportunity to make the entire heavy industry and chemical sector climate-neutral at low cost. The capture of CO<sub>2</sub> is usually affordable for 30 euros per ton. The costs are therefore manageable and lower than the amount of the CO<sub>2</sub> tax, which soon will be paid in Germany. The costly conversion of all these complex infrastructures and industrial plants for climate reasons is then no longer necessary.*

*The decisive factor in this context is the possibility of multiple recycling of CO<sub>2</sub>, which is opened up by methanol. This results from the fact that the resulting climate-neutral methanol can also be used to generate the process energy required in heavy industrial and chemical processes at costs which, like the costs for fuels, are not far away from the current costs for process energy. The multiple recycling of CO<sub>2</sub> through the production and use of methanol is therefore a key issue.*

*CO<sub>2</sub> emissions then only arise from the use of methanol-based synthetic fuels in transport and in the area of individual heating / cooling. Even assuming a massive further growth of*

*these areas of the economy in the context of the continuing growth of the world population and the hopefully possible implementation of the SDGs by 2050, a maximum of 10 billion tons of CO<sub>2</sub> per year will still be emitted, which corresponds to about 25% of today's emissions. These 10 billion tons can be removed from the atmosphere annually through activities in the field of Nature-based Solutions. By financing smart compensation projects, such as those promoted by the Development and Climate Alliance, development as well as climate and environmental protection can be massively promoted at the same time. The costs involved in promoting measures in the field of Nature-based Solutions are manageable. It is recommended that, in accordance with the polluter-pays principle, those who emit CO<sub>2</sub> (i.e. individual mobility, heat/cold) should bear these (manageable) costs. This idea leads to a worldwide carbon-neutral civilization with, among others, the „double-green“ synthetic fuels, which are described in more detail below.*

### **„Double-green“ Methanol and Climate Neutrality**

Methanol produced on the basis of green electricity and recycled CO<sub>2</sub> (CCU) is called green methanol. It is produced by combining green hydrogen with recycled CO<sub>2</sub> (CCU). Its combustion is climate-neutral because it only emits the CO<sub>2</sub> that was previously captured (CCU process) and would otherwise have been released into the atmosphere. This happens later during the combustion of methanol if it is not captured a second time (**multiple recycling**). With such a definition of the climate neutrality of methanol, however, the problem of double counting arises if the industries, where the CO<sub>2</sub> was captured, also want to declare themselves as climate neutral. Therefore, the following describes how the problem of double counting can be solved with „double-green“ methanol.

**„Double-green“ methanol** is created when the supplier of the green methanol for a certain amount/batch of methanol acquires and registers high-quality climate certificates to the extent that CO<sub>2</sub> would be released when burning this amount of methanol, if this CO<sub>2</sub> is not recycled. The markets for individual mobility and individual heating/cooling solutions are provided with „double-green“ methanol (and derived products). As soon as the „double-green“ methanol is brought into these markets, the corresponding CO<sub>2</sub> certificates are decommissioned.

The situation is different in the markets where the emitted CO<sub>2</sub> by the combustion of methanol is captured again. In this case the use of green methanol is adequate. In the future, these will be the larger market segments due to the intended multiple recycling of CO<sub>2</sub>.

The use of „double-green“ fuel not only saves the emissions that would be produced by using a fossil fuel, but twice the amount. This is due to the prior separation of CO<sub>2</sub>, e.g. in industrial processes. Further positive effects are generated if high-quality climate certificates are used, which additionally unfold positive SDG effects for development and environmental protection. With regard to certificates, it is best to orientate oneself towards the approaches and standards of the **Development and Climate Alliance**, and even better towards the sub-category of certificates of the **Nature-based Solutions**, since these induce a sequestration of CO<sub>2</sub>. The alliance promotes high-quality development and climate

protection projects in non-industrialized countries. The compensation of CO<sub>2</sub> emissions from the combustion of green methanol or green derivatives such as methanol gasoline or methanol heating oil generates massive positive development and environmental effects. The „double-green“ methanol then acts **in the sense of the SDGs**. The positive climate, environmental and developmental effects are manifold: removal of CO<sub>2</sub> from the atmosphere (negative emissions), consistent protection of rainforests (= prevention of certain deforestation and flaring) and biodiversity conservation, large-scale reforestation (including agroforestry) and massive humus growth in agriculture, which simultaneously creates jobs and secures food, restoration of mangrove forests, renaturation of wetlands, etc.

**Example: achievable volumes in the transport sector in Germany / Reforestation to generate corresponding negative emissions**

In Germany, around 50 million tons of petrol and diesel are used in road traffic every year. Combustion generates about 160 million tons of CO<sub>2</sub> emissions per year, about 18% of the annual German CO<sub>2</sub> emissions. If a switch to „double-green“ methanol gasoline and methanol diesel was made, 160 million tons of CO<sub>2</sub> from industrial processes would be recycled, i.e. not emitted. What would be the result?

1. In the first step, 160 million tons of CO<sub>2</sub> would be saved – they would be converted into green methanol and derived products.
2. In step 2, the combustion of the green methanol and derived products with a volume of 160 million tons of CO<sub>2</sub> would also be neutralized by means of high-quality certificates. This would be done by biological sequestration (negative emissions), which makes the process „double-green“.

In total, this would be about 36% of the German emissions that would be mitigated. The transport sector would then no longer be the problem, but **part of the solution**.

If one compensates with reforestation, 160 million tons of CO<sub>2</sub> are offset by about 16 million hectares of reforestation. It is assumed that 10 tons of CO<sub>2</sub> are bound per hectare and year. The area to be reforested for this purpose is 400 km x 400 km. At a price of 10

euros per ton, this results in costs of 1.6 billion euros per year that would flow into reforestation activities.

### **A further option: rainforest protection**

A simple solution for rainforest protection is raise 50 € per hectare of rainforest per year as long as the rainforest is left untouched. This is more than a factor of 10 higher than what is currently paid under REDD+. The rainforest stores up to 700 tons of CO<sub>2</sub> per hectare above and below ground. (Unplanned) flaring can release 500 tons and more of CO<sub>2</sub> per hectare. Assuming an annual probability of 6 per mille (6‰) for such a flaring, it is a matter of the avoidance of an average of about 3 tons of CO<sub>2</sub> released per hectare of rainforest per year. If paid 50 € per year – unconditionally – for the preservation of one hectare of rainforest, this is 16.70 € per calculated ton of CO<sub>2</sub>. Since the global rainforest area is still about 1 billion hectares, the worldwide potential for the protection of rainforests is 50 billion € per year and the annual reduction of 3 billion tons of CO<sub>2</sub> emissions worldwide. The avoidance effect of the German transport sector (petrol and diesel, cars and trucks) is 160 million tons of CO<sub>2</sub> per year, about 1/18 of the global potential of 3 billion tons per year for consistent rainforest protection of the type described above.

If the 160 million tons of CO<sub>2</sub> in German road traffic saved in the above example are compensated for by rainforest protection measures of the type described above, the fuel used in Germany would generate about 2.71 billion euros per year for rainforest protection. From the worldwide still available rainforest 5.5% would be able to be protected in such a way, which is about 55 million hectares of rain forest surface.

### **Ways to transparency: certification and decommissioning of certificates**

Hydrogen must be certified as green on the basis of the renewable energy (which must be certified as such). This is not only demanded by the EU. The renewable energy traceably must have be used for the electrolysis process.

A distributor of green methanol can, as described above, "refine" it to a „double-green“ variant by purchasing (in the sense of the Alliance) Nature-based Solutions certificates in order to balance later compensation, which are used in the areas of individual mobility and individual cooling/heating solutions. As soon as the „double-green“ methanol reaches these markets, the corresponding certificates are decommissioned.

## **Conclusion**

Every CO<sub>2</sub> recycling via methanol creates new industrial climate-neutral processes. This is a decisive contribution of methanol to solving the challenges in the energy and climate sector. By means of „double-green“ fuels it can further succeed to make the entire civilization net climatic-neutral. This is feasible on the basis of inexpensive renewable energy on a gigantic scale alone.

## Appendix

### Comparison

<b>„Double-green“ synthetic fuels</b>	<b>Battery electrical solutions</b>
Solution for the stock of cars (combustion engines). These represent almost 100% of the vehicles, in Germany and even more so worldwide	Solution only for new vehicles (passenger cars)
Solution for 'normal' citizens, especially in the lowest-income part of the world, who will drive the combustion engines that are already existing for decades to come	Solution for the wealthy in rich countries. This means that citizens with enough money buy the vehicles and / or the purchase is made possible with a lot of public support (only possible in rich countries)
Really "green" solution during operation	Driving with often dirty (black) electricity
Solution with great development and job potential for many low-income countries, e.g. in North Africa, a.o. via renewable energy production and nature-based projects	Solution to the detriment of the foreign exchange outflow from high-income countries to low-income countries by focusing on green electricity locally
In the „double-green“ variant, double CO <sub>2</sub> effects + development effects	Numerous human rights violations in the production of cobalt etc.
The existing infrastructure can still be used to a large extent	A new infrastructure is needed
Germany's automobile manufacturers can defend their position in the market	Germany's automobile manufacturers are massively endangered by competition
The process of producing automobiles will also become climate-neutral in the medium term by enabling CO <sub>2</sub> recycling in heavy industry via CCU (e.g. steel industry)	The production of the electric car and its battery generates almost as many emissions as a current combustion engine over a large part of its life. Electric vehicles essentially do nothing to ensure that the industrial production process is moving towards climate neutrality
Present jobs in the automotive industry in Germany, especially with many supplier companies, will be retained	Massive reduction of present jobs in the industry