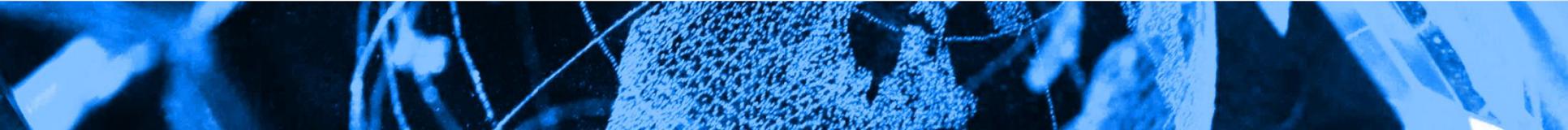


Initiative for Green Hydrogen, Methanol and CO₂-Recycling

The Global Energy Perspectives Project of
Global Energy Solutions e.V.

F. J. Radermacher

Thessaloniki, September 7th, 2020



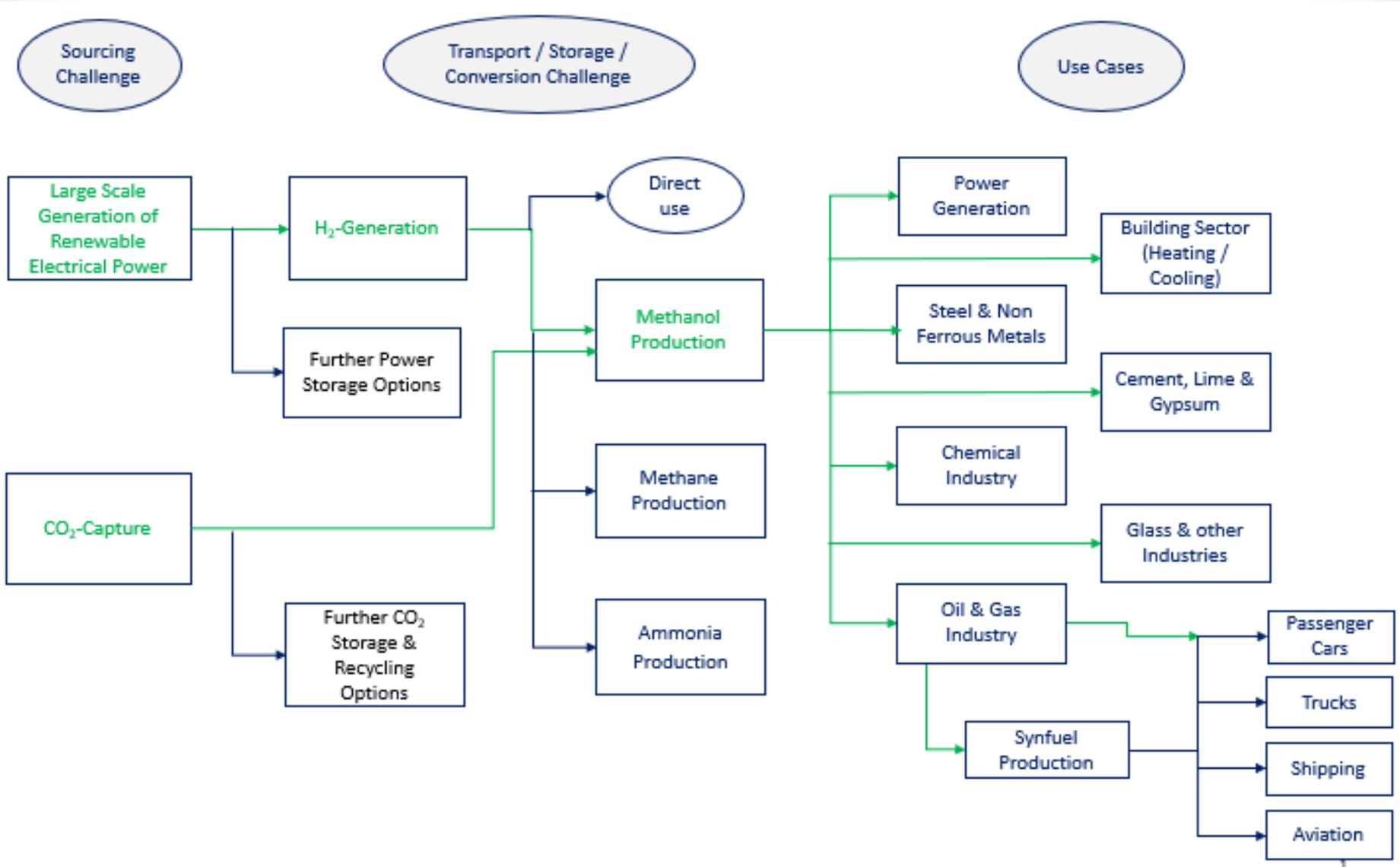
Preliminary remarks

Sustainable development requires a global solution to our energy and climate issues. The greatest problem pressures lie in the densely populated developing and emerging countries, which is why it is absolutely essential to think beyond national borders.

Business cases to be analyzed within the project

1. Production of large amounts of green electricity in the solar deserts of the world
2. Local electrolysis to produce green hydrogen
3. Local synthesis of green methanol by means of CO₂ injection from CCU processes
4. International transport of green methanol for use in a wide range of energy processes
5. Use of methanol (as process energy) and its derivatives, e.g. in the areas of individual mobility, heat/cold; the latter using high-quality CO₂ certificates to achieve carbon neutrality

Basic Global Roadmap Scheme



Global Energy Perspectives – Hypotheses (I)



- (H1) A worldwide solution to the global energy and climate challenges for 10 billion people in 2050, which is compatible with prosperity and freedom and which fosters achieving the SDGs, will require twice the amount of primary energy that is used today in the long term.¹ Only a comparatively small proportion will still be based on fossil fuels. The rest will be renewable.
- (H2) In the future, about 50% of the green energy required will be provided by green electricity, which will be used directly in various forms (e-mobility, household electricity, etc.).
- (H3) The second half will be provided by green hydrogen (produced by electrolysis) and derived products, the production of which requires quantities of renewable electricity about 1.4 times larger than the volume of (H2), due to efficiency losses.²
- (H4) The path described is economically attractive if the green electricity costs less than 2 Eurocents/kWh at the transfer point to electrolysis.

1 Of the current quantity, 80% is of fossil origin.

2 What is needed is a fifteen-fold increase in the current amount of renewable energy.

Global Energy Perspectives – Hypotheses (II)



- (H5) Providing the required quantities of affordable green electricity is the greatest challenge in the perspective described and represents the largest single cost factor.
- (H6) Without massive use of the world's large solar deserts, it will not be possible to produce the required amount of green electricity, let alone at acceptable costs. International cooperation in this area is therefore indispensable. At the same time, it promotes development to a considerable extent (2030 Agenda of the United Nations).
- (H7) The intercontinental export of green electricity and green hydrogen from the solar deserts will play a certain role but due to transport costs and other difficulties it will be of secondary importance.
- (H8) The most important export vehicle for green hydrogen is its conversion to methanol by combining it with CO₂, which - as a 'liquid electricity' - is the key to the transport, storage and other problems of the large volumes of energy. It also opens up many direct energy use possibilities (e.g. methanol cars).

- (H9) Methanol is the starting point for a wide range of carbon-neutral synthetic fuels that are competitive on the market.
- (H10) For the purposes described, methanol is clearly superior to the alternatives methane, ammonia, etc.
- (H11) Large parts of both industry and chemistry can be made carbon-neutral at low cost by capturing and recycling CO₂ (CCU). This is a very important contribution to global climate protection and to achieving global carbon neutrality.
- (H12) The possibility of capturing very large quantities of CO₂ in CCU processes and using them to produce green methanol products opens up unique opportunities in the direction of carbon neutrality. Green methanol is the enabler of CO₂-recycling in extreme huge quantities. Multiple recycling of CO₂ is a most crucial factor here. Green methanol is also used as input for process energy in industrial and chemical processes.

- (H13) Battery-electric solutions and the use of fuel cells have some potential in the mobility sector. However, the majority of mobility applications worldwide will continue to be based on the use of combustion engines in the future. These will be powered by carbon-neutral synthetic fuels.
- (H14) Developing the carbon-neutral potential of synthetic fuels for Europe requires timely adjustments to European Union and international regulations in the fuel sector and beyond, in the sense that they (finally) reflect the physical facts.

(H15) The use of methanol and derived products in areas where no (total) CCU is possible (e.g. individual mobility, individual heating/cooling, parts of industry and chemistry) requires a 'double green' path: In accordance with the polluter-pays principle and in North-South cooperation, high-quality CO₂ offsetting certificates, especially those generated through nature-based solutions, are to be acquired and retired for the respective amount of CO₂ emitted.³ In accordance with the polluter-pays principle, such certificates are also to be acquired and retired in the case of non-substitutable further use of fossil fuels and in the context of all other CO₂ sources (e.g. lime processing). By 2050, this will involve a volume of around 10 billion tons of CO₂ annually.

3. See <https://allianz-entwicklung-klima.de/wp-content/uploads/2020/03/200316-Allianz-Flyer-EN.pdf> and https://allianz-entwicklung-klima.de/wp-content/uploads/2020/03/Development_and_Climate_Alliance_Factsheet_EN_Digital.pdf

(H16) The idea of financing high-quality CO₂ offsetting certificates for the carbon neutralization of methanol and derived products in applications without a (total) CCU option and other CO₂-causing sectors will create a world that is carbon-neutral “on the balance sheet” over the next 50 years even though 10 billion tons of CO₂ will still be emitted each year by human activity. This form of organization in the field of energy and climate will raise considerable sums of money to promote development and implement the 2030 Agenda of the United Nations.

If electricity is available for 2 Cent/kWh with the process of electrolysis, the following cost for synthetic fuels (including taxes) result:

1. Cost of green hydrogen 1 Euro per kilo
2. Cost of green methanol (Europe) 350 Euro per ton
3. Cost of green methanol (Africa) 250 Euro per ton
4. Cost of green methanol when used as fuel 1 – 1.20 Euro per double litre, incl. VAT
5. Cost of green methanol-gasoline 1.70 – 1.90 Euro per litre
6. Cost of green methanol-diesel 1.80 Euro per litre
7. Cost of green methanol-kerosene 1 Euro