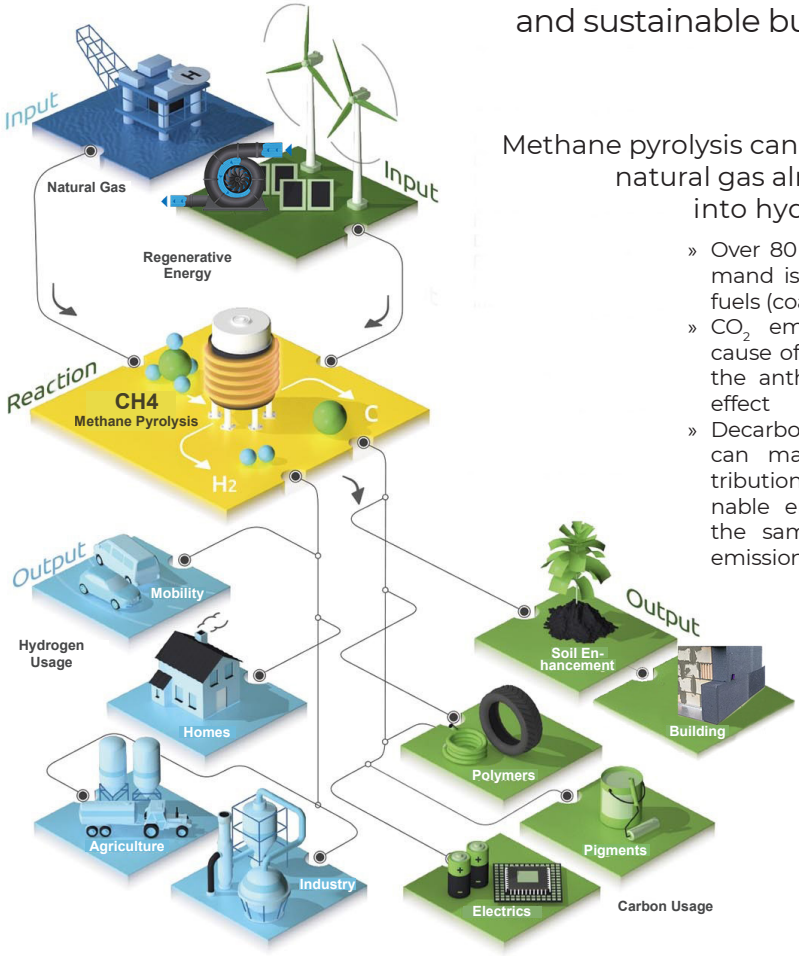
RESOURCES
INNOVATION
CENTER LEOBEN

MONTAN UNIVERSITÄT LEOBEN

Sustainable Production of Hydrogen and high-purity Carbon

Methane Pyrolysis

Hydrogen is an essential element of the future green energy supply scenario with reduced CO_2 emissions. Carbon contributes to resilient agriculture and sustainable building materials.



Methane pyrolysis can be used to convert natural gas almost emission-free into hydrogen and carbon

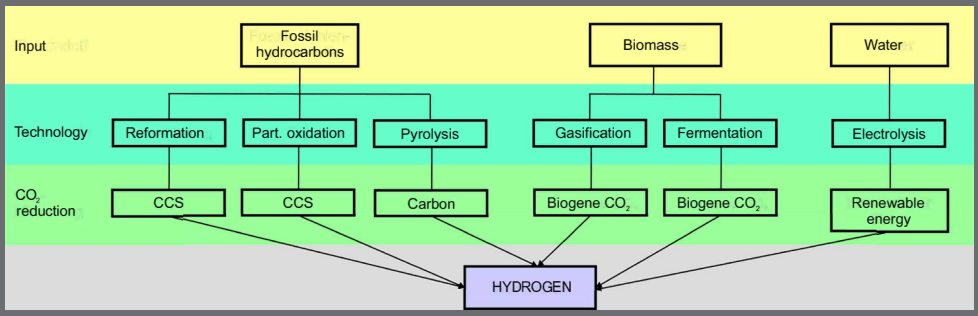
- Over 80 % of global energy demand is currently met by fossil fuels (coal, oil and natural gas)
- CO_2 emissions are the main cause of global warming due to the anthropogenic greenhouse effect
- Decarbonisation of fossil fuels can make a significant contribution to a stable, sustainable energy supply, while at the same time reducing CO_2 emissions.

Source: www.gas.info/energietraeger-wasserstoff/erzeugung-von-wasserstoff/methan-pyrolyse; adapted

Methane Pyrolysis

The thermal decomposition of methane (methane pyrolysis or methane electrolysis) involves the splitting of CH_4 into gaseous hydrogen and solid carbon.

The following processes are available:
» Plasmalysis
» Pyrolysis by means of molten metal or salt
» Pyrolysis using solid catalysts



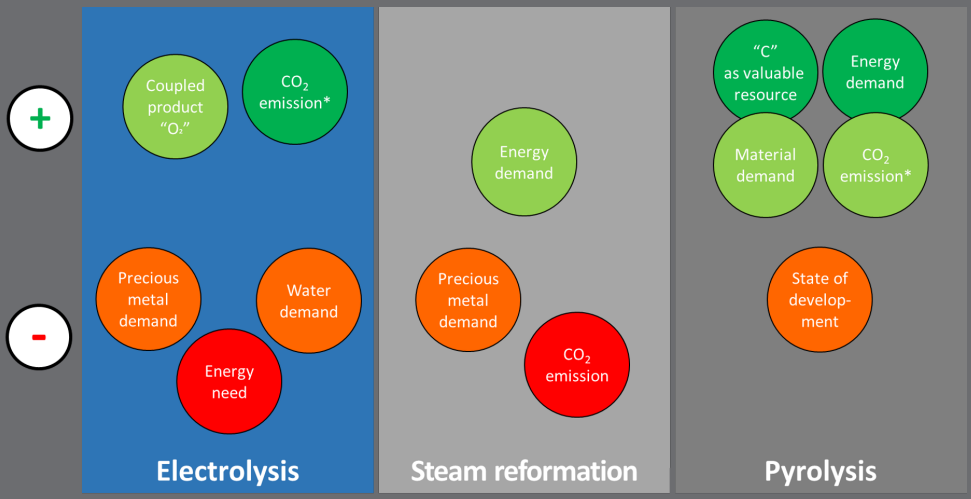
With the same energy input, pyrolysis can produce around four to five times the amount of hydrogen, compared to water electrolysis.

Considering the entire production chain, the CO_2 footprint of both production routes using renewable energy is comparable, approx. 3 kg CO_2 / kg H_2.

Pure Carbon from Pyrolysis

» Different modifications achievable, depending on process and process parameters (graphite, graphene, carbon black, carbon tubes)

» Valuable second product from an economic and ecological point of view (wide range of applications)



*) using renewable energy

Carbon in Agriculture

The use of carbon in agriculture has enormous potential to positively influence soils in the context of global climate change. Storing carbon in the soil leads to a positive influence on soil properties.

The advantages are:
» Improvement of mechanical, physical and chemical properties
» Increasing the water storage capacity
» Improvement of soil stability
» Reduction of nutrient losses and improved adsorption of organic and inorganic pollutants
» Medium and long-term humus build-up results in climate-fit and resilient soils.

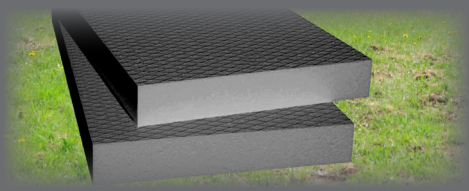
Carbon can also be used as a fertilizer by mixing it with organic residues such as liquid manure, compost and dung or by activating it with soil/microorganisms.

Carbon in Building Materials

The annual global production of cement, the most important building raw material, is around 2 - 4 billion tonnes.
The possibility of substituting around 10 % of cement with carbon from pyrolysis can be utilised without impairing the properties of the concrete.

Advantages:
» Reduction of CO_2 emissions by up to 10 % compared to conventional production
» Saving on raw materials

Carbon from pyrolysis (with the strongest possible ordered graphite structure) can also be used as an additive for XPS boards to increase insulation performance (deflection of heat radiation by graphite) and as a raw material in asphalt production.



Carbon in Special Applications

Carbon from pyrolysis can be used in many other sectors, in addition to agriculture and construction.

These include:
» Use as a raw material in the refractory industry
» Rubber and activated carbon products
» Use as an additive in lubricants
» Reducing agent in casting powders and in carbon electrodes for the metallurgical industry, e.g. steel and aluminum production
» Additive in inks and pigments
» High-tech products of electronics and electrical engineering as well as batteries
» Carbon nanotubes (CNT) for electronics and mechanical applications
» Storage of hydrogen

RESOURCES
INNOVATION
CENTER LEOBEN

MONTAN UNIVERSITÄT LEOBEN

Methane Pyrolysis Facts

- Energy demand: 12 - 15 kWh / kg H_2
- Emissions: ~3 kg CO_2 / kg H_2
- Production with renewable energy
- High availability of methane
- Use of existing natural gas networks

Project Coordinator:

Robert Obenaus-Emler
Resources Innovation Center
Montanuniversität Leoben
Franz-Josef-Strasse 18
8700 Leoben

Tel.: 03842-402-7613
E-Mail: emler@unileoben.ac.at

VTiU Verfahrenstechnik

Metallurgie Leoben

Nichteisenmetallurgie Non-Ferrous Metallurgy

Chair of Mineral Processing

Allgemeine und Analytische Chemie

Materials Science

Chair of Physics