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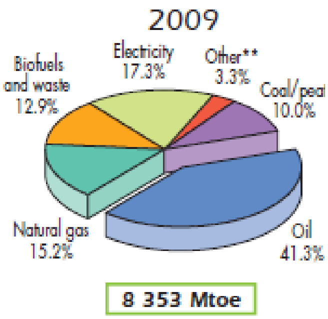
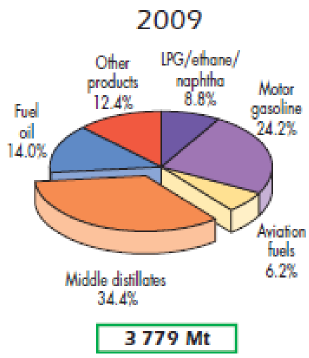
Added Value from combining nano Technology with Refinery Practices

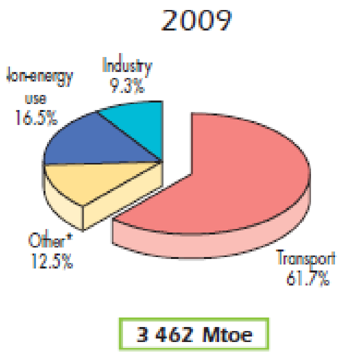
World Energy Consumption (IAE)



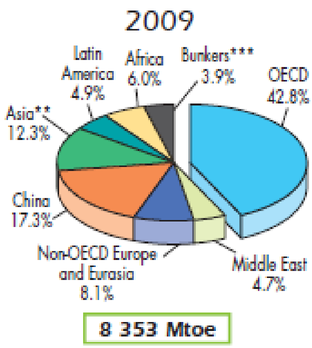
Consumption by Source



Refineries' Production



Use of Oil



Consumption by Countries

Renewable Energy:

Including Hydro Power Electricity, the share of all non-nuclear alternative fuels is 18,6% among all energies consumed (nuclear itself 2,8%). But particularly the use of Organic Matter, such as energy crops, agricultural debris and 2nd level waste of prior industrially used biomass is about 16%. Beyond that, global food production in energy equivalents represents about 58% of the above cited energy consumption, in addition. Half of this goes directly into human nutrition, while the other half is needed for raising life stock, contributing in the end 10% of human nutrition only. What very few people are aware of is that about 1/3 of all food production ends up as waste, as of today not really systematically used, although it represents another 8% of the world energy consumption.

Transformation Losses:

When we look at the primary energy supplies, we would see that before we get to consume any energy, over 30% of what's available for consumption will have gone into transformation losses. In the use of raw oil the usable content of energy gets maximized through refining technologies, primarily targeting at a minimization of waste from the process.

Organic matter, liquids or gases are always Carbon-Hydride combinations of different potencies of the individual base elements, Carbon and Hydrogen. By having developed Hydrogen as an intermediary within refineries, lower grade Carbon Hydrides can be upgraded by hydrogenation (leading to a higher Hydrogen potency) within the Carbon Hydride combination.

Utilization Practice for Biomass:

Also biomass is just Carbon Hydrides of different kinds. When deteriorating it falls into carbon rich residue and gas (for example compost and CO_2, in the case of exposure to air). Unfortunately food and kitchen waste as well as non recycled post use of industrially used biomass today mostly are just dumped into landfills, where they start decomposing into CH_4, CO_2, etc., so called landfill gas. Sometimes nowadays such gas is harvested for generating electricity from it, irrespective of such electricity is needed or not. But economically you loose it, if you don't use it.

There have also industrial processes been developed, to decompose biomass in an accelerated way. For the fermentation for example the Anaerobic Digestion of Organic wastes and the pyrolysis and/or gasification of organic matter of lower heating value $\geq$ 2kWh have been developed mature over the last decade. Such accelerated decomposition always results in mixed decomposition gases, which either need to be separated and cleaned, or are burdening the use of the energy generated.

However, guo – Business Development has raised the question: "why does energy related biomass utilization end at the decomposition into gases?" Why not apply proven added value concepts of refineries for organic matter just as it is used for oil?

Waste Management Today

Europe generally has excess capacities in waste incineration, as they had been created already before achievements in waste minimization and avoidance had been successful. Unfortunately therefore today most fermentable MSW in Europe goes into incineration, although it requires auxiliary fuel addition in the equivalent amount of 85% of its energy content.

In other parts of the world the cost for waste separation and dedicated treatment installations are often not easy to recover through the added value that can be accrued from electricity generation. Therefore the practice of dumping waste in landfills continues. Although roughly 50% of MSW is organic (2/3 fermentable and 1/3 with high enough calorific values to be thermally decomposed)

Economics for decomposition of Biomass is usually limited by logistic challenges to medium size installations, typically delivering 300 – 800m³/h Methane content. Lately promising achievements in gasification of biomass have demonstrated feasibility of bio-fuels, such as synthetic Methane or Hydrogen Fuel and Gas to Liquid gasoline synthesis, whereas added value in the later two usage applications is higher. Therefore energy efficient, low emission Hydrogen from organic matter feedstock may be more desirable than Methane, which is a very stable aggregate.

Low Emission Hydrogen by nano Carbon Capture from Methane

A Technology, originally developed for generating high quality nano Carbon as an additive for Composite Matrix Materials, from Methane releases pure Hydrogen.

Catalytic Chemical Vapor Deposition [CCVD] versus Steam Reforming [SMR]

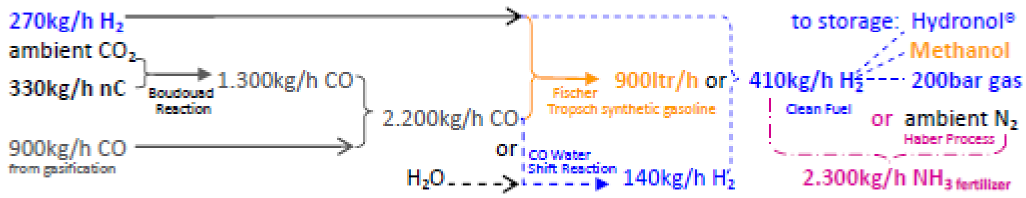
CH_4 + (Me $_{\text{Catalyst}}$) ——> 550 – 850°C Temperature at 37,8 kJ/mol H_2 ——> nC 2 x + H_2

no Water needed, nor CO_2 or CO formed, => low Carbon & scarce water conserving

CH_4 + 2 x H_2O ——> 750 – 800°C Temperature compared to 68,7 kJ/mol H_2 ——> CO_2 + 4 x H_2

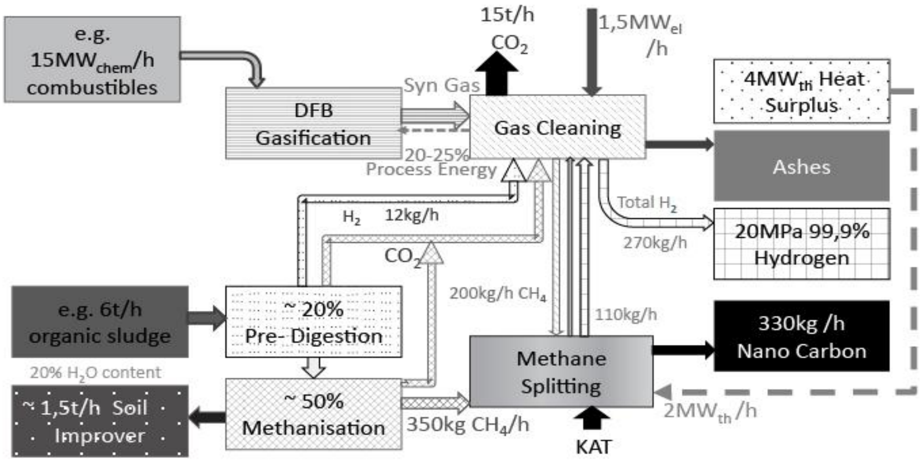
using 9 x mass of H_2 produced in H_2O and emitting 9 x mass of H_2 produced CO_2

Today Hydrogen is generally produced by SMR in large Petrochemical plants for mostly on site use and generates no commercially usable byproduct. E.g.: typical 450t/d MSW (50% organic content)



The Bio-Refinery Concept:

By combining fermentative and thermal decomposition of organic matter into one installation, the production of Hydrogen from Methane as intermediary for further refinery processes can benefit directly from internal heat generated by the plant, otherwise often lost in an energy balance due to lack of locally available synchronous usage paths.



nano Carbon [nC] unlocking dynamically growing Multi Billion Application Markets:

A nC price of € 15/kg can unlock nC loaded Thermoplastic materials at the cost of resin savings enabled through mechanical enhancements by the nC (resulting in ~50% weight saving per existing parts). Adjustable electrical conductivity of nC filled plastics will soar replacement of metal in household- appliance-, automotive, Solar Panel- and handheld wireless, etc. -industries, with all the advantages from weight savings, corrosion free, surface smoothness and freedom in design, injection molding or extrusion allow. But a broad diffusion of this technology into actual mass application markets will involve some time to market.

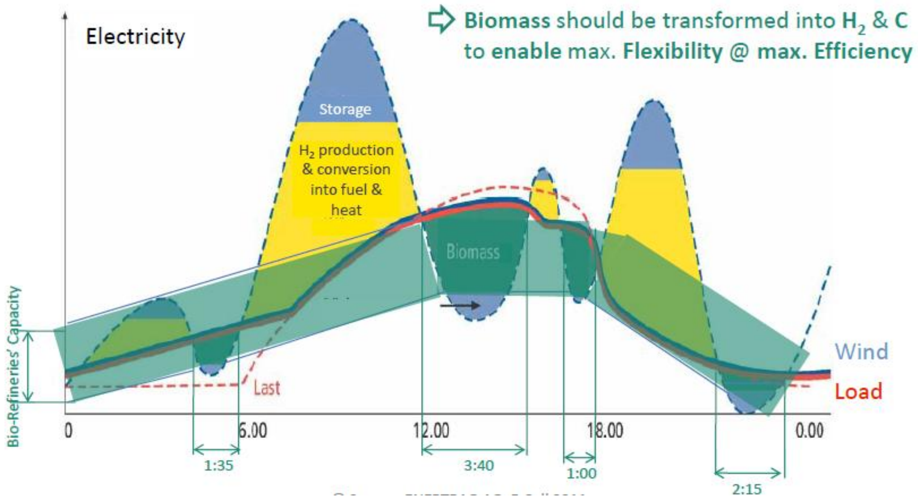
Bio-Refinery Business Development Opportunities:

Business Development from Technology has been a long standing, successful practice of us. It works best if built upon a technical core competence with unique selling propositions and a focus onto one theme. Here we suggest to look at our proprietary nCCU process technology to be used for anthropogenic Methane emission mitigation by turning it into value through Bio-Refineries of flexible multi product output, totalling in a higher added value(3 to 10 times) then straight electrification of decomposition gas from biomass can deliver.

By going into Carbon Hydride synthesis from the basic elements Carbon and Hydrogen as well as the CO_2 everywhere available in the context of biomass decomposition, storable energy carriers can be produced for later use on demand.

New Renewable Energy Synergies:

Photovoltaic as well as wind energy come with an unavoidable volatility of supply. When the wind fades or clouds may roll in, the supply has to be compensated by back-up capacities that can economically deliver peak demand supply for limited periods. Bio-Refineries of the herein introduced kind can potentially provide utility scale back-up electricity from the Hydrogen, otherwise used in the chemicals production, by modulating the e.g. fuel synthesis capacity accordingly for those periods of operation. For example in an electricity grid with wind power, this would look as follows:



Hydrogen as a part of energy concepts:

As can be seen above, there are also periods of excess electricity in networks with new renewable generation capacities. These could be used to either load batteries (e.g. of electric cars) or produce Hydrogen by electrolysis for later use, to the extent its storage and distribution can be economically arranged.

Future mobility may move towards electric power train systems. Few people are aware, but the original motorization concepts 120 years ago already had chosen that option for efficiency reasons. But until today battery weight has been being the show stopper, limiting reasonable travel range of such cars. But future hybrid vehicles with Hydrogen Fuel Cell range extenders might overcome that barrier. 2014 first volume roll-out of such cars will become part of the picture in our roads.

In a Hydrogen based infrastructure a distributed generating concept would work best, allowing to minimal logistics for it. Therefore the combination of MSW remediation and such infrastructure could be synergetic. The herein explained flexible Bio-Refinery concept also is an ideal model to accompany a transition period for vehicle fleets gradually changing from gasoline type of fuels towards increasingly Hydrogen.

Orders of Magnitude:

Electric vehicles enjoy 3 times the "fuel"-efficiency than gasoline vehicles. If all food waste was used through 25.000 nCCU based Bio-Refineries around the world, 1/3 of the transportation sector could be run on Hydrogen. Or alternatively 80% of aviation fuel could be covered from such repeatable and recyclable source. In contrary the common practice to generate electricity only from such organic decomposition gas would only achieve <7% of world electricity consuming as much Mtoe Energy Supply as transportation does.