BEYOND OIL AND GAS: THE METHANOL ECONOMY.

On Monday 8. June 2014, Mr. Obama is bypassing Congress and taking one of the biggest steps any American president has ever taken on climate change, proposing new rules to cut emissions at power plants. The president has definitely declared a war on coal.

Scientists have long warned that the Maldives, an archipelago of thousand islands in the Indian Ocean, will be wiped out by rising sea levels in the coming decades. President Clinton told that same story to Leonardo DiCaprio in an interview March 2000.

Both presidents, Clinton and now Obama, base their policy on climate change in recognition of IPCC's reports telling us that the changes are man-made and harmful and that we can prevent changes by reducing CO_2 emissions.

The Intergovernmental Panel on Climate Change (IPCC) bases their statements on other researchers' work and although the IPPC is suspected of making political conclusions, it has been the cause of a global movement and as such with a lot of inertia. Scholars with dissenting views are kept out of the good company. It is the case with Professor Henrik Svensmark, who suddenly found it difficult to publish his work. Just as with Bjørn Lomborg, who was directly accused of scientific misconduct. Not unlike Galileo Galilei. It took centuries before Pope Johannes Paul II eventually recognized formally, that it was wrong for the Catholic Church to condemn Galileo for his assertion that the Earth moves around the Sun.

The Fifth IPCC Assessment Report (AR5) makes a distinction between climate change attributable to human Activities (Emissions and Land-use Change), and climate variability attributable to natural causes. It is also noted that the IPCC now (2014) only feel sure that more than half of the warming in recent times is man-made, with the result that almost half of the warming may well be completely natural. Distance and difference between Henrik Svensmark's cosmic ray hypothesis and IPCC greenhouse hypothesis has been noticeably narrowed.

2014 a new paper in Environmental Research Letters gave additional support to Henrik Svensmark's cosmic ray hypothesis of climate change on Earth. Although Henrik Svensmark gradually are gaining recognition for his theory as published in The Chilling Stars, the greenhouse theory has that much inertia that it will determine policy decisions in the U.S. and Europe for many years.

With no opinions of our own - political or scientific - our company Agro Industries A/S draws the conclusion that there is political will for many years ahead to reduce greenhouse gas emissions. It is in line with our company policy on resource utilization without pollution. It also means that in the move from oil and gas to methanol, as predicted by Professor George Olah in his book "Beyond Oil and Gas: The Methanol Economy", we will base our methanol process on renewable energy sources. This decision is largely commercially motivated.

WASTE, A RENEWABLE RESOURCE.

The indirect land use change impacts of biofuels, also known as ILUC, relates to the unintended release of more carbon emissions due to land-use changes induced by the expansion of croplands for ethanol or biodiesel. ILUC produces other significant social and environmental impacts, affecting biodiversity, food prices and supply.

Concerns about ILUC are the driving force behind the European Commission's proposal in October 2012 to amend the Fuel Directive and the Directive on Renewable Energy. The proposal requires that motor fuels by 2020 contain 10 per cent energy of non-fossil origin. Also under the proposal half of these biofuels must be derived from waste. This proposed change is consistent with the overall objective of a fossil-free Europe by 2050.

None but the CEESA Group has calculated the outcomes of these goals. Technologies within our sphere of influence counts electrolysis and synthesis gas whether produced by gasification or steam reforming of methane. Out of a total Danish input of 135 TWh CEESA quantifies the following pathways relevant to technology of ours (Agro Industries A/S):

Electrolysis	6,3 TWh	Transformed to methanol for transportation
Gasification	10,2 TWh	Transformed to methanol for transportation
Biogas	7,9 TWh	Direct use for heating

The CEESA Group, however, does not see biogas as a source for transportation fuel. The reason given the large energy losses in the chemical reaction of methane to methanol - an energy loss that requires wise use of the heat wasted in the process.

Electrolysis is a most elegant route to methanol. Transportation costs and energy taxes have so far done this route impassable in Denmark.

Gasification on an industrial scale has proven practicable with wood chips as raw material, but not without technical problems. Straw is even more difficult to gasify, so the process is hardly mature for execution in forest poor Denmark.

What remains is biogas CEESA opt out as a source of motor fuel. It is not without reason that biogas is "overlooked" as a feedstock for liquid fuels.

Only because we have thoroughly examined all three paths and only because biogas is the only practicable of these and only because we have developed a concept that comprises the added value all the way to the consumer market, a profitable approach has been found. The approach adopted makes it possible to combine agriculture objective of the use of manure and the government's target for non-fossil fuels. No matter future energy solutions the agricultural objectives for livestock manure will survive.

THE VIRTUAL CLEARINGHOUSE

Where CEESA estimates a biogas potential of 7.9 TWh, we arrive at a potential of 13.5 TWh by a brand new process using pre-treated straw. Half and half it will become methanol – 6,7 TWh ~1,5 billion liters - and 6.7 TWh heat. CEESA estimates our total heating demand to 38.4 TWh. Although heat wasted from methanol synthesis represents only 17 % of our total heat demand, that amount of heat is high enough to require proximity to our metropolises to find outlets during summer time.

Due to economy of scale methanol factories today are built with capacities of 5.000 t a day meaning that one methanol refinery will handle the Danish biogas potential and more - advantageously placed on Amager. Other attractive locations could be Stockholm and Hamburg. Bio-methane is convenient passed up to these locations via the existing natural gas grid. New compact steam reformers may changes that picture.

This setup is handled in Denmark by Energinet.dk. This state owned company represents a virtual clearinghouse where energy of odd descent arrives to and again leaves as certified or uncertified energy. The certification is society's way of attaching a CO_2 quota to each unit of energy based on merit. The energy may be gas or electricity. Someday present distinction between energy nature is supposed to disappear and every form of energy and even each lot of energy will be measured only by its content of CO_2 neutral energy. A system of certificates prevents unloading of certified energy from the transport system not been properly tested and loaded.

CEESA group leaves methanol as the only future liquid motor fuel along with hydrogen and electricity. Methanol is supposed to be the primary fuel in engines powered by fuel cells and in high octane engines.

Iceland is probably the country that has gone furthest with hydrogen for transport, but its use is being phased out with only one filling station left in Reykjavik.

In Denmark, BetterPlace has focused a lot on electricity for transportation, but had to throw in the towel. Rumors of a possible Apple-Tesla partnership are persistent. In Apple's optics Tesla S is just like an iCar and a joint venture may change the future of electric cars.

The perspective of methanol as listed by the Nobel Laureate George Olah is the same, regardless of origin and methanol will - as one of our smallest and most versatile building blocks in organic chemistry - continue to remain one of the world's largest commodities.

In order to benefit from this future all it takes is to begin. A Danish demonstration plant must be next step.

EXPANSION – A LONG-TERM SCENARIO

To take the lead we must start now. To keep the lead we must meet demand.

On the commodity side, supply of straw and manure may probably be separated with advantage. Straw briquetting units can usefully be built to 100,000 t per year. The anaerobic digesters with straw briquettes as primary feedstock may be built with capacity of 200,000 m^3 fermenter volume corresponding to approx. 600,000 tonnes of liquid manure annually.

The Demo methanol section is modular and capacity can be increased incrementally. The planned location at ESØ is in short of outlets for heat, which favors an alternative location allowing for at least a 3-4 fold increase. Such an alternative location could be Energy Lab Skive. Further expansion will be done by building new facilities. This can be done in line with the market. Today 5,000 MTD (Metric Ton per Day) is a typical entry size methanol plant.

One possible scenario is a demonstration plant according to business plan "Farmers Gasoline BP 01-1e" followed by a few extensions, maybe a 100 MTD plant near Aarhus and eventually a 5,000 MTD Mega plant at Amager at a cost of 1.3 billion USD. It may be operated by 85 employees and consume 2,200 MW gas (at 200 DKK/MWh). A low-pressure steam turbine will generate all electricity for the plant and production breaks even (exclusive district heating) at 1½ DKK/l methanol. Comparison: Methanex European Posted Contract Price (Valid April 1 - June 30, 2014) is Euro 412/MT ~ 2,43 DKK/l.

With a safe outlet of methanol at a competitive price such Mega plant may allocate methanol for the *green* market according to biomethane availability. The Mega-plant has ample capacity to process Danish biogas with excess capacity for imported supplies.

The heat capacity will be just below 1,000 MW. Comparison: Amagerværket makes 710 MW for district heating.

Current tax penalizes the use of industrial waste heat for domestic heating. Society's desire to phase out fossil fuels are likely to create more favorable tax rules.

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