

# AGRO INDUSTRIES A/S

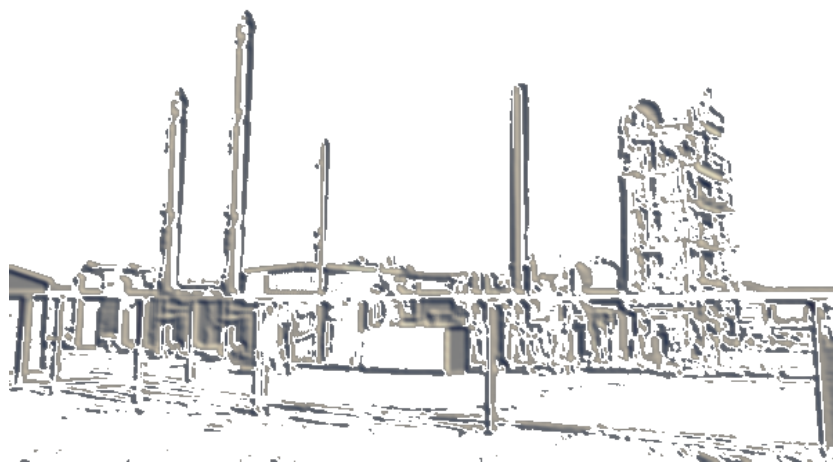
Business Plan

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Farmers Gasoline

BP 01-3e

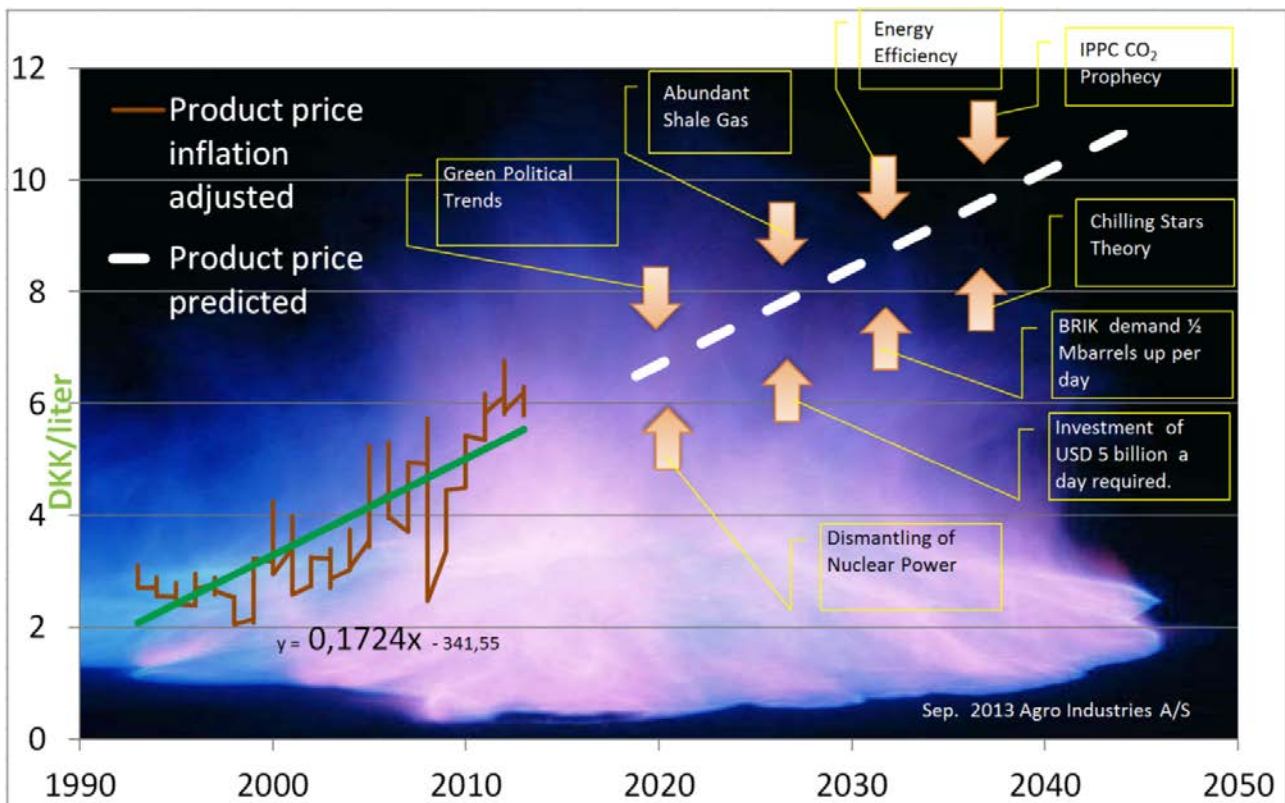
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**Methanol Economy**



The European Union has an ambitious target of becoming fossil free over the next thirty years. The target for the transport sector is at least 10 % reduction by 2020 and preferably with second-generation biofuels made from waste.



Very few items are getting more expensive in real terms. Gasoline is one of the few. Over twenty years, the average price corrected for inflation got up by 4 % p.a. The same will happen to the biofuels replacing gasoline [Re.: Annex 14, Energy Market].



# Business Plan for the Start-Up Company - *Farmers Gasoline*<sup>1</sup>.

## A Danish Project for Ten Million Liters/y of 2-Generation Biomethanol

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Readers are requested to treat this business plan confidential.

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<sup>1</sup> Danish Biomethanol ApS with the secondary name Farmers Gasoline ApS and CVR-no: 35234276.



## I EXECUTIVE SUMMARY

*Danish Biomethanol ApS (Farmers Gasoline ApS)* CVR-no: 35234276 is a private limited company founded with the purpose of biomethanol manufacturing. It will cost DKK 260 million to erect the combined technical facilities for biogas and ten million liters of bio-methanol annually. To succeed the company needs a substantial capital injection in the order of DKK 100 million in equity and the rest as grant and loans.

This present business plan focuses on a specific and limited project at ESØ in Tarm. This is, however, a demonstration plant only and just the beginning of a whole new industry with all its facets of production, marketing and engineering being part of any industry - and preferably part of a corporate holding.

Methanol and bio-methanol are chemically and physically identical. The difference is only raw material origin. Global demand for methanol has reached 65 million metric tons driven in large part by increased demand for cleaner energy. The fastest growing market for methanol is the energy sector, representing about 40 % of methanol demand. In China methanol has replaced 8 % of other fuels for transportation.

In the EU, the use of non-fossil fuel for transport is mandatory and the requirement rises to 10 % calculated on energy in 2020. This increase shall be by means of second-generation fuel made from waste. By using animal manure and straw as feedstock's the biomethanol is certified as second generation biofuel in the International Sustainability & Carbon Certification (ISCC-EU) system approved by the EU and will count double in member states biofuel obligation. The EU target creates a huge market for renewable alcohol.

By building neighboring biogas and methanol works at ESØ 90 I/S, DK 6880 Tarm an industrial symbiosis and an optimal energy household is achieved. Taking advantage of the industrial symbiosis of neighborhood an internal rate of return on total investment will be in the range of 17 % p.a.

Eventually Danish Biomethanol ApS will be owned by *New Energy Holding Ltd.* and local stakeholders. *New Energy Holding Ltd.* will be in control of operation and sales through agreements and / or ownership.

The planned biorefinery is based on proven technology. It remains to form an investor team - preferably with a lead investor. This task will be resolved by the shareholders of the Company supported by *Deloitte Financial Advisory Services P/S.*



## II COMPANY PURPOSE

Company aims is bio-methanol manufacturing. The company is part of a new concept spanning all stages throughout the entire value chain from farm waste to the consumer market [Re.: Annex 1 Idea].

The company was founded as a start-up company preparing its transition to a production company, and providing the capital needed to build and operate that production company.

## III CORPORATE STRUCTURE

*Danish Biomethanol ApS (Farmers Gasoline ApS)*, Cvr-no: 35234276 is a private limited company with a shared capital of DKK 80.000. Shareholder capital, however, in the order of DKK 100 million is needed to achieve business objective - a demonstration plant at ESØ, Tarm [Re.: Annex 2. *Danish Biomethanol A/S as an investment object*]. Address: c/o Agro Industries A/S, Agro Food Park 13, DK-8200 Aarhus N, Denmark.

### Key players:

- Lars Thomsen & Sønner A/S, VAT: DK11176275 was founded in 1987 by CEO Lars Thomsen, also the founder of the International Starch Group. The main activity has been delivery of turnkey factories for processing agricultural crops into starch and downstream products - directly or through subsidiaries Agro Industries A/S and International Starch Institute A/S. Majority shareholder of Danish Biomethanol Ltd.
- Agro Industries A/S, VAT: DK13250472 founded 1989 invented and engineered the new methanol concept [Re.: Annex 16 *The Methanol Economy*].
- International Starch Institutes A/S, VAT: DK17703188 founded 1994, technology partner.
- Cris-Ni ApS, VAT: DK78216417, co-promoter and partner in Danish Biomethanol Ltd.
- New Energy Holding A/S, VAT: DK36501928, manufacturing and holding company.
- New Energy Trading Ltd. being formed is a trading company representing the joint venture of Agro Industries A/S and Go' on Gruppen A/S VAT: DK31877385

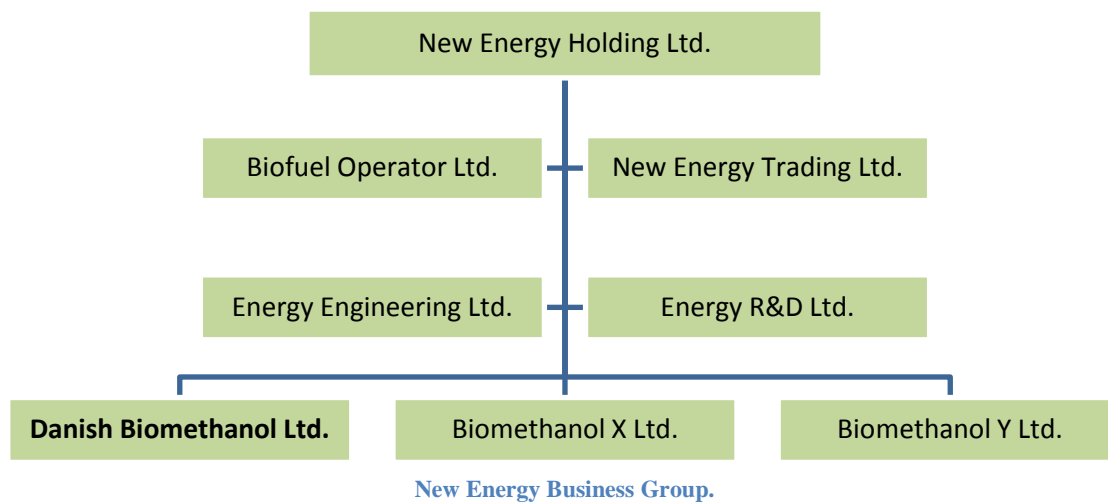
Eventually *Danish Biomethanol ApS* will be owned by *New Energy Holding A/S* and local stakeholders [Re.: Annex 2, *Danish Biomethanol Ltd. as an investment object*].

The operation of technical installations will be entrusted an operating company - with the working title *Biofuel Operator Ltd.* - under a Management and Operation and Maintenance (O&M) contract.



Sales of bio methanol will be entrusted trading companies under a Sales and Marketing Outsourcing Agreement. *New Energy Trading Ltd.* certified as a trader is the working title of a 50/50 joint venture of Agro Industries A/S and Go'on Gruppen A/S.

*Biofuel Operator Ltd.* and *New Energy Trading Ltd.* are influenced by *New Energy Holding Ltd.* through agreements and / or ownership.



The Group associate themselves with external technical and commercial expert knowledge and New Energy Holding Ltd. controls and/or influences The Group through agreements and/or ownerships. Ownership of subsidiaries may be shared with local stakeholders.



## IV MARKET

Sale of bio methanol is entrusted one or more trading companies under a Sales and Marketing Outsourcing Agreement.

The European Union has an ambitious target of becoming fossil free over the next thirty years. According to current legislation, member states must ensure that renewable energy accounts for at least 10 % of energy consumption in transport by 2020 and preferably with second-generation biofuels made from waste.

Very few items are getting more expensive in real terms. Gasoline is one of the few. Over twenty years, the average price corrected for inflation got up by 4 % pa. The same will happen to biofuels replacing gasoline [*Re.: Annex 14, Energy Market*].

On June 13, 2014, the EU Energy Council reached a political agreement on the future policy for biofuels. The main features are a seven percent cap on conventional biofuels, made from feed and food feedstock, and further support of the transition to second and third generation biofuels. From 2020, politicians agreed, ILUC factors will be used in accounting for a fuel's carbon footprint. The lack of certainty in the EU policy making is generally mentioned as the main obstacle for investments and commercialization of new technologies.

No doubt. 2020 opens up a huge market for bio-fuel made from waste – and waste we have - from rural and urban areas. ESØ recycling station south of Tarm expects household waste to be more than 30,000 tons a year - and a lot is ideal for biogas. Animal farms supply cattle and pig manure and large amounts of straw is available in the area.

The National Danish Energy Agreement has revitalized the biogas industry. Natural gas users are now encouraged to switch to biogas with a remuneration of DKK 115 per GJ. The agreement does not cover the period after 2020, but the political system is fully aware, that the industry also will require support in the future.

Biomethanol is more robust than other applications due to the high product value more likely to follow price development of gasoline, which for the last twenty years has grown steadily in real terms.



Methanol is an excellent motor fuel - preferred in motorsport and now available to the public. Compared to ethanol, as we know it, it has more advantages. Methanol attracts less energy tax – as much as 0.63 DKK less per liter - and no carbon dioxide tax. As a 2G-biofuel it counts double in the national energy obligations.

In Europe, max. 3 vol-% methanol is allowed to be blended in gasoline under the Fuel Quality Directive (FQD 2009/30/EC) and CEN standard (EN 228). Additions of 30 % methanol and more - so-called High Blends - are not limited by the directive. High Blends will gain ground much the same way as is seen for E85. Neat methanol - M100 - is already marketed for use in fuel cell powered motor vehicles.

The methanol industry spans the entire globe with over 90 methanol plants<sup>2</sup> – and by volume, methanol is one of the top five chemical commodities shipped around the world. Methanol is a truly global commodity. Global demand has reached 65 million metric tons driven in large part by increased demand for cleaner energy. The fastest growing market for methanol is the energy sector, representing about 40% of methanol demand. In China methanol has replaced 8 % of fuels for transportation. The Danish CEESA group predicts methanol as the dominant liquid motor fuel of the future [*Re.: Annex 11. CEESA – Energy towards 2050*].

Bio-methanol market is still in its infancy. The market leader is Dutch BioMCN with an annual glycerol based production capacity of 250 million liters. Glycerol has, however, got too expensive and is being replaced by biogas (2014). BioMCN has received a €199 million NER300 grant for a new €500 million wood based gasification plant adding a further 275 million liters to their annual capacity.

The International Renewable Energy Agency (IRENA) is an intergovernmental organization dedicated to renewable energy. Irena<sup>3</sup> estimates present and planned bio-methanol production within the EU to one billion liters. The quantity we have to squeeze into that market accounts for just 1 % [*Re.: Annex 15. Market Notes*]. US Open Fuel Standard Act<sup>4</sup> introduced to the congress 2013 requires by 2017 all vehicles to be capable of operating on gasoline, E85 and M85. The act has not yet been adopted.

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<sup>2</sup> The biggest methanol plant in Europa is owned by Statoil at Tjeldbergodden, Norway. The plant produces Methanol on gas from the Heidrun field through the Haltenpipe. The Heidrun Export Line moves excess gas from the field and is tied up to Åsgard Transport and on through Europipe II to Dornum, Germany. The plant production capacity is 2,400 metric tons of methanol per day. Market leader is Methanex operating sites in Canada, Chile, USA, Egypt, New Zealand and Trinidad and Tobago. Other operators and distributors in EU are BP Gelsenkirchen GmbH, Helm AG and Brenntag AG - all manufacturing and distributing *black* methanol of fossil origin.

<sup>3</sup> Production of Bio-methanol. IEA-ETSAP and IRENA© Technology Brief I08 – January 2013  
www.etsap.org – www.irena.org. [http://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20I08%20Production\\_of\\_Bio-methanol.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20I08%20Production_of_Bio-methanol.pdf)

<sup>4</sup> <http://www.openfuelstandard.org/>





The Competitive Edge			
Process	Aerobic Fermentation	Anaerobic Fermentation	Notes
End product	Ethanol	Methanol	
Operator	Maabjerg Energy Concept (Maabjerg)	Farmers Gasoline (ESØ)	
Investment	High <sup>5</sup>	Low	Maabjerg: DKK 2,7 billion ESØ: DKK 0,26 billion
Production Cost	High <sup>6</sup>	Low	Maabjerg: Not feasible without subsidy. ESØ: Breakeven near 2 DKK/l methanol.
Raw materials	Straw	Straw Animal Manure Household waste Natural Gas	Maabjerg: 300.000 t/year of straw. ESØ: Natural gas, but depends on waste for green biogas certificates.
Utilities	Enzymes Caustic Water		
Byproducts	C5-Molasses Solid biofuel	Fertilizer (digestate)	Maabjerg depends on anaerobic fermentation for byproduct utilization.
ENDK certified	No	Yes	ESØ feedstock is certified by Energinet.dk
Public incentives	No	Yes	Use of biogas is strongly supported in EU
Robustness	Low <sup>7</sup>	High	ESØ has 60.000 m <sup>3</sup> digester capacity ESØ is less sensitive to market changes.
Risk Assessment	Bad	Good	Maabjerg: Highly sensitive to cost of straw. ESØ: Independent of a single feedstock.

**Methanol has a competitive advantage over its main competitor - the second generation ethanol.**

Ethanol fermentation relies on straw, water, caustics and enzymes as primary feedstock's making it vulnerable to high straw cost. Ethanol fermentation cannot stand alone and must be associated with anaerobic fermentation for by-product utilization. The production costs exceed the cost of 1G-ethanol.

Methanol may stand alone using bio natural gas as feedstock, but depends on a biogas source for green certificates. These certificates may be acquired anywhere. Methanol synthesis may be centralized and the biogas counterpart decentralized. This allows for future capacity extension and economy of scale will drive down the investment per liter essentially.

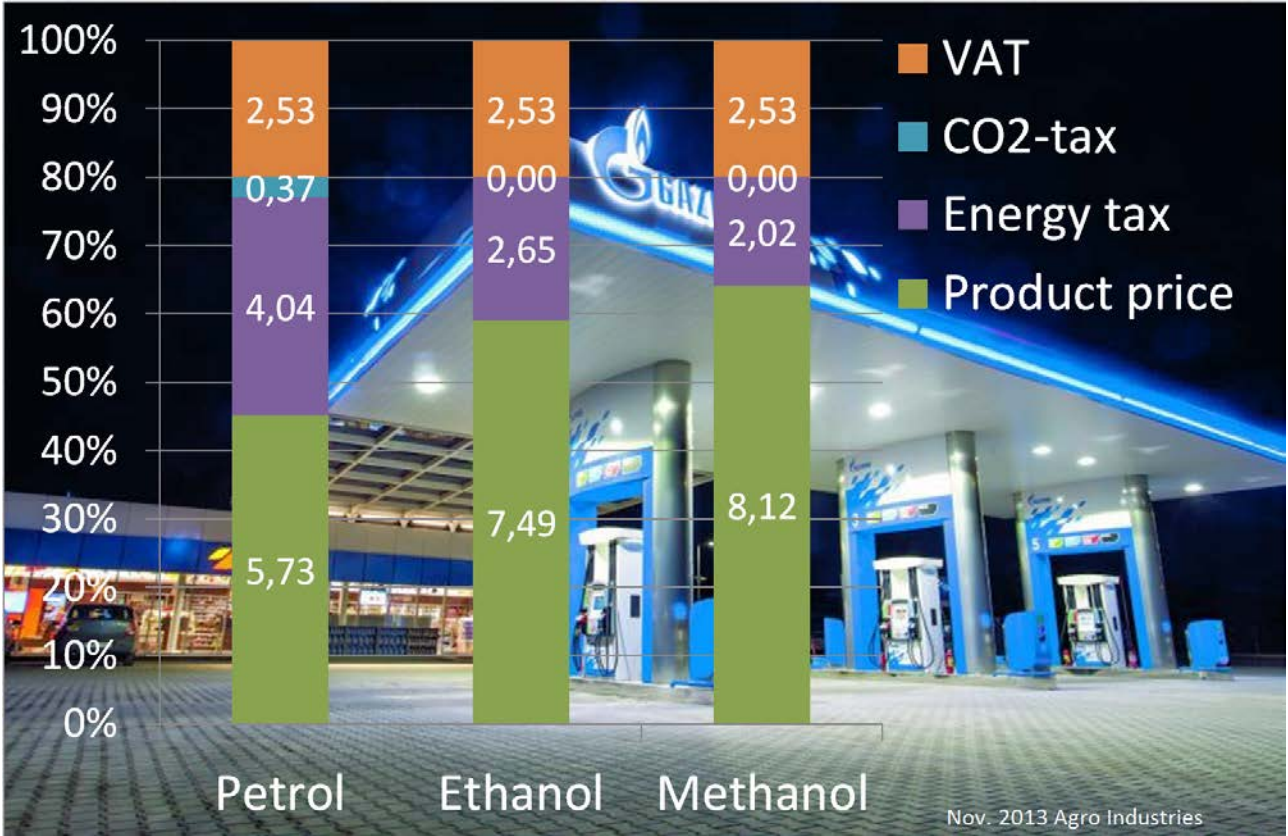
Methanol is so to speak produced indirectly from wasted biomass and any wasted biomass may serve as feedstock with origin certified by energinet.dk (ENDK). This flexibility adds to project robustness. The digestate from co-fermentation of straw and liquid animal manure is the only by-product and it represents an improved organic carbon-rich fertilizer.

<sup>5</sup> Maabjerg Energy Concept, Press release 12. January 2014: The investment is DKK 2.2 billion + EU has been asked for DKK 330 million in construction funding from the EU Biobased Industries Public Partnership program, as well as DKK 170 million as Danish business development support for the demonstration plant.

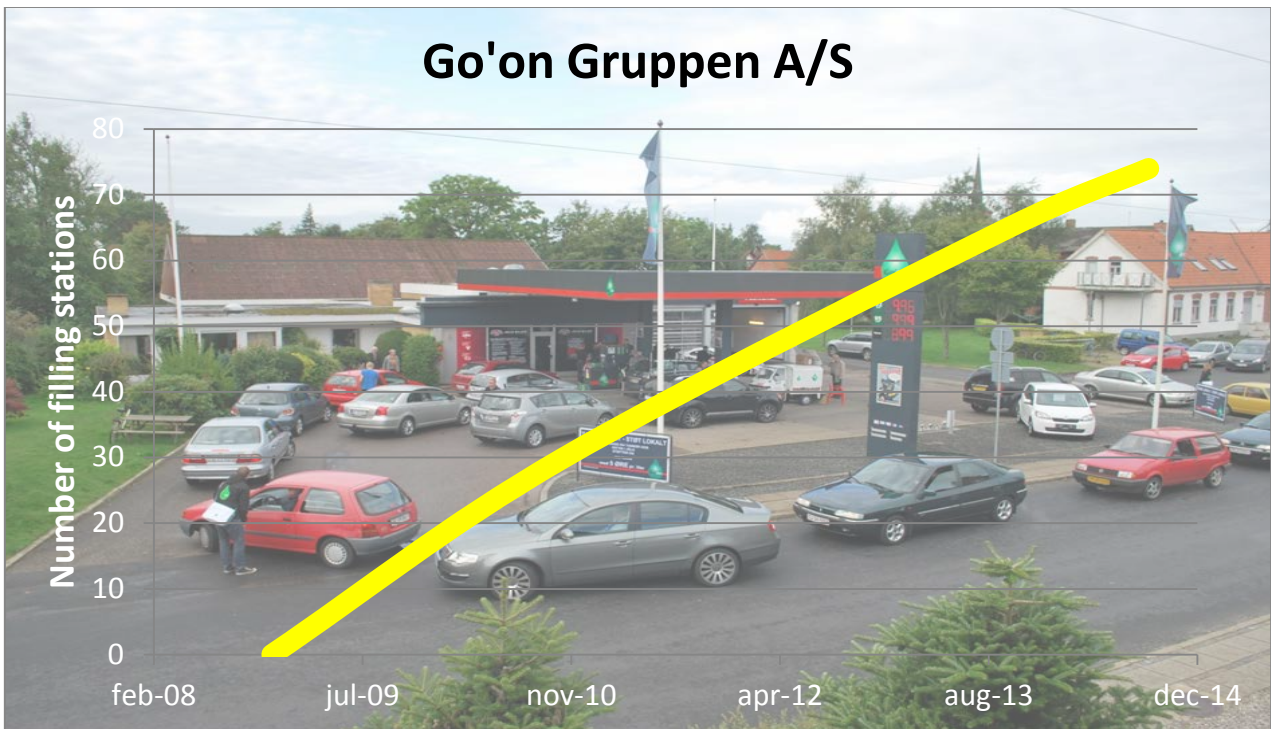
<sup>6</sup> Maabjerg Energy Concept, Press release 12. January 2014. EU NER300 program has been applied for DKK 290 million guarantee for the first five years, equivalent to one DKK per litre 2G bioethanol. Otherwise the project will not be feasible.

Ingeniøren, Sanne Wittrup 14. January 2014 “6,50 kroner kommer en liter bioethanol brygget på halm til at koste på Maabjerg Energy Concept (Production cost: 6,50 DKK/l bioethanol made from straw)”.

<sup>7</sup> The final decision about the realization of the Maabjerg project depends on whether the EU adopts blending requirements for 2G biofuels.



Price breakdown on gasoline ingredients at the pump. Methanol attracts less energy tax and no carbon dioxide tax. The product price includes approximately one DKK per liter in distribution costs. Source: EOF.



Jointly with Go'on Gruppen A/S - a young enterprising oil company at full speed towards the future - methanol and methanol blends are to be distributed from a common tankyard. Agro Industries A/S and Go'on Gruppen A/S are trading partners.



## V RAW MATERIALS AND LOGISTICS

Raw materials are limited to waste listed in Annex IX of Proposal of 17.10.2012 for amendments to the Renewable Energy Directive (RED) and the Fuel Quality Directive (FQD). In practical terms such waste is animal manure and straw [*Re.: Annex 9. Feedstock approved*].

Today's biogas manufacturers are, however, not that restricted in choice of feedstock. As the company must be in control of the carbon dioxide foot print it builds its own biogas works and energinet.dk will register and document the feedstock's in the form of green certificates with feedstock origin listed<sup>8 9</sup>. All it takes is to upgrade the biogas to natural gas specifications and inject it into the national gas grid. Each MWh injected generates one green certificate [*Re.: Annex 4. Feed Design*].

For the time being the bio natural gas certificates issued by energinet.dk and other national registries do not document sustainability according to RED. To allow national energy agencies to include biomethanol in the national biofuel obligations the methanol must be certified by the International Sustainability & Carbon Certification (ISCC EU) or an equivalent system approved by the EU. The energy agencies do also recognize biofuels that are not certified as long as they are verified by an auditor who works under the ISAE 3000 standard, which means that every link in chain of custody must be verified. Oil companies find this expensive, inconvenient and unsafe and buy almost exclusively certified biofuel.

At the ESØ demonstration plant biogas is upgraded and injected into a loop on a low-pressure service line of the national gas grid. The loop and grid are in its basic version connected via a one way valve [*Re.: Annex 13. Routes from Waste through Biogas to Biomethanol, figure 2*]. A supplementary high pressure service line enables flexible in- and outputs [*Re.: Annex 3, Biogas Upgrading*].

Transport of waste and digestate will be outsourced to a trucking company. Straw will be delivered on a daily basis. *Halmleverandørselskabet for Syd- og Sønderjylland a.m.b.a.* has the capacity and has offered to organize supplies.

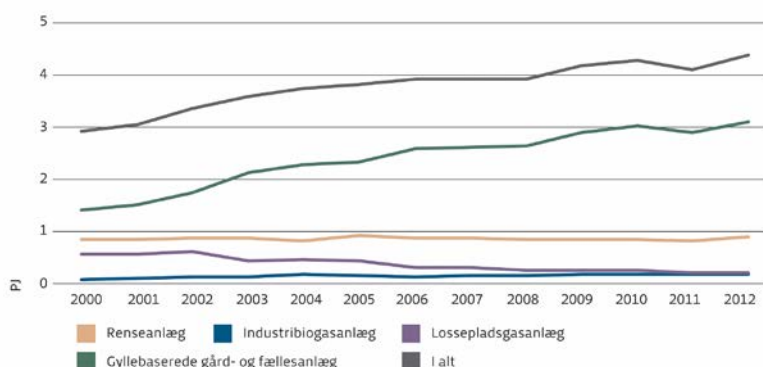
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<sup>8</sup> The rules for certification are set out in "Modelpapir for regler for bionaturgascertifikater i Danmark".

<sup>9</sup> A certificate specifies one of four systems categories: biogas, thermal gasification, landfill gas or synthesis gas. Information on raw materials used is not there yet, but underway. ISCC certification will make up for this deficiency.



The Energy Agency estimates the full potential of biomass useful for biogas equivalent to two billion liters methanol. For comparison Danes used 1.8 billion liters of gasoline in 2012 [Re.: Annex 4, Feed Design].



Danish Biogas Potential	
Animal manure	26
Land fill	1
Sewage sludge	4
Industrial waste	2½
Household waste	2½
Other	4
<b>Total</b>	<b>40</b>

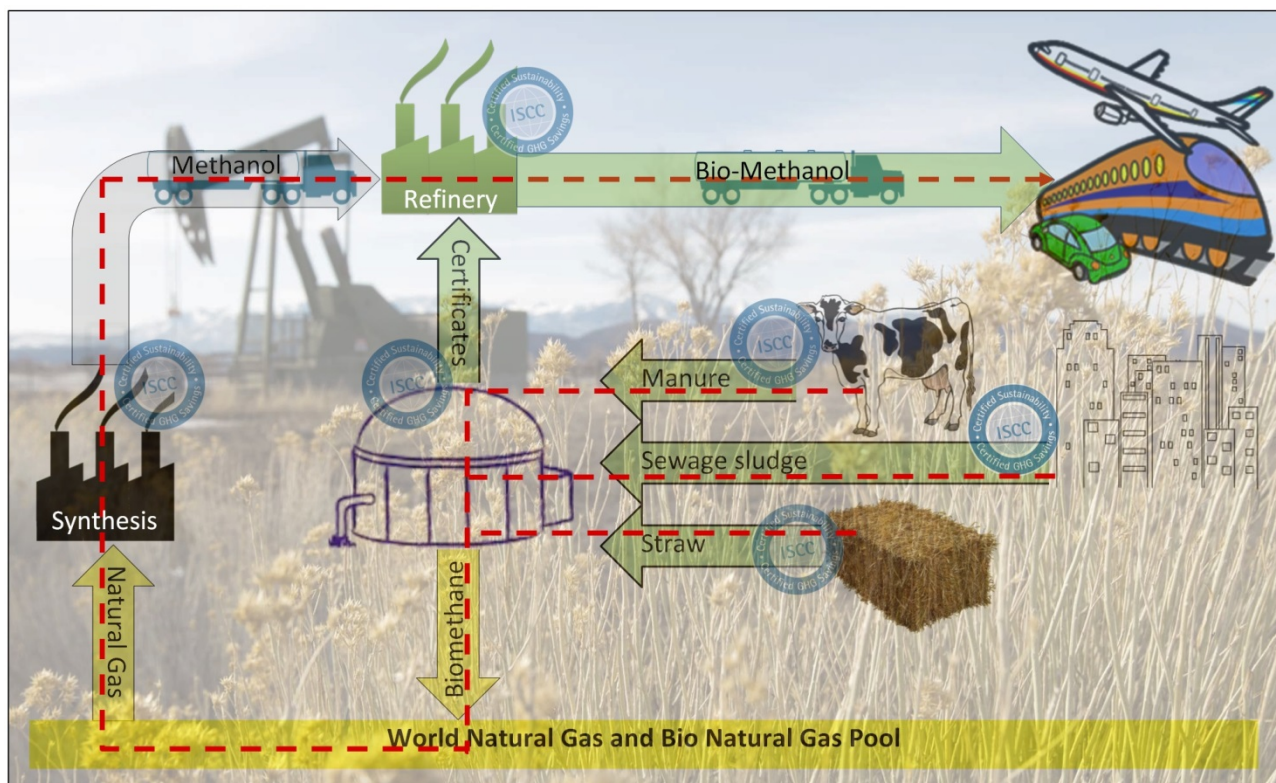
Estimate by the Energy Agency.

Biogas in PJ by Origin. Gyllebaserede gård- og fællesanlæg (animal manure), Lossepladsgasanlæg (land fill), Industribiogasanlæg (industry), Renseanlæg (sewage sludge), I alt (total). One PJ biogas may be converted to thirty million liter methanol plus additional energy useful for district heating.

40 PJ gas is equivalent to 1.2 billion liter methanol.

0.8 Billion liters more may be derived from straw.

**Certification Principle.**



Certification Principle. Each link in the chain of custody from agriculture to fuel supplier are ISCC-EU certified. Energinet.dk (ENDK) certifies volume and origin. ISCC-EU certifies RED-sustainability.

The world's inventories of natural gas and bio natural gas provide a common pool. It is an international political intention to increase the share of bio natural gas. There is political will to eliminate trade barriers.



## VI PROJECT ENGINEERING

Methanol may be produced in many ways<sup>10</sup>. We have decided to base production on waste and nothing but waste. Danish Biomethanol Ltd. is consequently planning a biogas factory at ESØ based on anaerobic digestion of waste. As an authorized upgrader the company will annually produce 10 million Nm<sup>3</sup> methane on waste as feedstock and upgrade it to national gas grid specification. Same place methanol works are planned for the manufacture of 10 million liters of biomethanol.

The technical equipment is supplied by a main contractor – with the working title *EPC Contractor A/S* - under an Engineering, Procurement and Construction (EPC) contract preferably with vendors and associates within the New Energy Business Group.

The biogas is produced from liquid animal manure and straw [*Re.: Annex 8. Flowchart Gas works*]. Known problems in straw handling are solved by briquetting with an extra gas yield as a bonus. The process<sup>11</sup> is demonstrated by Aarhus University on an industrial scale at Foulum as part of an EUDP-supported project J. No. 34 64010-0423 [*Re.: Annex 7. Straw briquetting*].

The methanol is produced from bio natural gas by the ICI low pressure methanol synthesis process practiced at most methanol works in the world [*Re.: Annex 6. ICI Methanol Process*]. The resulting biomethanol is certified according to ISCC (International Sustainability & Carbon Certification) system. The company plans to carry out large-scale factory test during operation of a compact steam reformer build with microchannel technology.

The biogas carbon dioxide will be reclaimed, blended with bio natural gas drawn from the grid and subjected to methanol synthesis.

Crude methanol is distilled to high purity and on a daily basis moved to port of Aarhus for intermediate storage and distribution by help from our partners.

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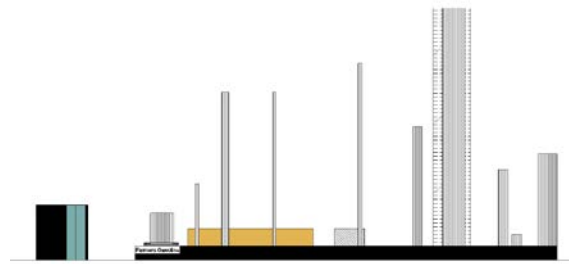
<sup>10</sup> One of the best things about methanol is that it can be made from so many different things in so many different places. The reason this is important is that it will help protect the fuel market against the wild fluctuations it has had since the oil embargo in the early '70s.

<sup>11</sup> Foulum video on YouTube: [http://www.youtube.com/watch?v=PdPjMUn\\_x3A](http://www.youtube.com/watch?v=PdPjMUn_x3A)



By building neighboring biogas and methanol works at ESØ 90 I/S, DK 6880 Tarm an industrial symbiosis and an optimal energy household is achieved [Re.: Annex 5. Feed Heating].

Economy of Scale. At the selected location and with the chosen design, capacity can be increased by supplying bio natural gas from home and abroad. Biogas transport and trade across borders are being encouraged through European cooperation<sup>12</sup>, but still not effective.



Methanol Works Skyline.

<sup>12</sup> Six national biomethane registries have 25. November 2013 decided to establish cooperation among them and signed a Letter of Intent which lays down the basic understanding about the planned joint activities. These six registries are:

Austria: Biomethan Register Austria ([www.agcs.at](http://www.agcs.at))

Denmark: Energinet.dk ([www.energinet.dk](http://www.energinet.dk))

France: Gaz Réseau Distribution France ([www.grdf.fr](http://www.grdf.fr))

Germany: Biogasregister ([www.biogasregister.de](http://www.biogasregister.de))

Switzerland: VSG (Federation of Swiss Gas Industry) ([www.erdgas.ch/biogas/](http://www.erdgas.ch/biogas/))

United Kingdom: Green Gas Certification Scheme ([www.greengas.org.uk](http://www.greengas.org.uk))



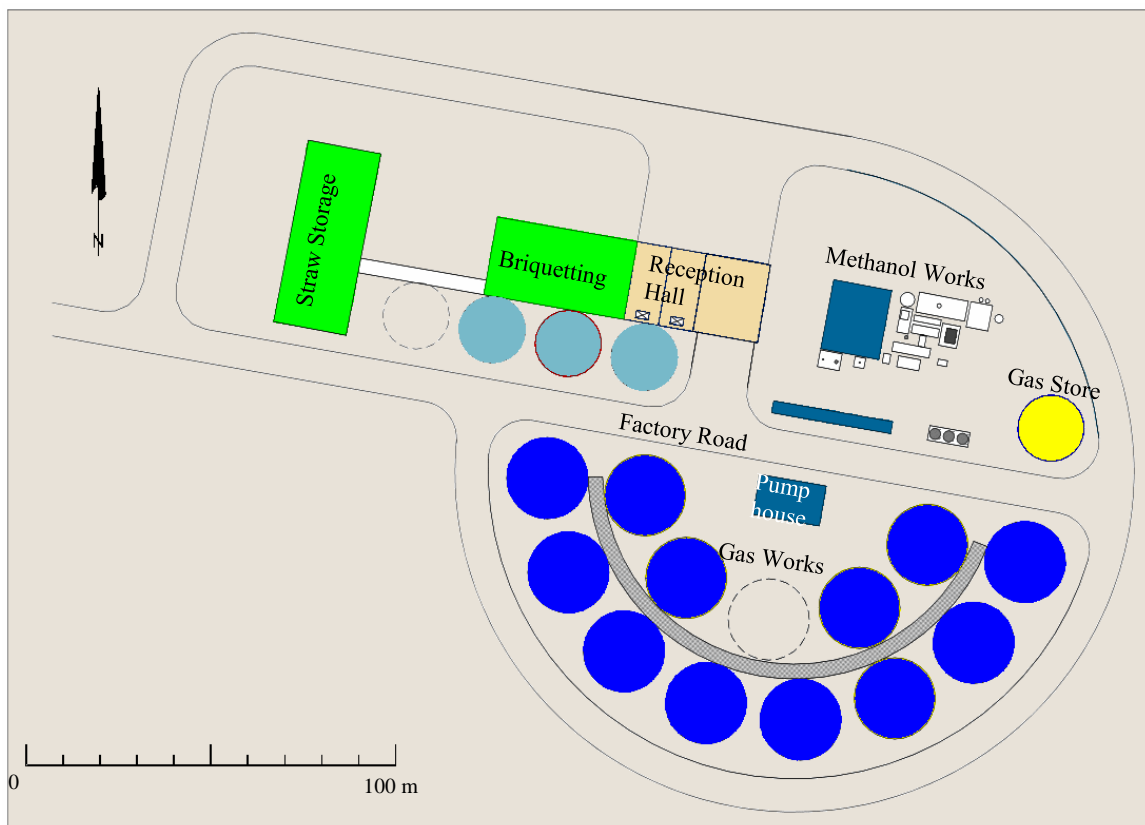
## VII LOCATION AND SITE



The facilities will be erected on leased land at ESØ 90 I/S, Vardevej 83A, 6880 Tarm, Denmark.

Two independent production sites are registered. They will share management, operation, control center and energy systems.

1. Gasværket (Gas Works), Pnr: 1019034832, c/o Dansk Biomethanol - ESØ 90 I/S, Vardevej 83 A, 6880 Tarm. Branche: 352100 Fremstilling af gas.
2. Methanolværket (Methanol Works), Pnr: 1018994697, c/o Dansk Biomethanol - ESØ 90 I/S, Vardevej 83 A, 6880 Tarm. Branche: 201400 Fremstilling af andre organiske basiskemikalier.



This digester arrangement (blue) allows an optimized internal flow and makes room for a central pump house. The opposite building has right a drive through reception hall for liquids and next two bunkers for tip loads (brown). Leftmost a hall for straw briquetting connected by a conveyor to 1000 m<sup>2</sup> day storage for straw bales (green). The yellow circle marks a gas buffer.



ESØ 90 I/S, Vardevej 83A, DK-6880 Tarm. Taking into account distances to neighbors, the preferred lease will be land no. 10b - a disused gravel pit surrounded by high earth banks.

## VIII ORGANISATION FOR PERSONNEL AND TRAINING.

The operation of technical installations is entrusted an operating company – with the working title *Biofuel Operator A/S* - under a Management and Operation and Maintenance (O&M) contract. Company: Operator will at an 80:20 ratio share pre-tax profits in excess of 8 % p.a. return on the invested capital [Re.: Annex 2. Danish Biomethanol Ltd. as an investment object].

New Energy Holding Ltd. and process suppliers are supposed to form the *Biofuel Operator A/S*. Foodjob Denmark ApS, an international recruitment company, will man the organization and keep it manned. The production requires a technical leader, skilled craftsmen on each of five shifts.

1 Director	DKK 984,000
1 Clerk	DKK 420,000
1 Technical Manager	DKK 624,000
<u>12 operators</u>	<u>DKK 420,000</u>
15 total	DKK 7.1 million

The straw briquetting plant is operating in two shifts only.

The labor force will participate in the erection of the facility and training is done as part of supervision during construction and during commissioning.





## IX THE IMPACT ON THE ENVIRONMENT

Manufacturing both biogas and methanol affects the environment in various ways and it is also creating jobs and income in the community.

- Raw material for the gas works is received by road.
- Road traffic for manufactured methanol is limited to a few tankers daily.
- Condensate and other drains are reused for slurring feedstock.
- The methanol plant is flushed with nitrogen when shut down.
- Biogas carbon dioxide is used for methanol synthesis reducing its outlet to the atmosphere.
- Labor at the factory is supplemented by outside service supplies.
- Feedstock is CO<sub>2</sub>-neutral<sup>13</sup>.

It is estimated that the daily operation creates the basis for two hundred jobs in agriculture, transport, services and trade in addition to three hundred man-years during plant construction.

## X TIME SCHEDULE

Environmental application has been prepared and filed, but EIA, local development plan and neighbor hearing remain to be done. The gas works may be supplied and erected within 12 months. The methanol works may take 6 months more. Time for environmental permits is to be added and it may take as much as 1½ year or even more from the time all information is made available to the authorities. Most likely the government (the environmental agency) will handle permits for the methanol works and Ringkøbing-Skjern Municipality permits for the gasworks [Re.: Annex 10. Time Schedule].

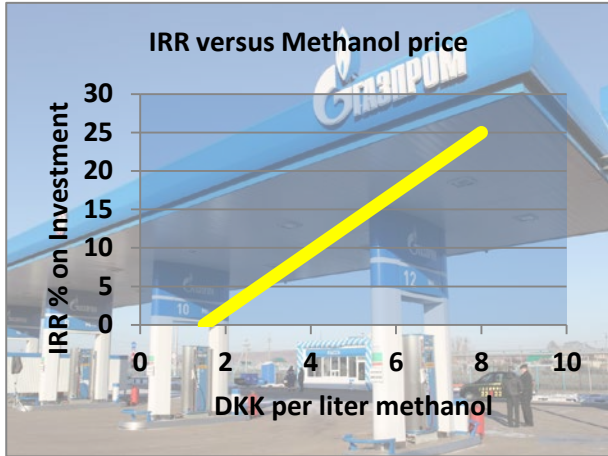
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<sup>13</sup> The carbon dioxide released during use of methanol made of straw and manure is completely re-absorbed within a year as opposed to wood fuel, where emissions are higher than from fossil fuels and re-absorption is delayed for so many years that CO<sub>2</sub> neutrality is questionable. Re.: British Department, of Energy & Climate Change.



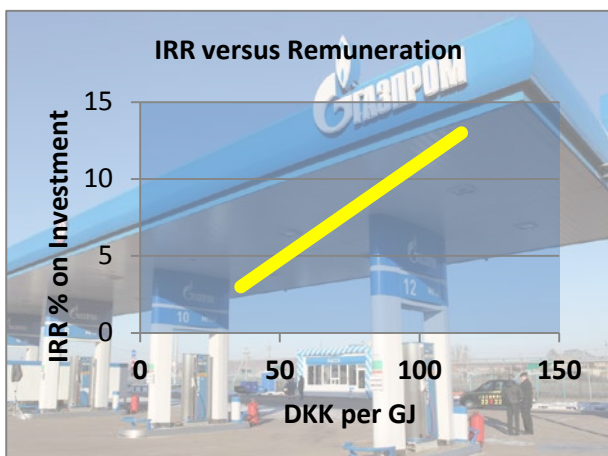
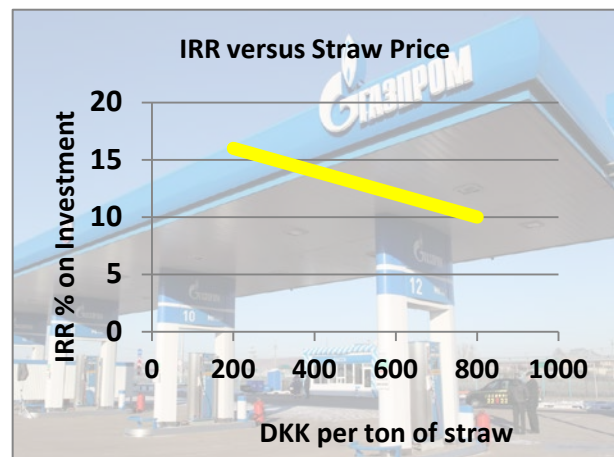
## XI FINANCIAL AND ECONOMIC EVALUATION.

An anchor budget is based on free manure and transportation at DKK 25 per t plus straw at DKK 550 per t delivered. The biogas is upgraded to ten million cubic meter bio natural gas per year, all handed over to HMN Gashandel I/S.



One million Nm<sup>3</sup> is sold to HMN (in their capacity as gas trader) at a price equal to Nord Pool Exchange closing price less one Danish øre per m<sup>3</sup> methane (HMN profit). Nine million Nm<sup>3</sup> is by HMN (in their capacity as gas transporter) conveyed a few meters to the methanol works against a minor transportation fee [Re.: Annex 3. Biogas Upgrading, Proposals by HMN Gashandel A/S].

Ten million Nm<sup>3</sup> bio natural gas is registered by energinet.dk, who issues an equivalent number of green certificates with a detailed specification of raw material origin. Certificates equivalent to 9 million Nm<sup>3</sup> bio natural gas are consumed and nullified by the methanol works. Residual certificates are offered for sale. Energinet.dk is issuing the green certificates and is administering the remuneration of DKK 115 per GJ for upgrading the gas. One certificate equals one MWh<sub>HHV</sub>.



Energinet.dk issues bio natural gas certificates on quantity and an ISCC body certifies sustainability of the bio natural gas under the RED (EU directive).

Retail price of methanol in the anchor budget is set at DKK 4,75 per liter. The graph shows how sales price affects feasibility [Re.: Annex 14, Energy Market].



## Anchor Budget, Manure-Straw Plant

<b>Investment</b>	MDKK
Technical facilities for straw briquetting <sup>14</sup> , biogas plant, upgrading, gas pipeline and methanol synthesis	255
Remote tank yard	5
<hr/>	
Total investment	260
<b>Funding</b>	
40% Equity	104
40% Grant <sup>15</sup>	104
20% Loan	52
<hr/>	
Total funding	260
<b>Turnover</b>	
Bio-natural gas sales <sup>16</sup> , 36.000 GJ <sub>LHV</sub> of DKK 60	2,2
Biogas upgrading remuneration, 360.000 GJ <sub>LHV</sub> of DKK 115	41,4
Methanol sales, 10 million liter of DKK 4,75	47,5
<hr/>	
Turnover total	91,1
<b>Operation</b>	
Staff incl. management	7,1
Administration	1,1
Feedstock, 26.500 t straw of DKK 550/t	14,6
Feedstock transportation, DKK 25/t	6,6
Maintenance, 3 % of investment	7,8
Electricity	5,7
Utilities, connection gas grid	1
<hr/>	
Total operational cost	43,9
<b>Gross Margin</b>	
Internal Rate of Return on total Investment, IRR% (inclusive depreciation, interest and tax)	17 %
Return On Sales, ROS	52 %

<sup>14</sup> Straw does not come cheap as liquid animal manure and it is more difficult to handle. Briquetting adds costs, but also makes straw easier to process and increase its gas potential. The budget price is DKK 550 per t delivered. A publication “Halm til Biogas” by Henrik B. Møller, Department of Engineering, Aarhus University states a gas gain by briquetting and a shorter retention time improving the overall throughput. Straw adds to feedstock supply security and all together justifies a straw briquetting add-on.

<sup>15</sup> The particular risk of demo projects and the special risks linked to changing energy policy justify public support. NER400 is applied for a 40% grant with reference to the EUR 199 million given the Dutch Woodspirit project.

<sup>16</sup> As mentioned Annex 4, Feed Design, the reactor design has a considerable safety margin, which can be used for the production of even more biogas for sale.



## XII RISK ASSESSMENT

Risk and contingency planning is the process of determining the risks a business faces and what we must do if those risks are realized. While it may not be possible to plan for every possible emergency, we can identify those most likely to face and those that will cost us the most if they come to pass. On this basis a number of risk factors are listed.

Feedstock supply - Lack of feedstock for the biogas plant.

A report prepared by AgroTech for the Energy Agency states, that only 5-8% of our manure is turned into biogas and that the biogas industry will hardly run out of manure and particular not in Varde and Ringkøbing-Skjern municipalities having the densest concentration of livestock. The most gas comes from straw, which is our largest unused biomass resource. Should these sources shrink, there is still more than 30,000 ton of unsorted household waste available in Varde and Ringkøbing-Skjern Municipalities.

Feedstock supply - Lack of natural gas for the methanol synthesis.

The plant is linked up to vast supplies of natural gas.

Feedstock supply - Lack of carbon dioxide for the methanol synthesis.

The methanol synthesis process may run without any additional carbon dioxide. Carbon dioxide, however, improves methanol yield and can at any time be extracted from own flue gas.

Feedstock supply - Lack of green certificates for second generation methanol.

By co-production of biogas the necessary certificates are ensured. Certificates limit the methanol to the equivalent quantity of certified biomethane available. Alternatively the methanol has to be sold at a reduced price as "*black*" methanol.

Subsidies - Reduced subsidies for biogas utilization.

Use of biogas for upgrading and injection into the natural gas grid is supported until 2020. It is unlikely, that Germany will accept dramatic changes, but reduced subsidies must be foreseen over time.



#### Distribution/Market - Lack of distribution channels.

The present market for biomethanol is close to one billion liters. A 1 % share of this market can likely be achieved only with price as selling point.

#### Market - Competition from the existing methanol industry.

Biofuels must deliver greenhouse gas (GHG) savings of at least 35 % compared to fossil fuels, rising to 50 % in 2017 and to 60 % in 2018 for biofuels from new plants. Methanol is produced predominantly in large and relatively inexpensive system with access to cheap natural gas and shale gas - often in remote communities with no use for excess process heat. Distributors may buy bio natural gas and have the methanol certified as green. Competitors must acquire sustainability certified bio natural gas in an unpredictable market. The amount of bio natural gas produced from waste alone will be limited for years to come. The demonstration plant, however, is assured own bio natural gas manufactured from agricultural residues eligible according to RED. Moreover the planned demonstration plant benefits on the industrial symbiosis between gas and methanol works, which compensates the plant's smaller size. This industrial symbiosis is, however, essential in order to achieve future mandated carbon footprints and may even require individually declared - and more expensive - electricity as described in [www.energinet.dk/eldeklaration](http://www.energinet.dk/eldeklaration) and must be in compliance with RED.

#### Market - Competition from the ethanol industry.

Experts: *Bioethanol has no future in Denmark*. Headline November 7, 2011 in the magazine *The Engineer (Ingeniøren)*<sup>17 18</sup>. Planes, ships and trucks should not be driven by bioethanol in the future energy system with 100 % renewable energy. Instead, they should run on methanol or DME, according to the recommendation for energy policy makers from the expertise of a large, interdisciplinary research project CEESA. Here 24 researchers presented the way to 100 % renewable energy supply [*Re.: Annex 11, CEESA - A 2050 scenario*]. Stena Line believes that methanol is as an alternative fuel for the future in ships<sup>19</sup>.

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<sup>17</sup> <http://ing.dk/artikel/eksperter-bioethanol-har-ingen-fremtid-i-danmark-123782>

<sup>18</sup> <http://ing.dk/artikel/regeringen-dropper-bioethanol-i-danmark-124541>

<sup>19</sup> Reducing emissions to atmosphere. <http://www.stenaline.com/en/stena-line/corporate/environment/atmosphere>



### Politics - Attitude Change

Political attitudes and renewable energy targets are unpredictable. Global cooling was a political conjecture during the 1970s although with little support in the scientific community. Such conjecture may change and put policy goals under pressure. For example, the EU has committed itself to phase out fossil fuel completely before 2050, while the International Energy Agency only predicts a 25 % reduction globally. Such disproportionality may end up being a political factor in the EU, if it comes to threaten our economy. Attitude change does not happen overnight and in the same way as the EU respects the investments made in the first generation ethanol; time will be given for depreciation.

### Technology - New developments.

New technology is as unpredictable as political thinking. **Nuclear Power.** New safe nuclear power stations take a long time to build and are very expensive to dispose of once they come to end of life. **Batteries.** Electric batteries have changed little and not in principle, since Alessandro Volta invented them more than a century ago. They are expensive and still their energy density is low. **Ethanol.** Fermentation of sugars is ancient. With enzymes, cellulose can now be fermented, but pre-treatment is expensive and cumbersome and fermentation still lose half of the dry matter as carbon dioxide - a waste of biomass objected to by the CESSA Group. **Hydrogen.** Hydrogen has always been difficult. Even in fuel cells it is displaced by the far more manageable methanol.

The International Energy Agency predicts indeed a multiplicity of energy solutions. Our process solves both an environmental problem in agriculture and provides us with liquid fuel - each useful and valuable. With a quick payback, we are not particularly exposed to changes. In fact, we have planned R & D instruments within the business group to take care of our technological development.

The investment is subject to all traditional risks – supply, market etc. - plus an extra political risk - a most complicated business case. The public interest in the implementation of the project justifies and urges the public to take part in this risk.

## Annex 1



**Harvest Scene 1921.** An agricultural era based on renewable energy, no electricity and no artificial fertilizers. The wind turbine in the background powered the stationary energy intensive threshing machine and mill. Horses provided traction for harvesters, plows and other mobile devices.

### **Project Idea.**

Farmers and Citizens - All bring their waste to their local gasoline works. It is broken down and converted into green renewable motor fuel – Farmers Gasoline.

The new concept spans all stages throughout the entire value chain from farm waste to the consumer market.



**Harvest Scene 1948.** The Marshall Plan (European Recovery Program) in 1948 and the following four years, was the beginning of agricultural mechanization in Denmark. It became also the end of renewable energy.



## Danish Biomethanol Ltd. as an investment object.<sup>20</sup>

The anchor budget estimates total investment MDKK 260 and a Gross Profit MDKK 33.5 from the planned operation at ESØ, Tarm. This is equivalent to an internal rate of return (IRR) of 13 % p.a. on investment and 20 % p.a. on equity provided 40 % equity and 60 % loan at 8 % p.a.

### Seed Capital.

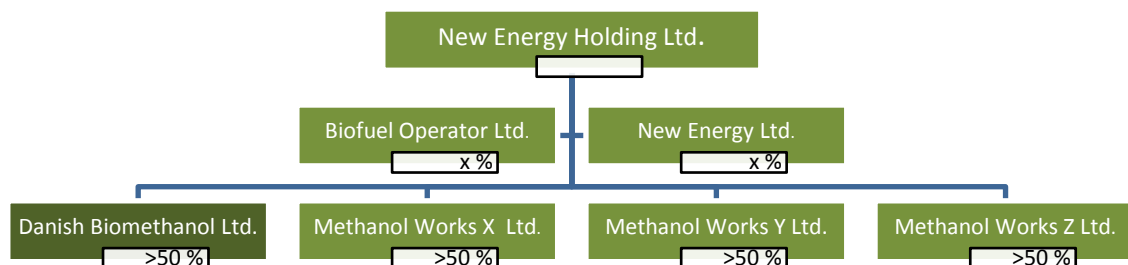
In order to provide such loan and equity a proper business case has to be drawn up and a few applications launched. The necessary venture capital to do so is estimated to be DKK 1½-2 million.



Deloitte Financial Advisory Services has proposed provision of capital in phases. Phase One will so to speak translate this present business plan into a financial language readable by investors and distribute an abstract through Deloitte worldwide. This is followed by a thorough business case analysis ready for presentation. In Phase Three the business case will be discussed and negotiated with interested investors.

### Business Group.

This present business plan focuses on a demonstration plant only and is just the beginning of a whole new industry with all its facets of production, marketing and development being part of any industry. Investors may take interest in future factories not limited to national boundaries and may even not be limited to production - thereto constitutes the provision of liquid renewable energy in the transport sector more and attractive business lines.



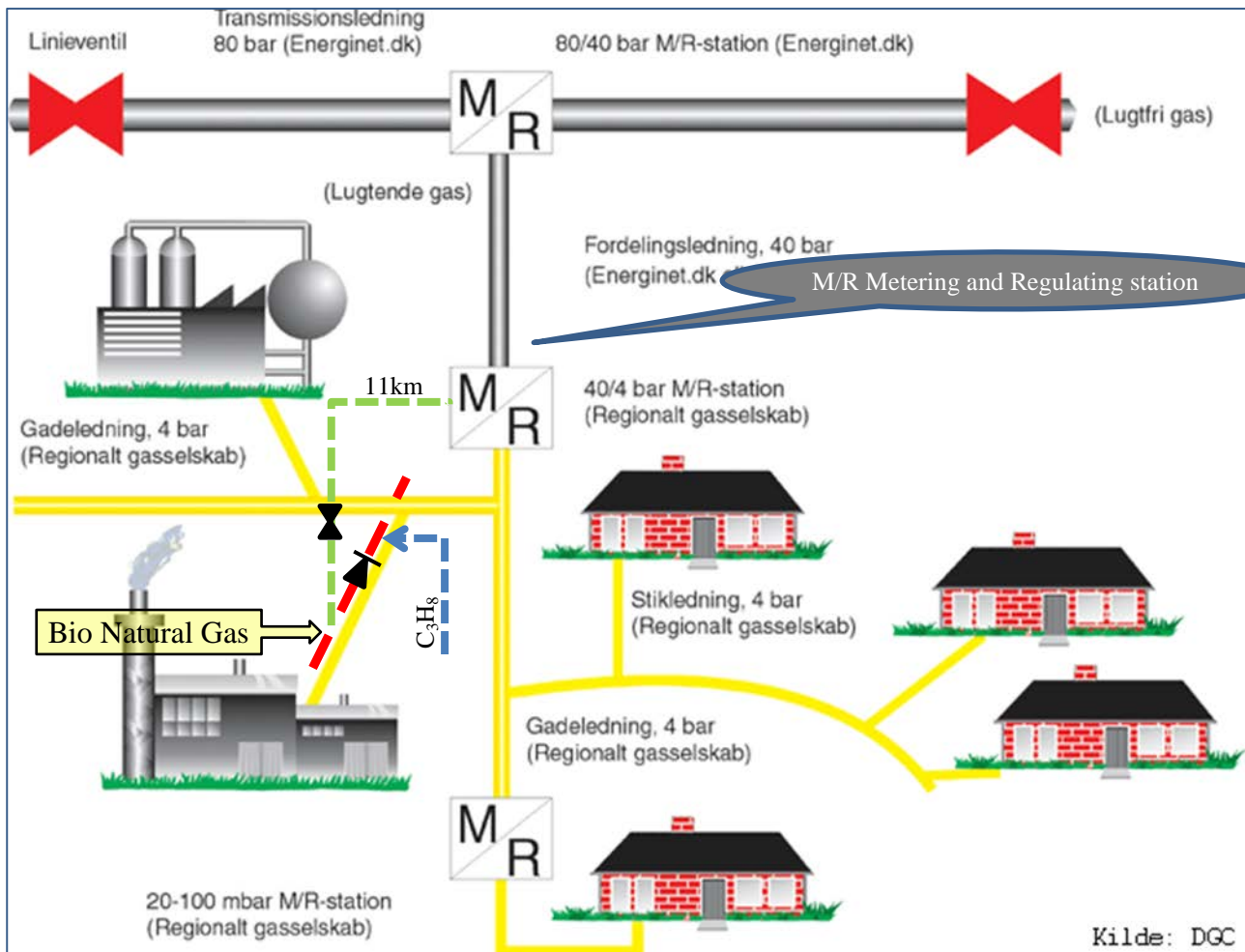
**New Energy Business Group.** This organization enables Works with technical management only and with individual local stakeholders. Associates / technology partners can be linked through ownership or agreements. Filling stations, an engineering company, R&D etc. may be associated as well.

<sup>20</sup> Danish Biomethanol Ltd. and New Energy Holding Ltd. are start-up companies each with 80 voting shares of DKK 1,000. Operation is financed through the issue of non-voting shares and high-interest bonds. By the final equity issue current shareholders will be offered buy-out.





## Biogas Upgrading



### HMN Gashandel A/S (HMN) Proposals.

- Scenario 1: Low pressure service line (yellow/red dotted) with one way valve.  
Capex MDKK 2.5. Opex MDKK 0.1
- Scenario 2: Low pressure service line with one way valve + propane (C<sub>3</sub>H<sub>8</sub>) line (blue dotted).  
Capex MDKK 3.5. Opex MDKK 0.1 + DKK 0.42/m<sup>3</sup> CH<sub>4</sub> upgraded with propane.
- Scenario 3: Extension line (green dotted) to 40 bars M/R-station with full compressor back up.  
Capex MDKK 11.7. Opex MDKK 0.1 + DKK 0.14 CH<sub>4</sub> compressed.

A preferred scenario. A two-way valve enables bio natural gas supply from distant biogas plants.

HMN selling price for bio natural gas certificates of one MWh<sub>HHV</sub> is in the range of 15-25 DKK. The energy content of one Nm<sup>3</sup> of natural gas is defined as 12,157 kWh Higher Heating Value (HHV). Bio natural gas (methane) contains less energy ~ 11 kWh<sub>HHV</sub> / Nm<sup>3</sup>.



## Feed Design.

Biogas capacity	Input								Output
	Feedstock	As is t/year	% DM	DM t	%	VS/DM	VS %	t VS	GVS
Pig slurry, hogs	155.000	5%	7.750	20%	80%	4%	6.200	280	1.909.600
Cattle manure slurry	110.000	8%	8.800	22%	80%	6%	7.040	200	1.548.800
Straw briquettes	26.500	86%	22.790	58%	90%	77%	20.511	290	6.543.009
<b>Total</b>	<b>291.500</b>	<b>13%</b>	<b>39.340</b>	<b>100%</b>			<b>33.751</b>		<b>10.001.409</b>
Total raw biogas m <sup>3</sup>								<b>62%</b>	<b>16.131.305</b>
Feed t/day:	810								
Retention days	75	50	25						
Fermentation		Primary	Secondary						
Temperature, °C		53	53						

Digester	Total		
Digester volume actual	60.000	40.000	20.000
Digester Size		5.000	5.000
Digester No.	12	8	4

Reactors are laid out for slurry as only feedstock and one month's residence. This raw material security, can with supplementary straw be utilized for increased gas production, because briquetting eliminates the long residence time otherwise associated with straw and brings it in line with the slurry<sup>21</sup>.

Feedstock is limited to those listed in Annex IX, Part A to the proposed amendment of the Renewable Energy Directive; Brussels, 17.10.2012, COM(2012) 595 final 2012/0288 (COD) - Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

Annex IX wastes available at ESØ are (b) Biomass fraction of mixed municipal waste, (d) Straw and (e) Animal manure and sewage sludge.

The Energy Agency estimates the Danish biogas potential (without straw) to 40 PJ. Adding straw and deducting food and feed the potential is 58 PJ enabling the manufacturing of two billion liters methanol.

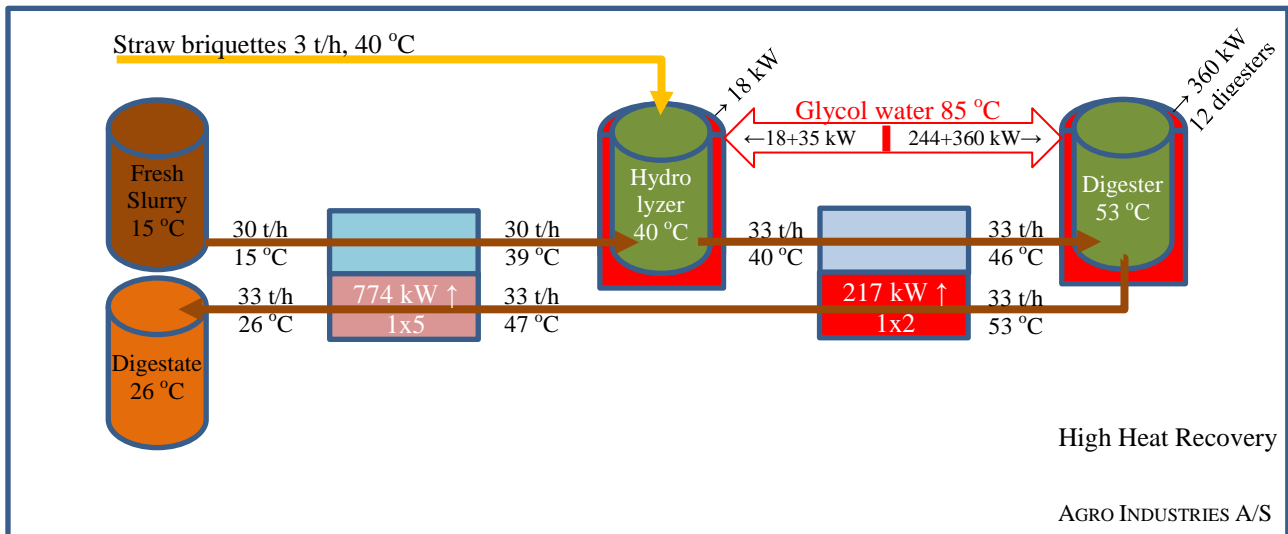
	Biogas potential PJ
Straw, 2.500.000 t	22
Animal manure	26
Land fill	1.0
Sewage sludge	4.0
Industrial waste	2.5
Domestic waste	2.5
<b>Total</b>	<b>58</b>

<sup>21</sup> "Briquettes of straw and dry grass double biogas production." by Henrik B. Møller and Mogens Møller Hansen, Foulum, University of Aarhus, FiB no. 47 • March 2014 3. The methane yield from the straw was 277 liter CH<sub>4</sub>/ kg volatile solids, or about 235 Nm<sup>3</sup> per tons straw with 25 retention days. Accordingly, the reactor design above offers considerable safety margin.



# Slurry Heating and Heat Recovery, Design Basis.

Total feed: 291.500 t/year.



Total waste heat available: 4.400 kW as steam and hot water. Self-heating is hardly an issue in lean cellulosic feeds and is disregarded in the design.

Tanks are organized as one hydrolyser at 40 °C, eight primary and four secondary digesters at 53 °C. For the hydrolyser and digesters heat loss to the atmosphere is 18 respective 30 kW per tank at 5 °C ambient temperature and max. heat transfer from digester coils are 250 kW resp. 280 kW.

Heating 30 t cold slurry of 15 °C to 40 °C by heat recovery takes 774 kW by heat exchanger + 35 kW from tank heating coils. Heat for straw is disregarded. Maintenance heat is delivered by tank heating coils.

Heating 33 t hydrolysate of 40 °C to 53 °C takes 217 kW by heat exchanger + 244 kW from tank heating coils.

Heating media	Process	High Heat Recovery 7 exchangers	Low Heat Recovery 3 exchangers
Glycol water, 85 °C	Slurry heating	35 kW	809 kW
	Hydrolysate heating	244 kW	461 kW
	Tank heat loss	378 kW	378 kW
Glycol water total		657 kW	1.648 kW
Hot digestate, 53 °C	Slurry heating	774 kW	
	Hydrolysate heating	217 kW	
Hot digestate, total		991 kW	
Total heat		1.648 kW	1.648 kW
Heat as glycol water per t feed		20 kW	50 kW

26. December 2013



## The ICI Methanol Process

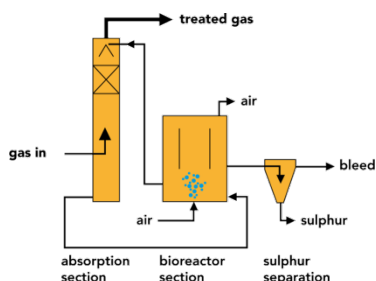


The Methanol plant at ICI in Billingham, September 1970.

Methanol is made by the ICI Low Pressure Methanol Synthesis Process<sup>22</sup> in 4 steps.

### STEP 1: FEED PURIFICATION

The two main feedstock's, natural gas and water, both require purification before use. Natural Gas contains low levels of sulfur compounds and undergo a desulfurization process to reduce, the sulfur to levels of less than one part per million.



Impurities in the water are reduced to undetectable or parts per billion levels before being converted to steam and added to the process.

<sup>22</sup> Methanol Holdings (Trinidad) Ltd. commissioned its M5000 Mega Plant in November 2005. The plant produces 5,000 metric tons of methanol per day making M5000 the largest methanol plant in the world.

We use same process for 21 t per day making ours the smallest plant in the world.

### STEP 2: REFORMING

Reforming transforms the methane (CH<sub>4</sub>) and the steam (H<sub>2</sub>O) into synthesis gas comprising hydrogen (H<sub>2</sub>) and carbon monoxide (CO).



The reaction takes place by passing hot mixture of methane and steam (860 °C) over a nickel catalyst.

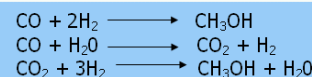
Carbon dioxide (CO<sub>2</sub>) is also added to the feed gas stream at this stage to increase methanol yield. This process is carried out in a Reformer furnace which is heated by burning natural gas as fuel.



Trinidad steam reformer.

### STEP 3: METHANOL SYNTHESIS

After removing excess heat from the synthesis gas it is compressed before being sent to the methanol synthesis reactor. Here the reactants are converted to methanol and separated out as crude product with a composition of methanol (68%) and water (31%). Traces of byproducts are also formed. Methanol conversion is at a rate of 5% per pass hence there is a continual recycling of the unreacted gases in the synthesis loop.



The reaction takes place by passing the synthesis gas through a packed column of a Cu-Zn catalyst at approx. 230 °C and 65 bar.

This continual recycling of the synthesis gas however results in a build-up of inert gases in the system and this is continuously purged and sent to the reformer where it is burnt as fuel. The crude methanol formed is condensed and sent to the methanol purification step which is the final step in the process.



Trinidad methanol reactor.

### STEP 4: METHANOL PURIFICATION

The 68% methanol solution is purified in two distinct steps in tall distillation columns called the topping column and refining column to yield a refined product with a purity of 99.85 % methanol classified as Grade AA refined methanol.

The methanol process is tested at various stages and the finished product is stored in a large secured tankage area off the plant until such time that it is ready to be delivered to customers.



### Manure-Straw Plant.

Manufacturing 2G-biomethanol from biogas is limited to waste as raw materials – Annex IX wastes.

Traditional manure-maize plant cannot provide biogas for 2G-methanol and therefore the installation at ESØ becomes the first Danish industrial manure-straw plant.



The plant at ESØ will process pig and cattle slurry, deep litter and straw. The feedstock will be picked up by the factory and improved carbon-rich digestate returned to the farms.

A new technology convincingly demonstrated at Foulum, University of Aarhus copes with difficulties in straw handling and slow release of its gas potential.



Straw bales are shredded and made into easily manageable briquettes under high pressure - 2.000 bar.

The high pressure and a temperature rise to 170 °C make the straw hygroscopic. In minutes the straw disperses. Even after a day with no stirring the suspension is still there and without troublesome floating layer on top of the substrate.

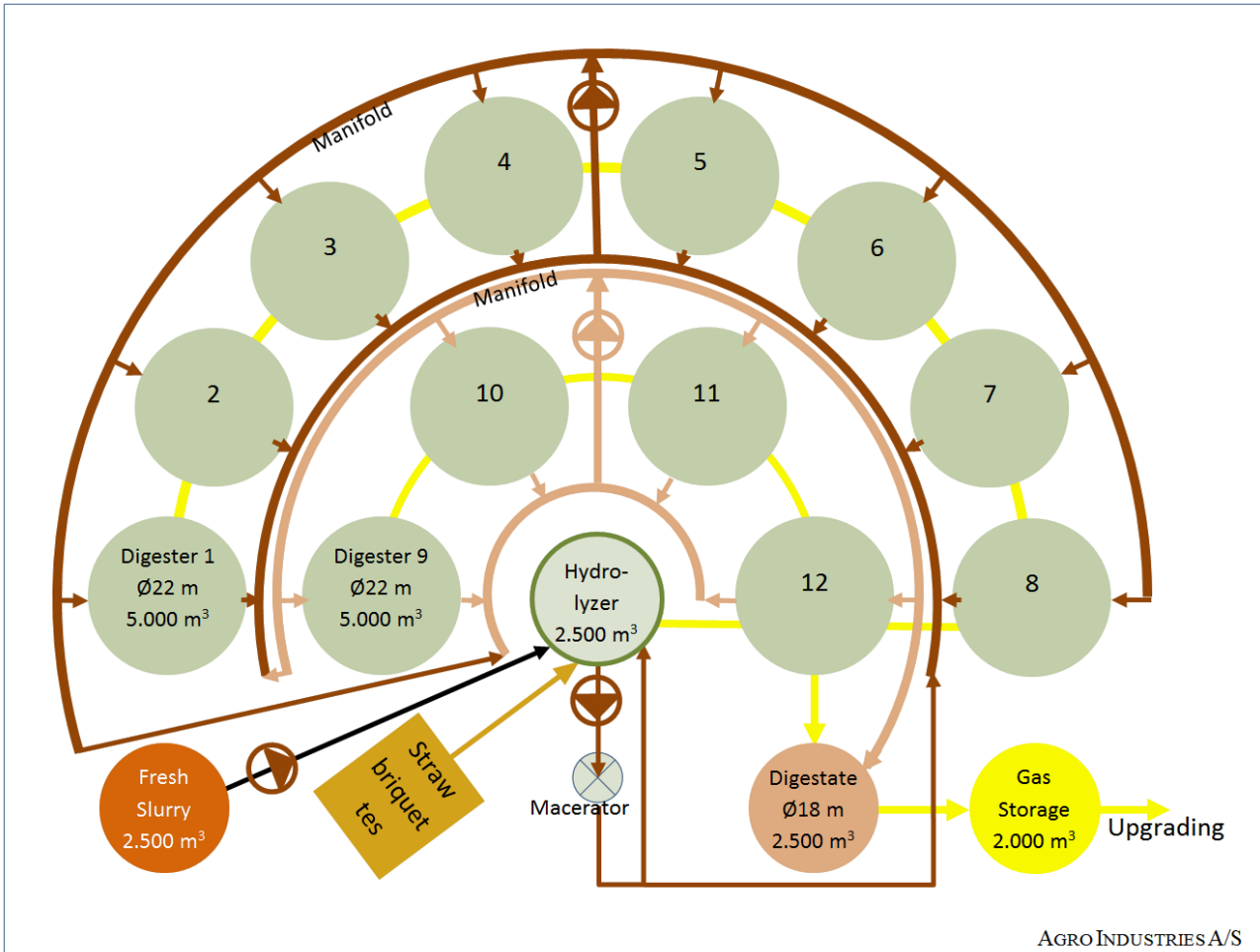


Same occurs with deep litter on pretreated straw.

Straw pellets exhibit stability in suspension, which can be utilized in the flow design. The straw also exhibit such a large water-holding capacity, that pellets advantageously

can be added dry and directly into the primary reactors.

Laboratory test at International Starch Institute.



Identical fermenters with multiple reversible inlets and outlets allow both batch and serial operation with optional interconnection. Here is used 8 primary fermenters and 4 secondary all manifold connected (valves, overflow connections and heat exchangers are not shown). Further flexibility is achieved by making all metallic parts in contact with fluid and gas in stainless steel.

**Diagram Gasworks.**

Input	Fresh Slurry	30 t/h
	Straw briquettes	3 t/h
Output	Biogas	1.700 Nm <sup>3</sup> /h
	Methane	1.050 Nm <sup>3</sup> /h
Capacity	Digesters, total	60.000 m <sup>3</sup>
Retention	Digesters, total	75 days
	Hydrolyzer	3 days



## Annex IX Wastes.

Brussels, 3 June 2014. Proposal for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources (first reading)<sup>23</sup>.

Annex IX Part A. Feedstocks and fuels whose contribution towards the target(s) referred to in Article 3(4) shall be considered to be twice their energy content:

- (a) Algae if cultivated on land in ponds or photobioreactors.
- (b) Biomass fraction of mixed municipal waste, but not separated household waste subject to recycling targets under Article 11(2)(a) of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.
- (ba) Bio-waste as defined in Article 3(4) of Directive 2008/98/EC from private households subject to separate collection as defined in Article 3(11) of that Directive.
- (c) Biomass fraction of industrial waste not fit for use in the food or feed chain, including material from retail and wholesale and the agro-food and fish and aquaculture industry, and excluding feedstocks listed in Part B of this Annex.
- (d) Straw.
- (e) Animal manure and sewage sludge.
- (f) Palm oil mill effluent and empty palm fruit bunches.
- (g) Tall oil pitch.
- (h) Crude glycerine.
- (i) Bagasse.
- (j) Grape marcs and wine lees.
- (k) Nut shells.
- (l) Husks.
- (m) Cobs cleaned of kernels of corn.
- (n) Biomass fraction of wastes and residues from forestry and forest-based industries, i.e. bark, branches, pre-commercial thinnings, leaves, needles, tree tops, saw dust, cutter shavings, black liquor, brown liquor, fibre sludge, lignin and tall oil.
- (o) Other non-food cellulosic material as defined in point r) of the second subparagraph of Article 2.
- (p) Other ligno-cellulosic material as defined in point s) of the second subparagraph of Article 2 except saw logs and veneer logs.
- (q) Renewable liquid and gaseous fuels of non-biological origin..

### ISCC Certification.



Local ISCC bodies take care of the ISCC-EU certification. ISCC is the first international certification system that can be used to prove sustainability and greenhouse gas savings for all kinds of biomass and bioenergy.

Other systems recognized by the European Commission as systems for the certification of sustainable biomass are REDCert and the Netherlands Technical Agreement (NTA) 8080.

ISCC issued "*List of material eligible for ISCC EU verification as of 8. September 2014*".

<sup>23</sup> <http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%2010300%202014%20INIT>



Time Schedule																																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
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Building- and Environmental Permits																																								
Recruitment of farmers as suppliers																																								
Initial Venture Capital Injection																																								
Development High-Blend Dispenser																																								
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Final Capital Injection																																								
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Permit																																								
Engineering																																								
Construction, 6 month																																								
Startup Gas, 2 month																																								
Full capacity, 7 month																																								
<b>Gas Upgrading</b>																																								
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Permit																																								
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<b>Sales</b>																																								
Gas																																								
Methanol, Third party																																								
Methanol																																								

**Digesters.** Fermenters are built and commissioned to create early revenue.

**Gas Upgrading.** Gas upgrading is build and commissioned early on to facilitate gas sales during construction period.

**Methanol Plant.** There is no need to complete the methanol works before the biogas supply is in place.

**Tank Yard Offsite.** There is ample time for planning and regulatory review of the tank yard, using Oiltanking Copenhagen's tanks at Prøvestenen until storage tanks are available in Grenaa.

**Delay** Ringkøbing-Skjern and the Environmental Protection Agency will jointly issue building and environmental permits.

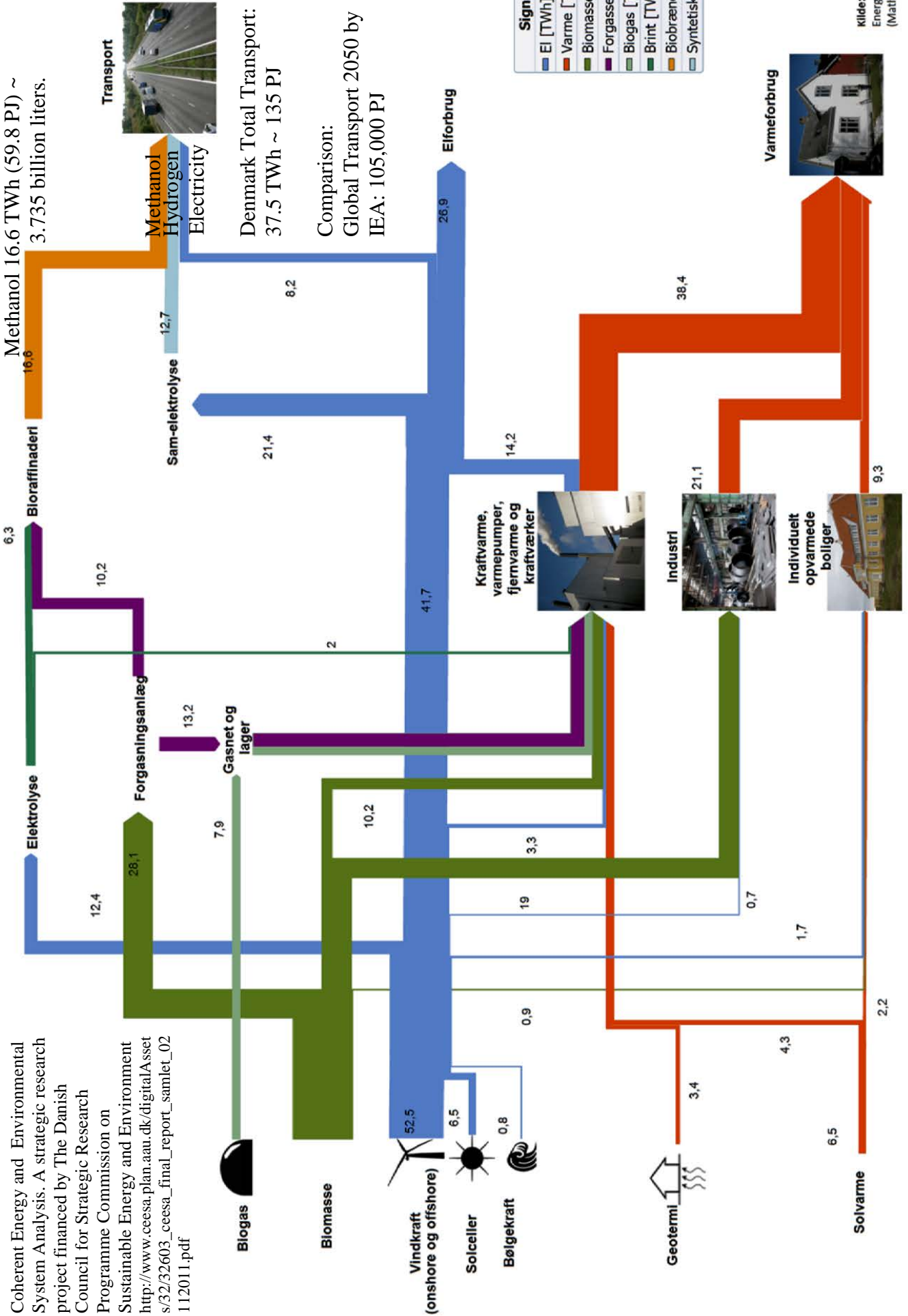
The time required for permits is yet to be determined and may cause a considerable delay.

November 22, 2013



# Annex 11

Sankey diagram of the CEESA 2050 100 % renewable energy scenario.

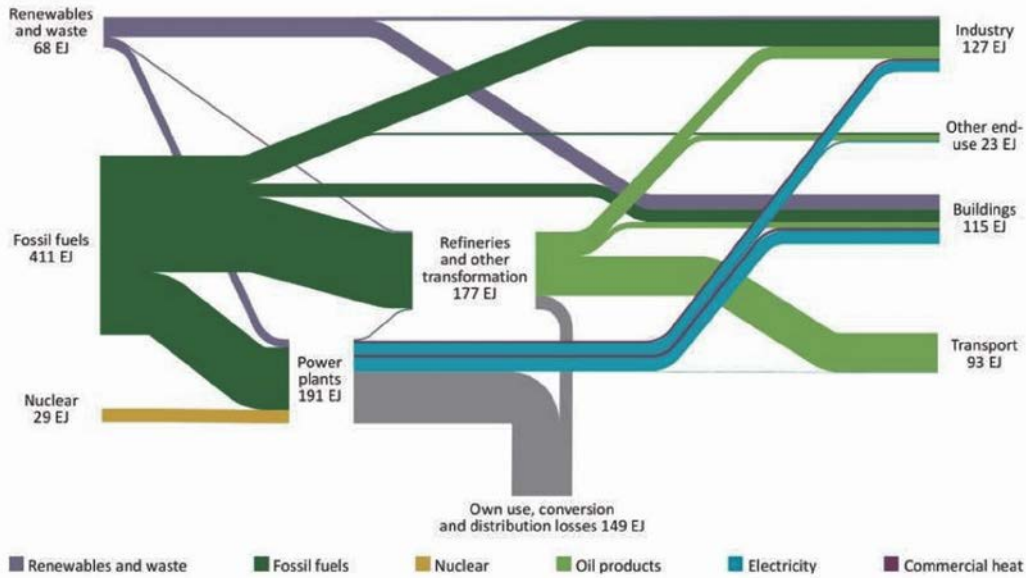


Kilde: CEESA 100% Renewable Energy Scenarios towards 2050 (Mathiesen et al. 2011)



# The Global Energy system today

ETP 2012

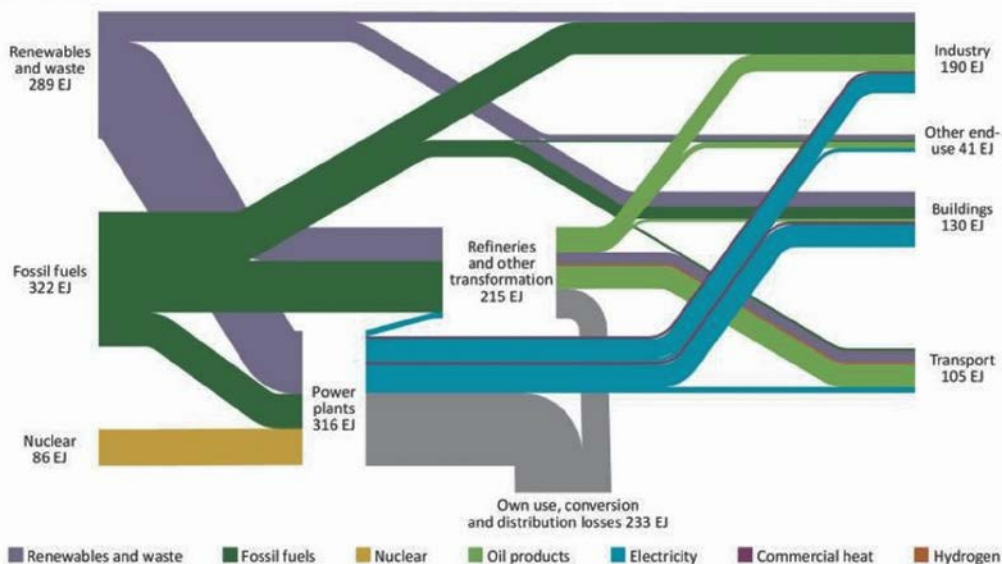


*Dominated by fossil fuels in all sectors*



# The future low-carbon energy system

ETP 2012



*The 2DS in 2050 shows a dramatic shift in energy sources and demands*



Source: Energy Technology Perspectives by International Energy Agency 2012. 2DS ~ The 2 °C Scenario. <http://www.slideshare.net/internationalenergyagency/etp-2012-slide-deck>, slide 56 and 57.

### Three Routes from Waste through Biogas to Biomethanol.

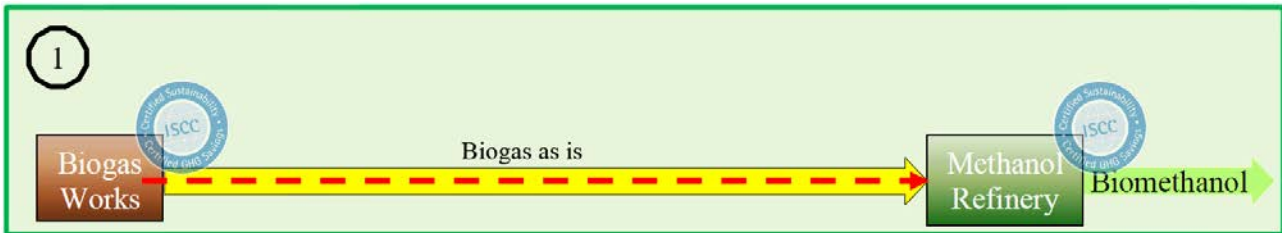


Figure 1. Basic Process. Crude biogas is fed directly into the methanol plant, without prior purification and with no connection to a gas grid. The process is valuable in places with no natural gas, but lacks an outlet for excess biogas. The red dashed line indicates the physical connection. This use of biogas is not subsidized in Denmark. The biomethanol is RED-sustainable.

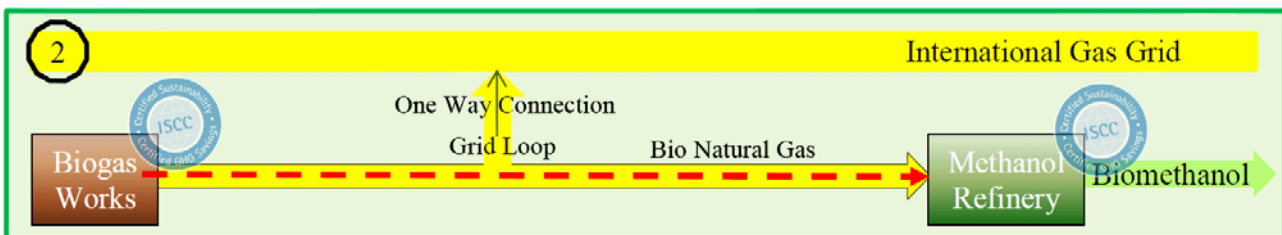


Figure 2. The Esø Demonstration Plant. Biogas is upgraded and injected into a loop on the national gas grid. The loop and grid are connected via a one way valve allowing excess bio natural gas to be released to the grid. Natural gas from the grid is not allowed to enter the loop. The red dashed line indicates the physical connection. This use of biogas is subsidized in Denmark. The biomethanol is RED-sustainable.

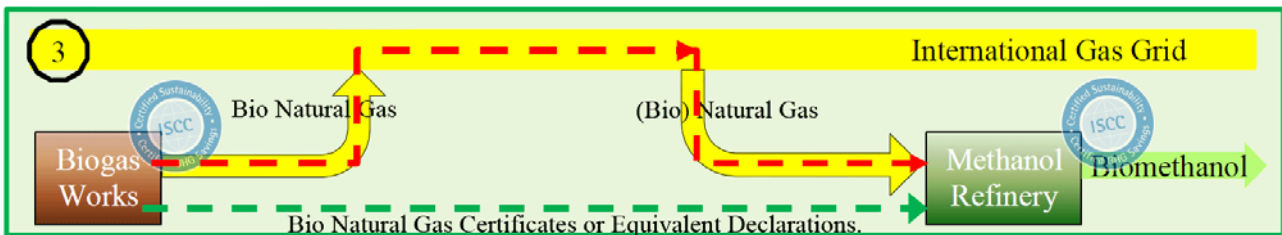


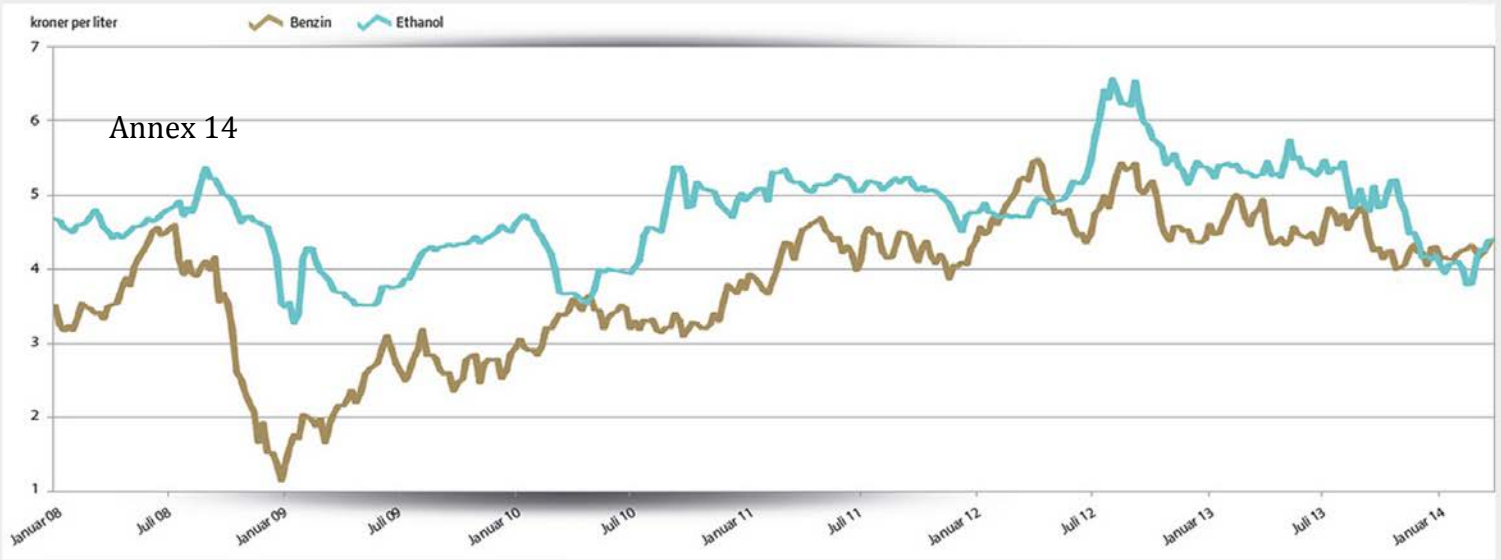
Figure 3. The Esø Extension. With increasing demand the methanol plant capacity is expanded and additional bio natural gas from distant biogas plants is transported through the national gas grid. Methanol synthesis can begin somewhere and be completed anywhere else physically connected by pipeline or tanker [Re.: Certification Principle. V RAW MATERIALS AND LOGISTICS].

The red dashed line indicates the physical connection. The green dashed line shows the flow of bio natural gas certificates or equivalent declarations. This use of biogas is subsidized in Denmark. The biomethanol is RED-sustainable.

The Agro Industries A/S concept enables - irrespective of location - conversion of biogas into liquid methanol for a high price biofuel market. The bio natural gas certificates/declarations are recognized by ISCC-EU<sup>24</sup> and the methanol will be ISCC-EU certified as sustainable and serve as a replacement for fossil fuels under the RED and FQD directives.

November 30, 2014.

<sup>24</sup> Under the ISCC EU certification scheme, the economic operator feeding biogas into the grid and the party taking biogas out of the grid must be certified. Both parties must be physically connected via the gas grid. The amounts fed into the grid and taken out of the grid must be verified by an independent third party, e.g. national authority or gas grid operator. Under ISCC, all locations where sustainable material is handled (processed or stored) must be covered by a certificate. Katharina Wübben, ISCC System GmbH, Hohenzollernring 72, 50672 Köln, Germany. Amtsgericht Köln HRB 68185



Gasoline and ethanol T2 FOB Rotterdam - DKK/liter. The international price recording on bioethanol since 2008 has generally been higher than the listing on gasoline (benzin). Source: Danish Oil Industry Association (EOF).

### The Consumer Market for Gasoline.

EOF also publishes Gasoline retail prices. Q1 2014 average list price of Regular 95 octane was 12.68 DKK/l at the pump. Breakdown:

Breakdown on ingredient, DKK per liter at the pump		
Gasoline ingredient	Gasoline	Methanol
VAT	2,54	2,54
CO <sub>2</sub> -Tax	0,38	
Energy taxes	4,11	2,05
Distribution according to EOF	1,00	1,00
<b>Gasoline</b>	<b>4,65</b>	
<b>Methanol</b>		<b>7,09</b>
Total at the pump, DKK/l	12,68	12,68

There is no CO<sub>2</sub> tax on biofuels and methanol attracts less energy tax due to lower calorific value<sup>25</sup>. Price wars may affect the actual price at the pump.

### Nord Pool Energy Exchanges.

Q1 2014 Average		
		DKK/MWh
Nord Pool Spot	Electricity	211,55
GasPoint Nordic	Natural Gas <sub>HHV</sub>	183,42

Gas is sold by the Higher Heating Value (HHV)<sup>26</sup>.

<sup>25</sup> Lower calorific values for gasoline, ethanol and methanol, respectively: 32, 21 and 16 MJ/l.

<sup>26</sup> The energy content of one Nm<sup>3</sup> of natural gas is set at 12,157 kWh Higher Heating Value (HHV). This corresponds to 11 kWh by Lower Heating Value (LHV).

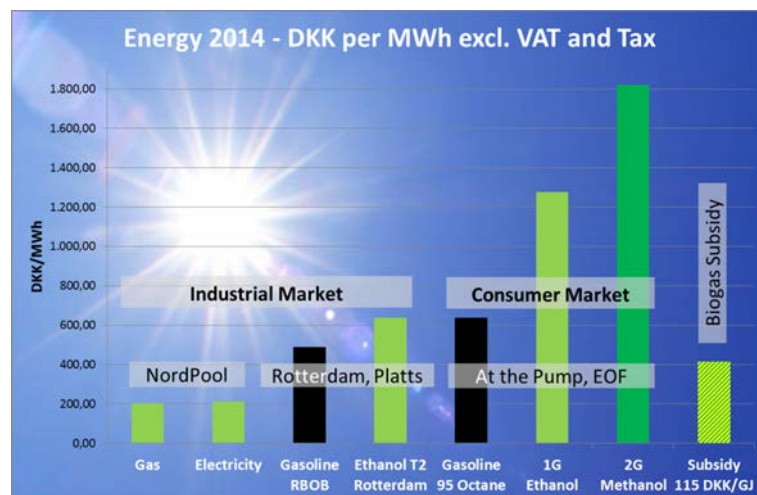
Methane Nm<sup>3</sup>: 11,06 kWh<sub>HHV</sub> and 9,97 kWh<sub>LHV</sub>.

### Biomethanol.

There is no international listing of biomethanol, but currently it follows the market leader - ethanol T2 spot - plus a RED-premium due to double counting. This corresponds to min. 4,75 DKK/l bio-methanol FOB Rotterdam.

In the future, bio-methanol rather follows gasoline with an extra bio-premium because it's counting double.

Over twenty years, the average gasoline price corrected for inflation got up by 4 % p.a. The same will happen to biofuels replacing gasoline.



For comparison the lower heating value is used for all products.

RBOB gasoline refers to "Reformulated Blendstock for Oxygenate Blending".

Ethanol T2 refers to Ethanol FOB Rotterdam incl. duty.



## Annex 15

**MARKET NOTES****Market Study for the Production of Second Generation Bioliqids, 2011.**<sup>27</sup>

The study estimates an EU market potential of 3.2 Mt/a of biomethanol and identifies the key price drivers as the EU price for ethanol, crude oil and EU incentives. It concludes the following relation:

*Price of bio-methanol = price of ethanol + RED benefit.* The price of methanol is unlikely to fall below that of conventional ethanol.

**Production of Bio-methanol, 2013**<sup>28</sup>.

The International Renewable Energy Agency (IRENA) is an intergovernmental organization dedicated to renewable energy. The study estimates present and planned bio-methanol production within the EU to one billion liters.

**199 miljoen euro subsidie van Europa voor BioMCN, 2013**<sup>29</sup>.

Een van de grootste producenten van tweede generatie biobrandstoffen ter wereld, het Nederlandse bedrijf BioMCN, gaat zijn productiecapaciteit verdubbelen naar 500 miljoen liter methanol per jaar. *«Methanol has its own market price - about 340 euro per tonne of fossil methanol - but we sell our methanol approx. double that because it is renewable».*

**MMSA Global Methanol Supply and Demand**<sup>30</sup>

Alternative Fuels 2010: 10.508 million MT (Gasoline Blending & Combustion 5.775, Biodiesel 998, DME 3428, Fuel Cells 5, Methanol-to-Olefins 302). Others: 57.020. Total demand: 67.528.

<sup>27</sup> Market Study for the Production of Second Generation Bioliqids, March 2011. Prepared by: Wyton Energy Consulting. For: North East Process Industry Cluster (NEPIC). [http://www.nebr.co.uk/\\_cmslibrary/files/market\\_study\\_second\\_generation\\_bioliqids.pdf](http://www.nebr.co.uk/_cmslibrary/files/market_study_second_generation_bioliqids.pdf)

<sup>28</sup> Production of Bio-methanol. IEA-ETSAP and IRENA© Technology Brief I08 – January 2013 [http://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20I08%20Production\\_of\\_Bio-methanol.pdf](http://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20I08%20Production_of_Bio-methanol.pdf)

<sup>29</sup> 199 miljoen euro subsidie van Europa voor BioMCN, Engineeringnet Magazine - mei 2013. [http://www.mainpress.com/nederlands/dossier\\_automation/pdf/BioMCN.pdf](http://www.mainpress.com/nederlands/dossier_automation/pdf/BioMCN.pdf)

<sup>30</sup> Methanol Market Services Asia (MMSA) is a consulting Singapore based firm.

**Global Methanol Market**<sup>31</sup>, 2012

Projected demand by 2016 = 92.3 Million Metric Tons with Gasoline/Fuel applications becoming the largest demand sector..

**Methanol Policy Forum 2012 - Washington D.C. Session 4: Renewable Methanol**<sup>32</sup>

While the lion's share of methanol made around the world today comes from natural gas, renewable methanol production is ramping up considerably. Not only does the consumer get the clean burning benefits of methanol (no particulate matter, lower NOx emissions, etc.), but renewable production pathways are also able to lower the greenhouse gas emissions even further on a 'well-to-wheels' basis.

**Denmark's largest fuel supplier looking at Methanol infrastructure, 2013**<sup>33</sup>

OK a.m.b.a. the largest fuel supplier in Denmark is looking at the infrastructure for methanol fuel cell vehicles. With 660 refueling stations out of a total of 2000 in Denmark OK is focused on the distribution and sale of liquid fuels for the transportation sector.

**Fuel Ethanol in Europe, Platts Biofuels Conference. 2013**<sup>34</sup>

In 2012, the EC proposed to limit the volume of biofuels from food crops to 5% (by energy). Forecast EU fuel ethanol demand to 2020 with this limit is 9 billion liters. The proposal to amend the RED has damaged confidence in the fuel ethanol market. Following rapid industry expansion 2008-2010, fewer new ethanol plants will come on-stream in future

<sup>31</sup> Global Methanol Market, Review, Dewey Johnson Sr. Director Chemical Market Research, June 2012. [http://www.ptq.pemex.com/productosyservicios/eventosdesdescargas/Documents/Foro%20PEMEX%20Petroqu%C3%ADmica/2012/PEMEX\\_DJohnson.pdf](http://www.ptq.pemex.com/productosyservicios/eventosdesdescargas/Documents/Foro%20PEMEX%20Petroqu%C3%ADmica/2012/PEMEX_DJohnson.pdf)

<sup>32</sup> <http://www.methanol.org/Energy/Transportation-Fuel/Methanol-Policy-Forum-2012/Session-4--Renewable-Methanol.aspx>

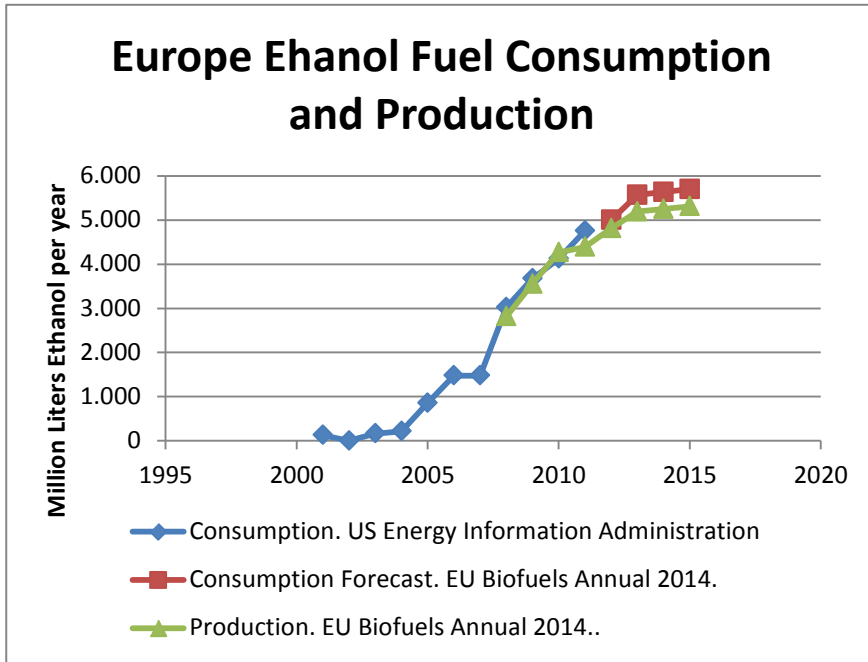
<sup>33</sup> Denmark's largest fuel supplier looking at Methanol infrastructure. Thursday, June 13th, 2013. <http://ing.dk/artikel/benzinselskab-vil-saelge-traesprit-og-oege-elbilers-raekkevidde-til-800-km-159605>

<sup>34</sup> Fuel Ethanol in Europe. LMC International, Oxford, UK. Platts Biofuels Conference, June 2013. <http://www.platts.com/IM.Platts.Content/ProductsServices/ConferenceandEvents/2013/pc399/presentations/CarolineMidgley.pdf>



## EU Biofuels 2014

EU Biofuels Annual Highlights<sup>35</sup>: By October 2014, the European Commission aims to reach an agreement on the future policy for biofuels. Main features are a seven percent cap on conventional biofuels and further support of the transition to second generation biofuels. The EC has effectively cut off imports from the most competitive suppliers but expansion of the domestic market for biofuels is dwindling.

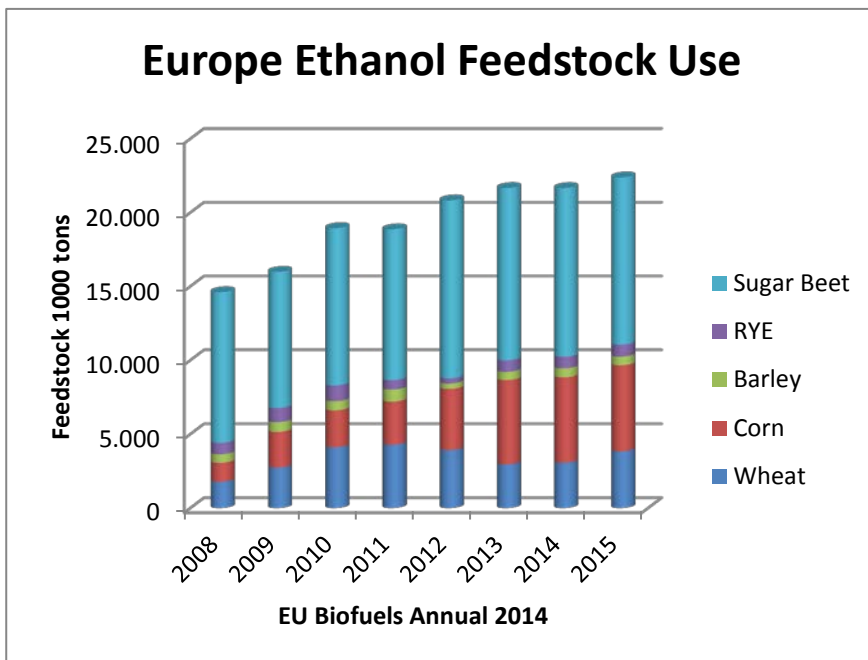


Due to the cap on food based bioethanol, expansion of first generation bioethanol is expected to be limited, while expansion of cellulosic bioethanol production is restrained due to the lack of certainty in the EU policy making process.

### 2G-Ethanol Cases.

April 2011 Chemtex announced that it has broken ground on a 40.000 t/y cellulosic ethanol plant to be constructed in Crescentino, Vercelli, Italy. Chemtex will be the first commercial second generation ethanol producer in the world. *"We strongly believe that PROESATM<sup>36</sup> is the break-through"*.

June 2014 Biochemtex and Beta Renewables announced a 55.000 t/y plant to be built in Strazske, Slovak Republic. The Strazske plant will be the third in the world based on PROESATM technology, following Crescentino, Italy, and Alagoas, Brazil.



<sup>35</sup> [http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual\\_The%20Hague\\_EU-28\\_7-3-2014.pdf](http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_The%20Hague_EU-28_7-3-2014.pdf)

<sup>36</sup> The Proesa TM process is a second-generation cellulosic biomass technology. It takes non-food biomass, like energy crops (reeds) or agricultural waste (straw) and turns it into high-quality, fermentable C5 and C6 sugars.

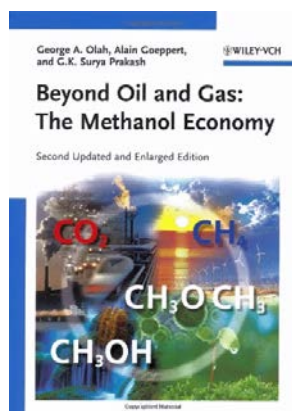


## Annex 17

## THE METHANOL ECONOMY

Nobel prize winner George A. Olah launched the methanol economy concept in the 1990s and in 2005 he and G. K. Surya Prakash and Alain Goeppert, published the book *"Beyond Oil and Gas: The Methanol Economy"*. A Danish version based on renewable methanol was published by us on the Internet in 2008.

The book encouraged the introduction of a methanol economy in Denmark and led to the founding May 15 2011 of the *Danish Methanol Association* with Nobel laureate George Olah as an honorary member.



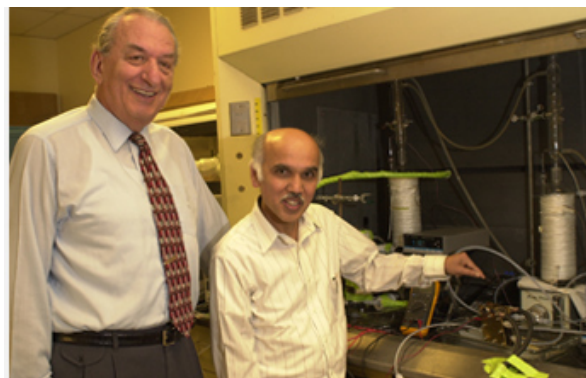
Project realization began May 29 2011 with our request to DBH Technology A/S on the use of carbon dioxide released by ethanol fermentation on their upcoming plant in Grenaa. August, six months later *"Bio-Methanol Fuel Project - An Opportunity Report"* is prepared by *Agro Industries A/S* on behalf of *Danish Methanol Association*. The report describes a factory in Grenaa with Dual Lines. One line utilizes power from the Kattegat wind farm with its sea cables coming ashore just in Grenaa. With hydrogen from electrolysis carbon dioxide is reduced to methanol. The accompanying oxygen is used for gasification of wood chips in a second line. The project was based on a technological symbiosis of the neighboring bio-refineries. Political headwinds to the neighbor's use of wheat for fuel brought the total project into a headwind.

Presentation March 29, 2012 at Foulum of the government's new energy policy by Member of Parliament S. Gade, became the next milestone. The new policy gave strong support to the use of biogas. The use of biogas as a carbon and energy source made it possible to build smaller, to decimate investment and even make a demonstration plant profitable.

This event sparked our engineering of a demonstration plant based on classic anaerobic digestion of animal manure and straw and to an equally classic conversion of methane to methanol by catalytic synthesis. The associated feasibility study *"Animal Manure to Green Petrol - A feasibility study"* was presented March 2013.

In order to extend this study to a business plan *Danish Biomethanol Ltd.* was established May 1, 2013. With this company as the focal point a final business plan *"Farmers Gasoline BP 01"* was completed February 2014 and now again in a third update.

With the business plan as a tool a roadshow began. Feedback, however, showed clearer interest in the methanol concept as a whole than in Danish Biomethanol Ltd. as a stand-alone production company. In recognition of this, the focus today is the establishment of a business group with *New Energy Holding Ltd.* in the lead.

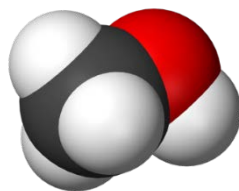


George A. Olah (left) and G. K. Surya Prakash in the lab.

Next stop is a professional business case analysis - based on this present business plan - which can serve as assessment for our forthcoming investors before they take the first sod.

Without awaiting the analysis, but rather as a part thereof, the vitally important marketing is carried out concurrently.

November 6, 2014



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