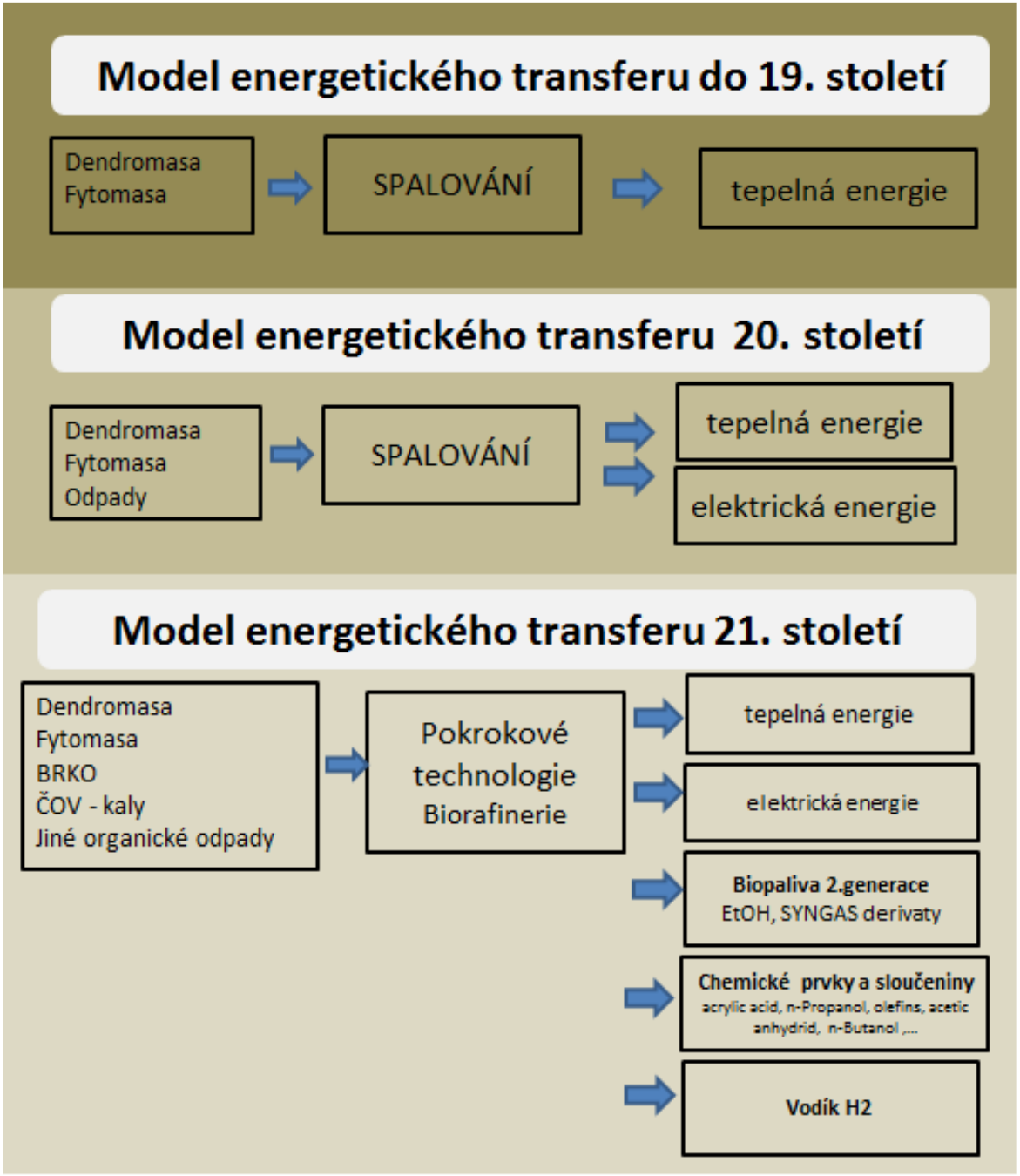
BIOPALIVA
česká technologická platforma

EVROPSKÁ UNIE
EVROPSKÝ FOND PRO REGIONÁLNÍ ROZVOJ
INVESTICE DO VAŠÍ BUDOUCNOSTI

Technologie transferu komunálního odpadu na energii (alternativa spalování) stav 2016

Ing. Leoš Gál
předseda ČTPB


Model energetického transferu do 19. století
Dendromasa
Fytomasa
SPALOVÁNÍ
tepelná energie
Model energetického transferu 20. století
Dendromasa
Fytomasa
Odpady
SPALOVÁNÍ
tepelná energie
elektrická energie
Model energetického transferu 21. století
Dendromasa
Fytomasa
BRKO
ČOV - kaly
Jiné organické odpady
Pokrokové
technologie
Biorafinerie
tepelná energie
elektrická energie
Biopaliva 2.generace
EtOH, SYNGAS derivaty
Chemické prvky a sloučeniny
acrylic acid, n-Propanol, olefins, acetic anhydrid, n-Butanol ,...
Vodík H2

ČR uvažuje a plánuje o masivní investice do spaloven odpadů...

Česká technolgická platforma biopaliv (ČTPB)

1. **Varuje**. Cesta spaloven je technologický model minulého století. Jeho největší nevýhodou je, že vzácný chemický obsah organických odpadů proměňuje pouze na teplo a elektrickou energii. Navíc, realizace investicí do spaloven, dlouhodobě ekonomicky předurčí cestu vstupní suroviny na okamžitou výrobu tepla a elektrické energie. Tímto „zablokuje“ faktickou možnost pokrokovějším cestám chemických separací a v konečné fázi i získávání vodíku do palivových článků.

Česká technologická platforma biopaliv (ČTPB)

2.Navrhuje v rámci své činnosti v příštích letech realizovat **odborné a komplexní posouzení dostupných technologií B2G – W2B** z hledisek:

Technické – Technologické – Ekonomické - Sociologické- Environmentální

Porovnat možnosti likvidace odpadů touto cestou jako alternativu nakládání s odpady vzhledem ke spalování. A to především z perspektivního a dlouhodobého pohledu jako i z reálných podmínek odpadů v ČR.

Česká technologická platforma biopaliv (ČTPB)

ČTPB vytvoří kvalifikované teamy odborníků z jednotlivých oblastí k expertnímu posuzování technologií

Posuzování hledisek	Technické a Technologické	Ekonomické	Sociologické	Environmentální
Rezortní členění problematik spadajících pod rezorty	MPO a Mze	MF	MMR	MŽP
Expertní potenciál členové ČTPB a jiní	VŠCHT, VTP Kralupy, VURV,...	VŠE	municipality, kraje, regiony	EIA experti, vliv na životní prostředí
CÍL 1. fáze	Posouzení variability vstupu, technické a technologické náročnosti, údržby, spolehlivosti,...	Posouzení ekonomických parametrů	Posouzení sociologických dopadů	Posouzení environmentálních dopadů
CÍL 2. fáze	Konjugace výsledků jednotlivých expertů a konfrontace vhodnosti jednotlivých technologií pro konkrétní podmínky a potřeby v krajích ČR			

Česká technologická platforma biopaliv (ČTPB)

Dosavadní praxe:

Prvotní byl návrh technologie, který jednotlivé rezorty posuzovali.

Návrh ČTPB je opačný:

Prvotní expertní posuzování dostupných technologií definuje výhody a nevýhody jednotlivých technologií z partikulárních rezortních hledisek. Následně bude hledání nejschůdnějšího kompromisu – jako kvalifikovaný výběr nejvhodnější technologie pro konkrétní podmínky v konkrétním regionu ČR.

Výhody :

- Kvalifikované expertní informace ohledně jednotlivých technologií
- Možnost včas v předstihu a kvalifikovaně vybírat nejvhodnější lokální technologii dle lokálních podmínek
- Vynaložené náklady na realizaci kvalifikovaného posouzení jsou vzhledem k finanční náročnosti realizací zanedbatelné a vzhledem na eliminaci méně vhodné technologie, velmi efektivně vynaložené.

Technologie komerčně dostupné

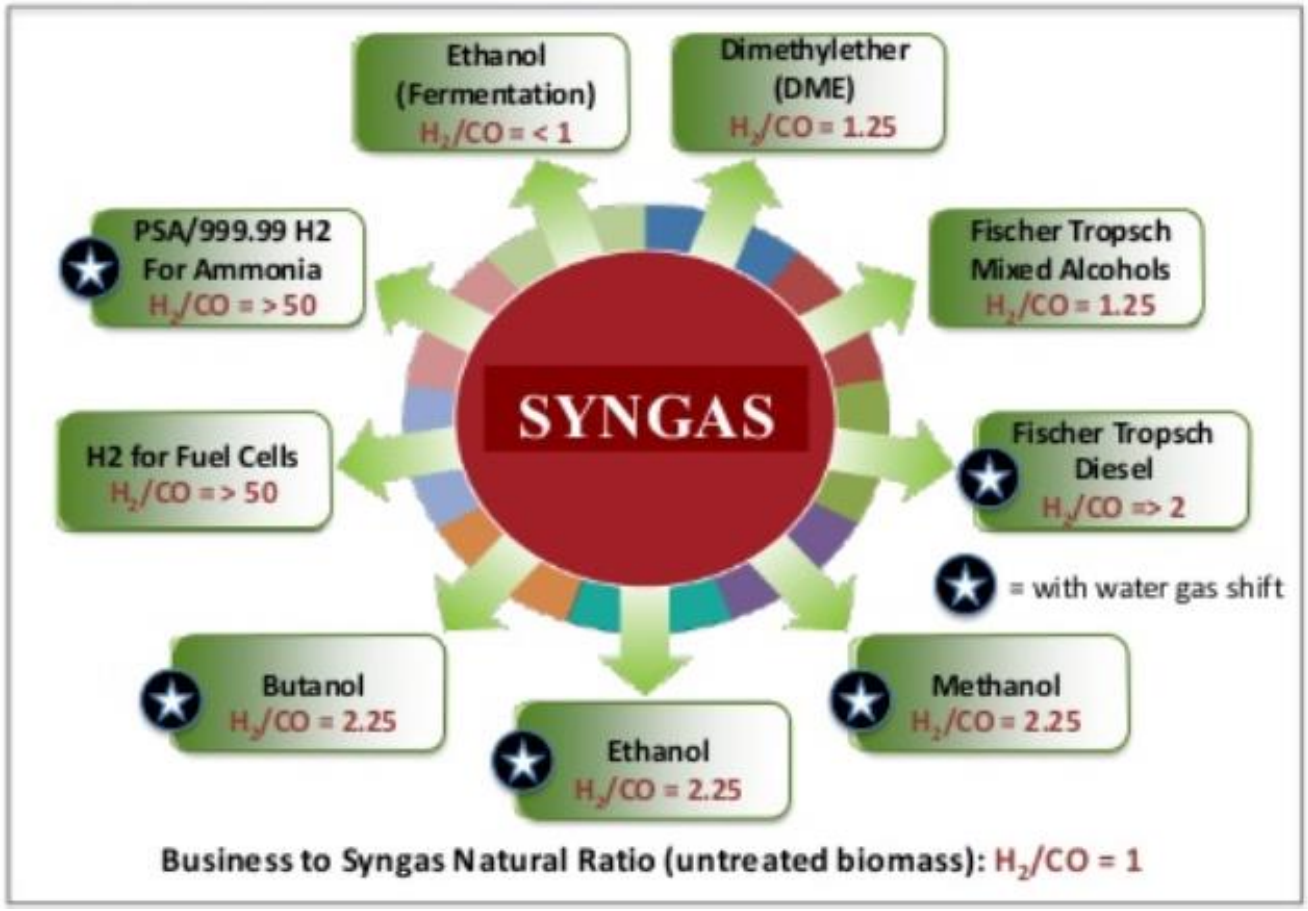
Dle Eurostatu lze z 1 m3 odpadů produkovat 375 litrů EtOH.

KO - Bezkonfliktní potenciál vstupní suroviny

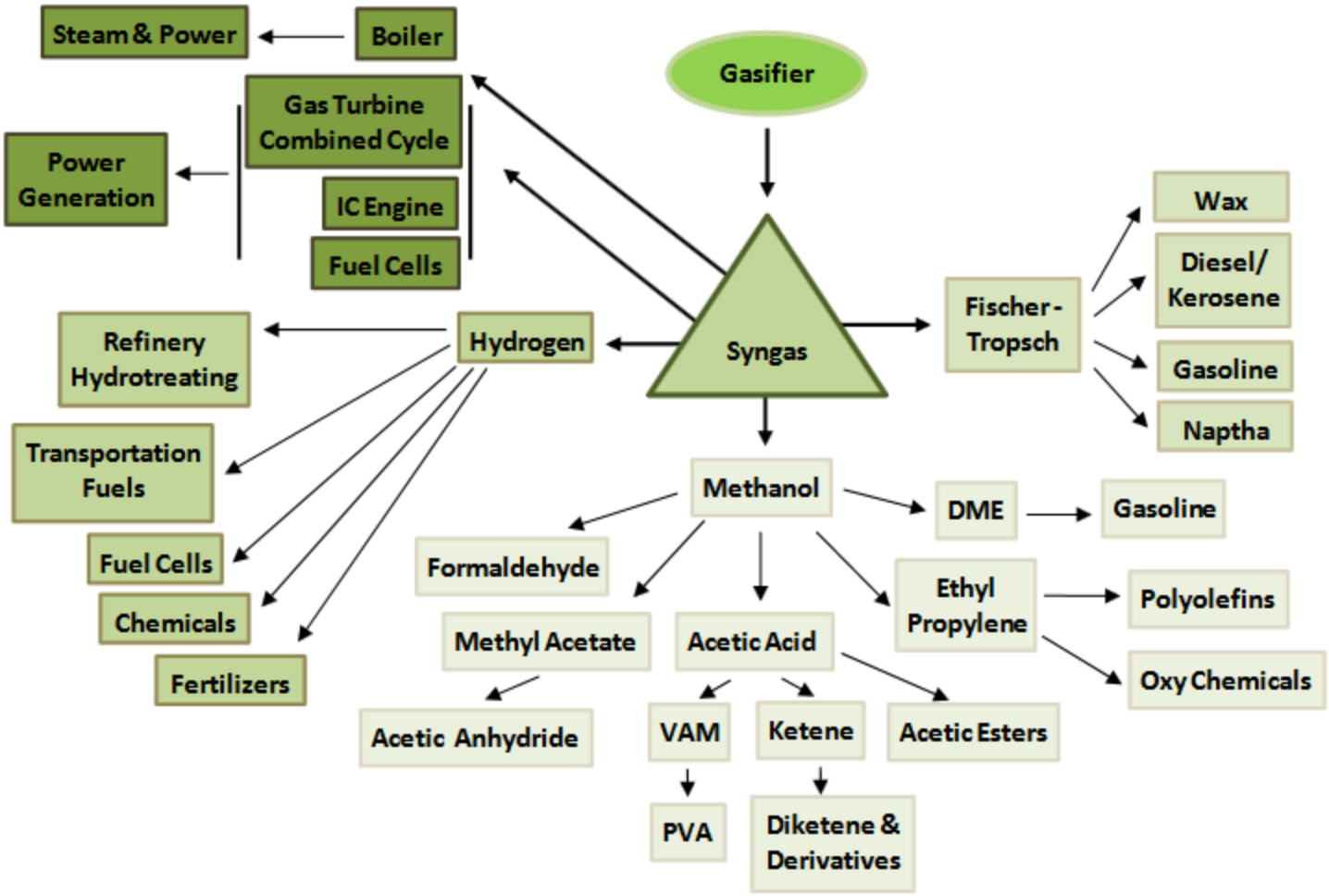
It is estimated that a potential 44 million tonnes of Municipal Solid Waste MSW could be available in the EU in 2030

Wasted - Europe's Untapped Resource: An assessment of advanced biofuesl from wastes and residues)

BIOFUELS
Czech Technology Platform



Gasification Output Pathways[15]



TECHNOLOGICKÉ CESTY transferu SYNGASu

1. Termo-chemická - katalytická (vysoké teploty, tlaky)

   FT – vyžaduje čistotu (S,CO2 – můžou deaktivovat katalýzu), stabilní poměr H2:CO

   Pro heterogenní vstupy (MSW, biomasa) prakticky nevhodné, Efektivita transferu 45%

2. GAS Fermentation - Mikrobionální –metabolická

(pH,mezofilní 27-40°C, termofilní 55-80°C)

Nevyžadují konstantní poměr H2:CO, nepotřebují externí gas-shift proces, tolerantnější k nečistotám, lepší výnosnost a efektivita transferu 57%, nižší emise CO2

Komercionalizace : INEOS Bio, Coscata, Lanza Tech

Vhodnější na SYNGAS jsou mezofilní mikroby jako:

Clostridium aceticum
Acetobacterium woodii
C. Carboxydivorans
C. ljungdahlii…

https://books.google.cz/books?id=DnyfnOsTLfcC&pg=PA82&lpg=PA82&dq=syngas+to+biofuel+pathways&source=bl&ots=TfC9MGFOR3&sig=RuNeDqyeCGRvrjJas1yXJD28ozc&hl=cs&sa=X&ved=0ahUKEwihyvisl7bLAhWo9HIKHXGeBmkQ6AEIPzAD#v=onepage&q=syngas%20to%20biofuel%20pathways&f=false

Ethanol can be produced either directly from acetyl-CoA in a two-step reaction via acetaldehyde, or via acetate and subsequent reduction to acetaldehyde. The latter proceeds via a ferredoxin: aldehyde oxidoreductase, coupled to, for example, CO oxidation, while the direct route utilises an aldehyde dehydrogenase or a bifunctional aldehyde/alcohol dehydrogenase enzyme [150]. Acetaldehyde is finally reduced to ethanol via an alcohol dehydrogenase. In some acetogens, micro-compartments have been found in which this reaction may take place [91]. In the next two sections, strategies to optimise for ethanol production, either by fermentation or mutagenesis and genetic modification, are discussed.

Ethanol can be used as a complete transportation fuel, and it is also used to supplement gasoline as a fuel blend, improving octane and reducing emissions. Commercial applications of gas fermentation to date have primarily focused on the production of ethanol [150], using the following organisms as biocatalysts.

C. ljungdahlii was isolated from chicken waste in 1988 by Barik *et al.* [151] and later described by Tanner *et al.* in 1993 [152]. With autotrophic growth on CO, and on H_2 and CO_2, this organism has become one of the most well studied acetogens following the elucidation of its genome [91].

C. ljungdahlii also grows heterotrophically on a range of substrates including fructose, glucose, ethanol and pyruvate [152]. When synthesis gas is used as a substrate, both acetate and ethanol are produced, with an ideal growth temperature of 37 °C [152]. Early work with a cell recycled culture with a 560 h fermentation time achieved an ethanol concentration of 48 g L^{-1} [153].

"*C. ragsdalei*" or strain "P11" was isolated from duck pond sediment by researchers from The University of Oklahoma and Oklahoma State University and is described in a patent [154]. "*C. ragsdalei*" has been explored for the production of ethanol from syngas [155–157], with growth temperatures of 32 °C–37 °C [157] and a batch fermentation reported ethanol concentration of 1.99 g L^{-1} [158]. In a 100 L stirred tank reactor (STR) an ethanol concentration of 25.26 g L^{-1} was achieved over a fermentation duration of 59 days [159].

C. autoethanogenum was isolated from rabbit faeces in 1994 and has a reported ideal growth temperature of 37 °C [160]. Minimal research was done on *C. autoethanogenum* as a gas fermenting organism until the past five years when it has undergone research for the production of ethanol with synthesis gas or pure carbon monoxide as feedstock [161–164]. Only low-level ethanol production of 0.32 g L^{-1} [164], 0.28 g L^{-1} [160] and 0.26 g L^{-1} [163] has been reported for this strain, with CO as the sole carbon source.

A. bacchi was isolated from livestock-impacted soil in 2010 and has been recently investigated for the production of ethanol from syngas, with a reported ideal growth temperature of 37 °C [165]. This was notably carried out at an initial pH between 7.7 and 8.0, with *A. bacchi* moderately alkaliphilic [166]. *A. bacchi* strain CP15 achieved a maximum reported productivity of 1.7 g L^{-1} with 76% ethanol yield from utilised CO with pure coal derived syngas (40% CO, 30% CO_2, 30% H_2). Using biomass syngas (20% CO, 15% CO_2, 5% H_2, 60% N_2), ethanol yield from utilised CO has been reported at 65% [166].

Technologie transferu KO W2B (Waste to biofuels)

1. **INEOS Bio proces technology** Švýcarsko – USA

2. **ENERKEM technology** Kanada

3. **Fiberight technology** USA

4. **ST1** Finsko

5. **Perseo** Španělsko

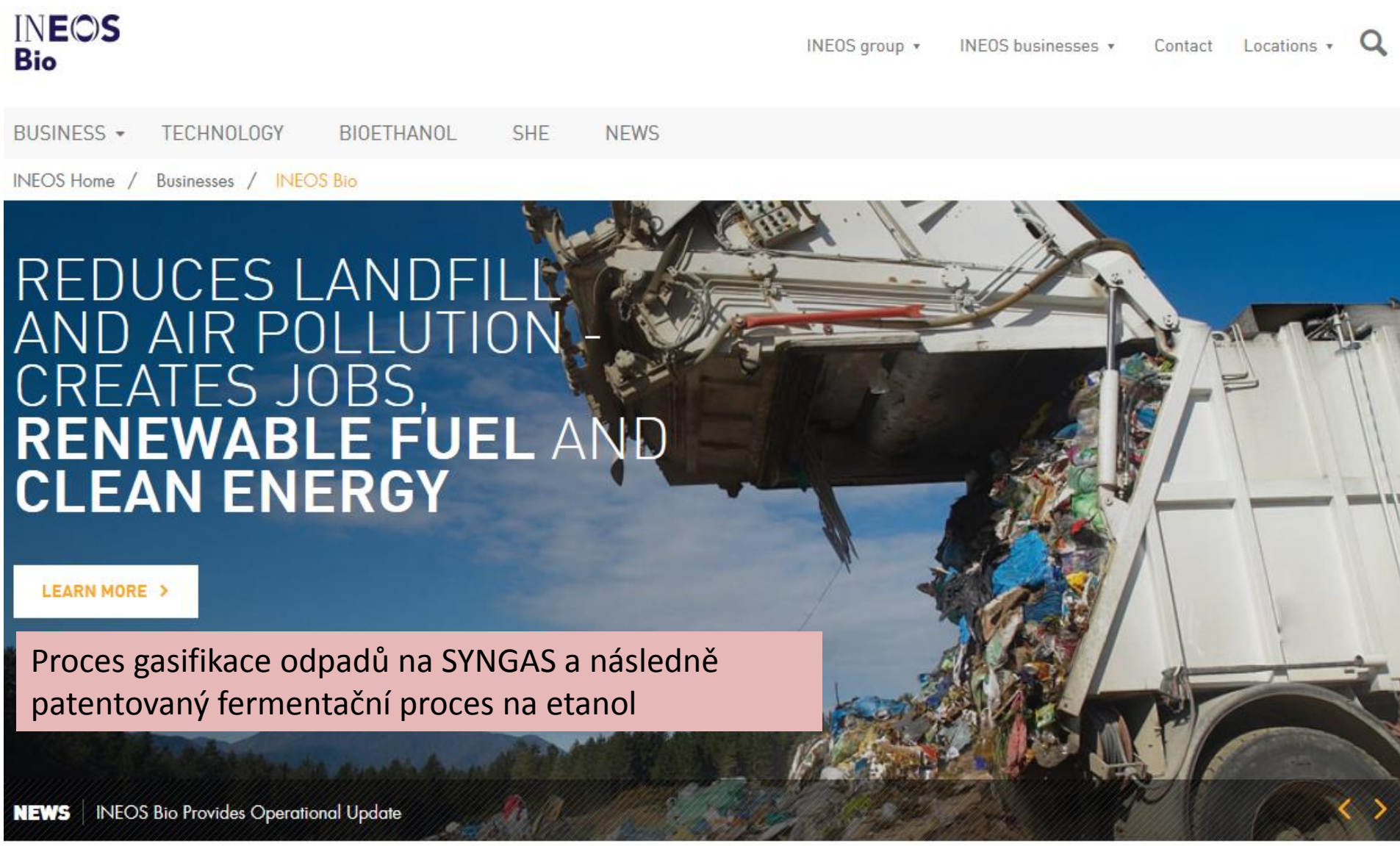
6. **Maabjerg Energy Concept** DÁNSKO

7. **Primus Green Energy** USA

8. **FULCRUM BioEnergy** USA

1. INEOS Bio proces technology

Švýcarsko – USA



Proces gasifikace odpadů na SYNGAS a následně patentovaný fermentační proces na etanol

1. INEOS Bio proces technology

Švýcarsko – USA

INEOS Bio's advanced bioenergy technology takes wastes and sustainably turns them into advanced biofuel and renewable power.

Backed by decades of experience in developing and licensing industrial-scale technology, INEOS Bio creates more sustainable communities and transportation by converting waste and non-food crop biomass into advanced biofuel. The INEOS Bio bioenergy technology solution uses a flexible approach that is safe, fast and reliable, allowing it to be commercialized wherever there is waste. By taking this localized approach, INEOS Bio reduces landfill and air pollution, creates jobs, generates tax revenue and safely produces renewable fuel and clean energy.

http://www.ineos.com/News/INEOS-Group/INEOS-Bio-Produces-Cellulosic-Ethanol-at-Commercial-Scale
http://www.ineos.com/businesses/ineos-bio/technology

1. INEOS Bio proces technology

Švýcarsko – USA

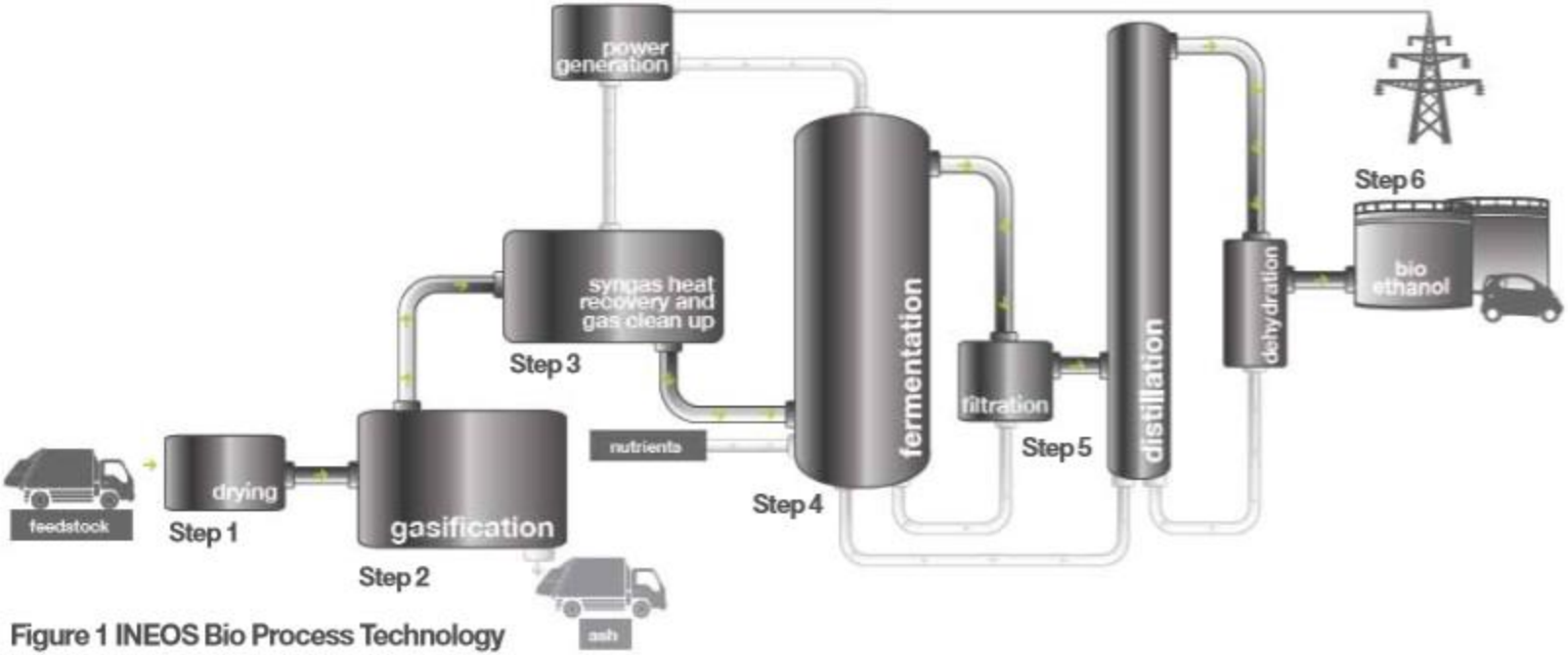


Figure 1 INEOS Bio Process Technology

1. INEOS Bio proces technology

Švýcarsko – USA

Step 1:

Feedstock reception and processing

The biomass waste materials are delivered to the INEOS Biorefinery, stored and dried using low grade heat from the gasification process.

Step 2:

Gasification

The gasification step provides the process with feedstock flexibility. All types of biomass waste can be used, including green waste, waste wood, food waste, and the biodegradable portion of mixed household and commercial waste. The prepared, dried biomass waste is converted to carbon monoxide and hydrogen gases. These gases contain important chemical energy and are the building blocks for the production of bioethanol. The mineral content from the biomass is extracted from the gasifier and is reused.

Step 3:

Gas clean up and heat recovery

The hot gases are cooled and cleaned, with the heat recovered to generate renewable power for use in the process and for export.

http://www.ineos.com/globalassets/ineos-group/businesses/ineos-bio/company/ineos-us-bio-bro_awfinal.pdf

1. INEOS Bio proces technology

Švýcarsko – USA

Step 4:

Fermentation

The cool, clean gases are introduced into the INEOS Bio patented fermentation process. Naturally occurring bacteria combine the gases to produce bioethanol. This biochemical synthesis occurs rapidly at low temperature and pressure and at high yield and selectivity. This high performance, coupled with tolerance to variations in gas composition, means fewer process steps, high energy efficiency, low bioethanol production costs and attractive investment returns.

Step 5:

Distillation and dehydration

The fermenter liquid is continuously extracted, distilled and purified to anhydrous bioethanol, meeting EPA road fuel quality standards, ready for blending and use in cars. The INEOS Bioethanol from waste counts towards the EPA Renewable Fuel Standard (RFS) Cellulosic ethanol targets.

Step 6:

Power generation

Power is generated by recovering heat from the hot syngas and by combusting vent gas from the fermentation stage of the process. The power is eligible for Renewable Energy Credits (REC).

Step 4:

Fermentation

The fermentation step is at the heart of the INEOS Bio process technology. The syngas is introduced into the INEOS Bio patented fermentation process, where naturally occurring bacteria combine gases to them efficiently, selectively and rapidly to produce bioethanol. The fermenter is agitated to aid gas-liquid transfer. The INEOS Bio fermentation process takes only a few minutes, compared to 1–3 days for conventional, first generation and cellulosic fermentation processes. The INEOS bio-chemical synthesis takes place at low temperature and pressure and with high yield and selectivity. This high performance, coupled with tolerance to variations in syngas composition and to common catalyst poisons, means fewer process steps, high energy efficiency, low bioethanol production costs and attractive investment returns.

Nutrients are added to provide for cell growth and automatic regeneration of the biocatalyst. INEOS Bio's proprietary combination of microorganism, nutrients, process design and conditions produces bioethanol at industrial quantities and at a commercially attractive and competitive cost. The bioethanol is synthesized according to the following principal reactions:

$$6CO + 3H_2O \rightarrow CH_3CH_2OH + 4CO_2 \quad (2)$$

$$6H_2 + 2CO_2 \rightarrow CH_3CH_2OH + 3H_2O \quad (3)$$

Carbon and hydrogen in the initial raw material is converted into ethanol; with high yields achieved. Combining equations (1) – (3) gives:

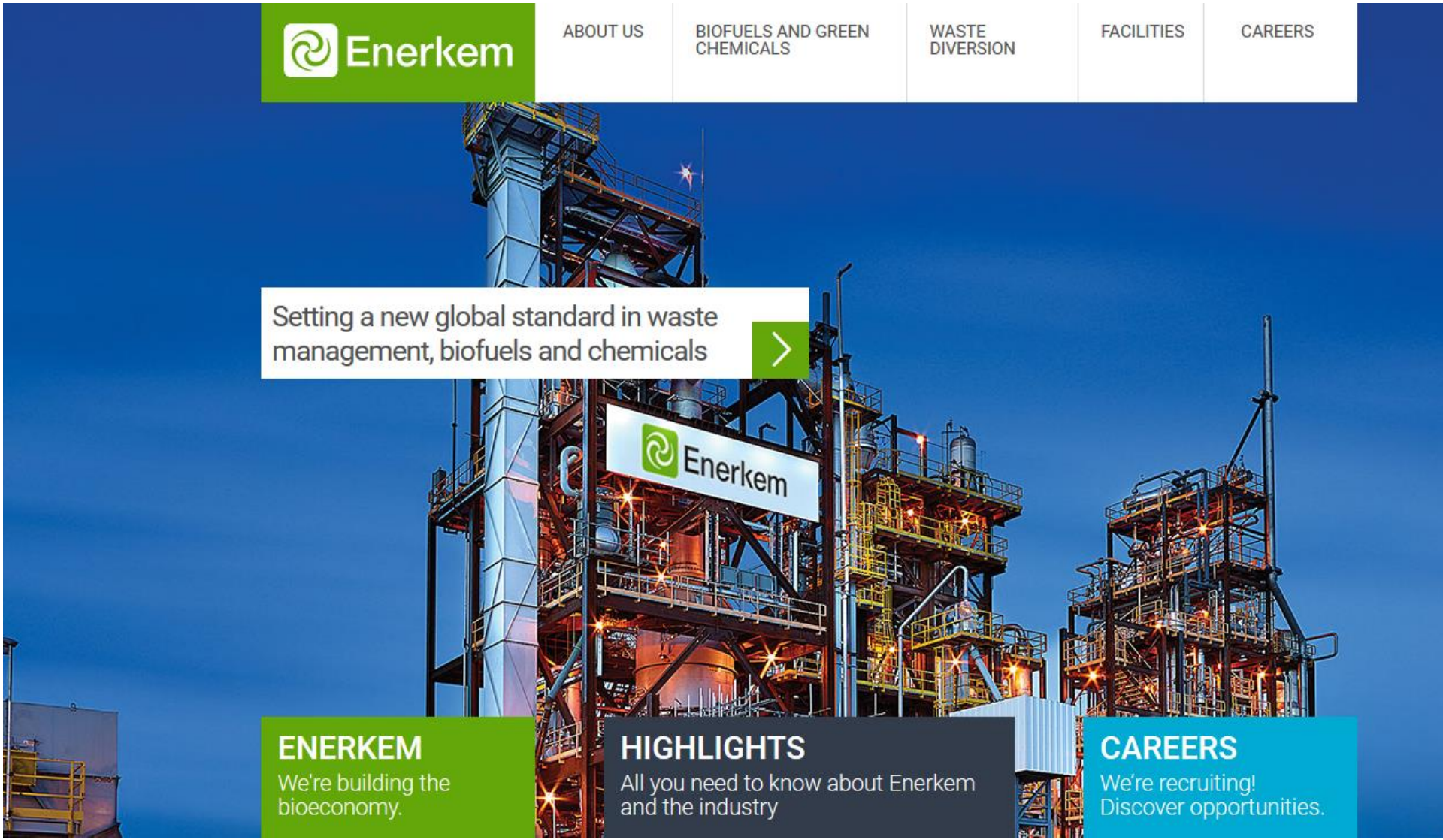
$$8CH_2O + O_2 \rightarrow 2.33CH_3CH_2OH + 3.33CO_2 + H_2O \quad (4)$$

Table 2: Comparison of ethanol yields from biomass – EtOH gallons per dry US ton

	Current measured	Theoretical maximum
INEOS Bio process technology	75–100	135–145
Acid hydrolysis and fermentation	55–65	80
Enzymatic hydrolysis and fermentation	60–70	85

2. ENERKEM technology

Kanada

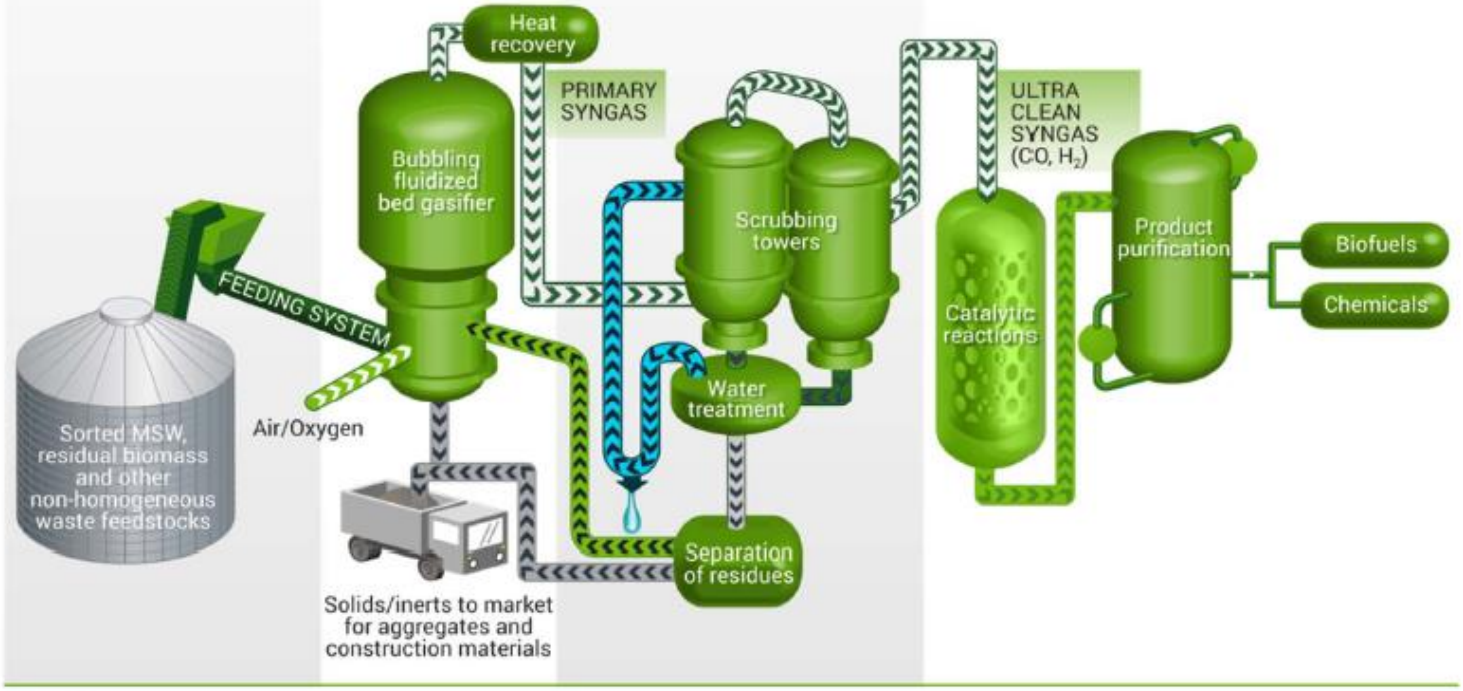


2. ENERKEM technology

Kanada

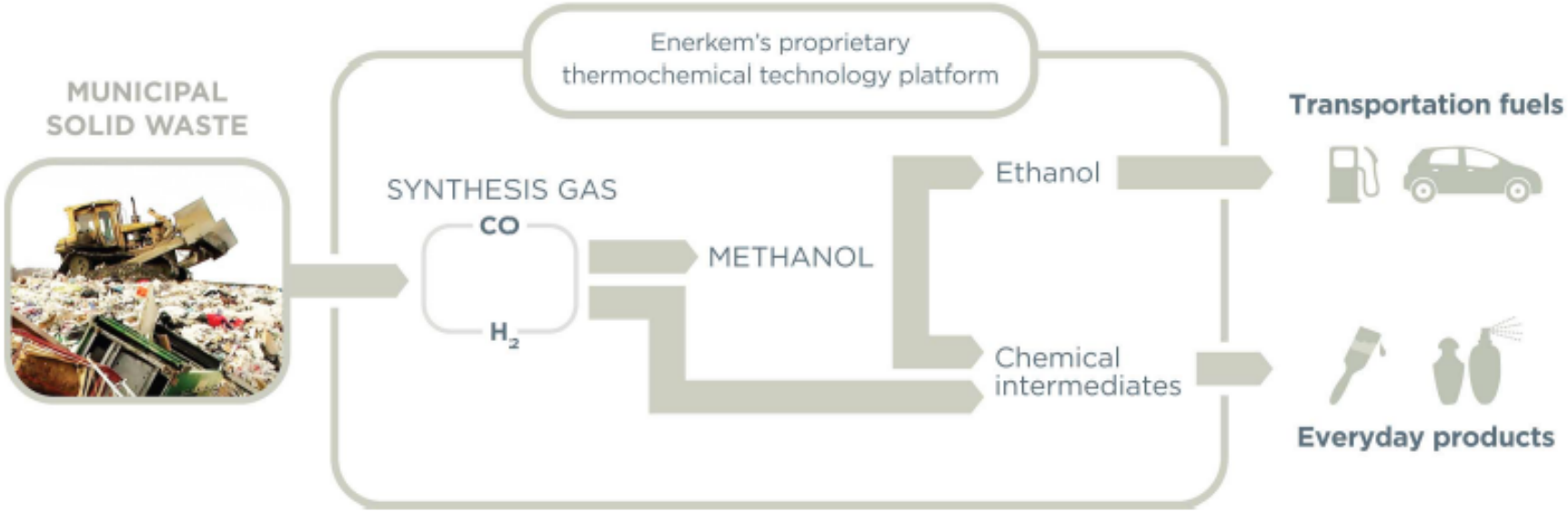
An efficient "carbon-recycling" process

Feedstock preparation	Gasification	Cleaning and conditioning process	Catalytic synthesis and product purification
Sorting, shredding, drying (if required) and feeding	Conversion of carbon-rich residues into synthetic gas	Primary syngas purification	Conversion of chemical-grade syngas into final renewable products



2. ENERKEM technology

Kanada



Enerkem Inc. has developed a liquid phase methanol process using syngas produced from biomass. The chemical reaction is carried out in a slurry reactor using a $Cu/ZnO/Al_2O_3$ catalyst at temperature ranging from 230 to 260 °C and 50 to 100 atm. The commercial reactor used a liquid entrained reactor in which fine grains of catalyst are slurried in an inert high-boiling oil typically white mineral oil.

2. ENERKEM technology

Kanada

The Enerkem Alberta Biofuels facility will help to increase the City of Edmonton's waste diversion rate from 50% to 90%.

Edmonton

Alberta Innovates Energy and Environment Solutions

Type: commercial

Status: initiated production (biomethanol) in 2015; ethanol module currently being added; ethanol production start planned for 2017

Feedstock: post-sorted municipal solid waste (after recycling and composting)

Products: methanol, ethanol

Capacity: 38 million litres / 10 million gallons per year

Enerkem Alberta Biofuels LP
Site 460, 250 Aurum Road NE
Edmonton (AB) T6S 1G9 CANADA

2. ENERKEM technology

Kanada

PROJECTS AND PARTNERSHIPS

PARTNERING WITH MUNICIPALITIES, WASTE MANAGEMENT AND PETROCHEMICAL GROUPS GLOBALLY

Enerkem is open to partnerships with industry leaders to implement facilities that utilize municipal solid waste to produce clean fuels and renewable chemicals. In addition to licensing its technology, Enerkem provides fully fabricated modular equipment and handles assembly on site.

Several Enerkem biorefineries are now in development around the world, based on the company's modular and standardized manufacturing approach. This includes a series of publicly announced projects in North America and globally. Some of Enerkem's current partnerships are summarized below.

2. ENERKEM technology

Kanada

COST-EFFECTIVE SOLUTION

A LOWER-COST OPTION FOR WASTE MANAGEMENT THAN INCINERATION OR LANDFILLING

Converting waste into biofuels and chemicals with Enerkem's technology is competitive with landfilling and less capital intensive than incinerating waste – actually 2x more capital efficient per ton of waste converted.

Biofuels with lower production costs than gasoline and other comparative alternatives

Enerkem's technology uses non-conventional feedstock to produce biofuels and renewable chemicals, at the lowest cost relative to traditional production methods. Enerkem's attractive cost structure is driven by:

- Our low-severity operations (lower temperature, pressure and energy requirements)
- Our compact facilities built according to Enerkem's modular and standardized approach
- A low-value feedstock

3. Fiberight technology

USA

Fiberight

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Business Overview

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Renewable Fuels

Fiberight is one of the first companies in the US to achieve actual production of 2nd generation biofuels at an industrial scale. Fiberight's proprietary extraction, pulping and digestion processes have the potential to unlock over 5 billion gallons of renewable biofuel contained in the 175 million tons of Municipal Solid Waste (MSW) generated each year in the United States. Fiberight's facilities operate at low temperatures in a closed-loop system resulting in nominal levels of emissions or effluents. Our intention is to build, own and operate biorefineries that 1) ends the practice of perfecting good materials being buried or burned rather than recycled 2) provides a cost-competitive recycling market that transforms trash into valuable end-products, including cellulosic ethanol that meets EPA RFS2 renewable biofuel targets and 3) reduces our country's dependence upon fossil fuels and foreign oil.

Latest News

- CPI Collaboration
- US firm developing plans to turn household waste into sugar on Teesside
- Plan for New Municipal Waste Processing Plant Moves Forward

News Topics

- BioFuel Industry Info
- Business News
- Our Environment

3. Fiberight technology

USA

https://www.youtube.com/watch?v=GkF6voicQ8E

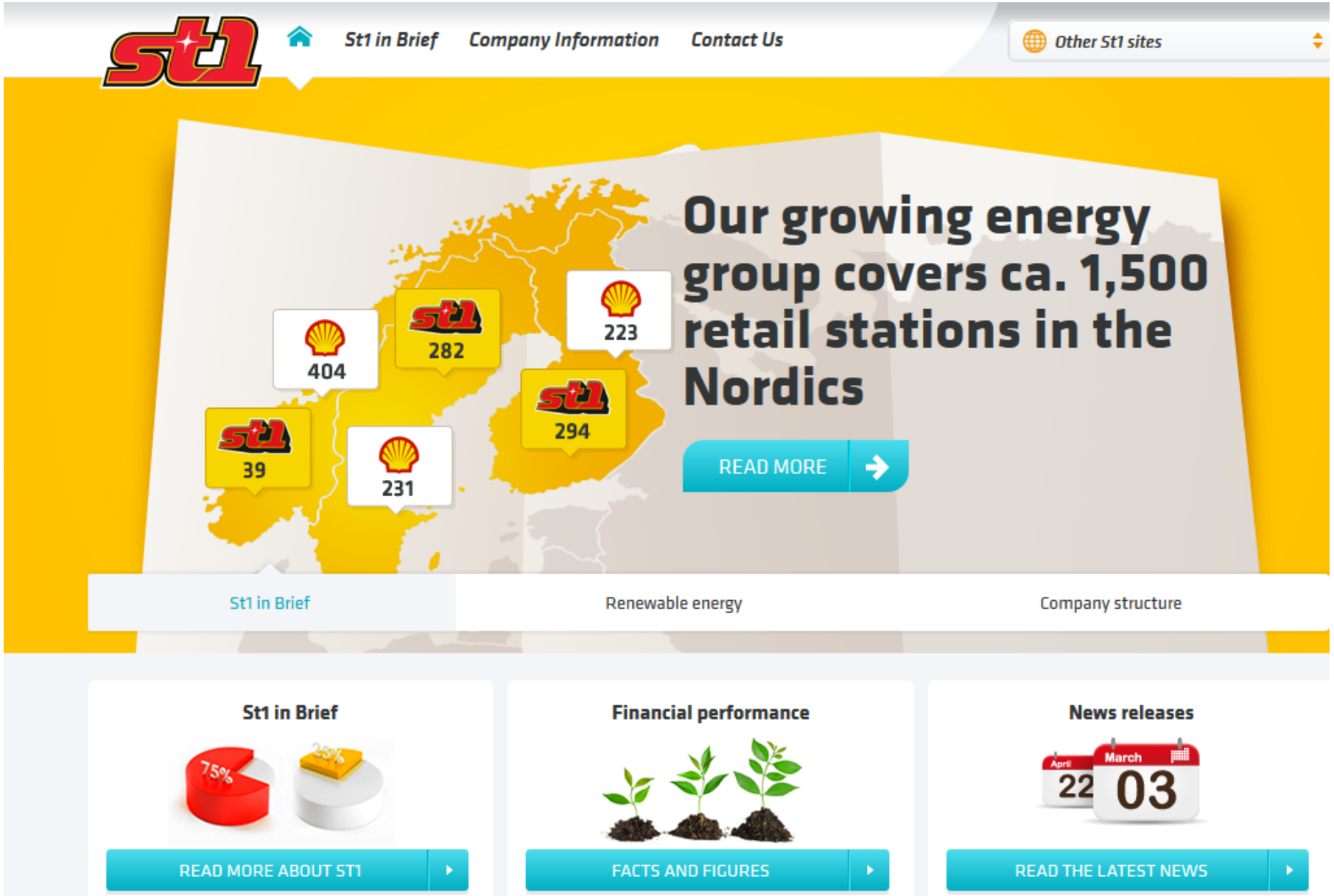
3. Fiberight technology
USA

Fiberight developed a **Targeted Fuel Extraction (TFE)** process to cost effectively and efficiently convert municipal solid waste (MSW) into cellulosic biofuel

Fiberight Zpracování KO na výsledný EtOH s označením **Trashanol™**.

V září 2015 zahájená kooperace s britskou CPI (Centre for Process Innovation) pod akademickým dohledem LEEDS ACADEMY konsorcium 7 subjektů je cílem zapojit SME do komercionalizace zpracovávání KO.

4. ST1
Finsko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39
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Our growing energy group covers ca. 1,500 retail stations in the Nordics
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4. ST1
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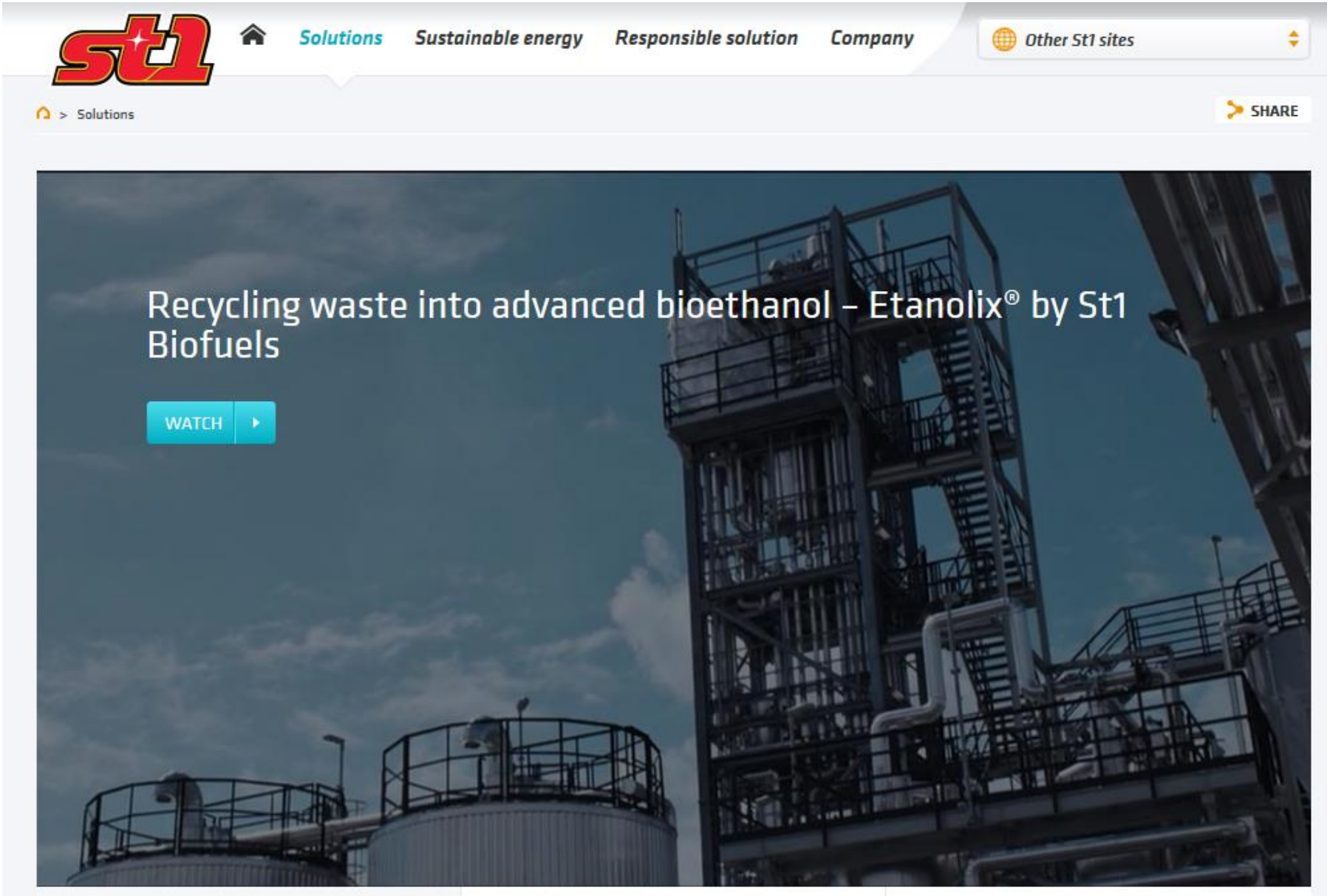
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Recycling waste into advanced bioethanol – Etanolix® by St1 Biofuels
WATCH

4. ST1
Finsko

BIONOLIX® – RECYCLE MUNICIPAL AND RETAIL BIOWASTE INTO BIOETHANOL

The Bionolix® plant makes it possible to produce sustainable biofuel from municipal and commercial biowaste. Pre-handling of packaged biowaste enables more efficient recycling. Thus, the amount of biodegradable waste ending up in landfills can be minimized.

The Bionolix® plant meets the criteria set by EU legislation for the treatment of out-of-date food. Bionolix® process recycles biowaste into ethanol, a base chemical for various applications. Instead of mere energy recovery, biowaste can be treated as feedstock for bioethanol production. The stillage from the process can be used in biogas production. Biogas can be used for local electricity and district heating or other local energy needs. Furthermore, the side product of biogas production may be utilized as an organic soil conditioner to fertilize land. For example, in Finland we have two side products from the process, which are organic soil conditioner and liquid fertilizer.

The Bionolix® technology is being tested and operated since 2010 in the Karanoja waste treatment area in Hämeenlinna, Finland. Bionolix is the next commercially available plant type in the portfolio.

5. Perseo
Španělsko

“Producción de Etanol a partir de Residuos Sólidos domÉsticos Orgánicos”

Ethanol production from organic fraction of MSWs

5. Perseo
Španělsko

perseo bioethanol

IMECAL

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| Maps Location

PREMIO FEMEVAL 2011

PERSEO Bioethanol® has developed a process technology able to convert the organic fraction of urban waste into a liquid biofuel of second generation for transport, plus an organic solid fuel able to produce thermal and electric energy by cogeneration.

The disposal of urban solid waste produced daily by our society, is one of the major environmental problems of our day. Today, the urban waste are treated in plants to recover value materials (plastics, metals, glass, etc.) but remain a 50% of organic material that produces emissions and odors and pollute the land, air and water.

Sustainable energy for future is a need, IMECAL through the PERSEO Bioethanol® technology and their experimental is a pioneer in transforming waste into second-generation liquid biofuels.

5. Perseo
Španělsko

perseo bioethanol

Sustainable Bioethanol from Municipal Solid Waste

TBB. The Business Booster BY KIC INNOENERGY

Simplified Perseo Process Technology Overview

Sustainable process to turn bio-waste fraction from MSW into bioethanol, energy and disposable ash.

5. Perseo
Španělsko

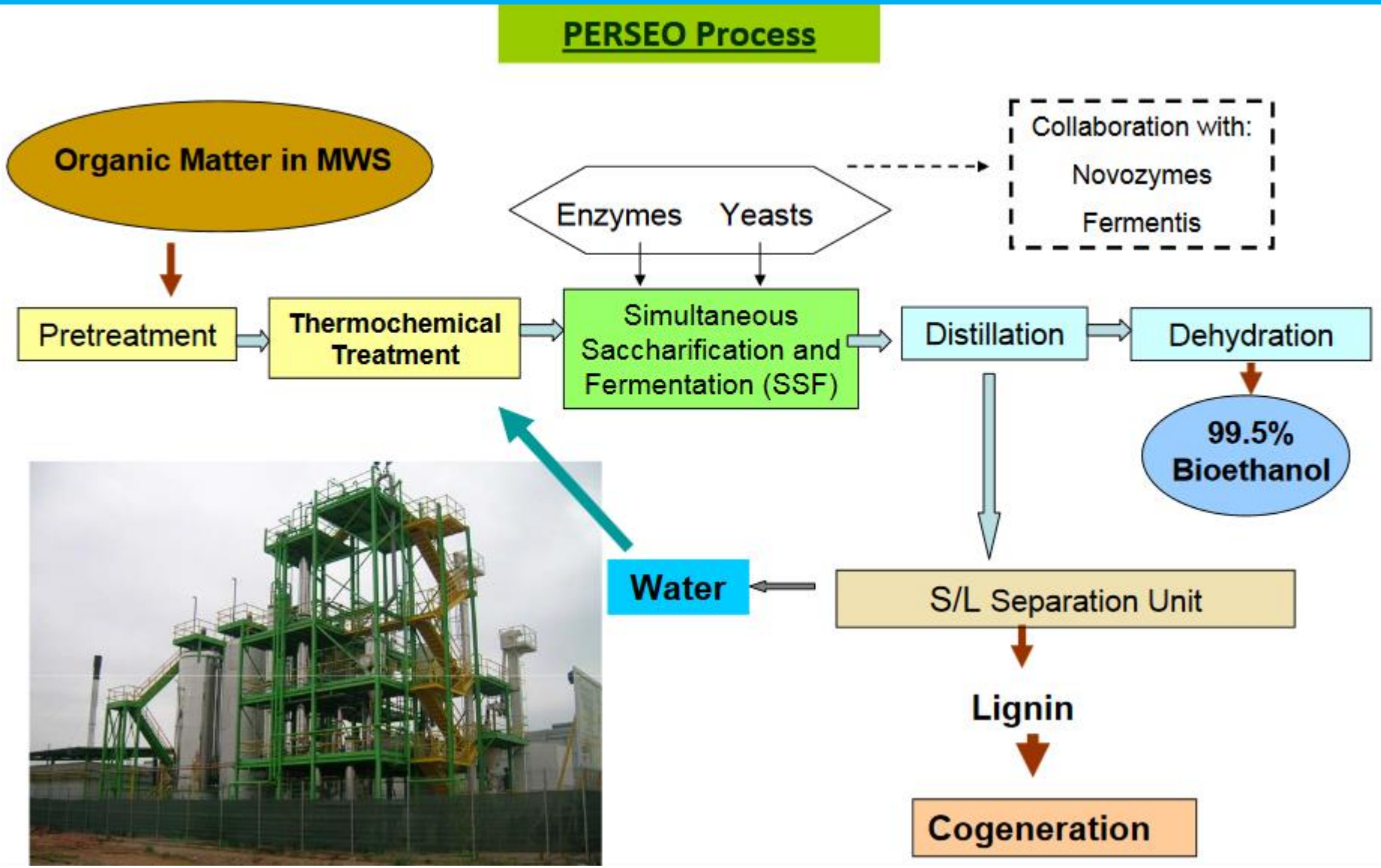
PERSEO Bioethanol® has developed a process that is feasible, replicable and profitable:

- Development of a simple biotechnological process with good yields of bioethanol conversion.
- Process proven at semi-industrial scale: optimisation and improvement to obtain a feasible and profitable process.
- Biorefinery concept development.
- Solving sorting problems in order to guarantee a stable process.
- Better economical results than current WT technologies.

http://www.imecal.com/perseo/ingles/bio_2G.html

http://www.kic-innoenergy.com/venture/imecal-s-a-2/

5. Perseo
Španělsko



https://www.researchgate.net/publication/265560236_PERSEO_Project_Bioethanol_from_daily_organic_fraction_of_municipal_solid_waste

5. Perseo
Španělsko

Goal:

Produce **LIGNOCELULLOSIC BIOETHANOL** at **35 cent. EURO per LITER.**

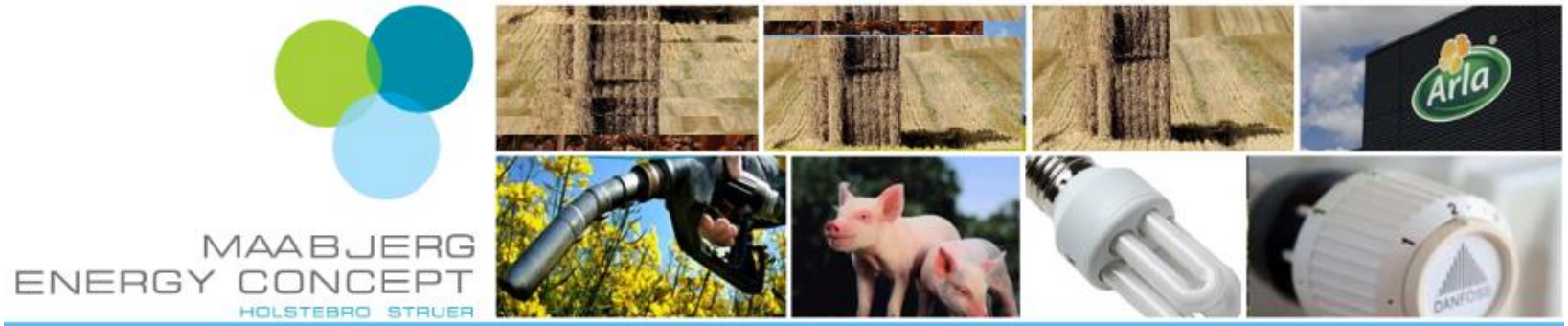
- **Feedstock cost: 0 € / l bioethanol**
- Additives, Enzymes and Yeast costs: 0.1 € / l bioethanol
- Instalation fixed costs and amortization: 0.2 € / l bioethanol.
- Utilities and labour: 0.05 € / l bioethanol

Data based on:

- Real Plant of 500 Ton Organic Fraction from MSW per day.
- Daily production: 16.000 liters ethanol.
- Investment on instalation fix assets: 12-15 Mill. Euro.
- TIR: 10 years.

6. Maabjerg Energy Concept

Dánsko



The MEC BIOREFINERY

EBTP - 6th Stakeholder Plenary Meeting of the European Biofuels Technology Platform

Niels Henriksen, DONG Energy/Inbicon

6. Maabjerg Energy Concept

Dánsko

Input & output

MAABJERG ENERGY CONCEPT
HOLSTEBRO STRUER

Input

- 90 GWh power
- 50.000 tons of household waste
- 100.000 tons of industrial waste
- 120.000 tons of waste water sludge
- 185.000 tons of biomass from dairies etc.
- 500.000 tons of manure
- **300.000 tons of straw**

MEC – plants

Biomass based power and heating

58.000 t
Lignin

2. Generation bioethanol

92.000 t
Vinasses

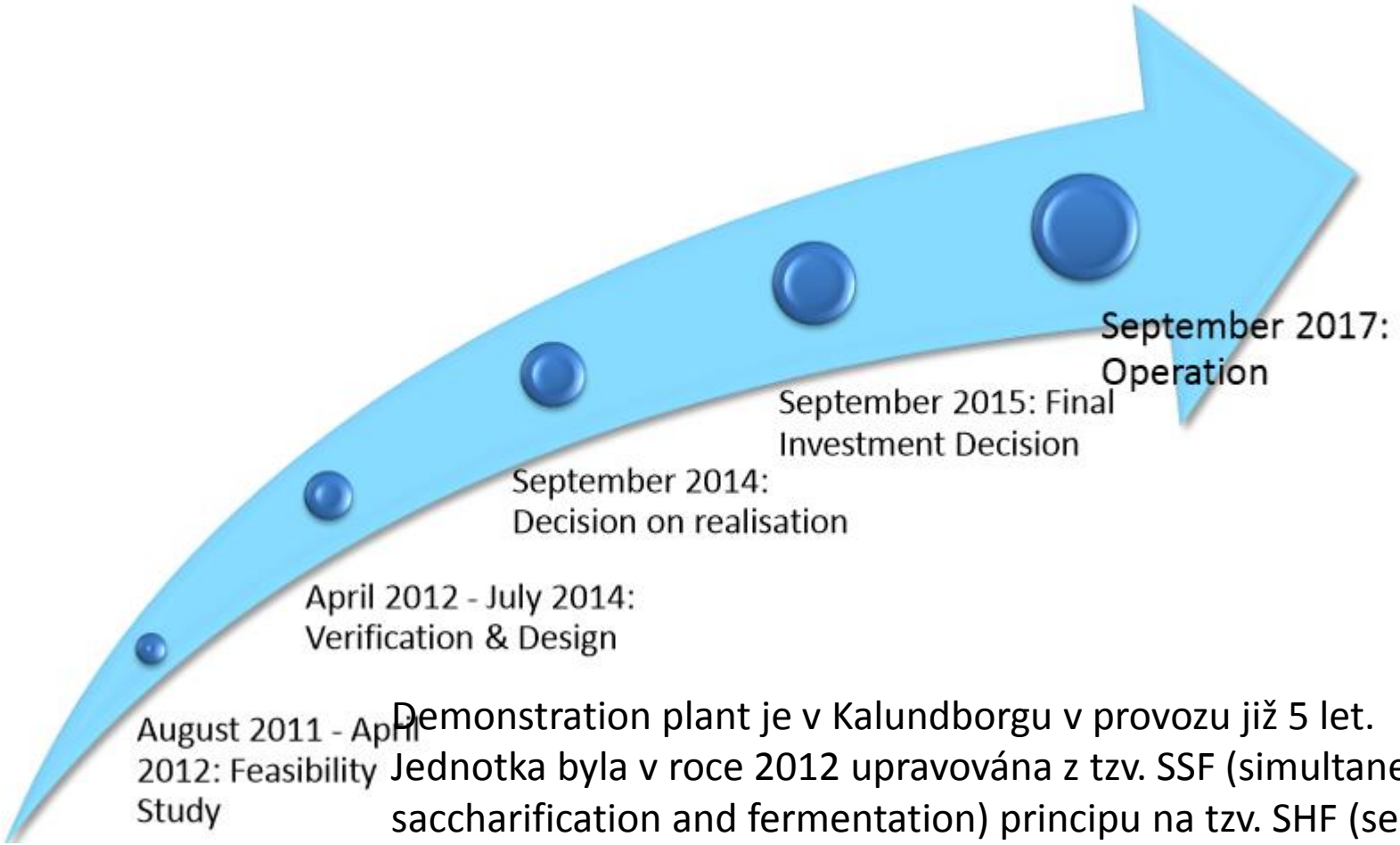
CNG
Biogas

Output

- 140 GWh power
- 1.766 TJ of heating for 20.000 house holds
- 80 mill. litres of 2G bio ethanol
- 34.000 tons of lignin
- 10 mill. m^3 of biogas
- 16 mill. m3 of CNG
- 600.000 tons of fertiliser

6. Maabjerg Energy Concept

Dánsko



Demonstration plant je v Kalundborgu v provozu již 5 let. Jednotka byla v roce 2012 upravována z tzv. SSF (simultaneous saccharification and fermentation) principu na tzv. SHF (separate hydrolysis and fermentation) princip. Tato úprava výrazně snížila náklady na enzymy. Poslední úprava byla v roce 2013 kdy byli vyvinuty speciální kvasinky a produkce EtOH z biomasy se zvýšila nad 40%.

6. Maabjerg Energy Concept

Dánsko

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7. Primus Green Energy

USA

PRIMUS GREEN ENERGY™
Your GTL Partner™

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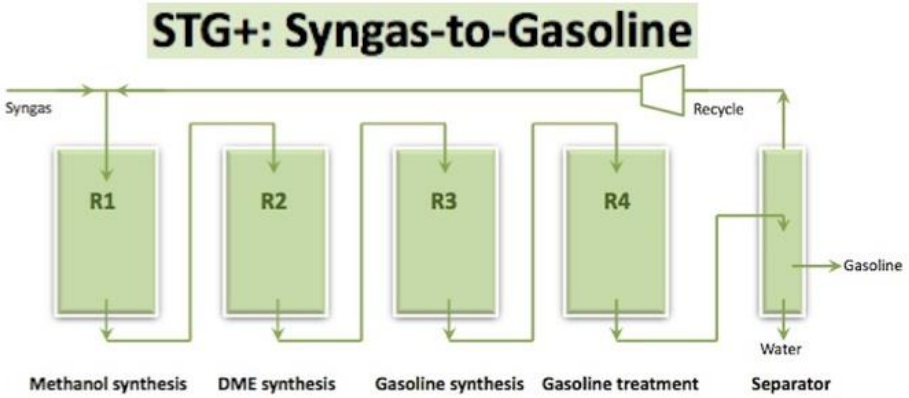
Products

- **Overview of Primus STG+™ Technology**
- Primus Gas-To-Gasoline System
- Primus Gas-To-Methanol System

Overview of Primus STG+™ Technology

As a global leader in the gas-to-liquids (GTL) space, Primus has developed a range of flexible, advanced GTL systems to meet the increased demand for gas monetization technologies. All of Primus' GTL systems feature our breakthrough STG+™ technology. With STG+™ technology at their core, our GTL systems are simple and economical at scales as small as 5000 MMBtu/day of feed gas. The STG+™ process is highly integrated and utilizes a unique single-loop approach that eliminates wastewater and produces a single finished product. Primus' STG+™ process has been optimized for a number of applications, including flared gas utilization, monetization of stranded ethane, conversion of pipeline natural gas into valuable liquids and monetization of excess syngas from underutilized reformers. To learn more about Primus' STG+™ technology, download the white paper entitled "Introduction to Primus' STG+™ Technology" here.

7. Primus Green Energy
USA



VIDEO

Factor/Process	Primus STG+™	Haldor Topsoe TIGAS	ExxonMobil MTG
Product Flexibility	Gasoline or methanol or diluent	Gasoline	Gasoline
Durene Reduction	Integrated	Separate	Separate
Number of Major Steps	2 (Syngas,Gasoline Synthesis)	3 (Syngas, TIGAS, durene reduction)	4 (Syngas, methanol, MTG, durene reduction)
Scale Flexibility	Small to large	Small to large	Limited to methanol plant size
Catalyst Sourcing	Multiple sources	In-house	Combined
Integration Economies	Highly integrated	Unknown	Little integration; separate plants
Footprint	Small	Medium	Larger

http://www.primusge.com/wp-content/uploads/2015/09/White-paper-GTL-Comparison-V32.pdf

8. FULCRUM BioEnergy
USA

147,000 tons of prepared MSW feedstock into more than 10 million gallons of SPK jet fuel or diesel annually (1 galon US = 3,785 litrů) ....**tedy 37,8 Mio litrů/rok**

8. FULCRUM BioEnergy

USA

Gasification System

Fulcrum has licensed from ThermoChem Recovery International, Inc. a highly efficient and economic gasification system for the conversion of the MSW feedstock to syngas. During the gasification process, the prepared MSW feedstock rapidly heats up upon entry into the steam-reforming gasifier and almost immediately converts to syngas. A venturi scrubber captures and removes any entrained particulate, and the syngas is further cooled in a packed gas cooler scrubber. The cleaned syngas is then processed through an amine system to capture and remove sulfur and carbon dioxide. The syngas then enters the secondary gas clean-up section that contains compression to increase syngas to the pressure required by the FT process. The end syngas product is very clean with zero sulfur content.

Fischer-Tropsch Process

The FT portion of Fulcrum's process is an adaptation of the well-established Fischer-Tropsch process which has been in commercial operations for decades. In the FT process, the purified syngas is processed through a fixed-bed tubular reactor where it reacts with a proprietary catalyst to form three intermediate FT products, a Heavy Fraction FT Liquids (HFTL) product, a Medium Fraction FT Liquids (MFTL) product and a Light Fraction FT Liquids (LFTL) product, commonly called Naphtha. The Naphtha is recycled to the partial oxidation unit with remaining tail gas to be reformed to hydrogen and carbon monoxide. We have demonstrated our FT process using fixed-bed tubular reactors identical in size to those that will be deployed at our plants.

Fuel Upgrading

In the last step, hydrotreating, hydrocracking and hydroisomerization upgrading steps are used to upgrade the combined HFTL and MFTL products into jet fuel.

Technologie transferu KO W2B (Waste to biofuels)

1. **INEOS Bio proces technology** Švýcarsko – USA

2. **ENERKEM technology** Kanada

3. **Fiberight technology** USA

4. **ST1** Finsko

5. **Perseo** Španělsko

6. **Maabjerg Energy Concept** DÁNSKO

7. **Primus Green Energy** USA

8. **FULCRUM BioEnergy** USA

Záměr –účel této prezentace

ČTPB chce veřejně informovat o technologickém stavu a možnostech zpracování komunálního odpadu **modernějším – efektivnějším – environmentálně lepším** způsobem než je likvidace odpadu spalováním.