



Biomass-to-Methanol, is there enough biomass?

"The 3 E's"

2015 European Methanol Policy Forum

13 & 14 October - Brussels

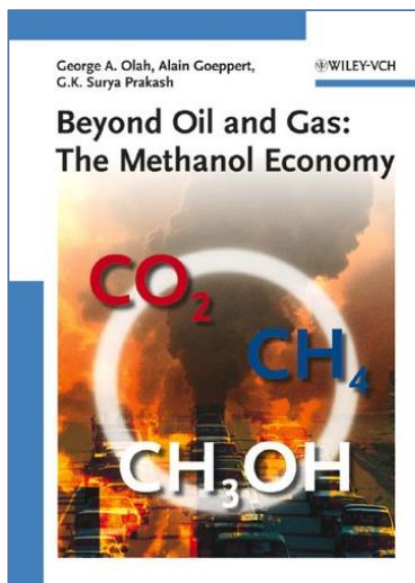
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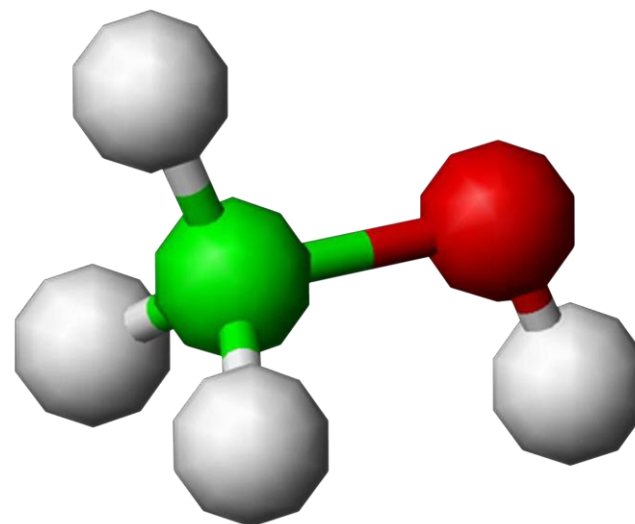
Founded in August 2011, Nordic Green is the result of two guys meeting by chance...



One was inspired by
"The Methanol Economy"



The other was looking for green products with
a unique identity in the market



*both wanting to make an impact,
perhaps even **change the world***

Today's agenda

- 1) Who is Nordic Green
- 2) Understanding bio-MeOH – in more than one way
 - 1) From a production POV
 - 2) From a customer POV
- 3) Our friends and allies
- 4) "Novel Concept"
- 5) "The 3 E's"
 - And why there is plenty of biomass in the future...
- 6) The nearer future...
- 7) Plato...

In an ideal world...

All the noble ideas triumph

**But in the real world; without
economics in place...
You crash and burn!**

Making sure message is not lost...



Our main-key to success is

“The Nordic Green Value Tool”,
enabling us to understand the VP from our
customers POV

Economics

We have made our way into several major fuel companies and more are in the pipeline by understanding the business-case from their POV: **“The Black Box”** of the gasoline companies.



We can calculate the earnings the companies will achieve with high accuracy based on a “snapshot”

One of the major companies said, about our prediction on their earnings:

“This is very very close”

Economics

A look inside...

Nordic Green has developed tools that breaks down into pieces all the different cost and value-adding components of bio-methanol in a Gasoline Low Blend.

There are five groups of components for Gasoline Low Blend and a total of nine factors. The factors are seen below (DK as example)

Impact factor	
Infrastructure	1. Infrastructure inv.
Logistics	2. Logistics
Gasoline impact	3. Price per m3
	4. Vapor pressure
	5. Octane boost
Biodiesel (EtOH)	6. Substitution
	7. Seasons
Tax	8. Energy-tax
	9. CO2-tax



Tool for calculating
fuel price structure & cost reduction of using 2G bio-methanol, Gasoline Low Blend

1. Fill in the information below

1. Fill in the field -

2. Summary

3. General information

4. Detailed information

4.1 Infrastructure

4.2 Logistics

4.3 Gasoline

4.4 Gasoline

4.5 Gasoline

4.6 Biodiesel

4.7 Biodiesel

4.8 Tax: Energy

4.9 Tax: CO2

4.10 Additional cost

5. Sensitivity analysis

6. Quote

Product

Unit

Butane factor on naphta (#)

Butane price (€/m3)

Gasoline (€/m3)

Difference (€/m3)

Cost factor for M1.7* (€/m3)

RVP butane (kPa)

Additional cost (€/m3)

Additional cost Sum (€/year)

Gasoline (m3/year) 1,000

Diesel sales (m3/year) 1,000

Source: Energinet og statistik 2011/12 p.23/33
http://www.eat.dk/Viden/Publikationer/Energinet

Type in the volume of fuel you sell per year (cubic meters)

Gasoline (m3/year) 1,000

Diesel sales (m3/year) 1,000

Source: Energinet og statistik 2011/12 p.23/33
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Type in number and type of terminals

No. of terminals in DK (#)

Can tanks be re-used

4.4 Vapour pressure

Vapour pressure

Product

Unit

Butane factor on naphta (#)

Butane price (€/m3)

Gasoline (€/m3)

Difference (€/m3)

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Type in number and type of terminals

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5. Sensitivity analysis

Break-even and Return on investment (ROI) analysis

Month	0	2	4	6	8	10	12	ROI (%)	Payback time	
									Month	Days
Worst (€)										
Medium (€)										
Best (€)										

How much of the total variance is attributed to factor 2 - 7) without investment

5% 10% -1%

24% 19% 41%

Higher vapour pressure of n

DRVP equations (black box parameter), page 11

Sensitivity analysis, page 20

Payback time, ROI (page 22), etc.

Frontpage, 24 pages in total, page 1

All parameters put into one page, page 2

5. Sensitivity analysis

Break-even and Return on investment (ROI) analysis

Month	0	2	4	6	8	10	12	ROI (%)	Payback time	
									Month	Days
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Medium (€)										
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Break-even

Conclusion

1) There is a Return On Investment between 456% and 10,789%. The most important factor is whether there are tanks that can be re-used or not and how many terminals there are to be upgraded. The medium ROI is 4,684%.

2) There is a break-even time of between 3 and 66 days. The medium break-even time is 08 days.

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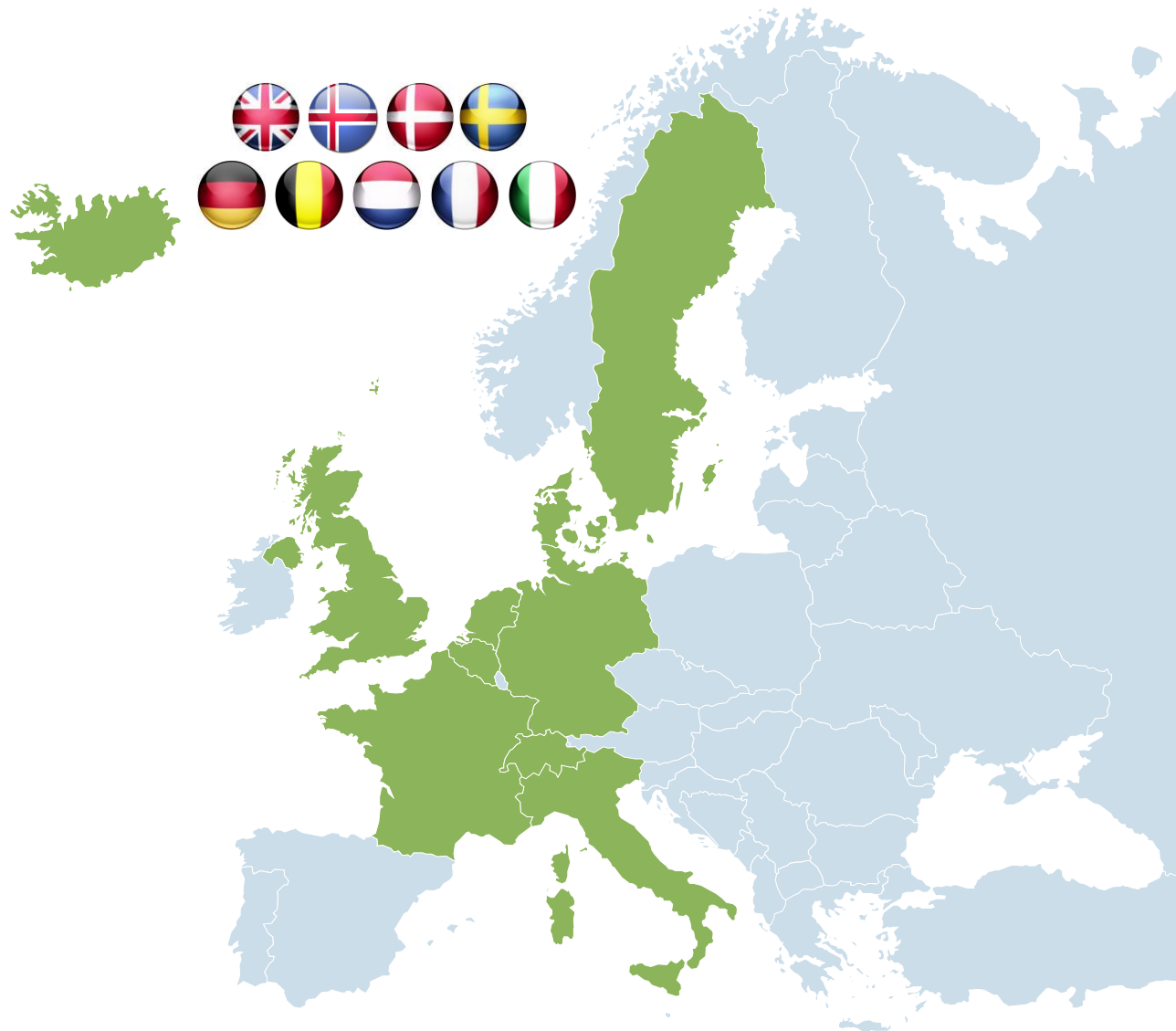
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DRVP equations
(black box parameter), page 11

Sensitivity analysis, page 20

Payback time, ROI (page 22), auto-generated quotation (not shown), page 24

Renewable methanol map



Nordic Green; Always expanding network



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11



Methanol – not only a fuel



Bio-methanol production pathways

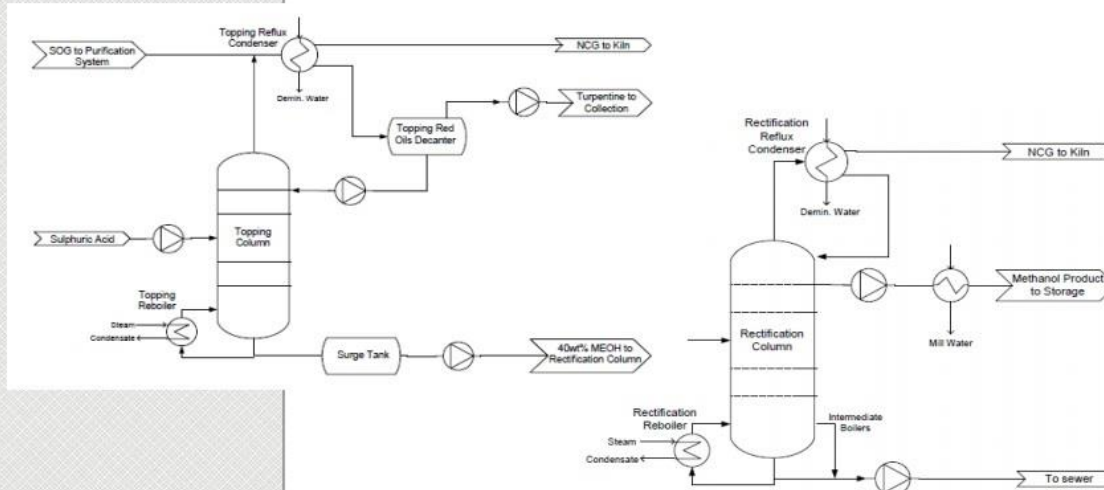
- | | |
|---|-----------------------|
| 1) Paper pulp | → Lundberg |
| 2) Black liquor conversion | → Chemrec |
| 3) Black liquor purification | → Invicotech AB |
| 4) Crude Glycerine | → BioMCN |
| 5) Biogas (both from sugar and municipal waste) | → BioMCN |
| 6) Electrolysis | → CRI |
| 7) Wood gasification | → VärmlandsMetanol AB |
| 8) Waste | → Enerkem |

Paper pulp

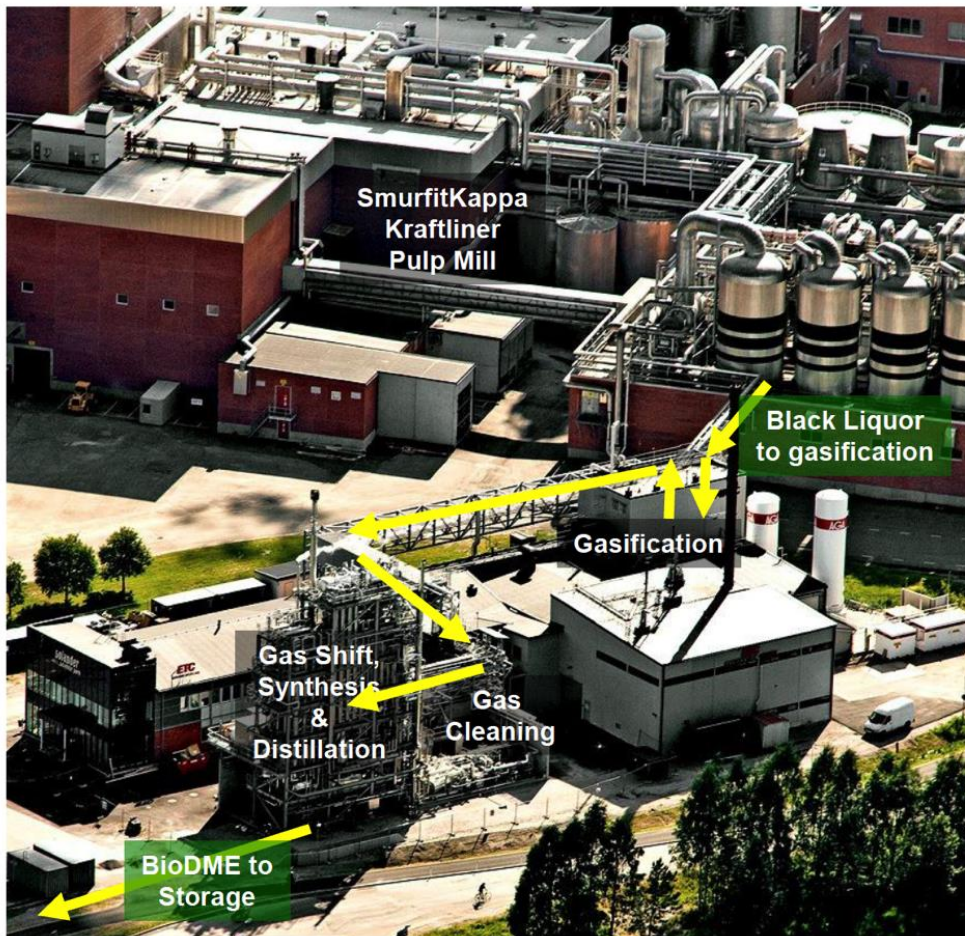
- It is obvious: "wood alcohol"

New Distillation Technology:

- ALPAC(Alberta Pacific Forest industries) , largest single line bleached kraft pulp mill in NA.
- Stripper Off Gas -> MeOH purified up till 99.85%wt



Chemrec – turning black liquor into MeOH and then into bio-DME



DME production capacity:	4 tons / d
---------------------------------	-------------------

Pipe installation: ~ 10 000 m

Hand valves & on/off valves: ~ 1400 pieces

Instruments: ~ 450 pieces

Vessels: ~ 30 pieces

Heat exchangers: ~ 25 pieces

Process Plant Foot Print: 20 x 30 m

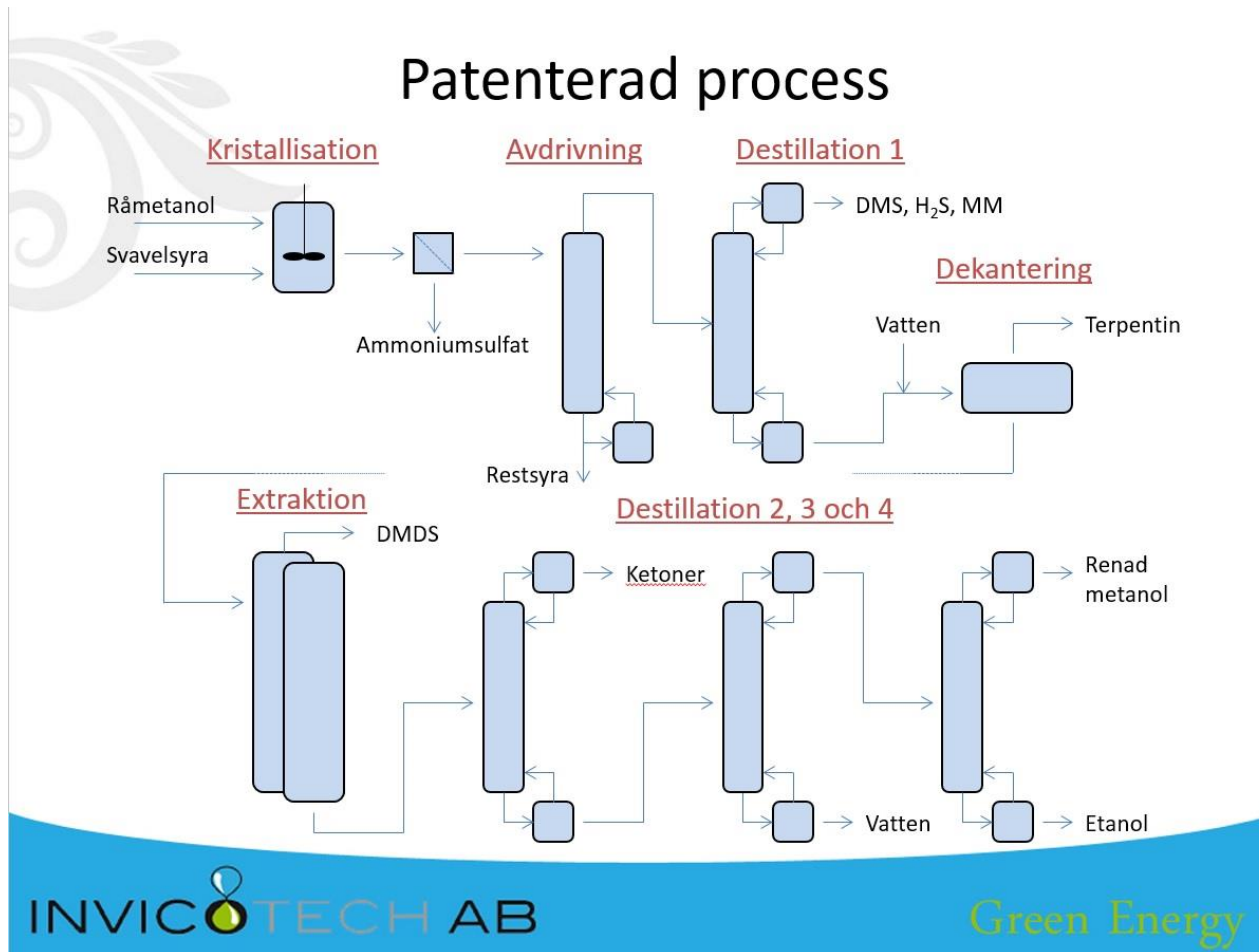
Investment cost (excl gasification): ~ 22 million €

European Project BioDME
7th Framework Programme



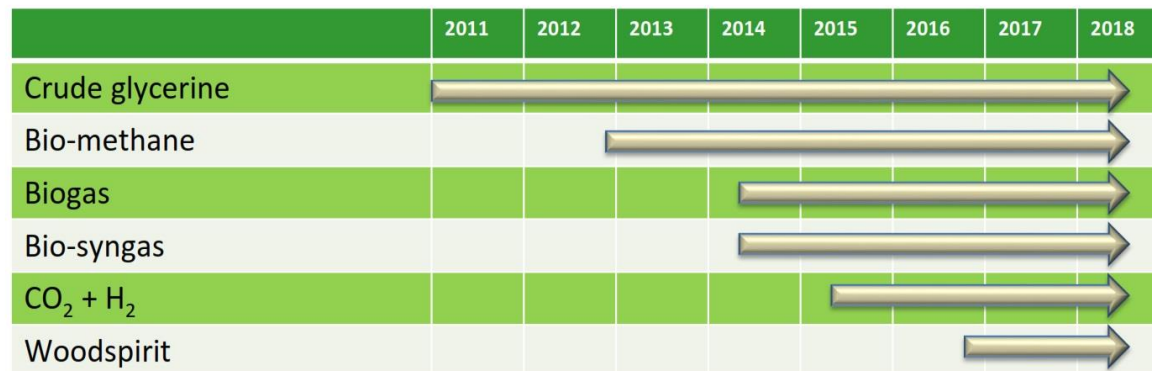
Black liquor purification

- often you find sulphur levels to be high



Biogas (from sugar and municipal waste)

Alternative feedstocks identified



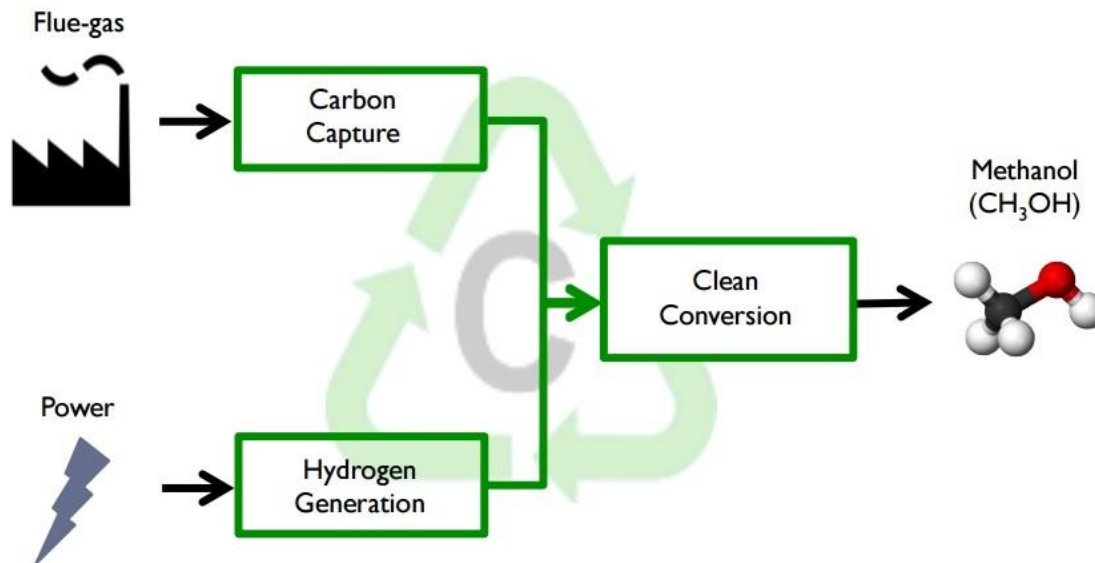
Use of alternative feedstock:

- increases capacity
- improves flexibility
- reduces risk

Electrolysis, by CRI



Emission to Liquid Technology



Carbon Recycling International

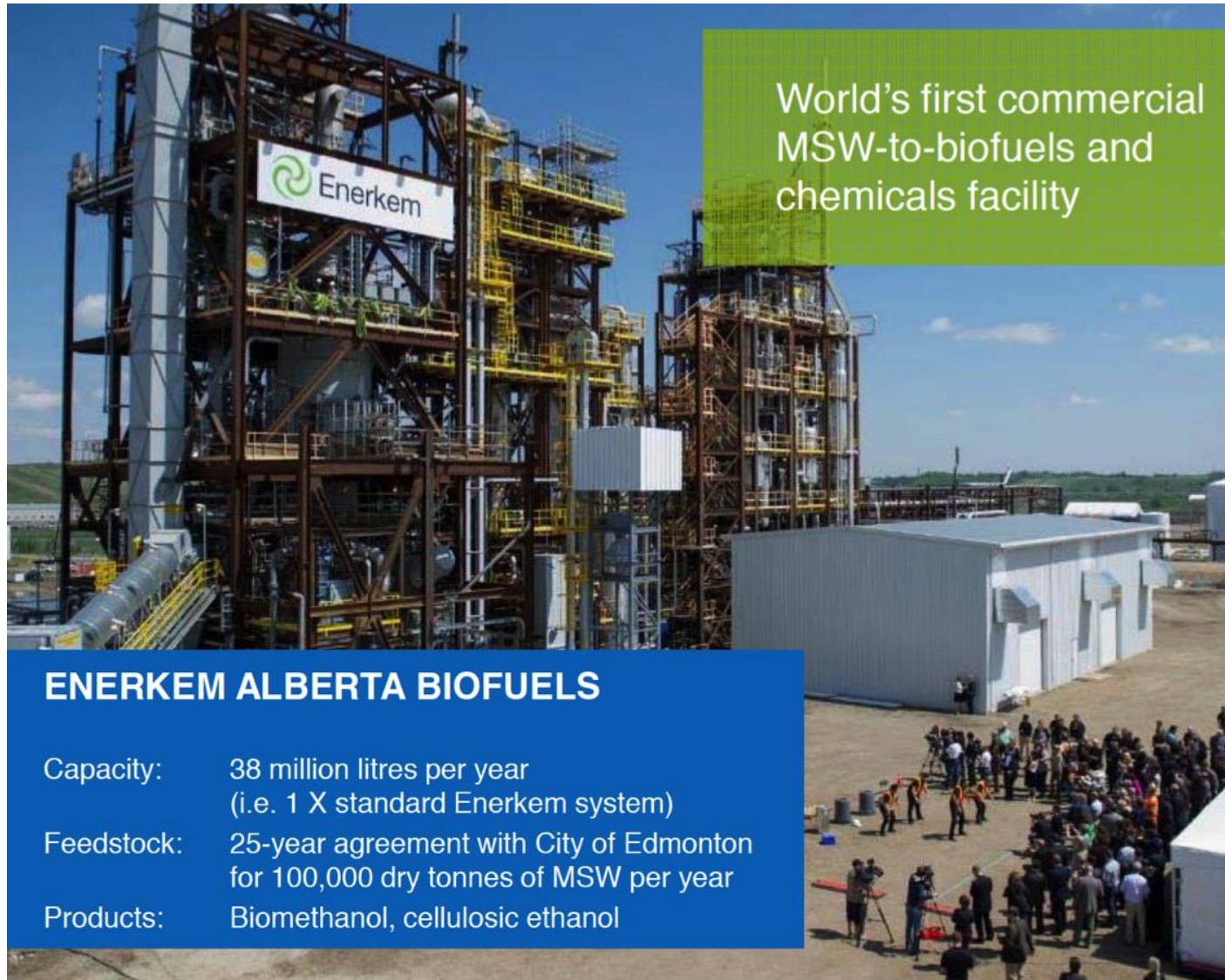
VärmlandsMetanol - a Pioneer Project



- 
- An aerial photograph showing a large industrial facility, the VärmlandsMetanol plant, situated in a forested area. The facility includes several large storage tanks, a central processing unit with tall chimneys, and a parking lot with many yellow vehicles. A road runs alongside the facility, and a town is visible in the background.
- Biomass as received 111 MW
 - Methanol energy 74 MW \approx 315 t/d
 - ✓ Investment cost € 350 million
 - ✓ Start up 36 months after investment decision
 - ✓ ThyssenKrupp Industrial Solutions EPC-contractor
 - ✓ 1 500 owners

Photo: Lars Nilsson
Photomontage: Structor

Enerkem, turning waste into alcohol



Huge investments are being incented

Further to this, billions of €'s are being awarded to bio-projects in the NER300-program and other programs

Thereby the EU are paving the way for private funding, estimated to be at least twice this size, on their own.

Included in this is the massive expansion “Wood Spirit”-project in NL.

We know also of methanol plants being planned/constructed/expanded in

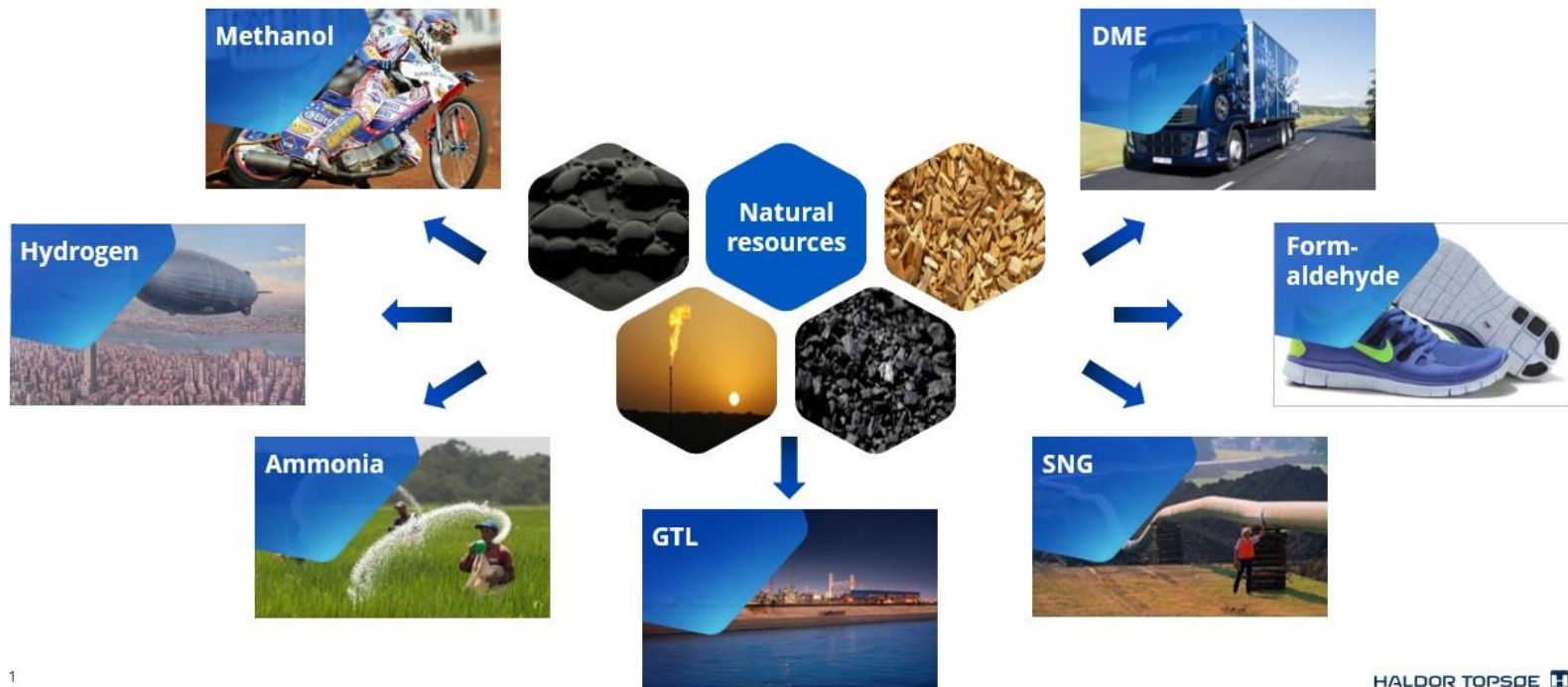
- Iceland
- Sweden
- Germany
- Spain
- France
- Finland
- Denmark
- Netherlands (besides Wood Spirit)
- And several in Eastern Europe



Nordic Green was recently appointed Haldor Topsoe Ambassador

What we do

Converting natural resources into chemicals



Traditional concept

1000 t/d wood → 523 t/d methanol

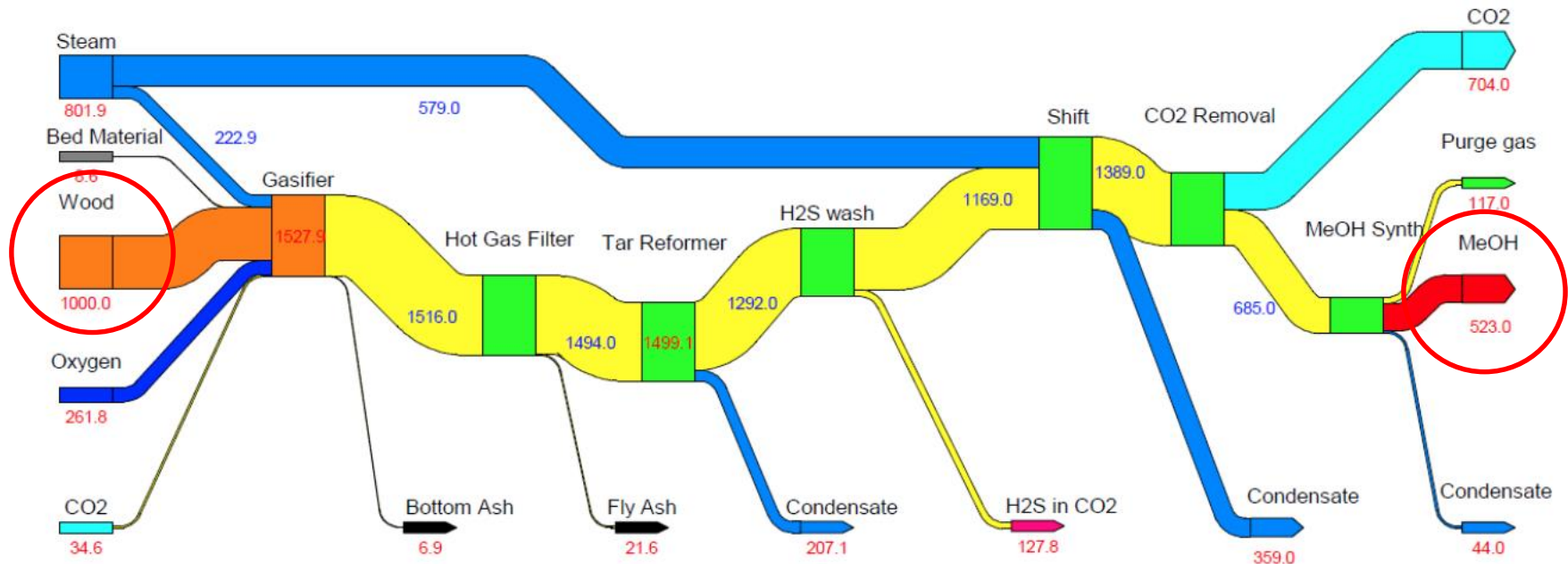


Figure 46: Traditional methanol production plant based on biomass gasification, units are in metric tons per day [t/day]

1000 t/d wood

Efficiencies (%)	Novel Concept
Methanol	59.2
District heating	22.6
Total	81.8
Carbon utilization	42

523 t methanol/d

Novel concept

1000 t/d wood → 1053 t/d methanol

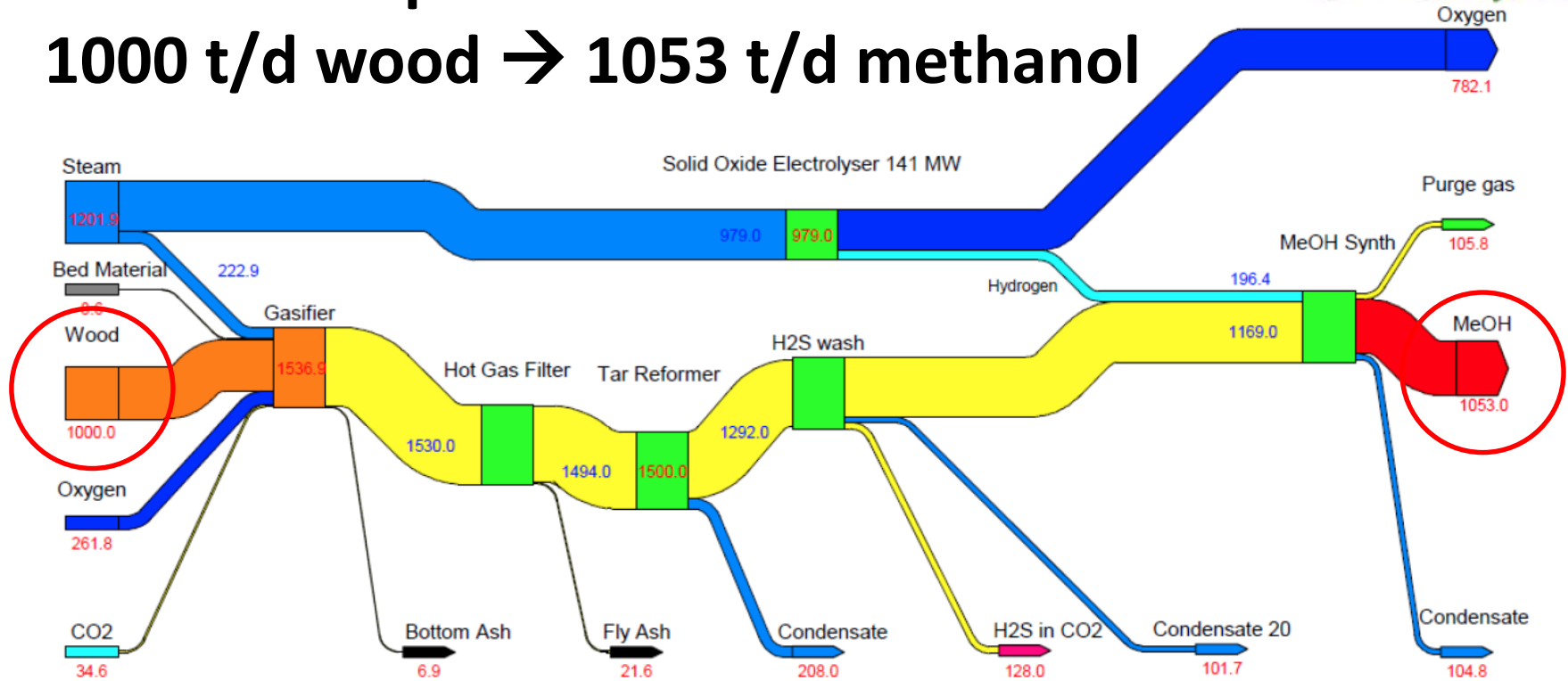


Figure 47: Sankey chart of mass flows in the gasification concept, units are in metric tons per day [t/day]

1000 t/d wood +
141 MW electricity
yields

Efficiencies (%)	Novel Concept
Methanol	70.8
District heating	10.8
Total	81.6
Carbon utilization	84

1053 t methanol/d

Methanol..

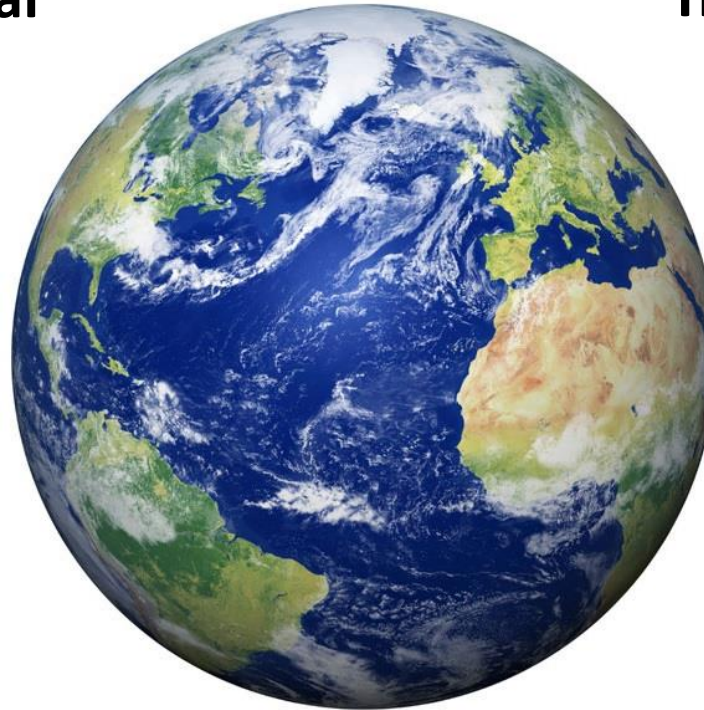
The two times two matrix

Bio-carbon from..	Biomass (concentrated)	Air (not concentrated)
Bio-hydrogen from...		
Biomass	Pro: Simply and cheap (if biomass is cheap) Con: Low carbon utilisation (rest is emitted as CO ₂) <i>1st to become commercial</i>	Not relevant
Electrolysis	Pro: Can effectively double the biomass potential Con: Depending on cheap electricity <i>2nd to become commercial</i>	Pro: Unlimited supply of both products Con: Most CAPEX and energy-intensive <i>3rd to become commercial</i>

Not enough bio-mass...(?)

Biomass potential

200 EJ/yr



Transport fuel demand

108 EJ (2010/7 bio)

168 EJ (2050/9-10 bio)

Conclusion

Since we can not convert ALL biomass to fuel and since there are losses the numbers DO NOT add up!.... Or do they...

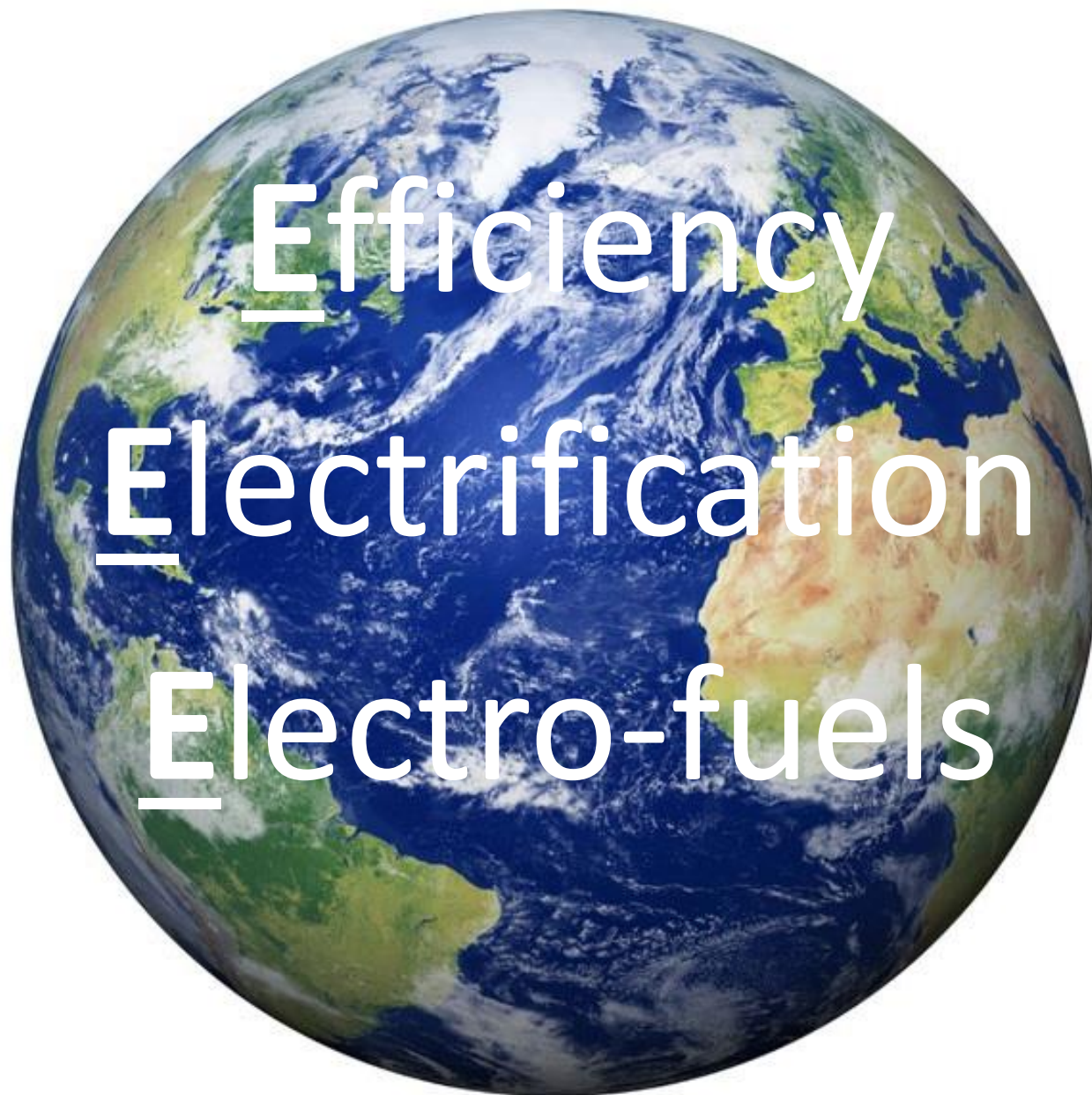
Wrong conclusion from IEA

“Biofuels can provide up to 27% of world transportation fuel by 2050”






We believe the IEA conclusion is wrong and if we use the three E's as our guiding principle there will in fact be plenty!

The three E's!



The three E's - Efficiency! (Index 100 -> 50)

EFFICIENCY GAINS AND COSTS			
	Technology	Reduction in CO ₂ emissions	Incremental price per vehicle
 Engine	Low-friction lubricants	0.5%	\$3
	Engine friction reduction	1–3%	\$50–100
	Variable valve timing and lift	3–4%	\$125–259
	Cylinder deactivation	6%	\$150–169
	Turbocharged downsized engine	5–7%	\$149–1,099
	Camless valve actuation	3–15%	\$501
	Gasoline direct injection (stoichiometric)	3–5%	\$209–346
 Transmission	Continuously variable transmission	6%	\$192–224
	Five-speed automatic	4.5–6.5%	\$99
	Six-speed dual clutch	5.5–13%	\$47–92
 Vehicle	Aerodynamic drag reduction (20% cars, 10% trucks)	2–3%	\$42
	10% reduction in tire-rolling resistance	1–2%	\$6
	10% reduction in weight	4.5%	\$518–666
	High-efficiency alternator and electrified accessories	1–2%	\$76
	Electric power steering	1.5–2%	\$94
	Integrated stop-start system	7.5%	\$351–437
	Hybrid motor assist	20–30%	\$2,854–4,431

Well known incremental innovations where we know the cost and the fuel reduction

We are not here to talk about engines so let's move on!

The three E's – Electrification (Index 50 -> 40)

Battery-costs will drop and cars like VW Golf-e, Tesla Model S, BMW i3 and Nissan LEAF will become common in the future

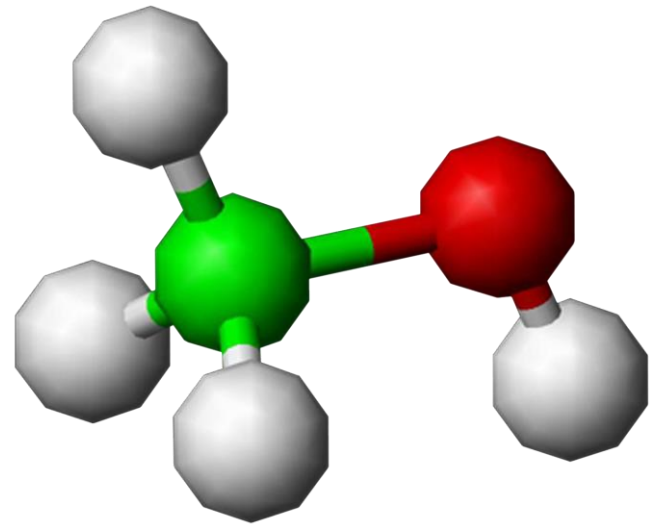


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The three E's - Electro-fuels (Remaining 40 -> 0)

Why methanol as electro-fuel?

The simplest of all liquid energy-carriers suitable as transport fuel and having the highest hydrogen to carbon ratio (4 hydrogen to each carbon atom)

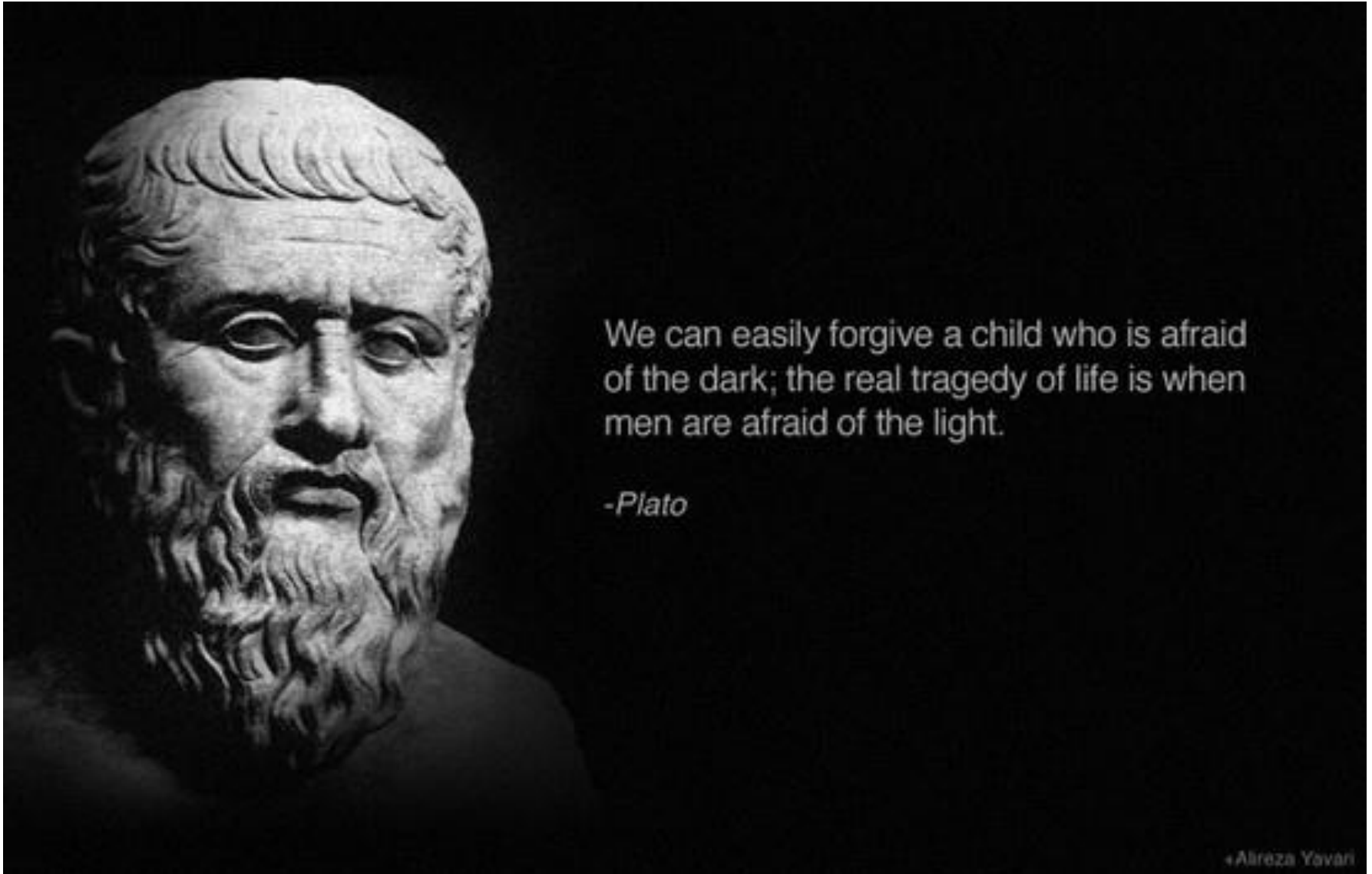


Meanwhile... for transport

(Bio-)MeOH offers a variety of easy implementable solutions:

- Switching from fossil to bio in esterification-process in biodiesels (Bio-)
- Low blends (Bio-)
- High blends, including GEM-fuels (Bio-)
- MTBE (Bio-)
- Shipping
- Trucking (DME)
- Synthetic gasoline
- Jet fuel

A few words of wisdom...



Thank you for your attention!

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