The future is our most important market

Refining with a sustainable vision

Sören Eriksson

Preems production and sales

Refining

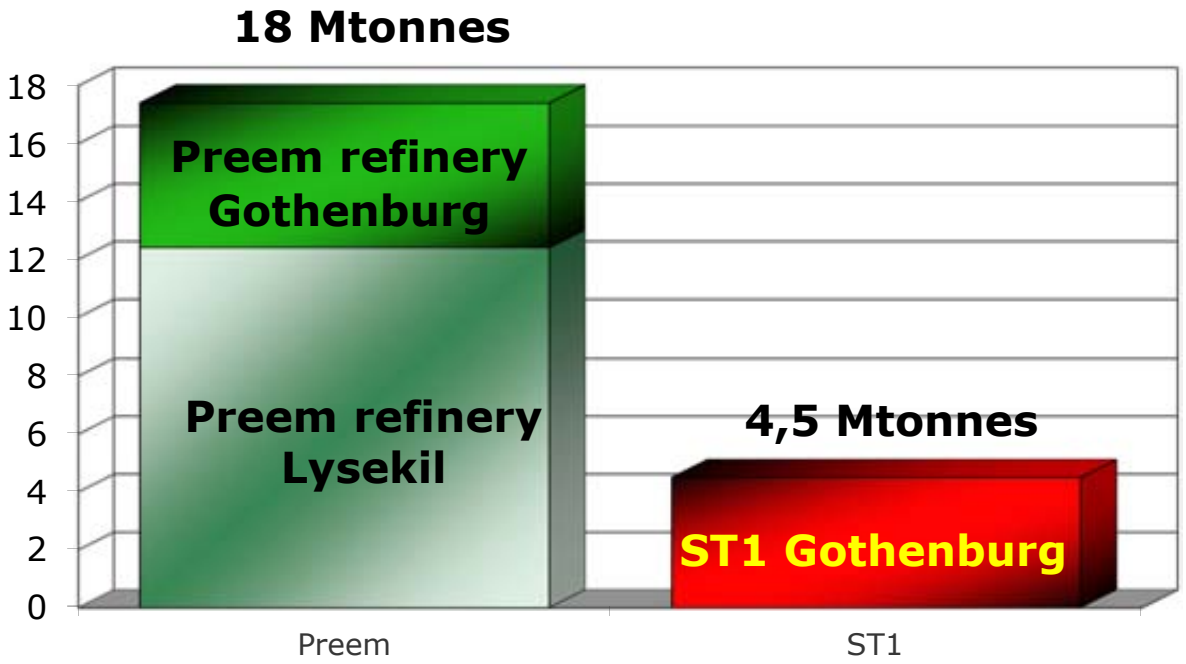
- 80 % of the total refing capacity in Sweden
- 30 % of the total refing capacity in Scandinavia
- 2/3 of the productionen is exported

Export

Market

- Supply of app. 15 % of the energy consumption in Sweden
- Deliver app. 50 % of all sold petroleumproducts in Sweden
- Total marketshare app. 30 %
- 400 gasoline- and och 200 dieselstations for commercial vehicles

Swedish Oil Refining



Preem refineries

Modern, environmenatal- and energy efficient

The preem refineries emits:

20% less carbon dioxide
70% less nitrogenoxides
90% less sulphuroxides

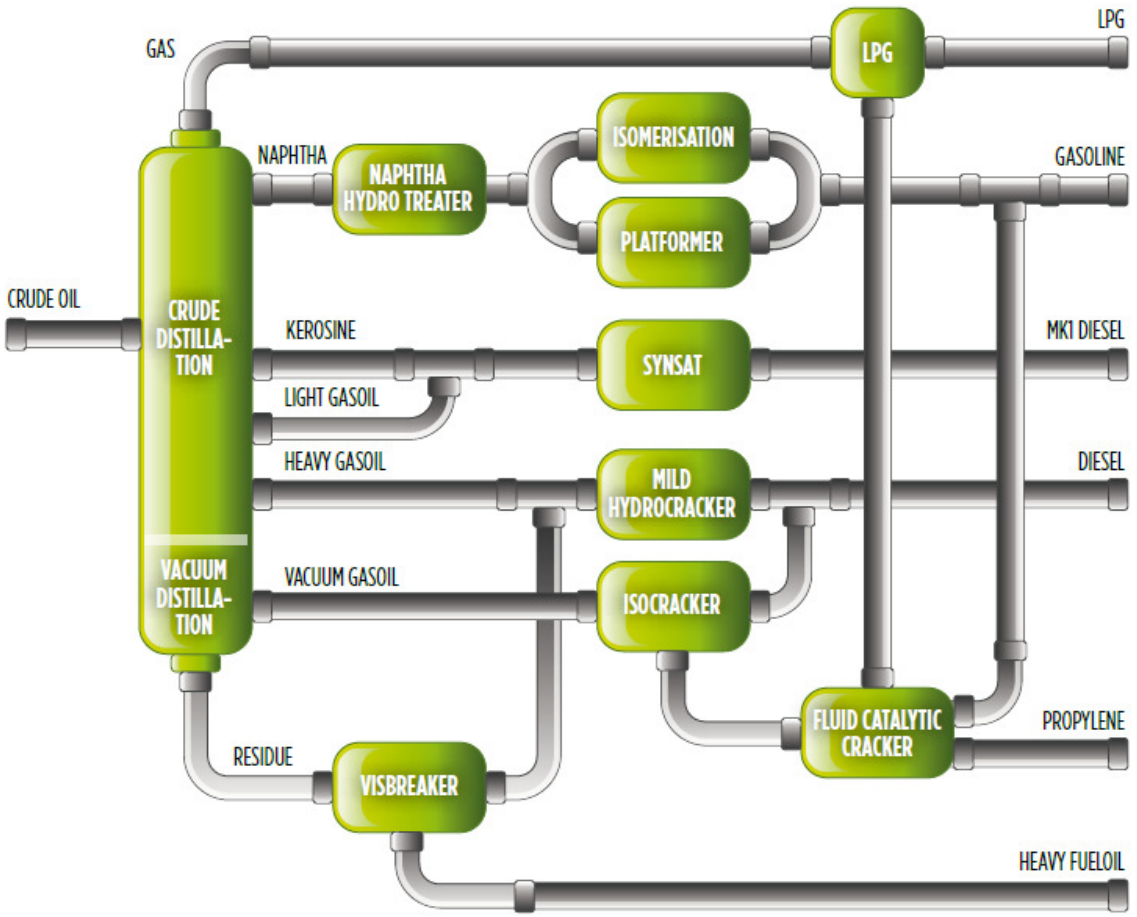
… per produced unit, compared with the average European refinery.

Preem deliver 540 GWh/year waste heat.

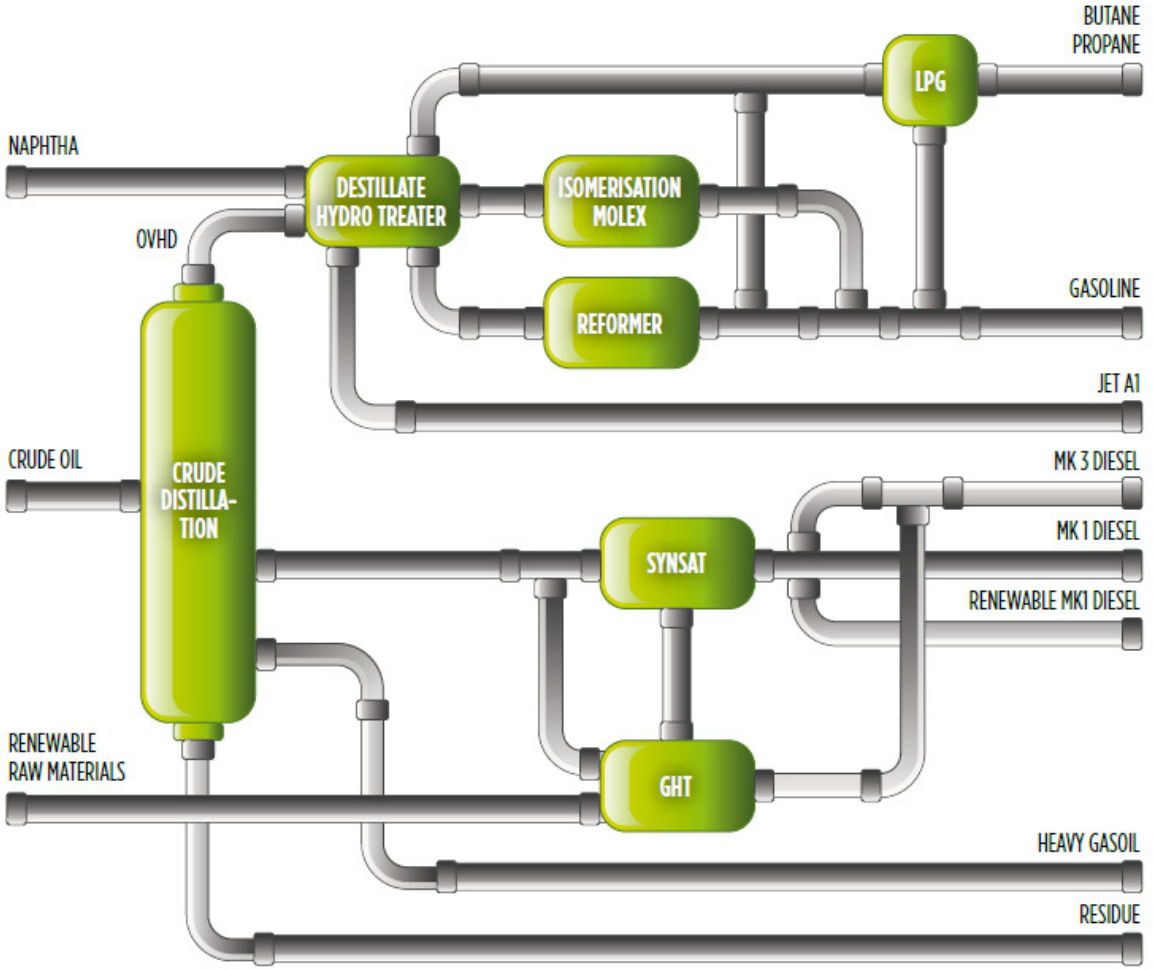
This energy could heat up to 36 000 small houses.

Remaining potential 1TWh = 67 000 small houses.

Preemraff Lysekil



Preemraff Gothenburg




VÅR VISION
Preem leads the transition
into a sustainable society

EU:s intention?

20/20/20 – 2020

- **20%** renewable share of the energy consumption,
- 10 energy % i transport fuels per MS Sweden reached abt. 12 % 2012.

- **20% increased** energy efficiency (9% until 2016, base year 2001-5)
- **20%** reduction of GHG, base year 1990

Unfortunately there is less and less interest from the EU member states for the original intention, regarding fulfilling the roadmap into a sustainable society, with a decreased amount of GHG, no or less interest in the security of supply question and last a less interest in the development of rural development by more and more special interests.

This year a new proposition from the commission dated 22/1 2014

EU-commission propose a 40 % reduction of GHG until 2030 (base year 2030)

The Commission propose only one target for renewable energy, 27 % of the energy used 2030, shall be renewable.

No target whatsoever for an increased energy efficiency and a decreased energy consumption.

A cost-efficient pathway towards 2050

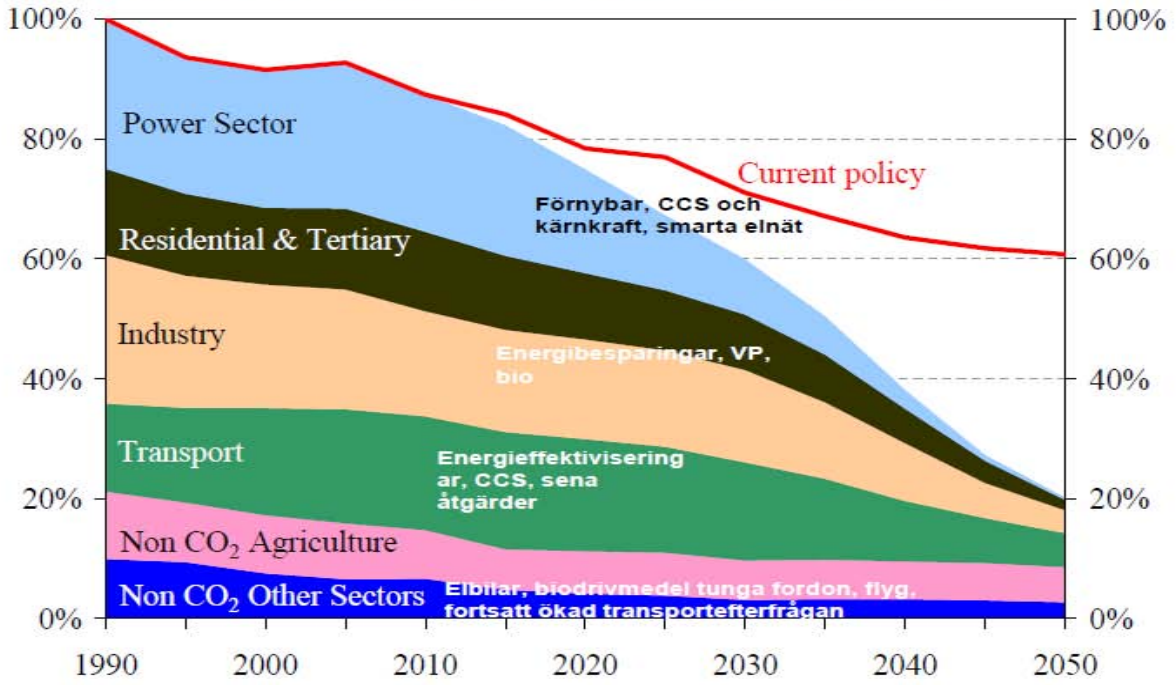
80% domestic reduction in 2050 is feasible

- with currently available technologies,
- with behavioural change only induced through prices
- If all economic sectors contribute to a varying degree & pace.

Efficient pathway:

-25% in 2020
-40% in 2030
-60% in 2040

Källa: NV



EU:s intention?

- The Commission seems to act against the use of renewable forest based material for transport fuel production. 60% of the growth of forest in Europe is located in Scandinavia and Scandinavia has also the largest number of paper mills in Europe.

- The ILUC proposal, Part A, Annex IX with a list were renewable material is given different values, creates uncertainty for a producer in this segment, especially when the commission is changing earlier agreed positions, due to vague reasons.

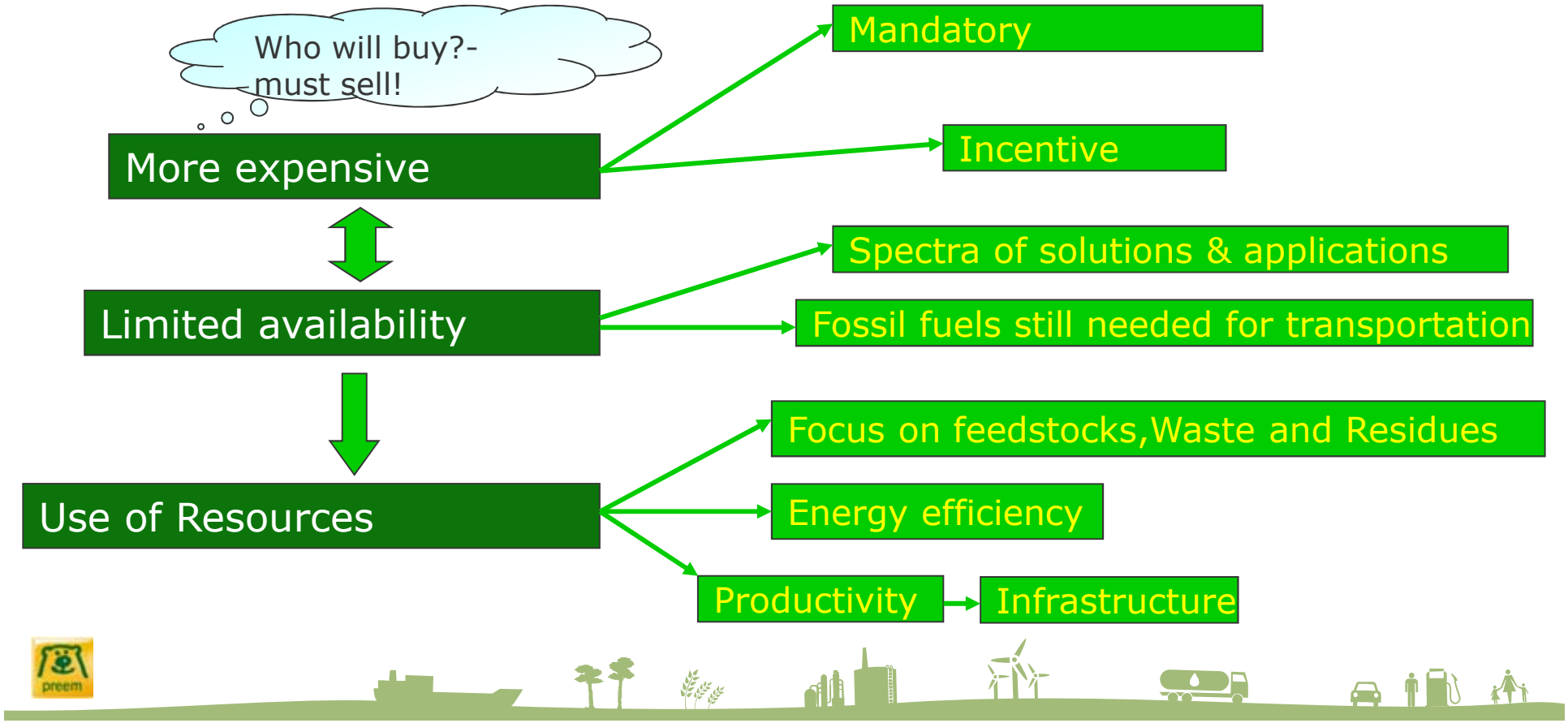
- The risk is obvious that we will not be allowed to use any part of rest products from the forestry or pulp mill factories - or from the agricultural sector.

- The list in the ILUC proposal creates uncertainty for the industry, it is better to use the GHG reduction as a driving force, according to RED calculations, irrespective origin, so the EU member states can handle this question by themselves.

- With todays political decisions, the bio industry, specially when we are discussing advanced biofuels will not grow, but instead be no more.

- No more investments will be done within this sector before those questions have been clarified, and no more jobs in this sector within EU will be created.

Renewable transportation fuel



Can our forests improve security of supply?

Yes.

CO2 reduction from biofuels

Biofuels should contribute to a reduction of at least 35 % of greenhouse gas emissions in order to be taken into account.

From 1 January 2017, GHG emissions savings should be minimum 50 %.

Preem Talloil Diesel has CO2 reduction of 89 % (*) compared to fossil diesel.

(*) Talloil counted as a co-product.

Preems road map-“Green” strategy”

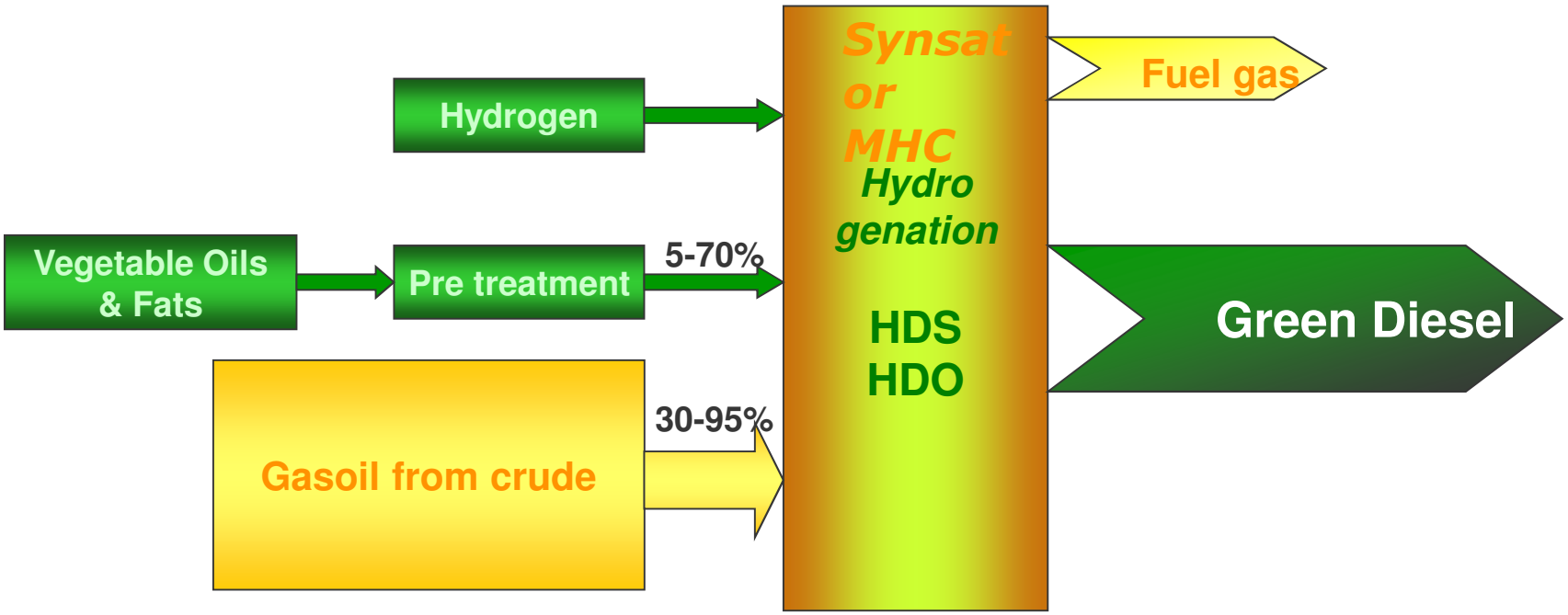
Production

- Move from Heating Oil to Transportation Fuels
- Blending of 1:st generation bio fuels established
- Co-operation regarding CO2 capture and sequestration
- Wind Power expansion
- Excess hot water sales

Transport fuels

- Co-processing of forest based “green” feed stocks initiated, like Tall oil diesel - doubling the capacity 2015
- Residues from pulp mills - Lignin upgrading in existing units
- Residues from other forestry industry- upgrading in new units
- New (old) technologies (Slurry Hydro Crackers) upgrading of HFO to diesel and gasoline. Units have already been sold both in Europe as well as in the Far East, gives the possibility to co process biomaterial in a large extent

Biorefining CO-Processing



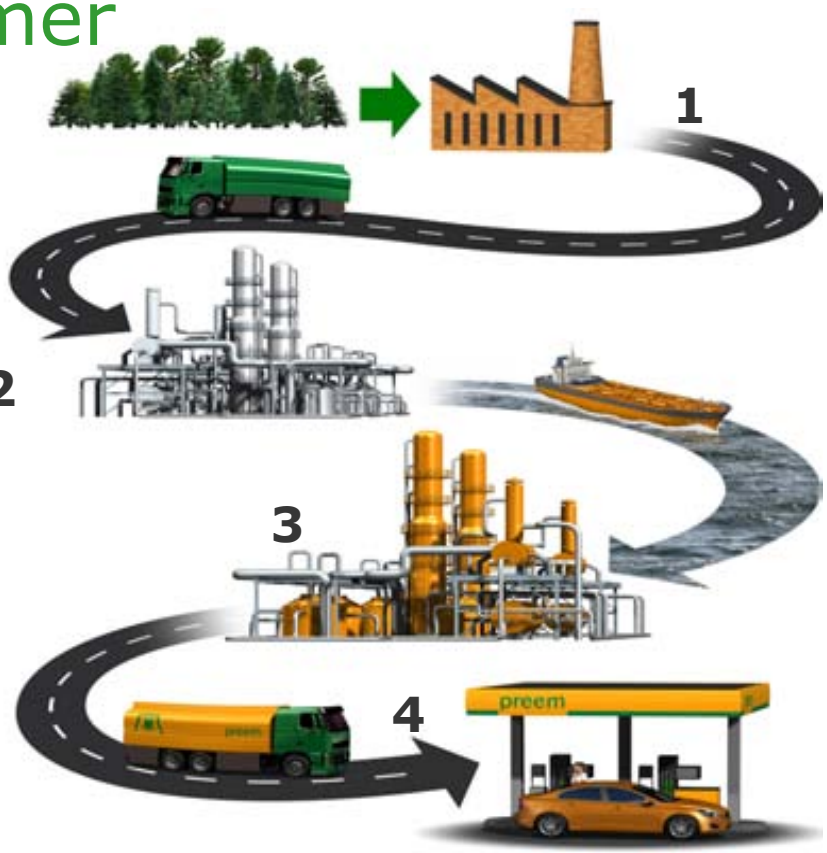
From Forest to the consumer

1. Raw talloil is a restproduct recovered from the black liqour stream in the Kraft papermill

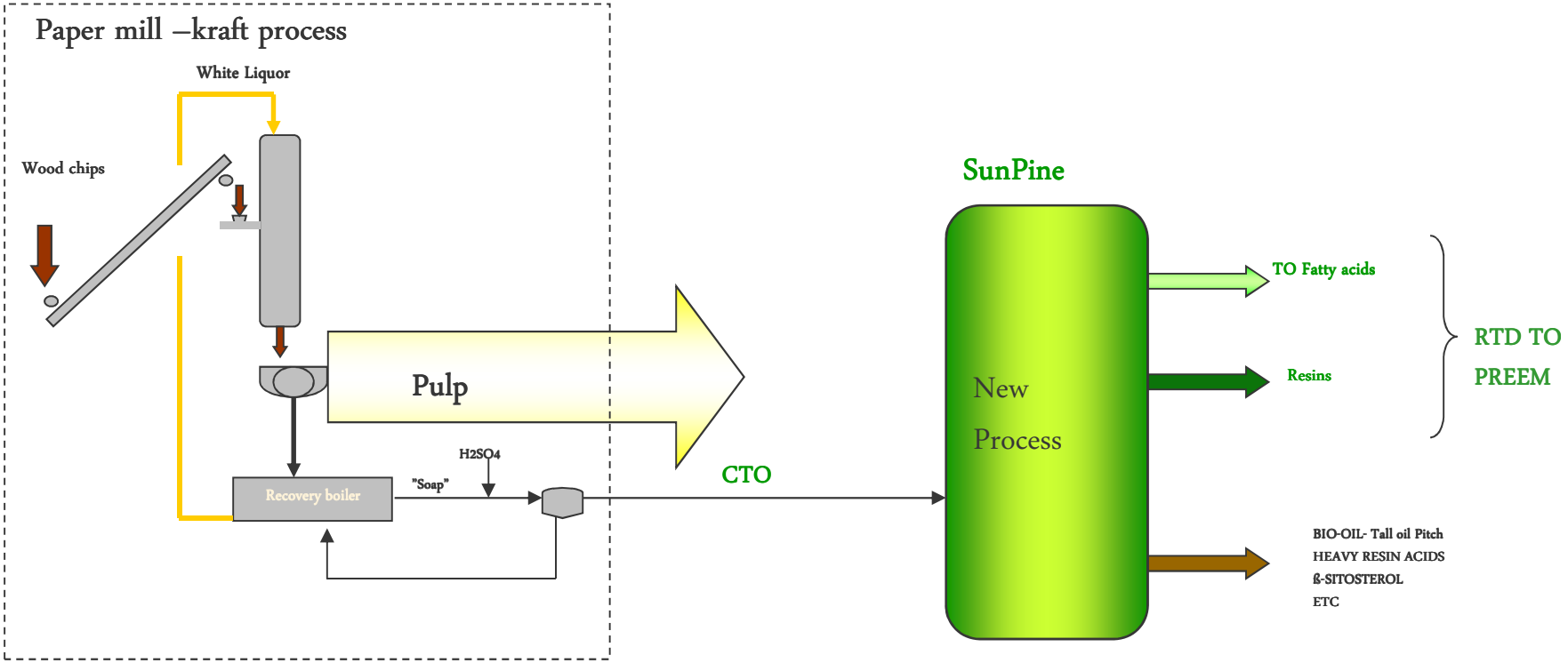
2. SunPine in Piteå produces rawtalldiesel from the Raw talloil

3. In Preems converted refinery in Gotheburg the raw talldiesel is upgraded to high quality diesel. EN590 incl, MK1 standard

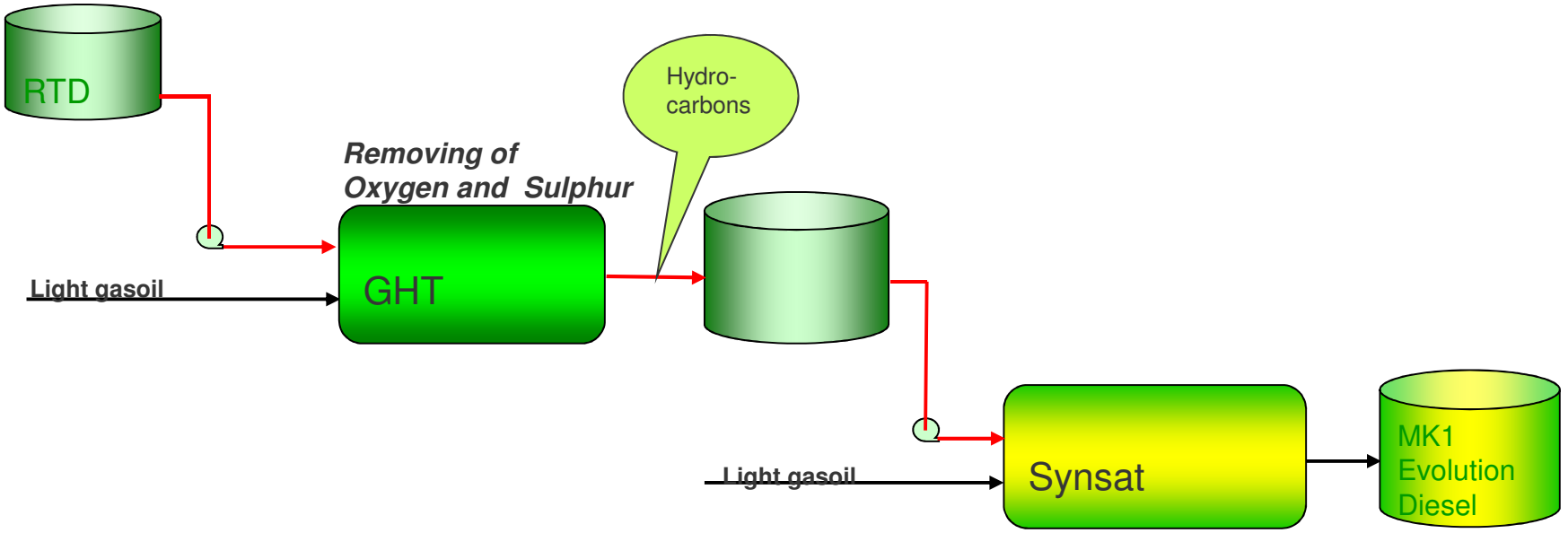
4. Evolution Diesel – a high quality diesel, containing only diesel type hydrocarbons. Reduces the emissions of CO2 by more than 30%. Can be used in all diesel vehicles. The future fuel – in todays vehicles.



SunPine Talloil Process



From RTD into Swedish MK1 Evolution Diesel (EN590)



Investment abt. 250 MSEK in our refinery,
totally after 2015 - 900 MSEK

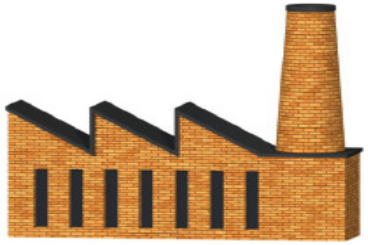
Preem Evolution Diesel

- Today Up to 35% renewable product content
- Reduces the CO2 emissions more than 30%
- The same type of hydrocarbons as in fossil diesel
- Can be used in any diesel vehicles

During 2013,reduced the CO2 emissions by 480 000 ton (corresponds to emissions from 216 000 cars).

The Pulp mill

About 30% of the log consists of lignin, today burnt in the recovery boiler



Lignin is the dominating component in the black liquor,
Abt. 6-8 million tons per year.

Lignin is today used as a fuel for creating heat and electricity.
When introducing new processes in the pulp mill the amount of lignin will increase - making it difficult to increase the throughput in the mill without large investments.

Lignin used as a transport fuel, will increase the capacity in the mill as well as the total value chain.

About 10- 20 Twh lignin is possible to use every year as a fuel feedstock, according to the Pulp industry

The transition has already begun.
Renewable gasoline next step

- Can be used in all gasoline engines.
- 70 % of the private cars in Sweden are using gasoline.
- The estimate is that abt. 1- 2 miljon tonnes of lignin could be recovered from the Kraft papermills.
- Target to start a renewable gasoline production by 2017.

Lignin deoxygenation by catalytic hydrogenation – Avoiding Molecular Hydrogen

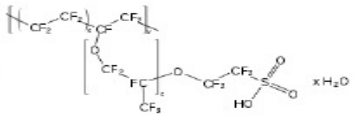
Table 4. Heterogeneous Catalytic Systems for the Hydrogenation and Hydrodeoxygenation of Lignin (Model Compounds)

entry	catalyst	support	reaction conditions: T (K)	P (MPa)	t (min)	lignin (model) compound	major products	conversion (%)	notes	ref
1	Cu–CrO	none	533	22	1080	lignin	methanol, 4-n-propylcyclohexanol, 4-n-propylcyclohexanediol, glycol	70		125
2	Cu–CrO	none	523	20	300	hydrol lignin	3-cyclohexyl-1-propanol, 4-n-propylcyclohexanol, 3-(4′-hydroxycyclohexyl)-1-propanol	12		126
3	Raney Ni	none	446	20	360	maple wood meal	4-ethylsyringol, 4-ethanolsyringol	27		127
4	Raney Ni	none	468	3.4	300	spruce wood meal	dihydroconiferyl alcohol, 4-n-propylguaiacol	16		128
5	Rh	carbon	468	3.4	300	spruce wood meal	dihydroconiferyl alcohol, 4-n-propylguaiacol	34		128
6	Rh	Al_2O_3	468	3.4	300	spruce wood meal	dihydroconiferyl alcohol, 4-n-propylguaiacol	13		128
7	Pd	carbon	468	3.4	300	spruce wood meal	dihydroconiferyl alcohol, 4-n-propylguaiacol	24		128
8	Rh	carbon	468	3.4	300	aspen wood meal	/	/		129
9	FeS[a]	none[a]	523–723	15.2–45.6	60–120	lignin	phenols, benzenes	/	a)	131
10	FeS	none[a,c]	648–698	5–15	60	kraft lignin	monophenols C_6–C_9	/	a	131
11	Co–Mo	SiO_2–Al_2O_3	573–723	10–20	/	polycyclic aromatics	gasoline hydrocarbons	/		137
12	Ni–Mo	SiO_2–Al_2O_3[c,e]	573	5	4	phenol	C_6 hydrocarbons	2		138
13	Ni–Mo	SiO_2–Al_2O_3[c,e]	598	5	4	phenol	C_6 hydrocarbons	17		138
14	Ni–Mo	SiO_2–Al_2O_3[c,e]	598	5	4	o-cresol	phenol/C_7 hydrocarbons	26		138
15	Co–Mo	Al_2O_3[f]	573	5	250	4-methylphenol	toluene	100		139
16	Co–Mo	Al_2O_3[c]	598	6.9	101	4-methylguaiacol	toluene, cresol isomers, methylcatechol	98		140
17	Co–Mo	Al_2O_3[c]	573	6.9	344	4-methylcatechol	toluene, cresol, alkylphenol, methylcyclohexane	99		140
18	Co–Mo	Al_2O_3[c]	573	6.9	240	eugenol	propylcyclohexane, propylphenol, propylguaiacol, propylcatechol	100		140
19	Co–Mo	Al_2O_3[c]	573	6.9	254	vanillin	methylcyclohexane, methylcatechol, cresol	98		140
20	Co–Mo	Al_2O_3[c]	573	6.9	443	o,p-biphenol	biphenyl, cyclohexylbenzene, dibenzofuran, 2-phenylphenol	92		140
21	Co–Mo	Al_2O_3[c]	573	6.9	361	o-hydroxydiphenylmethane	benzene, cyclohexane, toluene, phenol, diphenylmethane	100		140
22	Co–Mo	Al_2O_3[c]	573	6.9	379	phenylether	benzene, cyclohexane, phenol	98		140
23	Co–Mo	Al_2O_3[c]	523–598	3.4	400–600	anisole	phenol, benzene, cyclohexane	100		141
24	Co–Mo	Al_2O_3[c]	523	3.4	1200	guaiacol	catechol, phenol, benzene, cyclohexane	100		141
25	Co–Mo	Al_2O_3[c]	548–598	5	/	o-methoxyphenol	phenols, dioxygen compounds,	23–99		142

Journal of Analytical and Applied Pyrolysis 92 (2011) 477

The model compounds 1–5 (200 mg) or dry lignin (200 mg or 1000 mg) were suspended in water (12.0 mL) and Nafion® SAC-13 (200 mg or 130 mg), formic acid (0.5 mL, 0.61 g, ι = 1.22 mg/mL), and Pd-catalyst (20 mg or 200 mg) were added in the mentioned order. The mixture was manually mixed before the reactor was closed and heated by placing in a preheated oven at 300 ◦C for 2 h. The total reaction pressure was calculated to be around 95 atm, where 85 atm was due to the water vapour [18] pressure at 300 ◦C and 10 atm was the theoretical pressure of hydrogen coming from a complete conversion of the formic acid [19].

Nafion®



Hydride Donors available in biooil(s)!?

Some active academics in Scandinavia

Tanja Barth
professor
Kjemisk institutt

Universitetet i Bergen

M. Kleinert, T. Barth, (2008) Towards a lignocellulosic biorefinery: Direct one-step conversion of lignin to hydrogen-enriched bio-fuel. *Energy Fuels* (22), 1371-1379.

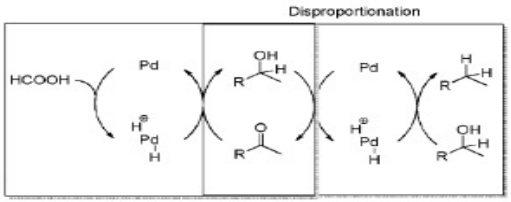
UPPSALA UNIVERSITET

Adobe Acrobat Document

Patent appl WO 2012/121659

(54) Title: REDUCTION OF C-O BONDS BY CATALYTIC TRANSFER HYDROGENOLYSIS

Figure 1.



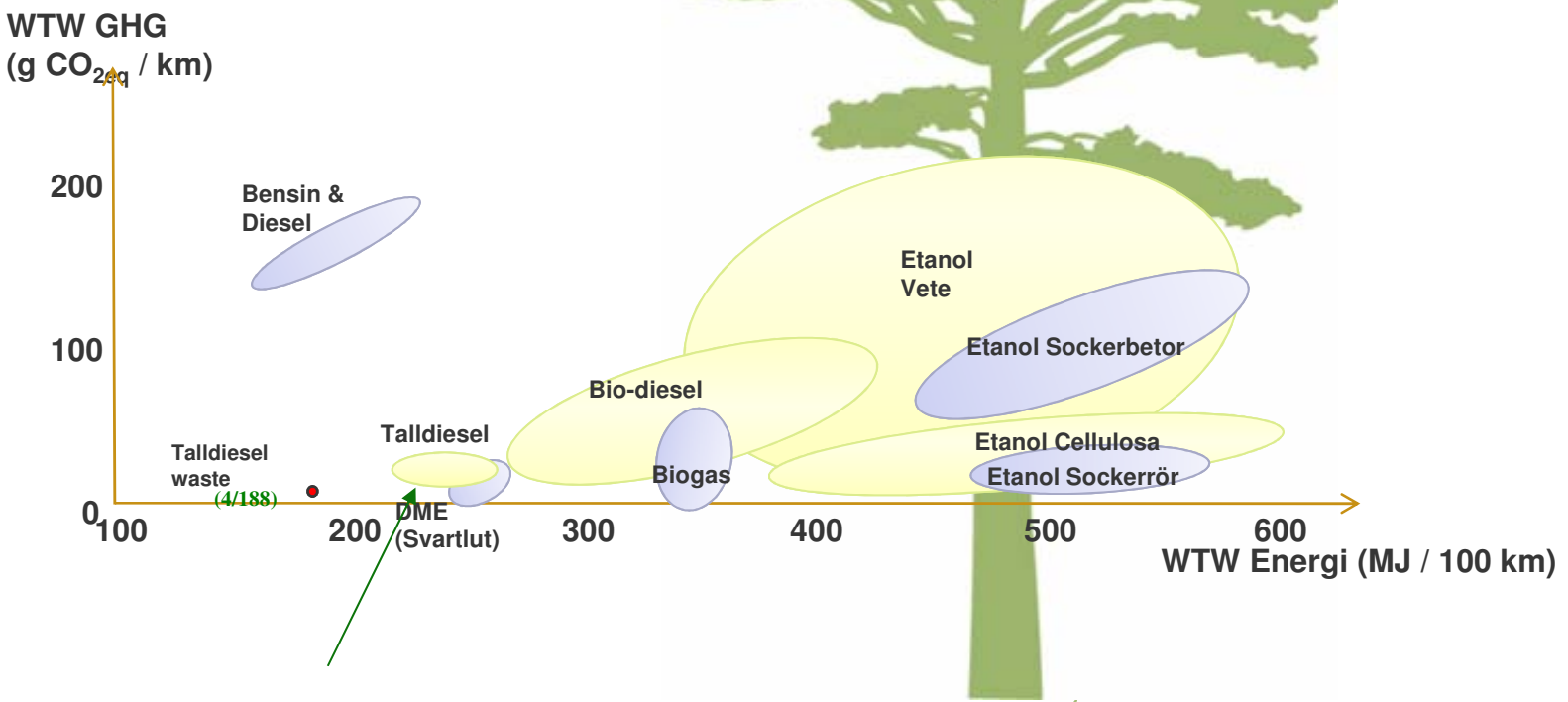
Hydrogen transfer reaction

Joseph Samec

Research fellow
Department of Chemistry
BMC - Synthetic Organic Chemistry

RI.SE Research Institutes of Sweden

WTW performance Hydrogenated TOD

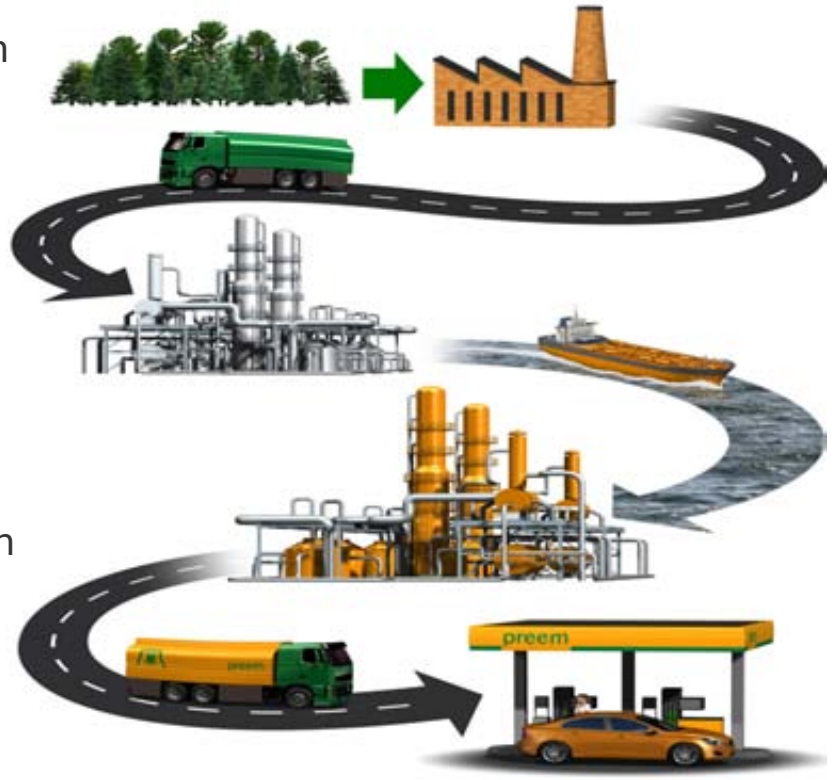


Advantages with forest based renewable gasoline and diesel

- 60% of the growth of forest in Europe is located in Scandinavia

- Lower carbon footprint
- ”Security of supply”
- Rural development
- Creates more job. Especially in northern Europe
- Innovation creates innovation, new value chains are created
- Low production costs compared with earlier technologies
- Fulfills todays standards like EN590 or EN 228 with more than 50 % renewable content

- No new infrastructure is needed



Thank you!