

Swedish initiatives for biofuels - Some Reflections

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Saw, boil or burn ????

- The main issue must be: Who can pay the best price for the raw material or how can I earn most money from my raw materials

Two Swedish biofuel alternatives

- Ethanol from fermentation of grain or wood including more efficient technologies with enzymes or improved yeast grades
- Production of Synthesis gas, Hydrogen and Carbon monoxide in the right proportions for the subsequent processes (normally well known processes)
- In addition to this about 100 MEURO of research money is spent on different research projects by STEM, (Swedish Energy Agency) often together with other parties

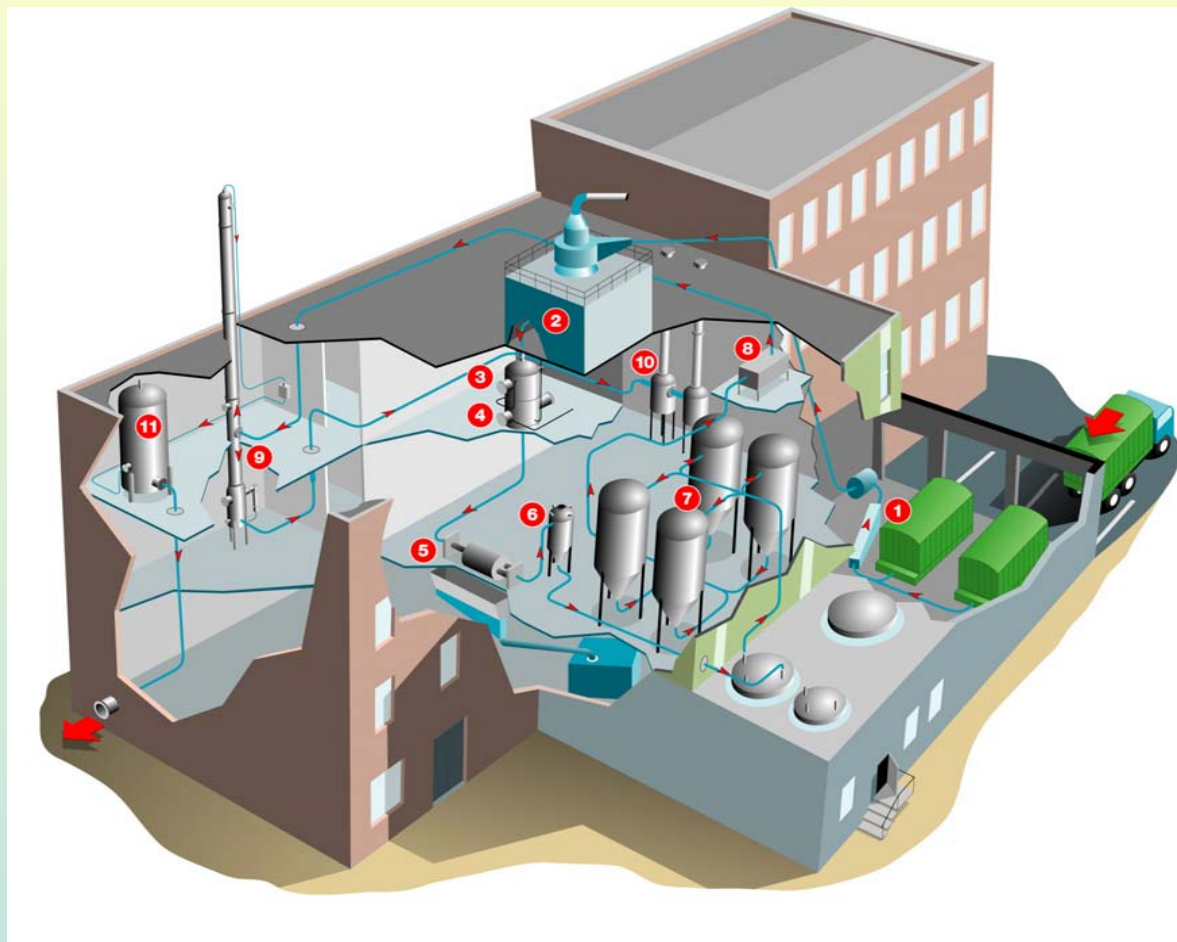
Three Swedish Pilot Plans

- Ethanol from wood via fermentation in Örnsköldsvik
- Biofuels or electricity from black liquor gasification in Piteå
- Synthesis gas from biomass in Värnamo for future biofuel production



Etanolanläggningen

- 1 Transport**
- 2 Basing**
- 3 Förhydrolysy**
- 4 Reaktorn**
- 5 Membranfilterpress**
- 6 Detoxifiering**
- 7 Fermentorerna**
- 8 Jästseparator**
- 9 Destillation**
- 10 Indunstning**
- 11 Uppsamlingstank**



CHEMREC'S DP-1 ANLÄGGNING VID ETC PITEÅ



DP-1 Project, Milestones

2004

Ordering critical Components	June
Financing completed	Sept
Start of mechanical erection	Oct

2005

Mechanical completion	May
Commissioning	May-Sep
Start of operation	Sep 30
Test runs & debugging	Oct-

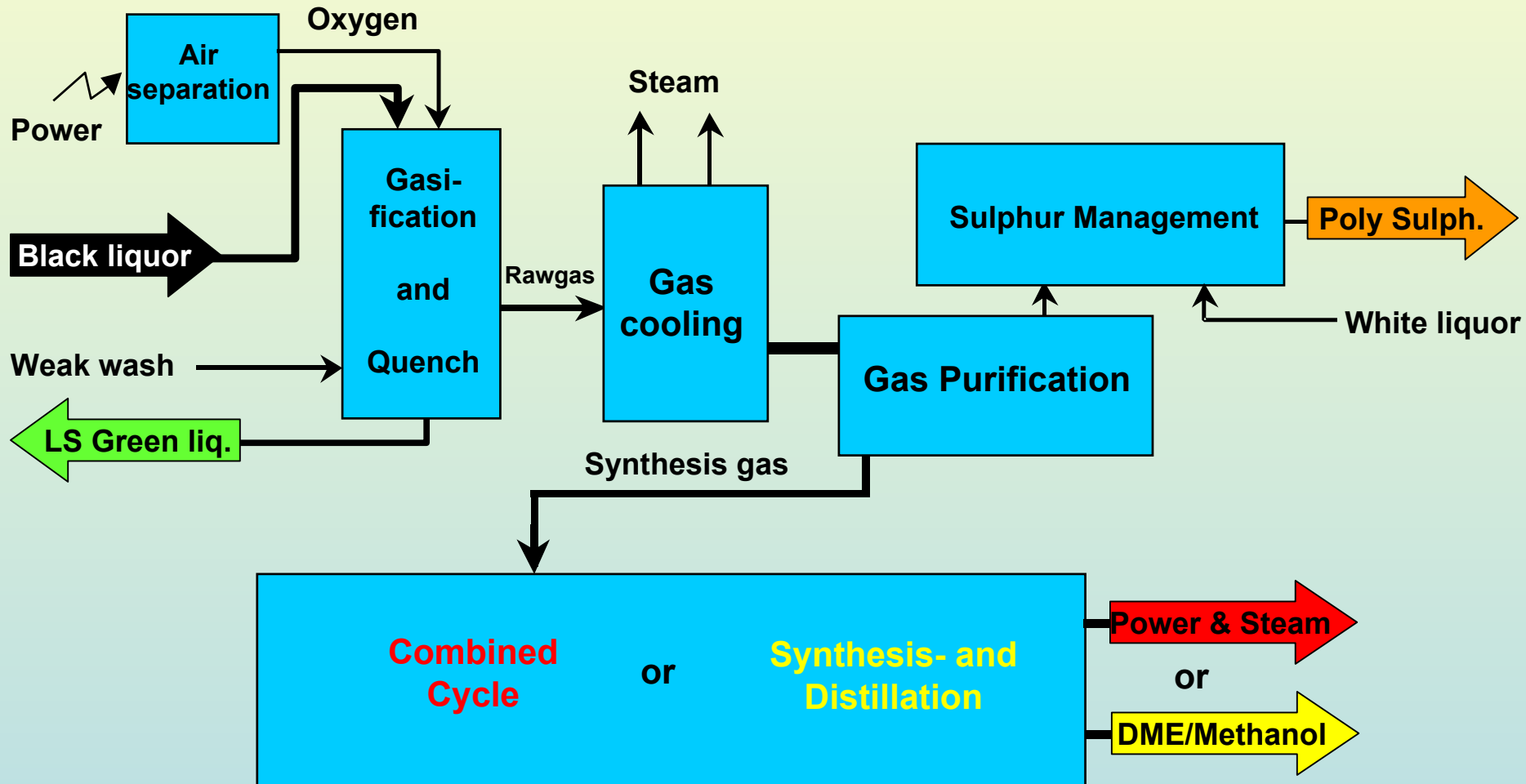
2006 -

Test runs & debugging	Jan-
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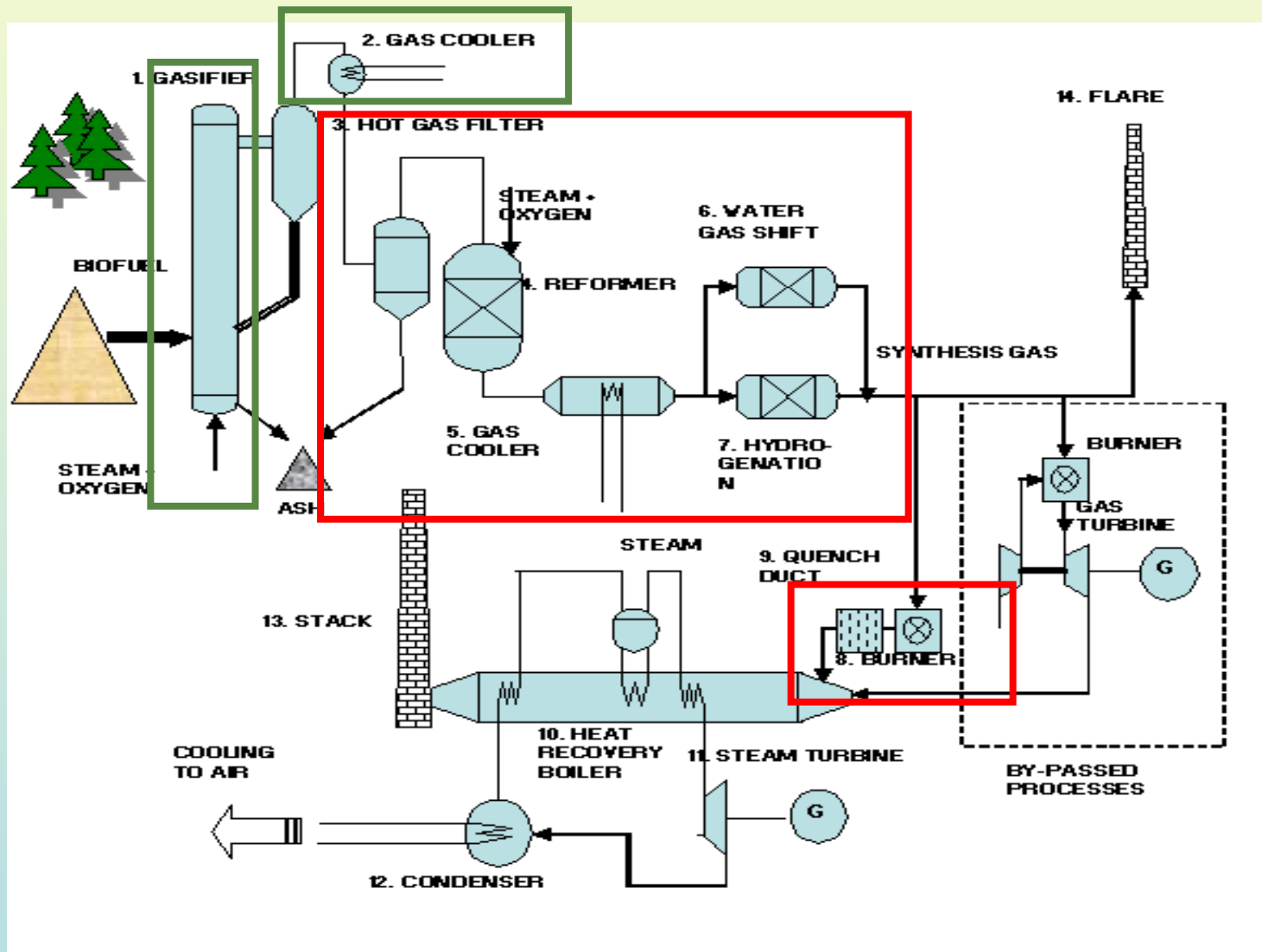
Black Liquor Gasification - General Scheme





Värnamo Växjö Biomass Gasification Centre

Värnamo Gasification Plant after rebuild (VVBGC)



Production of synthesis gas

- Gasification with or without pressure, gives a gas rich of CO and H₂
- This gas must be cleaned and CO must partly be converted to H₂ (by shift reaction) to get the right proportions for the subsequent processes.
- If these steps can be solved in an efficient way gasification will give a good flexibility for several different biofuel alternatives.

Ethanol

- A lot of energy is needed to produce ethanol
- To be efficient in ethanol production fermenting of hexose is not enough, fermenting of xylos is needed as well
- Ethanol efficiency from forest biomass is 1/2 to 1/3 compared to gasification (Azar, Berndes)
- DME efficiency from forest biomass is at the same level as ethanol from Brazil (Azar, Berndes)

Ethanol

- The best and most efficient way to produce ethanol is from sugar-cain (ca 2 SEK/l)
- From Swedish grain (ca 5 SEK/l)
- From forest biomass, which is the most difficult way with still a lot of research needed (more than 5 SEK/l)

Ethanol

- Conclusions
 - Ethanol is not an energy efficient way
 - Technology breakthrough is needed
 - Domestic production is more than twice as expensive as import (from developing countries)
 - A substantial competition for the raw material, wood, will take place, especially if Europe will follow the ethanol route

Black liquor gasification (BLGCC)

- Today's situation in Sweden is that BAT for recovery boilers gives + 3TWh el. compared with today's situation
- BLGCC gives + 8 TWh el.
- This means + 5 TWh excess electric power for the (outside pulp mill) demand

Black liquor gasification (BLGCC)

In case of biofuel production from BLGCC:

- The energy in the synthesis gas must be replaced in the mill - probably by other biofuels
- Investments must be made in shift reactors and biofuel plants
- Sweden has about 40 mills of which only about 5 have a capacity > 500 kton
- BLGCC is said to cover 25 % of Swedish needs.
Is this realistic?

Black liquor gasification (BLGCC)

Conclusions:

- Only a smaller portion of the Swedish demand of fuels can be produced from BLGCC and probably at high costs and the raw material is in competition with other use.
- It is much more likely that electric power production is the best use of the BLGCC technology. The Industry needs all el.power sources which it can get in order to reach reasonable power prices in the future

VVBGC and Chrisgas

- Partly new technology. Pressurized fluidized bed technology with oxygen
- The goal is hydrogen rich synthetic gas
- A European research project
- All kind of biofuels can be produced
- A big scale technology
- This route is twice as energy efficient as traditional ethanol processes (Azar et.al.)

VVBGC and Chrisgas

Conclusions

- A potentially flexible process
- No limitations in location of a full scale plant
- A high risk project

Summary remarks

- In a world with climate change and where oil will be more and more expensive, biofuels is an alternative.
- The price must decide where the raw material shall be used. Be aware of the risk with taxes giving the wrong results for the society in the long run.
- I today believe that cars for personal transport in the future will be driven by electricity and that trucks and heavier transport vehicles etc. will be driven by biofuels such as DME
- DME has good exhaust gas properties while ethanol is not better than gasolin. Best in this respect is electricity.
- Forest industry plants running more than 8000 h per year are more capitaleffective than district heating plants which are running with about 4000h
- Energy in all forms is an opportunity for the forest industry –this is sometimes called "Biorefinery"

Thanks for your attention