

The potential of sunliquid®



what is precious to you?

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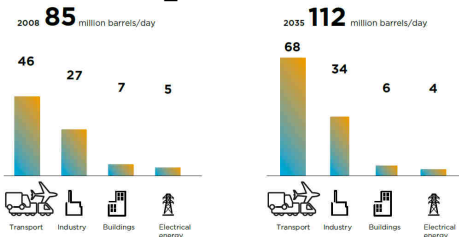
- Innovation in biofuels - Translating customer needs into product solutions
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Innovation in biofuels

Translating customer needs into product solutions

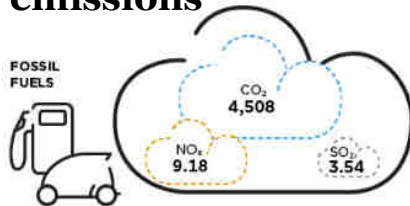
Global challenges

Global liquid fuel consumption



Source: James O'Sullivan (U.S. Energy Information Administration): International Energy Outlook 2011, September 2011, p. 29, available online at <http://eia.doe.gov>

Greenhouse gas emissions



Dependency on fossil energy and liquid fuel importation

Consumer trends and needs

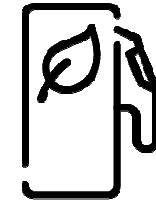
- **Market regulations** request a sig. share of fuels from renewable sources in the coming years (China, EU, USA)*
- **CO₂ and energy balance:** By 2018 the EU requests min. 60 % of greenhouse gas emission savings for sustainable biofuels (vs. fossil fuels) and targets a decarbonized economy by 2050
- **Superior sustainability** through use of agricultural wastes and higher greenhouse gas savings by using 2nd generation biofuel
- Circular economy incentivizes the **use of waste material and recycling of products**

Unmet needs targeted by sunliquid®

- **Flexible process for various renewable feedstocks**
- Integrated production of feedstock-specific enzyme to deliver **maximum efficiency, independent of suppliers**
- **Energy neutral / self-sustained:** no additional fossil energy required
- Nearly **carbon neutral:** High process yield, greenhouse gas emission reduction of approx. 95 % compared to fossil fuels
- **Based on agricultural wastes:** No additional land needed, no competition with food and feed in land requirement

*China 10 % by 2020, EU 10 % of transport fuel by 2020, USA equivalent of 15 % by 2022

Current challenges in biofuel production process



Chemical pre-treatment:

- High cost for chemicals in pre-treatment
- Negative impact on sustainability by use of chemicals

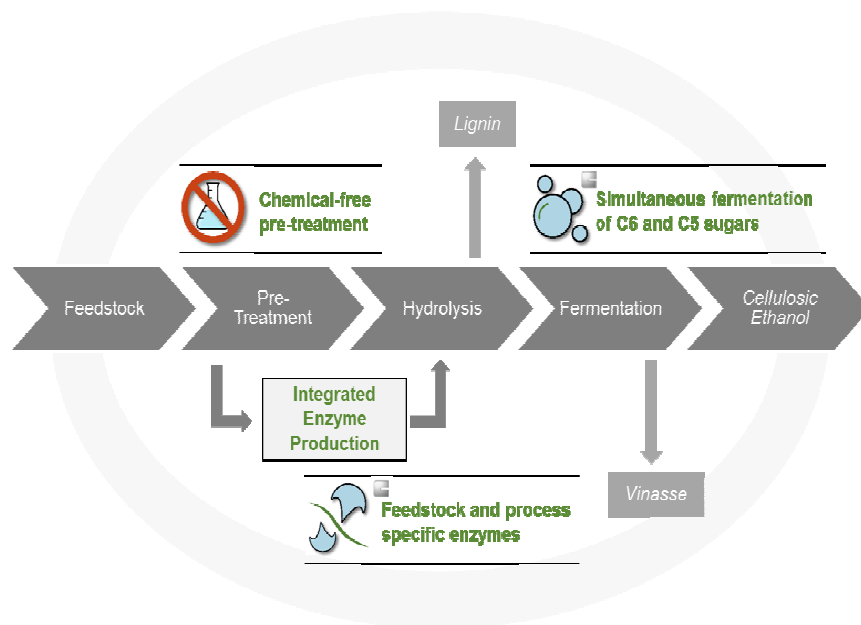
Enzyme hydrolysis:

- Different types of enzymes are needed to cleave different types of bonds
- The woody component lignin in the plant cell wall of the biomass increases the amount of enzymes required (cost intensive) compared to starch
- Enzymes for biomass are expensive, need to be recycled

Ethanol production and purification:

- Sugars with five carbon atoms cannot be used for glucose fermentation
- Separation of alcohol and water by distillation is energy intensive

Fully integrated sunliquid® process



- Unique **chemical-free** mechanical and thermal **pre-treatment** enables optimal hydrolysis. Purification steps are unnecessary allowing for a safer and more environmentally friendly process.
- **Lignin qualifies as boiler fuel** and fulfills total steam demand of plant and majority of electricity supply.
- **By-product** Vinasse can be **used as an organic fertilizer**.
- Distinctive **process-integrated enzyme production** reduces costs to minimum. Enzymes are produced exactly when and where needed, without additional costs for logistics, formulation or dependence on external suppliers.
- Clariant can quickly adapt **enzymes** to new **feedstock and process conditions**. This results in the most efficient hydrolysis with maximum yields and makes the process flexible for different boundary conditions.
- **High quality of enzymes validated in benchmarking with competitors**. Organism used for fermentation is highly optimized and able to simultaneously ferment both C5 and C6 sugars in a one-pot reaction. Thus the **ethanol yield rises by 50 %** versus only C6 fermentation.

Benefits of sunliquid®

Energy-self-sufficient process creates »green jobs«
and reduces dependence on fossil fuels

-95 %



REDUCED CO₂ EMISSIONS

Greenhouse gas emissions are reduced by 95 % compared to fossil fuels.

+50 %



MORE ETHANOL

Produces 50 % more ethanol than previous processes.



ENERGY SELF-SUFFICIENT

sunliquid® process is energy self-sufficient. No additional energy is needed.



LOCAL RESOURCES

Imports would be replaced by local fuel production. Circular economy: use of local resource and by-product organic fertilizer to return nutrients to the field.



GREEN JOBS

Green jobs and additional income for regional agriculture result.



REDUCED COSTS

Because the required enzymes are produced in the process itself.

Summary - sunliquid® Business Line Biofuels & Derivatives

Market:

- Bioethanol market: approx. CHF 60 bn
- Secured markets due to governmental programs in the EU, North America and China with further upside from federal programs in Brazil and India
- Sustainability strong value driver in the mobility and fuels market

Bioethanol plant Romania:

- Investment: slightly above CHF 100 m
- First production by 2020
- Entire production output of bioethanol already contracted

Biofuels & Derivatives guidance:

- At least CHF 100 m annual sales potential
 - Licenses for bioethanol production technology
 - Bioethanol sales from production plant in Romania
 - Growth potential of sunliquid® technology beyond fuels (not yet included)
- EBITDA* margins exceeding 40 %
- Attractive cash flow conversion from sunliquid® technology

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