The potential of sunliquid®

what is precious to you?
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Innovation in biofuels
Translating customer needs into product solutions

Global challenges

Global liquid fuel consumption
- Market regulations request a significant 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

Greenhouse gas emissions

Dependency on fossil energy and liquid fuel importation

Consumer trends and needs

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
Uniqueness of sunliquid®

Fully integrated sunliquid® process

The uniqueness of sunliquid®

- 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

*before exceptional items
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