Bio-refinery: Bringing commercial cellulosic ethanol production to the market with sunliquid®

CLARIANT

Public

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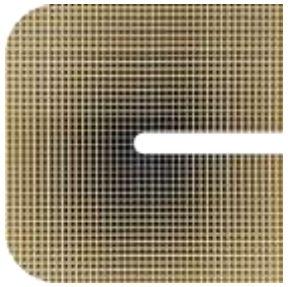
what is precious to you?

CLARIANT AT A GLANCE

Clariant at a glance – a global leader in specialty chemicals serving a broad industry

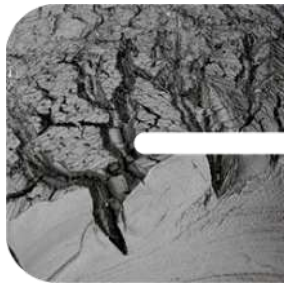
CARE CHEMICALS

Personal Care
Industrial Applications
Home Care
Crop Solutions
Food Ingredients
Encapsulation Technologies



CATALYSIS

Catalysts
Biofuels & Derivatives



NATURAL RESOURCES

Additives
Oil Services
Mining Solutions
Refinery Services
Functional Minerals

4 399 Sales 2019 (CHF m) from continuing operations

15,7% EBITDA margin[1] 2019 after exceptional items from continuing operations

17 223 Employees 2019 of total Group including discontinued operations[2]

118 Production sites worldwide of total Group including discontinued operations[2]

[1] excluding a CHF 231 million provision for an ongoing competition law investigation by the European Commission; [2] As of 31 December 2019, discontinued operations comprised the pigments and masterbatches businesses.

“TOO MUCH CARBON IN THE AIR”

ADVANCED BIOFUELS – MARKET CONCERNS ADDRESSED & SOLVED

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Lower emissions from transport urgent for reaching climate goals

TOO MUCH **CARBON IN THE AIR**

In 2018, the transport sector was responsible for

24% of GHG emissions worldwide

and

27% in the EU[1]

TRANSPORT DECARBONIZATION SOLUTIONS FOR ACHIEVING **CLIMATE AMBITIONS**

Vehicle technology & efficiency

Energy infrastructure efficiency & development

Mode shift in transportation

Advanced biofuels: key role in decarbonizing transport sector

[1] Source: International Energy Agency: https://www.iea.org/reports/tracking-transport-2019 and European Environment Agency: https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12

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Lignocellulosic ethanol: the ideal candidate for immediate improvement

Made from agricultural residues such as straw, non-food lignocellulosic materials & waste

Carbon negative: among the highest total life cycle reductions in GHG emissions[1]
Considering CO_2 capture or utilization

Fully validated technology
Commercially deployed product immediately lowers emissions

Unrivalled in use
Provides superior energy density in virtually all modes of transport

Low carbon abatement costs
Drop-in solution for existing engines and infrastructure

Enhanced energy security
Domestic production boosts energy independence & long-term security

Local sources & green jobs
Use of locally sourced feedstock & new revenue stream for farmers

[1] EtOH produced with sunliquid reaches > 120% GHG saving, % compared to gasoline including CCU/S (Carbon Capture Utilization & sequestration)
[2] https://www.biofuelsdigest.com/bdigest/2018/11/06/results-are-in-clariants-sunliquid-delivers-6x-lower-carbon-intensity-than-fossil-gasoline/ without CO_2 CCU/S

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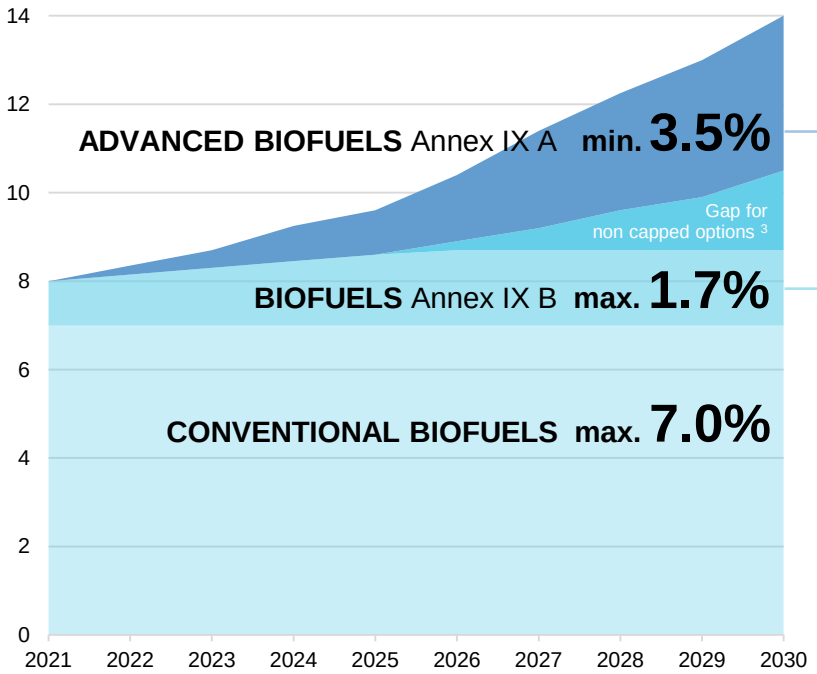
EU market for advanced biofuel under RED II: the supportive path to decarbonize mobility

PROJECTED DEVELOPMENT OF (THEORETICAL) SHARE OF RENEWABLE ENERGY SOURCES IN TRANSPORT
up to 2030 based on RED II provisions



RED II – ANNEX IX

PART A: »advanced« feedstocks and fuels
Targets: 2022: at least 0.2%, 2025: 1%, 2030: 3.5%
Defined feedstocks (excerpt):

- Straw
- Bagasse
- Nut shells
- Cobs cleaned of kernels of corn
- Other non-food cellulosic material
- Other lignocellulosic material

PART B: not considered as »advanced«
Target: capped to 1.7%

- Used cooking oil (UCO)
- Animal fats categories 1 and 2

3.5%

targeted share for advanced biofuels of the EU's transport fuel demand[1] by 2030

~ 200 plants

of 50kta cellulosic ethanol each[2]

[1] Source: http://www.etipbioenergy.eu/everyone/advanced-boifuels

[2] Assumption: 50kta sunliquid standard capacity; EU transport fuel demand in 2030 remains at similar levels as in 2016 - Total transport fuel demand (road & rail) in 2016: 306.567 ktoe; Source: Eurostat

[3] Additional advanced fuels from Annex IXA, renewable electricity (used for transport), any other NON capped options (e.g. H2 if not produced neither with FOOD feedstock nor ANNEX IXB feedstock)

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RED II: only Annex IX/A defines advanced feedstocks and fuels

FEEDSTOCK/ CONVERSION TECHNOLOGY	PRODUCT CATEGORY Benzine (cars)	Diesel (cars, trucks)	Kerosene (aviation)	Bunker fuel (e.g. ship)
Annex IX A (waste based, advanced technology)	Cellulosic ethanol	Advanced diesel from cellulosic fatty acids, cellulosic sugars to diesel (Clariant, Exxon, Genomatica collaboration) ED95	Hydrogenated oils from cellulosic feedstock, Alcohol-to-Jet from cellulosic feedstock, Fischer-Tropsch route from cellulosic feedstock, cellulosic sugars to diesel	Advanced diesel from cellulosic fatty acids, cellulosic sugars to diesel, cellulosic ethanol and lignin
Annex IX B (waste based, mature technology)		Biodiesel (Fatty acid Methyl Esters =FAME) from used cooking oil, animal fats	HVO from used cooking oil, animal fats	FAME and hydrogenated oils from used cooking oil, animal fats
Conventional biofuel (1G)	Ethanol from crop-based starch/sugar	FAME from rapeseed, palm, Hydrogenated vegetable oils (HVO) from conventional feedstock	HVO, Alcohol to Jet from crop-based starch/ sugar	Straight vegetable oils (no processing), FAME, HVO

SUNLIQUID®: CLARIANT'S SOLUTION TO DECARBONISE MOBILITY

what is precious to you?

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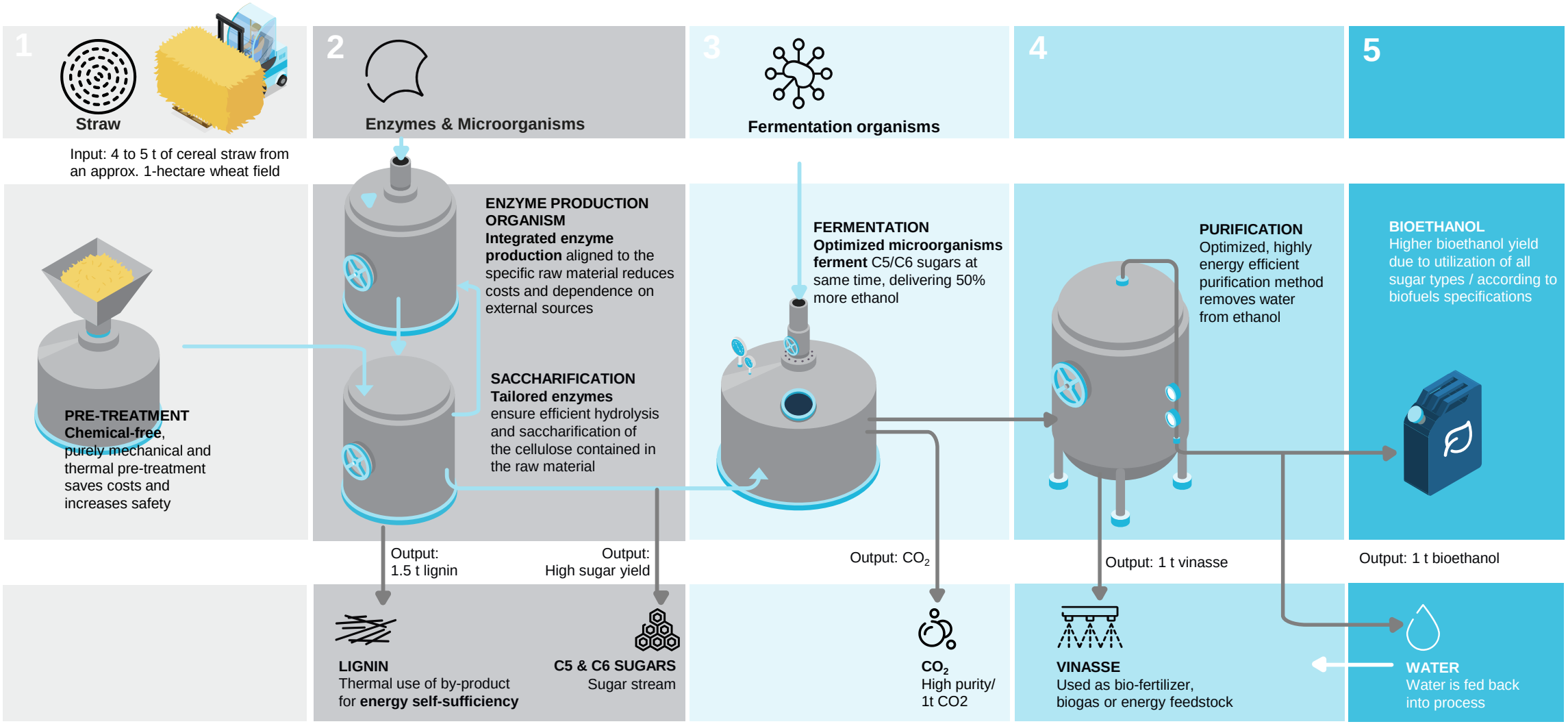
sunliquid®: fully integrated process



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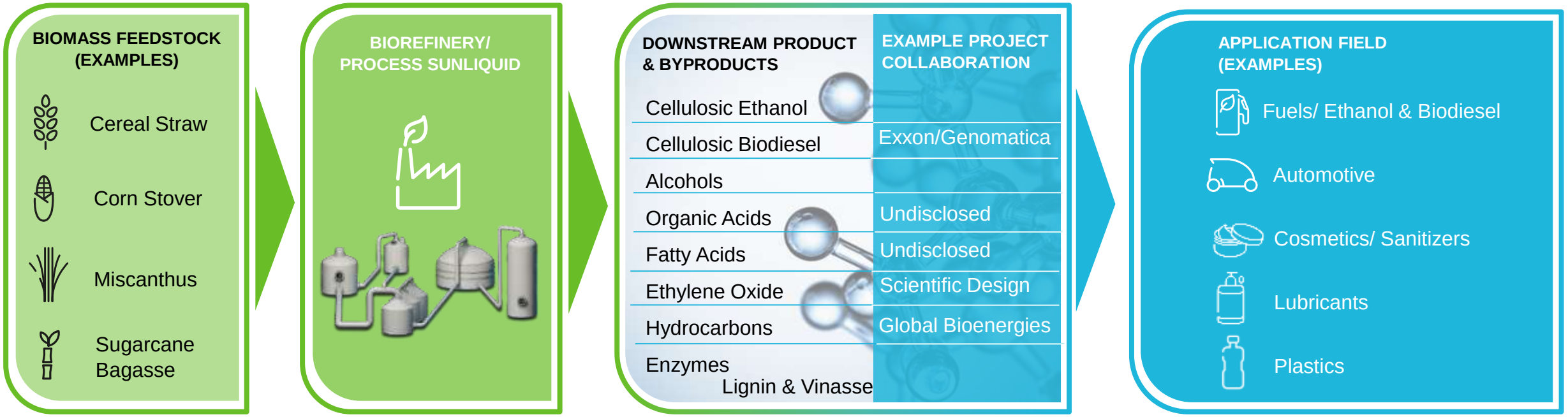
BUT that is not all: sunliquid®- the ideal platform for highly sustainable bio-based products



sunliquid®

- **Standalone, flexible sugar platform**
- **Development opportunities** for biobased products
- **Extensive know-how** in biocatalysis, strain optimization and heterogenous catalysis
- **Specifications** can be **adjusted to the nee**d of the added **downstream processing**

SUNLIQUID® PRE-COMMERCIAL PLANT

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Fully integrated process in operation at pre-commercial plant: reliable, stable & continued for >8 years acting as training facility

PRE-COMMERICAL SUNLIQUID® PLANT IN STRAUBING, GERMANY

Fully validated technology: >8 years of testing (1,000 t/a EtOH; ~4,500 t/a feedstock) with scaled-down commercial design reproducing all process steps

Validated pre-treatment: >8 years of operation with standard equipment from leading provider Valmet

Feedstock flexibility: multiple feedstocks tested, identical process with feedstock-specific enzymes & yeast

- Straw
- Miscanthus
- Rice straw/husks
- Corn stover
- Bagasse
- Sugarcane tops & leaves

Your team on site: testing of own feedstock with own team on site; training on plant operation, maintenance, start-up and shut-down

COMMERCIAL READINESS: SUNLIQUID® PLANT IN ROMANIA

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Commercial-scale flagship plant in Romania

COMMERICAL SUNLIQUID® OPERATIONS IN PODARI, ROMANIA

Investment: Clariant invests in own greenfield 2G flagship plant in SW Romania (> 100 million euros)

Capacity: 50,000 t/a EtOH; ~250,000 t/a feedstock (e.g. wheat & barley straw)

Job creation: approx. 1.200 (~100 inside plant/ ~300 outside plant/~800 construction of plant)

Economic growth: additional business opportunities for all actors along the value chain (e.g. provides farmers additional source of income)

Training facility: plant serves as training facility for own & client staff

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sunliquid® flagship plant en route to commercialization

2017

CLARIANT PLANT ROMANIA

Approval to invest in building a 50 kta plant in Romania

2018

GROUNDBREAKING PLANT ROMANIA

12 September 2018

2019

WORKSHOP WITH FARMERS IN OLTENIA

MANAGEMENT TEAM FORMED

ISCC CERTIFICATION

»TECHNOLOGY PROVIDER OF THE YEAR« PRIZE BY DIPLOMAT ROMANIA

2020

2021

* The project receives funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under Grant Agreement no. 322386 (FP7 SUNLIQUID) and from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program under Grant Agreement no. 709606 (BBI LIGNOFLAG)

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How our dedicated feedstock team supports you

FEEDSTOCK SUPPLY & LOGISTICS SERVICES

GRAIN HARVEST → BALING → TRANSPORT → INTERMEDIATE STORAGE → FACTORY STORAGE → PROCESSING

- Feedstock availability assessment
- Supply chain contract systems
- End-to-end supply chain assessment (from field to plant)


FROM STRAW TO BIOFUEL

SUNLIQUID® REFERENCES & SUPPORT

what is precious to you?

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Already 3 licenses sold in EU and own flagship in Romania

First EU license commercial plant
Slovakia

ENVIRAL

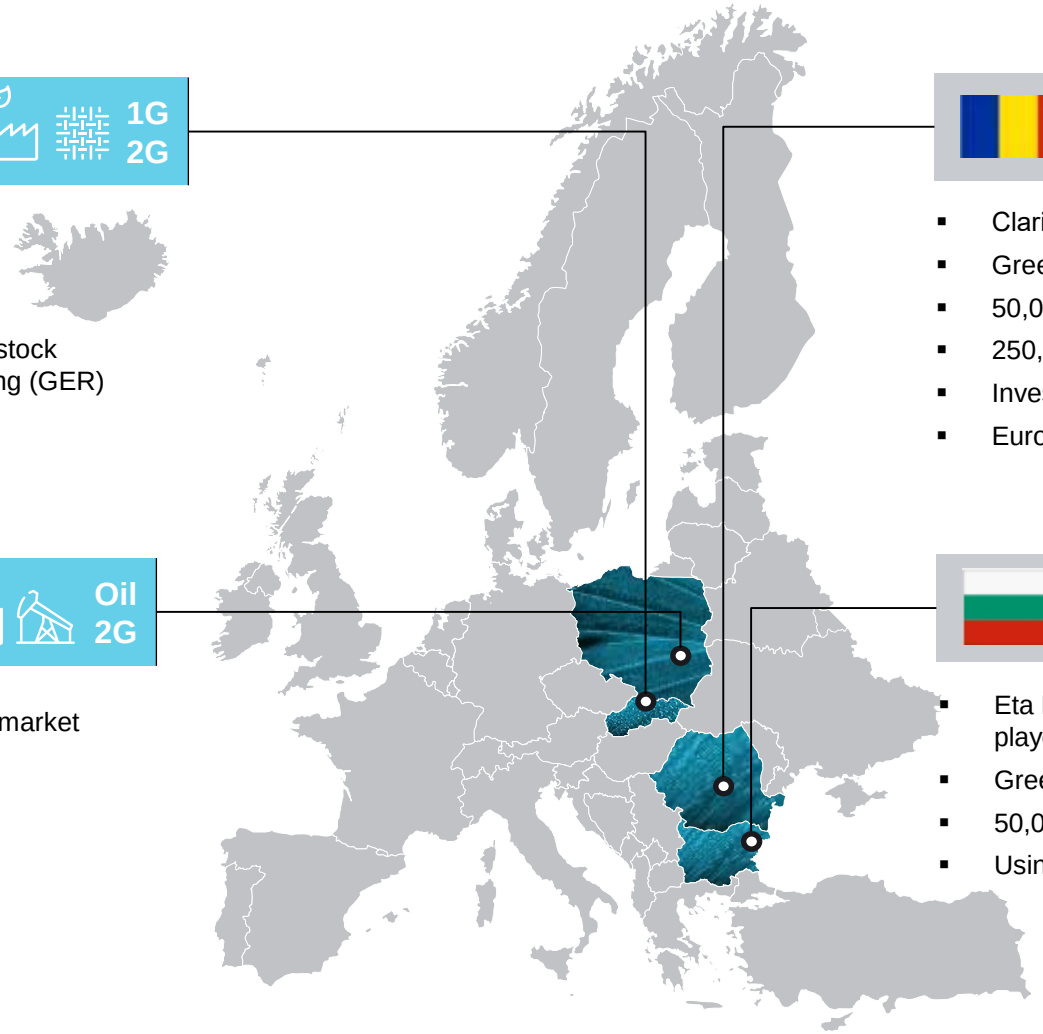
1G 2G

- Enviral: Slovakia's biggest ethanol producer
- Integrated into existing 1G plant
- 50,000 tpa ethanol
- Project based on excellent test results of Enviral's feedstock at Clariant's pre-commercial sunliquid® plant in Straubing (GER)

Clariant flagship commercial plant
Romania

2G

- Clariant's own investment in cellulosic EtOH flagship plant
- Greenfield site in Podari, Romania
- 50,000 tpa ethanol
- 250,000 tons of straw annually
- Investment value: over 100 million Euros
- European Commission & BBI Joint Undertaking funding*



Second EU license commercial plant
Poland

ORLEN Południe

Oil 2G

- ORLEN Południe: leading player in the fuels and energy market
- Integrated into the existing Jedlicze petroleum refinery
- 25,000 tpa ethanol
- Using locally sourced feedstock (wheat straw)

Third EU license commercial plant
Bulgaria

2G

- Eta Bio Ltd.: a company of the Pavlovi family, a major player in the Bulgarian agricultural sector
- Greenfield site in General Toshevo, Northeast Bulgaria
- 50,000 tpa ethanol
- Using locally sourced feedstock (wheat straw)

* The project receives funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under Grant Agreement no. 322386 (FP7 SUNLIQUID) and from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program under Grant Agreement no. 709606 (BBI LIGNOFLAG) combined grant equal to 40m EUR.

BBI JU

Bio-based Industries Consortium

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Commercial sunliquid® plant in China

License commercial plant
China

- Agreement signed for third sunliquid® cellulosic EtOH license/first license deal for sunliquid® in China
- Joint venture (JV) will be formed by Anhui Guozhen Group & Chemtex Chemical Engineering with the intention of realizing full-scale commercial plant
- 2G plant will be built at a greenfield site in Fuyang city, Anhui province in East China
- Planned annual plant capacity: 50,000 tons with an option to double capacity in a 2nd phase
- Using locally sourced feedstock such as wheat straw and corn stover

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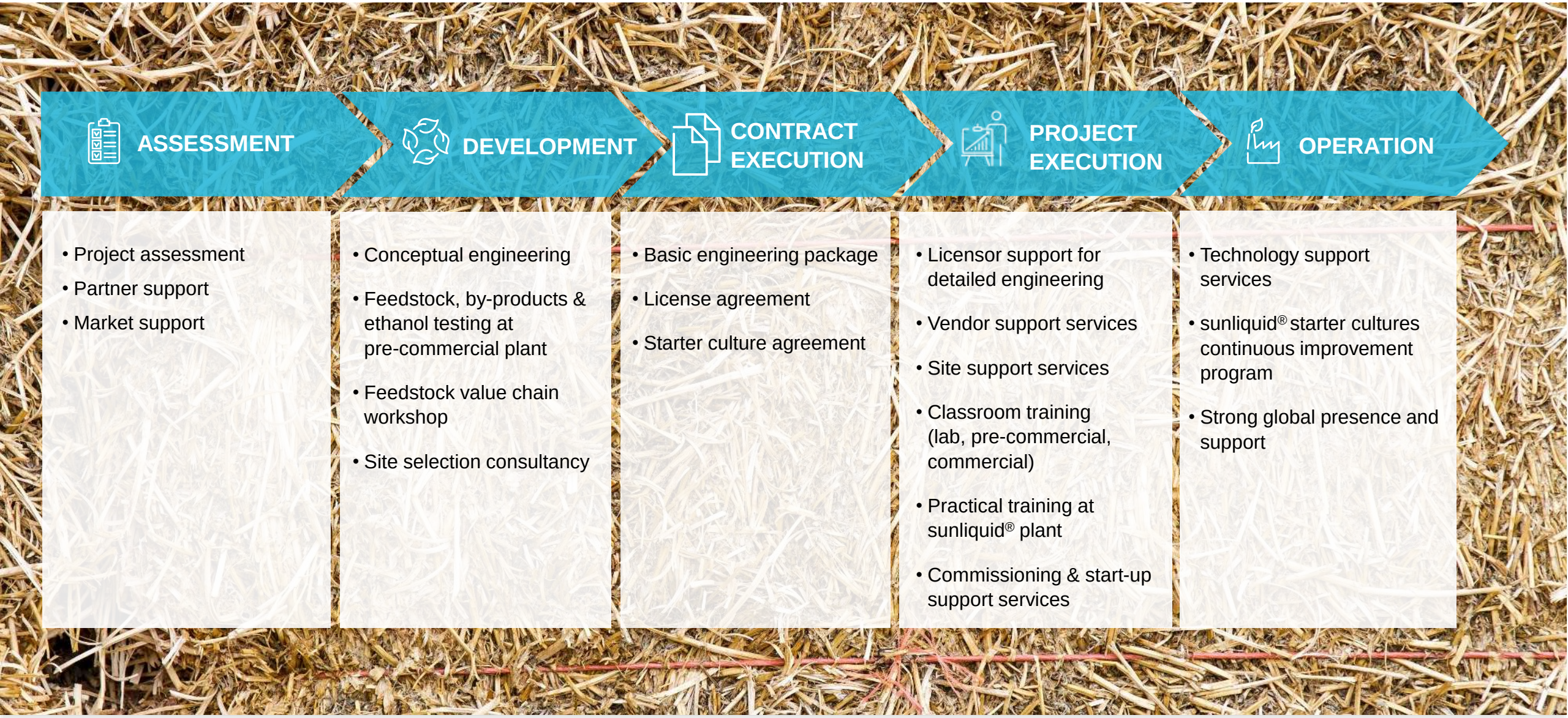
Tailored support for entire value chain from idea to operation



ASSESSMENT

- Project assessment
- Partner support
- Market support

DEVELOPMENT

- Conceptual engineering
- Feedstock, by-products & ethanol testing at pre-commercial plant
- Feedstock value chain workshop
- Site selection consultancy

CONTRACT EXECUTION

- Basic engineering package
- License agreement
- Starter culture agreement

PROJECT EXECUTION

- Licensor support for detailed engineering
- Vendor support services
- Site support services
- Classroom training (lab, pre-commercial, commercial)
- Practical training at sunliquid® plant
- Commissioning & start-up support services

OPERATION

- Technology support services
- sunliquid® starter cultures continuous improvement program
- Strong global presence and support

SUMMARY & OUTLOOK

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On our way to decarbonizing global mobility

Key conclusions:

- **Paris agreement** & global climate efforts will fail without **significant increase** of **sustainable energy solutions**
- **Variety of solutions** needed to **decarbonize transport sector** & achieve ambitious climate goals
- **Advanced biofuels** are a **key solution** & have **countless benefits** to make an **immediate impact**
- **Current market conditions** are favorable for **driving demand for advanced biofuels** even further

Legislation: global support mechanisms & mandates are current key drivers for strong growth

Technology: sunliquid® proven solution with >8 years of reliable, stable & continued pre-commercial operations, own commercial plant underway & 4 licenses sold

Feedstock: proven global abundance of agricultural residues → sunliquid® established clear, executable value chain from field to plant in Romania and can support you in replicating it

Business opportunity: low carbon abatement costs for advanced biofuels (no investments into infrastructure or engine adaption) → sunliquid®: sustainable high-margin investment with attractive OPEX & CAPEX

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»We are looking forward to partner with you to drive lignocellulosic ethanol forward«

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