



**FULLY INTEGRATED
CELLULOSIC ETHANOL
PRODUCTION**

**CLARIANT'S SUNLIQUID®
STORY**

CLARIANT 

Public

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Business Line Biofuels & Derivatives
04.03.2020

what is precious to you?

Clariant at a Glance – A Globally Leading Company in Specialty Chemicals

4 399

Sales 2019 (CHF m)
from continuing operations

692

EBITDA¹ 2019 (CHF m)
after exceptional items from
continuing operations

3

Core Business Areas

17 223

Employees 2019
of total Group including
discontinued operations

38

Net result 2019 (CHF m)
of total Group including
discontinued operations

15.7%

EBITDA margin¹ 2019
after exceptional items from
continuing operations

118

Production sites worldwide
of total Group including
discontinued operations

¹ excluding a CHF 231 million provision for an ongoing competition law investigation by the European Commission

Three Business Areas – the Right Portfolio for Future Growth



CARE CHEMICALS

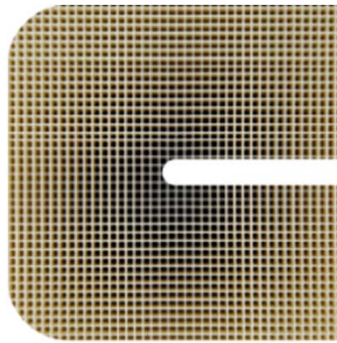
Industrial & Consumer Specialties

Consumer Care, Industrial Applications

New Business Development

Electronic Materials, Additive

Manufacturing/3D Printing



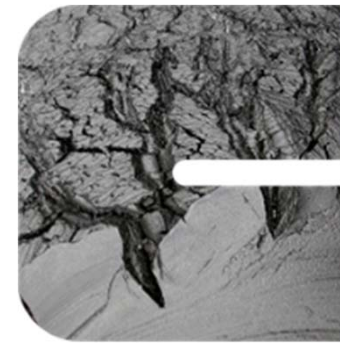
CATALYSIS

Catalysts:

Petrochemicals, Specialty Catalysts..

Biofuels & Derivatives

Cellulosic EtOH & cellulose derived products



NATURAL RESOURCES

Additives

Plastics, Coatings & Inks

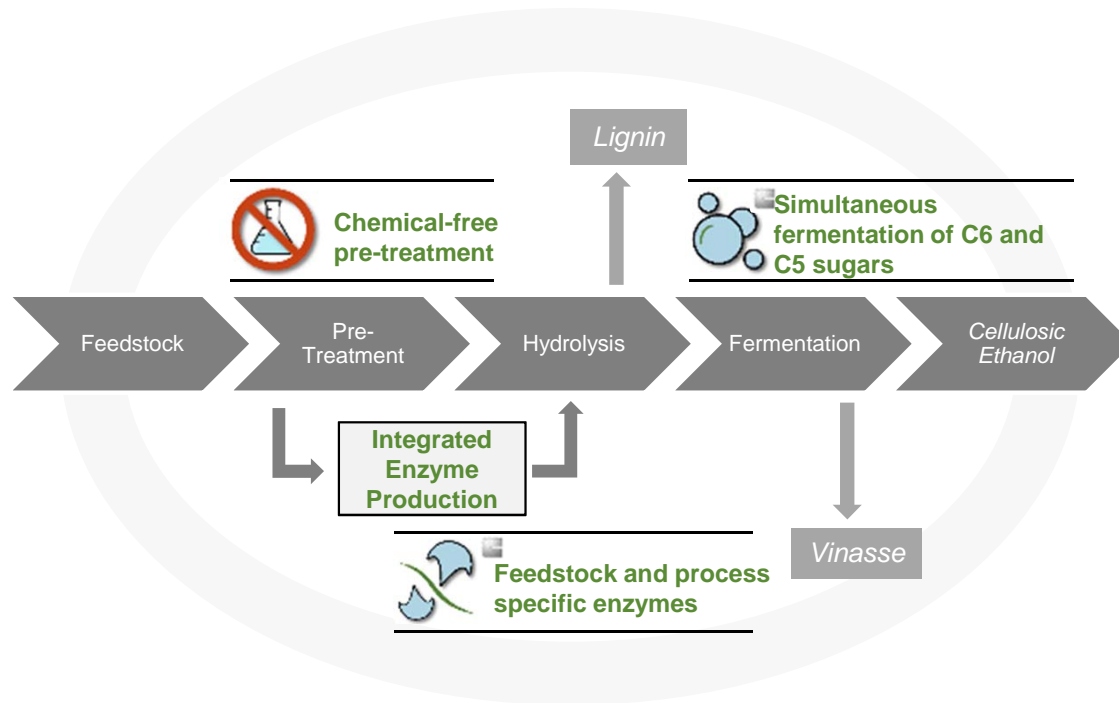
Functional Minerals

Purification, Functional Additives

Oil and Mining Services

Oil Services, Mining Solutions

sunliquid[®] process: fully integrated cellulosic ethanol production



The **chemical-free** mechanical and thermal **pre-treatment** enables an optimal hydrolysis. Purification steps are unnecessary and makes for a safer and more environmentally friendly process.



Through the **process integrated enzyme production** costs can be reduced to a minimum. Enzymes are produced exactly when and where needed, there are no costs for logistics or formulation and no dependence on external suppliers. **Feedstock and process specific enzymes** achieves a more efficient hydrolysis with maximum yields and makes the process flexible for different boundary conditions.



Excellent **by-product quality**. Low sulphur high dry-matter lignin. Vinasse as biogas substrate or organic fertilizer

SUNLIQUID REFERENCES

NEWS: Clariant signs license agreement with Anhui Guozhen & Chemtex for commercial cellulosic ethanol project in East China



Media Release

Clariant and Anhui Guozhen and Chemtex announce license agreement on sunliquid® cellulosic ethanol technology in China

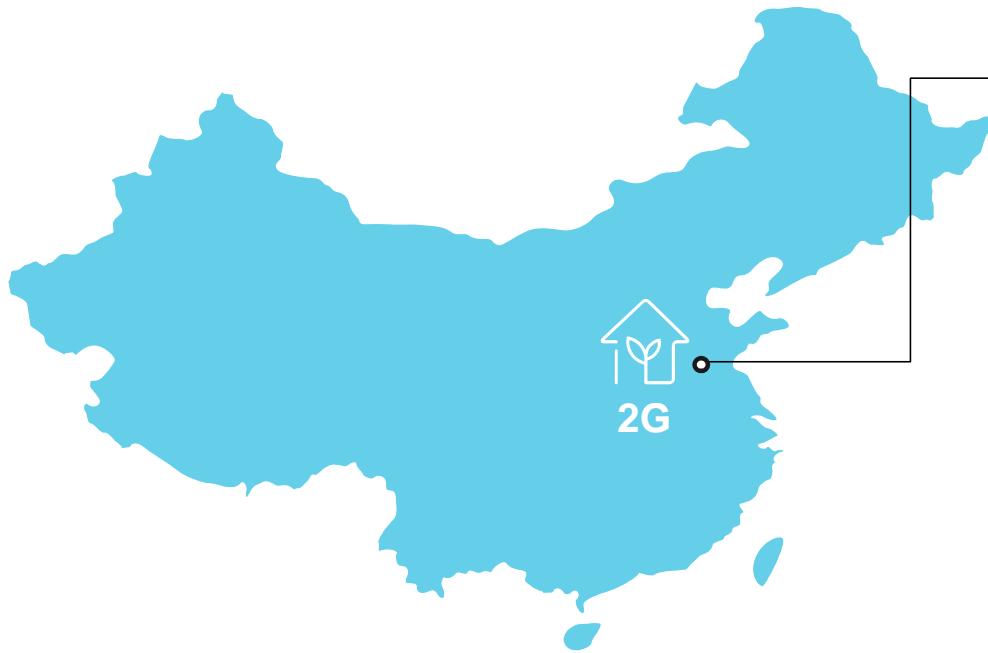
- Agreement marks first license deal for Clariant's sunliquid® technology in China and its third signed license deal overall
- Anhui Guozhen and Chemtex agreed to form a joint venture to realize a full scale commercial plant for the production of cellulosic ethanol in Anhui province with Clariant's sunliquid® technology
- Planned annual plant production capacity of 50.000 tons cellulosic ethanol with an option to double capacity will be one of the largest second generation plants in China so far
- Intended project will be a major step toward fulfillment of Anhui province ethanol blending mandate

Muttenz, January 6, 2020 – Clariant, a focused and innovative specialty chemical company, and Anhui Guozhen Group, a Chinese green energy company, and Chemtex Chemical Engineering, a multinational engineering company, today signed a license agreement on sunliquid® cellulosic ethanol technology.



Signing of license agreement on 6th January 2020

Market introduction: sunliquid[®] commercial plant footprint in China



Third license
commercial plant
China



- Agreement signed for third sunliquid[®] cellulosic EtOH license/ first license deal for sunliquid[®] in China
- Joint venture (JV) to be formed by Anhui Guozhen Group & Chemtex Chemical Engineering to realize full scale commercial plant
- 2G plant will be executed by the JV at a greenfield site in Fuyang city, Anhui province in East China
- Planned annual plant capacity: **50.000 tpa of EtOH** with an option to double capacity in a 2nd project phase
- Using locally sourced feedstock such as wheat straw and corn stover

NEWS: Clariant and Orlen Poludnie announce commercial cellulosic ethanol project



Media Release

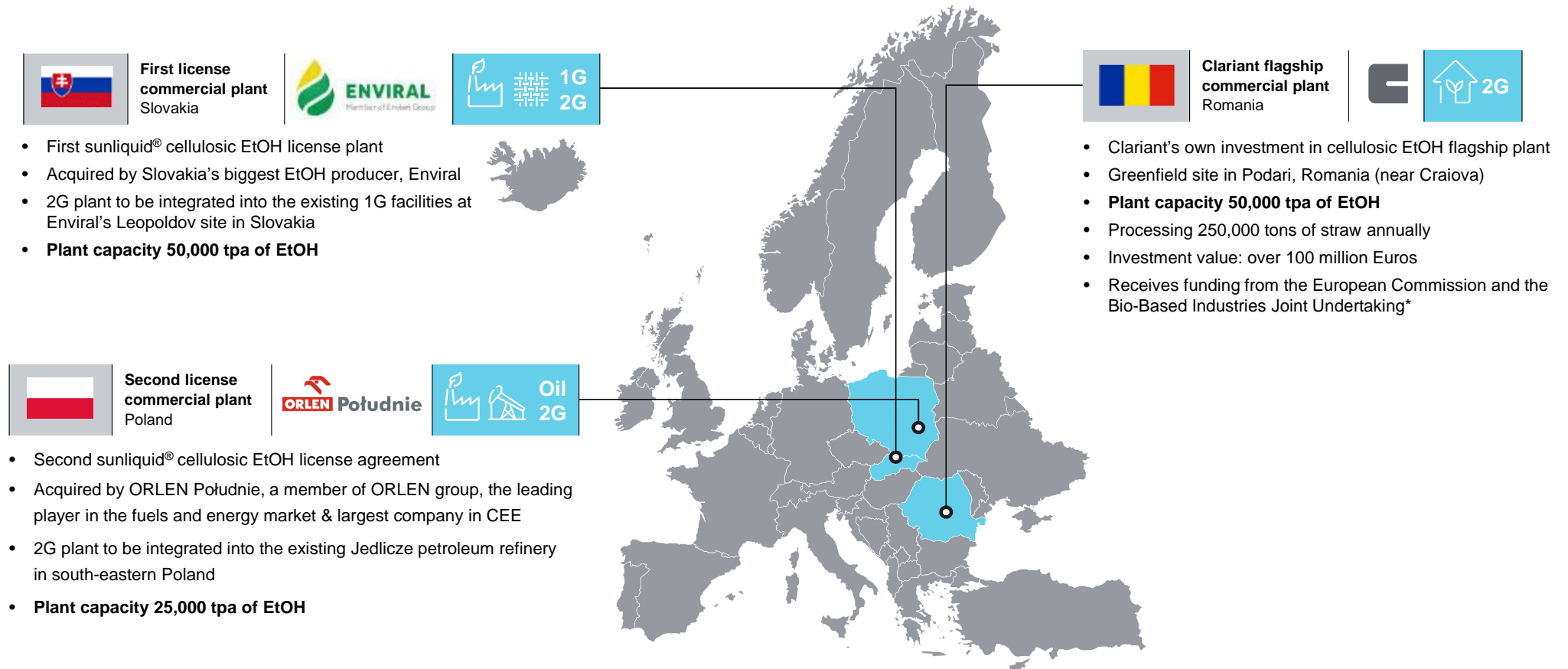
Clariant and ORLEN Południe announce license agreement on sunliquid® cellulosic ethanol technology

- Agreement marks second signed license deal for Clariant's sunliquid technology
- ORLEN Południe, member of ORLEN Group, intends to realize a full scale commercial plant for the production of cellulosic ethanol at its Jedlicze site in Poland with Clariant's sunliquid technology
- Cooperation is another major step toward the commercialization of sunliquid technology for advanced biofuels in Europe

Muttenz, September 20, 2019 – Clariant, a focused and innovative specialty chemical company, and ORLEN Południe, a member of ORLEN Group, which is a leader in the fuels and energy markets and the largest player in Central and Eastern Europe, today signed a license agreement on sunliquid cellulosic ethanol technology.



Market introduction: sunliquid[®] commercial plants footprint in the EU



* The project receives funding from the European Union's Seventh Framework Program 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)

Your committed partner for commercialization: Group Biotechnology



Munich R&D Center

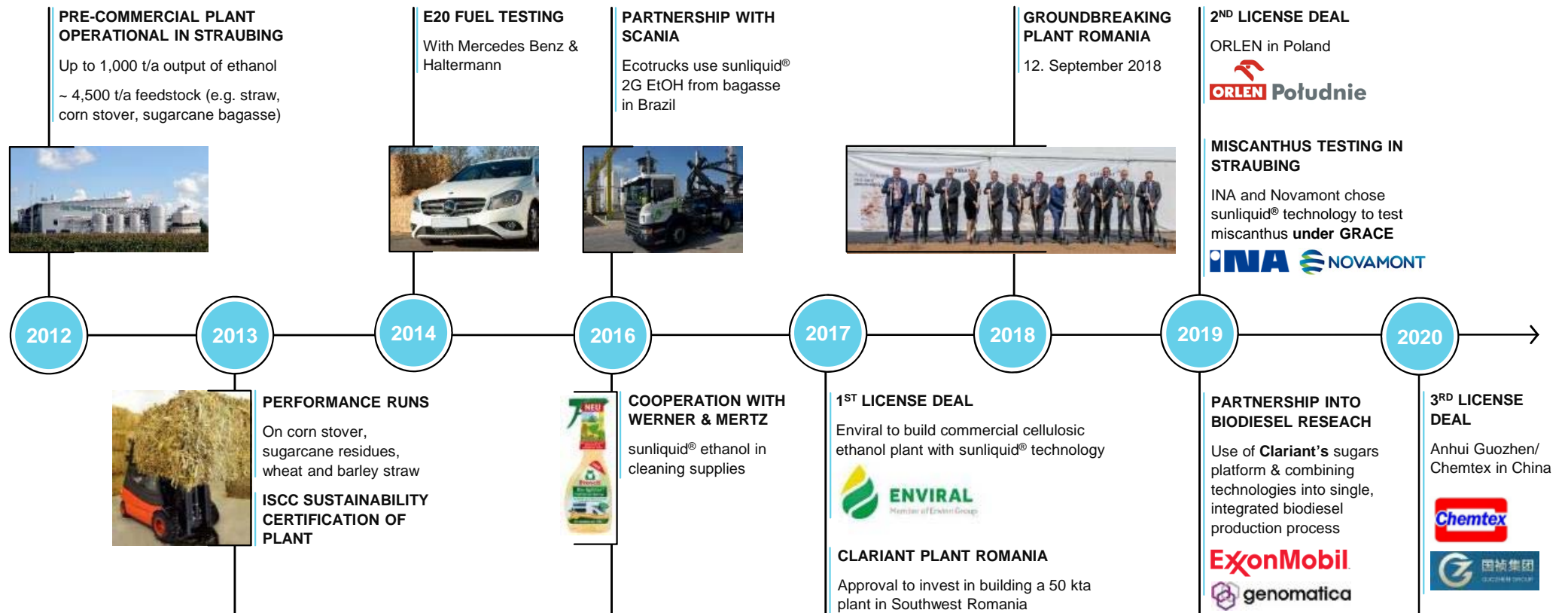
- Since 2006
- 118 employees
- Lab and office space: 6,500 m²
- Pilot plant since 2009
- Over 15 different feedstock tested on pilot-scale



Straubing pre-commercial plant

- Since 2012
- 22 employees
- Area: 2,500 m²
- Up to 1,000 t/a output of ethanol
- Wheat & barley straw, corn stover, sugarcane bagasse and straw, rice straw etc. converted to ethanol

Successful path: >7 years pre-commercial testing, own commercial plant and 3 licenses sold



sunliquid® flagship plant progress: en route to commercialization



CLARIANT PLANT ROMANIA
 Approval to invest in building a 50 kta plant in Romania

HARVESTED 2,7K TONS OF STRAW

CONSTRUCTION UNDERGOING
HARVESTED 20K TONS OF STRAW

2017

2018

2019

2020

2021



GROUND BREAKING PLANT ROMANIA
 12. September 2018

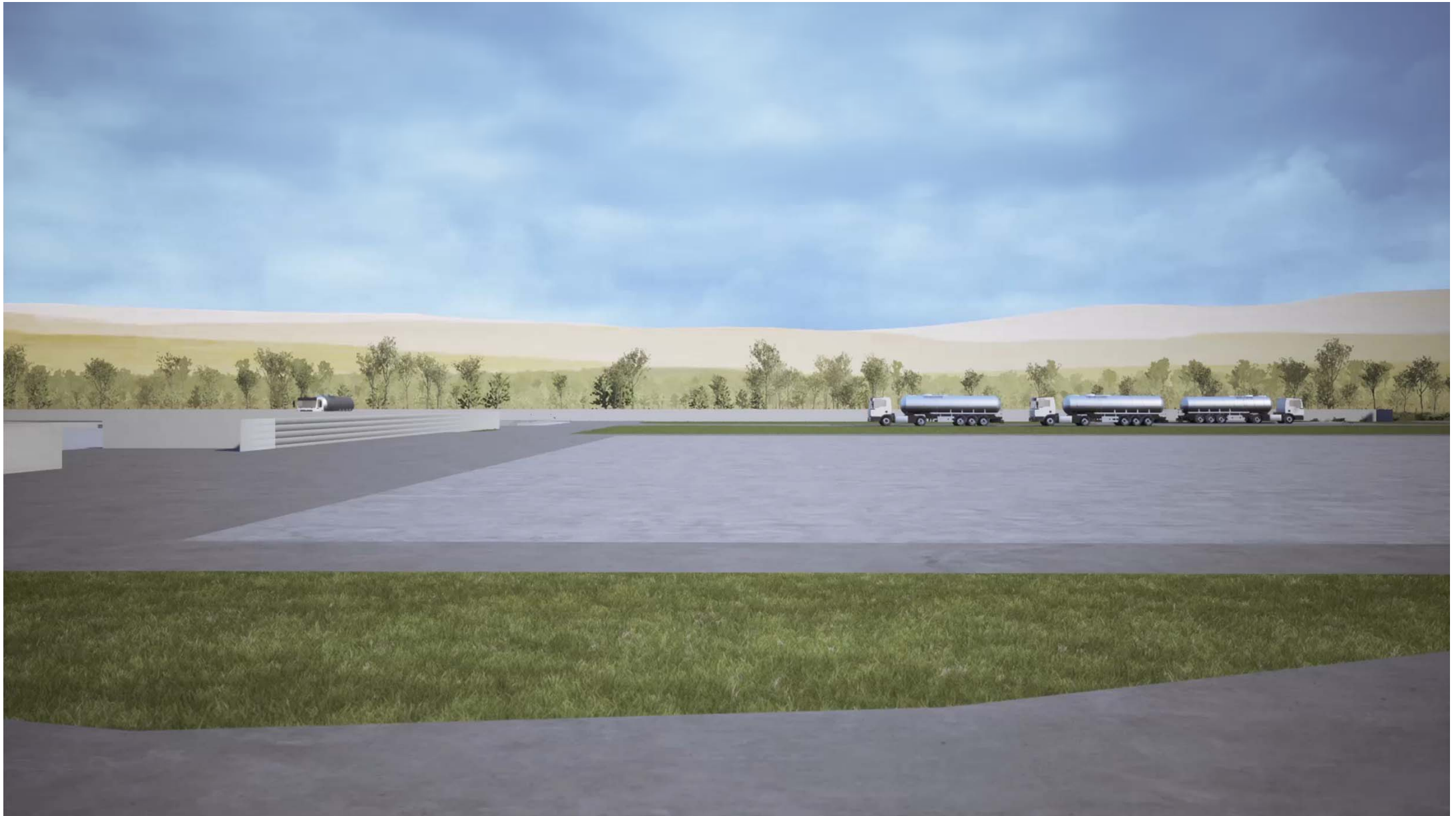


WORKSHOP WITH FARMERS IN OLTENIA
MANAGEMENT TEAM FORMED
ISCC CERTIFICATION
"TECHNOLOGY PROVIDER OF THE YEAR" PRIZE BY DIPLOMAT ROMANIA



EXPECTED CONSTRUCTION COMPLETION

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sunliquid® flagship plant progress: construction update



Reinforcement finished, foundation plate started – hydrolysis & fermentation vessels

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ADVANCED CELLULOSIC ETHANOL OPPORTUNITY FOR INDIA

Reasons to choose Clariant's sunliquid® technology to enable profitable production in India

Clariant's sunliquid® starter cultures and process technology enables operators to:

Use sunliquid® package adapted for the Indian market with significantly lower OPEX compared to other providers
including localized **energy generation** package and **ZLD concept**

Eliminate acid and alkali consumption in pre-treatment
Pre-treatment chemical costs of approx. **30 Cr INR/year** can be eliminated*

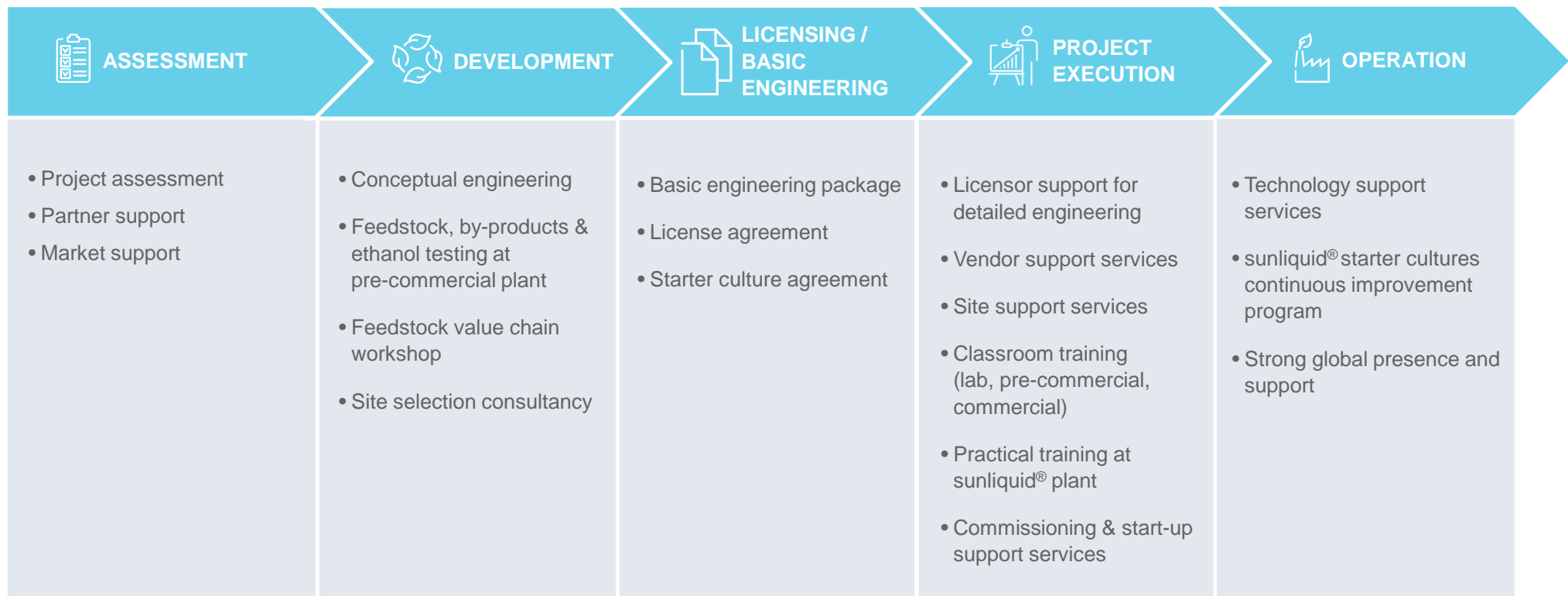
Obtain cost competitiveness and supply security through integrated enzyme & yeast production
Integrated on-site enzyme production **leads to lower transportation, purification & storage costs** compared to finished enzyme packages and enables operator influence on enzyme costs (e.g. lower feedstock costs leads to lower enzyme production costs)

Benefit from higher lignin quality
Lower moisture (35-40%) leads to higher lignin calorific value and **enables reduction/ elimination of secondary fuel**

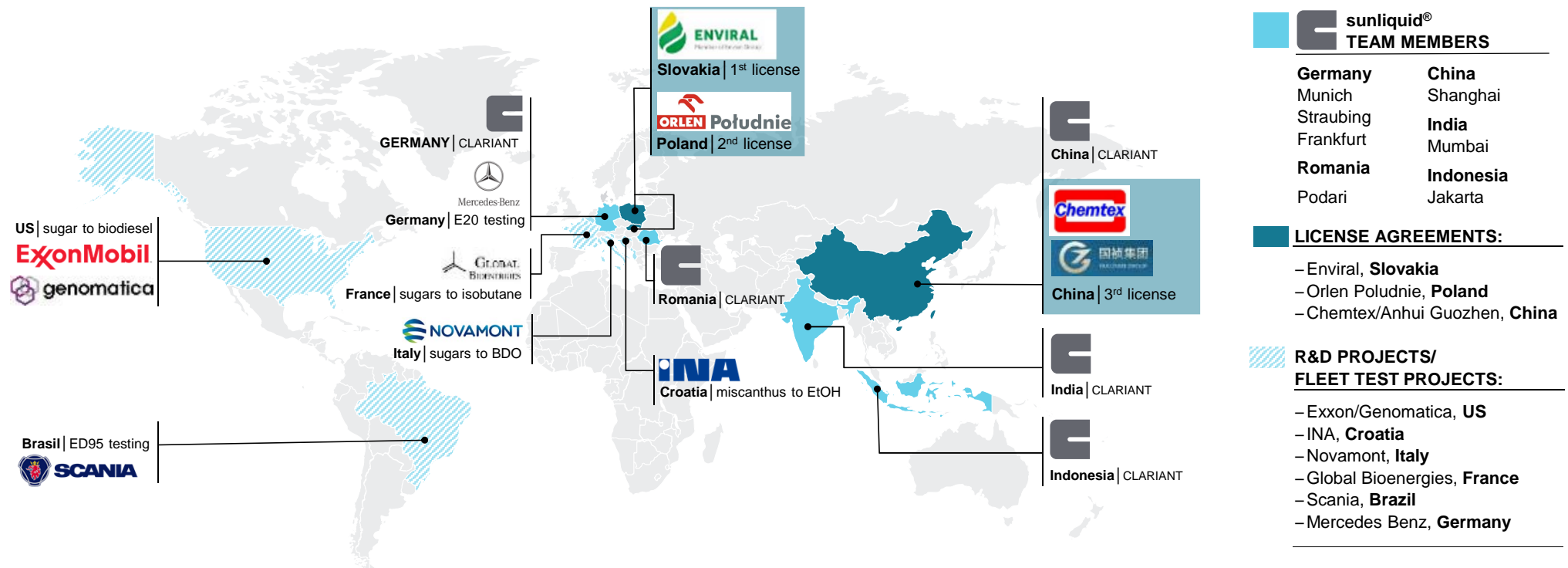
Benefit from higher vinasse quality
Direct co-combustion with lignin enables onsite power generation **enables reduction in electricity imports**, and future option for use as higher value organic fertilizer

*Calculation for 100 KLPD plant

Our offering: tailored customer services throughout the entire value chain from feedstock to operation



sunliquid®: licenses, partners and footprint on a global scale



- sunliquid® TEAM MEMBERS**
- | | |
|----------------------------------------------------|-----------------------------|
| Germany Munich Straubing Frankfurt | China Shanghai |
| Romania Podari | India Mumbai |
| | Indonesia Jakarta |
-
- LICENSE AGREEMENTS:**
- Enviral, **Slovakia**
 - Orlen Poludnie, **Poland**
 - Chemtex/Anhui Guozhen, **China**
-
- R&D PROJECTS/ FLEET TEST PROJECTS:**
- Exxon/Genomatica, **US**
 - INA, **Croatia**
 - Novamont, **Italy**
 - Global Bioenergies, **France**
 - Scania, **Brazil**
 - Mercedes Benz, **Germany**

sunliquid®: eagerly looking forward to its footprints in India

Thank you for your attention!

Questions?

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Backup

what is precious to you?

Opportunities & challenges for India: front-runner as a production country for 2G EtOH

Opportunities

- National Policy on Biofuels 2018 (E 20 by 2030)
- The JI VAN scheme provides a thrust to 2G EtOH
- Huge availability of surplus agricultural residue in India
- The cellulosic ethanol market brings economic, societal and environmentally friendly, sustainable benefits
- 2G EtOH initiative promotes “Make in India approach”
- Readiness of a few 2G EtOH technologies for global deployment

Challenges

- Biomass market and its supply chain not fully developed
- Too many simultaneous initiatives for different advanced biofuels within the industry stakeholders
- Absence of 2G ethanol pricing does not help to create a clear business case
- Non-delivery from a few technology providers for 2G ethanol resulting in a cautious approach by the industry

Chemical-free pre-treatment: 6x times lower chemical costs

Challenge: Use of chemicals impacts supply cost and by-product quality

Solution: Steam pre-treatment & tailored enzymes



6x lower chemical costs/y*



High quality co-products lignin and vinasse, no de-sulfurization of lignin required

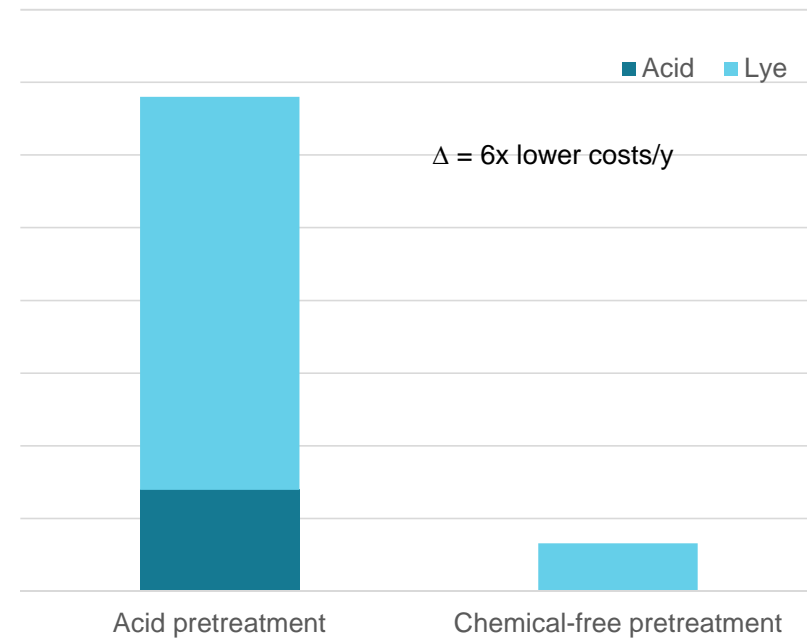


Less chemicals, less risks. Lower requirements to the equipment



Proven pre-treatment technology

Annual cost benefit through chemical-free pre-treatment*



Integrated enzyme-production: provide economic enzyme supply

Challenge: Supply of low cost & high performance enzymes

Solution: Integrated enzyme production of process and feedstock specific enzymes



Most economic solution with integrated enzyme production on cellulosic feedstock



High quality and adapted to feedstock and process requirements

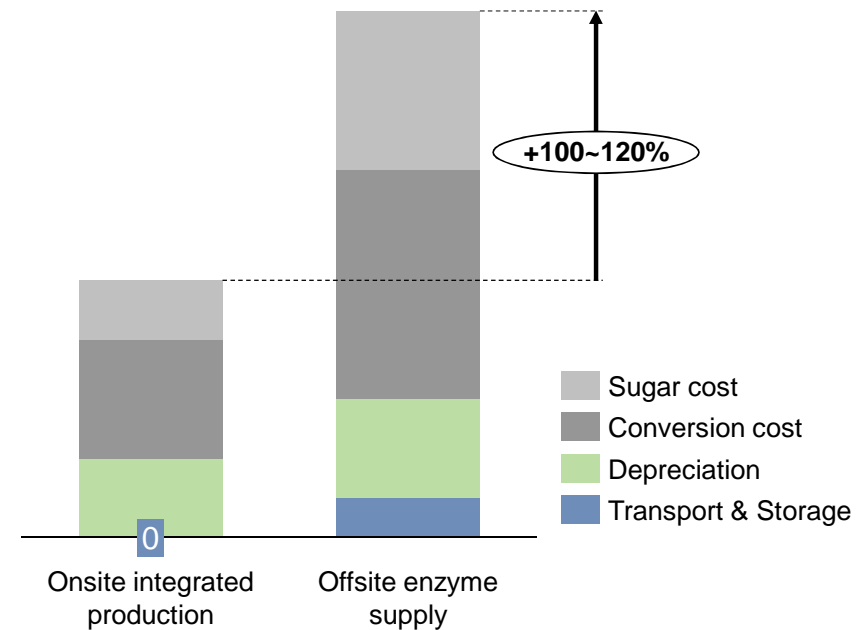


No enzyme stabilization or formulation



Less logistics (starter cultures vs. big ton/a enzymes volumes)

Cost benefit of integrated enzyme production



Integrated enzyme-production: provides feedstock flexibility

Challenge: Fragmented agricultural sector with small feedstock producers and multiple crops

Solution: Integrated enzyme production of feedstock specific enzymes



Economic production on cellulosic material as carbon source



Feedstock flexibility: hardware (equipment) always identical, software (starter cultures for enzyme production and yeast) change with feedstock campaigns

Examples of demonstrated feedstocks see right hand side

Bagasse



Sugarcane tops & leaves



Rice straw



Corn stover



Wheat straw



High quality lignin with low impurities and high heating value

Challenge: Good lignin quality essential for optimizing boiler CAPEX and OPEX

Solution: Chemical free pre-treatment & solid-liquid separation after hydrolysis



Lower impurities → lower sulfur and alkali metals by steam pre-treatment reduces SO_x emission and flue gas treatment and improves operability and availability of boiler



High dry matter (60% dry matter) → improves energy recovery and combustion performance. No co-firing of fossil fuels required



Optimized lignin properties → impacts boiler CAPEX



Lignin samples



Lignin burning test

CLARIANT experience:

- Lignin recovery at high dry matter content
- Understands lignin quality to optimize process and project economics
- Demonstrated with market leading vendors

High quality vinasse: demonstrated as organic fertilizer or fuel

Challenge: Chemical pre-treatment a waste water problem into an opportunity

Solution: Chemical free pre-treatment & early separation after fermentation. Good vinasse quality enables application as organic fertilizer (preferred), or as biogas or combustion feedstock.



Lower impurities → reducing sulfate



Dramatically reduces water treatment



Rich in nutrients → directly usable as valuable organic fertilizer



Share EU practice → CLARIANT experience certifying vinasse in Germany

Tests performed on the field & at industrial scale



As bio-fertilizer field test

CLARIANT experience vinasse as

- Organic fertilizer field-tested over 4years and qualified in Germany
- Biogas feedstock tested & technical assessment for projects
- Boiler fuel with analysis on proof as suitable fuel

Backup 2

Climate change can't wait: immediate action necessary in the transport sector to reduce GHG emission & comply with 1.5 °C global warming goal

TOO MUCH CARBON IN THE AIR

In 2015, the transport sector was responsible for

23%

of the GHG emissions worldwide

and

25.8%

in the EU¹

IMPLICATIONS ON THE ENVIRONMENT²

- Global temperature rising
- Melting of arctic ice & glaciers
- Sea level rising
- Ocean warming & acidification
- Areas below sea level becoming uninhabitable

TRANSPORT DECARBONIZATION SOLUTIONS TO ACHIEVE CLIMATE AMBITIONS



Vehicle technology & efficiency



Energy infrastructure efficiency & development



Mode shift in transportation



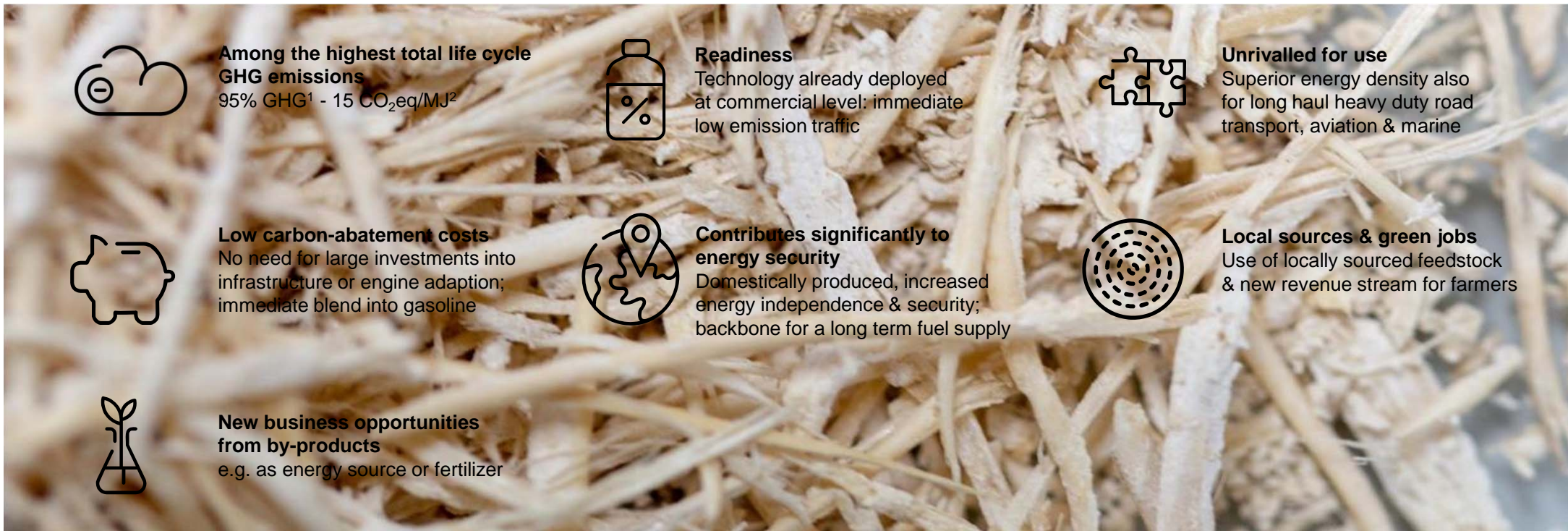
Advanced biofuels: key role to decarbonize transport sector


¹ Source: International Energy Agency: <https://www.iea.org/etp/tracking2017/transport/> and European Environment Agency: <https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-10#tab-related-briefings>


² Source: NASA: <https://climate.nasa.gov/evidence/>


Advanced ethanol: numerous benefits to make an immediate impact on private mobility & beyond


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





 **Among the highest total life cycle GHG emissions**
95% GHG¹ - 15 CO₂eq/MJ²


 **Readiness**
Technology already deployed at commercial level: immediate low emission traffic

 **Unrivalled for use**
Superior energy density also for long haul heavy duty road transport, aviation & marine

 **Low carbon-abatement costs**
No need for large investments into infrastructure or engine adaption; immediate blend into gasoline

 **Contributes significantly to energy security**
Domestically produced, increased energy independence & security; backbone for a long term fuel supply

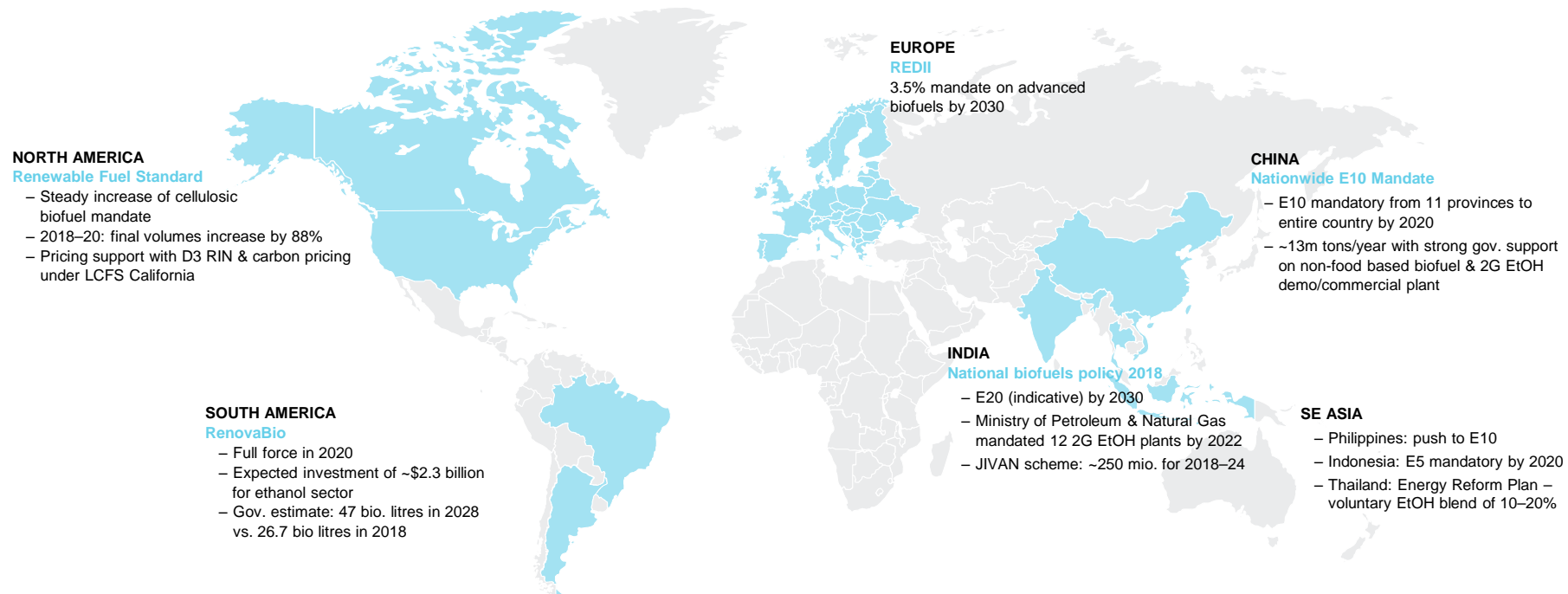
 **Local sources & green jobs**
Use of locally sourced feedstock & new revenue stream for farmers

 **New business opportunities from by-products**
e.g. as energy source or fertilizer

¹ cellulosic EtOH produced with sunliquid, % compared to gasoline without CO₂ CCU/S

² <https://www.biofuelsdigest.com/bdigest/2018/11/06/results-are-in-clariants-sunliquid-delivers-6x-lower-carbon-intensity-than-fossil-gasoline/> without CO₂ CCU/S

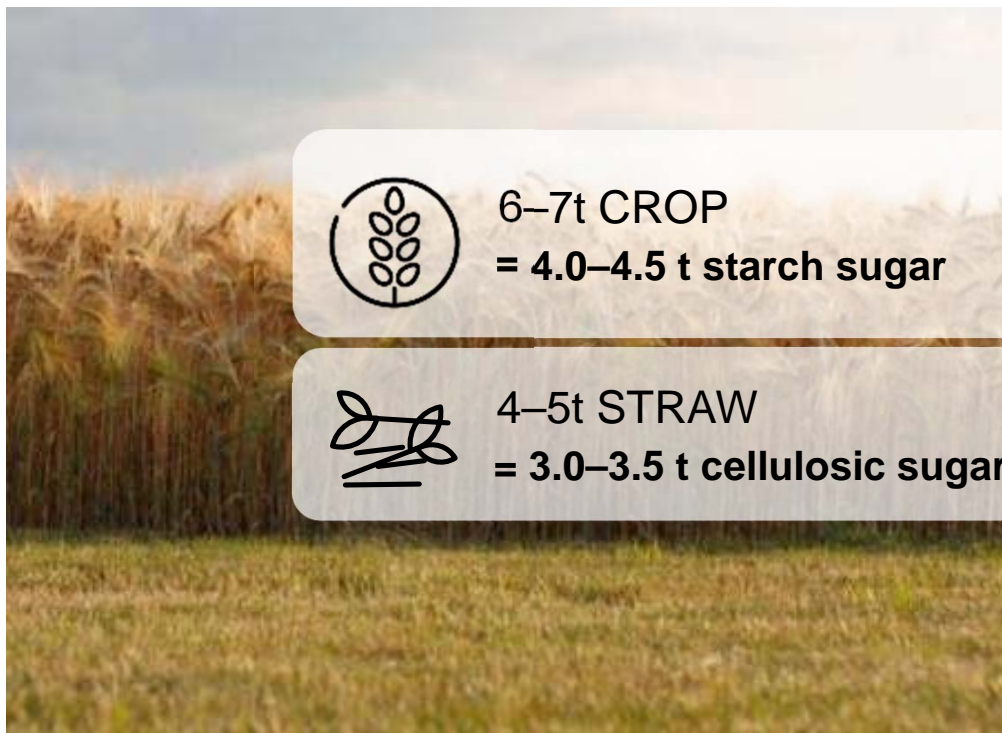
Gearing up for growth: global regulatory environment¹ is tail winding advanced biofuels demand



¹World Bioenergy Association
Majority of renewables in transport is policy driven (92%)
Biofuels mandates are established in more than 70 countries

The potential of agricultural residues

What is inside one hectare of cropland?

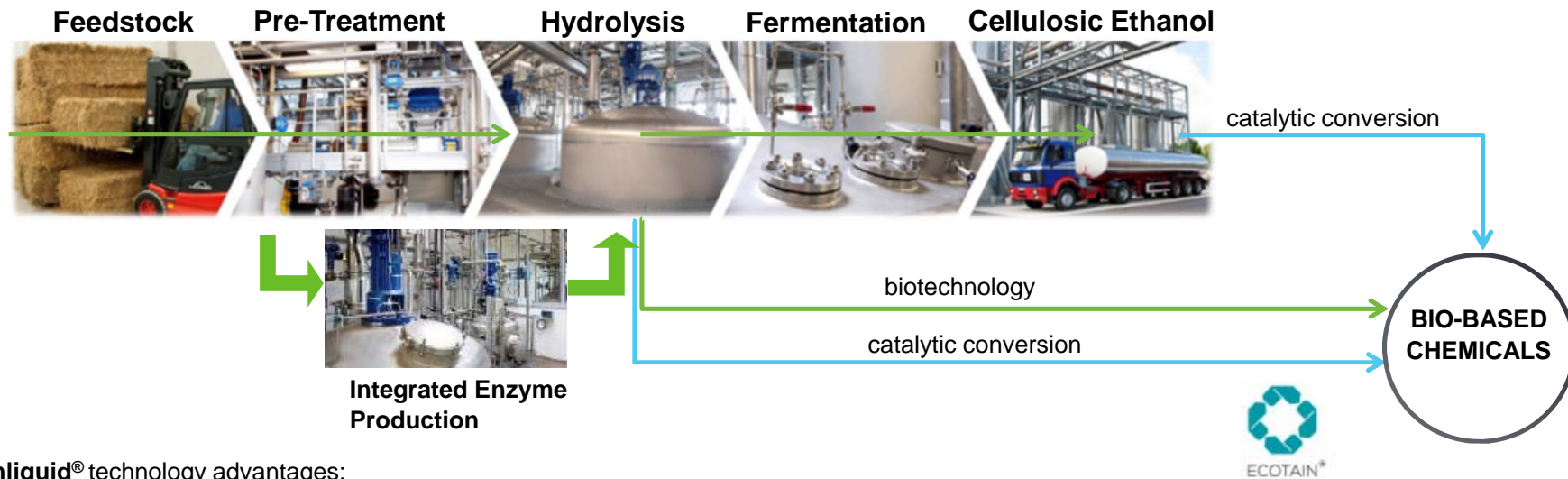


FEASIBLE BIOMASS FEEDSTOCK TYPE



Key message: agricultural by-products are an abundant and underutilized resource

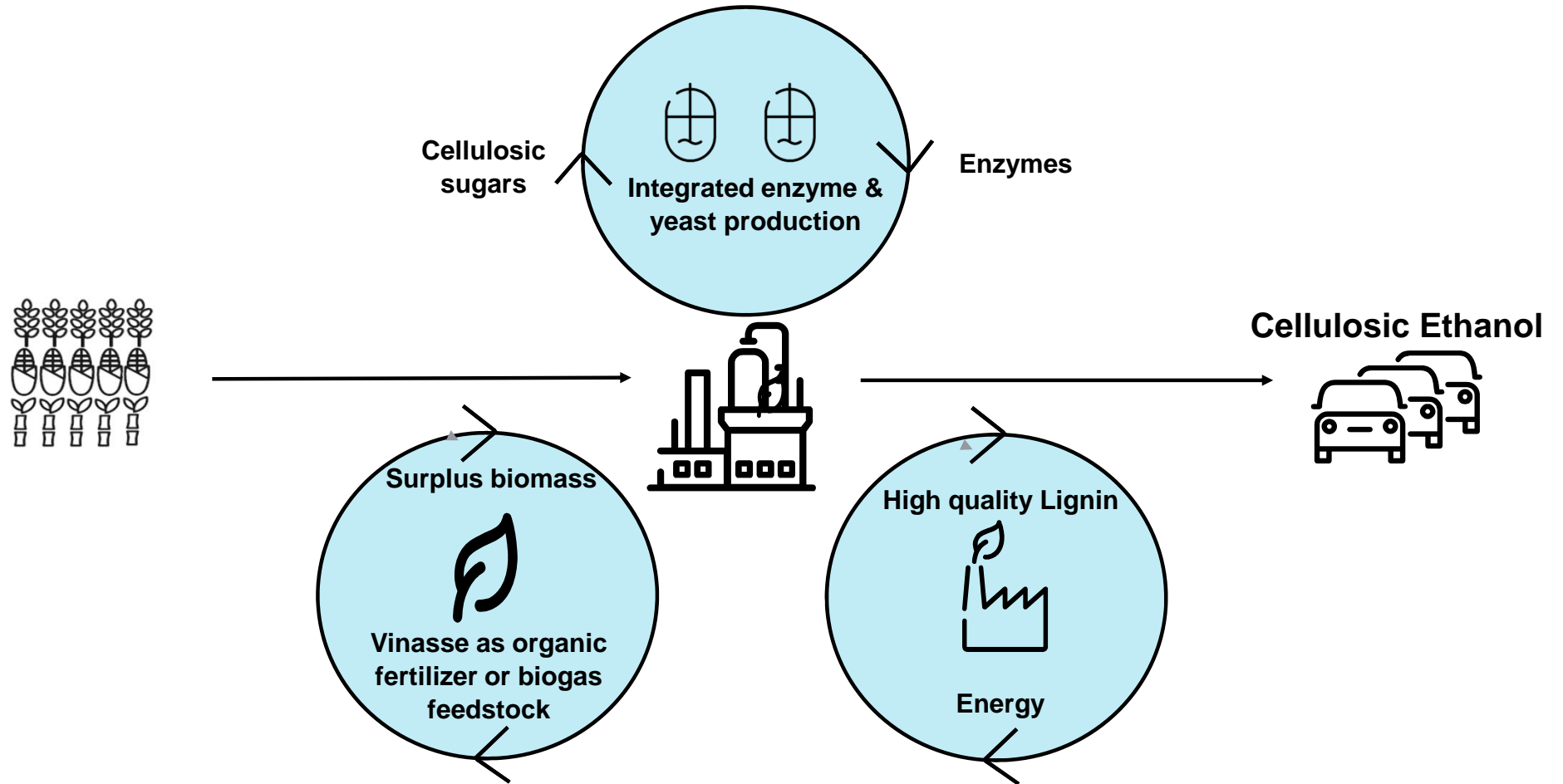
sunliquid® technology platform: full integrated process from feedstock to cellulosic sugars/ethanol from one vendor



sunliquid® technology advantages:

- Chemical free pre-treatment
- Integrated enzyme production: reduces costs to a minimum; eliminates transport & storage costs
- Optimized tailor-made enzymes
- Efficient co-fermentation of C5 and C6 sugars
- Energy self-sufficient
- Carbon footprint: carbon neutral

Clariant sunliquid® Integrated Solution



sunliquid®: a prime example for the circular economy

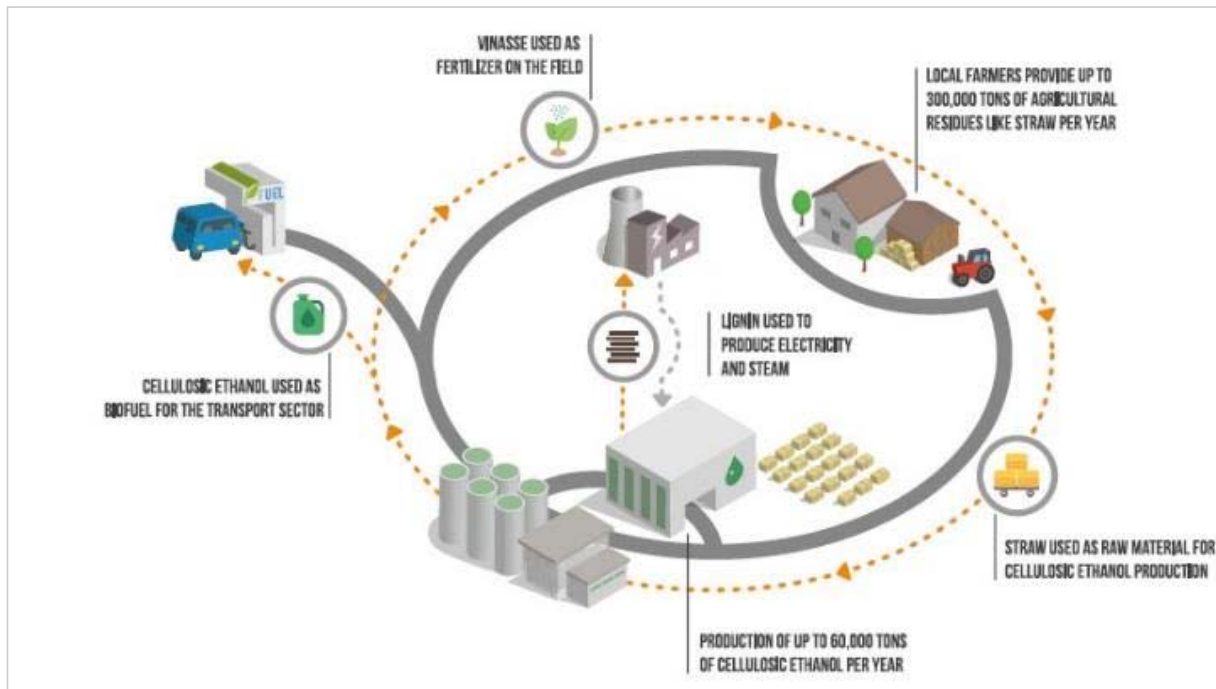


Illustration of the circular economy of sunliquid® process; stated numbers are based on sunliquid® flagship plant in Romania

All components either **minimize resources**, ensure their **optimal use**, or generate **new resources** that can be **sustainably used**:

- Agricultural waste is utilized instead of being discarded
- No fossil resources are required in the entire process
- Energy self-sufficient process conserves energy
- Cellulosic ethanol produced with sunliquid® saves around 95% GHG compared to gasoline
- Use of the by-product vinasse as fertilizer in agriculture saves cost- and energy-intensive cleaning or drying processes (organic fertilizer field-tested >4 years and qualified in Germany)
- Water extracted from the vinasse is fed back into the process cycle



Perfect circle in an extremely low-waste process with the comprehensive reuse & further use for renewable resources is created

>7 years of reliable, stable & continued operations in sunliquid[®] plant in Germany & scaling up in flagship plant in Romania

COMMERICAL OPERATIONS IN PODARI, ROMANIA



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



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



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

The sunliquid[®] pre-commercial plant

A FULLY INTEGRATED AND PROVEN PROCESS



2012

Start of operation at pre-commercial plant

up to **1,000**

t/a output of ethanol

~ **4,500**

t/a feedstock *
* (cereal straw, corn stover, sugarcane bagasse and others incl. customer's feedstock)

~ **7**

years confirmation of commercial-scale design

sunliquid® flagship plant progress: aerial map

