A look into different business models to process low carbon feedstocks

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Rethink Tomorrow

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Agenda

- Opportunity
- About Novozymes
- The cellulosic industry
- The demand
- Biorefining
- The business model
- Conclusion

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EU wants a cellulosic bio economy (RED II)

25 – 50 2G plants to be constructed

~3 billion liters

This is your opportunity to:

- Transform and green your energy
- Produce CO_2 negative liquid fuels
- Pathway to new fuels

Novozymes at a glance

World's Largest Dedicated Biotechnology Company

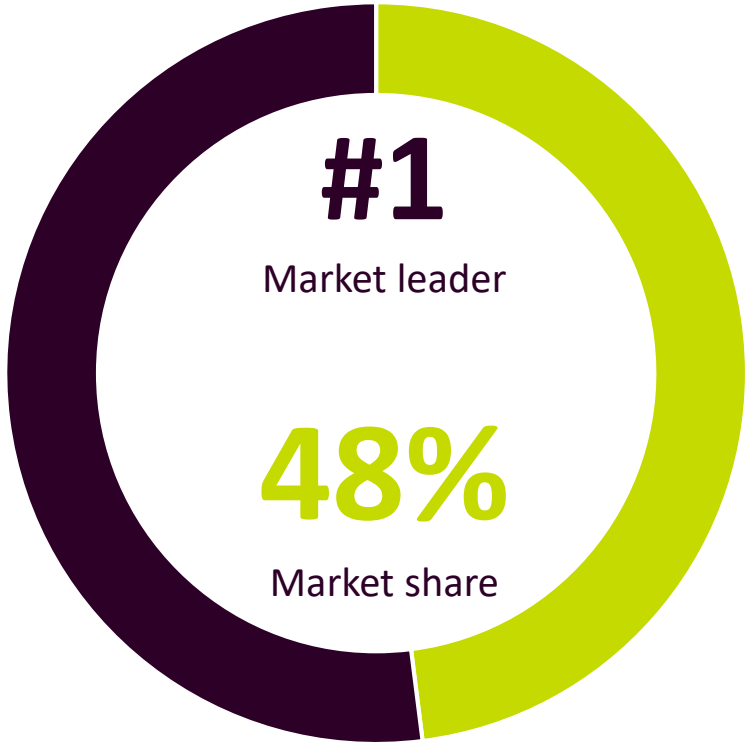
Global
- ~6,500 employees
- ~700 products sold in 140 countries
- Major production footprint in 3 regions

Leading Developer of industrial microorganisms
- Agriculture
- Animal Health & Nutrition

R&D intensive
- ~1,400 people employed in R&D
- ~7,000 patents
- ~13% of sales invested in R&D

Profitable
- USD 2bn in sales
- ~28% EBIT margin
- ~25% ROIC

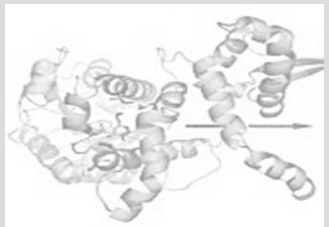
Majority owner Novo A/S
- Controls 25.5% of the capital
- ~70% of the votes
- 2 seats on the board of directors



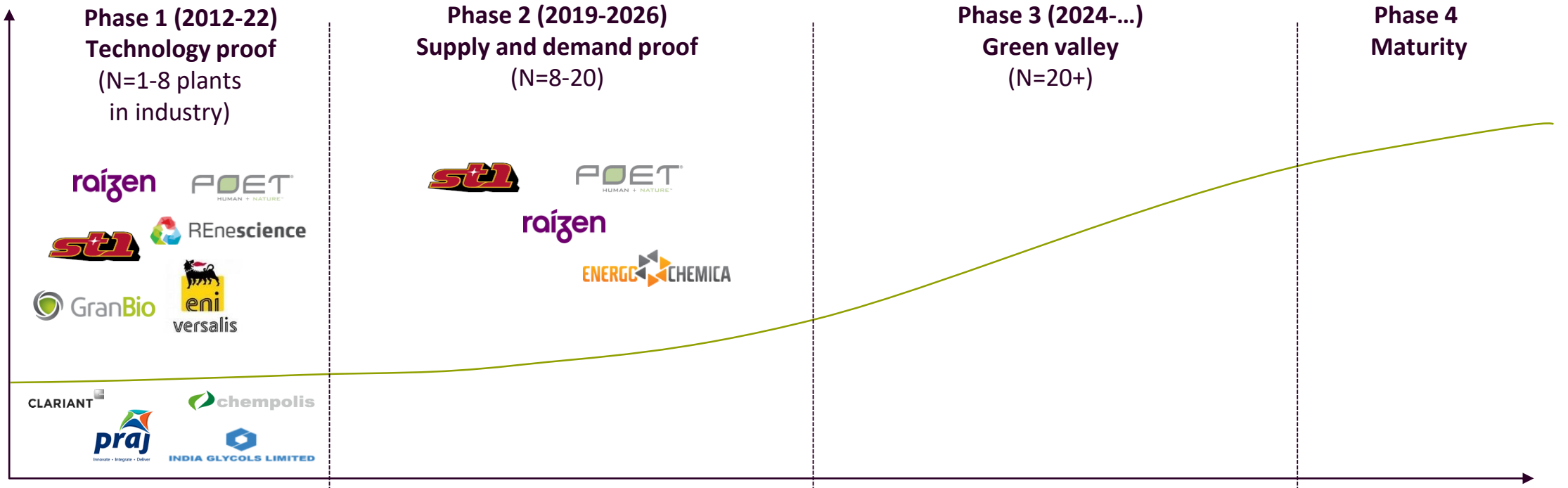
Uniquely diversified group

- creates synergies and opportunities

More than 18 years of large scale R&D and business development to become the leader in the 2G biotech space

	2001	2005	2009	2013	2015
Development stages of process technology	Foundation	Pilot stage	Demo stage	Commercial startup stage	Optimization stage
Important launches and uses of our enzymes	 Novozymes starts a large scale R&D effort for the cellulosic ethanol market	 Biomass conversion pilot plants worldwide testing Novozymes enzymes	 Launch of Cellic® CTec for the first 2G ethanol demonstration plants	BETA RENEWABLES, raizen, GranBio, POET Startup of the first full scale commercial 2G ethanol plants using Novozymes' Cellic® Ctec 3 technology	 Launch of products customized to partners' process and feedstock
Enzyme cost improvements					15X
Current Partners in India (>10 years of work with Praj)					

We are entering phase 2



Key value lever	• **Several "first-of-its-kind" advanced ethanol process technologies proven at commercial scale**	• **Several first movers replicating their technology with competitive economics** • **Strong LT policies in place**	• **Large scale roll out of advanced ethanol technology with full project bankability**	• **Best in class efficiency**

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Five 2G plants operating globally + several announced projects

DSM POET

CLARIANT

ENVIRAL

ENERGOCHEMICA

eni

st1

eni versalis

GranBio

raízen

Novozymes supply enzymes

IndianOil

Bharat Petroleum

HP

3-4 Oil Marketing Companies (OMC's)
Construction start expected in 2019

… it's expected that several new 2G plants will start construction in 2019:

EU

NA

CN

LA

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SITUATION
IEA predicts
50/50
RES vs. fossil
Electricity vs. biofuels
by 2060 in
global transportation
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Biofuel demand today and tomorrow

The IEA predicts

50/50

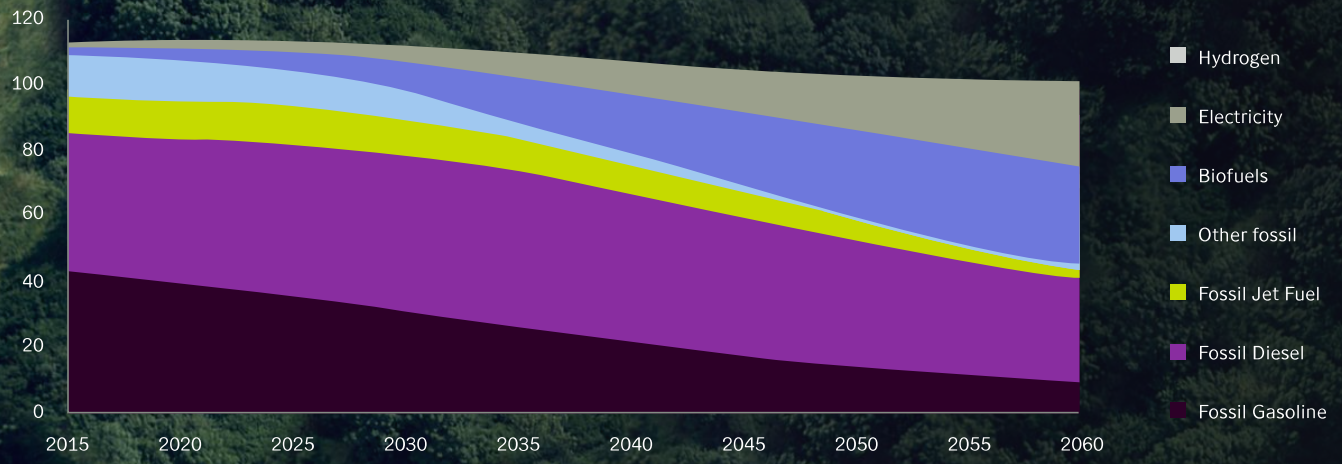
Renewables vs. fossil

Electricity vs. biofuels

by 2060 in global transportation

According to IEA, biofuels is an important option in a portfolio of solutions to decarbonise transport

In a 2DS scenario, biofuels provide nearly 30% of transport final energy demand in 2050 and beyond, **complementing** end-use efficiency and strong growth in electricity



Source: IEA 2017 Bioenergy Technology Roadmap

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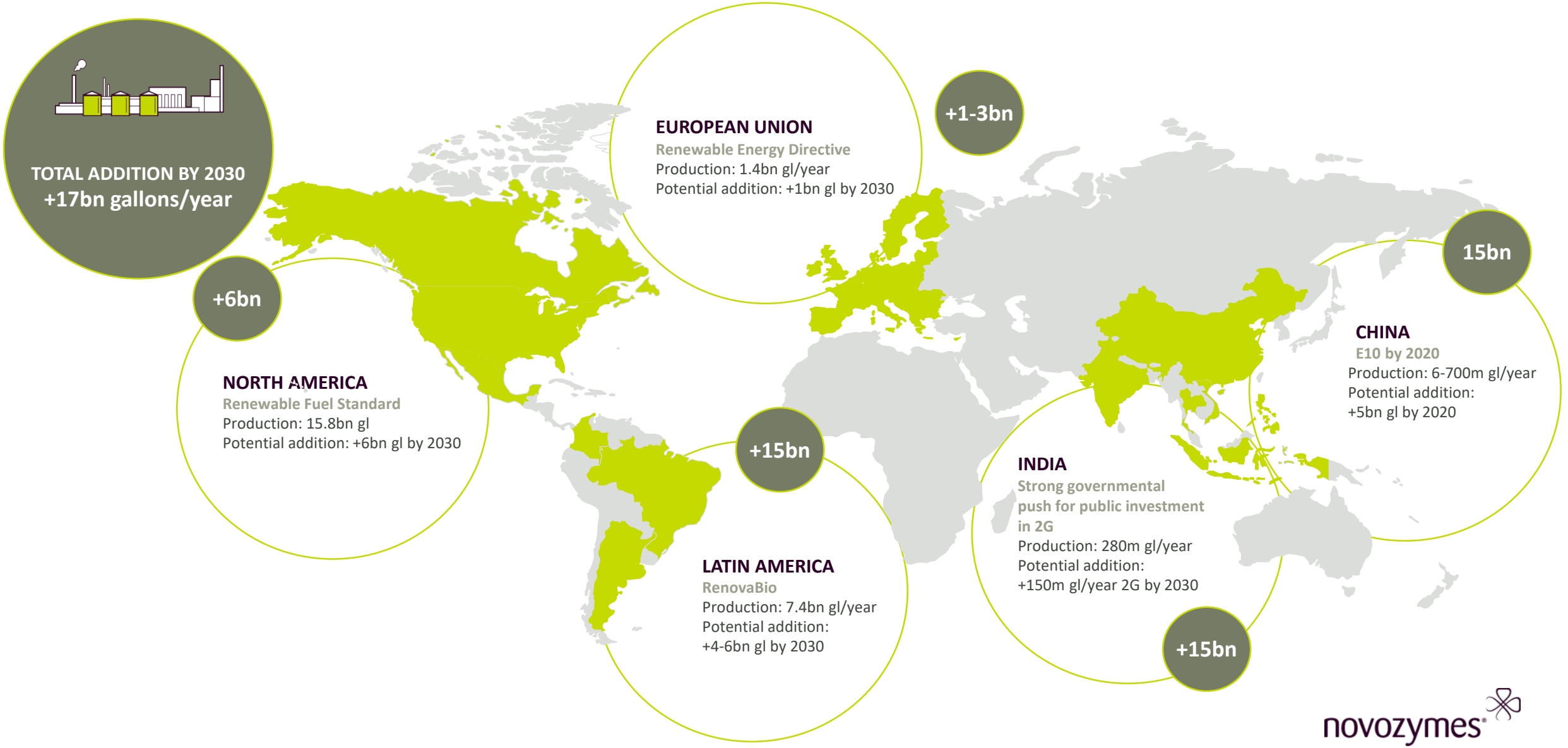
Current policy will lead to strong ethanol growth in the world



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The biorefining platform addresses three key dilemmas

Dilemma #1

No silver bullet solution

Dilemma #2

No crystal ball to predict new technology adoption

Dilemma #3

No way to meet climate targets without negative emissions

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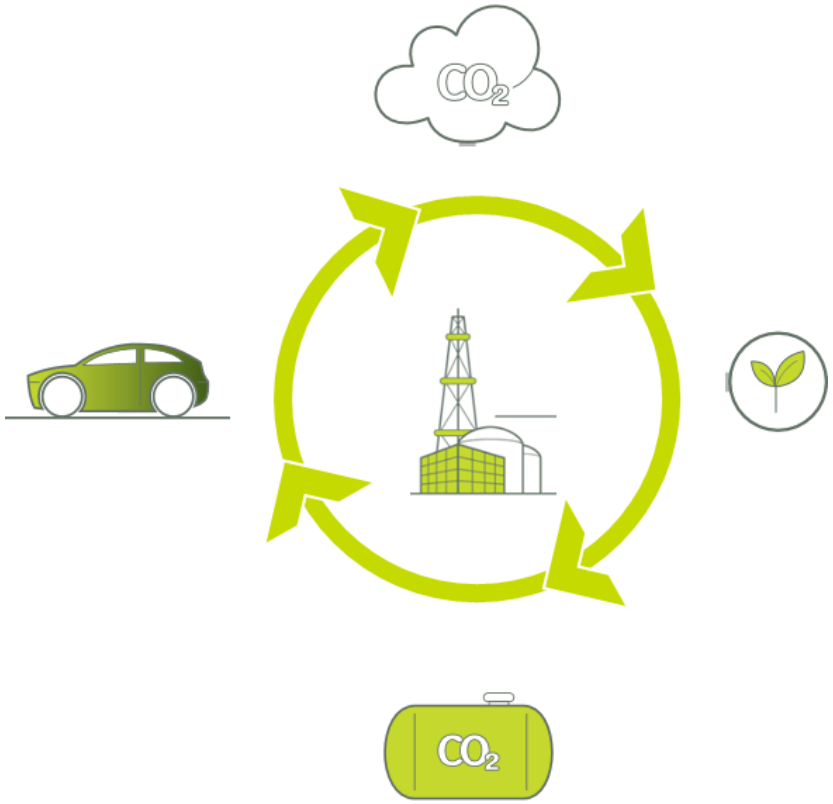
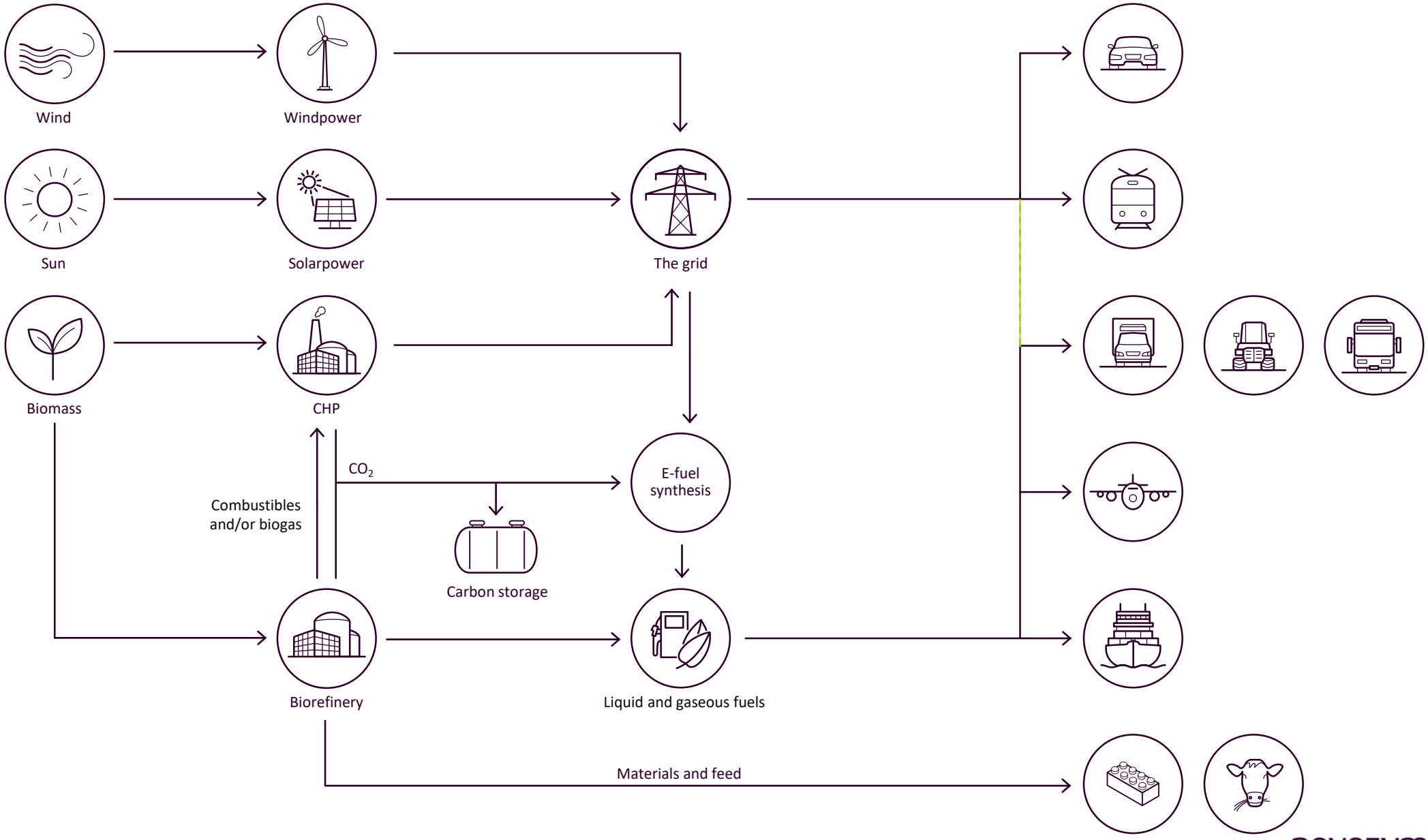
Biorefineries can help achieve net zero emission by mid century, providing negative emissions




Wind
Windpower
Sun
Solarpower
The grid
Biomass
CHP
CO_2
Combustibles and/or biogas
E-fuel synthesis
Carbon storage
Biorefinery
Liquid and gaseous fuels
Materials and feed

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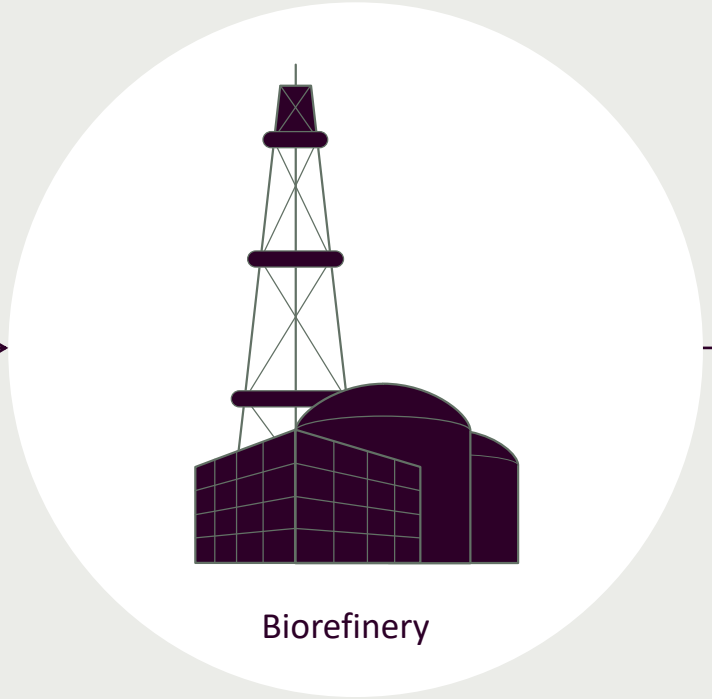
Sugar to X (“cracking” biomass)

Biomass → Sugar →



Biorefinery

Biochemical pathway

- Ethanol (gasoline replacement)
- Isobutanol (jet fuel replacement)
- ED 95 (diesel replacement)
- LEO (bunker fuel replacement)
- Synthetic gasoline (gasoline replacement)
- Plastic/materials (replacing fossil based materials)
- Protein

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Various cellulosic ethanol biorefinery models

Stand – alone 2G plant

Combined with 1G plant

Combined with power plant

Retrofitting of a refinery

CAPEX – €150-200 mio incl.onsite CHP (for steam and electricity) and a waste water treatment plant

Biomass

- Agricultural residues, forestry, energy crops, bio-fraction of MSW
- Availability within a radius 50-100 km for ag residues
- Cost: €60-90/ton

Typical Plant size

50-75 ml litres

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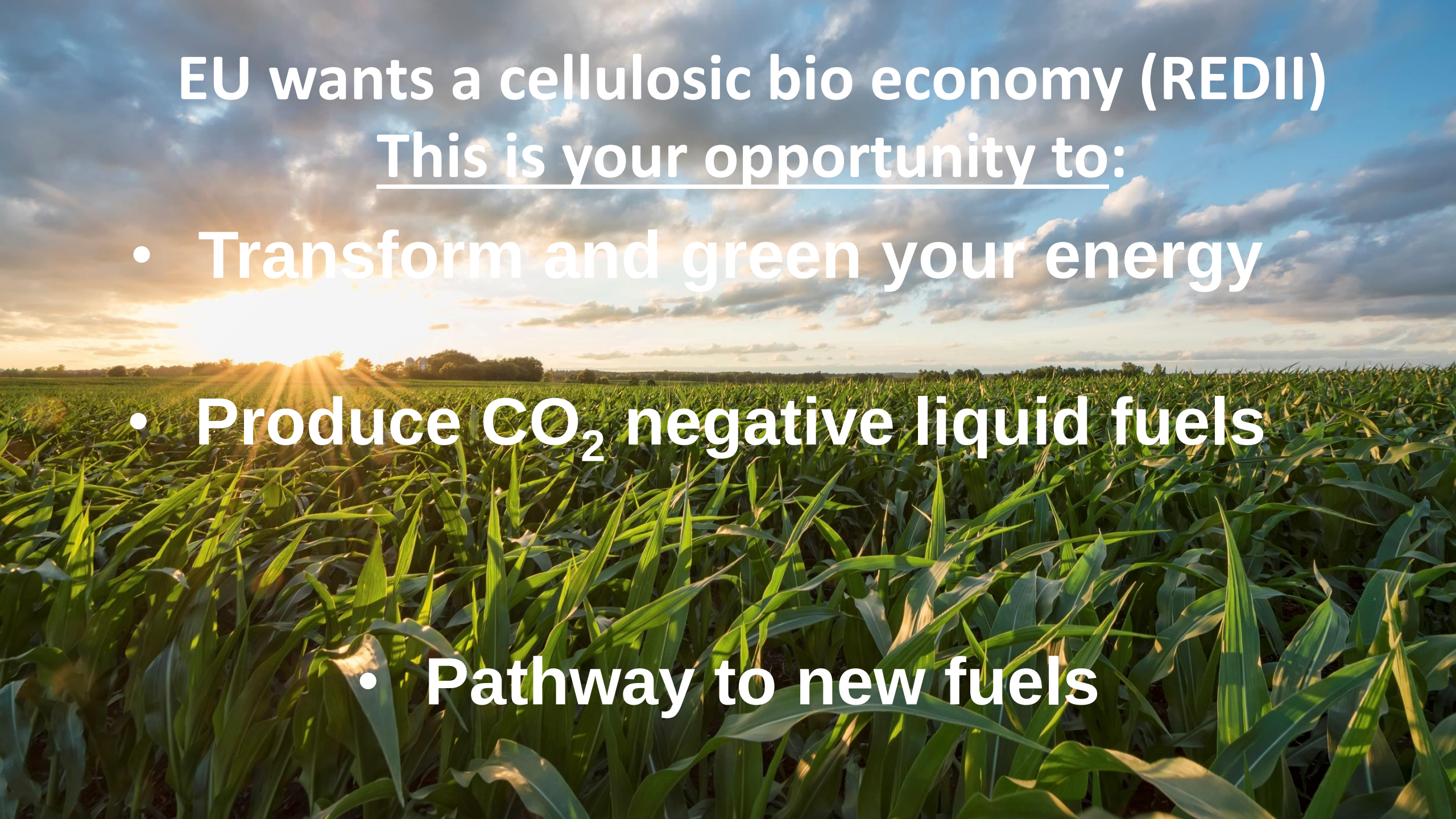
Bridging the gap to a sustainable future

- Is a call to define an effective pathway to mitigate climate change
- Is Novozymes contribution based on what we know works
- Is intended to start a conversation and an invitation to work together
- Is a living document (not final) for all to access and use without restrictions

Find the report on Novozymes.com



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THANK YOU!
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