



# EXECUTIVE SUMMARY

# A WORLD CLASS BIOTECHNOLOGY COMPANY

## DEVELOPER AND PRODUCER OF TAILOR-MADE INDUSTRIAL ENZYMES

- *MetGen is a biotechnology company providing complete bioprocessing solutions for pulp&paper mills as well as modern biorefineries. These solutions are based on profound knowledge and skills on synthetic biology, genetic engineering, industrial biotechnology, process engineering, and customer specific application testing.*
- *MetGen's carefully assembled technology platform has made the company the fastest and most cost efficient developer and producer of tailor-made industrial enzymatic solutions focusing on maximizing the value of lignocellulosic materials: existing solutions are aimed at improving the yield and value of pulp, paper, biochemicals, biomaterials, and eliminating waste streams. The company's enzymes have been developed to work in harsh industrial environments characterized by high temperatures and extreme pH.*
- *MetGen has created ground-breaking technologies and business models for forestry industry transition towards biochemical markets: the main development focus is on lignin valorization and sugar bioconversions for platform chemicals and bio-based plastics. The company already has multiple demonstrated applications for the lignin fractions its technology produces.*
- *The company has built an extremely strong team with complementary competencies which has generated a significant IP portfolio that protects the company's inventions.*
- *MetGen as a small independent company with its quick and low-cost development capabilities has few competitors: the time to market - developing an enzyme from idea to commercial/industrial scale supply - takes 6-9 months with 5-6 FTEs. The utilization of toll manufacturers provides flexibility and capability to serve even the largest possible customers.*
- *MetGen's capability of unifying players in the industry includes extensive and successful utilization of public funding. The company has a wide collaboration network and is the preferred enzyme developer in EU Horizon 2020 projects.*

### PRODUCT PORTFOLIO

**10** trademarked  
enzyme families

### PATENTS

**18** patent applications  
**7** patents granted

### RECENT HIGHLIGHTS 2019-2020

- *Pilot scale facility for lignin valorization technology at commercial use*
- *Based on its recent analysis of the European industrial enzymes market, Frost & Sullivan recognizes Finland-based MetGen with the 2019 European Technology Innovation Award for its enzyme technologies*
- *Lignin process license sold to Futurity (NZ)*
- *Successful scale up of lignin fractionation technology to ton-scale*

### LIGNIN VALORIZATION OPPORTUNITY

- *METNIN™ technology is capable of refining the whole bulk of soluble lignin*
- *Turning lignin into specific fractions with controlled chemical characteristics to match end-user applications*
- *Hundreds of end-user applications with >€1100 / ton value for lignin on average*
- *High yields and valorization of lignin combined with low capex and operational cost (150 €/ton of lignin) enable very lucrative business with current side stream*



# **BIOTECH AS A COMPETITIVE ADVANTAGE**

## ***MetGen offers biotech competence to:***

- *Identify and address potential opportunities and challenges where a biological approach is beneficial*
- *Assess and create related biotech solutions and conduct relevant application testing with industrial samples and process conditions*
- *Supply the solution, including the enzymes and engineering on an industrial scale without investment in production capacity*
- *Integrate the solution to existing processes or create new operations to support growth*
- *Access and develop biotech solutions without restrictions from dominating enzyme companies*

## ***Existing solutions and patents with applicability in several pulp and paper processes which can be developed further***

- *Improvement of fiber properties, strength improvement, humidity resistance (creep) increase and sizing improvement in packaging, strength improvement of market pulp and more affordable MFC*

## ***Potential to build a competitive advantage against other P&P producers by controlling access to the enzyme technology developed***

- *Enzyme technology can be utilized in a wide range of processes of the acquirer group*
- *Opportunities for cost savings, product enhancement and other competitive advantages against industry peers*
- *Capitalize on MetGen's know-how in developing new bio-based businesses synergistic with current operations*

## ***Ability to quickly develop, trial and produce new tailored enzymes***

- *New-to-the-world enzyme from idea to industrial supply in less than a year and 6-figure development cost with fail-fast methodology to avoid any unnecessary risk or cost → new innovations are enabled*
- *Alternative: extremely lengthy (years), expensive (+10M€), and risky (no guarantees) development programs with industrial biotech companies leading to possibility of purchasing enzymes at full price from a central supply*
- *Flexibility through MetGen's toll manufacturing model*

## ***New opportunities: lignin refining and valorization, hydrolysis, and sugar-to-chemicals bioconversions***

- *Proprietary enzymes are a key-element in the state-of-the-art METNIN™ technology to refine lignin into fractions. Massive potential opportunity in the replacement of oil-based chemicals with refined lignin. The technology is ready for industrial scale (5 – 50 kton/year) with a ready engineering package and three already sold licenses.*
- *Solutions enabling lignocellulosic biomass processing (including waste streams) into bio-renewable chemicals. Enzymes enabling wood to bioplastics conversion route.*

# METGEN'S COMPETENCES AND PRODUCTS

BUSINESS AREA / COMPETENCE	VALUE TO ACQUIRER	PRODUCTS / SERVICES	APPLICABILITY	BENEFITS
PULP & PAPER AND BIOGAS	<ul style="list-style-type: none"> <li>Process enhancement through existing solutions for different pulp and paper processes</li> <li>Proven capability to contract manufacture for pulp and paper applications</li> </ul>	<ul style="list-style-type: none"> <li>LIGNO™</li> <li>BRILA™</li> <li>POVON™</li> <li>PLATA™</li> <li>SEKALO™</li> <li>FORCI™</li> </ul>	<ul style="list-style-type: none"> <li>RCF modification</li> <li>Kraft and mechanical pulps</li> <li>Specialty pulps</li> <li>Barrier properties/moisture resistance/sizing</li> <li>Agricultural and integrated biogas plants</li> </ul>	<ul style="list-style-type: none"> <li>Process improvements</li> <li>Yield improvement</li> <li>Quality improvement</li> <li>Raw material saving</li> <li>New end-products and materials</li> <li>Improvements in total cost of operation</li> </ul>
BIOREFINERIES	<ul style="list-style-type: none"> <li>New business opportunities through lignin valorization and sugar refining</li> <li>Contract manufacturing and supply of tailor made enzymes</li> </ul>	<ul style="list-style-type: none"> <li>METNIN™ technology</li> <li>SUNO™</li> <li>PURECO™</li> </ul>	<ul style="list-style-type: none"> <li>Lignin refining</li> <li>Hydrolysis: pre-treated substrate</li> <li>Sugar bio-conversion: 2G sugar to biochemical, incl. bio-based plastics</li> </ul>	<ul style="list-style-type: none"> <li>Increasing number of products and value made from the same raw material as the main products or side streams</li> <li>Reducing waste (cost)</li> <li>Reducing hydrolysis enzyme related cost</li> <li>New business opportunities in developing bio-chemicals sector</li> </ul>
ENZINE® TECHNOLOGY PLATFORM	<ul style="list-style-type: none"> <li>Fast and low-cost development and production platform for novel industrial enzymatic solutions</li> </ul>	<ul style="list-style-type: none"> <li>Development of new, unique, patentable enzymes and solutions tailored to industry specific needs</li> <li>ENZINE® is an enzyme agnostic platform</li> </ul>	<ul style="list-style-type: none"> <li>Suitable for lignocellulosic enzymes due to a large library of existing prototypes</li> <li>ENZINE® can be used to create a new enzyme or a characteristic to an enzyme for any markets e.g. plastic degradation or biocementation</li> </ul>	<ul style="list-style-type: none"> <li>The fastest and by far the most affordable way to create new enzymes and bring them to industrial production</li> <li>Best case: 6 months from idea to industrial delivery</li> </ul>

# **CASE STUDY:** **IMPROVEMENT OF FIBER PROPERTIES**

*MetGen offers a wide range of novel pulp and paper enzymes specifically tailored to its customers' processes in the industry. MetGen's aim is to develop enzymatic solutions to fit customer needs better than competing on-shelf products. MetGen's pulp and paper enzymes aim to improve energy efficiency, end-product quality, and affordability of customer industrial processes.*

*MetZyme® product families offer new, bio-friendly solutions to improve processes and gain significant economic benefits. Improved efficiency results in reduced material costs, increased throughput, lower energy requirements, and less downtime due to process contaminants without requiring extensive changes to existing equipment or processes.*



## **CASE: BRILA™077 FOR TISSUE MILL IN EU**

### **Benefits**

- Increase in tensile strength
- Improved bulk, softness and stretch

### **Value generated by**

- 60% savings in refining energy consumption
- 10% reduction in BSWK consumption (total removal from the furnish)
- Net economic benefit: 50 €/ton of tissue (after treatment program cost)

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## **CASE: BRILA™035 FOR OCC PACKAGING BOARD MILL IN USA**

### **Benefits**

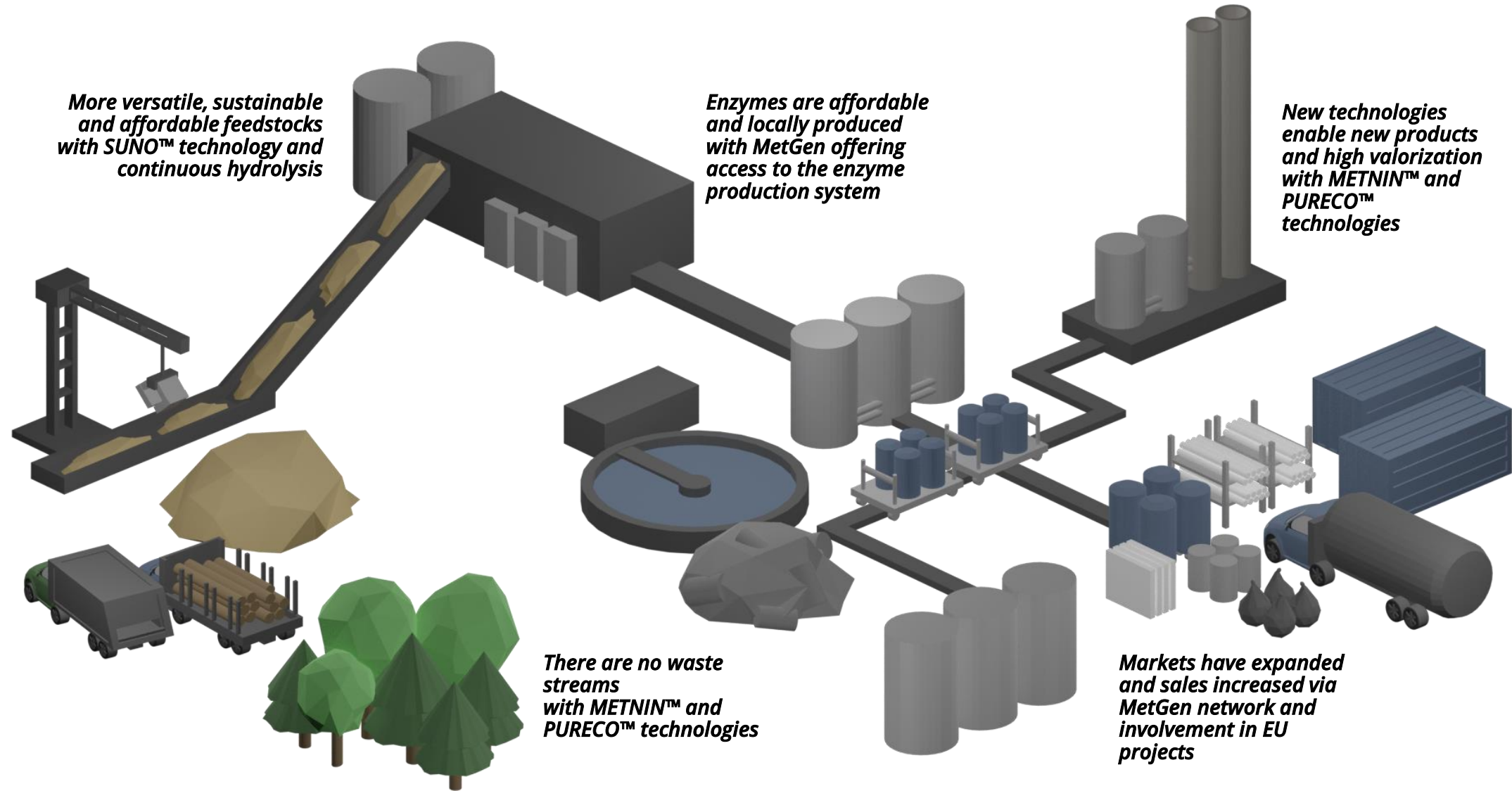
- Improved strength properties
- Better drainage

### **Value generated by**

- Basis weight was reduced by 0.55 lb and speed was increased by 89 fpm
- Increased MSF/ton by 2.4 %
- Increased production by 4.4 %
- Net economic benefit: \$1.0 million p.a. (after treatment program cost)



# HOW DOES METGEN ENABLE BIOREFINERIES?



# COMPLETE SOLUTIONS FOR BIOREFINERIES

## SUNO™ - TAILORED HYDROLYSIS

### Benefits

- Reduced enzyme cost and higher technical performance in terms of yield and purity

### Value generated by

- Reduced cost and waste, increased value, volume and number of products
- Lignin and hemicellulose are better separated

## CONTINUOUS HYDROLYSIS (in development)

### Benefits

- Enables efficient hydrolysis of recalcitrant feedstocks
- Re-use of enzymes divides the related processing cost on every round

### Value generated by

- Abundant sidestreams and even negative-cost wastestreams can be utilized with very low enzyme related cost

## PURECO™ - BIOCONVERSION OF SUGARS

### Benefits

- Unpurified glucose can be converted to intermediate sugars

### Value generated by

- Simple and robust processing step at least doubles the value of sugars produced.
- Next steps from here include conversions to platform chemistries already at the biorefinery (in development)

## ACCESS TO THE ENZYME PRODUCTION SYSTEM

### Benefits

- No increasing, unpredictable pricing or margins on enzymes
- Full transparency and freedom of scale

### Value generated by

- Including the enzymes into the biorefinery concept
- Savings in enzyme production cost

## CO-VALORIZATION OF SIDESTREAMS: METNIN™ TECHNOLOGY TO REFINE LIGNIN

### Benefits

- Full valorization of lignin in chemical and material applications
  - This will make the products we use more sustainable, reduce the use of petroleum and plastics, as well as help fight climate change by capturing CO<sub>2</sub>

### Value generated by

- Ready intermediates and products with >1 100€/ton price

## PLASTICS BIO DEGRADATION AND CO<sub>2</sub> CAPTURE (in pipeline)

### Benefits

- Biochemicals and materials gain sustainable end-of-life processing at the biorefinery: waste is recycled to new products or CO<sub>2</sub> to biocement

### Value generated by

- Low cost raw materials, carbon capture

# CASE STUDY: BIOREFINERY PRODUCTS

## APPLICATIONS OF LIGNIN-DERIVED CHEMICALS

*MetGen is taking its METNIN™ technology for lignin refining to a commercial and industrial level in multiple projects.*

*The technology allows for a wide variety of lignins to be fully valorized to high-end products and intermediates.*

*MetGen is collaborating with 100s of end-users but focuses on a selected few applications to ensure full off-take for refined lignin on markets with high value and volume.*

## CASE: MDF AND PLYWOOD PRODUCTION

*Replacement of phenol in phenol formaldehyde*

### Benefits

*Equal quality specs to phenol and low viscosity with renewable compounds*

### Value generated by

*50 – 80% replacement of phenol with more affordable and sustainable material*

## CASE: METNIN™ SHIELD for PACKAGING BOARD

*Improvement of recycled fiber board properties*

### Benefits

*Readily formulated, fully bio-based and IP protected solution for high humidity strength (creep resistance) and sizing improvement*

### Value generated by

*Savings in fiber cost, basis weight reduction, removing conventional sizing chemicals and creating high value OCC with potential to replace virgin fiber based packaging paper*

## CASE: RIGID INSULATION FOAM

*Replacement of polyols in polyurethane foam*

### Benefits

*Equal quality specs to oil-based polyol with improved hydrophobicity and fire retardancy*

### Value generated by

*Full replacement of polyols (market price of 3 000 - 4 000 EUR/ ton) with a lignin fraction (sold to customers with 1 000 - 2 000 EUR/ton)*

*Refined and activated lignin fractions can “drop-in” replace conventional chemicals including polyols, PF-resins, dispersants and epoxy resins. These together are estimated to have a global market size of over 40 billion euro. MetGen’s lignin fractions that replace conventional chemicals are sold to customers without a “green premium”, with a price which is 50-70% of the market price of the oil-based equivalent.*

	Polyols	PF-resins	Dispersants	Epoxy resins	Total
Global market size 2019, bn EUR	23	9.7	5	7	44.7





# **METGEN** **TECHNOLOGIES** **SUMMARY**

*Technologies reached commercial maturity.*

*Techno-economic assessment and basic engineering indicate commercial feasibility.*

*Large network of existing collaboration partners working at every stage of the value-chain – including end users – prove the market pull.*

*MetGen is looking for licensors, off-takers, and strategic collaboration partners to accelerate the industrial commercialization.*

**MetGen** – the friendly enzyme  
company invites you to join in  
the bio-based industry  
revolution.

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