Platform Chemicals Production from Alternative Feedstock

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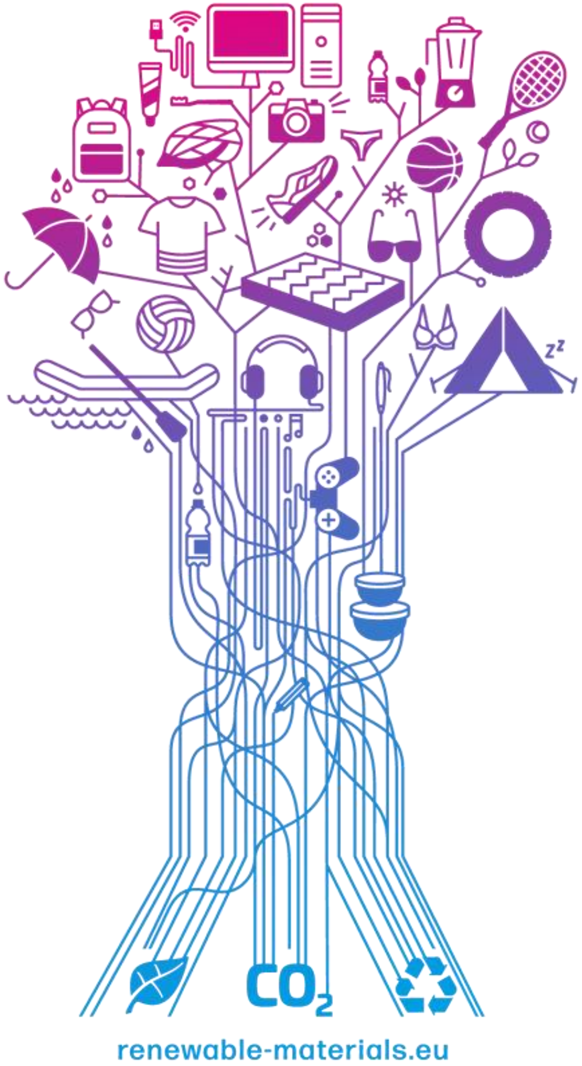
Leibniz Association

Contents

- **What are Platform Chemicals?**
- **Why Alternative Feedstock?**
- **Bioeconomy Relevance?**



[nova-Institute's renewable carbon approach]

Top Value Added Chemicals from Biomass

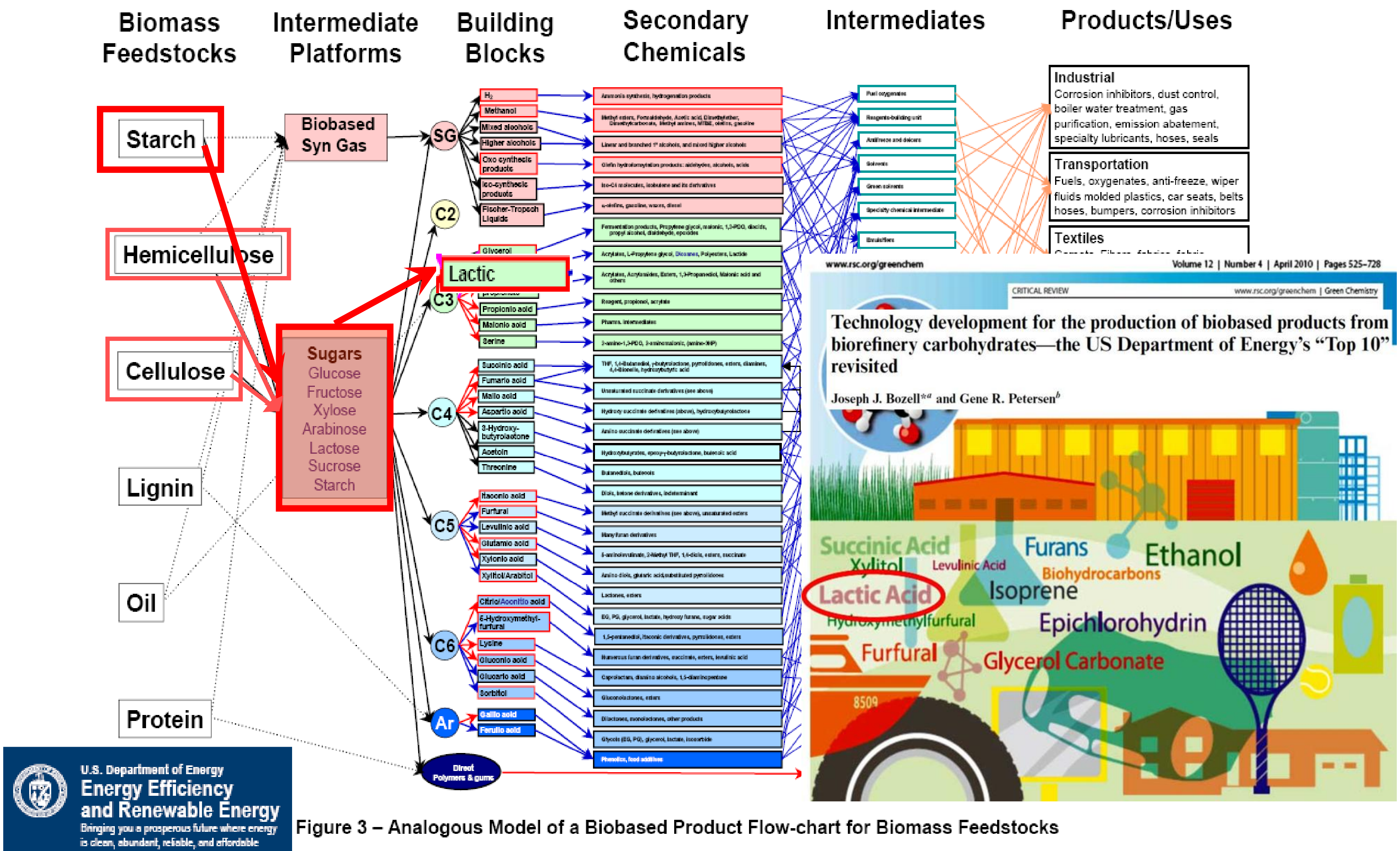


Figure 3 – Analogous Model of a Biobased Product Flow-chart for Biomass Feedstocks

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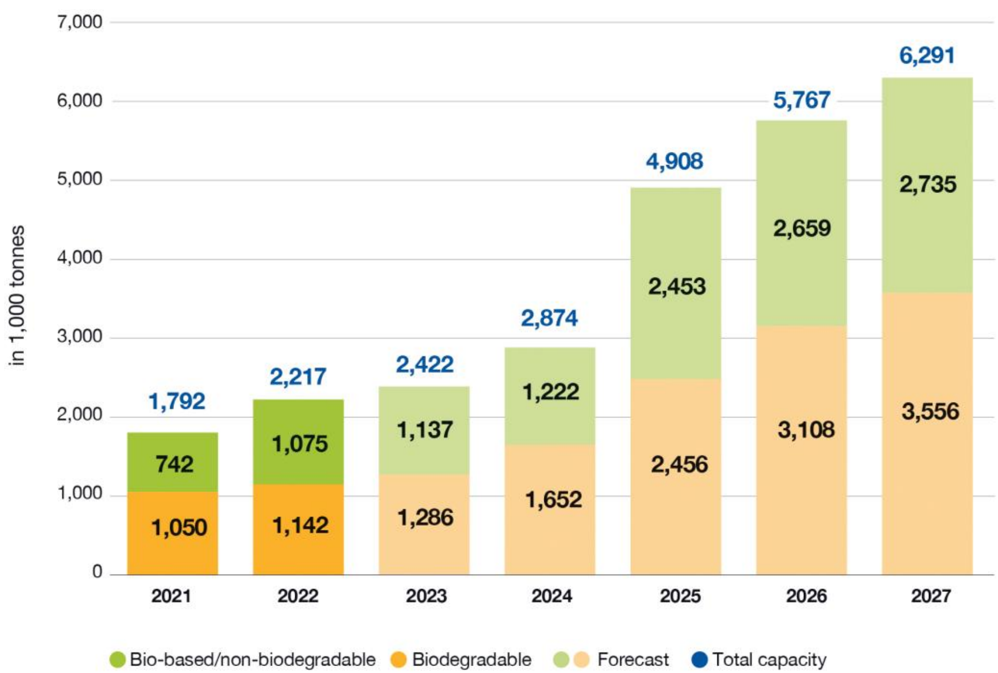
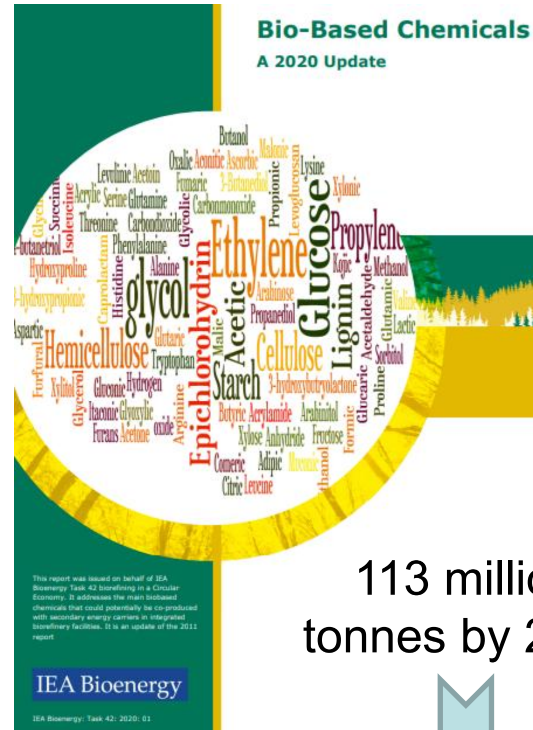
Promising Bio-based chemical targets as assessed 2021

Global production capacities of bioplastics 2022-2027





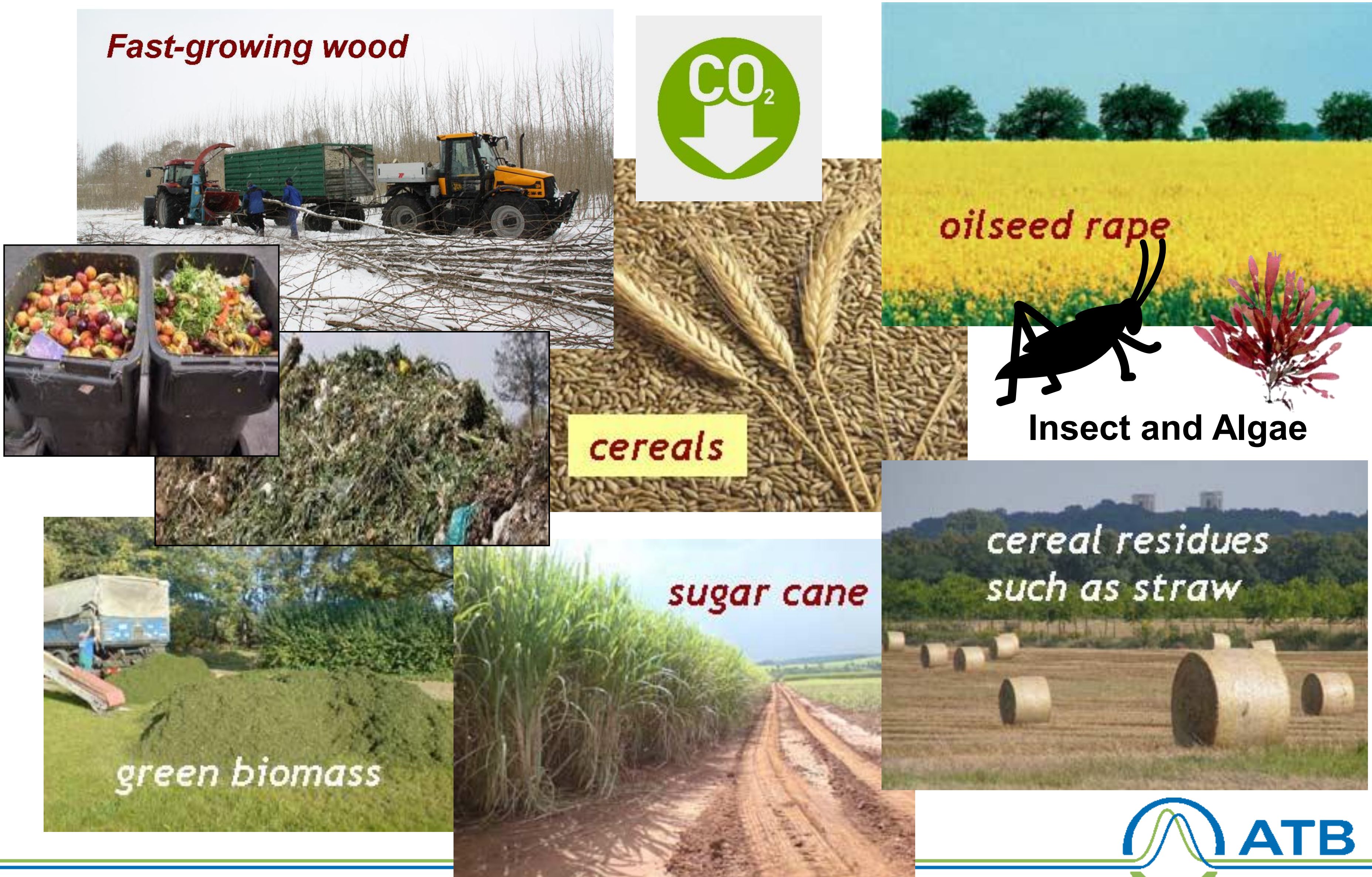
113 million tonnes by 2050

38% of all organic chemical production globally

more conservative scenario: 26 million tonnes

17.5% of the total organic chemical market

Examples of biomass resources

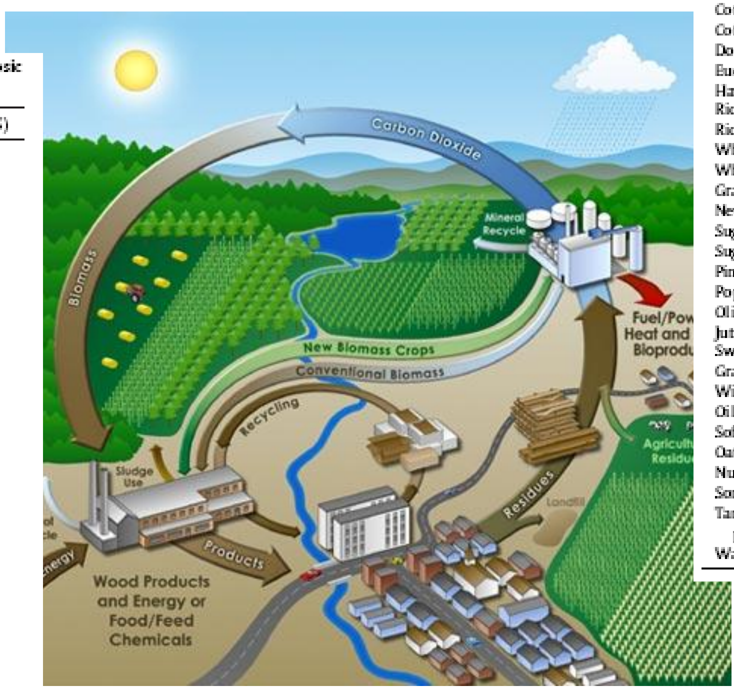


(Different) Composition & Behaviour of (lignocellulosic) Biomass

The contents of cellulose, hemicellulose, and lignin in various types of lignocellulosic biomass (% dry weight).[a]

Lignocellulosic materials	Cellulose (%)	Hemicellulose (%)	Lignin (%)
Algae (green)	20–40	20–50	NA[b]
Aspen hardwood	51	29	16
Birch Hardwood	40	39	21
Chemical pulps	60–80	20–30	2–10
Coastal Bermuda grass	25	35.7	6.4
Corn cobs	45	35	15
Cornstalks	39–47	26–31	3–5
Cotton seed hairs	80–95	5–20	0
Cotton, flax, etc.	80–95	5–20	NA[b]
Grasses	25–40	25–50	10–30
Hardwood	45 ± 2	30 ± 5	20 ± 4
Hardwood barks	22–40	20–38	30–55
Hardwood stems	40–55	24–40	18–25
Leaves	15–20	80–85	0
Newspaper	40–55	25–40	18–30
Nut shells	25–30	25–30	30–40
Paper	85–99	0	0–15
Pine softwood	44	26	29
Primary wastewater solids	8–15	NA[b]	24–29
Softwood	42 ± 2	27 ± 2	28 ± 3
Softwood barks	18–38	15–33	30–60
Softwood stems	45–50	25–35	25–35
Solid cattle manure	1.6–4.7	1.4–3.3	2.7–5.7
Sorted refuse	60	20	20
Spruce softwood	43	26	29
Swine waste	6.0	28	NA[b]
Switch grass	45	31.4	12.0
Waste papers from chemical pulps	60–70	10–20	5–10
Wheat straw	37–41	27–32	13–15
Willow Hardwood	37	23	21

M.A. Abdel-Rahman et al.
Journal of Biotechnology 156 (2011) 286– 301



Composition of representative lignocellulosic feedstocks.

Feedstocks	Carbohydrate composition (% dry wt)			References
	Cellulose	Hemicellulose	Lignin	
Barley hull	34	36	19	[12]
Barley straw	36–43	24–33	6.3–9.8	[13,14]
Bamboo	49–50	18–20	23	[15,16]
Banana waste	13	15	14	[17]
Corn cob	32.3–45.6	39.8	6.7–13.9	[18,19]
Corn stover	35.1–39.5	20.7–24.6	11.0–19.1	[20]
Cotton	85–95	5–15	0	[21]
Cotton stalk	31	11	30	[22]
Coffee pulp	33.7–36.9	44.2–47.5	15.6–19.1	[23]
Douglas fir	35–48	20–22	15–21	[24]
Eucalyptus	45–51	11–18	29	[16,25]
Hardwood stems	40–55	24–40	18–25	[26,27]
Rice straw	29.2–34.7	23–25.9	17–19	[28,29]
Rice husk	28.7–35.6	11.96–29.3	15.4–20	[30,31]
Wheat straw	35–39	22–30	12–16	[29,32]
Wheat bran	10.5–14.8	35.5–39.2	8.3–12.5	[33]
Grasses	25–40	25–50	10–30	[34,35]
Newspaper	40–55	24–39	18–30	[26]
Sugarcane bagasse	25–45	28–32	15–25	[16,36]
Sugarcane tops	35	32	14	[37]
Pine	42–49	13–25	23–29	[25]
Poplar wood	45–51	25–28	10–21	[38]
Olive tree biomass	25.2	15.8	19.1	[39]
Jute fibres	45–53	18–21	21–26	[40]
Switchgrass	35–40	25–30	15–20	[26]
Grasses	25–40	25–50	10–30	[26,27]
Winter rye	29–30	22–26	16.1	[41]
Oilseed rape	27.3	20.5	14.2	[41]
Softwood stem	45–50	24–40	18–25	[26,27]
Oat straw	31–35	20–26	10–15	[14]
Nut shells	25–30	22–28	30–40	[42]
Sorghum straw	32–35	24–27	15–21	[43,44]
Tamarind kernel powder	10–15	55–65	–	[45]
Water hyacinth	18.2–22.1	48.7–50.1	3.5–5.4	[46,47]

V. Menon, M. Rao
Progress in Energy and Combustion Science 38 (2012) 522-550

Percent dry weight composition of lignocellulosic feedstocks

Feedstock	Glucan (cellulose)	Xylan (hemicellulose)	Lignin
Corn stover[a]	37.5	22.4	17.6
Corn fiber[b,c]	14.28	16.8	8.4
Pine wood[d]	46.4	8.8	29.4
Popular[d]	49.9	17.4	18.1
Wheat straw[d]	38.2	21.2	23.4
Switch grass[d]	31.0	20.4	17.6
Office paper[d]	68.6	12.4	11.3

N. Mosier et al. / Bioresource Technology 96 (2005) 673–686

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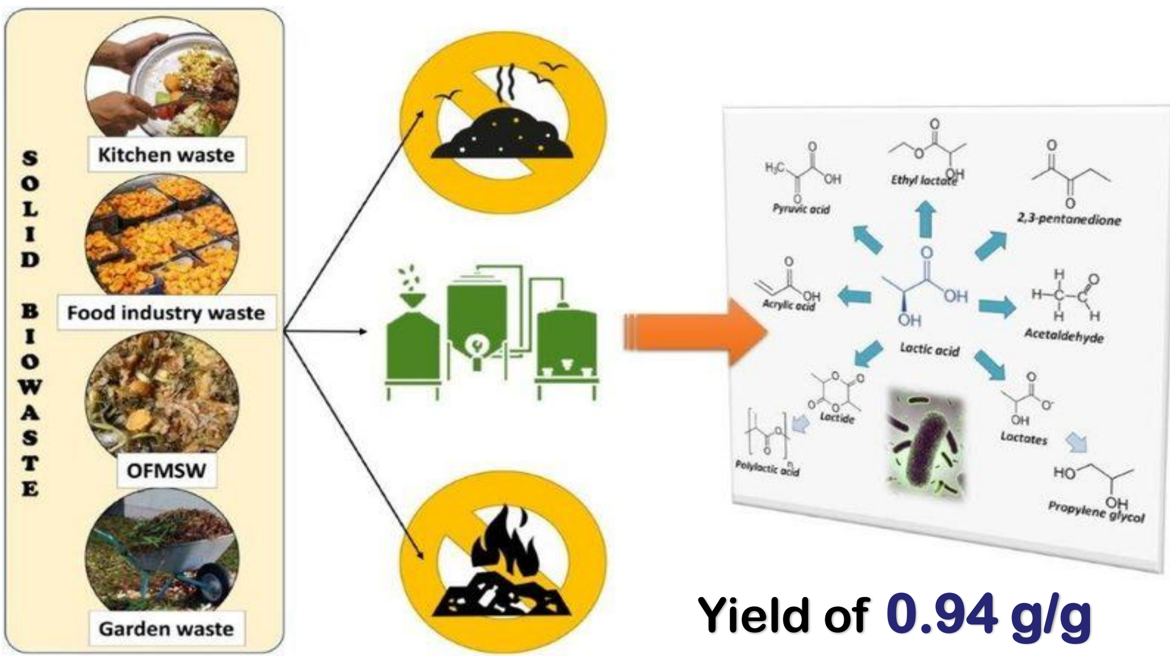
The processes for producing organic acids from biomass/residues include the following 4 main steps:

- Pretreatment - breaking down the structure of the feedstock matrix
- Enzymatic hydrolysis - depolymerizing biopolymers like starch, cellulose etc. to fermentative sugars, such as glucose (C6) and xylose (C5), by means of hydrolytic enzymes
- Fermentation - metabolizing sugars to organic acids, such as, lactic acid generally by LAB
- Separation and purification - purification of organic acids acid to meet the standards of commercial applications

Pilot plant facility for lactic acid fermentation at Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB Potsdam)

Key Platform Chemicals from Alternative Feedstock (LA as a monomer for PLA)



Yield of 0.94 g/g

Final LA concentration of 61.1 g/L

Max optical purity of 98.5% L-LA

López Gómez, J.P. et al.: Assessing the organic fraction of municipal solid wastes for the production of lactic acid, *Biochemical Engineering Journal* 150 (2019), 107251, https://doi.org/10.1016/j.bej.2019.107251
López Gómez, J.P. et al.: From Upstream to Purification: Production of Lactic Acid from the Organic Fraction of Municipal Solid Waste. *Waste Biomass Valor* 11 (2020) 10, 5247–5254, https://doi.org/10.1007/s12649-020-00992-9

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Chemicals from Biomass: A Market Assessment of Bioproducts with Near-Term Potential

Mary J. Biddy, Christopher Scarlata, and Christopher Kinchin - *National Renewable Energy Laboratory*

Data Gaps

Scale-up of lactic acid production would require **clean, cheap sugars from lignocellulosic biomass** to compete with commodity sugar and starch substrates. There is a **lack of data about lactic acid production and purification from biomass hydrolysates, including issues of C5 sugar** utilization, although it appears work has started to address some of these issues.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications
Technical Report NREL/TP-5100-65509 - March 2016/Contract No. DE-AC36-08GO28308

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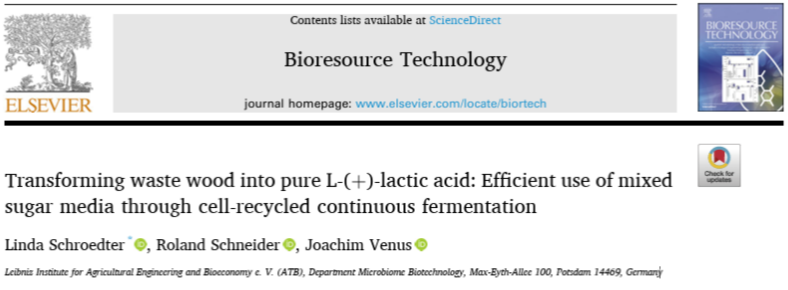
Technologies & Innovations – Continuous fermentation


Contents lists available at ScienceDirect

Bioresource Technology

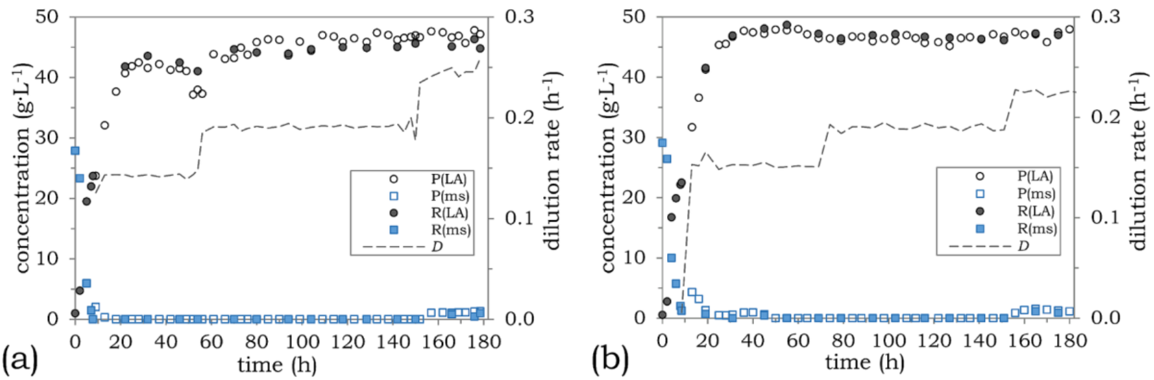
journal homepage: www.elsevier.com/locate/biortech

ELSEVIER

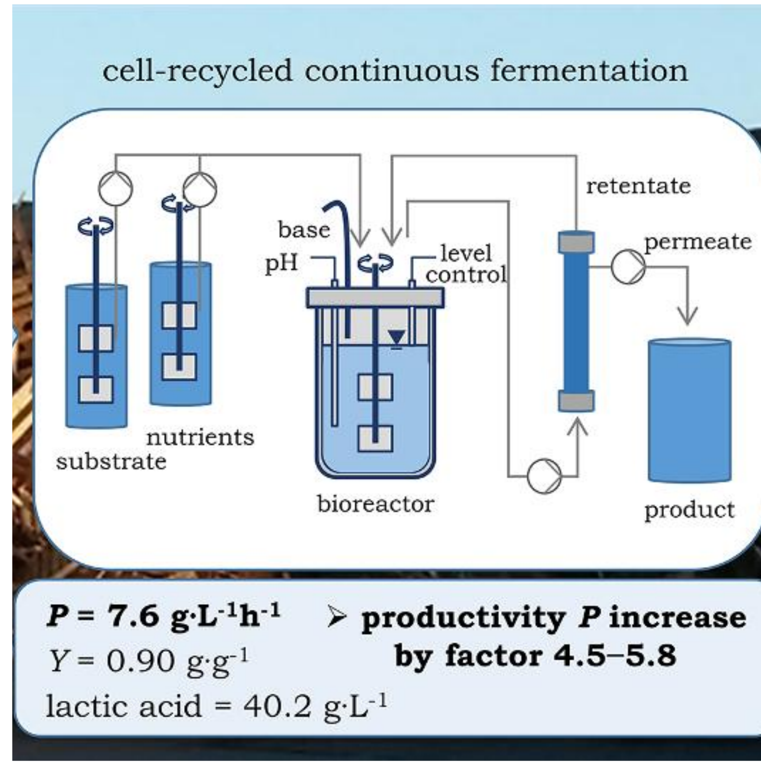
Transforming waste wood into pure L-(+)-lactic acid: Efficient use of mixed sugar media through cell-recycled continuous fermentation

Linda Schroedter*, Roland Schneider, Joachim Venus

Leibniz Institute for Agricultural Engineering and Bioeconomy e. V. (ATB), Department Microbiome Biotechnology, Max-Eyth-Allee 100, Potsdam 14469, Germany



Optically pure L-(+)-LA (>99.0 %)



DOMAIN-INVARIANT MONITORING FOR LACTIC ACID PRODUCTION: TRANSFER LEARNING FROM GLUCOSE TO BIO-WASTE USING INTERPRETABLE MACHINE LEARNING

http://dx.doi.org/10.2139/ssrn.5012080

Pilot scale production of succinic acid, followed by the downstream processing (DSP)

Food and Bioproducts Processing 151 (2025) 118–126

Contents lists available at ScienceDirect

Food and Bioproducts Processing

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ELSEVIER

IChemE

Pilot scale succinic acid production from fibre sludge followed by the downstream processing

Agata Olszewska-Widdrat [a,*], Laís Portugal Rios da Costa Pereira [a], Roland Schneider [a], Peter Unger [a], Charilaos Xiros [b], Joachim Venus [a,*]

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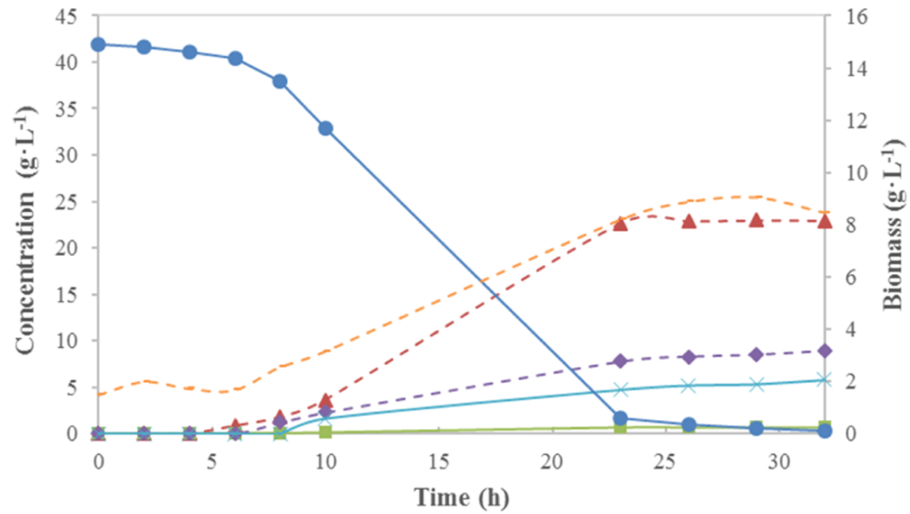
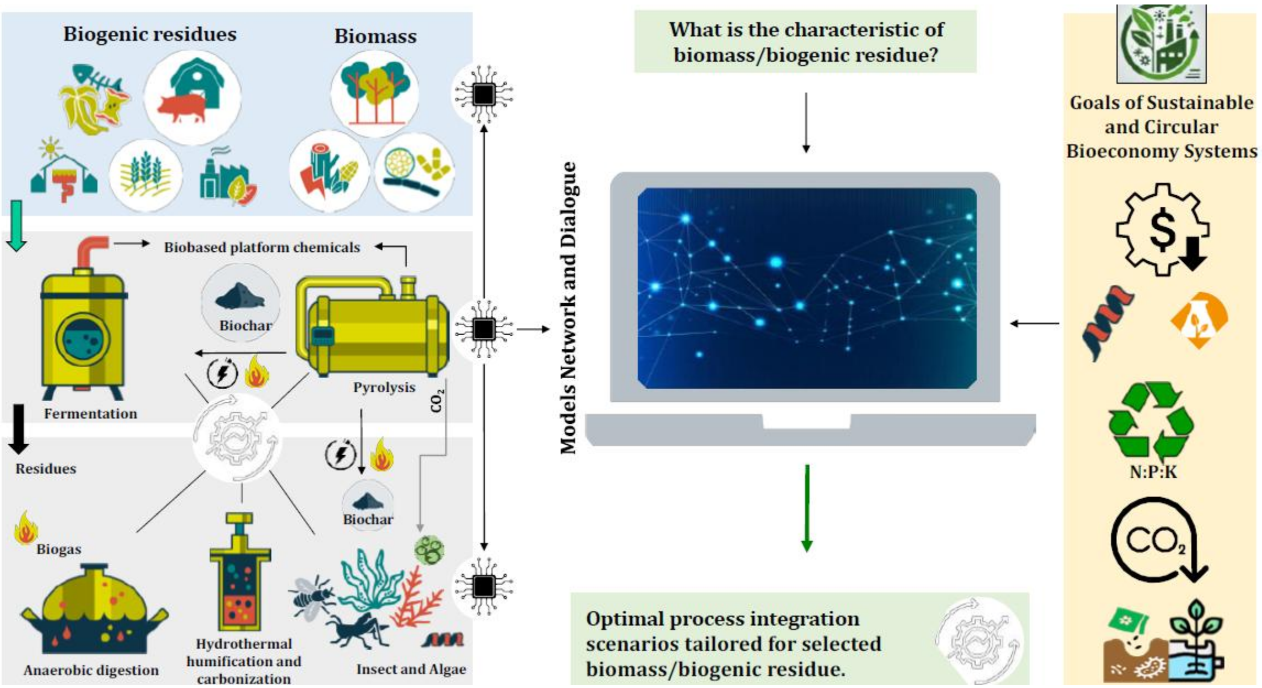
[b] RISE Processum AB, Örnsköldsvik, Sweden

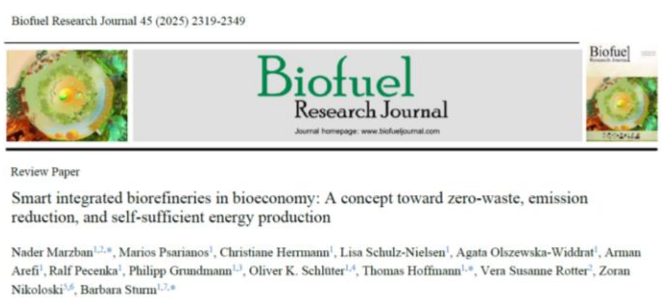


● Total sugars ▲ Succinic acid ♦Acetic acid ■Lactic acid
x Formic acid - - - - Biomass

Challenges & Future Perspective
Smart Integrated biorefineries in bioeconomy



The integration of thermochemical, biochemical, and biological technologies - a sustainable and circular bioeconomy framework.



Biofuel Research Journal 45 (2025) 2319-2349
Biofuel Research Journal
Journal homepage: www.biofueljournal.com

Review Paper

Smart integrated biorefineries in bioeconomy: A concept toward zero-waste, emission reduction, and self-sufficient energy production

Nader Marzban[1,2,*], Marios Psarianos[1], Christiane Herrmann[1], Lisa Schulz-Nielsen[1], Agata Olszewska-Widdrat[1], Arman Arefi[1], Ralf Pecenka[1], Philipp Grundmann[1,3], Oliver K. Schlüter[1,4], Thomas Hoffmann[1,*], Vera Susanne Rotter[2], Zoran Nikoloski[5,6], Barbara Sturm[1,7,*]

Pilots4U powered by CoPilot
BIOECONOMY INNOVATION COMMUNITY & DATABASE

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Conclusion & Call to Action

- Alternatives for the production
- Cheap biomass
- Continuous process
- Scale-up
- Innovation
- Collaboration
- Policy support

- **BBI Project BeonNAT** ”Innovative value chains from tree & shrub species grown in marginal lands as a source of biomass for bio-based industries” (BBI grant agreement Nº 887917) – **07/2020–06/2025**, https://beonnat.eu/
- **EU Project BIOMAC** “European Sustainable BIObased nanoMAterials Community” (H2020 grant agreement Nº 952941) – **01/2021–06/2025**, https://www.biomac-oitb.eu

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Thank you for your attention!

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https://youtu.be/JnkB0WRIO-o