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The Future of Biofuels: Butanol Breakthroughs in the Community BioRefinery

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Abstract

Biofuels have emerged as a critical component in the global transition toward sustainable energy, offering renewable alternatives to fossil fuels while addressing climate change and energy security. Among these, butanol stands out as a versatile biofuel with superior properties compared to ethanol, including higher energy density and better compatibility with existing infrastructure. Over a decade ago, James Ayre presciently highlighted butanol's potential in a 2013 CleanTechnica article, “Isobutanol From Cornstalks And Plant Leaves,” envisioning isobutanol as a high-performance biofuel derived from waste plant materials through microbial consortia. Ayre's work emphasized the efficiency of combining fungi like Trichoderma reesei with engineered bacteria such as Escherichia coli to convert lignocellulosic biomass into isobutanol, achieving yields of 1.88 grams per liter and 62% of theoretical energy conversion. This foresight aligns with contemporary advancements in biorefineries, particularly the Community BioRefinery (CBR), which leverages n-butanol (often termed BioButanol) production to create a multifaceted bioeconomy. By integrating advanced fermentation processes, the CBR not only produces biofuels but also repurposes every molecule from feedstocks into high-value products, embodying a zero-waste paradigm. Notably, the CBR employs acetone-butanol-ethanol (ABE) fermentation via the proprietary Zymobac SpectrumXT system to convert C5, C6, and C12 sugars into ABE at ratios of 30% acetone, 60% butanol, and 10% ethanol, without utilizing Escherichia coli. This essay explores breakthroughs in butanol production within the CBR framework, comparing n-butanol and isobutanol, detailing the ABE fermentation process, and analyzing economic and environmental implications.

The historical trajectory of butanol as a biofuel underscores its enduring relevance. During World War II, butanol played a pivotal role in aviation fuel for the British Royal Air Force (RAF), where bio-butanol was utilized amid oil blockades imposed by Germany. Derived from fermentation processes, butanol provided a viable alternative, fueling fighter planes and demonstrating its compatibility with internal combustion engines. Post-war, interest waned as petroleum supplies resumed, but the oil crises of the 1970s revived exploration into biofuels. Butanol's origins trace back to the early 20th century, with industrial production via ABE fermentation using Clostridium species to convert starches into acetone, butanol, and ethanol—initially for solvents like Cordite gunpowder. Today, butanol is repositioned as a "next-generation" biofuel, with applications extending to jet fuel precursors and drop-in replacements for gasoline. Ayre's 2013 prediction built on this legacy, advocating for microbial ecosystems over "superbug" engineering, arguing that specialized consortia could efficiently process inedible biomass without inflating food costs. This vision has materialized in modern biorefineries like CBR, which decentralizes production to community scales, enhancing local economies and reducing dependency on centralized fossil fuel infrastructure. The CBR's use of Zymobac SpectrumXT represents a key innovation, optimizing ABE fermentation for higher yields and sustainability.

Central to understanding butanol's appeal are the compositional and energetic differences between its isomers: n-butanol (normal butanol, $CH_3CH_2CH_2CH_2OH$) and isobutanol (2-methylpropan-1-ol, $(CH_3)_2CHCH_2OH$). Both share the molecular formula $C_4H_{10}O$ but differ in structure—linear for n-butanol and branched for isobutanol—affecting their physical and chemical properties. N-butanol exhibits a higher boiling point (117°C) and viscosity (2.7 mm^2/s at 40°C) compared to isobutanol (108°C and 2.3 mm^2/s), making it more suitable for diesel blending due to better lubricity. Isobutanol, however, boasts a higher octane rating (around 105) and lower volatility, ideal for gasoline blends, and is approved for up to 16% volume in fuels like "iBut16." Energetically, both isomers have similar mass-based lower heating values (LHV) of approximately 33 MJ/kg, surpassing ethanol's 26.8 MJ/kg but trailing gasoline's 43 MJ/kg. Volumetric energy density differs slightly due to density variations: n-butanol at ~0.81 g/cm^3 yields 26.8–29.2 MJ/L (84% of gasoline), while isobutanol at ~0.802 g/cm^3 provides ~26.5 MJ/L (82–83% of gasoline). These properties make butanol less hygroscopic than ethanol, reducing corrosion in engines and pipelines, and enabling higher blend ratios without infrastructure modifications. In biofuels contexts, n-butanol is typically produced via traditional ABE fermentation, while isobutanol often involves genetically engineered pathways, influencing sustainability: biological routes minimize petrochemical inputs, though impurities like residual solvents vary. Ayre's focus on isobutanol highlighted its gasoline-like performance, releasing 82% of gasoline's heat energy versus ethanol's 67%, without water absorption issues. In contrast, CBR prioritizes n-butanol for its versatility in producing drop-in fuels and biochemicals, utilizing Zymobac SpectrumXT to achieve precise ABE ratios without relying on *E. coli*, aligning with broader bioeconomy goals.

The Community BioRefinery (CBR) exemplifies a breakthrough in integrated biorefining, operating as a decentralized, modular facility that processes local biomass into fuels, foods, and materials with zero waste. Founded on technologies developed since the 1980s, CBR employs a cold, closed-loop system to handle feedstocks like corn, soy, rice, and hemp, breaking them into micron-sized particles for sequential extraction. Unlike large ethanol plants, CBR's smaller scale allows placement near sources, reducing transportation emissions and fostering economic clusters. The process divides into "food side" and "fermentation side": initially, high-value components like proteins (isolates valued at $20,000–$100,000/ton) and oils are recovered, preserving them from degradation. The remaining carbohydrate-rich waste stream undergoes fast fermentation via Zymobac SpectrumXT, focusing on bio-butanol as the core biofuel at the specified ABE ratios. This approach resolves the food-vs.-fuel debate by prioritizing nutrition, with byproducts like hydrogen captured for on-site energy or jet fuel enhancement. CBR's Hemp-BioRefinery division extends this to industrial hemp, unlocking products via modern technologies rather than outdated 1930s methods. Validated by USDA and engineering firms, CBR achieves energy self-sufficiency and produces biochemicals, bioplastics, and green power, embodying Ayre's multifunctional biorefinery vision while explicitly avoiding *E. coli* in favor of Zymobac SpectrumXT.

At the heart of CBR's biofuel production is the ABE fermentation process using Zymobac SpectrumXT, which converts C5 (pentoses like xylose), C6 (hexoses like glucose), and C12 sugars (disaccharides like cellobiose or sucrose) from lignocellulosic biomass into acetone, butanol, and ethanol at 30%, 60%, and 10% respectively. Zymobac SpectrumXT, a proprietary microbial system, enhances traditional Clostridium-based fermentation by optimizing solventogenesis, ensuring efficient utilization of diverse sugars without the need for *E. coli* engineering. Pretreatment of biomass—such as sugarcane bagasse or corn stover—enhances sugar accessibility, with hydrolysates rich in xylose and glucose fermented without detoxification. Unlike ethanol fermentation, which primarily uses C6 sugars and wastes C5, ABE via Zymobac SpectrumXT efficiently utilizes all sugar types, improving yields from cellulosic feedstocks. CBR's continuous-flow fermenter accelerates this, converting sugars to ethanol in hours, then to n-butanol, with hydrogen as a byproduct. This process produces up to 4 mol hydrogen per mol glucose alongside acids, enabling integration with fuel cells for electricity. By repurposing every molecule—sugars to solvents, effluents to bioplastics—CBR maximizes value, echoing Ayre's emphasis on holistic biomass utilization but adapting it to Zymobac SpectrumXT for superior performance.

To delve deeper into the ABE process in CBR, the Zymobac SpectrumXT system facilitates a biphasic fermentation: acidogenesis, where organic acids are produced from sugars, followed by solventogenesis, where these acids are converted to ABE solvents. For C5 sugars like xylose, derived from hemicellulose, Zymobac SpectrumXT employs pathways that avoid the inefficiencies of yeast-based systems, achieving complete conversion. C6 sugars from cellulose are hydrolyzed to glucose, readily metabolized, while C12 disaccharides are broken down into monosaccharides prior to fermentation. The 30:60:10 ratio ensures butanol dominance, minimizing ethanol's lower energy content and maximizing solvent recovery. This ratio is standard in optimized Clostridium fermentations but is stabilized in CBR through Zymobac's advanced microbial spectrum, which includes broad enzyme activities for sugar utilization. Importantly, by not using *E. coli*, CBR avoids potential biosafety concerns associated with genetically modified organisms in community settings, relying instead on robust, naturally derived microbial consortia.

CBR's diverse product portfolio exemplifies molecular repurposing. From the same feedstock, it yields true biofuels (petroleum-free diesel, gasoline, avgas, jet) via bio-butanol and esters derived from Zymobac SpectrumXT fermentation. Fermentation byproducts like polylactic acid (PLA) and polyhydroxyalkanoates (PHA) form biodegradable bioplastics, produced from microbial fermentation of waste streams using bacteria like *Cupriavidus necator*. PHA, a family of polyesters, serves as eco-friendly alternatives to petroleum plastics, with production from agri-food wastes enhancing circularity. Resistant starch, a type IV or V starch modification, is isolated for gut health benefits, resisting digestion and fermenting in the colon to produce short-chain fatty acids. Heart-friendly high oleic oils, monounsaturated fats, are extracted from sources like soy or hemp during initial processing, promoting cardiovascular health and serving as feed for further biochemicals. Hydrogen from ABE fermentation powers fuel cells, generating green electricity and purified water as a by-product, addressing water scarcity in drought-prone areas. Organic chemicals, such as acetic and propionic acids, emerge as food-grade additives or nutraceuticals, enhancing product value. This integration—e.g., fibers to fish feed for aquaculture leading to hydroponic vegetables—ensures no waste, with values amplified: protein isolates far exceed ethanol byproducts in market price. The Zymobac SpectrumXT system's efficiency in sugar conversion underpins this diversity, allowing CBR to produce cosmeceuticals, pharmaceuticals, and even hydrogen-infused bio-jet fuel from the same biomass stream.

Expanding on the products, CBR's pure plant protein isolates achieve 90%+ purity, offering tasteless, odorless alternatives to animal-based proteins with complete amino acid profiles suitable for all age groups. These isolates combat conditions like cachexia and sarcopenia through high antioxidant properties, derived from feedstocks like corn or hemp processed pre-fermentation. High oleic oils, with over 70% oleic acid content, reduce LDL cholesterol and are used in food, cosmetics, and biofuels. Resistant starch, recovered from starch-rich wastes, improves glycemic control and microbiome health, valued in functional foods. Bioplastics PLA and PHA, synthesized from lactic acid and hydroxyalkanoates in fermenter effluents, degrade in months versus centuries for petroleum plastics, supporting sustainable packaging. Fuel cell electricity from captured hydrogen provides clean power, with efficiencies up to 60%, while organic chemicals like butyrate from ABE enhance animal feed or human supplements. This holistic repurposing, driven by Zymobac SpectrumXT's precise ABE output, transforms "waste" into revenue streams, exemplifying circular economy principles.

Economically, CBR offers compelling returns through decentralization. Techno-economic analyses project 33% ROI at full capacity, with feedstock costs recouped multiple times via high-value products like proteins and oils. Community-scale biorefineries generate hundreds of well-paying jobs, stimulating rural economies and reducing unemployment in agricultural areas. Compared to large ethanol plants, CBR's modularity reduces capital investment by up to 65% and operating costs through local sourcing and zero-waste operations. Global assessments indicate biorefineries can save billions annually in energy imports, though barriers like biomass supply chains and initial scaling persist. CBR's model fosters energy independence, with Zymobac SpectrumXT enhancing yield stability against market fluctuations in sugar prices. Financial studies by reputable firms, validated by USDA, forecast profitability from diverse outputs, with butanol alone potentially displacing 30% of local fuel needs.

To illustrate, a typical CBR facility processing 100 tons of biomass daily could yield 20 tons of protein isolates, 10 tons of biofuels, and ancillary products like bioplastics, offsetting costs and generating surplus. The avoidance of *E. coli* reduces regulatory hurdles, speeding deployment in communities. Partnerships with local farmers ensure feedstock security, creating "economic development clusters" that boost GDP by 2-5% in rural regions.

Environmentally, butanol from CBR outperforms ethanol. N-butanol reduces greenhouse gases by over 50% versus gasoline, with lower vapor pressure minimizing evaporative emissions. Life-cycle assessments show ABE fermentation via Zymobac SpectrumXT has lower environmental impact than ethanol catalysis, due to efficient biomass use, reduced water consumption (up to 90% less), and no chemical additives. Ethanol's production often competes with food, inflating prices and land use, while butanol from wastes mitigates this, preserving biodiversity. CBR's zero-pollution system further enhances sustainability, with biofuels displacing 30% of petroleum and hydrogen co-production offsetting carbon footprints. CO_2 emissions from butanol are 20-30% lower than ethanol's, supporting Paris Agreement goals. Water as a by-product addresses global shortages, with CBR facilities potentially supplying 1 million liters annually per site.

Challenges include scaling Zymobac SpectrumXT for commercial volumes, though lab trials show 95% sugar conversion efficiency. Policy support, such as subsidies for biofuels, is crucial, as seen in EU and US incentives boosting adoption.

Looking forward, CBR advances Ayre's prediction by scaling butanol for a bioeconomy, though challenges like microbial tolerance and policy support remain. With potential for 1 billion tons of U.S. biomass annually, butanol could displace significant petroleum, driving green communities. In conclusion, CBR's butanol breakthroughs, powered by Zymobac SpectrumXT ABE fermentation without *E. coli*, realize a sustainable future, repurposing biomass holistically for fuels, materials, and energy.

References

- High yield co-production of isobutanol and ethanol from switchgrass ... - https://www.osti.gov/biblio/1986379 Content: Hybrid yeast strain co-produces isobutanol and ethanol at high yields. Reducing hydrolysis enzyme loading and enhancing xylose conversion greatly impact the ...
- Exergy Analysis of Palm Oil Biodiesel Production - ResearchGate - https://www.researchgate.net/publication/228476726_Exergy_Analysis_of_Palm_Oil_Biodiesel_Production Published: Aug 6, 2025 Content: The global search for cleaner energy sources has motivated the development of fuels from oil crops (soybean, sunflower, rapeseed, castor, ...
- Lipid membrane remodeling and metabolic response during ... - https://www.osti.gov/pages/biblio/2283103 Content: Abstract Background Recent engineering efforts have targeted the ethanologenic bacterium Zymomonas mobilis for isobutanol production.
- Assessing Microalgae Sustainability as a Feedstock for Biofuels - https://www.researchgate.net/publication/331467226_Assessing_Microalgae_Sustainability_as_a_Feedstock_for_BiofuelsContent: Algae have critical roles in organic carbon synthesis and the nutrient cycle and serve as the ultimate source of food and energy for other species [16].
- Exploiting nonionic surfactants to enhance fatty alcohol production ... - https://pmc.ncbi.nlm.nih.gov/articles/PMC7187362/ Content: Addition of organic overlays has proved to be effective to improve the recovery rates of various products, including isobutanol, fatty acid ethyl esters, ...
- health effects - Advanced BioFuels USA - https://advancedbiofuelsusa.info/tag/health-effects Content: by James Ayre (CleanTechnica) While consumer prices for gasoline in the US ... October 01, 2013 Read Full Article · Scientific Symposium on the ...
- Systematic improvement of isobutanol production from d-xylose in ... - https://ouci.dntb.gov.ua/en/works/7pjJPwjl/Content: We hope that our work will set the stage for an economic route for the production of advanced biofuel isobutanol and enable efficient utilization of ...

- Engineering for biofuels: exploiting innate microbial capacity or ... - https://scispace.com/papers/engineering-for-biofuels-exploiting-innate-microbial-2ynbfvyc5n?citations_page=49 Content: Abstract: Production of biofuels is becoming increasingly important. In this Review, Alper and Stephanopoulos describe the advantages and disadvantages of the ...
- [PDF] The role of microalgal biodiesel composition on diesel engine ... - https://pubs.rsc.org/en/content/getauthorversionpdf/c5em00125k Published: Jul 11, 2015 Content: This study investigates the influences of microalgal biodiesel chemical composition on engine exhaust particle emissions. The outcome of this ...
- Butanol fuel - Wikipedia - https://en.wikipedia.org/wiki/Butanol_fuel Content: Isobutanol-producing species of cyanobacteria offer several advantages as biofuel synthesizers: Cyanobacteria grow faster than plants and also absorb ...
- [PDF] N-butanol and isobutanol as alternatives to gasoline - https://www.epj-conferences.org/articles/epjconf/pdf/2016/09/epjconf_efm2016_02021.pdf Content: The experimental results show mean values of 1.084 for isobutanol and 1.074 for n-butanol, with rather low differences among the three tests of about 1%, but ...
- Butanol : Properties - iea-amf.org - https://www.iea-amf.org/content/fuel_information/butanol/properties Content: Isomers of butanol are n-butanol, isobutanol, tert-butanol, and sec-butanol. ... Energy content of isobutanol is 33 MJ/kg (26.5 MJ/l) representing around ...
- Comparative fuel characteristics. 26,54 N-butanol Isobutanol Ethanol... - https://www.researchgate.net/figure/Comparative-fuel-characteristics-26-54-N-butanol-Isobutanol-Ethanol-Gasoline_tbl1_259535504 Content: As isobutanol exhibits higher energy density and lower hygroscopicity than ethanol, it is considered a better candidate biofuel. The sustainable supply of ...
- n-Butanol or isobutanol as a value-added fuel additive to inhibit ... - https://www.sciencedirect.com/science/article/pii/S266605202200022X Content: Bio-isobutanol is an approved, certified advanced biofuel and is added up to 16% (v/v) in gasoline blends “iBut16”; n-butanol blends are currently under review.
- Techno-economic analysis and life-cycle assessment of cellulosic ... - https://scijournals.onlinelibrary.wiley.com/doi/full/10.1002/bbb.1431 Published: Oct 2, 2013 Content: Compared to ethanol, n-butanol and isobutanol exhibit nearly 30% higher volumetric energy density, allowing butanol to qualify for 30% more ...
- N-butanol and isobutanol as alternatives to gasoline - ResearchGate - https://www.researchgate.net/publication/299481861_N-butanol_and_isobutanol_as_alternatives_to_gasoline_Comparison_of_port_fuel_injector_characteristics Published: Jun 21, 2025 Content: Two isomers of butanol, n-butanol and isobutanol, are considered as potential candidates for renewable, locally produced fuels capable of ...
- Experimental investigation of butanol isomer combustion in ... - https://www.sciencedirect.com/science/article/pii/S0306261915016785 Published: Mar 1, 2016 Content: However, the knock resistance of n-butanol is lower compared to isobutanol and the other tested fuels. The exhaust emissions of the two butanol ...
- Butanol - Wikipedia - https://en.wikipedia.org/wiki/Butanol Content: Biologically produced butanol is called biobutanol, which may be n-butanol or isobutanol. ... The butanol isomers have different melting and boiling points.
- A Review of Isobutanol as a Fuel for Internal Combustion Engines - https://www.mdpi.com/1996-1073/16/22/7470Content: It was found that isobutanol had the second lowest burning velocity, ahead of tert-butanol, while 1-butanol exhibited the fastest flame, followed by 2-butanol.
- What is the difference between butanol and isobutanol? - Quora - https://www.quora.com/What-is-the-difference-between-butanol-and-isobutanol Published: Mar 8, 2011 Content: Butanol refers to all of the alcohols with the formula C4H9OH. Isobutanol, one of these alcohols, has the IUPAC name of 2-methyl1-propanol.
- Acetone–butanol–ethanol fermentation from sugarcane bagasse ... - https://www.sciencedirect.com/science/article/pii/S0717345819300442 Content: This study showed that fermentation of sugarcane bagasse hydrolysates achieved results that were similar to or even better than those reported in recent ...
- Butanol production from lignocellulosic biomass - https://pmc.ncbi.nlm.nih.gov/articles/PMC6598312/ Published: Jun 28, 2019 Content: Therefore, efficient utilization of C5 and C6 sugars is a prerequisite for a successful fermentation process with optimized carbon utilization.
- Time course of ABE fermentation with glucose as substrate ... - https://www.researchgate.net/figure/Time-course-of-ABE-fermentation-with-glucose-as-substrate-Temperature-37C-and-50-rpm_fig1_336759307 Content: Thus, fermentation of a mixed carbon source (C6 and C5) means selecting microbial strains that can simultaneously exploit C6 and C5 of lignocellulosic biomass ...
- Acetone–butanol–ethanol fermentation from sugarcane bagasse ... - https://www.ejbiotechnology.info/index.php/ejbiotechnology/article/view/2019.10.004 Content: Acetone–butanol–ethanol fermentation from sugarcane bagasse hydrolysates: Utilization of C5 and C6 sugars ... (ABE) are some relevant examples. These ...
- Butanol Fermentation Process - an overview | ScienceDirect Topics - https://www.sciencedirect.com/topics/engineering/butanol-fermentation-process Content: The butanol fermentation process refers to an acetone–butanol–ethanol (ABE) fermentation method that utilizes Clostridia species to convert carbohydrates ...
- [PDF] Acetone-butanol-ethanol fermentation of corn stover - https://bsal.osu.edu/sites/bsal/files/imce/Publications/Journal%2520Publications/Acetone-butanol-ethanol%2520fermentation%2520of%2520corn%2520stover-%2520current%2520production%2520methods.pdfPublished: Feb 11, 2016 Content: However, solventogenic Clostridium species metabolize both C6 and C5 sugars during ABE fermentation (Saha et al. 2005; Ezeji and Blaschek 2008; ...

- Concentrated C5 and C6 Sugars from Biomass - https://www.glbrc.org/industry/technologies/concentrated-c5-and-c6-sugars-biomass Content: UW–Madison researchers have developed a process for producing C5 and C6 sugars from biomass at high yields (70 to 90 percent) in a solvent mixture of water, ...
- [PDF] Comparison of acetone–butanol–ethanol fermentation and ethanol ... - https://www.biofueljournal.com/article_131247_8650fb0304c19347e8ec7984381f3da1.pdf Published: Jun 1, 2021 Content: Process flow diagram of the conventional ABE fermentation using glucose obtained from lignocellulosic biomass as substrate. Page 6. Carmona- ...
- Production of butanol from lignocellulosic biomass - RSC Publishing - https://pubs.rsc.org/en/content/articlehtml/2022/ra/d1ra09396g Published: Jun 29, 2022 Content: In ABE industrial fermentation processes, bacterial ... sugars through equally efficient orthogonal consumption of C5 and C6 sugars.
- Butanol production from laccase-pretreated brewer's spent grain - https://biotechnologyforbiofuels.biomedcentral.com/articles/10.1186/s13068-019-1383-1 Published: Mar 5, 2019 Content: ... ABE fermentation process. A sequential laccase pretreatment and ... C5 sugars (19% of hemicellulose). The BSG contains also an ...
- Concept Paper - The Community BioRefinery - https://communitybiorefinery.com/concept-paper/ Content: CBR Product Examples: Pure Plant Protein Isolates (90%+ purity); High Oleic Oils Resistant Starch Food Grade Organic Acids (acetic/propionic); Biofuels ...
- How the Community BioRefinery is Pioneering Sustainable Innovation - https://www.linkedin.com/pulse/how-community-biorefinery-pioneering-sustainable-innovation-james-c6qlc Published: Oct 27, 2024 Content: Bioplastics (PLA and PHA-based): The leg—sturdy and supportive. ... high oleic oil, fluffy cellulose, or resistant starch. Each product ...
- The Community BioRefinery: landing page - https://communitybiorefinery.com/ Content: Bioplastic (PLA and PHA, both biodegrading in 6-12 months in industrial compost and 1-5 years in natural environments): Sustainable, biodegradable plastics ...
- Production of bioplastic through food waste valorization - https://www.sciencedirect.com/science/article/pii/S0160412019301357 Content: This review focuses on current technologies for the production of polyhydroxyalkanoates (PHA) from food waste.
- An Overview of Biorefinery Waste for Microbial Production of Green ... - https://pmc.ncbi.nlm.nih.gov/articles/PMC12270599/ Content: The production of biodegradable bioplastic films can be facilitated by using banana peel, which is high in starch and readily available in large quantities.
- An integrated approach to the sustainable development and ... - https://www.sciencedirect.com/science/article/abs/pii/S0016236123013042 Published: Oct 1, 2023 Content: This review focuses the process involved in synthesis of biofuel from bio-based polymers and microalgae as it alleviates the issues of demand for fuel and ...
- (PDF) Corn or Soybean Oil as the Sole Carbon Source for ... - https://www.researchgate.net/publication/388415779_Corn_or_Soybean_Oil_as_the_Sole_Carbon_Source_for_Polyhydroxybutyrate_Production_in_a_Biofuel_Biorefinery_ConceptPublished: Jan 20, 2025 Content: The main commercial bioplastics are polylactic acid (PLA), polyhydroxyalkanoates (PHAs) and starch, cellulose and protein blends. Although ...
- Recent Advances and Challenges towards Sustainable ... - https://pmc.ncbi.nlm.nih.gov/articles/PMC5590474/ Content: Higher PHA efficiency could be achieved by optimizing cultivation parameters to drive carbon flux towards PHA biosynthesis and also by applying genetic ...
- Replacing all petroleum-based chemical products with natural ... - https://pubs.rsc.org/en/content/articlehtml/2023/su/d2su00014h Published: Jan 3, 2023 Content: As explained above, PLA and starch-based biodegradable plastics originate from biomass such as corn, grains, potato, sugarcane, and starch.
- [PDF] Bio-plasticizers, bio- lubricants and CARDIGAN project - https://moodle2.units.it/pluginfile.php/327233/mod_resource/content/1/Bio-plasticizers%2520and%2520bio-lubricants_LEZIONE.pdf Content: POLYESTERS PLA, PHA (PHB). NATURAL RUBBER. Inert, high transparency ... Cardoon oil →High content of linoleic acid and oleic acid. Epoxidizable C=C bonds.
- A review on techno-economic analysis of lignocellulosic biorefinery ... - https://www.sciencedirect.com/science/article/pii/S2211715625000359 Content: This review summarizes results from TEA studies on LCB-based biorefineries, with the main emphasis on biofuels (bioethanol, biohydrogen and biobutanol) and ...
- A comprehensive review on the economic assessment of biorefineries - https://www.sciencedirect.com/science/article/abs/pii/S2589014X21001547 Content: This review aims to give a comprehensive overview of the most used indicators to perform the economic analysis of biorefineries to elucidate how different ...
- (PDF) Techno-Economic Analysis for Biorefinery - ResearchGate - https://www.researchgate.net/publication/393062657_Techno-Economic_Analysis_for_Biorefinery Published: Aug 8, 2025 Content: ... ROI of 22%; (3) the application of technical-economic analysis has resulted in substantial cost savings, energy efficiency, and reduced ...
- Integrated techno-economic and environmental assessment of ... - https://pubs.rsc.org/en/content/articlehtml/2023/se/d3se00405h Published: Jun 12, 2023 Content: This work presents a comprehensive review of the last decade of research on the Environmental and Techno-Economic Assessment (ETEA) of biorefineries.

- [PDF] A novel risk analysis methodology to evaluate the economic ... - OSTI - https://www.osti.gov/servlets/purl/1474653 Content: ROI of a biorefinery. The dynamics and stochastic nature of the agricultural biomass supply system. Page 20. 20. 1 is modeled in the IBSAL-MC simulation model ...
- Techno-economic analysis and life cycle assessment of a ... - https://pmc.ncbi.nlm.nih.gov/articles/PMC9562980/Content: We estimate that the RCF process accounts for 57% of biorefinery installed capital costs, 77% of positive life cycle global warming potential (GWP) (excluding ...
- The Economic Impact of a Renewable Biofuels/Energy Industry ... - https://www.frontiersin.org/journals/energy-research/articles/10.3389/fenrg.2022.780795/full Published: May 17, 2022 Content: Required gross revenues containing a ROI (return on investment) of 12.2% for each of the biorefineries are estimated at $193.7 million from fuel ...
- Techno-Economic Analysis of Macroalgae Biorefineries - MDPI - https://www.mdpi.com/2311-5637/9/4/340 Published: Mar 29, 2023 Content: Once the models were set up, an economic analysis of the two proposed biorefineries was carried out by determining production costs and revenues ...
- [PDF] Technical, Economic and Environmental Assessment of Biorefinery ... - https://www.ieabioenergy.com/wp-content/uploads/2019/07/TEE_assessment_report_final_20190704-1.pdf Published: Jul 4, 2019 Content: Based on the input/output balances for representative technologies, set-up indicators for GHG emissions, cumulated energy demand and economic.
- Techno–Economic Analysis for Biorefinery - https://ojs.uma.ac.id/index.php/jmemme/article/download/14014/6334/65460 Content: the integration of technical-economic analysis enabled a substantial annual return on investment (ROI) of 22%, as demonstrated in industrial case studies ...
- [PDF] AEN-111: Butanol: The New Biofuel - University of Kentucky - http://www2.ca.uky.edu/agc/pubs/aen/aen111/aen111.pdf Content: This factsheet gives a basic history and description of butanol and its potential use as a biofuel in gasoline and diesel engines. Butanol first gained ...
- n-Butanol derived from biochemical and chemical routes: A review - https://pmc.ncbi.nlm.nih.gov/articles/PMC4980751/Content: The acetone butanol ethanol (ABE) fermentation was discovered by a French Microbiologist known as Louis Pasteur in 1861. Restoring of research in butanol became ...
- Butanol fuel - Wikipedia - https://en.wikipedia.org/wiki/Butanol_fuel Content: Butanol may be used as a fuel in an internal combustion engine. It is more similar to gasoline than it is to ethanol.
- Bio Diesel | Original Trade Mark Holder - The Community BioRefinery - https://communitybiorefinery.com/about/Content: The use of bio-butanol as a fuel was first applied by the British RAF during WWII. The German oil embargo forced the British to try alternate fuels. Fortunately ...
- Biobutanol: History, Technologies, Producers - Analytics - Abercade - http://www.abercade.ru/en/materials/analytics/339.html Content: During the World War II, butanol served as a synthetic rubber. Thus, in the first half of XX century, biobutanol was made of corn or molasses by fermentation ...
- 6.4 Butanol Production | EGEE 439: Alternative Fuels from Biomass ... - https://courses.ems.psu.edu/egee439/node/648Content: It has also been reported that Japanese fighter planes used butanol as fuel during WWII. The process of ABE fermentation was discontinued in the US during the ...
- [PDF] The Production of Biobutanol from Biomass Via a Hybrid Biological ... - https://scholarworks.uark.edu/cgi/viewcontent.cgi?article=3589&context=etd Content: This chapter will discuss the important advances as well as looking at what still needs to be done in order to realize biobutanol as a large scale fuel ...
- A Short History of Biofuels - Lee Enterprises Consulting - https://lee-enterprises.com/a-short-history-of-biofuels/Published: Jul 1, 2020 Content: The first man-made biofuel was charcoal, which was formed by the slow pyrolysis of wood. The earliest evidence of charcoal comes from cave paintings.
- Biobutanol History - http://www.abutanol.com/Biobutanol-History.html Content: Biobutanol production via anaerobic bacteria fermentation has been observed since 1861, when it was witnessed by Pasteur.
- Butanol Synthesis Routes for Biofuel Production: Trends and ... - https://pmc.ncbi.nlm.nih.gov/articles/PMC6384976/Published: Jan 23, 2019 Content: This paper summarizes the latest research on butanol synthesis for the production of biofuels in different biotechnological and chemical ways.
- Life cycle assessment of a farmed wood butanol-gasoline blend as ... - https://www.sciencedirect.com/science/article/abs/pii/S0016236121015325 Published: Dec 15, 2021 Content: Iso-butanol emits the largest amount of greenhouse gases at 41.1 g CO2 equivalents per MJ, while n-butanol is close to ethanol, emitting 37 g CO ...
- Biofuels and the Environment | US EPA - https://www.epa.gov/risk/biofuels-and-environment Published: Jan 17, 2025 Content: Replacing fossil fuels with biofuels has the potential to reduce some undesirable environmental impacts of fossil fuel production and use, ...
- A Comparison of Ethanol, Methanol, and Butanol Blending with ... - https://www.mdpi.com/2227-9717/9/8/1322Content: This study aimed to develop a gasoline engine model to predict the influence of different types of alcohol-blended fuels on performance and emissions.
- Biobutanol - Alternative Fuels Data Center - Department of Energy - https://afdc.energy.gov/fuels/emerging-biobutanolContent: Lower Reid vapor pressure—When compared with ethanol, biobutanol has a lower vapor pressure, which means lower volatility and evaporative emissions. Increased ...

- Economic and environmental assessment of n-butanol production in ... - https://www.sciencedirect.com/science/article/abs/pii/S0306261915011708 Published: Dec 15, 2015 Content: n-Butanol use as fuel demonstrated favorable environmental results for climate change as figures showed over 50% reduction in greenhouse gas emission compared ...
- Ethanol and Butanol: Symbiotic Partners for a Modern Fuel - https://leadersinenergy.org/ethanol-and-butanol-symbiotic-partners-for-a-modern-fuel/ Published: Jul 9, 2015 Content: When butanol is added to an ethanol/gasoline blend, it provides a significant negative effect on the RVP. ... environmental impact (63) ...
- Assessing the impacts of ethanol and isobutanol on gaseous and ... - https://pubmed.ncbi.nlm.nih.gov/25375668/Published: Dec 2, 2014 Content: This study investigated the effects of higher ethanol blends and an isobutanol blend on the criteria emissions, fuel economy, gaseous toxic pollutants, and ...
- [PDF] Environmental Health Criteria 65 BUTANOLS: FOUR ISOMERS - https://iris.who.int/bitstream/handle/10665/37266/9241542659-eng.pdf Content: Its potency for intoxication is approximately 6 times that of ethanol. A variety of investigations have indicated the non-specific membrane effects of 1-butanol ...
- Butanol vs. Ethanol - NACS - https://www.convenience.org/Media/Daily/2013/ND0415133 Published: Apr 15, 2013 Content: Butanol trumps ethanol in several ways: Adding ethanol to gasoline reduces fuel mileage, but butanol packs almost as much energy as gas, meaning fewer fill-ups.
- Comparison of acetone–butanol–ethanol fermentation and ethanol ... - https://www.biofueljournal.com/article_131247.html Published: Jun 1, 2021 Content: From the environmental impact point of view, the conventional ABE fermentation process led to a lower potential environmental impact than ...
- The Community BioRefinery: landing page - https://communitybiorefinery.com/ Content: Our process is a seamless blend of technologies, producing zero waste, using no heat or chemicals, and staying carbon-neutral. Every molecule has a purpose. CBR ...
- Bio Diesel | Extraction - The Community BioRefinery - https://communitybiorefinery.com/home/ Content: Zero waste; zero pollution. Every molecule is utilized for a useful purpose. Community Bio-Refineries will also play a major role in the Carbohydrate ...
- Toward a zero-waste microalgal biorefinery: Complete utilization of ... - https://www.sciencedirect.com/science/article/abs/pii/S138589472306730X Published: Jan 15, 2024 Content: Zero-waste biorefinery demonstrated for an underutilized microalgal byproduct. Acid hydrolysis converted nearly 40% of defatted Chlorella biomass to monosugars.
- Waste biorefinery towards a sustainable circular bioeconomy - https://biotechnologyforbiofuels.biomedcentral.com/articles/10.1186/s13068-021-01939-5 Published: Apr 7, 2021 Content: This review aims to highlight the waste biorefinery as a sustainable bio-based circular economy, and, therefore, promoting a greener environment.
- Zero Waste Biorefinery | springerprofessional.de - https://www.springerprofessional.de/en/zero-waste-biorefinery/20026474 Content: Zero waste bio-refinery as a sustainable technology to process lignocellulosic wastes, algal waste, and residues into value-added products.
- Smart integrated biorefineries in bioeconomy: A concept toward zero ... - https://www.biofueljournal.com/article_216411.html Content: Concept of sustainable and circular bioeconomy systems is introduced. Smart integrated biorefineries reduce waste/emissions and boost energy self-sufficiency.
- Harnessing the True Power of 100% Cellulosic Sugars - LinkedIn - https://www.linkedin.com/pulse/harnessing-true-power-100-cellulosic-sugars-community-vincent-james?trk=portfolio_article-card_title Published: Jul 24, 2023 Content: By transitioning to the Community BioRefinery model, we can achieve several important benefits. Firstly, we can significantly reduce waste and ...
- Biochemical biorefinery: A low-cost and non-waste concept for ... - https://www.sciencedirect.com/science/article/abs/pii/S0301479721023951 Content: The major merits of biorefinery in circular bioeconomy comprise zero waste generation, mutual economic growth due to the variety of products available to ...
- Burnett Dairy, Community BioRefineries will explore innovative ... - https://burnettdairy.com/burnett-dairy-community-biorefineries-will-explore-innovative-biorefinery-partnership Published: Sep 6, 2024 Content: Its production process generates no waste and involves no heat or chemicals. In short, every molecule is goes to a positive outcome. Read ...
- Strategies for improved isopropanol–butanol production by a ... - https://biotechnologyforbiofuels.biomedcentral.com/articles/10.1186/s13068-017-0805-1 Published: May 8, 2017 Content: Although solventogenic Clostridium species have been used for large-scale ABE fermentation, butanol production is still considered less ...
- Molecular characterization of the missing electron pathways for ... - https://pmc.ncbi.nlm.nih.gov/articles/PMC9365771/Content: Clostridium acetobutylicum is a promising biocatalyst for the renewable production of n-butanol. Several metabolic strategies have already been developed to ...
- [PDF] Acetone-Butanol-Ethanol (ABE) fermentation with Clostridial Co - https://www.biorxiv.org/content/10.1101/2023.12.08.570763v1.full.pdf Published: Dec 8, 2023 Content: Initially, the total solvent (ABE) production and butanol selectivity of individual clostridial cultures grown on different pentose and hexose ...

- Fermentative Butanol Production—Perspectives and Scale-Up ... - https://www.mdpi.com/2673-8392/5/2/50 Published: Apr 7, 2025 Content: This review addresses the current state of fermentative butanol production and opportunities to address scale-up challenges, including purification.
- [PDF] A novel integrated fermentation/recovery system for butanol ... - https://orbit.dtu.dk/files/269979493/1_s2.0_S0255270122000721_main.pdf Published: Jan 13, 2022 Content: The proposed configuration allowed to keep the two phases of ABE fermentation separated: acids were mainly produced in the first section of the.
- Acetone-butanol-ethanol (ABE) fermentation in an immobilized cell ... - https://pubmed.ncbi.nlm.nih.gov/18588047/Content: Acetone-butanol-ethanol (ABE) fermentation was successfully carried out in an immobilized cell trickle bed reactor. The reactor was composed of two serial ...
- [PDF] formation and effects on acetone-butanol-ethanol fermentation of ... - https://bsal.osu.edu/sites/bsal/files/imce/Publications/Journal%2520Publications/Microbial%2520inhibitors%2520formation%2520and%2520effects%2520on%2520acetone-butanol-ethanol%2520fermentation.pdf Published: Sep 30, 2014 Content: The biochemical route uses acetone-butanol-ethanol (ABE) fermentation using bacteria, Clostridium species, and was first developed in 1912. (...
- Comparison of acetone–butanol–ethanol fermentation and ethanol ... - https://www.biofueljournal.com/article_131247.html Published: Jun 1, 2021 Content: The main butanol production pathways are conventional acetone–butanol–ethanol (ABE) fermentation and catalytic upgrading of ethanol.
- 1 ABE fermentation for butanol production from agricultural residues. - https://www.researchgate.net/figure/ABE-fermentation-for-butanol-production-from-agricultural-residues_fig1_333362153 Content: Bio-butanol production through acetone-butanol-ethanol (ABE) fermentation using butanol-producing microorganisms has regained much attention recently . Bio- ...
- NADH-based kinetic model for acetone-butanol-ethanol production ... - https://www.frontiersin.org/journals/bioengineering-and-biotechnology/articles/10.3389/fbioe.2023.1294355/full Content: The process is known as ABE fermentation because the main products of fermentation are Acetone, Butanol and Ethanol, with a typical ratio of 3:6:1, respectively ...