

# **The Global Market for Biobased & Biodegradable Chemicals, Materials, Polymers, Plastics, Paints, Coatings and Fuels 2022**

<https://marketpublishers.com/r/G49C016F75D0EN.html>

Date: June 2022

Pages: 1175

Price: US\$ 1,900.00 (Single User License)

ID: G49C016F75D0EN

## **Abstracts**

There is growing consumer demand and regulatory push for bio-based chemicals, materials, polymers, plastics, paints, coatings and fuels with high performance, good recyclability and biodegradable properties to underpin transition towards more sustainable manufacturing and products. Materials from biomass sources include bulk chemicals, platform chemicals, solvents, polymers, and biocomposites.

The many processes to convert biomass components to value-added products and fuels can be classified broadly as biochemical or thermochemical. In addition, biotechnological processes that rely mainly on plant breeding, fermentation, and conventional enzyme isolation also are used. New bio-based materials that may compete with conventional materials are emerging continually, and the opportunities to use them in existing and novel products are explored in this publication.

Contents include:

In depth market analysis of bio-based chemical feedstocks, biopolymers, bioplastics, natural fibers and lignin, and bio-based coatings and paints.

Global production capacities, market demand and trends

Analysis of bio-based chemical including 11-Aminoundecanoic acid (11-AA), 1,4-Butanediol (1,4-BDO), Dodecanedioic acid (DDDA), Epichlorohydrin (ECH), Ethylene, Furan derivatives, 5-Chloromethylfurfural (5-CMF), 2,5-Furandicarboxylic acid (2,5-FDCA), Furandicarboxylic methyl ester (FDME), Isosorbide, Itaconic acid, 5 Hydroxymethyl furfural (HMF), Lactic acid (D-LA),

Lactic acid – L-lactic acid (L-LA), Lactide, Levoglucosenone, Levulinic acid, Monoethylene glycol (MEG), Monopropylene glycol (MPG), Muconic acid, Naphtha, 1,5-Pentametylenediamine (DN5), 1,3-Propanediol (1,3-PDO), Sebacic acid and Succinic acid.

Analysis of synthetic bio-polymers and bio-plastics market including Polylactic acid (Bio-PLA), Polyethylene terephthalate (Bio-PET), Polytrimethylene terephthalate (Bio-PTT), Polyethylene furanoate (Bio-PEF), Polyamides (Bio-PA), Poly(butylene adipate-co-terephthalate) (Bio-PBAT), Polybutylene succinate (PBS) and copolymers, Polyethylene (Bio-PE), Polypropylene (Bio-PP)

Analysis of naturally produced bio-based polymers including Polyhydroxyalkanoates (PHA), Polysaccharides, Microfibrillated cellulose (MFC), Cellulose nanocrystals, Cellulose nanofibers, Protein-based bioplastics, Algal and fungal.

Analysis of types of natural fibers including plant fibers, animal fibers including alternative leather, wool, silk fiber and down and polysaccharides.

Markets for natural fibers, including composites, aerospace, automotive, construction & building, sports & leisure, textiles, consumer products and packaging.

Production capacities of lignin producers.

In depth analysis of biorefinery lignin production.

Analysis of the market for bio-based, sustainable paints and coatings.

Analysis of types of bio-coatings and paints market. Including Alkyd coatings, Polyurethane coatings, Epoxy coatings, Acrylate resins, Polylactic acid (Bio-PLA), Polyhydroxyalkanoates (PHA), Cellulose, Rosins, Biobased carbon black, Lignin, Edible coatings, Protein-based biomaterials for coatings, Alginate etc.

Profiles of over 770 companies.

## Contents

### 1 EXECUTIVE SUMMARY

- 1.1 Market trends
- 1.2 Global production to 2030
- 1.3 Main producers and global production capacities
  - 1.3.1 Producers
  - 1.3.2 By biobased and sustainable plastic type
  - 1.3.3 By region
- 1.4 Global demand for biobased and sustainable plastics 2020-21, by market
- 1.5 Impact of COVID-19 crisis on the bioplastics market and future demand
- 1.6 Challenges for the biobased and sustainable plastics market

### 2 RESEARCH METHODOLOGY

### 3 THE GLOBAL PLASTICS MARKET

- 3.1 Global production
- 3.2 The importance of plastic
- 3.3 Issues with plastics use

### 4 BIO-BASED CHEMICALS

- 4.1 Types
- 4.2 Production capacities
- 4.3 Bio-based adipic acid
- 4.4 11-Aminoundecanoic acid (11-AA)
- 4.5 1,4-Butanediol (1,4-BDO)
- 4.6 Dodecanedioic acid (DDDA)
- 4.7 Epichlorohydrin (ECH)
- 4.8 Ethylene
- 4.9 Furfural
- 4.10 5-Chloromethylfurfural (5-CMF)
- 4.11 2,5-Furandicarboxylic acid (2,5-FDCA)
- 4.12 Furandicarboxylic methyl ester (FDME)
- 4.13 Isosorbide
- 4.14 Itaconic acid
- 4.15 3-Hydroxypropionic acid (3-HP)

- 4.16 5 Hydroxymethyl furfural (HMF)
- 4.17 Lactic acid (D-LA)
- 4.18 Lactic acid – L-lactic acid (L-LA)
- 4.19 Lactide
- 4.20 Levoglucosenone
- 4.21 Levulinic acid
- 4.22 Monoethylene glycol (MEG)
- 4.23 Monopropylene glycol (MPG)
- 4.24 Muconic acid
- 4.25 Naphtha
- 4.26 Pentamethylene diisocyanate
- 4.27 1,3-Propanediol (1,3-PDO)
- 4.28 Sebacic acid
- 4.29 Succinic acid (SA)

## **5 BIOPOLYMERS AND BIOPLASTICS**

- 5.1 Bio-based or renewable plastics
  - 5.1.1 Drop-in bio-based plastics
  - 5.1.2 Novel bio-based plastics
- 5.2 Biodegradable and compostable plastics
  - 5.2.1 Biodegradability
  - 5.2.2 Compostability
- 5.3 Advantages and disadvantages
- 5.4 Types of Bio-based and/or Biodegradable Plastics
- 5.5 Market leaders by biobased and/or biodegradable plastic types
- 5.6 Regional/country production capacities, by main types
  - 5.6.1 Bio-based Polyethylene (Bio-PE) production capacities, by country
  - 5.6.2 Bio-based Polyethylene terephthalate (Bio-PET) production capacities, by country
  - 5.6.3 Bio-based polyamides (Bio-PA) production capacities, by country
  - 5.6.4 Bio-based Polypropylene (Bio-PP) production capacities, by country
  - 5.6.5 Bio-based Polytrimethylene terephthalate (Bio-PTT) production capacities, by country
  - 5.6.6 Bio-based Poly(butylene adipate-co-terephthalate) (PBAT) production capacities, by country
  - 5.6.7 Bio-based Polybutylene succinate (PBS) production capacities, by country
  - 5.6.8 Bio-based Polylactic acid (PLA) production capacities, by country
  - 5.6.9 Polyhydroxyalkanoates (PHA) production capacities, by country

5.6.10 Starch blends production capacities, by country

## 5.7 SYNTHETIC BIO-BASED POLYMERS

5.7.1 Polylactic acid (Bio-PLA)

5.7.1.1 Market analysis

5.7.1.2 Producers

5.7.2 Polyethylene terephthalate (Bio-PET)

5.7.2.1 Market analysis

5.7.2.2 Producers

5.7.3 Polytrimethylene terephthalate (Bio-PTT)

5.7.3.1 Market analysis

5.7.3.2 Producers

5.7.4 Polyethylene furanoate (Bio-PEF)

5.7.4.1 Market analysis

5.7.4.2 Comparative properties to PET

5.7.4.3 Producers

5.7.5 Polyamides (Bio-PA)

5.7.5.1 Market analysis

5.7.5.2 Producers

5.7.6 Poly(butylene adipate-co-terephthalate) (Bio-PBAT)

5.7.6.1 Market analysis

5.7.6.2 Producers

5.7.7 Polybutylene succinate (PBS) and copolymers

5.7.7.1 Market analysis

5.7.7.2 Producers

5.7.8 Polyethylene (Bio-PE)

5.7.8.1 Market analysis

5.7.8.2 Producers

5.7.9 Polypropylene (Bio-PP)

5.7.9.1 Market analysis

5.7.9.2 Producers

## 5.8 NATURAL BIO-BASED POLYMERS

5.8.1 Polyhydroxyalkanoates (PHA)

5.8.1.1 Types

5.8.1.2 Synthesis and production processes

5.8.1.3 Market analysis

5.8.1.4 Commercially available PHAs

5.8.1.5 Markets for PHAs

5.8.1.6 Producers

5.8.2 Polysaccharides

- 5.8.2.1 Microfibrillated cellulose (MFC)
- 5.8.2.2 Cellulose nanocrystals
- 5.8.2.3 Cellulose nanofibers
- 5.8.3 Protein-based bioplastics
  - 5.8.3.1 Types, applications and producers
- 5.8.4 Algal and fungal
  - 5.8.4.1 Algal
  - 5.8.4.2 Mycelium
- 5.8.5 Chitosan
- 5.8.6 Microplastics alternatives
- 5.9 PRODUCTION OF BIOBASED AND SUSTAINABLE PLASTICS, BY REGION
  - 5.9.1 North America
  - 5.9.2 Europe
  - 5.9.3 Asia-Pacific
    - 5.9.3.1 China
    - 5.9.3.2 Japan
    - 5.9.3.3 Thailand
    - 5.9.3.4 Indonesia
  - 5.9.4 Latin America
- 5.10 MARKET SEGMENTATION OF BIOPLASTICS
  - 5.10.1 Packaging
  - 5.10.2 Consumer products
  - 5.10.3 Automotive
  - 5.10.4 Building & construction
  - 5.10.5 Textiles
  - 5.10.6 Electronics
  - 5.10.7 Agriculture and horticulture
- 5.11 BIO-BASED CHEMICALS, BIOPOLYMERS AND BIOPLASTICS COMPANY PROFILES 173 (318 company profiles)

## **6 NATURAL FIBERS**

- 6.1 Manufacturing method, matrix materials and applications of natural fibers
- 6.2 Advantages of natural fibers
- 6.3 Plants (cellulose, lignocellulose)
  - 6.3.1 Seed fibers
    - 6.3.1.1 Cotton
    - 6.3.1.2 Kapok
    - 6.3.1.3 Luffa

### 6.3.2 Bast fibers

#### 6.3.2.1 Jute

#### 6.3.2.2 Hemp

#### 6.3.2.3 Flax

#### 6.3.2.4 Ramie

#### 6.3.2.5 Kenaf

### 6.3.3 Leaf fibers

#### 6.3.3.1 Sisal

#### 6.3.3.2 Abaca

### 6.3.4 Fruit fibers

#### 6.3.4.1 Coir

#### 6.3.4.2 Banana

#### 6.3.4.3 Pineapple

### 6.3.5 Stalk fibers from agricultural residues

#### 6.3.5.1 Rice fiber

#### 6.3.5.2 Corn

### 6.3.6 Cane, grasses and reed

#### 6.3.6.1 Switch grass

#### 6.3.6.2 Sugarcane (agricultural residues)

#### 6.3.6.3 Bamboo

#### 6.3.6.4 Fresh grass (green biorefinery)

### 6.3.7 Modified natural polymers

#### 6.3.7.1 Mycelium

#### 6.3.7.2 Chitosan

#### 6.3.7.3 Alginate

## 6.4 Animal (fibrous protein)

### 6.4.1 Wool

#### 6.4.1.1 Alternative wool materials

#### 6.4.1.2 Producers

### 6.4.2 Silk fiber

#### 6.4.2.1 Alternative silk materials

### 6.4.3 Leather

#### 6.4.3.1 Alternative leather materials

### 6.4.4 Down

#### 6.4.4.1 Alternative down materials

## 6.5 MARKETS FOR NATURAL FIBERS

### 6.5.1 Composites

### 6.5.2 Applications

### 6.5.3 Natural fiber injection moulding compounds

- 6.5.3.1 Properties
- 6.5.3.2 Applications
- 6.5.4 Non-woven natural fiber mat composites
  - 6.5.4.1 Automotive
  - 6.5.4.2 Applications
- 6.5.5 Aligned natural fiber-reinforced composites
- 6.5.6 Natural fiber biobased polymer compounds
- 6.5.7 Natural fiber biobased polymer non-woven mats
  - 6.5.7.1 Flax
  - 6.5.7.2 Kenaf
- 6.5.8 Natural fiber thermoset bioresin composites
- 6.5.9 Aerospace
  - 6.5.9.1 Market overview
- 6.5.10 Automotive
  - 6.5.10.1 Market overview
  - 6.5.10.2 Applications of natural fibers
- 6.5.11 Building/construction
  - 6.5.11.1 Market overview
  - 6.5.11.2 Applications of natural fibers
- 6.5.12 Sports and leisure
  - 6.5.12.1 Market overview
- 6.5.13 Textiles
  - 6.5.13.1 Market overview
  - 6.5.13.2 Consumer apparel
  - 6.5.13.3 Geotextiles
- 6.5.14 Packaging
  - 6.5.14.1 Market overview
- 6.6 NATURAL FIBERS GLOBAL PRODUCTION
  - 6.6.1 Overall global fibers market
  - 6.6.2 Plant-based fiber production
  - 6.6.3 Animal-based natural fiber production
- 6.7 NATURAL FIBER COMPANY PROFILES 476 (137 company profiles)

## **7 LIGNIN**

- 7.1 INTRODUCTION
  - 7.1.1 What is lignin?
    - 7.1.1.1 Lignin structure
  - 7.1.2 Types of lignin



- 7.1.2.1 Sulfur containing lignin
- 7.1.2.2 Sulfur-free lignin from biorefinery process
- 7.1.3 Properties
- 7.1.4 The lignocellulose biorefinery
- 7.1.5 Markets and applications
- 7.1.6 Challenges for using lignin
- 7.2 LIGNIN PRODUCTION PROCESSES
  - 7.2.1 Lignosulphonates
  - 7.2.2 Kraft Lignin
    - 7.2.2.1 LignoBoost process
    - 7.2.2.2 LignoForce method
    - 7.2.2.3 Sequential Liquid Lignin Recovery and Purification
    - 7.2.2.4 A-Recovery+
  - 7.2.3 Soda lignin
  - 7.2.4 Biorefinery lignin
    - 7.2.4.1 Commercial and pre-commercial biorefinery lignin production facilities and processes
  - 7.2.5 Organosolv lignins
  - 7.2.6 Hydrolytic lignin
- 7.3 MARKETS FOR LIGNIN
  - 7.3.1 Market drivers and trends for lignin
  - 7.3.2 Production capacities
    - 7.3.2.1 Technical lignin availability (dry ton/y)
    - 7.3.2.2 Biomass conversion (Biorefinery)
  - 7.3.3 Estimated consumption of lignin
  - 7.3.4 Prices
  - 7.3.5 Heat and power energy
  - 7.3.6 Pyrolysis and syngas
  - 7.3.7 Aromatic compounds
    - 7.3.7.1 Benzene, toluene and xylene
    - 7.3.7.2 Phenol and phenolic resins
    - 7.3.7.3 Vanillin
  - 7.3.8 Plastics and polymers
  - 7.3.9 Hydrogels
  - 7.3.10 Carbon materials
    - 7.3.10.1 Carbon black
    - 7.3.10.2 Activated carbons
    - 7.3.10.3 Carbon fiber
  - 7.3.11 Concrete

- 7.3.12 Rubber
- 7.3.13 Biofuels
- 7.3.14 Bitumen and Asphalt
- 7.3.15 Oil and gas
- 7.3.16 Energy storage
  - 7.3.16.1 Supercapacitors
  - 7.3.16.2 Anodes for lithium-ion batteries
  - 7.3.16.3 Gel electrolytes for lithium-ion batteries
  - 7.3.16.4 Binders for lithium-ion batteries
  - 7.3.16.5 Cathodes for lithium-ion batteries
  - 7.3.16.6 Sodium-ion batteries
- 7.3.17 Binders, emulsifiers and dispersants
- 7.3.18 Chelating agents
- 7.3.19 Ceramics
- 7.3.20 Automotive interiors
- 7.3.21 Fire retardants
- 7.3.22 Antioxidants
- 7.3.23 Lubricants
- 7.3.24 Dust control
- 7.4 COMPANY PROFILES 663 (71 company profiles)

## **8 BIOBASED AND RENEWABLE FUELS**

### **8.1 BIOFUELS**

- 8.1.1 The biofuels market
- 8.1.2 Types
  - 8.1.2.1 Solid Biofuels
  - 8.1.2.2 Liquid Biofuels
  - 8.1.2.3 Gaseous Biofuels
  - 8.1.2.4 Conventional Biofuels
  - 8.1.2.5 Advanced Biofuels
- 8.1.3 Feedstocks
  - 8.1.3.1 First-Generation Feedstocks
  - 8.1.3.2 Second-Generation Feedstocks
  - 8.1.3.3 Third-Generation Feedstocks
  - 8.1.3.4 Fourth-Generation Feedstocks
  - 8.1.3.5 Market demand
- 8.1.4 Bioethanol
- 8.1.5 Bio-jet (bio-aviation) fuels

- 8.1.5.1 Description
- 8.1.5.2 Global market
- 8.1.5.3 Production pathways
- 8.1.5.4 Costs
- 8.1.5.5 Biojet fuel production capacities
- 8.1.5.6 Challenges
- 8.1.6 Biomass-based diesel
  - 8.1.6.1 Biodiesel
  - 8.1.6.2 Renewable diesel
- 8.1.7 Syngas
- 8.1.8 Biogas and biomethane
  - 8.1.8.1 Feedstocks
- 8.1.9 Biobutanol
  - 8.1.9.1 Production
- 8.2 ELECTROFUELS (E-FUELS)
  - 8.2.1 Introduction
    - 8.2.1.1 Benefits of e-fuels
  - 8.2.2 Feedstocks
    - 8.2.2.1 Hydrogen electrolysis
    - 8.2.2.2 CO<sub>2</sub> capture
  - 8.2.3 Production
  - 8.2.4 Electrolysers
    - 8.2.4.1 Commercial alkaline electrolyser cells (AECs)
    - 8.2.4.2 PEM electrolyzers (PEMEC)
    - 8.2.4.3 High-temperature solid oxide electrolyser cells (SOECs)
  - 8.2.5 Direct Air Capture (DAC)
    - 8.2.5.1 Technologies
    - 8.2.5.2 Markets for DAC
    - 8.2.5.3 Costs
    - 8.2.5.4 Challenges
    - 8.2.5.5 Companies and production
    - 8.2.5.6 CO<sub>2</sub> capture from point sources
  - 8.2.6 Costs
  - 8.2.7 Market challenges
  - 8.2.8 Companies
- 8.3 GREEN AMMONIA
  - 8.3.1 Production
    - 8.3.1.1 Decarbonisation of ammonia production
    - 8.3.1.2 Green ammonia projects

- 8.3.2 Green ammonia synthesis methods
  - 8.3.2.1 Haber-Bosch process
  - 8.3.2.2 Biological nitrogen fixation
  - 8.3.2.3 Electrochemical production
  - 8.3.2.4 Chemical looping processes
- 8.3.3 Blue ammonia
  - 8.3.3.1 Blue ammonia projects
- 8.3.4 Markets and applications
  - 8.3.4.1 Chemical energy storage
  - 8.3.4.2 Marine fuel
- 8.3.5 Costs
- 8.3.6 Estimated market demand
- 8.3.7 Companies and projects
- 8.4 COMPANY PROFILES 800 (114 company profiles)

## **9 BIO-BASED PAINTS AND COATINGS**

- 9.1 The global paints and coatings market
- 9.2 Bio-based paints and coatings
- 9.3 Challenges using bio-based paints and coatings
- 9.4 Types of bio-based coatings and materials
  - 9.4.1 Alkyd coatings
    - 9.4.1.1 Alkyd resin properties
    - 9.4.1.2 Biobased alkyd coatings
    - 9.4.1.3 Products
  - 9.4.2 Polyurethane coatings
    - 9.4.2.1 Properties
    - 9.4.2.2 Biobased polyurethane coatings
    - 9.4.2.3 Products
  - 9.4.3 Epoxy coatings
    - 9.4.3.1 Properties
    - 9.4.3.2 Biobased epoxy coatings
    - 9.4.3.3 Products
  - 9.4.4 Acrylate resins
    - 9.4.4.1 Properties
    - 9.4.4.2 Biobased acrylates
    - 9.4.4.3 Products
  - 9.4.5 Polylactic acid (Bio-PLA)
    - 9.4.5.1 Properties

- 9.4.5.2 Bio-PLA coatings and films
- 9.4.6 Polyhydroxyalkanoates (PHA)
  - 9.4.6.1 Properties
  - 9.4.6.2 PHA coatings
  - 9.4.6.3 Commercially available PHAs
- 9.4.7 Cellulose
  - 9.4.7.1 Microfibrillated cellulose (MFC)
  - 9.4.7.2 Cellulose nanofibers
  - 9.4.7.3 Cellulose nanocrystals
  - 9.4.7.4 Bacterial Nanocellulose (BNC)
- 9.4.8 Rosins
- 9.4.9 Biobased carbon black
  - 9.4.9.1 Lignin-based
  - 9.4.9.2 Algae-based
- 9.4.10 Lignin
  - 9.4.10.1 Application in coatings
- 9.4.11 Edible coatings
- 9.4.12 Protein-based biomaterials for coatings
  - 9.4.12.1 Plant derived proteins
  - 9.4.12.2 Animal origin proteins
- 9.4.13 Alginate
- 9.5 Market for bio-based paints and coatings
  - 9.5.1 Global market revenues to 2031, total
  - 9.5.2 Global market revenues to 2031, by market
- 9.6 Company profiles 942 (130 companies)

## **10 REFERENCES 1063**

## List Of Tables

### LIST OF TABLES

- Table 1. Market drivers and trends in biobased and sustainable plastics.
- Table 2. Global production capacities of biobased and sustainable plastics 2018-2030, in 1,000 tons.
- Table 3. Global production capacities, by producers.
- Table 4. Global production capacities of biobased and sustainable plastics 2019-2030, by type, in 1,000 tons.
- Table 5. Global production capacities of biobased and sustainable plastics 2019-2025, by region, tons.
- Table 6. Issues related to the use of plastics.
- Table 7. List of Bio-based chemicals.
- Table 8. Biobased MEG producers capacities.
- Table 9. Type of biodegradation.
- Table 10. Advantages and disadvantages of biobased plastics compared to conventional plastics.
- Table 11. Types of Bio-based and/or Biodegradable Plastics, applications.
- Table 12. Market leader by Bio-based and/or Biodegradable Plastic types.
- Table 13. Bioplastics regional production capacities to 2030, 1,000 tons, 2019-2030.
- Table 14. Polylactic acid (PLA) market analysis.
- Table 15. Lactic acid producers and production capacities.
- Table 16. PLA producers and production capacities.
- Table 17. Planned PLA capacity expansions in China.
- Table 18. Bio-based Polyethylene terephthalate (Bio-PET) market analysis.
- Table 19. Bio-based Polyethylene terephthalate (PET) producers.
- Table 20. Polytrimethylene terephthalate (PTT) market analysis.
- Table 21. Production capacities of Polytrimethylene terephthalate (PTT), by leading producers.
- Table 22. Polyethylene furanoate (PEF) market analysis.
- Table 23. PEF vs. PET.
- Table 24. FDCA and PEF producers.
- Table 25. Bio-based polyamides (Bio-PA) market analysis.
- Table 26. Leading Bio-PA producers production capacities.
- Table 27. Poly(butylene adipate-co-terephthalate) (PBAT) market analysis.
- Table 28. Leading PBAT producers, production capacities and brands.
- Table 29. Bio-PBS market analysis.
- Table 30. Leading PBS producers and production capacities.

- Table 31. Bio-based Polyethylene (Bio-PE) market analysis.
- Table 32. Leading Bio-PE producers.
- Table 33. Bio-PP market analysis.
- Table 34. Leading Bio-PP producers and capacities.
- Table 35. Types of PHAs and properties.
- Table 36. Comparison of the physical properties of different PHAs with conventional petroleum-based polymers.
- Table 37. Polyhydroxyalkanoate (PHA) extraction methods.
- Table 38. Polyhydroxyalkanoates (PHA) market analysis.
- Table 39. Commercially available PHAs.
- Table 40. Markets and applications for PHAs.
- Table 41. Applications, advantages and disadvantages of PHAs in packaging.
- Table 42. Polyhydroxyalkanoates (PHA) producers.
- Table 43. Microfibrillated cellulose (MFC) market analysis.
- Table 44. Leading MFC producers and capacities.
- Table 45. Cellulose nanocrystals analysis.
- Table 46. Cellulose nanocrystal production capacities and production process, by producer.
- Table 47. Cellulose nanofibers market analysis.
- Table 48. CNF production capacities (by type, wet or dry) and production process, by producer, metric tonnes.
- Table 49. Types of protein based-bioplastics, applications and companies.
- Table 50. Types of algal and fungal based-bioplastics, applications and companies.
- Table 51. Overview of alginate-description, properties, application and market size.
- Table 52. Companies developing algal-based bioplastics.
- Table 53. Overview of mycelium fibers-description, properties, drawbacks and applications.
- Table 54. Companies developing mycelium-based bioplastics.
- Table 55. Overview of chitosan-description, properties, drawbacks and applications.
- Table 56. Global production capacities of biobased and sustainable plastics in 2019-2025, by region, tons.
- Table 57. Biobased and sustainable plastics producers in North America.
- Table 58. Biobased and sustainable plastics producers in Europe.
- Table 59. Biobased and sustainable plastics producers in Asia-Pacific.
- Table 60. Biobased and sustainable plastics producers in Latin America.
- Table 61. Granbio Nanocellulose Processes.
- Table 62. Lactips plastic pellets.
- Table 63. Oji Holdings CNF products.
- Table 64. Application, manufacturing method, and matrix materials of natural fibers.



- Table 65. Typical properties of natural fibers.
- Table 66. Overview of cotton fibers-description, properties, drawbacks and applications.
- Table 67. Overview of kapok fibers-description, properties, drawbacks and applications.
- Table 68. Overview of luffa fibers-description, properties, drawbacks and applications.
- Table 69. Overview of jute fibers-description, properties, drawbacks and applications.
- Table 70. Overview of hemp fibers-description, properties, drawbacks and applications.
- Table 71. Overview of flax fibers-description, properties, drawbacks and applications.
- Table 72. Overview of ramie fibers- description, properties, drawbacks and applications.
- Table 73. Overview of kenaf fibers-description, properties, drawbacks and applications.
- Table 74. Overview of sisal leaf fibers-description, properties, drawbacks and applications.
- Table 75. Overview of abaca fibers-description, properties, drawbacks and applications.
- Table 76. Overview of coir fibers-description, properties, drawbacks and applications.
- Table 77. Overview of banana fibers-description, properties, drawbacks and applications.
- Table 78. Overview of pineapple fibers-description, properties, drawbacks and applications.
- Table 79. Overview of rice fibers-description, properties, drawbacks and applications.
- Table 80. Overview of corn fibers-description, properties, drawbacks and applications.
- Table 81. Overview of switch grass fibers-description, properties and applications.
- Table 82. Overview of sugarcane fibers-description, properties, drawbacks and application and market size.
- Table 83. Overview of bamboo fibers-description, properties, drawbacks and applications.
- Table 84. Overview of mycelium fibers-description, properties, drawbacks and applications.
- Table 85. Overview of chitosan fibers-description, properties, drawbacks and applications.
- Table 86. Overview of alginate-description, properties, application and market size.
- Table 87. Overview of wool fibers-description, properties, drawbacks and applications.
- Table 88. Alternative wool materials producers.
- Table 89. Overview of silk fibers-description, properties, application and market size.
- Table 90. Alternative silk materials producers.
- Table 91. Alternative leather materials producers.
- Table 92. Alternative down materials producers.
- Table 93. Applications of natural fiber composites.
- Table 94. Typical properties of short natural fiber-thermoplastic composites.
- Table 95. Properties of non-woven natural fiber mat composites.
- Table 96. Properties of aligned natural fiber composites.



- Table 97. Properties of natural fiber-bio-based polymer compounds.
- Table 98. Properties of natural fiber-bio-based polymer non-woven mats.
- Table 99. Natural fibers in the aerospace sector-market drivers, applications and challenges for NF use.
- Table 100. Natural fiber-reinforced polymer composite in the automotive market.
- Table 101. Natural fibers in the aerospace sector- market drivers, applications and challenges for NF use.
- Table 102. Applications of natural fibers in the automotive industry.
- Table 103. Natural fibers in the building/construction sector- market drivers, applications and challenges for NF use.
- Table 104. Applications of natural fibers in the building/construction sector.
- Table 105. Natural fibers in the sports and leisure sector-market drivers, applications and challenges for NF use.
- Table 106. Natural fibers in the textiles sector- market drivers, applications and challenges for NF use.
- Table 107. Natural fibers in the packaging sector-market drivers, applications and challenges for NF use.
- Table 108. Oji Holdings CNF products.
- Table 109. Technical lignin types and applications.
- Table 110. Classification of technical lignins.
- Table 111. Lignin content of selected biomass.
- Table 112. Properties of lignins and their applications.
- Table 113. Example markets and applications for lignin.
- Table 114. Processes for lignin production.
- Table 115. Biorefinery feedstocks.
- Table 116. Comparison of pulping and biorefinery lignins.
- Table 117. Commercial and pre-commercial biorefinery lignin production facilities and processes
- Table 118. Market drivers and trends for lignin.
- Table 120. Production capacities of technical lignin producers.
- Table 121. Production capacities of biorefinery lignin producers.
- Table 122. Estimated consumption of lignin, 2019-2031 (000 MT).
- Table 123. Prices of benzene, toluene, xylene and their derivatives.
- Table 124. Application of lignin in plastics and polymers.
- Table 125. Lignin-derived anodes in lithium batteries.
- Table 126. Application of lignin in binders, emulsifiers and dispersants.
- Table 127. Categories and examples of solid biofuel.
- Table 128. Comparison of biofuels and e-fuels to fossil and electricity.
- Table 129. Biorefinery feedstocks.

Table 130. Feedstock conversion pathways.
Table 131. First-Generation Feedstocks.
Table 132. Lignocellulosic ethanol plants and capacities.
Table 133. Comparison of pulping and biorefinery lignins.
Table 134. Commercial and pre-commercial biorefinery lignin production facilities and processes
Table 135. Operating and planned lignocellulosic biorefineries and industrial flue gas-to-ethanol.
Table 136. Properties of microalgae and macroalgae.
Table 137. Yield of algae and other biodiesel crops.
Table 138. Advantages and disadvantages of biofuels, by generation.
Table 139. Advantages and disadvantages of biojet fuel
Table 140. Production pathways for bio-jet fuel.
Table 141. Current and announced biojet fuel facilities and capacities.
Table 142. Biodiesel production techniques.
Table 143. Biodiesel by generation.
Table 144. Biogas feedstocks.
Table 145. Applications of e-fuels, by type.
Table 146. Overview of e-fuels.
Table 147. Benefits of e-fuels.
Table 148. Main characteristics of different electrolyzer technologies.
Table 149. Advantages and disadvantages of DAC.
Table 150. DAC companies and technologies.
Table 151. Markets for DAC.
Table 152. Cost estimates of DAC.
Table 153. Challenges for DAC technology.
Table 154. DAC technology developers and production.
Table 155. Market challenges for e-fuels.
Table 156. E-fuels companies.
Table 157. Green ammonia projects (current and planned).
Table 158. Blue ammonia projects.
Table 159. Ammonia fuel cell technologies.
Table 160. Market overview of green ammonia in marine fuel.
Table 161. Summary of marine alternative fuels.
Table 162. Estimated costs for different types of ammonia.
Table 163. Main players in green ammonia.
Table 164. Granbio Nanocellulose Processes.
Table 165. Types of alkyd resins and properties.
Table 166. Market summary for biobased alkyd coatings-raw materials, advantages,

disadvantages, applications and producers.

Table 167. Biobased alkyd coating products.

Table 168. Types of polyols.

Table 169. Polyol producers.

Table 170. Biobased polyurethane coating products.

Table 171. Market summary for biobased epoxy resins.

Table 172. Biobased polyurethane coating products.

Table 173. Biobased acrylate resin products.

Table 174. Polylactic acid (PLA) market analysis.

Table 175. PLA producers and production capacities.

Table 176. Polyhydroxyalkanoates (PHA) market analysis.

Table 177. Types of PHAs and properties.

Table 178. Polyhydroxyalkanoates (PHA) producers.

Table 179. Commercially available PHAs.

Table 180. Properties of micro/nanocellulose, by type.

Table 181. Types of nanocellulose.

Table 182: MFC production capacities (by type, wet or dry) and production process, by producer, metric tonnes.

Table 183. Market overview for cellulose nanofibers in paints and coatings.

Table 184. Companies developing cellulose nanofibers products in paints and coatings.

Table 185. CNC properties.

Table 186: Cellulose nanocrystal capacities (by type, wet or dry) and production process, by producer, metric tonnes.

Table 187. Edible coatings market summary.

Table 188. Types of protein based-biomaterials, applications and companies.

Table 189. Overview of alginate-description, properties, application and market size.

Table 190. Global market revenues for biobased paints and coatings, 2018-2031 (billions USD).

Table 191. Market revenues for biobased paints and coatings, 2018-2031 (billions USD), conservative estimate.

Table 192. Market revenues for biobased paints and coatings, 2018-2031 (billions USD), high estimate.

Table 193. Oji Holdings CNF products. 1027

## List Of Figures

### LIST OF FIGURES

Figure 1. Total global production capacities for biobased and sustainable plastics, all types, 000 tons.

Figure 2. Global production capacities of bioplastics 2018-2030, in 1,000 tons by biodegradable/non-biodegradable types.

Figure 3. Global production capacities of biobased and sustainable plastics in 2019-2030, by type, in 1,000 tons.

Figure 4. Global production capacities of bioplastics in 2019-2025, by type.

Figure 5. Global production capacities of bioplastics in 2030, by type.

Figure 6. Global production capacities of biobased and sustainable plastics 2020.

Figure 7. Global production capacities of biobased and sustainable plastics 2025.

Figure 8. Current and future applications of biobased and sustainable plastics.

Figure 9. Global demand for biobased and sustainable plastics by end user market, 2020.

Figure 10. Global production capacities for biobased and sustainable plastics by end user market 2019-2030, tons.

Figure 11. Challenges for the biobased and sustainable plastics market.

Figure 12. Global plastics production 1950-2018, millions of tons.

Figure 13. Bio-based chemicals production capacities, 2018-2025.

Figure 14. 1,4-Butanediol (BDO) production capacities, 2018-2025 (tonnes).

Figure 15. Dodecanedioic acid (DDDA) production capacities, 2018-2025 (tonnes).

Figure 16. Epichlorohydrin production capacities, 2018-2025 (tonnes).

Figure 17. Ethylene production capacities, 2018-2025 (tonnes).

Figure 18. L-lactic acid (L-LA) production capacities, 2018-2025 (tonnes).

Figure 19. Lactide production capacities, 2018-2025 (tonnes).

Figure 20. Bio-MEG producers capacities.

Figure 21. Bio-MPG production capacities, 2018-2025.

Figure 22. Naphtha production capacities, 2018-2025 (tonnes).

Figure 23. 1,3-Propanediol (1,3-PDO) production capacities, 2018-2025 (tonnes).

Figure 24. Sebacic acid production capacities, 2018-2025 (tonnes).

Figure 25. Coca-Cola PlantBottle.

Figure 26. Interrelationship between conventional, bio-based and biodegradable plastics.

Figure 27. Bioplastics regional production capacities to 2030, 1,000 tons, 2019-2030.

Figure 28. Bio-based Polyethylene (Bio-PE), 1,000 tons, 2019-2030.

Figure 29. Bio-based Polyethylene terephthalate (Bio-PET) production capacities, 1,000

tons, 2019-2030

Figure 30. Bio-based polyamides (Bio-PA) production capacities, 1,000 tons, 2019-2030.

Figure 31. Bio-based Polypropylene (Bio-PP) production capacities, 1,000 tons, 2019-2030.

Figure 32. Bio-based Polytrimethylene terephthalate (Bio-PTT) production capacities, 1,000 tons, 2019-2030.

Figure 33. Bio-based Poly(butylene adipate-co-terephthalate) (PBAT) production capacities, 1,000 tons, 2019-2030.

Figure 34. Bio-based Polybutylene succinate (PBS) production capacities, 1,000 tons, 2019-2030.

Figure 35. Bio-based Polylactic acid (PLA) production capacities, 1,000 tons, 2019-2030.

Figure 36. PHA production capacities, 1,000 tons, 2019-2030.

Figure 37. Starch blends production capacities, 1,000 tons, 2019-2030.

Figure 38. Production capacities of Polyethylene furanoate (PEF) to 2025.

Figure 39. PHA family.

Figure 40. BLOOM masterbatch from Algix.

Figure 41. Typical structure of mycelium-based foam.

Figure 42. Commercial mycelium composite construction materials.

Figure 43. Global production capacities of biobased and sustainable plastics 2020.

Figure 44. Global production capacities of biobased and sustainable plastics 2025.

Figure 45. Global production capacities for biobased and sustainable plastics by end user market 2019, 1,000 tons.

Figure 46. Global production capacities for biobased and sustainable plastics by end user market 2020, 1,000 tons.

Figure 47. Global production capacities for biobased and sustainable plastics by end user market 2030

Figure 48. PHA bioplastics products.

Figure 49. Global production capacities for biobased and sustainable plastics in packaging 2019-2030, in 1,000 tons.

Figure 50. Global production capacities for biobased and sustainable plastics in consumer products 2019-2030, in 1,000 tons.

Figure 51. Global production capacities for biobased and sustainable plastics in automotive 2019-2030, in 1,000 tons.

Figure 52. Global production capacities for biobased and sustainable plastics in building and construction 2019-2030, in 1,000 tons.

Figure 53. Global production capacities for biobased and sustainable plastics in textiles 2019-2030, in 1,000 tons.

Figure 54. Global production capacities for biobased and sustainable plastics in electronics 2019-2030, in 1,000 tons.

Figure 55. Biodegradable mulch films.

Figure 56. Global production capacities for biobased and sustainable plastics in agriculture 2019-2030, in 1,000 tons.

Figure 57. Algiknit yarn.

Figure 58. Bio-PA rear bumper stay.

Figure 59. formicobio technology.

Figure 60. nanoforest-S.

Figure 61. nanoforest-PDP.

Figure 62. nanoforest-MB.

Figure 63. CuanSave film.

Figure 64. ELLEX products.

Figure 65. CNF-reinforced PP compounds.

Figure 66. Kirekira! toilet wipes.

Figure 67. Mushroom leather.

Figure 68. Cellulose Nanofiber (CNF) composite with polyethylene (PE).

Figure 69. PHA production process.

Figure 70. Cutlery samples (spoon, knife, fork) made of nano cellulose and biodegradable plastic composite materials.

Figure 71. Non-aqueous CNF dispersion 'Senaf' (Photo shows 5% of plasticizer).

Figure 72. CNF gel.

Figure 73. Block nanocellulose material.

Figure 74. CNF products developed by Hokuetsu.

Figure 75. Made of Air's HexChar panels.

Figure 76. IPA synthesis method.

Figure 77. MOGU-Wave panels.

Figure 78. Reishi.

Figure 79. Nippon Paper Industries' adult diapers.

Figure 80. Compostable water pod.

Figure 81. CNF clear sheets.

Figure 82. Oji Holdings CNF polycarbonate product.

Figure 83. Manufacturing process for STARCEL.

Figure 84. Lyocell process.

Figure 85. Spider silk production.

Figure 86. Sulapac cosmetics containers.

Figure 87. Sulzer equipment for PLA polymerization processing.

Figure 88. Teijin bioplastic film for door handles.

Figure 89. Corbion FDCA production process.



- Figure 90. Visolis' Hybrid Bio-Thermocatalytic Process.
- Figure 91. Types of natural fibers.
- Figure 92. Cotton production volume 2018-2030 (Million MT).
- Figure 93. Kapok production volume 2018-2030 (MT).
- Figure 94. Luffa cylindrica fiber.
- Figure 95. Jute production volume 2018-2030 (Million MT).
- Figure 96. Hemp fiber production volume 2018-2030 (Million MT).
- Figure 97. Flax fiber production volume 2018-2030 (MT).
- Figure 98. Ramie fiber production volume 2018-2030 (MT).
- Figure 99. Kenaf fiber production volume 2018-2030 (MT).
- Figure 100. Sisal fiber production volume 2018-2030 (MT).
- Figure 101. Abaca fiber production volume 2018-2030 (MT).
- Figure 102. Coir fiber production volume 2018-2030 (MILLION MT).
- Figure 103. Banana fiber production volume 2018-2030 (MT).
- Figure 104. Pineapple fiber.
- Figure 105. Bamboo fiber production volume 2018-2030 (MILLION MT).
- Figure 106. Typical structure of mycelium-based foam.
- Figure 107. Commercial mycelium composite construction materials.
- Figure 108. BLOOM masterbatch from Algix.
- Figure 109. Hemp fibers combined with PP in car door panel.
- Figure 110. Car door produced from Hemp fiber.
- Figure 111. Mercedes-Benz components containing natural fibers.
- Figure 112. Algikicks sneaker, made with the Algiknit biopolymer gel.
- Figure 113. Coir mats for erosion control.
- Figure 114. Global fiber production in 2019, by fiber type, million MT and %.
- Figure 115. Global fiber production (million MT) to 2020-2030.
- Figure 116. Plant-based fiber production 2018-2030, by fiber type, MT.
- Figure 117. Animal based fiber production 2018-2030, by fiber type, million MT.
- Figure 118. Pluumo.
- Figure 119. Algiknit yarn.
- Figure 120. Amadou leather shoes.
- Figure 121. Anpoly cellulose nanofiber hydrogel.
- Figure 122. MEDICELLU.
- Figure 123. Asahi Kasei CNF fabric sheet.
- Figure 124. Properties of Asahi Kasei cellulose nanofiber nonwoven fabric.
- Figure 125. CNF nonwoven fabric.
- Figure 126. Roof frame made of natural fiber.
- Figure 127. Beyond Leather Materials product.
- Figure 128. Natural fibres racing seat.

- Figure 129. Cellugy materials.
- Figure 130. nanoforest-S.
- Figure 131. nanoforest-PDP.
- Figure 132. nanoforest-MB.
- Figure 133. Celish.
- Figure 134. Trunk lid incorporating CNF.
- Figure 135. ELLEX products.
- Figure 136. CNF-reinforced PP compounds.
- Figure 137. Kirekira! toilet wipes.
- Figure 138. Color CNF.
- Figure 139. Rheocrysta spray.
- Figure 140. DKS CNF products.
- Figure 141. Mushroom leather.
- Figure 142. CNF based on citrus peel.
- Figure 143. Citrus cellulose nanofiber.
- Figure 144. Filler Bank CNC products.
- Figure 145. Fibers on kapok tree and after processing.
- Figure 146. Cellulose Nanofiber (CNF) composite with polyethylene (PE).
- Figure 147. CNF products from Furukawa Electric.
- Figure 148. Cutlery samples (spoon, knife, fork) made of nano cellulose and biodegradable plastic composite materials.
- Figure 149. Non-aqueous CNF dispersion 'Senaf' (Photo shows 5% of plasticizer).
- Figure 150. CNF gel.
- Figure 151. Block nanocellulose material.
- Figure 152. CNF products developed by Hokuetsu.
- Figure 153. Marine leather products.
- Figure 154. Dual Graft System.
- Figure 155. Engine cover utilizing Kao CNF composite resins.
- Figure 156. Acrylic resin blended with modified CNF (fluid) and its molded product (transparent film), and image obtained with AFM (CNF 10wt% blended).
- Figure 157. Kami Shoji CNF products.
- Figure 158. 0.3% aqueous dispersion of sulfated esterified CNF and dried transparent film (front side).
- Figure 159. BioFlex process.
- Figure 160. Chitin nanofiber product.
- Figure 161. Marusumi Paper cellulose nanofiber products.
- Figure 162. FibriMa cellulose nanofiber powder.
- Figure 163. Cellulomix production process.
- Figure 164. Nanobase versus conventional products.



- Figure 165. MOGU-Wave panels.
- Figure 166. CNF slurries.
- Figure 167. Range of CNF products.
- Figure 168. Reishi.
- Figure 169. Nippon Paper Industries' adult diapers.
- Figure 170. Leather made from leaves.
- Figure 171. Nike shoe with beLEAF.
- Figure 172. CNF clear sheets.
- Figure 173. Oji Holdings CNF polycarbonate product.
- Figure 174. XCNF.
- Figure 175. CNF insulation flat plates.
- Figure 176. Manufacturing process for STARCEL.
- Figure 177. Lyocell process.
- Figure 178. North Face Spiber Moon Parka.
- Figure 179. Spider silk production.
- Figure 180. 2 wt.% CNF suspension.
- Figure 181. BiNFi-s Dry Powder.
- Figure 182. BiNFi-s Dry Powder and Propylene (PP) Complex Pellet.
- Figure 183. Silk nanofiber (right) and cocoon of raw material.
- Figure 184. Sulapac cosmetics containers.
- Figure 185. Comparison of weight reduction effect using CNF.
- Figure 186. CNF resin products.
- Figure 187. Vegea production process.
- Figure 188. HefCel-coated wood (left) and untreated wood (right) after 30 seconds flame test.
- Figure 189. Bio-based barrier bags prepared from Tempo-CNF coated bio-HDPE film.
- Figure 190. Worn Again products.
- Figure 191. Zelfo Technology GmbH CNF production process.
- Figure 192. High purity lignin.
- Figure 193. Lignocellulose architecture.
- Figure 194. Extraction processes to separate lignin from lignocellulosic biomass and corresponding technical lignins.
- Figure 195. The lignocellulose biorefinery.
- Figure 196. LignoBoost process.
- Figure 197. LignoForce system for lignin recovery from black liquor.
- Figure 198. Sequential liquid-lignin recovery and purification (SLPR) system.
- Figure 199. A-Recovery+ chemical recovery concept.
- Figure 200. Schematic of a biorefinery for production of carriers and chemicals.
- Figure 201. Organosolv lignin.

- Figure 202. Hydrolytic lignin powder.
- Figure 203. Estimated consumption of lignin, 2019-2031 (000 MT).
- Figure 204. Schematic of WISA plywood home.
- Figure 205. Lignin based activated carbon.
- Figure 206. Lignin/cellulose precursor.
- Figure 207. ANDRITZ Lignin Recovery process.
- Figure 208. DAWN Technology Process.
- Figure 209. BALI technology.
- Figure 210. Pressurized Hot Water Extraction.
- Figure 211. sunliquid production process.
- Figure 212. Domsj? process.
- Figure 213. TMP-Bio Process.
- Figure 214. Flow chart of the lignocellulose biorefinery pilot plant in Leuna.
- Figure 215. AVAPTM process.
- Figure 216. GreenPower+ process.
- Figure 217. BioFlex process.
- Figure 218. LX Process.
- Figure 219. METNIN Lignin refining technology.
- Figure 220. Enfinity cellulosic ethanol technology process.
- Figure 221: Plantrose process.
- Figure 222. Hansa lignin.
- Figure 223. UPM biorefinery process.
- Figure 224. The Proesa Process.
- Figure 225. Goldilocks process and applications.
- Figure 226. Schematic of a biorefinery for production of carriers and chemicals.
- Figure 227. Hydrolytic lignin powder.
- Figure 228. Liquid biofuel production and consumption (in thousands of m3), 2000-2021.
- Figure 229. Distribution of global liquid biofuel production in 2021.
- Figure 230. Ethanol consumption 2010-2027 (million litres).
- Figure 231. Global bio-jet fuel consumption 2010-2027 (M litres/year).
- Figure 232. Global biodiesel consumption, 2010-2027 (M litres/year).
- Figure 233. Global renewable diesel consumption, 2010-2027 (M litres/year).
- Figure 234. Total syngas market by product in MM Nm<sup>3</sup>/h of Syngas, 2021.
- Figure 235. Biogas and biomethane pathways.
- Figure 236. Properties of petrol and biobutanol.
- Figure 237. Biobutanol production route.
- Figure 238. Process steps in the production of electrofuels.
- Figure 239. Mapping storage technologies according to performance characteristics.

- Figure 240. Production process for green hydrogen.
- Figure 241. E-liquids production routes.
- Figure 242. Fischer-Tropsch liquid e-fuel products.
- Figure 243. Resources required for liquid e-fuel production.
- Figure 244. Schematic of Climeworks DAC system.
- Figure 245. Levelized cost and fuel-switching CO<sub>2</sub> prices of e-fuels.
- Figure 246. Cost breakdown for e-fuels.
- Figure 247. Classification and process technology according to carbon emission in ammonia production.
- Figure 248. Green ammonia production and use.
- Figure 249. Schematic of the Haber Bosch ammonia synthesis reaction.
- Figure 250. Schematic of hydrogen production via steam methane reformation.
- Figure 251. Estimated production cost of green ammonia.
- Figure 252. Projected annual ammonia production, million tons.
- Figure 253. ANDRITZ Lignin Recovery process.
- Figure 254. FBPO process
- Figure 255. Direct Air Capture Process.
- Figure 256. CRI process.
- Figure 257. Domsj? process.
- Figure 258. FuelPositive system.
- Figure 259. Infinitree swing method.
- Figure 260. Enfinity cellulosic ethanol technology process.
- Figure 261: Plantrose process.
- Figure 262. The Velocys process.
- Figure 263. Goldilocks process and applications.
- Figure 264. Paints and coatings industry by market segmentation 2019-2020.
- Figure 265. PHA family.
- Figure 266: Schematic diagram of partial molecular structure of cellulose chain with numbering for carbon atoms and n= number of cellobiose repeating unit.
- Figure 267: Scale of cellulose materials.
- Figure 268. Nanocellulose preparation methods and resulting materials.
- Figure 269: Relationship between different kinds of nanocelluloses.
- Figure 270. Hefcel-coated wood (left) and untreated wood (right) after 30 seconds flame test.
- Figure 271: CNC slurry.
- Figure 272. High purity lignin.
- Figure 273. BLOOM masterbatch from Algix.
- Figure 274. Global market revenues for biobased paints and coatings, 2018-2031 (billions USD).

Figure 275. Market revenues for biobased paints and coatings, 2018-2031 (billions USD), conservative estimate.

Figure 276. Market revenues for biobased paints and coatings, 2018-2031 (billions USD), high

Figure 277. Dulux Better Living Air Clean Biobased.

Figure 278: NCCTM Process.

Figure 279: CNC produced at Tech Futures' pilot plant; cloudy suspension (1 wt.%), gel-like (10 wt.%), flake-like crystals, and very fine powder. Product advantages include:

Figure 280. Cellugy materials.

Figure 281. EcoLine 3690 (left) vs Solvent-Based Competitor Coating (right).

Figure 282. Rheocrysta spray.

Figure 283. DKS CNF products.

Figure 284. Domsj? process.

Figure 285. CNF gel.

Figure 286. Block nanocellulose material.

Figure 287. CNF products developed by Hokuetsu.

Figure 288. BioFlex process. 1009

Figure 289. Marusumi Paper cellulose nanofiber products. 1012

Figure 290: Fluorene cellulose powder. 1031

Figure 291. XCNF. 1036

Figure 292. Spider silk production. 1045

Figure 293. CNF dispersion and powder from Starlite. 1047

Figure 294. 2 wt.? CNF suspension. 1051

Figure 295. BiNFi-s Dry Powder. 1051

Figure 296. BiNFi-s Dry Powder and Propylene (PP) Complex Pellet. 1052

Figure 297. Silk nanofiber (right) and cocoon of raw material. 1052

Figure 298. HefCel-coated wood (left) and untreated wood (right) after 30 seconds flame test. 1057

Figure 299. Bio-based barrier bags prepared from Tempo-CNF coated bio-HDPE film. 1058

Figure 300. Bioalkyd products. 1062

## I would like to order

Product name: The Global Market for Biobased & Biodegradable Chemicals, Materials, Polymers, Plastics, Paints, Coatings and Fuels 2022

Product link: <https://marketpublishers.com/r/G49C016F75D0EN.html>

Price: US\$ 1,900.00 (Single User License / Electronic Delivery)

If you want to order Corporate License or Hard Copy, please, contact our Customer Service:

[info@marketpublishers.com](mailto:info@marketpublishers.com)

## Payment

To pay by Credit Card (Visa, MasterCard, American Express, PayPal), please, click button on product page <https://marketpublishers.com/r/G49C016F75D0EN.html>

To pay by Wire Transfer, please, fill in your contact details in the form below:

First name:  
Last name:  
Email:  
Company:  
Address:  
City:  
Zip code:  
Country:  
Tel:  
Fax:  
Your message:

**\*\*All fields are required**

Customer signature \_\_\_\_\_

Please, note that by ordering from marketpublishers.com you are agreeing to our Terms & Conditions at <https://marketpublishers.com/docs/terms.html>

To place an order via fax simply print this form, fill in the information below and fax the completed form to +44 20 7900 3970

