

Circular Bioresources Economy: An Opportunity for California

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Bioeconomy on the Global Stage: 2009

The Bioeconomy to 2030

DESIGNING A POLICY AGENDA

Main Findings and
Policy Conclusions

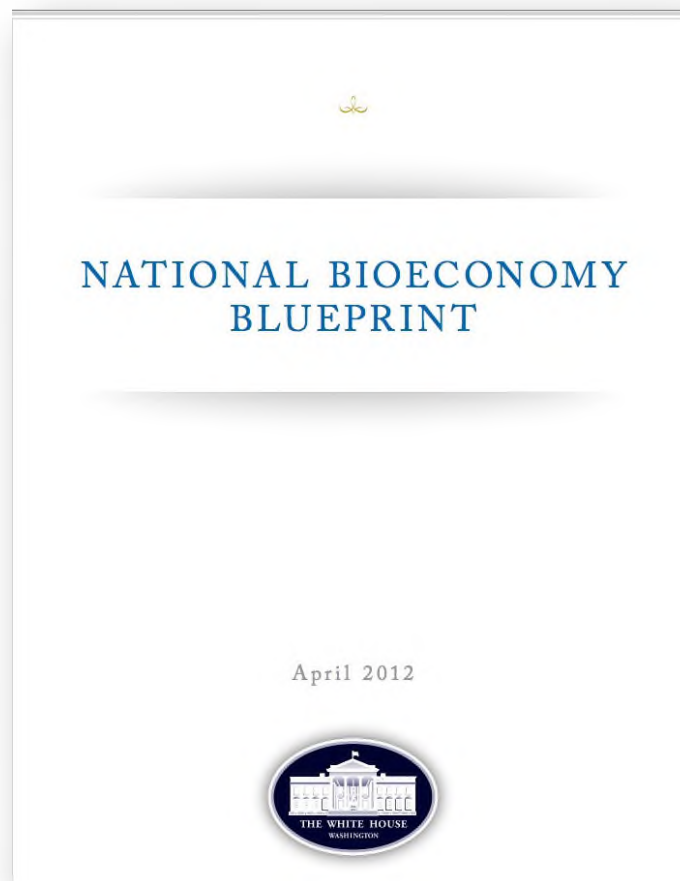
Bioeconomy:

A set of economic activities in which biotechnology contributes centrally to primary production and industry, especially where the advanced life sciences are applied to the conversion of biomass into materials, chemicals and fuels

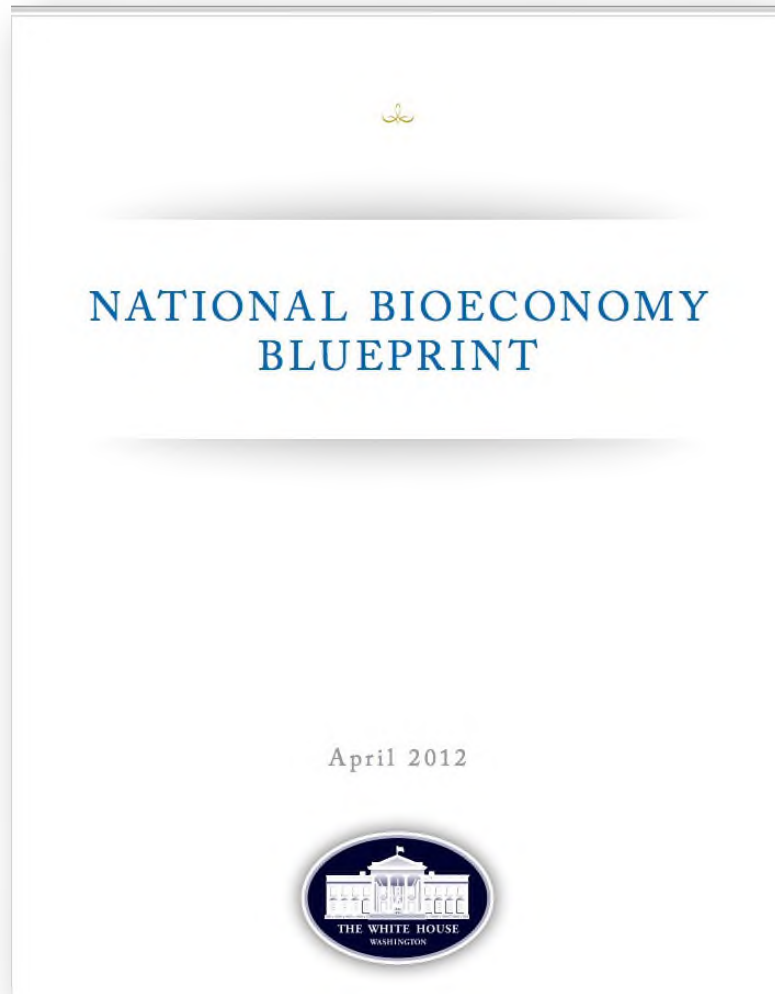


Bioeconomy on the National Stage: 2012

“Economic activities relating to the invention, development, production and use of biological products and processes.”



5 Objectives for Federal Agencies



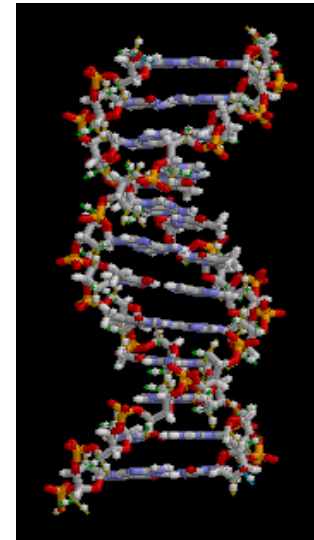
- ❖ Strategic, coordinated research investments
 - ❖ technologies
 - ❖ multidisciplinary
 - ❖ new funding mechanisms
- ❖ Lab to market focus
 - ❖ University entrepreneurship
 - ❖ Federal procurement
- ❖ Regulatory streamlining
 - ❖ Early stakeholder engagement
- ❖ Workforce
 - ❖ New multidisciplinary skills
- ❖ Public Private Partnerships
 - ❖ Precompetitive research focus

Pillars of the US Bioeconomy

BIOMASS

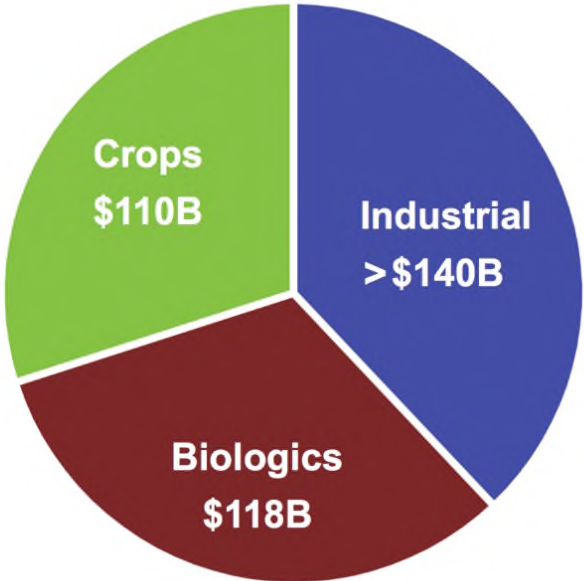


BIOTECHNOLOGY

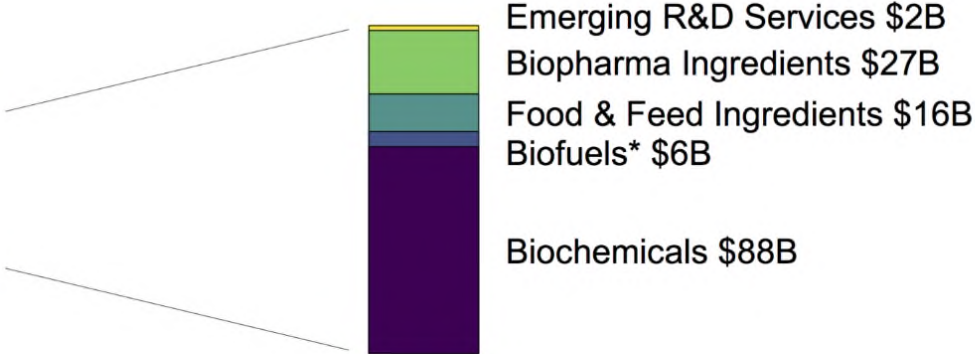


US Bioeconomy = \$370+ Billion

**Estimated 2016 U.S. Biotechnology Revenues:
At Least \$370 Billion, >2% Of GDP**
(Sources: Bioeconomy Capital, Agilent)



B2B Industrial Revenues



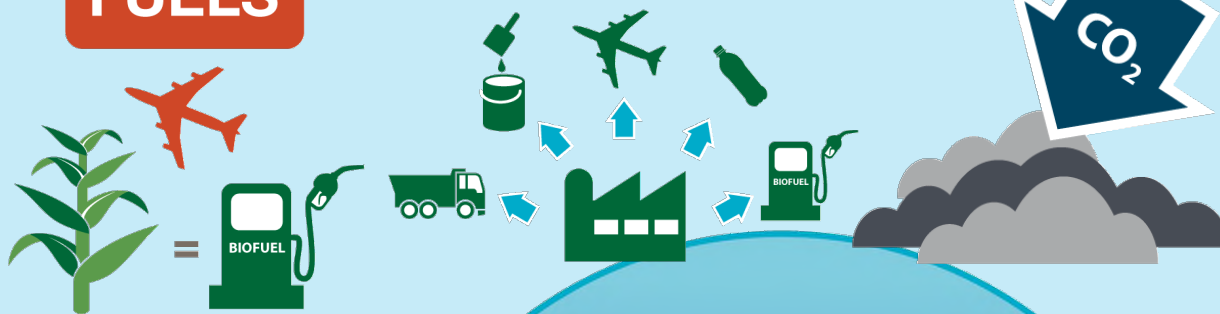
A billion dry tons of sustainable biomass has the potential to produce ...

50 billion gallons of biofuel
25% of transportation
FUELS

50 billion **POUNDS** of biobased chemicals and bioproducts

CO₂e reductions of 450 million **TONS**

1.1 million **DIRECT JOBS** and keeps \$250 billion in the U.S.

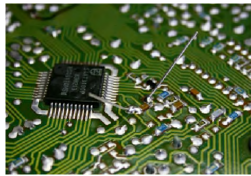


Projections based on:
Rogers, J.N., Stokes, B., Dunn, J., Cai, H., Haq, Z., and Baumes, H. (2016), An Assessment of the Potential Products and Economic and Environmental Impacts Resulting from a Billion Ton Bioeconomy. *Biofuels, BioProd. Bioref.*
Doi:10.1002/bbb.1728

DNA IS A PROGRAMMING LANGUAGE

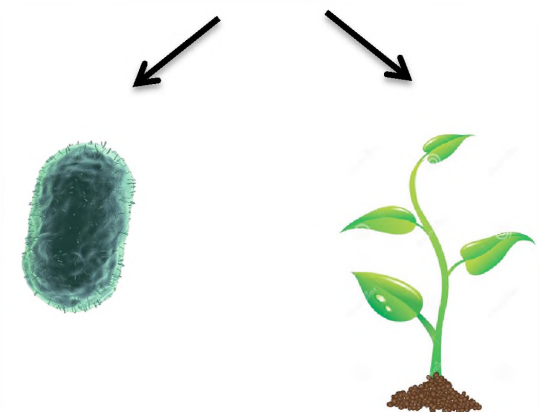
Computer Programming

011100010101



Biological Programming

CATTGACCTAGCA



CODE

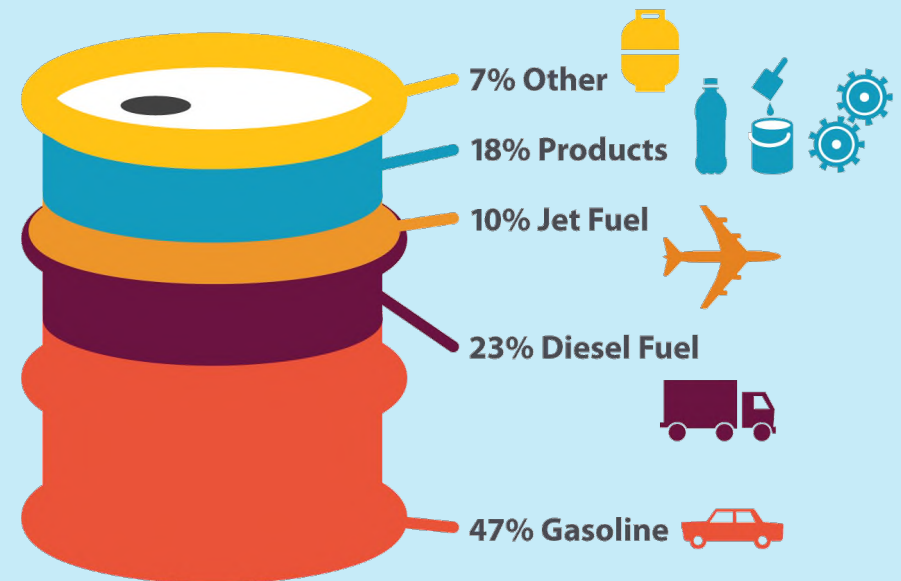
UNIT OF UTILITY

PRODUCTS

Petroleum Is the Primary Source for Transportation Fuels and Chemicals

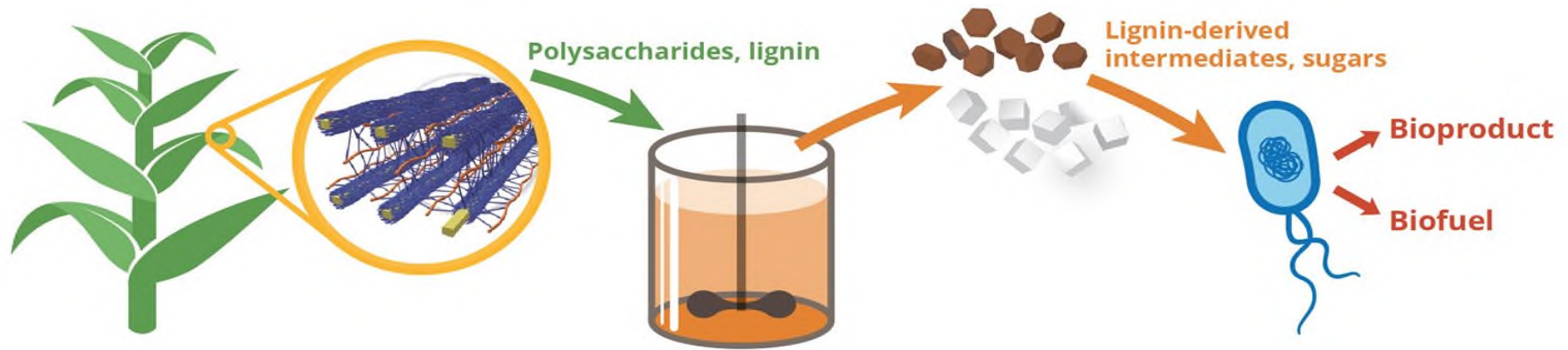


Petroleum products made from a barrel of crude oil



Source: U.S. Department of Energy

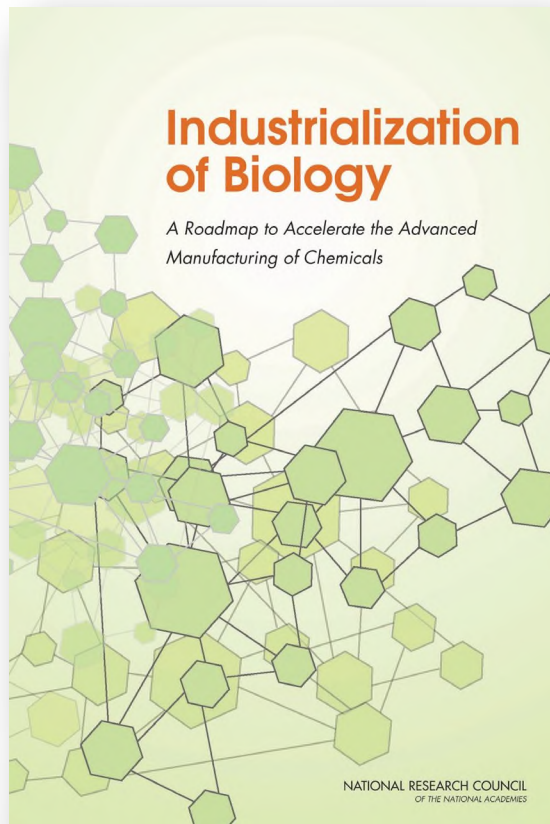
Engineering Biology Drives the US Bioeconomy



JBEI

Joint BioEnergy Institute

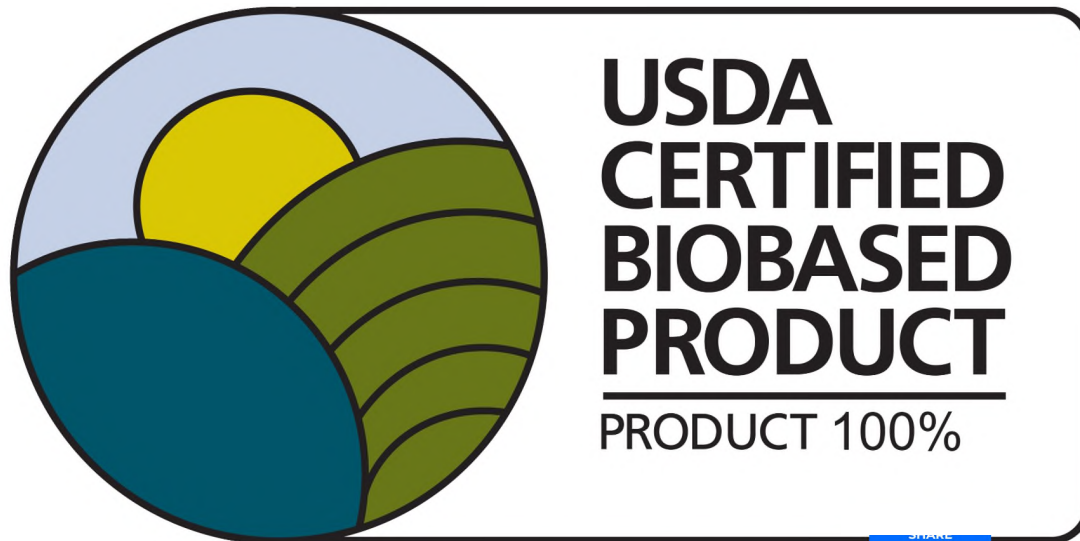
US National Academy of Sciences Industrialization of Biology, 2015



- **Biomanufacturing can transform the US manufacturing landscape**
- **Establish an on-going road-mapping mechanism to provide direction to technology development, translation and commercialization at scale**

Biobased product procurement: a policy pull

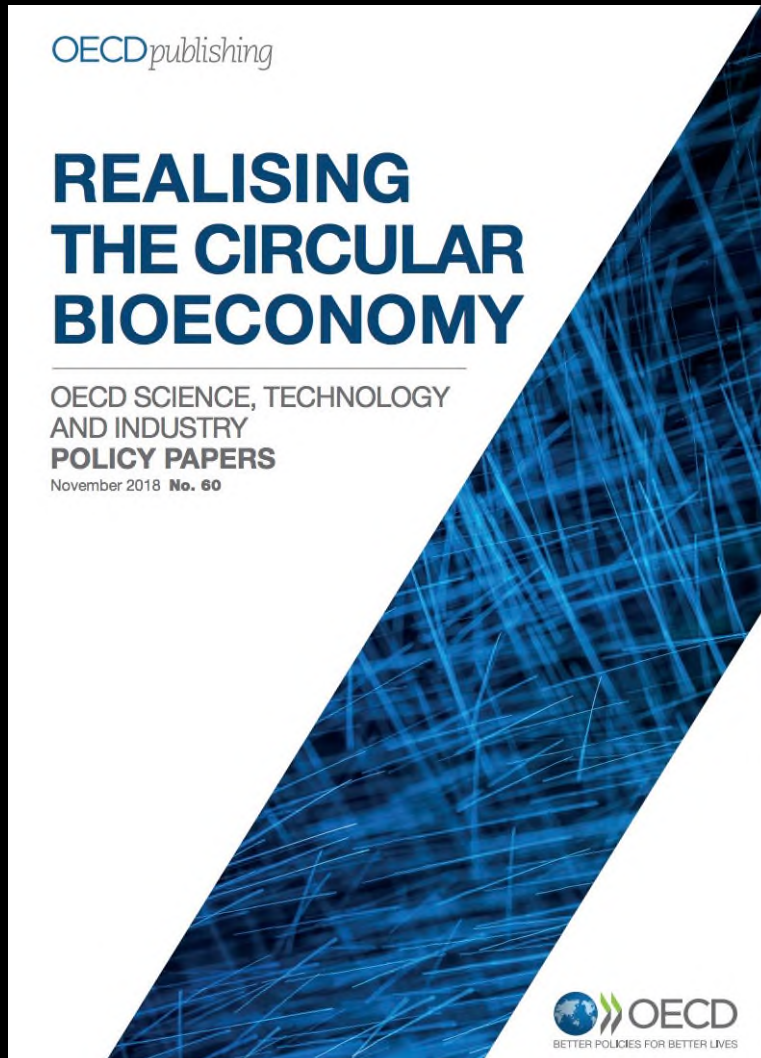
USDA BioPreferred: Federal procurement of certified biobased products provides certainty for new markets



Two components:

- Certified products
- Federal procurement man

TEN YEARS LATER: WASTE DRIVES BIOECONOMIES



- Driven by UN Sustainable Development Goals
- Natural resources are being depleted by traditional manufacturing
- Circular economy : materials are kept within use for as long as possible through recycling and remanufacturing
- Biobased manufacturing = using residues and waste materials as feedstocks

WASTE POLICIES: EU Resource efficiency examples



Industrial-scale composting of wine dregs in Italy

Cheese/whey waste in Ireland for polylactic acid for bioplastic

Bread waste in Netherlands for succinic acid, a precursor for many chemicals

Whiskey waste in Scotland for butanol, an advanced biofuel

Waste gas fermentation in Belgium for ethanol, a fuel additive

California Bioeconomy: Biomass data

2017 data from the Billion Ton report



- Less than 10 dt/SqMile
- 10-100 dt/SqMile
- 100-500 dt/SqMile
- 500-1,000 dt/SqMile
- Greater than 1,000 dt/SqMile

Only 15% of available biomass is used!

Circular Bioeconomy Can Be California's Next Gold Rush



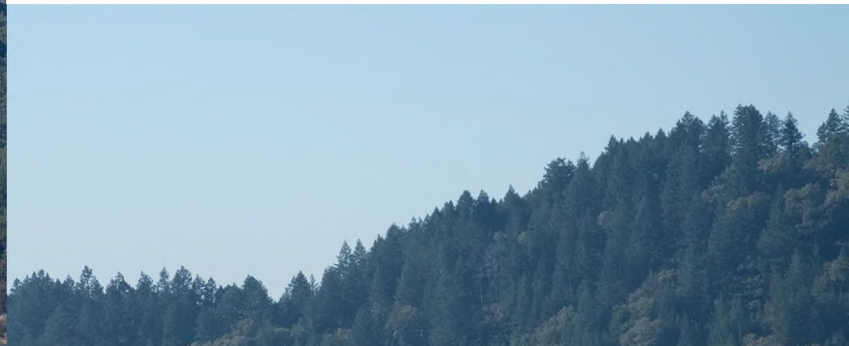
Diverse waste “gold”:

“F.O.G.” : fats, oils, greases

Animal waste from livestock

Specialty crop waste

Forest waste



Challenges and Levers for A California Circular Bioeconomy Strategy

CHALLENGES:

- Harnessing biomass to produce high-value products with consistent quality
- Biomass is not easily transported
- State's largest waste streams may be different from those supported at national level

STRENGTHS:

- California's innovation ecosystem
- Scientific research primacy, public and private
- World leadership in biotechnology
- Huge quantities of bioresources
- Procurement power, policy leadership can overcome the challenge



Thank You

