Forest Products & Agricultural Waste as Sustainable Feedstocks

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SUSTAINABLE BIOPLASTICS COUNCIL *of* MAINE

From Plants to Products: Seizing Maine's Market Share in the Bio-Based Economy

Aroostook Starch Co., LLC

Local Companies are Early Adopters

TRUE TEXTILES (Guilford, Maine)
First company to market dyed woven fabric made of bioplastic polylactic acid (PLA)

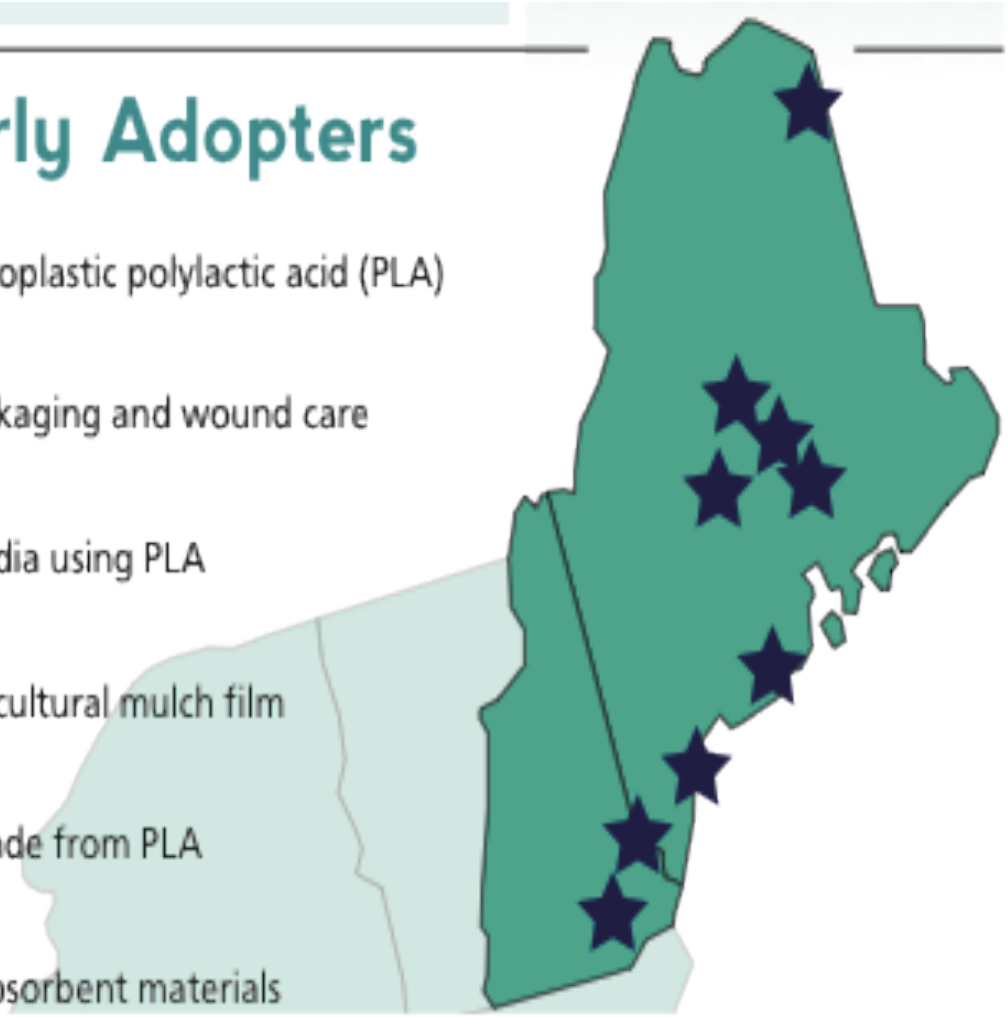
BIOVATION (Boothbay, Maine)
Uses non-woven PLA fibers for anti-microbial food packaging and wound care

GROW-TECH (South Portland, Maine)
Has developed a biodegradable stabilized growing media using PLA

CEREALUS (Waterville, Maine)
Developed zein-based stain resistant coatings and agricultural mulch film

STONYFIELD FARM (Londonderry, New Hampshire)
Its multipack containers for organic yogurt are now made from PLA

ITACONIX (Dover, New Hampshire)
Making a new biopolymer for dispersants and super-absorbent materials



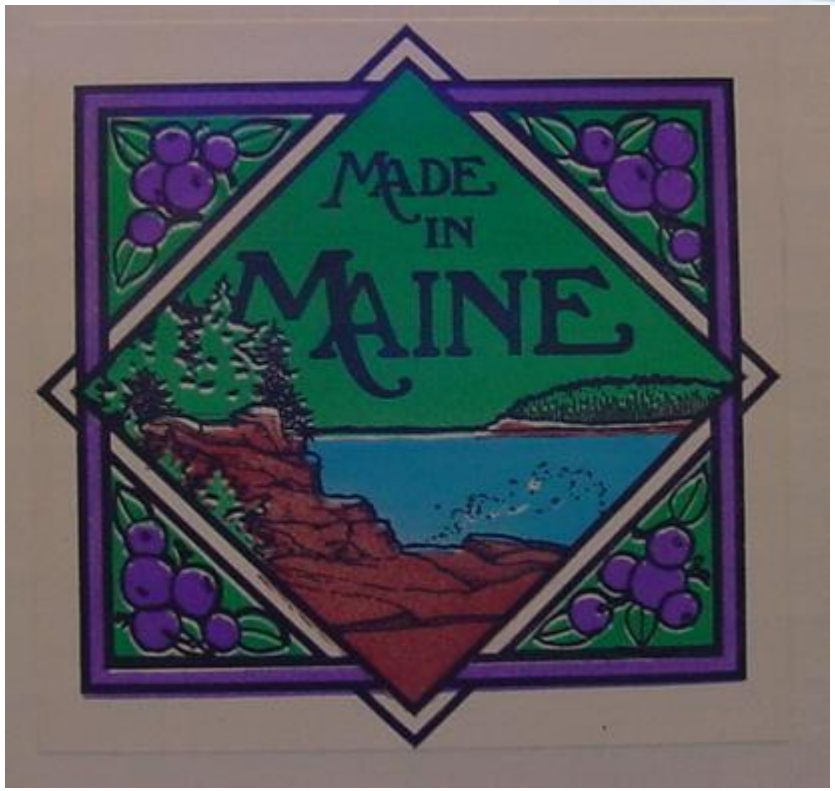
Safer Plastics From Potatoes Could Reduce Unnecessary Dangerous Chemicals In Maine

Why Invest in Maine's Bio-Based Economy?

The **MAINE TECHNOLOGY INSTITUTE** supports the emerging bioproducts industry. Maine offers many assets to attract biomaterials production:

- ✓ Certified sustainable forest products are a better feedstock than corn; they're not a genetically modified food crop, and emit less carbon and toxic chemicals across their lifecycle
- ✓ Agricultural waste and fallow fields - Aroostook County still produces more potatoes than any other county in the United States
- ✓ Idle industrial infrastructure that includes steam, power and permits, located close to feedstock sources
- ✓ Outstanding research and development expertise and technical capacity at the University of Maine and its Bioproducts Technology Center
- ✓ A dedicated workforce and community college system
- ✓ The 'Made in Maine' brand has demonstrated value in the marketplace


get real.
get maine!


MADE
IN
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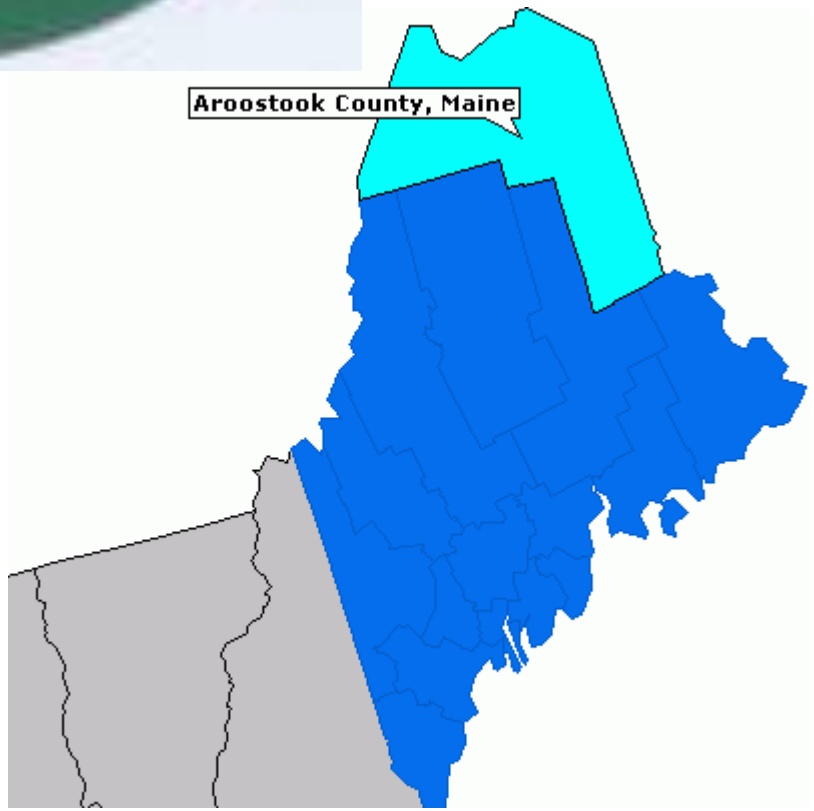

Aroostook County, Maine

The Evolving Biobased Plastics Landscape

Feedstocks

Agricultural building blocks

Polysaccharides

- Starch/Sugars
- **Lignocellulosics**
  - -wood
  - -straws, stover etc.
- **Others**
  - Pectins
  - Chitosan
  - Gums

Fats/proteins

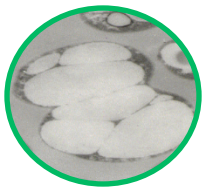
- **Animals**
  - Oils
  - Casein
  - Whey
  - Gelatin
- **Vegetable**
  - -oils
  - Zein
  - **soybean protein**
  - Gluten

Polymers

Direct Fermentation

Polyhydroxy alkanoates PHA's

PHB **PHBV**



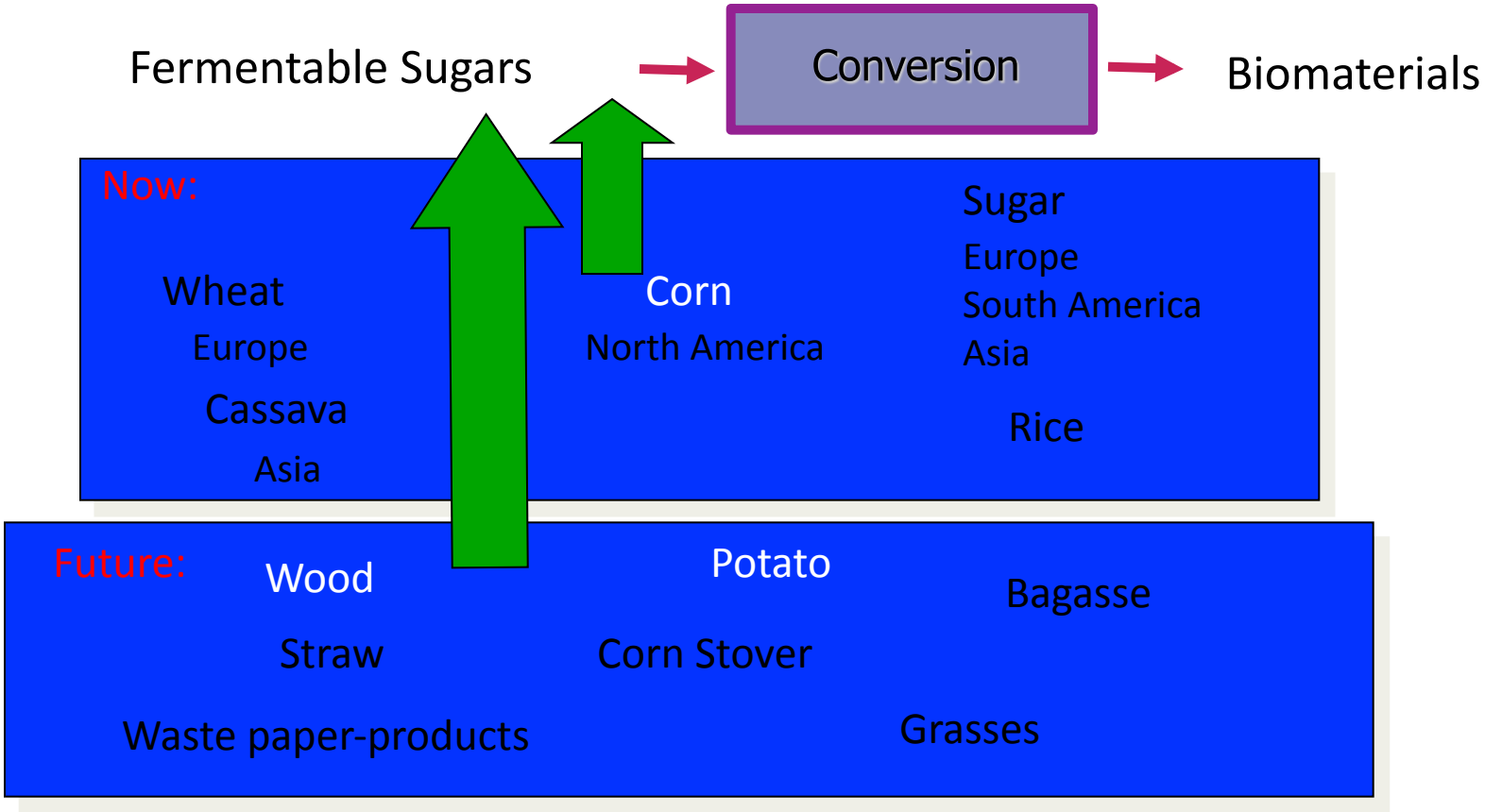
Bio-technological Origin

PLA
Nylon 11
Polyethylene
Polypropylene
Polyisoprene
Aliphatic Polycarbonate

Petroleum/ Natural based

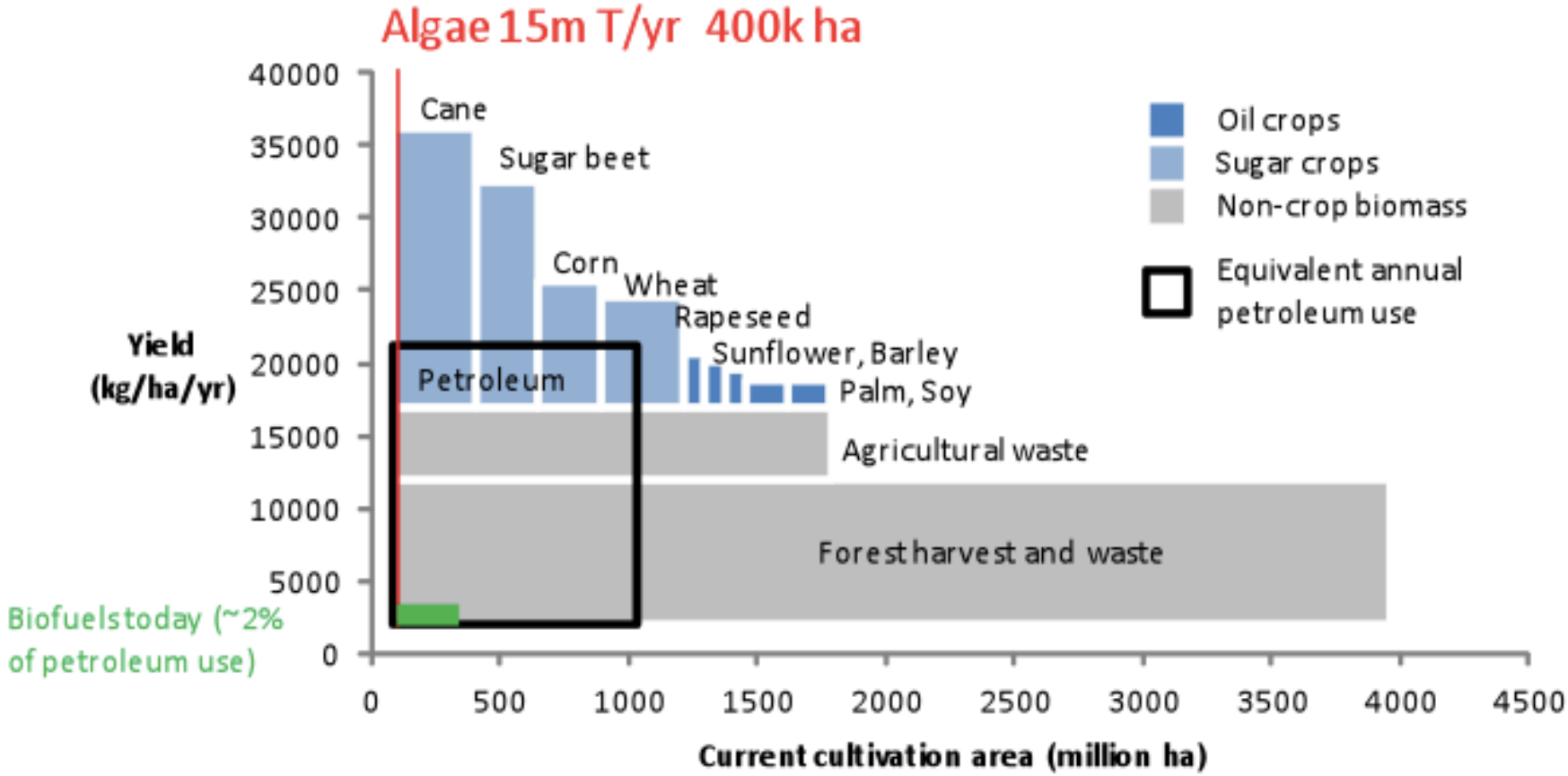
Starch blends
Nylon 6,10
Nylon 6,12
PTT
PBS
Polyurethanes

Current and Future Feedstocks



DRIVERS: 1. Local Supply 2. Improve Life Cycle Impact
3. Avoid competition with food 4. More efficient use of land
5. Additional revenues for farmers, foresters, others
6.Biofuels Industry

Bio-based products use just a small amount of available biomass today, but if they expand, feedstock will become a local and global constraint



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OLD TOWN FUEL & FIBER

Pulp and paper mills are key partners to develop a bio-based industry

- Pulp and paper companies have significant experience processing wood, separating the components of wood, and making products from wood

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy — Biomass Program

Red Shield Acquisition

RSA will construct an Integrated Biorefinery that will extract hemicelluloses from wood chips to make biofuel and other specialty chemicals at an existing pulp mill. The cellulose and lignin will be maintained in the pulp manufacturing process.

RSA in collaboration with the University of Maine will develop, demonstrate and commercialize a process to extract hemicelluloses from wood chips to make biofuel and specialty chemicals. When operating, the facility will produce 1.5 million gallons per year of butanol and create 16 new 'green collar' jobs and 80

Demonstration of an Integrated Biorefinery at Old Town Maine

Potential Impacts

As technology is proven at the IBR and economies of scale are achieved, It will provide a significant technical advantage over competing technologies since it can be integrated

Other Participants

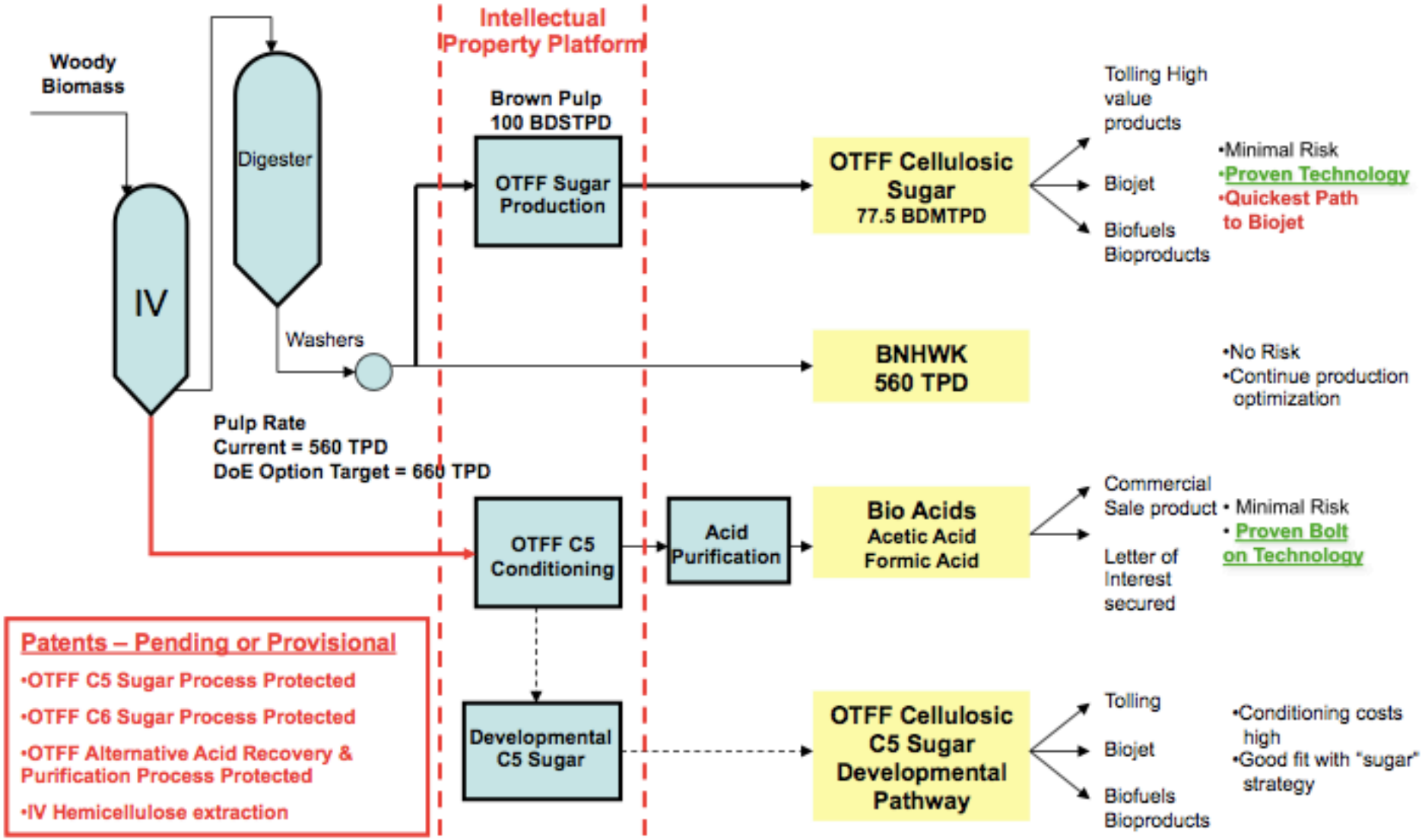
RSA has collaborative agreements with University of Maine, Integrated Process Technologies, and Waldron Engineering.

1.5 MGY butanol

2.2 MGY acetic acid

Feedstock = woody biomass

OTFF Biofuels and Bioproducts



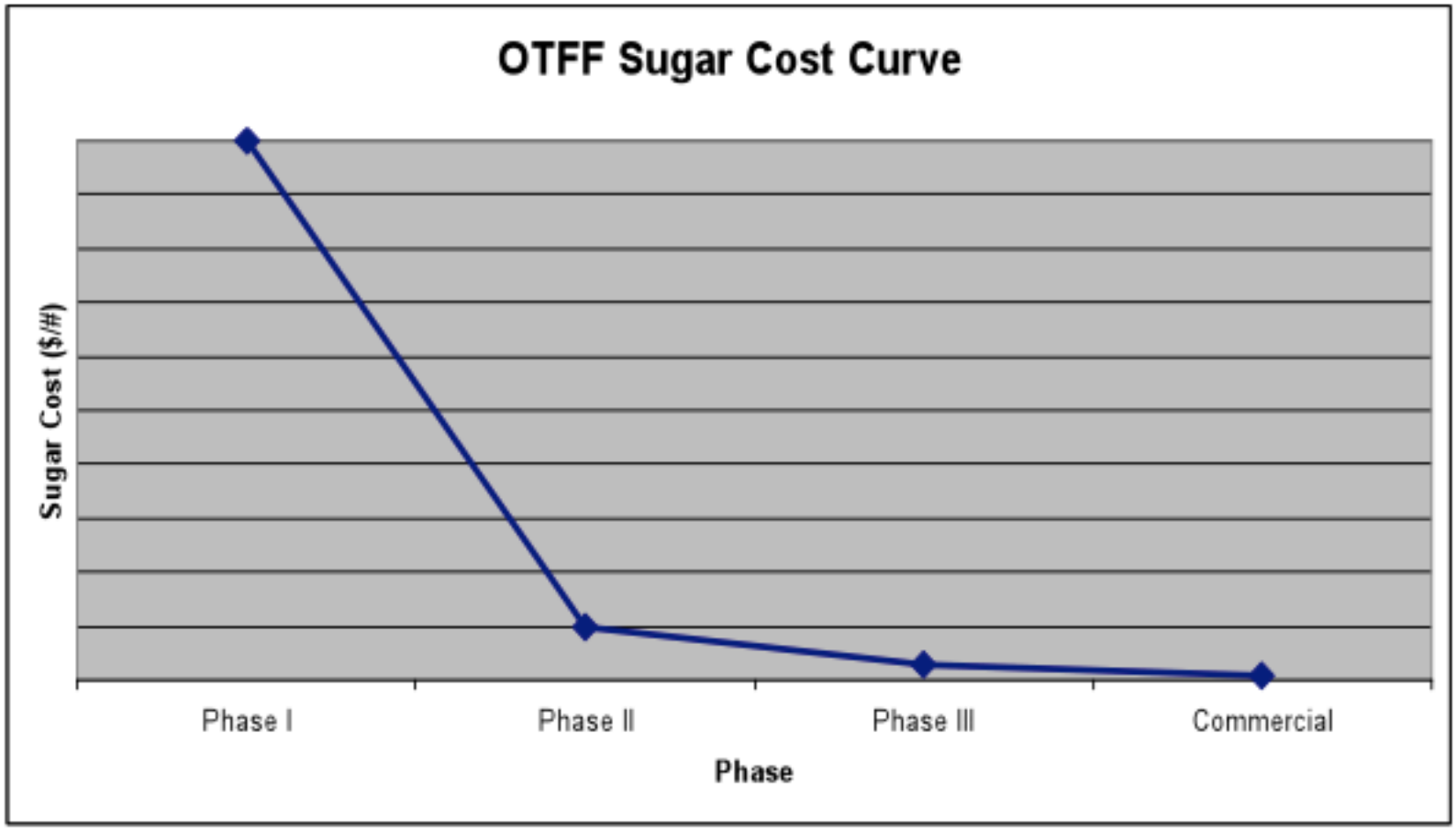
Phased Approach For Sugar Production

- **Phase I - 18 Metric Tons over 6 months**
  - Began February 2012
  - Capex < $1 MM
  - Capability exists now
- **Phase II - 50 Metric tons/month**
  - Beginning September 2012
  - Some new equipment required
  - Plan to operate at this level 6 to 9 months
- **Phase III – 77.5 Metric Tons/day (DOE)**
  - Significant synergistic equipment savings for feedstock preparation, hydrolysis and filtration
  - Plan to have operational in 12 to 16 months

Phase IV ~ Commercialization

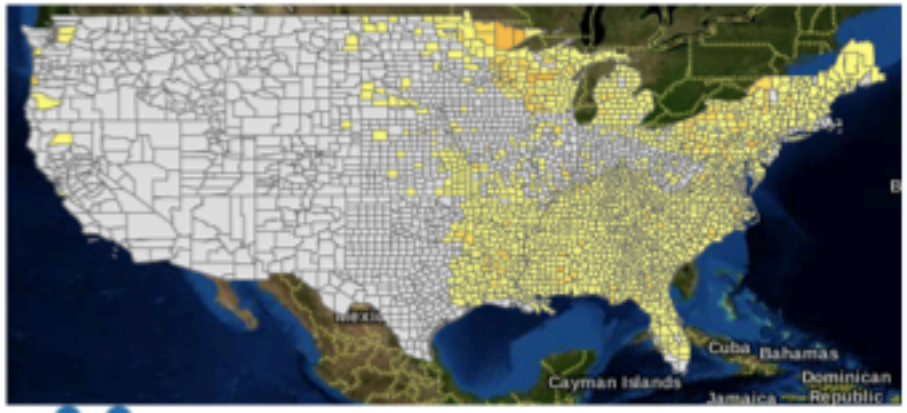
- **Deployment of Technology is Strategic**
  - **Commercialization of Sugar production at ~1000 TPD feedstock**
  - **Scalability factor of 10 from Phase III to Phase IV**
  - **Easily configurable to existing pulp mills ~ truly "bolt-on" technology**
  - **Independent of the type of pulp/paper process (not just Hardwood Kraft pulping)**
  - **Lower relative capex with minimal risks when compared to other cellulosic sugar technology**

OTFF Sugar Cost Curve



Wood products present a viable feedstock for Maine bio-based materials

Source: http://www.arcgis.com/home/webmap/viewer.html?webmap=f00788f6bf6fbd4d129edc7fb38500514e



Source: DOE Billion Ton Study

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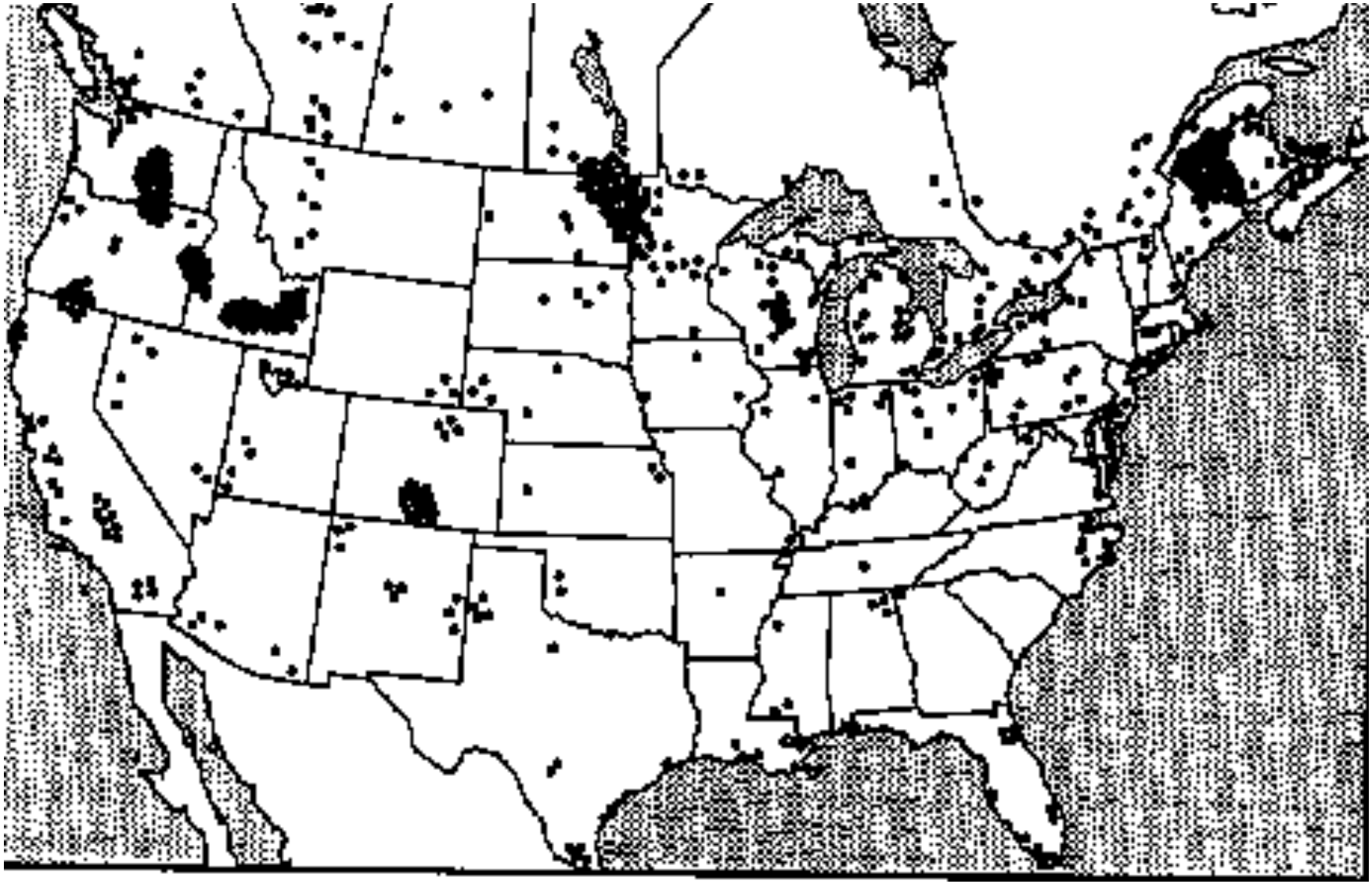
- Many emerging technology developers are converting wood into valuable products
- Whether through gasification, pyrolysis, or pretreatment/ fermentation
- Though forestry residues represent a solid opportunity, chances to exploit resources post-collection will be the most economical

Potato Harvesting Regions



The Sustainable Life Cycle of Bio-Based Products

FEEDSTOCKS

Sustainably harvested wood chips and potato waste can replace the fossil carbon in oil with renewable carbon from locally-sourced biomass.

SUGARS

OLD TOWN FUEL & FIBER converts wood chips into sugars, the chemical building blocks of nature.

AROOSTOOK STARCH recovers starch from potato waste, another good potential source for sugars.

BIO-BASED MATERIALS

Production of bio-based plastics, chemicals and fuels means new jobs near feedstock processing sites.

BIOFINE TECHNOLOGY, for example, can convert cellulose in wood to levulinic and formic acids.

CONSUMER PRODUCTS

Maine production of sugars and bio-based chemicals will help meet rapidly growing consumer demand for safer, more sustainable products. Several Maine companies already sell innovative new products made from corn-based bioplastics.

END-OF-LIFE

When the useful life of a bioplastic product is over, it should either be composted back into soil nutriments, if biodegradable, or recycled to make a new product.

Sustainable Materials Ideal

- Equivalent function (or better)
- Competitive cost (lower cost)
- Minimum environmental footprint
  - Small enough so the ecosystem can still balance
- Renewable resource
- Completely recyclable
  - Carbon level
  - Material level
- Safe ingredients (both human and environment)
- No persistent compounds
- No negative impact on food supply (enhance food and feed)
- No negative impact on water (conserve or produce clean water)

www.healthybuilding.net/bioplastics/index.html

- Non-genetically modified crops (GMO)
- Fair treatment of farmers & workers
- Non-toxic across entire life cycle

Brown.
It's the new green.

Growing Maine's Green Economy:
Better Living Through Green Chemistry

Friday, October 26th, 2007
8:30 a.m.–5:00 p.m.

At the Hannaford Lecture Hall in the Abromson Community Education Center
University of Southern Maine, Portland Campus


Thank you !