



Biorefining Forest Biomass

Working Biomass Group Meeting

Sacramento, CA Feb 18, 2014

Reliant BioFuels & Applied Biorefinery Sciences



A photograph of a forest during autumn. The scene is filled with a variety of trees, including tall evergreens and deciduous trees with vibrant yellow, orange, and red foliage. The lighting is soft, suggesting a late afternoon or early morning setting. The overall atmosphere is serene and natural.

Reliant BioFuels: Yuba City, CA

Applied Biorefinery Sciences: Syracuse, NY

Reliant BioFuels

Paul Mann, PhD

Phil Treanor





Applied Biorefinery Sciences


Syracuse, NY

(“ABS”)

**Dr. Thomas E. Amidon, Prof
SUNY-ESF**

**Dr. Joel R. Howard, CEO
ABS, LLC**

**Mr. Christopher D. Wood, VP
Engineering
ABS, LLC**



**Why should the
forest products industry
consider deploying
Biorefinery Technology?**

What is the need?

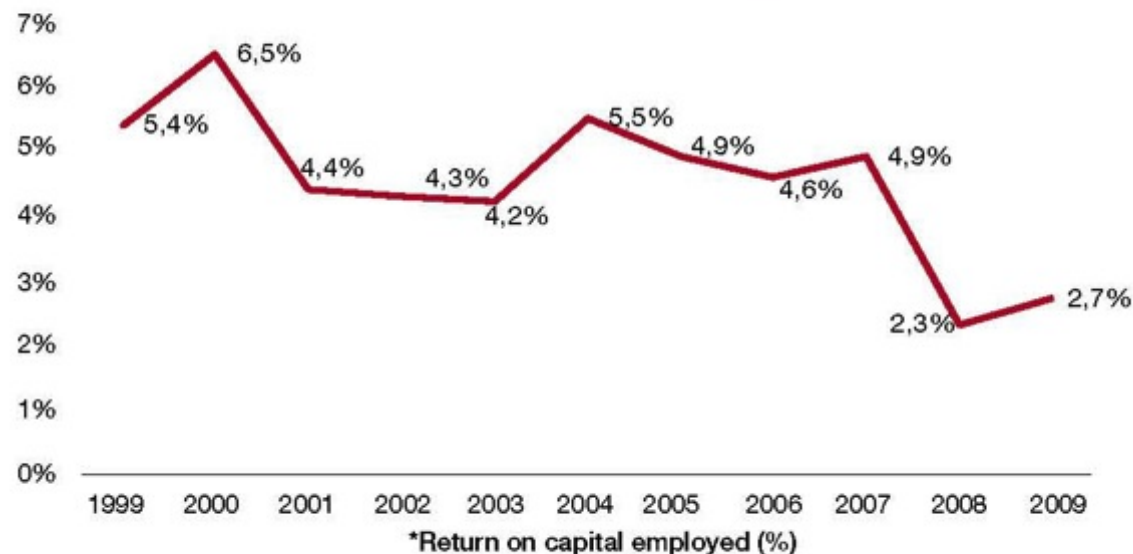
Where is the Pain?

According to PricewaterhouseCoopers' – Feb 2011 report

Growing the Future: Exploring new values and new directions in the Forest, Paper & Packaging industry.

Declining profits are the Pain

Figure 1: Industry Financial Performance: The Top 100 Forest, Paper & Packaging companies' ROCEs*



Source: PwC Global Forest, Paper & Packaging Industry Survey – 2010 Edition

What is CALIFORNIA'S Pain

- Forest biomass buildup
- Catastrophic fires
- Degradation of watersheds
 - Siltation of streams
 - Loss of fisheries
 - Loss of wildlife
 - Loss of hydropower
 - Loss of jobs
 - Drinking water compromised
 - Loss of wildflowers/native flora

How will it work?

First we must define:

“What is a Biorefinery?”

(under the ABS model)

What is a “Biorefinery”?

The Applied Biorefinery Sciences Perspective

Refinery? An industrial plant for purifying a crude substance

The diversity of products from, and economic strength of, a refinery is a function of:

- Feedstock chemical composition
- Capital investment
- Markets

What is a “Biorefinery”?

The Applied Biorefinery Sciences Perspective

A sugar refinery is an example of a single product refinery



What is a “Biorefinery”?

An oil refinery is a **multi-product** refinery

- gasoline
- diesel fuel
- asphalt base
- heating oil
- kerosene
- liquefied petroleum gas
- chemicals



So, what is a “Biorefinery”?

A “Biorefinery” under the ABS model is defined as:

- an industrial plant where crude biomass is processed and refined into more useful products.

How can
ABS Process™
Biorefinery Technology (“BT”)

Capture value not currently realized?

**By generating an
increased or improved variety of products
per volume of wood**

“More jobs from the same tree”

Pat Curran

President

Seaway Timber Harvesting

Massena, NY, USA

ABS Process™ BT

starts with raw (crude) biomass
that is
cooked in water

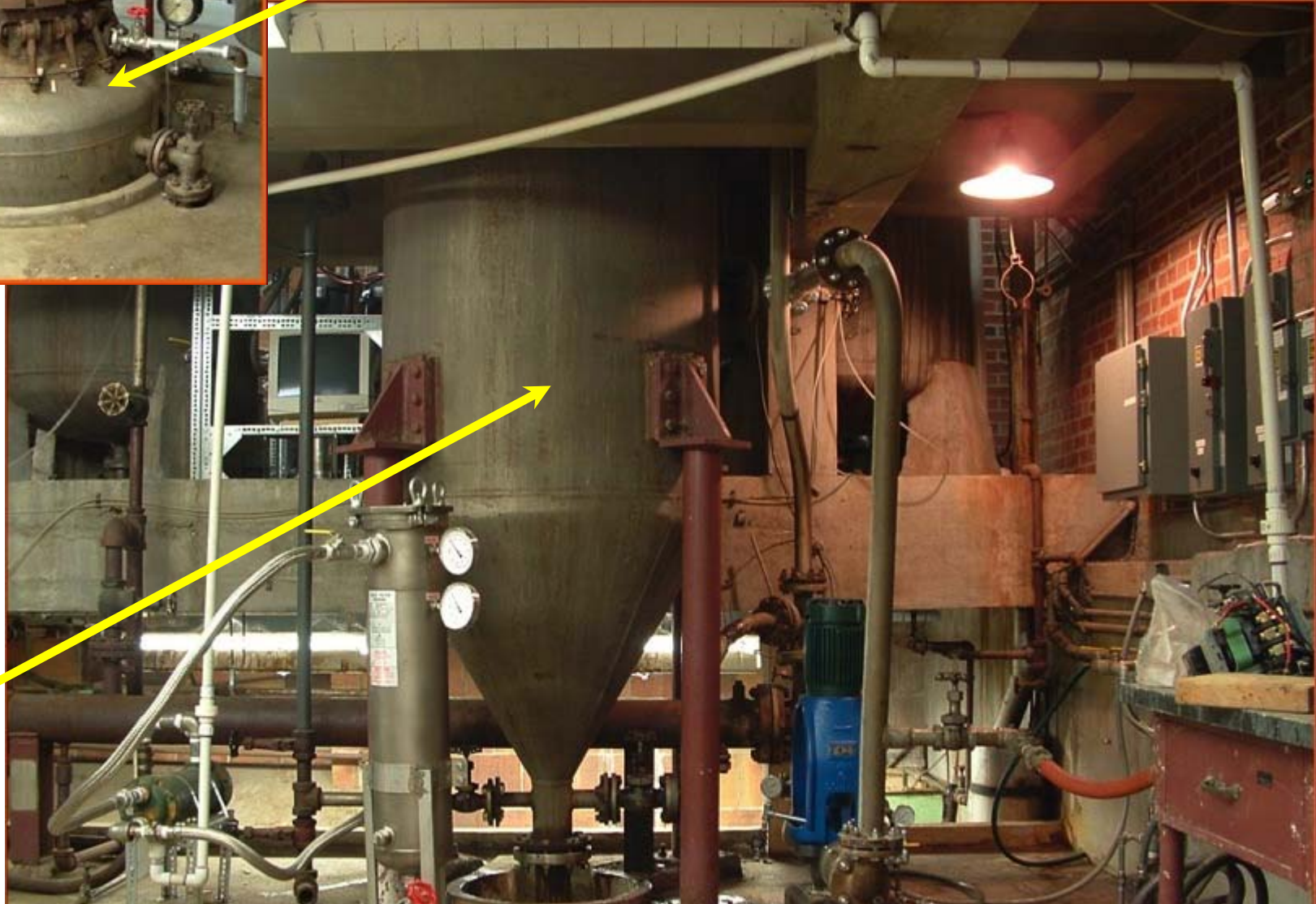


**SUNY ESF
Hot Water Extraction vessel**



Top

Bottom



Separation of products

After two hours:

- Remove wood/extract mixture from extractor
- Drain hemicellulose extract from wood



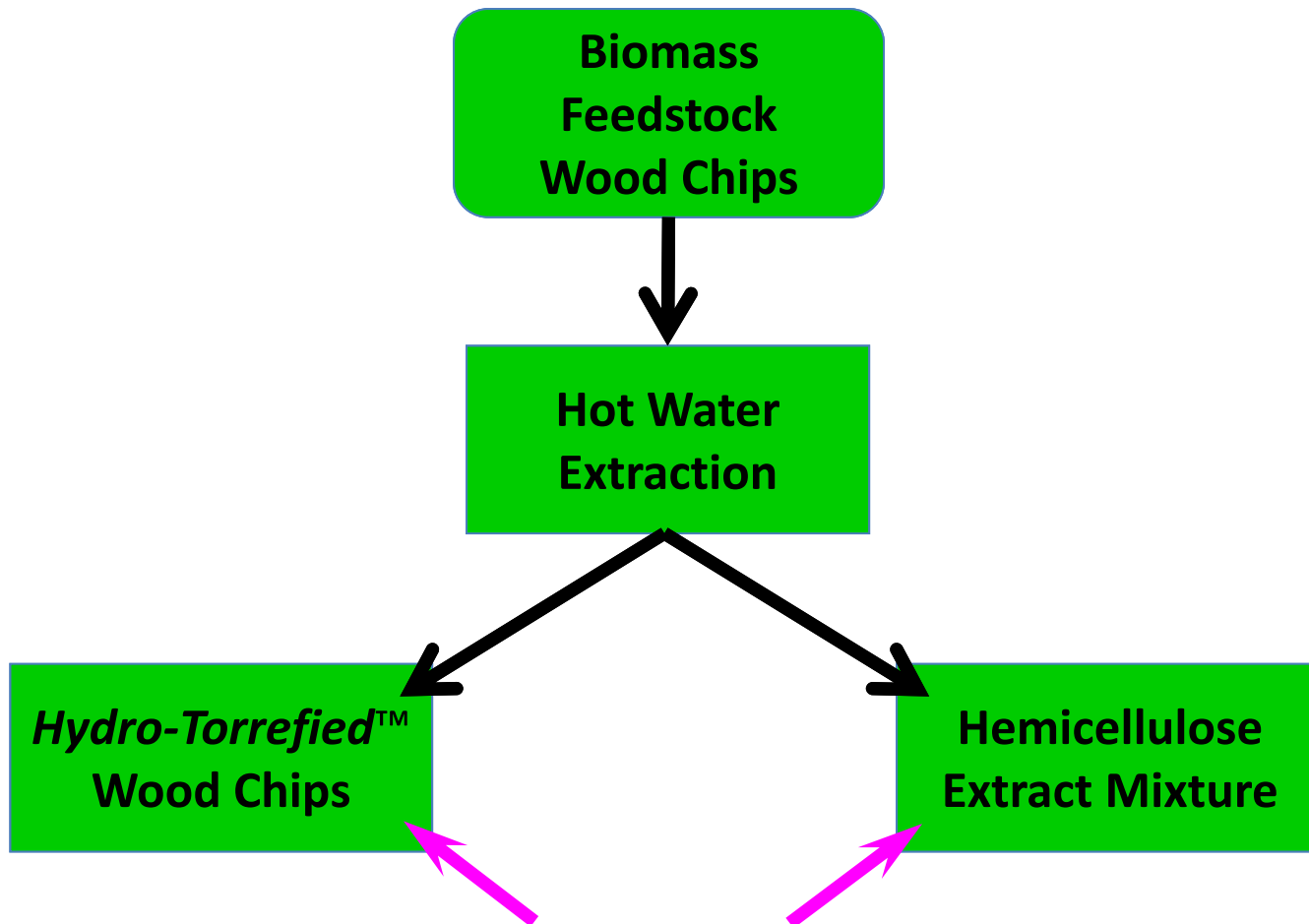
Biomass after processing two hours



Extract mixture after processing

Applied Biorefinery Sciences

Integrated Biorefinery – General Process Flow



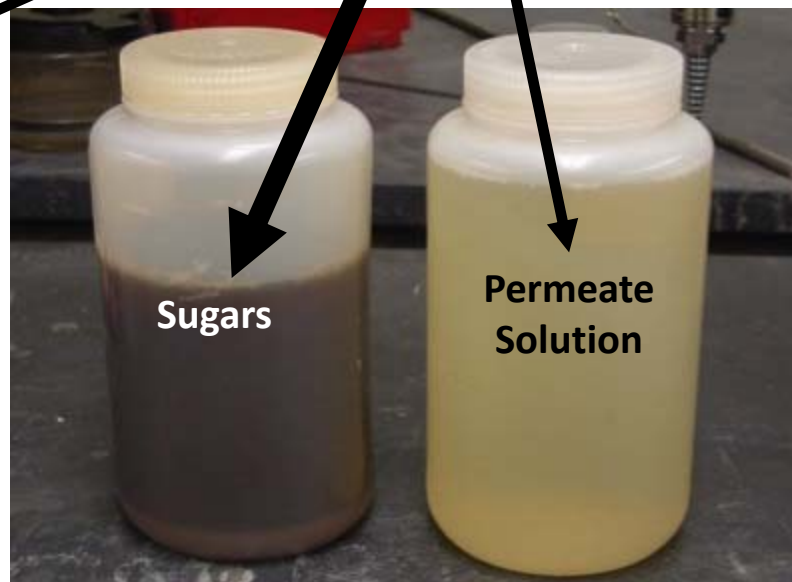
Yields two potential product streams instead of just one

Cellulose Product Recovery



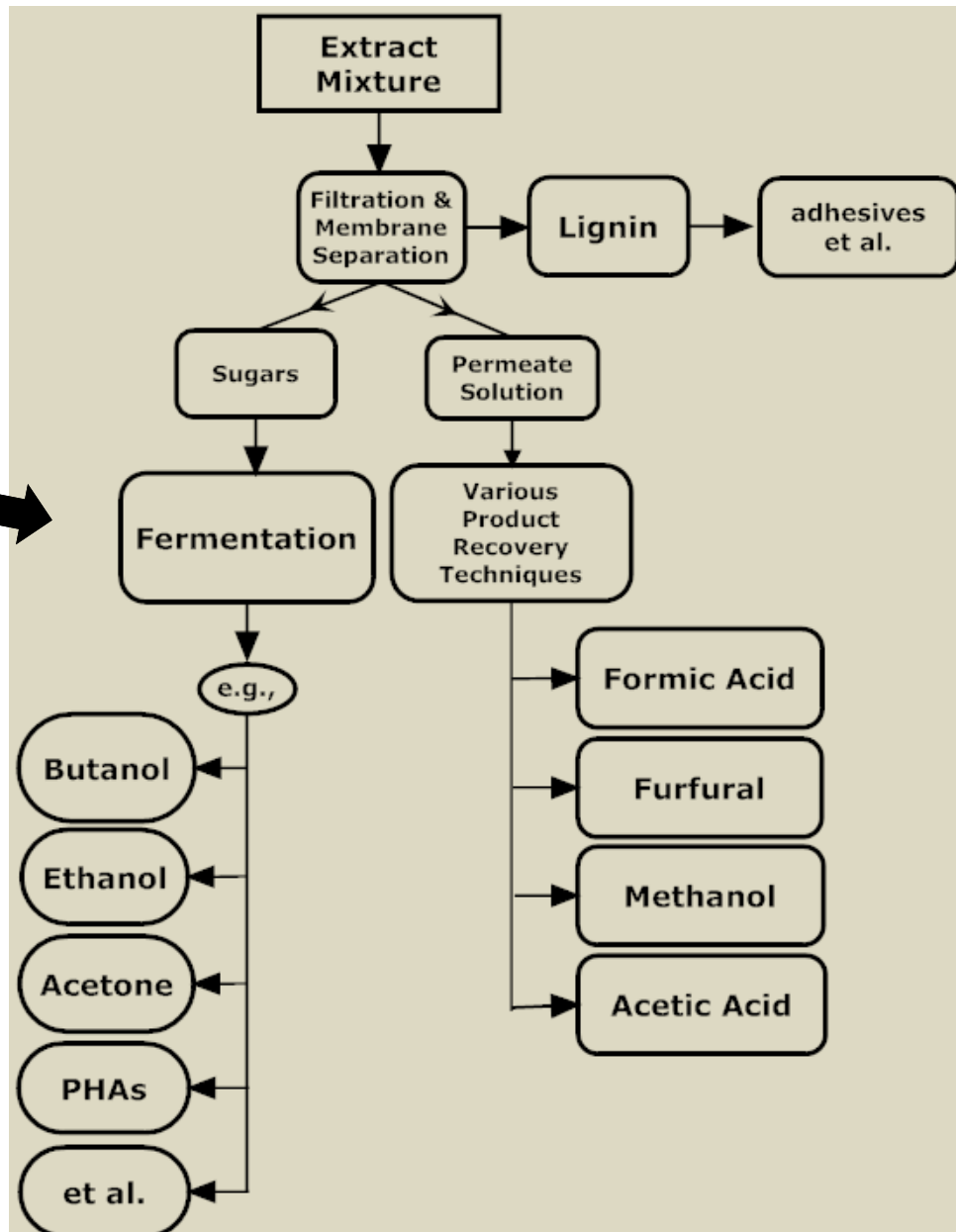
Cellulose Product Recovery

Using multiple methods and pathways,
separate extract mixture components
into



Hemicellulose Product Recovery

**Potential
Hemicellulose
Related
Products**



Hydro-Torrefied™ Wood Uses

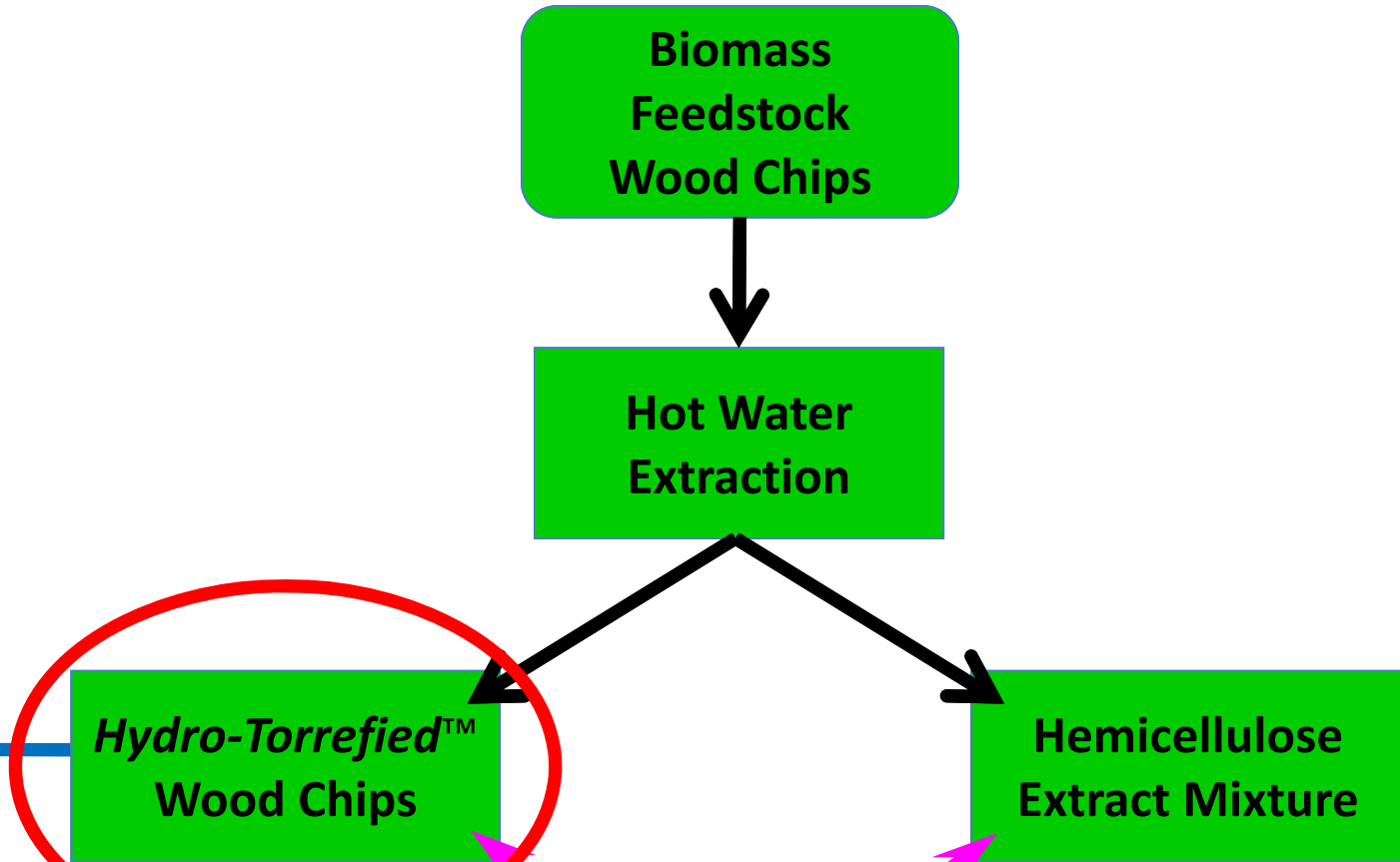
Biomass
Feedstock
Wood Chips

Hot Water
Extraction

Hydro-Torrefied™
Wood Chips

Hemicellulose
Extract Mixture

Two potential product streams instead of just one



Hydro-Torrefied™ **Wood Uses**

Raw Chips



***Hydro-Torrefied™* Chips**



*Hydro-Torrefied*TM Wood Uses

What has happened to the chips?



After extraction:

- darker color
- structure (cellulose & lignin) still intact
- same volume, **but**
- 20-23% less mass

Hydro-Torrefied™ **Wood Uses**

r extraction:

structural components (cellulose & lignin) remain intact, therefore

chips are usable and improved for making:

- **Fuel pellets**
- **Reconstituted wood products**
- **Pulp**
- **And other products**



Hydro-Torrefied™ **Wood Uses**

Hydro-Torrefied™ fuel pellets

decreased chip bulk density (due to hemicellulose extraction)

increased Btu content/lb

reduced ash content/lb

increased structural stability

- **higher % lignin** (less likely to break)
- **decreased hydrophilicity** (less likely to absorb water)

Simplified Business Model



Nature's Biorefinery



Market potential

- **California has largest dairy herd in the country**
- **Cows & heifers – 2.7 million***
- **Potential demand for C-5 Sugars**
 - **If fed 1 lb/day per cow**
 - **1290 T/day**
 - **491,000 T/yr**

*Hydro-Torrefied*TM Wood Uses

*Hydro-Torrefied*TM fuel pellets

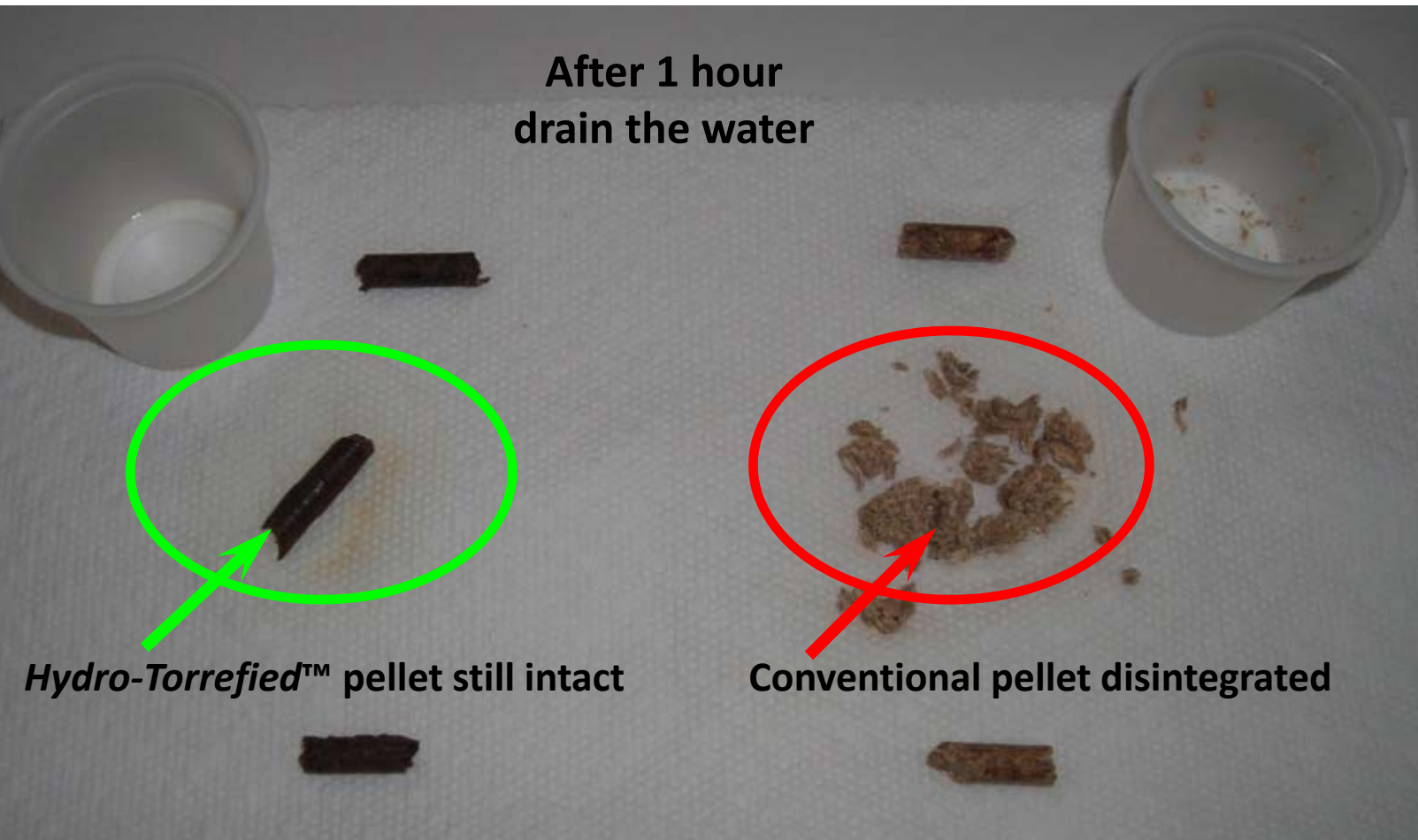
increased structural stability

- higher % lignin (less likely to break = fewer “nubs”)



Hydro-Torrefied™ **Wood Uses**

Compare a *Hydro-Torrefied™* pellet & a conventional pellet in water



Potential Pellet Market

Ship to Pacific Rim* nations to:

Blend with coal

Improve air quality

Domestic Coal Burning Generators

Public entities such as Schools, etc.

Residential Pellet Stoves

*** Dr. Thomas Amidon met with Environmental / Energy liaison & China Coal Specialist at US Embassy in Beijing.**



Potential feedstocks

Forest biomass:

Thinnings

Slash piles

Fire salvage

Hardwoods/softwoods



Potential feedstocks

Agricultural by-products:

Almond shells

Peach pits

Prune pits?

Olive pits

Orchard pullouts

Testing California's ag byproducts

at

USDA Western Regional Lab at Albany, CA





Concluding Statements

ABS ProcessTM

Biorefinery Technology

offers a complementary solution to:

Torrefaction

Pyrolysis

Slash pile burning

Land filling

Biomass power

to help solve

California's Forest Health Issues

Recommendation

**When developing policy to address
California's forest health issues,**

**Develop policy that is
results driven & technology neutral.**