Cost-Competitive Benzene, Toluene and Xylenes from Biomass Conversion
Anellotech’s Value Proposition
A low cost process for “drop in” green petrochemicals

**Low Cost**

**Feedstocks**
- Corn Stover
- Sugar Cane Bagasse
- Wood Chips
- Waste Paper

**Simple Process**
- One Reactor
- Economical Catalyst
- Min. Added Energy
- No H₂ Addition
- “Drop In”
- Benzene, Toluene, Xylenes (BTX)

**Key Chemicals**
- PET
- PS
- PC
- PU
- Nylon

**Large consumer markets**
- Packaging
- Automotive
- Apparel

**Key End Use Markets**
- Non-Food Biomass
- Base Aromatics
- Desired Green Products
Anellotech Origins

• Technology breakthrough from Huber research group at University of Massachusetts, Amherst

• Anellotech holds exclusive global rights to Catalytic Fast Pyrolysis™ technology

• First U.S. patent granted, more pending

• Significant strategic partner funding
Anellotech Benefits for BTX Supply Chain

- Feedstock diversity (biomass vs. crude oil)
- Green chemistry-based
- Cost advantaged vs. petroleum-derived
Cost Comparison of biomass vs. sugar
Biomass significantly lower on price per ton C+H basis

<table>
<thead>
<tr>
<th></th>
<th>Pricing Source</th>
<th>Cents/lb</th>
<th>$/tonne</th>
<th>% C+H</th>
<th>$/tonne C+H</th>
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</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>DOE</td>
<td></td>
<td>60</td>
<td>54%</td>
<td>111</td>
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<tr>
<td>Sugar</td>
<td>Bloomberg</td>
<td>18</td>
<td>400</td>
<td>47%</td>
<td>851</td>
</tr>
<tr>
<td>Cellulosic Sugar</td>
<td>Marketing Presentations</td>
<td>12</td>
<td>270</td>
<td>47%</td>
<td>574</td>
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</tbody>
</table>

Notes: Biomass based on pine (C_{3.8}H_{5.8}O_{2.7}) with 54% C+H content
Sugar (C_{n}H_{2n}O_{n}) has 47% C+H content
Other factors affecting cost include yield (feedstock efficiency, lignin vs. non-lignin, etc.)
Conversion Chemistry in One Reactor

- **Biomass**
- **Compressor**
- **Drying and Grinding**
- **Catalytic Fluidized Bed Reactor**
- **Catalyst Recycle Gas Recycle**
- **CO, CO2**
- **Catalyst Regenerator**
- **Steam/Electricity**
- **BTX Purification**
- **C9+ Aromatics**

Diagram showing the conversion process involving biomass, compressor, drying and grinding, catalytic fluidized bed reactor, catalyst regenerator, and CO2 separation. Arrows indicate flow directions.
Cost Drivers for Bio-Based BTX to Compete with Fossil-Based BTX

- Low Cost Feedstock (not food/sugar)
- One Chemical Reactor
- Minimal Low Cost Inputs
- Industrial Chemical Separations

Process Yield

OPEX

CAPEX

Profitable vs. Petro-derived BTX
Anellotech Cost Advantage
Simple and Low Cost CFP™ Process from non-food biomass

Simple process scheme with excellent process economics
✓ Low cost feedstock
✓ Nominal feedstock pretreatment
✓ One chemical reactor
✓ Economical zeolite catalyst
✓ Well-established conventional separation process
✓ No intermediate steps (no sugar extraction, bio-oil conversion, fermentation etc.)
✓ No other process inputs beyond usual utilities

Potential for attractive margins vs. market prices

Market Spot Price vs. Anellotech Fully Loaded (Cash + Depreciation) Costs

Spot Price
Today Target Cost
Future Target Cost

Price Source: Chemical Week, 18 January 2013
Leadership Team with 200+ Years Experience in Chemicals and Catalysis

Mr. David Sudolsky  
President & CEO  
• 25+ Years Business Management, Leadership  
• Dura Pharma, Booz-Allen, Union Carbide

Dr. Charles Sorensen  
VP, RD&E  
• 25+ Years Process Engineering, Catalysis, R&D  
• Corning, Exxon Mobil

Ms. Maureen Cannon  
VP, Business Development  
• 30+ Years Chemicals R&D, Business Management  
• Monsanto, McKinsey, Eastman Chemicals

Mr. Jeff Whiting  
VP, Operations  
• 30+ Years Chemicals Construction, Start-up, Operations  
• Monsanto/Solutia

Dr. Dennis McCullough  
Business Development Consultant  
• Former President Badger Licensing (Exxon-Shaw JV)  
• Shaw Group, ABB Lummus, Bechtel, Eastman

Dr. George W. Huber  
Board of Directors  
• Inventor CFP Technology, Co-founder  
• Professor, University of Wisconsin-Madison

Dr. Fred Pesa  
Board of Directors  
• Former R&D Head, BP USA  
• Expert in fluid bed catalysis

Dr. Ed Wolynic  
Board of Directors  
• Former Engelhard CTO and Group VP Strategic Technologies  
• Former UOP VP R&D
Anellotech’s Pearl River, NY Facilities
Room for Expansion…
Fully-equipped facility staffed by 24 catalyst scientists, chemical engineers and industry executives
Anellotech Development Strategy

U Massachusetts Intellectual Property Estate

Anellotech Catalyst Development

Anellotech Process Development

Anellotech Pilot/Demo Plant Testing & Scale-Up

Anellotech IP

Commercial Scale Plants

Dec. 2013: Kg.-scale BTX Production Capability On-line, On-Schedule
### Anellotech Process Commercialization

<table>
<thead>
<tr>
<th>Scoping and Development Units:</th>
<th>Operational</th>
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<tbody>
<tr>
<td>Pilot Unit</td>
<td>December 2013</td>
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<tr>
<td>Demonstration Unit:</td>
<td>2016</td>
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<tr>
<td>First Commercial Plant</td>
<td>2019 - 2020</td>
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<tr>
<td>Second Commercial Plant</td>
<td>2021 - 2022</td>
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</table>
Large BTX Market Potential

3 of the 5 largest commodity petrochemicals.....

USD, billion

Ethylene, $195
Propylene, $120
Butadiene, $25
Benzene, $69
Xylene, $81
Toluene, $45

“BTX” $195 bn

Polystyrene, Rubber
Polycarbonate, Epoxy, Phenolics
Nylon
Detergents
Polyurethane
PET films and resins
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