Sustainable, Renewable and Profitable Local Energy
Powered by ArborGen Purpose Grown Trees

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David Nothmann
ArborGen Today

- **Fully integrated global commercial tree seedling company**
  - Established channel to market: >5,000 customers
  - Ownership of extensive and diverse repository of germplasm
  - Proven production capabilities
  - Full range of seedling products spanning the entire technology spectrum

- **The largest global producer of tree seedlings for planting**
  - ~250 million seedlings sold
    - 27% share of total seedling market in Southeastern U.S.
    - 36% share of total seedling market in New Zealand
    - Significant share of the Australian pine seedling market
  - Emerging Brazil presence via collaborations with leading pulp producers

- **Forestry Biotechnology leader**
  - Full spectrum of technologies employed
  - Portfolio of over 230 patents and patent applications
  - 150 active biotech field trials in the US and Brazil (industry leader)
  - Robust pipeline: >15 biotech products in development
  - Unique and scalable production platform
Strategic Vision: “To Revolutionize Productivity in the Global Commercial Forestry Industry”
Employing various technologies and approaches to improve tree productivity

**Improved Germplasm**
- Conventional Breeding
- Varietal Technology

**Management Systems**
- Increased Densities
- Shortened Rotations
- Other Silvicultural Improvements

**Biotech Improvements**
- Improved Growth
- Shorter Rotation
- Stress Tolerance
- Improved Processing
- Improved Wood Quality

Productivity improvements increase the amount of biomass that can be produced from existing forestland to supply both existing and newly emerging demand.
ArborGen technology brings a step-change in tree productivity

- **Seedlings**
  - Elite Material
  - MCP™ - Opportunity for near-term landowner gains

- **Varieties**
  - Genetic Uniformity
  - Increased Productivity
  - Improved Product Mix
  - Management Efficiency

- **Value-Enhanced Traits**
  - Increased Growth Rates
  - Shorter Rotations
  - Improved Wood Quality
  - Improved Processing
  - Stress Tolerance
  - Breakthrough Applications

**Time and Product Testing**
33% projected increase to SE annual wood consumption in the next 15 years

**Electricity**
- Climate change legislation stalled; efforts now focused on a standalone national Renewable Electricity Standard (RES), in the order of 15-20%
- National RES = major impact in the SE where few states currently have renewable mandates
- Biomass = dominant renewable in US SE due to limited supply and/or high cost of wind, solar, hydro

Meeting 40% of a 15% RES from energy trees in the SE would require ~30 MM dry tons

**Pellets**
- Rapid growth in pellet demand primarily driven by exports
- European Union target: renewables = 20% of 2020 energy (10% in 2008)
  - Renewable electricity: disproportionately large share of total
- EU electricity market = 75% of US
- US pellet production concentrated in SE and pellet makers prefer clean round-wood and wood chips

Wood pellet plants in the SE project to use >10 MM dry tons by 2012

**Advanced Biofuels**
- Renewable Fuel Standard 2007 targets 36 billion gallons (EtOH-equiv) of renewable fuel by 2022
- Some slippage in date likely but Government recommitted to target in February 2010
- Advanced biofuels = 21 billion gal, 16 billion from cellulosic feedstocks
- Mid-West (corn, corn stover) will be one major supply region; SE (energy crops) will be the other

1/5 of 16 billion gallons from energy trees in the SE requires >30 MM dry tons
Sustainable solution for the Southeast: Purpose grown trees, not forest residues

- Multiple studies show a dramatic increase in biomass prices with increasing demand when only forest residues are considered.
- Plantation forestland is abundant and agricultural alternatives are limited.


> $50/green ton against current South Atlantic average of $23/green ton

“Residuals could be important but expected demand will quickly exceed residual availability.”

“Purpose Grown Trees”

“Forest Residues”
Purpose grown trees provide benefits throughout the biomass supply chain

**Feedstock Production**
- Equivalent or superior biomass productivity to other sources
- Low per-ton input costs
- Improved harvest efficiency
- Production within close proximity of facility

**Logistics**
- Year round harvest
  - Match supply with demand
  - No storage challenges
  - Multi-year rotation providing ‘living inventory’ of available biomass
  - Infrastructure well developed
    - Harvest & handling
    - Transportation

**Processing Conversion**
- Matching of physical and chemical traits to processes
- Fast growing trees can be utilized in multiple markets
- Consistency of feedstock improves processing efficiency

**Productivity gains: the most influential driver in determining wood delivered cost**
Tailored products address different biomass markets in the Southeast

- High planting density management systems
- Faster biomass growth with shorter rotations
- Products tailored for geography

- Populus
- Pine
- Subtropical Eucalyptus Species
- Pine
- Tropical Eucalyptus
**Pine: ArborGen practices and products significantly increase yield**

<table>
<thead>
<tr>
<th>Biomass Yield</th>
<th>Baseline</th>
<th>Currently Planted</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 6 Green Tons/Acre/Year</td>
<td>8 to 11</td>
<td>14 to 22</td>
<td></td>
</tr>
<tr>
<td>Biopower Yield$^1$</td>
<td>6,000 to 8,250</td>
<td>6,750 to 11,250</td>
<td></td>
</tr>
<tr>
<td>Biomass Management</td>
<td>3,000 to 4,500 kWh/Acre/Year</td>
<td>10,500 to 16,500</td>
<td></td>
</tr>
<tr>
<td>200 to 300 Gallons/Acre/Year</td>
<td>400 to 550</td>
<td>700 to 1,100</td>
<td></td>
</tr>
<tr>
<td>Biofuels Yield$^2$</td>
<td>450 to 750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO$_2$ Captured$^3$</td>
<td>6.7 to 9.2</td>
<td>11.7 to 18.3</td>
<td></td>
</tr>
<tr>
<td>3.3 to 5 Metric Tons CO$_2$/Acre/Year</td>
<td>7.5 to 12.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.5 MWh per dry ton of biomass, 50% moisture content, w.b.

$^1$100 gallons fuel per dry ton of biomass, 50% moisture content, w.b.

$^3$Above-ground biomass, 0.5 tons C per dry ton biomass, 3.67 tons CO$_2$ per ton Carbon, 50% moisture content, w.b.
**Pine: ArborGen practices and products significantly increase yield**

**FlexStand™ Systems**

Stands established to optimize production of multiple timber products for various markets

- Efficient use of genetic material
- Focus resources by product value
- Enables deployment of high value technology

**Biomass Management**

**High Density Pine Trial in GA (Age 6) 1,800 trees/acre**

- Increased planting densities and shortened rotations + whole-tree biomass utilization = increases productivity
- Projected yield: 80 - 130 green tons per acre at age 10
SE has high hardwood (HW) share, but HW “bioenergy” currently non-factor


“Bioenergy” is wood pellets, biopower and biofuels
“Other” is dominated by residuals and lowest-grade roundwood burnt for energy
Under “business as usual” expect increasing hardwood prices in the SE

Mixed (non-planted) HWs:
• Long rotations (poor yield)
• Generally very poor form, high branching, small diameter (poor fiber quality)
• High per ton harvest costs and often difficult harvest in inclement weather

Purpose grown trees can reduce average delivered cost

SUPPLY CURVE ILLUSTRATION

Current Market

Wood Cost ($ / ton)

% of Total Furnish

Current Average Cost

Average Cost w/ Purpose Grown

Last 20% is very expensive
**Hardwoods:** ArborGen practices and products significantly increase yield

<table>
<thead>
<tr>
<th>Biomass Yield</th>
<th>Naturally Regenerated</th>
<th>Planted Trees</th>
<th>Biomass Management</th>
<th>Biotech Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2 Green Tons/Acre/Year</td>
<td>10 to 14</td>
<td>12 to 18</td>
<td>27 to 40</td>
<td></td>
</tr>
<tr>
<td>Biopower Yield(^1)</td>
<td>750 to 1,500 kWh/Acre/Year</td>
<td>7,500 to 10,500</td>
<td>9,000 to 13,500</td>
<td>20,250 to 30,000</td>
</tr>
<tr>
<td>Biofuels Yield(^2)</td>
<td>50 to 100 Gallons/Acre/Year</td>
<td>500 to 700</td>
<td>600 to 900</td>
<td>1,350 to 2,000</td>
</tr>
<tr>
<td>CO(_2) Captured(^3)</td>
<td>0.8 to 1.7 Metric Tons CO(_2)/Acre/Year</td>
<td>8.3 to 11.7</td>
<td>10 to 15</td>
<td>22.5 to 33.3</td>
</tr>
</tbody>
</table>

\(^1\) 1.5 MWh per dry ton of biomass, 50% moisture content, w.b.
\(^2\) 100 gallons fuel per dry ton of biomass, 50% moisture content, w.b.
\(^3\) Above-ground biomass, 0.5 tons C per dry ton biomass, 3.67 tons CO\(_2\) per ton Carbon, 50% moisture content, w.b.
Biomass focused management of hardwoods

- Increased planting densities and shortened rotations along with the ability to utilize whole-tree biomass increase productivity
- The ability to coppice allows for the production of multiple harvest crops from a single planting

**Tropical Eucalyptus**
- 27 to 33 green tons/acre/year
- 2.5 year rotation
- 3 harvests

**Subtropical Eucalyptus**
- 14 to 18 green tons/acre/year
- 4 year rotation
- 3 harvests

**Populus**
- 12 to 15 green tons/acre/year
- 5 year rotation
Purpose grown hardwood portfolio

- **US hardwood portfolio targets growth to improve landowner and processor economics**
- **Significantly shorter rotations compared to non-planted mixed hardwoods**
- **Lower delivered wood costs and more reliable supply**
  - Reduced harvesting costs
  - Reduced transport costs
  - More volume per acre
  - Ability to utilize marginal land (improved landowner return)
- **Improved processing and product traits**
  - Consistent and reliable supply
  - For pulp / paper: (1) less chemical & energy use, (2) increased pulp yield and (3) higher pulp price (better quality)

<table>
<thead>
<tr>
<th>Product</th>
<th>Est. green tons/acre/year</th>
<th>Freeze Tolerant</th>
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<tbody>
<tr>
<td>SFE</td>
<td>20 to 35</td>
<td>No</td>
</tr>
<tr>
<td>FTE</td>
<td>17 to 25</td>
<td>Yes</td>
</tr>
<tr>
<td>Eben</td>
<td>14 to 18</td>
<td>Yes</td>
</tr>
<tr>
<td>CW</td>
<td>10 to 15</td>
<td>Yes</td>
</tr>
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</table>
“Local” works for your facility: 
_Illustration_

<table>
<thead>
<tr>
<th>Biopower Facilities*</th>
<th>SuperTree Nursery</th>
<th>ArborGen Headquarters</th>
<th>Distribution Point</th>
<th>Sales Office</th>
<th>Orchards</th>
<th>Bioenergy Field Trials (as of Nov. 2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>Electricity</td>
<td>Liquid Fuels</td>
<td>Pellets</td>
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</tbody>
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**Forest Residues**
- 2 to 4 green tons/acre/year
- >570,000 acres
- ~45 miles

**ArborGen Pine**
- 8-13 green tons/acre/year\(^1\)
- 120,000 to 200,000 acres
- 20-26 miles

**ArborGen Populus**
- 12-15 green tons/acre/year\(^1\)
- 140,000 to 180,000 acres
- 22-24 miles

**ArborGen Eucalyptus**
- 14-33 green tons/acre/year\(^1\)
- 50,000 to 110,000 acres
- 13 to 19 miles

\(^1\)includes only currently available products
\(^2\)Assumes access to 15% of the local land base

*Source: Forisk and ArborGen analysis*
ArborGen: your neighbor and partner in making a close proximity model possible
Planting purpose grown trees now ensures sufficient future availability

Example: Biopower

US Renewable Electricity Generation 2020 (EIA Forecast)\(^1\)

<table>
<thead>
<tr>
<th>Biomass Share of Renewables</th>
<th>Purpose Grown Tree Biomass Share(^2)</th>
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<tr>
<td>20%</td>
<td>65%</td>
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US Biopower Generation 2020 from Tree Biomass

= 94 billion kWh

125 million green tons of wood per year

Requiring 1.2 billion seedlings planted annually in 2015\(^3\)

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\(^1\) Annual Energy Outlook 2010 Reference case.

\(^2\) Based on projected share of biomass represented by wood assuming wood consumption from currently announced projects (Forisk Consulting Wood Bioenergy South, 2010) grows at the same rate as biomass electricity generation from EIA.

\(^3\) Assumes planting 5 years ahead of energy demand.
SUMMARY

- Demand for woody biomass is on the rise
- Biopower and Biofuels production based on woody biomass critical to revitalizing rural economies in the Southeast
- Purpose grown trees have numerous supply chain advantages over alternatives
- Trees are and will be managed to meet sustainability targets
- ArborGen technology is revolutionizing productivity potential
  - Increased yields
  - Shortened rotations
  - Increased carbon up-take
  - Increased environmental adaptability
  - Improved processing efficiency (pulp & bioenergy)
  - Improved wood quality

CALL TO ACTION

- When sourcing wood today:
  - Think local
  - Encourage re-planting of purpose grown trees at biomass (higher) density
    - FlexStands
    - Short rotation hardwoods
    - Eucalyptus
  - Obtain options (contracts) now for future wood needs
- Work together with ArborGen in meeting with landowners