Forest Biorefinery Product Portfolio—
Selection and Implications to Enterprise Transformation

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Presentation Outline

- Presentation objective
- Introduction to key forest biorefinery concepts
- Phased approach for forest biorefinery implementation
- Value creation via product portfolio definition
- Enterprise Transformation and the forest biorefinery
- Take-away messages
Objective of this presentation

A phased-approach for biorefinery implementation is presented, in order to define an appropriate **product portfolio** likely to be sustainable.

The product portfolio selection implicitly defines the **Enterprise Transformation** needed for the future biorefinery.
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Some Forest Industry Strategies to Survive and Thrive

Go for Survival in Commodities, or
Make the Most of Our Existing Industry

Buy/Build Elsewhere In Emerging Markets, or
Make the Most of Our Pulp and Paper Competency in Emerging Economies

To thrive
Diversify Core Business with Marketing & Technological Partners, or
Make the Most of Our Existing Value Chain by Migration to New Business Paradigms

- Diminishing Returns
- Global Competition
- Forest Biorefinery
One forest biorefinery definition:

- Full utilization of incoming woody biomass for the production of:
  - Wood products
  - Pulp and paper products
  - Energy
  - Chemicals

Another (more practical) forest biorefinery definition:

- Maximizing the economic value from trees
- Improved business model
- Corporate transformation…
The Challenge: Evolving to New Business Models While Mitigating Risks

- Pulp & Paper Sector: Stalemate situation
- Opportunity: Biorefinery
- Identify & Mitigate risks
  - Technical
  - Economic
  - Commercial
Identifying the Right Biorefinery Configuration is Complex…

BIOMASS
- White wood
- Bark/Forest Residues
- Agri waste
- MSW
- Industrial waste
- Energy crops

PROCESSING
- Biochemical Transformation
  - Anaerobic Digestion Fermentation
- Biomass Pre-processing Technologies
  - Steam Explosion
  - Chemical Treatment
- Thermochemical Transformation
  - Pyrolysis
  - Gasification
  - De-Polymerization
- Chemical & Others
  - Lignin chemistry
  - Chemical Synthesis
  - Reformation
  - Others

Product Concentration & Purification

BIO PRODUCTS MARKETS
- Energy
- Biofuels (Transportation)
- Commodity chemical (Building Block)
- Added Value chemicals (Specialty)
- Materials
- Pharmaceuticals / Nutraceuticals
Key Issues to consider for FBR Implementation

- Company transformation
  definition and systematic implementation

- Incremental product
  implementation strategy across the corporation

- Biorefinery process design for product diversification and targeted return on investment

- Biorefinery product selection for sustaining return over the short and long terms
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Some Key Competitive Factors

Main competitive advantages for forestry companies:
- Access to biomass availability and harvesting know-how
- Existing infrastructure in close proximity to forest biomass
- Established supply chain for wood, pulp and paper products

Main competitive disadvantages for forestry companies:
- Lack of capital
- Lack of product development culture
- Lack of knowledge of product quality requirement, supply chain practices, etc. for new bioproducts
Strategic Approach for Implementing the Biorefinery

**Implementation: compete with all capital spending**

### Phase I: Lower Operating Costs

- Replace fossil fuels at mill (natural gas, Bunker C), and/or
- Produce “building block” chemical
- Minimum risk technologies

**Main challenges**

- Compete internally for capital

### Phase II: Increase Revenues:

- Exportable green energy, and/or
- Manufacture of derivatives
- Market development for new products
- Higher process complexity and technology risk
- Partners essential

**Select the most sustainable product platform and partner(s)**

### Phase III: Improve Margins:

- Knowledge-based manufacturing and production flexibility
- Business flow transformation
- Product development culture
- Off-shoring, Outsourcing, etc…

**Company culture transformation**

**Supply Chain Management**

**key to success**

**Main challenges**

- Strategic Vision: Phase II must determine Phase I & III
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Strategic Vision: Phase II must determine Phase I & III

Margins Improvements
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  - Approach for building a product portfolio
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Forest biorefinery Value Resides in the Product Portfolio

- The product portfolio is the enabler for value creation and should be strategically determined to achieve value over the longer term.

- The product portfolio strategy is the basis for process selection and business strategy definition required for value optimization.

- How should the product portfolio be selected and designed in order to support a sustainable business plan? – **is the key question**
Products derived from Biomass Opportunities

Market size / price for co-products derived from biomass

- **Biomass-derived Commodities**
  - Cellulose-based fibers
  - Fatty acids
  - Specialty Celluloses

- **Biomass-derived Specialty Chemicals**
  - Gallic acid
  - Aldehydes (Vanillin, SA, TMBA)
  - Sterols
  - Essential Oils
  - Chitosan & derivatives
  - Vitamins
  - Bioactive Polyphenols
  - Maltol
  - cis-3-Hexenol

- **Biomass derived Pharmaceuticals**
  - Fro anthocyanidins
  - Chiral drugs
  - Taxans
Forest Biorefinery Product Family

Waste
- Chips Biomass
- Pulp and Paper Mill
- Yield?

Co-products or wastes?
- Building Block
- Yield?
- Derivative
- Yield?
- Derivative

P&P Products

$\$\$\$ Main Biorefinery Products to Market $\$\$\$\$

Reducing Volumes, Flexible Throughputs…

Increasing Process Complexity
Value Chains need to be considered for long term biorefinery sustainability:

- Production **flexibility** = market flexibility (supply/demand)
- Unique **supply chain** is key for competitive position in the longer term
- **Margins stability** and **risk mitigation** challenges are addressed while diversifying the product portfolio
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“Towards a Product-Centered Chemical Industry - Rethinking the Role of R&D and its Interaction with Marketing and Business Strategy”
FOCAPD (2004)

- Chemical Engineering is moving from being process-centric to product-centric, for example DuPont’s ‘Rapid Market Analysis’ as starting point for product-centric activities
- Product centered: market trends $\rightarrow$ product specifications $\rightarrow$ components and subsystems $\rightarrow$ chemicals and materials $\rightarrow$ manufacturing systems design
Some Lessons Learned Thus Far...

△ Biorefinery technology will be critical for competitive position in the short-term, the unique supply chain will be essential for competitive position in the longer-term.

△ In order to be competitive in the longer term: product design for the product portfolio must precede process design.

△ To minimize risks and ensure successful business development requires partnering along the value chain.

△ To mitigate against market price volatility requires designing for manufacturing flexibility.

△ The key to success in the forest biorefinery will be through implementing “knowledge-based manufacturing” along with flexible manufacturing supported by advanced supply chain management.
Technology Push/Market Pull considerations: critical overview

**What products could we manufacture?**
- e.g. NREL 2004

**What products should we manufacture?**
- e.g. Penner 2006

- **Novel product**
  - Innovation

- **Substitution**

- **Process-centric design**

- **Substitution**

- **Replacement**

- **Product-centric design**

- **Adaptation**

- **Market Pull**

- **Technology Push**
NREL Approach for Defining Promising Biorefinery Chemicals

NREL, Top 10 Value Added Chemicals, 2004

Model of biobased Flow-chart for Biomass Feedstock

Biomass → Precursors → Platforms → Building Blocks → Solvent Chemicals → Intermediates → Products/Uses

Carbohydrate Platform

Technology Push
Technology Push/Market Pull considerations: critical overview

- What products **could** we manufacture? e.g. NREL 2004
- What products **should** we manufacture? e.g. Penner 2006

The most appropriate choice for a company

- Innovation
  - Novel product
- Market Pull
  - Replacement
- Technology Push
  - Process-centric design
- Adaptation
  - Substitution
Product Portfolio Definition: Which Biorefinery Sequence?

**Individual Product Analysis**
- Which replacement/substitution products should be considered?
  - Promising technologies
  - Product growth
  - Potential for competitive advantage with green product
  - Competitive manufacturing costs/existing value chain

**Product family analysis:**
- Creating added value along the value chain
- What are the competitive factors associated with the aggregated product family?

**Product Portfolio:**
- What potential new supply chain opportunities are there?
- Will a unique supply chain result, that can’t be achieved by others?

**Partnership Selection:**
- Who are the promising partners for the candidate product families?
- Do their corporate visions align with yours, i.e. implementing the biorefinery in partnership?
Key issues

- Multiproduct strategy and its implementation are critical for the success with the biorefinery, and imply changes in the core business.

- This must therefore be complemented with the systematic analysis of the implied and essential Enterprise Transformation.
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Enterprise Transformation is considered as a core strategy for other industries and companies, to create sustainable profitability.

- **2 transformation concepts:**
  - **‘Inside-out’**: Improve bottom-line results via transforming the enterprise by changing processes within the existing organization, including changes in manufactured products. Current vision, mission and strategies are maintained.
  - **‘Outside-in’**: Core vision, mission and strategies are changed to create a newly focused to the outside market that is sustainable with vastly improved bottom-line results.

- Transformation to the forest biorefinery implies potential for both types of transformation.
Inside-Out Transformation -- GP

- Under Koch Industries ownership – GP essentially pursuing past marketplace directed focuses ~
  - Similar or identical products and services delivered to essentially same marketplace & customer base.

- GP reworking details on how to function to deliver same basket of goods & services to the marketplace better, more profitably, & more sustainable
Alternatively – outside the paper industry ~ UPS (now “Big Brown”) has pursued an Outside-In transformation ~

- UPS adopted entirely new vision & mission.
- Once the leading long distance package shipping/handling firm globally – UPS concluded standing pat would assure a slow decline in sustainability & profitability
- To assure a sustainable & profitable long term existence, UPS morphed to a major supply chain services organization with an entirely new reason for existence.
Another firm following an Outside-in transformation in the forest products industry space is Potlatch.

Once vertically/horizontally integrated producer driven by mix of paper & solid wood products delivered to a defined marketplace and customer base:

- Potlatch altered its entire macro reason for existence by transforming itself into a Real Estate Investment Trust (or a “REIT”)
- Now driven by totally new mission/vision focused first on timber/timberland returns at the core – resulting in major transformation of key ways Potlatch now operates from the inside out
- Where in a way Potlatch did create an Inside-Out transformation but one driven at the heart by a comprehensive “Outside-in” transformation
Can P&P Companies adopt this Culture?

⚠️ Core business transformation, by product portfolio adjustments related to market evolutions.

⚠️ Cyclical adaptation to reinvent the business and transform the enterprise, while avoiding declining activities.

Biorefinery opportunity for pulp and paper industry

Proactivity is critical enabler for successful enterprise transformation

204 Years of Innovation

- Chemistry
- Energy
- Materials Science
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Margins improve with Enterprise Transformation

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The definition of a **strategic product portfolio** is critical for the success of the biorefinery and the related industry transformation.

It is a strategic task that implies **product-centric analyses** as well as process design and key considerations on supply chain definitions and partnership strategies.

The definition of the biorefinery product portfolio needs to be considered **simultaneously** from a market and a technical perspective.

The transformation to the forest biorefinery resides in the **phased implementation** enabling the shift between an inside-out to an inside-in transformation.
Various companies have been successful at transformation, but this is less obvious for pulp and paper companies.

Both inside-out and outside-in transformation types are essential for biorefinery implementation.

Product portfolio management, and changes in this, imply the transformation is needed and as well:

- Processes implied
- Unique supply chain for long-term competitive advantage
- Supply chain synergies that can be realized
- Appropriate biorefinery partners

A methodology is needed for specific companies to identify their strategy.

This should be used to define a practical and phased implementation for the biorefinery at a given company.
Thank You!

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