



Guided Tour: Implementing the Forest Biorefinery at a Pulp and Paper Mill

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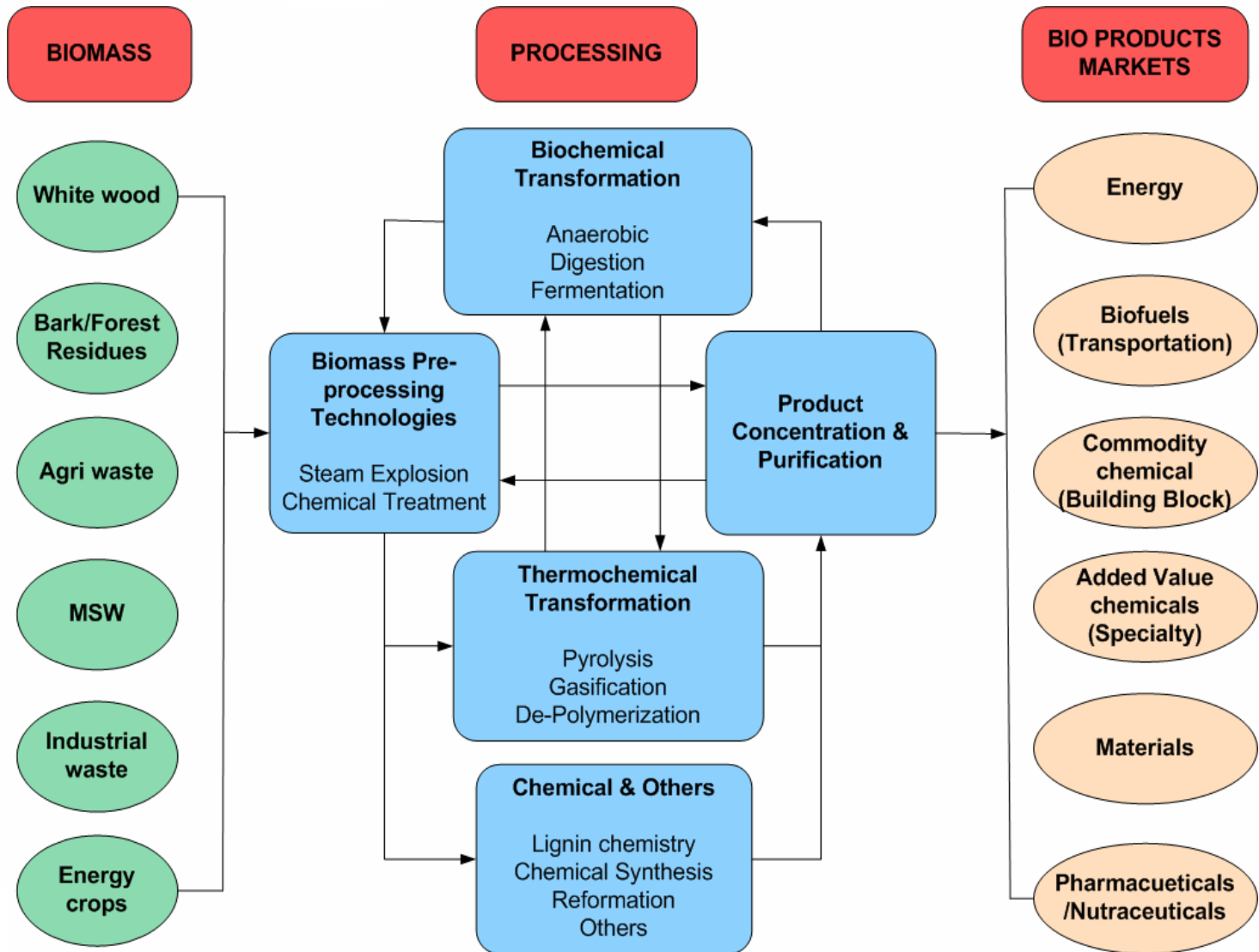
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Science and Technology, Georgia Institute of Technology (Atlanta)



Presentation Outline

- △ Types of Enterprise Transformation
- △ Biorefinery platform definition
- △ Product Portfolio and method for its determination
- △ Phased Approach for forest biorefinery implementation

Identifying the Right Biorefinery Configuration is Complex...





Key Questions to be Addressed Related to Implementing the FBR

- △ What are the key factors regarding biorefinery product selection, that will provide a sustained return over the short and long terms?
 - What supply chain management changes are implicated for product delivery and the targeted new market(s)?
 - Who are the best partner(s) for a winning business strategy?

- △ What biochemical, thermochemical and chemical biorefinery processes enable product diversification, while providing the targeted return on investment?

How will the mill/company transformation to the forest biorefinery impact the day-to-day pulp and paper operations, at each step of implementation?



Enterprise Transformation: Definitions

2 transformation concepts:

■ **Inside-out:**

- Transform the enterprise by changing processes within the existing organization, including changes in manufactured products



■ **Outside-in:**

- Core vision, mission and strategies are changed to create a new focus to outside markets that is sustainable, using new and integrated delivery techniques and with vastly improved bottom-line results



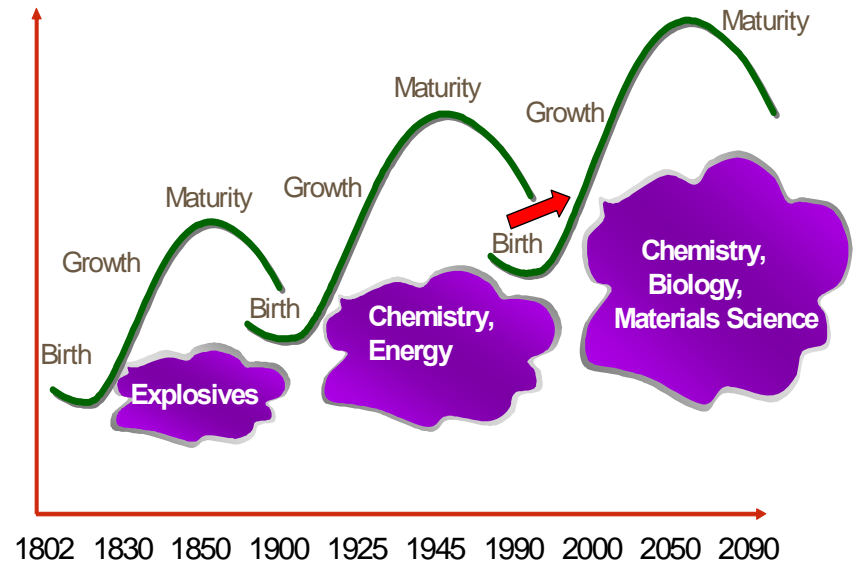
➤ **Transformation to the forest biorefinery implies both types of transformation**

Can Forestry Companies Adopt this Culture?

- Core business transformation, by product portfolio adjustments related to market evolution.
- Cyclical adaptation to reinvent the business and transform the enterprise, while avoiding declining revenues.



204 Years of Innovation



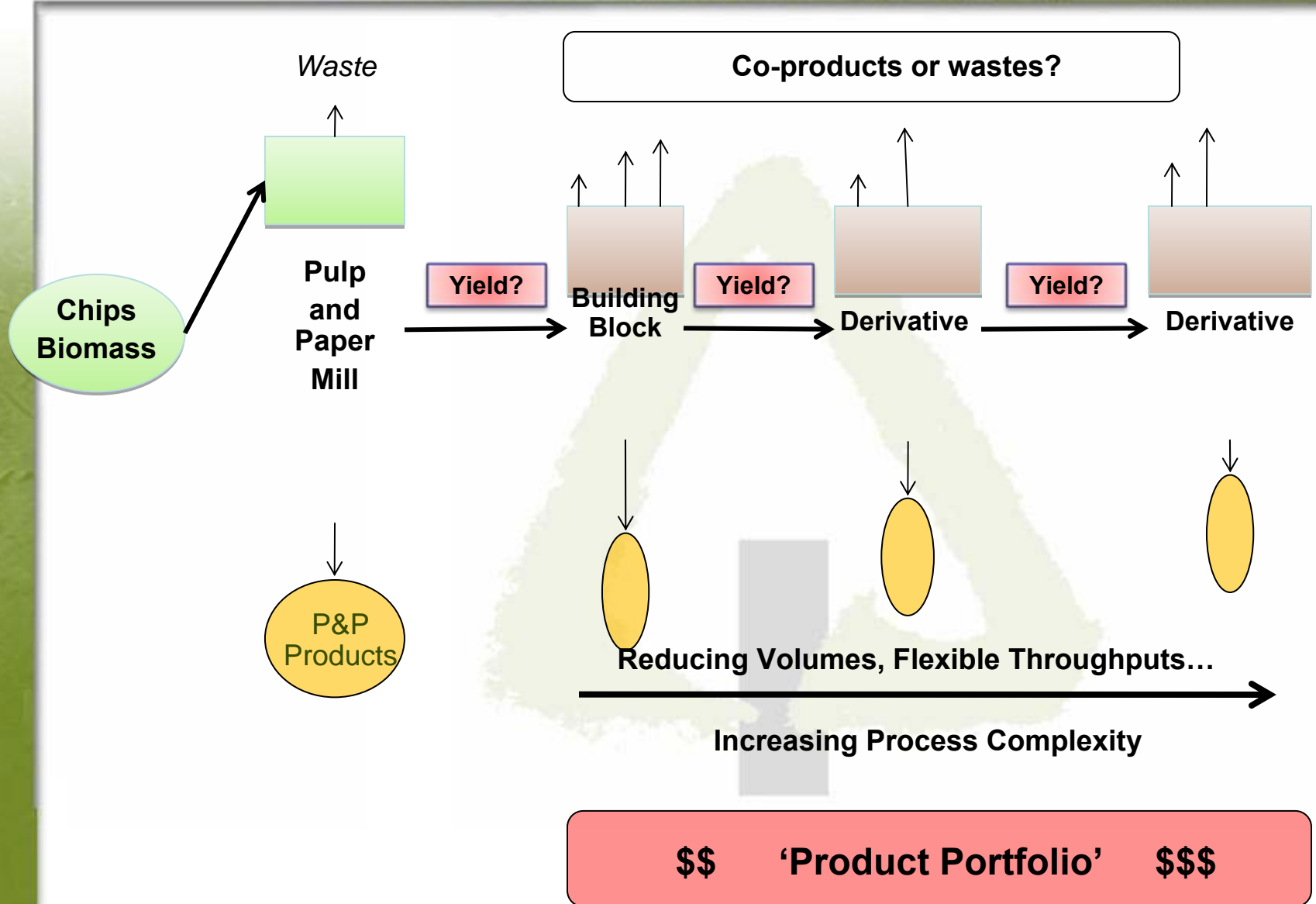
Biorefinery opportunity for
forestry industry



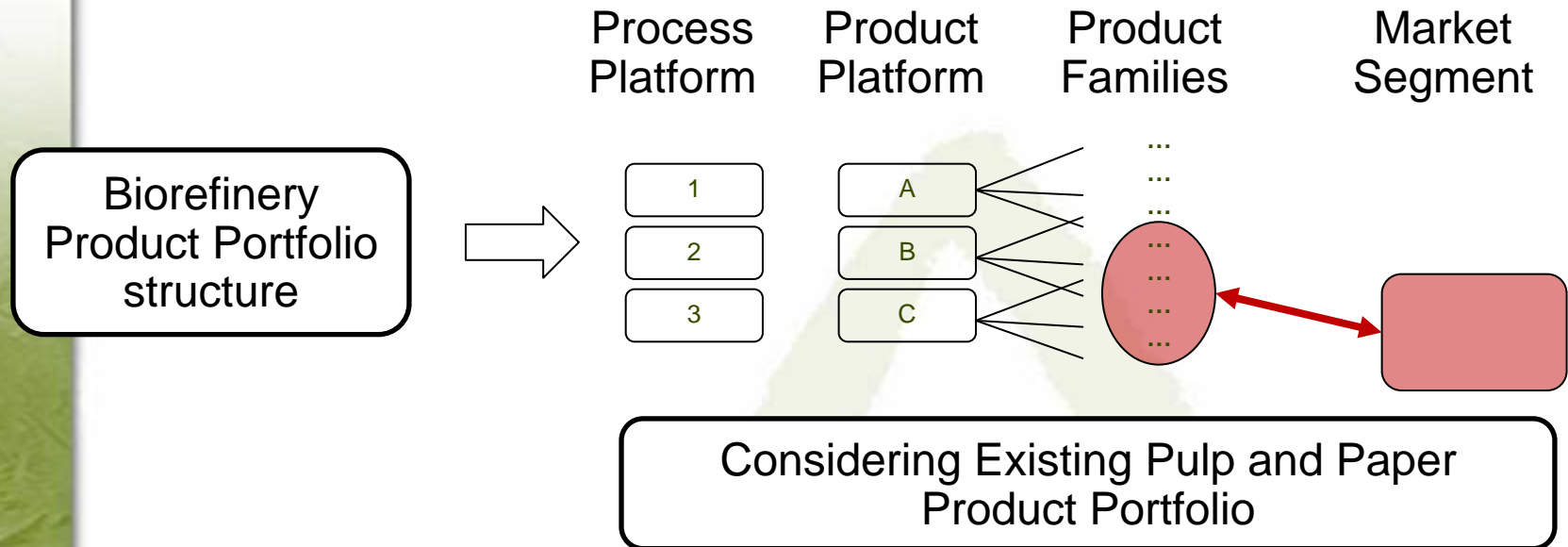
Presentation Objectives

To demonstrate how forestry companies should consider a **market-driven product selection** while establishing their biorefinery strategies, and characterize the implied **company transformation**.

Biorefinery Platform Definitions



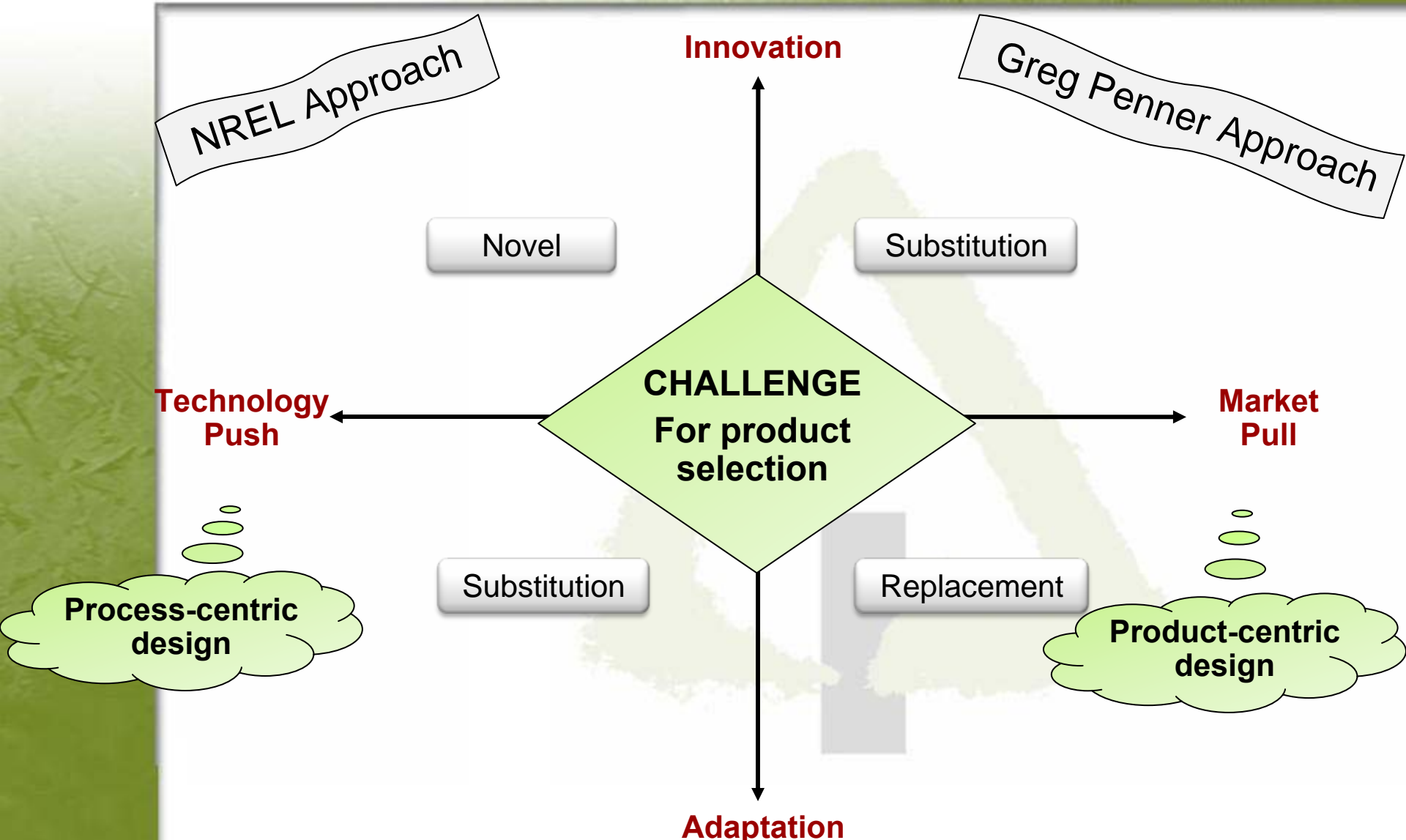
Product Portfolio Definition



Value Chains need to consider long term biorefinery sustainability:

- Unique supply chain is key for competitive position over the longer term
- Production flexibility (supply/demand)
- Margins stability and risk mitigation challenges must be systematically addressed while diversifying the product portfolio incrementally

Product Portfolio for the Forest Biorefinery





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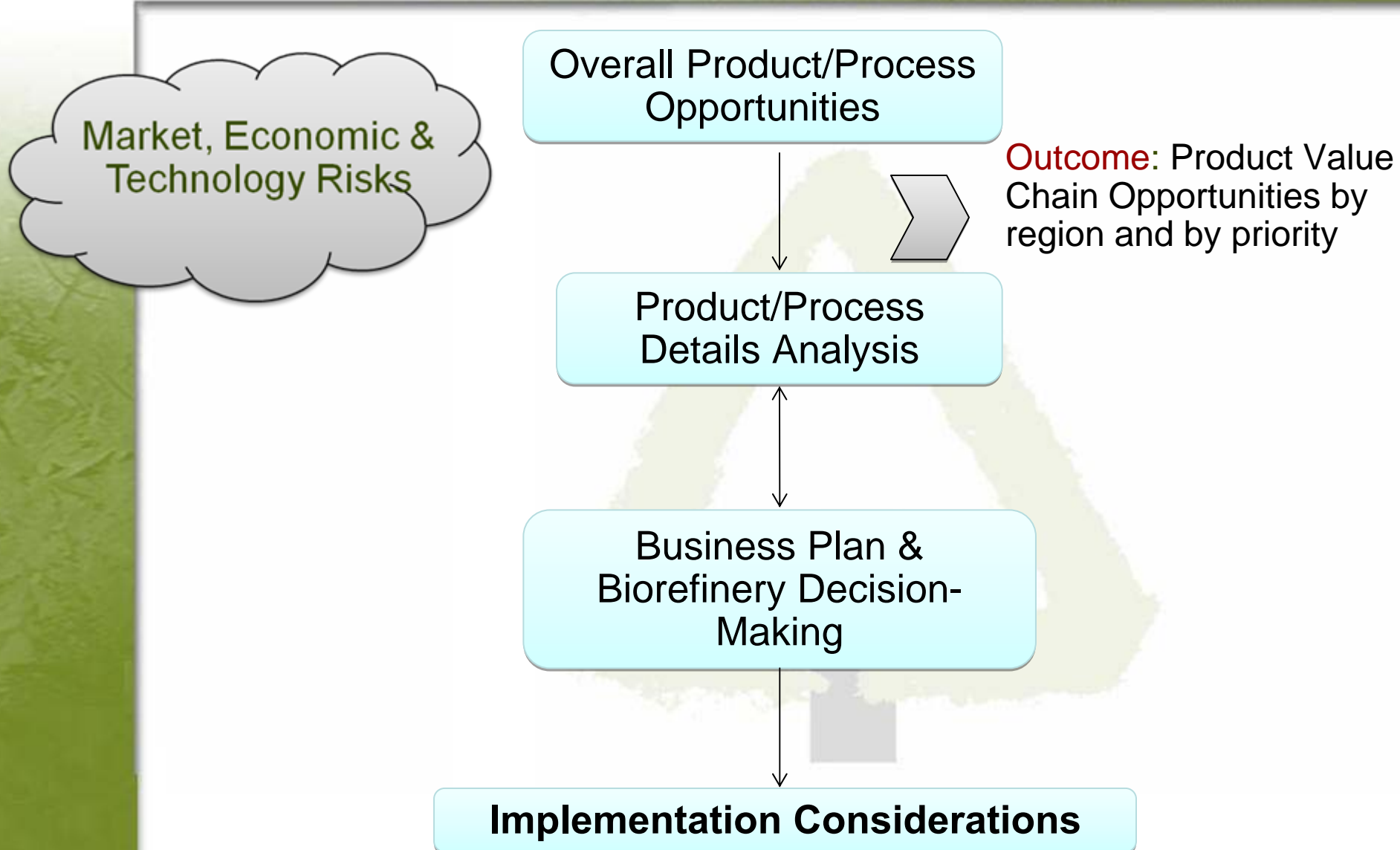
■ Objectives:

- Presenting a **Methodology** for determining the mill-based product portfolio, including building block chemicals and derivatives, while considering product/process design
- Presenting a **Phased Approach** for incrementally implement biorefinery activities while setting a biorefinery strategy

Example based on Ethanol to Ethylene and Polyethylene value chain

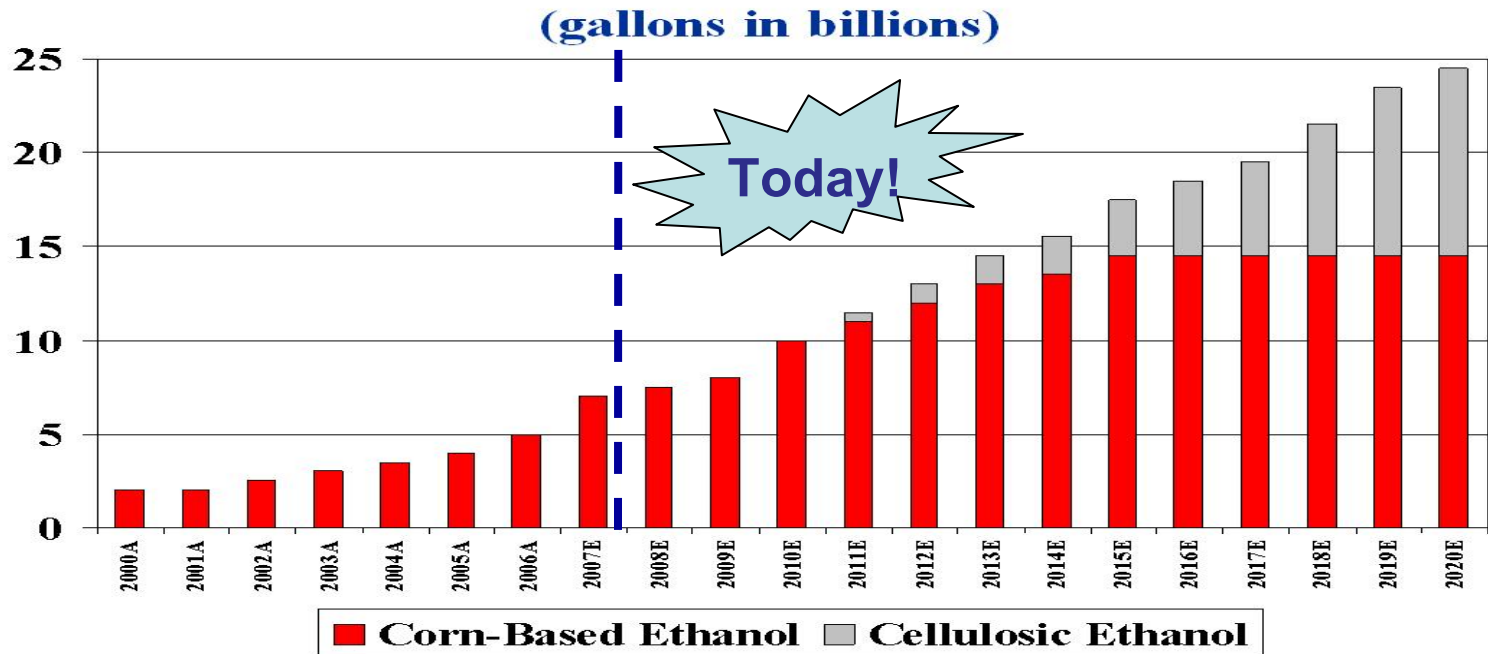
Proposed Methodology to drive the product design:

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Selecting the Most Promising Building Block Chemical

Bank of America Ethanol Forecast



Alternative Energy report by Eric K. Brown

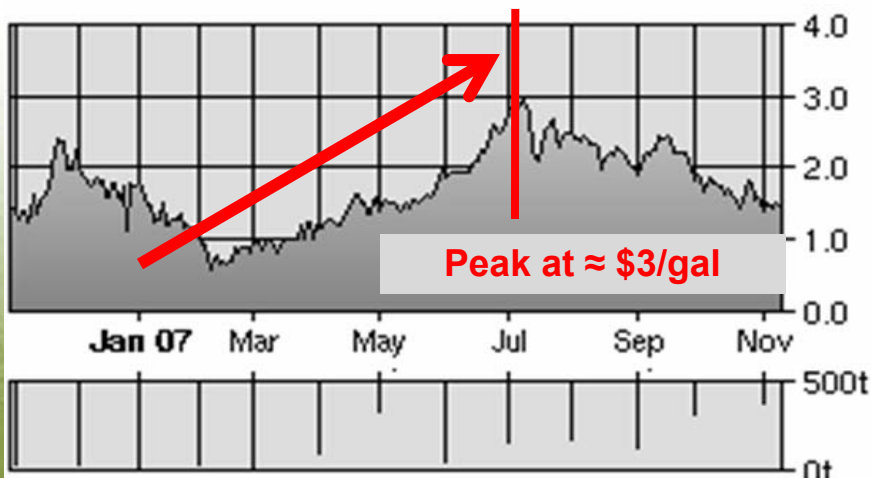
Source: Renewable Fuels Association, National Biofuels Board, Banc of America Securities LLC estimates

Cellulosic ethanol as the most promising building block?

- Large market – supply/demand structure
- Technology know-how is relatively well-developed
- Processing costs need to be lower compared to the conventional process
- Fierce volatility on the market...



Ethanol Price Volatility



Source: Gulf Ethanol Corp

In 6 months: ethanol prices dropped by more than 50%

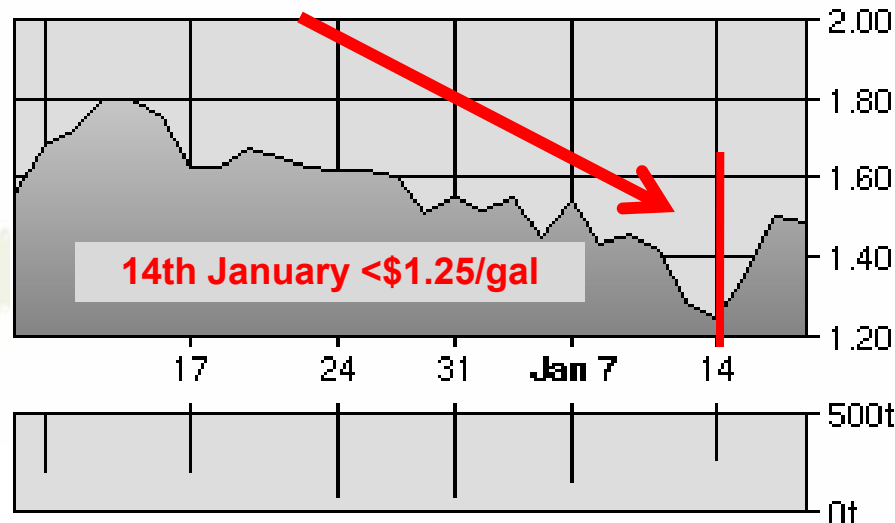
Price is not the challenge, price volatility and competition are

How can we stabilize operating margins in a context of volatility and market uncertainty?

Choosing ethanol as a building block for the biorefinery implementation?

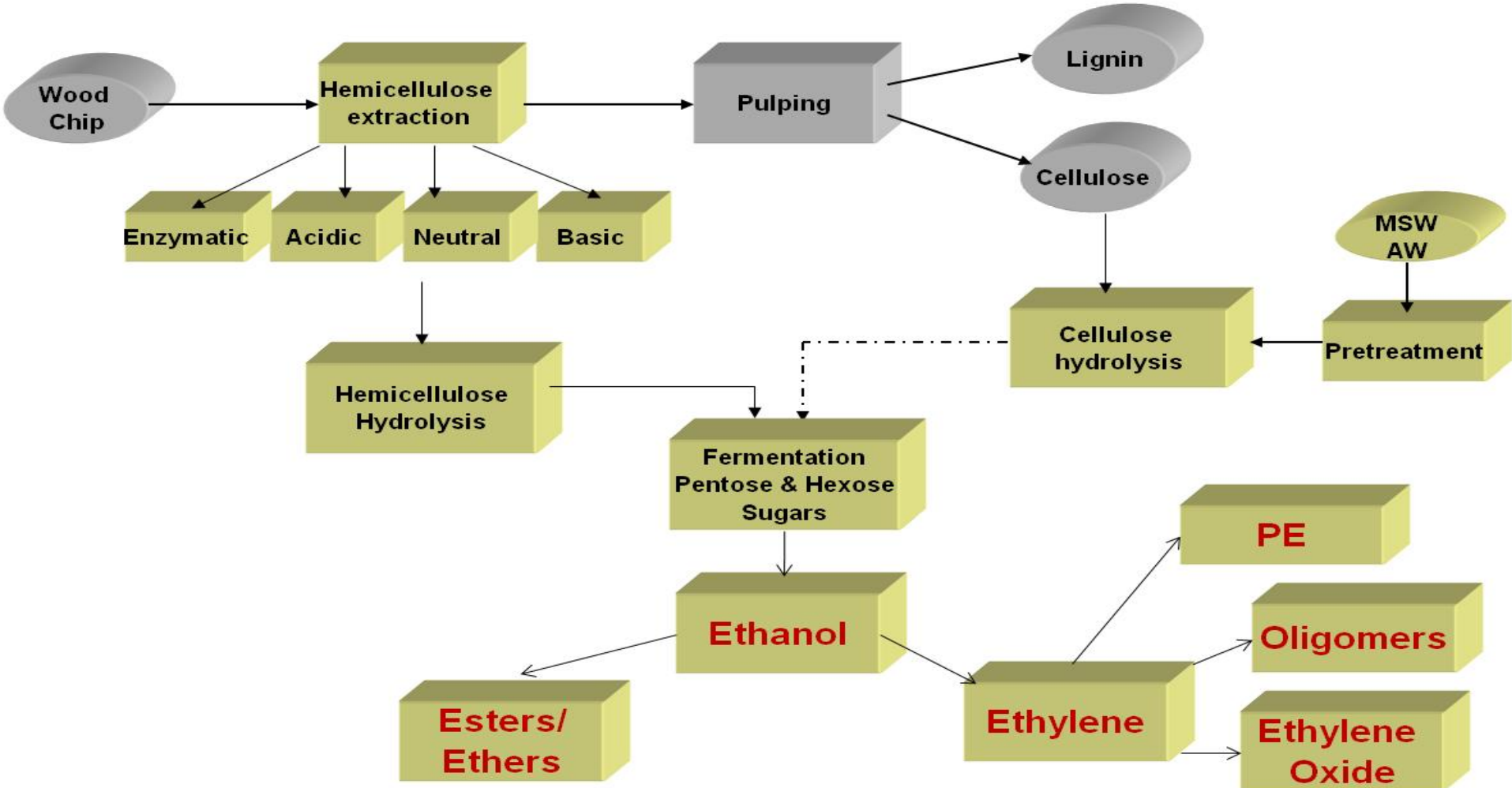
Benefit from increasing ethanol market - there will always be a demand –

Reduce the impact of volatility on biorefinery activities by diversifying the ethanol product family



Source: Gulf Ethanol Corp

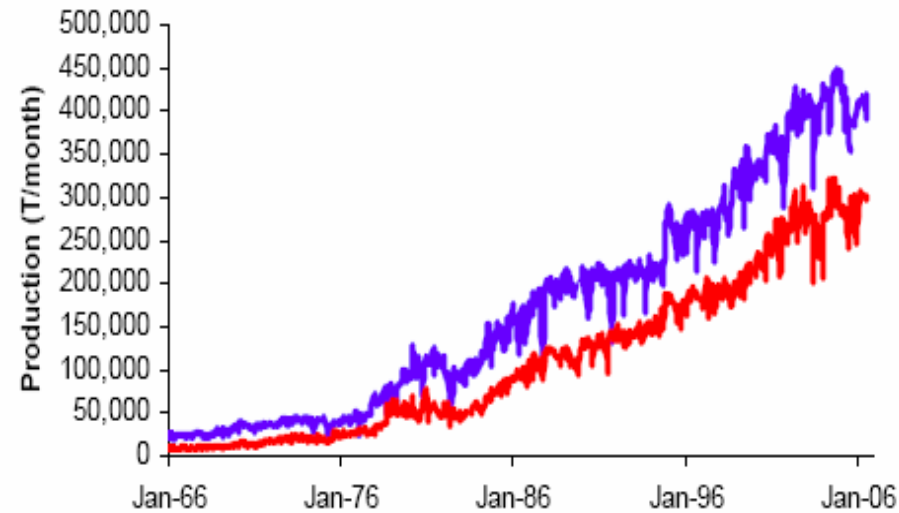
Building a Product Platform



Market Considerations

Greg Penner, market opportunity for biobased chemicals, 2007

— Ethylene — Polyethylene



△ Ethylene to polyethylene value chain in Canada:

- The largest petrochemical value chain in Canada (LLDPE – LDPE – HDPE)
- Sufficient ethylene availability for the polyethylene value chain on a national basis

△ Future challenges:

- Securing the feedstock costs: 'a salient economic driver'
 - 85% of the PE production cost is driven by ethylene cost (driven by natural gas and crude oil price)
- Regional imbalances to be secured:
 - Quebec and Ontario facing negative trade balance for LDPE

△ Opportunities

- Maintain the existing value chain:
 - Develop biomass-based green ethylene at lower cost basis than petroleum-based
- Benefit from the existing value chain:
 - Enter a well-established market
 - Existing Infrastructure - e.g. Nova invested in Flexi-Cracker technology

Technology Considerations

Technical Potential:

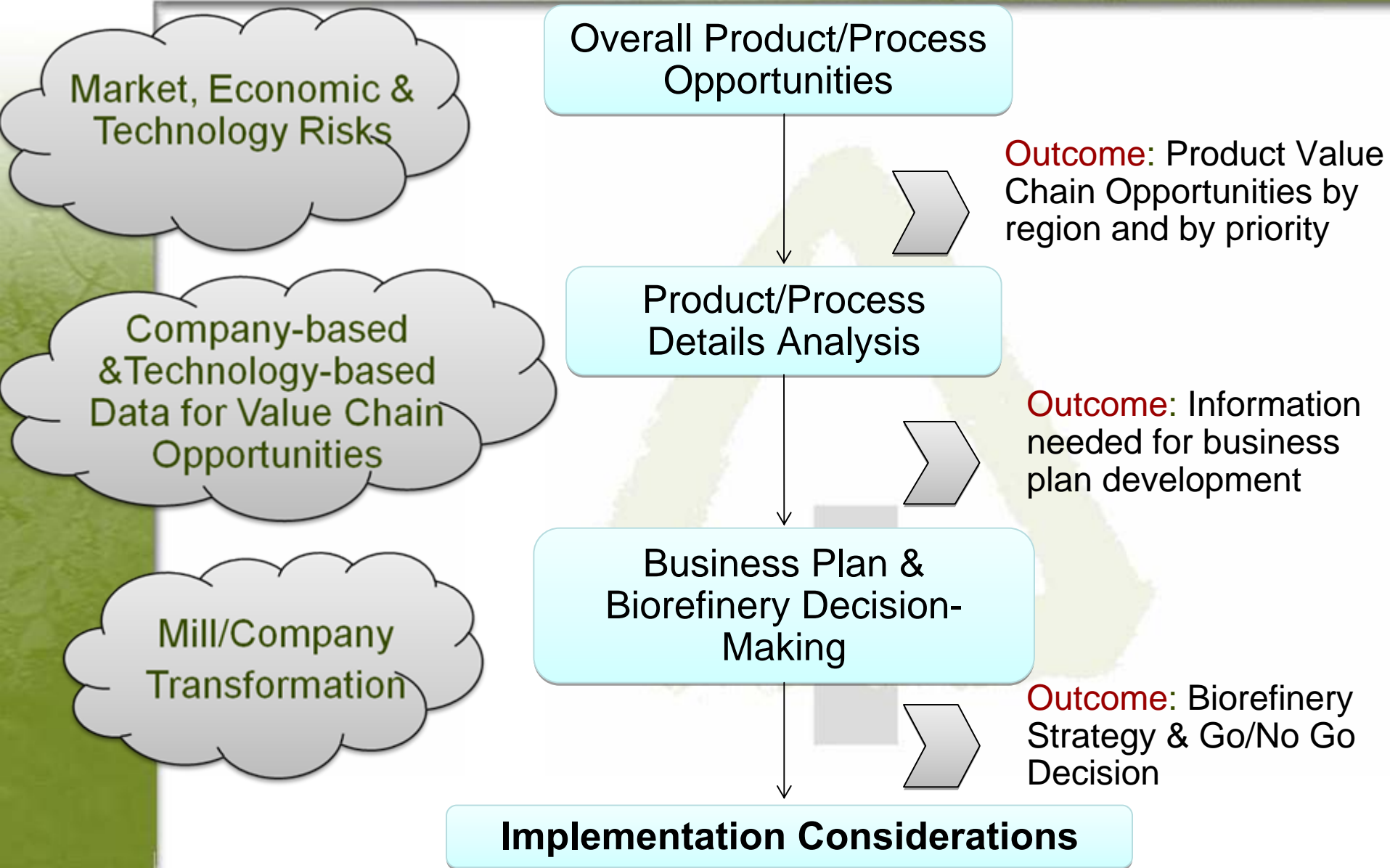
- Conversion of lignocellulosic biomass to ethanol:
 - No commercial scale operation yet
 - Demonstration plants in place will lower technical risks
 - First plants evaluated for scale-up, goal to reduce capital and operating costs of subsequent plants
- Sugarcane ethanol based polyethylene production in Brazil:
 - JV Dow – Crystalsev: 350 000T/y of LLDPE Dowlex by 2011
 - Braskem activities: 120 to 200 000t/y of HDPE by 2009

Economic potential:

- Ethanol production cost will be a driver
- First-to-market will be critical to secure the green market segment for polyethylene

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Phased 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

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...

Core business
transformation
SCM key to
success

Strategic Vision: Phase II must determine Phase I & III

Main challenges

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Margins improve with Enterprise Transformation

Strategic Vision: Phase II must determine Phase I & III



Take-Away Messages

- ⚠ Both inside-out and outside-in **transformations** are implied by the biorefinery product portfolio
- ⚠ The definition of a biorefinery **product portfolio** is critical, and needs to consider **both** market and technical perspectives
- ⚠ These product-centric analyses **are followed by** process design, partner identification, and other key considerations concerning supply chain changes
- ⚠ With the overall strategy defined, transformation to the forest biorefinery is best achieved using a **phased implementation**



Intégration des
procédés dans
l'industrie
papetière

Process
Integration
in the Pulp & Paper
Industry

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Thank you!

