



Creating the Equation for Growth

Opportunities in Natural Fiber Composites

Lucintel Brief

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Lucintel

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Executive Summary

- **Global natural fiber composites market reached \$2.1B in 2010, with compound annual growth rate of 15% in last five years**
- **Automotive & Construction: largest segments among natural fiber composite applications**
 - **Bast fiber such as flax, Kenaf, hemp, etc. are materials of choice for automotive, while wood plastic composite are preferred by building and construction players**
- **North American natural fiber composites market was largest for wood plastic division whereas Europe is leader in automotive segments**
 - **Driven by Government support, environmental regulations, and customer acceptance**
- **By 2016, natural fiber composite market expected to reach \$ 3.8B (10% CAGR)**
- **Strong market opportunities driven by (i) Rising prices of petroleum based products, (ii) strong government support for eco-friendly products, (iii) higher acceptance and (iv) lower price of natural fiber composites**
- **Major challenges for natural fibers composite industry is natural fiber quality, such as fiber degradation during processing, sensitive to humidity and fiber consistency/quality**
- **Performance improvement in materials will drive growth for natural fiber composites in new application areas**







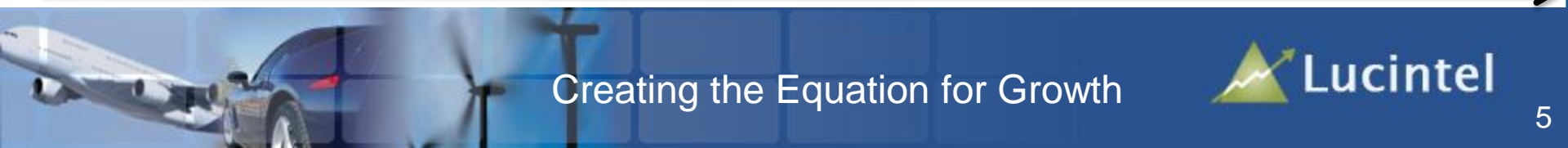
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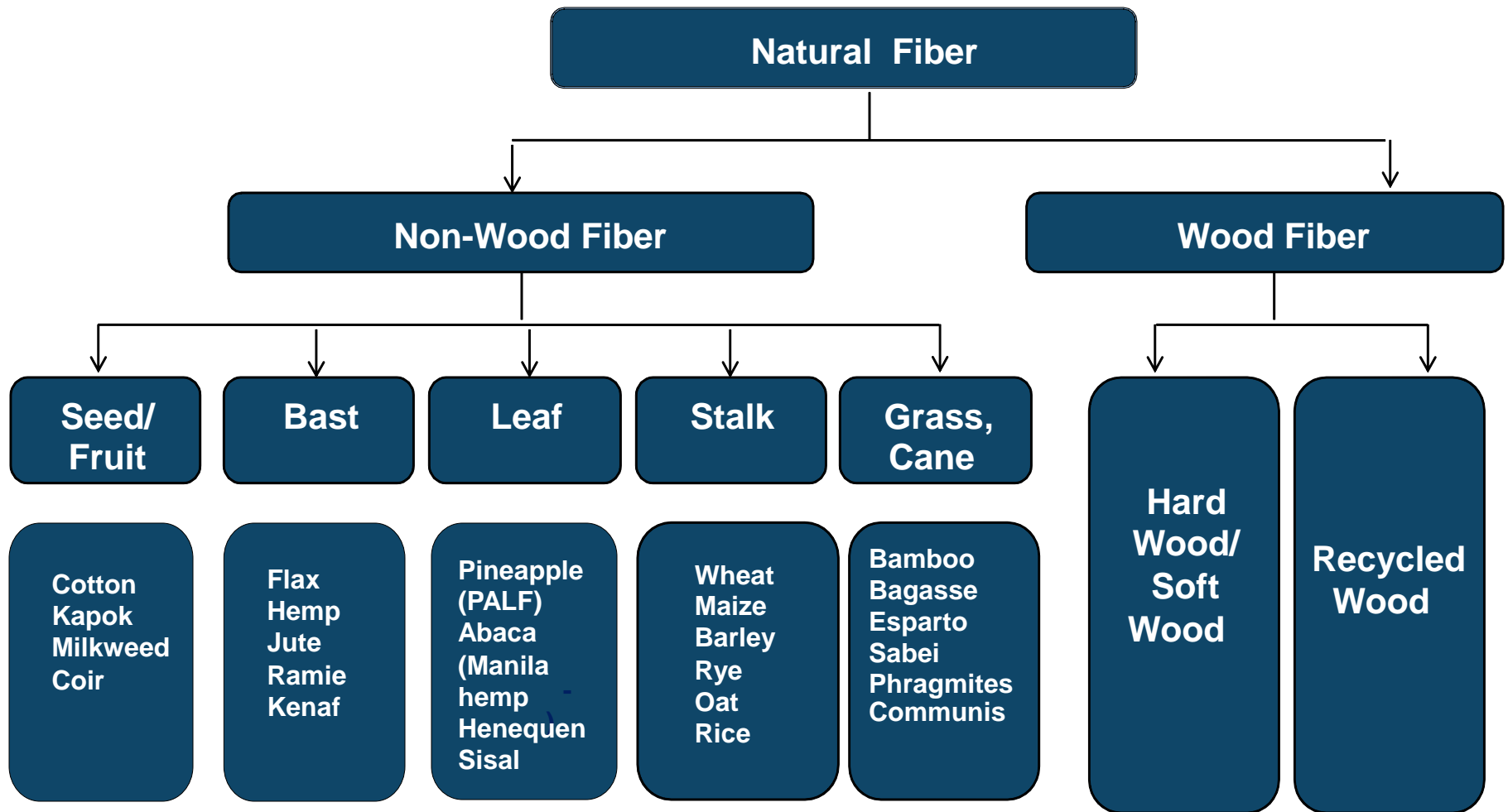


Evolution of Natural Fiber Composites: Henry ford developed first car with hemp fiber but due to economic limitations did not enter the market

Applications	Clay/mud reinforced composites	Fuselage skins of spitfires	Prototype composite car by Henry Ford	Body of "Trabant" car in Germany	Number of Automotive applications	E&E: Cases of cellular phones	Sporting goods
Materials	Straw	Flax+ Phenolic	Hemp	Cotton + Polyester	Flax, Hemp, kenaf, Abaca	Kenaf + PLA	Flax, Hemp, kenaf
Time Frame	In Egypt clay/mud reinforced by straw to build walls.	Shortage of Aluminum in England, led to use natural fiber		First production car built from Natural fiber composites			
Time Frame	3000 year ago	1939	1942	1950-1990	2000 onwards	2004 onwards	2006 onwards



Reinforced Natural Fiber Classification: Vegetable fibers are used as reinforced material with two segments wood and non wood fibers



Natural Fiber Composite Applications



Automotive

Door panels
Seat backs
Headliners
Dash boards
Trunk liners

Compression
Molding
Injection
Molding



Electrical & Electronics

Mobile cases
Laptop cases

Injection
Molding



Sporting Goods

Tennis Racket
Bicycle
Frames
Snowboards

Oven Cure



Construction

Door panels
Decking
Railing
Window
Frames

Extrusion
Compression
Molding
Injection
Molding

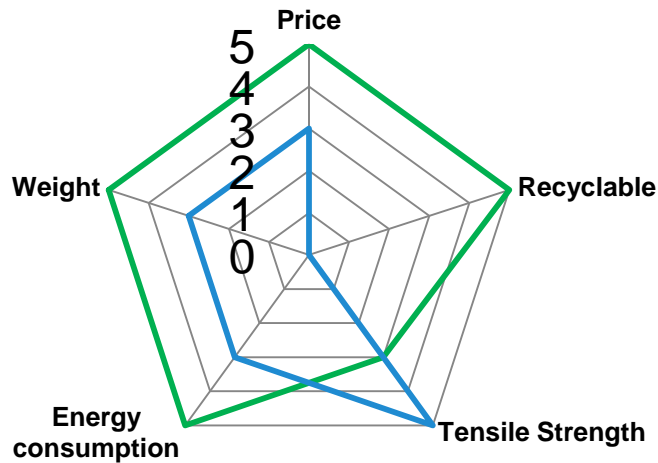


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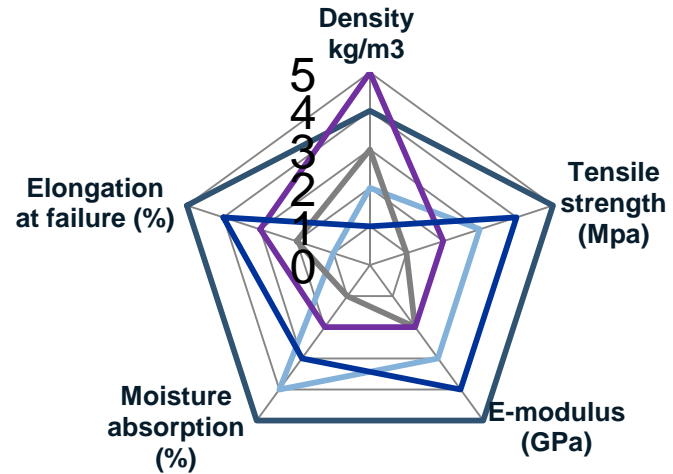
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Competitive analysis: Natural fiber v/s synthetic Fibers



— Natural Fiber — Glass Fiber



— Flax — Hemp — Jute — Sisal — Abaca

- Natural fiber composites excel in most parameters except strength
- Strength of glass fiber composites is higher compared to natural fibers

- Flax fibers offer highest reinforcing potential amongst natural fibers
- Flax offers higher tensile strength compared to others making it suitable for composite applications



Competing Natural Fiber in Different Applications

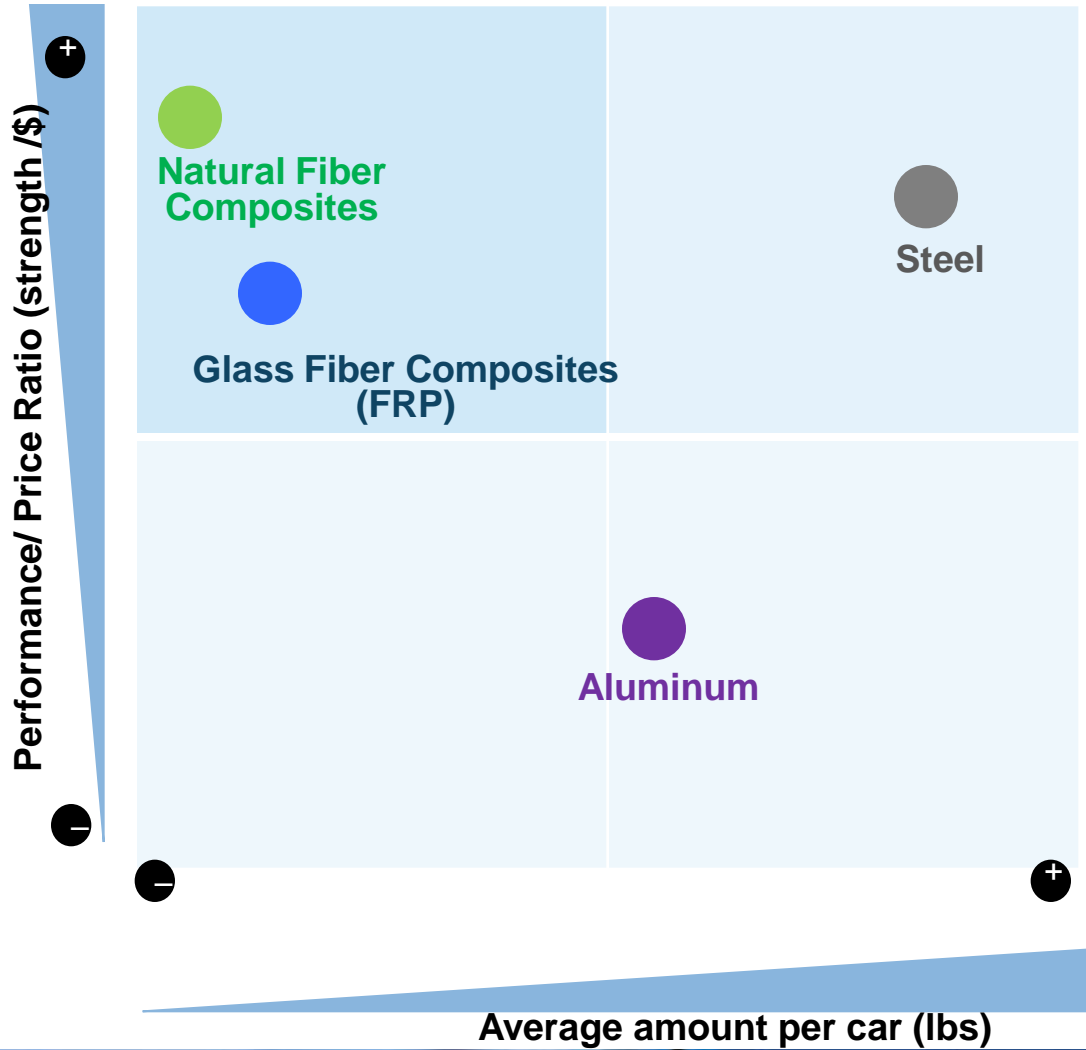
Key Fibers	Automotive	Construction	E & E	Sporting Goods
Flax	●	◐	●	●
Hemp	●	○	○	●
Jute/Kenaf	◐	◐	◐	○
Sisal	◐	○	○	○
Abaca	◐	○	○	○
Wood	◐	●	○	○

● High ◐ Medium ◑ Low-Medium ○ Low ○ None

- Flax, hemp & kenaf are widely used for automotive interior application, with usage of these fibers just begun in E & E and sporting goods applications
- Wood fiber is material of choice for construction due to lower life cycle cost and ease of maintenance
- Past shows European players have strong usage of flax, hemp and kenaf, whereas wood fiber has shown significant growth in North America region



Performance Price Comparison of Competing Materials for Automotive Applications

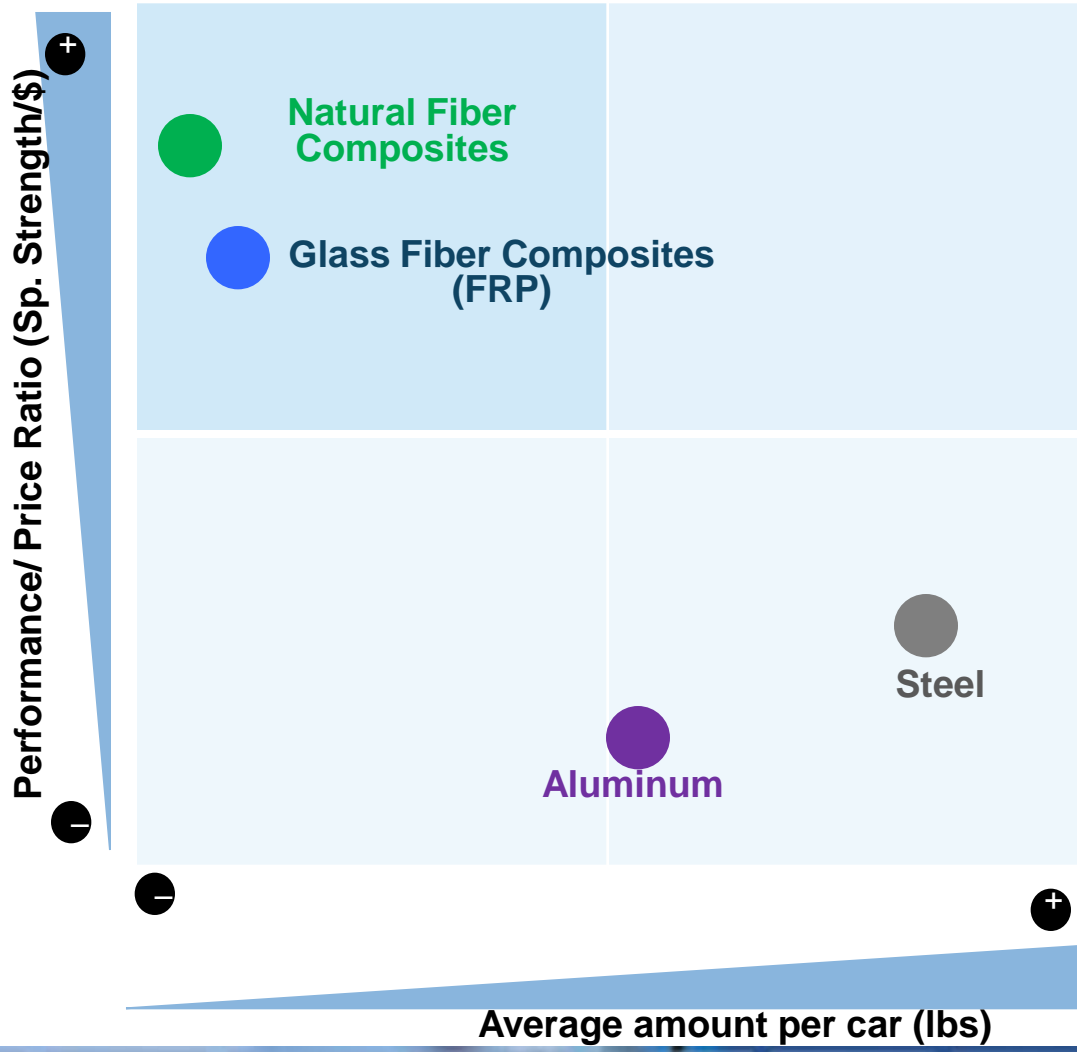


Materials	Average amount per car (lbs)	Performance /Price ratio (Strength/\$)
Steel	2000	1.1
Aluminum	600	0.2
FRP	77	0.7
Natural Fiber Comp.	35.2	1.5

When taking into consideration the density of steel, its relative performance compares well to composites



Performance Price Comparison of Competing Materials for Automotive Applications



Materials	Average amount per car (lbs)	Performance /Price ratio (Specific strength/\$)
Steel	2000	0.15
Aluminum	600	0.08
FRP	77	0.36
Natural Fiber Comp.	35.2	1.15

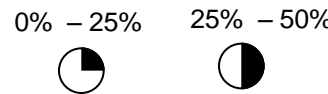
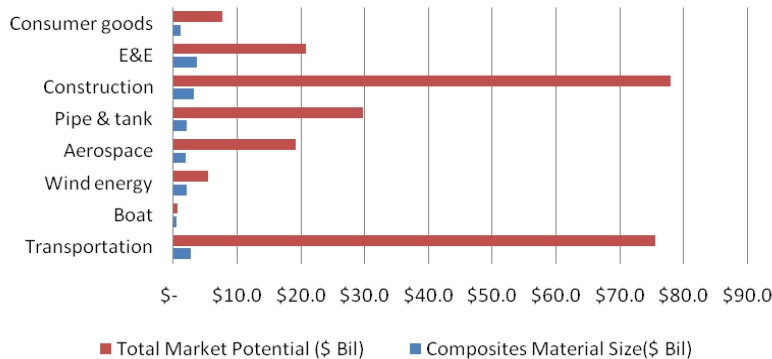
For equal volumes, composites outperforms steel and aluminum. Natural fibers has additional strong penetration potential



Composites (fiber reinforced plastics– glass and carbon fiber based) Penetration in Various Market Segments: Natural fiber composites have significant potential in transportation and construction market

Market Segment	Composite Materials Market	Structural Materials Market (Steel, Al & Composites)	Composites Penetration	Performance Gap	Price Gap
Transportation	\$2.7 B	\$75.7 B	3.6%		
Marine	\$0.5 B	\$0.7 B	68%		
Aerospace	\$2.0 B	\$19.1 B	10%		
Pipe & tank	\$2.1 B	\$29.6 B	7%		
Construction	\$3.1 B	\$78 B	4%		
Wind Energy	\$2.0 B	\$5.4 B	38%		
Consumer Goods	\$1.1 B	\$7.7	14%		

Composites Penetration compared to Competing Materials (Steel & Al)



Source: Lucintel

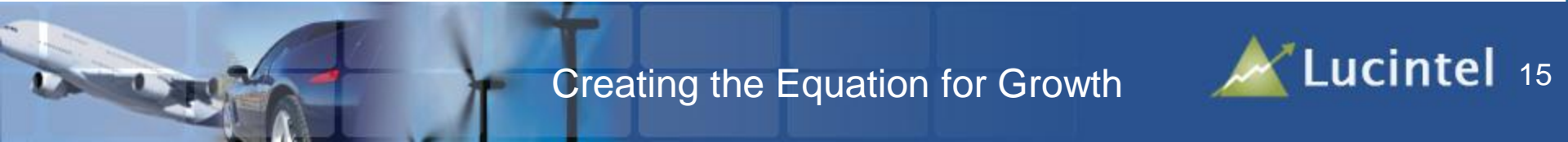
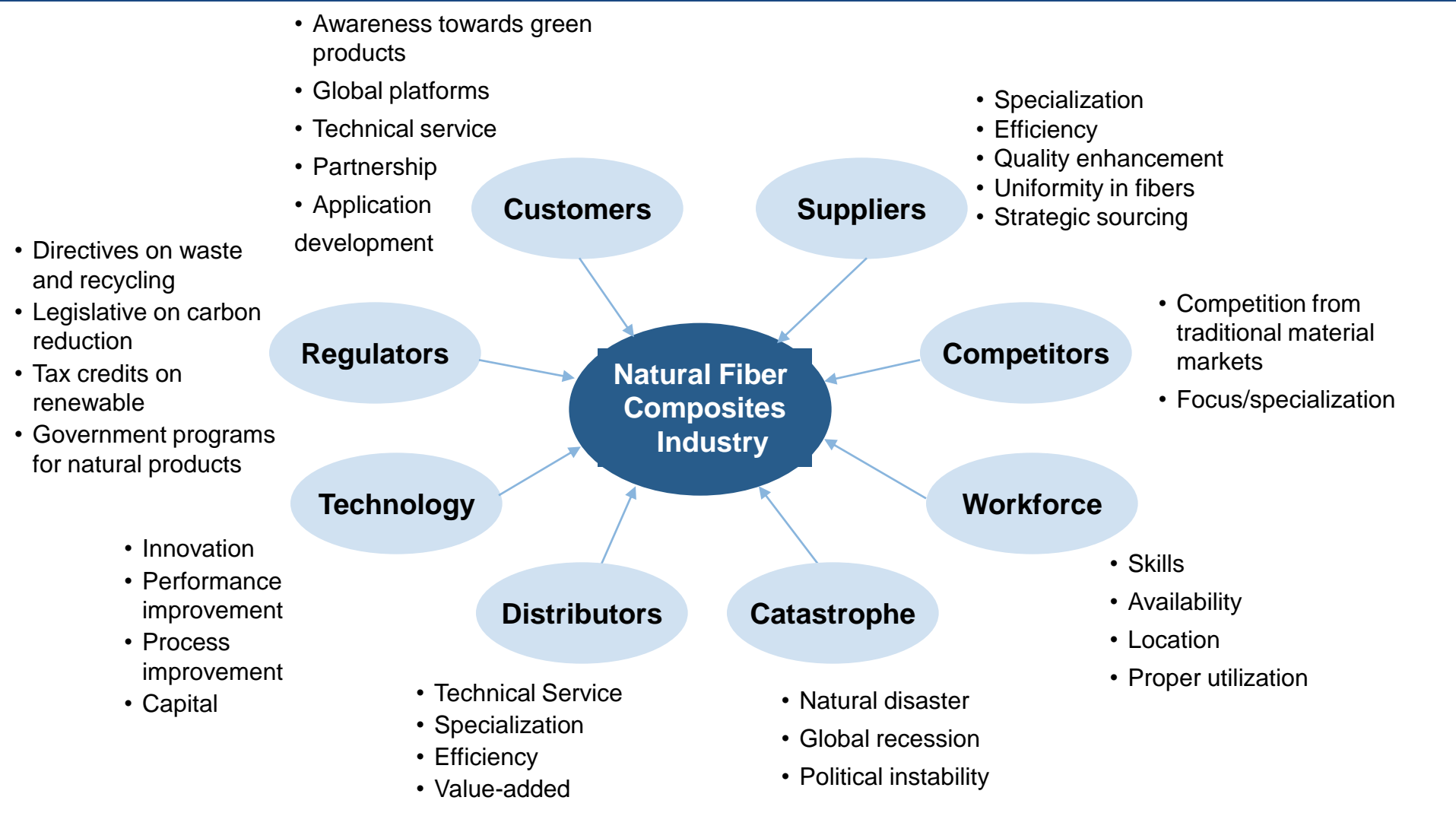


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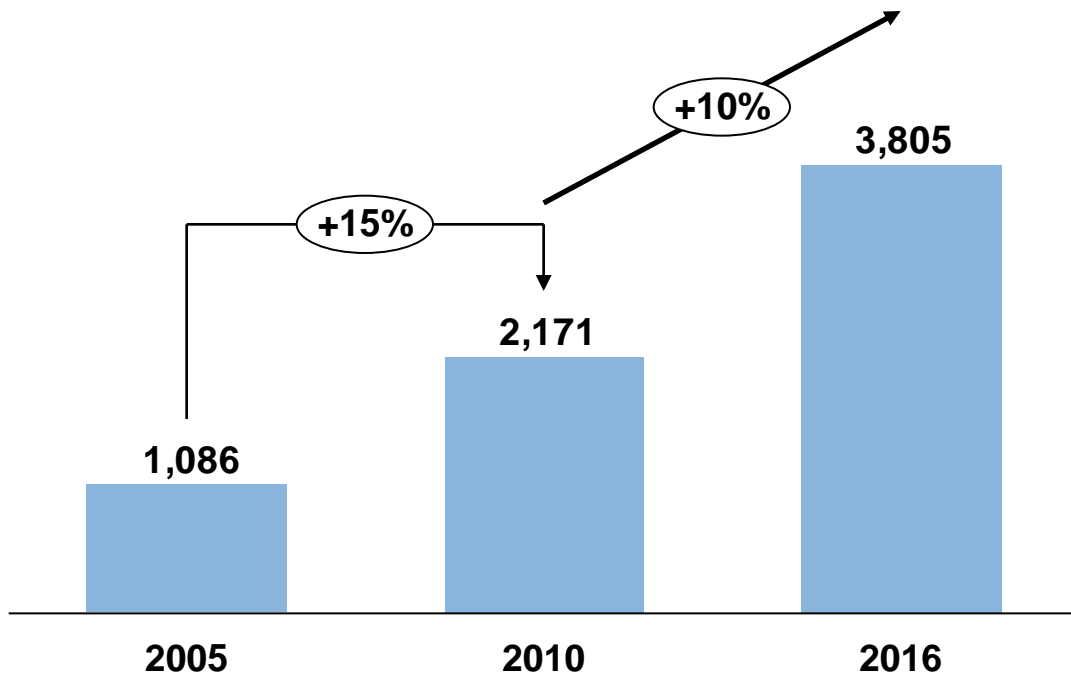


External Forces Shaping the Natural Fiber Composites Industry: Future higher market fragmentation expected due to emerging economies. Companies in Developed nations with innovation capability can thrive and gain share.



Natural Fiber Composites Trend and Forecast 2005 - 2016

Natural Fiber Composites Trend & Forecast 2005 – 2016 (US\$M)

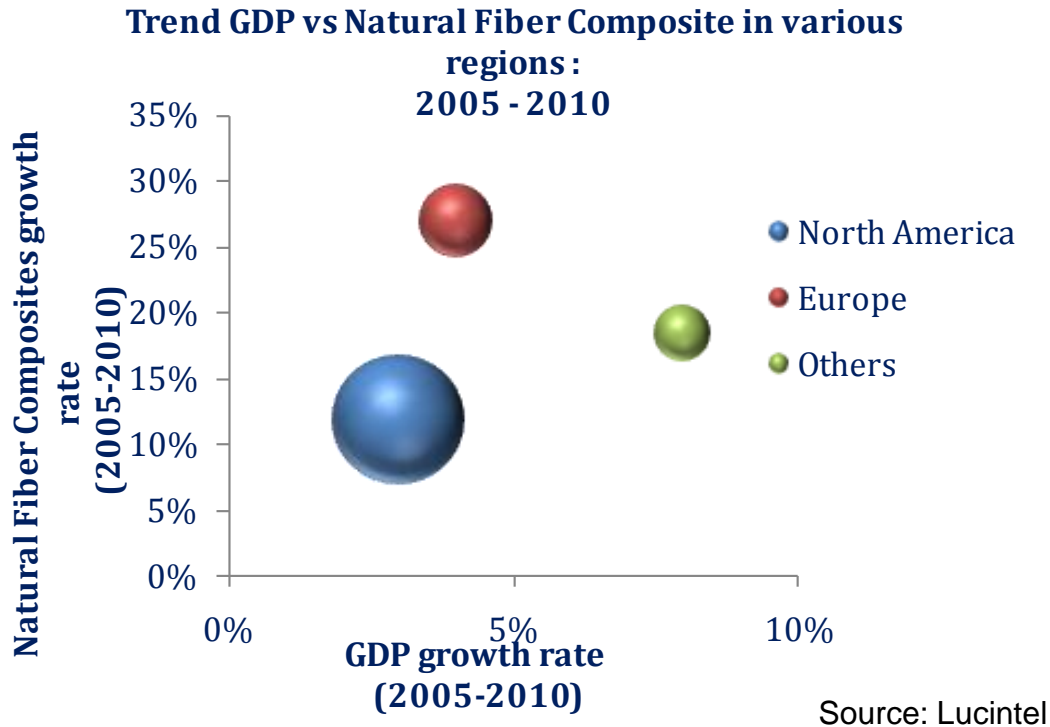


Notes: Market includes wood and non wood natural fiber composite markets

Key Insights

- Natural fiber composites has experienced healthy growth in last 5 years
- Market has two segments: wood fiber and non-wood fibers
 - Automotive is largest segment for non-wood fibers
 - Construction is for wood fibers
- Europe is largest region for Automotive applications
- North America is largest region for Building & Construction applications
- Natural fiber composites are new to E&E and Sporting goods applications
- Environmental concerns are making natural fiber composites suitable in various new applications

Trend in GDP in Various Regions : 2005 - 2010



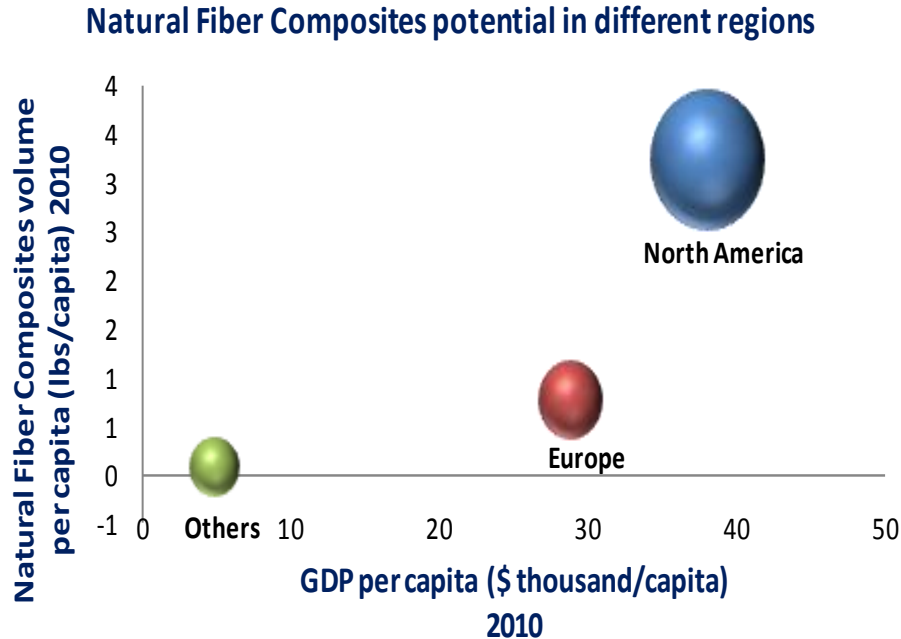
Notes:

- Others includes Asia and rest of the world
- Bubble size represents market size 2010 (\$ M)

- Natural fiber composites has observed positive growth in each region, and surpassed GDP growth
- Natural Fiber Composites industry performed well relative to GDP during last 5 years, and is expected to continue to grow higher than GDP over next 5 years



Natural Fiber Composites Potential in Different Regions



Source: Lucintel

Notes:

- Others includes Asia and rest of the world
- Bubble size represents market size 2010 (\$ M)

Market Leader:

- North America is leader in natural fiber composites consumption followed by Europe

Potential Market:

- Europe shows potential due to increasing awareness and acceptance of natural fiber composites by automotive players
- Asia has significant growth potential as penetration per capita is significantly lower than developed nations

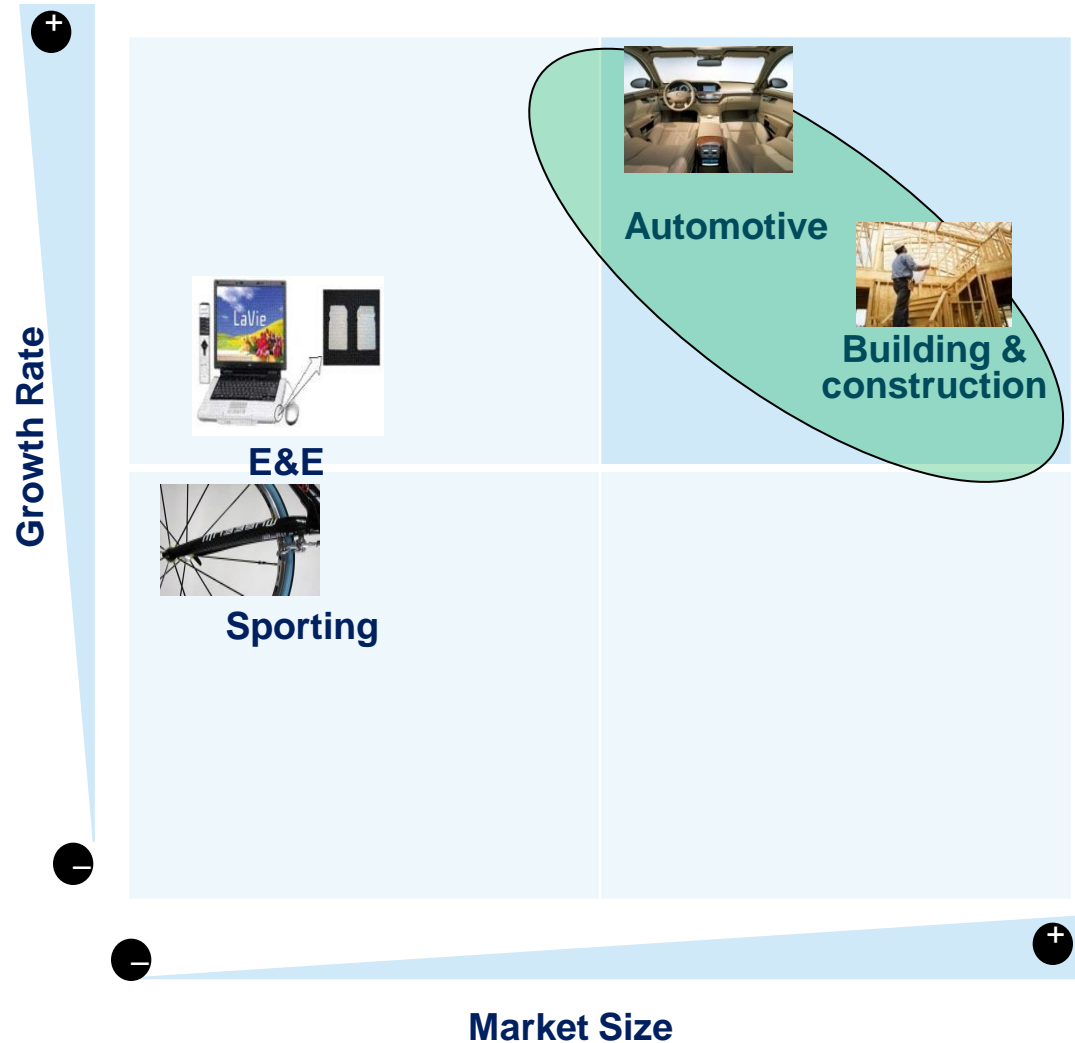


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Growth Opportunities of Natural Fiber Composites in Various Applications



Key Insights

- Demand for natural fiber composites expected to be high in automotive and construction applications due to:
 - Awareness towards green products and increasing acceptability
 - Need for light weight and cost effective products
 - Reduce global warming impact
 - Governmental support
- Natural fiber composites are new in E& E and sporting segments, but has healthy potential to capture good market share in near future

Drivers and Challenges

Major Drivers

Raw material source

- Natural fiber composites made with easily available renewable sources

Properties

- Lighter weight, low energy consumption and low cost product

Volatility in Oil prices

- Impacts substitute materials market and NFC costs less so
- Encourage world to use NFC

Environmental advantages

- Natural fiber composites are eco friendly and help to reduce global warming effect

Government Support

- Legislative/policy commitment to carbon reduction

Key Challenges

Material quality

- Uniformity and consistency of raw material are major industry challenges
- Lower impact strength, not suitable for applications requiring optimal strength
- Low UV resistance limits market

Processing

- Natural Fiber variability and subsequent degradation while manufacturing composite products
- Technological improvements needed

Inventory of raw material

- Fibers are hydrophilic which drives potential degradation and biological attack by fungi
- Subsequent difficulty to store for long periods of time made more acute by dependency on seasonal production

Innovations in Natural Fiber Composites Market



Eco Mobile by NEC 2006:

- First time in world an environmentally sound material has been used for a mobile phone casing

Model Name:

- “FOMA(R) N701iECO”

Material used:

- Reinforcement: Kenaf
- Resin: Poly Lactic acid

Advantages

- Heat resistant
- Environment friendly



Innovations in Automotive:

1.OEM & Model Name:

- Ford Motor Co., 2010 FordFlex CUV

Applications:

- Trim bin

Material & Process:

- Wheat-Straw-Reinforced PP, Injection molding

2. OEM & Model Name:

- BMW 2008MY BMW 7 Series Luxury Sedan

Applications:

- Door Panel

Material & Process:

- Prepreg of Natural fiber with acrylic polymer, Compression molding

3.Process Innovation

- Highly automated D-LFT process by Damlier Chrysler



Racing Bicycle with NFC:

- Museeuw Bikes has developed first racing bike with flax carbon epoxy prepreg

Model Name:

- MF1, MF3, MF5

Material used:

- Reinforcement: Flax, Hemp
- Resin: Epoxy

Advantages

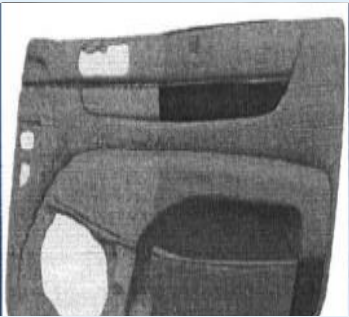
- Good anti-vibration property
- low cost



Natural fiber in automotive applications: Bast fiber such as flax, hemp & kenaf are most suitable natural fibers for various automotive applications and are focused on lower strength needs



Interior Door Panel



Door Panel



Door Inserts

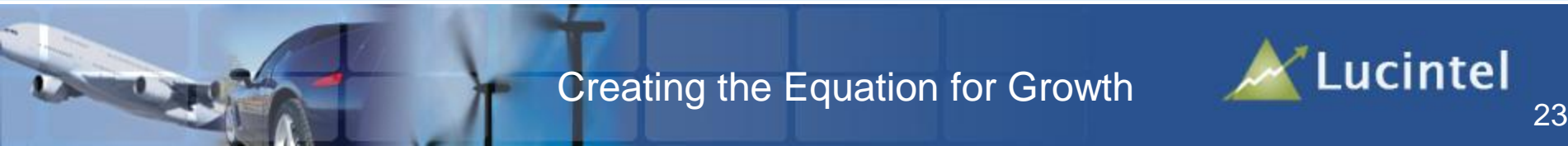
Applications	Fiber	Size of Opportunity	Advantages	Disadvantages
Door panel/inserts	Kenaf/ Hemp Wood fiber	Medium	<ul style="list-style-type: none"> • Lower weight • Lower cost • Eco friendly • Friendly processing • Thermal recycling is possible • Good thermal and acoustic insulation 	<ul style="list-style-type: none"> • Lower strength • High moisture absorption • Lower durability • Poor fire resistance
Rear parcel shelves	Kenaf Flax	Medium		
Seatbacks	Flax	Medium		
Spare tire covers	Flax	Medium		
Other interior trim	Kenaf Flax	Small		
Spare-wheel pan	Abaca	Medium		





DaimlerChrysler's model with abaca + pp



Mercedes E class reduced 20% weight with NFC



Emerging Natural Fiber Composite Applications in Construction

	Applications	Fiber	Size of Opportunity	Key Drivers	Disadvantages
 <p>Decking</p>	Decking	<ul style="list-style-type: none"> • Wood flour/fiber: mainly natural wood alternatives construction applications 	High	<ul style="list-style-type: none"> • Low life cycle cost • Low & easy maintenance • Low moisture absorption • Lower variability than wood 	<ul style="list-style-type: none"> • Lower strength • High moisture absorption • Lower durability • Poor fire resistance
	Railing Systems		High		
	Window frame		High		
	Fencing		Medium		
 <p>Railing</p>	Panels	<ul style="list-style-type: none"> • Flax • Rice husk • Bagasse 	High	<ul style="list-style-type: none"> • Eco friendly • Government regulation 	



Window frame

Panels



Fencing

Door frame



Creating the Equation for Growth

Natural fiber in other applications: Flax and kenaf fibers have strong penetration in sporting goods and electronics applications

	Applications	Fiber	Size of Opportunity	Advantages	Disadvantages
	Tennis Racket	Flax	Medium	<ul style="list-style-type: none"> • Good anti vibration • Lower cost • Eco friendly 	<ul style="list-style-type: none"> • Lower strength • High moisture absorption • Lower durability • Poor fire resistance
Laptop Cases	Bicycle Frame, Fork, Seat Post	Flax	Medium		
	Snowboarding	Hemp	Small		
	Mobile Cases	Kenaf	Medium		
	Musical Cases	Laptop Cases	Flax		



Bicycle with NFC frame



Tennis Racket



Snowboard

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Natural Fiber Composites Market Potential Analysis in Automotive in 2015

Applications

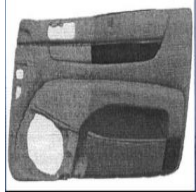
NFC Potential in 2015

NFC Potential Strength Improvement

Door Panels

Door inserts

Shelves



145 M lbs
US\$ 72 M

@ Current Strength

Spare wheel pan cover

Headliners



234 M lbs
US\$ 117 M

@ 25% Improvement

Bumpers

Protection trim



324 M lbs
US\$ 162 M

@ 50% Improvement

Source: Lucintel

Methodology: Sensitivity analysis between consumption volume & strength performance of natural fiber

Conclusions

- **New business models need to be re-invented to address the fast changing complex world**
- **Higher specific properties with lower prices of natural fiber composites are making it attractive for various applications**
- **Good anti-vibration properties & low cost are key drivers for higher adoption of natural fiber composites in sporting goods segment**
- **Due to lower life cycle cost & easy maintenance of wood plastic composites, it is gaining more acceptance in building & construction applications**
- **Eco-friendly measures taken by electronic companies are the major growth drivers for natural fiber composites in Electrical & Electronics applications**
- **Rising prices of petroleum based products, strong government support to eco-friendly products, higher acceptance and positive growth of end use industries will drive natural fiber composites growth to new horizon**
- **Performance improvement of natural fibers will help to cater more applications and industries in near future**



Conclusions

- **New business models need to be re-invented to address fast changing complex world**
- **Higher specific properties with lower prices of natural fiber composites are improving attractiveness for various applications**
- **Good anti-vibration properties & relative low cost are key drivers for higher adoption of natural fiber composites in sporting goods segment**
- **Due to lower life cycle cost & easy maintenance of wood plastic composites, gaining more acceptance in building & construction applications**
- **Eco-friendly measures taken by electronic companies are major growth drivers for natural fiber composites in Electrical & Electronics applications**
- **Rising prices of petroleum based products, strong government support to eco-friendly products, higher acceptance and positive growth of end use industries will drive natural fiber composites growth**
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Composite Materials

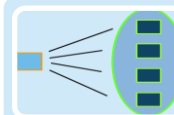
Consulting



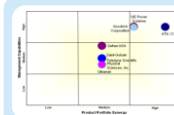
Growth and Strategic Consulting



Benchmarking



Opportunity Screening



Partner Search and Evaluation



Due Diligence and M&A



Market Entry Strategy

Lucintel has an extensive toolkit to address key strategic questions for increasing your company's profitability and market presence



Key Questions

- **Is market space / opportunity of current product offerings sufficiently robust?**
- **Markets are focus for many: how can my company profitably differentiate?**
- **Based on our core skills, where should we focus?**
- **Should we build or buy? Is build even an option?**
- **What game changer actions exist and/or is a more incremental approach best?**
- **What is the order sequence of market entry segments / products?**

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