

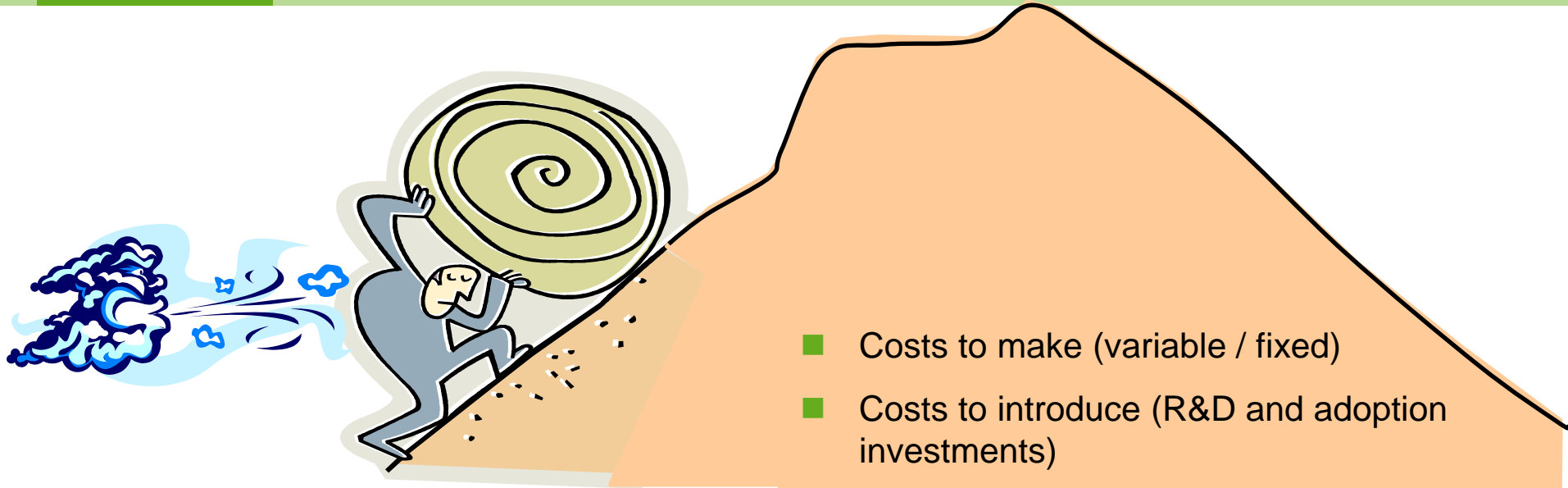


Bio-Based Materials: *Ready for Mainstream?*

Natural Fiber Composites Bio-based and Bio-Degradable materials

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Changing a material or a technology: *Drivers and Barriers – in general*



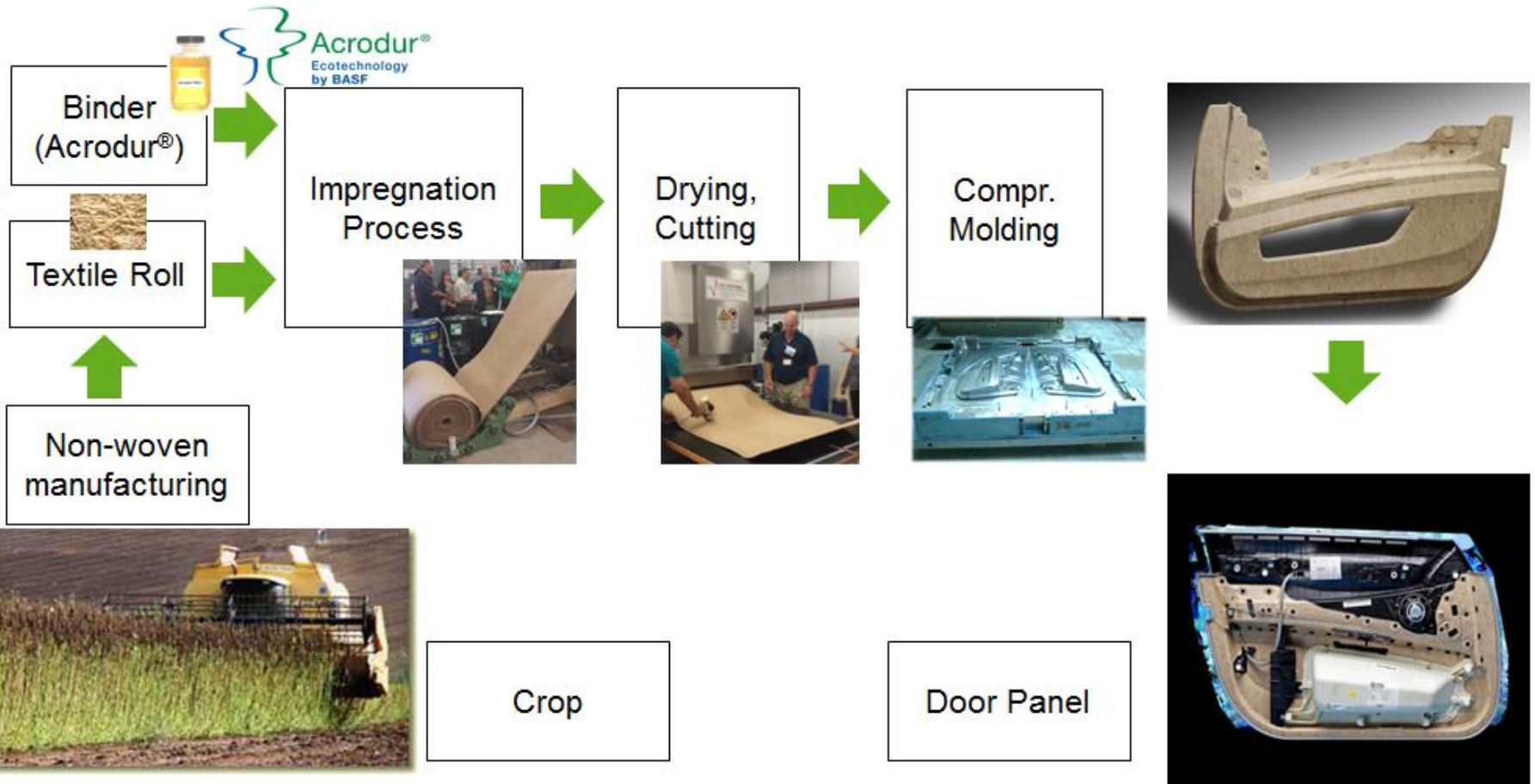
- Advantageous performance
- Advantageous economics
- Excitement (consumer demand, trends)
- Availability (new or incumbent)
- Regulation

- Costs to make (variable / fixed)
- Costs to introduce (R&D and adoption investments)
- Design adjustments needed
- Risks (manufacturing processes, robustness in function, lack of experience, ...)
- Availability (robustness in supply chain)
- Regulation
- Fears (mindsets, perceptions, beliefs)

Natural Fiber Composites: *What is it?*



Natural Fiber Composites: *... from the crop to the door panel .*



Natural Fiber Composites

Ready for mainstream?

Advantages:

- Composite usage in automotive is growing to addressing need for light weighting:
 - Enable lighter, thinner parts
- Interest in renewable materials is growing
 - addressing need for “green”.



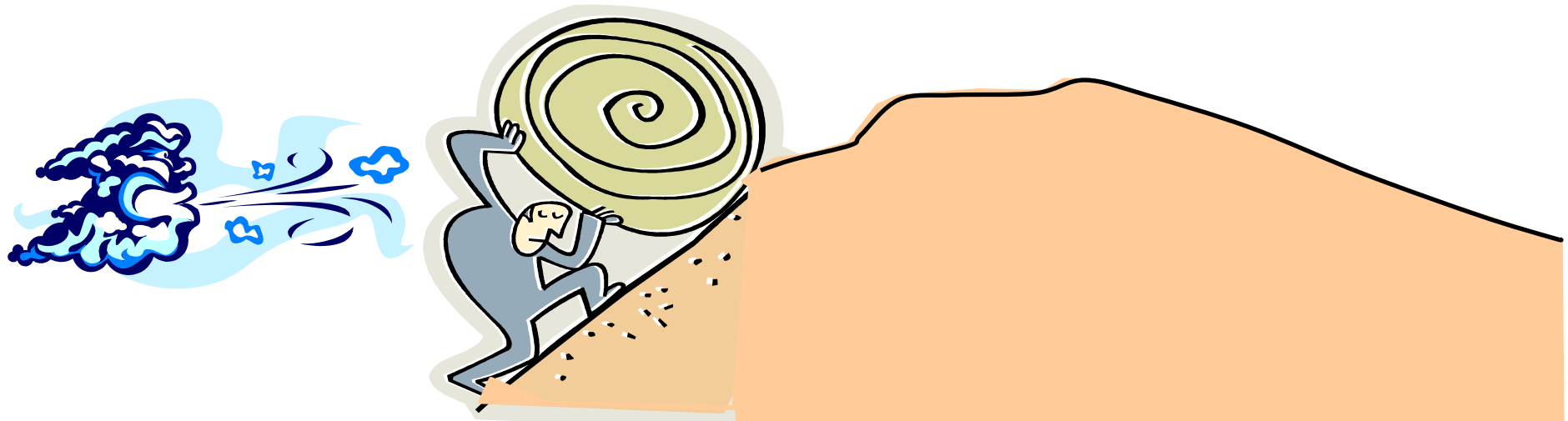
Ready?

- To determine readiness for mainstream, change drivers and barriers need to be reviewed...

let's do that!



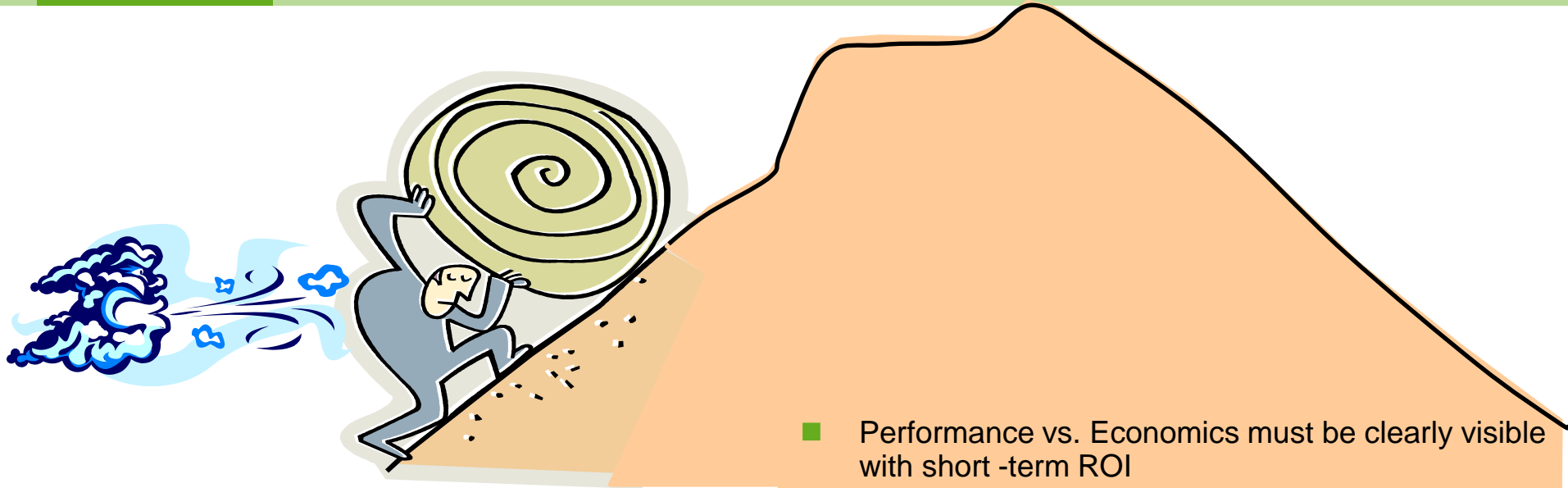
Natural Fiber Composites: *Drivers and Barriers – Europe*



- Strong demand for biomaterials – even at the consumer level
- Very strong fuel efficiency need drives light-weighting demand
- Good availability of natural fibers in region
- Willingness to invest with long-term ROI
- OEM's often want to be “first-to-market”

- Piece cost and implementation cost critical but at slight premium can be accepted
- Risks critically considered
- Technological innovation often offset by conservative, “slow” decision-making.

Natural Fiber Composites: *Drivers and Barriers – NAFTA*



- Call out for biomaterials exists – behind the economics
- (Consumer pull not a main factor)
- Fuel efficiency regulations drive strong light-weighting demand

- Performance vs. Economics must be clearly visible with short -term ROI
- OEM's / Tiers want proven solutions
- Piece and implementation cost can be a barrier to prevent new technologies.
- Premium for green solution mostly not accepted
- Risks considered even more carefully than in Europe
- Technological innovation often offset by conservative, “slow” decision-making.

Natural Fiber Composites: Binder Comparisons

- Natural Fiber – Polypropylene
 - Already in many applications in automotive interior



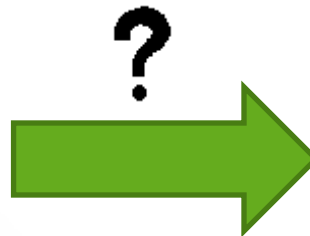
- Thermoplastic forming is relatively simple (does not require hot tools)
- Good weight savings / strength potential

- **BASF Acrodur[®] thermosets / thermoplastics**
 - Improved NF content



- Further advantages proven for weight vs. performance
- Improved thermal stability
- Molding requires hot tool (thermoset version only), wet impregnation is new process

Natural Fiber Composites: *Bio-Based Polymers for Binder?*



Petro-B.
Binder (28%)

Natural
Fiber (72%)



BIO-Based
Binder (28%)

Natural
Fiber (72%)

Natural Fiber Composites: *Bio-Based Polymers for Binder?*



- Performance – can be comparable.
- Excitement – yes and no!
- Availability – yes
- Regulation - questionable

- Costs to make – premium likely
- Costs to introduce – at raw material supplier
- Design adjustments needed – no.
- Risks – technically low
- Availability – uncertain competition with food supply chain
- Fears – relatively high

Natural Fiber Composites: Outlook

- Economic optimization (1 step or 1.5 step processes for A-Surface)
- Combined technologies Compression and Injection Molding (smart design), ideally in 1 step processing
- Further strengthening and light-weighting
- Regional fiber sourcing will allow for improved supply chain and cost reduction



Bio-Based & Bio-Degradable Materials

2 examples in other applications

- Pluracol – a bio-based alternative for Polyols in Polyurethanes
- EcoVio – a bio-degradable foil used consumer applications

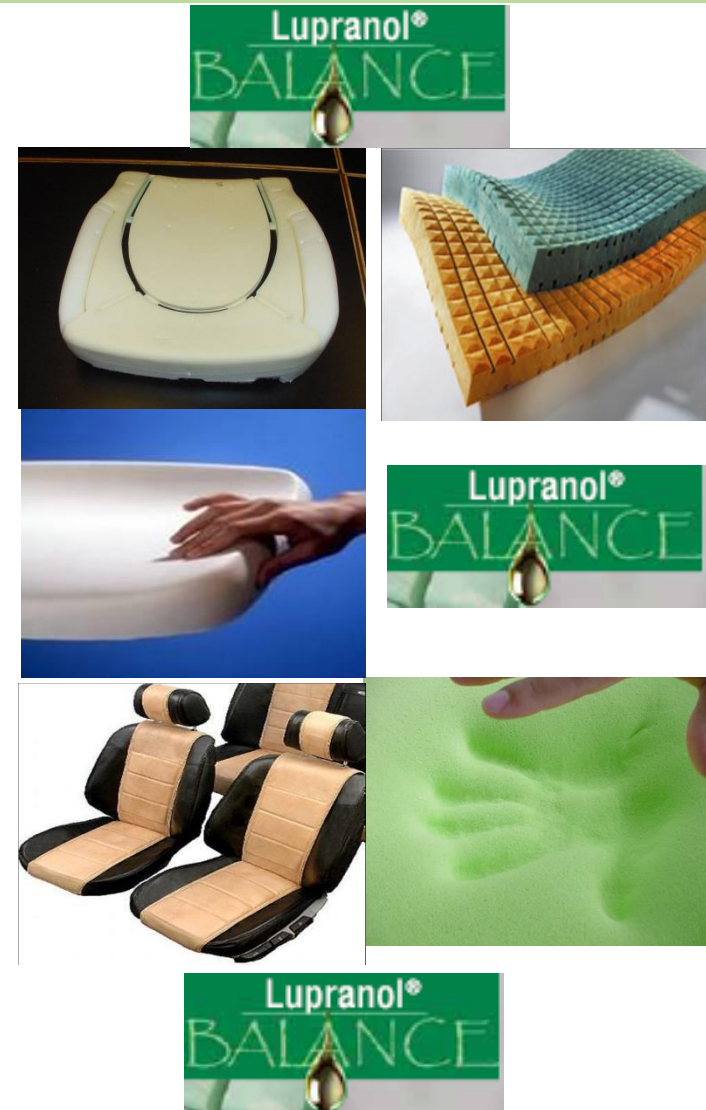
Pluracol[®] (Lupranol[®]) BALANCE Biopolyols Sustainable Foam Alternative

● Product Features

- High Renewable Biomass Content (Up to 20wt% in Polyurethane Foam)
- Low Odor
- Easy Processing
- Excellent Physical Properties

● Future Outlook

- Lupranol[®] Balance Biopolyols for
 - Automotive-seating (molded) and
 - Viscoelastic Foam Applications



EcoVio® Bio-Degradable Polymers

Application	
Organic waste bags and shopping bags	
Mulch films	
Paper-coating	
Shrink film applications	
Foam packaging	
Thermoformed packaging	
Injection molding applications	

ecovio® for thermoformed packaging

'ecovio® T' IS OPTIMALLY SUITED FOR SHEETING WHICH IS SUBSEQUENTLY THERMOFORMED. THE COMPOSTABILITY OF 'ecovio® T' DOES NOT PRECLUDE CONVENTIONAL PROCESSING.

With ecovio® T, processing on conventional sheeting equipment is possible with and without calenders. The result: A stiff yet very tough sheet which wraps extremely well – ideal prerequisites for the thermoforming of demanding components. Whether inline or offline – the sheet, produced in a processing window of 105-140°C, can be thermoformed through a die with or without pre-stretching. This results in thermoformed components of high design freedom which are compostable after use.

- Mostly biobased
- Usable on conventional flat-film equipment
- Very wide processing window
- Suitable for single- and multi-layered sheeting
- Suitable for food

ecovio® for injection molding applications

'ecovio® IS' CAN BE USED FOR A WIDE RANGE OF PACKAGING APPLICATIONS. IT ALLOWS CUSTOMERS TO PRODUCE COMPOSTABLE PLASTIC PARTS ON STANDARD INJECTION MOLDING MACHINES.

Products made of ecovio® IS benefit from an optimal balance of stiffness and toughness. Depending on the application, the flow behavior is flexibly tunable: from a medium to a high flow capacity. The surface look ranges from beige to light gray, depending on the amount of mineral fillers. Especially for plastic components in packaging or for applications with high mechanical loads, these products are a good choice.

- Mostly biobased
- Usable on conventional injection molding machines
- Runs on single- and multi-purpose tools
- Suitable for food

Bio-Based Materials: *Ready for Mainstream?*

