

The Raw Material Shift - The industry`s search for raw materials independent of mineral oil

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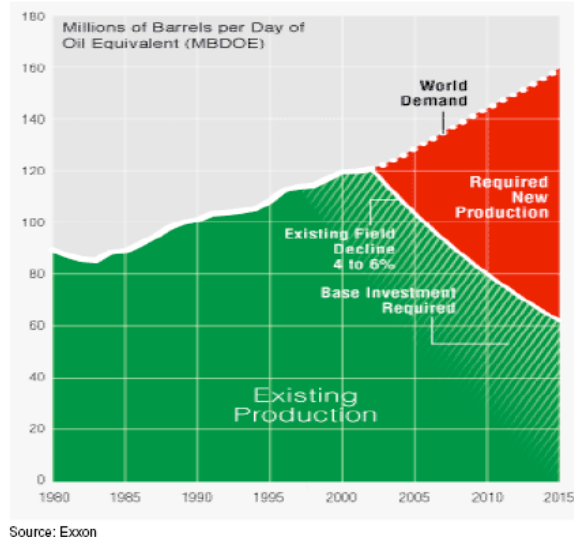
Raw material and energy shift

- The transition of raw material and energy supply from fossil to renewable resources.
- Finite supplies of fossil raw materials and energy sources – first shortages.
- Continuously heavily increasing demand – mainly from Asia.
- For three years steadily increasing prices for fossil raw materials and energy sources.

Mineral oil: Supplies

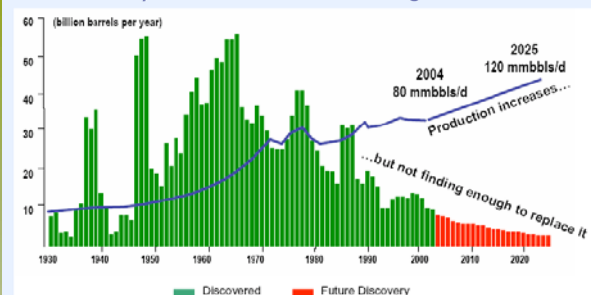
In order to keep pace with demand, production has to increase

Um mit der Nachfrage Schritt zu halten muß die Produktion steigen



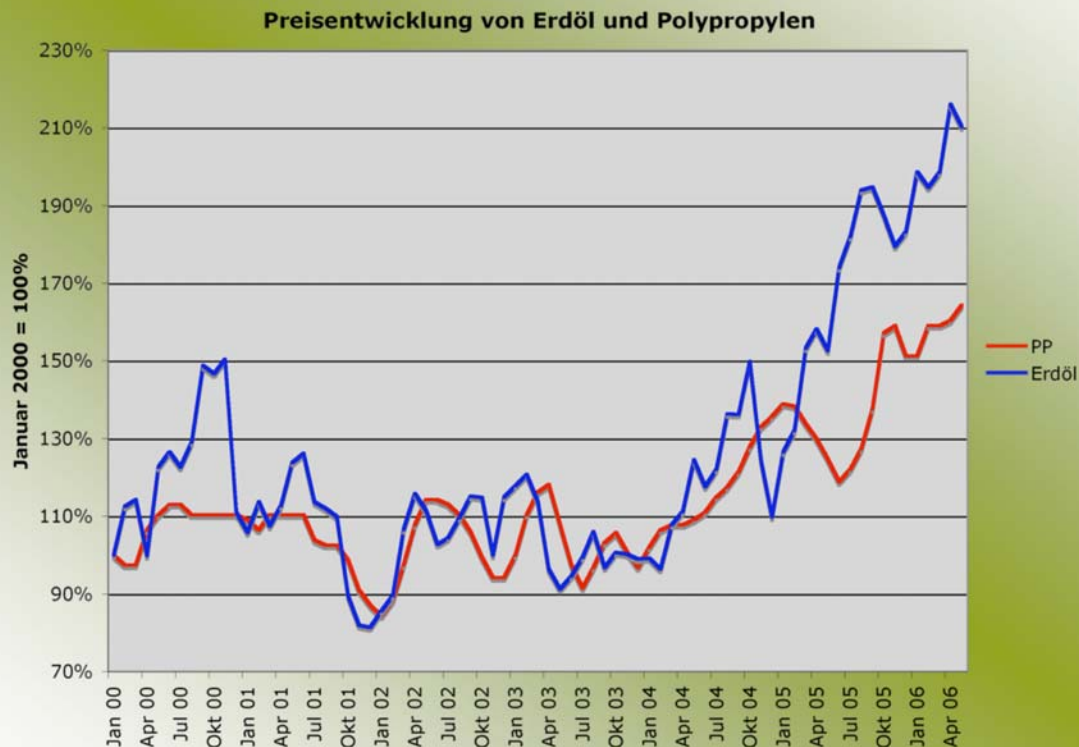
Mineral oil reserves and oil production - growth becomes more difficult

Ölreserven und Ölproduktion – Wachstum wird schwieriger



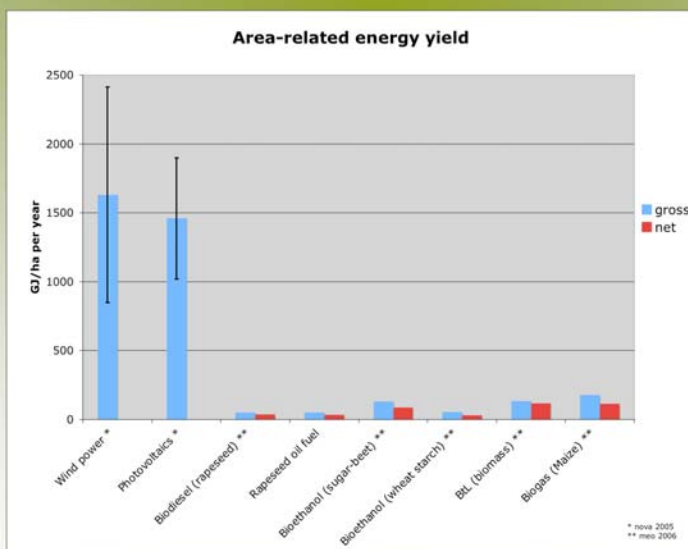
Mineral oil & PP: prices

Price development of mineral oil and polypropylene



Energy shift

Biofuels merely a short to medium term option?

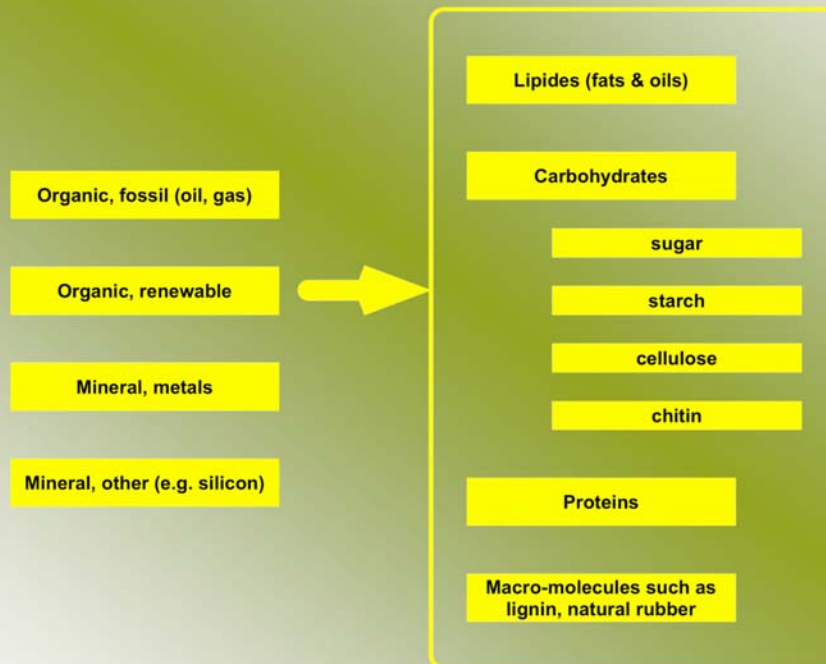


- Large areas required. For meeting global energy needs, several planets would be required.
- Low area efficiency as a result of the low efficiency of photosynthesis: Only 1% of the irradiated solar energy are utilised.
- In view of increasing area competition, this proves to be disadvantageous for biomass energy.
- Alternatives such as solar energy and wind power do generate substantially more energy per area.
- The chart shows the gross energy yield of existing plants in Germany. Also BtL or sun fuel do not render relevant advantages here.
- In the short to medium term, biofuels do have good chances, because they can be easily integrated into existing systems and are politically wanted. A share of 10-20% in global energy demand is possible.
- In the mid to long term, the share will decrease again, as other non-fossil techniques will be more efficient and cheaper.

Raw material shift

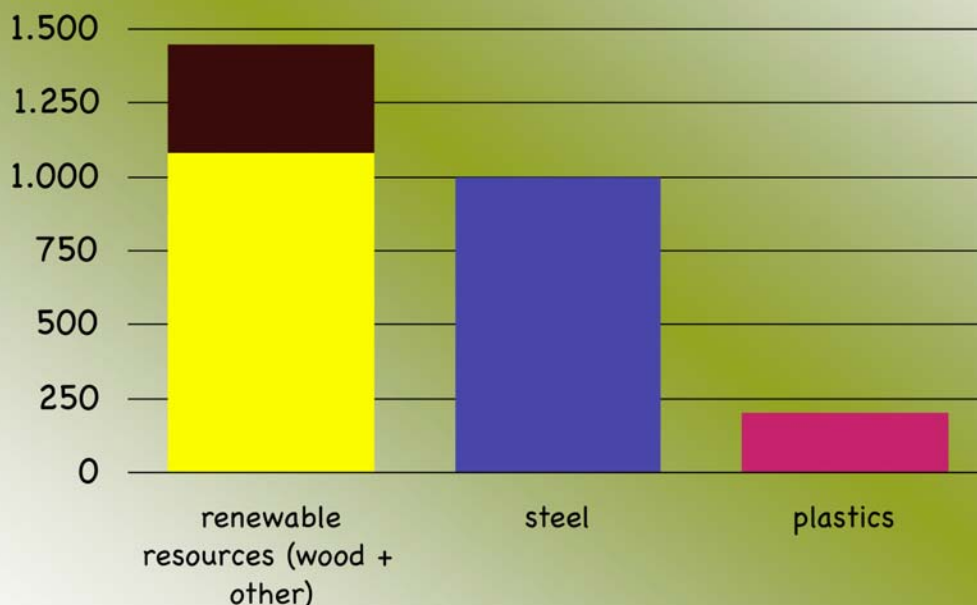
Without alternative in the mid to long term!

Potential sources for raw materials and work materials



Raw material shift

Renewable resources are the most important raw materials and work materials already today

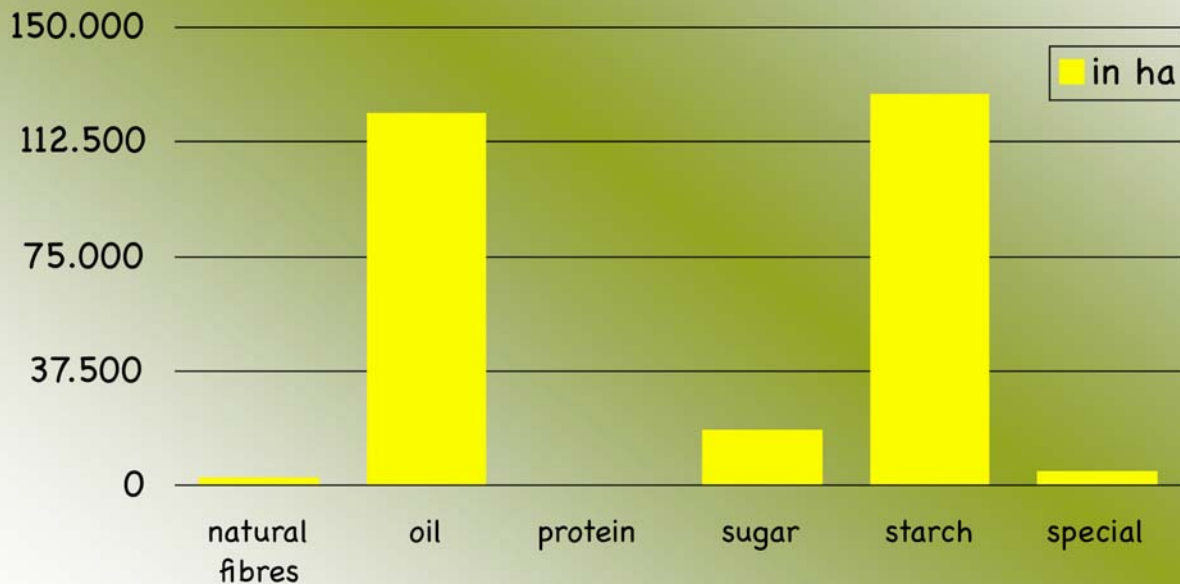


Global amounts in mio. tons (without energetic utilisation)

Source: FAO / nova-Institut 2006

Raw material shift

Industrial crop cultivation for material utilisation in Germany (without energy!)



Wood (material): 10.3 million ha – industrial crops (material): 275,200 ha (2005)

Three basic ways of material utilisation of renewable resources

Full utilisation of the synthesis already provided by nature

Examples: wood, natural fibres, vegetable oils, natural rubber

> 95%

< 5%

Utilisation of the synthesis already provided by nature in the form of components

Techniques: classic chemistry and industrial biotechnology
Examples: cellulose, bioplastics such as PLA and PHB

No utilisation of the synthesis already provided by nature, breakdown of carbon chains

Techniques: "extreme biorefinery" - biomass carbon as input for existing refinery process chains

0% - the future?

Raw material shift already today in hundreds of product lines!

- some examples -

- **Packaging sector:** cardboard and paperboard (as well as bioplastics) are extending their market share, increasingly at the cost of plastics. The sale of corrugated cardboard in the packaging sector is rising by 5% per year (compared to worldwide economic growth of 3%)
- **Packaging sector:** Jute sacks are increasingly capturing back market shares ahead of woven PP sacks.
- **Paper production:** Starch is increasingly driving synthetic latex out of the paper production market (1 million tons in the EU).
- **Natural rubber:** Synthetic rubber is rapidly losing market shares to natural rubber, almost not being competitive any longer.
- **Car seats:** coirs & natural latex are catching up with PUR foams.
- **Flocculants:** Modified starch is increasingly replacing polyacrylates.
- **Biotechnology:** In the industrial („white“) biotechnology, starch and sugar are increasingly replacing classic chemistry with mineral oil and natural gas as feedstocks.

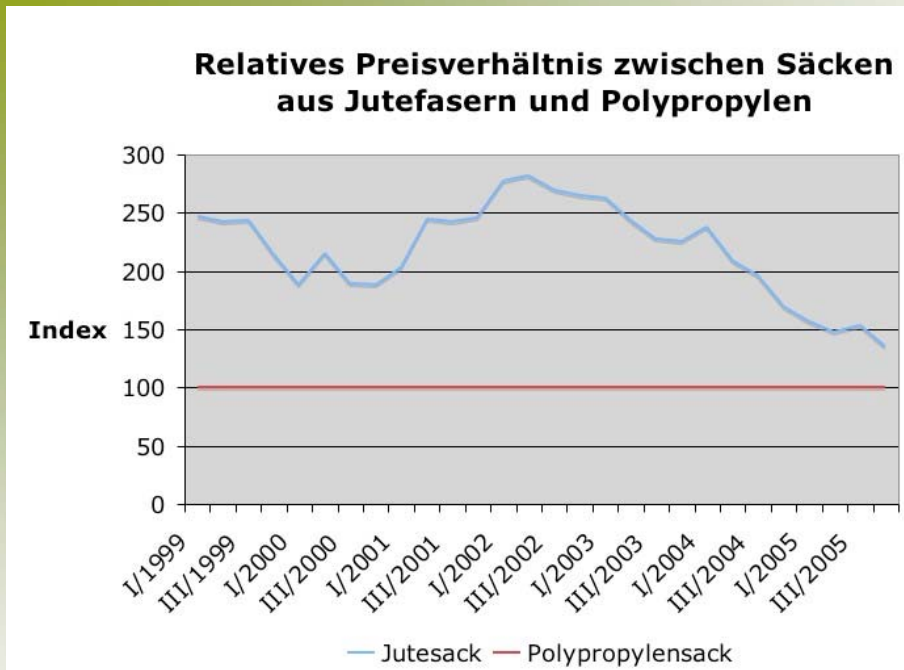
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- details about four examples -

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The comeback of jute sacks

Relative price relation between sacks made of jute fibres and PP

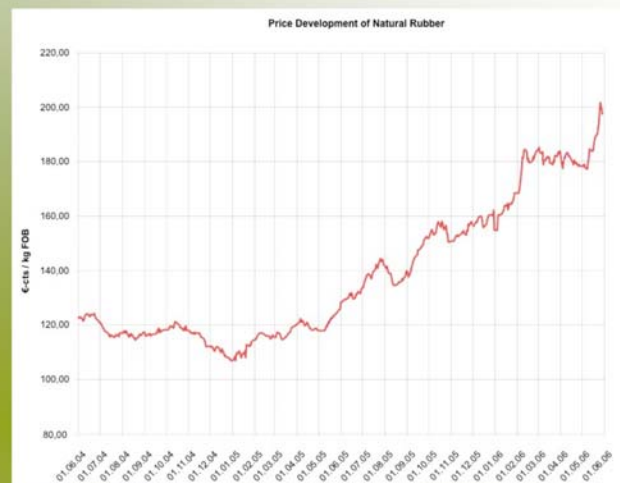
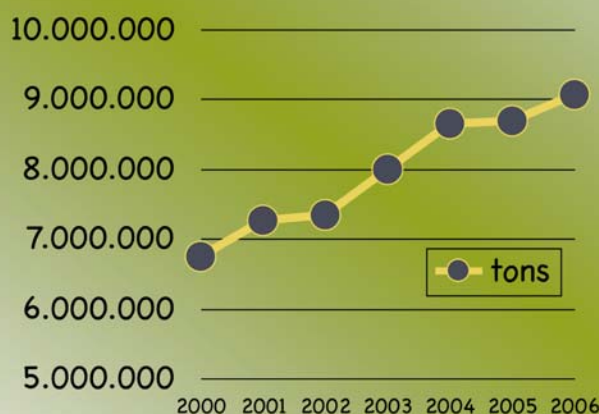


After jute packaging sacks – e.g. for rice or sugar – for price reasons have continuously been substituted by woven polypropylene sacks in recent decades, prices are head to head nowadays.

Since last year, jute sacks have been capturing back market share.

(Source: FAO 2005)

The comeback of natural rubber



- The production of natural rubber has never been as large as today (2006: 9 million tons), but nevertheless cannot meet the demand. The set-up of new plantations takes 6-7 years until the first harvest comes in and is in area competition with palm oil plantations.
- After decades of decline, the market share of natural rubber has rapidly increased in recent years and today equals the level of 1964 again (30% à 42.3%)!
- The worldwide tyre industry raised the use of natural rubber from 39 to 42% in 2005 – and would have liked to further increase this share.
- The synthetic alternatives (Styrene Butadiene Rubber & Polyisoprene) suffer from high oil prices and limited capacities.
- Price carrousel: After synthetic rubber had been cheaper for decades, the price of natural rubber amounted to merely about 84% of synthetic rubber at the end of 2005 –after the current price increases of natural rubber, the two are on the same level again.

Car seat cushions made of coir and natural latex



Bild 2 Die FaserTec-Anlagen werden mit Kokosfaser-Coils beschickt



Bild 3 Der Wollwatteszuschnitt wird mittels einer Einlegehilfe und Vakuum eingelegt, um eine faltenfreie Oberfläche des Lehnepolsters zu erreichen

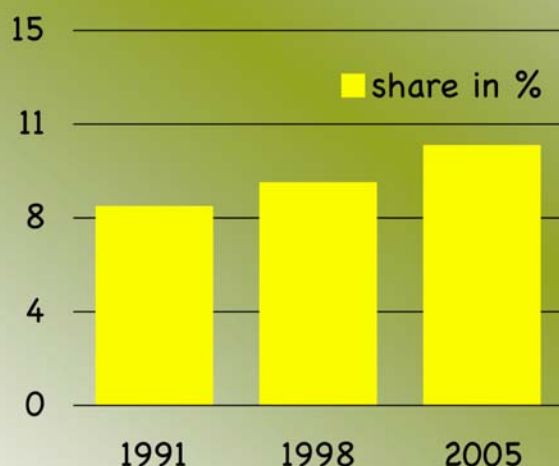


Bild 4 Die Lehnepolster werden vom FaserTec-Rundisch zur Stanze transportiert

Back substitution thanks to increased process automatization and high petroleum prices: "... FaserTec has reached the price level of foams – due to the continuous price increase and the shortage of crude oil which, as basic material for the production of PUR, has an influence on the price of foam cushions, FaserTec products could become even cheaper than foam cushions one day."

Source: Klusmeier, W. (Johnson Controls GmbH) in: „Technische Textilien“ 1/2006.

Use of renewable resources in the chemical industry, Germany 1991-2005



The chemical industry is already worried about getting enough renewable resources for material utilisation – market distortion as a result of the subsidisation of the energy sector.

Renewable resources 2005	in tons
Fats and oils	1,150,000
Cellulose	320,000
Sugar	240,000
Starch	147,000
Proteins	55,300
Others	61,000
Total	1,973,300

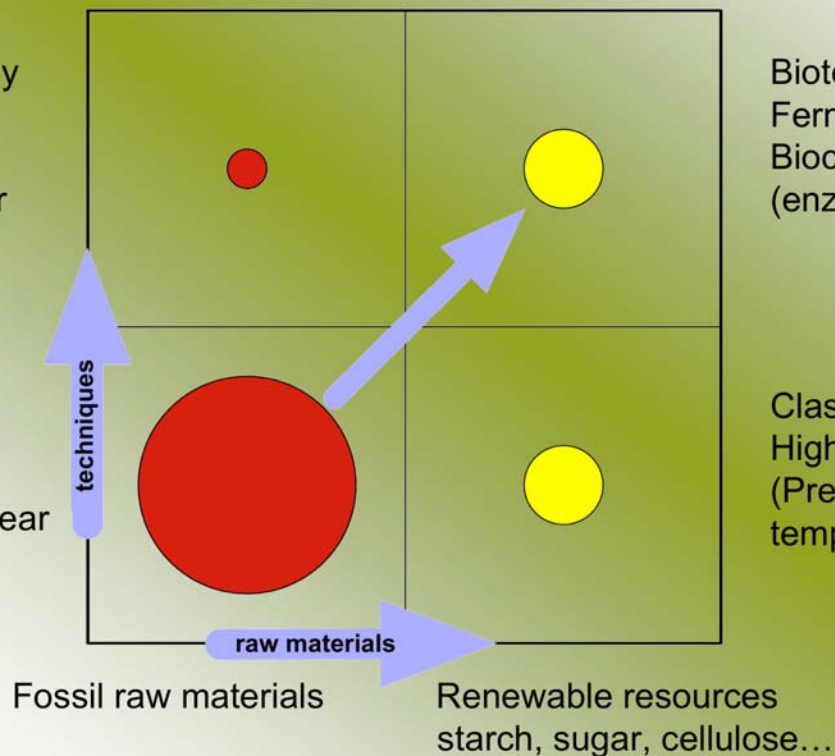
Sources: meó, VCI, FNR

Industrial („white“) biotechnology and renewable resources

Today

Biotechnology
40 billion €
worldwide +
10% per year

Classic chemistry
+ 2-3% per year



Biotechnology
Fermentation
Biocatalysis
(enzymes)

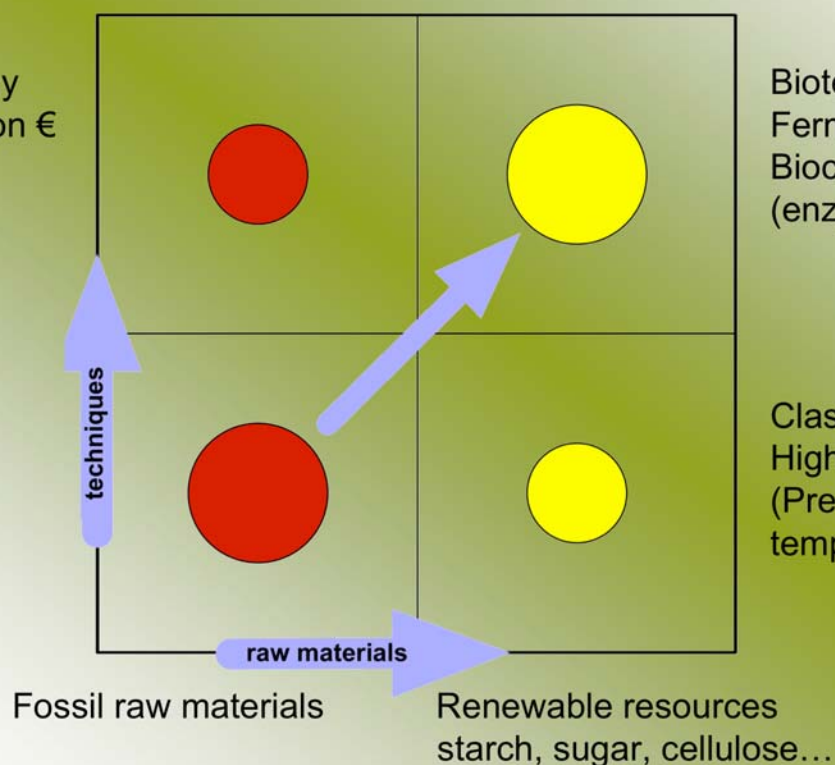
Classic chemistry
High use of energy
(Pressure &
temperature)

Industrial („white“) biotechnology and renewable resources

2015

Biotechnology
130-150 billion €
worldwide

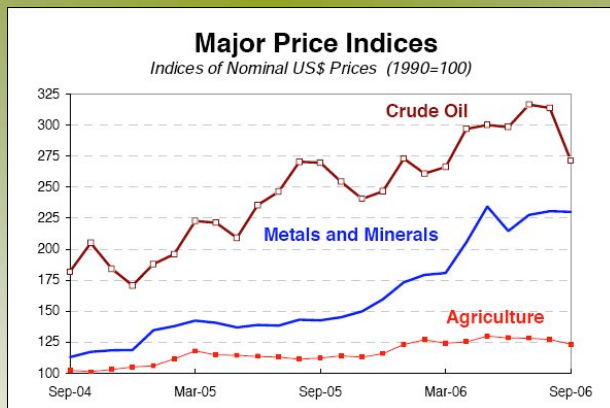
Classic chemistry



Biotechnology
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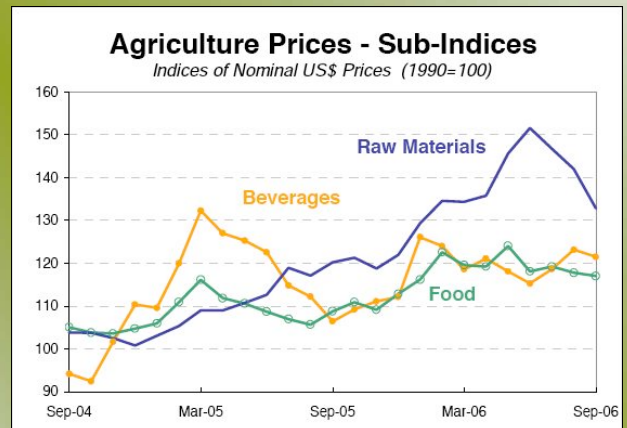
Raw materials will never be cheap again
– whether mineral, fossil or renewable.
Supply shortages will be prevalent.



● From approx. 40 to 90 \$/barrel, the sugar price is linked to the petroleum price, from 100 to 120 \$/barrel, also the starch price. Bioethanol presently is the driving force.

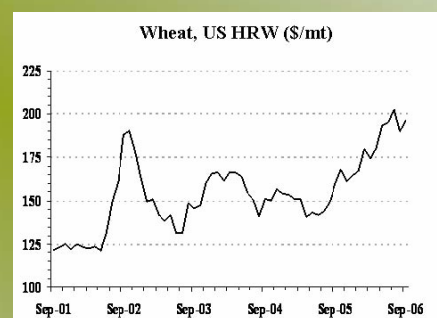
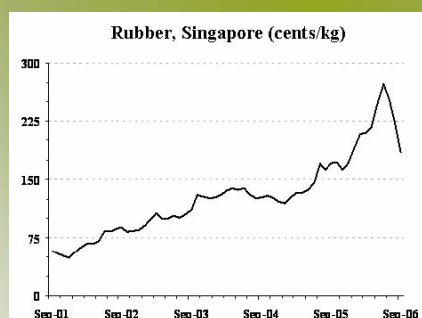
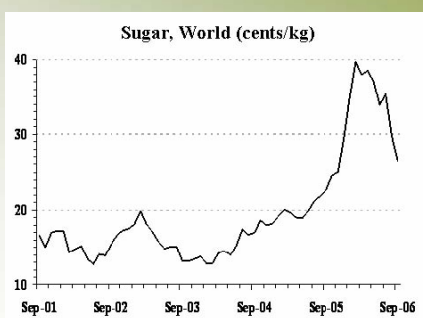
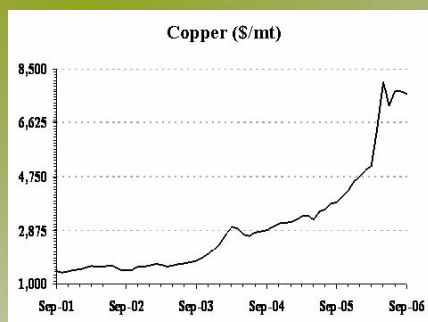
● In Germany, wheat can be cultivated competitively on a world market price level!

- Strongly increasing worldwide demand for agricultural raw materials.
- Set-aside lands are a thing of the past also in the EU, each hectare is needed.



Source: World Bank

Raw materials will never be cheap again
– whether mineral, fossil or renewable.
Some examples:

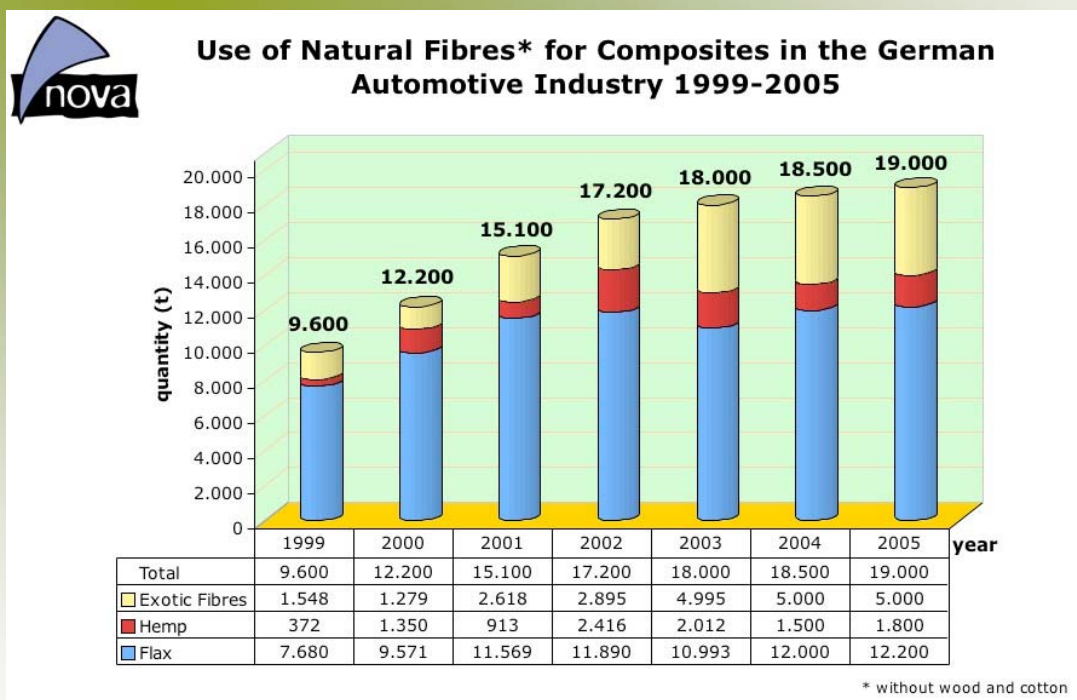


Source: World Bank

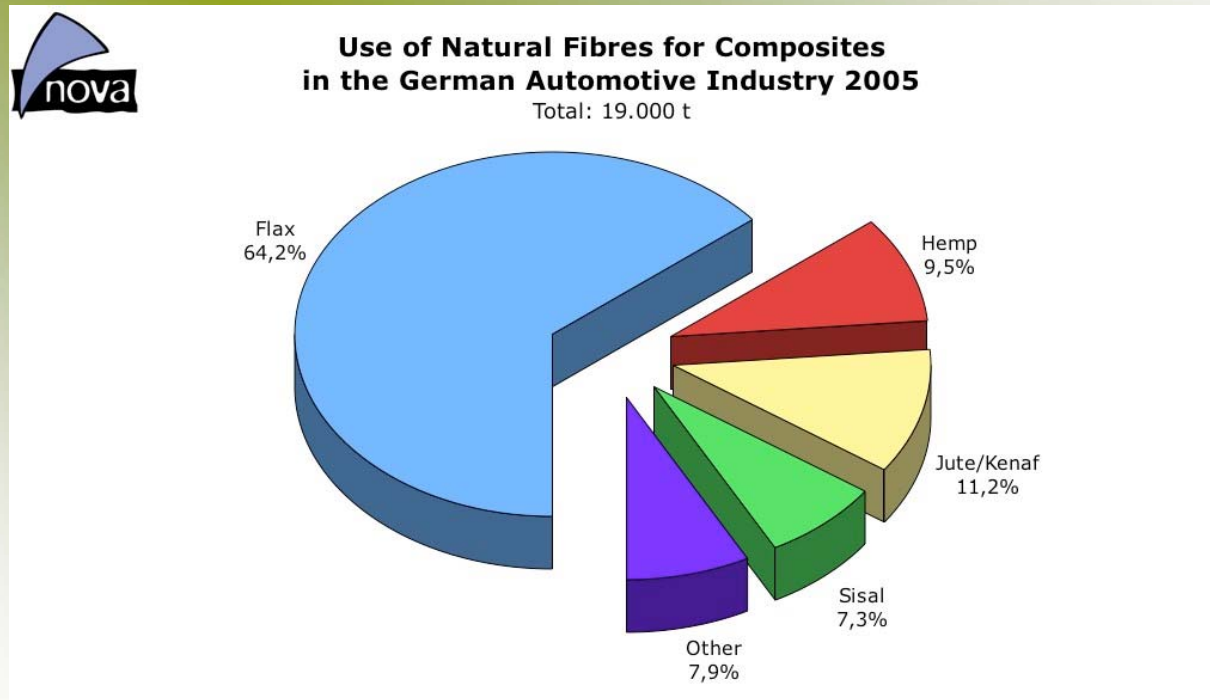
Raw material shift

- The raw material shift is unstoppable - we are already right in the middle of it. Hundreds of product lines are already being converted from mineral oil to renewable resource based raw and work materials.
- The heavy subsidisation of the energy shift is (yet) retarding the raw material shift.
- Which techniques will win the race? Many – but not all of them!
- Area shortage can lead to socio-economic problems – in any case, to high raw material prices.
- In the past 25 years, a lot of work materials have been developed.
- Bioplastics, natural fibre reinforced plastics and wood plastic composites are already today used in the German automotive and construction industry at an amount of almost 200,000 tons/year – with a strongly rising tendency.

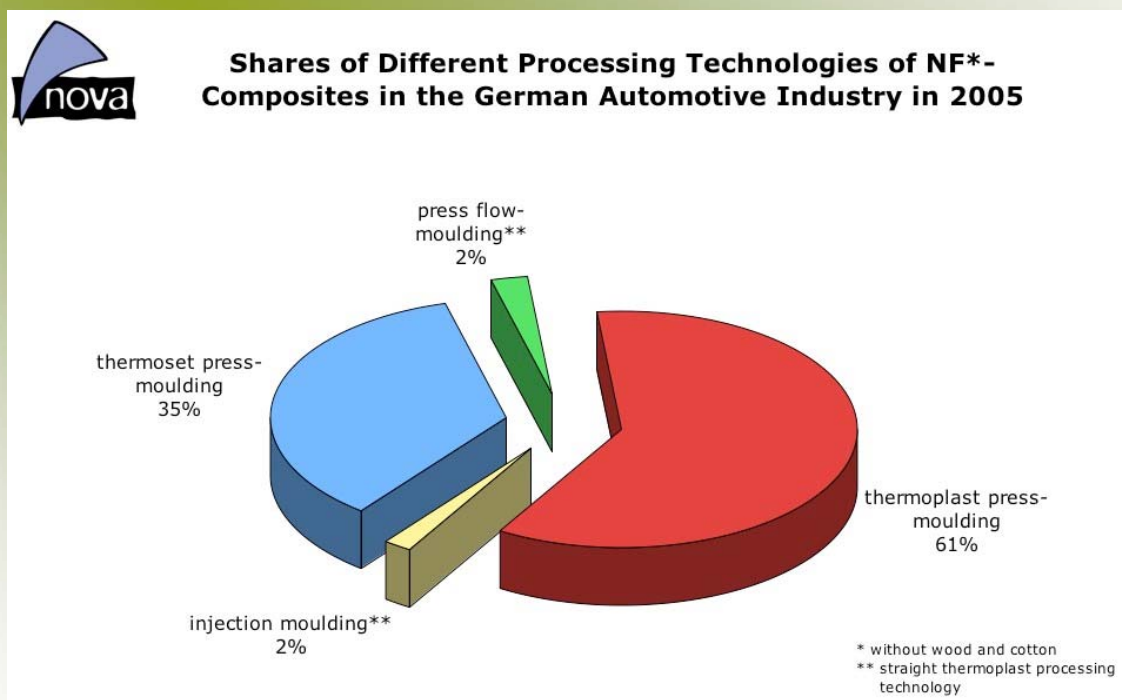
Use of Natural Fibres in the German Automotive Industry



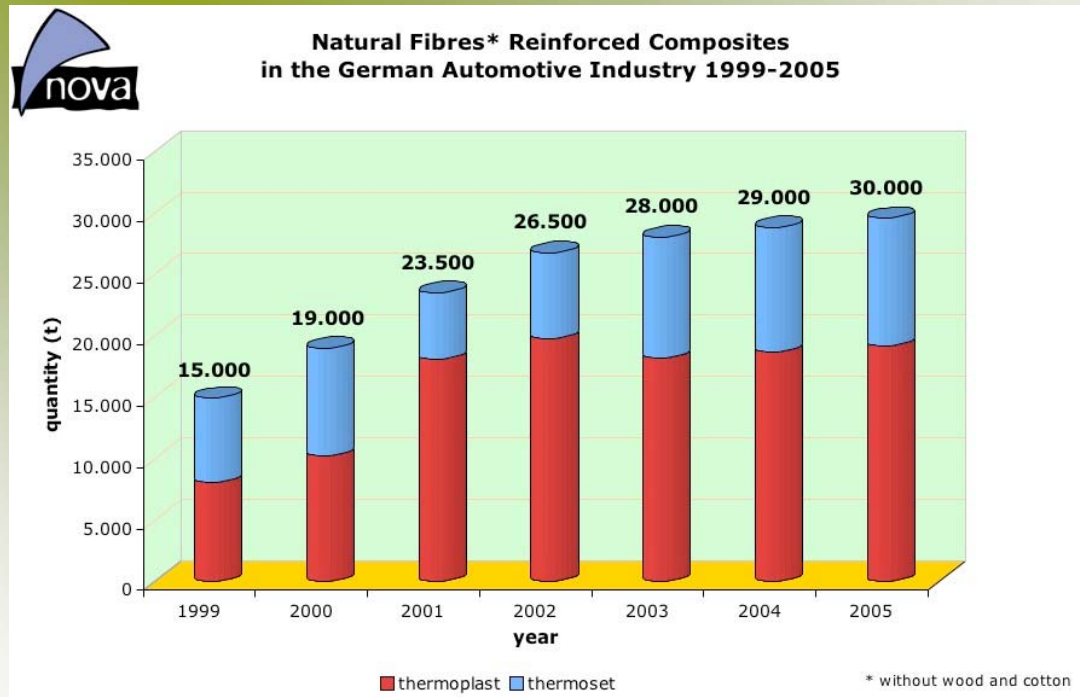
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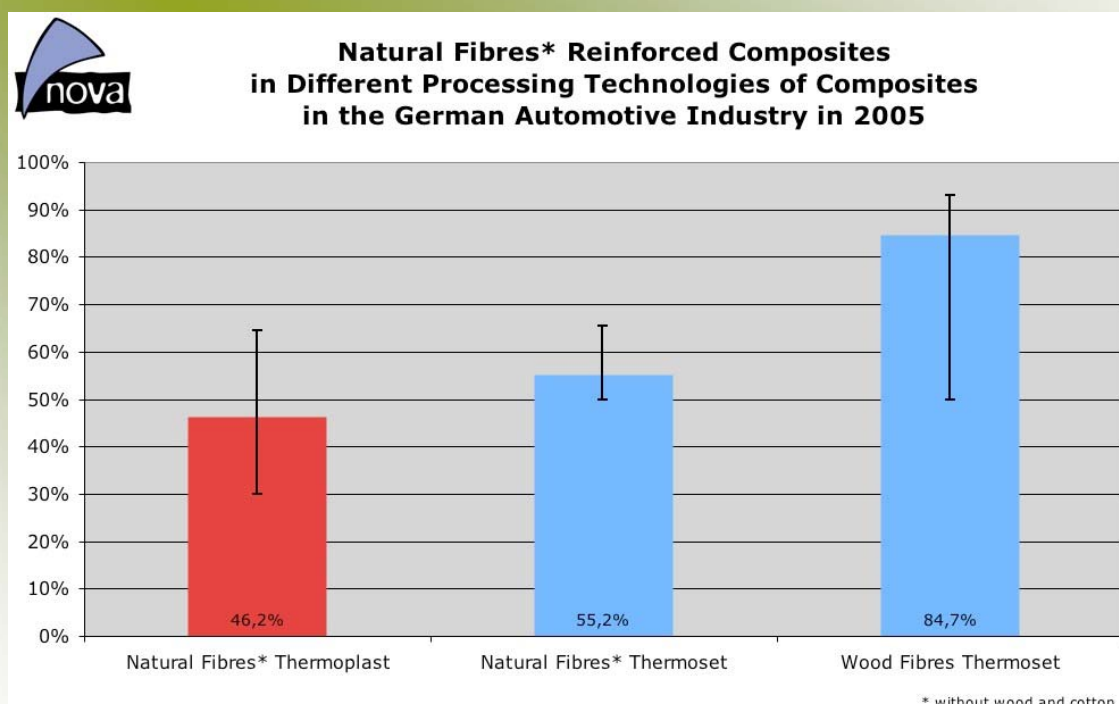
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