

# Bioeconomy: What Drives the Development?

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*Lecture, Forest Cluster Graduate School Seminar: Bioeconomy,  
April 15, 2011, KCL auditorium, Espoo*

**METLA**

# Outline

1. What do we mean by *bioeconomy*?
2. Motivation and background
3. Bioeconomy driving forces (forest sector)
4. Biorefinery and forest industry
5. Case examples
6. Conclusions

Background literature references

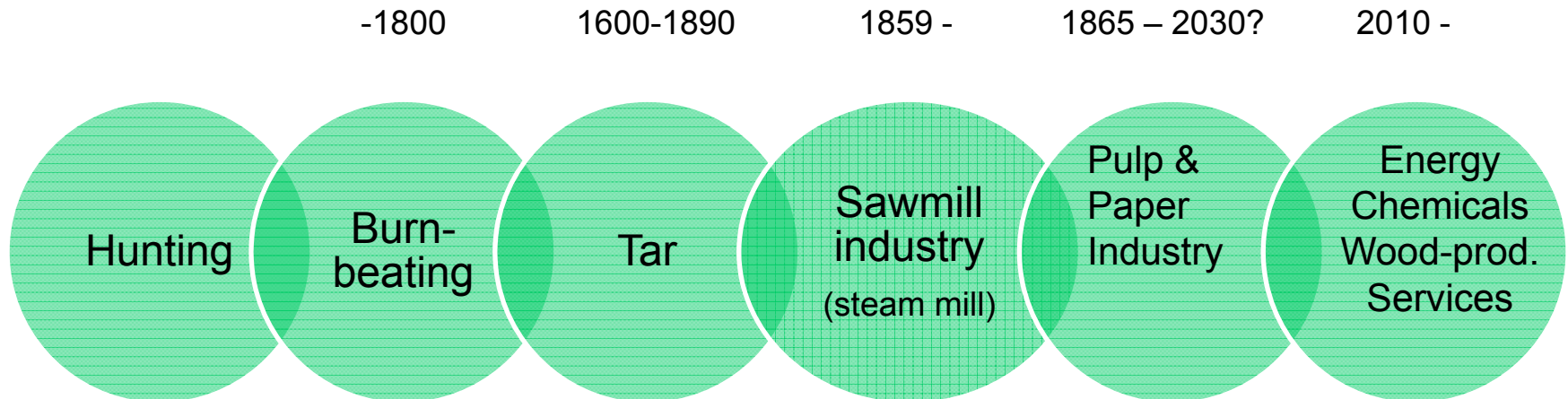
*Purpose: Provide a synthesis of bioeconomy development and its implications to forest industry*

# What do we mean by *Bioeconomy*?

- Bioeconomy concept has been popularised in recent yeras
- *Bioeconomy* refers to the sustainable production and conversion of biomass into a range of food, health, fibre and industrial products and energy (“The European Bioeconomy 2030”, EU White Paper, April 2011)
- *Bioeconomy* refers to all economic activity derived from scientific and research activity focused on understanding mechanisms and processes at the genetic and molecular levels and its application to industrial process (Wikipedia)
- Definitions tend to be general. Many things can be called bioeconomy (biodiesel, wooden design furniture, pulp, functional food, etc.)
- Also a buzzword, like ”infromation economy” decade a go

# Bioeconomy has always been there, but we have not called it by that!

## The Forest "Bioeconomy" History of Finland



The use of forests has changed due to the needs and technology

# Motivation of the Concept

- Previously (last 10 yrs or so), bioeconomy was very much linked to biotechnology. Stressed the research and technology aspects (OECD; EU)
- Recently, interest has grown on the economic and environmental aspects of the concept (new products, jobs, mitigation of climate change, sustainability)
- Ideally, in bioeconomy, all biomass in production process is utilized efficiently or re-cycled
- Bioeconomy concept can be seen as *a way of thinking*
- Promotes products and businesses based on renewable biomass. Stresses cross sectoral thinking. Co-ordination of different sectors/industries in enhancing biomass-based and sustainable economy

# Examples of the Bioeconomy Trend

- *Forestcluster Ltd* (Metsäklusteri Oy) in Finland. Suggestion to enlarge the cluster to cover bioeconomy and biomass resources in a more extensive way, than only forest industry and forest biomass (Prime Minister's Office Publications 15/2010)
- Forest Products Association of Canada (FPAC) launched *Bio-pathways Partnership Network*. Explores new business ventures that help to exploit economic opportunities of bio-based materials. Network participants = forest industry, chemical, energy, pharmaceutical, auto, aerospace, and plastics.
- Social, economic and environmental advantage of integrating new bio-products in existing mill operations. "Business as usual will not work in the future" (Pulp & Paper Canada News, April 12, 2011)
- Similar development taking place in USA, Sweden, Japan, etc.

# Bioeconomy Driving Forces

Bioeconomy has a potential to marry the interests of the *society, environment, industry, and forest sector*

1. Politics. International and national agreements and policies to mitigate climate change
2. Need to reduce fossil energy (environmental, economic, and security reasons)
3. Desire to support local biomass based industries
4. Structural change of global forest industry
5. Technological change

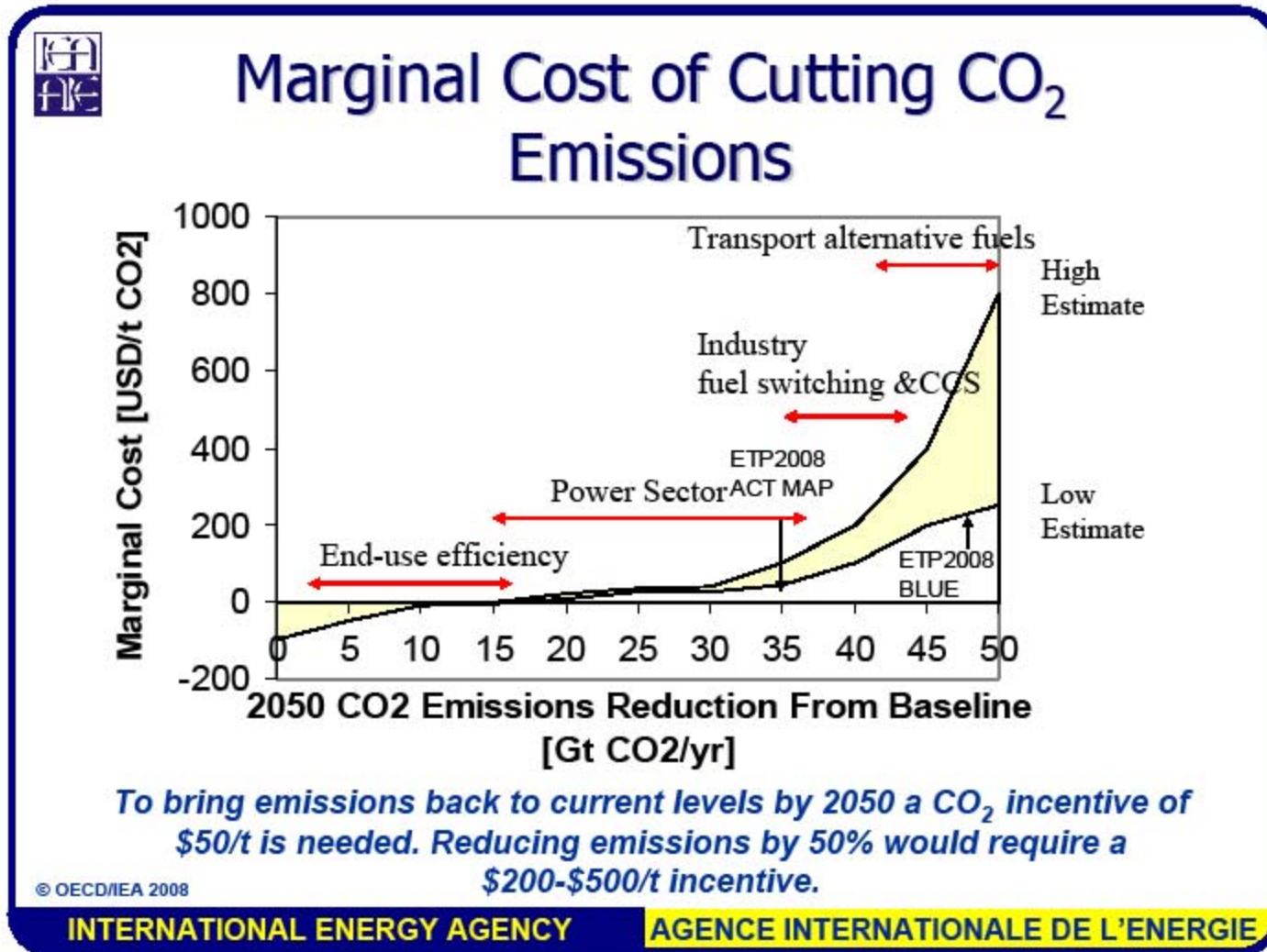
# 1. Politics

# The more the politics supports renewable energy use, the higher the demand for wood to energy

- ❑ Kyoto (2013?)
- ❑ EU energy policy 2020
- ❑ National energy policy
- ❑ Regional & agricultural policies
- ❑ Energy security policies (e.g. OPEC, Russia)

→ all the above policies tend to enhance bioeconomy

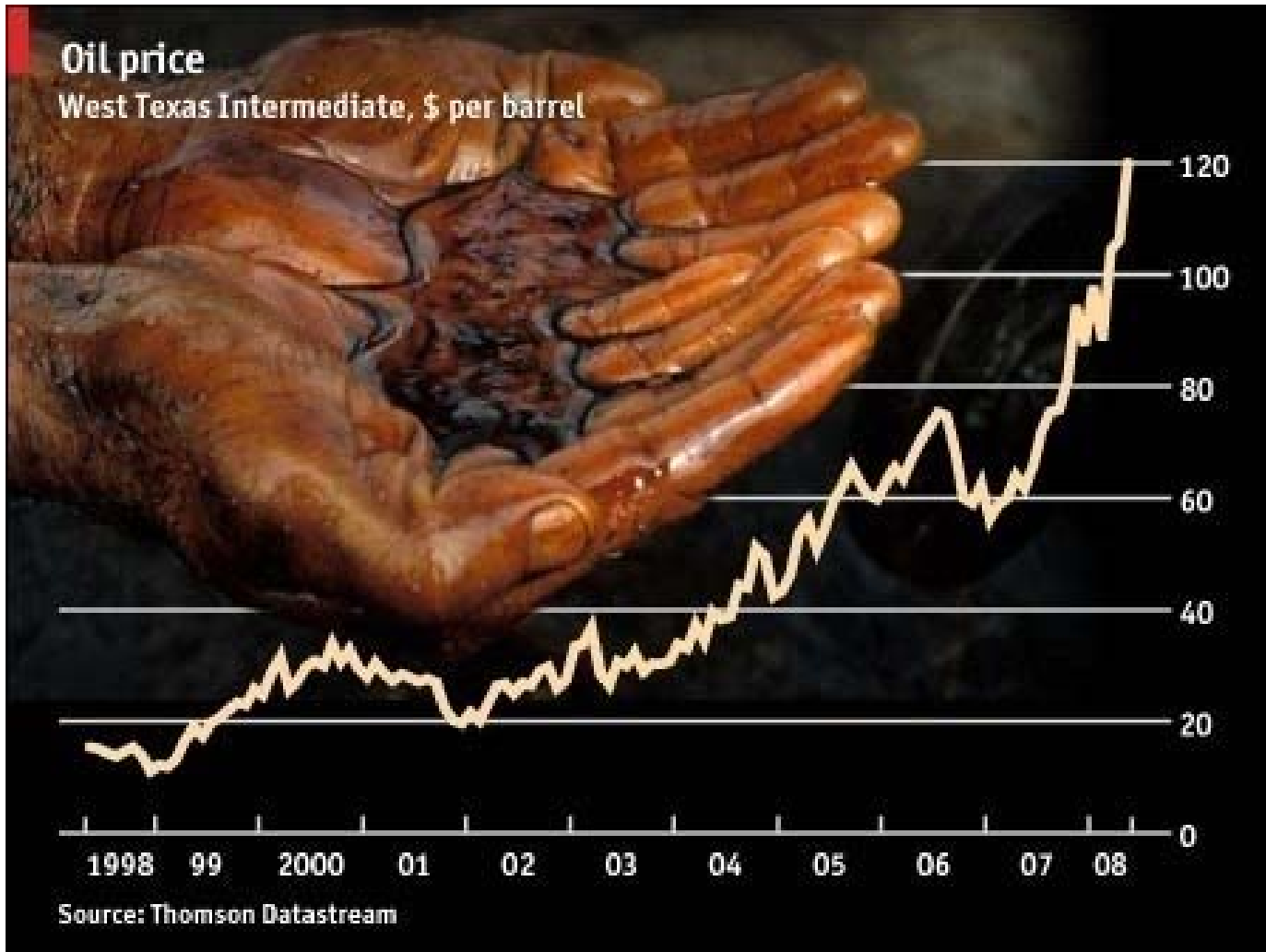
# The higher the price of CO<sub>2</sub>, the higher the demand for bioeconomy (wood energy)



## **2. Need to reduce fossil energy**

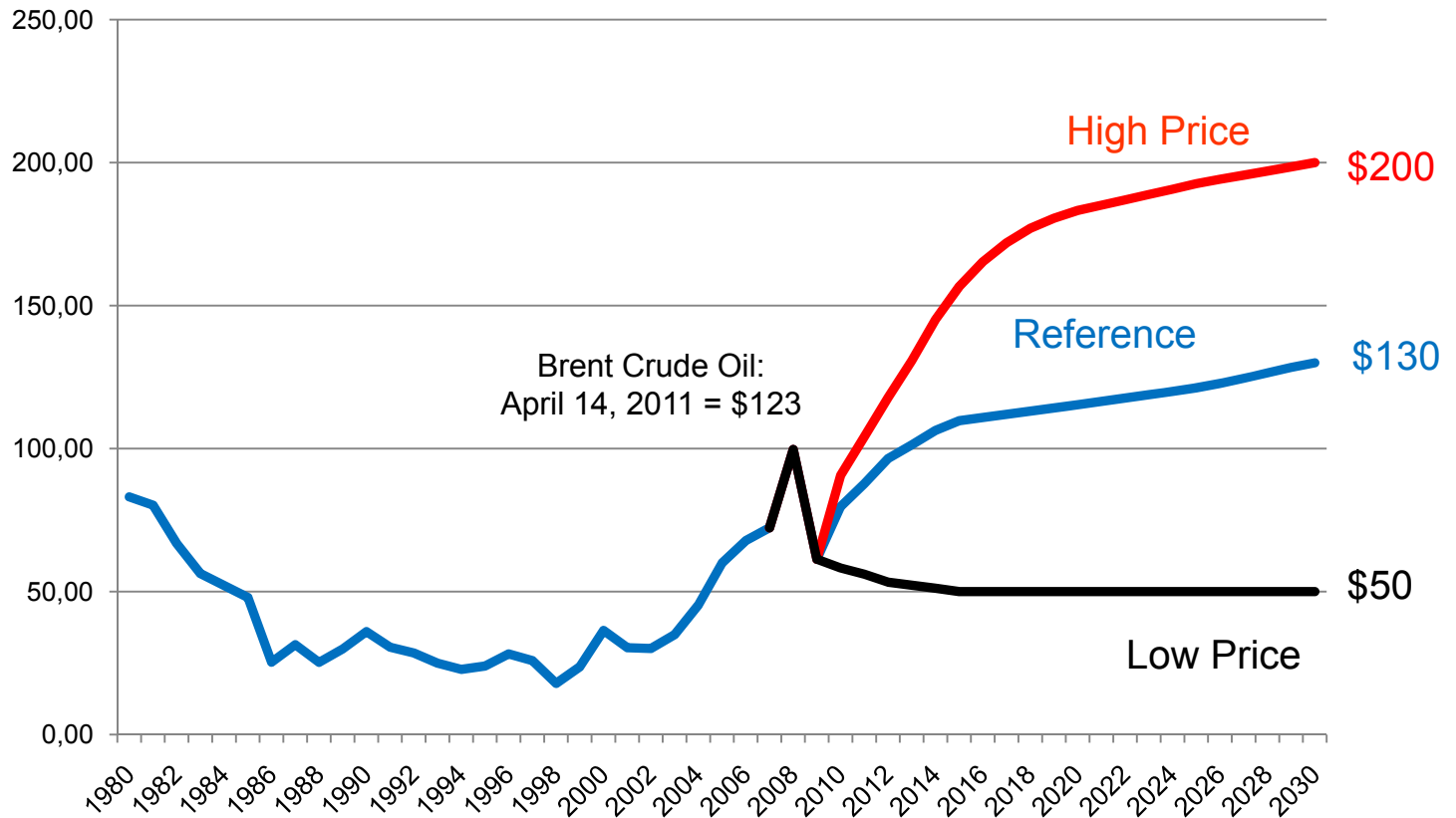
**(environmental, economic & security reasons)**

# The higher the price of oil, the higher the demand for wood to energy



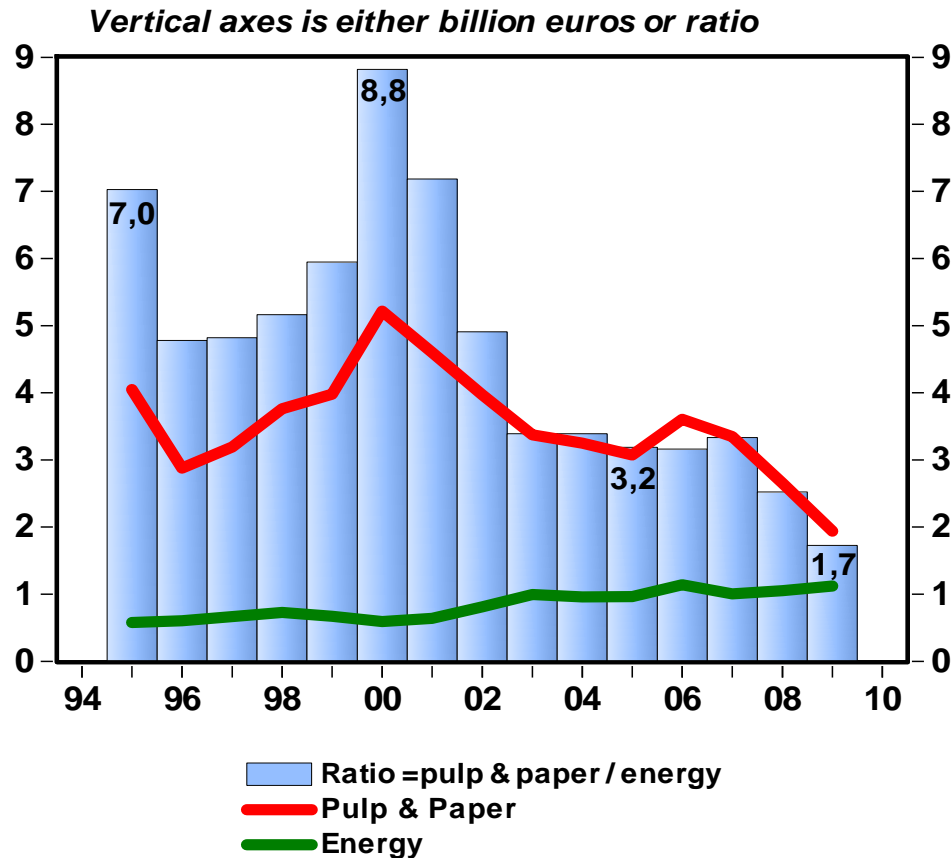
# World oil prices are generally expected to stay over \$100

nominal dollars per barrel



Data Source: USA EIA, International Energy Outlook, March 2009

# Value Added in Finnish Pulp and Paper industry vs. Energy Industry\*



In 2000, pulp and paper industry value added was 8.8-times higher

↓  
 In 2009, it was 1.7-times higher

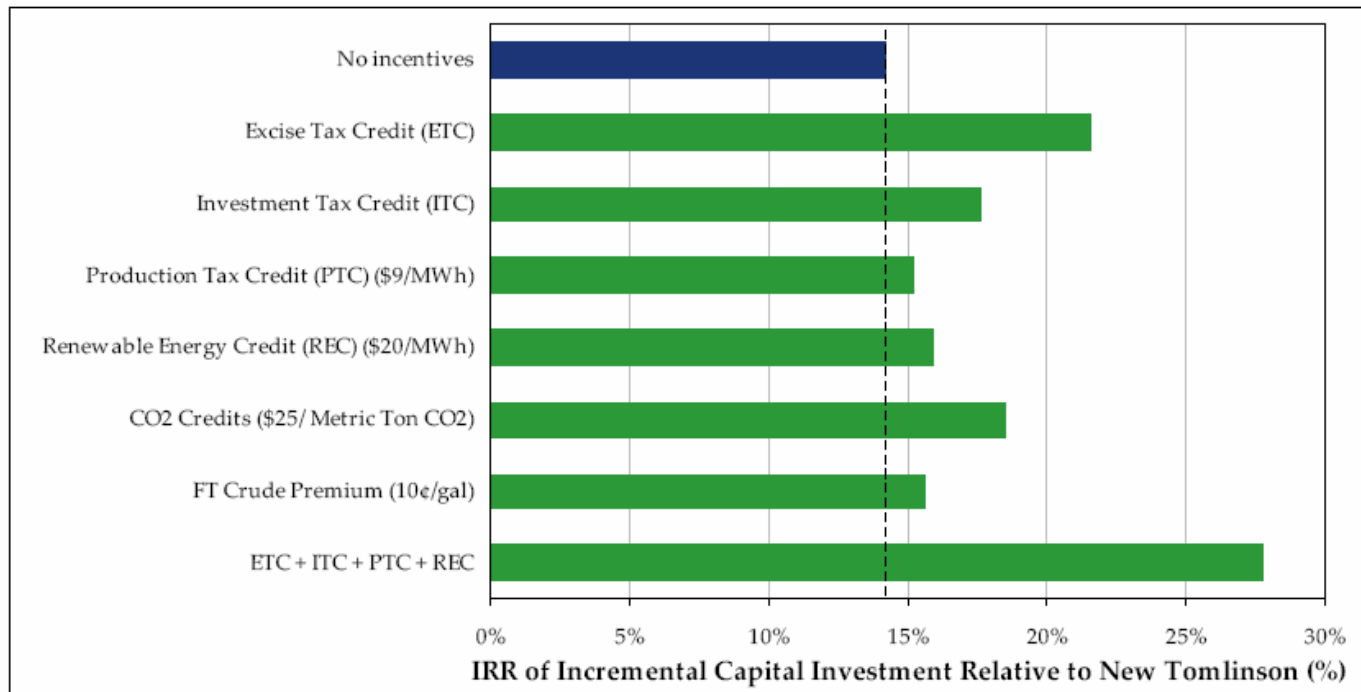
↓  
 Economic interest in energy production is going to increase furthermore

\*The selected energy industry covers sectors, which can potentially use wood in energy production (as a substitute for coal, oil, gas, peat). Thus, it does not include nuclear, water or wind power industries.

Source: Hetemäki, L. Toimialojen jalostusarvot muutoksessa, in Hetemäki, Niinistö, Seppälä & Uusivuori 2011. Murroksen jälkeen.

# Sensitivity of Investments to Policy and Energy Prices

Figure 72: IRR on incremental capital investment in FTa biorefinery relative to a new Tomlinson system with different environmental benefits monetized under our REP scenario.



Note: Investment tax credit = 20% gasification tax credit

If energy prices are higher (\$78 vs. \$50), IRR about 5-10 percentage points higher than above. Depending on technology, policy incentives and energy prices, the range of IRR is 10 – 46%

Source: Larson, E.D., Consonni, S., Katofsky, R.E., Iisa, K. & Frederick, J. (2006). A Cost-Benefit Assessment of Gasification-Based Biorefining in the Kraft Pulp and Paper Industry. Final report (4 volumes), 21 December 2006, Princeton University.

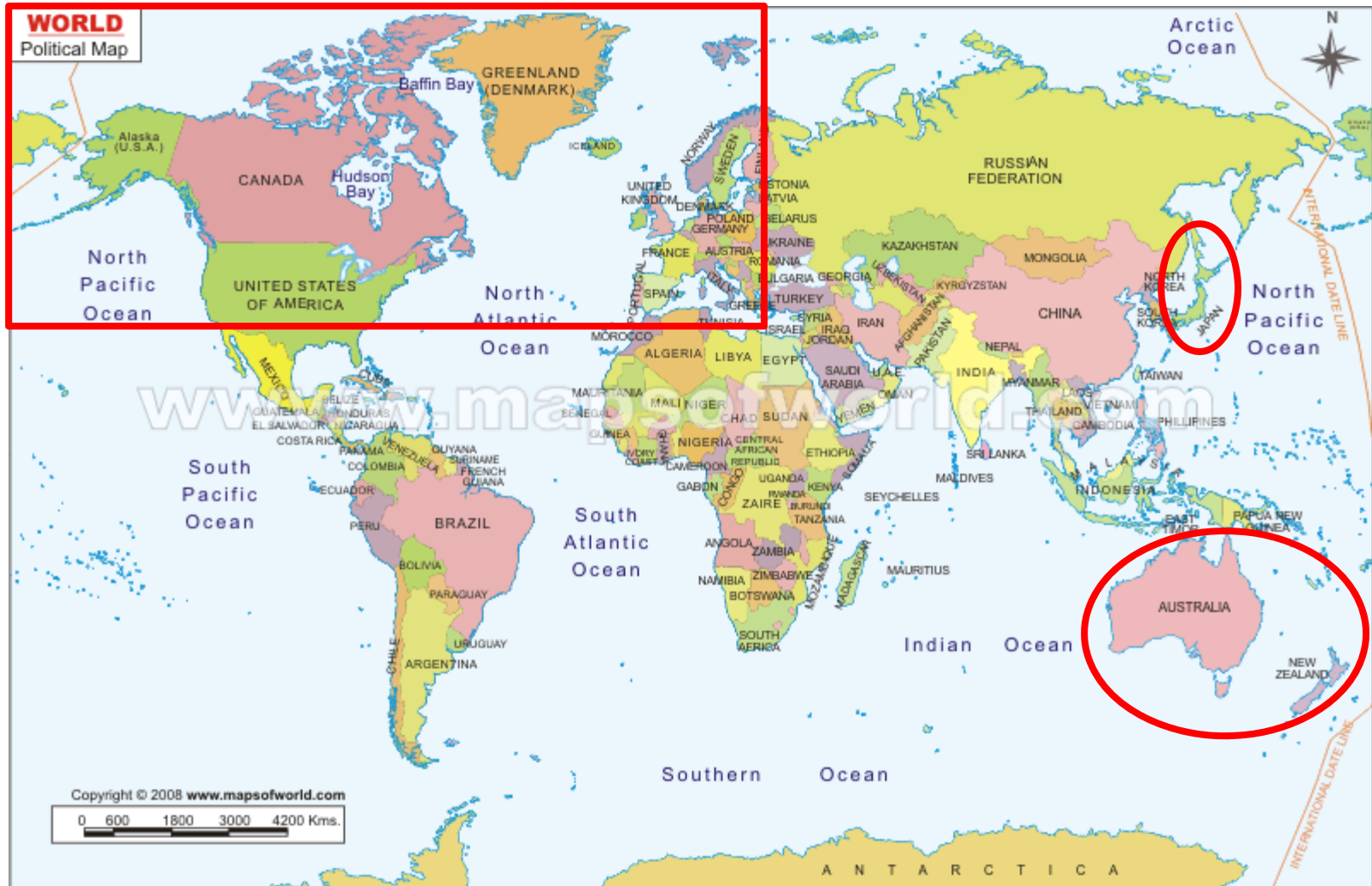
### 3. Desire to support local biomass based industries

- Biomass resources and biomass-based industries are usually distributed across the country
- EU and national government regional policies support regional bioeconomy development
- Income, jobs, etc.

## **4. Structural change of global forest industry**

# There is a Dichotomy of Forest Products Markets

→ In traditional OECD-countries production (and demand) growing slowly, stagnating or declining; in non-OECD countries growth very rapid



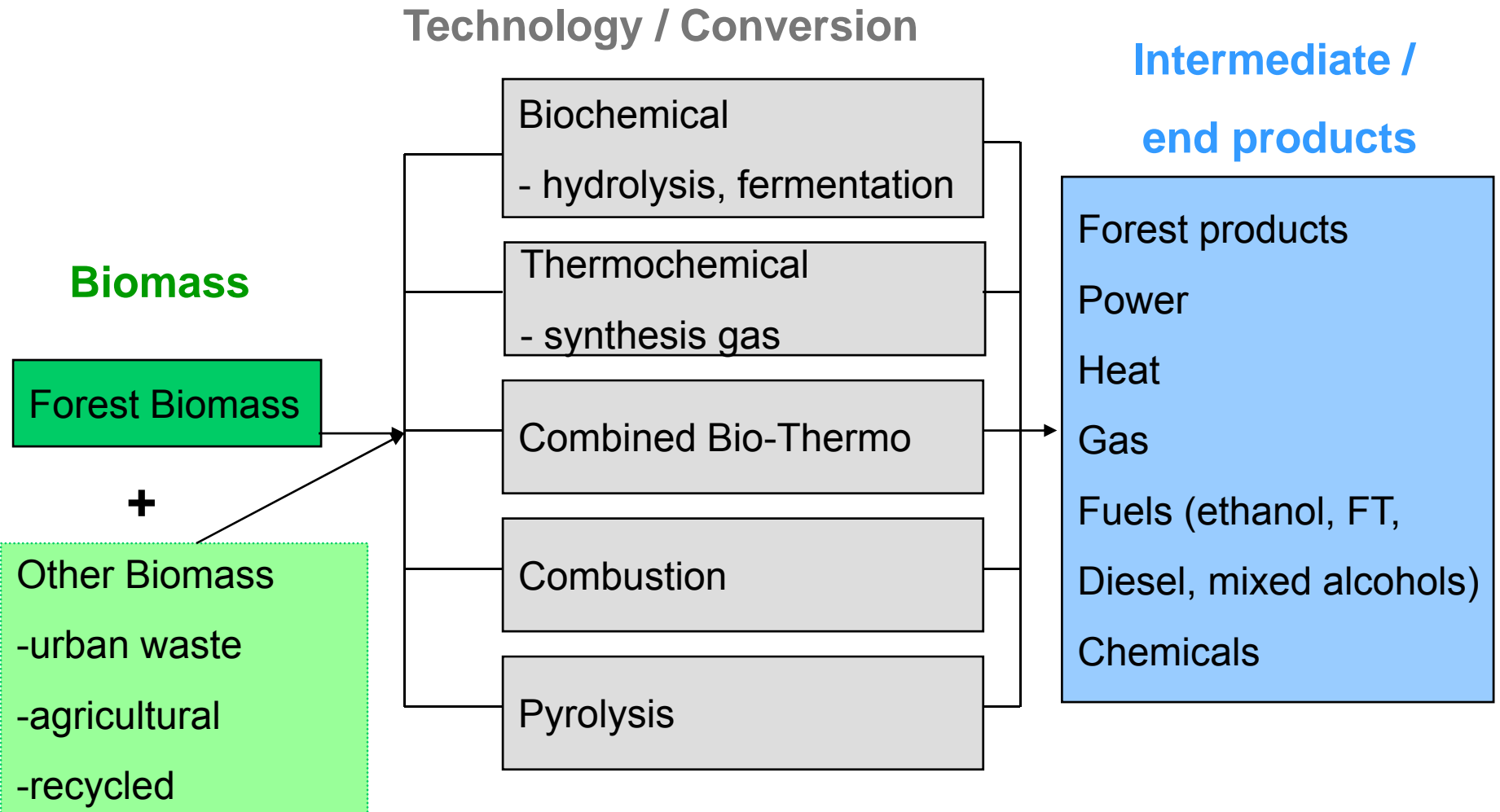
# Re-structuring Forest Industry

- Help to re-structure and re-innovate struggling forest sector in countries such as Canada, Finland, Sweden, USA
- Synergies between new and current forest products
- Image-factor. Something different from the "sunset industry" and "smokestack" label often linked to existing forest sector
- Bioeconomy, green technology, carbon neutral

# 5. Technological change

# Examples of Forest Biorefinery Technologies

Politics & energy prices are the major drivers for technology development





At the Finnish Forest Research Institute (Metla) laboratory, researchers study how hemicellulose can be refined to ethanol

# Conclusions from the drivers

- Society (politics) and forest industry have a number of reasons to promote bioeconomy
- Some of the incentives are global, some national
- Bioeconomy trend is likely to increase, rather than decrease
- Finland will use increasingly wood for energy. It will use policy measures to promote this
- In the longer-run (5-10 yrs), you probably do not need anymore as strong policies to support bioeconomy development
- The markets will take care of this

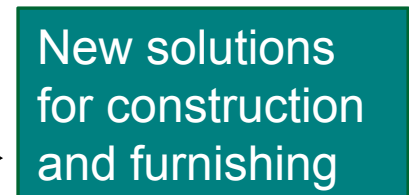
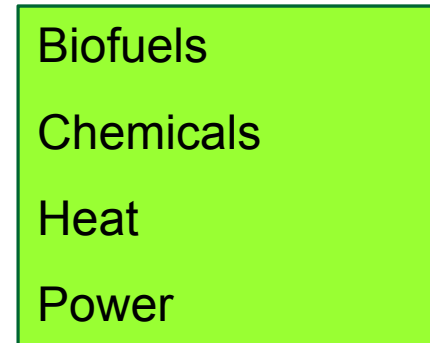
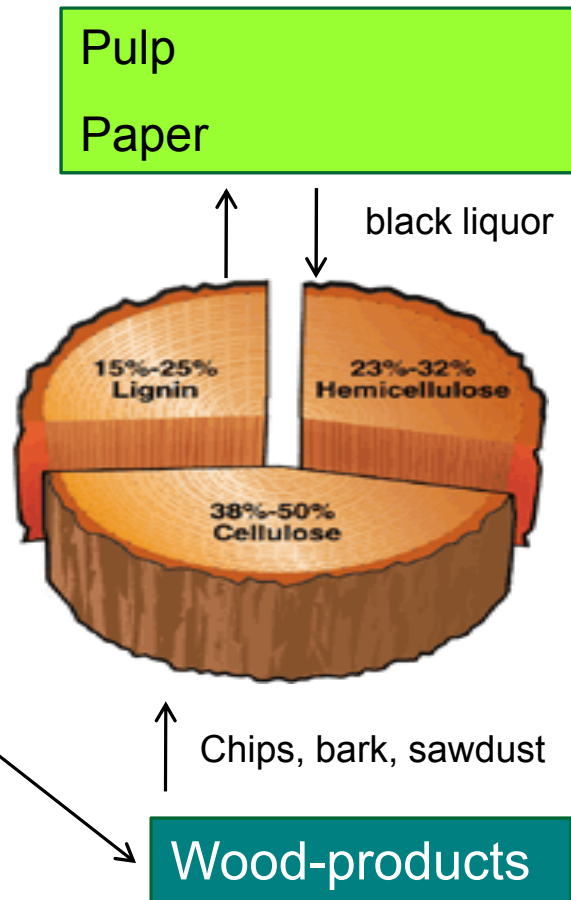
# New products outlook

# The New Products Are Based On:

More efficient use and processing of raw-materials and waste streams to produce current and new products

→ applying new technology

Roundwood, residues, stumps, branches, bark, etc.



# Forest Biorefinery

- The concept of *forest biorefinery* has become common
- Forest biorefinery (FB) is a facility that integrates biomass conversion processes and equipment to produce energy products and chemicals, along with the conventional forest products (pulp & paper, wood-products)
- The FB can use e.g. harvesting residues, pulping liquors, recycled paper, municipal and industrial wastes, and peat
- FB can be a large-scale industrial facility, integrated into a pulp and paper mill, or a medium- or small scale facility integrated into a sawmill or plywood mill
- Most of the discussions have focused on pulp & paper integrated biorefineries

# Forest Biorefinery

- Many forest industry plants are already today "biorefineries"
  - However, the term *forest biorefinery*, which came to more wider use only about 2005-2006, is specially linked to the introduction of following factors:
    1. New technology and production processes
    2. New products and business strategies
- Thus, using the biorefinery concept, instead of pulp and paper mill or sawmill, helps to make the distinction with the current operations
- Biorefineries using forest biomass are not restricted to forest industry (also energy- and chemicals industries)

# Forest Biorefinery: The Setting

- Companies in e.g. North America and Europe are considering investments in pulp and paper mill integrated biorefineries
- There are a number of different possibilities as regards to the choice of raw-materials, outputs and technology
- Viability of each depends on end markets, substitute markets (e.g. oil), biomass markets, and policies:
  - At what energy price and subsidy levels are forest biorefineries profitable?
  - What type of raw-material basis, technology or end product-mix is most profitable?
  - How do different policy measures effect wood consumption and prices, and what are the costs of the policies?

# Industry Case Examples

# Lingoboost demonstartion plant in Sweden

Wermland Paper,  
Bäckhammar pulp mill

LignoBoost  
demonstration plant



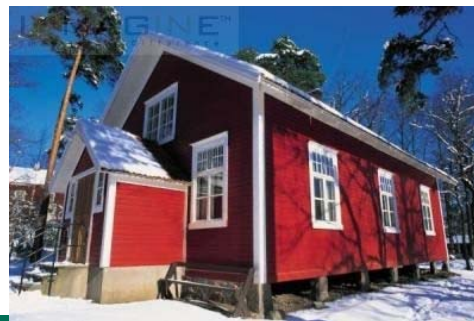
4000 t/a lignin by  
rail to Stockholm



Fortum Värme  
power company



“lignincake” energy value  
equal to coal

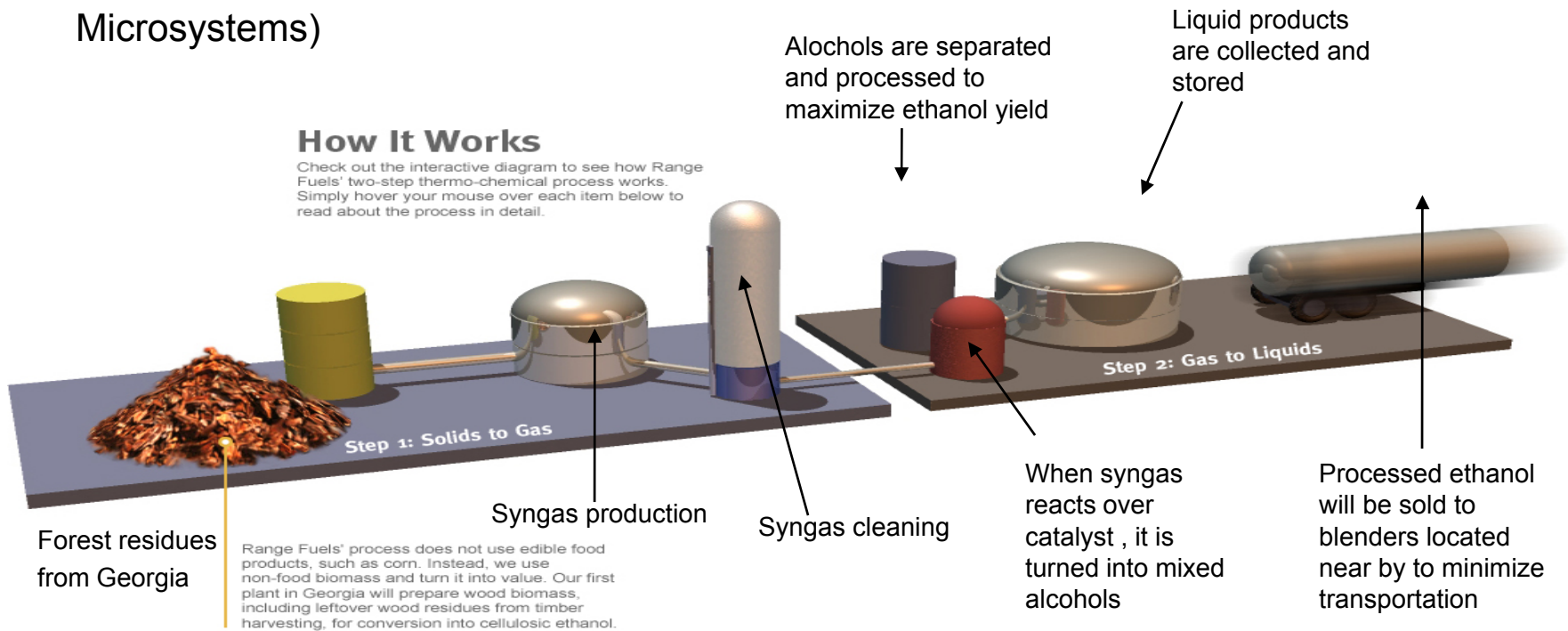


“Green” electricity and heating to 13 000  
family houses in Stockholm

- This would cut CO<sub>2</sub> emissions by about  
100 000 tons /annum compared to using  
coal

# Example: Range Fuels, Georgia, USA

- First commercial scale forest raw material based ethanol mill in USA
- Investment USD 225 million / Energy Department (DOE) gave \$76 mill. in 2007 and Department of Agriculture \$80 mill. loan in 2009
- Production capacity 380 mill. litres/yr (in first pahse 75 mill. litres/yr)
- Started to produce August 2010. Founder: Vinod Khosla, investor (founder of Sun Microsystems)

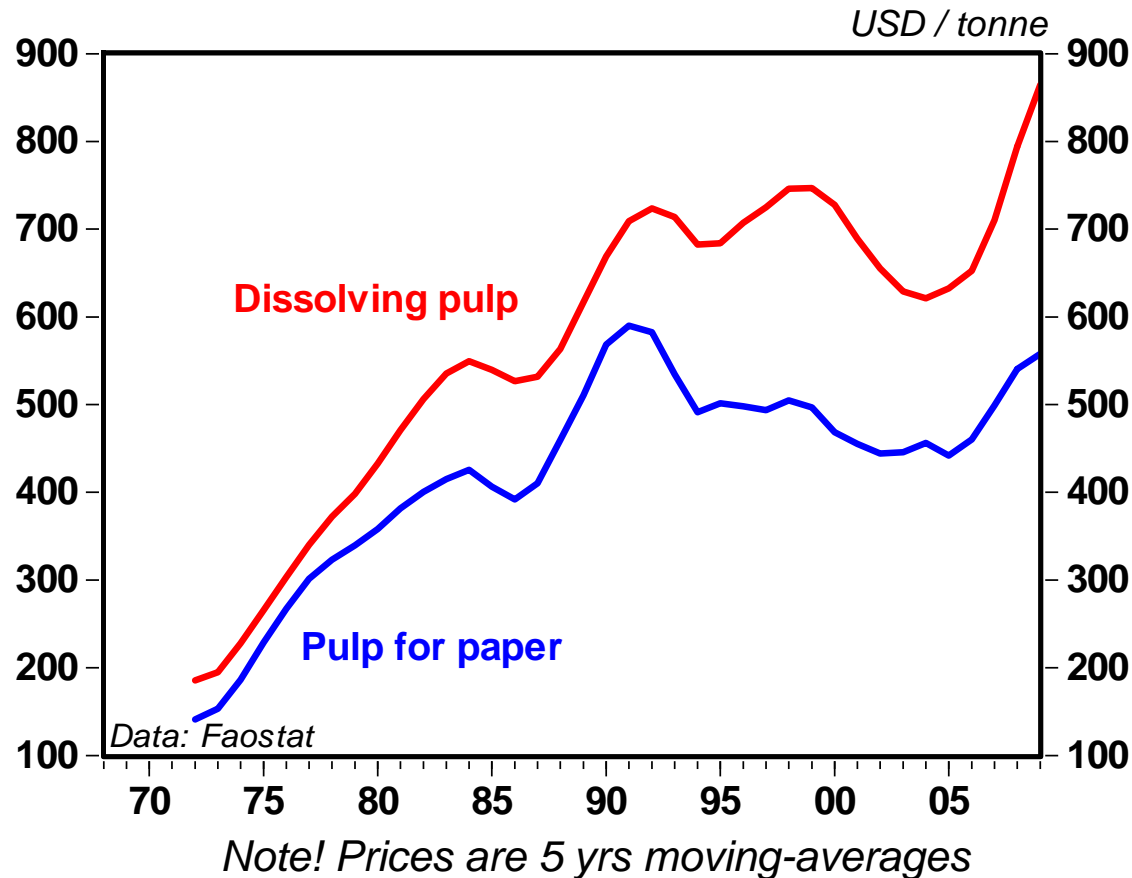


Lähde: [http://www.rangefuels.com/conversion\\_process](http://www.rangefuels.com/conversion_process)

# Example of Transformation: Case Domsjö

- Domsjö (Sweden) sulphite pulp mill founded 1903. Produced still pulp for paper in late 1990s (appx. 200 000 t)  
<http://www.domsjoe.com/>
- MoDo sold mill in 2000 for investment group (6 persons)
- Mill was transferred to modern biorefinery. Focus on products with good demand prospects
- Now it produces: **1. Dissolving pulp** (250 000 t), which is used for viscose (substitute e.g. for cotton and nylon); **2. lignosulfonate** (used for additive in concrete); **3. ethanol** (mainly for chemicals)
- In 2010, started a 300 mill. € investment project: black liquor gasification plant to produce biofuels for heavy trucks (€55 million R&D grant given by Swedish Energy Agency)

# World Price of Dissolving Pulp and Pulp for Paper, 1968-2009



Dissolving pulp has become economically more attractive



- Domsjö mill in Sweden (Örnsköldsvik) is an example, how an old unprofitable pulp mill has been transferred to profitable biorefinery
- Similar developments is taking place e.g. in Canada
- Investors have come outside the existing forest industry

# Tembec: Example from this week

- Tembec announced (April 11, 2011) that it will construct a pilot plant for the development of a high performance structural product known as Next Generation Sustainable Fibre (“Next Gen”). Process will use pulp and lignosulfonates within a modified phenolic resin to produce a structural material with unique strength-to-weight and durability characteristics
- Applications in e.g. in infrastructure and engineered components. Initial end-use application will be a railway tie for environmentally sensitive areas, with other applications such as automotive components, land and marine transportation infrastructure, and energy and transmission infrastructures
- Growing demand for environmentally friendly, lightweight structural composites
- Heavy Canadian local and federal government support (subsidy)

# Biorefinery Uncertainties & Risks

1. Energy prices (nobody knows)
2. Policy (regulations may change)
3. Advancement in biofuels production & technologies (when do new technologies become applicable on commercial scale?)
4. Rawmaterial availability & prices (forest biomass demand-supply changes)
5. Where to invest (Scandinavia and North America vs. South America and Russia)?

## Bioeconomy products: Comparative resource advantages



The annual growing period is long and productivity high in Brazilian eucalyptus plantation compared to the planted birch forest in Finland

# Conclusions

- Bioeconomy concept has become popular – a buzzword
- The importance is in how it changes thinking & strategies
- There are major global and national drivers which make bioeconomy development attractive
- Wood energy is the single biggest "new" forest related bioeconomy development in the near future (chemicals in the longer run)
- Energy sector and forest sector become ever more integrated
- New industries and investors are coming to forest sector

# Background literature

## General background

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**Thank you!**