# Markets and Policies for Forest Biorefineries: Current Status & Outlook

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# Outline

1. What do we mean by Forest Biorefinery?
2. Current Status
3. Policies
4. Energy prices and markets
5. Outlook
6. Conclusions

→ the perspective is “macro”

# What is forest biorefinery? Definitions:

1. A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, and value-added chemicals from biomass

   (*National Renewable Energy Laboratory, USA / www.nrel.gov/biomass/biorefinery + Wikipedia*)

2. Efficient use of the entire potential of raw materials and by streams of the forest-based sector towards a broad range of high added value products (by co-operation in and between chains)

   *(EU Forest-Based Sector Technology Platform / Biorefinery Taskforce, April 17, 2007)*

3. Full utilization of the incoming wood biomass for production of fibres, chemicals and energy

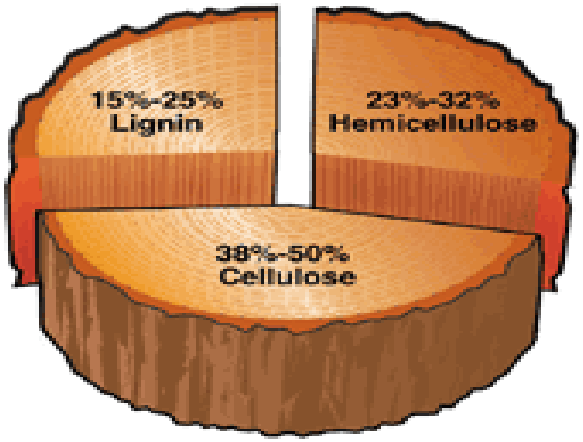
   (STFI-Packforsk, Sweden)

# → Better use and processing of raw-materials and waste streams to produce current and new products

Roundwood, residues, stumps, branches, bark, + other biomass

Pulp & Paper

black liquor




Biofuels

Heat

Power

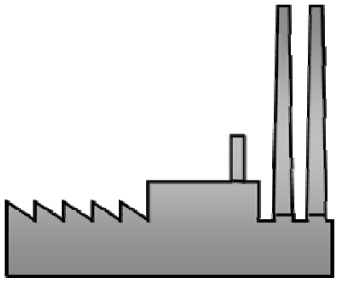
Chemicals

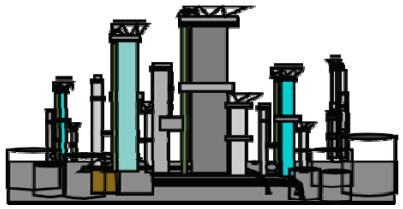
chips, bark, sawdust

Wood Products

# Forest Industry Biorefinery Products: Some Examples

Pulp and paper mill / sawmill





Integrated bioconversion unit

## Intermediate Products

- chips, sawdust
- hemicellulose
- lignin
- sugars
- lipids (fatty & rosin acids)

## Final Products

- pulp, paper, board
- wood products
- heat
- electricity
- ethanol, diesel, DME, hydrogen
- polymers

Important features:

1. Multioutput technology. Products can be *complements* or *substitutes*
2. Intermediate products can play a central role for the economic viability
3. Potential for CO2 reductions through product substitution

**Focus in this presentation is on energy, not chemicals!**

# What is the current state?

- Forest based projects in operation, pilot scale, or constructing pilot units, e.g.:

  1. Stora-Enso & Neste Oil (Finland); 2. UPM & Cargil (USA); 3. LignoBoost (Sweden); 4. Range Fuels (USA); 5. Tolko Industries (Canada), 6. Bio Ethanol Japan Kansai (Japan), etc.

- Intensive R&D, specially in North America, Japan, Sweden and Finland. Different countries have stressed somewhat different products & technologies
- USA has clearly invested the most (e.g. DOE). Global companies have the advantage of being able to utilize the know-how in different countries more readily (e.g. UPM)
- In general, large scale thermochemical platform units seem to be closer to commercial applications than biochemical platoform units
- R&D so far very much technologically and company driven. This is understandable, since new technological breaktrhoughs are still in need

# Current situation cont.

- There are *n* possible biorefinery platforms. Within each platform, there are *n* different technologies. If there is a possibility to mix paltforms, then there are *n x n x n* potential technology options open to us. This number may very well be over 30!
- Viability of each option, depends on end markets (demand, supply, prices), substitute markets (e.g. oil), biomass markets, national, regional (EU) and global policies (energy, environment, security, regional)
- Thus, the pulp and paper industry is in the following situation:

  *”I know biorefinery is very important, and I need to be at the front of this developmet. But, to which of the 30 or so baskets should I put my eggs (money)? Which country should I invest? Do I need partners from the energy industry?, etc.*

# Technology is necessary, but not sufficient to forest biorefinery to succeed!

- The important role of technology is well understood – it has been, and still should be, at the center of the development
- But, the closer to commercial applications we come, the more there is a need for socio-economic analyzis and research:

1. Policy (energy-, climate change- & agric. policies)
2. Energy markets & prices (oil)
3. Technology development (less costly technology processes)
4. Pulp and paper markets (energy production is married to a pulp and paper production)
5. Social-environmental issues (sustainability & efficient utilization of scarce biomass)

→ Focus here in 1. & 2.

# POLICY:

# What are the important issues and impacts?

# Biorefinery development depends on various policy sectors (regulations)

1. **Energy security**. Oil and gas production will be increasingly concentrated in a small number of countries, and government controlled companies (e.g. OPEC, Russia)
2. **Climate change mitigation policies**. Policies getting stricter → costs of fossil energy consumption increases
3. **Agricultural policies** (EU, USA). Strong lobby groups for agricultural sector

- However, there may be conflicts between polices 1.-3.

# Policy & impacts depend on the priorities

| | Policy Priority | |
|---|---|---|
| | **Energy security & agricultural policy** | **Efficiency & costs to consumer** |
| **Policies/Regulations** | tariff & quota, export tax on raw material, subsidies, standards | technology, risk investment & R&D support, international agreements |
| **Positive Impacts** | domestic production, rural employment & income, security, foreign policy ”freedom” & military costs | efficient resource allocation & cost efficiency, less adminstrative costs, more predictable op.env. |
| **Negative Impacts** | trade wars, complex and manifold regulations, regional differences, uncertainity, resource misallocations | loss of domestic production & rural employment, imported energy dependency |

Note! Various environmental implications under both policy priority

# Currently there are, and most likely will be in the future:

- Tariffs, quotas, subsidies, standards, etc.

- Complexity of the regulations and regional differences increase the uncertainity related to biroefinery investments:

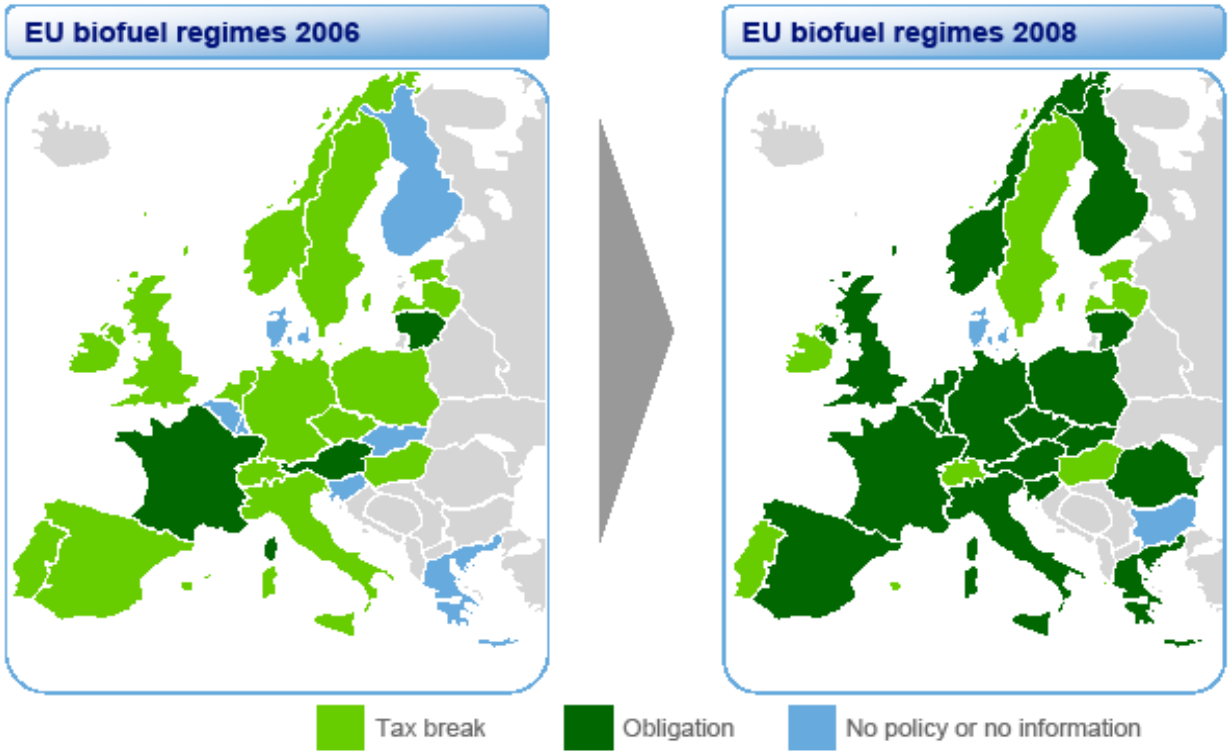
- in which country to invest?
- in which product to invest (market size, product prices)?
- impacts to raw material availability & prices?
- how long will the polices be in place?

→ Companies need to invest in policy know-how. Somebody has to understand the policy implications and be well informed of the developments (some bad experiences from companies neglecting this)

# Example: Biofuel Policy in EU

**Government policies will boost demand further - moving towards mandated use**

NESTE OIL




Source: Neste Oil

*Source: Neste Oil, November 26, 2007*

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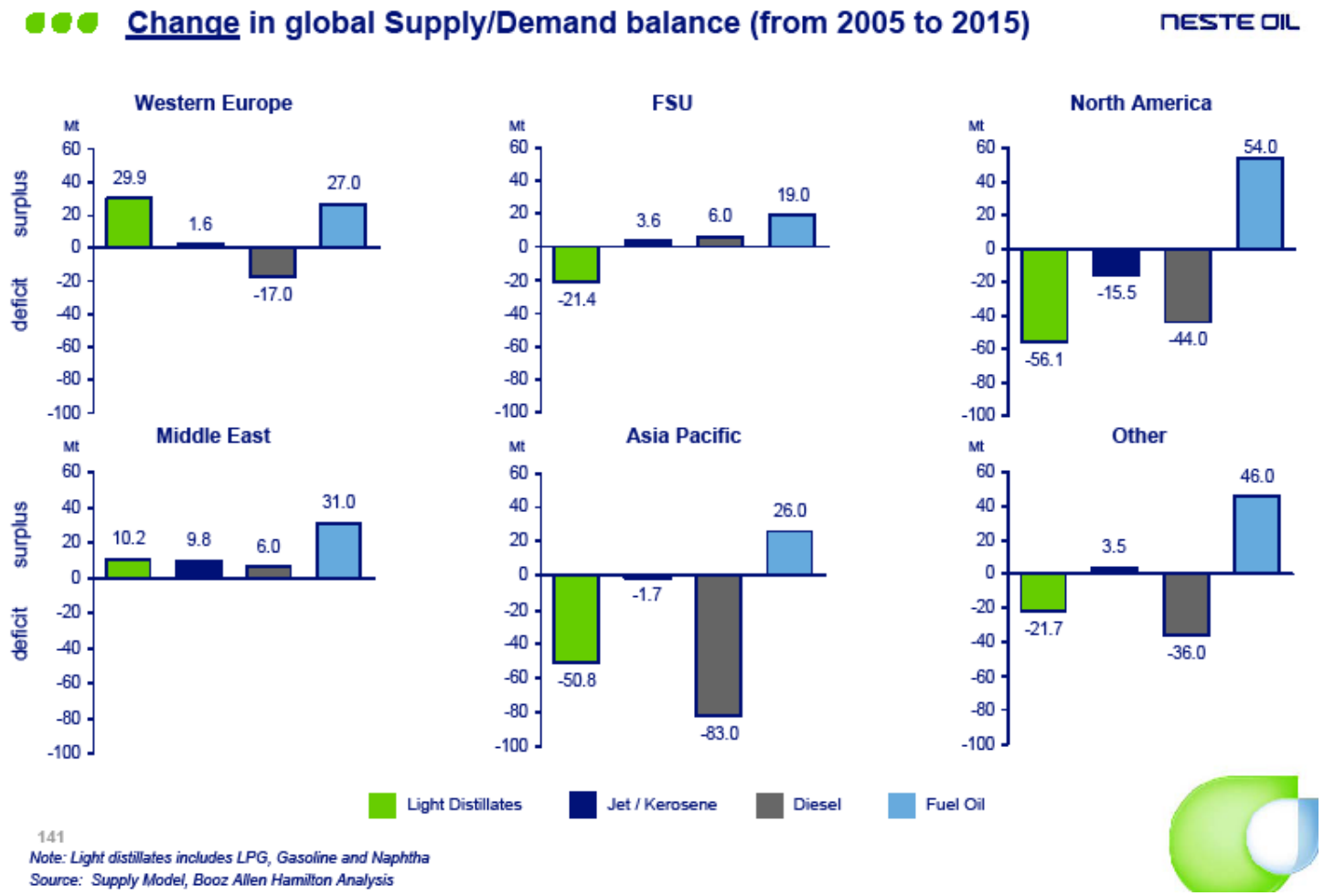
The policies across EU countries differ!

# Policy changes supply-demand balances for biofuels

*No new markets need to be created for biorefinery products. They have been created by political decisions even before production has been started up!*



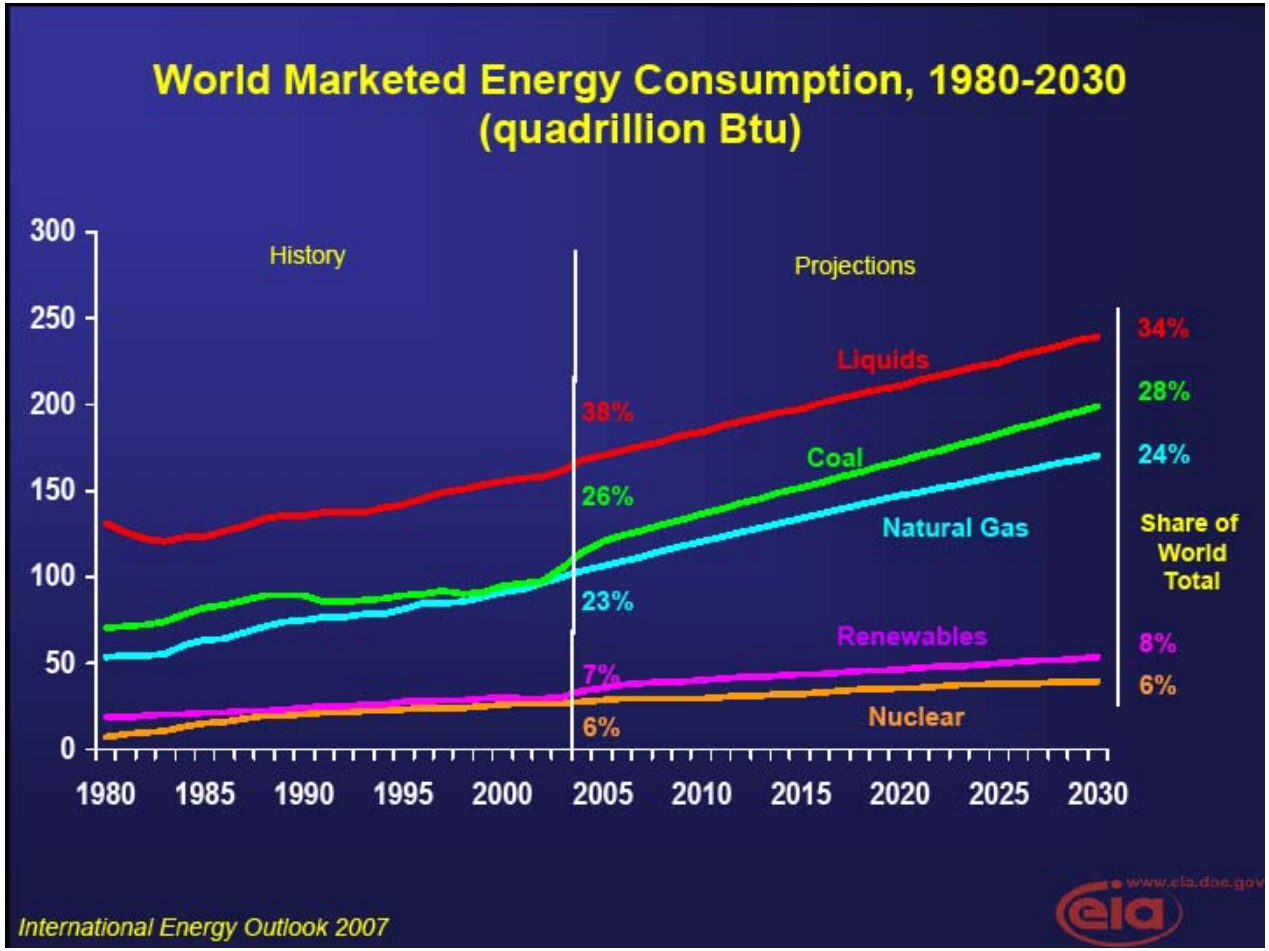

*Source: Neste Oil, November 26, 2007*

# ENERGY PRICES:

# What are the important issues and impacts?

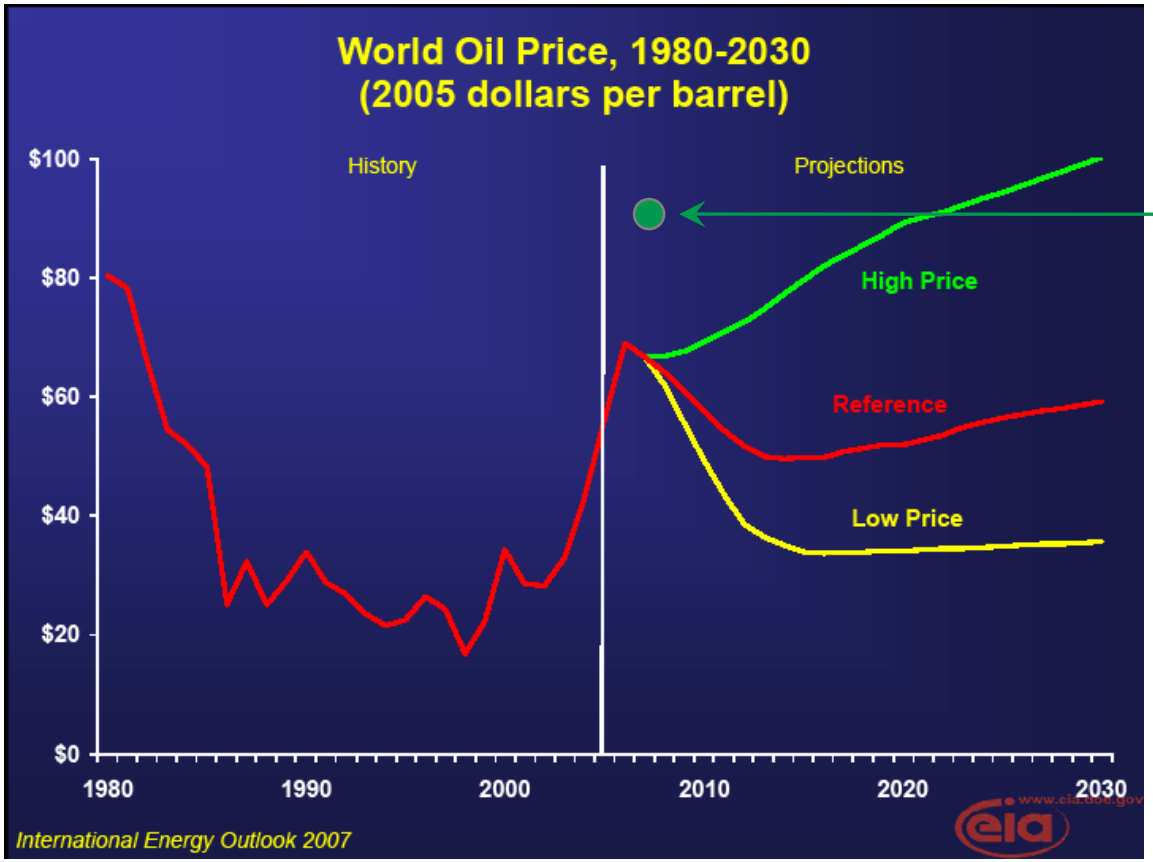
# World Energy Demand Growth Continues

57 percent increase over the 2004 to 2030 period




Demand increase → Price and CO2 increase

# Oil price



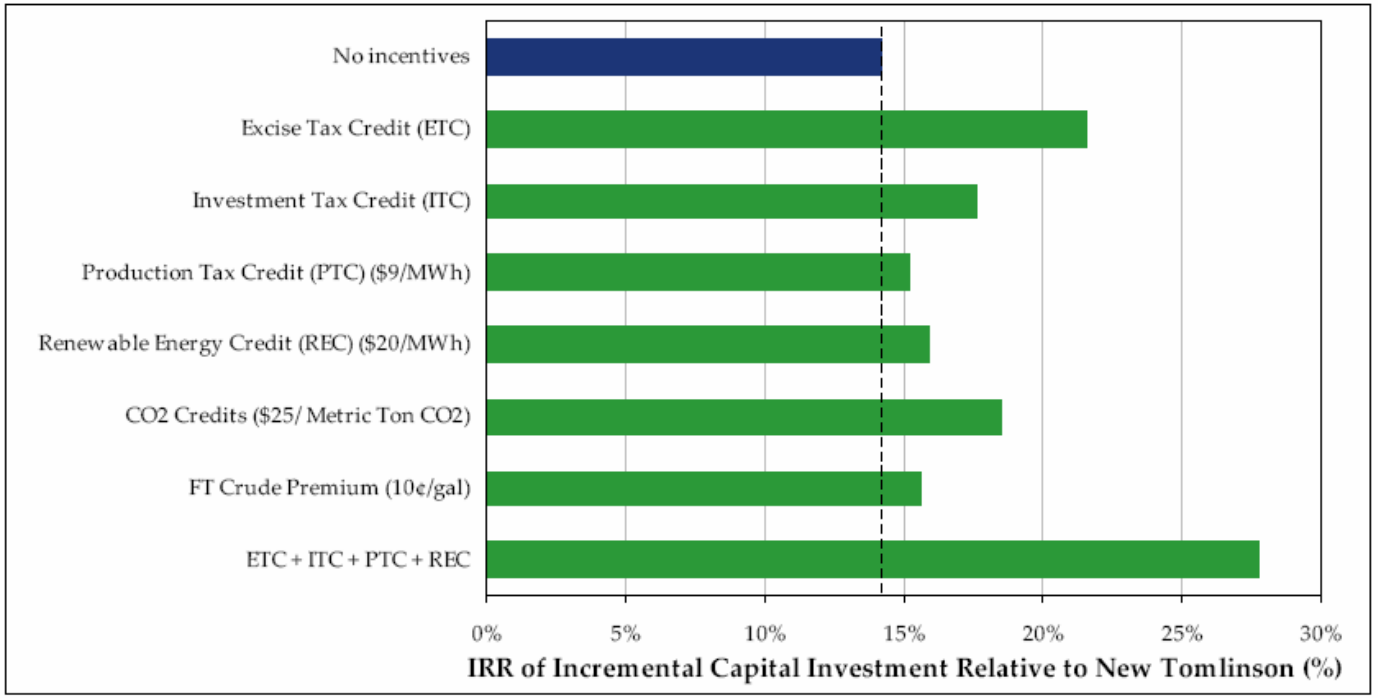

Price
December 2007

*"One of the most challenging aspects of the biorefinery economic analysis is deciding what future energy prices to use"* (Eric Larson et al. 2006)

→ The range between "high" and "low" may spell the range between feasibility and infeasibility for cellulosic biofuel development ($34 – 100)

# Sensitivity 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.**

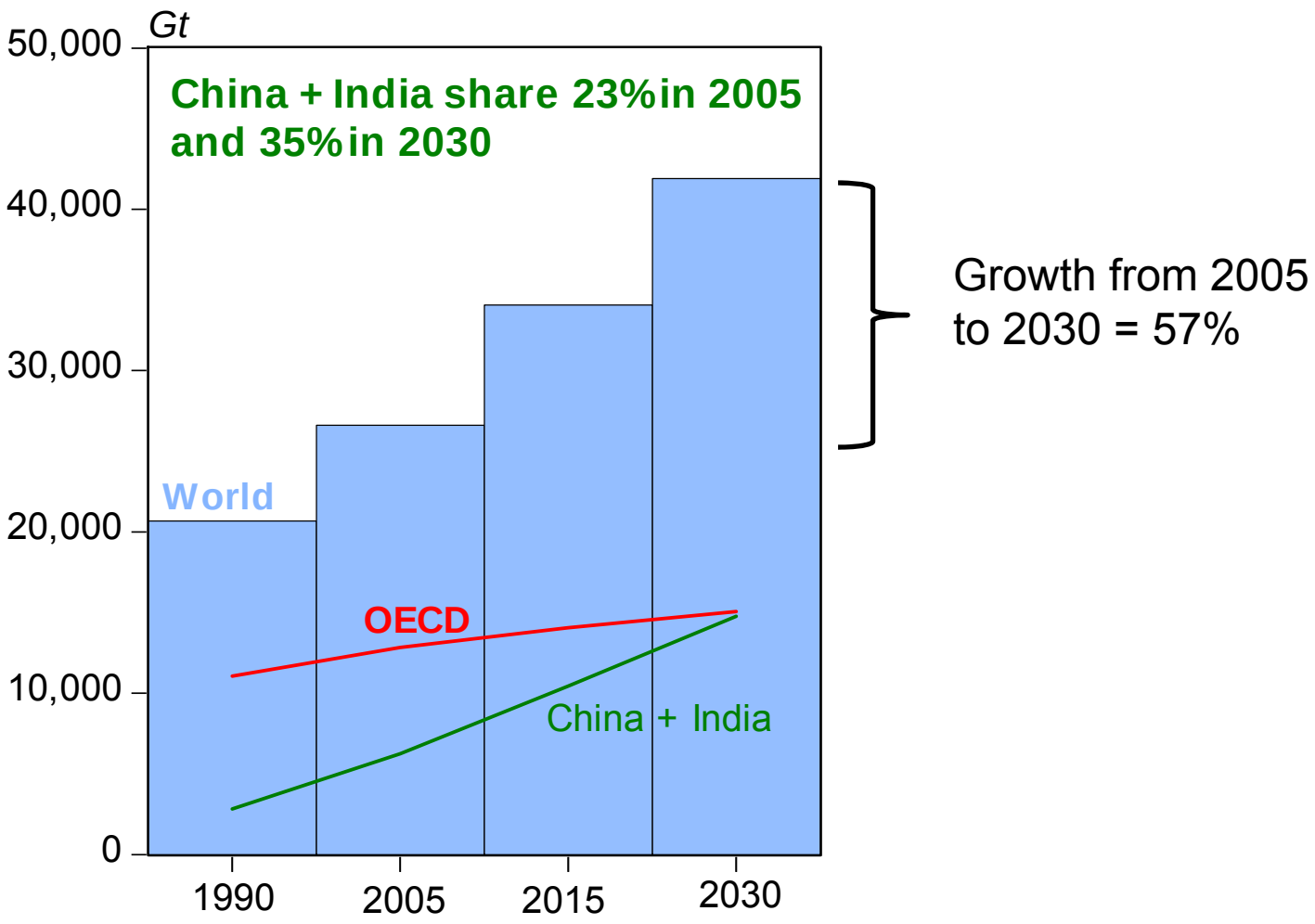



Note: Investment tax credit = 20% gasification tax credit

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.*

# World Carbon Dioxide Emissions Increase




*Data and outlook: IEA World Energy Outlook 2007 reference scenario*

# Impact of a $CO_2$ Value on Fossil Fuel Prices

→ Realistic starting point: One way or an other, you pay for the CO2 emissions tomorrow

| Fuel | $CO_2$ content per million Btu | Delivered Price (2005, all sectors, per million Btu) | Impact of $10 per ton $CO_2$ value | | Impact of $50 per ton $CO_2$ value | |
|---|---|---|---|---|---|---|
| | | | $ | percent | $ | percent |
| Coal | 0.094 | 1.57 | 0.94 | 59.9 | 4.70 | 299 |
| Oil | 0.074 | 18.60 | 0.74 | 4.0 | 3.70 | 19.9 |
| Nat. Gas | 0.053 | 9.65 | 0.53 | 5.5 | 2.65 | 27.5 |

*Source: Howard Gruenspecht, USA EIA, November 16, 2007*

- A $25/ton value on $CO_2$ raises gasoline prices by about 23 cents per gallon
- CO2 price will play increasingly important role in the biorefinery development

# The long-term outlook (enlightened guestimation)

- There will be a number of different forest biorefinery concepts, which vary according to local conditions and markets
- 2008-2012: pulp & paper industry integrated biorefineries based on syngas gasification (FT), fermentation, etc. platforms are *mainly* at the demonstartion/pilot stage
- 2012-2015: first commercial scale forest industry biorefineries come to operation (e.g. 100 000 - 150 000 t/a biodiesel units)
- 2012-2020: forest biorefineries investment boom
- 2015 - :major impact on the forest sector and local bioenergy markets, but realtively small impact on global energy markets
- To what extent forest biorefineries will be located in South-America, Asia, Russia *vs.* Scandinavia and North America?

# Factors that may slow down the development

1. Unwanted policy measures & low oil price
2. Engineering capacity deficiency due to energy industry investment boom

   → Rise in engineering capacity prices

   → Raw material prices (steel etc.)
3. Sustainability issues and the stance of NGO's:

   *"The expansion of biofuels to achieve a 15% reduction in fuel consumption may prove challenging, and it may cause numerous unintended ecological consequences…"* (The Wilderness Society, Science and Policy Brief, May 2007, No. 1)

→ Impacts from increased forest biomass removals:

- biodiversity, soil productivity, carbon sequestration

# Conclusions

1. Biorefinery products have global markets, but local regulations → uniform markets unrealistic target in the near future

2. Risks: policy, oil price, pulp & paper markets, technology, feedstock price, sustainability

3. The closer to commercial biorefinery investments we are, the more we need to know about the non-technological issues, i.e. markets, policy and societial values

   → more research is needeed on these issues

4. How do we maximize benefits from the use of wood biomass? What is the optimal usage of biomass? Answers will vary from region to region because:

   different policies; demand, resources, existing industries, etc.

# Conclusions

5. Need to invest in policy know-how *in the company (in addition to industry association knowledge)*

6. How to minimize potential side impacts of increased forest biomass utilization to forests? Pro-active rather than reactive strategy

7. Need to prepare scenarios for the different outcomes (at Metla we are building a simulation model to help to analyze impacts of different policies and market developments to forest sector)

# Thank you!