Converting a kraft pulp mill to an efficient resource - summary of a large Swedish R&D-program

By Peter Axegård, Innventia

INNVENTIA


Research and development of efficient new processe, materials and products made from renewable wood-based raw materials

Innventias RD&I Covers

- **Pulp, paper and packaging board**
- **Bio-energy, bio-chemicals and bio-materials**

- **Sustainability, CSR and LCA**

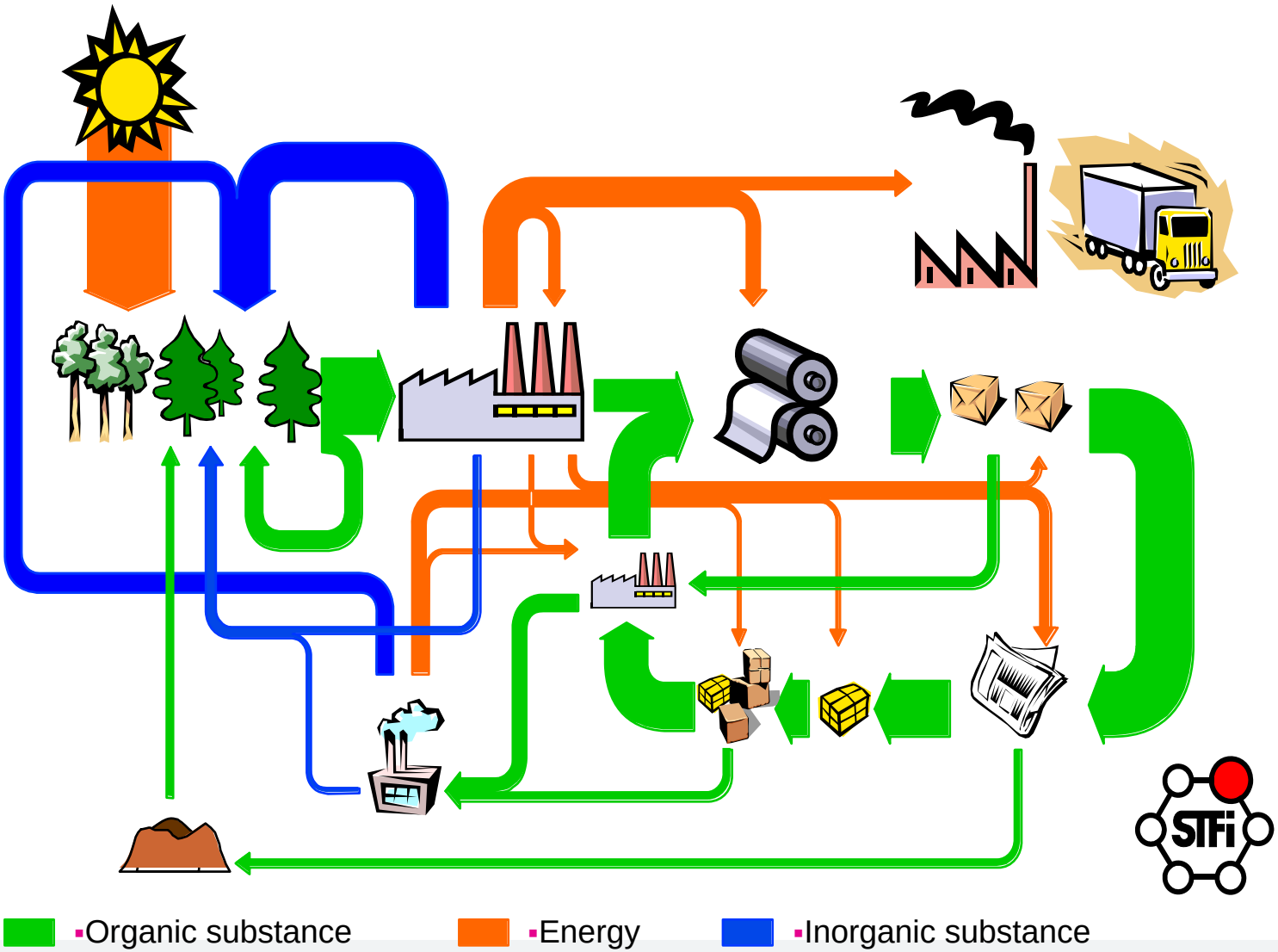
Presentation is Based on

- Eco-Cyclic pulp mill program 1996-2002 (KAM)
- Future resource adopted pulp mill program 2002-2004 (FRAM)

The Kraft Process has Imperfections

Capital intensive	**1 billion US $**
Low pulp yield	**40- 45 %**
Solid waste	**3 - 5 % of production**
Air emissions	**odor, TRS, VOC, NO_X**
Water discharges	**organic and inorganic substances**
Water use	**10 - 30 m^3 ptp**
Heat losses	**20 - 30 GJ ptp**

The Ecocyclic Pulp Mill Vision



The Ecocyclic Pulp Mill vision

A completely ecocyclic system for high quality pulp and paper products which efficiently uses the energy potential of the biomass

The Eco-Cyclic Pulp Mill Vision Explored 1996-2005

- Eco-Cyclic Pulp Mill (KAM) program
- Future Resource Adopted Pulp Mill (FRAM) program
- Total budget 24 Million US$ (164 MSEK)

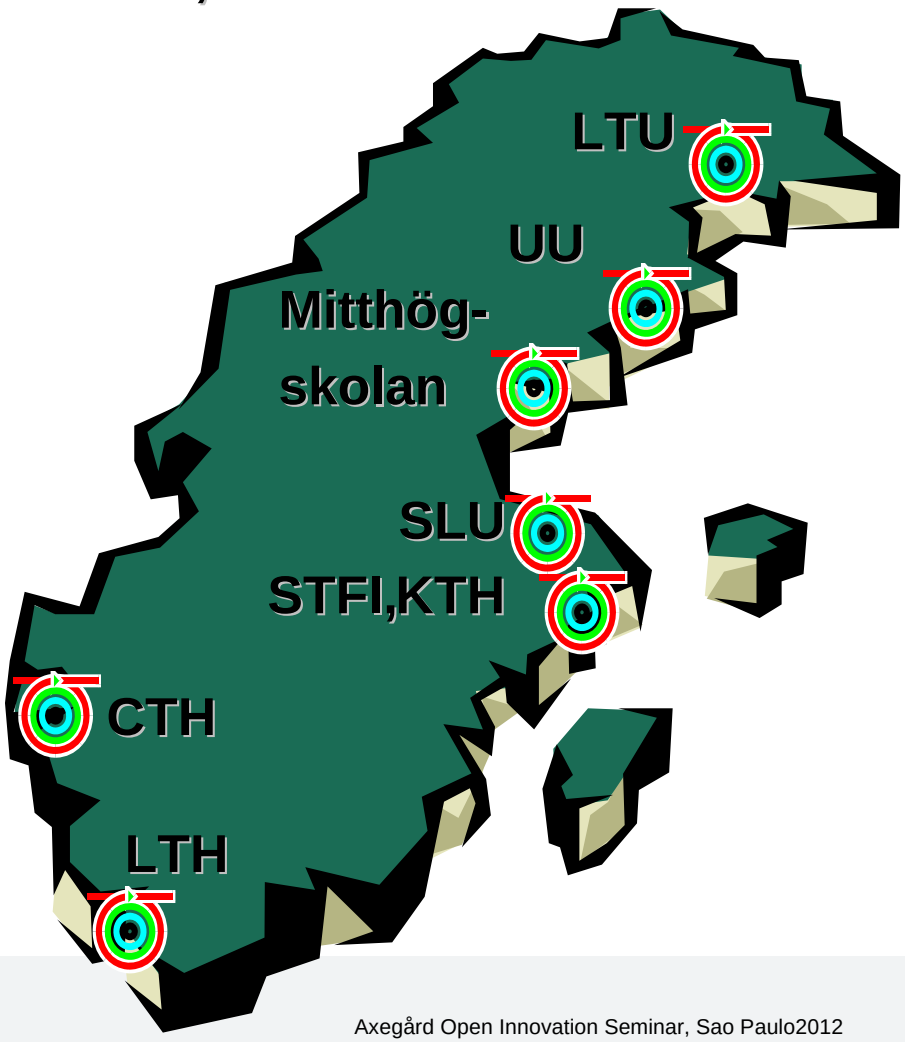
- Heavy industrial involvement

- Overall objective - To improve the performance of modern kraft pulping with a focus on energy

- Over 100 publications and reports
- 20 post graduate students
- 4 patent applications

Eco-Cyclic Pulp Mill Network

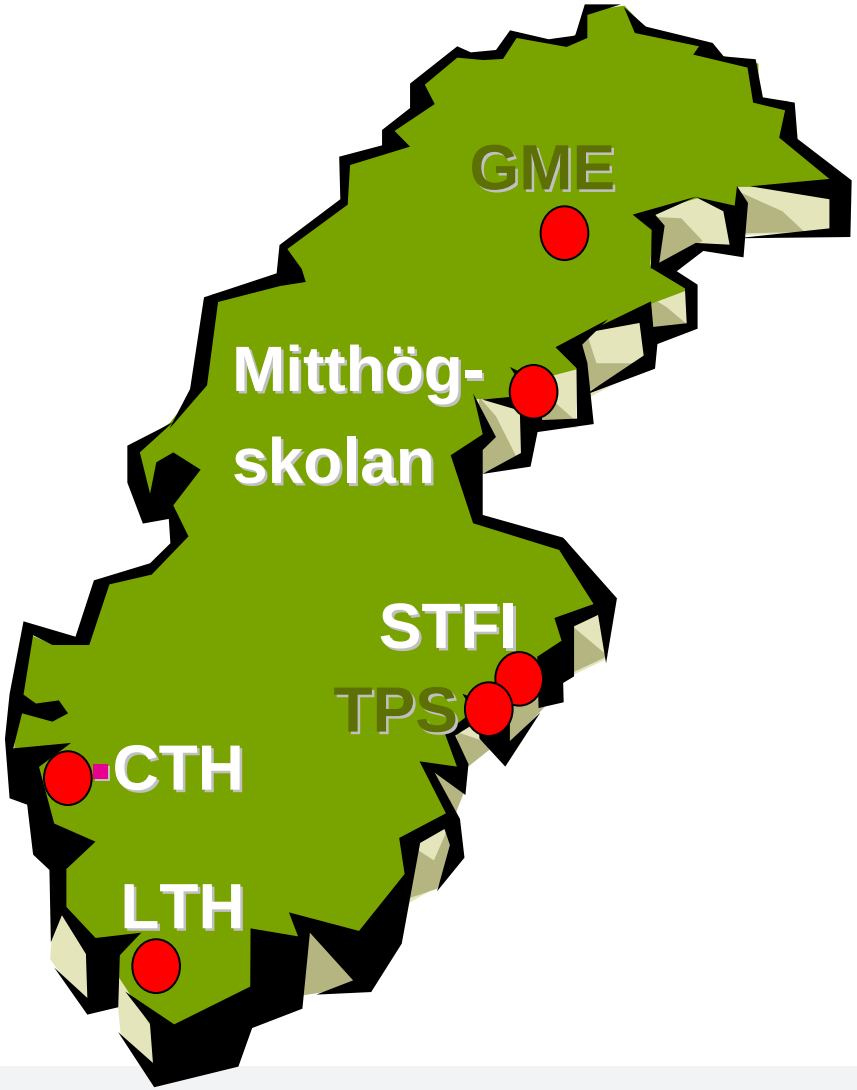
Univ of Idaho, USA



Industrial Partners

- Södra Cell
- MoDo Paper
- AssiDomän
- Eka Chemicals
- StoraEnso
- Purac
- Solvina
- ÅF
- Nykomb Synergetics
- Kiram
- Korsnäs

FRAM Network



Industrial Partners

Bäckhammars bruk
Holmen Paper
Stora Enso
Södra Cell

Fortum Värme
Sydkraft
LignoTech

Orelis (Rhodia)
Epcon
Anox
Aga Linde

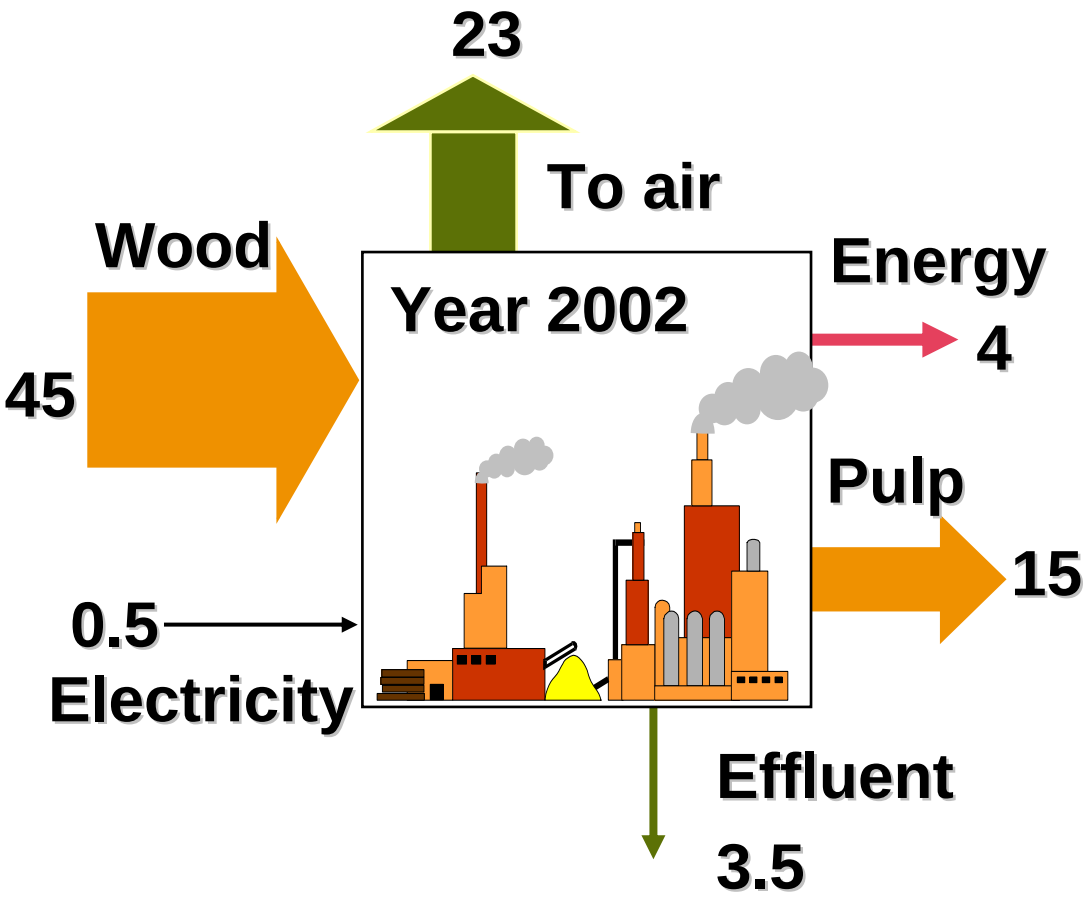
Larox

ÅF

Theoretical Kraft Pulp Mills

- **A Reference (BAT) Mill with modern technology**
  - A theoretical, bleached kraft pulp mill using recent technology in operation in Finland and Sweden
- **Model Mills**
  - At least one sub-process not commercially tested
- **The Reference Mill and Model Mills evaluated**
  - Variable costs, capital investment, pulp quality, energy balance, life cycle fossil CO_2, water use, solid waste

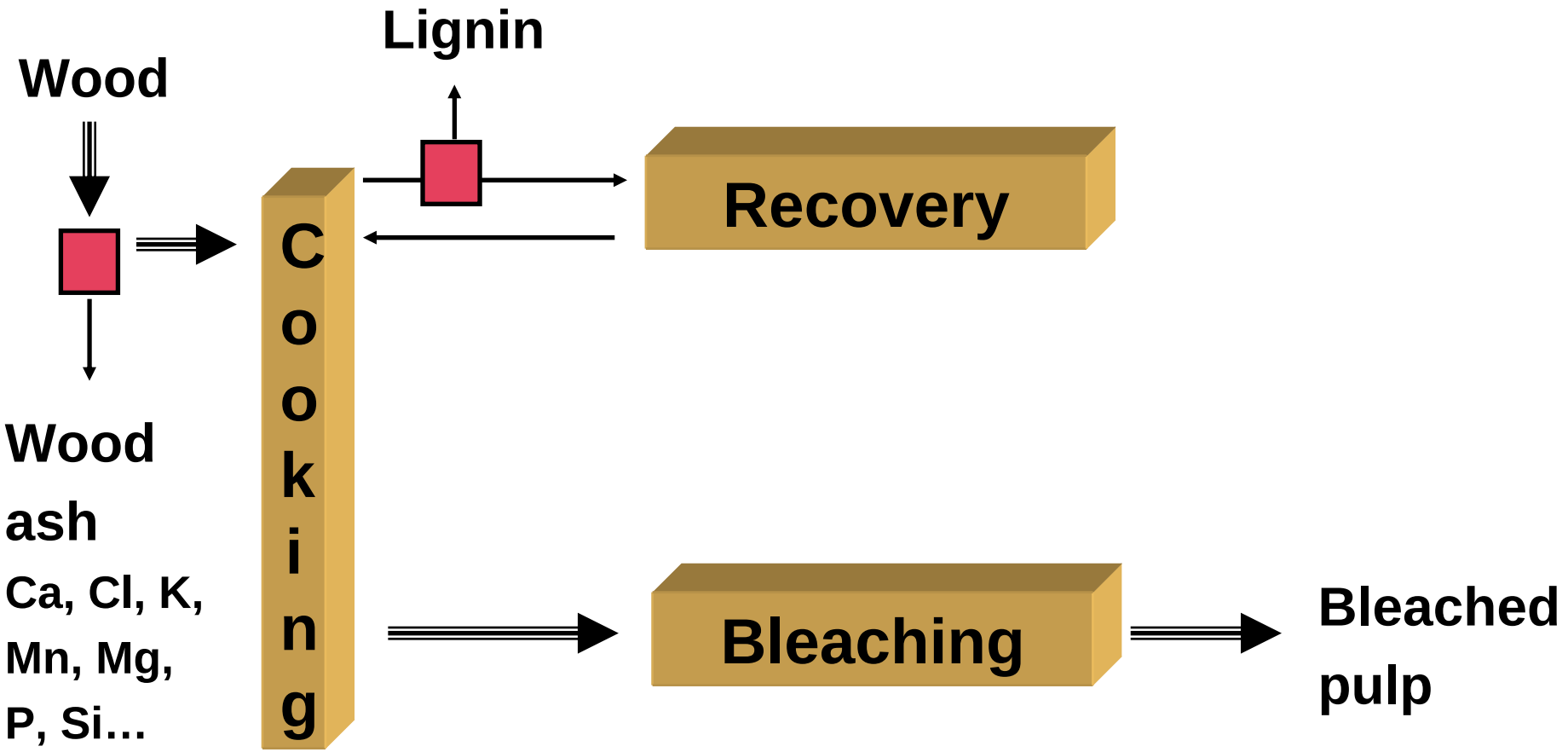
Energy Balance for Modern Kraft Pulp Mill, GJ ptp



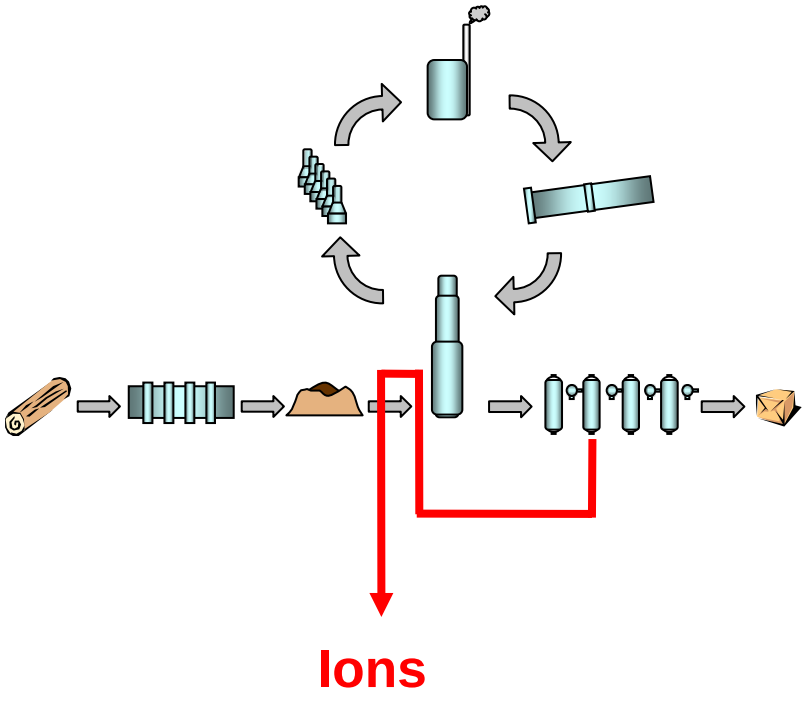
Promising Future Alternatives

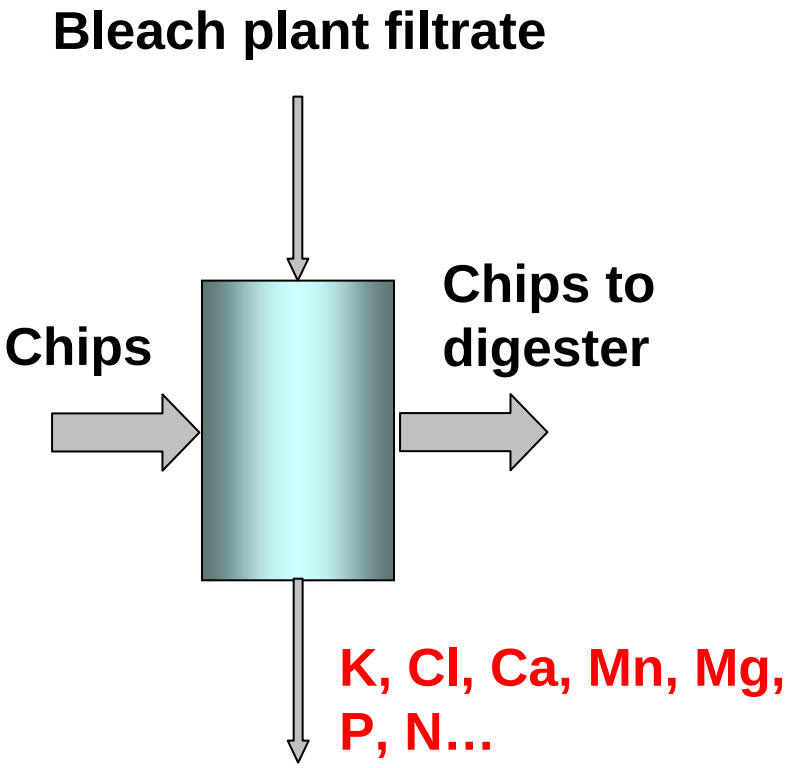
- **Model Mill #1** **Chip leaching**
- **Model Mill #2** **Lignin removal**
- **Model Mill #3** **BLG electricity**

Identified Needs for Separation Processes for Improved Mill Efficiency



Model Mill #1
Chip Leaching

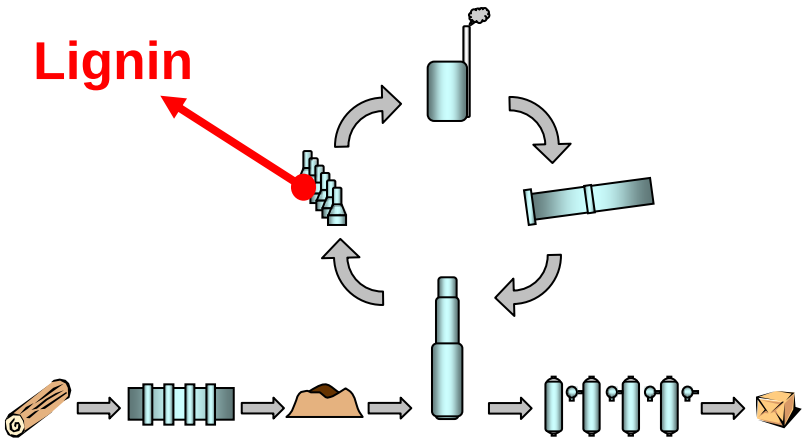


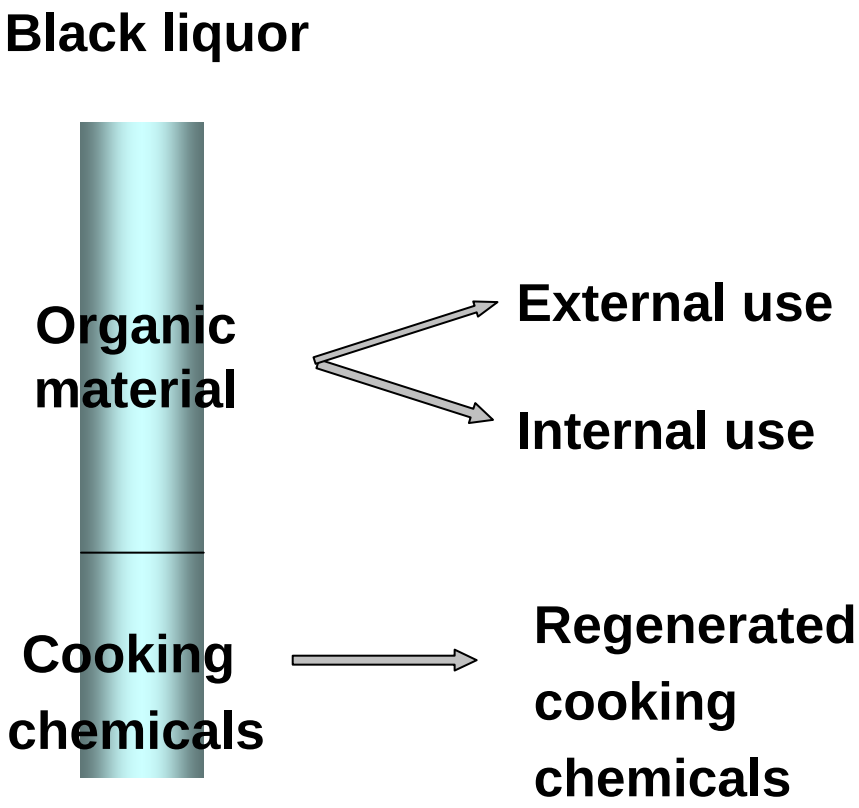


Effluent “free” with Chip Leaching
1 kg COD ptp

- **COD below 1 kg ptp**
- **Mill effluent 6 - 7 m^3 ptp**
- **Minimal external treatment**
- **Efficient spill liquor handling system**
- **Extra evaporation needed using low grade steam**

Model Mill #2
Lignin Removal from Black Liquor

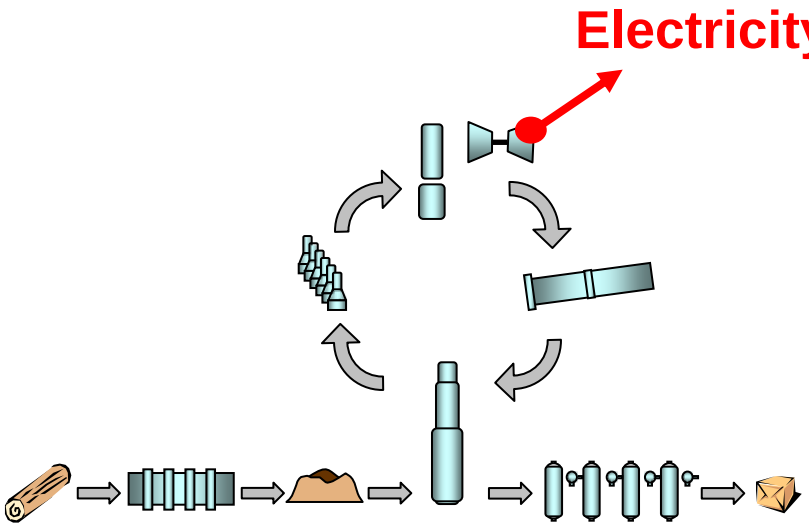


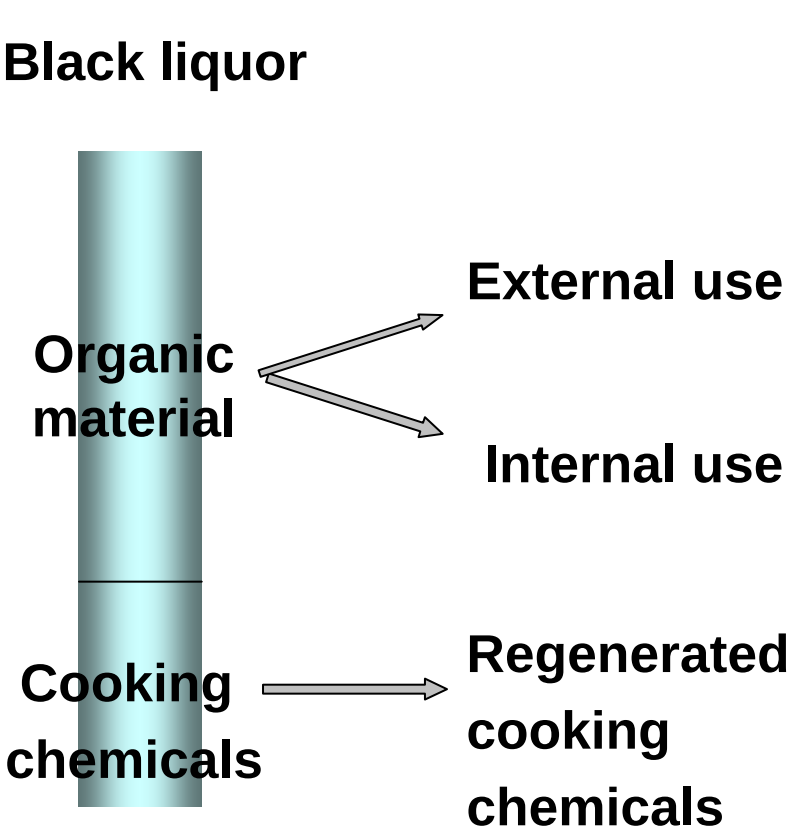


Effects of Lignin Removal

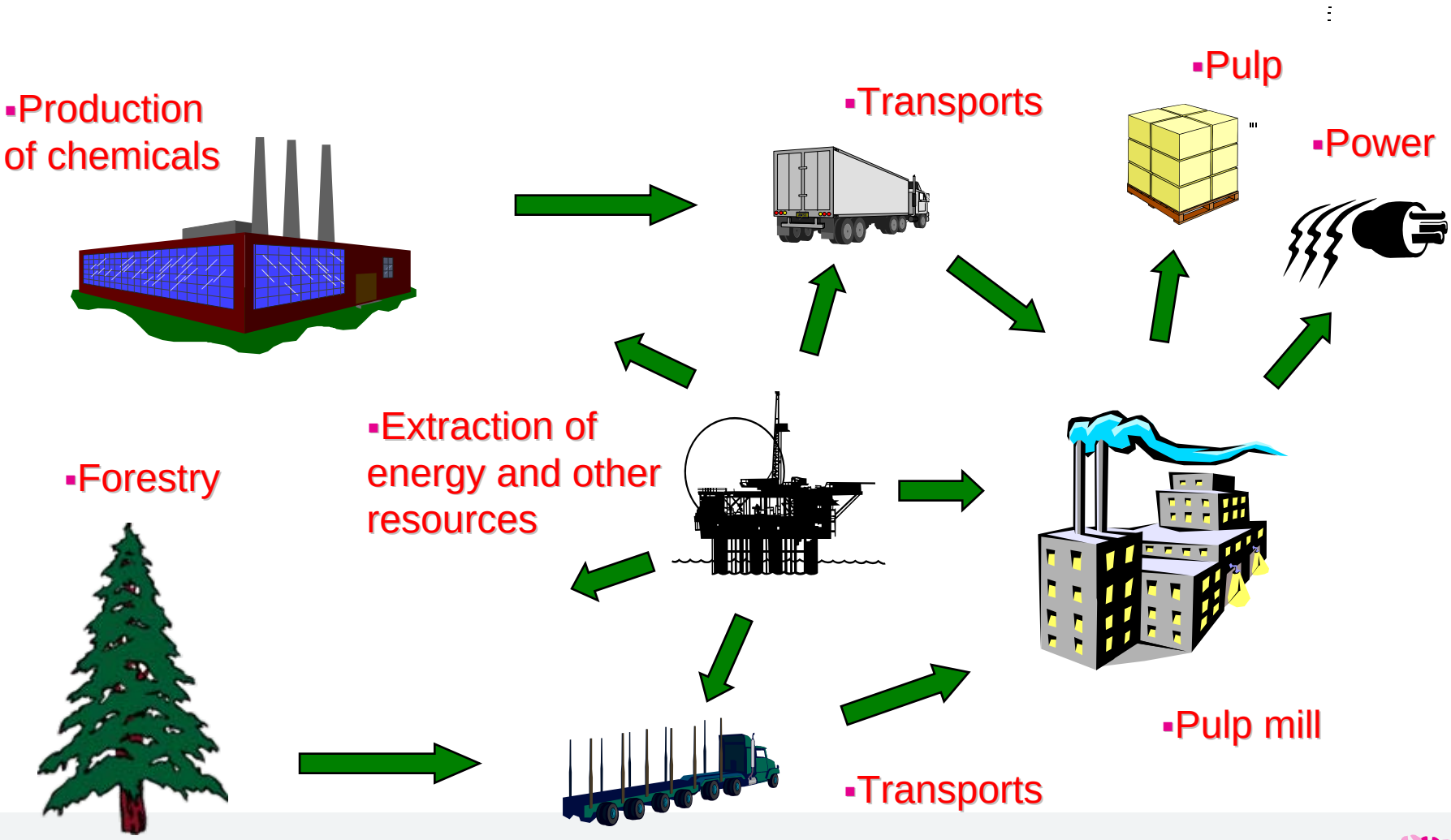
- **Valuable by-product (especially in Europe)**
- **Higher production in recovery boiler limited mills**
- **Higher energy efficiency**

Model Mill #3
Black Liquor Gasification - Combined Cycle



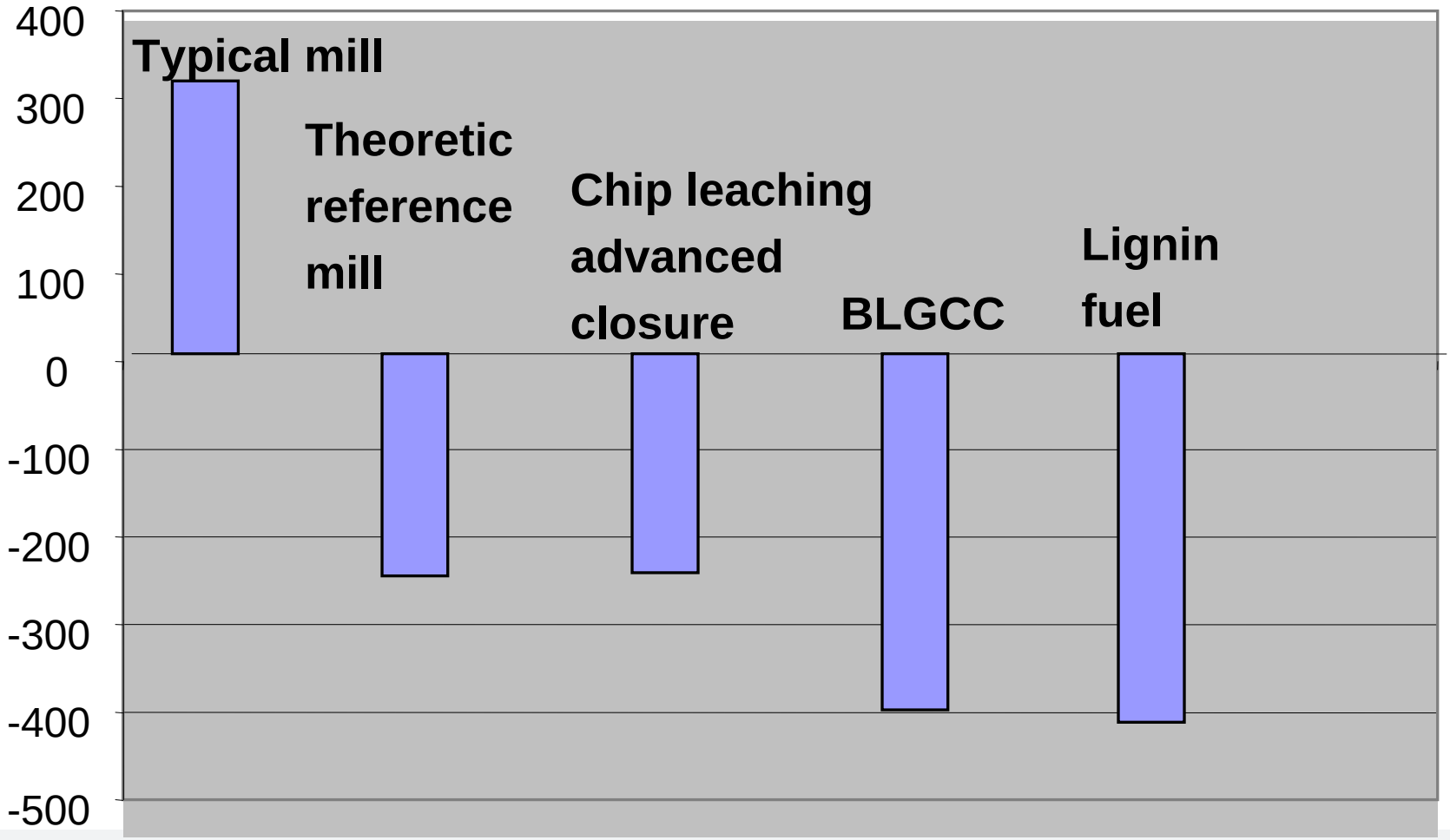


Life-cycle CO_2 Emissions



INNVENTIA

Fossil CO_2 from Plant to Pulp Bale, kg ptp



Comparison of Different Model Mills

	Sold fuel GJ ptp	Sold power kWh ptp	Net operating costs %	Capital invest-ment %	Fossil CO_2 kg ptp
Sw. Average 2000	-0,6	-140	120	n.a	+320
Reference mill	3,1	540	100	100	-260
#1 Chip leaching	3,1	500	100	101	-250
#2 Lignin removal	7,5	0	99	101	-420
#3 BLGCC	2,3	1050	95	108	-390

Other Results Implemented in Mills

- Cd-purification of recovery boiler dust
- Less NOx-emissions by pH-control of condensates
- More efficient peroxide bleaching by Mn-control
- Two-stage oxygen delignification

Possible by-products from a Kraft Pulp Mill kg/ton pulp

	Softwood	Bagasse	Eucalypt	
Pulp	1000	1000	1000	
Electricity	870		670	kWh/t
Or products from dissolved organic substances in black liquor				
Lignin	600	470	440	2/3 can be removed
Xylan	70	260	210	50 % can be removed

Summary (1)

- Modern kraft pulp mills have low emissions and very energy efficient
- Large potential in upgrading existing mills
- The kraft process has no viable alternative
- The kraft process has significant potential for further development
- Removal of lignin from black liquor has interesting potential

Summary (2)

Key issues for further improvement

- **Minimization of solid by-products**
- **Improved cooking and maximum strength delivery**
- **Best use of surplus energy**
- **“Smart kidneys” and “metals management” for water closure and process efficiency**

- **Addition of side-processes**


Thank you for your attention
Innventia
Boosting Business with Science