STFI-PACKFORSK

THE KRAFT PULP MILL AS A BIOREFINERY

Peter Axegård

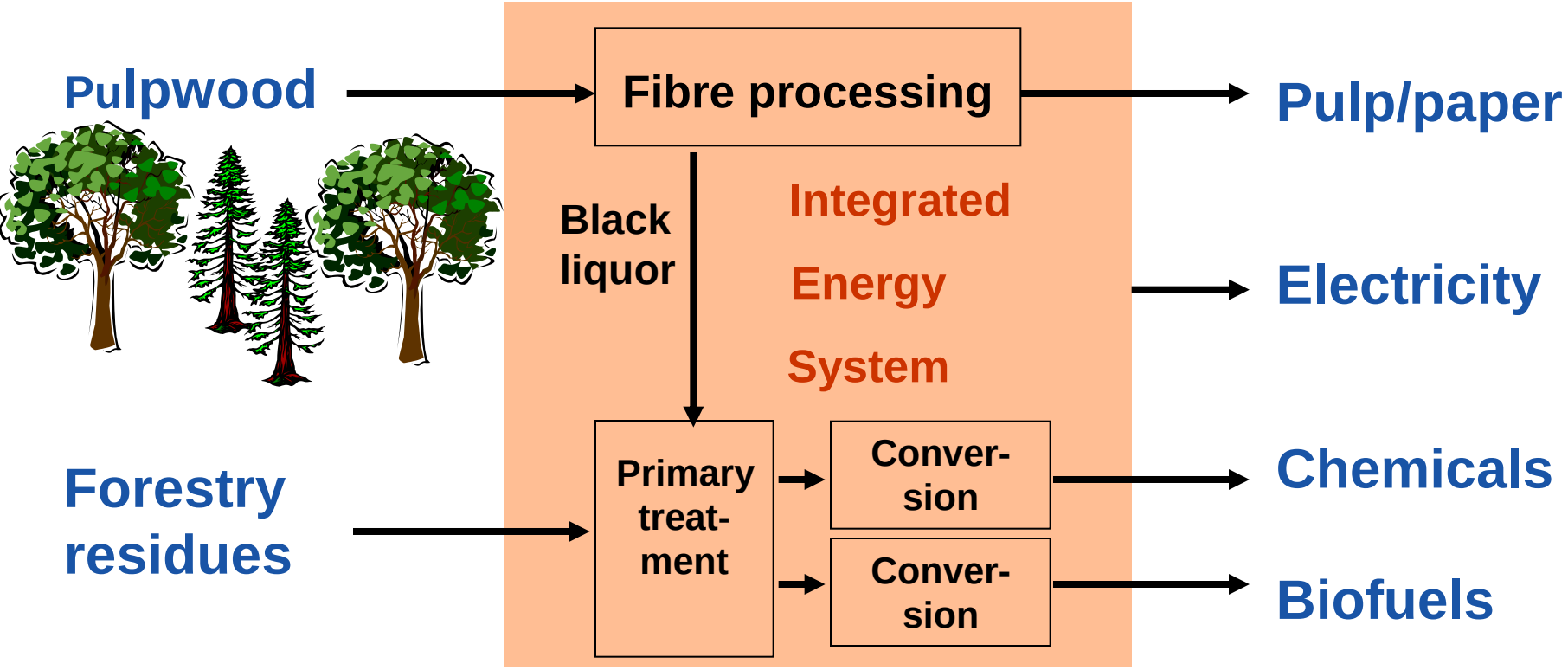
STFI-Packforsk AB

The Pulp Mill Biorefinery

STFIs definition

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

STFIs Biorefinery Activities



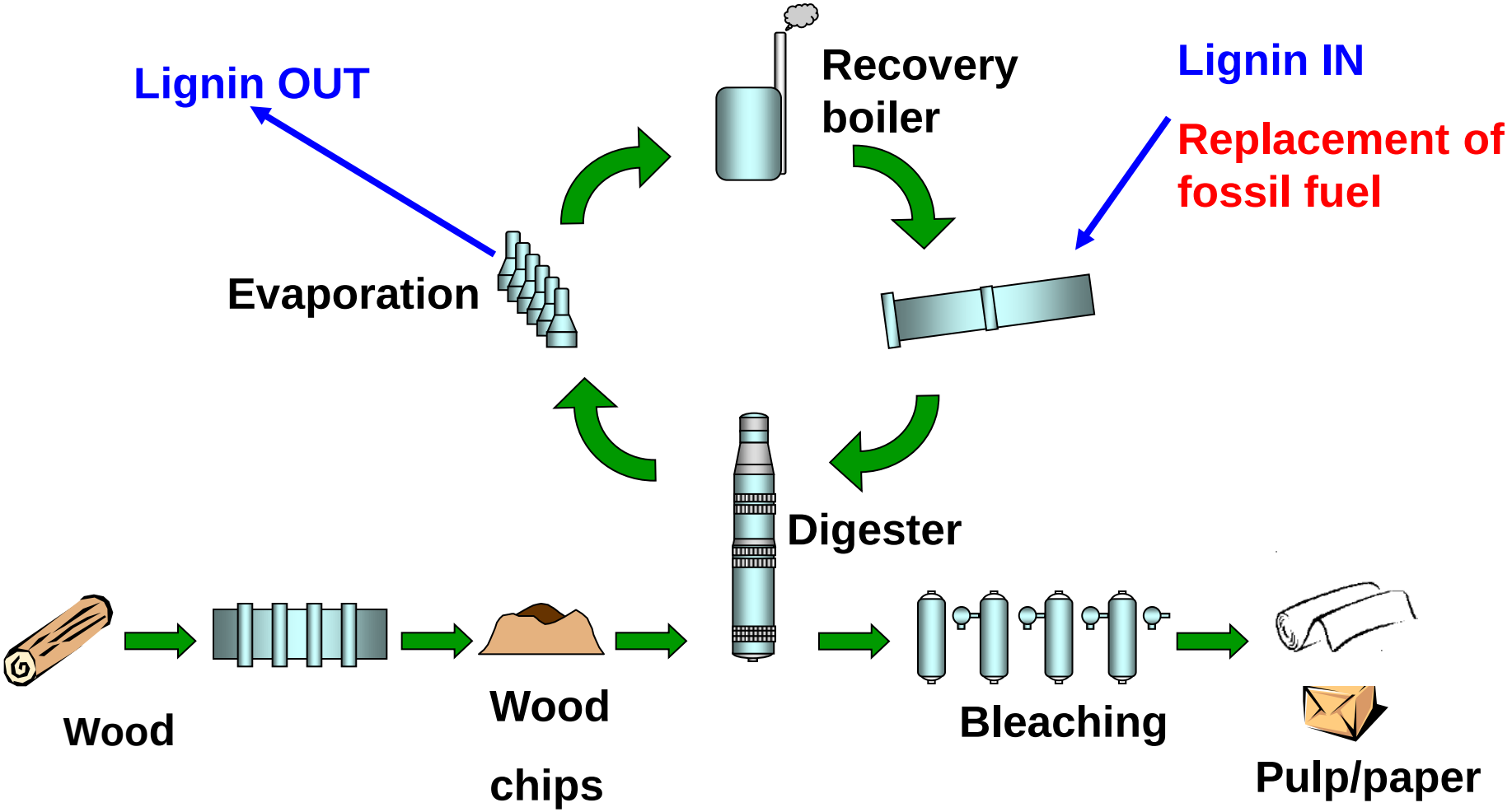
Large Effort on Lignin Removal

- **Projects:**
  - **KAM, 1996 - 2002**
  - **FRAM1, 2002- 2005**
  - **FRAM2, 2005 - 2008**
  - **Demo plant, 2006 - 2008**
  - **Total budget on lignin, 115 MSEK (approx. 12 m€)**

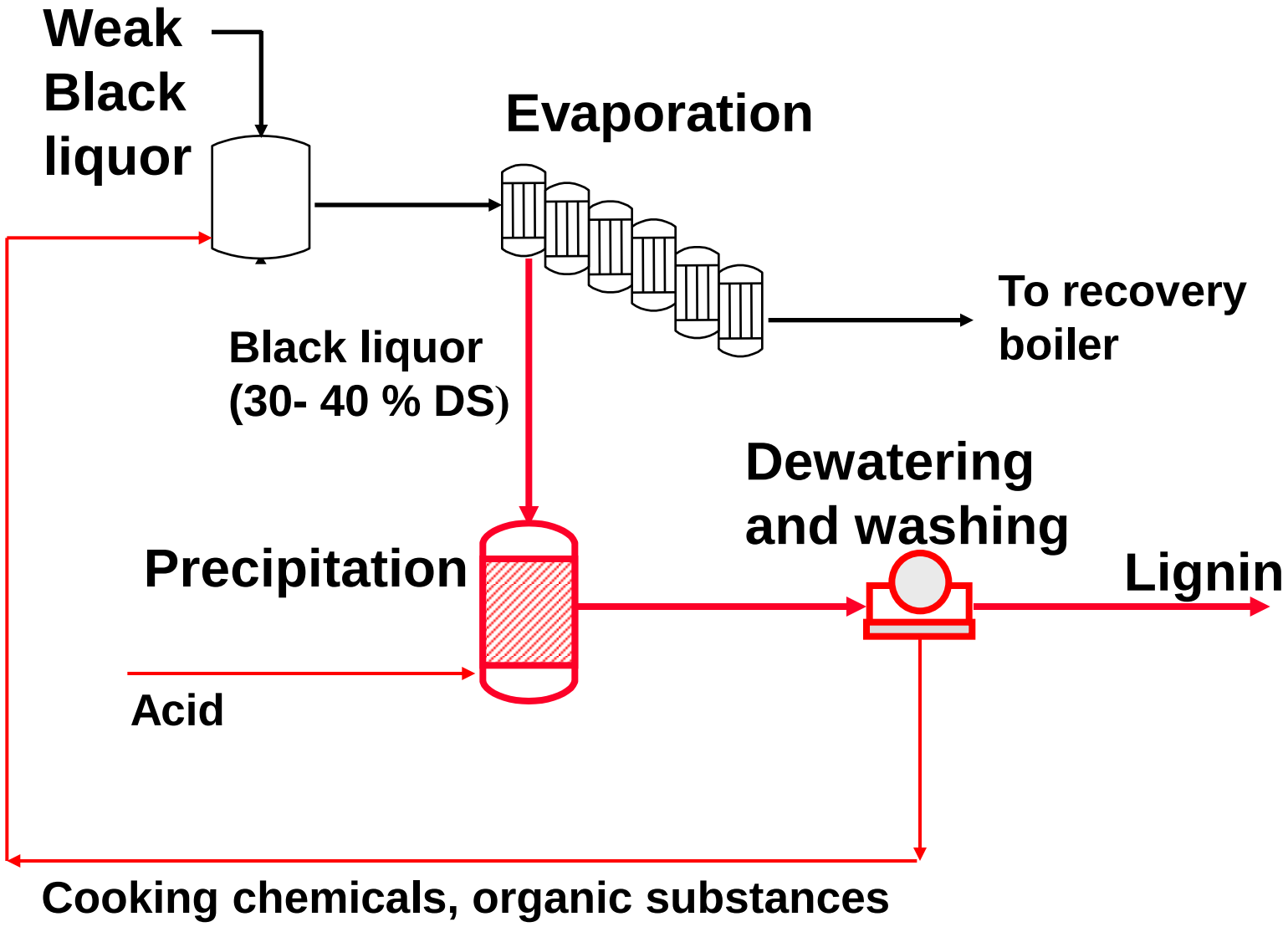
Removal of Lignin from Black Liquor Industrial Value

- **Low capital-cost alternative to de-bottleneck a flow gas limited or thermally limited recovery boiler**
- **Lignin can replace mineral oil as a fuel and also be a feed-stock for “green” chemicals and materials**

Lignin from Kraft Black Liquor



Traditional One Stage Process

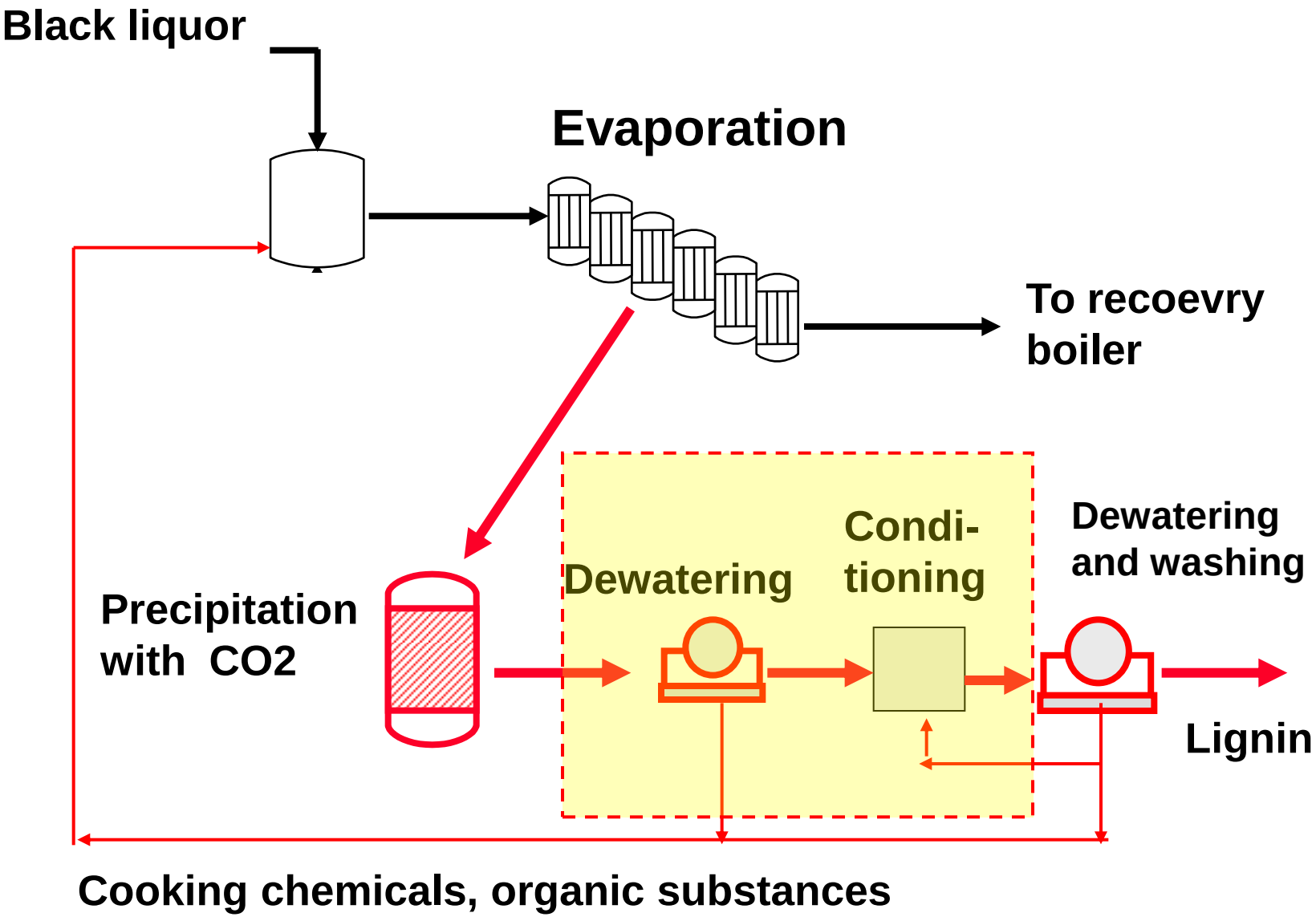


Problems With One Stage Washing

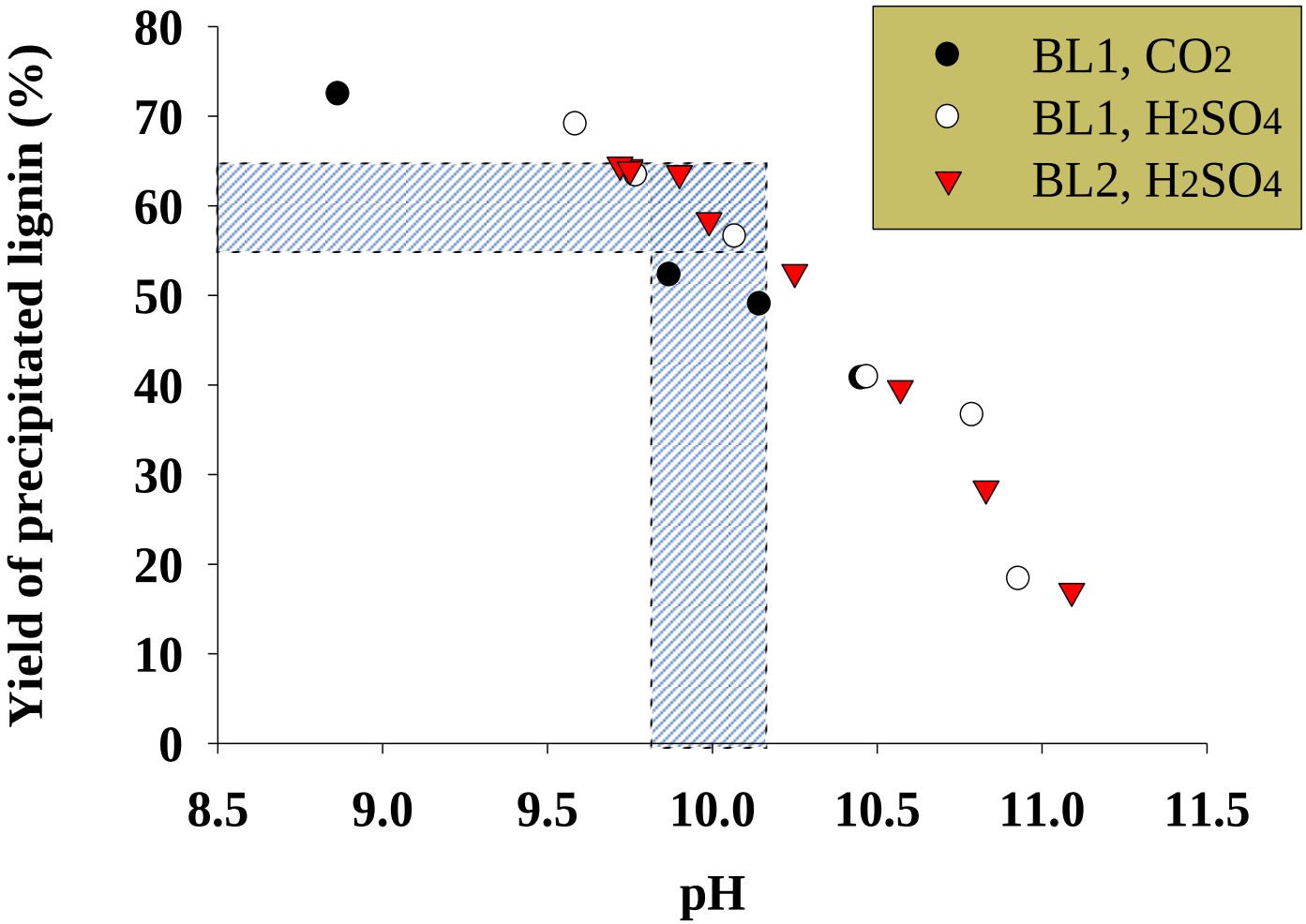
- **Poor control of pH and ionic strength**
- **Very slow dewatering, large lignin losses and lignin with low purity and high water content**

Good Scientific Opportunities

New Process for Lignin Removal



Yield of Precipitated Lignin from Kraft Mill Black Liquor



Different Scales for Lignin Removal

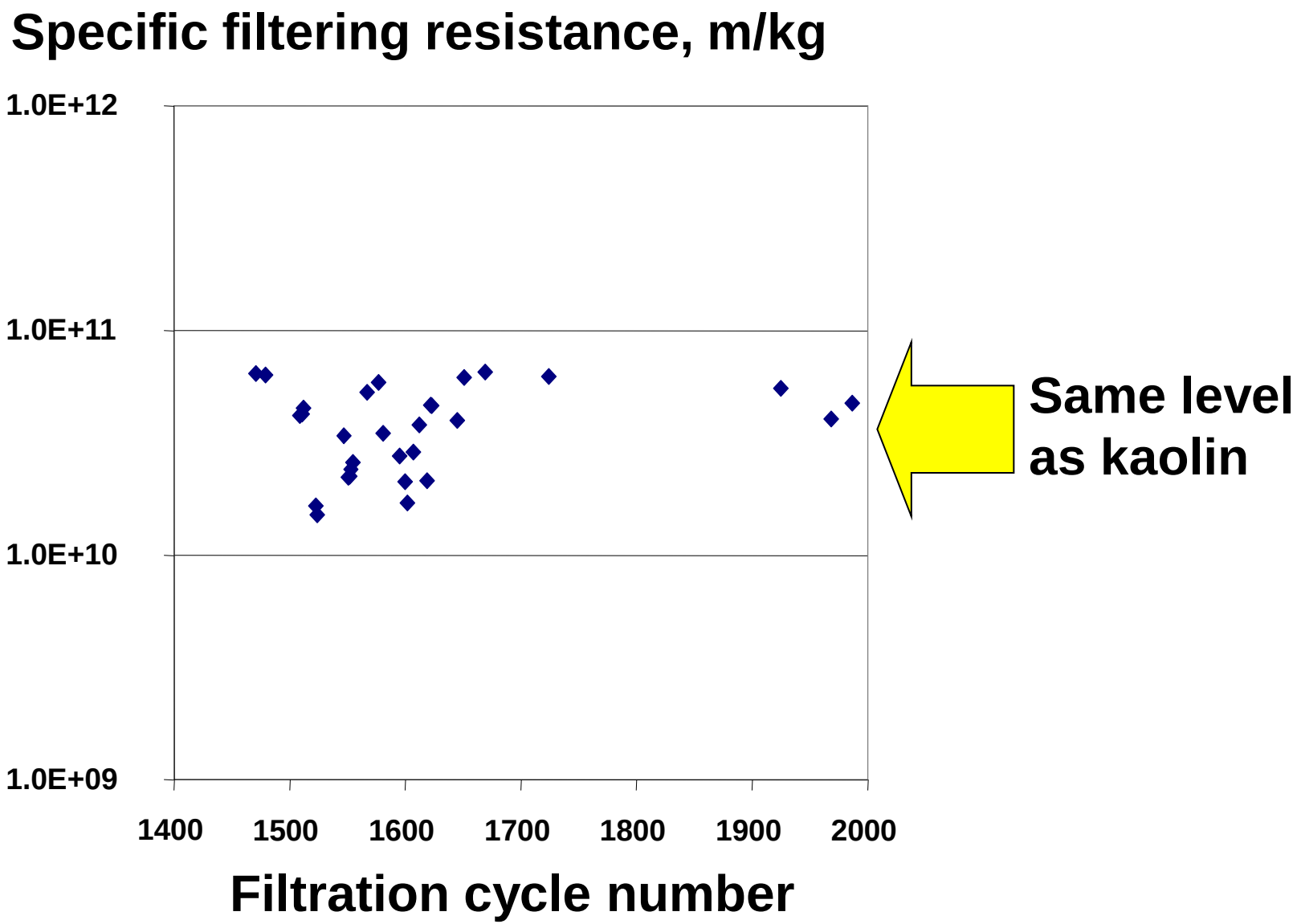
Laboratory
0.1 kg lignin/h

Bench scale
1 kg lignin/h

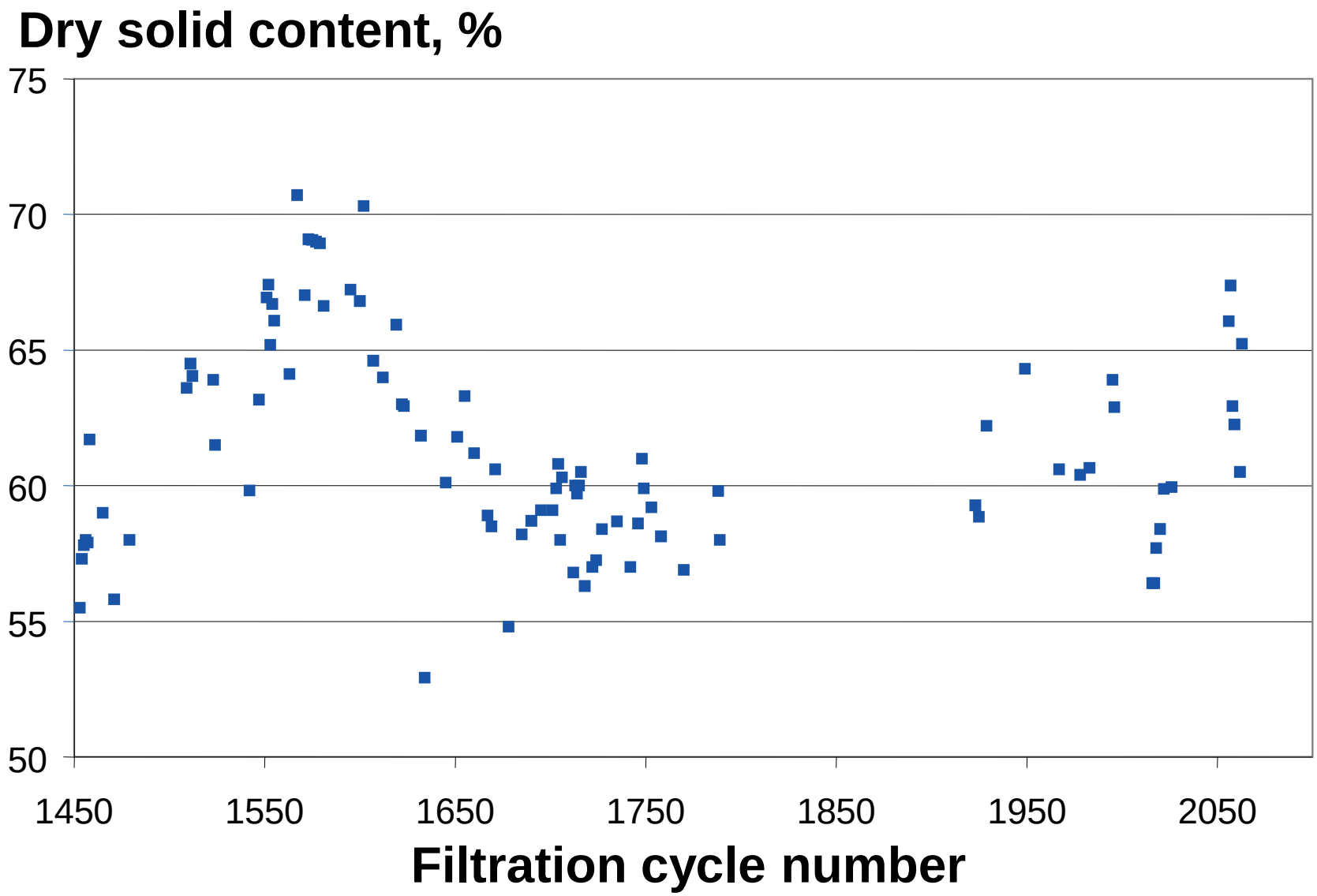
Pilot
100 kg lignin/h

Mill Trial 2004 With Filter Pilot (1.7 m^2)

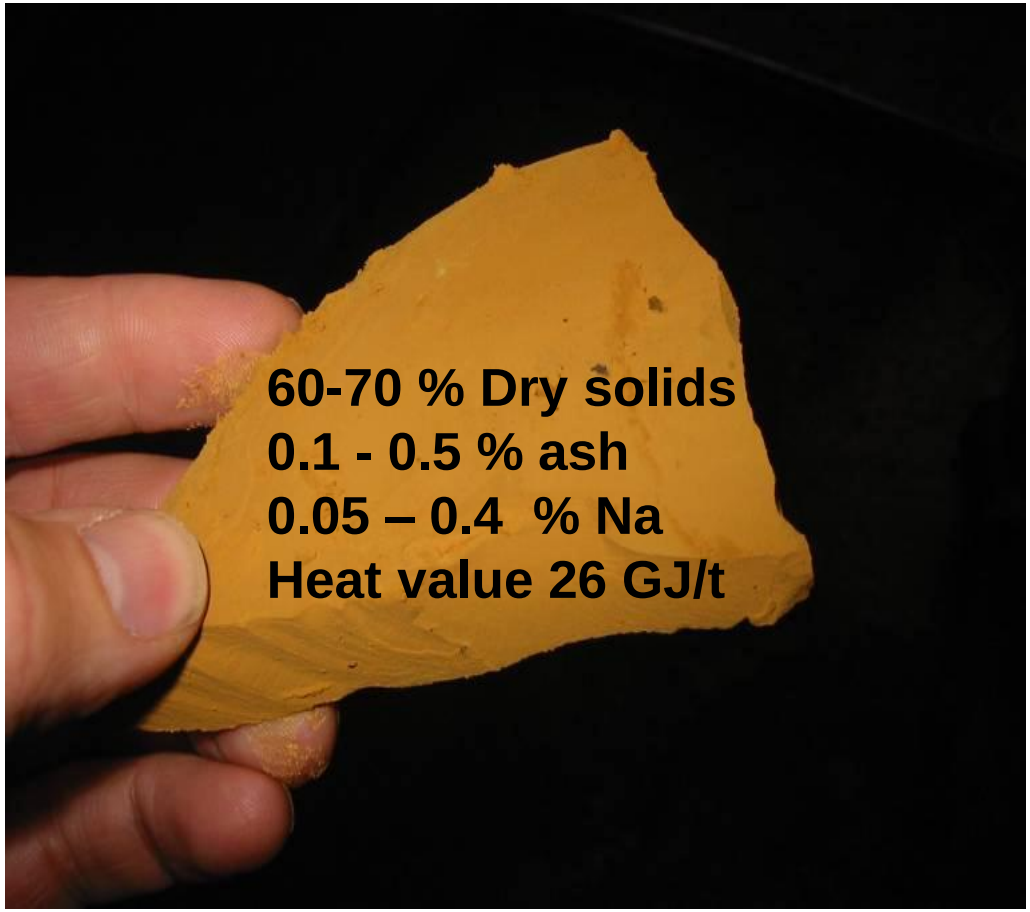
Mill Trial 2004 With Filter Pilot

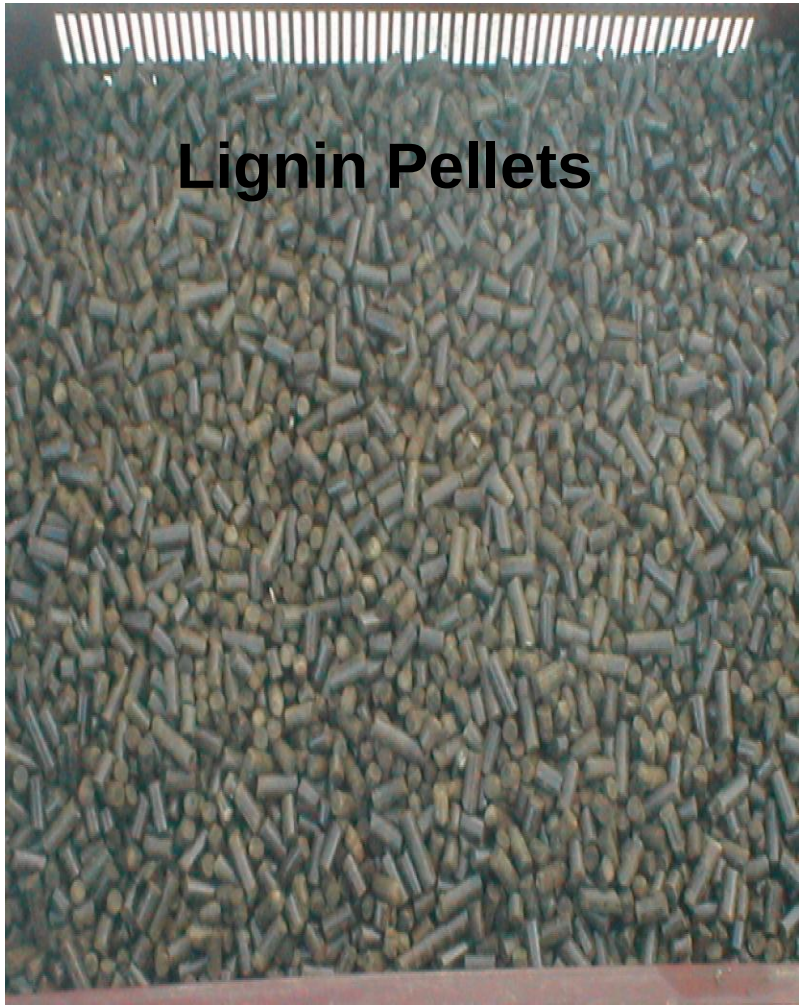


Mill Trial 2004 With Filter Pilot



Lignin From Mill Pilot





Typical Properties of Lignin

C	64.0	%
O	26.4	%
H	5.7	%
Na	0.03	%
Ash	0.2	%
Dry solids	65-70	%
Heat value	26 GJ/t	

Mill Trial 2006 In Portugal

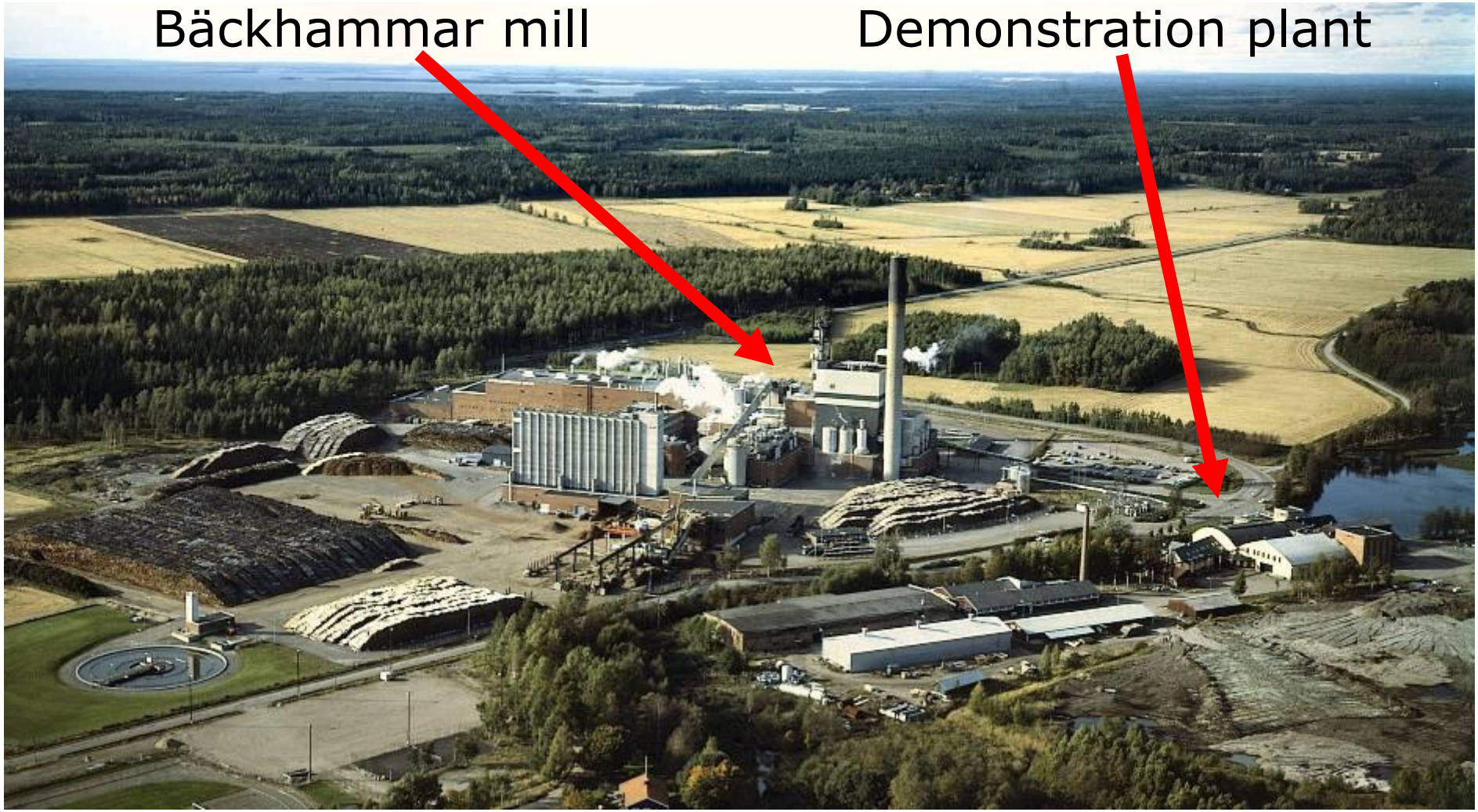
Mill Trial 2006 In Portugal

STFI Has Established A Company - LignoBoost AB

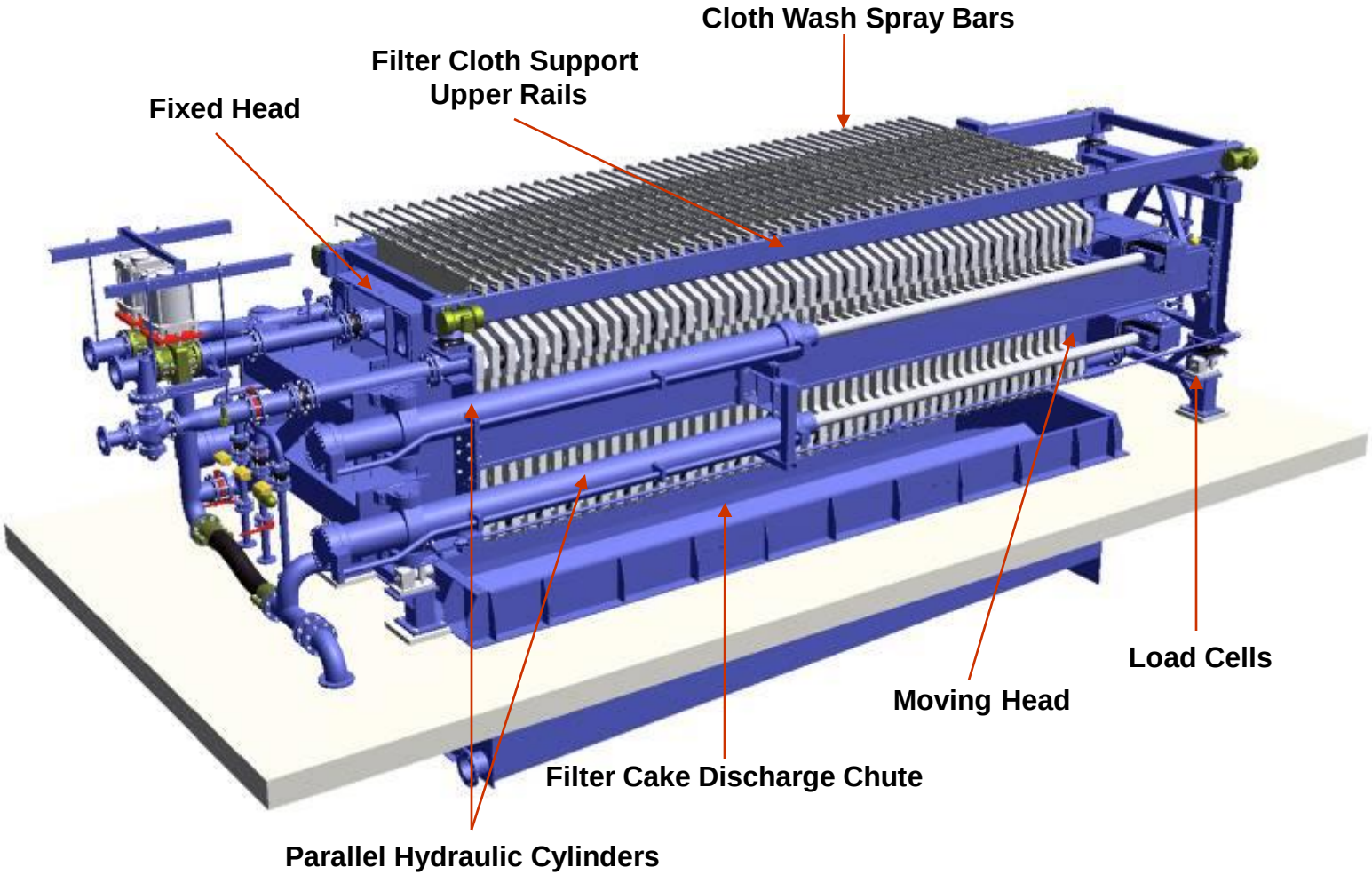
- For demonstrating the process in a demo plant
  - demo plant started late 2006
  - production 4.000 tonnes/y
  - capacity 10.000 tonnes/y
  - lignin will be used in lime kilns and other incinerators
- Sell licences, engineering and turn-key systems
- Licences to three companies have already been sold

LIGNOBOOST

Demonstration of Lignin Production Start-Up December 2006



Key Machine - Filter from Metso Minerals



Metso Filter in Demo Plant

Lignin Produced First Day

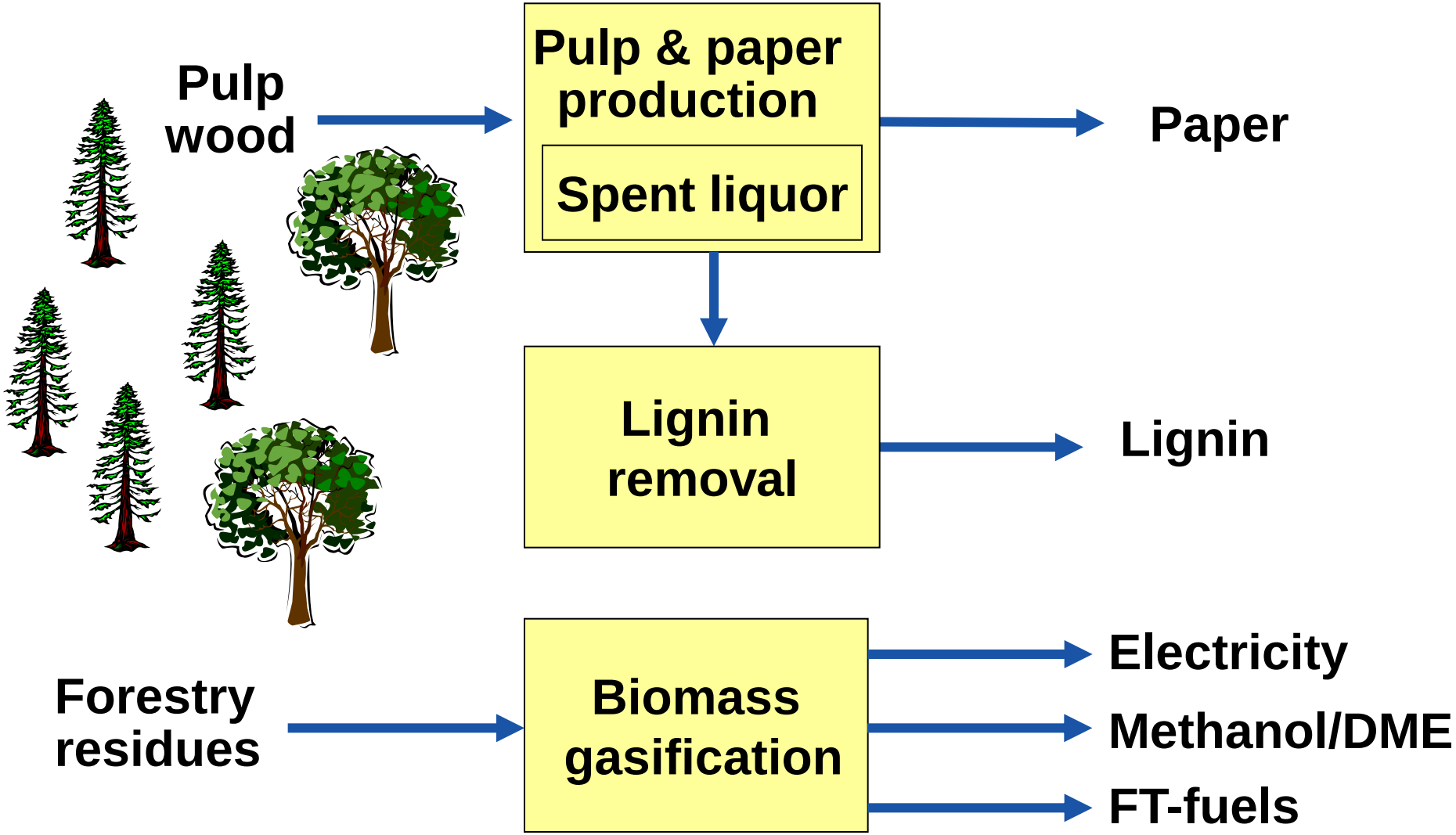
FRAM2 – Program 2006 – 2008

Objective: **Develop the LignoBoost- process and lignin incineration applications into industrial practice**

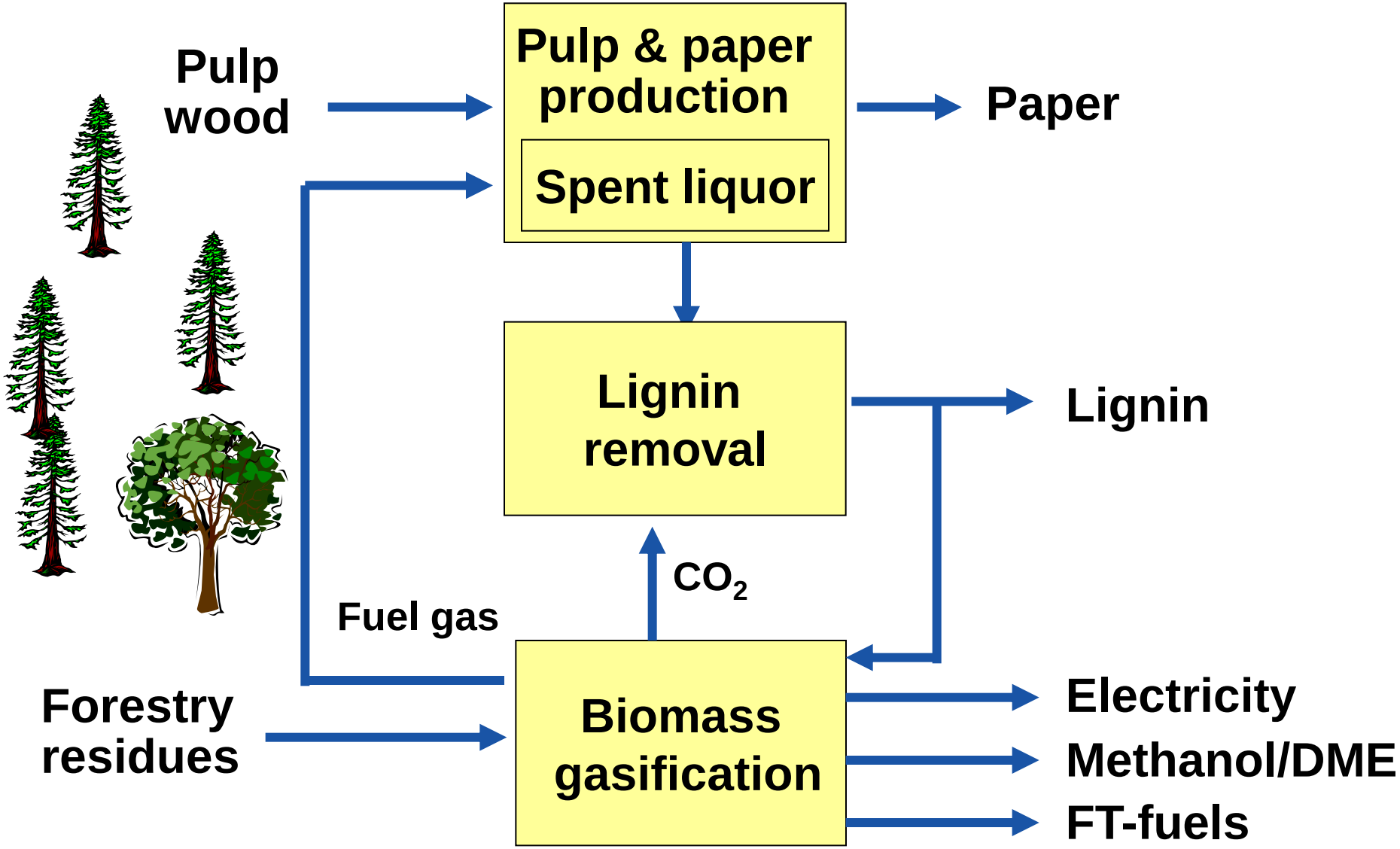
Projects:

- **Effect of wood species and cooking process**
- **Design data using bench equipment in mills**
- **Reduction of investment and operational costs**
- **CO2 from lime kiln flue gases**
- **Trials in lime kilns, heat/power plants and bark boilers (lignin handling included)**
- **Case studies for 3 - 4 mills**

Nordic Biorefining Alternatives



STFI-VTT Scheme: Integrating Biomass Gasification with Lignin Removal



Opportunities - Integrating Biomass Gasification with Lignin Removal

- **Recovery boiler development**
- **Heat integration for high energy efficency**
- **and …. No principal limitation in removal of valuable components from black liquor**

kg/t pulp	**Spruce**	**Birch**	**Eucalypt**
Lignin	**510**	**340**	**340**

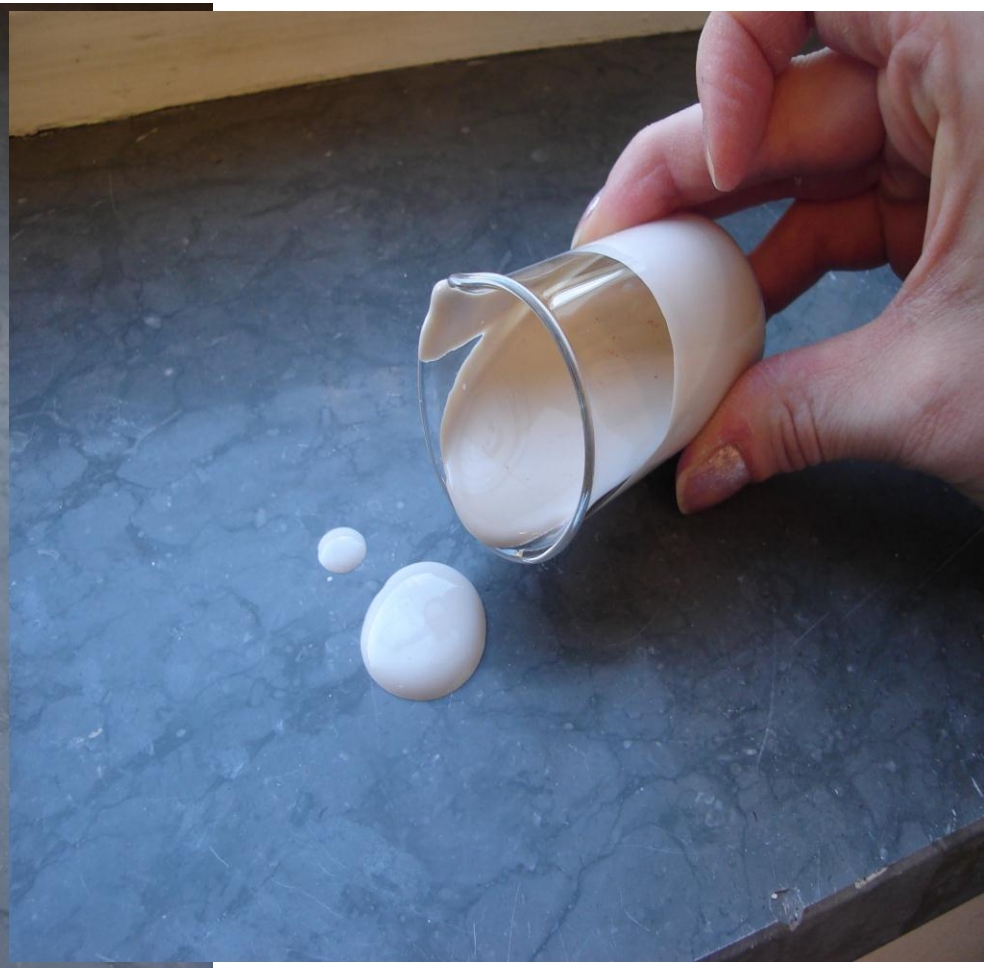
Potential Lignin Applications

- **Energy**
  - **Heat value of 1 tonne of lignin equals 0.65 tonne of mineral oil**
  - **Fuel for lime kilns, heat and power, oil replacement, syngas ….**
- **Chemicals**
  - **Phenols, binders, dispersants, sequestering**
- **Materials**
  - **Carbon fibre composites, porous carbon, active carbon**

Kraft Lignin as a Dispersant

Unmodified SW lignin

Sulfonated SW kraft lignin



Conclusions

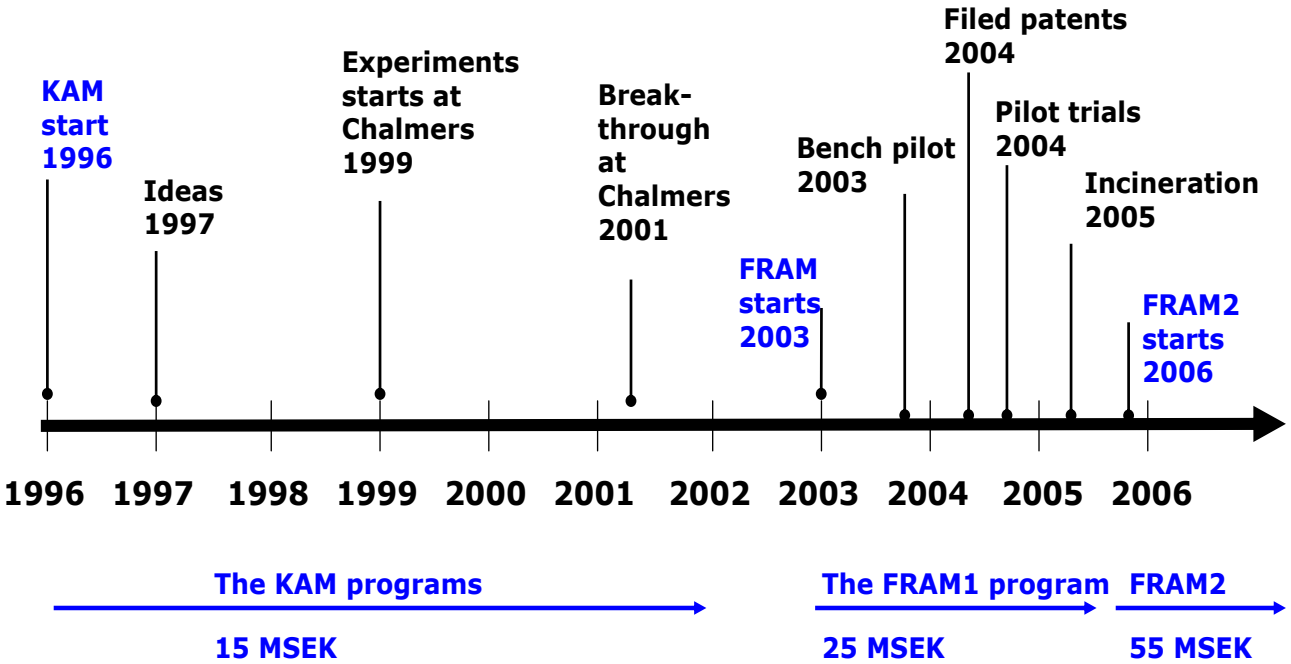
- A new process, LignoBoost, for separation of lignin from kraft black liquor has been developed
- Eliminates recovery boilers bottlenecks
- The lignin has very good properties
  - 65-70 % dry solids content
  - Ash content 0.1-0.5 %
  - Sodium 0.01- 0.4 %
  - Heating value 26 GJ per ton
- Promising fuel and potential chemical feed-stock
- Demonstration plant started December 2006
- Commercial installation 2007?

Other Benefits of Lignin Removal

- **Good match with gasification of forestery residues**
- **Basically all organics in black liquor can be removed**
- **Future simplified recovey boilers**

STFI-PACKFORSK

STFI-PACKFORSK



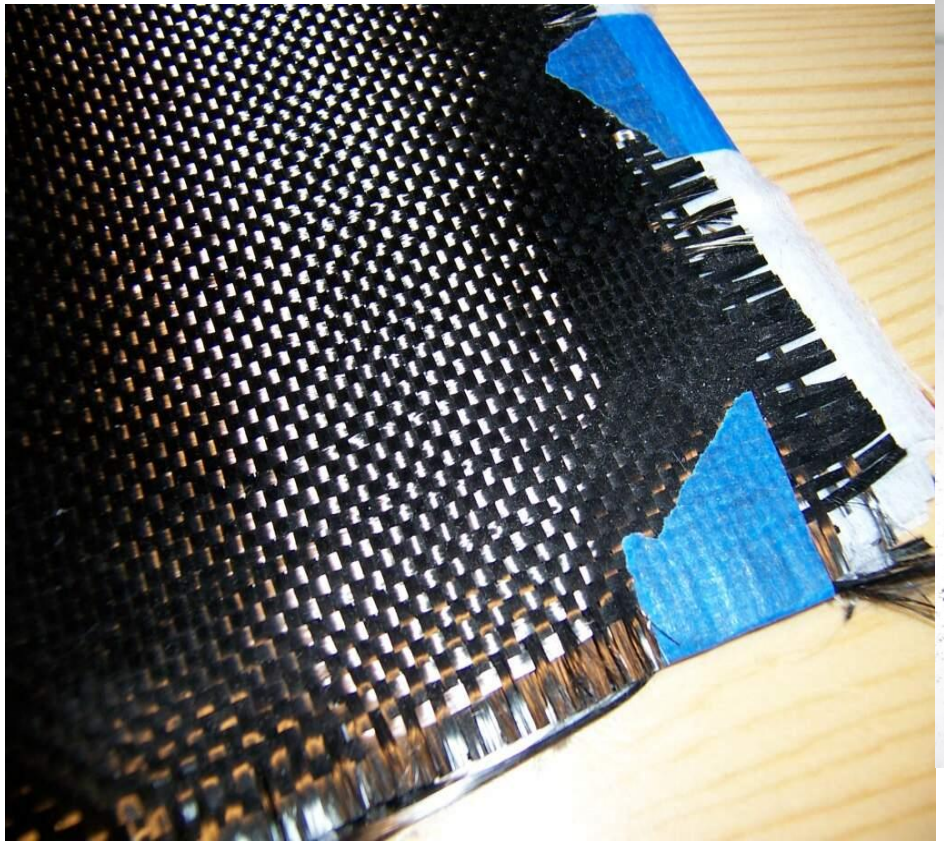
turning science into reality

The Future Kraft Pulp Mill is a Biorefinery Producing

- **Fibers for paper and fibre based composites**
- **Chemicals from hemicelluloses and lignin**
- **Solid and liquid fuels or electricity from black liquor and forestry residues**

STFI-PACKFORSK

Carbon Fibres



Activated Carbon

Xylan Applications

- **Fibre functionalization, increased fibre bonding…**
- **Barrier in packaging etc**
- **Hydrogels and thickeners**

- **Fermentation to succinic acid or ethanol**

Opportunities - Integrating Biomass Gasification with Lignin Removal

- **Recovery boiler development**
- **Heat integration for high energy efficency**
- **and …. No principal limitation in removal of valuable components from black liquor**

kg/t pulp	Spruce	Birch	Eucalypt
Lignin	510	340	340
Xylan	30	100	40