Current status of biomass cofiring

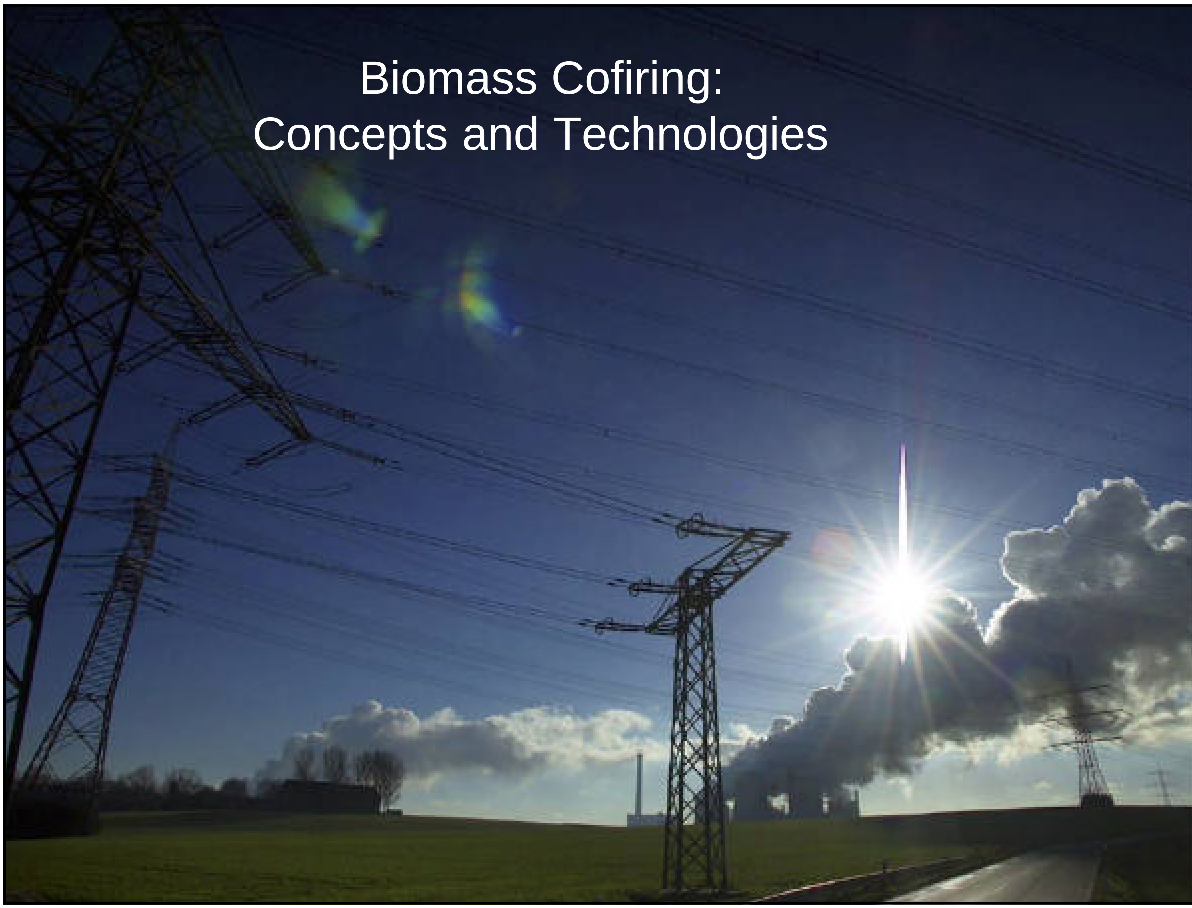
ExCo55, Copenhagen, May 25, 2005

TNO | Kennis voor zaken

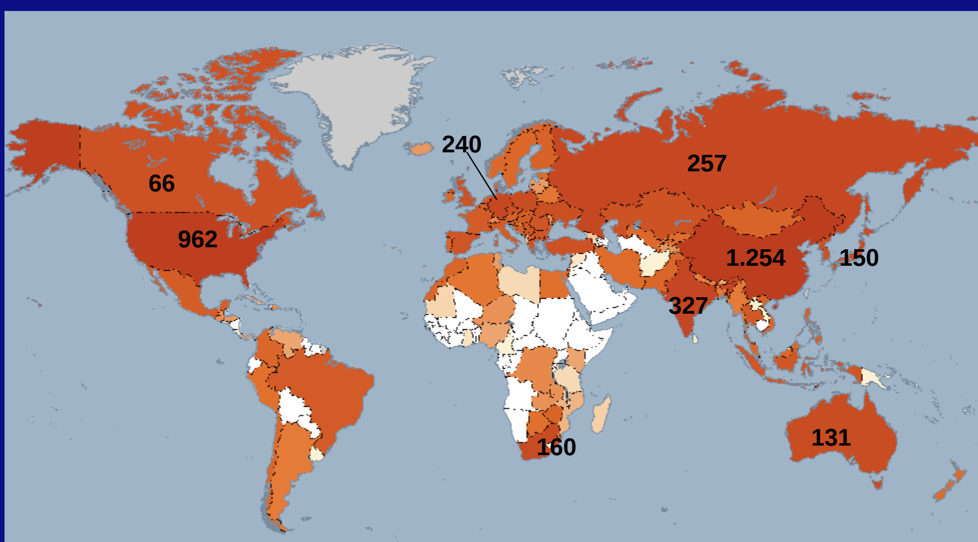
Jaap Koppejan, Project Manager Bioenergy

Presentation overview

- Concepts applied
- Global status of application
- R&D issues

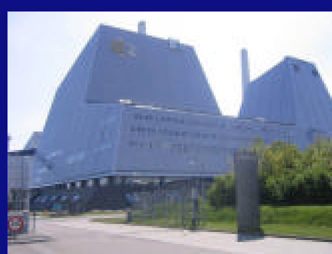

Biomass Cofiring:
Concepts and Technologies

Global coal utilization (Mton/y)



- 5%$_e$ cofiring globally ˜ 40 GW ˜ -300 Mton CO_2/year

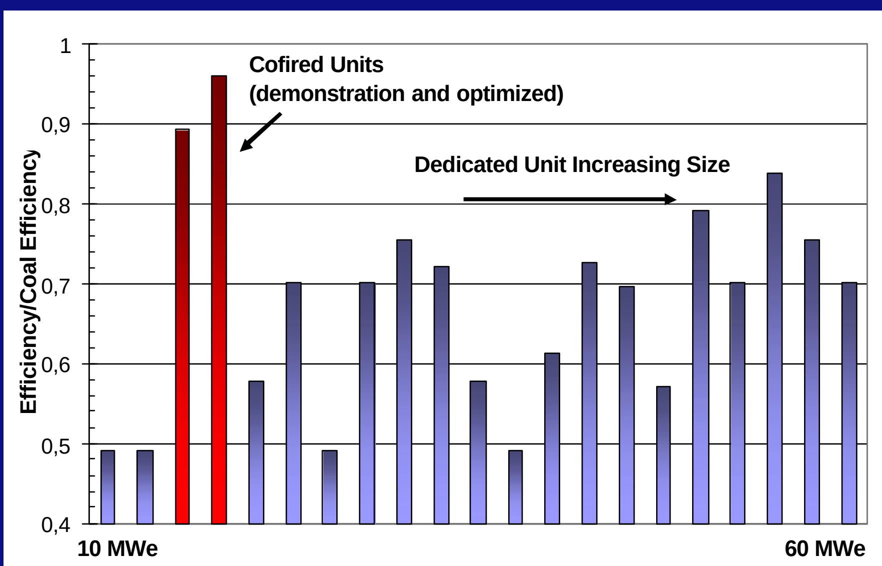
Biomass Cofiring: Examples



Why co-firing biomass with coal?

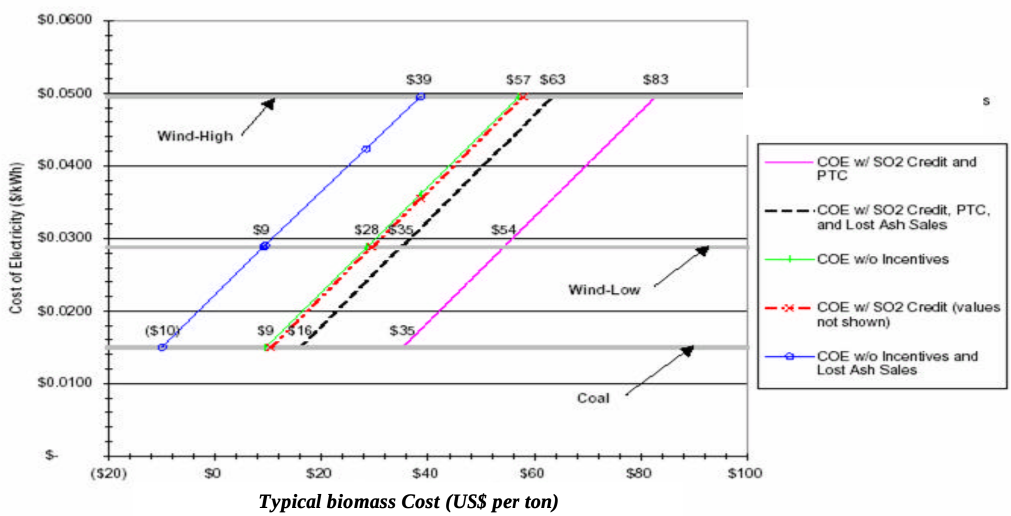
- Strong reduction in emissions of greenhouse gases and other pollutants
- It stongly supports the formation of a biomass commodity market
- Large opportunities, short term
  ($5\%_e$ cofiring globally ˜ 40 GW ˜ -300 Mton CO_2/year)
- Cheap option for renewable energy
- Highly efficient
- Job creation

Biomass co-firing: Best use of resources



Source: Baxter, 2004

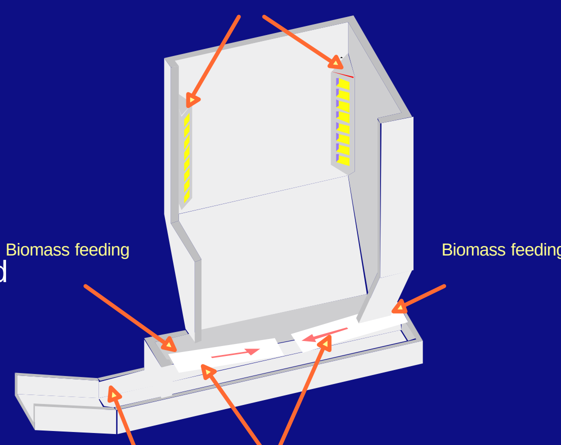
Generation costs of cofiring are low



Source: Antares Group Inc

Biomass co-firing concepts

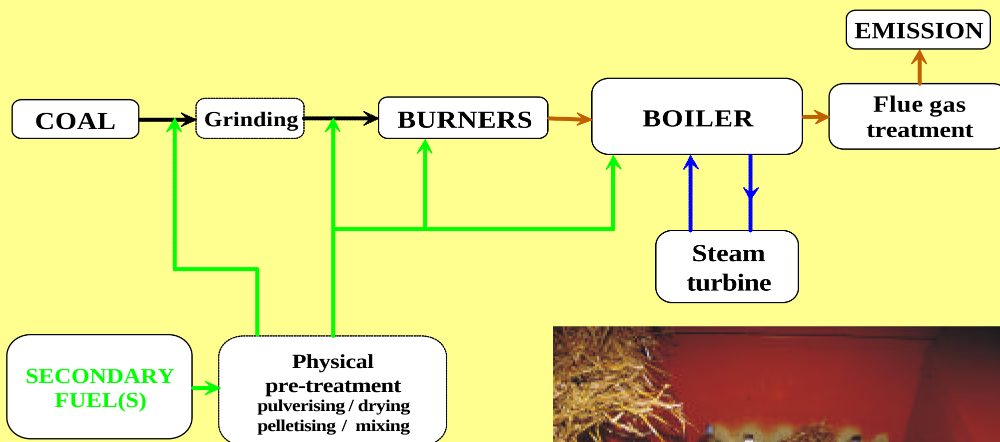
- Direct co-combustion in coal fired power plants
- Indirect co-combustion with pre-gasification or other thermal pretreatment
- Indirect co-combustion in gas-fired power plants
- Parallel co-combustion (steam side integration)



Direct co-firing of biomass

Delta Electricity, Australia

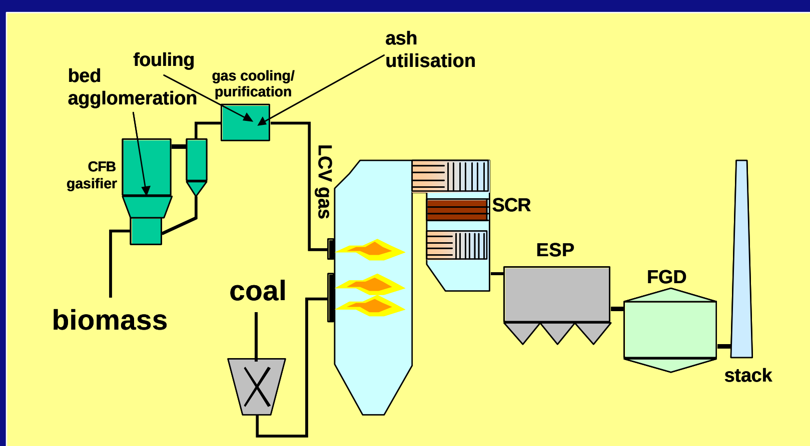
Direct co-firing of biomass (cont.)



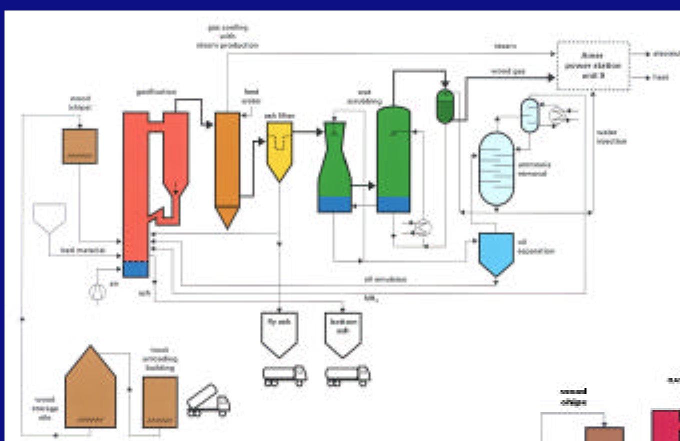
The key issue is the behaviour of the blended fuel in the coal mills (brittle fracture, heat balance,..)

Biomass co-firing via pre-gasification

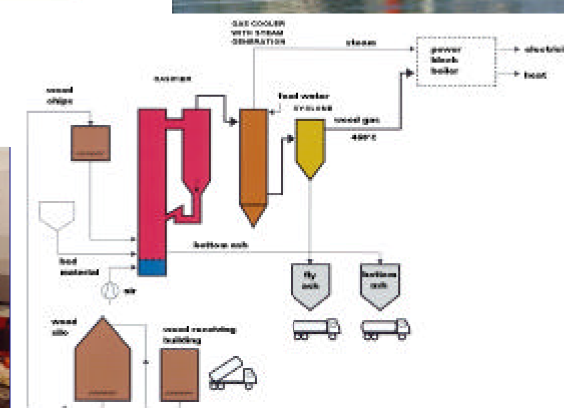
- Option for waste-derived fuels
- Amer (NL), Lahti (Finland)
- Investment costs: 300-1100 euro/kW$_e$



Amer-9 wood gasifier



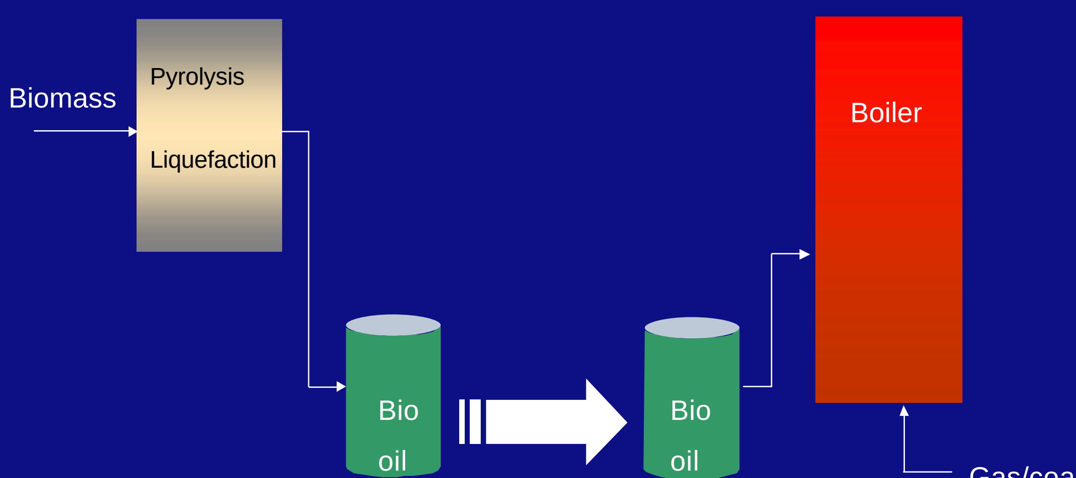
CFB gasifier
- waste wood
- 83 MWth input
- 170 kton CO_2 red



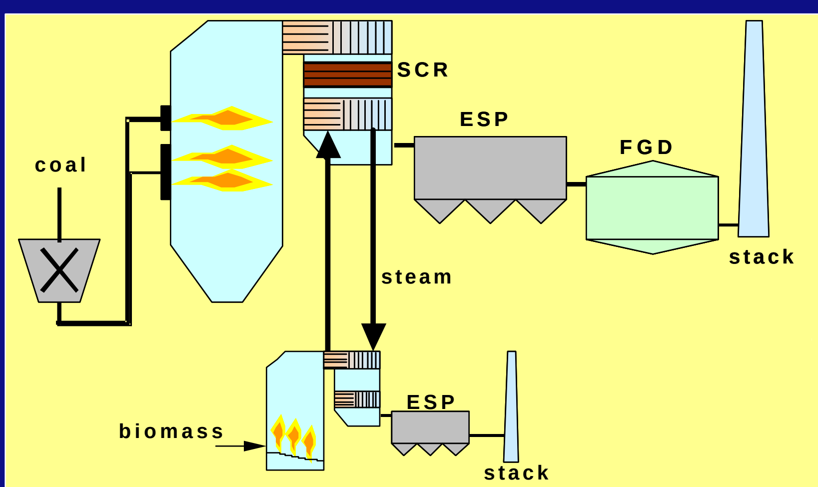
Biofuel/Multifuel Gasifier at Kymijärvi Power Plant, Lahti, Finland

Lahti CFB Gasifier Fuels

Indirect co-firing for gas fired boilers



Parallel co-combustion
(steam-side coupling)



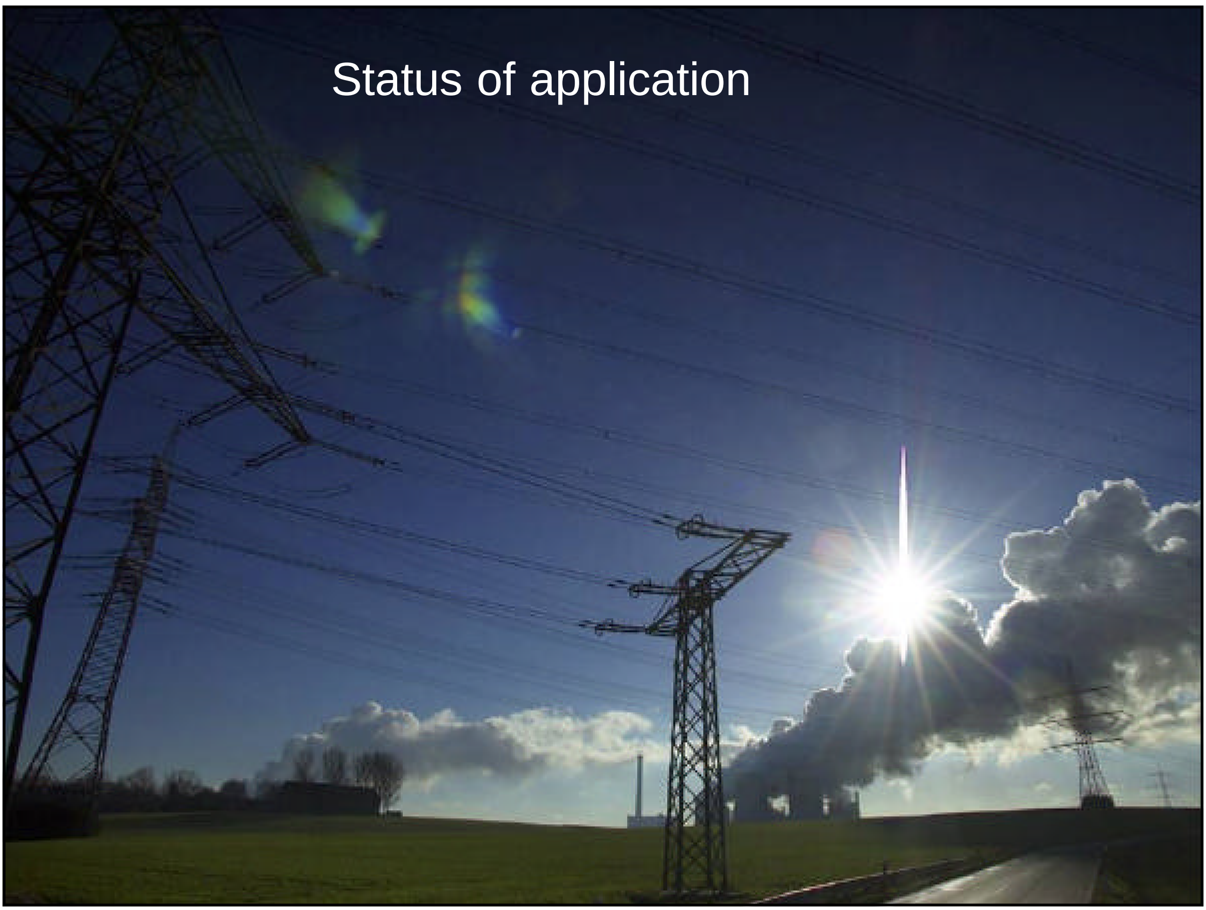
Parallel co-combustion (steam-side coupling)

Enstedvaerket power plant – Abenraa, Denmark

- Straw
- Highly corrosive nature of straw at high temperatures
- Contamination of the coal ash.
- Biomass boiler: 40 MW_e and coal-fired unit: 660 MW_e

Vasteras CHP plant – Vasteras city, Sweden

- CHP plant has four units using coal and oil with an overall capacity of 500 MWe and 900 MW for district heating.
- CFB boiler for biomass 200 t/ steam)


Status of application

Status as of 2004

- approx. 40 pulverised coal fired power plants worldwide that cofired biomass on a commercial basis
- on average 3% energy input,
- some 3.5 Mton of coal substituted
- around 10 Mton of CO_2 reduction.

Global activities on biomass co-firing

Australia:
About 5 PC power plants cofire up to 5 mass% of wood (demolition wood, fresh wood)

USA:
Approx 40 PC plants have demonstrated cofiring capabilities, hardly any commercial operation

EU:
National goals of 5 – 12% of power production using biomass, near term goals are mostly being accomplished through co-firing

Scandinavia:
150 fluidized bed boilers use secondary fuels such as sawdust, wood chips, forest residues which are co-fired with peat, wood or coal

Germany:
PC plants (lignite and coal) cofire sewage sludge commercially, trials with straw and wood

The Netherlands:
Already applied in all available Dutch coal-fired plants at up to $20\%_m$ (about $10\%_e$)

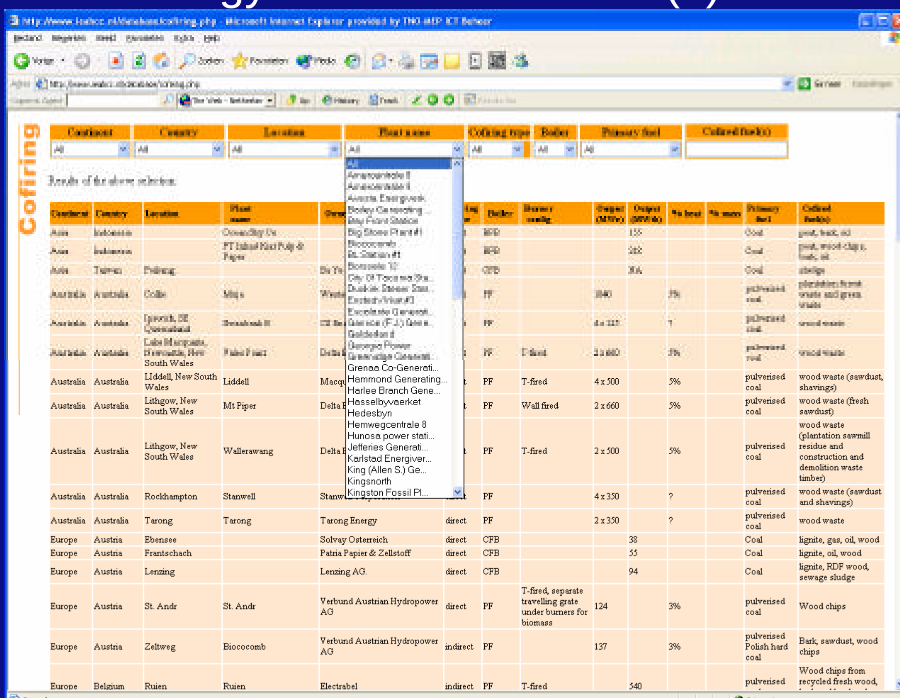
Coal Covenant in the Netherlands

- Agreed May 2002, to be accomplished in 2008
- 3.3 Mton CO_2 reduction by co-firing biomass in coal fired power stations
- equals 475 MW_e installed capacity
- 12 % replacement of coal (heat) input
- requiring ~ 2.2 Mton of biomass/waste per year

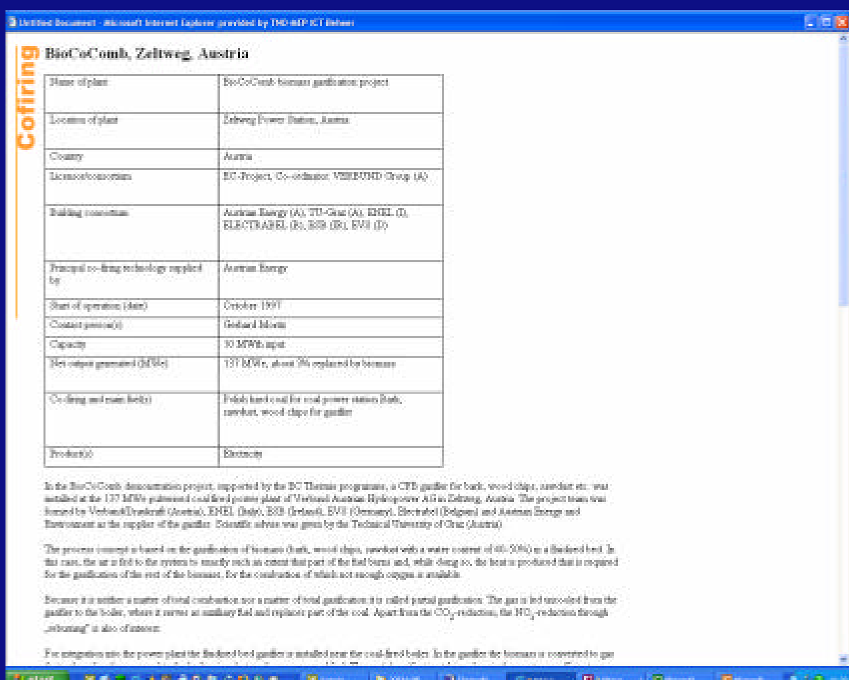
Global overview of biomass/coal cofiring initiatives

- Recently done by IEA Bioenergy Task 32
- Internet database produced at www.ieabcc.nl
- 135 plants identified that co-fire biomass in plants that originally fire coal as main fuel
- 105 direct, 1 direct + parallel, 5 indirect, 24 yet unknown

IEA Bioenergy Task 32 database (1)



IEA Bioenergy Task 32 database (2)



BioCoComb, Zeltweg, Austria

Name of plant	BioCoComb biomass gasification project
Location of plant	Zeltweg Power Station, Austria
Country	Austria
Licensor/consortium	EC-Project, Co-ordinator: VERBUND Group (A)
Building consortium	Austrian Energy (A), TU-Graz (A), ENEL (I), ELECTRABEL (B), ESB (IR), EVS (D)
Principal co-firing technology supplied by	Austrian Energy
Start of operation (date)	October 1997
Contact person(s)	Gerhard Moritz
Capacity	10 MWth input
Net output generated (MWe)	137 MWe, about 3% replaced by biomass
Co-firing and main fuel(s)	Polish hard coal for coal power station Bark, sawdust, wood chips for gasifier
Product(s)	Electricity

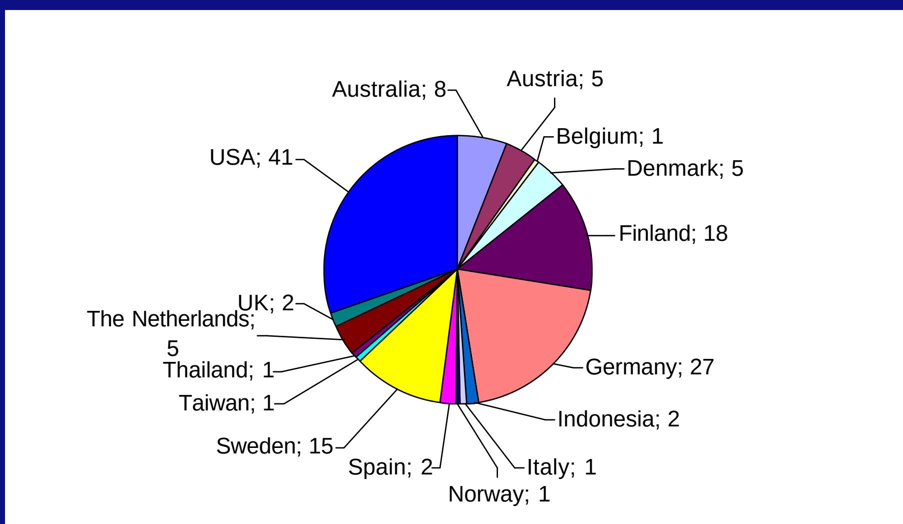
In the BioCoComb demonstration project, supported by the EC Thermie programme, a CFB gasifier for bark, wood chips, sawdust etc. was installed at the 137 MWe pulverised coal fired power plant of Verbund Austrian Hydropower AG in Zeltweg, Austria. The project team was formed by Verbund/Draukraft (Austria), ENEL (Italy), ESB (Ireland), EVS (Germany), Electrabel (Belgium) and Austrian Energy and Environment as the supplier of the gasifier. Scientific advice was given by the Technical University of Graz (Austria).

The process concept is based on the gasification of biomass (bark, wood chips, sawdust with a water content of 40-50%) in a fluidised bed. In this case, the air is fed to the system to exactly such an extent that part of the fuel burns and, while doing so, the heat is produced that is required for the gasification of the rest of the biomass, for the combustion of which not enough oxygen is available.

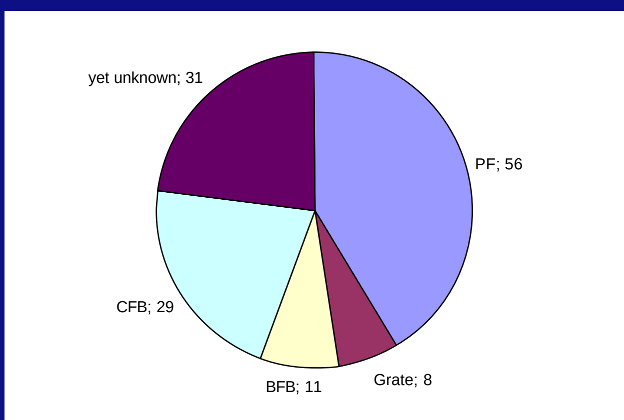
Because it is neither a matter of total combustion nor a matter of total gasification it is called partial gasification. The gas is fed uncooled from the gasifier to the boiler, where it serves as auxiliary fuel and replaces part of the coal. Apart from the CO_2-reduction, the NO_x-reduction through „reburning" is also of interest.

For integration into the power plant the fluidised bed gasifier is installed near the coal-fired boiler. In the gasifier the biomass is converted to gas

Countries where cofiring has been done:



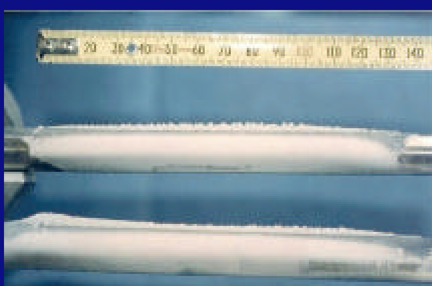
Database details



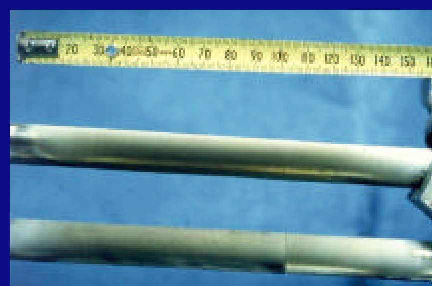
Fuel	Number of plants that co-fire this fuel
Wood	41
Sludge	30
Peat	20
Straw	16
Oil	12
Bark	10
RDF	7


Research and demonstration issues

Ash deposition may widely vary

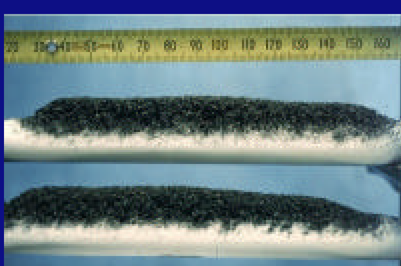


Red Oak Wood

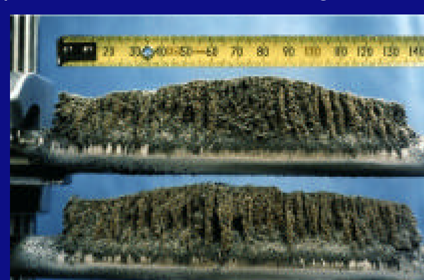


Pittsburgh #8 coal

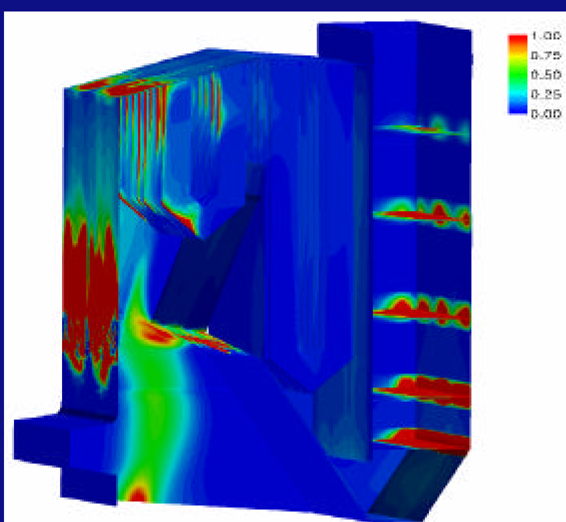
Danish Wheat Straw

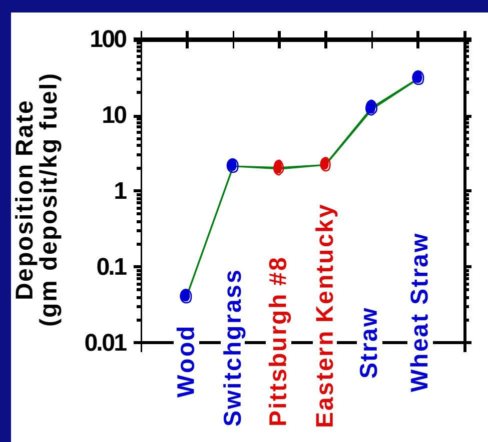


15% Imperial Straw / 85% Pittsburgh #8 Coal

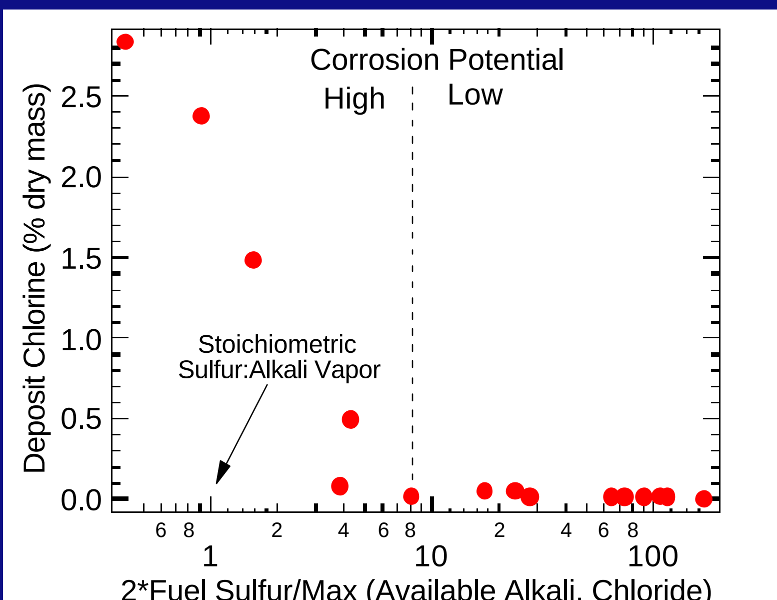


Ash deposition may widely vary (2)

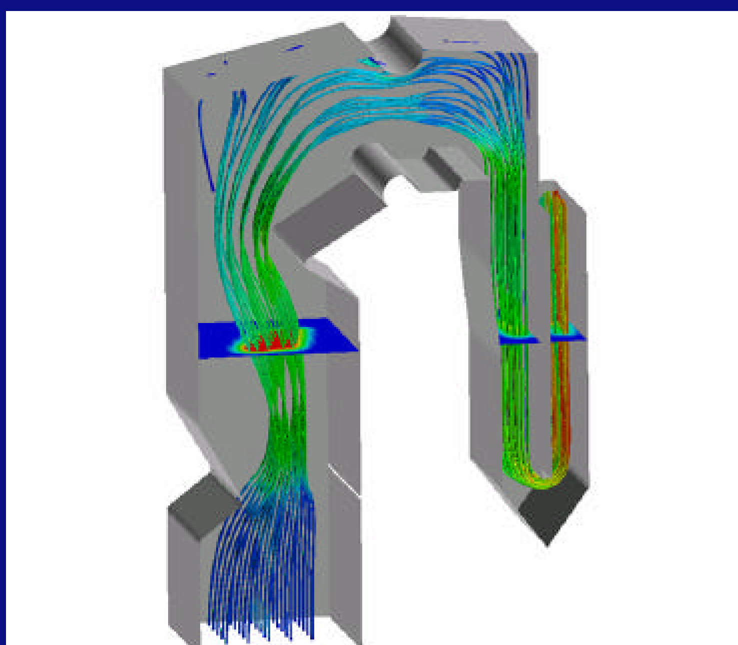




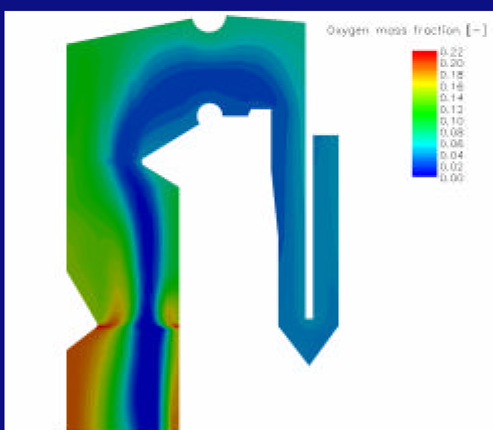
Corrosion rates can sometimes be predicted with (sometimes complex) chemical mechanisms

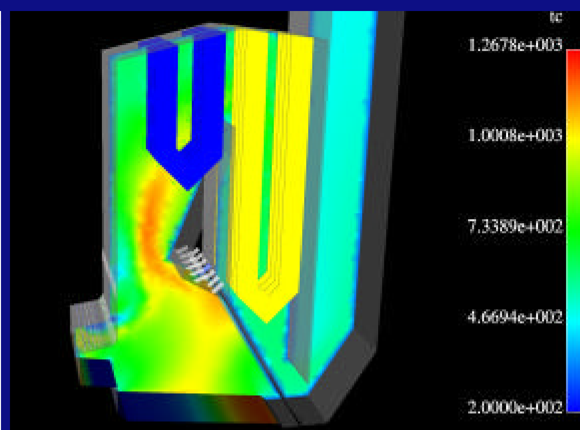


Striated Flows: particle path trajectories



Insufficient mixing in a boiler may lead to unexpected and problematic combustion conditions

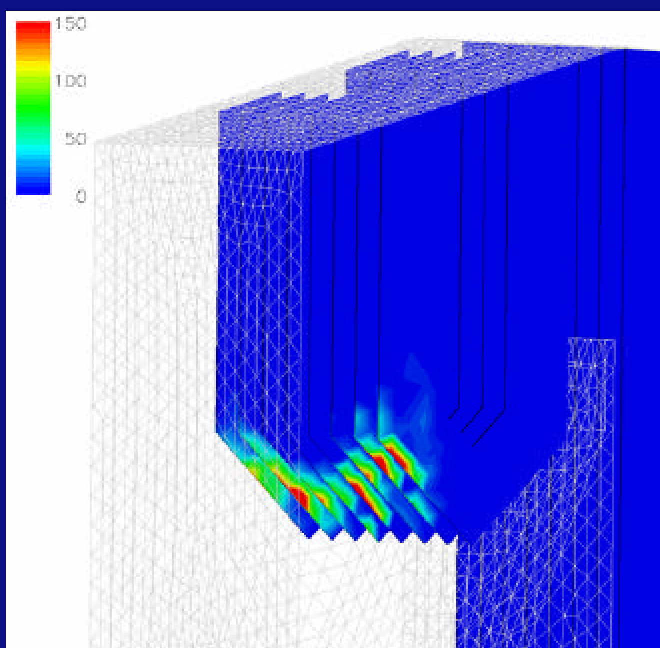




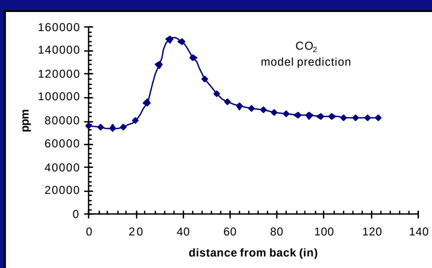
Oxygen Contours

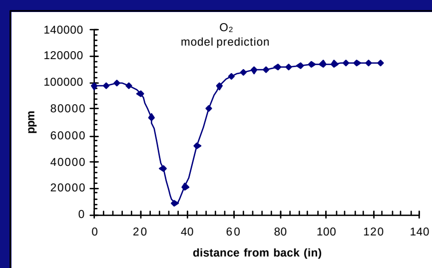
Temperature variations

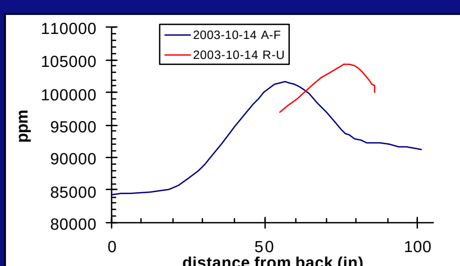
Striated flows: Ash deposition [g/m^2/h]

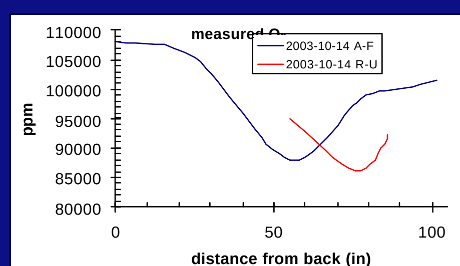


Striated Flows: Model vs. experiments

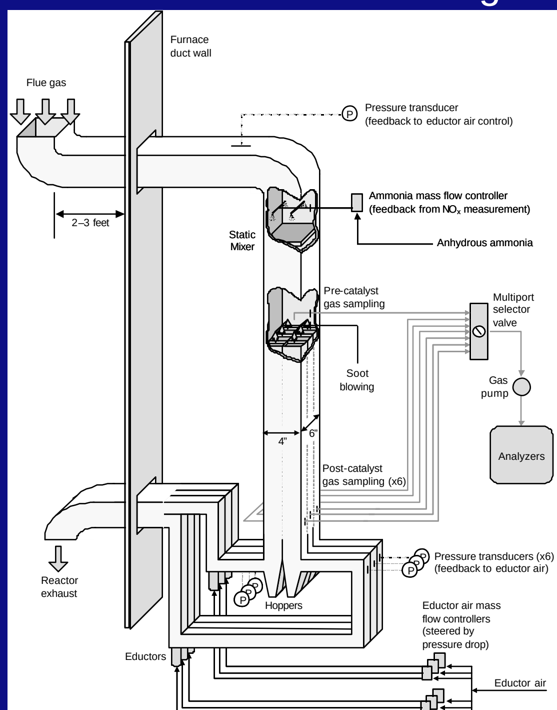




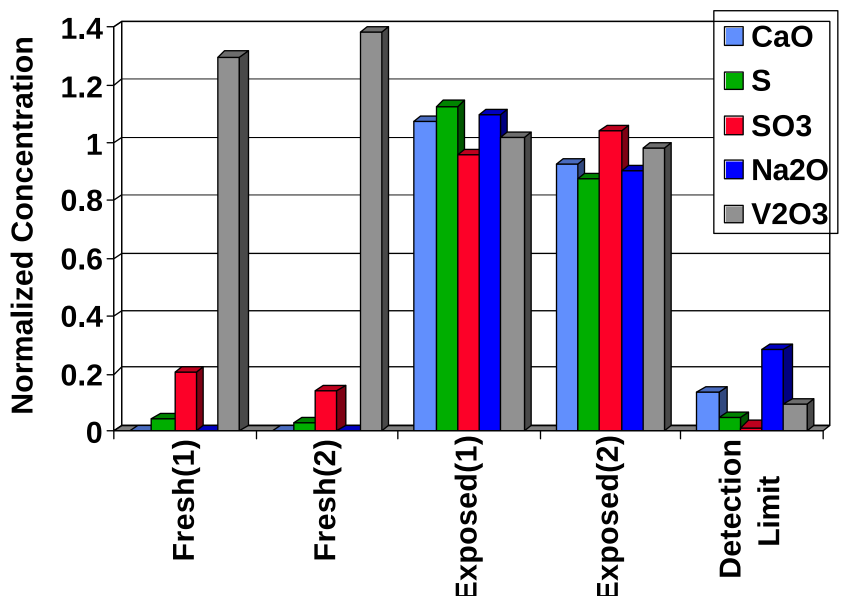




Task 32 project: SCR deactivation through biomass cofiring

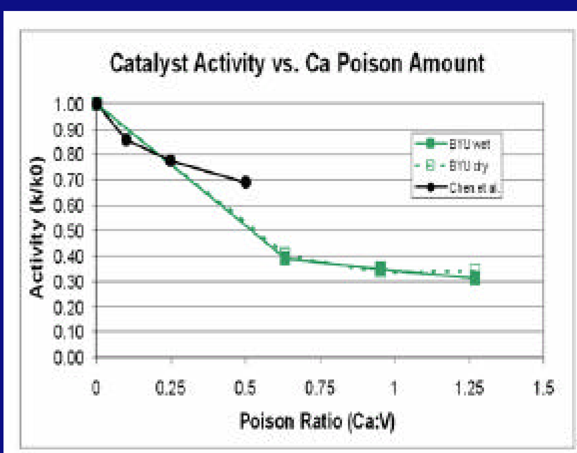


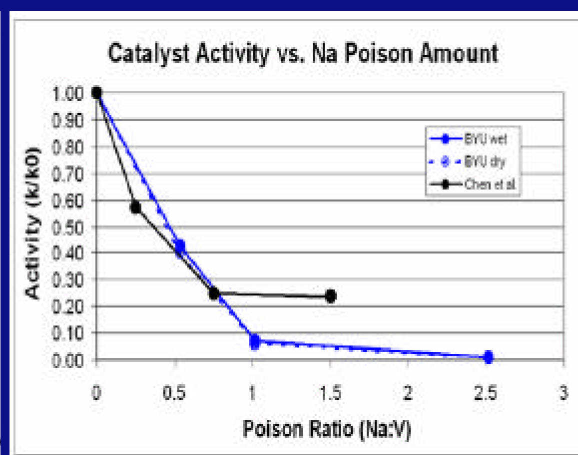
SCR deactivation



Source: Larry Baxter, BYU, 2004

Project: SCR deactivation





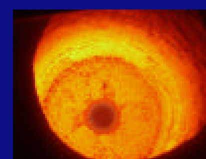
Technical challenges for cofiring

- Cost effective methods for getting more and and wider varieties of fuels into the boiler
- Occurance of insufficienct gas mixing / stratified flows in the boiler
- Fouling and corrosion of the boiler (alkali metals, chlorine)
- Continuation of fly ash utilization (unburned carbon, contamination, behaviour in cement)
- Impact on performance of flue gas cleaning (SCR $DeNO_x$, performance of FGD unit)

Non-technical barriers

- Economic aspects
  - lack of financial incentives
  - uncertain fuel prices/availability
- Legislative aspects (utilization of fly ash in cement, determining green share of electricity produced, unclear emission legislation)
- Public perception of co-firing of biomass/waste
- Getting the permits through

Concluding remarks



- Co-firing represents a cost effective, short term option at a large scale
- Although more needs to be done, there is already a wealth of practical experience under different conditions
- IEA Bioenergy Task 32 wants to contribute to the problems the cofiring community is facing

Task 32 workshops 2004-2006

Topic	Organising Country	Planning
Co-firing	Netherlands	Rome, May 2004
Public perception of biomass cofiring	Canada + USA	Victoria, Aug- Sept. 2004
Aerosols	Austria	Austria, March 2005
Small scale systems	Netherlands	Paris, Oct 2005
Fuel Flexibility	Sweden	?, Spring 2006
Cofiring (tentative)	NL (with Task 33)	Netherlands, 2006
Corrosion and deposit formation	UK	Glasgow, autumn 2006

Thank you for your attention