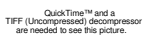
Perspectives on the Pulp and Paper Industry



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Executive Director, AET

Outline

- North America Pulp & Paper Industry
- Printing & Writing Paper Market
- Manufacturing Fundamentals
- Environmental Protection
  - Measures of Progress
- Summary

Source: Canfor Ltd.

N. American Pulp & Paper Industry

- Bleached pulp production is ~ 35 million tons

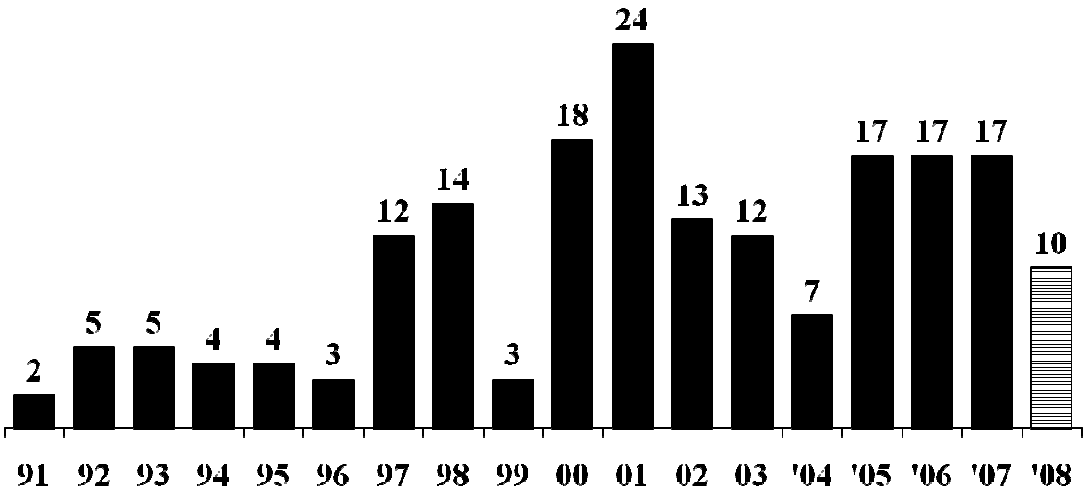
- Printing and Writing Grades
  - Uncoated Free Sheet
  - Coated Free Sheet
  - Uncoated Groundwood
  - Coated Groundwood

- Printing and Writing Grades
  - ~ 25 million tons
    - 50% UFS
    - 25% CFS

N. American Pulp & Paper Industry

- US P&P industry
  - 6% of GDP comparable to automotive and plastics industries
  - $200 Billion Annual Sales
  - 1 Million employees
  - $54 Billion payroll

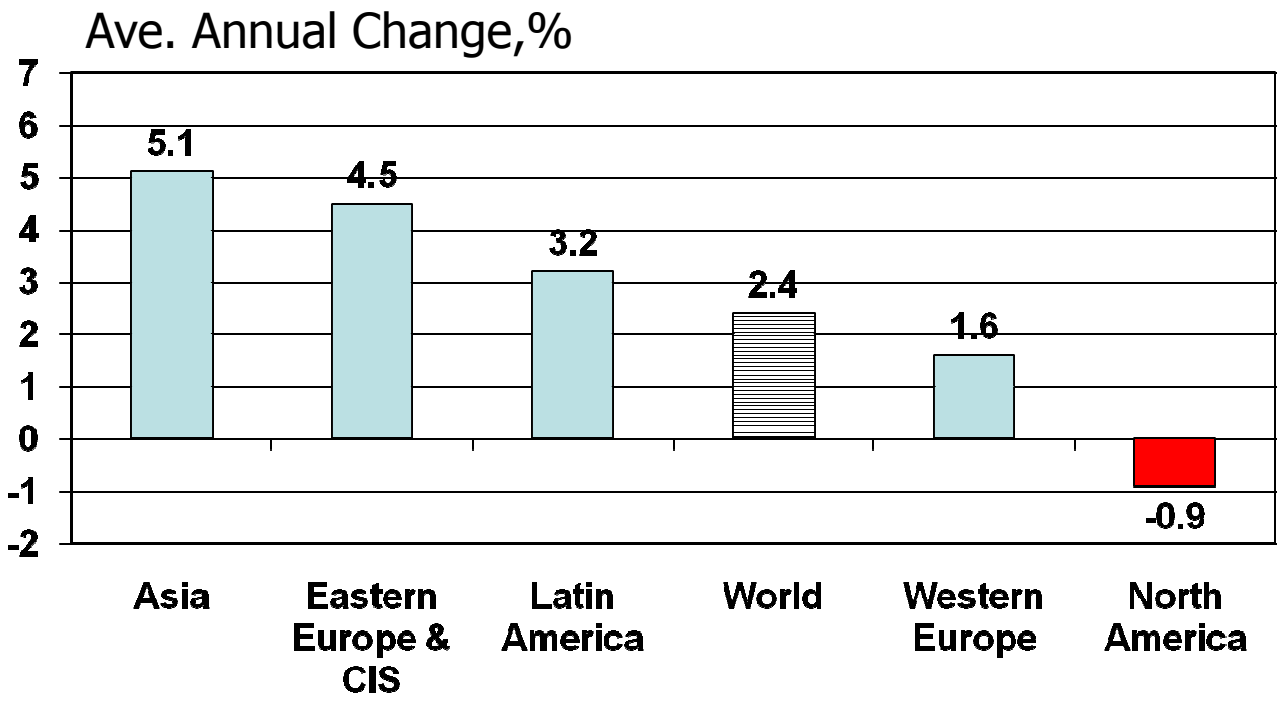
US Paper Mill Closures



Source: AF&PA

International Capacity Change 1998-2008

- Significant growth in emerging economies
- North America declining on average 1% per year



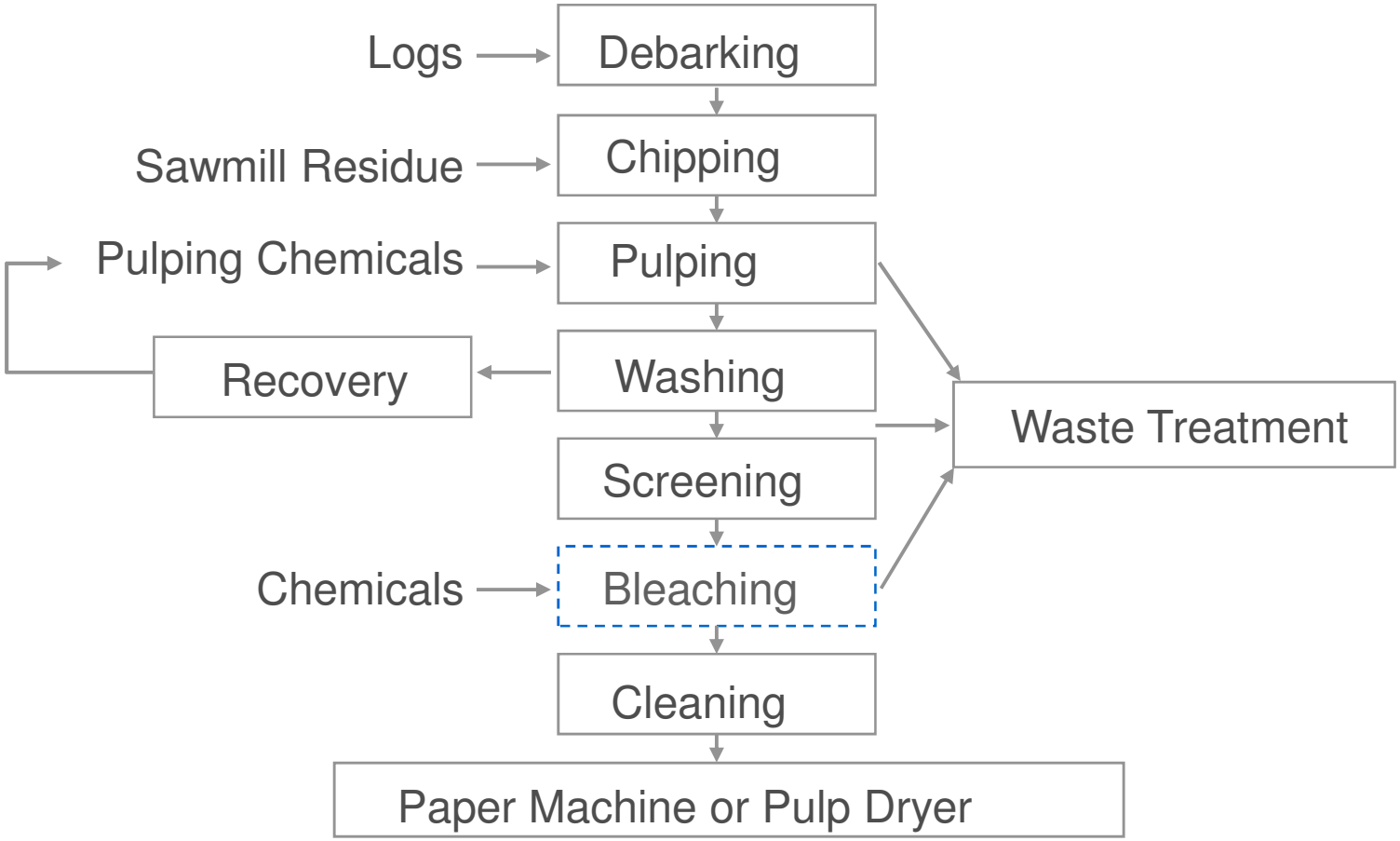
Manufacturing Fundamentals

- Basic overview
- Bleached kraft pulp manufacturing
  - Pulping
  - Bleaching
  - Waste treatment
  - Environmental Protection

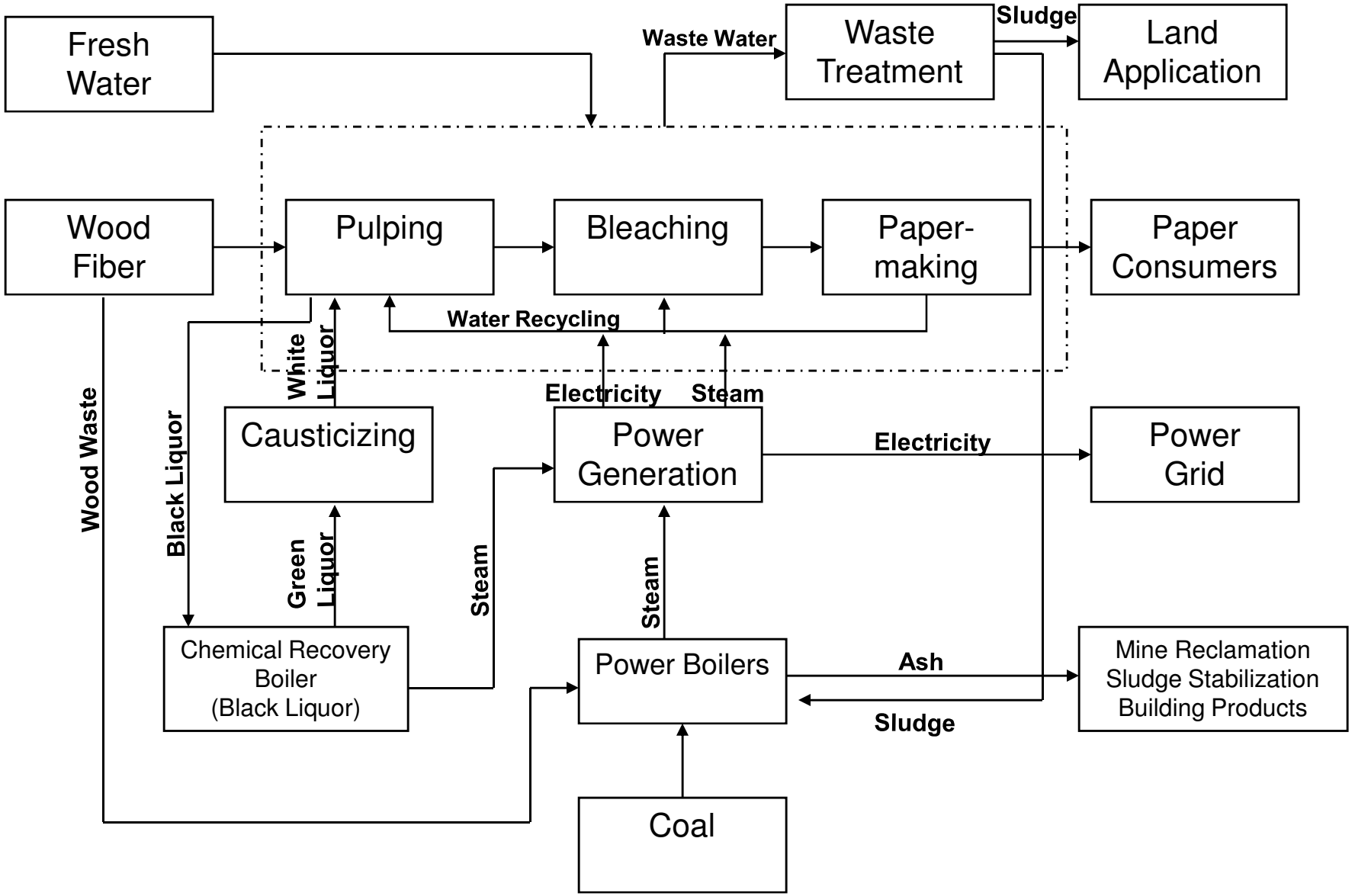
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Manufacturing Overview

The Paper Mill Flowsheet



Pulp and Paper Mill Eco-industrial Park



Eco-industrial Park

Photo Courtesy of: Celso Foelkel, Celsius Degree

Minimum Impact Manufacturing

- A Minimum Impact Mill:
  - Minimizes the number of trees used to make a piece of paper
  - Maximizes energy production
  - Minimizes water consumption, solid waste, and air emissions
  - Make high quality paper that is easily recyclable
  - Treats and disposes of waste optimally
  - Creates sustainable value to society

Minimum Impact Mill Technologies

- ✓ Dry Debarking
- ✓ High Yield Pulping Process
- ✓ Efficient Brownstock Washing
- ✓ Oxygen Delignification
- ✓ ECF Bleaching
- ✓ Low Odour Recovery Boiler
- ✓ Condensate Stripping and Recovery
- ✓ Minimum SO_2 and NO_x Emissions
- ✓ Electrostatic Precipitators
- ✓ Efficient Primary, Secondary, and in special cases Tertiary Waste Treatment
- ✓ Minimum Effluent Volume
- ✓ Minimum Power Consumption

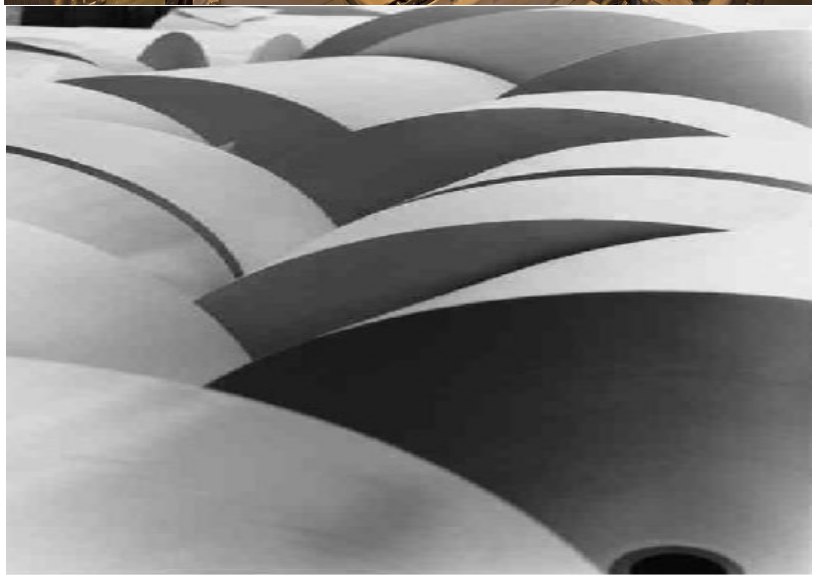
Maximizing Yield

- Efficient wood chipping to minimize fines and oversize
- Modern digester system
  - Selective to lignin, preserve cellulose
  - Cooking to a relatively high lignin content (kappa no.)
  - Efficient knot removal and screening system
  - Re-cook knots and screen rejects - no waste

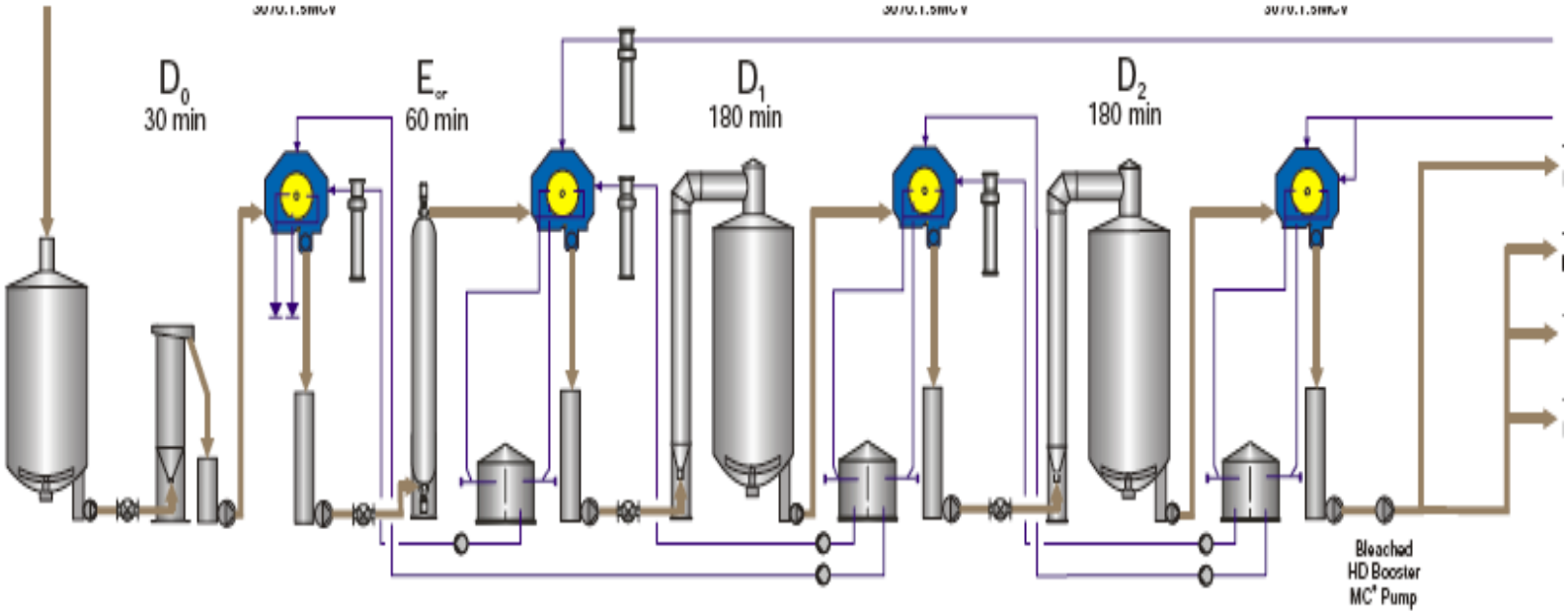
Bleaching in the Pulp & Paper Industry

What is Bleaching?

- Turns brown pulp
  - Unbleached wood fibers
  - Raw material for brown paper bags, cardboard
- Into bleached pulp
  - Raw material for printing and writing papers
  - Packaging
  - Sanitary products



Bleaching Flowsheet



Bleach Plant

Maximizing Yield

- Selective two-stage oxygen delignification
  - Excellent lignin removal with cellulose preservation
- Elemental Chlorine-Free (ECF) bleaching sequence
  - Excellent lignin removal with cellulose preservation
  - Minimum damage to cellulose fibres
  - High pulp strength
  - High brightness

Source: Veracel Celulose

High Quality Pulp for Paper

- Selective two-stage oxygen delignification
  - Excellent lignin removal with cellulose preservation
- Elemental Chlorine-Free (ECF) bleaching sequence
  - Using chlorine dioxide, oxygen and peroxide
  - Excellent lignin removal with cellulose fibre quality preservation
  - High pulp strength
  - Excellent run-ability on paper machines
  - High recycle-ability
  - High brightness 90% ISO
  - Low brightness reversion

Source: Veracel Celulose

A Pulp Machine

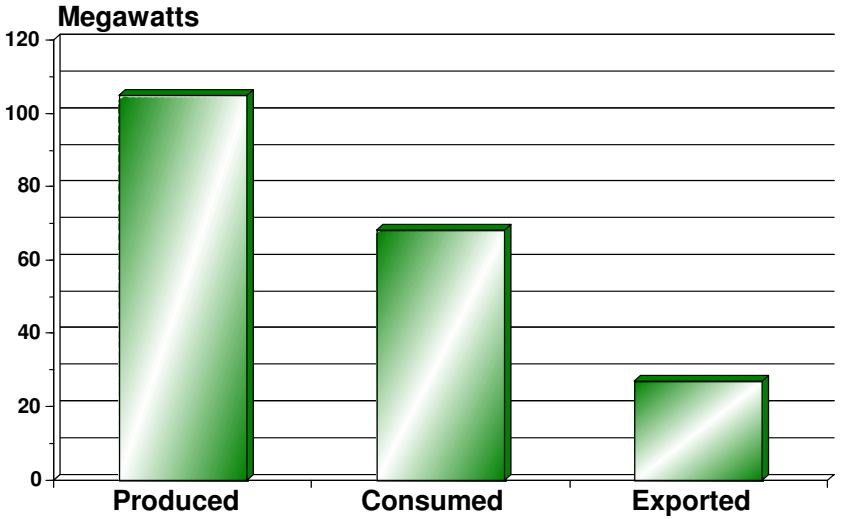
Photo Courtesy of: Celso Foelkel, Celsius Degree

A Paper Machine

Photo Courtesy of: Metso

Maximize Energy Production

- Burning of bark waste in power boiler
- Efficient recovery, evaporation, and combustion of black liquor in recovery boiler
  - Recovery boiler provides 90% of energy production; and
  - Mill steam requirements
- Minimize within mill power consumption with power saving technologies such as variable frequency drives etc.
- In a “State-of-the-Art” mill 70% of power generated is consumed and 30% is renewable “green” power exported to grid



Environmental Protection

- The Call for Green Chemistry
- Elemental Chlorine Free Bleaching
- Eco-system Recovery
- Environmental Protection Technology
- Waste Treatment
- Measures of Progress

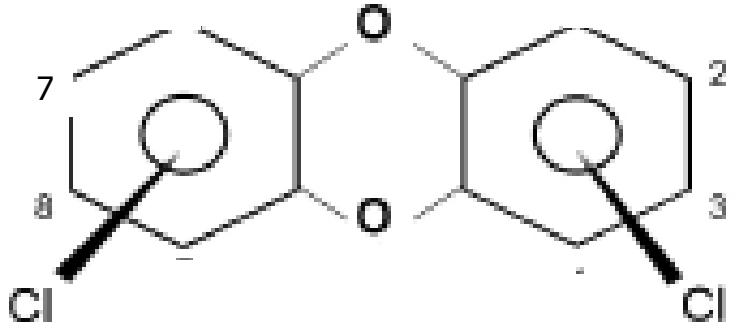
The Call for Green Chemistry

- 1985 Dioxin (2378-TCDD) discovered in fish downstream of bleached pulp mills
- 1987 American Forest & Paper Association (AF&PA) and US EPA publish results of cooperative “5 Mill Study” - confirming presence
- 1987-1989 research shows 2378-TCDD and 2378-TCDF are formed during chlorine bleaching
  - Chlorination of dibenzodioxin (DBD) and dibenzofuran (DBF)
  - DBD and DBF were found in de-foaming agents used in unbleached pulp preparation at that time

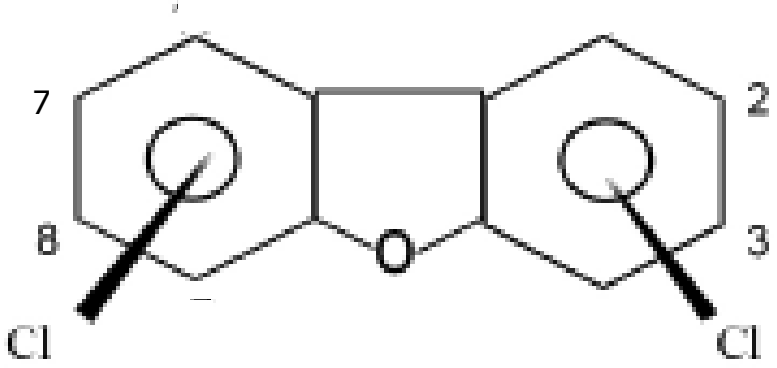
Dioxins and Furans

- There are over 135 possible Polychlorinated Dibenzo Dioxins (PCDD) and 75 possible Polychlorinated Dibenzofurans (PCDF)
- Of those, only 17 are considered to express “dioxin-like” toxicity
  - The compounds with the Cl in the 2, 3, 7, and 8 positions on the molecule
- Of the 17, only two, 2378-TCDD and 2378-TCDF are potentially produced with chlorine bleaching

PCDD



PCDF



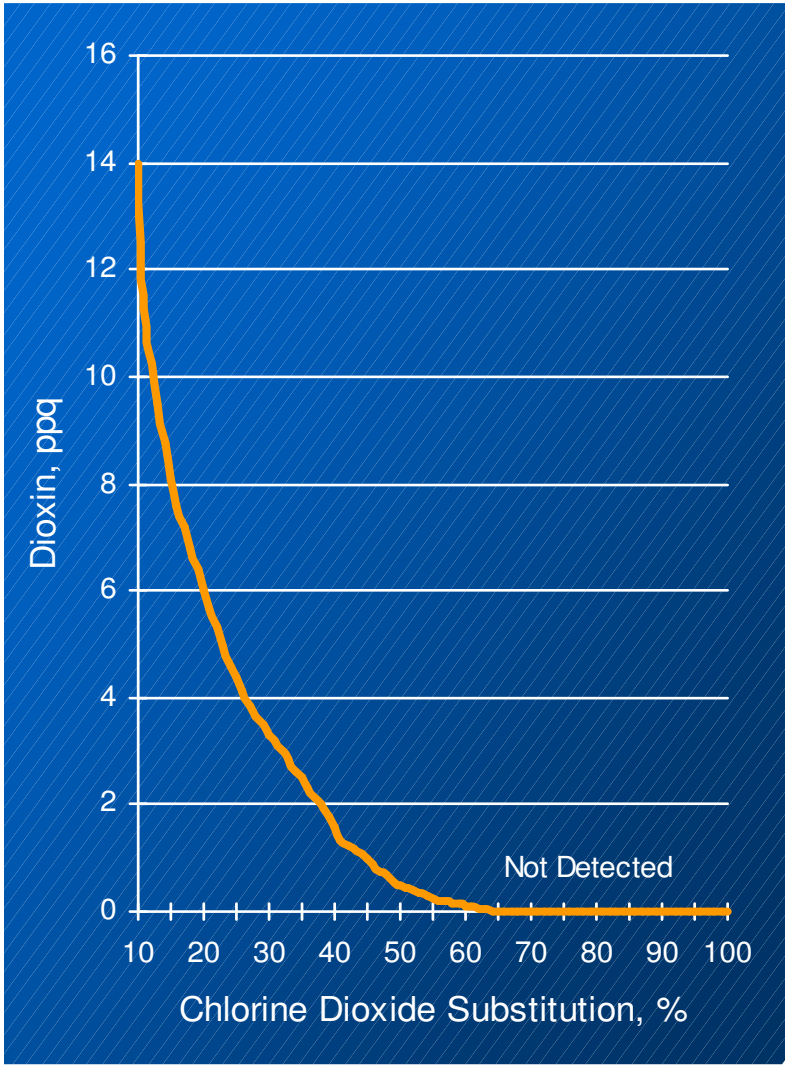
The Call for Green Chemistry

- Chemistry that prevents pollution[1]:
  - Chemistry that eliminates or reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment; and
  - reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.
- Technology that prevents pollution:
  - Equipment or technology modifications, processes or procedure modifications, reformulation or redesign of products, and substitution of raw materials.

[1.] ***Pollution Prevention Act of 1990. 42 USC 18101. Laws of 101st Congress - 2nd Session.***

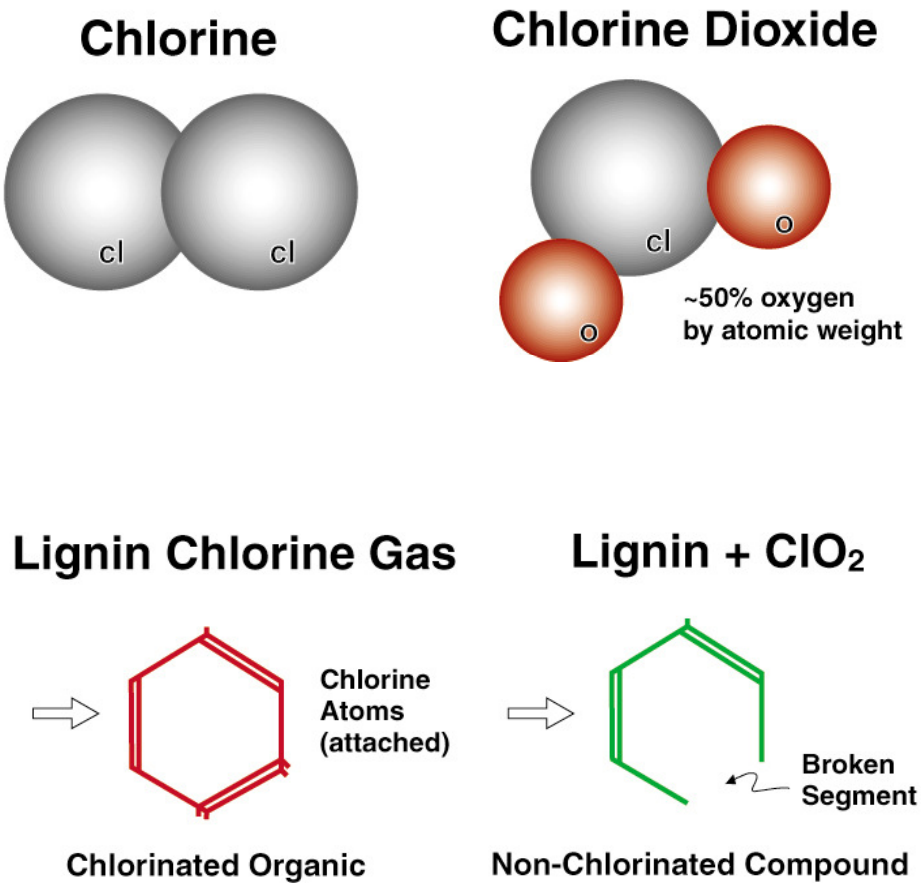
Green Chemistry: Found!

- International research discovers:
  - Replacement of chlorine with chlorine dioxide in the first stage of bleaching eliminates formation of dioxin and furan
- Mills began implementing this technology known as: **"Elemental Chlorine-Free (ECF) Bleaching"**
- ECF bleaching is **Green Chemistry** and fits the definition of Pollution Prevention
  - Technology modification with chemical substitution
  - Eliminates hazardous substances
  - Eliminates public and environmental health hazard



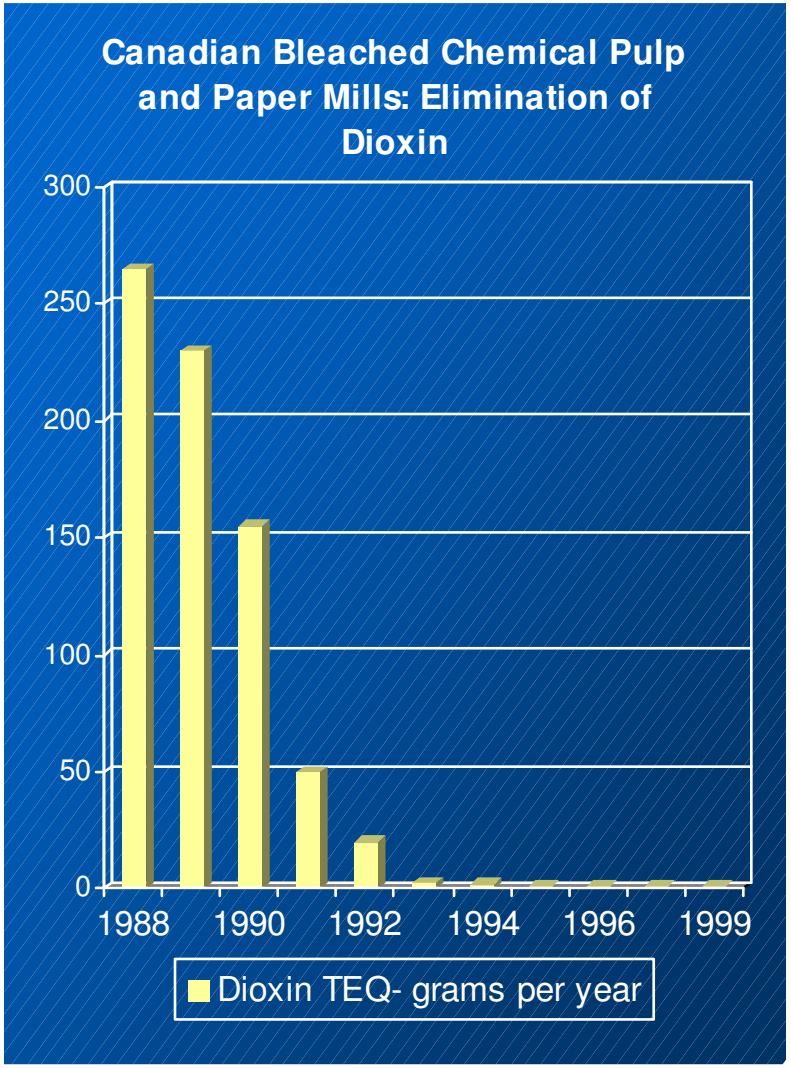
ECF: Green Chemistry Found!

- ECF is Green Chemistry:
  - The chemistry is different and reacts differently during bleaching
- Reaction products are similar to substances found in nature
- Reaction products
  - Degrade naturally
  - Do not persist in the environment
  - Represent a negligible environmental risk to aquatic ecosystems



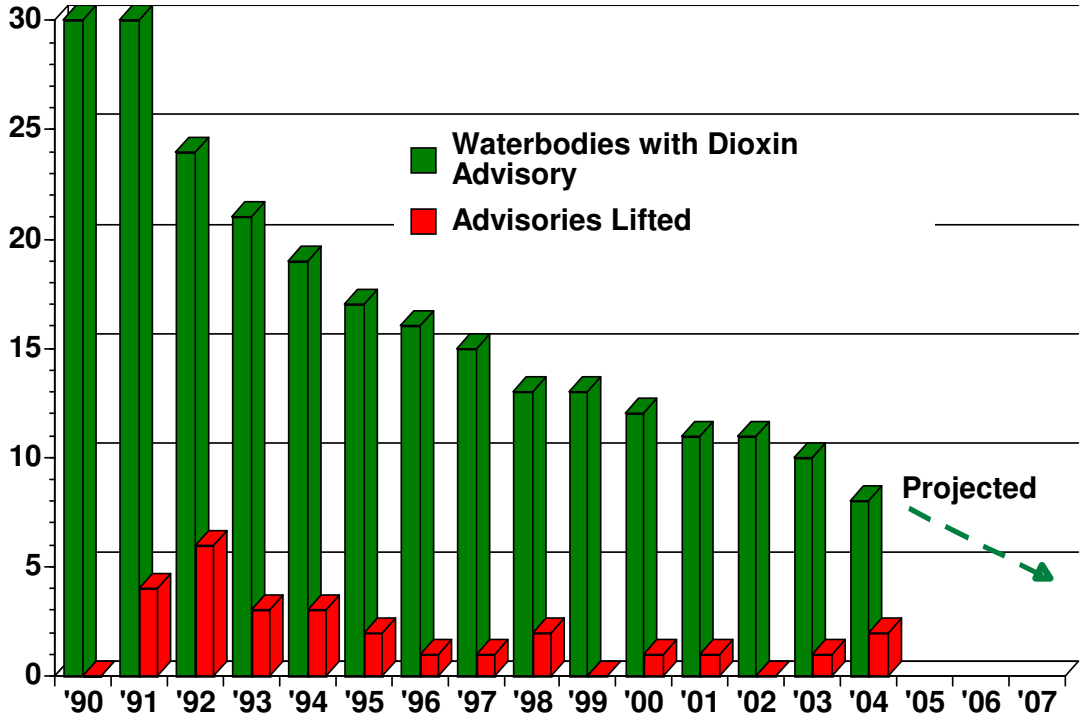
Pollution Prevention

- Pollution prevention means more than stopping pollution or end-of-pipe treatment
  - Pollution prevention means stopping pollution before it starts!
- In the late 80s the international pulp and paper industry voluntarily implemented a pollution prevention strategy to eliminate persistent, bioaccumulative toxic compounds
  - The key component of that successful strategy was ECF!



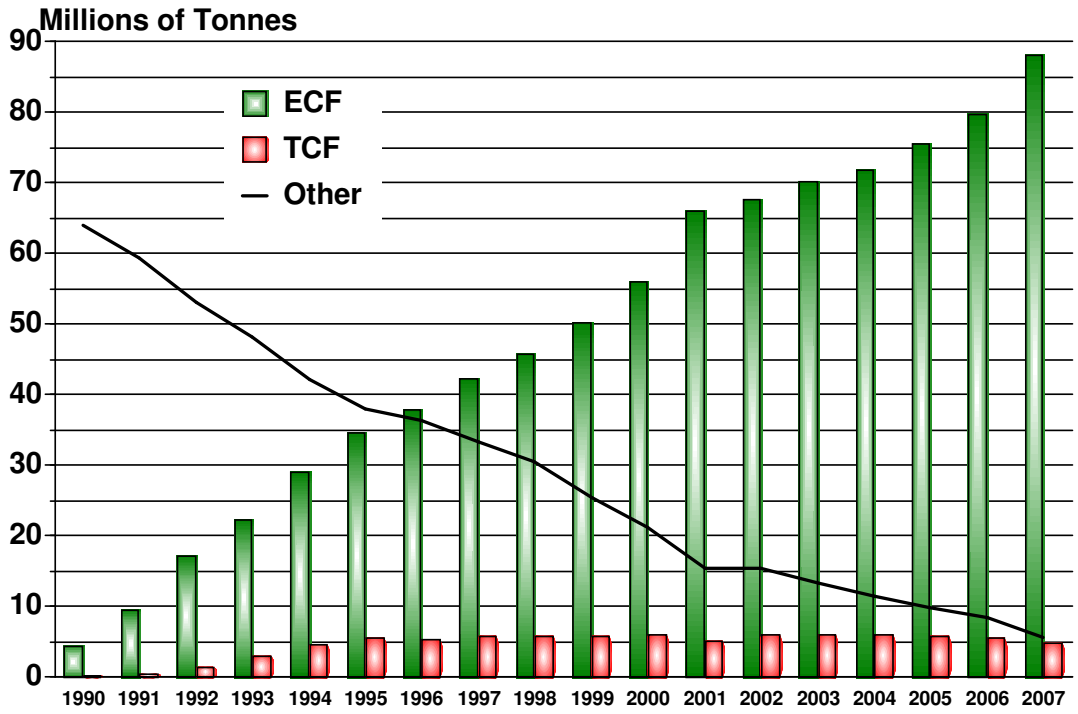
Eco-System Recovery

- ECF and the elimination of dioxin are key contributors to the sustainable recovery of affected eco-systems
- Since 1990 U.S. authorities have lifted 27 fish consumption advisories downstream of pulp and paper mills
  - The U.S. EPA predicts all remaining advisories will be lifted following full implementation of ECF bleaching
- Similar results have occurred in fresh water and marine environments in Canada

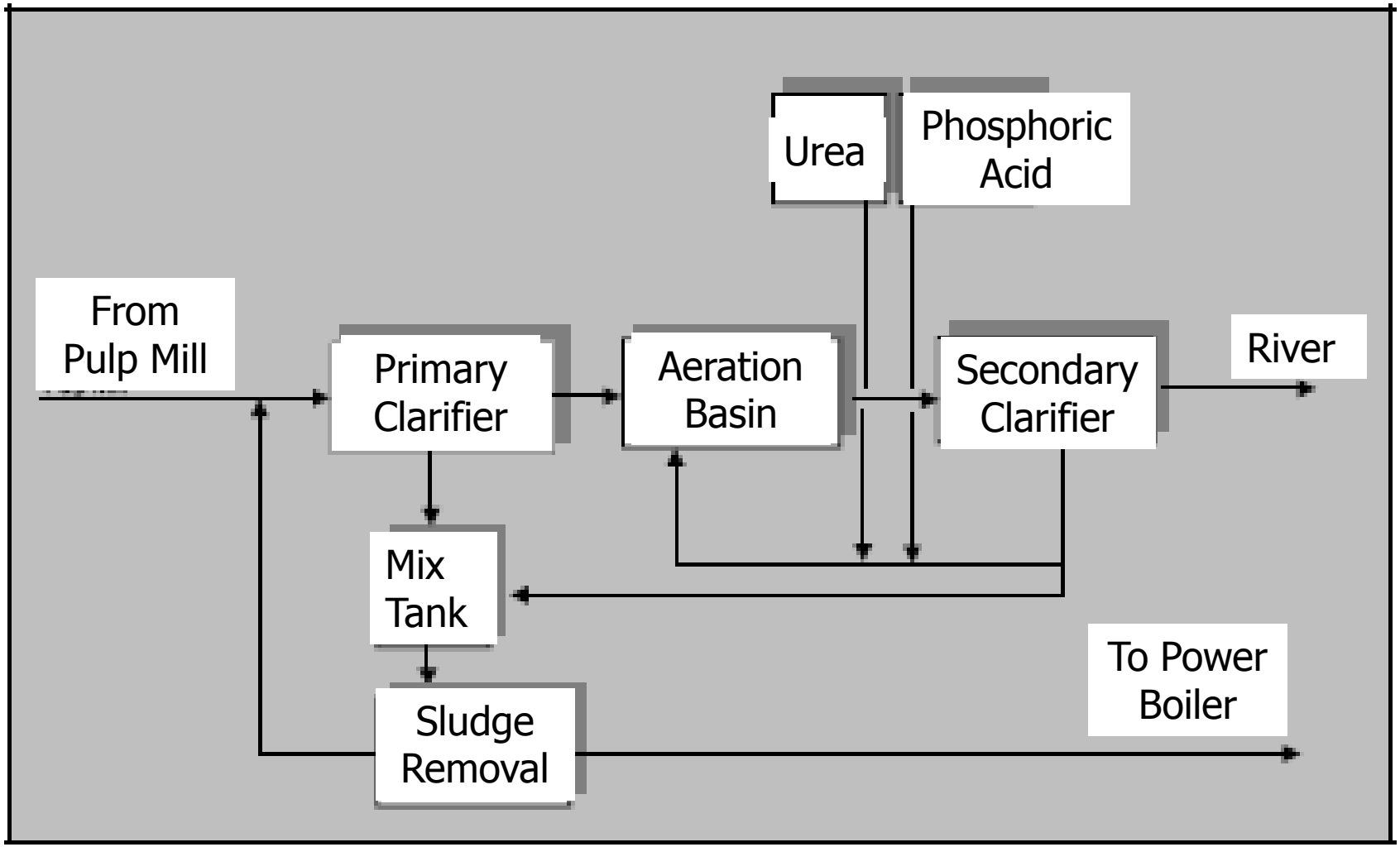


World Bleached Chemical Production

- Graphic shows growth of ECF bleaching technology since 1990
- ECF represents more than 89% of world Bleached Chemical Pulp Production
- TCF is less than 5% and declining
- TCF represents ~ 5% of market and is forecast to decline



Eco-System Protection: Waste Treatment



Source: N. McCubbin Consultants, Inc.

Biological Treatment

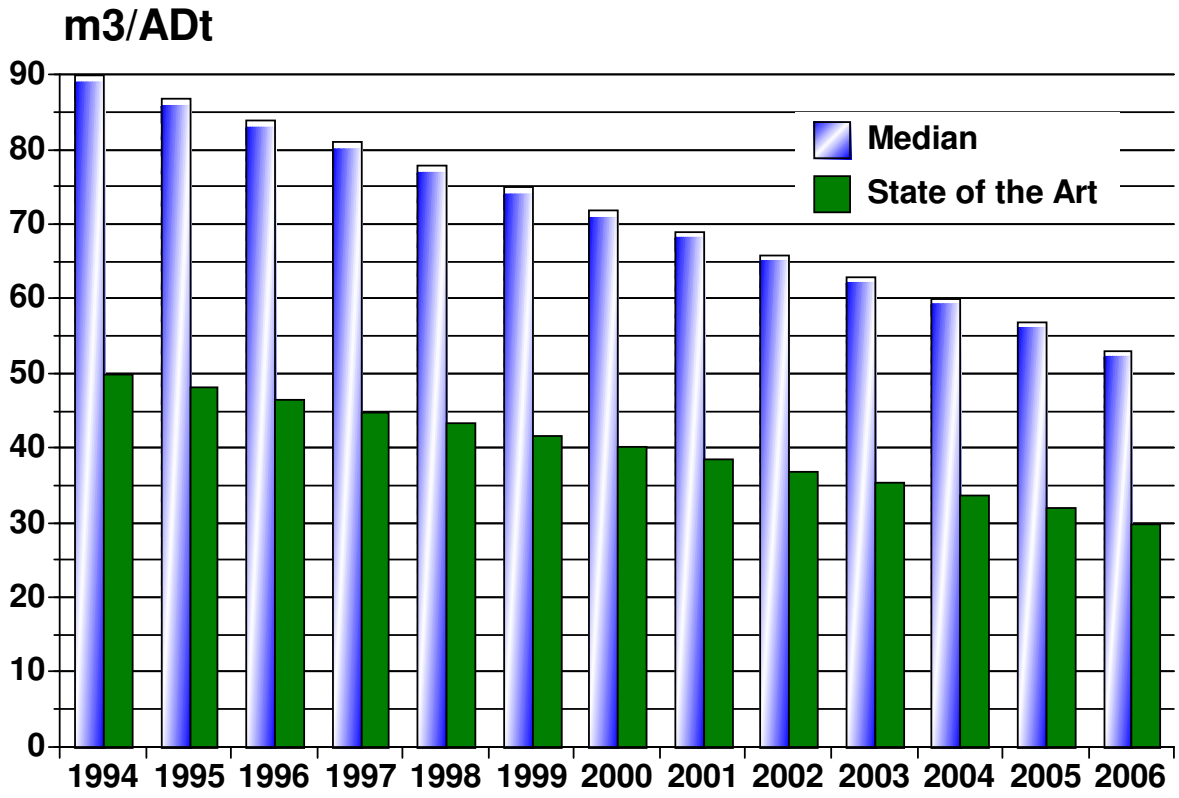
- Mills typically have primary and secondary treatment
  - Primary for removal of solid material
  - Secondary to minimize oxygen consuming compounds

Measures of Progress

- Specific Water Consumption
- Emission to Aquatic Enviroments
- Emissions to Atmosphere
- GHG Emissions
- Comparison of 1 million tonne per year from yesterday to today

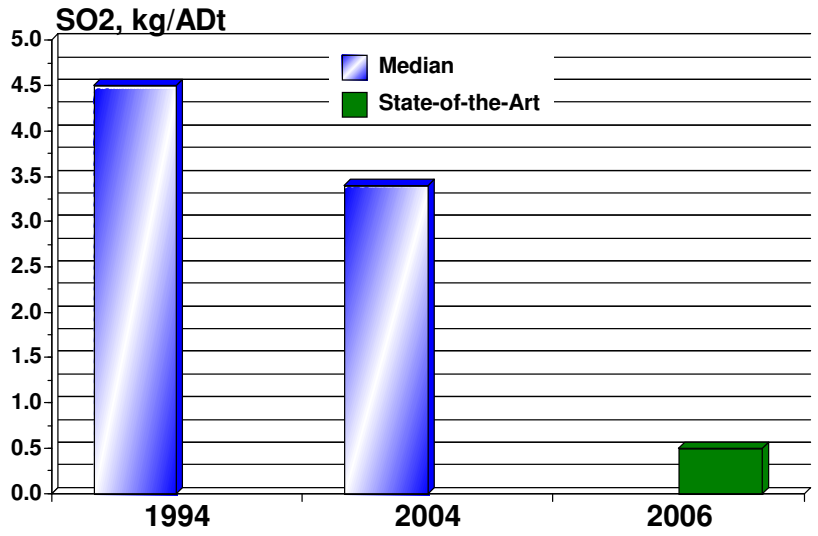
Minimize Water Consumption

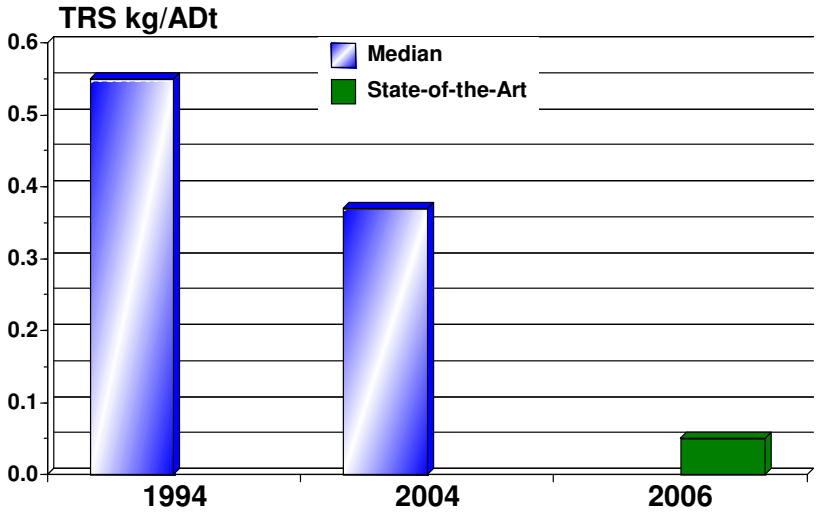
- Modern debarking system;
- Evaporator condensate recovery and reuse for within mill washing;
- Counter current washing with high efficiency washers;
- Filtrate reuse within the bleach plant; and
- Surface condenser water reuse using cooling towers



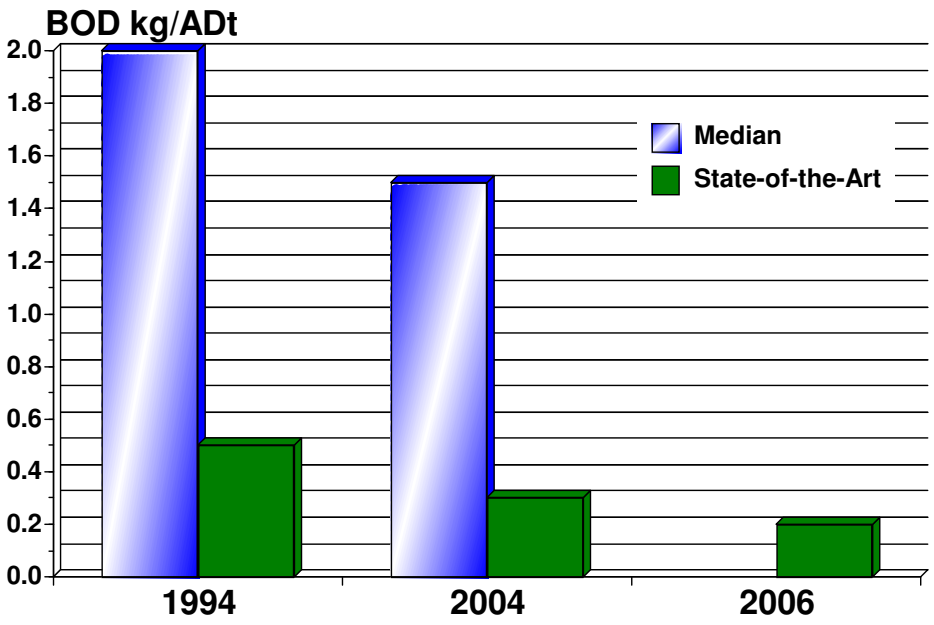
Minimize Air Emissions

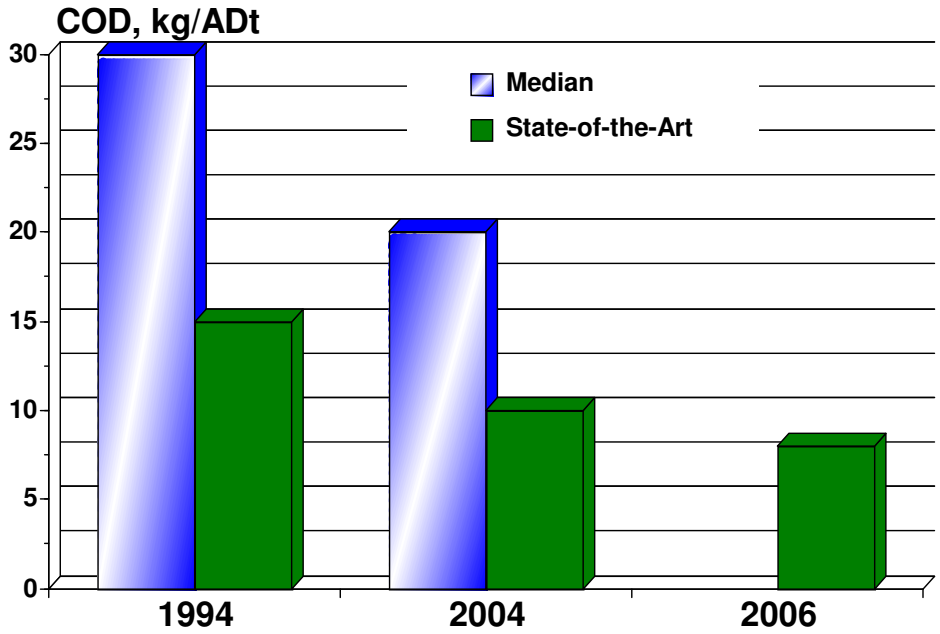
- Low odor design recovery boiler
- Condensate stripping and combustion of odorous gases
- Low and high concentration non-condensable gas collection and combustion
- Elimination of dissolving tank vent
- Electrostatic precipitators on recovery boiler and lime kiln



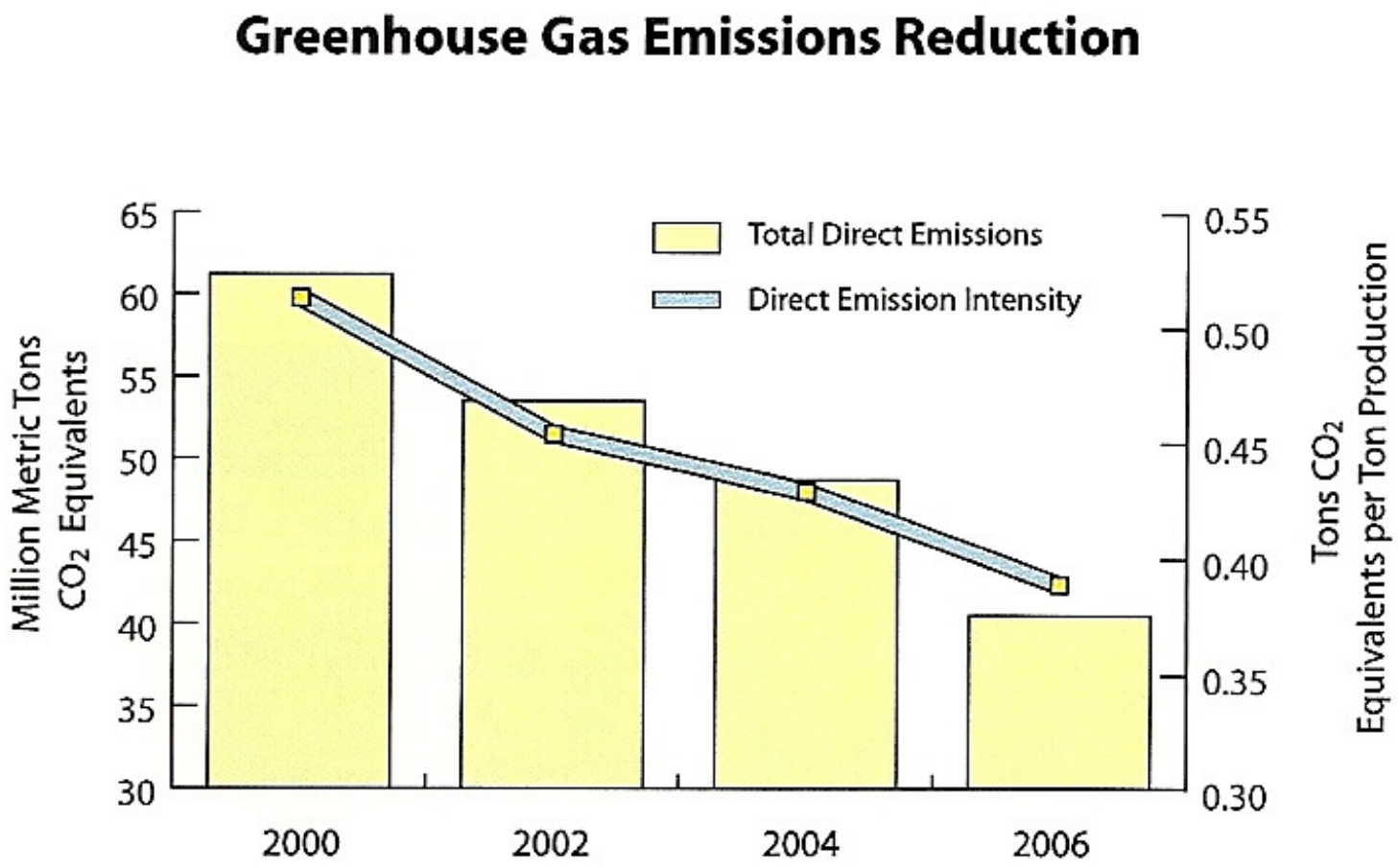


Ecosystem Protection



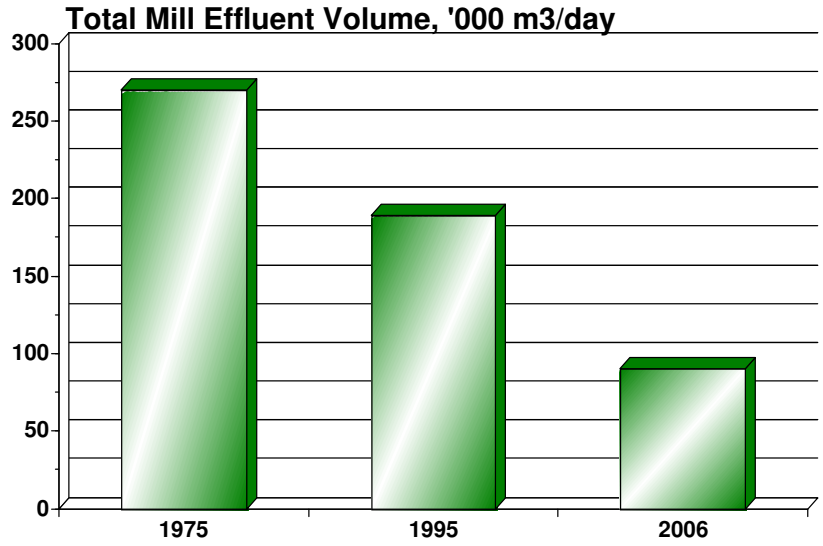


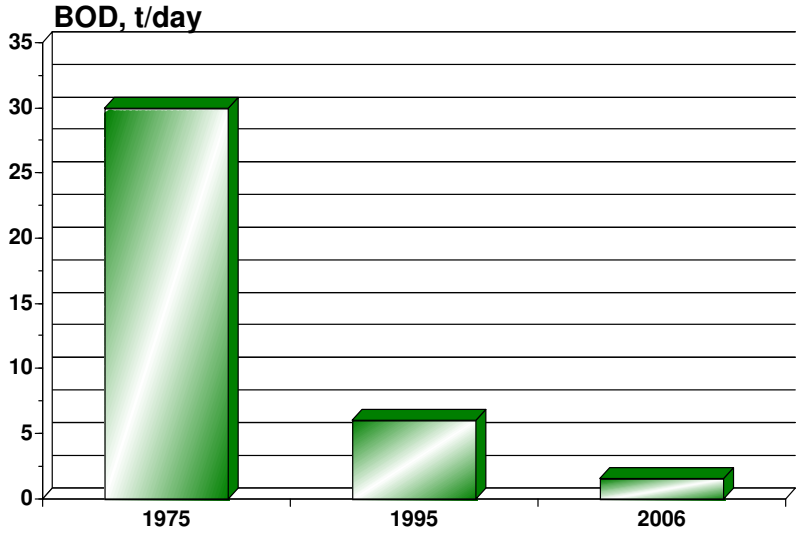
GHG Emissions

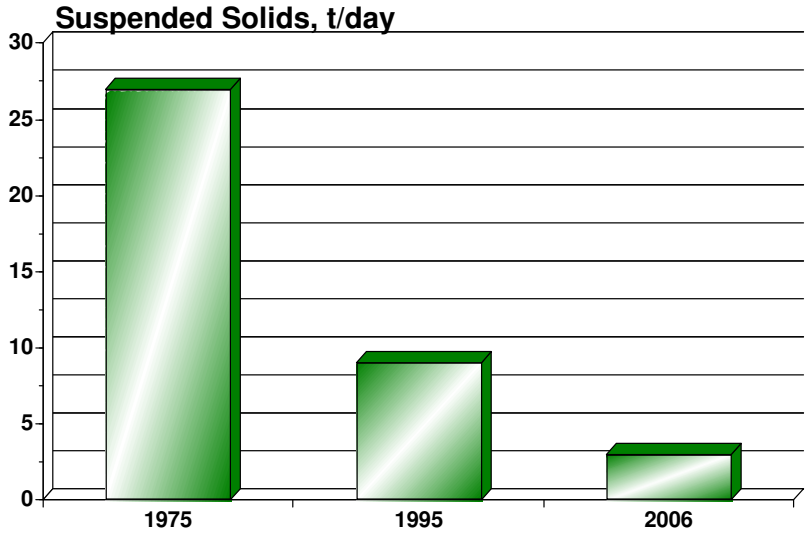


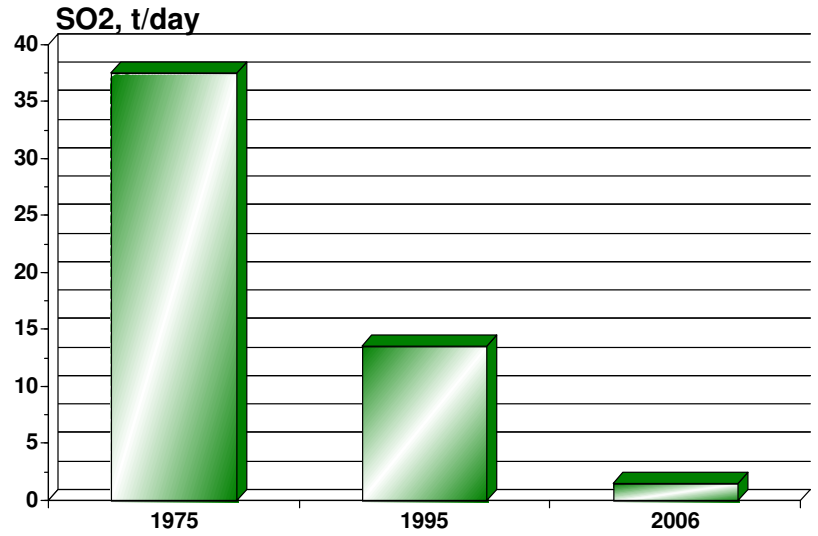
US Pulp and Paper Mills; Data from AF&PA

Industry Progress:
3000 t/d Bleached Pulp Production









Summary

- The industry's environmental progress over the last 30 years, while maintaining economic viability, bodes well for the next 30 years, and provides confidence that the Minimum-Impact Mill of the next generation will be realized

- "It is an industry we are so proud of we encourage our grandchildren to join"

Photo Courtesy of: Canfor Ltd.

Photo Courtesy of: Celso Foelkel, Celsius Degree

Thanks

What is AOX?

- AOX means "**A**dsorbable **O**rganic Halogen (**X**)"

- AOX is the result of a test to determine the amount of chlorine attached to organic substances
  - AOX is not a "thing", it is simply a number

- AOX does not determine
    - the compounds present;
    - whether the compounds are persistent;
    - whether the compounds are bioaccumulative;
    - the toxicity and biological properties of the compounds; or
    - the degree of chlorination.

- Due to these limitations, AOX does not provide environmentally relevant information

- There is no relationship between AOX test results and the presence of dioxin