Appita
ASIA COMMITTEE

61st Appita Annual Conference & Exhibition
GOLD COAST AUSTRALIA 6-9 MAY 2007

Non-Wood Fibre - 2010 and Beyond

Prospects for non-wood paper production in Asia Pacific

Keynote Address

Robert (Bob) W. Hurter, MBA, P. Eng.
HurterConsult Incorporated
4 - 5330 Canotek Road
Ottawa, Ontario, Canada K1J 9C1
e-mail: bobhurter@hurterconsult.com
Web site: www.HurterConsult.com

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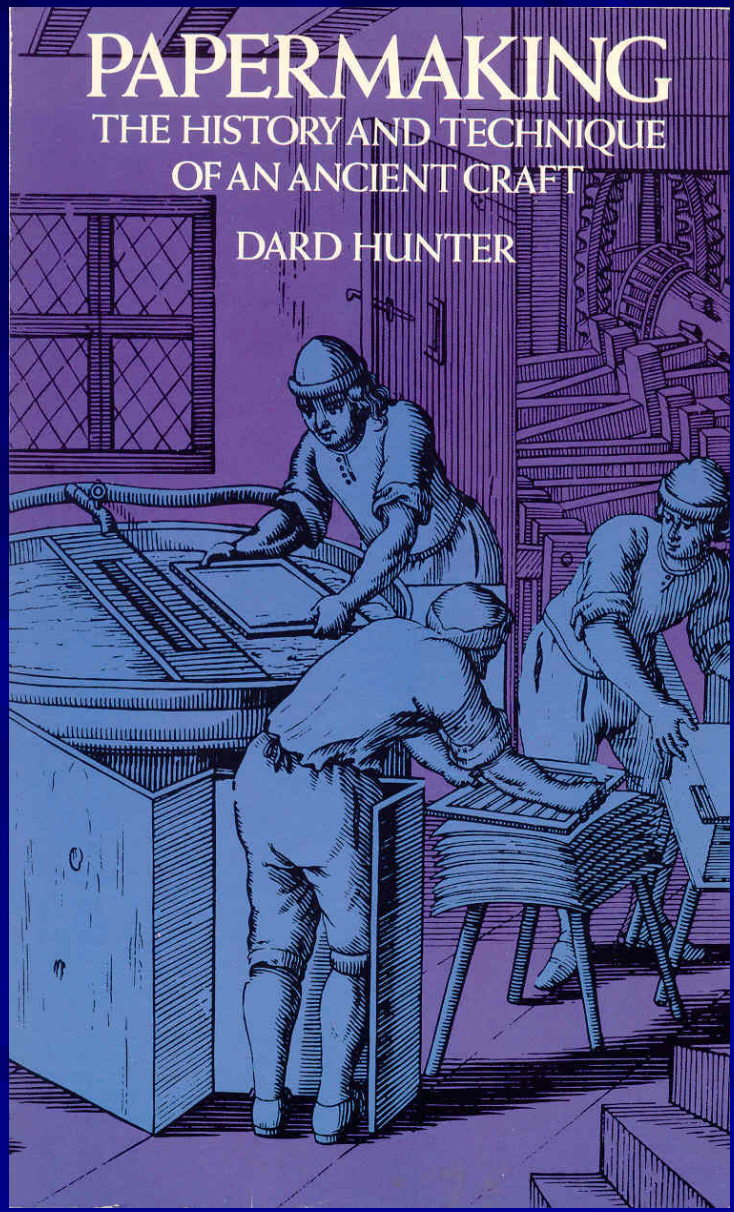
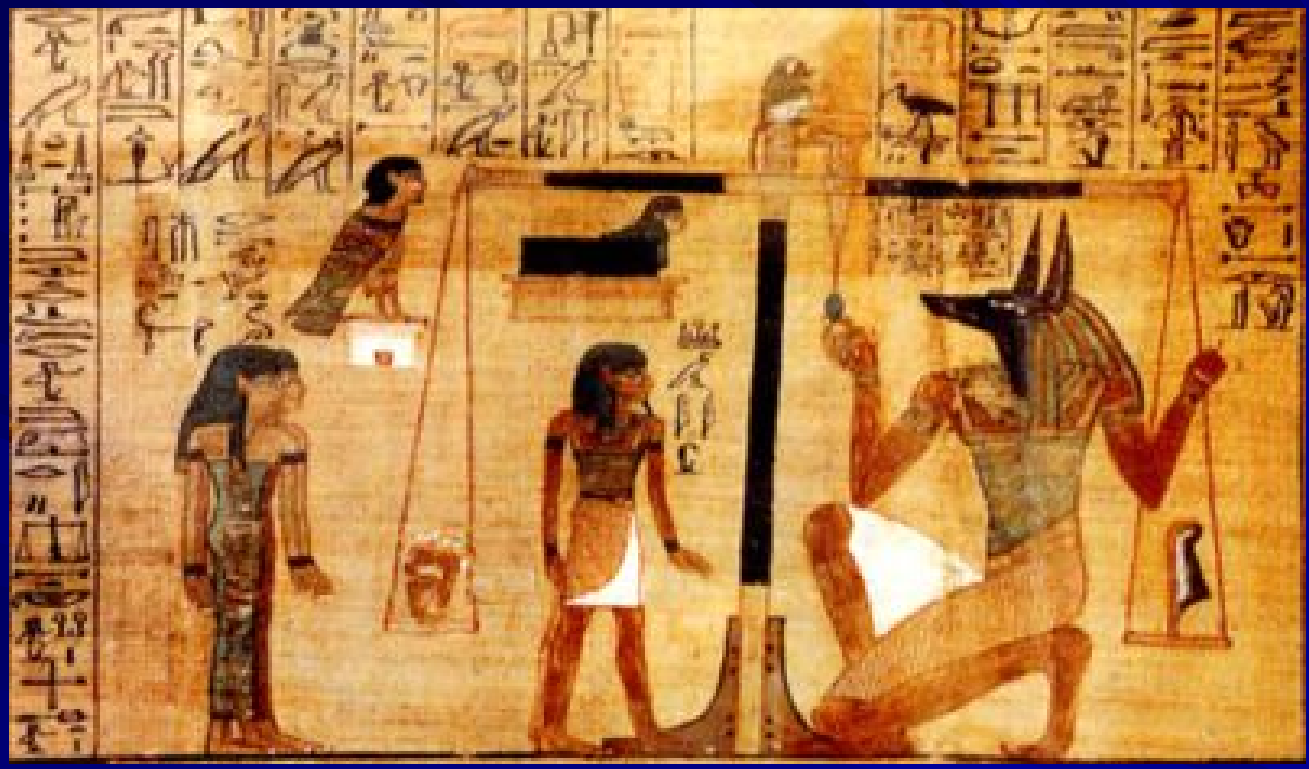
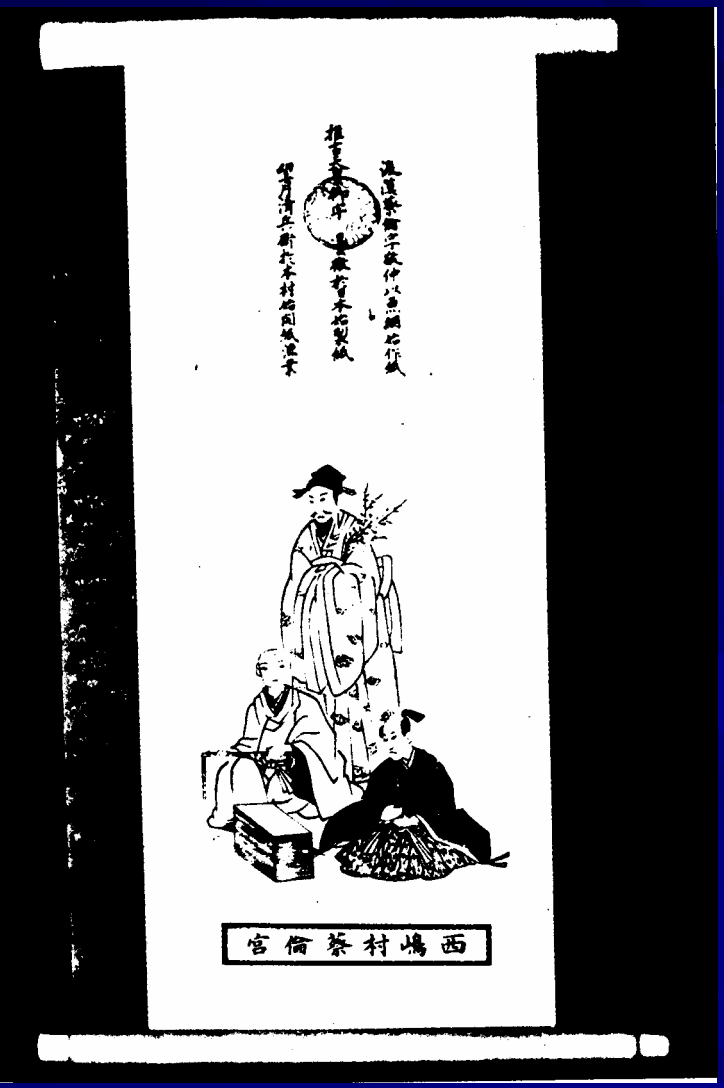
Topics

- a brief history of papermaking
- estimated availability of nonwood fibre raw materials
- some technological advancements that could improve the economics of nonwood fibre pulp and paper production
- possible threats to nonwood fibres
- a few possible nonwood projects


PAPERMAKING
THE HISTORY AND TECHNIQUE
OF AN ANCIENT CRAFT
DARD HUNTER



Papyrus from Ani’s Book of the Dead



- True paper was developed in China
- First true papers made from vegetable fibres credited to Ts’ai Lun in 105 A.D.
- No authentic portrait of Ts’ai Lun exists
- For the next 1800 years nonwood fibres were the primary source of raw materials for pulp and paper

- 8th to 10th centuries - art of papermaking spread from China to the Arab countries
- Early 11th century – from the Maghreb to Arab-held Spain
- Next 4 centuries – throughout Europe

- **Mid 18th century – European mills having problems getting enough cotton and linen rags**
  - **investigation into alternative vegetable fibre raw materials begins**
  - **wide variety of potential raw materials studied**
  - **most promising – cereal straw and wood**
  - **late 18th century – some straw pulp being produced**

- 1798 – Nicholas-Louis Robert devises first machine for making paper by the roll
- 1801 – patent granted in England – shared with Henry and Sealy Fourdrinier
- 1807 – improved machine built by Bryan Donkin, the Fourdriniers' engineer

Model built from Robert's drawings

- Early 19th century – considerable straw pulp production and some woodpulp but rags still the principal raw material
- Mid 19th century – paper demand continuing to increase but rag supply had tightened
- 1863 – Ausutus Stanwood's mill, Maine
  - imported Egyptian mummies and used the wrappings and papyrus for papermaking
  - only competition for the mummies was the Egyptian National Railroad

Mummy in Vatican Museum

- **1875 to 1900 – straw pulp production becomes substantial in Europe and North America**
  - **straw became the major source of pulp**
  - **used in a variety of papers**
  - **straws primarily used – wheat, rye, rice – same as today**
- **1800 to 1900 – concurrent development of wood pulping**
  - **1867 – Tilghman invents sulphite process**
  - **1884 – Dahl invents Kraft process**
- **1900’s - Woodpulp production increases rapidly and wood soon becomes the main raw material for the paper industry**

- 1930’s – still quite a few straw pulp mills in Europe
- 1950’s - most straw pulp mills in the West closed
- 1950’s – introduction of the Kamyr continuous digester for wood
- Today
  - wood is the dominant fiber raw for pulp and paper production with over 90% of global pulping capacity
  - single line woodpulp mills of 2,000 mt/day are more or less standard and the largest line located in China is 3,000 mt/day

Nonwood fibres still important raw materials

- in many countries where wood resources are limited or simply do not exist

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Cereal Straws

	BDMT / year
Barley	195,000,000
Oat	55,000,000
Rice	360,000,000
Rye	40,000,000
Wheat	600,000,000
Total	1,250,000,000

Wheat Straw

Pith containing Nonwoods

	BDMT
Sugarcane bagasse	102,000,000
Corn stalks	750,000,000
Grain & sweet sorghum stalks	252,000,000
Total	1,104,000,000

Sugarcane

Bast Fibre Plants (whole stalk)

	BDMT
Textile flax, hemp, jute, kenaf, etc.	14,000,000
Oilseed flax straw	2,000,000
Cotton stalks	68,000,000
Total whole stalk	84,000,000
Bast fibre only	21,000,000

Kenaf

Bamboo, Reeds & Grasses

	BDMT
Bamboo	30,000,000
Grass seed straw	3,000,000
Papyrus	5,000,000
Reeds	30,000,000
Sabai grass	200,000
Total	68,200,000

Reeds

Cotton

	BDMT
Staple fibre	18,300,000
1st & 2nd cut linters	2,700,000
Total	21,000,000

Cotton

Leaf Fibre Plants

	BDMT
Sisal, henequen, maguay	500,000
Abaca (Manila hemp)	100,000
Total	600,000

Sisal

All Selected Nonwoods

	BDMT
Cereal straws	1,250,000,000
Pith containing nonwoods	1,104,000,000
Bast fibre plants	84,000,000
Bamboo, reeds & grasses	68,000,000
Cotton	21,000,000
Leaf fibre plants	600,000
TOTAL	2,527,800,000

Other Nonwoods

- **Other nonwood fibres also can be available for pulping**
- **Malaysia – the world's largest producer of palm oil**

	BDMT / year
Oil palm empty fruit bunches (EFB)	5.5 – 6.5 million
EFB fibre	3.5 - 4.1 million
Bleached pulp (40% yield)	1.4 – 1.6 million

Oil Palm EFB

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Bamboo Farming

- **THE PROBLEM**
  - traditional method - planting material extracted from existing forest
  - high cost planting material
  - 2002 study for Far North Queensland identifies costs of A$ 30 - 40 per plant
- **THE NEED**
  - lower cost source of planting material

Bamboo Farming

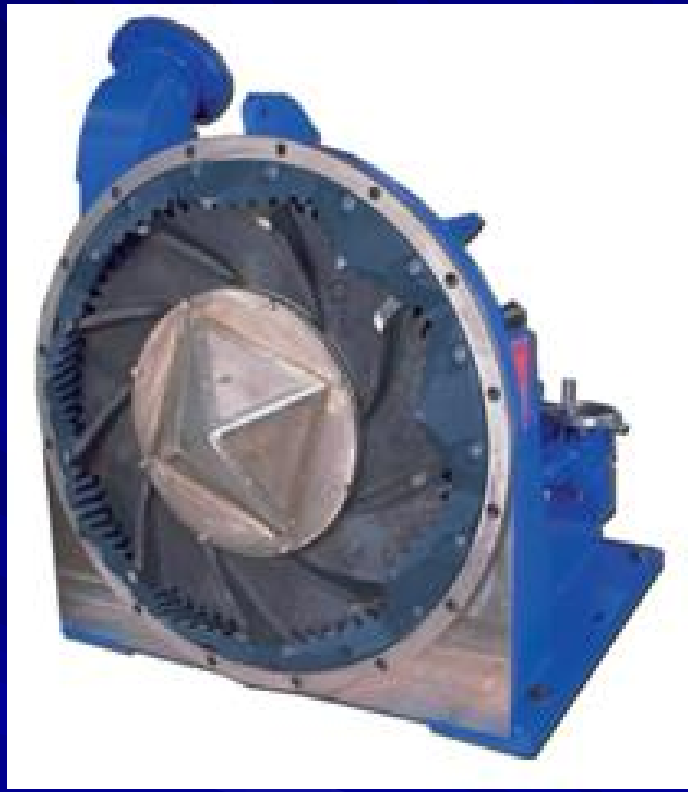
- **A SOLUTION**
  - WestWind Technology LLC, Athens, Tennessee, USA
  - patented mass propagation technology under controlled laboratory setting for bamboo and giant reeds
  - can establish bamboo farms on a turnkey basis with guaranteed biomass density coverage of 90% at the first harvest for about US$ 5,000 per hectare
  - planting material only for about US$ 1,000 per hectare

Whole Stalk Bast Fibre Plant CTMP

- **THE PROBLEM**
  - traditional kenaf chipping followed by cleaning and live bottom bins may result in non-uniform flow to refiners
  - increases difficulty of producing uniform quality pulp
- **THE NEED**
  - method to prepare the raw material in a manner that provides uniform raw material sent to the refiners

Whole Stalk Bast Fibre Plant CTMP

- **A SOLUTION**
  - Tornado Pulper - Bolton Emerson Americas, Inc. marketed by GL&V (www.glv.com)
  - rotor & stator with cutting elements
  - processes raw material into uniform, pumpable slurry that can be fed to the refiners
  - 1st installation being supplied by Andritz for a 100,000 mt/year kenaf APMP mill in Vietnam



Tornado Pulper

Cereal Straw Desilication

- **THE PROBLEM**
  - silica in nonwood plant fibres causes problems in the chemical recovery system
  - historically the focus is on black liquor desilication
- **THE NEED**
  - is there a way to remove the silica prior to cooking

Cereal Straw Desilication

- **A SOLUTION**
  - Alberta Research Council (ARC), Edmonton, Alberta, Canada www.arc.ab.ca – Wade Chute
  - Tornado pulper → junk cyclone → disk refiner → screening
  - mechanical only - up to 60% silica removal
  - can add a small alkali dose < 0.5% NaOH or equivalent
  - adding alkali - up to 80% silica removal
  - ARC has filed for a patent

Nonwood Pulping

- **THE PROBLEM**
  - pith containing nonwood raw materials require depithing for good pulp quality
  - traditional mechanical depithing methods are energy intensive
- **THE NEED**
  - find another way to remove pith that is less energy intensive

Nonwood Pulping

- **A SOLUTION**
  - North Carolina State University & HurterConsult Inc. www.HurterConsult.com
  - patented EAZy process – U.S.A., Mexico, China, pending in other countries
  - mild extraction → acidification → ozone → ECF or TCF bleaching

Nonwood Pulping

- **A SOLUTION**
  - low temperature (less than 120 ^{0}C) "extraction" versus traditional high temperature (165 ^{0}C) cooking
  - ozone applied in a manner that does not degrade fragile nonwood plant fibres
  - acid & ozone steps act as chemical depithing agents as well as traditional bleaching steps
  - very short sequence ECF or TCF bleaching – moderate to high brightness i.e. single P stage – 87 – 89 %ISO

Nonwood Pulping

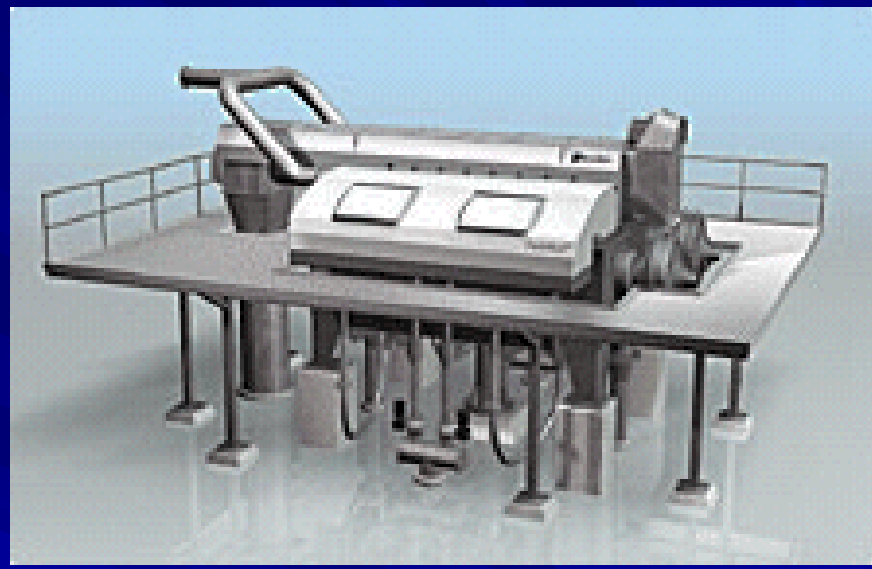
- **A SOLUTION**
  - maintain high pulp freeness and excellent pulp properties
  - low energy process
    - no mechanical depithing
    - low processing temperatures
    - short sequence bleaching

Nonwood Pulp Washing

- **THE PROBLEM**
  - many nonwood pulps require much larger washer surface areas than woodpulps for various types of vacuum and pressure washers
- **THE NEED**
  - find another way to wash nonwood pulps

Nonwood Pulp Washing

- **A SOLOTION**
  - press washing - adopted for most newer woodpulp mills
  - not been used in nonwood pulp mills
  - Metso installing press washing in new 500 ton/day ECF bagasse pulp bleach plant at Tamil Nadu Newsprint & Papers Ltd.
  - will press washing impact on bagasse pulp quality



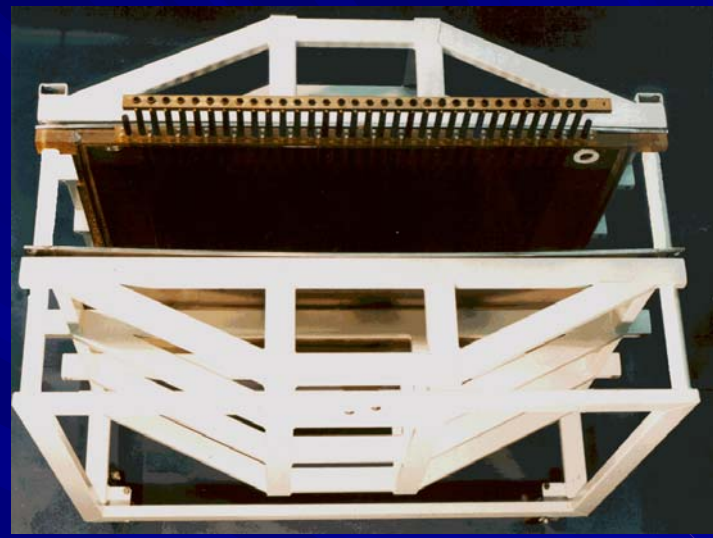
Metso TwinRoll Press Washer

Black Liquor Chemical Recovery

- **THE PROBLEM**
  - nonwoods contain silica which enters the black liquor causing problems in conventional chemical recovery systems
  - viscosity of concentrated black liquor makes it dificult to achieve high solids content
- **THE NEED**
  - find other ways to recover nonwood black liquor

Black Liquor Chemical Recovery

- **A SOLUTION #1**
  - Electrosep Inc., Oregon, U.S.A (www.electrosepinc.com)
  - nonfouling electrolytic membrane technology
  - caustic recovered directly as NaOH
  - lignin separated by the membrane
  - hemicellulose goes through the membrane and can be fermented
  - may be ideal for smaller mills
  - 1st commercial installation on wheat straw in India - 2007

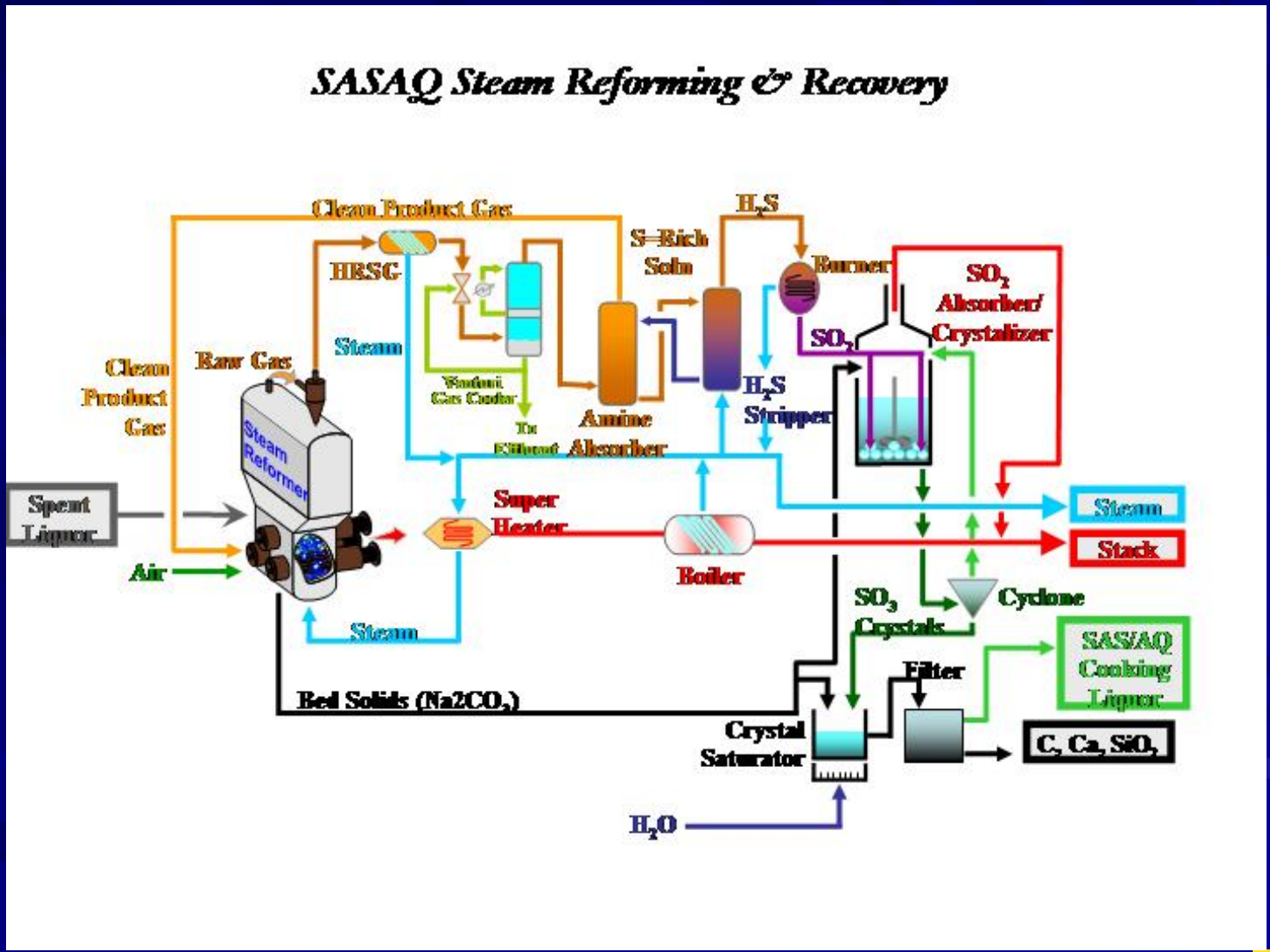


Black Liquor Chemical Recovery

- **A SOLUTION #2**
  - ThermoChem Recovery International Inc., Baltimore, U.S.A (www.tri-inc.net)
  - low temperature gasification (steam reforming)
  - commercial success - NORAMPAC, Trenton, Ontario, Canada – over 18,000 hours
  - energy positive at 60% black liquor solids
  - may allow for switch to higher yield sulphite cooking

TRI Pulse Combustor

Black Liquor Chemical Recovery



New Technology Summary

- nonwood pulping needs new technologies to become more economical
- the foregoing illustrates a few newer technologies that can improve the economics of nonwood pulp production

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Threats to Nonwood Fibres

Bio-Mania

Corn Stalk Pulp & Paper Mill

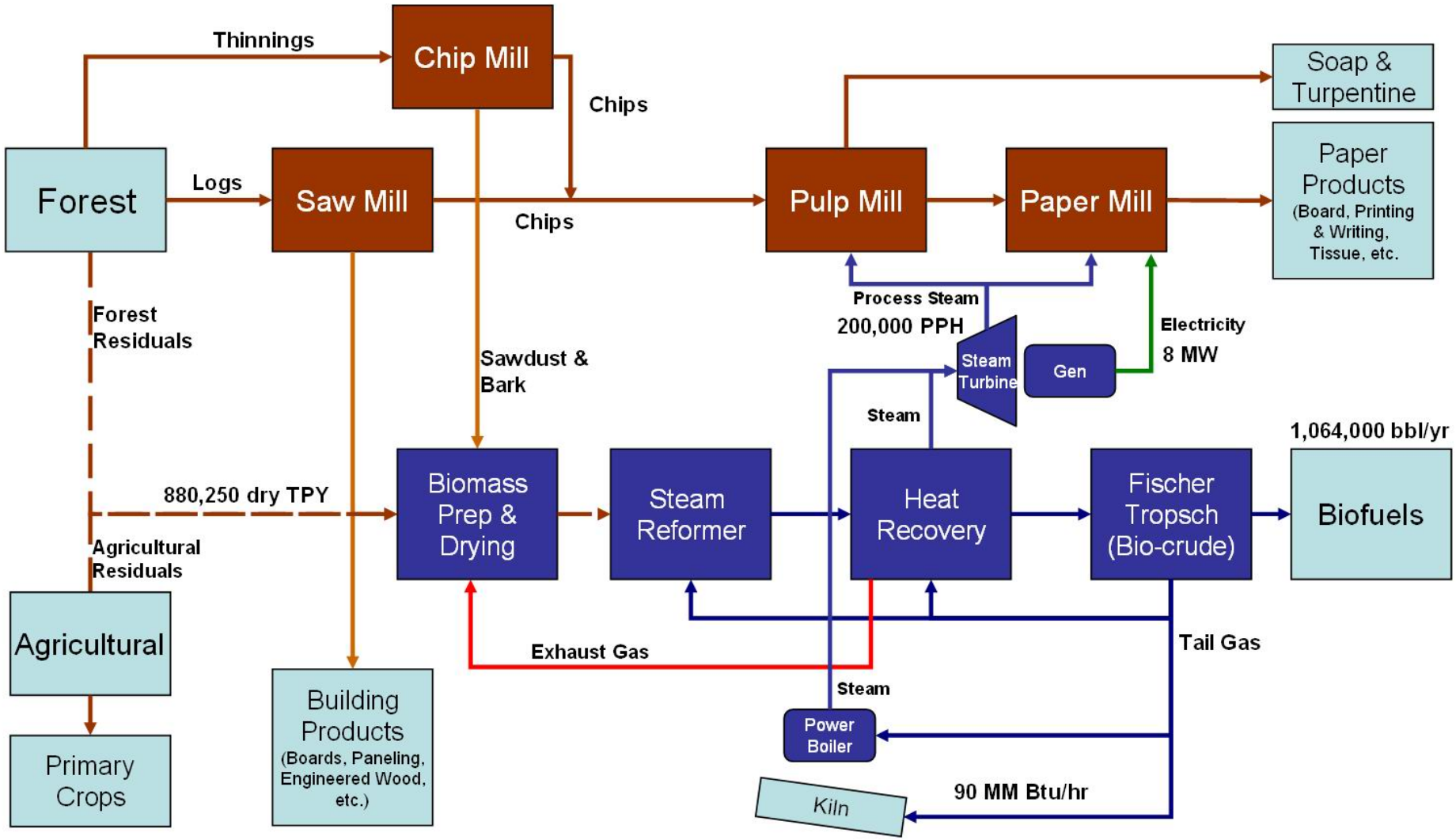
- 200,000 mt/year fine paper
- 100,000 bdmt/y corn stalk pulp line
- gasification biorefinery

- 300,000 mt/y corn stalks for pulping
- 680,000 mt/y corn stalks for biorefinery

- biorefinery
  - all steam & power for complex
  - 819,000 barrels/y F-T liquid biofuel fuel
  - adds US$150 million to project (total US$ 650 million)
  - increases ROE from 18% to 26%

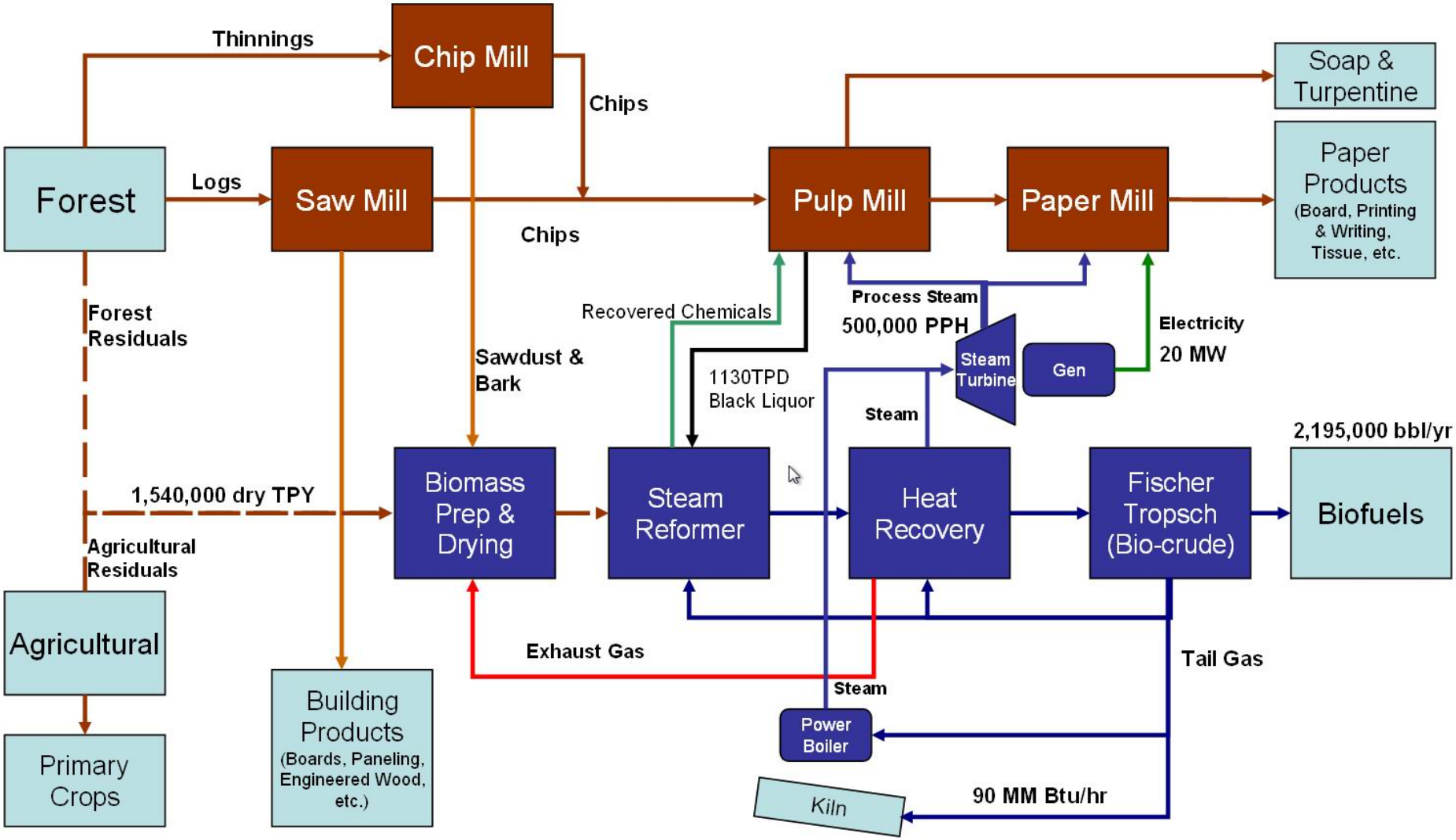
Corn

1000 ton per day integrated woodpulp & paper mill



PHASE 1

1000 ton per day integrated woodpulp & paper mill



PHASE 2

1000 ton per day integrated woodpulp & paper mill

- over 450 integrated pulp and paper mills and another 400-500 nonintegrated paper mills that are good potentials for biorefineries
- total possible biomass usage is in the order of 1.0 – 1.2 billion dry tons/year

100 million gallon/year corn grain ethanol plant

- uses 160,000 kg hour steam & over 15 MW electricity
- normally generated using fossil fuels
- add a gasification based bio-refinery sized for all steam and power
  - produces 3,100 barrels/day (1,130,000 barrels/year) of F-T liquid fuel AND about 20 MW of export electricity
  - uses 2,400 dry tons/day (875,000 tons/year) biomass

Iogen Corporation, Ottawa, Canada

- proprietary technology for the enzymatic conversion of cellulose to fermentable sugars
- operating a pilot plant in Ottawa converting wheat straw to ethanol
- planning commercial plants in various locations
- size of commercial plant based on 750,000 mt/year wheat straw feedstock

Threats to Nonwood Fibres

SUMMARY

- biomass to energy projects consume large amounts of biomass
- these projects could pose a significant threat to the use of nonwoods for pulp and papermaking affecting:
  - availability
  - cost

Threats to Nonwood Fibres

SUMMARY

- incorporating a biorefinery in a pulp and paper project is a double edged sword
  - possible negative - can significantly increase biomass demand
  - definitely positive – can increase the project economics and “green” perception

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AFH TISSUE/TOWELING

- fastest growing market worldwide
- economic development in China and India
- companies are positioning themselves to serve this market
- possible project
  - **nonwood-based tissue/toweling mill in the order of 40,000 – 60,000 mt/y for AFH local markets**

PAPERBOARD

- demand packaging material (linerboard and medium) for export goods is growing in Asia
- board made from imported wastepaper
- cereal straws excellent raw material for board
- possible projects
  - **add-on cereal straw line to wastepaper-based board mill**
  - **new cereal straw-based board mill**

PRINTING/WRITING PAPER FOR EXPORT

- USA, Canada, Europe
- target market – environmentally conscious consumer
- price must be competitive with wood-based paper
- mill must meet Western environmental norms
- possible nonwoods include cereal straws, bagasse, bamboo, kenaf, hemp etc.

PRINTING/WRITING PAPER FOR EXPORT

- many Western companies have paper purchasing policies
- grade structure should include higher value grades such as financial and commercial opaques
- possible project
  - **200,000 mt/y printing/writing paper mill for export markets**

BAMBOO / GIANT REED MARKET PULP

- lack of wood resources in Asia
- bamboo & giant reeds can provide good quality pulp
- bamboo & giant reed farming
- planting to first harvest typically 3 – 4 years – about the same time frame to plan and build a market pulp mill
- possible project
  - **1,000 mt/day (or more) market pulp mill for domestic and export markets**

CONCLUDING REMARKS

- Many other possible projects
  - depends on country, local & exports markets, nonwoods available
- Nonwoods will continue to be important in Asia Pacific
- Opportunities exist for increasing the use of nonwoods in Asia Pacific – all that is required is imagination and creativity