International Energy Agency
Bioenergy Agreement
Task 32, Triennium 2004 - 2006
Biomass Combustion and Cofiring

WORKSHOP

PUBLIC PERCEPTION OF BIOMASS COFIRING

Arranged by:

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Content:
Minutes of the workshop

August 30, 2004
Victoria, Canada

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Programme

Date: Monday August 30

Location: Victoria Conference Centre, Victoria, Canada

Chairperson: Sjaak van Loo

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11:10	Cofiring concepts and comparison with other renewable energy options Larry Baxter, Brigham Young University, USA
11:35	Public perception/relations issues of cofiring Brett Corderoy, Delta Electricity, Australia
12:00	A review of cofiring initiatives in Canada Fernando Preto, Canmet, Canada
10:20	Full-scale investigations of straw co-firing Bo Sander, ELSAM Engineering, DK
12:25	Summary Sjaak van Loo
12:30	*Lunch break*
13:30	Comments from NGO's Gabe Petlin, Green-E Paul Craig, Sierra Club
15:00	Discussion and conclusion
15:30	Closing

Summary of the meeting

Task 32 of the IEA Bioenergy Agreement (Biomass Combustion and Cofiring) has organised a workshop on 30 August, 2004 at the Conference on Science in Thermal and Chemical Biomass Conversion, Victoria, Canada to discuss the public perception of cofiring biomass in coal-fired power plants and how this can be improved.

22 representatives from utilities, NGO's, governmental organisations, and R&D organisations participated in this meeting. Although the majority of the participants were North American, participants from other parts of the world were also present. The programme is given on page 3, a summary of the workshop follows below:

Sjaak van Loo, Task leader of Task 32, chaired the meeting and welcomed all participants. Before the workshop, contact was made with several NGO's to discuss options for participation. Although only a few could make it to this workshop, the initiative was conceived very positively as it was recognised that cofiring is a topic of increasing importance considering the large impact it could have on a short term. It should therefore receive attention of all stakeholders, including NGO's. One of the NGO's contacted before the meeting (Union of Concerned Scientists) mentioned that as a result of the interactions before the meeting, they were prepared to look open minded towards different aspects of cofiring.

Sjaak van Loo briefly presented some observations made earlier by Task 32 on biomass cofiring. From the results of a large number of different experiences worldwide it can be observed that

- Biomass co-firing has been demonstrated successfully in more than 150 installations worldwide, for most combinations of fuel and boiler type.
- The electrical conversion efficiencies for biomass, when co-fired in coal-fired plant, are similar to those for the coal, i.e. they are significantly higher than those for small, dedicated biomass power plants based on similar energy conversion technologies.
- Co-firing in existing coal-fired boilers is, in almost all cases, the lowest cost biomass power production option, and can be implemented relatively quickly.
- Well-managed biomass co-firing projects involve low levels of technical risk.
- In addition to the reduction of CO_2 emissions, biomass co-firing may also lead to reductions in the emissions of other pollutant species through the typically lower concentration of several undesired fuel components.

For the above reasons, Task 32 has concluded that in most instances, the co-firing of biomass in existing coal-fired boilers can provide an attractive approach to development of the biomass-to-energy capacity.

Prof. **Larry Baxter** (Brigham Young University, USA), presented an overview of options to cofire biomass in coal fired power plants. There is already a wealth of experience existent with cofiring various types of biomass in different types of coal power plants, using various cofiring concepts. He argued that from an energy resource utilization perspective, cofiring receives high credits since economies-of-scale factors enable use of certain plant efficiency features (e.g. higher steam pressures and temperatures, steam reheating features) at the scale these combustion installations typically operate. This makes that the typical biomass-to-electricity efficiency[1] is significantly higher for cofiring than for most of the other bio-electricity options.

From an economic point of view, cofiring biomass is typically more attractive than other renewable energy options. For a typical coal power plant with normal generation costs of 2 $\$¢/kWh_e$, generation costs (excluding any incentives) may vary between 2..5 $\$¢/kWh_e$ for biomass fuel with a price ranging from 0 to 40 $/ton. Although this is slightly higher than generation costs for coal, it is still cheaper than unsubsidised wind energy, which is typically about 5 $\$¢/kWh_e$ (depending on wind conditions).

On an LCA basis, cofiring biomass makes sense mainly for CO_2 arguments, however also SO_2 reduction plays an important role as the sulphur contents in biomass is usually negligible when compared with coal. On an LCA basis, biomass residues are favourable over dedicated energy crops as a cofiring fuel, because of the water and fertilizer needs of fast growing energy crops.

Over 40 USA based coal fired power plants now have experience with cofiring different biomass forms. The major technical challenges are associated with fireside issues such as formation of NO_x, ash deposition, carbon conversion, ash management and utilization and corrosion, however also fuel preparation and storage is usually an issue, however all of these issues depend on fuel used and boiler type. The demonstrations show that in a well designed cofiring scheme, all of the mentioned issues are resolvable.

Brett Corderoy (Delta Electricity, Australia) presented some of the experience Delta Electricity (a New South Wales territory generator) has gained with public perception issues associated with cofiring forest residues. Brett Corderoy was the Project Manager for the development stage of Delta's co-firing biomass, organising the tests, full-scale trials at the power stations, calculations re: energy/efficiency and trace metal limitations for wood based fuels and gaining relevant regulatory authority approvals. Co-firing is now a commercial operation within Delta Electricity. Delta cofires construction and demolition wood waste and fresh wood residues that are produced as a result of processing wood derived from commercial forest operations (softwood pine).

Although native forest residues are explicitly excluded from the fuels to be used[2], a number of NGO's were initially afraid that this was going to happen and have therefore started a very strongly and vocal media campaign, using posters, advertisements and internet. The negative impact of this media campaign on the public perception of cofiring results in a price for Renewable Energy Certificates for cofiring which is still about 10% lower than for other renewable energy options (this is also known as the 'dead Koala RECs problem[3]').

Delta Electricity now increasingly involves communities in the development of new projects. Although winning community support does not guarantee project approval or an absence of

[1] Reference is made to the efficiency based on a Higher Heating Value.
[2] As stated in the Commonwealth Regulatory Act of 2000 and the derived NSW Protection of the Environment Operations Act and Regulation, residues from native forest operations are not allowed to be cofired. This is being controlled with regular audits on fuel supply.
[3] REC stands for Renewable Energy Certificates. As in other countries, in Australia a trading scheme is used tot trade the renewable character of the electricity.

appeal from consent authorities, it provides more comfort and a more positive perception to these authorities.

One important issue that needed to be resolved in Australia was the adoption of a methodology for calculating the efficiency of the conversion of biomass to electricity when cofiring. Delta did not agree with the methodology initially proposed by the Regulator for calculating this fraction based on LHV as it did not fit with existing methods for coal efficiency using HHV. The Regulator allowed organisations, who could develop their own methodology to calculate the number of RECs generated, submit their method to the Regulator for review and approval prior to accrediting the power stations. Delta's methodology was accepted by the regulator administering the REC's for use at Delta power stations only. Other power stations co-firing have either developed their own method or used the method prescribed by the Regulator based on their requirements.

Fernando Preto is group leader biomass conversion at CANMET Energy Technology Centre - Ottawa, Canada. He presented the most important results from a recent study on opportunities for biomass cofiring in Canada. With about 27.000 MW of installed capacity, coal power has an important contribution to the electricity supply in Canada after hydropower (65,000 MW). However, in order to identify real opportunities for cofiring it is important to look at the availability of biomass in limited distance to the plant. In comparison to coal, biomass has a relatively low energy density and high collection and transportation costs. In the absence of any financial incentives associated with the renewable character of the fuel, it is hard to compete with coal. The study concludes that there is an actual cofiring potential of 343 MW_e in a total of 9 power plants. In the state of Ontario, there is no physical cofiring potential as all coal fired power plants will be enforced to shut down in 2007 due to environmental aspects.

Three fuel preparation scenarios were considered in the study:
1. A small char plant processing waste wood from a single source, such as a sawmill with a feed capacity of 100,000 BDt/y. The char is trucked to the coal-fired power plant.
2. A large central char plant processing wood waste from several sources in the forestry supply area with a feed capacity of 1,000,000 BDt/y. The char is trucked to the coal-fired power plant.
3. A large fluidized bed wood gasification plant located at the coal-fired power plant with a feed capacity of 1,000,000 BDt/y. The gas produced is fed to the coal-fired furnace.

At an assumed feedstock price of 0 Can$/GJ, the cost of delivered fuel for a distance of 140 km from source to power plant are 4.02, 6.19 and 4.69 Can$/GJ, respectively. This is significantly higher than the costs of coal, which are in the range of 0.6-2.4 CAN$/GJ. A premium of at least 7 CAN$¢/$kWh_e$ is required to make cofiring feasible at a biomass price of 41 $/g.m.t. The absence of such incentives makes it hard to implement cofiring schemes in Canada as done in other countries. Two initiatives from coal fired power plants to cofire biomass failed basically due to unfavourable economics and lack of policy incentives. The initiative of Ontario Power Generation (OPG) for co-firing at Thunder Bay GS was also affected by a lack of “public relations” benefits to co-firing cofiring.

As biomass cofiring is not yet exercised by the Canadian power companies, one cannot yet speak of a true ‘public perception’ as such. In general there is some opposition to biomass use, mainly due to the below reasons:

- The general public associates biomass in large part to years of high emissions from wood stoves and outdoor wood boilers. Environment Canada efforts focused on non-GHG emissions issues: PM, VOCs, dioxins, etc.
- Some public opposition is also present in cases of reverse co-firing for industrial installations, i.e. introducing coal to wood-burning systems.
- Electricity produced from the biomass part in a fuel mix used in a power plant is not considered as “Green” if the conversion process uses more than 15% fossil fuel energy. This is typically the case when cofiring biomass in a coal power plant. In order to qualify for “Green Electricity”, it also should come from a closed loop system, i.e., it is not “Green” if usually more attractive biomass residues are used. These definitions do not contribute to a positive opinion on biomass cofiring.
- There is a common perception in Canada that it is better to landfill waste than to burn it in an incinerator since MSW is not a controllable fuel and incineration may lead to unwanted emissions. There are a large number of trucks transporting MSW from Ontario to Detroit. It is therefore difficult to convey the message that burning biomass is good for the environment.

Considering the above situation, Canadian utilities recognise that co-firing is the best short-term solution to biomass utilization, however without a significant shift in either economics or policy/incentives efforts will remain at a low level.

Gabe Petlin (Green-E) commented on the earlier presentations and shared his personal views on the option of biomass cofiring. Green-E is an organisation involved in promoting the use of renewable energy in voluntary markets through the trade in renewable energy certificates. The group works with stakeholders from government, utilities, etc., who are represented in the governing board. In the overall renewable energy supply of approx. 17,000 MWe, the Green-E trading scheme covers approx. 1,500 MWe.

The list of renewable energy forms that are part of the Green-E trading scheme does include energy from biomass, however only in stand-alone power systems. Cofiring biomass with coal is therefore not (yet) part of this scheme.

In order to be included in the Green-E trading scheme, cofiring biomass will have to be considered by the stakeholders of Green E on several aspects. Green-e has no reason to oppose co-firing. Main arguments that could support certification of cofiring as one of the renewable energy forms eligible under the trading scheme, are
- emission benefits
- improving economics
- policy support
- the availability and demand for renewable energy

With regard to emission benefits, it is realised that it may be difficult to assess the real emission reduction that can be achieved by cofiring and determine the true amount of renewable electricity that is generated from the biomass fuel, keeping in mind that both coal and biomass have fluctuating heating values and the efficiencies of the same plant for both fuels may be different. On these aspects a lot can be learned from European countries where such exercises have already been done.

Considering the efforts required in establishing a certification procedure for biomass cofiring, Green-E will only start the design of such a certification scheme once it is commercially done. Green-e is willing to explore options with Task 32 for preparation of information materials on cofiring.

Paul Craig explained the position of the Sierra Club with regard to biomass cofiring. Sierra Club is one of the largest environmental NGO's in the USA. Paul Craig is member of the Sierra Club National Committee on Global Warming and Professor Emeritus of Engineering at the University of California.

Sierra Club recognizes that the world energy system needs to change drastically. The need for such an energy transition can be illustrated by peaking oil prices; however it could take at least 50 years to change the energy system to more sustainable pathways. Sierra Club pays particular attention to environmental aspects, while economic aspects are considered of minor importance.

Sierra Club recognizes that there is a communication problem with conveying the concept of co-firing. Many people are against coal power plants in general, so even replacement of coal with biomass carries a negative image if it is done in a traditional coal fired power plant.

However, Paul Craig concluded from the presentations held by the other speakers in the workshop that substitution of coal with biomass can be an attractive option for large scale, short term implementation of renewable energy if the following criteria are met:

- Cofiring should be done in existing coal power plants only, it should not be an excuse to build new coal power plants.
- Considering the negative environmental impacts associated with the growing phase of many fast growing energy crops, biomass residues constitute the preferable group of fuels.

Sierra Club recognizes that not all forms of renewable energy have the same environmental impact, but these could vary in effect and duration. When developing new renewable energy projects, generators should therefore compare and convey the downsides with the advantages as well as comparing alternatives. In the past, some power plants have had a negative attitude towards some environmental groups, however in order to establish and maintain credibility, it is important to recognise mistakes and assume that NGO's are equal partners in discussions.

In order to obtain a positive public opinion it is crucial to inform the general public with references and objective information material that is also easily understandable. There seems to be a clear role for the IEA as independent recognized organisation to transfer such objective knowledge. Sierra Club indicated that it would appreciate to work with Task 32 in preparing such information material (policy guidance documents) and educating its members on different aspects of biomass cofiring.

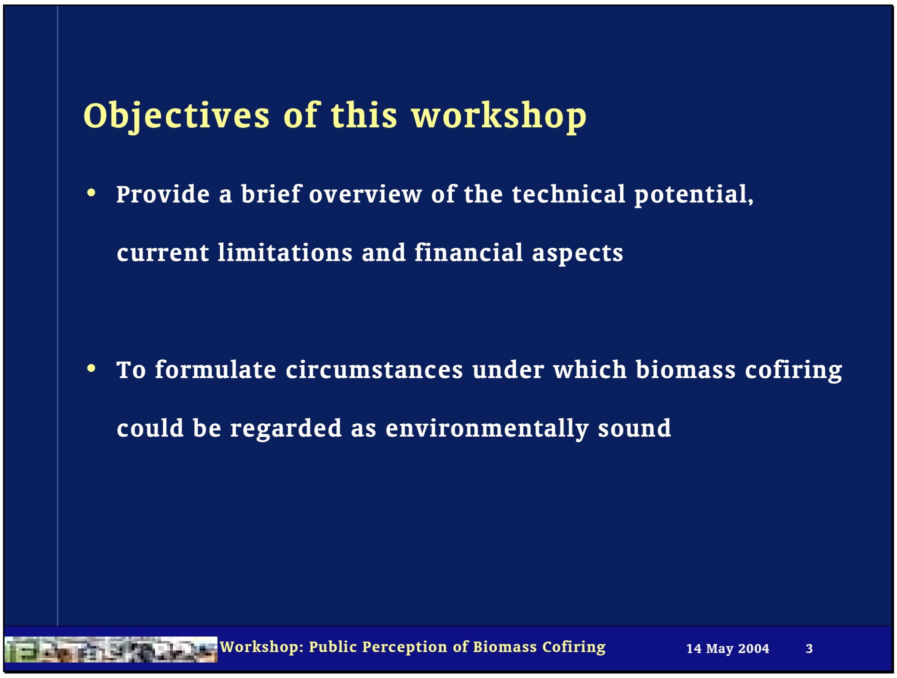
Finally, Paul Craig stated that generators should look at long term or "intergenerational" trade-offs, often accepting short-term cost for long-term benefit.

After the presentations a **discussion** took place amongst the audience. It was argued that for many people it is easy to misunderstand the benefits of cofiring because it is associated with coal. Public support for cofiring however remains crucial for further development of the biomass to energy capacity. The example from Australia shows that internet campaigns from opposing environmental groups (even when based on misunderstandings) have had a very negative impact on public opinion and the price of renewable energy certificates originating from bioenergy.

The participations in the workshop agreed that new coal plants should never be justified solely on the basis that they can co-fire biomass, however other arguments may justify the construction of new coal fired power plants (such as a mismatch between demand for energy and availability of renewable energy including biomass, reliability of the electricity grid, cost of energy supply, dependency on import of fuels, etc.). In cases where it is decided that a new coal power plant is going to be constructed anyway because of such reasons, then it makes sense to seriously consider co-firing biomass right from the start as an environmental benefit.

Utilities present at the meeting indicated that generators are more sensitive towards economic aspects than environmental impacts of cofiring. It should therefore be translated into adequate financial incentives. They also showed their willingness to corporate with the NGO’s present on dissemination of information in an adapted way.

Annex 1. Welcome and introduction (Sjaak van Loo)



Workshop Agenda

Time	Topic	Speaker(s)
11:00	Welcome and introduction	Sjaak van Loo, IEA Task 32
11:10	Cofiring concepts and comparison with other renewable energy options	Larry Baxter, BYU, USA
11:35	Public perception/relations issues of cofiring	Brett Corderoy, Delta Electricity, Australia
12:00	A review of cofiring initiatives in Canada	Fernando Preto, Canmet, Canada
12:25	Summary	Sjaak van Loo
12:30	*Lunch break*	
13:30	Comments from NGO's and Discussion	Sierra Club, Union of Concerned Scientists, Green-e
14:45	Formulation of joint statement	
15:15	Conclusion	Sjaak van Loo, IEA Task 32
15:30	Closing	

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Observations by Task 32

- Biomass co-firing has been demonstrated successfully in more than 150 installations worldwide, for most combinations of fuel and boiler type.
- The electrical conversion efficiencies for the biomass, when co-fired in coal-fired plant, are similar to those for the coal, i.e. they are significantly higher than those for small, dedicated biomass power plants based on similar energy conversion technologies.

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Observations by Task 32

- Co-firing in existing coal-fired boilers is, in almost all cases, the lowest cost biomass power production option, and can be implemented relatively quickly.
- Well-managed biomass co-firing projects involve low levels of technical risk.
- In addition to the reduction of CO_2 emissions, biomass co-firing may also lead to reductions in the emissions of other pollutant species.

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Opinion of IEA Bioenergy Task 32

In most instances,
the co-firing of biomass in existing coal-fired boilers
provides an attractive approach to
nearly every aspect of
the development of biomass-to-energy capacity

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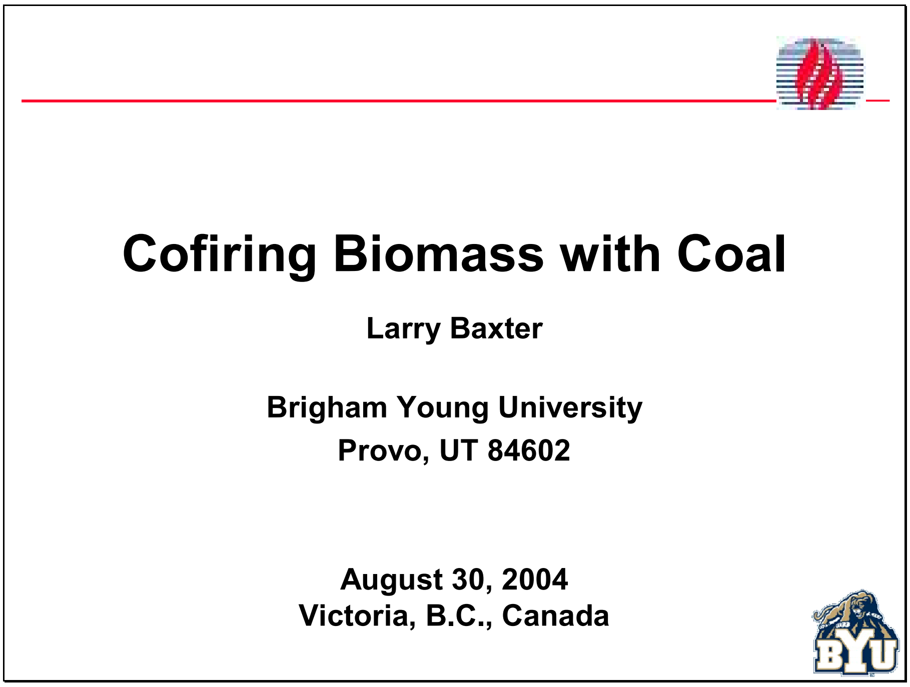
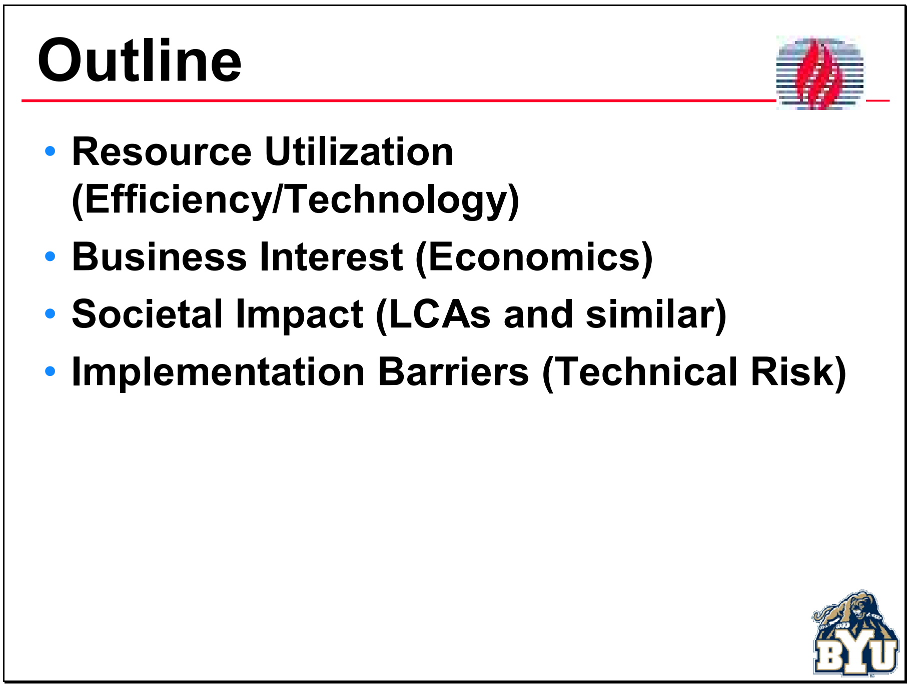
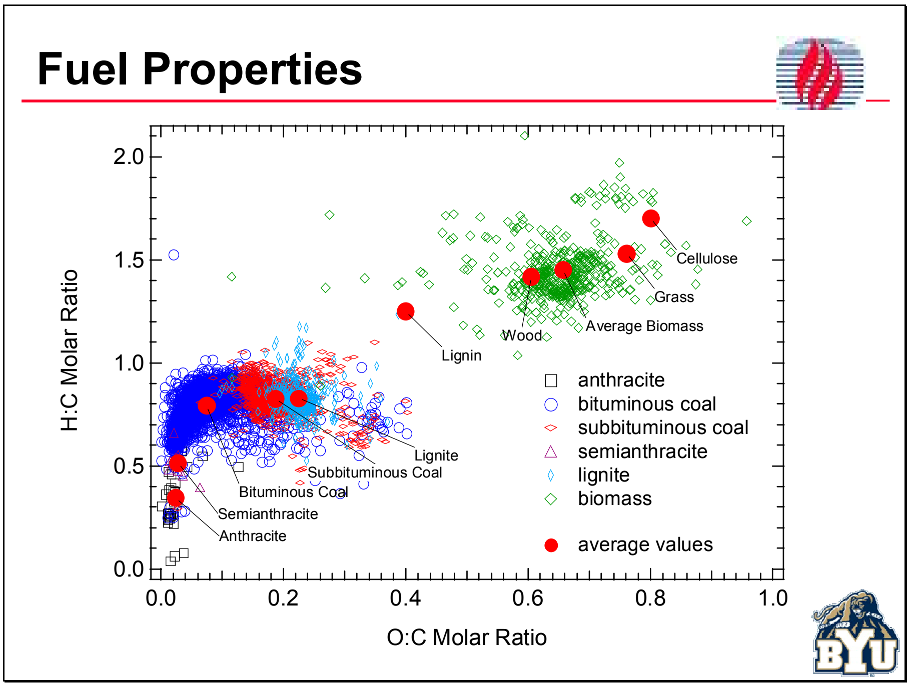
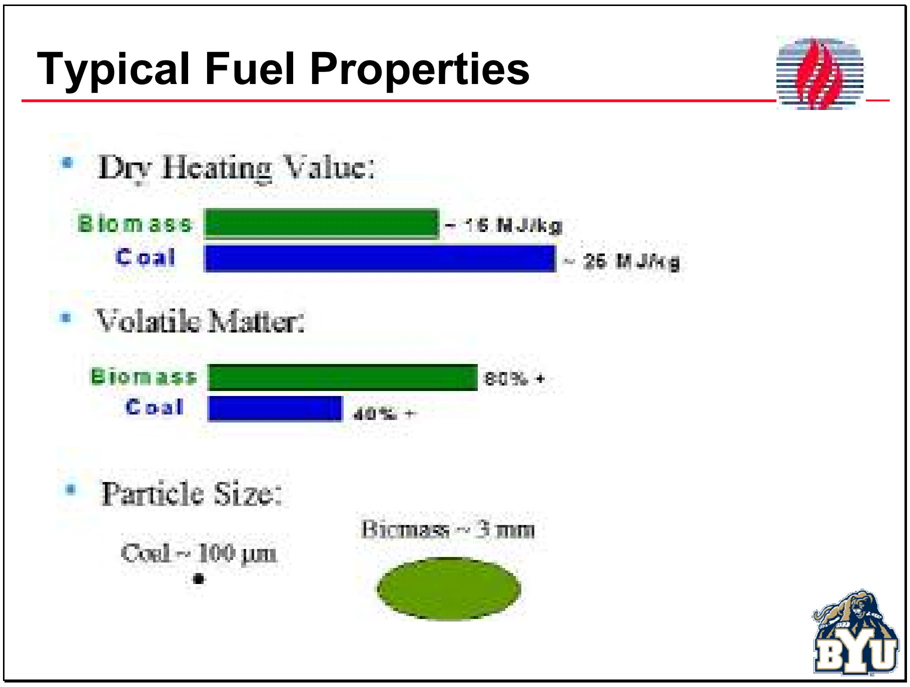
Annex 2. Cofiring concepts and comparison with other renewable energy options (Larry Baxter, Brigham Young University, USA)

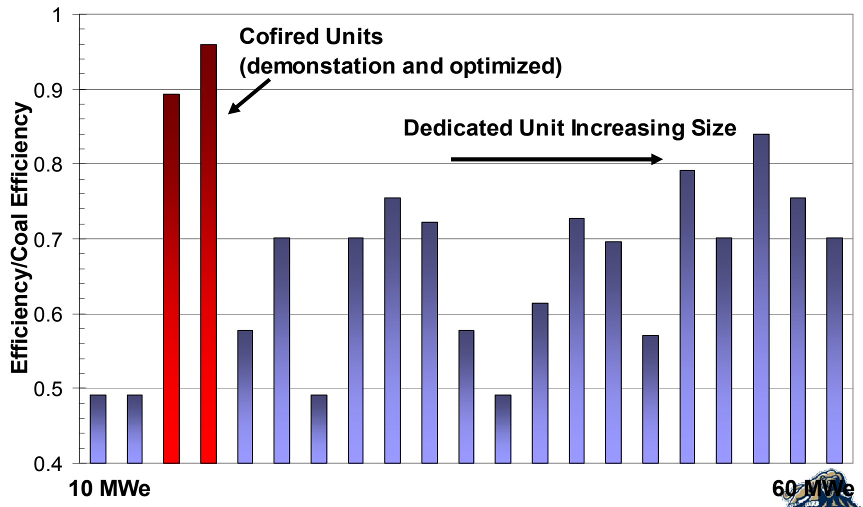




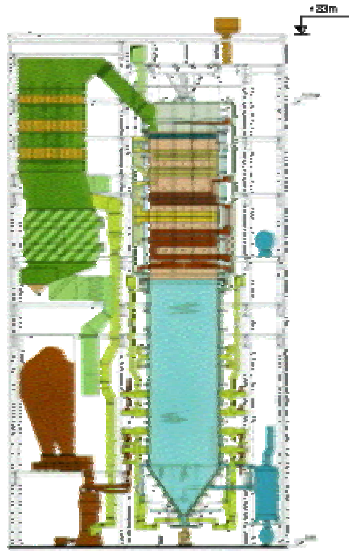

Fuel Properties
H:C Molar Ratio
O:C Molar Ratio
2.0
1.5
1.0
0.5
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Cellulose
Grass
Average Biomass
Wood
Lignin
Lignite
Subbituminous Coal
Bituminous Coal
Semianthracite
Anthracite
anthracite
bituminous coal
subbituminous coal
semianthracite
lignite
biomass
average values
BYU


Typical Fuel Properties
Dry Heating Value:
Biomass
~ 15 MJ/kg
Coal
~ 25 MJ/kg
Volatile Matter:
Biomass
80% +
Coal
40% +
Particle Size:
Coal ~ 100 μm
Biomass ~ 3 mm
BYU

Biomass Cofring Best Uses Resource

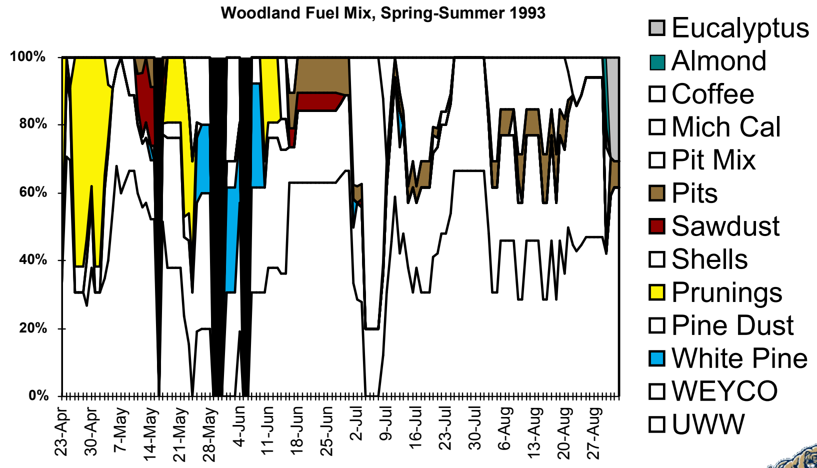


Modern coal fired boiler

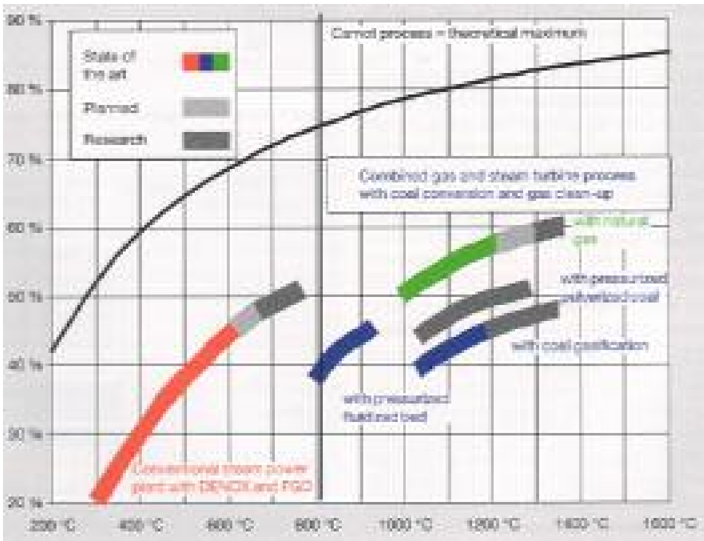


From, Babcock Borsig

Commercial Fuel Mix Varies

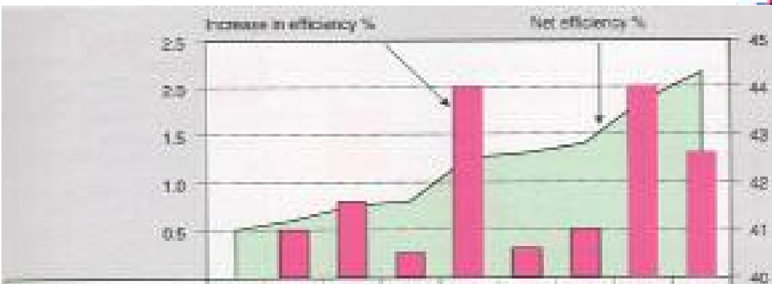


Effect of variables to efficiency



From, Benesch, 2001

Effect of variables to efficiency

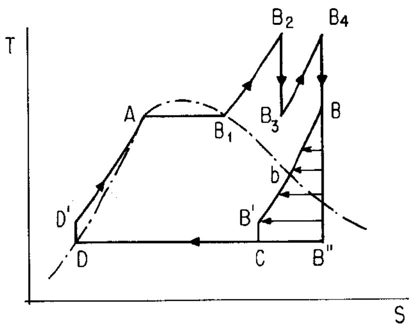


Efficiency	%	41.0	41.2	41.5	41.6	42.5	42.8	42.8	43.7	44.3
Improvement	%	0	0.5	0.8	0.25	2.0	0.3	0.5	2.0	1.3
Main steam pressure	bar	250	250	250	250	250	300	300	300	300
Feedwater temperature	°C	280	280	280	280	280	280	300	300	300
Main steam temperature	°C	530	530	540	540	540	540	540	580	580
Reheater steam temperature	°C	540	540	560	560	560	560	580	600	600
Condenser pressure	bar	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.04
Waste gas temperature	°C	130	130	130	125	125	125	125	125	125
Others	%	0	0	0	0	2	2	2	2	2

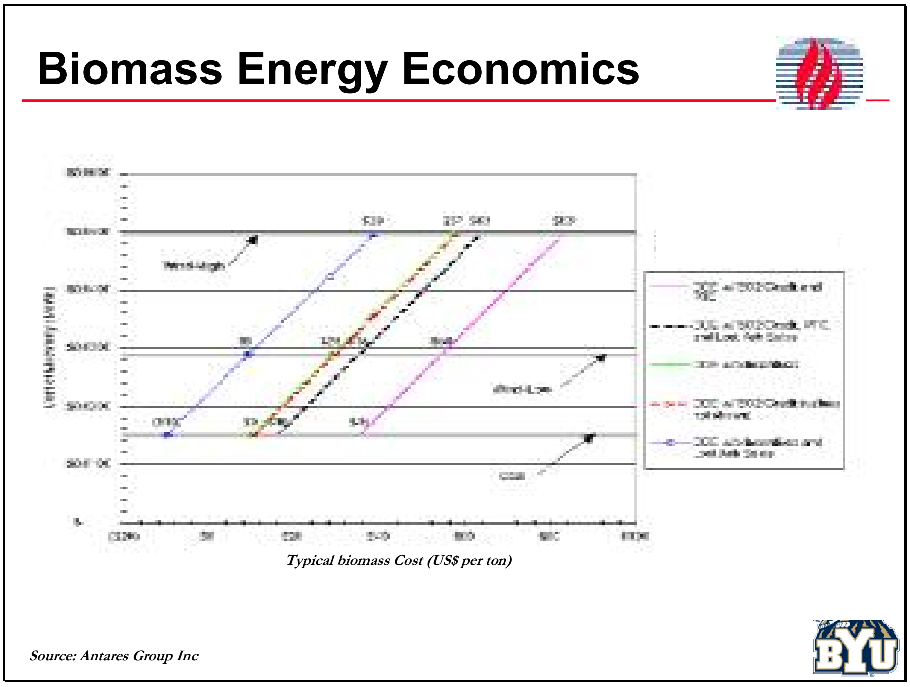
From, Benesch, 2001

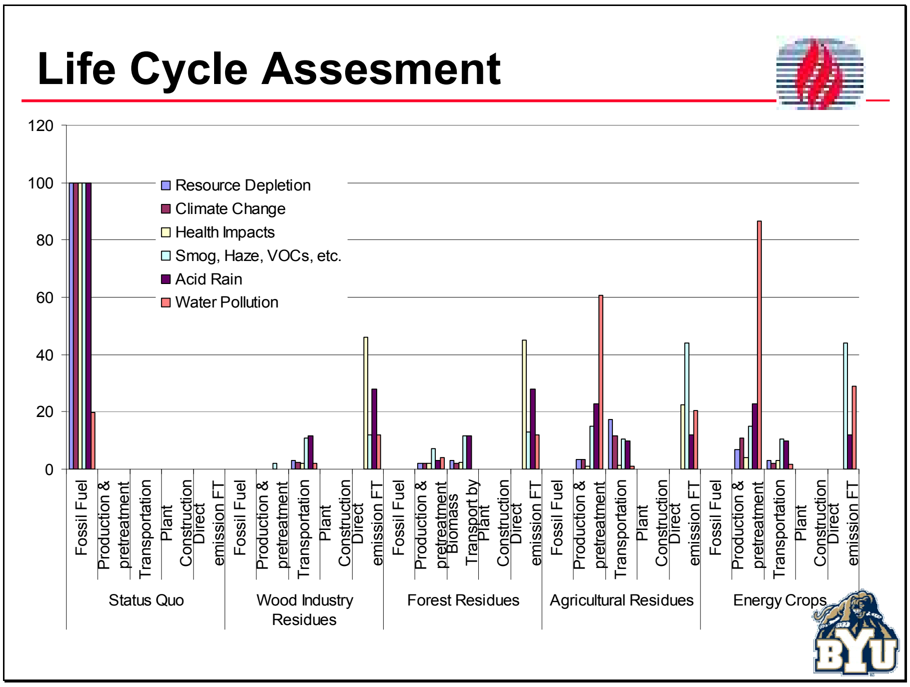
Reheat Cycle

- In quest to increase efficiency to 40 % reheat cycles became popular
- After first expansion B_2 - B_3 a new superheat B_3 - B_4
- Steam from final expansion B - B´ used to preheat D ´ - A



From, Bidard and Bonnin, 1979


Biomass Energy Economics
Typical biomass Cost (US$ per ton)
Source: Antares Group Inc


Life Cycle Assesment
120
100
80
60
40
20
0
Resource Depletion
Climate Change
Health Impacts
Smog, Haze, VOCs, etc.
Acid Rain
Water Pollution
Fossil Fuel
Production & pretreatment
Transportation
Plant Construction
Direct emission FT
Biomass Transport by Plant
Status Quo
Wood Industry Residues
Forest Residues
Agricultural Residues
Energy Crops

US Cofiring Experience

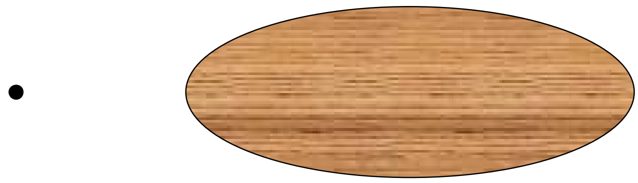
- Cofiring conducted in over 40 commercial boilers since 1989. A few recent examples
  - Bailley – 475 MW_e cyclone – wood and pet coke
  - Willow Island – 188 MW_e cyclone – wood & tires
  - Seward/Albright – 150 MW_e t-fired – wood
  - Gadsden – 70 MW_e t-fired – switch grass
  - Ottumwa – 725 MW_e t-fired – switch grass
  - Dunkirk – 100 MW_e t-fired – wood (poplar)
  - Greenidge – 110 MW_e t-fired – wood residue

Major Technical Cofiring Issues

- Fireside Issues
  - Pollutant Formation
  - Carbon Conversion
  - Ash Management
  - Corrosion
- Balance of Process Issues
  - Fuel Supply and Storage
  - Fuel Preparation
  - Ash Utilization

Recent work indicates all issues are resolvable, but there are poor combinations of fuel, boiler, and operation.

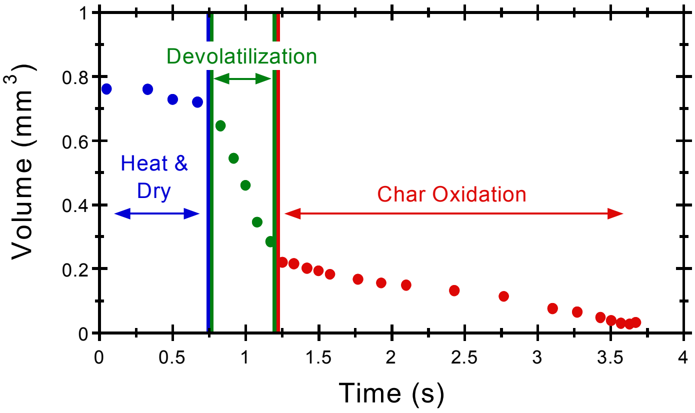
Carbon Burnout

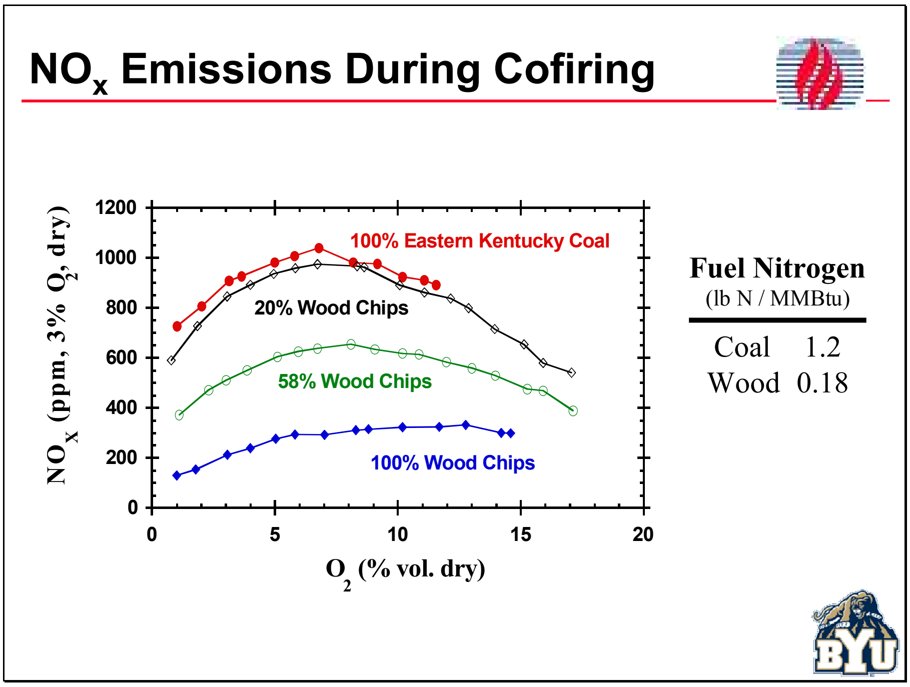


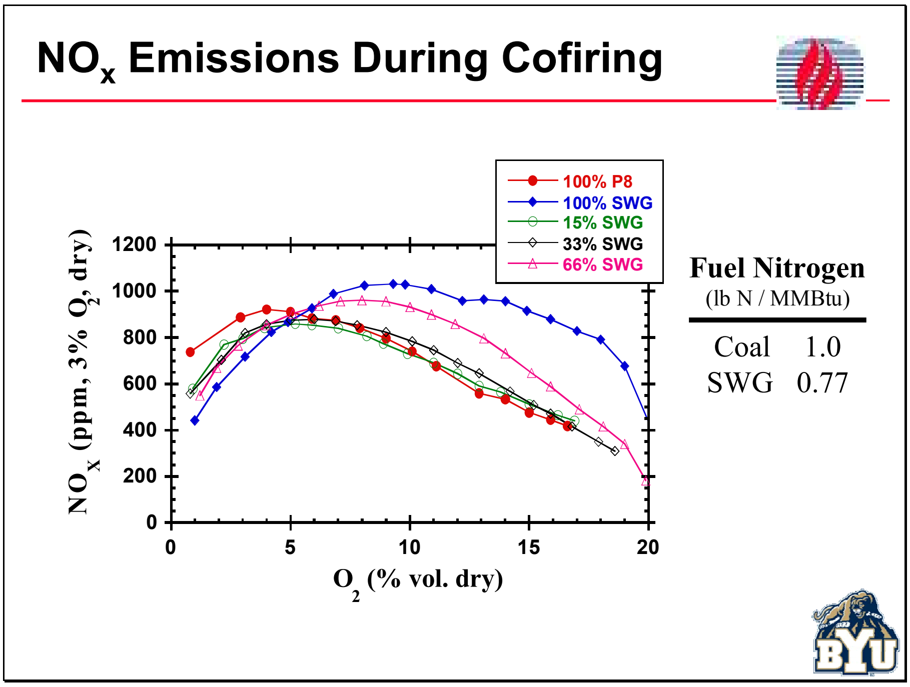
Pulverized Coal Particle
~ 100 µm

Biomass Particle
1 mm x 3 mm +

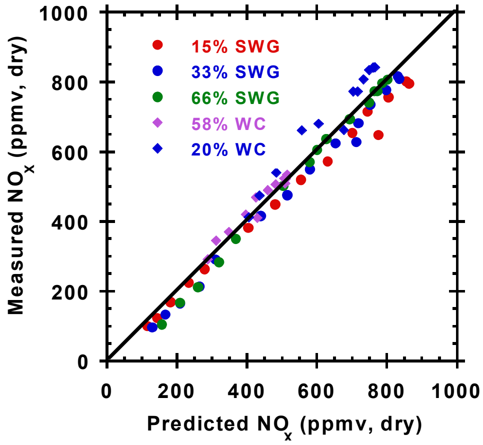
Combustion History: Switchgrass



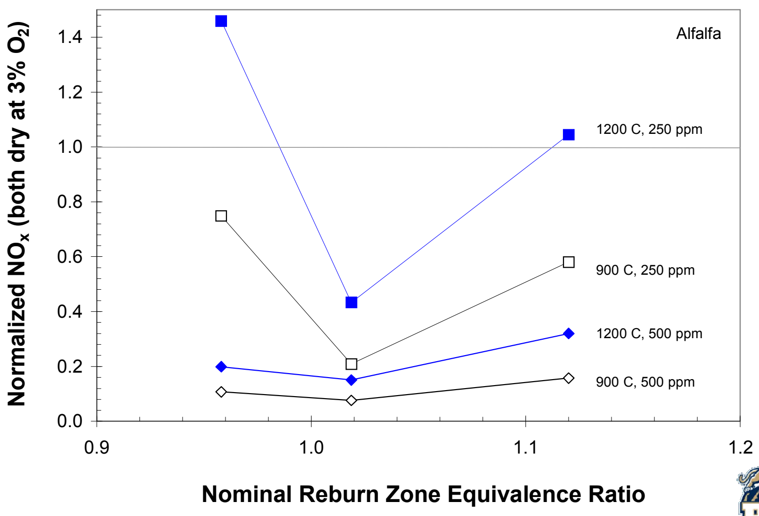

NOx Emissions During Cofiring
NOX (ppm, 3% O2, dry)
1200
1000
800
600
400
200
0
0
5
10
15
20
O2 (% vol. dry)
100% Eastern Kentucky Coal
20% Wood Chips
58% Wood Chips
100% Wood Chips
Fuel Nitrogen
(lb N / MMBtu)
Coal 1.2
Wood 0.18


NOx Emissions During Cofiring
100% P8
100% SWG
15% SWG
33% SWG
66% SWG
NOX (ppm, 3% O2, dry)
1200
1000
800
600
400
200
0
0
5
10
15
20
O2 (% vol. dry)
Fuel Nitrogen
(lb N / MMBtu)
Coal 1.0
SWG 0.77

NO_x Emissions



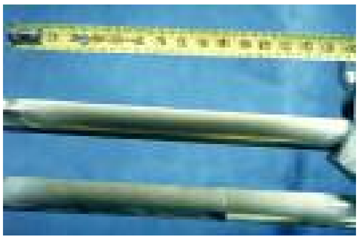
Stoichiometry & Temperature



Cofiring Deposition

1

3



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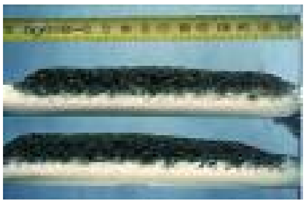
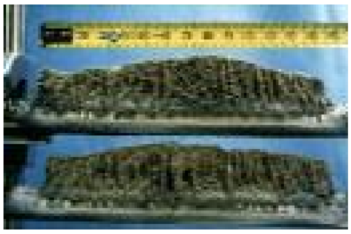
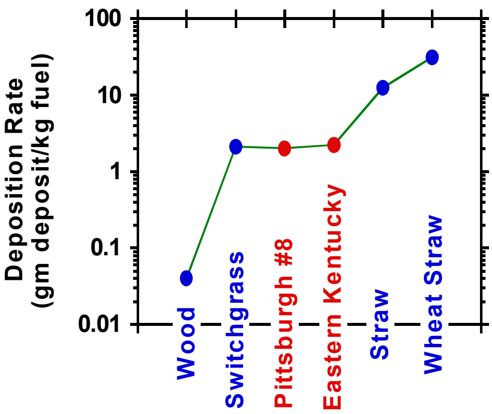


4



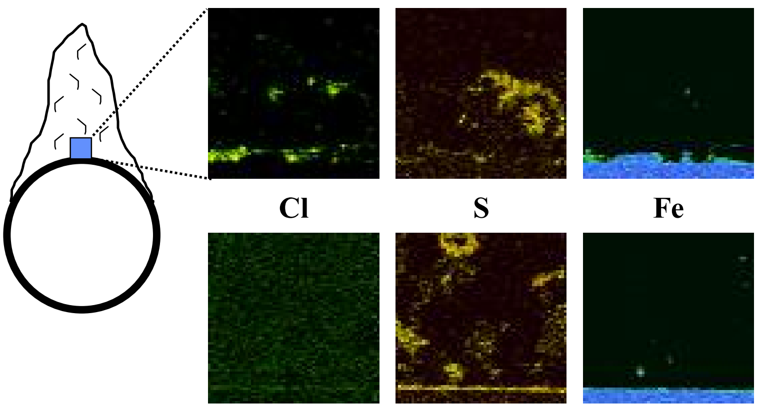
Deposition Rates Vary Widely

- Cofiring biomass can lead to either decrease or increase in deposition rates.
- Cofiring decreases deposition relative to neat fuels.



Cofiring Mitigates Corrosion

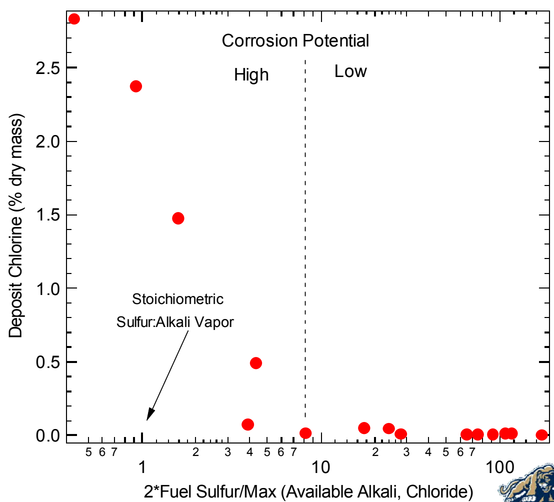
100% Imperial Wheat Straw



85% E. Kentucky 15% Wheat Straw

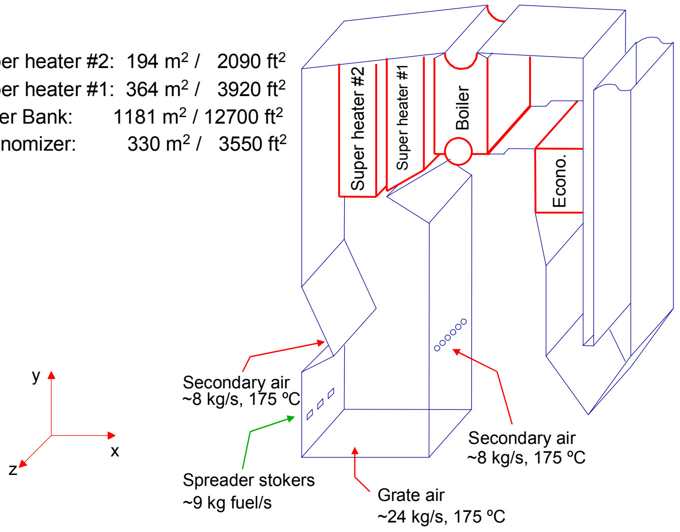
Chlorine-based Corrosion

- **Deposit chlorine content near zero for most commercially relevant biomass-coal blends.**
- **Fuel-based index predicts deposit chlorine content.**

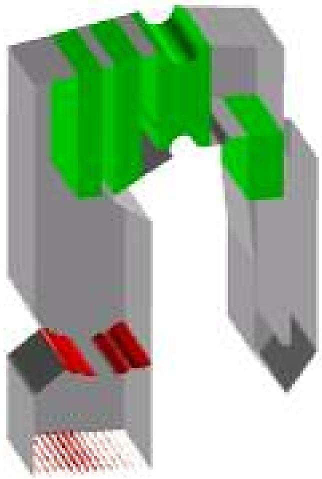


Stoker: Geometry

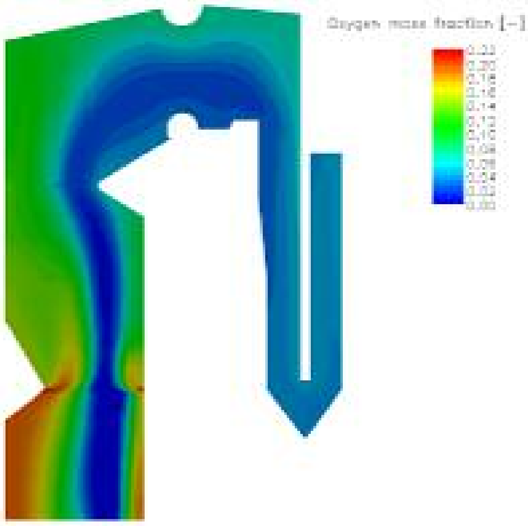
Super heater #2:	194 m² /	2090 ft²
Super heater #1:	364 m² /	3920 ft²
Boiler Bank:	1181 m² /	12700 ft²
Economizer:	330 m² /	3550 ft²



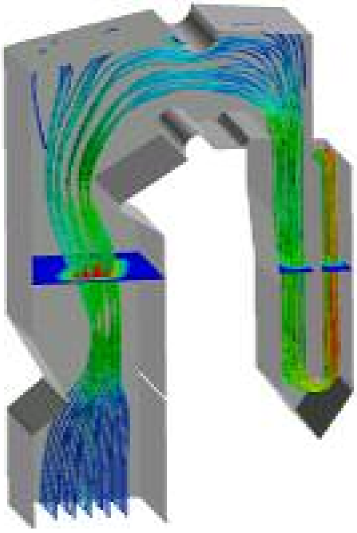
Outline of CFD model



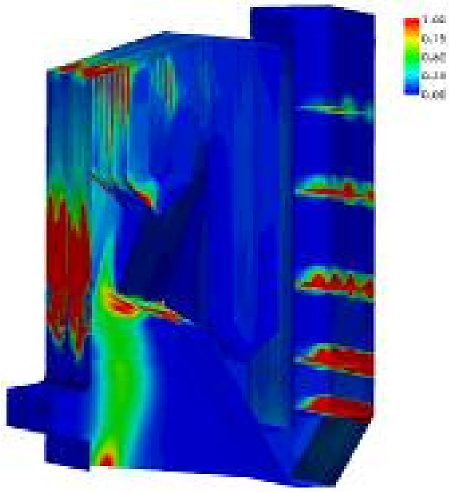
Oxygen Contours



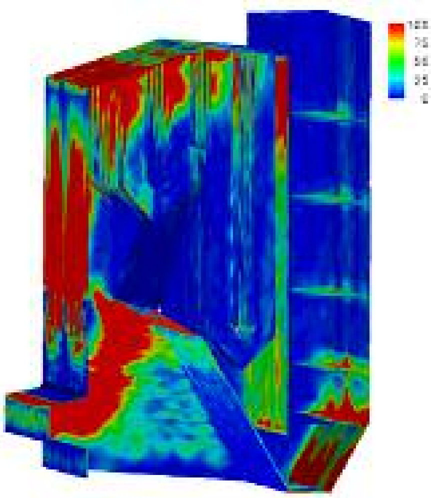
Particle Transport

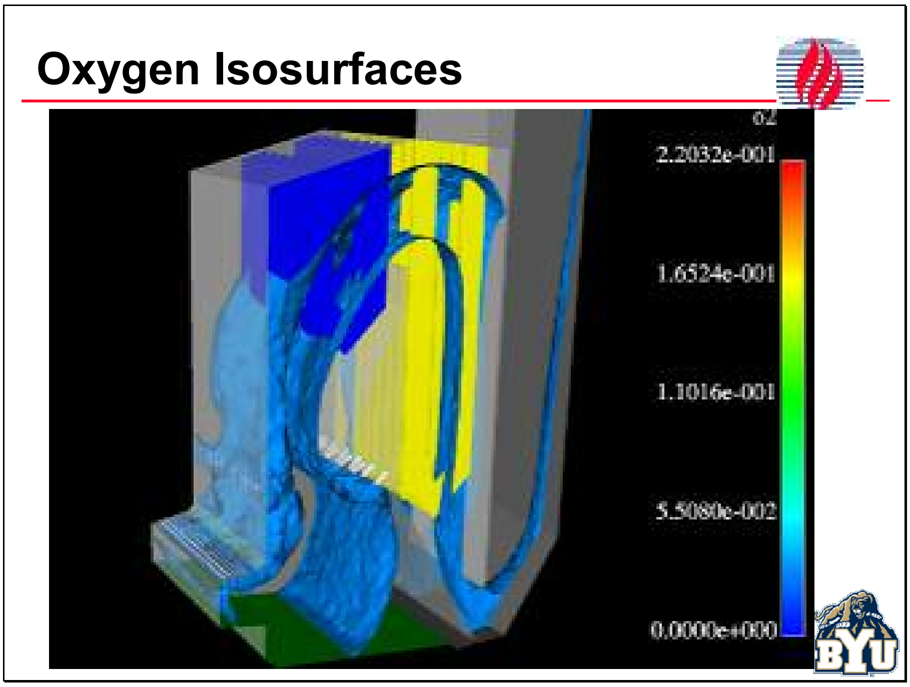


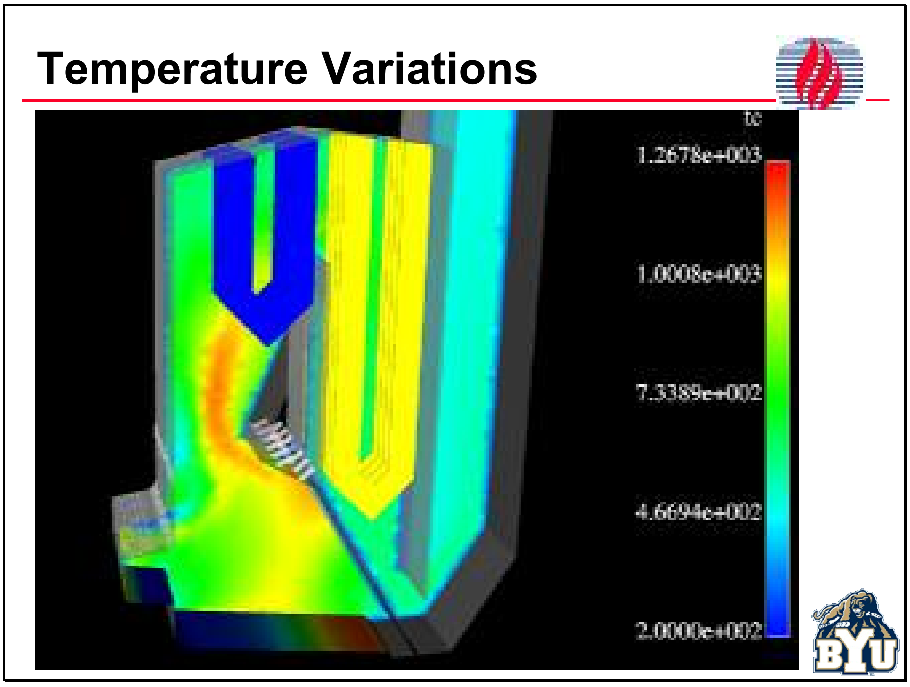
Initial Deposition Rates Vary



Temporal Deposition Variation




Oxygen Isosurfaces
o2
2.2032e-001
1.6524e-001
1.1016e-001
5.5080e-002
0.0000e+000
BYU


Temperature Variations
tc
1.2678e+003
1.0008e+003
7.3389e+002
4.6694e+002
2.0000e+002
BYU

Conclusions

- Fuel Selection
  - Wood fuels are attractive
    - Potential for reduced NO_x emissions
    - Slight decrease ash deposition rates
  - Herbaceous fuels (straw) more problematic
    - Increased ash deposition rates
    - Interactions within the deposit
- Carbon Burnout
  - Predictions indicate big (> 1/4 inch) biomass particles may not burnout

Conclusions (cont')

- NO_x Formation
  - Usually reduction in NO_x when cofiring wood.
  - Herbaceous, fertilized fuels offer less reduction, possibly increase.
  - Volatile yield and aerodynamics offer potential additional NO_x reductions.
- Corrosion
  - Chlorine in deposits can be minimized by increasing gas sulfur content.

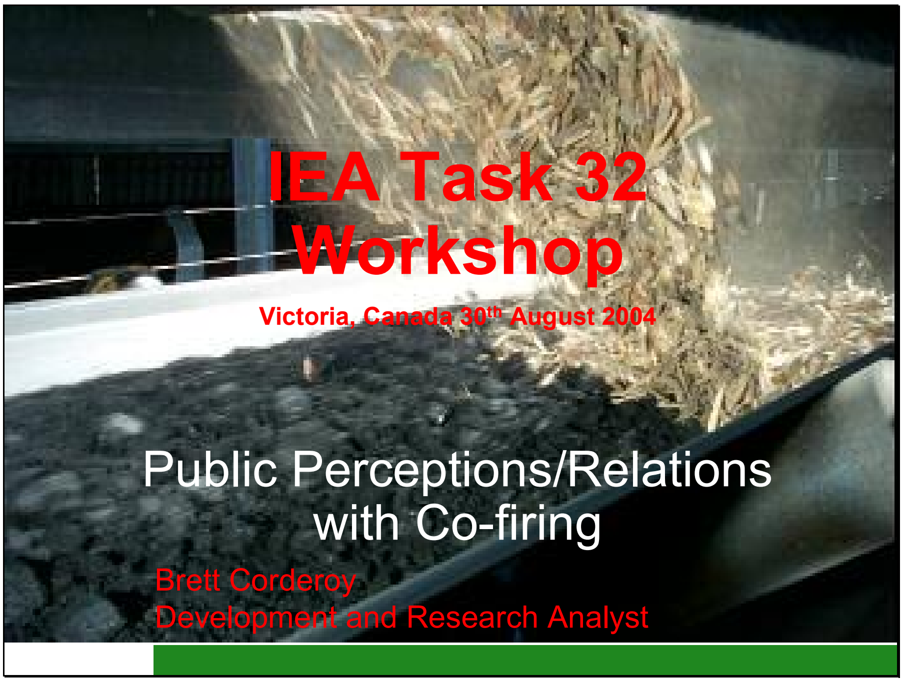
Conclusions (cont')

- Ash Deposition
  - Usually reduction in deposition when cofiring wood.
  - Potentially large increase in ash management problems when cofiring herbaceous fuels, especially those with high alkali, chlorine, and ash contents.
  - Deposit chemistry reflects interactions between coal and wood.

Acknowledgements

- Work sponsored by US DOE through the Office of Energy Efficiency and Renewable Energy's Biomass Power Program. Portions were performed while PI was at Sandia National Laboratories and portions were performed under contract to the National Renewable Energy Laboratory.
- The authors are grateful for the laboratory assistance of Gian Sclippa and the supervisory contributions of Don Hardesty (Sandia) and Kevin Craig (NREL).
- Many of the results illustrated are based on work initiated at Sandia National Laboratories by the same authors.

Annex 3. Public perception/relations issues of cofiring (Brett Corderoy, Delta Electricity, Australia)



Delta electricity

BIOENERGY Australia

Members of Task 32

Alstom	Power generation Manufacture, construction, commissioning company
CSIRO	Research
WMAA EfW	potential fuel suppliers
Delta Electricity	NSW Generator
Stanwell	Qld Generator
CS Energy	Qld Generator

Australian co-firing status

Legislative Framework

Commonwealth

Renewable Energy Act 2000 & Regulations 2001

The Act and Regulation defines the eligible renewable energy sources

Native Biomass for electricity generation is **not** allowed as the primary purpose of harvesting

Audit of fuel supplies and quantities

State Legislation

NSW Protection of the Environment Operations Act and Regulation

Native forest bio-material is not to be used for electricity generation

Records Must be kept

Audit of fuel sources and quantities

Regulators

Commonwealth Regulator; Office of the Renewable Energy regulator, ORER.

Accreditation, REC registration, Audit of process. Large fines

NSW Department of Environment and Conservation (EPA) administers the POEO Regulation. Also Regulator for operating licence

Delta electricity

NSW EPA

Co-firing fuel types
- Softwood Pine plantation (Non-native)
- Construction and demolition wood waste

Need to satisfy EPA that community is protected.
- Tonnes of fuel biomass relative coal
- Control and Assurance of fuel supply quality
- Trails and emission tests

Licence changes to allow co-firing = 12months

Delta electricity

Public Relations and Perception

NSW National Parks (4.9 million hectares or 12.1M acres)

no forestry operations allowed.

Delta electricity

NSW State forests (2.9 million hectares or 7.2M acres) forestry operations legal under Commonwealth and State legislation.

State Forests native hardwoods	2.2M Ha
Softwood plantations	212,000 Ha
Hardwood plantations	57,000 Ha
Crown Lands forest	1M Ha
Private holdings with forests	8.6M Ha
Leasehold	9.5M Ha

Native Biomass for electricity generation is **not** allowed as the primary purpose of harvesting

Delta electricity

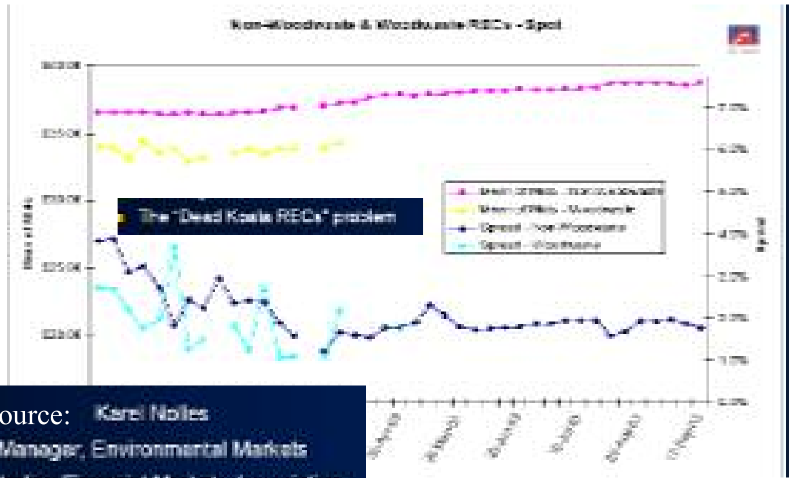
Construction and demolition wood waste and Municipal Green Waste

National and State

NGO. Initial campaign strong and vocal.

BIOMASS NEWSLETTER April 2000 Edition No. 1
NCCNSW Forest Campaign; http://nccnsw.org
TAKE ACTION AGAINSY NATIVE FOREST BIOMASS
What is Biomass energy?
Biomass and CO2
Potential for a Whole New Market for Woodchips
Who is Promoting Forestry Biomass and Why?
What is Being Burnt and Where Does it Come From?
Make sure your electricity is sustainable
More Information and contact details

Impact on REC Price for Biomass



Source: Karel Nolles
Manager, Environmental Markets
Australian Financial Markets Association
September 2003

http://www.ergo.ee.unsw.edu.au/Nolles_EMA_Miami_presentation.pdf

Delta electricity

Local

Delta Electricity; Two regions

NSW Central Tablelands; heavy industry, Rural to semi rural,

NSW Central Coast; rapid population growth, tourism, heavy industry

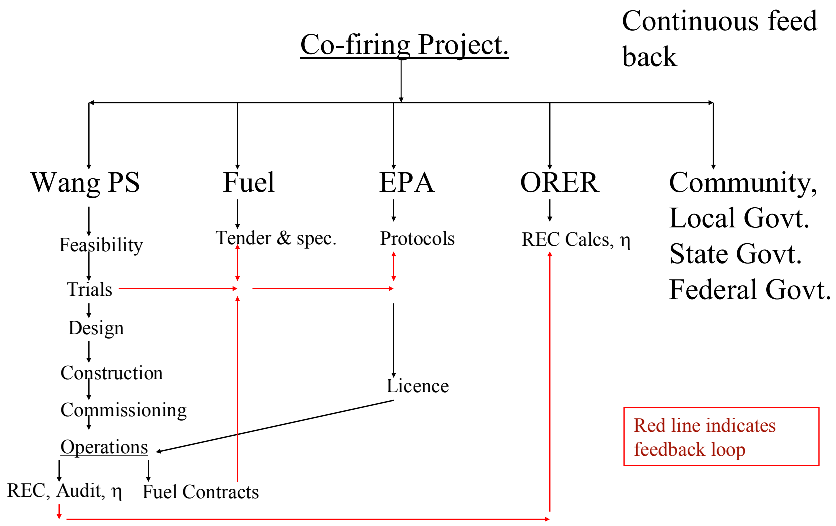
Issues; What is Biomass and co-firing

Quantity of fuel

Extra vehicle movements (managed by curfew)

Quality of fuel (EPA licence requirements)

Delta electricity



Delta electricity

Consultation Objective

Maximise potential for project approval by consent authority

Winning community support does not guarantee:

- project approval
- an absence of appeal

Winning community support allows for

- comfort to consent authority
- positive perception of project

Delta electricity

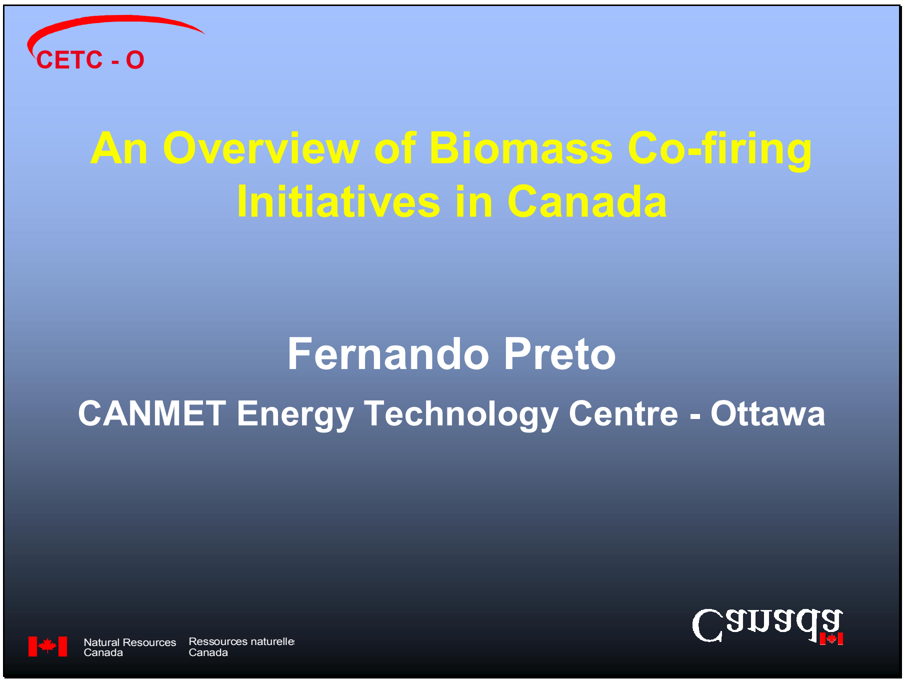
Delta Experience

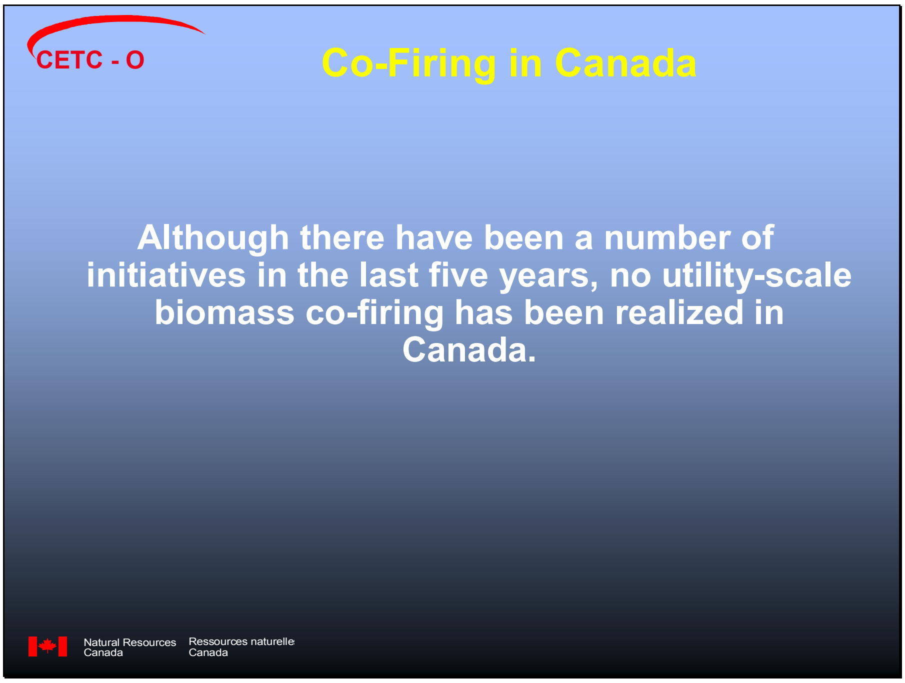
Summary

Co-firing

- EPA "consent authority"
- within existing operations
- incinerator perception
- transport concern
- existing consultation forums
- legislative requirements
- regulator requirements
- community support essential

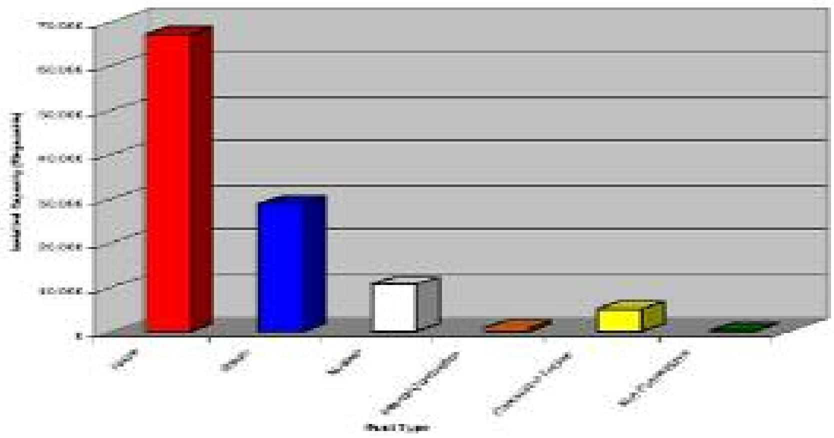
Annex 4. A review of cofiring initiatives in Canada (Fernando Preto, Canmet, Canada)





CETC - O

Power Generation in Canada



Natural Resources Canada   Ressources naturelle Canada

CETC - O

Basis for CANMET/TEAM Initiative (1999)

- Combustion of wood waste for power generation and steam raising is widely practiced but not in electric utilities for both practical and economic reasons
- Biomass fuels have typically high moisture and low energy density which limits transport distances
- Economics of scale works against construction of small plants
- Pulverized coal fired plants have limits to how much biomass can be fired (~10%) without comprehensive fuel handling and feeding retrofits.
- Incentives: No carbon taxes or incentives in Canada
- Needed: Methods to co-fire with minimal equipment retrofit

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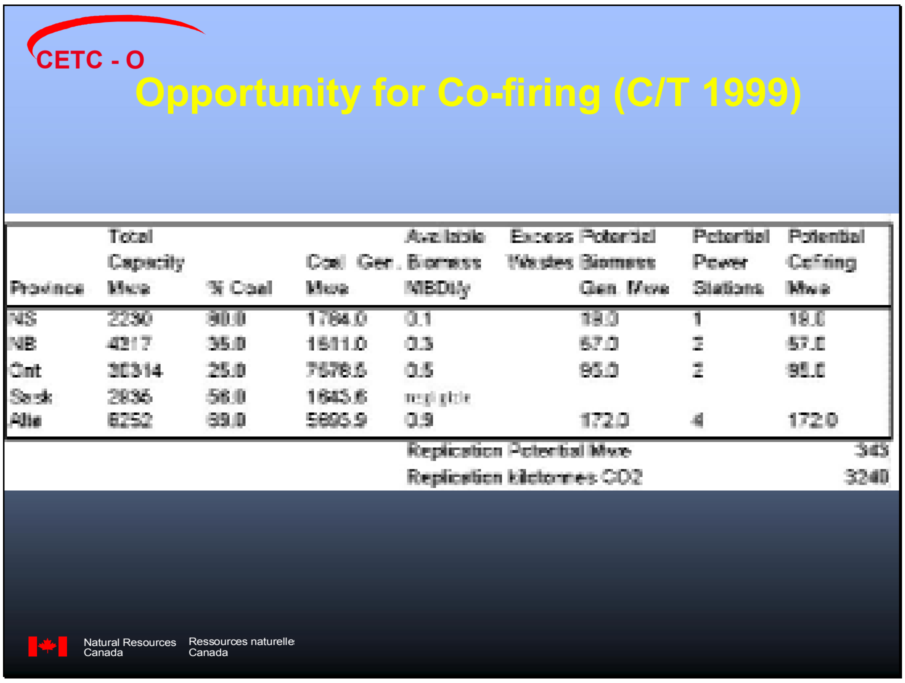
CETC - O
Opportunity for Co-firing (C/T 1999)

Province	Total Capacity Mwe	% Coal	Coal Gen. Mwe	Available Biomass MBDt/y	Excess Wastes	Potential Biomass Gen. Mwe	Potential Power Stations	Potential Cofiring Mwe
NS	2230	80.0	1784.0	0.1		19.0	1	19.0
NB	4217	35.0	1611.0	0.3		57.0	2	57.0
Ont	30314	25.0	7578.5	0.5		95.0	2	95.0
Sask	2836	58.0	1645.6	negligible				
Alta	6252	89.0	5695.9	0.9		172.0	4	172.0
				Replication Potential Mwe				343
				Replication kilotonnes CO2				3240

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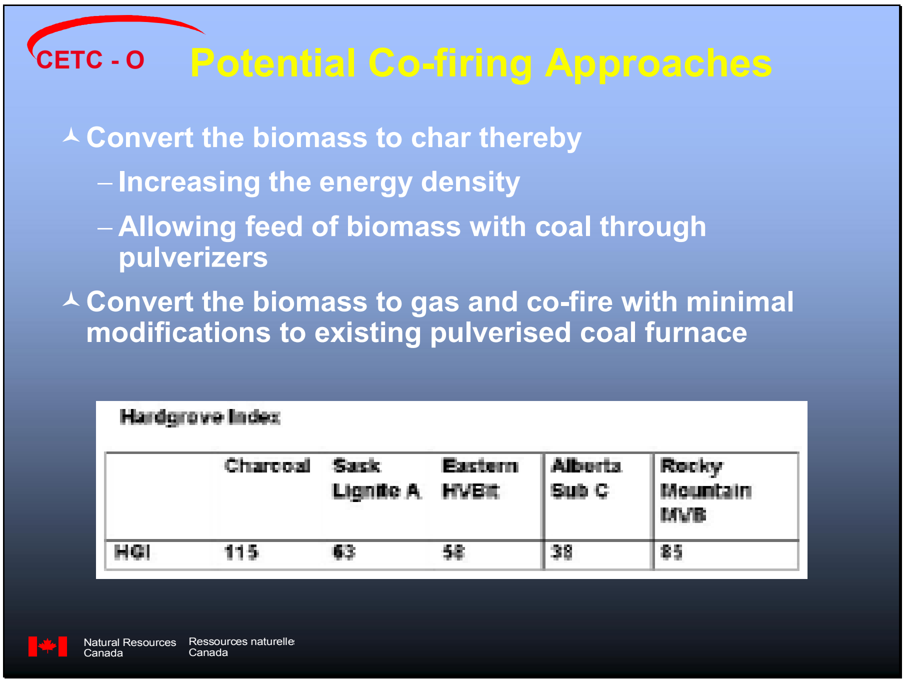
CETC - O
Potential Co-firing Approaches
Convert the biomass to char thereby
– Increasing the energy density
– Allowing feed of biomass with coal through pulverizers
Convert the biomass to gas and co-fire with minimal modifications to existing pulverised coal furnace
Hardgrove Index

	Charcoal	Sask Lignite A	Eastern HVBit	Alberta Sub C	Rocky Mountain MVB
HGI	115	63	58	38	85

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Ressources naturelle Canada

CETC - O

Charcoal Suitable as Coal Replacement

Comparative Proximate Analyses (As Fired)

	Units	Charcoal #I	Sask Lignite A	Eastern HVBit	Alberta Sub C	Rocky Mountain MVBit
Moisture	Wt %	3.13	35.7	8.3	25.1	9.0
Ash	Wt %	1.68	9.9	6.4	11.6	12.0
Volatile Matter	Wt %	12.26	24.5	31.6	26.6	23.0
Fixed Carbon	Wt %	82.93	29.9	53.7	36.7	54.0
HHV	BTU/lb	13818	6590	13116	7645	12400

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Stage 1: Economics

- To estimate probable cost range for three case studies for biomass supply via:
  - small local char plant
  - large central char plant
  - on-site gasifier (FBC) plant

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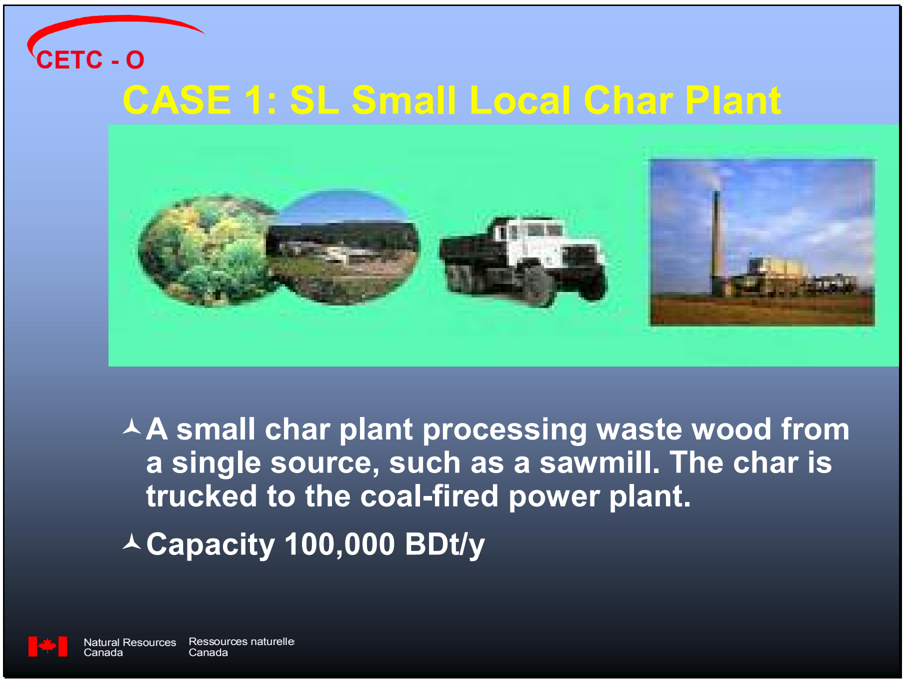
CETC - O
CASE 1: SL Small Local Char Plant
A small char plant processing waste wood from a single source, such as a sawmill. The char is trucked to the coal-fired power plant.
Capacity 100,000 BDt/y
Natural Resources Canada
Ressources naturelle Canada


CETC - O
CASE 2: LC Large Central Char Plant
A large central char plant processing wood waste from several sources in the forestry supply area. The char is trucked to the coal-fired power plant.
Feed Capacity 1,000,000 BDt/y
Natural Resources Canada
Ressources naturelle Canada

CETC - O

CASE 3: OG On-Site Gasifier (FBC) Plant

- A large fluidized bed wood gasification plant located at the coal-fired power plant. The gas produced is fed to the coal-fired furnace.
- Feed Capacity 1,000,000 BDt/y

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CETC - O

Range of Costs for Biomass

		Energy Cost $/GJ		
Transport km	Feedstock/gmt	Raw Fuel	Char	FB Gasifier
0.00	-0.50	-0.05	-0.04	-0.05
20.00	7.00	0.75	1.16	0.88
140.00	41.15	4.02	6.19	4.69

Based on survey of various pulp mills
Feedstock prices include transport
Most common price is approx. $7/gmt delivered
Cost of harvesting and transporting scrub timber approx. $40/gmt

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CETC - O

Range of Cost of Coal, $/GJ

	Sub-Bituminous	Bituminous
	Low	High
Cost of Coal	0.64	2.05
O&M Prep	0.00	0.08
O&M Ash	-0.02	0.12
SO2 Control	0.00	0.12
Total	0.62	2.37

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CETC - O

Incremental Cost of Biomass Co-firing

	Credit Required c/kWh		
Biomass Cost	SR	LC	OG
Free	1.5		
$7/gmt	3	1.1	0.3
$41/gmt	12.6	9.6	7.1

A large plant, in this case an On-site Fluid Bed Gasifier offers the least expensive option for significant biomass co-firing

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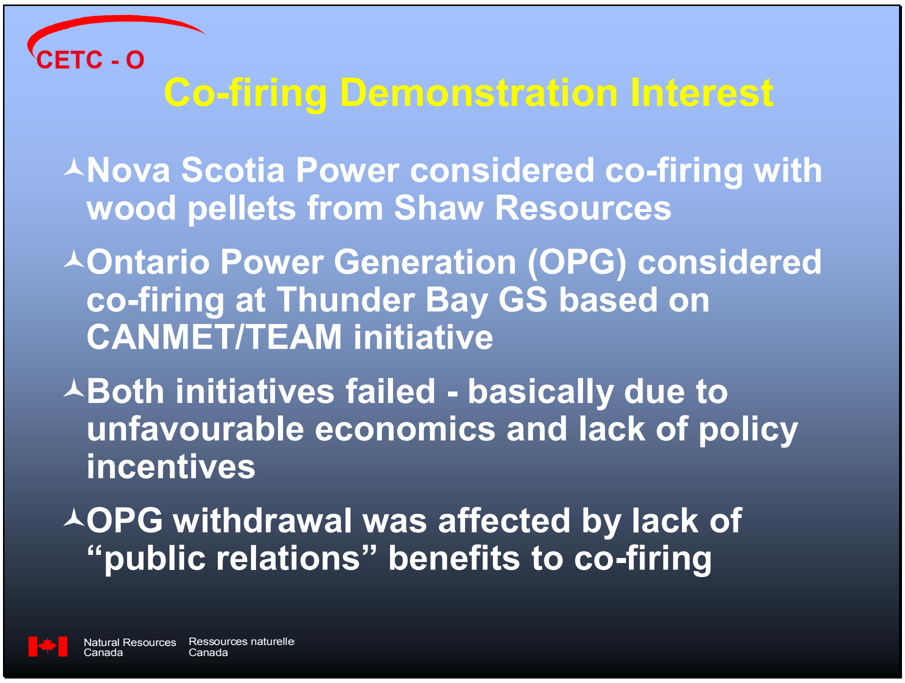
CETC - O
Co-firing Demonstration Interest
Nova Scotia Power considered co-firing with wood pellets from Shaw Resources
Ontario Power Generation (OPG) considered co-firing at Thunder Bay GS based on CANMET/TEAM initiative
Both initiatives failed - basically due to unfavourable economics and lack of policy incentives
OPG withdrawal was affected by lack of "public relations" benefits to co-firing
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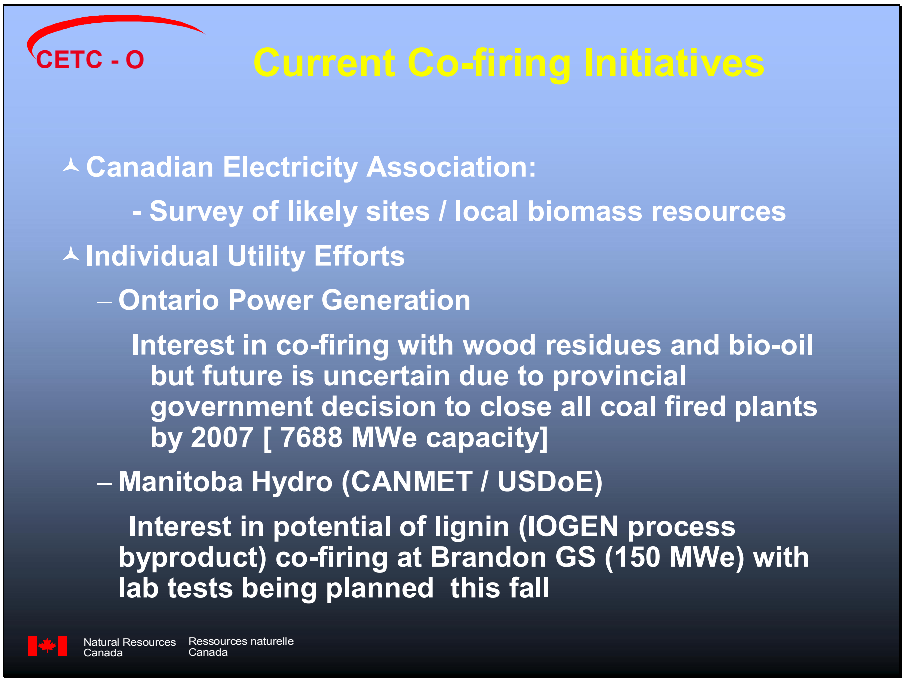
Ressources naturelle Canada


CETC - O
Current Co-firing Initiatives
Canadian Electricity Association:
- Survey of likely sites / local biomass resources
Individual Utility Efforts
– Ontario Power Generation
Interest in co-firing with wood residues and bio-oil but future is uncertain due to provincial government decision to close all coal fired plants by 2007 [7688 MWe capacity]
– Manitoba Hydro (CANMET / USDoE)
Interest in potential of lignin (IOGEN process byproduct) co-firing at Brandon GS (150 MWe) with lab tests being planned this fall
Natural Resources Canada
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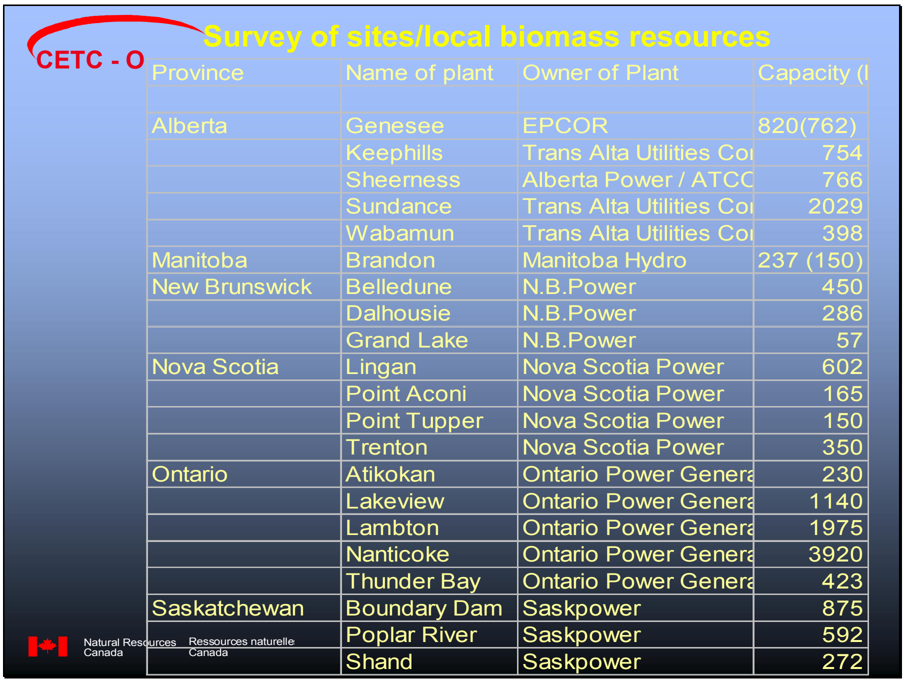
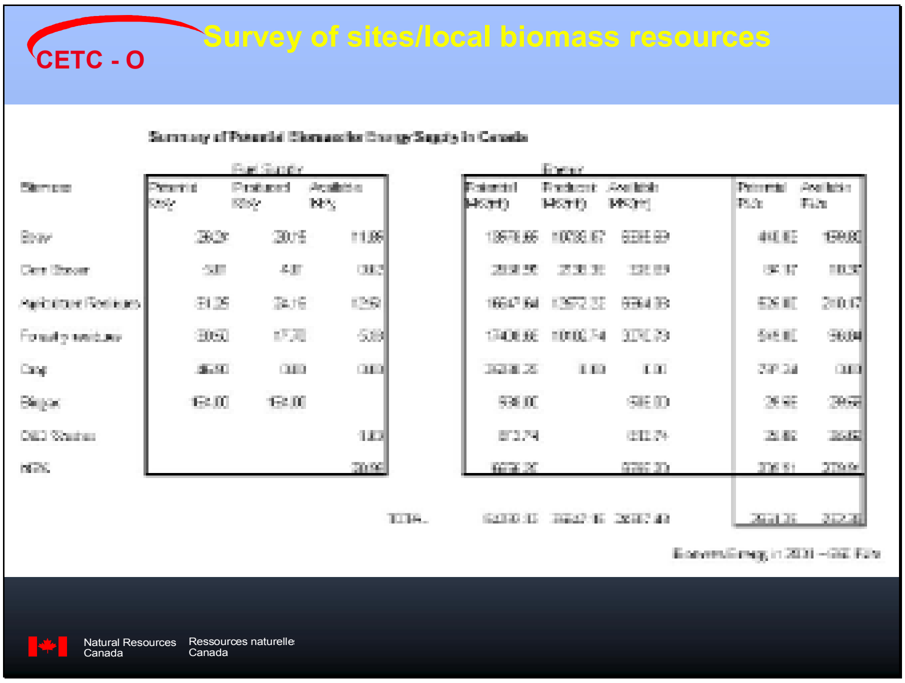


Province	Name of plant	Owner of Plant	Capacity (I
Alberta	Genesee	EPCOR	820(762)
	Keephills	Trans Alta Utilities Co	754
	Sheerness	Alberta Power / ATCC	766
	Sundance	Trans Alta Utilities Co	2029
	Wabamun	Trans Alta Utilities Co	398
Manitoba	Brandon	Manitoba Hydro	237 (150)
New Brunswick	Belledune	N.B.Power	450
	Dalhousie	N.B.Power	286
	Grand Lake	N.B.Power	57
Nova Scotia	Lingan	Nova Scotia Power	602
	Point Aconi	Nova Scotia Power	165
	Point Tupper	Nova Scotia Power	150
	Trenton	Nova Scotia Power	350
Ontario	Atikokan	Ontario Power Genera	230
	Lakeview	Ontario Power Genera	1140
	Lambton	Ontario Power Genera	1975
	Nanticoke	Ontario Power Genera	3920
	Thunder Bay	Ontario Power Genera	423
Saskatchewan	Boundary Dam	Saskpower	875
	Poplar River	Saskpower	592
	Shand	Saskpower	272



CETC - O

Public Perception of Co-firing

- Co-firing as such has no “public perception” as such
- In general there is some opposition to biomass use due in large part to years of emissions from wood stoves and outdoor wood boiler
- Environment Canada efforts focused on non-GHG emissions issues: PM, VOCs, dioxins
- Some public opposition in case of reverse co-firing for industrial installations, I.e. introducing coal to wood-burning systems.

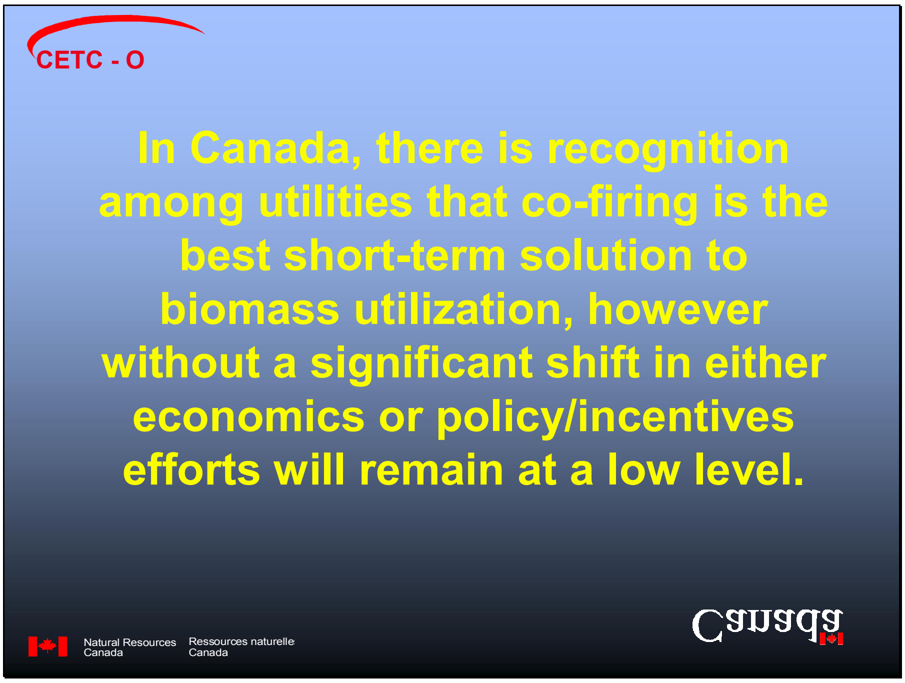
Natural Resources Canada   Ressources naturelle Canada

CETC - O

“Green Electricity” Designations
(Under Discussion)

- Electricity is not considered as “Green” if the conversion process uses more than 15% fossil fuel energy
- “Green Electricity” only if it comes from a closed loop system, I.e., not “Green” if use a waste stream

Natural Resources Canada   Ressources naturelle Canada


CETC - O
In Canada, there is recognition among utilities that co-firing is the best short-term solution to biomass utilization, however without a significant shift in either economics or policy/incentives efforts will remain at a low level.
Natural Resources Canada
Ressources naturelle Canada
Canada