

White Earth & Chisago, Isanti, Pine Counties Biofuels Feasibility Studies*

Joint projects with the University of Minnesota

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The Charge:

Conduct **economic and technical feasibility** of;

- 1) Biofuels or bioenergy demonstration plant using existing resources in WE and CIP regions.
- 2) Developing, harvesting, and marketing native prairie plants and seeds for bioenergy production in the WE region & the capacity of the seed bank at Wild River State Park to expand existing prairie grass plantings in the CIP region.

The focus areas:

- 1) **How much** biomass resource present and future.
- 2) **Cost** of biomass and environmental impact
- 3) Best technologies for **converting biomass to fuels or energy**

Methodology

1. Quantify Biomass

- **Gather** grassland and brushland **field data** Fall 2007 & 2008.
- **Utilize published data** for agricultural residue and forest biomass.
- Develop **Crop Productivity Index(CPI)** to predict future yields.
- Determine **sustainable biomass supply potential** for WE & CIP regions.
- Identify **source of seed** necessary for new prairie plantings.

Methodology

2. Cost of Biomass

- Develop **crop selection model** with biomass price as output that **incorporates crop yields, production costs** (including shipping & handling) for various crop choices.
- **Farmer decides** on crop selection and/or residue harvest **based on highest annual return.**
- Determine **impact on environment, wildlife habitat & water quality.**

Methodology

3. Conversion of biomass to fuels or energy

- Evaluate combined heat & power platforms and biomass fuel pellets as special cases.
- Evaluate biochemical and thermochemical cellulosic biomass conversion platforms for liquid fuels that could be technically viable within the next 4-8 years.
- Utilize techno-economic models based on as much “real” data as possible.
- Determine economic viability based on IRR (Internal rate of return) and NPV (Net Present value).

Biomass Supply

- Agricultural residues
 - Corn stover
 - Wheat straw & other small grains
- Forest Biomass
- Grasslands
- Brushlands

Theoretical ethanol yields if all existing cellulosic biomass was sustainably harvested and converted to ethanol.

Issues

- Forest biomass has a long regeneration cycle compared to grasses and agricultural residues.
- Removal of even 25% of wheat straw will require incremental fertilizer to replace depleted nutrients and increased erosion is likely.

Realism

- Forest biomass should be restricted to about 10% of total sustainable removal rate. Merchantable timber has higher value uses.
- Brushland too small for harvest costs. Lowlands difficult to harvest.

	White Earth		CIP	
	As delivered tons WE	Ethanol potential Million gal./year	As delivered tons CIP	Ethanol potential Million gal./year
Grasses @ 15% moisture	340,000	25	440,000	33
Corn Stover @ 15% moisture	453,000 @ 50% removal	33	175,000	16
Wheat straw @ 15% moisture	890,000 @ 25% removal	33	X	X
Forest biomass @ 50% moisture	1,500,000 @ 2 ton/acre green	72	1,500,000	72
Brushlands @ 50% moisture	30,000 @ 2 ton/acre green	3	50,000	5
Total		166		126

Adjusted theoretical ethanol conversion capacity from existing cellulosic biomass when harvested sustainably

	White Earth		CIP	
	As delivered tons WE	Ethanol potential Million gal./year	As delivered tons CIP	Ethanol potential Million gal./year
Grasses @ 15% moisture	340,000	25	440,000	33
Corn Stover @ 15% moisture	453,000 @ 50% removal	33	141,000	14
Wheat straw @ 15% moisture	890,000 @ 25% removal	33	X	X
Forest biomass @ 50% moisture	786,000 @ 0.2 ton/acre green	7	778,000 @ 0.2 ton/acre	7
Total		Reduce from 166 to 98		Reduce from 126 to 54

A word about the cost of biomass.

- **Cost often stated without specifying moisture content. (Like comparing grapes to raisins).**
- **Initial governmental work from the '90's often quoted without updating for current market conditions.**
- **Costs often quoted on a *farm gate* basis. Should be *plant gate* or delivered basis.**
- **Opportunity cost often not applied to new forms of biomass.**
- **Inputs such as fertilizer, cultivation, harvesting, etc. often understated.**

Cost of Biomass - Crop Selection Model

Developed by Steve Taff and Victor Gauto, Applied Economics Dept.

Model determines the price /supply relationship with respect to factors such as crop yields, full production costs, and shipping and handling to the conversion plant gate.

The basic algorithm is: if the price offered by a bioenergy plant is high enough, a field's owner will grow the desired feedstock.

The model assumes that landowners are deciding which crop to grow, not whether they want to stay in business.

Example: Select between corn/corn stover and low-fertilization grasses.

Delivered volume in (thousands of tons @ 15% moisture) with biomass @ \$76 ton

Corn price \$/bu.	Corn stover	Low-fert. grass
2	0	3834
4	26	3834
6	2265	45

Grass @ \$76 beats corn @ \$4 and stover @ \$76.

Corn @ \$6 and stover @ \$76 beats grass @ \$76

Base case for \$4 corn.

Aside from profit are there other factors that come into play when crop selections change?

Changes in crop cover causes changes in

- Bare soil exposure
- Evapo-transpiration rates
- Rainfall infiltration and runoff
- Commercial fertilizer use

These in turn impact environmental factors such as:

- Water pollution of streams, lakes and groundwater
- Green house gas emissions
- Soil sedimentation
- Wildlife habitat

While there are not yet sufficient data available to be very quantitative some general direction can be gleaned from **“Minnesota Land Economics”**, <http://landeconomics.umn.edu>

Compared to annual crops, grasses have:

- Erosion factors only 5% of annuals
- Nitrogen losses of 2 lbs/acre vs. 10 lbs./acre
- CO₂ sequestration 1.6 metric tons per acre greater than annuals

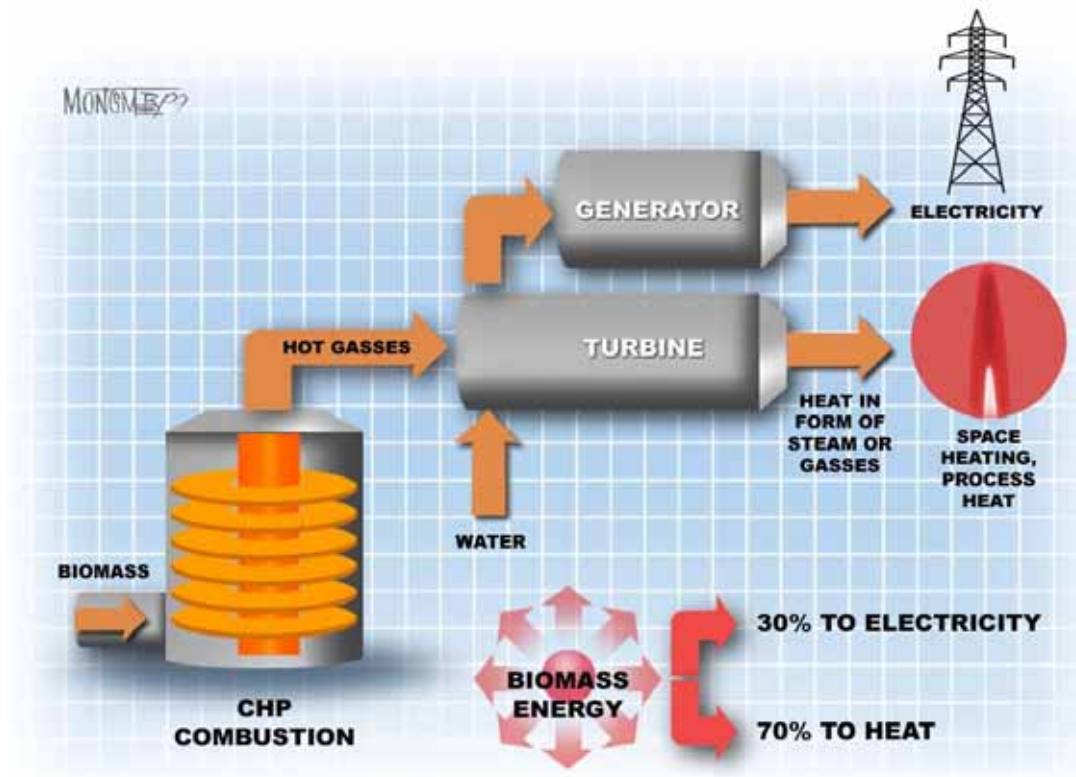
Conversion of biomass to biofuels or energy.

In our highly “connected” world there are many bits and pieces of information about Biofuels. Some are correct and some are not. A statistician might easily conclude that there is a lot of noise in the data.



The goal today is to filter out the “noise” and focus on reality!

Combined Heat & Power



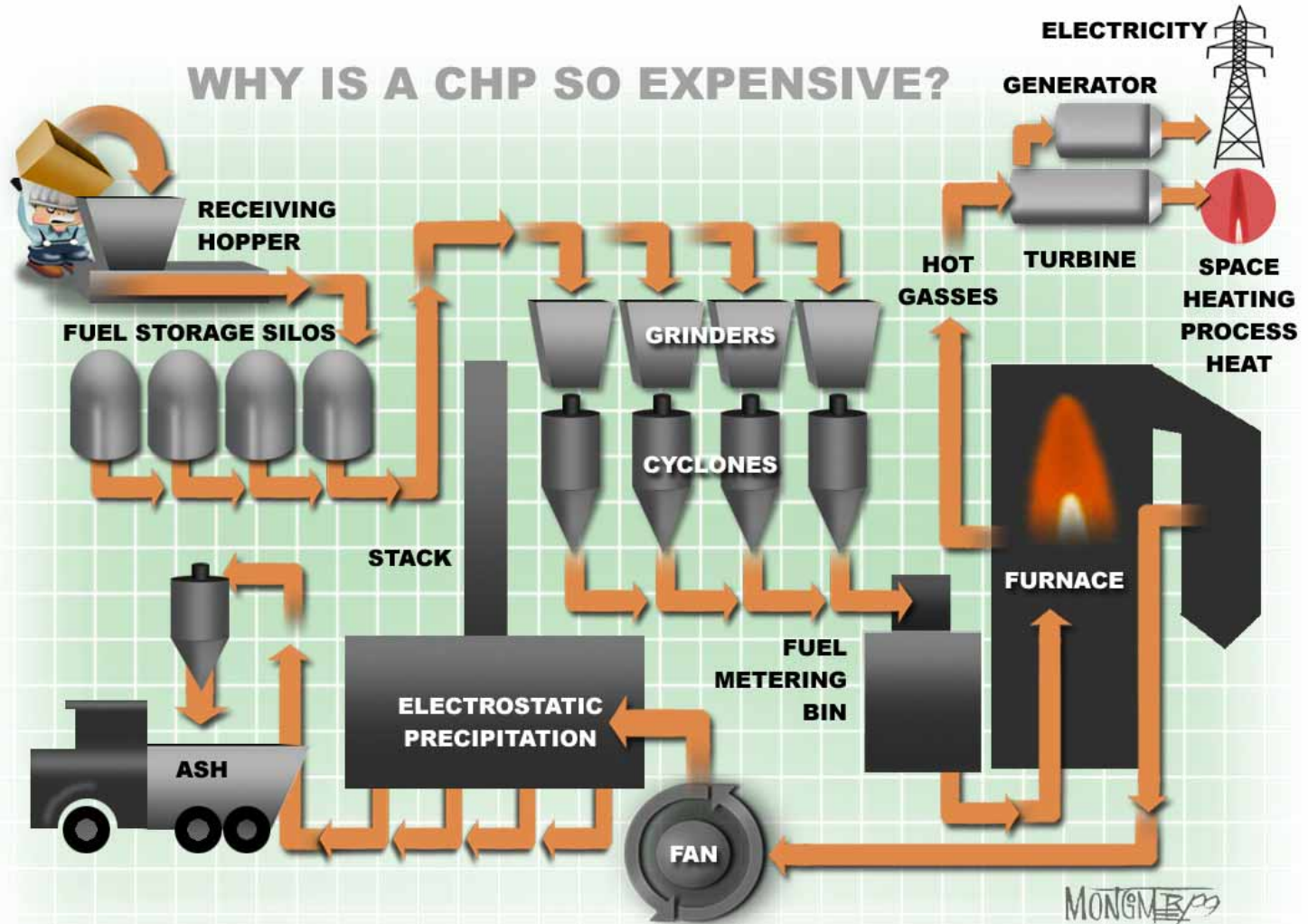
Poster Child for CHP

Koda Energy combines heat and power needs of Rahr Malting with electrical needs of nearby Mystic Lake casino.

- **16.5 mw** electricity plus **125MM** BTU/hr thermal energy. (30/70 ratio)
- **\$55MM** capital.
- Biomass from Rahr and within 50 mile radius.
- \$6MM/yr in outside biomass purchases.
- Yearly payroll of \$750,000.
- Dec. 2008 start-up

Economically viable only if utilize all the heat. In even the most efficient operations about 70% of the biomass ends up as heat

WHY IS A CHP SO EXPENSIVE?



Can combined heat and power be employed at White Earth?

- Scenario 1: Sell electricity to casino(excess to the grid) and use steam to replace oil and propane currently used for heating casino.
- Scenario 2: Generate only enough steam to replace oil and propane and only some of electricity for casino
- As it turns out, CHP plants convert biomass in the ratio of 5-6 parts steam and 1 part electricity.
- The economics are driven by the steam and not the electricity generated
- If you cannot use all the steam you cannot get an acceptable return!

What does this mean for White Earth?

- To get an acceptable return the CHP venture would have to emulate the Koda power venture.

- The casino is not a viable customer for the steam due to the relatively small amount required and cost of converting existing oil/propane boilers to steam.

- A purchaser would have to be found to buy all the steam generated in supplying the casino's electrical needs.

- Good partners would be operations such as a **potato processing plant, a pasta plant, dehydrating plants, green house operations and the like. District heating if distribution system in place.**

Biofuel Pellets- a first step towards sustainably utilizing existing cellulosic biomass resources

Biofuel pellets are a viable and economical option for space heating

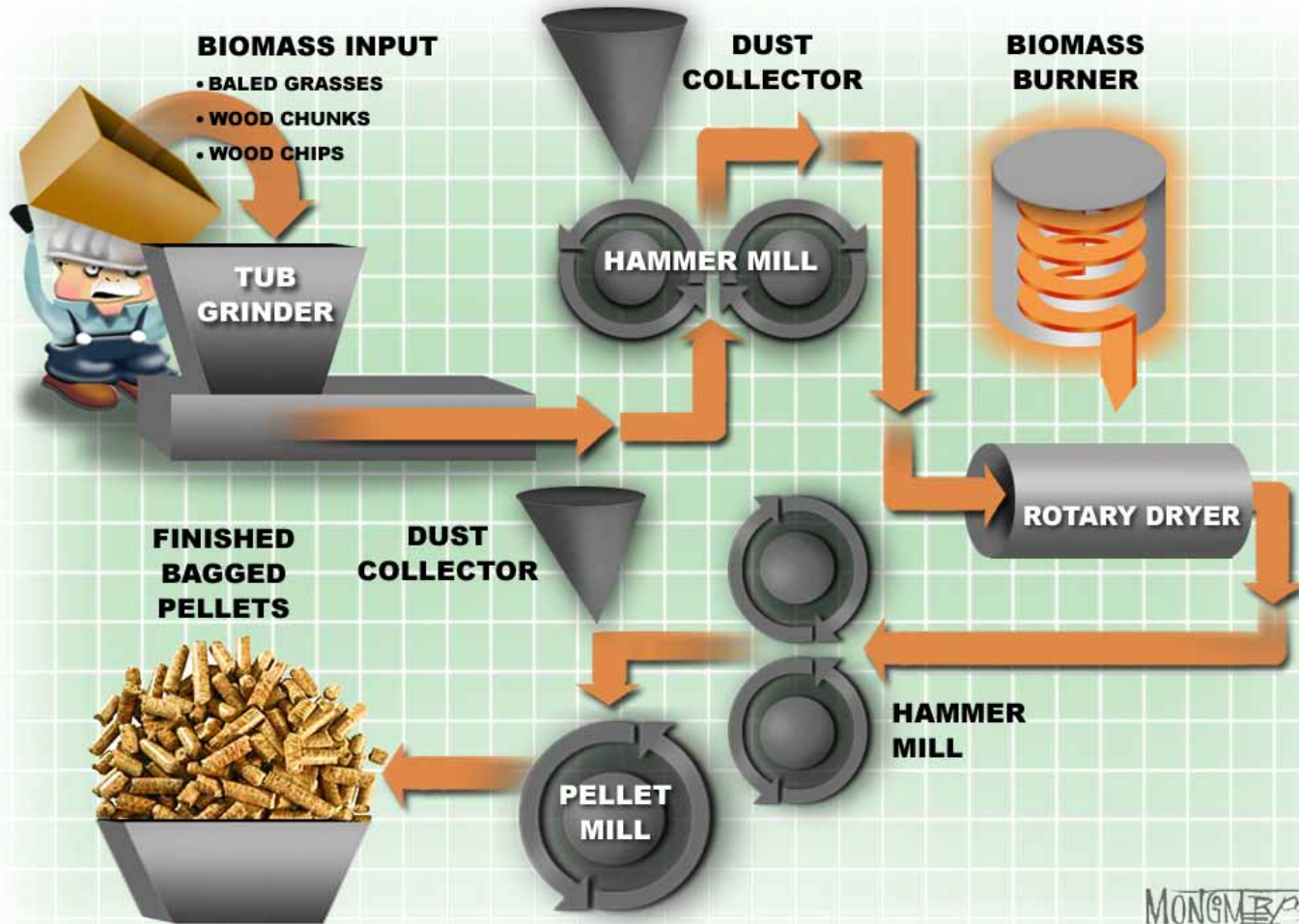
- Pelletizing technology has **matured and is reliable**.
- Fossil fuel prices are continually increasing.
- Pellet heating is a **sustainable, green technology**.
- It is the least expensive way to provide space heating in areas without natural gas.

Comparative Heating Fuel cost (net cost/million BTU)

Source: pelletsales .com

Heating oil @ \$2.95/gal.	\$26.00
Natural gas @ \$16.85/1000CF	21.00
Propane @ \$2.25/gal	20.59
Wood pellets @\$200/ton	14.58

BIOMASS PELLETIZING SYSTEM



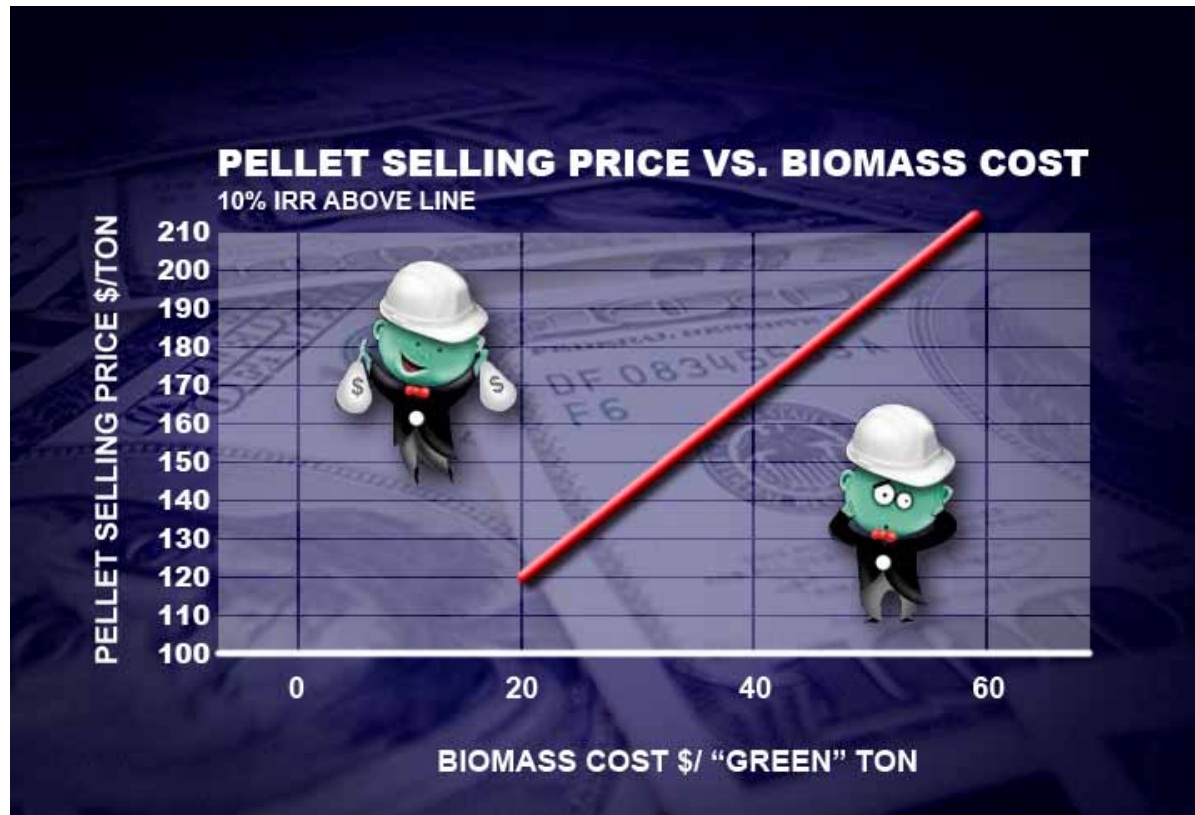
Pellet Mill Economic Parameters

Conditions for 7ton/hr. ; 6% moisture pellets nominal capacity plant

- Capital investment \$12.1 million
- Yearly production 42,000 tons(6% moisture) on 5day/3shift basis
- Yearly payroll \$930,000.
- Project life 15 years
- Start-up costs, working capital, inventory included in calculations

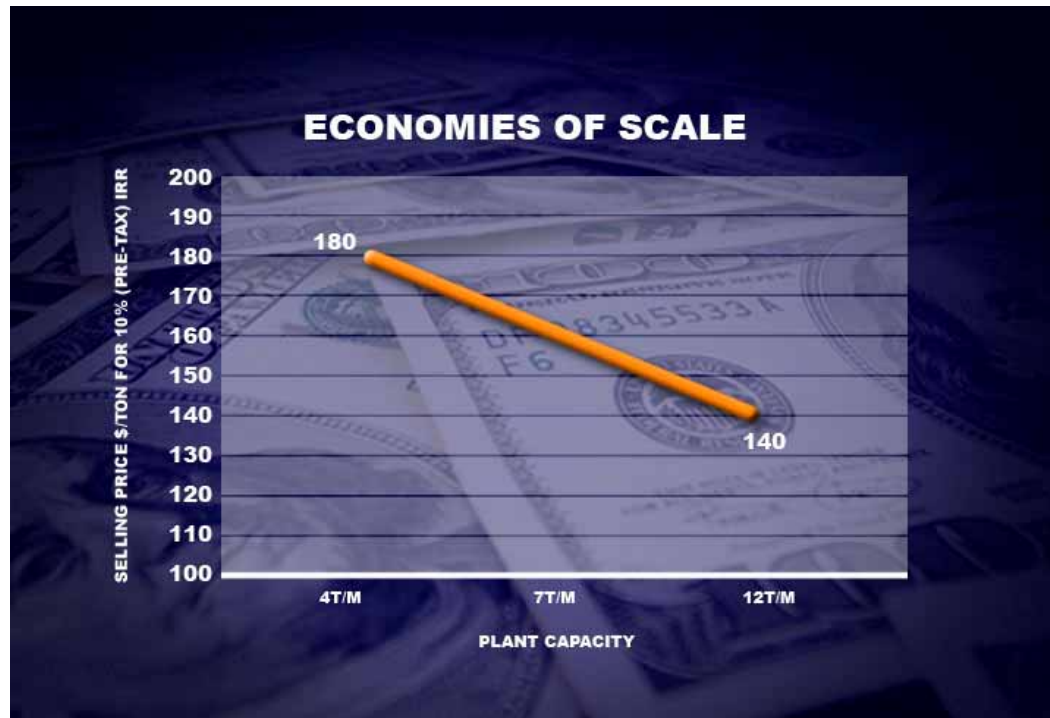
Profitability will be driven by:

- Cost of Biomass**
- Selling price of pellets**
- Plant scale**



- Pellet selling price is market driven.
- Then profitability highly leveraged on biomass cost
- To succeed need some advantage such as;
 - Part of a sawmill operation
 - Access to “clean” and cheap waste wood
 - Captive resources such as tribal lands

Does plant scale matter??



All other things being equal, the “big” guy wins!

As long as they can sell all the capacity of the plant!

Conclusions for wood pellet operation at White Earth

A White earth pellet plant could be a successful enterprise that meets several tribal needs:

- Yearly payroll \$900,000 - \$1,200,000
- Sustainable harvest of existing forest resources currently under utilized
- Employment opportunity for local loggers
- Significant energy self sufficiency with renewable resources
- Reduction of reservation carbon footprint
- Significant cost savings opportunity for casino and tribal homeowners

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