Assistant Secretary-Indian Affairs

Office of Indian Energy and Economic Development

Woody Biomass Utilization

NAEMI – Renewable Energy Development for Oklahoma Tribes

September 19, 2007

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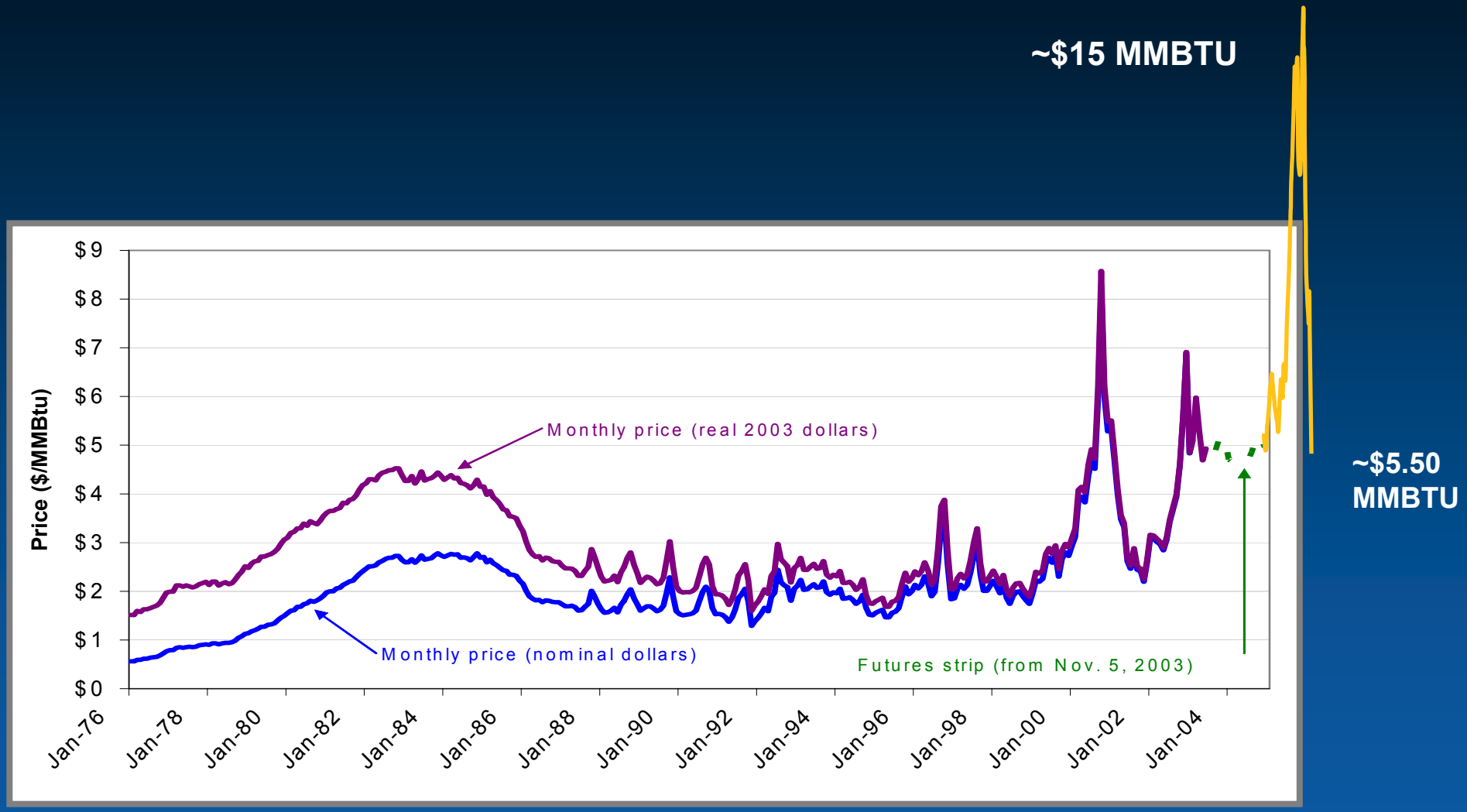
Products from Woody Biomass

- Heat
- Power or CHP
- Pellets
- Liquid Fuels (Ethanol or Bio-oil)
- Composites (not in this talk)

Biomass Energy Benefits

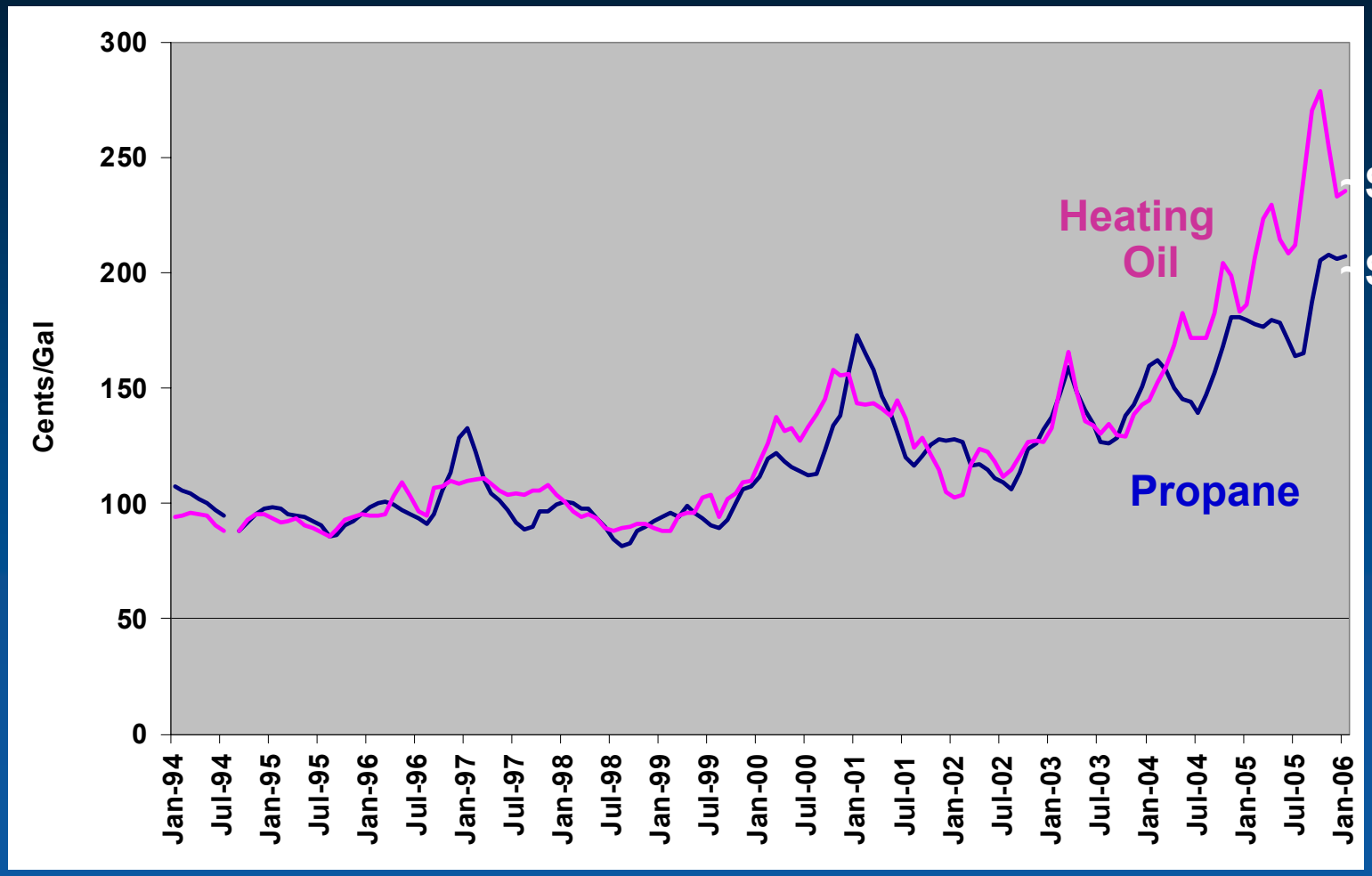
- Forest Health
  - Hazard fuels reduction
  - Reduced slash treatment costs
  - Reduced threat of a catastrophic fire
- Jobs and economic development
  - In woods (harvest, chipping, trucking)
  - New industries
  - Outlet for residues
  - Improve bottom line of existing industry
- Revenue
  - Electricity
  - Renewable Energy Credits (REC)
- Other
  - Offset costs of heating Tribal facilities
  - Potential to develop greenhouse and aquaculture facilities
  - Keeps energy dollars in the community
  - Reduce greenhouse gas emissions

Natural gas prices are now more volatile, at a higher level.



Source: NREL

Propane and heating oil over the years



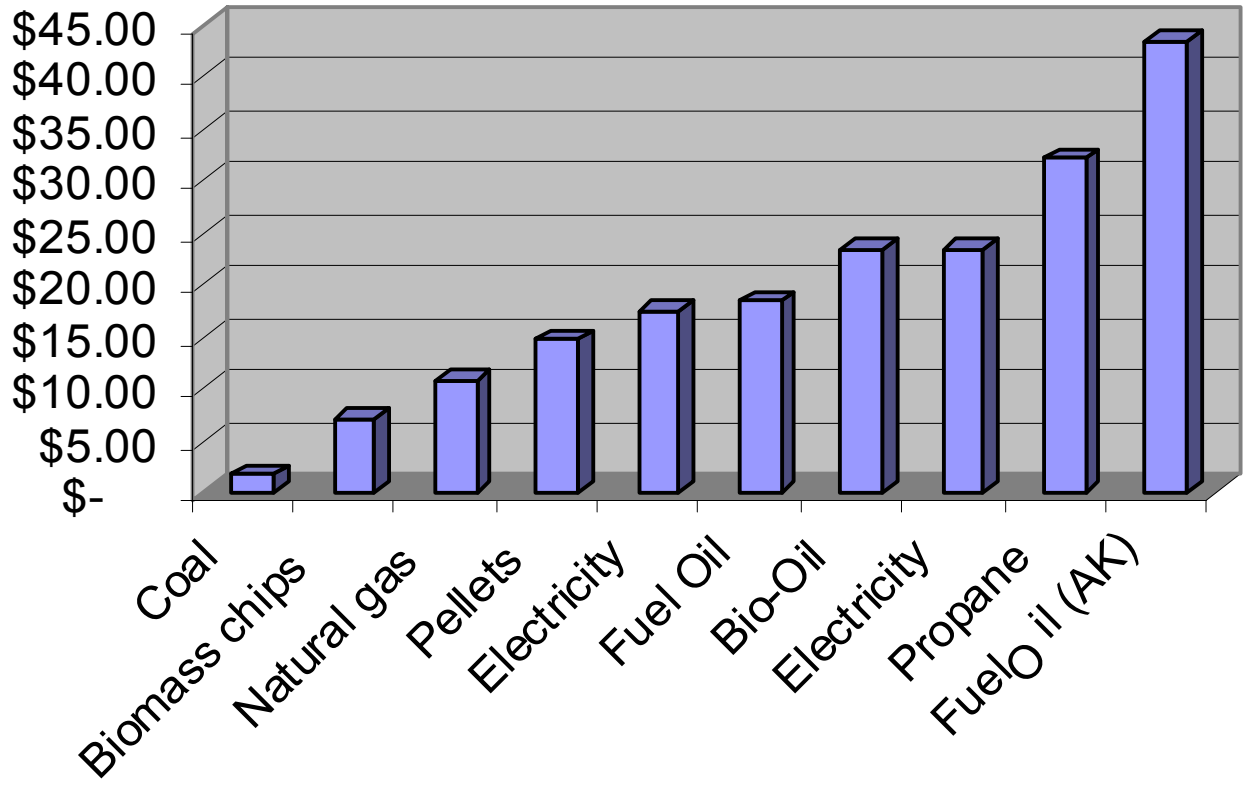
Cost of Delivered Heat

$20/MMBTU

$28/MMBTU

Source: DOE-EIA/NREL

Heating fuel cost comparisons ($/MMBtu delivered)



Four Main Biomass Heating Systems

- Large, automated wood chip
  - Typically buildings over 100,000 square feet, or smaller if there is year-round need for hot water
- Semi-automated surge bin
  - 10,000 – 100,000 square feet
  - Bucket loader
- Pellet
  - 5,000 square feet and up
  - Systems less expensive, less storage
- Cord wood
  - 5,000 – 50,000 square feet
  - Manual loading of wood 1-3 times per day

Automated Systems

- Higher capital costs,
- Storage needs,
- Fuel must be consistent, no sticks
- Less labor

Surge-bin system

Smaller,

Simpler,

Cheaper,

More labor

Source: USFS Fuels for Schools Program

Pellet Systems

- Fuel is twice as costly
- Storage smaller, cheaper
- Boiler smaller, cheaper

Source: USFS Fuels for Schools Program

Pellet Storage

Source: USFS Fuels for Schools Program

Garn – Cordwood

- Less expensive, more labor

Source: USFS Fuels for Schools Program

Emissions comparison

	lbs/green ton			
Disposal method	**PM10**	**NOx**	**VOC**	**CO**
Pile burning (1)	19 to 30	3.5	8 to 21	54 to 312
Prescribed burn (2)	24	4.0	13	224
Forest fire (2)	15	4.0	21	140
Biomass boiler (3)	**2.1**	**2.8**	**0.6**	**1.7**
Average Reduction	***89%***	***30%***	***96%***	***99%***

(1) Patrick Gaffney, California Air Resource Board, 916-332-7303
Available at www.gisc.berkeley.edu/~jscar/agburn/agburnefs.html
(2) Environment Australia. Emissions Estimation Technique Manual for Aggregrated Emissions from Prescribed Burning and Wildfires, Version 1.0. September 1999.
(3) Based on Chiptec gasifier - other systems similar

Courtesy, Forest Energy, Show Low, AZ and McNeil Technologies

Pellet Die and Rollers

Courtesy, Forest Energy, Show Low, AZ

Hot pellets exiting pellet mill
Courtesy, Forest Energy, Show Low,

Production Cost per Ton
(15-18 Jobs at the Plant, plus in-woods)

Expense Category	*Total $*	*$/ton*
Payroll	$ 638,550	$ 30.37
Feedstock cost	$ 540,317	$ 25.70
Packaging	$ 510,924	$ 24.30
Utilities	$ 325,645	$ 15.49
Debt repayment	$ 212,178	$ 10.09
Front-end loader operation	$ 109,601	$ 5.21
Advertising and sales	$ 77,100	$ 3.67
Dyes and rollers	$ 41,120	$ 1.96
Dryer fuel	$ 25,052	$ 1.19
Repairs and maintenance	$ 10,280	$ 0.49
Insurance	$ 2,570	$ 0.12
Legal	$ 2,570	$ 0.12
Total	$ 2,495,907	$ 118.72

Source: McNeil Technologies

Biomass Power

- 500+ facilities in U.S
- Almost all commercial systems are combustion/steam turbine (20-30% efficient)
- 1-110 MW (average is ~20)
- Smaller systems (< 5 MW still have poor economics
- Best economics will be cogeneration (produce and use heat and power)

Biomass Gasification

- More efficient, 30- 40%
- Manages mineral matter
- Fuel gas ($CO + H_2 + CH_4$) can be used in engines or to make steam, or to make liquid fuels
- Pre-commercial, early commercial
- Installed Cost $2,500+ / kW
- Promise of smaller systems

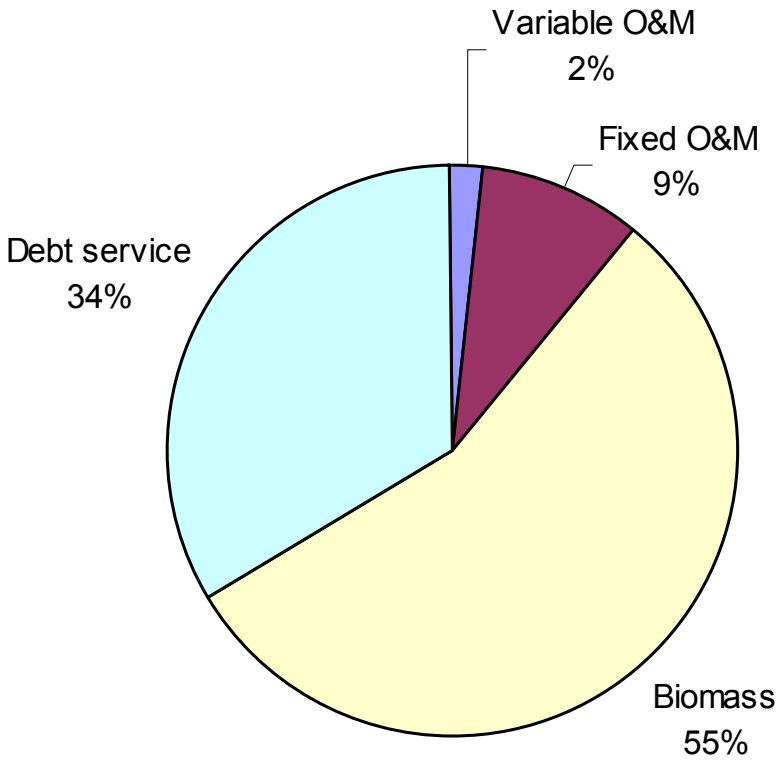
Large-scale biopower (20 MW)

Small to Medium Scale

- Chiptec (Vermont)
- Close-coupled gasification
  - (gas is ignited right away to produce steam for traditional steam turbine
- Hundreds of thermal only systems
- A few power generation systems
- Simple technology

Micro Scale (Community Power Corp 15 kW)

Biomass Plant – Typical Distribution of Annual Operating Costs



Tribal Ownership, no Tax Credits

Category	Units	Value
Variables		
Tribal equity investment	$	$ 8,385,947
Government grant	$	$ -
Biomass fuel cost	$/green ton	$ 25
Equity	%	40.0%
Interest rate on debt	%	5.0%
Term on long term debt	Years	15
1st yr. elec. selling price	$/kWh	$ 0.085
Renewable energy credit	$/kWh	$ -
Thermal sales	Load	Fishery
Ownership	Tribal / Joint Venture	Tribal
Calculated Results		
Nominal Levelized Cost (inc. taxes)	$/kWh	$ 0.083
Minimum debt service coverage ratio	ratio	74%
Average debt service coverage ratio	ratio	139%
After-Tax IRR on Equity		
Tribal project alone	%	-1%
Tribe return with JV partner	%	0%
JV Partner	%	0%
Net Present Value		
Tribal project alone	$	$ (4,446,353)
Tribe return with JV partner	$	$ -
JV Partner	$	$ -

Source: McNeil Technologies

Joint Venture With Tax Credits

Category	Units	Value
Variables		
Tribal equity investment	$	$ 166,058
Government grant	$	$ -
Biomass fuel cost	$/green ton	$ 25
Equity	%	40.0%
Interest rate on debt	%	5.0%
Term on long term debt	Years	15
1st yr. elec. selling price	$/kWh	$ 0.085
Renewable energy credit	$/kWh	$ -
Thermal sales	Load	Fishery
Ownership	Tribal / Joint Venture	JV
Calculated Results		
Nominal Levelized Cost (inc. taxes)	$/kWh	$ 0.072
Minimum debt service coverage ratio	ratio	74%
Average debt service coverage ratio	ratio	139%
After-Tax IRR on Equity		
Tribal project alone	%	0%
Tribe return with JV partner	%	34%
JV Partner	%	13%
Net Present Value		
Tribal project alone	$	$ -
Tribe return with JV partner	$	$ 357,595
JV Partner	$	$ 703,505

Source: McNeil Technologies

The Unique Role of Biomass

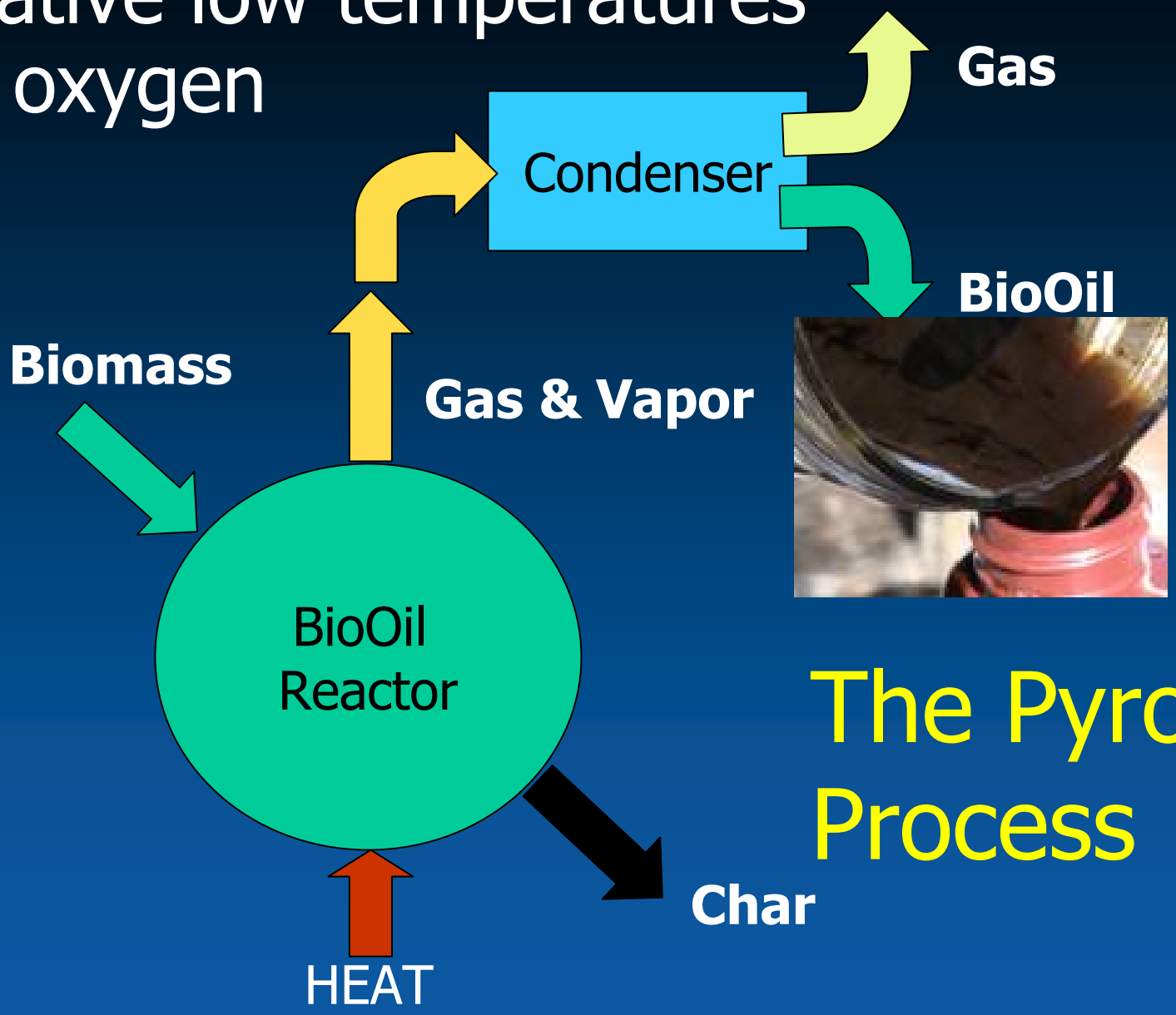
While the growing need for sustainable electric power can be met by other renewables…

Biomass is the only renewable that can meet our demand for carbon-based liquid fuels and chemicals

What is Bio-Oil?

- Not biodiesel
  - Biodiesel is derived from natural oils like soybean oil, and which meets the specifications of ASTM D 6751.
- Bio-Oil
  - Organic, liquid fuel produced through a process known as pyrolysis.
  - A heating oil like substance

Relative low temperatures
No oxygen



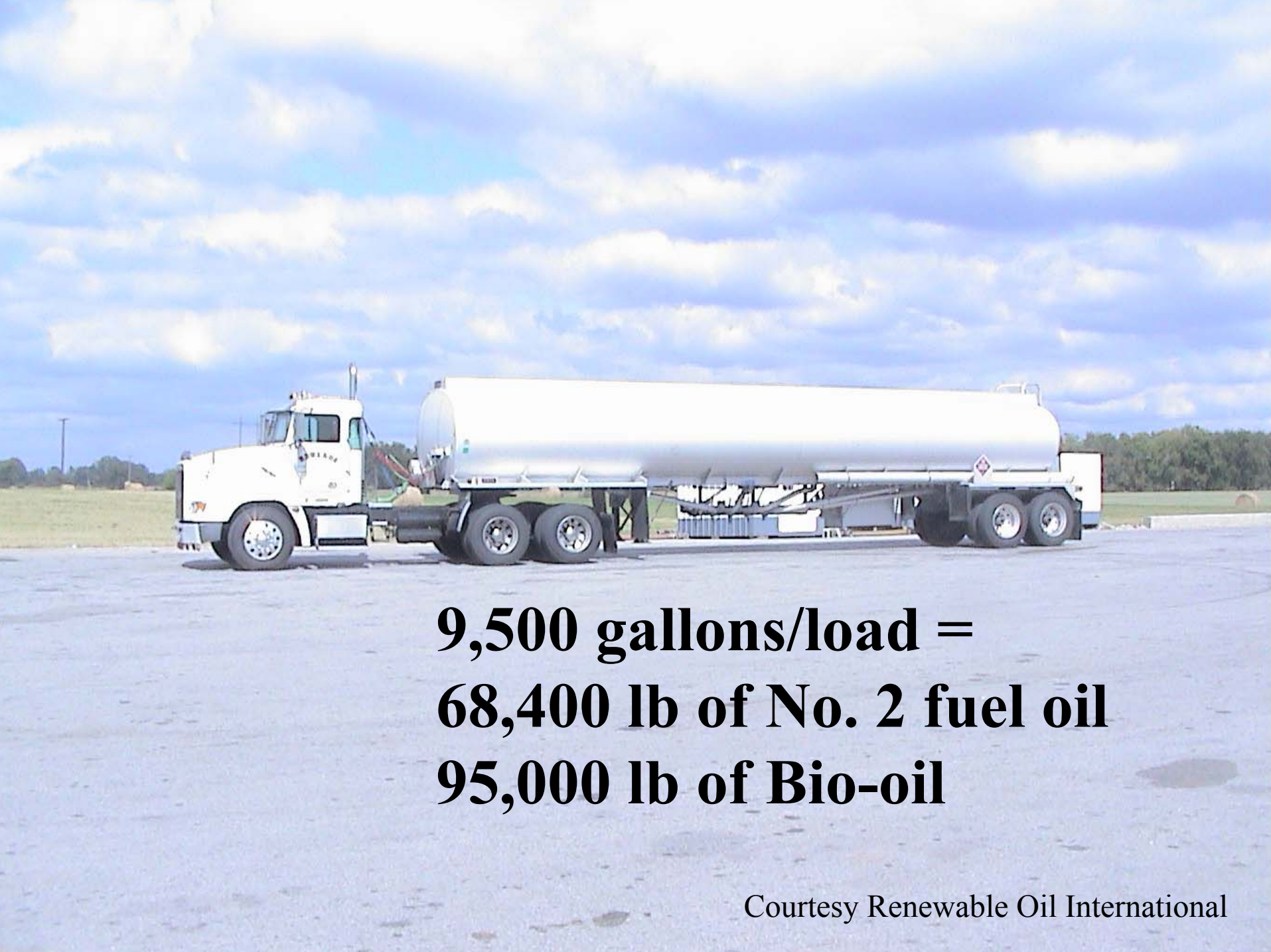
The Pyrolysis Process

Courtesy Renewable Oil International

Why Bio-Oil?

- Liquid fuel allows for variety of applications, esp. boiler fuel and power generation
- Can use most of existing infrastructure (e,g. refineries)
- Density is much greater than for other biomass forms thereby reducing transportation costs
- Air emissions lower than fossil emissions
- Storage as liquid, de-couple production and use
- Further refining to produce transportation fuel

56,000 lb/net load typical
for green wood chips
Courtesy Renewable Oil International



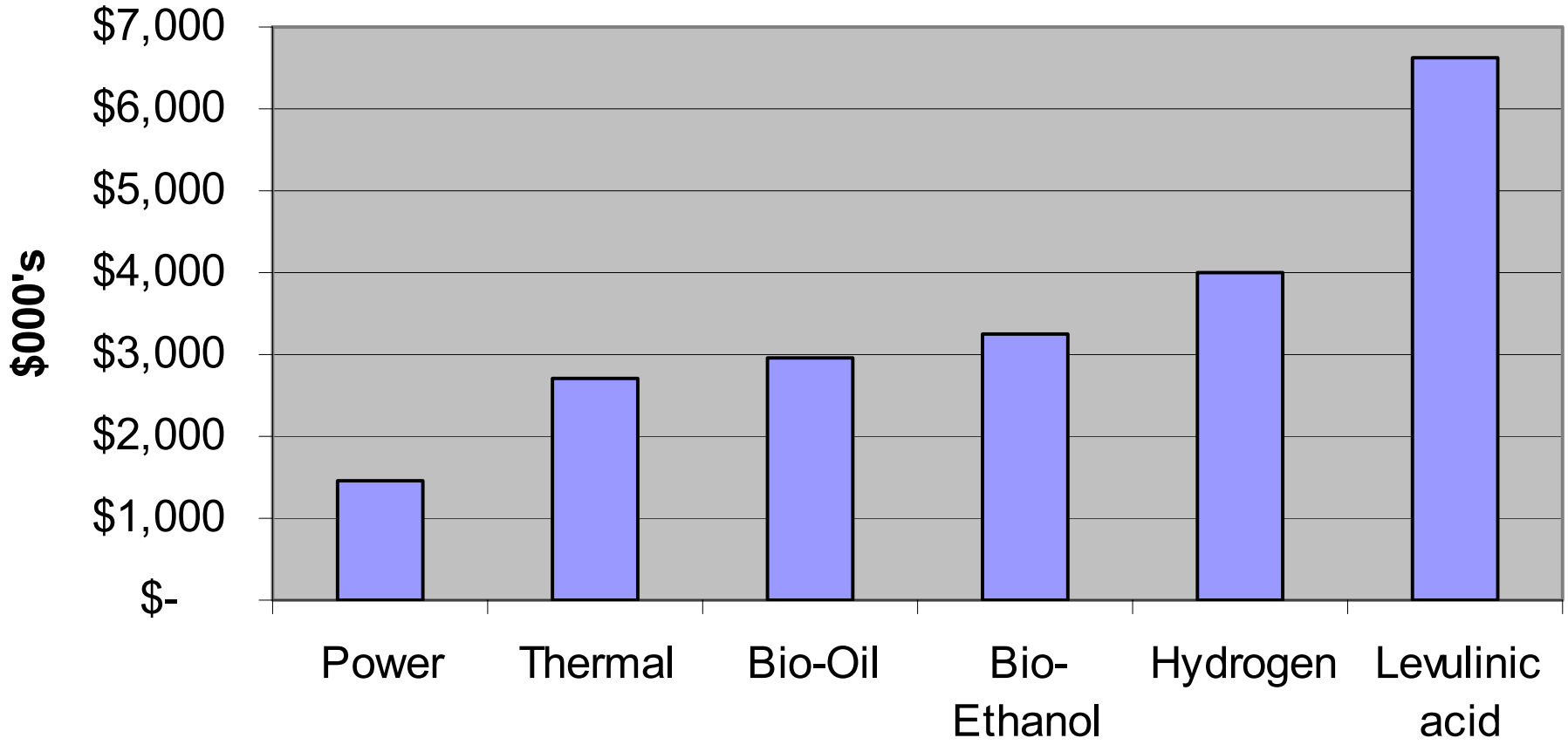
9,500 gallons/load =
68,400 lb of No. 2 fuel oil
95,000 lb of Bio-oil

Courtesy Renewable Oil International

2X Btu per load with Bio-oil

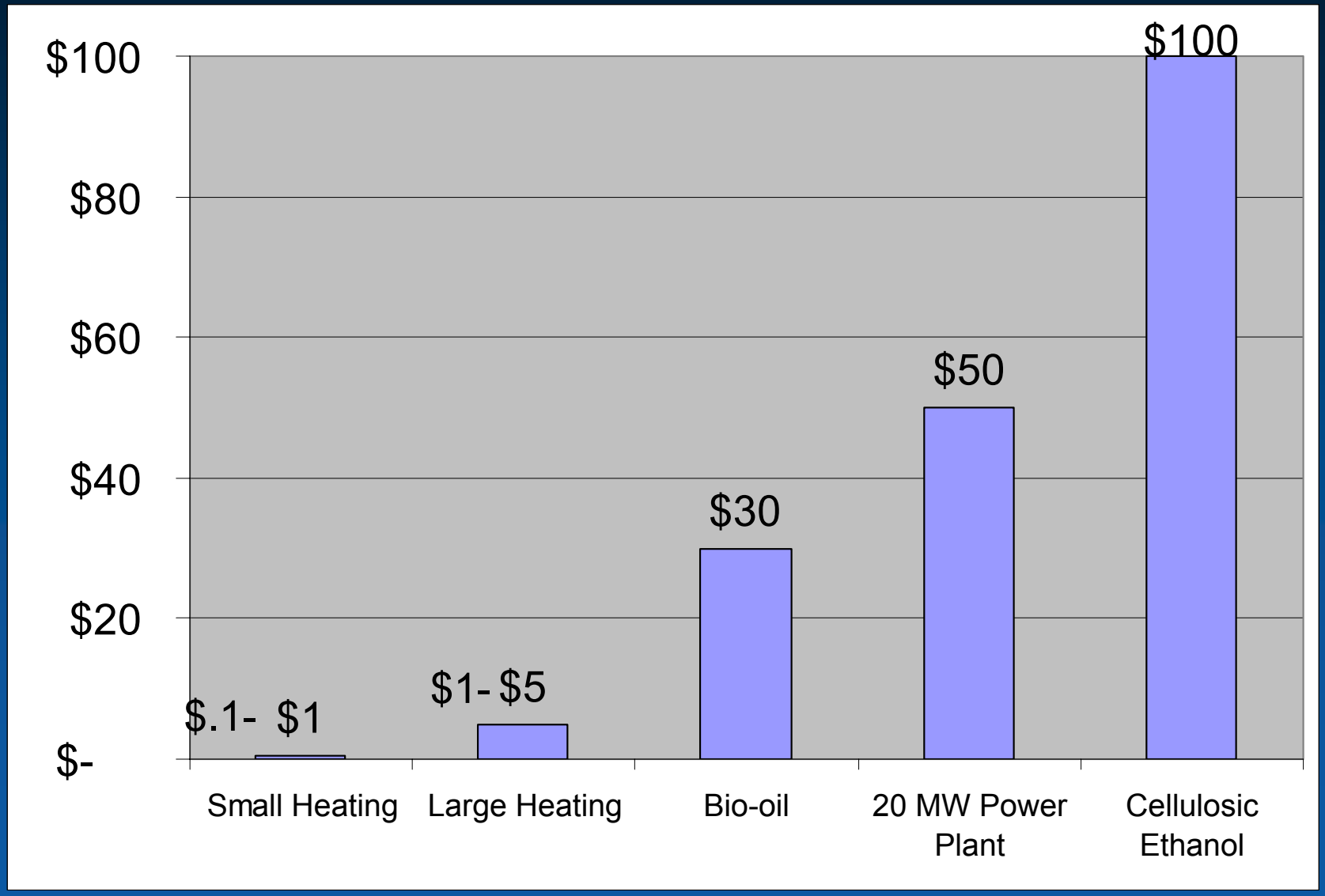
Courtesy Renewable Oil International

Comparative biomass values

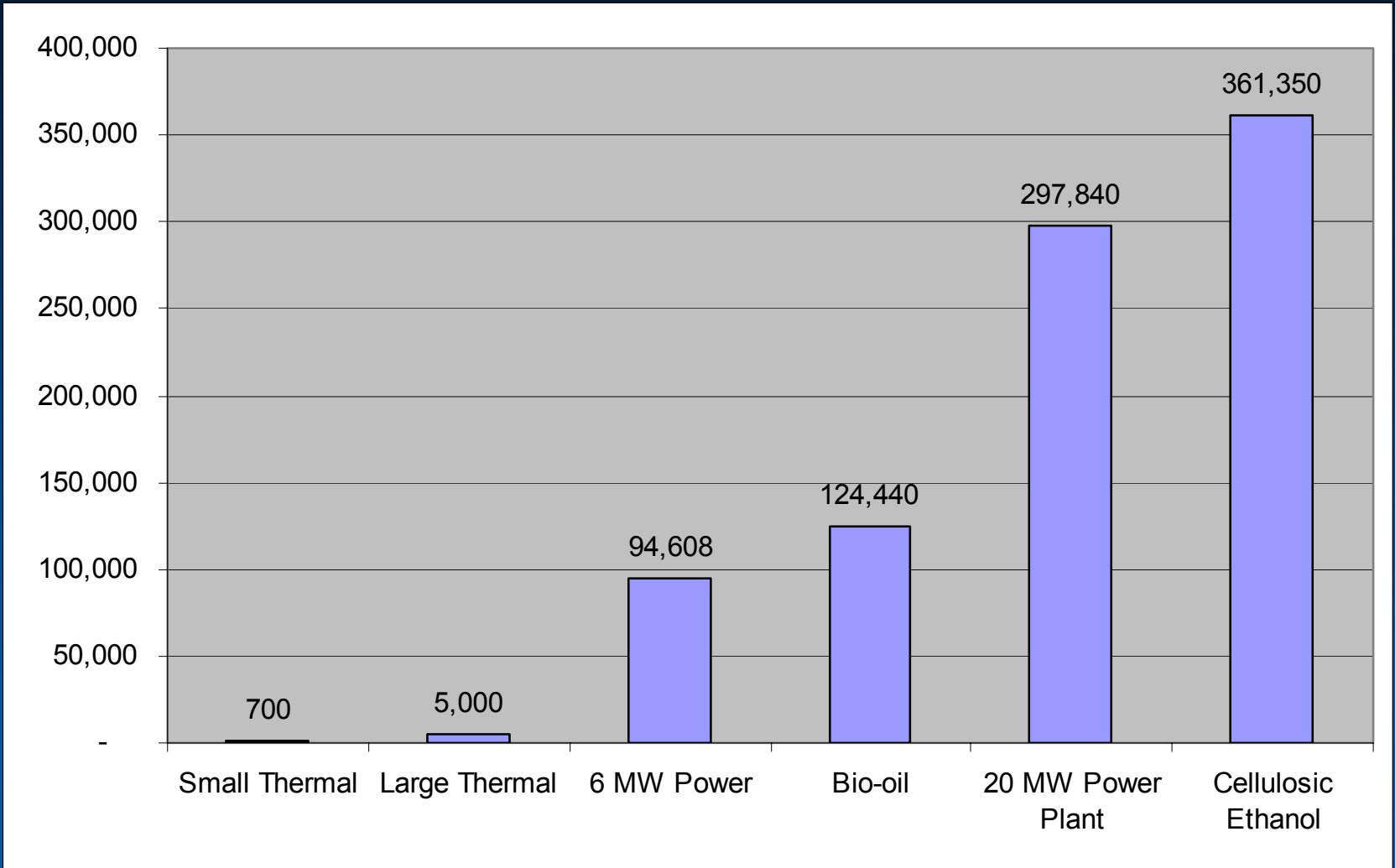


Source: McNeil Technologies

Capital costs of bioenergy applications (million $)



Annual biomass fuel requirements (green tons/year)



Biomass Energy - Summary

- Commercial technologies, except for ethanol and bio-oil
- Each project is unique
- Every project needs a local champion
- Reliable fuel supply is essential
- Cogeneration and liquid fuels are significantly more complex than thermal only