Assistant Secretary-Indian Affairs

Office of Indian Energy and Economic Development

Woody Biomass Integration for Heat, Power and Fuels

NAEMI Biomass Training
May 16, 2006

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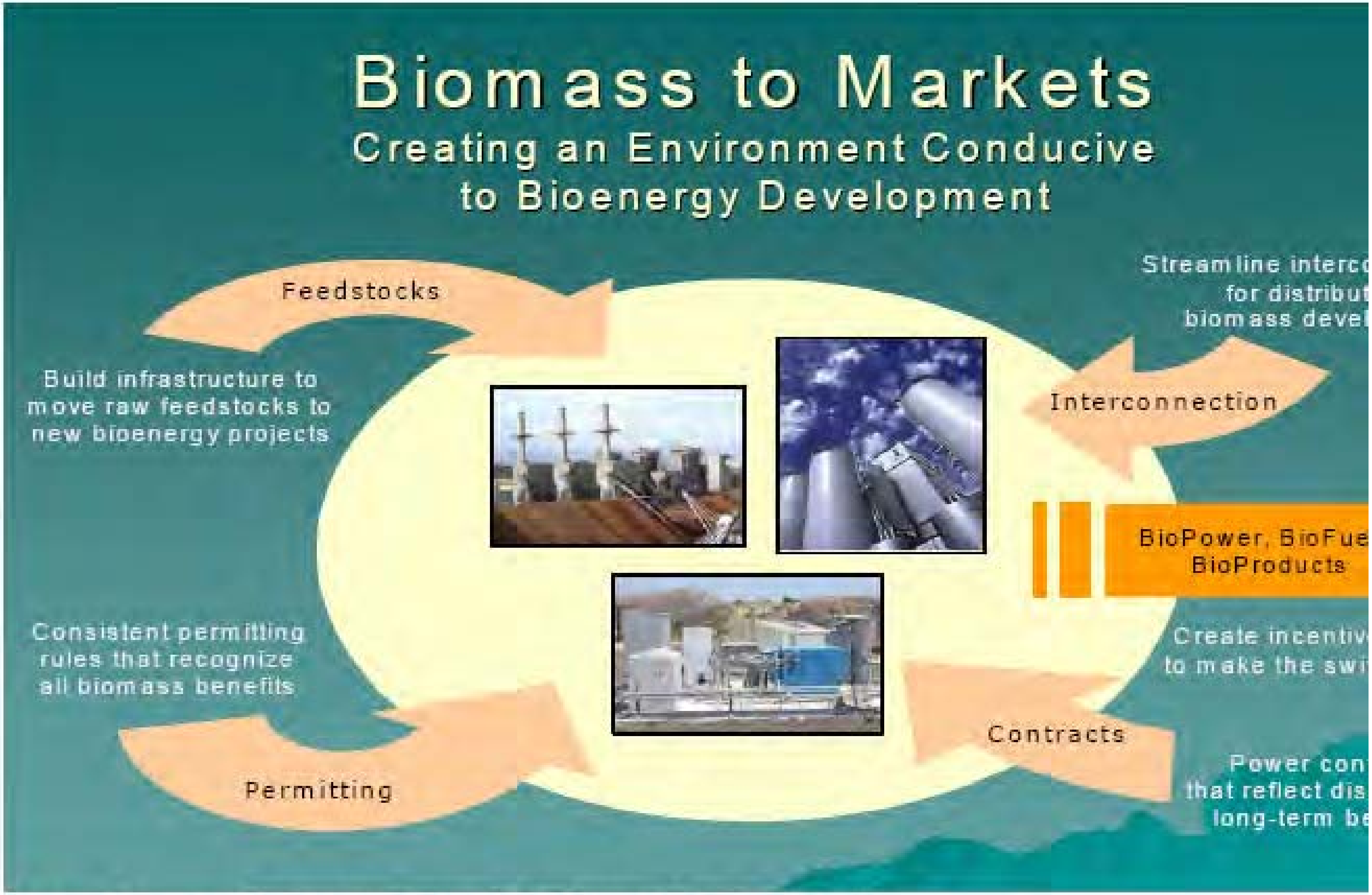
Overview

- Forest health as the driver
- Biomass feedstock issues
- Technologies and applications
- General economics
- Moving forward with your project
  - Feasibility study steps
- Summary

Complex Issues

- Resource management policy
- Forest thinning science, fire mitigation objectives, budgets
- Economics of forest thinning
  - Biomass removal vs. mastication
- Biomass supply infrastructure and costs
- Existing energy/utility infrastructure
  - Least cost planning is utility model
  - Competing resources (e.g. wind, coal)
  - Interconnection – technical and economic
  - Power purchase agreements, heat use, offset retail purchases
  - Portfolio standards, tax credits
- Multiple biomass conversion technologies
- Multiple potential sites/applications
- Fuel delivery, handling and storage
- Environmental emissions
- Financing and ownership options
- Green pricing, green tags, RECs



- Increased economic availability of the feedstocks;
- Streamlined interconnection;
- Permitting process that account for biomass benefits;
- Long-term contracts for bioenergy; and
- Incentives to make the switch to a sustainable and renewable resource.

Source: WGA Biomass Task Force Report, 2006

Benefits of Bioenergy

- Hedge against volatile fossil fuel prices
- Rural economic development
  - Biomass $ stay in local economies
  - Jobs (5-7 jobs per MW)
- Turns waste into a product
- Fuel supply diversity, energy security
- Distributed generation benefits

Environmental Benefits

- Promote healthier forests
  - Reduce wildfire threat
  - Watershed health and supplies
- Reduced emissions when compared to prescribed burns or wildfires
- Reduce SOx and fossil CO_2 emissions
- Diversion from landfills

Emissions:

Comparing Open Burning to Wood System Output

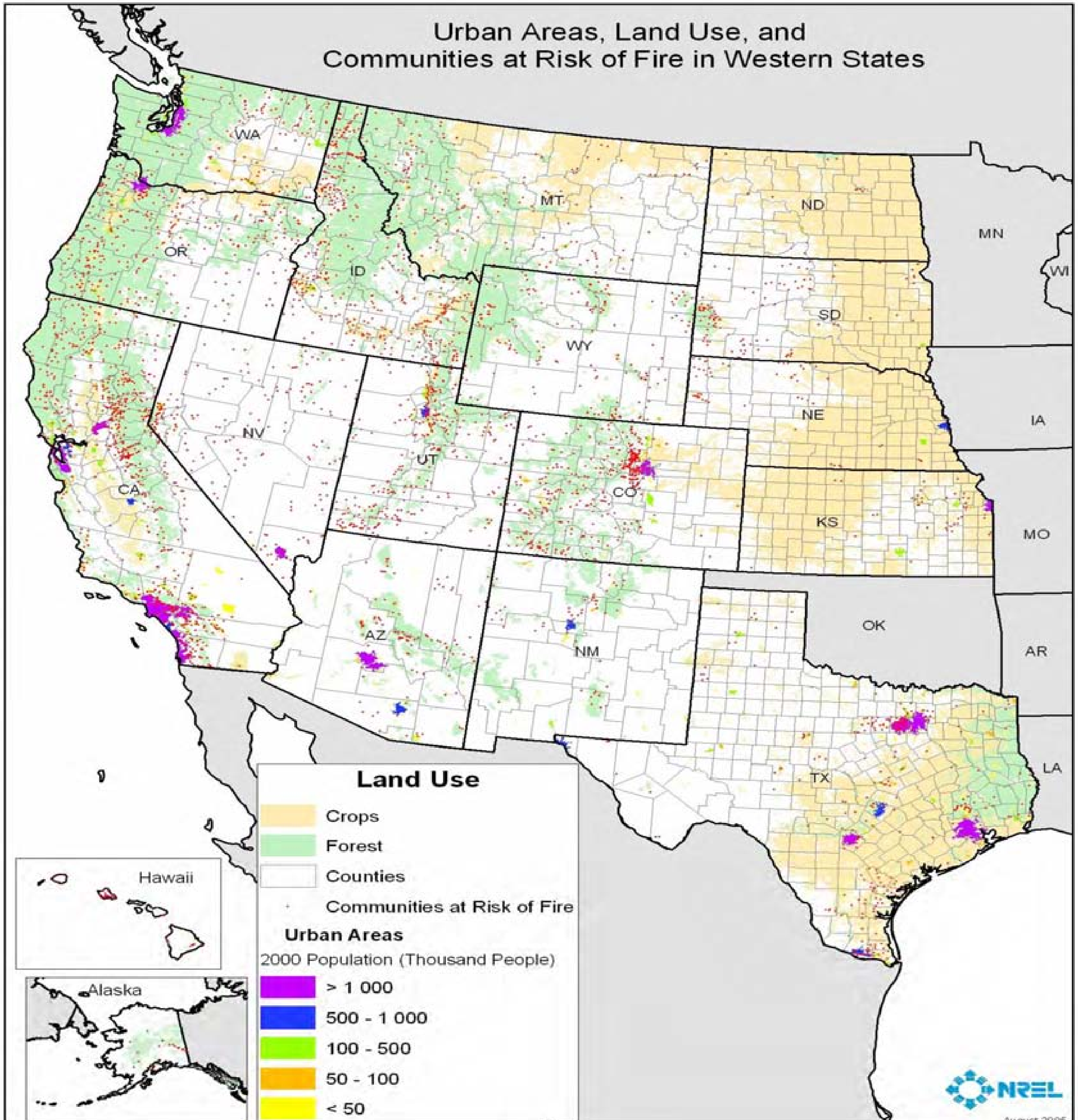
	PM10	NOx	SO2	VOC	CO
	(lbs/ green ton)				
Pile Burning (1)	19 to 30	3.5	0.1	8 to 21	154 to 312
Prescribed Burning (2)	24	4.0	??	13	224
Forest Fire (2)	15	4.0	??	21	140
Chiptec Gasifier	**2.07**	**2.76**	**0.26**	**0.62**	**1.68**

(1) Patrick Gaffney, California Air Resources Board, 916-332-7303. Available at www.gisc.berkeley.edu/~jscar/agburn/agburnefs.html

(2) Environment Australia. Emissions Estimation Technique Manual for Aggregated Emissions from Prescribed Burning and Wildfires, Version 1.0. September 1999.

Late 1800s

Today



Urban Areas, Land Use, and
Communities at Risk of Fire in Western States
WA
OR
CA
NV
ID
MT
WY
UT
CO
AZ
NM
ND
SD
NE
KS
OK
TX
MN
WI
IA
MO
AR
LA
Hawaii
Alaska
Land Use
Crops
Forest
Counties
Communities at Risk of Fire
Urban Areas
2000 Population (Thousand People)
> 1 000
500 - 1 000
100 - 500
50 - 100
< 50
NREL
August 2005

Hayman Fire

Agency	Amount ($)
USFS	$ 121,855,850
Other Federal	$ 15,892,000
State/Counties	$ 6,391,976
Private Sector	$ 43,228,000
Non Profits	$ 1,284,200
Total	$ 188,652,026
Acres Burned	137,000
$/acre	**$ 1,377**

- Does not include losses of habitat and deaths of 5 firefighters
- Costs of biomass removal typically $500-$1000 /acre

Forest management to reduce wildfire risk

- *Hand thinning, mechanical thinning*
  - *- Chip on site*
  - *- Product and biomass removal*
  - *- Pile and burn*
- *Mastication*
- *Prescribed burns*





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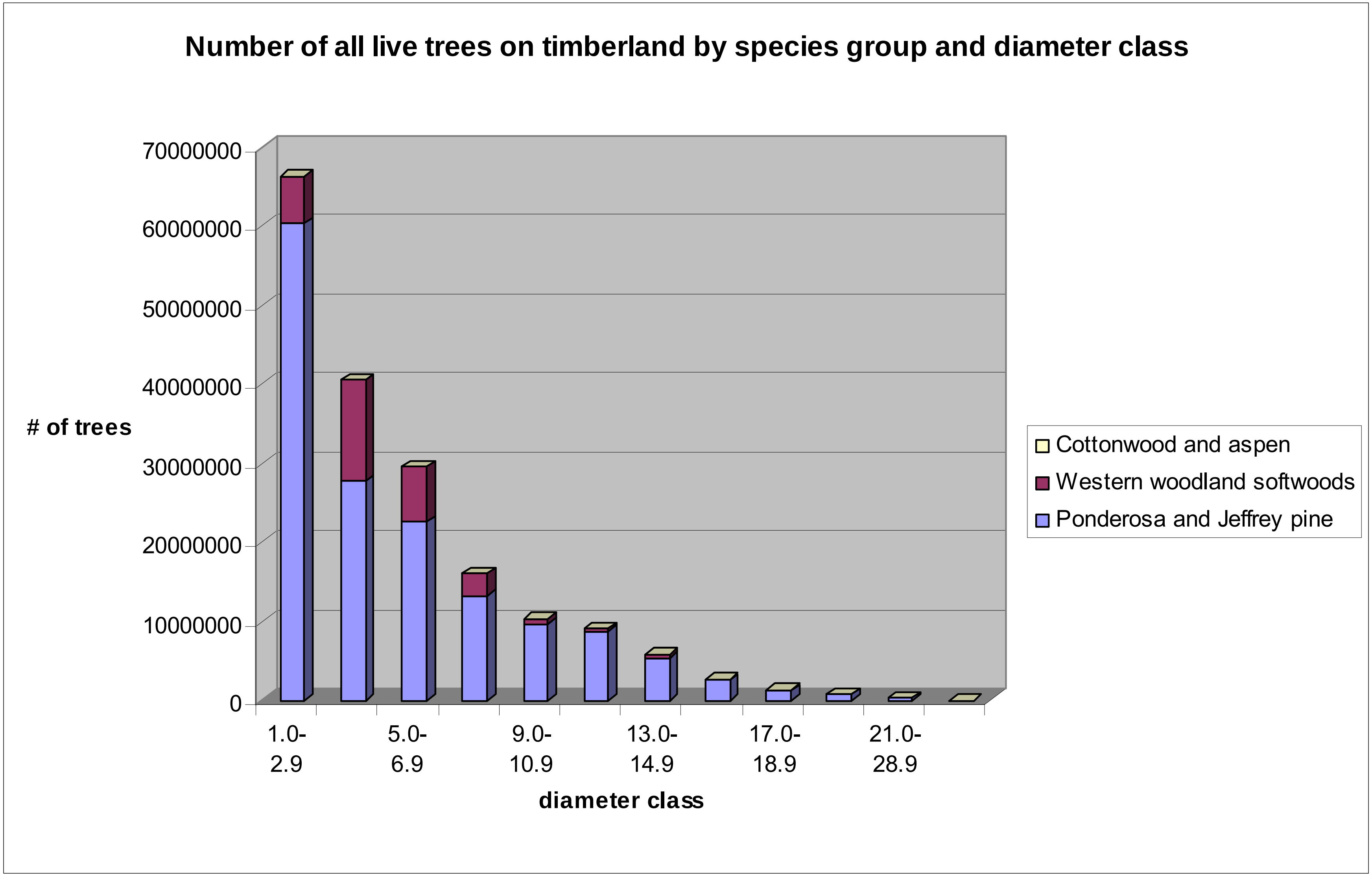
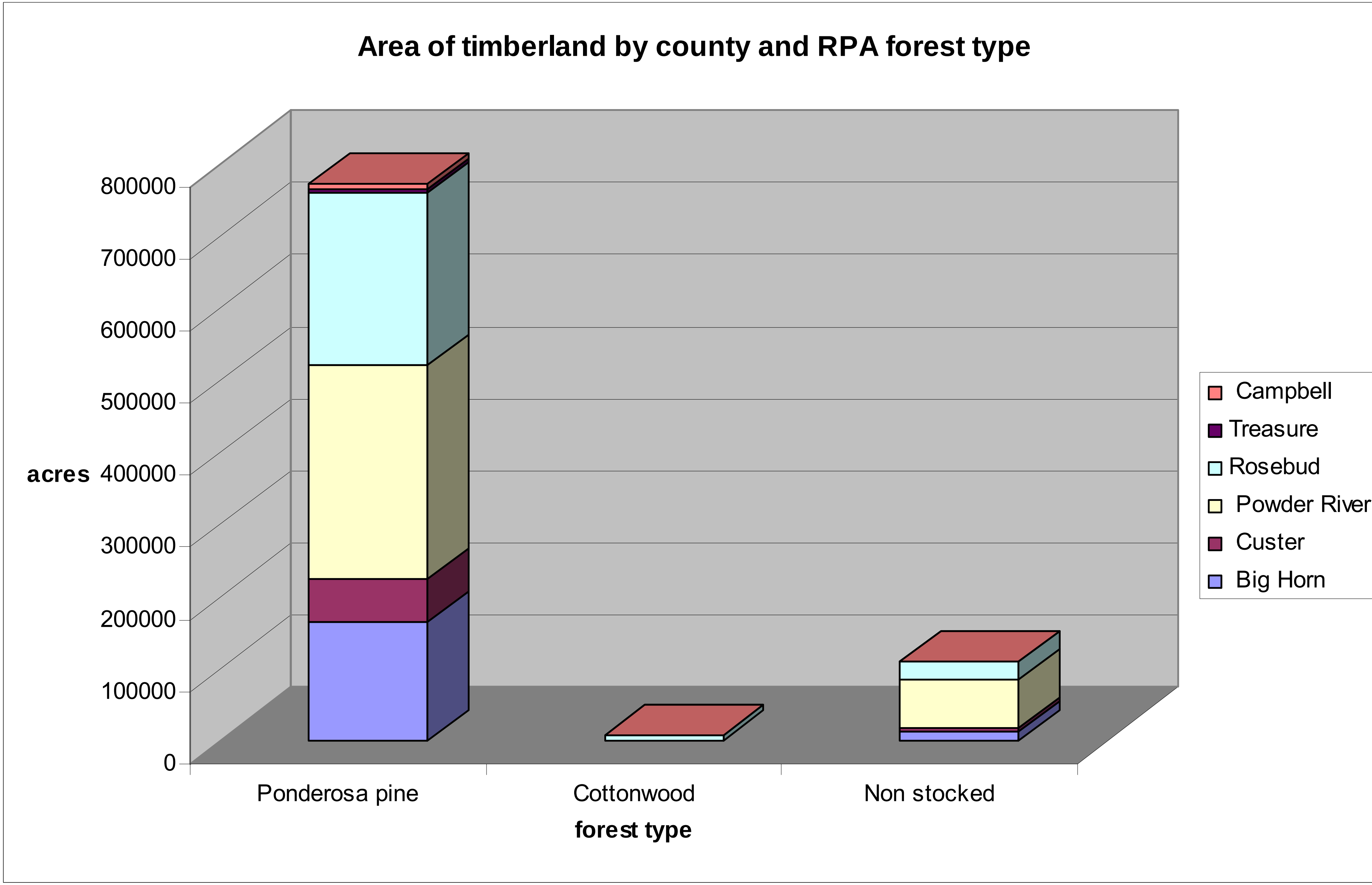
Biomass Resources

- Single most important issue in terms of economics and project sustainability
- Locate and quantify potential sources of biomass
  - Tribal, federal, state, local, private
  - Timber harvest, WUI, hazardous fuels
- Determine availability of a sustainable supply
  - Gross, technical, historic, economic
- Quality
  - form, species, seasonality, energy content, moisture content, chemical analysis
- Transportation, storage, handling

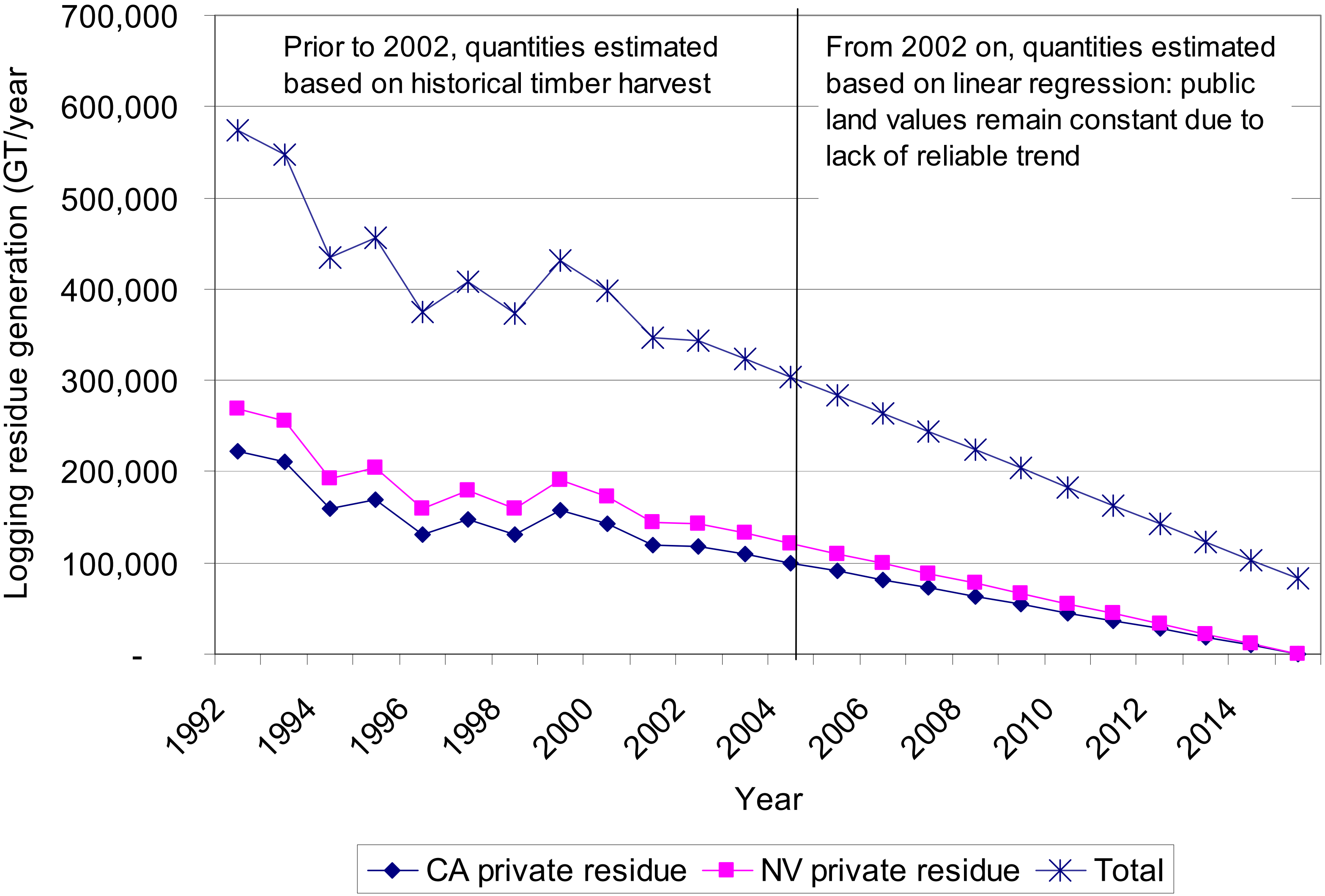
Northern Cheyenne Tribe, Biomass study



Source: McNeil Technologies, Northern Cheyenne Tribe Biomass Study, 2005

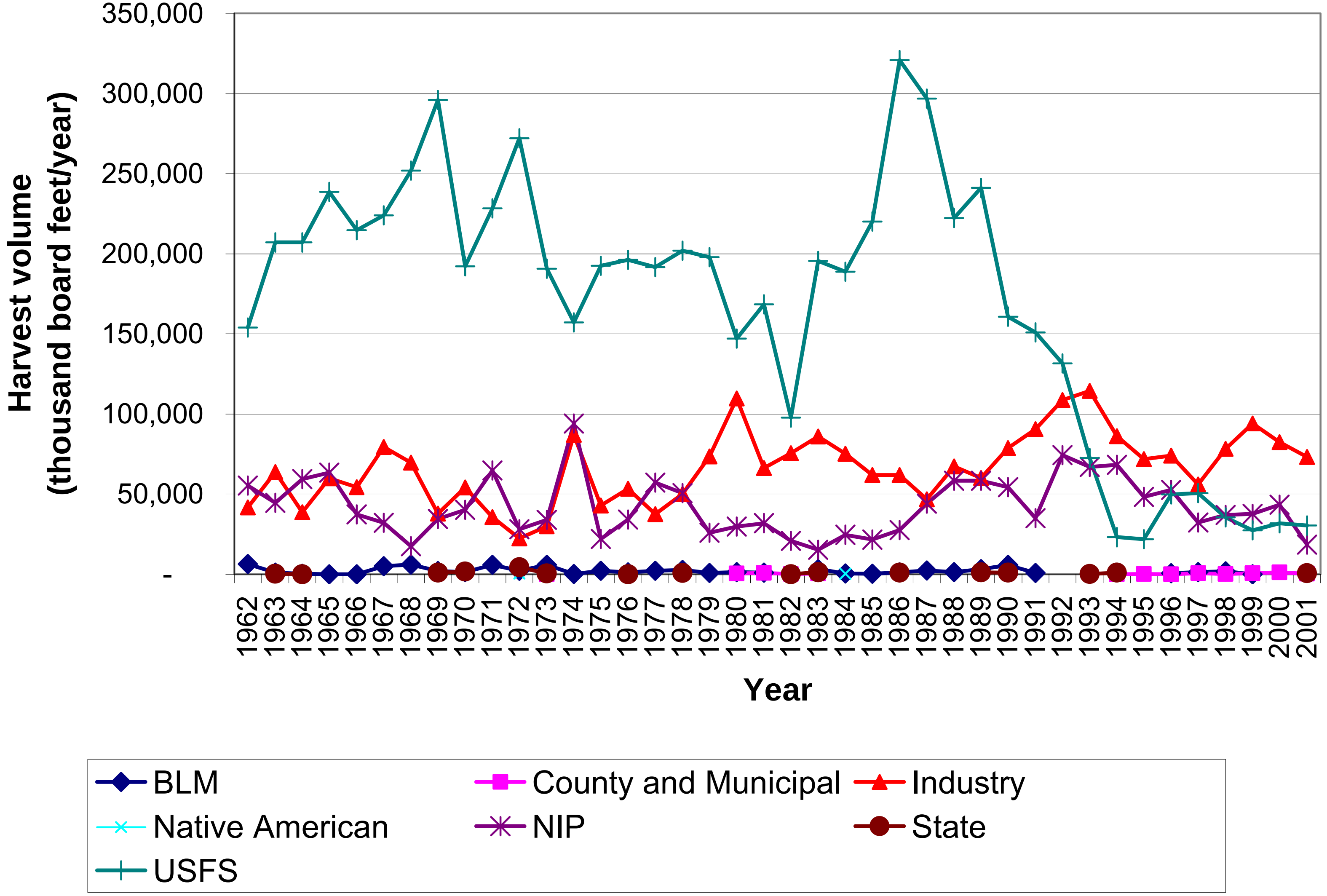

Area of timberland by county and RPA forest type
acres
800000
700000
600000
500000
400000
300000
200000
100000
0
Ponderosa pine
Cottonwood
Non stocked
forest type
Campbell
Treasure
Rosebud
Powder River
Custer
Big Horn

Industry Trends Affecting Biomass Availability – Historic and Projected Total Harvest Residue Generation (Northern California)



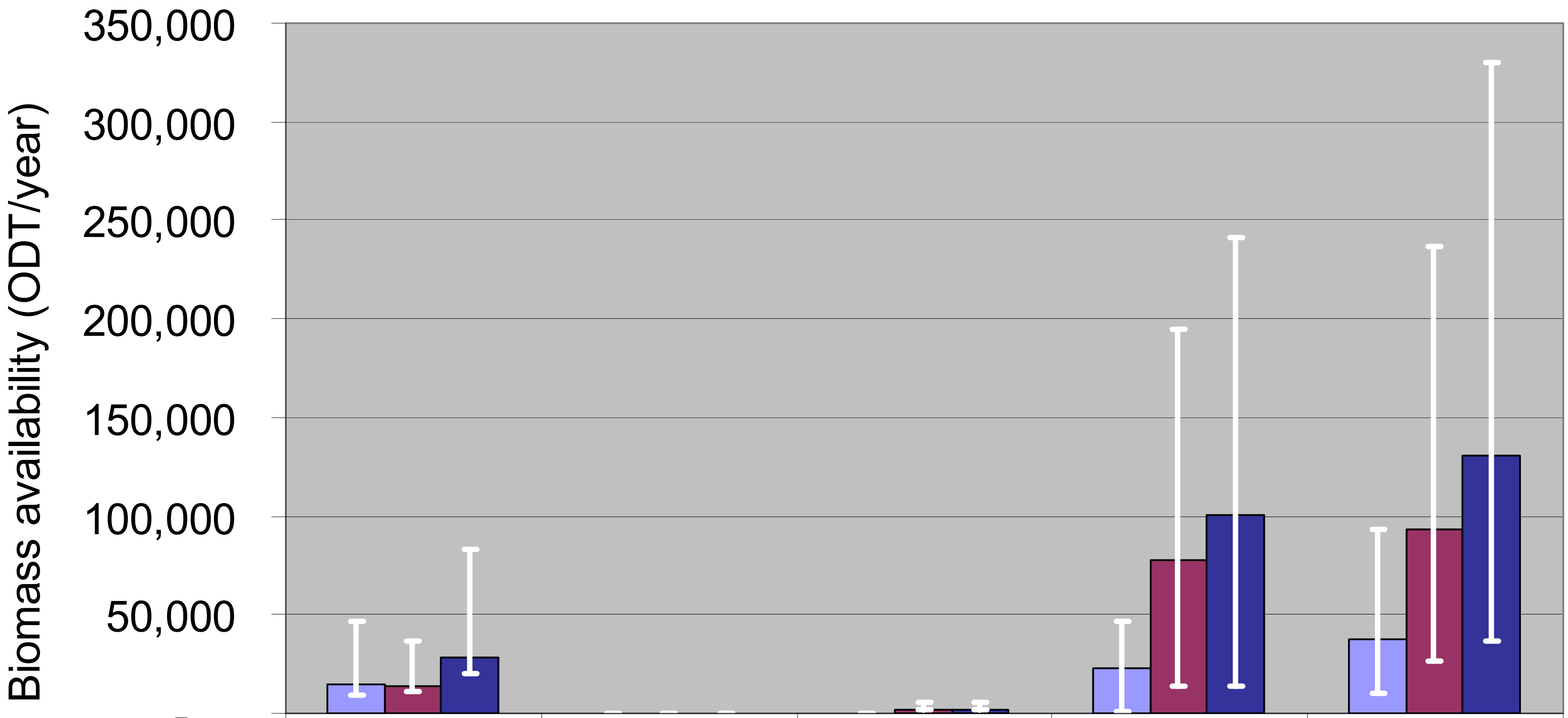
Source: McNeil Technologies, Biomass Distributed Generation Valuation Analysis and Project Development for Public Utility Service Territories, California Energy Commission, April 2006.

Oregon - Historical Timber Harvest Volume



Source: Oregon Department of Forestry County-level Timber Harvest Database

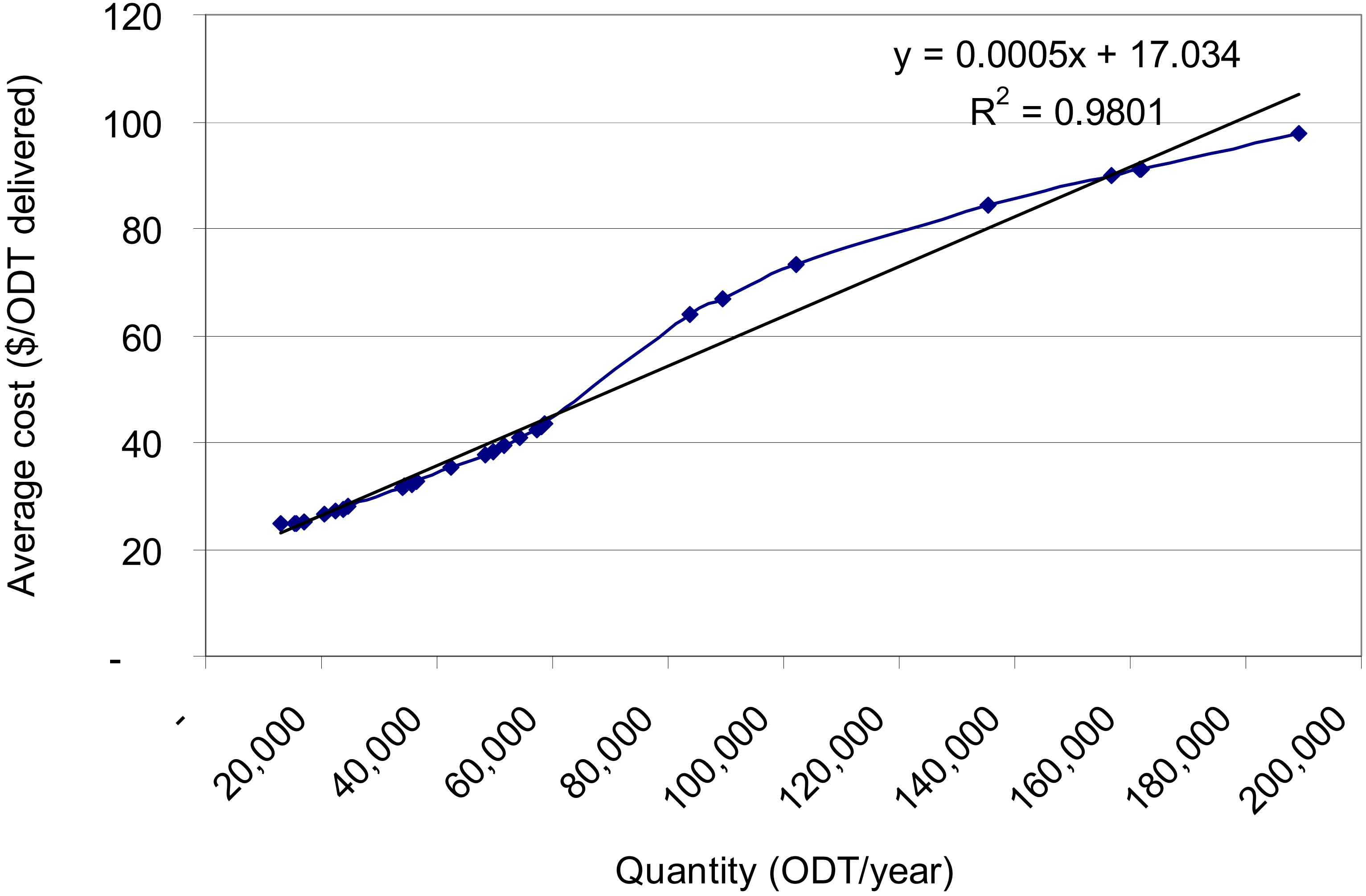
Sample Forest Biomass Availability
Truckee, California



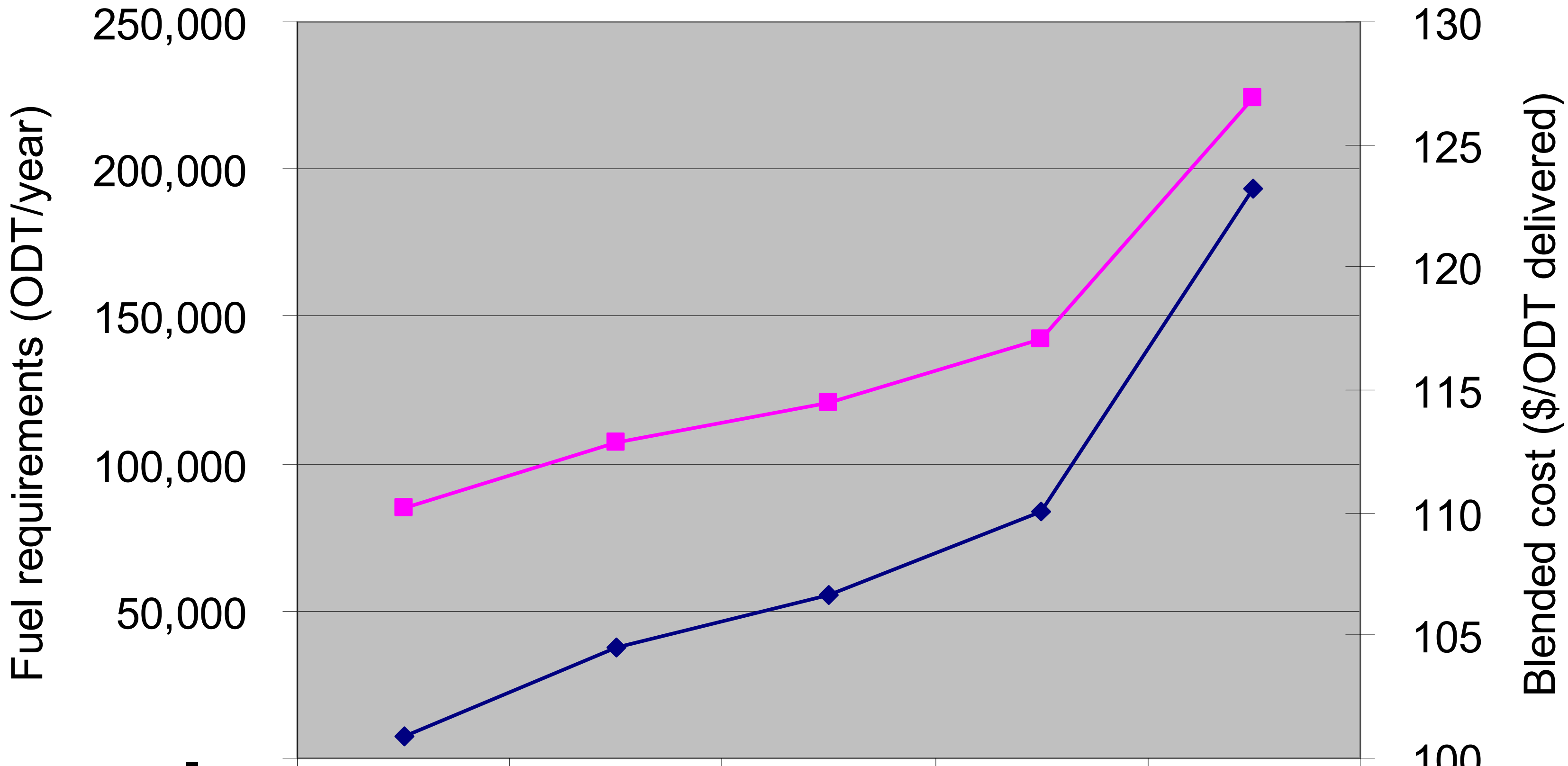
	USFS	BLM	Other public land	Private land	Total
Fuels	14,173	19	48	23,085	37,306
Timber	14,042	-	2,229	77,375	93,646
Total	28,215	19	2,277	100,460	130,951

Source: McNeil Technologies, CEC, April 2006

Biomass Supply Curve



Biomass Cost – Forest Biomass Only, Truckee, CA (Full Costs of Biomass Removal)



	1	3	5	10	25
Forest	7,539	37,695	55,537	83,768	193,310
$/ODT	110	113	114	117	127

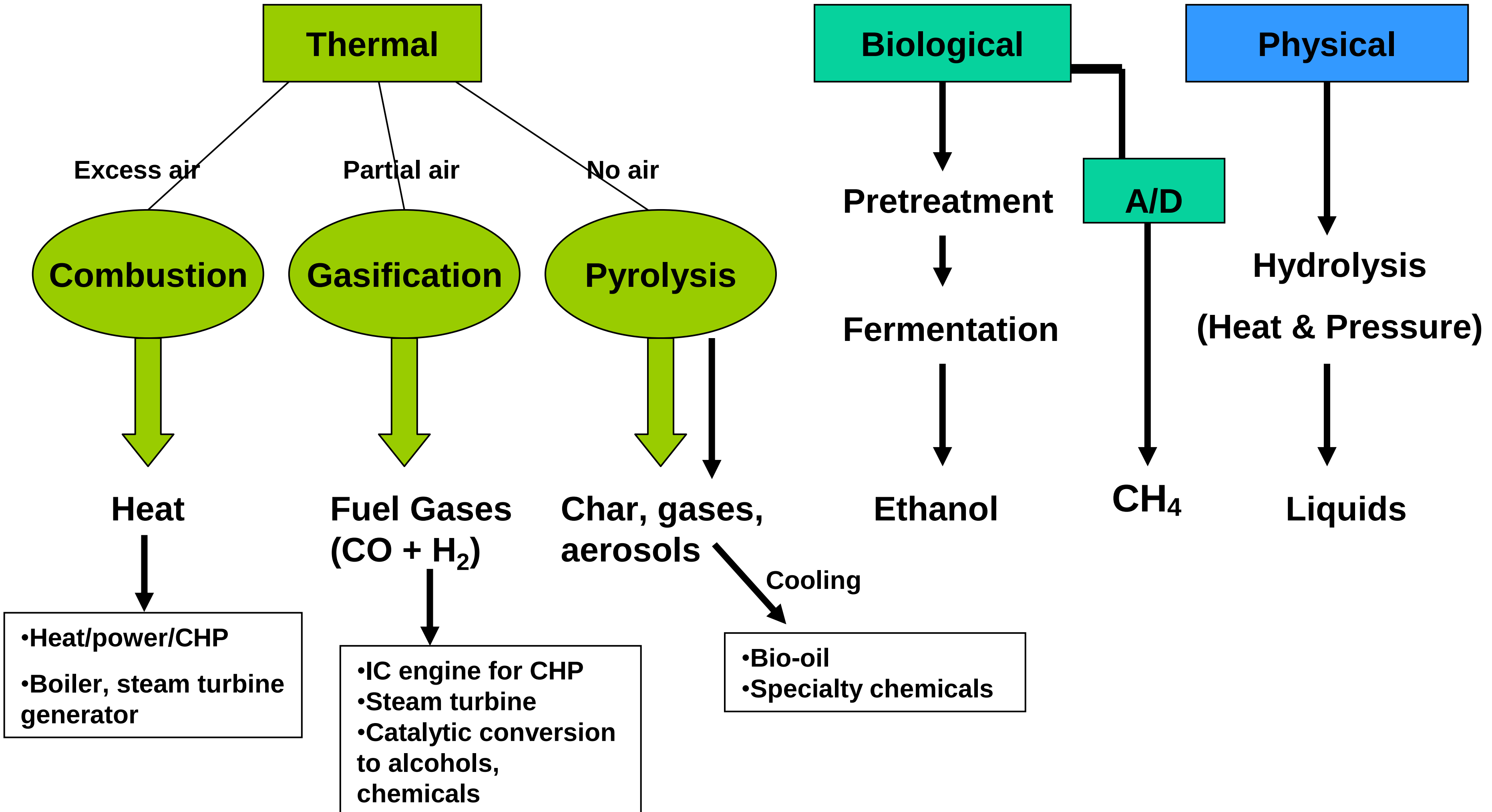
Plant size (MW)

Source: McNeil Technologies, CEC, April 2006

Biomass Supply Questions

- How much do I need?
- Where is it going to come from?
- How reliable is the source?
- Who will bring it to me?
- What will it cost?
- What is the quality of the fuel?
- How will I screen it, and where will I store it?

Biomass Energy Pathways



Source; NREL and DEMD

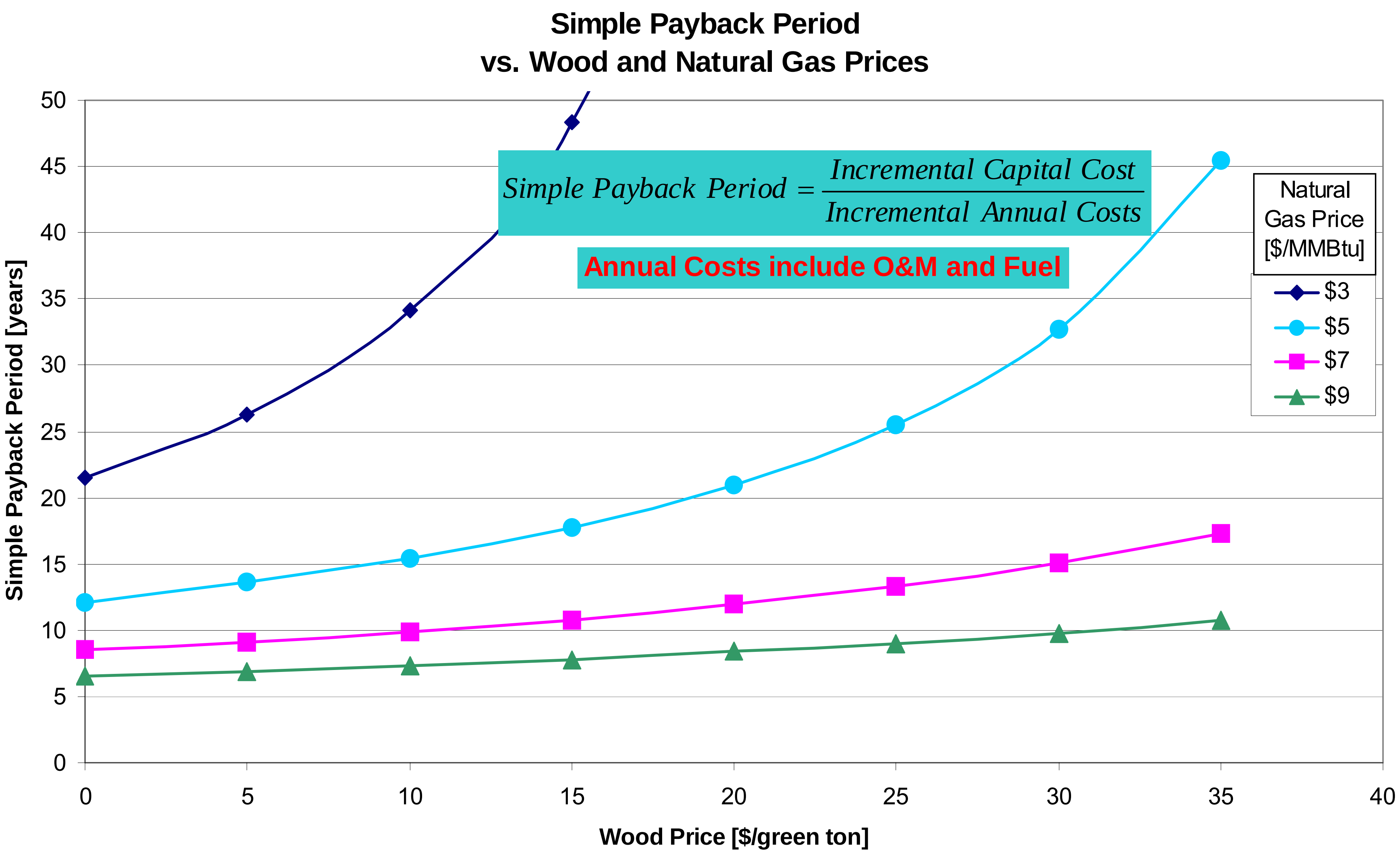
Biomass Facility Heating Technology

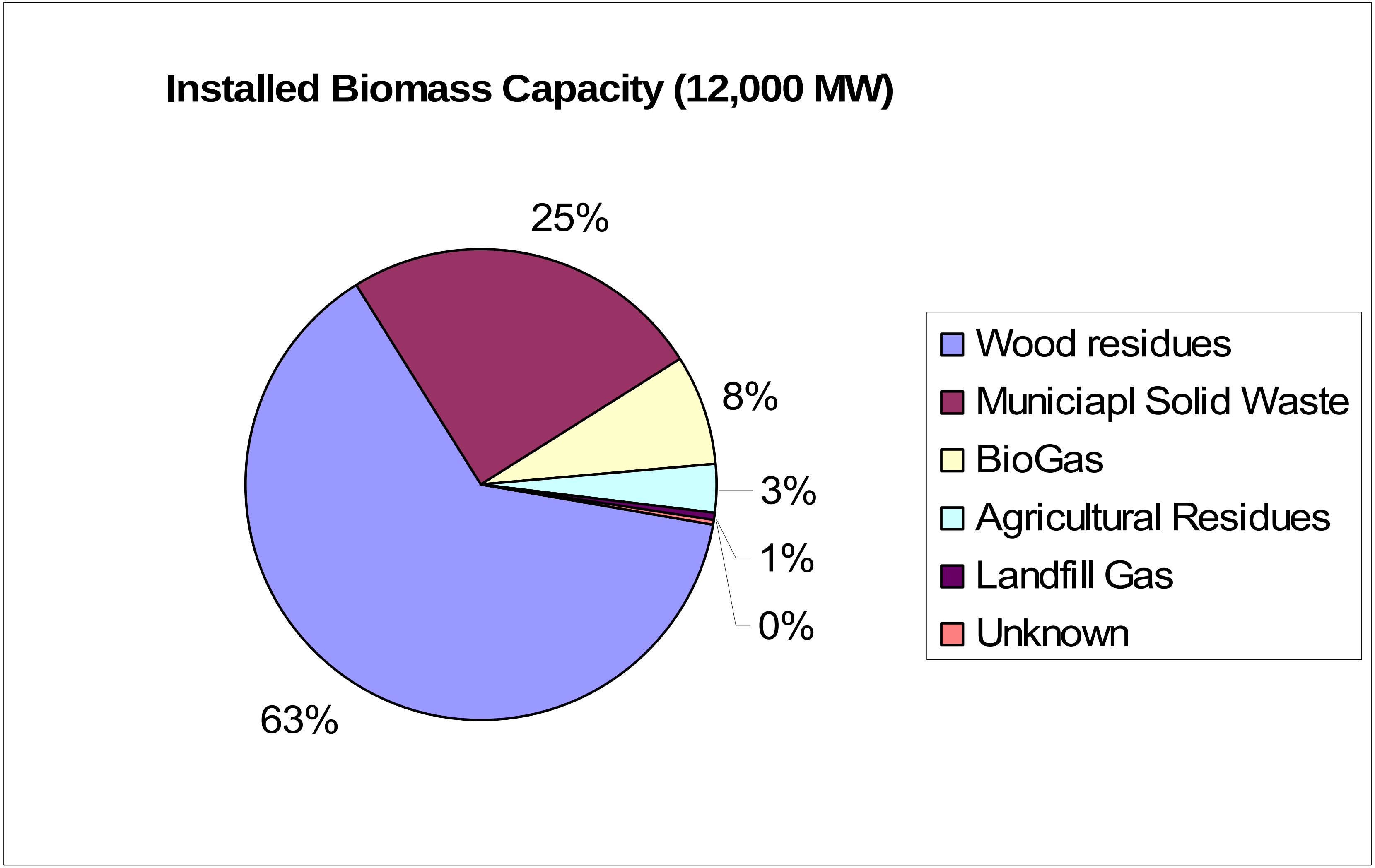
- Commercial, proven technologies
  - Hot water or low pressure steam
- Positive operator experience
  - Low maintenance, truly automated
  - Clean burning
- Moderate payback periods depending on wood cost and alternate system

Vermont Army National Guard

Spaulding High School, Barre Vermont (Messersmith)

Biomass Heating





Source: NREL, REPIS

Biomass Power Technology Overview

- Combustion
- Gasification
  - Steam cycle
  - Direct use of gas in internal combustion engine
  - Gas turbine
  - Catalytic conversion to liquid fuels
- Co-firing wood with coal
- Pyrolysis oils (bio-oils to generator)

Biomass Power

- Almost all commercial systems are combustion/steam turbine
- Most are grate stokers, but some fluidized bed combustion
- 1-110 MW (average is 20)
- Heat rate 11,000 – 20,000 Btu/kWh
- Installed costs $1,700 - $3,500/kW
- 500+ facilities in U.S

Combustion

- Strengths
  - Commercial, proven, simple, low cost
  - Steam cycle
  - Multiple vendors
  - Used equipment available
  - Fuel flexibility (moisture, size)
- Weaknesses
  - Inefficient conversion process (11-20%)
  - Poor emissions profile
  - Water needs
- Opportunities
  - Lenders are comfortable with the technology
  - “Tried and true”

Biomass Gasification

- More efficient than combustion, 30%- 40%
- Manages mineral matter
- Fuel gas ($CO + H_2 + CH_4$) can be used in prime movers
- Pre-commercial, early demo
- Installed Cost $2,500+ / kW

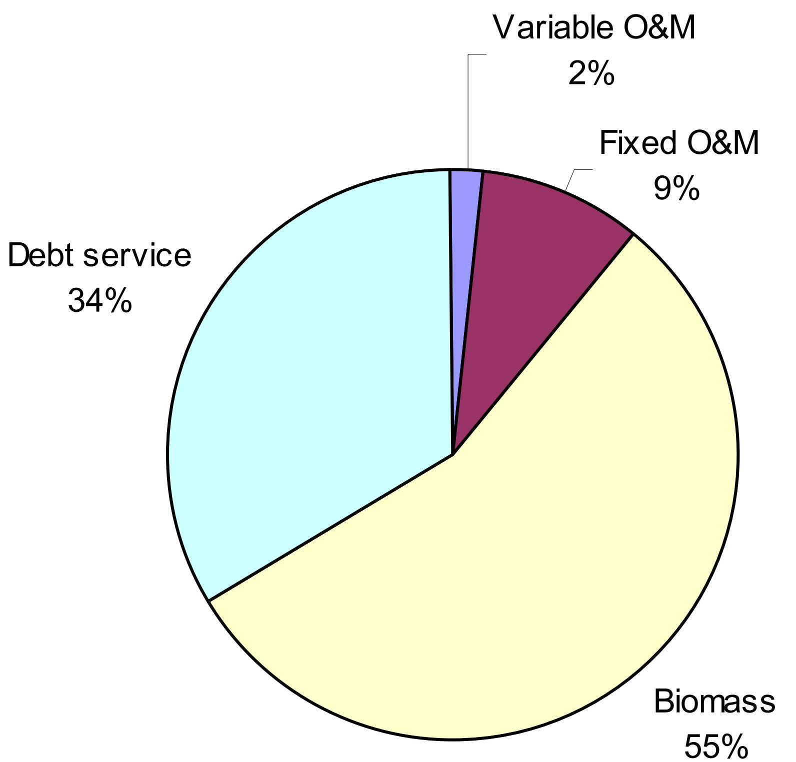
- Biomass Power: 15 kW to 50 MW
- Stand alone or CHP
- Co-fire with coal

STRPG Gasifier (Emerging Technology)

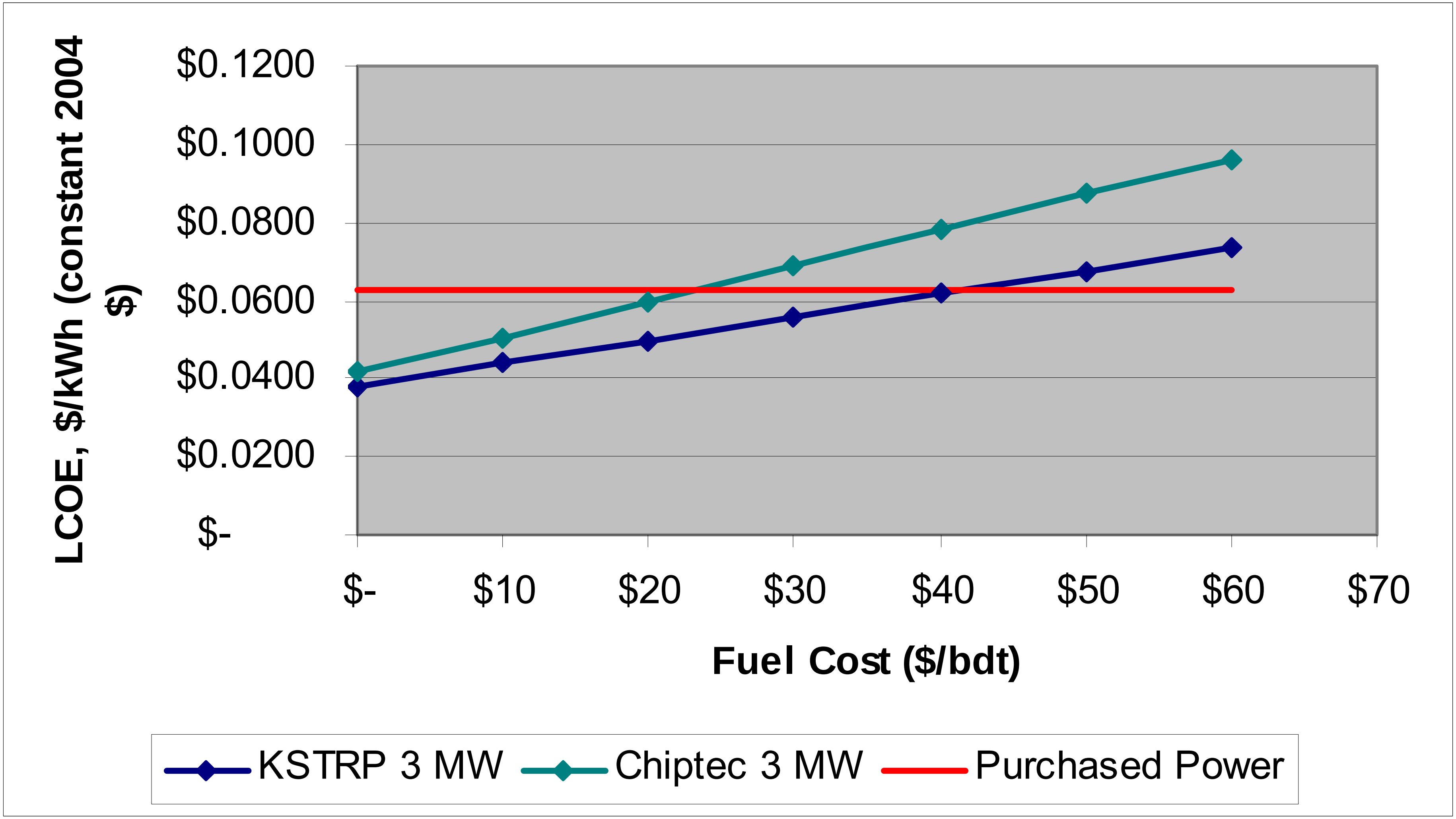
- Bioconversion Technologies (BCT)
- Pyrolysis with steam reformation
- High conversion efficiency
- <u>Needs</u> ~40% moisture fuel
- Produces clean syn gas, used in GE Jenbacher Engine
- Can produce heat, electricity, or ethanol and other chemicals
- Lowest projected capital costs
- <u>Minimal water requirements</u>
- Semi-mobile

Fabrication of Chiptec 3 MW Burner Unit

5 MW Biomass Plant – Annual Operating Costs

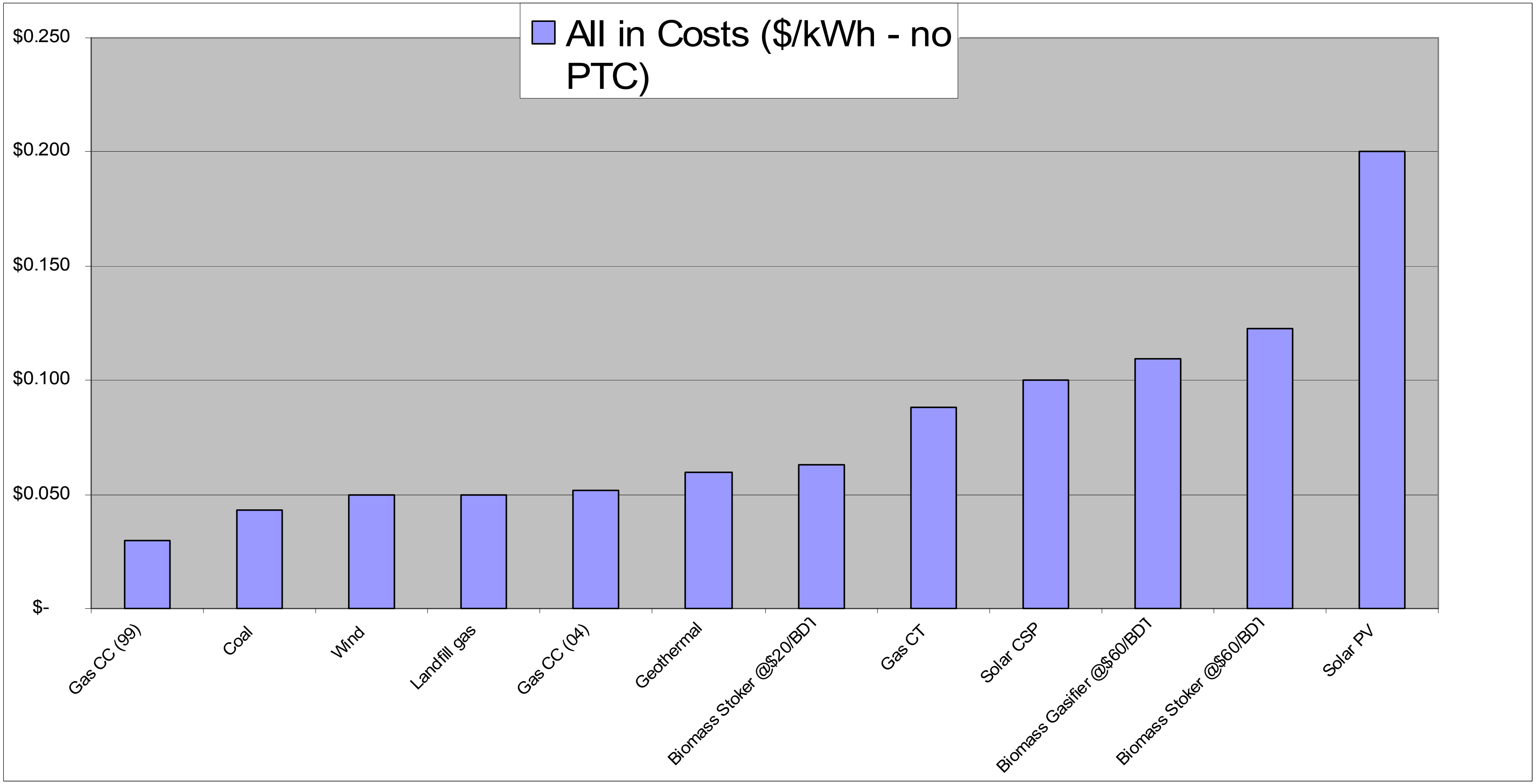


Estimated Levelized Cost of Energy vs. Fuel Cost



Source: McNeil, CEC, April 2006

Comparative Costs of Electric Generation



Cellulose Ethanol Technology

- Concentrated acid hydrolysis
- Dilute acid hydrolysis
- Enzymatic hydrolysis
- Biomass gasification and fermentation
- Technologies are not considered commercially viable at this time

Pyrolysis

- Creates a liquid fuel (BioOil)
  - Easy to transport liquid
  - Can be co-fired with coal
  - Can be burned in Orenda combustion turbine
- Early commercial development for energy
  - First commercial installation for energy generation coming on line in Canada
- One company working on a mobile technology to make oil at remote locations
- Odor, caustic, short shelf life
- May be hazardous if spilled (sinks in water)

Bioenergy Feasibility Studies: Steps

- Last chance to spend a little money before you spend a lot
- Biomass Supply Analysis: Resource assessment and costs
- Demand: Assess on-site loads, local market analysis for product
- Siting, interconnection, water, transportation, (infrastructure needs)
- Technology characterization
- Environmental review
- Barriers and opportunities
- Economic analysis, financing

Conclusions

- Forests need to be treated
- Fuel supply is available but sometimes expensive
  - Infrastructure has been lost in many locations
- Proven technologies vs. emerging
- Partnerships are needed
- Makes economic sense in many locations now
- Use of biomass has many other benefits that are not included in economics
- Fuel quality, proper system sizing and design are critical

Moving Forward

- Set reasonable expectations for all parties
- Identify a strong champion
- Match the application load to the biomass resource and technology
  - Small systems have lower fuel risk and costs, but are more inefficient
- Conduct site-specific resource assessment, economic analysis

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