Assistant Secretary-Indian Affairs

Office of Indian Energy and Economic Development

Resource Assessment for Biofuel Production

NAEMI Biomass Training
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Overview

- Bio-fuel options
- Case study
- Resource assessment
  - Woody biomass
  - Ag residues
  - Methodology
  - Data sources
- Sample economics

Technology and Feedstock Options

- Corn Ethanol
  - Traditional fermentation (corn, wheat)
- Biodiesel
  - Oil seeds (soy, canola, sunflower, rape seed)
  - Waste grease (restaurant, fast food, trap)
  - Animal fats, tallow
- Cellulosic Ethanol
  - acid hydrolysis w/ fermentation (residues, wood)
  - thermal gasification and catalytic conversion (Fisher-Tropsch liquids using any organic feedstock)
- Bio-oil (refined to Syndiesel, green diesel, renewable diesel)
  - Fast pyrolysis
  - Thermal conversion (thermal depolymerization)

Case Study

- *Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon*
  - **http://www.oregon.gov/ENERGY/RENEW/Biomass/assessment.shtml**
  - **Or Google "Eastern Oregon Biomass"**
- Snapshot in time
- Funded by Oregon Office of Energy and USFS
- Work performed by McNeil Technologies and Dr. James Kerstetter

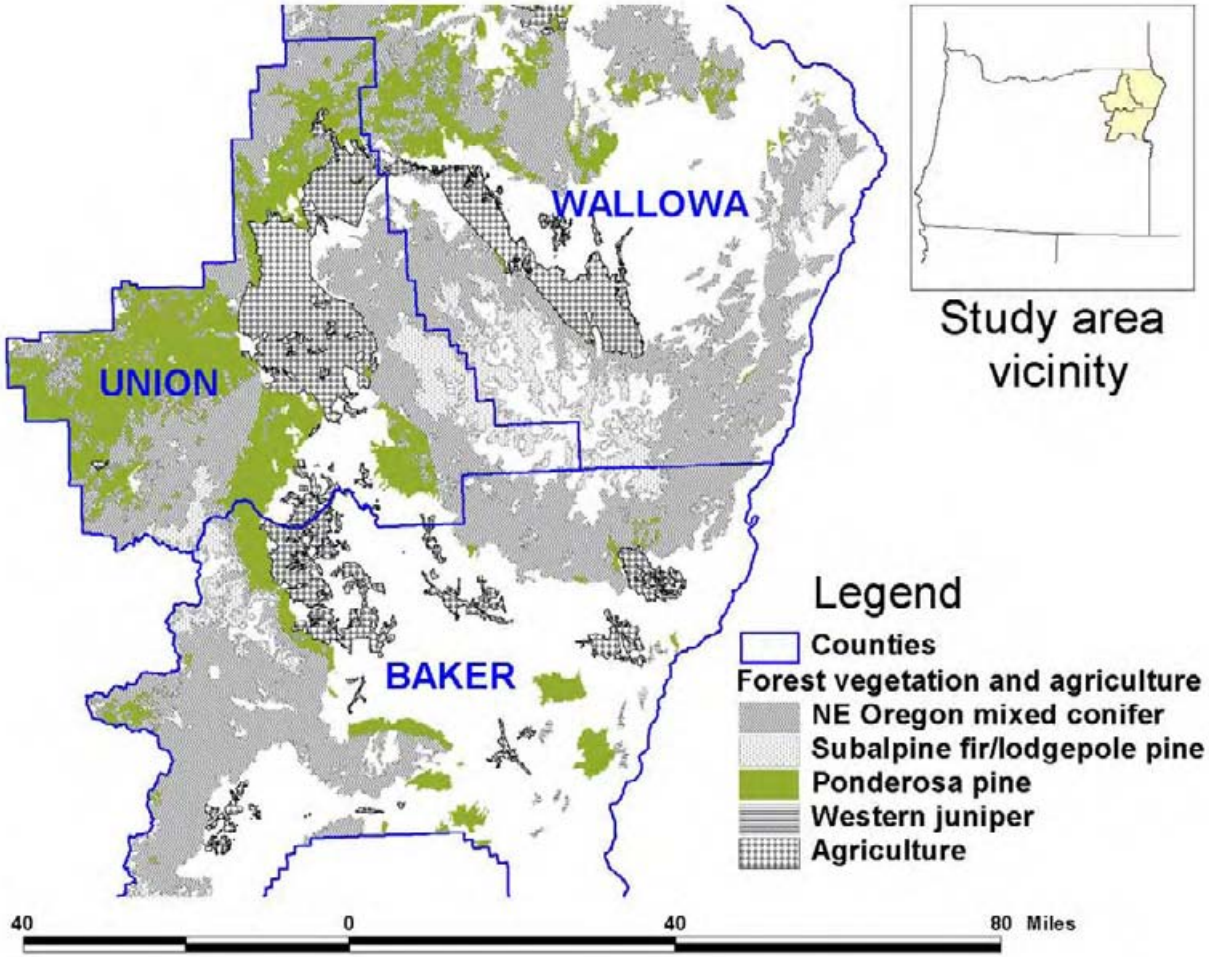
General Approach

- Determine generation of residues
- Determine availability
- Estimate roadside collection costs
- Determine delivered costs
- Develop supply curves
- Economics

Biomass Resources in Study Area

- Woody Biomass Resources
  - Primary & secondary mill residues
  - Forestry operations
    - Fuels reduction
    - Commercial timber operations
    - Timber stand improvement
    - Pre-commercial thinning
- Agricultural Resources
  - Wheat straw
  - Barley straw
  - Oat straw
  - Kentucky bluegrass

Forest Resource Overview



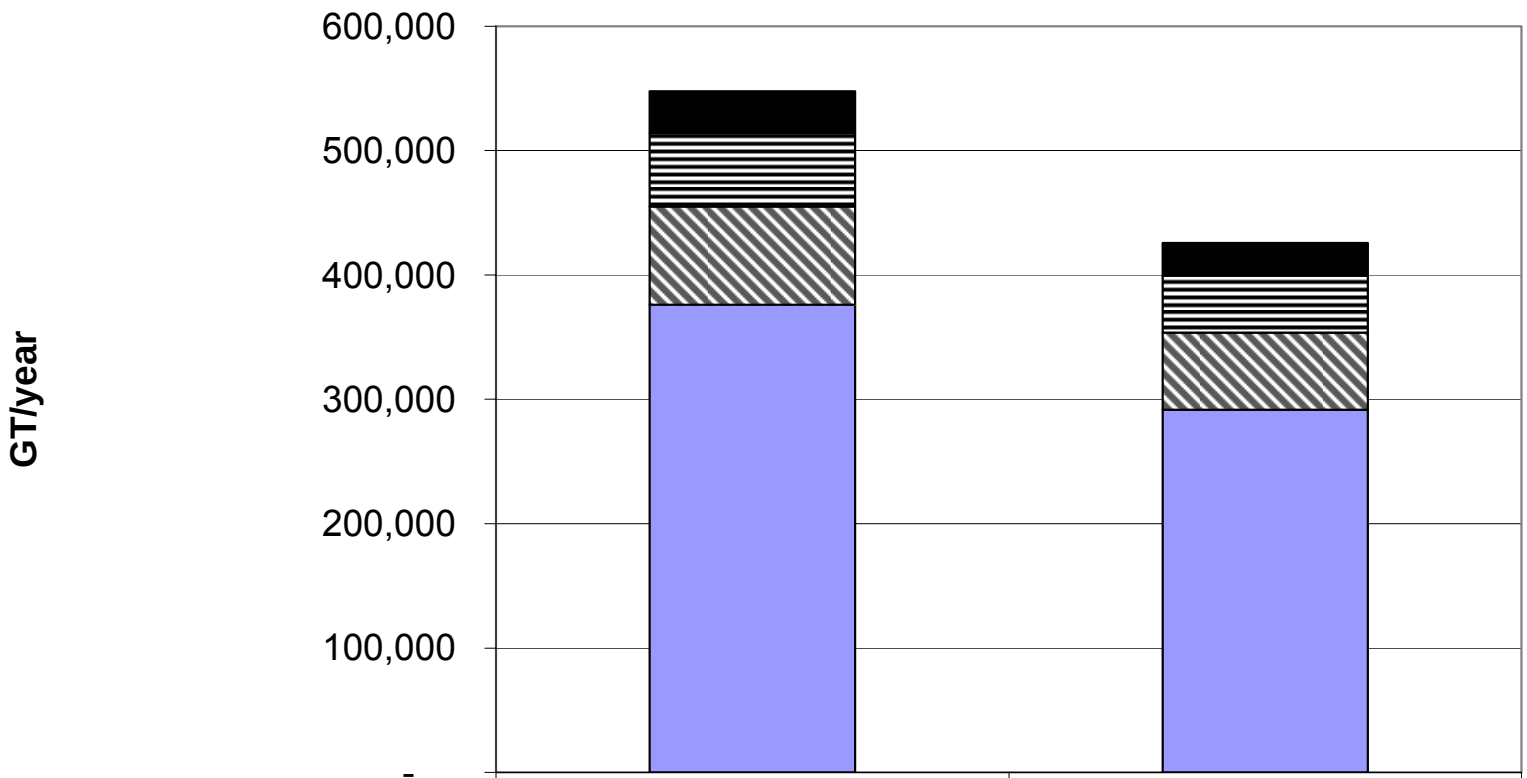
- Total area in counties: 5,259,514 acres[1]
- Total forested area: 2,539,669 acres (48.3% of land area) [1]
- Dominant forest types: mixed conifer, Ponderosa pine, Subalpine fir-Lodgepole pine, Western juniper[1]

[1]Source: Oregon Department of Land Conservation and Development. Rural Lands Database.

Forest Biomass Resource Assessment Approach

- Develop data and information on active, planned and proposed thinning projects on federal land
- Collect information on timber harvest and noncommercial thinning (all land ownership)
- Combine this information with yield data based on local and regional experience to develop estimate of biomass generation
- Determine biomass availability as a proportion of overall biomass generation
  - Slope < 30% as percent of total forest land
- Published values for harvest, skidding and chipping costs

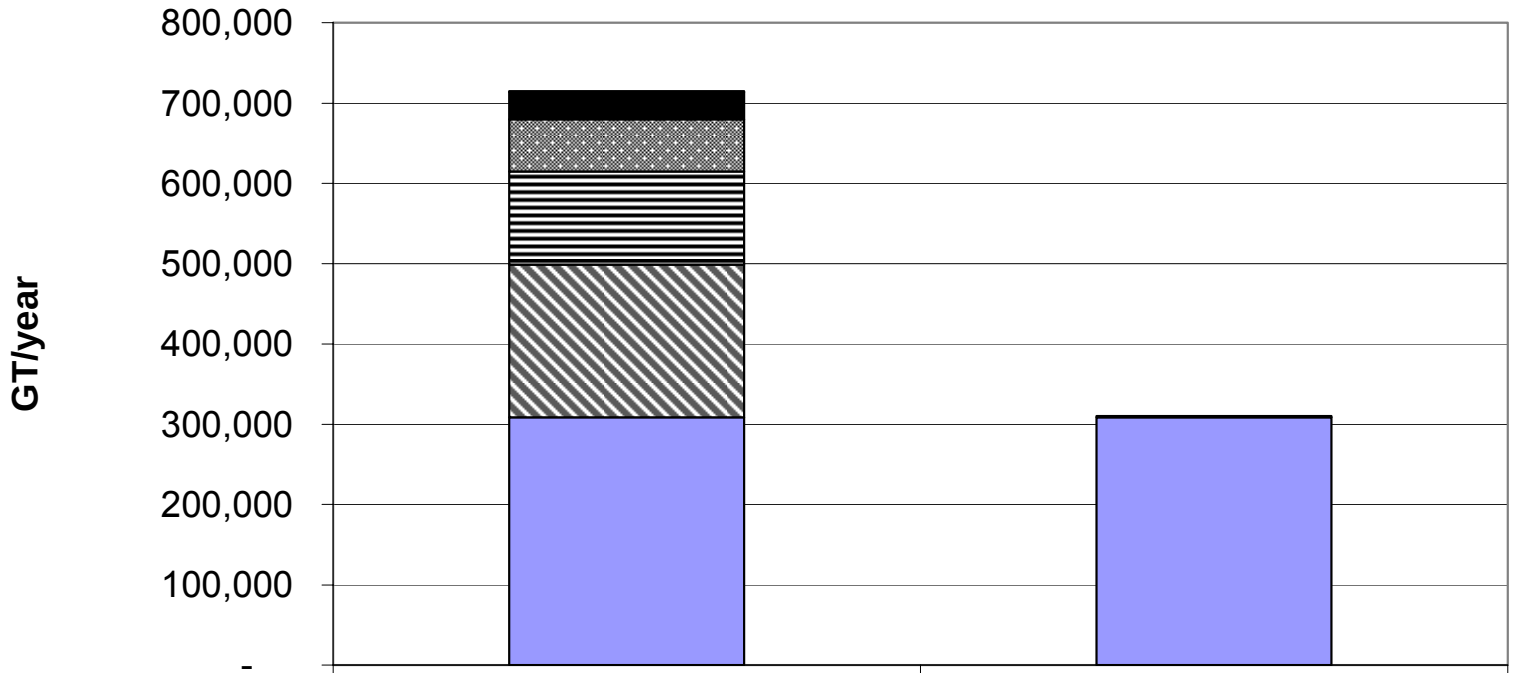
Forest Biomass Generation and Availability



	Generation	Available
Non-commercial thinning	33,710	26,355
Fuels treatment	58,807	45,976
TSI	79,120	61,857
Timber harvesting residues	375,983	291,745

- Generated: 547,620 GT/year
- Available: 425,934 GT/year

Mill Residue Generation and Availability



	Generation	Available
Veneer cores	1,458	1,458
Plywood trim	33,875	-
Planer shavings	64,603	-
Sawdust	115,961	-
Hog fuel	190,160	-
Chips	308,794	308,794

Approach: Ag Residue Generation

- Generation related to crop type, acres planted and crop yields
- Data Source: USDA, National Agricultural Statistics Service (NASS)
  - Annual survey (sampling). On-line at: http://www.nass.usda.gov:81/ipedb
  - Census of Agriculture is conducted every 5 years can be used to check survey data
- Used 10 years of past data
- Residue factors indicate quantity of residues per pound of grain produced
  - obtained from NRCS, soil conditioning index (SCI) computer model
  - 1.3 – 1.7 pound residue /pound of grain

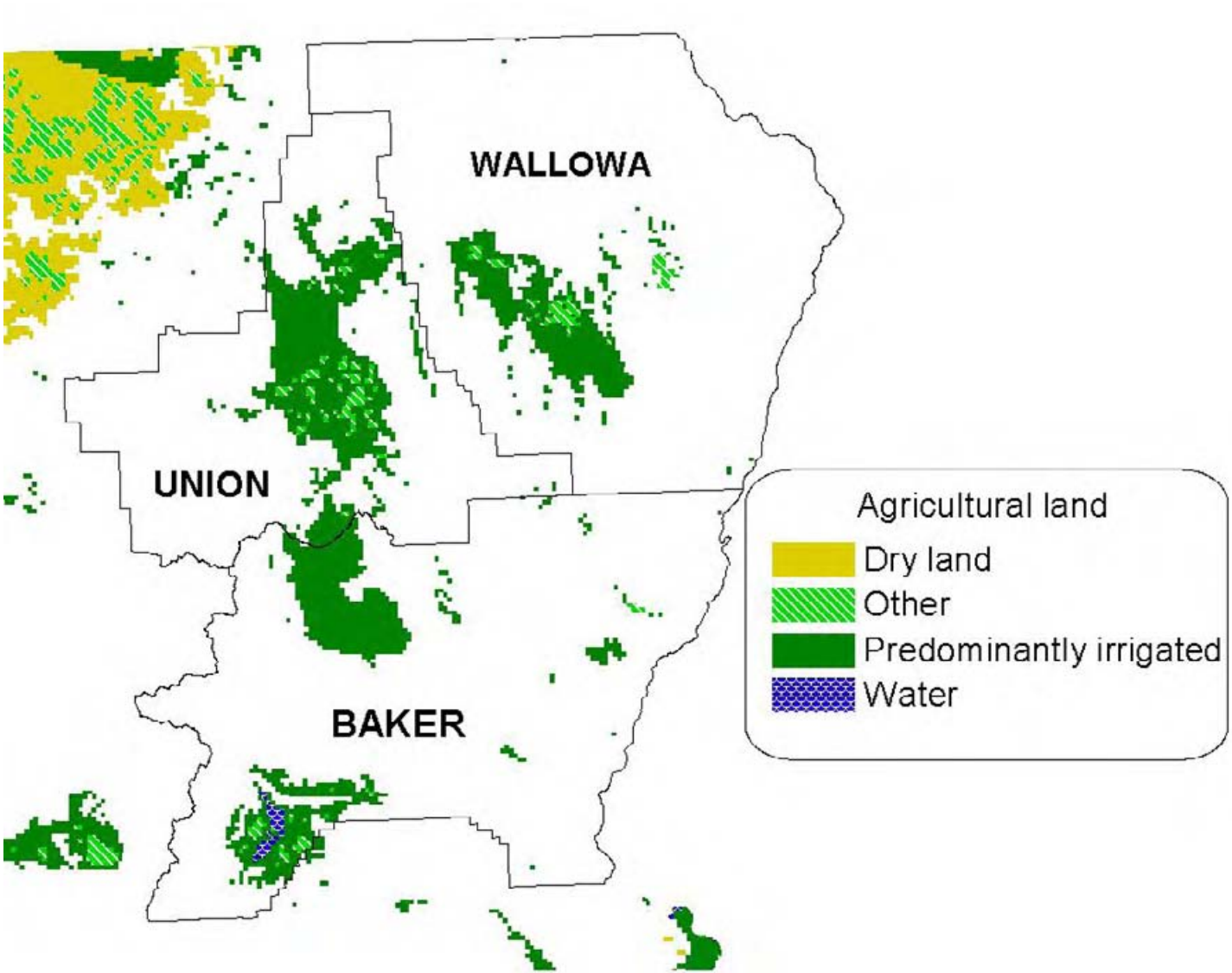
Residues Required for Soil Productivity

- Weather
- Crop rotation
- Existing soil fertility
- Slope of the land
- Wind patterns
- Rainfall patterns
- Historic farming culture
- Tillage practices

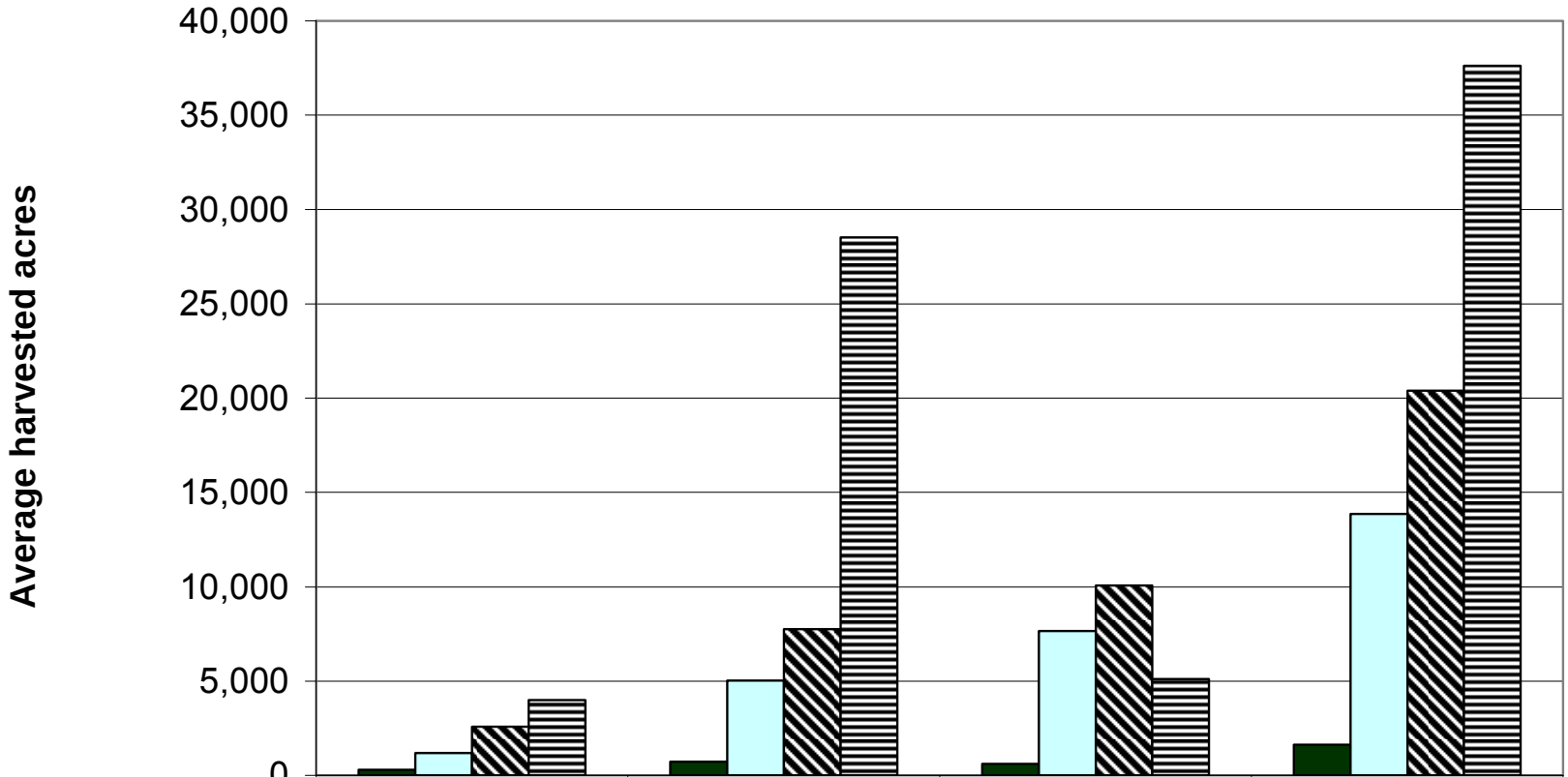
Approach: Availability

- Determine quantity of residue needed to remain on farmland for soil conservation, nutrient cycling
  - Tremendous variation in numbers and approaches
  - Contact local or regional NRCS office, Soil Conservation Service or extension agents
- We used USDA Soil Conditioning Index model to determine how much material could be removed from local soils without affecting soil productivity
- Calculate actual residue availability by subtracting residues needed to remain on-site from estimated total generation

Location of Agricultural Land

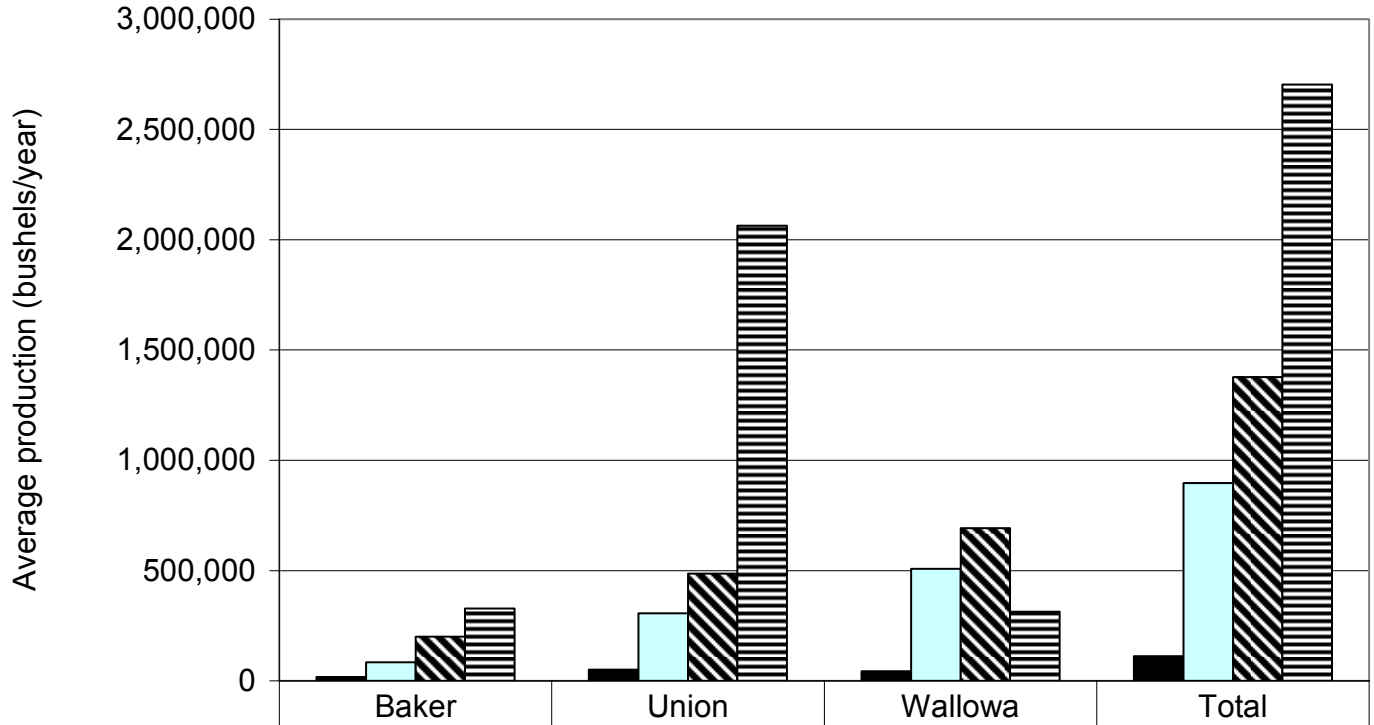


Agriculture Overview – Average Harvested Acres by Crop



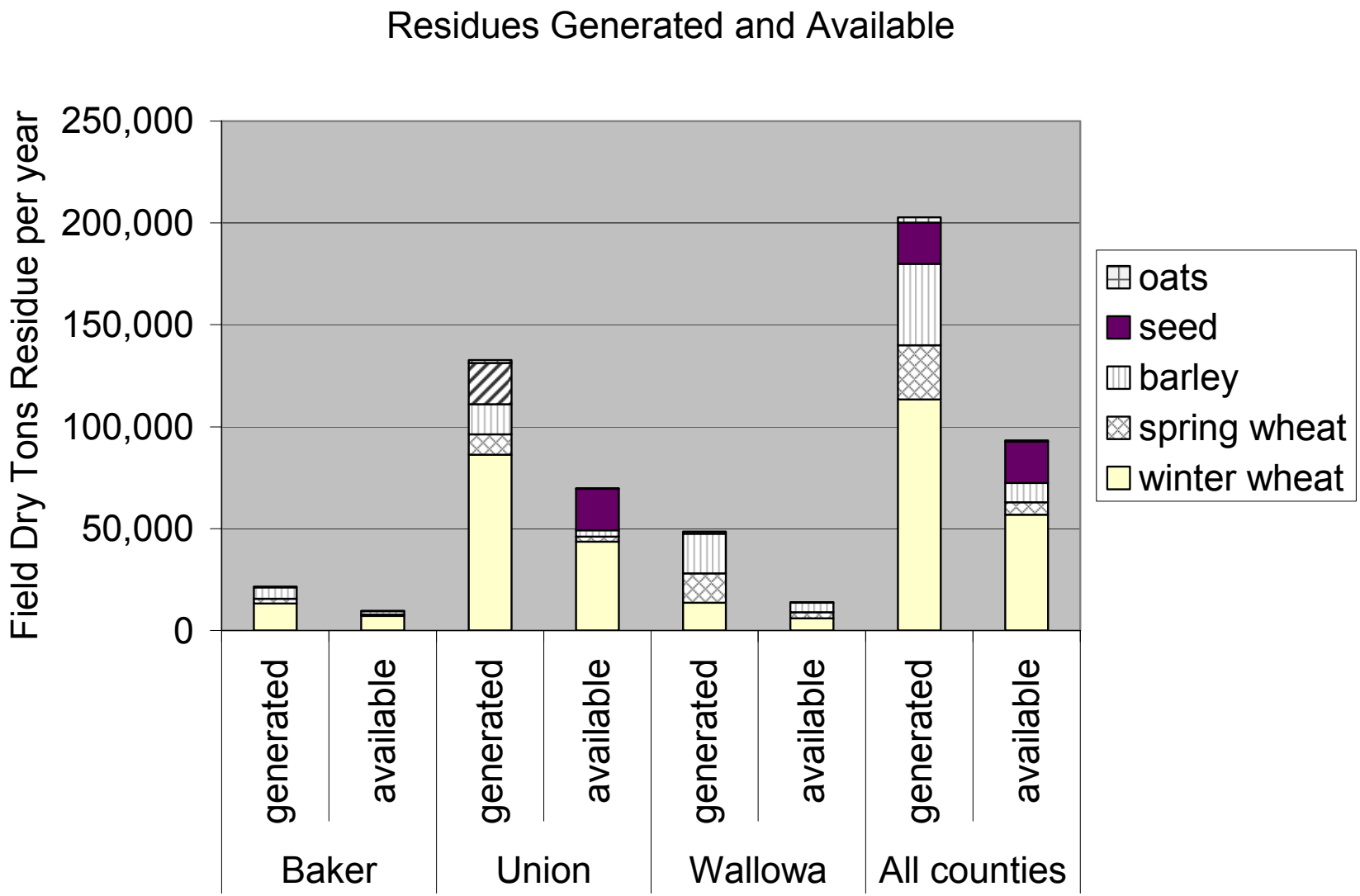
	Baker	Union	Wallowa	Total
Oats	299	720	611	1,630
Spring wheat	1,180	5,020	7,650	13,850
Barley	2,580	7,750	10,070	20,400
Winter wheat	3,990	28,530	5,100	37,620

Average Crop Production: 1992-2001 (bushels/year)



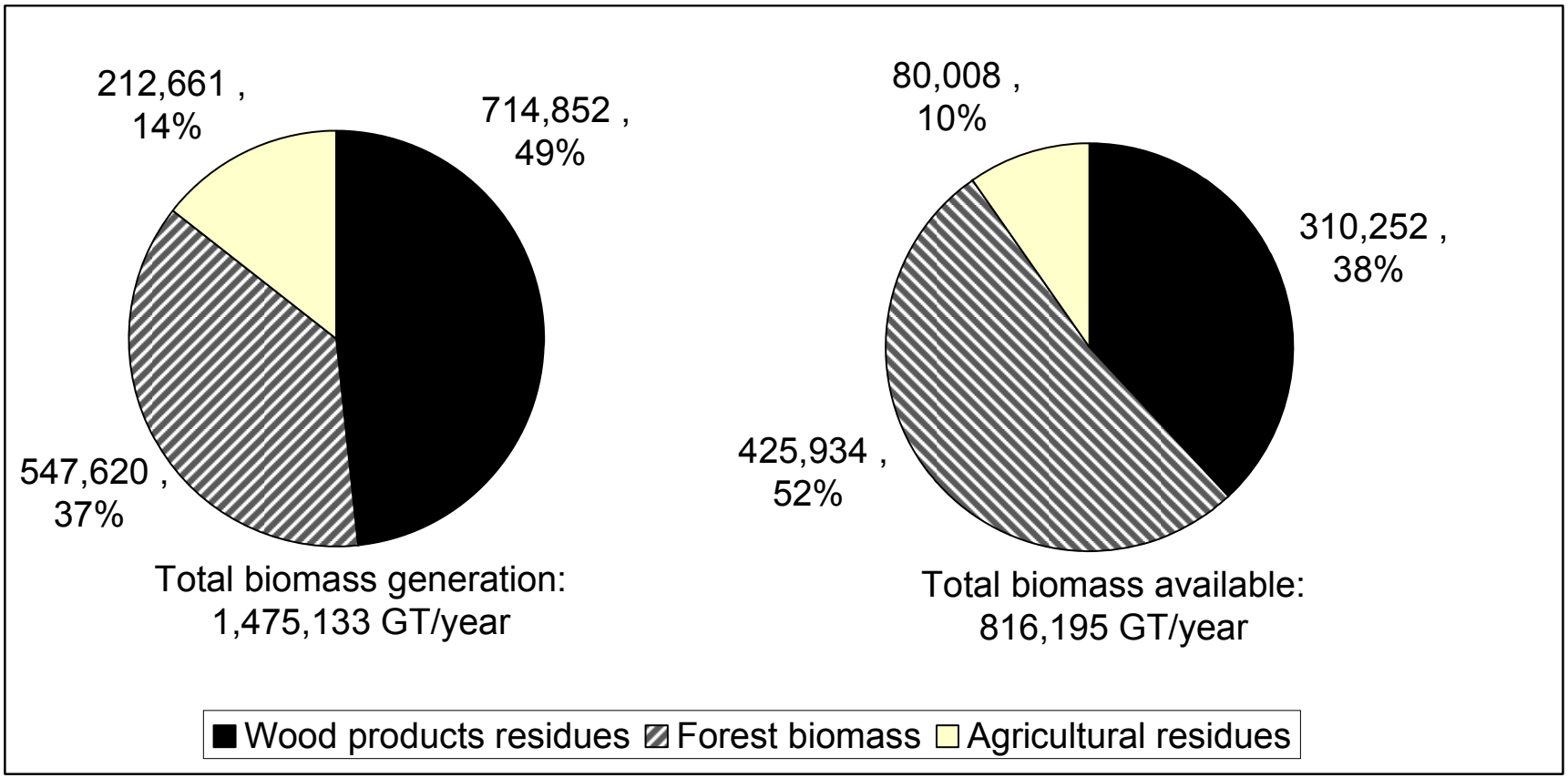
	Baker	Union	Wallowa	Total
Oats	17,292	51,296	42,983	111,571
Spring wheat	83,698	305,631	507,119	896,447
Barley	200,384	485,577	690,985	1,376,945
Winter wheat	326,904	2,063,318	313,051	2,703,273

Agricultural Biomass Residues: Generated and

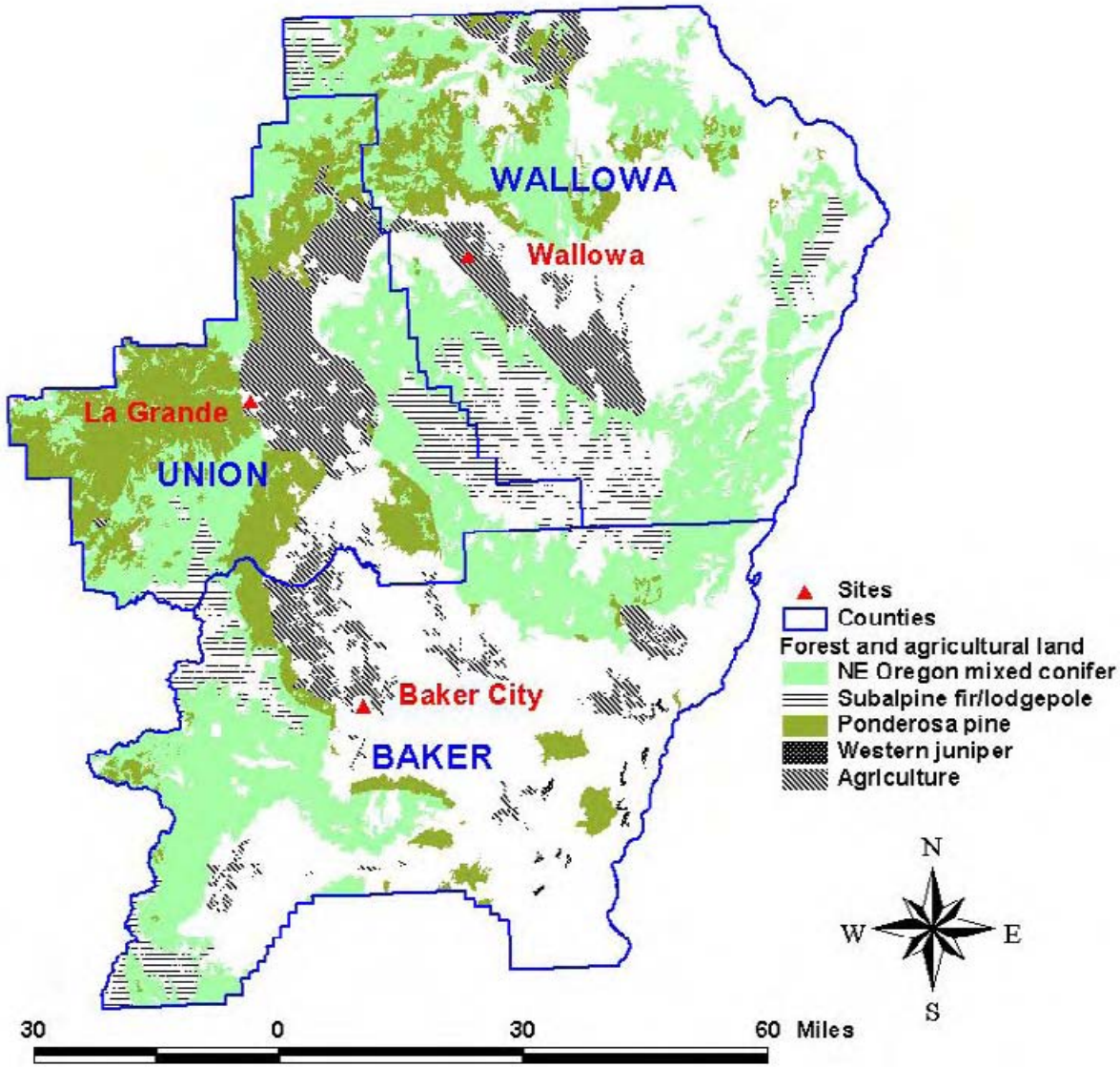


- Total generated: ~213 thousand field dry tons
- Total available: ~80 thousand field dry tons

Overall Biomass Supply



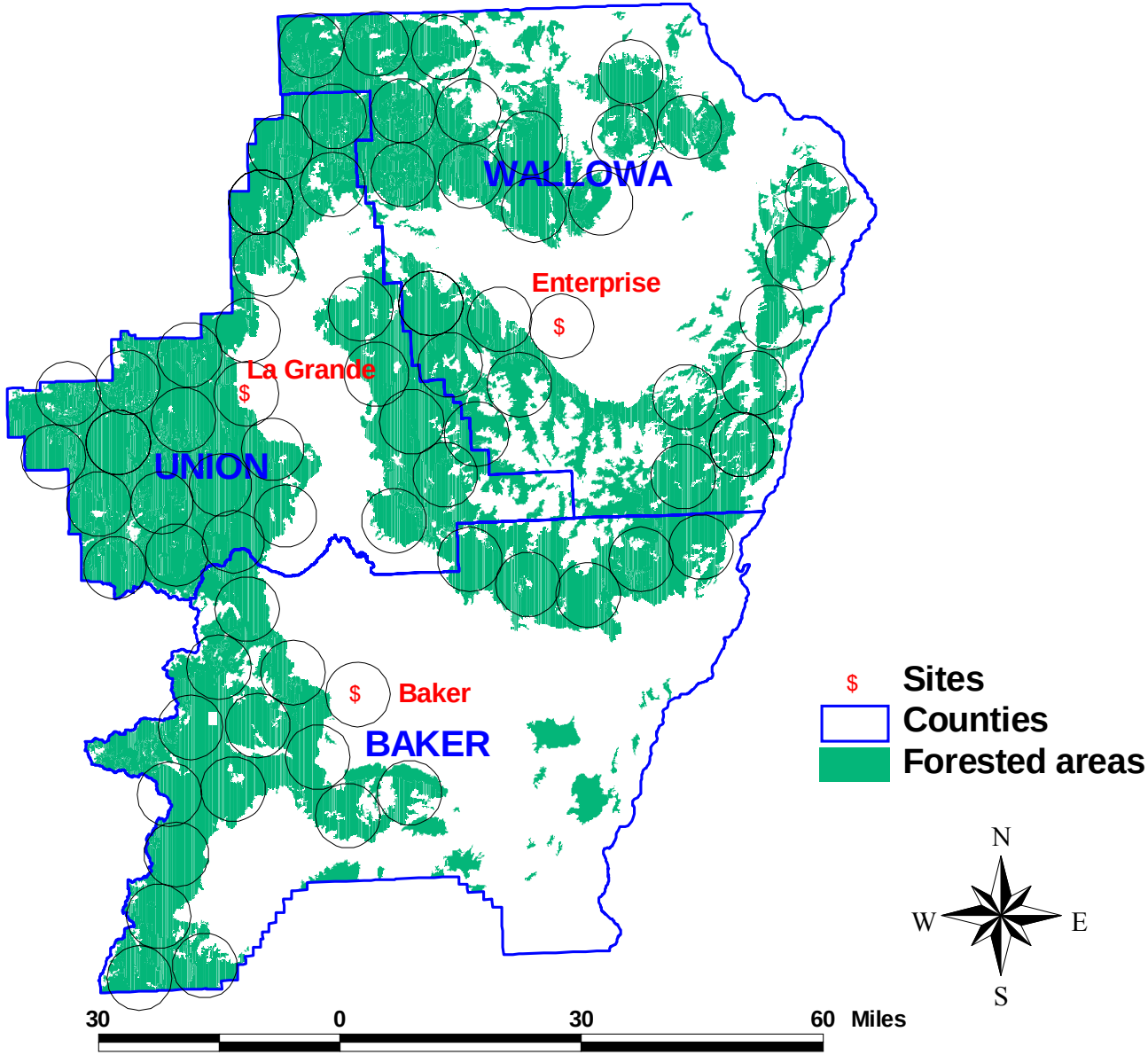
Candidate Ethanol Plant Sites



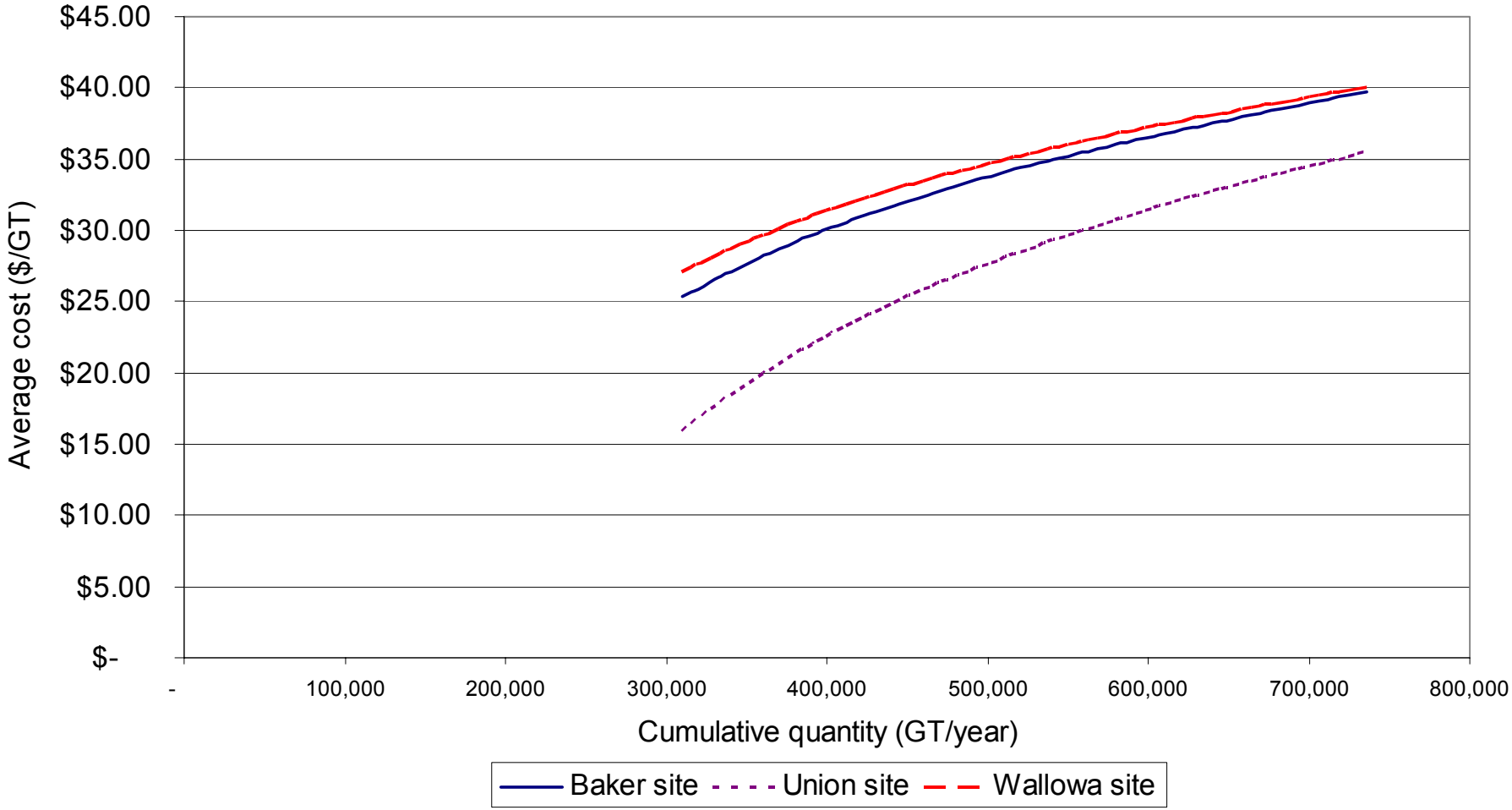
Developing Biomass Supply Curves

- Evaluated roadside biomass costs
  - Ag biomass costs included baling, swathing and stacking costs, fertilizer value of residues (for Kentucky Bluegrass we include $10/ton payment to landowner)
  - Forest biomass costs included published costs for felling, bucking, skidding and chipping
- Estimated transportation distance from supply areas to potential plant location
- Transportation cost assumptions include $5.50 fixed cost per ton plus $0.088 per ton-mile
- Estimated delivered biomass costs by adding roadside costs to transportation costs

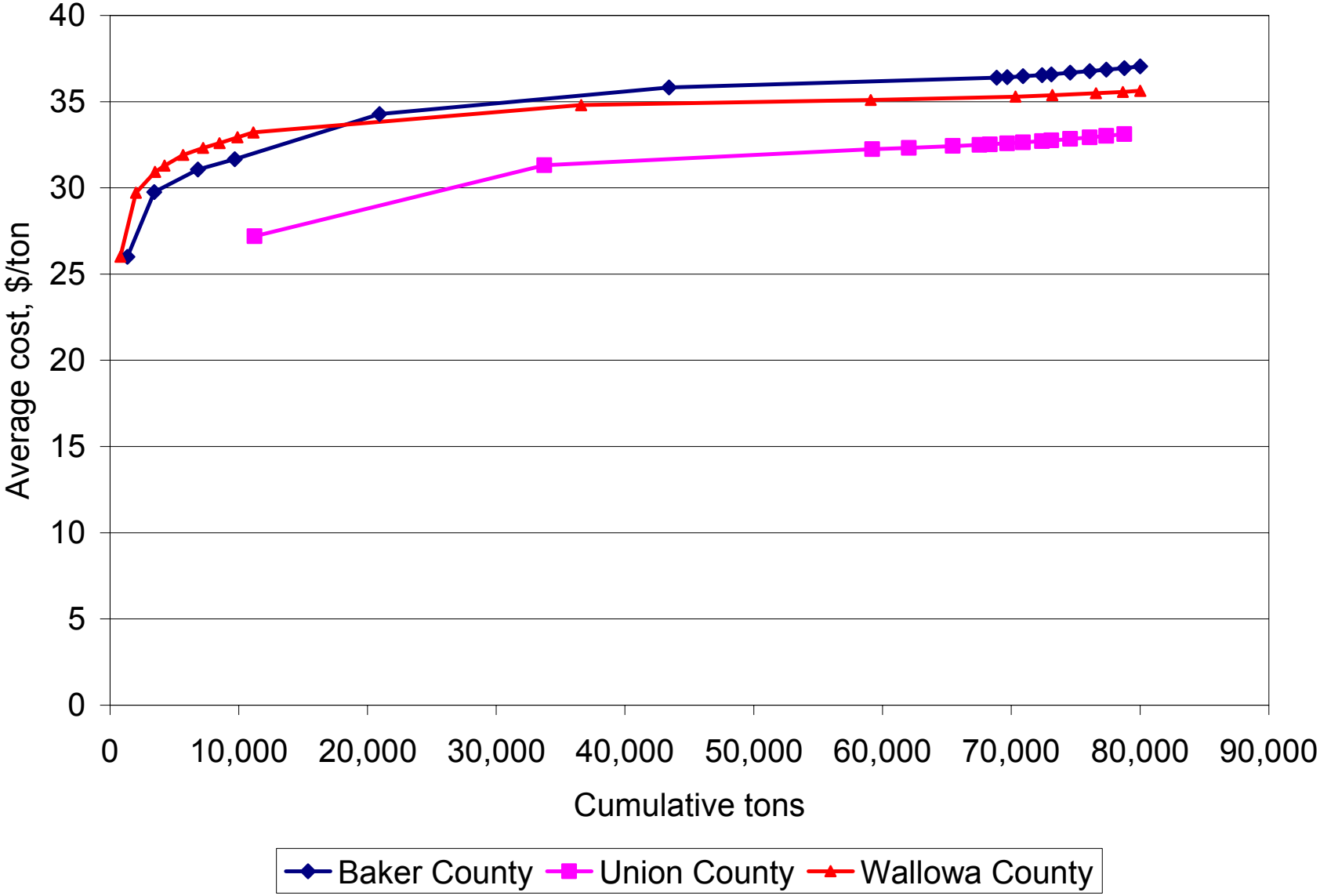
Forest Biomass Supply Radii



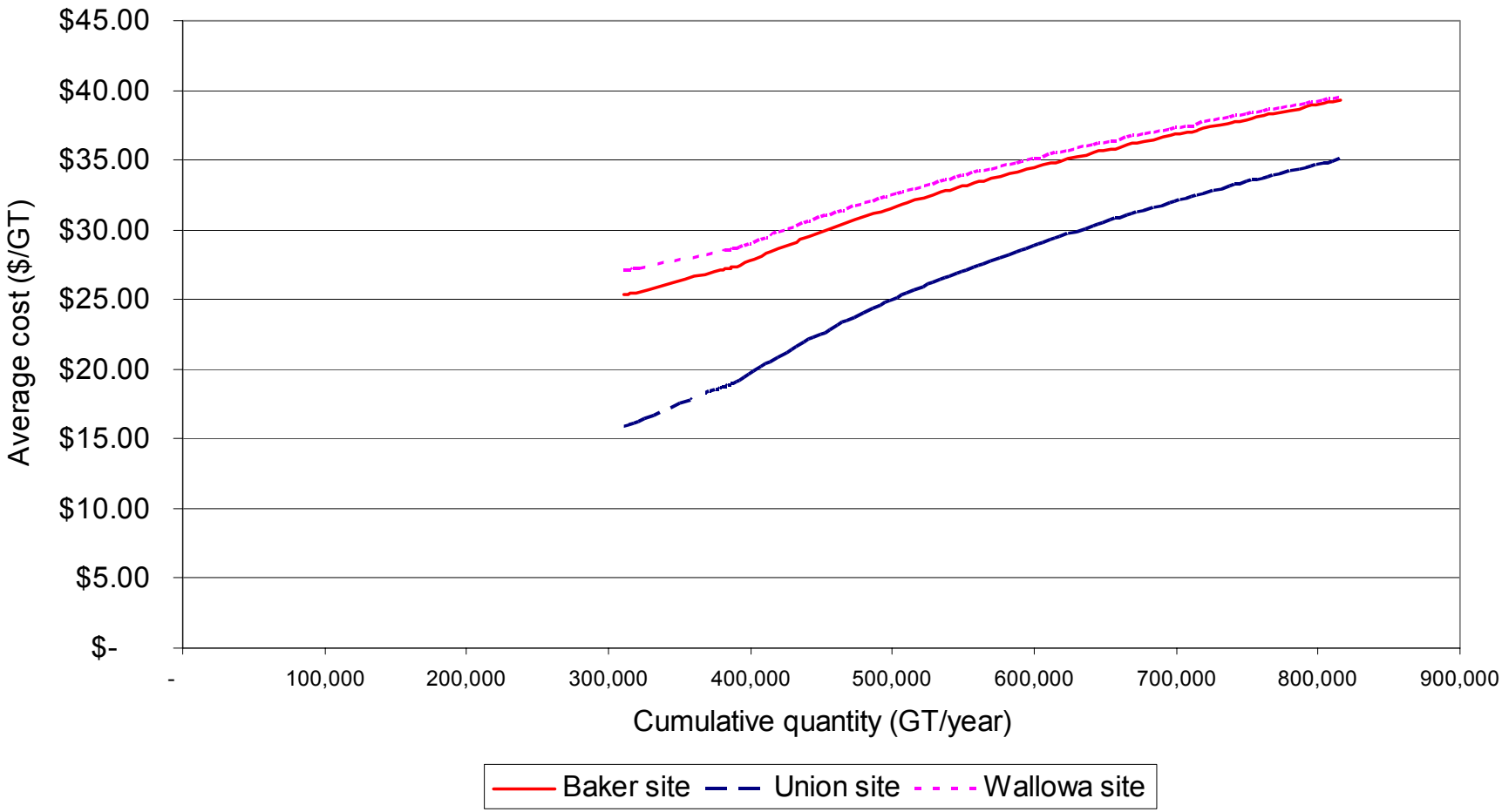
Biopower Supply Curve (Forest and Mill Residues)



Agricultural Residue Supply



Overall Supply – All Sources (Ethanol Plant)



Cellulose Ethanol Technology

- Concentrated acid hydrolysis
- Dilute acid hydrolysis
- Enzymatic hydrolysis
- Biomass gasification and catalytic conversion (mixed alcohols, FT liquids)
- Technologies are not considered commercial at this time
  - Iogen operating first demonstration scale plant in Canada
    - Feasibility study with Shell and VW in Europe
  - Others are getting closer

Theoretical Ethanol Yields from Hydrolysis/Fermentation-type Processes

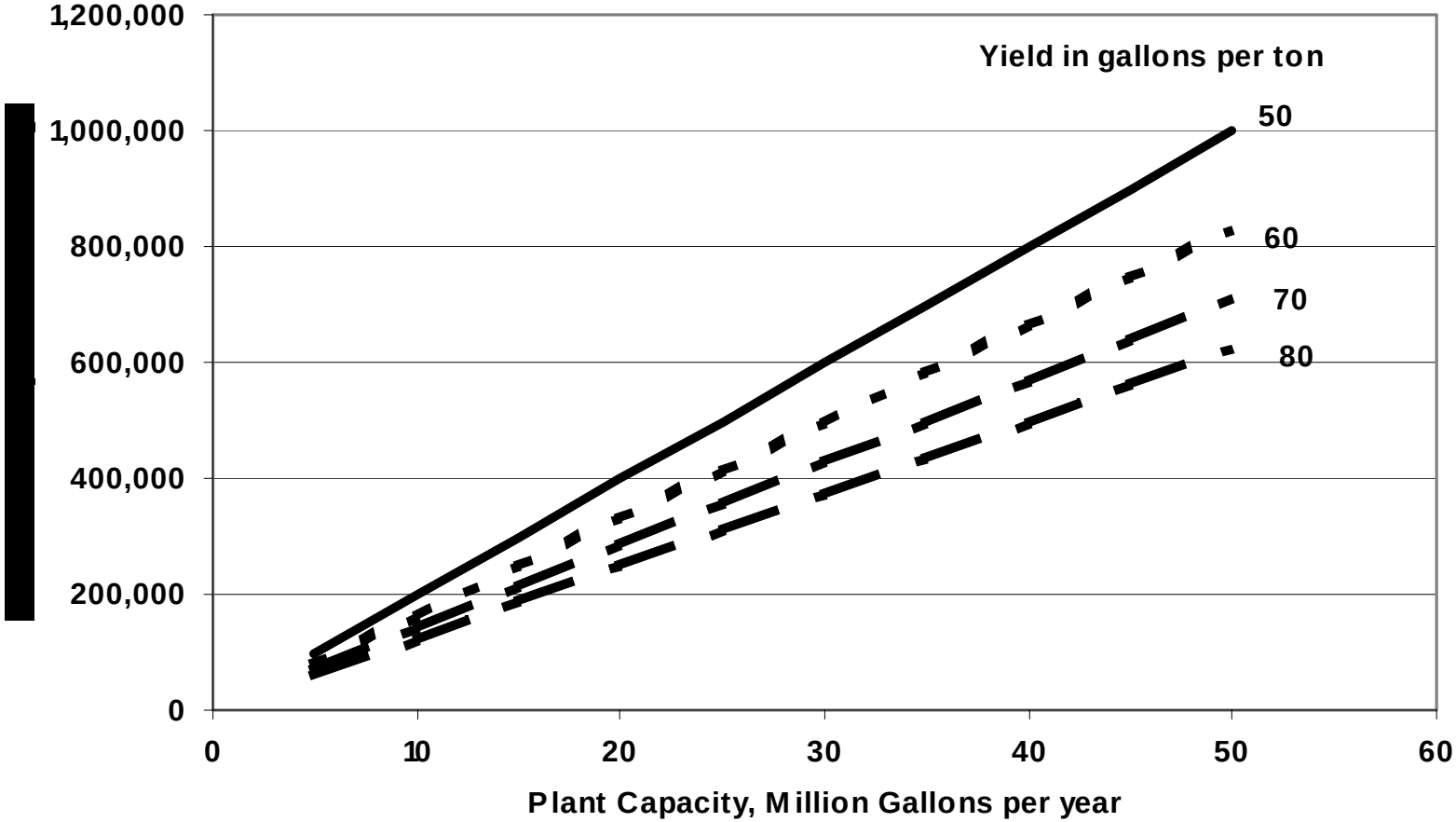
Wyman method	Cellulose (wt %)	Hemicellulose (wt %)	Theoretical ethanol yield (gallons/ODT)	75% of theoretical yield (gallons/ODT)
Pine	40.4	24.9	113	84.7
Poplar	41.3	32.9	128.6	96.4
Barley straw	42.4	22.7	112.5	84.4
Wheat straw	33.5	25.4	102	76.5

NREL method	Glucan (wt %)	Mannan (wt %)	Galactan (wt %)	Xylan (wt %)	Arabinan (wt %)	Theoretical ethanol yield (gallons/ODT)	75% of theoretical yield (gallons/ODT)
Pine	46.5	11.7	-	8.9	2.4	120.6	90.5
Poplar	49.9	4.7	1.2	17.4	1.8	130.4	97.8
Barley straw	37.5	1.3	1.7	15	4	103.6	77.7
Wheat straw	36.2	0.3	1.5	19.1	2.6	104.1	78.1

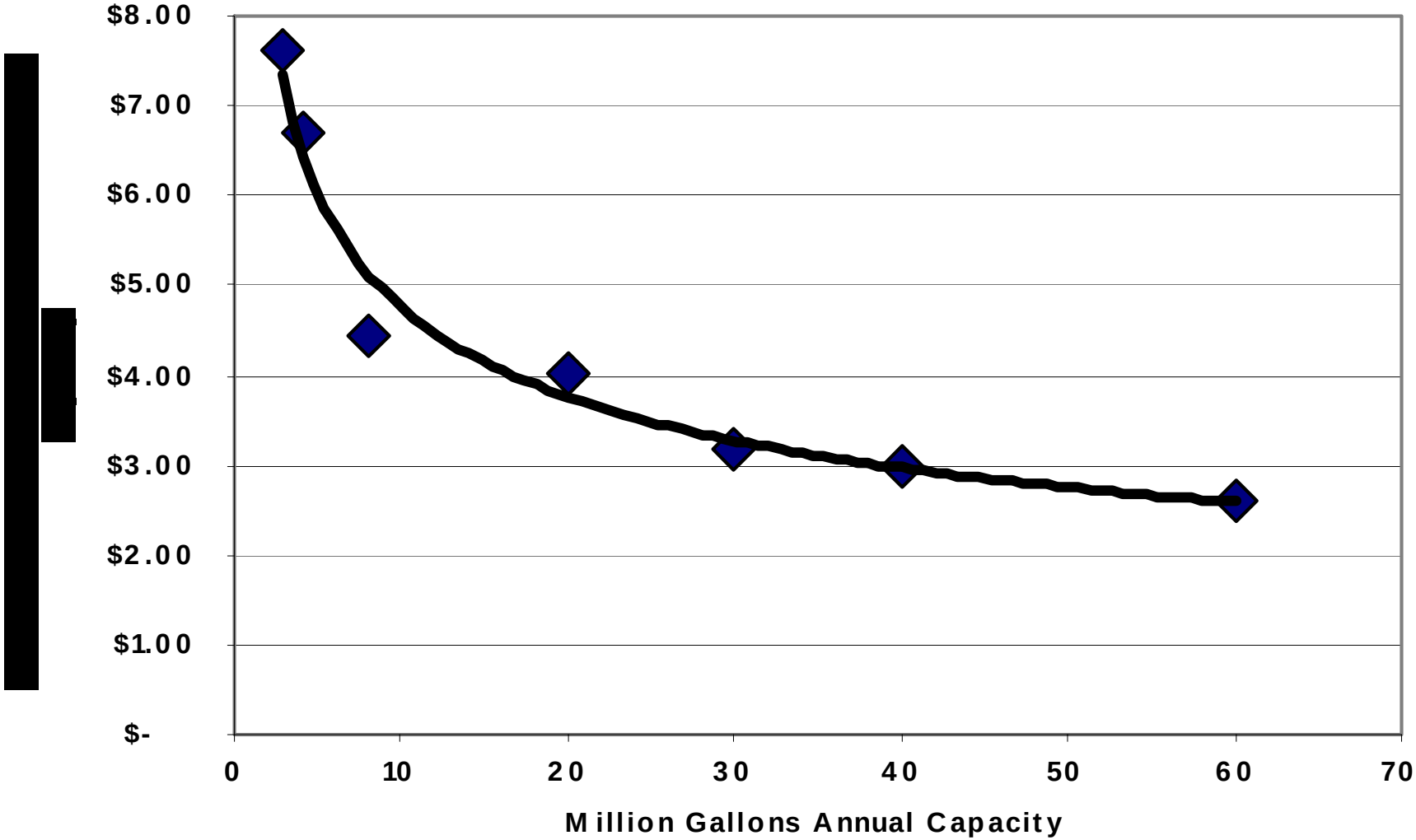
In practice, yields likely to be in range of 60-70 gals/ODT

Yields from gasification processes estimated at 50-60 gals/ODT

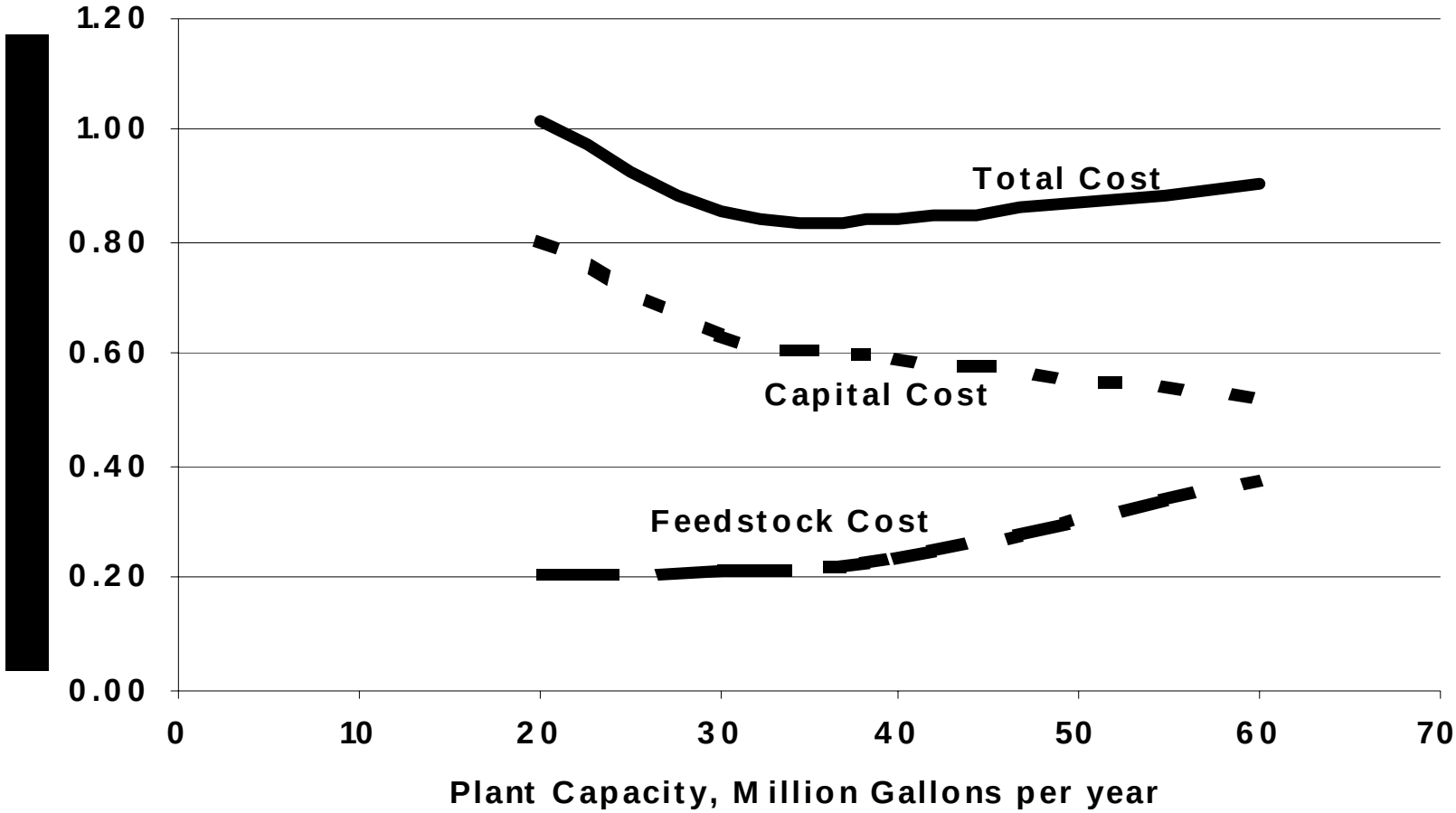
Feedstock Requirements vs. Yield



Economies of Scale for Ethanol Production



Ethanol Production Costs



Sample Plant

- 15,000,000 gallons/year
  - 1,640 GT/day (600,000 GT/yr)
  - 30 people at plant
- Biomass harvest jobs:

Category	Units	Value
Supply		
Crew	# people	6
Chip van capacity	GT	23
Daily deliveries	Vans / day	6
Daily quantity	GT	138
Demand		
Plant Capacity	Million gallons/year	15
Feedstock requirements	GT/year	600,000
Feedstock requirements	GT/day	1,644
Transportation requirement	Van / day	72
Number of crews	Crews	12
Direct Employment	People	78

Contact

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