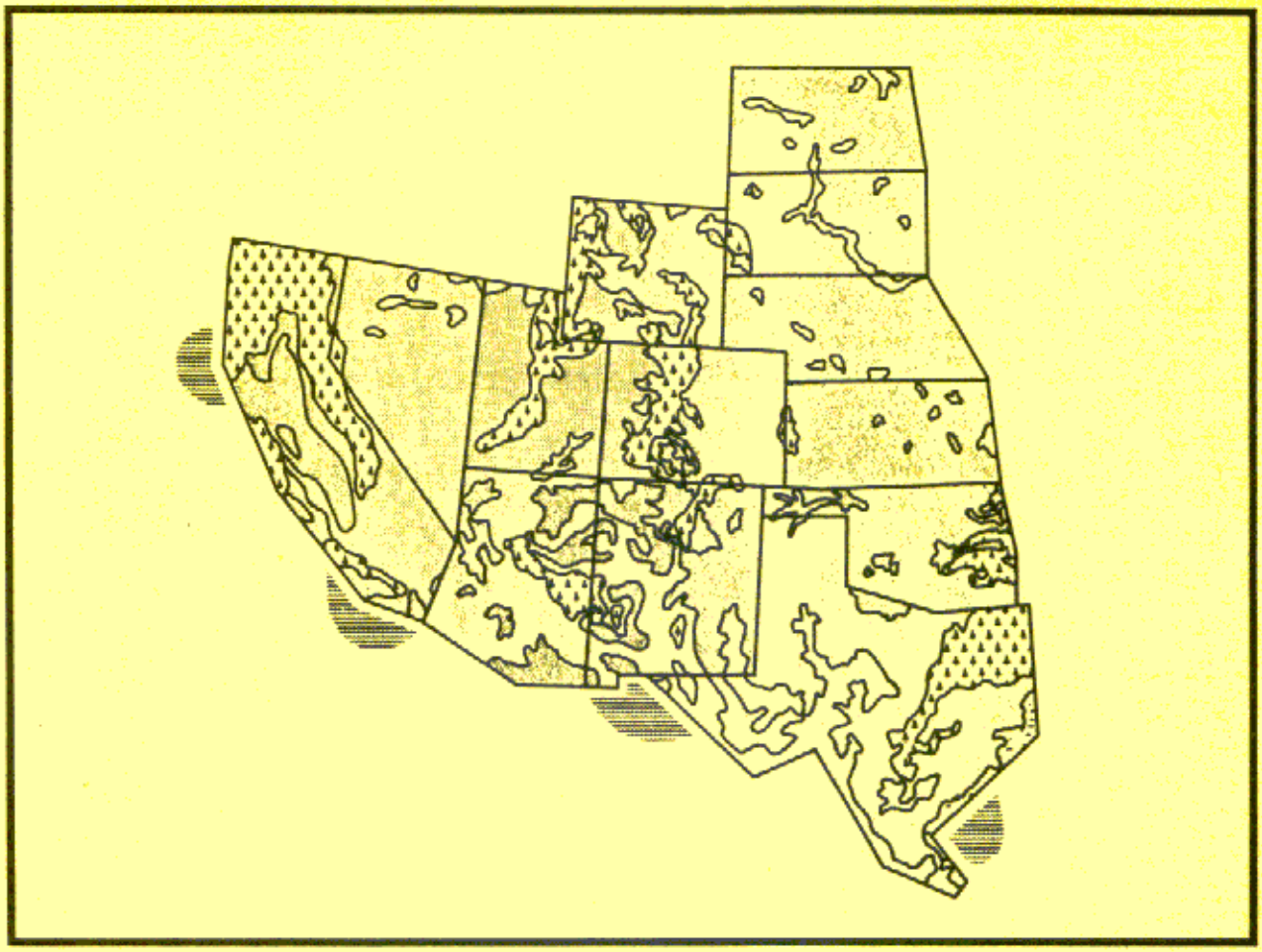
Western Regional
BIOMASS
Energy Program

BIOMASS ENERGY
A Resource Assessment



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Acknowledgement

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Background

The concept of *bioenergy* involves the natural, technical, and industrial processes through which the combination of air, water, soil nutrients, and energy from the sun are converted to different biomass forms. These in turn can be used to produce electricity, heat, gases, and other products. An overview of biomass resource categories, conversion processes, and products is shown in Figure 1.

At the present time, wood and wood waste combustion systems are the main sources of energy from biomass, with industrial applications being the largest, and residential usage of wood fuel increasing.

Other technologies that are beginning to contribute as sources of energy are: generation of methane from farm and industrial wastes by small-scale processes that decompose materials in the absence of air; mass burning of municipal solid wastes and refuse-derived fuels (trash) to produce steam and electricity; extracting gases from municipal landfills; and converting crop plants into ethanol and methanol fuels. Biomass energy use, the economics of which are very site specific, is primarily limited to widely scattered small-scale plants. Large-scale combustion systems are mainly operated by industry, rather than electric utilities.

Future biomass resources may also include carbon and hydrogen (hydrocarbon) bearing plants and microalgae (free-floating microscopic plants).

The major processes currently used in the United States to convert biomass into energy are combustion (direct burning), thermochemical (heat associated with chemical changes), and biochemical (biological changes such as decomposition and fermentation). A fourth process, called photochemical or photoconversion, uses light as an energy source for chemical reactions. It is in the developing stage.

Expanding commercial use is expected in recovering methane gas from community landfills and also using trash as a burnable fuel. Methane gas is also being extracted from cattle manure through a process called anaerobic (without air) digestion. The ethanol fuel industry continues to grow steadily, primarily in the motor fuel octane enhancement field, by fermenting farm crops such as corn to obtain alcohol and using the residue for livestock feed. Another promising method is changing biomass into a pelletized form, providing a dry, uniform, easily stored and shipped fuel that can be made from a variety of wood wastes and crop residues.

Research and development work by the U.S. Department of Energy, the Gas Research Institute, and others is continuing in a large number of areas that will result in providing a strong technical base that will reduce risks and encourage more use of biomass energy.

Sources of Biomass

Wood and Wood Wastes

Trees (eucalyptus, poplar, firs, pines, lucaena, locusts, willows, sycamore, red alder, elms, maples)
Shrubs (chaparral, mesquite)
Forest Residue (logging residues, clearing, removal)
Mill Residue (bark, sawdust, coarse residues)

Other Wastes

Municipal Solid Waste (paper, food and yard wastes, plastics, wood, tires)
Livestock waste (manure)
Process waste (industrial, food processing)
Sewage (sludge)

Agricultural Crops and Residues

Crop residues (cane tops, straw, husks, citrus peels, corn stalks)
Cotton gin trash
Bagasse (sugar cane pulp)
Molasses
Starch crops (corn, wheat, sorghum, barley)
Sugar crops (cane, beet, sorghum)
Forage crops (alfalfa, grasses, fescue, clover)
Oilseed crops (soybean, sunflower, safflower)

Salt and Fresh Water Aquatic Plants

Algae (kelp, oil producing microalgae, spirulina)
Water weed
Water hyacinth
Reeds and rushes

Unconventional Crops

Arid land plants (guayule, rabbit brush, golden rod, creosote bush, sassafras, gopher plant, milkweed)
Saline plants (salt bush, reed grass, seepwood, Russian-thistle, greasewood)

Conversion Methods

Combustion
(direct burning)

Primary Products (steam, heat, cooking, gas)
Secondary Products (methanol, acids, electricity)

Thermochemical
(heat from chemical changes)

Gasification
Primary Products (oil, low- or medium-Btu gas, charcoal)
Secondary Products (methane, methanol, hydrogen, ammonia)

Liquefaction
Primary Product (oil)

Biochemical
(biological changes)

Anaerobic Digestion
(changes in the absence of air)
Primary Product [methane (biogas)]
Secondary Product (ammonia)

Fermentation
(changing complex compounds to simple ones)
Primary Product (ethanol)
Secondary Product (ethylene)

Photochemical
(using light to cause chemical reactions)
Primary Product (hydrogen)
Secondary Products (oxygen, carbon dioxide)

Figure 1. Sources of biomass and conversion methods.

Nebraska Biomass Resources

High potential exists in Nebraska for biomass resources from agricultural crops and residues, grain and sugar crops, and animal waste. The most feasible conversion technologies for these resources are gasification, liquefaction, fermentation, and anaerobic digestion. Municipal solid waste is also a feasible biomass resource option in areas where the population is greater than 25,000.

Vast cropland and grazing land are contained throughout most of Nebraska. Therefore, the primary emphases have been on agricultural manure conversion to methane using anaerobic digestion and on corn conversion to alcohol using fermentation. Although alcohol research is now limited, several alcohol plants throughout the state are economically feasible.

The U.S. Department of Agriculture, located in Clay Center, has researched the use of livestock manure combined with crop residues for the production of methane gas. A few large cattle feedlots exist in eastern and east central Nebraska. Where the cattle are confined, gathering livestock manure is easier and less expensive. The manure is converted to methane using anaerobic digestion.

The University of Nebraska has been involved in several biomass studies.

Contact for More Information

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No.	County								
1	SIOUX	23	GRANT	45	WASHINGTON	67	CASS	89	NUCKOLLS
2	DAWES	24	HOOKER	46	DOUGLAS	68	CHASE	90	THAYER
3	BOX BUTTE	25	THOMAS	47	KIMBALL	69	HAYES	91	JEFFERSON
4	SHERIDAN	26	ARTHUR	48	CHEYENNE	70	FRONTIER	92	PAWNEE
5	CHERRY	27	McPHERSON	49	DEUEL	71	GOSPER	93	RICHARDSON
6	KEYA PAHA	28	LOGAN	50	KEITH	72	PHELPS		
7	BROWN	29	BLAINE	51	PERKINS	73	KEARNEY		
8	ROCK	30	LOUP	52	LINCOLN	74	ADAMS		
9	BOYD	31	CUSTER	53	DAWSON	75	CLAY		
10	HOLT	32	GARFIELD	54	SHERMAN	76	FILLMORE		
11	KNOX	33	WHEELER	55	HOWARD	77	SALINE		
12	CEDAR	34	VALLEY	56	MERRICK	78	GAGE		
13	DIXON	35	GREELEY	57	POLK	79	OTOE		
14	DAKOTA	36	BOONE	58	BUTLER	80	JOHNSON		
15	ANTELOPE	37	MADISON	59	SAUNDERS	81	NEMAHA		
16	PIERCE	38	STANTON	60	SARPY	82	DUNDY		
17	WAYNE	39	CUMING	61	BUFFALO	83	HITCHCOCK		
18	THURSTON	40	BURT	62	HALL	84	REDWILLOW		
19	SCOTTS BLUFF	41	WANCE	63	HAMILTON	85	FURNAS		
20	BANNER	42	PLATTE	64	YORK	86	HARLAN		
21	MORRILL	43	COLFAX	65	SEWARD	87	FRANKLIN		
22	GARDEN	44	DODGE	66	LANCASTER	88	WEBSTER		

NEBRASKA