An Introduction to Biomass

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Presentation Outline

- Introduction
  - Biomass in the U.S. energy context
  - Assumptions and methodology for the biomass forecast in NEMS
  - Why are biomass supplies of concern?
- Modeling inputs and methodology for forecast
  - Capital cost
  - Availability of feedstocks
  - Transportation costs
  - Updating agricultural residues
- The "Billion Ton Vision"
- Experience from a utility perspective
- Conclusions

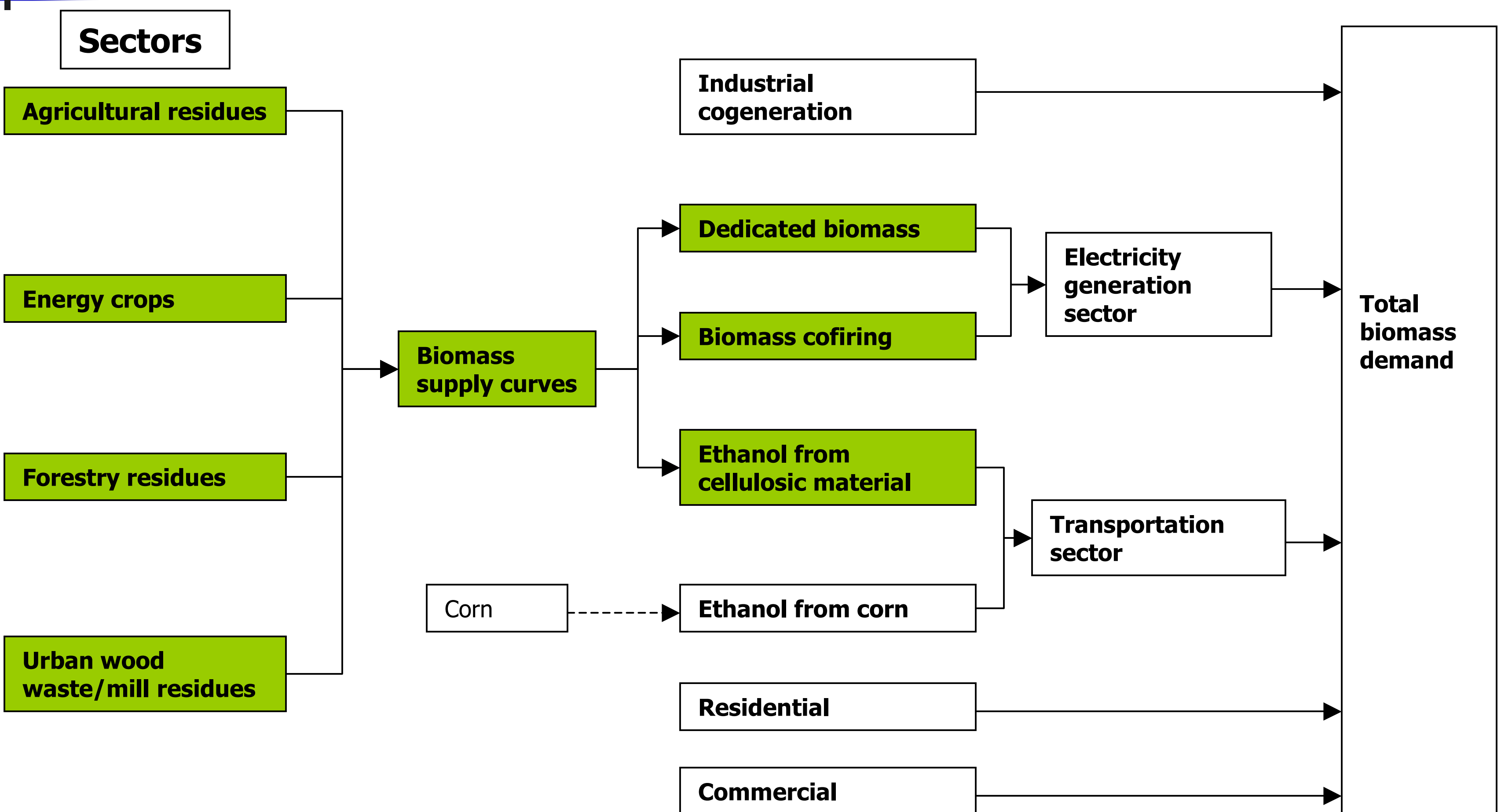
U.S. Energy Consumption in 2004

Energy source	Consumption (Quads)
Conventional hydroelectricity	2.69
Biomass (wood, black liquor, other wood waste)	2.02
Waste (MSW, LFG, other biomass)	0.56
Ethanol	0.30
Geothermal	0.35
Photovoltaics and solar thermal	0.06
Wind	0.14
Renewables	**6.12**
Coal	22.45
Natural gas	23.14
Petroleum	40.59
Nuclear	8.22
Total	**100.41**

- Biomass, waste, and ethanol accounted for 2.88 Quads or 2.9% of total US energy consumption in 2004
- Renewables (including conventional hydroelectricity) accounted for 6.1% of total US energy consumption in 2004

Source: EIA, Monthly Energy Review, January 2006

Biomass Utilization in NEMS



Biomass Supply Curve Components

- Forest products: salvageable dead wood, logging residues, and excess polewood
- Urban wood waste and mill residues: mill residues, urban wood waste, and construction and demolition debris
- Agricultural residue: wheat straw, corn stover, other crops
- Energy crops: switchgrass, hybrid poplar and hybrid willow (assumed to be available on a commercial basis beginning in 2010)

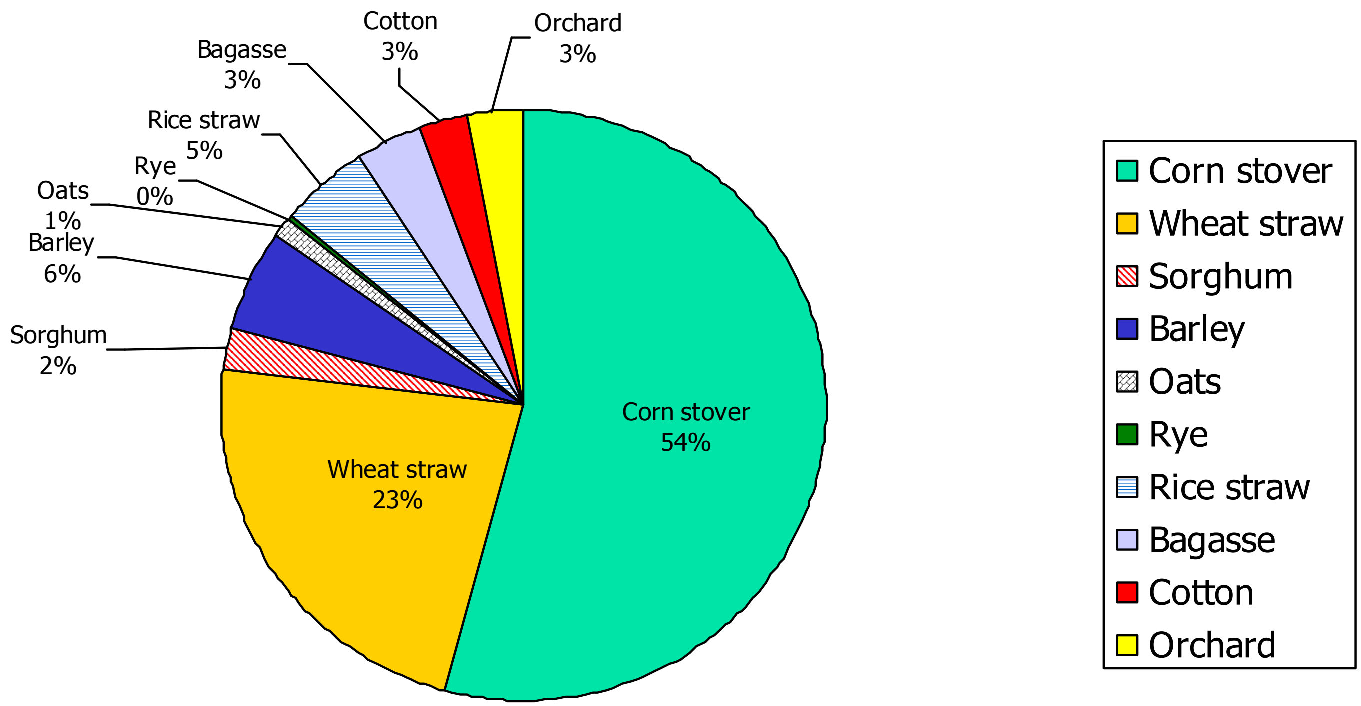
Biomass Transportation Cost Assumptions in NEMS

- Transportation cost included in all feedstock types and therefore supply curve represents delivered price (farm + transportation cost)
- Urban wood waste and mill residues transportation cost: $0.24/ton-mile, maximum supply distance 100 mile radius
- Forest residues, agricultural residues, energy crops transportation cost: $10/ton and a maximum supply distance of 50 mile radius
- Agricultural residues: $12/dry ton
- No biomass is transported across NEMS regions or greater than 100 miles

Agricultural Residue Updates

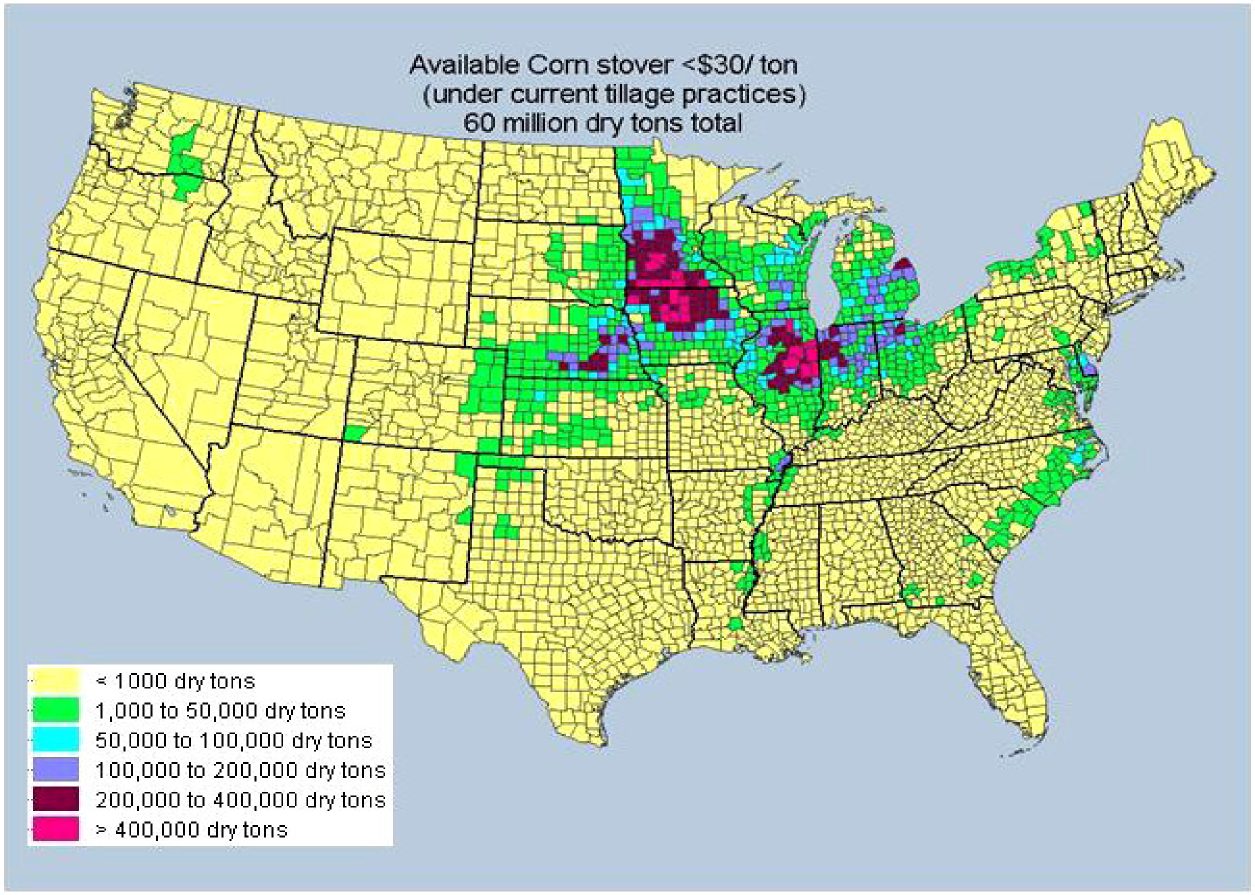
- Revised corn stover supplies – reduction in available residues due to soil quality concerns
- Inclusion of “other” crops
  - Barley, cotton, oats, orchard prunings, rice, rye, sorghum, sugarcane
  - Varying extraction amounts based on sustainability requirements
- Assumptions regarding growth of no-till farming practices
- Wheat stover correction
- Transportation cost

Agricultural Residue Supplies

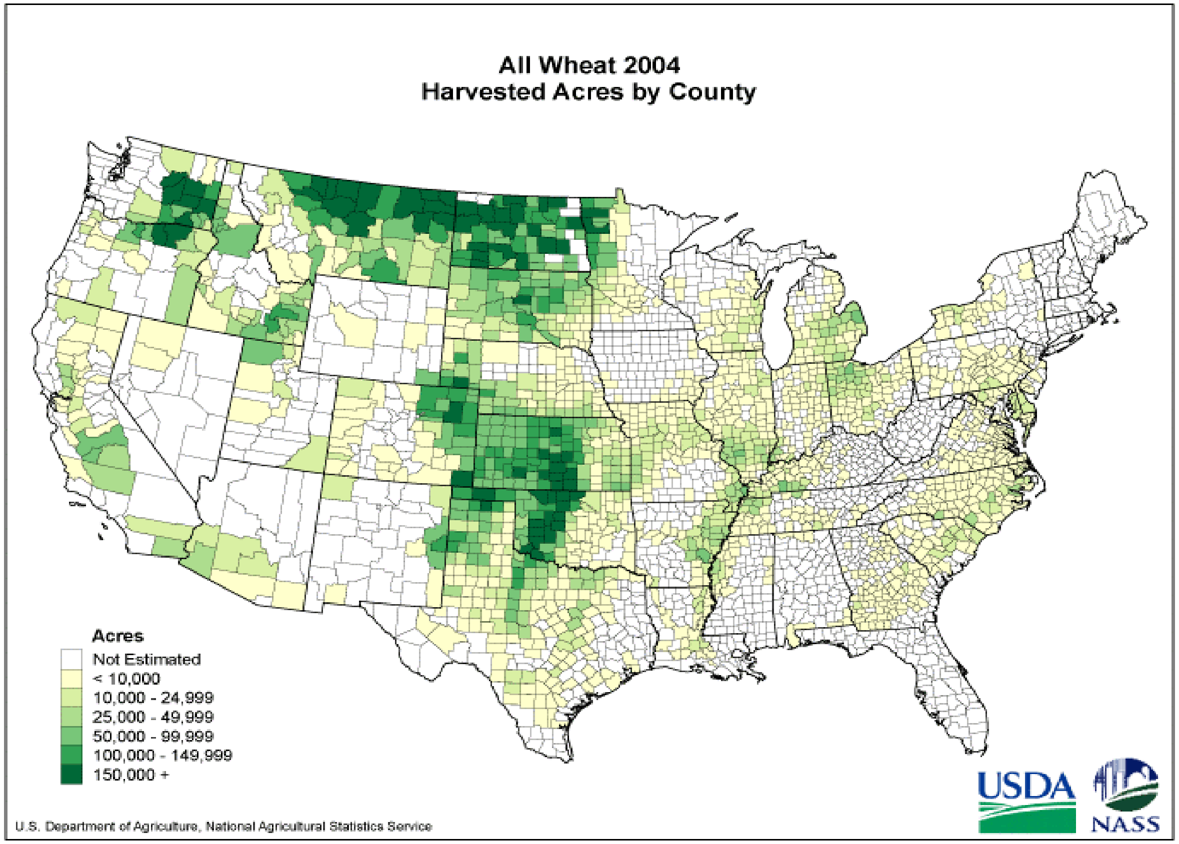


- Total available supplies: 127 million dry tons/year
- Soybean and hay have been considered but excluded from supply curve due to poor quality of residues (soybean) and competing use as fodder (hay)
- Acerage devoted to these crops plus soybean and hay account for 92% of total cropland in the U.S.

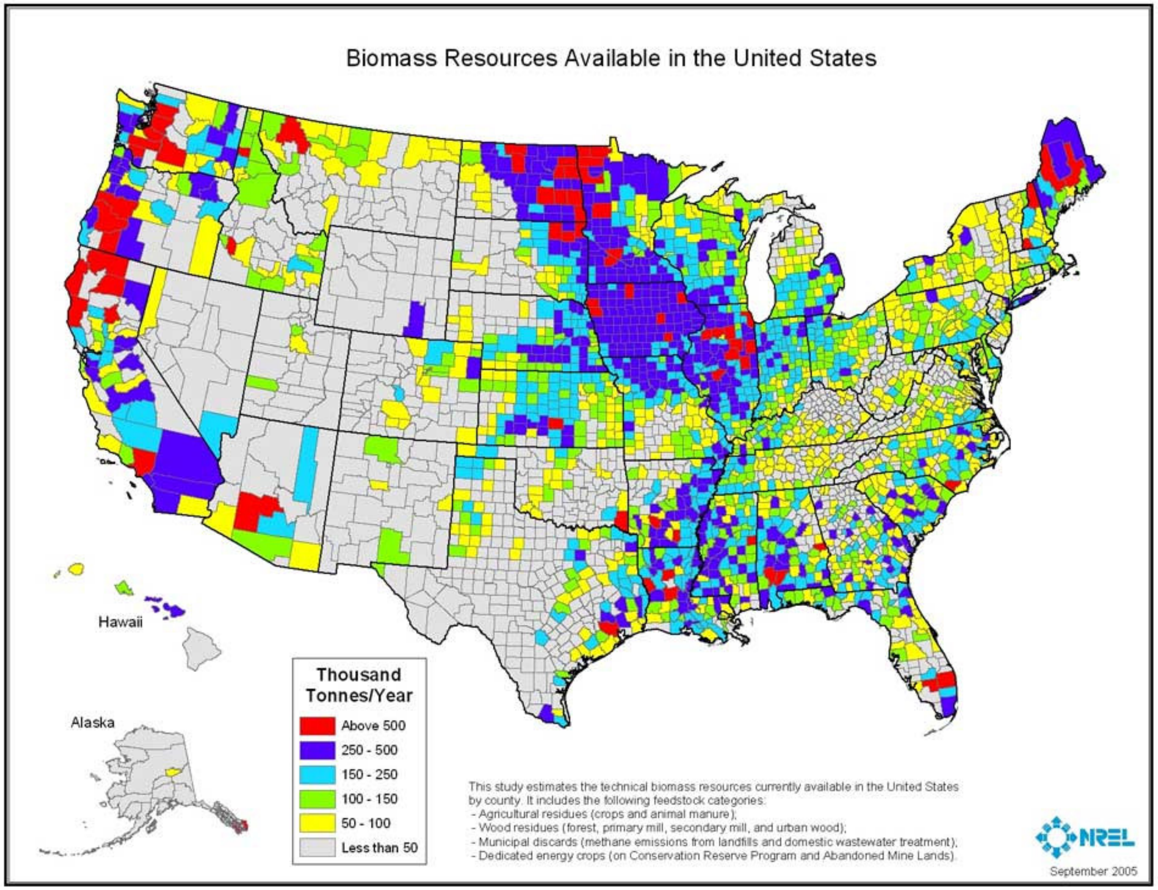
Geographical Distribution of Corn Stover



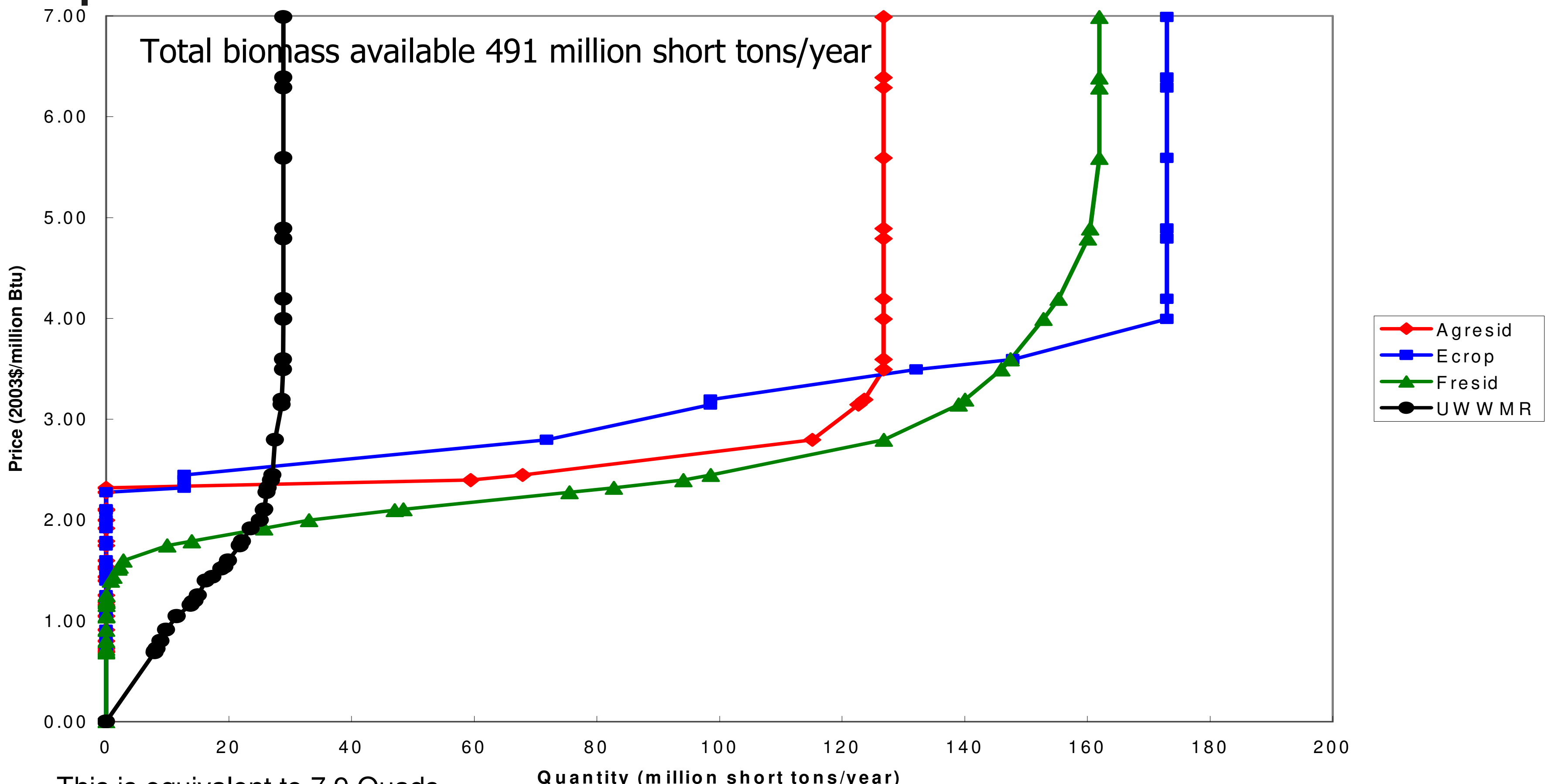
Geographical Distribution of Wheat



Geographical Distribution of Biomass



Availability of Biomass in U.S.



This is equivalent to 7.9 Quads

Sources: Oak Ridge National Laboratory, Antares Corp., and James Easterly

Maximum Available Biomass Quantities

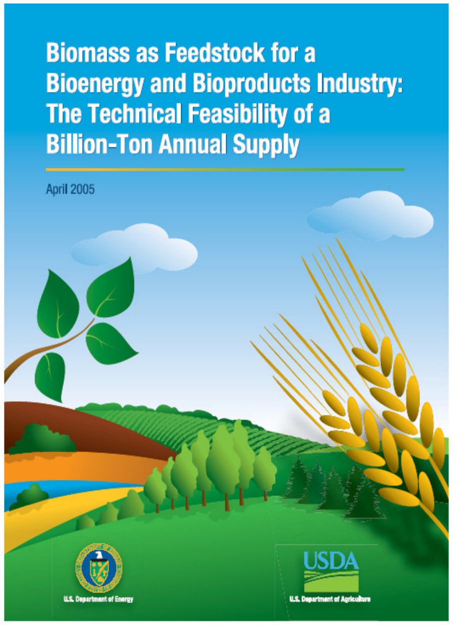
Biomass type	Quantity (million dry tons per year)
Agricultural residue	127
Energy crops	173
Forestry residues	162
Urban wood waste/mill residue	29
Total	**491**

- DOE program goal is to achieve 1.3 billion tons sustainably and economically through feedstock research and development programs

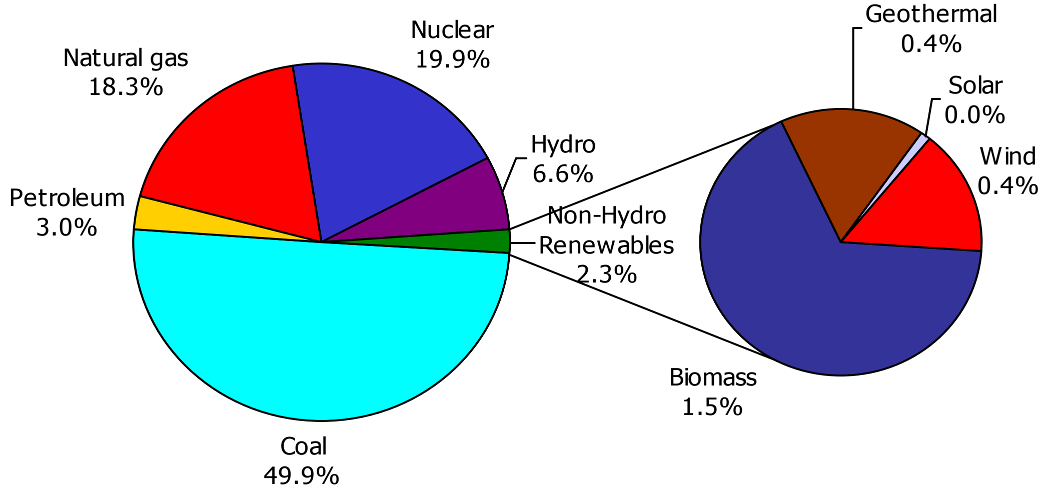
Source: Oak Ridge National Laboratory, Antares Corp., and James Easterly

DOE's "Billion ton Vision"

- Biopower will supply 5% of industrial and electric sector electricity demand by 2020
- Biofuels will supply 20% of transportation fuels by 2030
- Bioproducts will supply 25% of chemicals and materials by 2030
- Biomass will be harvested on a sustainable and economically attractive basis
- This will require 1 billion tons of biomass to be harvested annually
- According to EERE this can be achieved if:
  - Yields of crops increase by 50%
  - Harvest technology is capable of recovering 75% of crop residues
  - All cropland is managed with no-till methods
  - All available manure is used for biofuels
  - All other available residues are utilized



Biomass in Electricity Generation, 2004



	Capacity (GW)	Generation (bkWh)	CF (%)
Wood/wood waste	5.89	37.29	72
MSW/LFG	3.32	19.59	67
Other	0.5	3.15	72
Total	9.71	60.0	71

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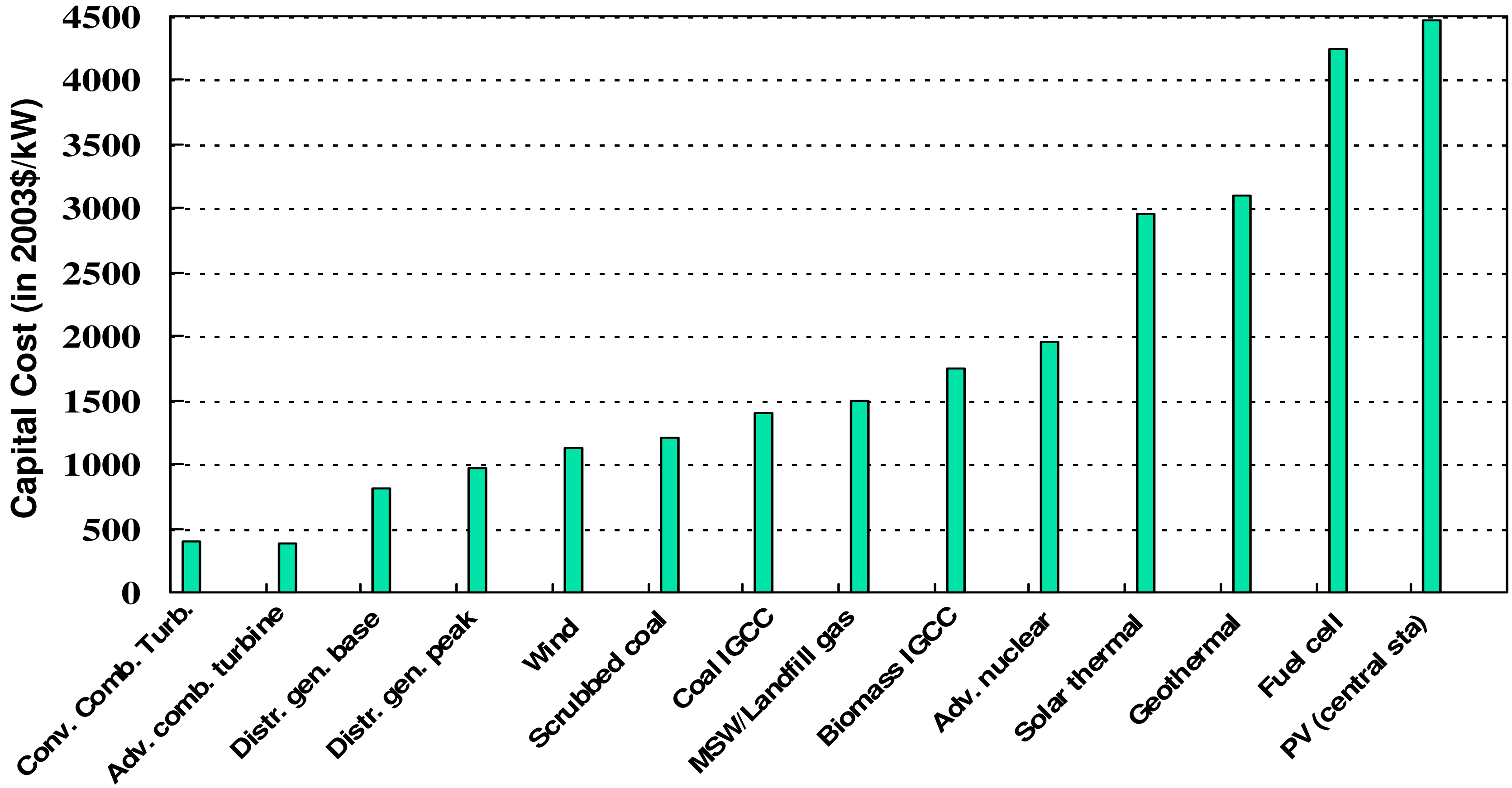
Biomass Integrated Gasification Combined Cycle Cost Assumptions in NEMS

Attribute	**Value**
On-line year	2008
Unit size	80 MW
Construction lead time	4 years
Capacity factor	80%
Capital cost in 2004 (2003$)	$1,757/kW*
Fixed O&M cost	$47.18/kW
Non-fuel variable O&M cost	0.296 cents/kWh

* Includes contingency and technological optimism factors

Capital Cost of Electricity Generating Technologies



Costs include contingency and technological optimism, but does not include regional multipliers

Source: EIA, "Assumptions to the Annual Energy Outlook 2005 (AEO2005)", April 2005, Table 38, p. 67

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Biomass Use Under Alternative Scenarios

- AEO2006 reference case: current laws and regulations
  - Total biomass consumption grows from 2.9 Quads in 2004 to 4.2 Quads by 2030
  - Biomass capacity in electricity generation sector grows from 6.4 GW in 2004 to 11.9 GW by 2030
- National Commission for Energy Policy report "no safety valve" case
  - 59.6 GW by 2025
  - GHG allowance price $35.15/metric tonne CO2 (2003$) by 2025
- Salazar report "no safety 4.0" case – GHG intensity reductions
  - 94.6 GW by 2030
  - GHG allowance price $52.05/metric tonne CO2 (2004$) by 2030
- The role of biomass – State of the Union emphasis on ethanol - petroleum substitution, carbon-constraint, renewable portfolio standard

Experiences from a Utility Perspective

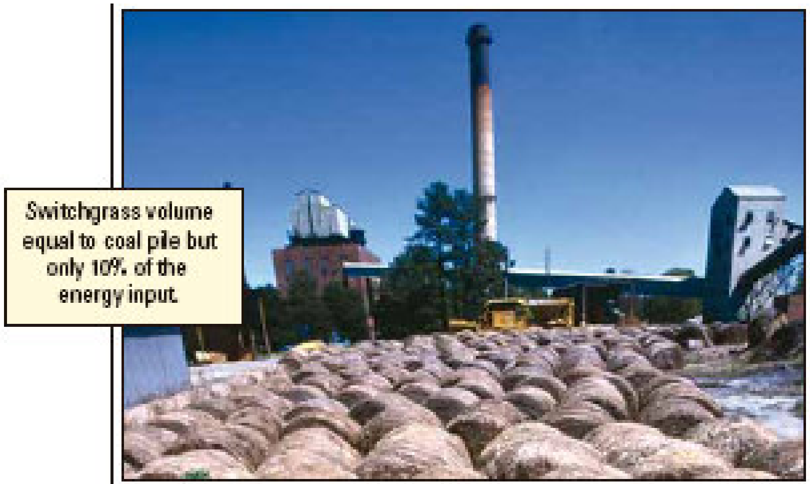

Figure 9

Southern Company Environmental Assessment Report to Shareholders

Figure 11

Experiences from a Utility Perspective

- Biomass ash may aggravate catalyst plugging.
- Chemical elements in biomass ash likely to accelerate catalyst deactivation rates.

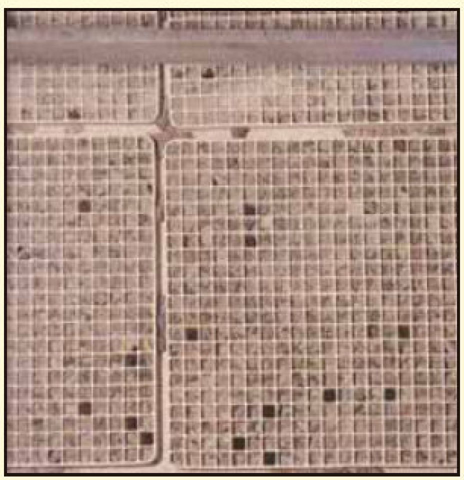

Figure 13

Alabama Power's Plant Gadsden
Co-firing switchgrass

Figure 10

Supply Curve Uncertainties

- Climate change remains a big unknown for all forms of biomass supply
- Competing uses of biomass – mulch market
- Agricultural waste: Impact of biomass removal on soil quality
- Forestry residues: Impact of changes in fire prevention policies
- Urban wood waste/mill residues: Impact of increasing quantities of recycling
- Energy crops: Competing uses of land (commodity crops versus energy crops)

Factors That Lead to Growth of Biomass

- Climate policies
  - "Climate Stewardship Act of 2003", Sen. McCain and Lieberman, S.139 stabilization of GHG's at 2000 levels by 2010 to 2015, GHG reduction to 1990 levels after 2015
  - National Commission on Energy Policy GHG intensity reduction scenarios
- Renewable portfolio standards – 10% RPS versus 20% RPS
- Production tax credits – long term permanent extensions versus short term year-to-year extensions
- High and sustained natural gas prices or world oil prices
- Technological innovations that lead to reduced cost – ethanol from cellulose, biomass gasification
- Policies with respect to other generation technologies – nuclear, coal, natural gas

Conclusions

- Maximum of 491 million dry tons of biomass available
- Agricultural residues supplies have been updated to include a variety of crops and tillage practices
- Sustainability of extracting agricultural residues without impacting soil quality is a key issue
- Climate change impacts on residue availability remains a big unknown
- Scenarios with carbon taxes show significant growth in biomass for electricity generation
- "Biomass for Electricity Generation" paper available at: http://www.eia.doe.gov/oiaf/renewable.html