Biomass for Electricity Generation in NEMS

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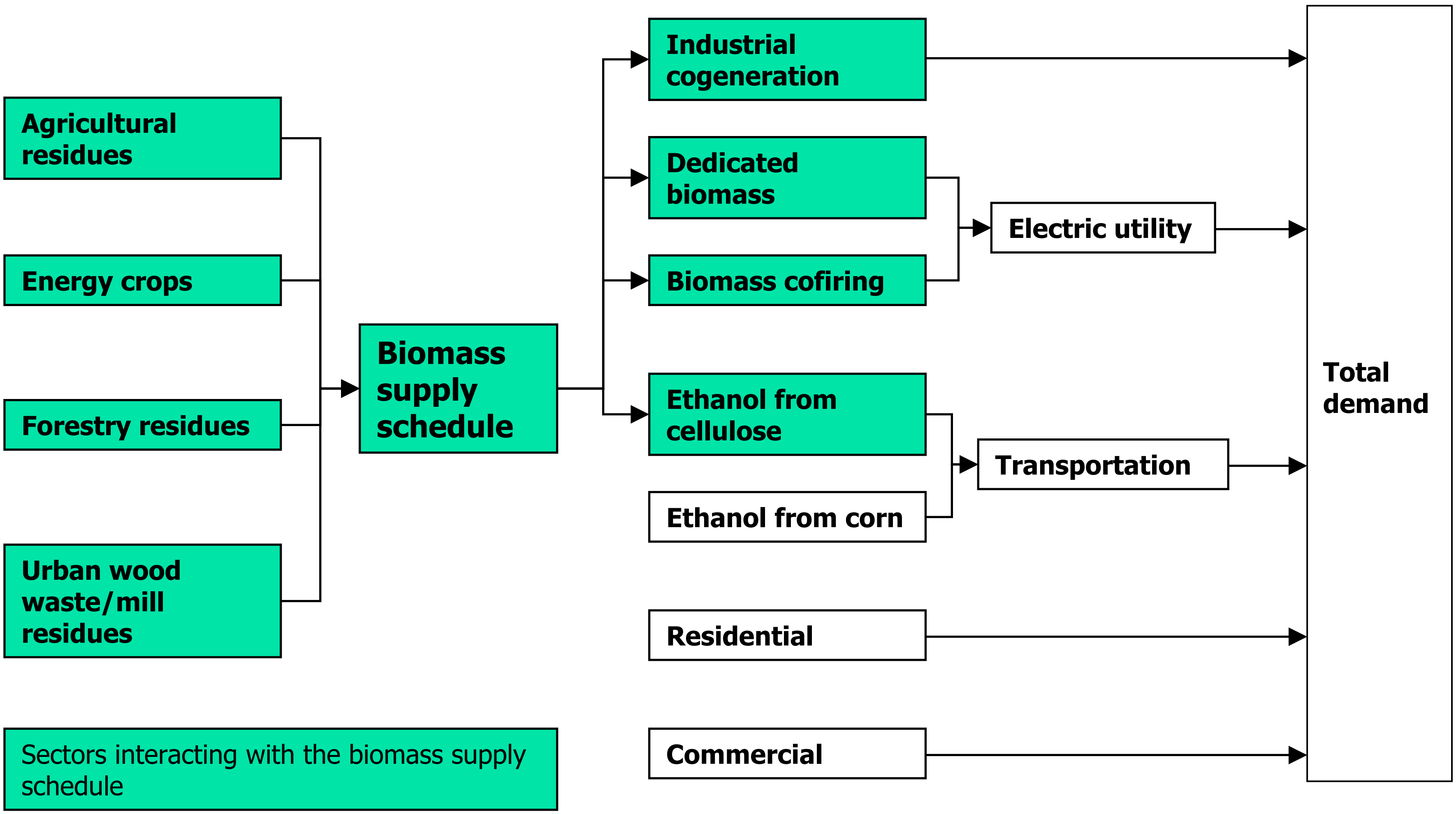
Presentation Outline

- Introduction
  - Present assumptions and methodology for the biomass forecast in NEMS
  - Why are biomass supplies of concern?
- Modeling inputs and methodology for forecast
  - Capital cost
  - Supply schedules
  - Conversion technology
- Forecasts - Reference case, high renewables case, 20% RPS case
- Conclusions

Why Are Biomass Supplies of Concern?

- AEO2002 reference case: adequate supplies to meet demand
- AEO2002 High renewables case: demand higher due to increased supply assumptions
- 20% RPS study: aggressive demand for biomass due to assumption of nationally mandated RPS provision, supply could be constraining
- Can biomass substitute for fossil fuels on a very large scale in environmental cases?
  - Uncertainty of available quantities at high prices
  - Price impacts of large-scale use of biomass

Biomass Utilization in NEMS



Modeling Assumptions and Methodology for Forecasts

- Capital costs
- Biomass supply schedule
- Transportation cost
- Biomass conversion technologies in NEMS
- Assumptions regarding carbon taxes, Production Tax Credit, Renewable Portfolio Standards

Biomass* Capital Cost Assumptions in NEMS

Attribute	Value
On-line year	2005
Unit size	100 MW
Construction lead time	4 years
Overnight cost (2000$)	$1,536/kW
Contingency factor	1.07
Technological optimism	1.05
Total cost – 2000	$1,725/kW
Total cost – 2020	$1,303/kW

* Defined as biomass gasification and combined cycle

Overnight Capital Costs and Capacity Factors in AEO2002

Technology Type	Capital cost (2000$/kW)	Maximum capacity factor (%)
Conventional combustion turbine	339	92
Advanced combustion turbine	474	92
Generic distributed generation – peak	559	5
Generic distributed generation – base	623	50
Wind	982	39
Conventional pulverized coal	1,119	85
Integrated gasification combined cycle (coal)	1,338	85
MSW/Landfill gas	1,429	90
Biomass gasification combined cycle	**1,725**	**80**
Geothermal	1,746	95
Fuel cells	2,091	87
Advanced nuclear	2,144	90
Solar thermal	2,539	42
Photovoltaic (central station)	3,831	30

Reference case, for new plants initiated in 2001

Supply Schedule Components

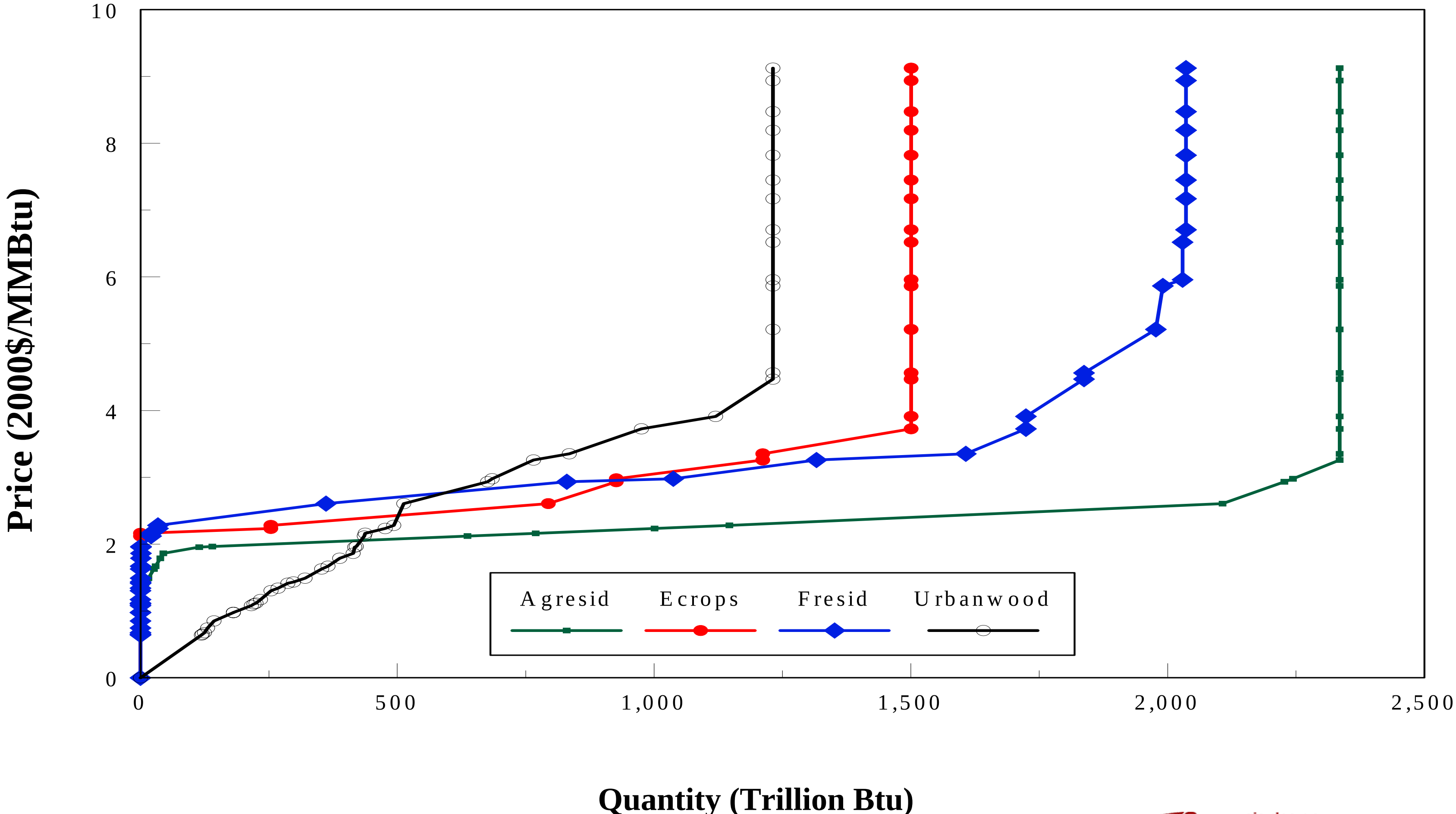
- Forest products: salvageable dead wood, logging residues, and excess polewood

- Urban wood waste and mill residues: mill residues, urban wood waste, and construction and demolition debris

- Agricultural residue: wheat straw and corn stover

- Energy crops: switchgrass, hybrid poplar, and willow (available from 2010)

Biomass Supply Schedule, 2020



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Transportation Cost

- Transportation cost included in all feedstock types and therefore supply curve represents delivered price (farm-gate + transportation)

- 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, maximum supply distance 50 mile radius

- No biomass is transported across EMM regions

- In future, capability to transport biomass across regions could be included for sensitivity cases

Conversion Technologies

- Dedicated biomass: biomass integrated gasification combined cycle (BIGCC) - Hot gas filtration is assumed
- Biomass co-firing with coal
  - Up to 5% on heat-input basis allowed depending on resource availability
  - No capital cost or O&M cost penalty
  - Retrofit existing coal plants
  - Modification planned to allow more biomass for additional capital and O&M costs
- Industrial cogeneration

Capacity History and Forecasts (GW)

Sector	2000	2020		
		AEO2002 Reference Case	AEO2002 High Renewables case	20% RPS case
Electric generators*	1.39	1.97	2.09	61.41
Industrial cogenerators	5.26	8.43	10.21	8.44
Biomass capacity	**6.65**	**10.40**	**12.30**	**69.85**
Total installed capacity**	**808**	**1,136**	**1,147**	**1,205**

* Dedicated biomass only, no biomass cofiring

** Includes electric generators and cogenerators

AEO2002 reference case: aeo2002.d102301a, AEO2002 high renewables case: hirenew02.d102300a, 20% RPS: rps20.d011702b

Generation History and Forecasts (Billion kWh)

Sector	2000	2020		
		AEO2002 Reference Case	AEO2002 High Renewables Case	20% RPS Case
Dedicated biomass	7.46	11.25	12.09	408.1
Biomass cofiring	0.91	4.07	3.97	67.69
Electric generators*	8.37	15.32	16.06	475.8
Industrial cogeneration	29.63	48.99	59.92	49.06
Biomass generation**	**38.00**	**64.31**	**75.98**	**524.9**
Total generation***	**3,841**	**5,471**	**5,474**	**5,434**

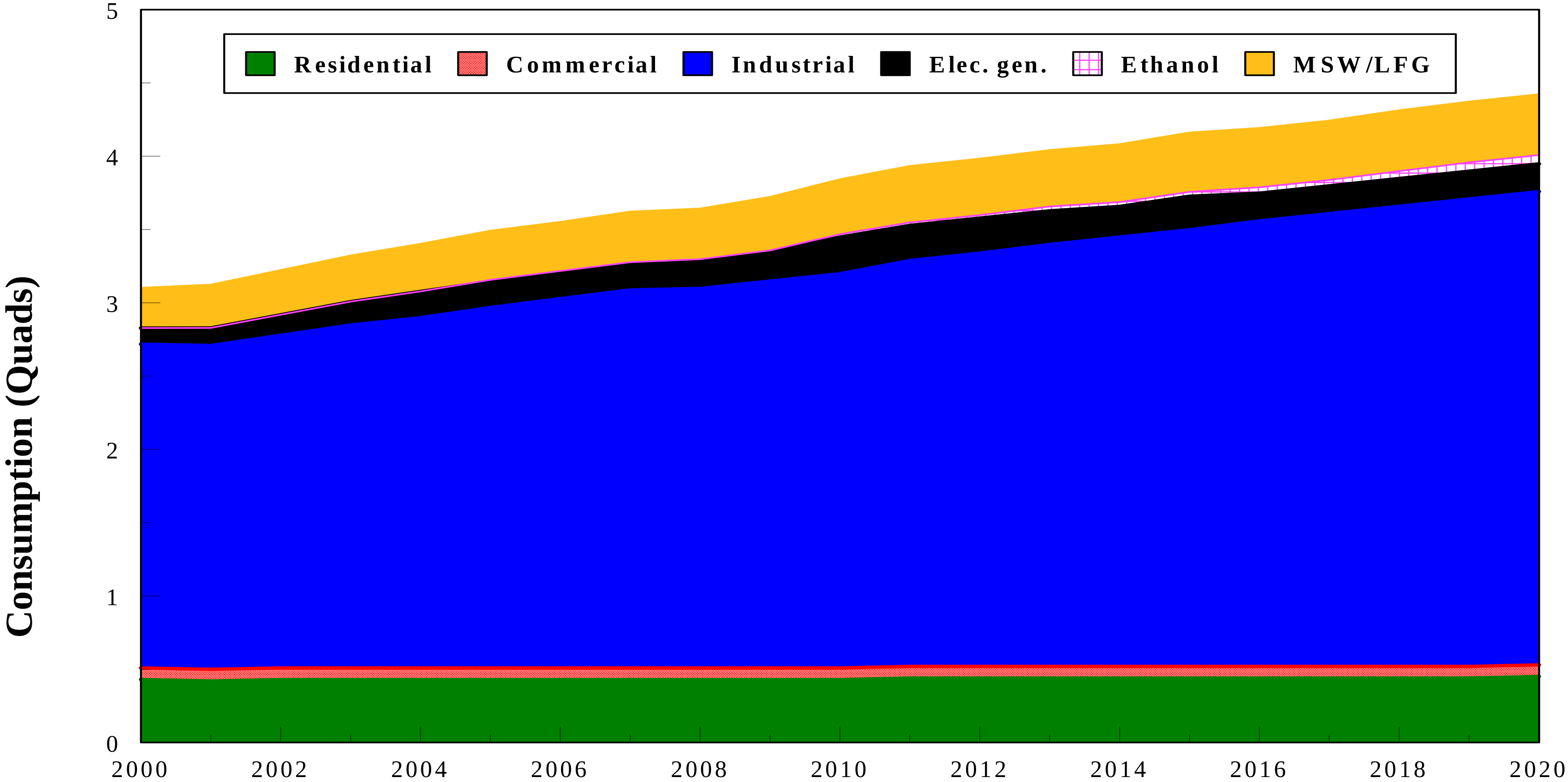
* Electric generators = Dedicated biomass + biomass cofiring

** Biomass generation = Electric generators + industrial cogeneration

*** Includes electric generators and cogenerators

AEO2002 reference case: aeo2002.d102301a, AEO2002 high renewables case: hirenew02.d102300a, 20% RPS: rps20.d011702b

Consumption Forecast by Sector, AEO2002 Reference Case



AEO2002 reference case: aeo2002.d102301a

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Consumption Under Different Scenarios

	Biomass consumption, 2020 (Quads)	Maximum available biomass* (Quads)
AEO2002 reference case	3.48	8.28
AEO2002 high renewables case	4.13	9.10
20% RPS case	7.67	8.28

* At greater than $7/MMBtu (2000$)

Biomass consumption = Dedicated biomass + cofiring + industrial cogeneration + cellulosic ethanol

AEO2002 reference case: aeo2002.d102301a, AEO2002 high renewables case: hirenew02.d102300a, 20% RPS: rps20.d011702b

Supply Curve Uncertainties

- 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)

Conclusions

- Maximum of 590 million (wet) tons of biomass available in 2020
- AEO2002 reference case capacity grows from 6.6 GW in 2000 to 10.4 GW by 2020
- AEO2002 high renewables case capacity grows to 12.3 GW by 2020
- 20% RPS case capacity grows to 69.8 GW by 2020