# Potential Biomass Demand and Recent Assessments of Biomass Expansion

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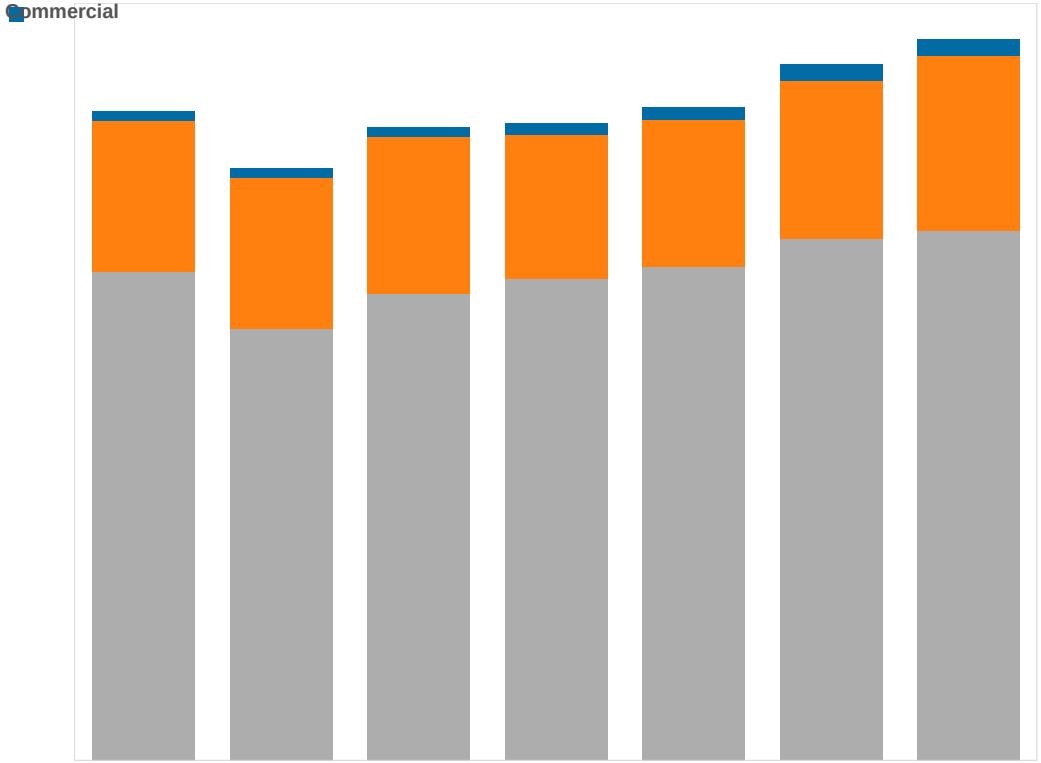
# Presentation Outline

- Current biomass consumption levels for electricity generation
  - By source and sector
- Projected demand for biomass electricity
  - Supply potential and relative costs
    - Which sources of biomass show the greatest potential in the near term? Long term?
- Recent assessments of biomass expansion and GHG emissions
  - Focus on forestry
- Conclusions

# Current Biomass Consumption Levels at Industrial and Electricity Generation Facilities

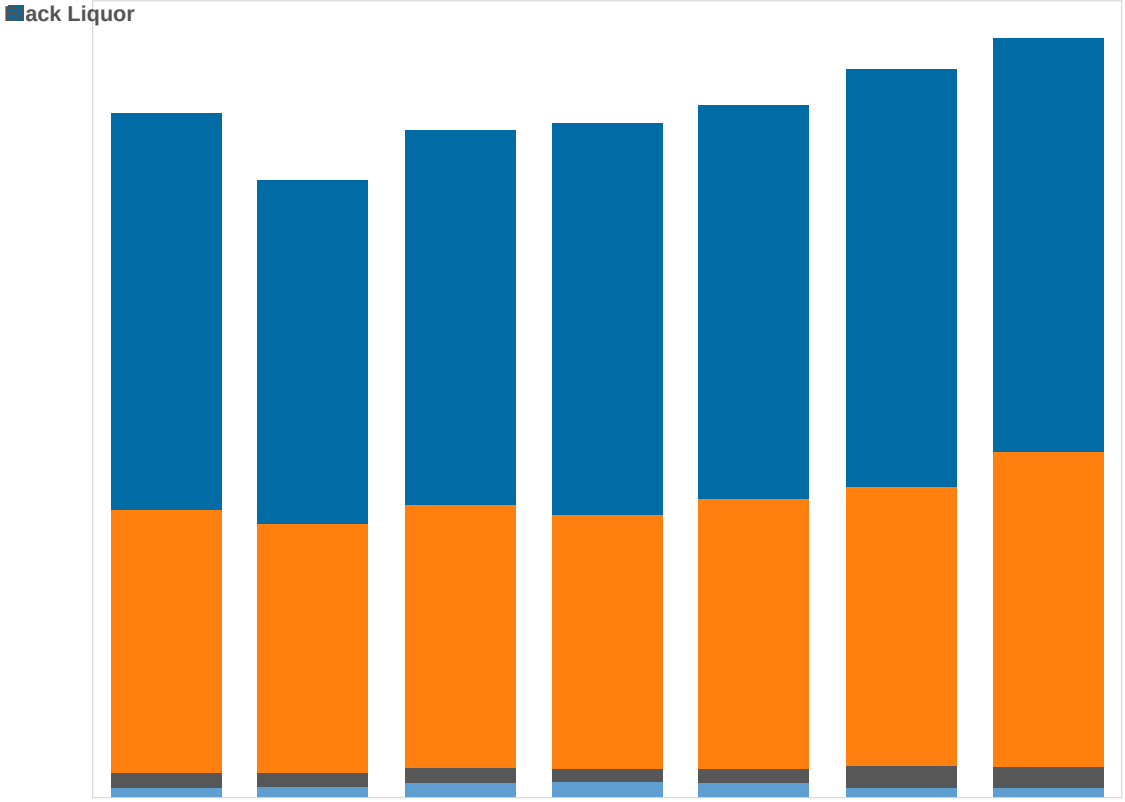
# Biomass Fuel Consumption by Source and Sector




- Industrial sector is the largest consumer of biomass energy
- Steady growth in biomass consumption over last several years
  - Following economic decline in 2008/2009

*Source: EIA-923 (2016)*

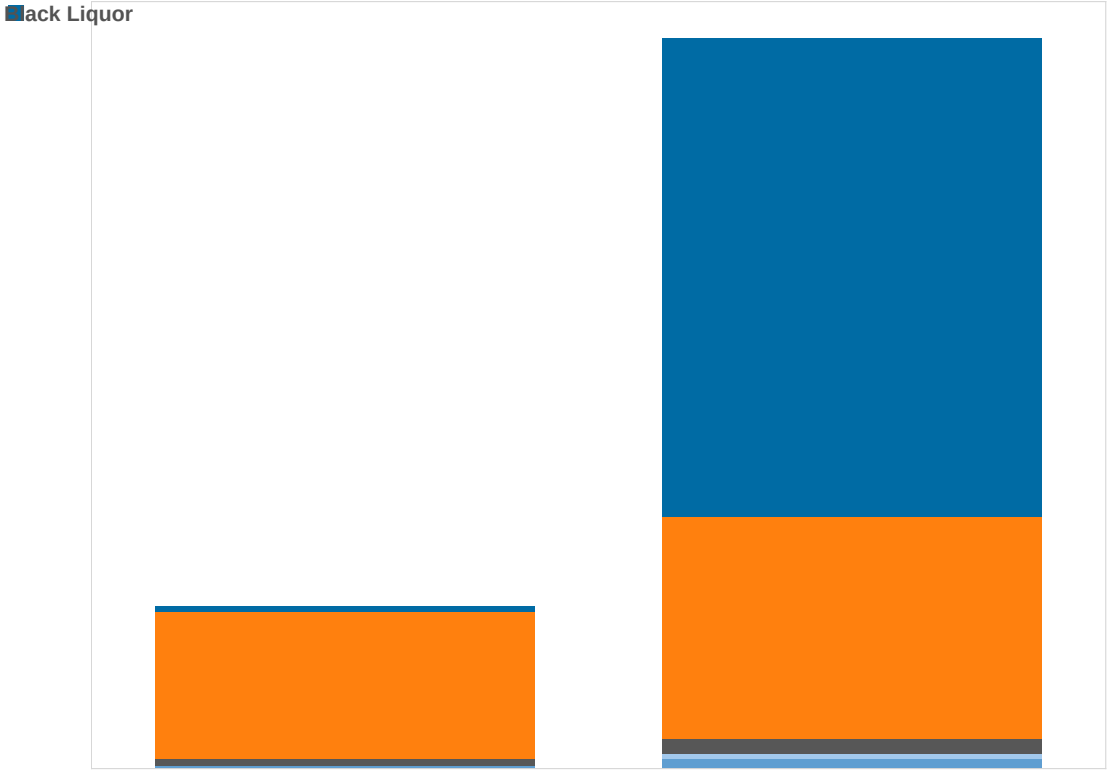
# Biogenic Fuel Consumption by Source




- Modest growth in wood waste solids and agricultural by-products

*Source: EIA-923 (2016)*

# Biogenic Fuel Consumption by Source and Sector (2014)



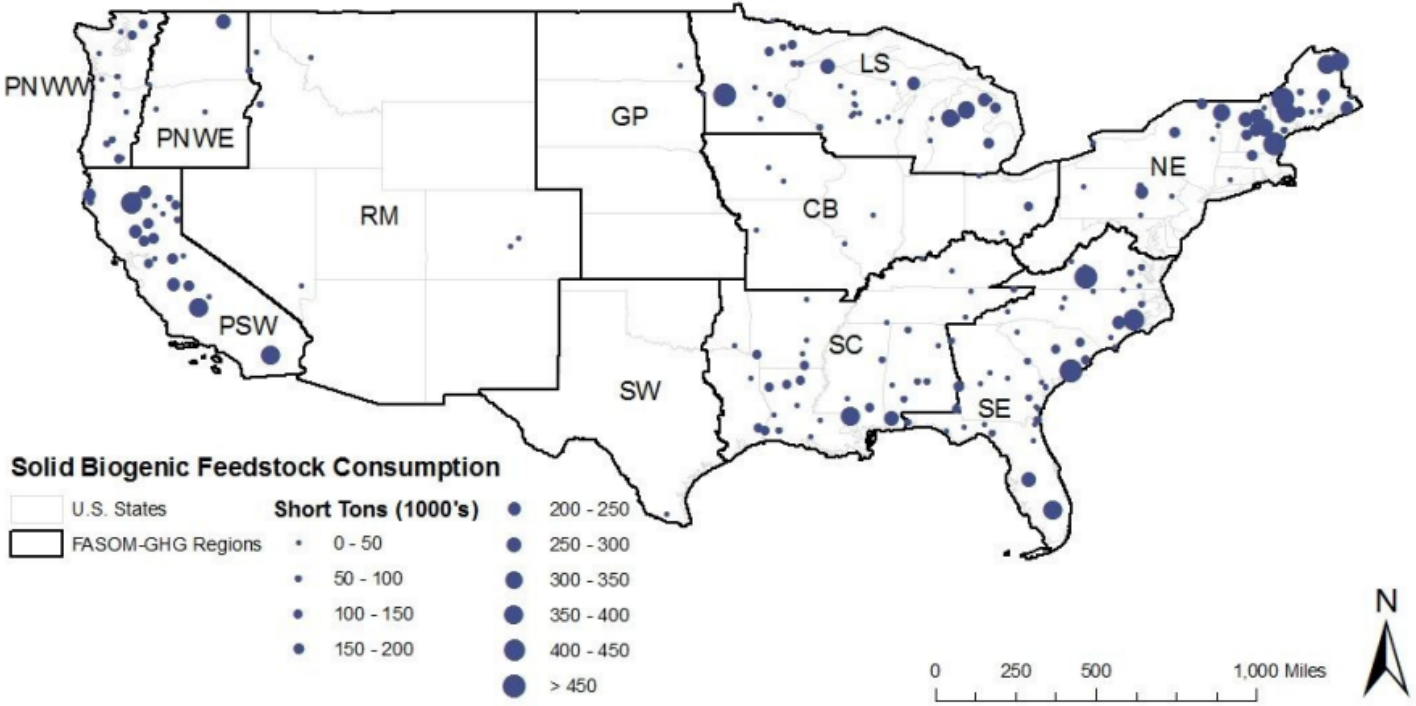

- Industrial sector biomass consumption currently much higher than electric utility consumption
- Industrial by-products (e.g. black liquor) largest share of biomass fuel consumption

*Source: EIA-923 (2016)*

# Where is woody biomass being consumed for energy?

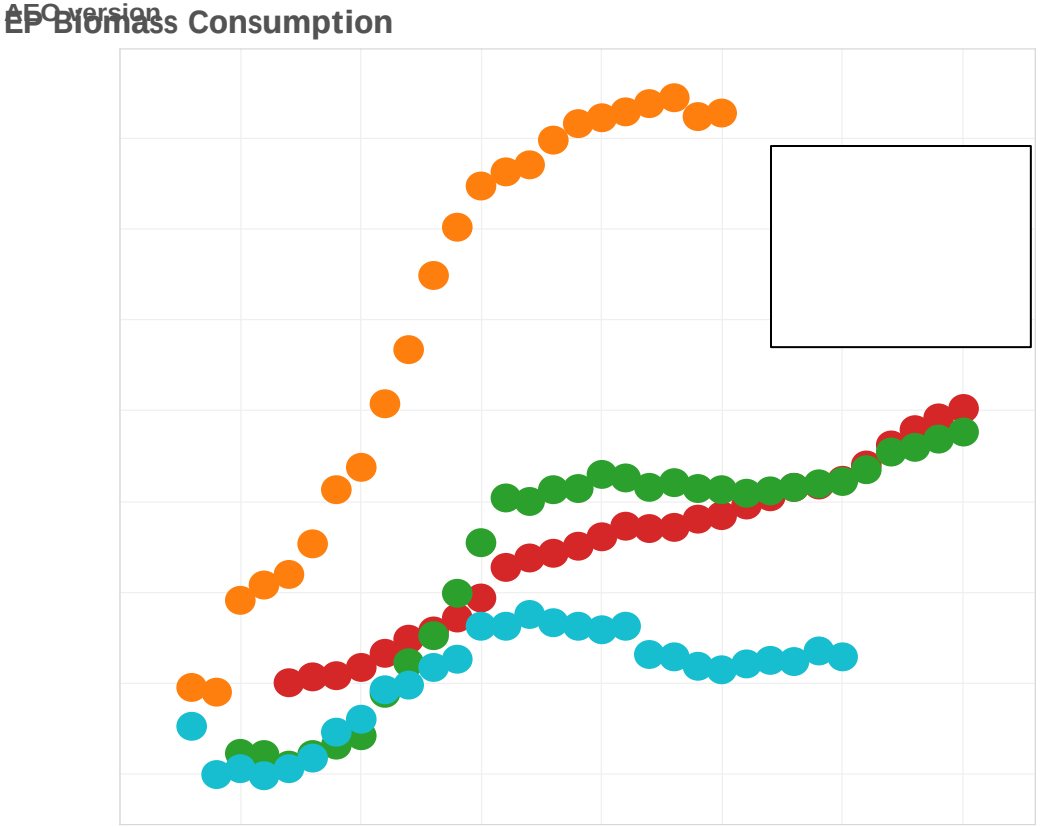
- Locations of electricity and a subset of industrial sector facilities consuming biomass for energy generation

*Source: EIA-923 (2012)*



# Biomass Demand Projections for Electricity Generation

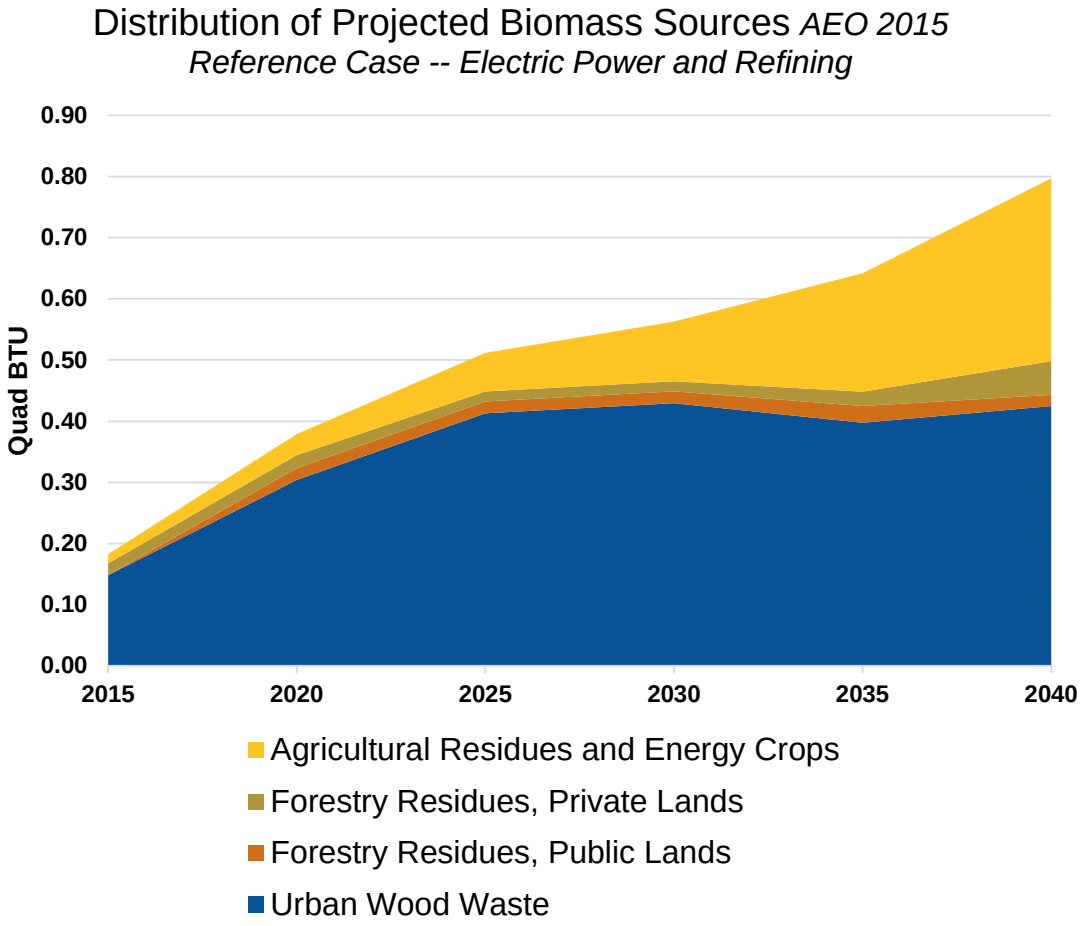
# Annual Energy Outlook– Electricity Sector Demand Projections



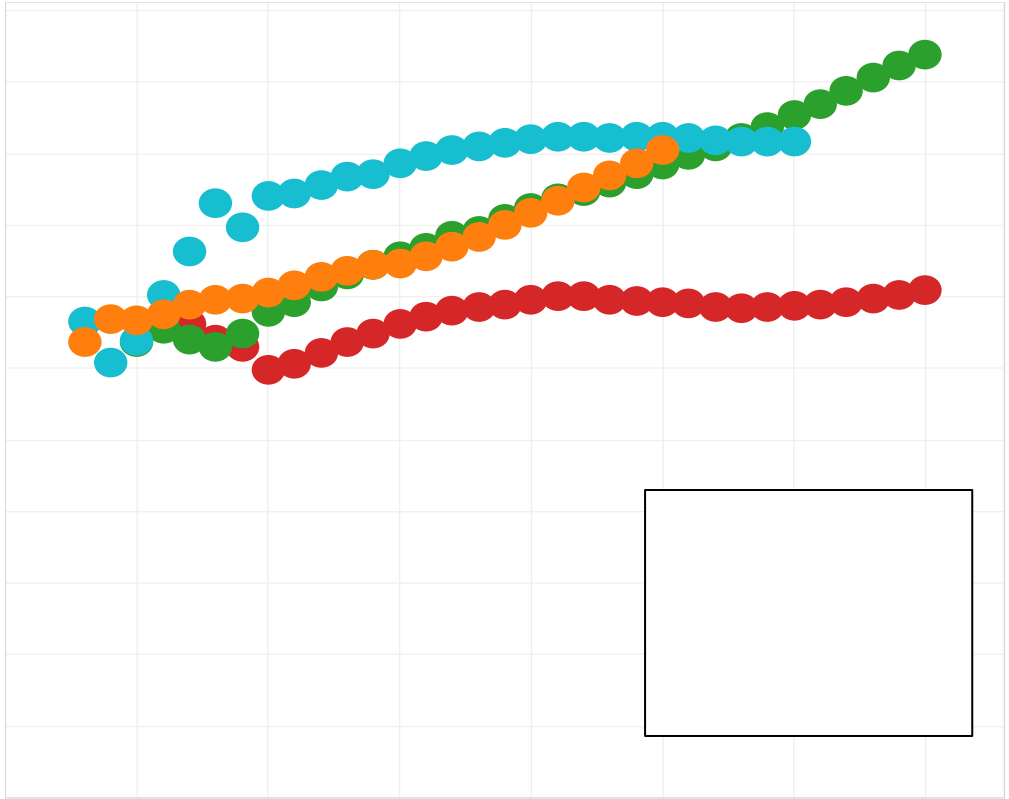

- Large differences in projected biomass consumption from AEO Reference Case Scenarios
- Driven by:
  - Policy assumptions
  - Macroeconomic conditions
  - Energy markets
  - Relative prices of alternative renewable energy sources

# Feedstock Distribution in AEO 2015 Reference Case

- Pulpwood to conventional energy ***does not enter the feedstock mix*** in the AEO 2015 Reference Case
- Logging and mill residues account for ~10% of the projected mix
- Agricultural feedstock use grows over time
- Urban waste wood includes MSW and construction debris
  - Tied to housing starts



# Annual Energy Outlook– Electricity Sector Demand Projections

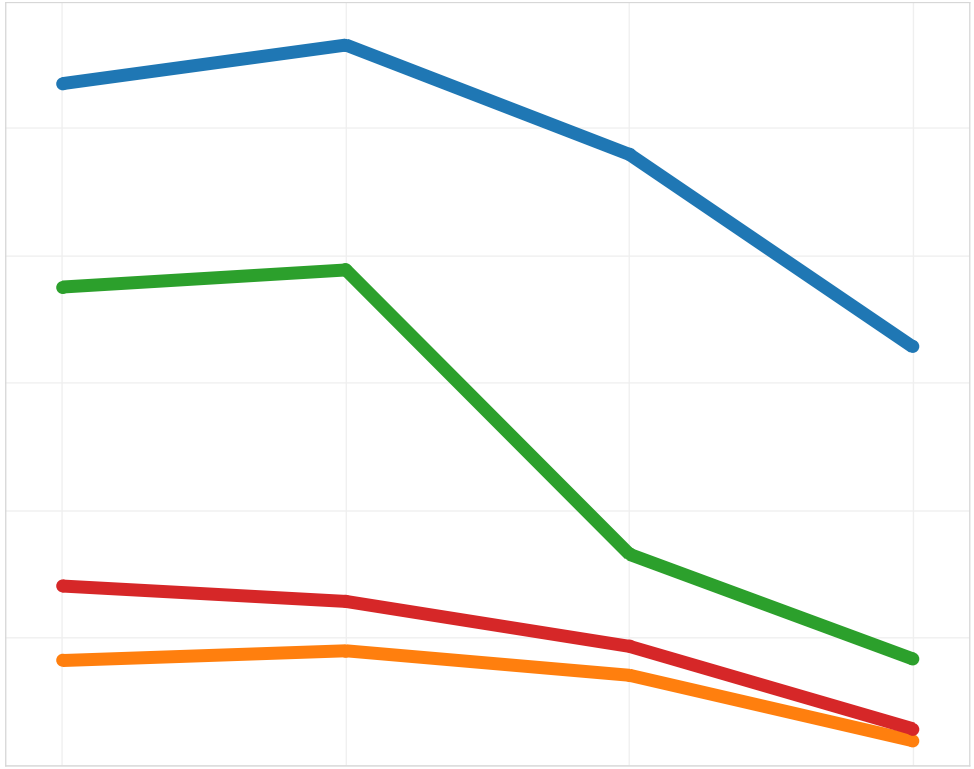



- Projected industrial sector demand shows modest growth over time
- Industrial sector biomass projections are more consistent over time under the AEO Reference Case

# Milling Residue Utilization Rates Increasing Nationally

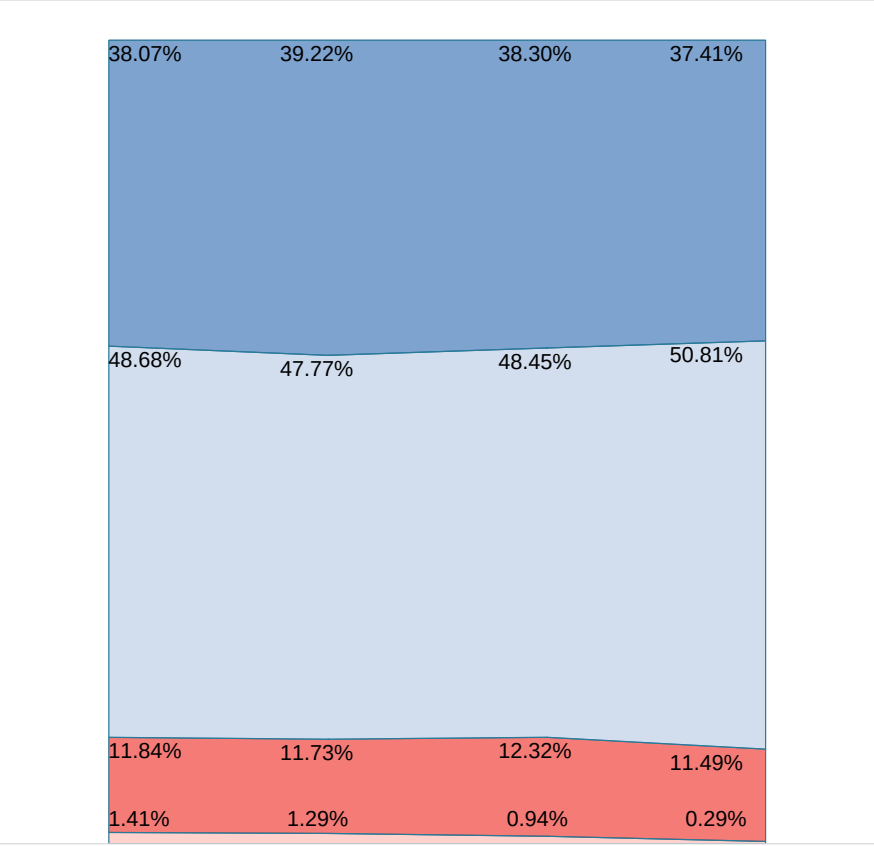
***Milling residues % Unutilized (U.S.)***

*Source: USFS RPA (1997-2012)*



- Utilization rates for milling residues increasing
- Figure shows % of milling residues that ***are unused***
  - less waste

# Disposition of Mill Residues over time

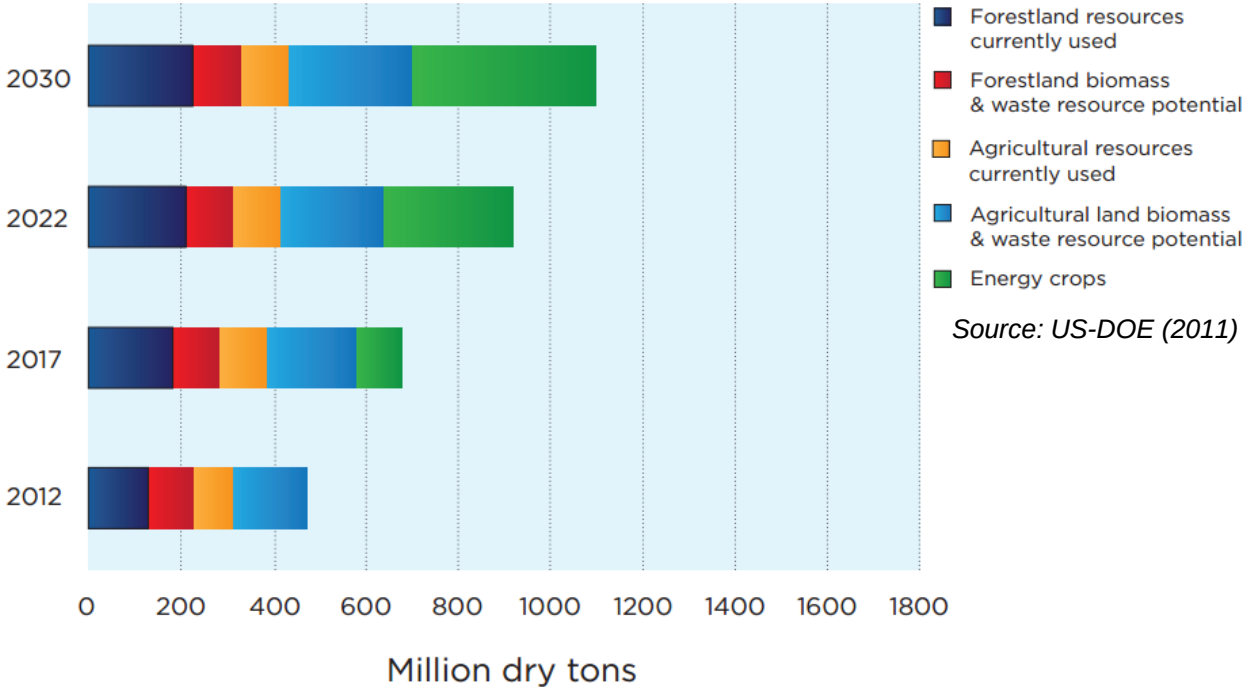



- Slightly higher proportion allocated to fuel use
- Expanded use of industrial byproducts at existing facilities could be constrained

*Source: USFS RPA (1997-2012)*

# Where will new biomass sources come from?

- Billion Ton Update (BTU) provides a comprehensive national assessment of biomass potential and costs for different sources.
  - Figure shows biomass supply potential over time at $60/dry ton

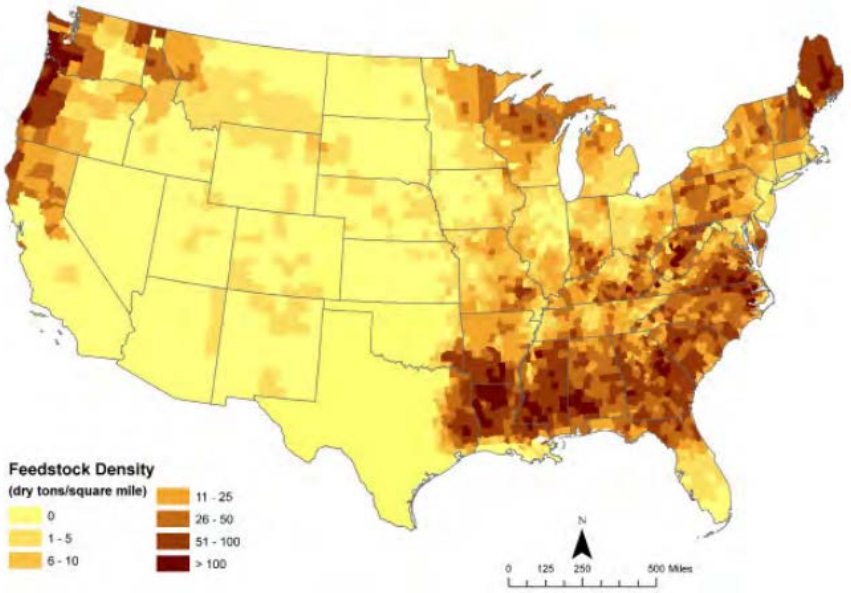



*Source: US-DOE (2011)*

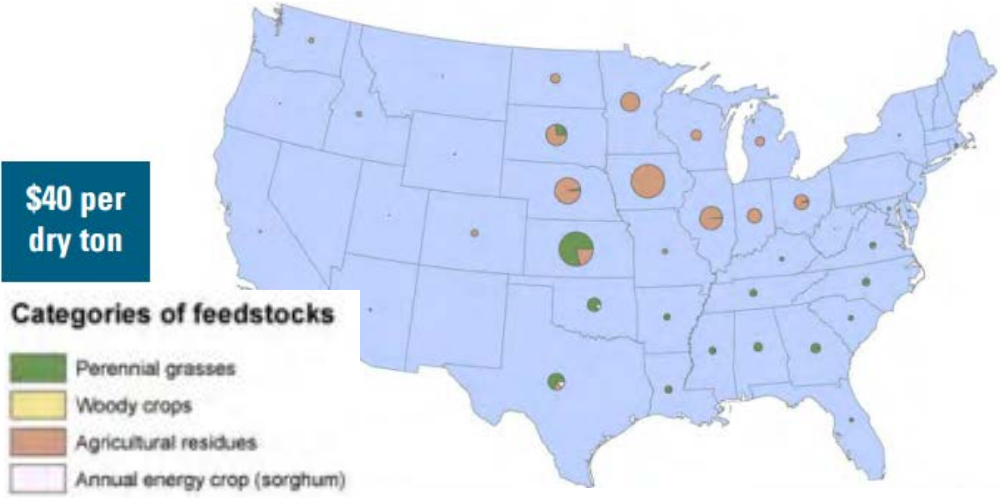
# Feedstock Availability at $40/ton from the BTU (US-DOE, 2011)

- *Different regions will rely on different biomass sources*

**$40 per dry ton**




**$40 per dry ton**




- *Above*: Logging residue availability by county
- *Left*: State distribution of agricultural feedstock groups

# Cost Comparison of Different Feedstock Groups (DOE, 2011)

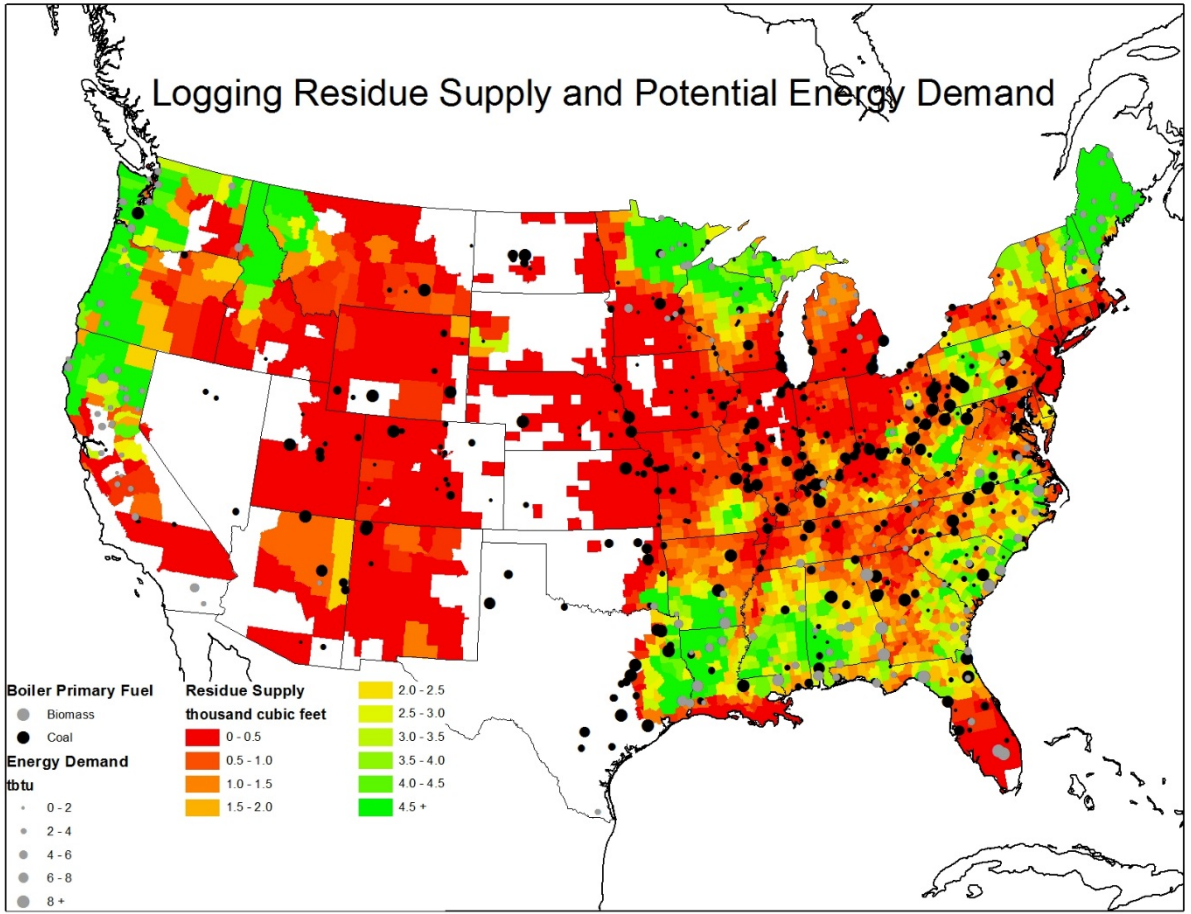
- Conventional pulpwood to energy is a high cost source of biomass
  - BTU results imply that pulpwood would not be cost-competitive with other biomass resources, especially at low feedstock prices.

**Table 3.3** Summary of Potential Forest Biomass and Wood Wastes (2012)

| Feedstock ($ per dry ton) | <$20 | <$30 | <$40 | <$60 | <$80 | <$100 |
|---|---|---|---|---|---|---|
| | Million dry tons | | | | | |
| Other Removal Residues | 4.4 | 12 | 12 | 12 | 12 | 12 |
| Integrated Composite Operations | 9.5 | 30 | 36 | 40 | 42 | 43 |
| Without Federal Land | 8.3 | 26 | 31 | 35 | 36 | 37 |
| Treatment Thinnings, Other Forestland | 0 | 0 | 0 | 3.2 | 6.4 | 6.4 |
| Without Federal Land | 0 | 0 | 0 | 1.8 | 3.6 | 3.6 |
| Mill Residues, Unused Primary | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| Mill Residues, Unused Secondary | 6..1 | 6.1 | 6.1 | 6.1 | 6.1 | 6.1 |
| Urban Wood Waste – C & D | 4.4 | 11 | 14 | 22 | 22 | 22 |
| Urban Wood Waste – MSW | 7.7 | 8.7 | 9.2 | 10 | 10 | 10 |
| Conventional Pulpwood to Energy* | 0 | 0 | 0 | 1.5 | 19 | 40 |
| **Total – All Land** | **33** | **70** | **79** | **97** | **119** | **142** |
| *Total – Without Federal Land* | *32* | *66* | *75* | *90* | *111* | *133* |

# Why is pulpwood to conventional energy considered high cost?

- High opportunity costs
  - Pulpwood is a valuable resource
- High travel costs
  - Given location of existing coal-fired boilers
  - Map shows:
    - locations of existing coal boilers capable of co-firing biomass, and
    - forest biomass availability



# Projections Discussion

- Current biomass consumption in the electric and industrial sectors predominately relies on industrial byproducts
- Future biomass demand will depend on policy and market forces
- Relative prices of renewable energy sources matter
- Both agriculture and forestry can expect to play an important role in meeting future bioenergy demand

# Recent Assessments of Biomass Energy Expansion

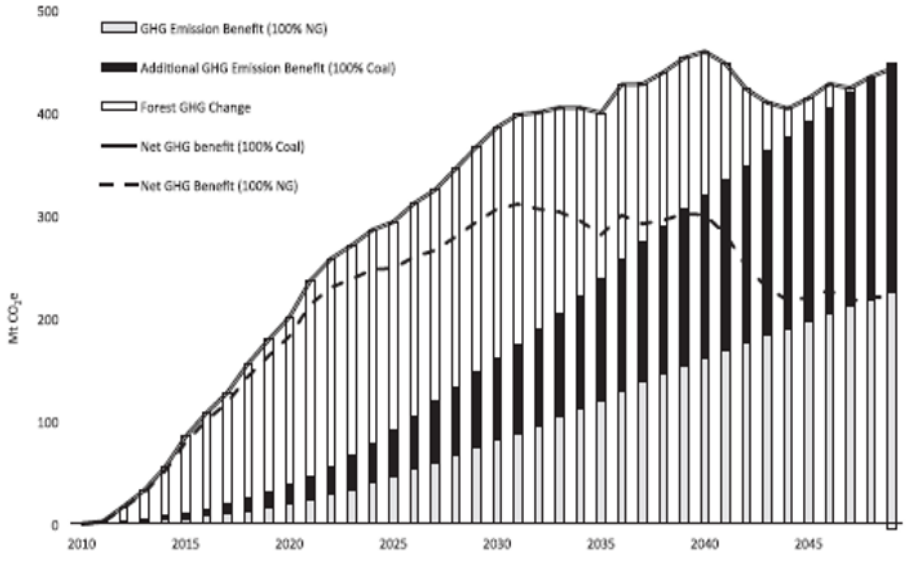
# Recent Assessments of Biomass Expansion

- There is a growing literature that seeks to quantify the GHG implications of biomass energy expansion
  - Recent focus on forest biomass
- Results vary greatly and are impacted by:
  - Modeling approach
    - Biophysical or integrated economic modeling?
    - Retrospective or prospective analysis?
  - Feedstock group
  - Spatial scale
    - Site or stand level? Regional? National?
  - Temporal scale
    - Near- or long-term assessment

# Why Integrated Economic Modeling?

1. Economic modeling offers a system-wide perspective that captures incentives and trade-offs
   - Market feedback effects
     - Induced *intensive* and *extensive* margin expansion with increased demand/prices
2. Ideal for isolating ***additional*** impact of increased biomass relative to a baseline
3. Can be conducted at various spatial scales
   - Regional, national, global
4. Offers a prospective assessment approach for projecting impacts of biomass expansion
   - Simulation or dynamic optimization

# Regional Economic Modeling Assessments




Galik et al. 2015. *Energy Policy*

- Galik et al. (left) evaluate GHG benefits of a regional RPS in the Southeastern U.S.

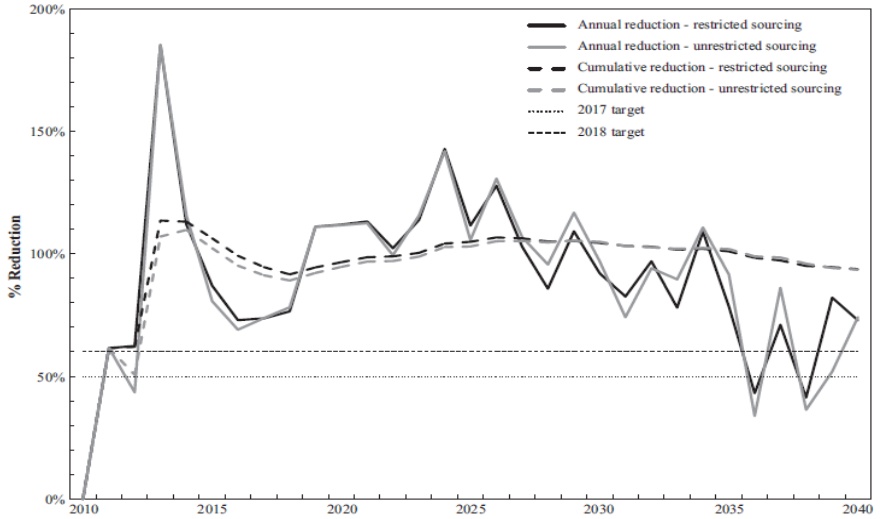



**Fig. 5** Percent emission reduction achieved by pellet use compared to a coal alternative under both restricted and unrestricted sourcing scenarios. Horizontal lines indicate draft sustainability guideline greenhouse gas reduction targets for years 2017 and 2018.

- Galik and Abt (right) compare GHG emissions impacts of wood pellet expansion in the Southeast to assumed EU target reductions

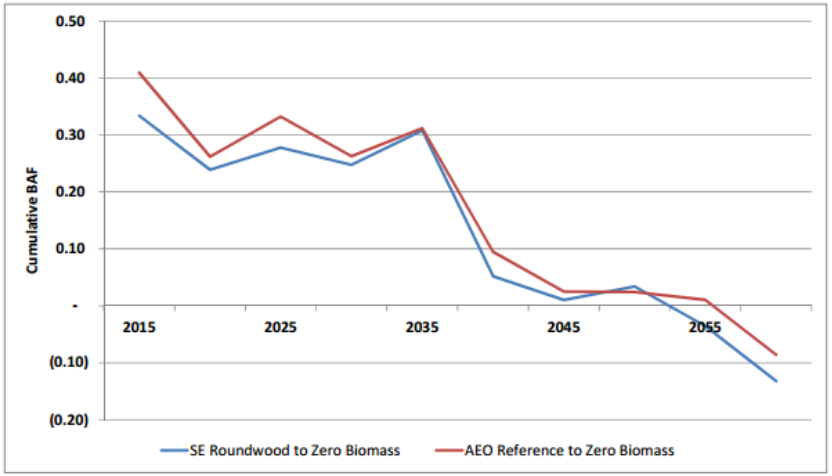
Galik and Abt. 2015. *GCB Bioenergy.*

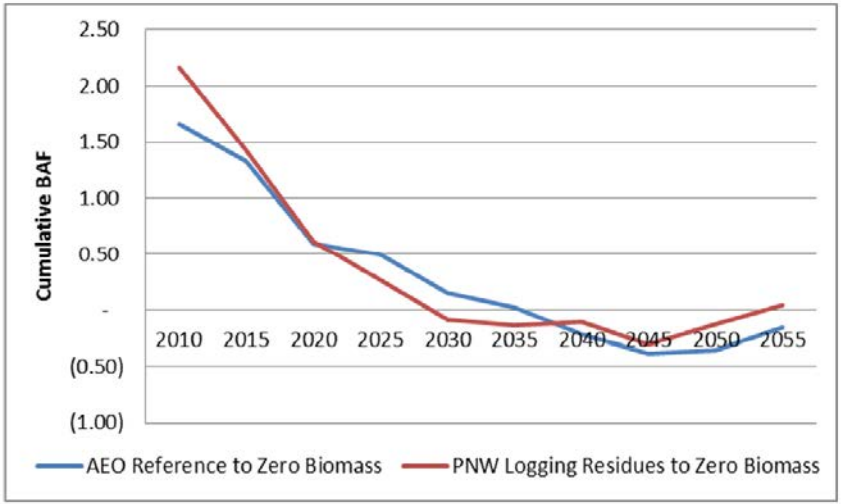
# National Economic Modeling Assessment

- Latta et al. 2013 use a dynamic economic model of the U.S. forest and agricultural sectors to project land use change and emissions from bioenergy expansion
  - Examines scale effects of different biopower generation levels
  - Evaluates effects of restricting demand growth to different feedstock groups
    - See Latta presentation from the workshop for more discussion on this paper

# National Economic Modeling Assessment

- EPA (2014) used the same economic model as in Latta et al. (2013) to assess potential landscape emissions of different feedstocks
  - Results reported in technical appendices from the updated Biogenic $CO_2$ Assessment Framework Report (2014)
    - Applied a ***future anticipated baseline approach (FABA)***
    - Scenarios were purely hypothetical and developed to illustrate the FABA methodology
      - *Left:* SE roundwood case study; *Right:* PNW logging residue case study

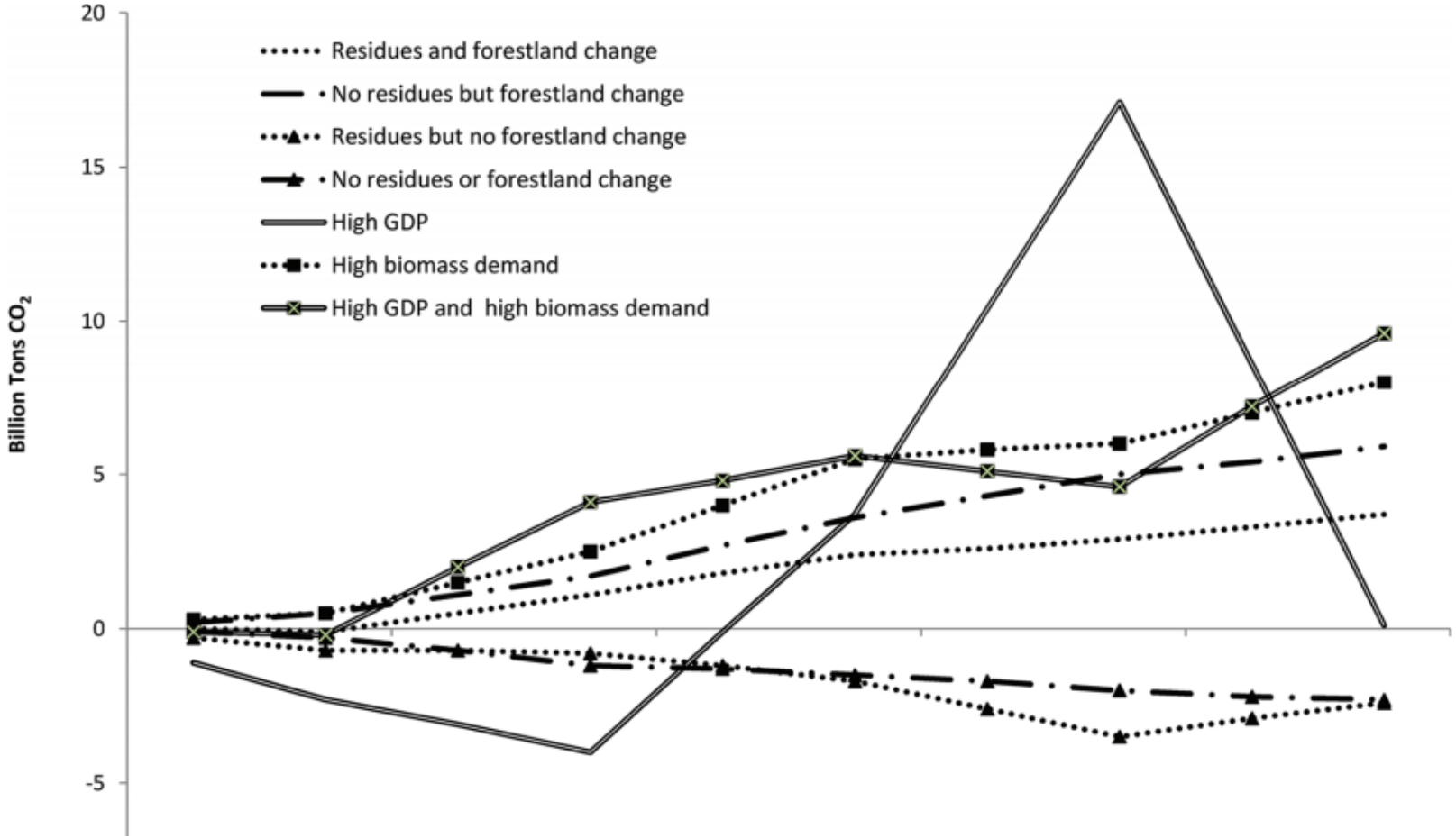


# Global Economic Modeling

- Daigneault et al. (2012) use a dynamic model of the global forest sector to compare carbon stocks across a range of policy scenarios
  - Forest bioenergy expansion in the U.S. can result in ***increased*** forest carbon stocks
    - Drives investment in new forests and increases management intensity over time
  - Restricting use of forest residues or investments in new forestlands results reduces the GHG benefit

# Daigneault et al. (2012) Results



# Conclusions

- Projections of biomass demand vary
  - Markets, policy, and feedstock costs matter
- Agriculture and forestry are both expected to play a role in providing requisite feedstock
- Economic modeling provides an important framework for projecting impacts of bioenergy policy

# More Information

## Contact

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