Modeling land use changes and GHG effects with wood pellet production in the U.S.

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Motivation

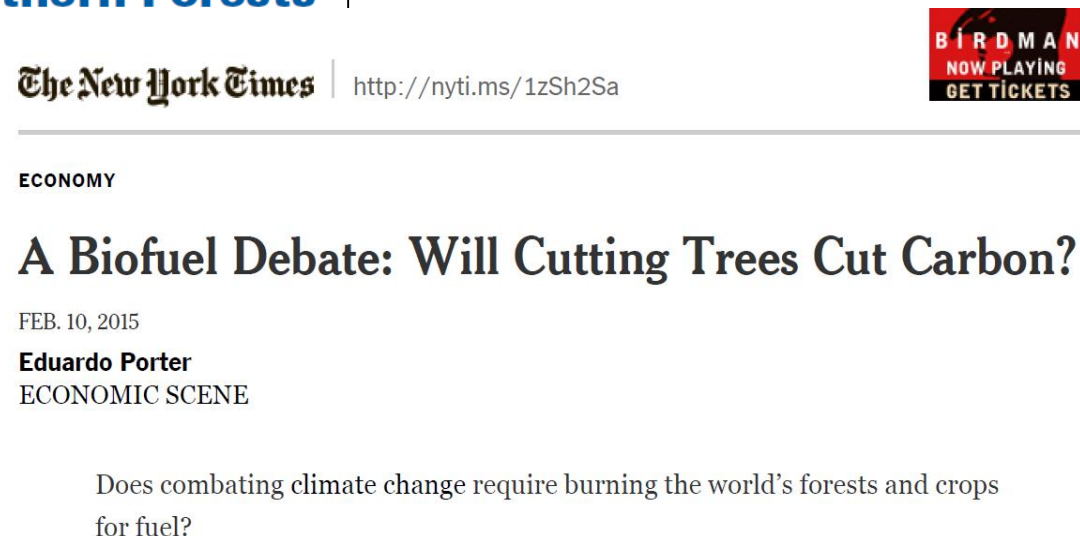
- Six-fold increase in export of pellets from US to EU to meet renewable energy and GHG mitigation targets
  - 98% of pellets for export from US South
- Skepticism about the GHG savings from displacing coal with pellets for electricity generation

NRDC FACT SHEET

APRIL 2013
FS:13-04-A

Burning Trees for Electricity Will Accelerate Climate Change and Destroy Southern Forests

Power companies in the United States and Europe are expanding their use of t
biomass—as a fuel source to replace fossil fuels. The wood is chipped or turne
in power plants just the same as coal. To meet this increasing demand, a new,
manufacturing facilities has emerged across the southeastern United States to
utilities on both sides of the Atlantic. In the Southeast, the massive fuel needs
could double logging rates and significantly increase carbon emissions, contribu
at a time when we need to actively cut our carbon pollution. As important, loca
watersheds could be devastated.



The New York Times | http://nyti.ms/1zSh2Sa

ECONOMY

A Biofuel Debate: Will Cutting Trees Cut Carbon?

FEB. 10, 2015

Eduardo Porter
ECONOMIC SCENE

Does combating climate change require burning the world's forests and crops for fuel?

GHG Savings with Pellets

- Direct effect through displacing fossil fuels with pellets
  - Carbon intensity of coal/gas vs carbon emissions due to production, harvest, transport of forest biomass
- Indirect effects as increased demand for forest biomass for pellets
  - Creates incentives for increasing harvesting of trees
  - Diverts forest biomass from forest products to pellets
  - Changes in forestland: afforestation/deforestation

Land Use Change with Increased Pellet Demand

- Conversion of privately-owned, commercially managed land across uses depends on
  - expected returns to alternative uses
    - Biophysical factors
    - Macro-economic factors
  - length of planning horizon
  - extent to which decision makers are forward-looking

Purpose of this study

- Quantify the direct and indirect market-driven effects of increased demand for pellets from EU from
  - Forest biomass only (mill residues, pulpwood and logging residues)
  - Forest and ag biomass (from crop residues, dedicated energy crops and short rotation woody biomass)
- on GHG intensity of electricity generation for 2007-2032 period relative to coal-based electricity

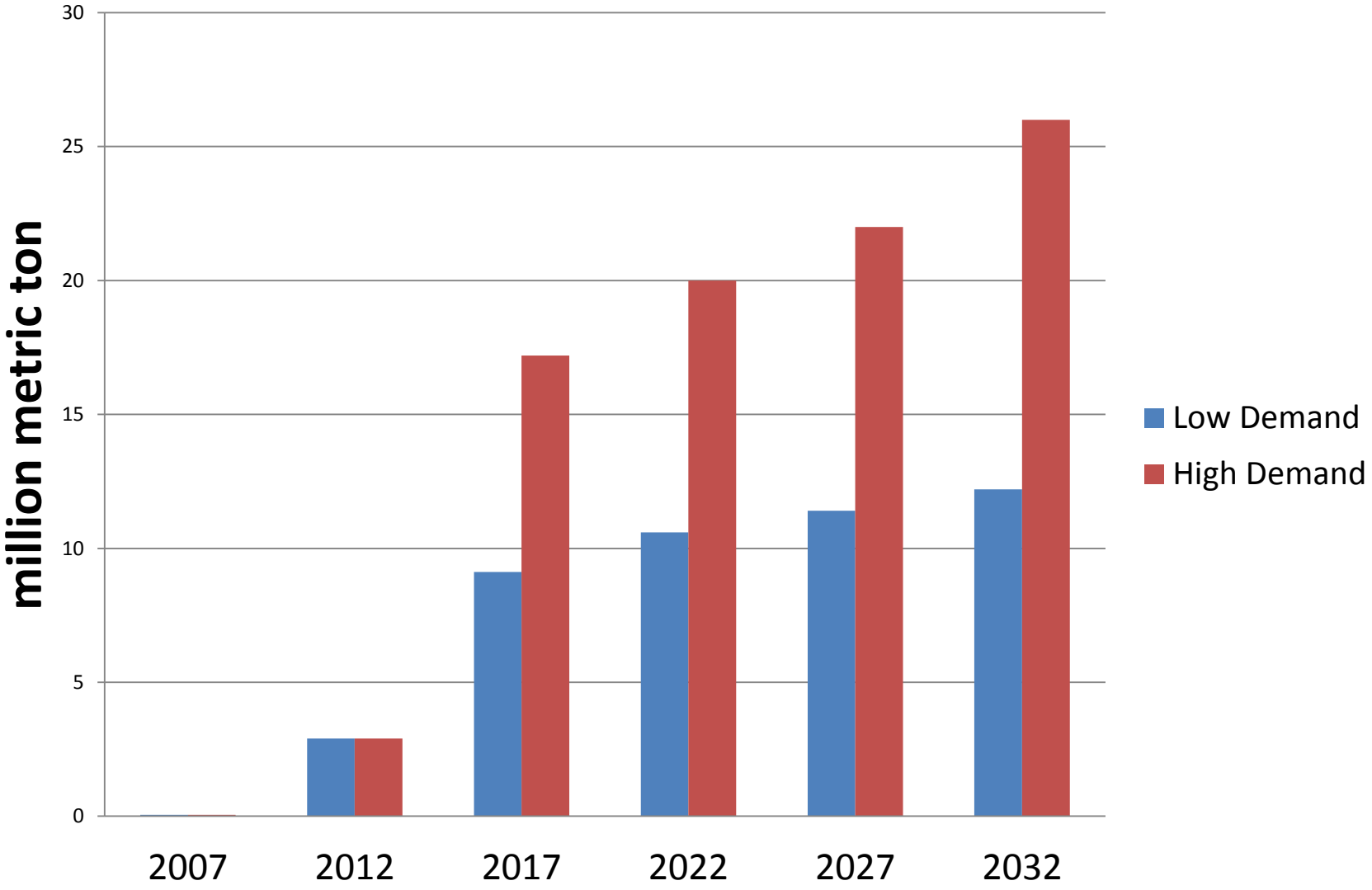
Coupling Biofuel and Environmental Policy Analysis Model with FASOM

- BEPAM-F: Integrated model of agricultural and transportation sectors with LCA of ag emissions
  - With forestry module and forest carbon model from FASOM
- Dynamic optimization: Land allocation determined to maximize consumer and producer surplus across sectors
  - Given constraints on land availability, material balances, biophysical dimensions, technology
  - National demands for agricultural commodities and forest products
  - Endogenously determined market prices, land allocation, quantities of ag and forest products, harvest age/acres, GHG emissions
- Differences between BEPAM and FASOM
  - BEPAM: Heterogeneity in cropland across 295 Crop Reporting Districts in the US
  - Annual time scale
  - Rolling horizon: Ag landowner have a 10 year planning horizon; model takes first year's decision as realized; updates land use, technology costs and re-optimizes for next 10 years
  - FASOM: 11 forest marketing regions homogenous in their forest production sectors
  - 5 year time scale
  - Fully forward looking: 100 year time horizon

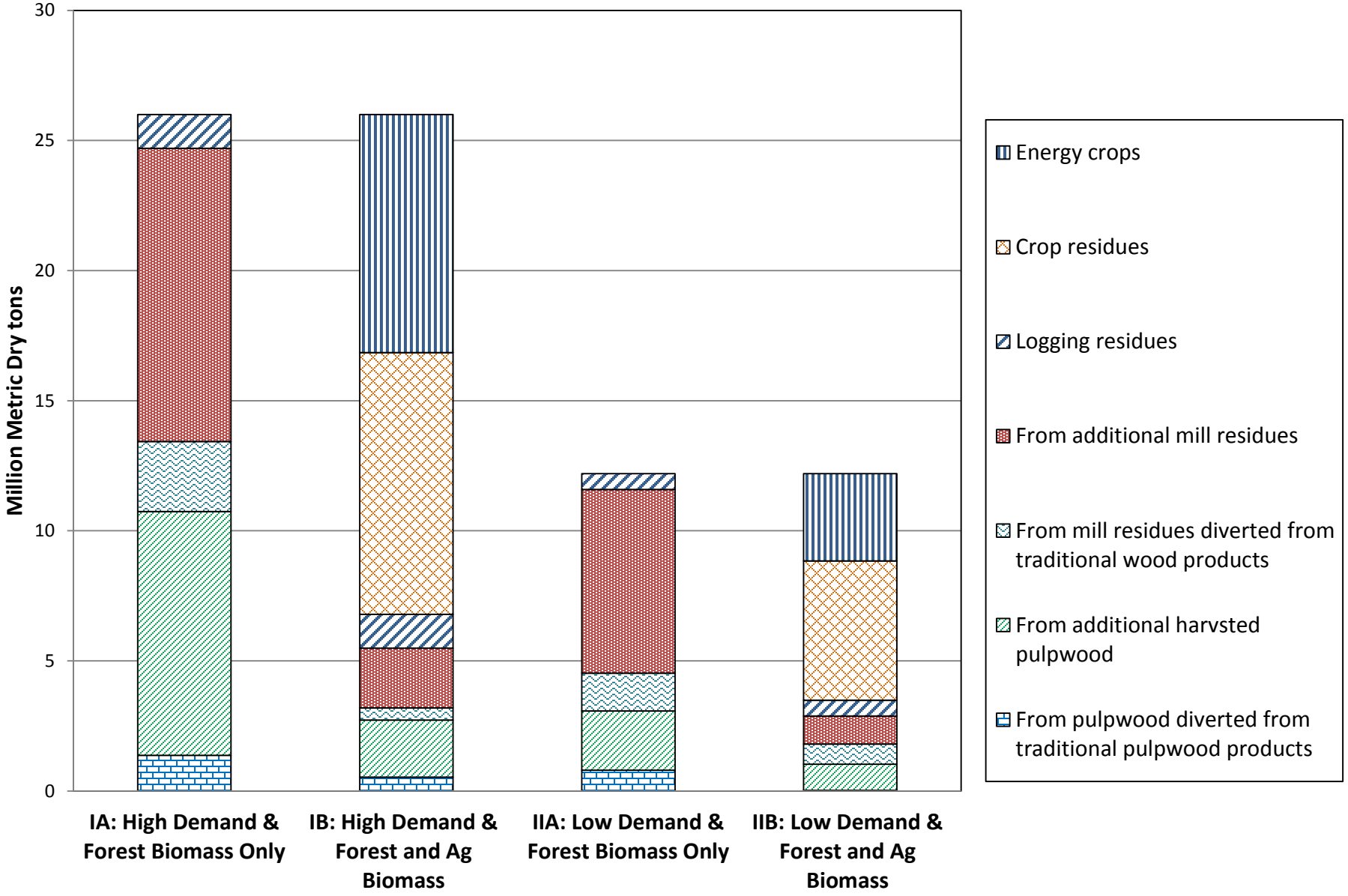
Integrative Features of BEPAM-F

- Rolling horizon model:
  - Landowners have a 15-50 year time horizon taking demand conditions, initial land availability and age distribution of forest stock as given
  - Solving each 30 (15 or 50) year market equilibrium problem,
    - take the first five year period's solution values for prices, land available in different categories, and age distribution of forest stock as 'realized',
    - move the horizon one period forward and solve the updated model again
  - Overlay the CRDs on the forestland in the 11 forest marketing regions in FASOM together with recent county-level data FIA data on forest inventory
    - Changes in forestland due to the pellet demand shock are allocated to the distribution of trees by age, species, and timber land acres at the CRD level.
    - Economic incentives for conversion of land from one use to another is based on a more spatially disaggregated assessment of the returns to land from agriculture.

Targeted Demand for Pellet Exports

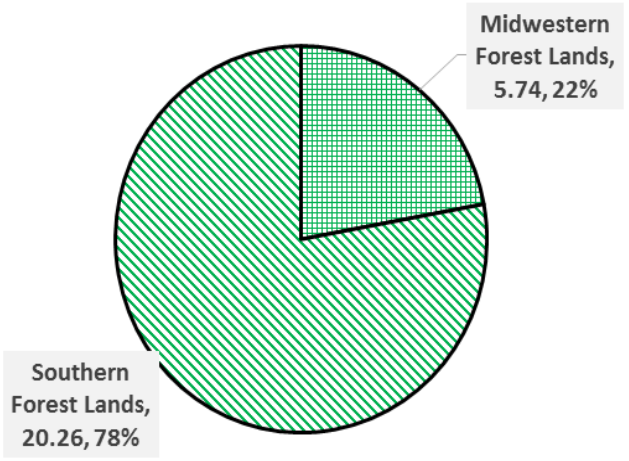


Biomass sources for pellet production in 2032

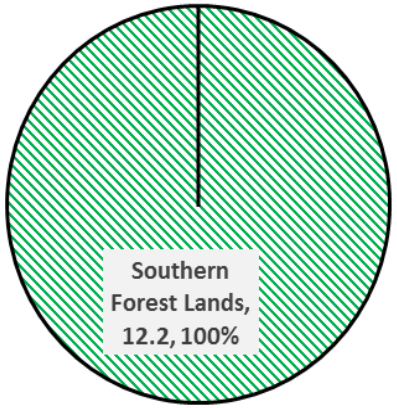


Region-wise supply of feedstocks for production of pellets in 2032

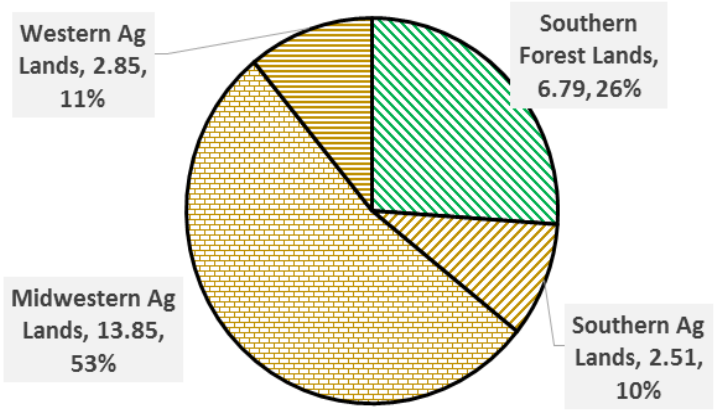
IA: High Demand & Forest Biomass Only



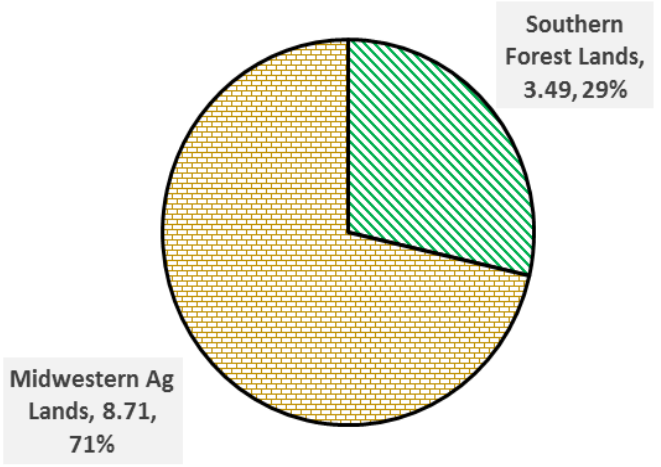
IIA: Low Demand & Forest Biomass Only



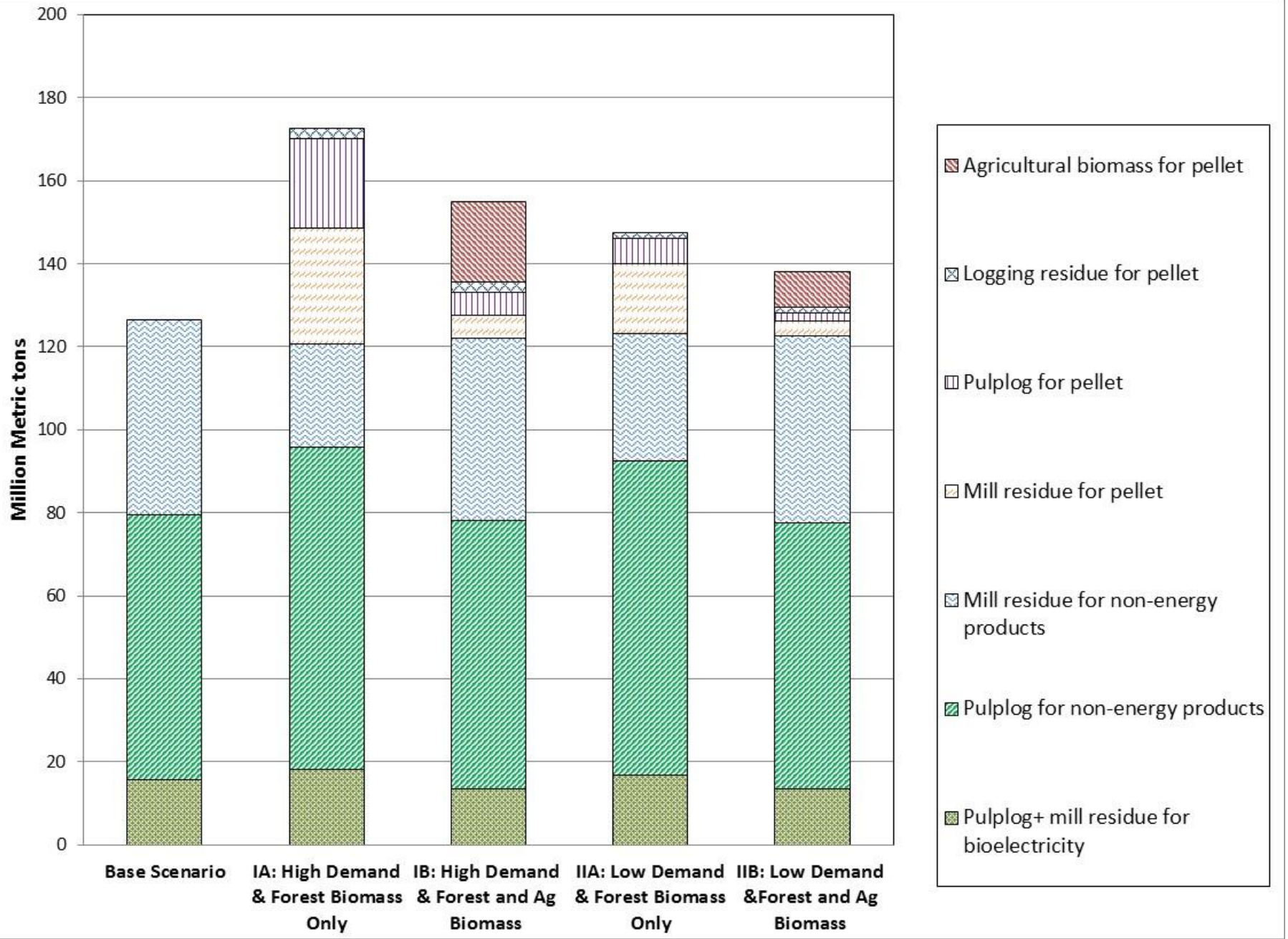
IB: High Demand & Forest and Ag Biomass



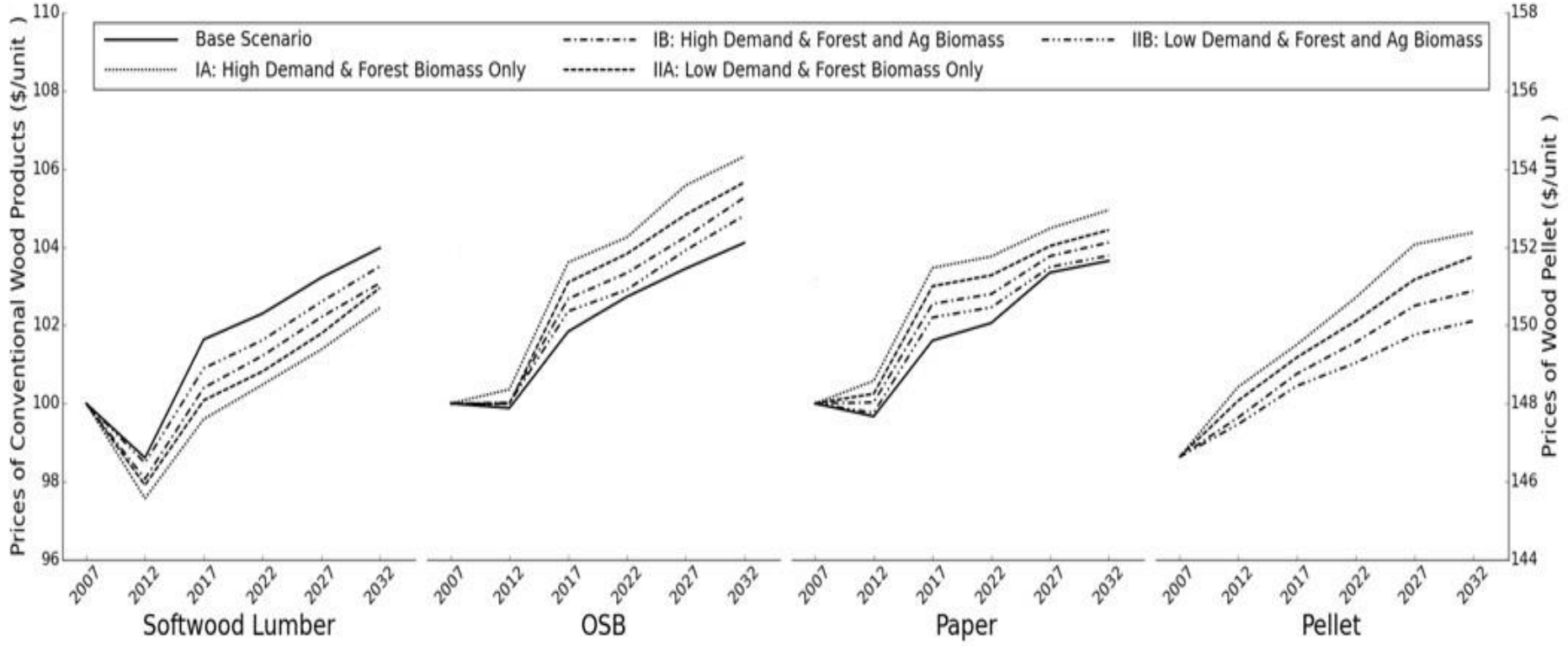
IIB: Low Demand &Forest and Ag Biomass



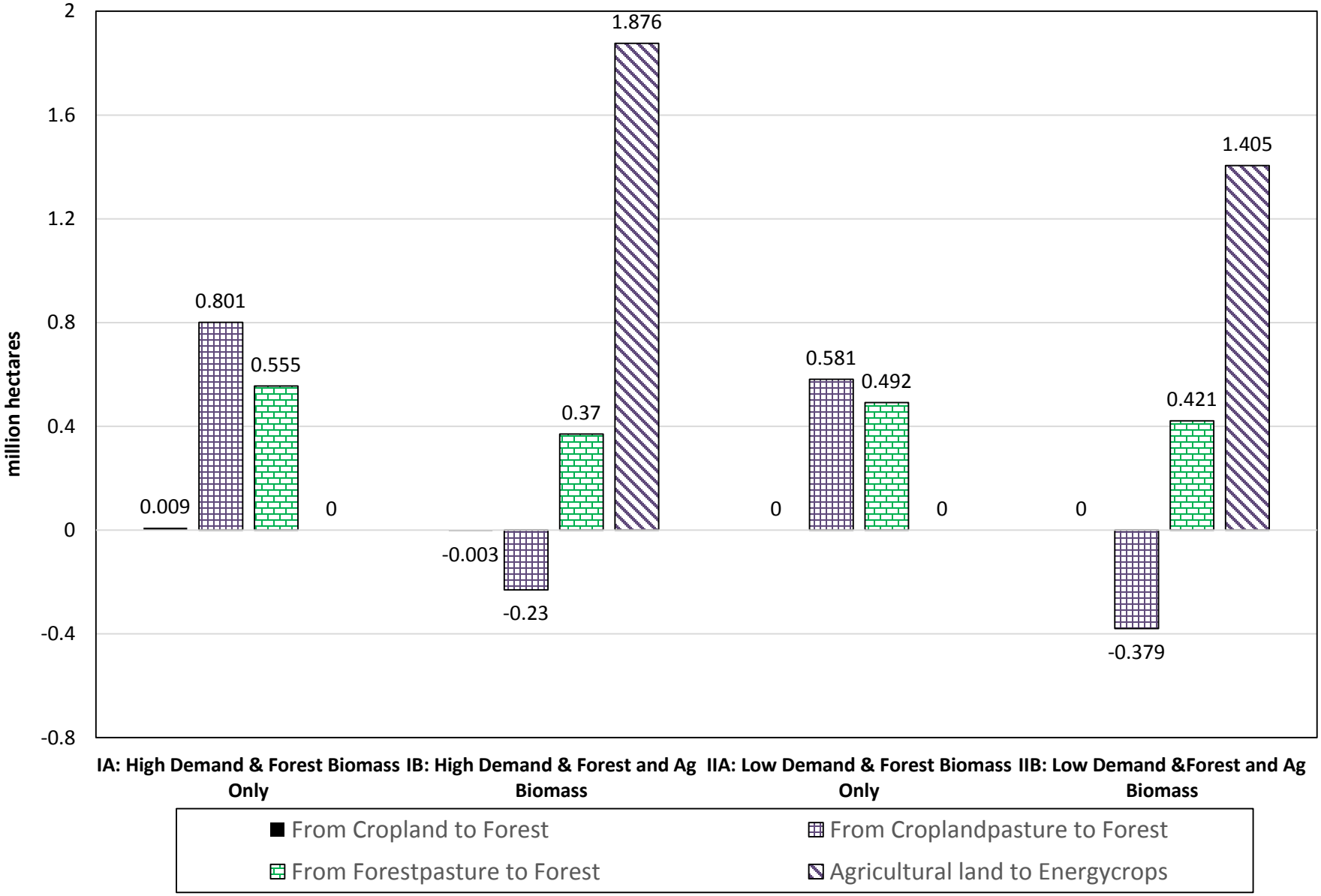
Biomass production for pellets and other uses in 2032



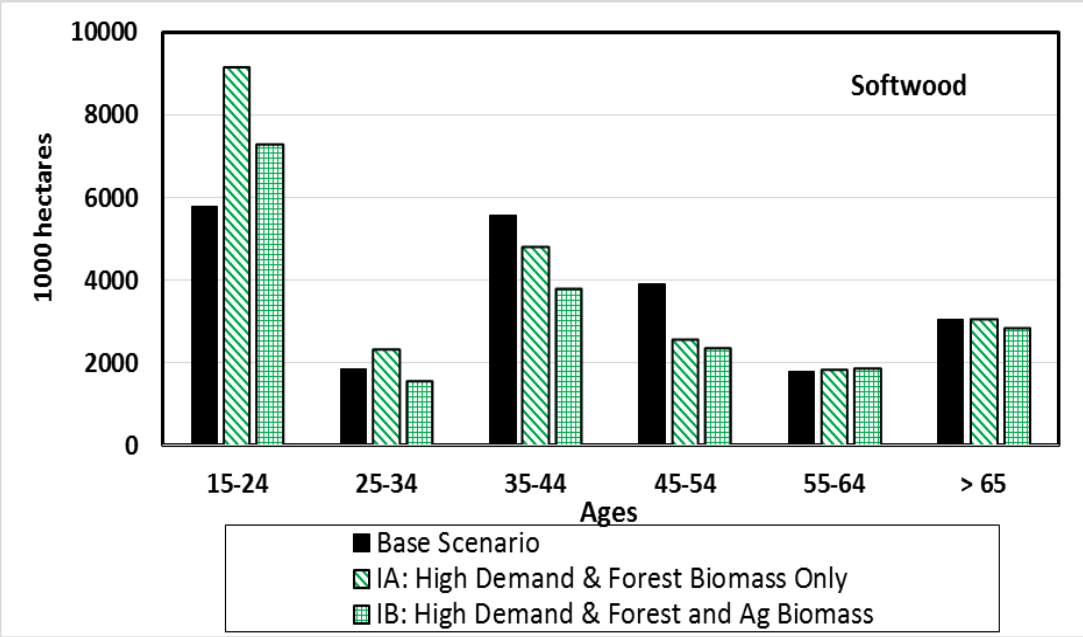
Prices of selected finished wood products

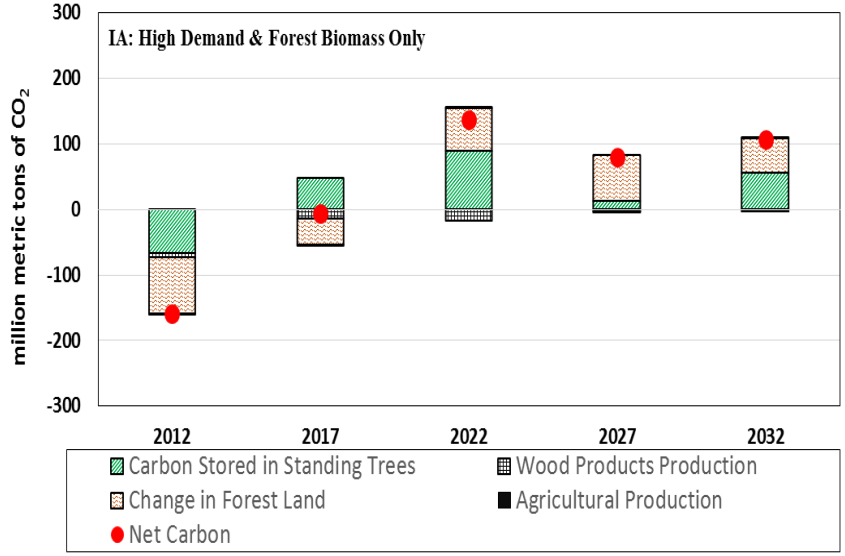


Land use change between 2007 and 2032 relative to base scenario



Distribution of Forest Harvest Age in the Southern US

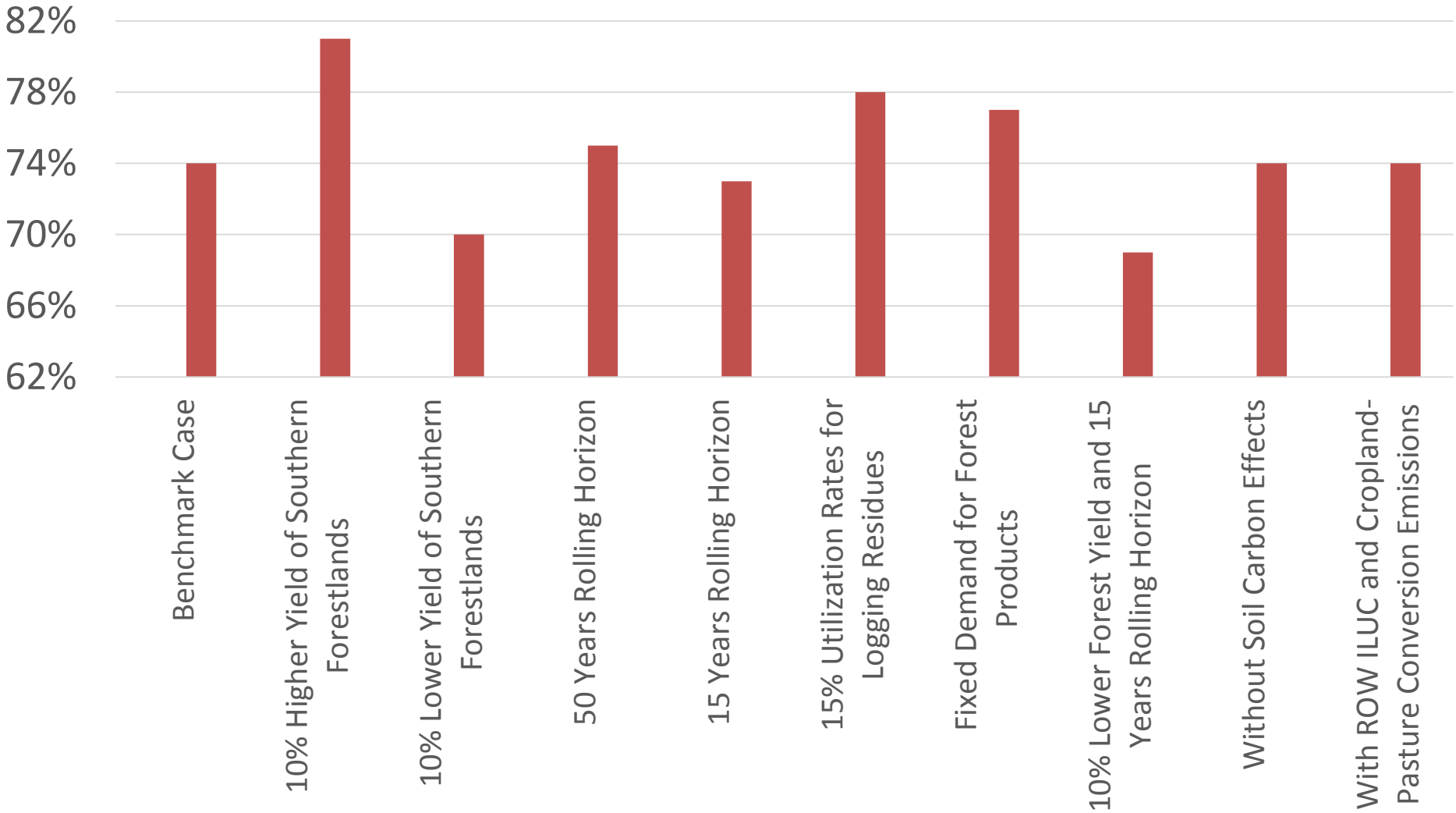




GHG Intensity of Pellets

Change in GHG Emissions Due to (g CO2 per MJ)	IA: High Demand & Forest Biomass	IB: High Demand & Forest and Ag Biomass	IIA: Low Demand & Forest Biomass	IIB: Low Demand Forest and Ag Biomass
Pellet Production, Transportation, Electricity Gen.	**58.17**	**55.69**	**58.17**	**57.04**
Change in Carbon Stored in Forest	129.13	40.97	192.75	50.15
Conventional Wood Product Production	-85.26	-16.56	-141.04	-32.91
Land Use	-24.42	-0.83	-45.45	-1.57
Aboveground Emissions of Agricultural Production	-0.41	1.24	0.78	1.57
SOC of Agricultural Production	0.41	-24.83	0.78	-30.56
GHG Intensity of Pellets	**77.62**	**55.68**	**66.00**	**43.72**
GHG Intensity of Avg. Coal-Based Electricity in UK	299.44	299.44	299.44	299.44
Savings in GHG Emissions Relative to Grid Electricity (%)	**74%**	**81%**	**78%**	**85%**

Savings in GHG Emissions Relative to Coal Based Electricity in High Demand Scenario



Summary

- Indirect effects on GHG intensity of pellets include both positive and negative effects
  - account for net increase of 11-26% of GHG intensity of forest biomass based pellets

- 69%-89% savings in GHG intensity relative to coal based electricity across different scenarios and assumptions including market effects

- GHG intensity of pellets using ag. biomass 28%-34% lower than with forest biomass only