From the Woods to the Refinery

CORRIM Life Cycle Analyses of Woody Feedstocks

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Consortium for Research on Renewable Industrial Materials

A non-profit corporation formed by 17 research institutions to conduct cradle to grave environmental studies of wood products

Who is CORRIM?

- Seventeen years of LCI/LCA work on durable wood products
- Biofuel LCI/LCA research support from:
  - Eight institutions/cooperators and 20+ authors
  - USFS, USFS-Forest Products Laboratory
  - Trade associations
  - Private Foundations and donors

Many Demands on Forest Landscapes

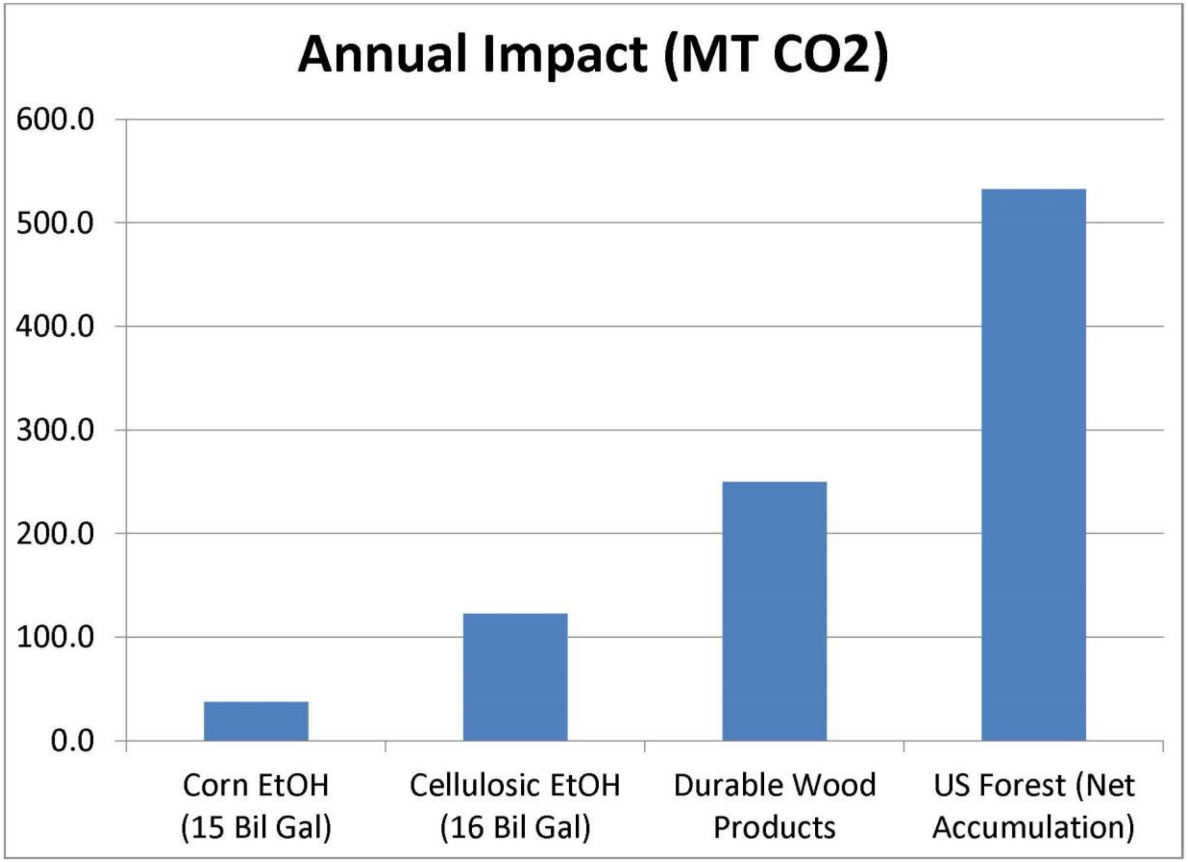
- Society views a clearcut very differently than a farm field with harvest stubble

- Durable wood products, and paper fiber
- In addition to commercial values there are concerns about aesthetics, water, wildlife, recreation, biodiversity and carbon storage
- Could be a source or sink for carbon depending on system, and land use change

Integrated Harvesting

Whole Tree Chipping

Carbon Impacts of Durable Wood Products is Greater than that of RFS Biofuels



IBSS Southeastern Partnership for Integrated Biomass Supply Systems

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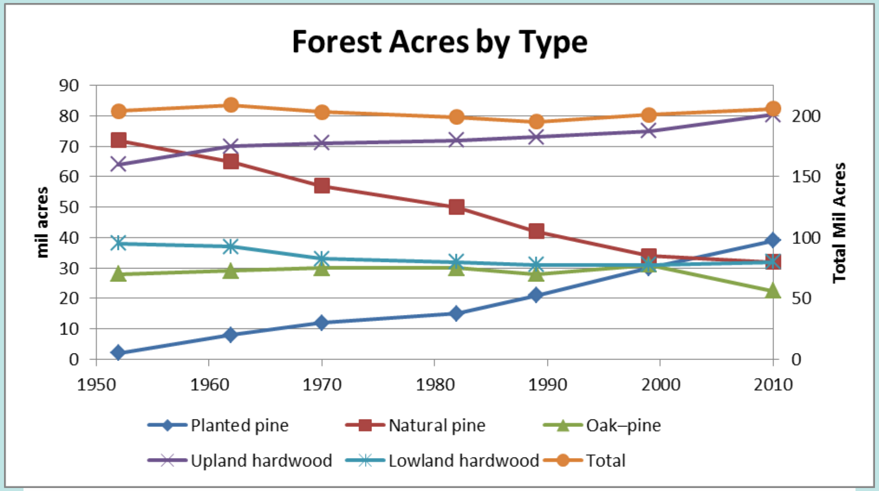
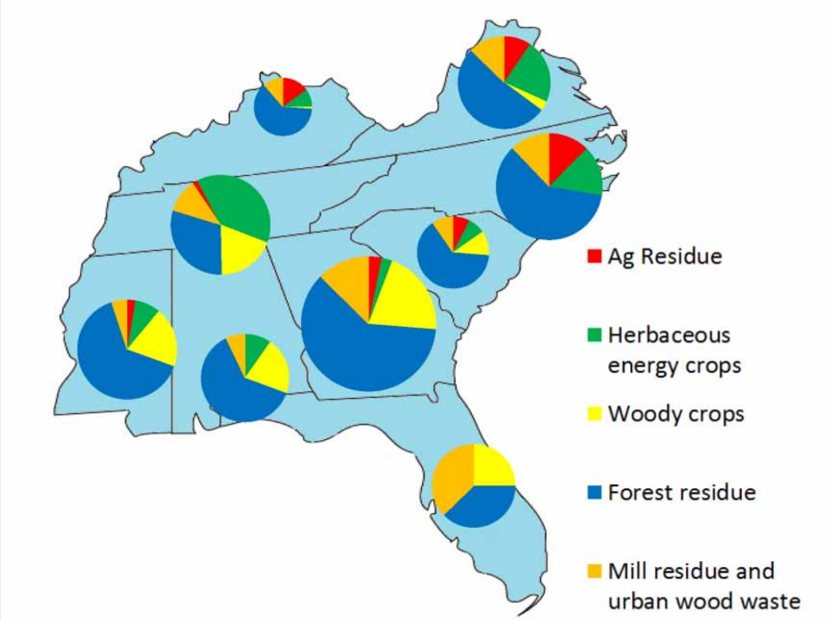
Drivers for Bioenergy and Forest Utilization

- More acres of forest that we had 100 years ago
- Significant regional differences in growing season, growth and yield, land ownership patterns, harvest methods, and joint production possibilities
- Biofuels can not “afford” the logs used for durable wood products, but pulp and paper may be impacted
- Opportunities exist for integration of joint production systems with residues or Short Rotation Woody Crops
- Hardwoods and Softwoods are very different in BC processes
- Potential for year round harvesting, with proven systems

Dynamics in Forestry and Biofuels





- Almost 90% of commercial harvesting from private lands
- To have harvest residues you need harvesting
- USDA Roadmap notes that 50% of biomass/biofuels will come from the SE
- Wood type matters, BC vs TC
- Feedstock quality matters
  - Moisture content, composition, cleanliness/ash

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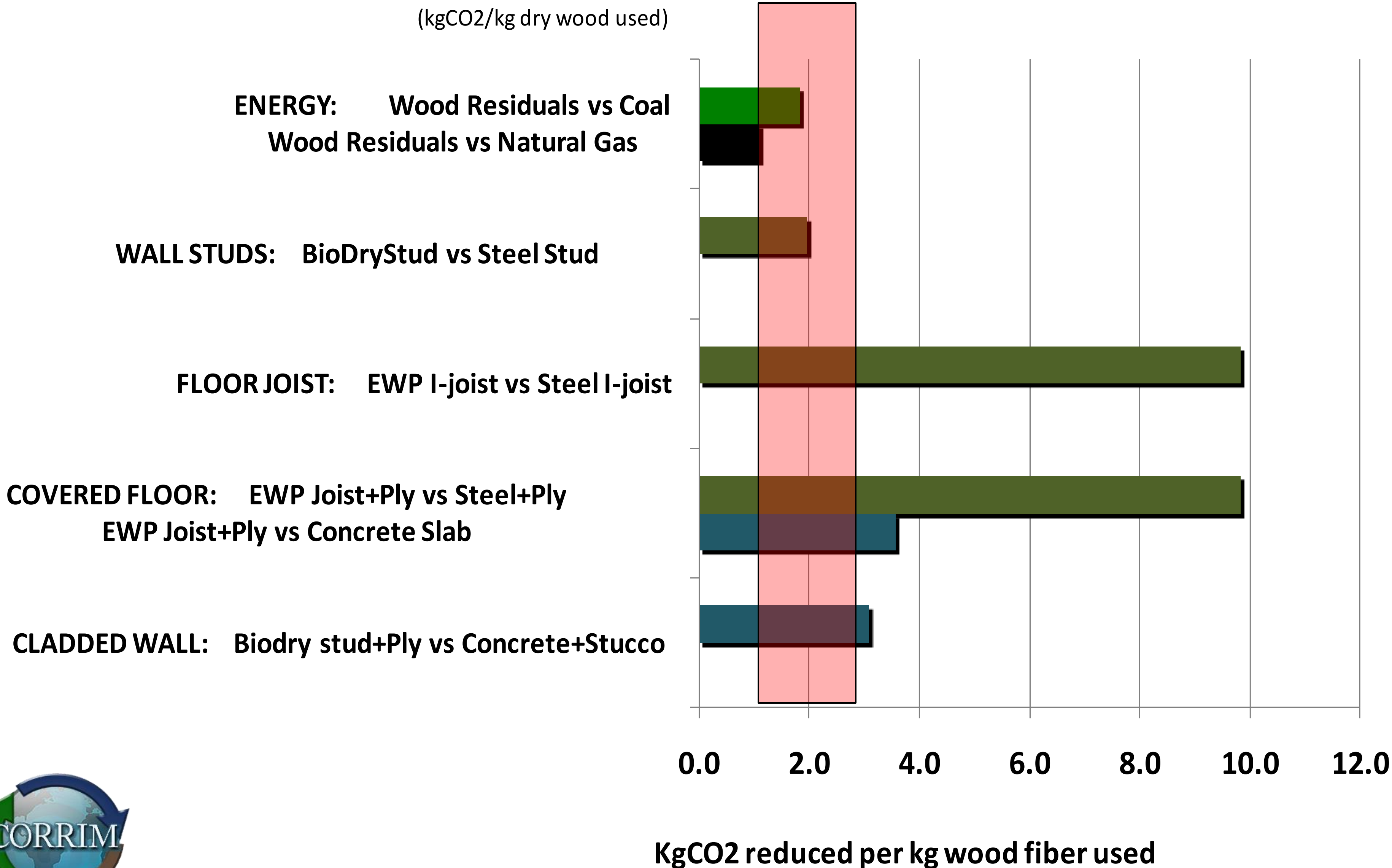
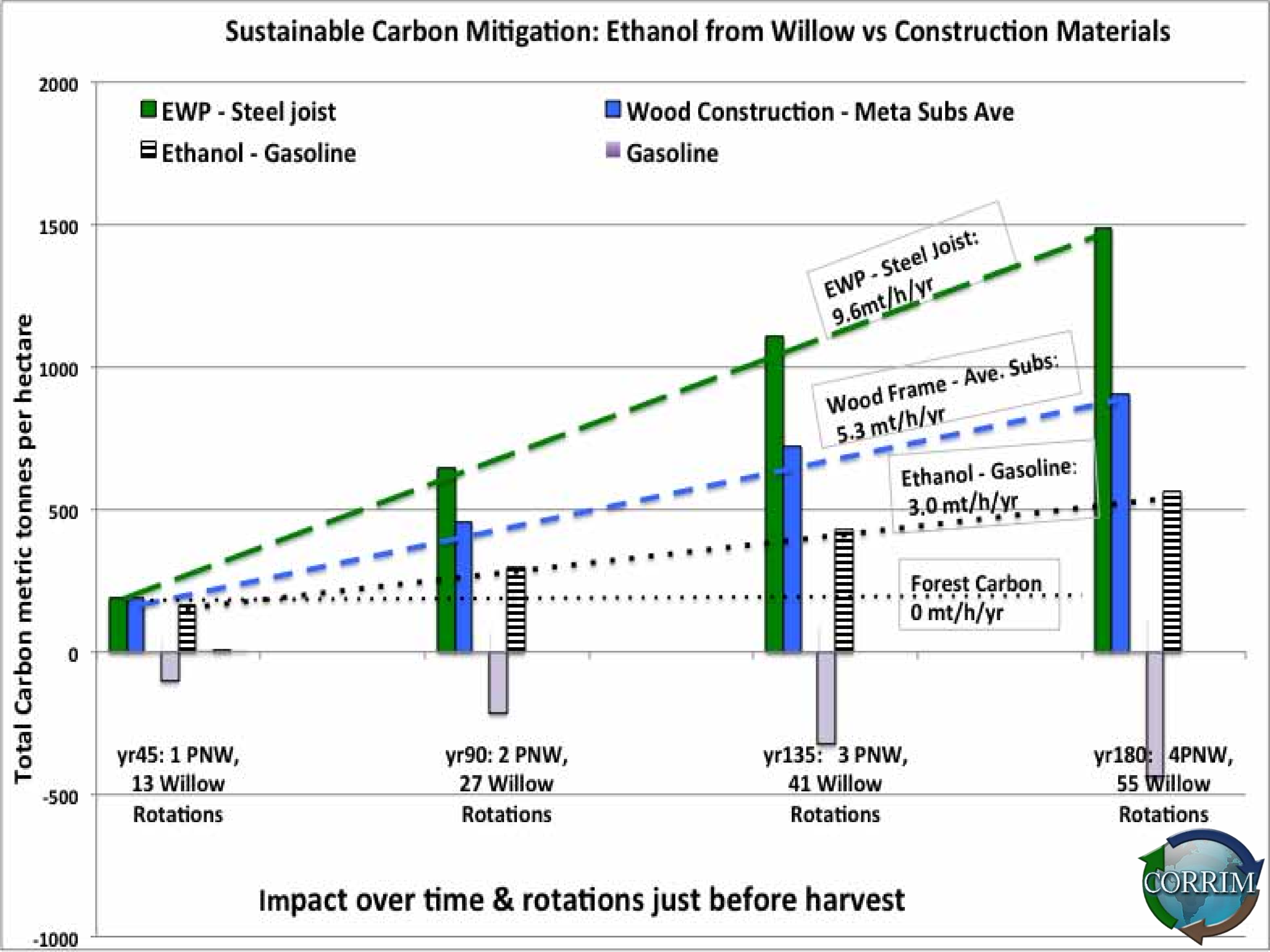
Carbon Emission Reduction

by Displacing Non-wood Products

(kgCO2/kg dry wood used)




Sustainable Carbon Mitigation: Ethanol from Willow vs Construction Materials
EWP - Steel joist
Wood Construction - Meta Subs Ave
Ethanol - Gasoline
Gasoline
2000
1500
1000
500
0
-500
-1000
Total Carbon metric tonnes per hectare
EWP - Steel Joist: 9.6mt/h/yr
Wood Frame - Ave. Subs: 5.3 mt/h/yr
Ethanol - Gasoline: 3.0 mt/h/yr
Forest Carbon 0 mt/h/yr
yr45: 1 PNW, 13 Willow Rotations
yr90: 2 PNW, 27 Willow Rotations
yr135: 3 PNW, 41 Willow Rotations
yr180: 4PNW, 55 Willow Rotations
Impact over time & rotations just before harvest
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Temporal Implications

Plant at Time Zero - Operations and Emissions

Year	Pine		Eucalyptus		Unmanaged Hardwood	
1	4.00E-02	E, G	-5.69E-02	E, G	-4.47E-03	G
2	-4.82E-02	G	-6.24E-02	G	-4.47E-03	G
3	-4.82E-02	G	-6.24E-02	G	-4.47E-03	G
4	-4.82E-02	G	-6.24E-02	G	-4.47E-03	G
5	-4.82E-02	G	2.61E-01	H, P, U	-4.47E-03	G
6	-4.82E-02	G			-4.47E-03	G
7	-4.82E-02	G			-4.47E-03	G
8	-4.82E-02	G			-4.47E-03	G
9	-4.82E-02	G			-4.47E-03	G
10	-4.82E-02	G			-4.47E-03	G
11	-4.82E-02	G			-4.47E-03	G
12	-4.82E-02	G			-4.47E-03	G
13	5.11E-01	H, P, U			-4.47E-03	G
14					-4.47E-03	G
.					-4.47E-03	G
.					-4.47E-03	G
50					2.51E-01	

G=Growth
E=Establish
H=Harvest
P=Fuel production
U=Fuel use

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6	-4.82E-02	G			-4.47E-03	G
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9	-4.82E-02	G			-4.47E-03	G
10	-4.82E-02	G			-4.47E-03	G
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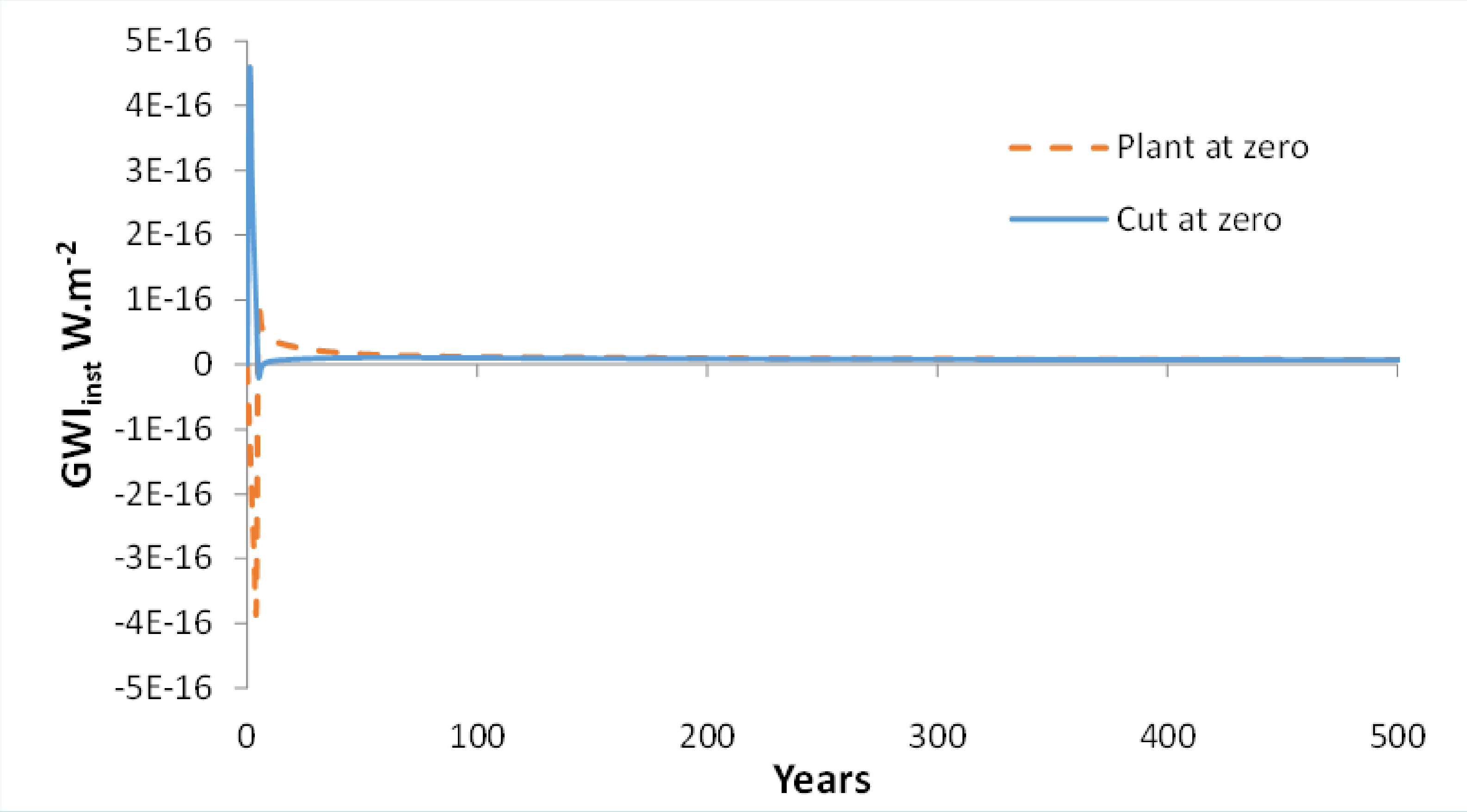
Instantaneous Radiative Force
1 MJ biofuel from Eucalyptus



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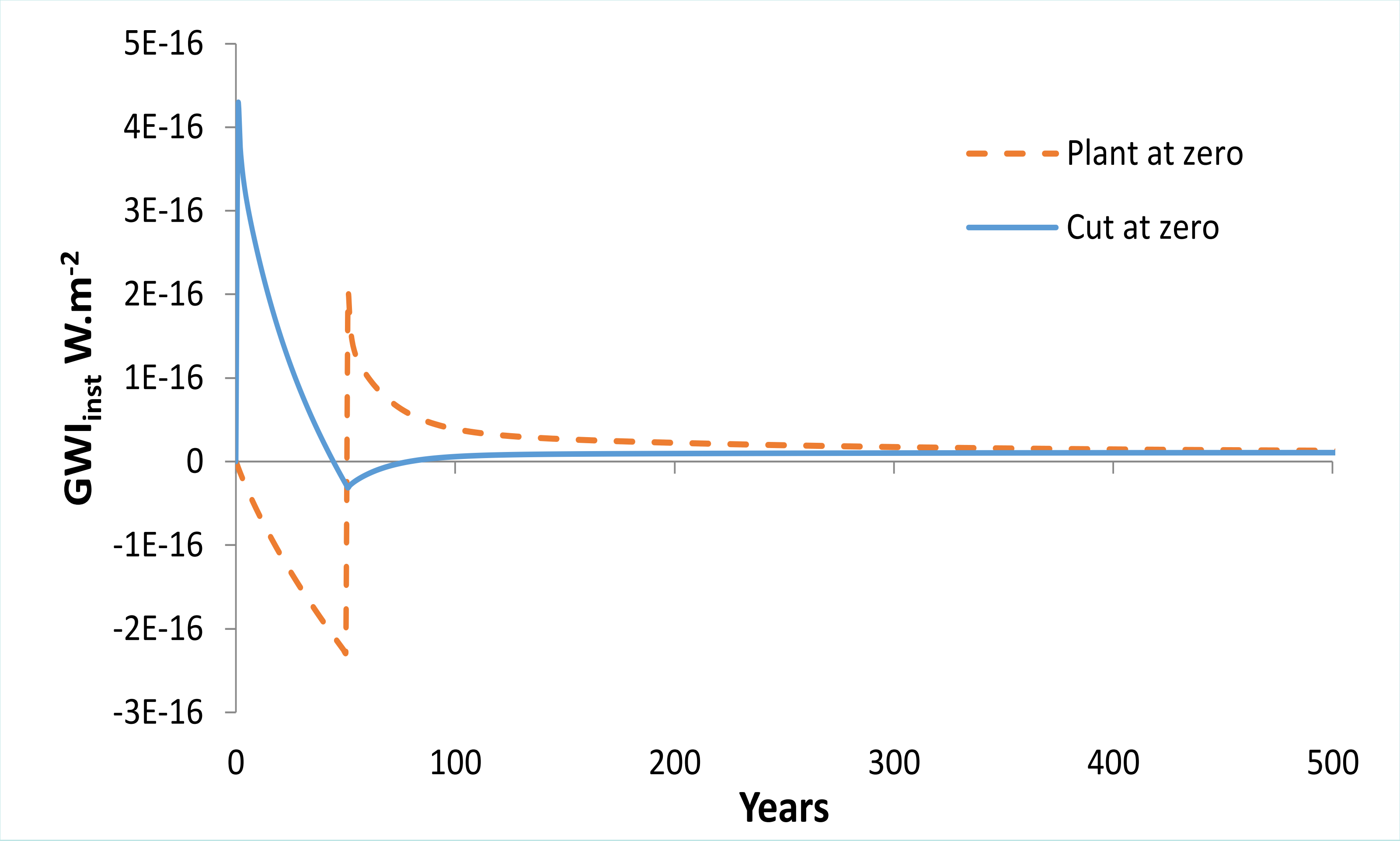

Where do we go from here?

- Three sets of critical factors need to be defined
  - Regional variability in feedstock quality, recovery options and cost
  - Integration with existing harvest operations
  - Allocation of burdens between products and processes

SWRC - 100% of the LCA Burdens are Assigned to Biomass/Biofuel

- Suitable for either BC or TC conversion
- Major differences in growth season, establishment and harvesting
- All need to be lower costs, and more efficient
  - Poplar - Greenwood Resources commercial system, but unique location and system
  - Eucalyptus - commercial in FL for 20 yrs, large scale P&P trials in the SE US
  - Willow – long-term trials in NY, 2-3 rotation coppice

Residues from Commercial Systems – This is tough!

- All softwoods, only suitable for TC processes
- Different growth rates (ODT/Ac/Yr) and management intensities, rotation age, site prep, planting density, thinning
- Different options for residues, paper, vs. chip & saw

Commercial Pine Plantation in the SE US

- Plant 436 trees/Ac; (10*10 spacing)
- Thin to 200 tree/Ac at 8-14 yrs, (trees reach 45 ft. height) giving 21 gT/Ac
- Final harvest at 23-30 yrs, giving 38 gT/Ac pulp wood, 21 gT/Ac chip/saw, 76 gT/Ac saw logs

Implications of Using Woody Feedstocks for DOE Models

- BC Models are sensitive to biomass composition, sugar types, residue fuel value
- TC models are sensitive to MC, much less sensitive to composition
- Ash has a very important real world impact product quality; models do not yet include this impact

Conclusions

- Durable wood products can sequester very large quantities of carbon today, but require larger trees
- Allocation of LCA credits and burdens with dedicated energy crops (grass, residues or SRWC) is relatively easy
- Allocation of LCA credits and burdens for commercial wood products is complex
- Private landowner “willingness” to sell is complex, and includes more than price