Should the corn ethanol subsidy of $200+/tonneC make the wood industry happy? Be careful which subsidy you ask for.

- Life Cycle Inventories and Assessment for Wood Products & Biofuels -

for

Western Forest Economists

Annual Meeting

May 5, 2009

Bruce Lippke
Professor and Director Rural Technology Initiative
College of Forest Resources, University of Washington
and
President CORRIM

Consortium for Research on Renewable Industrial Materials

A non-profit research corporation formed by 15 research institutions to develop life cycle environmental measures for all wood-use stages of processing (from cradle to grave)

What carbon should we store and how?

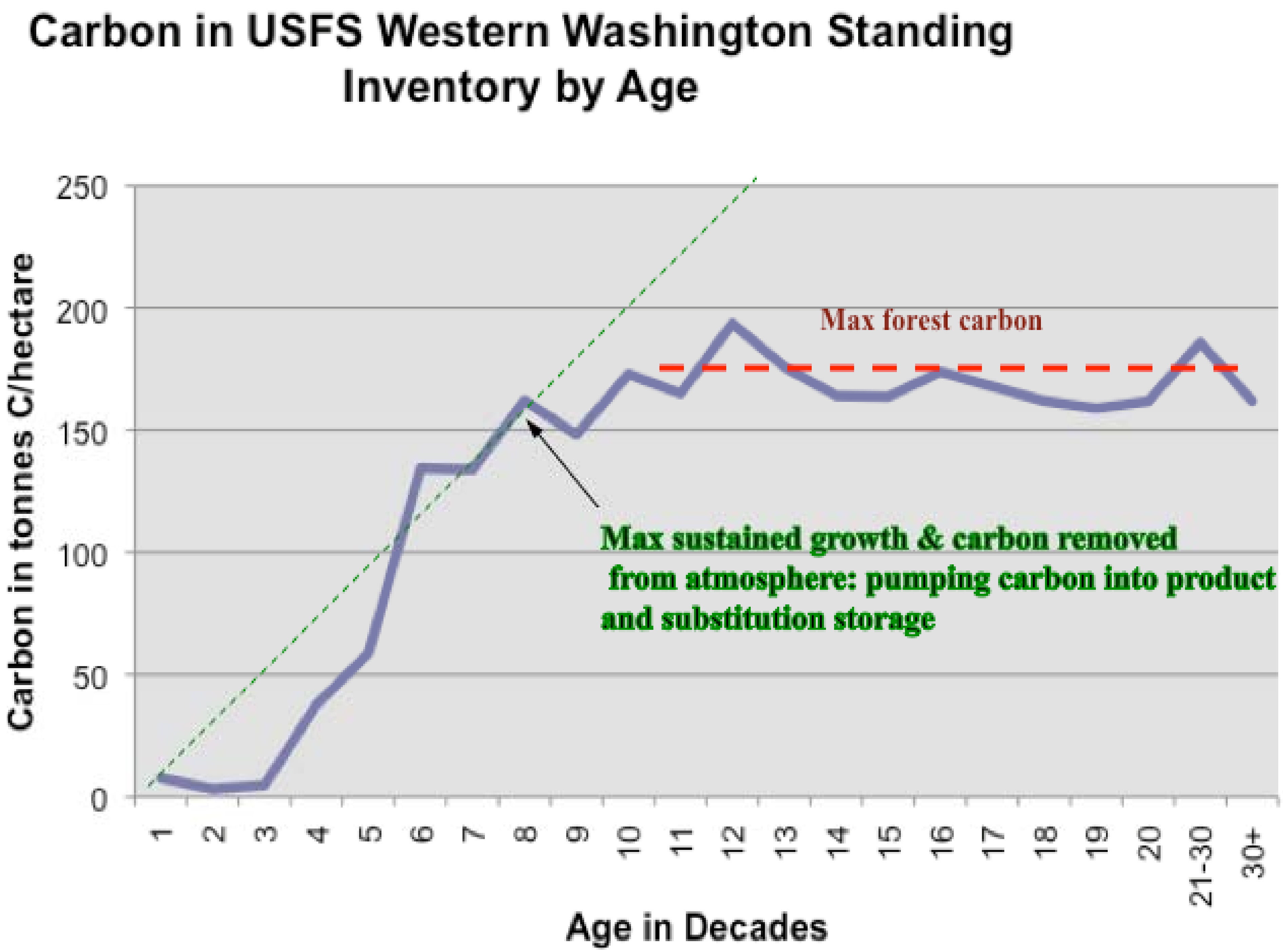
- Carbon is not a toxin you can bottle and hide
  - every living thing and every manufacturing process modifies carbon
  - there are millions of linked carbon pools

- How do you motivate storing carbon in one pool without negatively impacting the others?

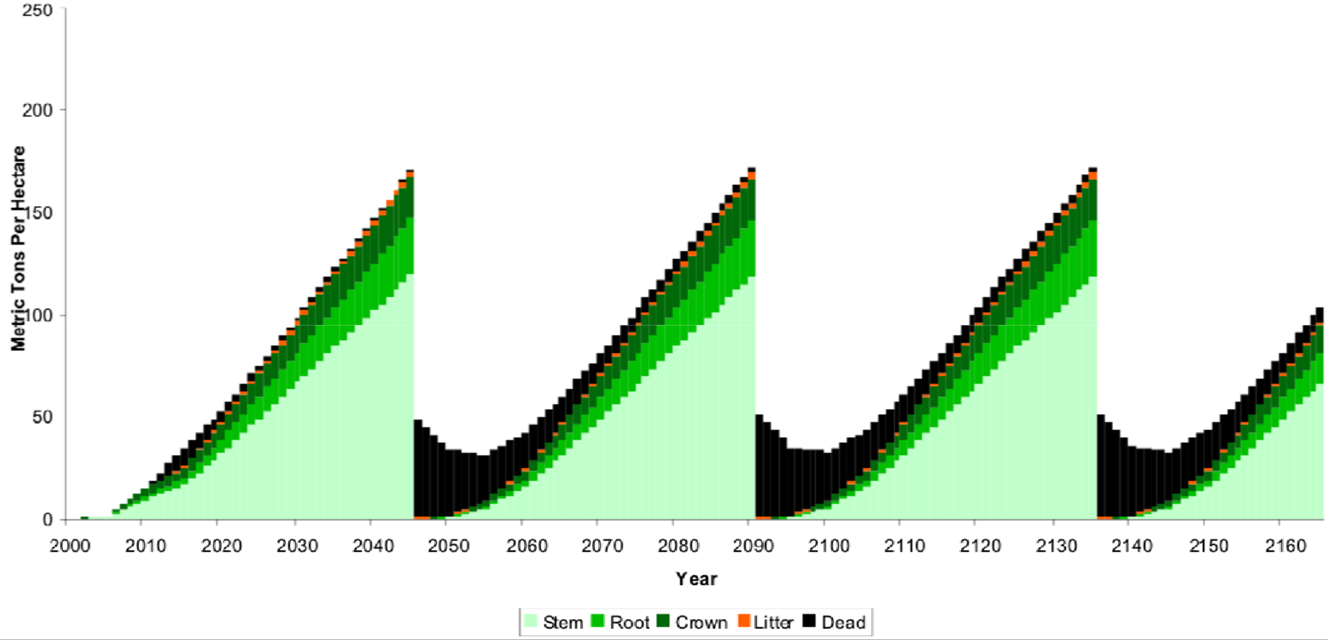
Carbon Sequestration ‘in, or by using’ Forests?

Options:

1. Store carbon in the forest
2. Sustainably pump it into buildings
3. Displace emissions from fossil intensive fuels by substitution *i.e. use it like the cavemen did*
4. Displace emissions from fossil intensive products by substitution *i.e. for steel, brick, concrete*
5. Reduce forest fires for more of all of the above

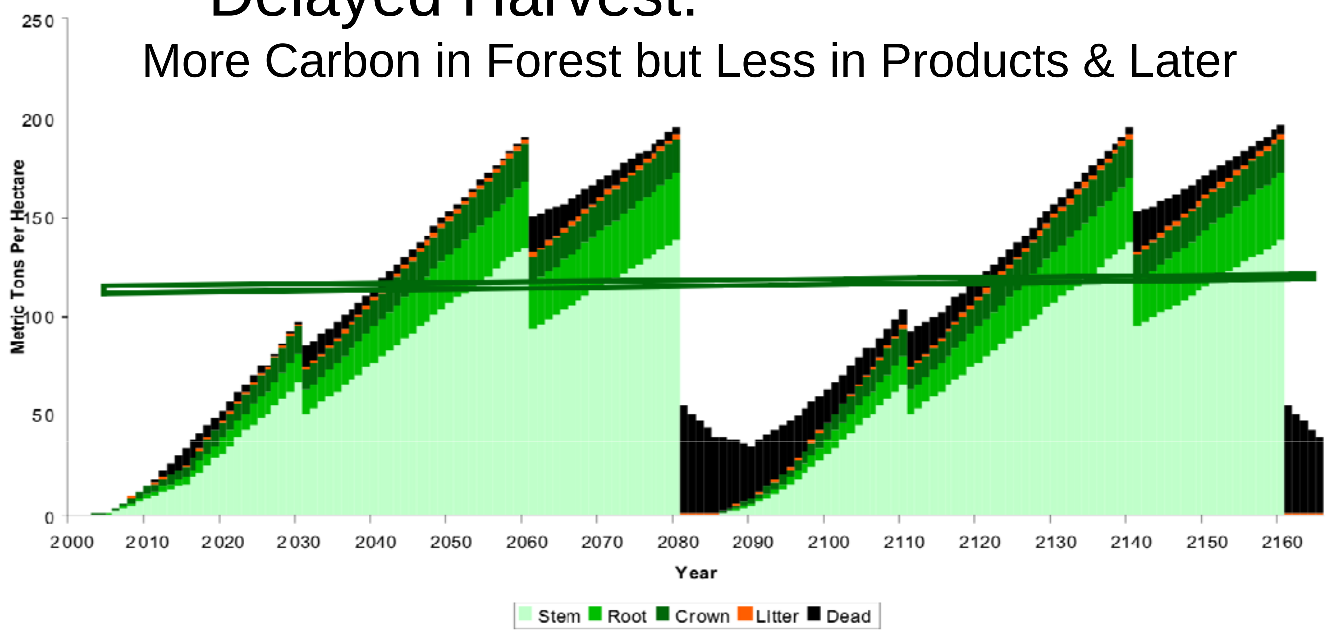

Carbon in USFS Western Washington Standing Inventory by Age
Max forest carbon
Max sustained growth & carbon removed from atmosphere: pumping carbon into product and substitution storage
Carbon in tonnes C/hectare
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21-30
30+
Age in Decades

Forest Carbon vs Rotation



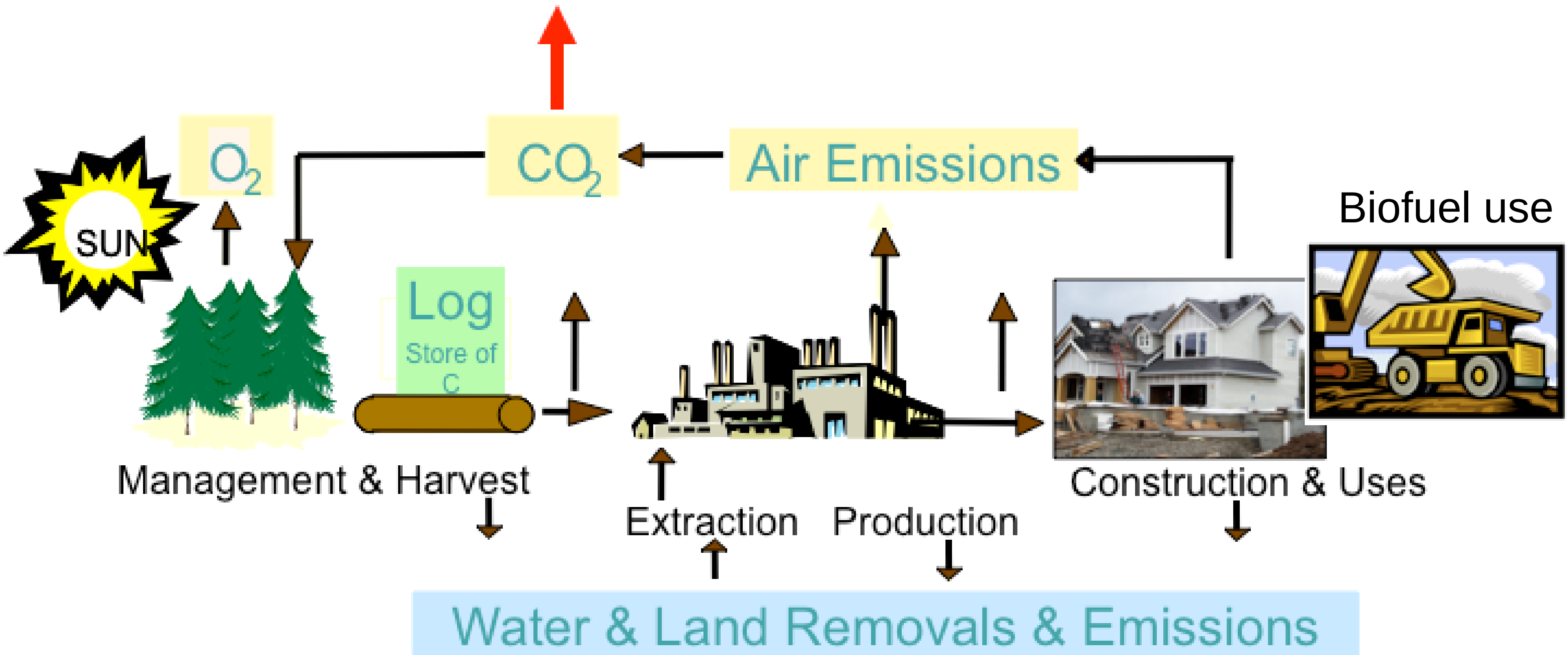
Delayed Harvest:

More Carbon in Forest but Less in Products & Later

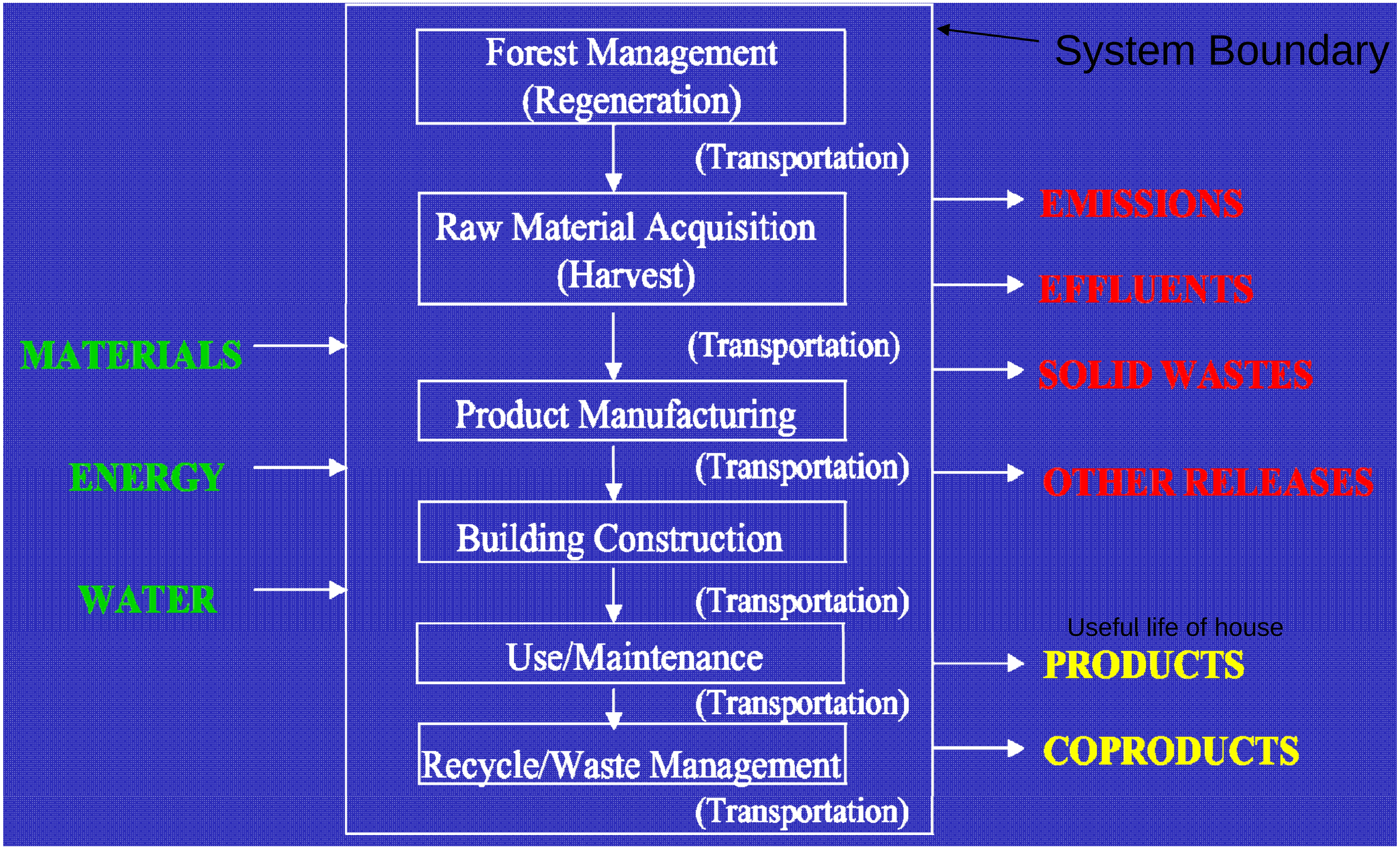


Life Cycle Inventories & Assessment of Products & Buildings & Biofuels

measures of all the inputs and outputs for every stage of processing



Life Cycle Inventory Analysis
‘cradle to grave”



LCI/LCA is the ~~accepted~~ method

- ISO standards have been established
- Principles accepted by IPCC
- EPA is now *emphasizing* the importance of LCI

▪ NREL's all-materials US LCI database contains all CORRIM's data on wood, as well as steel, concrete and other source data for primary materials.

▪ LCA health & ecosystem risk indices are being based on hundreds of LCI emissions (GHG, air & water pollution, waste, energy)

LCI/LCA is the ~~accepted~~ method

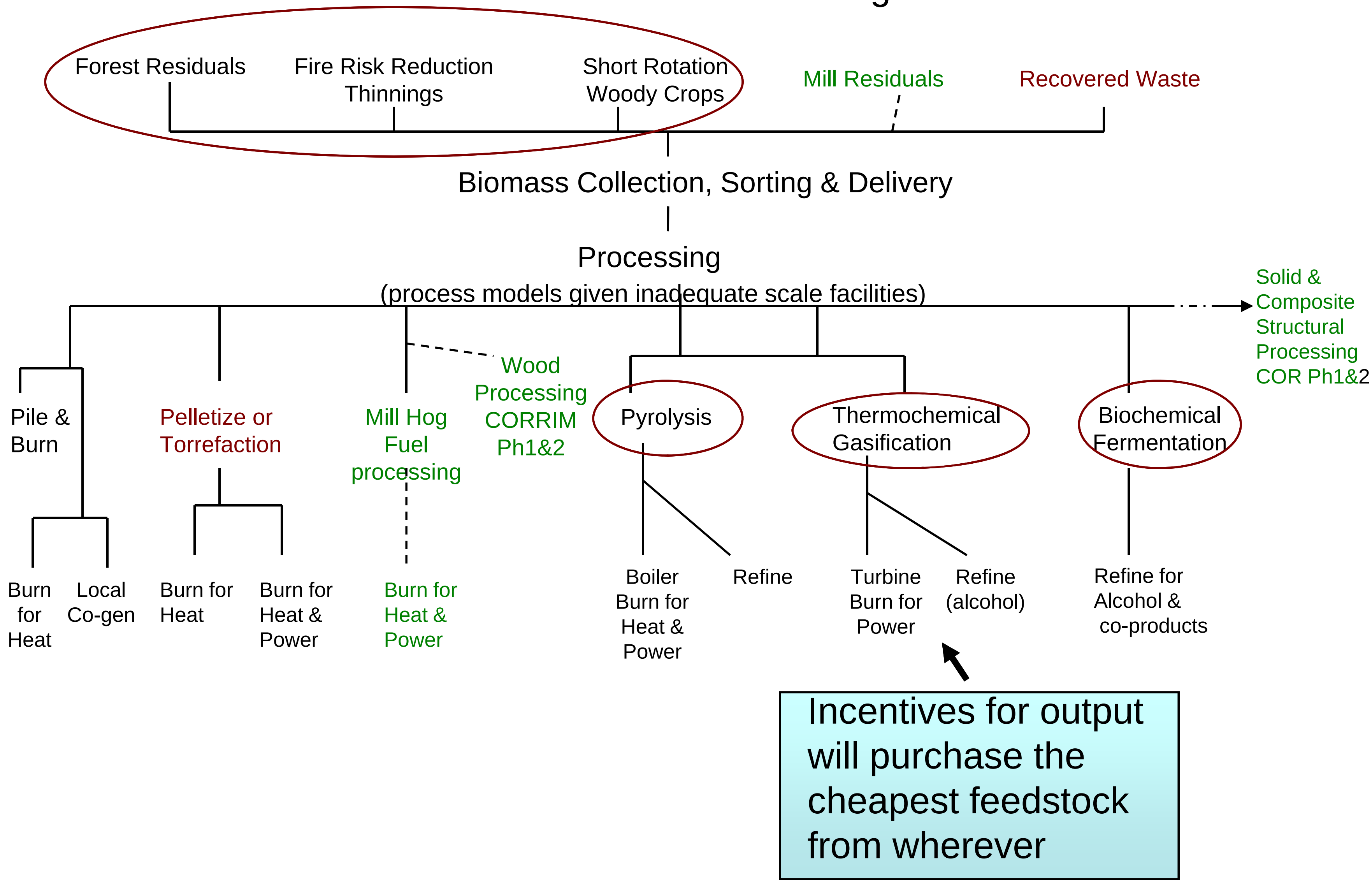
- US EISA 2007 sets GHG thresholds for biofuels requiring LCA – a Congressional mandate

- Congress's $.51/gal ethanol tax credit
  - Takes 5 gal corn-ethanol to displace 1 gal gasoline

    $2.60/19lbs CO2 or $295/mtCO2 (metric-ton)
  - Estimated 1.1 gal wood-ethanol or $63/mtCO2
- CCX: $2, ECX: $13, Congress: $295 /mtCO2

- $244 billion/yr to offset gasoline from imported oil
- While stealing feedstocks from carbon saving uses

Biomass Collection & Processing LCI/LCA



Be careful what incentives you ask for

- $295/mt CO2 = $1000+/mt C = $500+/mt dry wood
  - $1500/mbfs or more than the price of solid wood

    10 times price of chips for pulp

    15 times price of energy wood

- Result: ethanol producer can bid the feedstock away from pulp and solid wood uses, increasing rather than decreasing fossil intensive substitutes & emissions
- Raise the price of construction materials like corn ethanol did to food prices

Load of forest residuals and hauling to biomass facility

Residuals piles at processing yard

Slash ground to uniform feedstock

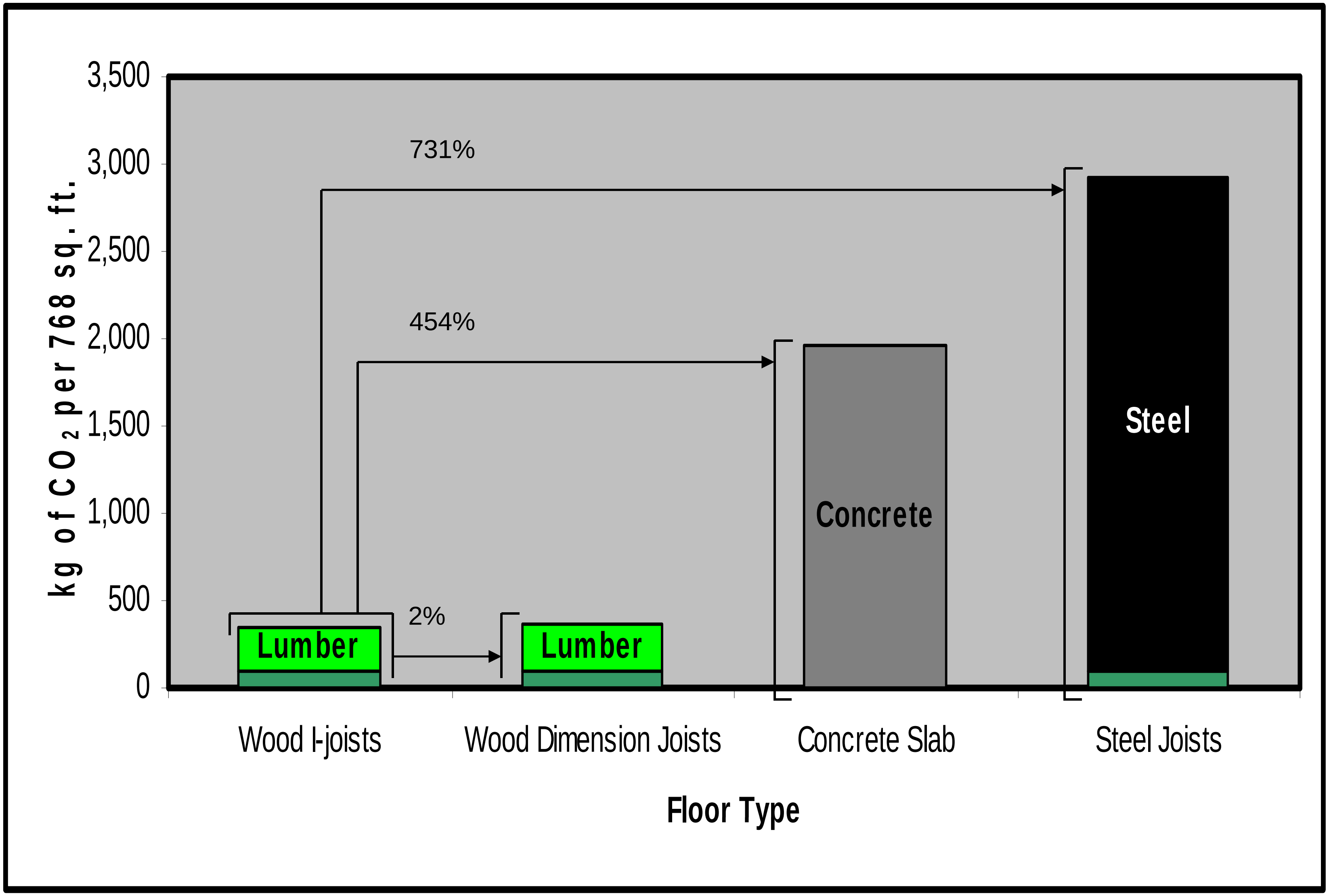
50% of the merch solid-log volume

Uses of Life Cycle Carbon accounting

- Incentives to remove forest residuals to increase biofuels *can be productive*;

  - Not if the incentive diverts wood feedstocks from higher valued uses like fiberboards that substitute for fossil intensive products.
  - Forest residuals are higher cost than other feedstock and will need ***direct incentives*** rather than end product ethanol subsidies

Emissions from Product & Design Alternatives in Floors



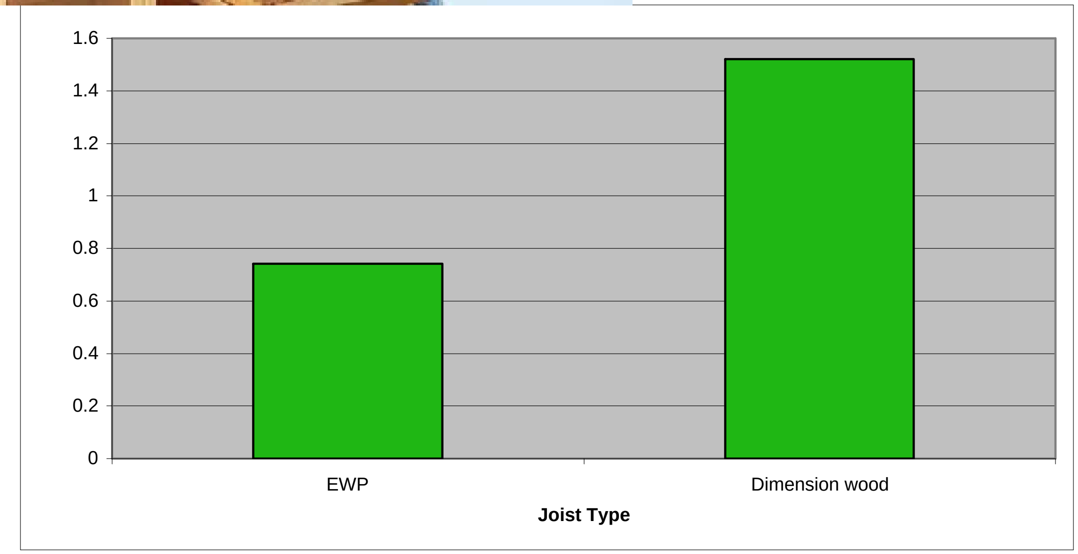
Resource use for I-joist vs. dimension lumber floors:

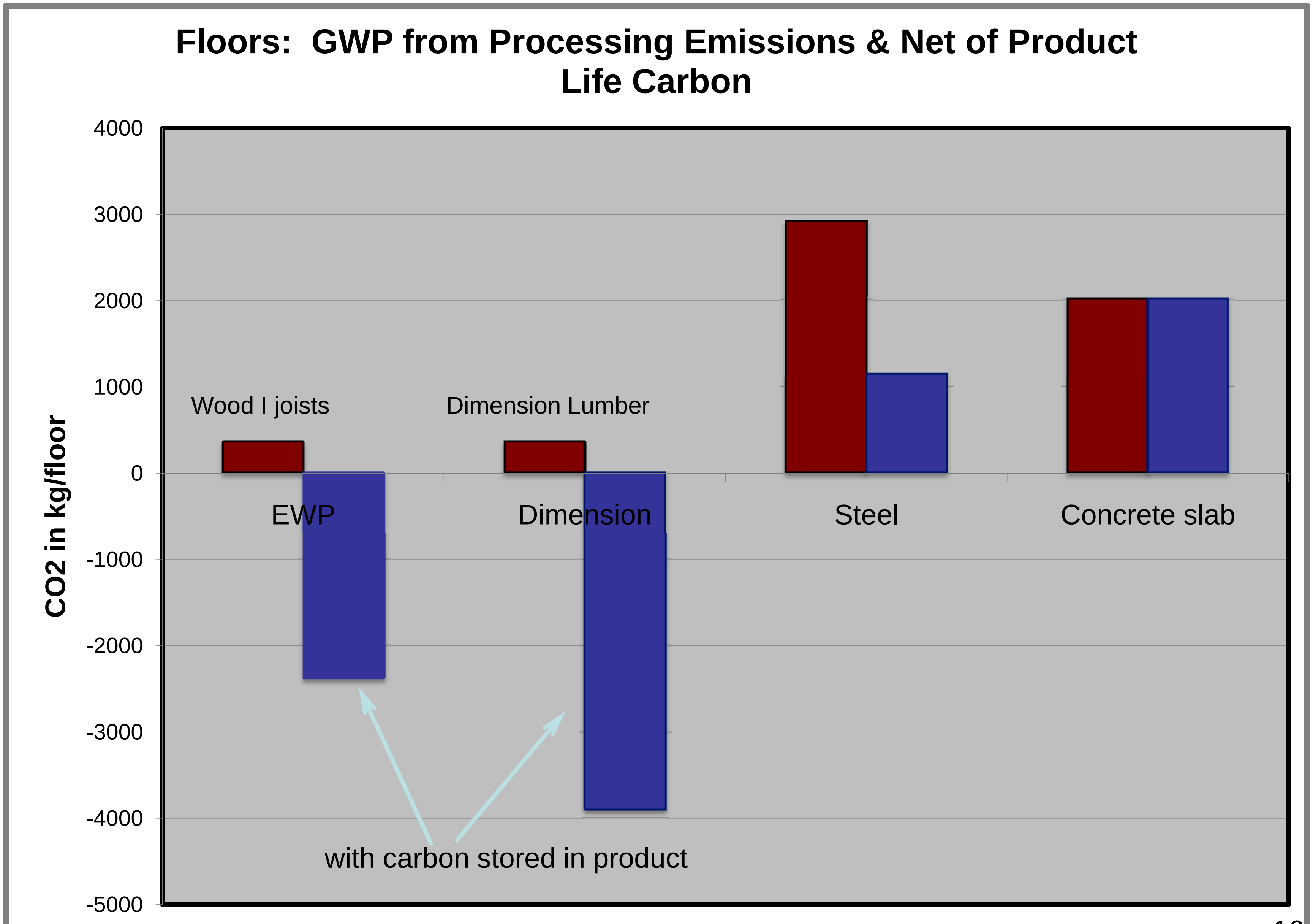
-I-joists use 1/2 the fiber

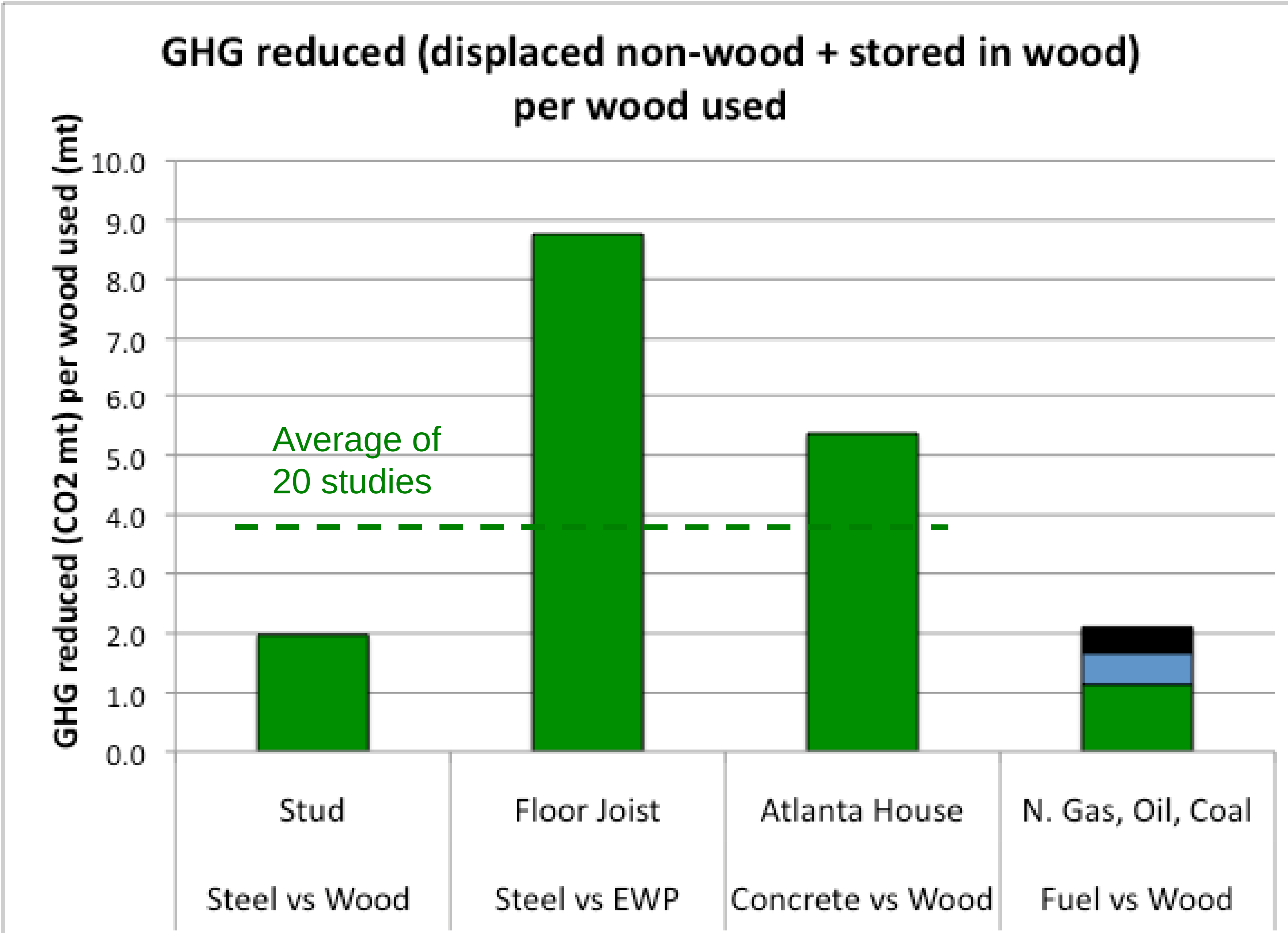
-from underutilized species

-cut to length with less waste

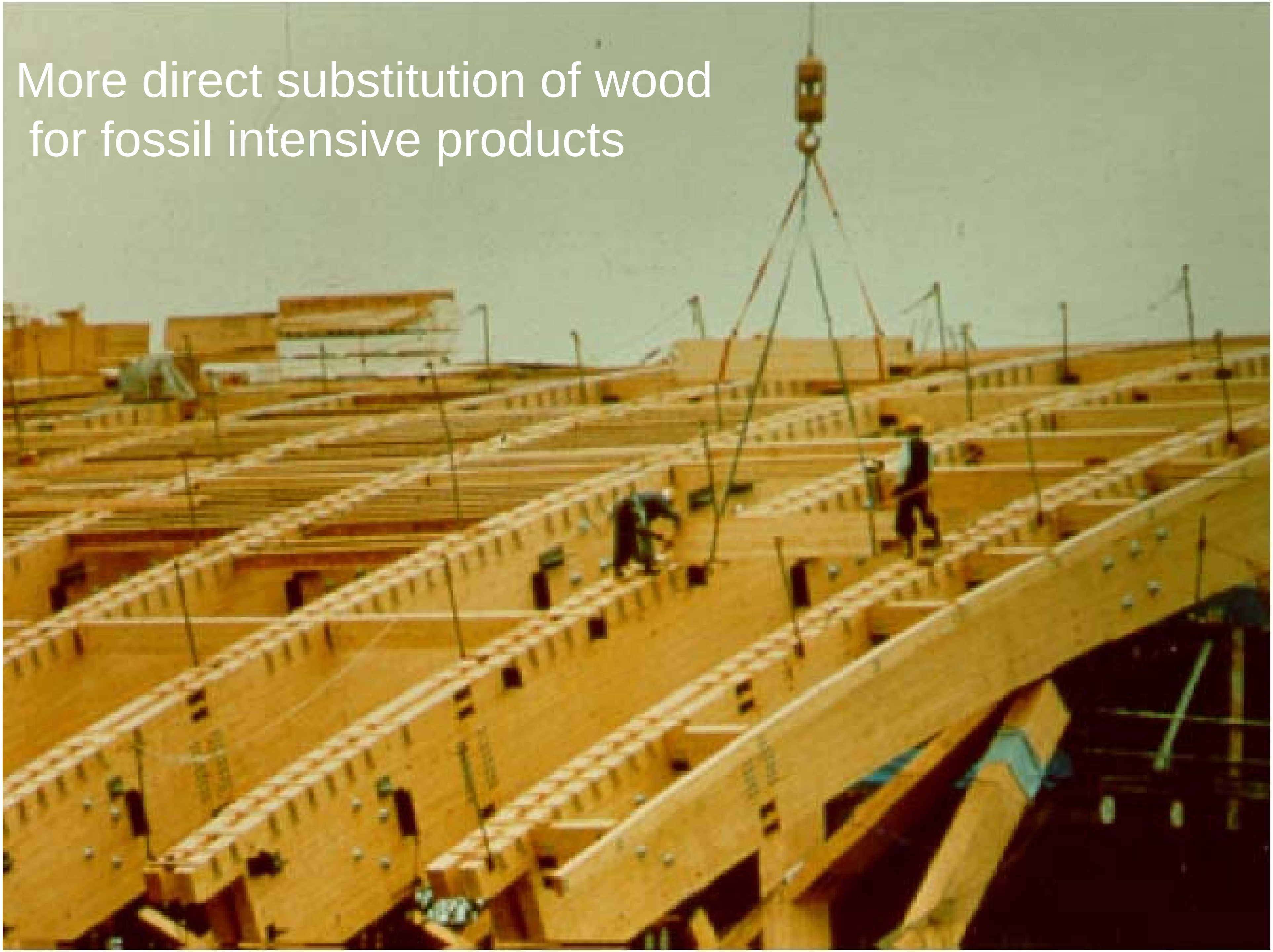
-doubling resource use efficiency




Floors: GWP from Processing Emissions & Net of Product Life Carbon
CO2 in kg/floor
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
Wood I joists
Dimension Lumber
EWP
Dimension
Steel
Concrete slab
with carbon stored in product



GHG reduced (displaced non-wood + stored in wood) per wood used
GHG reduced (CO2 mt) per wood used (mt)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Average of 20 studies
Stud
Steel vs Wood
Floor Joist
Steel vs EWP
Atlanta House
Concrete vs Wood
N. Gas, Oil, Coal
Fuel vs Wood

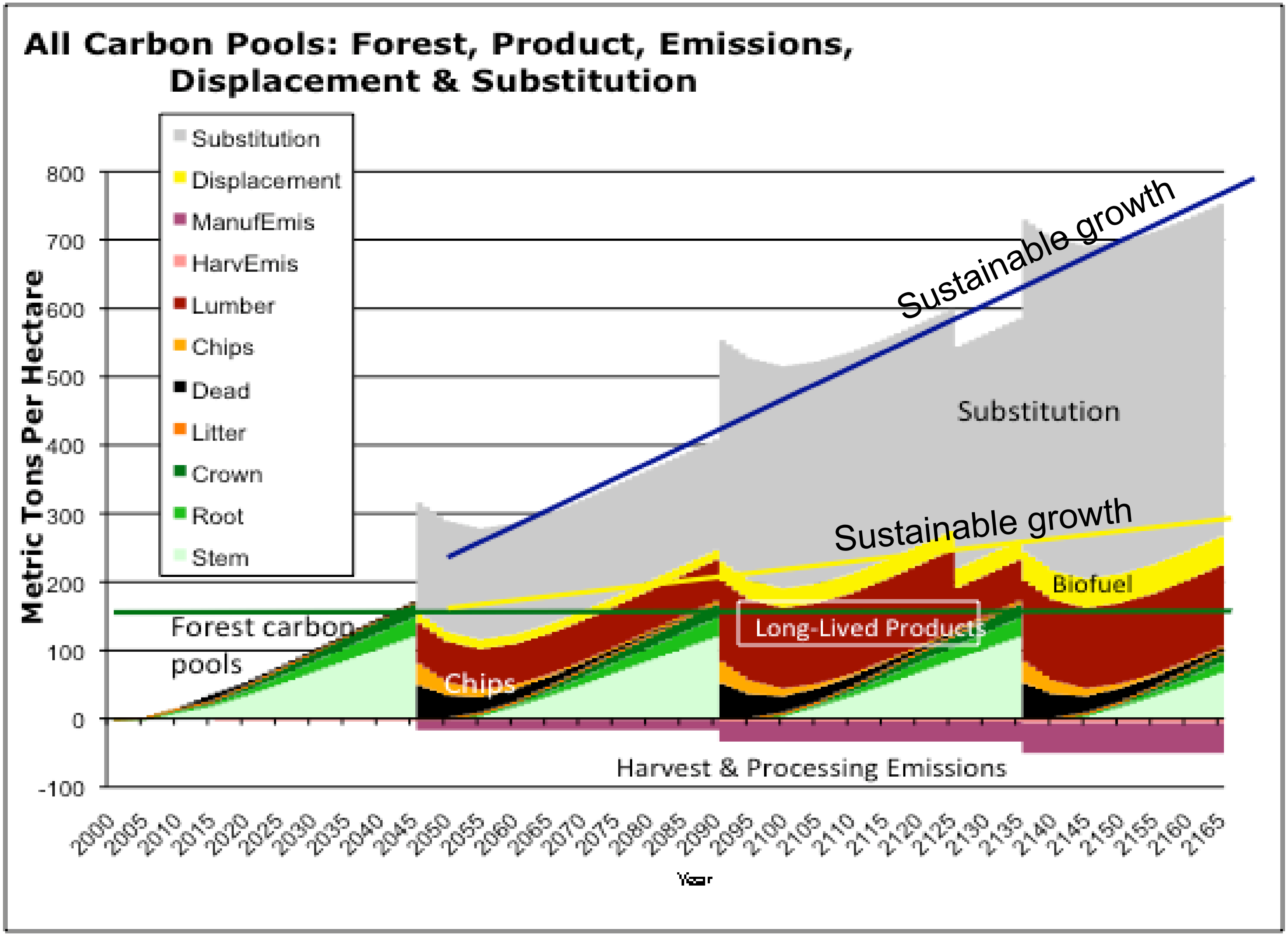

More direct substitution of wood
for fossil intensive products

Tacoma Dome: Engineered Wood

Munich Stadium

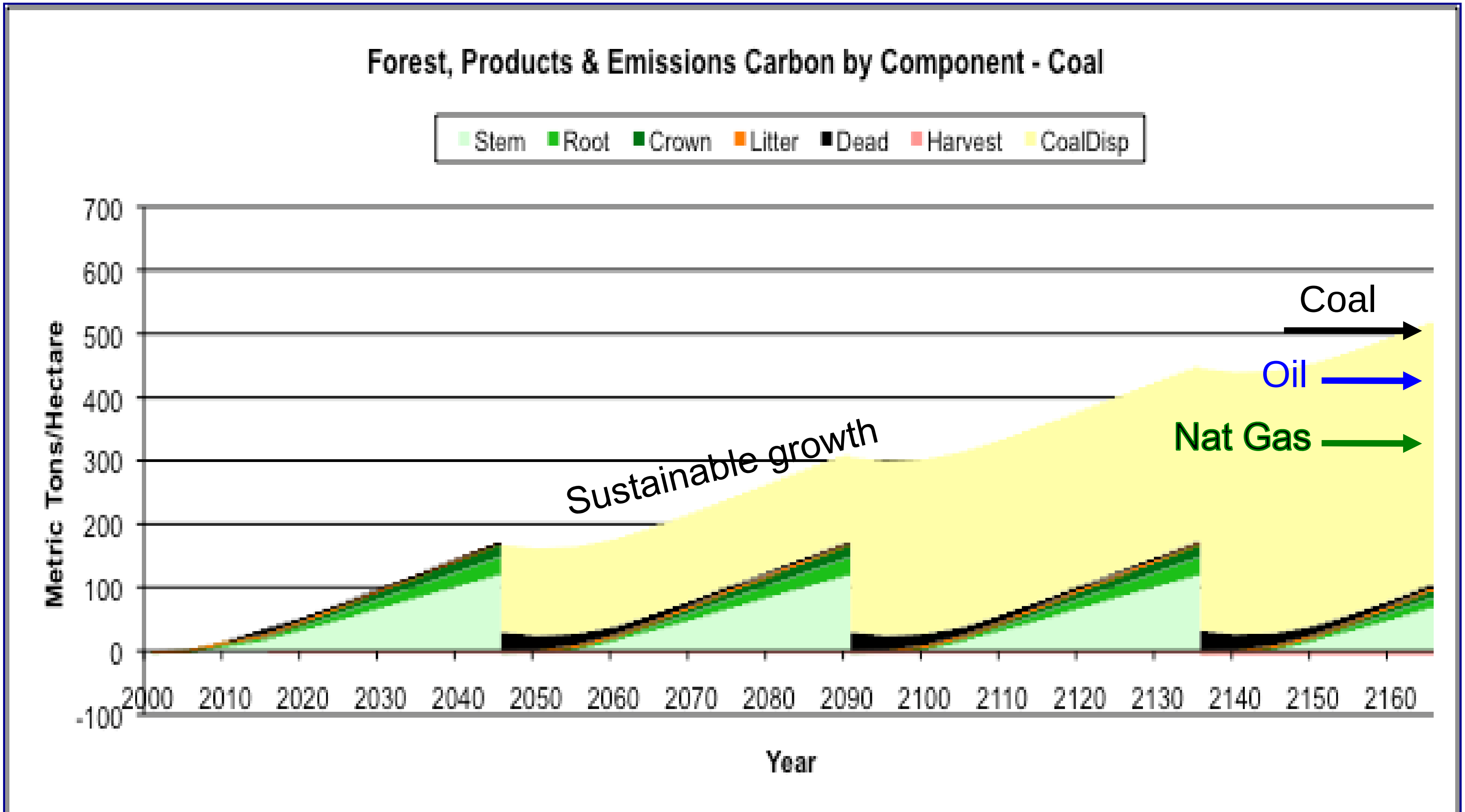
Many designs that more directly substitute wood for non-wood than typical housing

Sustainable Forest, Product, & Substitution Carbon Pools



Carbon from Forest & Biofuel Displacement of Coal/Oil/Nat Gas

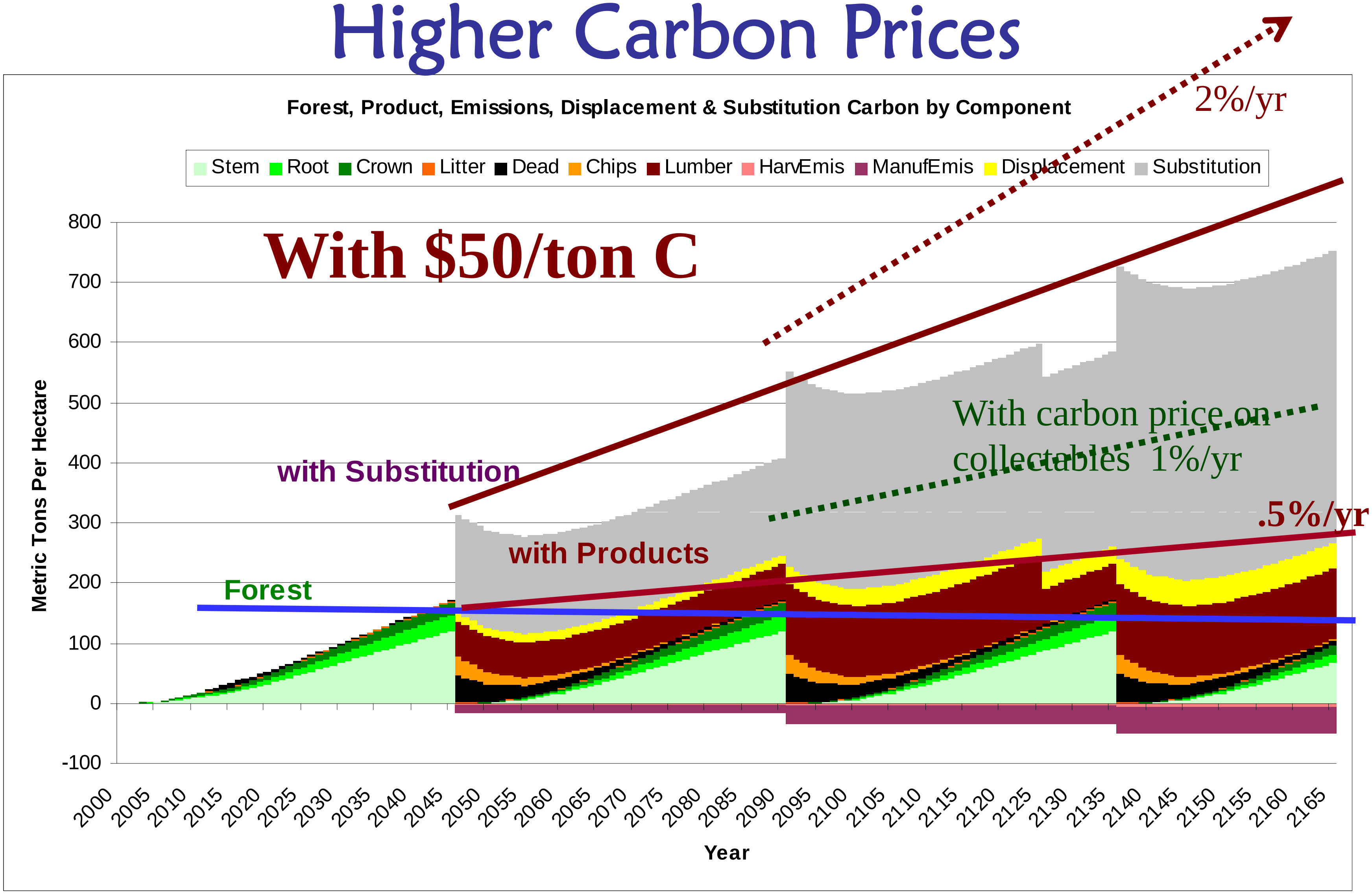
(not reviewed)



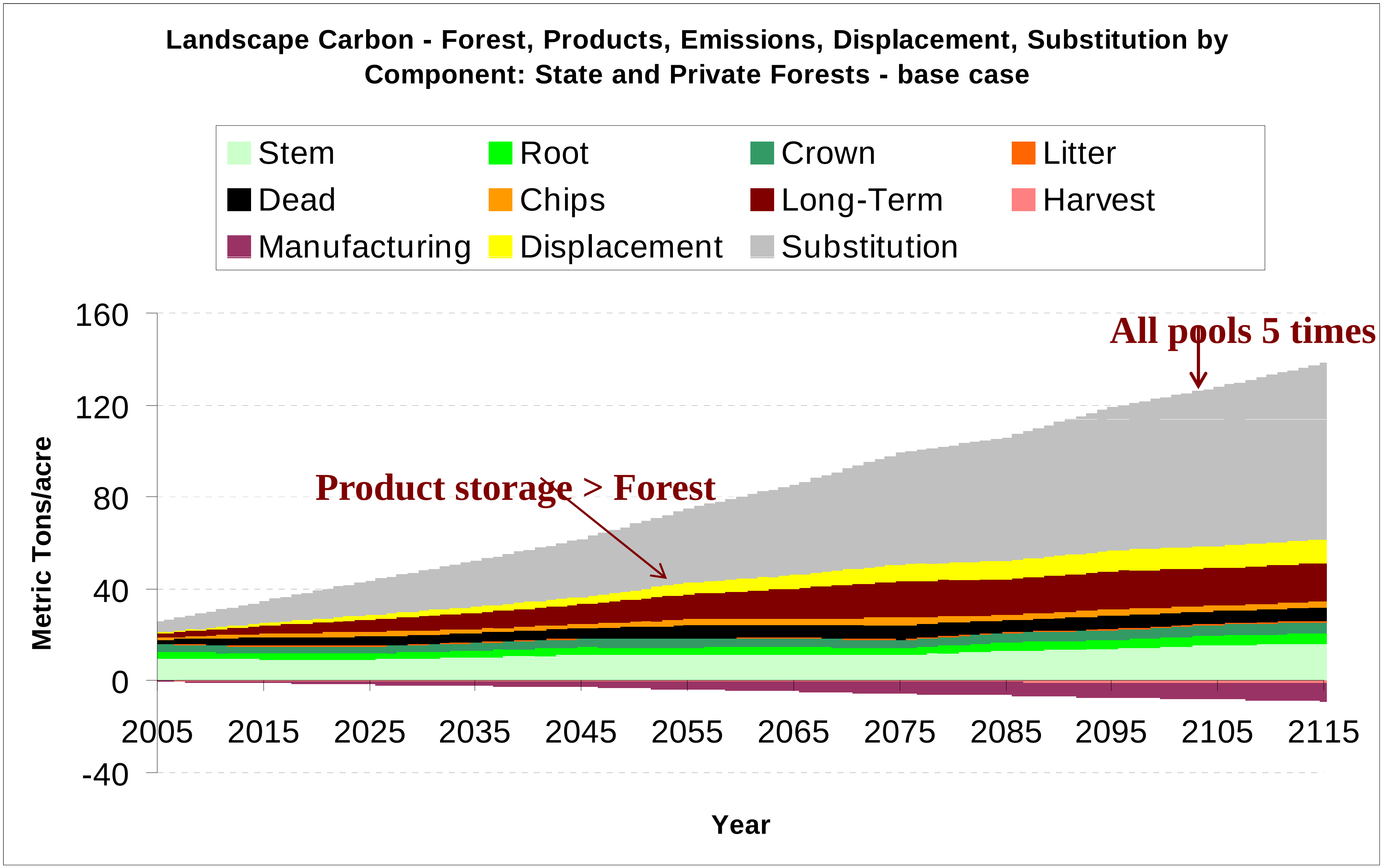
Impact of Higher Fossil Fuel/Carbon Prices

- ✓ Pay to collect forest residuals & waste
- ✓ Pay to use more wood in construction or other fossil substitutes (furniture etc.)
  - Where the carbon displacement leverage is highest
- ✓ Use more biofuels (*but solid wood prices must rise more than biofuel feedstock to avoid counter productive result)*
- ✓ Pay to grow it faster & use it sooner, not grow it longer *(with correct accounting)*

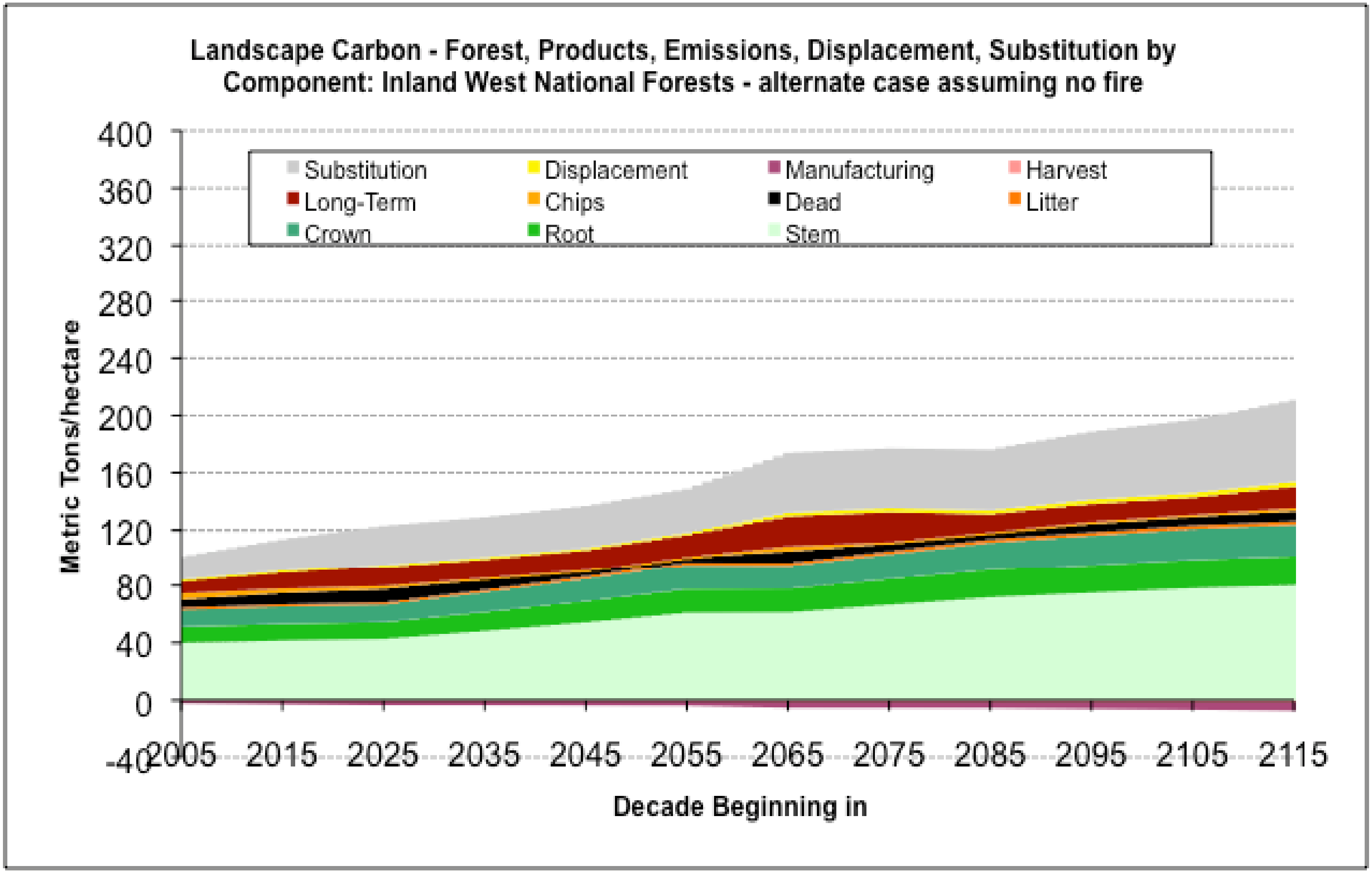
Forest, Product and Substitution Pools with Higher Carbon Prices

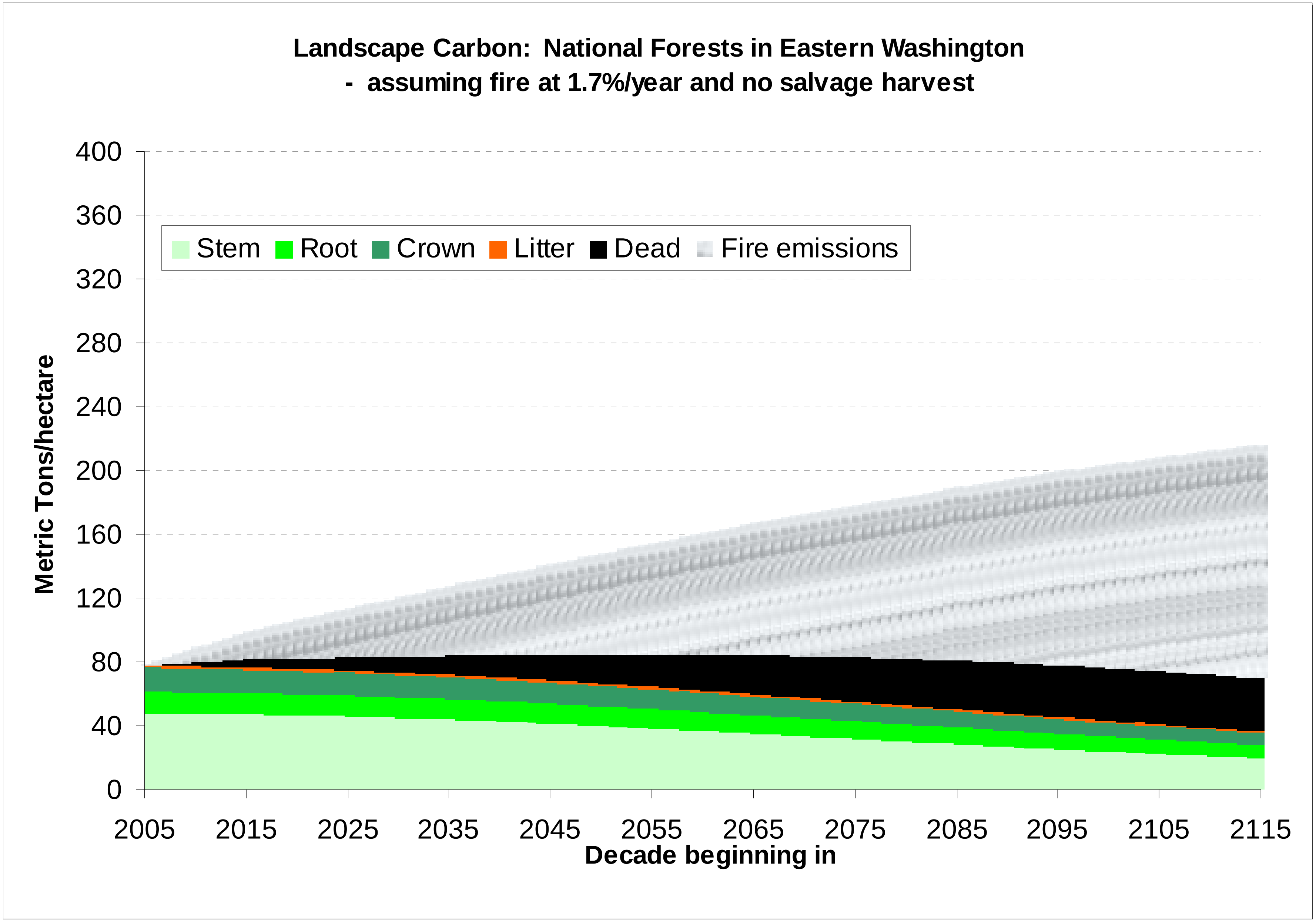


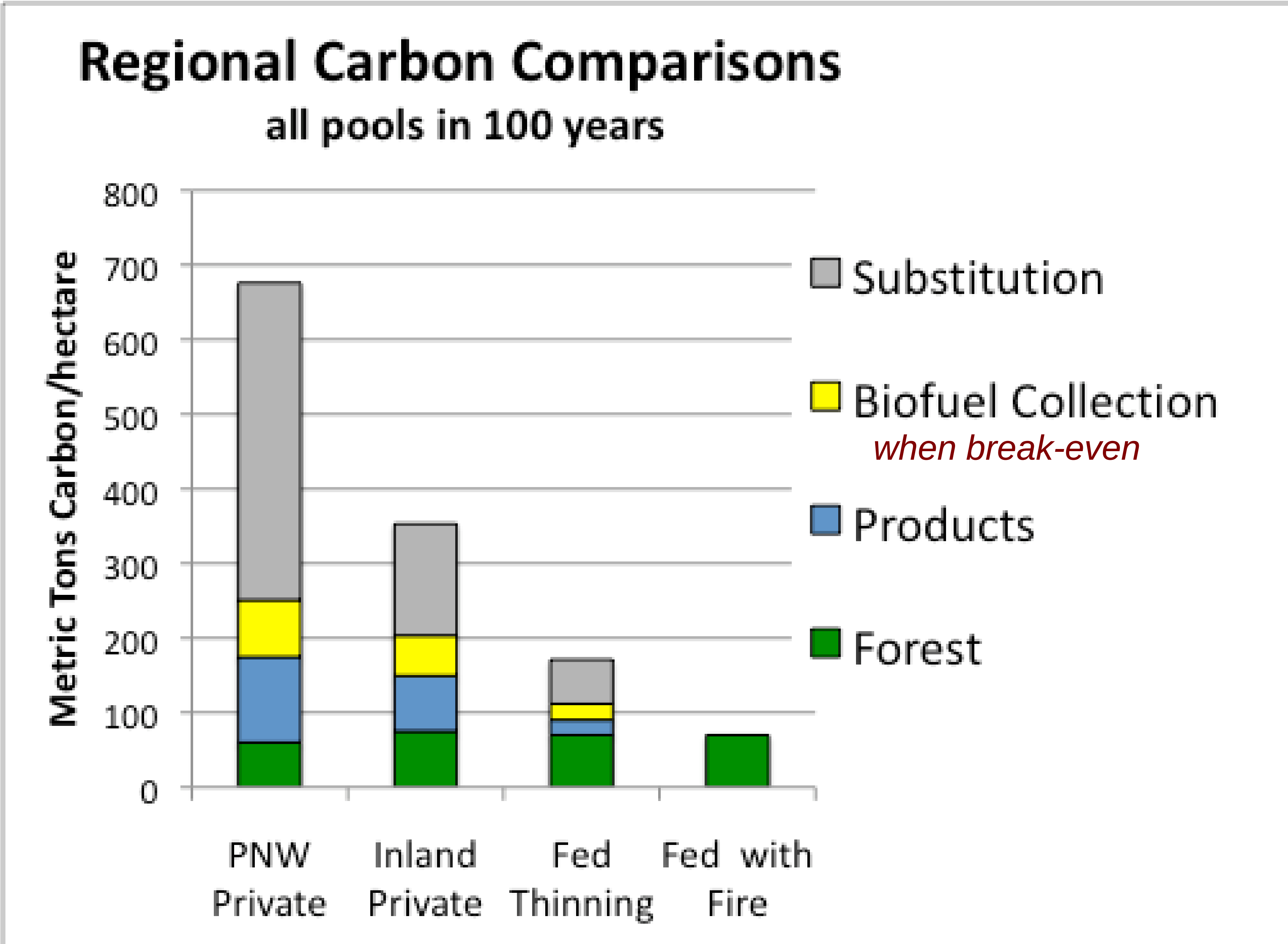
Carbon Pools across State & Private Inland West (per acre average)



If increased Forest Service thinnings were fast enough to avoid fire




Landscape Carbon: National Forests in Eastern Washington
- assuming fire at 1.7%/year and no salvage harvest
Stem
Root
Crown
Litter
Dead
Fire emissions
Metric Tons/hectare
0
40
80
120
160
200
240
280
320
360
400
2005
2015
2025
2035
2045
2055
2065
2075
2085
2095
2105
2115
Decade beginning in


Regional Carbon Comparisons
all pools in 100 years
Metric Tons Carbon/hectare
800
700
600
500
400
300
200
100
0
Substitution
Biofuel Collection
when break-even
Products
Forest
PNW Private
Inland Private
Fed Thinning
Fed with Fire

Carbon prices will matter, the rules better be right

- Econ models show \$50/tonC rising to \$150 in order to alter CO2 (\$14 to 41/tonCO2)
- ECX \$14 to 30/tonCO2 (i.e. \$50 to \$110/tonC)

- Equal to Timber SEV @ \$50

  (3xSEV with value of displacement included)
- and growing with time!

Uses of Life Cycle Carbon accounting

- track carbon across multiple carbon pools -

- Policy based on single carbon pools will likely be counterproductive.
- Incentives to <u>deliver</u> more carbon faster will increase carbon in all pools (although producing less old forest habitat).
- *<u>Given the high leverage from substitution, builders have the greatest opportunity to reduce emissions by displacing fossil intensive products in design and product selection</u>*
  - And bid the savings back through the resource supply chain motivating increased investments to reduce emissions.

Uses of Life Cycle Carbon accounting

- Arbitrary rules such as requiring permanency in the product to 100 years ignore life cycle assessments
  - Wood uses from the acre are better than permanent, ***growing*** sustainably

- Incentives that recognize the losses in carbon from fires and the costs of fighting fires would encourage below cost thinnings to reduce fire & insect risk.
  - Reducing carbon emissions from fires also increases, feedstocks for biofuels & substitution
  - Improves forest resiliency to climate change but we need more *site-specific* (by forest type) research on how much to thin.

Some Conclusions

- Fossil energy is too cheap and will out-compete wood markets in every downturn until the fossil fuel cost structure is increased.
- We have a long way to go to get the rules consistent with good science so they are not counterproductive.
- Incentives to increase production of ethanol will bid away existing feedstocks before they pay for the increased cost to collect forest residuals and thinnings
- Incentives for small scale production like renewal energy standards (targets) will proliferate small scale incremental uses of biofuels preempting the supply needed for scale ethanol plants.
- Incentives to deliver more wood for products and available waste & residuals for biofuels will increase carbon mitigation

The "forest woodlot": carbon storage or a pump to stores?

- If your back yard wood-lot is left to grow, once it reaches its carrying capacity it no longer takes carbon out of the air.
- If you cut the dying wood each year to burn in your stove, you can sustainably (forever) avoid freezing while displacing the emissions from energy alternatives you would otherwise need.
- If you cut the wood before the tree growth slows down you may have enough for your neighbor as well,
- Or use that wood to build your growing family's next house displacing even more emissions from the fossil intensive products you will not need, and for their family's after that.
- With more good wood lots <u>pumping</u> carbon you can serve a big part of the nation's housing & energy need, reducing carbon emissions.

Support Acknowledgements

- CORRIM- Consortium for Research on Renewable Industrial Materials
  - 15 research institutions and 23 authors
  - DOE & 5 companies funded the Research Plan
  - USFS/FPL, 10 companies & 8 institutions funded Phase I
- USFS, 10 companies & 6 institutions currently funding Phase 2
- Many product manufactures surveyed

The Details

CORRIM: **www.CORRIM.ORG**

Athena: **www.athenaSMI.ca**

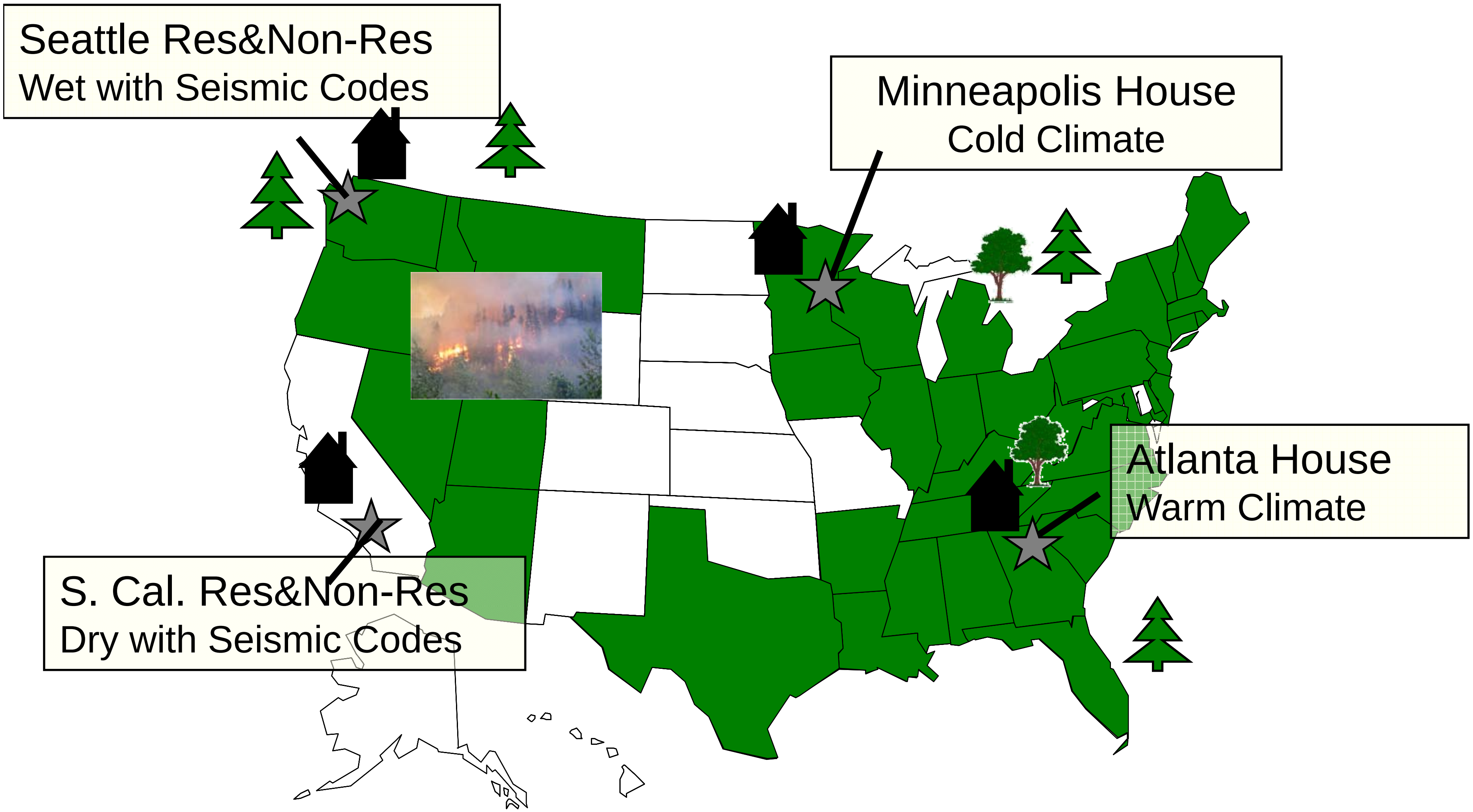
LMS: **http://LMS.cfr.washington.edu**

USLCI database: **www.nrel.gov/lci**

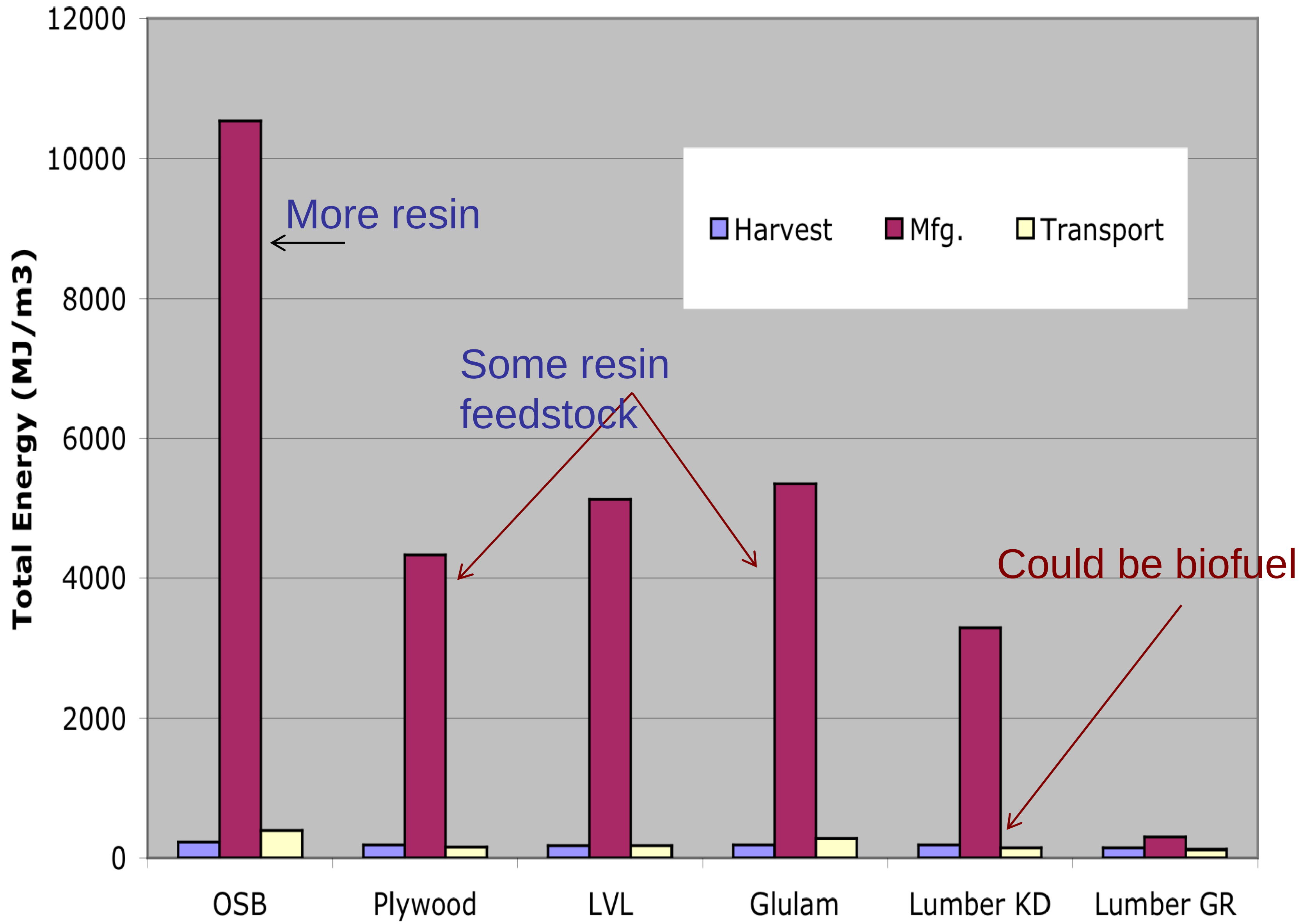
Biofuel use provides a major new opportunity

- Thinnings to reduce fire and insect risk
  - Capturing the product and displacement carbon rather than burning forest residuals
  - Need scale volumes inclusive of federal thinnings for scale investments in regional ethanol processing
  - Improves forest resiliency to climate change
- Thinnings avoid the future social costs of “no-management”
  - cost of fighting fires, fatalities, facility losses, restoration costs, water lost, timber and habitat lost, community impacts of smoke, carbon lost

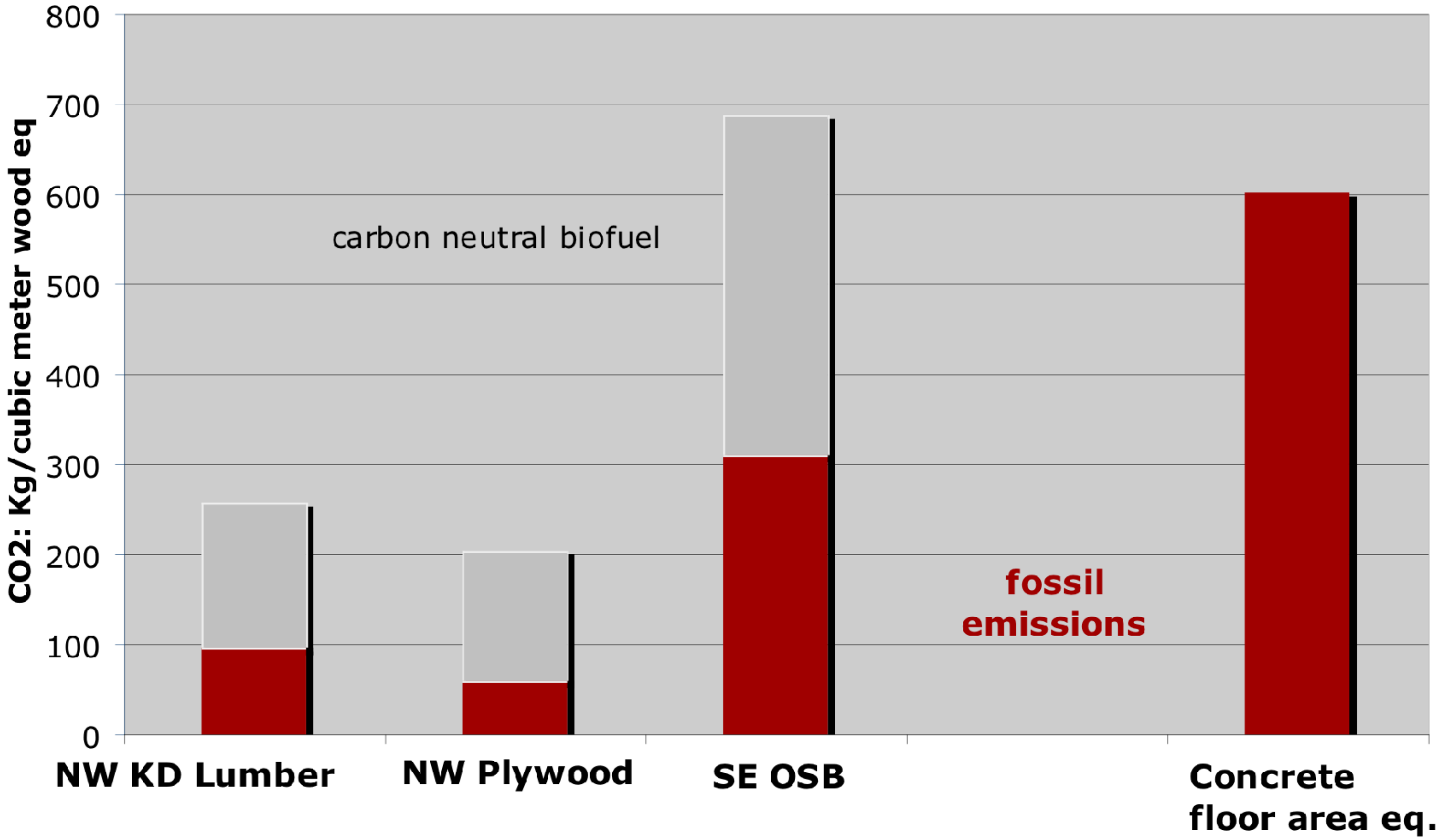
Phase1&2: 4 Forest Supply Regions, 9 Products, and 4 Construction Sites

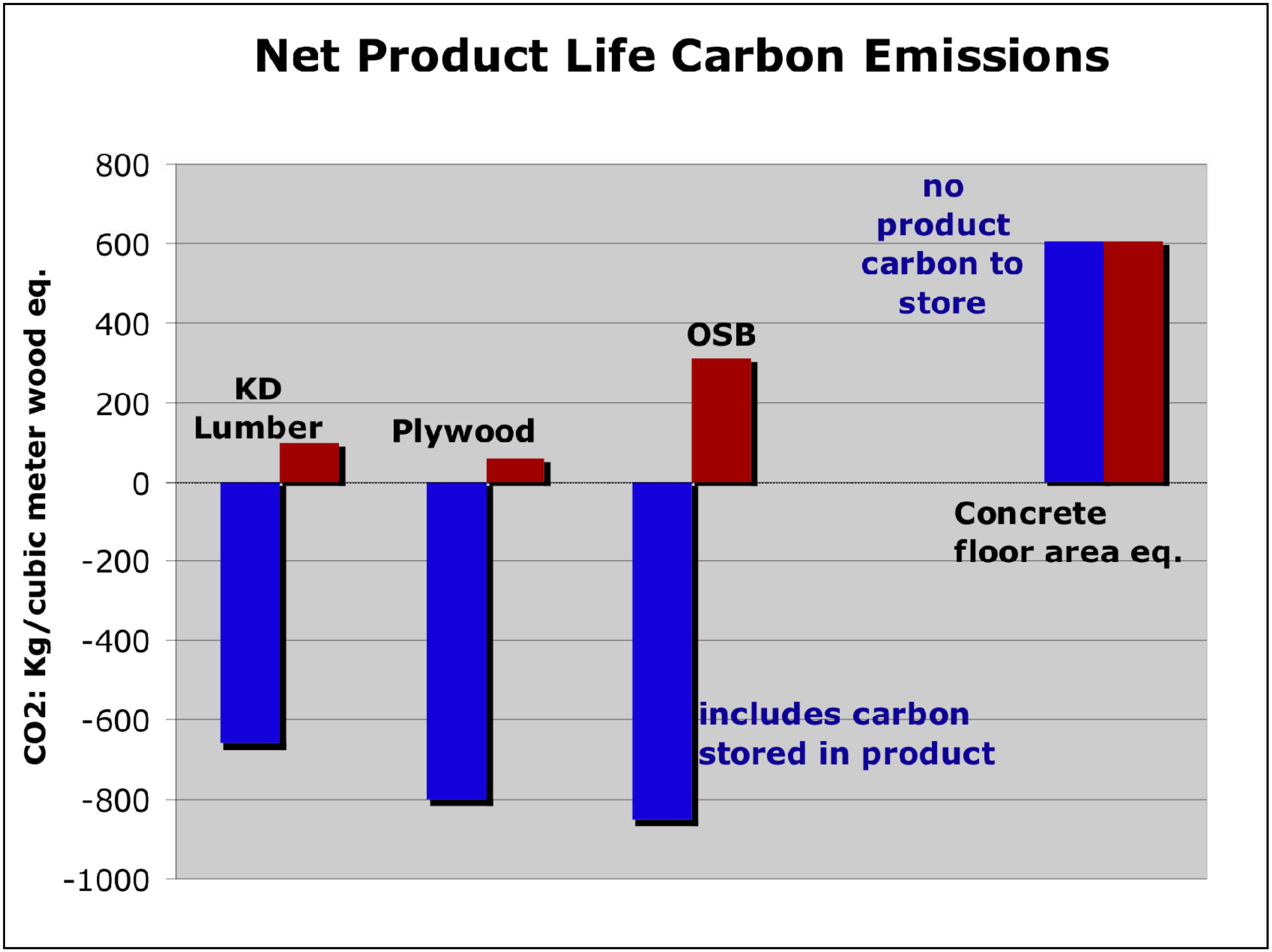


Total Energy for Life Cycle Stages (MJ/m3) SE/PNW ave.

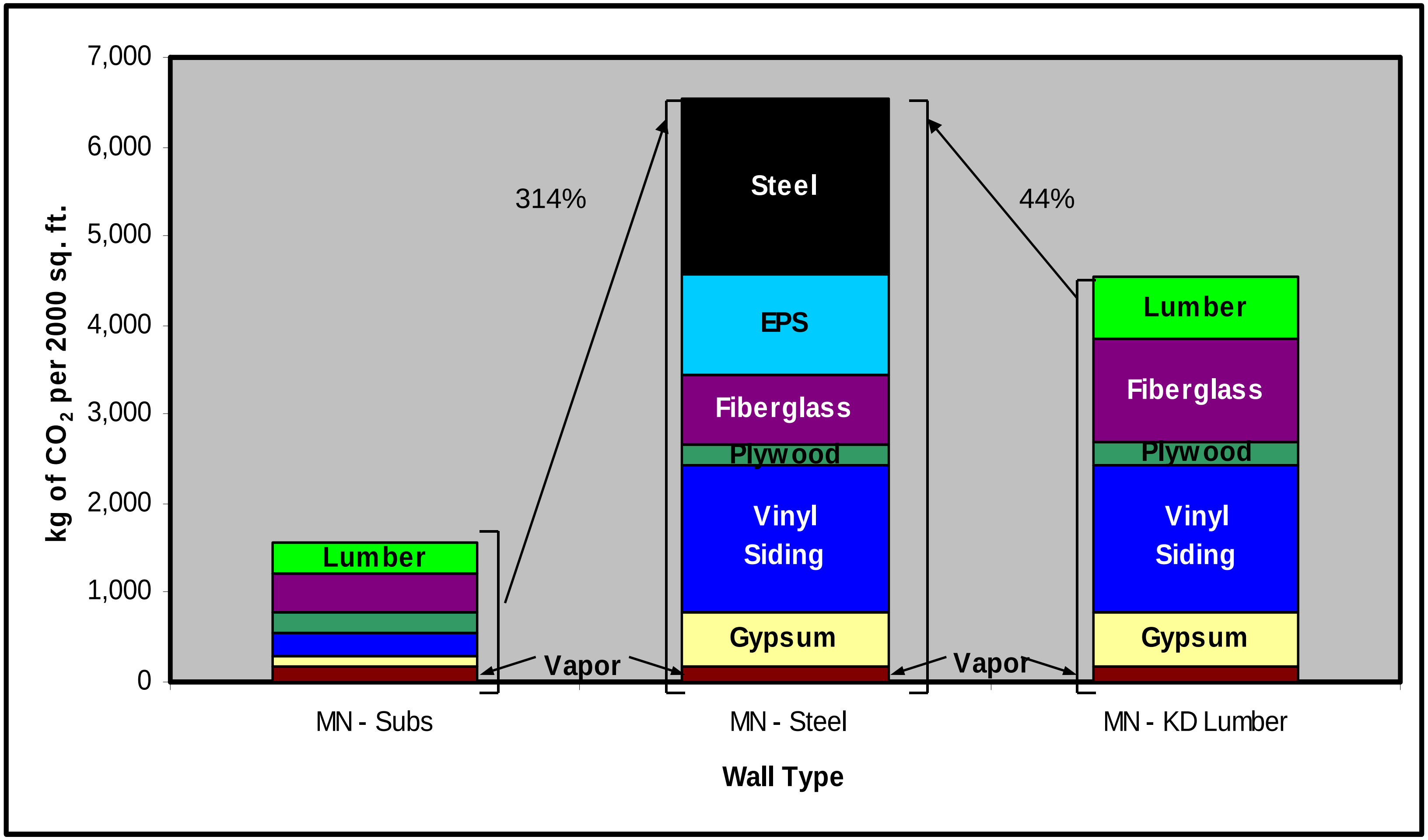


Product Manufacturing Carbon Emissions

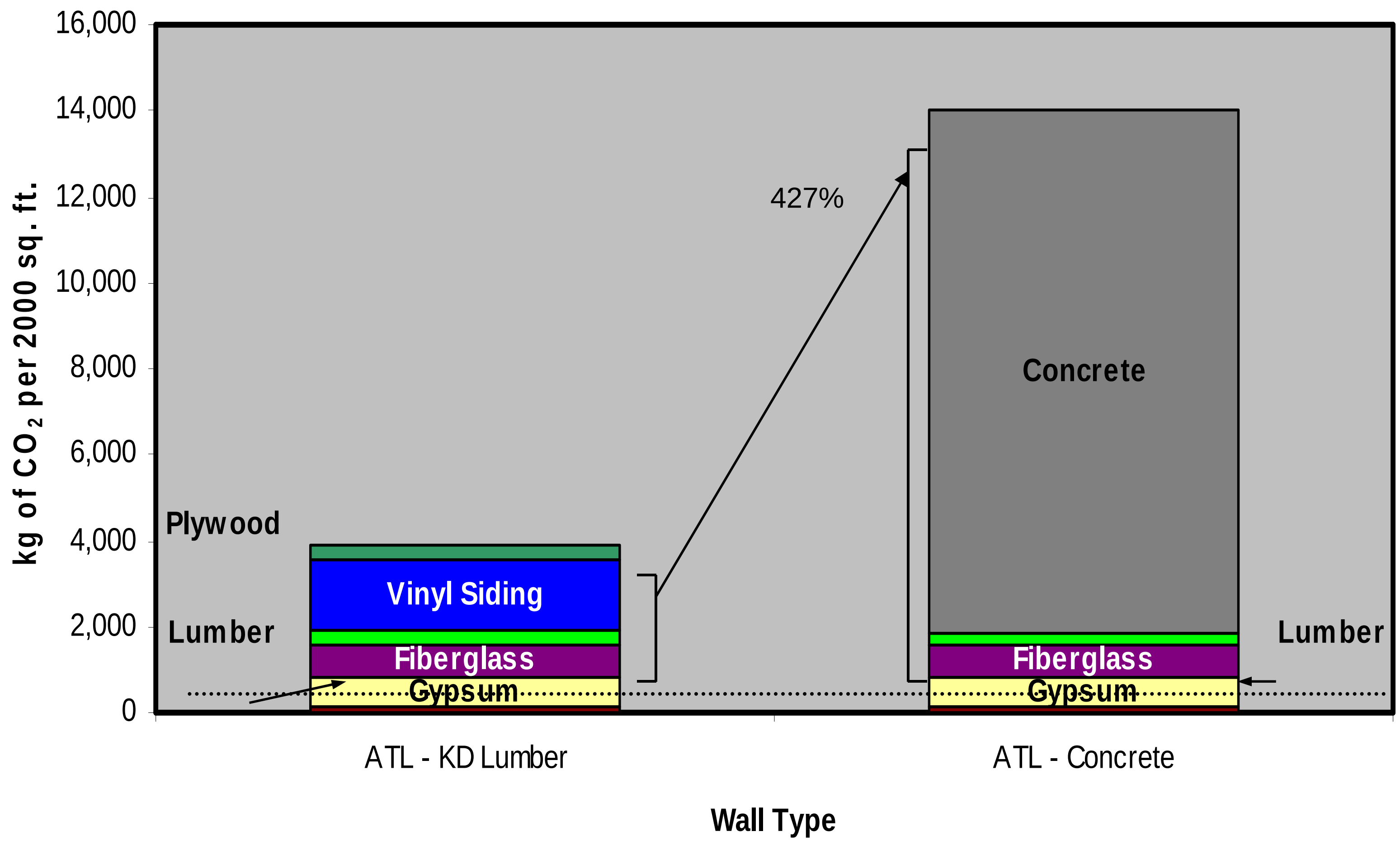



Net Product Life Carbon Emissions
CO2: Kg/cubic meter wood eq.
800
600
400
200
0
-200
-400
-600
-800
-1000
KD Lumber
Plywood
OSB
no product carbon to store
Concrete floor area eq.
includes carbon stored in product

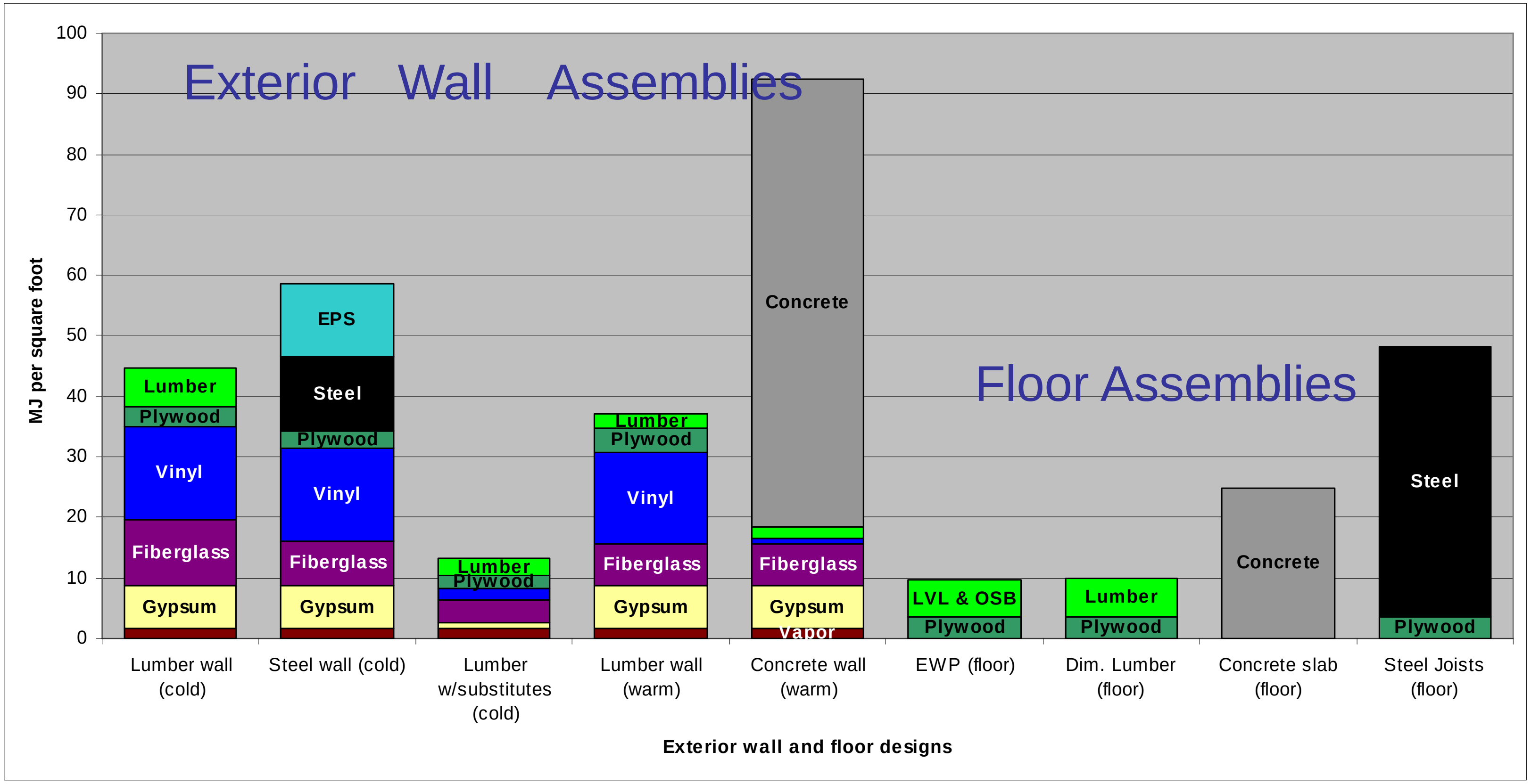
Minneapolis Walls: GWP (GHG) by component



Atlanta Walls: Global Warming Potential: GWP by component



Detailed fossil fuel consumption across wall & floor designs



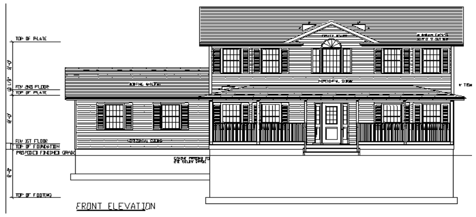
Life Cycle Assessment (LCA) In Terms of Performance Indices

- Embodied & Fossil Energy
- Global Warming Potential
- Air Emissions
- Water Emissions
- Solid Waste
- Ecosystem Impacts

CORRIM

Houses Designed to Local Code:
LCA comparisons

Minneapolis House
Cold Climate



Wood vs. steel *framed* house designed to same R code.

Concrete basement, sheetrock, insulation, wood trusses, vinyl windows, vinyl siding and asphalt roofing.

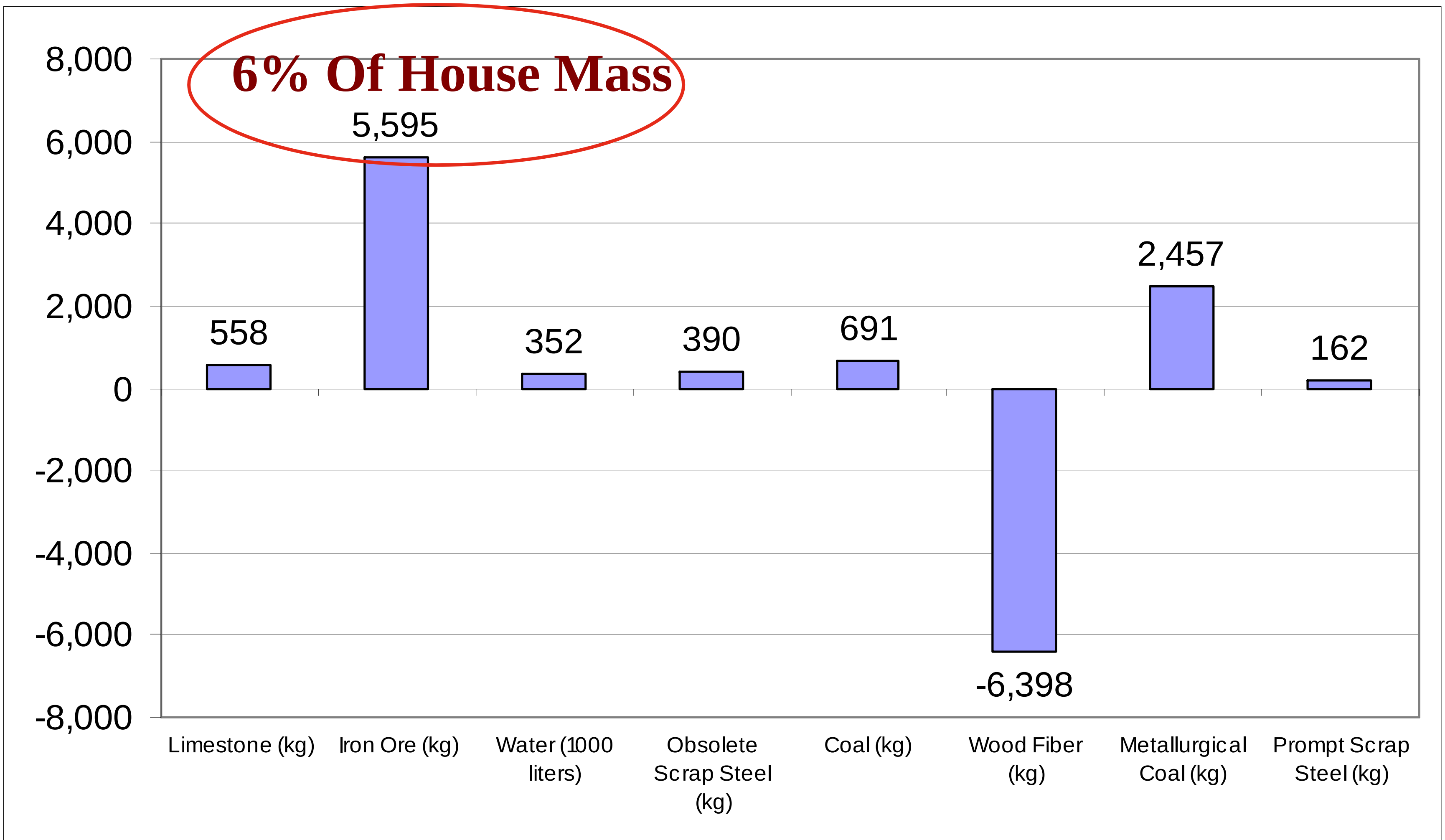
Atlanta House
Warm Climate

Wood *framed* vs. concrete block exterior walls designed to same R code.

Slab on grade, sheetrock, insulation, wood trusses, vinyl windows, stucco/vinyl siding and asphalt roofing.

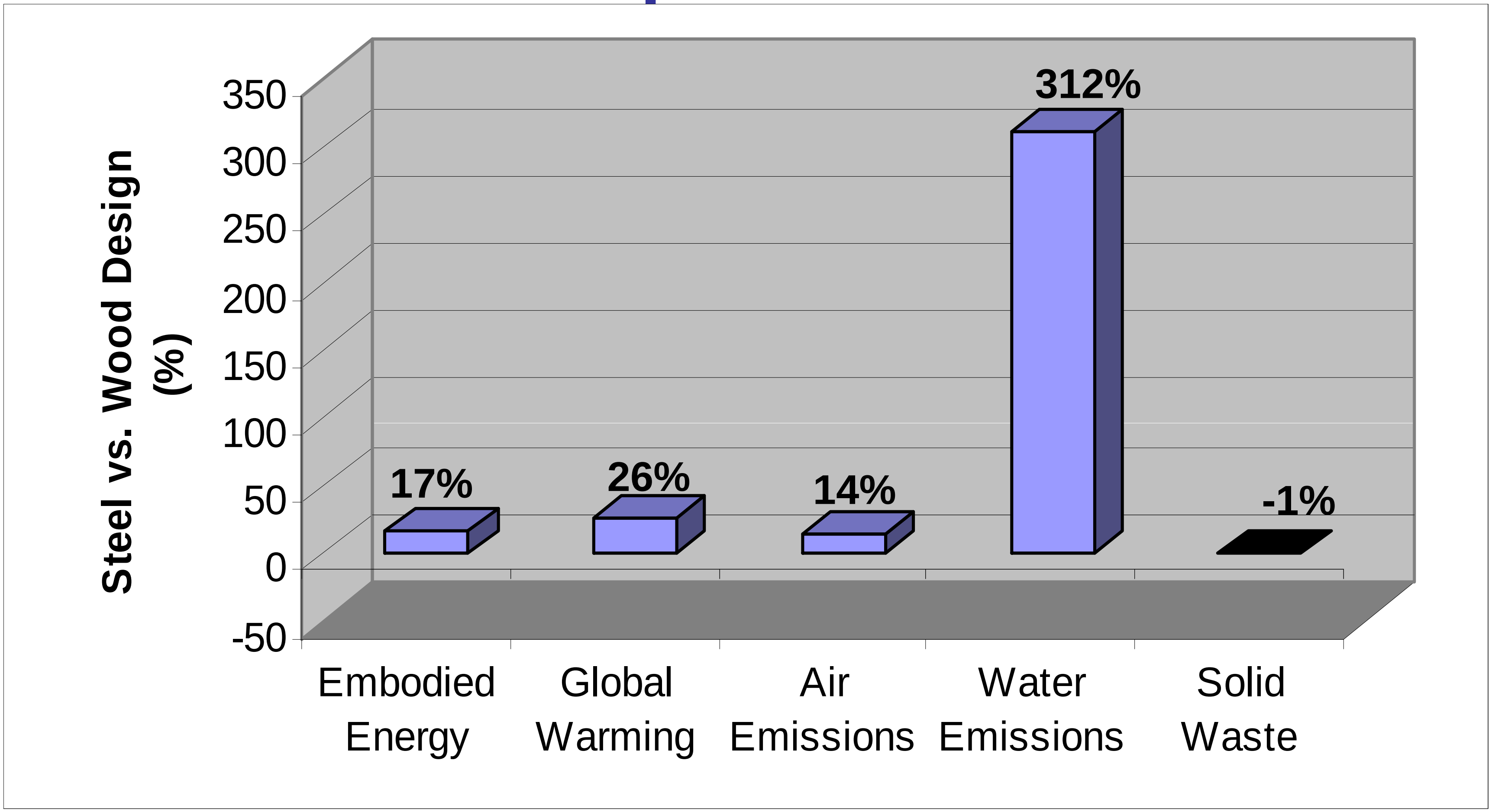
Design Differences: Minneapolis

Steel Frame minus Wood Frame
Extraction (primary materials in kg)



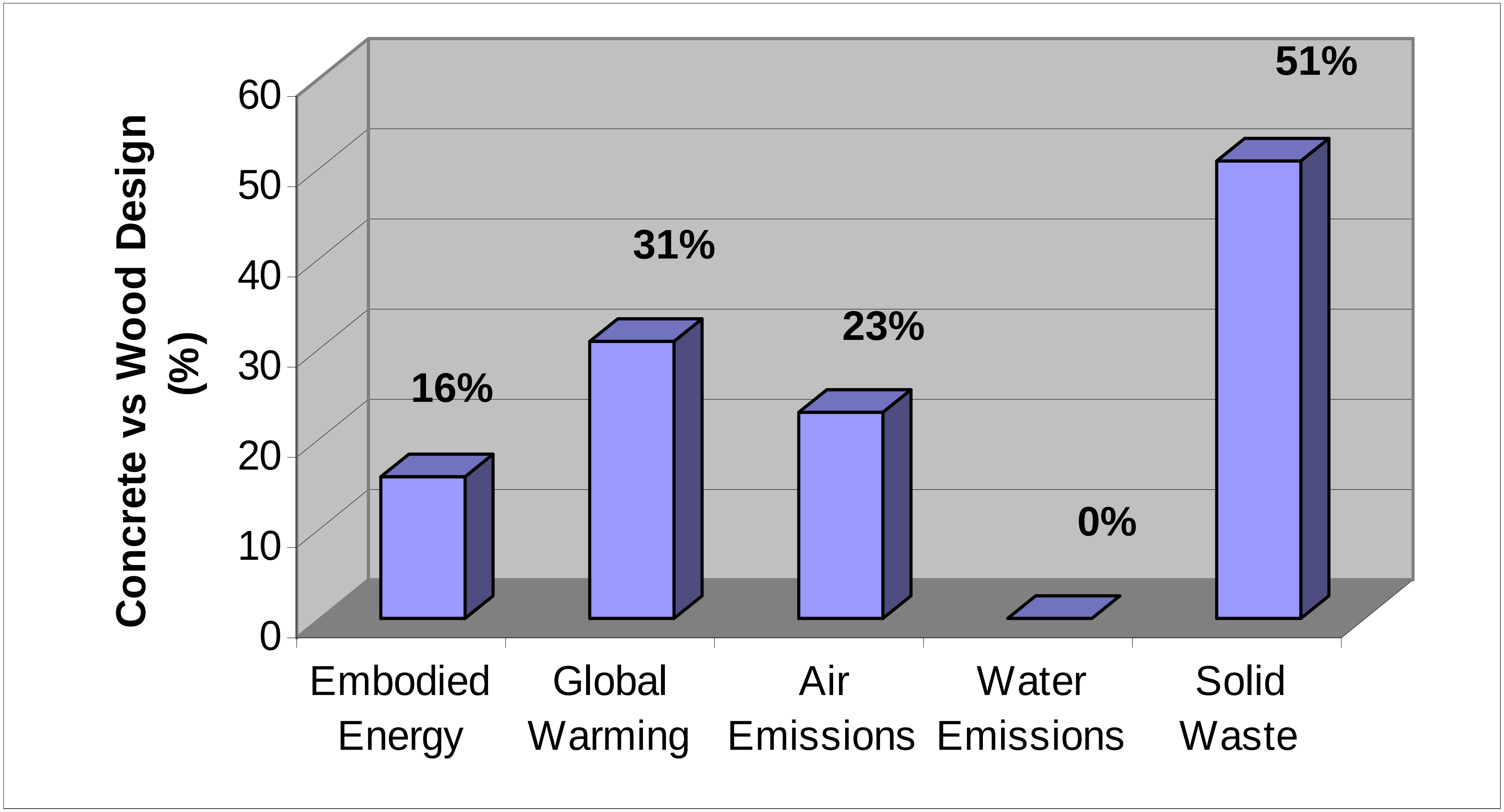
Summary Performance Indices

Life Cycle Assessment (LCA) for Minneapolis House

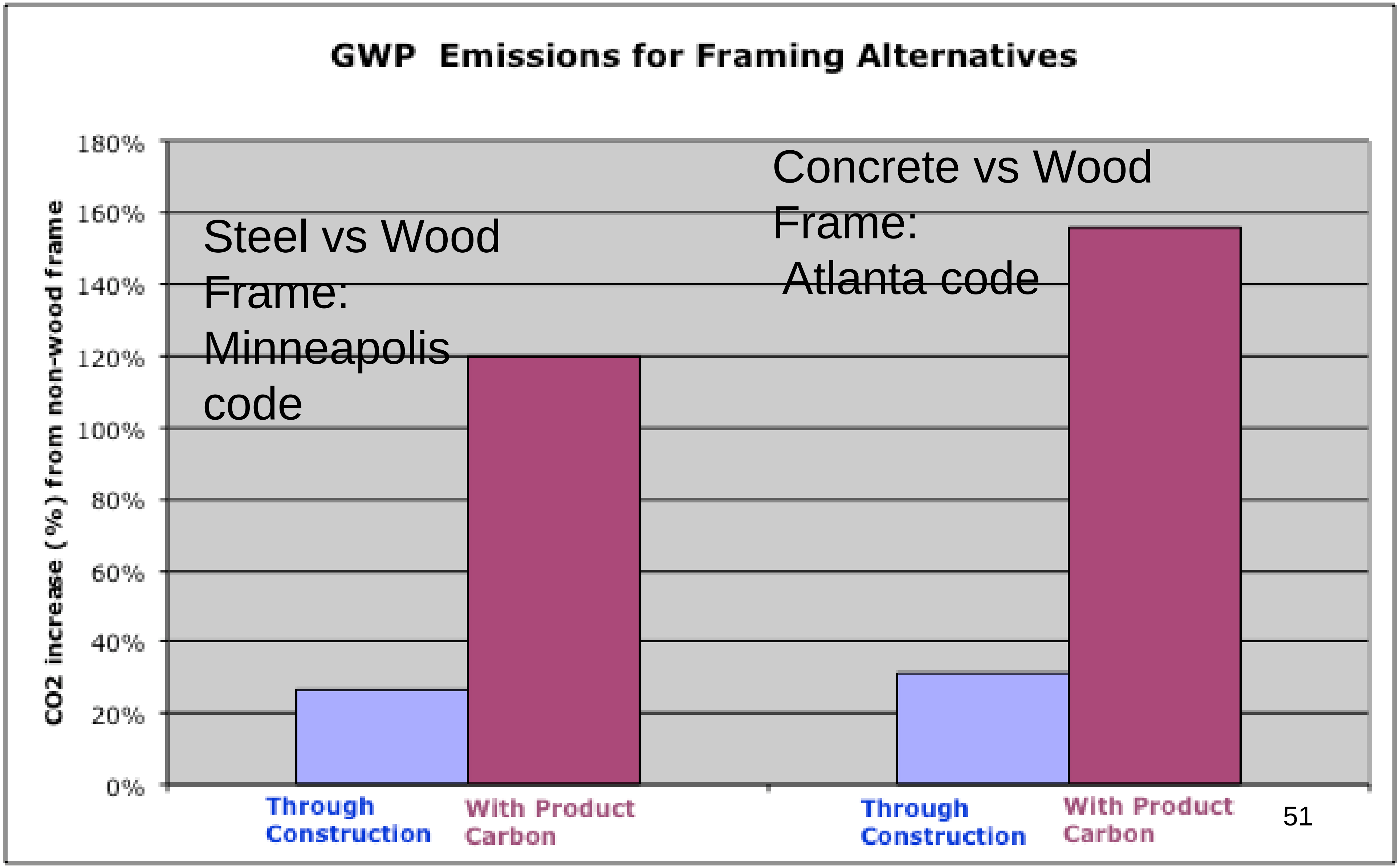


Summary Performance Indices:

Life Cycle Assessment (LCA) for Atlanta House



With Carbon in Products



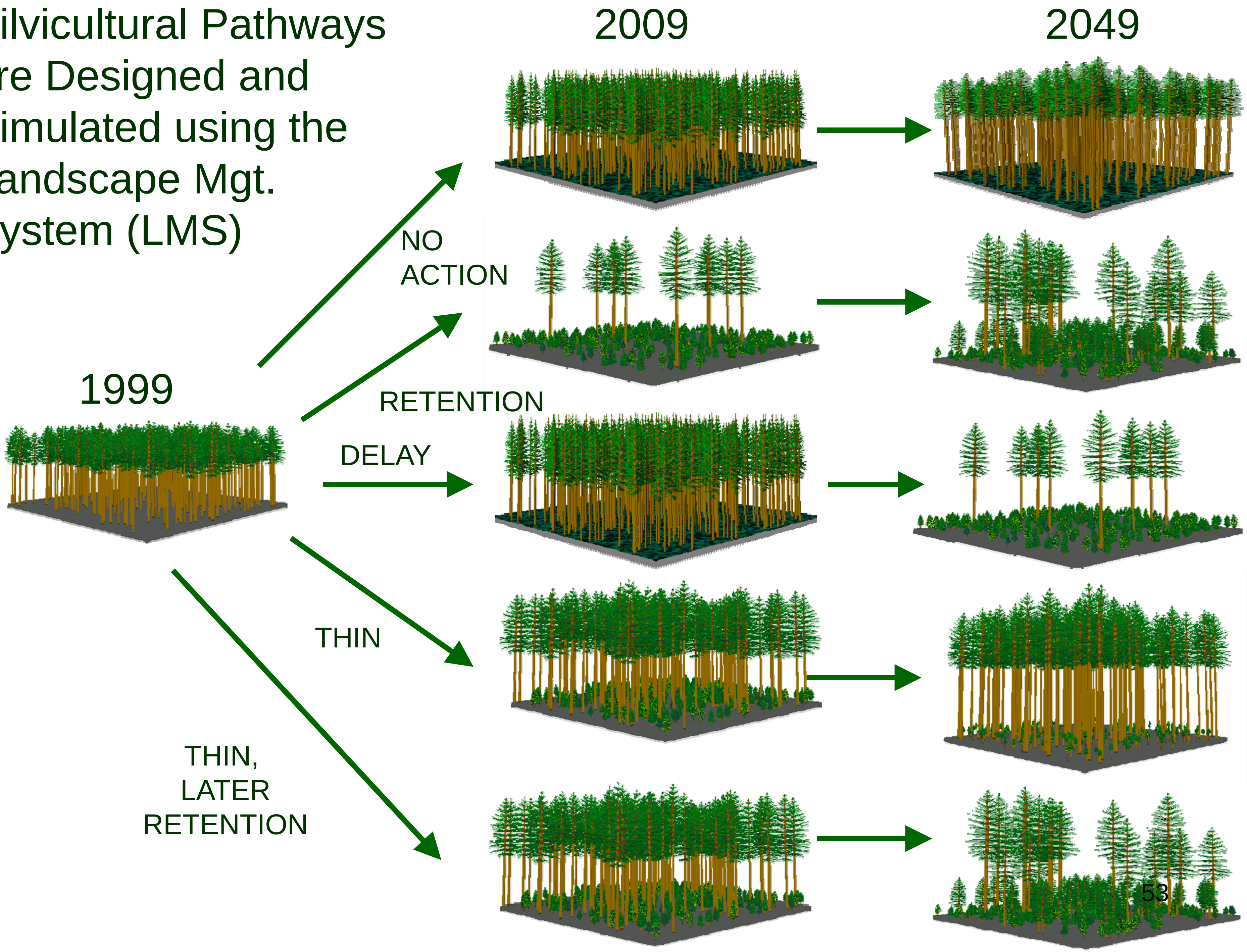
Linking product life cycles to forest carbon: tracking carbon from forests to uses

- ✓ LCI provides a cross section of every stage of processing at a point in time

- ✓ *Tracking carbon pools over time*: attach each current process to their time event (current processes, not predicted technology change)

- ✓ Simulate forest carbon with growth models linked to product & substitution impacts

Silvicultural Pathways are Designed and Simulated using the Landscape Mgt. System (LMS)



Carbon in Forests, Products and Concrete Frame Substitutes