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LCA of Feedstock Supply Chain

Forest conditions: Inland West

Presenter

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Co-authors

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At

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US Energy Independence and Security Act of 2007

- No Federal agency shall enter into a contract for procurement of an alternative or synthetic fuel, including a fuel produced from nonconventional petroleum sources, for any mobility-related use, other than for research or testing, unless the contract specifies that the ***lifecycle*** greenhouse gas emissions associated with the production and combustion of the fuel supplied under the contract must, on an ongoing basis, be less than or equal to such emissions from the equivalent conventional fuel produced from conventional petroleum sources.

US Energy Independence and Security Act of 2007

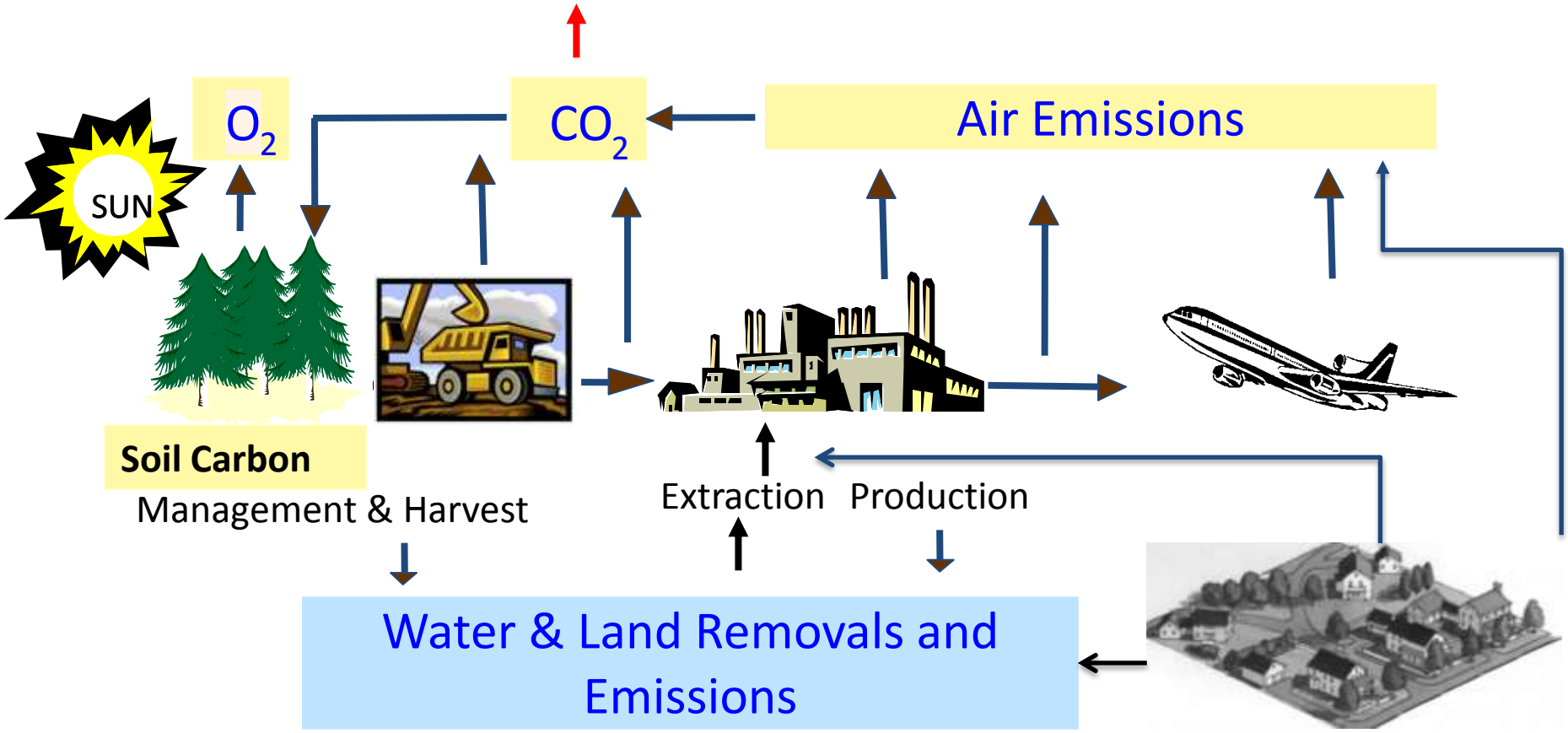
- To move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes.

Subtitle A—Renewable Fuel Standard

- "(E) CELLULOSIC BIOFUEL.—The term 'cellulosic biofuel' means renewable fuel derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass and that has lifecycle greenhouse gas emissions, as determined by the Administrator, that are at least 60 percent less than the baseline lifecycle greenhouse gas emissions.

H.R.6: (Enrolled as Agreed to or Passed by Both House and Senate), **PROCUREMENT AND ACQUISITION OF ALTERNATIVE FUELS.** (Source: http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf)

Life Cycle Assessment of Bio- Jet Fuel



* municipal solid wastes (MSW), lawn wastes, wastewater treatment sludge, urban wood wastes, disaster debris, trap grease, yellow grease, waste cooking oil, etc.

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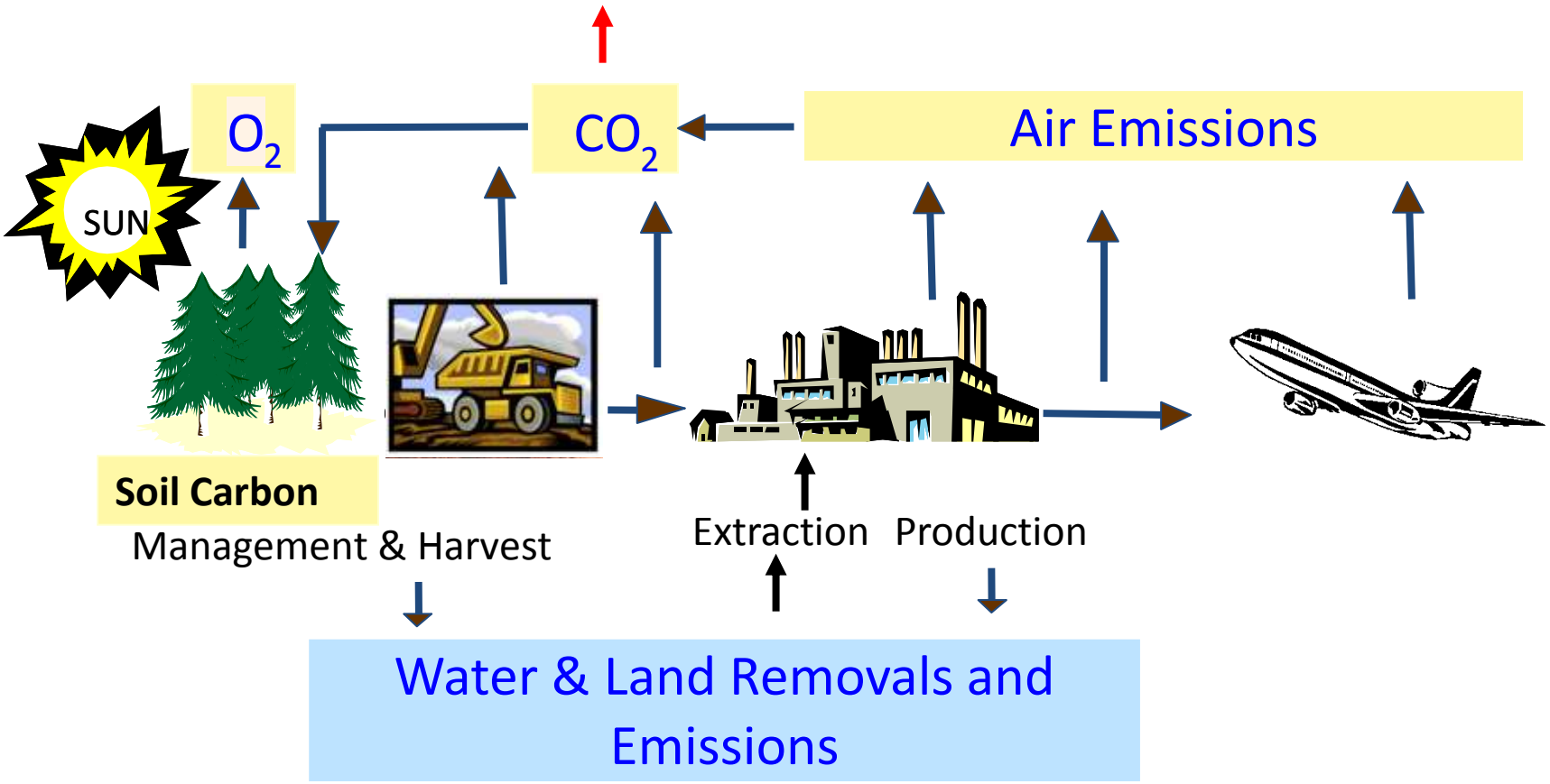
Life Cycle Assessment of Bio- Jet Fuel



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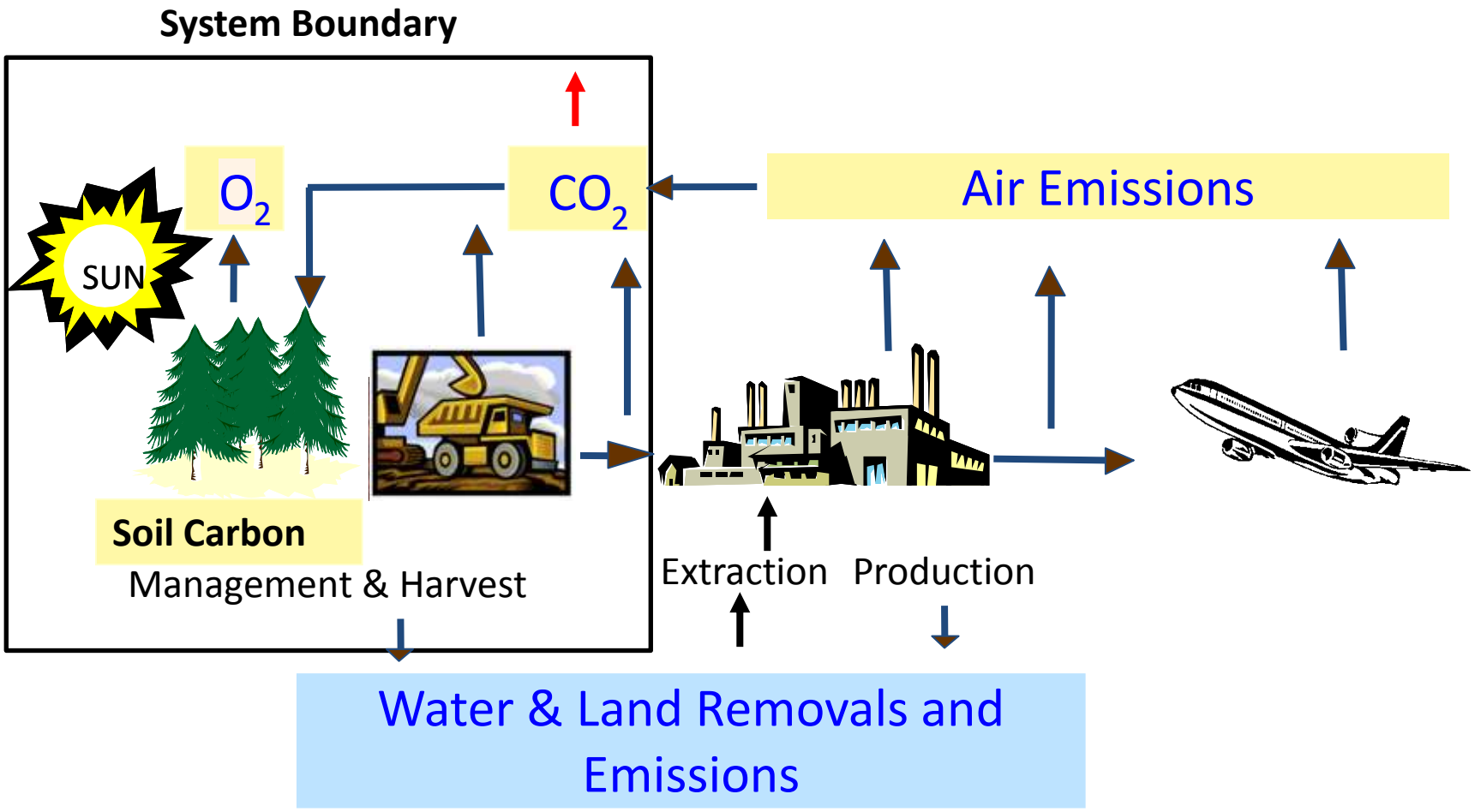

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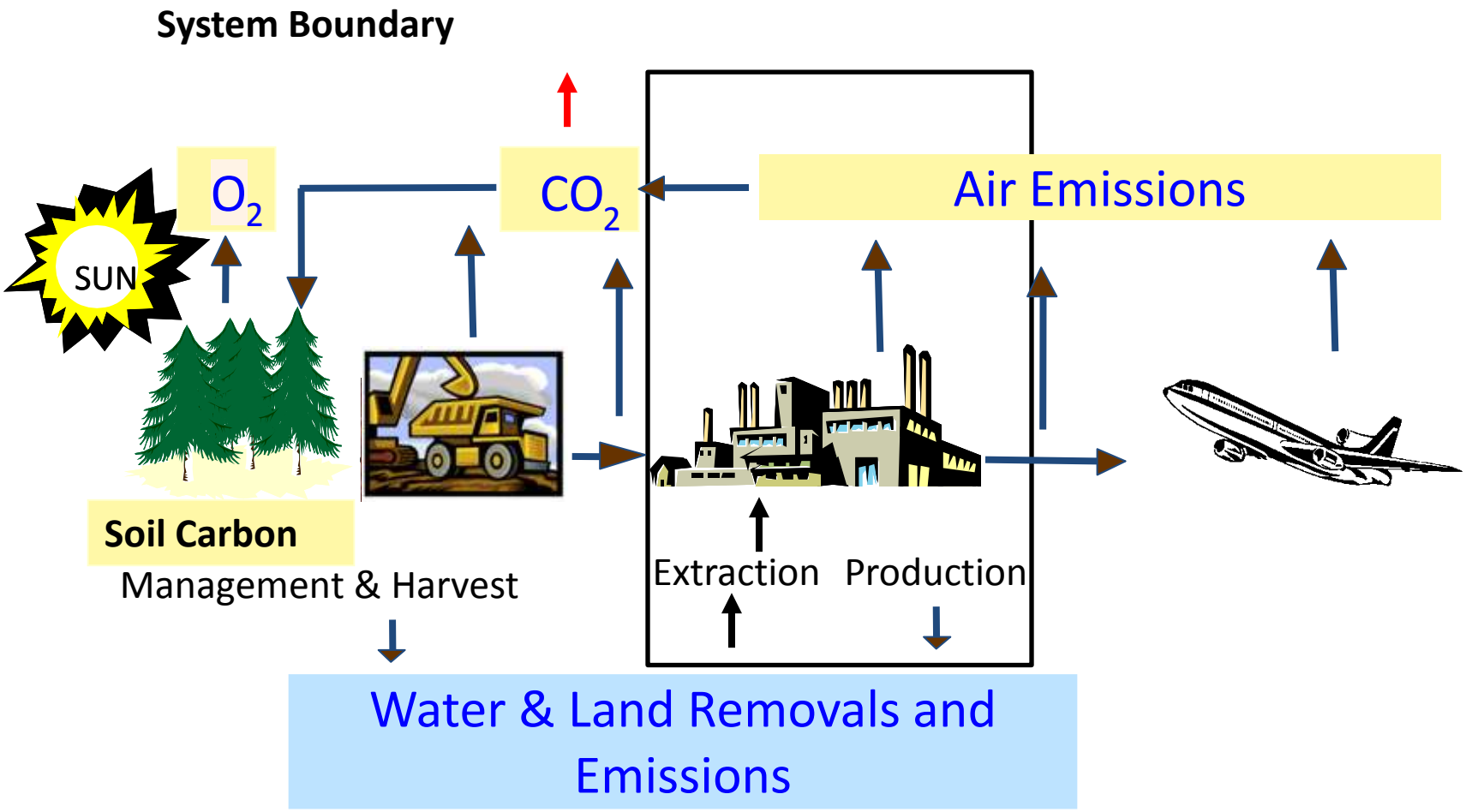
System Boundary
O_2
CO_2
Air Emissions
SUN
Soil Carbon
Management & Harvest
Extraction
Production
Water & Land Removals and Emissions

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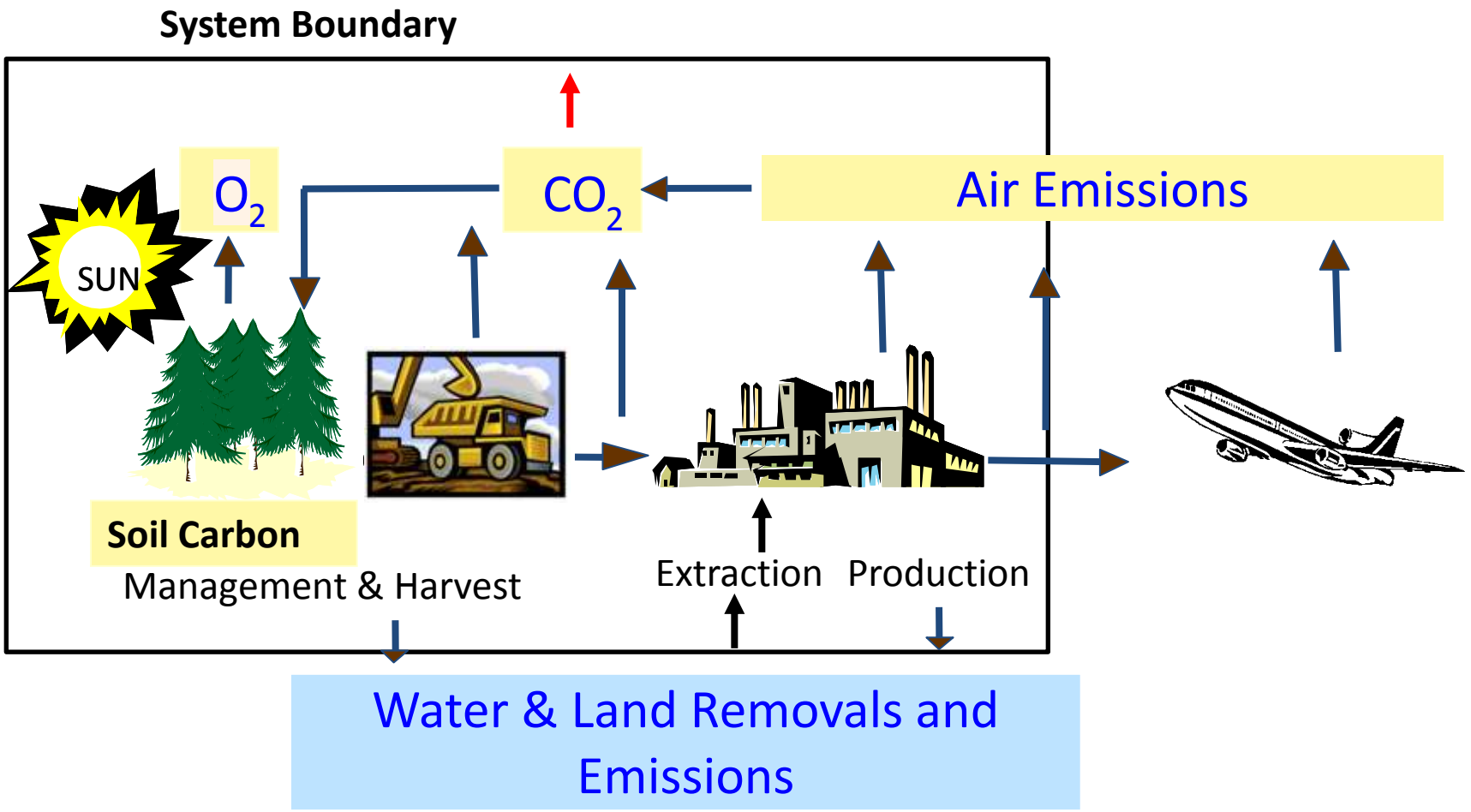
Life Cycle Assessment of Bio- Jet Fuel



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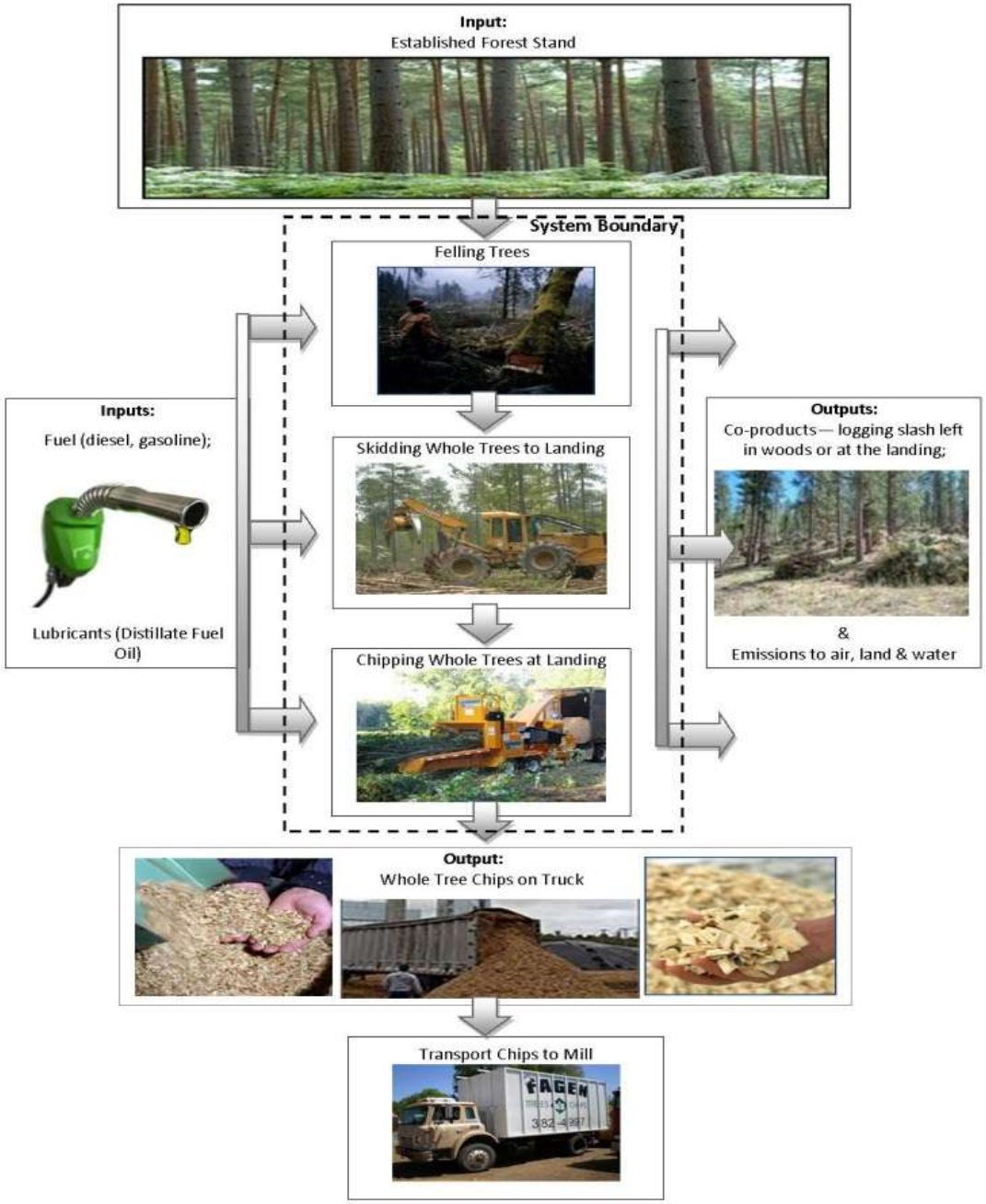
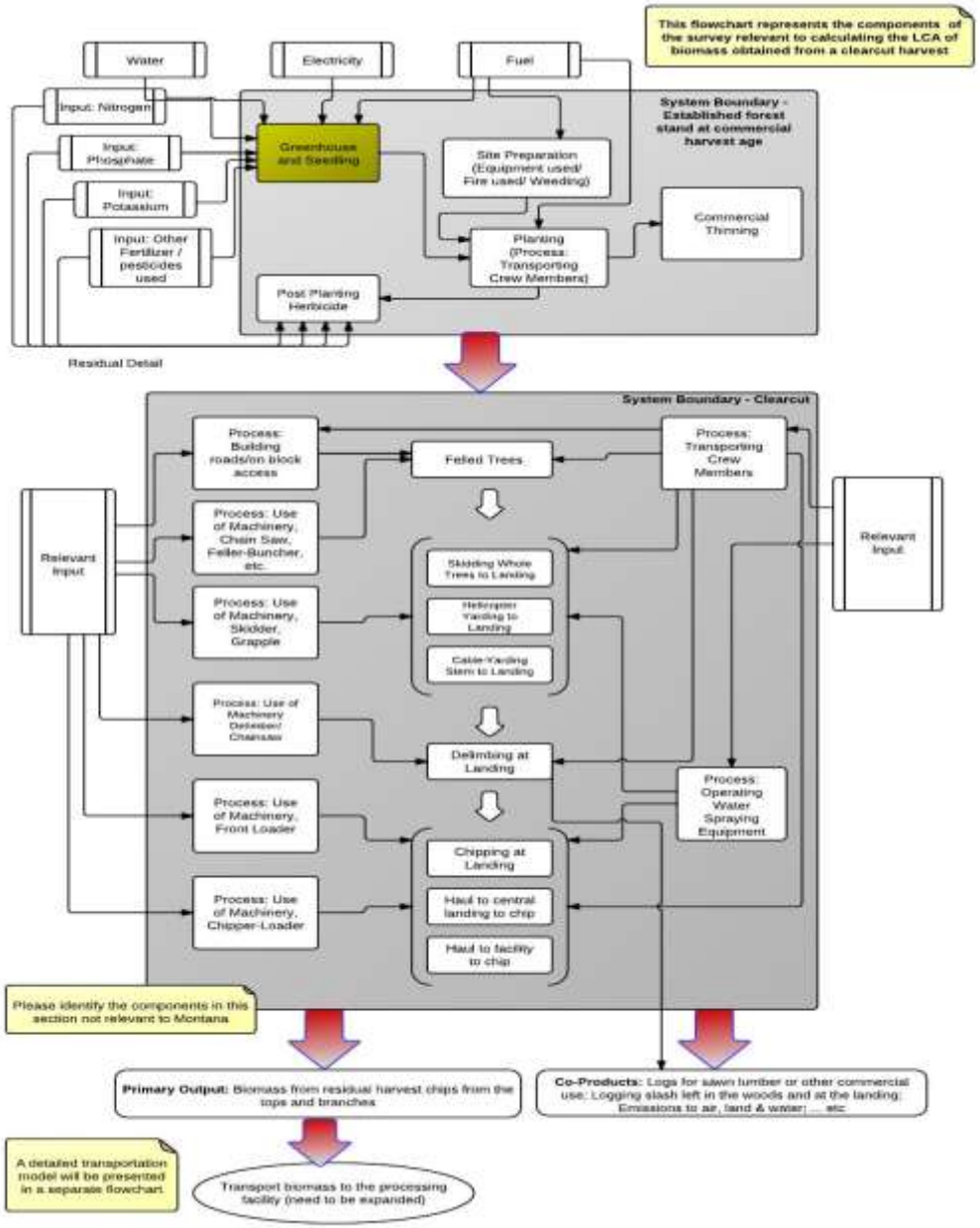
Example:
System Boundary for LCA of Forest Thinning



Aspects of feedstock supply chain – LCA perspective



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Relevant Characteristics of Forest Biomass

- **Difficulty handling** and economic viability issues
  - Low bulk density
  - Varying sizes and shapes of woody biomass
  - Inconsistent mix of multiple species
  - Various handling complications in cases of
    - Salvage of mountain pine beetle killed trees
      - Stage of beetle attack at the time of harvest is critical
    - Post fire salvage operations (can we use it for Bio-fuel?)

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Biomass Handling Methods: **in woods**

Grinding:

Chipping:

Bundling:

Source: Han-Sup Han et al. 2012

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Biomass recovery and production systems

Slash recovery operation

- Dump truck slash shuttle & centralized grinding
- Roll-off/Hook-lift truck slash shuttle & centralized grinding
- Bundling slash & Centralized grinding
- Grinding on site & Hog fuel shuttle
- Pile-to-pile on site grinding

Whole tree chipping

- Medium Chipper – Small/large trees
- Large Chipper – Small/large trees

Integrated harvesting

- Chipping (whole tree) & Grinding (slash)
- Grinding only (slash & whole tree)

Source: Han-Sup Han et al. 2012

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Scenarios developed for recovery of landing residue

Benchmark scenario:

1. Harvest standing forest using a Feller-buncher
2. Take harvest to primary landing using a track-skidder
3. Shuttle Loose Residue from Primary Landing to secondary using a dump truck (30 CY capacity)
4. Chip at the secondary landing and haul to biomass processing facility using a chip van (140 CY capacity)
5. Transportation Scenario:

	Spur Road	1 ½ lane	Gravel	Highway	Interstate	Total
Avg. miles/hr	6	20	29	55	62	
One way haul miles	2.5	5	10	20	37.5	75

Developed by: **CORRIM**

1st Alternate Scenario:

1. A larger Roll-off container (50 CY capacity) can access the primary landing for shuttling the loose residue to secondary landing for chipping.
2. Everything else remains constant

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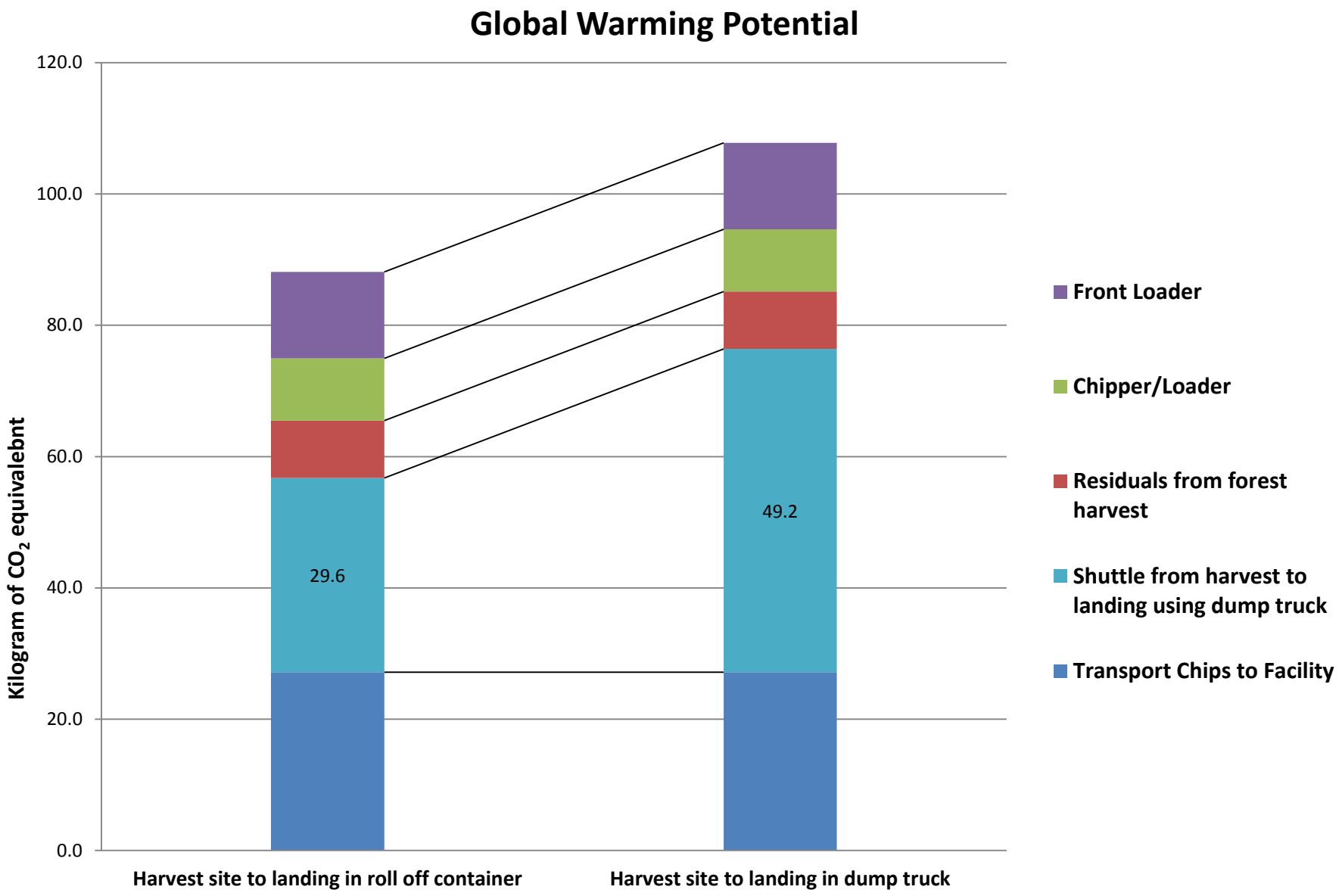
Global Warming Potential
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Kilogram of CO_2 equivalebnt
29.6
49.2
Harvest site to landing in roll off container
Harvest site to landing in dump truck
Front Loader
Chipper/Loader
Residuals from forest harvest
Shuttle from harvest to landing using dump truck
Transport Chips to Facility

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Alternate distance scenarios

Second series of scenarios (Total distance stays constant; spur road distance increases):

	Spur Road (miles)	1 ½ lane (miles)	Gravel (miles)	Highway (miles)	Interstate (miles)	Total (miles)
Alternate Scenario 2	3.5	5	10	20	36.5	75
Alternate Scenario 3	5	5	10	20	35	75

- All other factors same as baseline case

Third series of scenarios: (Interstate road distance increases)

	Spur Road (miles)	1 ½ lane (miles)	Gravel (miles)	Highway (miles)	Interstate (miles)	Total (miles)
Alternate Scenario 4	2.5	5	10	20	62.5	100
Alternate Scenario 5	2.5	5	10	20	82.5	120

- All other factors same as baseline case

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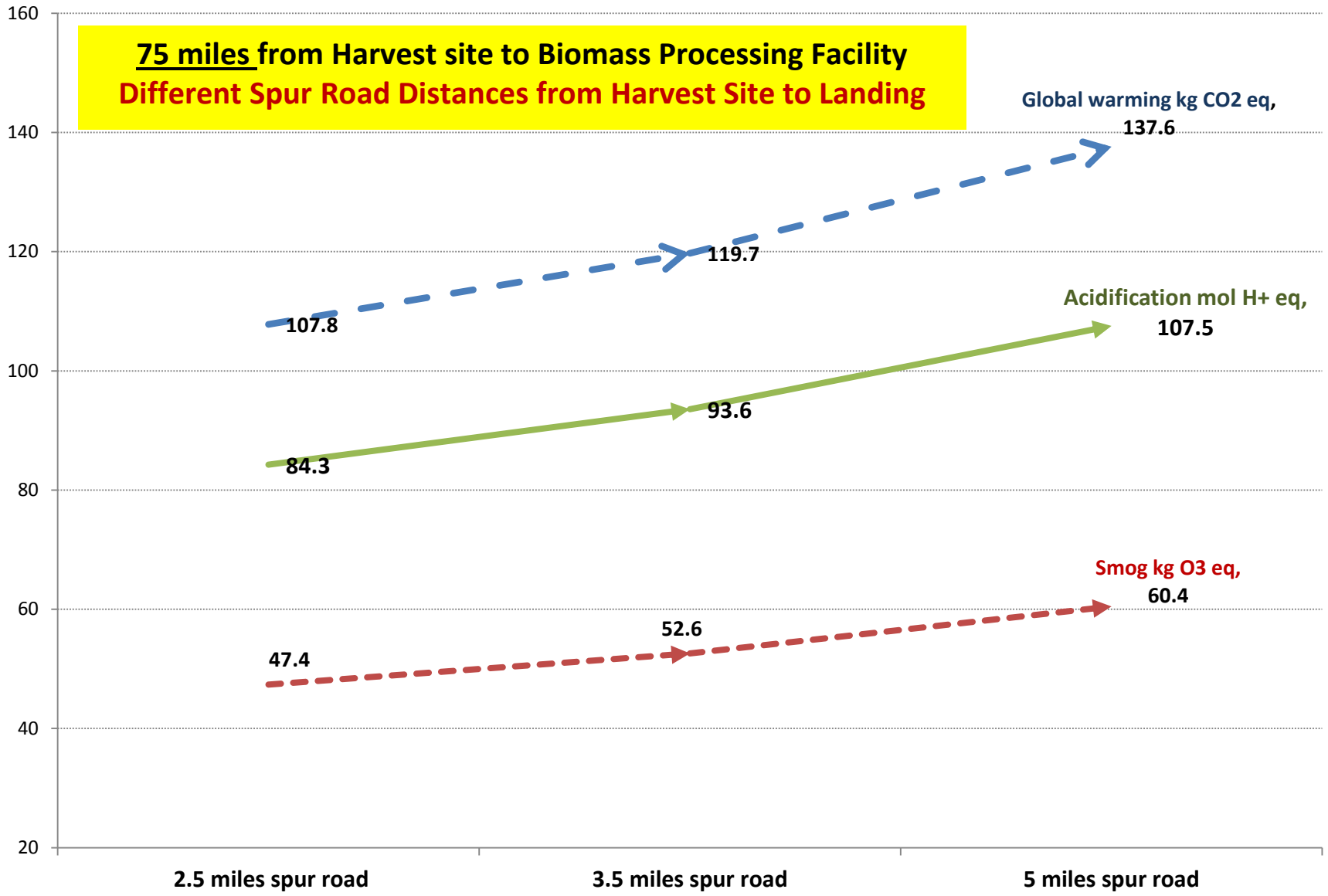
Alternate distance scenarios (baseline, 2 and 3)



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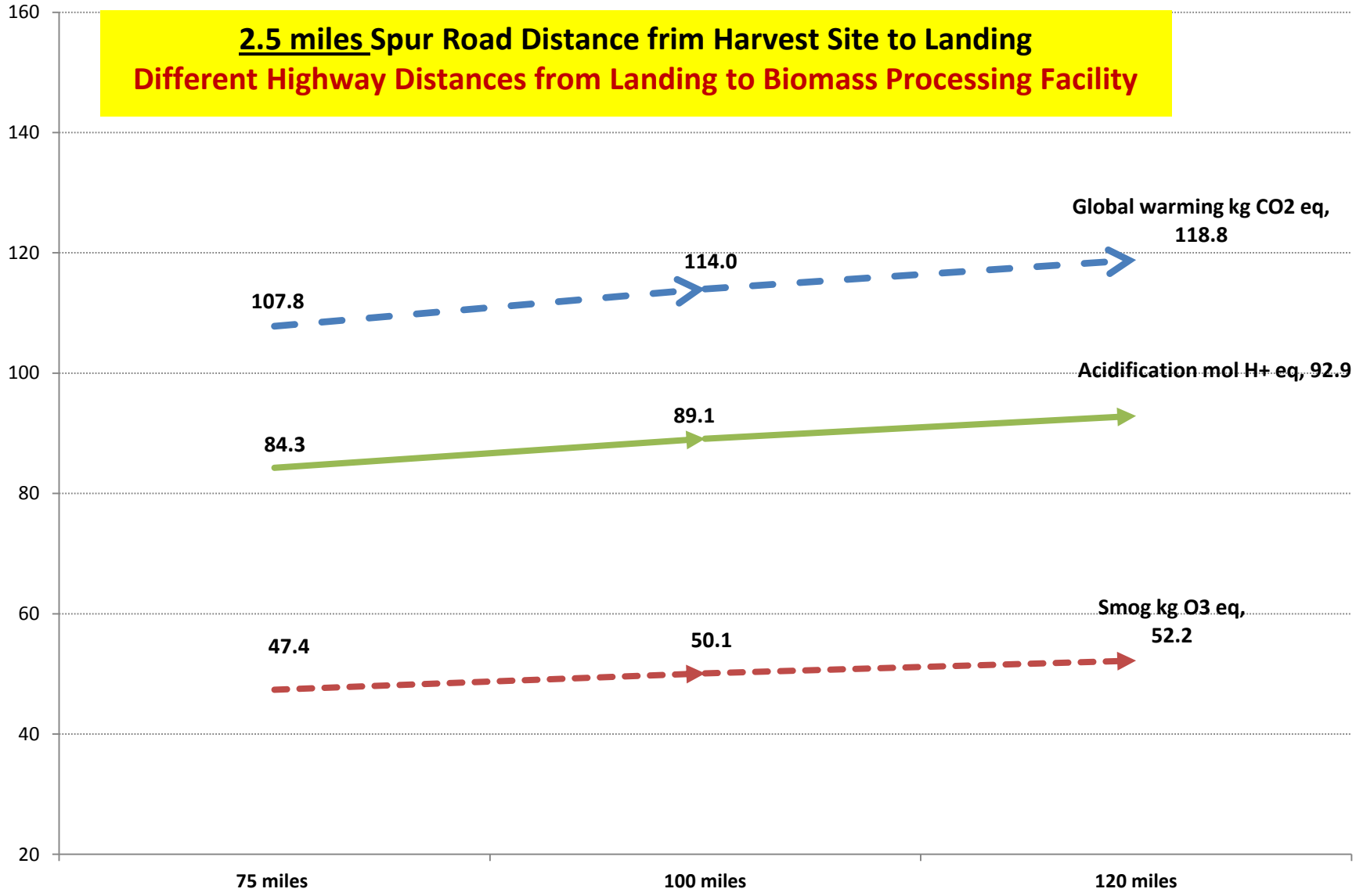
Alternate distance scenarios (baseline, 4 and 5)



Other Scenarios and Concluding Remarks

Other scenarios:
Scenarios based on helicopter yarding and cable yarding are developed and the results will be presented at the poster session.

Observations and future :
The forest road transportation of loose residue is the primary contributor to global warming potential for woody biomass.

Options that reduce the carbon footprint associated with loose residue collection may be critical.

Strategic forest road development may reduce the global warming potential of feedstock collection over the long run.

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We need your feedback and suggestions

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