

Life-Cycle Inventory Analysis of Manufacturing Redwood Decking

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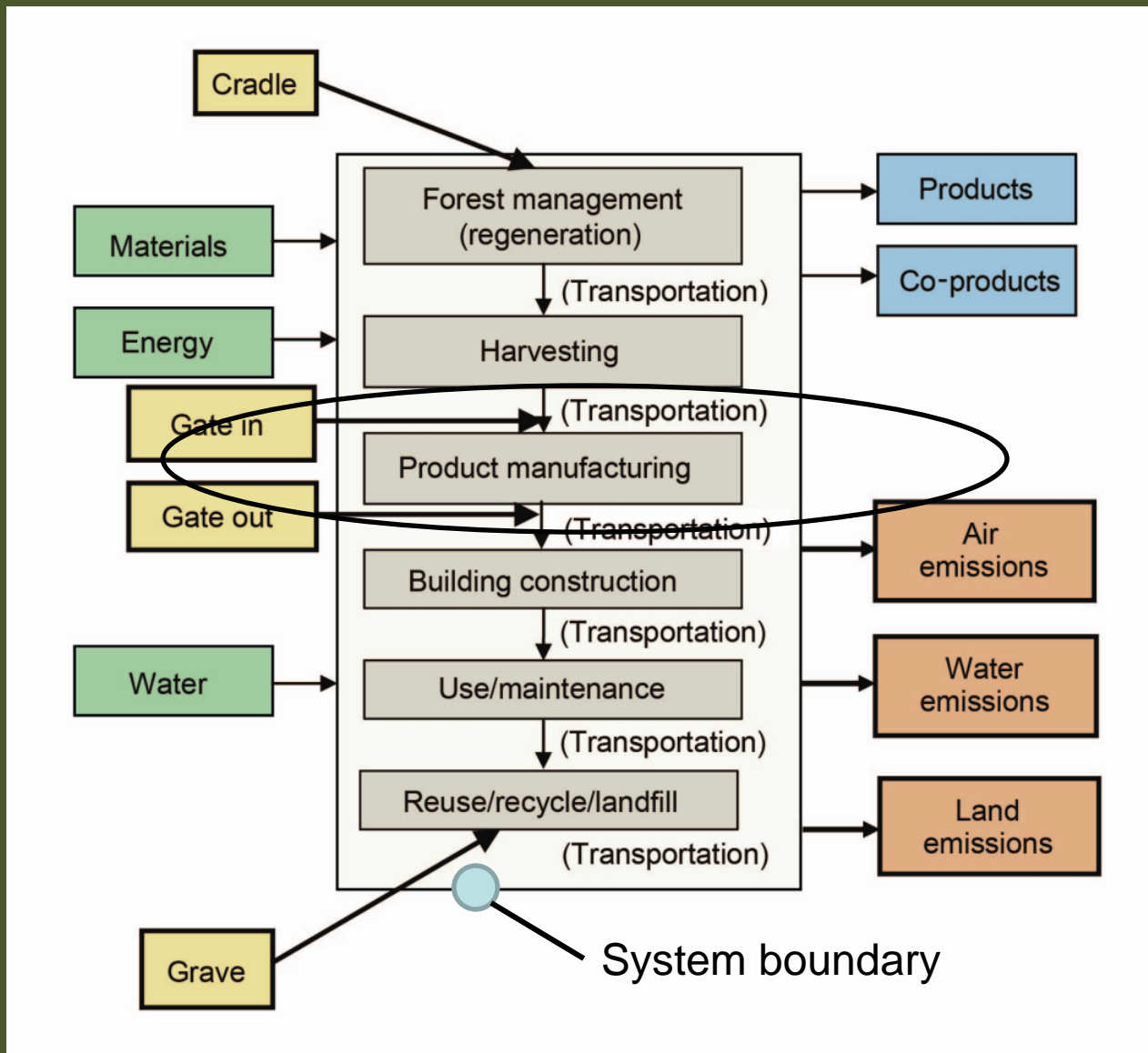
SWST 66th International Convention

Beijing, China

Objectives

- Conduct life-cycle inventory (LCI)
 - Manufacturing redwood (*Sequoia sempervirens*) decking
 - Categorize emission profile
 - ISO 14040/14044 standards
 - Consortium on Research for Renewable Industrial Material (CORRIM) Research Guidelines (www.corrim.org)
- LCI part of comparative LCA
 - Virgin wood-plastic composite (WPC)
 - Recycled WPC
 - Plastic (cellular polyvinyl chloride (PVC))

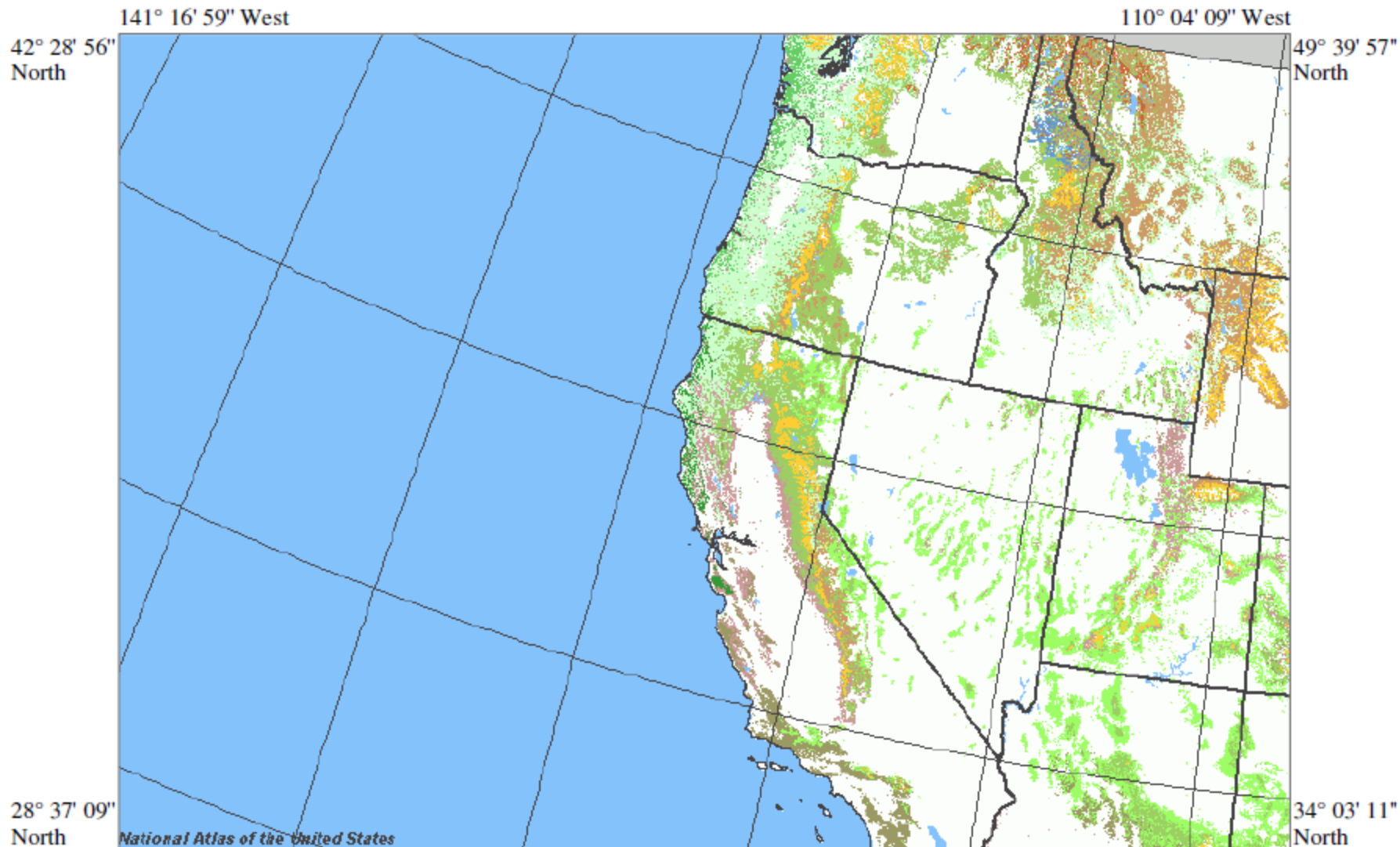
LCA tracks all inputs and outputs



Background: Purpose of LCI/LCA

- Product improvement
 - Monetary value
 - Identify “hot” spots; drying wood
- Support for strategic choices
 - Green building practices
 - Material selection
 - Carbon footprint
 - Environmental Product Declarations (EPDs)
- Benchmarking – baseline data

US+Western+forest+map



National Atlas of the United States

133° 31' 37" West
Lambert Azimuthal Equal-Area
Projection



Miles 100 200 300

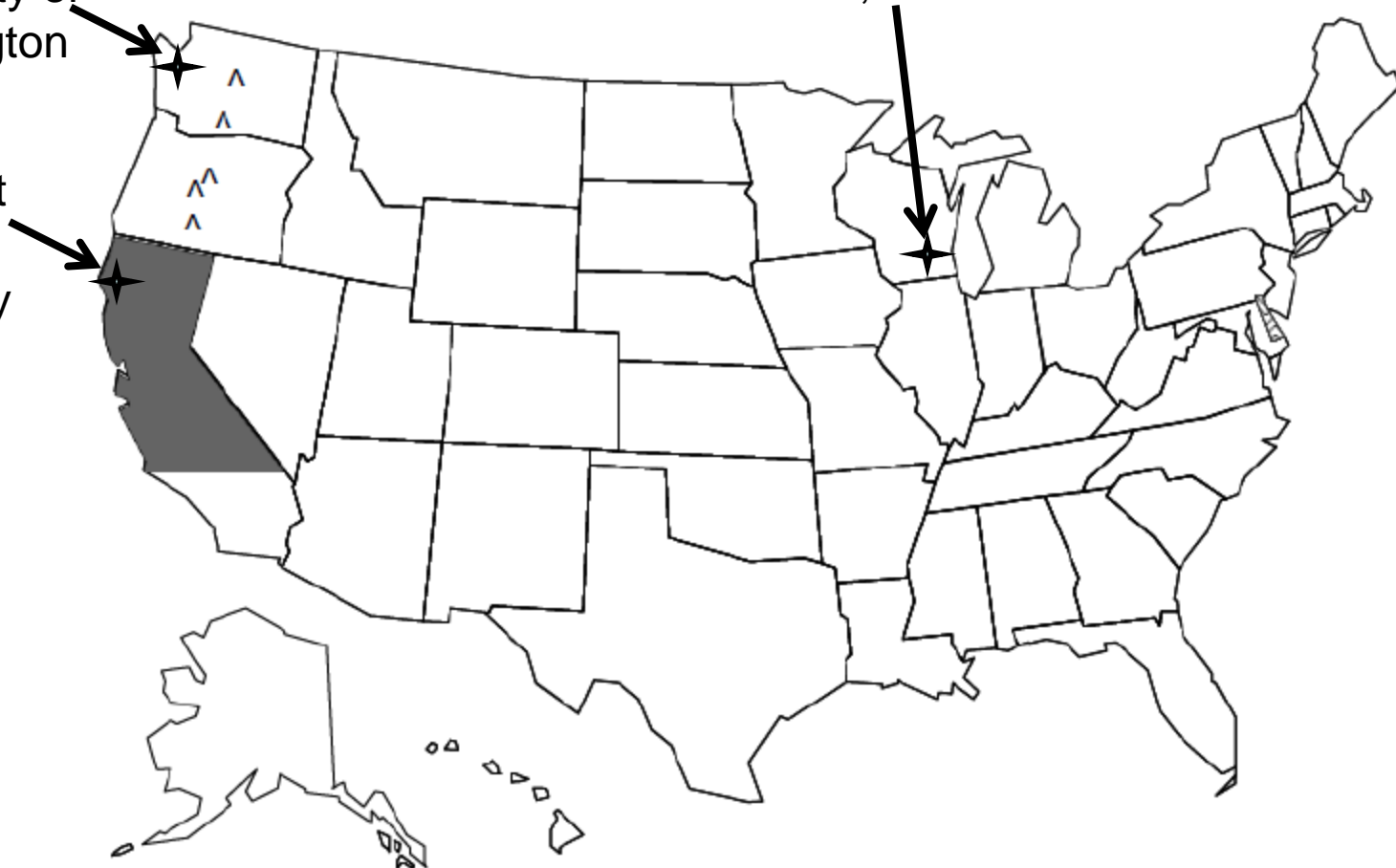
107° 49' 26" West
<http://nationalatlas.gov>
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Shaded regions shows area of redwood decking production (northern California)

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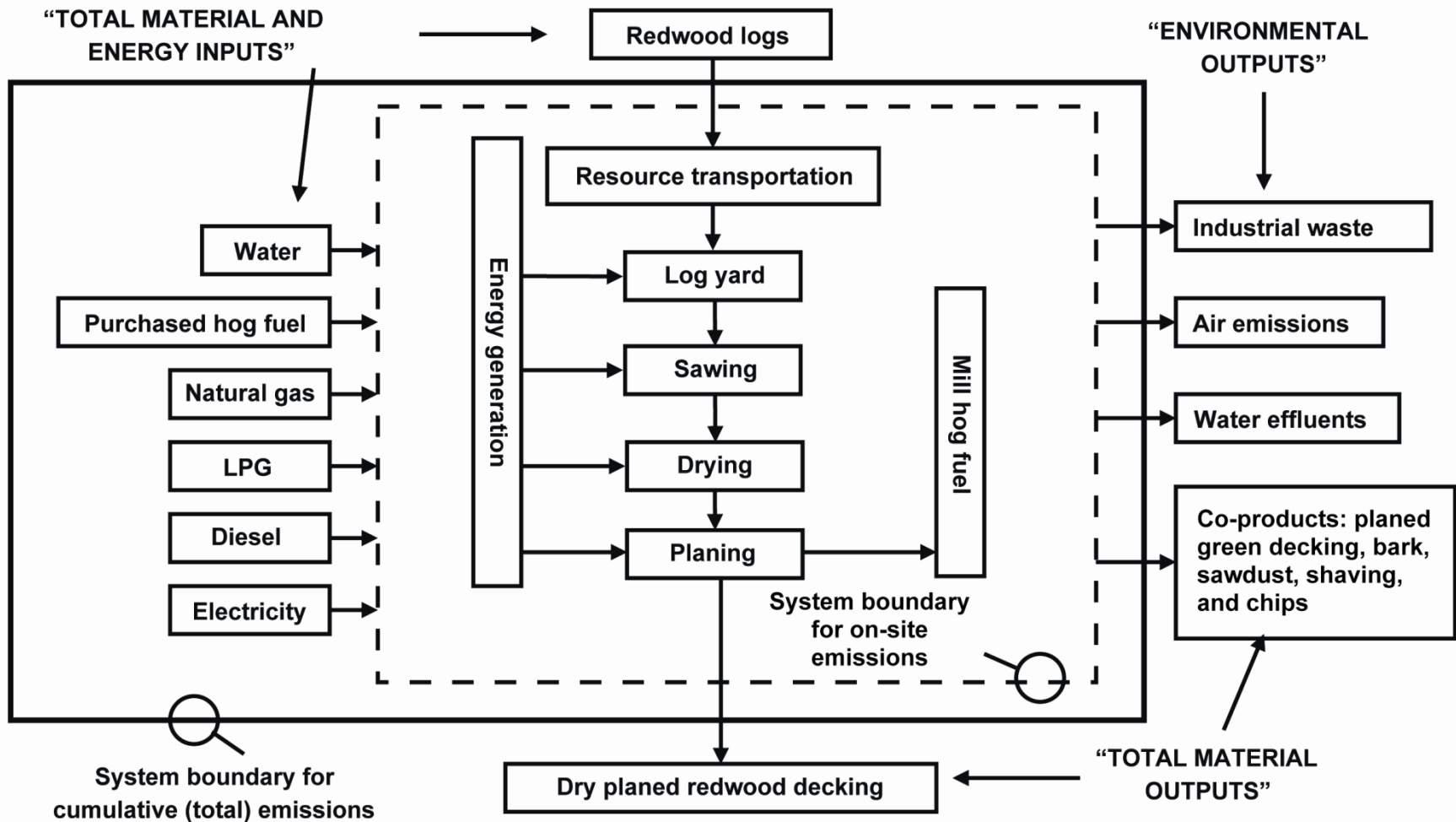
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Goal and scope of LCI

- Defines the system boundaries – what unit processes to include
- Determines the functional unit
 - similar to production unit
 - quantity of the studied product
 - typically measured in physical units such as volume, area, or mass of the product
 - links life-cycle stages together

System Boundaries



Parameters

- Surveyed 83% annual production in 2010
 - Total 2010 production was 880 thousand m³
- All emissions assigned to redwood decking - none to wood residues
- Functional unit - one cubic meter of decking
- Density of decking = 380 OD kg/m³

Unit-process approach

- Surveyed redwood mills
 - Primary (process) annual production data
 - Site visits
- Weight-averaged survey data per m³
 - Per unit process
- Entered data into SimaPro
 - Used secondary LCI data for electricity/fuels
- Reported LCI flows per m³

Results

- Log reduced to 55.6% of original volume
 - 1.8 m³ log to 1 m³ planed decking
- 1,500 MJ energy per m³ of decking
- Primary energy use
 - Coal (33%) electricity
 - Natural gas (20%) electricity
 - Woody biomass (14%) thermal energy
 - Minimal kiln drying
 - Some decking sold green

Mass balance of redwood decking

Material (OD kg)	Sawing process		Boiler process	Dryer process		Planer process		All process combined		
	In	Out	In	In	Out	In	Out	In	Out	Diff
Green logs (wood)	648	-	-	-	-	-	-	648	0	-648
Green logs (bark)	71	-	-	-	-	-	-	71	0	-71
Green chips	-	147	-	-	-	-	-	0	147	147
Green sawdust	-	68	-	-	-	-	-	0	68	68
Green bark	-	71	-	-	-	-	-	0	71	71
Green shaving	-	12	-	-	-	-	-	0	12	12
Green hog fuel	-	32	-	-	-	-	-	0	32	32
Rough green decking	-	388	-	388	-	-	-	388	388	0
Rough dry decking	-	-	-	-	388	388	-	388	388	0
Planed dry decking	-	-	-	-	-	-	380	0	380	380
Dry shavings	-	-	8	-	-	-	8	8	8	0
Sum	719	719	8	388	388	388	388	1503	1495	-8

Air emissions per m³

Substance	kg	Primary source
Biomass CO ₂	20.6	Burning mill residues
Fossil CO ₂	69.7	Burning coal for power
VOCs ¹	0.0521	Drying wood
PM10	0.0577	Burning coal for power

Total CO₂ emitted $20.6+69.7=90.3$ kg

697 kg CO₂ stored as carbon in redwood decking

¹ Volatile organic compounds

Conclusion

- Carbon storage exceeds carbon emissions
 - Factor of eight (697/90.3 ~ 8)
- Low overall manufacturing emissions
 - Low carbon emissions
- Low cumulative energy (unallocated)
 - 1,500 MJ/m³ (redwood decking)
 - 3,950 MJ/m³ (western softwood lumber)

Acknowledgements

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Questions?

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