



Wood in LCIs and LCA Tools

Speaker Background

Maggie Wildnauer

- Consulting Director, Sustainability @ Sphera
- Credentials:
 - M.S. Structural Engineering, MIT
 - B.S. Civil Engineering, Johns Hopkins
 - LEED GA
- Key experiences
 - LCA Practitioner for 7 years
 - Provided background data for the Tally tool
 - Contributed to LCA data in Quartz
 - Former researcher at Concrete Sustainability Hub



Life Cycle Inventory (LCI)

Materials Production

Flow	Quantity
Electricity	100,000 MWh
Fuel oil	100,000 MJ
Emissions	100,000 tons

+

Manufacturing

Flow	Quantity
Natural Gas	100,000 ft ³
Electricity	100,000 MWh
Waste	100,000 tons

+

Distribution

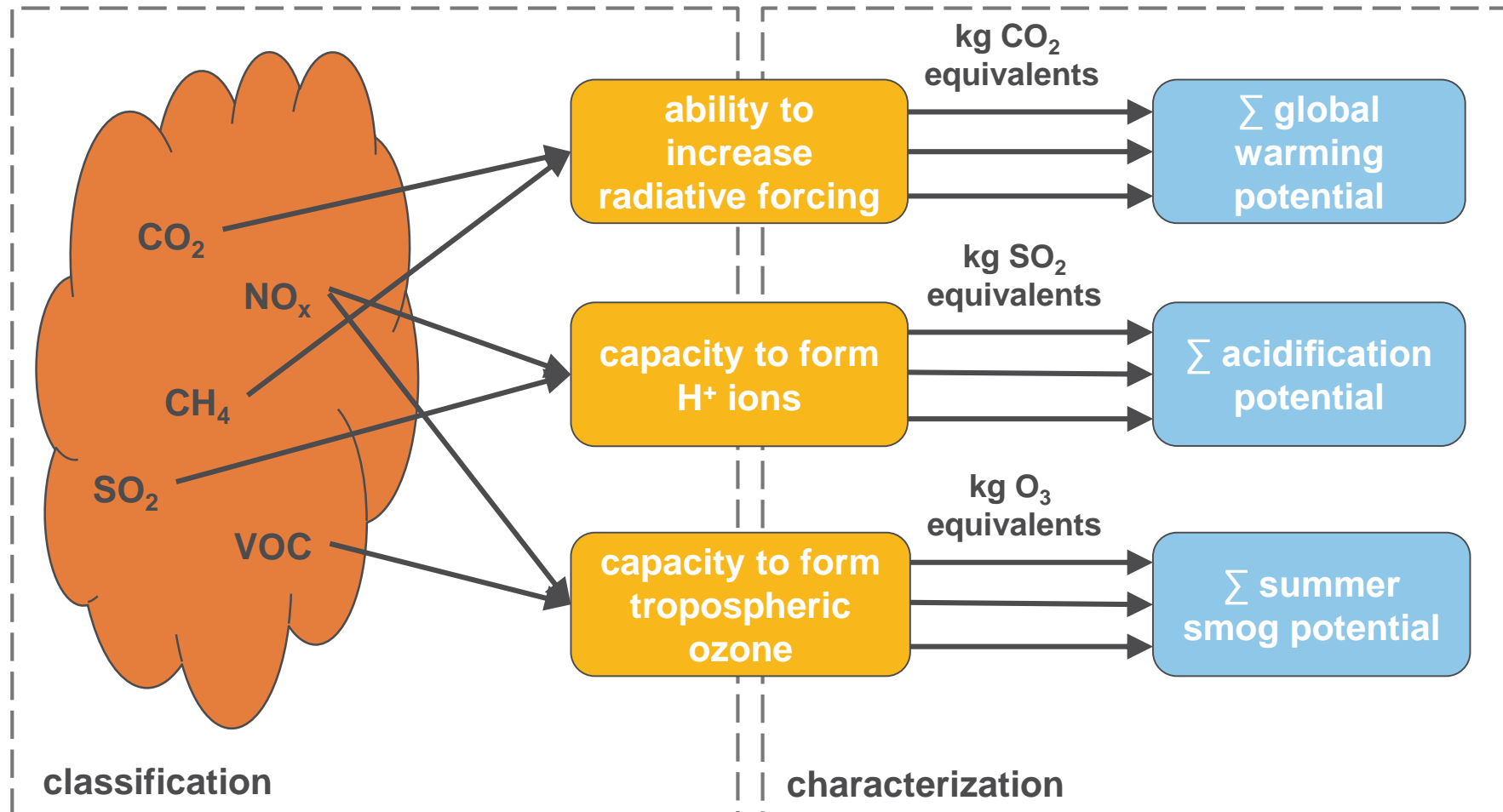
Flow	Quantity
Diesel Fuel	100,000 gal.

- Translate to natural resources and emissions to air, water, and soil
- Primary and secondary data sources (e.g., LCI databases)

Resources		Emissions	
0.5 MJ	Crude oil	6.5 kg	CO ₂ , to air
0.9 MJ	Hard coal	0.03 kg	NO _x , to air
200 kg	Ground water	0.03 kg	Nitrates, to water
...		...	

= *elementary flows/exchanges*

Life Cycle Impact Assessment (LCIA)



Life Cycle Impact Assessment (LCIA)

Inventory value	*	GWP Factor	=	Impact potential
25 kg CO ₂	*	1	=	25 [kg CO ₂ -Equivalent]
2 kg CH ₄	*	30	=	60 [kg CO ₂ -Equivalent]
...	*	...	=	...
Total:				85 [kg CO ₂ -Equivalent]

Elementary flow/exchange LCI value

LCIA result

Topics

LCA Software

- GaBi
- SimaPro
- Open LCA
- Umberto



SimaPro



umberto®
know the flow.

LCI Databases

- GaBi
- Ecoinvent
- US LCI / Federal LCA Commons



LCA Tools

- Tally
- Athena Impact Estimator for Buildings
- EC3
- OneClick LCA



LCIA Databases

- Quartz (suspended)



LCI Software

- Software
 - GaBi
 - SimaPro
 - Open LCA
 - Umberto
- Characteristics
 - Can use multiple LCI Databases within each software
 - Requires an experienced LCA practitioner
 - Methodological decisions are up to the practitioner



LCI Software (GaBi screenshots)

RNA: Softwood plywood CORRIM [CORRIM] -- DB Processes

Object Edit View Help

Name RNA Softwood plywood CORRIM agg

Parameters

Parameter	Formula	Value	Minimum	Maximum	Standard	Comment
LCA						
VF						
LCC: 810 EUR						
LCWE						
Documentation						

Completeness No statement

Inputs

Flows	Quantities	Amount	Units	Trz	Standard	Origin	Cor
Biomass (MJ) [Renewable energy resc]	Energy (net calor	172	MJ	0 %	(No statement)		
Carbon dioxide [Renewable resources]	Mass	1.08E003	kg	0 %	(No statement)		
Crude oil (in kg) [Crude oil (resource)]	Mass	2.1	kg	0 %	(No statement)		
Crude oil ecoinvent [Crude oil (resource)]	Mass	11.3	kg	0 %	(No statement)		
Fresh water [Water]	Mass	454	kg	0 %	(No statement)		
Gas, natural, in ground [Natural gas (resource)]	Standard volume	19.7	Nm3	0 %	(No statement)		
Ground water [Water]	Mass	28.8	kg	0 %	(No statement)		
Hard coal (in kg) [Hard coal (resource)]	Mass	27.3	kg	0 %	(No statement)		
Limestone (calcium carbonate) [Non renewable]	Mass	1.78	kg	0 %	(No statement)		
Natural gas (in kg) [Natural gas (resource)]	Mass	0.0068	kg	0 %	(No statement)		
Natural gas (in MJ) [Natural gas (resource)]	Energy (net calor	75.6	MJ	0 %	(No statement)		

Outputs

Flows	Quantities	Amount	Units	Trz	Standard	Origin	Cor
Softwood plywood [Materials from forest]	Volume	1	m3	X 0 %	(No statement)		
1,1,1-Trichloroethane [Halogenated organic compound]	Mass	2.14E-009	kg	0 %	(No statement)		
1,2-Dibromoethane [Halogenated organic compound]	Mass	5.82E-011	kg	0 %	(No statement)		
2,4-Dichlorophenoxyacetic acid (2,4-DCPA) [Organic emissions to air]	Mass	5.18E-011	kg	0 %	(No statement)		
2,4-Dichlorophenoxyacetic acid (2,4-DCPA) [Organic emissions to water]	Mass	1.21E-009	kg	0 %	(No statement)		
2,4-dimethylphenol [Organic emissions to air]	Mass	3.18E-006	kg	0 %	(No statement)		
2,4-Dinitrotoluene [Group NMVOC to air]	Mass	1.36E-011	kg	0 %	(No statement)		
2-chloro-1-phenylethanone [Halogenated organic compound]	Mass	3.39E-010	kg	0 %	(No statement)		
2-hexanone [Organic emissions to air]	Mass	7.4E-007	kg	0 %	(No statement)		
Acenaphthene [Group NMVOC to air]	Mass	6.01E-009	kg	0 %	(No statement)		
Acenaphthylene [Group PAH to air]	Mass	2.94E-009	kg	0 %	(No statement)		
Acetaldehyde [Ethanol] [Group NMVOC to air]	Mass	0.00399	kg	0 %	(No statement)		
Acetic acid [Hydrocarbons to fresh water]	Mass	2.38E-005	kg	0 %	(No statement)		
Acetochlor [Pesticides to fresh water]	Mass	7.18E-010	kg	0 %	(No statement)		
Acetochlor [Pesticides to air]	Mass	1.68E-008	kg	0 %	(No statement)		
Acetone [dimethyl ketone] [Organic emissions to air]	Mass	1.13E-006	kg	0 %	(No statement)		
Acetone [dimethyl ketone] [Group NMVOC to air]	Mass	0.00271	kg	0 %	(No statement)		
Acetophenone [Group NMVOC to air]	Mass	7.27E-010	kg	0 %	(No statement)		
Acid (calculated as H+) [Inorganic emissions to air]	Mass	6.87E-011	kg	0 %	(No statement)		
Acids, unspecified [Other emissions to air]	Mass	3.19E-006	kg	0 %	(No statement)		

System: No changes. ts-GaBi Last change: System 1/31/2019 6:00:00 PM GUID: {B25638F6-...}

Nation	Name	Type	Parent folder	QA
...	CML2001 - Jan. 2016, Global Warming Potential (GWP	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	EN15804 - Global warming potential (GWP)	kg CO2 eq. For Ökobau.dat xml-Export (and general EPDs) same as CML 2001 - April 2013	LCIA Indicators	✓
...	IPCC AR5 GWP20, incl biogenic carbon	kg CO2 eq. GWP	Incl biogenic carbon	✓
...	IPCC AR5 GWP100, incl biogenic carbon	kg CO2 eq. GWP	Incl biogenic carbon	✓
...	IPCC AR5 GWP100, incl biogenic carbon, incl Land Use	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP100, Land Use Change only, no norm/w	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP20, Land Use Change only, no norm/we	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP20, incl biogenic carbon, incl Land Use C	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP20, excl biogenic carbon	kg CO2 eq. GWP	Excl biogenic carbon	✓
...	IPCC AR5 GWP100, excl biogenic carbon	kg CO2 eq. GWP	Excl biogenic carbon	✓
...	IPCC AR5 GWP20, Land Use Change only, no norm/we	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP100, Land Use Change only, no norm/w	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP100, excl biogenic carbon, incl Land Use	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	IPCC AR5 GWP20, excl biogenic carbon, incl Land Use	kg CO2 eq. GWP	Global Warming Incl Lar	✓
...	CML2001 - Dec. 07, Global Warming Potential (GWP 10	kg CO2 eq.	OUTDATED CML 2001 -	✓
...	CML2001 - Nov. 09, Global Warming Potential (GWP 10	kg CO2 eq.	OUTDATED CML 2001 -	✓

- Provides life cycle inventories by elementary flows/exchanges
- Can apply any impact assessment methodology to obtain LCIA results
- Typically include details on carbon contents of products

LCI Databases

- LCI Databases
 - GaBi
 - Ecoinvent
 - US LCI / Federal LCA commons
- Characteristics
 - Emissions to air
 - Carbon dioxide, non-fossil/biogenic [To Environment]
 - Methane, non-fossil/biogenic [To Environment]
 - Natural resource inputs
 - Carbon dioxide from air
 - Carbon, organic, in soil or biomass stock
 - Elemental composition as a property of reference flow/exchanges (i.e. carbon content both fossil and non-fossil) does not contribute to final impacts but can be used to ensure carbon balances



Biogenic Carbon Modeling in LCA Software

- Challenges in modeling biogenic carbon
 - Biomass feedstock carbon contents may vary
 - Not all carbon-containing flows and emissions may be tracked throughout manufacturing of the final product
 - If multi-output processes are allocated using any other allocation key than the carbon content, the carbon balance will not be closed → either too many or too little inputs of carbon-containing flows
- Pragmatic solution
 - Find out the biogenic carbon content of the final product
 - Add a process inventory that makes sure that the cradle-to-gate carbon balance matches the biogenic carbon content of the product

Biogenic Carbon Modeling in LCA Software

- Biogenic carbon is only 'carbon neutral' if all of the CO_2 that was removed from the atmosphere is released as CO_2 again, i.e. not transformed to CH_4
- Without the proper accounting of biogenic carbon flows, the contribution of bio-based materials to climate (net source or sink) may be inaccurate or omitted
- Accounting for 100% of all biogenic carbon flows in the product system can be challenging
- 'Back-calculating' the carbon removals from the carbon content of the material in question is a pragmatic way to close the carbon balance

GWP100 Characterization Factors

Emission	TRACI 2.1 (IPCC AR4)		IPCC AR5	
	Incl. biogenic	Excl. biogenic	Incl. biogenic	Excl. biogenic
Carbon dioxide, fossil	1	1	1	1
Carbon dioxide, biogenic	1	0	1	0
Methane, fossil	25	25	30	30
Methane, biogenic	25	22.3	30	28
Nitrous oxide	298	298	265	265

LCA Tools

Tool	Data Source	LCIA Methodology (North America)	Treatment of biogenic carbon
Tally	GaBi, EPDs conducted using GaBi data	TRACI 2.1	GWP including and excluding biogenic carbon
Athena Impact Estimator for Buildings	Primarily from LCAs conducted by the Athena Institute	TRACI 2.1 (though LCI also presented)	GWP including biogenic carbon
One Click LCA	Various public and private sources (both generic data and EPDs) using a variety of background data sources	TRACI 2.1	Unclear, may depend on selected EPDs
EC3	Publicly available EPDs (manufacturing impacts only)	Likely TRACI 2.1 but dependent on EPDs, GWP only	Estimates to include biogenic carbon where not provided by the EPD

LCA Tools

- LCA Tools for Buildings
 - Tally
 - Athena Impact Estimator for Buildings
 - OneClick LCA
 - EC3
- Characteristics
 - May present impact assessment results only (though Athena does present LCI results)
 - Impact categories are selected by the tool creator or the source of data (i.e., EPD)
 - Where LCI is presented (i.e. Athena) the user could manually apply other impact category methodologies if desired
 - Interpretation of results is up to the user of the tool



Additional Comments

- Inclusion or exclusion of things like forest management and land use change (direct and indirect), etc. will depend on the details of the background data
 - ISO 21930 allows for wood from sustainably managed forests to be counted as having zero emissions from land-use change (incl. CSA, FSC, SFI standards)
- Selection of GWP indicator including or excluding biogenic carbon is up to the LCA practitioner in EPDs
 - ISO 21930 mandates the declaration of emissions and removals of biogenic carbon if included in the GWP calculation

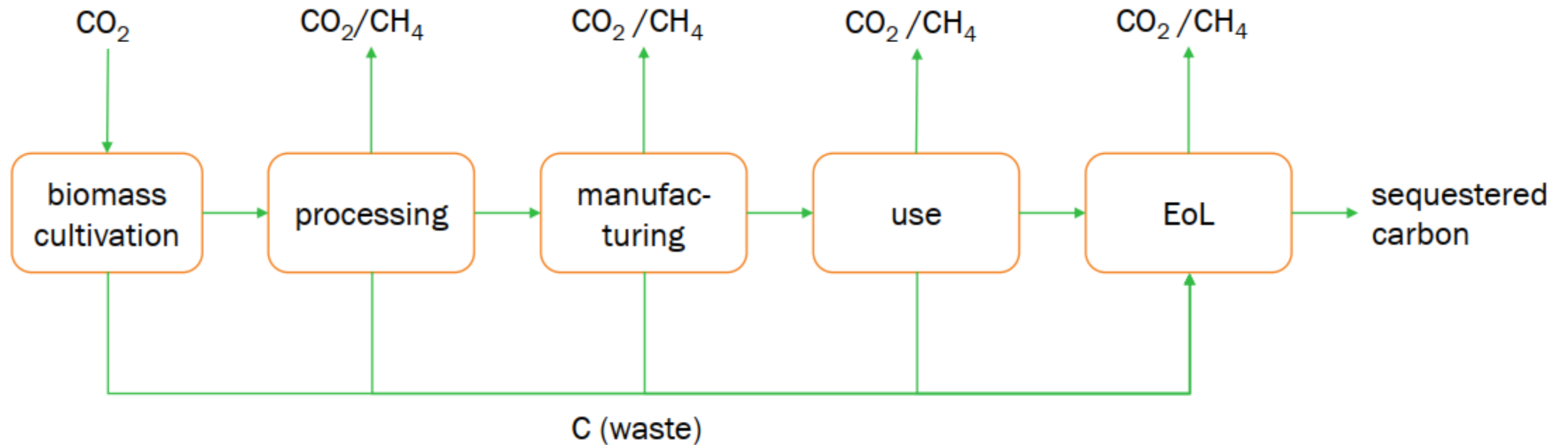
Conclusions

- LCA Software and LCI Databases allow the practitioner to choose whether to include biogenic carbon or not
 - Ensuring you've accurately modeled the carbon flows in your model is crucial
- System boundaries for LCI Data will vary and the practitioner should review the assumptions of the background data selected
- LCA Tools have often made the decision for the user, though tools like Tally still allow for distinction between GWP including and excluding biogenic carbon



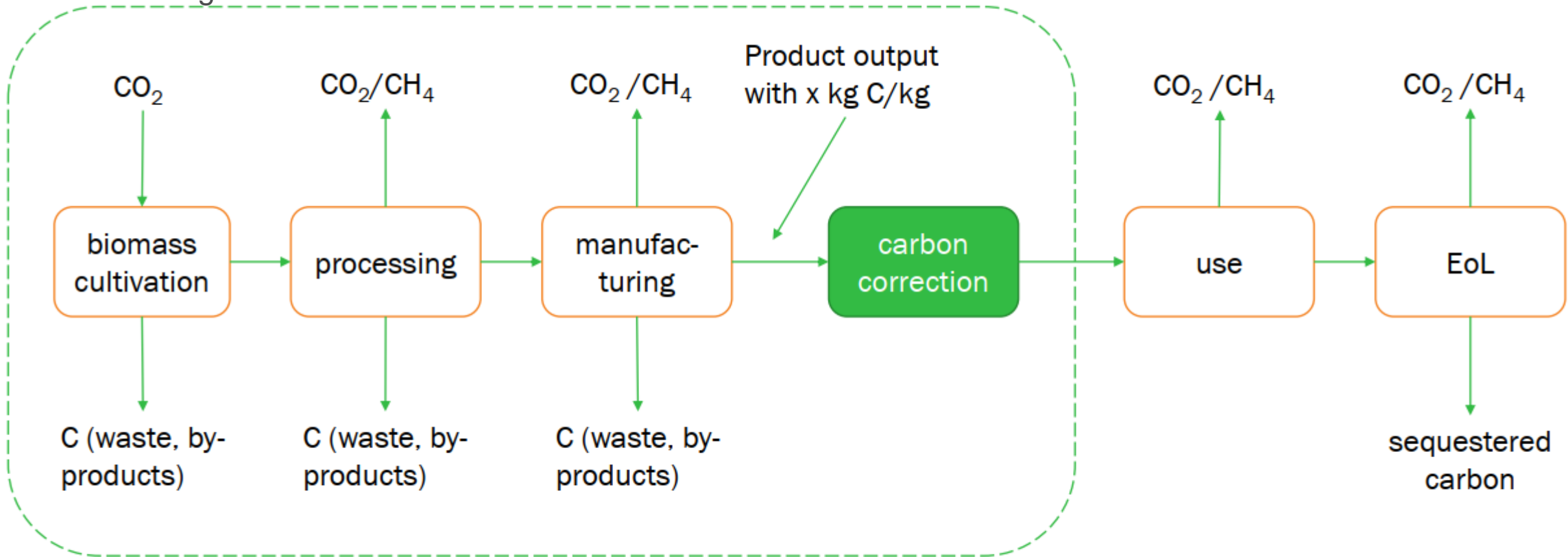
Additional Slides

Biogenic Carbon Modeling in LCA software



Biogenic Carbon Modeling in LCA software

Cradle-to-gate



$\text{GWP excl. bio CO}_2 - \text{GWP incl bio CO}_2 \equiv \text{C content of product}$


Name GLO Carbon balance correction (renewables) ts u-so - Unit process, single operat

Parameters

Parameter	Formula	Value	Minimum	Maximum	Standard	Comment, units, defaults
PE_corr		0			0 %	[MJ] manual adaption of PE balance; only relevant if allocation; PE in product plus upstream process
CO2uptakeResour		0			0 %	[kg] value of the flow Carbon dioxide [Resources] from the balance
CO2biogEmission		0			0 %	[kg] value of the flow Carbon dioxide, biotic [Inorganic emissions to air] from the balance
CH4biogEmission		0			0 %	[kg] value of the flow Methane (biotic) [Organic emissions to air (group VOC)] from the balance
C_Content		0	0	1	0 %	[kg/kg] biogenic carbon in product
CO2_uptake	$C_Content * 44 / 12$	0				[kg] CO2 uptake associated with 1 kg product (calculated based on C and water content)
co2upstream	$CO2uptakeResour - CO2biogEmission - CH4biogEmission * 44 / 16$	0				[kg/kg] product, biogenic CO2 balance in the model (could be negative)
CO2Correction	$CO2_uptake - co2upstream$	0				[kg] of CO2, a correction to have the right biogenic carbon storage
product	1	1				
Parameter						

LCA VF LCC: 0 EUR LCWE Documentation

Completeness All relevant flows recorded

Inputs

Parameter	Flows	Quantities	Amount	Factor	Units	Trz	Standard	Origin	Comment
product	Product (unspecified) [Valuable substances]	Mass	1	1	kg	X	0 %	Calculated	
CO2Correcti	Carbon dioxide [Renewable resources]	Mass	0	1	kg		0 %	Calculated	
PE_corr	Primary energy from solar energy [Renewable energy resources]	Energy (net calor	0	1	MJ		0 %	Calculated	
Flows									

Outputs

Parameter	Flows	Quantities	Amount	Factor	Units	Trz	Standard	Origin	Comment
product	Product (unspecified) [Valuable substances]	Mass	1	1	kg	X	0 %	Calculated	
Flows									