

Assessing Carbon Reduction Through Asphalt Recycling: From Methodology to Practice

Outline

01 Methodological Framework

02 Case Study

03 Key Takeaways

Motivation – Keyword: Reduction



Durchschnittliche Nährwerte		
	Je 100 g (1 Portion)**	% (100)
Brennwert	104 kJ / 25 kcal	1
Fett	0,5 g	<1 %
- davon gesättigte Fettsäuren	0,1 g	<1 %
Kohlenhydrate	3,6 g	7 %
- davon Zucker	3,6 g	7 %
Eiweiß	1,5 g	3 %
Salz	0,30 g	6 %

Motivation



Benefits:

- Regulated information
- Science-based
- Understandable
- Includes different indicators

Allows consumers to make informed decisions

Motivation



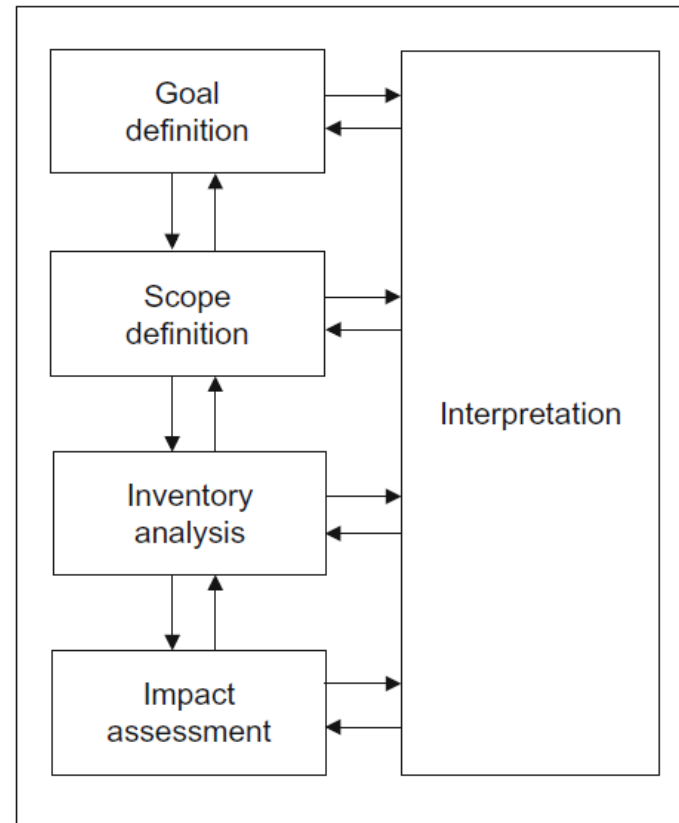
Benefits:

- Regulated information
- Science-based
- Understandable
- Includes different indicators

Provides information to support informed decisions

Methodological Framework

Life cycle assessments



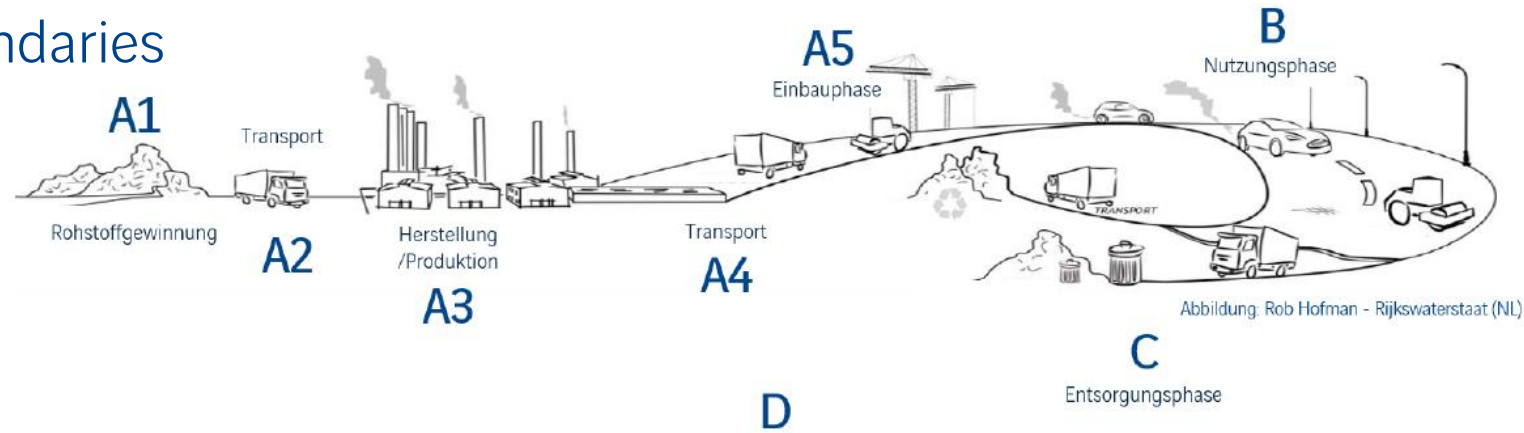
Methodological Framework

Goal

- Evaluation of the environmental impacts of a material, product or process
- A declared or functional unit is required as the basis for comparison
 - **DU: 1 t Asphalt produced at a specific plant**
 - **FU: 1 km of road pavement designed for a load class Bk 100 in NRW**

Scope

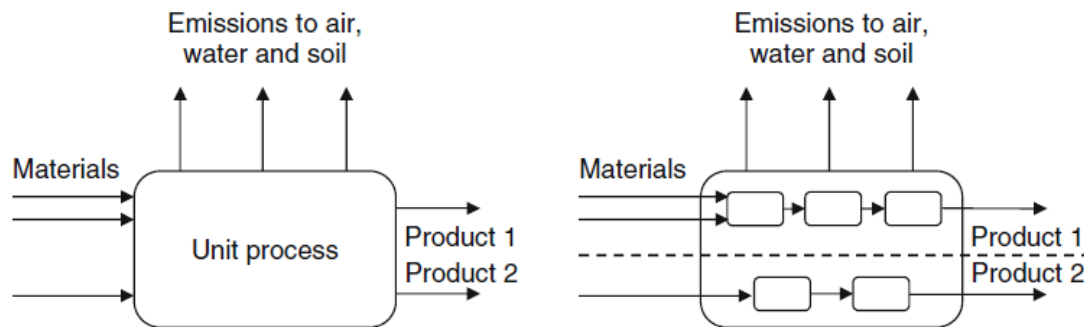
- System boundaries



Methodological Framework

Life cycle inventory

- Identification and characterisation of all materials and processes
- Data gathering (inputs and outputs)
 - **Clear rules are necessary**



Products							
Outputs to technosphere: Products and co-products							
Gravel, crushed (CH) production Cut-off, U							Comment: The largest use of construction sand and gravel is as
Outputs to technosphere: Avoided products							
Inputs							
Inputs from nature							
Subcompartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Gravel	1,04	kg	Lognormal	1,2214			(2,3,4,2,1,na)
Water, unspecified natural origin, CH	0,001111945	m3	Lognormal	1,2214			(3,3,5,2,1,na)
Occupation, mineral extraction site		land					(2,3,4,1,1,na)
Occupation, water bodies, artificial		land					(2,3,4,1,1,na)
Transformation, from unspecified		land					(2,3,4,1,1,na)
Transformation, to mineral extraction site		land					(2,3,4,1,1,na)
Transformation, to water bodies, artificial	6,27E-6	m2	Lognormal	2,056699999			(2,3,4,1,1,na)
Inputs from technosphere: materials/fuels							
Building, hall, steel construction (CH) building construction, hall, steel con	2,85E-6	m2	Lognormal	3,0999			(3,5,4,1,1,na)
Conveyor belt (GLO) market for Cut-off, U	9,51E-8	m	Lognormal	3,2097			(5,4,4,2,1,na)
Gravel/sand quarry infrastructure (CH) gravel/sand quarry construction C	4,75E-11	p	Lognormal	3,0452			(1,3,4,1,1,na)
Industrial machine, heavy, unspecified (RER) market for industrial machine	9,51E-5	km	Lognormal	3,0999			(3,5,4,2,1,na)
Lubricating oil (RER) market for lubricat							
Recultivation, limestone mine (CH) proc							
Steel, low-alloyed, hot rolled (GLO) mark							
Synthetic rubber (GLO) market for Cut-							
Tap water (CH) market for Cut-off, U							
Inputs from technosphere: electricity/heat							
Diesel, burned in building machine (GLO)							
Electricity, medium voltage (CH) market for Cut-off, U	0,00398	kWh	Lognormal	1,2214			(2,3,4,1,1,na)
Heat, central or small-scale, other than natural gas (CH) market for Cut-	0,00491	MJ	Lognormal	1,2214			(2,3,4,1,1,na)
Outputs							
Emissions to air							
Subcompartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Particulates, < 2.5 um	4,0E-10	kg	Lognormal	3,2097			(2,3,4,1,4,na)
Particulates, > 10 um	5,6E-9	kg	Lognormal	1,7607			(2,3,4,1,4,na)
Particulates, > 2.5 um, and < 10um							(2,3,4,1,4,na)
Water/m3							(2,2,4,1,1,na)
Emissions to water							
Water, CH							(2,2,4,1,1,na)
Emissions to soil							
Final waste flows							
Non material emissions							
Social issues							
Economic issues							
Outputs to technosphere: Waste treatment							
Subcompartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Municipal solid waste (CH) market for Cut-off, U	2,12E-6	kg	Lognormal	1,222600000			(2,3,4,1,1,na)
Waste mineral oil (CH) market for waste mineral oil Cut-off, U	2,5E-6	kg	Lognormal	1,222600000			(2,3,4,1,1,na)

1 kg crushed gravel

Input from nature

Input from the technosphere
- Materials, fuels, energy, heat

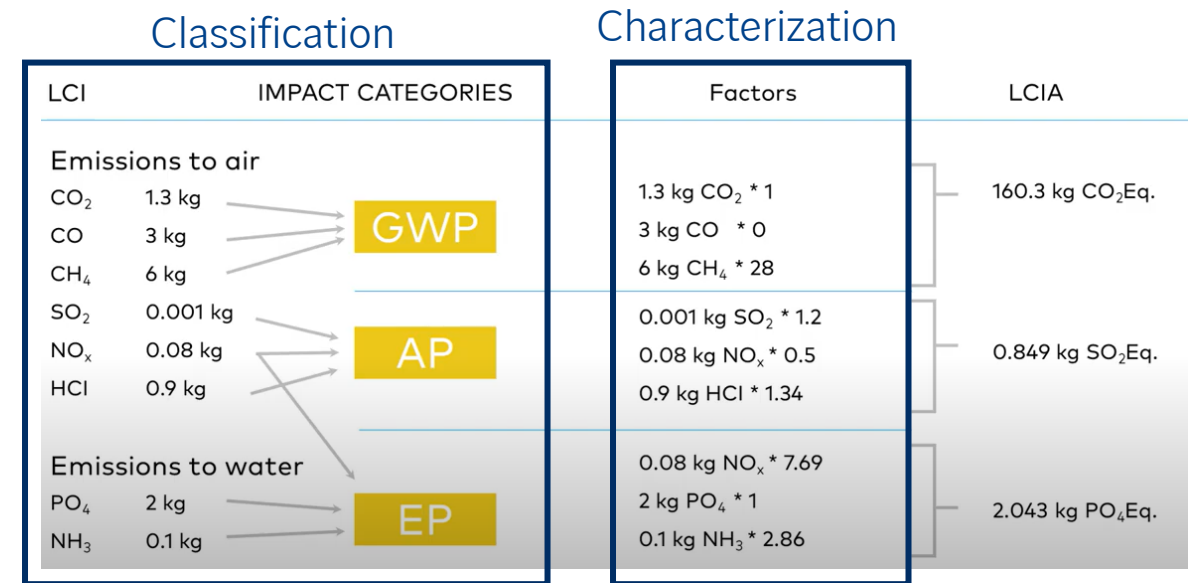
Outputs (Emissions)

- Water
- Soil
- Air

Methodological Framework

Impact Assessment (LCIA)

- Translates inventory flows into potential environmental impacts
 - **Provides environmental indicators reported in EPDs**
- Software necessary
- Several impact categories
 - **NOT ONLY CO₂-eq.!!**
- Allows a hot-spot analysis
 - **Identification of optimization opportunities**



Case study

- A client requested production data to estimate the environmental impact of WMA mixtures
- Project involved the production of:
 - **AC 11 D S**
 - With PmB
 - No RAP
 - **AC 16 B S SG**
 - With PmB
 - 10% RAP

Case study

Goal and Scope

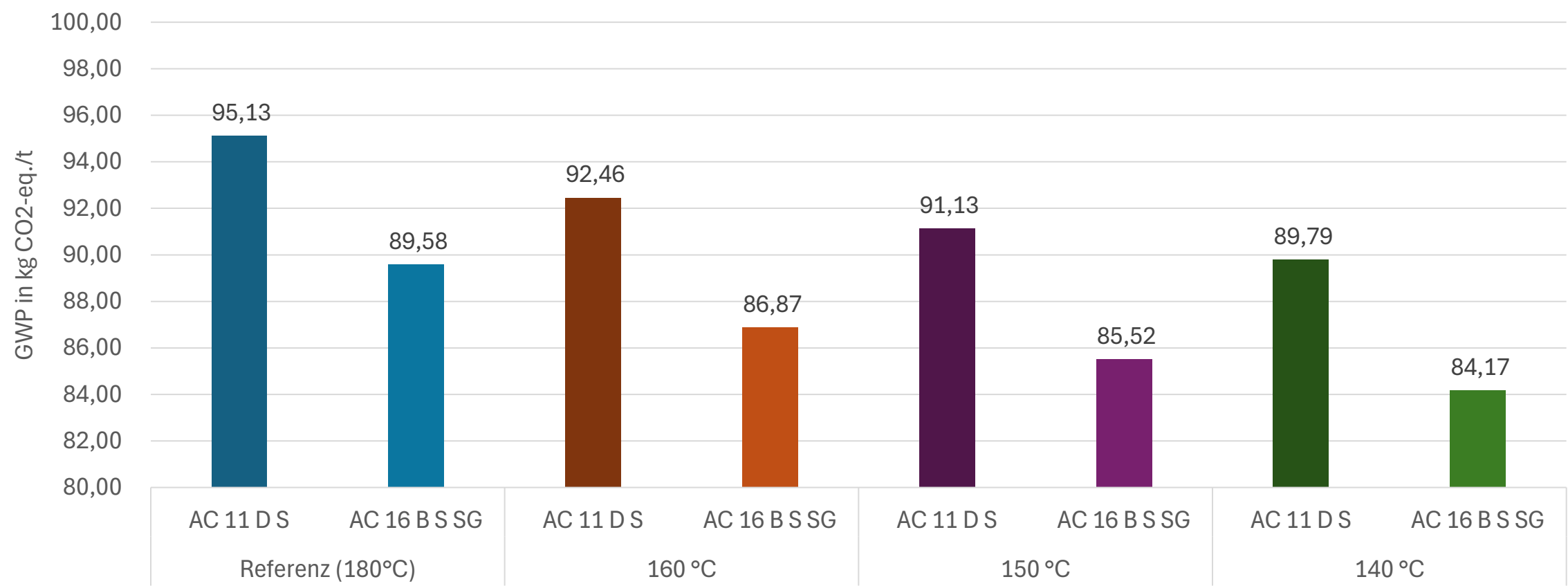
- Assess the environmental impact of WMA and compare it with the effect of increasing RAP content
- **DU:** 1 tonne of asphalt mixture produced at a plant in NRW
- Cradle to gate → modules **A1 to A3** (comparative LCA study, no EPD prepared)
- Calculated with SimaPro and ecoinvent 3.11, except for PmB, which was modelled using Eurobitume 2026 data

Scenarios

- Reference:
 - **Asphalt production at 180°C**
- Variants:
 - **Asphalt production at 160°C, 150°C and 140°C**
 - **Increase of RAP of content:**
 - AC 11 D S: 0% to 30% in 10% increments
 - AC 15 B S SG: 10% to 40% in 10% increments

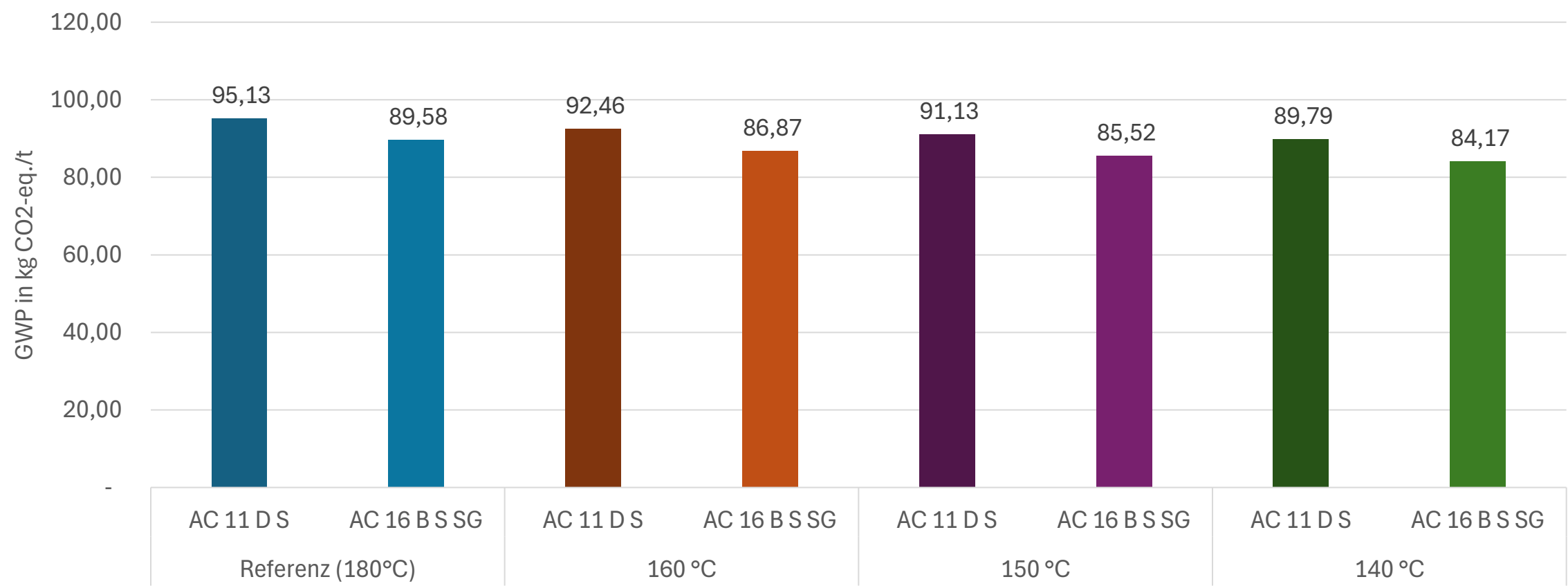
Case study - Results

Impact of WMA



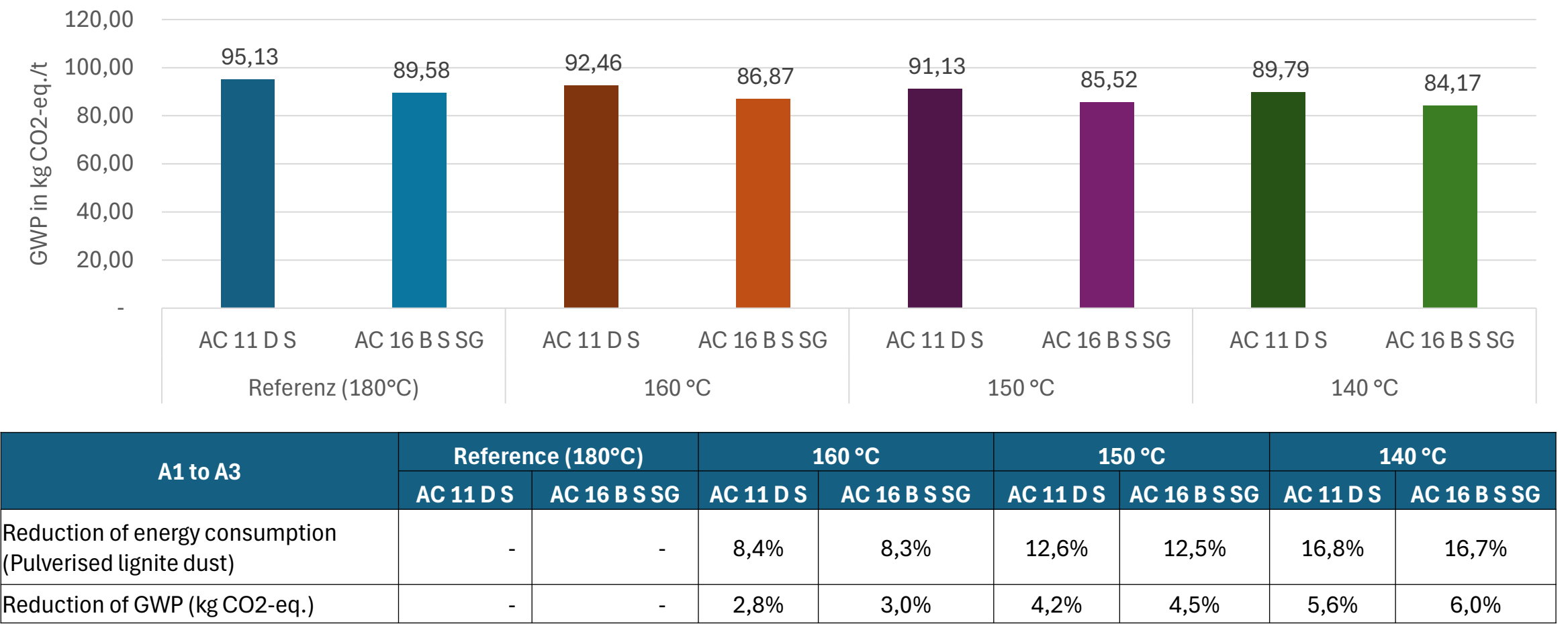
Case study - Results

Impact of WMA



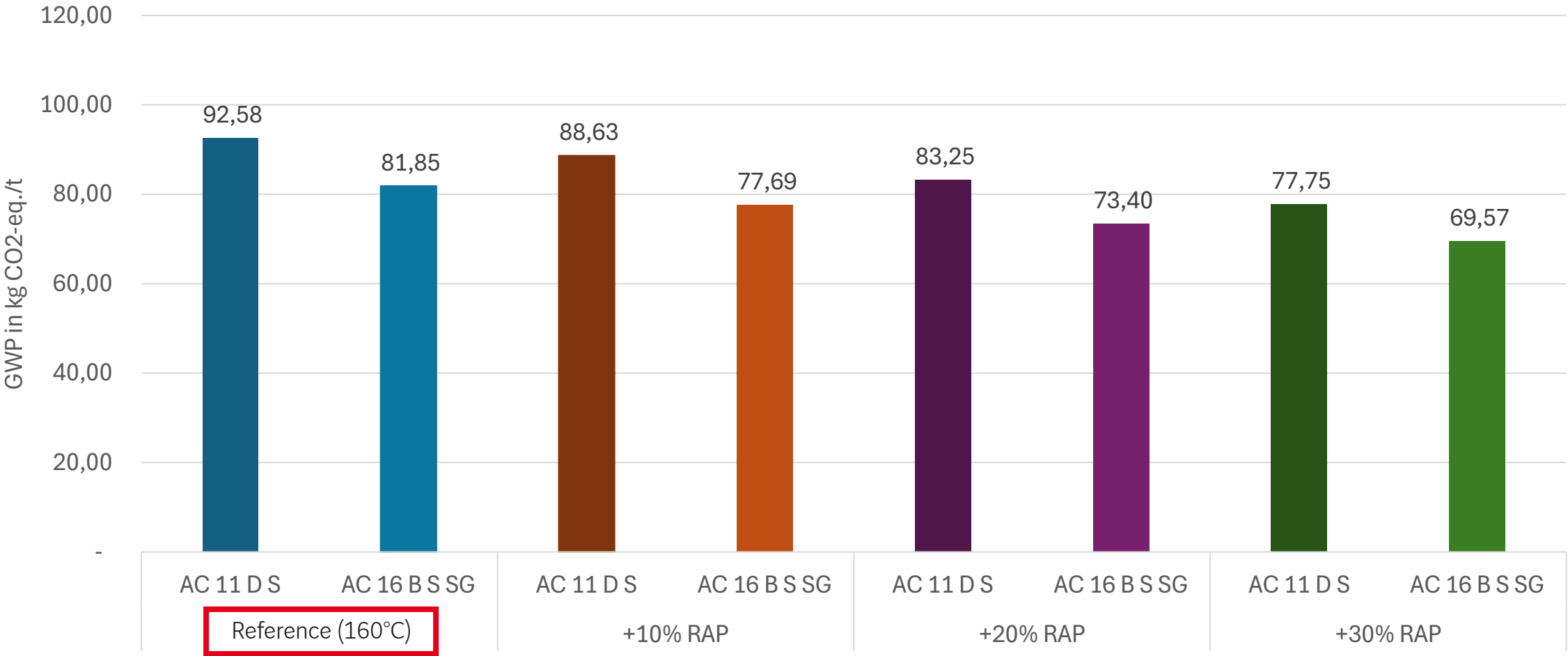
Case study - Results

Impact of WMA



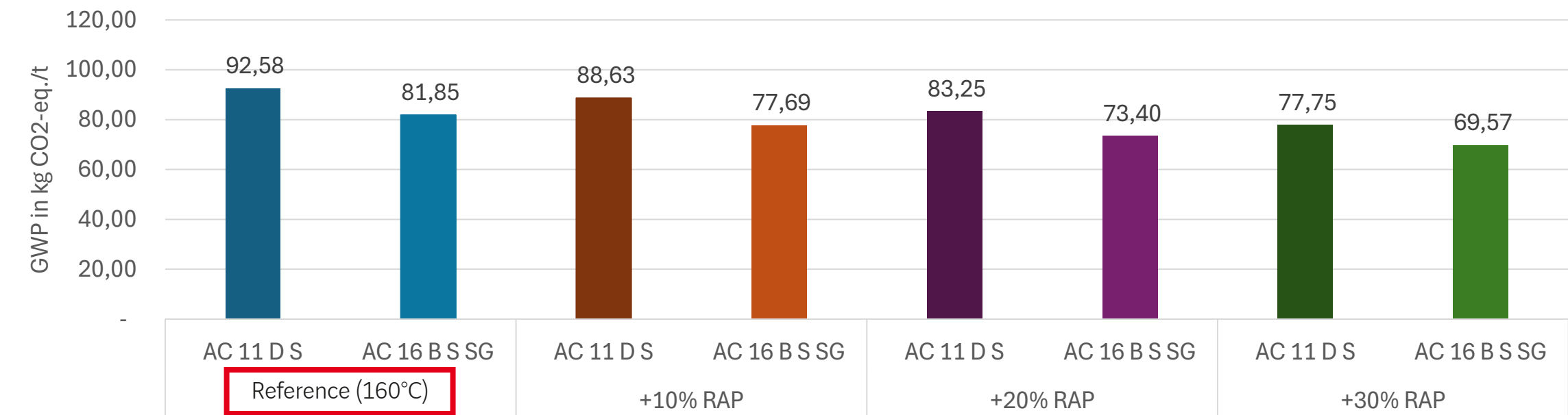
Case study - Results

Impact of recycling



Case study - Results

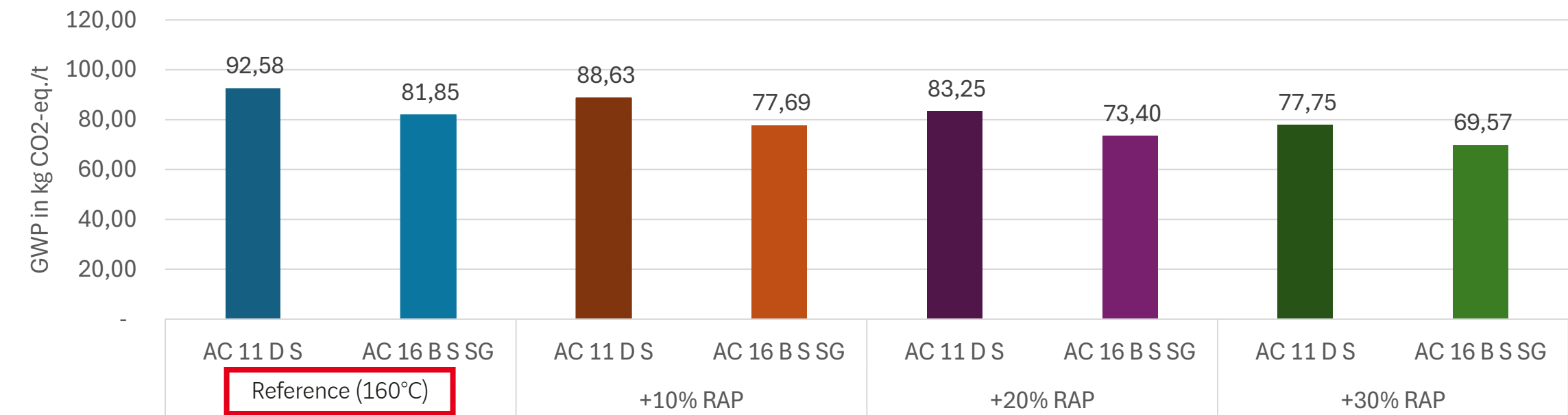
Impact of recycling



A1 to A3	Reference (160°C)		+10% RAP		+20% RAP		+30% RAP	
	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG
Reduction of GWP (kg CO2-eq.)	-	-	4,3%	5,1%	10,1%	10,3%	16,0%	15,0%

Case study - Results

Impact of recycling

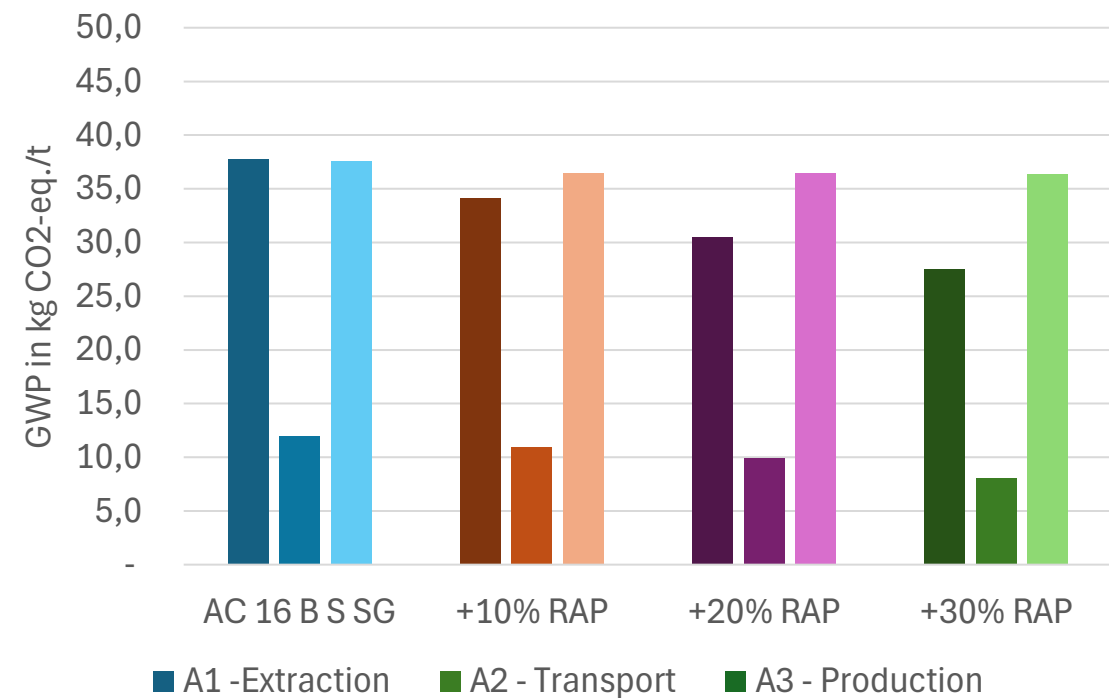
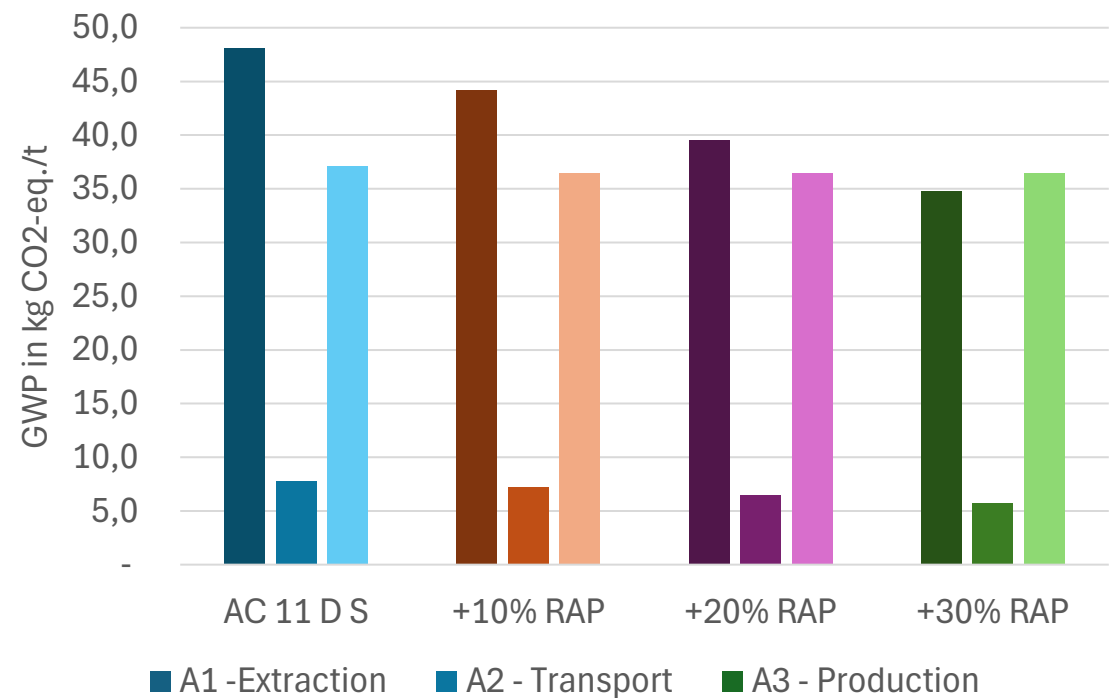


A1 to A3	Reference (160°C)		+10% RAP		+20% RAP		+30% RAP	
	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG
Reduction through recycling	-	-	4,3%	5,1%	10,1%	10,3%	16,0%	15,0%

A1 to A3	Reference (180°C)		160 °C		150 °C		140 °C	
	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG	AC 11 D S	AC 16 B S SG
Reduction through WMA	-	-	2,8%	3,0%	4,2%	4,5%	5,6%	6,0%

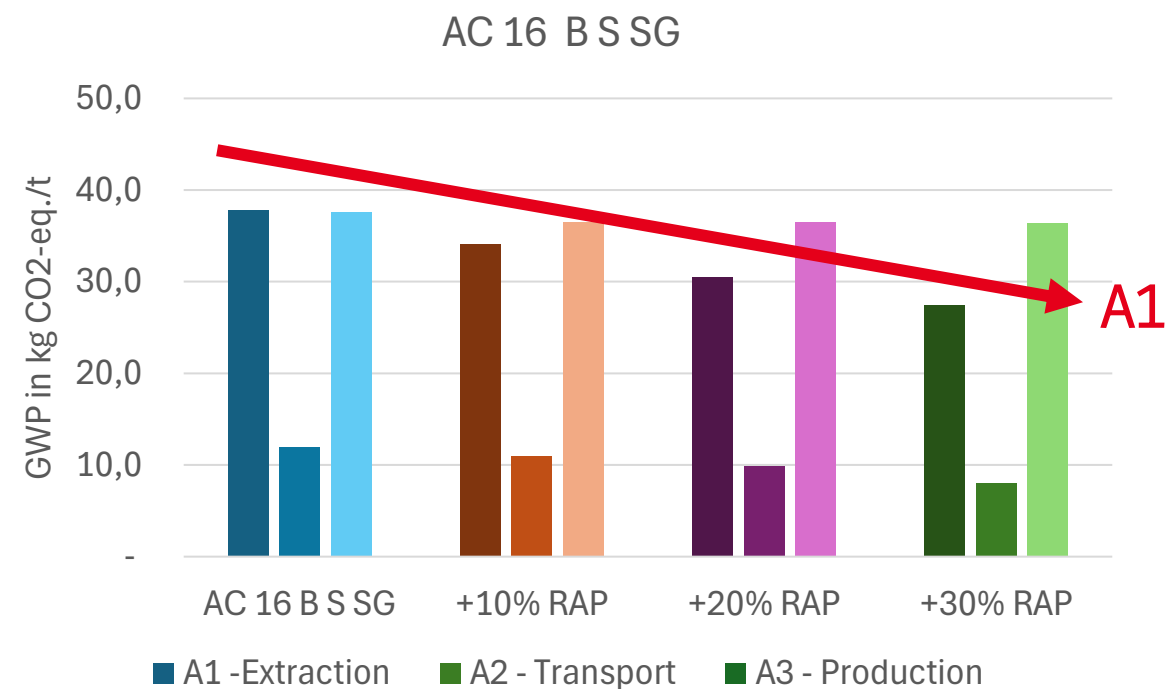
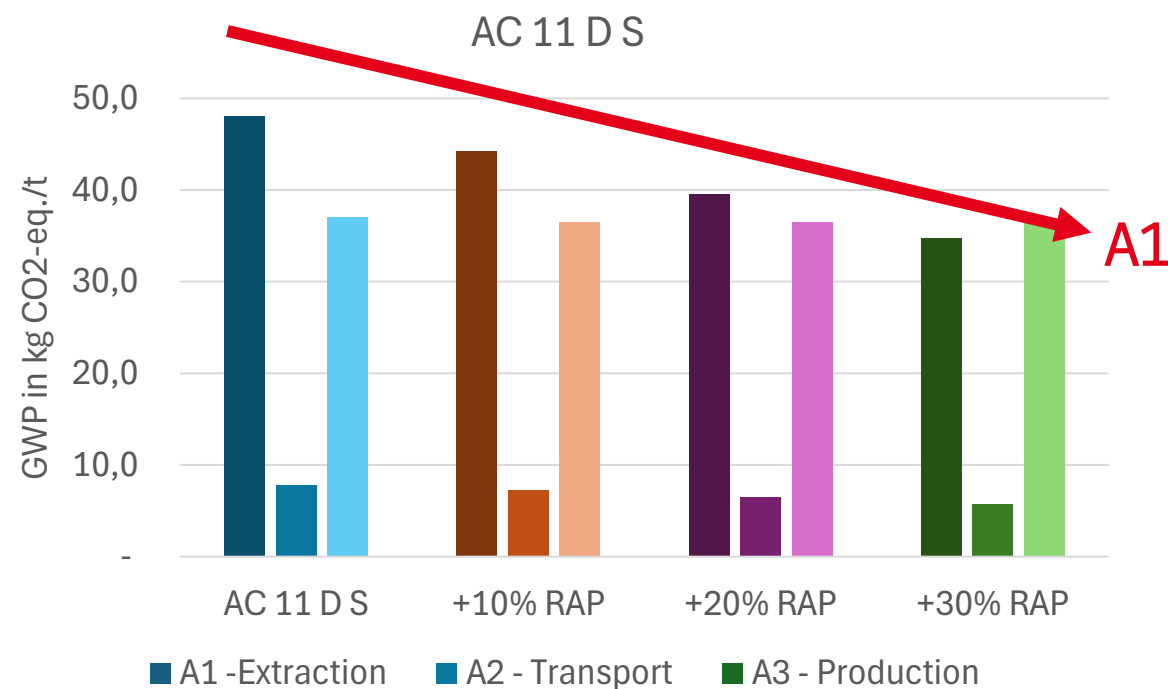
Case study - Results

Impact of recycling



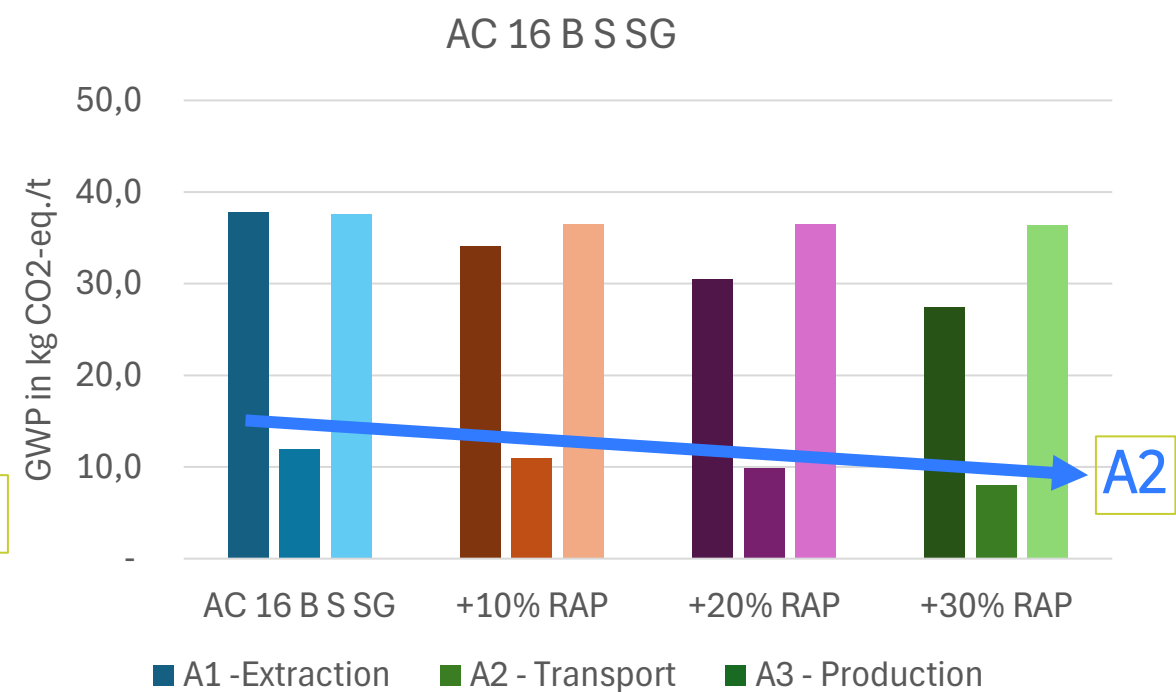
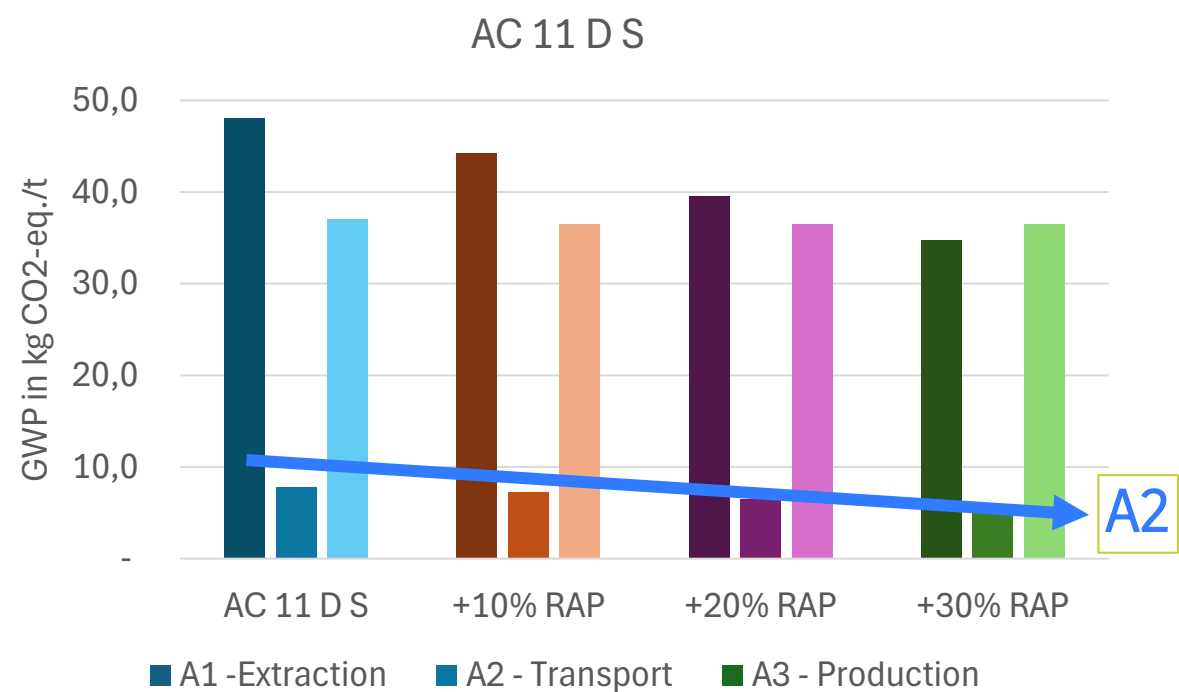
Case study - Results

Impact of recycling



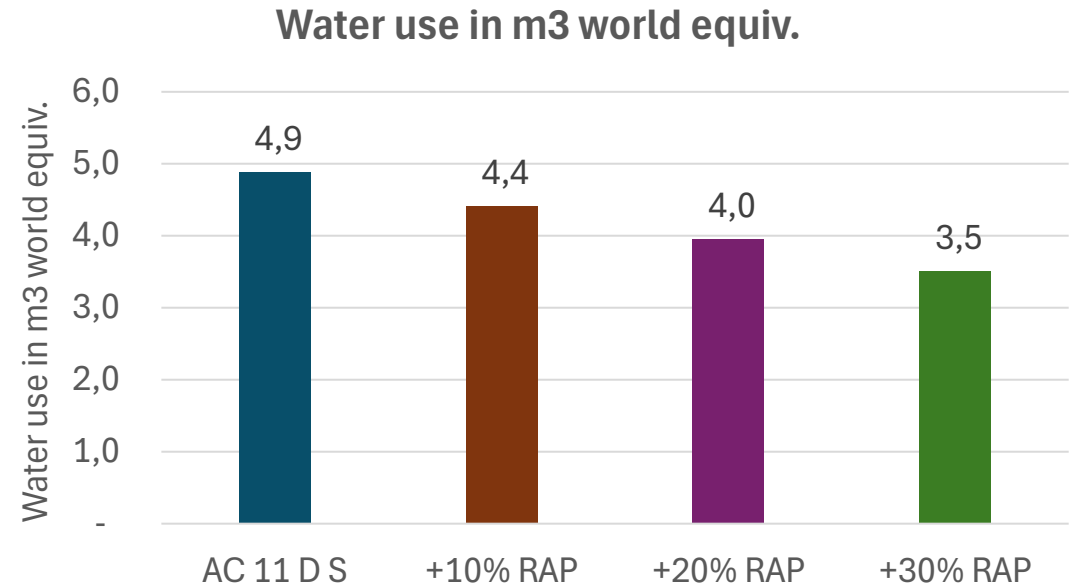
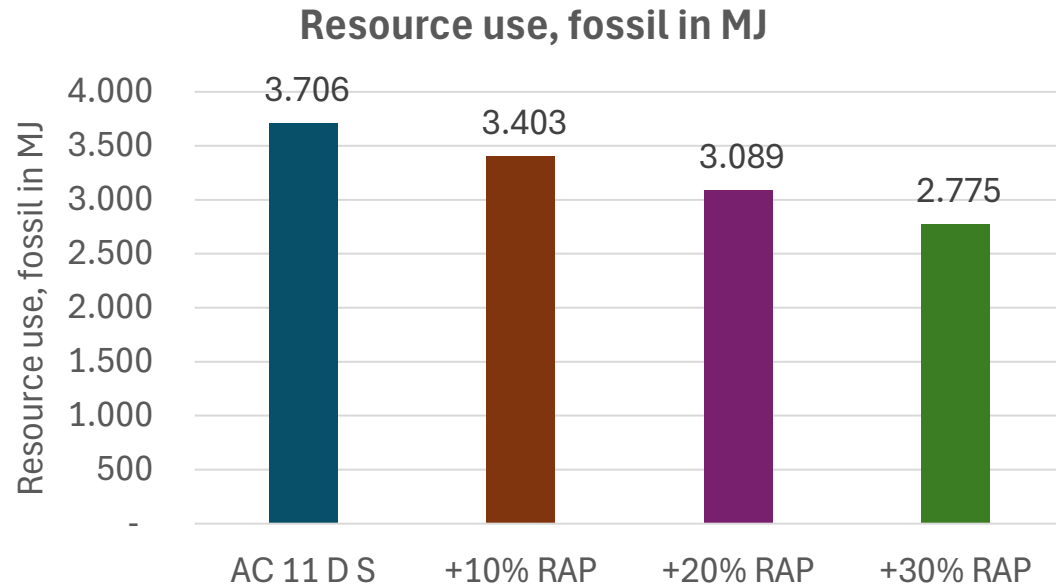
Case study - Results

Impact of recycling



Case study - Results

Impact of recycling on further impact categories



Key takeaways

- **Transparent methodology** is essential for meaningful environmental comparisons.
- **GWP** is important, but it should **not be the only indicator** guiding decisions.
- **WMA and recycling address different challenges**, yet increased RAP delivered the larger A1-A3 carbon reduction in this case study

