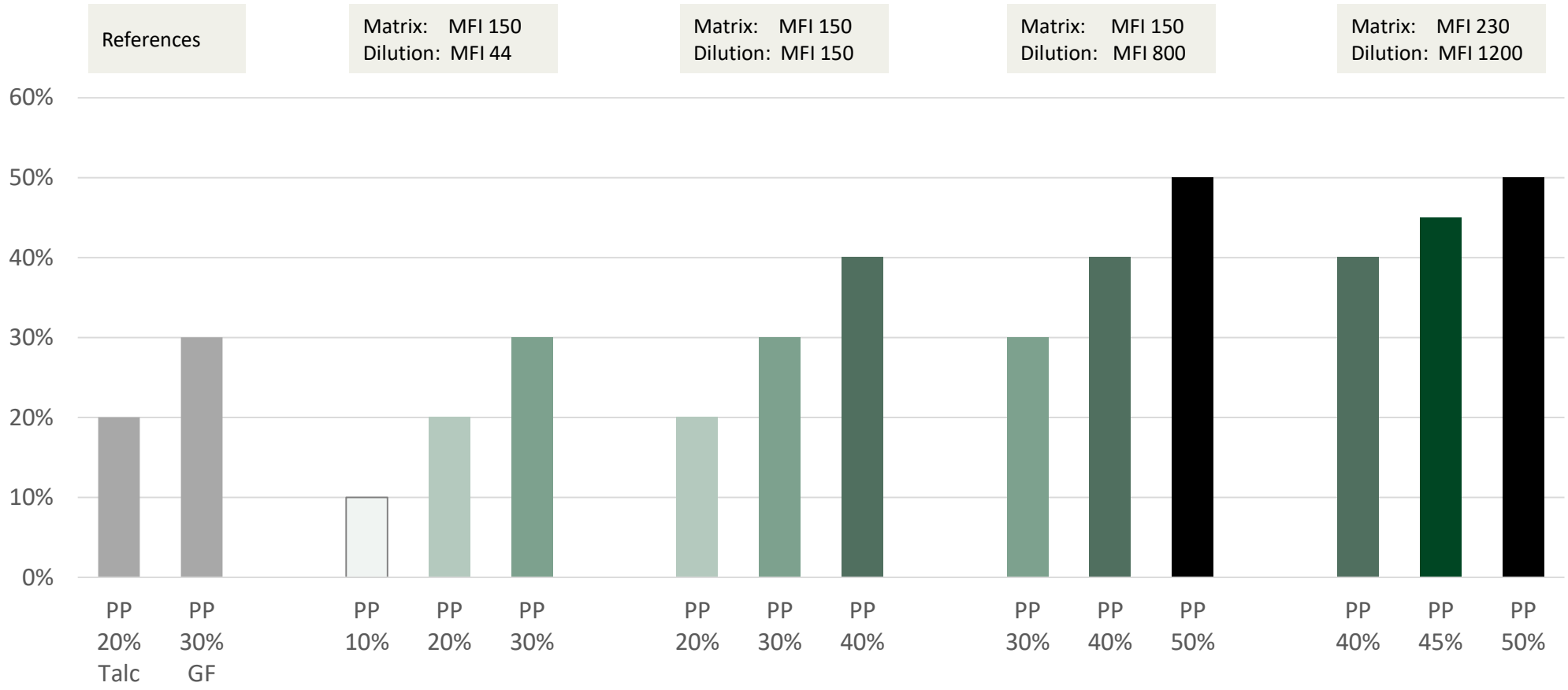
Syklocomp mechanical data

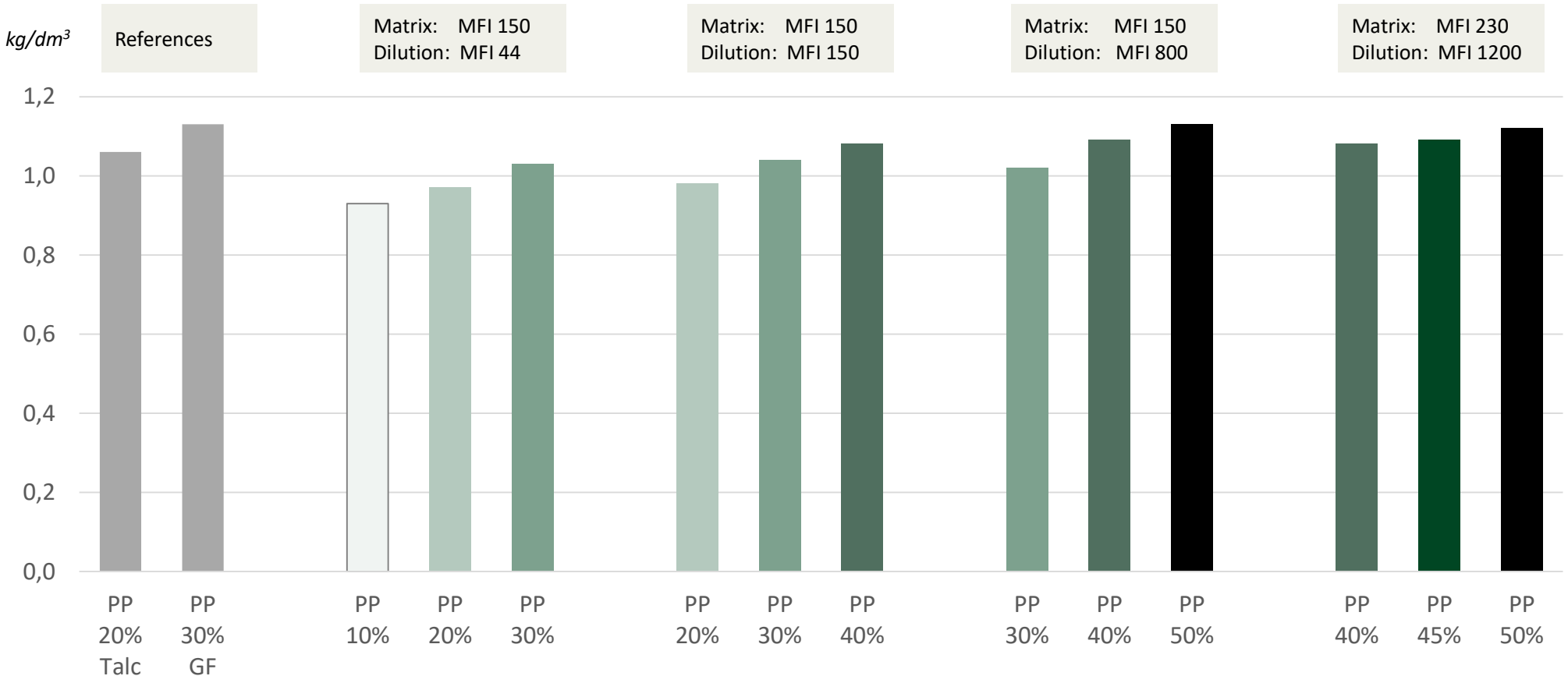
Syklo mechanical behavior

- Syklocomp masterbatch reinforces different plastics by adding an interpenetrating 3D cellulose network in the plastic
- The mechanical behavior is dependent on
  - Percentage of cellulose reinforcement i.e. filling ratio
  - The selected dilution polymer and it's mechanical properties
  - Different additives, for example impact modifiers
- If the filling ratio of the final composite is low (10%-20%) the dilution polymer is typically selected so that the mechanical properties of the polymer enhance the compound optimally
- If the filling ration is high (30%-40%) it is typically beneficial to select a polymer that has better flowability and the main contribution to the mechanical properties come from the fibers
- In this document Syklo presents different PP based compounds with different fiber-plastic –combinations
- There is also information available for some applications Syklo has worked with corresponding data and estimated CO2 footprint data

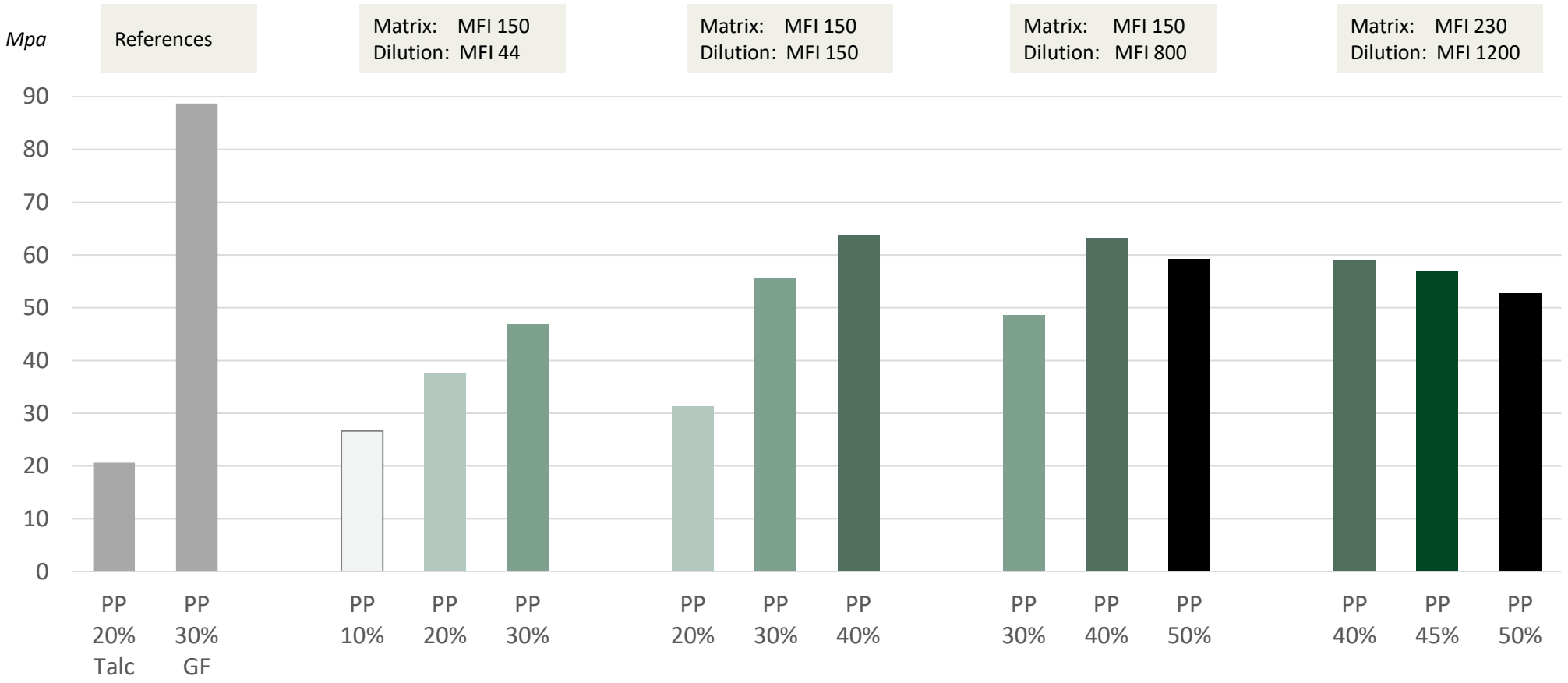
Filler content



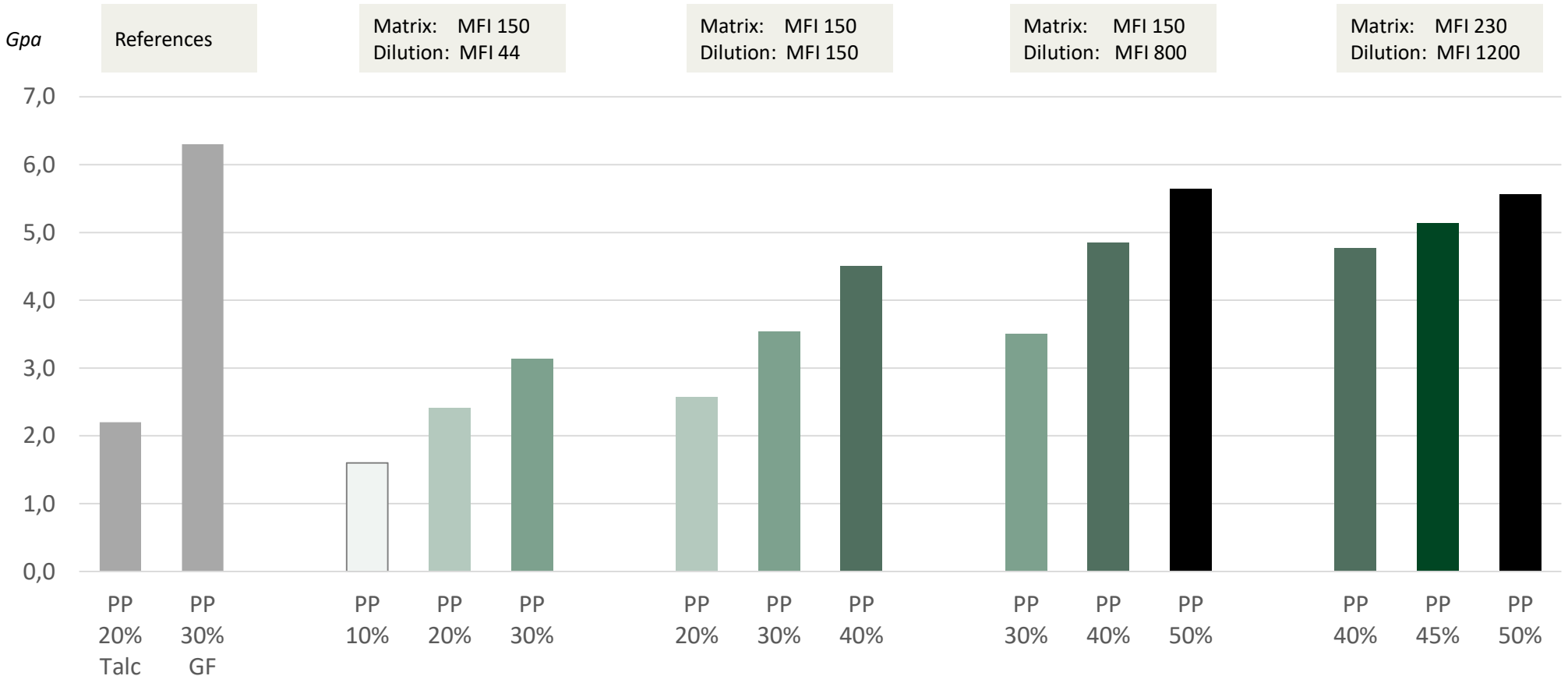
Density


kg/dm³
References
Matrix: MFI 150
Dilution: MFI 44
Matrix: MFI 150
Dilution: MFI 150
Matrix: MFI 150
Dilution: MFI 800
Matrix: MFI 230
Dilution: MFI 1200
1,2
1,0
0,8
0,6
0,4
0,2
0,0
PP 20% Talc
PP 30% GF
PP 10%
PP 20%
PP 30%
PP 20%
PP 30%
PP 40%
PP 30%
PP 40%
PP 50%
PP 40%
PP 45%
PP 50%

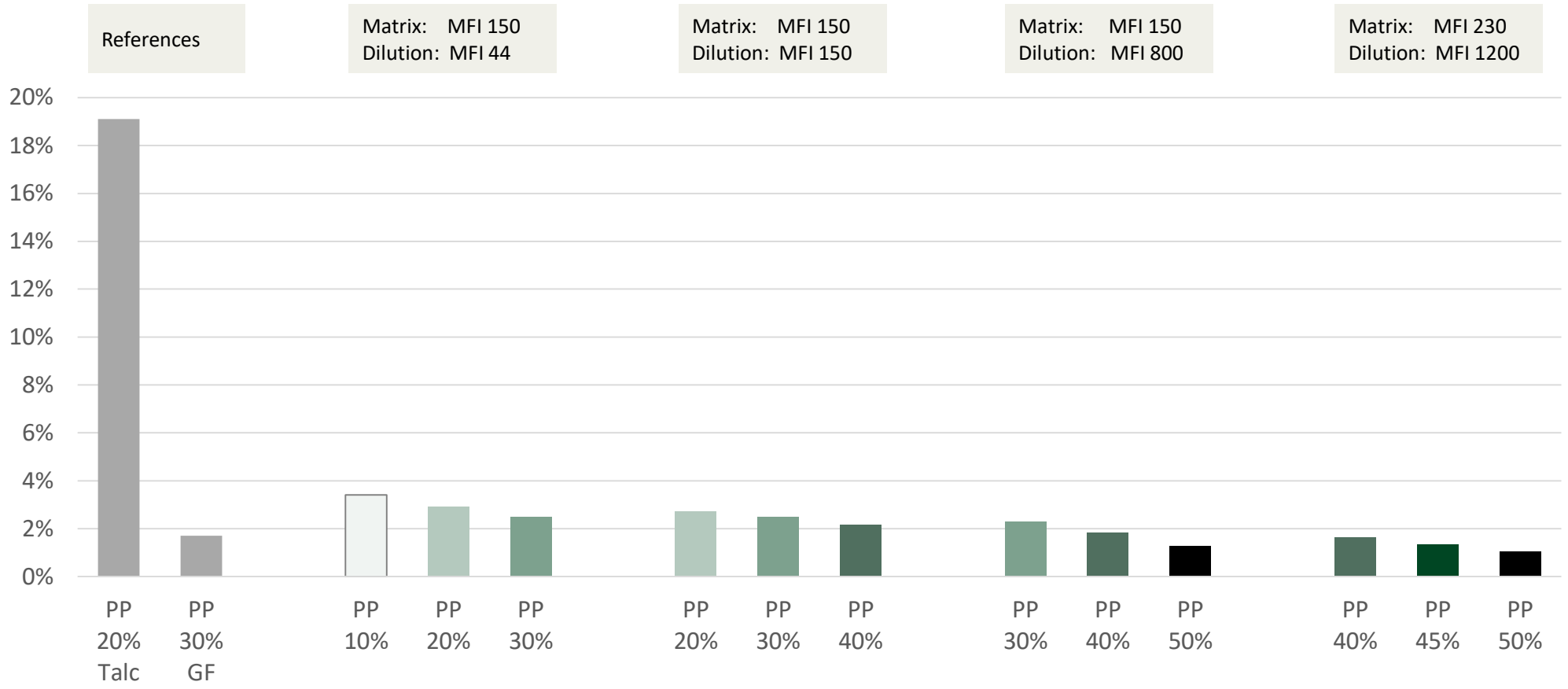
Tensile strength



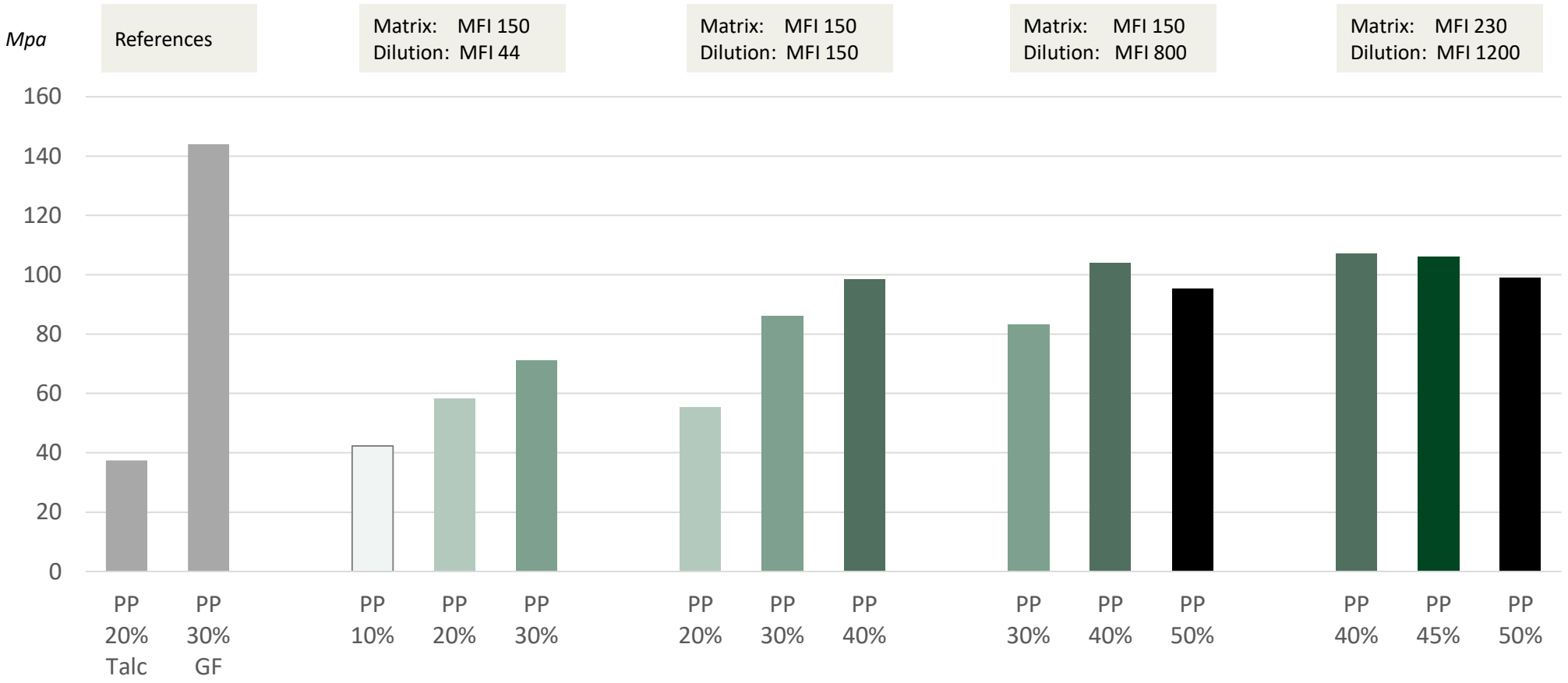
Tensile modulus



Elongation at break

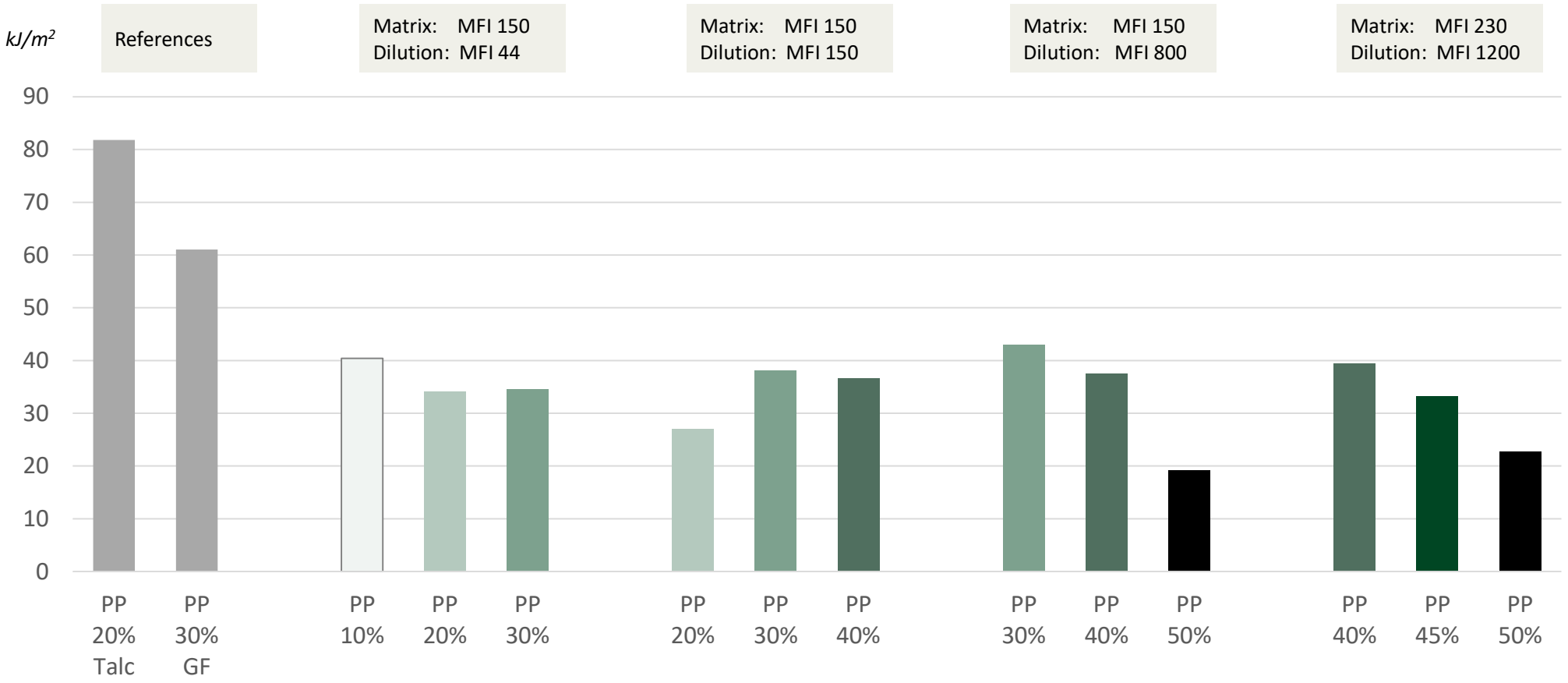


Flexural strength

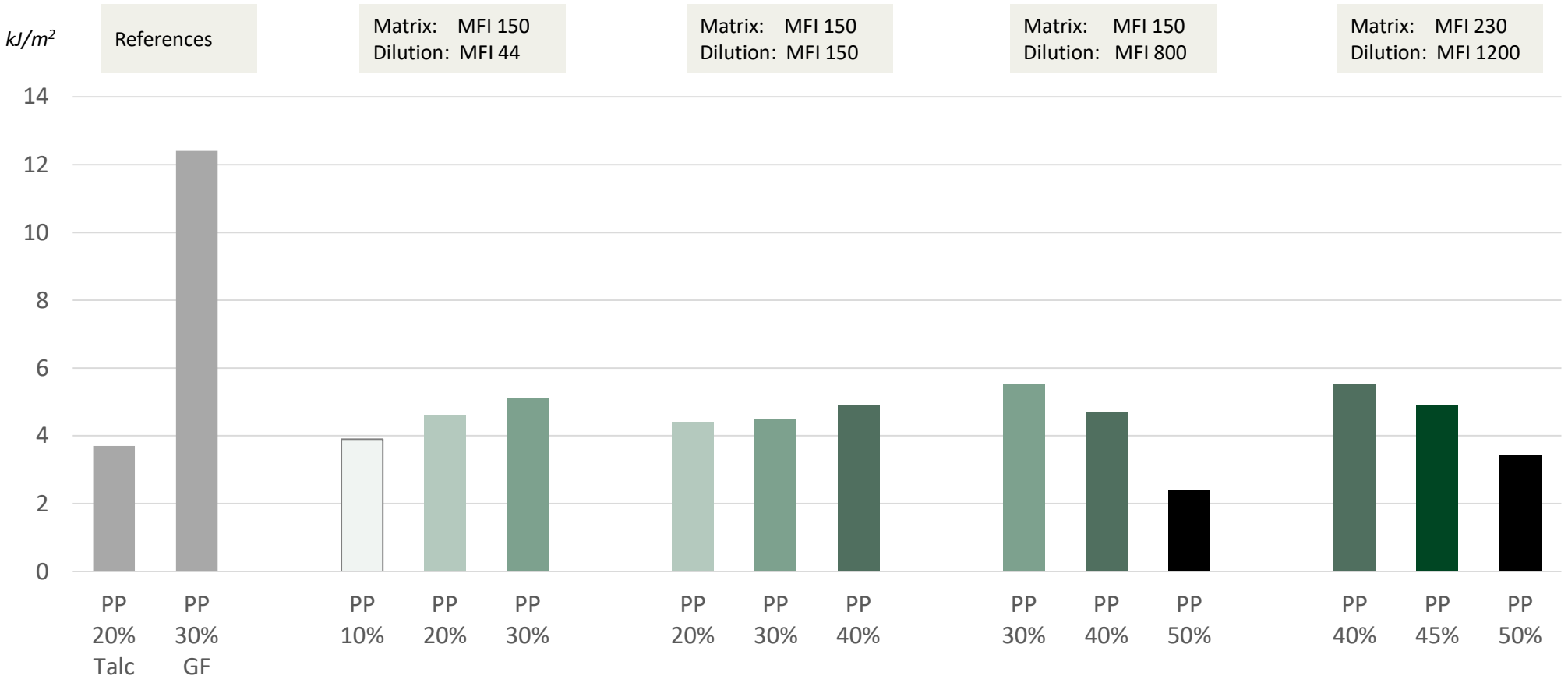


Flexural modulus

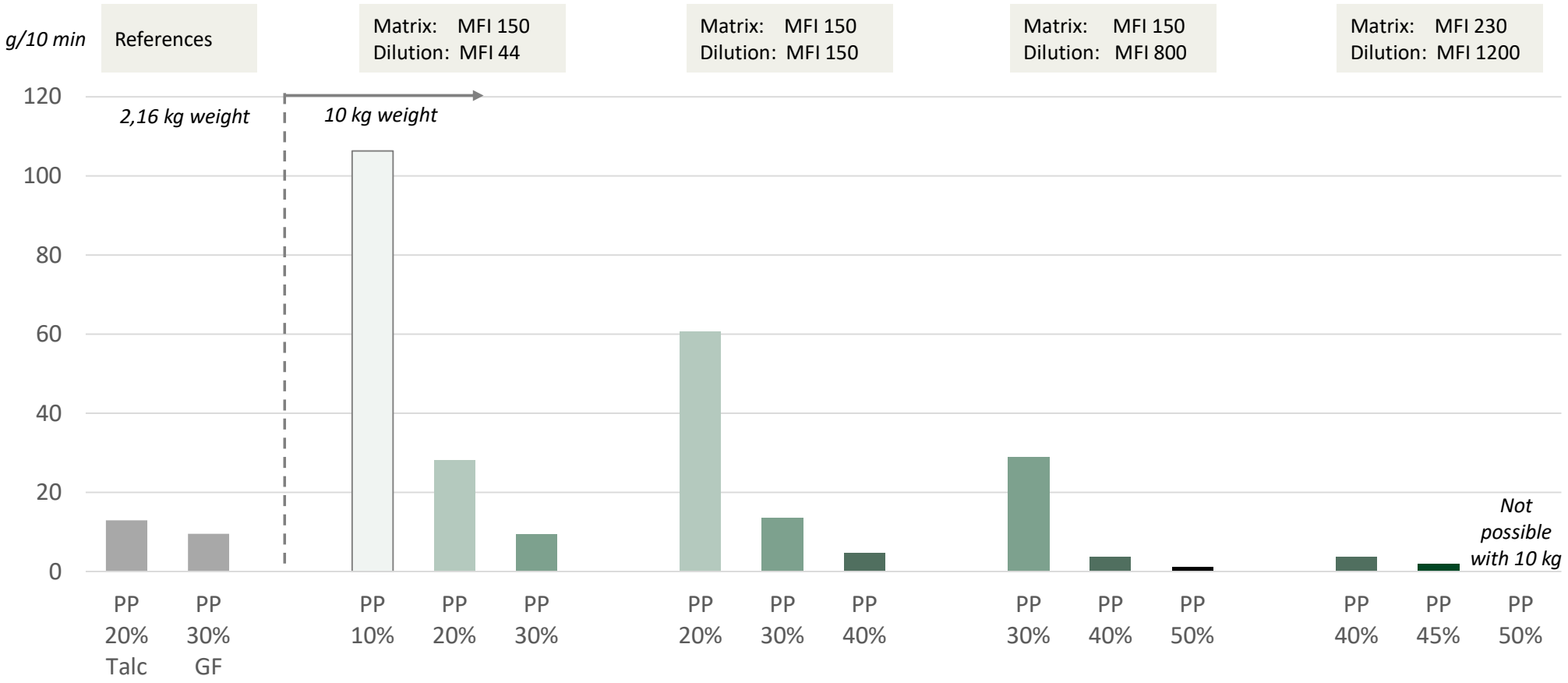
Charpy impact, unnotched



Charpy impact, notched



MFI



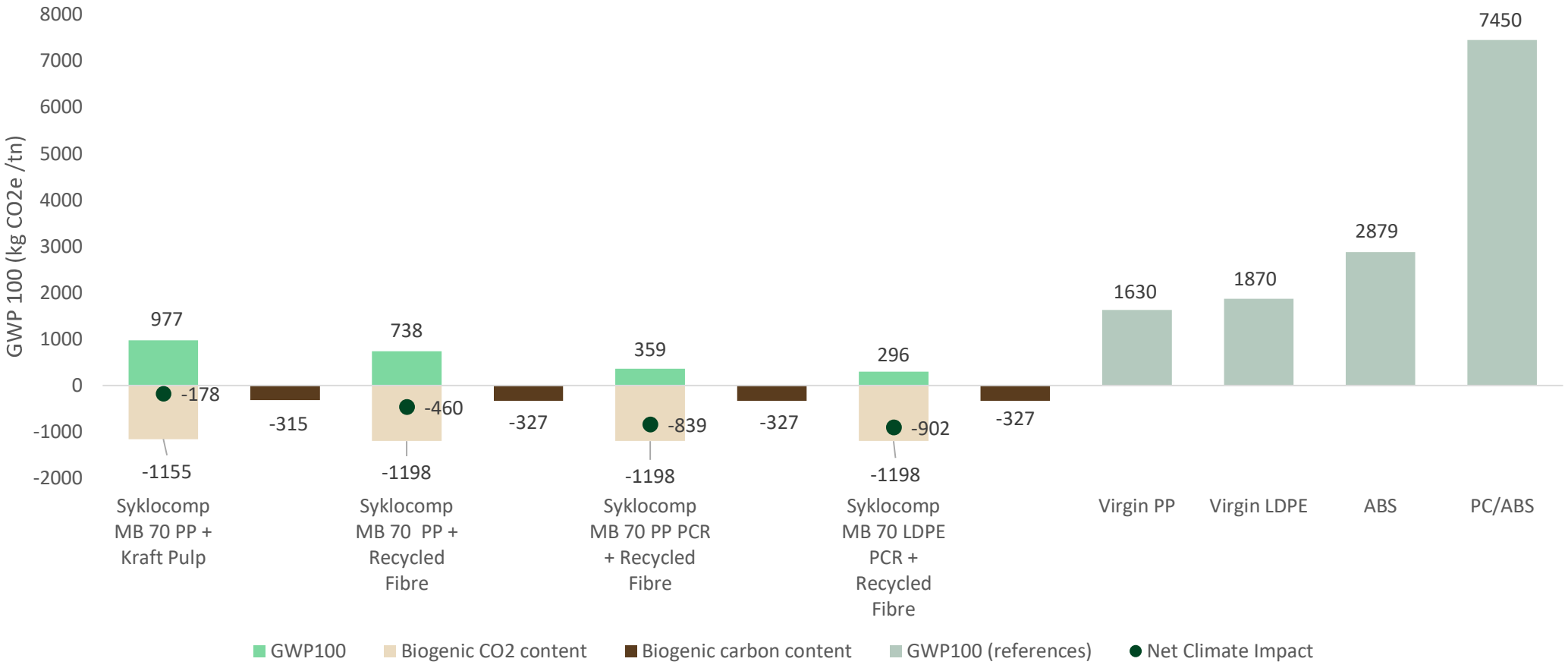
References: 230 C, 2,16 kg (ISO XXX)
Biocomposites 200 C, 10 kg (ISO XXX)

Syklo

Syklo

LCA

Syklocomp – GWP 100 (cradle to gate)



CO2 Reduction Potential – Customer Cases

Application	Original compound	Original CO2 footprint	Biocomposite compound	Improved CO2 footprint, estimated	CO2 Reduction	Improved CO2 footprint (including carbon sink), estimated	CO2 Reduction (including carbon sink)
Soundbar speaker enclosure	ABS	~5 000 kg CO_2e/t [1]	PP with 42 % cellulose	1 200 kg CO_2e/t [2]	**- 76 %**	500 kg CO_2e/t [2]	**- 90 %**
Scissors	PP + glass fiber	~2 000 kg CO_2e/t [1]	Recycled PP with 34% cellulose	800 kg CO_2e/t [2]	**- 60 %**	240 kg CO_2e/t [2]	**- 88 %**
Ventilation element	PC/ABS	~7 500 kg CO_2e/t [1]	PP with 40% cellulose	1 300 kg CO_2e/t [2]	**- 83 %**	640 kg CO_2e/t [2]	**- 91 %**
Flexible ventilation element	SEBS	~5 000 kg CO_2e/t [1]	TPV with 20% cellulose	3 900 kg CO_2e/t [2]	**- 22 %**	3 570 kg CO_2e/t [2]	**- 29 %**
School chair	PP	~2 000 kg CO_2e/t [1]	Recycled PP with 30% cellulose	800 kg CO_2e/t [2]	**- 60 %**	300 kg CO_2e/t [2]	**- 85 %**
AC outside unit propeller	PP + 20% glass fiber + 20% mineral filler	~2 000 kg CO_2e/t [1]	PP with 45% cellulose	1 200 kg CO_2e/t [2]	**- 40 %**	460 kg CO_2e/t [2]	**- 77 %**
Car door panel	PP + 20% long glass fiber	~2 000 kg CO_2e/t [1]	PP with 45% cellulose	1200 kg CO_2e/t [2]	**- 40 %**	460 kg CO_2e/t [2]	**- 77 %**

1. High-level estimate
2. Based on a LCA study..

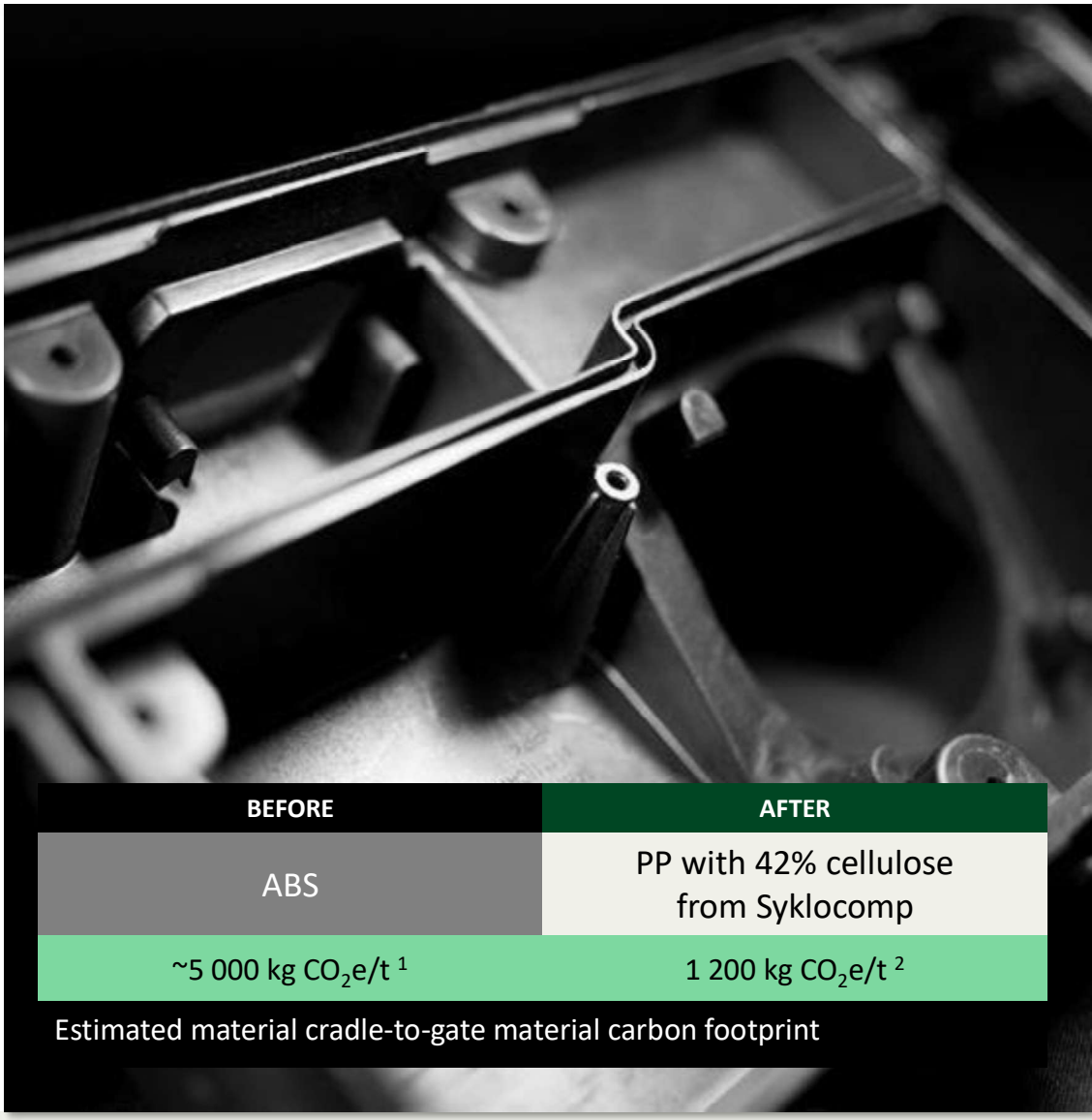
Syklo

Application related data

Soundbar speaker enclosure

Designed to improve acoustic properties and introduce a new sustainable material in speakers.

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,1
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	4,4
tensile strength @ break	ISO 527	MPa	64
elongation @ break	ISO 531	%	2,3
flexural modulus	ISO 178	GPa	4,2
max flexural strength	ISO 178	MPa	90
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	43
Charpy impact strength (notched)	ISO 180	kJ/m^2	6,8



BEFORE	AFTER
ABS	PP with 42% cellulose from Syklocomp
~5 000 kg CO_2e/t [1]	1 200 kg CO_2e/t [2]

Estimated material cradle-to-gate material carbon footprint

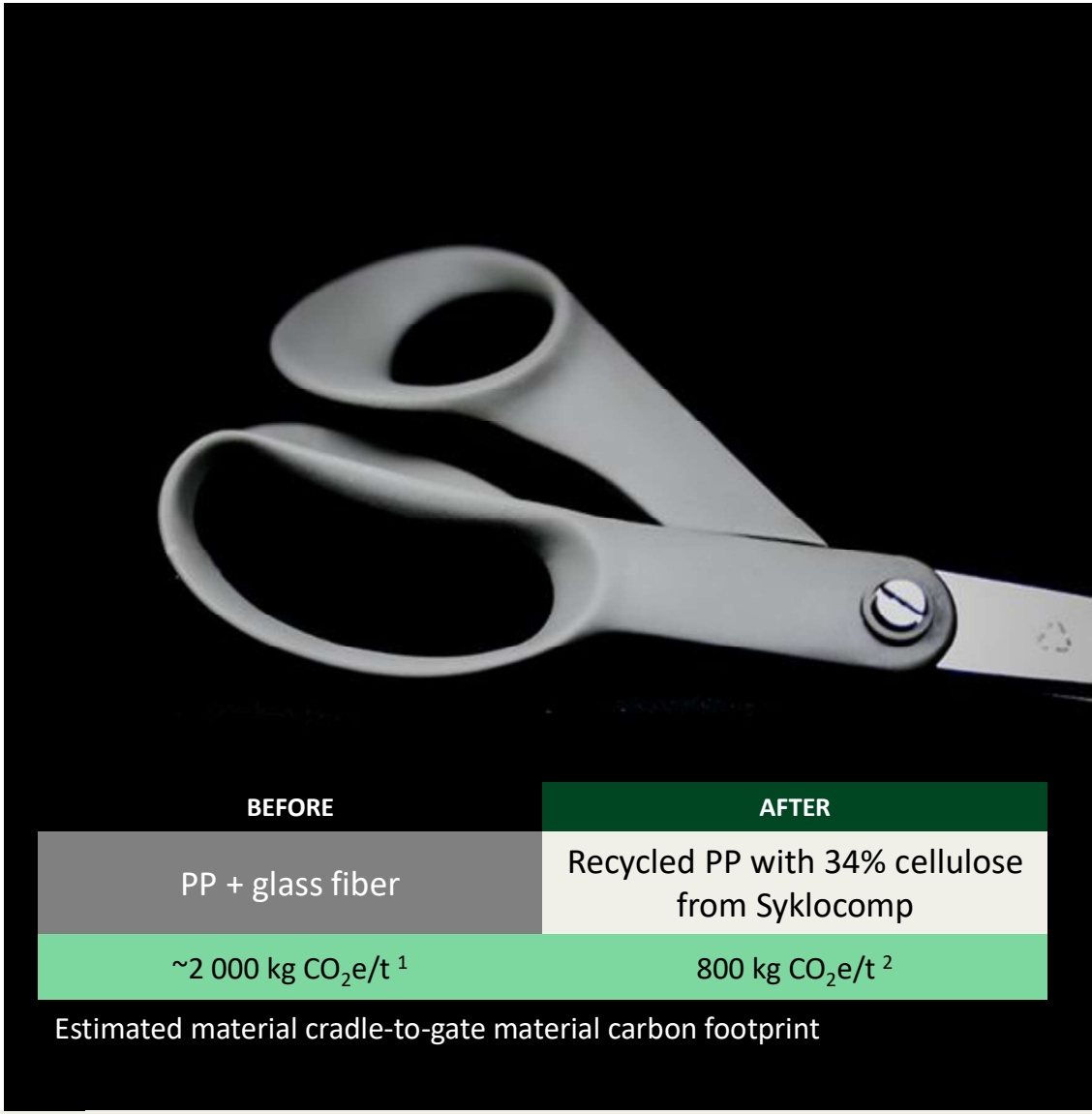
1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo

Recycled scissors

Customer designed eight scissor models that uses recycled PCR PP reinforced with 34% virgin cellulose fiber. The material had to pass the same dynamic testing as glass fiber reinforced PP for lifetime warranty.

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,1
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	3,4
tensile strength @ break	ISO 527	MPa	49
elongation @ break	ISO 531	%	2,5
flexural modulus	ISO 178	GPa	3,3
max flexural strength	ISO 178	MPa	69
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	36
Charpy impact strength (notched)	ISO 180	kJ/m^2	6,1



BEFORE	AFTER
PP + glass fiber	Recycled PP with 34% cellulose from Syklocomp
~2 000 kg CO_2e/t [1]	800 kg CO_2e/t [2]

Estimated material cradle-to-gate material carbon footprint

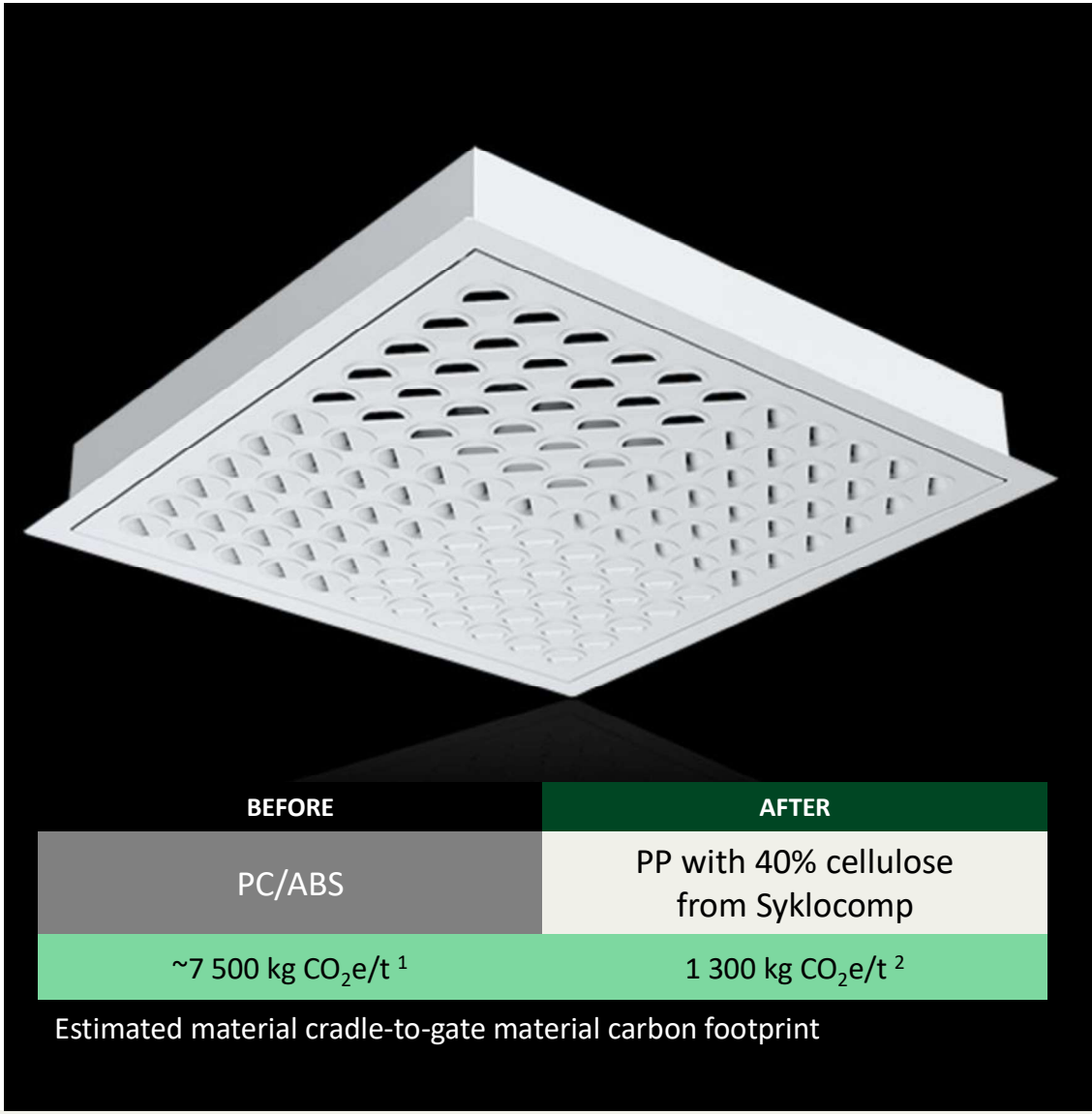
1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo

Ventilation elements

Replacing PC/ABS with PP based biocomposite with 40% cellulose fiber. Further benefits to lower carbon footprint were process energy savings and 70% faster production in injection molding.

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,1
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	4,5
tensile strength @ break	ISO 527	MPa	57
elongation @ break	ISO 531	%	1,8
flexural modulus	ISO 178	GPa	5,0
max flexural strength	ISO 178	MPa	101
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	34
Charpy impact strength (notched)	ISO 180	kJ/m^2	5,7



BEFORE	AFTER
PC/ABS	PP with 40% cellulose from Syklocomp
~7 500 kg CO_2e/t [1]	1 300 kg CO_2e/t [2]

Estimated material cradle-to-gate material carbon footprint

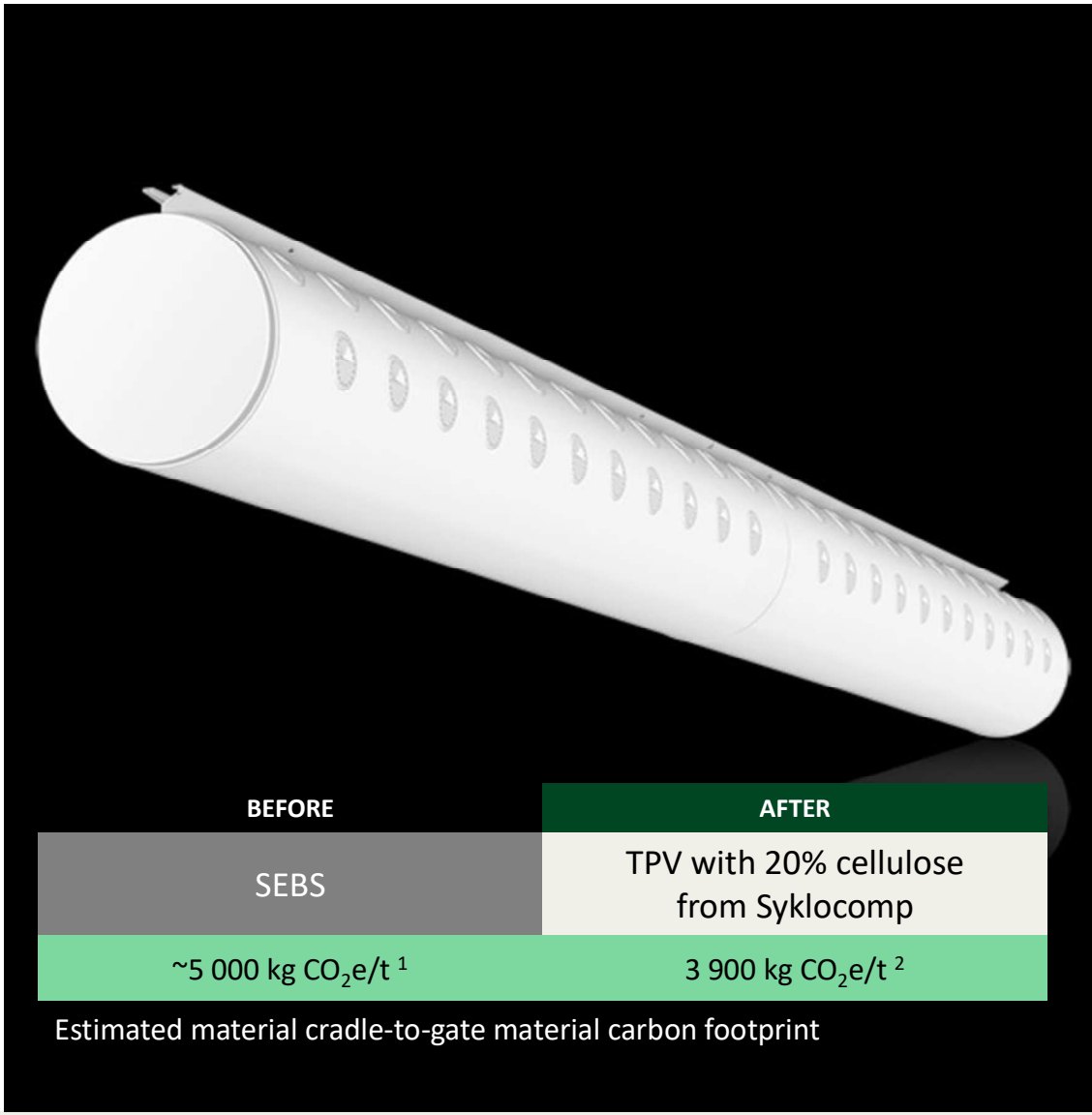
1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo

Ventilation elements

Replacing SEBS with 20% cellulose fiber reinforced TPV and still retaining excellent flexibility, processability and haptic properties in the product

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,0
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	0,2
tensile strength @ break	ISO 527	MPa	11
elongation @ break	ISO 531	%	17
flexural modulus	ISO 178	GPa	0,2
max flexural strength	ISO 178	MPa	6,1
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	NB
Charpy impact strength (notched)	ISO 180	kJ/m^2	NB



Estimated material cradle-to-gate material carbon footprint

1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo

School chair

Replacing virgin PP with 30% cellulose fiber reinforced PCR PP that was impact modified to meet the company specification for school chair.

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,0
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	2,1
tensile strength @ break	ISO 527	MPa	37
elongation @ break	ISO 531	%	3,3
flexural modulus	ISO 178	GPa	2,2
max flexural strength	ISO 178	MPa	52
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	42
Charpy impact strength (notched)	ISO 180	kJ/m^2	8,6

BEFORE	AFTER
PP	Recycled PP with 30% cellulose from Syklocomp
~2 000 kg CO_2e/t [1]	800 kg CO_2e/t [2]

Estimated material cradle-to-gate material carbon footprint

1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo

AC outside unit propeller

Replacing 20% glass fiber reinforced PP with impact modified PP45

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,1
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	4,5
tensile strength @ break	ISO 527	MPa	58
elongation @ break	ISO 531	%	1,6
flexural modulus	ISO 178	GPa	4,6
max flexural strength	ISO 178	MPa	85
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	20
Charpy impact strength (notched)	ISO 180	kJ/m^2	2,9

BEFORE	AFTER
PP + 20% glass fiber + 20% mineral filler	PP with 45% cellulose from Syklocomp
~2 000 kg CO_2e/t [1]	1 200 kg CO_2e/t [2]

Estimated material cradle-to-gate material carbon footprint

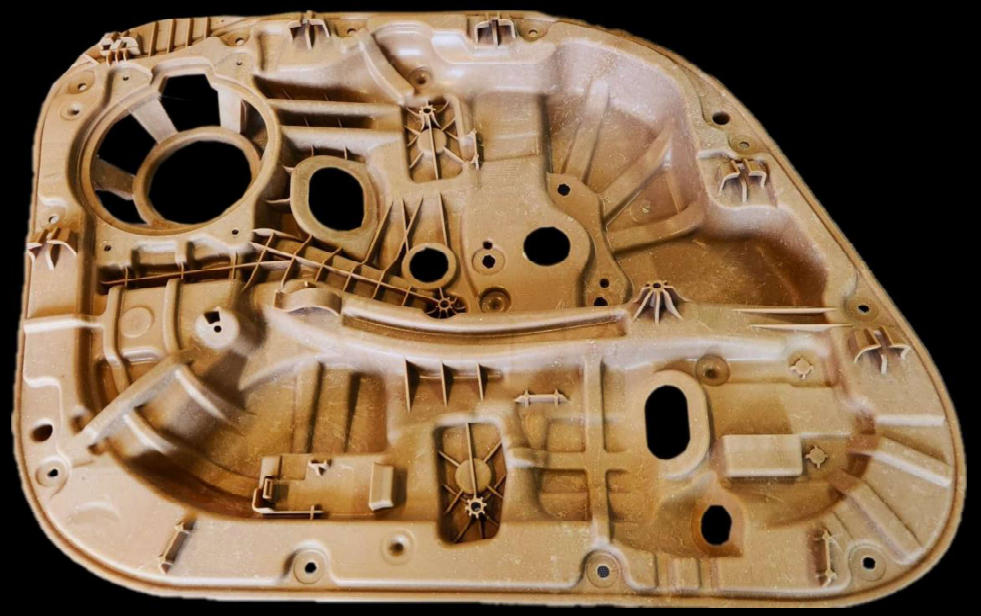
1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo

Car door panel

Replacing PP 30% long glass fiber composite with PP45

PHYSICAL PROPERTIES	Test method	unit	
melt index	ISO 1133	g/10 min	N/A
density	ISO 2781	g/cm^3	1,1
MECHANICAL PROPERTIES			
tensile modulus	ISO 527	GPa	4,5
tensile strength @ break	ISO 527	MPa	57
elongation @ break	ISO 531	%	1,8
flexural modulus	ISO 178	GPa	5,0
max flexural strength	ISO 178	MPa	101
Charpy impact strength (un-notched)	ISO 179	kJ/m^2	34
Charpy impact strength (notched)	ISO 180	kJ/m^2	5,7



BEFORE	AFTER
PP + 20% long glass fiber	PP with 45% cellulose from Syklocomp
~2 000 kg CO_2e/t [1]	1200 kg CO_2e/t [2]

Estimated material cradle-to-gate material carbon footprint

1. High-level estimate
2. Based on a LCA study. The effect of potential carbon sink not included in the carbon footprint figures.

Syklo