Supplementary Material

Environmental impact of an innovative aeronautic carbon composite manufactured via heated vacuum-assisted resin transfer moulding

Table S1. Proxies and references used to model the life cycle inventory (LCI) data (inputs and outputs) for the different scenarios.

Material	Proxies	References
Carbon fibre	-	Based on [1]
Acetone	-	-
Release Agent	Organic chemical	Based on [2]
Resin	Epoxy resin	Based on the product technical sheet
Mould cleaner	Methyl ethyl ketone	Based on [2]
Peel Ply	Nylon 6-6	Based on [3]
Vacuum Bag	Nylon 6-6	Based on [4]
Hoses	Polyamide	Based on [5]
Flow mesh	Polypropylene	Based on [3]
Paper Tape	Tissue paper	Based on [6]
Cloth	Nonwoven polyester	Based on the product technical sheet
Spiral Tubes	Polyethylene	Based on [7]
Release Film	Tetrafluoroethylene	Based on the product technical sheet
Breather	Nonwoven polyester	Based on the product technical sheet
Yellow Tape	Synthetic rubber	Based on the product technical sheet
Blue Tape	Silicon product	Based on the product technical sheet
Electricity	Medium voltage	-
Residues	Waste plastic	-

Note: The environmental data regarding the material and proxies was retrieved from EcoInvent 3.8.

Table S2. LCI of the inputs and outputs to process 1 kg of residues by Mild hydrolysis.

Process steps	Input	Quantity	Unit	Output	Quantity	Unit
Transportation	Transport	1.15E-04	tkm	-	-	-
Mild hydrolysis	Residues	1.00	kg	Wastewater	1.35	kg
	Water	1.35	kg	Plastic Residues	0.460	kg
	Acetic acid	0.45	kg	Carbon fibres	0.540	kg
	Sodium Hydroxide	0.036	kg	-	-	-
	Electricity	1.80	kWh	-	-	-

Table S3. LCI of the inputs and outputs to process 1 kg of residues by Supercritical hydrolysis.

Process steps	Input	Quantity	Unit	Output	Quantity	Unit
Transportation	Transport	1.15E-04	tkm	-	-	-
Supercritical hydrolysis	Residues	1.00	kg	Wastewater	10.4	kg
	Water	10.0	kg	Carbon fibres	0.60	kg
	Natural gas	24.7	MJ	-	-	-

Table S4. LCI of the inputs and outputs to process 1 kg of residues by Supercritical hydrolysis with heat recovery.

Process steps	Input	Quantity	Unit	Output	Quantity	Unit
Transportation	Transport	1.15E-04	tkm	-	-	-
Supercritical hydrolysis	Residues	1.00	kg	Wastewater	10.4	kg
	Water	10.0	kg	Carbon fibres	0.60	kg
	Natural gas	24.7	MJ	Heat recovered	22.2	MJ

Table S5. Midpoint impacts for the production of one aeronautic composite laminate via VARTM, by phase of production.

	ADP elements	ADP fossil	GWP	ODP	HTP	FAETP	MAETP	TETP	POCP	AP	EP
	kg Sb eq	MJ	kg CO_2 eq	kg CFC-11 eq	kg 1,4-DB eq	kg 1,4-DB eq	kg 1,4-DB eq	kg 1,4-DB eq	kg C_2H_4 eq	kg SO_2 eq	kg PO_4^{3-} eq
Fibre cut	$3{,}4x10^{-05}$	$1{,}2x10^{+02}$	$7{,}3x10^{+00}$	$2{,}5x10^{-07}$	$2{,}6x10^{+00}$	$2{,}3x10^{+00}$	$5{,}0x10^{+03}$	$8{,}7x10^{-03}$	$7{,}7x10^{-03}$	$5{,}3x10^{-02}$	$3{,}7x10^{-01}$
Technical fabrics cut	$1{,}5x10^{-06}$	$3{,}0x10^{+01}$	$1{,}7x10^{+00}$	$2{,}1x10^{-08}$	$4{,}0x10^{-01}$	$1{,}0x10^{-01}$	$2{,}6x10^{+02}$	$4{,}7x10^{-02}$	$2{,}8x10^{-04}$	$3{,}7x10^{-03}$	$1{,}1x10^{-03}$
Mould preparation	$4{,}7x10^{-06}$	$9{,}4x10^{+00}$	$5{,}4x10^{-01}$	$4{,}9x10^{-07}$	$3{,}6x10^{-01}$	$3{,}8x10^{-01}$	$6{,}0x10^{+02}$	$1{,}3x10^{-03}$	$1{,}4x10^{-04}$	$1{,}8x10^{-03}$	$1{,}1x10^{-03}$
Resin preparation	$6{,}5x10^{-05}$	$9{,}9x10^{+01}$	$5{,}7x10^{+00}$	$7{,}7x10^{-07}$	$9{,}9x10^{+00}$	$4{,}3x10^{+00}$	$5{,}7x10^{+03}$	$8{,}8x10^{-03}$	$2{,}8x10^{-03}$	$2{,}2x10^{-02}$	$7{,}7x10^{-03}$
Infusion preparation	$4{,}1x10^{-06}$	$9{,}7x10^{+00}$	$5{,}9x10^{-01}$	$4{,}7x10^{-08}$	$3{,}9x10^{-01}$	$2{,}1x10^{-01}$	$4{,}4x10^{+02}$	$7{,}4x10^{-04}$	$1{,}3x10^{-04}$	$2{,}3x10^{-03}$	$8{,}9x10^{-04}$
Debulking	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$	$0{,}0x10^{+00}$
Infusion	$1{,}1x10^{-07}$	$4{,}8x10^{-01}$	$9{,}0x10^{-01}$	$5{,}3x10^{-09}$	$7{,}3x10^{-01}$	$1{,}7x10^{+00}$	$1{,}6x10^{+03}$	$1{,}9x10^{-03}$	$4{,}6x10^{-05}$	$2{,}8x10^{-04}$	$3{,}8x10^{-03}$
Cure cycle	$7{,}4x10^{-08}$	$3{,}2x10^{-01}$	$5{,}9x10^{-01}$	$3{,}5x10^{-09}$	$4{,}8x10^{-01}$	$1{,}1x10^{+00}$	$1{,}1x10^{+03}$	$1{,}3x10^{-03}$	$3{,}0x10^{-05}$	$1{,}9x10^{-04}$	$2{,}5x10^{-03}$
Electricity	$3{,}1x10^{-05}$	$1{,}7x10^{+02}$	$1{,}4x10^{+01}$	$6{,}5x10^{-07}$	$4{,}6x10^{+00}$	$4{,}9x10^{+00}$	$2{,}0x10^{+04}$	$3{,}9x10^{-02}$	$3{,}5x10^{-03}$	$9{,}3x10^{-02}$	$2{,}1x10^{-02}$
Total	$\mathbf{1{,}4x10^{-04}}$	$\mathbf{4{,}3x10^{+02}}$	$\mathbf{3{,}1x10^{+01}}$	$\mathbf{2{,}2x10^{-06}}$	$\mathbf{1{,}9x10^{+01}}$	$\mathbf{1{,}5x10^{+01}}$	$\mathbf{3{,}5x10^{+04}}$	$\mathbf{1{,}1x10^{-01}}$	$\mathbf{1{,}5x10^{-02}}$	$\mathbf{1{,}8x10^{-01}}$	$\mathbf{4{,}1x10^{-01}}$

Table S6. Midpoint impacts for the production of one aeronautic composite laminate via autoclave, by phase of production.

	ADP elements	ADP fossil	GWP	ODP	HTP	FAETP	MAETP	TETP	POCP	AP	EP
	kg Sb eq	MJ	kg CO_2 eq	kg CFC-11 eq	kg 1,4-DB eq	kg 1,4-DB eq	kg 1,4-DB eq	kg 1,4-DB eq	kg C_2H_4 eq	kg SO_2 eq	kg PO_4^{3-} eq
Prepreg cut	$4{,}5x10^{-05}$	$1{,}2x10^{+02}$	$7{,}6x10^{+00}$	$4{,}2x10^{-07}$	$4{,}7x10^{+00}$	$3{,}1x10^{+00}$	$5{,}9x10^{+03}$	$1{,}5x10^{-02}$	$7{,}0x10^{-03}$	$5{,}0x10^{-02}$	$3{,}1x10^{-01}$
Autoclave preparation	$2{,}2x10^{-05}$	$2{,}1x10^{+01}$	$6{,}6x10^{+00}$	$1{,}9x10^{-04}$	$2{,}0x10^{+00}$	$6{,}5x10^{-01}$	$1{,}2x10^{+04}$	$2{,}1x10^{-03}$	$4{,}2x10^{-04}$	$6{,}3x10^{-03}$	$1{,}9x10^{-03}$
Autoclave	$5{,}5x10^{-08}$	$2{,}3x10^{-01}$	$4{,}4x10^{-01}$	$2{,}6x10^{-09}$	$3{,}6x10^{-01}$	$8{,}2x10^{-01}$	$7{,}9x10^{+02}$	$9{,}4x10^{-04}$	$2{,}2x10^{-05}$	$1{,}4x10^{-04}$	$1{,}9x10^{-03}$
Final cut	$1{,}4x10^{-08}$	$5{,}9x10^{-02}$	$1{,}1x10^{-01}$	$6{,}6x10^{-10}$	$9{,}0x10^{-02}$	$2{,}1x10^{-01}$	$2{,}0x10^{+02}$	$2{,}4x10^{-04}$	$5{,}7x10^{-06}$	$3{,}5x10^{-05}$	$4{,}7x10^{-04}$
Electricity	$3{,}5x10^{-06}$	$1{,}9x10^{+01}$	$1{,}6x10^{+00}$	$7{,}4x10^{-08}$	$5{,}2x10^{-01}$	$5{,}5x10^{-01}$	$2{,}2x10^{+03}$	$4{,}4x10^{-03}$	$3{,}9x10^{-04}$	$1{,}0x10^{-02}$	$2{,}4x10^{-03}$
Total	$\mathbf{7{,}1x10^{-05}}$	$\mathbf{1{,}6x10^{+02}}$	$\mathbf{1{,}6x10^{+01}}$	$\mathbf{1{,}9x10^{-04}}$	$\mathbf{7{,}7x10^{+00}}$	$\mathbf{5{,}4x10^{+00}}$	$\mathbf{2{,}1x10^{+04}}$	$\mathbf{2{,}3x10^{-02}}$	$\mathbf{7{,}8x10^{-03}}$	$\mathbf{6{,}7x10^{-02}}$	$\mathbf{3{,}1x10^{-01}}$

Table S7. Midpoint impacts for the EOL scenarios.

	ADP elements	ADP fossil	GWP	ODP	HTP	FAETP	MAETP	TETP	POCP	AP	EP
	kg Sb eq	MJ	kg CO_2 eq	kg CFC-11 eq	kg 1,4-DB eq	kg 1,4-DB eq	kg 1,4-DB eq	kg 1,4-DB eq	kg C_2H_4 eq	kg SO_2 eq	kg PO_4^{3-} eq
Mild hydrolysis	$1{,}1x10^{-05}$	$2{,}8x10^{+01}$	$1{,}8x10^{+00}$	$2{,}2x10^{-07}$	$1{,}1x10^{+00}$	$1{,}4x10^{+00}$	$2{,}6x10^{+03}$	$4{,}1x10^{-03}$	$8{,}0x10^{-04}$	$8{,}4x10^{-03}$	$3{,}8x10^{-03}$
Supercritical hydrolysis	$5{,}3x10^{-07}$	$2{,}2x10^{+01}$	$1{,}3x10^{+00}$	$1{,}8x10^{-07}$	$5{,}8x10^{-02}$	$4{,}4x10^{-02}$	$7{,}1x10^{+01}$	$3{,}1x10^{-04}$	$8{,}4x10^{-05}$	$1{,}0x10^{-03}$	$3{,}1x10^{-04}$
Supercritical hydrolysis + WHR	$1{,}5x10^{-07}$	$2{,}3x10^{+00}$	$1{,}4x10^{-01}$	$2{,}0x10^{-08}$	$1{,}9x10^{-02}$	$1{,}2x10^{-02}$	$1{,}9x10^{+01}$	$1{,}4x10^{-04}$	$1{,}1x10^{-05}$	$1{,}6x10^{-04}$	$1{,}6x10^{-04}$

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