
SUSTAINABILITY
LG Chem

Today in the market...

The automotive industry is getting proactively prepared to address environment-wise pressure with its value chain suppliers.

Government

(June 2021)

The European Commission is ***"considering rules on mandatory recycled content" for certain plastic components of new vehicles,*** *a move it says will help to bring cars in line with circular use principles*

EuRIC is calling on lawmakers to set a binding target for post-consumer thermoplastics – polymers that can be continually melted and recast ***– in new cars of 25% by 2025, 30% by 2030, and 35% by 2035.***

Automotive OEM

"By a couple of years the ***target is 20% and by 2030 the target will increase to 40~50% "***

"We will replace artificial materials with ***recycled and sustainable raw materials*** *throughout their entire value chain"*

"We have committed to increasing the sustainable materials ***- at least 50% of the materials will be sustainable by 2030"***

"We have established an interim target of 20% renewable and ***recycled plastic by 2025"***

"We will use ***40kg recycled or bio plastic in all fleets by 2025"***

"*We have set a goal of* ***using 25% recycled plastics in cars starting in 2025"***

Your Concern?

Virgin-like Quality?

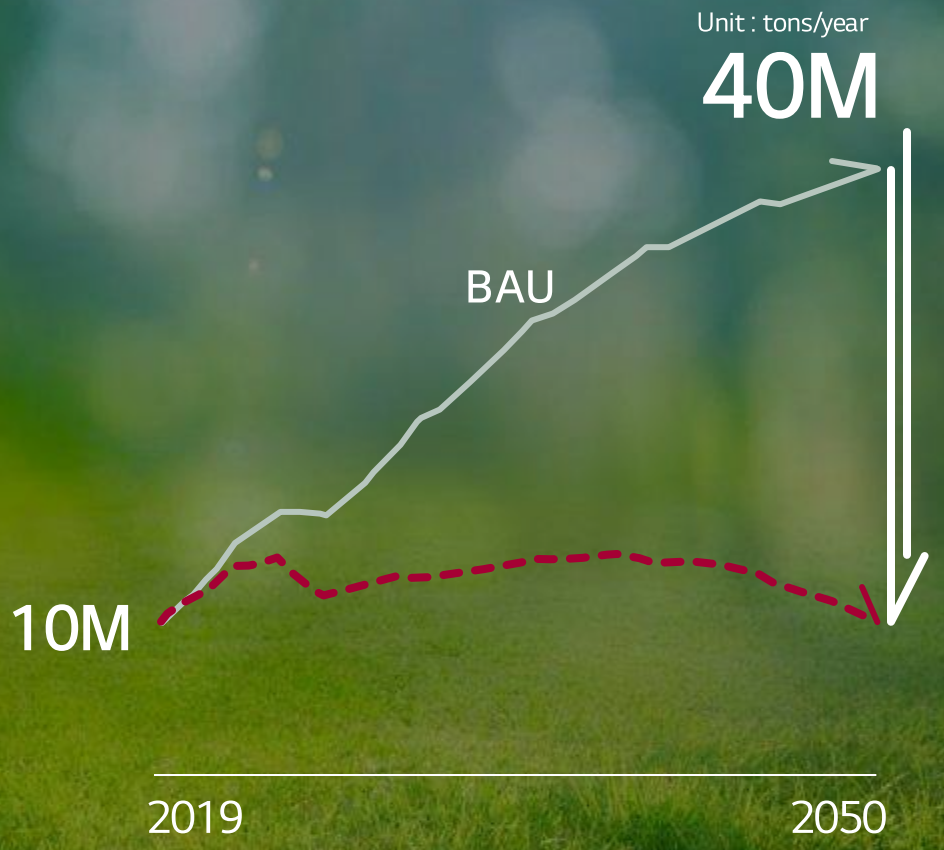
Positive Environmental Impact?

Our Goal :

To achieve the transition to circular economy,
we must develop more sustainable product through collaboration with global customers,
while maintaining virgin-like quality and with far better environmental benefit.

VISION & CORE VALUES

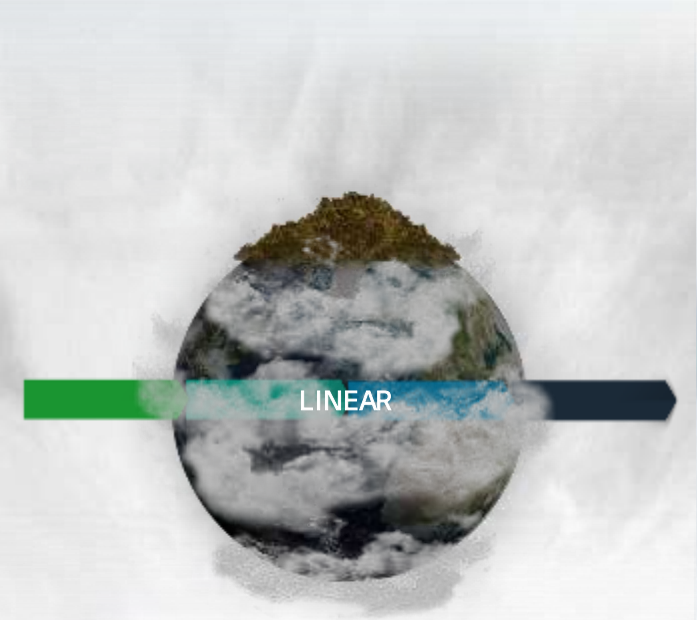
CARBON NEUTRAL GROWTH 2050



We are proud to be the first Korean chemical company to declare ‘Carbon Neutral Growth by 2050’.
It is our firm determination to keep carbon emissions flat to 2019 level while pursuing a sustainable growth.


RENEWABLE ENERGY
100%
WATER
WIND
SOLAR
We are also the first mover in Korea to commit to RE100, which means our products will be made with renewable energy by 2050. To take action in this regard, battery plants in Europe and the US are now running on clean energy.

CIRCULAR ECONOMY



There is no planet B. Moving away from linear economy towards recycling economy is not our final destination.
Instead, we are on our way to circular economy making our products more adaptable to recycling and increasing use of bio sources.

Sustainable Product Portfolio

Mechanical Recycle (=Post Consumer Recycle)	PC	PC/ABS		
Chemical Recycle	PC	PC/ABS	PBT	TPEE
Bio-Based	PA56 (Replace PA66)		PBT	TPEE
Bio-Mass Balanced	PC	PC/ABS		

Sustainable Product Brand

LG Chem created an eco-friendly brand to show our willingness to respond to the environment

Concept

Name of Brand : LETZero

Meaning : Let + Zero(0) → 'Meaning of Zero Environmental Harm, Zero Carbon Emissions'

Product group : Mechanical Recycle, Bio-Mass Balanced, Bio-Based

Brand Story

- First eco-friendly brand launch as part of ESG management and sustainability strategies in LG Chem
- LETZero is a family brand that integrates 3 eco-friendly product line produced by LG Chem
- Increase the interest in eco-friendly materials applied to final products as the number of 'green consumer' aimed at purchasing the products that help environment
- Plans to build more customer-focused company through LETZero launch

Image

[Application Example- Draft]

[Application Example for Co-branding - Draft]

Mechanical Recycle

Technical Description

Grinding — Compounding

Consumer Product -> Post Consumer Recycled (PCR) Resin -> PCR Compound

Source : Sheet, Wafer tray, Headlamp

Business Summary

PCR Sales Record : 13,400MT ('20)

PCR Sales '20~25 CAGR : 20%

PCR Content (%)

PC	90
PC/ABS	75

Color

Speed

Average of 5.6 days for color development

Accuracy

Less than 7% of re-coloring until approval

Quality Control (3rd party Certification)

UL ECV, 746D

(Environmental Claim Validation)

TUV

Technical Inspection Association

(Technischer Überwachungsverein)

Mechanical Recycle

PC Product Portfolio

		Recycled Type	Virgin Type	Description	Certification
Non-Reinforced PC Comp.	Non-FR	ER1000D/MA	GP1000M	PCR 50%, Transparent	-
		ER1000MH	-	PCR 60%, Transparent, Extrusion	-
		ER1004A/N	SC1004A	PCR 30%/50%, IM[1)]	ECV, TUV
	FR	ER1006FH	EF1006F	PCR 20%, V0 @ 1.0 mm	UL,TUV, ECV
		ER1006FD		PCR 30%, V0 @ 1.0 mm	UL 746D, TUV
		ER1006FN		PCR 50%, V0 @ 1.0 mm	UL 746D, TUV
		ER1006FU		PCR 50%, V0 @ 1.5 mm, UL 746C F1	-
		ER1006FZ/FX		PCR 75%/85%, V0 @ 1.0 mm	-
		ER1007F/FA	SF1007F	PCR 30%, High Flow, IM, V0 @ 0.8 mm	UL 746D
		ER1007FZ		PCR 60%, High Flow, IM, V0 @ 0.8 mm	
		ER1008RF	GN1008RF	PCR 30%, IM, V0 @ 0.6 mm	TUV
		ER1008RFN		PCR 50%, IM, V0 @ 0.6 mm	
Reinforced PC Comp.	Non-FR	ER2102	GP2102	GF 9% + PCR 30%	TUV
		ER2102N		GF 9% + PCR 50%	TUV
	FR	ER2101F	GN2101FA	GF 10% + PCR 60%, V0 @ 1.5 mm	-
		ER2201F	GN2201FM	GF 20% + PCR 50%, V0 @ 1.5 mm	UL 746D
		ER2203FN	-	GF 20% + PCR 50%, V0 @ 0.8 mm	
		ER2253F	GN2253F	GF 25% + PCR 30%, V0 @ 0.8 mm	TUV
		ER2303F	-	GF 30% + PCR 30%, V0 @ 0.8 mm	UL 746D
		ER2403FT	GN2403FT	GF 40% + PCR 30%, V0 @ 0.8 mm	TUV

1) Impact Modified

Mechanical Recycle

PC/ABS Product Portfolio

		Recycled Type	Virgin Type	Description	Certification
Non-Reinforced PC/ABS Comp.	Non-FR	ER5002N	HI5002A	PCR 50%, Low PC %	-
		ER5006N	HR5006A	PCR 50%, Medium PC %	-
		ER5006NC	HR5007A	PCR 50%, Medium high PC %	-
		ER5007N	HR5007AC	PCR 50%, High PC %	-
	FR	ER5001RF	GN5001RF	PCR 30%, V0 @ 1.5 mm, RTI 80℃	UL 746D
		ER5001RFK		PCR 30%, V0 @ 1.2 mm	TUV
		ER5001RFZ		PCR 60%, V0 @ 1.2 mm	TUV
		ER5001RFA	GN5001RFA	PCR 30%, V0 @ 1.2 mm	TUV
		ER5001RFG	GN5001RFG	PCR 30%, V0 @ 1.2 mm	TUV
		ER5001RFH	GN5001RFH	PCR 60%, V1 @ 1.2 mm	UL 746D
Reinforced PC/ABS Comp.	Non-FR	ER5100N	GP5100	GF 10% + PCR 50%	-
		ER5200A	GP5200	GF 20% + PCR 40%	-
		ER5300A	GP5300	GF 30% + PCR 30%	-
	FR	ER5151RFL	GN5151RFL	MF 15% + PCR 30%, V0 @ 1.2 mm	TUV
		ER5151RFA	GN5151RFA	MF 15% + PCR 50%, V0 @ 1.0 mm	TUV
		ER5254F	GN5254FD	MF 25% + PCR 30%, V0 @ 1.0 mm	UL746D

Stellantis Approval for PCR PC/ABS

FCA
FIAT CHRYSLER AUTOMOBILES

RECYCLED POLYCARBONATE + ABS ALLOYS

MATERIALS STANDARDS
55231/02
Page: 1/8
Date: 08-SEP-2021

TMD | Code | Ch. | Revision

PURPOSE OF THE STANDARD

To define the characteristics of Recycled Polycarbonate + ABS alloys, reinforced or not.

Annex 1
Lists of commercial denominations of Recycled Polycarbonate + ABS alloys, according to different classes. Such materials represent an applicative obligation for use.

MS.50089_RevE	07-JUL-2021	New specification

Alfa Romeo · Lancia · Fiat · Abarth · Jeep · Dodge · RAM · Mopar

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FCA
FIAT CHRYSLER AUTOMOBILES

RECYCLED POLYCARBONATE + ABS ALLOYS

55231/02
ANNEX 1
Page: 1/1
Date: 08-SEP-2021

TMD | Code | - | Revision

SUPPLIER NAME	COMMERCIAL NAME	RECYCLED TYPE	RECYCLED CONTENT (%)
MS.50089 PC+ABS-R.1900F.30LNT			
SIRMAX	GREEN ISOBLEND B45	POST INDUSTRIAL	30
MAIP	LIFETWO 04 T2	POST INDUSTRIAL	70
LOTTE	GW-1040	POST CONSUMER	20
LG	LUPOY ER 5002 N	POST CONSUMER	50
MS.50089 PC+ABS-R.1800F.40LMT			
GEBA	GEBABLEND 65HI	POST INDUSTRIAL	100
HOFFMANN+VOSS	DYBLEND-R	POST INDUSTRIAL	100
LG	LUPOY ER5006N	POST CONSUMER	50
RAVAGO	MABLEXECO PCB	POST INDUSTRIAL	100
MAIP	LIFETWO 04 T3 V	POST INDUSTRIAL	65
MS.50089 PC+ABS-R.2000F.40LHT			
GEBA	GEBABLEN 85HI	POST INDUSTRIAL	100
SIRMAX	GREEN ISOBLEND B85	POST INDUSTRIAL	30
MAIP	LIFETWO 04 T4	POST INDUSTRIAL	65
ALBIS	ALTECH PC+ABS ECO 1000/568	POST INDUSTRIAL	70
LOTTE	GW-1079	POST CONSUMER	20
LG	LUPOY ER5007N	POST CONSUMER	50

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Goal One :
Maintaining Virgin-Like Quality

Goal One Problem :
Maintaining Virgin-Like Quality is Not Easy

Virgin

PCR

Quality Control of Full Value Chain (Sourcing to Final Product)

PCR Source
- Collect
- Sorting

PCR Resin
- Crunch/Clean/Dry
- Compound with PCR source

Process
- Modify /Reinforcement
- Compound with Virgin product

PCR Product
- Packaging
- Quality Assurance (Provide COA)

Quality Control Points

- Use highly qualified PCR source

- Stricter warehouse inspection than virgin source
- Invest and provide guidance to improve quality (annual audit)

- Use customized screw Configuration (Less residential time)

- 3rd party certification (UL ECV, TUV)

Warehouse Inspection for PCR Resin

Strict inspection for screening contaminated PCR resin. Year after year, we are providing guidance to our PCR supplier in order to improve the quality.

Inspections for Virgin source

2

- Melt Flow Rate
- Color(Yellow Index)

Inspections for PCR source

6

- Melt Flow Rate
- Color(Yellow Index, Darkness)
- Izod Impact Strength
- HDT[1)]
- Foreign Material
- Halogen/Heavy metal

1) Heat Deflection Temperature

Control of PCR Source

Past Version

Water Bottle

CD/DVD

Very High and Low (MFR 3~70) Molecular Weight Source
-> Broad Dispersion + Unstable Quality between Lots

Today Version

Wafer Tray

Sheet

Auto Headlamp

Proper (MFR 15~25) Molecular Weight Source
-> Narrow Dispersion + Stable Quality between Lots

Virgin-Like Quality

LUPOY : Brand name for PC, PC/ABS
ER : Environmentally Recycled

Test Class		Test Method	Test Condition	Unit	LUPOY HR5007AC (Virgin PC/ABS)	LUPOY ER5007N (PCR PC/ABS)
Physical	Specific gravity	ISO 1183	-	g/cm^3	1.14	1.15
	Melt Flow rate	ISO 1133	260℃, 5kg	g/10m	19	21
Mechanical	Tensile Elongation	ISO 527	50mm/min	%	> 100	> 90
	Tensile Strength	ISO 527		MPa	52	53
	Flexural Modulus	ISO 178	2mm/min	MPa	2,200	2270
	Flexural Strength	ISO 178		MPa	84	84
	Notched Izod Impact	ISO 180/A	23℃	KJ/m^2	51	52
			-30℃		37	37
	Notched Charpy Impact	ISO 179-1	23℃		53	55
Thermal	Heat Distortion Temp	ISO 75	1.8MPa	℃	109	106
	Vicat Softening Temp	ISO 306	50N, 50℃/hr		130	131
Heat Aging (90℃/1000hr)	Tensile Strength	ISO 527	50mm/min	MPa	56	56
	Notched Charpy Impact	ISO 179-1	KJ/m^2	MPa	47	49
Others	TVOC	VDA278	90℃	μg/g	< 0.1	< 0.1
	Odor	VDA270 (B,3)	80℃, 2hr	Level	3	2

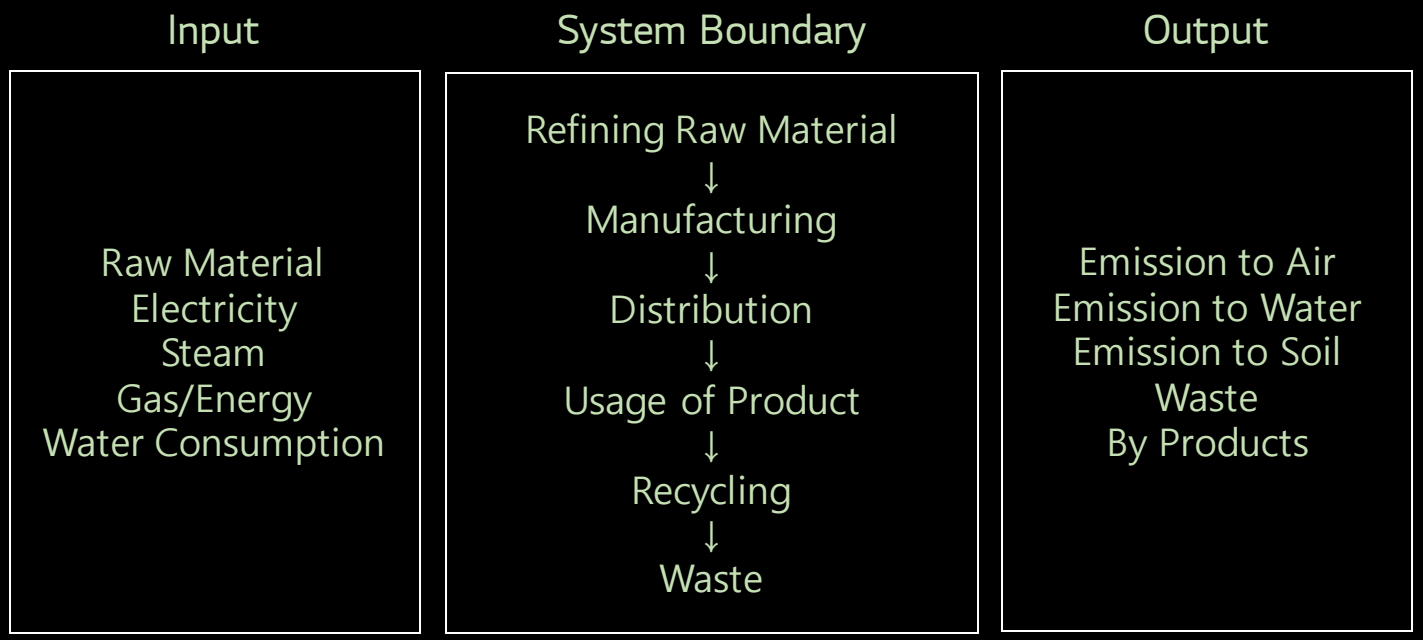
Note) Typical values are only for material selection purpose and variation within normal tolerances are for various colors.
Values given should not be interpreted as specification and not be used for part or tool design.

Goal Two :
Providing Better Environmental Benefit

Goal Two Problem :
Providing Better Environmental Benefit is Not Simple

Life Cycle Assessment (LCA)

Full Examination and Calculation of Entire Value Chain



Environmental Benefit

PCR PC 50%
PC/ABS

CO_2 Emission

-40%

Water Consumption

-30%

Cumulative Energy Demand

-30%

LCA Report (Virgin vs PCR)

LETZer

PCR Type

LG Chem

LCA Results report

- Target product
  - LUPOY ER5007N (1 kg)
- Data collection period
  - 2020.01.01 ~ 2020.12.31.
- Standard
  - According to ISO 14040 & 14044

Life Cycle Assessment Results

Impat Category	Unit	Quantities
Climate Change	kg CO2 eq.	1.90E+00
Acidification	kg SO2 eq.	1.13E-02
Ozone depletion	kg CFC11 eq.	2.94E-07
H2O depletion	m3 H2O eq.	2.38E-02
Eutrophication	kg PO43- eq.	1.46E-03
Photochemical oxidation creation	kg ethylene eq.	7.97E-04
Abiotic Resource depletion	kg Sb eq.	1.68E-02

Life Cycle Assessment Background Information

1. Functional Unit

To produce 1kg of polycarbonate (PC) based compound, in Korea, in the year of 2020

2. System Boundary

Cradle to Gate (excluding environmental burden of the first cycle of recycled materials)

3. Characterization Method

CML 2001 (Climate Change, Acidification, Ozone depletion, Eutrophication, Photochemical oxidation creation, Abiotic Resource depletion)
ReCipe 1.08 Midpoint (Water depletion)

4. Data Source

- Upstream: On-site data were collected for recycled materials, secondary data being utilized for the other materials.
- Manufacturing: On-site data were collected.
- Downstream: Not applicable

5. Data quality and Sensitivity

6. Allocation

Since raw materials, utilities, energy consumptions, and wastes in the process are not separately managed between the product and by-products, an allocation according to the production weight ratio was considered. As for a by-product which reuses internally, it was considered as a close loop.

LETZer

Virgin Type

LG Chem

LCA Results report

- Target product
  - LUPOY HR5007AC (1 kg)
- Data collection period
  - 2020.01.01 ~ 2020.12.31.
- Standard
  - According to ISO 14040 & 14044

Life Cycle Assessment Results

Impat Category	Unit	Quantities
Climate Change	kg CO2 eq.	3.60E+00
Acidification	kg SO2 eq.	2.43E-02
Ozone depletion	kg CFC11 eq.	8.91E-07
H2O depletion	m3 H2O eq.	4.05E-02
Eutrophication	kg PO43- eq.	3.54E-03
Photochemical oxidation creation	kg ethylene eq.	1.03E-03
Abiotic Resource depletion	kg Sb eq.	3.49E-02

Life Cycle Assessment Background Information

1. Functional Unit

To produce 1kg of polycarbonate (PC) based compound, in Korea, in the year of 2020

2. System Boundary

Cradle to Gate (excluding environmental burden of the first cycle of recycled materials)

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Bio-Based

Technical Description

Bio PBT/TPEE

Fermentation (In-house) → Polymerization (In-house)

Bio-Mass → Bio-BDO → Bio PBT
→ Bio TPEE

Bio PA56 (Replace PA66)

Fermentation → Polymerization → Compounding (In-house)

Bio-Mass → Bio-PMDA[1] → Bio PA56 → Bio PA56 Compound

Source

Corn

Sugarcane

Milestone

*Timeline may change during development

- March. 2021
- Dec. 2021
- Dec. 2024

PBT/TPEE : Feasibility Test → Bio-BDO Production (In-house)

PA56 : Feasibility Test → Mass Production

1) Pentamethylenediamine

Bio-Mass Balanced

Bio Polycarbonate (PC)

Technical Description

Used Cooking Oil

Mass-Balance Approach
(Follow Allocation Rule from Input to Output)

Certification for Bio-Mass Source

Supply Chain

Input (Bio-Mass Source) → Mix with Petrochemical material (NCC) → Intermediate (Monomer, Polymer) → Mix with Petrochemical material → Output (Polymer Compound)

Milestone

*Timeline may change during development

PC :	April 2021	Jul 2021	Dec.2021
	Source Bio-Mass ISCC[1] Certi.	Install Storage Tank	Mass Production

1) International Sustainability and Carbon Certification

Bio-Mass Balanced

ISCC PLUS Certificate

Certificate Number: ISCC-PLUS-Cert-DE105-87652601

Control Union Certifications Germany GmbH
Dorotheastr. 30, D-10318 Berlin

certifies that

LG Chem Ltd. (Iksan)
Seogam-ro 99, 54587 Iksan-si, Jeollabuk-do
Republic of Korea

complies with the requirements of the certification system

ISCC PLUS
(International Sustainability and Carbon Certification)

Place of the audit
(if different from the legal address of the system user as stated above; only applicable for paper traders):
Address of the audit / n.a.

This certificate is valid from 09.04.2021 to 08.04.2022.

The site of the system user is certified as:
Other Conversion Unit (Compounding)

The scope of the certificate includes the following chain of custody options:

Mass balance

Berlin, 09.04.2021
Place and date of issue

CUC Germany GmbH
Stamp, Signature of issuing party

Annex to the certificate:

Sustainable materials handled by the certified site
(This annex is only applicable for material handled under the scopes: farm/plantation, point of origin, central office, (farm/plantation or point of origin) first gathering point, processing unit (any type) but **not** for material that is only traded and/or stored)

This annex is only valid in connection with the certificate:

ISCC-PLUS-Cert-DE105-87652601 issued on 09.04.2021

Input material	Output material	Add-ons (voluntary)[1]	ISCC waste process applied[2]	SAI/ FSA[3]	FEFAC[4]
Bio-circular Acrylonitrile butadiene styrene (ABS)	Bio-circular PC blends		yes	N.A.	N.A.
Circular PC	Circular PC Blends		yes	N.A.	N.A.
Bio-circular PC	Bio-circular PC Blends		yes	N.A.	N.A.

1) ISCC PLUS add-ons (voluntary application, see www.iscc-system.org for further information):
- 202-01: Environmental management and biodiversity
- 202-02: Classified chemicals
- 202-03: SAI Gold
- 205-01: GHG emission requirements
- 205-02: Consumables
- 205-03: Non GMO for food and feed
- 205-04: Non GMO for technical markets

2) Yes: The raw material meets the ISCC definition of waste or residue, i.e. it was not intentionally produced and not intentionally modified, or contaminated, or discarded, to meet the definition of waste or residue

No: The raw material complies with the ISCC Principles 1 – 6 for the cultivation of sustainable biomass

3) Farm Sustainability Assessment (FSA) was developed by the Sustainable Agriculture Initiative (SAI)

SAI Silver Compliance: ISCC Compliant material can be claimed as "Equivalent to FSA 2.1 Silver"

SAI Gold Compliance: ISCC Compliant material incl. add-on SAI Gold can be claimed as "Equivalent to FSA 2.1 Gold"

4) FEFAC: European Feed Manufacturers' Federation. ISCC compliant materials can be claimed as "in line with FEFAC soy sourcing guidelines"

Chemical Recycle

Chem. Recycled PBT/TPEE

Chem. Recycled PC

Technical Description

Glycolysis (In-house) Re-polymerization (In-house)

Waste PET → BHBT[1] → C-RC PBT
→ C-RC TPEE[2]

Alcoholysis (In-house) Re-polymerization (In-house)

Waste PC → BPA[3] → C-RC PC

Source

Waste PET

Waste PC

Milestone

*Timeline may change during development

	Jun. 2021	Dec. 2022	Dec. 2024
PC :	Pilot line Construction	Pilot Test	Mass Production
PBT/TPEE :		Feasibility Test	Mass Production

1) Bis(4-Hydroxybutyl) Terephthalate 2) Thermoplastic Elastomer Ether 3) Bisphenol-A

LG Chem | Overseas Sites

● Manufacturing Subsidiaries (24) ● Sales Subsidiaries (13) ● Regional Branch Offices (5) ● R&D Center (1)

*EP (Engineering Plastic)

Europe

- Wroclaw (Est.2005) – EP (41kMT)
  (Est.2016) - Automotive Battery
- Moscow
- Frankfurt
- Istanbul

America

- Atlanta
- Torrance
- Troy
- Holland (Est2000) - Automotive Battery
- Evansville (Est.2018) - Sealant
- Sao Paulo
- Mexico City

Asia

- Beijing (Est2004) - Polarizer
- Tianjin (Est2004) – EP (50kMT)
  (Est2005) - PVC,VCM,EDC
  (Est2009) - SBS
- Guangzhou (Est.2002) – EP (60kMT)
  (Est. 2018) - Polarizer
- Chongqing (Est2015) – EP (20kMT)
- Ningbo (Est1996) – EP (30kMT),ABS,SBL
- Nanjing (Est2003) - Mobile Battery, Polarizer
  (Est2014) - Automotive Battery
  (Est. 2017) - ESS Battery
- Huizhou (Est2009) - ABS
- Wuxi (Est2017) – ESS Battery Pack
  (Est2018) - Cathode Material
- Quzhou (Est2018) - Precursor
- Taipei (Est2004) - Polarizer
- Tokyo
- Iksan & Other Partners – EP (210kMT)
- Daesan – TPEE (20kMT) — Polymerization
- Yeosu – PC (170kMT) — Polymerization
- Haiphong (Est2017) - Polarizer
  (Est2018) – EP (11kMT)
- Ho Chi Minh (Est1995)-Plasticizers
- Bangkok
- Jakarta
- Kuala Lumpur
- Amman


Thank you