BOREALIS

Funded by the European Union
NextGenerationEU

SPIRIT

Sustainable Plastics Industry Transformation

Jari Lehtinen

February 2023

SPiRiT

Borealis at a glance

Ownership structure:

75%
OMV, Austria

25%
ADNOC, United Arab Emirates

120
Countries. Head Office in Vienna, Austria

6900
employees worldwide

Production and distribution of polyolefins solutions, base chemicals and fertilizers

Our JV's: Borouge – one of the world‘s largest integrated polyolefin complexes (Ruwais, UAE)


Borealis Porvoo

#2
Among polyolefin producers in Europe

#8
Among polyolefin producers worldwide

1.4 bnEUR
net profit, total sales 12.3 bnEUR (2021)

>100
Priority patents filed in 2021, #1 in Austria

3
Polyolefin recycling operations in Europe

SPIRIT

SPIRIT mission
Sustainable plastics industry transformation

- Plastics are irreplaceable materials of modern society which enable growth and help us save resources

"The plastics dilemma"

- To create a more sustainable future, we have to solve the current three key challenges of plastics industry

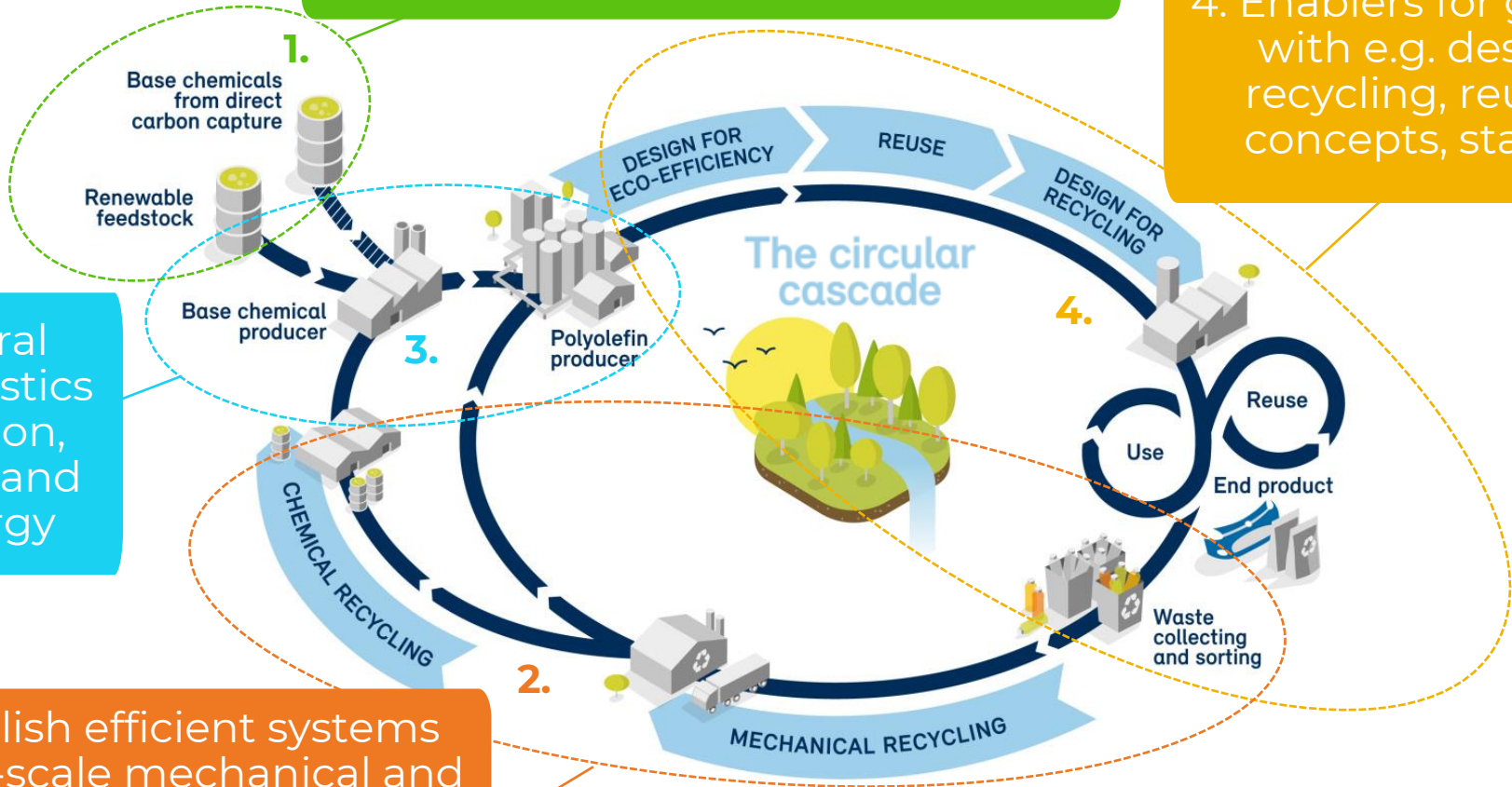
SPIRIT programme themes
Four R&D areas

1. Transform the fossil feedstock into renewable and recycled feedstock

4. Enablers for green transition with e.g. design for/from recycling, reuse, recycling concepts, standardisation

3. Carbon-neutral production of plastics with electrification, green hydrogen and renewable energy

2. Establish efficient systems for large-scale mechanical and chemical recycling of plastics



SPIRIT is a Business Finland programme

Ecosystem funding

- 4-year RD&I programme 2022-2025 (TRL ≤ 6)
- Borealis won the BF leading companies challenge competition("Veturi" company)
  - Committed to invest 50 M€ more into R&D, for which 40% funding decision at 20 M€
- BF reserves additional funding resources
  - Parallel partnership projects fitting the SPIRIT roadmap can separately apply additional funding (40-70% of costs)
  - Up to max 50 M€ budgeted for the entire ecosystem
  - Three calls annually (Jan, Apr, Sep)

→ Overall 150 M€ RD&I effort into SPIRIT roadmap!

BUSINESS FINLAND

Funded by the European Union
NextGenerationEU

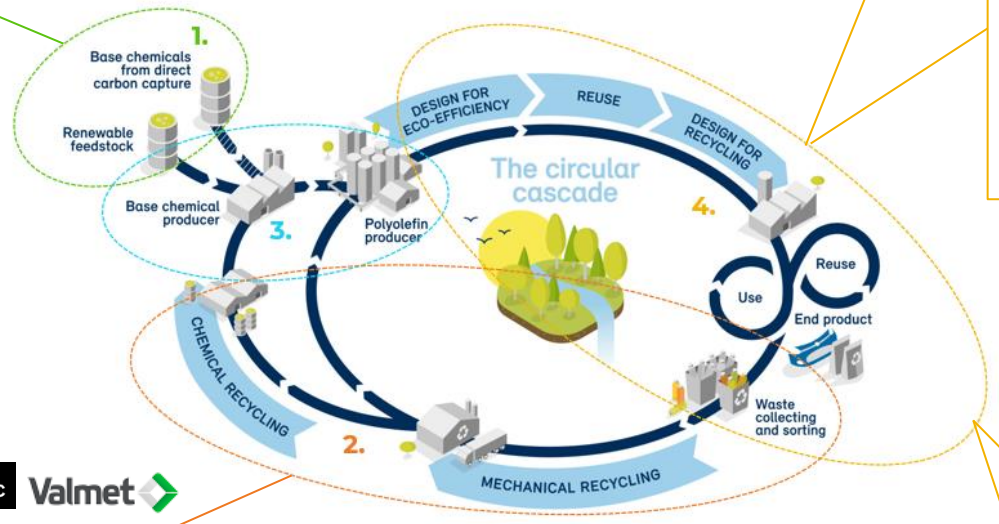
Notes: TRL = Technical Readiness level, "Veturi" means locomotive

Some first partnership project examples...

ForestCUMP: BF approved co-innovation consortium, VTT & LUT + 11 companies, biogenic CO_2 from pulp mills and energy sector, CCU HT-FT technology targeting light hydrocarbons (olefins), public research budget 2.9 M€ (BF 70%) + company projects

DREAM: BF approved, Rani Plast company project, data-driven approach for recycling ecosystem and advanced modelling of environmental performance

SULKI: BF approved, Orthex company project CirPE evolving into larger SULKI consortium (e.g. brand owners), closed-loop recycling solution for PP products in food-contact applications



“Plastex”: BF approved Plastex company project, closed-loop recycling solution for blow moulded HDPE products in food-contact applications (e.g. water containers)

Zero ink: BF approved Cajo Technologies company project, laser based marking of plastic products/packaging without labels /stickers/printing

UrbanMill: BF approved co-innovation consortium, VTT & A! + 13 companies, chemical recycling technology, themes like different plastic types (e.g. liquid packaging, PA, etc.), pre- and post-treatment, public research budget 3.0 M€ (BF 70%) + company projects

SPiRiT

Some packaging related issues…

- Design for Recycling (DfR)…
- From multi-material to mono-material…
- Separable materials…
- Labels, stickers, printing, colours…
- Function of packaging: protection, marketing…
- Shopping trends (e.g. pre-ordering groceries, internet, etc.)…
- Re-use over single use…
- Renewable materials, mass balance…
- Recycled materials, collection, sorting, food-contact applications…
- LCA, overall sustainability, green washing…

SPiRiT

Examples of “good” and “bad” packaging recyclability can be found in every supermarket

All packages are fulfilling the main requirements of packaging – protecting (reducing food waste) and marketing of the product

Transparent or white plastics…Different colours of plastics
All printing in carton, packaging parts to be separated…. Paper based sticker attached to plastic (not separable)

How to join SPIRIT?

- SPIRIT ecosystem is open for all partners with fresh ideas and commitment to contribute to the sustainable plastics industry transformation
- Visit our website **www.spiritprogramme.com** or contact the SPIRIT core team

1. Renewable feedstock

Antti Ilves
antti.ilves@
borealisgroup.com
Tel. +358 50 379 0284

2. Circular plastics

Jaakko Tuomainen
jaakko.tuomainen@
borealisgroup.com
Tel. +358 50 379 4525

3. CO_2 reduction

Mikko Rönkä
mikko.ronka@
borealisgroup.com
Tel. +358 50 379 4266

4. Enablers for green transition

Auli Nummila-Pakarinen
auli.nummila-pakarinen@
borealisgroup.com
Tel. +358 50 379 4588

5. Programme and ecosystem leadership, communications

Jari Lehtinen
jari.lehtinen@borealisgroup.com, Tel. +358 50 379 4270

SPIRIT

SPiRiT

Thank you!

www.spiritprogramme.com

BOREALIS

Funded by the European Union
NextGenerationEU

Design for recycling is an extremely important enabler

Examples of good packaging design

- Use whenever possible a mono-material (PE, PP or PET) to form the flexible or rigid packaging body
- Use transparent, clear or white, for the main body of the pack
- Design the package in such a way that it can be fully emptied
- Ensure that when paper is designed in combination with plastics on a single pack, it must be separable (and separated by the end user in order to access the contents)
- Packaging must contain a recycling symbol and a sorting instruction

Be sure to. . .	Doing so is important because...
1. Use PE or PP whenever possible to form a mono-material flexible or rigid packaging body.	Mono-materials are more easily recyclable than multi-layer, multi-material packaging. Generally speaking, the most efficient and widespread collection, sorting and recycling systems are currently in place for mono-material PE, PP and PET. While collection and sorting systems for other plastics do exist in certain regions, they are not yet available on an industrial scale.
2. Use transparent, clear or white, for the main body of the pack.	With existing technologies, it is difficult, costly and sometimes impossible for recyclers to remove pigments from the pack body. White pigment body of packaging ONLY if barrier to light is required.
3. Design the package in such a way that it can be fully emptied after use.	If the content of the pack cannot be fully emptied, the residue complicates the recycling process. It is more expensive and produces an inferior recycle (recycled plastic) because the odour, colour or mechanical properties contaminate the final result, and the environmental (LCA) impact of the product is inferior.
4. Use compatible and separable combinations of polymer types, barrier layers, dyes and adhesives.	Minimising incompatibilities produces a recyclate with better properties and therefore more suitable for a second life in consumer goods packaging. We recognise that in certain cases there are markets where incompatible resins are necessary to match an application's requirements. For these types of packaging it is necessary to design the packaging so that it can easily be separated from the PE and PP recycling streams during the washing process (owing to the difference in densities).
5. Use aluminium foil as a barrier layer only when it can be easily separated from the pack for aluminium recycling.	Aluminium foil as an inseparable barrier layer is problematic in the recycling process. If required every effort should be made to ensure that aluminium foil can be separated from the main pack body (or fragments thereof containing aluminium particles) for aluminium recycling by means of eddy-current separation.
6. Follow specific density guidelines when selecting pack components, including labels, sleeves and metallisation.	In the recycling process polyolefins are sorted by density in a water-based float sink system. This cleanly separates waste streams according to polymer types, such as PE, PP or PET. However, if barrier layers, foaming agents or fillers are used, they change the density of the polymers and this may lead to incorrect sorting. As the type of labels used also affects density, labels and sleeves should ideally be removable and separable by density.
7. Design labels, sleeves and other on-pack printing in such a way that they can be easily separated from the main pack body. For both PE and PP packs, use the same polymer and same colour for the entire pack – body, caps, closures and labels.	Labels, sleeves and other on-pack components complicate the recycling process and contaminate the recycled product. Ideally they should be completely removable. On-pack pigments and colours applied through direct, reverse or trap printing can only be removed in the recycling process through a short friction washing cycle using natural water at temperatures of up to 50° C. If that is not sufficient to remove the label from pack body such as for in-mould labels use washable inks. It is preferable to print only the most essential information to fulfil legal requirements (sell-by date, batch number, etc.) directly on the main body pack. Consistency in components helps the optical scanner sort the packs correctly for recycling.
8. Use as little surface space as possible for printing or labelling on the pack.	As a rule, the less space taken up by a label or printing inks, the more likely the pack is to be recognised during sorting and results in higher quality recyclates.
9. Use light-coloured, non-gassing inks for essential on-pack information.	Inks that cannot be removed and thermally neutralised during recycling disrupt the process. It is therefore very important to use light-coloured, non-gassing inks that are temperature resistant up to 240° C.
10. Ensure that when paper is designed in combination with plastics on a single pack, it must be separable and separated from the main plastic body by the end user in order to access the contents.	Paper fibres cannot be effectively removed in the recycling process as it clings to polymer flakes and degrades under heat, setting off gasses, and otherwise causing discolouration and odours. It is essential that the end user can separate the paper from the main plastic body of the pack.

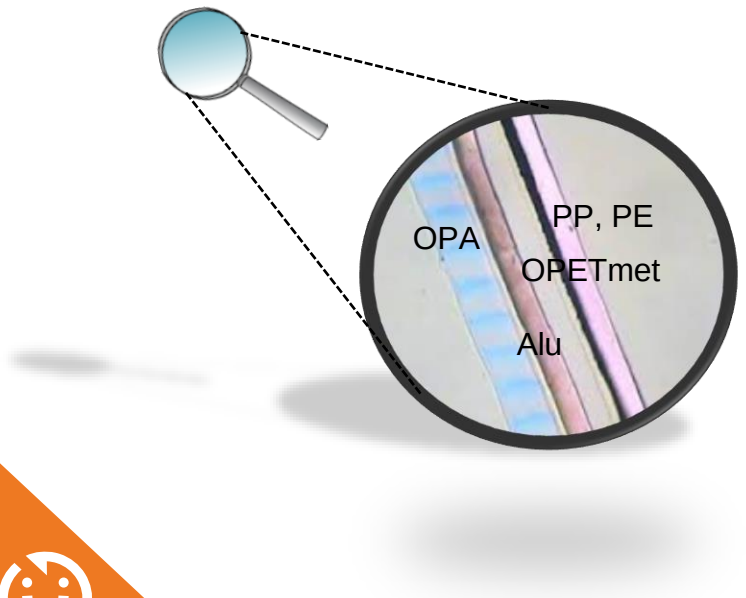
For further information and additional technical guidance on designing Polyolefin packaging for recyclability, contact
sustainability@borealisgroup.com
www.borealiseverminds.com

More info: Borealis EverMinds™ - 10 codes of conduct
10 Codes of Conduct for Design for Recyclability | Must watch for all packaging designers – YouTube

Design for recycling
From multi-material to mono-material solutions

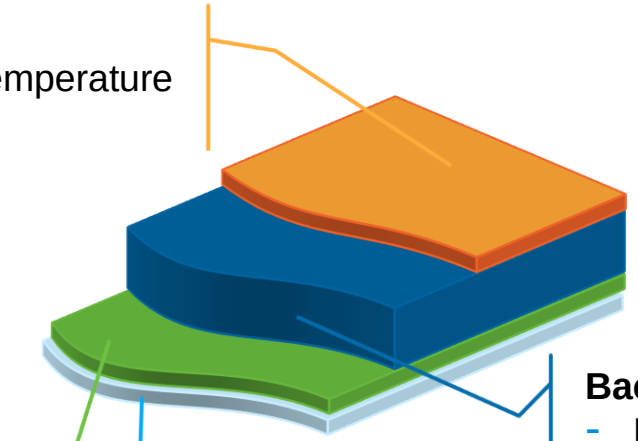
- Polyolefins are essential in packaging – roughly 70 % of all packaging are polyolefins (PE or PP)
- In mono-material solutions the target is 100 % PE (typically 90-95%) or 100 % PP (typically 90-95%)

Current solution



Future mono-material solution (PE or PP)

Sealant:
- Low sealing temperature
- Tight sealing



Backbone:
- Mechanical strength
- Stiffness

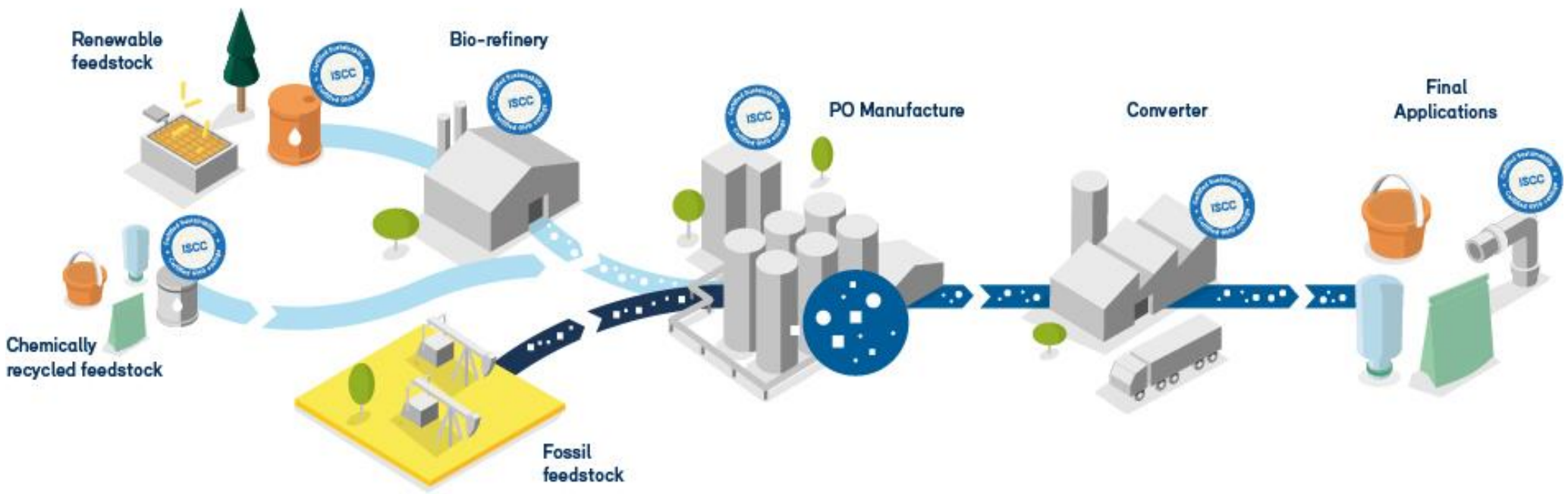
Barrier layer
- Shelf life
- Lamination of layers

Surface layer
- Thermal resistance
- Printing substrate

What is mass balance?

A system that allows Renewable & Chemical feedstock to be allocated and traced

The Mass Balance Model



Both Borcycle C & Bornewables use the ISCCPlus (International Sustainability & Carbon Certification) certification. This certification system ensures the traceability of the renewable, sustainably produced feedstock from its point of origin through the **entire chain of custody**.