

The Sustainable Plasticizers for the New Era of Wire & Cable

Innovations, Market Trends, and Real-World Impact

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CEH Plasticizers

S&P Global
Commodity Insights

Chemical Economics Handbook
December 2024

Plasticizers

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Latest version : December 2024
Update every 3 years

Agenda

- **Introduction**
 - New Era of Wire & Cable?
 - Overview of PVC Wire and Cable Market
 - Importance of Plasticizers
- **Types of plasticizers**
 - Traditional vs Sustainable Plasticizers
- **Why Sustainability Matters**
 - Environmental Impact, Regulatory, Consumers
- **Choosing Sustainable Plasticizers for Wire & Cable**
- **Innovations in plasticizers and their applications**
 - Example of sustainable plasticizers;
 - ECOLIBRIUM, Pevalen™ Pro 100, ELATUR DINCD, ECODEHCH, rDOTP
- **Conclusion & Recommendations**

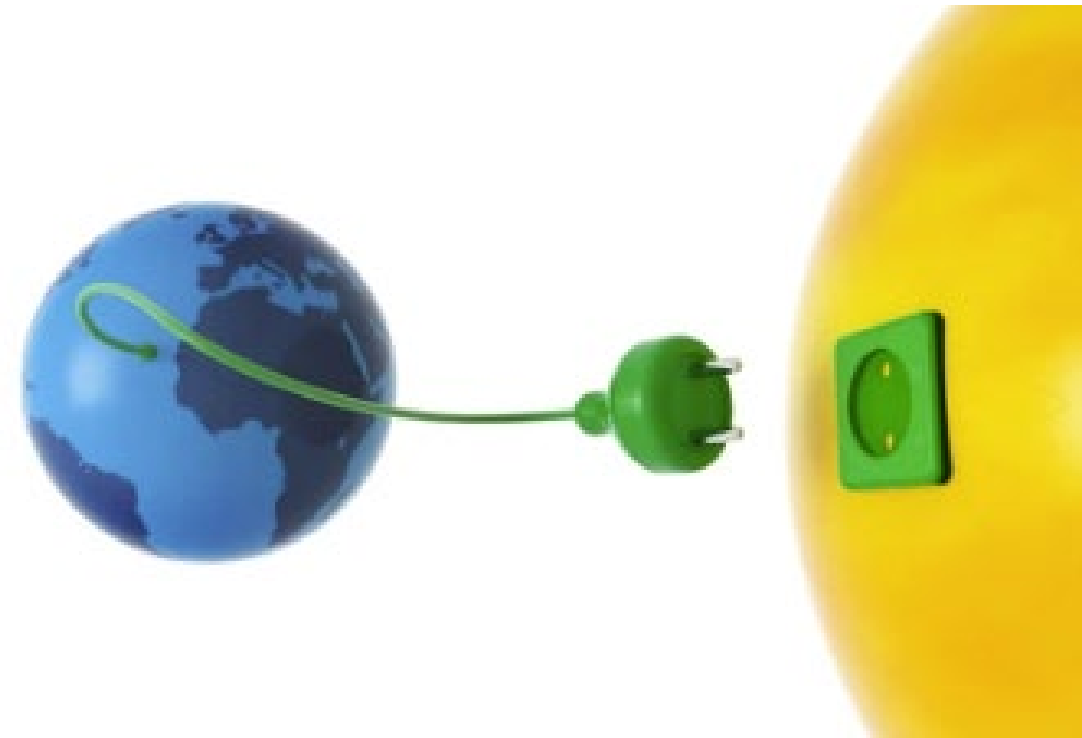
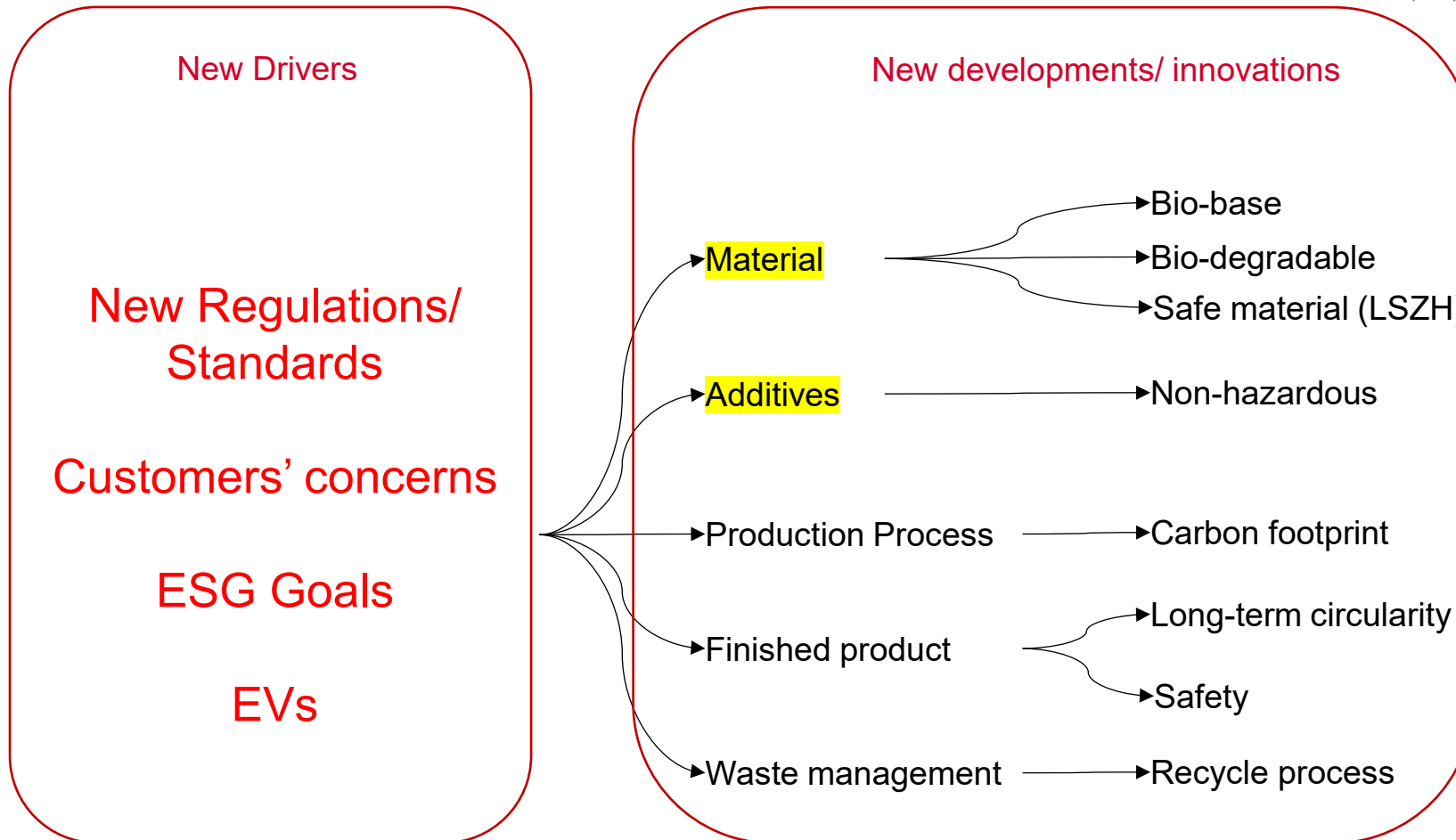


Photo credit: <https://www.shutterstock.com/image-illustration/planet-earth-sun-connected-by-electric-179808563>

New Era of Wire & Cable?



TAOKA Chemical developed new ester type biodegradable plasticizer, BPC-110 series, which can be used for biodegradable polymers such as polylactide plastics (PLA).



<https://www.shutterstock.com/image-vector/plastic-recycling-types-material-resin-code-213796000Z>, <https://www.shutterstock.com/image-vector/vector-ball-stick-model-thermoplastic-polymer-195103362Z>, TAOKA, BASF, <https://kvcable.com/what-are-some-of-the-environmentally-friendly-types-of-cables-currently-being-heavily-developed/>

Wire Insulation Materials

Thermoplastics, Thermoset, Fluoropolymers, etc.

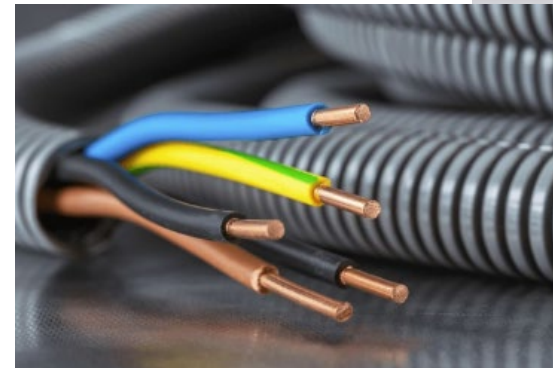
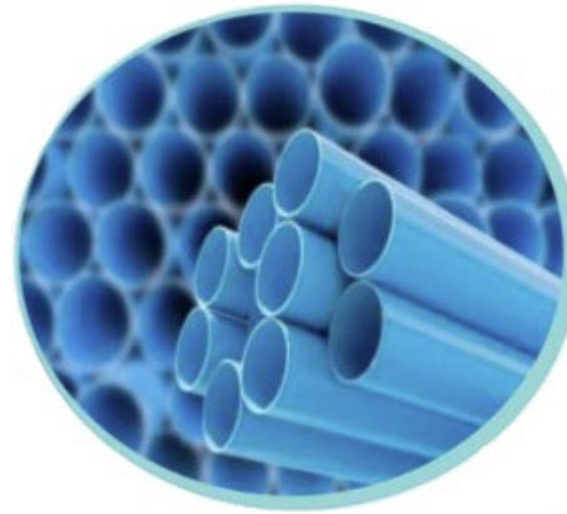
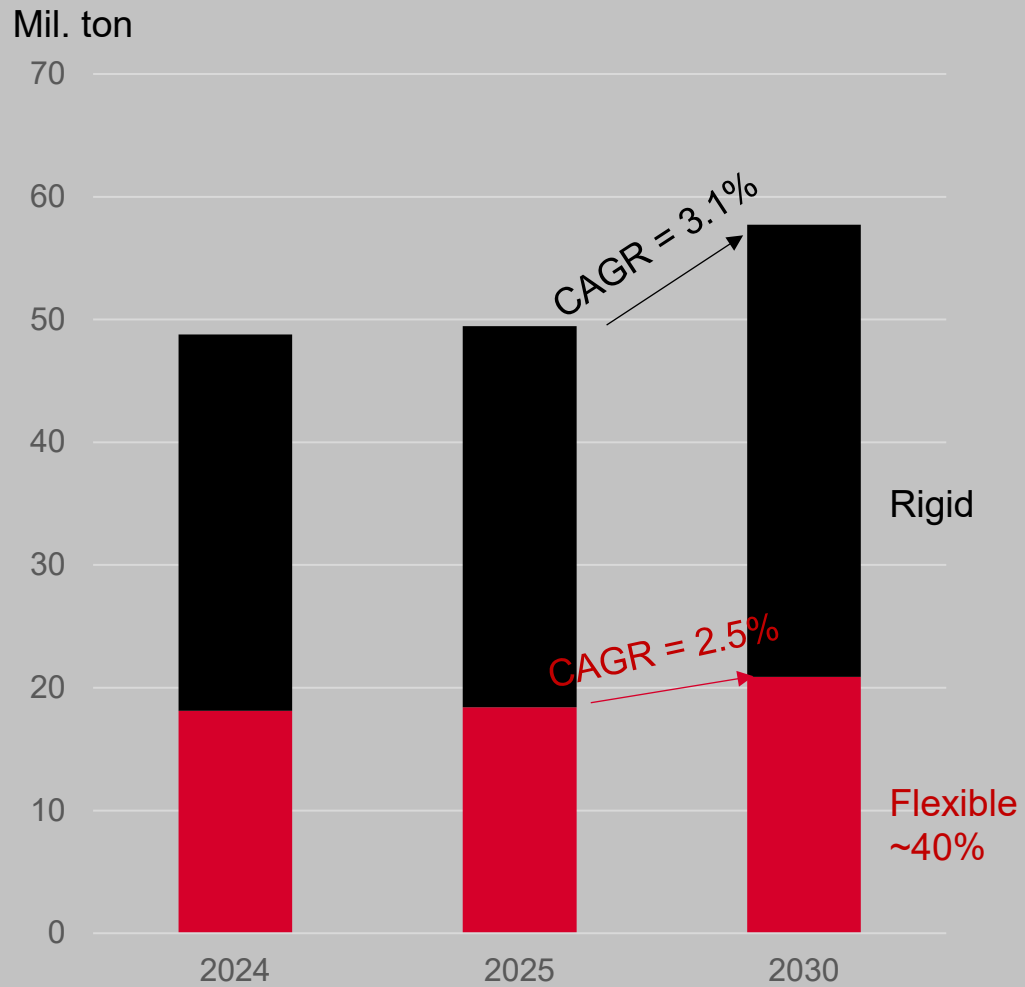
- Polyvinyl Chloride (PVC)
- Polyethylene (PE)
- Polyvinylidene Fluoride (PVDF)
- Cross-Linked Polyethylene (XLPE)
- Ethylene Propylene Rubber (EPR)
- Polytetrafluoroethylene (PTFE)
- Fluorinated Ethylene Propylene (FEP)
- Silicone Rubber

Example of insulation materials and their features and applications

Material	Temp. rating	Dielectric Strength	Flexibility	Typical Applications
PVC	Moderate	Good	High	Residential wiring, Appliances
XLPE	High	Excellent	Moderate	Indus. Cables, Underground
PTFE	Very High	Excellent	Low	Harsh Environments
Silicone Rubber	High	Good	Very High	Appliances

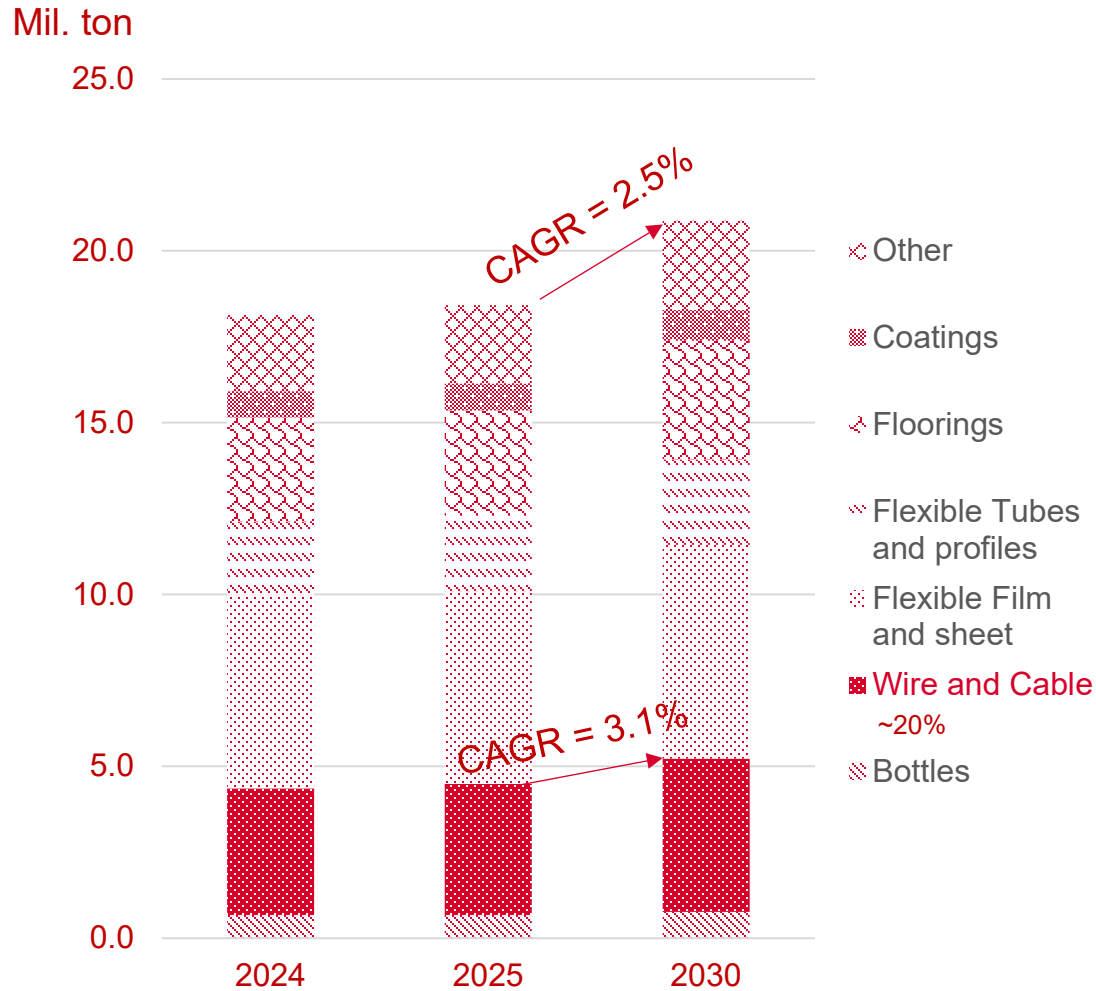
<https://www.tevelec.com/electrical-wire-insulation-materials/>

Global PVC consumption



Source: S&P Global Commodity Insights
 Photo credit : <https://www.shutterstock.com/image-photo/pressure-flexible-pvc-tubing-vinyl-hose-1472418788>, <https://www.istockphoto.com/photo/white-leaded-glass-window-gm154959485-16294134>

Global Flexible PVC consumption



The Versatile Workhorse: Categorizing PVC for Wire & Cable Applications

PVC for Wire & Cable is the fastest growing segment:

- Projected growth for PVC in Wire & Cable is 3.1% per year during 2025-30, outpacing the 2.5% CAGR for total global flexible PVC consumption.

Category	Key property	Products
Standard/ Appliance grade	Flexibility (70C) and cost -effective	Appliance power cords, internal electronic wiring, lamp cords
Durable construction grade	Flame retardancy and general insulation (70C-90C)	Building wire, conduit wiring, control cables
High heat/ Automotive	High thermal stability (105C) and low volatility	Automotive wiring harnesses, motor lead wire, high temp. electronic wiring
Outdoor/ Weather resistance	UV resistance and cold flexibility	Outdoor power cables, garden hoses, patio/deck wiring, underground service drop cable sheathing
Industrial/ Robotic	High Flexibility and oil/chemical resistance	Control cables for industrial machinery, jacket for instrument cables

Source: S&P Global Commodity Insights

General formula for flexible PVC compound

Plasticizer is the major component for flexible PVC

Component (PHR)	Semi-Rigid PVC	Flexible PVC	Super Flexible PVC
PVC resin	100	100	100
Plasticizers	5-25	40-60	80-150+
- Primary	5-25	35-55	70-140+
- Secondary	0-5	5-15	10-30
Stabilizers	2-5	2-5	2-5
Lubricants	0.5-2	0.5-2	0.5-2
Fillers (e.g. CaCO ₃)	5-20	5-20	0-5
Pigments	0.1-2	0.1-2	0.1-2
Example products	<ul style="list-style-type: none"> • Credit cards • Blister packaging • ID badges • Rigid pipe fittings 	<ul style="list-style-type: none"> • Electrical cable insulation • Garden hoses • Gaskets and Seal • Vinyl flooring 	<ul style="list-style-type: none"> • Medical tubing • Blood bags • Inflatable rafts

Note: PHR : Parts per hundred resin

Plasticizer component ~27%-32%

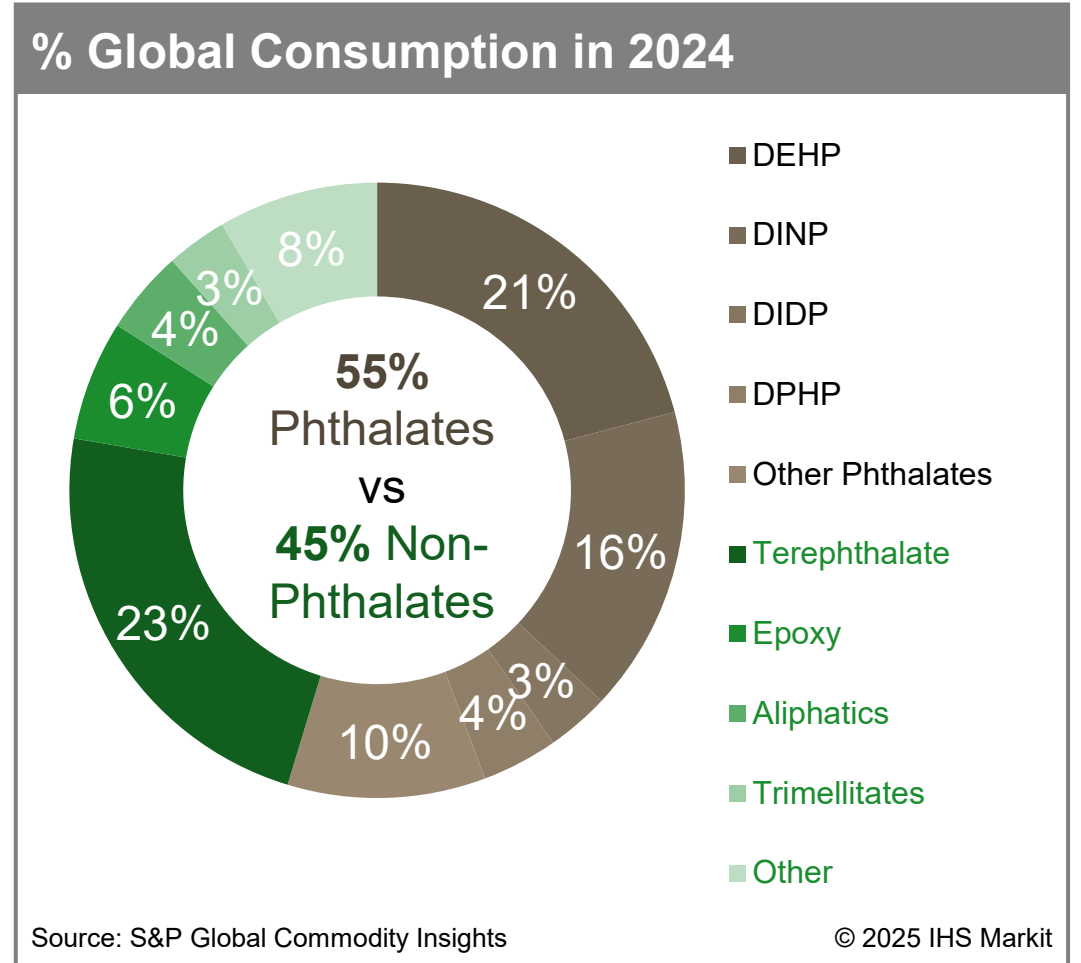
Classification of plasticizers : Primary vs Secondary Plasticizers

Primary Plasticizers	Secondary Plasticizers
Phthalates : DEHP, DINP, DIDP, DPHP	Adipates : DOA*
Benzoate esters*	Chlorinated Paraffins
DINCH*	Citrates: ATBC*, TEC*
ECODEHCH	Epoxidized Soybean Oil (ESBO)
ELATUR® DINCD	Polymeric Plasticizers: Polyester Plasticizers
ECOLIBRIUM™	Phosphates : TCP, TPP
PEVALEN™ Pro 100	Sebacates : DOS*
Terephthalates : DOTP or DEHT or rDOTP	
Trimellitates : TOTM*	

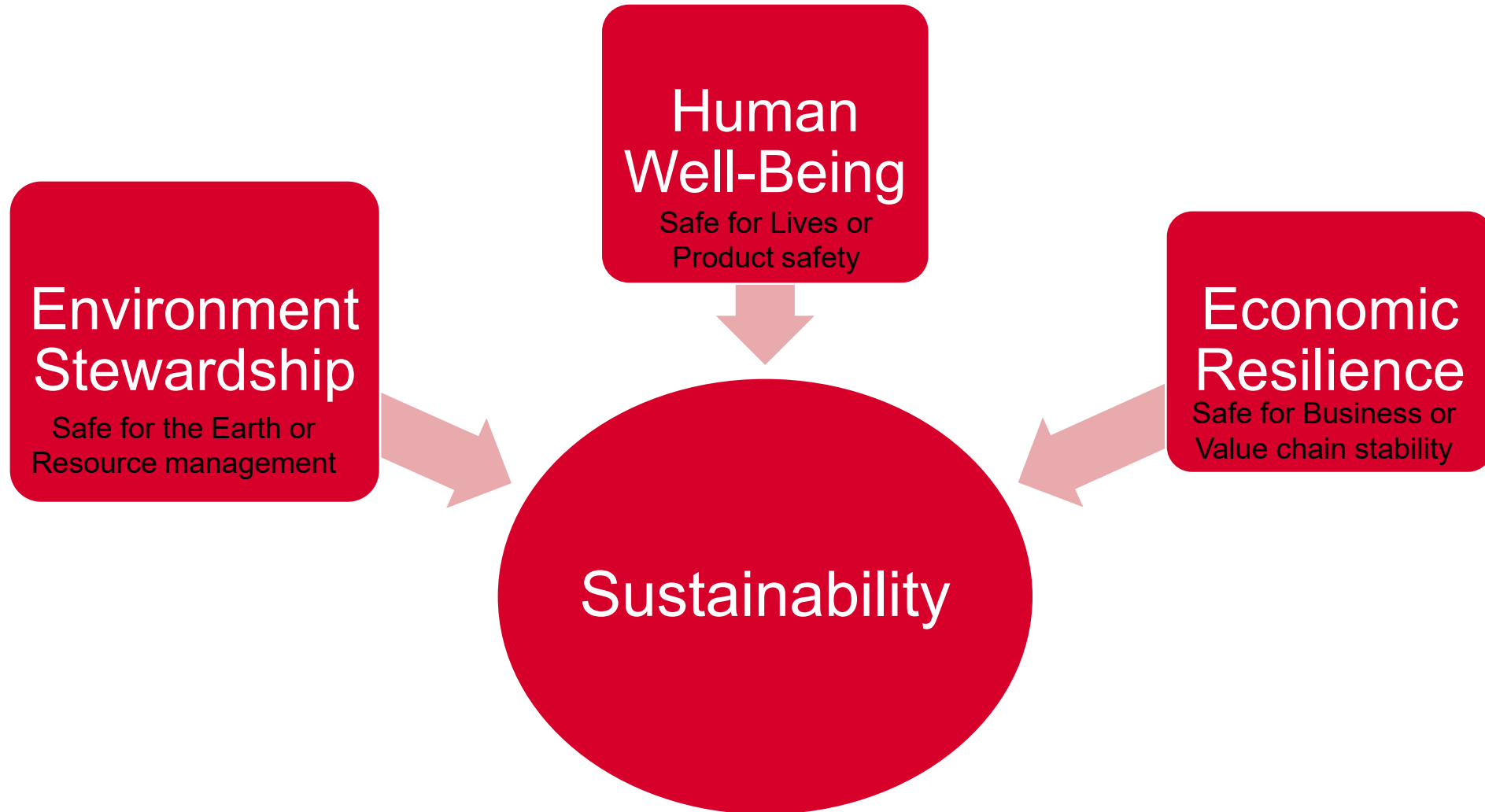
* Can serve as primary or secondary plasticizers

Types of Plasticizers

- **Traditional (Phthalates)**
 - DEHP, DINP, DIDP, DPHP, others
 - Broad range of processing and performance compatibility
- **Sustainable (Non-phthalates)**
 - DOTP, Epoxy, Aliphatics, Benzoates, others.
 - Support sustainability goal



The Threefold Commitment: Defining Sustainability



Key Levers: Materials Innovation, Process Optimization and Regulatory Compliance

Materials Innovation

- New feedstock (Bio-based, circular, etc.)
- Non-Hazardous & high-performance



Process optimization & carbon footprint

- Reduced GHG
- Low carbon footprint



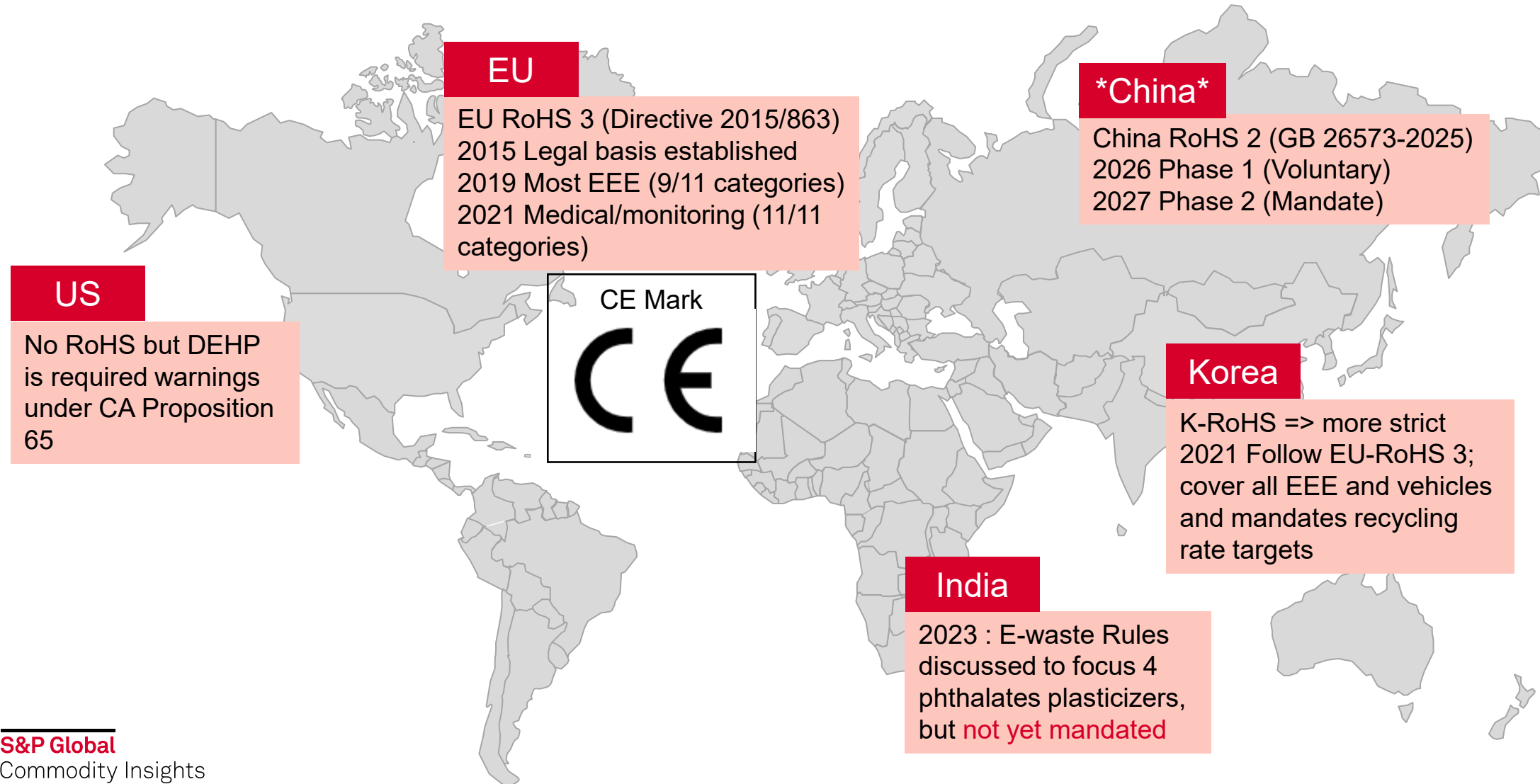
Regulatory compliance & risk mitigation

- RoHS (for EEE market access)
- REACH (for chemical safety and authorization)



The Global Domino Effect: Safety by Export Mandate

EU RoHS compliance is a mandatory prerequisite for affixing the **CE Mark** on the final EEE product.



More detail on China RoHS 2

- Phase 1 : RoHS standard GB/T 26572-2011 (recommended/voluntary)
 - Restrict DEHP (along with DBP, BBP, DIBP) as hazardous substances in electronic and electronic products
 - Content of DEHP, DBP, BBP, and DIBP combined cannot exceed 0.1% by weight
 - Effective date : **January 1, 2026**

- Phase 2 : RoHS GB 26572-2025 (mandatory; replacing GB/T 26572-2011)
 - Restrict 10 substances (aligned with EU RoHS) –
 - Heavy metals (4); Pb, Hg, Cd, Cr⁶⁺
 - Flame retardants (2); PBBs, PBDEs
 - Phthalate Plasticizers (4); DEHP, BBP, DBP, DIBP
 - Effective date: **August 1, 2027**

Impact of phthalate limitation in wire & cable

Industry-wide shift to DOTP since 2012 but as of now, the shift is continuing...

Concerns of DEHP in EU and US since early 2000s

Plasticizer makers exit DEHP ahead of regulation (2012, Perstorp)

2015 Transition period
2019 and 2021 EU-RoHS 3
2026 CN-RoHS 2

The shift is still ongoing (more countries?, more phthalate e.g. DINP?)

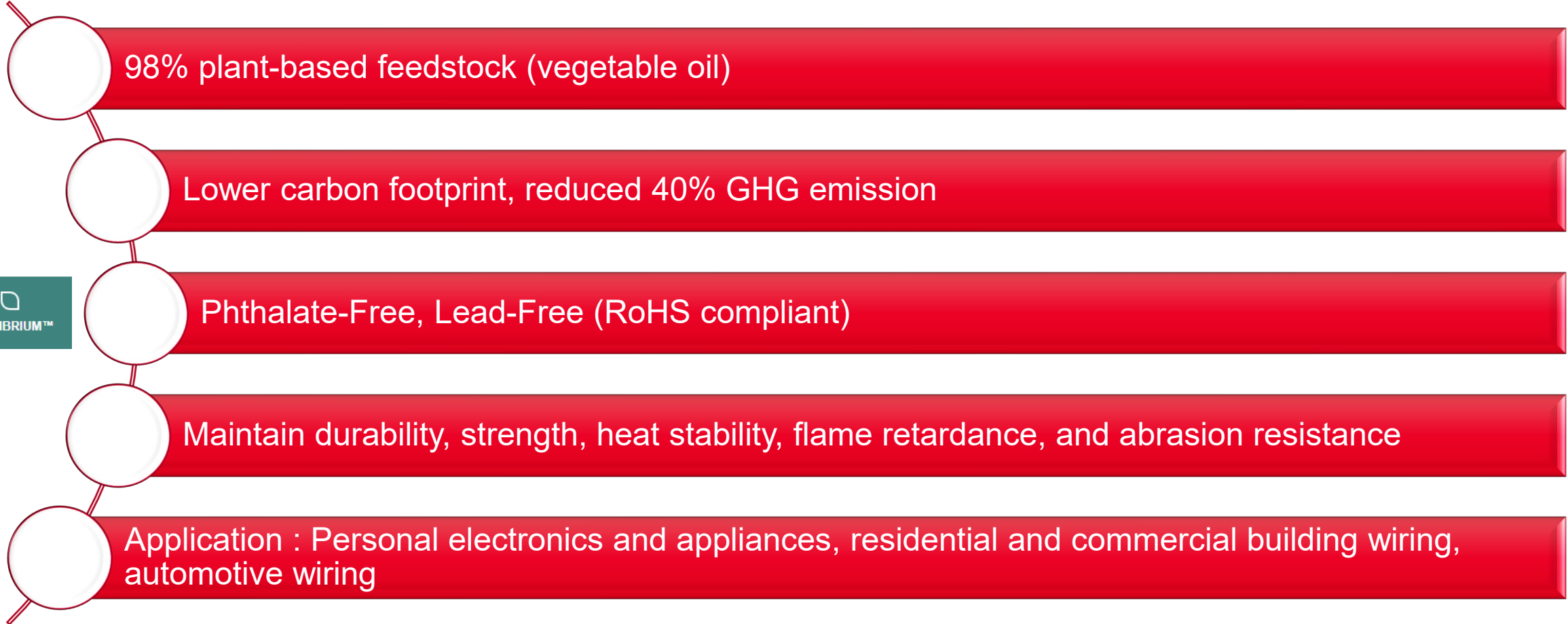
Matching sustainable plasticizers to Wire & Cable products



Wire & Cable Product	Typical Sustainable Plasticizer Used	Key Benefits
<ul style="list-style-type: none"> Low-voltage electrical cable 	DOTP, Epoxidized soybean oil (ESBO), Citrates, ECOLIBRIUM™	Flexibility, thermal stability
<ul style="list-style-type: none"> Automotive wire & cable 	Citrates, ECOLIBRIUM™, Adipates, Pevalen™ Pro 100	Low toxicity, compliance with standards
<ul style="list-style-type: none"> Appliance cords 	DOTP, Adipates, Benzoates	Flexibility, low volatility
<ul style="list-style-type: none"> High-performance cables 	Trimellitates (TOTM), DINCH	High temperature resistance
	DOA, ELATUR DINCD, Pevalen ECODEHCH	Low temperature resistance, UV stability
<ul style="list-style-type: none"> Flame-retardant cable 	TOTM, Citrates, ECOLIBRIUM™	Flame retardancy, durability
<ul style="list-style-type: none"> Recycled-content cables 	PET-based recycled plasticizers	Sustainability, circular economy

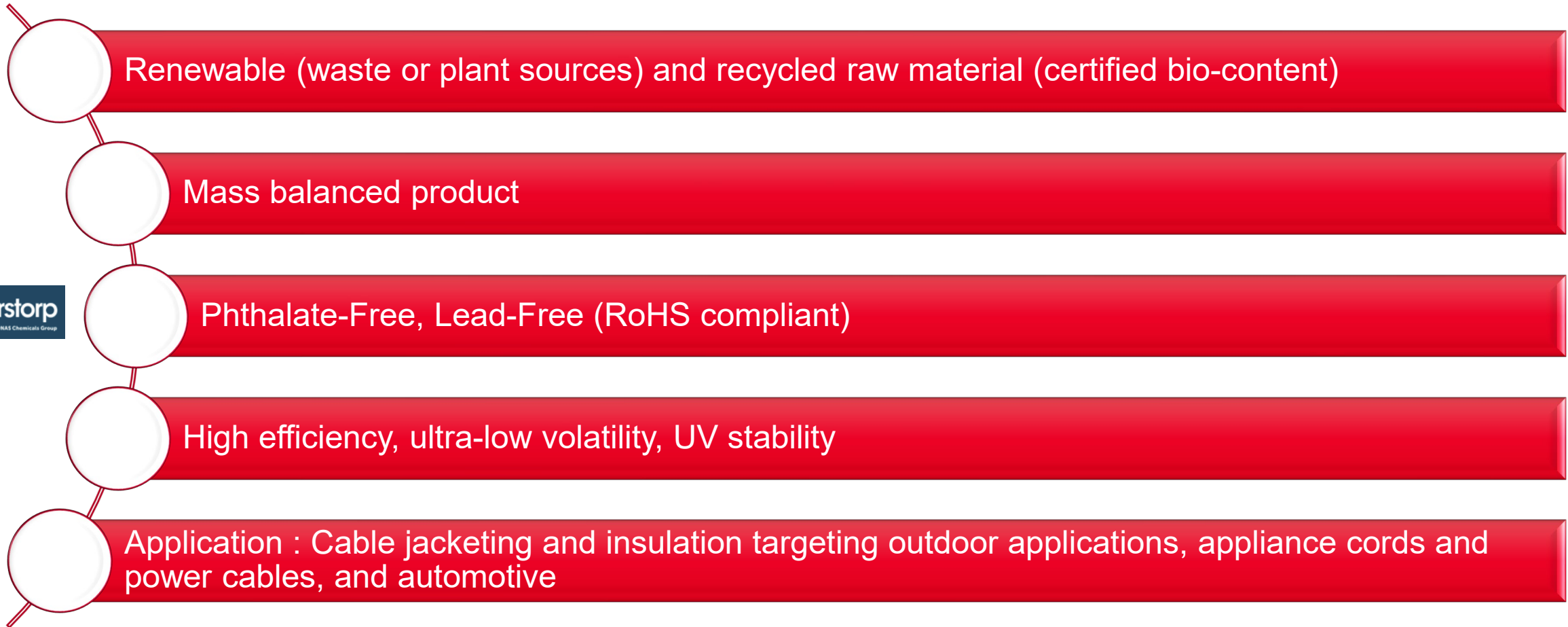
Innovation Spotlight: Bio-Based/Circular Plasticizers

DOW's ECOLIBRIUM™



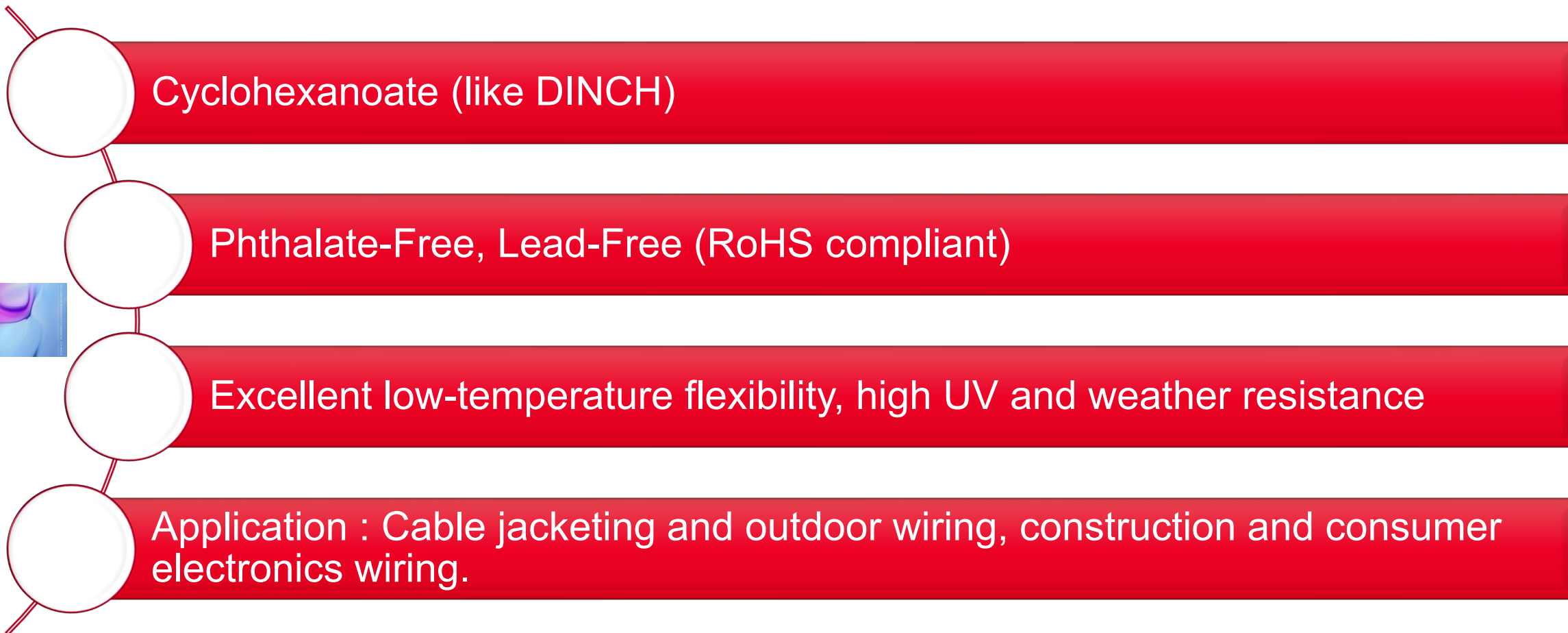
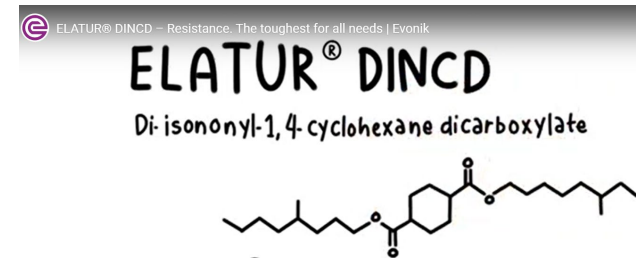
Innovation Spotlight: Bio-Based/Circular Plasticizers

Perstorp's Pevalen™ Pro 100 (Pentaerythritol Tetravalerate)



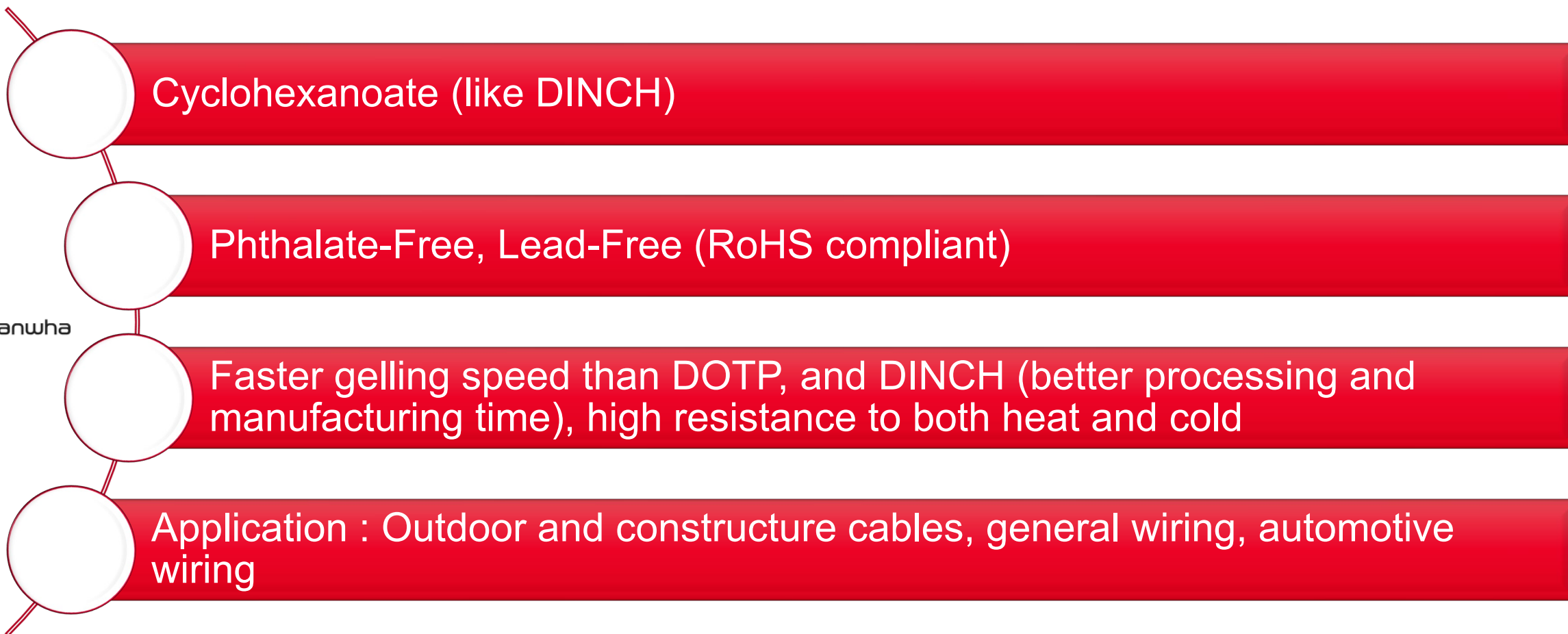
Innovation Spotlight: Cyclohexanoate plasticizer

Evonik's ELATUR® DINCD (Di-isononyl-1,4-cyclohexane dicarboxylate)



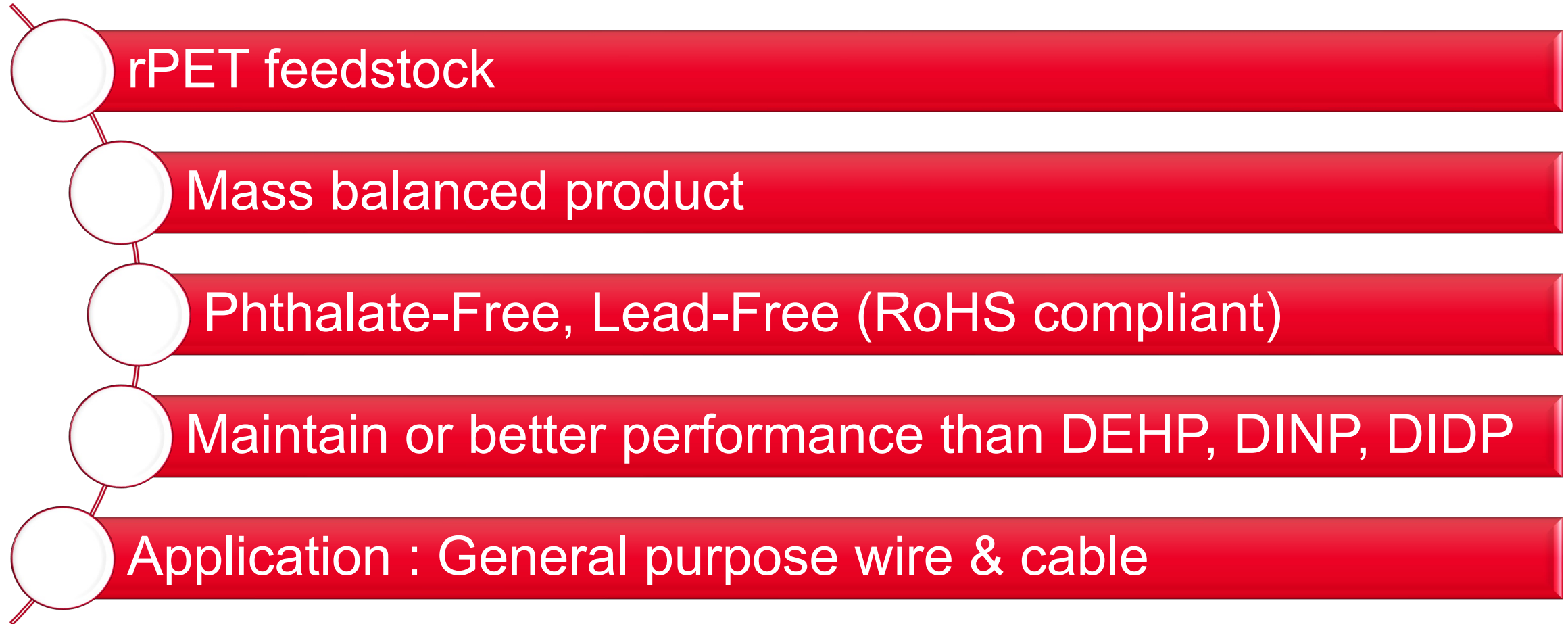
Innovation Spotlight: Cyclohexanoate plasticizer

Hanwha Solution's ECODEHCH



Innovation Spotlight: rPET plasticizer (rDOTP)

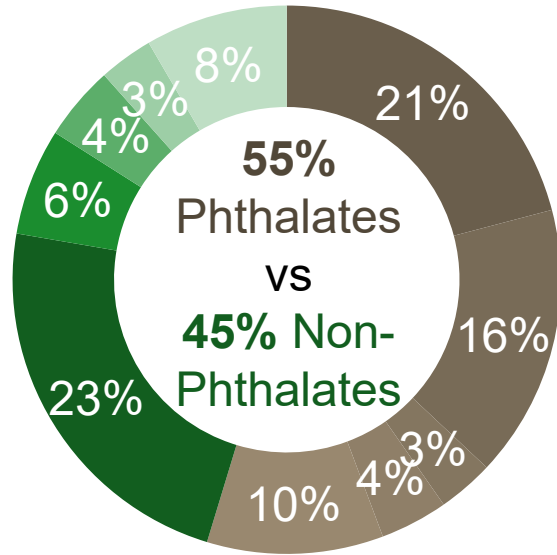
Eastman 168 Renew, Meltem Kimya's MELFLEX rDOTP, LG Chem



Sustainable plasticizers consumption will grow faster during 2024-29

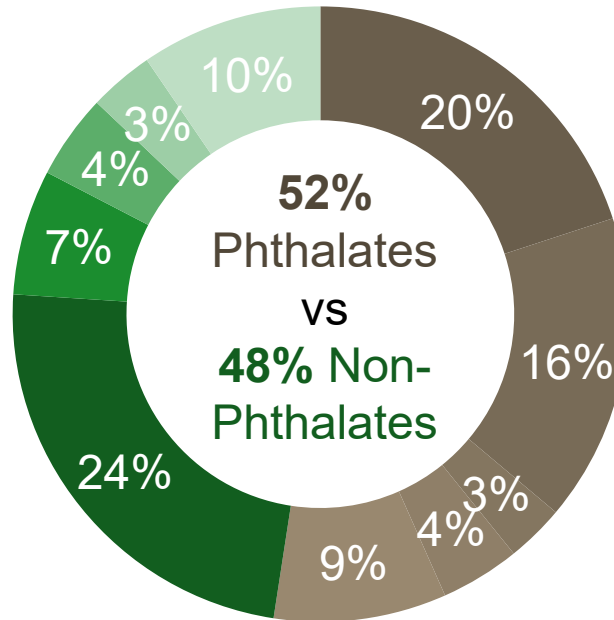
Total plasticizer consumption growth = 2.3%
 - Traditional plasticizer growth = 1.4%
 - Sustainable plasticizer growth = 3.3%

78%
Phthalates
vs
22% Non-Phthalates



2012

2024



2029

- DEHP
- DINP
- DIDP
- DPHP
- Other Phthalates
- Terephthalate
- Epoxy
- Aliphatics
- Trimellitates
- Others

Source: S&P Global Commodity Insights

Conclusion & Recommendations

Material is the key area for sustainability achievement

- Bio-based, biodegradable material are still the material of choice
- Plasticizer is the major component to improve sustainability of the products

EU RoHS is the De Facto Global Gatekeeper for EEE

- Compliance drives a universal move away from traditional phthalates to safer sustainable plasticizers
- Manufacturers choose one global, compliant material to streamline production and avoid regulatory market lock

The shift from traditional plasticizer to sustainable plasticizers is still ongoing

- The shift started for more than 10 years but as more and more countries restricted phthalate plasticizers content in wire & cable
- More sustainable plasticizers development to serve sustainability goal

Don't forget about cost structure

- There are three components of sustainability; Human well-being, Environment stewardship, and Economic resilience



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Thank you