Extraction and purification techniques for the recovery of bio-based volatile fatty acids and polyhydroxyalkanoates from organic waste: state of the art

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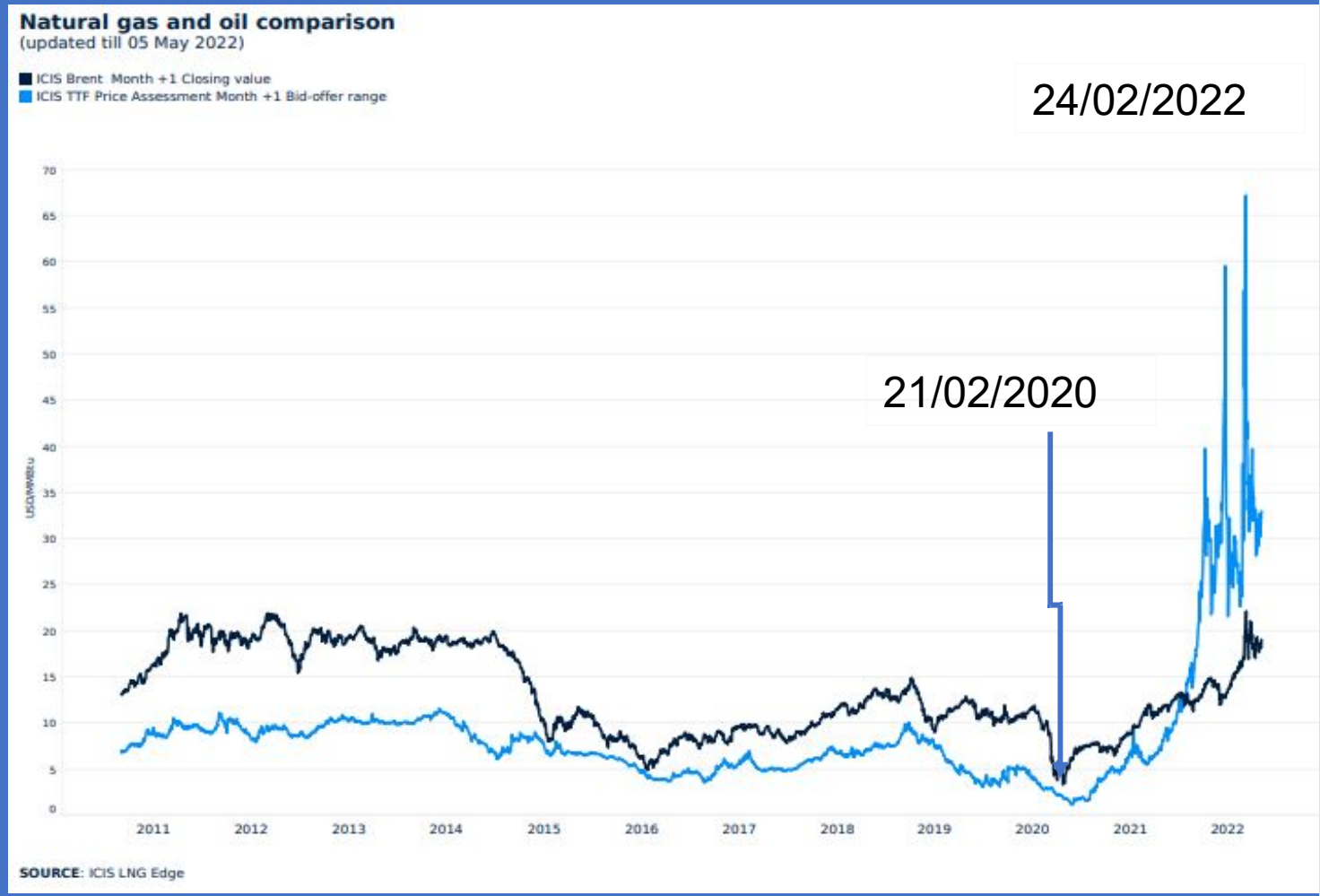
Price of raw materials

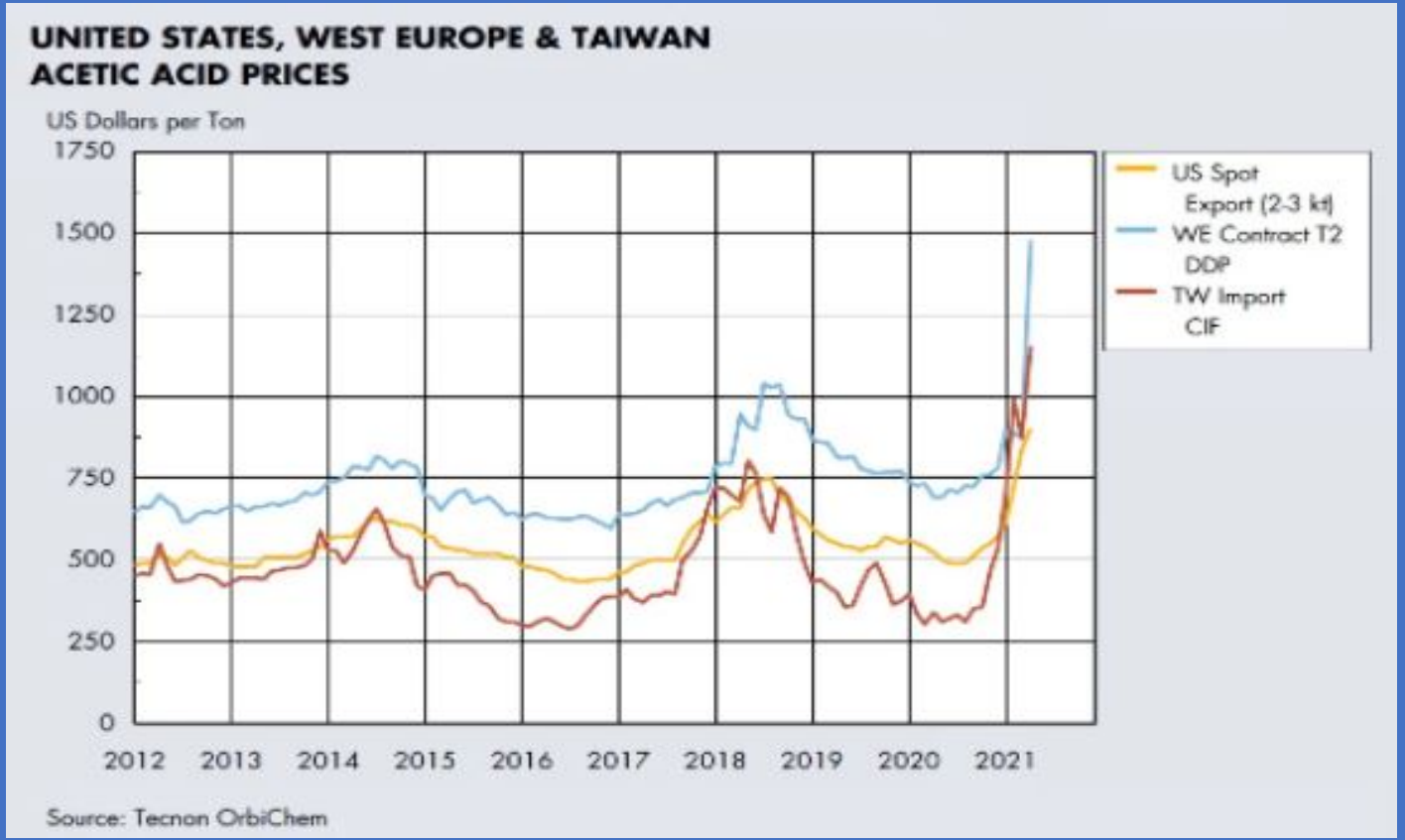
- Historically, Europe has built its trade and industrial preeminence on **raw materials.**
- **Covid-19** Pandemic
- **Russia's invasion**



SOURCE: ICIS LNG Edge

…and chemicals!

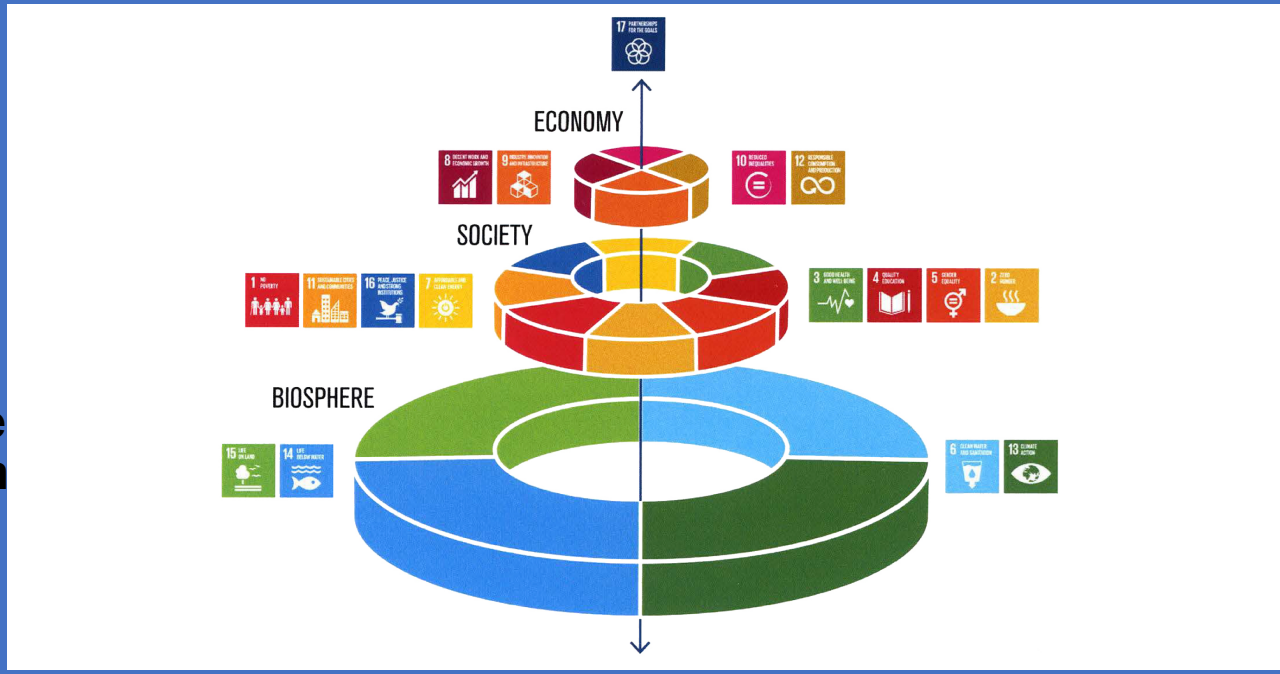
The market price of **Acetic Acid** increased by **150 %** during the last 2 years (**2020-2021**)



SOURCE: ICIS LNG Edge

Green Deal & Sustainable Development Goals

EU countries are committed to the **Sustainable Development Goals** (SDGs)



These states are committed to achieving these goals by 2030; the SDGs take into account in a balanced way the three dimensions of **sustainable** development: **econom society** and **Biosphere**.

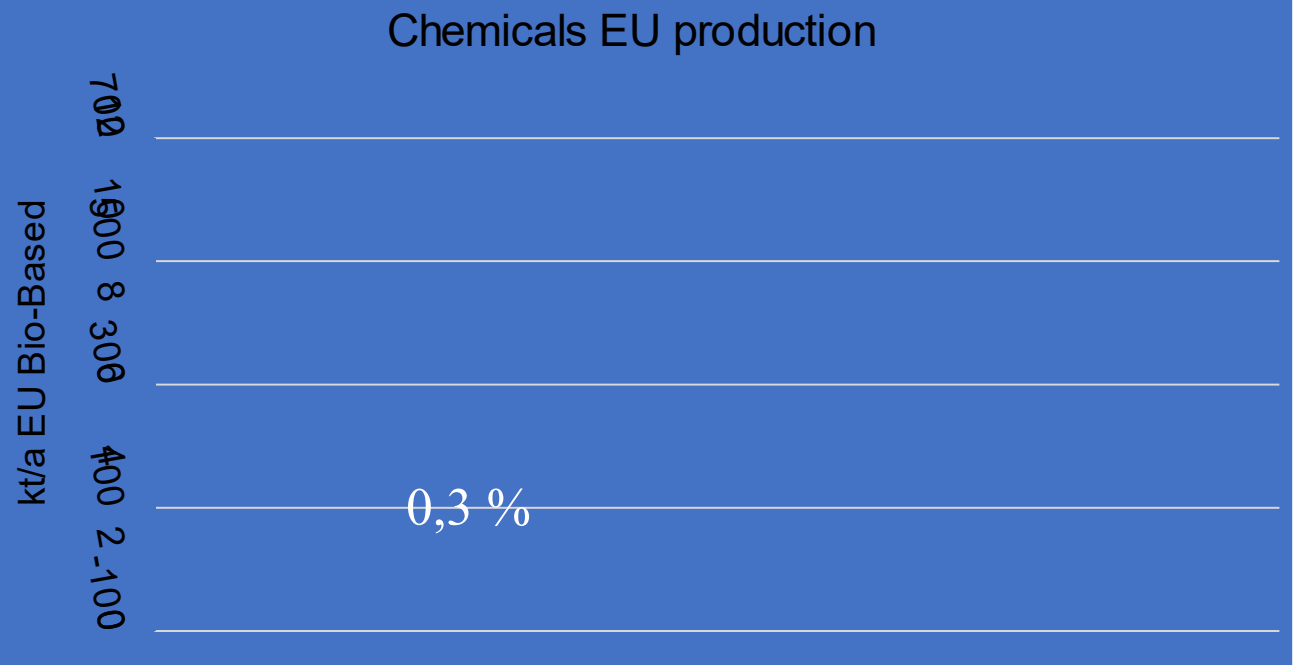
The **Green Deal** guides the development towards **laws** and **investments** proposed by the European Commission (EC) with the overall objective of achieving **climate neutrality** in Europe by **2050**.

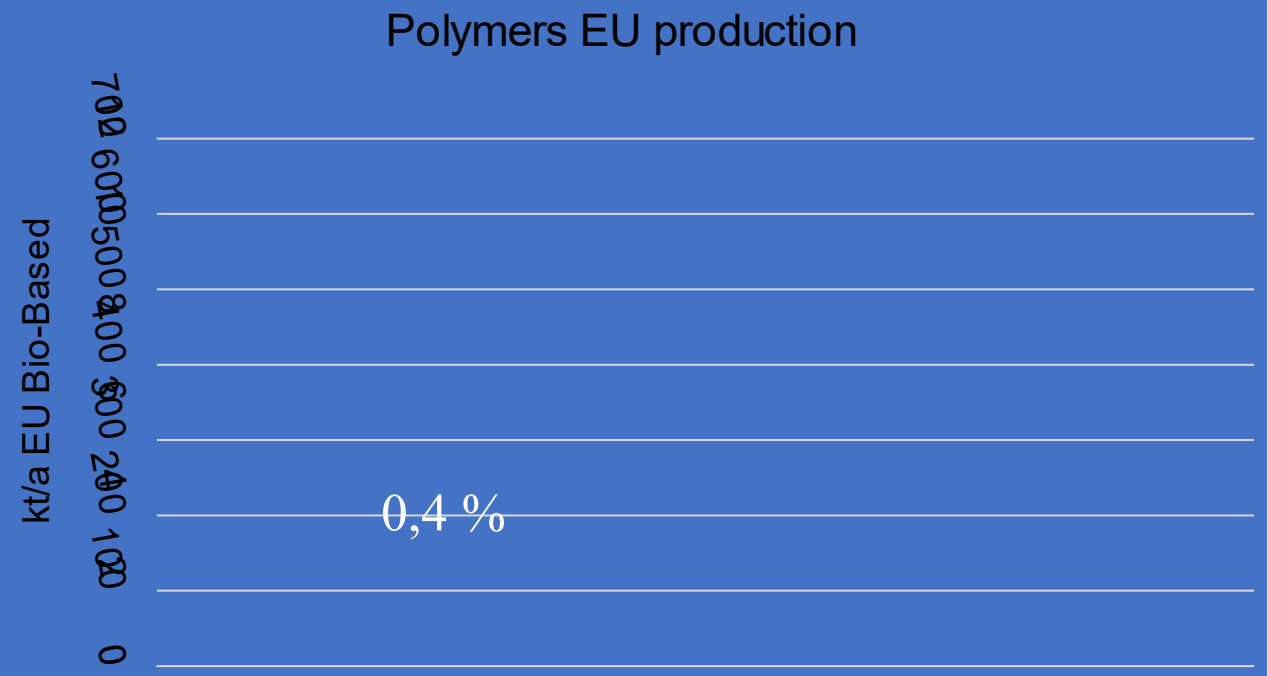
Market for bio-based chemicals

VFAs as bio-based **building block from bioconversion of organic matter**

Volatile Fatty Acids as a **renewable carbon source with multiple applications:**

- pharmaceutical,
- food
- Chemical precursors for biogas, biodiesel, biohydrogen and **bioplastics** (**PHAs**) production





European R&I actions

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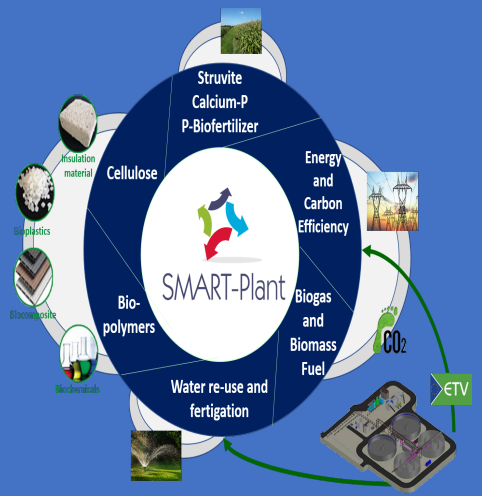
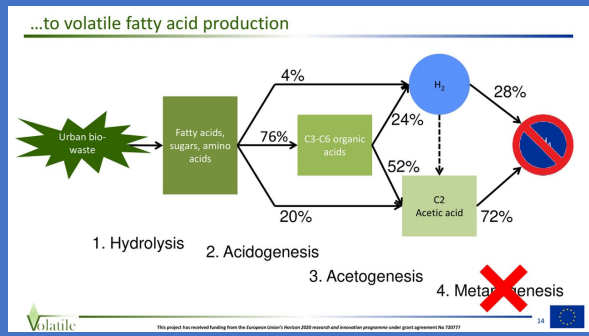


Smart Plant

PHARIO-Project

RES URBIS



VOLATILE

Recovery PHAs 50%
Reducing environmental impact 80%
TRL 6-8

Recovery PHAs 50%
Reducing environmental impact 80%
TRL 6-8

Recovery PHAs 50%
Reducing environmental impact 70%
TRL 5-6

Recovery VFAs 70%
Reducing environmental impact 70%
TRL 5-6

https://www.smart-plant.eu/index.php/recourse-recovery-products

STOWA 2017-15 PHARIO: STEPPING STONE TO A SUSTAINABLE VALUE CHAIN FOR PHA BIOPLASTIC USING MUNICIPAL ACTIVATED SLUDGE

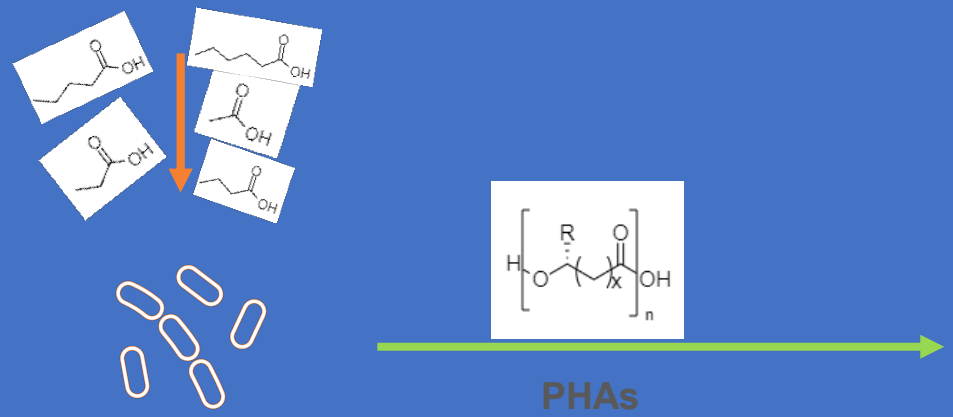
https://cordis.europa.eu/project/id/730349/it

https://doi.org/10.1093/femsle/fnab056

Recovery of VFAs/PHAs from organic waste towards the market

Organic Waste | Biological Production | Recovery | Purification | Market

0,8 – 2,5 (€/kg)



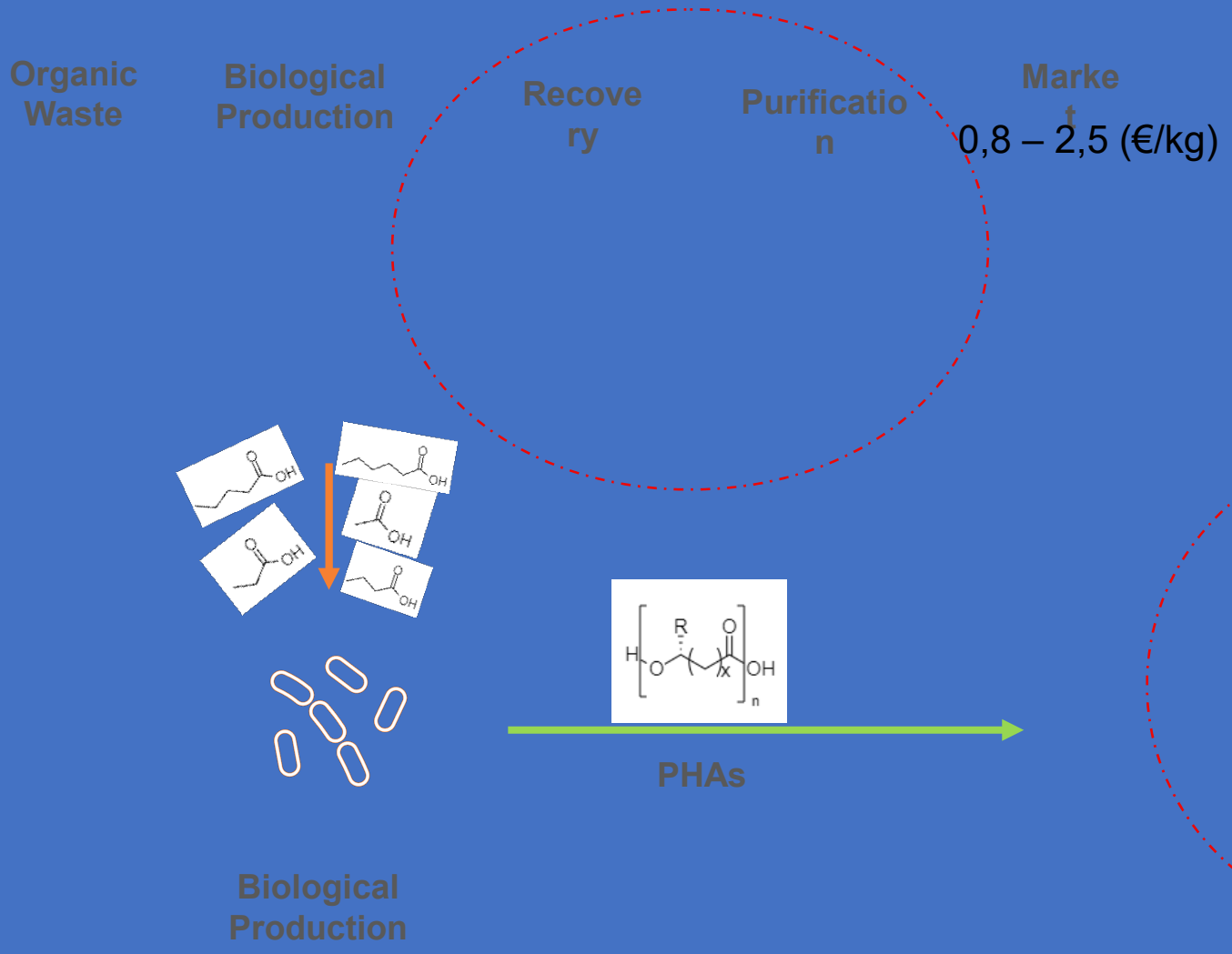
Biological Production

PHAs

Recovery | Purification | Market

2,2 -5(€/kg)

Recovery of VFAs/PHAs from organic waste towards the market



Unfortunately, these are the main **bottlenecks** (technical, regulations, social…)

Recovery and purification of VFAs

Recovery methods	Type of processes	Purification methods	Type of processes
Resin	Adsorption Gas stripping and adsorption		
Membrane process	Electrodialysis Reverse osmosis Membrane distillation Micro,Ultra,Nano-Filtration Membrane contactor	Reverse osmosis & Nanofiltration	Polyamide (PA)-based membranes Pressure: 8-26 bar Membrane area m2: 0,003-0,00147
Solvent	Trioctylphosphine oxide (TOPO) Tri-n-octylamine (TOA) 2-ethylhexyl alcohol Kerosene	Distillation	Process's temperature >100 °C
Add chemicals	Esterification (CaCl2) Precipitation (Ca(OH)2 or CaCO3 and H2SO4)	Filtration	Evaporation condensation reaction

Carbon footprint of the recovery techniques

https://www.epa.gov/ghgreporting/documents/pdf/2013/documents/memo-2013-technical-revisions.pdf

Carbon footprint of the recovery techniques

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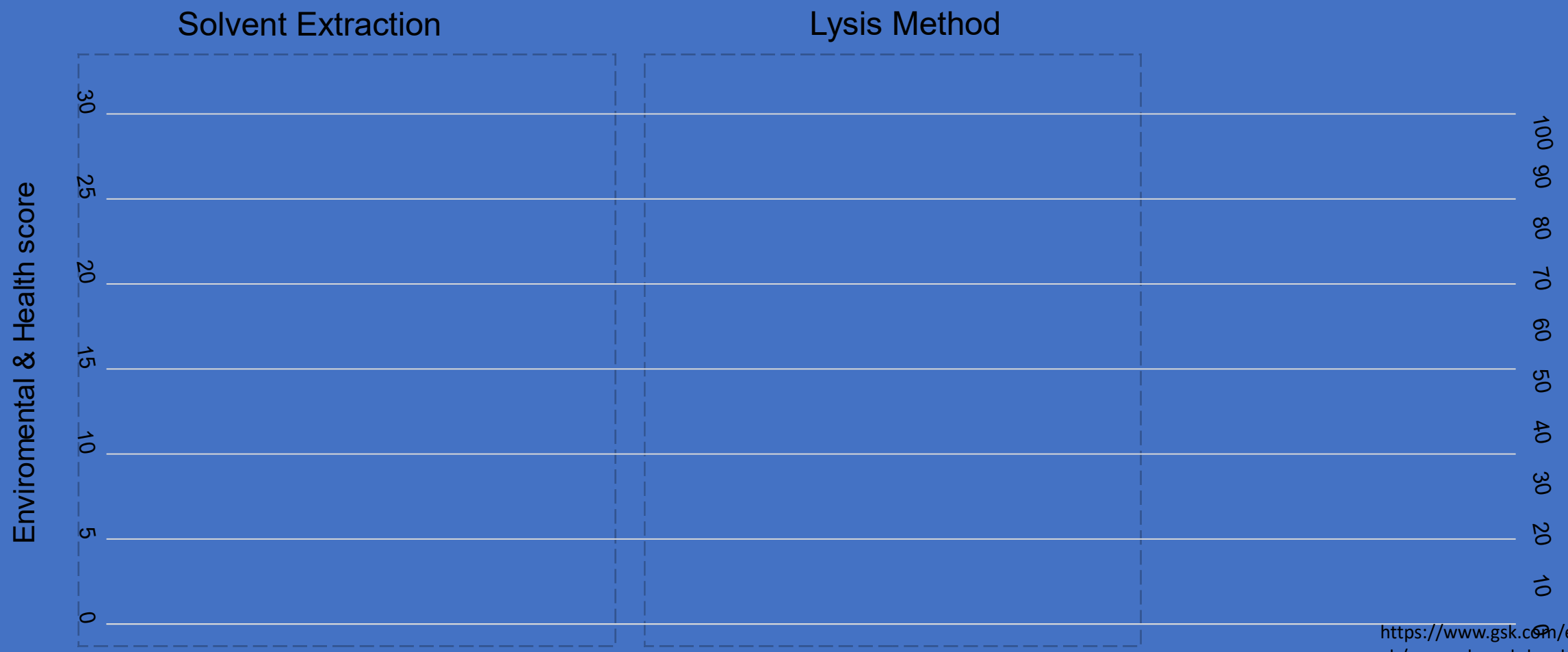
Extraction and purification of PHAs

Extraction methods	Type of processes	Purification methods	Type of processes
Solvent extraction	Halogenated Solvent (CHCl3) Alcohol (BuOH) Carbonates (di-metylcarbonate)	Precipitation	MeOH EtOH
Lysis method	Oxidants (NaClO) Surfactants (SDS) Alkali (NH4OH)	Ozone treatment	O3
Mechanical disruption	Add surfactants (SDS)	Peroxide treatment	H2O2

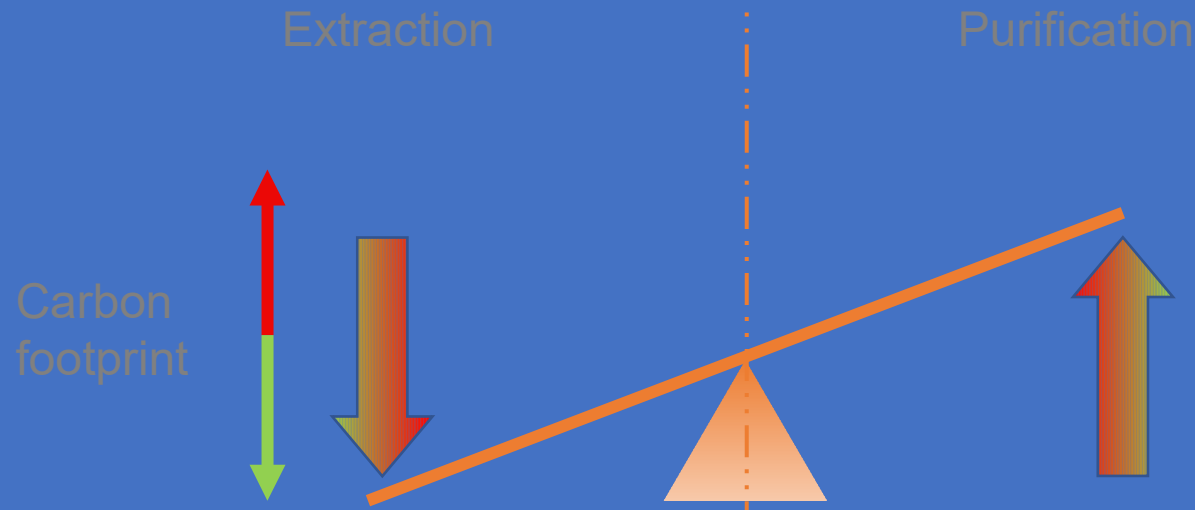
E&H impact of recovery techniques



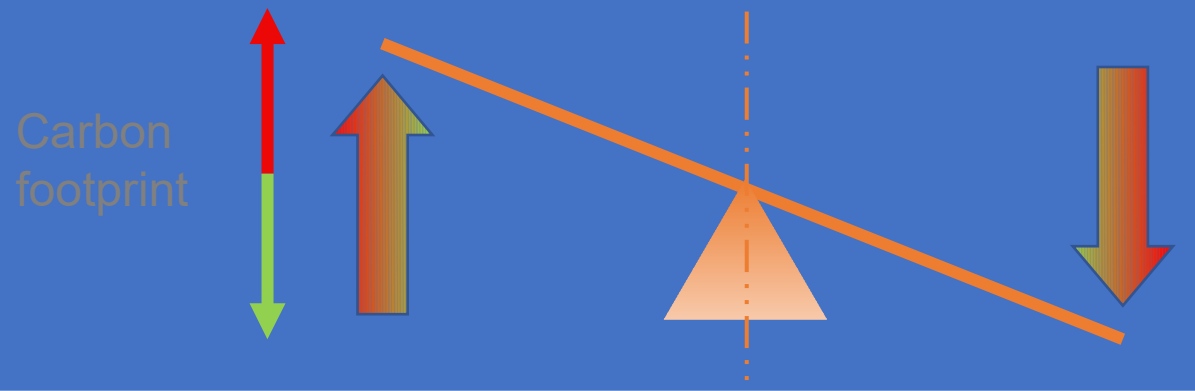
https://www.gsk.com/en-gb/research-and-development/

Trade-off balancing

Less impactful solvents can make purification processes **more difficult**



More impactful solvents can facilitate purification processes while maintaining **high** product **quality**



S.W.O.T Analysis

Strength

- Diversified use of **raw materials**
- Potential promotional **benefits**
- Functional advantages of **newly** developed **materials**

Weaknesses

- Hight production/**recovery cost**
- Need for technology **improvements** (recovery/purification)

Opportunity

- Need **to reduce** dependence on **fossil material**
- Creates a **market** for biobased building blocks
- Growing awareness of the **impact of fossil** products on the environment

Threats

- Lack of qualified workforce
- Low **oil price**
- Low public awareness of bio-based products
- Continuous changes in **environmental legislation**
- Lack of **subsidies** for bio-based products produced
- Higher **cost** of **bio-based plastics**

Thank You

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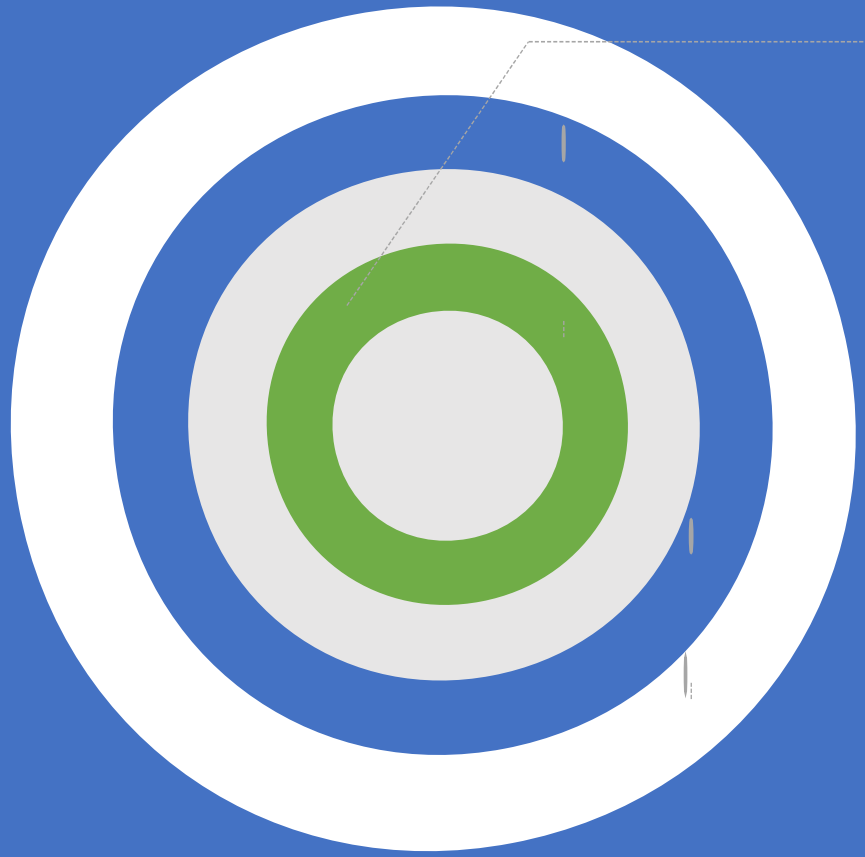
Conclusion



Investment subsidies for bio-based products (Country level)

Optimisation of recovery/purification processes

CO_2 tax and homogenisation of environmental legislation

Raising awareness of biobased products

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