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Kirei–Making Life Beautiful

Sustainabilitystrategies from the perspective of a performance additive manufacturer

INDUSTRIAL FLUIDS
& LUBRICANTS

ILMA
6th International Metalworking Fluids Conference
Sustainability
Wednesday, January 10

Dr. Michael Stapels; Kao Chemicals GmbH Emmerich, Germany

Outline: A journey of sustainability

1. Lubricant industry

   - Focus on carbon footprint
   - Impact on High performance additives

2. Conclusion / discussion

   - Quality is sustainable
   - CF (light) vs LCA

Outline: A journey of sustainability

1. **Lubricant industry**
    - Focus on carbon footprint
    - Impact on High performance additives

2. Conclusion / discussion
    - Quality is sustainable
    - CF (light) vs LCA

Sustainability in the lubricant industry

product carbon foot print

cradle to gate

company carbon foot print

cradle to grave

scope 1 / 2 / 3 emissions

cradle to cradle

decarbonization

gate to gate

renewable carbon

Life cycle assesment (LCA)

How do we do in the lubricant industry?

Carbon foot print

Definition: The product carbon footprint is the total mass of all GHG emissions over the whole life cycle of the product.

In simple terms: The sum of all emissions which where induced (directly & indirectly) by all activities related to the **production**…

Exploration / Mining / Farming / Tier-n Pre-Suppliers

Exploration

https://www.ueil.org/sustainability/

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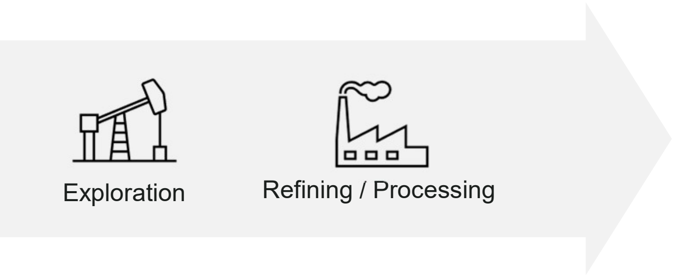
- Min B/O- Manufacturers
- Syn. & Veg B/O- Manufacturers
- Re-refiners
- Additive Manufactures
- Specialty Manufacturers



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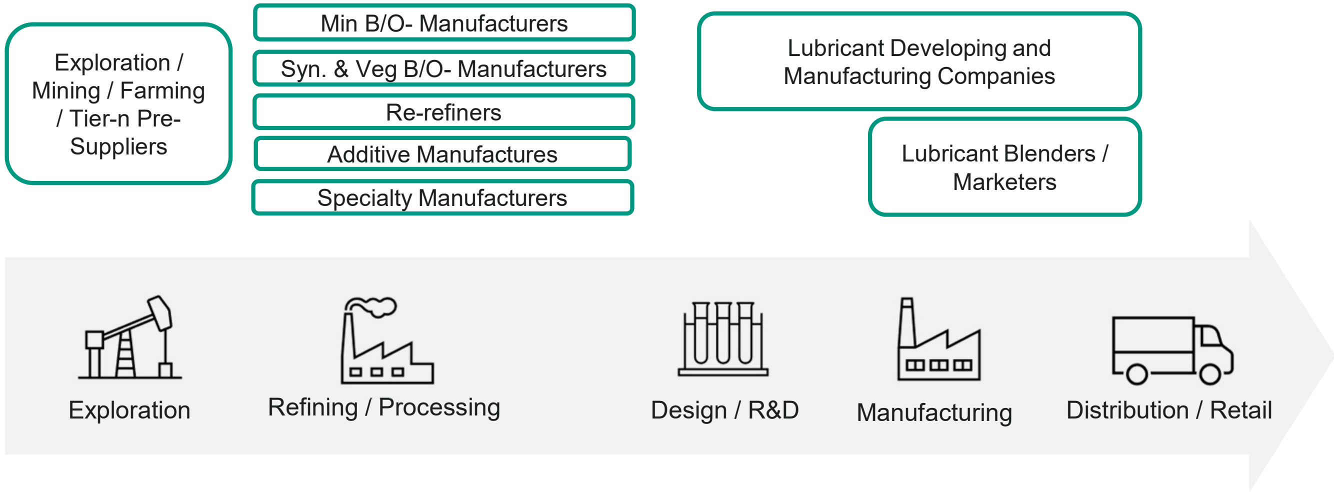

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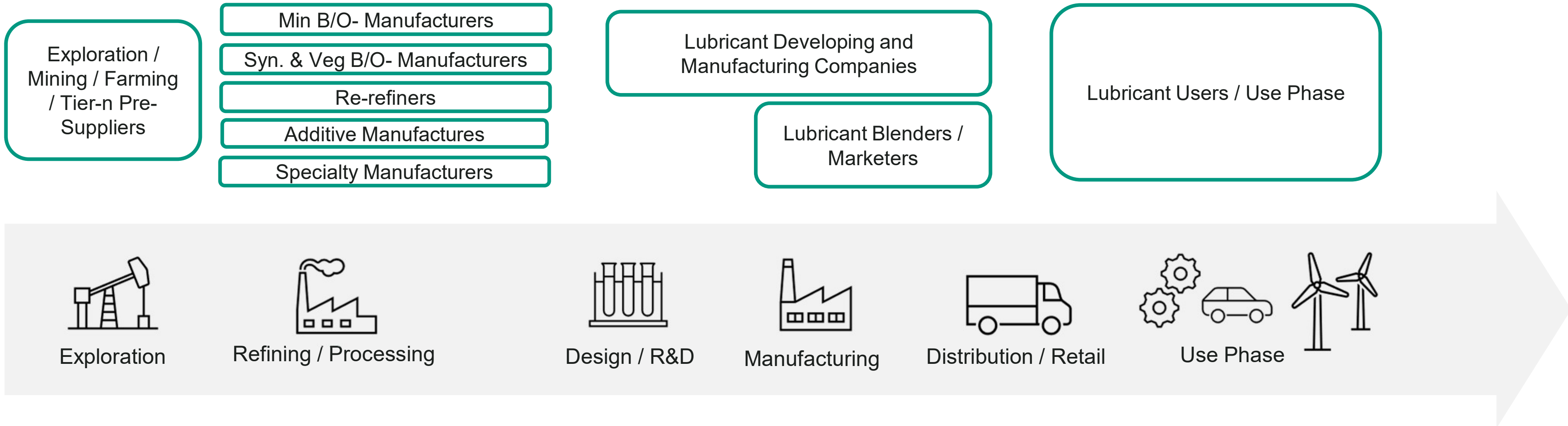

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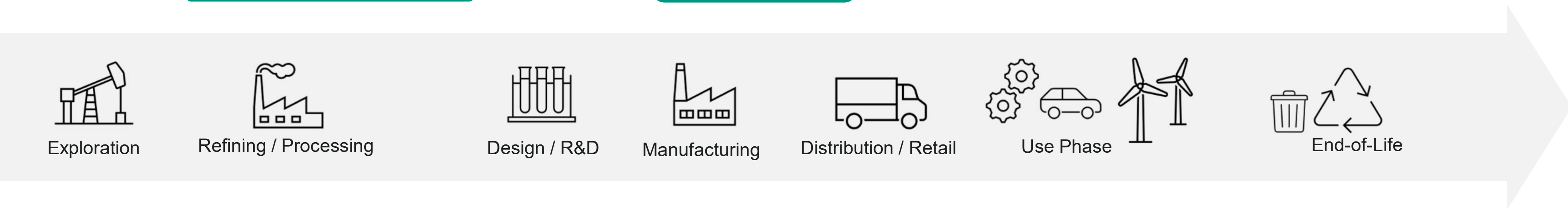
- Lubricant Developing and Manufacturing Companies
- Lubricant Blenders / Marketers
- Lubricant Users / Use Phase
- Used Oil Collectors / Recyclers



How do we do in the lubricant industry?

Cradle-to-gate

Definition: The product carbon footprint is the total mass of all GHG emissions over the whole life cycle of the product.

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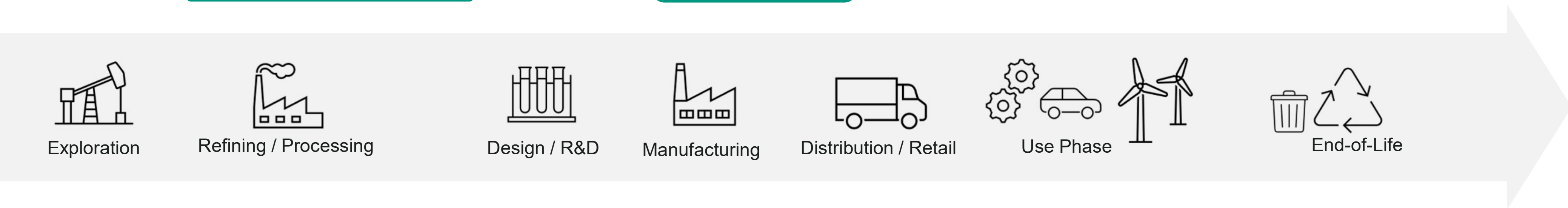

Cradle-to-Cradle

Cradle-to-Cradle describes a complete circular product life cycle where the product at the end of its useful life is regenerated into the original raw materials, products or is re-purposed. Ultimately, there is **no waste**.

How do we do in the lubricant industry?

Cradle-to-grave

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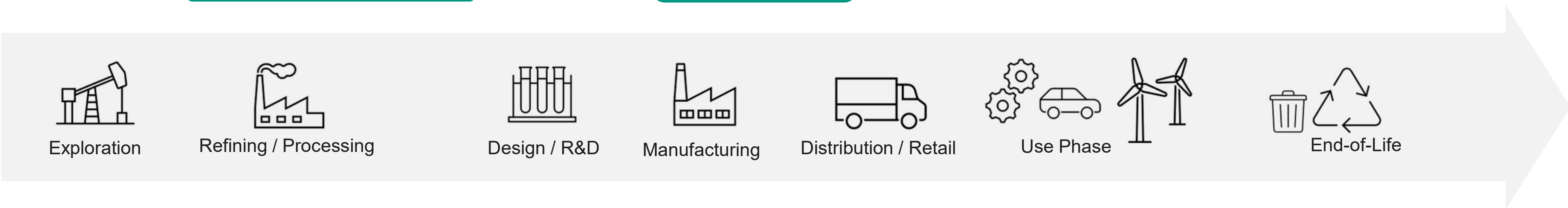

Cradle-to-grave

Cradle-to-Grave describes a linear product life cycle, from resource extraction through to end-of-life disposal.

How do we do in the lubricant industry?

Cradle-to-gate

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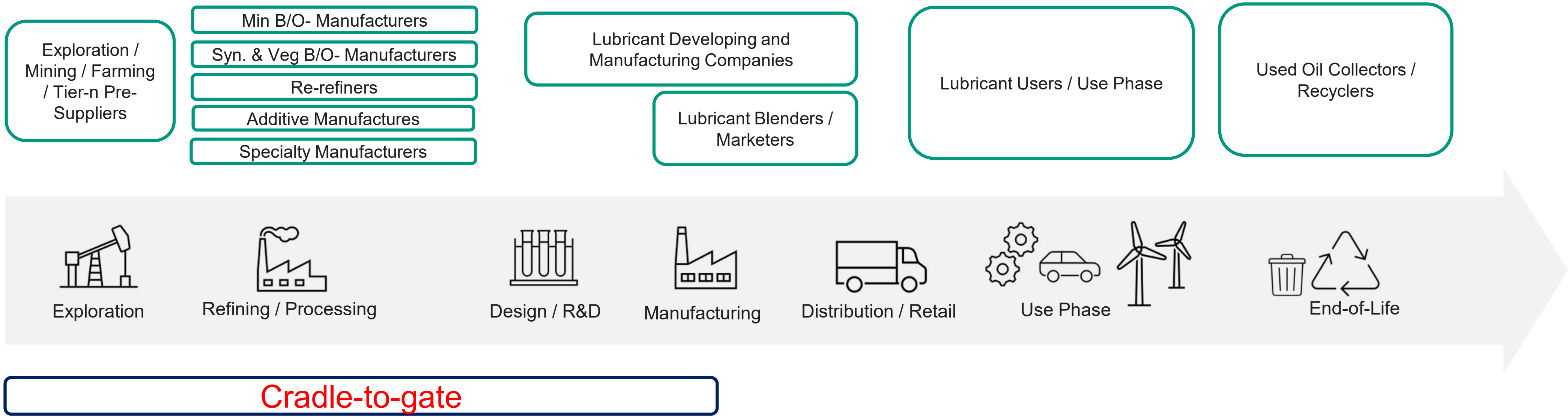

Cradle-to-Gate describes a partial assessment of a product life cycle, from resource extraction to the factory gate.

*Gate-to-Gate scope includes GHG-Protocol Scope 1, 2 & selected Scope 3-emissions (Water, Waste, Business Travel, Commuting) for all units/companies in a lubricant company
**Cradle-to-Gate scope includes Gate-to-Gate scope PLUS purchased raw materials, goods, packing etc.

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Gate-to-gate

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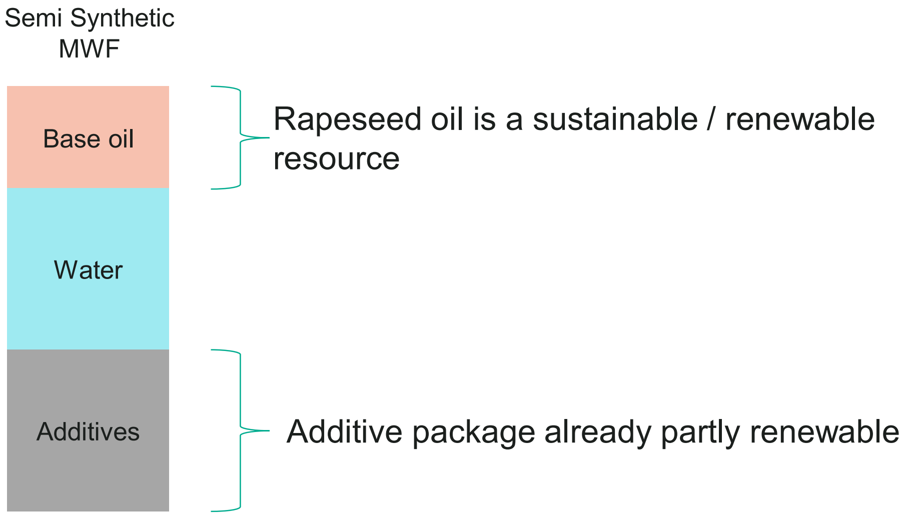
Gate-to-gate

Gate-to-Gate describes a partial assessment of a product life cycle from a supplier's factory gate to the exit gate of an organisation which adds further value to the raw materials.

Increasing renewable carbon content in next generation MWFs

Bio-based oils as an alternative to mineral oil



Guideline formulation

Semi synthetic starting formulation	% w/w
Bio-based oil phase	32.0
Emulsifier package	15.5
Amine package	5.0
Coupling agent	5.0
Deionized Water	42.5

	% w/w
Canola oil	20.0
Trimethylolpropane Trioleate N	5.0
Tall oil fatty acid	7.0
PEG-4 canola amide	5.0
Triethanolamine	4.0
Monoethanolamine	1.0
Propylene glycol butyl ether	5.0
Fatty alcohol alkoxylate HLB = 5	5.0
Alkoxylated stearyl phosphate ether	2.0
Deionized Water	42.5
Fatty alcohol alkoxylate HLB = 8	3.5
	100.0

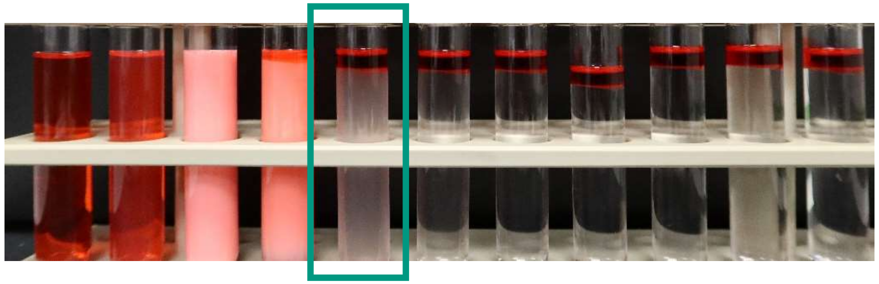
Lowering PCF = more sustainable (?)

Loss of emulsion stability

>100°gh/1700 ppm

1 

40°gh/710 ppm

2 

70°gh/1250 ppm

3 

Emulsion stability test / in-house method:
Electrolyte scan Mg^{2+}

Procedure:
Prepare a dilution and add step by step different amounts of a salt-dilution (possible to add oil-soluble colours)
Emulsion: Concentration and water hardness need to be defined (starting emulsion: e.g. 10 % in dist. water)
Duration: 24 h
Temperature: 60 °C

	1 % w/w	2 % w/w	3 % w/w
Naphthenic base oil	32.0		
Vegetable base oil		32.0	32.0
Standard emulsifier package	15.5	15.5	
improved emulsifier package			15.5
Amine package	5.0	5.0	5.0
Coupling agent	5.0	5.0	5.0
Deionized Water	42.5	42.5	42.5

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Lowering PCF = more sustainable (?)

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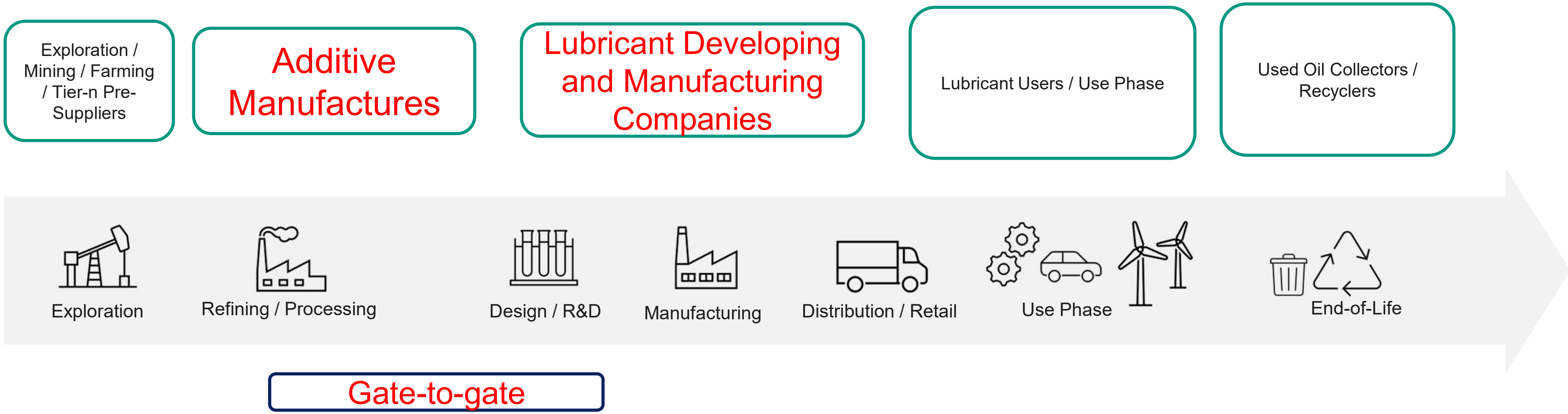
Gate-to-Gate - example

Additive producer → Lubricant manufacturer



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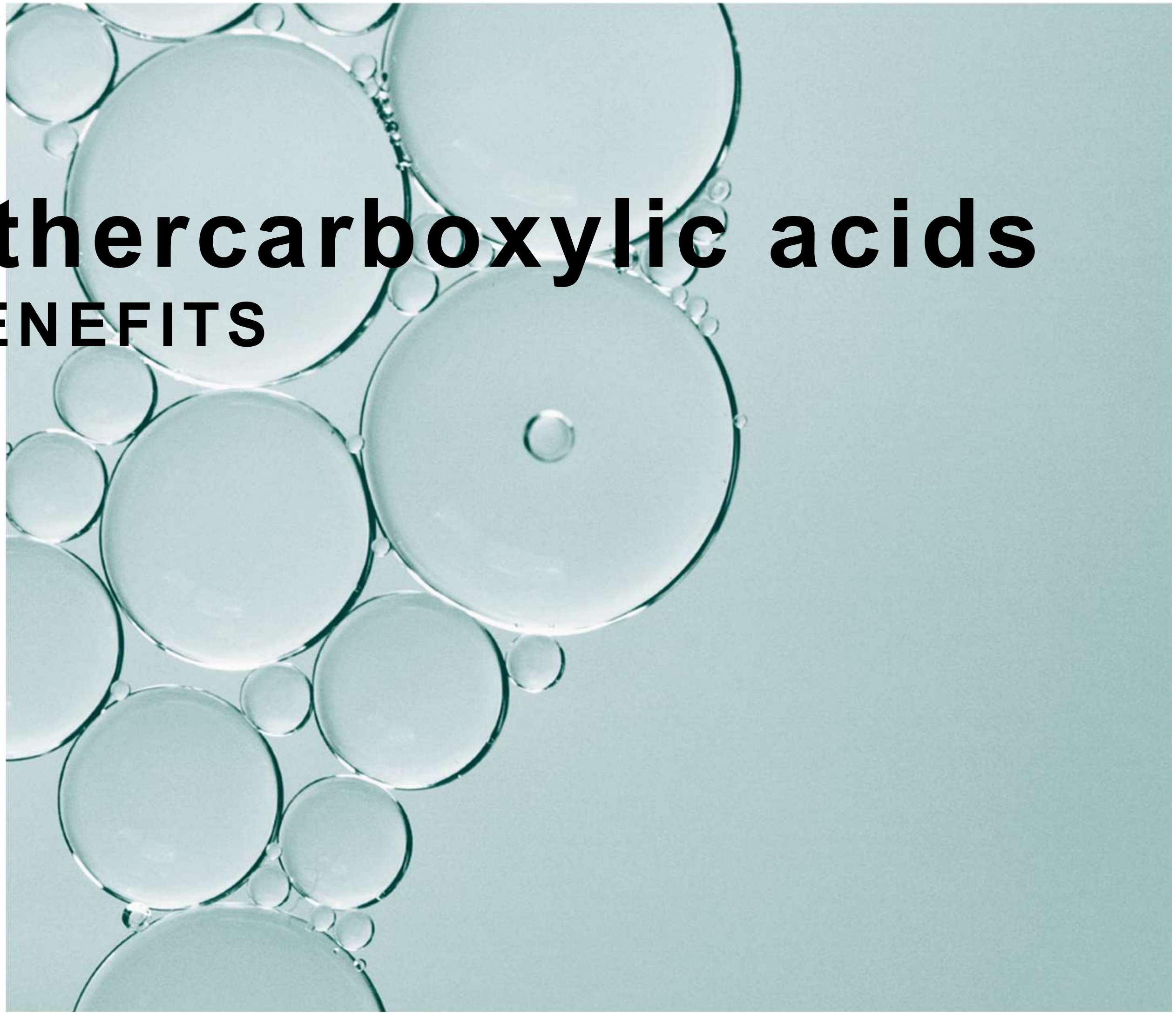
Ethercarboxylic acids

BENEFITS



INDUSTRIAL FLUIDS
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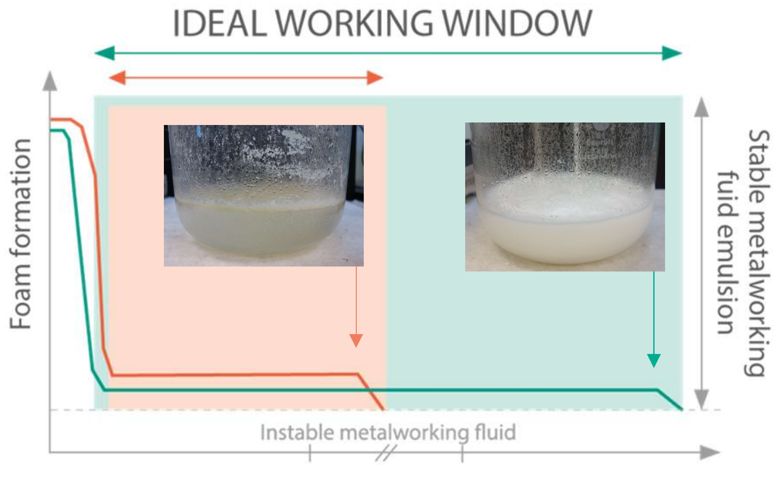

Fluid lifetime and water hardness

— main emulsifier sulfonate, fatty acids, fatty alcohol ethoxylates

— **+ ethercarboxylic acids**

* Electrolyte scan with 10% colored MWF starting with DE Water (0 ppm) and increasing concentration of magnesium

FLUID LONGEVITY / SUMP LIFE

The addition of ethercarboxylic acids leads to:

- limited formation of soaps and insoluble agglomerates through a wide range of water hardness levels
- a dispersion of soaps which prevents drag out of lubricity components and the cleanliness/stability of fluids, resulting in less maintenance
- extended fluid operation window, which leads to a longer fluid lifetime

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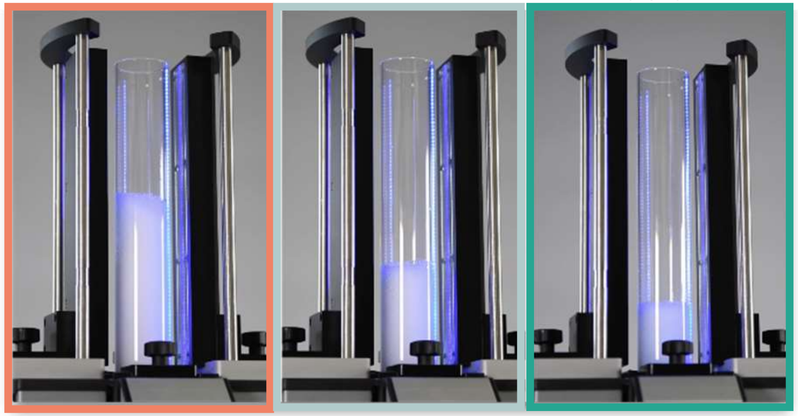
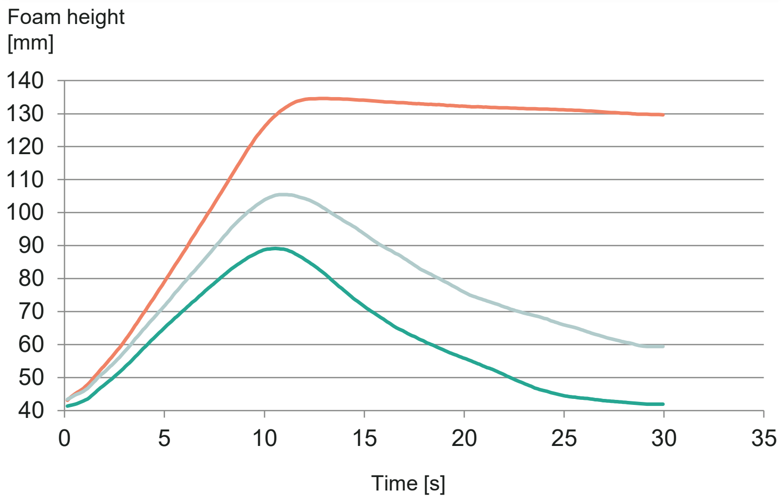
FOAM CONTROL

No ethercarboxylic acid	Add on ethercarboxylic acid	Well balanced ethercarboxylic acid

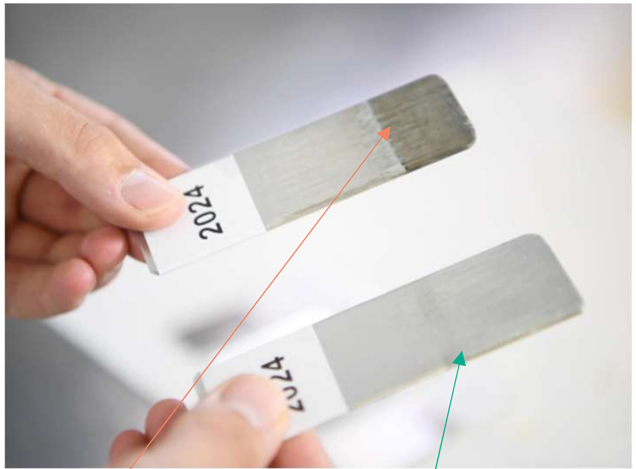




* 5% metalworking fluid emulsions at 178 ppm water measured with a Krüss DFA100 Dynamic Foam Analyzer

- Fine dispersed lime soaps are the key to foam control
- Just adding Ethercarboxylic acids on top of your fluid is not enough, adding and balancing can make a great difference
- The best foam control in combination with hard water stability is achieved through synergistic effects when nonionic and anionic co-emulsifiers are used together

CORROSION INHIBITION



* Aluminum 2024 alloy set for 24h at 40°C in a 5% dilution of product in demineralized water, adjusted to pH 9.4

Without ethercarboxylic acids

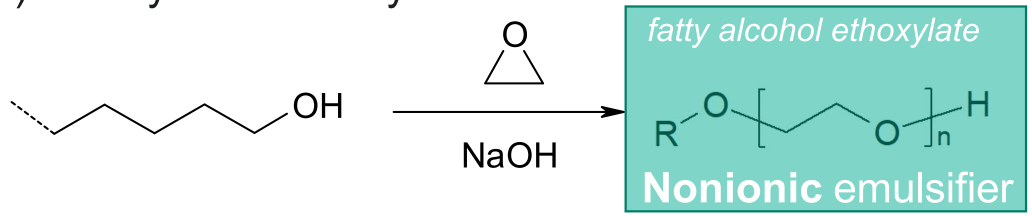
With ethercarboxylic acids

* 5% dilution of MWF in 357 ppm water according to Corrosion –DIN 51360 part2 chip-filter-test

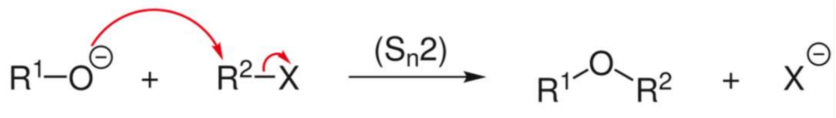
- Ethercarboxylic acids support anti-corrosion properties when used in combination with common corrosion inhibitors such as fatty acid alkanol amines.
- low degree of will be beneficial
- For light metal protection short chain alkoxylated ethercarboxylic acids performs the best

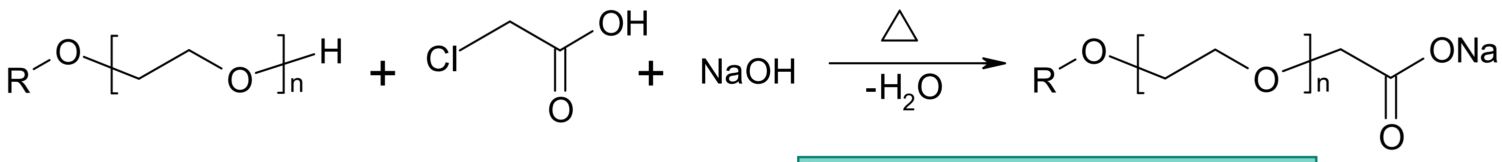
Manufactoring process of an additive – example: ethercarboxylic acid

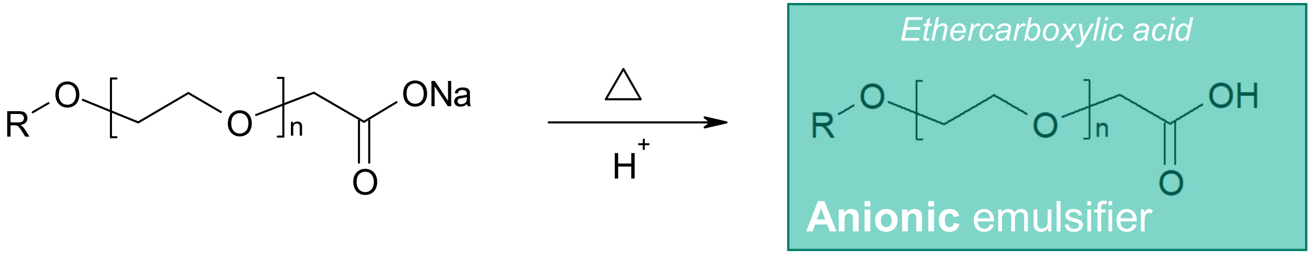
1.) Ethoxylation of fatty alcohol



mechanism: Williamson ethersynthesis

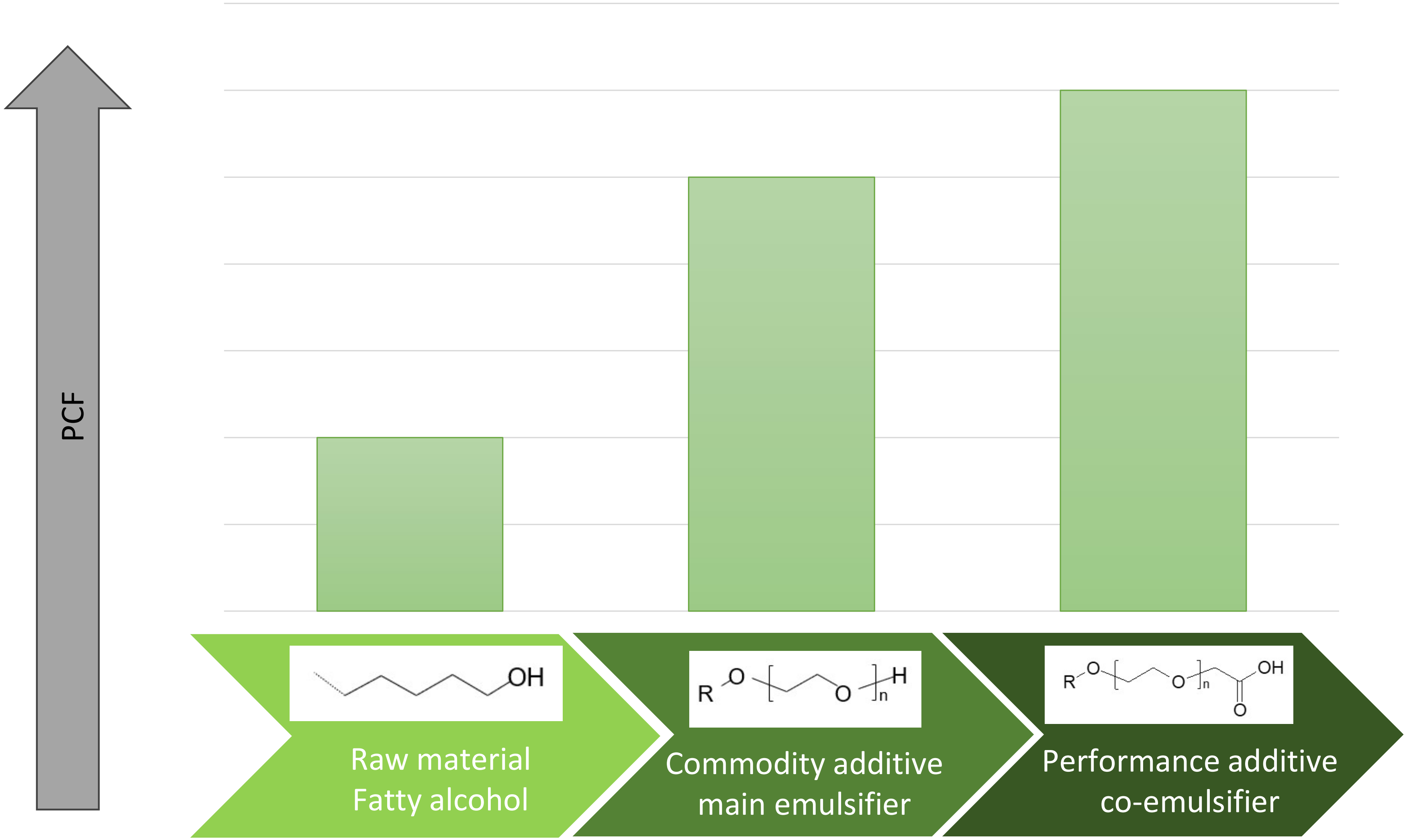






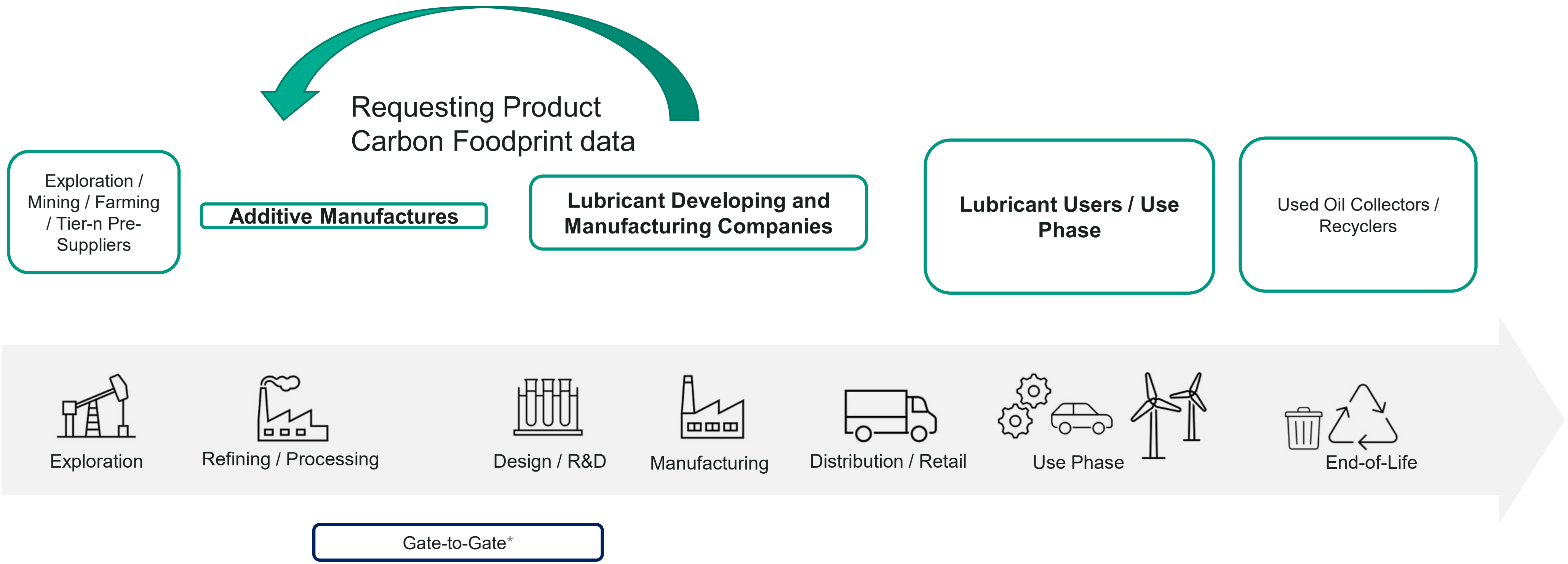
Simple truth: The more steps a chemical reaction the larger the product carbon footprint

Product carbon footprint (PCF) for different additive types



Carbon Footprint of an additive

Situation for an additve producer



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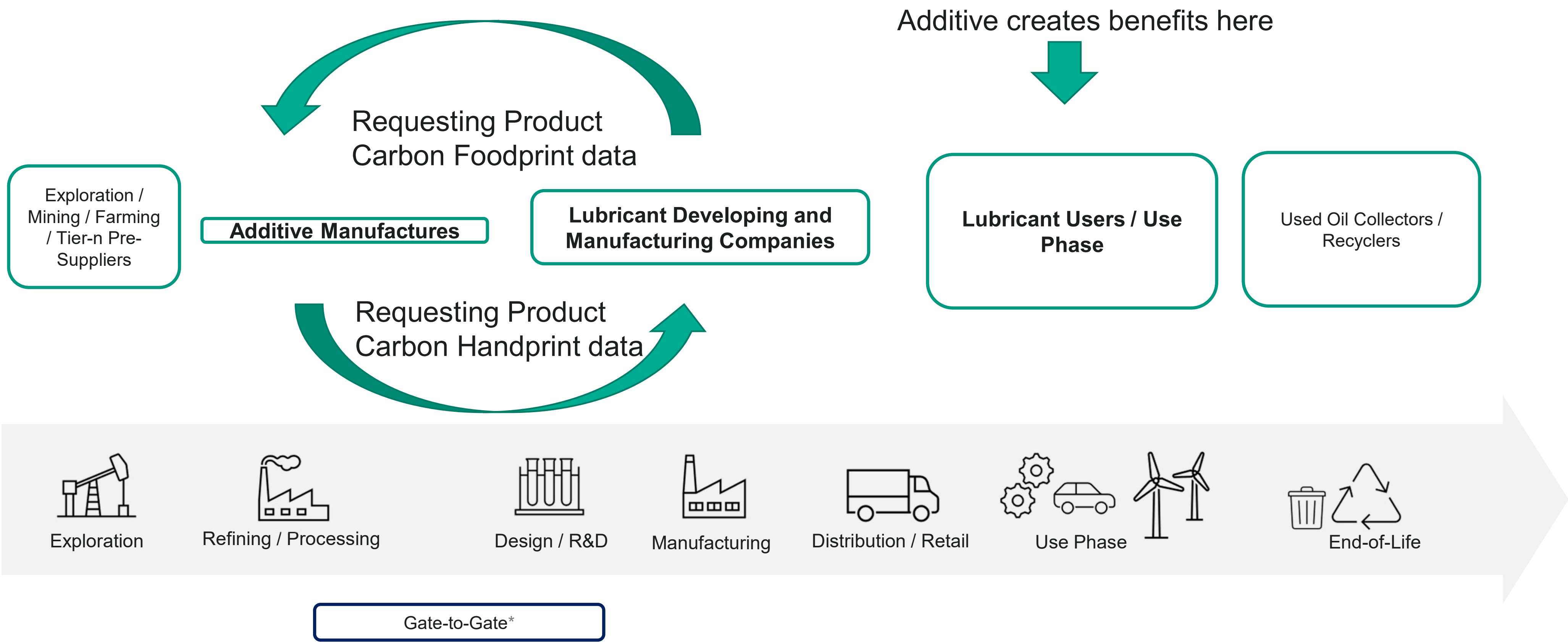
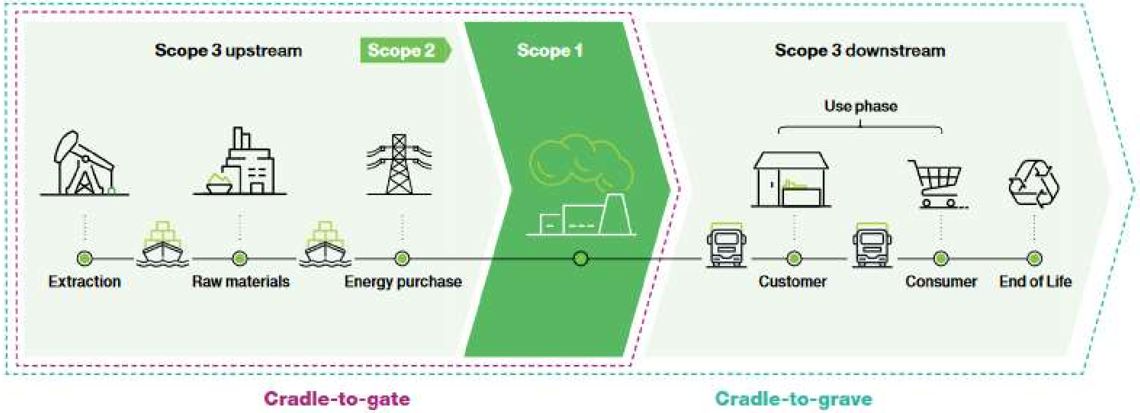


Scope 3 downstream effects or carbon handprint



Scope 3 emissions:
indirect emissions that occur in an organisation's value chains, for example, purchased goods and services, use of product sold, waste disposal and business travel.

- Upstream Scope 3 emissions generally refers to everything prior to an organisation's incoming gate like raw material production,transport etc.
- Downstream Scope 3 includes emissions from products in use.

Product carbon handprint

describes the positive environmental impact of the product in use throughout its lifetime.
The value of the handprint can often be expressed in avoided emissions.
Handprint savings resulting from the use of high-quality products can be much higher than the product carbon footprint itself, resulting in a net benefit to the environment.

https://www.ueil.org/wp-content/uploads/2023/02/Understanding-the-product-carbon-footprint-of-lubricants-April-2022.pdf

Carbon Footprint of an additive

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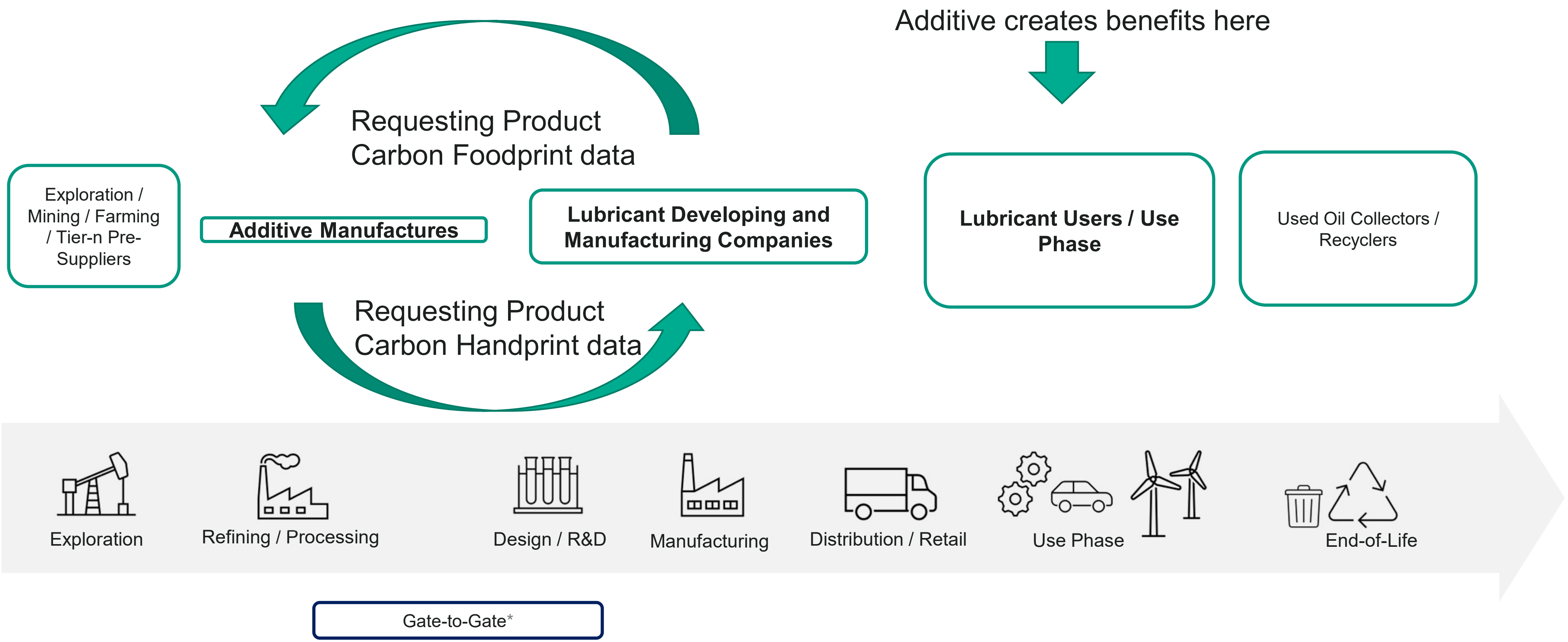

Problem: The benefits* of the ethercarboxylic acid can be only seen during the lubricant use!

* Longer sump life / improved corrosion protection, etc

Outline: A journey of sustainability

1. Politics – biomass as a sustainable energy source

2. Lubricant industry

   - Focus on carbon footprint
   - Impact on High performance additives

3. **Conclusion / discussion**

   - Qualty is sustainable
   - CF (light) vs LCA

Quality Is an Environmental Issue

Gränsfors Bruk, a Swedish company that has been hand-forging axes for over 100 years

Responsibility for 'The Total': Branby thinks in systems; he calls his worldview and philosophy 'The Total', as it encompasses ethics, business, production process, products and the world in which we inhabit. For him, 'What we take, what we make and what we waste' are in fact all questions of ethics. We have, he says, an unlimited responsibility for 'The Total', a responsibility that we try but do not always succeed in taking. One part of that responsibility is the quality of the product and how many years it will endure. Rather than designing in obsolescence, Gabriel designs it out.

"A **high-quality product**, in the hands of those who have **learned how to use it** and how to look after it, will very likely be **more durable**…increased durability means that we take less (decreased consumption of material and energy), that we need to produce less (gives us more time to do other things we think are important or enjoyable), and destroy less (**less waste**)."

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Carbon footprinting is LCA light

Open Access Article

A System Thinking Normative Approach towards Integrating the Environment into Value-Added Accounting—Paving the Way from Carbon to Environmental Neutrality

by Robert Miehe [1,*], Matthias Finkbeiner [2], Alexander Sauer [1,3] and Thomas Bauernhansl [1,4]

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Recently, especially carbon footprinting (CF) has been adopted as ‘LCA light’ in accordance with the Greenhouse Gas Protocol. According to the strategy ‘balance, reduce, substitute, compensate’, the approach is intended to provide the basis for optimization towards climate neutrality. However, **two major problems** arise: (1) due to the predominant focus on climate neutrality, other decisive life-cycle impact categories are often ignored, resulting in a misrecognition of potential trade-offs, and (2) LCA is not perceived as an equal method alongside cost and value-added accounting in everyday business, as it relies on a fundamentally different system understanding.

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Any questions?