TRANSFORMERS MAGAZINE'S
INDUSTRY NAVIGATOR

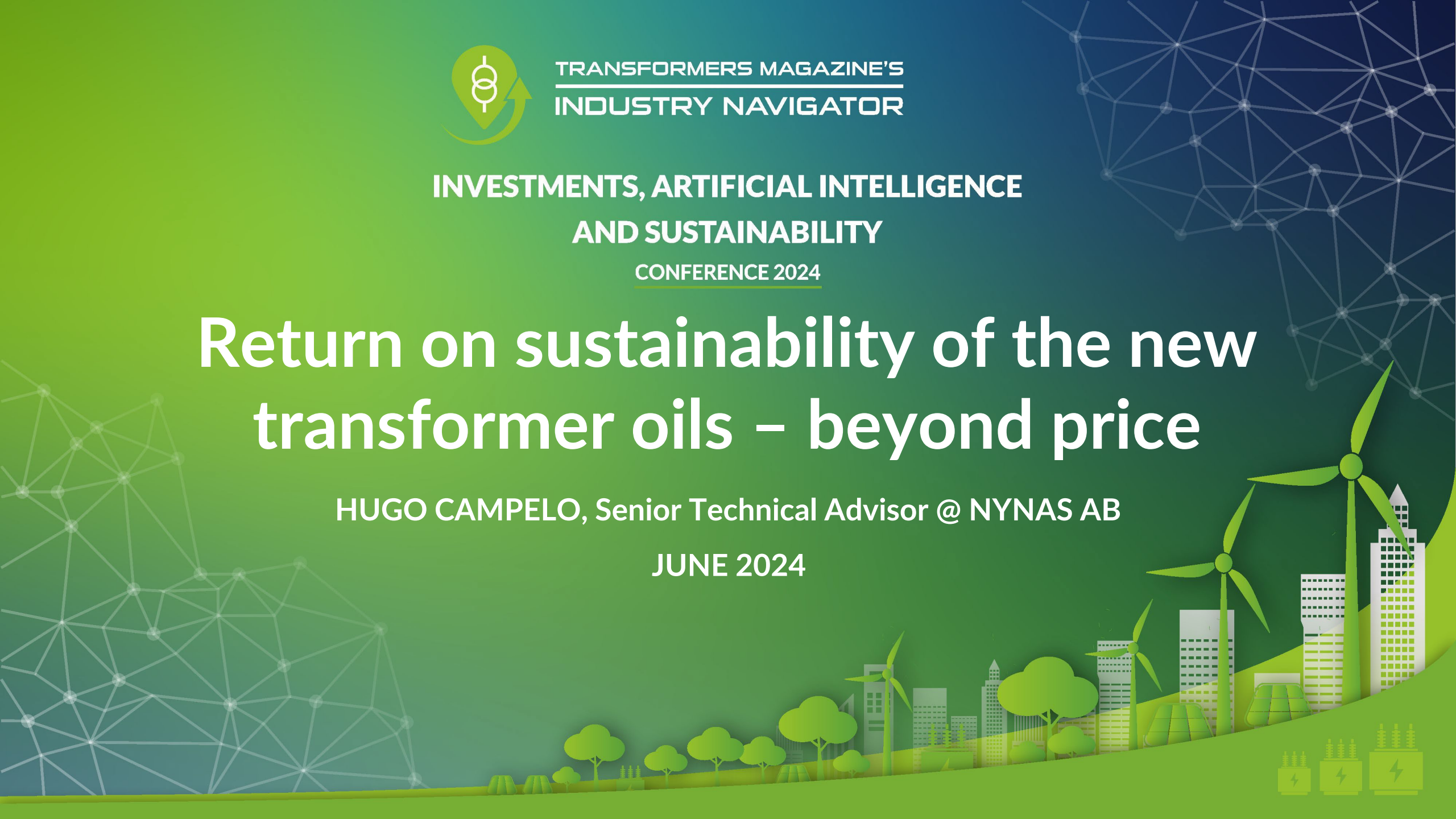
INVESTMENTS, ARTIFICIAL INTELLIGENCE AND SUSTAINABILITY

CONFERENCE 2024

Return on sustainability of the new transformer oils – beyond price

HUGO CAMPELO, Senior Technical Advisor @ NYNAS AB

JUNE 2024



Before starting

Sustainability is a level-playing field wherein the game is driven by the speed and scale of the implementation. The winners of this game are all of us!

Level-playing

Scale

Speed

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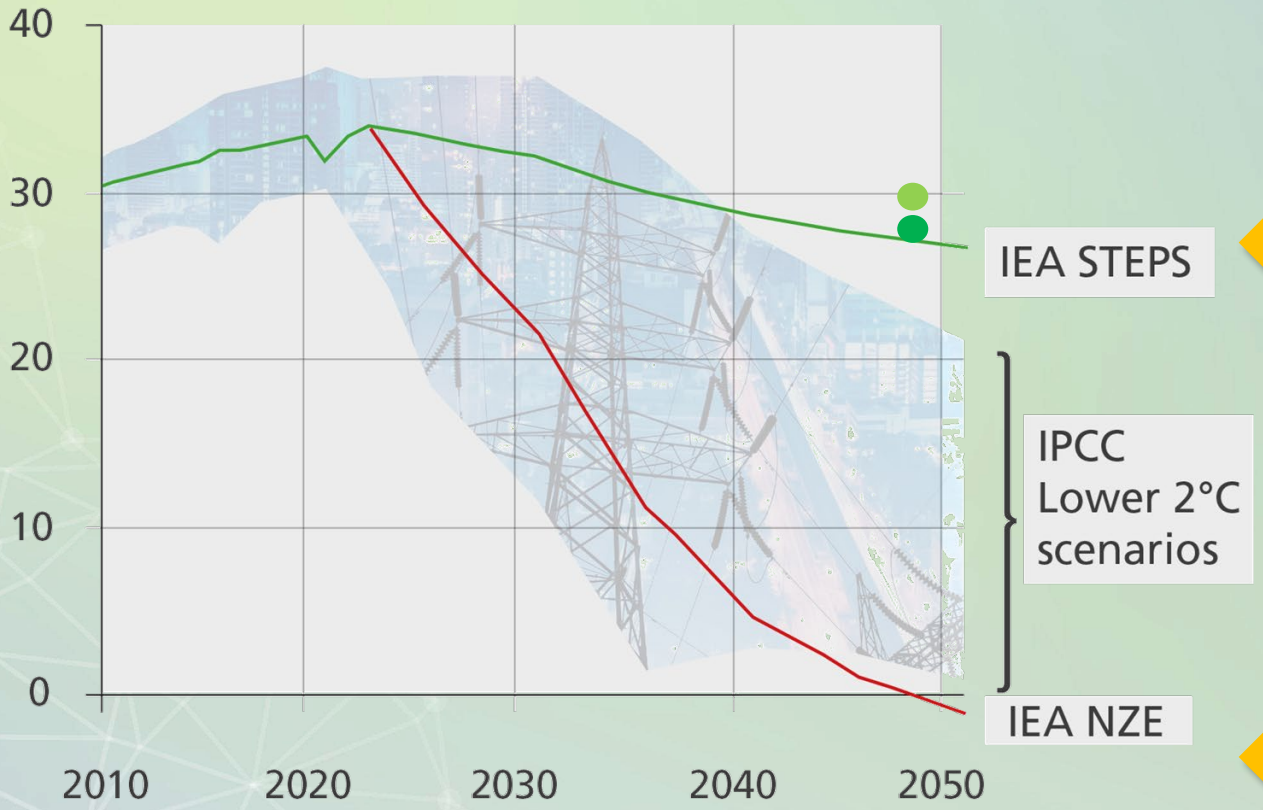
Context

Global energy-related emissions
CO_2 Billion metric tons



Policies in place and/or under adoption

Gap already exists

Need/Ambition

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Context

Besides lowering the carbon footprint: Booming pressure on the demand side, between 10-30% CAGR over a 5-year horizon, new transformers.

CLIMATE / ENVIRONMENT / SCIENCE

The world's power grids, 50 million miles' worth, need a major overhaul

Workers erect a steel tower at the 220kV line project in Jiangsu Province, China, on October 16th, 2023. Photo by Costfoto / NurPhoto via Getty Images

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By Justine Calma,
energy with a dec
podcast.

Oct 17, 2023, 2:5

UTILITY BUSINESS

Hitachi Energy to Invest Additional $1.5 Billion to Ramp Up Global Transformer Manufacturing Capacity By 2027

April 29, 2024

The company also announced an investment of around $180 million in a 30,000-square-meter transformer factory in the Vaasa region, Finland.

T&D World Staff

RELIABILITY

Siemens Energy Expanding N.C. Facility for New, Refurbished Large Transformers

February 16, 2024 Paul Ciampoli

Home / periodical / article / Siemens Energy Expanding N.C. Facility for New, Refurbished Large Transformers

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Siemens Energy is expanding its operations in Charlotte, N.C., with a large power transformer manufacturing and service facility, it said on Feb. 15.

This will be Siemens Energy's first power transformer manufacturing and refurbishment facility in the U.S.

Siemens Energy's $150 million investment will lead to the production of 24 new large power transformers initially, and ultimately increase to 57 units per year when the plant begins operating at full capacity.

Additionally, the facility is planned to start with 12 units of repair and refurbishment service per year, eventually increasing to 24 units at full capacity.

With the combined effort, the factory and service facility will be able to deliver 81 new production and service units at full load annually.

According to a 2023 Government Accountability Officer report regarding efforts the Department of

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What are the tools available on the supply side?

Concerning Nynas transformer oil supply chain - the tools are:

- Traditional grades with reduced carbon footprint (Nytro® 4000X EVO and other Nytro® EVO grades)
- New oils from bio-crudes (Nytro® BIO 300X)
- Re-refined oils from used transformer oils (Nytro® RR 900X)
- Natural Liquids from bio-feedstocks (Nytro® NE 100)

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What are the tools available on the demand side?

$$EXTCO_{(\$)} = TCO_{(\$)} + ECI_{(\$)}$$

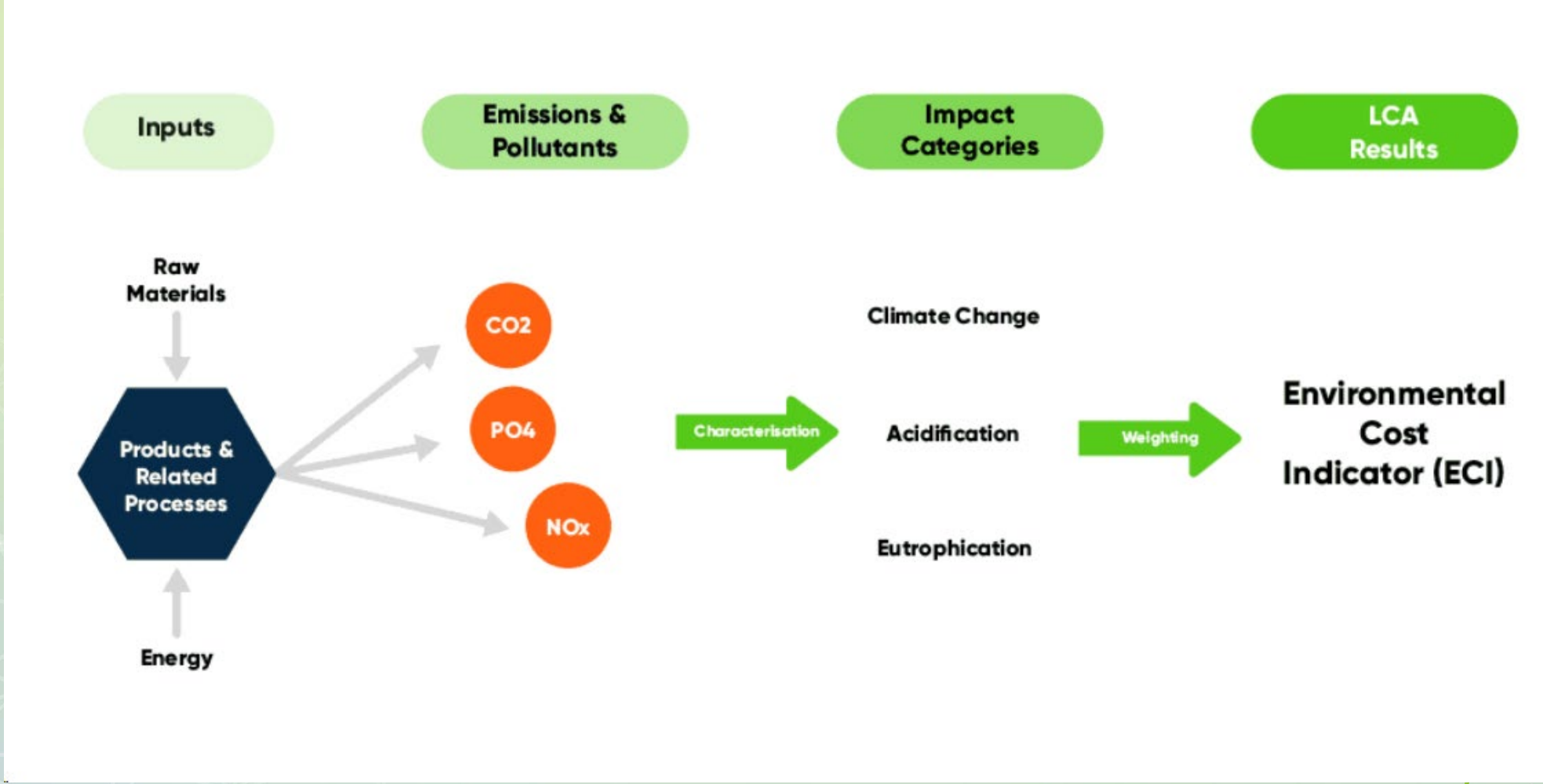
Extended
Total Cost of Ownership

Previous **Total**
Cost of Ownership

New **Environmental**
Cost Indicator


SHOW ME THE MONEY!

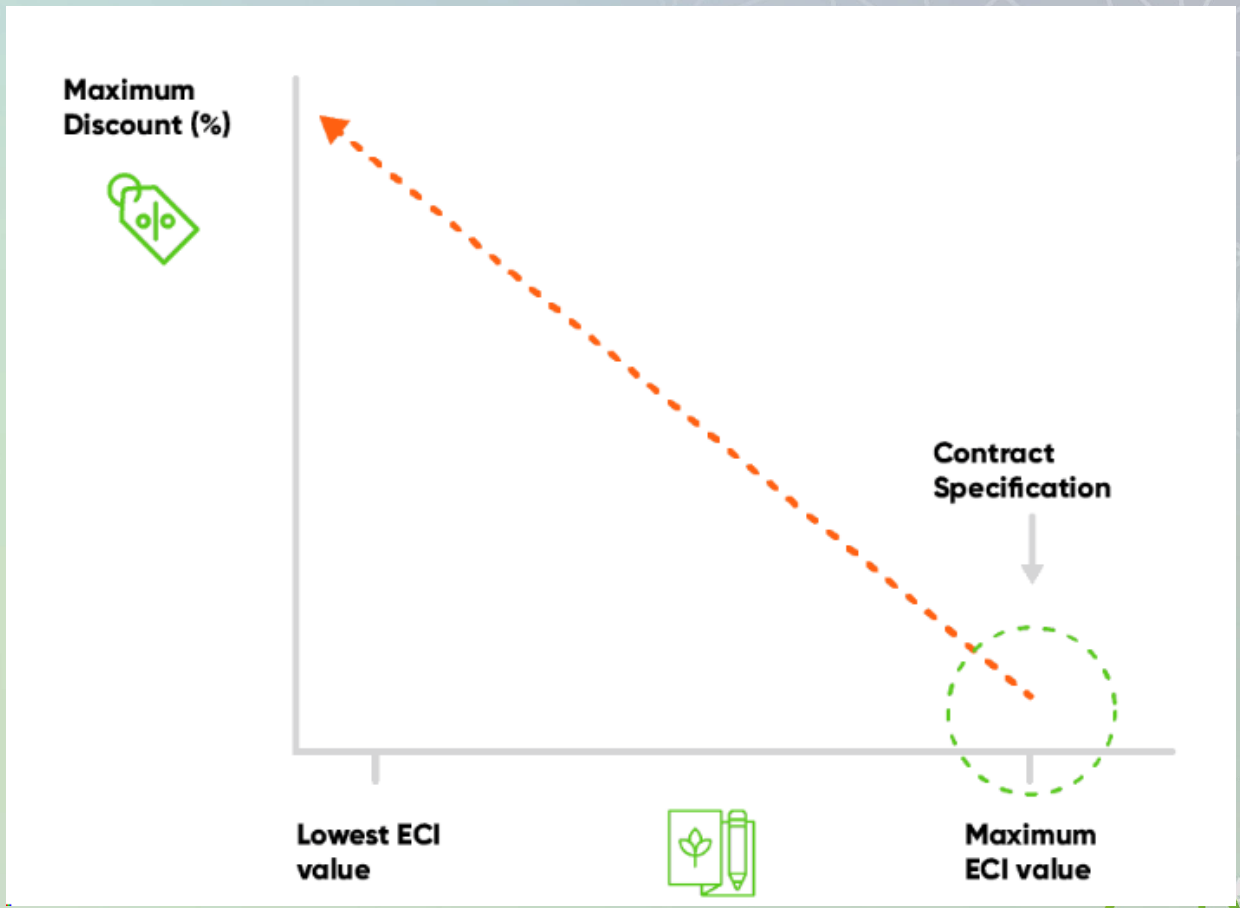
What are the tools available on the demand side?



Source: Luc Hillege, "Environmental Cost Indicator - Ecochain - LCA (Life Cycle Assessment) software company" (link)".

What are the tools available on the demand side?

Impact category	Unit	Weighting Factor (€/ unit)
Global warming	kg CO_2-eq	0,05 €
Ozone depletion	kg CFC-11-eq	30,00 €
Acidification of soil and water	kg SO_2-eq	4,00 €
Eutrophication	kg PO_4^{3-}-eq	9,00 €
Depletion of abiotic resources – elements	kg Sb-eq	0,16 €
Depletion of abiotic resources – fossil fuels	kg Sb-eq	0,16 €
Human toxicity	kg 1,4 DB-eq	0,09 €
Freshwater ecotoxicity	kg 1,4 DB-eq	0,03 €
Marine water ecotoxicity	kg 1,4 DB-eq	0,0001 €
Terrestrial ecotoxicity	1,4 DB-eq	0,06 €
Photochemical oxidant creation (Smog)	kg C_2H_4	2,00 €



Source: Luc Hillege, "Environmental Cost Indicator - Ecochain - LCA (Life Cycle Assessment) software company" (link)".

The tools under IEC 60296

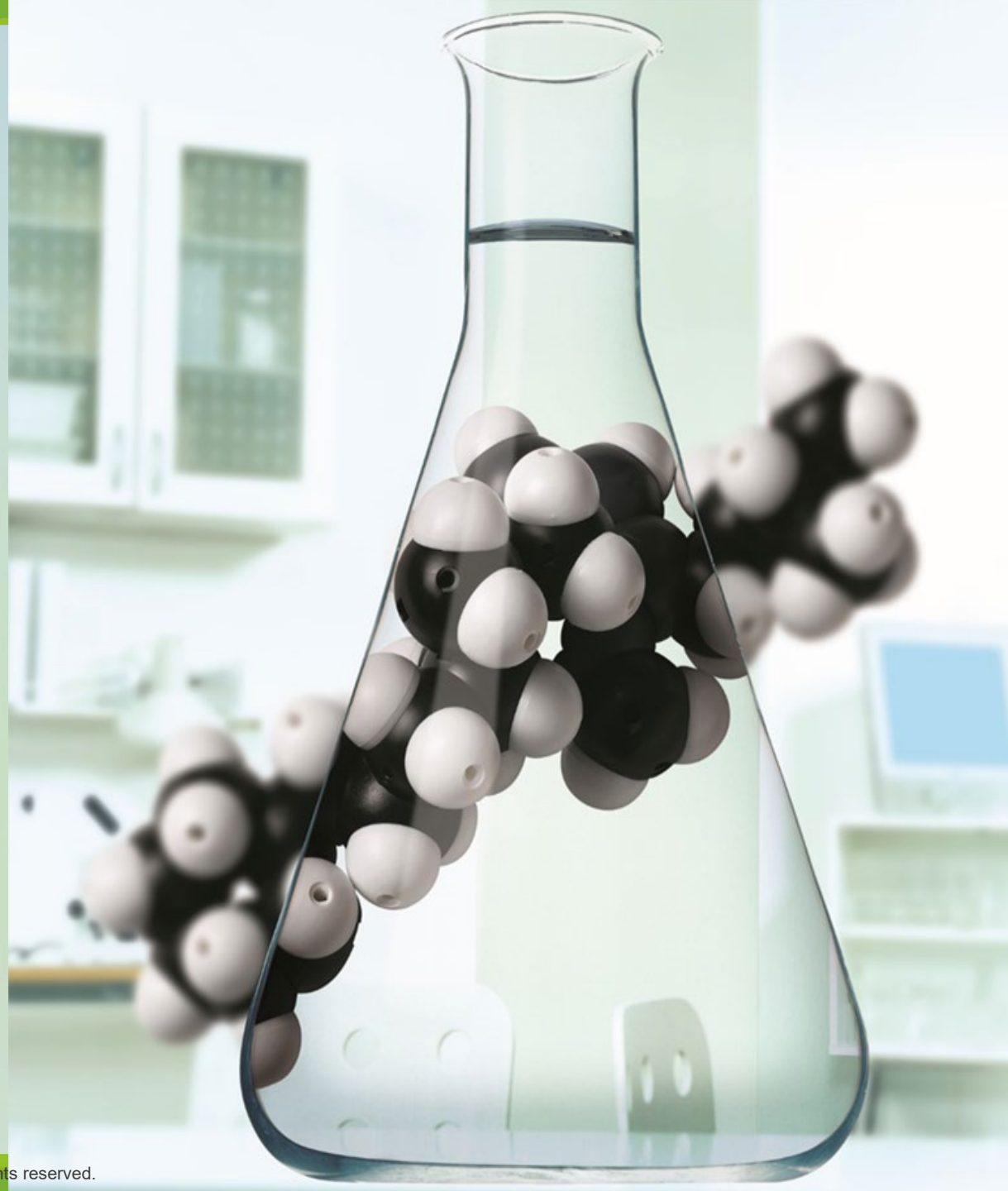
IEC 60296
Ed. 5 (2020)

Unused (Virgin)

Recycled

Unused… mineral insulating oil deriving from petroleum products and/or other hydrocarbons previously not been used in, nor been in contact with electrical equipment or other equipment not required for manufacture, storage or transport"

Recycled means…"mineral insulating oil previously used in electrical equipment that has been subjected to re-refining or reclaiming (regeneration) after removal from the electrical equipment"



The tools under IEC 60296

Two different recycled sub-types exist. Re-refined and Reclaimed.

- Recycled
  - Re-refined
  - Reclaimed

"recycled mineral insulating oil…subjected to a process similar to that used for the production of unused mineral insulating oil from virgin feedstock, in order to reduce the level of undesired compounds."

"recycled mineral insulating oil …which has been subjected … to chemical and physical processing to reduce soluble and insoluble contaminants."

Although different, both re-refined and reclaimed share the same general classification: TRAI or TRBI. **Confusions are common**.

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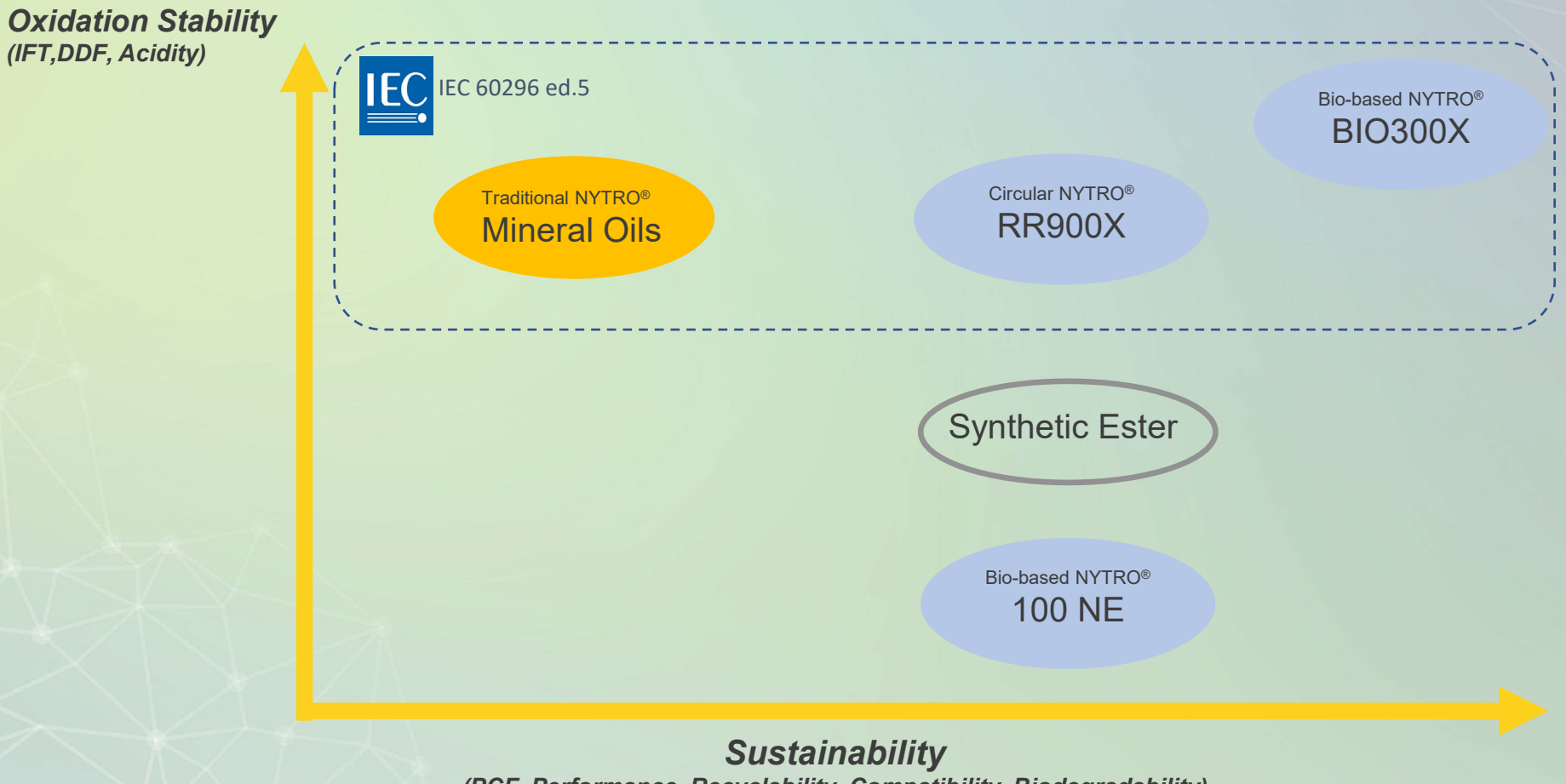
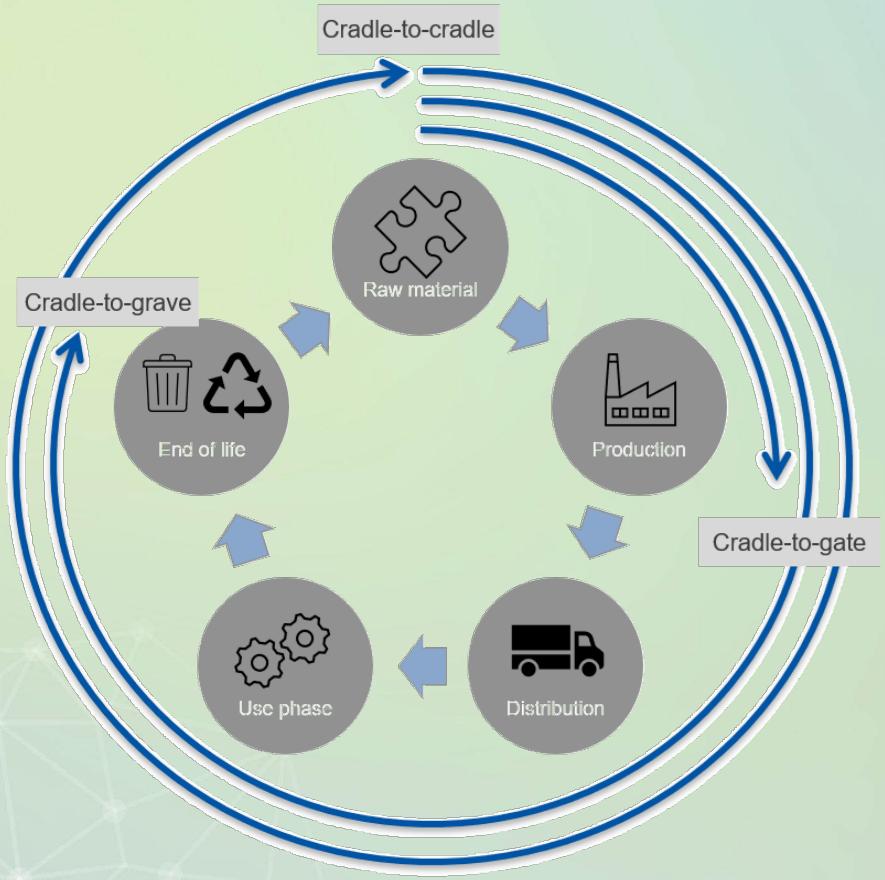
The tools beyond IEC 60296

	IEC Standard
Mineral oil & other hydrocarbons	IEC 60296 (Ed.5 2020 new revision)
Synthetic Esters	**IEC 61099**
Natural Esters	**IEC 62770**
Modified and blended esters	**IEC 63012**
Silicone oils	**IEC 60836**

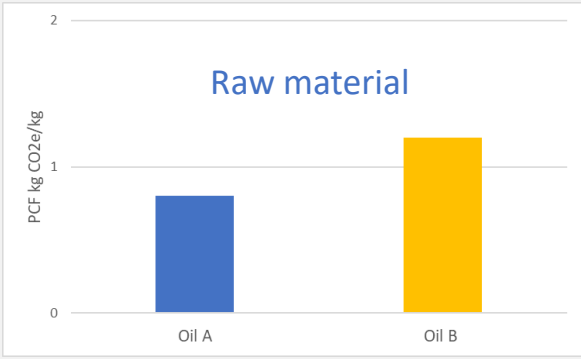
The Nynas toolbox overview

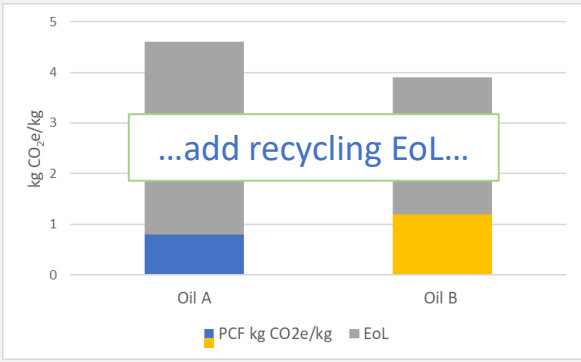


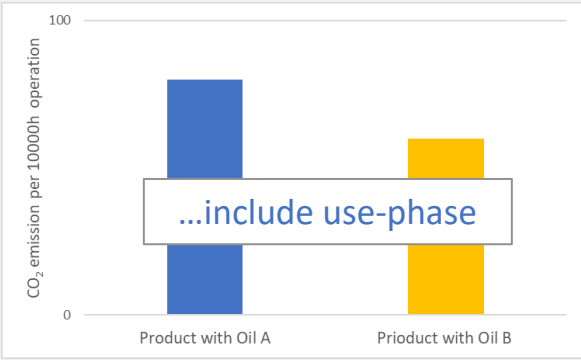

Always compare apples with apples!



Carbon emissions - Considerations

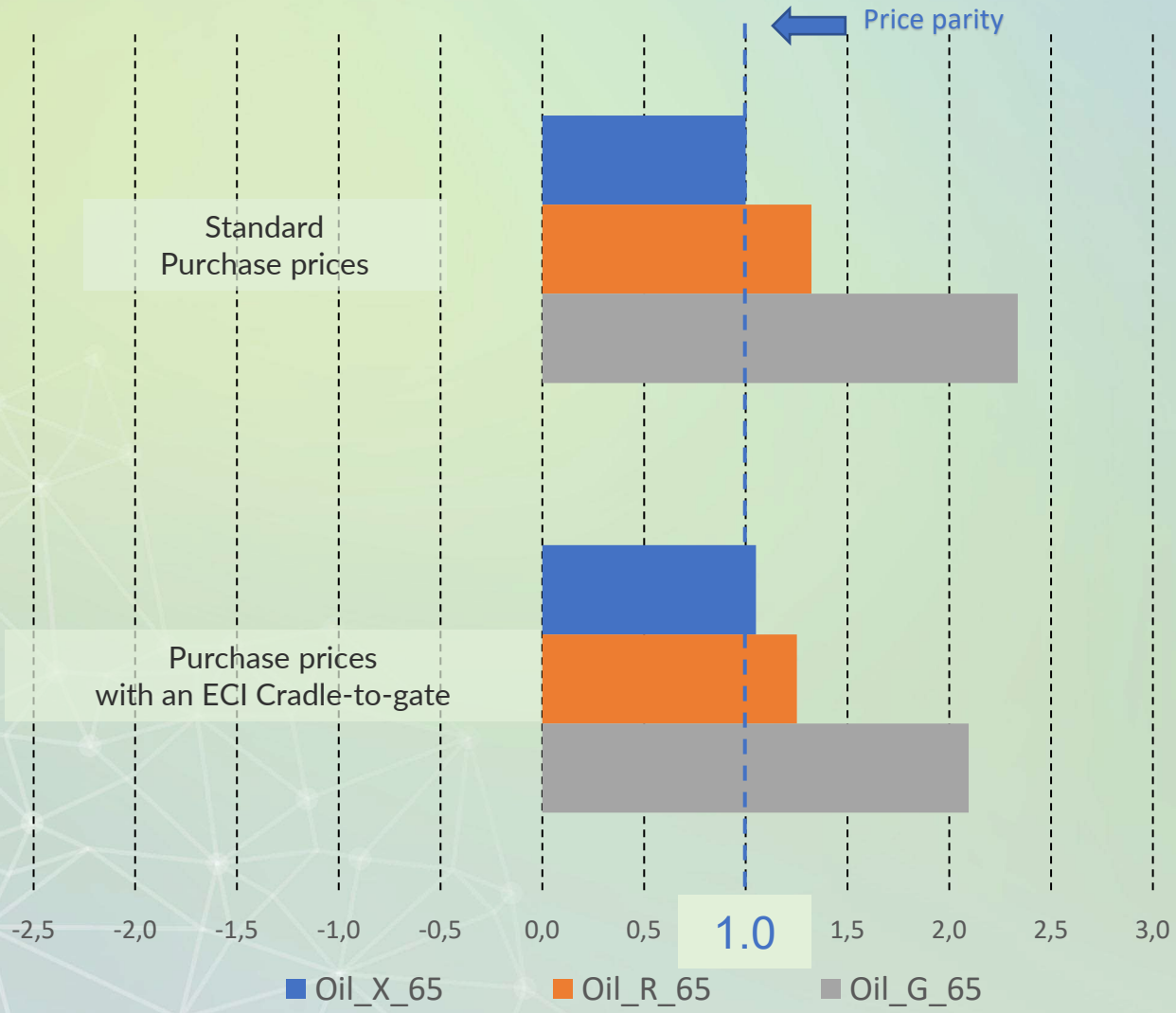






Do not neglect the use-phase and the end-of-life

How to best choose and possibly move faster



- Relative variation of the oil purchase prices **with and without an environmental cost indicator (ECI) cradle-to-gate**
- 40 MVA ONAN/ONAF Case Study
- Base Scenario 0
  - Carbon prices 116 €/ton

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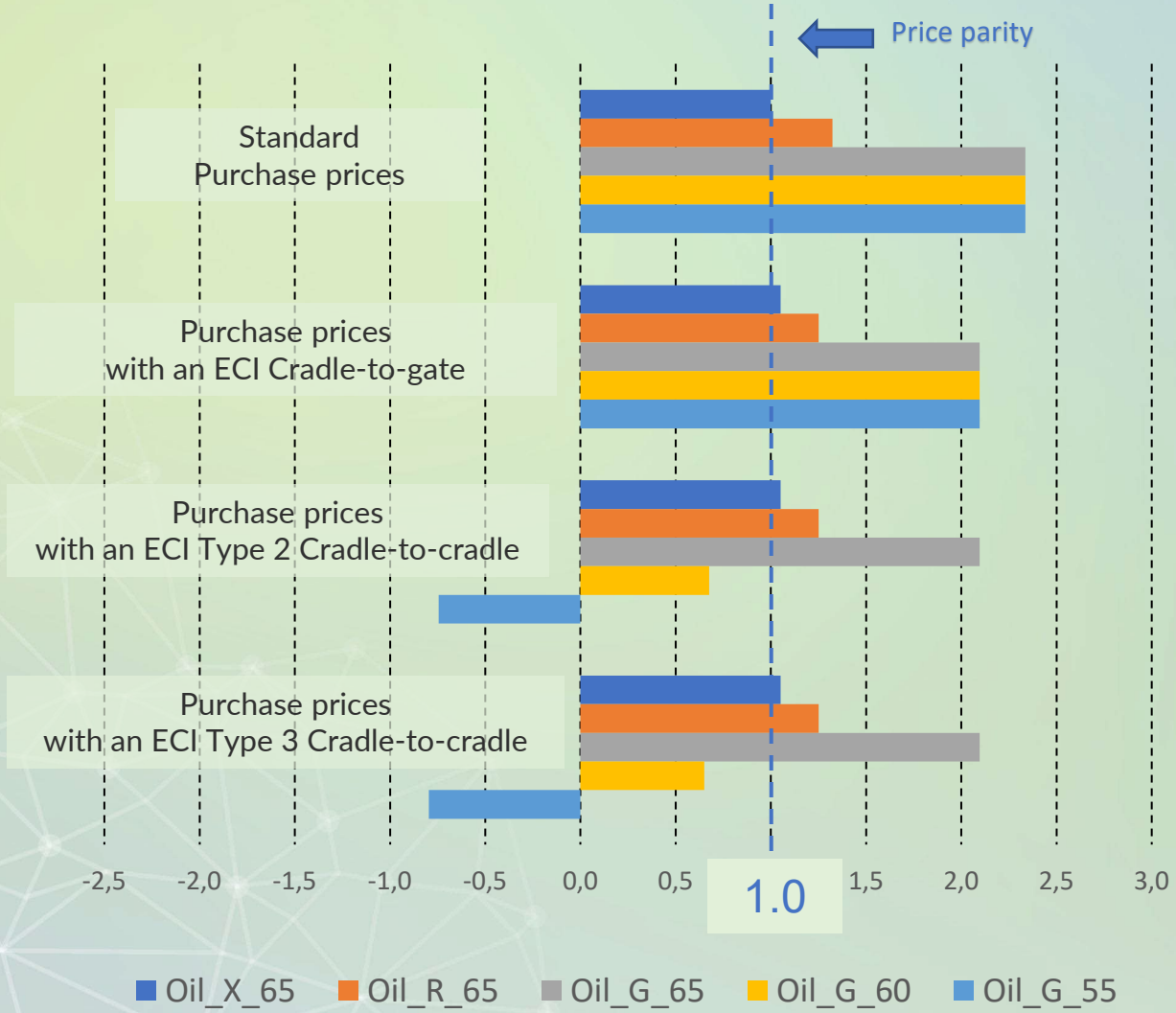
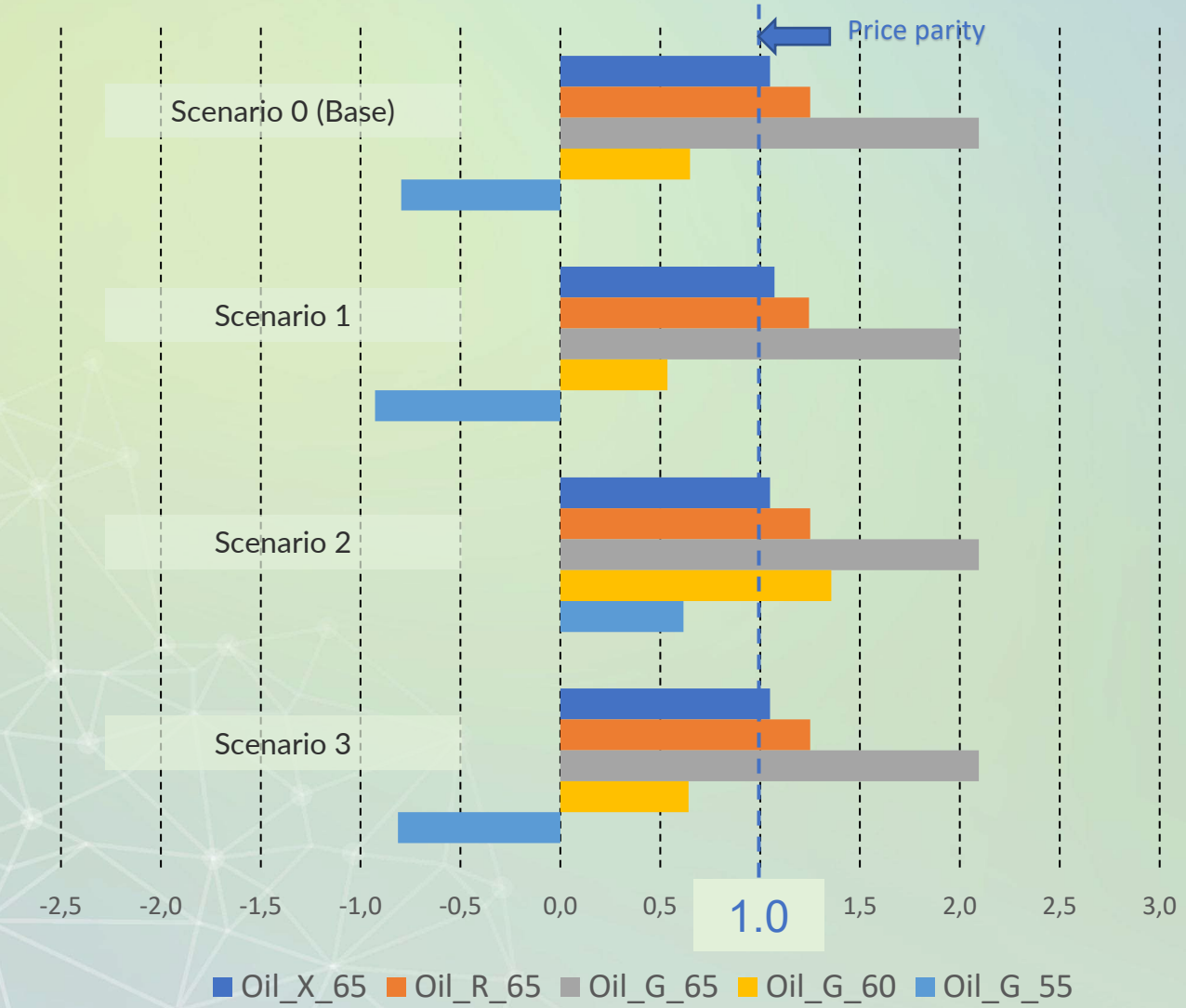
How to best choose and possibly move faster



- Relative variation of the oil purchase prices **with and without different environmental cost indicators (ECI)**
- Same 40 MVA ONAN/ONAF Case Study
- Same Base Scenario 0 with extended assumptions

  - Carbon prices 116 €/ton
  - *Load factor of 25% has been assumed (0.5 p.u.)*
  - *Average price of the electricity 0.177 €/kWh*
  - *Average emissions per MWh 219 kCO_2eq*

How to best choose and possibly move faster



- Relative variation of the oil purchase prices **with the same environmental cost indicator type 3 (ECI 3) for 3 additional scenarios**
- Same 40 MVA ONAN/ONAF Case Study
  - *Scenario 0: Baseline (previous slide)*
  - *Scenario 1: Carbon prices 200 €/ton*
  - *Scenario 2: Average price of the electricity 0.089 €/kWh*
  - *Scenario 3: Load factor 0.5 (0.71 p.u.)*

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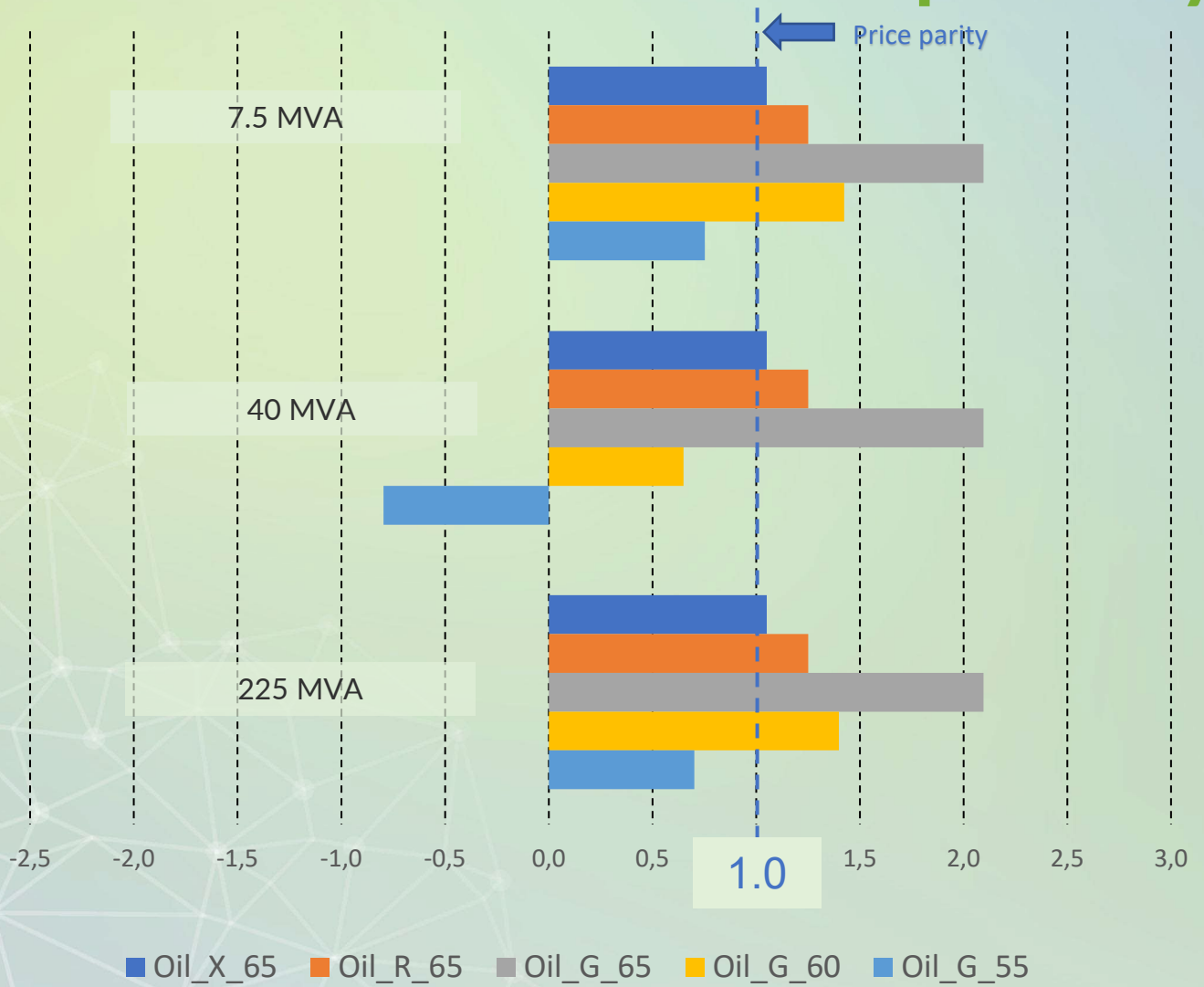
How to best choose and possibly move faster



- Relative variation of the oil purchase prices with and without environmental cost indicator (ECI 3) **for two additional transformers of different sizes.**
- Base Scenario 0 used
  - Carbon prices 116 €/ton
  - Load factor of 25% has been assumed (0.5 p.u.)
  - Average price of the electricity 0.177
  - Average emissions per MWh 219 kCO_2eq

Final remarks

- Multiple transformer liquids are already available on the upstream supply side allowing increased environmental and operational performances
  - Most of them come with a premium over the conventional prices
- On the demand side environmental cost indicators are under discussion in multiple working groups at the moment (DNV JIP, CIGRE,…) and some European utilities have already started implementing these hard-criteria in new transformer tenders
  - The simplest indicators including only LCA outputs from cradle-to-gate may not be sufficient to balance the premium price of some solutions
  - Extending these indicators to include the use-phase and end-of-life can be impactful and change the conclusions or decisions to be taken

Adapting the traditional return on investment indicators is critical. Roadmaps and ambitions are not self-sufficient. At least to address the existing gap between policies/actions and ambitions.

Thanks for your attention!

Hugo Campelo

Senior Technical Advisor
+351 934796480
hugo.campelo@nynas.com

Supporting the sustainable transition

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