



Doing More with Less ***Leveraging the Power of LCA***

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April 15, 2026
SOCMA Sustainability & Safety Workshop
Milwaukee, WI



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Director of Sustainability Services

- Masters Biomedical Engineering & Bachelors Chemical Engineering
- 19 years of Environmental Consulting Experience

Highlights

- Coordinates Trinity's service offerings in environmental sustainability, leveraging our environmental compliance expertise to address today's challenges associated with transition to low carbon economy
- Over a decade of experience in CA working across variety of industry sectors and air basins with established relationships with local agencies and CARB
- Accredited lead verifier for LCFS



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What is Life Cycle Assessment?

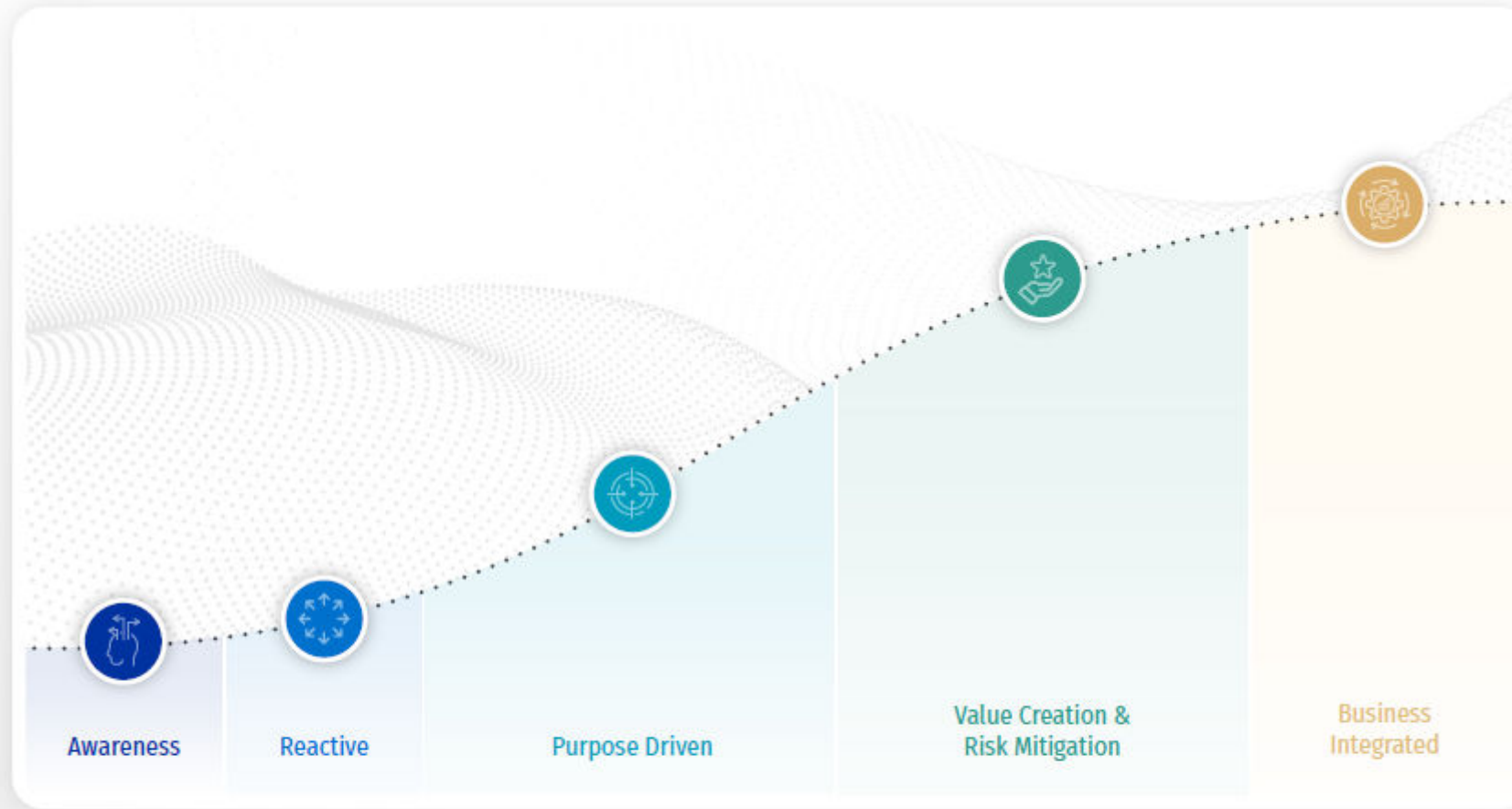
“Life Cycle Assessment (LCA) is the compiling and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle.”

- ISO 14040:2006

LCA forms the basis of an Environmental Product Declaration (EPD)



Environmental Sustainability Maturity Curve



Our approach is to meet our clients wherever they are on their sustainability journey, and to become a trusted partner to establish or reinforce a foundation in the early stages, and strategically support the evolution of their program as it matures to align with the company's overarching business plans, timelines, and key objectives.

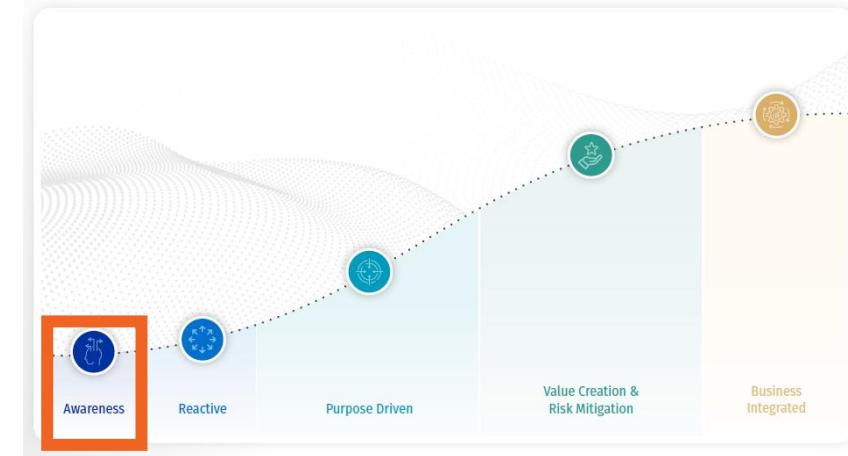
Level 1: AWARENESS

Awareness Traits:

- Basic metrics (e.g., Scope 1/Scope 2) quantified
- Organization acknowledges need to assess climate risks and strategies
- Management responsibility identified
- Some operational sustainability/climate initiatives in place
- External reporting may be incomplete or inaccurate

Next Steps:

- Screening LCA Model for assessment of potential environmental impacts
- Visually appealing Sankey diagram provides transparency



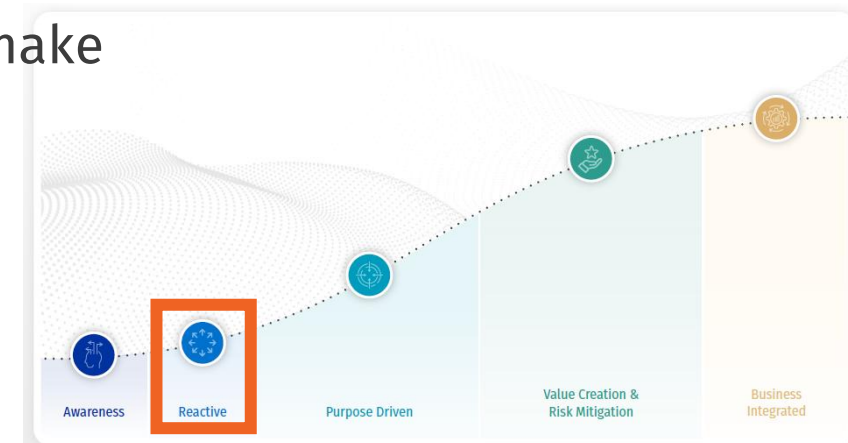
Level 2: REACTIVE

Reactive Traits:

- Collecting metrics data of varying quality, transparency, and accuracy
- Limited strategy and public disclosure
- Inquisitive start to supply chain mapping
- Focus is compliance with regulatory frameworks and supply chain requests
- Data management processes/systems highly manual

Next Steps: One Model, Maximum Flexibility

- Invest upfront in the setup of an enterprise-wide model to make managing change and analyzing impacts at all levels of your organization possible
- Collaborate with LCA practitioners to set up model



LCA for Certain Scope 3 Categories

Upstream Scope 3 Emissions:

1. Purchased goods *and services*
2. *Capital goods*
3. Fuel- and energy-related activities (not included in scope 1 or scope 2)
4. Upstream transportation and distribution
5. Waste generated in operations
6. *Business travel*
7. *Employee commuting*
8. *Upstream leased assets*

Downstream Scope 3 Emissions:

9. Downstream transportation and distribution
10. Processing of sold products
11. End-of-life treatment of sold products
12. Use of sold products
13. *Downstream leased assets*
14. *Franchises*
15. *Investments*

Market Drivers

Customer Requests

Example Customer Product Environmental Performance Request

Environmental performance – Product

1. Does the product have an Environmental Product Declaration (EPD), either Product specific, Group or Industry Average or equivalent?

If yes, please provide a link or a pdf copy.

2. If no on Q1, does the product have a life cycle assessment (LCA) based on ISO 14040-series on LCA requirements or equivalent?

If yes, please provide a link or a pdf copy.

3. If no on Q1-Q2, can you provide GHG-performance data on product or product group level based on a cradle-to-gate approach (upstream and core modules)?

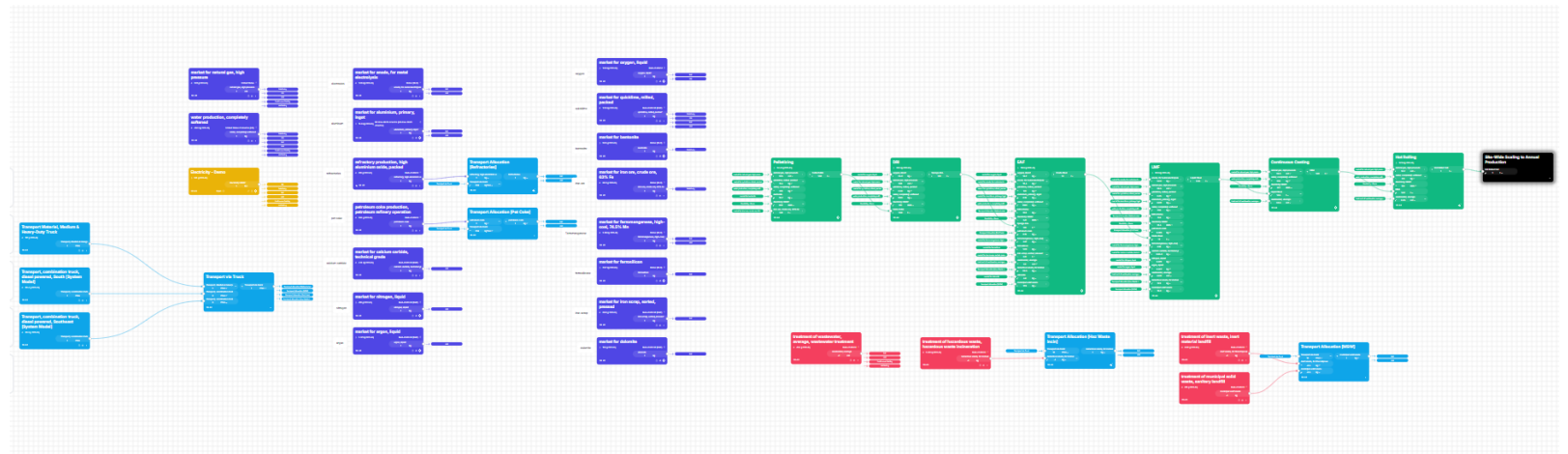
If yes, please provide the result, measured in kg CO₂e/ton of dry content or equivalent. Please provide a brief description of method of calculations and any limitations in emissions included. Please provide a link or a pdf copy if available.

4. If no on Q1-Q3, can you provide GHG-performance data on product or product group level on selected parts of the value chain?

If yes, please provide the result, measured in kg CO₂e/ton of dry content or equivalent. Please provide a brief description of method of calculations and any boundary limitations in emissions included. Please provide a link or a pdf copy if available.

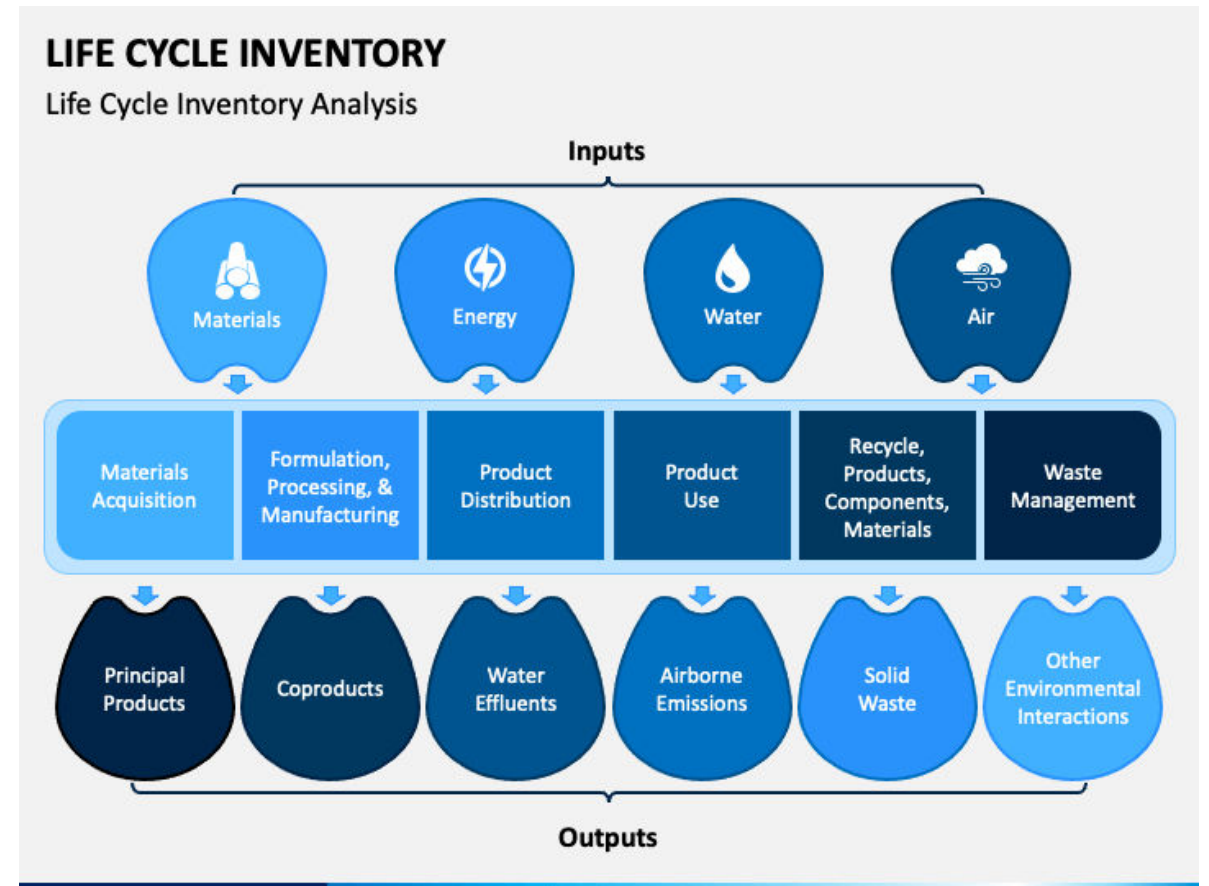
Doing more: LCA as a Tool

- Single integrated model built once
- Reusable across multiple applications, including:
 - Product Carbon Footprinting
 - EPD development
 - Water use mapping
 - Energy consumption tracking
 - Sustainability planning and scenario analysis

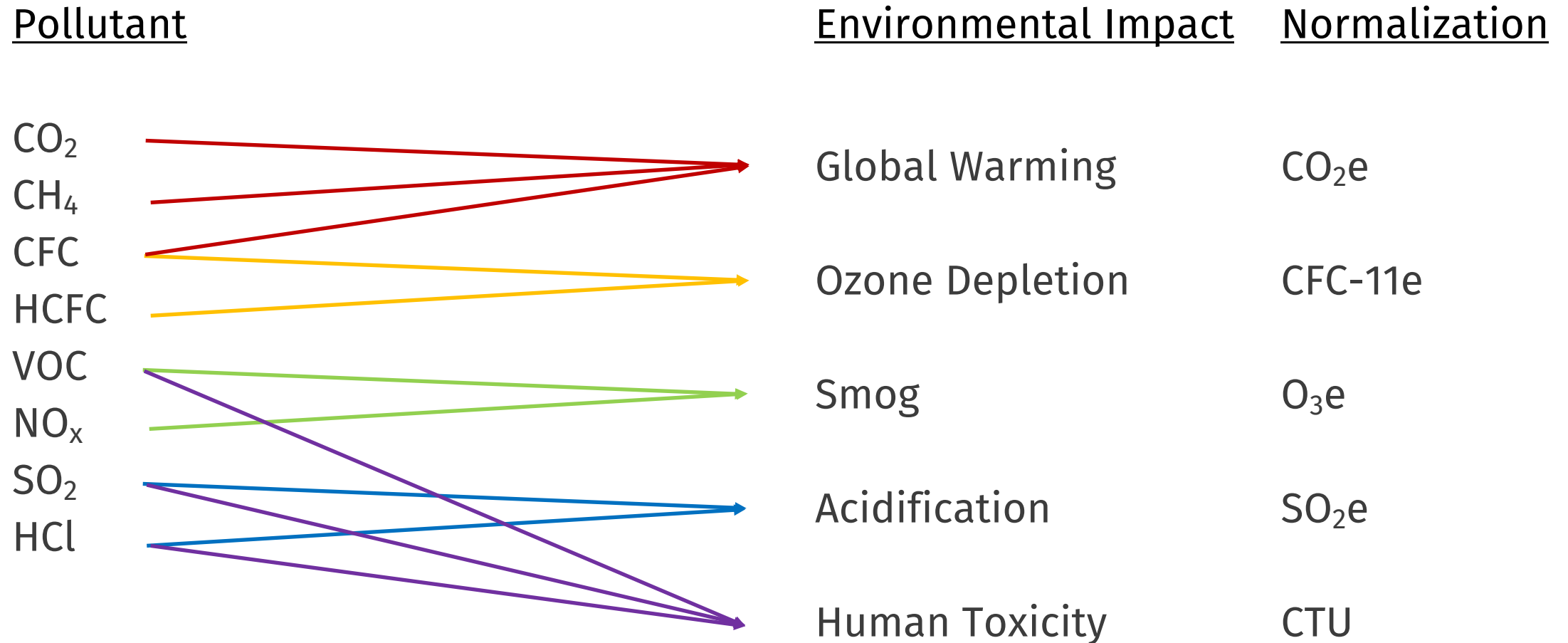


What Goes into an LCA

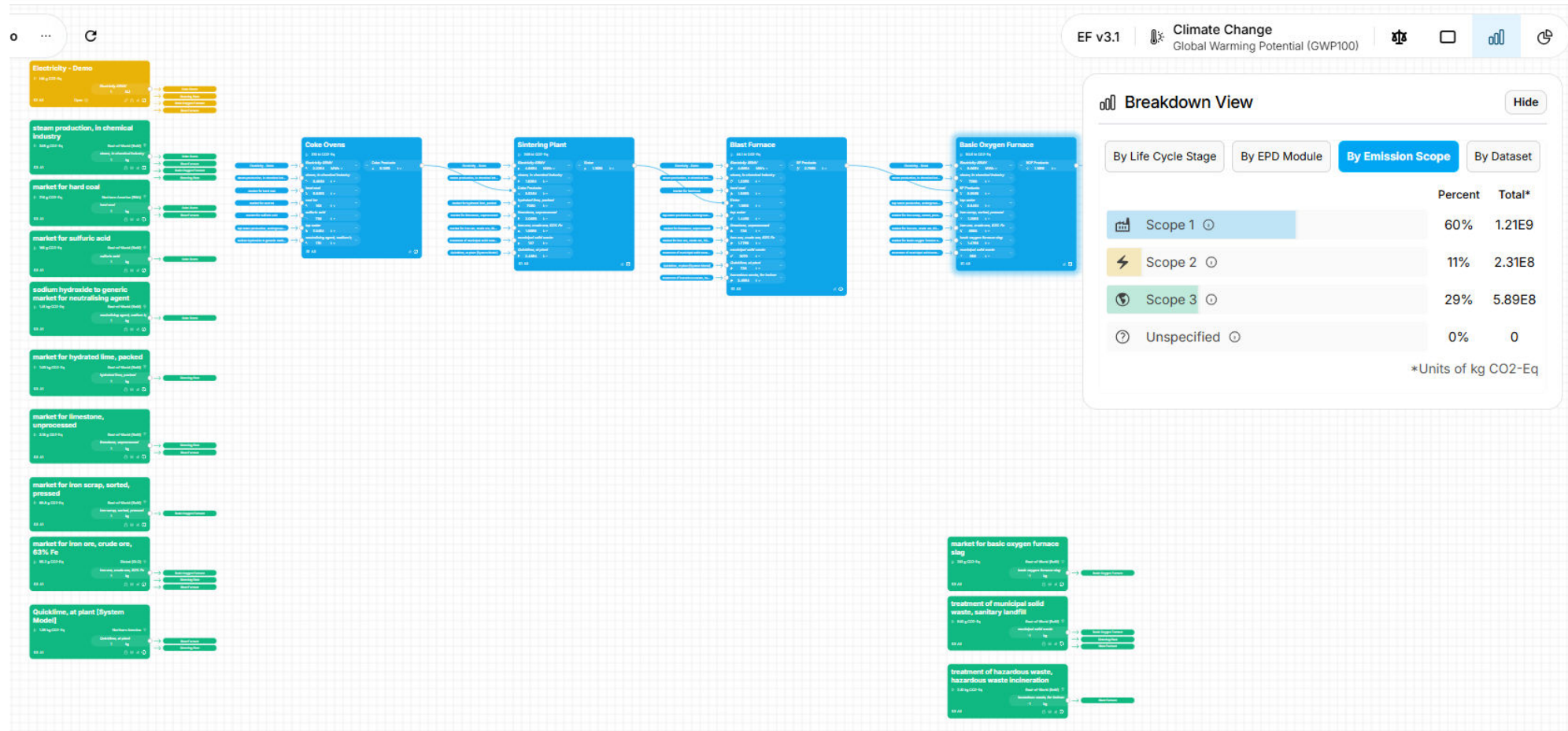
- The Life Cycle Inventory (LCI) phase quantifies all the inputs and outputs of a product system.
- Process units are developed for each life cycle stage and connected to form a single large process flow diagram.
- Elemental Flows to/from nature



Example Impact Assessment Process



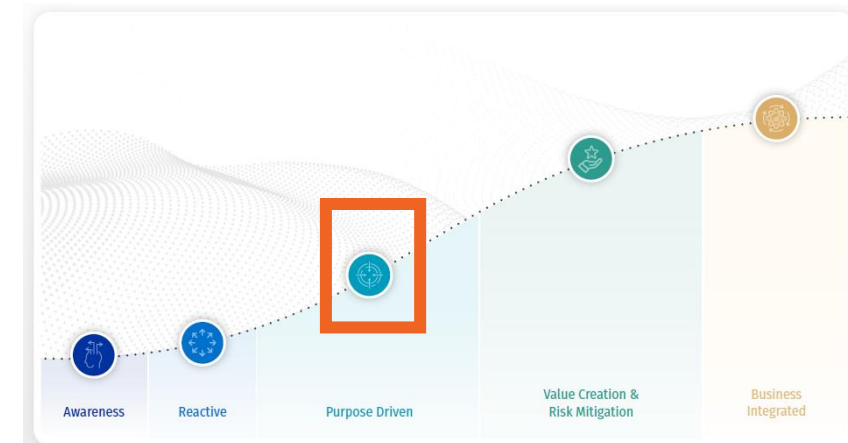
GHG Inventory Applications



Level 3: PURPOSE DRIVEN

Purpose Driven Traits

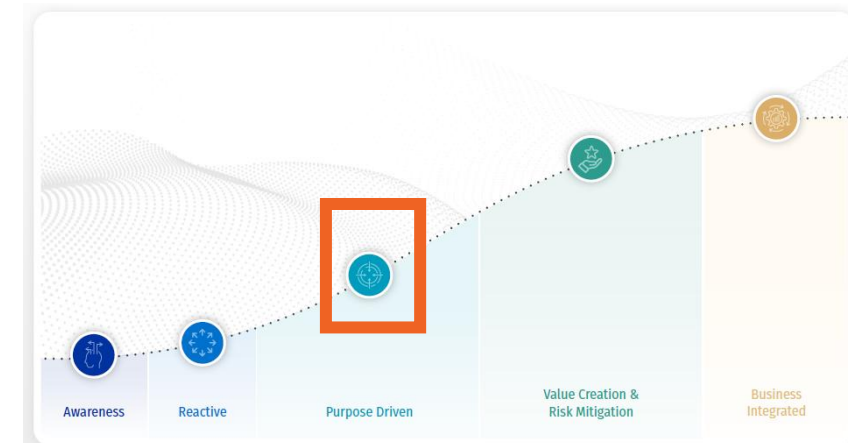
- Climate-related risks are defined, and opportunities start to emerge
- Public disclosures become standard practice
- Focus shifting to value chain - product lifecycle analyses and external data
- Board-level governance activities
- Business processes and centralized data management system drives data quality, security, and timeliness



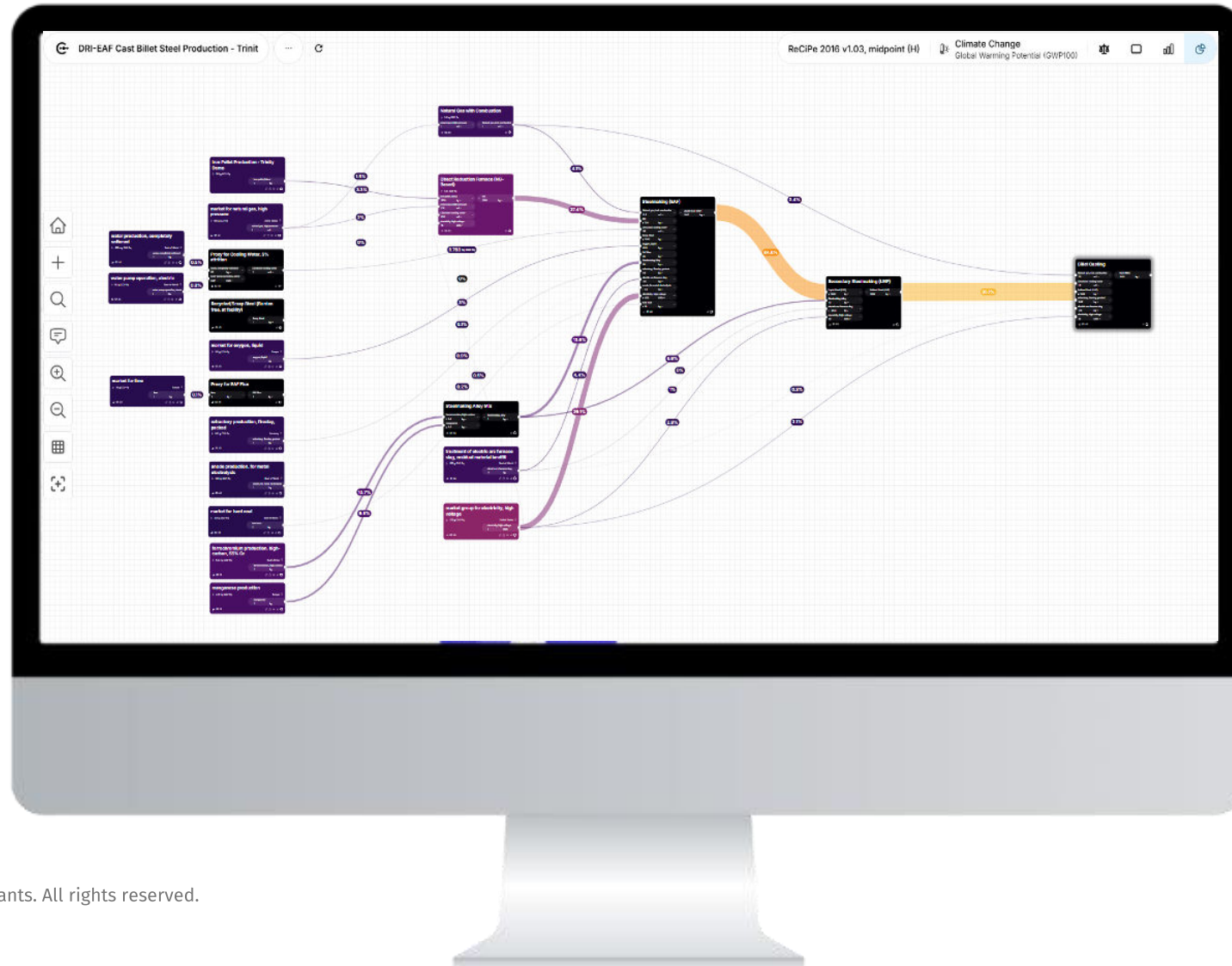
Level 3: PURPOSE DRIVEN

Next Step: Hot Spot Analysis

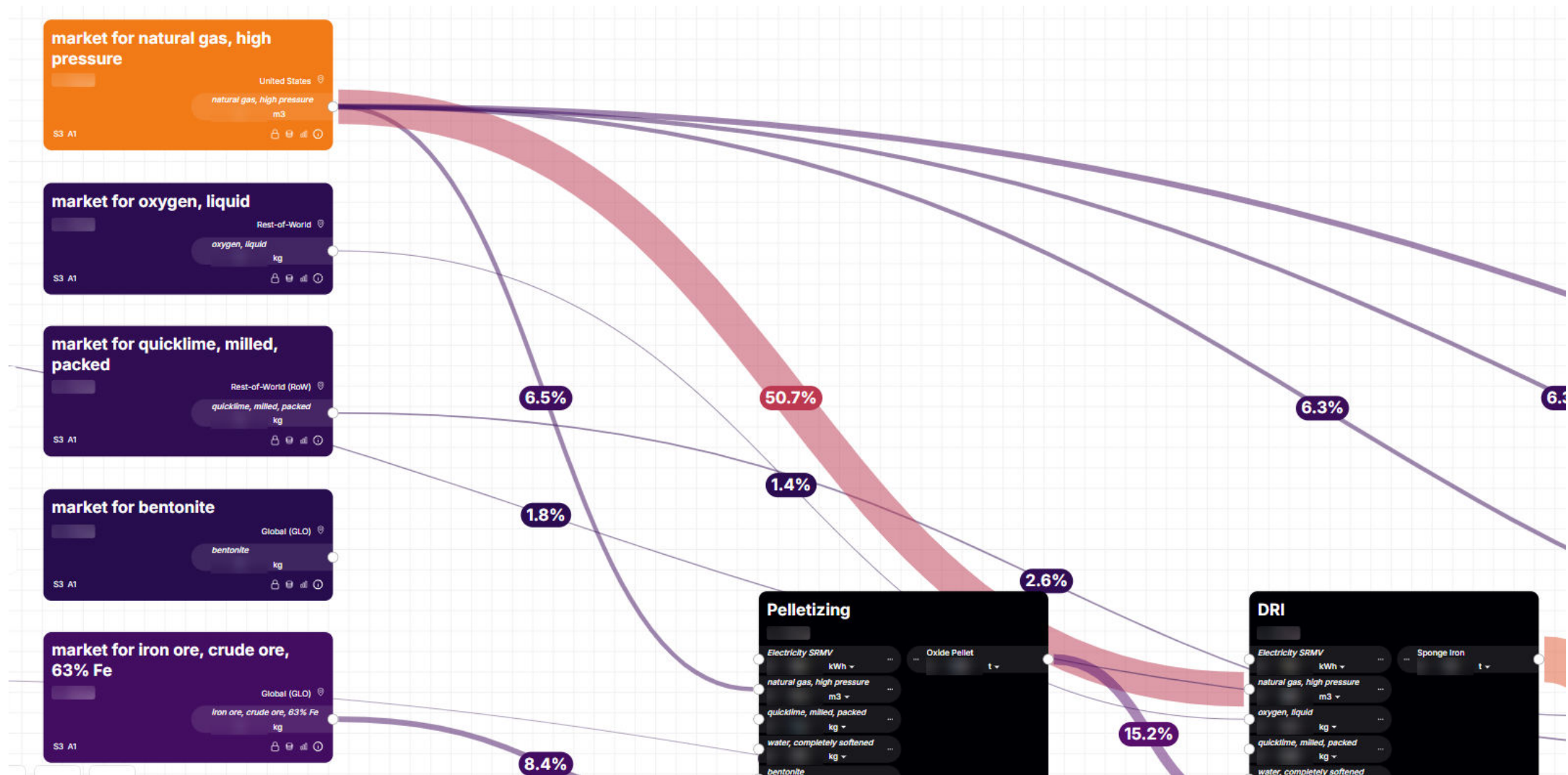
- Expand focus to include all environmental impacts
- Quickly identify risks and opportunities associated with certain facilities, product-lines, or aspects of the supply chain through the comprehensive hot spot analysis
- Hotspot analyses may help identify data quality issues
- Data quality improvements directly impact your competitive advantage in the market



Sankey Diagram Hotspot Analysis Uncovers Data Quality Issues and Opportunities for Strategic Focus



Hotspot Example – Cumulative Energy Demand



Level 4: VALUE CREATION & RISK MITIGATION

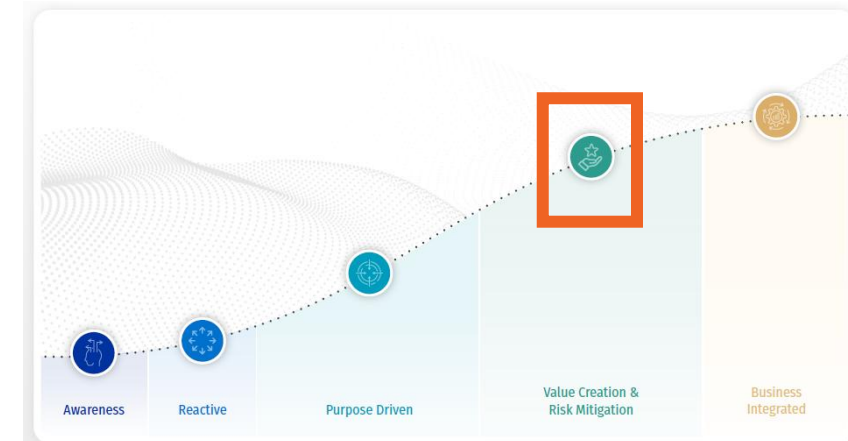
Value Creation/

Risk Mitigation Traits

- Integration of climate/sustainability risks and opportunities into enterprise management
- Science-based target setting
- Mature data management processes and analytics to inform strategic planning and prepare comprehensive disclosures

Next Steps

- Integrate primary data into LCA through existing data management systems and upstream sources in value chain
- Integrate cost information into scenario analysis to inform target setting and reduction strategies
- Use enterprise model to identify the risks and opportunities of real or likely changes.



Scenario Analysis - Electrification

Integrated Steel Mill Demo /

Scenario Analysis

Split View

Copy Results

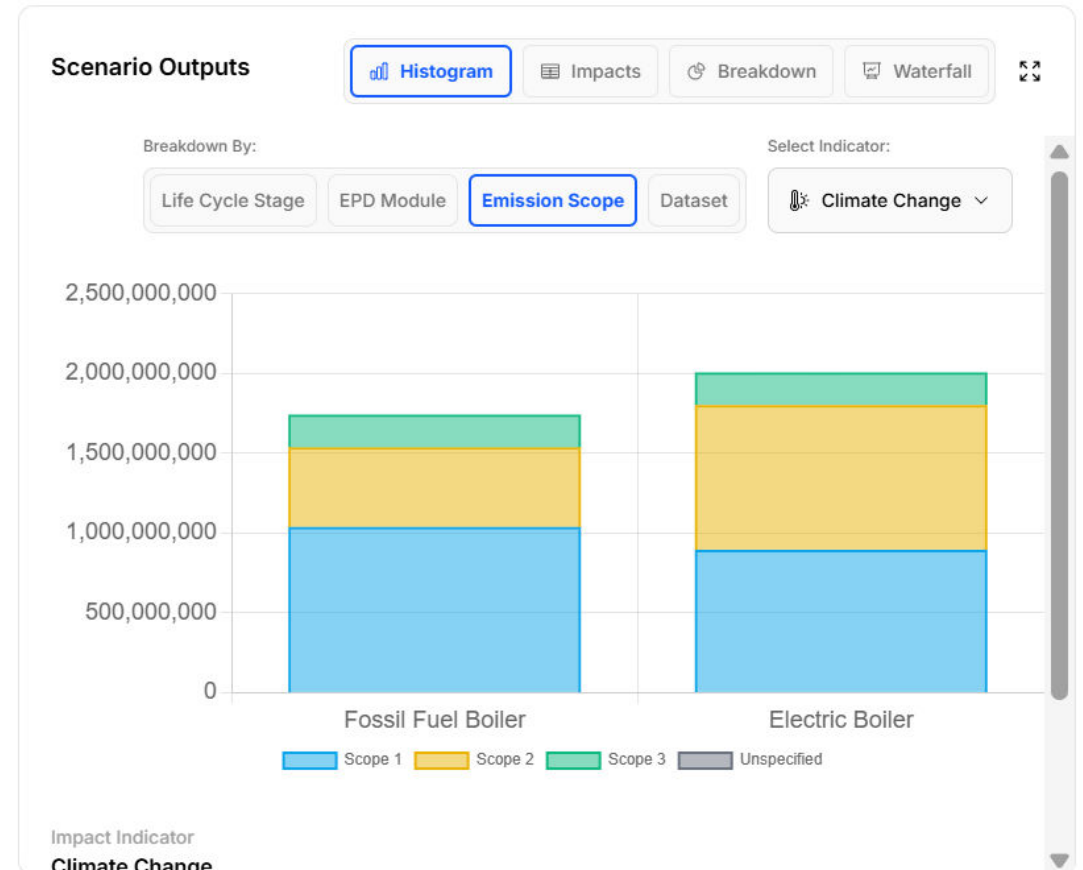
Run Analysis

Scenario Inputs

Filter Sort New Scenario

Parameter	Fossil Fuel Boiler	Electric Boiler
i_sinter_BF	1.16E6	1.16E6
i_coke_BF	3.84E5	3.84E5
i_water_BF	1.44E5	1.44E5
i_vapor_BF	1.22E5	0
i_BFGas_BF	4.03E5	4.03E5
i_cokegas_BF	2.14E4	2.14E4
i_elec_BF	4.99E4	3.79E5
Emissions CO2 BF	5.52E4	2.76E4

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Note: Values saved in local browser storage



Scenario Analysis - Bio-Fuel Substitution

Pulp & Paper Demo /

Scenario Analysis

Split View

Copy Results

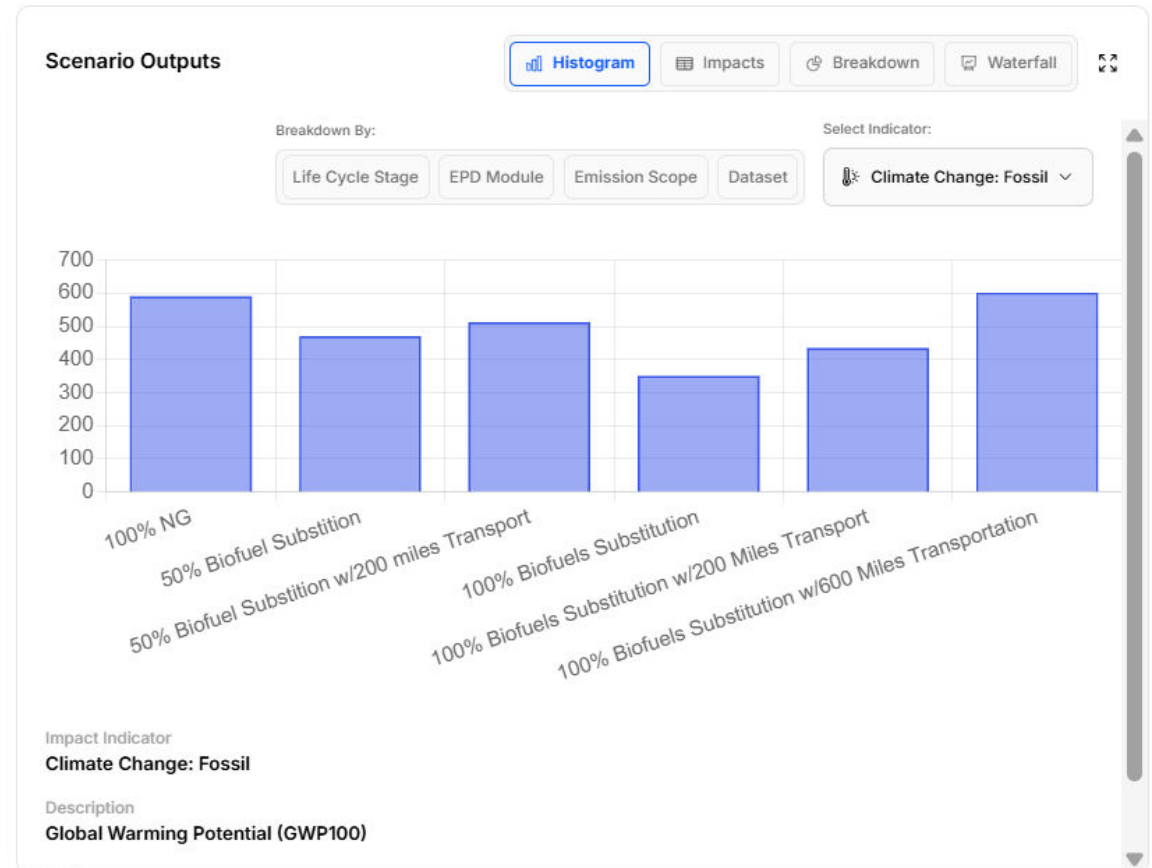
Run Analysis

Scenario Inputs

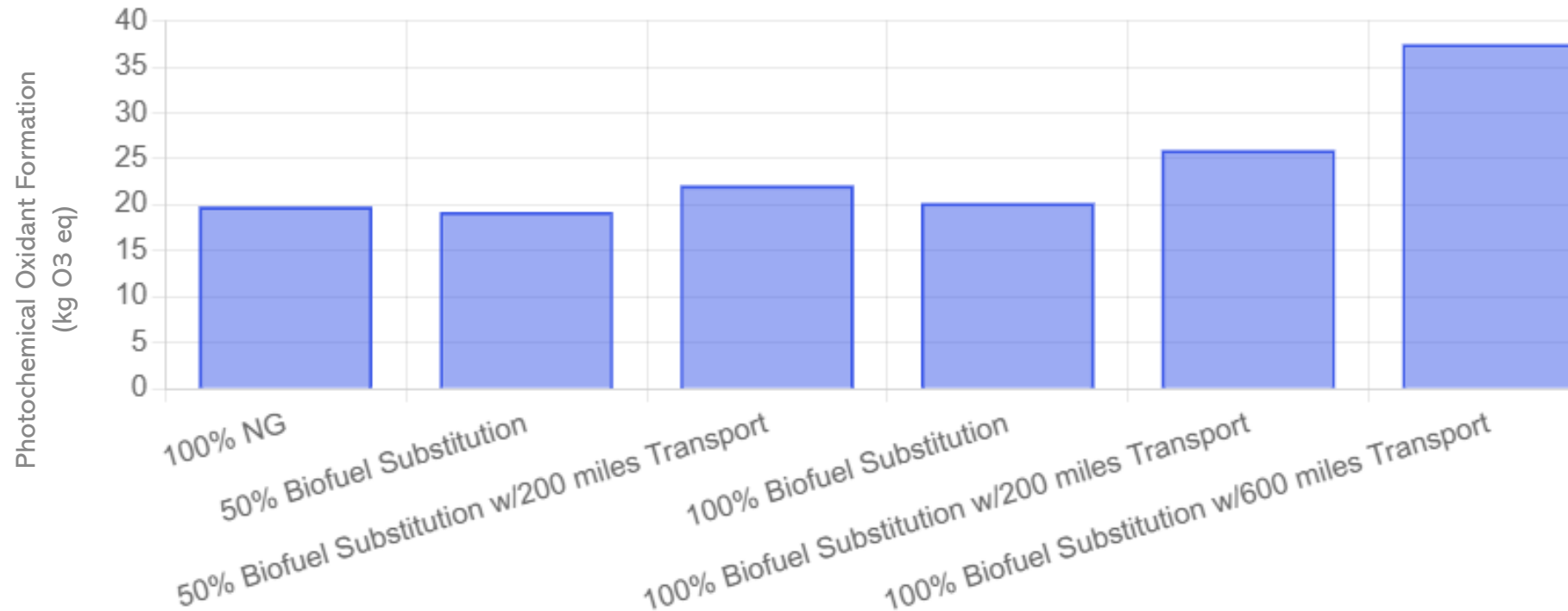
Filter Sort New Scenario

Parameter	100% NG	50% Biofuel	50% Biofuel	100% Biofuel	100% Biofuel
Fuels_Biofuel	0	2.37	2.37	4.74	4.74
Fuels_Reuse_Derived_Fuel	0.535	0.535	0.535	0.535	0.535
Water_Input_total	14.1	14.1	14.1	14.1	14.1
Purchased_pulp_barge	41.5	41.5	41.5	41.5	41.5
Tr_Paper_rail	614	614	614	614	614
Tr_Paper_barge	320	320	320	320	320
Steam	0.449	0.449	0.449	0.449	0.449
Bought_Electricity	1.35	1.35	1.35	1.35	1.35
Fuels_Natural_gas	4.74	2.37	2.37	0	0
Fuels_How_fuel_oil	0.0433	0.0433	0.0433	0.0433	0.0433

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Note: Values saved in local browser storage



Biomass Fuel Substitution – Smog Formation



Impact Indicator

Photochemical Oxidant Formation

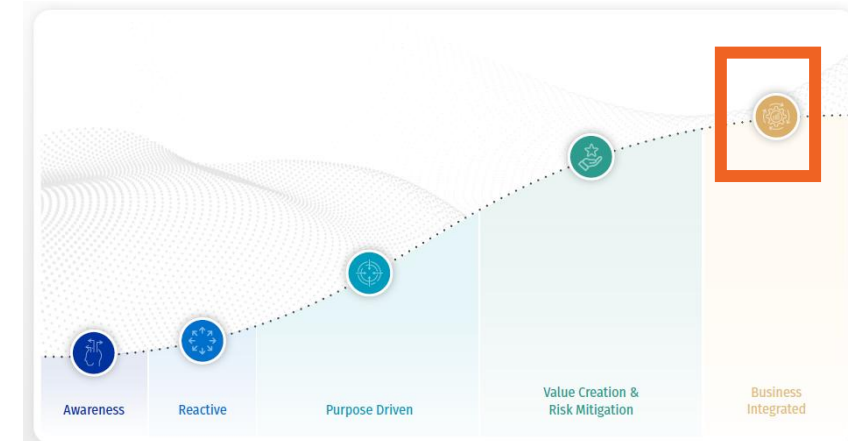
Level 5: BUSINESS INTEGRATED

Business Integrated Traits

- Full integration of sustainability strategies into business strategy, planning & operational excellence
- Public disclosure alignment with predominant standards & frameworks
- Value chain engagement
- Executive compensation tied to performance
- Use of digital tools to provide on-going evaluation of risks & opportunities.

Next Steps

- With transparency, better data, efficient pathways to managing change and evaluating scenarios, organizations have a clear, verifiable, science-backed basis for strategy development that lowers impacts AND supports the business.

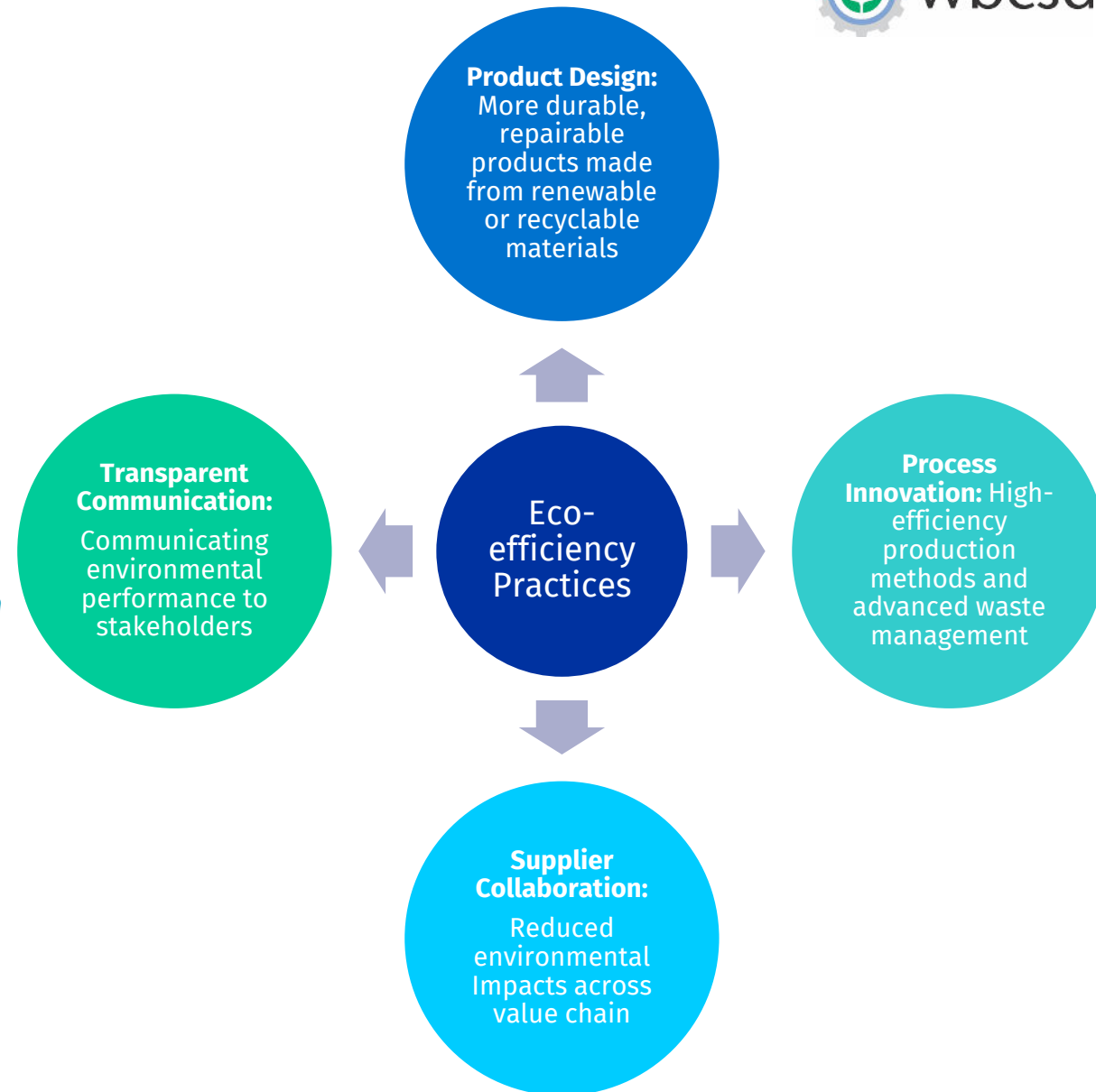


What is Eco-Efficiency?

“Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, *while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth’s estimated carrying capacity.*”

“Eco-efficiency opportunities can emerge at any point in the entire life-cycle of a product. This means employees need to understand what eco-efficiency is, the value it can bring to a company and how to make it happen. This in turn *requires building skills and understanding in order to integrate eco-efficiency across business operations, sectors, countries and issues, and allowing space for innovation and creativity*”

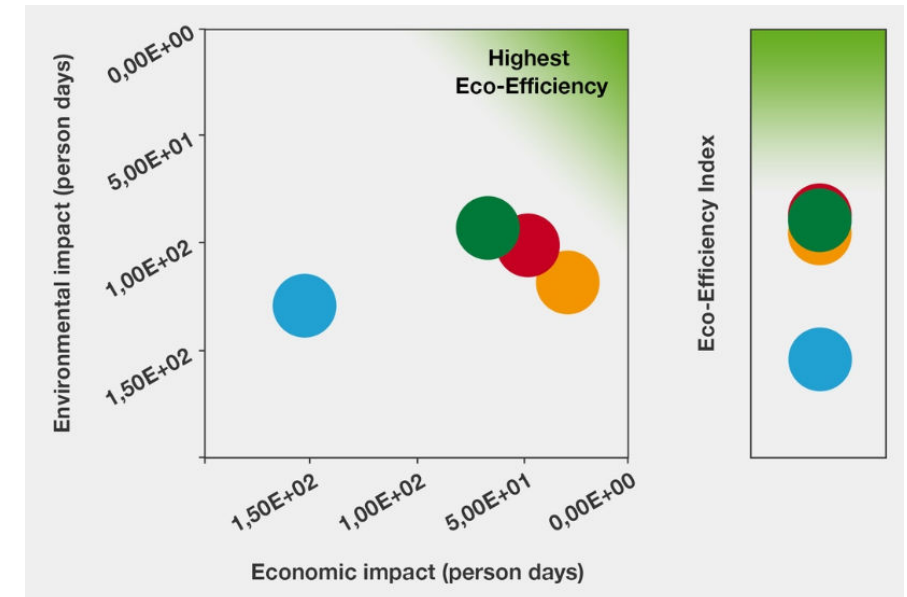
- **World Business Council for Sustainable Development (WBCSD)**



Reference: WBCSD Eco-Efficiency, <https://docs.wbcspd.org/2006/08/EfficiencyLearningModule.pdf>

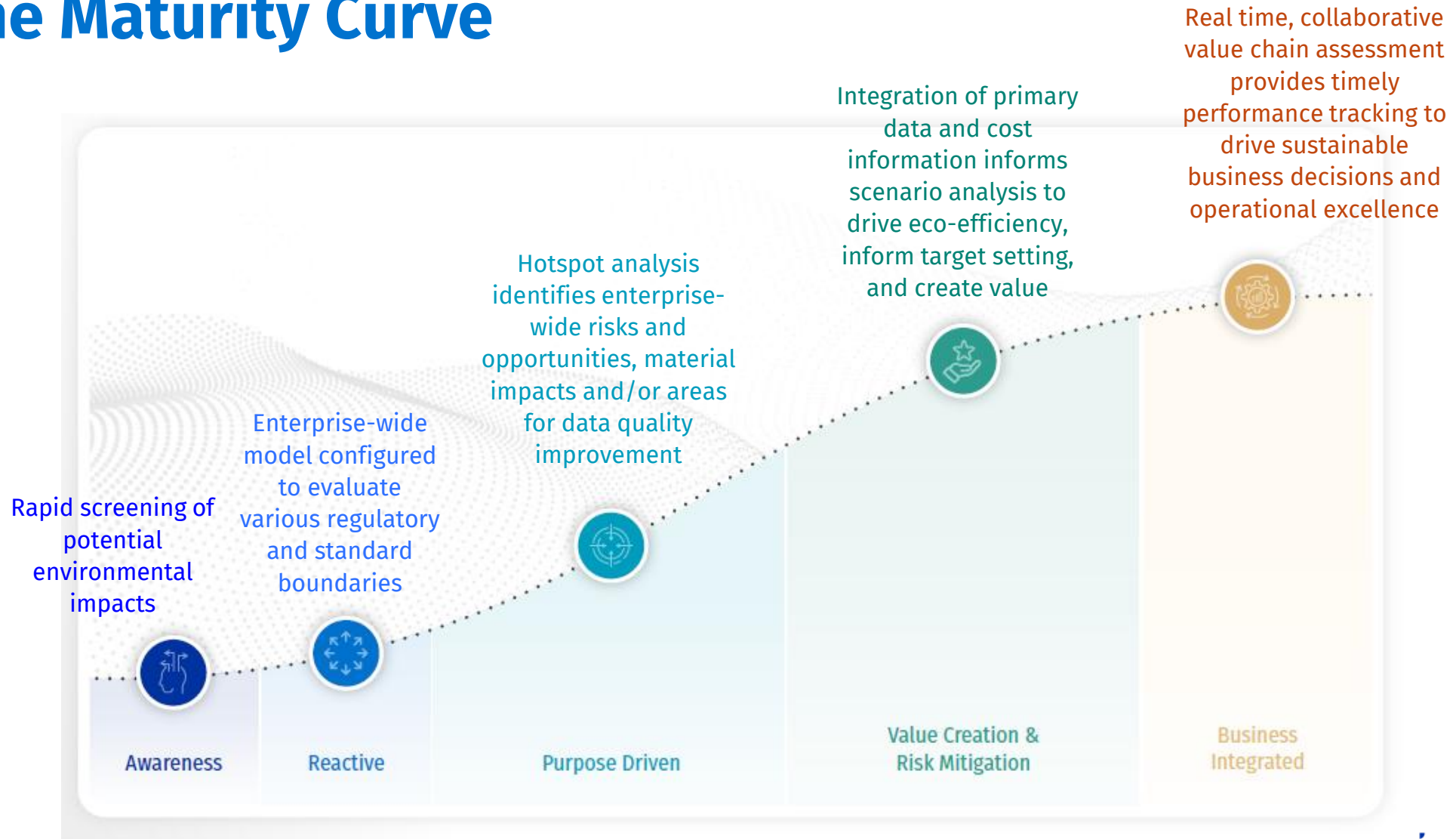
Fundamental Elements of Eco-Efficiency

- ▶ LCA (ISO 14040/14044) to assess environmental impacts
 - Raw materials consumption (Resource depletion)
 - Water consumption (Water use)
 - Land use (Land use)
 - Human toxicity potential (Toxicity)
 - Eutrophication (Eutrophic. fr, Eutrophic. mar),
 - Acidification (AP)
 - Ozone depletion (ODP)
 - Photochemical ozone creation (POCP)
 - Climate change (GWP)
- ▶ Assessment of life cycle cost and aggregation to an overall eco-efficiency based on ISO 14045



Eco-Efficiency Portfolio and Eco-Efficiency Index

Accelerating Your Organization's Progress up the Maturity Curve





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