



Progress beyond



SUSTAINABLE PORTFOLIO MANAGEMENT GUIDE

Driving long-term sustainable growth



Progress beyond

1

OVERVIEW

2

METHODOLOGY
IN BRIEF

3

KEY DECISION-
MAKING TOOL

4

ASSESSMENT
FOR
PRACTITIONERS

5

CASE STUDIES

TABLE OF
CONTENTS



“ Investing in sustainable **Solutions** is the smartest decision for Solvay and society at large

“Sustainability is our license to operate and it has to inform any decision we are making in business development, strategy, innovation, capital expenditure, and M&A. Among the tools we are using, the Sustainable Portfolio Management (SPM) is our compass to grow our business AND be good for people and the planet. I’m proud that in the past six years, the growth of our sustainable solutions has been 5% higher than the average sales growth of our portfolio - and I’m confident SPM will help us reach our holistic Solvay One Planet goals, which address the Climate, the Nature, and the Better Life dimensions.”



Ilham Kadri
CEO, Solvay

“Thousands of organizations have now made commitments to deliver better sustainability outcomes. However, few organizations have developed the necessary tools and management practices to drive strategy implementation and achieve those outcomes in a way that is profitable and therefore scalable. The sustainable portfolio management tool represents an important example of such much needed management innovations that will allow organizations to integrate sustainability issues in their strategy and capital allocation decisions making sustainability not a compliance issue but a driver of innovation and growth.”



George Serafeim
Charles M. Williams Professor, Harvard Business School and author of “Purpose + Profit: How Business Can Lift Up the World”



The SPM global and systematic assessment helps alert the business to **sustainability market signals**, even weak ones, to anticipate their impact and develop the right answers in a timely way. It enables value to be captured in emerging ecosystems and helps business to grow its portfolio by leveraging on opportunities and turning challenges into solutions.

The Sustainable Portfolio Management (SPM) is a **fact based and robust compass** to steer Solvay's portfolio towards better business-orientated sustainable solutions. SPM is designed to boost Solvay's business performance and deliver higher growth. With SPM, decision-makers are informed on the contribution of Solvay's products to sustainability considering both:

- Their **environmental manufacturing footprint** and its correlated risks and opportunities – vertical axis – quantitative assessment by 21 impact indicators.
- How in their **applications** they bring **benefits** or **face challenges** in a **holistic market perspective** – horizontal axis – qualitative assessment on social and environmental topics covering 4 main themes: Health & Safety, Climate Change, Resources and Opinion Leaders.

The goal is to position the business portfolio in 4 resulting categories: Challenges, Transitions, Potentials and Solutions. Each category will require a true call for action by all decision makers. This SPM tool helps Global Business Units deliver on their business ambitions.

The SPM tool is consistent with the Product Sustainability Assessment (PSA) guidance of the World Business Council for Sustainable Development (WBCSD). Solvay's products have experienced significantly different annual revenue growth rates depending on whether customers and consumers are seeking out Solvay's products to match their unmet social or environmental needs. Over the Years and on average, the growth of our sustainable Solutions has been 5% higher than the average sales growth of our portfolio.



1 OVERVIEW



Progress beyond

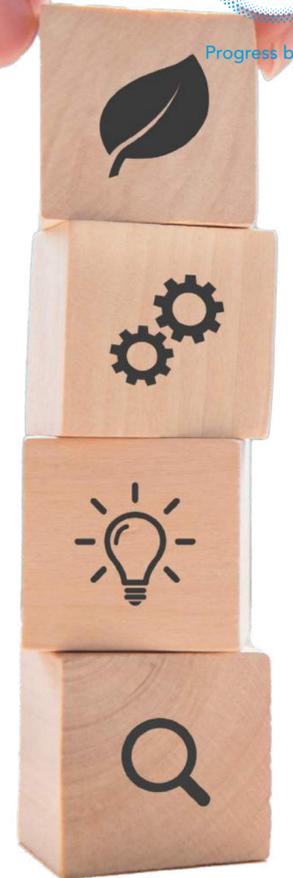
1.1. KEY DECISION-MAKING TOOL

SPM is a **key tool to integrate the sustainability dimension** in strategic and operational decisions of key business processes: strategy, research and innovation, investment, marketing and sale, merger and acquisition.

This is an exceptional onboarding tool to deliver our ambition and commitments towards our ten Sustainability targets.

The SPM tool clearly addresses all the characteristics of the

Circular Economy which is at the heart of our vision to create more value for the future through the development of sustainable solutions.



Sustainable
Development, Our
Ambition →



"SPM is recognised as a state of the art tool, essential to embed sustainability in our key business decisions among which investments, innovation, acquisitions. SPM has proven to be resilient to crises such as Covid, and its capacity to integrate new regulations such as the EU Green Deal. By raising the shadow cost of CO2 up to 100€/t in advance to the market, the tool has also proven its anticipation capability. By asking the right questions and measuring the appropriate data, SPM is helping Solvay to walk the talk in our journey towards sustainable growth."

Pascal Chalvon Demersay
Chief Sustainability Officer, Solvay



1 OVERVIEW

SPM tool covers all scopes of management processes:

- Portfolio management decisions and differentiation strategy
- Strategic project-related decisions in Research and Innovation (R&I), capital expenditures (CAPEX) and Mergers and Acquisitions (M&A)
- Product footprint improvement
- Business development
- Procurement

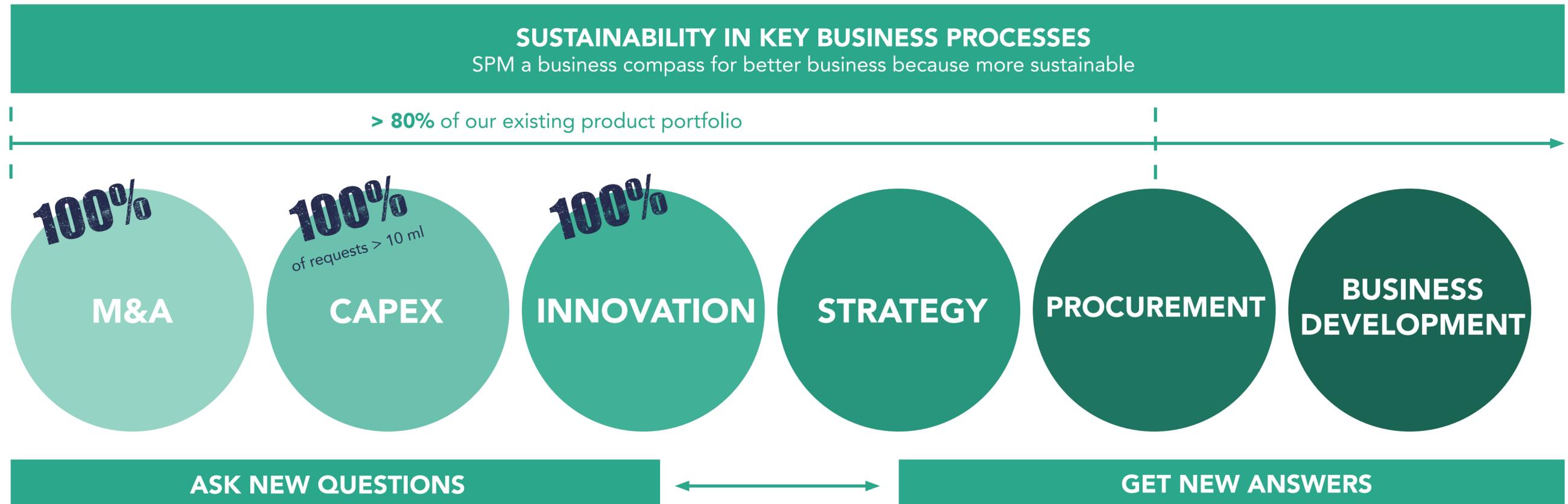
- All R&I projects
- All CAPEX projects for requests above 7 million EUR
- All M&A projects

The SPM tool combines pragmatism, adaptability, scientific justification and process reliability and leads to more value creation through a robust and more differentiated strategy. It is adapted to different information needs, time and resources available.

SPM tool is the pathway to impact measurement which is key to determine the true contribution of our business solutions for the customers and the planet.

From 2016, within Solvay, the methodology is applied in:

- More than 80% of the existing product portfolio in a consistent way (i.e. total sales revenue)



2.1. METHODOLOGY IN A NUTSHELL

The SPM tool in Solvay is often referred to as a camera as it takes a snapshot of a product's sustainability risks and opportunities in their competitive business environment. It develops a dynamic vision of sustainability market signals and their potential impact on portfolio and strategic projects helping the business:

- Take the right decisions to address successfully sustainability needs of the marketplace
- To meet customers and stakeholders expectations both today and tomorrow.

The SPM snapshot is projected on a heat map matrix where products in their applications are plotted according to two axes (see figure below):

1. Operations Vulnerability (vertical axis)

Goal:

To assess the environmental impact of our products based on a life cycle assessment thinking (cradle to gate) we monetize it on the principle of the polluter is the payer then we compare to the value the market is ready to purchase to ensure that our value creation is not done at a too high environmental expense. In other words, we assess risks and opportunities of substitution.

→ The higher the ratio, the higher the risk for Solvay of losing business to more sustainable solutions.

→ The lower the ratio, the higher the probability to displace a less environmentally-friendly competing technology.

2. Market Alignment (horizontal axis)

Goal:

To assess if a product in its applications is part of the problem or part of the solutions from a market/customer perspective. It covers a series of sustainability topics environmental, health and social. In other words, we assess risks and opportunities to be selected in or selected out by the market.

How:

Analyzing the market signals of sustainability benefits and roadblocks and categorizing products on a five-scale spectrum from 'challenged' to 'star potential'.

3. Sales volumes

Sales turnover is the third dimension represented in the SPM Heat Map. The darker the shading, the higher revenue at stake.

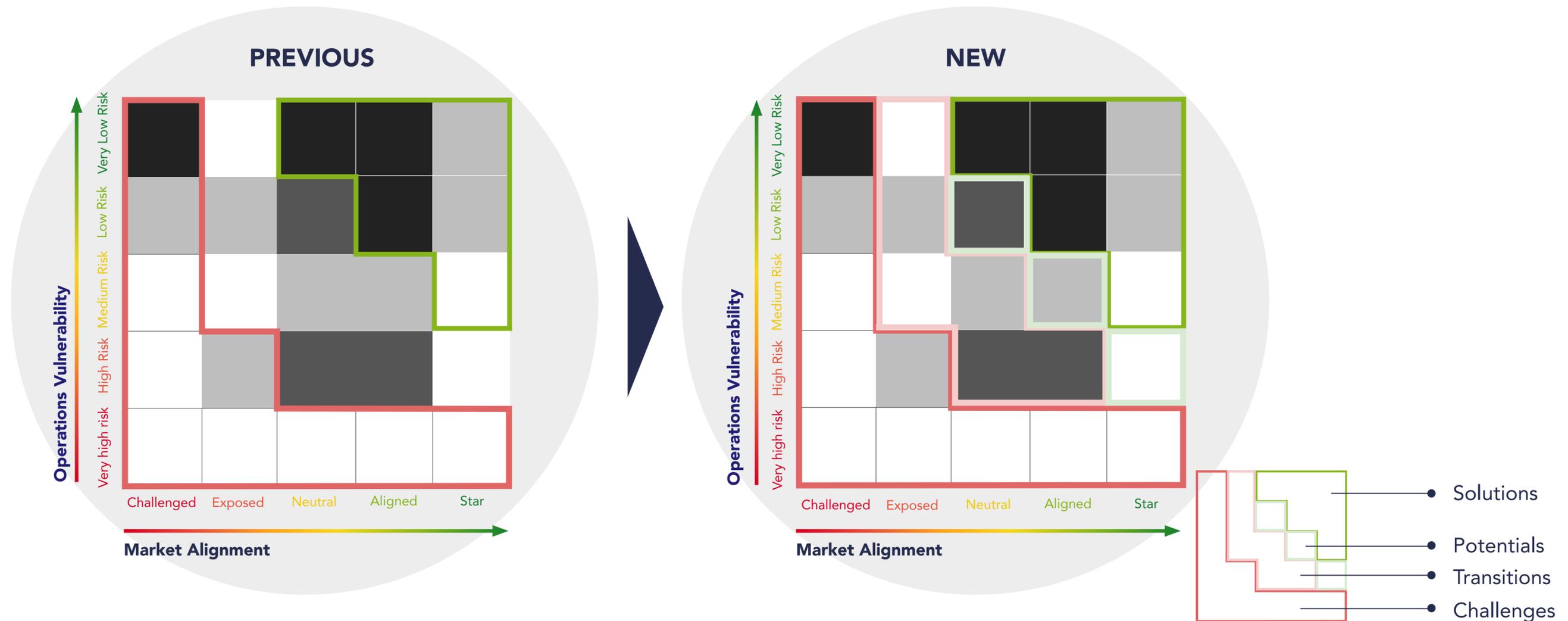


2

METHODOLOGY IN BRIEF

SPM

2 new categories to trigger actions:
"Neutral" becomes "Transitions" and "Potentials"



2

METHODOLOGY IN BRIEF

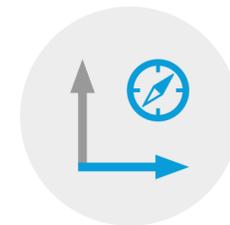


2.2. SCOPE OF SPM

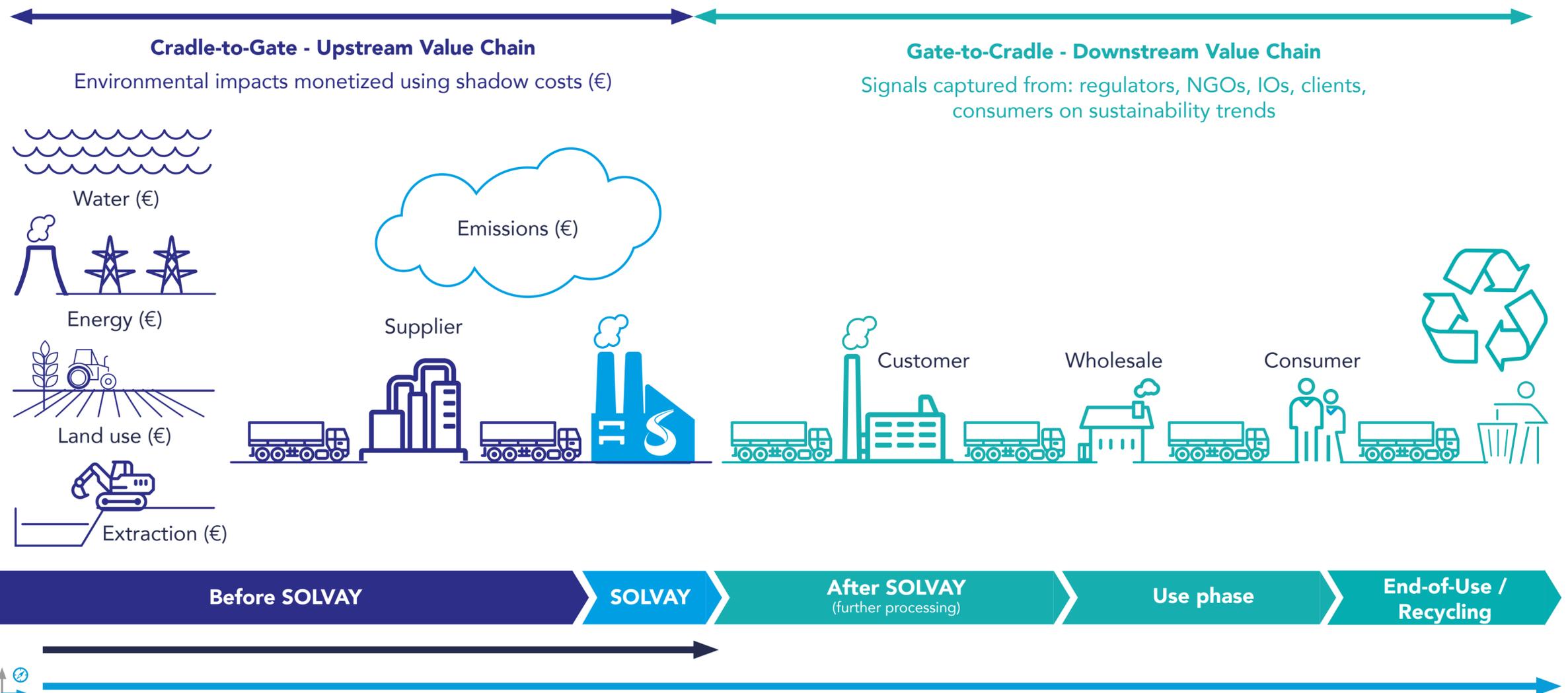
The tool covers:



Operation vulnerability analysis: the upstream, cradle-to-gate scope of the value chain to define sustainability-related business risks and opportunities based on a quantitative LCA. 21 product impact points analyzed, monetized and compared to sales value using LCA methodology.



Market alignment analysis: the entire value chain (up and downstream), cradle-to-cradle to pinpoint sustainability benefits and roadblocks in the product portfolio applying evidence-based analysis of market signals.



2.3. MEASURING OPERATIONS VULNERABILITY: THE VERTICAL AXIS

Operations Vulnerability calculation steps:

STEP 1

Impact Assessment

1. Calculation of a product's ecoprofile

We calculate the ecoprofile of a product using a Life-Cycle Assessment (LCA) performed by our in-house experts in line with the ISO 14040 and ISO 14044 standards.

With this procedure, we create an inventory of impacts on surrounding ecosystems e.g. resource consumption, emissions to soil, air and water, including human toxicity potential, of a product occurring upstream from extraction, through production, until it leaves Solvay's premises (in a cradle-to-gate approach). 21 indicators of impacts are used.

The environmental calculation methods and shadow costs were reviewed with the help of third party QUANTIS in 2020 in order to take into account the best practices that are currently applied in the LCA discipline.

STEP 2

Impact Evaluation

2. Monetization of negative impacts

We use 'shadow costs' drawn from authoritative scientific sources to define what it would cost to remedy or prevent negative impacts.

These are costs which Solvay does not currently incur, i.e. they have not been internalized yet. The impact valuation defines the financial risk of internalizing these negative impacts. Shadow costs that were applied till end 2020 were also reviewed by third party QUANTIS in order get their recommendations out of in-depth literature review and analysis.

STEP 3

Operations Vulnerability

3. Financial risk of negative impacts (externalities)

The risk of losing business or the opportunity of gaining new business depends on the balance between the economic value and the damage that is created.

The absolute financial value of the potential impacts of one kg of product is insufficient to inform the decision-maker. That is why we calculate the implications of the financial impacts by dividing the value of the impacts by the sales value of the product. The result is the Operations Vulnerability ratio expressed as a percentage, which can range from 2% to over 200% of the sales value for some products. This ratio is plotted on the vertical axis of the heat map on a five scale levels in the following order from the bottom to top of the vertical axis very high risk, high risk, median risk, low risk and very low risk.

2.4. ASSESSING MARKET ALIGNMENT: THE HORIZONTAL AXIS

Qualitative, evidence-based collection of sustainability-related market signals

Consumers and stakeholders across the value chain (manufacturers, wholesale and retail) are putting more and more emphasis on sustainability.

In order to understand the risks and opportunities arising in the value chain, the right signals have to be captured from different stakeholders.

Similar approaches from Solvay's peers, such as AkzoNobel, BASF, Clariant, DSM and Evonik among others, have shown that a qualitative or semi-quantitative analysis is best adapted to interpret signals¹. Those experiences were shared in the WBCSD workstream PSA (Portfolio Sustainability Assessment) to establish a PSA guidance. This tool is thus not only limited to Solvay but a common ground for multiple investors, customers and authorities who recognize the legitimacy of the SPM tool which is consistent with the WBCSD PSA methodology and

considered as a benchmark.

While Life-Cycle Analysis is limited to environmental impact assessments, SPM analysis also addresses social issues such as healthcare, ageing population and healthy living. We defined these questions based on the analysis of a number of different authoritative sources to understand what sustainability means for a chemist and for chemical products. This led to a questionnaire of 114 questions structured around 4 themes: Health and safety, Climate change, Resources and Opinion leaders. This helps an SPM expert and GBU representatives to identify market signals and holistically assess a product's social & environmental performance in its applications.

We analyze products in their end-user applications, based on **Product-Application Combinations** or **PACs**. One product can have several PACs.

The Market Alignment analysis of PACs consists of two steps:

STEP 1

Market
Alignment
Profiling

To identify the sustainability signals for each PAC, a Working Group of the SPM expert and Business Unit answer the relevant questions of the questionnaire on environmental and social issues to collect information on obstacles, concerns, benefits, benchmark (Star potential) and amplifiers.

STEP 2

Impact
Assessment

The information gathered is applied to a decision tree, which positions the product on a 1-5 scale of Challenged (1), Exposed (2), Neutral (3), Aligned (4), Star (5).



¹ Our benchmark shows that quantitative, e.g. monetized analysis of impacts occurring in the entire value chain requires lengthy and costly procedures that are difficult to use in fast-paced strategic corporate decision-making cycles, as well as in operational decisions on allocation of future spending such as innovation projects.

2

METHODOLOGY IN BRIEF



Qualitative, evidence-based sustainability-related market signals are assessed using the questionnaire and are then run through a decision tree.

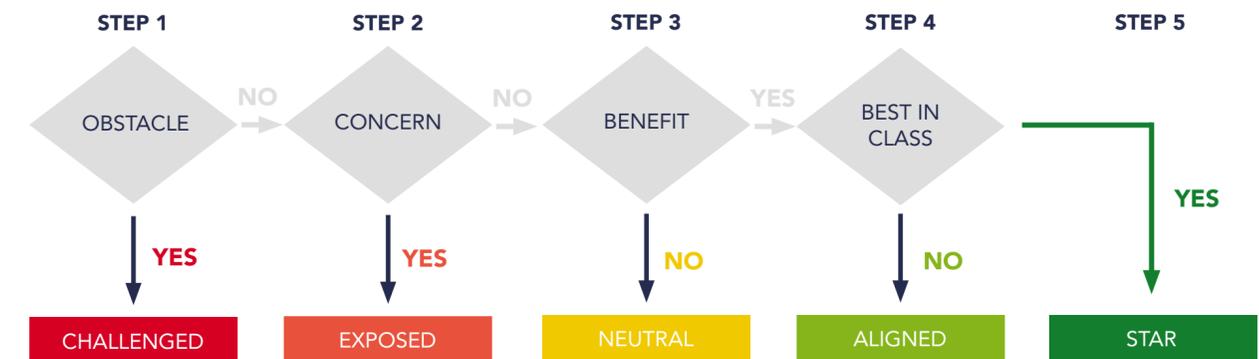
The questionnaire is structured around 4 main themes : Health & Safety, Climate Change , Resources and Opinion Leaders and 29 sub-themes.

Grouped Theme	Sub-Theme
1 - Health and Safety	Human Toxicity Classifications
	Eco Toxicity Classifications
	Substance Lists
	SIN List
	Medical Care
	Chronic Diseases
	Healthy Habits
	Food Availability
	Water and Air Quality
	Safety and Prevention
	Limitation from aging
	Topical Care
	2 - Climate Change
3 - Resource	Energy Efficiency
	Renewable Energy
	Resource Efficiency
	Renewable-based Materials
	Scarce Materials
	Freshwater
	Availability
	Waste Generation
	Waste Valorization
	Recyclability
	Biodegradability
	Raw Materials
	4 - Opinion Leaders
Major Customers	
Ecolabels	
Downstream Sustainability	

For each sub-theme that is material for the PAC, we look first at Obstacles and Concerns (Steps 1 and 2). Any Obstacle identified will immediately rank the PAC as Challenged and anything raising Concern as Exposed.

Then we turn our attention to the positive signals (Steps 3-5). If we find no negative and no particularly positive impacts, we categorize the PAC as Neutral (Step 3). If the PAC analyzed demonstrates a direct, significant and measurable benefit to the market, impacting positively upon at least one of the sustainability benefits assessed, we list the product as Aligned (Step 4). If, in addition, the PAC shows outstanding benefits that it can be considered as the benchmark and actively replacing a less efficient PAC, the PAC is categorized as Star (Step 5).

Fast track SPM Market Alignment decision tree:



2

METHODOLOGY IN BRIEF

Questionnaire covers Circular Economy approach

The SPM methodology considers both negative and positive signals with regards to the requirements of the circular economy.

The SPM methodology doesn't assess the full circularity of the value chain a given product in given application is involved in. To illustrate, the Product-Application combination Silica in personal car tyres has the benefit Energy Efficiency, which is going in the direction of a more circular economy even though the personal car tyre business model cannot be considered as circular. In other words, SPM

helps only to identify the building blocks towards a more circular economy and not circular business models.

All the answers are also recorded in the Global SPM Database and are fully-auditable.

Taxonomy

Taxonomies are classification systems created by authorities, institutions, and investors that are used to determine and report which activities are sustainable.

The set up of specific sustainability criteria per activity that are shared and recognized will have to be integrated in sustainability performance tools such as SPM.

In this respect SPM will remain consistent with the development of the PSA guid-

ance of the WBCSD with regard to the integration of European taxonomy criteria and thresholds. Others to be considered e.g. Climate Bonds or Corporate Knights taxonomies

The override option

The market alignment decision tree aims at identifying market signals for any relevant sub-themes without any compromise on negative signals and regardless their materiality level. Therefore the results may look counter intuitive with regards to observed market trends. The SPM expert after analysis may decide as per clear exception to override the market alignment results provided that a deeper investigation will be carried on the PAC with a review by a third party. The PAC under override procedure will be by default part of annual review by third party.

For transparency's sake the number of PACs under override as their turnover at stake will be reported. Reviews of the Market Alignment methodology application are conducted on a regular basis by a third party.

The % of the product portfolio assessed and the % of sustainable solutions published in Solvay's annual report since 2016 have been reviewed by the statutory auditor with reasonable assurance.



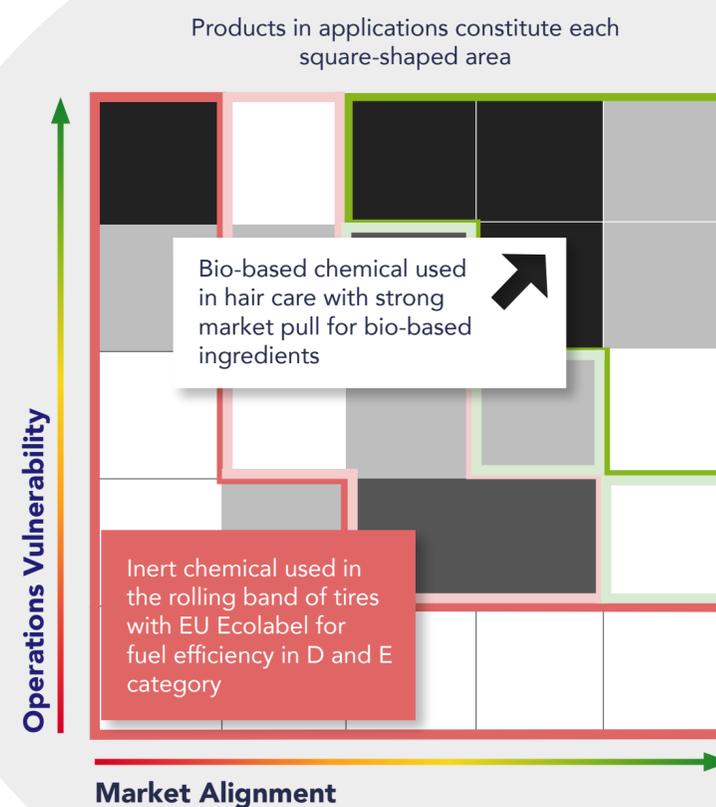
¹ We would consider it circular whether the value of the materials is maintained forever.

2.5. MAPPING RESULTS - SPM HEAT MAP

Results of the **Operations Vulnerability** and **Market Alignment** assessments are plotted on a heat map which shows the risks and opportunities of the PACs for Solvay.

Business Units receive a drilled-down report which allows them to analyze the PAC's position on the heat map and suggest actions to maintain or improve performance and reach Group-level targets.

SPM Heat Map 3.0



Legend:

In the SPM 3.0 we substitute the Neutral category by two new categories: Transitions and Potentials.

- The Potentials category mirrors the potential to join the Solutions category by acting on the manufacturing environmental footprint, which do not have negative nor outstanding sustainability performance, if any. These are products that consumers need, but which environmental footprint can be improved
- Transitions: The Transitions category identifies low negative sustainability concerns, here both on the manufacturing axis and on the market axis.

2

METHODOLOGY IN BRIEF



The heat map is the highest-level portfolio steering instrument of the SPM assessment. It categorizes products and PACs in four higher level categories.

Raising the bar on ambition while keeping robustness of the SPM methodology requires to ease the communication of the SPM Heatmap and make it more directly actionable. Therefore in the SPM 3.0 we substitute the Neutral category by two new categories: Transitions and Potentials.

- **The Potentials** category mirrors the potential to join the Solutions category by acting on the manufacturing environmental footprint. which do not have negative nor outstanding sustainability performance, if any. These are products that consumers need, but which environmental footprint can be improved
- **Transitions:** The Transitions category identifies low negative sustainability concerns, here both on the manufacturing axis and on the market axis.

Solutions and Challenges category remain unchanged.

- **Solutions:** PACs with a better sustainability contribution to Solvay customers and value chain, combined with a favorable balance between value and environmental impact.
- **Challenges:** PACs for which there are either strong negative signals resulting from sustainability drivers in the marketplace, or serious operations vulnerability challenges.

These are products where there may be a significant negative impact on revenue over time and where products may eventually disappear.

Over the last three years, Solvay's products have experienced significantly different annual revenue growth rates depending on whether customers and consumers are seeking out Solvay's products to match their unmet social or environmental needs.

Typical annual growth rate per SPM category:

- Solutions (unmet needs to achieve higher social or environmental standards): +5%
- Challenges (sustainability concerns or roadblocks): -5%

(based on turnover with the same product, same application and same SPM ranking over the last 3 years representing 45% of Group revenue).

Changes in the business perimeter during the year are taken into account in the scope of the year (Y) SPM.



2.6. AUDITABILITY FOR RELIABLE DATA

In order to integrate the results of the SPM assessment to strategic and operational planning, we developed a sustainability assessment framework which could be audited by third-party accounting and sustainability assessment experts.

1. Dedicated data management module for SPM

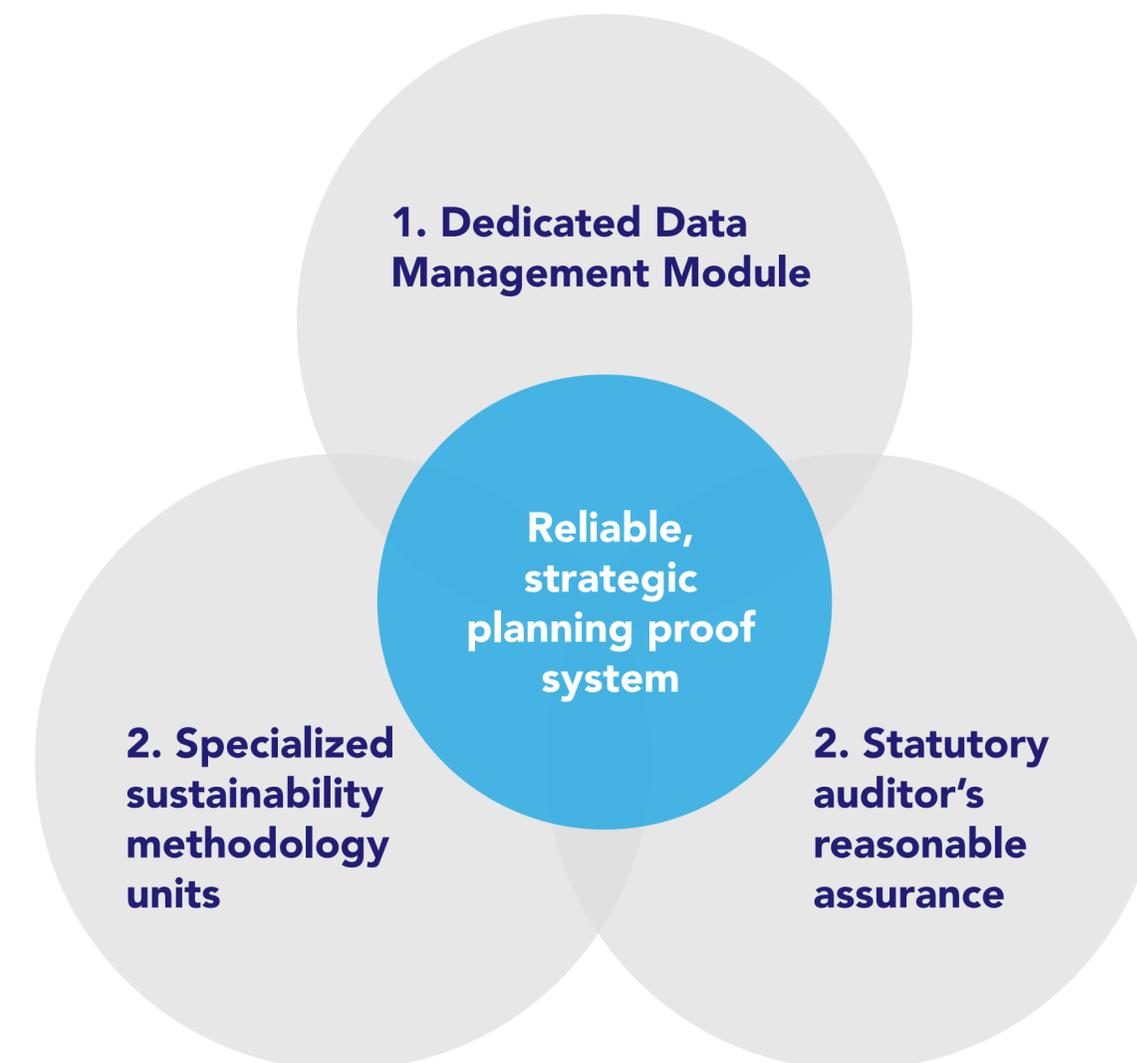
Data from both axes of the SPM assessment are documented and recorded in Solvay's Global SPM Database. A user-friendly module developed in-house and hosted in the SAP system allows around 1,500 SPM assessments (PAC) to be carried out per year.

2. Specialized sustainability methodology audits

Third-party verification of the Market Alignment assessments is carried out at PAC level. Solvay can submit a number of PACs per Year for deeper review by the third party to improve the robustness of the assessment. The objective is to ensure that all PACs with higher value for Solvay will be reviewed by a third party every five years at least.

3. Statutory auditor limited to reasonable assurance

Each year, we report Group-level turnover breakdown following the SPM Heat Map categories (Challenges, Transitions, Potentials and Solutions). The % of the product portfolio assessed and the % of sustainable solutions published in Solvay's annual report since 2016 have been reviewed by an independent third party (reasonable assurance).



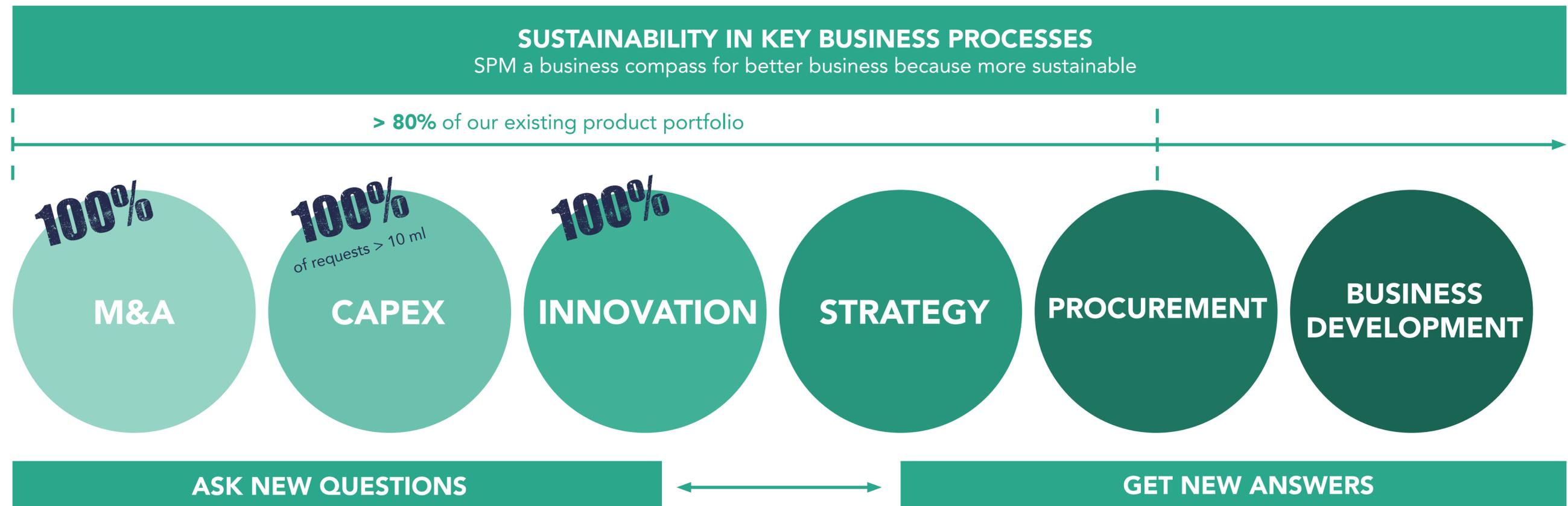
2.7. EXTERNAL RECOGNITION

Within a context of growing awareness, all social and environmental impact measurements have become imperative in regards to sustainable portfolio management. It has indeed been recognized as a key strategic tool for decision makers. That is how Solvay's SPM tool is now considered as a benchmark by stakeholders, investors, customers and suppliers, authorities and academia.

Recognition	Promoted as Best Practice by International Organizations	Global Partnerships and Academics
<ul style="list-style-type: none"> • European Commission, DG Enterprise & Industry • SusChem, European Technology Platform for Sustainable Chemistry + Kohlberg Kravis Roberts (KKR) - global investment firm • CIRAIG (with whom Solvay also embraced on a high level research platform on LCA methodologies) • The Conference Board 	<ul style="list-style-type: none"> • CSR Europe • The World Business Council for Sustainable Development (WBCSD, PSA Group) • ICIS Article 	<ul style="list-style-type: none"> • TNO to advance scientific research • WBCSD to advance sectoral Portfolio Steering Assessment (within the framework of Action2020 - Business Solutions on safe products) • QUANTIS • World Alliance for 1000 efficient Solutions - Bertrand Picard Foundation • Harvard Business School - Reimagining Capitalism: SPM Business case • IMD Lausanne - "Winning Sustainability Strategies" IMD Lausanne Pr Benoît Leleux, Jan Van der Kaai (Finch & Beak) • HEC Paris

'ASK NEW QUESTIONS, GET NEW ANSWERS'

SPM is a compass to help key business processes integrate the sustainability dimension. 'Ask new questions, get new answers!' is the SPM motto to help the business differentiate and create more value.



3.1. STRATEGY

The SPM tool is also applied to strategic projects using the same logic as for the portfolio to make sure that they are heading toward business solutions to support growth and value creation.

In the early stages of projects, we use what we call SPM “Fast track” assessments, a simplified approach of SPM which does not involve too many resources. It gives directions towards integrating sustainability dimensions among others straight from the beginning of the project before performing a full SPM assessment when the project is confirmed in a stage gate process.

The SPM logic around project assessment is to:

- Prepare an SPM snapshot of the starting point and the anticipated end-point of any project and continuously review the latter as the project evolves
- Position the project within the BU/GBU portfolio where it belongs

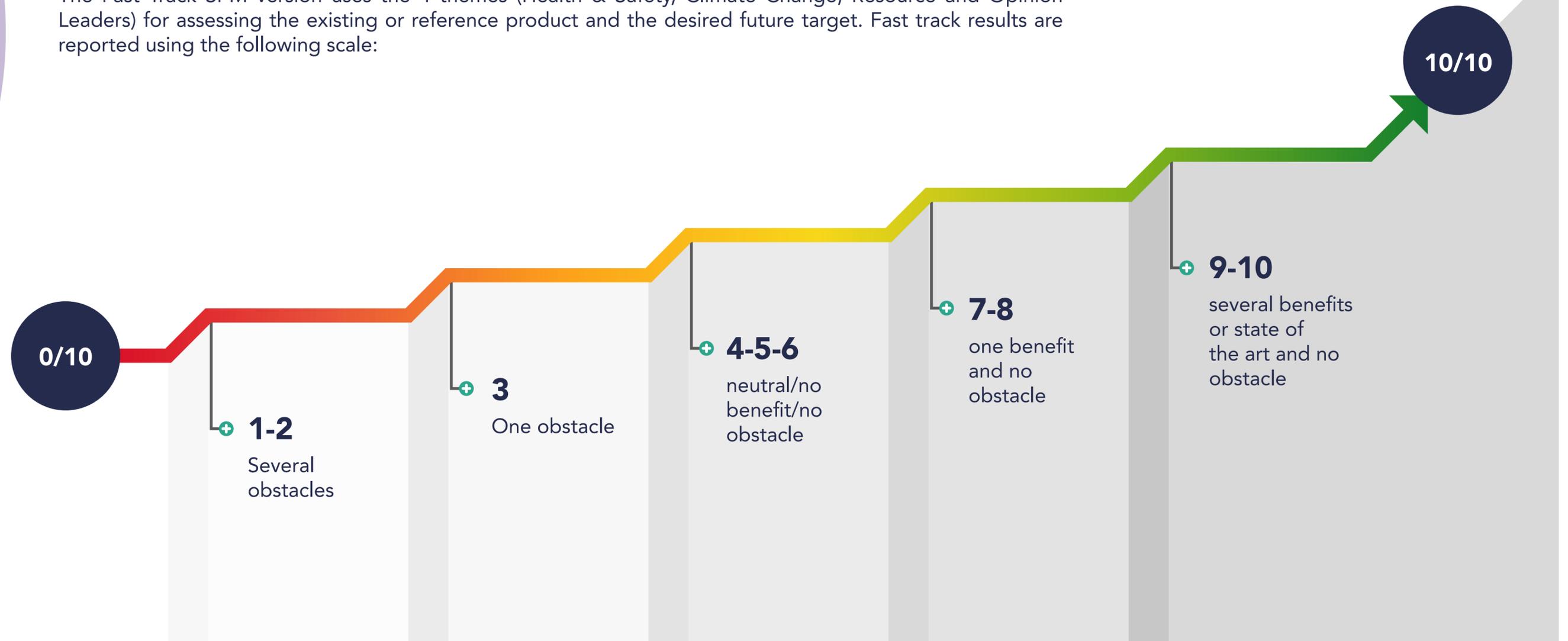
All SPM snapshots are taken by the SPM team and are linked to financial performance bridges in a similar way as in the Business Strategy Review process.



3.2. RESEARCH & INNOVATION

As of 2013, 100% of R&I projects are analyzed with the SPM tool. Using SPM logic, a product is analyzed in a so-called stage-gate process starting already at the ideation phase with the use of Fast track version of the SPM tool within each phase.

The Fast Track SPM version uses the 4 themes (Health & Safety, Climate Change, Resource and Opinion Leaders) for assessing the existing or reference product and the desired future target. Fast track results are reported using the following scale:

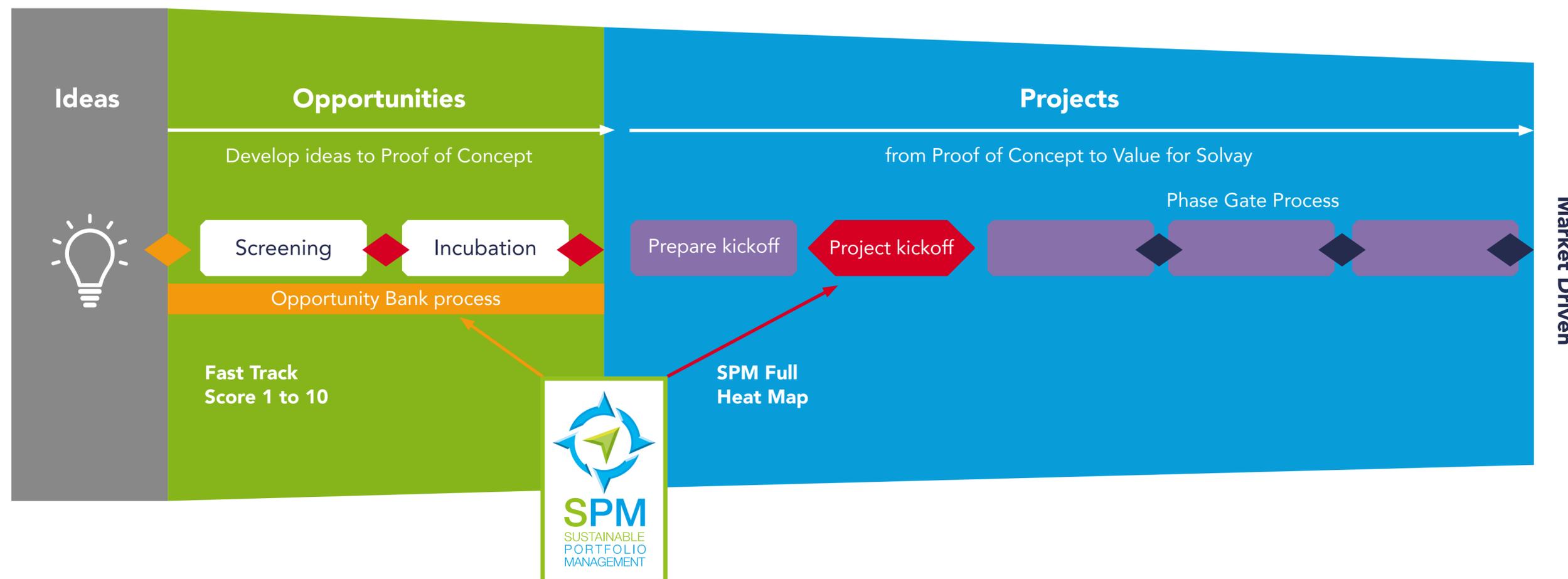


3

KEY DECISION-MAKING TOOL



It provides a first direction before applying a full SPM assessment at the stage gate of the project.



The reference product can either be a Solvay product or a competitor's product. The executive summary of the SPM analysis is uploaded to the innovation workflow management system.

Every time a project steps into another phase, i.e. passes a gate, a full SPM analysis is applied to the future product and the data is stored in the SPM Database.

The full SPM results are summarized in a spider diagram of six impact indicators

- Climate Change, Non-renewable resource consumption, Human health, Ecosystem quality, Water management, Social impacts to illustrate the position of the target versus the reference on the 2 SPM axes.

The innovation pipeline is a key element in achieving the 2030 target of realizing 65% of Solvay's revenues from sustainable solutions.



3

KEY DECISION-MAKING TOOL



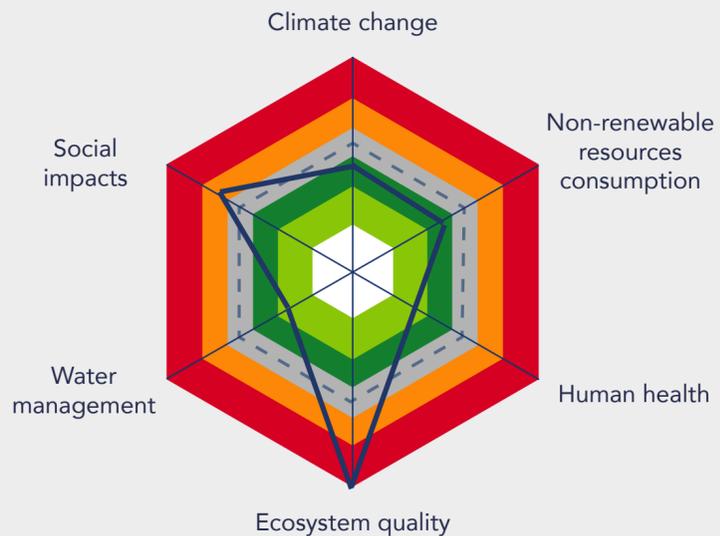
SPM logic and tool applied to innovation projects: SPM ranking gives the position from major improvement to major deterioration of the manufacturing footprint in absolute value of the target vs the reference. While SPM Heat map gives a position based on relative value following Operations Vulnerability and

Market Alignment. It is important as a project that scores in SPM heat Map Solutions may presents a SPM ranking very deteriorated that need to be addressed before moving forward namely through Ecodesign.

Manage project portfolio

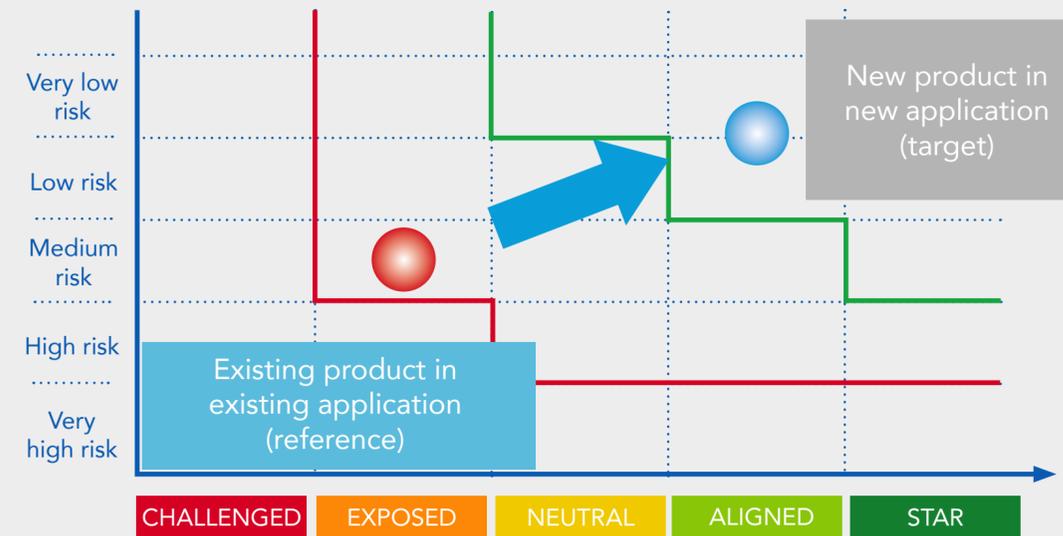
Operations Vulnerability (cradle-to-gate)

New product in new application vs. existing product in existing application (Reference)

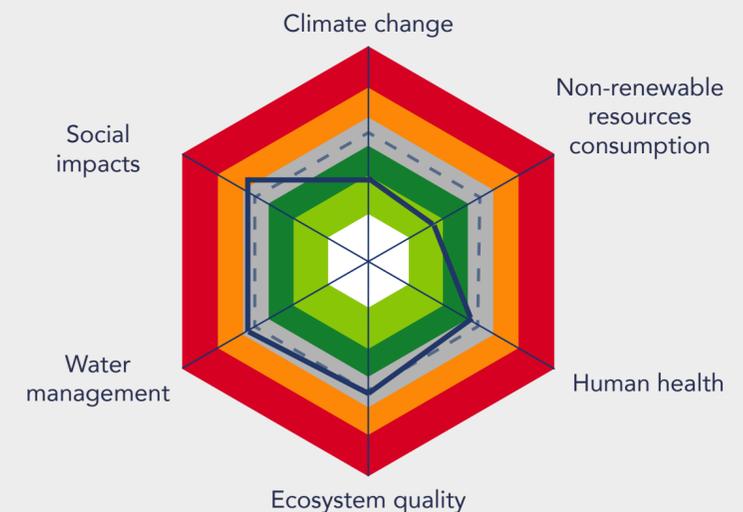


- Major deterioration
- Deterioration
- No change
- Improvement
- Major improvement
- New product in new application
- - Existing product in existing application (reference)

Guide for eco-design



Market alignment (cradle-to-cradle)



- Challenged
- Exposed
- Neutral
- Aligned
- Star
- New product in new application
- - Existing product in existing application (reference)

SPM applies simultaneously and consistently to:

- The "starting point" of the project (the reference)
- The "expected output of the project (the target)"



3.3. CAPITAL EXPENDITURES (CAPEX) PROJECTS

Planned CAPEX projects are also subject to SPM analysis. Different organizational levels and functions use the results of the SPM assessment depending on the value of the planned investment. The SPM team works directly with the Business

Units, the Investment Committee and the Executive Committee, providing the analysis required integrating long-term, sustainability-driven signals into investment decisions.

3.4. DUE DILIGENCE ON MERGER & ACQUISITION (M&A) PROJECTS

We perform a full SPM analysis based on public information and information from

the M&A data room, before the binding offer.

3.5. BUSINESS DEVELOPMENT

SPM can position sales revenue on a heat map at customer level and help identify sustainability topics. Connecting with customers on sustainability helps both differentiate and create value for Solvay and the customer and helps deliver the

company's sustainable solutions target. This approach helps the company better understand and build a dynamic vision of our customers' sustainability challenges and anticipate trends in order to continue to deliver business solutions.

3.6. PROCUREMENT

SPM helps also to engage the dialogue with suppliers on sustainability which is key to finding new ways to deliver sustainable solutions for the downstream market. The choice of raw materials can improve the environmental and social

performance of our business solutions for our customers and the whole value chain.



3.7. SPM TOOLKIT

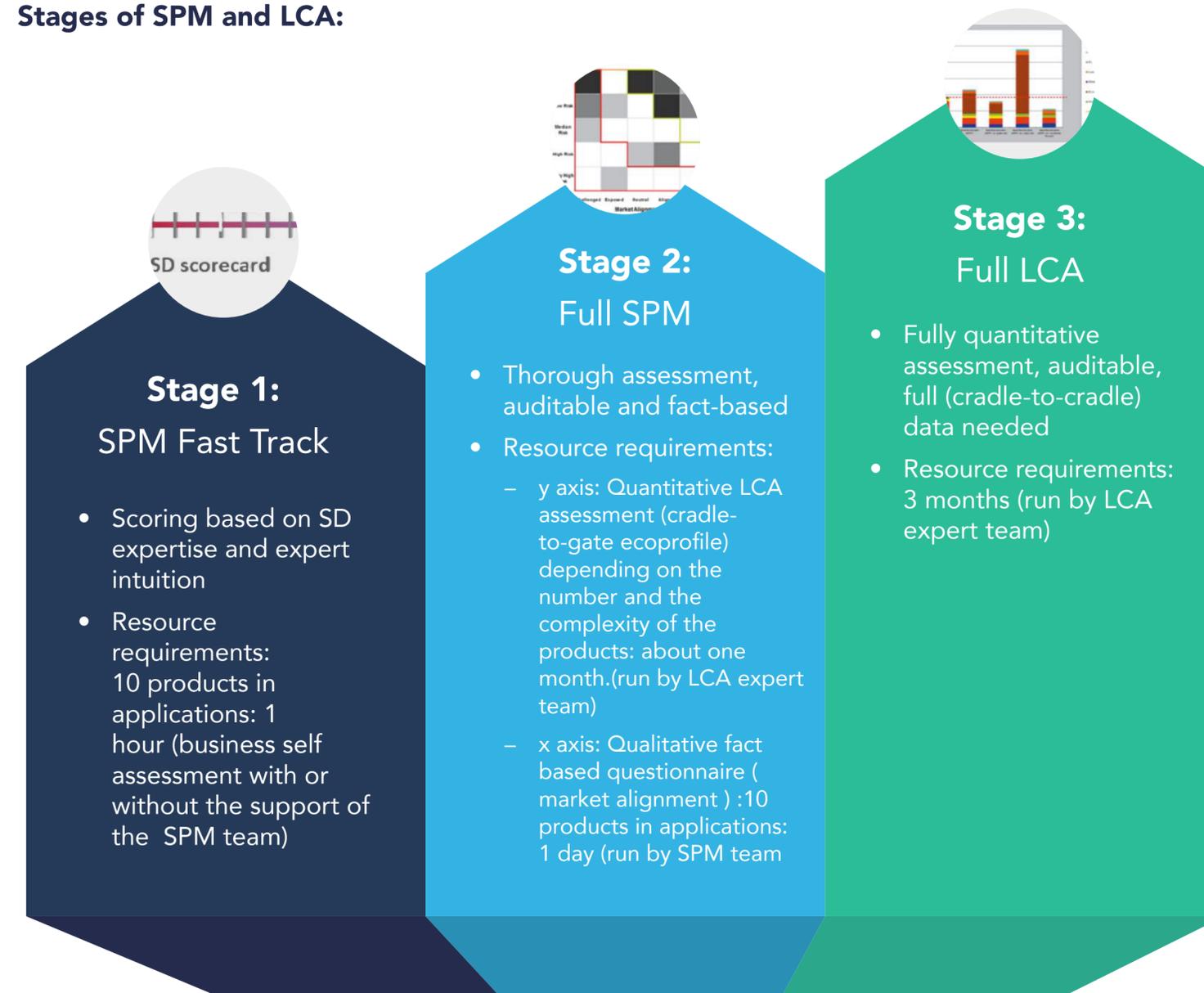
The SPM tool is flexible and can be adapted to the needs and maturity level of projects in the different key business processes (Strategy, R&I, CAPEX, Marketing & Sales, M&A, Procurement...).

The Fast track SPM assessment can be applied to screen projects from R&I, CAPEX, Marketing, Procurement... so that we ensure the sustainability dimension

is taken into account at the earliest stage in the selection of the projects.

While the SPM Heat Map reports the 2 axes of Operations Vulnerability (vertical axis) and Market Alignment (horizontal axis) in a single matrix, those complementary assessments can be done independently showing the operational flexibility of the SPM tool in its implementation.

Stages of SPM and LCA:



The SPM toolkit and LCA approach are complementary.

When a deeper analysis is necessary, an additional full cradle-to-cradle LCA can be performed for a specific product in specific applications.

This is a sound and longer lasting scientific examination that can be considered to complement the SPM assessment either to confirm environmental benefits along the full value chain or to compare to competing products/solutions in the market e.g. to benchmark better technical performance resulting in lower energy consumption or lower pollutant emissions during the use phase.

4.1. INTRODUCTION - THE PROCESS

The SPM assessment process takes place year-round and involves both Corporate Functions (Strategy, Marketing & Sales, R&I, Sustainable Development) and Business Units (Management Teams, Strategy, Marketing & Sales, R&I, Production, Procurement, Business Development etc.). SPM assessments require close collaboration between the Corporate SPM Expert and the Business Unit SPM Correspondent.

The SPM Correspondent is typically the Marketing Strategy Manager of the Business Unit:

- They coordinate the SPM assessment with the support of the Corporate SPM team to ensure the right expertise is brought in
- Clarify expectations on both sides. Product and market experts from the Business Unit are key contributors in defining the relevant Product-Application Combinations (PACs) and in going through the process effectively.

The Corporate SPM team provides a comprehensive executive report of the assessment to the Business Unit management team.

The SPM Corporate Expert ensures that the results and learnings are embedded in the decision-making process and action plans of the Business Unit at the strategic and operational level.

Changes in the business perimeter during the year are taken into account in the scope of the year (Y) SPM.

A Fast track version of the SPM tool is used to assess early-stage R&I, CAPEX, M&A, Marketing & Sales, Procurement, etc. projects, through simplified modules to ensure that projects are developed while integrating the sustainability dimension using SPM approach.

4

ASSESSMENT FOR PRACTITIONERS

4.2. PREPARATION FOR THE SPM ASSESSMENT

In order to achieve the SPM tool's dual goal of being robust and lean in execution, thorough segmentation of products is of vital importance.

Solvay's organizational structure is built around product lines managed by Global Business Units reflecting the markets where the company operates and not around geographical segmentation.

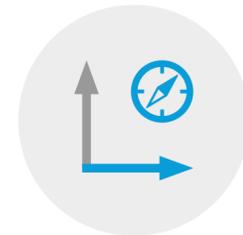
and application segmentation is carried out first.

For each axis of the SPM Heat Map, a segmentation analysis is done with the relevant Business Unit experts:

In SPM, the segmentation and assessment follows the same logic so a product



For **Operations Vulnerability**, we work with industrial or technology experts from the Business Units and LCA practitioners



For **Market Alignment**, we work with the market experts from the Business Units Although the segmentation and assessment is carried out by market, the risks and potential negative impact of products and applications are considered from a global point of view, not based on a geographical selection, as this could hide certain negative effects of products. For example, if a product is banned in two OECD countries, but not in others, SPM will rank that product as Challenged in every country and not only in the countries where it is banned.



4.3. OPERATIONS VULNERABILITY - THE VERTICAL AXIS

Analysing the business risks of sustainability.

4.3.1. The product segmentation

In the product segmentation, we assume that the criteria (inventory threshold, characterization model, mid-points etc.) for establishing an eco-profile have already been defined.

In order to define a product segment and assess its environmental impact, the following 3-step approach is undertaken at Business Unit-level:

1

Analysis of existing products and production processes (LCA perspective)

The SPM expert, the LCA expert and the Business Unit representative analyze the eco profiles of existing products, where one product can be manufactured in many different factories, using different raw materials, or using different energy sources etc.

The analysis looks for similarities or significant differences in the cradle-to-gate value chain processes and raw material supply, which may allow several products to be merged in the SPM analysis into the products segment.

2

Identification of differentiating factors in eco profiles (LCA perspective)

EcoProfiles are compared and differentiating factors are examined to determine if the differences are material enough to justify a separate SPM product assessment.

If the differences are material, the procedure is repeated with the next product in the family.

If the differences are not material, the procedure is repeated to check if the reference product could be integrated in a product segment at a higher level in the value chain.

3

Revenue segmentation to identify SPM products (Financial perspective)

Within the product segment, the identified revenue per product line is plotted (at the lowest level of financial reporting).

Products are selected to cover at least over 80% of the annual external revenue of the Business Unit portfolio.

For the last 20% of products that are not covered by the SPM, there will be a screening to ensure that all risks are addressed and to avoid any highly problematic issues e.g. hazardous products.

Internal sales are out of scope.

4

ASSESSMENT FOR PRACTITIONERS

4.3.2. The Operational Vulnerability Assessment

Operations Vulnerability calculation steps:

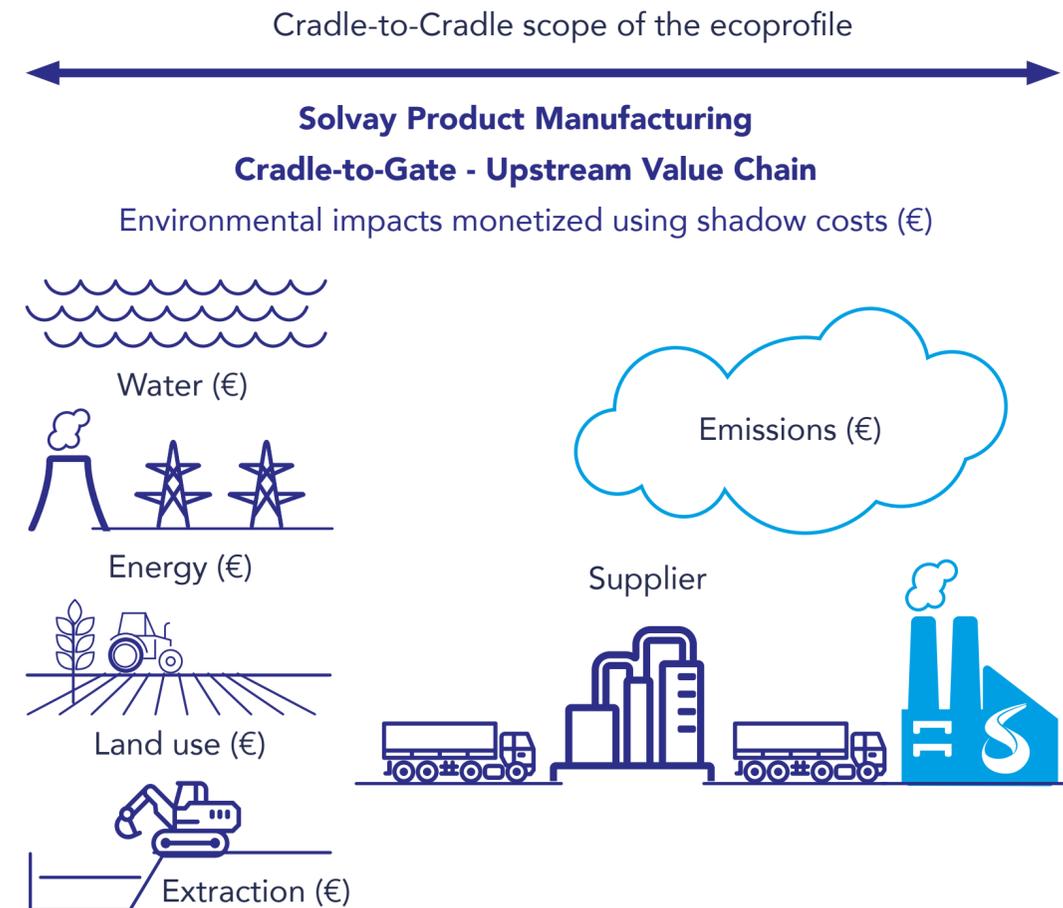


STEP 1:

Impact Assessment: calculation of a product's ecoprofile

We calculate a product's ecoprofile using a Life-Cycle Assessment (LCA) procedure performed by LCA practitioners in conformity with the ISO 14040 and ISO14044 standards using publicly-available and Solvay-specific scientific data.

This allows us to create an inventory of all the environmental impacts of a product (resource consumption, emissions to soil, air and water) including human toxicity in a 'cradle-to-gate' approach, from raw material extraction to production until it leaves Solvay's premises.



4

ASSESSMENT FOR PRACTITIONERS

The impact assessment element of the Operations Vulnerability calculation:

Step 1:
Impact Assessment

Material & Emission Inventory (kg)



Impact equivalents (equivalent/kg)



Impact (equivalent)

LCA practitioners calculate the environmental footprint of one kilogram of product. This includes:

1. Establishing a Life Cycle Inventory (LCI) of substances exchanged with nature (withdrawals and emissions), as well as of land surfaces transformed and occupied for the production of one kilogram of product.
2. Classifying and characterizing the impacts into 21 impact indicators, depending on the specific features of the substances. For emissions, the physical, chemical and toxic characteristics are considered, for resources, energy content as well as depletion rate are considered. This classification is done by applying the corresponding impact characterization methods.

The characterization method proposes - for each substance *i* involved in the impact *j* - a characterization factor $CF_{i,j}$ to express the intensity of the contribution of substance *i* to impact *j*, compared to a reference substance impact *j*.

$$CF_{i,j} = \frac{Impact_{i,j}}{Impact_{ref,j}} \left(\text{in } \frac{kg \text{ ref}_{eg}}{kg \text{ i}} \right)$$

3. Third, for each impact *j*, summing up the contributions of all involved substances:

$$Impact_j = \sum_i CF_{i,j} \times m_i \quad Impact_j = \sum_i CF_{i,j} \times m_i : m_i \text{ mass of substance } i \text{ emitted by the considered system}$$

The computation of the environmental footprint of product manufacturing can be summarized as follows:

The 21 indicators of environmental impact – also called mid-points – take into account inputs and outputs in the form of emissions to soil, air and water, as well as energy consumption and human toxicity (see table below for a list of indicators and their description). See Annex 1.1 p 62 for the detailed list.



4

ASSESSMENT FOR PRACTITIONERS

Note to highlight the update we have made on LCA methods and shadow costs to adopt the best practices of the LCA discipline:

Over the years, the LCA standards and database have evolved regularly in order to give a better evaluation of the environmental impact.

Therefore we have integrated these evolutions in our methodology in order to keep up with the developments underway in the LCA discipline as SPM needs up-to-date and robust information to make the right decisions.

Methods were adjusted by our LCA experts and reviewed by third-party QUANTIS for external validation.

For most of the eco profiles, the quality is estimated by an LCA expert mixing completeness of primary data input, complexity to access robust secondary data, ease to build the proxies, age of the data versus relevance of the technology,... The quality is defined on a 5-level scale: Very Good, Good, Fair, Poor, Very Poor. In the framework of SPM analysis, the quality level of the ecoprofile is not a critical parameter but needs to be defined according to the criticality of the SPM position on the vertical axis. Nevertheless, in order to ensure a consistency across SPM assessments, the minimum quality level recommended for the ecoprofile is "Fair".

Solvay considers an ecoprofile valid as long as the production technology, including the effluent treatment, utility management and emissions control remain unchanged. If no change, an ecoprofile should then be revised about every 5 years.

As of today, LCA experts use LCA software Simapro to calculate the ecoprofile for SPM assessment purposes. Simapro relies on existing databases: Ecoinvent V 3.8, ELCD, Agrifootprint, Industry data 2.0.

The ecoprofile of a product is reported in a table and the data is stored in specific software used by the expert team and also in Solvay's SPM Database. For a sample of an ecoprofile reporting table, see Annex 1.2 p 66



4

ASSESSMENT FOR PRACTITIONERS



Environmental impact : Solvay ecoprofile table

Impact category	Unit	Methods
IPCC GWP100a - 2013	kg CO2 eq	IPCC 2013
Trapped Biogenic CO2	kg CO2 eq	Computation
Human Toxicity, Cancer	DALY	USEtox 2
Human Toxicity, non-Cancer	DALY	USEtox 2
Respiratory Inorganics	DALY	UNEP recommendation methodology
Freshwater ecotoxicity	CTue	USEtox 2
Mineral Resource Depletion	kg Sb eq	CML 2022 (ultimate reserve)
Land Use Occupation	m2a	Land use
Terrestrial Acidification	kg SO2 eq	CML IA baseline
Freshwater Eutrophication	kg P eq	Eutrend / ILCD 2011
Marine Eutrophication	kg N eq	Eutrend / ILCD 2011
Ozone Depletion	kg CFC-11 eq	ODP Steady State
Photochemical Ozone Formation	kg NMVOC eq	Lotos-Euros model
Water Consumption	m3	Inventory
Renewable, Biomass	MJ	Inventory
Renewable, Solar, Water, Wind	MJ	Inventory
Coal Energy	MJ	Inventory
Crude Oil Energy	MJ	Inventory
Natural Gas Energy	MJ	Inventory
Nuclear Energy (Uranium)	MJ	Inventory
Primary Forest Energy	MJ	Inventory
Non-renewable Energy	MJ primary	Inventory
Particulate Matter	kg PM2.5	Inventory



4

ASSESSMENT FOR PRACTITIONERS



STEP 2:

Impact Valuation: Monetization of negative impacts

Impact Valuation assigns a monetary value to very different impact measurement categories following the 'polluter pays' principle. Such monetization outlines the financial cost for Solvay if the externalities had to be paid based on the shadow costs calculation. A shadow cost is an estimation of the 'cost for the planet', a theoretical monetization (in euro) of each environmental impact (scientifically called mid-point) of the ecoprofile in order to consolidate and compare them. Monetization can be seen as the cost for society at large. The shadow cost is calculated based on what it would take to prevent environmental or human toxicity damage (avoidance cost route) or to remediate the damage caused (repair cost route). A range of values is defined for both routes and each ecoprofile indicator for the year 2020, resulting in an average, a minimum and a maximum value to be used in sensitivity analysis. Detailed examples of how we define shadow costs are included in the QUANTIS report dated 2019.

Shadow costs are not yet available in standardized databases for all environmental impacts so Solvay and the consultancies supporting the development of the SPM tool had to find and reference authoritative research and sometimes make in-house analysis and decisions on monetary figures. For Solvay, the shadow costs estimation should not be considered as an objective as such but as a tool to integrate the environmental costs in business decisions, to reflect on how to reduce them for existing products or minimize them at an early stage for new product development projects. This is why the option was taken to keep the shadow costs for 5 to 10 years for comparison purposes to measure the progress versus the initial assessment. In addition this does not prevent the use of minimum, maximum values or other database values to carry out a sensitivity analysis of the business model.

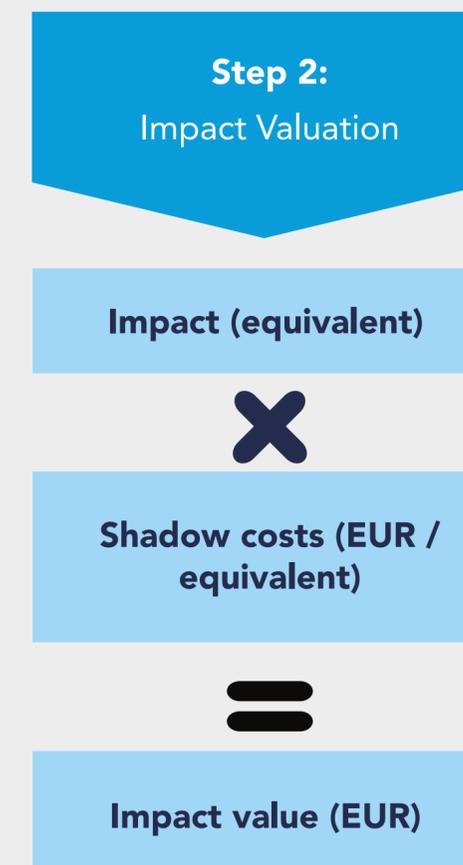
The time horizon used in the SPM methodology is 10 years – currently to 2030 – with a revision of the data planned every 2-3 years.

First, shadow costs used by SPM were set up by TNO in 2009 and some revised in 2012. In 2018, Solvay appointed QUANTIS to make a deep review based on extensive literature research and critical analysis then to make their best recommendations for Solvay decisions. The new shadow costs were implemented for 2021 assessments (see Annex 1.3 p 67).

Calculation

Once impact equivalents have been determined, we multiply them by the shadow costs to arrive at the monetized value of external environmental impact per kg of product:

The Impact Valuation element of the Operations Vulnerability calculation:



Finally, we add the **monetized impact values** to the product's ecoprofile for each impact category, adding the value of all categories to give the total external environmental impact value for one kg of a product.



4

ASSESSMENT FOR PRACTITIONERS

STEP 3:

Operations Vulnerability calculation: financial risk of negative impacts (externalities)

The risk of losing business or the opportunity to gain additional business depends on the balance between the economic value and the environmental damage created. The absolute financial value of the potential impacts of one kg of product is not sufficient to inform the decision-maker. This is why the implications of the financial impacts are calculated by dividing the value of the impacts by the sales value of the product.

The result is the Operations Vulnerability ratio expressed as a percentage which can range from 2% to over 200% of the sales value of the product. While monetization of the environmental footprint brings sustainability considerations closer to decision-makers, to ensure the externalities are taken into consideration in strategic and operational decisions, our products' environmental footprints are compared to the value added of our activities.

The best approximation of this comparison is to use the products' sales price against the monetized environmental footprint of the products. The calculation is a simple division of the Impact Value expressed in EUR and the annual average of the product sales value (to mitigate the impact of price fluctuations). This gives the Operations Vulnerability (OV) rate. This is expressed in a five scale levels of OV in the following order from the bottom to the top of the vertical axis : very high risk , high risk, median risk, low risk and very low risk The higher the rate, the higher the sustainability risk of the particular product. The lower the ratio, the higher the opportunity to displace a less environmentally-friendly competing product.

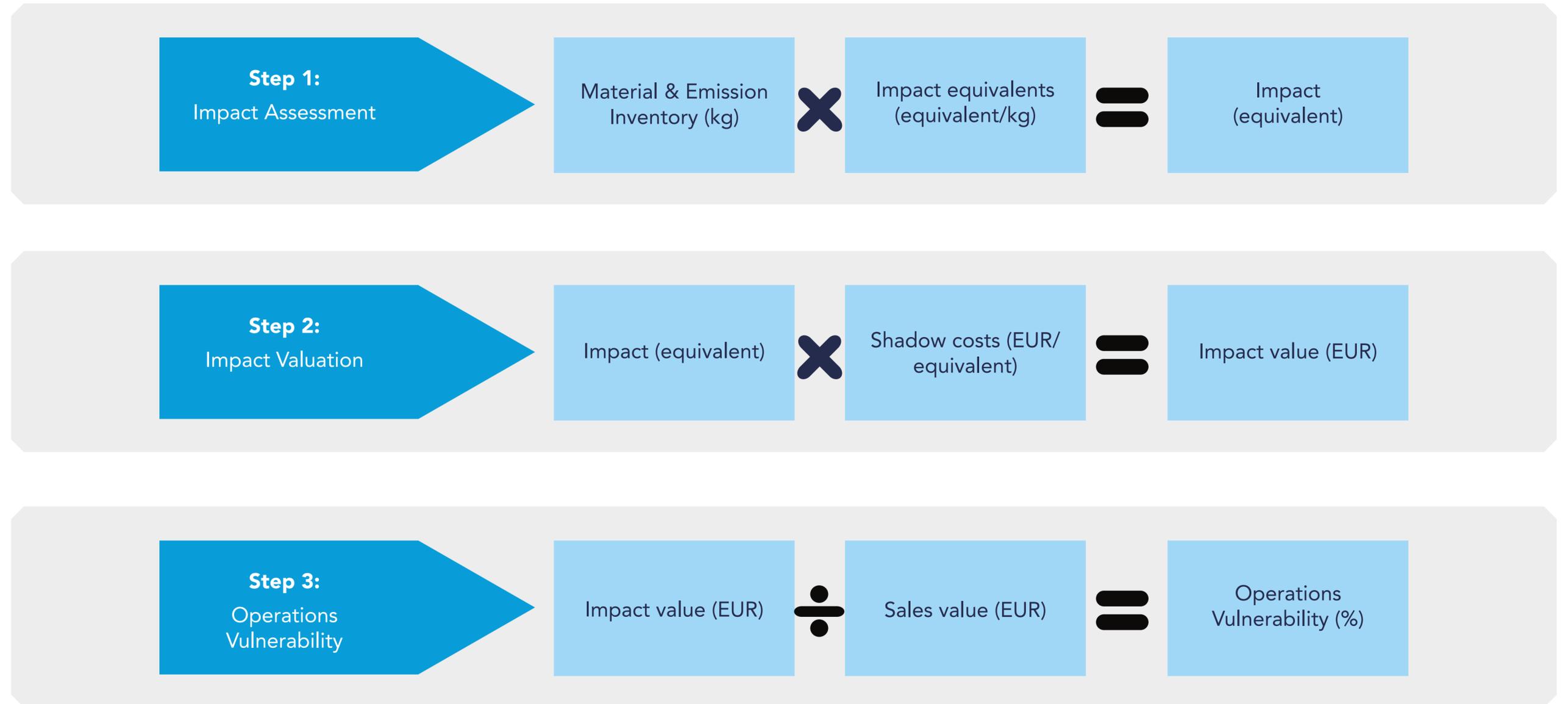
On the one hand, the rate compares the environmental footprint to the value added to society at large. The best approximation of the latter is the sales price offered on the market. On the other hand, the rate also expresses how risky environmental footprints can be if buyers on the market are looking for intermediary products with a low environmental footprint. Operations Vulnerability expresses whether a product presents a long-term risk or opportunity in sustainability-oriented markets.



4

ASSESSMENT FOR PRACTITIONERS

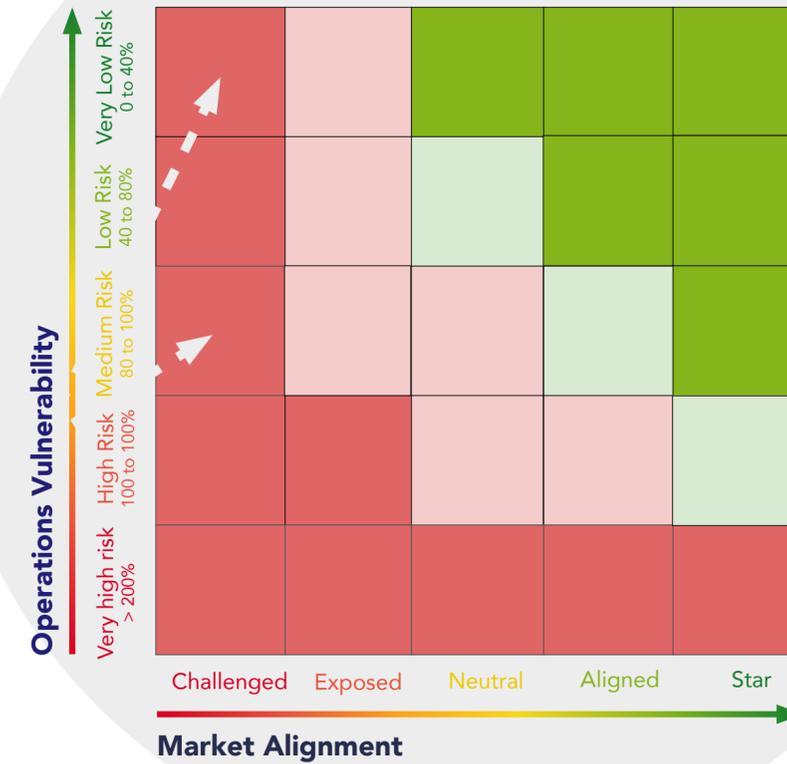
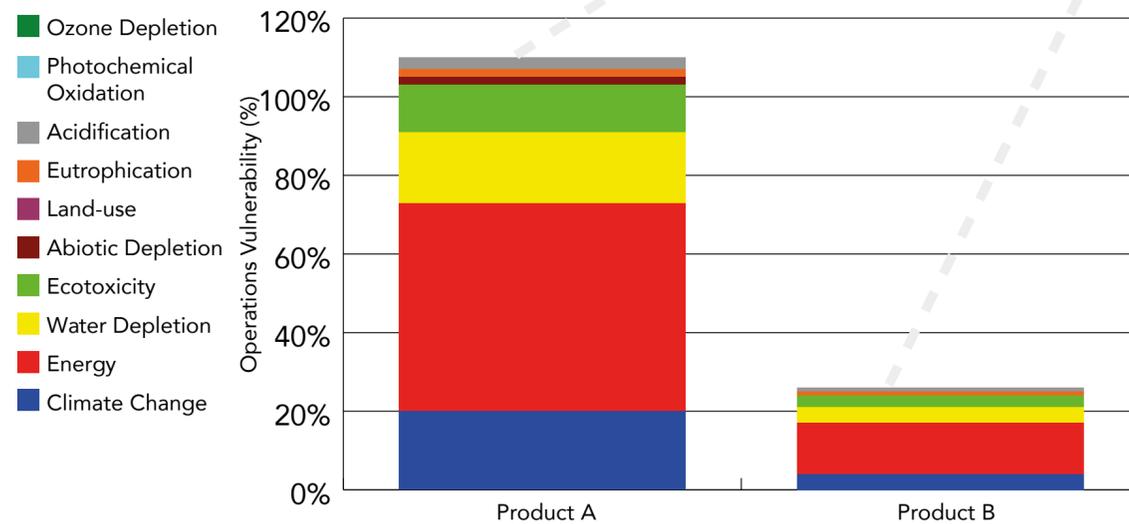
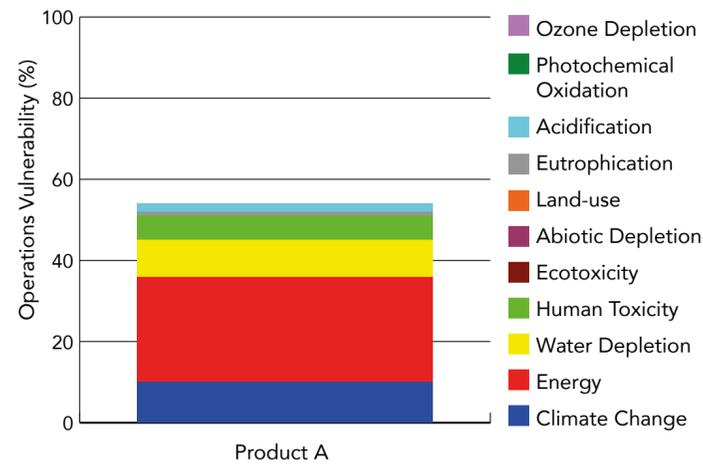
This concludes the 3-step Operations Vulnerability calculation process, which we summarize below.



4

ASSESSMENT FOR PRACTITIONERS

The **Operations Vulnerability** of a product is represented on a chart, detailing the monetized contribution of each impact category. Note that the ratio can be higher than 100% **if the cost of impacts exceeds the sales value**. The same presentation can be built for a group of products (e.g.: BU's portfolio), aggregated according to their turnover.



Advantages of Operations Vulnerability approach:

- Quantitative
- Analyzes one product in one application over one fiscal year
- Scientific Life-Cycle Assessment based on ISO standards
- Cradle-to-gate to ensure feasibility of calculations and reasonable leverage
- Comprehensive: takes into consideration air, water, soil emissions, human toxicity and energy consumption
- Monetization based on authoritative academic sources
- Auditable
- LCA-expert review



4

ASSESSMENT FOR PRACTITIONERS

4.4. MARKET ALIGNMENT - THE HORIZONTAL AXIS

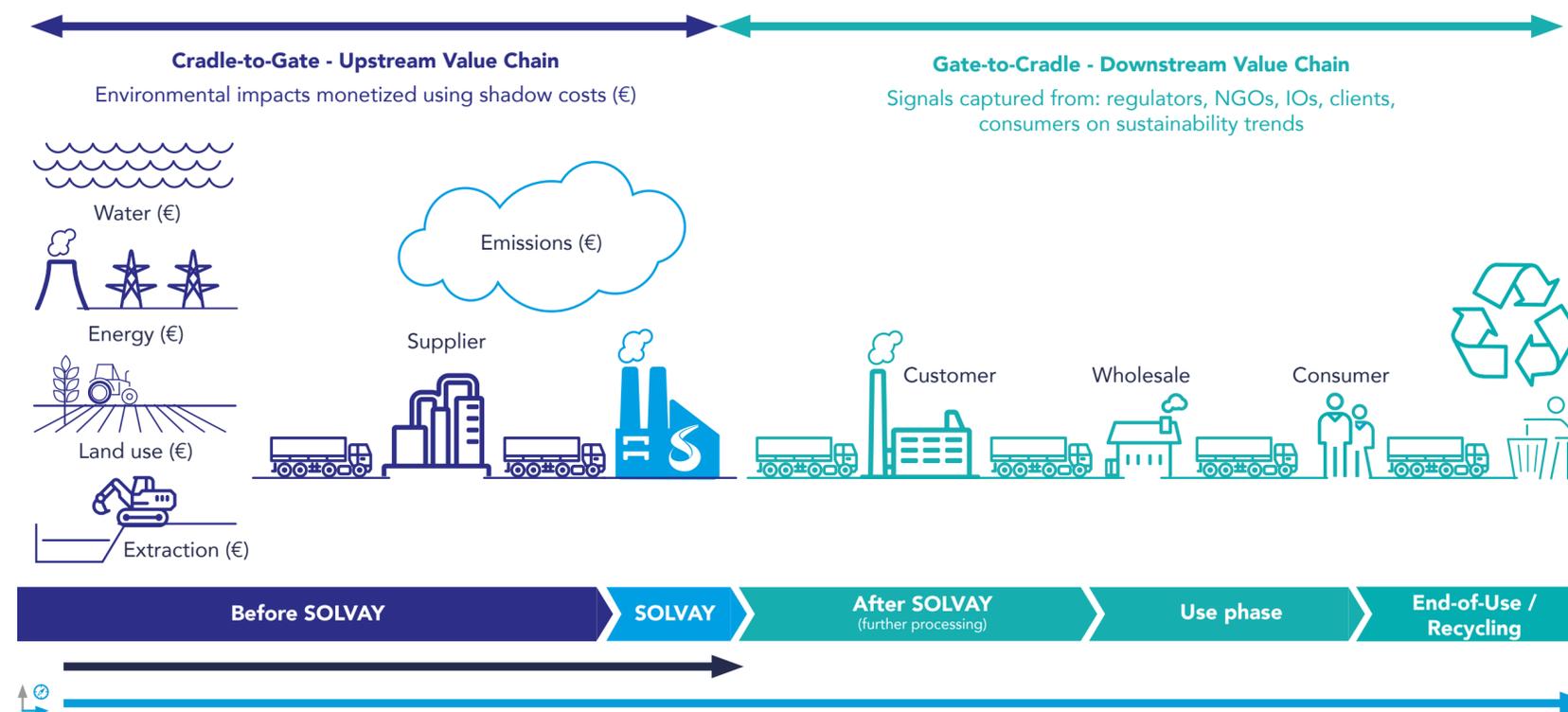
Qualitative, evidence-based collection of sustainability-related market signals Consumers and value chain stakeholders (manufacturers, wholesale, retail) are putting ever more emphasis on sustainability. In order to understand the risks and opportunities arising from the value chain, the right signals have to be captured from different stakeholders.

4.4.1. Market sustainability trends

Benchmarking against our peers, companies like AkzoNobel, BASF, Clariant and DSM, has shown that a qualitative or semi-quantitative analysis is best adapted to interpret market signals³. Furthermore, full cradle-to-cradle Life-Cycle Assessment is not material for Solvay as it is limited to environmental impact assessment, while our analysis also addresses in addition social issues such as

healthcare, ageing population or healthy living.

Detecting early market signals allows us to act in a timely fashion and make the necessary changes in the portfolio by anticipating the future of a product in its application in terms of environmental, health, economic and social sustainability.



³ Our benchmark shows that quantitative, e.g. monetized, analysis of impacts occurring in the entire value chain would take too long and be too costly and not be practical for application in a fast-paced strategic corporate decision-making environment.

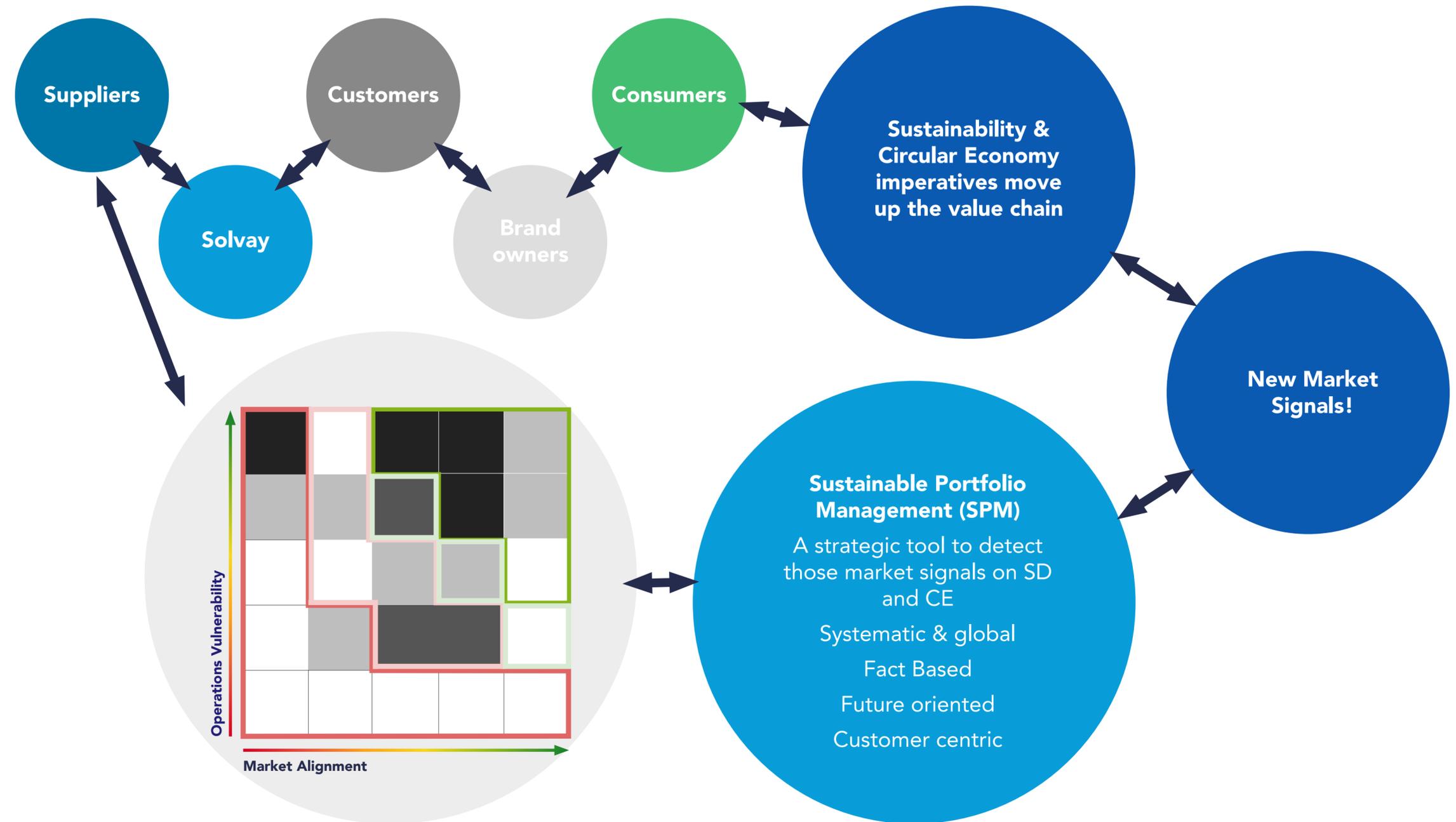


4

ASSESSMENT FOR PRACTITIONERS

Solvay's products are not sold directly to the consumer but consumers' purchasing decisions impact our business. It helps us to understand the applications for our products and their potential to reduce consumers' environmental footprint.

The Solvay leadership internalized this trend and set the ambitious goal that by 2030, 65% of revenue should be generated by sustainable solutions.



4

ASSESSMENT FOR PRACTITIONERS

4.4.2. Product Application Combination (PAC)

In order to define the right application segment to focus on, the following steps are taken at Business Unit-level and per product segment:

1

Market-based application segmentation

- a. For a product processed or used in the downstream value chain, close to the consumer, we look at internal commercial reporting (at financial consolidation level) with a market expert from the relevant Business Unit.
- b. For products processed or used higher up the downstream value chain, further from the consumer, we use market reports from authoritative sources to identify market/application segmentation

2

Sustainability-driven application segmentation

The application level derived from both previous steps, a) or b), is unlikely to mirror sustainability drivers in the market and further segmentation is required, based on expert considerations.

3

Revenue segmentation to identify SPM applications

For a product segment, applications accounting for more than 80% of annual external revenue are selected, and possibly problematic products added to the selection (e.g. products blacklisted in the downstream value chain).

Application segmentation is done from a global point of view. Further application segmentation according to regional characteristics is only acceptable when there are positive market signals for Solvay which may increase the relevance of the solutions in the market.

However regional segmentation should not be used for negative signals as global regulation or corporate rules generally supersede the regional approach. For the regional approach, we are guided by the World Business Council for Sustainable Development (WBCSD) approach.



4

ASSESSMENT FOR PRACTITIONERS



We analyze products in their end-user applications, based on Product-Application Combinations (PACs). One product may have several PACs.

1

Market Alignment Profiling

Identifying sustainability signals for each PAC by answering the questionnaire on environmental and social issues to collect information on obstacles, concerns, benefits, benchmark (Star) potential and amplifiers.

The questionnaire is structured around 4 themes:

Health & Safety

Climate

Resources

Opinion Leaders

... and 29 sub-themes.

Each sub-theme includes a description of the topic that is covered. A specific question has been developed for each level of performance in such a way that the answer should only be Yes or No.



2

Market Alignment Categorization

For the relevant sub-theme, the information gathered and the answer are applied to a decision tree which positions the product on a 1-5 scale of performance level as Challenged (1), Exposed (2), Neutral (3), Aligned (4), Star (5). This category is then added to the SPM Heat Map for the relevant sub-theme.

Market Alignment categories:

1

CHALLENGED

2

EXPOSED

3

NEUTRAL

4

ALIGNED

5

STAR

Market Alignment analysis steps:

Step 1:

Market Alignment Profiling
(via questionnaire)



Step 2:

Market Alignment
Categorization (via decision
tree)

4

ASSESSMENT FOR PRACTITIONERS



Progress beyond

The Market Alignment questionnaire mirrors sustainability market trends which can act in favor of or against the demand for Solvay products. It is the lens through which the SPM experts assess a PAC.

The list of sustainability trends linked to the decision-making layers of the SPM lens was established in 2009 in cooperation with Arthur D. Little and Dutch research organization TNO. Studies from eleven of the most reputed institutes⁴ were consulted to map the most material potential sustainability impacts in the chemical industry. Since 2009 the questionnaire has been enriched by

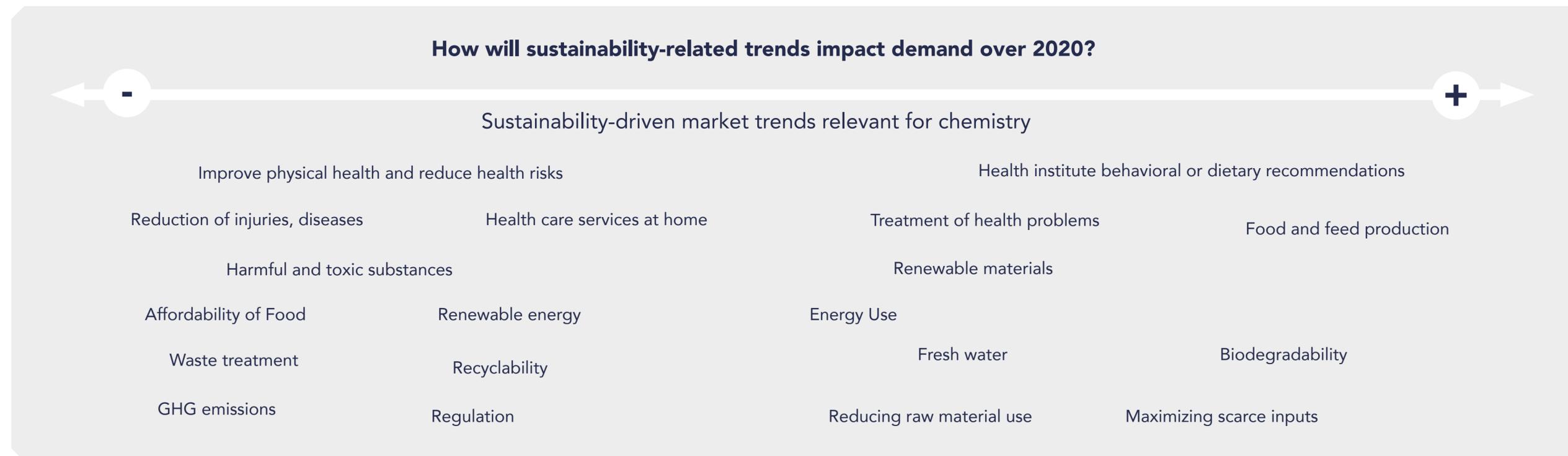
new questions covering mainly raw materials, responsible sourcing and circular economy.

The Market Alignment questionnaire is structured in 4 themes : Health & Safety, Climate Change, Resources and Opinion leaders and 29 sub-themes. For each sub-theme, questions are formulated to assess the applicability of each trend to a specific product in its application and to define the level of performance of the PACs according to the decision tree pathway.

4.4.3. Market alignment questionnaire and categorization

An additional set of questions on negative and positive 'Amplifiers' were added to benchmark PACs against competitors and fine-tune the positioning in the final SPM report.

Sustainability-driven market trends assessed by Arthur D. Little and TNO:



⁴ Rocky Mountain Institute, Worldwatch Institute, WWF, Greenpeace, United Nations Environment Programme, Wuppertal Institute, World Business Council for Sustainable Development, International Institute for Sustainable Development, London School of Economics, Sierra Club and Öko Institut.

4

ASSESSMENT FOR PRACTITIONERS

The Market Alignment questionnaire formulates questions assessing the applicability of each trend to a specific product in its application. Questions are formulated simply

Hereunder are examples of questions addressing the sub-themes Climate change and Raw materials.

Examples of questions

CLIMATE CHANGE	
Benefit	Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly reduce emission of substances with a GHG potential?
Concern	Is <Product> in <Application> reported by at least one authoritative body to contribute directly, measurably and significantly to climate change (absolute or relative)?
Obstacle	Is <Product> in <Application> reported by at least one authoritative body as a major direct, measurable and significant contributor to climate change in the marketplace and being actively displaced by solutions that have a significantly better profile?
Star	Is <Product> in <Application> reported by authoritative body amongst the best-in-class solutions in the market to directly, measurably and significantly reduce emissions of substances with a GHG potential AND actively displacing less efficient solutions?
Amplifier	From the standpoint of climate change, from cradle to grave, and in comparison with its next best comparably priced alternatives, the <Product> in <Application> is anticipated to lead to: <ul style="list-style-type: none"> • Worse profile? • No significant change? • Better profile?

RAW MATERIALS	
Benefit	Does <Product> in <Application> present direct, measurable and significant positive social impact in its raw materials sourcing, which is valorized by actors in the downstream value chain?
Concern	Does <Product> in <Application> present direct, measurable and significant negative social impact in its raw materials sourcing, which is leading to delisting by actors in the downstream value chain?
Amplifier	From the standpoint of raw materials sourcing and its social impact for workers, small holders or communities, among others, and in comparison with its next best comparably priced alternatives, the <Product> in <Application> is anticipated to lead to: <ul style="list-style-type: none"> • Higher negative impact? • No significant change? • Higher positive impact?



4

ASSESSMENT FOR PRACTITIONERS

An obstacle-type question on a product ban is strict:

Is the Product in its Application banned or restricted for use by at least
. * one supranational **OR** . * two OECD members or key partners **OR** . * the state of California and one OECD member or key partner?

A concern of the same category is less strict:

Is the Product in its Application banned or restricted for use by at least
. * one OECD member or key partner **OR** . * the state of California?

A benefit-type question on energy efficiency is formulated as follows:

Does the Product in its Application help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly reduce their energy consumption?

The corresponding amplifier will compare energy efficiency potential to that of a competing product:

From the standpoint of energy efficiency, from cradle to grave, and in comparison with its next best comparably priced alternatives, the Product in its Application is anticipated to lead to:
Lower energy efficiency **OR** No significant change **OR** Higher energy efficiency.

The Amplifier should be considered as a point of attention to be reviewed regularly according to the market trends but does not influence the SPM scoring.

Questions are formulated simply leading to a Yes or No answer regardless of the materiality in order to mark the signals. Answers have to be supported by fact based evidence.



4

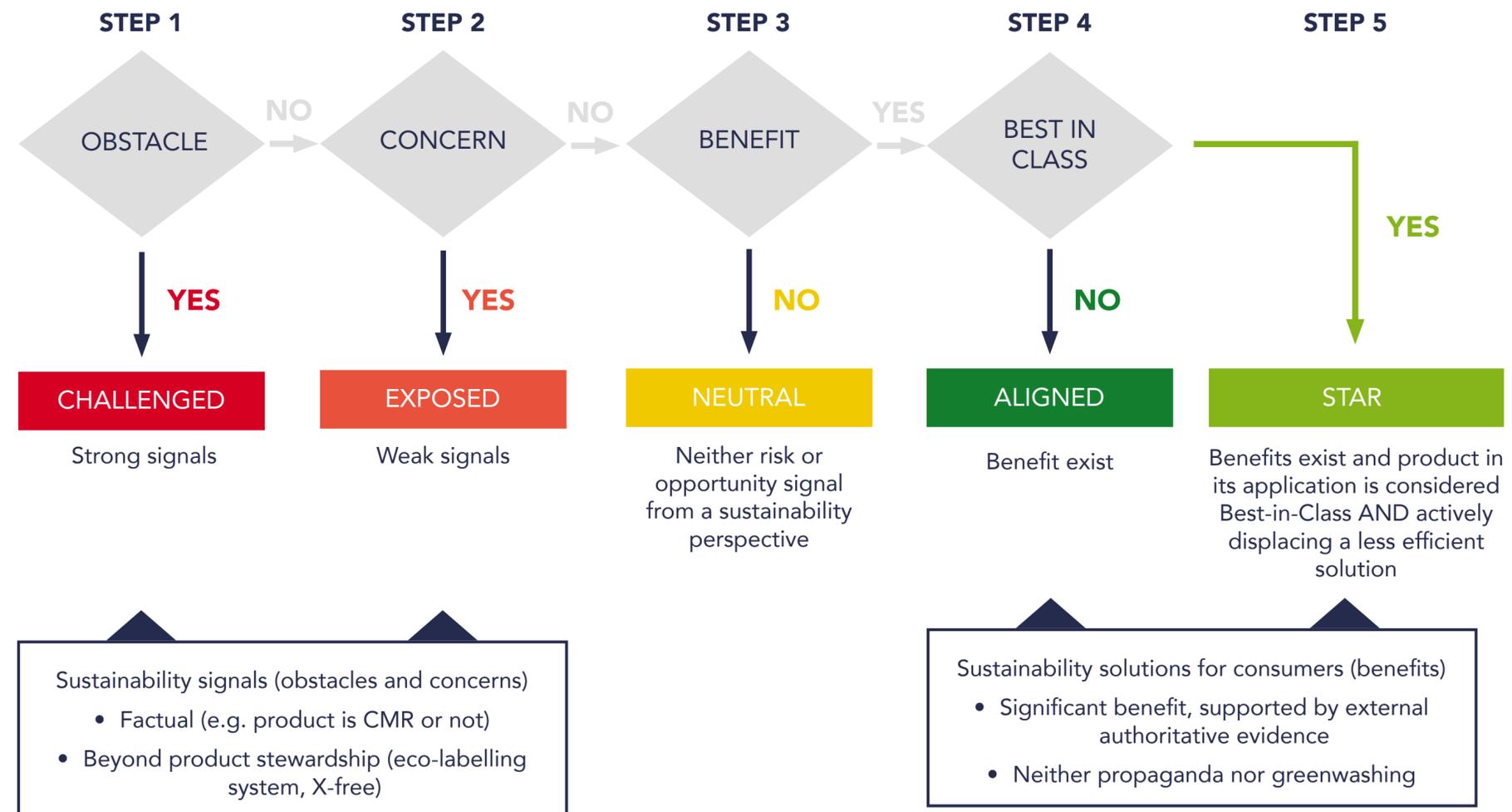
ASSESSMENT FOR PRACTITIONERS

Market Alignment Categorization

The decision tree guides the SPM expert in plotting the PAC on the horizontal axis of the SPM Heat Map, based on the answers collected to the questions in the market alignment questionnaire. One 'Yes' or 'No' answer is sufficient to move to the next stage in the decision tree. As explained in the Product Segmentation sub-

chapter above, Solvay does not compromise on negative signals. If an obstacle is identified then the product is classed as Challenged or if a concern is found it will be classed as Exposed.

Market Alignment decision tree in detail:



4

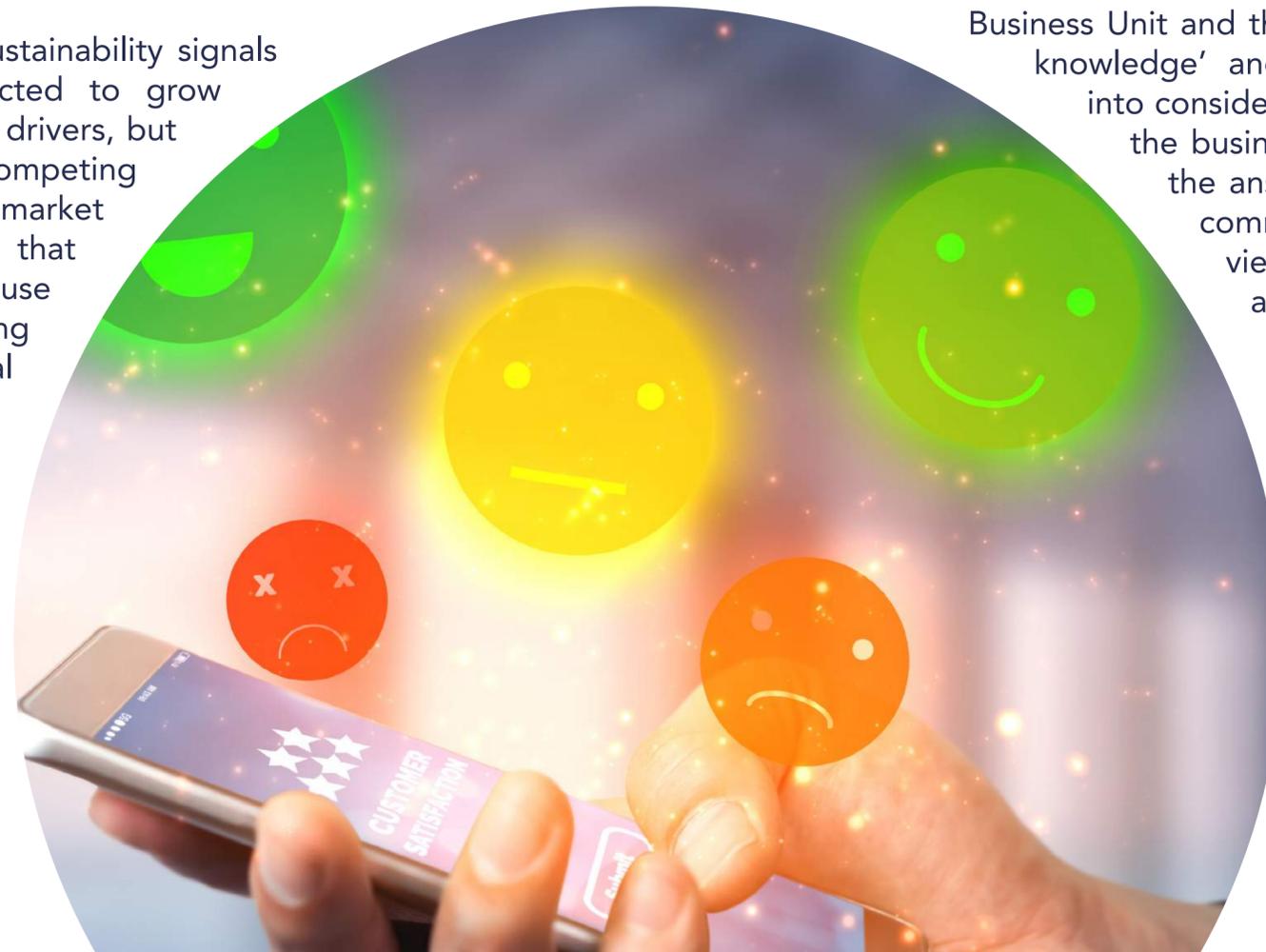
ASSESSMENT FOR PRACTITIONERS

Market alignment categories can be summarized as follows:

- **Challenged:** PAC with strong negative signals resulting from sustainability drivers in the marketplace. These are products whose revenue could experience a significant negative impact and eventually disappear.
- **Exposed:** PAC with weak negative sustainability signals. These are products which might negatively impact or have difficulty growing due to sustainability drivers.
- **Neutral:** PAC with neither positive nor negative signals resulting from sustainability drivers in the marketplace. These are products that consumers need but which do not contribute to environmental footprint reductions.
- **Aligned:** PAC with positive sustainability signals where the revenue is expected to grow moderately from sustainability drivers, but where the growth is curbed by competing solutions from the existing market leader. These are products that customers want to buy because they contribute to decreasing their own environmental footprint or/and bring positive social contribution.
- **Star:** PAC with positive

sustainability signals, with revenue expected to grow substantially from sustainability best in class solutions as they are displacing less efficient solutions in the market. The PAC comes from a fast-growing sustainability-driven market e.g. wind energy and where the Solvay product outperforms the leading alternative.

Once the product's Market Alignment category is defined, 'Amplifier' questions on benefits and drawbacks help position the PAC. This set of questions is a good instrument to cross-check answers to other questions and drive Ecodesign. The SPM team assesses the signals for each PAC with the related businesses. Any answer must be agreed between the Business Unit and the SPM expert to ensure both 'business knowledge' and 'methodological integrity' are taken into consideration. In case of disagreement between the business representative and the SPM Expert, the answer of the business is recorded, with a comment explaining the different point of view of the SPM Expert. The SPM Expert after analysis may still decide to activate the override option as a clear exception as described in the guide 2.4 page 10.

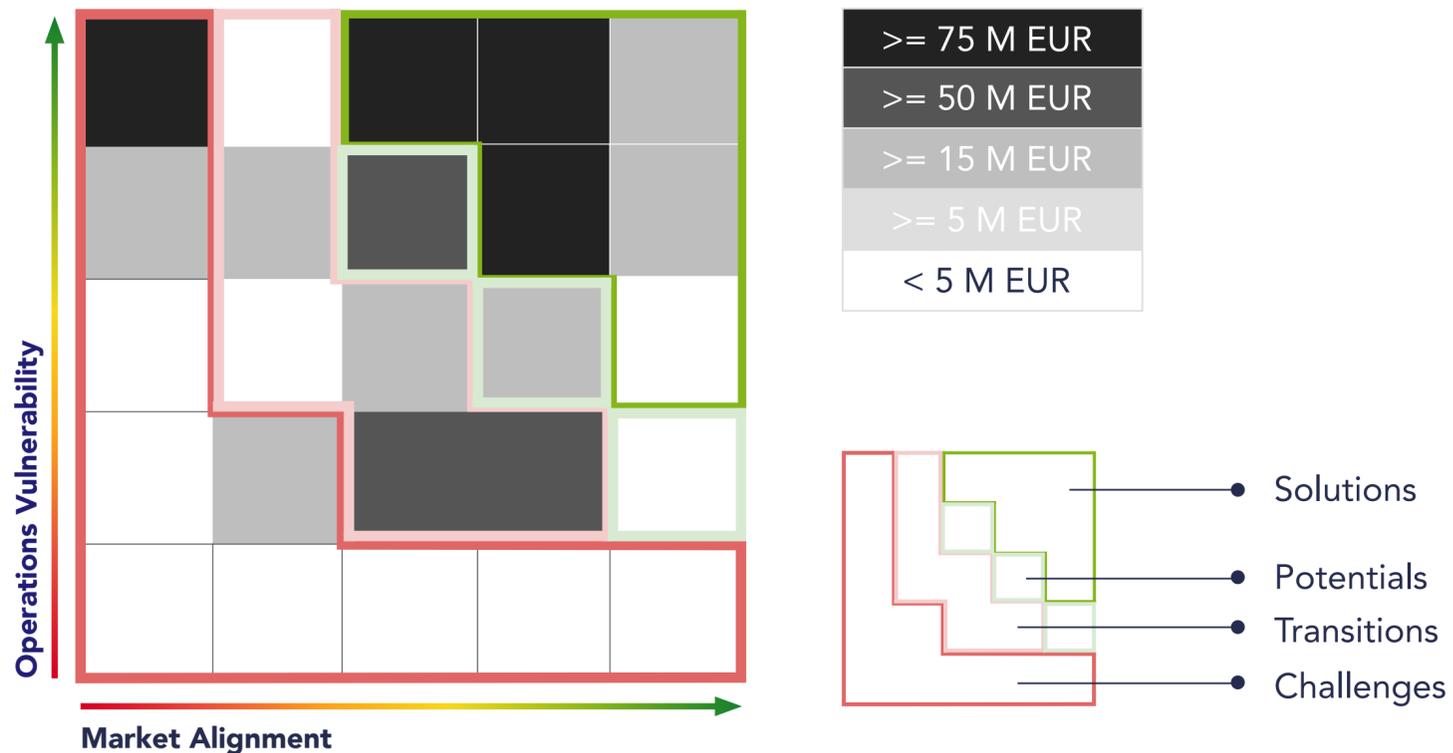


4.5. MAPPING OUT RESULTS – SPM HEAT MAP

In the SPM assessment, the process is as important as the output, e.g. mapping results for selected products' Operations Vulnerability and for selected PACs' Market Alignment. The process helps sensitize business experts to the importance of sustainability in marketing and the results allow senior executives to make strategic decisions on a portfolio level, while practitioners identify improvement areas related to single products.

The SPM Heat map

The single most important output of the assessment is the SPM Heat Map, which shows business positions related to environmental footprint and sustainability-related market opportunities or challenges through the lens of Solvay's turnover.



4

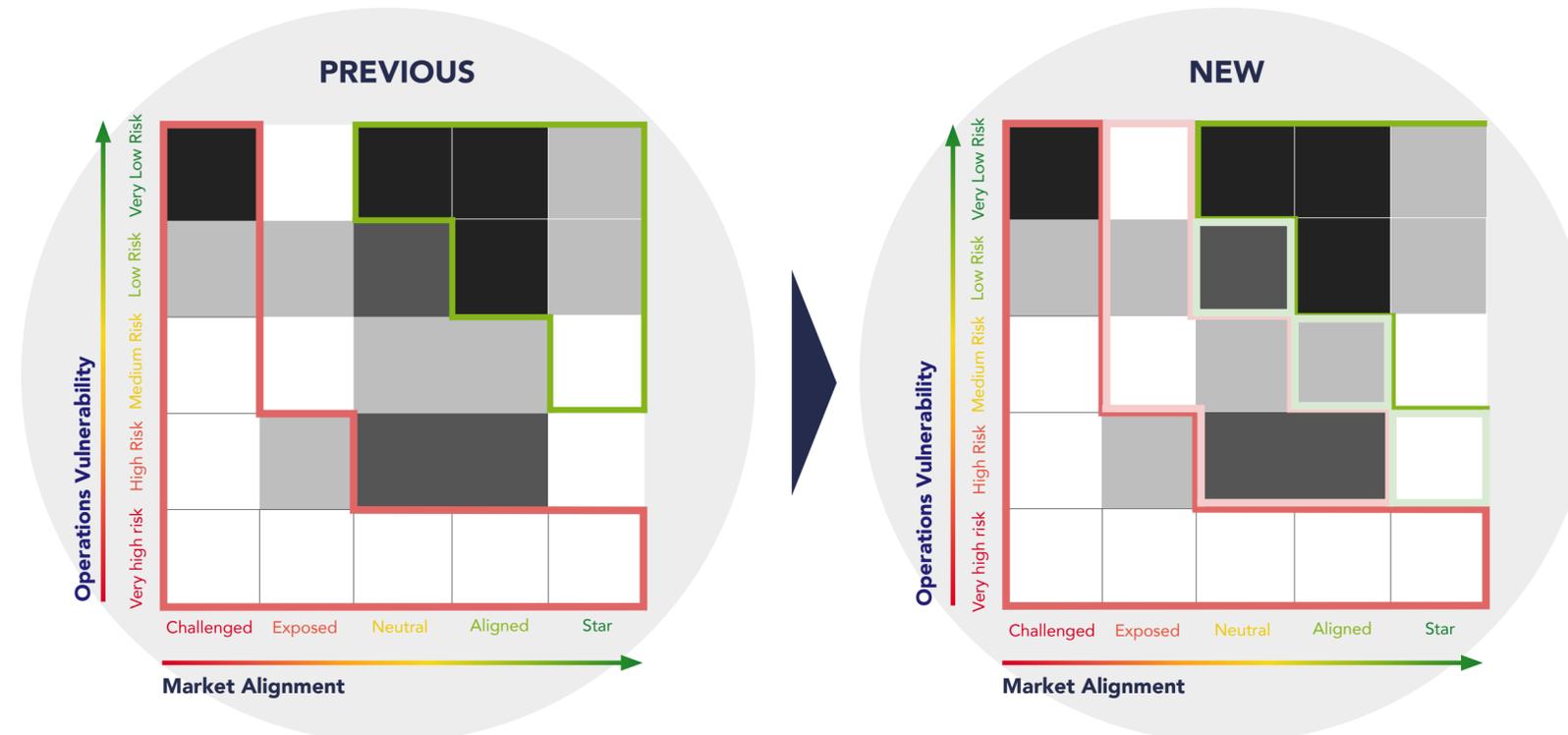
ASSESSMENT FOR PRACTITIONERS

The heat map is the highest-level portfolio steering instrument of the SPM assessment. It categorizes products and in applications (PACS) in four higher level categories

- **Solutions:** PACs with a better sustainability contribution which bring higher social and environmental contributions to Solvay customers and value chain performance, and demonstrate a lower environmental impact in its manufacturing phase
- The **Potentials** category reflects the potential to join the Solutions category using the Ecodesign approach to reduce the manufacturing environmental footprint.

- The **Transitions** category reflects the names used by peers (BASF, AkzoNobel) to identify low-level negative sustainability concerns, on the manufacturing and/or market axis. The central box on the Heat Map is exceptional as there is literally no sustainability concern and no potential to differentiate on sustainability in the marketplace. It will be attached to the Transitions category.
- **Challenges:** PACs for which there are either strong negative signals resulting from sustainability drivers in the marketplace, or serious operations vulnerability challenges. These are products where there may be a significant negative impact on revenue over time and where products may eventually disappear.

SPM - 2 new categories to trigger actions: "Neutral" becomes "Transitions" and "Potentials"



4

ASSESSMENT FOR PRACTITIONERS

The SPM Heat Map is a pragmatic benchmarking tool which constantly evaluates a group of PACs to represent market-related sustainability risks and opportunities in a single matrix. It supports decision-making on a strategic portfolio level. It identifies challenges and spurs action.

The SPM tool is flexible depending on the organizational and functional level using it within the company.

The GBU Management Committee will use it to map the entire GBU for strategic review. Furthermore, in particular cases, for example a special homecare product line, the matrix can forecast sales in that segment.

It can also be used by key account managers to show clients the differentiating sustainability factor a Solvay product can bring to their product. In short, SPM

can be adapted to the scope of the discussions it needs to inform.

Nonetheless, Business Unit (BU) directors and managers use other representations of the SPM results to help them identify areas for improvement in a product's environmental footprint. Such representations are for example, stack charts on the SPM-related evolution of the Business Units (BUs) over time, financial bridge charts on BUs or PACs which need explanation (where year-on-year changes in certain areas are significant) or stack charts on the positioning of products within a GBU according to a monetized environmental footprint compared to unit sales value (EUR/kg) etc.

Such representations help cascade SPM analysis to the strategic and operational level of the Business Unit.





5.1. SOLVAir® IN FLUE GAS CLEANING – IMPROVING AIR QUALITY

Introduction

As a market leader in flue gas treatment, Solvay developed SOLVAir® which is a highly efficient flue gas cleaning solution. This product uses Sodium Based Sorbent for Air Pollution Control by dry injection in order to remove acid gases (HCl, SO_x, HF, NO_x...) from

exhaust for all types of industries such as energy from waste, industrial, marine and energy production. It contributes to overcoming health and environmental related challenges for cleaner air and a safer environment. For data we have used order of magnitude and shorten some fact based answers as case studies were developed to illustrate the assessment process.

Product segmentation

SOLVAir® is a sodium bicarbonate and is produced by different factories and processes. From an LCA perspective these factories and processes use different energy levels and sources which means they will have a different environmental impact.

From an SPM perspective, it is important to segment products with almost similar impacts into one SPM product assessment and differentiate those that have significantly different impacts into separate SPM product assessments.

Impact assessment

1 kg of SOLVAir® sodium bicarbonate has a cradle-to-gate impact of kg of CO₂ equivalent, DALY (Disability-adjusted life year) equivalent (regarding human and

ecotoxicity), MJ of energy consumption (coal, gas, oil), kg of SO₂ equivalent (acidification) and m³ of water consumption.

Impact Valuation

SOLVAir® sodium bicarbonate has potential externality costs with Global Warming Potential, non-renewable resources and human health, representing more than

80% of the total product externalities

Operations Vulnerability

SOLVAir® sodium bicarbonate - flue gas cleaning

The Operations Vulnerability analysis shows that SOLVAir® sodium bicarbonate production has potential externality costs mainly due to Global Warming Potential, non-renewable resources and human health potential making up more than 80%

of the total shadow cost. Compared to the revenue of this product segment, this result amounts to a 'Low to very Low' Operations Vulnerability risk.

Application Segmentation

Patented SOLVAir® Solutions provide a wide range of sodium based products, services, technologies and treatment systems for air emissions control that meet the demand of both industrial and municipal activities like energy-from-waste incinerators, energy production, marine industry and industrial players (ceramic,

steel,...). Since the desire of countries to phase out the coal fired plants, a further segregated application was needed. Therefore, we have defined two flues gas cleaning applications: the coal fired plants and the waste incineration process.

Market Alignment profiling

The flue gas cleaning processes where Sodium Bicarbonate is involved absorb SO₂, HCl or HF with and without water in the flue gas, reducing emissions well below the limits stated in EU directives. In fact, flue gas cleaning is mandatory in country regulations to respect threshold limit values. There is also a European directive that prohibits landfilling of non-treated domestic waste. Furthermore,

there exists a new regulation BREF (EU Best Available techniques reference documents), which is more stringent and therefore more favorable to SOLVAir® development. This implies low emission limits (NO_x, SO₂), no effluent, mix of municipal and industrial waste and no fumes. Therefore, there is a positive impact in the countries' aspect.

In addition, air pollution is one of the main causes of serious environmental and health risks. When released in the atmosphere, acid gases have an impact on health and cause acid rain impacting forests, water and soil. Additionally, it causes the corrosion of steel structures such as bridges and buildings and the wearing out of stone buildings and statues. Thanks to this absorption and neutralization of these flue gases, there are fewer toxic substances in the air, which implies a better air quality. Therefore, human health and the environment are positively impacted.

Concerning the resources, the sodium bicarbonate is operating at higher temperature, which allows to recover marketable energy that will be used for

district heating and therefore maximizing the yield of the incinerator. This implies a great energy efficiency. Furthermore, flue gas cleaning allows to decrease waste generation. Finally, dry process gives the possibility of waste valorization.

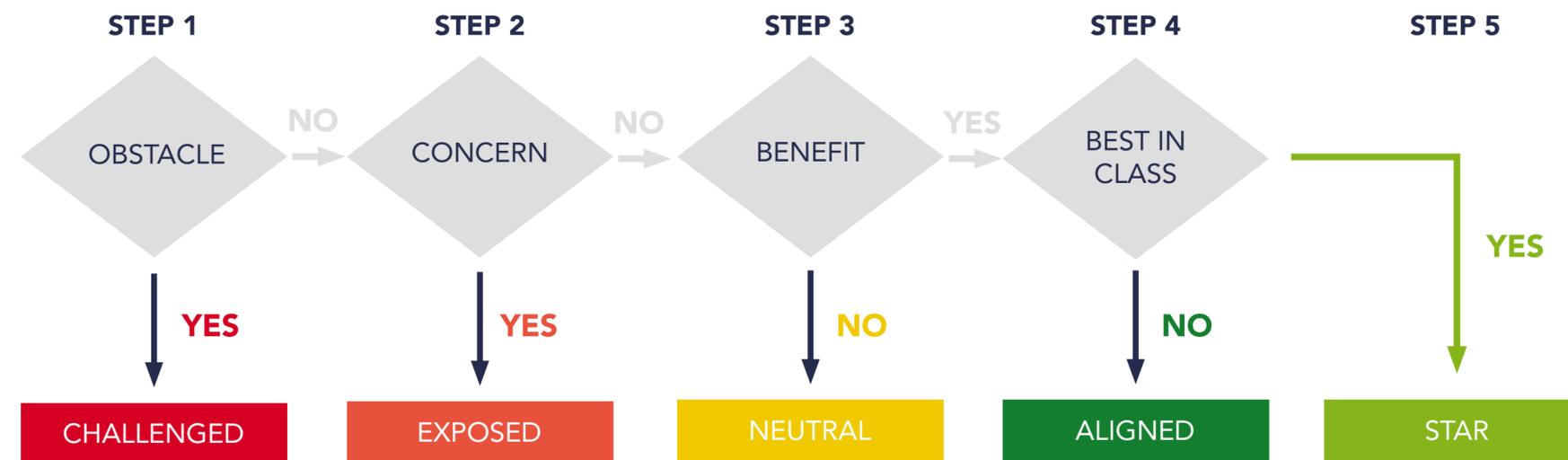
SOLVAir® in the application Coal fired plants

Due to the position of increasing countries to phase out the use of coal for power plants, SOLVAir® in the coal fired plant application falls in a different market alignment category.

Market alignment questionnaire and categorizations

Following the market alignment profiling, we will answer the questions on the relevant sub themes and define the level of performance according to the decision tree process. The answers of the questions should be fact-based and

well documented by reliable sources of information. In this business case, we have shortened the answers as the purpose is to illustrate the assessment process and therefore some fact-based ones are not appearing in those examples.



Health and safety

Water and air quality-Benefit

Obstacle:

Is <Product> in <Application> reported by at least one authoritative body as
 . * a major direct, measurable and significant contributor to (increased) deterioration of water or air quality in the market place

AND

. * being actively displaced by solutions that have a significantly better profile?

NO

NO

Concern:

Is <Product> in <Application> reported by at least one authoritative body to contribute directly, measurably and significantly to lower water or air quality (absolute or relative)?

Benefit:

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly increase the quality of water or air?

YES, the absorption and neutralization of these flue gases improve the air quality."

NO

Star potential:

Is <Product> in <Application>

. * reported by authoritative body amongst the best-in-class solutions in the market to directly, measurably and significantly improve water or air quality

AND

. * actively displacing less efficient solutions?

Human toxicity classifications-Benefit

Does <Product> in <Application> help consumers or actors in the downstream value chain to directly, measurably and significantly substitute a substance from

. * Priority 1 list, at a concentration below 0.1% (w/w)

OR

. * Priority 2 list, at a concentration above 1.0 % (w/w)?

“Yes, thanks to the absorption and neutralization of the flue gases, there are fewer toxic substances in the air, which is better for human health.”

Eco toxicity classifications- Benefit

Does <Product> in <Application> help consumers or actors in the downstream value chain to directly, measurably and significantly substitute a substance from

. * Priority 1 list, at a concentration below 0.1% (w/w)

OR

. * Priority 2 list, at a concentration above 1.0 % (w/w)?

“Yes, thanks to the absorption and neutralization of the flue gases, there are fewer toxic substances in the air, which is better for the environment’s health.”

5

CASE STUDIES

Resource

Energy efficiency-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly reduce their energy consumption?

“Yes, the sodium bicarbonate is operating at higher temperature than Lime, allowing to recover more marketable energy that will be used for district heating and therefore maximizing the yield of the incinerator.”

Waste generation-Star Potential

Is <Product> in <Application>
. * reported by authoritative body amongst the best-in-class solutions in the market to directly, measurably and significantly reduce the generation of waste
AND
. * actively displacing less efficient solutions?

“Yes, Sodium bicarbonate is more efficient than limestone and wet. Flue gas treatment allows to decrease waste generation compared to the lime. There will be half the residue amount with Sodium bicarbonate than with lime.”

Waste valorization-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly increase waste valorization?

“Yes, as the flue gas treatment residue can be recycled, Solvay offers their Residual Sodium Chemicals recycling to two operators in France (Resolest) and Italy (Solval).”



Opinion Leaders

Countries-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly substitute a substance banned or restricted for use or comply with regulation having a strong sustainability focus by at least

. * one supranational

OR

. * two OECD members or key partners

OR

. * the state of California and one OECD member or key partner?

“Yes, Flue gas treatment processes where Sodium Bicarbonate is involved absorb SO₂, HCl or HF with and without water in the flue gas, reducing emissions well below the limits stated in EU directives.”

SOLVAir® in the application Coal fired plants

The assessment of SOLVAir® in coal fired plant is similar to the one for the

municipal waste incineration expected to regard to opinion leader and climate change questions, which brings the PAC into the obstacle category.

Climate Change-Obstacle

Is <Product> in <Application> reported by at least one authoritative body as

. * a major direct, measurable and significant contributor to climate change in the marketplace

AND

. * being actively displaced by solutions that have a significantly better profile?

“Yes, the production of electricity from coal is the most impacting in terms of CO₂ emissions and other technologies (gas or renewables or nuclear) are replacing the coal, even if new coal fired plants are still built in some countries. ”

Opinion Leaders

Countries-Obstacle

Is <Product> in <Application> banned or restricted for use by at least

. * one supranational

OR

. * two OECD members or key partners

OR

. * the state of California and one OECD member or key partner?

“Yes, after the COP21 in Paris in 2015, several countries have signed an agreement for a phasing out of fired coal electricity generation before 2030, with several of them before 2025. This removal is an important obstacle concerning the application of coal fired plants. ”

Downstream Sustainability-Concern

Do at least two major actors (or an industry coalition) implement or publicly commit to implement

. * a strategy to deliver on a significant improvement of their sustainability performance,

. * which is anticipated to have a direct, measurable and significant negative impact on the consumption of <Product> in <Application> in the next 10 years?

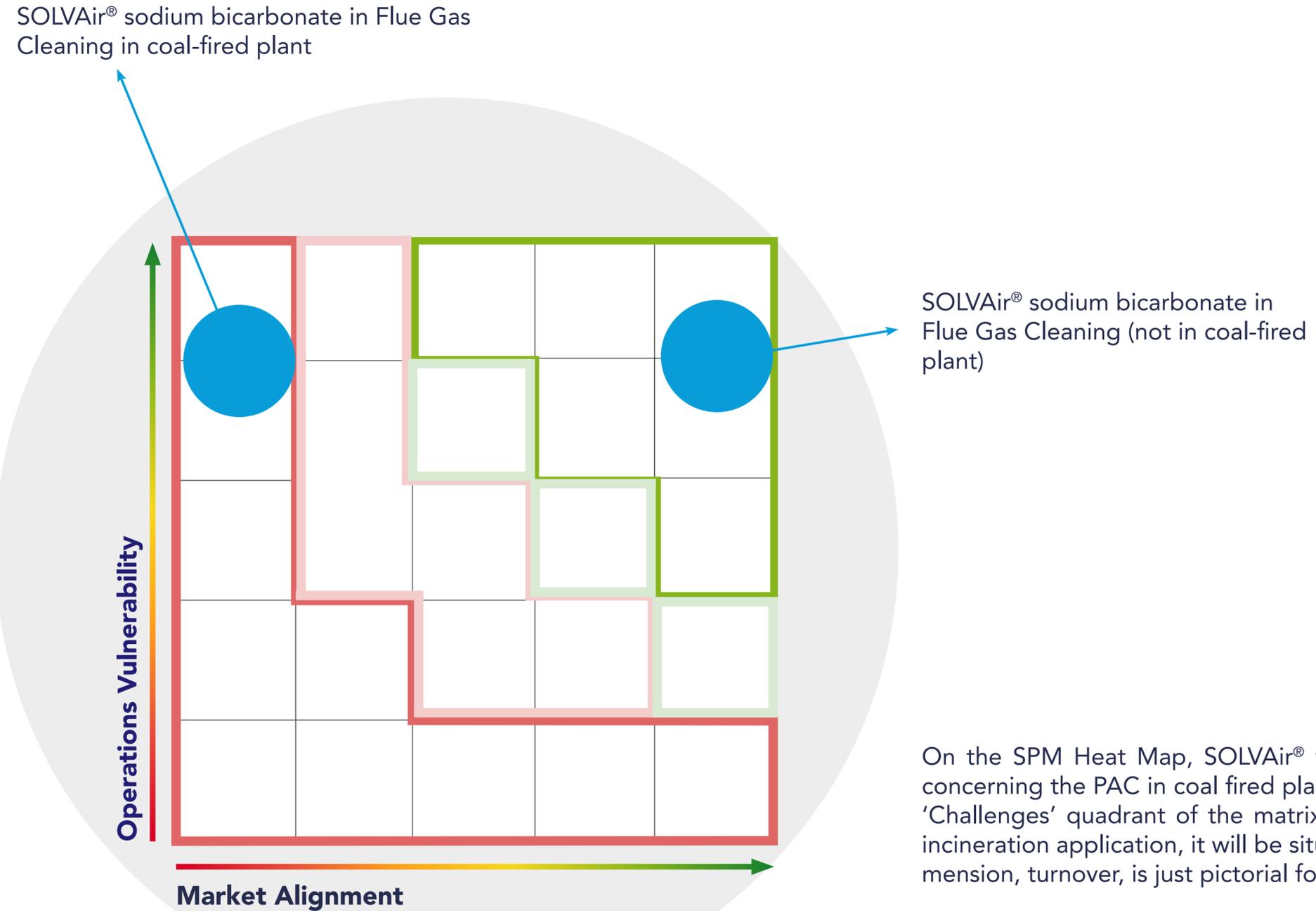
Public commitment has to be supported by clear and well defined targets and KPIs, and be reported publicly.

“Yes, a clear trend expressed by several countries or major electricity companies to progressively reduce the number of coal fired part of electricity.”

The Market Alignment analysis reveals that SOLVAir® in the coal fired plant application faces two obstacles in the countries and climate change aspects and one concern about the downstream sustainability, SOLVAir® in this application is therefore categorized as ‘Challenged’ in Market Alignment.

5

CASE STUDIES



On the SPM Heat Map, SOLVAir® will be positioned in two points. Firstly, concerning the PAC in coal fired plant application, it will be positioned in the 'Challenges' quadrant of the matrix. Secondly, regarding the PAC in waste incineration application, it will be situated in the 'Solutions' side. The third dimension, turnover, is just pictorial for confidentiality reasons.





5.2. HIGHLY DISPERSIBLE SILICA (HDS) – IMPROVING ENERGY EFFICIENCY, COUNTRIES AND SAFETY & PREVENTION

Introduction

Regulations (CAFE in the USA, European regulation) are challenging automotive and tire manufacturers to decrease their CO₂ emissions. As a key supplier to the automotive industry, Solvay proposes the product Silica as an answer to the sustainable mobility challenge. Solvay's Highly Dispersible Silica is used in tread

and non-tread parts, playing a key role in fuel economy by reducing the rolling resistance and in safety by improving the wet grip. For data we have used order of magnitude and shorten some fact based answers as case studies were developed to illustrate the assessment process.

Product segmentation

Silica HDS is produced by different factories and processes. From an LCA perspective these factories and processes use different energy levels and sources which means they will have a different environmental impact.

From an SPM perspective, it is important to segment products with almost similar impacts into one SPM product assessment and differentiate those that have significantly different impacts into separate SPM product assessments.

Impact assessment

1 kg of Silica HDS has a cradle-to-gate impact of kg of CO₂ equivalent, MJ of energy consumption (coal, gas, oil, renewable energy) DALY

(Disability-adjusted life year) equivalent (regarding human and ecotoxicity), and m³ of water consumption.

Impact valuation

Silica's potential has externality costs with mainly Global Warming Potential, human toxicity, human health and non-renewable resources, representing more than 80% of the total cost.



Operations Vulnerability

The Operations Vulnerability analysis shows that the Silica HDS production has potential externality costs with Global Warming Potential, human toxicity, human health and non-renewable resources. Compared to the revenue of this

product segment, the Operations Vulnerability analysis shows that the Silica HDS production has a “low” operations vulnerability risk.

Application Segmentation

Silica HDS meets the tire industry’s demands in safety requirements, contributing greatly to car makers meeting their sustainability objectives in lowering fuel consumption and CO2 emissions without compromising on safety.

However there is no consistent public information about the sales breakdown of tires in the different label categories ranging from A to F, which could allow a

more granular segmentation for assessment purposes.

Therefore, we consider Silica HDS, which is mainstream, to answer to the tires market needs to develop high performance tires with regard to fuel economy, safety and wear resistance vs standard tires.

Market Alignment profiling

Firstly, Silica HDS provides improved wet grip efficiency, ensuring better safety for passengers.

In addition, CAFE (USA) and (Europe) regulations oblige car manufacturers to achieve high fuel economy, and green tires are one of the most cost effective cost contributors. Lower the fuel consumption and reduce the environmental footprint by replacing carbon black in tires production are today the main challenges of the tires manufacturers. Therefore, Silica HDS is responding to the market needs thanks to the positive impact in energy efficiency. By decreasing

the rolling resistance of tires by 25%, the technology allows to reduce vehicle fuel consumption and CO2 emissions by as much as 7%.

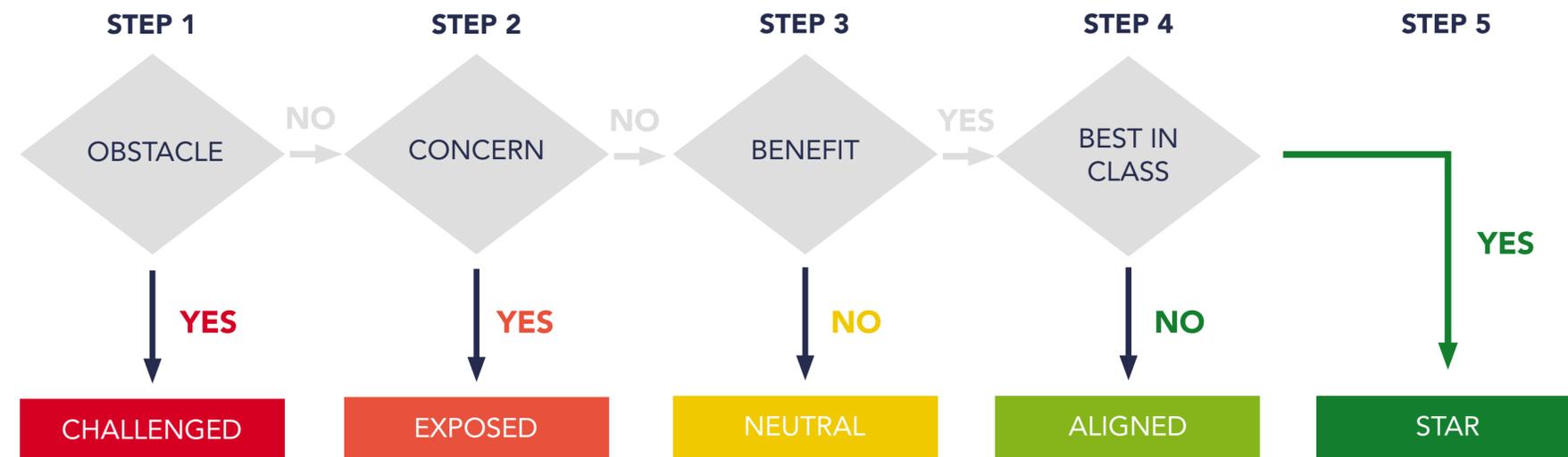
Finally, tire labelling regulations are challenging the automotive industry to reduce CO2 emissions of vehicles and increase road safety all around the globe. In Europe, this regulation imposes a standard label for passenger car, van and truck tires in order to help end-consumers to make more informed choices when buying tires. Silica HDS is contributing to fulfill the requirement of labels.



Market Alignment questionnaire and categorizations

Following the market alignment profiling, we will answer the questions on the relevant sub themes and define the level of performance according to the decision tree process. The answers of the questions should be fact-based and well documented by reliable sources of information. In this business case, we

have shortened the answers as a purpose is to illustrate the assessment process and therefore some fact-based ones are not appearing in those examples.



Climate change-Benefit

Obstacle:

Is <Product> in <Application> reported by at least one authoritative body as

. * a major direct, measurable and significant contributor to climate change in the marketplace

AND

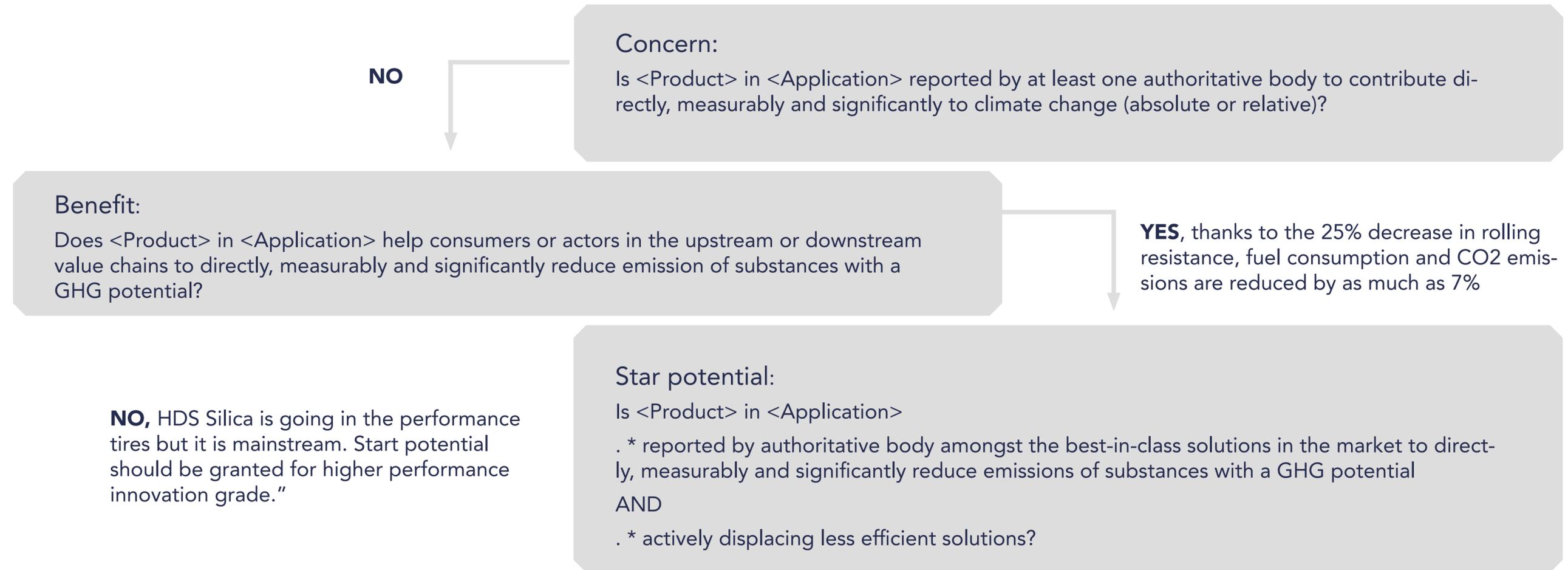
. * being actively displaced by solutions that have a significantly better profile?

NO



5

CASE STUDIES



Health and Safety

Safety and prevention-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly support safety and prevention?

"Yes, Silica HDS is mostly used in tire treads where it contributes to superior wet grip allowing to improve safety."



5

CASE STUDIES



Resource

Energy efficiency-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly reduce their energy consumption?

"Yes, Silica HDS is mostly used in tire treads where it contributes to superior rolling resistance and so a reduction of fuel consumption."

Energy efficiency-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly reduce the consumption of non renewable resources (energy excluded)?

"Yes, Silica HDS increases life span of the tyres due to better wear resistance."

Opinion Leaders

Countries-Benefit

Does <Product> in <Application> help consumers or actors in the upstream or downstream value chains to directly, measurably and significantly substitute a substance banned or restricted for use or comply with regulation having a strong sustainability focus by at least

. * one supranational

OR

. * two OECD members or key partners

OR

. * the state of California and one OECD member or key partner?

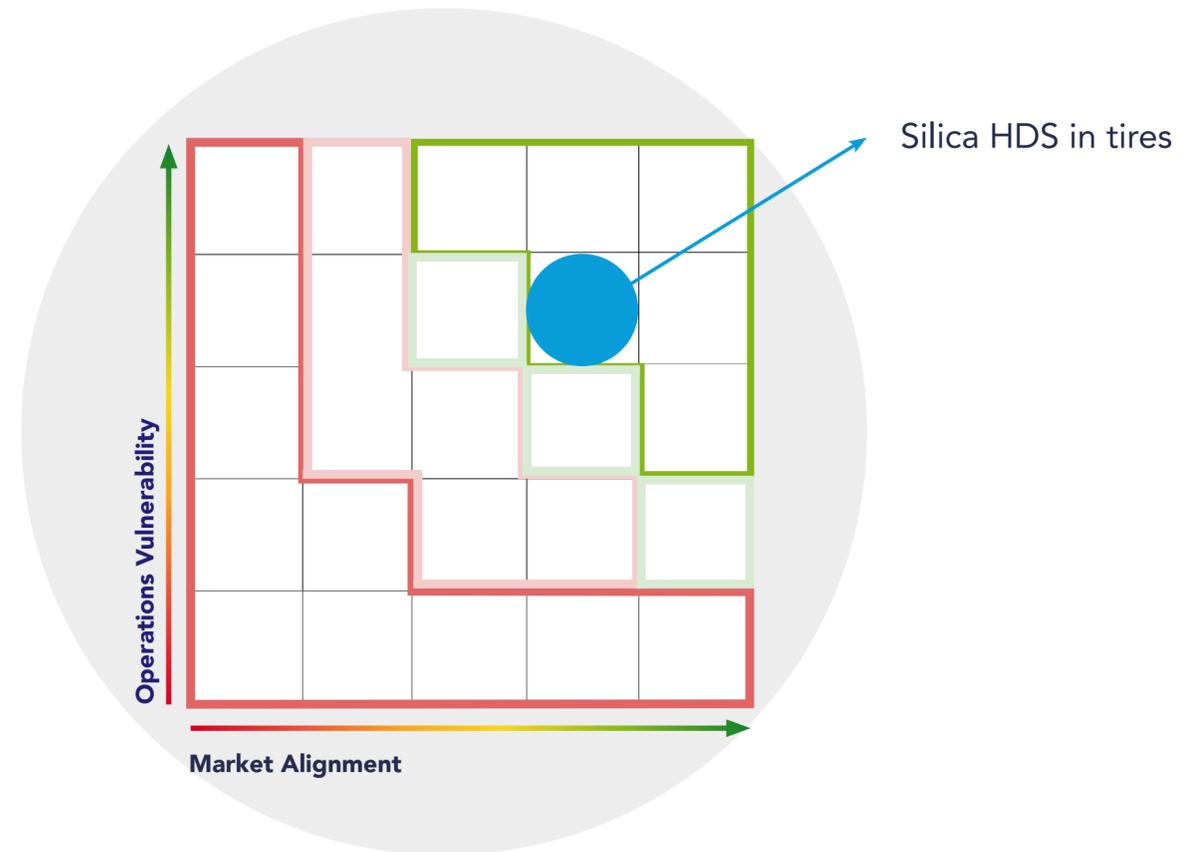
"Yes, CAFE (USA) and (Europe) regulations oblige car manufacturers to achieve high fuel economy and green tires are one of the most cost effective cost contributors."



5

CASE STUDIES

The Market Alignment analysis shows that Silica HDS has no market level obstructions or concerns and it has an energy efficiency, a safety & prevention, country benefits and stimulated an eco-label. Silica HDS is therefore categorized as 'Aligned' in Market Alignment.



On the SPM Heat Map, Silica HDS will be positioned in the 'Solutions' quadrant of the matrix by combining the result on the vertical and horizontal axis. The third dimension, turnover, is just pictorial for confidentiality reasons.





Annex 1

METHODOLOGY

1.1. THE 21 INDICATORS (MID-POINTS)

	Impact Category / Mid-Point	Description	Characterization method and Equivalent measurement tool
1	Greenhouse gas emissions	<p>Reports the potential contribution to climate change, through the greenhouse effect of gases. It is the sum of the individual contributions of each greenhouse gas emitted, the 'Global Warming Potential (GWP)' (characterization factor) multiplied by the emitted quantity.</p> <p>The GWP is the ability of the gas to absorb or reflect UV radiation, integrated over a given time horizon (100 years according to the Kyoto Protocol: GWP100) in the atmosphere, compared to (divided by) GWP100 of CO₂.</p>	IPCC GWP100a - 2013
2	Biogenic CO ₂ uptake	A complete assessment of CO ₂ exchange with the atmosphere takes into account CO ₂ uptake from the atmosphere from plants growing during the photosynthesis process, in the case of bio-sourced products. As a consequence, on a cradle-to-gate basis, bio-sourced products establish a trap for CO ₂ until their destruction into CO ₂ again (total oxidation). The CO ₂ uptake is computed from a theoretical biogenic CO ₂ content in the product under consideration.	Theoretical computation Unit: kg of CO ₂ equivalent (kg CO ₂ eq.).
3	Human Toxicity, Cancer	Eco and Human Toxicity Assessment: Toxicity assessment models, such as the USEtox™ model, provide consensus-based, chemical specific characterization factors that quantify the environmental fate of chemical emissions and their impact on human health and on ecosystems, by assessing exposure and effect. We move from CTUn unit to Daly in 2021.	USEtox2
4	Human Toxicity, non Cancer		USEtox2
5	Respiratory inorganics (particle matter)		UNEP-SETAC recommended methodology
6	Freshwater Ecotoxicity		USEtox2





Annex 1

METHODOLOGY

7	Mineral Resource Depletion	Abiotic resources are natural resources such as ores, minerals or other resources which are regarded as non-living. Abiotic depletion reflects the speed of decrease in the total reserve of resources. For each substance, the rate of extraction (in kg/yr) is considered, as well as the quantity of the ultimate resource. The reference substance is Antimony (Sb), one of the substances that will disappear first and for which ultimate resource data is robust. Note that for fossil substances, the ultimate resources are considered, based on their energy content (Higher Heating Value HHV).	ILCD 2011 - based on CML 2002 - Ultimate Reserve
8	Land Use Occupation	Land use involves the management and modification of natural environment or wilderness into built environment such as fields, pastures and settlements. It has also been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it". Land use may have a large impact on the services of ecological systems and the natural capital stocks that produce them and which are critical to the functioning of the Earth's support system. Examples of ecosystem services are: nutrient cycling, soil formation, recreation, water regulation and supply, climate regulation, habitat, flood and storm protection, food and raw materials production, genetic resources, atmospheric gas balance and pollination. The method used simply inventories the land occupation for the production of 1 kg of the product: surface area multiplied by the time of occupation.	Land Use
9	Terrestrial Acidification	Some acidic substances (Sulfur Dioxide (SO ₂), Nitrogen Oxide - NO _x , Ammonia) emitted to the air fall back to the soil or water in the rain (the well-known acid rain phenomenon), disturbing the development of certain living species. The acidification potential indicator not only considers the intrinsic acidity of the substance but also its lifecycle in the atmosphere after its emission, based on the RAINS-LCA model (transportation over regions and probability for deposition in a given region depending on its geographical point of emission). An average is then calculated to get a global characterization factor.	CML IA baseline





Annex 1

METHODOLOGY

10	Freshwater Eutrophication	Eutrophication is defined as the enrichment of water and soil in nutrients (Nitrogen and Phosphorous), as a result of human intervention. Oxygen depletion is a possible consequence of this enrichment. The method used takes account of the emission of nitrogenous and phosphorous substances in three compartments: air, water and soil. It is based on the ability of a substance to contribute to the profusion of algae (biomass potential).	Eutrend / ILCD 2011
11	Marine eutrophication		Eutrend / ILCD 2011
12	Ozone Depletion	Ozone molecules in the stratosphere absorb large quantities of UV radiation coming from the sun, thus removing the life-threatening UV-C radiation and reducing the harmful UV-B radiation. The destruction of the stratospheric ozone layer (particularly over the Poles) is mainly due to a catalytic destruction of ozone by atomic Chlorine and Bromine. The main source of these halogen atoms in the stratosphere is photo dissociation of chlorofluorocarbon (CFC) and bromofluorocarbon compounds. These compounds are transported into the stratosphere after being emitted at the surface of the earth, mainly due to human activity. Characterization factors are established according to the effective destruction of the ozone layer attributable to the annual emission of a given substance, as compared to the effective destruction attributable to the annual emission of CFC-11.	ILCD 2011 - based on ODP Steady State
13	Photochemical Ozone Formation	Under certain climatic conditions, air emissions from industry and transport can react in a complex manner under the influence of solar radiation and lead to photochemical ozone formation responsible, in particular, for possible respiratory problems. As a measure for estimating airborne substances' potential for forming atmospheric oxidants, POCP (Photochemical Ozone Creation Potential) values are used. The POCP value of a particular hydrocarbon is a relative measure of how much the ozone concentration measured at a single location varies if emission of the hydrocarbon in question is altered by the same amount as that of a reference hydrocarbon, usually ethylene. The POCP value is not a constant, but can vary over distance and time, since formation of oxidants along the path of an air pocket is determined by the composition of the prior mixture and the meteorological conditions, which can also vary spatially and chronologically.	ILCD 2011 - based on Lotos-Euros model





Annex 1

METHODOLOGY

14	Water Consumption	The impact category on water scarcity is accounted for by measuring the amount of freshwater consumption from ground and surface water sources presently available in life-cycle inventory databases. With regard to SPM global approach we do not take into account the assessment at regional or local level. However in case of specific project, using methodologies that include water stress (e.g. Aware) can be considered.	Inventory
15	Renewable, Biomass	Solvay analyzes energy consumption by its origin or primary source. All energy sources are accounted for to be able to identify the cost of the externality. Primary energy sources are divided into renewable and non-renewable resources. For determining the energy content of resources, the method considers the fundamental material input and the net calorific.	Inventory
16	Renewable, Solar, Water, Wind		Inventory
17	Coal Energy		Inventory
18	Crude Oil Energy		Inventory
19	Natural Gas Energy		Inventory
20	Nuclear Energy [Uranium]		Inventory
21	Primary Forest Energy		Inventory





Annex 1

METHODOLOGY

1.2. EXAMPLE OF AN IMPACT ASSESSMENT TABLE

Impact Category	Element	per kg of product	Unit	External costs (in €/kg)
IPCC GWP100a - 2013	IPCC GWP100a - 2013	1.3535692	kg CO2 eq	0.135357
Trapped Biogenic CO2	Computation	0	kg CO2 eq	0
Human Toxicity, Cancer	USEtox2	0.000000739415	DALY	0.051759
Human Toxicity, non Cancer	USEtox2	0.000001399925	DALY	0.097995
Respiratory Inorganics	UNEP recommendation methodology	0.000001677015	DALY	0.117391
Freshwater Ecotoxicity	USEtox2	64.573609	CTUe	0.003158
Mineral Resource Depletion	CML 2022 (ultimate reserve)	0.000002954993	kg Sb eq	0.000005
Land Use Occupation	Land Use	0.053900155	m2a	0.011858
Terrestrial Acidification	CML IA baseline	0.0066189059	kg SO2 eq	0.035742
Freshwater Eutrophication	Eutrend / ILCD 2011	0.00028164648	kg P eq	0.000524
Marine Eutrophication	Eutrend / ILCD 2011	0.0013646383	kg N eq	0.006073
Ozone Depletion	ODP Steady State	0.00000020521	kg CFC-11 eq	0.000015
Photochemical Ozone Formation	Lotos-Euros model	0.0056062091	kg NMVOC eq	0.011773
Water Consumption	Inventory	0.019303969	m3	0.019304
Renewable, Biomass	Inventory	0.37083804	MJ	0.001113
Renewable, Solar, Water, Wind	Inventory	0.37892107	MJ	0
Coal Energy	Inventory	5.7424041	MJ	0.02297
Crude Oil Energy	Inventory	35.914542	MJ	0.646462
Natural Gas Energy	Inventory	11.037956	MJ	0.088304
Nuclear Energy [Uranium]	Inventory	1.0013342	MJ	0.00015
Primary Forest Energy	Inventory	0.0007133867	MJ	0.000039





Annex 1

METHODOLOGY

1.3. SHADOW COST VALUATION IN SELECTED IMPACT CRITERIA

The Natural Capital Protocol highlights the potential to use monetary valuation of environmental impacts when a company already uses an LCA-based approach to evaluate the environmental impacts of its products or processes. SPM being a key decision-making tool, it is most important that the monetization factors are as robust as possible. Therefore, the method for the determination of the factors recommended fulfil the following requirements:

- Present up-to-date factors: SPM (and the factors used in it) being set up in 2012 so 10 years old, it was time to provide updated factors.
- Be as consistent as possible with regard to the type of costs: because of the high uncertainty of monetization factors, it is important to have as consistent a method as possible.
- Be consistent with the previous set of monetization factors. If no major update

of the state-of-the-art in monetization is available, or if the uncertainties of new methodologies are too high, it might be recommended to maintain existing SPM factors.

- Have a global or at least European scope
- Be scientifically robust
- Provide a clear and complete documentation: being able to follow the rationale for defining the costs is important to determine its reliability.
- Cover a great share of the indicators of SPM: due to the advanced character of the SPM tool and its specific set of environmental indicators, there is no “off-the-shelf” method which can provide the corresponding monetization factors one to one to the environmental factors.

Impact Category	How is the shadow cost defined?	Shadow cost
Water	<p>In the case of SPM, the assessment is made on the level of water consumed, without any reference to a location. However, it is still important to reflect the issue of water stress in the assessment. The high range of the values reflect the high uncertainty in the assessment of scarcity today and in future. Currently, no clear consensus exists on the definition of water scarcity, while different methods converge on using a fraction of water footprint analysis to define the impact. We therefore base the impact category for water scarcity on high-quality freshwater consumption from ground and surface water sources presently available in the LCI databases.</p> <p>Water treated in desalination plants can be seen as the maximum price for freshwater. The current value used in SPM is of 1 € / m³, based on the future price of water from desalination plants. Value of 0.15€/m³, which is about 6 times lower, is based on a review of average prices to mitigate water stress. When applying the world average water stress index of the AWARE-WULCA methodology, a price of 3 €/m³ is reached. Given the uncertainties and local circumstances, we concluded to maintain the shadow cost of (high quality ground and surface) freshwater at 1 EUR/m³.</p>	1 EUR/m ³





Annex 1

METHODOLOGY

Impact Category	How is the shadow cost defined?	Shadow cost
Land use	<p>In SPM, the land use is referring to the occupation of 1 average m² during one year. No differentiation is made regarding to the type of land. In order to define the potential externalities caused by land use one needs to understand and value ecosystem services that are limited by land use. Ecosystem services contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. The approach of valuating ecosystem services has been retained for this indicator, as it reflects the current development around better accounting for the services provided by "nature" and is the same approach as the previous SPM monetization. This field is in development, and therefore the values are subject to future updates, but the theory of internalising the various services provided by different biomes allows to better reflect on the interactions between human activities and Nature. In SPM, this approach was selected, based on the factors developed in Costanza (1997). (Groot, 2012) provides an update of these factors, which is used here. To reflect the activities of Solvay and the main source of raw materials, it is suggested to focus on the four terrestrial biomes (Tropical forest, temperate forest, woodlands and grasslands). The average value of the ecosystem services for these biomes is calculated and converted in €/m² (1.37 \$/€10) to obtain the value of 0.22 €/m². Costanza et al. (1997) estimated the (then) current economic value of 17 ecosystem services on a global scale. Current valuations are mostly based on this 'ecosystem services approach'.</p> <p>The ILCD Handbook (2002) recommends using the Potentially Disappeared Fraction of species (PDF) concept as an indicator for calculating the damage caused to the natural environment.</p> <p>For valuing land use, Kuik et al. (2007) developed an approach which allowed a 0.47 EUR per (PDF/m²/y) price tag on externalities derived from land use. However, this approach does not reflect specific local conditions and is highly-sensitive to population density, area size and the amount of change inherent to the calculation.</p> <p>After examining several other calculation methods, TNO came to the following conclusions regarding the different approaches to account for the externality costs of land use:</p> <ul style="list-style-type: none"> • Agricultural land prices reflect many socioeconomic developments. • The shadow cost based on ecosystem services used in CML is higher than the market price of land. <p>Damage estimates using Potentially Disappeared Fraction (PDF) result in an even higher shadow cost. The scale of this shadow cost is partly explained by sensitivity to factors such as population density, area size and the amount of change.</p> <p>Based on other considerations including crop differentiation potential, the experts recommended using the shadow cost for land use impact category in CML 2000, which is somewhat limited in gauging ecosystem services, but transparent in its calculation method, which is an important factor for auditing the methodology.</p>	0,22 EUR/m ² a





Progress beyond

Annex 1

METHODOLOGY

<p>CO2</p>	<p>Solvay followed a scientific logic to define a reasonable long-term estimation. This figure went through sensitivity analysis before being deployed. Such a measurement can drive the development of new products which can contribute to reducing CO2 emissions. Overall, while the carbon price is shown to increase in future, the exact amount and the range remains very uncertain.</p> <p>The price calculations for carbon based on IPCC targets have been made for a 2°C pathway. With regard to the IPCC recommendations of a 1.5°C target, there are not yet reliable numbers for carbon pricing. However, carbon prices to achieve this objective are likely to be a lot higher than for the 2°C target. The IPCC special report mentions a factor of 3 to 4. The International Energy Agency (IEA) develops in its World Energy Outlook (IEA 2017) a "Sustainable Development Scenario", which sets a pathway to achieve key energy-related components of the United Nations Sustainable Development Agenda, including urgent action to tackle climate change (SDG 13), in line with the Paris Agreement. In the Sustainable Development Scenario, the use of carbon pricing instruments becomes much more widespread, especially within the advanced economies (IEA 2017). As a consequence, the price for CO2 is higher as with the other policy scenarios. For 2025, the price of carbon would be 63\$, in 2040 140\$, which corresponds to 125 Euro.</p> <p>We decided to take 100 EUR per ton of CO2 equivalent as the shadow cost in our calculations also consistent with the cost of the Carbon Capture Storage.</p>	<p>100 EUR/ metric ton of CO2</p>
------------	---	---



Annex 2

Q&A

JOURNEY

Why did Solvay develop a proprietary tool to manage its portfolio in a more sustainable way?

The CEO and top management of Solvay wanted to understand how sustainability trends impact the profit and loss account of the company. The question was raised by Christian Jourquin, CEO of Solvay in 2006 and the SPM tool was launched in 2008 to become a strategic management tool in 2015. At the time when Solvay started developing the SPM tool, there were no ready-made sustainable portfolio assessment methodologies available which combined scientific robustness with the specifics of the corporate financial decision-making processes. CEO Ilham Kadri pushes it further together with the innovation as the sustainability is not negotiable to ensure the future growth of the company. SPM embeds sustainability into all decision-making processes and trigger the portfolio shift towards opportunities that grow sustainable solutions to deliver on the Group business ambition.

METHODOLOGY

Is the environmental manufacturing footprint more acceptable when the product value is high?

SPM works with acceptable environmental footprints to make the methodology viable in present-day context. The 'Solutions' category of products, however, will not tolerate Operations Vulnerability below median risk and Market Alignment below Neutral. Solvay's strategy moves in the direction of favoring Solutions over Potentials and Transitions PACs, or those with Challenges.





Annex 2

Q&A

Why not doing a full LCA analysis (cradle to cradle) on Product Application Contribution (PAC) ?

For the SPM tool to be robust enough for decision-making on strategic and operational levels, we drew on scientific knowledge as much as possible, especially on Life-Cycle Assessment (LCA). With such a goal in mind, we needed to ensure a good balance between the reliability and time-efficiency of the analysis.

On the vertical axis (Operations Vulnerability) of the SPM Heat Map, a cradle-to-gate scope of the value chain is covered, because this is where we have control over raw materials and production processes. On this axis a quantitative LCA based calculation resulting in a ecoprofile is carried out.

However, on the horizontal Market Alignment axis, a full cradle-to-cradle LCA would:

- Be excessively time-consuming as detailed information on application and end-use phases is often not available
- Not cover important elements such as healthcare
- Be less focused on elements that are material for Solvay e.g. toxicity and ecotoxicity

In addition the time needed to complete such cradle-to-cradle LCA will come out of the timeframe of business decision-making process and therefore become not relevant anymore.

Such decisions cannot be put on hold for several months for a full LCA to be carried out. This challenge prompted us to use an LCA-minded approach to assess relevant sustainability trends from a consumer and market perspective on the horizontal axis.

DECISION-MAKING

Why is Solvay not conducting a comprehensive, quantitative and monetized Life-Cycle Assessment of products from cradle-to-cradle?

Full-scale, cradle-to-cradle Life-Cycle Assessment (LCA) is a thorough, yet time-consuming scientific examination of a product in its different applications along the value chain. Therefore we limit the assessment to the manufacturing phase cradle-to-gate. It helps to confirm and ascertain the environmental benefits of a single product compared to competing products in the market. These benefits could come from better technical performance, lower energy consumption or lower pollutant emissions during the use phase.

The SPM tool relies on qualitative thinking in the Market Alignment phase to complete the LCA-snapshot and make sure that other material topics (e.g. healthy living) are addressed in the analysis, which LCA does not cover.





Annex 2

Q&A

Why is the Market Alignment analysis not quantified and monetized?

Monetizing market signals and impacts without reliable scientific data gives significant uncertainty about the reliability of the calculations. Basing long-term strategy on such numbers would be even more difficult and risks getting stuck in discussions on the validity of the analysis. Also, the monetization of the entire value chain on a long-term horizon would be very time-consuming, Solvay opted for a qualitative analysis of market signals. This analysis is robust, rigorous and auditable.

On the horizontal Market Alignment axis, a full cradle-to-grave LCA would:

- Be excessively time-consuming as detailed information on application and end-use phases is often not available
- Not cover important elements such as healthcare
- Be less focused on elements that are material for Solvay e.g. toxicity and ecotoxicity

In addition the time needed to complete such cradle-to-grave LCA will come out of the timeframe of business decision-making process and therefore become not relevant anymore.

Such decisions cannot be put on hold for several months for a full LCA to be carried out. This challenge prompted us to use an LCA-minded approach to assess relevant sustainability trends from a consumer and market perspective on the horizontal axis.

Are authoritative sources changing at the same pace as the revision of tool, or are there compromises to be made on that front?

Solvay is continuously scanning authoritative sources, particularly during the annual reviews of the SPM snapshots. If strong signals are received on a changing trend which would significantly affect the validity of the tool, a review process cycle is activated to update the tool, which also implies changing all snapshots. However, the sustainability megatrends we have taken into consideration have not changed so far and we do not expect them to change significantly before 2020. Signals on volatility in e.g. commodity prices, legislative behavior etc. are continuously collected and funneled into the Market Alignment analysis.





Annex 2

Q&A

How does SPM contribute to the UN Sustainable Development Goals (SDGs) mapping and integration in our non financial targets?

The chemical industry manufactures intermediate products used in a wide variety of applications around the world. In essence, it is the industry of industries. As such, the chemical industry is at the heart of whether global sustainable development challenges are impacted negatively or positively. These global issues are well known and captured in the UN Sustainable Development Goals (SDGs) launched in 2015, and can be summed up as:

- Climate Change
- Increasing global population
- Scarcity of raw materials
- Scarcity of water
- Geopolitical environment changes
- Human development gaps
- Biodiversity stress

SPM contributes particularly to the following SDGs:

2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. Ensure healthy lives and promote well-being for all at all ages
6. Ensure availability and sustainable management of water and sanitation
9. Ensure access to affordable, reliable, sustainable and modern energy for all
11. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
12. Ensure sustainable consumption and production patterns
13. Take urgent action to combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss.





Annex 2

Q&A

For Solvay, as a leading and responsible chemical company, we need to understand the business meaning and impact of sustainability trends underlying such global issues. In the long-term, these trends are key elements of risk mapping and the drivers of business growth.

The Solvay Group is continuously analyzing stakeholder expectations related to these global issues. We are building our sustainability strategy and toolbox, the Solvay Way, around these expectations. In general, we see the following:

- Customers increasingly ask for products and services with sustainability benefits, which can decrease their impact on the Planet and on other citizens.
- Institutional investors, hedge funds and responsible, Environmental-Social-Governance (ESG)-minded investors¹⁰ are increasingly considering and requiring proof of the link between addressing sustainability challenges and business performance, especially in relation to climate change.
- Corporate responsibility for and management of sustainability are moving beyond companies' own operations and into the entire value chain.
- Legal instruments targeting corporate sustainability are on the increase. Transparency requirements are present in countries on all continents and are especially on the rise in Europe.
- Circular economy business models and moving towards cradle-to-cradle thinking and reducing waste is gaining ground in all sectors (governments, civil society and corporate).
- Corporate improvement goals related to sustainability are becoming factors of market competitiveness, as more and more companies are using them.
- NGOs, rating agencies, governments are scrutinizing companies on their commitments and performance.





Annex 3

GLOSSARY

BU: Business Unit.

CORPORATE SOCIAL RESPONSIBILITY (CSR): CSR is defined in the European Commission's Communication on CSR (A Renewed EU Strategy 2011-14 for Corporate Social Responsibility, October 25, 2011) as: "The responsibility of enterprises for their impacts on society... [which involves] having a process in place to integrate social, environmental, ethical, human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders, with the aim of:

- Maximizing the creation of shared value for their owners/shareholders and for their other stakeholders and society at large
- Identifying, preventing and mitigating their possible adverse impacts."¹¹

CRADLE-TO-GATE ASSESSMENT/LIFECYCLE ASSESSMENT: The assessment of a partial product lifecycle, starting from extraction/ harvesting of raw materials (cradle) and ending at the factory gate (before transport to the consumer).

CRADLE-TO-GRAVE ASSESSMENT/LIFECYCLE ASSESSMENT: The assessment of a full product lifecycle, starting from extraction/harvesting of raw materials (cradle) to the use phase and end-of-life (grave).

CRADLE-TO-CRADLE ASSESSMENT/LIFECYCLE ASSESSMENT: Same as cradle-to-grave assessment but used when the product is recycled at the end of life.

ECOLOGICAL FOOTPRINT: An ecological footprint is the measure of human demand/load on the Earth's ecosystems and natural resources.

ECOPROFILE: A 'cradle-to-gate' study for a product, taking into account materials and energy inputs and outputs in the form of emissions to land, air and water and energy consumption.

EXTERNAL COSTS: Theoretical valorization of the 'environmental' costs for 1 kg of a product. This valorization is based on the ecoprofile (impacts by kg of the product) and the shadow costs (value by impact).

GBU: Global Business Unit, there are 15 GBUs in Solvay, each comprising several Business Units (BUs).

GREENHOUSE GAS: A gas that contributes to the natural greenhouse effect. The Kyoto Protocol covers a basket of six greenhouse gases (GHGs) produced by human activities: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Annex I Parties' emissions of these gases taken together are to be measured in terms of carbon dioxide equivalents on the basis of the gases' global warming potential. An important

natural GHG that is not covered by the protocol is water vapor. Source: European Commission. Climate change: Glossary of common terms and acronyms. http://glossary.eea.europa.eu/EEAGlossary/G/greenhouse_gas

IDEATION PHASE (IN R&I): A phase of product research comprising 1) Screening (brainstorming), 2) Product incubation (with market research and SWOT analysis), 3) Preparation kick-off through which the new product enters into the feasibility and production.

KYOTO AGREEMENT SCOPE 1: Scope 1 emissions: Direct emissions from GHG sources owned or controlled by the reporting organization. From the Carbon Disclosure Project Supply Chain Report 2010 - CDP.

KYOTO AGREEMENT SCOPE 2: Scope 2 emissions: Emissions that do not physically occur from within the organization's reporting boundary and are therefore 'indirect' emissions. Scope 2 emissions are caused by the organization's consumption of electricity, heat, cooling or steam brought into its reporting boundary. This category is often called 'purchased electricity' because it represents the most common source of Scope 2 emissions. From the Carbon Disclosure Project Supply Chain Report 2010 - CDP.



¹¹ A Renewed EU Strategy 2011-14 for Corporate Social Responsibility, p.6 (http://ec.europa.eu/enterprise/policies/sustainable-business/corporate-social-responsibility/index_en.htm).



Annex 3

GLOSSARY

KYOTO AGREEMENT SCOPE 3: Scope 3 emissions: An organization's indirect emissions other than those covered in Scope 2. They are from sources that are not owned or controlled by an organization, but which occur as a result of its activities. From the Carbon Disclosure Project Supply Chain Report 2010 - CDP.

MID-POINT: The direct measure of an externality expressed with an indicator, as opposed to the damage caused by an externality, which is called an end-point.

OPERATIONS: All the production processes and related activities executed to manufacture a product. (In SPM, we define Operations as covering the cradle-to-gate phase).

OPERATIONS VULNERABILITY: All the production processes and related activities executed to manufacture a product. (In SPM, we define Operations as covering the cradle-to-gate phase).

PAC (PRODUCT APPLICATION COMBINATION): The combination of a product and one of its market applications as seen by the final consumer (e.g. Sodium Carbonate in double glazing). The PAC is the key element of the Market Alignment assessment.

PRODUCT: A product is in essence a product family (e.g. soda ash, Na_2CO_3). If different products have several production processes which can lead

to significant differences in environmental impacts or in energy consumption, several products will be registered and analyzed with the SPM tool, and named with the following formula 'product + production process'. E.g. ' Na_2CO_3 synthetic dense' and ' Na_2CO_3 natural Trona-process').

R&I: Research and innovation, both a Group- and business-level function.

RARE EARTHS: Rare earth elements are a series of chemical elements found in the Earth's crust that are vital to many modern technologies, including consumer electronics, computers and networks, communications, clean energy, advanced transportation, healthcare, environmental mitigation, national defense and more.

Because of their unique magnetic, luminescent and electrochemical properties, these elements help make many technologies perform with reduced weight, reduced emissions, and energy consumption, or give them greater efficiency, performance, miniaturization, speed, durability and thermal stability. <http://www.rareearthtechalliance.com/What-are-Rare-Earths>

SHADOW COSTS: The shadow costs are the conversion factor (in EUR per unit of impact) for monetizing the overall cost for the community of individual impacts on the surrounding ecosystems e.g. for ozone depletion in EUR/kg CFC11 equivalent.

SPM SNAPSHOT: As an assessment tool, SPM defines the practical risks and opportunities of the 'sustainable development' dimension of product and innovation portfolios, with an accurate profile of the portfolio at a particular point in time.

SUSTAINABILITY: Products and processes that meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

SUSTAINABILITY TRENDS/MEGATRENDS: Megatrends are long-term processes of transformation with a broad scope and a dramatic impact. They are considered to be powerful factors which shape future markets. There are three characteristics in which megatrends differ from other trends:

1. Time horizon: megatrends can be observed over decades. Quantitative, empirically unambiguous indicators are available for the present. They can be projected, with high probabilities, at least 15 years into the future.
2. Reach: megatrends impact comprehensively on all regions, and result in multidimensional transformations of all societal subsystems, whether in politics, society, or economy. Their precise features vary according to the region in question.
3. Intensity of impact: megatrends impact powerfully and extensively on all actors,



Annex 3

GLOSSARY

whether it is governments, individuals and their consumption patterns, or corporations and their strategies.”

(Source: “20 most important megatrends”, Zpunkt, 2007)

RESPONSIBLE EDITOR : BRUNO VAN PARYS

© Copyright notice: Pictures, graphisms, charts,,diagrams, texts reproduced in the SPM Reference Guide are the exclusive property of Solvay Group and are protected under national and international laws. Their unauthorised use or reproduction, in part or totally, is prohibited.

