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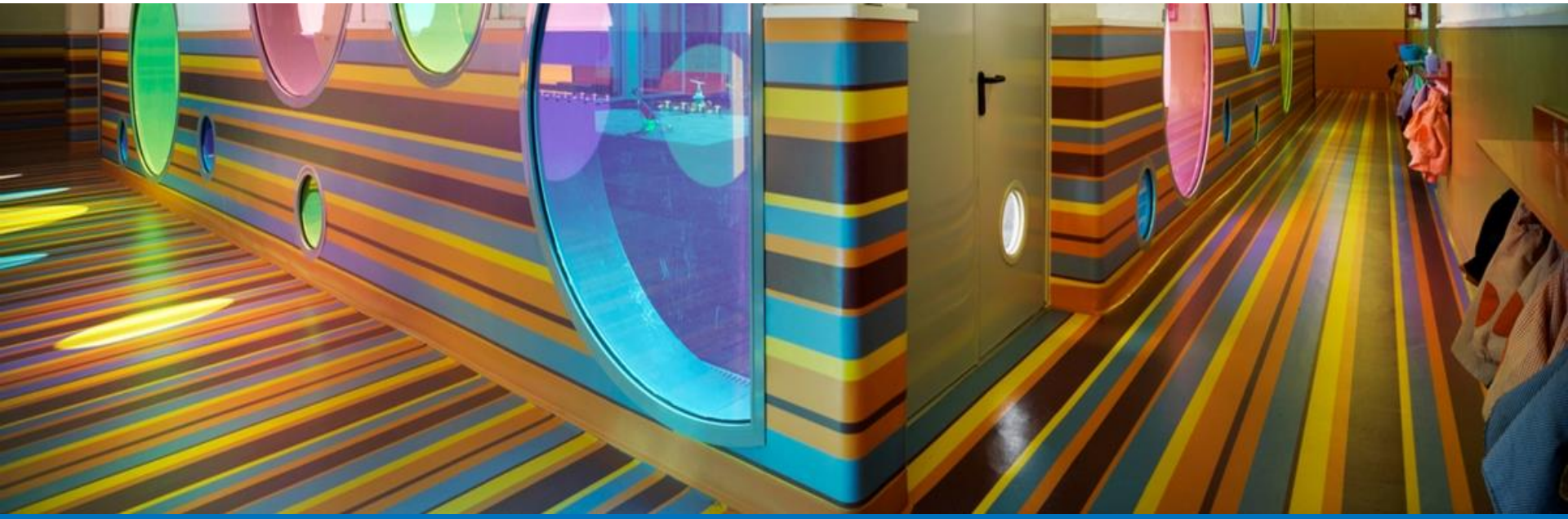


Additive Sustainability Footprint – A S F

Presentation from The Natural Step
EPPA Expert Meeting, Milan, June 29, 2017

Richard Blume TNS

The Natural Step

What is ASF?

The Additive Sustainability Footprint methodology is a voluntary, European-wide approach to assess and promote the sustainable use of PVC additives in different product applications.

It was initiated by the **VinylPlus Additive Task Force** (Challenge 3) using scientific input (such as REACh, LCA, etc.) and the sustainability principles developed by TNS (The Natural Step).

ASF builds on existing standards

ASF builds on available life cycle information and informed analysis by industry experts to provide a qualitative screening assessment of the relative performance of additives in relation to a science-based definition of sustainability (both social and ecological).

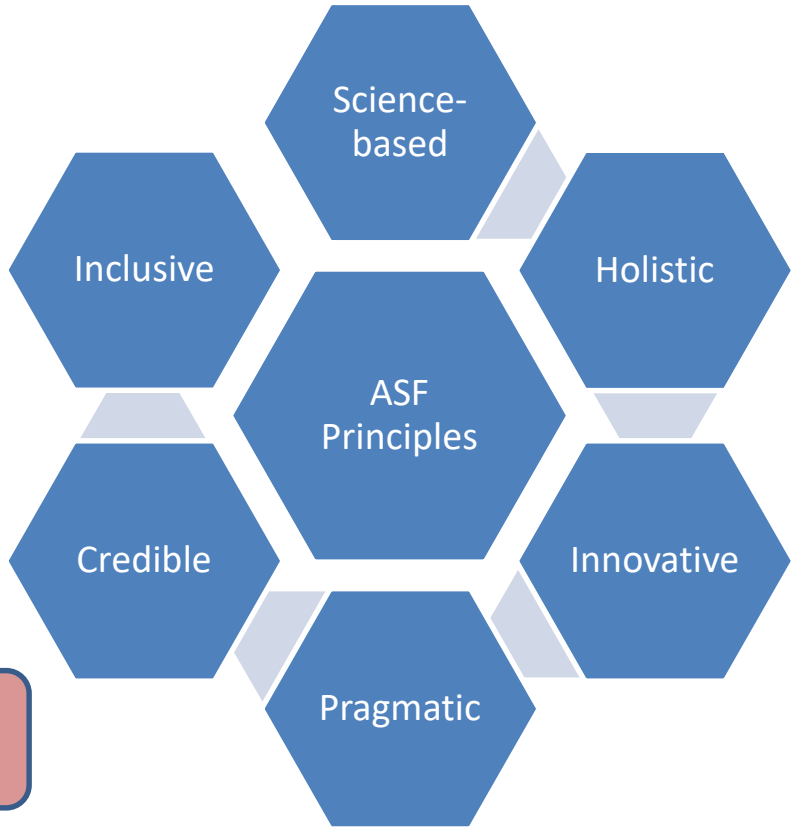
The methodology is compatible with schemes such as Environmental Product Declarations (EPD) and Product Environmental Footprint (PEF), but takes a wider perspective giving a clear picture of where to aim and what to do to improve additive sustainability performance.

Guiding principles

Use robust sustainability critiera

Consult and egage stakeholders to get it right

Take full life cycle & product applications into account



Follow a transparent and trust-worthy process

Guide improvement over time

Build on existing schemes and available data e.g. EPD / PEF

Who's involved?

WORKING GROUP

PARTNERS

EXPERTS
AND OTHER STAKEHOLDERS

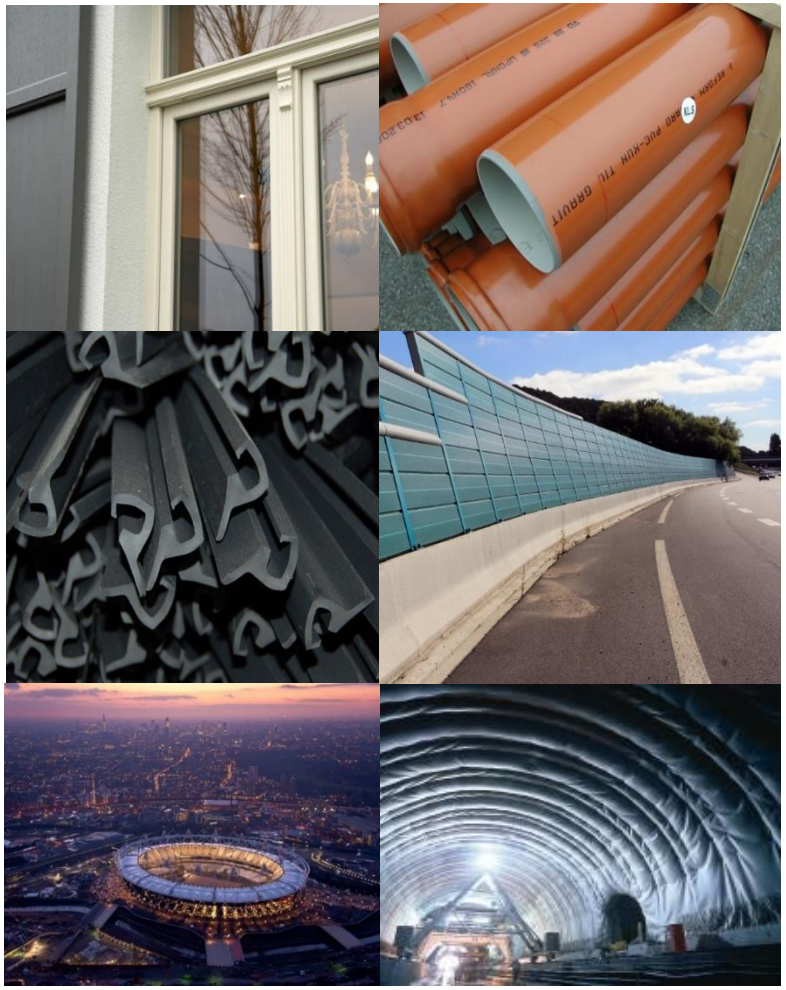
Key points about ASF

- Based on a set of science-based sustainabilty principles (social + environmental)
- Qualitative, strategic screening of the entire additive system from raw material sourcing, application and end of life considerations.
- Guided self-assessment based on best available information within an industry expert group.
- External guidance, input from The Natural Step – ASF is a customization of TNS's sustainability life cycle assessment (SLCA).
- Draws on LCA data where available – a complement to EPD / PEF but not a substitute for quantifiable product claims.
- Multiple uses and benefits supporting innovation toward sustainable use of additives.

Background on the rationale

Additives matter!

- Up to 200 different additives are used to convert PVC into various applications (can account for up to 50% of the mass of a finished PVC product).
- Different additives - fillers, pigments, impact modifiers, plasticizers - serve a range of functions and performance benefits for PVC to be used in for thousands of applications right across society.
- There are different sustainability issues for different additives and the sustainability performance and potential of finished products are heavily influenced by the additives they contain.



WHY ASF?

- ✓Live up to stakeholder expectations and VinylPlus sustainability commitments
- ✓Build knowledge and greater understanding of additive sustainability performance
- ✓Innovate for sustainability through proactive development of more sustainable additive systems
- ✓Create trust in industry with a credible and transparent additive assessment methodology

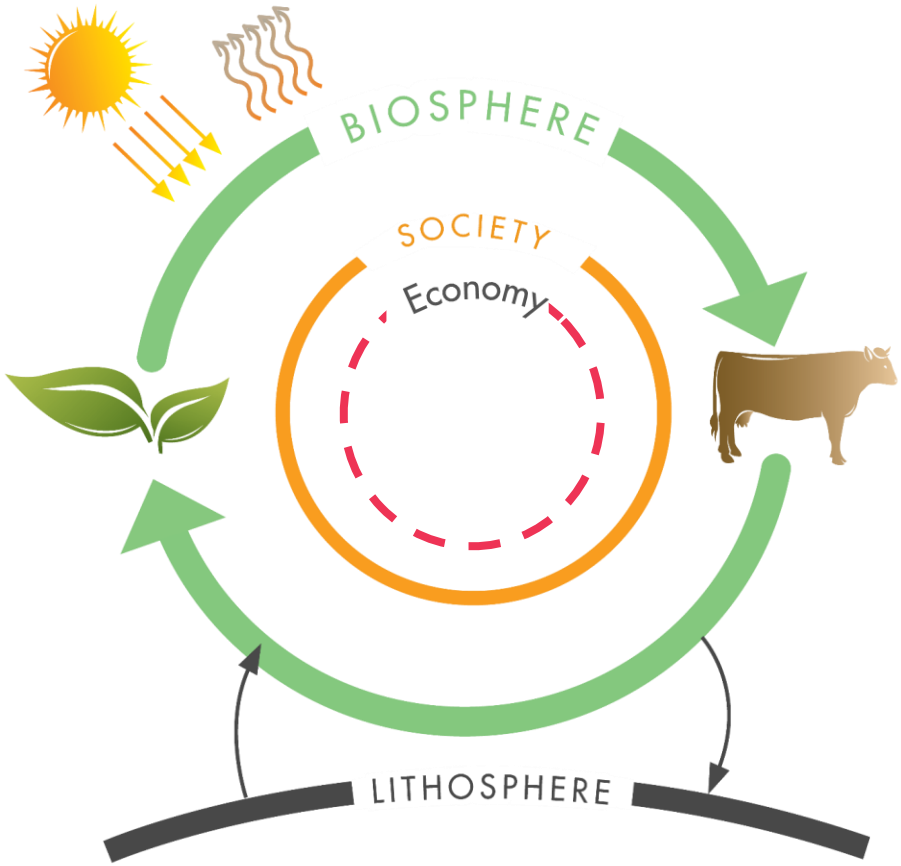
WHAT BENEFITS DO WE EXPECT?

Different stakeholders can relate to and benefit from the ASF:

- Additive producers gain insight to guide sustainable innovation of additive systems
- PVC converters gain insight into additive / supply chain sustainability, which can guide the specification of additives that can make formulations and products more sustainable and help when communicating with customers.
- Industry bodies benefit from a common approach and a frame for explaining complex sustainability considerations
- NGO's & societal stakeholders can trust industry's commitment to sustainability with a transparent, yet detailed approach
- Market acceptance for superior PVC products can be improved since ASF helps to meet VinylPlus product label criteria.
- General: ASF can provide practical guidance on sustainable material management within the circular economy.

A SUSTAINABLE SYSTEM

The Natural Step

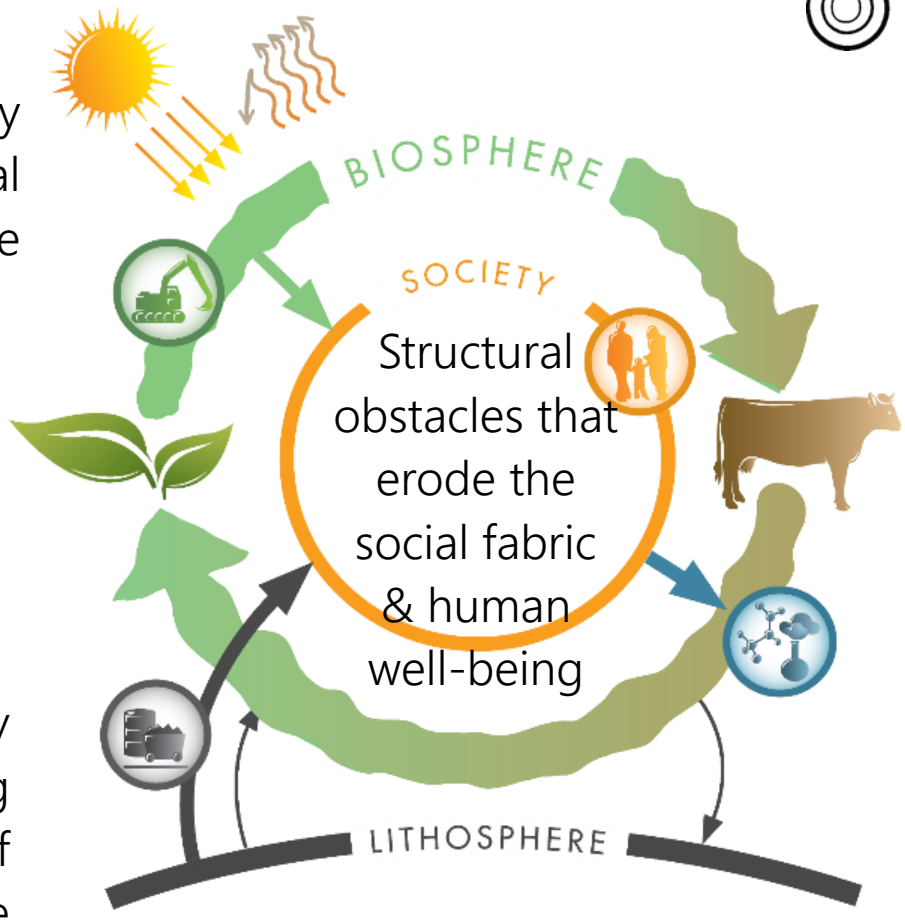


TNS Framework and system conditions
(Framework for strategic sustainable development)

SYSTEM ERRORS TO ADDRESS

The Natural Step

Systematically increasing physical degradation of nature



Systematically increasing concentrations of substances from the earth's crust

Systematically increasing concentrations of substances produced by society

In a sustainable society…

… nature is not subject to systematically increasing concentrations of substances from the Earth's crust, e.g. heavy metals and fossil fuels.

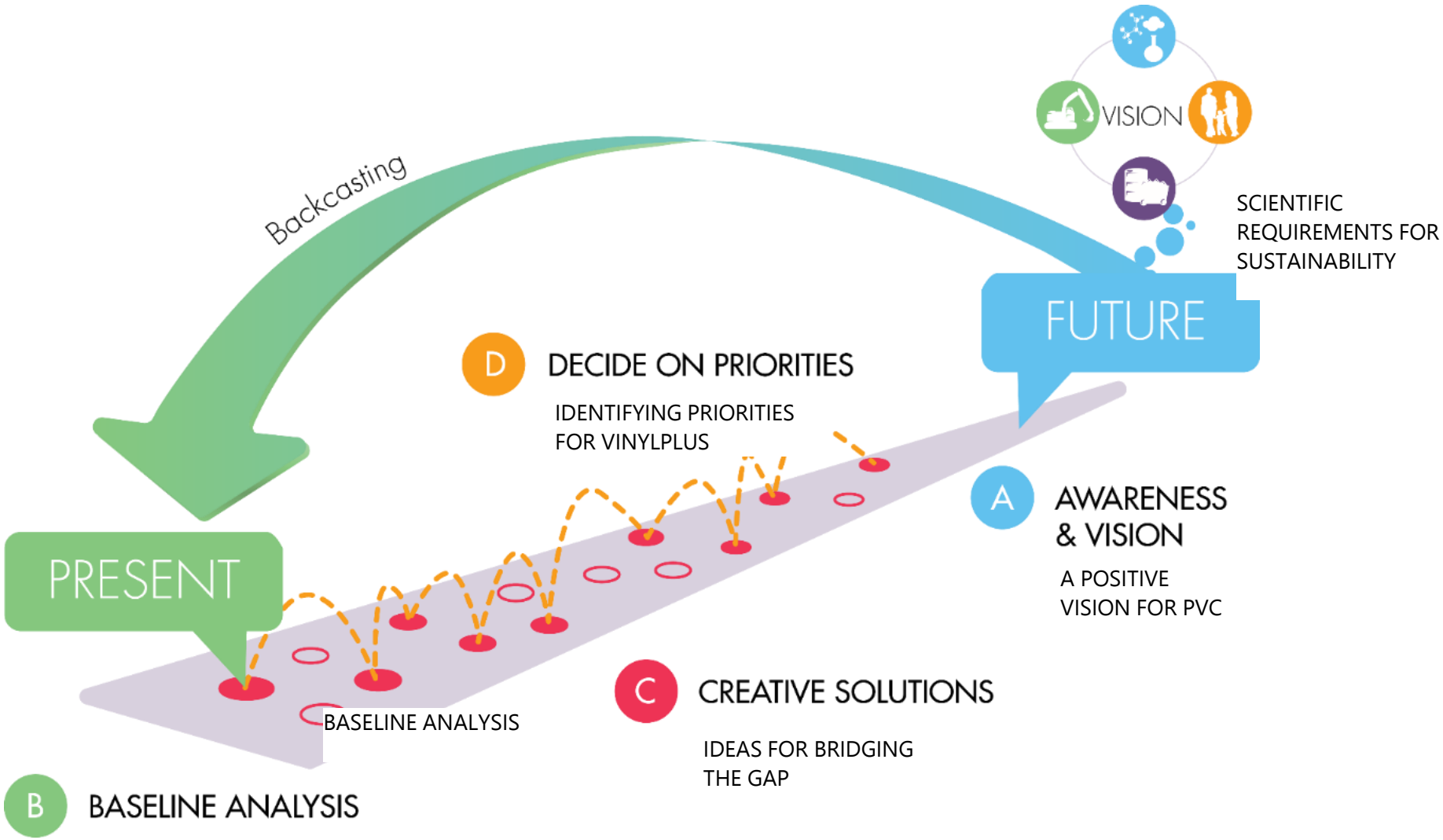
… nature is not subject to systematically increasing concentrations of substances, produced by society, e.g. nitrates and dioxins.

… nature is not subject to systematically increasing degradation by physical means, e.g. overfishing and destroying habitat.

… people are not subject to structural obstacles to health, influence, competence, impartiality and meaning-making.

*The Natural Step "system conditions for a sustainable society" are a set of peer-reviewed sustainability principles that are part of the Framework for Strategic Sustainable Development – see Broman, G.I. and Robèrt, K.H., 2017. A framework for strategic sustainable development. Journal of Cleaner Production, 140, pp.17-31.

FUTURE-PROOFING THE INDUSTRY



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Sustainable use of additives? THE VISION

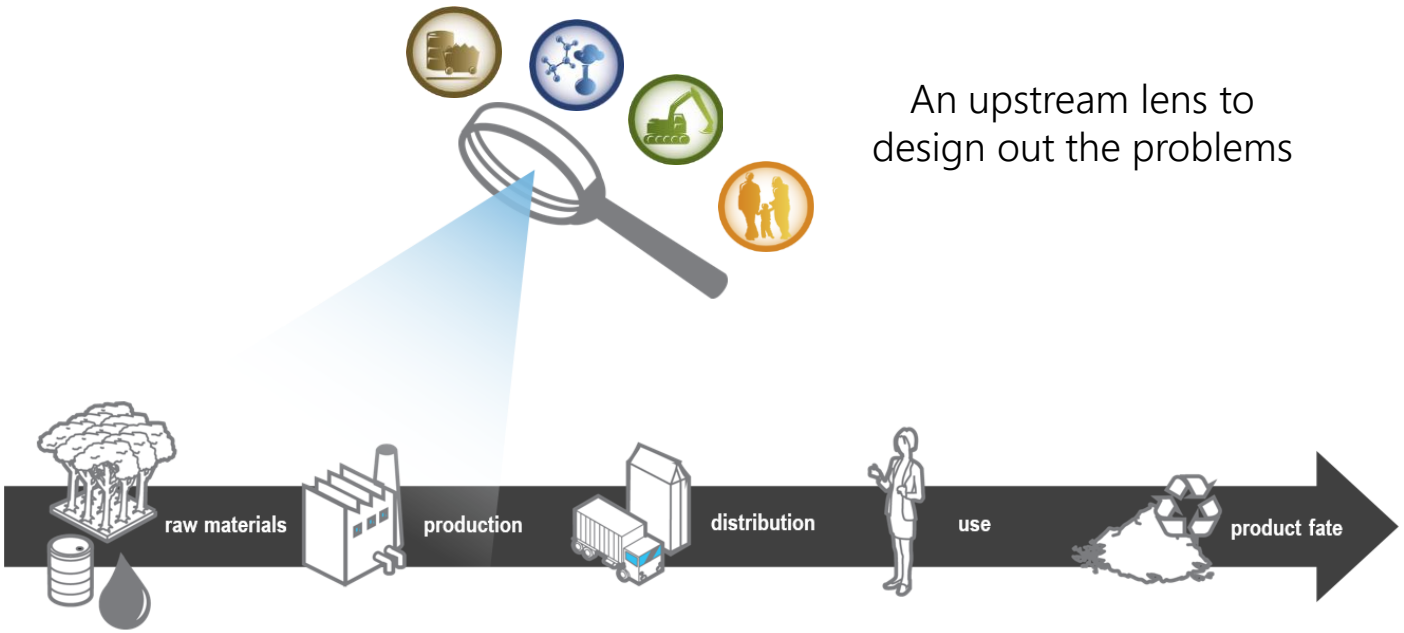
- Additives are sustainably produced using materials that are responsibly sourced.
- Additives support the sustainable management of PVC products (e.g. safe and recyclable).
- The functional benefits of additives enable PVC products to support sustainable development (e.g. meeting the UN Sustainable Goals)

Additives relevance to the 4 System conditions

System Conditions for a sustainable society	Related topics	Success criteria for the sustainable use of additives
 1. Substances from the Earth's crust must not systematically increase in concentration in nature.	• Metals & minerals • Energy • Renewable / recycled materials	• Scarce metals, minerals and fossil carbon must not be released to nature at a rate that exceeds the rate of re-assimilation. This implies the phase-out, or the recapture in controlled loops, of scarce mined materials. • The energy sources must be renewable. • The sources of raw materials must be renewable, or the resources must be fully recycled.
 2. Substances produced by society must not systematically increase in concentration in nature	• Circular flows (bio-degradability / technical loops) • Efficient production • Benign emissions	• Raw materials used for production of additive components must be degradable unless managed in controlled-loop systems or incorporated into articles which can be recycled. • Additive components that are able to migrate must be degradable unless managed in controlled-loop systems. • Across product life cycles, emissions or discharges resulting from the production/use of additive systems must be kept to a minimum as a resource conservation measure but, where unavoidable, should only comprise degradable substances. • Controlled-loop systems and recycling processes must themselves avoid pollution and must also be optimized to retain the highest resource potential.
 3. Nature must not be systematically degraded by physical means.	• Water use • Resource use • Land use • Ecosystem disturbance	• Sourcing of raw materials used for production of additives must come from well-managed ecosystems.


4. People must not be subject to structural obstacles to health, influence, competence, impartiality and meaning.
	• Health & safety
	• Basic rights
	• Skills and knowledge
	• Equity (resource efficiency / depletion)
	• Well-being / meaning
		• The additives enable reliable technical performance to deliver functionality that helps to support diverse human needs.
		• PVC products including their additives must not lead to negative impacts on the wellbeing of humans or the environment.
		• The additives must not restrict the capacity for efficient management of resources through mechanical & feedstock recycling either by:
		  ○ reduction in the quality and quantity of the recyclate
		  ○ preventing the mixing of PVC from multiple end-of-life and post-industrial products in recycling streams (compatibility)

Additive sustainabiltiy footprint = assess current performance and progress across the value chain



Asking smart questions for each life cycle stage and sustainability principle

	RAW MATERIALS	ADDITIVE PRODUCTION	PACKAGING & DISTRIBUTION	PVC COMPOUNDING / CONVERTING	PRODUCT USE	PRODUCT FATE
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?
	?	?	?	?	?	?

System conditions across life cycle

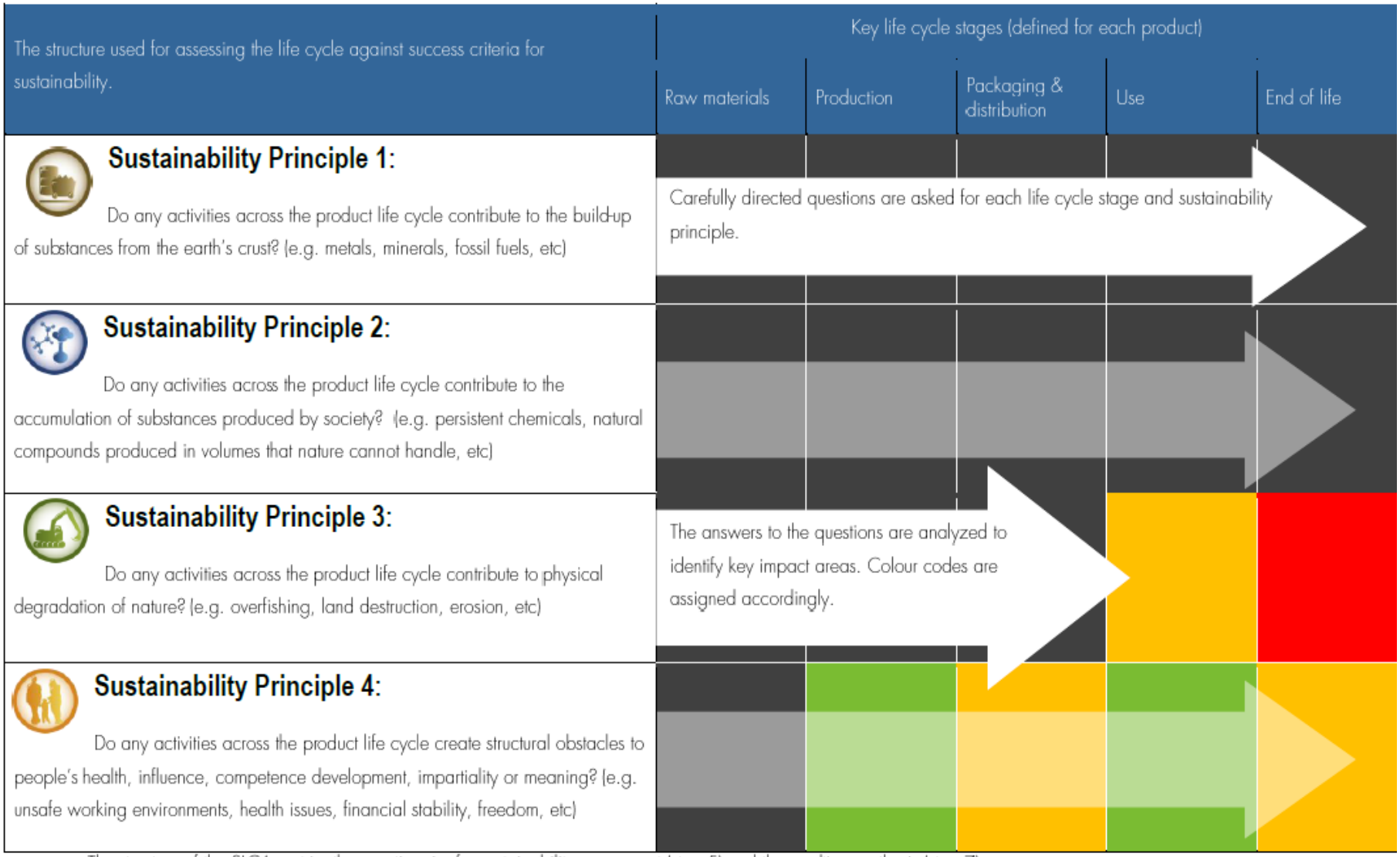


Table 1. The structure of the SLCA matrix, the questionaire for sustainability assessment (step 5) and the resulting synthesis (step 7)

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Baseline

Today's situation

SLCA provides a gap analysis of current performance and progress to align the value chain with science-based sustainability principles

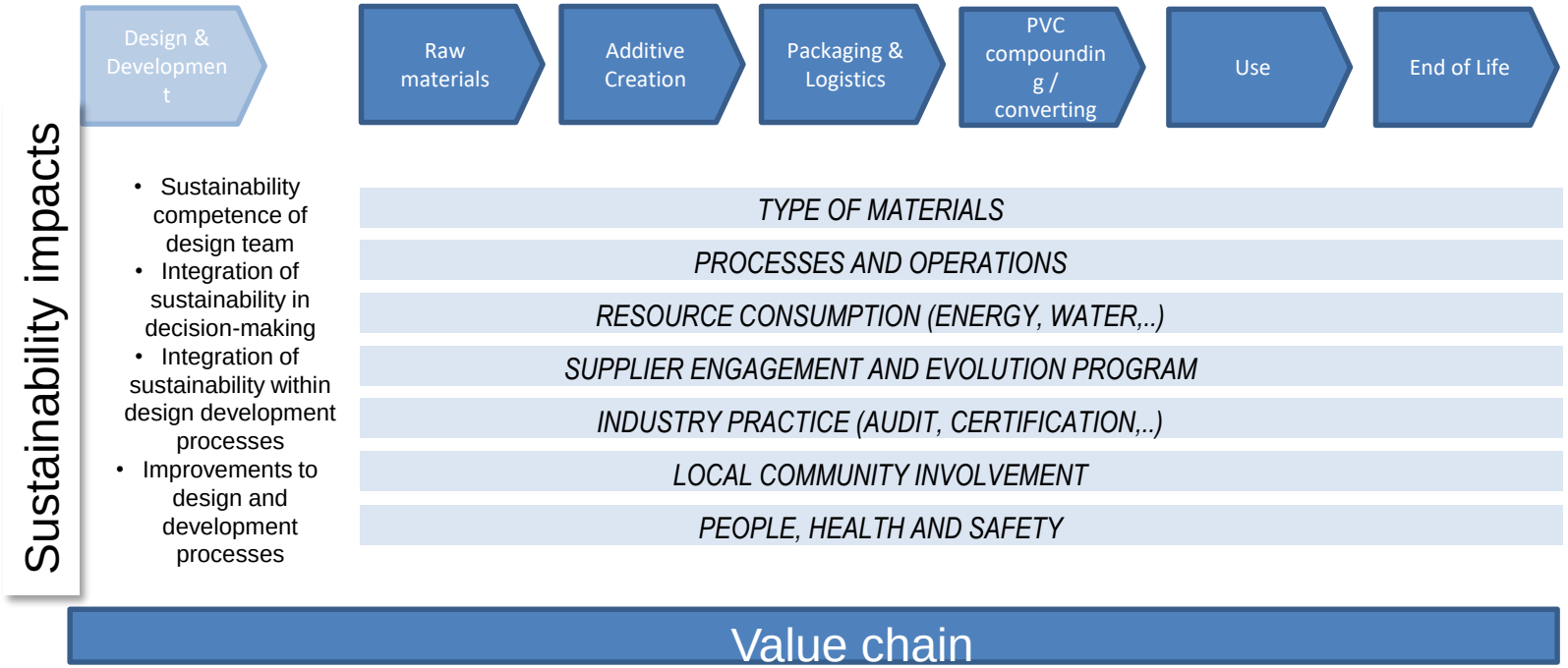
Vision

The goal

	RAW MATERIALS	PRODUCTION	PACKAGING & DISTRIBUTION	PRODUCT USE	END-OF-LFE
SP1: Materials from the earth's crust					
SP2: Problematic man-made substances					
SP3: Degradation of nature					
SP4: Meeting people's needs					

Sustainability Life Cycle Assessment (SLCA) is a strategic approach to assessing the life cycle of product systems using science-based sustainability principles

Sustainability Life Cycle Assessment



ASF - PROCESS STEPS

Step 1: Defining the purpose of the study and assessment scope
Step 2: Defining a Sustainable Product-Service System
Step 3. Setting the system boundaries
Step 4. Conduct an inventory analysis of the system
Step 5: Perform a sustainability assessment
Step 6. Analyze and synthesize the results

Step 7. Vision refinement & Idea generation for future improvements
Step 8. Prioritisation actions to create a more sustainable additive system
Step 9. The innovation action roadmap
Step 10. Measure and progress report

System conditions over Live cycle

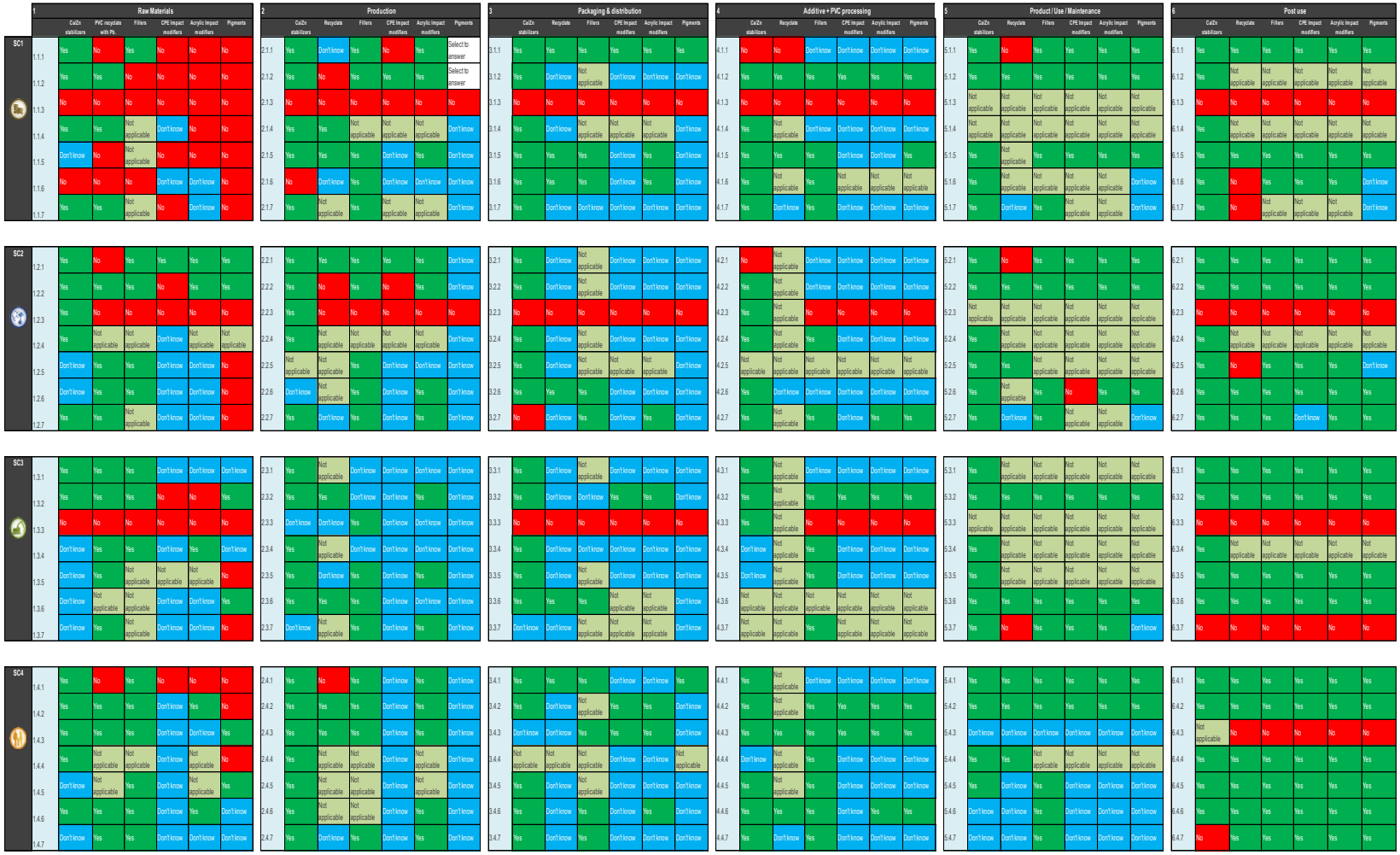
Q #	1. Raw material sourcing for additives	2. Additive Creation / Synthesis	3. Additive packaging and logistics	4. PVC compounding / processing	5. PVC product use / maintenance	6. Post-use
Impacts						
SC1.1 Material impacts	Raw material attributes (use of scarce metals / minerals e.g. metal-based stabilizers or as residual metals)	Process aid attributes (use of scarce metals & mineral inputs for creation processes)	Scarce metals, mineral and fossil hydrocarbon inputs for logistics / packaging	Scarce metals & mineral inputs necessary for additive processing in PVC formula	Scarce metals and minerals used during product use and maintenance	Release of s… minerals and hydr… during post-use processi…
SC1.2 Process impacts	Impacts from raw material sourcing (release of scarce metals, minerals, hydrocarbons)	Emissions / waste from creation processes (release of scarce metals, minerals, hydrocarbons)	Emissions / waste from packaging and logistics (release of scarce metals, minerals, hydrocarbons)	Emissions / waste from processing (release of scarce metals, minerals, hydrocarbons)	Leakage / release of scarce metals by migration or break-down during product use and maintenance	Resource recovery of scarce metals, minerals and hydrocarbons
SC1.3 Energy-related impacts	Energy used in raw material sourcing (fossil vs. non-fossil)	Energy used in creation / synthesis (fossil vs. non-fossil)	Energy used in packaging and logistics (fossil vs. non-fossil)	Energy used in additive processing in PVC formula (fossil vs. non-fossil)	Energy used in product use and maintenance (fossil vs. non-fossil)	Energy used during post-use processing (fossil vs. non-fossil)
Progress						
SC1.4 Substitutions	Targets and actions for phase out / substitution of scarce metals / minerals	Targets and actions for phase out / substitution of scarce metals / minerals during creation	Targets and actions for phase out / substitution of scarce metals / minerals / fossil hydrocarbons during packaging and logistics	Targets and actions reducing reliance on / necessity for scarce metals & mineral inputs	Reduced reliance on / necessity for scarce metals & mineral inputs during use / maintenance.	Targets and actions to prevent the loss / release of scarce metals during post-use
SC1.5 De-materialization	Targets and actions for resource efficiency during raw material sourcing (including use of recycled materials)	Targets and actions resource efficiency during creation (e.g. reducing material inputs, waste minimization)	Targets and actions resource efficiency during creation (e.g. reducing material inputs, waste minimization and closed loop packaging systems)	Resource efficiency in PVC polymer use (e.g. filler)	Resource efficiency resulting from additives enhancing the durability / useful life of the PVC product in relation to its function.	Targets and actions to improve resource recovery of scarce metals, minerals and hydrocarbons.
SC1.6 Energy optimization	Targets and actions for sourcing raw materials from suppliers using renewable energy	Targets and actions for energy efficiency and substitution to renewable energy in creation	Targets and actions for energy efficiency and substitution to renewable energy in packaging and logistics	Energy savings due to additives improving process efficiency (e.g. extrusion)	Energy avoided as a result of additives enhancing the durability / useful life of the PVC product in relation to its function.	Targets and actions to design additives that can be efficiency managed post-use.
SC1.7 Management	Raw material sourcing in accordance with a responsible sourcing policy to address impacts from metals, minerals and hydrocarbons.	Targets and actions to design additives that are compatible with PVC recyclate	Existence of purchasing guidelines / agreements for responsible packaging & logistics	Disclosure of information concerning existence of scarce metals within additive formulation	Ensuring permanent information on additives used in the product is available to asset owners in order to facilitate eventual recycling.	Ensuring systems and technologies are available or developed to manage legacy additives.

Under review

Example of questionnaire

	Impact questions
1.1.1	Are the raw materials free from metals, minerals and hydrocarbons that risk accumulating in nature (e.g. due to scarcity in nature such as with Cu, Ag, Sn, Cd, Hg, etc. or due dispersed use / disposal)?
1.1.2	Are the raw materials sourced in ways that avoid release of substances from the earth's crust that can accumulate in nature? (i.e. during virgin extraction, sourcing of natural resources and/or recycled or reused materials etc.)?
1.1.3	Are all raw materials extracted, processed and transported using renewable energy sources?
	Progress questions
1.1.4	Are there targets and actions being taken to phase out use of metals, minerals and hydrocarbons that risk accumulating in nature (i.e. through product development, R&D, switching to bio-alternatives etc)?
1.1.5	Are there targets and actions being taken to improve resource efficiency and achieve zero waste/emissions of metals / minerals / hydrocarbons in supply chain? (e.g improved processes, switching to materials with lower sourcing impacts etc.).
1.1.6	Are there targets and actions being taken to source raw materials from suppliers using renewable energy?
1.1.7	Are raw materials sourced in accordance with a responsible sourcing policy that addresses the risk of metals, minerals and hydrocarbons accumulating in nature?

1008 questions answered



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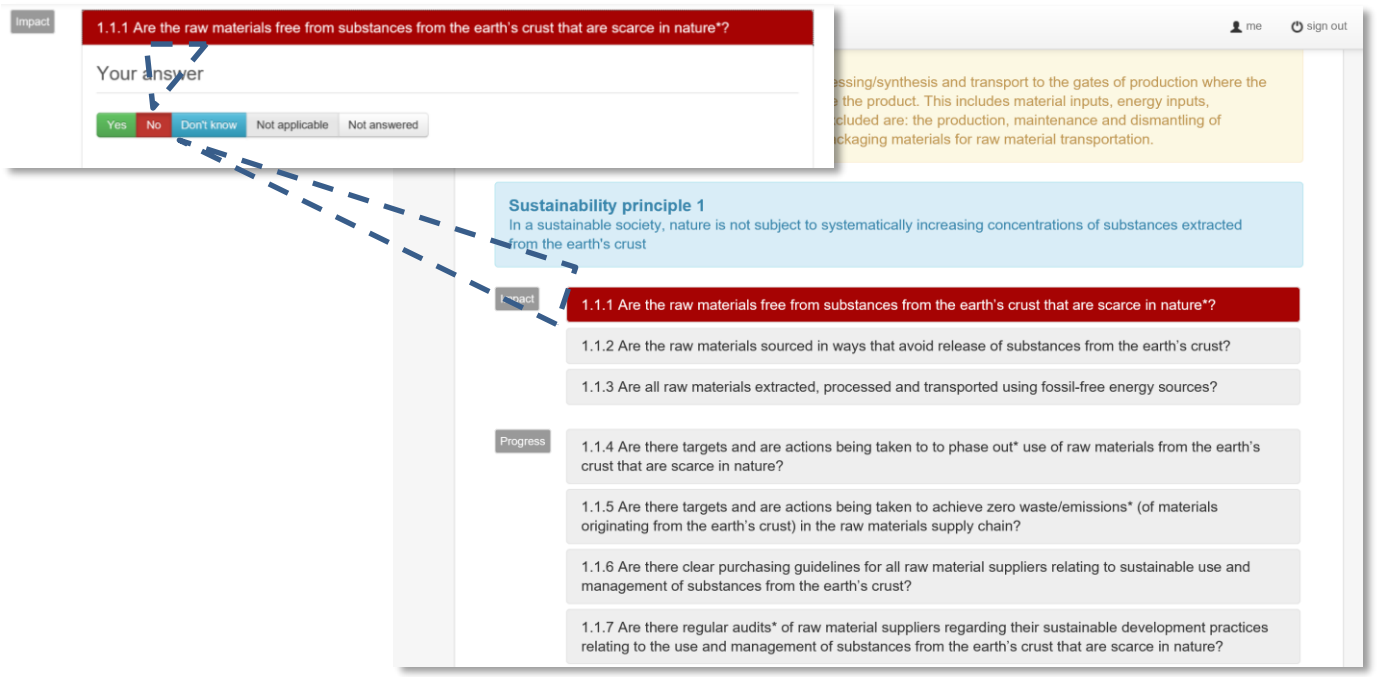
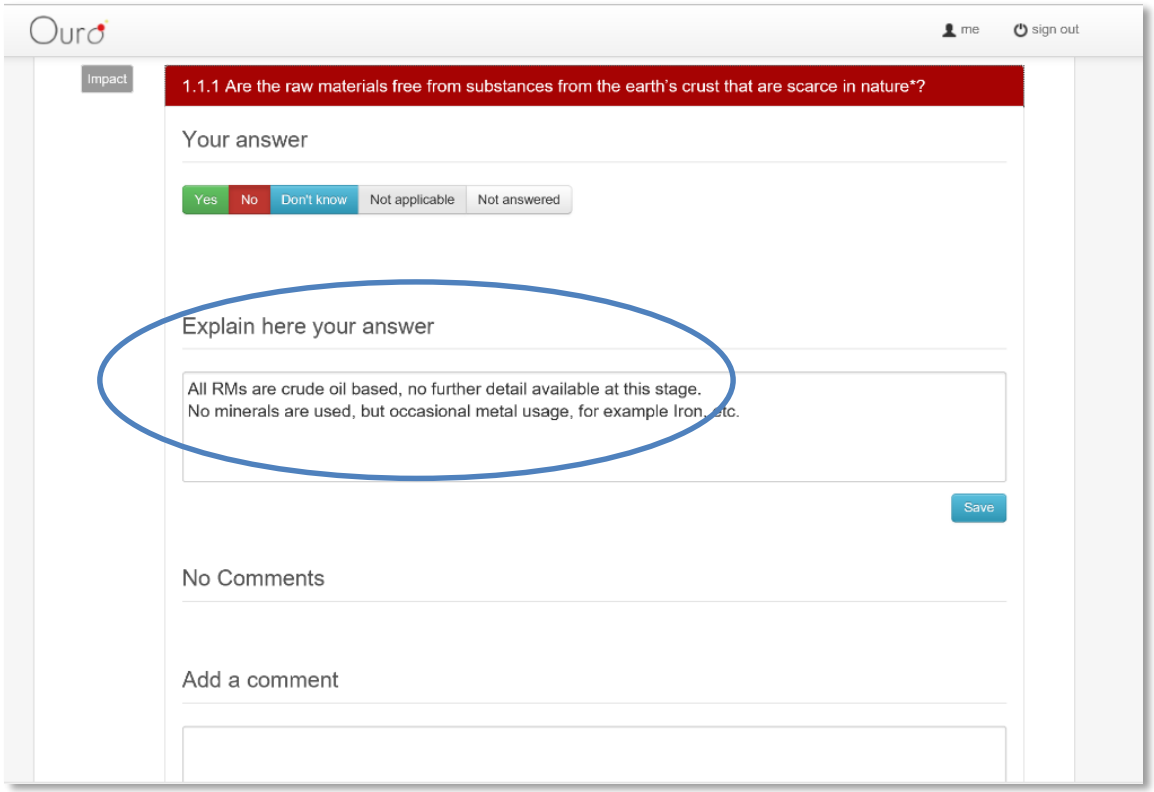
E Tool available from TNS (SLCA analysis)



Assessment motivation and comments



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Vinylplus product label now integrates ASF in clause 6.1 (update june 2017)

a) REACH compliant substances	The manufacture of the product which is being evaluated has included only REACH compliant additives (substances) and has not used the following additives: • Substances containing cadmium or lead, except as included and permitted in any recyclate.
b) Safe substance management & traceability	The organisation can demonstrate that the product which is being evaluated: • carries permanent information regarding the additives used in its manufacture in order to facilitate future recycling. • meets the volatile organic compound (VOC emission criteria (see tool box for more details) • measures the levels of lead and cadmium in the recyclate it uses • discloses to customers the maximum levels of lead and cadmium in the recyclate it uses • provides information to his customer for the assembly, installation, maintenance and end of life of the product regarding the additives used
c) Avoidance of substances requiring authorization	The organisation demonstrates that the product which is being evaluated: • has been manufactured without using additives (substances) which are on the REACH candidate list or listed on Annex XIV, even if authorized, except as included and permitted in any recyclates.
d) Additive Sustainability footprint evaluated	The key additives (substances) included in the product evaluated have been assessed according to the ASF (Additive Sustainability Footprint), a methodology developed by VinylPlus for a sustainable use of additives based on the TNS System Conditions .

Who answers the questionnaire?

- **GROUP ASSESSMENT**
  - Applies to the most common additives, assessed at application level
  - VinylPlus and its Additive Task Force may convene working groups and experts to complete generic assessments of wider relevance e.g. additives used in a Window profile

- **COMPANY-SPECIFIC ASSESSMENTS**
  - May be relevant for additives in products applying for the VinylPlus label
  - Under Label Clause 6 the key additives in the product need to be reviewed
  - To get the maximum points the ASF methodology needs to be applied (sub-clause 6.1 (d))
  - The generics assessments may be used as a base case but need to be reviewed / complemented to ensure that the actual additives and life cycle match the base-case.
  - If no base case exists, specific assessment will be needed. It is suggested that converters treat this as a supplier requirement in future.

How will the answers be verified?

- This is a voluntary self-assessment and continuous improvement process relying on best available information
- Various forms of verification will apply for different parts of the questionnaire (e.g. compliance with an industry charter, LCA data)
- The overall process and guidance for ASF is secured by VinylPlus with an external 'sustainability review' by The Natural Step.
- The Natural Step also suggests consultation on overall methodology to build awareness and endorsements over time.
- Since ASF uses a simple answer nomenclature (Yes / No / Don't Know), evidence for the answers is requested by those completing the answers.
- Uncertainties and the reasoning for answers are available for scrutiny.

What is the added value of the ASF next to PEF?

- Compatible (covers PEF aspects, same life cycle stages)
- Wider scope (social and environmental)
- Guide innovation (goal-oriented)
- Qualitative + quantitative
- Not a Black box (transparency)
- Ready to go!

Key Points of differentiation

- Strategic perspective / goal-oriented
- Applicability to decision-making & innovation
- Scope & system boundaries
- Social dimension included in ASF
- Data requirements, type and depth of analysis
- Reduced timeframes for assessments & cost

Comparison of LCA & TNS approach

Life Cycle Assessment (technical)		Strategic Life Cycle Management
Detailed compilation and evaluation of materials and energy flows between a chosen system and its environment		Sustainability assessment of a product life-cycle using backcasting from sustainability principles
Detailed analysis		First overview then detailed analysis as required
Covers resource consumption and emissions of known pollutants within chosen scope		Covers potential socioecological and economic problems from a full systems perspective
Objective is to facilitate choice of material/process or product with lowest environmental load values		Objective is to identify strategic pathways towards sustainability

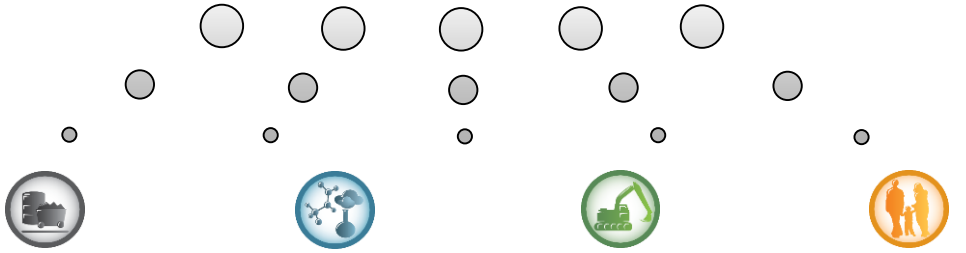
Source: Ny, H., MacDonald, J.P., Broman, G., Yamamoto, R. and Robèrt K.-H. 2006. Sustainability Constraints as System Boundaries. An Approach to Making Life-Cycle Management Strategic. *Journal of Industrial Ecology*, vol. 10, issue 1-2, 61-77.

QUANTITIVE
+ QUALITATIVE
ASSESSMENT

Selected impacts

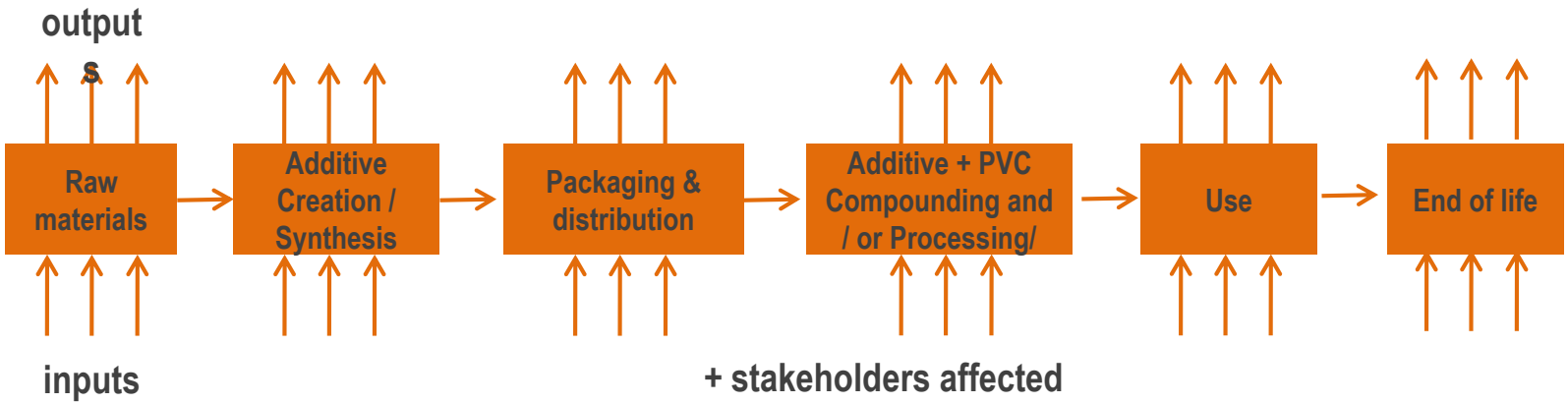
Environmental impacts: Energy consumption, Raw material consumption, Greenhouse effect, Summer smog, Acidification, Over-fertilisation, Environmental toxins, Problems with waste, ...Social impacts: health & safety, basic rights and needs, employment, well-being, skills / competence

Design requirements for sustainability



System Condition 1 System Condition 2 System Condition 3 System Condition 4

Inventory analysis



Example on complementarity

"Substances from the Earth's crust must not systematically increase in concentration in nature".

Burning of fossil fuels

Are production facilities using renewable energy? — Yes / No

Are there targets / actions to increase use of renewable energy? — Yes / No

Climate Change / Global Warming Potential

Greenhouse gas emissions

How large are the green-house gas emissions? → kg CO2 eq