AIM ALFEN INTEGRATED MANAGEMENT SYSTEM

LiDS Wheel Methodology

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ALFEN
POWER TO ADAPT

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1 Introduction

In general, environmental impact is characterized by both emissions and resource depletion. Alfen has the objective to reduce the environmental impact throughout the lifecycle of its products. The environmental impact of products is largely determined in the development process, where the materials, production methods, distribution systems, product use, etc. is defined. Therefore various eco-efficient' tools focus on the 'design' stage of products [201]. The combination of eco-efficient design is called 'EcoDesign', which is development that focusses on meeting "*the needs of the present without compromising the ability of future generations to meet their own needs*" [202].

Worldwide various EcoDesign methodologies are used to reduce environmental impacts. These methodologies vary from quantitative analyses, which are more scientific, to qualitative analyses, which are more pragmatic. Alfen has chosen to use the 'LiDS Wheel' described by Brezet and Van Hemel (1997). The methodology uses universal EcoDesign guidelines and gives engineers incentives to push the development to more eco-efficient decisions. The tool is widely used to evaluate and compare products and services throughout the life-cycle, from beginning-of-life (idea) to end-of-life (reuse, recycle or landfill). The LiDS Wheel is a qualitative tool that gives the ability to seek for a quantitative foundation and verification [201].

1.1 Scope

This report is written for Alfen's employees involved in the NPD process.

1.2 Purpose

The purpose of this document is to describe how EcoDesign, and more specific, the LiDS wheel, must be applied in Alfens' new product development (NPD) process. This report is scoped towards all EcoDesign activities in the NPD process, from product initiation to product launch.

1.3 Reading guidance

The structure of this report is as follows. In chapter 2, the abbreviations and definitions are briefly summarized. Chapter 3 sums up the references used in this report. From chapter 4 on, the methodology description starts where in chapters 4 and 5 respectively the different methodologies and the EcoDesign process for Alfen are described. This report closes with the responsibilities in chapter 6.

2 Abbreviations & Definitions

2.1 Abbreviations

Abbreviatin	Description
AIM	Alfen Integrated Management system
APQP	Advanced Product Quality Planning
LiDS	Lifecycle Design Strategies
NPD	New Product Development
SG	Stage Gate

Table 1 - Abbreviations

2.2 Definitions

Definition	Description
EcoDesign	Considers environmental aspects at all stages of the product development process, striving for products which make the lowest possible environmental impact throughout the product life cycle
Ecolizer	The Ecolizer is an ecodesign design tool and is aimed at all designers and companies that want to know and tackle the environmental impact of their products.

Table 2 - Definitions

3 References

3.1 AIM Documents

Ref.	Document Title	AIM Document Number	Extern Document Number
[101]	New Product Development Process	AIM-RD-GEN-3.03-MP	
[102]	Verification and Validation	AIM-RD-GEN-3.03-WI-01	
[103]	NPD Deliverables overview	AIM-RD-GEN-3.03-MP-001	
[104]	LiDS analysis form	AIM-QHSE-GEN-3.03-MA-01-001	
[105]	EcoDesign Eve Double Pro-Line	AIM-QHSE-GEN-0.00-02-RP-01	
[106]	Alfen CSR Policy	AIM-QHSE-GEN-2.02-01-MA-04	

Table 3 – AIM Documents

3.2 External Documents

Ref.	Document Title	Alfen Document Number	Extern Document Number
[201]	ECODESIGN, Ontwerpen voor een duurzame en circulaire economie		ISBN 9789401445924
[202]	Our Common Future: Report of the World Commission on Environment and Development.		UN. Secretary-General; World Commission on Environment and Development 1987
[203]	Design for Sustainability (D4S): A Step-By-Step Approach		United Nations Environment Programme, 2009
[204]	Ecolizer		www.ecolizer.be

Table 4 – External Documents

4 Responsibilities

The following responsibilities are assigned:

4.1 Project Manager NPD

Ensures that the LiDS wheel is implemented in the project and the deliverables are part of the Stage Gate reviews.
Ensures that the Alfen Sustainability targets are addressed in the New Product Development [106].

4.2 Project Engineer NPD

Ensures that the LiDs wheel is implemented and that all phases are addressed and that the choices made are adequately documented.

4.3 QHSE Advisor

Part of the NPD project team and where necessary facilitates the workshops and support the Project Manager and Project Engineer in the execution of their tasks as identified above.

5 Methodologies

For new product development, Alfen follows its own NPD process. In this process, the LiDS wheel EcoDesign methodology is used to make better environmental decisions throughout the lifecycle of Alfen's products. In this chapter, the methodologies that are used are further described.

5.1 Alfen's New Product Development (NPD) Process

In order to work as efficient as possible within a growing company, the NPD process is introduced within Alfen. The NPD process has as basis the APQP framework which is tailor made to the Alfen needs. APQP stands for Advanced Product Quality Planning; its purpose is to produce a product quality plan which will support development of a product or service that will satisfy the customer.
New Product Development (NPD) is the total process that takes a product from idea to market introduction [101].

To ensure that a clear definition of the NPD process is required. This process supports Alfen to:

- Ensure that the needs of our customers drive the developments
- Execute our projects on time, within budget and according to specification
- Define clear roles and responsibilities to create a clear focus for all people involved
- Focus on firm decision making

A visual representation of Alfen's NPD process is presented in Figure 1 below. The detailed description of the NPD process is described in the New Product Development process [101].

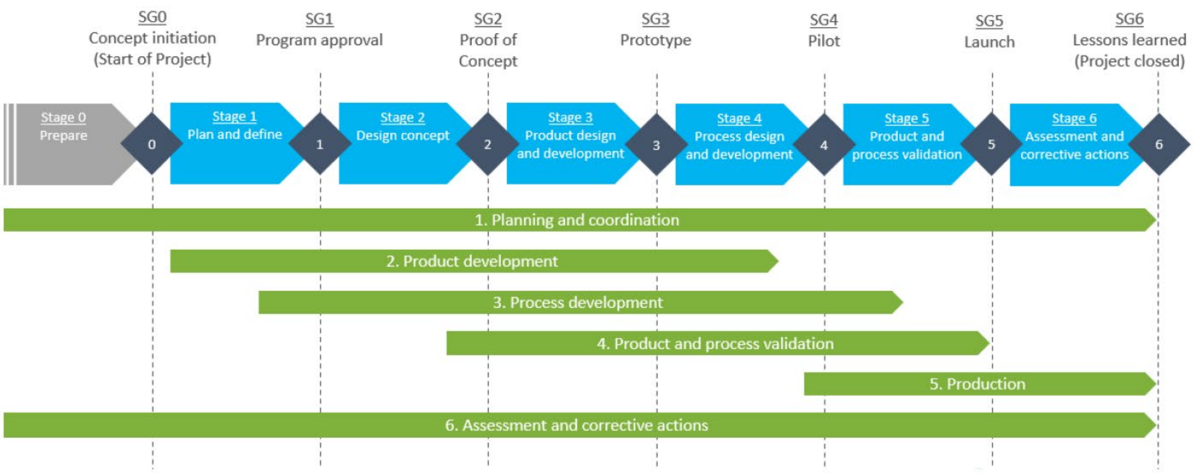


Figure 1: Alfen's NPD Process

5.2 Lifecycle Design Strategy (LiDS) Methodology

The 'LiDS Wheel' described by Brezet and Van Hemel (1997) uses universal EcoDesign guidelines and gives engineers incentives to push the development to more eco-efficient decisions. The tool is widely used to evaluate and compare products and services throughout the life-cycle, from beginning-of-life (idea) to end-of-life (reuse, recycle or landfill). The LiDS Wheel is a qualitative tool that gives the ability to seek for a quantitative foundation and verification.

The LiDS Wheel is an EcoDesign tool to reduce environmental impacts throughout the product lifecycle. It is a tool that is used for both reflection of one product and comparison between two or more products. The LiDS Wheel has 8 spokes (or steps) which actively pushes for more eco-friendly decisions. Products are ranked from 0 to 5 on each step. The LiDS Wheel is presented in Figure 2.

Please note that these stages all are linked to each other. Therefore, in practice this tool is used with multiple iterations. In addition, because the LiDS Wheel is about the whole product life cycle, the iterations are multi-disciplinary. A 'silo mentality' in development almost never leads to the expected outcome, successful development is non-linear and always a (disciplinary) team effort. The 8 steps are described after the figure below.

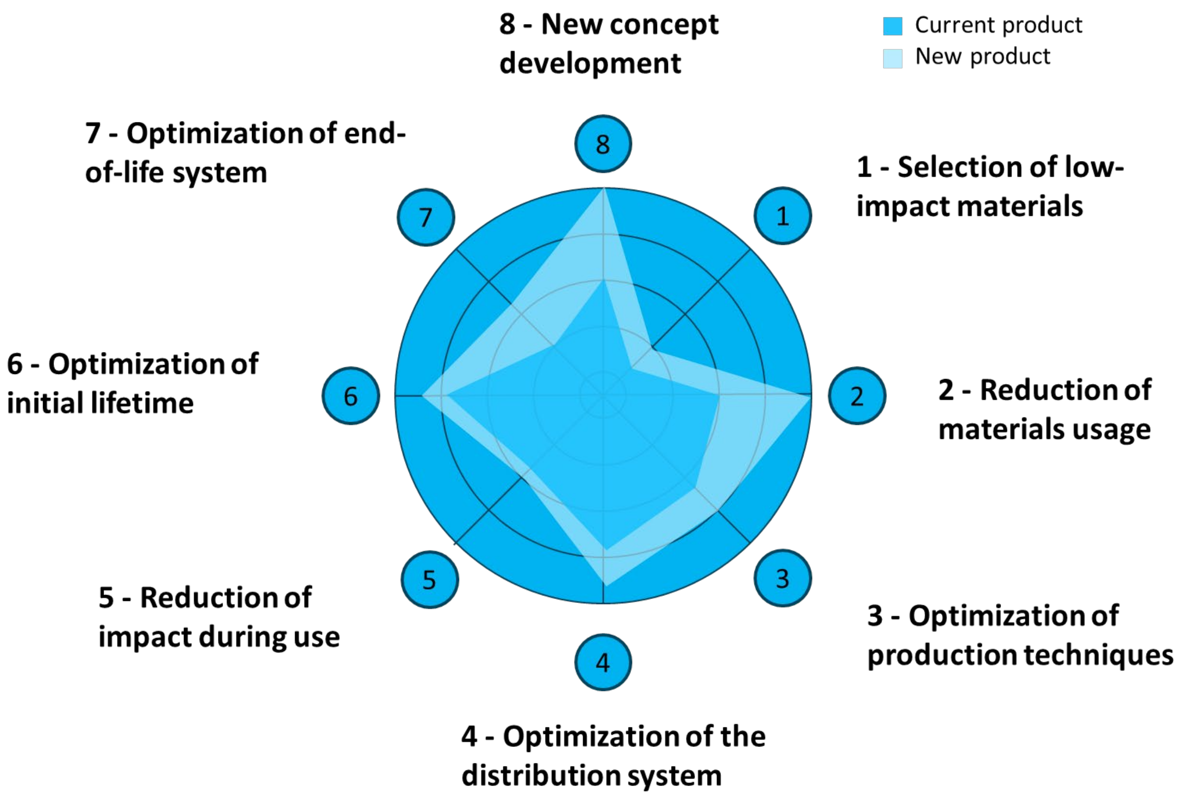


Figure 2: LiDS Wheel

5.2.1 Step 1: Selection of low-impact materials

The first step of the LiDS Wheel looks at the materials that are used in the product. Low-impact materials are materials that are non-toxic, not scarce, have a low energy density and are easy to recycle. In this step of the LiDS Wheel, it is common to have a quantitative verification to one ore multiple eco-parameters. There are various lists of materials and their eco-score, which are updated yearly. One commonly used parameter is the is the Eco-indicator (or eco-score) from Ecolizer.

Criteria of step 1: Selection of low-impact materials

- ✓ Non-toxic materials
- ✓ Non-scarce materials
- ✓ Low energy content
- ✓ Recycling
- ✓ Recyclable materials

5.2.2 Step 2: Reduction of materials usage

A logical, but also challenging step is to reduce the amount and volume of products. Key in this step is to not loose focus on functional and technical requirements. A product should perform as expected and should last as desired. However, by smart use of enforcement ribs instead of thicker walls, a product could meet or even outperform a similar product with more material. Also, less material and less volume has a positive effect on the environmental impact during distribution. The less weight, the less fuel. And the less volume, the more units fit into one transport.

Criteria of step 2: Reduction of materials usage

- ✓ Weight reduction
- ✓ Reduction of (transport) volume

5.2.3 Step 3: Optimization of production techniques

Especially for products, the choice of production techniques is an important step for the environmental impact. The amount of energy that is used, the source of this energy (e.g. renewable sources), the amount of processes, the amount of waste and the use of auxiliary material all have an impact on the environment. The production techniques must be in line with the chosen materials, therefore you see that step 1 and 3 are often performed simultaneously.

Criteria of step 3: Optimization of production techniques

- ✓ Environmentally friendly production processes
- ✓ Less production processes
- ✓ Efficient use / renewable energy
- ✓ Little downtime and waste
- ✓ Efficient use / clean auxiliary materials

5.2.4 Step 4: Optimization of the distribution system

In this step, we look at the distribution system as a whole. Optimization of the distribution system can be done in type of packaging, weight of packaging, ease of transport, type of transport, distance of transport, etc. Normally, designers don't look too much at the distribution system. Therefore, a multidisciplinary team, including supply chain, could make better decisions.

Criteria of step 4: Optimization of the distribution system

- ✓ Less / clean packaging
- ✓ Efficient means of transport

5.2.5 Step 5: Reduction of impact during use

The most important step during the product lifecycle is the use stage. This step challenges the designer to make the product as energy-efficient as possible, let the user use as less energy and materials during the use stage.

For example, a coffee machine could have low impact materials and be as light as possible. However if the machine is not energy efficient or has aluminium cups for every cup of coffee, the bottom line is that the environmental impact during this stage could diminish earlier efforts.

Criteria of step 5: Reduction of impact during use

- ✓ Low energy consumption
- ✓ Environmentally friendly resource
- ✓ Few necessary auxiliary materials
- ✓ Environmentally friendly auxiliary materials
- ✓ No waste of energy / auxiliary materials

5.2.6 Step 6: Optimization of initial lifetime

The longer a product lasts, the less products have to be build to perform a task, the better for the environment. This step is logical. However, products aren't always build to last. Especially software is a bottleneck in consumer electronics. For example: Nokia's form early 2000 still work perfectly, and Apple iPhones from 2010 are practically useless.

This step also looks at the modularity of products, and the serviceability. If certain parts fail, how easy is it to repair or restore the product for its function?

Criteria of step 6: Optimization of initial lifetime

- ✓ High operational reliability
- ✓ Easy maintenance / repair
- ✓ Modular construction
- ✓ Low fashion sensitivity
- ✓ Strong user - product relationship

5.2.7 Step 7: Optimization of end-of-life system

After a product has reached the end of it's useful life, it still contains parts and materials that could be useful for other applications. Most of the products are either burned in an incinerator or dumped on a landfill. In consumer electronics the copper, gold and silver are extracted, however this is a difficult and energy-consuming process.

Criteria of step 7: Optimization of end-of-life system

- ✓ Reuse of entire product
- ✓ Reuse of parts
- ✓ Reuse of materials

5.2.8 Step 8: New concept development

The last step in the LiDS Wheel is a more abstract step. In other publications, this step is sometimes referred as ‘step 0’, as the new concept developments looks at the products and services as a whole. At first, this step looks at an optimal needs fulfilment. Focus on the ‘job to be done’, and ask the customer until you have the latent needs clearly in line. If Henri Ford would have asked a customer in 1901 what kind of product he/she wants, the answer would be ‘a faster horse’. However, by focussing on the latent need, the customer actually askes for a fast and reliable way of transportation.

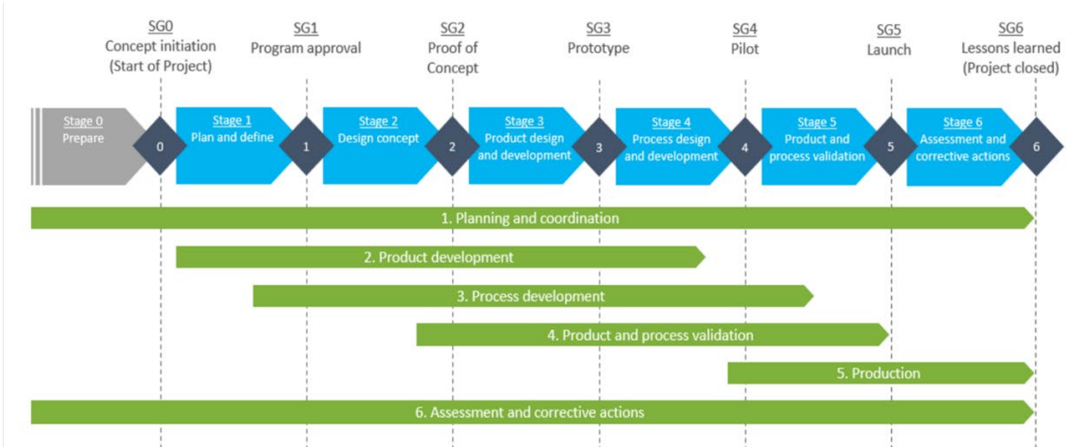
In addition, this step looks if dematerialisation is possible. An example of dematerialisation is where the (physical) CD and DVD market is changed to a more digital market, with services such as Spotify and Netflix. This step also looks to see if shared use of products is an option, or if some functions can be integrated with other products.

Criteria of step 8: New concept development

- ✓ Dematerialisation
- ✓ Joint product use
- ✓ Efficient fulfilment of (additional) positions

6 EcoDesign process Alfen

This chapter describes how to apply the LiDS methodology in the NPD process in more detail. Paragraphs 5.1 – 5.7 present the 6 stages of the NPD process, and within these stages, the specific LiDS Wheel actions are described in more detail. The criteria for guidance in the LiDS Wheel is attached in appendix A. Furthermore, appendices B, C and D show respectively the LiDS Excel sheet, table and graphs.



LiDS step	LiDS 8	n/a	LiDS 1-8	LiDS 1-8	LiDS 3-4	LiDS 1-8	n/a
Level of detail	Low	n/a	Low	High	High	High	n/a
Focus points	Concept development	n/a	Concept development	Product development	Process development	Validation points	n/a

Figure 3: NPD process with LiDS interactions

6.1 Stage 0 – Prepare

Key EcoDesign deliverable: Described sustainability aspects in business case concept

In this first stage, there must be a check if the idea meets Alfen's sustainable goals and the specific sustainable voice of the customer. This check is performed in the concept version of the business case.

Within the LiDS Wheel, Alfen must look at LiDS 8 specifically. This step of the LiDS wheel is about the product as a concept. What choices can be made on a high level, before the detailed design choices are made. The product could be offered as a service, serve multiple uses, could be suitable for shared use, of have items and parts that the customer does not need or want.

6.2 Stage 1 – Plan and Define

Key EcoDesign deliverable: Described sustainability aspects in business case final

In this stage, the business case from stage 0 is further described in a final version.

6.3 Stage 2 – Design Concept

Key EcoDesign deliverable: LiDS Wheel (initiated)

Stage 2, 3 and 4 are the most important stages of the development. In these stages the key design choices are made and evaluated that could impact the environment. These choices and evaluations must be performed multidisciplinary, to make sure that noting is unnoticed. Advised is that in anyway mechanical design, software design, supply chain, QHSE, purchase and management is included.

In stage 2, the product development team must start with the rationale for the LiDS wheel. This means that all 8 steps of the LiDS wheel are briefly evaluated on the new design concept. This is an assessment on a high level, without any scores.

6.4 Stage 3 – Product Design and Development

Key EcoDesign deliverable: LiDS Wheel (adjusted)

The steps below assume that there already is a score for the current product, and it describes the process of comparing this product to a newly developed successor. However, please note that the LiDS Wheel is also very well applicable for a 'single' score (e.g. without a comparison).

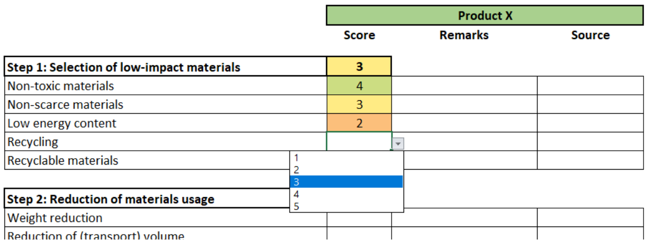
The steps below and the attached templates are designed for a complete 'end' product. In the LiDS wheel this is usually the starting point. However, the tool can be flexible in use, meaning that also different components can be evaluated. The product breakdown structure could help with defining which components should be included or not. An example of the LiDS Score on product level is described in EcoDesign Doc Eve Double [105].

(1) Introduction

A. Start the session with defining the goal, scope and process step, make sure that this is clear for all involved.
B. Thereafter, start with sharing details about the products to be compared with each other. Let this be an open discussion to gather information about the differences and design choices.

(2) Individual scores

A. Start with LiDS in the Excel and compare the different criteria between both products. The Excel (see appendix B) has a drop-down function to give scores between 1 and 5.



	Product X		
	Score	Remarks	Source
Step 1: Selection of low-impact materials	**3**		
Non-toxic materials	4		
Non-scarce materials	3		
Low energy content	2		
Recycling			
Recyclable materials			
Step 2: Reduction of materials usage			
Weight reduction			
Reduction of (transport) volume			

B. With filling in these scores, trust your experience and 'gut feeling'. If there are any remarks or doubts, mention them. Advised is to keep the universal LiDS guidelines close (see appendix A).
C. The different individual scores are presented in two graphs in the Excel sheet (see appendix D). Look at these graphs, what do they tell you? What is most remarkable? Form a conclusion for yourself.

(3) Group discussion and group scores

A. After the individual scores are analyzed, it is now the step to compare the different scores with each other. This is done step by step in a group discussion. Start with the first criterium of LiDS 1 (Non-toxic materials) and discuss the different scores. Why does one person give it a score 2 and the other a score 4? Try to get consensus about the score. From these discussions, fill in one new Excel sheet.
B. When it is unclear if (for example) the one material is better or worse than the other, or if one means of transportation is better or worse than the other, a small side step is to seek for quantitative verification. An easy and useful tool is that one of Ecolizer [204], as presented in Figure 3 below (https://www.ecolizer.be/catalogue/77). This This is a combined score for measuring resources depletion, emissions and damage to the environment. This score is measured in 'millipunten' or mPt (English: Environmental points). The higher the mPt, the higher the environmental impact.

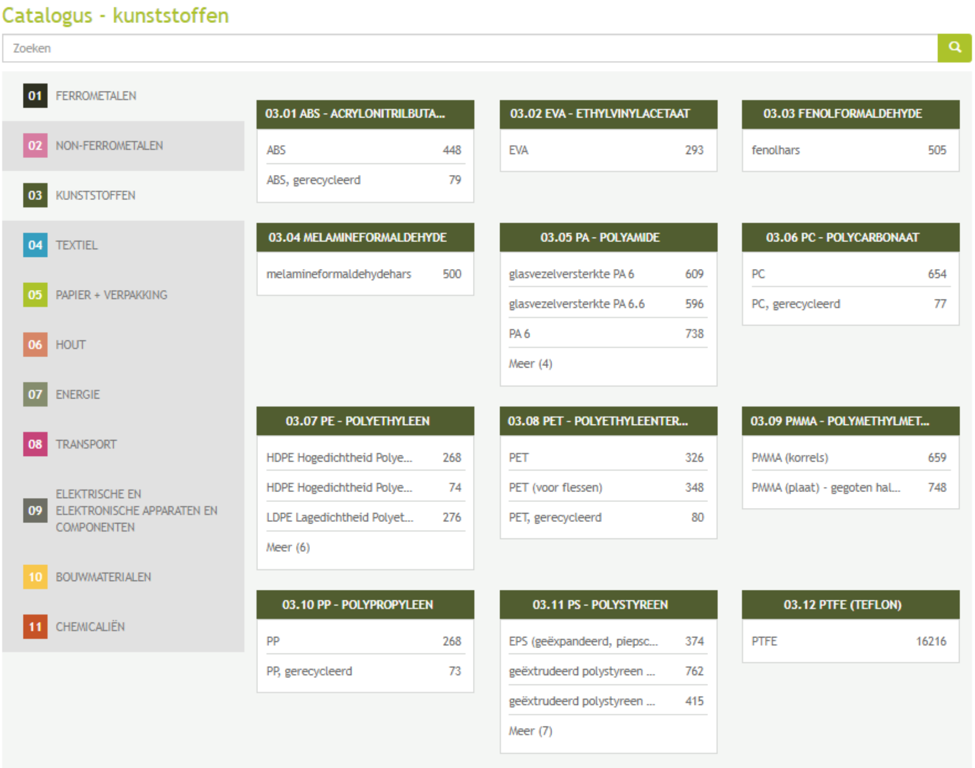


Figure 4: Ecolizer online tool

6.5 Stage 4 – Process Design and Development

Key EcoDesign deliverable: LiDS Wheel (adjusted)

As shown earlier, stage 2, 3 and 4 are concurrent processes, they happen simultaneously and so should the different LiDS steps be evaluated. Changes in the materials directly impact the means of production. Also, with optimizing the environmental impact in the use stage, this could impact the technical properties of the product itself. Therefore, the LiDS wheel in from stage 2 and 3 must be re-evaluated and adjusted in stage 4. Advised is to keep 'running' the LiDS wheel until there is a design freeze. The iterations can be performed much quicker than the initial comparison, as only the changes must be reviewed.

Stage 4 is different from stage 3 as here more knowledge is known about the production process and distribution means. Therefore, it is advised to focus in this stage more extensively on LiDS 3 (production techniques) and LiDS 4 (distribution system).

6.6 Stage 5 – Product and Process Validation

Key EcoDesign deliverable: LiDS Wheel (finalized)

In this stage of NPD process is the validation of the designed product and process, any changes must be re-reviewed in the final LiDS wheel. As described in stage 4 and 5, these iterations should mostly focus on the changes that impact the LiDS scores.

6.7 Stage 6: Assessment and Corrective Actions

Key EcoDesign deliverable: Not applicable

There are no EcoDesign deliverables in the last stage of the NPD process. However, Alfen must keep an eye on the feasibility of the LiDS scores. In addition, after product launch, the environmental impact from the production techniques (more efficient), distribution system (better means of transportation), product use (software updates) and end-of-life actions (re-use) must be continuously improved.

Appendices

Number	Title
Appendix A	Guidance criteria
Appendix B	Excel Sheet LiDS analysis
Appendix C	LiDS Table empty
Appendix D	LiDS Graph empty

Appendix A Guidance Criteria

From: Design for Sustainability (D4S): A Step-By-Step Approach [203].

1) Selection of low-impact materials

a) Cleaner materials

1. Do not use materials or additives which are prohibited due to their toxicity. These include PCBs (polychlorinated biphenyls), PCTs (polychlorinated terphenyls), lead (in PVC, electronics, dyes and batteries), cadmium (in dyes and batteries) and mercury (in thermometers, switches, fluorescent tubes).
2. Avoid materials and additives that deplete the ozone layer such as chlorine, fluorine, bromine, methyl bromide, halons and aerosols, foams, refrigerants and solvents that contain CFCs.
3. Avoid the use of summer smog-causing hydrocarbons.
4. Find alternatives for surface treatment techniques such as hot-dip galvanization, electrolytic zinc plating and electrolytic chromium plating.
5. Find alternatives for non-ferrous metals such as copper, zinc, brass, chromium and nickel because of the harmful emissions that occur during their production.

b) Renewable materials

6. Find alternatives for exhaustible materials.

c) Lower energy content materials

7. Avoid energy-intensive materials such as aluminum in products with a short lifetime.
8. Avoid raw materials produced from intensive agriculture.

d) Recycled materials

9. Use recycled materials wherever possible, to increase the market demand for recycled materials.
10. Use secondary metals such as secondary aluminum and copper instead of their virgin (primary) equivalents.
11. Use recycled plastics for the inner parts of products which have only al supportive function and do not require a high mechanical, hygienic or tolerance quality.
12. When hygiene is important (as in coffee cups and some packaging) a laminate can be applied, the center of which is made from recycled plastic, covered with or surrounded by virgin plastic.
13. Make use of the unique features (such as variations in colour and texture) of recycled materials in the design process.

e) Recyclable materials

14. Select just one type of material for the product as a whole and for the various sub-assemblies.
15. Where this is not possible, select mutually compatible materials.
16. Avoid materials which are difficult to separate such as compound materials, laminates, fillers, fire retardants and fiberglass reinforcements.
17. Preferably use recyclable materials for which a market already exists.
18. Avoid the use of polluting elements such as stickers which interfere with recycling.

f) Materials with positive social impact, i.e., by generating local income

19. Make use of materials supplied by local producers.
20. Stimulate arrangements for recycling of materials by local companies which can substitute (part of) the raw materials of the company.

2) Reduction of materials usage

a) Reduction in weight

21. Aim for rigidity through construction techniques such as reinforcement ribs rather than 'overdimensioning' the product.
22. Aim to express quality through good design rather than over dimensioning the product.

b) Reduction in (transport) volume

23. Aim at reducing the amount of space required for transport and storage by decreasing the product's size and total volume.
24. Make the product foldable and/or suitable for nesting.
25. Consider transporting the product in loose components that can be nested, leaving the final assembly up to a third party or even the end user.

3) Optimization of production techniques

a) Alternative production techniques

26. Preferably choose clean production techniques that require fewer harmful auxiliary substances or additives (for example, replace CFCs in the degreasing process and chlorinated bleaching agents).
27. Select production techniques which generate low emissions, such as bending instead of welding, joining instead of soldering.
28. Choose processes which make the most efficient use of materials, such as powder coating instead of spray painting.

b) Fewer production steps

29. Combine constituent functions in one component so that fewer production processes are required.
30. Preferably use materials that do not require additional surface treatment.

c) Lower/cleaner energy production

31. Motivate the production department and suppliers to make their production processes more energy efficient.
32. Encourage them to make use of renewable energy sources such as wind energy, water power and solar energy. Where possible, reduce the use of fossil fuels and reduce environmental impact by, for example, choosing low-sulphur coal or natural gas.

d) Less production waste

33. Design the product to minimize material waste, especially in processes such as sawing, turning, milling, pressing and punching.
34. Motivate the production department and suppliers to reduce waste and the percentage of rejects during production.
35. Recycle production residues within the company.

e) Fewer/cleaner production consumables

36. Reduce the production consumables required – for example, by designing the product so that during cutting waste is restricted to specific areas and cleaning is reduced.
37. Consult the production department and suppliers as to whether the efficiency with which operational materials are used during production can be increased – for example, by good housekeeping, closed production systems and in-house recycling.

f) Safety and cleanliness of the workplace

38. Choose production technologies that require fewer harmful substances and generate less toxic emissions.
39. Use production techniques that generate less wastes, and organize efficient in-company re-use and recycle systems for the remaining waste.
40. Implement systems for in-company working conditions, health and safety like SA8000.

4) Optimization of distribution system

a) Less/cleaner/reusable packaging

41. If all or some of the packaging serves to give the product a certain appeal, use an attractive but lean design to achieve the same effect.
42. For transport and bulk packaging give consideration to reusable packaging in combination with a monetary deposit or return system.
43. Use appropriate materials for the kind of packaging – for example, avoid the use of PVC and aluminum in non-returnable packaging.
44. Use minimum volumes and weights of packaging.
45. Make sure the packaging is appropriate for the reduced volume, foldability and nesting of products – see strategy 2b.

b) Energy efficient transport mode

46. Motivate the sales department to avoid environmentally- harmful forms of transport.
47. Transport by container ship or train is preferable to transport by lorry.
48. Transport by air should be prevented where possible.

c) Energy efficient logistics

49. Motivate the sales department to work preferably with local suppliers in order to avoid long-distance transport.

50. 50: Motivate the sales department to introduce efficient forms of distribution – for example, the simultaneous distribution of larger amounts of different goods.
51. 51: Use standardized transport packaging and bulk packaging (Europallets and standard package module dimensions).

d) Involve local suppliers (distributed economies)

52. Explore options for contracting more local transport/ distribution.
53. Form logistic consortia with fellow companies in the community to jointly outsource distribution and transport in an efficient way and by involving local distributors.

5) Reduction of impact during use

a) Low energy consumption

54. Use the lowest energy consuming components available on the market.
55. Make use of a default power-down mode.
56. Ensure that clocks, stand-by functions and similar devices can be switched off by the user.
57. If energy is used to move the product, make the product as light as possible.
58. If energy is used for heating substances, make sure he relevant component is well insulated.

b) Clean energy source

59. Choose the least harmful source of energy.
60. Do not encourage the use of non-rechargeable batteries – for example, a portable radio can be supplied with a battery charger, encouraging the use of rechargeable batteries;
61. Encourage the use of clean energy such as low-sulphur energy sources (natural gas and lowsulphur coal), fermentation, wind energy, water power and solar energy. An example is a solar heater which does not require energy for heating water during the summer.

c) Fewer consumables needed

62. Design the product to minimize the use of auxiliary materials – for example, use a permanent filter in coffee makers instead of paper filters, and use the correct shape of filter to ensure optimal use of coffee.
63. Minimize leaks form machines which use high volumes of consumables by, for example, installing a leak detector.
64. Study the feasibility of reusing consumables –reusing water in the case of a dishwasher.

d) Cleaner consumables

65. Design the product to use the cleanest available consumables.
66. Make sure that using the product does not result in hidden but harmful wastes – for example, by installing proper filters.

e) Reduce wastage of energy and other consumables

67. Misuse of the product as a whole must be avoided by clear instructions and appropriate design.

68. Design the product so that the user cannot waste auxiliary materials – for example, a filling inlet must be made large enough to avoid spillage.
69. Use calibration marks on the product so that the user knows exactly how much auxiliary material, such as washing powder, to use.
70. Make the default state that which is the most desirable from an environmental point of view – for example, ‘no cup provided by drinks dispenser’ or ‘doublesided copies’.

f) Health supporting, social added value

71. Make sure the product has zero or minimal impact on the health of the user by avoiding use of toxic substances, low radiation levels etc.
72. Design the product in accordance to the socio-economic needs and possibilities of the user groups.
73. Assess the opportunities to design products for low-income groups.

6) Optimization of initial lifetime

a) Reliability and durability

74. Develop a sound design and avoid weak links. Special methods such as the Failure Mode and Effect Analysis have been developed for this purpose.

b) Easier maintenance and repair

75. Design the product in such a way that it needs little maintenance.
76. Indicate on the product how it should be opened for cleaning or repair – for example, where to apply leverage with a screwdriver to open snap connections.
77. Indicate on the product itself which parts must be cleaned or maintained in a specific way – for example, by colour-coded lubricating points.
78. Indicate on the product which parts or sub-assemblies are to be inspected often, due to rapid wear.
79. Make the location of wear on the product detectable so that repair or replacement can take place on time.
80. Locate the parts which wear relatively quickly close to one another and within easy reach so that replacements are easy to dismantle for repair or replacement.

c) Modular product structure

81. Design the product in modules so that the product can be upgraded by adding new modules or functions at a later date for example, plugging in larger memory units in computers.
82. Design the product in modules so that technically or aesthetically outdated modules can be renewed. For example, make furniture with replaceable covers which can be removed, cleaned and eventually renewed.

d) Classic design

83. Design the product’s appearance so that it does not quickly become uninteresting, thus ensuring that the product’s aesthetic life is not shorter than its technical life.

e) Strong product-user relation

84. Design the product so that it more than meets the (possibly hidden) requirements of the user for a long time.
85. Ensure that maintaining and repairing the product becomes a pleasure rather than a duty.
86. Give the product an added value in terms of design and functionality so that the user will be reluctant to replace it.

f) Involve local maintenance and service systems

87. Design the product with the possibilities of local service and maintenance companies in mind.
88. Jointly develop new innovative service and repair centers in the region that can be involved both in servicing the new products an existing products.

7) Optimization of end-of-life system:

a) Re-use of product

89. Give the product a classic design that makes it aesthetically pleasing and attractive to a second user.
90. Make sure that the construction is sound so that it does not become prematurely obsolete in the technical sense.

b) Remanufacturing/refurbishing

91. Design for dismantling (from product to sub- -assemblies) to ensure easy accessibility of the product for inspection, cleaning, repair and replacement of vulnerable or innovation-sensitive sub-assemblies or parts.
92. The product should have a hierarchical and modular design structure; the modules can then each be detached and remanufactured in the most suitable way.
93. Use detachable joints such as snap, screw or bayonet joints instead of welded, glued or soldered connections.
94. Use standardized joints so that the product can be dismantled with a few universal tools – for example, use one type and size of screw.
95. Position joints so that the person responsible for dismantling the product does not need to turn it around or move it.
96. Indicate on the product how it should be opened non-destructively – for example, indicate where and how to apply leverage with a screwdriver to open snap connections.
97. Locate the parts that are relatively quickly worn out close to one another, so that they can be easily replaced.
98. Indicate on the product which parts must be cleaned or maintained in a specific way – for example, by using colour-coded lubricating points.

c) Recycling of materials

99. Give priority to primary recycling over secondary and tertiary recycling.
100. Design for disassembly (from sub-assemblies to parts).
101. Try to use recyclable materials for which a market already exists.

102. If toxic materials have to be used in the product, they should be concentrated in adjacent areas so that they can easily be detached.

d) Safer incineration

103. The more toxic materials there are in a product, the more the responsible party has to pay for its incineration. Toxic elements should therefore be concentrated and easily detachable so they can be removed, paid for and treated as a separate waste stream.

e) Taking in consideration local (informal) collection recycling systems

104. Assess the possibilities of existing formal or informal recycling activities in the community to be involved in the take-back and recycling of the product.
105. Jointly develop and/or support new and efficient collection and recycling systems in the region.

Appendix B Excel Sheet LiDS analysis

(see AIM-QHSE-GEN-3.03-MA-01-001)

Appendix C LiDS Table empty

	Product A			Product B		
	Score	Remarks	Source	Score	Remarks	Source
Step 1: Selection of low-impact materials						
Non-toxic materials						
Non-scarce materials						
Low energy content						
Recycling						
Recyclable materials						
Step 2: Reduction of materials usage						
Weight reduction						
Reduction of (transport) volume						
Step 3: Optimization of production techniques						
Environmentally friendly production processes						
Less production processes						
Efficient use / renewable energy						
Little downtime and waste						
Efficient use / clean auxiliary materials						
Step 4: Optimization of the distribution system						
Less / clean packaging						
Efficient means of transport						
Step 5: Reduction of impact during use						
Low energy consumption						
Environmentally friendly resource						
Few necessary auxiliary materials						
Environmentally friendly auxiliary materials						
No waste of energy / auxiliary materials						
Step 6: Optimization of initial lifetime						
High operational reliability						
Easy maintenance / repair						
Modular construction						
Low fashion sensitivity						
Strong user - product relationship						
Step 7: Optimization of end-of-life system						
Reuse of entire product						
Reuse of parts						
Reuse of materials						
Step 8: New concept development						
Dematerialisation						
Joint product use						
Efficient fulfillment of (additional) positions						

Appendix D LiDS Graph empty

	Product A	Product B
Step 1: Selection of low-impact materials		
Step 2: Reduction of materials usage		
Step 3: Optimization of production techniques		
Step 4: Optimization of the distribution system		
Step 5: Reduction of impact during use		
Step 6: Optimization of initial lifetime		
Step 7: Optimization of end-of-life system		
Step 8: New concept development