Chapter 3
Strategy Development

After the detailed analyses undertaken in Chapter 2, it is time to decide on the kind of strategy that will help your company achieve competitive advantage through Ecodesign. In doing so, one should examine the corporate, market, product, production and management aspects of your business and design an integrated strategy.

It should be emphasized that, while developing a good strategy always requires a thorough understanding of a given situation, it also requires enough flexibility to manoeuvre in those areas where potential action might be better, if taken later.

3.1 Corporate Considerations

Positioning the company in the marketplace is one of the most important strategic issues of corporate level management. The desired view of the future is, in essence, where the company would like to be in regard to its environmental performance 5, 10, or 20 years hence. The basis for this work was laid with the trend analysis in Section 1.2 and the corporate analysis in Section 2.1.

As a first step, the environmental mission and vision of the company should be reviewed to ensure that it integrates sustainability, environmental aspects of the whole life cycle, co-operation with customers and suppliers, and perhaps also international behaviour. An example of one company's environmental policy follows:

W. Wimmer et al., *ECODESIGN – The Competitive Advantage*,
Alliance for Global Sustainability Bookseries 18,
DOI 10.1007/978-90-481-9127-7_3, © Springer Science+Business Media B.V. 2010

Example: Policy for Environmental Protection, Health Management and Safety 2010 (Siemens)

As a global company we are facing special responsibility for worldwide long-term challenges such as demographic change, climate change and diminishing resources. Sustainability is the key to securing our company's future. Our commitment to being a socially responsible company requires that we meet the demands of commerce in an ecologically and socially sound manner. Hence, achieving excellence for Environmental Protection, Health Management and Safety is a high priority within Siemens. A demonstrated commitment will increase the competitive advantage of businesses and our customers, and lay the foundation for a successful future.

Siemens strives through out innovative products, systems and solutions to improve the quality of life the world over. This includes high energy efficiency for climate protection, supply of clean water, health protection, and environmentally compatible transportation systems. For this, we consider the entire product lifecycle.

We design, develop, manufacture and market our products and services so as to protect the environment and human health in a manner that meets or exceeds any applicable regulations, and in order to minimize the impact on our natural resources. We design our working conditions in ways that safeguard our employees' performance, safety, health, motivation and satisfaction.

Environmental Protection, Health Management and Safety contribute towards human health and the company's assets. Our global system for managing EHS is the basis for continuous improvement of our performance on these areas.

All managers and employees act in accordance with this policy and observe the relevant regulations [1].

A review may or may not result in any changes to your company's mission and vision statements. However, *strategic environmental targets* should be developed for *production* that take into account (a) sustainability of processes; (b) emissions; (c) energy; (d) waste and water reduction; and (e) quantity of renewable energies.

Similarly, *strategic product targets* should be developed that take into account: (i) leadership with environmentally compatible products; (ii) avoidance of special hazardous substances; (iii) reduction of energy consumption; and (iv) contribution to governmental energy reduction targets.

Alert

For setting future targets, it is not necessary to conduct difficult scenario analyses. Many companies have displayed their outlook for the next 20 years on their homepages. Also, governments such as the EU, have published long-term targets or studies from which targets and necessary changes can be derived.

Don't be concerned about proposing production related energy reduction targets such as 20% to 30% within 5 years. It is possible! Values are relative, and relate to certain levels of product turnover. Similar improvements can also be achieved for products [1].

An environmental rating of the products might also be of interest. In many cases, cost reduction targets can be combined with environmental ones. The Boston Consulting Group proposed in the 1990s that the environmental properties of products will become the third decisive factor in competition together with cost and quality (cf. Introduction).

Depending on the targets set, your company can become a "green" one or a "me too" company. In the second case, environmental properties are only fulfilled where legally required. If the company wants to become a market leader, the environmental positioning will need to be specified. For example, a company can choose to become a "zero carbon company" or a "zero waste company" where it is shown that the total contribution of the company to global warming or waste is zero [2] or the company can set several targets [3]. However, such a strategy is not always without risk, and accusations of "green washing" might arise, especially if targets are vague or not actually achievable. It might be better to show overall contribution and reduction potential. Japanese companies, like Sony, have changed their strategy from "zero carbon" 10 years ago, to now using more realistic and achievable targets [3].

The international policy of any company should refer to the same standards worldwide, including environmental management systems in every plant, take back of waste products, and reference to international reduction targets. A communication strategy should reflect the success already achieved. More and more companies like GE or Siemens communicate now the percentage of their portfolio which consists of "green" products.

Often, this kind of aggressive improvement strategy creates a culture of innovation within the company, involving employees, and often including a proposal system for innovation. Suppliers should also be involved early in any new developments, including those suppliers that supply components that have the potential to save energy. It is worth noting that environmentally improved components are more likely to be available when they are requested by the customer rather than when the customer relies on chance!

Checklist for Corporate Considerations – Section 3.1

Check for Strategic Considerations

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Have you decided which corporate level changes are required to achieve necessary future environmental performance?	Yes ☺ No ☹	From scenario planning, consumption levels of products (e.g. in 10 years) can be estimated, which can lead to a 10 year action plan	Adjust scenario (e.g. with customers and suppliers)	1.2, 2.1, 2.2, 2.5, 4.1; 4.2
Have you decided what is to be included in a new mission and vision?	Yes ☺ No ☹	Environmental positioning means shifting the company to sustainability	Check whether employees accept and live it	2.1
Do you have targets for reducing production related environmental impacts?	Yes ☺ No ☹	Targets are required to facilitate better environmental performance	Annual reporting	3.4, 3.5, 4.4, 4.5
Are targets set to reduce the impact of all products sold in the market?	Yes ☺ No ☹	Total impact is politically important. Products with very small sales are less important	Annual reporting	2.1, 2.3, 4.3
Have you determined your green "flagship" products with which you can advertise?	Yes ☺ No ☹	You can also include reduced impact from use of renewable energy	Show annual progress	2.3, 3.3
Have you decided in which markets "green" products should be promoted?	Yes ☺ No ☹	General marketing strategy for environmentally compatible products is required	Implement program	3.2, 4.2
Has the company defined which environmental targets contribute to (a) cost reduction, (b) risk reduction, and (c) improved security of resource supply?	Yes ☺ No ☹	Impact reduction often also means cost savings. Risks occur if there is No reaction (e.g. to legal trends). Scarcity of materials can cause high costs	Build up environmental reporting with costs, risks, improved safety	3.5, 4.5
Are statements on what your company has already achieved ready for communication?	Yes ☺ No ☹	Public awareness of your progress is important	Extend statements (e.g. to free of … lead, asbestos, etc.)	4.1, 4.2

Of course, more is always possible! Ambitious targets cannot be achieved through continuous and incremental improvement alone. New developments will need to be launched, including the discovery and development of entirely new technologies.

To get a sense of environmental trends, contact with different environmental associations might be worthwhile. Also, by participating in an international rating system, such as the Dow Jones Sustainability Group Index (DJSGI) [4], some insight into future requirements might be obtained. Both can provide feedback on how your company is viewed by those outside your organization. How your company will be viewed in the future depends on long-term programs and commitments and the trust your customers have in your products.

3.2 Market Considerations

In Section 2.2, a series of questions were posed about the market sector in which your company and its products are situated. The purpose of this section is to help you decide, first of all, whether to engage in any environmental marketing at all and, if so, to determine the right kind of strategy.

For the purposes of developing an appropriate environmental marketing strategy, the following are important issues. They relate to:

- The size and level of your direct competition
- The degree of segmentation of your market sector
- The environmental trends acting on and influencing your market sector
- The degree to which your competitors are active in environmental marketing
- Whether your competitors' environmental messaging is well received
- The level of customer interest in your product's environmental attributes

3.2.1 Pros and Cons of Environmental Marketing

For some companies, the use of environmental factors in their marketing strategy is deliberately avoided. The reasons for this may vary, but the following appear to be the most common:

- For companies that manufacture or distribute different products in the same category that compete with each other (usually consumer goods products), they may not want to have some products identified as environmentally superior, thereby leaving the impression that they are also selling environmentally inferior products.
- Some companies are concerned about promoting the environmental aspects of one of their products, thereby creating the impression that the whole company is an environmental leader.

- Some companies may be uncomfortable about promoting the environmental virtues of their products, while their manufacturing facilities (either domestically or abroad) may be operating at a low level from the perspective of sustainable development. This could include human rights issues or pollution issues in less regulated countries.
- Some companies have experienced high levels of scrutiny after proudly advertising the environmental progress of a specific product group. Advocacy groups then demanded more information about other aspects of the products in question, as well as the company's other products and overall corporate operations.

In summary, the primary reasons that a company may choose to avoid environmental marketing is concern about raising expectations and avoiding time consuming, often undue, and certainly unwanted scrutiny. However, choosing the avoidance option may be a short-sighted view. As noted in previous chapters, customers are increasingly interested in the environmental performance of the products they buy and this trend will impact on your sector sooner or later. Furthermore, governments in many regions and countries are now also looking at the environmental aspects of products. Many governmental agencies, if they have not done so already, are considering how they can accelerate the reduction of environmental impacts arising from product manufacture and use.

All of this should lead a company to the conclusion that (i) product related environmental performance needs to be improved and (ii) promoting this progress will give comfort to both consumers and governmental agencies that action is being taken. As well, this type of initiative could lead to competitive market advantage.

3.2.2 Elements of an Environmental Marketing Strategy

Effective marketing begins with an examination of the problem or opportunity, continues with a review of how the opportunity might be exploited, examines the motivations and needs of the client, and then designs and positions the product, concept, or service accordingly. The main elements of any type of marketing strategy are

– Assessing the target audience for the marketing efforts
– Getting the message right
– Ensuring that the right media are employed

3.2.2.1 Target Audience

In this section we apply these basic marketing practices to environmental challenges through an examination of the motivations and needs of the client or audience.

Marketing has always been concerned with consumers' motivations – that is, what drives people and organizations to demand and, ultimately, purchase different goods and services? What do they want? If a purveyor of goods or a service knows what is being called for in the marketplace, then there is a much greater likelihood that the good or service will be purchased and that his business will thrive.

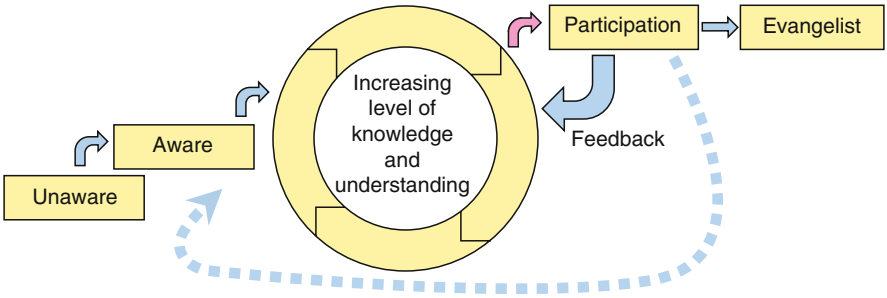

Fig. 3.1 Sustainable motivation

The following schematic (Fig. 3.1), taken from a UNEP report on "Sustainable Motivation" provides an interesting view of how consumers' values can progress from "unaware" to "evangelist".

The authors argue that, "from the perspective of motivation, we need to understand why people make the move illustrated by the pink arrow – that is, from knowledge and understanding to participation. Crucially, it is because they have gone round the loop of increasing knowledge and understanding sufficient times and that an opportunity arises for them to take that step. Much of what we need to know about motivation will be rooted in how that knowledge and understanding is created. People will be at different stages of this cycle…"

This is similar to the view that real education is the three-step process of: (i) raising awareness; (ii) enhancing understanding; and then (iii) seeing action.

Marketing has a potentially key role to play in helping to educate consumers. However, traditionally, much "environmental marketing" has concerned itself only with efforts to try to identify so-called "green consumers" – that is, that segment of the overall population that is most likely to buy those products with some "green" or "environmental" advantage. Identification of these green consumers originally focused upon isolating unique demographic characteristics – speculating that wealthier, female, more educated, and younger individuals were those who should be targeted.

In the 1990s, however, strategies to isolate these green consumers began to prioritize attitudinal characteristics that revealed those with particular "world-views" (like liberalism) and socialization patterns that uncovered people who were connected to relevant social networks. While certainly more sophisticated, these efforts continued to prove relatively disappointing, with green marketing efforts showing little improvement from the original modest level of accomplishments. Indeed, we would argue that marketing efforts on environmental issues have generally fallen into the trap of targeting those who are terrified of dramatic environmental damage; want to 'do the right thing'; or want to save money. This is an incomplete approach. Figure 3.2, from a TerraChoice Environmental Marketing Inc. presentation, provides some detail on the spectrum of environmental interest.

This demonstrates that about 20% of consumers have a strong disposition toward the environment and would be most likely to take action on that front.

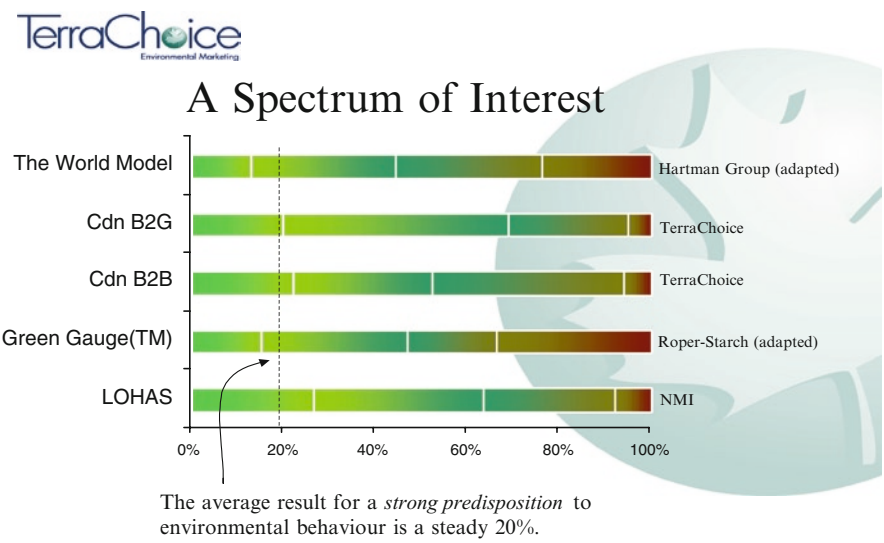

Fig. 3.2 Shades of Green – a spectrum of Interest

We can likely conclude that the "green 20%" represents the kinds of consumers that are traditionally being "targeted" with the "we are going to die" and the "right thing to do" kinds of messages. If this 20% is correct, then some 80% are left out if marketing efforts were focused only on the green end of the spectrum. However, economic self-interest and "self gratification" are most probably in the interests of both the "green" 20% and the remaining 80%.

We therefore think that it is time to try something new. That "something new" is to move the focus away from the "green consumer", and to consider "all consumers" as the potential market for environmental products, activities, services, and facilities. To do this, we review the ideas of Abraham Maslow in order to reflect upon peoples' and organizations' motivations in a general sense. We acknowledge, of course, that there is nothing particularly original in such a review, for Maslow has been a mainstay of marketing studies for many years. Where there has been much less attention, however, is the investigation of the way in which Maslow's ideas about the "hierarchy of needs" might be applied directly to strategies for environmental marketing. This is the new area that we hope to open up for further discussion. But, first, we present a brief review of Maslow's hierarchy of needs.

In 1943, psychologist Abraham Maslow wrote a paper entitled "A Theory of Human Motivation", in which he proposed that there exists a hierarchy of human needs. He postulated that as humans fulfil basic needs, they then desire higher needs. Maslow's original work – and the ways in which he subsequently elaborated it – has formed the basis of much consideration of what catalyses, directs, and/or generates human behaviour.

Maslow argued that the hierarchy of needs consists of five levels, often (as we present in Fig. 3.3) depicted as a pyramid. The four lower levels were grouped together as "deficiency needs", while the top level was called "being needs". Maslow also argued that the higher needs come into focus only once the lower needs have been met. Before, for example, the need for love/belonging can be part of one's desires, one's physiological and safety needs must have been fulfilled. Let us briefly review what Maslow meant by each of these five levels.

Once physiological needs are met, people turn to their "safety needs". These are the needs for security – the need to ensure that the individual is not in danger from external forces (for example, wild animals, criminals, natural disasters, etc.).

The third layer of human needs consists of the desire for relationships with others – perhaps friends, lovers and/or a community in general. These are referred to as the "love/belonging" needs, and they encompass the requirement for humans to belong, to be accepted by others.

The highest of the deficiency needs is the esteem needs. The dictionary definition of "esteem" is 'favourable opinion, regard, respect' [5] and Maslow suggested that this level of needs included both self-esteem and the esteem of others. It, therefore, is in addition to simply 'belonging' to a group (part of the third level) and is suggestive of having the respect of others.

Finally, actualization – or, "self-actualization", as it has often come to be called – refers to the intrinsic needs of humans to make the most of their unique abilities. It is, at its simplest, the need to "be what you can be". Maslow, himself, added to this level in subsequent work, introducing the term "self-transcendence", to suggest that this is all about connecting to something beyond the self (beyond one's own ego) or about helping others fulfil their potential.

Maslow's ideas, though widely used, are not without their critics. Although we do not review the broader debate about the value of Maslow's work here, it is not our intention to suggest that the "hierarchy of needs" should necessarily be accepted

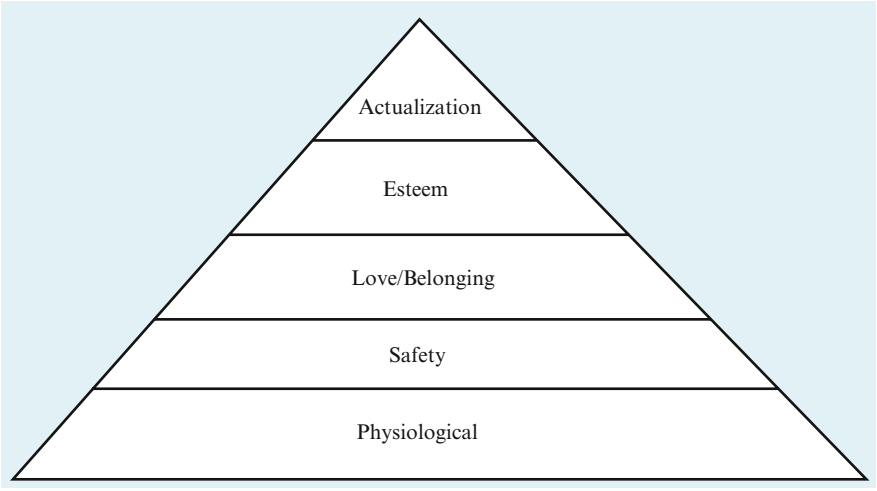

Fig. 3.3 Maslow's hierarchy of needs

"as fact". Instead, it is our desire to use the levels introduced by Maslow to generate additional ideas about how strategy surrounding environmental marketing could be developed.

Above, we make the point that most environmental marketing has targeted relatively small portions of the overall population – that is, it has searched for the "elusive green consumer". Indeed, many of the formalized scales used to classify the population into different groups have been used by marketers of green products. Frequent Green Gauge Reports by Roper Starch Worldwide [6] for example, try to identify so-called "true-blue greens", with the message being that targeting this segment of the population will yield success in selling environmental products.

Indeed, we can even interpret Maslow's work in a similar way. More specifically, much environmental marketing to date has seemed – consciously or unconsciously – to focus upon either end of Maslow's hierarchy of needs. At the bottom, environmental product messages that aim to strike fear into the hearts of consumers effectively serve to suggest that their most basic physiological and safety needs are not being met. At the top, meanwhile, those messages that encourage people to act for altruistic reasons are, in effect, offers to meet consumers' actualization needs. The example of the "what would Jesus drive" campaign is an example of this.

In reality, however, most people in industrialized nations are operating at neither the bottom nor the top of Maslow's spectrum. Most generally, they have enough to eat, and they do not live in constant fear of being attacked on the street. With these first two sets of needs having been met, therefore, most people can consider higher levels of needs.

Nevertheless, most people have fulfilled neither their love/belonging needs nor their esteem needs, thus not allowing them to focus their energies upon meeting their actualization needs. Instead, the majority of the population is operating in this middle ground: people are interested in figuring out how they can develop supportive family relationships, cultivate quality friendships, gain the respect of peers, and so on. Indeed, we speculate – as per the notional population distribution in Fig. 3.4 – that those trying to fulfil "survival needs" and "self-transcendence needs" make up relatively small parts of the total population. Instead, the vast majority, fall somewhere in between in what we refer to as the Self-Gratification envelope.

Given the likelihood that most of the consumer population is primarily concerned with "social" and "esteem" or "self-gratification" needs, it makes sense to initiate a discussion about how environmental marketing could serve to position products to help the consumer population meet their self-gratification needs.

Our purpose, therefore, is to stimulate thinking about how recognition of human motivations – guided by Maslow's hierarchy of needs – can guide environmental marketing so that the entire market potential is considered.

Based on the above discussion, one can easily conclude that there is no standard target audience. If a company is in the consumer goods field, even this audience is highly fragmented. For example, if the product category at issue is cosmetics, the target audience is most likely women and, within that audience, different types of cosmetic products might be aimed at either different age or ethnic groups, or different occupation categories. However, if the product category is yard care or "do-it-yourself", then the target audience is most likely men who live in houses and are between the ages of 25 and 75.

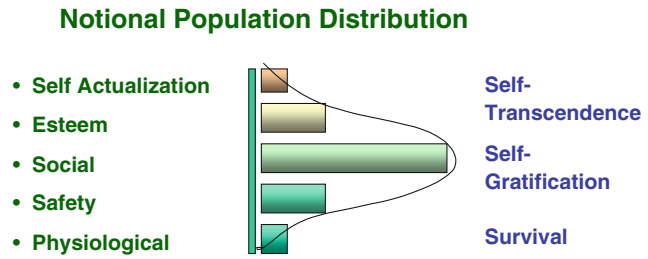

Fig. 3.4 Notional population distribution

However, the purpose of identifying the target audience is to determine its main likes, dislikes, orientation, and any possible predisposition. This in turn helps to better craft the message. In terms of environmental marketing, the kinds of things that should be reviewed in relation to target audience include the likely age grouping for the product category, this group's environmental orientation in terms of knowledge, interest, and possibility of being swayed by environmental messaging.

3.2.2.2 The Environmental Message

Once the target audience is adequately identified, the next step in the strategy is to develop the right message. Here, consideration needs to be given to whether the messaging aims to:

– Inform the audience about the environmental aspects of the product or
– Identify that the product has environmental leadership characteristics relative to competing products

Other considerations are whether or not (a) an independent party plays a role in confirming the voracity of the message, (b) all aspects of the life cycle are included; or (c) what kind of label, if any, should be used.

Regardless of the decision, the following principles, which are taken from the study by TerraChoice Environmental Marketing Inc. on the "Six Sins of Greenwashing" [7] are useful guides:

(i) Be cautious about highlighting one environmental attribute while ignoring other potentially more significant environmental attributes.
(ii) Ensure that any claims are, as a minimum, verifiable. Often, the best approach is to have an independent party verify claims.
(iii) Avoid any claim that is non-specific or vague. A term such as "natural" or "chemical-free" can be both true and false depending on interpretation and context.
(iv) Ensure that claims are relevant. Claiming that your home ink-jet printer is free of DDT is technically correct, but there are no printers made with DDT.
(v) Similar to the first principle, avoid promoting the environmental aspects of a product that is, by definition, harmful to the environment, just a bit less so than

competing products. A company's cigarettes will not be considered green just because they use less packaging, and have lower levels of tar and nicotine.

(vi) Be truthful.

3.2.2.3 Choosing the Medium

A range of media could be used to promote the environmental aspects of your products. These include the usual print, radio and television advertisements, in-store messaging tools (shelf-talkers, etc), and product labels. Between the type of target audience, the product category, and the kind of messaging approach chosen, the appropriate media will probably become more obvious. For example, if

(a) The product category is home office equipment (e.g. printers, computers, fax machines)
(b) The target audience (i.e. the primary purchasers) are home owners who are interested in energy conservation and indoor air quality
(c) The message is that your products are energy leaders, have very low indoor air quality impact, are easy to disassemble, with many reusable components
(d) You have chosen to use a third-party environmental leadership certification

then, the appropriate media could begin with a certification label, and might include press releases about achieving the certification, and in-store promotional materials.

3.2.3 Making the Right Choice

Table 3.1 [8] highlights several marketing considerations for three types of environmental labels, Types I, II, and III as defined by ISO in their 14020 series of standards. Of course, there are many more and different kinds of labels in the market today, so these are provided only by way of example.

In summary, there is no one right environmental marketing strategy that can be universally employed. While there is a process that one can follow to help get to the right approach, there may be risks. This section has hopefully helped you develop an appropriate environmental marketing strategy in full knowledge of both the opportunities and the risks, and thus helping you mitigate any risks that have not yet been addressed.

3.3 Product Design Considerations

… an existing product should be redesigned, but this time environmental issues should be taken into account …

… the market is demanding products that are designed to better address environmental issues …

Table 3.1 ISO label types

Different types of environmental labels and declarations, advantages, disadvantages and application areas [Lee and Uehara, 2003]

Item	Type I	Type II	Type III
Generic Name	Eco Labeling	Self-declared environmental Claim	Environmental product declaration
Target Audience	Retail Consumers	Retail/ industrial/ institutional consumers	Industrial/ Institutional/ Retail Consumers
Communication Method	Environmental Label	Text and Symbol	Environmental Profile Data sheet
Scope	Whole life cycle	Single aspect	Whole life cycle
Use of LCA	No	No	Yes
Advantage	Easily identified	Market oriented	Detailed data via common method
	Quick decision	Flexible approach to market needs	Credibility via scientific quantitative data
	Credibility through third party	Tool for inter-business competition	
Disadvantage	Only uses a symbol (logo)	Relatively low credibility	Complicated LCA analysis
	No detailed information	Need to face consumers directly (no third party)	Insufficient back ground data
	No linkage to company's unique effort	Claim is about a single issue or limited	Not easy to comprehend
Application area	Home use products/ simple function products/low priced products	Products in general	Products for industrial use/relatively complicated and high priced products/durable products

Checklist for Market Considerations – Section 3.2

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Is your target audience aware of environmental issues?	Yes ☺ No ☹	Feedback from customers may provide part of the answer	Research or conduct market analysis	2.2, 3.2, 4.2
Is your competitor already using environmental marketing?	Yes ☺ No ☹	If yes, check to see whether there is any traction (i.e. success) as a result of the efforts?	Determine what the customers for your product category want	2.2, 3.2
Is the environmental message you want to communicate clear?	Yes ☺ No ☹	Also, check the message against the principles in 3.2	Conduct focus groups to determine clarity of message	4.2
Are the environmental marketing instruments chosen already?	Yes ☺ No ☹	If yes, check to ensure that results will deliver what you expect	Focus groups can help choose the optimal instrument	4.2

… a competitor is working to have the first ecoproduct on the market …
… the B2B market is requiring good environmental performance in tenders …

You may have experienced one of the above situations or found yourself in similar discussions during a product development process. So, how to start? Where and when should you start including environmental issues into the product development process? Ideally, the best time to consider environmental improvements is when developing a new product, or redesigning an existing one. The earlier environmental issues can be considered in the product (re)development process the better.

Integrating environmental issues in an appropriate way should begin with a list of product specifications, which is the usual starting point for product development (see Fig. 3.5). The key point is that environmental considerations are addressed during this very early stage in the process when there is still enough "room to manoeuvre" should new requirements arise, such as those related to environmental perspectives.

The question now is how to translate "environment" into more familiar terms for product developers, and which can be taken into account in the list of product specifications. What is important for the product being designed? Is it a high recycling rate, a long lifetime, optimized packaging, low energy consumption during use, light weight design, avoidance of certain problematic substances, or … ?

Well, you may say that probably all of the ideas listed are valuable and should be considered. That's probably correct, but, realistically, there is often not enough time or resources available in the product development process to address all of the possible environmental performance improvements. As such, the most significant ones will need to be selected. Effective methods to guide this selection are presented in Section 2.3.

The whole process is similar to cost improvements. There are, most likely, many possibilities leading to lower costs, but those that result in the most significant reductions should be considered for further follow-up, at least initially.

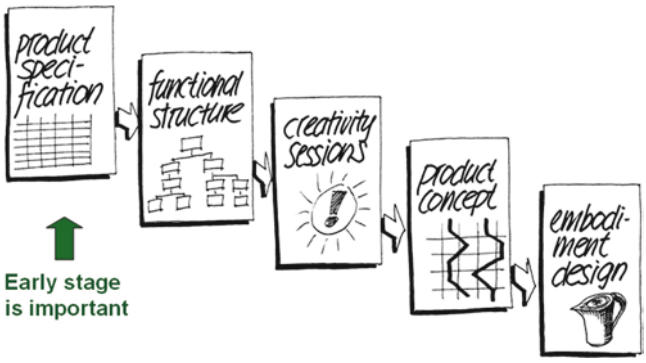

Fig. 3.5 Product development process [23]

To assist in knowing what is "most relevant" and how to follow up on those, three steps are proposed:

- A *pre-study* on the environmental performance of a previous or similar products.
- *Staff training* to help everyone better understand environmental issues needs to be done up front. A successful improvement process is based on awareness and understanding of the environmental situation and context.
- *Support* to work out improved environmental performance of products is needed. Appropriate tools and methods for easy integration in the product development process are required as well as a good environmental data source for decision-making during product design.

3.3.1 Pre-study

The purpose of the pre-study is to gain insight into the most relevant product-related environmental issues. Using the methods described in Section 2.3, the environmental profile (i.e. the distribution of the environmental impacts over the product life cycle) needs to be worked out. In doing this, we typically face two challenges: (i) life cycle data from the product we are going to design may be very limited; and (ii) most likely, the time to perform the pre-study is limited.

As a consequence, the best way forward is to choose a similar product, either a predecessor model of the product, or another product that has a similar product life cycle (use of raw materials, manufacture, distribution, use, and end of life). Once this "representative" product is found, the "right" method has to be chosen. Since, at this early stage in product development, the aim is to define the right improvement strategy, there is no need for a time consuming LCA according to ISO 14040, or any other detailed assessment of environmental performance. The level of detail in doing the environmental assessment should be appropriate to the intended result. Working with assumptions is fine at this point. A quick evaluation is sufficient where we aim at being "approximately right instead of exactly wrong". "Approximately right" refers to using assumptions in case there are not enough data, such as assumptions on the way the product will be manufactured (considering main production processes) or the way the product will be distributed (referring back to the distribution of a similar product).

The use stage of a product needs special attention when it comes down to defining the use scenario. How and in which way will the product be used? How frequently? What is the energy or material consumption during the use stage? If there are uncertainties, and there will be, one can propose and test different use scenarios like "intensive use" or "less intensive use" to see the differences in outcomes, and to evaluate the consequences for the environmental impacts in the use stage. A practical example would be the use of a scenario for a washing machine for a family household compared with a household of a single person. One application could easily have up

to four to six times more "intensive usage", resulting in a much larger environmental impact. Consequently, the environmental design strategies may be different for these two different types of washing machines.

The pre-study process results in the environmental profile of the product and from that the key environmental performance indicators (KEPI) can be derived. At this stage, it should be clear what we are aiming at in the product development process. The vague starting term of "environment" is now translating into, for example, "reduction of energy consumption during use", "product weight reduction", or any other strategy depending on the KEPI.

3.3.2 Staff Training

The "pre-study" could be conducted by an environmental leader within the organization. However, if it is the first time such a study has been done, it is advisable to seek external support, especially when there is limited knowledge or time within the organization to run the pre-study. To be successful with the redesign of the product, the product development staff should receive training and motivation in order to improve the environmental performance of their own products. This is a critical issue, since improving a product always means identifying and dealing with weaknesses. This knowledge transfer has to be implemented in a sensible way, avoiding resistance due to criticism of previous work done, often, by the same product development team.

It is recommended that workshops, or other awareness and training activities with foreign products not developed by the trainees, be conducted. This way, it is much easier to get acceptance and to identify weak points.

The overall aim is to develop insight into the overall environmental context, identifying why certain issues are more important than others, and also linking the potential activities in the development process (in terms of milestones and deliverables). Here, staff members may need some guidance. Ideally, at the end of such a training process, the basic connections between the environment and the product's life cycle are established, potential activities are identified and linked to the product development process and simple methods and tools are introduced to support daily work.

3.3.3 Support

The whole process of calculating the environmental profile of the reference product requires practical tools and reliable environmental data. Support in decision making is also needed later in the development process, when searching for and implementing new solutions. What are the environmental consequences of new or alternative design decisions? Getting to understand this, but also being able to plan for enhanced environmental performance, is the key to supporting design teams. Certainly it is not all about environment. Thinking in environmental terms is an additional task for the design team and, therefore, support is required.

Simple "if this – then that" rules, easy to understand evaluations, or key values and data are helpful at this stage. Complicated assessments are often difficult to accept and may even be inappropriate. Environmental data should be prepared beforehand and communicated during staff training. Also, some practical exercises should be conducted to get staff comfortable with working with these data and tailor-made indicators. There are no general rules on how to prepare these decision support systems, but it is advisable to take into account the characteristic of a product and its environmental profile. Useful indicators for a raw material-intensive product could be CO_2-equivalent per kg of material or energy values in MJ per kg of material to see the difference a decision for an alternative material could make. Similar data should be prepared for other processes in the product life cycle.

Using that set of environmental data, the design team can not only identify or calculate potential improvements but also check whether the improvement in one stage in the life cycle is going to affect the impact at another stage. In the product redesign, shifting the environmental impact from one stage in the product life cycle to another stage must be avoided.

3.3.4 Product Characteristics

The pre-study identifies the basic characteristics of a product. Two possibilities exist: one, where the use stage in the product life cycle is most relevant; and the other, where the use stage of the product is not relevant, but the use of raw materials and/or the manufacturing stage are important. Certainly, there are exceptions, but most of any product's environmental impacts can be found in these two scenarios (see Figs. 3.6 and 3.8).

3.3.5 Use-Intensive Products

A use-intensive product is a product whose main environmental impact occurs during the operation of the product. This arises either from consuming energy or materials (or both) during use. The environmental impact in the use stage is usually 10–20 times higher than the impact from the use of raw materials or during the manufacturing stage (Fig. 3.6).

Such use-intensive products need to be improved by carefully looking at the user's behaviour and the specific use scenarios. Design for optimal use, and reduction of energy or material consumption will also be required.

The main questions are:

What does the use-scenario look like?
What is needed to optimize product use?

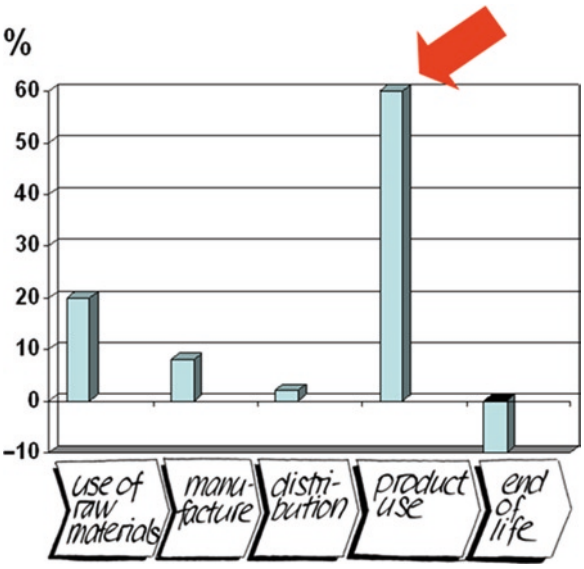

Fig. 3.6 Use-intensive product

Answers to these questions can be found in revising the working principle of the product and in implementing different or new functions to the product. Potential strategies are [9]:

- Optimizing product functionality
- Reducing consumption at use stage
- Avoidance of waste at use stage, etc.

Example: Philips Digital Pocket Memo

A very successful product redesign of a Digital Pocket Memo (DPM) was undertaken at Philips Dictation Systems in Vienna, Austria. The task was to bring environmental knowledge into the product redesign process.

The pre-study showed that the DPM was a use-intensive product due basically to the amount of battery energy required to operate the device. For the intended use over 4 years (4,000 h of operation), about 300 batteries were required. This caused roughly ten times more environmental impact than from the use of raw material and manufacturing stages together.

As a consequence of this pre-study, the improvement strategy looked at the energy system of the DPM. The objectives were (a) to reduce the energy consumption to operate the DPM and (b) to run the device on rechargeable batteries. The resulting redesign yielded a total carbon footprint reduction of 86%. Figure 3.7 shows the predecessor model and the redesigned product.
The improvements were realized through:

Fig. 3.7 Previous and environmentally redesigned Digital Pocket Memo

- Finding smart energy management allowing 17 h of dictation on one set of batteries (previously 11 h)
- Delivering the device with rechargeable batteries, table stand, and external charger to avoid use of batteries
- Improving product functionality, such as providing USB charging function

Full documentation of the environmental performance of the product has been compiled in the form of an Environmental Product Declaration (EPD) [10].

The resulting new product also provides financial benefits for its user. Since one battery is about one Euro at the current market price, the redesign delivers significant savings.

3.3.6 Raw Material/Manufacturing Intensive Products

Products which have only minor or even no consumption of energy or material in their use stage are most likely raw material or manufacturing-intensive products. An environmental profile of such products is shown in Fig. 3.8.

Potential improvement strategies for "raw material-intensive" products are

- Selecting the right materials
- Reducing material inputs, etc.

But there is a limit to the strategies in reducing the environmental impact due to the kind and amount of materials used in a product. If further improvements are intended, the End of Life stage in the product life cycle will necessarily have to be

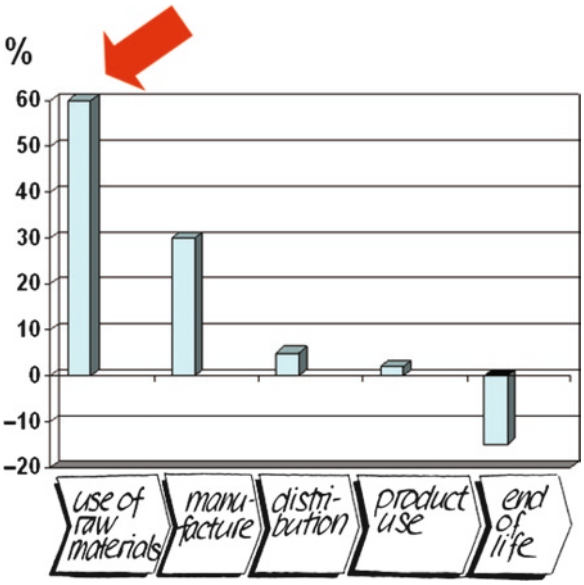

Fig. 3.8 Raw material-/manufacturing-intensive product

considered as well. A combined approach redesigning the Use of Raw materials and End of Life stages will be needed. Of the combined considerations the following product improvement strategies may result:

- Reuse of components
- Recycling of materials, etc.

Subsequently, establishing a resource management system should be discussed and potential competitive advantages identified, especially when looking at the economic benefits of reusing your own components. This may require a different design for most of the products. They will need to be designed such that disassembly can be easily done and processes for upgrading of components can be predicted.

The product structure is also important. An optimized structure is not covered by environmental recommendations alone. However, for recycling, easy disassembly and the chance to get mono-type materials are both very important. In addition, both improvements can provide cost reductions of up to 50%! As mentioned, easy disassembly usually also means easy assembly, and using more environmentally compatible materials (only one type of plastic and one metal) is a well known way to reduce types and parts. But it all depends on the kind of production in which a company is involved. There are three choices:

(i) Identify the product functions required. For a vacuum cleaner, it might be the motor, the housing, the filter, the tube, the brush, etc. These functions are optimised in the form of individual and easily connectable components which also facilitate reuse and repair, if required.

(ii) Combine all parts made of the same or similar materials or which can be made from these materials, where possible, into one or a few parts. This will result in a strong component, material type reduction, and usually cost savings (during storage, logistics, and purchasing). Disassembly is easier when joints are optimised. Materials can be optimized for inscription, recycling, price, and environmental impact. A number of production processes may be eliminated as, for example, only one injection moulding step is necessary for one integrated part, instead of many for many parts.

(iii) If you are in a business like personal computers, it is usual practice to purchase nearly all of the components and the task of your company is to assemble these components. Nevertheless, your chance for improvement is not zero! You can group components to units for simple assembly and disassembly, you can select components that are more energy efficient, or you can optimize the software to deliver some level of energy reduction.

It is certain that nearly all design strategies are hybrid strategies. But considering structural design alternatives also helps to overcome any biases or prejudices that may exist.

All in all, at the product level, we need, to provide the basis of good analysis to determine the best improvement strategies and, at the staff level, with appropriate training and awareness raising to ensure that the new tasks of developing an ecoproduct are understood. Methods, tools, and checklists are needed to support the product development team in the implementation of Ecodesign.

An ecoproduct can be easily identified when

- Ecodesign is integrated into the early stage of product design and development
- The KEPI and the environmental profile are known
- Design changes result in significant environmental improvements and a shift of environmental impacts from other life cycle stages is avoided
- Environmental improvements are communicated to the market

Furthermore ecoproducts have the potential to attract new business opportunities and deliver competitive advantage.

Checklist for Product Considerations – Section 3.3

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Do you know the environmental performance of the predecessor model?	Yes ☺ No ☹	One should know the Key Environmental Performance Indicators and the Environmental Profile before starting new product development	Perform a pre-study before starting new product development	2.3

(continued)

Checklist for Product Considerations – Section 3.3 (continued)

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Is your staff trained in environmental thinking and decision making?	Yes ☺ No ☹	It is important to develop a good understanding about environmental issues in the product development team	Perform training workshops to ensure a high level of environmental awareness in the development team	
Is enough support provided to ensure qualified decision making in the design process?	Yes ☺ No ☹	Robust data and environmental assessment results, as well as practical databases are needed to make quick environmental decisions in product development	Provide in-house data bases for the most common materials, processes, etc.	
Do you know how to improve the environmental performance of your product?	Yes ☺ No ☹	Determine product design improvements based on the environmental characteristics of your product	Use Ecodesign tools to derive improvement ideas: e.g.: www.ecodesign.at/pilot	

3.4 Production Considerations

3.4.1 Factors to Consider in Production

There are at least four factors to consider in the production of a product. They are

- Resources
- Energy and utility
- Emissions
- Hazardous materials

The environmental goal for the production process is the minimization of the consumption related to the four factors. The resources factor refers to the raw materials of which the product and its component parts are comprised, and to the ancillary materials such as chemicals used in the production processes. The energy and utility factor refers to the energy, water, and air consumed, including electricity for the operation of the production facilities, and for the maintenance of the production conditions such as temperature and humidity. The emissions factor refers to the wastewater, air pollutants, and solid wastes discharged into the environment. The hazardous materials factor refers to the restricted substances and materials used in producing the component parts, either in the product itself or as used in the production processes.

3.4.1.1 Efficient Use of Resources

The consumption of resources is linked directly to the cost and environmental impact of a product. Efficient use of resources reduces not only the cost of the product but also the environmental impact resulting across the entire life cycle of the product. Reducing resources input per product contributes to the conservation of natural resources. In addition, it also helps reduce waste generation.

There are two types of resources: materials for building products and parts thereof (often called raw materials) and chemicals for the various processes, including utilities such as water and air for the operation of the equipment and processes (often called ancillary materials).

Most companies actively seek to reduce the consumption of materials going into the parts and products as part of enhancing productivity. In general, they are less interested in reducing the consumption of chemicals than reducing material consumption. This is because reducing the consumption of chemicals does not translate as readily or as significantly into the level of cost savings achievable from reductions in material consumption. The recent EU regulation on chemicals, REACH, however, will change the attitude towards the management of chemicals in production sites. As such, companies will give greater consideration to the reduced use of chemicals in their premises.

3.4.1.2 Efficient Use of Energy and Utility

Energy (including electricity), liquified natural gas (LNG) and oil, and utilities (such as water, air, cooling water, steam, and vacuum), are all normally used for the operation and maintenance of production facilities. The use of energy not only directly affects costs but also the level of GHG emissions. In particular, the Climate Change Convention and implementation of the Kyoto Protocol and the Copenhagen Accord, including the cap-and-trade system, will cause product manufacturers to set GHG emission reduction targets. This will lead to the reduction of energy consumption. Therefore, companies should monitor the energy consumption activity in their production processes, and develop GHG emission inventory databases by measuring and/or calculating GHG emissions from each and every energy consumption activity. You can use GHG emission databases to monitor and identify improvement opportunities for the mitigation of GHG emissions in your production facilities.

Treatment facilities, such as wastewater treatment plants and air pollution control devices, are an integral part of production facilities. Without successful control of emissions, the entire production process may be at risk of closure. Since the waste emissions depend on the design of the supply and use of the utilities, the design of the utilities must consider the treatment of the waste emissions from the utilities.

3.4.1.3 Minimization of Emissions

Emissions are classified into three categories: Emissions to water, emissions to air, and emissions to land. Emissions are an unavoidable output from any production activity. The real question is how to minimize emissions in the first place, and how to treat the residuals at the lowest cost and highest environmental efficiency.

Two important aspects of the emissions to water are (i) the concentration of pollutants (quality) in the wastewater and (ii) the wastewater flow rates (quantity). Concentration and flow rate are linked to the loss of ancillary materials and consumption of process water, respectively. Therefore, you should implement good housekeeping of the process chemicals and process water in order to minimize emissions to water. In this respect, reusing wastewater can be one viable option.

Of all the possible emissions to air, GHG emissions are currently the most important, at least based on the level of political and public debate. Thus, you should quantify (measure) and manage the GHG emissions from the production sites. This topic is discussed in depth in Section 3.4.2. Another important aspect to consider for the minimization of emissions to air is the separate collection and treatment of the air discharge streams. When a mixture of air pollutants are discharged, the capacity of the circulation pumps and pollution control equipment increases unnecessarily because of the need to handle larger amounts of polluted air.

Emissions to land include solid waste and liquid waste discharges. In order to minimize the emissions of liquid wastes, they need to be collected and treated separately. When solid waste that has a consistently similar composition is regularly discharged, most of this waste can be reused and recycled. In this kind of situation, you should consider the implementation of closed-loop recycling of the solid waste. This not only reduces the emissions to land but also the cost of raw materials.

3.4.1.4 Reduction of the Use of Hazardous Materials

In general, hazardous materials are classified into two groups, prohibited and controlled. Prohibited materials are banned from use in the product and, as such, they are screened out during the purchasing stage. However, prohibited materials and/or substances can sometimes find their way into component parts, although not intentionally added. Therefore, purchased parts and products should be regularly and systematically checked for the presence of the prohibited materials and substances. Controlled substances are not banned for use but may be regulated in the future. In some cases, customers specifically request that their products not contain these materials/substances. Therefore, part and product manufacturers should set up and implement a management or control system that distinguishes the parts containing controlled substances from those containing none. Most ERP manufacturers operate their hazardous substance/material control system under the title of a green supply management system. If your company does not have such a system, a communication channel between suppliers along the supply chain should be established to control the hazardous materials and substances in the parts.

3.4.2 Carbon Footprint

In order to remain competitive in the marketplace, you should reduce the carbon footprint of your products as well as in your company and operations. The cap-and-trade system for carbon emissions will force manufacturing companies to adopt measures to mitigate carbon emissions from their products, production processes, and production facilities. We have discussed the method for determining the carbon footprint of a product in Section 2.3.1.3.

Carbon management can be defined as management that identifies GHG emissions improvement opportunities from the production sites (and preferably from the entire life cycle of a product) and implements corrective measures to reduce GHG emissions. In order for the successful implementation of carbon management in a production site, GHG emissions should be quantified. Based on the quantified GHG emissions data, you can identify reduction opportunities from the production site.

3.4.2.1 Quantification of GHG Emission

There are several internationally recognized guidelines for the quantification of GHG emissions from production sites [11–13]. A GHG emissions quantification method is described in Section 2.3.1.3.

In order to quantify GHG emissions from a production site, the system boundary for data collection should first be defined. Here, the system boundary is defined by the production sites of the product and component parts. In other words, the system boundary is Gate to Gate which includes key parts (e.g., capacitors, resistors, printed wiring boards) for ERP and key unit manufacturing processes (e.g., extrusion, moulding). This includes collecting data such as GHG emissions from stationary combustion sources, mobile combustion sources, process emissions, as well as fugitive emissions. The GHG emissions data then becomes the GHG emissions database and can be used for GHG emissions accounting and certification.

3.4.2.2 GHG Emission Reduction in the Production Site

The analysis of quantified GHG emission data can reveal weak points in production sites in terms of the amount of GHG emissions. The contribution analysis is the method of choice here. In this method, GHG emissions from individual unit processes or facilities are divided by the sum of GHG emissions from the entire production site. Those unit processes or facilities contributing more than a certain percentage value (e.g. 1%) to the total, are identified as weak points. Corrective measures will then be applied to improve those weak points to reduce GHG emissions.

A common sense approach is often the best approach to reducing GHG emissions from production facilities. For instance, replacing existing low efficiency boilers and heat exchangers with higher efficiency boilers and heat exchangers can

significantly reduce GHG emissions from the stationary emissions sources, as well as increasing efficiency (i.e. reducing operating costs).

However, a systematic approach is required when reducing GHG emissions associated with electricity consumption. In any systematic approach, the equipment requiring electricity for operation must be identified and the related electricity consumption determined (calculated or measured). Most equipment in production processes and utility supply facilities consume large amounts of electricity. Pumps and heaters, known to consume high amounts of electricity, can be replaced by ones with higher efficiency. In order to reduce electricity consumption systematically, however, a coordinated effort between process engineers and equipment suppliers are necessary from the equipment design stage onwards.

Table 3.2 summarizes major sources of GHG emissions and reduction measures from a production site.

Table 3.2 GHG emission sources and reduction measures from the production site

GHG Emission sources	Reduction measures
Stationary combustion (boiler, steam)	Increase combustion efficiency, waste heat recovery
Electricity consumption (production, utility, facilities, operation)	Design for energy savings during the facility design (equipment selection), optimum operation
Process emissions (chemicals)	Process optimization, installing abatement facilities, use of alternative chemicals

Alert

Carbon Management: For successful carbon management, it is advisable to expand the system boundary from the production site to all of the life cycle stages, including suppliers of parts, use, and end-of-life. Often GHG emissions from the production stage can be minor compared with the other life cycle stages, in particular for the use-intensive products such as ERP. In this respect, the carbon footprint of a product can be used to identify weak points of the product and, thus, corrective measures can be applied to reduce GHG emissions of a product over its entire life cycle.

3.4.3 Green Supply Chain and Regional/Local Aspects of Production

Current supply chain management is focused on ensuring the flow of a part containing no hazardous substances. For this purpose, green supply chain management systems, such as the Eco-partner and Green-partner, are in place along the part supply chain of most major electronics manufacturers.

Benefits of a green supply chain are not limited to the control of parts free of hazardous substances. The system can also be useful to implement Ecodesign. Information can be collected on material composition, weight, and the GHG emission data for each part in the green supply chain and the collected information can be used for Ecodesign. Based on the collected information of the part, a producer can evaluate its suppliers in terms of the GHG emissions potential and other environmental aspects of the part. The information and evaluation of results can be stored in the producer's parts database and can be used to communicate with suppliers.

Depending on the location of the production facility, different local and regional regulations may apply. Regulations such as air pollution control, wastewater discharge limits, and solid waste treatment methods differ from region to region and from country to country. Strict compliance with the applicable regulations is a must for any production facility.

Other major environmental aspects to consider in the production process include total nitrogen and phosphorus concentration in the wastewater, ozone depleting substance emissions in the air, GHG emissions, and toxic substances in the waste stream, among others. Nitrogen and phosphorus in wastewater can cause eutrophication, ozone depleting substances cause stratospheric ozone layer depletion, and GHG and toxic substances cause global warming and ecotoxicity, respectively.

Energy often comprises a significant portion of the product cost. In the case of the liquid crystal display (LCD) production plant, for instance, the electricity cost exceeds 1% of the total cost of the production of LCD. Thus, energy is not only an environmentally important factor, but also an important cost factor. For successful reduction in the energy intensity of a production process, an energy savings strategy must be adopted during the design of the production facilities. If this is not feasible, then optimization and improvement of the high energy consuming equipment should be a priority.

Checklist for Production Considerations – Section 3.4

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Have you considered four factors in production? Efficient use of resources; Efficient use of energy and utility; minimization of emissions; and Reduction of the use of hazardous materials	Yes ☺ No ☹	The goal of considering four factors in production is to minimize the consumption of the four factors during the production of the product	Perform analysis of the four production factors: resources, energy and utility, emissions, and hazardous materials	3.4.2

(continued)

Checklist for Production Considerations – Section 3.4 (continued)

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Have you analyzed the carbon footprint and implemented a carbon management system?	Yes ☺ No ☹	Reduction of the carbon footprint of a product and its production facilities is a must to remain competitive in the market	Develop carbon footprint, identify weak points of the carbon footprint, and improve the weak points	2.3.1.3, 4.4.4
Are you certified as a green supplier in the green supply chain?	Yes ☺ No ☹	Getting certified as a green supplier is a must to remain as a supplier to many finished product manufacturers	Establish and implement green supply chain management system	4.4.2
Do you comply with the local and regional environmental regulations on your production facilities?	Yes ☺ No ☹	Major environmental regulations on the production facilities include: Air pollution control, wastewater discharge limit, and solid waste treatment methods	Investigate different regulations in different localities and regions, and implement measures for the compliance with the regulations	1.2
Have you considered energy savings and optimized the energy use of the production facilities?	Yes ☺ No ☹	Energy savings are both environmental and cost factors for production facilities	Design production facilities for energy savings. Optimize and improve high energy consuming equipment	

3.5 Management Considerations

Environmentally conscious design will never be undertaken for environmental purposes alone. Management, by definition, has to balance costs, quality, and dependability together with the technical and environmental requirements. Different optima are possible for different kinds of products. In the final analysis, the products that sell best are those which meet customer requirements in the best way possible. Obviously, it is more profitable for a company to sell one million products, each of which reduces energy consumption by 10%, than selling a similar product which reduces energy consumption by 50%, but of which only a thousand can be sold because of design or appearance limitations!

3.5.1 What Approach to Take for Chosen Business Model

The decision for a business model [cf. Section 1.3], from the perspective of sustainability, must address, inter alia, the following:

– Integration of the application system of the product
– Integration of services

– Long-term planning
– Planning for reuse
– Life cycle thinking

As described in Section 1.3, many more factors should be investigated in order to select the most appropriate environmental solutions. But a change in business model from a company selling only hard goods to one with a service orientation, or one with a more life cycle based direction, opens many more opportunities for environmentally benign solutions. The change of Xerox from a manufacturer of copiers to a company selling everything in combination with documents "We are the document company!" enables leasing models instead of sales or take-back business models and allows recycling of used copiers and user friendly services.

Combined with the model chosen, questions arise about costs, quality, dependability, and technical features.

3.5.2 Costs

Many environmental costs associated with a product are usually not calculated when they are placed on the market and are used by the customer. Increasingly, environmental aspects or attributes of a product are becoming an important decision-making factor for customers, together with quality and price.

Costs should also be examined at all stages of the product life cycle. Costs cannot only be saved by changes in product design. Sooner or later, the impact of the total costs will return to the producer. With the application of the principle of "*producer responsibility*" by politicians, for example, the costs associated with recycling and take-back are being transferred to the producer. Some customers, such as those in the automobile industry, have taken the opportunity to load some of the external costs on their suppliers. Life cycle costs [14] are also a reason for increasing the cost of raw materials, particularly if the related mining activity creates environmental problems. Recycling is usually cheaper than mining. New ideas and innovations are needed to overcome these cost increases.

Examples for innovative cost reduction solutions

– Valuable packaging for IC can be cleaned and reused as new.
– Cardboard packaging can often represent 6–10% of the product's value. However, they can often be reduced to zero if the product can be sent without packaging!
– Maintenance and service costs can be reduced by environmentally friendly remote control.
– Software application can be substitutes for hardware or can help optimize processes.
– Software programs can be drivers of high energy consumption (e.g. by their battery loading commands).

More and more environmental regulations contribute to rising production costs or, as for carbon dioxide, certificates contribute to the costs of running plants. As a minimum, new investments in environmentally compatible technologies will need to be made in order to achieve or maintain competitive advantage. For other products, a cost increase could result because of regulations that require that hazardous materials be removed and substitutes found. A manufacturer has, through his Ecodesign process, the possibility to find cheaper alternative solutions or achieve some level of competitive advantage.

Promotion of environmentally improved products can be organized by governments. Examples include

- The "*toprunner*" approach in Japan.
- Ecolabels with energy classifications in Europe or in the US (with Energy Star).
- Direct intervention by governments (through taxes for cars, pay back, or prohibition of the worst technologies in the market such as the prohibition of incandescent light bulbs in some countries).

In this last example, old technologies will have to be replaced by more environmentally benign ones to avoid future cost increases.

Examples

"Toprunner" – Improvement by competition: The top performing product becomes standard after 2 years. Those consuming the highest energy have to be phased out. Prices can increase.

Energy classification is used for refrigerators in Europe – Class A++ and better in a scheme from A (best) to G (worst). The best products save roughly as much energy during their expected life as the difference in cost. The program is voluntary, but market pressures have pushed the average toward the better products; a similar effect is happening in Japan by the toprunner program.

Regulation: Some governments regulate the market in specific directions: Prohibition of incandescent light bulbs in Australia, Europe, and New Zealand has eliminated the use of less efficient lamps. The Ecodesign directive demands minimum requirements for all ERP in Europe. Differential taxes for cars with differing environmental impacts result in promotion of "cleaner" cars. Emission trading is another tool for reducing CO_2 emissions of plants.

Cost savings of between 25% and 50% are achievable by reusing "qualified-as-good-as-new" components [18], recycling of materials, or reselling of products.

Rising costs of energy and resources have to be integrated in the planning phase through the development of alternative or energy saving components.

A calculation of *activity based costing* instead of departmental costs is a much better way to identify the opportunities for product alternatives [15]. Environmental costs for end users are of increasing importance from a sales perspective. Even small cost differences may be important to the end user because of limited budgets. End users and purchasers are often not the same. The purchaser often only selects according to the lowest product price and not necessarily according to the total costs, and frequently without involvement of the end user. Getting the end user involved in the purchasing process may well lead to better long-term customer satisfaction.

3.5.3 Quality

Quality criteria should also extend to environmental requirements. During the introduction of RoHS, it could be seen that many quality departments were not interested in the regulation because they believed it related only to environmental issues. However, if the limit of a substance like lead is exceeded in a component, it could very well result in the total loss of that non-complying set of components and require the procurement of replacement components. As such, this kind of failure is a non-repairable failure. Complaints, therefore, will end up on the desks of the quality managers. To avoid these kinds of situations, environmental and quality managers will need to co-operate intensively and should integrate such complaints or failures in their early warning system.

Another new kind of quality problems occurs when environmental problems, together with the transfer of a production plant, are transposed to a developing country. Then problematic processes or chemicals may continue to be used. They have only disappeared from one location and are transferred to another! However, environmental rating agencies or the media may discover that a company continues to use special chemicals or processes somewhere in the world. When this happens, good news does not follow. The parent company might receive a poor environmental rating and any resulting public exposure could seriously reduce the company's market share.

Also, insurance companies may not be willing to pay for damages caused by substances which are already prohibited in many countries, if they are continued to be used in developing countries, even though these substances may not be restricted there! For instance, asbestos is still allowed in countries like China, India, and Russia. The illness resulting from exposure will be the same as it occurs in other countries. It will only be a matter of time before the lawyers begin to launch individual or class action law suits.

As quality people are accustomed to dealing with statistics, a new field for them will be the *risk assessment* and management of materials and components that are supplied to the company. The risk assessment can be combined with potential cost calculations on the basis that the worst case occurs – in which suppliers

cannot supply! This is not the typical FMEA application but, in these types of circumstances, it will be necessary to inform the board of directors! Managers also need to see what a new law or regulation could cost as compared to the current state of the art. Examples are provided in Annexes 4 and 5. An early warning system can reduce the risk to nearly zero! But a good early warning system is only effective if (a) the information gathered worldwide is complete and distributed to all that need it in the company, and (b) measures are taken to deal with the risks.

Industry associations or manufacturers organizations (e.g. EIA, DigitalEurope, Orgalime, ZVEI) are good sources to help analyze trends in forthcoming legislation. Care also needs to be taken in dealing with import and export declarations. Company officials dealing with this subject need appropriate expertise and must be well informed.

It is always useful to integrate environmental requirements into any product development process. Many companies create their own checklists based on own experience (we refer here to the integration of IEC 62430 [Annex 9] into the development scheme).

Quality staff should look for milestones in product development to ensure that the required environmental attributes are, in fact, completely integrated into the product. Integration of the environmental attributes is not only necessary for components and products, they should also be integrated into capital projects, from design, to installation, to the final operation [Annex 2], and into services, maintenance, and software. Generally product, processes and management system have to be audited.

Suppliers should also meet the same kinds of requirements. Supplier audits often do not include questions about the integration of the environmental requirements into production processes related to supplied components or products. Much work can be saved if the suppliers have to fulfil at least some basic requirements, without which a relationship with the supplier may not be possible.

Alert

Generally speaking, customers assume that producers are prepared to, and actually do follow legislation and are a step ahead of any related trends, thereby ensuring that they will continue to operate in conformity to legal requirements. However, it is often the case that a customer is only interested in the lowest price of the supplied component. So his attitude might be “I do not want a change”.

If these kinds of debates exist at the staff level, time is being wasted. In reality, it will be important to make the necessary changes early enough to accommodate the sales logistic needs of both the supplier and the purchasing company. Therefore such discussion should happen at the senior corporate level (i.e. the CEO level).

3.5.4 Technical

The technical challenges from the environmental side are manifold:

– "Innovation jumps" will be required for the product category sooner rather than later!
– Production processes that are out-of-date will have to be changed.
– Sometimes new technologies (e.g. for coatings or joints) may have to be applied without full knowledge of their long-term stability. How can we solve this problem?

Required environmental attributes are frequently an *innovation* driver. With old technologies, environmental improvement is usually very limited or perhaps even impossible. However, improvements in the range of 10–50% may be needed to fulfil world-wide demands for energy reduction, or for cost reductions in a market that has experienced dramatic increases in resource prices. The innovation potential for a washing machine working with water is rather low after 50 years of intensive development. Innovation is required with other washing liquids, materials, or technologies. [Examples: Washing with liquid carbon dioxide: [16] clothes that don´t become dirty by "Lotus effect": [17] Sanyo Japan].

Similar questions occur for old, out-dated industrial processes. They may have been leading-edge 50 years ago. But today, employee health issues could become costly if processes continue to rely on lead soldering, or if equipment cleaning processes continue to employ toxic chemicals. If alternative processes are evaluated, these costs or problems are often overlooked. Fortunately, alternative processes are available, the necessary conversion is not difficult, and the test costs are not very high. The biggest surprise – new technology processes can, in some cases, be much cheaper! Compression technology for joints, for example, can be cheaper than soldering.

A company should ask itself: Which kind of processes do we use? Is there a chance that, for example, the chromate coatings become prohibited? If so, what alternative is available? Do we sell the regulated motors by which we can, for example, save 50% of energy, or do we continue to sell old equipment? Customers will not accept poor technical attributes in the future.

The industrial processes of a company should be classified into:

(i) Those where there is high potential for restrictions on hazardous substances (rare or toxic) – in which case, changes are required immediately.
(ii) Those that use substances that could become cost drivers – in which case, alternative options should be seriously examined.
(iii) Those that use old processes but where improvement may be possible by changing ovens, drives, stand-by systems, better temperature management – in which case, some mid-term action is needed.
(iv) Those where the processes either need no immediate action or where the possibility of changes may be very limited.

The best way forward is to implement a *systematic process for environmental innovation*. One of the first issues in this kind of process is the age of a product or a

technology when new product development starts. The predicted end of a product or technology should be estimated, as should the timing for the introduction of any new technology.

Alert

Managers might hear from their staff that no more improvement is possible or that 50% energy saving with this equipment can never be achieved. In reality, both objectives may well be achievable, but only with a new technology or by examining the full life cycle. In any case, the necessary investment must be organized by management.

3.5.5 Dependability

When new properties or behaviour is introduced into a product, customers will want assurances that the product has a high level of dependability and will perform over a considerable amount of time, particularly so when a price increase is involved.

The first question occurs when a customer calculates the energy saving over the product's lifetime. Perhaps the cost difference between an environmental premium product and an environmental poor product can be saved after some 10 years of product life. But if the normal guarantee for the new product is only 3 years, the investment might be at risk. The solution to this problem is an opportunity for producers and politicians!

In saturated markets, most policy targets can only be achieved if the existing products can be rather quickly substituted by those with better environmental qualities. However, no-one would willingly scrap a 5 year old refrigerator that still functions well and purchase a new one. The solution of this problem is again an opportunity for politicians and producers.

The concept is to include "qualified-as-good-as-new" components in new products. Many components have a life span that exceeds the normal expected life of the products in which they fit. In IEC 62 309 [18], the framework conditions are described under which no risk should occur for the customer. The environmental and the cost benefits can be very high. Nevertheless, the challenge is the "common wisdom" (albeit incorrect) that "reused products cannot be reliable". They can be reliable! The solution is to convince customers about the advantages of reuse and offer them the same quality checks and guarantees as for new products. Similarly, another "common wisdom" (again incorrect) is that environmentally compatible products cost too much and don't work as well as competing products. Companies could work together with associations and politicians to overcome the problems of the afore-mentioned "common wisdoms".

Alert

The long-term stability of new materials cannot always be tested sufficiently. In this case accelerated tests have to be applied. There remains a risk for some special applications but this should not prevent a company from applying such solutions. One could start testing as early as information about now legislation is available or when they determine that the product has, on average, a much shorter market life and the risk is much lower.

3.5.6 Management System

Management systems were installed as cost-saving measures and aimed at reducing failure rates and levels of work. A structured and systematic way to work is always superior to a chaotic way. Customers have more faith and trust in an enterprise that is well managed.

In this book, the authors have attempted to describe a number of environmental management activities and systems that are designed to achieve a more systematic approach to the implementation of environmental improvements and requirements. For Ecodesign, the inclusion of IEC 62430 into a product development scheme will often be sufficient (cf. Annex 9).

The easiest way to integrate environmental aspects into product design and development is to take – if available – the existing ISO 9001 system [20] and include aspects of IEC 62 430. In ISO 9001, the product development scheme is already included and, as such, the Ecodesign requirements easily fit. Many companies have also integrated Ecodesign in the ISO 14 001 system corresponding to the EC EMAS system. ISO 14 001 has its origin in the production and the way a plant has installed its industrial environmental protection management. Requirements for products are very rare in this standard and too general. A structure for Ecodesign is not available in ISO 14001. However, IEC 62430 fits into both standards. In Annex 9, we include an example for a possible structure for Ecodesign in ISO 14 001.

Indeed, in many enterprises *one* general management system containing the requirements of all necessary systems has already been installed. If required, certification can cover all of the management systems. “All in one” is naturally cheaper and integrates the different responsibility centres.

Alert

Not every management system must be certified! Only where customers require a certificate is it desirable. It is also possible to self-declare that an environmental system is in conformity with ISO 14001 or another standard.

It makes a lot of sense to integrate the requirements of ISO 9001(quality), energy management, OHSA 18000 (health & safety), and social responsibility. They all contain environmental requirements that should be dealt with together in an overall management system.

The next step – directed by software process requirements – seems to be the "process framework" [20]. This summarizes all of the repetitive processes in an enterprise in a structured hierarchy, with up to eight levels. If such a system becomes an international standard, it could potentially include all future management systems and their requirements in the corresponding software. Special extracts could allow for concentration on, for example, the environmental processes and requirements. Such a system could also be certified according to the management system standards if the elements of these standards were completely included in the "Business Process Framework".

In other chapters, we have mentioned several management systems, including:

- Energy management
- Chemical and material management
- Management of restricted substances
- Structured and planned innovation (ideas generation, patents, targets)
- Risk assessment (with suppliers, for the enterprise) and risk management
- Management of the whole life cycle including life cycle costing
- Management of reuse by a more general product planning
- Environmental supplier management

There is no need to complicate life by installing different and individual management systems for all of the different management requirements. For Ecodesign in the Ecodesign directive, Annex 1 provides a detailed description of the maximum requirements a company would have to meet for systematic implementation of Ecodesign (including documentation, target definition, alternative evaluation, and reporting for products to get the CE mark).

Management requirements are included in the Ecodesign directive and can be found in Annex 8. Requirements of the ERP CE-mark include environmental aspects in addition to the requirements of the European "Low Voltage Directive" (LVD) [21].

At the industry sector level in the EU, the mandated statistical reports require special reporting on a country by country basis. However, these figures do not necessarily reflect the reality for any one company. The Global Reporting Initiative [22] has developed a more ideal and standardized system in which many companies take part, but often not all have comparable world-wide data. Rating agencies like the Dow Jones Sustainability Group Index have developed more future-oriented reporting systems with figures that could influence the financial success of an enterprise. Reporting contents are changing every year and the ranking provides investors with information that could be used to influence decisions on stock purchase. More and more, financial success can directly relate to the degree to which companies manage environmental issues.

As previously mentioned, certification is not always necessary. Self-declaration could be sufficient, but customers must be willing to trust the declaration. On the other hand, *environmental audits* should be performed on suppliers and also internally. Together with the environmental audit, some companies sometimes forget to organize an annual *management review* with their management board. During this discussion, improvements identified by the audits should be decided upon and targets for the following year determined. It is important to describe the policy, the environmental principles and different organizational procedures in an "Environmental Principles" brochure. This type of information is required by ISO 14001 and allows interested parties to see what should be and what is done by the enterprise.

Checklist for Management Considerations – Section 3.5

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Have you chosen a sustainable business model?	Yes ☺ No ☹	It may be necessary to choose a model covering more than one generation of product, take-back and recycling, and service	Optimization, e.g., by including external partners, customers, competition, etc.	1.3, 3.1, 4.1, 4.2
Does your company want to become a market leader?	Yes ☺ No ☹	If yes, you must be best in environmental aspects and in management	Benchmarking	1.3, 2.5, 4.1, 4.5
Are your environmental aspects and strategic cost targets defined?	Yes ☺ No ☹	Future cost increases might depend on scarcity of energy, resources etc.	Make sure sustainability is part of company values	Annex
Does quality management include the fulfilment of environmental aspects?	Yes ☺ No ☹	Quality and environmental managers have to co-operate	Annual review	2.5, 4.5
Is your risk management planned and does it include environmental risks and potential costs?	Yes ☺ No ☹	Risks could come from new legislation, standards, changes in market conditions, changes in management systems	Regular update recommended	2.5, Annex 4
Are costs over the life cycle, or activity-based costs, integrated in the cost management for product development?	Yes ☺ No ☹	Many environmental projects would have a short payback period if they were calculated correctly	Check procedure	2.5, 4.5

(continued)

Checklist for Management Considerations – Section 3.5 (continued)

Assessment questions	Answer	Comments	Recommended follow-up activities	Related sections
Are Ecodesign directive requirements integrated into product design & development?	Yes ☺ No ☹	In a management system Annex IV or V of Ecodesign directive has to be integrated	Review for correctness	1.2, 2.5, 3.3, 4.3
Is a communication system planned to inform customers and the public about advantages of products and company?	Yes ☺ No ☹	Product declarations, green portfolio, future scenarios and targets	Test acceptance of information	2.2, 3.2, 4.2
Is a take back, reuse, and recycling system planned based on the acceptance of customers?	Yes ☺ No ☹	For refurbishment, dependability of the products or components and trust by customers are required	Build up environmental communication for your company and products	2.5, 3.3, 4.3, 4.4
Is there a list of all of the important environmental processes and their systematic management?	Yes ☺ No ☹	Management of hazardous substances, energy, take-back and recycling, innovation, suppliers, etc.	Identify regularly new processes	2.5, 4.5
Are technologies evaluated and systematically changed if required?	Yes ☺ No ☹	New processes need time to develop, therefore planning is necessary	Report about kind of processes and risks	2.5, 4.4
Is continuous improvement of the environmental strategy planned?	Yes ☺ No ☹	Basis: Global reduction targets, trends, competition	Observe market for environmental trends	2.5, 4.5

3.6 Integrated Strategy

By running through the checklists in this chapter, one can find one's own roadmap towards sustainability and identify where to go and why.

We have tried to identify the different considerations at the corporate, market, product, production, and finally management levels, and brought forth a range of ideas for possible implementation. All of these considerations should be combined into one picture in order to develop a company specific strategy.

The following decision matrix might be useful to develop the process strategy. It is advised to not only list strategies, but also assign responsibilities and define deadlines to achieve the identified improvements.

Level of consideration	Key question	Your own evaluation	Your own key strategy for improvement
Corporate	What code of conduct should the company follow?		
Market	How does the company want to position the company's products in the marketplace?		
Product	What does the environmental profile of the product look like?		
Production	How can the company's production processes improve environmentally, including issues related to energy and resource consumption, and hazardous substances?		
Management	How can the company ensure that the required (often strong) improvement takes place?		