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A case study of the adoption of a reference standard for ISO 14006 in the lift industry

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Abstract The Spanish UNE 150301 standard was used as a basic reference point in paving the way for the ISO 14006 ecodesign standard. This article aims to analyze the pioneering UNE 150301 standard, as well as its adoption process and its practical results in the lift industry. Since the UNE 150301 standard is in a very early stage of dissemination, an empirical study based on a qualitative methodology has been designed. An exploratory case study has therefore been carried out with the participation of a company from the lift industry which is, in fact, the first Spanish industrial company to have adopted the aforementioned ecodesign standard. The company subjected to analysis has integrated ecoindicators into the design process to analyze the environmental impact of its products on each stage of their life cycle. Using these ecoindicators, the company has observed that the main impact is evident in the usage stage, due to energy consumption. The company has managed to improve products by means of a continuous improvement process, with reductions in terms of both cost and environmental impact. The adoption of the standard UNE 150301 can be a useful tool in reducing the environmental impact of the products and in obtaining some competitive advantages, such as cost reduction, improvement in energy efficiency of the product, and a better adaptation to laws and regulations.

Keywords Ecodesign · ISO 14006 · UNE 150301 · Environmental impact · Life cycle · Lift industry

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Introduction

Current theories maintain that the function of the industrial designer is essential in ecodesign because they develop their work during the initial phases of the product development process (Lofthouse 2004). For these reasons, the fundamental aim of designers along these lines should be to maximize the value of the product in a sustainable way, while minimizing its negative impact (Platcheck et al. 2008; Michelsen and Fet 2010). As a result, there is a large amount of scientific literature which analyze the different ecodesign strategies and tools available (among others, Cerdan et al. 2009; Fernández-Alcalá 2007; Bare 2010).

On the other hand, the need on the part of modern-day society to promote international standards which may contribute toward sustainable development have had a major influence on those ecodesign standards that can be considered to be one of the most noteworthy general tools available (Bengoetxea 2007; Knight and Jenkins 2009; Jong-Hwan et al. 2009; Bare 2010, Chiang et al. 2011). Moreover, we should remember that in recent years we have witnessed a speeding-up in the standardization process in an economy which is characterized by globalization and the deregulation of markets (Heras 2006).

This standardization process has been especially significant in the lift components sector. However, there is no unification in terms of the standards used worldwide. For instance, Fig. 1 shows how, depending on the region in the world where the lift is being marketed, different safety rules for their construction and installation need to be followed. Among these standards, attention should be drawn to the use of the European EN 81-1/2, the American ASME A17.1 and the Japanese JIS. This entails a problem for manufacturers as, depending on the country where their products are destined, they have to follow different protocols. For these

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Fig. 1 Main standards used worldwide for lift manufacture. *Source* Adapted from Lamelle (2007)

reasons, the International Organization for Standardization (ISO) TC 178 committee is working to unify the different standards used worldwide (Lamelle 2007).

As far as environmental management is concerned, attention should be drawn to the role played by the ISO 14000 family of standards. Along these lines, we should turn to the ISO Technical Report ISO/TR 14062 (BSI 2002) in the field of ecodesign. This document describes the integration process of environmental aspects into the product design and development process (Knight and Jenkins 2009).

Within this context, the Spanish Standardization and Certification Association (AENOR) decided to take a further step in this direction in Spain in June 2003 and publish an ecodesign regulation: the UNE 150301 standard (AENOR 2003). As an important background to this standard, the fact that both Spanish public institutions and private business have experienced major growth in terms of the adoption of different environmental management standards has to be taken into account—such standards include the ISO 14001 standard and the EMAS model. This is true to the extent that Spain is currently ranked third in the world in terms of the number of ISO 14001 certificates issued and the first in terms that are played down with regard to the size of its economy (Heras et al. 2008).

The above mentioned UNE 150301 standard goes beyond other environmental standards such as the ISO 14040 standard, which are used to analyze the life cycle of the product, the ISO 14031 standard, which is a tool to develop the environmental performance evaluation (EPE), or the ISO/TR 14062 standard, which is designed to integrate environmental aspects in the development of products—as its purpose is to provide organizations with elements of an Environmental Management System in order for the design and development process involving products and/or services to be effective—also from the environmental standpoint (AENOR 2003). Furthermore, it should be specially mentioned that this Spanish standard was used as a basis for creating the ISO 14006 ecodesign standard (Ihobe 2008). Indeed, the drafting of this standard was approved in Beijing in 2008 by the ISO/TC 207 committee. The aim of this standard is to integrate design and development into a management system in such a way as to reduce the environmental impact of the products designed—not only in the design and manufacturing phases, but also throughout the life cycle of the product.

The ISO/TC 207 committee used this standard as basic reference points in the drafting process of the ISO 14006 (Ihobe 2008; ISO 2011): on the one hand, standards which analyze the life cycle of the product and form the basis of its design, such as the UNE 150301 standard, ISO 14040 (ISO 2006) and ISO/TR 14062, which is going to be repealed; and on the other, the ISO 14001 and ISO 9001 standards, with which an attempt is made to facilitate their integration as far as possible. This standard is not, in principle, certifiable, although the different national committees are able to opt to transform it into a certifiable regulation in their own countries (Ihobe 2010).

The aim of this article is to analyze how the UNE 150301 standard has been adopted in the lift industry. This article, which has been developed in the company Orona, was chosen owing to the major ecodesign potential these products have as, among other aspects, they consume a large amount of energy during their life cycle—which is approximately 30 years (Ihobe 2010).

Following the introduction, the article then goes on to analyze the structure and content of the UNE 150301 standard and its dissemination in Spain. It later continues in the third section to describe how the case study carried out is analyzed. The fourth section contains the discussion, and the fifth the conclusions of interest to those groups involved in the adoption of this type of standard, and the references are provided in the sixth—and last—section.

The Spanish UNE 150301 standard

The UNE 150301 standard is an ecodesign standard which, by means of a system based on continuous improvement, helps us to reduce environmental impact on the different stages of the life cycle of the product: obtaining and consumption of materials, factory production, distribution and sale, usage, and end of life.

The UNE 150301 standard was passed by AENOR, which also enjoyed the support of Ihobe in promoting it, the latter being a public environmental management company funded by the Basque Government. These two bodies are represented on the ISO/TC 207 technical committee, which is responsible for developing the ISO 14006 standard.

The UNE 150301 standard is divided into four main sections (see Table 1): The first three contain, as in the case of other standards, the classic points regarding the "Purpose and field of application" (1), "Standards for consultation" (2) and "Definitions" (3). Section 4, titled "Requirements of the Environmental Management System for the Design and Development Process" (EMSDDP), is the part in which the cycle involving the continuous improvement of this standard is described (see Fig. 2).

We asked the New Product Department of AENOR to analyze the diffusion of the standard in Spain. It provided

Table 1 Structure of the UNE 150301 standard

1 Purpose and field of application	
2 Standards for consultation	
3 Definitions	
4 Requirements of the EMSDDP	
4.1 General requirements	
4.2 Environmental policy of reference	
4.3 Planning	4.3.1 Identification and assessment of aspects
	4.3.2 Legal and other requirements
	4.3.3 Objectives and goals
	4.3.4 PDD environmental management programme
4.4 Implementation and operation	4.4.1 Structure and responsibilities
	4.4.2 Training, awareness-raising and professional competence
	4.4.3 Communication
	4.4.4 Documentation pertaining to the EMSDDP
	4.4.5 Control of documentation
	4.4.6 Operational control
	4.4.6.1 Planning of design and development
	4.4.6.2 Initial elements of design
	4.4.6.3 Results of design and development
	4.4.6.4 Review of design and development
	4.4.6.5 Verification of design and development
	4.4.6.6 Validation of design and development
	4.4.6.7 Control of changes in design and development
4.5 Checking and corrective action	4.5.1 Monitoring and measurement
	4.5.2 Non-conformity, corrective action and preventive action
	4.5.3 Registers
	4.5.4 Audit of the EMSDDP
4.6 Review by the management	

Source put together by the authors from the UNE 150301 standard (AENOR 2003)

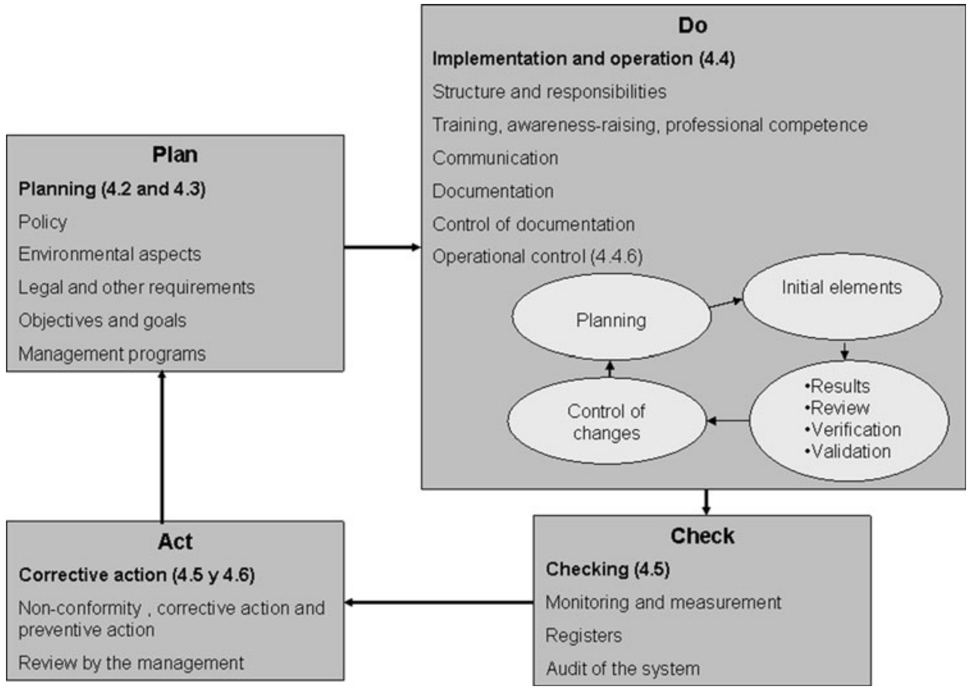


Fig. 2 Continuous improvement process of the UNE 150301 standard. *Source* put together by the authors from the UNE 150301 standard (AENOR 2003)

us with a list of certified organizations that included geographic and business sector information. According to this information in Spain as at 2011, there were 65 certified companies. Especially of note is the fact that 34 of the 65 cases of implementation have taken place in the Basque Autonomous Community (CAPV), one of the autonomous regions with the greatest concentration of ISO 14001 registered companies (see Fig. 3). This is due, among other factors, to the major campaign that has been pursued by the Basque Government via Ihobe, which has organized numerous events to spread the word about the standard to companies and provide aid that amounts to 50% of the auditing and consultancy costs involved in the implementation process (Arana et al. 2010).

In terms of distribution according to sector, it should be stressed that, although the standard initially focused on the industrial sector, there are 44 architects' studios that have been certified, and 87% of the companies that have implemented the standard are related to the building trade (see Fig. 3). This may be to a large extent because, in the case of tenders for public works, this certificate is regarded in a positive light (Arana and Heras 2010).

Case study

A case study was designed to analyze the complex process involving adoption of the UNE 150301 standard in a company from the lift sector. In planning research of a descriptive, mainly exploratory nature, this methodology enables the process to be studied more in depth and a better understanding of what is being studied to be gained (Eisenhardt 1989; Maxwell 2005; Yin 2003).

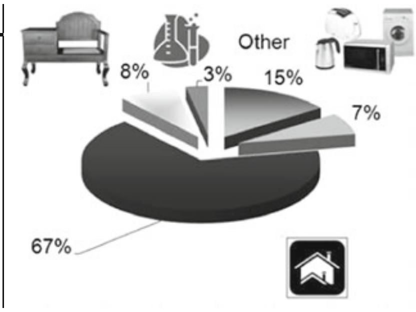
Orona, the company chosen for the case study, is a cooperative company that was set up in 1964. Today, the Orona Group, which belongs to Mondragon Corporation, is the world leader in the cooperative movement—a consolidated business project which has become the leading Spanish company in the lift sector and a supplier of technology and materials of great importance in terms of international context, boasting a commercial network that enables them to sell their products in over 85 countries.

The implementation of UNE 150301 arose from a partnership between this company and a technology center with which the former habitually collaborates, and with Ihobe. To get implementation of the standard underway, work was carried out involving comparing two ranges of different products, by analyzing their life cycles. When carrying out this study, they noted that there were many related aspects which enabled them to reduce costs and become more environmentally friendly. To measure the environmental impact, the first step was to analyze its main sources. To this end, the life cycle of the lift was first analyzed by taking into account the fact that its average lifespan is around 30 years. The main sources of environmental impact in each part of the lift are shown in Table 2.

To measure the environmental impact, they used the Simapro software. They used the method ecoindicator '99 and IPCC 2001 GWP 20[a] (Global Warning Potential) to measure the CO_2 emission. The development of the MET matrix (Tischner and Dietz 2000) was very important for Orona in analyzing the sources of environmental impact of

Fig. 3 Distribution according to location and sector of certified companies. *Source* put together by the authors from AENOR data

Comunidad	Total
Basque Autonomous Comunity	34
Navarre	9
Madrid	9
Catalonia	6
Castile and Leon	4
Principality of Asturias	1
Region of Valencia	1
La Rioja	1
Total	65



their products—aspects that they had previously classified in a different way without taking many variables into account.

Once the environmental impact of the product had been analyzed, work got underway on the new design by putting together a plan of objectives aimed at obtaining environmental improvement. The objectives were arranged in order of importance, the main ones being as follows: reducing travel consumption, lighting consumption, raw material consumption, and standby maneuvering consumption.

A plan of action was proposed based on these objectives, which is summarized in Table 3. Once an action had been carried out, the results were then measured and, if these were deemed to be good, then the action was implemented definitively. In this analysis, the main aspect that they proved was that reducing the weight of the lift means improvement in terms of both ECO points and cost—as this results in reducing steel consumption and energy consumption of the lift as well, during its useful life—because less weight of material will be transported on each shipment (see Tables 3, 4).

When carrying out this study, they noted that there were many other related aspects which enabled them to reduce costs and become more environmentally friendly: input reduction (i.e., raw materials, water, energy, etc.), output decrease (waste, wastewater, air emissions, etc.), using by-products (if any), and replacement of different raw materials with other materials consuming less resources and having less or non-toxic potential.

Subsequently and within this ecodesign project, they added a part of the German VDI 4707 standard project (Boehm 2008) for classifying lifts according to their energy efficiency in a way similar to that done nowadays with electrical household appliances. This aspect, despite not being necessary to obtain the UNE certificate, helped them to complement the design methodology by classifying the products according to the variable that has the greatest environmental impact during the life cycle.

One of the main problems encountered during adoption of the UNE standard is related to the life cycle of a lift which is approximately 30 years, and this period is very long for the purpose of estimating the capacity for recycling that may exist at the end of that life cycle. Despite all this, Orona is currently marketing its lifts with a manual in which the recycling of each component of their lifts using modern technology is indicated.

The results obtained from adoption of the standard—which are summarized below in Table 4 and Fig. 4—have proved to be very positive for those in charge of them, as they have complied with the objectives set out. In this respect, we should note that the UNE 150301 standard is a tool of great use in the company in systematizing the continuous improvement process, taking environmental objectives into account in the design and development process of the product.

Discussion

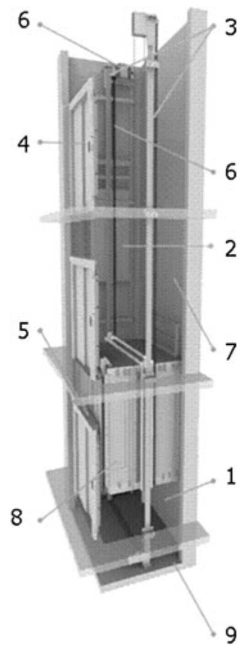
In the case analyzed, the company has relatively large size, and it works with quality control, environmental and safety systems that have been introduced in accordance with the most widespread international benchmarks available (generally speaking, ISO 9001, ISO 14001 and OHSAS 18001). For the same reason, we have noted that the company that has adopted the standard can be considered to be innovative in this aspect, as they have adopted these standards in very early phases.

The company analyzed seems satisfied with the implementation of this standard, as they consider it to have helped them to improve—mainly, not only by reducing the environmental impact of their products (the most relevant ones are the decrease of the Respiratory inorganics and Fossil fuels categories), but also by improving other aspects such as their cost and quality. This point is shared by previous studies that have been carried out in companies that manufacture electrical household appliances (Viñoles et al. 2008; Justel-Lozano 2008; Arana-Landin and Heras-Saizarbitoria 2011).

The company considers the MET matrix to be an essential element in arranging their improvement measures in their order of importance. In Fig. 4, the main impact

Table 2 Main sources of environmental impact of the lift in each stage of its life cycle

Materials



1. Cabin	2. Counterweight	3. Guide system
Steel—DDd12 113.7 kg	Steel—DD12 150.75 kg	Steel 87.10 kg
Stainless steel plate 147.20 kg	Screws 7.00 kg	Steel—Fe 430 B 826.07 kg
Galvaniz steel plate 61.86 kg	Steel—F1110 0.22 kg	Steel—A 360 B 40.53 kg
Steel 2.15 kg	Flame cutting weight 885 kg	Steel—DD 12 82.99 kg
Aluminium 6063 5.03 kg		Steel—ST-44 15.65 kg
Marble 86.24 kg		Plastic—PU 2.24 kg
4. Floor doors (n doors)	5. Cabin door	6. Traction unit
Steel—AP02 × 0.123 kg	Steel 4.6479 kg	Steel 127.29 kg
Steel—AP10 1.176 kg	Steel—AP10 0.1961 kg	Steel—A 410B 0.60 kg
Steel—C45 0.463 kg	Steel—DC03 0.4216 kg	Steel—AISI 304 0.24 kg
Steel—F1 36.780 kg	Steel—F1 7.7795 kg	Steel—AP02X—0.28 kg
Steel—F141 0,009 kg	Steel—F212 0.1923 kg	Steel—F-1252 25.49 kg
Steel—F212 0.356 kg	Steel—F211 0.1282 kg	Steel—F-211 1.54 kg
Steel—F211 0.093 kg	Steel—DD12 8.5692 kg	Steel—Fe-430 0.59 kg
Steel—AP10 1.176 kg	Steel—DD12 8.5692 kg	Steel—St-52 0.80 kg
Steel—DD12 38.591 kg	Galvaniz steel pla 38.8 kg	Bronze—Gz-Cusn10B 3.4 kg
Steel 16,480 kg	Rubber 0.6021 kg	Bronze—Gz-Cusn12Ni 6.5 kg
Galvaniz steel plate 132 kg	Rubber 0.0235 kg	Copper 11.40 kg
Stainless steel plate 209.5 kg	Plastic 0.2394 kg	Cast iron—GG-20 130 kg
Aluminium—6060 34.274 kg	Polycarbonate 0.2467 kg	Cast iron—GG-25 30.00 kg
Aluminium—l2630 0.652 kg	PVC 0.0456 kg	Grease—LGHQ3 0.10 kg
Polyamide 0.892 kg		Aluminum 6.62 kg
Polycarbonate 0.335 kg		Synthetic steel 2.50 kg
PVC 8.733 kg		
7. Framework	8. Cabin chassis	9. Electrical part
Steel 4.00 kg	Steel—DD11 1.31 kg	Steel 24.33 kg
Steel—A360B 106.81 kg	Steel—DD12 229.17 kg	Copper 23.00 kg
Steel—A410B 13.54 kg	Steel—F1140 36.00 kg	Sn/Pb 0.25 kg
Galvanized steel plate 4.8 kg	F211 0.21 kg	Silicon 1.00 kg
Steel—F-111 3.76 kg	Steel 22.75 kg	Plastic 29.27 kg
Steel—S235JR 1.35 kg	Galvaniz steel plate 1.20 kg	Pb + H_2SO_4 4.00 kg
Steel—ST-44 39.07 kg	Polyurethane 2.92 kg	Ni Cd 0.80 kg
Steel—ST52 6.61 kg	Rubber 0.07 kg	
Rubber 16.19 kg	Rubber 1.73 kg	

Manufacturing

Raw materials	Chemical products	Energy	Water emissions
Water 3.34 m^3	Paint (water) 5.34 l	Electricity 374 kw	Waste 2.80 l
Wood 14.68 kg	Paint (solvent) 2.32 l	Natural gas 10.89 m^3	
Cardboard 10.37 kg	Solvent 0.86 l		
	Corabond adhesive 1.03 l		

Transport and packaging

Transport	Packaging
Distance transported 589 km	Wood 75 kg
Lifts per journey 3	Cardboard 15 kg

Table 2 contiuned

Usage	
Forecast: 6 floors + 2 garages—Nominal load 630 kg—Total 140,000 journeys/year—Lifespan 30 years	
Travel consumption	Manoeuvring, lighting and regulating
6 persons up/down—74% load—5,600 journeys	Lighting 28,380 Kwh
3 persons up/down—37% load—42,000 journeys	Manoeuvring 18,090 Kwh
1 persons up/down—18% load—42,000 journeys	Regulating 5,340 Kwh
0 persons up/down—0% load—25,200 journeys	
Consumption: 1,208.21 kwh/year—Total 36,246 kwh	
Maintenance	
Transport	Replaced elements
Car maintenance 3750 km	Oil 50.5 l
	Steel 168.48 kg
	Plastic 3.6 kg
	Bulbs 15 units
	Manoeuvring plates 6 units

Source: put together by the authors from the data obtained from Orona

Table 3 Summary of the main actions and environmental results of the redesign

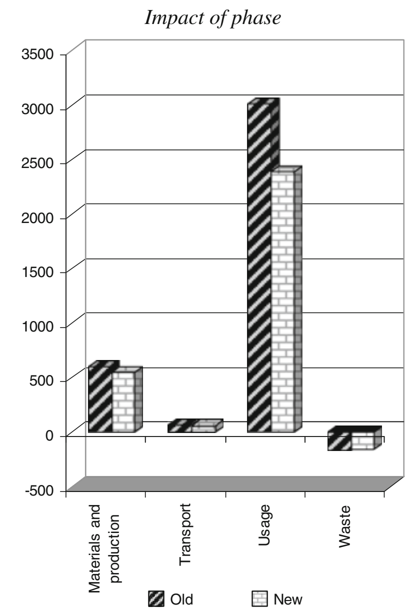
Phases	Actions	Results
Materials	Reducing the amount of materials used for the different units Redesign of the traction unit, framework, cabin, counterweights and guide systems	10% reduction in environmental impact of materials: traction unit 42%, framework 60%, cabin chassis 10%, counterweight 6%, and guide systems 3%.
Transport	Reduction in weights and spaces of the product and packaging	5% reduction in environmental impact of transport
Usage	Introducing a regeneration system. Taking advantage of the energy generated during braking 40% variation in the counterweight, controlling brake motor and variator Replacement of lamps with LEDs	21% reduction in environmental impact of the usage phase due to the 54% reduction in consumption of travel
End of life cycle	Creation of a recycling manual for the lift with up-to-date technology	10% reduction in recycled material due to the reduction in material used

Source put together by the authors from data obtained from Orona

categories of the new and the old models can be observed. In the old model, the highest impacts were related with the Respiratory inorganics (44% of the product impact) and the Fossil fuels (34%). The impacts of both categories in the new model were reduced by 20%. To sum up, Table 4 shows a comparison of the environmental impact of the old and the new design products according to phases. In this context, we can observe that the main impact is in the usage stage and it is related with the energy consumption. In companies that produce electrical and electronic devices, usually the most important impact of the stage of their life cycle is found in the usage stage (Muñoz et al. 2009; Arana-Landin and Heras-Saizarbitoria 2011; Hischier and Baudin 2010; Viñoles et al. 2008; 2008; Justel-Lozano 2008; Mahlia and Yantia 2010; Sanchez et al. 2007), and if this phase is as long as that occurs in this case, the importance of the environmental impact of this stage will then be greater than the impacts of other products with a shorter usage phase (Arana-Landin and Heras-Saizarbitoria 2011; Justel-Lozano 2008).

As a result, the organization analyzed has set out an improved reduction in energy consumption as their main objective, as this is their greatest source of environmental impact. In this respect, the company has obtained major improvements, and we should therefore take note of some recent research that analyzes the adoption of other

Table 4 Results of the environmental impact of the lift during each phase in points (Pt)

Phases	Significant aspects	Impact old (Pt)	Impact new (Pt)	Impact of phase
Materials and production	Cabin	74	74	
	Counterweight	69	65	
	Cabin chassis	24	21	
	Traction unit	88	50	
	Electrical part	103	103	
	Floor doors	147	147	
	Guide system	70	67	
	Framework	14	5	
	Manufacture	9	9	
Transport	Transport	63	59	
Usage	Travel consumption	1.218	570	
	Lighting consumption	954	954	
	Manoeuvring consumption	594	624	
	Regulating consumption	179	179	
	Spare part maintenance	65	60	
End of life cycle	Material recycling	−169	−154	

Source put together by the authors from data obtained from Orona

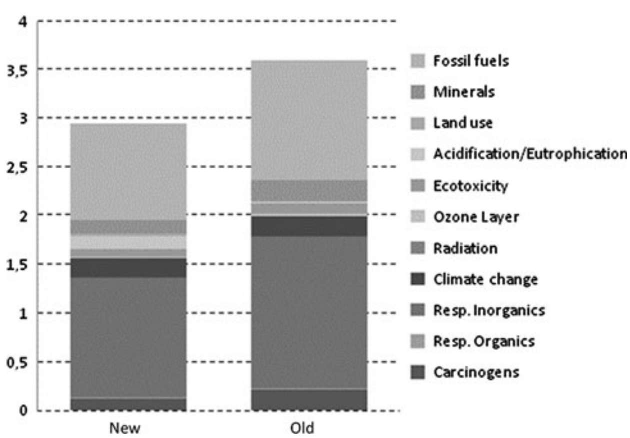


Fig. 4 Results of the environmental impact of the lift in kilopoints (kPt). *Source* put together by the authors from data obtained from Orona

standards related to energy efficiency—albeit via a more procedural approach. In addition to helping to reduce environmental impact, these also help to reduce energy costs (Mahlia and Yantia 2010; Sanchez et al. 2007).

Lastly, one of the aspects that the company considers as essential is the relationship between the reduction in environmental impact and cost. The company points out that they have obtained reductions in cost via ecodesign actions.

Conclusions

Ecodesign standards such as UNE 150301 are of great help in systematizing actions geared toward controlling and creating measures to reduce the environmental impact of the product throughout the different stages of its life cycle. This is one of the main reasons that led the ISO/TC 207 committee to work on drafting the ISO 14006 ecodesign standard, which used the UNE 150301 as a reference point.

It seems clear that a standard, such as ISO 14006, launched by the ISO, will be more useful and will have a higher potential for International dissemination than the Technical Report ISO/TR 14062.

As a basic guide for implementing the UNE ecodesign standard, the company started using ecodesign indicators to carry out an initial diagnosis so as to then get underway with the continuous improvement process. Once the continuous improvement process has been carried out, the new product should have less environmental impact than that of the product it replaces.

Furthermore, by reducing environmental impact, more economical products can be designed with this process, not only in terms of their manufacture, but also in terms of their usage by optimizing the energy. For example, in this case, they have managed to obtain a more economical product via a reduction in the weight of the lift, as they have reduced the consumption of raw materials while at the same time increasing the quality of the product, thus achieving greater energy efficiency as a result of transporting less weight on each travel.

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