Environmental fact sheet: CITY

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2025

Contents

Foreword

Environmental protection is a practice of protecting the natural environment, for the benefit of both the environment and humans. With awareness of environmental protection increasing worldwide, demand for more efficient products to reduce energy and resource consumption is more urgent than ever. The possible environmental impacts associated with products have sparked interest in developing methods to understand and minimize these impacts. Life-cycle assessment (LCA) is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. LCAs can help avoid a narrow outlook on environmental concerns by compiling an inventory of relevant energy and material inputs and environmental releases; Evaluating the potential impacts associated with identified inputs and releases and also interpreting the results to help make a more informed decision.

An important aspect on the companies' awareness is the ISO 14000 family of standards, which provides practical tools for companies and organizations of all kinds seeking to manage their environmental responsibilities. ISO 14006 provides guidelines to assist organizations in establishing, documenting, implementing, maintaining and continually improving their management of eco-design as part of an environmental management system (EMS).

Vertical – transportation products are indispensable to urban mobility and accessibility. Passenger comfort and attractive design must be integrated into a large, complex system. combining that with an environmental approach is a creative challenge.

Introductory information

KLEEMANN Hellas S.A. is active in the field of construction and design integrated marketing lift systems. It is one of the largest companies in this sector to the European and international market and produces more than 10,500 lift systems annually.

Since 2012, KLEEMANN implements an environmental management system (EMS) for its facilities. This system has been certified according to ISO 14001 and covers the production unit (office facilities and factories) in the industrial area of Kilkis. The company also applies quality management system certified in accordance with ISO 9001 and implements principle eco-design products in accordance with ISO 14006.

The strategic objective for our company is the sustainable development in full harmonization with the environmental protection, resulting in environmentally superior products. That aim can be achieved by adhering to fundamental rules, criteria and mechanisms for environmental protection, pollution prevention and protection of human health. This ensures preservation of natural resources and the gradual restoration of the environment. Main goal is to redesign all of our products on the basis of eco-design process. The strategy is motivated by three factors: nature, society, economy.

The largest lifts company in Greece presents the model of eco-design. The procedure of LCA in our products is constantly a growing part of research and development. This is the main and most important pillar of innovation on technological achievement. It is the most important step on achieving an integrated environmental approach on the products' design.

Description of steps and procedures of eco-design

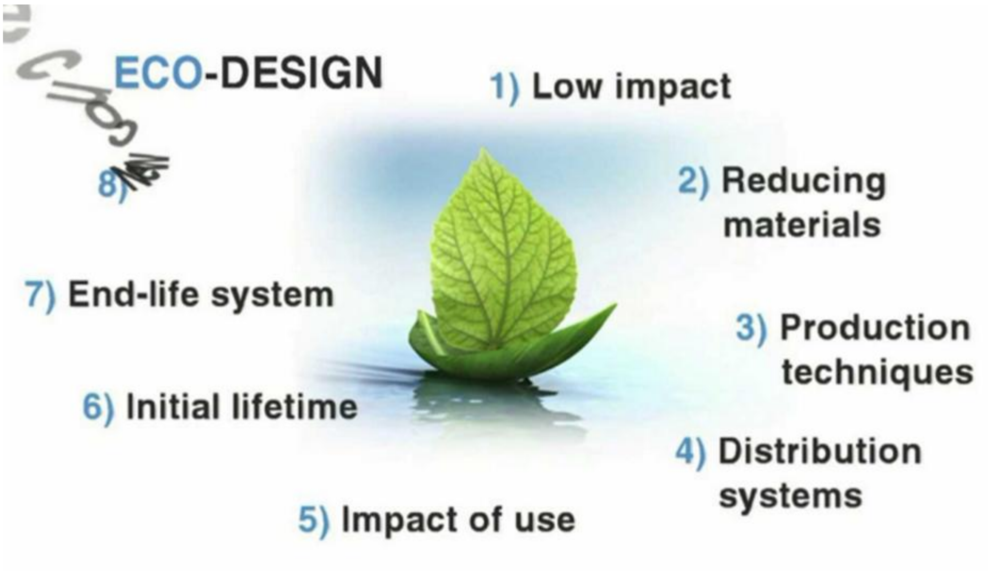
Scope: Eco-design is an approach of designing products with special consideration for the environmental impacts of the product during its whole lifecycle. In a life cycle assessment, the life cycle of a product is usually divided into procurement, manufacture, use, and disposal. It is a growing responsibility and understanding of our ecological footprint on the planet.

Terminology: The flow of energy and materials, as well as the type of pollutants examined in each system, is the part of a product's life. The system is determined by the boundaries, which are defined in advance. System boundaries in this study are the receipt of raw materials in our facilities up to the final recycling and disposal of the product.

Required data: The data required for the completion of the study are the units of materials and energy required for the entire life cycle of a product as well as the quantification of their effects.

However, in a study of life cycle it is clear that some of the data will be taken from some pertinent cases and are necessarily accepted as they appear in them. As much as we are stretching the limits of the system the analysis of inputs and outputs becomes more difficult. If no suitable data is available, the best estimation is used.

The data relating to the production process are calculated accurately, while the impact of the extraction and production of raw materials have not been addressed. Also, on the basis of



the pattern of usage and calculation of consumed energy in a lift system, ISO25745 was carried out, and a number of considerations and assumptions for the average operation throughout the life cycle of the lift.

Procedure description

Upstream procedures

- These are procedures which take place regardless the manufacture of the product such as mining raw materials, transport within the supply chain. These are processes which will not be examined in this document.

Production and core processes

- These are the principal manufacturing processes of the product. The procedures of carrying materials and waste management resulting from the above, even if carried out by third parties, are also included.

Downstream procedures

- These are the processes no more controlled by the product manufacturer, but by the product owner. This covers the private transport of the product to the consumer, consumption of the energy or other consumables, adequate maintenance and end of-life processes of the used product.

Calculations and environmental impact assessment

The part of the measurement of environmental impact is the criterion for the improvement actions that are required in order to reduce the first. To calculate these, Software Sima Pro® 8 was used, with method ReCiPe Endpoint, hierarchist version, for the major part of the Environmental Impact Assessment.

Moreover, the ISO 25745-2 was used for the classification of the product in the field of energy efficiency during its usage stage. ISO 25745-2:2015 specifies a method to estimate energy consumption based on measured values, calculation, or simulation, on an annual basis for traction, hydraulic and positive drive lifts on a single unit basis, and an energy classification system for new, existing, and modernized traction, hydraulic, and positive drive lifts on a single unit basis. It applies to passenger and goods passenger lifts with rated speeds greater than 0,15 m/s and only considers the energy performance during the operational portion of the life cycle of the lifts.

In the case of the integrated lift system and for the present document the study of the system begins from the purchase of raw materials to the final disposal.

The method of eco-design is applied to a lift system which is developed, manufactured and distributed by KLEEMANN. The adoption of such a model design contributes as a catalyst to reduce the environmental impact and cost.

Product structure and reference model

The product evaluated under the principles of eco-design is a traction electric passenger lift system. The reference model is the newly designed CITY, an MRL (machine-room-less) traction elevator that combines advanced engineering with exceptional flexibility, enabling tailored configurations through modular material options, optimized shaft dimensions, and a sustainability-oriented design philosophy. This results in superior space utilization and energy efficiency, aligned with contemporary environmental performance standards.

The development of this new model was driven by the strategic objective of gradually replacing one of the most widely used elevator types currently in operation. Designed to meet a broad spectrum of installation and performance requirements, the new model retains compatibility with diverse building layouts while significantly improving its environmental and operational footprint.

Due to its technical advantages, adaptability, and ecological benefits, this new generation elevator is projected to progressively substitute the legacy model in approximately 99% of applicable use cases over time, making it the de facto standard for future installations. This new product features a design that saves up to 50 mm in shaft width or allows the accommodation of an additional passenger in the cabin, while also reducing installation time by up to 25%.

The main advantages of the product are:

Sustainable design: CITY helps buildings reduce carbon emissions with its ecofriendly design and packaging, while also boosting property value. With its lightweight structure and sustainable packaging, is a perfect choice for eco-friendly building practices. It uses no welding or painting and also requires less energy to operate than a heavier MRL elevator. Consequently, it enhances the building’s green credentials, lowers its carbon footprint, and boosts the whole value of the construction.

Superior engineering and design: Engineered to meet the standards of a remarkably smooth ride with a minimal downtime, CITY offers a variety of quality materials to encourage a mix and match approach and enable the process of creating the right look and feel. It represents long-term value through its pre-engineered design that combines durability with efficiency. Precisely constructed to endure, it lowers total ownership costs by focusing on key performance features, ensuring your property benefits from both affordability and reliability.

Digital connectivity: CITY integrates advanced digital tools, including KLEEMANN Live and Lift Control Mobile apps. Embrace digital convenience by exclusively ordering the product online through our KLEEMANN Portal.

Optimized shaft efficiency: A design that saves up to 50 mm in shaft width or allows the accommodation of an additional passenger in the cabin.

Installation time: Reduced installation time up to 25%.

General Specifications of CITY

- Rated Load (Kg): 320- 400- 450- 630- 1000
- Suspension: 2:1
- Machine Room: MRL
- Max Travel (m): 21
- Max Travel – Stops: 8
- Max Speed (m/s): 1.0
- Min Pit Depth (mm): 900
- Min Headroom (mm): 3300
- Maximum car entrances: 2
- Complies with: EN81-20, EN81-70

Vertical lifts typically have an operational lifespan of approximately 25 years, assuming regular and appropriate maintenance throughout their service life. On average, a lift in a standard building completes around 36,500 trips annually to serve users efficiently. In the context of the present study, the reference model presents the following specifications:

Reference model	CITY
Type	Traction, Electric operated passenger lift
Estimated lifetime	25 years
Trips per day	100
Nominal load	630kg
Nominal speed	1m/s
Travel	12m
Number of stops	5
Daily travel time	0.3h

Significant Aspects

One of the most significant benefits introduced by the new elevator system is the substantial reduction in welding requirements during the manufacturing and installation processes. Traditional elevator structures often rely heavily on welding, which contributes considerably to both the environmental and operational footprint. Welding is not only material-intensive, but also highly energy-consuming, requiring substantial thermal input that leads to elevated carbon emissions. Furthermore, the time demands associated with welding—due to preparation, execution, cooling, and post-processing—contribute to inefficiencies and increased working hours.

From an environmental perspective, welding carries a dual burden: the direct emission of greenhouse gases due to electricity consumption (especially in energy-intensive arc welding methods), and the generation of hazardous fumes and particulates that compromise air quality. By minimizing welding operations, the current design approach achieves a dual objective: it not only enhances production efficiency, but also significantly lowers the embodied energy and ecological impact of the elevator structure. This aligns with global sustainability targets and the push for greener, leaner manufacturing protocols.

In addition to the welding reduction, another notable innovation lies in the construction of the guide rails used for both the cabin and the counterweight. These guides, which often span several meters in length, have been redesigned as hollow profiles filled with high-density expanded polystyrene (EPS) of premium quality. This hybrid configuration results in considerable weight reduction compared to traditional solid components, thereby lowering the energy demands during transportation and installation. More importantly, the EPS core functions as an effective acoustic dampener, drastically reducing the noise generated by the elevator's operation. As a result, the overall acoustic pollution in the elevator shaft and its surrounding environment is significantly mitigated—an important consideration for residential and healthcare buildings where low noise levels are essential.

Moreover, the use of high-grade galvanized steel sheet throughout the structure, further enhances both environmental and functional performance. Galvanization not only provides superior corrosion resistance, but also virtually eliminates the need for additional surface treatments, such as painting. This design choice brings about a major reduction in the use of harmful substances such as solvents, primers, and topcoats, many of which contain volatile organic compounds (VOCs) with well-documented adverse effects on environmental and human health. The omission of paint-related processes also simplifies logistics and reduces manufacturing time and costs.

In summary, the elevator system innovative design demonstrates a strong commitment to sustainability and lifecycle optimization. By targeting critical aspects, such as welding, structural materials, acoustic performance, and surface treatments, the product not only meets modern engineering requirements, but also aligns with environmental best practices. These improvements support a more efficient, quieter, and greener vertical transportation solution.

Analysis of life cycle parameters of the new products

The life cycle analysis, which is an important and integral tool for the eco-design steps, is divided at the level of registration of a product's life cycle stages on the following main categories:

1. Raw materials
2. Manufacturing processes
3. Transport & Packaging
4. Installation
5. Operation - Use
6. Maintenance - Repairs
7. Disposal - Recycling

The CITY achieves greater energy efficiency by reducing:

- Quantity of raw materials
- Quantity of paints and solvents
- Total unit weight

In accordance to the relevant literature, the major environmental impact on the life cycle of a life is during the usage stage, followed by the stage when materials are acquired and energy is consumed during construction. These are the stages that company takes into account and interfere with the process of eco-design. The service plays also an important role in product's life cycle. The other parameters related to the life cycle of a product, such as packaging, transport and installation shall contribute much lower in overall impact.

Raw materials

The company is gradually trying to co-operate with suppliers who meet the environmental criteria which are set by standards. So up to the present time 50% of suppliers operate, minimum, with an environmental management system and ISO14001 certification.

The total mass of the elevator for the life cycle inventory without packing is 2970kg. Roughly 71% of the elevator materials are metals and almost 24% is the concrete of the counterweights. Following is presented the sub-assemblies and the materials they are consisted of:

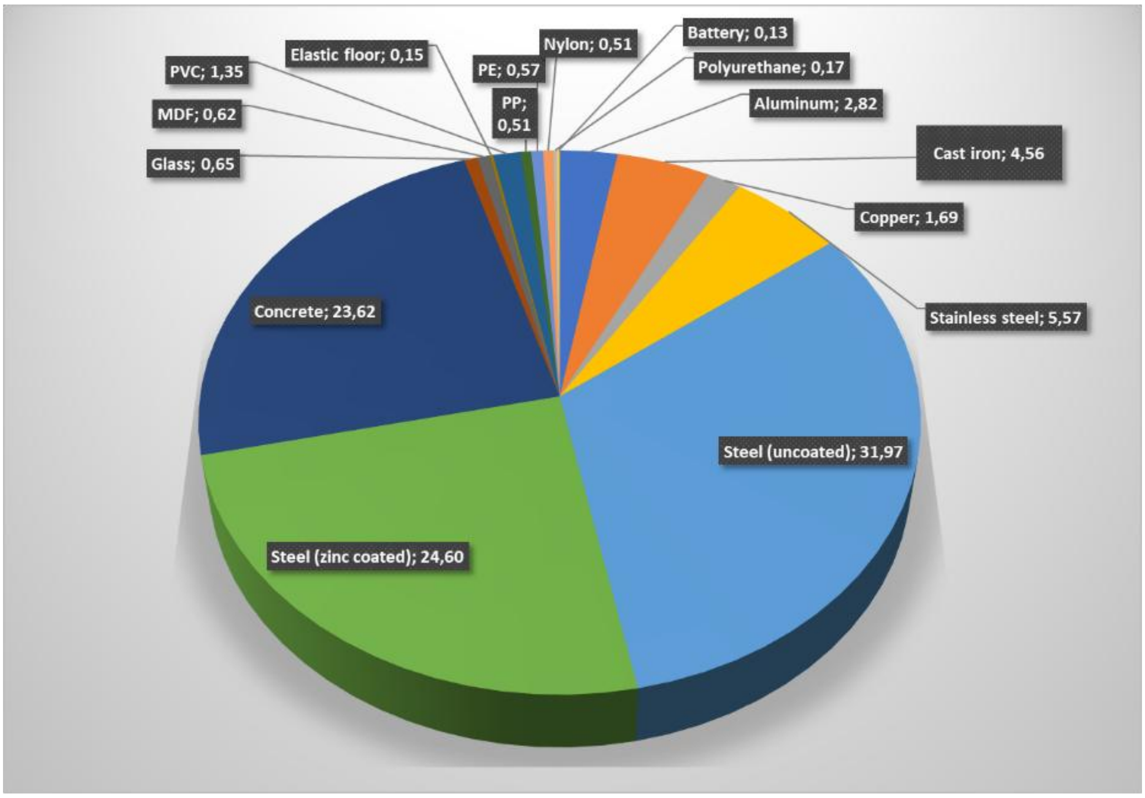
KLEEMANN
Your 1st Choice in Lifts

Elevator 3270kg

- **Cabin & Cabin Doors 380kg**
  - Steel (uncoated) 165.8kg
  - Aluminium 16kg
  - Stainless steel 149.65kg
  - Elastic floor 4.5kg
  - LED 3kg
  - Glass 19.2kg
  - MDF 18.5kg
  - Steel (zinc coated) 3kg
  - Polyurethane 2kg
- **Car Frame 177kg**
  - Steel (uncoated) 25kg
  - Steel (zinc coated) 137.78kg
  - Cast iron 5kg
  - Plastic (pulley) 8kg
  - Polyurethane 1kg
  - Aluminium 0.5kg
- **Ctw Frame 51.3kg**
  - Steel (uncoated) 9.5kg
  - Steel (zinc coated) 40kg
  - Plastic (pulley) 1.3kg
  - Polyurethane 0.5kg
- **Ctws 821kg**
  - Steel (uncoated) 121kg
  - Concrete 700kg
- **Doors 403kg**
  - Steel (uncoated) 375.38kg
  - Stainless steel 15.33kg
  - Aluminium 9.72kg
  - Polyurethane 3kg
- **Electronic Equipment 248kg**
  - Steel (uncoated) 65kg
  - Steel (zinc coated) 6kg
  - Copper 40kg
  - Aluminium 50kg
  - PVC 40kg
  - PP 15kg
  - PE 17kg
  - Nylon 5kg
  - Plastic (mix) 3kg
  - Printed wiring board 2kg
  - Battery 4kg
  - Others 1kg
- **Guide Rails and Brackets 637kg**
  - Steel (uncoated) 98kg
  - Steel (zinc coated) 537kg
  - EPS 2kg
- **Shaft Components 71kg**
  - Steel (uncoated) 60kg
  - Steel (zinc coated) 5kg
  - Cast iron 5kg
  - Plastic mix 1kg
- **Machine 175kg**
  - Steel (uncoated) 30kg
  - Cast iron 125kg
  - Copper 10kg
  - Aluminium 7kg
  - Plastic 0.5kg
  - Magnet 3kg
- **Paint 5kg**
- **Lubricants 2kg**
- **Packing 300kg**
  - Wood 241kg
  - Steel (uncoated) 7kg
  - Nylon 17kg
  - Carton 35kg

Gathered data about the materials used (paint, lubricants and packaging are not included) are presented on the following:

	Material	Weight (kg)	Weight (%)
1	**Metals**	**2109.8**	**71.20**
A	*Aluminum*	*83.5*	2.82
B	*Cast iron*	*135*	4.56
C	*Copper*	*50*	1.69
D	*Stainless steel*	*165*	5.57
E	*Steel (uncoated)*	*947.3*	31.97
F	*Steel (zinc coated)*	*729*	24.60
2	**Concrete**	**700**	**23.62**
3	**Glass**	**19.2**	**0.65**
4	**MDF**	**18.5**	**0.62**
5	**EPS**	**2**	**0.07**
6	**Elastic floor**	**4.5**	**0.15**
7	**PVC**	**40**	**1.35**
8	**PP**	**15**	**0.51**
9	**PE**	**17**	**0.57**
10	**Nylon**	**15**	**0.51**
11	**Polyurethane**	**5**	**0.17**
12	**Plastics (mix)**	**5**	**0.17**
13	**LED**	**3**	**0.10**
14	**Battery**	**4**	**0.13**
15	**Magnet**	**3**	**0.10**
16	**Printed wiring board**	**2**	**0.07**
	TOTAL	**2963**	**100.00**



Manufacturing processes

Listed below is the consumed energy during the manufacturing processes such as laser, welding, saw, drill, bending, CNC, punching and scissors, through which each component and the individual parts of the product are made. The facilities of the company have been amended as to the production line (lean flow), which ensures low stocks and flexibility at the same time.

	Shaft Components	Guide Rails and Brackets	Car Frame	Cabin	Ctws Frame	Total (min)
Laser	2.31	11.28	37.9	2.65	17.33	**129.44**
Welding	17.64	29	10		5	**196.96**
Saw	6.05		3.94	40	2.6	**74.12**
Drill	2				3.17	**17.89**
Bending	3.25	11.22	51.01	15	16.42	**94.44**
CNC	2		8.5		20	**177.6**
Punching				51.54		**18.64**
Scissors				35		**45.56**
Painting	22	1	10.24	7.53		
Consumed Energy	**27.09kWh**	**28.04kWh**	**73.99kWh**	**69.9kWh**	**38.38kWh**	**237.4kWh**

Transportation & Packaging

Transportation: Average mileage for the product from the production site to the installation site is 800km (average distance from the factory to the various installations in accordance with the measurements of 2014). The carriage of cargo is up to 16tones.

Packaging: For the packaging of products wood, nylon, nails and cartons are used. The packaging for by-product required is listed below:

Material	Quantity [kg]
Wood pallet	241
Nylon	17
Steel (nails etc)	7
Carton boxes	35

Installation

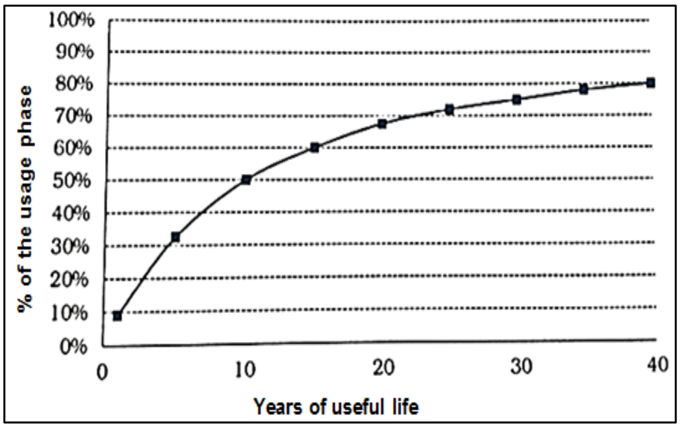
KLEEMANN provides all the necessary auxiliary tools to the installer so that the time and energy to be spent are reduced to the minimum level. Because of this and because the time and the energy per installation can vary these data are not calculated in detail. An approximation over the installation concerning the man-hours needed is generally 4days for 2workers and one day for each extra elevator stop.

Operation – Use

It has been pointed out, on the basis of surveys which have been carried out on this field, that the maximum impact on the environment can be observed in the consumption period.

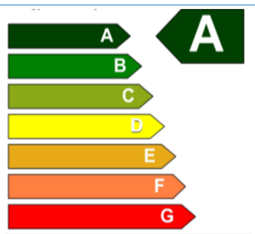
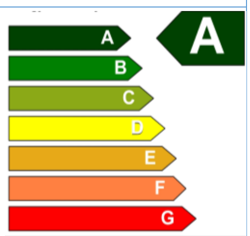
Showing the catalytic role has for the products of lifts. More specifically, if a product has usage duration of 25-30 years the use phase would be responsible for 75% of the whole environmental impact, whereas the same phase would only represent 50% of the environmental bill if it had a reduced life of 10years. On the other hand, an increased product life will always reduce the impact of the materials phase, because the number of functional units served will increase.

In the following figure, the percentage of environmental impact associated with the use phase of the lift (y-axis) and in accordance with the years of working life (x-axis) (LCA and energy modeling of lifts, Ana Lorente Lafuente, 2013).

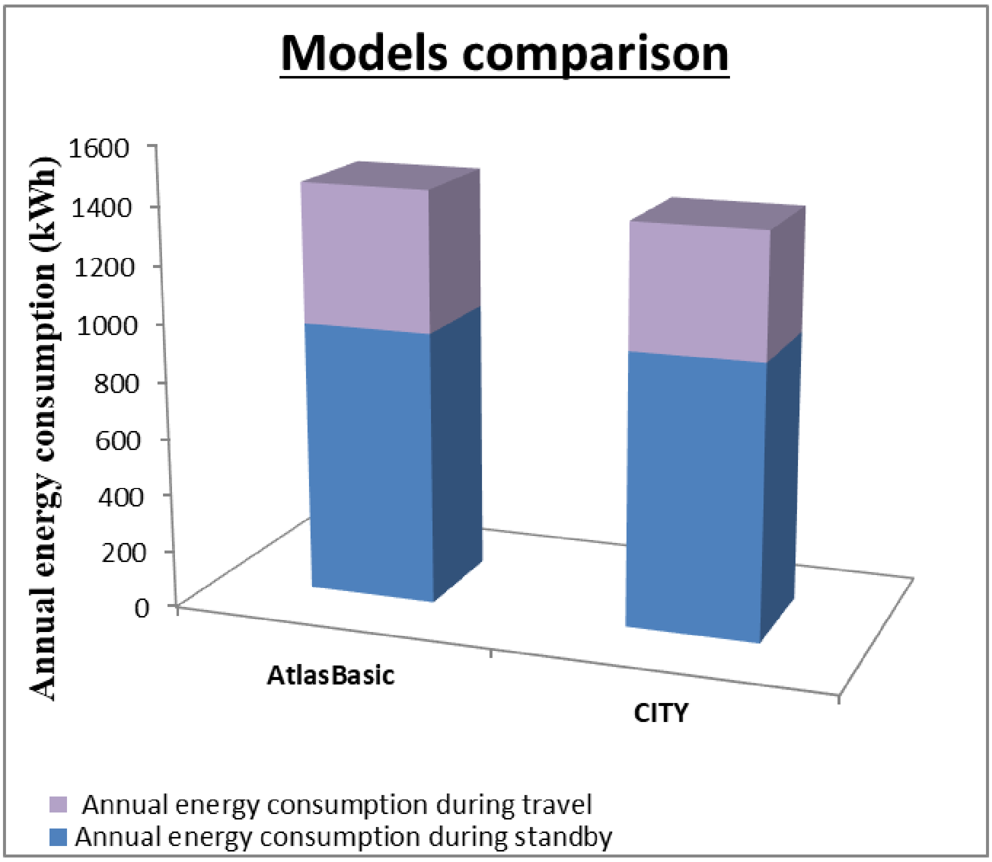


Therefore, it is significant that the new model is upgraded concerning its energy efficiency during the eco-design. The energy class is A for both products, but the nominal demand per year is improved.

Following the methodology of ISO25745, the results are:

	AtlasBasic	CITY
Nominal load [kg]	630	630
Nominal speed [m/s]	1	1
Operating days per year	365	365
Standby demand [W]	33	33
Specific travel demand [mWh/(kg·m)]	1.32	1.16
Usage category according to ISO25745	1	1
Nominal demand per year [kWh]	528	506
Energy efficiency class according to ISO25745		

The annual energy consumption can be illustrated graphically as is presented:



Maintenance - Repairs

KLEEMANN offers all the spare parts that this process requires. The maintenance work is a continuous process throughout the phase of operation of the lift. It consists of (a) the periodic preventive maintenance and (b) the unregulated operations required after a failure.

Preventive maintenance is obligatory by the legislation of each country; however, the frequency varies. In each case the lift can be considered serviced six times a year from a team of two technicians. The maintenance procedure in addition to the transfer of technicians at the spot includes a limited use of tools and materials (light, grease, etc). The ecological footprint of this phase can be estimated from the fuel consumption for the transfer of staff (6 x 15 km per year), from the use of electricity during maintenance (max 6 x 1 kWh including the motion of the lift).

Finally, the lubricant used to lubricate the guides can be estimated as 2 lt per year.

The work required after a failure of the lift is difficult to assess accurately.

However, on the basis of the engineering of the lifts and the statistics, these amounts can be tackled satisfactorily.

Disposal - Recycling

Key element in the final stage of the life cycle is the easiest and the fullest possible recycle of the product. The best scenario for a lift is to be designed in such a way that its materials can be dismantled and easily separated into various categories for recycling.

KLEEMANN lifts comprise a high percentage of metal, alloy steel, cast iron, aluminum alloy and copper that can be recycled directly.

Following is presented figuratively the partitioning of the materials in the reference model. This figure could be used as a guide during the dismantling of the product after its end of life. Some parts of different materials will:

- Be material recycled
- Be incinerated
- End up at a landfill.

General instructions for disposal: The basic distinction in hazardous substances and in secondary raw materials should be carried out during the course of the dissolution in accordance with the following classification:

- Hazardous waste
- Waste Electrical and electronic equipment
- Non-magnetic steel waste
- Scrap aluminum
- Magnetic steel and scrap
- Residues containing copper (cables, motor)
- Lead waste (batteries)
- The waste for incineration

If the whole lift at the end of its life is able to be transferred to the central plant of KLEEMANN, the company takes over its full recycling.

Environmental Impact Assessment

Terminology

Materials: For the calculation of the indicator for the production of materials, including all the procedures, from the extraction of raw materials to the final production stage. The calculation includes even the transfers made during the production of the material.

Manufacturing processes: Indicators of production processes represent the emissions both from the production process itself, as well as those which were released during the production of electricity used from each production process.

Transport: Indicators of transport include the effects of emissions caused both for the production of fuels and their combustion during the process of transport of the products.

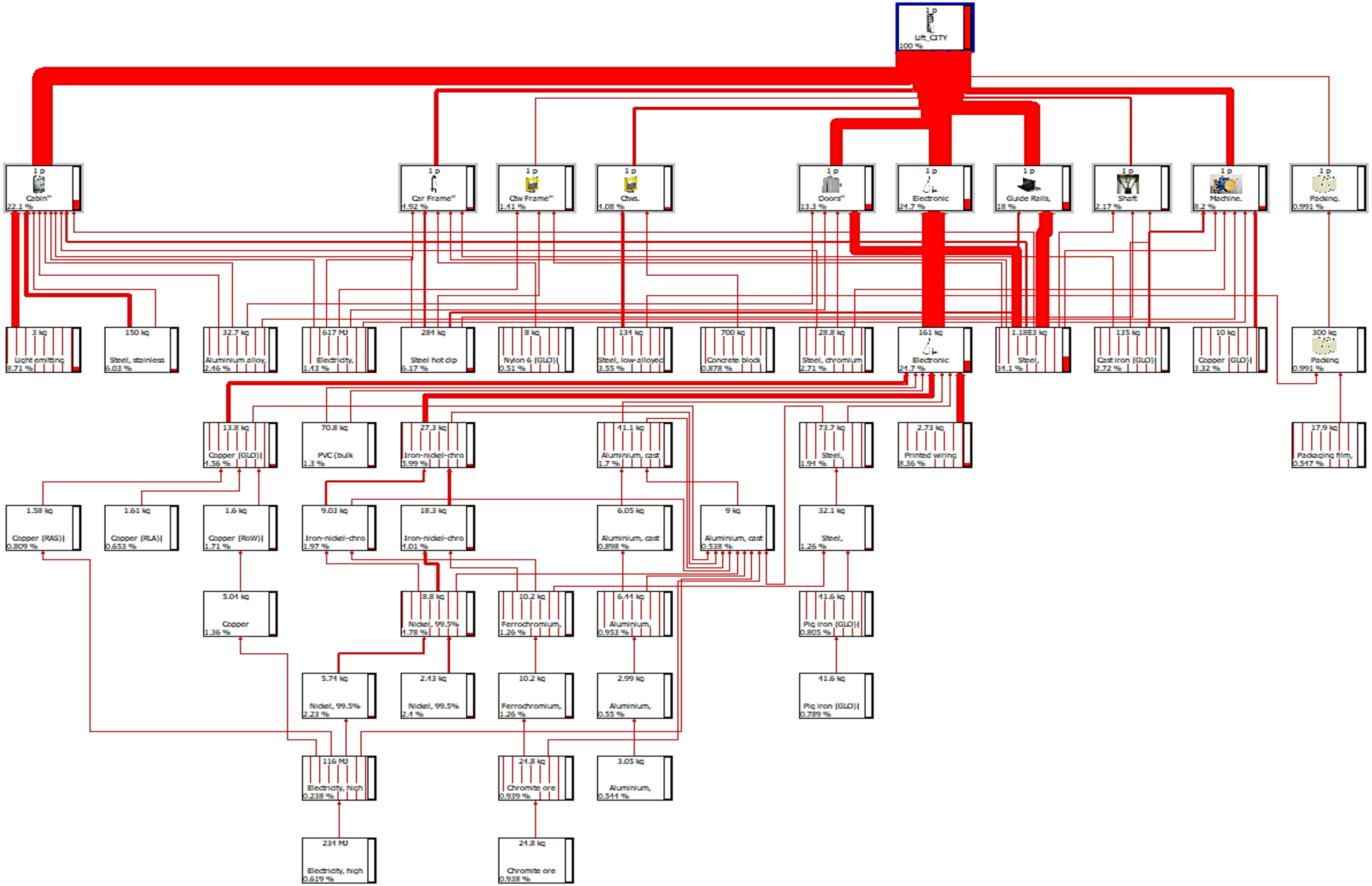
Power Consumption: Indicators of energy are referred to the mining of various fossil fuels, such as lignite, and their use for the electricity production. These indicators will vary from country to country due to different technology and the energy mix used for the production of electricity. These indicators include a separate indicator for the production of energy in the country of usage.

Disposal Procedures and collection: This category includes indicators for the recycling of various materials, incineration, burial at burial site and using biological treatment

The assessment of operational phase based on system UCTE mix of electricity low voltage. If a different mixture is applied of electricity of medium or high voltage, a new study can be carried out for the environmental impacts.

The results of this study illustrate the environmental impact of the product Atlas RPH-R lifecycle. It is also possible to devise again the study and with other methods of analysis. On the diagrams extracted from the software SimaPro® is illustrated a comparative study between the earlier model AtlasBasic to the newly designed CITY.

First of all, is shown the Product Structure Tree, where the elevator is presented as function of its life cycle, including the manufacturing part, the transportation, the usage phage, till the disposal scenario. The sub-assemblies that contribute with the major percentage are described through the materials and the processes they are consisted of. The tree displays materials whose content exceeds 0.5%.


1 p
Lift_CITY
100 %
1 p
Cabin"
22.1 %
1 p
Car Frame"
1.92 %
1 p
Ctw Frame"
1.41 %
1 p
Ctws.
1.08 %
1 p
Doors"
13.3 %
1 p
Electronic
24.7 %
1 p
Guide Rails,
18 %
1 p
Shaft
2.17 %
1 p
Machine.
8.2 %
1 p
Packing.
0.991 %
3 kg
Light emitting
8.71 %
150 kg
Steel, stainless
6.03 %
32.7 kg
Aluminium alloy,
2.46 %
617 MJ
Electricity,
1.43 %
284 kg
Steel hot dip
6.17 %
8 kg
Nylon 6 {GLO}|
0.51 %
134 kg
Steel, low-alloyed
3.55 %
700 kg
Concrete block
0.878 %
28.8 kg
Steel, chromium
2.71 %
161 kg
Electronic
24.7 %
1.18E3 kg
Steel,
34.1 %
135 kg
Cast iron {GLO}|
2.72 %
10 kg
Copper {GLO}|
3.32 %
300 kg
Packing
0.991 %
13.8 kg
Copper {GLO}|
1.56 %
70.8 kg
PVC (bulk
1.3 %
27.3 kg
Iron-nickel-chro
5.99 %
41.1 kg
Aluminium, cast
1.7 %
73.7 kg
Steel,
1.91 %
2.73 kg
Printed wiring
8.36 %
17.9 kg
Packaging film,
0.517 %
1.58 kg
Copper {RAS}|
0.809 %
1.61 kg
Copper {RLA}|
0.653 %
1.6 kg
Copper {RoW}|
1.71 %
9.03 kg
Iron-nickel-chro
1.97 %
18.3 kg
Iron-nickel-chro
1.01 %
6.05 kg
Aluminium, cast
0.898 %
9 kg
Aluminium, cast
0.538 %
32.1 kg
Steel,
1.26 %
5.01 kg
Copper
1.36 %
8.8 kg
Nickel, 99.5%
1.78 %
10.2 kg
Ferrochromium,
1.26 %
6.41 kg
Aluminium,
0.953 %
41.6 kg
Pig iron {GLO}|
0.805 %
5.74 kg
Nickel, 99.5%
2.23 %
2.43 kg
Nickel, 99.5%
2.4 %
10.2 kg
Ferrochromium,
1.26 %
2.99 kg
Aluminium,
0.55 %
41.6 kg
Pig iron {GLO}|
0.789 %
116 MJ
Electricity, high
0.238 %
24.8 kg
Chromite ore
0.939 %
3.05 kg
Aluminium,
0.511 %
234 MJ
Electricity, high
0.619 %
24.8 kg
Chromite ore
0.938 %

Damage Assessment

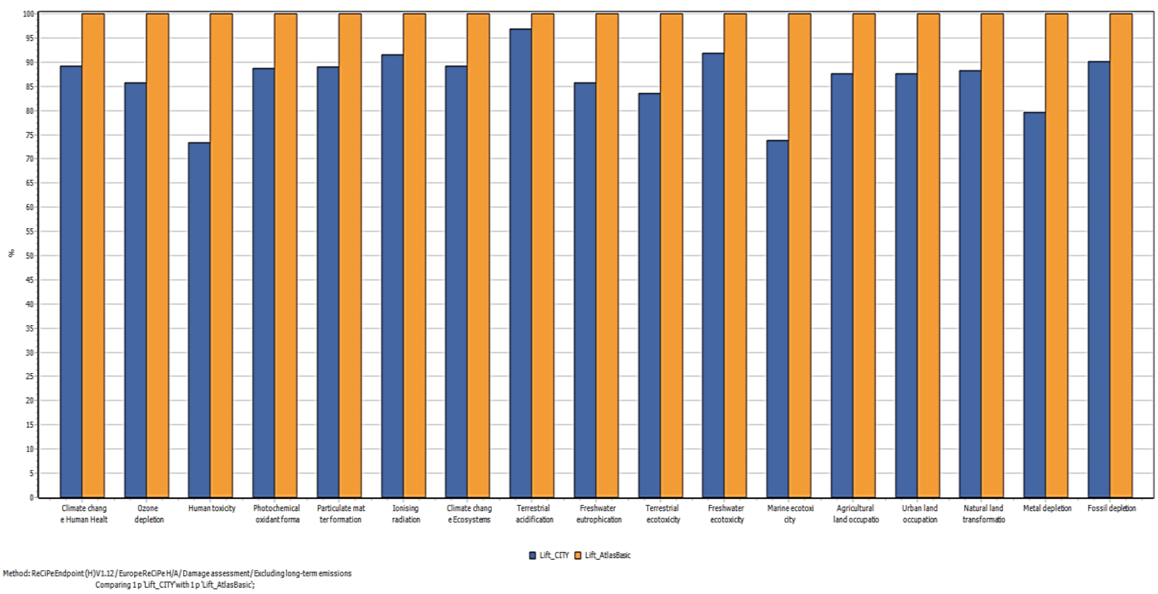
To quantify the impact of a product across different environmental categories, we apply characterization factors (CFs). CFs quantify how much 1 kg of an emitted substance contributes to a specific impact category — for example, how much 1 kg of a substance contributes to freshwater ecotoxicity. The charts below compare the two elevator models (the newly designed CITY and older AtlasBasic) across multiple impact categories.

The first chart presents a detailed breakdown of the environmental impacts in 18 midpoint categories. The CITY model consistently demonstrates reduced environmental impact compared to AtlasBasic across nearly all categories:

- Climate change – Human Health: ~13% lower impact
- Human toxicity: ~21% lower
- Particulate matter formation: ~10% lower
- Ionizing radiation: ~11% lower
- Terrestrial acidification: ~13% lower
- Freshwater eutrophication: ~18% lower
- Marine ecotoxicity: ~27% lower
- Agricultural land occupation: ~15% lower
- Natural land transformation: ~20% lower
- Metal depletion: ~12% lower
- Fossil depletion: ~11% lower

These reductions reflect improvements in materials selection, energy use, and emissions control in the CITY model, leading to a better environmental performance throughout the life cycle.

The reduction in human health impact is particularly significant, not only due to direct emissions, but also due to indirect factors like reduced toxicity and particulate emissions. This is crucial, as environmental health is a cumulative result of several smaller improvements across multiple categories.

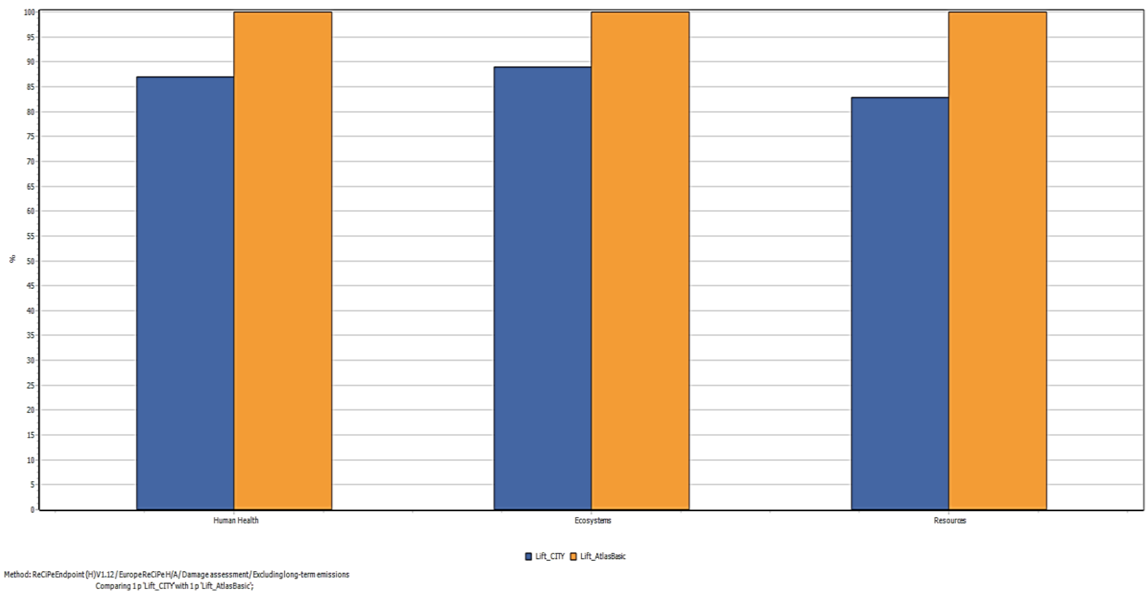


The second chart summarizes the total environmental damage per model, aggregated into three endpoint categories: Human Health, Ecosystems, and Resources. The results clearly indicate that CITY has a significantly lower overall environmental burden:

- Human Health: ~10% lower impact
- Ecosystems: ~9% lower
- Resources: ~14% lower

These results confirm that the CITY model delivers substantial environmental benefits, particularly in terms of resource efficiency and ecosystem preservation.

Damage assessment allows the grouping of individual impact indicators into broader categories, using common units. For example, human health impacts are measured in DALYs (Disability Adjusted Life Years), enabling the summation of impacts from different causes, such as climate change or carcinogenic substances. This makes it easier to assess and compare the real-world consequences of each model's environmental profile.



Normalization

Normalization is a method that allows impact category indicator results to be compared against a common reference value. Typically, this reference is the average annual environmental load per person in a given region (e.g., Europe), which enables each impact category to be expressed in the same unit. This transformation makes it easier to identify which environmental effects are most significant relative to a baseline, and to compare them directly.

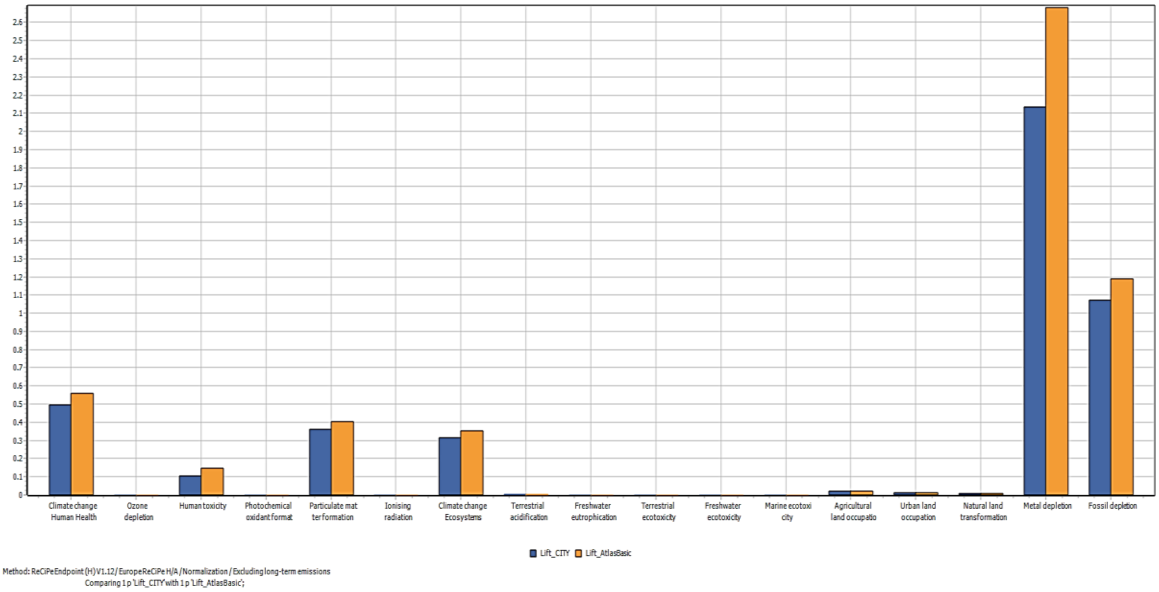
In the chart above, the results of the two elevator models (CITY and AtlasBasic) are normalized and compared across various impact categories. The most dominant normalized impacts for both models are observed in:

- Metal depletion:
  - AtlasBasic: 2.45 units
  - CITY: 2.10 units
    - ✓ ~14% reduction in the Lift_CITY model
- Fossil depletion:
  - AtlasBasic: 1.10 units

- CITY: 0.95 units
  - ✓ ~13.6% reduction
- Climate change – Human Health:
  - AtlasBasic: 0.55 units
  - CITY: 0.47 units
    - ✓ ~15% reduction
- Particulate matter formation:
  - AtlasBasic: 0.28 units
  - CITY: 0.25 units
    - ✓ ~11% reduction

In several other categories (e.g., Human toxicity, Photochemical oxidant formation, Freshwater eutrophication, Marine ecotoxicity), the CITY model shows consistent yet more modest reductions in normalized impact compared to the AtlasBasic.

These results highlight that, even when normalized to societal averages, the CITY model performs better environmentally, especially in critical areas related to resource depletion and climate change. The data reinforce the findings from the characterization and damage assessment stages, confirming that the newer model not only performs better in absolute terms but also contributes less to the most significant environmental pressures on a per capita basis.



Weighting

The weighting method implies that all data classes are consolidated into a single value representing the overall impact. This is achieved by assigning specific weights to different categories based on valuation principles. Weighting expresses the relationship between community values and environmental variations. The Pt (Points) on the graph is the unit used in the weighting step of Life Cycle Assessment to express the overall environmental impact of a product. One Pt corresponds to the average annual environmental load of one European citizen.

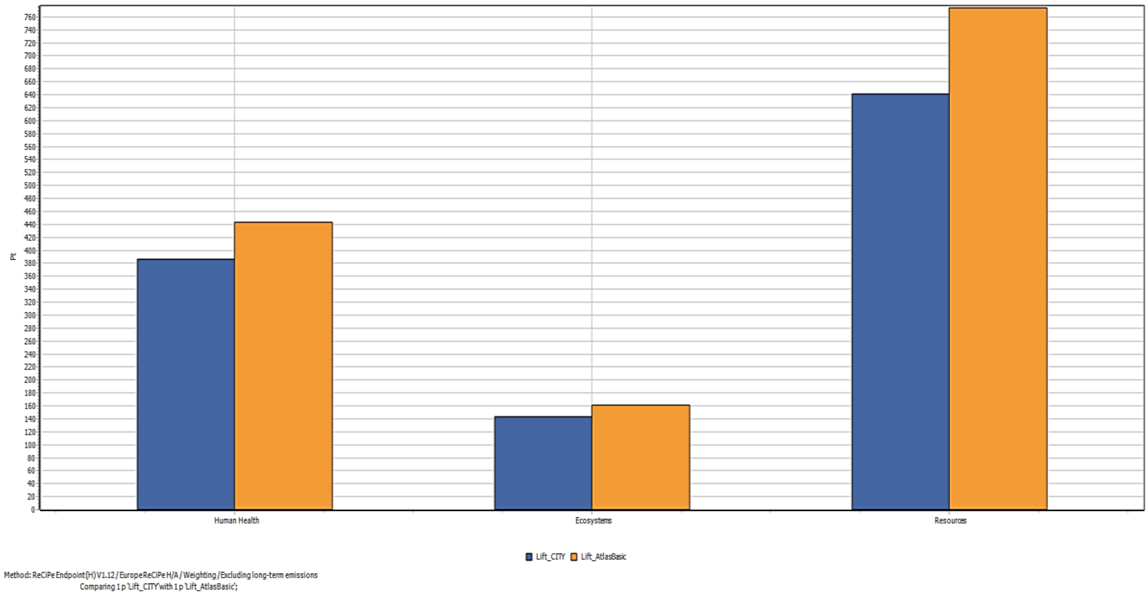
From the graphs provided, three main impact areas are highlighted:

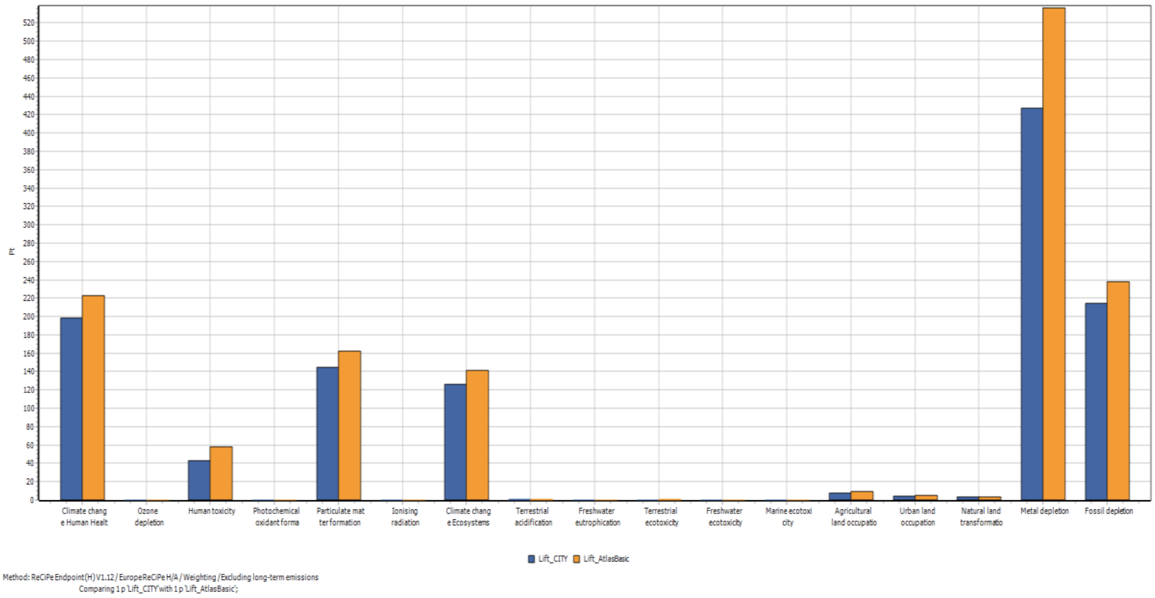
- Human Health: The graphs indicate that Human Health impacts are substantial, with the AtlasBasic model showing approximately 400 Pt impact, while the CITY model is slightly lower at around 350 Pt.
- Ecosystems: Impacts on ecosystems are notably smaller compared to other categories. The AtlasBasic model presents an impact close to 100Pt, whereas CITY is around 80Pt.
- Resources: This category represents the highest impact among all, with AtlasBasic reaching approximately 740 Pt, and CITY following at about 650 Pt.

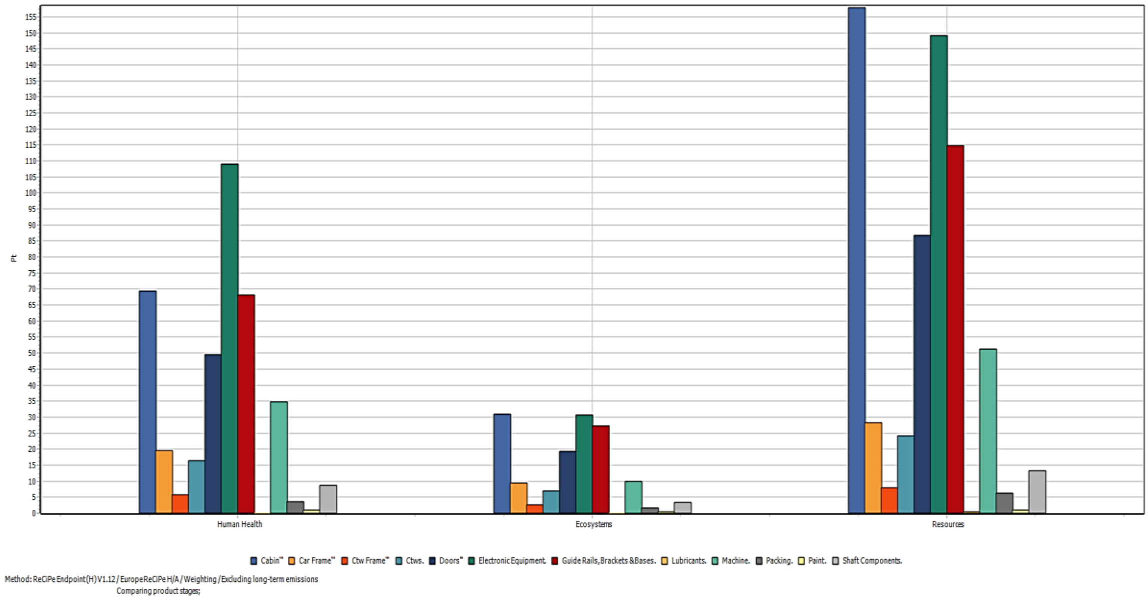
Furthermore, the breakdown of subcategories like Climate Change, Ozone Depletion, and Metal Depletion provides insights into specific environmental stressors. For instance, Metal Depletion alone contributes more than 500 Pt to the total impact in the AtlasBasic model.

The ReCiPe method, as utilized in this analysis, is one of the most updated and comprehensive frameworks for assessing environmental effects, particularly suited for European contexts. It integrates harmonized category indicators at both midpoint and endpoint levels, reflecting nuanced ecological and resource-based damages.

These values underscore the importance of prioritizing specific environmental areas during life cycle assessments and policy implementations.







Single Score

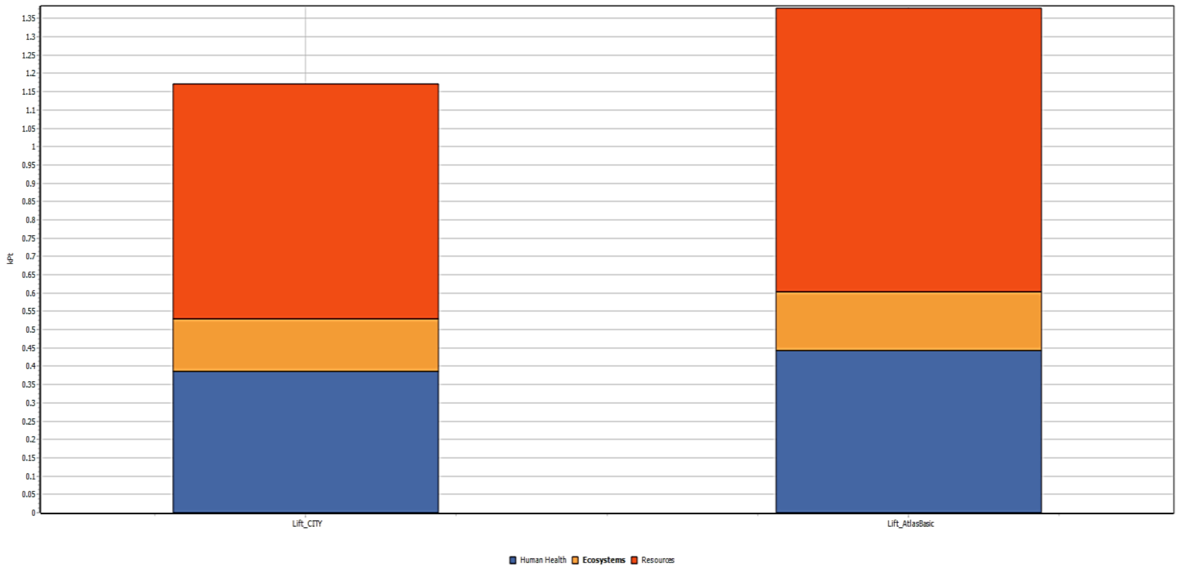
To compare different environmental effects and identify potential environmental “hot spots,” a method known as weighting is applied. The various calculated environmental impacts are weighted and aggregated into a single index called the “single score,” which represents the overall environmental burden of a product or system.

Comparison between CITY and AtlasBasic shows that the total single score for AtlasBasic is approximately 1.35 units, which is around 15% higher than that of CITY, measured at 1.17 units. Also, AtlasBasic exhibits increased impacts across most environmental categories, particularly in Human Health, contributing roughly 0.5 units (or about 37% of the total impact), and Ecosystems, which account for over 0.6 units. In contrast, CITY demonstrates slightly lower impact in Ecosystems, with around 0.65 units, making up approximately 55% of its total single score.

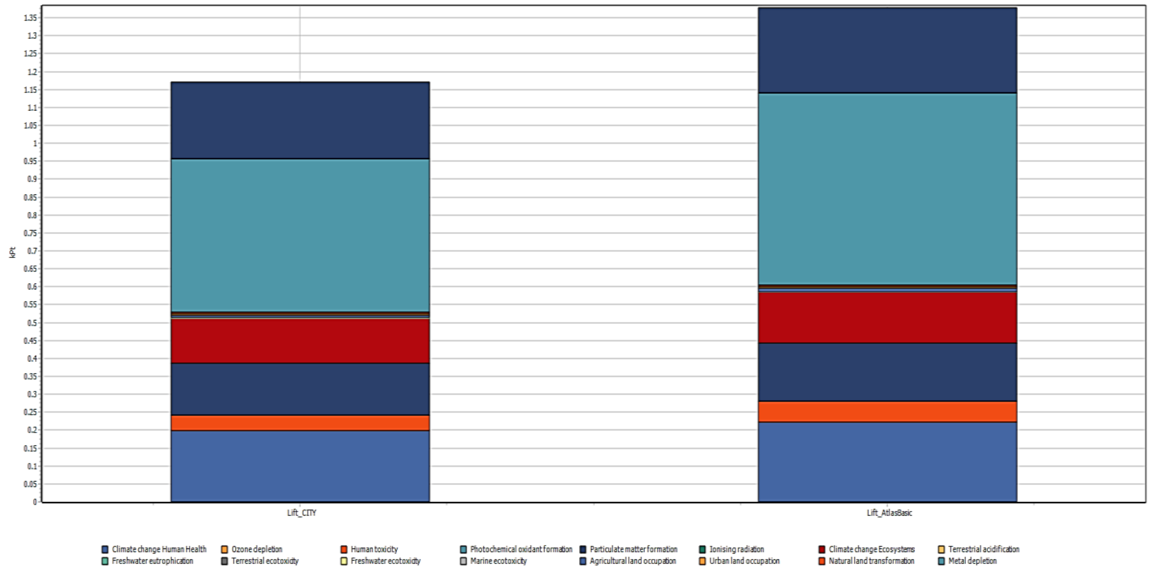
Presenting a breakdown by Impact Category the results, as illustrated in the third graph, the categories contributing most significantly to the single score include:

- Climate Change – Human Health: around 0.3 units in both systems.
- Freshwater Eutrophication and Ecotoxicity: considerably higher in AtlasBasic, with combined contributions exceeding 0.35 units.
- Human Toxicity and Terrestrial Acidification: also show greater contributions in AtlasBasic compared to CITY.

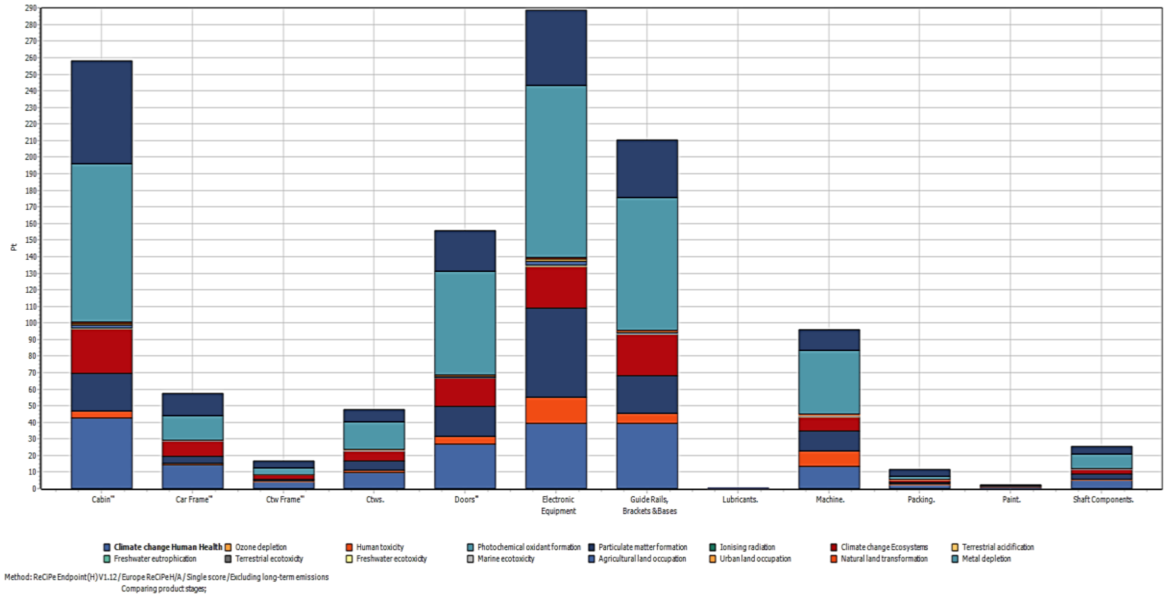
A breakdown by subsystems shows that the most environmentally impactful subsystem is Electronic Equipment, contributing over 250 units, marking it as the primary environmental "hot spot." Other significant contributors include the Cabin, Guide Rails, Brackets & Bases, and Mechanical Components, each exceeding 100 units in certain cases.



Method: ReCiPe Endpoint (H) V1.12 / Europe ReCiPe H/A / Single score / Excluding long-term emissions
Comparing 1 p 'Lift_CITY' with 1 p 'Lift_AtlasBasic';



Method: ReCiPe Endpoint (H) V1.12 / Europe ReCiPe H/A / Single score / Excluding long-term emissions
Comparing 1 p 'Lift_CITY' with 1 p 'Lift_AtlasBasic';



Land use impacts are expressed in units of Potentially Disappeared Fraction (PDF) × m² × year/m². The extraction of raw materials is quantified based on the surplus energy required per kilogram of minerals, while excess fossil fuel use is expressed as energy per extracted megajoule (MJ), kilogram, or cubic meter (m³).

General Conclusions

The comparative life cycle assessment of the two elevator models, CITY and AtlasBasic, reveals that the CITY model demonstrates a consistently lower environmental impact across nearly all categories assessed. Whether examining midpoint indicators (e.g., climate change, human toxicity, fossil depletion), endpoint categories (human health, ecosystems, resources), or aggregated results via normalization and weighting, the CITY model performs better in both absolute and relative terms.

Key conclusions include:

- Across Midpoint Categories: CITY achieves notable impact reductions (10–27%) in critical areas such as human toxicity, particulate matter formation, eutrophication, and metal/fossil depletion, indicating improvements in materials and energy use.
- At Endpoint Level: CITY reduces overall damage by ~10% to human health, ~9% to ecosystems, and ~14% to resources, confirming broader life cycle performance gains.
- Normalization Results: Even when normalized against European per capita impacts, CITY retains lower burdens, particularly in metal and fossil depletion, showcasing meaningful reductions in globally significant pressures.
- Weighted Impact (Pt): Using the ReCiPe weighting method, CITY scores approximately 15% lower in total environmental burden. Human health and resources remain the most impacted areas in both models, but CITY consistently shows lower point values.
- Single Score Analysis: The CITY model achieves a ~15% lower overall environmental single score, reflecting a more sustainable design. Environmental "hot spots" are concentrated in electronic equipment and mechanical subsystems, indicating key areas for further optimization.

Overall, the CITY model demonstrates a more environmentally responsible option, validating the benefits of targeted eco-design, material efficiency, and improved energy management. These results reinforce the importance of adopting life cycle thinking and impact assessment methods for product development and environmental decision-making.

To allow for further comparison between different environmental impact indicators, three additional methods were applied. The results of these methods are presented in the following table.

Impact category	Unit	EPD		IPCC		CML	
		CITY	AtlasBasic	CITY	AtlasBasic	CITY	AtlasBasic
Acidification	*kg SO2 eq*	72.1	74.6			78.5	80.5
Eutrophication	*kg PO4--- eq*	11.9	13.8			11.9	13.8
Global warming (GWP100a)	*kg CO2 eq*	7170	8040	7280	8160	7170	8040
Photochemical oxidation	*kg C2H4 eq*	4.47	4.74			4.47	4.74
Ozone layer depletion (ODP)	*kg CFC-11 eq*	0.000579	0.000685			0.000579	0.000685
Abiotic depletion	*kg Sb eq*	0.494	0.461			0.494	0.461
Abiotic depletion (fossil fuels)	*MJ*					89300	99100

BEAR IN MIND: If required a corresponding study with other methods in addition to the ReCiPe Endpoint, hierarchist version, can be carried out by the company for any proper use.

The continuous development of all products based on the principles of life cycle analysis, impact assessment, and eco-design forms the foundation for the sustainable evolution of services and products. This approach ensures that offerings to the end customer are made with respect for both people and the environment.

Appendix

Acidification potential: Phenomenon by which atmospheric rainfall has a pH which is lower than average. This may cause damage in forests and cultivated fields, as well as in water ecosystems and objects in general. This phenomenon is due to the emissions of SO_2, of NO_x, and NH_3, which are included in the Acidification Potential (AP) index expressed in masses of SO_2 produced.

Eutrophication potential: Enrichment of the watercourses by the addition of nitrates and phosphates. This causes imbalance in water ecosystems due to the overdevelopment encouraged by the excessive presence of nourishing substances, so is increased the growth of aquatic plants and can produce algal blooms that deoxygenate water and smother other aquatic life. In particular, the Eutrophication Potential (EP) includes phosphorous and nitrogen salts and it is expressed in grams of oxygen (kg O_2).

Global warming potential (GWP100): Phenomenon by which the IR irradiation emitted by the earth's surface are absorbed by the molecules in the atmosphere, as a result of solar warming, and then re-emitted in the form of heat, thus giving rise to a process of global warming of the atmosphere. The indicator used for this purpose is GWP (Global Warming Potential). This mainly includes the emissions of carbon dioxide, the main greenhouse gas, as well as other gases with a lower degree of absorption of infrared rays, such as ethane (CH_4), nitrogen protoxide (N_2O), chlorofluorocarbons (CFC), which are expressed according to the degree of absorption of CO_2 (kg CO_2).

Ozone depletion potential (ODP): Degradation and depletion of the ozone layer in the stratosphere, which has the property of blocking the UV components of sunlight thanks to its particularly reactive compounds, originated by chlorofluorocarbons (CFC) or by chlorofluoromethanes (CFM). The substance used as a point of reference for assessing the ODP (Ozone Depletion Potential) is trichlorofluoromethane, or CFC-11. ODPs are calculated as the change that would result from the emission of 1kg of a substance to that from emission of 1 kg of CFC-11 (a Freon).

Photochemical oxidation: The index used to translate the level of emissions of various gases into a common measurement to compare their contributions to the change of ground-level ozone concentration. POCPs are calculated as the change that would result from the emission of 1 kg of a gas to that from emission of 1 kg of ethylene.

Depletion of abiotic resources: Two impact categories: Abiotic depletion (elements, ultimate reserves) and abiotic depletion (fossil fuels). Abiotic depletion (elements, ultimate reserves) is related to extraction of minerals due to inputs in the system. The Abiotic Depletion Factor (ADF) is determined for each extraction of minerals (kg antimony equivalents/kg extraction) based on concentration reserves and rate of deaccumulation. Abiotic depletion of fossil fuels is related to the Lower Heating Value (LHV) expressed in MJ per kg of m^3 fossil fuel. The reason for taking the LHV is that fossil fuels are considered to be fully substitutable.

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