TrainERGY project

ZINCO Ltd

Case Study

Submission Date:	**19/05/2017**
Place:	**Naples, Italy**

Sector Analysed:	**Metal Industry**
Product Analysed:	**Zinc foil**

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1 Introduction

The main goal of this case study is to examine the supply chain of ZINCO Ltd (ZIL) and develop best practices of carbon management. ZIL is involved in the manufacturing of zinc foil, a product which is widely used in building, aerospace and automotive industry. Due to non-disclosure agreement (NDA), information is confined only to the manufacturing process. No information is provided with respect to their suppliers, distribution network or customers. Therefore, no safe assumption can be made regarding the complexity of their supply chain. The analysis is based on the hypothesis that the company has a high level of awareness of their supply chain, an assumption that is reflected on the proportion of direct and indirect emissions. Owning to the energy intensive nature of zinc foil manufacturing, serious environmental concern with respect to Carbon dioxide (CO_2) emissions are put forth. To facilitate the evaluation of the latter and overcome common pitfalls of traditional life cycle assessment (LCA) tools, the firm has implemented Supply Chain Environmental Analysis Tool (SCEnAT) which is developed by (Acquaye et al., 2011). SCEnAT is an advanced environmental impact computation tool with Big Data analytics (BDA) capabilities and detailed visualisations. Particularly, the tool was used to perform a set of decision-making supporting tasks such as 'supply chain mapping', SC carbon calculations, low carbon interventions and performance evaluation. First, the ZIL supply chain was created using the primary data provided by the company. Secondary data were obtained from ECOINVENT database based on GWP 100a. Successively, the SC map was converted to carbon map using SCEnAT, identifying the CO_2 hotspots. To optimise energy efficiency and reduce CO_2 emissions, two different SC scenarios were explored and their performance was assessed. Conclusively, an optimised environmental friendly SC was suggested to ZIL. The output generated by SCEnAT and the findings related to different SC scenarios are discussed further in this report.

2 Overview

2.1 Firm description

Zinco Ltd (ZIL) is a manufacturing company based in the Yorkshire region which involves in the metal industry, particularly in the production of zinc foil. ZIL's zinc foil is primarily sold to the aerospace and automotive industry due to its material properties. The firm is a subsidiary of a global company which engages in the design and manufacturing of architectural aluminium systems. Zinco is a large firm having more than 300 employees. On the zinc supply chain, ZIL plays a central role as manufacturer and connects upstream and downstream several actors in the network. Due to the aforementioned non-disclosure agreement, no information with regard to their suppliers, annual production and distribution network is provided.

2.2 Product description

Zinco Ltd (ZIL) is involved in the production of zinc foil. Due to zinc's electrochemical properties, it has a high electromagnetic shielding effect which makes it highly suitable to the aerospace and automotive industry as well as to marine and land applications. Owning to non-disclosure agreement no information with regard to the annual production is provided.

2.3 Supply chain of the product

Taking into consideration the limitations stemming from the non-disclosure agreement, ZIL supply chain is confined to processes between manufacturing and final customer. A schematic representation of ZINC's supply chain is provided in Figure 1.

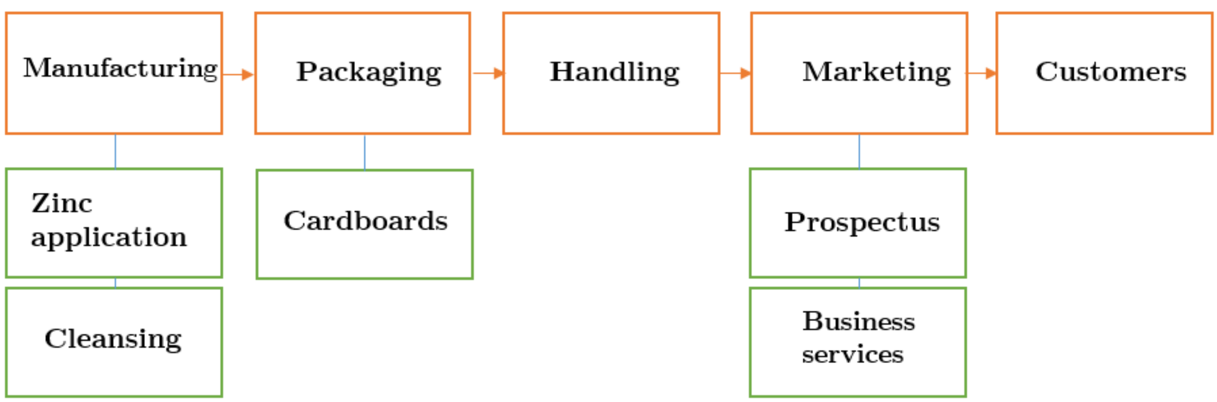

Figure 1: ZINC Ltd supply chain

Zinc foil production is illustrated as a network of five key processes namely, manufacturing, packaging, handling, marketing and final customer. Certain processes is broken down in different sub-processes. For instance, manufacturing process is comprised of zinc application and cleansing whereas others such as handling process, does not include any. To simplify the diagram, certain stages have been merged into one process, such as "zinc application" and "cleansing" into "manufacturing" or

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"prospectus" and "business services" into "marketing". Each process and sub-process includes different inputs which are not showcased in Figure 1. Each arrow signifies the flow of outputs among processes. Specifically, the flow from manufacturing to packaging signifies the produced zinc foil; from packaging to handling, the packaged product; from handling to marketing the respective labelling and from marketing to customers all the services with respect to management and formulation of contracts with potential customers. Pertaining to transport flows and secondary inputs, no assumptions can be made due to insufficient data. Analysis is based on the assumption that the company has a very good knowledge of their supply chain thus, no further optimisation is required.

3 Main Analysis

3.1 Process approach

3.1.1 Resources and materials

Table 1 provides an overview of the resource and materials costs analysis. Quantity is specified according to the production of 1kg of zinc foil. It is evident that the highest cost is associated with business services which accounts for 69.56% of total cost. In terms of energy utilities, electricity cost (24%) is approximately twenty-four times higher than oil consumption thus, it is safe to assume practices towards the optimisation of energy usage are deemed necessary. Paper cartons came third in cost analysis accounting for 4%.

Table 1: Resource and material cost analysis

Supply Chain Input	Quantity	Unit	Unit Cost	Unit (£/Unit)	Total Cost (£)	Cost (%)
Electricity	11.5	kWh	0.12	£/kWh	1.38	24.00%
Oil	0.02	L	1.19	£/L	0.0238	0.41%
Zinc	0.05	kg	1.12	£/kg	0.056	0.97%
Chemical adhesive	0.047	kg	0.05	£/kg	0.00235	0.04%
Water	17	L	0.0019184	£/L	0.0326128	0.57%
Chemicals	0.078	L	0.08	£/L	0.00624	0.11%
Plastic wrapping	0.12	kg	0.12	£/kg	0.0144	0.25%
Paper cartons	1	kg	0.23	£/kg	0.23	4.00%
Paper	0.105	kg	0.05	£/kg	0.00525	0.09%
Ink	0.0019	kg	0.02	£/kg	0.000038	0.00%
Services	0.04	FTE	100	FTE	4	69.56%
				Total	5.7506908	100.00%

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It is evident that zinc foil production is a labour and energy intensive process. In addition, the high cost of paper cartons makes it all the more imperative to explore alternative low-cost replacements. Nonetheless, decisions should not only be based on cost but also on energy efficiency.

3.2 SCEnAT Analysis

3.2.1 SC Carbon Map

Following cost assessment, carbon analysis is conducted on a per kg zinc foil production basis. CO_2 emissions data along with their respective unites is provided in Table 2. Data analysis was conducted using SCEnAT tool. According to the results, electricity input was the main source of greenhouse gas emissions, accounting for 75.23%. Paper cartons follow with 18.28% whereas zinc, which is the key production input is responsible only for 2.20%. With reference to remaining inputs, chemicals and paper comprising approximately only 1.50% respectively.

Table 2: Total CO_2 emissions analysis

Supply Chain Input	Quantity	Unit	GHG Intensity [kg CO2-eq/unit]	Total emissions [kg CO2-eq/unit]	Emissions (%)
Electricity	11.5	kWh	0.606	6.969	75.23%
Oil	0.02	L	0.76	0.0152	0.16%
Zinc	0.05	kg	4.0798	0.20399	2.20%
Chemical adhesive	0.047	kg	0.66002	0.03102094	0.33%
Water	17	L	0.00031855	0.00541535	0.06%
Chemicals	0.078	L	1.8599	0.1450722	1.57%
Plastic wrapping	0.12	kg	0.52402	0.0628824	0.68%
Paper cartons	1	kg	1.6939	1.6939	18.28%
Paper	0.105	kg	1.2991	0.1364055	1.47%
Ink	0.0019	L	0.67	0.001273	0.01%
			Total	9.26415939	100.00%

A visual representation of the SC Carbon map in SCEnAT prior and after the computation of results is provided in Figure 2 and 3 respectively.

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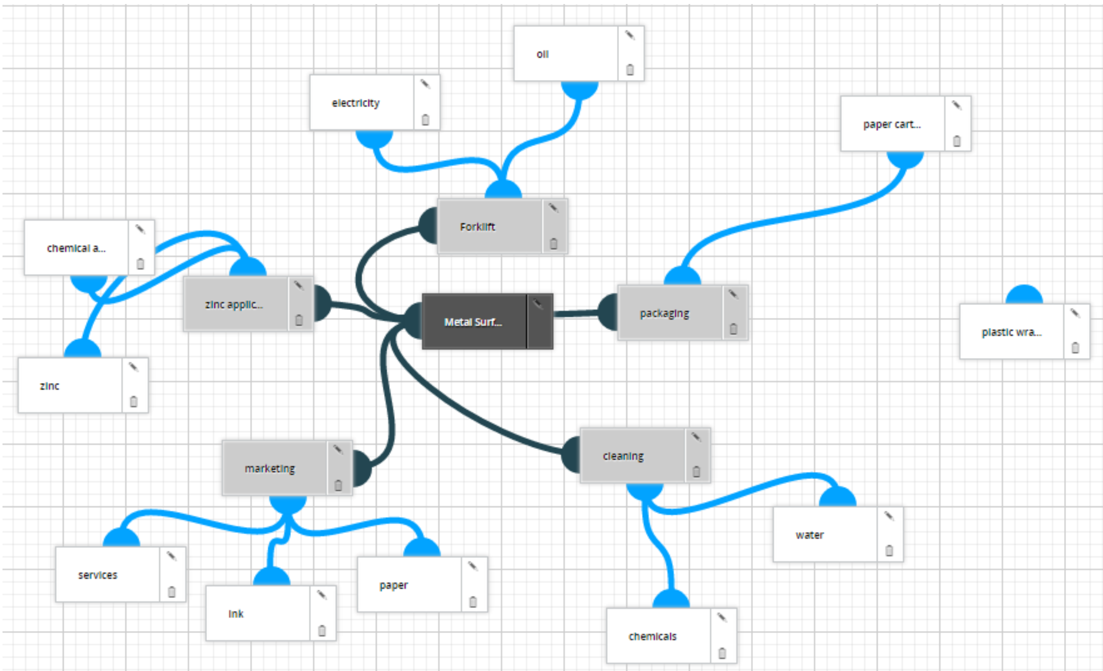

Figure 2: Zinc foil SC carbon map prior to computational results

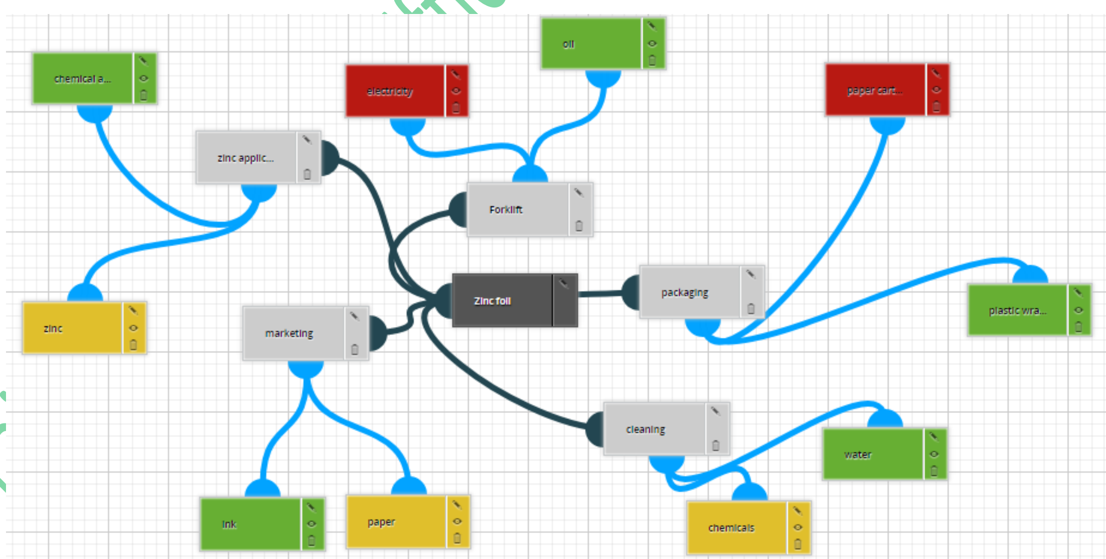

Figure 3: Zinc foil SC carbon map after computational results

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The benchmarking analysis (Figure 4) reveals that electricity and cardboard boxes are the two hotspots even if compared to industry standards. Evidently, utilities appear increased by 26.9% whereas wood and paper by +11.3%.

Sector Emissions

	Personal Services	Business Services	Transport and Communication	Trade	Construction	Utilities	Equipment	Metals	Minerals
Sector Total	0.0%	0.0%	0.5%	0.0%	0.0%	82.6%	0.0%	0.0%	0.0%
Benchmark Total	0.0%	0.3%	3.7%	0.3%	0.1%	55.7%	0.4%	25.2%	2.7%
Benchmark Comparison	0.0%	↓ -0.3%	↓ -3.2%	↓ -0.3%	↓ -0.1%	↑ 26.9%	↓ -0.4%	↓ -25.2%	↓ -2.7%

	Chemicals	Fuels	Wood and Paper	Textiles	Food	Mining	Fishing	Forestry	Agriculture
Sector Total	2.8%	0.2%	11.4%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%
Benchmark Total	0.9%	1.6%	0.2%	0.0%	0.0%	8.1%	0.0%	0.0%	0.7%
Benchmark Comparison	↑ 1.9%	↓ -1.4%	↑ 11.3%	0.0%	0.0%	↓ -5.6%	0.0%	0.0%	↓ -0.7%

Figure 4: Benchmarking analysis

With respect to direct and indirect emissions, the company seems to have a thorough knowledge of their supply chain as analysis indicated that there is a very low share of indirect emissions (Figure 5). This can be accredited to very few indirect inputs which nonetheless is accredited to the lack of information due to non-disclosure agreement with ZIL.

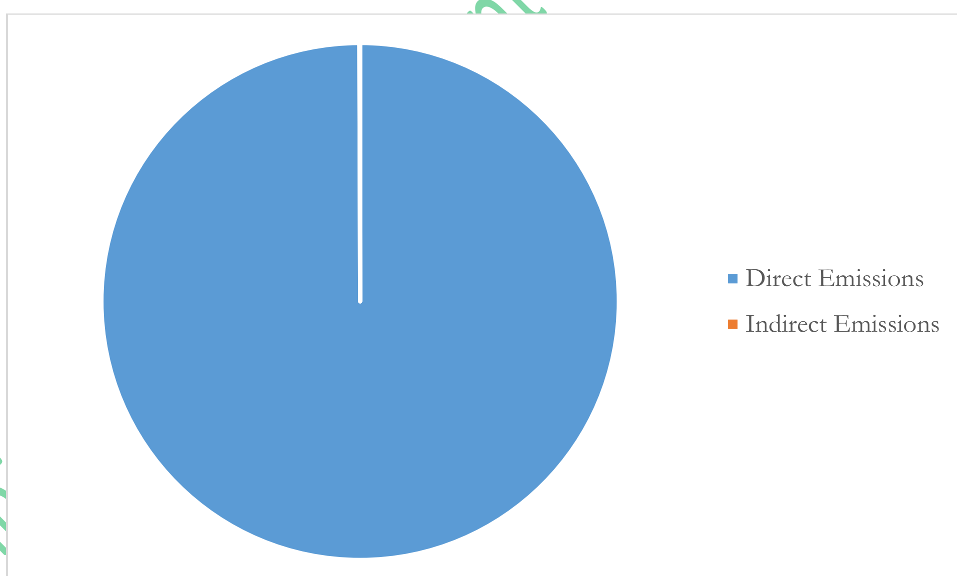

Figure 5: Direct vs Indirect Emissions

3.3 Results

Figure 6 shows each input's cost and CO_2 emissions in default scenario. It is apparent that electricity and cardboards are the main hotspots both in terms of carbon emissions and cost. These observations highlight the necessity to replace the aforementioned inputs with others of high energy and cost efficiency. A schematic representation of the results is also provided in Figure 3 above.

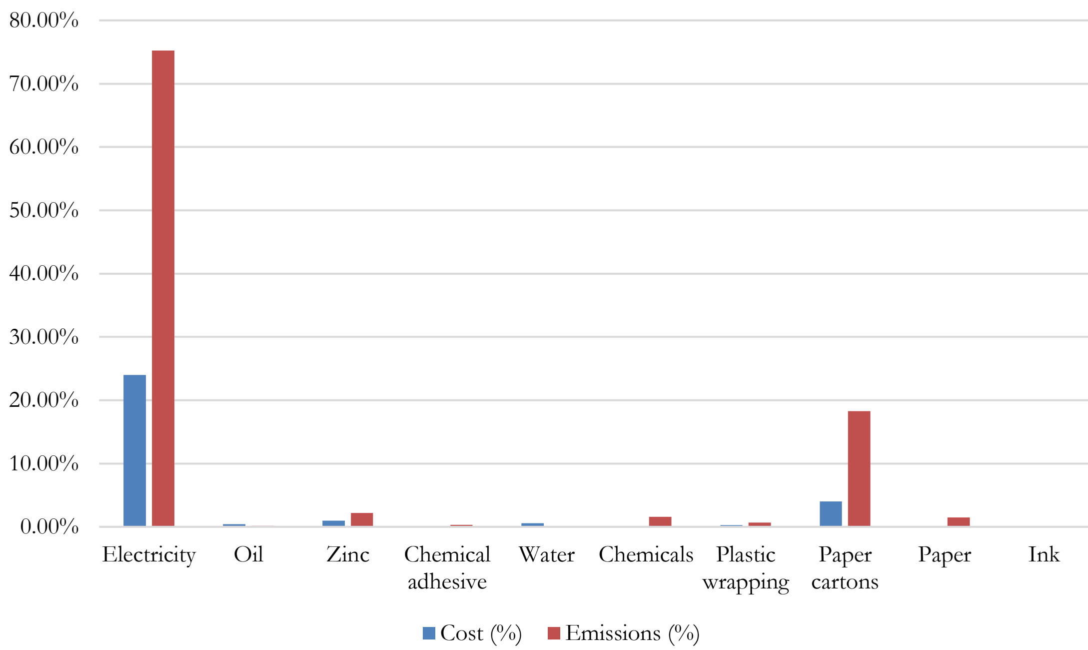

Figure 6: Comparison of CO_2 emissions and cost input proportions in original supply chain

4 Possible improvements

Analysis has shown that electricity exhibited the highest CO_2 emissions (75.23%) followed by cardboards (18.28%). Consequently, alternate inputs were suggested to ZINCO supply chain based on the following two scenarios.

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4.1 Scenario 1

In scenario 1, resource and material cost as well as carbon dioxide emissions were evaluated after replacing electricity with wind energy. Results of the analysis are presented in Table 3 and 4 respectively. Figure 7 provides a comparison between total cost and carbon emissions per SC input in Scenario 1. It is evident that CO_2 emissions related to wind energy have significantly dropped by 70% to original scenario. Respective total cost remains significant but still less than 20%. In scenario 1, main source of carbon emissions is cardboard (paper cartons).

Table 3: Scenario 1 resource and material cost analysis

Supply Chain Input	Quantity	Unit	Unit Cost	Unit (£/Unit)	Total Cost (£)	Cost (%)
Wind Energy	11.5	kWh	0.082	£/kWh	0.9430	17.75%
Oil	0.02	L	1.19	£/L	0.0238	0.45%
Zinc	0.05	kg	1.12	£/kg	0.0560	1.05%
Chemical adhesive	0.047	kg	0.05	£/kg	0.0024	0.04%
Water	17	L	0.0019184	£/L	0.0326	0.61%
Chemicals	0.078	L	0.08	£/L	0.0062	0.12%
Plastic wrapping	0.12	kg	0.12	£/kg	0.0144	0.27%
Paper cartons	1	kg	0.23	£/kg	0.2300	4.33%
Paper	0.105	kg	0.05	£/kg	0.0053	0.10%
Ink	0.0019	kg	0.02	£/kg	0.0000	0.00%
Services	0.04	FTE	100	FTE	4.0000	75.28%
				Total	5.3137	100%

Table 4: Scenario 1 total CO_2 emissions

Supply Chain Input	Quantity	Unit	GHG Intensity [kg CO2-eq/unit]	Total emissions [kg CO2-eq/unit]	Emissions (%)
Wind Energy	11.5	kWh	0.011335	0.1304	5.37%
Oil	0.02	L	0.76	0.0152	0.63%
Zinc	0.05	kg	4.0798	0.2040	8.41%
Chemical adhesive	0.047	kg	0.66002	0.0310	1.28%
Water	17	L	0.00031855	0.0054	0.22%
Chemicals	0.078	L	1.8599	0.1451	5.98%
Plastic wrapping	0.12	kg	0.52402	0.0629	2.59%
Paper cartons	1	kg	1.6939	1.6939	69.84%
Paper	0.105	kg	1.2991	0.1364	5.62%
Ink	0.0019	L	0.67	0.0013	0.05%
			Total	2.4255	100%

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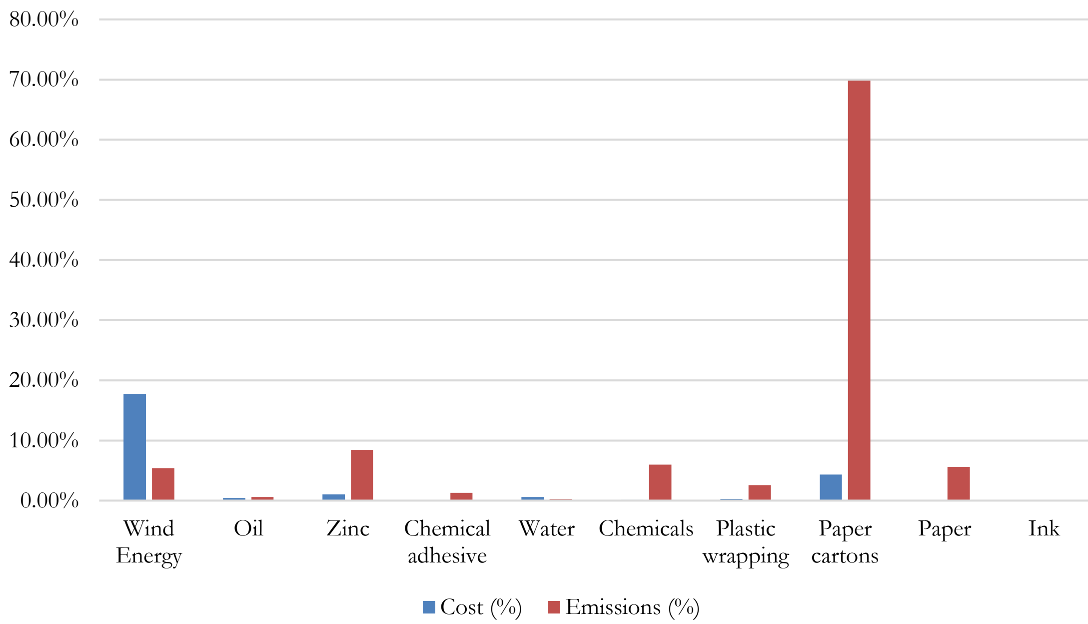

Figure 7: Comparison of CO_2 emissions and cost input proportions in Scenario 1

4.2 Scenario 2

In Scenario 2, paper cartons were replaced by recycled paper cartons. Table 5 and 6 provide an overview of material total cost and total carbon emissions. In addition, Figure 8 offers an aggregated view of total results into a graph. By comparing Figure 8 and 6, a major cost reduction can be noticed with regard to cardboard as both the respective proportion of total cost and total carbon emissions have reduced by half. Nevertheless, recycled cardboards constitute the second major source of cost and CO_2 emissions after electricity.

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Table 5: Scenario 2 resource and material cost analysis

Supply Chain Input	Quantity		Unit	Unit Cost	Unit (£/Unit)	Total Cost (£)	Cost (%)
Electricity	11.5		kWh	0.12	£/kWh	1.38	24.62%
Oil	0.02		L	1.19	£/L	0.0238	0.42%
Zinc	0.05		kg	1.12	£/kg	0.056	1.00%
Chemical adhesive	0.047		kg	0.05	£/kg	0.00235	0.04%
Water	17		L	0.0019184	£/L	0.0326128	0.58%
Chemicals	0.078		L	0.08	£/L	0.00624	0.11%
Plastic wrapping	0.12		kg	0.12	£/kg	0.0144	0.26%
Recycled paper cartons	1		kg	0.085	£/kg	0.085	1.52%
Paper	0.105		kg	0.05	£/kg	0.00525	0.09%
Ink	0.0019		kg	0.02	£/kg	0.000038	0.00%
Services	0.04		FTE	100	FTE	4	71.36%
					Total	5.6056908	100.00%

Table 6: Scenario 2 total CO_2 emissions

Supply Chain Input	Quantity	Unit	GHG Intensity [kg CO2-eq/unit]	Total emissions [kg CO2-eq/unit]	Emissions (%)
Electricity	11.5	kWh	0.606	6.969	82.97%
Oil	0.02	L	0.76	0.0152	0.18%
Zinc	0.05	kg	4.0798	0.20399	2.43%
Chemical adhesive	0.047	kg	0.66002	0.03102094	0.37%
Water	17	L	0.00031855	0.00541535	0.06%
Chemicals	0.078	L	1.8599	0.1450722	1.73%
Plastic wrapping	0.12	kg	0.52402	0.0628824	0.75%
Recycled paper cartons	1	kg	0.82913	0.82913	9.87%
Paper	0.105	kg	1.2991	0.1364055	1.62%
Ink	0.0019	L	0.67	0.001273	0.02%
			Total	8.39938939	100.00%

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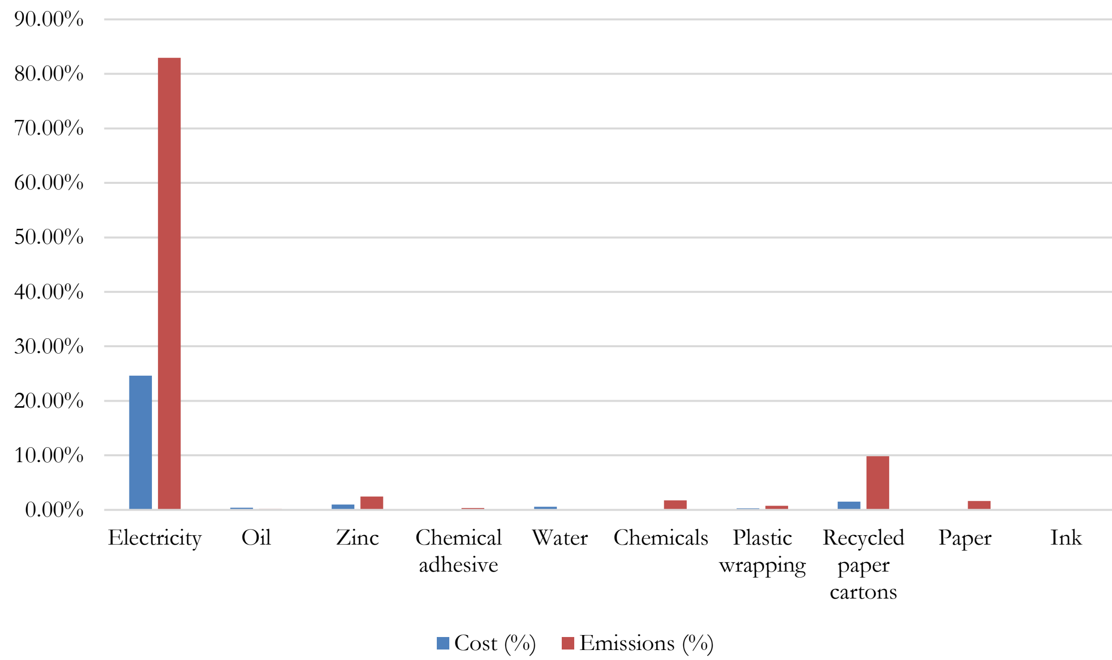

Figure 8: Comparison of CO_2 emissions and cost input proportions in Scenario 2

5 Final conclusions

Analysis of the original scenario highlighted electricity and cardboards as major sources of carbon emissions. Based on these findings, two options were considered towards minimizing their environmental impact. In the first one, electricity was replaced by the environmental friendly wind energy whereas in the second one, carton boxes were substituted with recycled cardboards. A comparison of all scenarios is provided in Figure 9. Analysis showed the ZINCO Ltd could greatly benefit from the use of renewable energy sources and recycled cardboards. However, it is clear that there is a correlation between the environmental performance of electricity and cardboards. In particular, the overall carbon impact of electricity is inversely proportional to cardboards. Regarding the implementation of both Scenario 1 and 2, hotspots are focalized on zinc. Thus, future suggestions should focus on the possibility of recycling the waste generated throughout the production chain.

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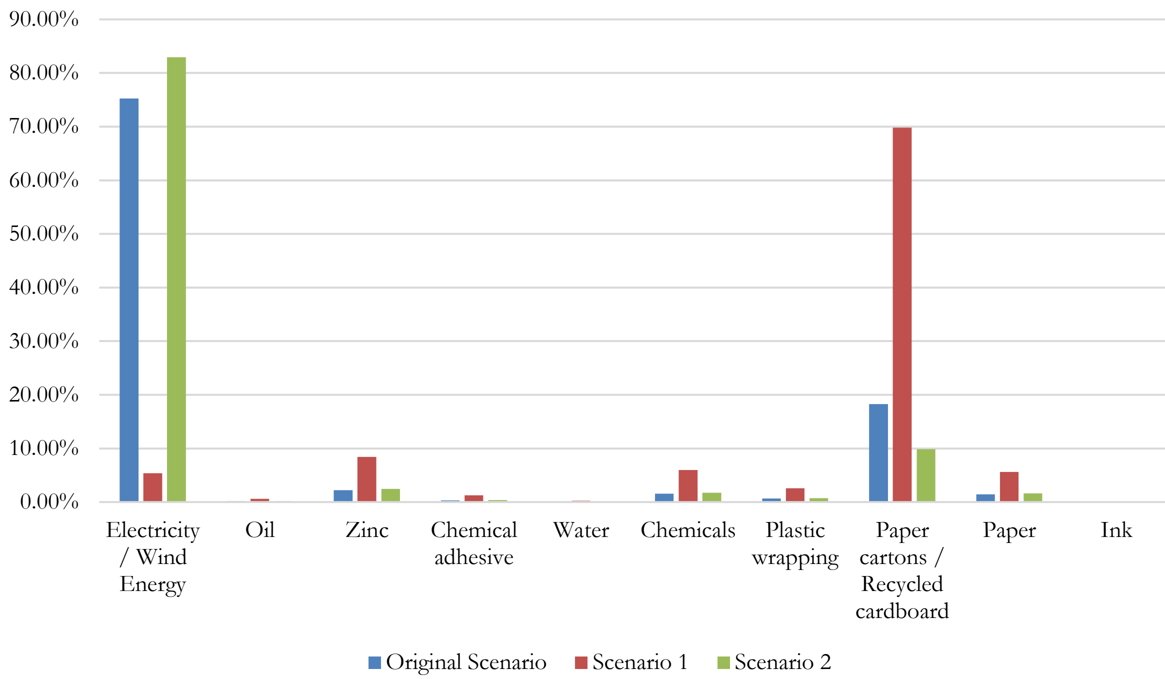

Figure 9: Comparison of scenarios with respect to CO_2 emissions

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