TrainERGY project

Case Study - Template

Submission Date:	09 March, 2018
Place:	Thessaloniki, Greece

Sector Analysed:	Manufacture
Product Analysed:	PCB Boards

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Table of Contents

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

1 Introduction

The main goals of this analysis is to examine the manufacturing process of main and led printed circuit board (PCB) of an autonomous siren of PLAKETA Ltd, identify hotspots and suggest relative improvements. PLAKETA Ltd. is an innovative manufacturing company specialising in the development of innovative electronic safety and security systems using state of the art technology. Case study is focusing solely on the manufacturing process of the PCB, thus transportation flows are not taken into consideration in the analysis. The energy intensive nature of this process puts forth serious environmental concerns with respect to carbon dioxide (CO_2) emissions. By reducing these CO_2 emissions PLAKETA Ltd is aiming to implement an internal mechanisms that ensures environmental sustainability and support current legislation that set specific requirements regarding greenhouse gas emissions. To identify the hotspots of the manufacturing process, the company has deployed Supply Chain Environmental Analysis Tool (SCEnAT), an advanced computation tools with Big Data Analytis (BDA) capabilities and intuitive visualisations.

Starting from supply chain mapping, the tool was used to perform carbon and cost calculations in order to identify hotspots and facilitate corrective decision support. The process of supply chain mapping was carried away using the data provided by the company and the cycle inventory database ECOINVENT. After filling missing data inputs regarding quantity, cost and emissions, SCEnAT analysed life-cycle greenhouse gas emissions (GHG) pointing out key hotspots. Given current global shift towards renewable energy sources, two different scenarios were explored and their environmental performance was evaluated.

1.1 Firm description

PLAKETA Ltd. is a market leader in electronic safety and security industry. The company engages in developing innovative state-of-the-art electronic safety and securing systems. The firm currently employs 164 people allocating 15% of its profits to R&D while its products are exported to 70 countries worldwide. It is one of the oldest and largest electrical and electronics manufacturers in Europe. Following an expansion of its product lines in late 90s, the company won many industry awards for its successful and innovative business activities.

1.2 Product description

Current case study is focusing on the construction of the PCB board for an autonomous security siren. Construction of the PCB comprises of five phases corresponding to five different type of machines namely, FlexLink, SI-P950, SI-G200 AA, SI-GSOO BB and HOTFLOW 2/12. The phases for the construction of the PCB is shown in Table 1.

Table 1: PCB construction phases

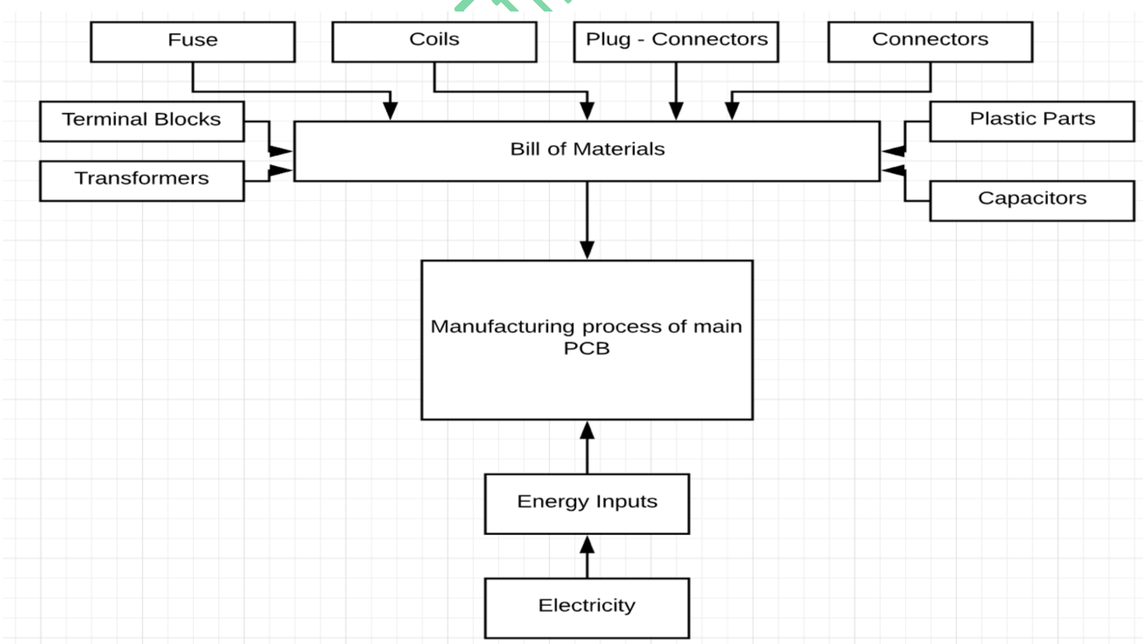
Main PCB = Production of 6 units				
Phases	Type of machine	Power of machines	Completion time	Energy consumption
1st	FlexLink	500W	1sec	0,13 Wh
2nd	SI-P950	2kW	30sec	16,67 Wh
3rd	SI-G200 AA	1kW	28sec	7,78 Wh
4th	SI-G200 BB	1kW	20sec	5,56 Wh
5th	HOTFLOW 2/12	48kW	360sec	4800 Wh

According to the case study description, PCB = production of 6 units, thus the electricity input that is going to be used in SCEnAT, will be:

$$P_{unit} = \frac{4830{,}149\ Wh}{6} = 805{,}03Wh$$

1.3 Supply chain of the product

Figure 1 provides a schematic representation of the manufacturing process of main PCB board of autonomous siren provided in the case study. The process is illustrated as a network of two key categories, namely the bill of raw materials and construction process of the PCB



This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

2 Main Analysis

2.1 Process approach

The components provided in Table 2, are attached on the PCB through 5 construction phases. Table 1 provides an overview of these phases. During phases 1-4 components are accurately placed onto a printed circuit board (PCB) whereas HOTFLOW 2/12 reflow oven at 5th phase solders them on the PCB using a paste.

Table 2: List of components used in the manufacturing process

Short Description	Quantity
CAPASITORS	1
FUSE	1
TERMINAL BLOCKS	2
PLUG-CONNECTORS	8
CONNECTORS	1
COILS	1
TRANSFORMERS	1
PLASTIC PARTS	1

2.1.1 Resources and materials

Table 3 provides an overview of the resource and material cost analysis. Quantity is specified according to the production of 1 main PCB board according to the construction phases presented in Table 1. Quantities for the first eight inputs signify the physical existence of one unit. Although capacitor has the highest cost per unit (£23), highest total cost is associated with electricity (73%). Given that amount of electricity required, it is evident that the construction of main PCB is an energy intensive process thus; actions should be focusing on the use of alternative and cost-efficient energy sources.

Table 3: Resource and material cost analysis

Process Inputs	Quantity	Unit	Average Unit Cost	Unit (£/unit)	Total Cost	Cost %
Connectors	1.00	/	1.23	£	1.23	0.93%
Coils	1.00	/	1.00	£	1.00	0.76%
Transformers	1.00	/	2.45	£	2.45	1.86%
Capacitor	1.00	/	23.00	£	23.00	17.45%
Fuse	1.00	/	1.30	£	1.30	0.99%

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Terminal Blocks	2.00	/	0.76	£	1.52	1.15%
Plug connectors	8.00	/	0.56	£	4.48	3.40%
Plastic Parts	1.00	/	0.23	£	0.23	0.17%
Electricity	805.03	kWh	0.12	£/kWh	96.60	73.29%

2.1.2 Energy usage (per single unit of analysed product)

Table 4 provides a summary of total GHG intensity per input. Similar to total cost assessment, analysis was carried out based on the production of 1 main PCB board. No specific measurement units were attached to process inputs apart from electricity (kWh). According to SCEnAT, electricity is responsible for almost all CO_2 emissions (98%). Plug connectors come second accounting for only 1.23%. Given the fact that the construction process is standardised, id est no alternative configurations are possible, focus should be placed solely on alternative and more environmental friendly energy sources.

Table 4: Total emissions analysis

Process Inputs	Quantity	Unit	GHG Intensity (kg CO_2-eq/unit)	Total Emissions (kg CO_2-eq)	Emissions %
Connectors	1.00	/	1.12	1.12	0.11%
Coils	1.00	/	1.44	1.44	0.14%
Transformers	1.00	/	1.22	1.22	0.12%
Capacitor	1.00	/	1.24	1.24	0.12%
Fuse	1.00	/	1.45	1.45	0.14%
Terminal blocks	2.00	/	0.89	1.78	0.18%
Plug connectors	8.00	/	1.56	12.48	1.23%
Plastic parts	1.00	/	0.98	0.98	0.10%
Electricity	805.03	kWh	1.29	1038.49	98.00%

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

2.2 SCEnAT Analysis

2.2.1 SC Carbon Map

Figure 2 shows the carbon map of PCB board manufacturing process in SCEnATI. Different colours represent different levels of GHG emissions. Red (electricity) has the greatest impact followed by plug connectors (yellow). Nonetheless, as Table 4 indicates, plug connectors account only for almost 1% of total GHG emissions.

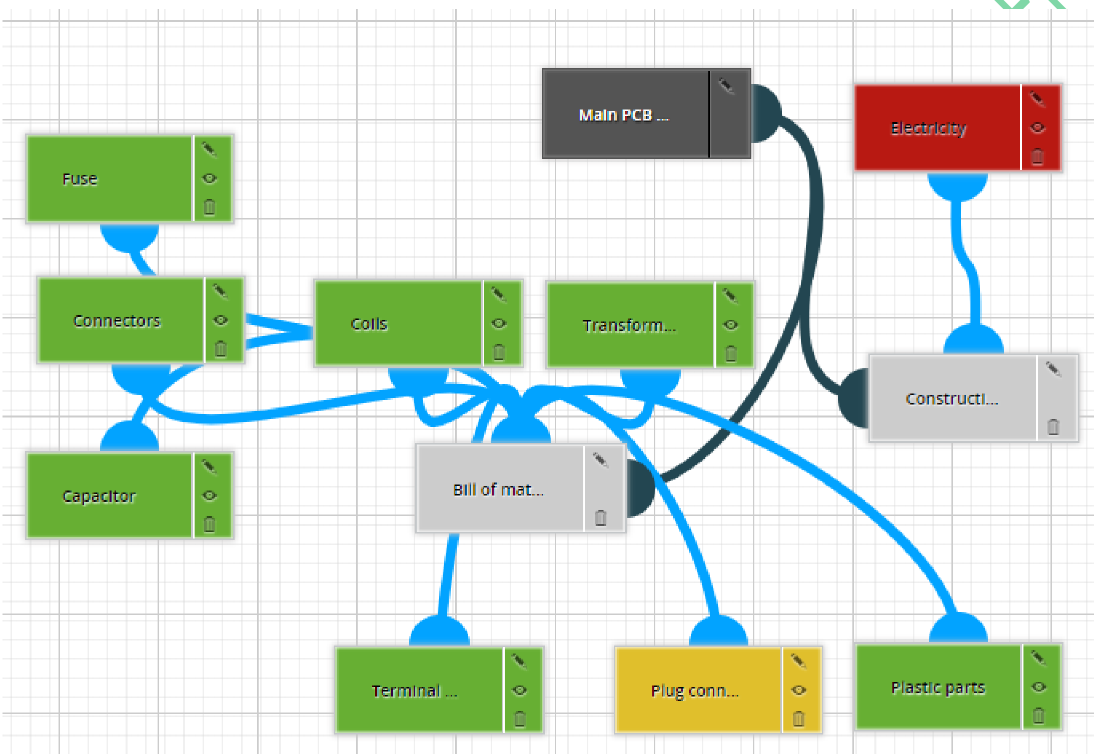


Figure 2: Manufacturing process carbon map

2.2.2 Results

Figure 3 offers a compact view of total cost and total emissions per process input. According to the analysis in the previous section, electricity energy input not only poses a significant cost burden but also constitutes the main source of carbon emissions (98%). Therefore, possible improvements should focus on the use of alternative energy sources that will ensure both the environmental and economic sustainability of manufacturing operations.

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

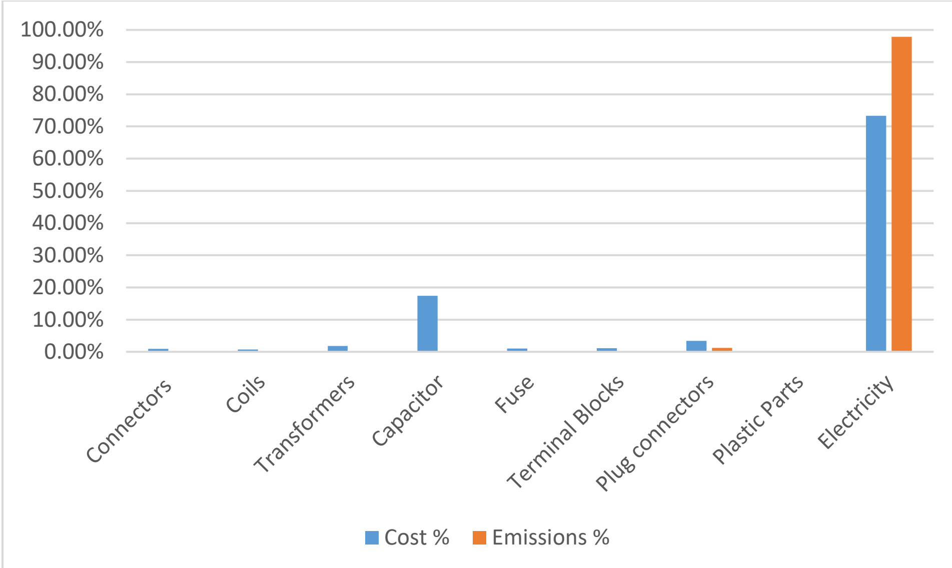


Figure 3: Compact view of total cost and carbon emissions

3 Possible improvements

Electricity input being the key hotspot for both CO_2 emissions and cost, improvement suggestion are focusing on the use of two alternative energy sources namely, natural gas and wind energy.

3.1 Scenario 1

In scenario 1, we evaluated the carbon dioxide emissions and cost of manufacturing process by replacing the source of electricity from grid to natural gas. Table 5 and Table 6 provide an overview of total cost as well as GHG emissions respectively for this scenario. In addition, Figure 4 and Figure 5 offer a comparative view of these two scenarios with respect to cost and CO_2 emissions. It is evident that sourcing energy from natural gas has a positive impact on cost by reducing it almost by 75%. Significant reductions were also realised in carbon emissions, cutting them in half. Nonetheless, energy remains the key source of carbon emissions, accounting for 96% of the total.

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Table 5: Resource and material cost analysis of scenario 1

Process Inputs	Quantity	Unit	Average Unit Cost	Unit (£/unit)	Total Cost	Cost %
Connectors	1.00	/	1.23	£	1.23	2.02%
Coils	1.00	/	1.00	£	1.00	1.64%
Transformers	1.00	/	2.45	£	2.45	4.02%
Capacitor	1.00	/	23.00	£	23.00	37.72%
Fuse	1.00	/	1.30	£	1.30	2.13%
Terminal Blocks	2.00	/	0.76	£	1.52	2.49%
Plug connectors	8.00	/	0.56	£	4.48	7.35%
Plastic Parts	1.00	/	0.23	£	0.23	0.38%
Natural gas	805.03	kWh	0.03	£/kWh	25.76	42.25%

Table 6: Total carbon emissions of scenario 1

Process Inputs	Quantity	Unit	GHG Intensity (kg CO_2-eq/unit)	Total Emissions (kg CO_2-eq)	Emissions %
Connectors	1.00	/	1.12	1.12	0.23%
Coils	1.00	/	1.44	1.44	0.29%
Transformers	1.00	/	1.22	1.22	0.25%
Capacitor	1.00	/	1.24	1.24	0.25%
Fuse	1.00	/	1.45	1.45	0.29%
Terminal Blocks	2.00	/	0.89	1.78	0.36%
Plug connectors	8.00	/	1.56	12.48	2.52%
Plastic Parts	1.00	/	0.98	0.98	0.20%
Natural gas	805.03	kWh	0.59	473.81	96%

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

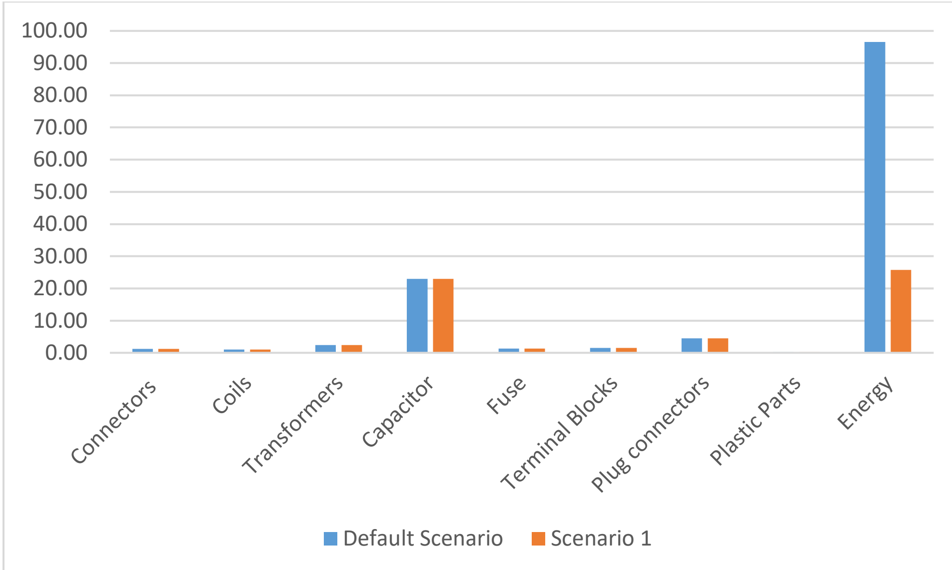


Figure 4: Comparative view of total cost between default scenario and Scenario 1

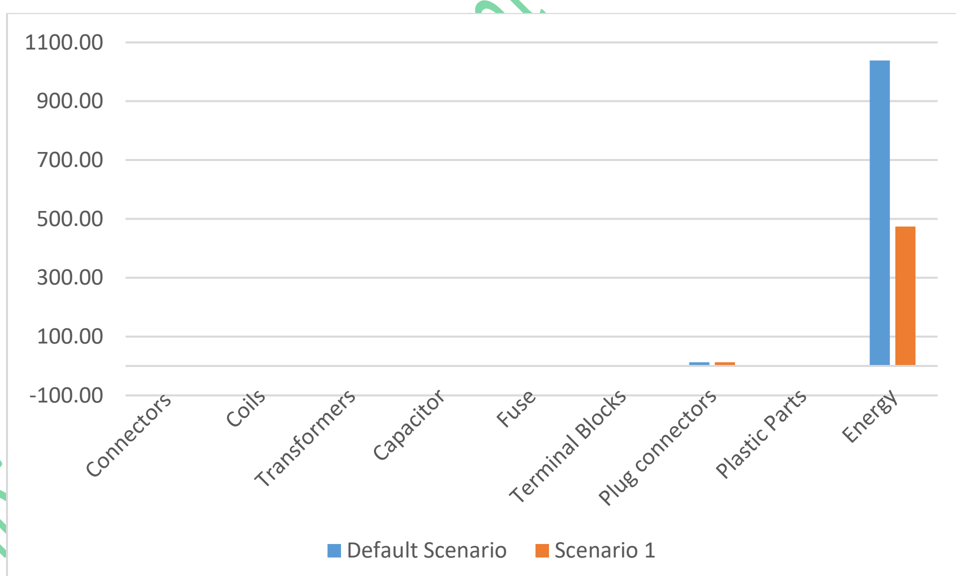


Figure 5: Comparative view of total carbon emissions between default scenario and Scenario 1

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

3.2 Scenario 2

In Scenario 2, we replaced the energy source from grid electricity to wind energy, which is a renewable source of energy. Similar to Scenario 1, Table 7 and Table 8, summarise the impact on cost and carbon emissions.

Table 7: Resource and material cost analysis of scenario 2

Process Inputs	Quantity	Unit	Average Unit Cost	Unit (£/unit)	Total Cost	Cost %
Connectors	1.00	/	1.23	£	1.23	1.22%
Coils	1.00	/	1.00	£	1.00	0.99%
Transformers	1.00	/	2.45	£	2.45	2.42%
Capacitor	1.00	/	23.00	£	23.00	22.72%
Fuse	1.00	/	1.30	£	1.30	1.28%
Terminal Blocks	2.00	/	0.76	£	1.52	1.50%
Plug connectors	8.00	/	0.56	£	4.48	4.43%
Plastic Parts	1.00	/	0.23	£	0.23	0.23%
Wind energy	805.03	kWh	0.08	£/kWh	66.01	65.22%

Table 8: Table 6: Total carbon emissions of scenario 2

Process Inputs	Quantity	Unit	GHG Intensity (kg CO_2-eq/unit)	Total Emissions (kg CO_2-eq)	Emissions %
Connectors	1.00	/	1.12	1.12	3.63%
Coils	1.00	/	1.44	1.44	4.67%
Transformers	1.00	/	1.22	1.22	3.96%
Capacitor	1.00	/	1.24	1.24	4.02%
Fuse	1.00	/	1.45	1.45	4.70%
Terminal Blocks	2.00	/	0.89	1.78	5.77%
Plug connectors	8.00	/	1.56	12.48	40.47%
Plastic Parts	1.00	/	0.98	0.98	3.18%
Wind energy	805.03	kWh	0.01	9.13	30%

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

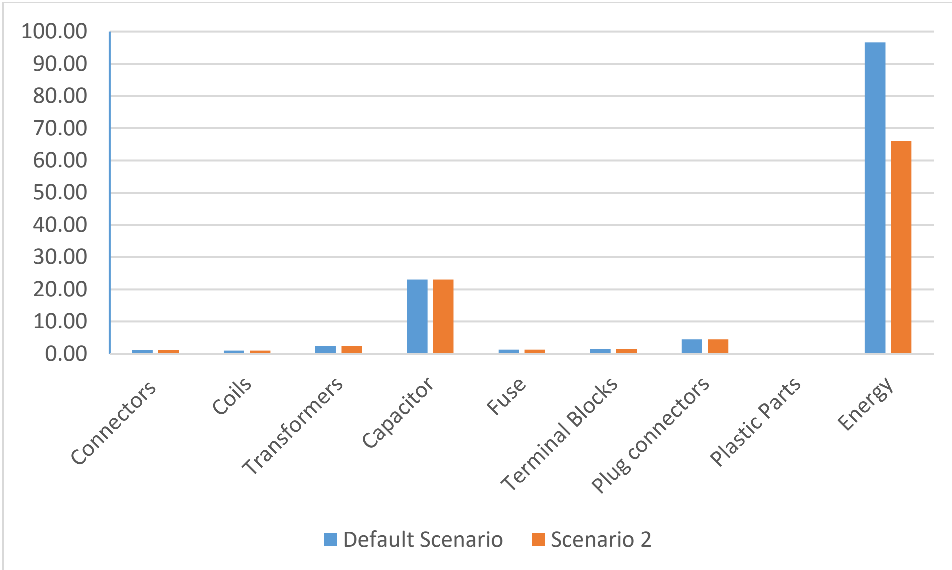


Figure 6: Comparative view of total cost between default scenario and Scenario 2

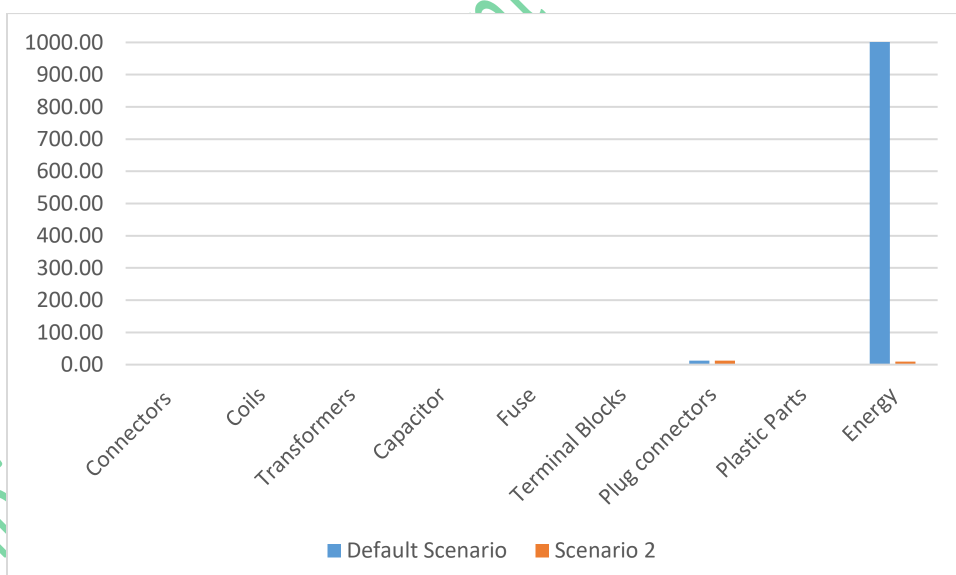


Figure 7: Comparative view of total carbon emissions between default scenario and Scenario 2

According to Figure 6 and 7, we can see that although the shift towards wind energy is not associated with significant reductions in cost, it eliminates GHG emissions.

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

4 Final conclusions

Based on the analysis of suggested scenarios, we conclude that PLAKETA ltd, would be benefited by shifting away from national electricity grid to alternative sources of energy. Both scenarios reduced the total cost and greenhouse gas emissions associated with the manufacturing process of PCB board. A comparative view of all scenarios is provided in Figures 8 and 9. Although Scenario 1 reduces significantly total costs, its impact on carbon emissions is incremental compared to Scenario 2. On the other hand, although Scenario 2 eliminates GHG emissions, it is associated with higher costs that Scenario 1. Therefore, the final decision depends on PLAKETA Ltd marketing strategy. It the firm wants to put all its weight on building an environmental friendly profile, then the use of wind energy would be the optimal choice. Alternatively, if the firm wants a balanced solution that reduces both cost and carbon emissions, then Scenario 1 would be the way to go.

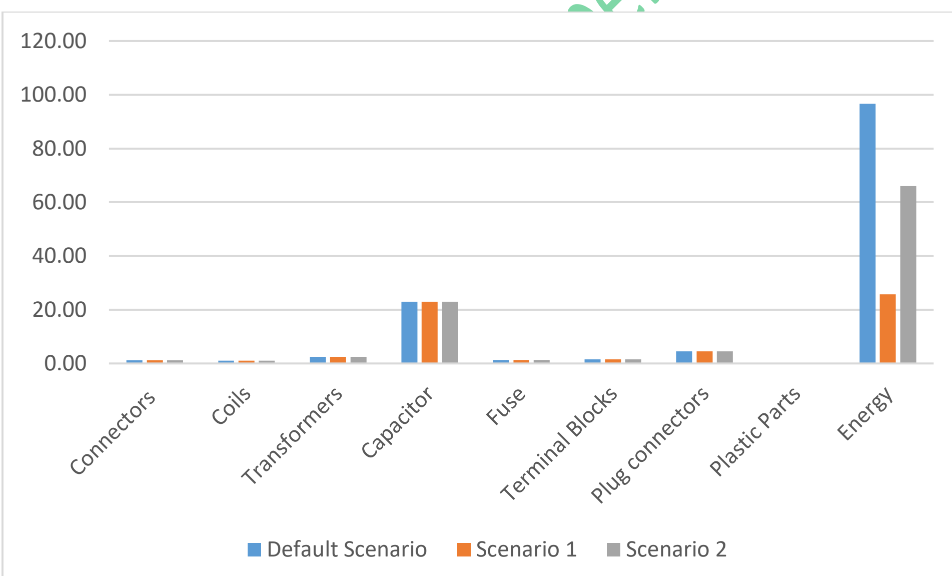


Figure 8: Comparative analysis of all scenarios with respect to total costs

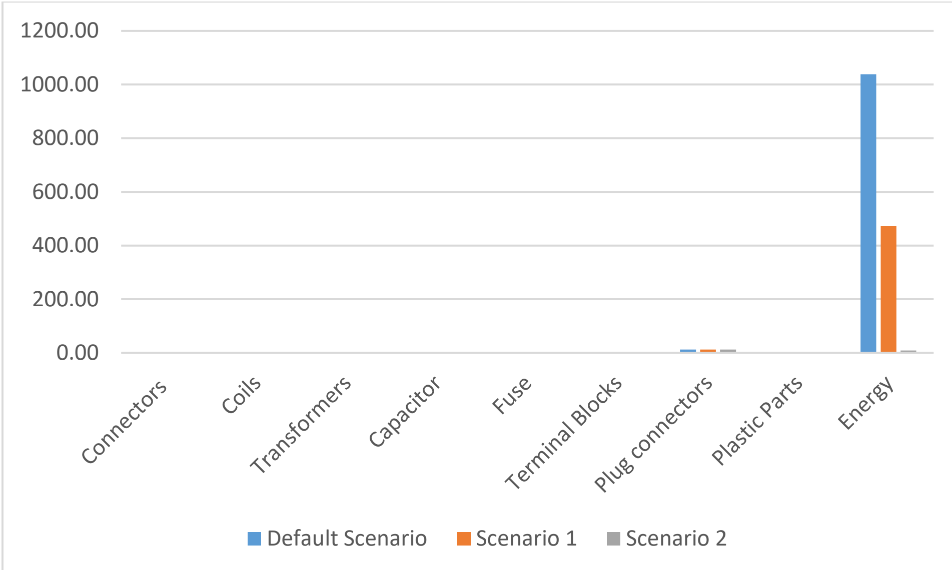


Figure 9: Comparative analysis of all scenarios with respect to carbon emissions

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.