**Sustainability Metrics Module - Case Study 1**

**Fender Formulation Case study**

The first case analyzed here involves comparing five different automobile fenders made of steel, aluminum, and three different plastics formulations (Saur et al. 2000).

Twelve indicators including energy, water, and resource use, as well as waste and emissions generated were used to compare the different options.

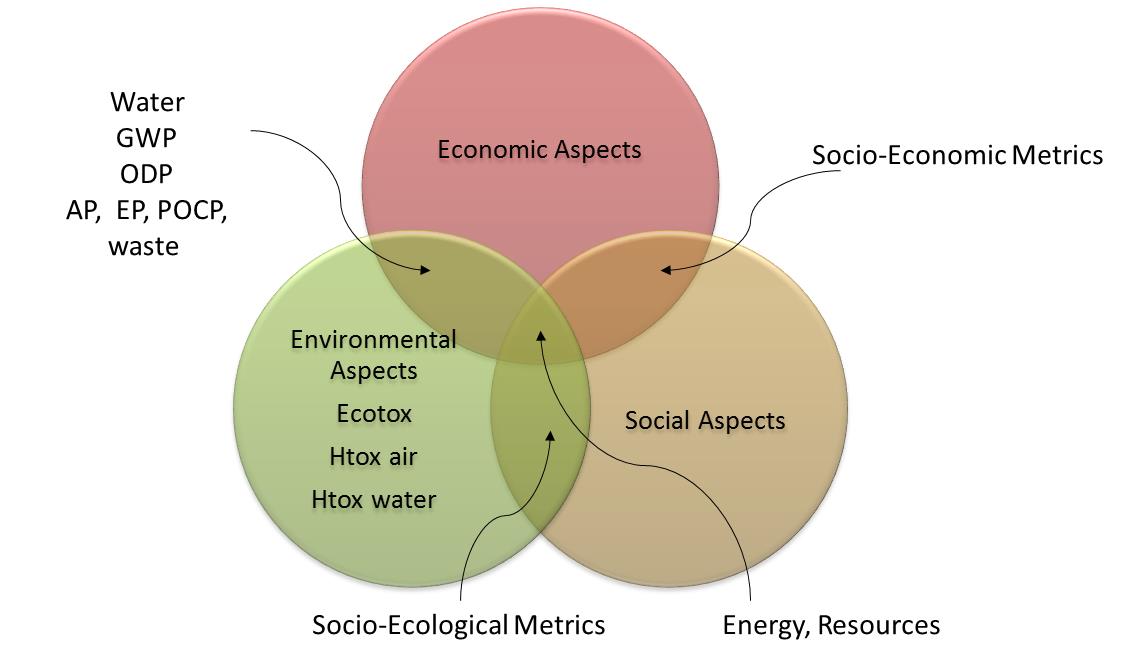
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Al | St | PC/PBT | PP/ EPDM | PPO/PA |
| energy | **1290** | ***1120*** | 1060 | 810 | 1080 |
| resources | 15 | **25** | 18 | ***14*** | 21 |
| water | **36** | 27 | 22 | **17** | 25 |
| GWP | 104 | 105 | 83 | **62** | **115** |
| ODP | 1 | **0.1** | 0.4 | 0.2 | **1.2** |
| AP | **28** | 19 | 20 | ***16*** | 20 |
| EP | 4.4 | 4.2 | 3.9 | ***3.5*** | **7.2** |
| POCP | **6.7** | **9.2** | 8.7 | 8 | 9.1 |
| Htox air | **3.8** | 3.7 | 2.5 | ***1.9*** | 2.5 |
| Htox water | 0.66 | 0.92 | **0.99** | **0.62** | 0.74 |
| Eco tox | 2.9 | **3.4** | 2.7 | **1.9** | 2.4 |
| waste | **3.7** | 1.2 | 1 | **0.25** | **0.25** |

**Query 1:** Map the indicators on a venn diagram as 1D, 2D and 3D indicators. Justify why you put it in a given category of indicators.

**Answer:**

Ecotoxicity, Human Toxicity Air and Human Toxicity Water are categorized as environmental metrics. Water, Global Warming Potential, Ozone Depletion Potential, Acidification Potential, Eutrophication Potential, Photochemical Ozone Creation Potential, and Waste are categorized in eco-efficiency metrics. Energy and resources are 3D metrics, or sustainability metrics.

(Other analyses may also be true, for example Human Toxicity Air and Human Toxicity Water can be socio-ecological metrics)



**Query 2:** How do the indicators show on a radar plot?

**Query 3:** Compute the Sustainability Footprint (De) by filling the blanks in the excel workbook.



**Answer:**



**Query 4:** Plot the De and conclude which is the best fender formulation option.

Conclude that the PP/EPDM formulation is the best based on the lowest De.

**Sustainability Metrics Module - Case Study 2**

**Automotive Shredder Residue Case study**

This case study demonstrates a method to compare among options when negative values of indicators are present.

In an interesting case of sustainably managing automotive shredder residues (Vermeulen et al. 2012):

* Four process options to consider for recommending the option that is the most sustainable among the options:

(1) landfilling,

(2) recycling the metal values coupled with landfilling the rest,

(3) energy recovery, and

(4) recycling metal values and recovering energy from the rest.

* + Nine metrics, all normalized to one metric ton of automotive shredder residue, for comparative sustainability analysis of these four process options:

(1) energy intensity,

(2) material intensity,

(3) water consumption,

(4) land use,

(5) short-term global warming potential,

(6) long-term global warming potential,

(7) short-term human toxicity impact,

(8) long-term human toxicity impact, and

(9) treatment cost.

Analyze which of these processes is the best option.

**Query 1:** From the Table given in the Excel Sheet compare the indicators for the various options. Reflect on which of the strategies is best option according to the information given by each metric.



**Answer:**

EI suggests recycle+energy recovery is the best option

MI suggests recycle+energy recovery is the best option

WC suggests recycle+energy recovery is the best option

LU suggests recycle+energy recovery is the best option

GWLT suggests recycle+landfill is the best option

GWST suggests recycle+energy recovery is the best option

HTLT suggests recycle+energy recovery is the best option

HTST suggests recycle+energy recovery is the best option

TC suggests landfill is the best option

**Query 2:** Complete the calculation for the De.

**Answer:**



**Query 3:** Plot the De on a graph and explain which one is the best option. Also reflect upon the contribution of the indicators towards the sustainability footprint De.

**Answer:**

The contribution of the indicators can be interpreted from the Table above. Clearly, the indicators having normalized value of zero contribute towards making recycle+energy recovery the best option among others. However, this distinction is not so clear for other options, and we need a method like the sustainability footprint calculation to come to a single decision point for sustainability analysis.

**Reference:**

Saur C, Fava J, and Spatari S (2000) Life cycle engineering case study: automobile fender designs. Env Prog 19(2):72–82

Vermeulen, Isabel, et al. "Sustainability assessment of industrial waste treatment processes: The case of automotive shredder residue." Resources, Conservation and Recycling 69 (2012): 17-28.