# EuP Preparatory Studies “Imaging Equipment” (Lot 4)

## Final Report on Task 5 “Definition of Base Cases”

Compiled by Fraunhofer IZM and PE Europe

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# Content

# Introduction

This is the final report on Task 5 “Definition of Base-Cases” for the EuP Preparatory Studies on Imaging Equipment (Lot 4). The findings presented in this report are reflecting the research conducted by the IZM consortium as well as important feedback by industry and other stakeholders. The statements and recommendations presented in the final report however are not to be perceived as the opinion of the European Commission.

We like to acknowledge the fruitful collaboration and trustful working relationship with various industry partners, non-industry stakeholders and the European Commission throughout the study. We like to thank all stakeholders for their contribution and critical reviews of our reports.

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# 5. Definition of Base-Case

## Introduction

The objective of the Task 5 is the environmental and economical assessment of imaging equipment. The product-specific inputs for this assessment are base cases that have been selected and discussed in the Task 4 report. Following the MEEuP methodology we apply the VHK EcoReport tool for the base case analysis. In chapter 5.1 the main input data are given for each base case. The particular data are referenced in the Task 4 report. Chapter 5.2 provides the detailed eco-assessment of the base case as well as the analysis of specific eco-design aspects such as energy efficiency and material issues. A life cycle cost (LCC) analysis is provided in chapter 5.3. The final chapter summarizes total environmental impacts on EU-25. During the following analysis we will indicate already some improvement potentials or necessities for eco-design. These aspects will not be comprehensively discussed in this report. They provide however a first input for the analysis of best available technologies (Task 6) and respective improvement potentials (Task 7).

The definition of six bases cases shown in the Table 1 below reflects the results of the preceding task reports as well as the availability of product data for an assessment. These base cases represent considerably large market segments with an expected environmental impact in the European Union. However, they are not covering the full scope of the imaging equipment market.

**Table 1: Lot 4 Base Cases**

| Base Case | Code | Technology | Function | Image | Speed | Format | Weight | Year | Price |
|---|---|---|---|---|---|---|---|---|---|
| V1 | EPCMM | EP-Copier | MFD | mono | 26 ipm | A3 | 68 kg | 2005 | 4.000 € |
| V2 | EPCMC | EP-Copier | MFD | color | 26 ipm | A3 | 143 kg | 2005 | 8.000 € |
| V2 | EPPSM | EP-Printer | SFD | mono | 32 ipm | A4 | 23 kg | 2005 | 900 € |
| V4 | EPPSC | EP-Printer | SFD | color | 32 ipm | A4 | 43 kg | 2005 | 1.500 € |
| V5 | IJPMP | IJ-Printer | MFD | color | 20 ipm | A4 | 9 kg | 2005 | 200 € |
| V6 | IJPMW | IJ-Printer | MFD | color | 20 ipm | A4 | 9 kg | 2005 | 200 € |

The base cases are averaged product examples. They have been specified by considering the principle marking technology (EP and IJ), functional spectrum (SFD and MFD), main performance data (colour and speed) and typical application environment (home and workgroup). The focus is set on average office devices for image handling up to paper format A3. These are mass manufactured products with a typical sales price of under 10,000 €. But even within this limited spectrum of products[1] it is difficult to set the boundaries for a generalization of the assessment's results.

[1] Please note that other marking technologies, larger paper formats, specific image quality and further specifications are not considered.

If we take the example of the 32 ipm monochrome EP-Printer/SFD (Base Case V3) the legitimate question it to what other products does the assessment results apply. Do they apply to a similar monochrome EP-Printer/SFD which is twice or even three times as fast? Such a 64 ipm or 96 ipm machine will probably have a different engine, fixing and power supply unit design. It will have larger trays and sorter options, which means more motors and mechanical parts. We can assume that the electronics and digital interfaces are more complex in order to provide extended functional performance. We also have to consider the use and the image creation volume that is determined by the application environment. That could be a small or large office workgroup (frequency of use is different) as well as very fast EP Printers (> 58 ipm). In terms of energy consumption over lifetime, all these factors will result in a different material composition and mass (which influences the eco-impact of the manufacturing phase) as well as in different energy consumption values and patterns (which influences the eco-impact of the use phase). Finally, we could assume that in terms of eco-design, the higher speed and complexity of the faster machines may result in different improvement strategies. In consequence, the MEEuP methodology – that means the eco-assessment of a specific product example which is economically representatively for the market – leads to a product specific assessment result, which is applied over a larger market segment. We have to consider that the boundaries of the chosen market segment are not equal with the boundaries of environmental impacts or resulting eco-design strategies. A generalization of the base case's assessment results and their application to specific product segment has to be made very consciously.

# 5.1. Product-specific Inputs

## 5.1.1. Base Case V1: EP-Copier/MFD monochrome

### Table 2: Material and life cycle specific inputs for the Base Case V1

Table . Life Cycle Impact (per unit) of Base_Case_V1_EP-Copier_MFD-mono

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base_Case_V1_EP-Copier_MFD-mono | 0 | 0 |

| | Life Cycle phases --> | | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | Materials | unit | | | | | | | | | | |
| 1 | Bulk Plastics | g | | | | 13228 | | | 9259 | 3968 | 13228 | 0 |
| 2 | TecPlastics | g | | | | 5406 | | | 3784 | 1622 | 5406 | 0 |
| 3 | Ferro | g | | | | 39141 | | | 1957 | 37184 | 39141 | 0 |
| 4 | Non-ferro | g | | | | 1834 | | | 92 | 1742 | 1834 | 0 |
| 5 | Coating | g | | | | 0 | | | 0 | 0 | 0 | 0 |
| 6 | Electronics | g | | | | 2485 | | | 1848 | 637 | 2485 | 0 |
| 7 | Misc. | g | | | | 6048 | | | 302 | 5745 | 6048 | 0 |
| | Total weight | g | | | | 68141 | | | 17243 | 50899 | 68141 | 0 |

| Pos nr | USE PHASE Description | | unit | Subtotals |
|---|---|---|---|---|
| 211 | Product Life in years | 6 | years | |
| | Electricity | | | |
| 212 | On-mode: Consumption per hour, cycle, setting, etc. | 250 | kWh | 250 |
| 213 | On-mode: No. Of hours, cycles, settings, etc. / year | 1 | # | |
| 214 | Standby-mode: Consumption per hour | | kWh | 0 |
| 215 | Standby-mode: No. Of hours / year | | # | |
| 216 | Off-mode: Consumption per hour | | kWh | 0 |
| 217 | Off-mode: No. Of hours / year | | # | |
| | TOTAL over Product Life | 1,50 | MWh (=000 kWh) | 65 |
| | Heat | | | |
| 218 | Avg. Heat Power Output | 0 | kW | |
| 219 | No. Of hours / year | 0 | hrs. | |
| 220 | Type and efficiency (Click & select) | | | 85-not applicable |
| | TOTAL over Product Life | 0,00 | GJ | |
| | Consumables (excl. spare parts) | | | material |
| 221 | Water | 0 | $m^3$/year | 83-Water per m3 |
| 222 | Auxilliary material 1 (Click & select) | 439 | kg/ year | 57-Office paper |
| 223 | Auxilliary material 2 (Click & select) | 1,758 | kg/ year | 79-Toner |
| 224 | Auxilliary material 3 (Click & select) | 0 | kg/ year | 85-None |

| Pos nr | DISPOSAL & RECYCLING Description | | unit | Subtotals |
|---|---|---|---|---|
| | Substances released during Product Life and Landfill | | | |
| 227 | Refrigerant in the product (Click & select) | 0 | g | 1-none |
| 228 | Percentage of fugitive & dumped refrigerant | 0% | | |
| 229 | Mercury (Hg) in the product | 0 | g Hg | |
| 230 | Percentage of fugitive & dumped mercury | 0% | | |
| | Disposal: Environmental Costs perkg final product | | | |
| 231 | Landfill (fraction products not recovered) in g en % | 3407 | 5% | 88-fixed |
| 232 | Incineration (plastics & PWB not re-used/recycled) | 13681 | g | 91-fixed |
| 233 | Plastics: Re-use & Recycling ("cost"-side) | 5590 | g | 92-fixed |
| | Re-use, Recycling Benefit | in g | % of plastics fraction | |
| 234 | Plastics: Re-use, Closed Loop Recycling (please edit%) | 373 | 2% | 4 |
| 235 | Plastics: Materials Recycling (please edit% only) | 5218 | 28% | 4 |
| 236 | Plastics: Thermal Recycling (please edit% only) | 13044 | 70% | 72 |
| 237 | Electronics: PWB Easy to Disassemble ? (Click&select) | 637 | YES | 98 |
| 238 | Metals & TV Glass & Misc. (95% Recycling) | 45822 | | fixed |

## 5.1.2. Base Case V2: EP-Copier/MFD colour

### Table 3: Material and life cycle specific inputs Base Case V2

**Table . Life Cycle Impact (per unit) of Base Case V2 - MFD - Copier Color**

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base Case V2 - MFD - Copier Color | 0 | 0 |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **26262** | | | 18383 | 7878 | **26262** | **0** |
| 2 | TecPlastics | g | | | **17422** | | | 12196 | 5227 | **17422** | **0** |
| 3 | Ferro | g | | | **75416** | | | 3771 | 71646 | **75416** | **0** |
| 4 | Non-ferro | g | | | **7636** | | | 382 | 7254 | **7636** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **2460** | | | 1738 | 722 | **2460** | **0** |
| 7 | Misc. | g | | | **14250** | | | 712 | 13537 | **14250** | **0** |
| | Total weight | g | | | **143446** | | | 37182 | 106264 | **143446** | **0** |

| Pos nr | USE PHASE Description | | unit | Subtotals |
|---|---|---|---|---|
| 211 | **Product Life in years** | 6 | years | |
| | **Electricity** | | | |
| 212 | **On-mode: Consumption per hour, cycle, setting, etc.** | 370 | kWh | **370** |
| 213 | **On-mode: No. Of hours, cycles, settings, etc. / year** | 1 | # | |
| 214 | **Standby-mode: Consumption per hour** | 0 | kWh | **0** |
| 215 | **Standby-mode: No. Of hours / year** | | # | |
| 216 | **Off-mode: Consumption per hour** | 0 | kWh | **0** |
| 217 | **Off-mode: No. Of hours / year** | | # | |
| | **TOTAL over Product Life** | **2,22** | **MWh (=000 kWh)** | **65** |
| | **Heat** | | | |
| 218 | **Avg. Heat Power Output** | 0 | kW | |
| 219 | **No. Of hours / year** | 0 | hrs. | |
| 220 | **Type and efficiency (Click & select)** | | | **85-not applicable** |
| | **TOTAL over Product Life** | **0,00** | **GJ** | |
| | **Consumables (excl. spare parts)** | | | **material** |
| 221 | **Water** | 0 | $m^3$/year | **83-Water per m3** |
| 222 | **Auxilliary material 1 (Click & select)** | 439 | kg/ year | **57-Office paper** |
| 223 | **Auxilliary material 2 (Click & select)** | 2,636 | kg/ year | **79-Toner** |
| 224 | **Auxilliary material 3 (Click & select)** | 0 | kg/ year | **85-None** |

| Pos nr | DISPOSAL & RECYCLING Description | | unit | Subtotals |
|---|---|---|---|---|
| | **Substances released during Product Life and Landfill** | | | |
| 227 | **Refrigerant in the product (Click & select)** | 0 | g | **1-none** |
| 228 | **Percentage of fugitive & dumped refrigerant** | 0% | | |
| 229 | **Mercury (Hg) in the product** | 0 | g Hg | |
| 230 | **Percentage of fugitive & dumped mercury** | 0% | | |
| | **Disposal: Environmental Costs perkg final product** | | | |
| 231 | **Landfill (fraction products not recovered) in g en %** | 7172 | 5% | **88-fixed** |
| 232 | **Incineration (plastics & PWB not re-used/recycled)** | 31301 | g | **91-fixed** |
| 233 | **Plastics: Re-use & Recycling ("cost"-side)** | 13105 | g | **92-fixed** |
| | **Re-use, Recycling Benefit** | **in g** | **% of plastics fraction** | |
| 234 | **Plastics: Re-use, Closed Loop Recycling (please edit%)** | 874 | 2% | **4** |
| 235 | **Plastics: Materials Recycling (please edit% only)** | 12232 | 28% | **4** |
| 236 | **Plastics: Thermal Recycling (please edit% only)** | 30579 | 70% | **72** |
| 237 | **Electronics: PWB Easy to Disassemble ? (Click&select)** | 722 | **YES** | **98** |
| 238 | **Metals & TV Glass & Misc.** (95% Recycling) | 93403 | | **fixed** |

## 5.1.3. Base Case V3: EP-Printer/SFD monochrome

**Table 4: Material and life cycle specific inputs Base Case V3**

**Table . Life Cycle Impact (per unit) of Base Case_V3_EP-Printer-SFD-mono**

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base Case_V3_EP-Printer-SFD-mono | 0 | vhk |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | 4613 | | | 3690 | 923 | 4613 | 0 |
| 2 | TecPlastics | g | | | 5307 | | | 4245 | 1061 | 5307 | 0 |
| 3 | Ferro | g | | | 7290 | | | 364 | 6925 | 7290 | 0 |
| 4 | Non-ferro | g | | | 807 | | | 40 | 767 | 807 | 0 |
| 5 | Coating | g | | | 0 | | | 0 | 0 | 0 | 0 |
| 6 | Electronics | g | | | 823 | | | 461 | 362 | 823 | 0 |
| 7 | Misc. | g | | | 4265 | | | 213 | 4052 | 4265 | 0 |
| | Total weight | g | | | 23104 | | | 9015 | 14089 | 23104 | 0 |

| Pos nr | USE PHASE Description | | unit | Subtotals |
|---|---|---|---|---|
| 211 | Product Life in years | 6 | years | |
| | Electricity | | | |
| 212 | On-mode: Consumption per hour, cycle, setting, etc. | 270 | kWh | 270 |
| 213 | On-mode: No. Of hours, cycles, settings, etc. / year | 1 | # | |
| 214 | Standby-mode: Consumption per hour | 0 | kWh | 0 |
| 215 | Standby-mode: No. Of hours / year | 0 | # | |
| 216 | Off-mode: Consumption per hour | 0 | kWh | 0 |
| 217 | Off-mode: No. Of hours / year | 0 | # | |
| | TOTAL over Product Life | 1,62 | MWh (=000 kWh) | 65 |
| | Heat | | | |
| 218 | Avg. Heat Power Output | 0 | kW | |
| 219 | No. Of hours / year | 0 | hrs. | |
| 220 | Type and efficiency (Click & select) | | | 85-not applicable |
| | TOTAL over Product Life | 0,00 | GJ | |
| | Consumables (excl. spare parts) | | | material |
| 221 | Water | 0 | $m^3$/year | 83-Water per m3 |
| 222 | Auxilliary material 1 (Click & select) | 666 | kg/ year | 57-Office paper |
| 223 | Auxilliary material 2 (Click & select) | 2,662 | kg/ year | 79-Toner |
| 224 | Auxilliary material 3 (Click & select) | 0 | kg/ year | 85-None |

| Pos nr | DISPOSAL & RECYCLING Description | | unit | Subtotals |
|---|---|---|---|---|
| | Substances released during Product Life and Landfill | | | |
| 227 | Refrigerant in the product (Click & select) | 0 | g | 1-none |
| 228 | Percentage of fugitive & dumped refrigerant | 0% | | |
| 229 | Mercury (Hg) in the product | 0 | g Hg | |
| 230 | Percentage of fugitive & dumped mercury | 0% | | |
| | Disposal: Environmental Costs perkg final product | | | |
| 231 | Landfill (fraction products not recovered) in g en % | 1155 | 5% | 88-fixed |
| 232 | Incineration (plastics & PWB not re-used/recycled) | 8297 | g | 91-fixed |
| 233 | Plastics: Re-use & Recycling ("cost"-side) | 1984 | g | 92-fixed |
| | Re-use, Recycling Benefit | in g | % of plastics fraction | |
| 234 | Plastics: Re-use, Closed Loop Recycling (please edit%) | 198 | 2% | 4 |
| 235 | Plastics: Materials Recycling (please edit% only) | 1786 | 18% | 4 |
| 236 | Plastics: Thermal Recycling (please edit% only) | 7936 | 80% | 72 |
| 237 | Electronics: PWB Easy to Disassemble ? (Click&select) | 362 | YES | 98 |
| 238 | Metals & TV Glass & Misc. (95% Recycling) | 11838 | | fixed |

## 5.1.4. Base Case V4: EP-Printer/SFD colour

### Table 5: Material and life cycle specific inputs Base Case V4

Table . Life Cycle Impact (per unit) of Base Case_V4_EP-Printer-SFD-color

| Nr | Life cycle Impact per product: | | | | | | | | | Date | Author |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case_V4_EP-Printer-SFD-color | | | | | | | | | 0 | 0 |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **14998** | | | 11999 | 3000 | **14998** | **0** |
| 2 | TecPlastics | g | | | **2424** | | | 1939 | 485 | **2424** | **0** |
| 3 | Ferro | g | | | **15901** | | | 795 | 15106 | **15901** | **0** |
| 4 | Non-ferro | g | | | **1619** | | | 81 | 1538 | **1619** | **0** |
| 5 | Coating | g | | | **2** | | | 0 | 2 | **2** | **0** |
| 6 | Electronics | g | | | **1533** | | | 1173 | 360 | **1533** | **0** |
| 7 | Misc. | g | | | **6625** | | | 331 | 6294 | **6625** | **0** |
| | Total weight | g | | | **43103** | | | 16318 | 26785 | **43103** | **0** |

| Pos nr | USE PHASE Description | | unit | Subtotals |
|---|---|---|---|---|
| 211 | Product Life in years | 6 | years | |
| | Electricity | | | |
| 212 | On-mode: Consumption per hour, cycle, setting, etc. | 360 | kWh | 360 |
| 213 | On-mode: No. Of hours, cycles, settings, etc. / year | 1 | # | |
| 214 | Standby-mode: Consumption per hour | 0 | kWh | 0 |
| 215 | Standby-mode: No. Of hours / year | 0 | # | |
| 216 | Off-mode: Consumption per hour | 0 | kWh | 0 |
| 217 | Off-mode: No. Of hours / year | 0 | # | |
| | TOTAL over Product Life | 2,16 | MWh (=000 kWh) | 65 |
| | Heat | | | |
| 218 | Avg. Heat Power Output | 0 | kW | |
| 219 | No. Of hours / year | 0 | hrs. | |
| 220 | Type and efficiency (Click & select) | | | 85-not applicable |
| | TOTAL over Product Life | 0,00 | GJ | |
| | Consumables (excl. spare parts) | | | material |
| 221 | Water | 0 | $m^3$/year | 83-Water per m3 |
| 222 | Auxilliary material 1 (Click & select) | 666 | kg/ year | 57-Office paper |
| 223 | Auxilliary material 2 (Click & select) | 3,994 | kg/ year | 79-Toner |
| 224 | Auxilliary material 3 (Click & select) | 0 | kg/ year | 85-None |

| Pos nr | DISPOSAL & RECYCLING Description | | unit | Subtotals |
|---|---|---|---|---|
| | Substances released during Product Life and Landfill | | | |
| 227 | Refrigerant in the product (Click & select) | 0 | g | 1-none |
| 228 | Percentage of fugitive & dumped refrigerant | 0% | | |
| 229 | Mercury (Hg) in the product | 0 | g Hg | |
| 230 | Percentage of fugitive & dumped mercury | 0% | | |
| | Disposal: Environmental Costs perkg final product | | | |
| 231 | Landfill (fraction products not recovered) in g en % | 2155 | 5% | 88-fixed |
| 232 | Incineration (plastics & PWB not re-used/recycled) | 14298 | g | 91-fixed |
| 233 | Plastics: Re-use & Recycling ("cost"-side) | 3484 | g | 92-fixed |
| | Re-use, Recycling Benefit | in g | % of plastics fraction | |
| 234 | Plastics: Re-use, Closed Loop Recycling (please edit%) | 348 | 2% | 4 |
| 235 | Plastics: Materials Recycling (please edit% only) | 3136 | 18% | 4 |
| 236 | Plastics: Thermal Recycling (please edit% only) | 13938 | 80% | 72 |
| 237 | Electronics: PWB Easy to Disassemble ? (Click&select) | 360 | YES | 98 |
| 238 | Metals & TV Glass & Misc. (95% Recycling) | 23712 | | fixed |

### 5.1.5. Base Case V5: IJ-Printer/MFD Personal

**Table 6: Material and life cycle specific inputs Base Case V5**

**Table . Life Cycle Impact (per unit) of Base Case V5_IJ-Printer-MFD-Personal**

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base Case V5_IJ-Printer-MFD-Personal | 0 | 0 |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4453** | | | 4008 | 445 | **4453** | **0** |
| 2 | TecPlastics | g | | | **489** | | | 440 | 49 | **489** | **0** |
| 3 | Ferro | g | | | **1929** | | | 96 | 1832 | **1929** | **0** |
| 4 | Non-ferro | g | | | **293** | | | 15 | 279 | **293** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **478** | | | 336 | 142 | **478** | **0** |
| 7 | Misc. | g | | | **1712** | | | 86 | 1627 | **1712** | **0** |
| | **Total weight** | g | | | **9355** | | | 4981 | 4374 | **9355** | **0** |

| Pos nr | USE PHASE Description | | unit | Subtotals |
|---|---|---|---|---|
| 211 | **Product Life in years** | 4 | years | |
| | **Electricity** | | | |
| 212 | **On-mode: Consumption per hour, cycle, setting, etc.** | 18,28 | kWh | **18,28** |
| 213 | **On-mode: No. Of hours, cycles, settings, etc. / year** | 1 | # | |
| 214 | **Standby-mode: Consumption per hour** | 0 | kWh | **0** |
| 215 | **Standby-mode: No. Of hours / year** | 0 | # | |
| 216 | **Off-mode: Consumption per hour** | 0 | kWh | **0** |
| 217 | **Off-mode: No. Of hours / year** | 0 | # | |
| | **TOTAL over Product Life** | **0,07** | **MWh (=000 kWh)** | **65** |
| | **Heat** | | | |
| 218 | **Avg. Heat Power Output** | 0 | kW | |
| 219 | **No. Of hours / year** | 0 | hrs. | |
| 220 | **Type and efficiency (Click & select)** | | | **85-not applicable** |
| | **TOTAL over Product Life** | **0,00** | **GJ** | |
| | **Consumables (excl. spare parts)** | | | **material** |
| 221 | **Water** | 0 | $m^3$/year | **83-Water per m3** |
| 222 | **Auxilliary material 1 (Click & select)** | 5,2 | kg/ year | **57-Office paper** |
| 223 | **Auxilliary material 2 (Click & select)** | 0 | kg/ year | **85-None** |
| 224 | **Auxilliary material 3 (Click & select)** | 0 | kg/ year | **85-None** |

| Pos nr | DISPOSAL & RECYCLING Description | | unit | Subtotals |
|---|---|---|---|---|
| | **Substances released during Product Life and Landfill** | | | |
| 227 | **Refrigerant in the product (Click & select)** | 0 | g | **1-none** |
| 228 | **Percentage of fugitive & dumped refrigerant** | 0% | | |
| 229 | **Mercury (Hg) in the product** | 0 | g Hg | |
| 230 | **Percentage of fugitive & dumped mercury** | 0% | | |
| | **Disposal: Environmental Costs perkg final product** | | | |
| 231 | **Landfill (fraction products not recovered) in g en %** | 468 | 5% | **88-fixed** |
| 232 | **Incineration (plastics & PWB not re-used/recycled)** | 4590 | g | **91-fixed** |
| 233 | **Plastics: Re-use & Recycling ("cost"-side)** | 494 | g | **92-fixed** |
| | **Re-use, Recycling Benefit** | **in g** | **% of plastics fraction** | |
| 234 | **Plastics: Re-use, Closed Loop Recycling (please edit%)** | 99 | 2% | **4** |
| 235 | **Plastics: Materials Recycling (please edit% only)** | 395 | 8% | **4** |
| 236 | **Plastics: Thermal Recycling (please edit% only)** | 4448 | 90% | **72** |
| 237 | **Electronics: PWB Easy to Disassemble ? (Click&select)** | 142 | **YES** | **98** |
| 238 | **Metals & TV Glass & Misc.** (95% Recycling) | 3922 | | **fixed** |

## 5.1.6. Base Case V6: IJ-Printer/MFD Workgroup

### Table 7: Material and life cycle specific inputs Base Case V6

**Table . Life Cycle Impact (per unit) of Base Case V6_IJ-Printer-MFD-Workgroup**

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base Case V6_IJ-Printer-MFD-Workgroup | 0 | 0 |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4453** | | | 4008 | 445 | **4453** | **0** |
| 2 | TecPlastics | g | | | **489** | | | 440 | 49 | **489** | **0** |
| 3 | Ferro | g | | | **1929** | | | 193 | 1736 | **1929** | **0** |
| 4 | Non-ferro | g | | | **293** | | | 29 | 264 | **293** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **478** | | | 336 | 142 | **478** | **0** |
| 7 | Misc. | g | | | **1712** | | | 171 | 1541 | **1712** | **0** |
| | **Total weight** | g | | | **9355** | | | 5177 | 4177 | **9355** | **0** |

| Pos nr | USE PHASE Description | | unit | Subtotals |
|---|---|---|---|---|
| 211 | **Product Life in years** | 4 | years | |
| | **Electricity** | | | |
| 212 | **On-mode: Consumption per hour, cycle, setting, etc.** | 21,99 | kWh | **21,99** |
| 213 | **On-mode: No. Of hours, cycles, settings, etc. / year** | 1 | # | |
| 214 | **Standby-mode: Consumption per hour** | 0 | kWh | **0** |
| 215 | **Standby-mode: No. Of hours / year** | 0 | # | |
| 216 | **Off-mode: Consumption per hour** | 0 | kWh | **0** |
| 217 | **Off-mode: No. Of hours / year** | 0 | # | |
| | **TOTAL over Product Life** | **0,09** | **MWh (=000 kWh)** | **65** |
| | **Heat** | | | |
| 218 | **Avg. Heat Power Output** | 0 | kW | |
| 219 | **No. Of hours / year** | 0 | hrs. | |
| 220 | **Type and efficiency (Click & select)** | | | **85-not applicable** |
| | **TOTAL over Product Life** | **0,00** | **GJ** | |
| | **Consumables (excl. spare parts)** | | | **material** |
| 221 | **Water** | 0 | $m^3$/year | **83-Water per m3** |
| 222 | **Auxilliary material 1 (Click & select)** | 19,5 | kg/ year | **57-Office paper** |
| 223 | **Auxilliary material 2 (Click & select)** | 0 | kg/ year | **85-None** |
| 224 | **Auxilliary material 3 (Click & select)** | 0 | kg/ year | **85-None** |

| Pos nr | DISPOSAL & RECYCLING Description | | unit | Subtotals |
|---|---|---|---|---|
| | **Substances released during Product Life and Landfill** | | | |
| 227 | **Refrigerant in the product (Click & select)** | 0 | g | **1-none** |
| 228 | **Percentage of fugitive & dumped refrigerant** | 0% | | |
| 229 | **Mercury (Hg) in the product** | 0 | g Hg | |
| 230 | **Percentage of fugitive & dumped mercury** | 0% | | |
| | **Disposal: Environmental Costs perkg final product** | | | |
| 231 | **Landfill (fraction products not recovered) in g en %** | 935 | 10% | **88-fixed** |
| 232 | **Incineration (plastics & PWB not re-used/recycled)** | 4590 | g | **91-fixed** |
| 233 | **Plastics: Re-use & Recycling ("cost"-side)** | 494 | g | **92-fixed** |
| | **Re-use, Recycling Benefit** | **in g** | **% of plastics fraction** | |
| 234 | **Plastics: Re-use, Closed Loop Recycling (please edit%)** | 99 | 2% | **4** |
| 235 | **Plastics: Materials Recycling (please edit% only)** | 395 | 8% | **4** |
| 236 | **Plastics: Thermal Recycling (please edit% only)** | 4448 | 90% | **72** |
| 237 | **Electronics: PWB Easy to Disassemble ? (Click&select)** | 142 | **YES** | **98** |
| 238 | **Metals & TV Glass & Misc.** (95% Recycling) | 3922 | | **fixed** |

# 5.2. Base-Case Environmental Impact Assessment

## 5.2.1. Base Case V1: EP-Copier/MFD monochrome

### 5.2.1.1. Overview of assessment results for Base Case V1

Table 8 shows the environmental impact assessment results for the Base Case V1 (EP-Copier/MFD monochrome) deriving from the MEEuP EcoReport result table. If we take the total energy consumption (GER) as a reference for the environmental impact the results indicate that the use phase contributes most significantly to the overall environmental impact. The reason for this tremendous impact is simply explained in the fact that Table 8 shows assessment results which include office paper. According to our use phase assumptions that have been discussed in Section 4.3.1., the Base Case V1 has 6 year lifetime with a paper output of 87,880 pages per year.

**Table 8: Eco-assessment results from MEEuP EcoReport for Base Case V1 (incl. paper)**

**Table . Life Cycle Impact (per unit) of Base_Case_V1_EP-Copier_MFD-mono (incl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base_Case_V1_EP-Copier_MFD-mono (incl. Paper) | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | **Resources Use and Emissions** | | Material | Manuf. | **Total** | **BUTION** | | Disposal | Recycl. | **Total** | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **13228** | | | 9259 | 3968 | **13228** | **0** |
| 2 | TecPlastics | g | | | **5406** | | | 3784 | 1622 | **5406** | **0** |
| 3 | Ferro | g | | | **39141** | | | 1957 | 37184 | **39141** | **0** |
| 4 | Non-ferro | g | | | **1834** | | | 92 | 1742 | **1834** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **2485** | | | 1848 | 637 | **2485** | **0** |
| 7 | Misc. | g | | | **6048** | | | 302 | 5745 | **6048** | **0** |
| | **Total weight** | g | | | **68141** | | | 17243 | 50899 | **68141** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 5361 | 1498 | **6859** | **510** | **121708** | 1190 | 1024 | **165** | **129243** |
| 9 | of which, electricity (in primary MJ) | MJ | 1559 | 807 | **2367** | **1** | **31582** | 0 | 95 | **-95** | **33855** |
| 10 | Water (process) | ltr | 1243 | 27 | **1270** | **0** | **201662** | 0 | 81 | **-81** | **202851** |
| 11 | Water (cooling) | ltr | 3095 | 424 | **3520** | **0** | **42895** | 0 | 129 | **-129** | **46286** |
| 12 | Waste, non-haz./ landfill | g | 89120 | 4317 | **93437** | **272** | **198787** | 4195 | 295 | **3900** | **296397** |
| 13 | Waste, hazardous/ incinerated | g | 1666 | 5 | **1671** | **5** | **1293** | 13681 | 96 | **13585** | **16555** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 307 | 85 | **392** | **32** | **2186** | 89 | 60 | **28** | **2637** |
| 15 | Ozone Depletion, emissions | mg R-11 eq | | | | negligible | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 1959 | 382 | **2341** | **95** | **17395** | 182 | 132 | **50** | **19881** |
| 17 | Volatile Organic Compounds (VOC) | g | 15 | 4 | **19** | **7** | **539** | 4 | 2 | **2** | **567** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 992 | 0 | **992** | **2** | **253** | 29 | 1 | **28** | **1275** |
| 19 | Heavy Metals | mg Ni eq. | 499 | 1 | **500** | **14** | **703** | 323 | 9 | **313** | **1530** |
| | PAHs | mg Ni eq. | 1304 | 4 | **1308** | **18** | **78** | 0 | 9 | **-9** | **1394** |
| 20 | Particulate Matter (PM, dust) | g | 246 | 68 | **314** | **1156** | **4537** | 1632 | 6 | **1626** | **7632** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 810 | 1 | **811** | **0** | **229** | 97 | 42 | **55** | **1095** |
| 22 | Eutrophication | g PO4 | 19 | 2 | **21** | **0** | **13931** | 6 | 1 | **4** | **13956** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | negligible | | | | | |

In order to show the magnitude of paper consumption on the environmental impact, Table 9 below shows the same assessment results excluding paper.

**Table 9: Eco-assessment results from MEEuP EcoReport for Base Case V1 (excl. paper)**

**Table . Life Cycle Impact (per unit) of Base_Case_V1_EP-Copier_MFD-mono (excl. Paper)**

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base_Case_V1_EP-Copier_MFD-mono (excl. Paper) | 0 | 0 |

| Nr | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Resources Use and Emissions** | | Material | Manuf. | **Total** | **BUTION** | | Disposal | Recycl. | **Total** | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **13228** | | | 9259 | 3968 | **13228** | **0** |
| 2 | TecPlastics | g | | | **5406** | | | 3784 | 1622 | **5406** | **0** |
| 3 | Ferro | g | | | **39141** | | | 1957 | 37184 | **39141** | **0** |
| 4 | Non-ferro | g | | | **1834** | | | 92 | 1742 | **1834** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **2485** | | | 1848 | 637 | **2485** | **0** |
| 7 | Misc. | g | | | **6048** | | | 302 | 5745 | **6048** | **0** |
| | **Total weight** | g | | | **68141** | | | 17243 | 50899 | **68141** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 5361 | 1498 | **6859** | **510** | **16348** | 1190 | 1024 | **165** | **23883** |
| 9 | of which, electricity (in primary MJ) | MJ | 1559 | 807 | **2367** | **1** | **15797** | 0 | 95 | **-95** | **18070** |
| 10 | Water (process) | ltr | 1243 | 27 | **1270** | **0** | **1102** | 0 | 81 | **-81** | **2291** |
| 11 | Water (cooling) | ltr | 3095 | 424 | **3520** | **0** | **42895** | 0 | 129 | **-129** | **46286** |
| 12 | Waste, non-haz./ landfill | g | 89120 | 4317 | **93437** | **272** | **20864** | 4195 | 295 | **3900** | **118474** |
| 13 | Waste, hazardous/ incinerated | g | 1666 | 5 | **1671** | **5** | **402** | 13681 | 96 | **13585** | **15664** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 307 | 85 | **392** | **32** | **712** | 89 | 60 | **28** | **1164** |
| 15 | Ozone Depletion, emissions | mg R-11 eq | | | | | negligible | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 1959 | 382 | **2341** | **95** | **4167** | 182 | 132 | **50** | **6653** |
| 17 | Volatile Organic Compounds (VOC) | g | 15 | 4 | **19** | **7** | **7** | 4 | 2 | **2** | **35** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 992 | 0 | **992** | **2** | **142** | 29 | 1 | **28** | **1164** |
| 19 | Heavy Metals | mg Ni eq. | 499 | 1 | **500** | **14** | **412** | 323 | 9 | **313** | **1240** |
| | PAHs | mg Ni eq. | 1304 | 4 | **1308** | **18** | **44** | 0 | 9 | **-9** | **1361** |
| 20 | Particulate Matter (PM, dust) | g | 246 | 68 | **314** | **1156** | **164** | 1632 | 6 | **1626** | **3259** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 810 | 1 | **811** | **0** | **120** | 97 | 42 | **55** | **986** |
| 22 | Eutrophication | g PO4 | 19 | 2 | **21** | **0** | **2** | 6 | 1 | **4** | **27** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | | negligible | | | | |

### 5.2.1.2. Assessment results according to the consideration of paper

The comparison of the use phase figures of Table 8 (incl. paper) and Table 9 (excl. paper) is very interesting. Taking again the Total Energy (GER) as the general eco-indicator, we can indicate the tremendous impact of paper consumption. From the use phase impact of 121,708 MJ the absolutely largest portion of 105,360 MJ is related to paper consumption alone. The remaining 16,348 MJ are the impact of energy and toner consumption. Figure 1 below shows this comparison again graphically. The environmental impact of paper is not only reflected by the eco-indicator Total Energy. All resource and emission impact categories are clearly affected by paper consumption. The impact category Eutrophication (gr. $PO_4$) and the water categories are displaying this impact even more (see Figure 2 and Figure 3 further below for details).

In conclusion we will indicate in all following product assessments the impact of paper separately. The use of paper is an environmentally very relevant factor. Paper should be used efficiently and environmental burdens reduced by effective recycling. But the overall paper use does not depend on a single imaging equipment design. We will therefore separate paper from the environmental assessment of the product cases and focus on other material and design issues. Design options to reduce the use of paper (e.g. duplex units) and other consumables will be named and discussed in Task 7.

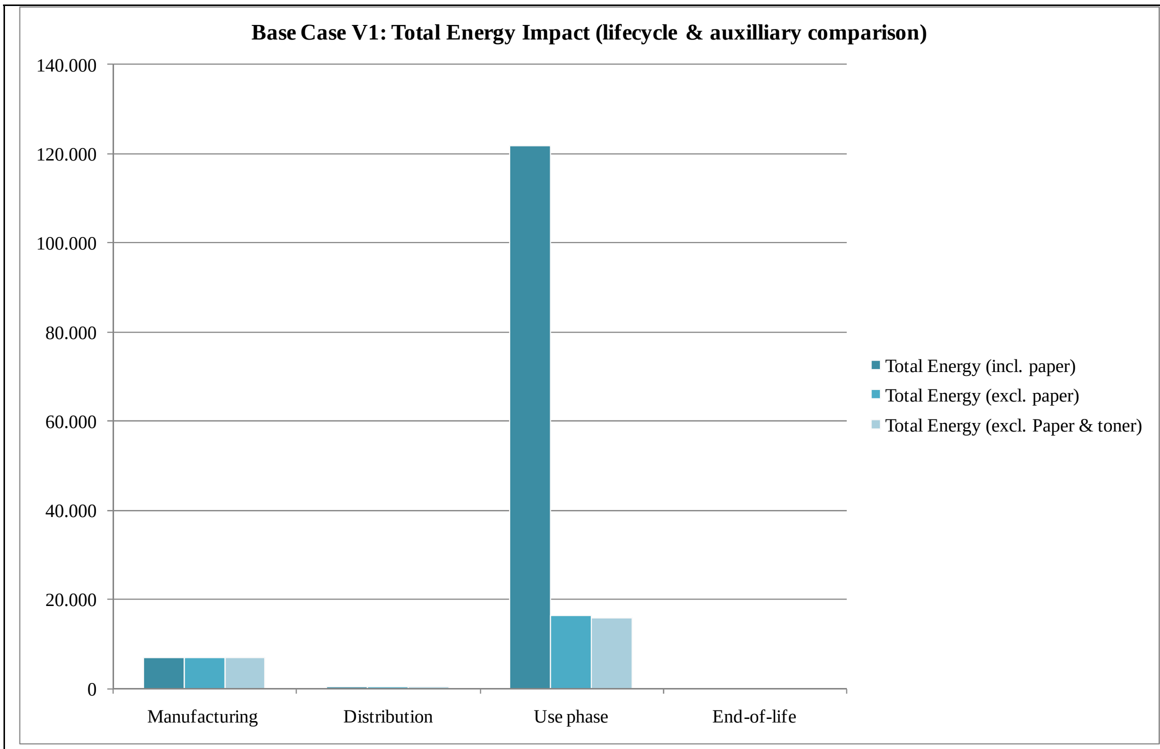


**Figure 1: Total energy impact comparison including auxiliaries for Base Case V1**

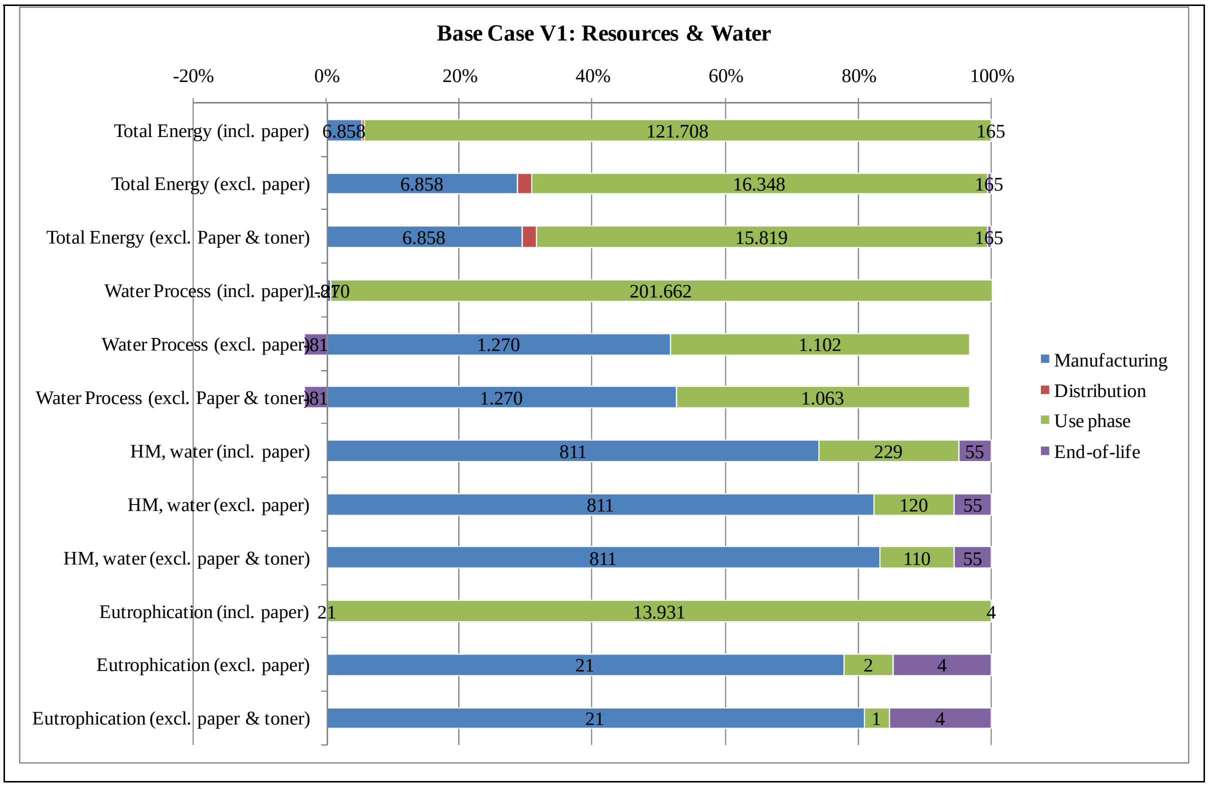


**Figure 2: Distribution of resources related impacts for Base Case V1**

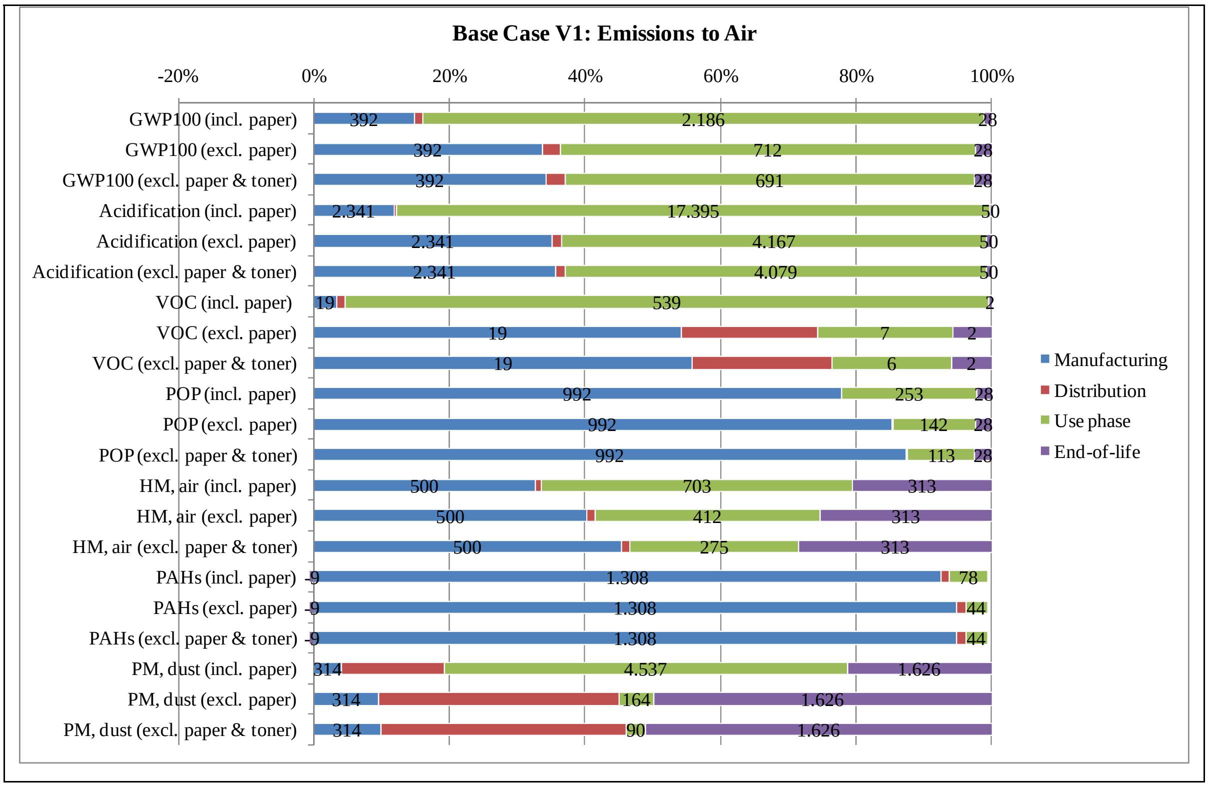


**Figure 3: Distribution of emissions to air for Base Case V1**

### 5.2.1.3. Assessment of single impact categories related to life cycle phases

The following assessment of single eco-impacts related to the life cycle phase “Manufacturing”, “Distribution”, “Use”, and “End-of-life” excludes the aspect of paper. For the Base Case V1 the energy consumption related to materials and manufacturing processes accumulates to roughly one third of total (6,858 MJ) with two thirds (16,348 MJ) related to the energy consumption in the use phase. By taking the impact category Total Energy (GER) as general eco-indicator the “Use” phase has the single highest impact followed by the “Manufacturing” phase. The “Distribution” and “End-of-life” phases have a very minor impact (see Figure 1). The 1:3 eco-impact ratio of the “Manufacturing” to the “Use” phase correlates with the resources-oriented impact categories “Total Energy”, “Greenhouse Gases”, and “Acidification”. The eco-impact categories which are indicating toxicity such as POP, Heavy Metals, and PAHs, as well as Volatile Organic Compounds (VOC) show a 50% or higher impact ratio with regards to the manufacturing phase. The auxiliary material “Toner” does not show a particular large impact. A detailed comparison of the single eco-impact categories related to resources and emissions are shown in the Figure 2 and Figure 3 above.

As a matter of fact the MEEuP EcoReport allows only a limited analysis of the manufacturing phase. The reason for this statement is that the data input is mainly materials[2]. An allocation of materials to functional modules or components of the product is missing. In preparation of the product assessments (Tasks 4 and 5) we have asked industry partners to provide bill of materials (BOMs) related to functional modules such as the scanning or fixing unit in order to overcome the gap. That proved to be a difficult and expensive task for the industry. Therefore, we only received a limited amount of product data with actual material allocations to functional modules (thanks to all contributing partners). These specific BOMs indicated some very general material-component allocations. The chassis (e.g. frame, screws) and most mechanical parts (e.g. rollers, clutch) are Ferro-metals such as galvanized steel. The electro-mechanics (e.g. stepper motors, wires) are a mix of Ferro and Non-Ferro Metals with copper as dominant material mass. The Aluminum content varies in the individual products. Plastics are used in the full spectrum of Bulk and Tec Plastics for housing functionality (e.g. covers, trays, doors, cartridges) and small mechanical parts (e.g. spacer, gear wheel, blends, buttons). Depending on the particular function and technical requirements (e.g. thermal and mechanical stability) manufacturers have usually the option to utilize different Bulk and Tec Plastics. The decision for one or another plastic is then influenced by costs and aesthetic design (e.g. colour, surface appearance) requirements. Bulk Plastics PS and ABS, as well as Tec Plastics PC are the most commonly used materials. Glass (input category miscellaneous) is mainly found in the scanner lamp and plate. LCDs, ICs and populated electronic boards are listed under the

[2] Material related input categories are Bulk plastics, Tec Plastics, Ferro-metals, Non-Ferro, Coating and Miscellaneous. Only the input category Electronics is allocating components.

various electronics input categories. In the case of motors (e.g. small stepper motors) some allocations have been made to the electronics category 44-big caps & coils. In conclusion, a detailed material-component analysis is not possible based on the results of the EcoReport.

Details regarding the environmental impacts of various materials for the Base Case V1 are provided in Table 10 on the following page. In this table the material inputs are listed by category (e.g. Bulk Plastics, 5-PS) and their eco-impact weighted through a colour code. Materials causing more than 50% of the total impact in the respective category are indicated with red colour. Materials or components causing 30% to 50% of the total impact in the respective category are indicated with orange colour. Materials or components causing 10% to 30% of the total impact in the respective category are indicated with yellow colour. Everything else is marked in grey.

This colour scheme indicates that considerable eco-impacts are related to the utilization of two materials: Galvanized Steel (21-St sheet) and Polystyrene (5-PS). According to the aggregated material input for the Base Case V1 (see table in Section 4.1.1.3), galvanized steel amounts to almost 36 kg and 56% of total product weight[3]. Steel is used for frame structures, rollers and other mechanical parts. Again, the high weight ratio (56%) influences the fact that Galvanized Steel shows up in the impact category “Non hazardous waste”. According to the MEEuP methodology this “Non hazardous waste” category reflects the waste generation during ore extraction and metal processing. Ferro-metals on the other hand have a high recycling potential, which makes its use a little less problematic from an environmental point of view. Nevertheless, the emissions to air related to Galvanized Steel in the Base Case V1 are considerable. The concentration of steel in the product dominates the impact category POP (94%), GWP (33%), and VOC (33%).

Polystyrene (PS)[4] is the second largest material fraction by weight. PS amounts to 7.5 kg or roughly 12% of total product mass. Although Polystyrene shows up under the impact categories “Energy Feedstock” and “Cooling Water” due to its relatively high mass proportion in the product, this Bulk Plastic is not so much resources critical than others. The environmental impact of PS is much stronger related to the high PAHs (polycyclic aromatic hydrocarbons) concentration, which is an indicator for toxicity, measured in Ni equivalents. In the Base Case V1 Polystyrene amounts to 70% of total PAHs. As a general observation, all plastics materials that have a high mass ratio in the product (e.g. PC and ABS) are indicated in the VHK EcoReport assessment.

[3] We subtracted the 4 kg of packaging material from the 68 kg of total product weight.
[4] Please note that VHK EcoReport does not provide an input category for PPE or PPS. Both plastics have been allocated in the spreadsheet to the input PS.

**Table 10: Detailed impact assessment of input materials of Base case V1**

## Colour coding

**Red:** Process causes more than 50% of total impact in the respective impact category.

**Orange:** Process causes between 30% and 50% of total impact in the respective impact category.

**Yellow:** Processes between 10% and 30% of total impact in the respective impact category.

Nr: 0 Product: Base_Case_V1_EP-Copier_MFD-mono Date: 00.01.00 Author: 0

MATERIALS EXTRACTION &

| | Product | | | | Energy | | | Water | | Waste | | Emissions to Air | | | | | | | to Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nr | co mp one | wght | cat. | material | GER | electr | feedst | water (proces) | water (cool) | haz. Waste | non-haz. Waste | GWP | AD | VOC | POP | HM | PAH | PM | Metal | EUP |
| | | in g | | | MJ | MJ | MJ | ltr. | ltr. | g | g | kg CO2eq | g SO2eq | mg | ng i-Teq | mg Ni eq | mg Ni eq | g | mg Hg/20eq | mg PO4 eq |
| 1 | 0 | 150,423 | 1-BlkPla | 1-LDPE | 11,70 | 2,00 | 7,75 | 0,45 | 6,77 | 0,67 | 6,65 | 0,29 | 1,12 | 0,07 | 0,00 | 0,00 | 0,02 | 0,14 | 0,00 | 4,00 |
| 2 | 0 | 671,599 | 1-BlkPla | 2-HDPE | 51,42 | 6,60 | 36,33 | 2,28 | 20,82 | 3,65 | 25,75 | 1,21 | 4,09 | 0,11 | 0,00 | 0,00 | 0,23 | 0,58 | 0,00 | 20,02 |
| 3 | 0 | 249,376 | 1-BlkPla | 4-PP | 18,13 | 1,81 | 13,15 | 1,20 | 9,98 | 1,10 | 7,02 | 0,49 | 1,40 | 0,00 | 0,00 | 0,00 | 0,10 | 0,19 | 0,00 | 41,04 |
| 4 | 0 | 7614,38 | 1-BlkPla | 5-PS | 660,40 | 27,56 | 361,91 | 37,31 | 1347,75 | 5,22 | 166,27 | 21,26 | 131,15 | 0,00 | 0,00 | 0,00 | 920,15 | 11,42 | 0,00 | 422,55 |
| 5 | 0 | 239 | 1-BlkPla | 6-EPS | 19,99 | 0,81 | 11,43 | 1,36 | 42,06 | 0,22 | 9,05 | 0,65 | 4,33 | 0,00 | 0,00 | 0,00 | 14,54 | 0,43 | 0,00 | 29,79 |
| 6 | 0 | 1727,58 | 1-BlkPla | 7-HI-PS | 159,33 | 8,07 | 84,88 | 9,50 | 321,33 | 1,11 | 51,91 | 5,01 | 33,57 | 0,00 | 0,00 | 0,00 | 105,04 | 3,11 | 0,00 | 102,86 |
| 7 | 0 | 2575,42 | 1-BlkPla | 10-ABS | 244,72 | 17,90 | 117,88 | 23,95 | 424,94 | 25,75 | 236,75 | 8,55 | 45,77 | 0,00 | 0,00 | 0,00 | 4,66 | 7,47 | 5,00 | 1622,11 |
| 8 | 0 | 395,956 | 2-TecPla | 11-PA 6 | 47,32 | 5,99 | 15,41 | 6,34 | 86,71 | 7,52 | 69,80 | 3,39 | 15,46 | 0,00 | 0,00 | 0,00 | 0,16 | 2,14 | 19,41 | 741,34 |
| 9 | 0 | 4900,9 | 2-TecPla | 12-PC | 572,47 | 72,83 | 186,19 | 68,61 | 558,70 | 49,01 | 865,27 | 26,43 | 124,62 | 0,00 | 0,00 | 0,00 | 1,78 | 32,84 | 0,80 | 2470,15 |
| 10 | 0 | 27,1335 | 2-TecPla | 14-Epoxy | 3,82 | 0,67 | 1,16 | 0,52 | 10,42 | 0,52 | 11,03 | 0,18 | 1,19 | 0,00 | 0,00 | 0,00 | 0,00 | 0,41 | 0,00 | 261,83 |
| 11 | 0 | 81,3298 | 2-TecPla | 16-Flex PUR | 8,50 | 1,52 | 3,24 | 5,69 | 24,24 | 2,63 | 44,63 | 0,36 | 2,61 | 0,00 | 0,00 | 0,00 | 1,64 | 0,67 | 0,27 | 462,41 |
| 12 | 0 | 0 | 2-TecPla | 0 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 13 | 0 | 1 | 2-TecPla | 19-Aramid fibre | 0,26 | 0,08 | 0,04 | 0,21 | 1,06 | 0,03 | 1,21 | 0,01 | 0,11 | 0,00 | 0,00 | 0,00 | 0,00 | 0,03 | 0,18 | 12,29 |
| 14 | 0 | 35737,5 | 3-Ferro | 21-St sheet galv. | 1215,08 | 81,43 | 2,65 | 0,00 | 0,00 | 0,00 | 61522,85 | 101,04 | 266,78 | 4,87 | 929,18 | 126,68 | 2,47 | 96,75 | 126,87 | 2329,00 |
| 15 | 0 | 2549,18 | 3-Ferro | 22-St tube/profile | 43,34 | 11,66 | -0,40 | 0,00 | 0,00 | 0,00 | 2041,09 | 3,51 | 9,16 | 0,30 | 30,59 | 6,59 | 0,08 | 2,56 | 4,00 | 97,71 |
| 16 | 0 | 11,216 | 3-Ferro | 24-Ferrite | 0,57 | 0,04 | 0,00 | 0,44 | 0,00 | 0,00 | 28,96 | 0,05 | 0,13 | 0,00 | 0,44 | 0,40 | 0,00 | 0,05 | 0,03 | 0,88 |
| 17 | 0 | 842,781 | 3-Ferro | 25-Stainless 18/8 co | 52,29 | 8,17 | 3,41 | 63,83 | 7,11 | 0,00 | 842,78 | 5,23 | 47,21 | 0,11 | 6,49 | 124,99 | 0,02 | 6,67 | 72,79 | 1961,94 |
| 18 | 0 | 627,039 | 4-Non-fe | 26-Al sheet/extrusio | 120,78 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 2457,99 | 6,49 | 42,20 | 0,04 | 3,13 | 2,28 | 60,53 | 10,61 | 21,96 | 3,10 |
| 19 | 0 | 14,256 | 4-Non-fe | 28-Cu winding wire | 2,03 | 0,00 | 0,00 | 0,00 | 0,00 | 0,01 | 285,69 | 0,11 | 4,33 | 0,00 | 0,06 | 0,81 | 0,08 | 0,04 | 0,09 | 2,26 |
| 20 | 0 | 528,556 | 4-Non-fe | 29-Cu wire | 61,60 | 0,00 | 0,00 | 0,00 | 0,00 | 0,13 | 10577,46 | 3,28 | 154,39 | 0,01 | 1,98 | 29,10 | 2,84 | 1,50 | 49,73 | 81,67 |
| 21 | 0 | 661,64 | 4-Non-fe | 30-Cu tube/sheet | 33,69 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 5302,39 | 1,80 | 41,42 | 0,00 | 6,81 | 21,89 | 3,54 | 0,97 | 24,91 | 40,94 |
| 22 | 0 | 2,66667 | 4-Non-fe | 31-CuZn38 cast | 0,10 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 8,11 | 0,00 | 0,09 | 0,00 | 0,07 | 0,15 | 0,01 | 0,00 | 0,02 | 0,04 |
| 23 | 0 | 34,896 | 6-Electro | 42-LCD per m2 scrn | 124,34 | 79,21 | 0,00 | 1,57 | 23,38 | 0,03 | 1,81 | 6,43 | 2,07 | 0,01 | 0,01 | 0,03 | 0,00 | 0,02 | 0,01 | 0,00 |
| 24 | 0 | 556,197 | 6-Electro | 44-big caps & coils | 213,18 | 0,00 | 0,00 | 19,28 | 30,59 | 10,90 | 334,02 | 12,05 | 78,88 | 0,07 | 1,20 | 4,26 | 113,83 | 19,81 | 41,28 | 3,97 |
| 25 | 0 | 91,9248 | 6-Electro | 45-slots / ext. ports | 17,20 | 5,45 | 0,00 | 6,86 | 23,47 | 1,57 | 28,28 | 0,92 | 16,95 | 0,00 | 0,13 | 3,49 | 0,18 | 1,19 | 2,92 | 594,73 |
| 26 | 0 | 4,8685 | 6-Electro | 46-IC's avg., 5% Si, | 26,82 | 26,09 | 0,00 | 24,43 | 0,00 | 1,23 | 25,23 | 2,06 | 13,57 | 0,33 | 0,24 | 2,17 | 0,07 | 0,35 | 18,21 | 104,58 |
| 27 | 0 | 35,5758 | 6-Electro | 47-IC's avg., 1% Si | 31,10 | 23,95 | 0,11 | 21,75 | 3,68 | 22,93 | 62,20 | 2,09 | 29,04 | 0,00 | 0,35 | 6,58 | 0,10 | 0,86 | 0,34 | 152,85 |
| 28 | 0 | 142,622 | 6-Electro | 48-SMD/ LED's avg. | 423,42 | 411,54 | 0,00 | 131,99 | 0,00 | 18,64 | 403,75 | 23,82 | 231,11 | 1,07 | 2,14 | 60,15 | 0,65 | 7,25 | 2,10 | 313,13 |
| 29 | 0 | 116,425 | 6-Electro | 49-PWB 1/2 lay 3.75 | 32,72 | 17,52 | 0,99 | 19,80 | 8,94 | 201,79 | 305,66 | 1,31 | 24,89 | 0,27 | 0,32 | 4,21 | 0,42 | 0,59 | 1,72 | 429,20 |
| 30 | 0 | 299,378 | 6-Electro | 50-PWB 6 lay 4.5 kg | 109,93 | 43,76 | 2,55 | 145,21 | 22,99 | 566,36 | 1219,46 | 4,70 | 118,55 | 0,31 | 1,52 | 20,97 | 2,06 | 11,09 | 37,55 | 731,31 |
| 31 | 0 | 62,546 | 6-Electro | 52-Solder SnAg4Cu | 14,63 | 12,12 | 0,00 | 4,39 | 0,00 | 0,28 | 14,25 | 0,73 | 4,03 | 0,00 | 0,08 | 0,21 | 0,12 | 0,09 | 0,00 | 0,38 |
| 32 | 0 | 1793,42 | 7-Misc. | 54-Glass for lamps | 29,10 | 23,19 | 0,00 | 15,28 | 0,00 | 0,48 | 24,26 | 1,49 | 5,39 | 0,01 | 0,14 | 0,32 | 0,00 | 0,12 | 0,07 | 0,64 |
| 33 | 0 | 4201,67 | 7-Misc. | 56-Cardboard | 117,65 | 8,39 | 67,23 | 29,61 | 0,00 | 0,19 | 219,82 | 2,95 | 4,37 | 0,00 | 0,06 | 0,14 | 0,02 | 0,05 | 0,05 | 361,60 |
| 34 | 0 | 52,5267 | 7-Misc. | 57-Office paper | 2,10 | 0,31 | 1,42 | 4,00 | 0,00 | 0,02 | 3,55 | 0,03 | 0,26 | 0,01 | 0,00 | 0,01 | 0,00 | 0,09 | 0,00 | 277,78 |
| 35 | 0 | 1140,33 | 6-Electro | 98-controller board | 891,14 | 660,79 | 3,47 | 596,80 | 120,46 | 743,99 | 1915,36 | 58,76 | 498,74 | 7,36 | 7,25 | 83,80 | 68,84 | 25,54 | 380,10 | 5361,99 |

Electronics are also indicated in the MEEuP EcoReport assessment. Electronic components (actives and passives) as well as their packaging and system integration (chip-board interconnection, multi-layer boards) demands precious materials and resource intensive manufacturing processes. This aspect is reflected in the assessment results. The quality of the data is difficult to evaluate because the assessment of environmental burdens in relation to the functional value-add of advanced microelectronics and micro-electromechanical systems (MEMS) is very difficult. Against that background, we only conclude that electronics have an environmental impact and should be therefore carefully designed and integrated.

Whereas Table 10 provides data on the level of individual entries the following figure compares the impacts / indicators for the manufacturing stage aggregated per material category: Although electronics are of minor total weight (first column), it dominates 9 indicators out of 16, among them Total Energy (GER) and Global Warming Potential. For three indicators electronics contribute even by more than 75% to the total indicator value, among them hazardous waste.
This aggregated data leads to the conclusion, that electronics are a very relevant factor for impacts at the manufacturing stage.

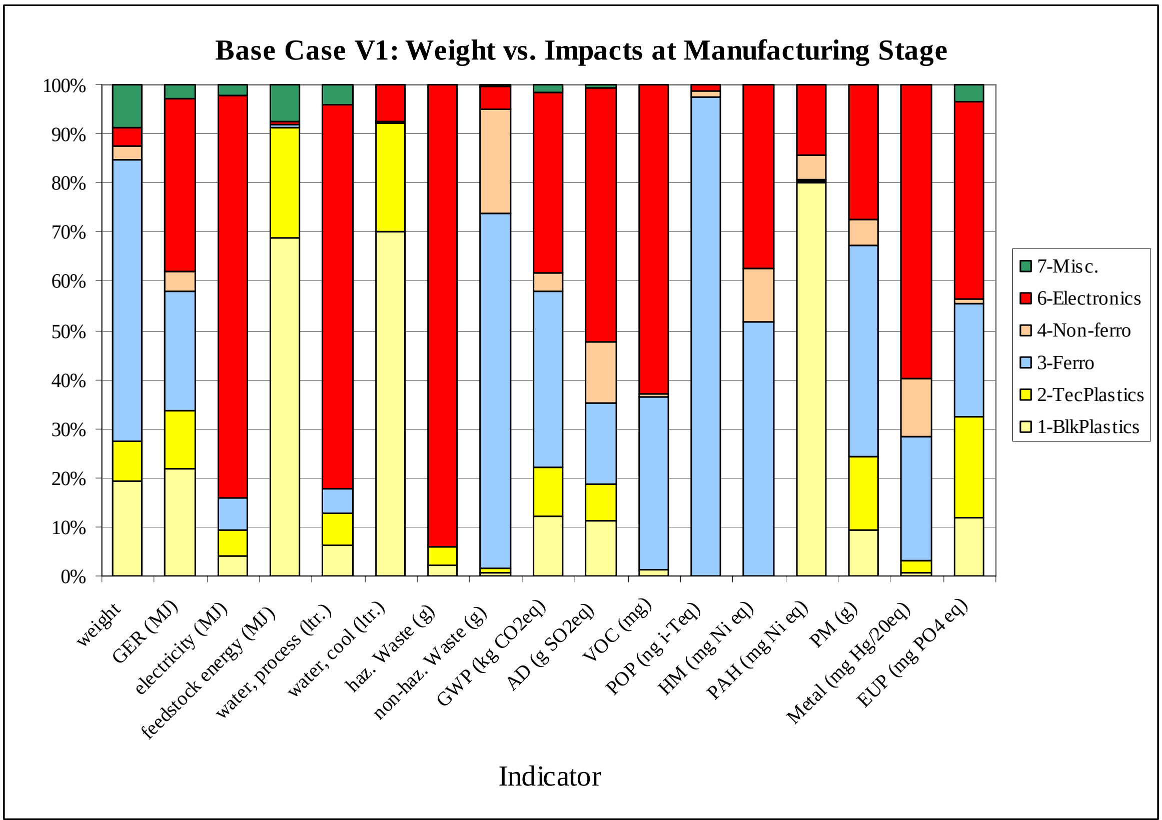


**Figure 4: Weight of Material Classes versus Impacts / Indicator Values at Manufacturing Stage for Base Case V1**

## 5.2.2. Base Case V2: EP-Copier/MFD Colour

### 5.2.2.1. Overview of assessment results for Base Case V2

Table 11 shows the MEEuP EcoReport environmental impact assessment results for the Base Case V2 (EP-Copier/MFD colour). If we take the total energy consumption (GER) as a reference for the environmental impact, the results indicate that the use phase contributes most significantly to the overall environmental impact. Similar to the previous product case the consideration of paper use[5] does have an overall effect on the results.

**Table 11: Eco-assessment results from MEEuP EcoReport for Base Case V2 (incl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case V2 - MFD - Copier Color (with paper)**

| Nr | Life cycle Impact per product: | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case V2 - MFD - Copier Color (with paper) | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | **Resources Use and Emissions** | | Material | Manuf. | **Total** | **BUTION** | | Disposal | Recycl. | **Total** | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **26262** | | | 18383 | 7878 | **26262** | **0** |
| 2 | TecPlastics | g | | | **17422** | | | 12196 | 5227 | **17422** | **0** |
| 3 | Ferro | g | | | **75416** | | | 3771 | 71646 | **75416** | **0** |
| 4 | Non-ferro | g | | | **7636** | | | 382 | 7254 | **7636** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **2460** | | | 1738 | 722 | **2460** | **0** |
| 7 | Misc. | g | | | **14250** | | | 712 | 13537 | **14250** | **0** |
| | **Total weight** | g | | | **143446** | | | 37182 | 106264 | **143446** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 10601 | 3151 | **13752** | **887** | **129602** | 2682 | 2270 | **412** | **144654** |
| 9 | of which, electricity (in primary MJ) | MJ | 2376 | 1790 | **4166** | **2** | **39172** | 0 | 133 | **-133** | **43207** |
| 10 | Water (process) | ltr | 1880 | 44 | **1924** | **0** | **202192** | 0 | 108 | **-108** | **204007** |
| 11 | Water (cooling) | ltr | 6863 | 894 | **7757** | **0** | **63526** | 0 | 286 | **-286** | **70997** |
| 12 | Waste, non-haz./ landfill | g | 250571 | 9448 | **260019** | **454** | **210052** | 8835 | 433 | **8402** | **478927** |
| 13 | Waste, hazardous/ incinerated | g | 2739 | 6 | **2745** | **9** | **1489** | 31301 | 124 | **31177** | **35421** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 585 | 177 | **761** | **54** | **2530** | 199 | 133 | **67** | **3412** |
| 15 | Ozone Depletion, emissions | mg R-11 eq | | | | negligible | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 4450 | 780 | **5231** | **164** | **19414** | 411 | 241 | **170** | **24979** |
| 17 | Volatile Organic Compounds (VOC) | g | 22 | 5 | **26** | **13** | **543** | 8 | 3 | **5** | **587** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 1967 | 0 | **1967** | **3** | **326** | 62 | 1 | **61** | **2357** |
| 19 | Heavy Metals | mg Ni eq. | 1234 | 1 | **1235** | **23** | **908** | 726 | 11 | **715** | **2881** |
| | PAHs | mg Ni eq. | 1914 | 4 | **1919** | **30** | **99** | 0 | 11 | **-11** | **2036** |
| 20 | Particulate Matter (PM, dust) | g | 483 | 131 | **614** | **2106** | **4618** | 3687 | 11 | **3677** | **11015** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 1210 | 1 | **1211** | **1** | **287** | 218 | 48 | **170** | **1669** |
| 22 | Eutrophication | g PO4 | 46 | 3 | **48** | **0** | **13932** | 12 | 2 | **11** | **13991** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | negligible | | | | | |

In order to show again the magnitude of paper consumption on the environmental impact, Table 12 below shows the same assessment results excluding paper.

[5] According to our use phase assumptions that have been discussed in task 4.3.2, the Base Case V2 has 6 year lifetime with a paper output of 87,880 pages per year.

**Table 12: Eco-assessment results from MEEuP EcoReport for Base Case V2 (excl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case V2 - MFD - Copier Color (excl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case V2 - MFD - Copier Color (excl. Paper) | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **26262** | | | 18383 | 7878 | **26262** | **0** |
| 2 | TecPlastics | g | | | **17422** | | | 12196 | 5227 | **17422** | **0** |
| 3 | Ferro | g | | | **75416** | | | 3771 | 71646 | **75416** | **0** |
| 4 | Non-ferro | g | | | **7636** | | | 382 | 7254 | **7636** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **2460** | | | 1738 | 722 | **2460** | **0** |
| 7 | Misc. | g | | | **14250** | | | 712 | 13537 | **14250** | **0** |
| | **Total weight** | g | | | **143446** | | | 37182 | 106264 | **143446** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 10601 | 3151 | **13752** | **887** | **24242** | 2682 | 2270 | **412** | **39294** |
| 9 | of which, electricity (in primary MJ) | MJ | 2376 | 1790 | **4166** | **2** | **23386** | 0 | 133 | **-133** | **27421** |
| 10 | Water (process) | ltr | 1880 | 44 | **1924** | **0** | **1632** | 0 | 108 | **-108** | **3447** |
| 11 | Water (cooling) | ltr | 6863 | 894 | **7757** | **0** | **63526** | 0 | 286 | **-286** | **70997** |
| 12 | Waste, non-haz./ landfill | g | 250571 | 9448 | **260019** | **454** | **32129** | 8835 | 433 | **8402** | **301004** |
| 13 | Waste, hazardous/ incinerated | g | 2739 | 6 | **2745** | **9** | **599** | 31301 | 124 | **31177** | **34530** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 585 | 177 | **761** | **54** | **1056** | 199 | 133 | **67** | **1938** |
| 15 | Ozone Depletion, emissions | mg R-11 ec | | | | negligible | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 4450 | 780 | **5231** | **164** | **6187** | 411 | 241 | **170** | **11752** |
| 17 | Volatile Organic Compounds (VOC) | g | 22 | 5 | **26** | **13** | **10** | 8 | 3 | **5** | **54** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 1967 | 0 | **1967** | **3** | **215** | 62 | 1 | **61** | **2246** |
| 19 | Heavy Metals | mg Ni eq. | 1234 | 1 | **1235** | **23** | **618** | 726 | 11 | **715** | **2591** |
| | PAHs | mg Ni eq. | 1914 | 4 | **1919** | **30** | **65** | 0 | 11 | **-11** | **2002** |
| 20 | Particulate Matter (PM, dust) | g | 483 | 131 | **614** | **2106** | **245** | 3687 | 11 | **3677** | **6642** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 1210 | 1 | **1211** | **1** | **178** | 218 | 48 | **170** | **1560** |
| 22 | Eutrophication | g PO4 | 46 | 3 | **48** | **0** | **3** | 12 | 2 | **11** | **62** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | negligible | | | | | |

### 5.2.2.2. Assessment results according to the consideration of paper

The comparison of Table 11 (incl. paper) and Table 12 (excl. paper) indicates that from the use phase impact of 129,602 MJ the absolutely largest portion of 105,360 MJ is related to paper consumption alone. The remaining 24,242 MJ are the impact of energy and toner consumption. Figure 5 below shows this comparison again graphically. In comparison to the Base Case V1 shows the Base Case V2 similar dimensions in the individual impact categories (see Figure 6 and Figure 7). If we exclude paper from the assessment, it becomes obvious that the overall environmental impact correlates directly with the product weight (material mass) in the manufacturing phase and with energy consumption in the use phase.

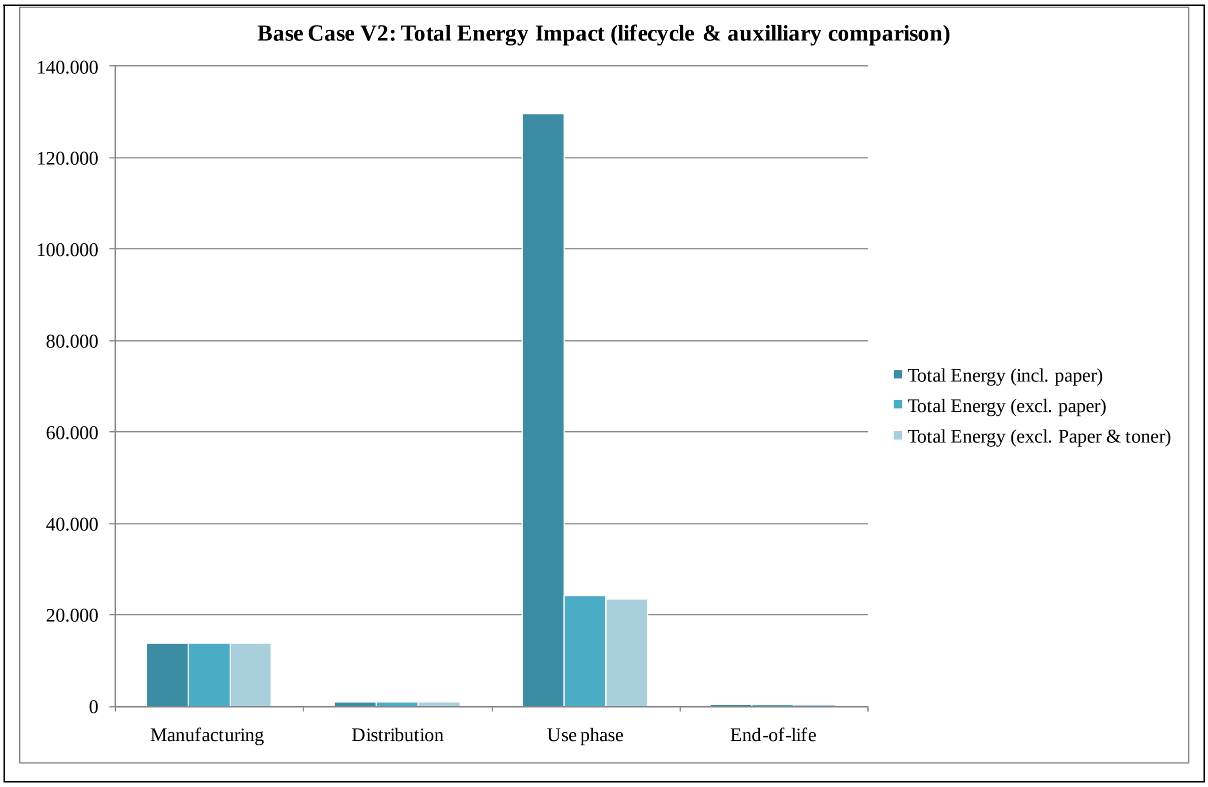


**Figure 5: Total energy impact comparison including auxiliaries for Base Case V2**

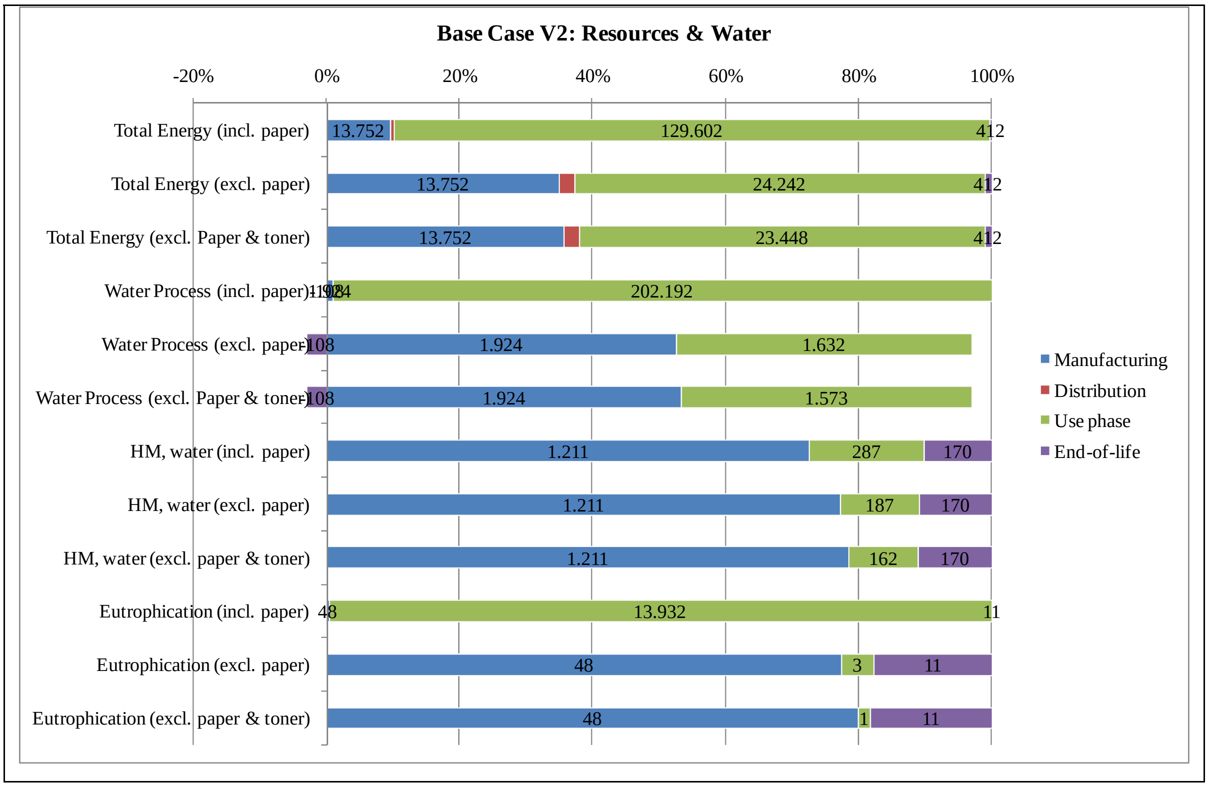


**Figure 6: Distribution of resources related impacts for Base Case V2**

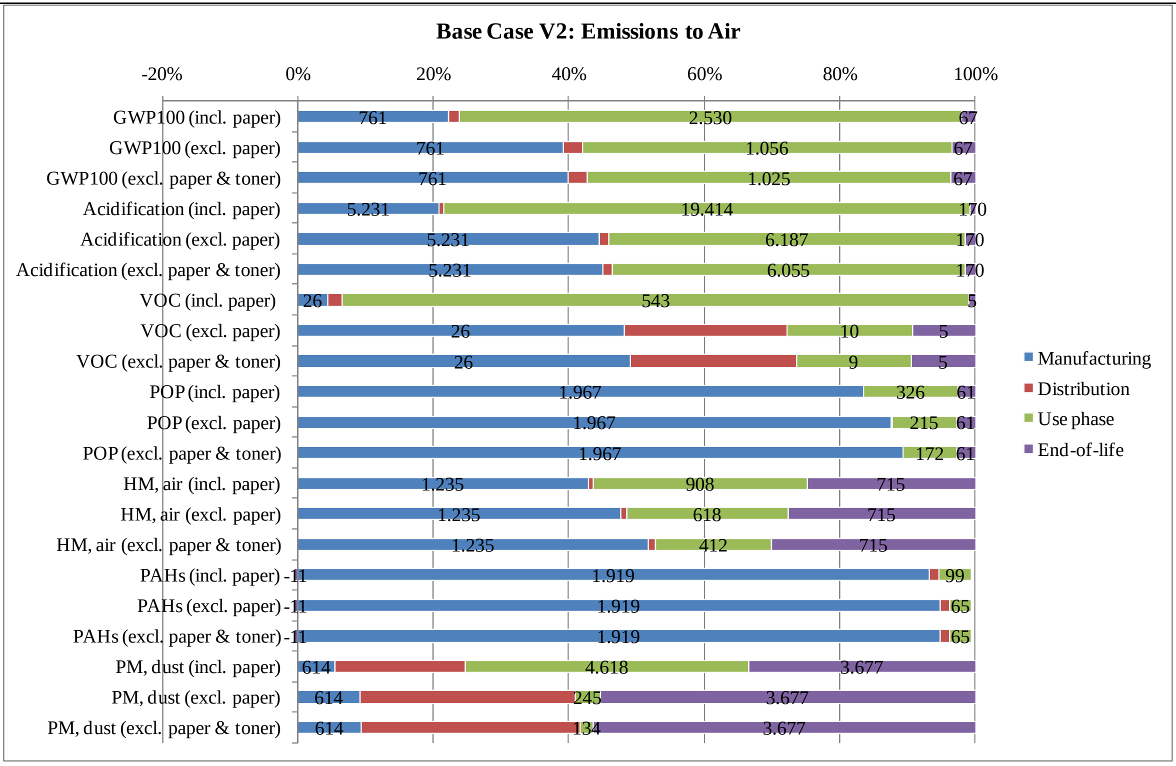


**Figure 7: Distribution of emissions to air for Base Case V2**

### 5.2.2.3. Assessment of single impact categories related to life cycle phases

The following assessment of single eco-impacts related to the life cycle phase “Manufacturing”, “Distribution”, “Use”, and “End-of-life” excludes the aspect of paper. By taking the impact category Total Energy as general eco-indicator, the “use” phase with 24,242 MJ has the single highest impact followed by the “manufacturing” phase with 13,752 MJ. The “Distribution” and “End-of-life” phases have again a very minor impact (see Figure 5). In terms of “Greenhouse Gases”, and “Acidification” shows the Base Case V2 a roughly 40:60 eco-impact ratio between the “manufacturing” and “use” phase. The eco-impact categories which are indicating toxicity such as POP, Heavy Metals, and PAHs, as well as Volatile Organic Compounds (VOC) show a much higher impact ratio with regards to the manufacturing phase. The auxiliary material “Toner” does not show a particular large impact.

Regarding data acquisition, data quality and methodological aspects of the assessment, see also Section 5.2.1.3

Details regarding the environmental impacts of various materials for the Base Case V2 are provided in Table 13 on the following page. In this table the material inputs are listed by category (e.g. Bulk Plastics, 5-PS) and their eco-impact weighted through a colour code. Materials causing more than 50% of the total impact in the respective category are indicated with red colour. Materials or components causing 30% to 50% of the total impact in the respective category are indicated with orange colour. Materials or components causing 10% to 30% of the total impact in the respective category are indicated with yellow colour. Everything else is marked in grey.

Galvanized Steel (21-St sheet) has again a considerable eco-impact because it amount 72 kg or 51% of total mass. This impact is very similar in its proportions when compared to the first base case. The Base Case V2 on the other hand has a higher amount of stainless steel (3 kg) and also copper wiring (4 kg) even when taking the factor two in total weight between the two product cases into account. Both materials show particular environmental impacts in the waste and emissions categories. In terms of other Ferro and non-Ferro metals shows the comparison of both base cases similar proportions according to their total material mass.

Concerning the impact of plastics, PC is with 15 kg the single largest fraction followed by PS (10 kg) and ABS (7 kg). The eco-impact of PC and ABS is caused by the higher resource consumption, however regarding emissions and particular toxicity their impact is relatively small. The Base Case V2 has with 6 kg a considerable amount of EPS, which was very little used in the Base Case V1. The eco-impact of PS and EPS is related to the high PAHs (polycyclic aromatic hydrocarbons) concentration.

What is interesting to notice is the fact that the mass of Electronics in Base Case V2 is with 2.5 kg almost identical (in total) to the Base Case V1. But, if we compare the single “Electronics” input categories we can detect differences, which have an impact on the assessment results. In the Base Case V1 most electronic components have been allocated to the category 44-big caps & coils, whereas in the Base Case V2 the same electronic components have been allocated to the category 49-PWB (in sense of a populated PWB). The actual effects of this different component allocations in the single impact categories are however minimal.

**Table 13: Detailed impact assessment of input materials of Base case V2**

**Colour coding**

**Red:** Process causes more than 50% of total impact in the respective impact category.

**Orange:** Process causes between 30% and 50% of total impact in the respective impact category.

**Yellow:** Processes between 10% and 30% of total impact in the respective impact category.

Nr: 0 Product: Base Case V2 - MFD - Copier Color Date: 00.01.00 Author: 0

MATERIALS EXTRACTION & PRODUCTION

| Product | | | | | Energy | | | Water | | Waste | | Emissions to Air | | | | | | | to Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nr | comp | wght | cat. | material | GER | electr | feedst | water (proces) | water (cool) | haz. Waste | non-haz. Waste | GWP | AD | VOC | POP | HM | PAH | PM | Metal | EUP |
| | | in g | | | MJ | MJ | MJ | ltr. | ltr. | g | g | kg CO2eq | g SO2eq | mg | ng i-Teq | mg Ni eq | mg Ni eq | g | mg Hg/20eq | mg PO4 eq |
| 1 | 0 | 298,772662 | 1-BlkPlas | 1-LDPE | 23,24 | 3,98 | 15,40 | 0,90 | 13,44 | 1,33 | 13,20 | 0,57 | 2,22 | 0,15 | 0,00 | 0,00 | 0,04 | 0,27 | 0,00 | 7,95 |
| 2 | 0 | 1980,53695 | 1-BlkPlas | 2-HDPE | 151,63 | 19,47 | 107,15 | 6,73 | 61,40 | 10,77 | 75,94 | 3,58 | 12,07 | 0,32 | 0,00 | 0,00 | 0,68 | 1,70 | 0,00 | 59,05 |
| 3 | 0 | 169,0009 | 1-BlkPlas | 4-PP | 12,28 | 1,23 | 8,91 | 0,81 | 6,76 | 0,75 | 4,76 | 0,33 | 0,95 | 0,00 | 0,00 | 0,00 | 0,06 | 0,13 | 0,00 | 27,81 |
| 4 | 0 | 10214,8291 | 1-BlkPlas | 5-PS | 885,93 | 36,98 | 485,51 | 50,05 | 1808,02 | 7,01 | 223,05 | 28,51 | 175,95 | 0,00 | 0,00 | 0,00 | 1234,39 | 15,32 | 0,00 | 566,86 |
| 5 | 0 | 6184,68689 | 1-BlkPlas | 6-EPS | 517,41 | 20,90 | 295,69 | 35,25 | 1088,50 | 5,75 | 234,10 | 16,71 | 112,15 | 0,00 | 0,00 | 0,00 | 376,30 | 11,13 | 0,00 | 770,77 |
| 6 | 0 | 94,5133896 | 1-BlkPlas | 8-PVC | 5,35 | 1,05 | 2,17 | 1,04 | 5,86 | 0,47 | 6,34 | 0,20 | 1,42 | 0,00 | 0,00 | 0,00 | 0,00 | 0,27 | 0,27 | 29,68 |
| 7 | 0 | 7319,27016 | 1-BlkPlas | 10-ABS | 695,48 | 50,87 | 335,00 | 68,07 | 1207,68 | 73,19 | 672,84 | 24,30 | 130,06 | 0,00 | 0,00 | 0,00 | 13,23 | 21,23 | 14,20 | 4609,98 |
| 8 | 0 | 880,020719 | 2-TecPla | 11-PA 6 | 105,17 | 13,31 | 34,24 | 14,08 | 192,72 | 16,72 | 155,12 | 7,53 | 34,36 | 0,01 | 0,00 | 0,00 | 0,36 | 4,75 | 43,14 | 1647,65 |
| 9 | 0 | 14990,2594 | 2-TecPla | 12-PC | 1751,01 | 222,76 | 569,48 | 209,86 | 1708,89 | 149,90 | 2646,59 | 80,84 | 381,17 | 0,00 | 0,00 | 0,00 | 5,44 | 100,43 | 2,46 | 7555,39 |
| 10 | 0 | 89,9049871 | 2-TecPla | 14-Epoxy | 12,65 | 2,21 | 3,83 | 1,71 | 34,52 | 1,71 | 36,55 | 0,59 | 3,95 | 0,00 | 0,00 | 0,00 | 0,01 | 1,35 | 0,00 | 867,57 |
| 11 | 0 | 995,832754 | 2-TecPla | 15-Rigid PUR | 103,82 | 17,39 | 38,51 | 59,75 | 299,75 | 19,51 | 425,39 | 4,16 | 30,86 | 0,00 | 0,00 | 0,00 | 20,11 | 7,33 | 43,02 | 3172,52 |
| 12 | 0 | 466,480513 | 2-TecPla | 16-Flex PUR | 48,73 | 8,73 | 18,56 | 32,65 | 139,01 | 15,11 | 255,99 | 2,09 | 14,98 | 0,00 | 0,00 | 0,00 | 9,41 | 3,84 | 1,56 | 2652,22 |
| 13 | 0 | 72588,3738 | 3-Ferro | 21-St sheet galv. | 2468,00 | 165,39 | 5,39 | 0,00 | 0,00 | 0,00 | 124962,34 | 205,23 | 541,88 | 9,90 | 1887,30 | 257,30 | 5,03 | 196,52 | 257,70 | 4730,55 |
| 14 | 0 | 5,98114795 | 3-Ferro | 24-Ferrite | 0,30 | 0,02 | 0,00 | 0,24 | 0,00 | 0,00 | 15,44 | 0,03 | 0,07 | 0,00 | 0,23 | 0,21 | 0,00 | 0,02 | 0,01 | 0,47 |
| 15 | 0 | 2822,10803 | 3-Ferro | 25-Stainless 18/8 coil | 175,09 | 27,35 | 11,42 | 213,73 | 23,80 | 0,00 | 2822,11 | 17,51 | 158,10 | 0,38 | 21,73 | 418,53 | 0,08 | 22,33 | 243,74 | 6569,67 |
| 16 | 0 | 1587,14805 | 4-Non-fe | 26-Al sheet/extrusion | 305,72 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 6221,62 | 16,42 | 106,82 | 0,10 | 7,92 | 5,77 | 153,22 | 26,85 | 55,58 | 7,85 |
| 17 | 0 | 179,333333 | 4-Non-fe | 27-Al diecast | 9,89 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 134,50 | 0,64 | 2,80 | 0,01 | 6,01 | 0,15 | 3,17 | 0,73 | 1,16 | 0,22 |
| 18 | 0 | 3910,9319 | 4-Non-fe | 28-Cu winding wire | 558,17 | 0,00 | 0,00 | 0,00 | 0,00 | 3,12 | 78375,08 | 28,81 | 1188,28 | 0,12 | 15,53 | 221,04 | 21,63 | 11,83 | 25,30 | 618,71 |
| 19 | 0 | 954,569798 | 4-Non-fe | 29-Cu wire | 111,26 | 0,00 | 0,00 | 0,00 | 0,00 | 0,23 | 19102,85 | 5,92 | 278,83 | 0,01 | 3,57 | 52,56 | 5,14 | 2,71 | 89,82 | 147,50 |
| 20 | 0 | 1004,00895 | 4-Non-fe | 30-Cu tube/sheet | 51,13 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 8046,13 | 2,74 | 62,85 | 0,00 | 10,33 | 33,22 | 5,38 | 1,47 | 37,80 | 62,13 |
| 21 | 0 | 82,3333333 | 6-Electro | 42-LCD per m2 scrn | 293,37 | 186,90 | 0,00 | 3,71 | 55,16 | 0,08 | 4,28 | 15,18 | 4,87 | 0,03 | 0,02 | 0,06 | 0,01 | 0,05 | 0,02 | 0,00 |
| 22 | 0 | 0 | 6-Electro | 44-big caps & coils | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 23 | 0 | 165,882796 | 6-Electro | 45-slots / ext. ports | 31,03 | 9,84 | 0,00 | 12,38 | 42,36 | 2,84 | 51,04 | 1,66 | 30,58 | 0,00 | 0,23 | 6,30 | 0,32 | 2,15 | 5,28 | 1073,22 |
| 24 | 0 | 9,71189337 | 6-Electro | 46-IC's avg., 5% Si, Au | 53,51 | 52,04 | 0,00 | 48,72 | 0,00 | 2,45 | 50,32 | 4,11 | 27,07 | 0,66 | 0,47 | 4,34 | 0,14 | 0,71 | 36,32 | 208,62 |
| 25 | 0 | 31,9915816 | 6-Electro | 47-IC's avg., 1% Si | 27,97 | 21,54 | 0,10 | 19,56 | 3,31 | 20,62 | 55,93 | 1,88 | 26,11 | 0,00 | 0,31 | 5,92 | 0,09 | 0,77 | 0,31 | 137,45 |
| 26 | 0 | 274,313167 | 6-Electro | 48-SMD/ LED's avg. | 814,40 | 791,55 | 0,00 | 253,86 | 0,00 | 35,85 | 776,56 | 45,81 | 444,52 | 2,05 | 4,11 | 115,68 | 1,24 | 13,94 | 4,04 | 602,25 |
| 27 | 0 | 706,504649 | 6-Electro | 49-PWB 1/2 lay 3.75kg | 198,57 | 106,35 | 6,03 | 120,13 | 54,26 | 1224,55 | 1854,82 | 7,93 | 151,02 | 1,64 | 1,91 | 25,54 | 2,52 | 3,59 | 10,42 | 2604,49 |
| 28 | 0 | 280,872833 | 6-Electro | 50-PWB 6 lay 4.5 kg/m | 103,13 | 41,05 | 2,40 | 136,24 | 21,57 | 531,35 | 1144,08 | 4,41 | 111,22 | 0,29 | 1,43 | 19,68 | 1,93 | 10,40 | 35,23 | 686,10 |
| 29 | 0 | 6,13223377 | 6-Electro | 51-PWB 6 lay 2 kg/m2 | 2,99 | 2,04 | 0,07 | 2,47 | 0,64 | 26,10 | 14,32 | 0,12 | 1,35 | 0,00 | 0,02 | 0,20 | 0,02 | 0,04 | 2,00 | 17,45 |
| 30 | 0 | 1904,51801 | 7-Misc. | 54-Glass for lamps | 30,90 | 24,62 | 0,00 | 16,23 | 0,00 | 0,51 | 25,76 | 1,59 | 5,72 | 0,01 | 0,15 | 0,34 | 0,00 | 0,12 | 0,08 | 0,68 |
| 31 | 0 | 12166,6667 | 7-Misc. | 56-Cardboard | 340,67 | 24,31 | 194,67 | 85,75 | 0,00 | 0,56 | 636,52 | 8,54 | 12,65 | 0,01 | 0,16 | 0,42 | 0,05 | 0,13 | 0,16 | 1047,08 |
| 32 | 0 | 178,368057 | 7-Misc. | 57-Office paper | 7,13 | 1,07 | 4,82 | 13,58 | 0,00 | 0,06 | 12,05 | 0,10 | 0,90 | 0,04 | 0,01 | 0,02 | 0,00 | 0,30 | 0,01 | 943,28 |
| 33 | 0 | 902,307833 | 6-Electro | 98-controller board | 705,13 | 522,86 | 2,75 | 472,23 | 95,32 | 588,69 | 1515,56 | 46,50 | 394,64 | 5,82 | 5,74 | 66,31 | 54,47 | 20,21 | 300,76 | 4242,77 |

## 5.2.3. Base Case V3: EP-Printer/SFD Monochrome

### 5.2.3.1. Overview of assessment results for Base Case V3

Table 14 shows the MEEuP EcoReport environmental impact assessment results for the Base Case V3 (EP-Printer/SFD monochrome). If we take the total energy consumption (GER) as a reference for the environmental impact, the results indicate that the use phase contributes most significantly to the overall environmental impact. Similar to the previous product cases the consideration of paper use[6] does have an overall effect on the results.

**Table 14: Eco-assessment results from MEEuP EcoReport for Base Case V3 (incl. paper)**

Table . Life Cycle Impact (per unit) of Base Case_V3_EP-Printer-SFD-mono (incl. Paper)

| Nr | Life cycle Impact per product: | Date | Author |
|---|---|---|---|
| 0 | Base Case_V3_EP-Printer-SFD-mono (incl. Paper) | 0 | vhk |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4613** | | | 3690 | 923 | **4613** | **0** |
| 2 | TecPlastics | g | | | **5307** | | | 4245 | 1061 | **5307** | **0** |
| 3 | Ferro | g | | | **7290** | | | 364 | 6925 | **7290** | **0** |
| 4 | Non-ferro | g | | | **807** | | | 40 | 767 | **807** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **823** | | | 461 | 362 | **823** | **0** |
| 7 | Misc. | g | | | **4265** | | | 213 | 4052 | **4265** | **0** |
| | **Total weight** | g | | | **23104** | | | 9015 | 14089 | **23104** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 2025 | 631 | **2656** | **205** | **177679** | 650 | 545 | **105** | **180644** |
| 9 | of which, electricity (in primary MJ) | MJ | 497 | 322 | **819** | **0** | **41001** | 0 | 49 | **-49** | **41771** |
| 10 | Water (process) | ltr | 525 | 13 | **538** | **0** | **305465** | 0 | 43 | **-43** | **305960** |
| 11 | Water (cooling) | ltr | 1504 | 172 | **1677** | **0** | **46678** | 0 | 49 | **-49** | **48306** |
| 12 | Waste, non-haz./ landfill | g | 26265 | 2025 | **28290** | **125** | **292456** | 1423 | 151 | **1272** | **322142** |
| 13 | Waste, hazardous/ incinerated | g | 1763 | 3 | **1766** | **2** | **1795** | 8298 | 52 | **8246** | **11809** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 102 | 36 | **138** | **14** | **3012** | 48 | 35 | **14** | **3177** |
| 15 | Ozone Depletion, emissions | mg R-11 eq | | | | negligible | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 755 | 166 | **920** | **40** | **24590** | 98 | 74 | **25** | **25575** |
| 17 | Volatile Organic Compounds (VOC) | g | 3 | 2 | **5** | **2** | **816** | 2 | 1 | **1** | **824** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 190 | 20 | **210** | **1** | **325** | 10 | 0 | **10** | **545** |
| 19 | Heavy Metals | mg Ni eq. | 178 | 47 | **225** | **6** | **942** | 175 | 5 | **170** | **1344** |
| | PAHs | mg Ni eq. | 170 | 2 | **172** | **8** | **86** | 0 | 5 | **-5** | **261** |
| 20 | Particulate Matter (PM, dust) | g | 90 | 31 | **121** | **387** | **6841** | 866 | 3 | **863** | **8212** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 311 | 0 | **311** | **0** | **294** | 54 | 24 | **30** | **635** |
| 22 | Eutrophication | g PO4 | 13 | 1 | **13** | **0** | **21135** | 3 | 1 | **3** | **21151** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | negligible | | | | | |

In order to show also in this case again the magnitude of paper consumption on the environmental impact, Table 15 below provides the same assessment results excluding paper.

[6] According to our use phase assumptions that have been discussed in task 4.3.3, the Base Case V3 has 6 year lifetime with a paper output of 133,120 pages per year.

**Table 15: Eco-assessment results from MEEuP EcoReport for Base Case V3 (excl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case_V3_EP-Printer-SFD-mono (excl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | | | Date | Author |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case_V3_EP-Printer-SFD-mono (excl. Paper) | | | | | | | | | 0 | vhk |

| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Resources Use and Emissions** | | Material | Manuf. | **Total** | **BUTION** | | Disposal | Recycl. | **Total** | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4613** | | | 3690 | 923 | **4613** | **0** |
| 2 | TecPlastics | g | | | **5307** | | | 4245 | 1061 | **5307** | **0** |
| 3 | Ferro | g | | | **7290** | | | 364 | 6925 | **7290** | **0** |
| 4 | Non-ferro | g | | | **807** | | | 40 | 767 | **807** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **823** | | | 461 | 362 | **823** | **0** |
| 7 | Misc. | g | | | **4265** | | | 213 | 4052 | **4265** | **0** |
| | **Total weight** | g | | | **23104** | | | 9015 | 14089 | **23104** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 2025 | 631 | **2656** | **205** | **17839** | 650 | 545 | **105** | **20804** |
| 9 | of which, electricity (in primary MJ) | MJ | 497 | 322 | **819** | **0** | **17053** | 0 | 49 | **-49** | **17823** |
| 10 | Water (process) | ltr | 525 | 13 | **538** | **0** | **1199** | 0 | 43 | **-43** | **1694** |
| 11 | Water (cooling) | ltr | 1504 | 172 | **1677** | **0** | **46678** | 0 | 49 | **-49** | **48306** |
| 12 | Waste, non-haz./ landfill | g | 26265 | 2025 | **28290** | **125** | **22532** | 1423 | 151 | **1272** | **52218** |
| 13 | Waste, hazardous/ incinerated | g | 1763 | 3 | **1766** | **2** | **444** | 8298 | 52 | **8246** | **10458** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 102 | 36 | **138** | **14** | **776** | 48 | 35 | **14** | **941** |
| 15 | Ozone Depletion, emissions | mg R-11 ec | | | | | negligible | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 755 | 166 | **920** | **40** | **4523** | 98 | 74 | **25** | **5508** |
| 17 | Volatile Organic Compounds (VOC) | g | 3 | 2 | **5** | **2** | **7** | 2 | 1 | **1** | **16** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 190 | 20 | **210** | **1** | **157** | 10 | 0 | **10** | **377** |
| 19 | Heavy Metals | mg Ni eq. | 178 | 47 | **225** | **6** | **502** | 175 | 5 | **170** | **903** |
| | PAHs | mg Ni eq. | 170 | 2 | **172** | **8** | **35** | 0 | 5 | **-5** | **210** |
| 20 | Particulate Matter (PM, dust) | g | 90 | 31 | **121** | **387** | **207** | 866 | 3 | **863** | **1577** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 311 | 0 | **311** | **0** | **129** | 54 | 24 | **30** | **470** |
| 22 | Eutrophication | g PO4 | 13 | 1 | **13** | **0** | **2** | 3 | 1 | **3** | **18** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | | negligible | | | | |

## 5.2.3.2. Assessment results according to the consideration of paper

The comparison of Table 14 (incl. paper) and Table 15 (excl. paper) indicates that from the use phase impact of 177,679 MJ the largest portion of 159,840 MJ is related to paper consumption alone. The remaining 17,839 MJ are the impacts of energy and toner consumption. Figure 8 below shows that according to the use pattern assumption 90% of the products total energy consumption in the use phase is related to paper. If we exclude paper from the assessment, it becomes obvious that the overall environmental impact correlates directly with the product weight (material mass) in the manufacturing phase and with energy consumption in the use phase (see also Figure 9 and Figure 10 further below for details).

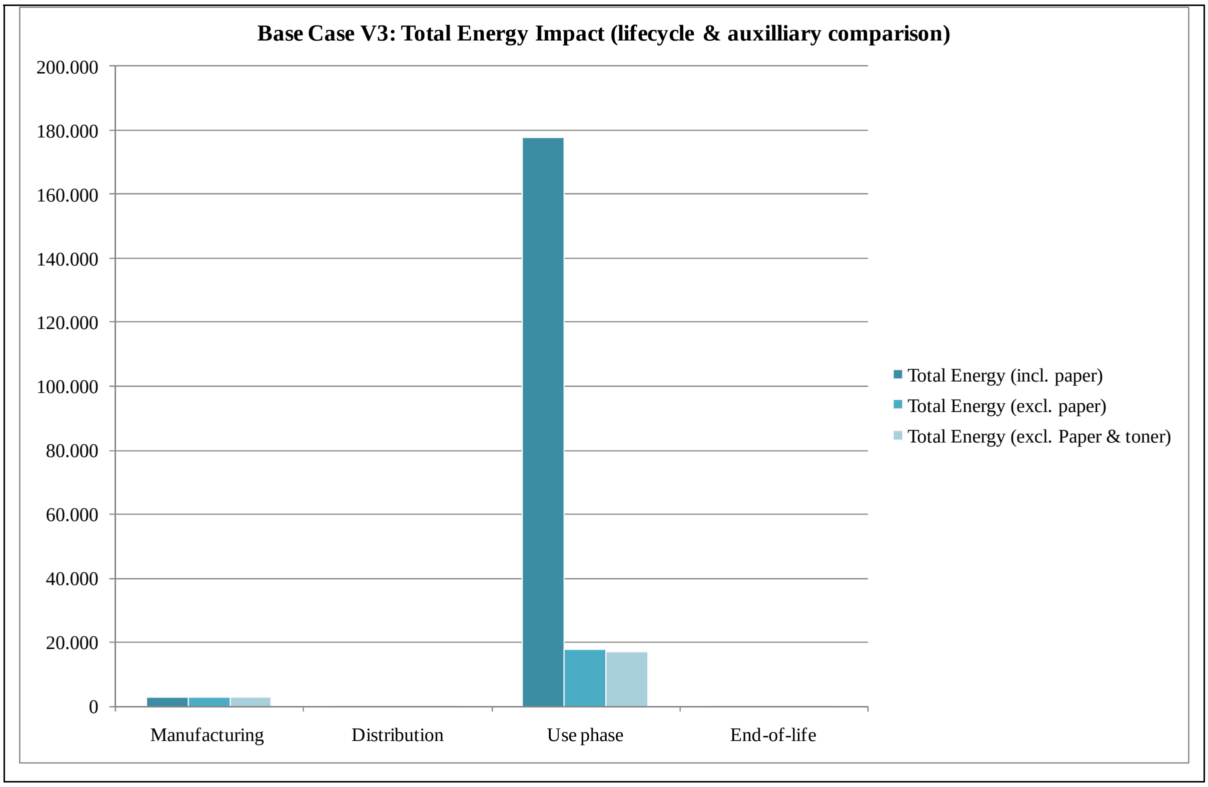


**Figure 8: Total energy impact comparison including auxiliaries for Base Case V3**

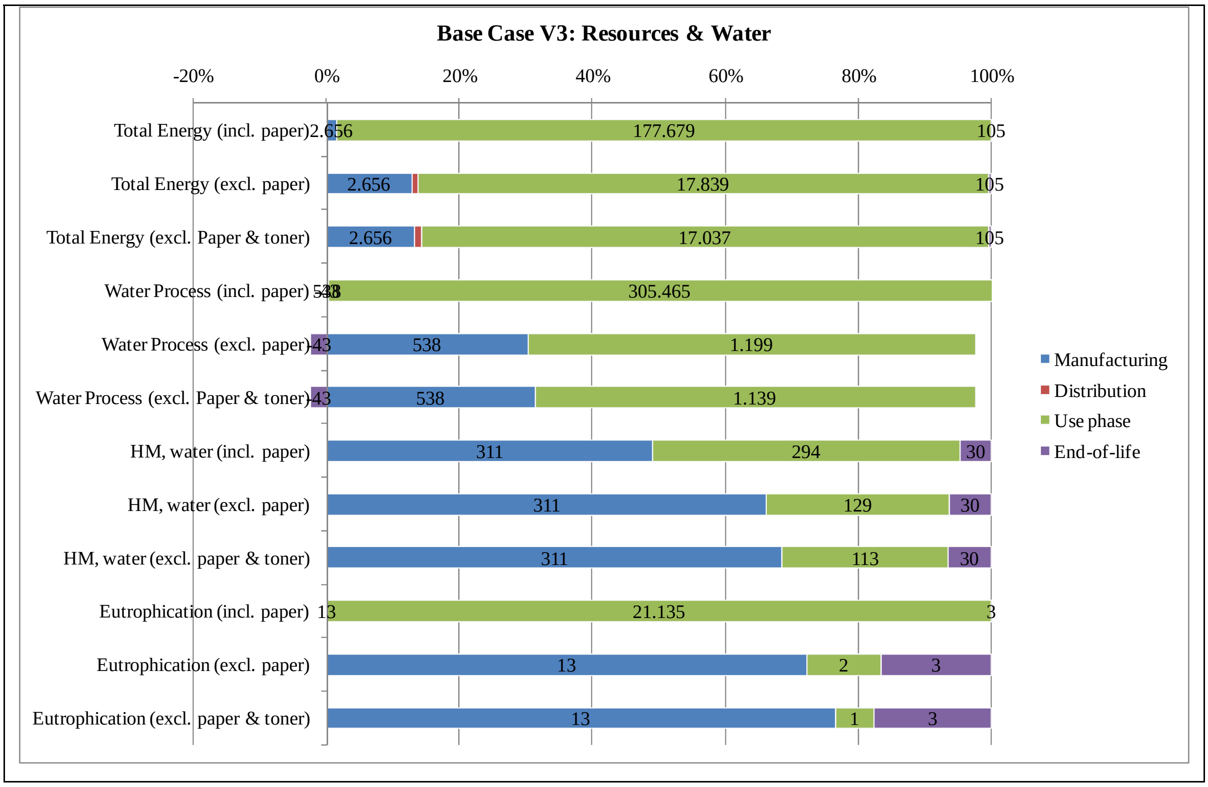


**Figure 9: Distribution of resources related impacts for Base Case V3**

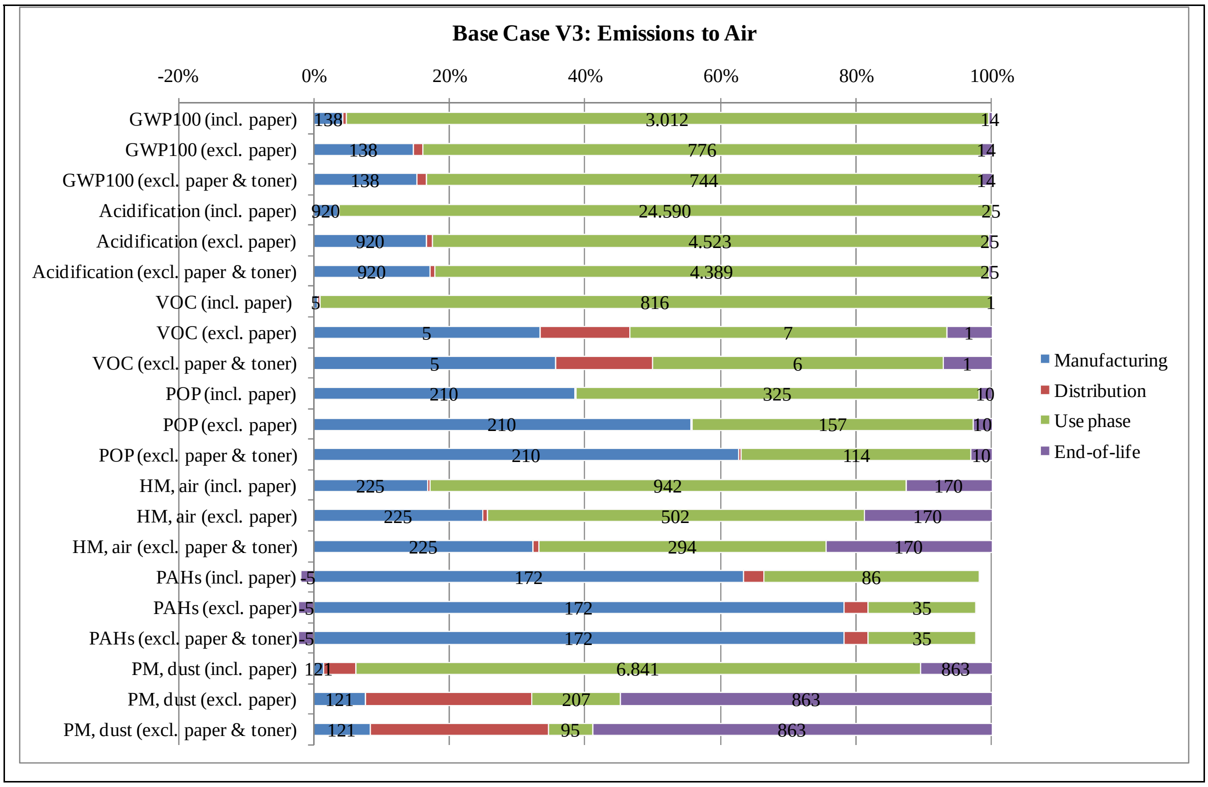


**Figure 10: Distribution of emissions to air for Base Case V3**

### 5.2.3.3. Assessment of single impact categories related to life cycle phases

The following assessment of single eco-impacts related to the life cycle phase "Manufacturing", "Distribution", "Use", and "End-of-life" excludes the aspect of paper. By taking the impact category Total Energy as general eco-indicator the "use" phase with 17,839 MJ has the single highest impact followed by the "Manufacturing" phase with 2,656 MJ. The "Distribution" and "End-of-life" phases have again a very minor impact. In terms of "Greenhouse Gases" and "Acidification" shows the Base Case V3 a similar eco-impact ratio between the "Manufacturing" (<15%) and "Use" phase (>85%). The eco-impact categories which are indicating toxicity such as POP, Heavy Metals, and PAHs, as well as Volatile Organic Compounds (VOC) show a much higher impact ratio with regards to the manufacturing phase. The auxiliary material "Toner" does not show a particular large impact.

Regarding data acquisition, data quality and methodological aspects of the assessment, see also Section 5.2.1.3

Details regarding the environmental impacts of various materials for the Base Case V3 are provided in Table 16. In this table the material inputs are listed by category (e.g. Bulk Plastics, 5-PS) and their eco-impact weighted through a colour code. The very even distribution of materials of the Base Case V3 does not indicate particular environmental impacts. Although PC (4.2 kg) and ABS (2.9 kg) show-up in the assessment, their alternatives would indicate probably higher impacts in resources and emissions. Galvanized and stainless steel, copper wiring as well as Electronics have again a certain eco-impact because their total mass. In general this impact is very similar in their proportions compared to the other base cases. A direct comparison of Total Energy related to the manufacturing phase of the Base Case V1 (EP-Copier/MFD monochrome) and the Base Case V3 (EP-Printer/SFD monochrome) shows that the factor three difference in product mass (V1 68 kg and V3 23 kg) is roughly the same in terms of the energy related impact. This comparison indicates that even with different material distribution (compare percentages of material inputs by category) as well as different product complexity, the impact increases proportionally to the weight.

**Table 16: Detailed impact assessment of input materials of Base Case V3**

**Colour coding**

**Red:** Process causes more than 50% of total impact in the respective impact category.

**Orange:** Process causes between 30% and 50% of total impact in the respective impact category.

**Yellow:** Processes between 10% and 30% of total impact in the respective impact category.

Nr: 0 Product: Base Case_V3_EP-Printer-SFD-mono Date: 00.01.00 Author: vhk

MATERIALS EXTRACTION & PRODUCTION

| Product | | | | | Energy | | | Water | | Waste | | Emissions to Air | | | | | | | to Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nr | comp | wght | cat. | material | GER | electr | feedst | water (proces) | water (cool) | haz. Waste | non-haz. Waste | GWP | AD | VOC | POP | HM | PAH | PM | Metal | EUP |
| | | in g | | | MJ | MJ | MJ | ltr. | ltr. | g | g | kg CO2eq | g SO2eq | mg | ng i-Teq | mg Ni eq | mg Ni eq | g | mg Hg/20eq | mg PO4 eq |
| 1 | 0 | 114,87 | 1-BlkPlas | 1-LDPE | 8,94 | 1,53 | 5,92 | 0,34 | 5,17 | 0,51 | 5,08 | 0,22 | 0,86 | 0,06 | 0,00 | 0,00 | 0,02 | 0,11 | 0,00 | 3,06 |
| 2 | 0 | 366,87 | 1-BlkPlas | 2-HDPE | 28,09 | 3,61 | 19,85 | 1,25 | 11,37 | 2,00 | 14,07 | 0,66 | 2,24 | 0,06 | 0,00 | 0,00 | 0,13 | 0,32 | 0,00 | 10,94 |
| 3 | 0 | 43,433 | 1-BlkPlas | 3-LLDPE | 3,21 | 0,44 | 2,06 | 0,10 | 5,04 | 0,15 | 1,33 | 0,08 | 0,26 | 0,00 | 0,00 | 0,00 | 0,00 | 0,06 | 0,00 | 1,70 |
| 4 | 0 | 82,183 | 1-BlkPlas | 4-PP | 5,97 | 0,60 | 4,33 | 0,39 | 3,29 | 0,36 | 2,31 | 0,16 | 0,46 | 0,00 | 0,00 | 0,00 | 0,03 | 0,06 | 0,00 | 13,52 |
| 5 | 0 | 851,84 | 1-BlkPlas | 5-PS | 73,88 | 3,08 | 40,49 | 4,17 | 150,77 | 0,58 | 18,60 | 2,38 | 14,67 | 0,00 | 0,00 | 0,00 | 102,94 | 1,28 | 0,00 | 47,27 |
| 6 | 0 | 3,7333 | 1-BlkPlas | 6-EPS | 0,31 | 0,01 | 0,18 | 0,02 | 0,66 | 0,00 | 0,14 | 0,01 | 0,07 | 0,00 | 0,00 | 0,00 | 0,23 | 0,01 | 0,00 | 0,47 |
| 7 | 0 | 191,25 | 1-BlkPlas | 8-PVC | 10,83 | 2,12 | 4,39 | 2,10 | 11,86 | 0,96 | 12,83 | 0,41 | 2,87 | 0,00 | 0,00 | 0,00 | 0,01 | 0,55 | 0,54 | 60,05 |
| 8 | 0 | 4,0667 | 1-BlkPlas | 9-SAN | 0,36 | 0,02 | 0,19 | 0,02 | 0,66 | 0,02 | 0,13 | 0,01 | 0,06 | 0,00 | 0,00 | 0,00 | 0,00 | 0,01 | 0,00 | 1,14 |
| 9 | 0 | 2954,5 | 1-BlkPlas | 10-ABS | 280,74 | 20,53 | 135,23 | 27,48 | 487,49 | 29,55 | 271,60 | 9,81 | 52,50 | 0,00 | 0,00 | 0,00 | 5,34 | 8,57 | 5,73 | 1860,87 |
| 10 | 0 | 626,39 | 2-TecPla | 11-PA 6 | 74,86 | 9,48 | 24,37 | 10,02 | 137,18 | 11,90 | 110,41 | 5,36 | 24,46 | 0,01 | 0,00 | 0,00 | 0,25 | 3,38 | 30,71 | 1172,77 |
| 11 | 0 | 4219,4 | 2-TecPla | 12-PC | 492,86 | 62,70 | 160,29 | 59,07 | 481,01 | 42,19 | 744,95 | 22,75 | 107,29 | 0,00 | 0,00 | 0,00 | 1,53 | 28,27 | 0,69 | 2126,64 |
| 12 | 0 | 47,95 | 2-TecPla | 13-PMMA | 5,28 | 0,63 | 2,01 | 0,47 | 1,25 | 0,07 | 5,02 | 0,29 | 2,09 | 0,00 | 0,00 | 0,00 | 0,00 | 0,24 | 0,13 | 99,16 |
| 13 | 0 | 38,816 | 2-TecPla | 14-Epoxy | 5,46 | 0,95 | 1,66 | 0,74 | 14,91 | 0,74 | 15,78 | 0,26 | 1,71 | 0,00 | 0,00 | 0,00 | 0,00 | 0,58 | 0,00 | 374,57 |
| 14 | 0 | 50,847 | 2-TecPla | 15-Rigid PUR | 5,30 | 0,89 | 1,97 | 3,05 | 15,30 | 1,00 | 21,72 | 0,21 | 1,58 | 0,00 | 0,00 | 0,00 | 1,03 | 0,37 | 2,20 | 161,99 |
| 15 | 0 | 139,26 | 2-TecPla | 16-Flex PUR | 14,55 | 2,61 | 5,54 | 9,75 | 41,50 | 4,51 | 76,42 | 0,62 | 4,47 | 0,00 | 0,00 | 0,00 | 2,81 | 1,15 | 0,46 | 791,79 |
| 16 | 0 | 184,13 | 2-TecPla | 18-E-glass fibre | 12,12 | 3,88 | 1,99 | 10,00 | 49,96 | 1,30 | 57,30 | 0,62 | 5,37 | 0,00 | 0,00 | 0,00 | 0,01 | 1,50 | 8,72 | 580,26 |
| 17 | 0 | 6506,7 | 3-Ferro | 21-St sheet galv. | 221,23 | 14,83 | 0,48 | 0,00 | 0,00 | 0,00 | 11201,34 | 18,40 | 48,57 | 0,89 | 169,17 | 23,06 | 0,45 | 17,62 | 23,10 | 424,04 |
| 18 | 0 | 212,55 | 3-Ferro | 22-St tube/profile | 3,61 | 0,97 | -0,03 | 0,00 | 0,00 | 0,00 | 170,18 | 0,29 | 0,76 | 0,02 | 2,55 | 0,55 | 0,01 | 0,21 | 0,33 | 8,15 |
| 19 | 0 | 3,4667 | 3-Ferro | 23-Cast iron | 0,03 | 0,00 | 0,00 | 0,00 | 0,01 | 0,00 | 1,09 | 0,00 | 0,01 | 0,00 | 0,02 | 0,01 | 0,00 | 0,05 | 0,00 | 0,09 |
| 20 | 0 | 108,99 | 3-Ferro | 24-Ferrite | 5,51 | 0,37 | 0,01 | 4,29 | 0,00 | 0,00 | 281,45 | 0,46 | 1,22 | 0,02 | 4,25 | 3,92 | 0,00 | 0,44 | 0,26 | 8,57 |
| 21 | 0 | 458,03 | 3-Ferro | 25-Stainless 18/8 coil | 28,42 | 4,44 | 1,85 | 34,69 | 3,86 | 0,00 | 458,03 | 2,84 | 25,66 | 0,06 | 3,53 | 67,93 | 0,01 | 3,62 | 39,56 | 1066,27 |
| 22 | 0 | 213,01 | 4-Non-fe | 26-Al sheet/extrusion | 41,03 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 834,99 | 2,20 | 14,34 | 0,01 | 1,06 | 0,77 | 20,56 | 3,60 | 7,46 | 1,05 |
| 23 | 0 | 388,64 | 4-Non-fe | 28-Cu winding wire | 55,47 | 0,00 | 0,00 | 0,00 | 0,00 | 0,31 | 7788,38 | 2,86 | 118,08 | 0,01 | 1,54 | 21,97 | 2,15 | 1,18 | 2,51 | 61,48 |
| 24 | 0 | 45,633 | 4-Non-fe | 27-Al diecast | 2,52 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 34,23 | 0,16 | 0,71 | 0,00 | 1,53 | 0,04 | 0,81 | 0,18 | 0,30 | 0,06 |
| 25 | 0 | 96,06 | 4-Non-fe | 29-Cu wire | 11,20 | 0,00 | 0,00 | 0,00 | 0,00 | 0,02 | 1922,35 | 0,60 | 28,06 | 0,00 | 0,36 | 5,29 | 0,52 | 0,27 | 9,04 | 14,84 |
| 26 | 0 | 29,366 | 4-Non-fe | 30-Cu tube/sheet | 1,50 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 235,34 | 0,08 | 1,84 | 0,00 | 0,30 | 0,97 | 0,16 | 0,04 | 1,11 | 1,82 |
| 27 | 0 | 2,6667 | 4-Non-fe | 31-CuZn38 cast | 0,10 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 8,11 | 0,00 | 0,09 | 0,00 | 0,07 | 0,15 | 0,01 | 0,00 | 0,02 | 0,04 |
| 28 | 0 | 31,867 | 4-Non-fe | 32-ZnAl4 cast | 0,90 | 0,00 | 0,00 | 0,07 | 0,00 | 0,02 | 48,85 | 0,04 | 0,20 | 0,00 | 1,91 | 0,07 | 0,03 | 0,04 | 0,01 | 0,02 |
| 29 | 0 | 113,73 | 6-Electro | 44-big caps & coils | 43,59 | 0,00 | 0,00 | 3,94 | 6,25 | 2,23 | 68,30 | 2,46 | 16,13 | 0,01 | 0,25 | 0,87 | 23,27 | 4,05 | 8,44 | 0,81 |
| 30 | 0 | 87,417 | 6-Electro | 45-slots / ext. ports | 16,35 | 5,18 | 0,00 | 6,53 | 22,32 | 1,49 | 26,90 | 0,88 | 16,12 | 0,00 | 0,12 | 3,32 | 0,17 | 1,13 | 2,78 | 565,56 |
| 31 | 0 | 6,3678 | 6-Electro | 46-IC's avg., 5% Si, Au | 35,08 | 34,12 | 0,00 | 31,95 | 0,00 | 1,60 | 32,99 | 2,70 | 17,75 | 0,43 | 0,31 | 2,84 | 0,09 | 0,46 | 23,82 | 136,79 |
| 32 | 0 | 9,1458 | 6-Electro | 47-IC's avg., 1% Si | 8,00 | 6,16 | 0,03 | 5,59 | 0,95 | 5,90 | 15,99 | 0,54 | 7,46 | 0,00 | 0,09 | 1,69 | 0,03 | 0,22 | 0,09 | 39,29 |
| 33 | 0 | 45,021 | 6-Electro | 48-SMD/ LED's avg. | 133,66 | 129,91 | 0,00 | 41,66 | 0,00 | 5,88 | 127,45 | 7,52 | 72,95 | 0,34 | 0,67 | 18,99 | 0,20 | 2,29 | 0,66 | 98,84 |
| 34 | 0 | 65,509 | 6-Electro | 49-PWB 1/2 lay 3.75kg | 18,41 | 9,86 | 0,56 | 11,14 | 5,03 | 113,54 | 171,98 | 0,74 | 14,00 | 0,15 | 0,18 | 2,37 | 0,23 | 0,33 | 0,97 | 241,49 |
| 35 | 0 | 97,312 | 6-Electro | 50-PWB 6 lay 4.5 kg/m | 35,73 | 14,22 | 0,83 | 47,20 | 7,47 | 184,09 | 396,38 | 1,53 | 38,53 | 0,10 | 0,50 | 6,82 | 0,67 | 3,60 | 12,21 | 237,71 |

## 5.2.4. Base Case V4: EP-Printer/SFD colour

### 5.2.4.1. Overview of assessment results for Base Case V4

Table 17 shows the MEEuP EcoReport environmental impact assessment results for the Base Case V4 (EP-Printer/SFD colour). If we take the total energy consumption (GER) as a reference for the environmental impact, the results indicate that the use phase contributes most significantly to the overall environmental impact. Similar to the previous product cases the consideration of paper use[7] does have an overall effect on the results.

**Table 17: Eco-assessment results from MEEuP EcoReport for Base Case V4 (incl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case_V4_EP-Printer-SFD-color (incl. Paper)**

| Nr | Life cycle Impact per product: | | Date | Author |
|---|---|---|---|---|
| 0 | Base Case_V4_EP-Printer-SFD-color (incl. Paper) | | 0 | 0 |

| Nr | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **14998** | | | 11999 | 3000 | **14998** | **0** |
| 2 | TecPlastics | g | | | **2424** | | | 1939 | 485 | **2424** | **0** |
| 3 | Ferro | g | | | **15901** | | | 795 | 15106 | **15901** | **0** |
| 4 | Non-ferro | g | | | **1619** | | | 81 | 1538 | **1619** | **0** |
| 5 | Coating | g | | | **2** | | | 0 | 2 | **2** | **0** |
| 6 | Electronics | g | | | **1533** | | | 1173 | 360 | **1533** | **0** |
| 7 | Misc. | g | | | **6625** | | | 331 | 6294 | **6625** | **0** |
| | **Total weight** | g | | | **43103** | | | 16318 | 26785 | **43103** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 3525 | 1103 | **4628** | **345** | **183770** | 1132 | 990 | **142** | **188884** |
| 9 | of which, electricity (in primary MJ) | MJ | 782 | 601 | **1383** | **1** | **46694** | 0 | 55 | **-55** | **48023** |
| 10 | Water (process) | ltr | 865 | 17 | **882** | **0** | **305876** | 0 | 46 | **-46** | **306712** |
| 11 | Water (cooling) | ltr | 2788 | 299 | **3087** | **0** | **62464** | 0 | 81 | **-81** | **65470** |
| 12 | Waste, non-haz./ landfill | g | 54462 | 3829 | **58291** | **193** | **300594** | 2653 | 172 | **2481** | **361559** |
| 13 | Waste, hazardous/ incinerated | g | 1306 | 3 | **1309** | **4** | **1938** | 14298 | 55 | **14243** | **17494** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 176 | 63 | **239** | **22** | **3276** | 84 | 64 | **20** | **3557** |
| 15 | Ozone Depletion, emissions | mg R-11 eq | | | | | negligible | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 1285 | 280 | **1565** | **65** | **26123** | 171 | 113 | **59** | **27813** |
| 17 | Volatile Organic Compounds (VOC) | g | 8 | 3 | **11** | **5** | **818** | 3 | 1 | **2** | **835** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 415 | 44 | **459** | **1** | **386** | 19 | 0 | **18** | **865** |
| 19 | Heavy Metals | mg Ni eq. | 373 | 104 | **477** | **10** | **1146** | 306 | 5 | **300** | **1933** |
| | PAHs | mg Ni eq. | 1008 | 2 | **1010** | **12** | **106** | 0 | 5 | **-5** | **1123** |
| 20 | Particulate Matter (PM, dust) | g | 140 | 48 | **189** | **739** | **6929** | 1509 | 4 | **1505** | **9361** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 460 | 0 | **460** | **0** | **340** | 93 | 24 | **69** | **870** |
| 22 | Eutrophication | g PO4 | 31 | 1 | **32** | **0** | **21136** | 5 | 1 | **5** | **21172** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | | negligible | | | | |

In order to show also in this case again the magnitude of paper consumption on the environmental impact, Table 18 below provides the same assessment results excluding paper.

[7] According to our use phase assumptions that have been discussed in task 4.3.4, the Base Case V4 has 6 year lifetime with a paper output of 133,120 pages per year.

**Table 18: Eco-assessment results from MEEuP EcoReport for Base Case V4 (excl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case_V4_EP-Printer-SFD-color (excl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case_V4_EP-Printer-SFD-color (excl. Paper) | | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **14998** | | | 11999 | 3000 | **14998** | **0** |
| 2 | TecPlastics | g | | | **2424** | | | 1939 | 485 | **2424** | **0** |
| 3 | Ferro | g | | | **15901** | | | 795 | 15106 | **15901** | **0** |
| 4 | Non-ferro | g | | | **1619** | | | 81 | 1538 | **1619** | **0** |
| 5 | Coating | g | | | **2** | | | 0 | 2 | **2** | **0** |
| 6 | Electronics | g | | | **1533** | | | 1173 | 360 | **1533** | **0** |
| 7 | Misc. | g | | | **6625** | | | 331 | 6294 | **6625** | **0** |
| | **Total weight** | g | | | **43103** | | | 16318 | 26785 | **43103** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 3525 | 1103 | **4628** | **345** | **23930** | 1132 | 990 | **142** | **29044** |
| 9 | of which, electricity (in primary MJ) | MJ | 782 | 601 | **1383** | **1** | **22746** | 0 | 55 | **-55** | **24075** |
| 10 | Water (process) | ltr | 865 | 17 | **882** | **0** | **1610** | 0 | 46 | **-46** | **2446** |
| 11 | Water (cooling) | ltr | 2788 | 299 | **3087** | **0** | **62464** | 0 | 81 | **-81** | **65470** |
| 12 | Waste, non-haz./ landfill | g | 54462 | 3829 | **58291** | **193** | **30670** | 2653 | 172 | **2481** | **91635** |
| 13 | Waste, hazardous/ incinerated | g | 1306 | 3 | **1309** | **4** | **587** | 14298 | 55 | **14243** | **16143** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 176 | 63 | **239** | **22** | **1040** | 84 | 64 | **20** | **1321** |
| 15 | Ozone Depletion, emissions | mg R-11 ec | | | | negligible | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 1285 | 280 | **1565** | **65** | **6057** | 171 | 113 | **59** | **7746** |
| 17 | Volatile Organic Compounds (VOC) | g | 8 | 3 | **11** | **5** | **10** | 3 | 1 | **2** | **27** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 415 | 44 | **459** | **1** | **218** | 19 | 0 | **18** | **696** |
| 19 | Heavy Metals | mg Ni eq. | 373 | 104 | **477** | **10** | **705** | 306 | 5 | **300** | **1492** |
| | PAHs | mg Ni eq. | 1008 | 2 | **1010** | **12** | **55** | 0 | 5 | **-5** | **1072** |
| 20 | Particulate Matter (PM, dust) | g | 140 | 48 | **189** | **739** | **294** | 1509 | 4 | **1505** | **2726** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 460 | 0 | **460** | **0** | **175** | 93 | 24 | **69** | **705** |
| 22 | Eutrophication | g PO4 | 31 | 1 | **32** | **0** | **3** | 5 | 1 | **5** | **40** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | negligible | | | | | |

## 5.2.4.2. Assessment results according to the consideration of paper

The comparison of Table 17 (incl. paper) and Table 18 (excl. paper) indicates that from the use phase impact of 183,770 MJ the largest portion of 159,840 MJ is related to paper consumption alone. The remaining 23,930 MJ are the impact of energy and toner consumption. Figure 11 below shows that according to the use pattern assumptions 87% of the products total energy consumption in the use phase is related to paper. If we exclude paper from the assessment, it becomes obvious that the overall environmental impact correlates directly with the product weight (material mass) in the manufacturing phase and with energy consumption in the use phase. Further details of the assessment are shown in Figure 12 and Figure 13 below.

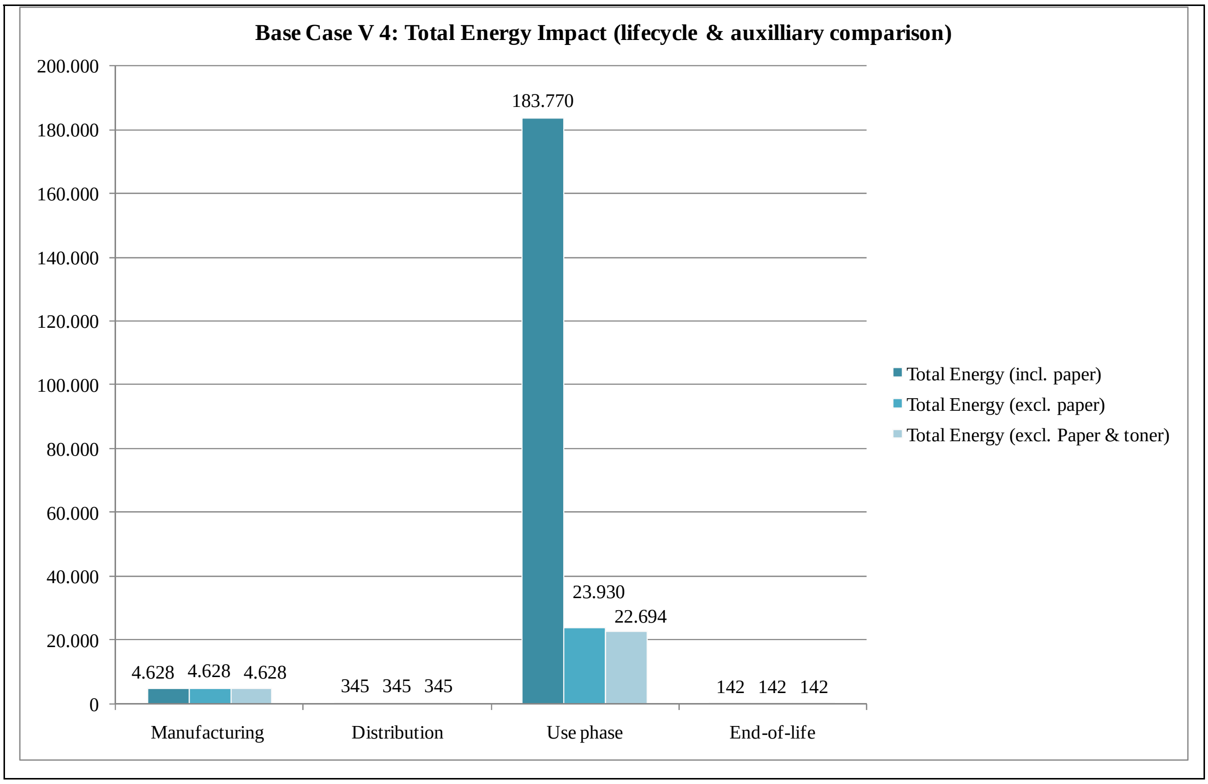


**Figure 11: Total energy impact comparison including auxiliaries for Base Case V4**

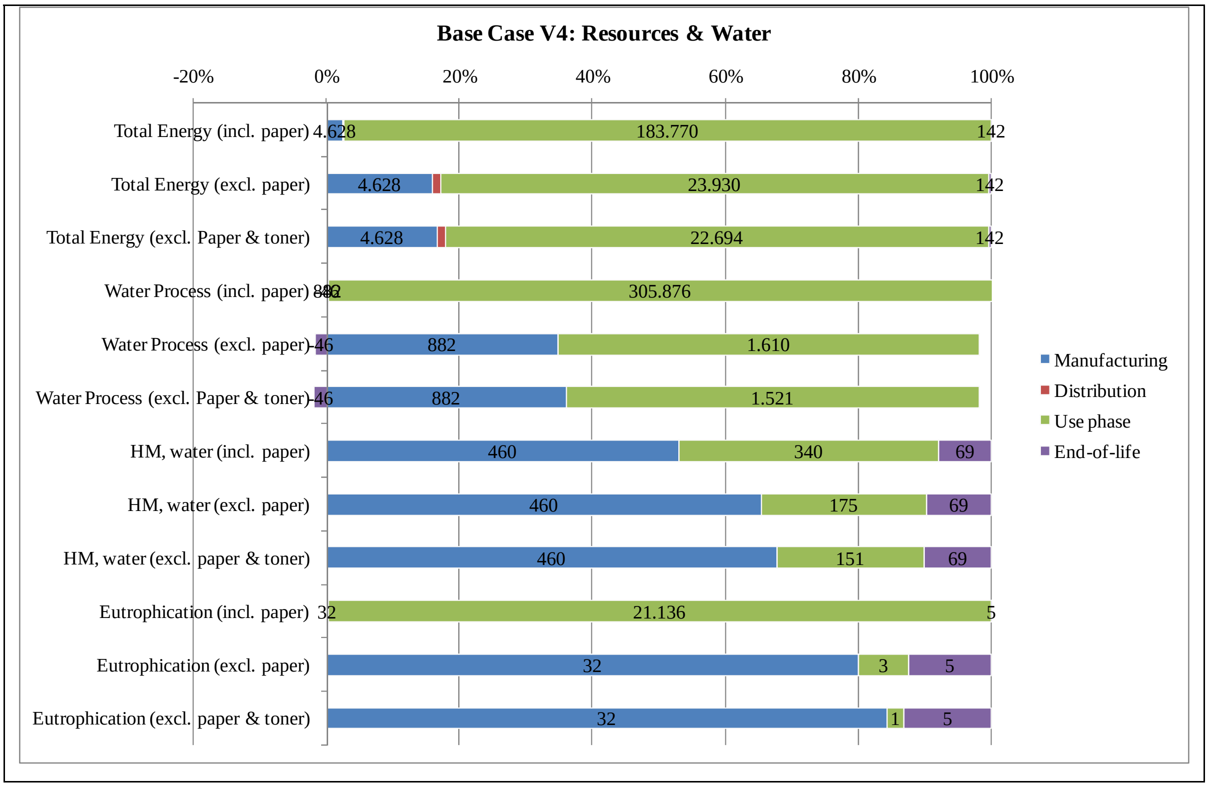


**Figure 12: Distribution of resources related impacts for Base Case V4**

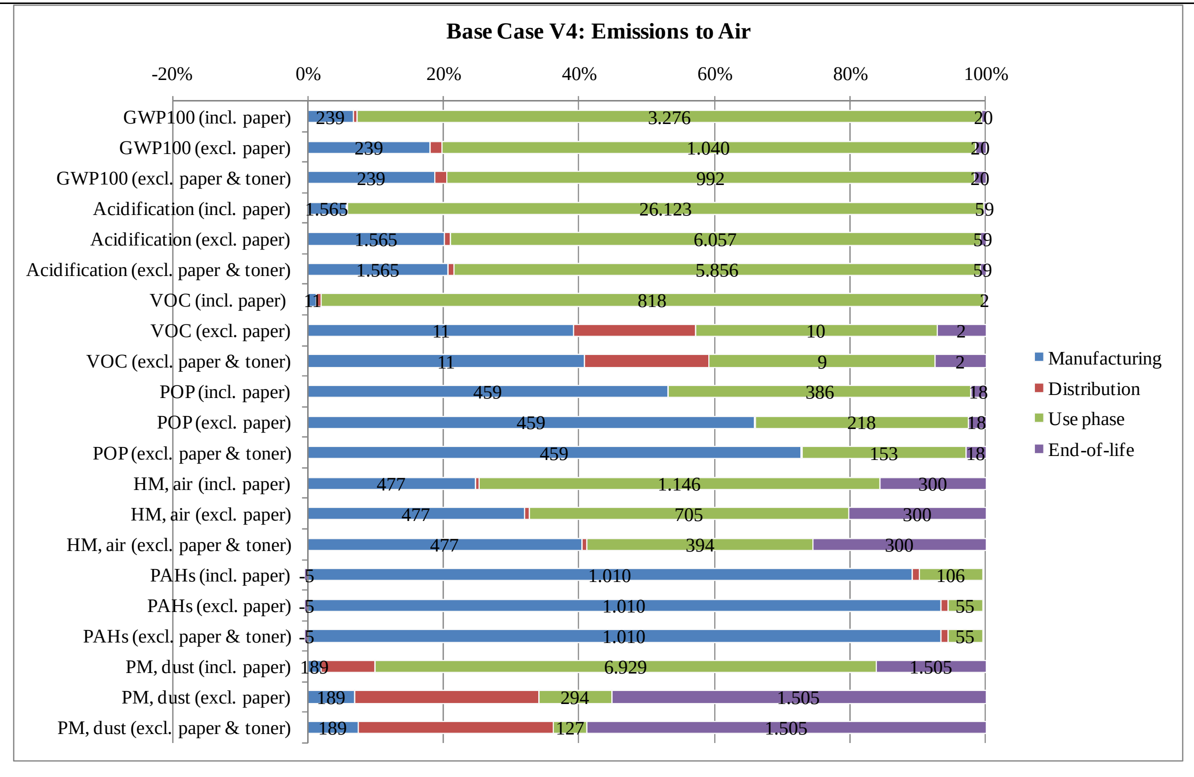


**Figure 13: Distribution of emissions to air for Base Case V4**

### 5.2.4.3. Assessment of single impact categories related to life cycle phases

The following assessment of single eco-impacts related to the life cycle phase “Manufacturing”, “Distribution”, “Use”, and “End-of-life” excludes the aspect of paper. By taking the impact category Total Energy as general eco-indicator the “Use” phase with 23,930 MJ has the single highest impact followed by the “manufacturing” phase with 4,628 MJ. The comparison of the manufacturing phase’s Total Energy impact between the monochrome EP-printer (Base Case V3) and the colour EP-Printer (Base Case V4) shows that the impact increases almost proportionally to the respective product weight. The “Distribution” and “End-of-life” phases have again a very minor impact. In terms of “Greenhouse Gases” and “Acidification” shows the Base Case V4 an eco-impact ratio of 20:80 between the “Manufacturing” and “Use” phase. The eco-impact categories which are indicating toxicity such as POP, Heavy Metals, and PAHs, as well as Volatile Organic Compounds (VOC) show a much higher impact ratio with regards to the manufacturing phase. The auxiliary material “Toner” does not show a particular large impact and correlates with the mass (kg/a) of assumed consumption.

Regarding data acquisition, data quality and methodological aspects of the assessment, see also Section 5.2.1.3

Details regarding the environmental impacts of various materials for the Base Case V4 are provided in Table 19. In this table the material inputs are listed by category and their eco-impact weighted through a colour code. Bulk Plastics such as 5-PS and 10-ABS as well as Ferro Metal 21-St sheet galv. are contributing most significantly to the overall impact due to the relatively high mass volume. Non-Ferro such as 25-stainless steel and 29-Cu wire as well as Electronics (46-ICs, 48-SMD/LED and 49-PWBs) is also significant according to the MEEuP EcoReport assessment.

**Table 19: Detailed impact assessment of input materials of Base Case V4**

**Colour coding**

**Red:** Process causes more than 50% of total impact in the respective impact category.

**Orange:** Process causes between 30% and 50% of total impact in the respective impact category.

**Yellow:** Processes between 10% and 30% of total impact in the respective impact category.

Nr: 0 Product: Base Case V4_EP-Printer-SFD-color Date: 00.01.00 Author: 0

MATERIALS EXTRACTION & PRODUCTION

| Product | | | | | Energy | | | Water | | Waste | | Emissions to Air | | | | | | | to Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nr | com | wght | cat. | material | GER | electr | feedst | water (proces) | water (cool) | haz. Waste | non-haz. Waste | GWP | AD | VOC | POP | HM | PAH | PM | Metal | EUP |
| | | in g | | | MJ | MJ | MJ | ltr. | ltr. | g | g | kg CO2eq | g SO2eq | mg | ng i-Teq | mg Ni eq | mg Ni eq | g | mg Hg/20eq | mg PO4 eq |
| 1 | 0 | 1182,2 | 1-BlkPlast | 1-LDPE | 91,97 | 15,73 | 60,93 | 3,55 | 53,20 | 5,26 | 52,23 | 2,24 | 8,80 | 0,58 | 0,00 | 0,00 | 0,16 | 1,09 | 0,00 | 31,47 |
| 2 | 0 | 60,975 | 1-BlkPlast | 2-HDPE | 4,67 | 0,60 | 3,30 | 0,21 | 1,89 | 0,33 | 2,34 | 0,11 | 0,37 | 0,01 | 0,00 | 0,00 | 0,02 | 0,05 | 0,00 | 1,82 |
| 3 | 0 | 1224,9 | 1-BlkPlast | 4-PP | 89,04 | 8,89 | 64,58 | 5,88 | 48,99 | 5,42 | 34,46 | 2,42 | 6,87 | 0,02 | 0,00 | 0,00 | 0,47 | 0,92 | 0,00 | 201,56 |
| 4 | 0 | 6575,7 | 1-BlkPlast | 5-PS | 570,31 | 23,80 | 312,54 | 32,22 | 1163,90 | 4,51 | 143,59 | 18,36 | 113,26 | 0,00 | 0,00 | 0,00 | 794,63 | 9,86 | 0,00 | 364,91 |
| 5 | 0 | 200,55 | 1-BlkPlast | 6-EPS | 16,78 | 0,68 | 9,59 | 1,14 | 35,30 | 0,19 | 7,59 | 0,54 | 3,64 | 0,00 | 0,00 | 0,00 | 12,20 | 0,36 | 0,00 | 24,99 |
| 6 | 0 | 330,07 | 1-BlkPlast | 7-HI-PS | 30,44 | 1,54 | 16,22 | 1,82 | 61,39 | 0,21 | 9,92 | 0,96 | 6,41 | 0,00 | 0,00 | 0,00 | 20,07 | 0,59 | 0,00 | 19,65 |
| 7 | 0 | 226,2 | 1-BlkPlast | 8-PVC | 12,81 | 2,51 | 5,19 | 2,49 | 14,02 | 1,13 | 15,18 | 0,49 | 3,39 | 0,00 | 0,00 | 0,00 | 0,01 | 0,66 | 0,64 | 71,03 |
| 8 | 0 | 506,98 | 1-BlkPlast | 9-SAN | 45,32 | 1,94 | 23,91 | 3,09 | 82,64 | 2,08 | 16,00 | 1,52 | 7,09 | 0,00 | 0,00 | 0,00 | 0,20 | 0,86 | 0,00 | 142,46 |
| 9 | 0 | 4690,6 | 1-BlkPlast | 10-ABS | 445,70 | 32,60 | 214,69 | 43,62 | 773,95 | 46,91 | 431,20 | 15,58 | 83,35 | 0,00 | 0,00 | 0,00 | 8,48 | 13,60 | 9,10 | 2954,35 |
| 10 | 0 | 1258,7 | 2-TecPlas | 11-PA 6 | 150,43 | 19,04 | 48,98 | 20,14 | 275,66 | 23,92 | 221,88 | 10,78 | 49,14 | 0,01 | 0,00 | 0,00 | 0,51 | 6,80 | 61,70 | 2356,69 |
| 11 | 0 | 1129,1 | 2-TecPlas | 12-PC | 131,89 | 16,78 | 42,89 | 15,81 | 128,71 | 11,29 | 199,34 | 6,09 | 28,71 | 0,00 | 0,00 | 0,00 | 0,41 | 7,56 | 0,19 | 569,07 |
| 12 | 0 | 3 | 2-TecPlas | 13-PMMA | 0,33 | 0,04 | 0,13 | 0,03 | 0,08 | 0,00 | 0,31 | 0,02 | 0,13 | 0,00 | 0,00 | 0,00 | 0,00 | 0,02 | 0,01 | 6,20 |
| 13 | 0 | 20,85 | 2-TecPlas | 15-Rigid PUR | 2,17 | 0,36 | 0,81 | 1,25 | 6,28 | 0,41 | 8,91 | 0,09 | 0,65 | 0,00 | 0,00 | 0,00 | 0,42 | 0,15 | 0,90 | 66,42 |
| 14 | 0 | 12,43 | 2-TecPlas | 16-Flex PUR | 1,30 | 0,23 | 0,49 | 0,87 | 3,70 | 0,40 | 6,82 | 0,06 | 0,40 | 0,00 | 0,00 | 0,00 | 0,25 | 0,10 | 0,04 | 70,67 |
| 15 | 0 | 14655 | 3-Ferro | 21-St sheet galv. | 498,26 | 33,39 | 1,09 | 0,00 | 0,00 | 0,00 | 25228,51 | 41,43 | 109,40 | 2,00 | 381,02 | 51,95 | 1,01 | 39,68 | 52,03 | 955,05 |
| 16 | 0 | 25,65 | 3-Ferro | 22-St tube/profile | 0,44 | 0,12 | 0,00 | 0,00 | 0,00 | 0,00 | 20,54 | 0,04 | 0,09 | 0,00 | 0,31 | 0,07 | 0,00 | 0,03 | 0,04 | 0,98 |
| 17 | 0 | 171,91 | 3-Ferro | 23-Cast iron | 1,72 | 0,02 | -0,01 | 0,22 | 0,63 | 0,00 | 54,21 | 0,18 | 0,56 | 0,02 | 1,03 | 0,34 | 0,00 | 2,41 | 0,16 | 4,51 |
| 18 | 0 | 219,01 | 3-Ferro | 24-Ferrite | 11,08 | 0,75 | 0,02 | 8,61 | 0,00 | 0,00 | 565,55 | 0,93 | 2,44 | 0,04 | 8,54 | 7,87 | 0,00 | 0,89 | 0,52 | 17,22 |
| 19 | 0 | 829,99 | 3-Ferro | 25-Stainless 18/8 co | 51,49 | 8,04 | 3,36 | 62,86 | 7,00 | 0,00 | 829,99 | 5,15 | 46,50 | 0,11 | 6,39 | 123,09 | 0,02 | 6,57 | 71,68 | 1932,15 |
| 20 | 0 | 448,38 | 4-Non-fer | 26-Al sheet/extrusi | 86,37 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 1757,65 | 4,64 | 30,18 | 0,03 | 2,24 | 1,63 | 43,28 | 7,58 | 15,70 | 2,22 |
| 21 | 0 | 18,665 | 4-Non-fer | 27-Al diecast | 1,03 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 14,00 | 0,07 | 0,29 | 0,00 | 0,63 | 0,02 | 0,33 | 0,08 | 0,12 | 0,02 |
| 22 | 0 | 297,65 | 4-Non-fer | 28-Cu winding wire | 42,48 | 0,00 | 0,00 | 0,00 | 0,00 | 0,24 | 5964,81 | 2,19 | 90,43 | 0,01 | 1,18 | 16,82 | 1,65 | 0,90 | 1,93 | 47,09 |
| 23 | 0 | 531,83 | 4-Non-fer | 29-Cu wire | 61,98 | 0,00 | 0,00 | 0,00 | 0,00 | 0,13 | 10642,90 | 3,30 | 155,35 | 0,01 | 1,99 | 29,28 | 2,86 | 1,51 | 50,04 | 82,18 |
| 24 | 0 | 291,15 | 4-Non-fer | 30-Cu tube/sheet | 14,83 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 2333,31 | 0,79 | 18,23 | 0,00 | 3,00 | 9,63 | 1,56 | 0,42 | 10,96 | 18,02 |
| 25 | 0 | 22,834 | 4-Non-fer | 31-CuZn38 cast | 0,88 | 0,00 | 0,00 | 0,00 | 0,00 | 0,01 | 69,48 | 0,04 | 0,80 | 0,00 | 0,58 | 1,30 | 0,08 | 0,03 | 0,20 | 0,35 |
| 26 | 0 | 8,8 | 4-Non-fer | 32-ZnAl4 cast | 0,25 | 0,00 | 0,00 | 0,02 | 0,00 | 0,00 | 13,49 | 0,01 | 0,06 | 0,00 | 0,53 | 0,02 | 0,01 | 0,01 | 0,00 | 0,01 |
| 27 | 0 | 2,19 | 5-Coating | 40-Cu/Ni/Cr plating | 6,04 | 5,66 | 0,00 | 0,41 | 3,81 | 0,13 | 43,80 | 0,27 | 3,67 | 0,01 | 0,87 | 42,38 | 0,01 | 0,12 | 0,34 | 208,06 |
| 28 | 0 | 0,015 | 5-Coating | 41-Au/Pt/Pd | 3,38 | 3,04 | 0,00 | 0,00 | 0,00 | 0,39 | 2812,57 | 0,27 | 0,01 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| 29 | 0 | 13,95 | 6-Electron | 42-LCD per m2 scrn | 49,71 | 31,67 | 0,00 | 0,63 | 9,35 | 0,01 | 0,73 | 2,57 | 0,83 | 0,01 | 0,00 | 0,01 | 0,00 | 0,01 | 0,00 | 0,00 |
| 30 | 0 | 517,59 | 6-Electron | 44-big caps & coils | 198,39 | 0,00 | 0,00 | 17,94 | 28,47 | 10,15 | 310,83 | 11,22 | 73,40 | 0,06 | 1,12 | 3,96 | 105,93 | 18,43 | 38,42 | 3,69 |
| 31 | 0 | 88,239 | 6-Electron | 45-slots / ext. ports | 16,51 | 5,23 | 0,00 | 6,59 | 22,53 | 1,51 | 27,15 | 0,88 | 16,27 | 0,00 | 0,12 | 3,35 | 0,17 | 1,14 | 2,81 | 570,88 |
| 32 | 0 | 19,809 | 6-Electron | 46-IC's avg., 5% Si, | 109,14 | 106,15 | 0,00 | 99,38 | 0,00 | 4,99 | 102,64 | 8,39 | 55,22 | 1,34 | 0,97 | 8,85 | 0,29 | 1,44 | 74,09 | 425,52 |
| 33 | 0 | 19,934 | 6-Electron | 47-IC's avg., 1% Si | 17,43 | 13,42 | 0,06 | 12,19 | 2,06 | 12,85 | 34,85 | 1,17 | 16,27 | 0,00 | 0,20 | 3,69 | 0,06 | 0,48 | 0,19 | 85,64 |
| 34 | 0 | 78,43 | 6-Electron | 48-SMD/ LED's avg. | 232,85 | 226,31 | 0,00 | 72,58 | 0,00 | 10,25 | 222,03 | 13,10 | 127,09 | 0,59 | 1,18 | 33,08 | 0,35 | 3,99 | 1,16 | 172,19 |
| 35 | 0 | 605,13 | 6-Electron | 49-PWB 1/2 lay 3.75l | 170,07 | 91,09 | 5,16 | 102,89 | 46,47 | 1048,84 | 1588,67 | 6,79 | 129,35 | 1,41 | 1,64 | 21,87 | 2,16 | 3,07 | 8,92 | 2230,76 |

## 5.2.5. Base Case V5: IJ-Printer/MFD personal

### 5.2.5.1. Overview of assessment results for Base Case V5

Table 20 shows the MEEuP EcoReport environmental impact assessment results for the Base Case V5 (IJ-Printer/MFD personal). If we take the total energy consumption (GER) as a reference for the environmental impact, the results indicate that both, the use phase and the manufacturing phase contribute significantly to the overall environmental impact. Similar to the previous product cases the consideration of paper use[8] does have an overall effect on the results.

**Table 20: Eco-assessment results from MEEuP EcoReport for Base Case V5 (incl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case V5_IJ-MFD-Personal (incl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case V5_IJ-MFD-Personal (incl. Paper) | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4453** | | | 4008 | 445 | **4453** | **0** |
| 2 | TecPlastics | g | | | **489** | | | 440 | 49 | **489** | **0** |
| 3 | Ferro | g | | | **1929** | | | 96 | 1832 | **1929** | **0** |
| 4 | Non-ferro | g | | | **293** | | | 15 | 279 | **293** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **478** | | | 336 | 142 | **478** | **0** |
| 7 | Misc. | g | | | **1712** | | | 86 | 1627 | **1712** | **0** |
| | **Total weight** | g | | | **9355** | | | 4981 | 4374 | **9355** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 1162 | 275 | **1437** | **91** | **1614** | 344 | 275 | **69** | **3211** |
| 9 | of which, electricity (in primary MJ) | MJ | 416 | 144 | **560** | **0** | **898** | 0 | 18 | **-18** | **1440** |
| 10 | Water (process) | ltr | 205 | 5 | **211** | **0** | **1637** | 0 | 16 | **-16** | **1832** |
| 11 | Water (cooling) | ltr | 958 | 76 | **1034** | **0** | **2058** | 0 | 14 | **-14** | **3078** |
| 12 | Waste, non-haz./ landfill | g | 55417 | 851 | **56269** | **70** | **2858** | 575 | 55 | **520** | **59717** |
| 13 | Waste, hazardous/ incinerated | g | 385 | 1 | **387** | **1** | **29** | 4590 | 20 | **4570** | **4987** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 57 | 16 | **73** | **7** | **46** | 26 | 19 | **7** | **132** |
| 15 | Ozone Depletion, emissions | mg R-11 eq | negligible | | | | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 320 | 71 | **392** | **19** | **306** | 52 | 35 | **16** | **733** |
| 17 | Volatile Organic Compounds (VOC) | g | 2 | 1 | **3** | **1** | **5** | 1 | 0 | **0** | **8** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 54 | 6 | **59** | **0** | **6** | 4 | 0 | **4** | **70** |
| 19 | Heavy Metals | mg Ni eq. | 49 | 13 | **62** | **4** | **16** | 93 | 2 | **91** | **172** |
| | PAHs | mg Ni eq. | 277 | 1 | **278** | **4** | **5** | 0 | 2 | **-2** | **285** |
| 20 | Particulate Matter (PM, dust) | g | 28 | 13 | **42** | **99** | **39** | 445 | 1 | **444** | **624** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 107 | 0 | **107** | **0** | **7** | 29 | 9 | **19** | **133** |
| 22 | Eutrophication | g PO4 | 5 | 0 | **5** | **0** | **110** | 2 | 0 | **1** | **117** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | negligible | | | | | | | | |

In order to show also in this case again the magnitude of paper consumption on the environmental impact, Table 21 below provides the same assessment results excluding paper.

[8] According to our use phase assumptions that have been discussed in task 4.3.5, the Base Case V5 has 4 year lifetime with a paper output of 1,040 pages per year.

**Table 21: Eco-assessment results from MEEuP EcoReport for Base Case V5 (excl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case V5_IJ-MFD-color (excl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case V5_IJ-MFD-color (excl. Paper) | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | **Resources Use and Emissions** | | Material | Manuf. | **Total** | **BUTION** | | Disposal | Recycl. | **Total** | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4453** | | | 4008 | 445 | **4453** | **0** |
| 2 | TecPlastics | g | | | **489** | | | 440 | 49 | **489** | **0** |
| 3 | Ferro | g | | | **1929** | | | 96 | 1832 | **1929** | **0** |
| 4 | Non-ferro | g | | | **293** | | | 15 | 279 | **293** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **478** | | | 336 | 142 | **478** | **0** |
| 7 | Misc. | g | | | **1712** | | | 86 | 1627 | **1712** | **0** |
| | **Total weight** | g | | | **9355** | | | 4981 | 4374 | **9355** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 1162 | 275 | **1437** | **91** | **782** | 344 | 275 | **69** | **2379** |
| 9 | of which, electricity (in primary MJ) | MJ | 416 | 144 | **560** | **0** | **773** | 0 | 18 | **-18** | **1315** |
| 10 | Water (process) | ltr | 205 | 5 | **211** | **0** | **53** | 0 | 16 | **-16** | **248** |
| 11 | Water (cooling) | ltr | 958 | 76 | **1034** | **0** | **2058** | 0 | 14 | **-14** | **3078** |
| 12 | Waste, non-haz./ landfill | g | 55417 | 851 | **56269** | **70** | **1453** | 575 | 55 | **520** | **58312** |
| 13 | Waste, hazardous/ incinerated | g | 385 | 1 | **387** | **1** | **22** | 4590 | 20 | **4570** | **4980** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 57 | 16 | **73** | **7** | **34** | 26 | 19 | **7** | **120** |
| 15 | Ozone Depletion, emissions | mg R-11 ec | | | | | negligible | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 320 | 71 | **392** | **19** | **202** | 52 | 35 | **16** | **629** |
| 17 | Volatile Organic Compounds (VOC) | g | 2 | 1 | **3** | **1** | **0** | 1 | 0 | **0** | **4** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 54 | 6 | **59** | **0** | **6** | 4 | 0 | **4** | **69** |
| 19 | Heavy Metals | mg Ni eq. | 49 | 13 | **62** | **4** | **14** | 93 | 2 | **91** | **170** |
| | PAHs | mg Ni eq. | 277 | 1 | **278** | **4** | **4** | 0 | 2 | **-2** | **284** |
| 20 | Particulate Matter (PM, dust) | g | 28 | 13 | **42** | **99** | **5** | 445 | 1 | **444** | **590** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 107 | 0 | **107** | **0** | **6** | 29 | 9 | **19** | **132** |
| 22 | Eutrophication | g PO4 | 5 | 0 | **5** | **0** | **0** | 2 | 0 | **1** | **7** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | | negligible | | | | |

### 5.2.5.2. Assessment of ink

For the base cases V5 and V6 the ink is the key auxiliary material. However, environmental data on ink is not available as the detailed composition is confidential and proprietary. One outdated study "Life Cycle Assessment of an Inkjet Print Cartridge"[9] claimed to have considered also ink and ink manufacturing, but this aspect is not mentioned as a significant one in the conclusions of the study. According to industry sources ink is modeled for the Japanese Eco-Leaf declarations as "water", which consequently results in a negligible impact. Actually water-based inks consist of 60-80% water typically. Ingredients are the pigments, humectants, surfactants and stabilizers. "The black carbon powder used in regular [black] ink is refined from pure oil and the liquid used in cartridges

[9] D. Pollock, R. Coulon: Life Cycle Assessment of an Inkjet Print Cartridge, Proceedings of the 1996 IEEE International Symposium on Electronics and the Environment, 6-8 May 1996, pages 154 – 160; another more recent study provided an LCA for inkjet printers (J. Ord, T. DiCorcia: Life Cycle Inventory for an Inkjet Printer, December 2005, http://www.engin.umich.edu/labs/EAST/me589/gallery/f05/inkjet.pdf), but excluded explicitly the ink

is boiled down from a volume six times larger."[10] Compared to other uses of fossil fuels in the printer life cycle (plastics and energy consumption) the resource consumption for the ink can be neglected. Although different feedback asked for a better covering of these impacts, unfortunately a statement regarding the impacts of the manufacturing processes of the ink as such is not possible in this study.

#### 5.2.5.3. Assessment results according to the consideration of paper

The comparison of Table 20 (incl. paper) and Table 21 (excl. paper) indicates that approx. half of the use phase impact of 1,614 MJ is related to paper consumption alone (832 MJ). The remaining 782 MJ is the impact of energy consumption. This correlation is also shown in Figure 14. If we exclude paper from the assessment, it becomes obvious that the overall environmental impact correlates directly with the product weight (material mass) in the manufacturing phase and with energy consumption in the use phase. Further details of the assessment are shown in Figure 15 and Figure 16 below.

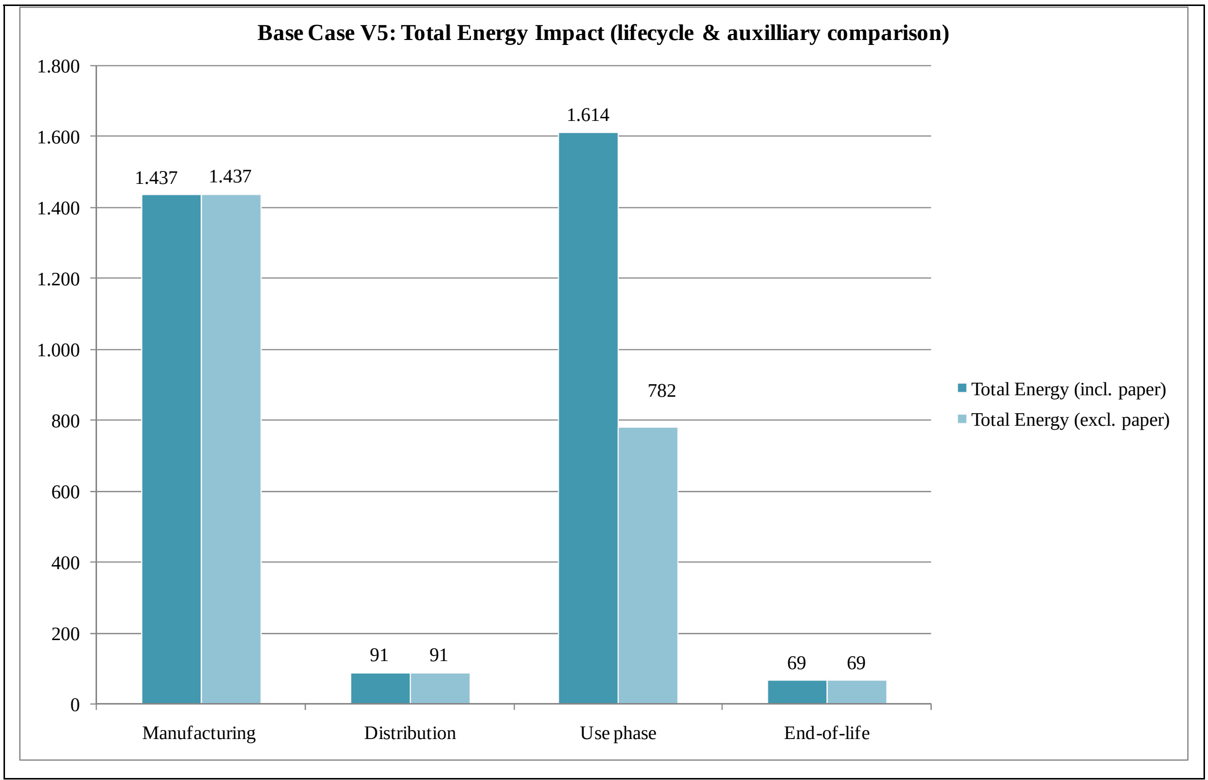


**Figure 14: Total energy impact comparison including auxiliaries for Base Case V5**

[10] Press release: Invention: From old tyres to printer ink, NewScientist.com news service, Barry Fox, 18:20 26 July 2005, http://technology.newscientist.com/article/dn7734.html, accessed on August 22, 2007

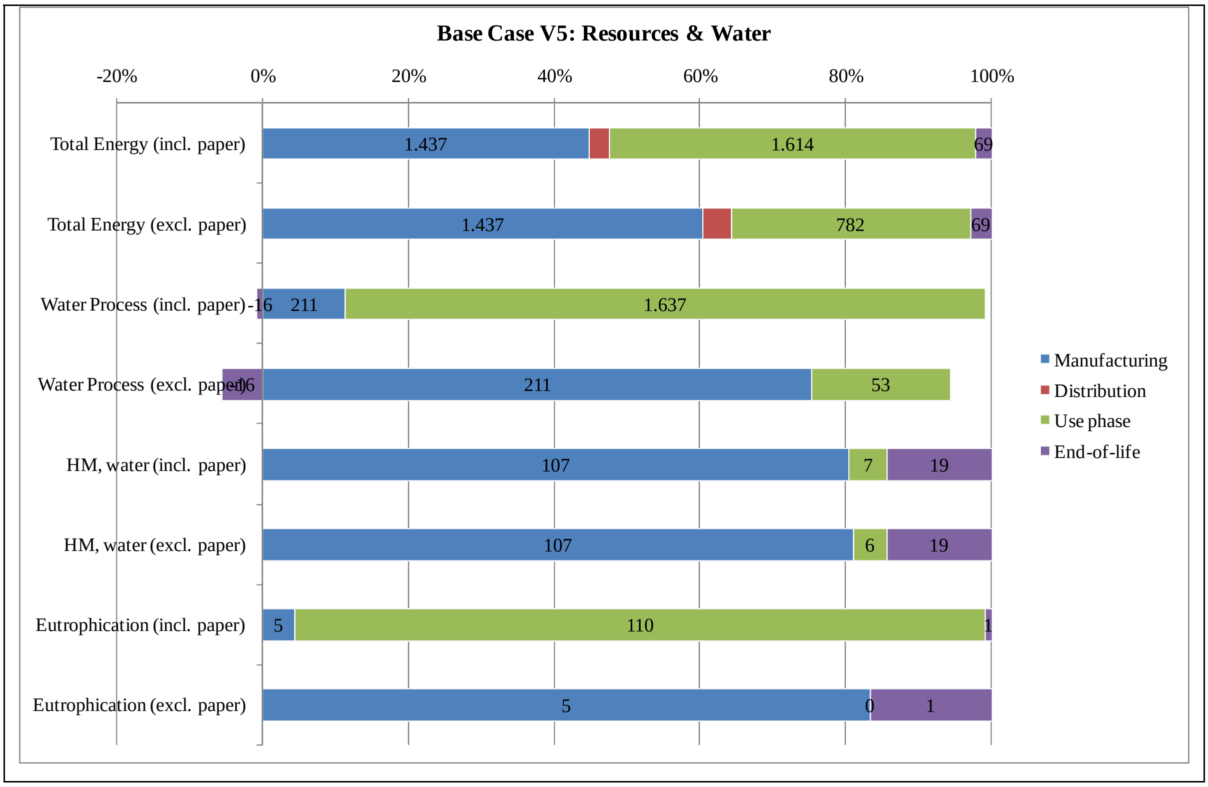


**Figure 15: Distribution of resources related impacts for Base Case V5**

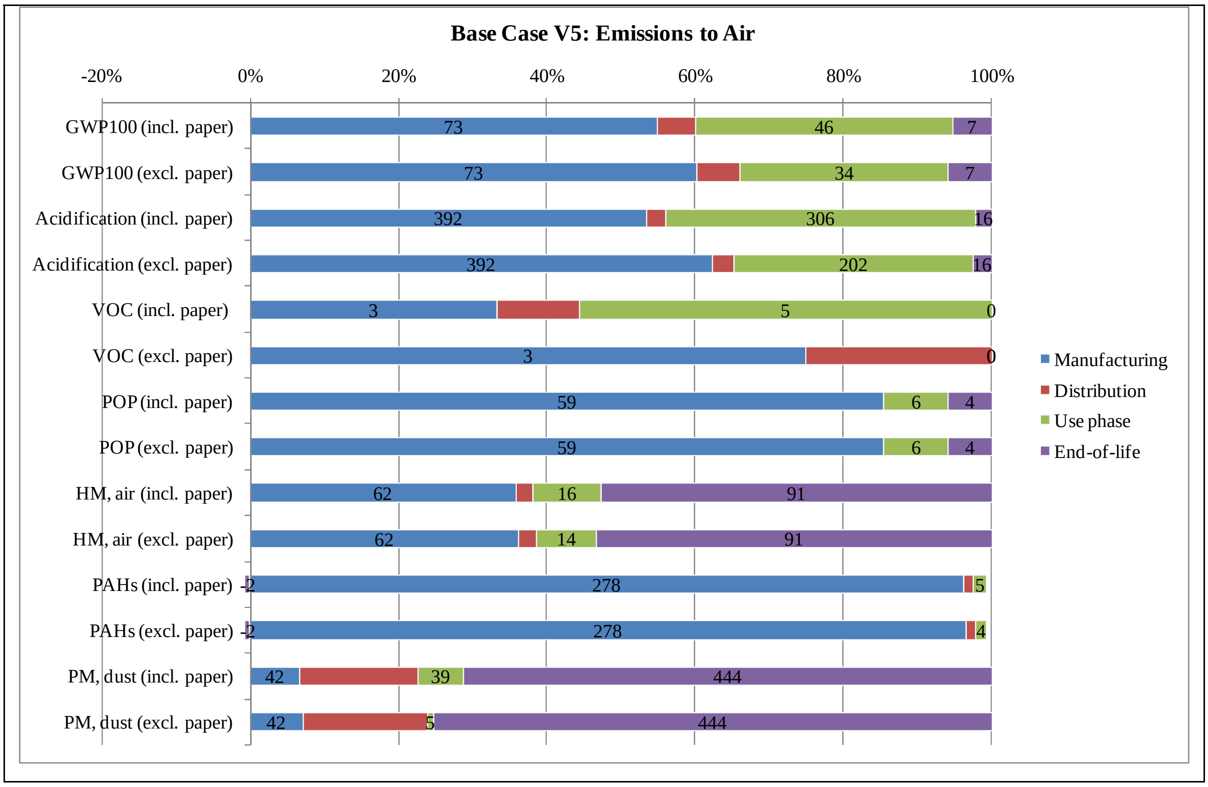


**Figure 16: Distribution of emissions to air for Base Case V5**

### 5.2.5.4. Assessment of single impact categories related to life cycle phases

The following assessment of single eco-impacts related to the life cycle phase “Manufacturing”, “Distribution”, “Use”, and “End-of-life” excludes the aspect of paper. By taking the impact category Total Energy as general eco-indicator the “Manufacturing” phase with 1,437 MJ has the single highest impact followed by the “Use” phase with 782 MJ. The “Distribution” and “End-of-life” phases have a very minor impact. In terms of “Greenhouse Gases” and “Acidification” the Base Case V5 shows an eco-impact ratio of 2:1 between the “Manufacturing” and “Use” phase. The eco-impact categories which are indicating toxicity such as POP, Heavy Metals, and PAHs, as well as Volatile Organic Compounds (VOC), show an even higher impact ratio with regards to the manufacturing phase.

Regarding data acquisition, data quality and methodological aspects of the assessment, see also Section 5.2.1.3

Details regarding the environmental impacts of various materials for the Base Case V5 are provided in Table 22. In this table the material inputs are listed by category and their eco-impact weighted through a colour code. Due to the generally higher relative environmental relevancy of the manufacturing stage compared to the previous Base Cases V1-V4 the assessments identify a larger number of relatively relevant material entries: Bulk Plastics such as 7-HI-PS, 5-PS and 10-ABS as well as Ferro Metal 21-St sheet galv. and electronic parts (42-LCD, 46-IC’s avg. 5% Si, 49-PWB 1/2 lay, 98-controller board) are contributing most significantly to the overall impact. In the category hazardous waste the gold platings in the printing units are the most relevant aspect.

**Table 22: Detailed impact assessment of input materials of Base Case V5**

**Colour coding**

**Red:** Process causes more than 50% of total impact in the respective impact category.

**Orange:** Process causes between 30% and 50% of total impact in the respective impact category.

**Yellow:** Processes between 10% and 30% of total impact in the respective impact category.

Nr: 0 Product: Base Case V5_IJ-MFD-Personal Date: 00.01.00 Author: 0

PRODUCTION

| Product | | | | | Energy | | | Water | | Waste | | Emissions to Air | | | | | | | to Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nr | com | wght | cat. | material | GER | electr | feedst | water (proces) | water (cool) | haz. Waste | non-haz. Waste | GWP | AD | VOC | POP | HM | PAH | PM | Metal | EUP |
| | | in g | | | MJ | MJ | MJ | ltr. | ltr. | g | g | kg CO2eq | g SO2eq | mg | ng i-Teq | mg Ni eq | mg Ni eq | g | mg Hg/20eq | mg PO4 eq |
| 1 | 0 | 97,063 | 1-BlkPlast | 1-LDPE | 7,55 | 1,29 | 5,00 | 0,29 | 4,37 | 0,43 | 4,29 | 0,18 | 0,72 | 0,05 | 0,00 | 0,00 | 0,01 | 0,09 | 0,00 | 2,58 |
| 2 | 0 | 40,845 | 1-BlkPlast | 2-HDPE | 3,13 | 0,40 | 2,21 | 0,14 | 1,27 | 0,22 | 1,57 | 0,07 | 0,25 | 0,01 | 0,00 | 0,00 | 0,01 | 0,04 | 0,00 | 1,22 |
| 3 | 0 | 76,207 | 1-BlkPlast | 4-PP | 5,54 | 0,55 | 4,02 | 0,37 | 3,05 | 0,34 | 2,14 | 0,15 | 0,43 | 0,00 | 0,00 | 0,00 | 0,03 | 0,06 | 0,00 | 12,54 |
| 4 | 0 | 767,61 | 1-BlkPlast | 5-PS | 66,57 | 2,78 | 36,48 | 3,76 | 135,87 | 0,53 | 16,76 | 2,14 | 13,22 | 0,00 | 0,00 | 0,00 | 92,76 | 1,15 | 0,00 | 42,60 |
| 5 | 0 | 51 | 1-BlkPlast | 6-EPS | 4,27 | 0,17 | 2,44 | 0,29 | 8,98 | 0,05 | 1,93 | 0,14 | 0,92 | 0,00 | 0,00 | 0,00 | 3,10 | 0,09 | 0,00 | 6,36 |
| 6 | 0 | 2334,5 | 1-BlkPlast | 7-HI-PS | 215,31 | 10,90 | 114,69 | 12,84 | 434,22 | 1,49 | 70,15 | 6,77 | 45,37 | 0,00 | 0,00 | 0,00 | 141,95 | 4,20 | 0,00 | 139,00 |
| 7 | 0 | 41,243 | 1-BlkPlast | 8-PVC | 2,33 | 0,46 | 0,95 | 0,45 | 2,56 | 0,21 | 2,77 | 0,09 | 0,62 | 0,00 | 0,00 | 0,00 | 0,00 | 0,12 | 0,12 | 12,95 |
| 8 | 0 | 2,6675 | 1-BlkPlast | 9-SAN | 0,24 | 0,01 | 0,13 | 0,02 | 0,43 | 0,01 | 0,08 | 0,01 | 0,04 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,75 |
| 9 | 0 | 1041,7 | 1-BlkPlast | 10-ABS | 98,99 | 7,24 | 47,68 | 9,69 | 171,89 | 10,42 | 95,76 | 3,46 | 18,51 | 0,00 | 0,00 | 0,00 | 1,88 | 3,02 | 2,02 | 656,13 |
| 10 | 0 | 211,75 | 2-TecPlas | 11-PA 6 | 25,31 | 3,20 | 8,24 | 3,39 | 46,37 | 4,02 | 37,33 | 1,81 | 8,27 | 0,00 | 0,00 | 0,00 | 0,09 | 1,14 | 10,38 | 396,46 |
| 11 | 0 | 84,941 | 2-TecPlas | 12-PC | 9,92 | 1,26 | 3,23 | 1,19 | 9,68 | 0,85 | 15,00 | 0,46 | 2,16 | 0,00 | 0,00 | 0,00 | 0,03 | 0,57 | 0,01 | 42,81 |
| 12 | 0 | 16,648 | 2-TecPlas | 13-PMMA | 1,83 | 0,22 | 0,70 | 0,16 | 0,43 | 0,02 | 1,74 | 0,10 | 0,73 | 0,00 | 0,00 | 0,00 | 0,00 | 0,08 | 0,05 | 34,43 |
| 13 | 0 | 5,87 | 2-TecPlas | 14-Epoxy | 0,83 | 0,14 | 0,25 | 0,11 | 2,25 | 0,11 | 2,39 | 0,04 | 0,26 | 0,00 | 0,00 | 0,00 | 0,00 | 0,09 | 0,00 | 56,64 |
| 14 | 0 | 37,783 | 2-TecPlas | 15-Rigid PUR | 3,94 | 0,66 | 1,46 | 2,27 | 11,37 | 0,74 | 16,14 | 0,16 | 1,17 | 0,00 | 0,00 | 0,00 | 0,76 | 0,28 | 1,63 | 120,37 |
| 15 | 0 | 116,35 | 2-TecPlas | 16-Flex PUR | 12,15 | 2,18 | 4,63 | 8,14 | 34,67 | 3,77 | 63,85 | 0,52 | 3,74 | 0,00 | 0,00 | 0,00 | 2,35 | 0,96 | 0,39 | 661,50 |
| 16 | 0 | 15,655 | 2-TecPlas | 18-E-glass fibr | 1,03 | 0,33 | 0,17 | 0,85 | 4,25 | 0,11 | 4,87 | 0,05 | 0,46 | 0,00 | 0,00 | 0,00 | 0,00 | 0,13 | 0,74 | 49,33 |
| 17 | 0 | 0,0375 | 2-TecPlas | 19-Aramid fibr | 0,01 | 0,00 | 0,00 | 0,01 | 0,04 | 0,00 | 0,05 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,01 | 0,46 |
| 18 | 0 | 1863,1 | 3-Ferro | 21-St sheet gal | 63,34 | 4,24 | 0,14 | 0,00 | 0,00 | 0,00 | 3207,28 | 5,27 | 13,91 | 0,25 | 48,44 | 6,60 | 0,13 | 5,04 | 6,61 | 121,41 |
| 19 | 0 | 38,065 | 3-Ferro | 24-Ferrite | 1,93 | 0,13 | 0,00 | 1,50 | 0,00 | 0,00 | 98,29 | 0,16 | 0,42 | 0,01 | 1,48 | 1,37 | 0,00 | 0,15 | 0,09 | 2,99 |
| 20 | 0 | 27,443 | 3-Ferro | 25-Stainless 18 | 1,70 | 0,27 | 0,11 | 2,08 | 0,23 | 0,00 | 27,44 | 0,17 | 1,54 | 0,00 | 0,21 | 4,07 | 0,00 | 0,22 | 2,37 | 63,88 |
| 21 | 0 | 67,182 | 4-Non-fer | 26-Al sheet/ext | 12,94 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 263,35 | 0,70 | 4,52 | 0,00 | 0,34 | 0,24 | 6,49 | 1,14 | 2,35 | 0,33 |
| 22 | 0 | 36 | 4-Non-fer | 28-Cu winding | 5,14 | 0,00 | 0,00 | 0,00 | 0,00 | 0,03 | 721,44 | 0,27 | 10,94 | 0,00 | 0,14 | 2,03 | 0,20 | 0,11 | 0,23 | 5,70 |
| 23 | 0 | 145,53 | 4-Non-fer | 29-Cu wire | 16,96 | 0,00 | 0,00 | 0,00 | 0,00 | 0,04 | 2912,32 | 0,90 | 42,51 | 0,00 | 0,54 | 8,01 | 0,78 | 0,41 | 13,69 | 22,49 |
| 24 | 0 | 43,971 | 4-Non-fer | 30-Cu tube/she | 2,24 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 352,38 | 0,12 | 2,75 | 0,00 | 0,45 | 1,45 | 0,24 | 0,06 | 1,66 | 2,72 |
| 25 | 0 | 0,7011 | 4-Non-fer | 31-CuZn38 cas | 0,03 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 2,13 | 0,00 | 0,02 | 0,00 | 0,02 | 0,04 | 0,00 | 0,00 | 0,01 | 0,01 |
| 26 | 0 | 0,035 | 5-Coating | 40-Cu/Ni/Cr pla | 0,10 | 0,09 | 0,00 | 0,01 | 0,06 | 0,00 | 0,70 | 0,00 | 0,06 | 0,00 | 0,01 | 0,68 | 0,00 | 0,00 | 0,01 | 3,33 |
| 27 | 0 | 0,249 | 5-Coating | 41-Au/Pt/Pd | 56,10 | 50,43 | 0,00 | 0,00 | 0,00 | 6,49 | 46687,50 | 4,42 | 0,09 | 0,00 | 0,00 | 0,03 | 0,00 | 0,00 | 0,00 | 0,00 |
| 28 | 0 | 74,305 | 6-Electron | 42-LCD per m2 | 264,76 | 168,67 | 0,00 | 3,34 | 49,78 | 0,07 | 3,86 | 13,70 | 4,40 | 0,03 | 0,02 | 0,06 | 0,01 | 0,04 | 0,02 | 0,00 |
| 29 | 0 | 90,494 | 6-Electron | 44-big caps & c | 34,68 | 0,00 | 0,00 | 3,14 | 4,98 | 1,77 | 54,34 | 1,96 | 12,83 | 0,01 | 0,20 | 0,69 | 18,52 | 3,22 | 6,72 | 0,65 |
| 30 | 0 | 28,178 | 6-Electron | 45-slots / ext. p | 5,27 | 1,67 | 0,00 | 2,10 | 7,20 | 0,48 | 8,67 | 0,28 | 5,19 | 0,00 | 0,04 | 1,07 | 0,05 | 0,37 | 0,90 | 182,30 |
| 31 | 0 | 2,6925 | 6-Electron | 46-IC's avg., 5% | 14,83 | 14,43 | 0,00 | 13,51 | 0,00 | 0,68 | 13,95 | 1,14 | 7,50 | 0,18 | 0,13 | 1,20 | 0,04 | 0,20 | 10,07 | 57,84 |
| 32 | 0 | 4,1933 | 6-Electron | 47-IC's avg., 1% | 3,67 | 2,82 | 0,01 | 2,56 | 0,43 | 2,70 | 7,33 | 0,25 | 3,42 | 0,00 | 0,04 | 0,78 | 0,01 | 0,10 | 0,04 | 18,02 |
| 33 | 0 | 13,797 | 6-Electron | 48-SMD/ LED's | 40,96 | 39,81 | 0,00 | 12,77 | 0,00 | 1,80 | 39,06 | 2,30 | 22,36 | 0,10 | 0,21 | 5,82 | 0,06 | 0,70 | 0,20 | 30,29 |
| 34 | 0 | 107,42 | 6-Electron | 49-PWB 1/2 lay | 30,19 | 16,17 | 0,92 | 18,26 | 8,25 | 186,18 | 282,01 | 1,21 | 22,96 | 0,25 | 0,29 | 3,88 | 0,38 | 0,55 | 1,58 | 395,99 |
| 35 | 0 | 29,299 | 6-Electron | 50-PWB 6 lay 4. | 10,76 | 4,28 | 0,25 | 14,21 | 2,25 | 55,43 | 119,34 | 0,46 | 11,60 | 0,03 | 0,15 | 2,05 | 0,20 | 1,09 | 3,68 | 71,57 |
| 36 | 0 | 7,1759 | 6-Electron | 51-PWB 6 lay 2 | 3,50 | 2,39 | 0,08 | 2,89 | 0,74 | 30,54 | 16,75 | 0,15 | 1,57 | 0,00 | 0,02 | 0,24 | 0,02 | 0,05 | 2,34 | 20,42 |
| 37 | 0 | 5,0918 | 6-Electron | 52-Solder SnAg | 1,19 | 0,99 | 0,00 | 0,36 | 0,00 | 0,02 | 1,16 | 0,06 | 0,33 | 0,00 | 0,01 | 0,02 | 0,01 | 0,01 | 0,00 | 0,03 |
| 38 | 0 | 650,2 | 7-Misc. | 54-Glass for la | 10,55 | 8,41 | 0,00 | 5,54 | 0,00 | 0,17 | 8,80 | 0,54 | 1,95 | 0,00 | 0,05 | 0,11 | 0,00 | 0,04 | 0,03 | 0,23 |
| 39 | 0 | 901,04 | 7-Misc. | 56-Cardboard | 25,23 | 1,80 | 14,42 | 6,35 | 0,00 | 0,04 | 47,14 | 0,63 | 0,94 | 0,00 | 0,01 | 0,03 | 0,00 | 0,01 | 0,01 | 77,54 |
| 40 | 0 | 161,11 | 7-Misc. | 57-Office paper | 6,44 | 0,97 | 4,35 | 12,27 | 0,00 | 0,05 | 10,88 | 0,09 | 0,81 | 0,03 | 0,01 | 0,02 | 0,00 | 0,27 | 0,01 | 851,99 |
| 41 | 0 | 115,75 | 6-Electron | 98-controller b | 90,46 | 67,07 | 0,35 | 60,58 | 12,23 | 75,52 | 194,42 | 5,96 | 50,62 | 0,75 | 0,74 | 8,51 | 6,99 | 2,59 | 38,58 | 544,27 |
| | OTA | 0 | 0 | 0 | 1.162 | 416 | 253 | 205 | 958 | 385 | 55.417 | 57 | 320 | 2 | 54 | 49 | 277 | 28 | 107 | 4.710 |

Whereas Table 22 provides data on the level of individual entries the following Figure compares the impacts / indicators for the manufacturing stage aggregated per material category: Although electronics are of minor total weight (first column), it dominates 10 indicators out of 16, among them Total Energy (GER) and Global Warming Potential. For 4 indicators electronics contribute even by more than 75% to the total indicator value, among them hazardous waste.

This aggregated data leads to the conclusion, that electronics are a very relevant factor for impacts at the manufacturing stage.

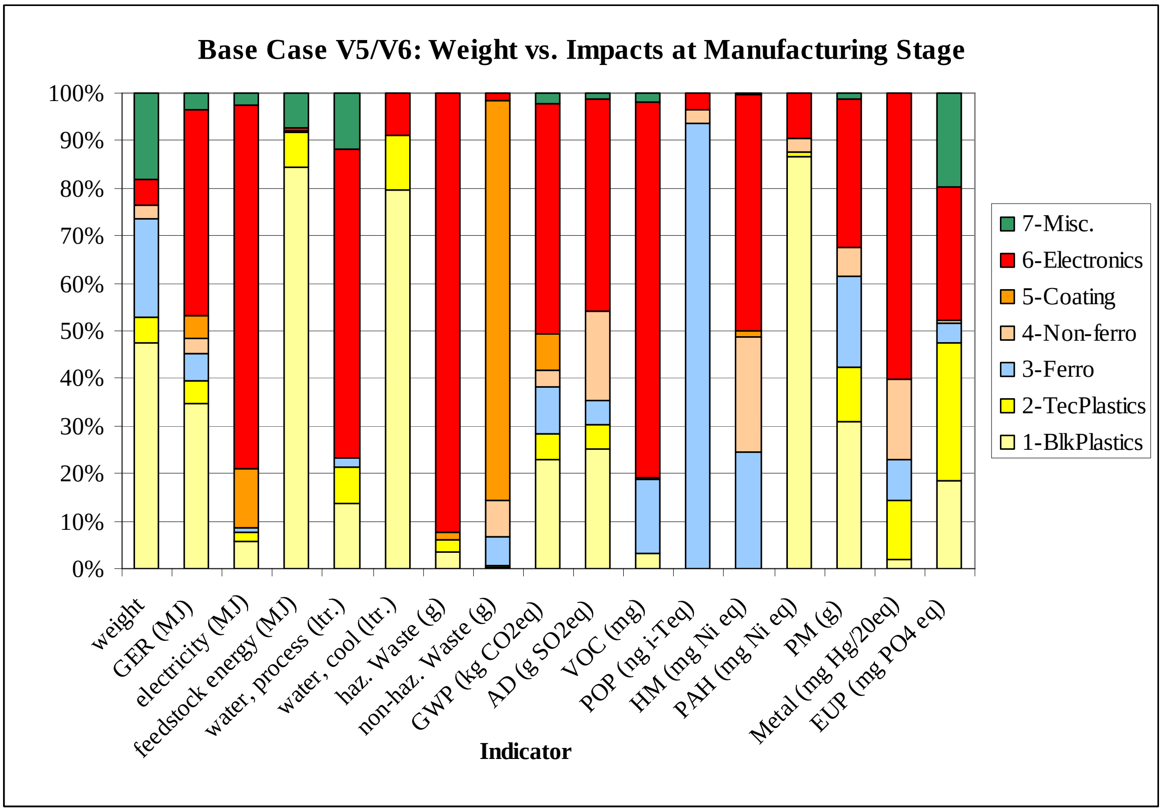


**Figure 17: Weight of Material Classes versus Impacts / Indicator Values at Manufacturing Stage for Base Cases V5/V6**

### 5.2.6. Base Case V6: IJ-Printer/MFD workgroup

#### 5.2.6.1. Overview of assessment results for Base Case V6

Table 23 shows the MEEuP EcoReport environmental impact assessment results for the Base Case V6 (IJ-Printer/MFD workgroup). If we take the total energy consumption (GER) as a reference for the environmental impact, the results indicate that the use phase contributes most significantly to the overall environmental impact. Similar to the previous product cases the consideration of paper use[11] does have an overall effect on the results.

**Table 23: Eco-assessment results from MEEuP EcoReport for Base Case V6 (incl. paper)**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Table . Life Cycle Impact (per unit) of Base Case V6_IJ-MFD-Workgroup (incl. Paper)** | | | | | | | | | | | |
| Nr | **Life cycle Impact per product:** | | | | | | | | Date | Author | |
| 0 | Base Case V6_IJ-MFD-Workgroup (incl. Paper) | | | | | | | | 0 | 0 | |
| | Life Cycle phases --> | | **PRODUCTION** | | | **DISTRI-** | **USE** | **END-OF-LIFE*** | | | **TOTAL** |
| | **Resources Use and Emissions** | | Material | Manuf. | **Total** | **BUTION** | | Disposal | Recycl. | **Total** | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4453** | | | 4008 | 445 | **4453** | **0** |
| 2 | TecPlastics | g | | | **489** | | | 440 | 49 | **489** | **0** |
| 3 | Ferro | g | | | **1929** | | | 193 | 1736 | **1929** | **0** |
| 4 | Non-ferro | g | | | **293** | | | 29 | 264 | **293** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **478** | | | 336 | 142 | **478** | **0** |
| 7 | Misc. | g | | | **1712** | | | 171 | 1541 | **1712** | **0** |
| | **Total weight** | g | | | **9355** | | | 5177 | 4177 | **9355** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 1162 | 275 | **1437** | **91** | **4058** | 376 | 275 | **101** | **5687** |
| 9 | of which, electricity (in primary MJ) | MJ | 416 | 144 | **560** | **0** | **1397** | 0 | 18 | **-18** | **1938** |
| 10 | Water (process) | ltr | 205 | 5 | **211** | **0** | **6003** | 0 | 16 | **-16** | **6198** |
| 11 | Water (cooling) | ltr | 958 | 76 | **1034** | **0** | **2473** | 0 | 14 | **-14** | **3493** |
| 12 | Waste, non-haz./ landfill | g | 55417 | 851 | **56269** | **70** | **6902** | 1148 | 55 | **1093** | **64335** |
| 13 | Waste, hazardous/ incinerated | g | 385 | 1 | **387** | **1** | **52** | 4590 | 20 | **4570** | **5010** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 57 | 16 | **73** | **7** | **85** | 28 | 19 | **9** | **173** |
| 15 | Ozone Depletion, emissions | mg R-11 ec | | | | negligible | | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 320 | 71 | **392** | **19** | **633** | 56 | 35 | **21** | **1065** |
| 17 | Volatile Organic Compounds (VOC) | g | 2 | 1 | **3** | **1** | **16** | 1 | 0 | **0** | **20** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 54 | 6 | **59** | **0** | **10** | 8 | 0 | **8** | **77** |
| 19 | Heavy Metals | mg Ni eq. | 49 | 13 | **62** | **4** | **25** | 102 | 2 | **100** | **191** |
| | PAHs | mg Ni eq. | 277 | 1 | **278** | **4** | **6** | 0 | 2 | **-2** | **286** |
| 20 | Particulate Matter (PM, dust) | g | 28 | 13 | **42** | **99** | **135** | 487 | 1 | **486** | **762** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 107 | 0 | **107** | **0** | **10** | 31 | 9 | **22** | **139** |
| 22 | Eutrophication | g PO4 | 5 | 0 | **5** | **0** | **413** | 2 | 0 | **2** | **419** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | negligible | | | | | |

In order to show also in this case again the magnitude of paper consumption on the environmental impact, Table 24 below provides the same assessment results excluding paper.

[11] According to our use phase assumptions that have been discussed in task 4.3.6, the Base Case V6 has 4 year lifetime with a paper output of 3,900 pages per year.

**Table 24: Eco-assessment results from MEEuP EcoReport for Base Case V6 (excl. paper)**

**Table . Life Cycle Impact (per unit) of Base Case V6_IJ-MFD-workgroup (excl. Paper)**

| Nr | Life cycle Impact per product: | | | | | | | Date | Author | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Base Case V6_IJ-MFD-workgroup (excl. Paper) | | | | | | | 0 | 0 | | |
| | Life Cycle phases --> | | PRODUCTION | | | DISTRI- | USE | END-OF-LIFE* | | | TOTAL |
| | Resources Use and Emissions | | Material | Manuf. | Total | BUTION | | Disposal | Recycl. | Total | |
| | **Materials** | **unit** | | | | | | | | | |
| 1 | Bulk Plastics | g | | | **4453** | | | 4008 | 445 | **4453** | **0** |
| 2 | TecPlastics | g | | | **489** | | | 440 | 49 | **489** | **0** |
| 3 | Ferro | g | | | **1929** | | | 96 | 1832 | **1929** | **0** |
| 4 | Non-ferro | g | | | **293** | | | 15 | 279 | **293** | **0** |
| 5 | Coating | g | | | **0** | | | 0 | 0 | **0** | **0** |
| 6 | Electronics | g | | | **478** | | | 336 | 142 | **478** | **0** |
| 7 | Misc. | g | | | **1712** | | | 86 | 1627 | **1712** | **0** |
| | **Total weight** | g | | | **9355** | | | 4981 | 4374 | **9355** | **0** |
| | | | | | | | | | see note! | | |
| | **Other Resources & Waste** | | | | | | | debet | credit | | |
| 8 | Total Energy (GER) | MJ | 1162 | 275 | **1437** | **91** | **938** | 344 | 275 | **69** | **2535** |
| 9 | of which, electricity (in primary MJ) | MJ | 416 | 144 | **560** | **0** | **929** | 0 | 18 | **-18** | **1471** |
| 10 | Water (process) | ltr | 205 | 5 | **211** | **0** | **64** | 0 | 16 | **-16** | **258** |
| 11 | Water (cooling) | ltr | 958 | 76 | **1034** | **0** | **2473** | 0 | 14 | **-14** | **3493** |
| 12 | Waste, non-haz./ landfill | g | 55417 | 851 | **56269** | **70** | **1634** | 575 | 55 | **520** | **58492** |
| 13 | Waste, hazardous/ incinerated | g | 385 | 1 | **387** | **1** | **25** | 4590 | 20 | **4570** | **4983** |
| | **Emissions (Air)** | | | | | | | | | | |
| 14 | Greenhouse Gases in GWP100 | kg CO2 eq. | 57 | 16 | **73** | **7** | **41** | 26 | 19 | **7** | **127** |
| 15 | Ozone Depletion, emissions | mg R-11 ec | | | | | negligible | | | | |
| 16 | Acidification, emissions | g SO2 eq. | 320 | 71 | **392** | **19** | **242** | 52 | 35 | **16** | **669** |
| 17 | Volatile Organic Compounds (VOC) | g | 2 | 1 | **3** | **1** | **0** | 1 | 0 | **0** | **4** |
| 18 | Persistent Organic Pollutants (POP) | ng i-Teq | 54 | 6 | **59** | **0** | **7** | 4 | 0 | **4** | **70** |
| 19 | Heavy Metals | mg Ni eq. | 49 | 13 | **62** | **4** | **16** | 93 | 2 | **91** | **173** |
| | PAHs | mg Ni eq. | 277 | 1 | **278** | **4** | **5** | 0 | 2 | **-2** | **285** |
| 20 | Particulate Matter (PM, dust) | g | 28 | 13 | **42** | **99** | **5** | 445 | 1 | **444** | **591** |
| | **Emissions (Water)** | | | | | | | | | | |
| 21 | Heavy Metals | mg Hg/20 | 107 | 0 | **107** | **0** | **7** | 29 | 9 | **19** | **133** |
| 22 | Eutrophication | g PO4 | 5 | 0 | **5** | **0** | **0** | 2 | 0 | **1** | **7** |
| 23 | Persistent Organic Pollutants (POP) | ng i-Teq | | | | | negligible | | | | |

Regarding the assessment of ink, see Section 5.2.5.2.

### 5.2.6.2. Assessment results according to the consideration of paper

The comparison of Table 23 (incl. paper) and Table 24 (excl. paper) indicates that from the use phase impact of 4,058 MJ the largest portion of 3,120 MJ is related to paper consumption alone. The remaining 938 MJ is the impact of energy consumption. Figure 18 below shows that according to the use pattern assumption more than 75% of the products total energy consumption in the use phase is related to paper. If we exclude paper from the assessment, it becomes obvious that the overall environmental impact correlates directly with the product weight (material mass) in the manufacturing phase and with energy consumption in the use phase. Further details of the assessment are shown in Figure 19 and Figure 20 below.

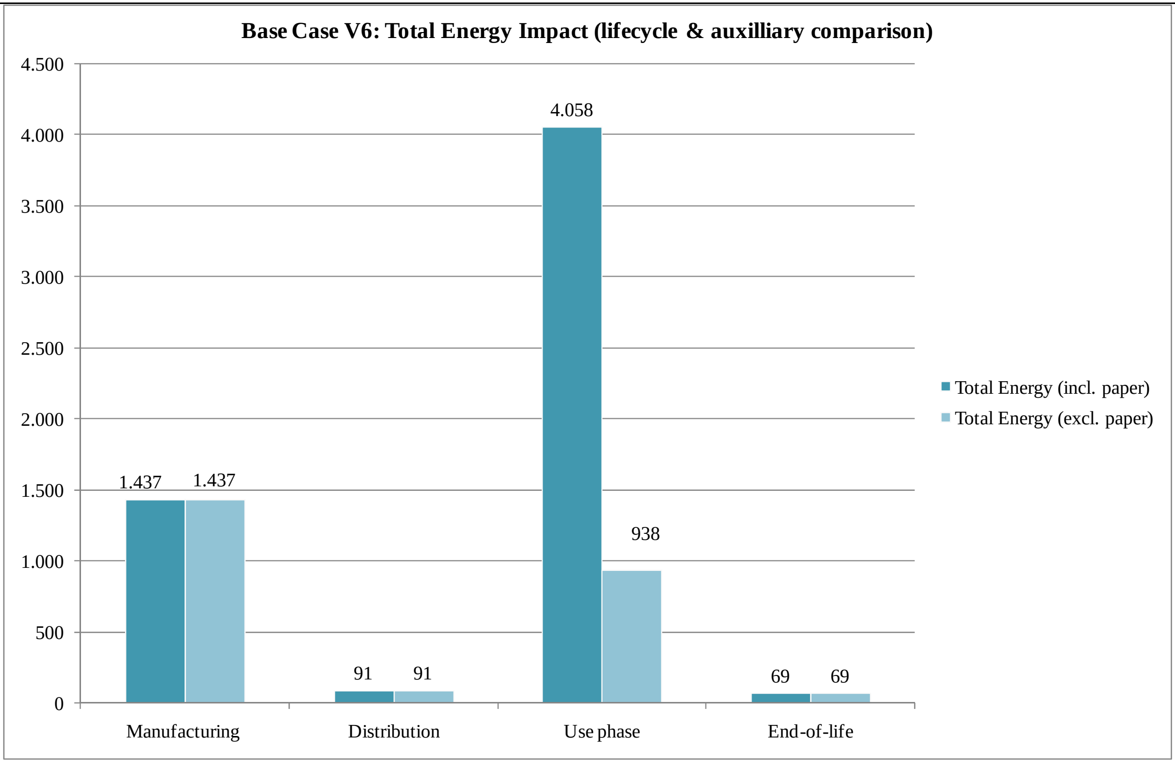


**Figure 18: Total energy impact comparison including auxiliaries for Base Case V6**

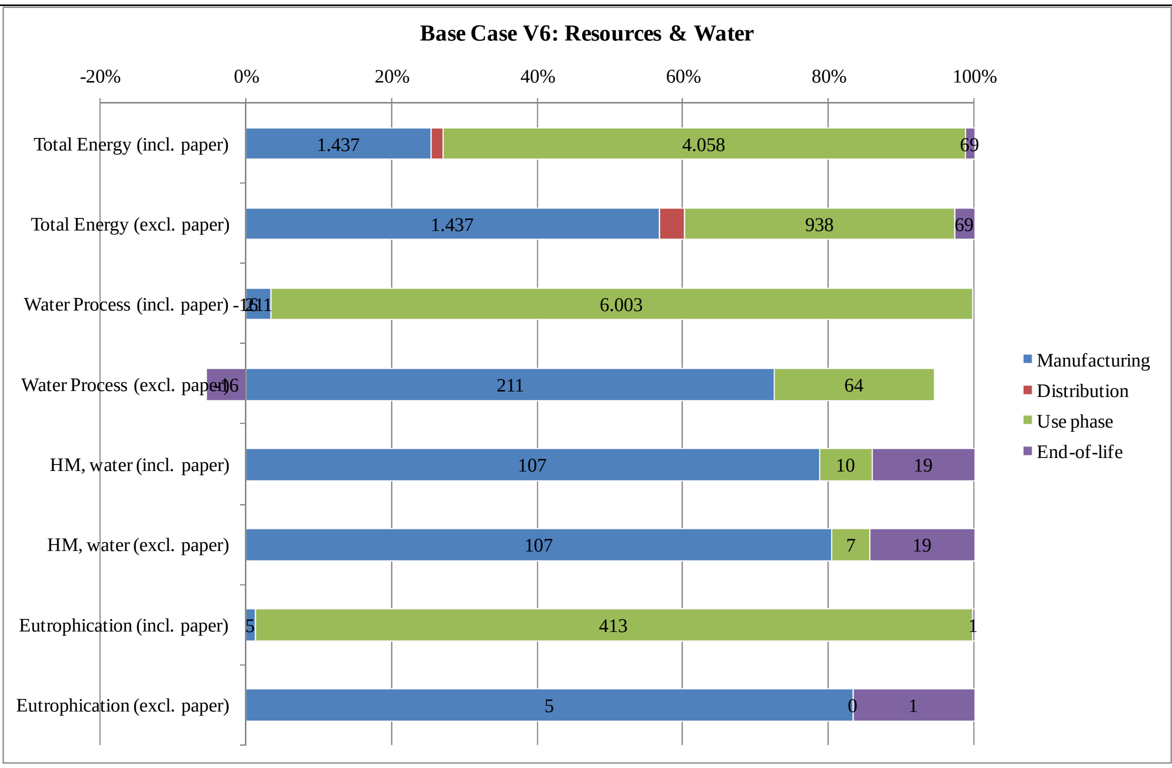


**Figure 19: Distribution of resources related impacts for Base Case V6**

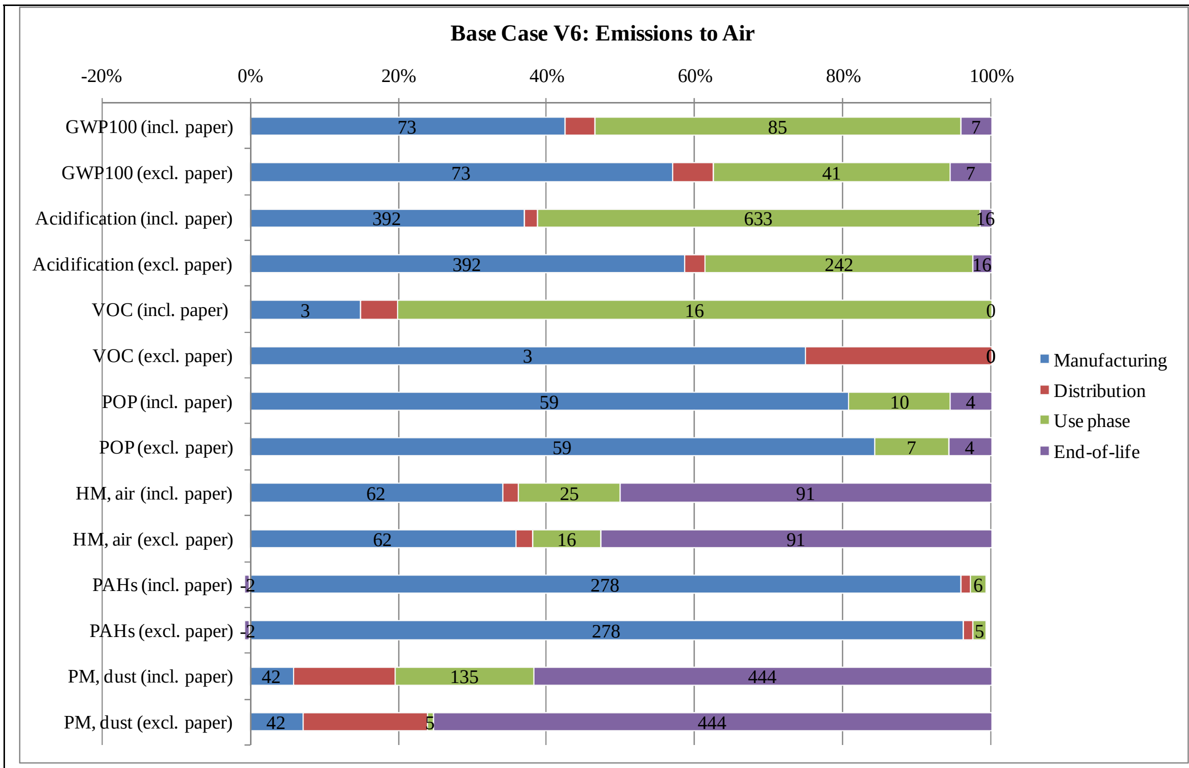


**Figure 20: Distribution of emissions to air for Base Case V6**

### 5.2.6.3. Assessment of single impact categories related to life cycle phases

The following assessment of single eco-impacts related to the life cycle phase "Manufacturing", "Distribution", "Use", and "End-of-life" excludes the aspect of paper. By taking the impact category Total Energy as general eco-indicator the "manufacturing" phase with 1.437 MJ has the single highest impact followed by the "use" phase with 938 MJ. The "Distribution" and "End-of-life" phases have a very minor impact. In terms of "Greenhouse Gases" and "Acidification" the Base Case V6 shows an eco-impact ratio of 65:35 between the "manufacturing" and "use" phase. The eco-impact categories which are indicating toxicity such as POP, Heavy Metals, and PAHs, as well as Volatile Organic Compounds (VOC), show an even higher impact ratio with regards to the manufacturing phase.

Regarding data acquisition, data quality and methodological aspects of the assessment, see also Section 5.2.1.3

Details regarding the environmental impacts of various materials for the Base Case V6 are the same as for Base Case V5 and are provided in Table 22. Relevancy of the various material categories is identical with Base Case V5 as well.

## 5.3. Base-Case Life Cycle Costs

### 5.3.1. Input data requirements

The base case life cycle cost calculation (LCC) requires following data input:

- Average Product life (data input see Task 3)
- EU annual sales for reference years 2005, 2010 and 2010 (data input see Task 2)
- EU stock or installed base for reference years 2005, 2010 and 2010 (data input see Task 2)
- Product price (average of the manufacturers listed prices and actual wholesale prices[12])
- Electricity rate (we calculate the electricity costs based on 0.14 Euro per kWh)
- Auxiliary 1 is office paper in kg/year (5 gr A4 paper)
- Auxiliary 2 is toner in kg/year (0.02 gr to 0.03 gr per page)
- Auxiliary 3 is ink (0.07 gr per page)
- Repair and maintenance costs (Euro per unit)

#### 5.3.1.1. Market data allocation

The MEEuP EcoReport requests data input regarding the European Union overall product stock and sales for the year 2005. Specific market data have been obtained and discussed in Section 2.2.2. The relevant allocation of these available market data to the base cases is shown in Table 25.

**Table 25: EU stock and sales data of base cases for reference years 2005**

| Base Case | Product Segment | 2005 EU Stock (in 1000 units) | 2005 EU Sales (in 1000 units) |
|---|---|---|---|
| **V1*** | EP-Copier mono | 5.970 | 1.019 |
| **V2*** | EP-Copier color | 381 | 137 |
| **V3*** | EP-Printer mono | 14.735 | 3.682 |
| **V4*** | EP-Printer color | 1.919 | 834 |
| **V5**** | IJ-MFD Personal | 68.412 | 12.330 |
| **V6***** | IJ-MFD Workgroup | 21.760 | 10.107 |
| * In the case of V1 to V4 the EU total is calculated based on aggregated market data for SFDs and MFDs together | | | |
| ** In the case of V5 the EU total is calculated based on market data for IJ-Printer SFDs what should reflect personal use | | | |
| *** In the case of V6 the EU total is calculated based on aggregated market data for MFDs what should reflect workgroup use | | | |

As a matter of fact, precise market data for the defined base cases could not be obtained. Regarding the base cases V1 to V4 the EU total will be calculated based on aggregated market data for SFDs

[12] Comparison of prices indicated that wholesale prices are 20 to 40 percent of the listed prices.

and MFDs together despite the distinction of both within the base cases. The general trend towards MFDs seems to allow the allocation of SFDs to the total. In the case of base case V5 the EU total is calculated based on market data for IJ-Printer SFDs in order to reflect personal use application. This approach seems feasible when allocating the InfoTrends data on the image creation volume regarding personal use environment to the assumed image creation volume of base case V5 (see Table 26). According to our calculation in Section 4.3.5 we assume an annual image volume of 1,040 pages per single device. If we now correlate the 1,040 pages per single device with the 71 billion images of total personal use, we receive a figure reflecting the stock of products in the EU. When comparing the resulting stock figure (68.2 million units) with the market data for IJ-SFDs (68.4 million units) the similarity is striking. However, if doing the same calculation for the base case V6 the stock of IJ-MFDs (21.7 million units) is ten times as high as the calculated value based on 3,900 pages/a and 8 billion images in workgroup environment.

**Table 26: EU stock and allocated image volume per application environment in 2005**

| **Base Case** | **Product Segment** | 2005 EU Stock (in 1000 units) | Images in Personal environment (in 1000 images) | Images workgroup Environment (in 1000 impressions) |
|---|---|---|---|---|
| **V1** | EP-Copier mono | 5.970 | | |
| **V2** | EP-Copier color | 381 | | |
| | **EP-Copier (total)** | **6.351** | **13.000.000** | **116.000.000** |
| **V3** | EP-Printer mono | 14.735 | | |
| **V4** | EP-Printer color | 1.919 | | |
| | **EP-Printer (total)** | **16.654** | **18.000.000** | **421.000.000** |
| **V5** | IJ-Printer SFD | 68.412 | | |
| **V6** | IJ-Printer MFD | 21.760 | | |
| | **IJ-Printer (total)** | **90.172** | **71.000.000** | **8.000.000** |

In conclusion, the correlation of image volume figures from InfoTrends to actual market figures shows a very good match for base case V5 but is insufficient in the case of V6. Under the limitation of not available market figures, we take the pragmatic approach of allocating the stock and sales figures for IJ-SFDs to the base case V5 (personal use) and the actual market figures for IJ-MFDs to the base case V6 (workgroup use). There is a further consideration supporting this approach. If we calculate the stock figures of IJ-SFDs (68.4 million units) and IJ-MFDs (21.7 million units) in percentage of total stock (90.2 million units) we receive 75% to 25% ratio. This ratio between IJ-products applied in personal use and IJ-products applied workgroup use seems feasible.

#### 5.3.1.2. Product prices and maintenance costs

The MEEuP EcoReport requests data input regarding average product sales prices as well as costs of auxiliary materials such as paper, toner and ink. Regarding the product price allocated to the single base cases we have averaged “listed prices” of manufacturers with “wholesale prices” of online distributors. Due to the fact that most devices have been introduced into the market in the year 2005, today's (2007) wholesale prices are considerably lower (up to 30%) than the original "list prices". A second aspect related particularly to the copier base cases V1 and V2 (this might also be relevant for V3 and V4) is the consideration of leasing business model. The product price is in the leasing case not fully transparent because the leasing costs usually include a certain amount of toner/paper consumption and maintenance over a limited time period. The duration of the leasing contract is usually 1 to 3 years and therefore less than the assumed lifetime of the product (6 years). Against that background the MEEuP EcoReport data input needs a pragmatic solution. The product price of each base case is a rough average of listed and wholesale price. The actual product price assumptions per base case are shown in Table 27 further below. References for prices, although asked for by the "Market Trasnformation Programme", will not be detailed in the report because they were mostly obtained from internet sources and are easily to be checked. The list prices provided by some manufacturers for their product case are treated confidential in order to prohibit the traceability of an individual product case.

Regarding costs for maintenance and repair we assume for base cases V1 to V4 an annual sum of 100 Euro, also in actual product cases no maintenance and repair costs occur. The cost factor has to be understood therefore in conjunction with the assumed product price. As indicated before, we assume a product price that is up to 30% lower than the actual list price. By adding 100 Euro annually for maintenance and repair in the base cases V1 to V4 we reflect existing maintenance in a possible leasing business model on the one hand and a somewhat high list price in a sales business model on the other hand. Regarding the inkjet base cases V5 and V6 no maintenance and repair costs are assumed.

**Table 27: Product prices and annual maintenance costs**

| Base Case | Product Segment | Sales Price (in €) | Maintenance* (in €) |
|---|---|---|---|
| **V1** | EP-Copier mono | 4.000 | 600 |
| **V2** | EP-Copier color | 8.000 | 600 |
| **V3** | EP-Printer mono | 900 | 600 |
| **V4** | EP-Printer color | 1.500 | 600 |
| **V5** | IJ-MFD Personal | 200 | 0 |
| **V6** | IJ-MFD Workgroup | 200 | 0 |
| * Maintenance & repair costs are caluculated for base cases V1 to V4 according to a six year product life | | | |

### 5.3.1.3. Auxiliary material costs

Regarding the costs for toner, ink and paper, MEEuP EcoReport requires a kilogram price (€/kg). The required information were obtained partially form manufacturers and partially by own calculations based on an internet recherché.

**Toner Costs:** There are big differences between manufacturer prices, wholesale, and retail prices for toner and ink. Brand name toner and ink tend to be more expensive, a difference also exists between new and refilled cartridges[13]. The actual cost of the toner and ink itself (without the cartridge) is not fully transparent. Usually costs are only available for cartridges. Table 28 provides the cost assumptions for black and colour toner (single and averaged tri-colour). Regarding black toner in the base cases V1 and V3 we assume a kilogram price of 500 Euro. Regarding the colour machine base cases V2 and V4 it is necessary to average the black and colour toner consumption. In order to make a plausible input into the MEEuP EcoReport we assumed a mix of 80% black toner and 20% tri-colour toner resulting in a total kilogram price of 900 Euro.

**Table 28: Toner cost assumptions**

| Toner | Price | Black | Yellow | Magenta | Cyan | Total |
|---|---|---|---|---|---|---|
| **Single Color** | in €/kg | 500 | 2.500 | 2.000 | 3.000 | **8.000** |
| **Average Color*** | in €/kg | 400 | | 500 | | **900** |
| * Average color costs for base cases V2 and V4 are calculated on the assumption that 80% of the images are black and 20% color | | | | | | |

**Ink costs:** Regarding the costs for ink no particular kilogram prices could be provided by manufacturers. The ink content of cartridges is usually given in ml. We make the pragmatic assumption that 1 ml equals 1 gram of ink. Wholesale price for 1 ml black ink is approximately 1 Euro or less. For the purpose of the study we assume that black ink costs 1000 Euro/kg. Tri-colour ink cartridge prices indicate that 1 ml colour ink costs approximately 2,3 Euro or less. For the purpose of the study we assume that tri-colour ink costs 2300 Euro/kg. The resulting inputs are shown in Table 29.

**Table 29: Ink cost assumptions**

| Ink | Price | Black | Tri-color | Total |
|---|---|---|---|---|
| **Single Color** | in €/kg | 1.000 | 2.300 | 3.300 |
| **Average Color*** | in €/kg | 700 | 690 | 1.390 |
| * Average color costs for base cases V5 and V6 are calculated based on the assumption thet 70% of images are black and 30% color | | | | |

[13] Further discussion to these points see Section 3.1.3.2 and 6.1.2.

**Paper costs:** A comparison of wholesale price for regular white and recycled office paper indicates an averaged kilogram price of 1.5 Euro.

### 5.3.2. LCC analysis for base case V1

Table 30 provides the input table for EU-totals and life cycle costs assessment for the base case V1.

**Table 30: Base case V1 inputs for EU-totals and LCC**

| Table . Inputs for EU-Totals & LCC | | | |
|---|---|---|---|
| nr | INPUTS FOR EU-Totals & economic Life Cycle Costs<br>Description | | unit |
| A | Product Life | 6 | years |
| B | Annual sales | 1,02 | mln. Units/year |
| C | EU Stock | 5,97 | mln. Units |
| D | Product price | 4000 | Euro/unit |
| E | Installation/acquisition costs (if any) | | Euro/ unit |
| F | Fuel rate (gas, oil, wood) | | Euro/GJ |
| G | Electricity rate | 0,14 | Euro/kWh |
| H | Water rate | | Euro/m3 |
| I | Aux. 1: Office paper | 1,5 | Euro/kg |
| J | Aux. 2 :Toner | 500 | Euro/kg |
| K | Aux. 3: None | | Euro/kg |
| L | Repair & maintenance costs | 600 | Euro/ unit |
| M | Discount rate (interest minus inflation) | 1,8% | % |
| N | Present Worth Factor (PWF) (calculated automatically) | 5,64 | (years) |
| O | Overall Improvement Ratio STOCK vs. NEW, Use Phase | 1,00 | |

Table 31 shows the results of the MEEuP EcoReport LCC assessment for the base case V1.

**Table 31: Life cycle costs assessment of base case V1**

| Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25 | | | | | |
|---|---|---|---|---|---|
| | Base_Case_V1_EP-Copier_MFD-mono (incl. Paper)<br>*Item* | LCC new product | | total annual consumer expenditure in EU25 | |
| D | Product price | 4000 | € | 4080 | mln.€ |
| E | Installation/ acquisition costs (if any) | 0 | € | 0 | mln.€ |
| F | Fuel (gas, oil, wood) | 0 | € | 0 | mln.€ |
| F | Electricity | 197 | € | 209 | mln.€ |
| G | Water | 0 | € | 0 | mln.€ |
| H | Aux. 1: Office paper | 3714 | € | 3931 | mln.€ |
| I | Aux. 2 :Toner | 4957 | € | 5248 | mln.€ |
| J | Aux. 3: None | 0 | € | 0 | mln.€ |
| K | Repair & maintenance costs | 564 | € | 597 | mln.€ |
| | **Total** | **13432** | € | **14065** | mln.€ |

The total life cycle costs for a product (base case V1) manufactured in 2005 totals in 13,432 €, thereof more than one third for toner. The costs for paper over the life cycle are in the same range as the initial product price.

The total annual consumer expenditure for this base case is 14 billion €, thereof 209 million Euro electricity costs.

### 5.3.3. LCC analysis for base case V2

Table 32 provides the input table for EU-totals and life cycle costs assessment for the base case V2.

**Table 32: Base case V2 inputs for EU-totals and LCC**

| Table . Inputs for EU-Totals & LCC | | | |
|---|---|---|---|
| nr | INPUTS FOR EU-Totals & economic Life Cycle Costs<br>Description | | unit |
| A | Product Life | 6 | years |
| B | Annual sales | 0,14 | mln. Units/year |
| C | EU Stock | 0,38 | mln. Units |
| D | Product price | 8000 | Euro/unit |
| E | Installation/acquisition costs (if any) | | Euro/ unit |
| F | Fuel rate (gas, oil, wood) | | Euro/GJ |
| G | Electricity rate | 0,14 | Euro/kWh |
| H | Water rate | | Euro/m3 |
| I | Aux. 1: Office paper | 1,5 | Euro/kg |
| J | Aux. 2 :Toner | 900 | Euro/kg |
| K | Aux. 3: None | | Euro/kg |
| L | Repair & maintenance costs | 600 | Euro/ unit |
| M | Discount rate (interest minus inflation) | 1,8% | % |
| N | Present Worth Factor (PWF) (calculated automatically) | 5,64 | (years) |
| O | Overall Improvement Ratio STOCK vs. NEW, Use Phase | 1,00 | |

Table 33 shows the results of the MEEuP EcoReport LCC assessment for the base case V2.

The total life cycle costs for a product (base case V2) manufactured in 2005 totals in 25,949 €, thereof more than 50% for toner. The costs for paper over the life cycle are half the initial product price.

The total annual consumer expenditure for this base case is 2,3 billion €, thereof 20 million Euro electricity costs.

**Table 33: Life cycle costs assessment of base case V2**

**Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25**

| | Base Case V2 - MFD - Copier Color (with paper) *Item* | **LCC new product** | **total annual consumer expenditure in EU25** |
|---|---|---|---|
| D | Product price | 8000 € | 1120 mln.€ |
| E | Installation/ acquisition costs (if any) | 0 € | 0 mln.€ |
| F | Fuel (gas, oil, wood) | 0 € | 0 mln.€ |
| F | Electricity | 292 € | 20 mln.€ |
| G | Water | 0 € | 0 mln.€ |
| H | Aux. 1: Office paper | 3714 € | 250 mln.€ |
| I | Aux. 2 :Toner | 13379 € | 902 mln.€ |
| J | Aux. 3: None | 0 € | 0 mln.€ |
| K | Repair & maintenance costs | 564 € | 38 mln.€ |
| | **Total** | **25949** € | **2329** mln.€ |

## 5.3.4. LCC analysis for base case V3

Table 34 provides the input table for EU-totals and life cycle costs assessment for the base case V3.

**Table 34: Base case V3 inputs for EU-totals and LCC**

**Table . Inputs for EU-Totals & LCC**

| nr | **INPUTS FOR EU-Totals & economic Life Cycle Costs** **Description** | | **unit** |
|---|---|---|---|
| A | Product Life | **6** | years |
| B | Annual sales | **3,68** | mln. Units/year |
| C | EU Stock | **14,73** | mln. Units |
| D | Product price | **900** | Euro/unit |
| E | Installation/acquisition costs (if any) | | Euro/ unit |
| F | Fuel rate (gas, oil, wood) | | Euro/GJ |
| G | Electricity rate | **0,14** | Euro/kWh |
| H | Water rate | | Euro/m3 |
| I | Aux. 1: Office paper | **1,5** | Euro/kg |
| J | Aux. 2 :Toner | **500** | Euro/kg |
| K | Aux. 3: None | | Euro/kg |
| L | Repair & maintenance costs | **600** | Euro/ unit |
| M | Discount rate (interest minus inflation) | **1,8%** | % |
| N | Present Worth Factor (PWF) (calculated automatically) | **5,64** | (years) |
| O | Overall Improvement Ratio STOCK vs. NEW, Use Phase | **1,00** | |

Table 35 shows the results of the MEEuP EcoReport LCC assessment for the base case V3.

**Table 35: Life cycle costs assessment of base case V3**

**Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25**

| | Base Case_V3_EP-Printer-SFD-mono (incl. Paper)<br>*Item* | **LCC new product** | | **total annual consumer expenditure in EU25** | |
|---|---|---|---|---|---|
| D | Product price | 900 | € | 3312 | mln.€ |
| E | Installation/ acquisition costs (if any) | 0 | € | 0 | mln.€ |
| F | Fuel (gas, oil, wood) | 0 | € | 0 | mln.€ |
| F | Electricity | 213 | € | 557 | mln.€ |
| G | Water | 0 | € | 0 | mln.€ |
| H | Aux. 1: Office paper | 5634 | € | 14715 | mln.€ |
| I | Aux. 2 :Toner | 7506 | € | 19606 | mln.€ |
| J | Aux. 3: None | 0 | € | 0 | mln.€ |
| K | Repair & maintenance costs | 564 | € | 1473 | mln.€ |
| | **Total** | **14817** | € | **39663** | mln.€ |

The total life cycle costs for a product (base case V3) manufactured in 2005 totals in 14,817 €, thereof more than 50% for toner. Compared to paper and toner costs the product price is a minor cost factor.

The total annual consumer expenditure for this base case is 39.7 billion €, thereof 557 million € electricity costs.

### 5.3.5. LCC analysis for base case V4

Table 36 provides the input table for EU-totals and life cycle costs assessment for the base case V4.

**Table 36: Base case V4 inputs for EU-totals and LCC**

| Table . Inputs for EU-Totals & LCC | | | |
|---|---|---|---|
| nr | INPUTS FOR EU-Totals & economic Life Cycle Costs<br>Description | | unit |
| A | Product Life | 6 | years |
| B | Annual sales | 0,83 | mln. Units/year |
| C | EU Stock | 1,92 | mln. Units |
| D | Product price | 1500 | Euro/unit |
| E | Installation/acquisition costs (if any) | | Euro/ unit |
| F | Fuel rate (gas, oil, wood) | | Euro/GJ |
| G | Electricity rate | 0,14 | Euro/kWh |
| H | Water rate | | Euro/m3 |
| I | Aux. 1: Office paper | 1,5 | Euro/kg |
| J | Aux. 2 :Toner | 900 | Euro/kg |
| K | Aux. 3: None | | Euro/kg |
| L | Repair & maintenance costs | 600 | Euro/ unit |
| M | Discount rate (interest minus inflation) | 1,8% | % |
| N | Present Worth Factor (PWF) (calculated automatically) | 5,64 | (years) |
| O | Overall Improvement Ratio STOCK vs. NEW, Use Phase | 1,00 | |

Table 37 shows the results of the MEEuP EcoReport LCC assessment for the base case V4.

**Table 37: Life cycle costs assessment of base case V4**

| Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25 | | | |
|---|---|---|---|
| | Base Case_V4_EP-Printer-SFD-color (incl. Paper)<br>*Item* | LCC new product | total annual consumer expenditure in EU25 |
| D | Product price | 1500 € | 1245 mln.€ |
| E | Installation/ acquisition costs (if any) | 0 € | 0 mln.€ |
| F | Fuel (gas, oil, wood) | 0 € | 0 mln.€ |
| F | Electricity | 284 € | 97 mln.€ |
| G | Water | 0 € | 0 mln.€ |
| H | Aux. 1: Office paper | 5634 € | 1918 mln.€ |
| I | Aux. 2 :Toner | 20272 € | 6902 mln.€ |
| J | Aux. 3: None | 0 € | 0 mln.€ |
| K | Repair & maintenance costs | 564 € | 192 mln.€ |
| | **Total** | **28253** € | **10353** mln.€ |

The total life cycle costs for a product (base case V4) manufactured in 2005 totals in 28,253 €, thereof more than two third for toner. Compared to paper and toner costs the product price is a minor cost factor.

The total annual consumer expenditure for this base case is 10.4 billion €, thereof 97 million € electricity costs.

### 5.3.6. LCC analysis for base case V5

Table 38 provides the input table for EU-totals and life cycle costs assessment for the base case V5.

**Table 38: Base case V5 inputs for EU-totals and LCC**

| Table . Inputs for EU-Totals & LCC | | | |
|---|---|---|---|
| nr | INPUTS FOR EU-Totals & economic Life Cycle Costs<br>Description | | unit |
| A | Product Life | 4 | years |
| B | Annual sales | 12,33 | mln. Units/year |
| C | EU Stock | 68,41 | mln. Units |
| D | Product price | 200 | Euro/unit |
| E | Installation/acquisition costs (if any) | | Euro/ unit |
| F | Fuel rate (gas, oil, wood) | | Euro/GJ |
| G | Electricity rate | 0,14 | Euro/kWh |
| H | Water rate | | Euro/m3 |
| I | Aux. 1: Office paper | 1,5 | Euro/kg |
| J | Aux. 2 :None | 1390 | Euro/kg |
| K | Aux. 3: None | | Euro/kg |
| L | Repair & maintenance costs | 0 | Euro/ unit |
| M | Discount rate (interest minus inflation) | 1,8% | % |
| N | Present Worth Factor (PWF) (calculated automatically) | 3,83 | (years) |
| O | Overall Improvement Ratio STOCK vs. NEW, Use Phase | 1,00 | |

Table 39 shows the results of the MEEuP EcoReport LCC assessment for the base case V5.

**Table 39: Life cycle costs assessment of base case V5**

| Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25 | | | | | |
|---|---|---|---|---|---|
| | Base Case V5_IJ-MFD-Personal (incl. Paper)<br>*Item* | LCC new product | | total annual consumer expenditure in EU25 | |
| D | Product price | 200 | € | 2466 | mln.€ |
| E | Installation/ acquisition costs (if any) | 0 | € | 0 | mln.€ |
| F | Fuel (gas, oil, wood) | 0 | € | 0 | mln.€ |
| F | Electricity | 10 | € | 175 | mln.€ |
| G | Water | 0 | € | 0 | mln.€ |
| H | Aux. 1: Office paper | 30 | € | 534 | mln.€ |
| I | Aux. 2 :None | 388 | € | 6942 | mln.€ |
| J | Aux. 3: None | 0 | € | 0 | mln.€ |
| K | Repair & maintenance costs | 0 | € | 0 | mln.€ |
| | **Total** | **628** | € | **10116** | mln.€ |

The total life cycle costs for a product (base case V5) manufactured in 2005 totals in 628 €, thereof more than 60% for ink (row "I"). The product price is the second dominating cost factor.

The total annual consumer expenditure for this base case is 10.1 billion €, thereof 175 million € electricity costs.

### 5.3.7. LCC analysis for base case V6

Table 40 provides the input table for EU-totals and life cycle costs assessment for the base case V6.

**Table 40: Base case V6 inputs for EU-totals and LCC**

| Table . Inputs for EU-Totals & LCC | | | |
|---|---|---|---|
| nr | INPUTS FOR EU-Totals & economic Life Cycle Costs<br>Description | | unit |
| A | Product Life | 4 | years |
| B | Annual sales | 10,11 | mln. Units/year |
| C | EU Stock | 21,76 | mln. Units |
| D | Product price | 200 | Euro/unit |
| E | Installation/acquisition costs (if any) | | Euro/ unit |
| F | Fuel rate (gas, oil, wood) | | Euro/GJ |
| G | Electricity rate | 0,14 | Euro/kWh |
| H | Water rate | | Euro/m3 |
| I | Aux. 1: Office paper | 1,5 | Euro/kg |
| J | Aux. 2 :None | 1390 | Euro/kg |
| K | Aux. 3: None | | Euro/kg |
| L | Repair & maintenance costs | 0 | Euro/ unit |
| M | Discount rate (interest minus inflation) | 1,8% | % |
| N | Present Worth Factor (PWF) (calculated automatically) | 3,83 | (years) |
| O | Overall Improvement Ratio STOCK vs. NEW, Use Phase | 1,00 | |

Table 41 shows the results of the MEEuP EcoReport LCC assessment for the base case V6.

**Table 41: Life cycle costs assessment of base case V6**

| Table . Life Cycle Costs per product and Total annual expenditure (2005) in the EU-25 | | | |
|---|---|---|---|
| | Base Case V6_IJ-MFD-Workgroup (incl. Paper)<br>*Item* | LCC new product | total annual consumer expenditure in EU25 |
| D | Product price | 200 € | 2022 mln.€ |
| E | Installation/ acquisition costs (if any) | 0 € | 0 mln.€ |
| F | Fuel (gas, oil, wood) | 0 € | 0 mln.€ |
| F | Electricity | 12 € | 67 mln.€ |
| G | Water | 0 € | 0 mln.€ |
| H | Aux. 1: Office paper | 112 € | 636 mln.€ |
| I | Aux. 2 :None | 1452 € | 8257 mln.€ |
| J | Aux. 3: None | 0 € | 0 mln.€ |
| K | Repair & maintenance costs | 0 € | 0 mln.€ |
| | **Total** | **1776** € | **10983** mln.€ |

The total life cycle costs for a product (base case V6) manufactured in 2005 totals in 1,776 €, thereof more than 75% for ink. Ink dominates all other cost factors.

The total annual consumer expenditure for this base case is 11 billion €, thereof 67 million € electricity costs.

### 5.3.8. LCC Summary

The LCC calculations for the EU-25 totals of the individual base cases is summarised in Table 42. In total the six base cases aggregated for the EU-25 is an annual expenditure of 87.5 billion €, thereof 1.1 billion € on electricity, 54.5 billion € on toner and ink. Be aware that these calculations are based on a TEC measurement scenario, which overestimates the real number of printed pages compared to paper market data (see 5.4.7 below).

**Table 42: LCC Summary all base cases**

| | total annual consumer expenditure in EU-25 (mln. €) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base Case | | | | | | Total |
| | V1 | V2 | V3 | V4 | V5 | V6 | |
| Product price | 4080 | 1120 | 3312 | 1245 | 2466 | 2022 | 14245 |
| Electricity | 209 | 20 | 557 | 97 | 175 | 67 | 1125 |
| Office paper | 3931 | 250 | 14715 | 1918 | 534 | 636 | 21984 |
| Toner | 5248 | 902 | 19606 | 6902 | 0 | 0 | 32658 |
| Ink | 0 | 0 | 0 | 0 | 6942 | 8257 | 15199 |
| Repair & Maintenance | 597 | 38 | 1473 | 192 | 0 | 0 | 2300 |
| **Total** | **14065** | **2329** | **39663** | **10353** | **10116** | **10983** | **87509** |

## 5.4. EU Totals

The objective of this final task in the report is the aggregation of the single base case's MEEuP EcoReport results and respective EU stock data to an overall environmental impact assessment for the European Union. The reference year for the EU totals assessment is 2005. At first it has to be said that there are some limitations related to this particular assessment. A comprehensive environmental impact assessment of EU totals concerning office imaging equipment would require a transparent structure of all market segments, their exact installed base of products, performance characteristics as well their individual environmental impacts. With the definition of six base cases – average products with considerable market shares – we intended covering a large portion of the highly divers office imaging equipment market. But as a matter of fact, these six base cases and their allocated stock figures provide only a rough estimate of the EU total impact.

In order to show a fairly realistic magnitude of the total environmental impact we have chosen the base cases consciously by focusing on the lower to medium end of the product performances range. Regarding the EP-products (V1 to V4), due to the fact that we correlate the imaging speed of these base cases with a particular use pattern and related image creation volume (Energy Star TEC methodology), the chosen moderate speed classes (V1 and V2 at 26 ipm, V3 and V4 at 32 ipm) will hopefully avoid an overestimation in EU total. According to more detailed market figures of product sales by speed classes compiled in Section 2.2.3 and 2.2.4 the chosen base cases reflect the largest segments in the market. Regarding EP-copiers, the 2005 placement figures for monochrome devices show that products up to 30 ipm have almost 80% of total market share although only 20% of total are in a range of 20 to 30 ipm. Regarding EP-printer, the 25 to 39 ipm segment is still gaining market shares and will become with more than 50% the single most dominant segment by 2008. It is obvious that this approach does not allow a very detailed breakdown of the total environmental impact in terms of specific speed classes and other performance characteristics. We can therefore not assess if a smaller share of high performance products (e.g. high speed, larger format) may have a proportionally larger impact. This is a limit of the study.

Regarding the IJ-products (V5 and V6), we have discussed the selection criteria in previous tasks. Due to the fact that the actual stock in 2005 is with almost 70% clearly dominated by SFDs, the chosen base cases V5 and V6 are certainly not an ideal match. Having said this, it also has to be said, that the focus on MFDs reflects the technical and therefore market trend more realistically. The relatively short product life cycle of 3 to 4 years results in a fast turnover of products. According to available market forecasts, the installed base of IJ-products will consist of over 70% MFDs by the year 2010. Against this background the choice of MFD base cases seems justified.

The missing segments are single function facsimile machines and flatbed scanners for which no base cases were developed. According to the available market figures both product groups show a dynamic decline due to the general increase in MFDs. At this point of the study we will neglect both product categories in the assessment.

### 5.4.1. Aggregated EU totals for base case V1

Table 43 shows the MEEuP EcoReport results for the EU total impact assessment of Base Case V1 (EP-Copier/MFD monochrome)[14]. In order to provide a balanced view on the product related impacts we excluded paper consumption in the right column of the table. The specific impact of paper has been discussed in the single base case assessments already. In order to put the impact of Base Case V1 into perspective of the whole EU imaging equipment market a comparative analysis of all base case results will follow in Section 5.4.7.

**Table 43: Base Case V1 summary environmental impacts for EU-stock**

Incl. Paper

**Table . Summary Environmental Impacts EU-Stock 2005, Base_Case_V1_EP-Copier_MFD-mono (incl. Paper)**

| **main life cycle indicators** | **value** | **unit** |
|---|---|---|
| **Total Energy (GER)** | **129** | PJ |
| *of which, electricity* | 3,2 | TWh |
| **Water (process)*** | **202** | mln.m3 |
| **Waste, non-haz./ landfill*** | **297** | kton |
| **Waste, hazardous/ incinerated*** | **17** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **3** | mt CO2eq. |
| **Acidifying agents** (AP) | **20** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **1** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **2** | ton Ni eq. |
| **PAHs** | **1** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **8** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 1 | ton Hg/20 |
| **Eutrophication** (EP) | 14 | kt PO4 |

***=caution: low accuracy for production phase**

Excl. Paper

**Table . Summary Environmental Impacts EU-Stock 2005, Base_Case_V1_EP-Copier_MFD-mono (excl. Paper)**

| **main life cycle indicators** | **value** | **unit** |
|---|---|---|
| **Total Energy (GER)** | **24** | PJ |
| *of which, electricity* | 1,7 | TWh |
| **Water (process)*** | **2** | mln.m3 |
| **Waste, non-haz./ landfill*** | **120** | kton |
| **Waste, hazardous/ incinerated*** | **16** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **1** | mt CO2eq. |
| **Acidifying agents** (AP) | **7** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **1** | ton Ni eq. |
| **PAHs** | **1** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **3** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 1 | ton Hg/20 |
| **Eutrophication** (EP) | 0 | kt PO4 |

***=caution: low accuracy for production phase**

[14] These figures are extracted from a seperate table of the result sheet in the MEEuP Eco Report.

### 5.4.2. Aggregated EU totals for base case V2

Table 44 shows the MEEuP EcoReport results for the EU total impact assessment of Base Case V2 (EP-Copier/MFD colour). In order to provide a balanced view on the product related impacts we excluded paper consumption in the right column of the table. The specific impact of paper has been discussed in the single base case assessments already. In order to put the impact of Base Case V2 into perspective of the whole EU imaging equipment market a comparative analysis of all base case results will follow in Section 5.4.7.

**Table 44: Base Case V2 summary environmental impacts for EU-stock**

**Incl. Paper**

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case V2 - MFD - Copier Color (with paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **10** | PJ |
| *of which, electricity* | 0,3 | TWh |
| **Water (process)*** | **13** | mln.m3 |
| **Waste, non-haz./ landfill*** | **51** | kton |
| **Waste, hazardous/ incinerated*** | **5** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **0** | mt CO2eq. |
| **Acidifying agents** (AP) | **2** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **0** | g i-Teq. |
| **Heavy Metals** (HM) | **0** | ton Ni eq. |
| **PAHs** | **0** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **1** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 0 | ton Hg/20 |
| **Eutrophication** (EP) | 1 | kt PO4 |

***=caution: low accuracy for production phase**

**Excl. Paper**

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case V2 - MFD - Copier Color (excl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **4** | PJ |
| *of which, electricity* | 0,2 | TWh |
| **Water (process)*** | **0** | mln.m3 |
| **Waste, non-haz./ landfill*** | **40** | kton |
| **Waste, hazardous/ incinerated*** | **5** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **0** | mt CO2eq. |
| **Acidifying agents** (AP) | **1** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **0** | g i-Teq. |
| **Heavy Metals** (HM) | **0** | ton Ni eq. |
| **PAHs** | **0** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **1** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 0 | ton Hg/20 |
| **Eutrophication** (EP) | 0 | kt PO4 |

***=caution: low accuracy for production phase**

### 5.4.3. Aggregated EU totals for base case V3

Table 45 shows the MEEuP EcoReport results for the EU total impact assessment of Base Case V3 (EP-Printer/SFD monochrome). In order to provide a balanced view on the product related impacts we excluded paper consumption in the right column of the table. The specific impact of paper has been discussed in the single base case assessments already. In order to put the impact of Base Case V3 into perspective of the whole EU imaging equipment market a comparative analysis of all base case results will follow in Section 5.4.7.

**Table 45: Base Case V3 summary environmental impacts for EU-stock**

**Incl. Paper**

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case_V3_EP-Printer-SFD-mono (incl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **447** | PJ |
| *of which, electricity* | 9,9 | TWh |
| **Water (process)*** | **752** | mln.m3 |
| **Waste, non-haz./ landfill*** | **827** | kton |
| **Waste, hazardous/ incinerated*** | **41** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **8** | mt CO2eq. |
| **Acidifying agents** (AP) | **64** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **2** | kt |
| **Persistent Org. Pollutants** (POP) | **2** | g i-Teq. |
| **Heavy Metals** (HM) | **4** | ton Ni eq. |
| **PAHs** | **1** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **22** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 2 | ton Hg/20 |
| **Eutrophication** (EP) | 52 | kt PO4 |

***=caution: low accuracy for production phase**

**Excl. Paper**

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case_V3_EP-Printer-SFD-mono (excl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **55** | PJ |
| *of which, electricity* | 4,3 | TWh |
| **Water (process)*** | **5** | mln.m3 |
| **Waste, non-haz./ landfill*** | **165** | kton |
| **Waste, hazardous/ incinerated*** | **38** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **3** | mt CO2eq. |
| **Acidifying agents** (AP) | **15** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **3** | ton Ni eq. |
| **PAHs** | **1** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **6** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 2 | ton Hg/20 |
| **Eutrophication** (EP) | 0 | kt PO4 |

***=caution: low accuracy for production phase**

### 5.4.4. Aggregated EU totals for base case V4

Table 46 shows the MEEuP EcoReport results for the EU total impact assessment of Base Case V4 (EP-Printer/SFD colour). In order to provide a balanced view on the product related impacts we excluded paper consumption in the right column of the table. The specific impact of paper has been discussed in the single base case assessments already. In order to put the impact of Base Case V4 into perspective of the whole EU imaging equipment market a comparative analysis of all base case results will follow in Section 5.4.7.

**Table 46: Base Case V4 summary environmental impacts for EU-stock**

Incl. Paper

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case_V4_EP-Printer-SFD-color (incl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **63** | PJ |
| *of which, electricity* | 1,5 | TWh |
| **Water (process)*** | **99** | mln.m3 |
| **Waste, non-haz./ landfill*** | **147** | kton |
| **Waste, hazardous/ incinerated*** | **14** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **1** | mt CO2eq. |
| **Acidifying agents** (AP) | **10** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **1** | ton Ni eq. |
| **PAHs** | **1** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **4** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 1 | ton Hg/20 |
| **Eutrophication** (EP) | 7 | kt PO4 |

***=caution: low accuracy for production phase**

Excl. Paper

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case_V4_EP-Printer-SFD-color (excl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **12** | PJ |
| *of which, electricity* | 0,8 | TWh |
| **Water (process)*** | **1** | mln.m3 |
| **Waste, non-haz./ landfill*** | **60** | kton |
| **Waste, hazardous/ incinerated*** | **13** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **1** | mt CO2eq. |
| **Acidifying agents** (AP) | **3** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **0** | g i-Teq. |
| **Heavy Metals** (HM) | **1** | ton Ni eq. |
| **PAHs** | **1** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **2** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 0 | ton Hg/20 |
| **Eutrophication** (EP) | 0 | kt PO4 |

***=caution: low accuracy for production phase**

### 5.4.5. Aggregated EU totals for base case V5

Table 47 shows the MEEuP EcoReport results for the EU total impact assessment of Base Case V5 (IJ-MFD Personal). In order to provide a balanced view on the product related impacts we excluded paper consumption in the right column of the table. The specific impact of paper is in the case of the two inkjet base cases less significant due to the relatively low print volume. This has been discussed in the single base case assessments already. In order to put the impact of Base Case V5 into perspective of the whole EU imaging equipment market a comparative analysis of all base case results will follow in Section 5.4.7.

**Table 47: Base Case V5 summary environmental impacts for EU-stock**

Incl. Paper

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case V5_IJ-MFD-Personal (incl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **47** | PJ |
| *of which, electricity* | 2,1 | TWh |
| **Water (process)*** | **30** | mln.m3 |
| **Waste, non-haz./ landfill*** | **750** | kton |
| **Waste, hazardous/ incinerated*** | **62** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **2** | mt CO2eq. |
| **Acidifying agents** (AP) | **10** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **2** | ton Ni eq. |
| **PAHs** | **4** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **8** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 2 | ton Hg/20 |
| **Eutrophication** (EP) | 2 | kt PO4 |

***=caution: low accuracy for production phase**

Excl. Paper

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case V5_IJ-MFD-color (excl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **33** | PJ |
| *of which, electricity* | 1,9 | TWh |
| **Water (process)*** | **3** | mln.m3 |
| **Waste, non-haz./ landfill*** | **726** | kton |
| **Waste, hazardous/ incinerated*** | **62** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **2** | mt CO2eq. |
| **Acidifying agents** (AP) | **9** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **2** | ton Ni eq. |
| **PAHs** | **4** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **7** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 2 | ton Hg/20 |
| **Eutrophication** (EP) | 0 | kt PO4 |

***=caution: low accuracy for production phase**

### 5.4.6. Aggregated EU totals for base case V6

Table 48 shows the MEEuP EcoReport results for the EU total impact assessment of Base Case V6 (IJ-MFD Workgroup). In order to provide a balanced view on the product related impacts we excluded paper consumption in the right column of the table. The specific impact of paper is in the case of the two inkjet base cases less significant due to the relatively low print volume. This has been discussed in the single base case assessments already. In order to put the impact of Base Case V6 into perspective of the whole EU imaging equipment market a comparative analysis of all base case results will follow in Section 5.4.7.

**Table 48: Base Case V6 summary environmental impacts for EU-stock**

**Incl. Paper**

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case V6_IJ-MFD-Workgroup (incl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **39** | PJ |
| *of which, electricity* | 1,2 | TWh |
| **Water (process)*** | **35** | mln.m3 |
| **Waste, non-haz./ landfill*** | **618** | kton |
| **Waste, hazardous/ incinerated*** | **50** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **1** | mt CO2eq. |
| **Acidifying agents** (AP) | **8** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **2** | ton Ni eq. |
| **PAHs** | **3** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **7** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 1 | ton Hg/20 |
| **Eutrophication** (EP) | 2 | kt PO4 |

***=caution: low accuracy for production phase**

**Excl. Paper**

**Table . Summary Environmental Impacts EU-Stock 2005, Base Case V6_IJ-MFD-workgroup (excl. Paper)**

| main life cycle indicators | value | unit |
|---|---|---|
| **Total Energy (GER)** | **21** | PJ |
| *of which, electricity* | 1,0 | TWh |
| **Water (process)*** | **2** | mln.m3 |
| **Waste, non-haz./ landfill*** | **584** | kton |
| **Waste, hazardous/ incinerated*** | **50** | kton |
| Emissions (Air) | | |
| **Greenhouse Gases** in GWP100 | **1** | mt CO2eq. |
| **Acidifying agents** (AP) | **6** | kt SO2eq. |
| **Volatile Org. Compounds** (VOC) | **0** | kt |
| **Persistent Org. Pollutants** (POP) | **1** | g i-Teq. |
| **Heavy Metals** (HM) | **2** | ton Ni eq. |
| **PAHs** | **3** | ton Ni eq. |
| **Particulate Matter** (PM, dust) | **6** | kt |
| Emissions (Water) | | |
| **Heavy Metals** (HM) | 1 | ton Hg/20 |
| **Eutrophication** (EP) | 0 | kt PO4 |

***=caution: low accuracy for production phase**

### 5.4.7. Comparative analysis of all base case assessments

The following comparative EU totals impact assessment of the stock aggregated base cases takes mainly the environmental impact category Total Energy (GER) as common indicator. We intend to put the impacts of the single base cases into an overall perspective to the imaging equipment stock in the European Union with the reference year 2005.

The first conclusion from the assessment is related to the tremendous environmental impact of office paper. As a matter of fact paper is a resource intensive material. The manufacturing of paper requires large amounts of water and energy which is also reflected in the resource impact categories waste. According to the MEEuP EcoReport assessment results, Total Energy (GER) impact of the combined six base cases for the EU stock in 2005 is 735 PJ of which 586 PJ or 80% are related to paper consumption (see Figure 21).

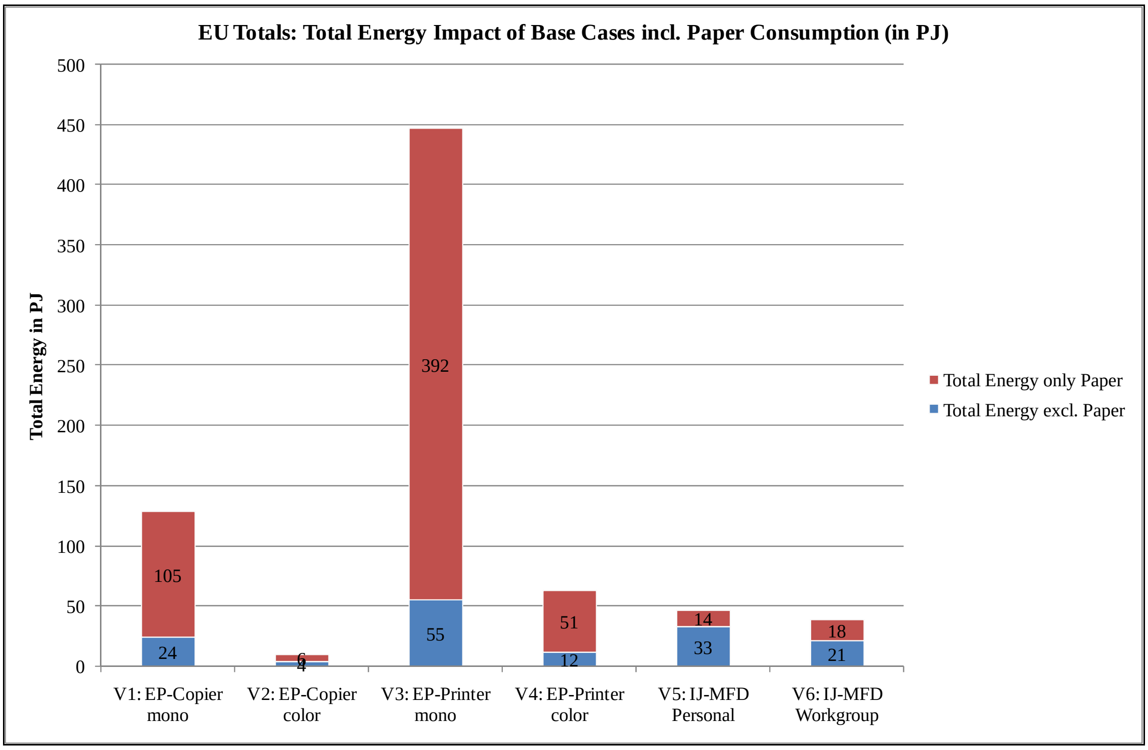


**Figure 21: Total Energy impact of base cases including paper (EU totals)**

The MEEuP EcoReport projects the generation and distribution of paper into the impact assessment of the use phase. But paper consumption is relative. Therefore, a comparative impact assessment should exclude paper in order to detect product design specific environmental aspects. Figure 22 shows the Total Energy (GER) impact of the stock aggregated base case segments according to lifecycle phases without paper consumption. Figure 23 shows the distribution of the impact per lifecycle phase (excl. paper).

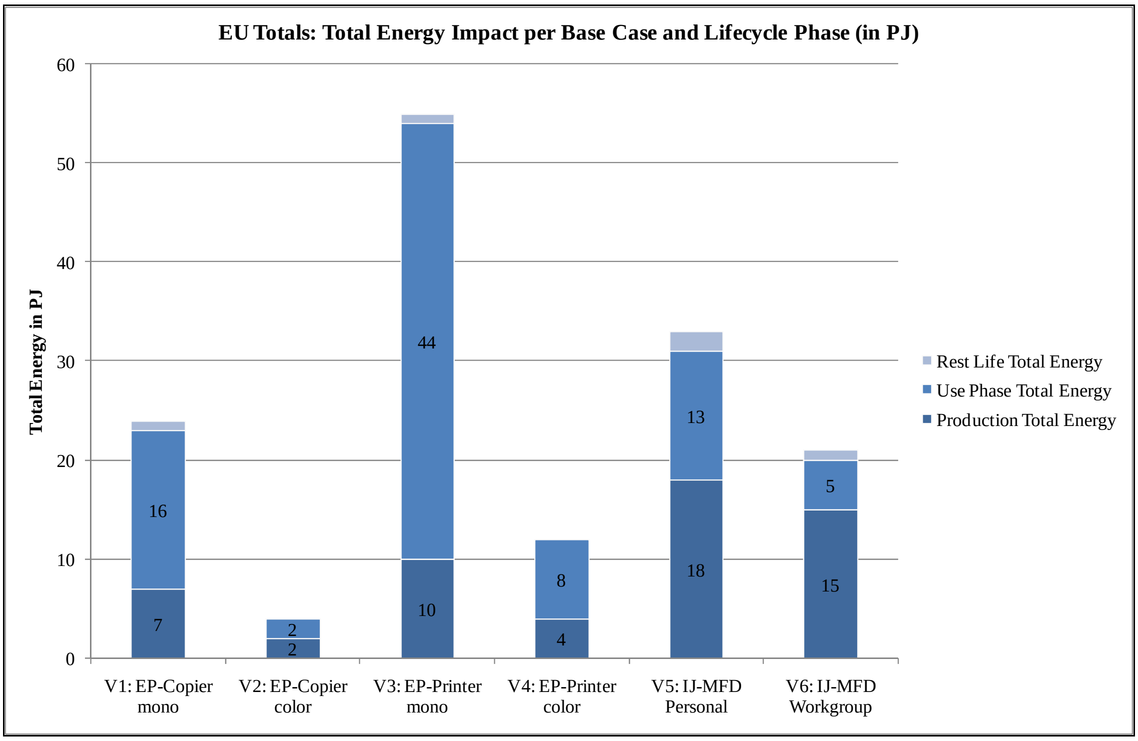


**Figure 22: Total energy impact per base case and lifecycle phase excluding paper (EU totals)**

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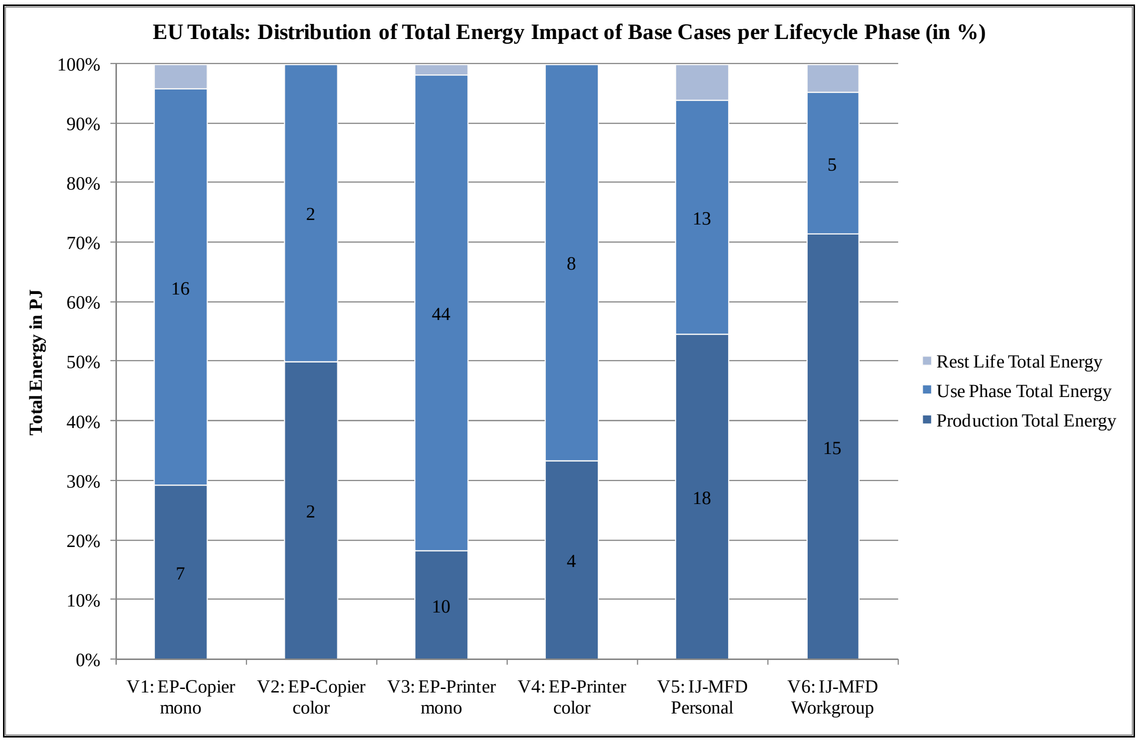


**Figure 23: Distribution of total energy impact per base case segment excluding paper (EU totals)**

When comparing the aggregated base case segments (see Figure 22 and Figure 23) we notice for the monochrome EP-Products (V1 and V3) that the primary environmental impact is related to the use phase. More than 65% of the eco-impact is related to the use phase in the case of the EP-Copier/MFD monochrome and 80% in the case of the EP-Printer/SFD monochrome. Regarding the colour EP-Products (V2 and V4) still the use phase has the highest impact. However due to the higher material mass of the product – please notice that the base case V2 has an average weight of 143 kg – the production phase contributes considerably to the overall impact.

Concerning the IJ-MFDs the primary environmental impact is also generated in the manufacturing phase. Although the material mass of the IJ-Products is low the even low image creation volume of both base cases V5 and V6 results in relatively high environmental impact related to the production phase. That however does not mean that in all product cases the use phase is less important. Figure 24 indicates that the total energy consumption in the use phase related to the six base cases is 6.19 TWh. This result is mainly influenced by energy consumption data that have been made available by the industry partners for their products. Concerning the EP-products (base cases V1 to V4) the energy consumption was based on Energy Star TEC values which may not reflect a prolonged ready and sleep mode phase. In reality the allowed default time settings of more than one hour would lead to considerably higher energy consumption depending on the actual time between print jobs. The possible impact of such situation is demonstrated in the Task 7 scenarios. We have to conclude that real life energy consumption might be considerably higher by up to 50%. The approximately realistic electricity consumption is 10 TWh/a. This value is in comparison to other product groups still moderate

According to feedback from the German UBA the value for the total energy consumption in Europe is much higher when extrapolated from the German ISI-Study[15]. In this study the energy consumption for household and office devices was calculated for 2001, 2004, 2010 and 2015. To compare these data with the value calculated via the six base cases, we have extrapolated the ISI data for Germany (2004) based on the following assumptions. In a first step we allocated the German data to the population of the EU-5 countries UK, France, Germany, Italy and Spain. Then we assumed that EU-5 represent approximately 70% of EU-25 total. Through that assumption we received respective data for the European Union product stock and energy consumption. The value for the energy consumption calculated in this way is indeed, as commented from UBA, with 20.8 TWh about 3.4 times higher than the value calculated via the base cases or double compared to the assumed 10 TWh/a, but there is also a big mismatch regarding the stock. Extrapolating the

[15] Study by Fraunhofer ISI: „Technische und rechtliche Anwendungsmöglichkeiten einer verpflichtenden Kennzeichnung des Leerlaufverbrauchs strombetriebener Haushalts- und Bürogeräte“, Schlomann, Barbara; Cremer; Clemens; Friedewald, Michael; Georgieff, Peter; Gruber, Edelgard; Corradini, Roger; Kraus, Dietmar; Arndt, Ulli; Mauch, Wolfgang; Schaefer, H.; Schulte, Martin; Schröder; Rainer, (2005), BMWi Dienstleistungsvorhaben 53/03, available at: http://publica.fraunhofer.de/eprints/N-33208.pdf (2007/11/30)

ISI-figures would lead to an EU-25 stock of 220.0 Mio devices (not including facsimiles and scanners) compared to 113.2 Mio devices calculated in this study (factor ~ 1.7). Regarding the different stock, the assumptions for the energy consumption are not so different for the ISI-Study (20.8 TWh/a) and this Lot 4 study (10 TWh/a).

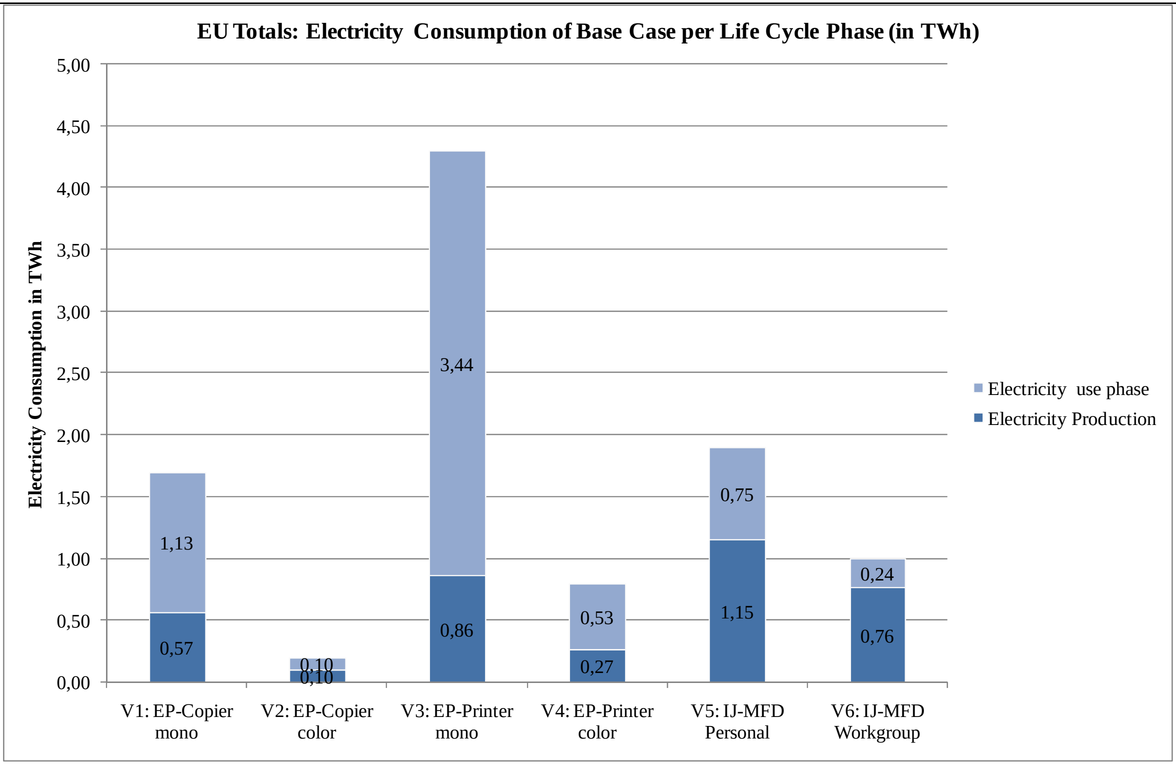


**Figure 24: Energy consumption of aggregated base case segments per life cycle excl paper (EU totals)**

These first results from the MEEuP EcoReport need further discussion. The high impact of paper correlates with the use pattern assumption and the application of TEC methodology for base cases V1 to V4 in particular. In order to put the results of the base case assessments into perspective, we calculated an adjustment factor based on available market data. InfoTrends provides an estimate for image creation volume or page output per product segment. Based on these figures we calculated the difference between the image creation volume according to the base case assumptions and the data provided by InfoTrends (see Table 49).

**Table 49: Calculation of real life paper consumption impact based on InfoTrends market data**

| BC | Product Segment | 2005 EU Stock (in 1000 units) | Image Volume according to InfoTrends data (in 1000 pages) | Image Volume according to base case assessments (in 1000 pages) | Factor of difference | Total Energy (GER) according to base case assessments (EU stock in PJ) | Total Energy (GER) with adjustment to InforTrends data (EU stock in PJ) |
|---|---|---|---|---|---|---|---|
| **V1** | EP-Copier mono | 5.970 | | *87880 | | 105 | |
| **V2** | EP-Copier color | 381 | | *87880 | | 6 | |
| | **EP-Copier (total)** | **6.351** | **129.000.000** | **558.125.880** | **4,3** | **111** | **26** |
| **V3** | EP-Printer mono | 14.735 | | *133120 | | 392 | |
| **V4** | EP-Printer color | 1.919 | | *133120 | | 51 | |
| | **EP-Printer (total)** | **16.654** | **439.000.000** | **2.216.980.480** | **5,1** | **443** | **88** |
| **V5** | IJ-Printer SFD | 68.412 | | **1040 | | 14 | |
| **V6** | IJ-Printer MFD | 21.760 | | **3900 | | 18 | |
| | **IJ-Printer (total)** | **90.172** | **79.000.000** | **156.012.480** | **2,0** | **32** | **16** |
| | Facsimile SFD | 13.241 | | | | | |
| | Facsimile MFD | 6.890 | | | | | |
| | **Facsimile (total)** | **20.131** | **28.000.000** | **28.000.000** | **1,0** | 6 | **6** |
| **Total** | **all products** | **133.308** | **675.000.000** | **2.959.118.840** | **4,4** | 592 | **136** |
| * paper volume of single base case V1 to V4 according to TEC methodology | | | | | | | |
| ** paper volume of single base cases V5 to V6 according to own use pattern assumption | | | | | | | |

According to this calculation[16] our adjusted Total Energy impact of paper consumption (real life scenario) is 136 PJ in total. This equals an adjustment factor of 4.4 over all segments[17]. A direct correlation of the adjusted paper consumption impacts (see Table 49) with the product-related environmental impact results excl. paper (see Figure 22) seems inaccurate because the use phase's energy and toner/ink consumption results would need adjustment as well. Such adjustment would ask for new "TEC pattern-specific" energy consumption values for the base cases V1 to V4. These data could not be obtained. However, we can calculate a rough adjustment factor by modeling the base case's energy consumption values based on the TEC methodology on the one hand and energy consumption estimates per mode on the other hand.

Table 50 provides a model of a possible daily use pattern for EP-Copier/MFD monochrome (V1) reflecting the weekly energy consumption according the TEC based value (4.81 kWh/week) we used for the assessment. The resulting 4.76 kWh/week in our model correlates very well with the 4.81 kWh/week used in the base case V1 assessment. This result indicates that the assumed energy consumption values and the daily use pattern are realistic for a scenario.

[16] In this calculation we included the available data for facsimile machines.
[17] According to feedback from EICTA this is overestimated and the "real life estimate" should be used.

**Table 50: Model of TEC based use pattern for base case V1**

| V1: EPCMM | TEC use pattern: 26 jobs X 13 images (26 ipm) | | | | Scenario 1: 15 min Ready | |
|---|---|---|---|---|---|---|
| **Mode** | **Active** | **Ready** | **Sleep** | **Off** | **Day** | **Week kWh** |
| Power (W) | 600 | 110 | 20 | 0 | | |
| hours/day | 0,22 | 6,50 | 5,28 | 12,00 | 24,00 | |
| Use (Wh/d) | 132,00 | 715,00 | 105,60 | 0,00 | 952,60 | **4,76** |
| **Comments:** 4,76 kWh/week correlates with the 4,81 kWh/week which is the average value used in the Base Case V1 assessment. This result indicates that the assumed power consumption values and the daily use pattern are realistic for a scenario. | | | | | | |

Now we adjust the use pattern by factor 4.4. Instead of 26 jobs per day only 6 jobs per day with 13 images each are calculated. We keep the 15 minutes ready mode time after each job and extent the sleep mode time duration to a total of 10.45 hours. As a result the weekly energy consumption drops to 2.02 kWh/week which equals a reduction factor 2.4 (see Table 51).

**Table 51: Model of adjusted use pattern for base case V1**

| V1: EPCMM | Adjusted use pattern: 6 jobs X 13 images (Factor 4,5) | | | | Scenario 1: 15 min Ready | |
|---|---|---|---|---|---|---|
| **Mode** | **Active** | **Ready** | **Sleep** | **Off** | **Day** | **Week kWh** |
| Power (W) | 600 | 110 | 20 | 0 | | |
| hours/day | 0,05 | 1,50 | 10,45 | 12,00 | 24,00 | |
| Use (Wh/d) | 30,00 | 165,00 | 209,00 | 0,00 | 404,00 | **2,02** |
| **Comments:** The application of adjustment factor 4,5 to the number of jobs per day (26/4,5 = 5,8) rounded to a total of 6 jobs, results under the assumption of a similar 15 min. ready mode use pattern in a reduction in power consumption by factor 2,36. | | | | | | |

In order to show that a similar value results also for other base cases Table 52 and Table 53 provides the same kind of calculation for the EP-Printer/SFD monochrome (base case V3). The calculation results in a energy consumption reduction factor of 2.5.

**Table 52: Model of TEC based use pattern for base case V3**

| V3: EPPSM | TEC use pattern: 32 jobs X 16 images (32 ipm) | | | | Scenario 1: 15 min. ready | |
|---|---|---|---|---|---|---|
| **Mode** | **Active** | **Ready** | **Sleep** | **Off** | **Day** | **Week kWh** |
| Power (W) | 550 | 100 | 20 | 0 | | |
| hours/day | 0,27 | 8,00 | 3,73 | 12,00 | 24,00 | |
| Use (Wh/d) | 148,50 | 800,00 | 74,60 | 0,00 | 1.023,10 | **5,12** |
| **Comments:** 5,12 kWh/week correlates with the 5,91 kWh/week which is the average value used in the Base Case V1 assessment. This result indicates, that the assumed power consumption values and the daily use pattern is realistic for a scenario. | | | | | | |

**Table 53: Model of adjusted use pattern for base case V3**

| V3: EPPSM | Adjusted use pattern: 7 jobs X 16 images (Factor 4,5) | | | | Scenario 1: 15 min. ready | |
|---|---|---|---|---|---|---|
| **Mode** | **Active** | **Ready** | **Sleep** | **Off** | **Day** | **Week kWh** |
| Power (W) | 550 | 100 | 20 | 0 | | |
| hours/day | 0,06 | 1,75 | 10,19 | 12,00 | 24,00 | |
| Use (Wh/d) | 33,00 | 175,00 | 203,80 | 0,00 | 411,80 | **2,06** |
| **Comments:** The application of adjustment factor 4,5 to the number of jobs per day (32/4,5 = 7,1) rounded to a total of 7 jobs, results under the assumption of a similar 15 min. ready mode use pattern in a reduction in power consumption by factor 2,48. | | | | | | |

If we now apply an average reduction factor 2 to the energy consumption in the use phase, in terms of the impact category Total Energy (GER) the result would indicate that the production phase is the primary source of the environmental impact of office imaging equipment (see Figure 25).

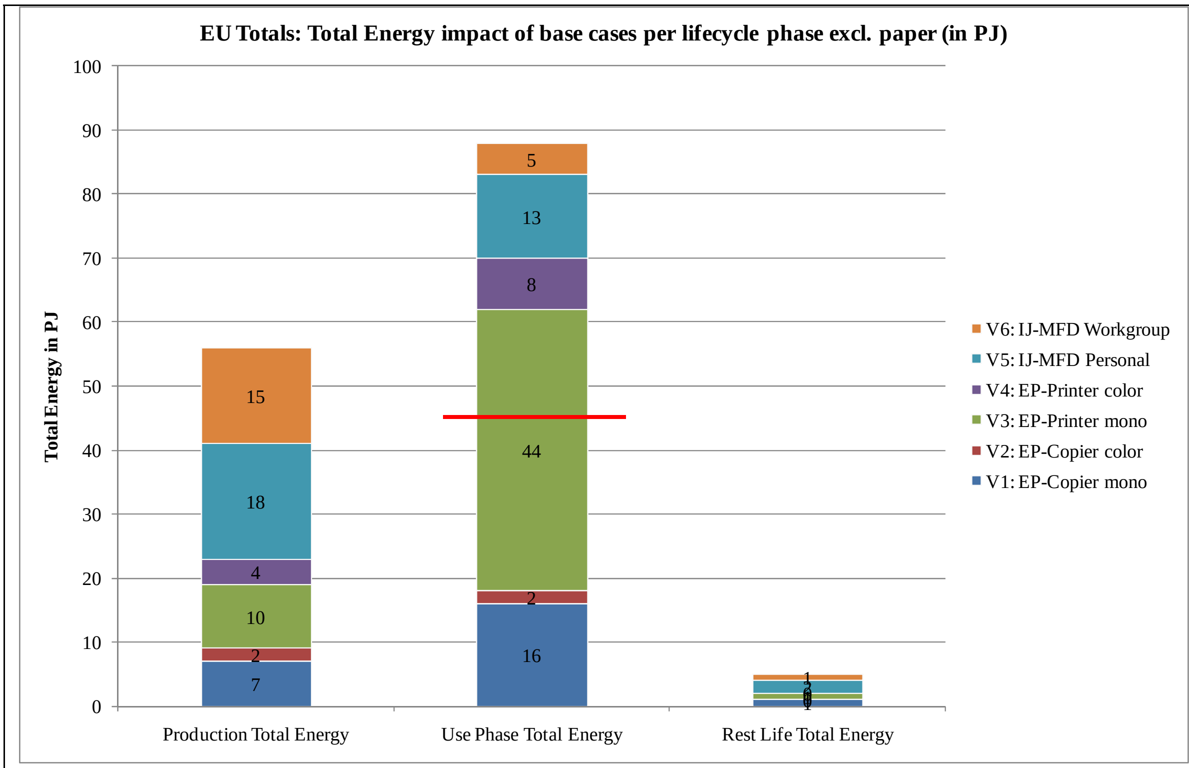


**Figure 25: Total Energy impact aggregated per life cycle phase excl. paper (EU totals)**

### 5.4.8. Conclusions

The environmental impact assessment provides an orientation for the priority setting in product eco-design. These priorities have to be matched with the actual eco-design improvement potential which will be assessed in Task 6. In this final part of the Task 5 report we would like to exemplify some priorities for product improvement resulting from the base case assessments.

The assessment shows that the environmental impact of high volume products with short life cycles such as the IJ-MFDs is mainly related to the production phase and the relative quantities of bulk materials and electronic components in particular. In this case a plausible eco-design strategy would include the further miniaturization of the products, less diversity of materials, recycling optimized material selection and physical product design. In reality however, desktop IJ-Products have been miniaturized over the past years already to very large extent. This higher integration required the utilization of functional materials which in turn increased material diversity. A good example for this trend is the higher integration of electronics, where in total less material is utilized but the diversity and value of the material mix is increasing. A detailed environmental assessment would be necessary to indicate to what extent higher integration reduces environmental impacts in field of electronics (components and board technology). The utilization of advanced electronics provides to the customer more functionality and usually reduces energy consumption. In terms of product eco-design a very fine balance therefore has to be found between the choice/utilization of materials and advanced components on the one hand and the impact of these components in terms of production related environmental impacts on the other hand.

A second example is the EP-Product. In general, EP-Products are much more intensively used and therefore designed for higher volume output over a longer product lifetime. They come as desktops for low and medium speed as well as freestanding machines in all speed classes. The assessments indicated that heavier freestanding machines generate a considerable environmental impact through high mass of materials such as Bulk Plastics and Ferro metals. That does not mean however, that the environmental improvement strategy should focus on material utilization in the first place. In contrary, the use optimization has priority and the better improvement potential. A machine that can print or copy hundreds of document pages in a few minutes creates a high value for the customer. It is therefore necessary that such a machine gets used constantly (see Task 3 report on user behavior for further discussion of this issue). In parallel, that means that such a machine should be very reliable and energy efficient over lifetime. Energy efficiency in turn is determined by the actual image creation volume or use pattern. There are differences is use even for the same machine as we discussed in Task 3 already. The eco-design has to balance for instance mode-specific power consumption and power management options.

In conclusion, the results of the environmental impact assessment only provide a rough orientation for eco-design priorities. Energy efficiency optimization in conjunction with the resource efficient utilization of materials and electronic components are the topics of product improvement. The actual improvement potential of a product case has to be individually assessed in Task 6 and 7.