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Life Cycle Assessment of 3 electrical products

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AREVA T&D and ENSAM

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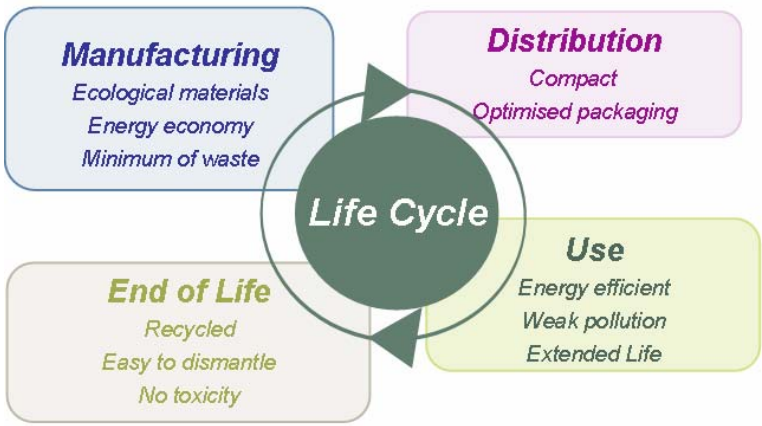
Agenda

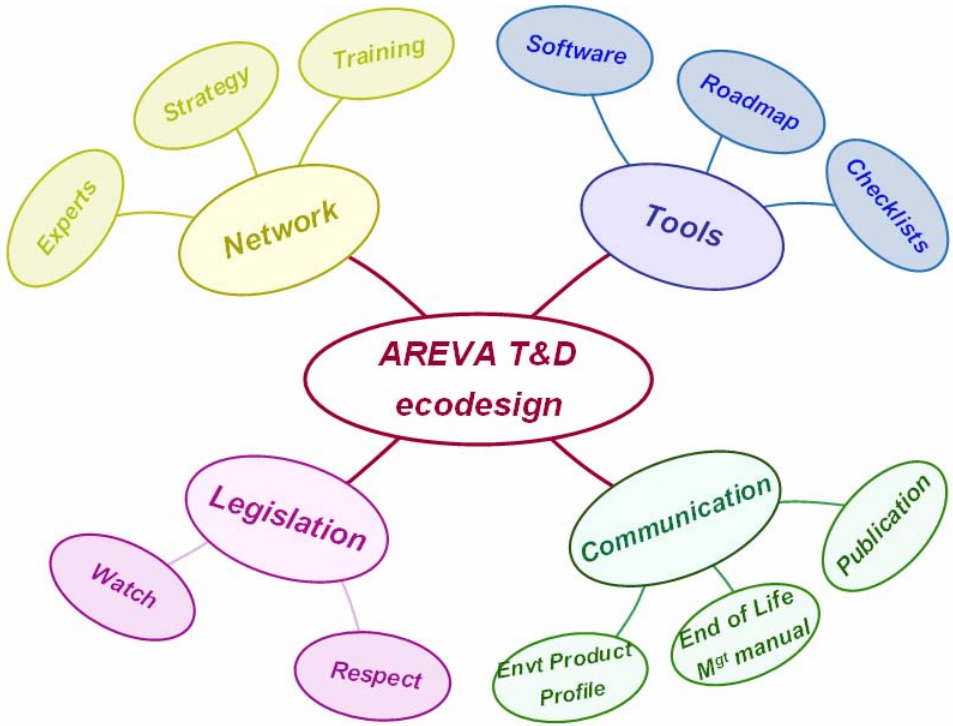
1. Introduction
2. Ecodesign within AREVA T&D
3. Introduction of electrical products
4. LCA of 3 electrical products
5. Conclusions

Ecodesign within AREVA T&D



Ecodesign within AREVA T&D

- Pioneer in ecodesign application since begining of 90’
- Participates in the development of EIME LCA software
- International ecodesign implementation : policy, experts
- Legislation watch
- Communication, training, intranet



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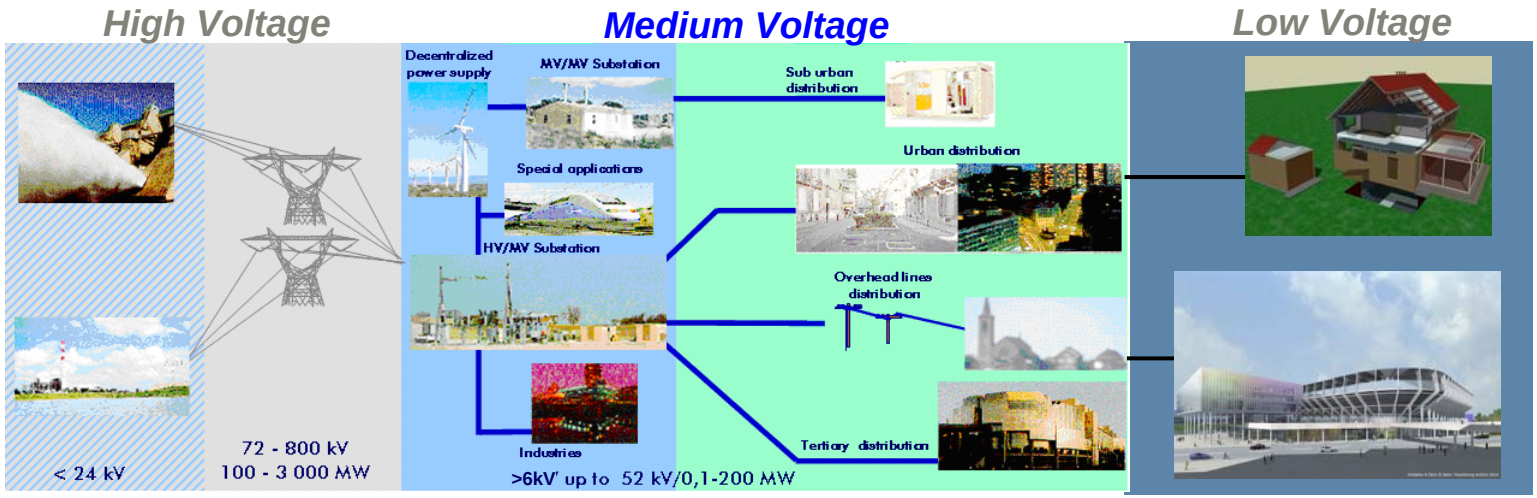
Introduction of electrical products

Introduction of electrical voltage products



- High and medium voltage products are used in power supply networks.
- Classed according to their functions: circuit breaker, disconnector, transformer, etc.
- Free service life > 20 years.
- Different design features from low voltage units.
- Are not concerned by RoHS and WEEE directives

Very important role in the protection and operation of the electrical network

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Life Cycle Assessment of 3 electrical products :

Introduction of selected products

- Low voltage : washing machine
- Medium voltage : air insulated switchgear
- High voltage : power transformer

3 representative products with different voltage level

Introduction of washing machine

A 5 kg capacity standard model : *ref technical report issued in 2002 by Circulos de Innovacion y technologia, university of Cadiz*

Bill of material

Material	Weight (kg)	Percentage (%)
Aluminum	1.21	2
Concrete	21.5	35.54
Copper	2.7	4.46
Iron	16.94	28
Plastic	6.05	10
Steel	10.29	17
Wood	1.82	3
Total	60.5	100

Manufacturing

Process	Quantity	Unit
Machining aluminum	2	kg
Welding, arc, steel	3	m
Injection molding	2	kg
Machining steel	20	kg
Panting	2	m2
Wood preservative treatment	100	cm3
Electroplating Zinc	2	m2
Electroplating Chrome	2	m2

Introduction of washing machine

Ditribution

Distribution	Quantity	Unit
Transport from producer to seller road (sea is negligible) : 50 machines / 1000 km. 16t truck. Full return.	60	tkm
Transport from seller to user. 1 machine / 30 km. delivery van.	30	km

Use (10 years / 2600 programs): the maintenance is not included !

Use	Quantity / *5kg cotton program at 60°*	Quantity /life cycle : 2600 *5kg cotton programs at 60°*	Unit
Electricity (France)	0.95*	2470	kwh
Water	0.046*	119.6	m3
Detergent	0.118*	306.8	kg

*Comparison of four methods for integrating environmental and economic aspects in the end-of-life stage of a washing machine. Pil-Ju Park, Kiyotaka Tahara, In-Tae Jeong, Kun-Mo Lee

Introduction of washing machine

End of Life

End of life	Quantity	Unit
Transport from user to collection point : Delivery van	30	km
Transport from collection point to dismantling	6	tkm
Incineration**	3	%
Recycling**	55,3	%
Landfill**	41,7	%

**An analysis of some environmental consequences of European electrical and electronic waste regulation. Y.Barba-Gutierrez, B.Adenso-Diaz, M.Hopp.

Introduction of Medium Voltage Switchgear

- **The medium voltage switchgear is a vacuum circuit breaker rated 12 kV**
- **3 epoxy poles 31.5kA / 1250A**
- **The operating mechanism is insured by spring mechanism**

Bill of material

Material	Weight (kg)	Percentage (%)
Steel	77	37,94
Stainless steel	0,9	0,44
Brass	1,68	0,83
Copper	82,75	40,77
Aluminium	16,7	8,23
EPDM	0,3	0,15
PC	0,19	0,09
Epoxy	21,1	10,40
Silicone	0,44	0,22
Ceramics	1,89	0,93
TOTAL	203	100

Manufacturing

Process	Quantity	Unit
Electroplating Chrome	1	m2
Electroplating Zinc	1	m2
Machining steel	78	kg
Injection moulding	0,9	kg
Cutting Al. laser	0,2	m2
Machining aluminium	20	kg
Welding arc, steel	1	m

Introduction of Medium Voltage Switchgear

Ditribution

Distribution	Quantity	Unit
Transport from producer to user road (sea is negligible) : 10 products / 1000 km. 16t truck. Full return.	203	tkm

Use : free of the maintenance during 20 years

Use	Quantity / *h*	Quantity /life cycle : 20 years	Unit
Electricity (France)	0.112	1962	kwh

Introduction of Medium Voltage Switchgear

End of Life

End of life	Quantity	Unit
Transport from user to producer (dismantling) road (sea is negligible) : 10 products / 1000 km. 16t truck. Full return.	203	tkm
Incineration**	14	%
Recycling**	81	%
Landfill**	5	%

Introduction of Power transformer

- The power transformer is an essential element of the electrical network. Its role is to interconnect parts of the network at different rated voltage levels. It is designed to handle all of the specified requirements of each individual network.
- This power transformer works above a power rating of 200 MVA three-phase and at a voltage lower than 800 kV.

Introduction of Power transformer

Bill of material

Material	Weight (ton)	Percentage (%)
Steel	243	61,78
insulation oil	89	22,63
Copper	38,5	9,79
Cardboard	16	4,07
Wood	3,7	0,94
Aluminium	1,8	0,46
Porcelain	1,3	0.33
TOTAL	393.3	100

Manufacturing

Process	Quantity	Unit
Welding arc, steel	10	m
Machining steel	250	t
Electroplating Zinc	10	m2
Electroplating Chrome	10	m2
Wire drawing, copper	40	t
Cutting Al. laser	0,5	m2
Machining aluminum	2	t
Machining wood	4	t
Preservative treatment for wood	0,002	m3

Introduction of Power transformer

Ditribution

Distribution	Quantity	Unit
Transport from producer to user road +sea : 1 product / 1000 km. 400t truck. Empty return	390000	tkm
Transport from producer to user sea : 10 products / 10000 km. ocean frighter	3900000	tkm

Use : free of the maintenance during 20 years

Use	Quantity / *h*	Quantity /life cycle : 40 years	Unit
Electricity (France)	1.6	350000	Mwh

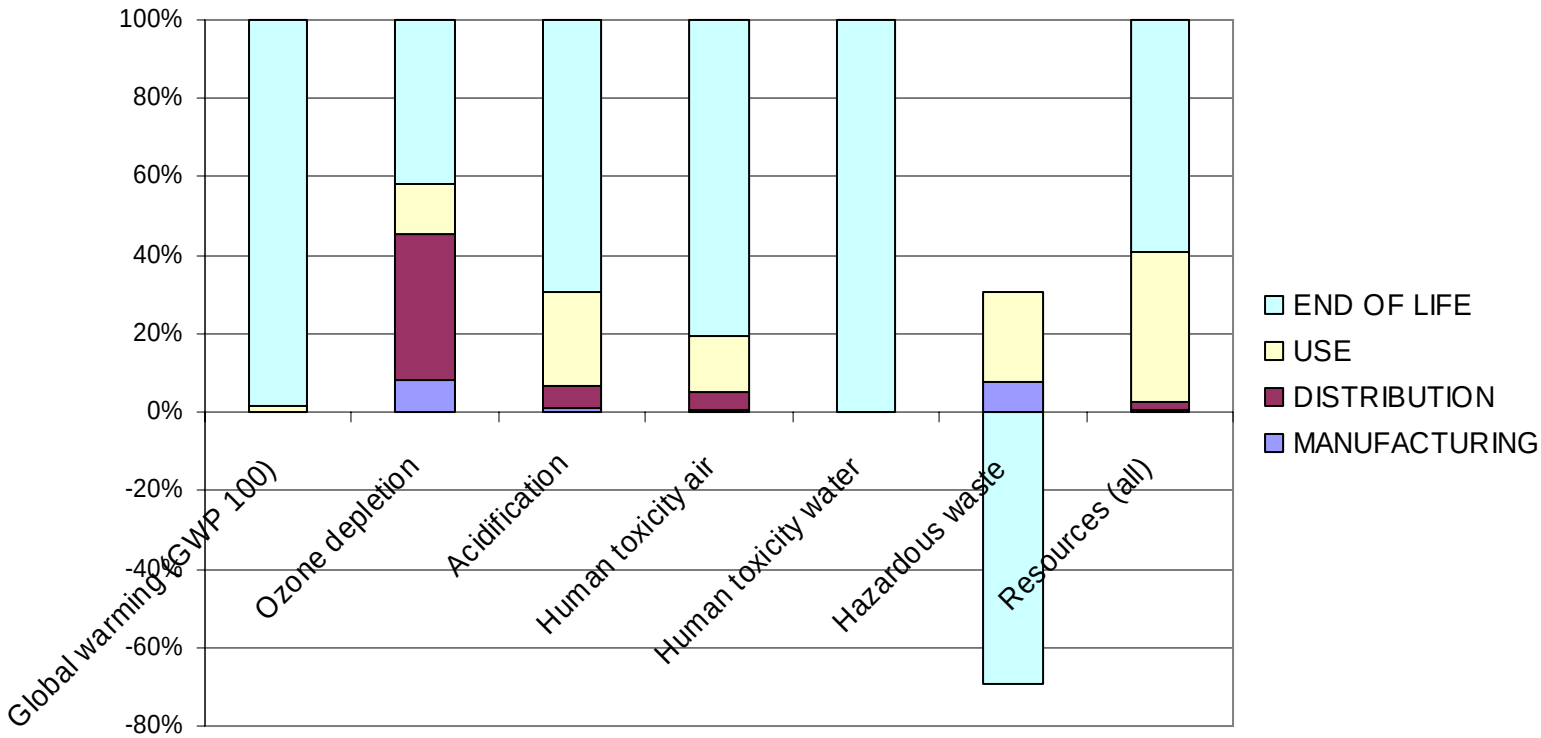
Introduction of Power transformer

End of Life

End of life	Quantity	Unit
Transport from user to : 1 product / 1000 km. 400t truck. Empty return	390000	tkm
Incineration**	24	%
Recycling**	76	%

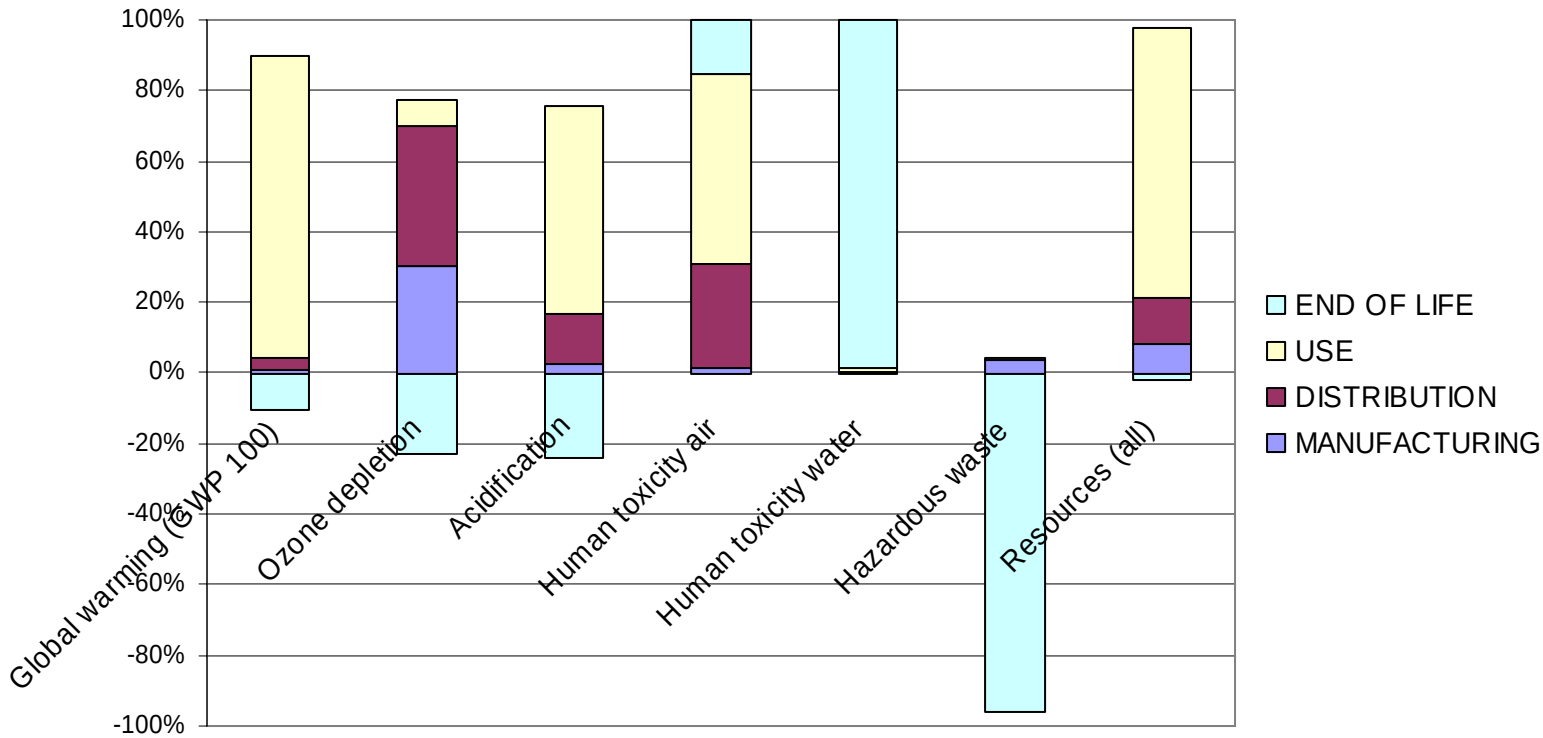
LCA of WASHING MACHINE

Indicator	Unit	MANUFACTURING	DISTRIBUTION	USE	END OF LIFE	TOTAL
Global warming (GWP 100)	g CO2	1,29E+04	7,58E+04	5,39E+05	3,41E+07	3,47E+07
Ozone depletion	g CFC11	2,23E-02	9,95E-02	3,46E-02	1,13E-01	2,69E-01
Acidification	g SO2	1,27E+02	6,41E+02	2,67E+03	7,74E+03	1,12E+04
Human toxicity air	m3	3,83E+06	3,89E+07	1,19E+08	6,66E+08	8,28E+08
Human toxicity water	m3	1,58E+02	2,18E+02	2,08E+04	1,63E+07	1,63E+07
Hazardous waste	kg	1,16E-02	0,00E+00	3,32E-02	-1,02E-01	-5,71E-02
Resources (all)	kg	2,39E-03	7,51E-03	1,33E-01	2,09E-01	3,52E-01



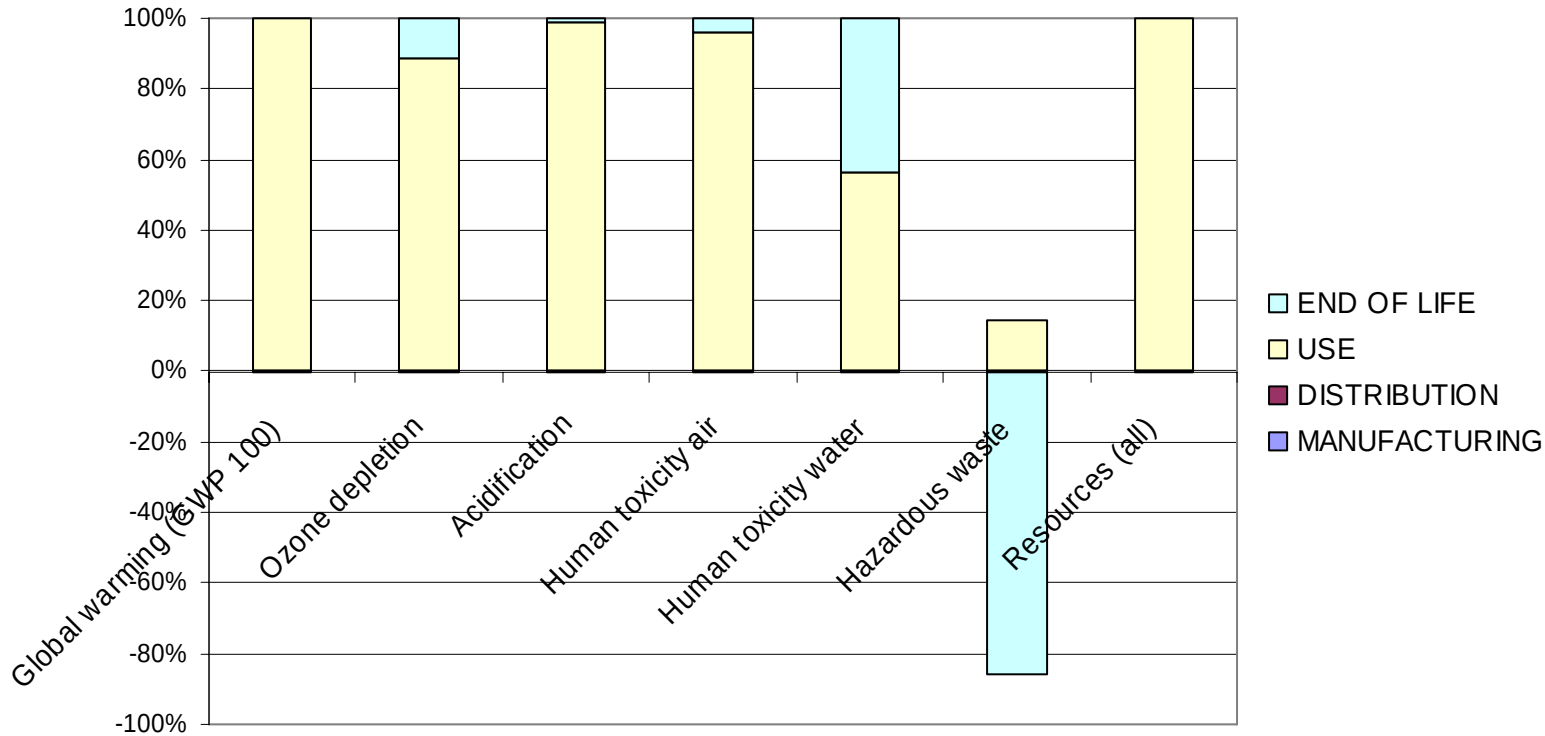
LCA of MV switchgear

Indicator	Unit	MANUFACTURING	DISTRIBUTION	USE	END OF LIFE	TOTAL
Global warming (GWP 100)	g CO2	1,44E+04	7,58E+04	1,83E+06	-2,23E+05	1,70E+06
Ozone depletion	g CFC11	7,53E-02	9,95E-02	1,73E-02	-5,72E-02	1,35E-01
Acidification	g SO2	1,08E+02	6,41E+02	2,68E+03	-1,09E+03	2,34E+03
Human toxicity air	m3	2,14E+06	3,89E+07	7,07E+07	2,06E+07	1,32E+08
Human toxicity water	m3	5,39E+01	2,18E+02	2,97E+03	2,02E+05	2,05E+05
Hazardous waste	kg	3,91E-02	0,00E+00	7,23E-03	-1,08E+00	-1,03E+00
Resources (all)	kg	4,92E-03	7,51E-03	4,46E-02	-1,29E-03	5,58E-02

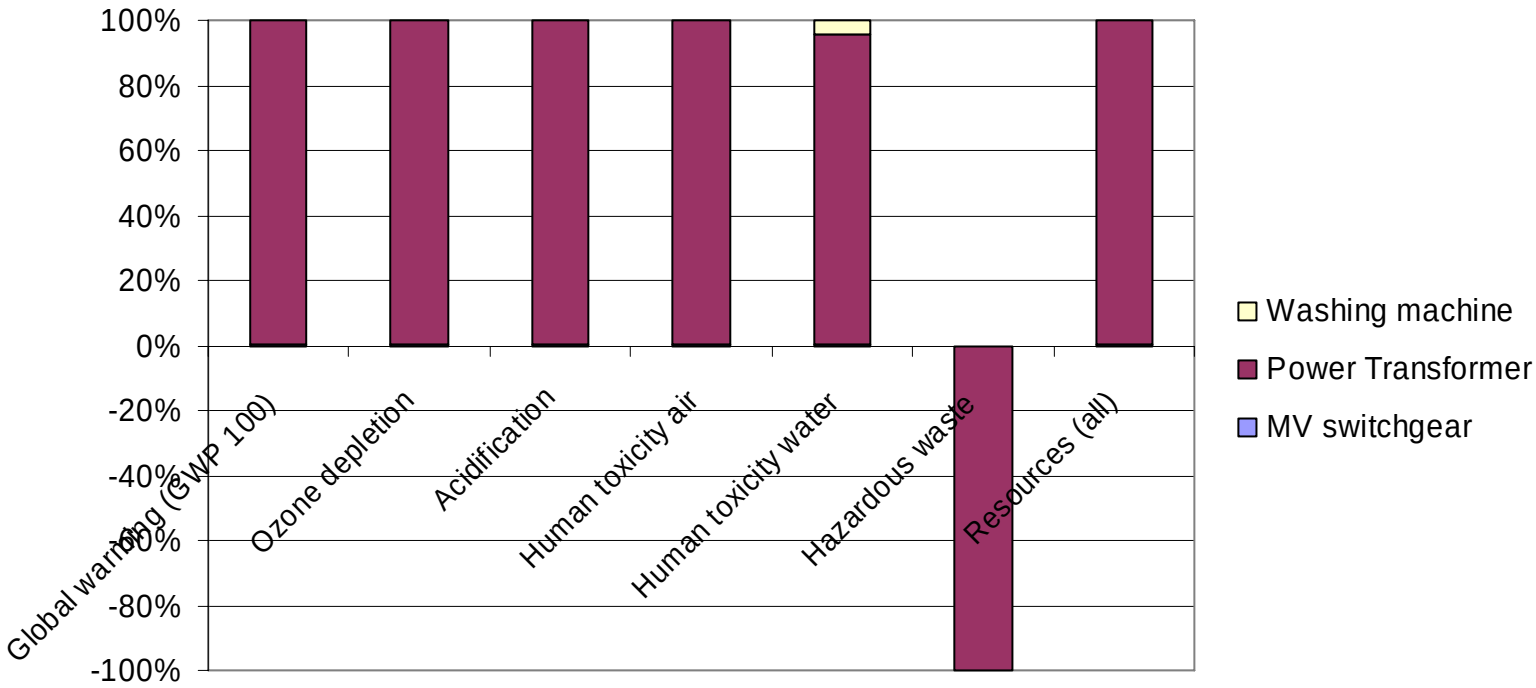


LCA of Power transformer

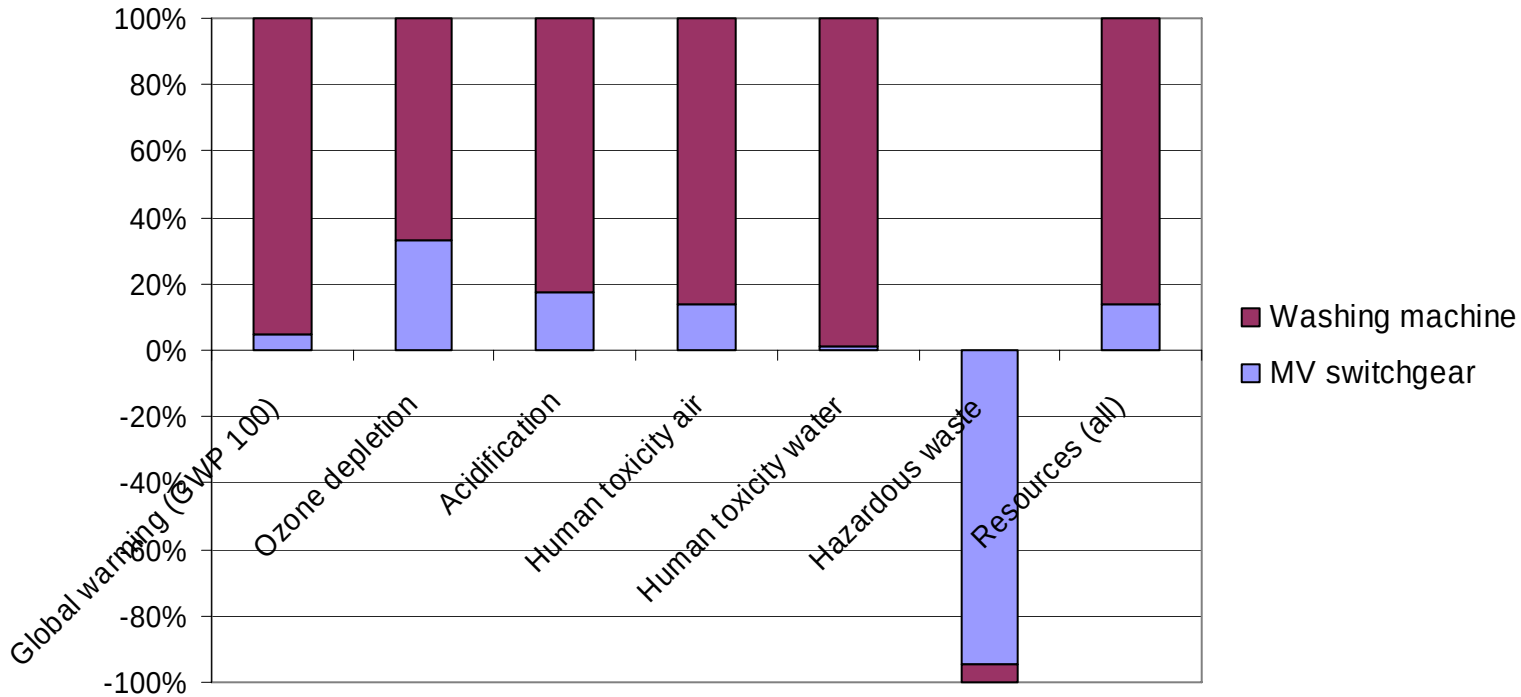
Indicator	Unit	MANUFACTURING	DISTRIBUTION	USE	END OF LIFE	TOTAL
Global warming (GWP 100)	g CO2	1,47E+05	6,83E+07	3,25E+10	1,12E+07	3,26E+10
Ozone depletion	g CFC11	2,46E-01	3,46E-02	1,27E+03	1,60E+02	1,43E+03
Acidification	g SO2	1,21E+03	3,98E+05	1,98E+08	2,41E+06	2,01E+08
Human toxicity air	m3	1,10E+08	3,66E+09	5,21E+12	2,09E+11	5,42E+12
Human toxicity water	m3	1,20E+03	1,28E+04	2,18E+08	1,68E+08	3,86E+08
Hazardous waste	kg	7,48E-01	0,00E+00	5,33E+02	-3,17E+03	-2,64E+03
Resources (all)	kg	7,65E-02	8,33E-01	3,28E+03	1,68E+00	3,28E+03



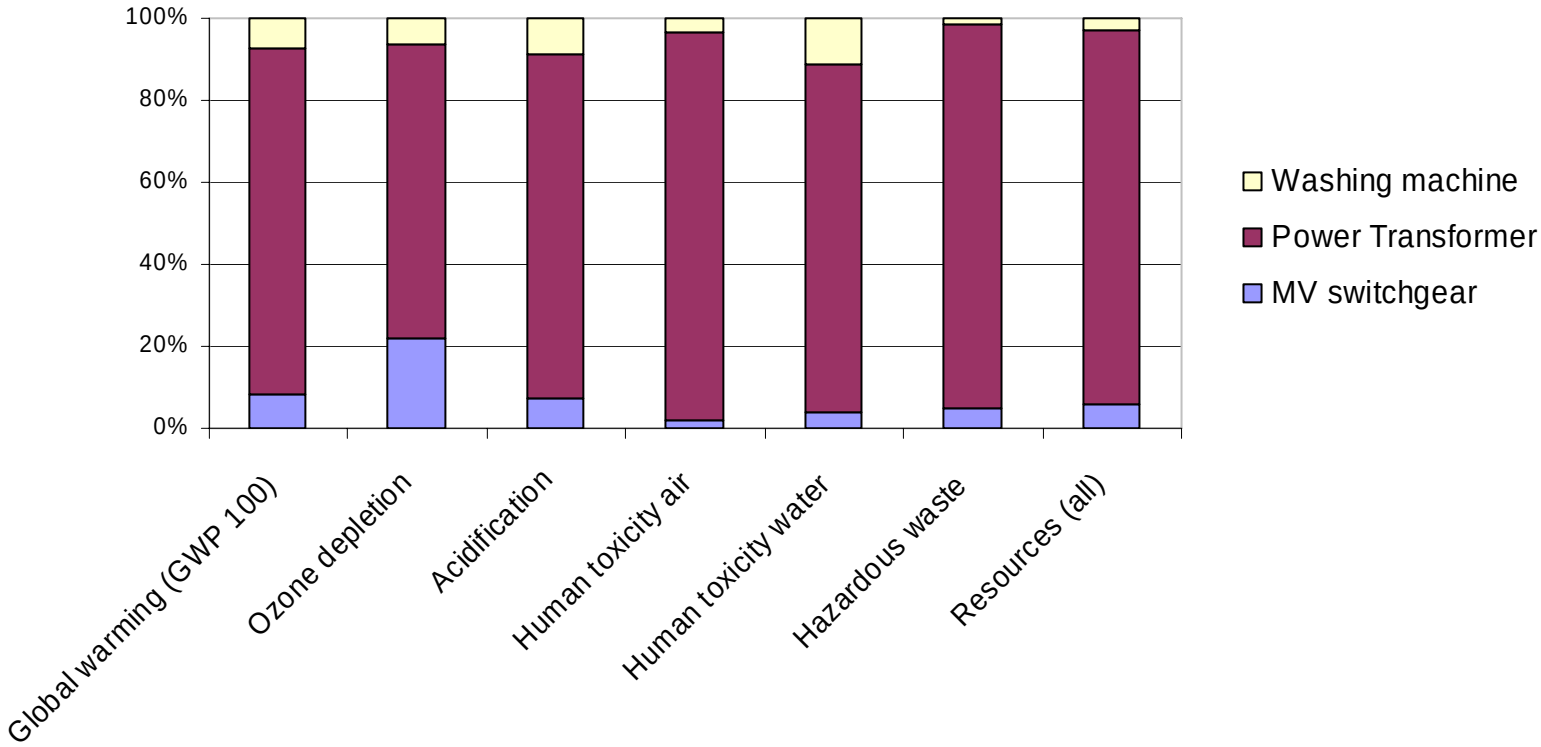
Global Life Cycle comparison



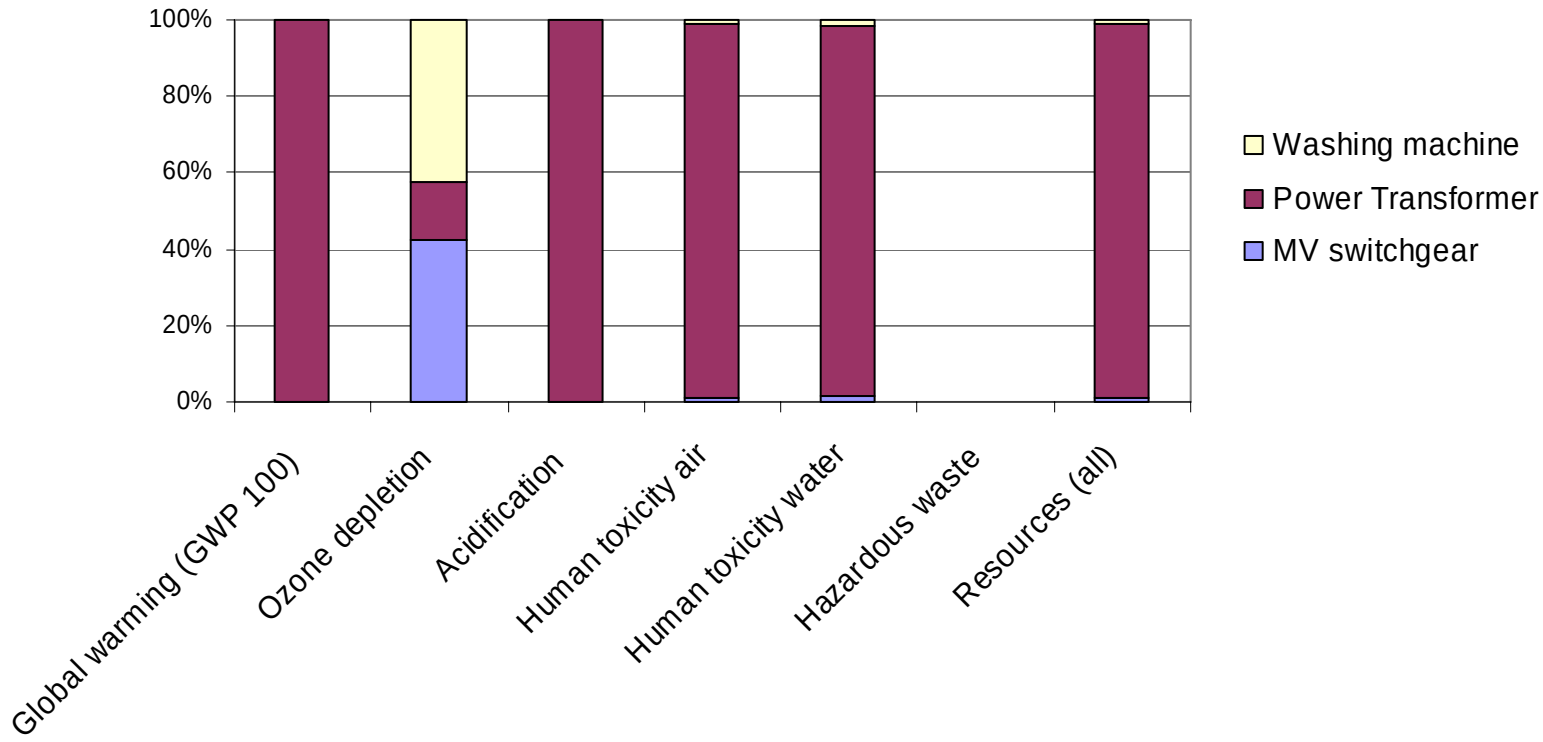
»Global Life Cycle comparison washing machine/switchgear



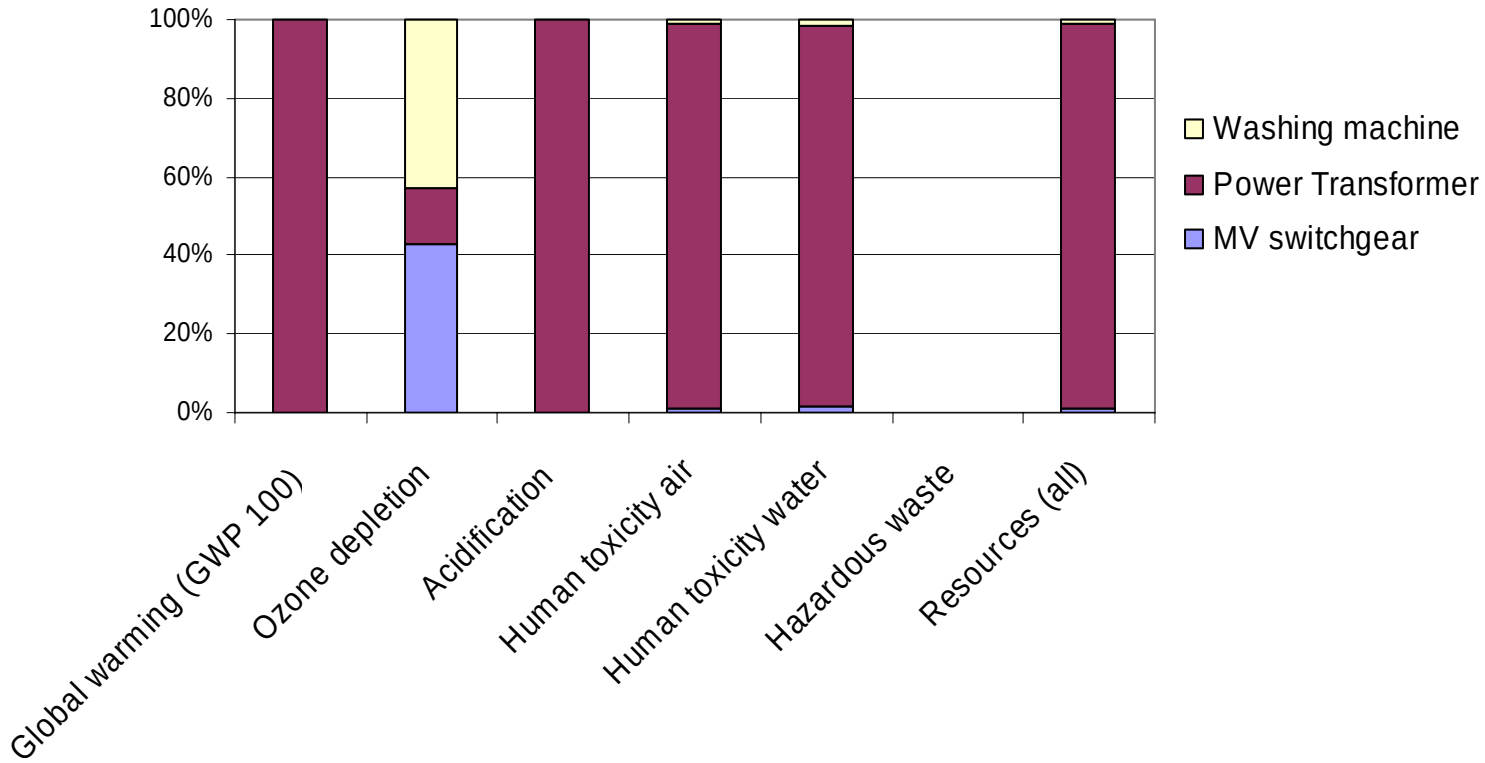
Manufacturing phase comparison



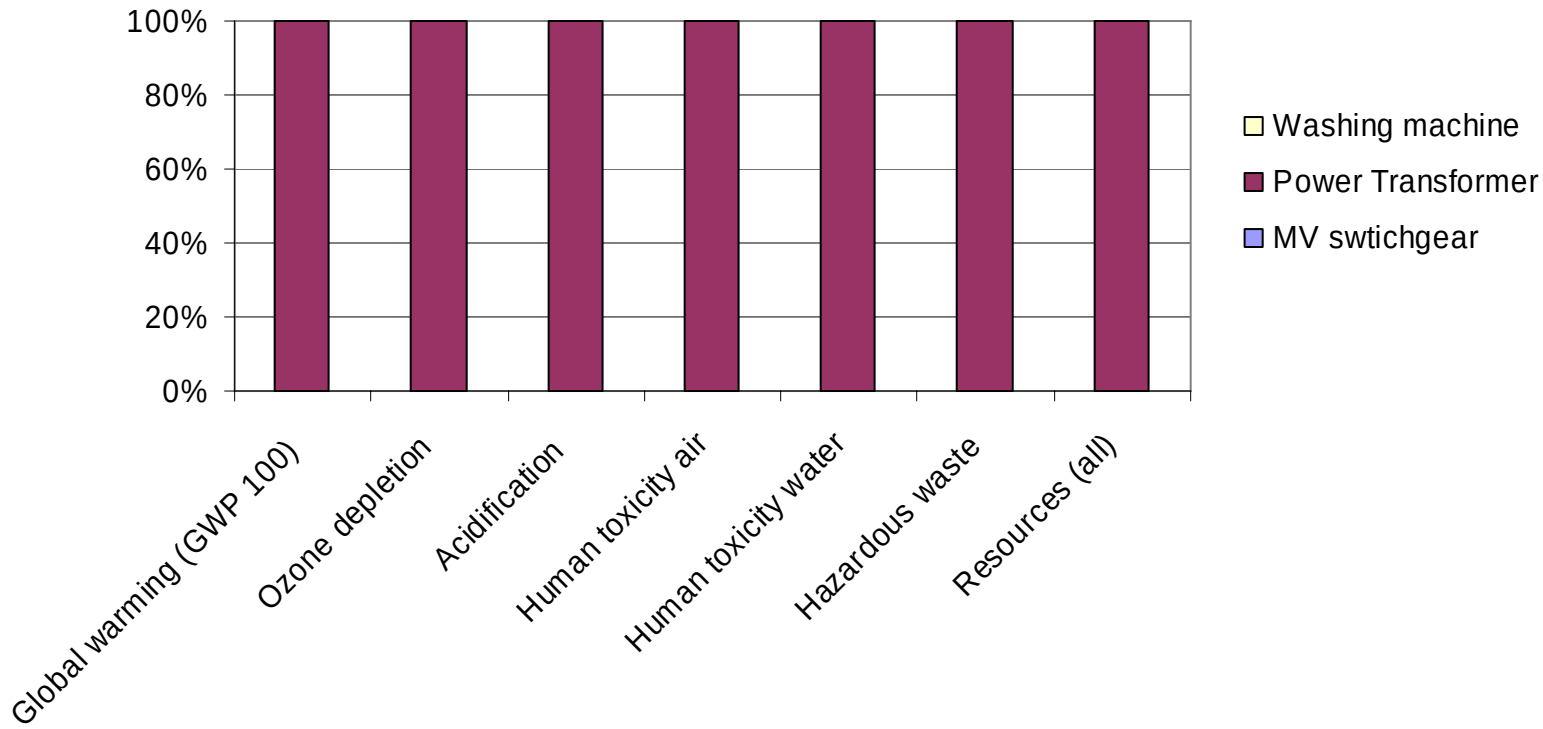
Distribution phase comparison



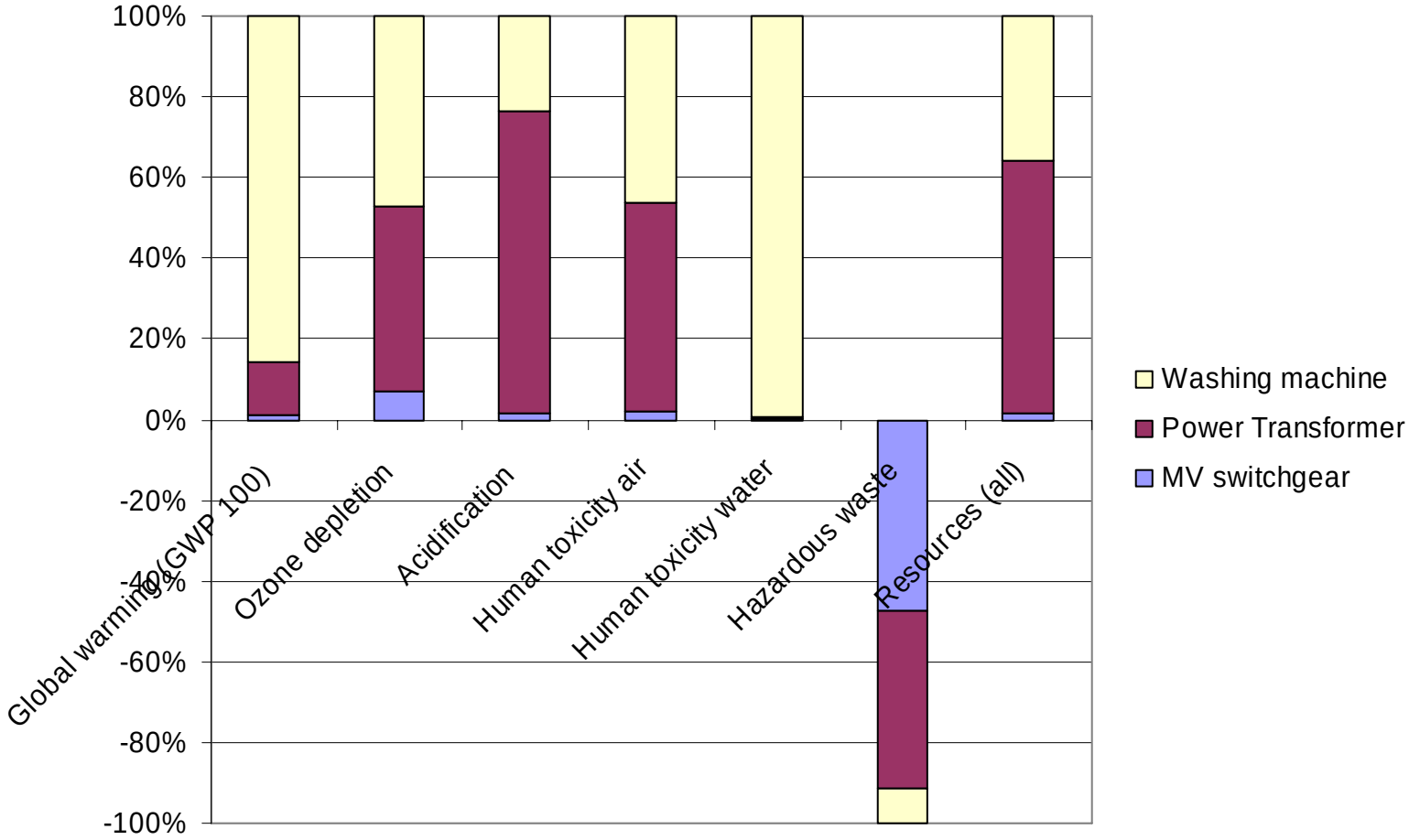
Use phase comparison



End of Life phase comparison

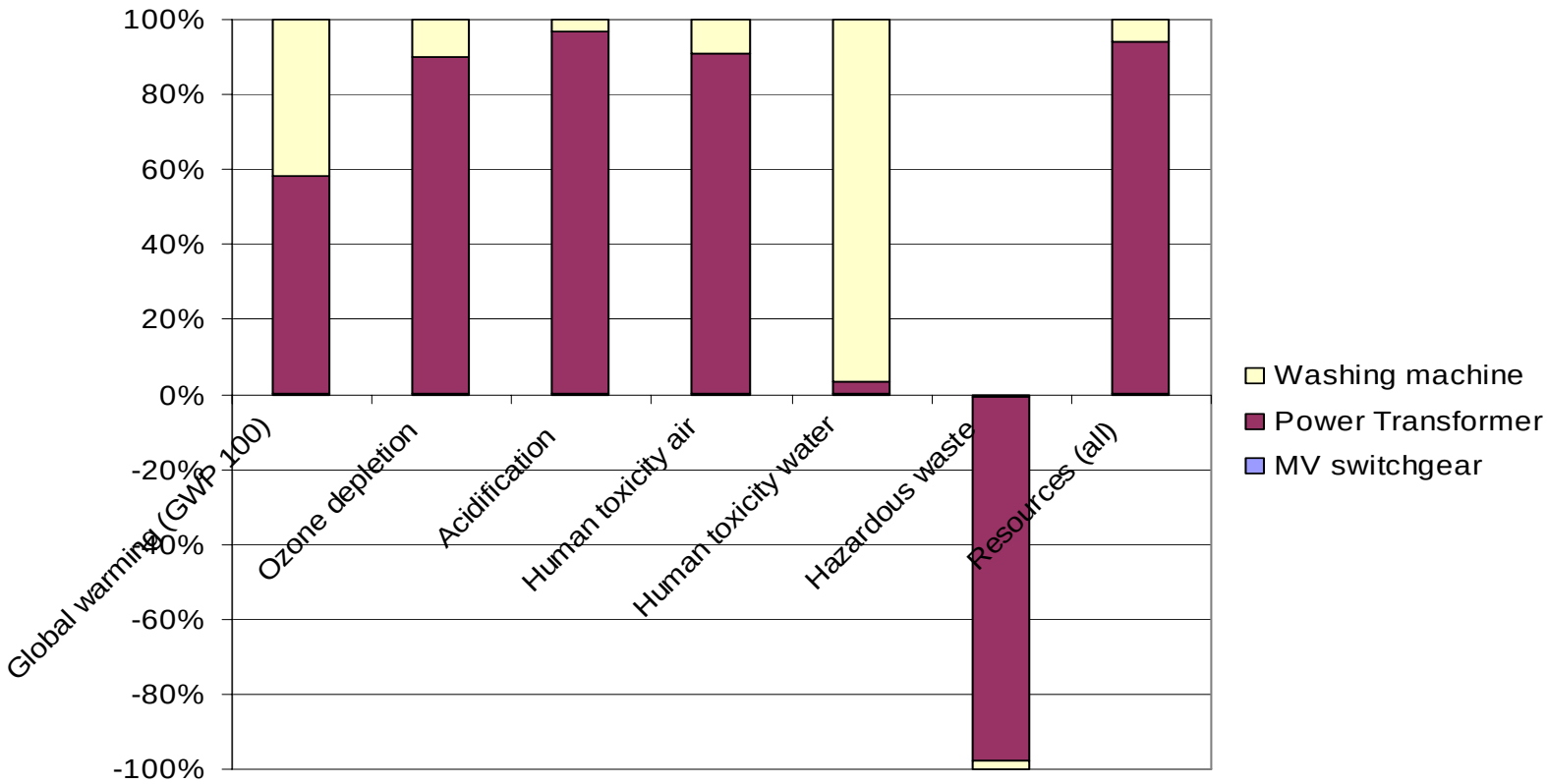


Comparison of 1kg impact

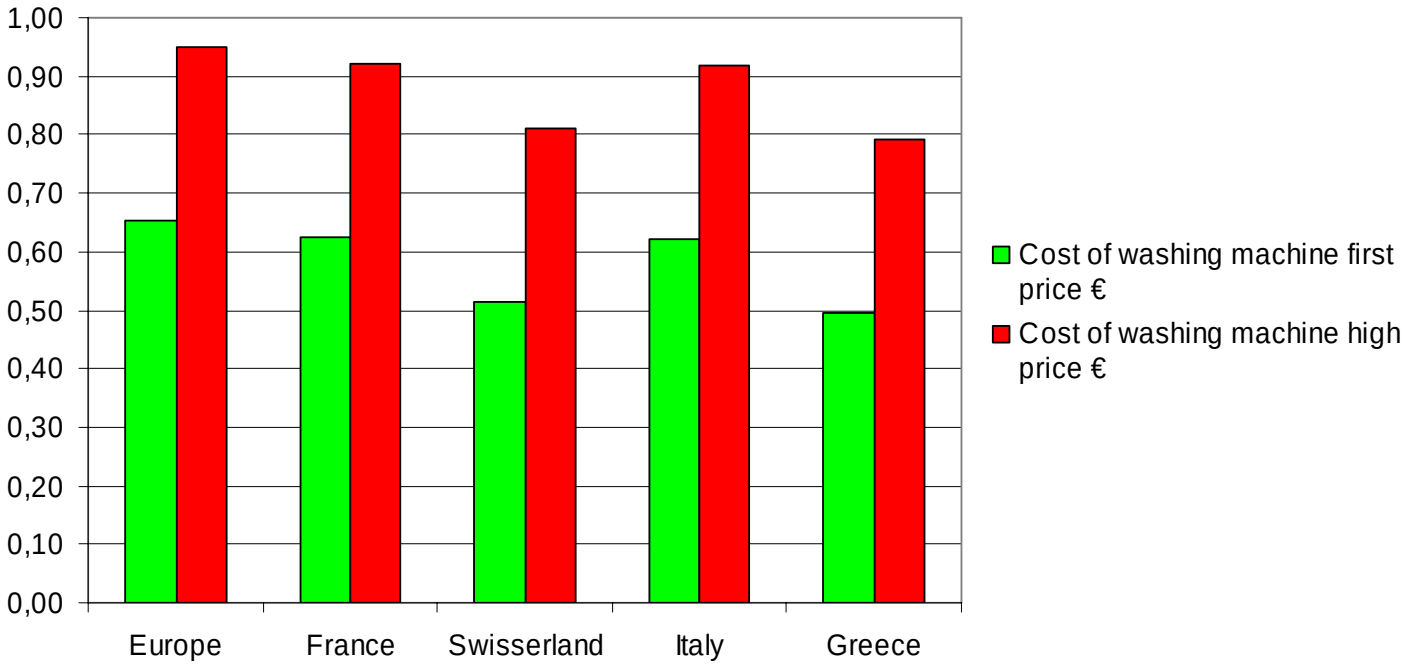


Comparison of global market

	Washing machine	MV switchgear	Power Transformer
International Market Quantity / year	35 E+6	650 E+3	50 E+3



Cost analysis



Cost of 5kg cotton program at 60°

The cost of the total life cycle : 1350 – 2565 €

Ways of improvement

- ✓ **Reduce the electricity consumption of MV and HV products → use alloys with low resistivity**
- ✓ **Improve the dismantling and the recyclability of the MV and HV products → develop specific circuit**
- ✓ **Use vegetal oil for power transformer**
- ✓ **Optimise the life span of all the products**
- ✓ **Replace water washing machine by dry washing machine**
- ✓ **Use launderette (commun washing machines) → *reduce the price?***

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CONCLUSIONS

Conclusions

- It is difficult to compare products with different functions
- The comparison of 1 kg of products shows the washing machine as more impacting than MV switchgear and power transformer
- The electrical consumption still th emost important source of environmental impact.