ANNEX 7 CALCULATION DETAILS OF GWP FOR THE 2006 & 2015 TARGETS

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In the following section the global warming potential (GWP) is calculated for different end-of-life options for the different ELV fractions.

When necessary[1], the following CO_2 equivalence factors were used to assess the GWP from life cycle inventory outputs (air emissions).

CO_2 Equivalence Factors of Various substances (GWP, 100 yrs)

substance (in air)	CO_2 equivalence factor
1 kg CO_2	1 kg eq CO_2
1 kg CH_4	23 kg eq CO_2
1 kg N_2O	296 kg eq CO_2
1 kg CF_4	5700 kg eq CO_2
1 kg C_2F_6	11900 kg eq CO_2

Source: GIEC (2001)

1.1 Steel

Ferrous metals are in majority composed of steel.

Based on life cycle inventories transmitted to BIO by IISI (International Iron and Steel Institute), the environmental impacts in terms of greenhouse gases emissions were calculated for both the reuse option and the recycling option of steel.

- Source of data: personal contact with IISI (International Iron and Steel Institute) in 2005
- Geographical representativeness: Europe
- Technical representativeness: average
- Recycling of steel

To calculate the impacts of the recycling of steel in terms of greenhouse gases emissions, the impacts generated by recycling minus the impacts avoided thanks to the production of hot rolled steel coil are taken into account.

[1] For all fractions except plastics where GWP was already calculated in available literature.

	Generated impacts: Recycling of 1 kg of steel	**Avoided** impacts: Production of 1 kg of hot rolled steel coil	Total impacts generated	GWP equivalence factors	**GWP 100 yrs**
	a	*b*	*a-b*	*c*	*(a-b) x c*
	kg of emissions released into the air			kg eq. CO_2/kg	**kg eq. CO_2/kg of steel**
CO_2	1,8022	2,1615	-0,3593	1	**-0,39**
CH_4	-4,798 E-04	4,7645 E-04	-0,95626	23	
N_2O	9,5285 E-05	1,19117292 E-04	-2,383 E-05	296	

- Reuse of steel

The environmental impacts resulting from the reuse of steel correspond to the impacts generated by the preparation of the piece with the view to reusing it, which are considered negligible, minus the impacts linked to the production of hot rolled coil from uranium.

	Avoided impacts: Production of 1 kg of hot rolled steel coil	GWP equivalence factors	**GWP 100 yrs**
	b	*c*	*(-b) x c*
	kg of emissions released into the air	kg eq. CO_2/kg	**kg eq. CO_2/kg of steel**
CO_2	2,1615	1	**-2,2**
CH_4	4,7645 E-04	23	
N_2O	1,19117292 E-04	296	

1.2 Aluminium

- Source of data: Environmental Profile Report for the European Aluminium Industry, European aluminium Association (EAA), 2000
- Geographical representativeness: Europe
- Technical representativeness: average
- Recycling of aluminium

To calculate the impacts of the recycling of aluminium in terms of greenhouse gases emissions, the impacts generated by recycling minus the impacts generated by the production of aluminium ingot are taken into account.

The recycling scenario takes into account scrap preparation, melting and alloying of aluminium scrap.

	Generated impacts: Recycling of 1085 kg of aluminium scrap to produce 1000 kg of aluminium ingot	**Avoided** impacts: Production of 1000 kg of aluminium ingot from bauxite	Total impacts generated	GWP equivalence factors	**GWP 100 yrs**
	a	*b*	*a-b*	*c*	*(a-b) x c / 1085*
kg of emissions released into the air				kg eq. CO_2/kg	**kg eq. CO_2/kg of alu scrap**
CO_2	801	10634	-9833	1	**-10,69**
CH_4	n.a.*	20	n.a.*	23	
N_2O	0,0014	0,0032	-0,0018	296	
PFC (composed of 90% CF_4 and 10% C_2F_6)		0,28	-0,28	6320**	

* data non available but can be considered relatively negligible
** The CO_2 equivalence factors (GWP, 100 yrs) of CF_4 is 5700 and C_2F_6 is 11900 (GWP, 100 yrs) thus for PFC it is 0,9*5700 + 0,1* 11900=6320.

- Reuse of aluminium

The environmental impacts resulting from the reuse of aluminium correspond to the impacts generated by the preparation of the piece with the view to reusing it, which are considered negligible, minus the impacts linked to the production of an equivalent piece from bauxite which are avoided. Based on data available, we selected a rolled aluminium sheet used for outer body part of car and considered that its production is avoided.

	Avoided impacts: Production of 1000 kg aluminium ingot from bauxite	**Avoided** impacts: Production of 1000 kg of rolled aluminium sheet from 1012 kg of aluminium ingot	Total impacts generated	GWP equivalence factors	**GWP 100 yrs**
	b	*b'*	*-(1,012 x b + b')*	*c*	*-(1,012 x b + b') x c / 1000*
kg of emissions released into the air				kg eq. CO_2/kg	**kg eq. CO_2/kg of alu sheet**
CO_2	10634	499	-11260,6	1	**-13,5**
CH_4	20	1,3	-21,5	23	
N_2O	n.a.*	n.a.*	n.a.*	296	
PFC	0,28		-0,28336	6320**	

* data non available but can be considered relatively negligible

** The CO_2 equivalence factors (GWP, 100 yrs) of CF_4 is 5700 and C_2F_6 is 11900 (GWP, 100 yrs) thus for PFC it is 0,9*5700 + 0,1* 11900=6320.

1.3 Plastics

- Source of data: Fraunhofer 2002
- Geographical representativeness: Germany
- Technical representativeness: average
- Data for recycling, recovery, and landfill

See Annex 6.

- Reuse of different plastic resins

The environmental impacts resulting from the reuse of plastic correspond to the impacts generated by the preparation of the piece with the view to reusing it, which are considered negligible, minus the impacts linked to the production of an equivalent piece from virgin resin which are avoided.

Remark: the avoided process considered is the production of granulates. This is a simplification because granulates transformation to a finished product is not taken into account.

	Avoided GWP: Production of 1000 pieces from virgin resin	weight per piece	**GWP 100 yrs**
	d	*e*	*-d / (1000 x e)*
	kg eq. CO_2/1000 plastic pieces	kg	**kg eq. CO_2/kg of plastic resin**
PP-TV	3022,99209	2,527*	**-1,2**
PVC	1217,46827	0,63175*	**-1,9**
particle plate in dashboard	2226,55619	1,89525*	**-1,2**
PUR flocculates	13078,370	2,4	**-5,4**
PA-GF	14600,000	0,474	**-31**
PP	8896,268	4,93	**-1,8**

*The dashboard (5,054 kg) of an ELV is made of: 12,5% PVC, 12,5% ABS, 25% PUR, 50% PP-TV. Thus the corresponding weight of the different resin parts are: 2,527 kg for the PP-TV part, 0,63175 kg for the PVC part, and 1,89525 kg for the rest composed of ABS and PUR.

The range for the GWP resulting from the reuse of plastic is **-31 to -1,2 kg eq. CO_2/kg of resin**.

1.4 Tyres

- Source of data: inventory listed in annex of 'Environmental Life Cycle Assessment of an average European car tyre', PréConsultants B.V. for the European Car Tyre Manufacturers and BLIC, 2001
- Geographical representativeness: Europe

- Technical representativeness: modern technology for recycling and cement kiln; average for waste incineration.
- Recycling and recovery of tyres

		Recycling of tyres as sport surfaces and floors[2]	**Cement kiln** (substitution = coal)	**Waste incineration** (credit for the avoided production of average European electricity)
CO_2	kg **/** kg of tyre	-2,66	-0,811	0,739
CH_4	kg **/** kg of tyre	-0,00115	-0,0169	-2,11 E-03
N_2O	kg **/** kg of tyre	-1,34 E-05	-4,25 E-05	-2,15 E-05
GWP 100 yrs	**kg eq. CO_2/kg of tyre**	**-2,7**	**-1,2**	**0,68**

[2] which represents 45% of the recycling routes. The other recycling routes are applications in construction as filling materials (22%), additive for bitumen application in road (8%), and consumer goods (24,4%).