Supporting Information of

Environmental profile of the manufacturing process of perovskite photovoltaics: harmonization of Life Cycle Assessment studies

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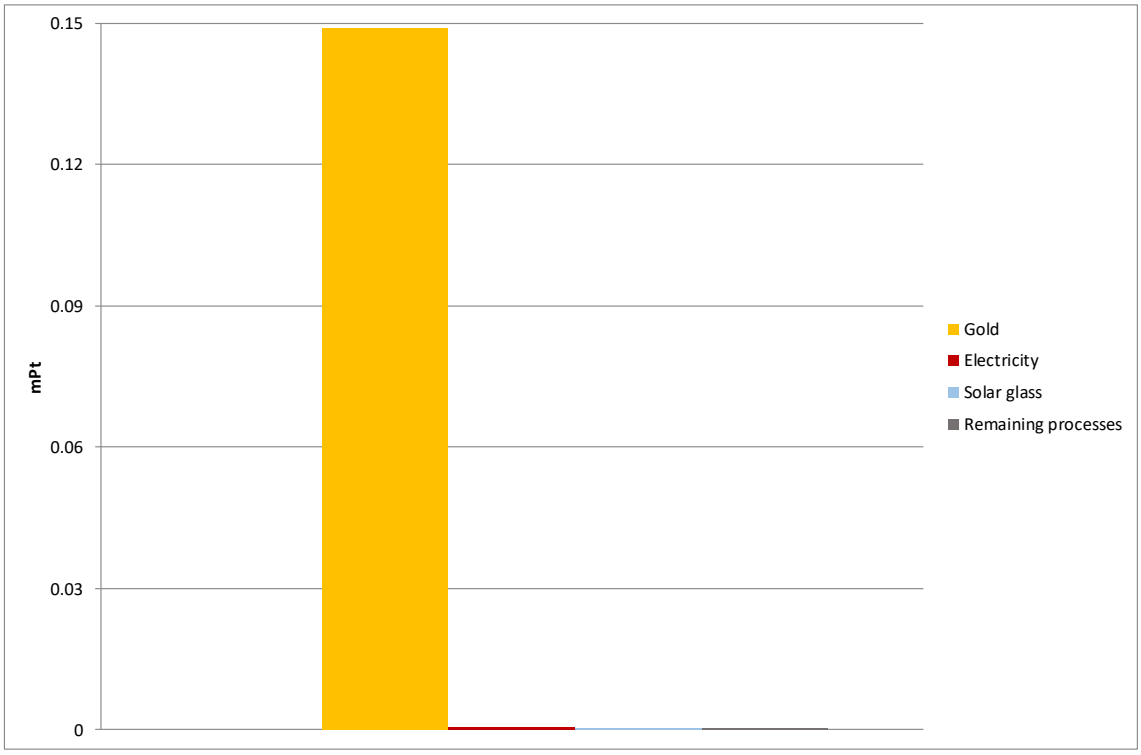

Figure 1. Process contribution of the manufacturing process of **G1** PSC configuration; calculation performed with ILCD 2011 method / Single score

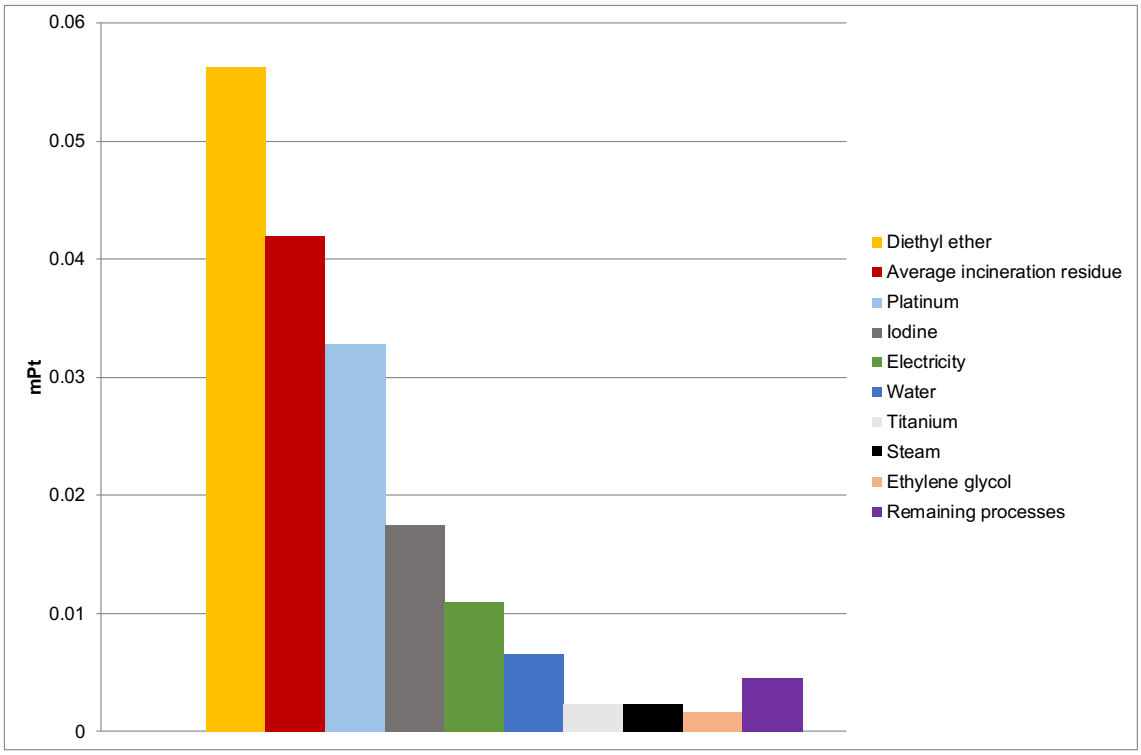

Figure 2. Process contribution of the manufacturing process of **Z** PSC configuration; calculation performed with ILCD 2011 method / Single score

Table 1. Direct electricity consumption of the manufacturing process of 1 cm^2 of PSCs.

Paper	Label	Direct electricity consumption (MJ)
Gong 2015	G1	$2.81 \cdot 10^{-3}$
Gong 2015	G2	$2.51 \cdot 10^{-3}$
Espinosa 2015	E	$3.51 \cdot 10^{-1}$
Serrano-Lujan 2015	S	$2.81 \cdot 10^{+1}$
Zhang 2015	Z	$6.43 \cdot 10^{-2}$
Celik 2016	C1	$9.59 \cdot 10^{-2}$
Celik 2016	C2	$1.11 \cdot 10^{-1}$
Celik 2016	C3	$5.05 \cdot 10^{-2}$
Alberola-Borràs 2018	AB1	$1.58 \cdot 10^{-1}$
Alberola-Borràs 2018	AB2	$1.59 \cdot 10^{-1}$
Alberola-Borràs 2018	AB3	$2.52 \cdot 10^{-1}$
Alberola-Borràs 2018	AB4	$2.22 \cdot 10^{-1}$

Table 2. Environmental profiles of the different ETL deposition processes reported in the selected LCA studies; calculation performed with ILCD 2011 / Normalization method

	TiO_2 deposition, G1	ZnO deposition, G2	TiO_2 deposition, E	TiO_2 deposition, S	TNT-based deposition, Z	SnO_2 deposition, C1-3	TiO_2 deposition, AB1-4
Climate change	8.13E-04	4.45E-04	2.39E-02	2.27E+00	1.04E-01	5.01E-02	7.84E-02
Ozone depletion	7.78E-05	2.01E-03	1.39E-03	1.31E-01	4.19E-03	2.78E-03	4.52E-03
Human toxicity, non-cancer effects	1.29E-02	6.62E-03	4.07E-01	3.74E+01	1.11E+00	7.32E-01	1.30E+00
Human toxicity, cancer effects	3.93E-02	1.87E-02	1.44E+00	1.13E+02	3.37E+00	3.22E+00	3.92E+00
Particulate matter	4.77E-04	2.61E-04	1.58E-02	1.30E+00	9.02E-02	1.04E-01	4.48E-02
Ionizing radiation human health	1.07E-02	4.83E-03	3.21E-01	3.22E+01	5.79E-01	4.40E-01	1.12E+00
Ionizing radiation ecosystem (interim)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation	2.78E-04	1.64E-04	7.91E-03	7.03E-01	4.58E-02	5.15E-02	2.45E-02
Acidification	5.82E-04	2.96E-04	2.06E-02	1.64E+00	6.98E-02	1.29E-01	5.67E-02
Terrestrial eutrophication	2.91E-04	1.52E-04	8.81E-03	8.16E-01	3.87E-02	5.84E-02	2.82E-02
Freshwater eutrophication	8.20E-04	3.66E-04	2.43E-02	2.40E+00	5.85E-02	3.59E-02	8.33E-02
Marine eutrophication	1.62E-04	8.33E-05	4.97E-03	4.57E-01	2.06E-02	2.47E-02	1.58E-02
Freshwater ecotoxicity	3.65E-02	1.61E-02	1.12E+00	1.09E+02	2.19E+00	1.35E+00	3.77E+00
Land use	9.64E-07	6.94E-07	3.15E-05	2.76E-03	9.96E-05	8.54E-04	9.54E-05
Water resource depletion	5.70E-04	2.88E-04	1.76E-02	1.68E+00	3.13E-02	2.13E-02	5.83E-02
Mineral, fossil & ren resource depletion	7.71E-04	3.88E-04	5.43E-02	1.88E+00	3.19E-01	7.97E+00	5.91E-02

Table 3. Environmental profiles of the different ETL production processes reported in the selected LCA studies; calculation performed with ILCD 2011 / Normalization method

	Titanium dioxide {RER}	TiO_2 production, G1	ZnO production, G2	TiO_2 production, E	TiO_2 production, S	TNT production, Z
Climate change	5.19E-05	1.74E-05	4.93E-05	1.91E-04	7.78E-05	1.62E-02
Ozone depletion	3.28E-06	1.40E-05	4.35E-04	7.97E-06	5.85E-06	6.09E-04
Human toxicity, non-cancer effects	1.15E-03	1.65E-04	6.54E-04	1.40E-03	8.50E-04	1.61E-01
Human toxicity, cancer effects	8.92E-03	6.19E-04	1.70E-03	3.15E-03	1.90E-03	4.89E-01
Particulate matter	8.82E-05	1.51E-05	2.97E-05	1.21E-04	7.53E-05	1.47E-02
Ionizing radiation human health	1.82E-04	2.24E-05	3.72E-04	2.22E-04	1.39E-04	7.21E-02
Ionizing radiation ecosystem (interim)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation	2.97E-05	1.18E-05	2.10E-05	8.12E-05	4.20E-05	7.37E-03
Acidification	1.24E-04	1.27E-05	3.01E-05	8.82E-05	5.20E-05	1.08E-02
Terrestrial eutrophication	2.36E-05	6.20E-06	1.59E-05	4.94E-05	2.91E-05	6.05E-03
Freshwater eutrophication	2.36E-05	6.55E-06	2.92E-05	4.86E-05	2.92E-05	8.09E-03
Marine eutrophication	1.42E-05	3.17E-06	8.56E-06	2.60E-05	1.53E-05	3.21E-03
Freshwater ecotoxicity	1.73E-03	2.11E-04	1.23E-03	1.90E-03	1.36E-03	2.87E-01
Land use	1.25E-07	1.79E-08	9.33E-08	1.70E-07	1.18E-07	1.48E-05
Water resource depletion	3.39E-05	4.42E-06	2.73E-05	1.72E-05	8.24E-06	3.84E-03
Mineral, fossil & ren resource depletion	1.01E-03	7.46E-05	4.93E-05	1.18E-03	9.70E-04	5.47E-02

Table 4. Environmental profiles of the different perovskite deposition techniques reported in the selected LCA studies; calculation performed with ILCD 2011 / Normalization method

	Perovskite deposition, G1-G2	Perovskite deposition, E	Perovskite deposition, C1-C3	Perovskite deposition, C2	Perovskite deposition, Z	Perovskite deposition, AB1	Perovskite deposition, AB2	Perovskite deposition, AB3	Perovskite deposition, AB4
Climate change	3.25E-07	2.08E-04	2.37E-05	4.22E-05	5.82E-04	4.65E-06	6.03E-06	1.23E-04	8.56E-05
Ozone depletion	2.11E-08	1.20E-05	1.43E-06	2.43E-06	1.03E-04	2.69E-07	3.48E-07	7.07E-06	4.94E-06
Human toxicity, non-cancer effects	5.37E-06	3.41E-03	3.89E-04	7.01E-04	1.41E-02	7.71E-05	9.98E-05	2.03E-03	1.42E-03
Human toxicity, cancer effects	1.54E-05	1.04E-02	1.16E-03	2.11E-03	2.15E-02	2.33E-04	3.02E-04	6.14E-03	4.29E-03
Particulate matter	2.04E-07	1.18E-04	1.37E-05	2.40E-05	6.81E-04	2.66E-06	3.44E-06	6.99E-05	4.88E-05
Ionizing radiation human health	3.88E-06	2.98E-03	3.29E-04	6.02E-04	1.58E-03	6.65E-05	8.62E-05	1.75E-03	1.22E-03
Ionizing radiation ecosystem (interim)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation	1.13E-07	6.41E-05	7.40E-06	1.30E-05	3.24E-04	1.44E-06	1.86E-06	3.78E-05	2.65E-05
Acidification	2.35E-07	1.50E-04	1.71E-05	3.05E-05	5.86E-04	3.37E-06	4.36E-06	8.87E-05	6.19E-05
Terrestrial eutrophication	1.17E-07	7.47E-05	8.59E-06	1.52E-05	2.48E-04	1.68E-06	2.17E-06	4.41E-05	3.08E-05
Freshwater eutrophication	3.02E-07	2.21E-04	2.45E-05	4.48E-05	3.19E-04	4.95E-06	6.41E-06	1.30E-04	9.11E-05
Marine eutrophication	7.01E-08	4.19E-05	5.57E-06	8.50E-06	1.33E-04	9.45E-07	1.22E-06	2.47E-05	1.73E-05
Freshwater ecotoxicity	1.35E-05	9.68E-03	1.10E-03	2.02E-03	1.17E-02	2.24E-04	2.90E-04	5.91E-03	4.12E-03
Land use	4.05E-10	2.49E-07	3.05E-08	5.12E-08	8.41E-07	5.68E-09	7.34E-09	1.49E-07	1.04E-07
Water resource depletion	2.06E-07	1.61E-04	1.70E-05	3.15E-05	1.72E-04	3.46E-06	4.49E-06	9.14E-05	6.38E-05
Mineral, fossil & ren resource depletion	1.69E-06	1.54E-04	2.36E-05	3.75E-05	9.70E-03	4.56E-06	4.88E-06	9.13E-05	6.48E-05

Table 5. Environmental profiles of the different HTL deposition techniques reported in the selected LCA studies; calculation performed with ILCD 2011 / Normalization method

	Spiro-MeOTAD deposition, G1-G2	Spiro-MeOTAD deposition, E	Spiro-MeOTAD deposition, S	CuSCN deposition, C1-C2	Iodine electrolyte deposition, Z	Spiro-MeOTAD deposition, AB1-4
Climate change	2.41E-07	1.46E-04	1.71E-02	5.03E-05	5.78E-04	5.51E-06
Ozone depletion	1.66E-08	1.04E-05	1.28E-03	2.91E-06	4.94E-05	3.64E-07
Human toxicity, non-cancer effects	3.15E-06	2.32E-03	2.69E-01	8.41E-04	5.24E-03	8.04E-05
Human toxicity, cancer effects	1.46E-05	7.07E-03	8.22E-01	2.52E-03	4.59E-02	3.18E-04
Particulate matter	1.73E-07	9.66E-05	1.17E-02	2.87E-05	3.29E-04	3.78E-06
Ionizing radiation human health	1.72E-06	1.97E-03	2.26E-01	7.20E-04	1.68E-03	3.64E-05
Ionizing radiation ecosystem (interim)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation	9.02E-08	5.02E-05	6.03E-03	1.55E-05	1.50E-04	2.01E-06
Acidification	1.38E-07	1.08E-04	1.27E-02	3.65E-05	2.68E-04	2.99E-06
Terrestrial eutrophication	7.32E-08	5.16E-05	6.01E-03	1.81E-05	1.41E-04	1.60E-06
Freshwater eutrophication	1.66E-07	1.51E-04	1.75E-02	5.37E-05	1.69E-04	3.56E-06
Marine eutrophication	3.94E-08	2.89E-05	3.37E-03	1.02E-05	7.37E-05	8.68E-07
Freshwater ecotoxicity	7.52E-06	6.35E-03	7.33E-01	2.43E-03	1.12E-02	2.01E-04
Land use	2.91E-10	1.73E-07	2.02E-05	6.13E-08	6.43E-07	6.30E-09
Water resource depletion	1.02E-07	1.08E-04	1.24E-02	3.75E-05	8.68E-04	2.19E-06
Mineral, fossil & ren resource depletion	3.01E-07	1.05E-04	1.22E-02	3.78E-05	6.19E-03	6.63E-06

Table 6. Environmental profiles of the different back contact deposition techniques reported in the selected LCA studies; calculation performed with ILCD 2011 / Normalization method

	Gold deposition, G1	Silver deposition, G2	Silver deposition, E	Aluminium deposition, C1-C2	Graphite deposition, C3	Platinum deposition, Z	Gold deposition, AB1-4
Climate change	2.67E-05	1.92E-06	9.82E-05	2.09E-05	1.42E-05	5.74E-05	5.36E-05
Ozone depletion	1.70E-06	1.22E-07	5.67E-06	1.21E-06	8.18E-07	1.31E-06	3.20E-06
Human toxicity, non-cancer effects	5.95E-02	1.69E-04	1.80E-03	3.46E-04	2.35E-04	1.15E-02	4.24E-02
Human toxicity, cancer effects	2.62E-02	1.48E-04	4.98E-03	1.05E-03	7.10E-04	7.19E-03	2.01E-02
Particulate matter	3.78E-05	1.55E-06	5.65E-05	1.19E-05	8.09E-06	3.45E-04	4.64E-05
Ionizing radiation human health	9.77E-05	2.24E-05	1.40E-03	2.99E-04	2.03E-04	1.28E-04	5.67E-04
Ionizing radiation ecosystem (interim	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Photochemical ozone formation	4.49E-05	1.08E-06	3.09E-05	6.46E-06	4.47E-06	8.53E-05	4.23E-05
Acidification	4.25E-05	1.77E-06	7.15E-05	1.52E-05	1.03E-05	6.48E-04	5.51E-05
Terrestrial eutrophication	5.72E-05	1.33E-06	3.61E-05	7.53E-06	5.10E-06	4.27E-05	5.27E-05
Freshwater eutrophication	8.51E-04	3.62E-06	1.06E-04	2.23E-05	1.51E-05	1.65E-04	6.35E-04
Marine eutrophication	3.19E-05	6.42E-07	2.01E-05	4.22E-06	2.86E-06	2.31E-05	2.95E-05
Freshwater ecotoxicity	5.93E-02	2.09E-04	4.88E-03	1.01E-03	6.92E-04	1.22E-02	4.34E-02
Land use	1.55E-07	3.02E-09	1.20E-07	2.55E-08	1.73E-08	9.19E-08	1.51E-07
Water resource depletion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mineral, fossil & ren resource depletion	2.81E-03	1.69E-04	2.84E-04	1.56E-05	1.06E-05	9.24E-04	2.00E-03