Channel Emissions Framework and Formulae: Print Publications Extended Version

Phase	Step & sub-step	Physical processes involved	Formula type	Scaling factors	Expected materiality	Formulae	Expected data hacks[5] **Global comment:** *The print channel has well-established and proven methodologies, so hacks and EFs are generally well known. On the basis of LCAs/FEs of finished products, it's completely acceptable to use them directly, making sure they cover all the required scope.*	Comments
CREATION	Physical print production	Paper production	Embodied & operational emission factors (based on LCA)[1]	• Number of ad format • Ad format weight • Type of paper (grade…)	High	$\sum_{p=0}^{P}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times EF\_paper\_production_p \end{pmatrix}$ p: physical print ad format P: total number of physical print ad formats involved in the ad campaign •number_ad_format_p : total number of physical print ad format of type p distributed in the ad campaign •ad_format_share_p: percentage of the overall publication that is occupied by the ad format of type p [%]. This % should be a percentage of the overall surface of the entire printed medium (magazine, newspaper, etc) where the ad appears. For double-sided medium, the percentage shall take into account only one side of the page concerned (e.g. a quarter page ad will account for 1/8th of the surface and weight of the full medium page). •total_medium_weight_p: weight of the entire printed medium (magazine, newspaper, etc.) where the ad format of type p appears [kg]. •EF_paper_production_p: emission factor for the specific paper grade/type (coated, uncoated, magazine paper; newspaper...), dependent on the country and energy used (paper mills), in printed medium (magazine, newspaper, etc.) where the ad format of type p appears [kgCO2e/kg of paper]. Varies widely depending on supplier, mill location and type of energy used.[3]	• **Paper weight hacks:** Bottom-up approach based on surface of medium, paper gsm, waste factors : total_medium_weight_p (kg of paper for entire print medium) = Area per page (m2) * Pagination (pp) * paper gsm (g/m2) / 1000 * (1 + printer waste factor) Additional hacks: if gsm is unavailable, assume [X] for magazines and [X] for newspaper. Top-down approach based on annual paper purchases by company: total_medium_weight_p (kg of paper for entire print medium) = Mass of paper annually purchased by the company producing the printed medium (magazine, newspaper, etc.) where the ad format of type p appears [tons] / number of annual printed copies of the printed medium	Corporate emissions of actors within the value chain are considered taken into account within the Corporate emissions overhead. Recycled paper[4]: As long as the measurement remains a carbon monocriterion and does not allow the benefits of recycled paper on other environmental impacts (resources, water consumption) to be taken into account, the industry's recommendation is to treat recycled paper as if it were new in terms of emission factors (in fact, technically, the emission factors for recycled paper are generally higher).
		Transport of paper from papermill to printer	Operational emission factors	• Number of ad format • Ad format weight • Type of paper (grade…)	Medium	$\sum_{p=0}^{P}\sum_{t=0}^{T}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times distance\_upstream_t \\ \times EF\_transport\_upstream_t \end{pmatrix}$ p: physical print ad format P: total number of physical print ad formats involved in the ad campaign t: transportation type T: total number of transportation types involved in upstream processes (e.g. sea, air, road...) •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •distance_upstream_t: total upstream distances travelled to all print sites with transportation type t [km] •EF_transport_upstream_t: emissions factor for the transportation type t used upstream [kgCO2e/t.km]	**Paper weight hacks:** see suggested hacks above in paper production step For very low resultant numbers, this step could either be skipped or have a simple multiplier factor.	
		Printing and finishing (including: prepress, printing, consumables including sourcing of raw materials, printing process including ink[2], glue, packaging, etc.)	Embodied & operational emission factors (based on LCA)[1]	• Printing process • Chemicals (ink, glue, special build materials used) • Energy type used within processes	Medium	$\sum_{p=0}^{P}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times EF\_printing\_process_p \end{pmatrix}$ p: physical print ad format P: total number of physical print ad formats involved in the ad campaign •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •EF_printing_process_p: emission factor for the printing process (offset, helio...) of the printed medium (magazine, newspaper, etc.) where the ad format of type p appears [kgCO2e/kg]. Should include energy used within the process (electricity, natural gas...), as well as an assumed portion of production and delivery of materials (plates, ink, chemicals) except paper. Finishing processes are likely to be included in those figures as printers/finishers may not track it separately. Varies widely depending on supplier, printing facility location, type of printing process and energy used.	• **Printing process** EF_printing_process_p: Some suppliers already provide this type of EF, these supplier-specific factors should be used wherever possible. If missing, adaptations could be made by "correcting" energy type and location based on other emission factors. Another option is to determine an overall factor that could be added to the paper production EF for consumables (inks, boxes, pallets, and so on). If finishing processes are not included within the figures a factor for number of finishing processes could be added.	
DISTRIBUTION	Physical print Storage & Delivery	Physical – Transportation to storage	Transportation from printer to storage in warehouse e.g. at distributor	Operational emission factors	• Distance travelled • Weight carried • Vehicle type	Medium	$\sum_{p=0}^{P}\sum_{t=0}^{T}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times distance\_storage_t \\ \times EF\_transport\_storage_t \end{pmatrix}$ p: physical print ad format P: total number of physical print ad formats involved in the ad campaign t: transportation type T: total number of transportation types involved in transportation to storage processes (e.g. sea, air, road...) •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •distance_storage_t: total distances travelled to storage sites with transportation type t [km] •EF_transport_storage_t: emissions factor for the transportation type t used to storage [kgCO2e/t.km]	-	-
		Physical - storage	Storage within the warehouse	Operational emission factors		Low	-		As storage is likely to be immaterial unless stored in a climate-controlled warehouse or dedicated office space (unlikely), it was chosen to not provide a formula for this step. For very low resultant numbers, this step could therefore either be skipped or have a simple multiplier / correction factor based on data.
		Physical – Downstream transportation for publications	Downstream transportations from storage to where publications are sold (points of sale...)	Operational emission factors	• Distance travelled • Weight carried • Vehicle type	Medium	$\sum_{p=0}^{P}\sum_{t=0}^{T}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times distance\_downstream_t \\ \times EF\_transport\_downstream_t \end{pmatrix}$ p: physical print ad format P: total number of physical print ad formats involved in the ad campaign t: transportation type T: total number of transportation types involved in downstreal processes (e.g. size of truck) •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •distance_downstream_t: total downstream distances travelled to all destinations (points of sale, ...) with vehicle type v [km] •EF_transport_downstream_t: emissions factor for the transportation type t used downstream [kgCO2e/t.km]	-	-
CONSUMPTION	Transportation and end of life of unsold products	Transportation of unsold products and returns back to central warehouse	Operational emission factors	• Distance travelled • Weight carried • Vehicle type	Medium	$\sum_{p=0}^{P,unsold}\sum_{t=0}^{T}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times distance\_return_t \\ \times EF\_transport\_return_t \end{pmatrix}$ p: physical print ad format P, unsold: number of physical print ad formats involved in the ad campaign that were unsold t: transportation type T: total number of transportation types involved in downstream processes (e.g. size of truck) •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •distance_returned_t: total distances travelled for unsold products which are returned with vehicle type v [km] •EF_transport_return_t: emissions factor for the transportation type t used for return shipments [kgCO2e/t.km]	Unsold products are likely to be estimated as an overhead percentage of the overall publications.	-
		Disposal/end of life of print materials for unsold products and returns	Standard disposal/ EoL emissions factors	• Weight • Type of disposal	Medium	$\sum_{p=0}^{P,unsold}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times EF\_EoL_p \end{pmatrix}$ p: physical print ad format P, unsold: number of physical print ad formats involved in the ad campaign that were unsold •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •EF_EoL_p: weighted average emissions factor for end-of-life disposal types [kgCO2e/kg]. EF_EoL_p= % * EF-recycled + % * EF-landfill + % * EF-incineration. Unsold products are likely to have a higher recycling ratio.		-
	End of life of sold products	Disposal/end of life of print materials after use by reader	Standard disposal/ EoL emissions factors	• Weight • Type of disposal	Medium	$\sum_{p=0}^{P,sold}\begin{pmatrix} number\_ad\_format_p \\ \times ad\_format\_share_p \\ \times total\_medium\_weight_p \\ \times EF\_EoL_p \end{pmatrix}$ p: physical print ad format P, sold: number of physical print ad formats involved in the ad campaign that were sold •number_ad_format_p ; ad_format_share_p ; total_medium_weight_p: see above descriptions in paper production step •EF_EOL_p: weighted average emissions factor for end-of-life disposal types [kgCO2e/kg]. EF_EOL_p= % * EF-recycled + % * EF-landfill + % * EF-incineration.	Regional/country level averages (e.g., incineration, landfill, recycling) can be important and are generally available.	-
ALL	Corporate emissions overhead	Allocated organizational emissions attributed to the specific (e.g. business travels, workplace, etc.) across all entities in the campaign value chain.	Corporate overhead	Campaign Revenue	High	-	-	Every organisation in the value chain should be reporting their verified enterprise GHG emissions inventory annually to ensure reasonable data quality at the enterprise level. More guidance will follow on this in the next update of the GMSF.

Key

- = Not yet applicable or to be investigated further

∑ = The mathematical sign for a sum

Channel Emissions Framework and Formulae: Direct Mail and Door Drops Extended Version

Phase	Step & sub-step	Physical processes involved	Formula type	Scaling factors	Expected materiality	Formulae	Expected data hacks[5] — Global comment: *The print channel has well-established and proven methodologies, so hacks and EFs are generally well known. On the basis of LCAs/FEs of finished products, it's completely acceptable to use them directly, making sure they cover all the required scope.*	Comments
CREATION	Physical print production	Paper production	Embodied & operational emission factors (based on LCA)[1]	• Number of ad format • Ad format weight • Type of paper (grade…)	High	$$\sum_{p=0}^{P} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ EF\_paper\_production_p \end{pmatrix}$$ p: physical print ad format. P: total number of physical print ad formats involved in the ad campaign. • $number\_ad\_format_p$: total number of physical print ad format of type p distributed in the ad campaign. • $ad\_format\_share_p$: percentage of the overall publication that is occupied by the ad format of type p [%]. This % should be a percentage of the overall surface of the entire printed medium (magazine, newspaper, etc.) where the ad appears. For double-sided medium, the percentage shall take into account only the side of the page concerned (e.g. a quarter page ad will account for 1/8th of the surface and weight of the full medium page). • $total\_medium\_weight_p$: weight of the entire printed medium (magazine, newspaper, etc.) where the ad format of type p appears [kg]. • $EF\_paper\_production_p$: emission factor for the specific paper grade/type (coated, uncoated, magazine paper; newspaper…), dependent on the country and energy used (paper mills), in printed medium (magazine, newspaper, etc.) where the ad format of type p appears [kgCO2e/kg of paper]. Varies widely depending on supplier, mill location and type of energy used.[3]	• **Paper weight hacks:** Bottom-up approach based on surface of medium, paper gsm, waste factors : $total\_medium\_weight_p$ (kg of paper for entire print medium) = Area per page (m2) * Pagination (pp) * paper gsm (g/m2) / 1000 * (1 + printer waste factor). Additional hacks: if gsm is unavailable, assume [X] for magazines and [X] for newspaper. Top-down approach based on annual paper purchases by company: $total\_medium\_weight_p$ (kg of paper for entire print medium) = Mass of paper annually purchased by the company producing the printed medium (magazine, newspaper, etc.) where the ad format of type p appears [tons] / number of annual printed copies of the printed medium	Corporate emissions of actors within the value chain are considered taken into account within the Corporate emissions overhead. Recycled paper[4]: As long as the measurement remains a carbon monocriterion and does not allow the benefits of recycled paper on other environmental impacts (resources, water consumption) to be taken into account, the industry's recommendation is to treat recycled paper as if it were new in terms of emission factors (in fact, technically, the emission factors for recycled paper are generally higher).
		Transport of paper from papermill to printer and envelope converter for Direct Mail and Door Drops	Operational emission factors	• Number of ad format • Ad format weight • Type of paper (grade…)	Medium	$$\sum_{p=0}^{P}\sum_{t=0}^{T} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ distance\_upstream_t \\ \times\ EF\_transport\_upstream_t \end{pmatrix}$$ p: physical print ad format. P: total number of physical print ad formats involved in the ad campaign. t: transportation type. T: total number of transportation types involved in upstream processes (e.g. sea, air, road…). • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • $distance\_upstream_t$: total upstream distances travelled to all print sites with transportation type t [km]. • $EF\_transport\_upstream_t$: emissions factor for the transportation type t used upstream [kgCO2e/t.km]	**Paper weight hacks:** see suggested hacks above in paper production step. For very low resultant numbers, this step could either be skipped or have a simple multiplier factor.	
		Printing and finishing (including: prepress, printing, consumables including sourcing of raw materials, printing process including ink[2], glue, packaging, etc.)	Embodied & operational emission factors (based on LCA)[1]	• Printing process • Chemicals (ink, glue, special build materials used) • Energy type used within processes	Medium	$$\sum_{p=0}^{P} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ EF\_printing\_process_p \end{pmatrix}$$ p: physical print ad format. P: total number of physical print ad formats involved in the ad campaign. • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • $EF\_printing\_process_p$: emission factor for the printing process (offset, helio…) of the printed medium (magazine, newspaper, etc.) where the ad format of type p appears [kgCO2e/kg]. Should include energy used within the process (electricity, natural gas…), as well as an assumed portion of production and delivery of materials (plates, ink, chemicals) except paper. Finishing processes are likely to be included in those figures as printers/finishers may not track it separately. Varies widely depending on supplier, printing facility location, type of printing process and energy used.	• **Printing process** $EF\_printing\_process_p$: Some suppliers already provide this type of EF, these supplier-specific factors should be used wherever possible. If missing, adaptations could be made by "correcting" energy type and location based on other emission factors. Another option is to determine an overall factor that could be added to the paper production EF for consumables (inks, boxes, pallets, and so on). *If finishing processes are not included within the figures a factor for number of finishing processes could be added.*	
DISTRIBUTION	Physical print: Storage & Delivery	Physical – Transportation to storage	Operational emission factors	• Distance travelled • Weight carried • Vehicle type	Medium	$$\sum_{p=0}^{P}\sum_{t=0}^{T} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ distance\_storage_t \\ \times\ EF\_transport\_storage_t \end{pmatrix}$$ p: physical print ad format. P: total number of physical print ad formats involved in the ad campaign. t: transportation type. T: total number of transportation types involved in transportation to storage processes (e.g. sea, air, road…). • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • $distance\_storage_t$: total distances travelled to storage sites with transportation type t [km]. • $EF\_transport\_storage_t$: emissions factor for the transportation type t used to storage [kgCO2e/t.km]	-	-
		Physical - storage	Operational emission factors	-	Low	-	As storage is likely to be immaterial unless stored in a climate-controlled warehouse or dedicated office space (unlikely), it was chosen to not provide a formula for this step. For very low resultant numbers, this step could therefore either be skipped or have a simple multiplier / correction factor based on data.	-
		Physical – Downstream transportation for direct mail[6]	Operational emission factors	• Distance travelled • Weight carried • Vehicle type	Medium	$$\sum_{t=0}^{T} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ distance\_downstream_t \\ \times\ EF\_transport\_downstream_t \end{pmatrix}$$ p: physical print ad format. P: total number of physical print ad formats involved in the ad campaign. t: transportation type. T: total number of transportation types involved in downstream processes (e.g. size of truck). • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • $distance\_downstream_t$: total downstream distances travelled to all destinations (points of sale, ported or postal subscribers) with vehicle type v [km]. • $EF\_transport\_downstream_t$: emissions factor for the transportation type t used downstream [kgCO2e/t.km]	-	-
CONSUMPTION	End of life processing	Transportation and end of life of unsold products	Operational emission factors	• Distance travelled • Weight carried • Vehicle type	Medium	$$\sum_{p=0}^{P,\ unsold}\sum_{t=0}^{T} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ distance\_return_t \\ \times\ EF\_transport\_return_t \end{pmatrix}$$ p: physical print ad format. P, unsold: number of physical print ad formats involved in the ad campaign that were unsold. t: transportation type. T: total number of transportation types involved in downstream processes (e.g. size of truck). • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • $distance\_returned_t$: total distances for unsold products which are returned with vehicle type v [km]. • $EF\_transport\_return_t$: emissions factor for the transportation type t used for return shipments [kgCO2e/t.km]	Unsold products are likely to be estimated as an overhead percentage of the overall publications.	-
		Disposal/end of life of print materials for unsold products and returns	Standard disposal/ EoL emissions factors	• Weight • Type of disposal	Medium	$$\sum_{p=0}^{P,\ unsold} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ EF\_EoL_p \end{pmatrix}$$ p: physical print ad format. P, unsold: number of physical print ad formats in the ad campaign that were unsold. • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • EF_EoL_p: weighted average emissions factor for end-of-life disposal types [kgCO2e/kg]. EF_EoL_p= % * EF-recycled + % * EF-landfill + % * EF-incineration. Unsold products are likely to have a higher recycling ratio.	-	-
	End of life of sold products	Disposal/end of life of print materials after use by reader	Standard disposal/ EoL emissions factors	• Weight • Type of disposal	Medium	$$\sum_{p=0}^{P,\ sold} \begin{pmatrix} number\_ad\_format_p \\ \times\ ad\_format\_share_p \\ \times\ total\_medium\_weight_p \\ \times\ EF\_EoL_p \end{pmatrix}$$ p: physical print ad format. P, sold: number of physical print ad formats involved in the ad campaign that were sold. • $number\_ad\_format_p$; $ad\_format\_share_p$; $total\_medium\_weight_p$: see above descriptions in paper production step. • EF_EoL_p: weighted average emissions factor for end-of-life disposal types [kgCO2e/kg]. EF_EoL_p= % * EF-recycled + % * EF-landfill + % * EF-incineration.	Regional/country level averages (e.g., incineration, landfill, recycling) can be important and are generally available.	-
ALL	Corporate emissions overhead	Allocated organizational emissions attributed to the specific (e.g. business travels, workplace, etc.) across all entities in the campaign value chain.	Corporate overhead	Campaign revenue	High	--	--	Every organisation in the value chain should be reporting their verified enterprise GHG emissions inventory annually to ensure reasonable data quality at the enterprise level. More guidance will follow on this in the next update of the GMSF.

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Footnotes for Print Publications/Direct Mail/Door Drops

Formula type
[1] A global LCA of print products would include all the lifecycle steps in its results. The appropriate stages of the relevant LCA must therefore be selected to match the GMSF steps.

Printing & finishing
[2] Different ink types should be accounted for within emissions factors. However we note expert input that inks are likely to be immaterial. One proposal is to treat all inks as the same because oil based inks are harmful due to higher VOCs and more intense to manufacture, where as vegetable based inks contribute to deforestation and often require more energy in the printing process for drying. This requires further investigation in the data guidance process.

Paper production
[3] Potentially more than one mill's paper may be used to produce one publication, therefore complexifying the application of the formula. This topic will be on the agenda for future guidance work to help identify hacks to account for multiple paper mills for different publications, transportation, etc.
[4] Documented emissions factors should speak for themselves. This topic will be on the agenda for future guidance work and this initial feedback is likely to be challenged.

Global comment
[5] Hacks are likely to be different between newspapers and magazines in future guidance work: as newspapers share limited variations across paper and print methods compared to magazines.

Storage & Delivery
[6] Generic formula for direct mail can be adapted with specific emissions factors and hacks relative to door drops.