# Part B: Product group definition | Graphene production | Part B #25-003

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| **Initiated by** | The Graphene Council - https://www.thegraphenecouncil.org/ | | |
| **Working group members** | Jim Mellentine, Thrive ESG (PCR committee chair)<br>Terrance Barkan, The Graphene Council<br>Chirag Ratwani, The Graphene Council<br>Monica Tisack, Mississippi Polymer Institute<br>Lauren Romine, Mississippi Polymer Institute<br>Samuel Lahasky, Mississippi Polymer Institute<br>Rey Rubio, MEP World Group<br>Ron Presswood, Elemental Advanced Materials<br>Jonathan Henry, Graphene Star Trading Limited<br>Marina Starkova, Graphene Star Trading Limited<br>Denis Wright, Sparc Technologies<br>Srishankar Jayababus, Bhargavi Labs<br>Seann Robbins, TMTP Labs<br>Junaid Ali, COMSATS University Islamabad<br>David Gossman, Specialty Graphene Research LLC<br>Ana Claudia Nioac de Salles, Fraunhofer Institute for Chemical Technology<br>Jean Carlos Bassani, SENAI Institute for Innovation in Electrochemistry, Brazil | | |
| **Public notices of development/ outreach** | • Public notice on the Sustainable Minds website announcing the creation of a Part B on March 21, 2025: http://www.sustainableminds.com/transparency-report-program/part-b<br>• Email blast on March 11, 2025 to mailing lists of LCA professionals, building and construction industry and trade associations, and manufacturers of graphene, requesting participation on the PCR committee.<br>• Email blast on July 14, 2025 to the same mailing lists requesting public comment. | | |
| **Non-participating parties** | All interested parties who requested participation were invited to join the working group. | | |
| **New Part B?** | Yes | **Part B version number** | 1.0 |
| **Publication date** | <Date> | | |
| **Validity period** | <5-year period beginning and end dates> | | |
| **Expected renewal schedule** | Sustainable Minds intends to notify the working group and post update/renewal information on its website approximately four months prior to expiration to determine update, extension, or expiration options for this Part B. | | |

## Product group

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| **Name** | Graphene |
| **Description** | Graphene as defined by the Graphene Classification Framework (ISO/DTS 9651). |
| **Exclusions** | Materials that are not classified by the Graphene Classification Framework (ISO/DTS 9651) are excluded from the scope of this PCR. |
| **Geographic representativeness** | North America |
| **Product-specific terms** | Graphene-related 2D materials (GR2M): defined specifically as carbon-based two-dimensional materials consisting of 1 to 10 layers, including graphene, graphene oxide, reduced graphene oxide, and functionalized variations thereof. This includes bilayer graphene, trilayer graphene, and few-layer graphene. |

## Program operator responsibilities

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| **Existing PCRs, EPDs, TRs, or LCAs** | • This Part B shall be used in conjunction with the latest version of Sustainable Minds Part A: LCA calculation rules and report requirements (version 2023 at the time of publication of this Part B; newest version shall be used when available)<br>• Relevant PCR: EPD International: Product Category Rules (PCR) for Graphite Products (PCR 2023:02)<br>• Existing EPDs used to inform some aspects of this Part B<br>  o EPD International, Graphenano Smart Materials, Precast Graphene Fluid Ultra/G100, Cradle to gate for 1 kg of admixtures, 2023. |

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| | https://api.environdec.com/api/v1/EPDLibrary/Files/b27fe000-e223-4e5b-cc71-08db4c1420c4/Data<br>o EPD International, Iterchimica, Gipave®, Cradle to gate for 1 kg of modifier, 2023. https://iterchimica.it/wp-content/uploads/Iterchimica-S.p.A.-EPD-Gipave-1.pdf<br>• Existing LCAs used to inform this Part B<br>o Cossutta M. et al., Comparative LCA of different graphene production routes, Journal: Green Chemistry: 2017, ISSN: 1463-9270<br>o Siddique S. et al., Environmental life cycle assessment of synthesis routes for industrial-scale graphene production from waste-based feed stocks, Environmental Science and Pollution Research, 27 March 2025, https://doi.org/10.1007/s11356-025-36352-0<br>o Beloin-Saint-Pierre D., Towards a more environmentally sustainable production of graphene-based materials, The International Journal of Life Cycle Assessment (2021) 26:327–343, https://doi.org/10.1007/s11367-020-01864-z |
| **Justification for new Part B if relevant non-expired PCR exists** | Not applicable. At the time of publication of this Part B, an active PCR for graphene production was not identified. |
| **Harmonization activities pursued** | Sustainable Minds announced the creation of this product group definition to other program operators, LCA analysts, and manufacturers via email, and posted an update on its website. No existing PCR was identified, and no feedback was received. Therefore, further harmonization activities were not necessary. |

## Functional performance

| **Standard/certification** (most recent edition, conformance required for PCR conformance) | **URL** |
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| ISO/DTS 9651 Nanotechnologies — Classification framework for graphene-related 2D materials<br>*Note for reviewers during public consultation:*<br>*This draft standard is in the approval phase. See the Graphene Classification Framework for the in-progress version of its contents: https://cdn.ymaws.com/www.thegraphenecouncil.org/resource/resmgr/standards/report/gcf_public_version0.1.pdf* | https://www.iso.org/standard/84232.html |

## System boundary

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| **System boundary** | The type of TR/EPD shall be specified as cradle to gate. The modules considered in the LCA shall be described in brief as per “System boundaries” outlined in ISO 21930:2017 section 5.2. Module D shall not be declared. It should be apparent as to what processes are considered in each module per the module descriptions in ISO 21930:2017 section 7.1.7.<br>Based on current commercial graphene production technologies, capital equipment is generally considered to be relatively small and long-lived, and therefore insignificant to graphene environmental impacts. Therefore, capital goods and system infrastructure flows (i.e., equipment expected to last longer than 12 months) shall be excluded from the system boundary by default, with justification required for alternative assumptions. |

## Declared unit

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| **Unit** | **1 kg of graphene product as defined by ISO/DTS 9651**<br>For graphene sold as a paste, dispersion, or slurry, 1 kg dry mass shall be used as the declared unit. |
| **Rationale** | Graphene has many varied applications, and is primarily sold to customers by mass, so this is a common unit that customers are familiar with and serve the broader market. |

## Additional rules for comparability

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| **1. TR/EPD types** | Industry-average EPDs shall not be developed using this PCR. |
| **2. Additional rules to Part A** | • EPDs shall disclose the LCA software and version used for modeling, and the database name(s) and version(s) used.<br>• EPDs that use secondary data for any unit process that contributes 30% or more to any environmental impact category result shall disclose the data source (database name and version, LCA modeling software type and version implemented, dataset name, dataset geography, dataset age, and dataset allocation method). This criterion applies to the LCI being used, and not the actual unit process data being reported by the manufacturer. |

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| | Materials considered confidential may be reported as “proprietary ingredient” along with the database name and version.<br>• EPDs shall disclose product information according to the technical data sheet contained in ISO/DTS 9561.<br>• EPDs may optionally disclose additional indicators that may be appropriate in other regions. |
| **3. Default life cycle stage scenario(s)** | No additional requirements beyond those already specified in Sustainable Minds Part A, ISO 21930:2017, and other applicable standards. |
| **4. Additional data quality requirements** | Data quality shall be assessed using either the US EPA Data Quality Pedigree Matrix, the ILCD Data Quality Matrix (DQA), or regional equivalent. |
| **5. Additional health and environmental information** | EPDs shall include the following statement immediately following the table of LCIA results:<br>*Nanomaterials such as graphene may be associated with potentially significant environmental and health effects that are currently not adequately characterized by current LCA methods. These potential effects should be considered separately from this EPD.* |

## Additional LCA calculation rules

| N/A | Optional | Required | *Indicate whether conformance is the manufacturer’s choice or required for TRs/EPDs.* |
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| | | **X** | ISO 21930:2017: conformance is required by construction product manufacturers |
| | **X** | | EN 15804:2012+A2:2019+AC:2021 may be optionally selected for conformance instead of ISO 21930. In cases of conflicting requirements, the selected standard must be followed. |

## Part B development information

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| **Part B review panel** | This Part B was reviewed for conformance to ISO 14025 and ISO 21930:2017 by the following parties:<br>Jack Geibig, Chair<br>Ecoform<br>Jgeibig@ecoform.com<br>Thomas P. Gloria, Ph. D.<br>Industrial Ecology Consultants<br>t.gloria@industrial-ecology.com<br>Dr. Cary Hill<br>ITA International<br>CHill@ita-intl.com |
| **Open consultation** | Sustainable Minds solicited public comments on this Part B from July 14, 2025 – August 13, 2025. This consultation period and list of parties to submit comments were made available to the review panel. |
| **Conflict statement** | Funding sources used to develop this Part B were disclosed to the working group during the development process. The policies identified in Sustainable Minds’ Program Governance were followed to identify and resolve any potential conflicts of interest. |
| **Sustainable Minds information** | This Part B was developed by Sustainable Minds and participating interested parties according to the Sustainable Minds Program Governance available at http://www.sustainableminds.com/transparency-report-program/how-it-works.<br>For questions about this or another Part B, to submit comments on this Part B, or to obtain a template for developing a transparency report, contact us using the information on the following page: http://www.sustainableminds.com/contact-us. |