Independent Expert Review Statement
HiQLCD Generic and Core Sectors Methodology Reports and supporting Editor Tool with representative Datasets

Generic Methodology report version: v3 and Methodology Reports of Core Sectors v2
Revised reports date with replies to comments received: 10 March 2026

I hereby confirm that I have carried out, at the request of the developers, an independent expert review of the ***HiQLCD generic and core Sectors Methodology Reports and supporting Editor Tool***, *together with a* ***selection of representative datasets*** from the database.

The ***high-quality life cycle database (HiQLCD)*** has been developed to provide representative life cycle inventory (LCI) data for Chinese industrial systems and supply chains. The database aims to improve the availability of transparent and regionally representative environmental information supporting life cycle assessment (LCA) studies and product carbon footprint calculations involving Chinese production systems.

The ***review covered the following materials***:

- HiQLCD Generic Methodology Report
- Steel Product Dataset Methodology Report
- Aluminium Industry Product Dataset Methodology Report
- HiQLCD Life Cycle Inventory Methodology Report for Grid Electricity Production and Supply
- HiQ Editor User Manual and supporting editor platform
- A selection of representative datasets

The objective of this review was to evaluate the methodological robustness, transparency and international compatibility of the HiQLCD database methodological framework and its supporting infrastructure. In particular, the review ***considered whether the methodology adequately addresses key aspects generally expected for internationally valuable LCI databases***. These aspects include completeness of inventory information, accuracy and precision of datasets, representativeness in geographical, temporal and technological terms, definition of functional units and system boundaries, application of cut-off rules and allocation procedures, methodological consistency across datasets, treatment of uncertainty, compatibility with established life cycle impact assessment (LCIA) methods, documentation practices, update mechanisms, and provisions for user support and community feedback.

The review was ***conducted in accordance with the principles and procedures for critical reviews*** described in ISO 14071:2014 and adapted as appropriate for the review of the methodology of a life cycle inventory database rather than a single LCA study. The review process included several rounds of iterative exchanges of comments and responses between the reviewer and the database developers, following established critical review practice.

1. ACT Promise of the HiQLCD Database

A central principle underlying the HiQLCD database is its ***ACT promise***, which positions the database as an ***Authentic, Chinese-Specific and Traceable*** life cycle inventory database.

Authenticity is reflected in the use of empirical industrial information, sector statistics and technical expertise representing actual production conditions in China. This contributes to improving the reliability of environmental modelling involving Chinese supply chains.

Chinese specificity is addressed through the deliberate development of datasets representing Chinese industrial systems, energy supply structures and production technologies. Where feasible, geographical representativeness is enhanced through regional or provincial differentiation, particularly for core background sectors such as electricity and coal.

Traceability is supported through structured dataset documentation. Each dataset contains short process descriptions and associated metadata explaining modelling assumptions, system boundaries, functional units and methodological characteristics, thereby ensuring a sound degree of transparency regarding the underlying modelling choices.

Together, these elements provide a coherent conceptual basis for the development of a China-focused life cycle inventory database intended to support both domestic and international LCA applications.

2. Methodological Framework based on International Guidance

The ***HiQLCD Generic Methodology Report*** is based on internationally recognized methodological guidance for life cycle assessment, environmental products declarations and life cycle inventory database development. These include the ***ISO 14040:2006 and ISO 14044:2006 standards for life cycle assessment, ISO 14067:2018 for product carbon footprint quantification***, ***ISO 14025:2006 on Type III Environmental Declarations, EN 15804:2012+A2:2019 for Environmental Product Declarations of Cement and Building***

Products prepared by a CEN Technical Committee (TC), the ***ILCD Handbook*** developed by the European Commission's Joint Research Centre (EC/JRC, 2010) and the ***Global Guidance Principles for Life Cycle Assessment Databases*** published by the United Nations Environment Programme (UNEP, 2011). Methodological practices applied in established international LCI databases such as ***ecoinvent*** have also been considered in the development of the HiQLCD methodological framework (Ioannidou *et al.* 2021; Sonderegger and Stoikou, 2023).

Within this framework, ISO standards together with the ILCD guidance constitute the primary methodological backbone of the HiQLCD approach. The database structure follows an ***ILCD-compatible dataset architecture***, facilitating interoperability with internationally used LCA software and databases.

In addition, the structure of the inventory flows and elementary flows enables ***application of widely used life cycle impact assessment methods***, including the IPCC method for climate change, CML, the Environmental Footprint method of the European Commission, ReCiPe and TRACI of the US EPA. Consequently, HiQLCD datasets can be applied directly within widely used LCIA frameworks employed in international LCA practice.

3. Data Quality Dimensions

The HiQLCD methodology demonstrates ***careful consideration of the principal data quality dimensions*** expected for internationally valuable LCI databases. The following dimensions were reviewed predominantly:

Completeness is addressed through structured dataset templates requiring documentation of relevant input and output flows at the unit process level. Accuracy and precision are supported through data quality evaluation procedures assessing reliability, completeness and representativeness of collected data.

Representativeness is addressed in geographical, temporal and technological terms. Where possible, geographical representativeness is enhanced through regional or provincial datasets reflecting variations in production conditions across China. Temporal representativeness is addressed through defined validity periods for datasets, while technological representativeness is supported through descriptions of production technologies and the use of technology-specific datasets where appropriate.

Functional units are defined in accordance with ISO guidance, ensuring comparability between product systems. ***System boundaries*** are defined according to the dataset scope and may represent gate-to-gate, cradle-to-gate, or cradle-to-gate-plus-end-of-life sections of product systems depending on the modelling objective. Many datasets represent unit process sections focusing on specific stages of production systems.

Cut-off rules are defined to allow omission of flows with negligible relevance, consistent with established LCA modelling practice. ***Consistency*** across datasets is supported through standardized dataset structures and modelling procedures. ***Uncertainty*** considerations are addressed through approaches such as pedigree-matrix scoring and statistical uncertainty analysis (Weidema and Wesnæs,1996).

Database infrastructure includes appropriate ***provisions for ongoing quality management***. The structured review workflows implemented within the HiQ Editor, the defined ***update procedures*** described in the methodology reports, and the ***planned user support and feedback mechanisms for users***, including enhanced documentation, training opportunities and structured feedback channels, provide a reasonable basis for maintaining data quality over time. It is recommended that the database developers continue to pursue periodic independent review of updated and newly added datasets to sustain the level of methodological rigor demonstrated in the current version.

4. Methodological Clarifications during Review Process of Generic Methodology Report

During the review process, ***several comments were raised and addressed in the revised versions of the reports***. These clarifications contributed to improving the transparency and methodological robustness of the methodology guidance provided for the HiQLCD database. Key clarifications are highlighted here:

Clarifications were introduced regarding ***allocation rules***. The documentation now explains more explicitly that economic allocation is generally applied as the default rule, while physical allocation approaches may be used where technically justified.

Further clarification was provided regarding ***confidentiality*** when datasets are derived from data originating from multiple companies. It was explained that confidentiality is ensured through aggregation of data from multiple sources, which anonymizes individual company contributions while simultaneously improving the representativeness of the resulting dataset.

The treatment of ***carbon content*** was also clarified. Carbon content is not modelled as a separate inventory flow but is calculated through specific flow properties associated with product and material flows. Biogenic carbon content in products and accompanying packaging is therefore derived from predefined carbon content properties combined with mass balance calculations.

Clarifications were also introduced regarding the modelling of ***waste flows*** and the relationship between waste classification and system modelling rules, including modelling approaches consistent with EN15804 when datasets are intended to support Environmental Product Declarations.

The modelling of ***water flows*** was further explained through the introduction of process-level water balance verification, ensuring consistency between water inputs and outputs and supporting compatibility with water footprint assessment approaches.

Finally, clarification was provided regarding ***uncertainty modelling***. Earlier versions of the database applied uncertainty estimation based on data quality scoring and analytical error propagation methods, while the methodology is now evolving toward Monte Carlo simulation using lognormal probability distributions.

5. Extension of review to core sectors methodology reports

In addition to the Generic Methodology Report, ***the Core Sectors Methodology Reports for steel, aluminium, and electricity have also significantly improved following the review process***. The revisions demonstrate improved clarity regarding technology coverage, allocation approaches, and energy modelling assumptions. Overall, these sector reports demonstrate good consistency with the generic methodology and show clear improvements in documentation quality and technical transparency.

The ***Steel Product Dataset Methodology Report*** represents a comprehensive and well-structured description of one of the most important industrial sectors within the database. The report demonstrates strong alignment with ISO and ILCD methodological requirements and shows good integration of multi-source industrial data. The dataset structure appropriately reflects the complexity of the Chinese steel sector, covering the full production chain from raw material preparation through ironmaking, steelmaking, and downstream processing. A relevant review comment concerned the current role of hydrogen-based technologies in steel production. The revised report appropriately clarifies that while hydrogen-based shaft furnace projects exist at industrial scale in China, the dominant technology currently remains gas-based direct reduction using mixed reducing gases, particularly coke oven gas combined with

hydrogen, mainly due to cost considerations and resource availability. This clarification improves the technological representativeness of the dataset and appropriately reflects the current transition stage of low-carbon steel technologies. Overall, the steel methodology report demonstrates a good balance between technological completeness and practical data availability.

The ***Aluminium Industry Product Dataset Methodology Report*** also shows clear improvements following the review comments, particularly regarding the description of energy supply structures. The clarification that primary aluminium production in China is mainly based on grid electricity, with an important contribution from hydropower in key producing provinces, provides important context for interpreting environmental performance. The acknowledgement of future developments such as renewable electricity sourcing and green electricity procurement is also a positive addition, as it demonstrates that the dataset developers are considering the rapid evolution of electricity supply structures in this sector.

The ***HiQLCD Life Cycle Inventory Methodology Report for Grid Electricity Production and Supply*** represents a well-structured and methodologically robust description of the Chinese electricity system. The report demonstrates strong alignment with ISO standards, ILCD guidance, and Environmental Footprint Declarations for dataset requirements. Particularly positive is the effort to provide geographic resolution of the electricity datasets, which capture provincial electricity mixes, covering all 31 provinces in mainland China, from power generation to electricity supply: Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. This modelling structure represents a significant strength of the database. A relevant review question concerned the apparent difference in allocation approaches compared to steel and aluminium datasets. The clarification that no economic allocation is applied in this case is appropriate, since the main multifunctional situation concerns combined heat and power generation. The explanation that allocation is instead based on the physical heat-supply ratio is methodologically sound and consistent with ISO guidance, which recommends physical relationships where appropriate. This clarification improves consistency of understanding across sector datasets and indicates methodological flexibility depending on sector characteristics.

6. Review of the HiQ Editor and representative Datasets

The ***HiQ Editor*** was also reviewed as part of the database infrastructure assessment. The editor is a web-based LCA data management platform designed to support the development,

editing and management of life cycle inventory datasets. The platform follows ISO-based LCA methodological principles and adopts an ILCD-compatible dataset architecture.

The system provides functionality for process management, flow management, source management, location management, unit management, LCIA method integration and version management. The ***editor supports dataset creation, allocation procedures, data quality evaluation, dataset merging and automated database calculations***. The platform also incorporates structured review workflows allowing datasets to be evaluated by LCA experts and sector specialists prior to publication. Based on the documentation and functionality described in the user manual, the HiQ Editor appears to function effectively and provides a suitable tool for editing and maintaining HiQLCD life cycle inventory datasets.

As part of the review assignment, ***46 datasets representing 37 representative industrial activities*** across several sectors were scanned. These datasets covered sectors including aluminium, steel, electricity generation, transport, coal, renewable energy technologies, plastics and chemicals, construction materials, lithium-ion batteries, electronic equipment, solid waste management and wastewater treatment.

The review's ***focus was on assessing whether the datasets are consistent with the methodological framework described in the HiQLCD Methodology Reports***. The reviewed datasets demonstrate appropriate definition of functional units, adequate system boundaries and documentation of technological characteristics through short dataset descriptions accompanying each dataset. The datasets generally reflect the modelling principles described in the database documentation. In the electricity sector, multiple datasets representing different generation technologies are available, including both fossil-based and renewable electricity production technologies. This improves the representation of electricity supply systems within LCA models. Overall, the reviewed datasets appear consistent with the guidance described in the HiQLCD methodological reports. ***No material data quality deficiencies were identified during the review*** of the representative datasets. Where review comments identified opportunities for improvement, these were addressed satisfactorily in the revised versions of the reports.

7. Overall Critical Review Conclusions

It should be noted that the scope of this review was limited to the assessment of the methodological framework, the supporting editor tool and a representative selection of datasets as described above. The ***review did not include independent verification of primary data at the facility level, nor did it involve a comprehensive audit of every dataset*** contained in the database. Such verification is outside the scope of a methodological review of this

nature and would constitute a separate data verification exercise. The conclusions of this review are therefore based on the assessment of the methodological documentation, the consistency of the reviewed datasets with the stated methodology, and the adequacy of the quality management infrastructure supporting the database

Starting from its ***ACT principle – Authentic, Chinese-Specific and Traceable – the HiQLCD database clearly follows international guidance and standards for the development of a China-focused life cycle inventory database***.

The methodological framework described in the HiQLCD Methodology Reports is ***based on internationally recognized guidance and standards*** for LCA, environmental products declarations and LCI database development. Based on the review of the methodological reports and supporting documentation, the HiQLCD methodological framework is considered to be consistent with the requirements of ISO 14040:2006 and ISO 14044:2006 for the development of life cycle inventory databases. The database framework also satisfies the relevant methodological requirements of ISO 14067:2018 for product carbon footprint quantification and is compatible with the requirements of ISO 14025:2006 and EN 15804:2012+A2:2019 for Environmental Product Declarations. Overall, the methodological approach chosen follows the methodological orientations provided in the ILCD Handbook of the European Commission and the Global Guidance Principles for LCA Databases developed by the United Nations. Methodological practices implemented in established international LCI databases such as ecoinvent have also informed the HiQLCD methodological framework.

The database structure and inventory flow definitions enable the ***application of widely used life cycle impact assessment methods***. These include internationally established approaches such as IPCC climate change characterization, CML, the Environmental Footprint (EF) method of the European Commission, ReCiPe and TRACI of the US EPA. Consequently, HiQLCD datasets can be applied directly within widely used LCIA methods

The ***database framework incorporates structured methodological approaches addressing the key aspects expected for high-quality LCI databases***, including completeness of inventory information, accuracy and precision of datasets, representativeness in geographical, temporal and technological terms, functional unit definition, specification of adequate system boundaries, application of cut-off rules, consistency across datasets, uncertainty considerations and compatibility with impact assessment methods.

A noteworthy feature of the HiQLCD database is the ***effort to reflect Chinese industrial production conditions through regionally differentiated datasets***. In particular, geographical differentiation at provincial level is implemented for electricity datasets and, where feasible,

elsewhere where regional variations are possible with currently available data, thereby improving the representativeness of modelling results for Chinese supply chains.

The ***revisions made during the review process have further improved the clarity and transparency of the methodology reports***. Clarifications introduced in response to review comments, including for instance those related to allocation procedures, confidentiality of industrial data, carbon content calculation, waste modelling, water balances and uncertainty modelling, contributed to strengthening the methodological guidance of the database.

Overall, the HiQLCD database represents a ***methodologically sound and well-structured life cycle inventory database initiative providing China-specific background data for life cycle assessment and product carbon footprint applications***. Based on the methodological reports and the supporting tool with the datasets reviewed, the database framework appears consistent with internationally recognized methodological guidance and standards for LCA database development and provides a solid basis for use in the assessment of the potential impacts of product systems involving Chinese production systems within global supply chains.

8. References

EC/JRC. 2010. *International Reference Life Cycle Data System (ILCD) - Documentation of LCA data sets*. First edition ed. Publications Office of the European Union.

EC/JRC. 2010. *International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance*. First edition ed. Publications Office of the European Union.

EC/JRC. 2010. *International Reference Life Cycle Data System (ILCD) Handbook - Nomenclature and other conventions*. First edition ed. Publications Office of the European Union.

CEN/TC51. 2022 *Cement and Building Lime - Environmental Product Declarations - Product Category Rules Complementary to EN 15804 EN 16908:2017+A1:2022*.

CEN/TC350. 2019. *Sustainability of Construction Works - Environmental Product Declarations - Core Rules for the Product Category of Construction Products EN 15804:2012+A1:2013/A2:2019*.

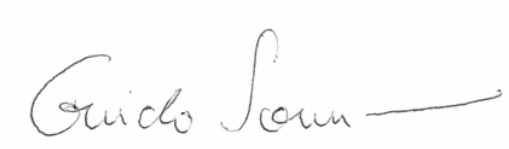
Ioannidou D., Foster C., Symeonidis A. *et al.* 2021. "Documentation for the 'Allocation, cut-off, EN15804' system model." ecoinvent Association.

ISO. 2006. *Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures ISO 14025:2006*.

ISO. 2006. *Environmental Management - Life Cycle Assessment - Principles and Framework ISO 14040:2006*.

ISO. 2006 *Environmental Management - Life Cycle Assessment - Requirements and Guidelines ISO 14044:2006*.
ISO. 2014. *Environmental Management - Life Cycle Assessment - Critical review processes and reviewer competencies ISO 14071:2014*
ISO. 2018. *Greenhouse Gases - Carbon Footprint of Products - Requirements and Guidelines for Quantification ISO 14067:2018*.
Sonderegger T., and Stoikou N. 2023. "Implementation of life cycle impact assessment methods in the ecoinvent database v3.10." ecoinvent Association.
UNEP. 2011. *Global Guidance Principles for Life Cycle Assessment Databases - A basis for greener processes and products 'Shonan Guidance Principles'*. Edited by Guido Sonnemann, and Bruce Vigon.
Weidema B.P., and Wesnæs M.S. 1996. "Data quality management for life cycle inventories—an example of using data quality indicators." *Journal of Cleaner Production* 4 (3-4):167–74.

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