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Building a climate-neutral future together

Sino-Swiss Cooperation on Zero Emissions Building

Technical Report

Lifecycle Assessment Data and the KBOB Database

Experiences from Switzerland

ENGLISH VERSION

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This report has been produced within the framework Sino-Swiss Zero Emissions Building Project; an international collaboration funded by the Swiss Agency for Development and Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development.

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The Sino-Swiss Zero Emissions Building Project is an international collaboration funded by the Swiss Agency for Development Cooperation in partnership with the Chinese Ministry of Housing and Urban-Rural Development. The project aims to reduce greenhouse gas emissions and enable carbon neural development of the building sector in China by sharing Swiss know-how on sustainable and zero emission building.

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Contents

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1. LIFE CYCLE ASSESSMENT DATA IN THE SWISS CONSTRUCTION SECTOR

1.1. LCA and embodied emissions

Life Cycle Assessment (LCA) is a methodology used to evaluate the environmental impact of a product, service, or process throughout its entire life cycle. This includes raw material extraction, production, use, and disposal. In terms of GHG emissions, the assessment considers both embodied (indirect) and operational (direct) emissions.

In the construction sector, embodied emissions refer to the GHG emissions of construction that occur during upstream processes in the supply chain (e.g. material extraction, production, processing, and disposal, including auxiliary materials). Operational emissions include the GHG emissions arising during the operation of a building from e.g. combustion of natural gas for heating.

Efforts to address climate change have primarily focused on reducing the operational energy demand of buildings. However, while newly constructed buildings can minimize operational GHG emissions, the share of embodied GHG emissions has substantially increased relative to this decline, sometimes even amounting to a higher value than operational GHG emissions. Sustainable practices must acknowledge and mitigate these embodied emissions, achievable through conducting LCAs.

To establish an LCA for a building, reliable and high-quality data are needed. In Switzerland, the KBOB recommendation 2009/1, issued by KBOB, ecobau, and IPB provides such data. The KBOB list is a standardized dataset that supports assessing the environmental impact of buildings. Architects and planners frequently make use of the KBOB list, especially in combination with certifications.

1.2. Embodied emissions in Swiss building standards and certifications

Switzerland has building standards and certifications such as Minergie-ECO or the Swiss sustainable building standard (SNBS) that aim to promote energy-efficient and more environmentally friendly building practices by accounting for the impact of embodied GHG emissions. The standards base their calculations on the numbers provided by the SIA, e.g. in the explanatory leaflet SIA 2032, and the KBOB list.

1.2.1. SIA

The SIA is a professional and interdisciplinary network with over 16’ 000 members from the fields of engineering and architecture. It aims to promote sustainable and high-quality design of the Swiss built environment . The explanatory leaflet SIA 2032 – “Embodied energy of buildings” lays the foundation to calculate the energy consumption of buildings throughout their construction, operation, and disposal. The key indicators for a building’ s energy consumption are either the embodied energy or the embodied GHG emissions. With the explanatory leaflet, the embodied energy / embodied GHG emissions of new buildings, renovations of buildings, as well as individual components can be calculated. SIA 2032 aims to base these calculations on uniform procedures and data sources, ensuring that calculations are comparable and reproducible. As such, the LCA data used for the calculations are based on the KBOB list [1] [2] [3].

1 energie schweiz, eco-bau & EnFK (2017). Graue Energie von Neubauten Ratgeber für Baufachleute.

2 SIA (2010). SIA Merkblatt 2032 - Graue Energie von Gebäuden.

3 SIA (2011). SIA Merkblatt 2040 - Effizienzpfad Energie.

1.2.2. Minergie-ECO

Minergie-ECO is a label for low-energy-consumption buildings that address certain ecological and social requirements. Building materials of Minergie-ECO buildings require to have low embodied energy. Depending on the project, the limiting value of the embodied energy is calculated differently. To further reduce the amount of embodied GHG emissions (here CO2), demolition ought to be avoided and building components reused. The calculations follow SIA' s explanatory leaflet 2032 [4] [5].

1.2.3. SNBS

The aim of the Swiss sustainable building standard (SNBS) is to incorporate the three dimensions of society, economy, and environment equally and as comprehensively as possible in planning, construction, and operation. The standard thus considers the entire life cycle of a property in a phase-appropriate manner . The NNBS [6] develops and maintains the SNBS [7]. For measuring the embodied energy / embodied GHG emissions, the SNBS follows the same rules as Minergie-ECO and bases the calculations on SIA' s explanatory leaflet 2032. In doing so, synergies between the label Minergie-ECO, the SIA explanatory leaflet and the SNBS are being created .

4 Minergie & ecobau (2020). Produktreglement MINERGIE-ECO ®. [Online]. Available from: www.minergie.ch.

5 Minergie (2022). ECO: Gesund und ökologisch bauen wird immer wichtiger. [Online]. 2022. Available from: https://www.minergie.ch/de/news/news-de/eco-gesund-und-oekologisch-bauen-wird-immer-wichtiger/.

6 Sustainable Building Sector Switzerland

7 NNBS (2023). Standards Nachhaltiges Bauen Schweiz SNBS. [Online]. 2023. Available from: https://nnbs.ch/snbs/.

1.3. Consideration of embodied GHG emissions in other countries

Beyond Switzerland, the management of embodied GHG emissions is similar in other countries. While there is an obvious demand to calculate the embodied GHG emissions, concrete policy regulations are yet on the rise. Countries like Australia, Canada, the USA, the UK, Germany, and Switzerland have a variety of voluntary instruments such as certification standards, recommendations, and guidelines, but they tend to lack nationwide regulations , . In the EU, only five countries – France, the Netherlands, Denmark, Sweden, and Finland - have passed laws to decrease embodied GHG emissions . The EU itself recognizes the importance of embodied GHG emissions in reaching its net zero goal, but the endeavours haven' t moved past votes . In the Asia-Pacific region, the Asia Low Carbon Buildings Transition is gaining momentum. More and more Asian and African countries are developing methods, databases, tools, and computational infrastructure to measure whole-life carbon emissions of buildings. Spanning across countries, the United Nations Environment Program and the Global Building Data Initiative aim to support capacity building, data generation, and benchmarking for reducing embodied GHG emissions and resource use .

2. THE KBOB PLATFORM

With the goal of providing high quality and up-to-date data on building materials, building technology, energy systems and transport in Switzerland, KBOB and ecobau launched the platform for life cycle assessment data in the construction sector – the KBOB platform. The specific numbers are summarized in the KBOB recommendation 2009/1 – or short the KBOB list - issued by KBOB, ecobau, and IPB. With this standardized dataset, building contractors, architects, and building engineers can assess the environmental impact of buildings.

The platform can be regarded as an institutionalization between its representatives: the building sector (SIA), research institutions (ETH, ecoinvent), the public building contractors (KBOB, ecobau), and the interest group of private professional building owners (IPB). KBOB and ecobau manage the platform.

In this chapter, KBOB, IPB and ecobau are being presented and the application of the KBOB list is being discussed.

2.1. KBOB

The KBOB was founded in 1968 as the coordination body of the federal construction authorities. After a reorganization in 1999, it now represents the interests of its members as builders and property owners. Not only does it represent interests in relation to the construction industry, but it is also the point of contact in the construction sector.

KBOB' s paramount goal is to save resources and increase quality. Together with its members (Figure 1), KBOB aims to safeguard the economic use of resources by accounting for social and ecological impacts throughout the entire lifecycle of property.

2.1.1. Organization of the KBOB

Members of the KBOB include the Federal Office for Building and Logistics (FOBL), arma suisse real estate, the board of the Federal Institute of Technology (ETH board), the Federal Office of Transport (FOT), the Federal Roads Office (FEDRO), the Swiss Conference of Cantonal Directors of Public Works, Planning, and the Environment (KPUK), the Swiss Association of Municipalities (SGV), and the Swiss Association of Cities (SSV). The Swiss Federal Railways (SBB) acts as an observer.

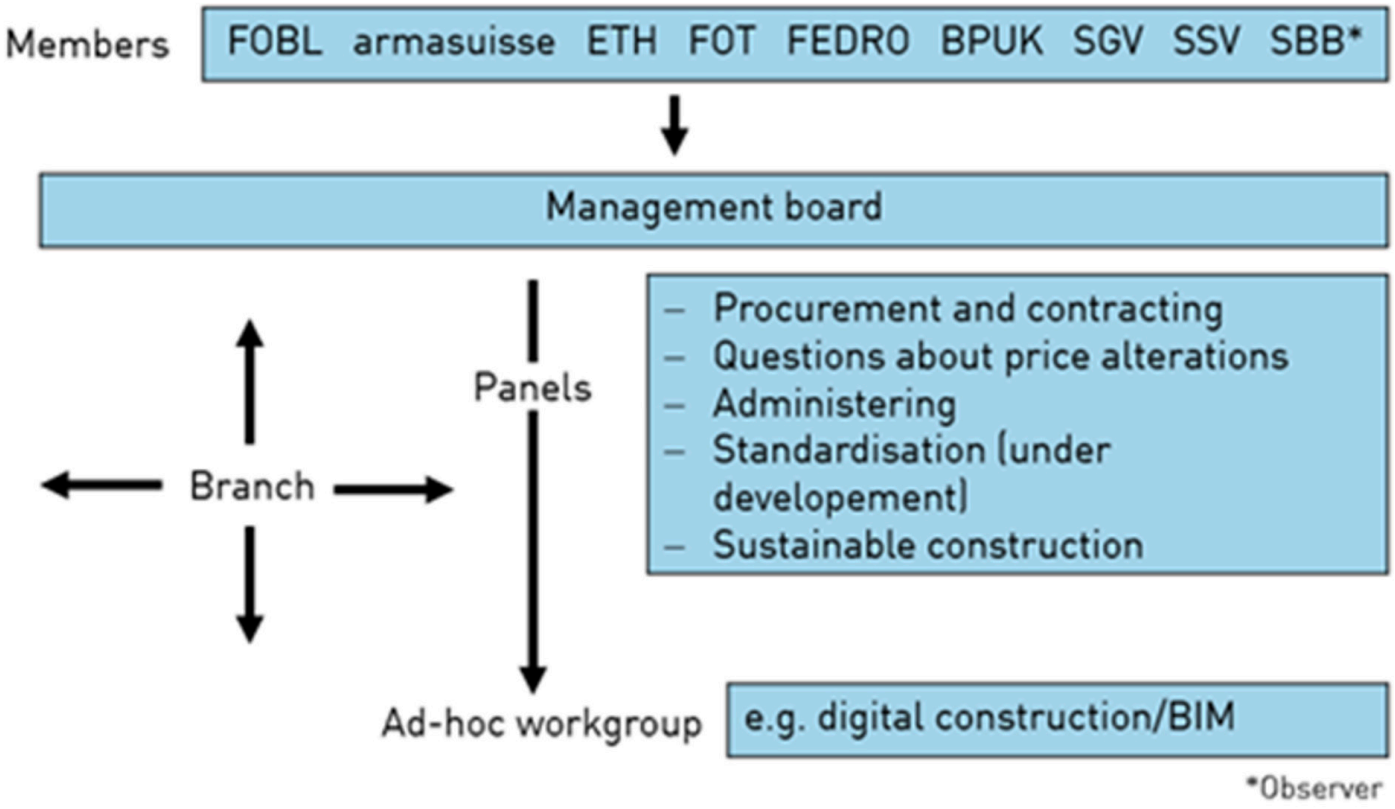

Figure 1. The organization of KBOB

The KBOB board sets the focal points of activity for KBOB, engages in discussions, and develops strategies. It delegates tasks to the four expert groups and ad-hoc working groups. The expert groups were established in crucial areas. They act on behalf of the board, address tasks of particular significance for KBOB, take responsibility for professional information exchange and experience-sharing among KBOB members. For additional tasks, the ad-hoc working groups are assigned.

2.2. Ecobau

Ecobau is an association aiming to establish sustainable, ecological and healthy construction methods in a broad basis by developing and disseminating planning tools that support planners and architects in all phases of construction (planning, implementation, dismantling). Additionally, ecobau operates and promotes the training of specialists .

2.2.1. Organization of ecobau

Ecobau' s board, responsible for the strategic management, takes care of efficient and transparent business management. It further implements strategies, answers questions and provides information, and sets up projects (Figure 2).

Planning tools offered by ecobau include building certifications and standards such as Minergie-ECO and SNBS, contract components, and product selections.

2.3. IPB

The Interest Group of Private Professional Builders (IPB) is a consortium of Swiss and international companies who invest and realize projects in the construction and real estate sector. The IPB represents one of the largest real estate portfolios in Switzerland .

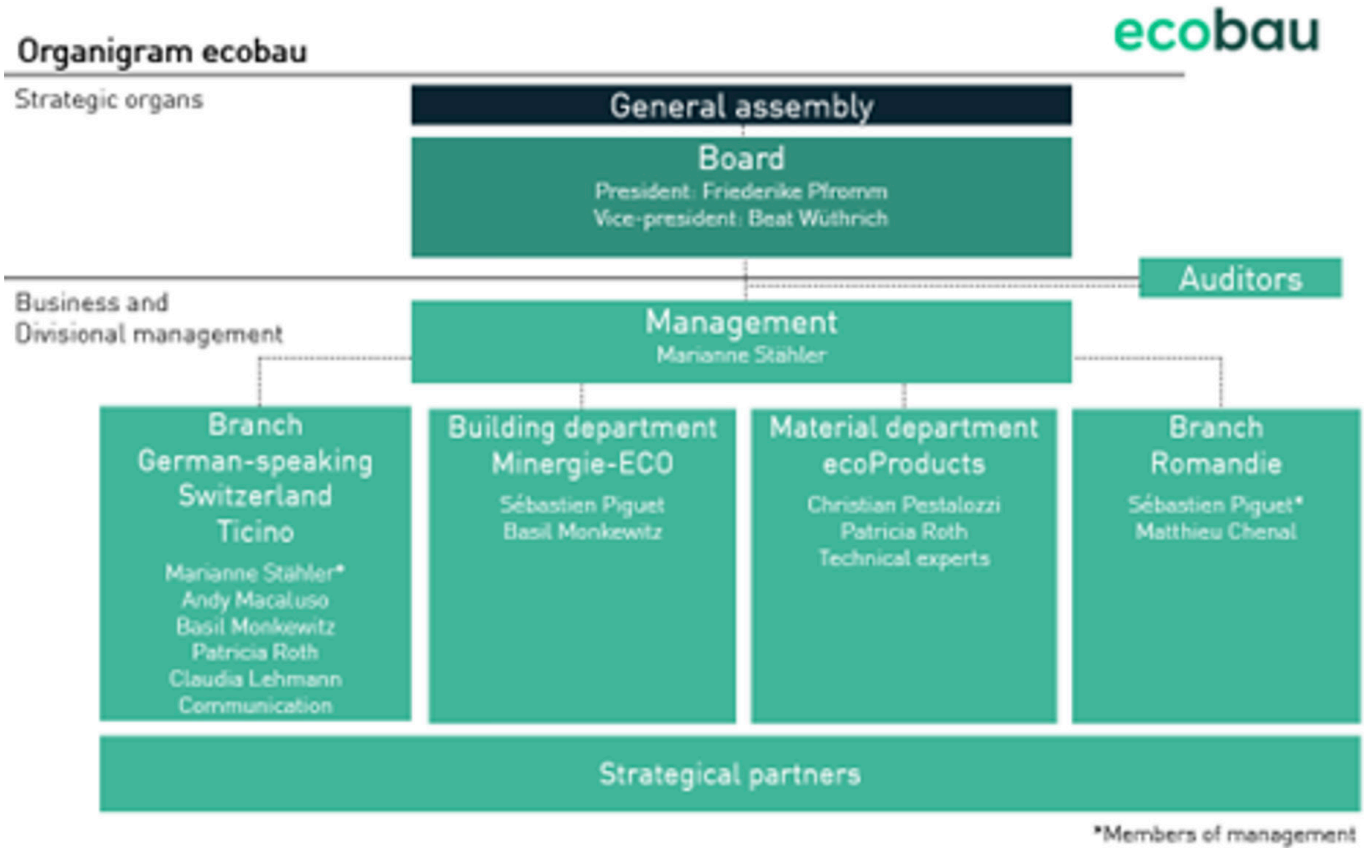

Figure 2. The organization of ecobau

2.4. The KBOB list

KBOB, ecobau and IPB have compiled LCA data of the building sector in the KBOB recommendation 2009/1 – the KBOB list. The data, based on the ecoinvent v2.2 database, are regularly updated. The KBOB list serves as an accepted database for calculating impacts by construction materials and processes, and energy and transport systems in terms of primary energy consumption, GHG emissions and environmental impacts. SIA uses the KBOB list as a base for the calculations in their various explanatory leaflets (e.g. SIA 2031 (2008) Energy certificates for buildings, SIA 2032 (2010) Embodied energy, SIA 2040 Energy efficiency path), and ecobau uses the list to base their instruments and planning tools on .

Based on the list, applicants may compare construction tools and decide for the ones they want to use in their projects. In that sense, the KBOB list has a direct influence on the market, favoring the providers with the optimized product range .

2.4.1. Using the KBOB list

The KBOB list, available in PDF or Excel versions, can be downloaded and used free of charge . However, detailed information on life cycle assessment data requires a fee-based ecoinvent license .

The LCA data from the KBOB list are applied in several Swiss certificates (e.g. Minergie-ECO, SNBS), planning tools (e.g. Eco-Devis, Lesosai), and standards (e.g. SIA 2032) (Figure 3).

2.4.2. Inclusion of producer- and product-specific LCA data

For producer- and product-specific LCA data to be included in the KBOB list, they must be verified and validated by a specialist. The data must comply with methodological specifications, which currently are the ecoinvent quality guidelines v2.2 and additional specifications for producer- and product-specific data. Furthermore, they must be representative for the Swiss market ..

There are two cases of creating KBOB-compliant data: (1) The creation of KBOB-compliant data to be included in the PDF/Excel versions of the KBOB list (Figure 4), (2) The creation of producer-specific, KBOB-compliant data that can be included in the Excel version of the KBOB list and that may be published independently by the producer/dealer/association (Figure 5).

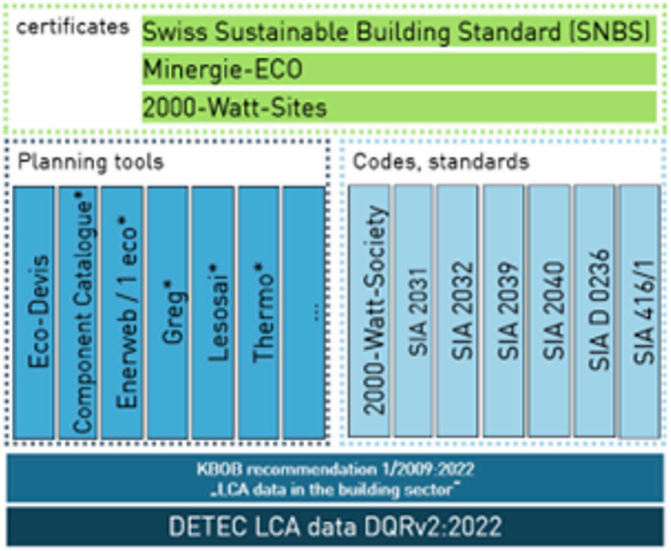

Figure 3. Certificates, planning tools and standards in the building sector relying on the KBOB list

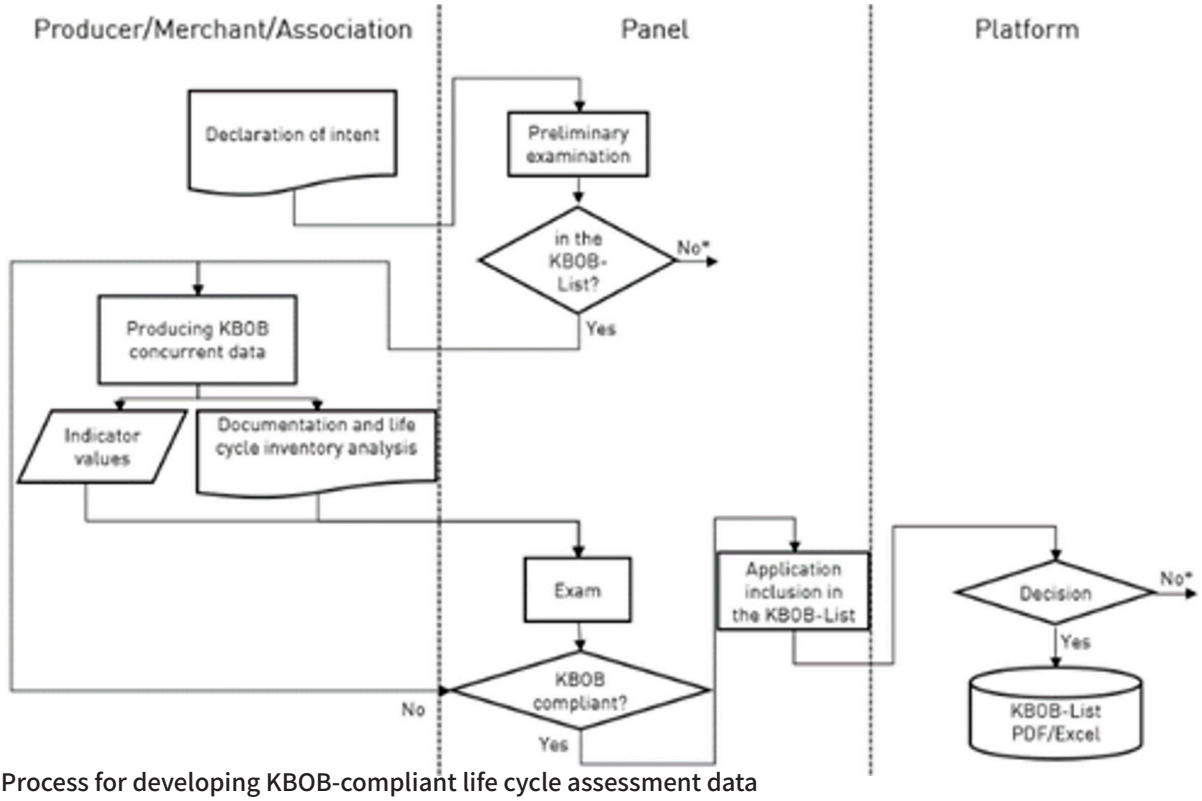

Figure 4. Process for developing KBOB-compliant life cycle assessment data

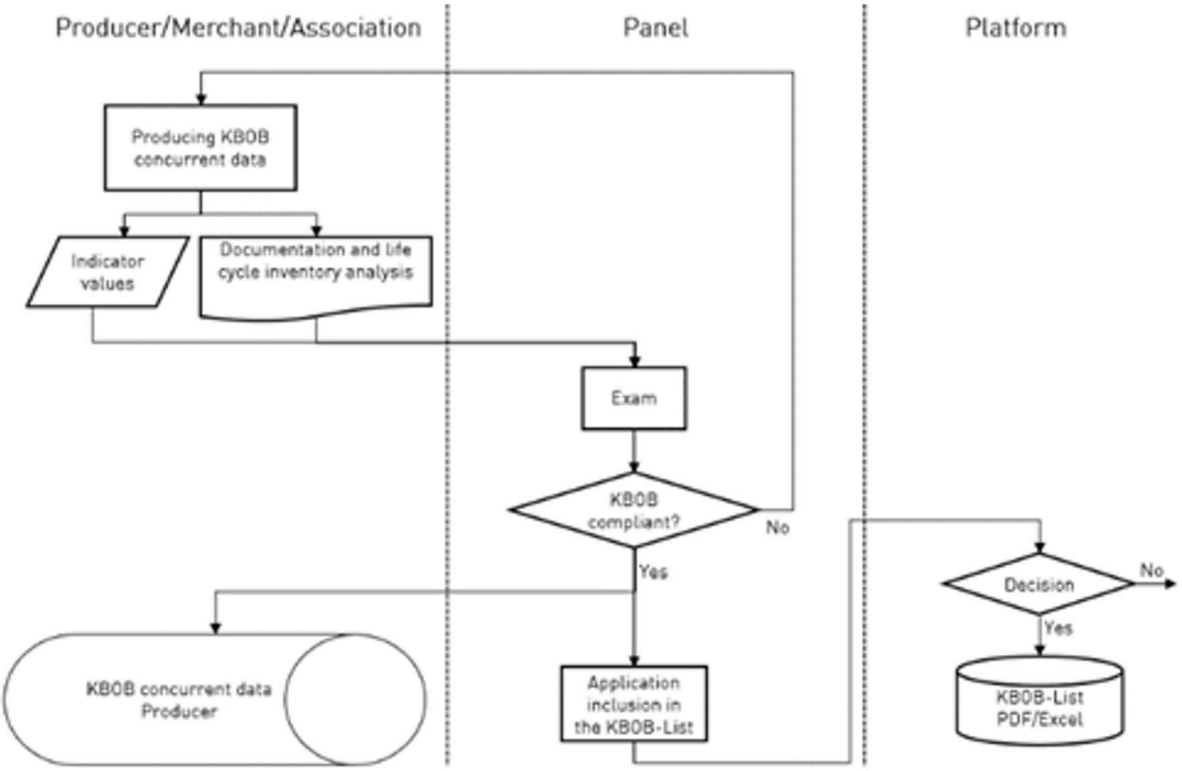

Figure 5. Process for developing producer-specific, KBOB-compliant life cycle assessment data

3. CHALLENGES FOR CHINA

The National Carbon Emission Index GB_T51366 only covers the production phase but not the disposal phase. Therefore, here we compare only the production phase in China and Switzerland, and then list the situation of disposal phase separately.

Some materials, such as wood, have no data in GB_T51366. In the case of wood, the lack of data may be due to two reasons. First, wood for the Chinese building sector is mainly imported, making it difficult to get precise data for carbon emissions. Also, emissions for wood are remarkably high since emissions from transportation is considered. That would be more of a reason to count and report emissions.

The National Carbon Emission Index records emissions in units of kg or m2, rather than m3 as used in other cases.

Generally, for the same material, production in China is less ecofriendly than in Switzerland. This shows the potential for improvements in manufacturing or the state grid.

Data in GB_T51366 comes from a database of the IKE institute in Chengdu. Further information on the Chinese material database can be found on the following website: https://www.ike-global.com/

The typical difference in emissions of the same building material between KBOB and GB_T51366 is within a reasonable range of 50%. But there are huge differences in carbon emissions between different materials. Feedback from Chinese investors and architects shows that the lack of material data in China makes it difficult to choose environmentally friendly materials. Before China' s carbon database is perfected, they can also use Swiss data (KBOB) as a temporary and reliable reference for decision-making.

3.1. Current status quo in China

At present, climate change has become the focus of global attention. Green and low-carbon economies have become the goal of global joint efforts. At the Climate Conference in December 2020, China put forward the goal of achieving carbon peak by 2030 and carbon neutrality by 2060. On September 22, 2021, the CPC Central Committee and The State Council issued the "Opinions of the CPC Central Committee and the State Council on fully, accurately and comprehensively implementing the new development concept and doing a good job in carbon peak carbon neutrality"; On October 26, 2021, The State Council issued the action plan for achieving the carbon peak before 2030. The above two documents are important programmatic documents for China' s efforts to achieve carbon peak and ultimately carbon neutrality.

According to the International Energy Agency' s (IEA) Global Building Tracker Report, energy, and process emissions from buildings (including the embodied emissions from new buildings) will account for 30% of global energy consumption in 2021. Carbon emissions from buildings will account for 27% of energy sector emissions, of which 8% are direct emissions from buildings and 19% are indirect emissions from the production of electricity and heat used in buildings. The construction sector is therefore a key sector to slow climate change and reduce its impacts.

On July 13, 2022, the National Development and Reform Commission of the Ministry of Housing and Urban-Rural Development issued a notice on the Implementation Plan for Peaking Carbon in the Field of Urban and Rural Construction, which put forward the requirements for peaking carbon emissions in urban and rural construction before 2030. It includes the basic establishment of the policy system and institutional mechanism for green and low-carbon development in urban and rural construction. Energy conservation in buildings and the recycling of waste as a resource have been greatly improved, and energy efficiency and resource utilization have reached an internationally advanced level. The structure and mode of energy use are more optimized, and the application of renewable energy is more adequate; Positive progress has been made in transforming urban and rural development into a green and low-carbon model, with a large amount of construction, consumption, and emissions being reduced. The overall systematic growth of the city has been enhanced, And the quality of construction, engineering, and the living environment was further improved. Green lifestyles have taken shape, and green and low-carbon operations have been achieved.

In construction, the focus of dual-carbon work mainly lies on the promotion of green and low-carbon construction methods in the construction process and the use of low-carbon building materials with high energy saving effects. Additionally, the improvement of building operation efficiency after the building completion saves energy and reduces emissions. Building products with the same energy-saving effect have different carbon emission factors due to different production processes and

materials transportation methods.

The impact of reducing building material carbonization mainly considers technological improvements in materials production. The implementation plan of carbon peak in the building materials industry is to “promote the reduction of the use of building materials products”. This includes improving the quality and application level of cement products, promoting the reduced use of cement, developing energy efficient construction technology, increasing the use of high-performance concrete, accelerating the development of new low-carbon cementing materials and encouraging research and development on carbon-fixing mineral materials and full-solid waste non-burning new cementing materials. At the same time, it is necessary to build a green building materials product system. with requirements and emission indicators for cement, glass, ceramics, lime, wall materials, wood and bamboo products.

3.2. Challenges

3.2.1. Wide geographical range

China has a vast territory and abundant resources. Its geographical scope, climatic conditions, material resources, economic development and population distribution vary greatly across different regions. Energy demand and resulting emissions from the construction and operation of long-term living spaces differ due to a variety of resources, technology, and usage habits.

3.2.2. Different climatic conditions

Due to the vast geographical area of China, the climatic conditions vary greatly. Buildings are adapted to local climatic conditions including cold areas, hot summer and cold winter areas, hot summer and warm winter areas and mild areas. Between climate zones, the difference between the average temperature of the coldest month and the average temperature of the hottest month is very large. Making use of natural resources and reducing the negative impact of air conditioning and heating by adopting energy-saving technologies are key, but detailed strategies and technologies vary from region to region based on condition.

3.2.3. Industrial distribution is unbalanced

There is a diverse distribution of mineral resources, industries, and particularly building material enterprises in various regions in China. In addition to the national unified industry standards, different provinces have some differences in the management of the same type of enterprises according to local characteristics, which leads to different levels of technology and building materials production links. For similar building materials, the difference in raw materials, production technology and level have a large impact on the carbon emission factor.

3.2.4. Balanced economic development

There are significant differences across China in the development orientation of cities, the economic development level of various regions, and the level of development and construction in various cities. The supply and demand of building materials in cities is unbalanced due to the uneven distribution of industries. Materials often need to be transferred from one area to another, and the transportation distance has an impact on carbon emissions. It is necessary to account for both the carbon emissions of the production and transportation processes.

We recognize these additional challenges:

- Regulations: A lack of coherency in regulations that work towards the same goal and are reproducible and comparable
- Ecological considerations: Scaling up construction practices that lower GHG emissions can shift environmental impacts. For example, going away from using concrete to timber raises the question of whether forests can be sustainably managed and meet the additional demand for timber. The act of construction/building itself and all the processes revolving around it lead to land-use change and biodiversity loss (not only through land-use change but also through the destruction of ecosystems when closing the ground and building on it).
- Costs: As long as more sustainable building is not financially competitive with standard building practices, the transition will be hard to make.

4. CONCLUSION OF EUROPEAN EXPERIENCES

The data presented on the platform for Life Cycle Assessment (LCA) data in the construction sector is an important tool, streamlining the calculation of embodied GHG emissions in the construction industry. It provides a comprehensive perspective on the environmental impact of building materials, and thus supports informed decision-making, and attainment of sustainability certifications.

LCA data plays a critical role in the selection of more environmentally friendly materials and communication of a project's environmental performance to diverse stakeholders. It makes the construction sector pursue continuous improvement by monitoring trends and fostering innovation. The broad ownership, involving governmental department, educational institutions, and industries, underscores the platform's support.

A notable advantage lies in the structured process for ensuring data quality and regular updates, reinforcing the reliability of the information provided. With a defined timeline for data validity and a requirement for producers to submit updates in case of significant changes, the platform maintains its relevance and accuracy.

Together with the ongoing development of certification schemes, planning instruments and software tools (e.g. certification systems, Eco-Devis, Lesosai, LCA Software, BIM), the utilization of the KBOB list contributes to the overarching goal of advancing the construction sector towards more sustainable practices.

The European experience in establishing databases for Life Cycle Assessment (LCA) in the construction sector is extensive and well-developed. There are several initiatives and projects aimed at improving the collection, management, and dissemination of LCA data for construction products and buildings. The EU's Construction Products Regulation (CPR) and its accompanying eco-design requirements are among the most notable initiatives. Additionally, the European Commission has also funded research and development projects that focus on the creation and implementation of LCA databases in the construction sector. These projects aim to improve the quality and availability of LCA data for the construction sector, and to encourage the use of LCA in the development of more sustainable and energy-efficient buildings. Overall, the European experience in establishing databases for LCA in the construction sector is positive, with significant progress being made in terms of data collection and management, as well as the development of best practices and standards.

There have been several initiatives and projects aimed at establishing databases for Life Cycle Assessment (LCA) in the construction sector in Europe. Some examples include:

- The European Commission's Construction Products Regulation (CPR), which aims to improve the environmental performance of construction products through the application of LCA principles.
- The Environmental Product Declarations (EPDs) program, which is a voluntary, industry-led program aimed at improving the environmental performance of construction products using LCA.
- The LCA database for the construction industry, developed by the International Energy Agency's Energy in Buildings and Communities Program (EBC).

These initiatives and projects aim to provide data and information on the environmental performance of construction products, which can be used to support decision-making in the construction sector and to improve the sustainability of building construction.

There are national and regional differences in the databases used in the EU for Life Cycle Assessments in the construction sector. These differences can arise due to various factors such as differences in building codes, regulations, and cultural practices.

To overcome these differences, there have been several initiatives and projects aiming for harmonizing the databases and methods used in LCA in the EU. One example is the European Network of Life Cycle Assessment in the Construction Sector (ENLACS), which was established to promote the harmonization and development of life cycle assessment methodologies and databases in Europe. Another example is the European Commission's Life Cycle Assessment Data Network (LCDN), which aims to provide a single point of access to life cycle assessment data and information in Europe, including data from different national and regional databases. In addition, there have been efforts to standardize the data collection, calculation and

reporting methods used in LCA to ensure the comparability and reliability of the results. This includes initiatives such as the International Organization for Standardization (ISO) standards on life cycle assessment: ISO 14044:2006

To overcome the differences in the databases used in the EU for life cycle assessment in the construction sector, it is important for stakeholders to coordinate their efforts towards a common goal of harmonization and standardization.

There are differences between the Swiss databases such as KBOB, and those of other EU countries. These differences include:

- Data sources: The data sources used in the Swiss databases may differ from those used in other EU countries, leading to different results and interpretations of the environmental impact of a building material or product.
- Methodologies: Different methodologies used for data collection and analysis can result in different results and interpretations of the environmental impact of a building material or product.
- Regulations: Regulations and standards for life cycle assessment vary between countries, which can result in different databases and methodologies being used.

To overcome these differences, a harmonization of data sources, methodologies, and regulations could be considered. This could be done through the development of common standards and guidelines, and through cooperation between the relevant organizations and stakeholders involved in the life cycle assessment process.

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