REQUIREMENTS OF BEST AVAILABLE TECHNIQUES AS THE SUPPLY CHAIN CRITERIA FOR THE ENVIRONMENTAL AND SUSTAINABILITY ASSESSMENT OF CONSTRUCTION

Prof. Dr. Sci. Ekaterina Potapova[1]

Prof. Dr. Sci. Tatiana Guseva[2]

Assoc. Prof. Dr. Yana Molchanova[1]

Assoc. Prof. Dr. Maria Vartanyan[1]

Prof. Dr. Sci. Bahitzhan Taimasov[3]

[1]Dmitry Mendeleev University of Chemical Technology of Russia, **Russian Federation**
[2]Research Institute 'Environmental Industrial Policy Centre', **Russian Federation**
[3]Auezov South Kazakhstan State University, **Republic of Kazakhstan**

ABSTRACT

The article considers opportunities for using Environmental Performance Levels associated with Best Available Techniques (BAT-AEPL) as the supply chain criteria for the environmental and sustainability assessment of construction industry. Organisations in various countries have been using the Environmental and Sustainability Standard BES 6001 to foster greening of the construction sector for over 15 years. Key requirements of BES 6001 address major management systems of suppliers: quality management (QMS), environmental management (EMS), and occupational health and safety management (OHSMS) systems. Various researchers emphasise the importance of energy management systems (EnMS), too. Authors of this article aim to demonstrate how BAT-AEPL can be used to set auditable quantitative requirements for EMS and EnMS. These requirements cover BAT-associated resource efficiency levels, which is very important for such sectors as cement, brick and glass production. In jurisdictions where BAT concept is introduced by the national or regional legislation, these requirements cover also BAT-Associated Levels of Emissions of such pollutants as nitrogen and sulphur oxides, dust, as well as specific pollutants that might be emitted while using alternative fuel (Refuse-Derived Fuel, RDF), for example, in cement production. Finally, carbon intensity of construction materials manufacturing processed and opportunities for its reduction are discussed in the Reference Documents on Best Available Techniques (BREFs) and in some cases, sectoral benchmarking procedures are associated with the revision of BREFs. The article provides sectoral examples and recommendations for the practical use of BREFs and BAT-AEPL for setting criteria for the environmental and sustainability assessment of construction industry.

Keywords: construction industry; construction materials industry; responsible sourcing; standardization; Best Available Techniques; reference documents; resource efficiency; environmental performance; carbon intensity, environmental and sustainability assessment

INTRODUCTION

The construction industry, encompassing the construction of buildings and infrastructure facilities, the extraction of raw materials, and the production of construction materials, plays a pivotal role in the development of both the economy and society. In the Eurasian Economic Union (EAEU), the construction materials industry's output grew by 0.3% and the volume of construction work performed rose by 4.7% in 2022 as compared to the previous year [1]. Today, the construction sector drives investment demand for materials, equipment, and human resources, greatly influencing the environment and the quality of life. In the context of sustainable development, the construction sector primarily addresses issues related to urban and town planning, energy and water supply, and infrastructure preparedness for climate change [2]. In the 1990s, the construction industry became one of the first sectors in various countries to develop green standards and methodologies. The ongoing relevance of this topic is evident as the number of such documents continues to grow, and the range of issues included in the field of green building consistently expands [3, 4]. From 2010 to 2012, such an issue started attracting attention as the choice of building materials and their suppliers within the framework of methodologies for developing construction projects and evaluating buildings, structures, and infrastructure [5]. This article discusses the peculiarities of using the requirements for Best Available Techniques (BAT) as evaluation criteria within a system for the responsible selection of building material suppliers.

METHODS

Various national and international standards cover the issues of the responsible sourcing construction materials. For example, the recently released Russian GOST R 70346 "Green standards for multifamily housing design, construction, and operation" [6] includes the assessment category entitled "Materials and Resource Efficiency", which includes the responsible approach to selecting construction materials as one of its evaluation criteria. However, this criterion only discusses the acquisition of materials from certified sources. Another example is the LEED green building rating system [7], which includes the "Materials and Resources" section. This section focuses on embodied greenhouse gas emissions by considering the carbon intensity of cement, concrete, ceramic products such as bricks and tiles, as well as glass, insulating materials, steel, and aluminium constructions.

The procedure for the responsible sourcing of construction materials is most clearly defined in the widely-implemented British BREEAM methodology [8]. Also, this methodology emphasises that assessing environmental performance and resource efficiency should cover the entire life cycle of construction materials, including their production technology.

The BES 6001:2022 standard is related to the BREEAM methodology and establishes requirements for the responsible sourcing of construction materials [9]. The standard describes approaches to the integrated management systems used by building materials suppliers, including QMS, EMS, EnMS as well as OHSMS.

The 2022 version of the standard places special emphasis on assessing the life cycle of materials used, including their carbon intensity. Focusing on approaches explored to achieve zero emissions by 2050, the standard requires that manufacturers develop a policy

aimed at reducing greenhouse gas emissions, which aligns with current green project trends in various sectors of the economy. Also, the standard requires a traceability of at least 70% of materials in the supply chain for those organizations that extract raw materials and produce materials (including through recycling).

RESULTS AND DISCUSSION

This section of the article is devoted to the analysis of the role of Best Available Techniques in the responsible sourcing of building materials. Although BES 6001 does not consider BAT, in 2012-2015 experts emphasized that it was necessary to consider compliance with relevant BAT requirements in regions where the BAT concept had become widespread. Aspects of accounting for BAT were already considered from 2011 to 2013 by a number of researchers in works devoted to the first version of the standard (e.g., [4, 5]).

The production of construction materials involves a wide variety of processes, such as the extraction and processing of non-metallic raw materials and the manufacture of a wide range of products, including cement, gypsum, lime, sheet glass, bricks, porous stone, prefabricated structures made of reinforced concrete, wood, or metal, roofing and thermal insulation materials, ceramic tiles, linoleum, and plumbing products [2]. Many of these sub-sectors fall under the BAT scope in many countries worldwide [10]. In particular, iron metallurgy as well as production of cement, ceramics and glass are BAT-regulated sectors in Russia, Kazakhstan and Belorussia. In these countries, green building rating systems develop based on both international and national standards. BREEAM-certified buildings include residential and administrative buildings erected in larger cities (Figure 1) [11].

Figure 1. BREEAM-certified residential building in Almaty

The BAT concept is a complex mechanism that enables the comparison of production processes within a given industry using objective resource and environmental efficiency metrics. It facilitates management decisions by taking into account both present and future (expected) requirements of national environmental, industrial, and climate policies [10].

For the construction materials sector, the technological indicators (BAT-Associated Emission Levels) include emissions of the most characteristic pollutants (also known as marker substances) such as carbon monoxide, nitrogen oxides, and, in some cases, sulphur oxides, as well as particulate matter (dust). For cement producers that use refuse-derived fuel (RDF), marker substances also include hydrogen chloride, hydrogen fluoride, a range of heavy metals such as mercury, cadmium, thallium, lead, and copper, as well as dibenzo-p-dioxins and polychlorinated dibenzofurans [12].

BAT-Associated Resource Efficiency Levels reflect specific energy consumption and the recycling of secondary resources in cement and glass production. The cement industry has significant potential in this area, including the partial replacement of natural raw materials with production waste such as metallurgical slag and the already mentioned use of alternative fuel [4, 12].

Finally, in 2021, specific greenhouse gas emissions indicators (carbon intensity factors) were proposed to be included in sectoral BREFs. Such indicators are derived as a result of the sectoral benchmarking procedures. In 2022, carbon intensity indicators were established for flat glass; it is expected that in 2023, such indicators will be set up for cement clinker, ceramic bricks and tiles.

The indicators of all three groups are based on the comparative analysis and identification of achievable levels of environmental performance, as well as resource, and carbon efficiency. Indicators are discussed with the regulated community and are intended to encourage business to develop and implement environmental and technological modernisation programmes [4].

Sectoral BREFs are applied to set quantified goals and objectives of environmental and energy management systems, identify priority environmental and energy aspects, and get information on sectoral CO_2 emissions (Table 1).

Table 1. Quantitative characteristics of Best Available Techniques for the production of ceramic bricks, flat glass and cement (according to [13])

Indicator	Indicator values		
	Production of ceramic bricks [13]	Flat glass production [13]	Cement production [13]
Emission indicators			
Dust (particulate matter)	95% removal efficiency	≤ 1 kg per ton of glass melt (furnace life of up to 10 years)	< 50 mg/m^3 (for production lines put into operation after 2008)
Nitrogen oxides (expressed as dioxides)	≤ 0.5 kg per ton of brick	≤ 10.4 kg per ton of glass melt (furnace life of up to 10 years)	< 500 mg/m^3 (for kilns with cyclone heat exchangers)
Sulphur dioxide	≤ 0.2 kg per ton of brick	No indicator	< 400 mg/m^3
Carbon monoxide	≤ 0.8 kg per ton of brick	≤ 0.8 kg per ton of glass melt (furnace life of up to 10 years)	< 500 mg/m^3

<table>
<tr><td colspan="4">Resource efficiency indicators</td></tr>
<tr><td>Power consumption</td><td>< 3.0 GJ per ton of brick</td><td>6.3 to 7.7 GJ per ton of glass melt</td><td>3.0 to 4.12 GJ per ton of clinker (dry process). Use of RDF is classified as BAT</td></tr>
<tr><td>Recycling</td><td>No indicator</td><td>11% of cullet in a melt charge</td><td>No numerical indicators. Replacement of natural raw materials with industrial waste is classified as BAT</td></tr>
<tr><td colspan="4">Greenhouse gas emissions indicators</td></tr>
<tr><td>Upper indicator (for restrictive measures)</td><td rowspan="2">Greenhouse gas emissions benchmarking will be performed while reviewing BREF in 2023</td><td>556 kg of CO_2-e per ton of glass melt</td><td rowspan="2">The values are under discussion. The best sector companies have achieved values below 600 kg of CO_2-e per ton of grey clinker</td></tr>
<tr><td>Lower indicator (for stimulus measures)</td><td>514 kg of CO_2-e per ton of glass melt</td></tr>
</table>

When forming a responsible supply chain for construction materials, it is advisable to establish requirements for the selected materials to be produced through the processes that comply with the BAT principles as evidenced by the following indicators:

- specific material, energy, and water consumption (the latter is especially relevant for plumbing products); minimum requirement is compliance with BAT;
- specific emissions (regarding air pollution and, in some cases, water pollution); minimum requirement is compliance with BAT;
- recycling; both in terms of using alternative fuel (as RDF) and partially replacing raw materials with industrial (such as metallurgical) waste:
- carbon intensity (specific greenhouse gas emissions); minimum requirement is not to exceed the upper level of the indicative GHG intensity parameter.

Thus, when choosing responsible suppliers of construction materials, it should be made sure that selected candidates comply with applicable BAT requirements. It is recommended to involve members of the BAT expert society in the selection process as they possess the necessary expertise to evaluate the information provided by businesses and give recommendations to decision-makers. It is important to note that only emission regulations are mandatory to comply with in any country, with indicator values approved by relevant executive authorities. Large businesses in Russia and Kazakhstan are expected to meet targets in this area.

Resource efficiency indicators, primarily those regarding energy use, can be applied in the process of implementing environmental industrial policies. Countries such as Spain (the Basque Country), the Netherlands, and Russia have used such approaches.

Finally, greenhouse gas emissions indicators are relevant to climate policy. The Republic of Kazakhstan has successfully completed its benchmarking process based on the European standards. In Russia, benchmarks of greenhouse gas emissions established in the sectoral BREFs are expected to be actively used in the design of the regulatory framework currently being prepared by the Ministry of Economic Development.

The Concept of Green Economy and the Roadmap for Low-Carbon Development being worked out for the Eurasian Economic Union, address both BAT implementation and green building issues. This opens opportunities for harmonising environmental, industrial and climate countries of EAEU member states.

CONCLUSION

The BAT concept in general and Reference Documents on Best Available Techniques in particular provide a solid background for the development of auditable criteria for assessing responsibility of suppliers of construction materials. While developing national criteria, it is advisable to work out standards based on the approaches presented in BREEAM-associated BES 6001:2022 standard. They should include requirements for quality, environmental and energy management systems, as well as the procedure for greenhouse gas emissions accounting based on indicators established in sectoral BREFs.

Such standards are intended to:

- promote the principles of responsible decision-making when selecting producers and suppliers of construction materials;
- establish clear-cut requirements as to which aspects of sustainable development should be taken into account when sourcing construction materials;
- develop conditions under which all stakeholders will be sure that materials and products have been selected responsibly;
- provide construction companies with the opportunity to score extra points in green building (construction) rankings.

The development and use of such standards will expand the scope of voluntary BAT reviews, enabling informed decisions when selecting responsible building material suppliers that demonstrate commitment to both national and global sustainable development goals, including SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action) and SDG 9 (Industry, Innovation, and Infrastructure).

REFERENCES

[1] The volume of construction work in the EAEU countries. URL: https://www.alta.ru/ts_news/99884/ (in Russian, retrieved 27.04.2023).

[2] Pheng L. S., Hou L. S. The Economy and the Construction Industry, Construction Quality and the Economy, 2019, vol. 21, pap. 54. DOI: 10.1007/978-981-13-5847-0_2.

[3] Darko A., Chan A. P., Owusu-Manu D.-G., Ameyaw E. E. Drivers for Implementing Green Building Technologies: An International Survey of Experts, Journal of Cleaner Production, 2017, 145, pp. 386-394. DOI: 10.1016/j.jclepro.2017.01.043.

[4] Tikhonova I. O., Guseva T. V., Shchelchkov K. A., Potapova E. N., Averochkin E. M. Best Available Techniques, General Binding Rules and Decarbonisation of the Construction Materials Industry, Proc. of the 21st International Multidisciplinary Scientific GeoConference SGEM, 2021, Bulgaria, vol. 21, is. 5.1, pp. 51-58. DOI: 10.5593/sgem2021/5.1/s20.007.

[5] Chepeleva C. V., Nikitina O. S., Shatrova S. A. Developing Green Building Activities in the Russian Federation, Scientific Epoch, 2016, no 8, pp. 153-157 (in Russian).

[6] GOST R 70346. Green Standards for Multifamily Housing Design, Construction, and Operation (in Russian).

[7] LEED Rating System. URL: tps://www.usgbc.org/leed (retrieved 24.04.2023).

[8] Soulti E., Leonard D. The Value of BREEAM. A Review of Latest Thinking in the Commercial Building Sector, London, UK, BRE Global, 2016. 12 p.

[9] BRE Environmental and Sustainability Standard BES 6001: Issue 4.0. Framework Standard for Responsible Sourcing, 2022. URL: https://files.bregroup.com/standards/BES_6001_V4-0.pdf (retrieved 28.04.2023).

[10] Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution, Activity 3: Measuring the Effectiveness of BAT Policies, 2019. URL: https://www.oecd.org/chemicalsafety/risk-management/best-available-techniques.htm #Activity3 (retrieved 28.04.2023).

[11] Assylbekov D., Nadee A., Hossain M. A., Akhanova G., Khalfan M. Factors Influencing Green Building Development in Kazakhstan, Buildings, 2021, 11, 634. DOI:10.3390/buildings11120634.

[12] Kristanto G. A., Rachmansyah E. The application of Refuse Derived Fuel (RDF) from Commercial Solid Wastes to Reduce CO_2 Emissions in the Cement Industry: a Preliminary Study, IOP Conference Series: Earth and Environmental Science, 2020, vol. 423, pap. 012014. DOI 10.1088/1755-1315/423/1/012014.

[13] Encyclopaedia of Technologies 2.0. Production of Non-Metallic Materials, Ed. By D. Skobelev, Moscow, Renome, 2022, 466 p.