Method for automated checking legal eligibility of integrated environmental permit⋆

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Abstract

This study analyzes the legal nature of the integrated environmental permit as an instrument of environmental modernization of industry, which encourages enterprises to implement the best available technologies to minimize their environmental impact. The integrated environmental permit contributes to the transformation of production towards sustainable development, increasing the investment attractiveness of enterprises. The developed method for automated checking legal eligibility of integrated environmental permit automatically checks whether the declared activity belongs to the list of activities subject to licensing through an integrated environmental permit, checks the completeness of the submitted package of documents and their compliance with the mandatory list, compares the technical parameters of the facility with the best available technologies (BAT), cross-checks the submitted data with various state databases and registers, generates an automated conclusion on the legal possibility/impossibility of issuing an integrated environmental permit. This method can be implemented as a module in the Unified Environmental Register system. The developed method minimizes the influence of the human factor, reduces the likelihood of subjective errors, unlawful decisions or manipulations during the analysis of documents and data. All checks are performed according to clear algorithms based on the current legislation. Automation makes it possible to speed up the processing of applications several times, which is especially important given the large number of business entities that require permits. Automation of processes allows Ukraine to bring its environmental regulation system closer to EU standards, in particular the provisions of Directive 2010/75/EU on industrial emissions (IED), which provides for the use of electronic controls and transparency. Thanks to automation, all documents, conclusions, history of submissions and decisions are stored in a single system, which allows for the generation of analytics, statistics and informed environmental decisions at the national level. The obtained results prove that the method for automated verification of legal eligibility of integrated environmental permits demonstrates high speed, reliability and accuracy in processing a large amount of information, which reduces the administrative burden, speeds up the issuance of individual environmental permits, increases the legal validity of decisions, ensures transparency and prevents errors.

Keywords

Integrated environmental permit, legal regulation of green technologies, best available technologies (BAT), automated checking legal eligibility of integrated environmental permit, information system "Unified Environmental Register".

1. Introduction

Legal regulation of green technologies exists both at the international level and in the national legislation of Ukraine. It is worth paying attention to the Paris Climate Agreement (2015), which obliges countries to reduce greenhouse gas emissions and develop a green economy [1]; the Kyoto Protocol (1997), as a predecessor to the Paris Agreement [2]. European legislation also plays a

ICyberPhyS'25: 2nd International Workshop on Intelligent & CyberPhysical Systems, July 04, 2025, Khmelnytskyi, Ukraine
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significant role, in particular, EU Directives 2009/28/EU [3] on the use of energy from renewable sources, 2010/31/EU [4] on the energy efficiency of buildings, 2008/98/EU [5] on waste management, European Green Deal, European Climate Law, EU Emissions Trading System, Circular Economy Action Plan, Fit for 55 Program, etc. Harmonization with European green standards (European Green Deal (achievement of EU climate neutrality by 2050), European Climate Law, EU Emissions Trading System, Renewable Energy Directive (achievement of 32% of renewable energy in the EU's overall energy balance by 2030), Energy Efficiency Directive (reduction of EU energy consumption by 32.5% by 2030), Circular Economy Action Plan, Fit for 55 program (reduction of EU greenhouse gas emissions by 55% by 2030), etc.) will help improve the quality of life in Ukraine and increase the country's competitiveness in the international arena.

Enterprises are the main implementers of green technologies, as they are the main consumers of natural resources and, at the same time, the main sources of pollution. Civil law of Ukraine regulates property relations related to the use of green technologies or the transfer of green technologies (licenses, know-how, leasing agreements, etc.); promotes investment in clean technologies through cooperation agreements, concession agreements; ensures the legal regime of intellectual property for green technologies, including patents, copyrights, etc. Considerable attention is paid to the Law of Ukraine "On Integrated Prevention and Control of Industrial Pollution" [6], which implements the provisions of Directive 2010/75/EU on industrial emissions [7].

Enterprises included in the list of polluting installations cannot obtain a permit to operate without complying with the best available technologies (BAT), which enterprises are required to implement to reduce their negative impact on the environment. The best available technologies and management methods are environmentally efficient and resource-saving solutions that have proven to be effective in the EU.

In the context of Ukraine's current course towards European integration and sustainable development, the implementation of an integrated approach to environmental protection in industry is of particular relevance. One of the key tools of this process is integrated environmental experience as a legal mechanism that provides for the authorization of industrial facilities to operate, taking into account all types of environmental impact. The use of integrated approaches in regulating the activities of industrial enterprises not only reduces the burden on the environment, but also stimulates the development of green technologies and modernization of production in accordance with the requirements of sustainable development.

Integrated environmental permit is a document of permitting nature in the field of environmental protection issued by a permitting authority and granting the right to operate facilities under the conditions specified in such permit, which operators of facilities must obtain before starting their operation.

The integrated environmental permit is issued by the permitting authority to the operator of the facility where a certain type of activity is or will be carried out.

The integrated environmental permit is issued in accordance with the conclusions of the best available technologies and management methods.

The term of the integrated environmental permit is unlimited.

It is worth noting that obtaining an integrated environmental permit is mandatory for the operator of the facility that carries out the above activities.

The types of activities that require an integrated environmental permit include: energy; production and processing of metals; mineral processing industry; chemical industry; waste management and other activities.

Currently, the integrated environmental permit is issued by the permitting authority based on a manual check of all legal grounds by a human, but automation of such checks will increase the accuracy and objectivity of the check, reduce the time for processing applications, ensure transparency and equality for all applicants, reduce the risk of corruption, ensure integration with state registers and sustainable data management. Thus, automating the verification of the legal possibility of issuing an integrated permit is not only a step towards the digitalization of public services, but also a tool to improve the efficiency of environmental control, fight corruption and

support sustainable development. In view of the above, automated verification of the legal possibility of issuing an integrated environmental permit as a tool for environmental modernization of industry is currently an urgent task for several key reasons related to both the efficiency of public administration and real-time compliance with environmental standards.

2. State-of-the-art

Article [8] discusses the experience of South Korea in implementing an information system for the effective functioning of the Integrated Environmental Permitting System (IEPS) (Fig. 1). The authors analyze the benefits and challenges associated with the use of such a system, in particular in the context of automating permitting processes. Advantages of implementing the IEPS information system: transparency and traceability of processes; speed of application processing; reduction of administrative burden; increased reliability and accuracy of data; possibility of analyzing and improving processes. Disadvantages and challenges of implementing IEPS: the need for significant initial investment; the need for staff training; ensuring cybersecurity and data protection; difficulty in integrating with existing systems. Thus, South Korea's experience demonstrates that the implementation of an information system for managing integrated environmental permits can significantly increase the efficiency, transparency, and reliability of regulatory processes. However, the successful implementation of such a project requires careful planning, investment in infrastructure and staff training, and a high level of cybersecurity.

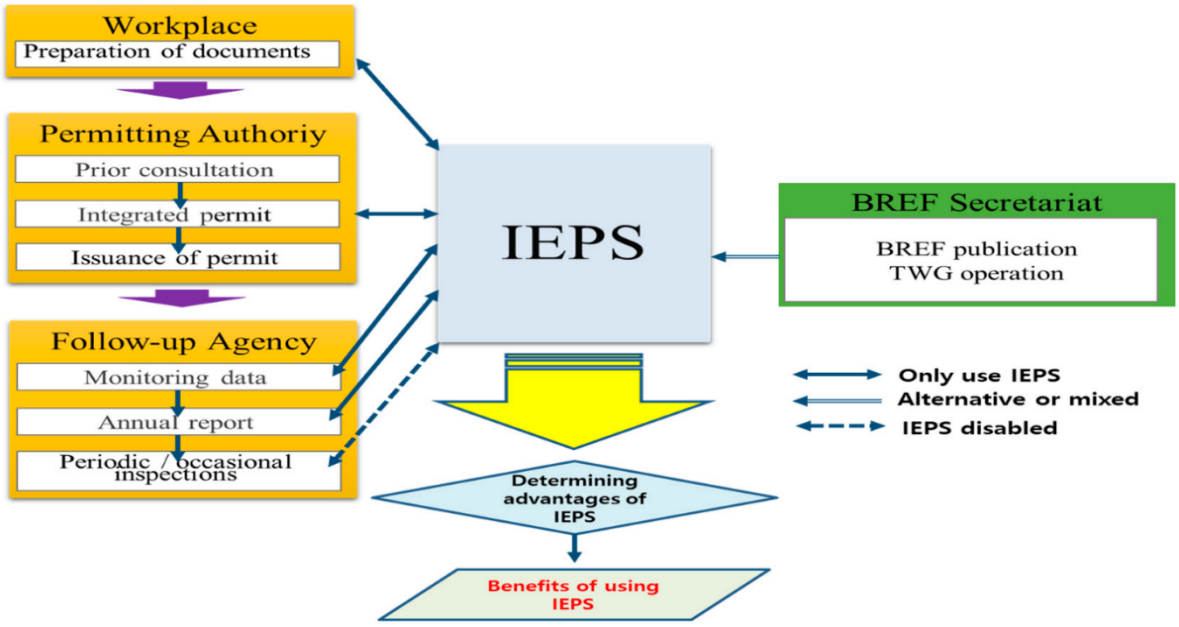

Figure 1: Concept of deriving benefits from the IEPS [8].

PhD thesis [9] examines the implementation of an integrated system of environmental permits in China, taking into account the experience of the European Union. The author analyzes the benefits and challenges associated with the integration of air, water, and soil emission permits into a single legal framework. Advantages of the integrated environmental permitting system: comprehensive approach to pollution management; increased regulatory efficiency; alignment with international standards; improved environmental efficiency. Disadvantages and challenges of implementing the integrated system: complexity of legal harmonization; need for institutional reforms; problems with implementation at the local level; lack of experience and expertise. The European Union's experience shows that an integrated environmental permitting system can significantly improve environmental management. However, a number of legal, institutional, and administrative challenges need to be

overcome for successful implementation in China. Careful planning, staff training, and adaptation of international experience to the national context are key success factors.

The article [10] analyzes the system of integrated environmental permits, in particular the requirements of Directive 2010/75/EU, the practice of its implementation in Poland and prospects for Ukraine. Advantages of implementing an integrated environmental permitting system: comprehensive regulation of pollution; application of the principle of best available technology; simplification of administrative procedures; improvement of the environmental situation. Disadvantages and challenges of implementing the integrated system: complexity of legislation adaptation; need for training; financial costs; need for effective control and monitoring. The introduction of an integrated environmental permitting system in Ukraine, taking into account the experience of the EU and Poland, can significantly improve the environmental situation and promote sustainable development. However, a number of legislative, organizational, and financial challenges need to be overcome for successful implementation.

Articles [11, 12] discuss the concept of an integrated approach to environmental management, which combines three key elements: the red line of environmental protection, the lower limit of environmental quality and the upper limit of resource use, along with a system of environmental permits (Fig. 2). Advantages of the Three Lines, One Permit policy: integrated environmental management; improved regulatory efficiency; increased transparency and accountability; and promotion of sustainable development. Disadvantages and challenges of implementation: difficulty in coordination between agencies; need to update legislation; challenges in implementation at the local level; need to raise public awareness. The "Three Lines, One Permit" policy represents a promising approach to integrated environmental management that can contribute to more efficient and sustainable use of natural resources. However, its successful implementation requires overcoming a number of organizational, legislative and educational challenges.

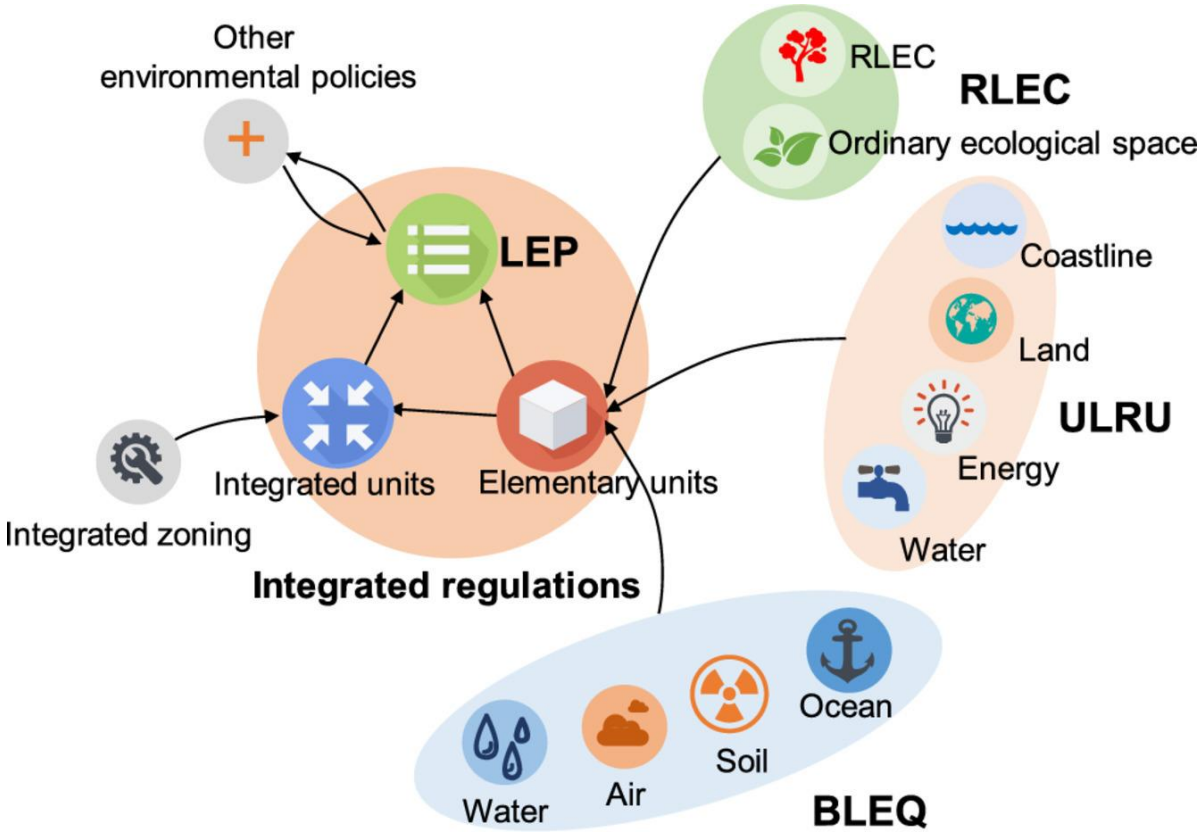

Figure 2: Concept of the "Three Lines One Permit" policy [11].

In article [13], the authors analyze the need to include river discharges in the pollutant discharge permit system, in order to improve water resources management and environmental protection. Inclusion of river discharges in the pollutant discharge permit system is an important step towards integrated water resources management. This contributes to improving water quality, increasing the efficiency of regulation and ensuring sustainable development.

Article [14] examines the effectiveness of existing air quality assessment methods in the context of an integrated environmental permit system in South Korea. The authors analyze current approaches to air quality assessment, identify their limitations and suggest ways to improve the methodology to ensure more accurate and effective air quality management.

Article [15] examines the issues of environmental safety and sustainable development in the context of modern environmental challenges. The authors analyze the impact of anthropogenic factors on the environment and propose strategies for preserving biodiversity and ecosystem services. Particular attention is paid to the role of environmental education and raising public awareness of the importance of nature conservation.

Article [16] considers the importance of integrating regional building permit policies to promote the sustainable development of green buildings. The authors explore how effective regional policies can influence the achievement of green building life cycle goals, particularly in terms of energy efficiency and resource conservation. They propose incentive models that can be implemented at the local level to support sustainable building initiatives.

Article [17] proposes a new approach to monitoring and managing pollutant emissions in industrial enterprises. The authors explore the use of surrogate parameters that can be measured using the Internet of Things (IoT) to assess the performance of pollution prevention equipment. This approach reduces monitoring costs and provides real-time data collection, which contributes to more effective management of environmental risks. This is especially useful for enterprises where the installation of traditional monitoring systems is economically impractical. The work is an important contribution to the development of integrated environmental policy, promoting the implementation of innovative technologies to achieve sustainable development and reduce the impact of industry on the environment.

Article [18] analyzes the digital transformation of environmental protection systems. It explores the architectural frameworks, implementation strategies and operational impact of modern digital platforms on streamlining environmental protection processes. The author considers integrated permit systems, real-time monitoring capabilities and public participation platforms, demonstrating how digital transformation increases regulatory efficiency, promotes transparency and accessibility. The article also examines key issues of system integration, user adoption, and policy alignment, offering solutions learned from practical implementations in various environmental areas, including air quality, hazardous waste management, and water protection. The author offers a promising framework for implementing emerging technologies while maintaining system scalability and long-term sustainability.

Article [19] analyses the implementation of integrated environmental permits (IEP) in the dairy industry. The study covers five dairy plants subject to the EU Directive 2010/75/EU on industrial emissions. The authors assess the level of implementation of best available technologies based on environmental permits, comparing them with the latest updates. The results show that although some plants have a significant number of implemented technologies, their environmental performance varies. The two plants with the largest number of implemented technologies were found to be the most polluting, indicating the need to adapt technologies to the specific conditions of each plant. The authors recommend identifying the most polluting streams and selecting appropriate technologies to reduce them.

Article [20] analyses the implementation of integrated environmental permits in the fish and seafood canning industry. assessed the implementation of the Integrated Pollution Prevention and Control (IPPC) Directive in the fish and seafood canning industry. The aim of the study was to assess the level of implementation of best available technologies in the fish and seafood canning sector in accordance with IPPC requirements. It was found that most enterprises comply with the basic IPPC

requirements, but there is room for further improvement, in particular in the aspects of energy efficiency and waste management. Specific measures are proposed to improve environmental performance, including the introduction of new technologies, optimization of production processes and strengthening of emission control. This study is an important step towards sustainable development of the food industry, in particular in the seafood canning sector, and can serve as a model for other regions striving to achieve high environmental standards.

The author [21] examines the concept of integrated environmental permitting in the Netherlands, analyzing its legal and practical aspects. The article emphasizes the importance of integrating environmental permits to simplify procedures and improve the effectiveness of environmental protection. However, it also points out the legal challenges associated with integrating different environmental regulations into a single system.

Article [22] describes the functioning of the SAHRIS (South African Heritage Resources Information System), developed by the South African Heritage Agency (SAHRA). This system contributes to the simplification of the permit application process and heritage management, in particular in cases where planned activities may affect cultural or natural resources. SAHRIS is an effective tool for cultural heritage management in South Africa, promoting transparency, efficiency and integration in the permit application and management processes of heritage sites. However, to achieve maximum impact, existing challenges need to be overcome and the system must be widely accessible and integrated.

Article [23] is devoted to the analysis of the impact of environmental permit policies on the state of the environment in Indonesia. The study is aimed at analyzing the consequences of environmental permit policies for the environment of Indonesia. Environmental permit policies are a tool of state regulation that has a preventive nature to control the activities of business entities and a repressive nature to respond to environmental problems caused by human activity. Its goal is to preserve the environment and prevent pollution and destruction that harm society. A normative and legal approach with a descriptive-analytical method was used. The study is based on the analysis of legislation, legal principles and doctrines to answer legal questions related to environmental permits. The data, both primary and secondary, were processed qualitatively.

Article [24] explores the use of fuzzy logic to optimize the whey ultrafiltration process for the purpose of recovering by-products. The integration of fuzzy logic into the whey ultrafiltration process is a promising direction for improving the efficiency of recovering valuable components and reducing the environmental burden from the dairy industry.

Article [25] analyzes the role of the administrative court in Indonesia in resolving environmental disputes, in particular, using the example of case No. 30/G/LH/2017/PTUN.MKS. The study highlights the need to review legal norms and case law in Indonesia to ensure effective protection of the environmental rights of the public. In particular, it is recommended to harmonize the definition of "interest" in various legislative acts and ensure a more substantive approach by the courts to considering environmental cases.

The works [26-29] are devoted to the development of a methodology for the development and application of clinical decisions support information technologies with consideration of civil-legal grounds, the main provisions and approaches of which can be used in the development of a method and a decision support system regarding the legal possibility of issuing an integrated environmental permit.

Article [30] is devoted to the development of a decision support system for optimizing the process of growing crops using remote sensing data. The results of the study demonstrate the effectiveness of the proposed system in increasing yields and reducing the costs of growing crops. The system allows farmers to make informed decisions based on current data on the condition of crops, which contributes to more efficient use of resources and increased productivity. The main approaches used in this article to develop a decision support system can also be used in the development of a method and decision support system for the legal possibility of issuing an integrated environmental permit.

The experience of leading countries and industries demonstrates the high effectiveness of integrated environmental permits, especially when using automated, digital solutions. All sources

note that the key obstacles remain: legal complexity; administrative burden; need for coordination and integration; technical and organizational difficulties. Against this background, the task of developing a method for automated verification of the legal possibility of issuing an integrated environmental permit is extremely relevant and corresponds to both national and international trends in environmental policy and digitalization of public administration. Such an approach: reduces the burden on regulators; provides unified approaches to legal assessment; reduces the risk of subjective errors and abuses; promotes transparency, efficiency and consistency in decision-making; allows for faster response to changes in legislation through algorithm updates. This is especially important in the context of environmental challenges and the pursuit of sustainable development, where time, accuracy and reliability are crucial factors.

3. The mechanism of obtaining the integrated environmental permit in Ukraine

The mechanism of obtaining an integrated environmental permit in Ukraine:

1. The installation operator shall submit to the permitting authority in electronic form through the means of the Register an application for obtaining an integrated environmental permit (amendments to it).
2. The permitting authority shall issue an integrated environmental permit (amendments to it) or make a decision to refuse to issue (amendments) based on the results of consideration of the application for obtaining an integrated environmental permit (amendments to it) and the documents attached thereto submitted by the installation operator, conclusions and proposals of competent authorities, as well as comments and proposals of other executive authorities, local government authorities (if submitted), based on the minutes of the coordination meeting (if held), taking into account the results of public discussion and cross-border consultations (if held).
3. The integrated environmental permit or a decision to refuse its issuance shall be issued within 30 working days from the date of completion of consideration of the application for obtaining an integrated environmental permit (amendments to it) and the documents attached to it by the competent authorities.
4. The conditions of an integrated environmental permit include:
    - maximum permissible emissions
    - water intake limits, water use limits, pollutant discharge limits, other water use characteristics (water transfer, return (waste) water discharge, water use in circulating and re-water supply systems), conditions for special water use
    - requirements and measures provided for by water legislation, legislation in the field of atmospheric air protection, waste management, prevention and elimination of the consequences of emergencies, energy conservation and land protection, public health and sanitary and epidemiological well-being of the population
    - requirements ensuring the protection of land and groundwater, as well as measures for accounting and management of waste generated as a result of the operation of the facility
    - requirements for monitoring emissions, monitoring of land and groundwater pollution, which determine the methodology, frequency of measurement and the procedure for assessing its results
    - obligation to periodically, within the deadlines set by the permitting authority, submit to it, based on the results of monitoring emissions and monitoring of land and groundwater pollution, a report by the facility operator on compliance with the conditions integrated environmental permit

- in cases provided for by law, the obligation to conduct an environmental audit and an energy audit
- requirements for regular implementation and assessment of the effectiveness of measures taken to prevent emissions into the ground and groundwater, and requirements for monitoring pollution of land and groundwater for the presence and concentration of hazardous substances used, produced or released by the installation or generated as a result of its activities and which are likely to be detected on the industrial site and may cause pollution of land and groundwater within the industrial site
- requirements for implementation of measures related to conditions other than normal operating conditions of the installation, in particular start-up, shutdown, leakage, malfunction, short-term downtime, termination of operation of the installation
- provisions for minimization of long-range or transboundary pollution
- requirements for monitoring by the installation operator of compliance with maximum permissible emissions or reference to relevant legal requirements for such monitoring
- requirements for termination of operation of the installation and/or use of the industrial site or part thereof.

The licensing authority shall refuse to issue an integrated environmental permit (amendments to it) if:

1. The installation operator has submitted an incomplete package of documents required for obtaining an integrated environmental permit (amendments to it).
2. The application for obtaining an integrated environmental permit (amendments to it) and the documents attached thereto, submitted by the installation operator, do not meet the requirements for form and content specified by law.
3. The installation operator has not provided written consent to the terms of the integrated environmental permit.
4. Inaccurate information has been found in the application for obtaining an integrated environmental permit (amendments to it) and the documents attached thereto, submitted by the installation operator.
5. The operation of the installation does not meet the established requirements.
6. Special economic and other restrictive measures (sanctions) have been applied to the owner of the installation, the operator of the installation or persons under their control in accordance with the Law of Ukraine "On Sanctions".
7. The operator of the installation has violated the procedure for obtaining an integrated environmental permit.

State supervision (control) shall be carried out over compliance with the conditions of the integrated environmental permit by operators of installations.

Verification of compliance by operators of installations with the conditions of the integrated environmental permit shall be carried out by the supervisory authority based on the list of installations subject to inspection for compliance with the conditions of the integrated environmental permit.

The licensing authority shall quarterly review, approve and send to the supervisory authority through the Register a list of installations subject to inspection for compliance with the conditions of the integrated environmental permit.

If, during the inspection of the installation operator's compliance with the conditions of the integrated environmental permit, non-compliance with such conditions is detected, a re-inspection

of the installation operator shall be carried out within six months after the completion of the inspection to eliminate the identified violations.

Based on the results of the installation inspection, the supervisory authority shall draw up an act on the results of the planned (unplanned) state supervision (control) measure. To eliminate the identified violations, the regulatory authority issues a prescription, order or other regulatory document indicating the deadline for eliminating the identified violation.

Documents drawn up by the regulatory authority based on the results of the installation inspection are brought to the attention of the installation operator and entered into the Register within 10 working days from the date of completion of the inspection.

Therefore, if an enterprise does not implement the best available technologies and management methods and does not receive an integrated permit, then: it cannot operate legally; it may be subject to fines; the activities of such an enterprise may be suspended; it loses opportunities for development, investment and further cooperation.

4. Method for automated checking legal eligibility of integrated environmental permit

Formalization of the method for automated checking legal eligibility of integrated environmental permit involves determining the structure, decision-making logic and legal compliance:

1. Input data is the set of structured data about the business entity: general information (name, address, code from Unified State Register of Enterprises and Organizations, etc.), type of activity (according to Classification of types of economic activity, type of industry), technical characteristics of the installation (types of processes, volumes of raw materials, auxiliary materials), data on emissions/discharges/waste (sources, volumes, types of substances, etc.), location (coordinates, location within the settlement/environmental protection zones), data on existing permits/environmental impact assessment.
2. Legal Compliance Engine is based on a logical-legal model that contains the following components: a base of legal requirements (Law of Ukraine "On Environmental Impact Assessment", Law "On the Permit System in the Sphere of Economic Activity", Resolution of the Cabinet of Ministers No. 194 of 21.02.2025 on Integrated Environmental Permit, Orders of the Ministry of Environmental Protection and Natural Resources of Ukraine, European Directive 2010/75/EU, the above-mentioned conditions of the integrated environmental permit, a mandatory list of documents (technical description of the installation, conclusions on best available technologies (BAT), information on emissions/wastes/waste, monitoring plans, results of public discussion, confirmation of payment of the fee), etc.); state registers (whether the legal entity is active, whether it is in a state of bankruptcy, whether it has been sanctioned in accordance with the Law of Ukraine "On Sanctions", whether it has any violations in the field of environment in accordance with previous regulations, environmental register, land cadastre, register of water users, etc.) – the detection of discrepancies or unreliable information automatically blocks further consideration; formalization of requirements in the form of logical rules in the format of decision trees, sets of predicates or production logics, for example::
   IF type_of_activity ∈ [list of activities subject to integrated environmental permit]
   AND environmental impact assessment submitted = TRUE
   AND technologies ∈ [list of best available technologies]
   AND distance_to_home ≥ regulatory
   THEN legally_possible= TRUE
   ELSE legally_possible= FALSE
3. BAT Compliance Layer checks the compliance of the technological process with the best available technologies (BAT) using the state BAT register, standardized BAT directories and an algorithm for comparing the applicant's technology with known BAT (in terms of

efficiency indicators, emission levels, control methods, etc.). In case of discrepancies, an automatic message is generated about the need to adapt the technologies to the standards.

4. Spatial Legality Layer analyzes spatial restrictions: overlaying the coordinates of the object on the layers of sanitary protection zones, nature conservation areas, water protection strips, etc. using GIS servers or WMS API. Example of a rule:
   IF object ∈ boundaries_of_the_restriction_zone
   THEN legally_possible = FALSE
5. Output – legal status (permission possible / impossible), explanation of the reasons (in case of a negative result), list of regulatory inconsistencies, recommendations for eliminating legal barriers, etc.

Scheme of method for automated checking legal eligibility of integrated environmental permit is represented on Fig. 3.

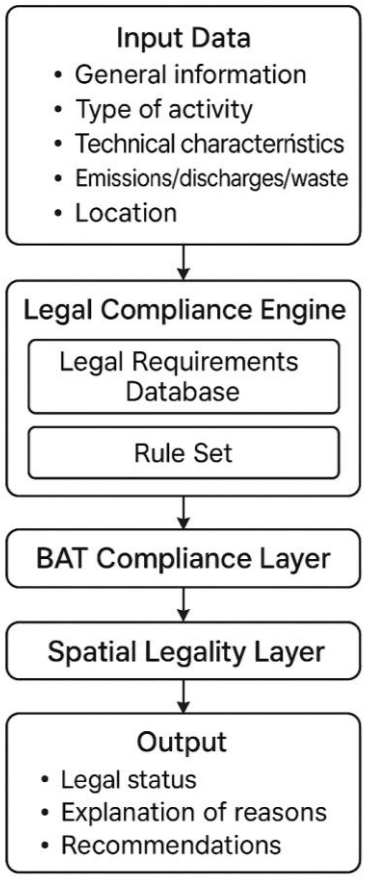

Figure 3: Scheme of method for automated checking legal eligibility of integrated environmental permit.

Taking into account the developed method for automated checking legal eligibility of integrated environmental permit, let's develop a binary decision-making model regarding the legal eligibility of integrated environmental permit. For this, let's denote:

$L_i \in \{0,1\}$ – result of checking the i-th legal condition;

$B_j \in \{0,1\}$ – compliance with the j-th BAT;

$G_k \in \{0,1\}$ – compliance with the k-th geographical criterion.

Then the legal possibility:

$Y = \bigwedge_i L_i \cap \bigwedge_j B_j \cap \bigwedge_k G_k$,

where $Y=1$ – permit is possible, Y=0 – refusal to issue a permit.

The developed method for automated checking legal eligibility of integrated environmental permit automatically checks whether the declared activity belongs to the list of activities subject to licensing through an integrated environmental permit, checks the completeness of the submitted package of documents and their compliance with the mandatory list, compares the technical parameters of the facility with the best available technologies (BAT), cross-checks the submitted data with various state databases and registers, generates an automated conclusion on the legal possibility/impossibility of issuing an integrated environmental permit. This method can be implemented as a module in the Unified Environmental Register system.

The developed method minimizes the influence of the human factor, reduces the likelihood of subjective errors, unlawful decisions or manipulations during the analysis of documents and data. All checks are performed according to clear algorithms based on the current legislation. Automation makes it possible to speed up the processing of applications several times, which is especially important given the large number of business entities that require permits. Automation of processes allows Ukraine to bring its environmental regulation system closer to EU standards, in particular the provisions of Directive 2010/75/EU on industrial emissions (IED), which provides for the use of electronic controls and transparency. Thanks to automation, all documents, conclusions, history of submissions and decisions are stored in a single system, which allows for the generation of analytics, statistics and informed environmental decisions at the national level.

5. Results

For 1st example, let's consider the analysis of an application for an integrated environmental permit from a waste processing enterprise using the developed method for automated checking legal eligibility of integrated environmental permit. Input data: type of facility - hazardous waste processing enterprise, geolocation - boundaries of the protected landscape zone, planned emissions - substances of hazard class I, documents - special water use permit, environmental impact assessment, urban planning conditions. As a result of the check, which lasted about 4 seconds, 2 inconsistencies were detected - no permit for air emissions, as well as an intersection with a development restriction zone. Based on such inconsistencies, a conclusion was generated about the legal impossibility of issuing an integrated environmental permit.

For 2nd example, let's consider an automated check of the current integrated environmental permit for compliance with the updated standards using the developed method for automated checking legal eligibility of integrated environmental permit in connection with the update of the BAT list. Parameters: 7 technological processes identified, basic BAT updated in 2024. Results: 3 out of 7 processes do not comply with the new standards, a conclusion was formed with a list of necessary updates.

For 3rd example, let's consider a mass check of document packages for a regional department using the developed method for automated checking legal eligibility of integrated environmental permit. The volume of checked cases is 142 applications in 30 days; the average processing time of one application is 2.9 seconds; the average number of detected violations/disputed provisions is 1.8 per application; the number of applications that passed the automatic check without comments is 38 (26.7%).

For 4th example, let's consider an automated check of legal compliance regarding the location of an object (industrial boiler house) using the developed method for automated checking legal eligibility of integrated environmental permit. Input data: geolocation of the facility, type of emissions (nitrogen, sulfur, dust), permit documentation. Automated verification showed that the facility is not in the red zone; the facility complies with zoning; the calculation of maximum permissible emissions is 92% of the standard. Therefore, the conclusion is recommended that the location of the facility is legally permissible, but increased filtration is recommended.

The performance indicators of the method for automated checking legal eligibility of integrated environmental permit (average values for 100+ cases) are given in Table 1.

Table 1
The performance indicators of the method for automated checking legal eligibility of integrated environmental permit (average values for 100+ cases)

Indicator	Value
Average time for full verification	3.2 seconds
Share of applications with detected discrepancies	64%
Level of accuracy in detecting legal violations	96.5%
Level of agreement with expert opinions	91%
Time savings compared to manual verification	up to 80%

The obtained results prove that the method for automated verification of legal eligibility of integrated environmental permits demonstrates high speed, reliability and accuracy in processing a large amount of information, which reduces the administrative burden, speeds up the issuance of individual environmental permits, increases the legal validity of decisions, ensures transparency and prevents errors.

6. Conclusions

This study analyzes the legal nature of the integrated environmental permit as an instrument of environmental modernization of industry, which encourages enterprises to implement the best available technologies to minimize their environmental impact. The integrated environmental permit contributes to the transformation of production towards sustainable development, increasing the investment attractiveness of enterprises.

The developed method for automated checking legal eligibility of integrated environmental permit automatically checks whether the declared activity belongs to the list of activities subject to licensing through an integrated environmental permit, checks the completeness of the submitted package of documents and their compliance with the mandatory list, compares the technical parameters of the facility with the best available technologies (BAT), cross-checks the submitted data with various state databases and registers, generates an automated conclusion on the legal possibility/impossibility of issuing an integrated environmental permit. This method can be implemented as a module in the Unified Environmental Register system.

The developed method minimizes the influence of the human factor, reduces the likelihood of subjective errors, unlawful decisions or manipulations during the analysis of documents and data. All checks are performed according to clear algorithms based on the current legislation. Automation makes it possible to speed up the processing of applications several times, which is especially important given the large number of business entities that require permits. Automation of processes allows Ukraine to bring its environmental regulation system closer to EU standards, in particular the provisions of Directive 2010/75/EU on industrial emissions (IED), which provides for the use of electronic controls and transparency. Thanks to automation, all documents, conclusions, history of submissions and decisions are stored in a single system, which allows for the generation of analytics, statistics and informed environmental decisions at the national level.

The obtained results prove that the method for automated verification of legal eligibility of integrated environmental permits demonstrates high speed, reliability and accuracy in processing a large amount of information, which reduces the administrative burden, speeds up the issuance of individual environmental permits, increases the legal validity of decisions, ensures transparency and prevents errors.

Further development of the method for automated checking legal eligibility of integrated environmental permit involves interdisciplinary improvement of technical and legal components. In particular, it is advisable to expand the regulatory framework of the model, taking into account the capabilities of automated monitoring of changes in legislation and their prompt reflection in the system. The use of methods of semantic analysis of legal texts will contribute to increasing the

relevance and accuracy of the check. At the same time, the implementation of artificial intelligence technologies, in particular natural language processing (NLP) and machine learning, is promising, which will allow for improved identification of key parameters of permit documentation and prediction of application review results. Another important direction is the creation of a risk analysis and scenario modeling module, which will provide flexibility when considering different types of objects and taking into account regional environmental and legal features. All these areas together will contribute to increasing the efficiency of environmental governance, transparency of permitting procedures and reducing corruption risks.

Declaration on Generative AI

During the preparation of this work, the authors used Grammarly in order to: grammar and spelling check; DeepL Translate in order to: some phrases translation into English. After using these tools/services, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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