REPUBLIC OF SERBIA

MINISTRY OF MINING AND ENERGY

DEVELOPMENT AND ADOPTION OF THE STRATEGY FOR THE MANAGEMENT OF MINERAL AND OTHER GEOLOGICAL RESOURCES OF THE REPUBLIC OF SERBIA FOR THE PERIOD FROM 2025 TO 2040, WITH PROJECTIONS UNTIL 2050

Belgrade, 2025.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AGE - Applied Geological Exploration
AP - Autonomous Province
BAT - Best Available Technique
BAU - Business as usual
BEGM - Basic Engineering-Geological Maps
BGE - Basic Geological Exploration
BHM - Basic Hydrogeological Map
BREF - Best Available Reference Documents
CEAP - Circular Economy Action Plan
CIT - Corporate Income Tax
DMC - Domestic Material Consumption
ECE - Economic Commission for Europe
EIA - Environmental Impact Assessment
EPS - Electric Power Industry of Serbia
ESC - Economic and Social Council
EU - European Union
GDP - Gross Domestic Production
GHG - Greenhouse Gases
IEA - International Energy Agency
IED - Industrial Emissions Directive
IRMA - Initiative for Responsible Mining Assurance
MAS - Main Aquifer System
MIN-GUIDE - Minerals Policy Guidance for Europe
MINLEX - Legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU
MRM - Mineral Raw Materials
MRMC - Mineral Raw Materials Complex
Mt - million tonnes
NGO - Non-Governmental Organizations
NPRE - National Plan to Reduce Emissions of major pollutants from old large combustion plants
PE – Public Enterprise
PERC - The Pan European Reserves and Resources Reporting Committee
PEST - Political, Economic, Social, and Technological
PROA - Publicly Recognized Organizers of Activities
REE - Rare Earth Elements
RES - Renewable Energy Sources
RMI - Raw Materials Initiative
RS - Republic of Serbia

SAA - Stabilization and Association Agreement
SEA - Strategic Environmental Assessment
SPRS - Spatial Plan of the Republic of Serbia
SRM - Secondary Raw Materials
SWOT - Strengths, Weaknesses, Opportunities, and Threats
TFEU - Treaty on the Functioning of the European Union
UN - United Nations
UNECE - United Nations Economic Commission for Europe
UNFC - United Nations Framework Classification
UNRMS - United Nations Resource Management System
USD - United States Dollar
VAT - Value-added Tax

1. Introduction and Methodological Approach

Mining is one of the oldest industries of the economy, dealing with the extraction of mineral raw materials, including the establishing of mineral resources and reserves. Mineral raw materials (MRM) are a non-renewable natural resource, and their utility value constantly changes depending on evolving needs and technologies. It is the task of the profession to continuously reassess and evaluate their value. In contrast, renewable natural resources explored and assessed through hydrogeological investigations include groundwater and geothermal energy.

The exploitation of non-renewable mineral wealth, i.e., MRM, as well as renewable geological resources, is unquestionably a necessary precondition for the existence of modern civilization. Faster and higher-quality economic growth as an indicator of socio-economic development, which also includes energy transition, requires increasing amounts of various mineral raw materials. As a result, mining activity, as the main pillar of the mineral raw materials complex (MRMC) management, in the context of the prevailing desire for continued growth in living standards, is not a matter of choice, but a necessity.

The possibility of choice arises only when determining the modalities, i.e., the methods by which this necessary precondition for the normal functioning of modern society will be ensured. Furthermore, it has increasingly been determined by the growing and continuing sensitivity to the value of preservation, improvement, and environmental protection, and stricter criteria for the acceptability of mining activities, considering their impact on the environment and the overall ecological condition of society. The standard response of the mining industry to these demands is rational mineral raw materials management within the context of sustainable management of the entire space and all its components.

The state (the Government as the representative of the executive authority) has a legal and regulatory framework (defined in the Parliament as the representative of the legislative power and regulated through the judiciary) to allow while respecting all established procedures, the processes of exploration and exploitation of mineral resources on its territory. Sustainable management of mineral resources is a synthesis of social, economic, and environmental goals that define the framework for public, public-private, and private sector operations in the field of mining, to enable the exploitation of mineral resources in an acceptable manner for present and future generations.

The management of mineral resources arises from a systems approach, with an understanding of their global availability in relation to societal needs, including particularly critical mineral raw materials. It is based on ecological, socio-economic sustainability, and technical feasibility, which determines which, when, and how mineral resources are explored, extracted, used, and recycled. In this regard, transparent reporting and independent verification of the level of development and the achieved effects of projects are necessary. ***Sustainable management of mineral and other geological resources should facilitate and support positive economic effects throughout the circular process (circular life cycle) of each project.*** Integrated and indivisible resource management requires an interdisciplinary approach and continuous improvement of competencies and capabilities. Therefore, it is important to strengthen the role and capacities for the management of mineral resources within the competent ministry, regulatory agencies, the Geological Survey of Serbia, and universities. This approach stems from responsible social, economic, and institutional development.

The Strategy for the Management of Mineral and Other Geological Resources of the Republic of Serbia for the Period 2025-2040, with Projections until 2050 (hereinafter Strategy), is conceptually designed as a national strategy and should become an integral part of the overall Strategy for the Economic Development of the Republic of Serbia.

The management of MRM and the development of the mining sector are based on the three pillars of sustainable mining in the context of comprehensive socio-economic development of the state from economic, ecological, and sociological perspectives (Figure 1.1). At the same time, the strategic directions are focused on three equally important hierarchical strategic directions that are built upon all three pillars of sustainable mining (Figure 1.2). The first strategic direction is the development of strategic documents, the second is the adoption of new, modern legal regulations (laws and secondary legislation), and the third is the development and strengthening of the institutional framework.

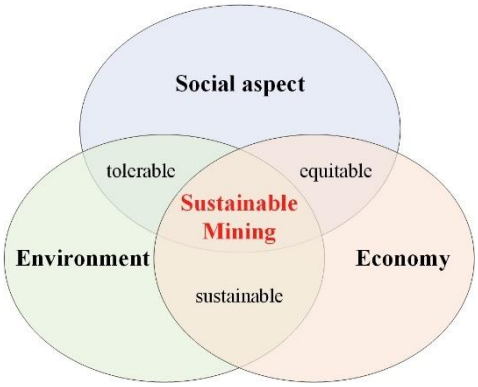

Figure 1.1. *The Three Pillars of Sustainable Mining*

For all three strategic directions, at the first strategic level, strategic programs, measures, and activities have been defined to enable the implementation of the main strategic goals and the objectives of mineral policy in the areas of basic and other geological research; secure and reliable supply of thermal power plants with domestic coal; substitution of mineral raw material imports by strengthening domestic mining capacities; increasing the production of metallic and non-metallic mineral raw materials; increasing the production of liquid and gaseous mineral raw materials; promotion and sustainable development of mining and geology; incentive measures for the development of higher stages of mineral raw material preparation and processing; incentive measures for the export of final products based on domestic raw materials; remediation and reclamation of abandoned mining sites; repurposing of former mining facilities for special uses; as well as other aspects important for the implementation of the Strategy.

Figure 1.2. *Strategic Directions and Processes of Sustainable Development of the Mining Sector*

To implement the accepted energy transition on time, the State (the Executive authority) must proactively ensure the protection of critical mineral deposits by incorporating them into spatial plans and promoting long-term sustainable solutions to address emerging social, environmental, and geopolitical challenges related to shortages and rising prices.

The sustainable development of mining activities must be based on comprehensive planning of the MRMC management, through a strategic document in synergy with other strategic and planning documents and objectives of the Republic of Serbia. The development of the Strategy for the Management of Mineral and Other Geological Resources is a multi-phase process, where based on a situational analysis (Stage I: analysis of the current state) realistic strategic goals should be defined (Stage II), to be implemented through a set of measures, programs, and activities (Stage III), following the algorithm shown in Figure 1.3.

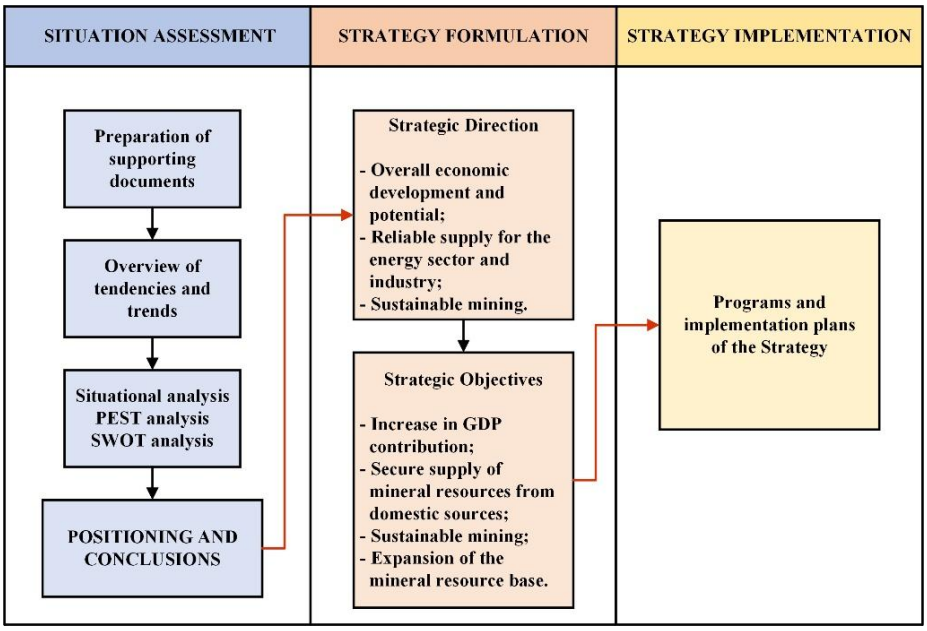

Figure 1.3. *Algorithm-Based Model for the Strategy of Mineral Resource Management*

This essential document – the Strategy for the Management of Mineral and Other Geological Resources, is a prerequisite for the sustainable development of the mining sector through 2050 and should indicate and address the following questions:

- What kind of mining does the Republic of Serbia need?
- What is the long-term goal of the Strategy?
- What type of mining exists in EU countries and the region?
- What are the modern principles of mining development?
- What types of mineral raw materials exist in the Republic of Serbia?
- What types of mineral raw materials are needed for the development of modern society in the Republic of Serbia?
- What are the proven reserves of mineral raw materials in the Republic of Serbia?
- What is the importance of groundwater in the Republic of Serbia?
- What is the importance of geothermal energy resources in the Republic of Serbia?
- What are the determined reserves of groundwater in the Republic of Serbia?
- What are the determined reserves of geothermal resources in the Republic of Serbia?
- What is the potential of geothermal resources in the Republic of Serbia?
- What is the production and consumption of mineral raw materials in the Republic of Serbia?
- How is mining activity regulated under the current legal framework of the Republic of Serbia?
- What are the institutional frameworks for resolving issues within the mining sector?
- Can the current legal framework ensure a quality balance between mining and environmental protection?
- What are the obligations of the Republic of Serbia towards the harmonization of legislation with the EU legislation?
- What should be the relationship between mining activity locations and spatial planning documents?
- Is the Republic of Serbia professionally equipped to carry out tasks in the field of mining and geology?
- What measures and activities are needed for the implementation of the Mineral Resource Management Strategy of the Republic of Serbia?

The goal of the Strategy is to define a policy for the sustainable management of mineral and other geological resources, as well as the conditions for the sustainable development of the mining sector through the year 2050. The Strategy draft covers the period from 2025 to 2040, with projections extending to 2050. The base year used is 2022.

Legal Framework for the Adoption of the Strategy

The legal framework for the adoption of this Strategy is defined by the provisions of Articles 11-13 of the Law on Mining and Geological Exploration ("Official Gazette of the RS," No. 101/15, 95/18 - second law, and 40/21). This law stipulates that mineral policy and the development plan for geological explorations and mining are implemented through the realization of the Strategy.

The Ministry of Mining and Energy is responsible for preparing, implementing, and monitoring the mineral policy and plans for the development of geological exploration and resource exploitation in the Republic of Serbia, following the Strategy adopted by the National Assembly upon the proposal of the Government. The Strategy is adopted for at least 10 years.

Reasons for Adopting the Strategy

The adoption of the Strategy was initiated under Article 12 of the Law on Mining and Geological Exploration, which stipulates that the general objectives for the development of mining and geological exploration are determined through the Strategy. The Strategy is adopted for the first time to define the measures and activities necessary to achieve the long-term strategic goals in the areas of geological exploration, exploitation, and valorization of mineral resources. The Strategy also establishes a dynamic development plan for the mining sector up to the year 2050, with clear visions, principles, and strategic guidelines for more efficient development.

The adoption of this Strategy aims to raise awareness among the professionals and the public about the importance of the exploitation of mineral raw materials and other geological resources, address current and emerging challenges, and support the positioning of the Republic of Serbia within the mining sector of Europe and the world.

The Strategy details the instruments, measures, and activities necessary to achieve the long-term goals of sustainable development in the mining sector, attract investments, implement global standards in environmental management and oversight, and strengthen cooperation between mining companies and local communities.

In the long term, the adoption of the Strategy should contribute to: the more efficient implementation of new and updated legal solutions in the field of geological exploration, mineral resource exploitation, and environmental protection; the establishment of a balance between economic development and environmental impact; the improvement of mineral resource extraction and processing; the establishing of mechanisms for the safe and stable supply of critical and strategic mineral raw materials; the encouragement of investments and job creation in the mining and mineral processing sectors; increased investment in geological exploration and the development of new mining technologies and methods; the strengthening of the public, private, and academic sectors; raising awareness of the importance of sustainable resource management; early risk identification and better risk management related to the exploitation and use of mineral resources; and the sustainable and planned use of space, among others.

Institutions Involved in the Development of the Strategy

The development of the Strategy was initiated by the Ministry of Mining and Energy, which is also responsible for its preparation, implementation, and monitoring. During the drafting process, a working group was formed, consisting of representatives from relevant institutions, professional organizations, and the academic community. In addition to the Ministry of Mining

and Energy, the following institutions participated in the development of the Strategy: the Ministry of Environmental Protection, the Ministry of Construction, Transport and Infrastructure, the Ministry of Agriculture, Forestry and Water Management, the Provincial Secretariat for Energy, Construction and Transport, the Geological Survey of Serbia, the Agency for Spatial Planning and Urbanism of the Republic of Serbia, the Chamber of Commerce and Industry of Serbia, the Serbian Geological Society, the Association of Mining and Geology Engineers, Electric Power Industry of Serbia (EPS), NIS JSC, Zijin Mining Group, Public Enterprise PEU Resavica, and NALED.

This multidisciplinary approach enables a comprehensive analysis and the adoption of measures that will contribute to the long-term development of the mineral and geological resources sector in the Republic of Serbia.

The Strategy represents a key document for planning and sustainable management of mineral resources, ensuring economic development, environmental protection, and the stability of the mining sector in the coming decades.

1.1. Foundational Elements for the Development of the Strategy for the Management of Mineral and Other Geological Resources in the Republic of Serbia

Mineral resources are the foundation of industrial production in the modern world. Ensuring energy and any other independence, as well as further economic and industrial growth, is the basic social and state priority. Through the implementation of the defined priorities, there is an opportunity to choose the modalities or the path in which the functioning of today's society will be ensured.

Throughout the history of mankind through this day, in times of geopolitical turmoil, the availability of mineral resources directly affects strategic decisions and contributes to peace, but also arouses misunderstandings and instigates conflicts. Mineral resources are often subject to manipulation and deception in various business forms. With the advent of new information technologies, including the capabilities of artificial intelligence and high-tech (cyber) crime, such practices have become increasingly prevalent.

Metallic, non-metallic, and energy mineral raw materials, as well as groundwater, hydrogeothermal, and petrogeothermal energy, are resources increasingly demanded due to rising living standards and a growing global population. In the period of 20 years, i.e. compared to 2002, there has been a 59.3% increase in the production of mineral resources. In 2022, global production reached 18.6 billion tonnes (excluding construction materials) [1]. Figure 1.4 shows the total mineral resource production from 1999 to 2022 (expressed in tons), clearly illustrating an upward trend.

In the same period, geothermal capacities have shown stable and continuous growth, averaging about 3% annually. The total installed capacity for the direct use of geothermal energy reached 30,180 MWt by the end of 2020, while electricity production from geothermal resources reached 96,552 GWh by the end of 2023.

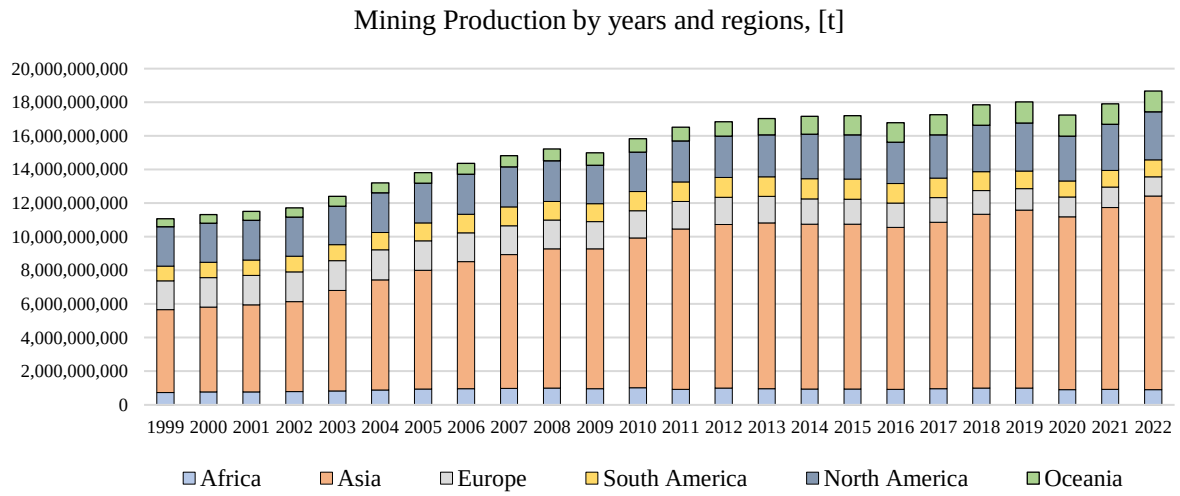

Figure 1.4. *Mining Production of Mineral Resources Worldwide from 1999 to 2022* [1]

It has been proven that the consumption of mineral resources is directly related to population growth (Figure 1.5). Statistical data and analyses indicate that the current average consumption is approximately 2.35 tons of mineral resources per capita per year [1,2]. Over the past 20 years, average consumption has increased by 25.8%. A decrease in the use of fossil fuels worldwide, according to forecasts from models in the World Bank report, will cause an increase in demand for 500% of certain critical minerals, especially graphite, lithium, and cobalt [3].

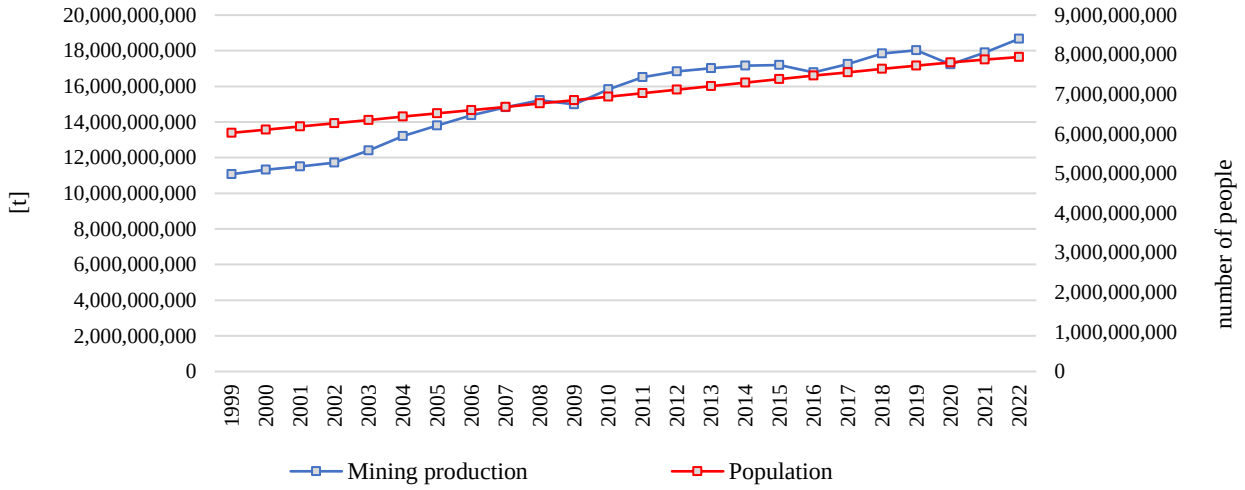

Figure 1.5. *The Correlation Between Total Mining Production and the World Population* [1,2]

In addition, it should be noted that there is a significant difference in Domestic Material Consumption (DMC), which includes produced and imported materials excluding exports, between developed and underdeveloped countries. Countries with high DMC per capita are Canada (57.5 tonnes), Australia (46.4 tonnes), and Finland (44.1 tonnes), while countries with low DMC per capita are Nigeria (3.5 tonnes), Madagascar (2.1 tonnes), Afghanistan (1.1 tonnes), and others [4].

To establish a policy for the sustainable management of mineral and other geological resources, as well as the conditions for the sustainable development of the mining sector, the EU and leading mining countries worldwide have adopted appropriate management systems. In 2022, the United Nations Economic Commission for Europe (UNECE) published principles and established the United Nations Resource Management System (UNRMS) for mineral resource management [5].

In recent years, due to the orientation towards the energy transition on one side and geopolitical turmoil, as well as the concentration of production, especially processing, in a relatively small number of countries on the other, the focus of the mining industry has been placed on critical raw materials (CRM). The importance of the exploitation of CRM is reflected in the adoption of management strategies in Canada (2022) [6], the United Kingdom (2022) [7], and Australia (2023) [8]. The United States has adopted a strategic policy and list of CRMs (2020) [9]. The European Commission adopted the Critical Raw Materials Act (2024) [10]. The EU also defined the Strategic Raw Materials List in 2023 [11]. Japan adopted a new international strategy for securing rare metal resources (2020) and, together with the U.S., a strategic agreement on critical minerals (2023) [12].

The Republic of Serbia is no exception in this regard, especially in the current period of development, characterized by capital projects in transportation and utility infrastructure, in construction (residential housing), capital projects for the construction of energy plants, and the ensuring of CRM from domestic sources in the coming period. In addition, it should be noted that the Republic of Serbia possesses significant mineral resources and reserves of lithium, copper, and nickel and that the EU has made a strategic commitment to its own (European, independent of China and other countries) production of these critical mineral raw materials.

The MRMC of the Republic of Serbia is highly significant, as its territory contains, in addition to CRMs, many other deposits and occurrences of metallic, non-metallic, and energy mineral raw materials, as well as substantial reserves of groundwater and geothermal energy.

In recent years, the competent Ministry of Mining and Energy, in cooperation with professional and scientific research organizations, has organized and held many consultations, presentations, and public debates in which all interested institutions and expert communities actively participated. These events highlighted several issues present in the field of mineral resource exploration and exploitation. In this way, a broad public discussion was conducted, involving representatives of state institutions, and business entities, and the expert public participated, from which the strategic commitments of all interested parties were derived and aligned.

Therefore, in alignment with the UNRMS, the following basic principles for sustainable mineral resource management have been established:

- The rights and responsibilities of the State for the management of mineral resources;
- Responsibility towards humanity;
- Integrated mineral resources management;
- Social agreement on the exploitation of mineral resources;
- Orientation towards sustainable mineral resources management;
- Detailed exploration with an increase in mineral resources and reserves;
- Economic feasibility of mineral resources exploitation with risk analysis;
- Circular economy approach to mineral resource exploitation;
- Prioritizing health and safety in exploration and exploitation;
- Continuous innovation of the mineral resources management processes;
- Transparency;
- Continuous strengthening of key competencies and capabilities.

A Strategy structured in this way is intended to be affirmed as one of the most complex and important mechanisms of modern management of non-renewable mineral resources, as well as of the unique space in which these resources are located. The purpose of the Strategy is based on the need to reduce contradictions, review the existing, and find new management patterns in the mineral resources sector. This is especially important given the current dominance of unclear management models in the sector, which results in the modest valorization of the

sector's total potential and its inadequate contribution to the economic and social development of society. Strategy places mineral resources, as well as mining and geological activities, within the framework of comprehensive socio-economic sustainable development.

This Strategy is a document intended to comprehensively analyze the position of all mineral and other geological resources available to the Republic of Serbia, to assess the current situation and define the desired future position, to contribute to the establishment of clear goals and priorities, and to identify the economic benefits of mineral resource exploitation through the introduction of new sustainable technologies and the reduction of mining's impact on the environment.

2. Overview and Analysis of the Current Situation

2.1. National Legal Framework and Development Strategies in the Republic of Serbia

The nation's position regarding mineral resources is defined by Article 87 of the Constitution of the Republic of Serbia, which states:

> *Natural resources, goods that are of general interest, and assets used by the authorities of the Republic of Serbia are state property. There may be other possessions and rights in state property, following the law.*
>
> *Natural and legal entities may acquire certain rights to goods of general use, under the conditions and in the manner prescribed by law.*
>
> *Natural resources are used under the conditions and in the manner prescribed by law.*
>
> *The property of autonomous provinces and local self-government units, the manner of its use and disposition, shall be regulated by law.*

According to the Law on Mining and Geological Exploration, the Geological Survey of Serbia is a state institution that, among other activities, conducts fundamental and entrusted applied geological exploration of mineral resources. The expert and scientific research work of the Geological Survey of Serbia is financed through funds from the budget of the Republic of Serbia and capital from the market. Analogous to most other countries worldwide, the Geological Survey of Serbia is a state-owned organization, predominantly funded by the state. The responsibilities of the Geological Survey of Serbia include the implementation of tasks defined in the Long-term Program for the Development of Basic Geological Exploration in the Republic of Serbia and the Annual Program for the Execution of Basic Geological Exploration, as well as other strategic tasks of national importance.

At the Geological Survey of Serbia, within the Mineral Resources Exploration Sector, there is an insufficient number of employees capable of meeting all the assigned tasks in the short-term and medium-term periods. Furthermore, the Institute lacks the geological expertise to effectively carry out the research process in all domains of basic geological research on mineral resources. It is necessary to reorganize the Geological Survey and innovate its strategic status, as well as its human and laboratory potential. Additionally, it is crucial to strengthen the scientific potential of the Laboratories and Research Centers in institutions that lead scientific development in the fields of mining and geology.

Development Strategies in the Republic of Serbia and Connection with the Strategy for the Management of Mineral and Other Geological Resources

The Strategy should be aligned with other development strategies, especially those whose goals and objectives overlap or have common outcomes. These include, primarily, the Energy Development Strategy, the Integrated National Energy and Climate Plan of the Republic of Serbia, the Spatial and Regional Plans of the Republic of Serbia, as well as the Low-Carbon Development Strategy of the Republic of Serbia.

In the Republic of Serbia, the recently adopted Energy Development Strategy of the Republic of Serbia until 2040, with projections until 2050, is currently in force. This strategy is aligned with the Integrated National Energy and Climate Plan of the Republic of Serbia until 2030, with projections until 2050. The Mineral Resources Management Strategy should ensure the security of the supply of energy facilities with enough energy mineral resources to guarantee energy security while minimizing environmental impact. The Strategy defines the energy resources and potentials of the Republic of Serbia, including fossil fuels (coal, oil, natural gas, and oil shale), nuclear mineral resources, and renewable energy sources (watercourses, biomass, wind, solar, renewable hydrogen, biogas, landfill gas, gas from wastewater treatment plants, geothermal energy sources, etc.).

All strategic documents have planned the use of coal until 2050, with a gradual reduction in coal participation and an increase in renewable energy sources. In the process of energy transition (known as decarbonization), geological exploration and mining are expected to play a key role in ensuring the necessary quantities of mineral resources needed for new energy technologies that support the energy transition (such as lithium, copper, nickel, cobalt, and, in the future, possibly uranium and others). Ensuring energy security, developing the energy market, and the overall transition to sustainable energy have emerged as key priorities for energy development in the Republic of Serbia, as well as the principles on which energy policy should be based. Delays in the construction of new power generation facilities may result in the Republic of Serbia becoming a significant importer of electricity in the coming years.

Additionally, if a decision is made to start using nuclear raw materials for electricity production in the Republic of Serbia after 2040, it will be necessary, during the implementation of this Strategy, to promptly begin the process of creating the required social, legal, institutional, regulatory, infrastructural, educational, staffing, research, and other conditions for its application.

The Integrated National Energy and Climate Plan of the Republic of Serbia for the period until 2030, with a vision through 2050, comprehensively and interactively considers the goals through five dimensions: Decarbonization, Energy Efficiency, Energy Security, Internal Energy Market, and Research, Innovation, and Competitiveness.

The Low-Carbon Development Strategy of the Republic of Serbia for the period from 2023 to 2030, with projections until 2050, was adopted as part of the country's first pillar of climate policy and published in the "Official Gazette of the RS", No. 46/23. This strategy, along with the accompanying Action Plan, prescribes in detail the measures and activities aligned with the obligations of the Republic of Serbia under the Paris Agreement and the United Nations Framework Convention on Climate Change.

The Water Management Strategy on the Territory of the Republic of Serbia until 2034 ("Official Gazette of the RS", No. 3/17) is a key public policy document that sets long-term directions for water management in Serbia. This strategy is particularly important from the perspective of circular economy in areas related to water supply and wastewater management.

The Strategy for Agriculture and Rural Development of the Republic of Serbia for the period from 2014 to 2024 ("Official Gazette of the RS", No. 85/14) is a key document intricately linked to the fifth pillar of the Green Agenda, focusing on sustainable resource management and environmental protection.

In addition to the already adopted strategies of the Republic of Serbia, a draft Environmental Protection Strategy of the Republic of Serbia for the period from 2025 to 2033 - the Green Agenda for Serbia - has been created, with its adoption expected. This strategy represents the overarching public policy document in the field of the environment. The purpose of the

Strategy is to contribute to achieving the goals of the Green Agenda, carbon neutrality, sustainable development, protection of natural resources, reduction of pollution, and the improvement of the quality of life for all citizens. The development of the Strategy represents the next step in long-term planning and the enhancement of environmental protection. During the drafting process, the objectives of the Green Agenda were integrated, according to the Sofia Declaration signed by the Republic of Serbia in November 2020, as well as measures for further harmonization with the regulations and standards of the EU, and the development of mechanisms for monitoring the implementation of the Strategy.

The objectives of the Strategy for the Management of Mineral and Other Geological Resources of the Republic of Serbia for the period from 2025 to 2040 and the Environmental Protection Strategy of the Republic of Serbia for the period from 2025 to 2033 should be aligned, including the alignment with other public policy documents.

2.2. Legislative and Institutional Framework for Geological Exploration and Mining and the Degree of Alignment with EU Policy and Legislation

Intensification of activities related to the exploration and confirmation of mineral deposits will result in the opening of new mines, following the priorities and mineral policy of the Republic of Serbia. This will be significantly affected by legal amendments outlined in specific objectives. For more comprehensive information, it is planned to align the classification of mineral raw materials with international classifications. The parallel use of Serbian and international classifications will allow the government to assess the existing and new base of resource and reserve, and to facilitate the activities of entrepreneurs concerning financial institutions that expect the application of international standards for resource and reserve classification.

One of the main secondary legal acts, traditionally applying categories and classes of geological reserves of mineral resources in the Republic of Serbia, which needs to be innovated and/or adopted, is the Rulebook on the Content of the Final Report and the Annual Report on the Results of Geological Exploration, mineral resources, and reserves for solid mineral resources ("Official Gazette of RS", No. 88 of December 13, 2019). The new Rulebook, under the applicable Law on Mining and Geological Exploration ("Official Gazette of RS", No. 101/2015, 95/2018 – other law, and 40/2021), should be developed in line with current international classifications - The Pan European Reserves and Resources Reporting Committee (PERC) [13], which contributes to gaining and maintaining customer confidence by promoting high reporting standards on valuations of mineral resources and reserves.

The previous implies the need for introducing three mandatory types of documents in accordance with the progress of the exploration process and the mineral project, namely in geological practice: *Report on Mineral Resources*; and in mining practice: *Prefeasibility Study* and *Feasibility Study*. The Report on Mineral Reserves can be prepared after the completion of the pre-feasibility study or feasibility study, at which point the mineral resources are converted into mineral reserves (indicated resources into probable reserves and measured resources into proven reserves).

Figure 2.1 shows the general relationship between exploration results, mineral resources, and mineral reserves according to the PERC reporting standard, supplemented by appropriate interpretations such as geology, mining, level of exploration, and consideration of modification factors.

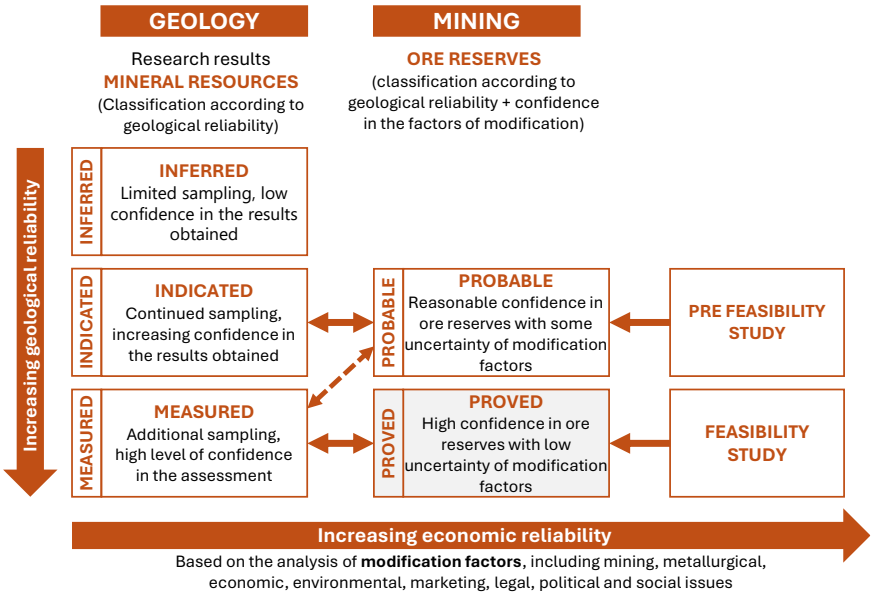

Figure 2.1. *The general relation between exploration results, mineral resources, and mineral reserves.*

It is also necessary to define the legal basis for the results of all geological explorations to flow within the state information system of the Republic of Serbia (accounting for business confidentiality and the interests of the data owners), to define access levels, methods, and conditions of their use, and to carry out the standardization and systematization of data on mineral resources, reserves, and mining production, which will facilitate the harmonization of the mentioned primary data.

Exploration and mining exploitation permits or licenses are required before any operator can begin the exploitation and processing of mineral resources. This process involves a wide range of interactions with various authorities and is often unsatisfactory. A commonly applied solution in practice is the establishment of a one-stop-shop contact point per region or country, which serves as a single point of contact for potential investors. Therefore, the Law on Mining and Geological Explorations should ensure coordination and provide a comprehensive regulatory framework for all contact points across different regulatory areas.

The financial arrangement is mainly represented by taxation and fees for the use of mineral resources, and it is an important policy factor for attracting investments in the development of the mining industry. Although such arrangements do not directly impact the issuance of permits for mineral resource development projects, they are highly relevant in ensuring equal opportunities across the EU, i.e. intact competitiveness as required by internal market legislation and the fundamental principles of the Treaty on the Functioning of the European Union (TFEU). Concession fees, understood as a fee for participating in concession tenders and concluding concession agreements, as well as their periodic renewal, are closely linked to resource tax systems or mineral resource taxation in active mining countries.

Mining legislation regulates ownership rights over mineral resources, the sustainable use of non-renewable raw materials, the balance between the interests and rights of landowners and resource rights holders (land use rights), and the security of ownership to attract capital for financing uncertain exploration projects, among other things. It should be intensively harmonized with the development of the mining industry.

The Government should strengthen the promotion and acceptance of mining at the local level, with an emphasis on transparency and an open permitting process from the initial stages of exploration, exploitation, and processing to mine closure.

Various stakeholders in mineral resource production pursue their interests and goals. Defining groups of stakeholders involved has become increasingly complex. Mining legislation has long been a matter of national concern for countries. There are three levels of influence: global, national, and local. At each level, various stakeholders interact through their respective roles, serving as either driving or regulatory forces.

The main goal of modern legislation regulating geological exploration and mining is to establish a legal framework that ensures the strong development of the mining industry under strictly controlled environmental protection conditions. For this purpose, such legislation must provide investors with the necessary incentives and guarantees, while also enabling the Government to guide the industry and implement a mining policy aligned with broader economic interests and national strategy.

2.3. Economic Role of Mineral Resources, Groundwater, and Geothermal Resources

The economic role of mineral resources is extremely significant, as all production chains begin with them. Mineral resources form the foundation of industrial production in the modern world, making the exploitation of these resources a prerequisite for further development. The growth of population, accompanied by economic growth as an indicator of social and economic progress, requires increasing quantities of mineral resources. The geopolitical position of countries is often determined by the availability of mineral resources.

Numerous data about known and produced quantities of mineral resources, as well as forecasts of the needs of the global and European economy, indicate that in the future there will be an increase in demand for all types of mineral resources, especially in developing countries striving to develop their economy and infrastructure. It is predicted that from 2010 to 2050, more mineral resources will be produced than the total amount produced from the beginning of humanity to today. The increased demand for mineral resources and their deposits requires innovations in the exploitation and processing of mineral resources, as well as significantly higher financial investments. The future of sustainable production and consumption of mineral resources will require intensive geological research, as well as recycling, reduction of negative impacts on the environment, reduced pollution, etc. All activities aim to ensure a stable and secure supply of mineral resources under environmentally acceptable conditions.

To adequately prepare for upcoming situations, many countries have defined so-called critical raw materials (CRM) and brought new mineral policies to boost their economies. Generally, global world investments in the development of CRM recorded an increase of 30% in 2022, following a 20% rise in 2021. The largest investments are related to the exploration of lithium, uranium, and nickel deposits. Globally, spending on geological exploration of CRM deposits rise by 20% in 2022 compared to previous years. Meanwhile, between 2015 and 2020, direct utilization of geothermal energy increased by 50% [14].

The development of many sectors of the economy of the Republic of Serbia until 2050 will be based on known and estimated quantities of ore reserves, i.e. its mineral and raw material potential. To properly map future needs, it is necessary to analyze global and European trends in the use of mineral resources and their management, including the needs of the Republic of Serbia and other countries' economies, especially those of the EU. Factors that significantly affect these assessments include available technical, financial, and other resources in research and production, as well as current regulations in the fields of geology, mining, environmental protection, and other related areas.

The territory of the Republic of Serbia contains a large number of mineral resources that are of interest for exploration and exploitation. These include primarily CRMs such as Sb, Co, Mg, Li, Ni, as well as others whose reserves are significant and in high demand, such as Cu, Au, Pb, Zn,

and more. For the development of the mining industry and geological research, effective resource management requires a well-established legal framework, a clearly defined strategy for geological exploration, and a dynamic development plan for the mining industry. It also involves securing and accessing scientific data of interest for resource access and environmental protection limitations, availability of production data, tax systems, respecting and protecting the interests of the regional community, as well as the local community directly impacted by mining activities.

Since the export of non-metallic raw materials (or at least most of them available in the Republic of Serbia) is practically unfeasible due to high transportation costs, and the export of metallic raw materials yields diminished economic effects, it is necessary to accelerate the development of the processing industry for all mineral resources. This would stimulate economic activity and create added value through higher levels of processing and the production of final products.

According to research results, the quantities of groundwater extracted in 2022 have been determined. The data collected and processed relates to the information from water supply and utility companies, as well as some legal entities engaged in groundwater extraction, who are required to maintain records of their operations. However, the actual extraction of groundwater in the Republic is significantly higher. Economically very important for bottling and drinking water production, the annual exploitable reserves of groundwater in the Republic of Serbia amount to about 800 million m^3, while 252 million m^3 were produced in 2022 [15].

The multiple benefits of using geothermal energy are reflected in the use of locally available renewable resources with relatively simple technology. Low operating costs, as well as a high-capacity and utilization factor, affect the high profitability of energy production (both heat and electricity). Adding zero emissions during energy production, geothermal resources represent one of the key resources in Europe in the energy transition process, primarily in the sector of district heating and cooling systems.

Natural resources, such as mineral and thermal waters, as well as medicinal muds and gases for health, recreational, and spa tourism, offer the potential for greenfield investments, which can ensure accelerated economic development. These investments serve as a driving force for local and regional growth and overall economic prosperity.

2.4. International Position, Liabilities, and Compliance with International Practice, and in Particular Activities and Commitments in the Process of Accession to the European Union, Including Environmental Protection and Climate Change

The Stabilization and Association Agreement (SAA) with the European Union [16], along with obtaining candidate status for EU membership and the opening of accession negotiations, has conditioned the Republic of Serbia to aim for full alignment with the EU's system, values, and legislation, with the goal being full EU membership. The Strategy for the Management of Mineral and Other Geological Resources is linked to negotiation chapters 15 (Energy), 27 (Environment, subgroups waste and climate), and 20 (Entrepreneurship and Industrial Policy, subsection: industrial policy).

The management of mineral resources includes environmental protection, which is a key component of sustainable development. The EU and the international community have established various legal and political frameworks to ensure that the exploitation of mineral resources is in line with the principles of sustainability and environmental protection. This chapter examines EU public policies, international initiatives, and obligations, as well as best practices in this field.

The European Union faces challenges in terms of sustainable management of mineral resources, especially in the context of increased demand for raw materials essential for technological advancement and the green transition. It has developed a comprehensive legal and regulatory

framework for managing mineral resources, aligned with the goals of sustainable development and environmental protection. In this regard, the circular economy is a central part of the European Green Deal, focusing on resource sustainability through recycling and reuse. At the global level, the management of mineral resources and environmental protection are governed by a range of conventions, directives, and agreements that set fundamental principles and objectives for sustainable development.

Raw Materials Initiative (RMI) [17] was launched to ensure the security of the supply of mineral resources that are crucial for European industry.

Industrial Emissions Directive (IED) [18] sets strict standards for pollutant emissions from industrial installations, including the mining industry.

Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC [19-20] sets out requirements for the management of waste from extractive industries to minimize negative impacts on the environment.

Circular Economy Action Plan, Document 52020DC0098 from 2020 (CEAP) [21], provides for specific measures to make more efficient use of mineral resources, reduce waste, and increase recycling.

The European Critical Raw Materials Act [22] is a detailed basis for building the EU's capacity and increasing the security of the supply of critical raw materials.

The integration of international standards and best practices is essential for the efficient management of mineral resources and environmental protection. Some of the key aspects include sustainable mining standards, technologies to reduce environmental impact, participatory governance, and climate neutrality.

Incorporating local communities and other stakeholders into the decision-making process on mining projects ensures transparency and accountability. Participatory approaches allow for better identification of potential risks and the development of plans to mitigate them. This includes organizing public consultations, working groups, and dialogue forums, where local communities, non-governmental organizations (NGOs), academic institutions, and other stakeholders can present their views and proposals. Participatory management contributes to building trust between mining companies and local communities, which is crucial for the long-term sustainability of projects.

The national framework of public policy of the Republic of Serbia in the field of sustainable management of mineral and other geological resources and environmental protection lays the foundation for the country's sustainable development. The Republic of Serbia is committed to aligning its legislation and public policies with European and international standards, especially in the areas of mineral resource management and environmental protection. This process includes adapting the legislative framework, implementing strategic priorities, ensuring sustainable use of natural resources, reducing negative environmental impacts, and addressing the challenges of climate change.

The national framework of public policy in the Republic of Serbia in the field of mineral resource management and environmental protection is defined through a series of adopted key strategic documents, laws, and by-laws aligned with EU policy and the Green Deal:

Low-Carbon Development Strategy of the Republic of Serbia for the period from 2023 to 2030, with projections until 2050 ("Official Gazette of the RS", No. 46/23);

Circular Economy Development Program in the Republic of Serbia for the period from 2022 to 2024 ("Official Gazette of the RS", No. 137/22);

Waste Management Program in the Republic of Serbia for the period from 2022 to 2031 ("Official Gazette of the RS", No. 12/22);

Air Protection Program in the Republic of Serbia for the period from 2022 to 2030 with an action plan ("Official Gazette of the RS", No. 140/22);

National Plan to Reduce Emissions of major pollutants from old large combustion plants (NPRE) ("Official Gazette of the RS", No. 10/20);

Water Management Strategy in the Territory of the Republic of Serbia until 2034 ("Official Gazette of the RS", No. 3/17);

Water Management Plan until 2027 ("Official Gazette of the RS", No. 33/23);

Strategy for Sustainable Urban Development of the Republic of Serbia until 2030 ("Official Gazette of the RS", No. 47 /2019).

The Republic of Serbia faces several key challenges in managing non-renewable mineral resources and protecting the environment. However, it has also set the following strategic priorities to address these issues: ***sustainable management of mineral resources, reduction of pollution and protection of natural resources, confronting climate change, and strengthening institutional capacities***.

Within the energy sector, the international position of the Republic of Serbia is conditioned by membership in the Energy Community, the SAA with the EU, as well as the acquisition of candidate status for EU membership and the opening of accession negotiations. In Chapter 15 [16], the Republic of Serbia committed to implementing the relevant legal framework and EU acquis in the fields of energy, climate, environmental protection, competition, the use of renewable energy sources (RES), and energy efficiency.

Additionally, the Republic of Serbia ratified the Paris Climate Agreement in 2017 [23], committing to reduce greenhouse gas (GHG) emissions in line with both the expressed collective will and its national circumstances. According to the Clean Energy for All Europeans regulatory package adopted by the EU in 2019 to meet the commitments of the Paris Agreement, the Republic of Serbia has taken on the obligation to develop a National Energy and Climate Plan, which will define decarbonization goals, increase the share of RES, and improve energy efficiency for the period up to 2030, with perspectives extending to 2050.

As part of the European Green Deal, the EU defined the Green Agenda for the Western Balkans [24], which was adopted by the Republic of Serbia at the regional summit in Sofia in November 2020. By signing the Sofia Declaration on the Green Agenda, the Republic of Serbia committed to working alongside the EU to achieve the goal of making Europe a climate-neutral continent by 2050, primarily through the introduction of strict climate policies and reforms in the energy and transport sectors.

The most important document on which the EU's approach to water resources is based is the Water Framework Directive [25]. Adopted in 2000, this document emphasizes the protection and rational exploitation of water resources, along with the necessary valorization of water resources and the definition of pressures on them. With the adoption of the current Law on Water in 2010, the Republic of Serbia has fully accepted the standards, terminology, and objectives contained in the Directive. The most important legal act addressing groundwater is the Law on Water, which focuses on tasks related to the protection of groundwater sources, maintenance and improvement of existing sources, as well as the development of new ones.

In terms of exploration and exploitation of geothermal energy, the adoption of the new Mining and Geological Research Law was crucial, as it regulated the jurisdiction of relevant ministries and the management of geothermal energy usage through the exploitation of underground waters and hydrogeology. The law defines a roadmap for the research and exploitation of geothermal energy and the process for obtaining permits, whether to produce thermal energy from geothermal resources or electricity when the resource is involved.

2.5. Analysis of the State in the Sector of Mineral and Other Geological Resources

The production of MRM worldwide is directly dependent on economic development and population growth. In 2022, a total of 19.06 billion tons of mineral raw materials (excluding construction materials) were mined worldwide [1]. The quantities produced represent an increase of nearly 100% compared to 40 years ago, and 60% compared to 20 years ago. According to available data published in *World Data Mining* [1], in terms of total global production (excluding construction materials), the Republic of Serbia ranks 44th.The trend of overall mining development (growth) from 1984 to 2022 is shown in Figure 2.2.

Four countries (China, the United States, Russia, and Australia) produce more than 50% of total global mineral production. An even higher level of concentration is related to the production of CRMs. For example, the production of rare earth minerals is 96.4% concentrated in just four countries: China, USA, Australia, and Myanmar.

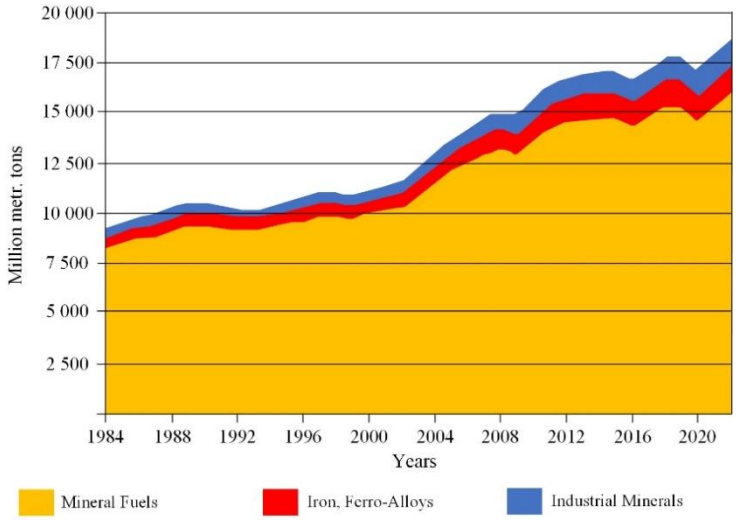

Figure 2.2. *Increase in total mining production in the world from 1984 to 2022* [1]

The total value of mining production in 2022 amounted to 7.51 trillion USD. According to available data (World Data Mining), the Republic of Serbia, with a value of 3.08 billion USD, ranks 82nd globally (excluding construction materials) [1]. Although all MRM are important, the focus is on CRMs due to the need for a secure and sustainable supply. This is particularly important for the EU, which faces a high risk of supply disruptions.

In the Republic of Serbia, mining production in 2022 amounted to 110.0 million tonnes of ore, of which 36.2 million tonnes were energy raw materials, 33.8 million tonnes metallic, and 42.5 million tonnes non-metallic MRM.

Coal in the Republic of Serbia represents the most important energy resource, currently participating in nearly 70% of the primary energy production structure. In recent years, the annual coal production through surface mining in Serbia has ranged from 35 to 38 million tonnes of lignite, approximately 400 thousand tonnes from underground mining, and about 200 thousand tonnes from underwater mining (Kovin). Coal processing includes the production of around 400 thousand tonnes of dried coal.

In the oil sector, the Republic of Serbia is a highly import-dependent country, with a relatively low share of domestic crude oil production. Domestic crude oil accounted for 23% of total demand in 2022, and 21% in 2023. The situation is even more unfavorable in the gas sector, where domestic production covers only about 10% of demand. There is a noticeable natural decline in natural gas production, similar to crude oil, due to the depletion of reserves, with the decline in gas production being much more pronounced. Since 2009, natural gas production has increased by 19% due to the commissioning of new fields, and this trend has continued since 2013.

Geological research conducted to date on the territory of the Republic of Serbia have identified more than 30 metallic mineral raw materials, concentrated in over 2,000 ore occurrences and deposits. In previous years, the production of metallic MRM through surface mining in Serbia amounted to 40,964,064 tonnes, while underground mining accounted for a total of 4,889,537 tonnes. Accordingly, by 2023, a total of 45,853,601 tonnes of metallic MRM had been extracted.

The production of non-metallic minerals in the Republic of Serbia in 2023 continues the growth trend recorded in previous years. In 2022, a total of 31,809,765 tonnes were produced, while in 2023 the volume increased to 36,906,318 tonnes. Limestone dominated production with 22,734,784 tonnes, followed by significant volumes of dolomite, sand and gravel, marble, clay, marl, and diabase.

The Republic of Serbia is considered a country rich in groundwater resources, relative to the size of its territory. This resource is used to supply 75% of the population with drinking water [26], and it accounts for 100% of the supply in the bottling of mineral and table water, balneotherapy, spa tourism, and the food industry. Groundwater is currently extracted from existing sources in quantities of about 23 m^3/s. This volume represents one-third of the total available groundwater potential in the territory of the Republic of Serbia. The largest reserves are found in alluvial aquifers, amounting to approximately 44 m^3/s, followed by karst terrains with about 14 m^3/s, and tertiary deposits with around 9.5 m^3/s [26].

The Republic of Serbia has a significant geothermal potential, as indicated by terrestrial heat flow density values, which are higher than the continental European average across most of its territory. Additional indicators include the presence of thermal and thermomineral waters, as well as existing boreholes and wells with a combined natural outflow exceeding 150 l/s and an average water temperature of around 60°C [27–28]. In Serbia, the energy potential of groundwater in shallow geothermal systems (with temperatures up to 30°C) is estimated at 5,000 MW, suggesting that up to one-fifth of the country's total heating demand could be substituted from these resources [1]. According to consolidated data from various sources, approximately 3,000 geothermal systems for heat energy production have been installed in Serbia to date, with a total thermal output of up to 200 MW.

According to assessments for the period from 2000 to 2016, the total estimated capacity of hydrogeothermal facilities in Serbia amounts to approximately 188 MWh, of which around 80 MWh is located in the Pannonian Basin area [29]. According to recorded data (Balance, 2023), the total balance reserves of mineral and thermomineral waters in the Autonomous Province of Vojvodina amount to 350 l/s. Of this, 7.8% belongs to Category A, 45.5% to Category B, and 46.7% to Category C reserves. In 2022, approximately 6.7% of the available reserves were utilized in the territory of Vojvodina (based on data submitted by users on the status of resources and reserves). The total balance reserves for the territory of the Autonomous Province of Kosovo and Metohija amount to 396 l/s.

Mineral resources, i.e. ***mineral raw materials of strategic importance*** for the Republic of Serbia according to Article 4 of the Law on Mining and Geological Exploration are:

- oil and natural gas;
- coal;
- copper and gold ores;
- lead and zinc ores;
- boron and lithium ores;
- oil clays (oil shales);
- other mineral raw materials specified by a special act of the Government at the proposal of the ministry in charge of geological exploration and/or mining affairs.

[1] Ministry of Mining and Energy, Provincial Secretariat for Energy, Construction and Transport, Faculty of Mining and Geology, Laboratory for Geothermal Energy and Energy Efficiency

Nickel, cobalt, and uranium are also considered important. According to the EU methodology (act on critical mineral raw materials), ***the critical non-metallic mineral raw materials*** are: barite, feldspar, fluorite, magnesite, natural graphite, and phosphates. In the coming period, the Republic of Serbia should establish a methodology for defining its CRMs.

As Serbia is a country with a long mining tradition, large quantities of mining waste have been deposited in landfills across the country for decades. According to the Mining Waste Registry, 250 inactive mining waste landfills have been identified, which, along with active landfills of mining and other industrial waste, could serve as a secondary source of critical and strategic mineral raw materials.

Balance and Potential Reserves of Mineral Raw Materials

The established ore reserves of MRM in the Republic of Serbia are significant, with substantial mineral potential and possibilities for further increase. The total balance and potential reserves of metallic mineral raw materials in the Republic of Serbia, as of the end of 2023, are presented in Table 2.1.

Table 2.1. Balance and Potential Reserves of Metallic Raw Materials in the Republic of Serbia

Economic Significance	Raw Material	Balance reserve (A+B+C_1)		Reserve C_2 category	
		tonnes, [t]	metals, [t]	tonnes, [t]	metals, [t]
Primary	Cu[1]	1,460,540,000	8,057,000	810,120,000	3,960,000
	Au[1]		296		309
	Ag[1]		1,726		529
	Cu[2]	3,090,000	20,100	649,380,000	1,550,000
	Au[2]		0.8		141
	Ag[2]		43		
	Au			119,180,000	180
	Pb	13,175,000	185,150	11,750,000	221,500
	Zn		413,690		368,500
	Ag[3]		11,509		n/a
	Au[3]		14		9.5
	Cu[3]	n/a	2,810	n/a	n/a
	Σ Cu		8,079,000		5,510,000
	Σ Au		311		639
	Σ Pb		185,150		221,500
	Σ Zn		413,690		368,500
	Σ Ag		13,278		
	Li	158,647,000	1,251,408	40,183,000	307,641
Secondary	Ni			198,500,000	669,000
	Co				55,550
	Mo	237,000,000	107,080	145,000,000	
	Sb			2,280,000	40,400
	U - C_2			12,400,000	4,680
	U - D_1			6,780,000	2,590
Tertiary	Fe	1,768.000	700,000	226,350,000	47,280,000
	Mn			83,000	27,400
	Cr			20,000	13,970
	Ti			56,000	
	Al	595,500 736,200[4]		2,140,000	
	SnO_2			9,100,000 m^3	2,165
	Ta-Nb			9,100,000 m^3	693
	WO_3			336,350	2,100
	Hg			83,000	27,390
	Re		21		

[1] Copper and Gold Deposits of the Bor Metallogenetic Zone;
[2] Copper and gold deposits in the area of Lece and the ophiolite melange of western Serbia;
[3] Amount of copper, gold, and silver in Pb-Zn and Pb-Zn-Cu deposits in Serbia;
[4] Bauxite deposit Petrovici (Pocuce); certificate of reserves from 1989, not part of the Balance of Reserves from 2022

The total reserves of non-metallic MRM in the Republic of Serbia excluding the territory of AP Vojvodina are presented in Table 2.2. The total reserves of non-metallic MRM in the territory of Vojvodina are presented in Table 2.3.

Table 2.2. Non-metallic mineral raw materials in the Republic of Serbia (without AP Vojvodina)

Raw Material Type	Unit	Quantity
Technical construction stone	[t]	923,141,456.69
	[m^3]	796,762,805.30
Architectural building stone	[t]	10,725,250.30
	[m^3]	690,775.50
Carbonate raw materials	[t]	227,540,622.31
	[m^3]	18,650,166.40
Brickmaking raw materials	[t]	88,358,976.00
	[m^3]	565,385.00
Building materials	[t]	21,554,148.73
	[m^3]	21,389,923.67
Borates	[t]	122,179.00
Magnesite	[t]	164,019.00
	[m^3]	396,834.00
Quartz raw materials	[t]	103,795,714.00
	[m^3]	12,468.00
Cement raw materials	[t]	266,777,782.00
Zeolite	[t]	875,167.00
Ceramic raw materials	[t]	4,350,468.00

Table 2.3. Non-metallic mineral raw materials in AP Vojvodina

Raw Material Type	Unit	Quantity
Brick-making raw materials	[t]	60,640,844.00
	[m^3]	821,152.00
Ceramic raw materials	[m^3]	281,600.00
Peat	[t]	448,446.00
Sand and gravel	[t]	1,667,725.00
	[m^3]	2,444,975.00
Sand	[t]	15,612,343.32
	[m^3]	3,470,241.90
Limestone breccia	[t]	204,943,416.00
Limestone	[t]	78,604,413.00
Purcolan tuff	[t]	2,032,958.00

In Table 2.4, the total balance reserves of coal (in tonnes) in the Republic of Serbia excluding Kosovo and Metohija are presented, while Table 2.5 shows the total balance reserves of oil, condensate, and natural gas.

Table 2.4. Coal balance reserves in the Republic of Serbia

Economic significance	Coal type	Reserve, [t]
Deposits in Exploitation		
Primary	Lignite	2,319,181,074
Secondary	Sub-bituminous	341,846,704
	Bituminous	60,405,279
Tertiary	Hard	1,381,389
	Anthracite	2,267,831

Economic significance	Coal type	Reserve, [t]
Deposits out of exploitation		
Primary	Lignite	467,441,619
Secondary	Sub-bituminous	54,487,952
	Bituminous	16,557,890
Total		
Primary	Lignite	2,786,622,693
Secondary	Sub-bituminous + Bituminous	473,297,825
Tertiary	Hard + Anthracite	3,649,220
Total		**3,263,569,738**

Table 2.5. Balance reserves of oil, condensate, and natural gas in the Republic of Serbia

Raw material	Serbia	AP Vojvodina	Total Republic of Serbia
Oil, $\times 10^3$ t	431.58	9,572.61	10,004.19
Dissolved gas, $\times 10^6$ m^3	65.10	1,091.51	1,156.61
Gas - Gas caps, $\times 10^6$ m^3	1.89	1,232.89	1,234.78
Condensate, t	3,082.08	808,938.58	812,020.66
Free gas, $\times 10^6$m^3	168.63	6,640.24	6,808.87
Natural gas - CO_2, $\times 10^6$ m^3		2,272.64	2,272.64

The total balance reserves of oil shale in Serbia amount to 352,759,195 tons, with a moisture content of 1.32-1.42%, ash content of 72.75%, total sulfur content of 2.20-3.40%, lower calorific value of 5.86-7.22 MJ/kg, organic substance content of 16.45-18.83%, and oil yield of 9.9-12.5%.

The reserves of groundwater established for the year 2022 are shown for the spring sources in central Serbia and AP Vojvodina (Table 2.6). In Table 2.7, the estimated groundwater reserves in the Republic of Serbia are presented, excluding artificial replenishment.

Table 2.6. Balance reserves of groundwater

Balance reserves	Central Serbia	AP Vojvodina	Total
Springs of public urban and rural water supply systems	112	222	334
Springs of industrial entities	404	384	788
Category A, [l/s]	2,393.60	120.70	2,514.3
Category B, [l/s]	6,446.83	5,844.08	12,290.91
Category C, [l/s]	3,365.45	5,370.13	8,735.58
Total reserve, [l/s]	**14,206.66**	**11,406.38**	**25,613.04**
Exploitation reserves, [m^3/year]	448,021,229.76	359,522,383.68	807,543,613.4
Produced during 2022, [m^3/ year]	124,130,753.40	127,446,704.12	251,577,457.5

Table 2.7. Estimated potential of groundwater

Hydrogeological unit	Alluvial sediments	MAS (Vojvodina)	Neogene deposits	Karst environment	Fractured environment	Total, [m^3/s]
Backa and Banat	9.39	4.91	0.55	0	0	14.85
Srem, Macva, Sava/Tamnava	21.11	0.55	0.99	0.10	0	22.75
Central Serbia	9.93	0	1.73	1.48	0.18	13.31
Eastern Serbia	1.06	0	0.24	2.98	0	4.27
Southwest Serbia	0.57	0	0.33	7.28	0	8.18
Western Serbia	1.74	0	0.12	1.89	0.03	3.77
Total	**43.79**	**5.46**	**3.95**	**13.72**	**0.21**	**67.13**

The balance reserves of geothermal waters for the area of the AP Vojvodina are shown in Table 2.8. The temperature of the geothermal waters ranges from 20°C to 72°C. The balance reserves for the area of the AP Kosovo and Metohija are shown in Table 2.9.

Table 2.8. Balance reserves of geothermal waters established for the year 2022

Balance reserves	
Category A, [l/s]	26.2
Category B, [l/s]	152.9
Category C_1, [l/s]	156.7
Total reserve, [l/s]	**349.50**
Exploitation reserves, [m^3/year]	11,021,832.00
Produced during 2022, [m^3/year]	738,898.40

Table 2.9. Balance reserves of mineral, thermal, and thermomineral waters for the area of the AP Kosovo and Metohija

Balance reserves	
Total reserve, [l/s]	396.56
Exploitation reserves, [m^3/year]	12,505,916.16

The potential of geothermal resources is presented in relation to the usage sector and the time frame of 2040-2050, as shown in Table 2.10.

Table 2.10. Estimated and planned capacities of geothermal resources

Sector of use	The estimated current capacity.	Planned capacity from 2040 to 2050
Production of heat and cooling energy in buildings	150-200 MWt	2,500 MWt
Electricity generation	0 MWe	50 MWe
Cogeneration of energy	0 MWe	200 MWe
The concept of resource parks	0	100% of spa centers fully or partially use geothermal energy
Agriculture	0,1% of energy needs	10% of energy needs
Industry	0,1% of energy needs	3% of energy needs
Production of CRMs	0	1%

The educational system of the Republic of Serbia in the field of mining and geology is organized through secondary and higher education. Within secondary education, some educational profiles in the field of mining and geology are accredited at 5 educational (school) institutions. In higher education, study programs in the field of mining and geology are accredited at three faculties within two Universities.

Secondary education in the field of geology includes active profiles such as geological technician for geotechnics and hydrogeology, geological technician for mineral resources exploration, and environmental protection technician. All three programs are active at the Geological and Hydrometeorological School "Milutin Milanković" in Belgrade. The total enrollment quota for each profile has been filled in the past 10 years. In the field of mining, the active educational profiles include mining technician and operator of machinery in surface mining, offered at technical schools in Lazarevac, Kostolac, and Bor, as well as operator of machines and equipment for oil and gas extraction at the Technical School in Zrenjanin, which has been replaced this school year by the profile operator of oil and gas extraction facilities. In the past 10 years, the average number of students enrolled in these profiles has been: mining technician – around 80 students; operator of machinery in surface mining – around 32 students; operator of oil and gas extraction facilities – around 27 students.

Mining and geology are studied through the higher education system in the Republic of Serbia at undergraduate, master's, and doctoral levels. Within the University of Belgrade, mining and geology are studied at the Faculty of Mining and Geology, while mining is also studied at the Technical Faculty in Bor, within the same University. Industrial Engineering in Oil and Gas Extraction and Environmental Protection Engineering are also studied at the University of Novi Sad, at the Mihailo Pupin Technical Faculty in Zrenjanin. In addition to these, Mining Engineering is also studied at the Faculty of Technical Sciences in Kosovska Mitrovica, University of Pristina.

The average annual number of graduates in Mining Engineering at the Faculty of Mining and Geology in Belgrade and the Technical Faculty in Bor over the last 10 years at the Bachelor level is 45 students, while at the Master level is 30 students. The Environmental Protection Engineering program at the Bachelor level is completed by an average of 15 students annually, while at the Master level it is completed by 13 students. The Oil and Gas Engineering program at the Bachelor level is completed by an average of 25 students annually, while at the Master level is completed by an average of 11 students.

The geology study programs cover 6 different areas: Geology, Hydrogeology, Geotechnics, Geophysics, Regional Geology, and Mineral Resources Exploration. In the last 10 years, the average annual number of students completing the Bachelor level is 61. The average number of students completing the Master's level annually is 35. A decline in the number of students is observed at both levels of study.

Mineral resources, as primarily non-renewable sources, are of vital importance to society at all stages of mineral raw material extraction. Therefore, the active participation of geological and mining professionals is essential. In addition to knowledge of mining technologies and geological exploration, experts must also possess knowledge of organization and management at all levels, as well as decision-making abilities, especially when it comes to decisions of strategic importance. This becomes even more significant considering that a new technological revolution is underway, and the fields of mining and geology are rapidly changing.

Currently, around 30,000 workers are employed in the mining sector in the Republic of Serbia. However, very few students enroll in secondary mining and geological schools, and the number of students in mining and geology is steadily declining. The question arises as to how the necessary workforce will be secured if the negative campaign regarding mining and geology continues. Due to the lack of qualified labor, mines often resort to internal qualifications within the mining system or training by publicly recognized activity organizers, but it has been shown that this method of education is far below the official system. It is necessary to achieve the educational goals as follows: 15% higher education, 35% secondary education, 40% vocational and qualified, and 10% unqualified and semi-qualified.

2.6. Overview and Analysis of the Status of Active Mines in the Republic of Serbia

The overview and analysis of the status of active mines in the Republic of Serbia are provided according to the types of mineral raw materials defined in the project task – solid energy raw materials, liquid and gaseous energy raw materials, metallic and non-metallic MRM.

Open-pit coal mining in the Republic of Serbia is currently carried out at three open-pit mines in the Kolubara Basin (Field E, Field G, and Tamnava-West Field) and one open-pit mine in the Kostolac Basin (Drmno), by applying high-productivity continuous-action machinery. In addition, the open-pit mines Field E and Radljevo in the Kolubara Basin are in the opening stage. Lignite production has, in recent years, been insufficient to supply thermal power plants and the broader consumer market, but with the completion of the new investment cycle, production is expected to return to previous levels.

Mining machines in the coal production sector are following a negative trend in terms of age structure. The procurement of new missing machines, as well as the planned revitalization and modernization of old equipment, create preconditions for successful operation by 2050 (and beyond if needed) are being created. In addition to the equipment for excavation and disposal in the Kolubara and Kostolac basins, the necessary capacities for coal preparation and processing have also been installed, including a total of 3 coal crushing plants and two coal dumps with a total capacity of over 1,000,000 tonnes, where seven dump machines are in operation. Coal preparation for supplying the Nikola Tesla thermal power plants is carried out through dry separation (Kolubara-processing).

The failure to complete planned investments has led to delays in opening the replacement coal mines (Field E and Radljevo), which resulted in increased exploitation at the surface mine Field G, which was planned to provide long-term conditions for coal homogenization. The low average realized ratio of planned to actual investments resulted in the non-realization of planned opening and maintenance works, as well as delays in acquiring additional new core equipment and selective work equipment. There have also been delays in the revitalization and modernization of existing equipment. All of this has resulted in reduced time and capacity utilization of equipment. An indirect consequence has been a decrease in the volume of overburden excavated. As a result, the reserves of exposed coal have been reduced, which directly impacts the security of thermal power plant supply and coal quality. This problem will only be resolved with the opening of the main (subseam) coal layer at the surface of mine Field E, which has a quality of about 9,000 kJ/kg. Excavating this coal will enable integrated coal quality management across the entire Kolubara Mining Basin.

The coal quality at the Drmno surface mine is adequate, with a value of over 8,300 kJ/kg. A potential issue in the upcoming period could arise from slightly lower-quality coal from the second coal seam, as well as the need for selective mining due to the increasing number of waste interlayers. Due to the occurrence of interlayers, it is necessary to acquire additional basic and auxiliary equipment.

For the opening of new open-pit mines, the procurement of new equipment, as well as the revitalization and modernization of existing equipment, and investments in drainage, expropriation, and other processes, over 1.8 billion € (or in another option 1.6 billion €) are planned. The start of operation of new equipment at the Radljevo mine is expected in 2026, and at Field E in 2026-2027. Based on this, it is anticipated that the required production will be established starting in 2027.

Within the PE PEU Resavica, nine parts of the company are registered which activities are carried out in following locations: Anthracite Mine Vrska Cuka – Avramica, Ibar Hard Coal Mines – Baljevac, Brown Coal Mine Rembas – Resavica, Brown Coal Mine Bogovina – Bogovina, Brown Coal Mine Soko – Soko Banja, Brown Coal Mine Jasenovac – Krepoljin, Lignite Mine Lubnica – Lubnica; Lignite mine Stavalj – Sjenica and RGP Aleksinac – Aleksinac mine.

Within the Public Enterprise for Underground Coal Exploitation "Resavica", low-productivity mining methods are applied. These are accompanied by a negative trend in the age structure of the equipment and low reliability, which necessitates significant reliance on manual labor. All of the above affects occupational health and safety. An additional hazard arises from increased methane emissions in certain mines, as well as the presence of explosive coal dust. The price at which PEU Resavica sells coal is regulated by acts of the Government of the Republic of Serbia. It is estimated that the production costs under the current method of exploitation are high, which negatively impacts the financial balance of the enterprise.

In mines where the raw material base is running out, it is necessary to extract the remaining reserves and prepare for their closure. For mines with significant reserves and the potential to introduce mechanized coal mining, investments should be made in acquiring appropriate machines to achieve a possible production of up to 2 million tonnes. This would greatly contribute to secure supply for industry, general consumption, and additional supply for thermal power plants in the Republic of Serbia. Such an approach would significantly reduce import dependency, generate economic savings, and support energy security. According to the Energy Development Strategy, coal for general consumption and industry will be used until 2040 (except in industries where it is indispensable), so by then, modernized production will be significantly reduced and concentrated.

In December 2018, a Strategic Partnership Agreement was signed between the Republic of Serbia, the former owner of the company RTB Bor, and the company Zijin Mining Group Co., Ltd. Through this agreement, RTB Bor was recapitalized, making Zijin Mining the majority owner with a 63% stake. A joint company was established under the name Serbia Zijin Copper d.o.o. in Bor.

Zijin Mining has made significant investments in copper mines with surface exploitation in Bor and Majdanpek, thereby improving their technical and technological infrastructure In terms of production of run-of-mine ore, the Veliki Krivelj and Majdanpek mines ranked among the largest open-pit mines in Europe in 2023. The company's strategic goals include increasing capacity and reducing operating costs, which has led to the procurement of new and replacement mining equipment. Additionally, a new copper smelter was built in Bor, utilizing modern technologies and enabling greater efficiency in ore processing. The smelter now has a processing capacity of over 200,000 tonnes of copper per year. At the Veliki Krivelj mine, efforts to increase flotation processing have been accelerated. A new flotation facility has been constructed with a capacity of 13.2 million tonnes (Mt), operating alongside and independently from the existing one with a capacity of 9.9 Mt. This will raise the total flotation capacity at Veliki Krivelj to 23.1 Mt.

As all necessary conditions for the opening and exploitation of the Kraku Bugaresku Cementacija 2 open-pit mine have been met, the investor (Serbia Zijin Copper d.o.o. Bor) has provided the required primary mining equipment, enabling efficient and cost-effective production of both waste rock and metal ore. Both the Northern and Southern open-pit mines in Majdanpek have modern equipment that ensures efficient and profitable production of waste rock and metal ore.

The Jama mine is equipped according to global standards in terms of applied equipment and mining technology. The exploitation of the copper and gold deposits at the Cukaru Peki mine is planned with a capacity of 3.3 million tonnes per year. The ore processing plant has an annual capacity of 3.300.000 tonnes of dry ore, which amounts to 10.000 tonnes of ore per day. The main product of the plant is a copper concentrate with traces of gold and silver.

There are seven active lead and zinc mines in the Republic of Serbia with classic preparation facilities: Rudnik, Rudnik (Gornji Milanovac) - lead concentrate, zinc concentrate and copper concentrate; GROT, Kriva Feja (Vranje) - lead concentrate and zinc concentrate; Lece, Gazdare (Medvedja) - lead concentrates with a high gold content, zinc concentrate with a low gold content and pyrite concentrate with gold content; Veliki Majdan mine, Ljubovija - lead concentrate with a significant proportion of silver and zinc concentrate; and Belo Brdo, Crnac and Podvirovi mine in Bosilegrad (currently suspended exploitation) - lead and zinc mines. All lead, zinc, and related minerals mines were privatized more than two decades ago.

Small deposits, with limited production capacities, and an unstable market have resulted in relatively simple processing procedures for non-metallic MRM. These typically involve

crushing and classification, most commonly through screening using various types of crushers, mills, sieves, and similar equipment. Due to the small-scale operations, preparation costs are often high, making it potentially more cost-effective to sell the raw material unprocessed rather than after processing. An additional challenge lies in the possibility of importing raw materials that are processed domestically at more competitive prices.

In conclusion, data indicate that the Republic of Serbia has significant global-level production of lignite and copper. There is also growth in the production of gold, palladium, and non-metallic mineral raw materials. Considerable quantities of natural gas and oil are produced as well, although data show a decline in their production over the past five years. Since 1960, a cadaster of issued exploitation permits has been maintained for the territory of the Republic of Serbia. To date, 677 exploitation fields have been approved, of which active exploitation is taking place at 189 fields, based on production reports submitted for 2023. In the territory of the Autonomous Province of Vojvodina, 142 exploitation fields have been approved, with 77 currently in active exploitation.

In 2022, the Republic of Serbia recorded copper metal production (contained in concentrate) of 203,998 tonnes, which is almost five times higher compared to 2018 [1]. Production in 2023 reached a record level of 240,000 tonnes, with trends indicating further growth expected in 2024. Lead production in Serbia in 2022 was approximately 25-30% lower than in 2018. A total of 9,960 tonnes of zinc was produced in 2022. The highest selenium production was recorded in 2018, with 28 tonnes produced, while in 2022, this dropped to 10 tonnes. In recent years, Serbia has seen an increase in gold production. Compared to 2018, when 839 kilograms of gold were produced through metallurgical processing, 2022 saw 1,128 kilograms of cathode gold produced, along with a significant increase in gold contained in concentrate, which reached 7,290 kilograms [1]. In 2022, 110 kilograms of palladium were produced [1]. In 2020, Serbia produced 15,900 kilograms of silver through metallurgical processing, while in 2022 the output was 7,400 kilograms. By 2023, silver production reached 16,051 kilograms contained in concentrate.

In the production of non-metallic raw materials in 2022, limestone dominates with 18,327,165 tonnes, followed by sand and gravel with 3,893,266 tonnes, dolomite with 2,643,623 tonnes, clay with 1,983,856 tonnes and marl with 1,219,721 tonnes. In addition to the above, 796,107 tonnes of diabase, 451,150 tonnes of dacite, 408,096 tonnes of andesite, 131,130 tonnes of gabbro, 64,634 tonnes of granite and granodiorite and 1,846 tonnes of magnesite were produced. The amount of salt produced in relation to global production is negligible.

2.7. The State of Exploration of the Territory of the Republic of Serbia, Needs Analysis, and Projections for Basic Geological Research

Basic geological exploration (BGE) of mineral deposits in the Republic of Serbia is conducted partially, primarily as exploration in four stages, at the level of mining districts and fields. The exploration mainly includes study-type investigations (metallogenetic and mineralogenetic analyses, potential assessments, etc.), the creation of prognostic metallogenetic (mineralogenetic) maps at a scale of 1:50,000, and exploration in the broader area of known mineral raw material deposits and ore occurrences. In most cases, these explorations are funded in a reduced scope compared to actual needs. Geological exploration of metallic mineral raw material deposits in the Republic of Serbia is conducted partially, within the scope of individual mineral raw material deposits (Cu, Au, Pb, Zn), primarily at the level of detailed exploration and exploration in the exploitation phase (Bors, Majdanpek, Rudnik, Grot, etc.) and to significantly lesser extent as basic geological exploration. Applied geological exploration (AGE), as well as BGE, are carried out to an extent that needs additional support to achieve a significant expansion of the mineral raw material base.

The recognition of mineral resources as a national asset and comparative advantage of the Republic of Serbia is of crucial importance for overcoming the existing challenges in the field of BGE and AGE. This would not only enable their responsible use but also enhance the economy, while simultaneously preserving the environment and implementing the principles of sustainable development. BGE and AGE of mineral resources in the Republic of Serbia require scientifically based and adaptable strategic management, aligned with the concept of sustainable development and the theory of natural resource conservation, in harmony with the economic, ecological, and social interests of the community and its residents. In this sense, the management of mineral resources and BGE of mineral raw materials in the Republic of Serbia until 2050 should be designed in a way that brings maximum profitable effects, or developmentally positive changes, based on increasing knowledge participation, adequate financing, legislative regulation, and strengthening the Geological Survey of Serbia as the state institution responsible for conducting BGE.

The long-term BGE program should include: plans for the development of general and specialized geological maps, exploration plans aimed at determining the potential of geological environments in terms of the presence of mineral and other geological resources, plans for geological explorations based on which the hydrodynamic and other properties of the geological environment are determined for the use and protection of groundwater and geothermal resources, exploration to determine the suitability of the geological environment for planning and construction, particularly regarding geological hazards, as well as research for environmental protection, preservation of geodiversity, and protection of geological heritage sites, etc.

In the upcoming period, special attention should be emphasized to the development of various types of mineral resource maps (metallogenetic, mineralogenetic, and prognostic maps of mineral resource) as graphic documents based on which the mineral potential of the terrain is assessed and areas for further geological exploration are selected. Additionally, geoecological, geochemical, and other maps that are used for the exploration and sustainable development of mineral resources should also be prioritized.

Priority long-term programs of BGE metallic and non-metallic mineral resources of the Republic of Serbia, from the aspect of implementation priorities, are classified into the following series: Legislative-legal and organizational priority programs. Priority programs are BGE and AGE mineral resources that have previously been assessed as raw materials of special economic and economic importance for the state (strategic mineral raw materials). Their implementation can be carried out in parallel.

Due to the complex social conditions in the Republic of Serbia, and inadequate and untimely financing of geological exploration, reserves of hard brown coal in some coal basins are at a low level of exploration, and the mines in these basins are marginalized. Determining the content and distribution of trace elements in coal, ash, and fly ash as potential environmental pollutants has been sporadically conducted, sometimes with an insufficient number of elements and methods with limited detection limits. The use of modern analytical testing methods has been almost absent until 2008/2009. The primary priority for further coal research in the Republic of Serbia is lignite deposits. The basins and lignite deposits currently in exploitation with resources of **primary geological-economic importance** are the Kolubara, Kostolac-Kovin, and Kosovo-Metohija basins, with the first two basins having priority in exploration.

Geothermal exploration in the Republic of Serbia has a very long tradition. Despite this, there are still tasks that remain unfinished and need to be further addressed in the coming years. After 2000, conditions were established for the continuation of practically halted geothermal exploration, particularly after 2008. In addition to drilling geothermal wells, it is important to note the re-establishment of work on strategic technological development projects in the Republic of Serbia, financed by the ministry responsible for scientific research.

The elements of the groundwater resource development policy are listed in Table 2.11.

Table 2.11. Elements of development policy

Type	Scope
Cadastral registry of underground water deposits	The cadastral registry of the most significant underground water deposits is of particular importance for current and prospective water supply.
Systematic Research Program	A program of systematic and continuous research to get to know all promising regions up to the level of basic hydrogeological research
A program of continuous research	
Exact Plans for Further Valorization, Use, and Protection of Groundwater Potential	Exact Plans for Further Valorization, Use, and Protection of Groundwater Potential, which would include the basic concept of the research process to form the Basic (State) Hydrogeological Network for Monitoring the Groundwater Regime, both First and Deeper
Basic hydrogeological maps	Basic Hydrogeological Maps for the Territory of the Republic of Serbia
Study of the Potentiality and Protection of Groundwater Resources	Study of the potentiality and protection of groundwater resources at the level of the entire territory of the Republic of Serbia

Given the exceptional importance of the Basic Hydrogeological Map (BHM) as a planning and water management foundation, and considering the current state, it is essential to define a new concept/strategy for its development. The accelerated implementation and completion of the BHM of Serbia should be a distinct priority in the field of basic hydrogeological investigations in the coming period. Other forms of basic hydrogeological investigations should reflect the current needs and interests of the Republic of Serbia in terms of more efficient management of groundwater resources. This is further supported by the fact that, of the total territory of the Republic of Serbia, basic hydrogeological investigations have been completed on approximately 27% (or 23,593 km²) [30].

Engineering geology and geotechnics focus on the study and management of geological conditions in both urban and rural areas to support the sustainable development of cities, villages, and natural and cultural assets, as well as to create opportunities for the development of mining and, primarily, the energy sector. In the past, a variety of engineering-geological investigations have been conducted on the territory of the Republic of Serbia, which, based on their purpose and content, can be classified as either fundamental or applied.

Regional engineering-geological investigations were conducted on the territory of the Republic of Serbia (excluding the territory of AP Vojvodina) during the period from 1968 to 1984. These investigations provided data on the engineering-geological conditions of the terrain over larger areas, typically corresponding to major geographic units, most often river basin regions.

An extremely important part of BGE includes engineering-geological investigations and the development of Basic Engineering-Geological Maps (BEGM), as well as the creation of geological hazard and risk maps, the development of a landslide cadaster, base data for spatial and urban planning, and investigations aimed at determining engineering-geological conditions for the remediation of structures and terrain.

The adopted plans and timelines for the development of BEGM have not been fully implemented so far. However, despite objective difficulties, the development of BEGM continues and is being carried out according to current capabilities. Given the significant backlog in meeting the planned timeline, it is essential to accelerate the process and complete BEGM for all map sheets covering the territory of the Republic of Serbia by the end of 2030.

Modern geological processes with the occurrence of landslides, primarily the processes of instability and erodibiness, represent major problems for rational economic and urban planning and design. Currently, about 45% of the territory of the Republic of Serbia is covered by the Landslide Cadaster, so it is necessary to provide conditions for faster implementation of this extremely important project for the country.

Given that the National Program for Disaster Risk Reduction is currently being developed, among which earthquakes are certainly included, one of the priority projects is the creation of a seismic zoning map, including geological investigations necessary for defining national parameters under EUROCODE 8 (EC8-1). This will serve as a foundation for the development of seismic hazard and risk maps.

Since World War II, many engineering-geological and geotechnical explorations have been conducted across the territory of the Republic of Serbia. This documentation must be collected and integrated into an information system in the coming period.

2.8. Situation and Comparative Analysis of Fees for the Use of Mineral Raw Materials and Other Geological Resources in Countries with Similar Mineral Potential and Mining Development of the EU, the Region, and the Republic of Serbia

According to the definitions of the financial regimes of the EU Member States, the following fees have been considered:

- Corporate Income Tax;
- Social Security Payments/Taxes;
- Resource tax (Royality) - fees for the use of mineral resources;
- Land Use Tax;
- Environmental Tax - typically charged with the declared aim of reducing the burden on various ecological media;
- Concession Fees;
- Fees for Issuing Geological Exploration Permits.

The reasons for the diversity of this regulation lie in the heterogeneity of mineral ownership rules in different member states. This influences the management of the procedure for issuing mining rights on state-owned land, and consequently, the function and content of concession fees. Concession-type permits and concession fees are applied in 14 member states. The analysis shows that a flat-rate concession fee is applied only in PT, SE, and HU, while in other countries, the concession fee is used as a fee for issuing exploration permits (PL, ES) or is included in the payment of royalty fees (BG, EL, FR).

Several tax rates, such as corporate income tax or social security tax, are uniform across the entire economy of a country, meaning that the mining and exploration industry is treated equally to other sectors.

Resource tax (royalty) is more specific to the mining and quarrying industry. This is a tariff system based on unit and value. These are costs, before corporate income tax, and are essentially insensitive to profit. The resource tax can also be a strategic tool in the hands of the Government to apply incentives or aggravation on mining investments.

Land use tax is also specific to the mining industry, as it typically occupies large areas and changes its use semi-permanently. Member states again follow very different practices, ranging from nominal rates to a high percentage of the commercial value of the land. One of the most important tools specific to non-energy raw materials is the financial guarantee. It is applied in most countries and aims to cover the costs of land reclamation after the end of exploitation. The main differences lie in the payment method, which can either be a lump sum paid in advance or installments over the lifetime of the mine.

Some form of environmental tax is applied in 16 member states to charge for emissions into land, water, and air. The procedures for calculating this type of tax are quite complex in most of these countries and are hardly comparable. On the other hand, 12 member states, including those with significant exploitation of metallic minerals (IE, PT, ES, SE), do not impose environmental taxes related to non-energy raw material exploitation. Some member states (DK, BE, UK) apply imposition on the amount of extracted raw material to encourage more efficient resource use. Financial incentives can promote investment in mining to provide a comparative advantage to certain types of activities and selected regions for mining. Finland serves as one of the best examples of positive government intervention in promoting exploration and mining exploitation.

Examples of fees for the use of mineral resources in certain EU countries

Germany - The holder of an exploitation license pays an annual fee for freely mined or incidentally mined resources from the exploitation area. The mining fee is calculated as ten percent of the average achievable market value of the resource. For resources with no market value, the competent authority determines the value on which the mining fee will be based, in consultation with experts.

Czech Republic - An entrepreneur is obliged to pay fees for mining lease and for the exploited minerals. An annual lease fee of 300 CZK is assessed for each hectare of surface designated within the mining lease area. If mining activities such as opening, preparation, and exploitation of mineral resources are permitted within the lease, the annual fee amounts to 1,000 CZK. The mining fee is calculated as the product of the fee base, defined as the quantity of extracted minerals expressed as the net output from the mine under lease. A regulated tariff is established for each type of exploited mineral resource.

Romania - The mining fee is calculated as a percentage of the value of mining production, as follows: 2% for coal, iron and non-ferrous metal ores, aluminum rocks and minerals, precious, radioactive, rare and dispersed metals, gemstones and jewels, residual mining products, bituminous rocks, therapeutic, thermal-mineral and geothermal waters, associated gases, non-combustible gases, mud, and therapeutic peat; 6% for non-metallic mineral resources; 6% for useful rocks, except for ornamental rocks which are subject to a 10% rate; 8% for salts. The value of mining production does not include the costs of processing the extracted products.

Hungary - The state is entitled to a share of profits through a Mineral Resource Usage Fee (Royalty) for mineral resources extracted by mining companies, which gain ownership of those resources, as well as for extracted geothermal energy. Based on permits issued by the competent authorities, the royalty rates depending on the value of extracted resources are: 12% for crude oil and natural gas (including carbon dioxide); 5% for non-metallic minerals extracted through surface mining, excluding energy resources; 2% for other solid mineral resources and generated geothermal energy.

The Minister, in agreement with the Minister of Finance, may reduce the royalty rate in the interest of mineral resource management or other public interests. No royalty is charged for crude oil extracted using enhanced recovery technologies. In cases of mining activity conducted under a concession agreement, the Minister determines the royalty rate based on various public interest considerations.

Bulgaria - According to the Underground Resources Act (2011), the system of fees for the use of mineral resources applies a fixed rate based on the type and value of the exploited mineral. The rate is a percentage of the gross revenue or the market value of the mineral at the mine site. This system keeps the structure of royalties relatively predictable and easy to administer. Examples of generally defined fees are shown. *Common minerals* - such as copper, gold, and lead: the royalty rate is usually around 1.5% to 3% of gross revenue and may slightly vary

depending on market conditions. *Industrial minerals* - such as sand, gravel, and other non-metals: the rate is lower, typically around 1%. *Precious stones and special minerals* - i.e., higher-value minerals such as gemstones: may be taxed at a slightly higher rate to achieve a greater share of revenue.

Croatia - The rates of fees for the use of mineral resources are defined through the Mining Act and the Regulation on Concession Fees for the Exploitation of Mineral Resources (2024). The amount of the minimum annual concession fee for the exploitation of mineral resources is determined for: fossil combustible materials, mineral resources for industrial processing, mineral resources for the production of building materials, architectural-building stone, metal mineral resources, and construction sand and gravel from the seabed, all types of salt (sea salts) and brine, and mineral waters from which mineral resources can be extracted (except for mineral waters used for medicinal, balneological, and recreational purposes or as drinking water and for other purposes, to which water regulations apply).

The fee for mineral resources under this Regulation consists of the following elements:

Fixed part – monetary fee for the area of the exploitation field determined by registration in the register of mineral resource exploitation fields. The minimum amount of the fixed fee is €200 per hectare of the established exploitation field area.

Variable part – financial fee for the extracted/removed quantity of mineral resources. The minimum amount of the variable fee is 7.5% of the market value of the extracted/removed mineral resource.

Purpose-specific part – monetary fee for the remediation of damage caused by mining activities in the local community. The minimum amount of the purpose-specific fee is 2.5% of the market value of the extracted/removed mineral resource.

Slovakia - Within the Government Regulation of 1994, fees for the use of mineral resources in Slovakia are defined in the following categories:

Calculation of payments for mining reservation - A legal or natural person calculates the annual payment for a mining reservation based on the area of the mining reservation.

Payment for mining reservation - The calculated fee for the mining reservation is paid by the organization to the state budget of the Slovak Republic.

Calculation of payments for extracted minerals - The organization that exclusively exploits a deposit calculates the fee for extracted minerals as a percentage of total revenues from extracted minerals or minerals after their processing and enrichment, estimated at market prices.

Fee rates for the use of mineral resources range from 2% to 10%, while for non-metallic resources, the rate is between 0.5% and 1%, depending on the type of mineral or resource.

In the **Republic of Serbia**, the amount and method of charging fees are determined by the Law on Fees for the Use of Public Goods ("Official Gazette of the RS", No. 95/2018, 49/2019, 86/2019 - adjusted dinar amounts, 156/2020 - adjusted dinar amounts, 15/2021 - additional adjusted dinar amounts, 15/2023 - adjusted dinar amounts, 92/2023, 120/2023 adjusted dinar amounts, and 99/2024 adjusted dinar amount), which stipulates the following:

The basis for the fee for the use of resources and reserves of mineral raw materials is:

1) The revenue that the fee payer generates from the utilized or sold mineral raw materials, is determined based on the income earned from the sale of unprocessed mineral raw materials or the income earned from the sale of technologically processed mineral raw materials.

2) Net income, which represents the revenue from the sale of the final product, is reduced by the costs of smelting, refining, transportation, transshipment, insurance, and sales. Net income cannot be reduced based on depreciation, capital costs, or tax reliefs.
3) For the use of hydrocarbons in liquid and gaseous form (oil and gas) and natural gases, the revenue that the fee payer generates from the sale of unprocessed mineral resources, or the value of the mineral resources if they are consumed for the needs of the fee payer's activity, evaluated according to the costs incurred for their production based on accepted international accounting standards.
4) The amount of extracted non-metallic raw material for the production of construction material, expressed in tonnes.
5) The utilized carbon dioxide, expressed in 1,000 m^3.

The Minister in charge of mining and geological exploration shall further regulate the methodology for determining the quantities and pricing of unprocessed hydrocarbons in liquid and gaseous states (oil and gas), as well as other natural gases. According to this law, the amount of the fee is determined by applying the following rates:

1) For all types of coal and oil shale, 3% of the revenue.
2) For hydrocarbons in liquid and gaseous states (oil and gas) and other natural gases, 7% of the revenue.
3) For radioactive raw materials, 2% of the revenue.
4) For metallic raw material - unrefined (raw) or refined through preparation, 5% of the revenue; subjected to pyro, hydro, or electro-metallurgical processes, 5% of the net revenue.
5) For technogenic raw materials resulting from the exploitation and processing of mineral resources, 1% of the revenue.
6) For non-metallic raw materials, other than non-metallic raw materials for the production of construction materials - untreated (run-of-mine) or purified by preparation 5% of the turnover - subjected to a pyro, hydro, or electro-metallurgical process 5% of the net turnover.
7) For all types of salts and saline waters: 1% of revenue.
8) For underground waters from which useful mineral raw materials are extracted, as well as underground waters related to mining technology and the gases that occur with them: 3% of revenue. The fee for non-metallic raw materials to produce building materials per tonne of extracted mineral raw materials is specified in Annex 1, Table 3 of this law. The amount of the fee referred to in Article 20 of the Article.
9) For 1,000 m^3 of used carbon dioxide, the fee is specified in Annex 1 of this law.

2.9. Impact of Mineral Exploitation and Environmental Protection Guidelines

The exploitation of mineral deposits significantly impacts the economic development of the Republic of Serbia, but it also presents challenges in the domain of environmental protection. The mining sector in the Republic of Serbia plays a key role in providing energy and industrial resources, but its activities are accompanied by an impact on the quality of air, water, and soil, as well as the generation of large amounts of mining waste. These impacts can be long-term, making it essential to continuously improve strategies for their control and minimization.

Modern methods of operation, monitoring, and analysis, as well as adequate supervision and control, help minimize the impact on soil, water, air quality, biodiversity, and the local community in general. Comprehensive sustainable guidelines and regulations can further contribute to reducing negative effects and ensuring the sustainability of mining activities.

It is necessary to distinguish the potential environmental impacts of the mining industry from those of other industries, such as processing. While the mining industry generally has a localized environmental impact, other industries that involve a certain degree of processing (such as metallurgical, chemical plants, and thermal power plants) can cause broader-scale effects. Differentiating these sources of pollution allows for more precise planning of environmental measures and more effective control of impacts on air, water, and soil.

The focus of the Strategy, with the Strategic Environmental Impact Assessment Report, refers to the potential impacts of the mining industry on the environment, as well as measures to mitigate and prevent them.

Mining activities in the Republic of Serbia include the exploitation and processing of metallic, non-metallic, and energy raw materials. The main mining areas are Bor, Majdanpek, Rudnik, Kostolac, the municipalities of Lazarevac, Lajkovac, and Ub, as well as smaller deposits throughout the country. The primary environmental impacts of mining may affect the following media:

- Air – dust and suspended particles generated during the extraction, transportation, and crushing of minerals.
- Soil – degradation due to excavation and disposal of mining waste.
- Water – potential leaching of heavy metals from tailings into surface and groundwater.

Potential impacts on air pollution in the environment are primarily associated with the dispersion of fine dust particles from dry surfaces and their distribution by wind beyond the boundaries of the mining complex. Active benches in open-pit mines and truck transport roads, under certain natural conditions (low moisture, high temperatures, increased wind speeds), become significant sources of dust emissions. Additional emissions, to a lesser extent, are caused by mining machinery operating during excavation, transport, and disposal, while secondary sources include all active surfaces that, under wind influence, release airborne particles from deposited dust into the atmosphere.

Air quality is assessed based on consolidated data from national and local monitoring networks, analyzing the measurement results of key pollutants, including sulfur dioxide, nitrogen dioxide, carbon monoxide, benzene, suspended particles PM10 and PM2.5, as well as lead in PM10 particles.

In Bor, a significant decrease in sulfur dioxide exceedances has been recorded in recent years, and no such exceedances were observed during 2023. In Kostolac, concentrations of PM10 particles were within the prescribed limits, while sulfur dioxide exceeded the permissible value only on one day. In the territory of Lazarevac, near processing facilities, the number of days with elevated concentrations of PM10 particles may show higher values compared to other locations, which cannot be directly attributed to the mining industry, while sulfur dioxide concentrations remained below the limit values.

Soil degradation is another aspect of potential environmental impact. The exploitation of mineral resources often requires the removal of vegetation, which leads to erosion and a reduction in soil fertility. Contamination of soil with heavy metals and chemicals can affect agricultural productivity. Mining activities related to the extraction of mineral resources often occupy large areas, which may threaten natural habitats and local species. The development of mining infrastructure can fragment habitats, reducing their connectivity and functionality, which represents a significant impact of mining activities on biodiversity.

One of the key challenges is waste management that arises from mining activities. Mining waste is generated by the extractive industry, and it includes waste resulting from the exploitation, preparation, and storage of mineral resources, as well as waste produced during the ore preparation process, which involves mechanical, physical, biological, thermal, or chemical

procedures (such as dimension alteration, separation, and leaching, or the processing of previously discarded waste), excluding smelting, thermic production processes (except for limestone roasting), metallurgical processes, and oil drilling waste.

Mining waste does not include waste generated during exploration, exploitation, and preparation of mineral resources that are not directly related to these activities (such as waste oils, food, worn-out vehicles, and used batteries and accumulators), nor does it include waste from the extractive industry that may be radioactive, or waste generated from the industrial processing of mineral resources.

Waste (overburden) is mining waste that needs to be relocated to carry out the exploitation of valuable mineral resources, while flotation tailings are mining waste generated during the flotation process of mineral resources. These can contain potentially toxic substances that may subsequently contaminate the soil.

Exploitation and processing of mineral resources sometimes involve the use of chemicals that can affect ***water quality***, just as acid mine drainage from tailings can impact both underground and surface waters. The degree of degradation of watercourses depends on various factors such as the frequency, volume, and chemical characteristics of the mine drainage water. Oxidation of sulfide minerals exposed to atmospheric conditions is a natural process. However, mining activities accelerate this oxidation process, and due to the fragmentation, the specific surface area of minerals increases multiple times. The impact of acid mine drainage on environmental quality is complex.

Reasons for the occurrence of these pollutions

The potential impact of mining activities on the environment in the Republic of Serbia may arise from technological and organizational challenges, as well as the need to improve the regulatory framework. Upgrading equipment and more widespread use of modern technologies could significantly contribute to reducing emissions and improving waste management. Existing tailings and waste dumps, with appropriate remediation measures, could be better integrated into the environmental protection system. Establishing more efficient monitoring and encouraging mining companies to adopt more environmentally responsible business practices could support the sustainable development of the sector.

Implementation of Environmental Protection Measures by Mining Companies

Mining companies in the Republic of Serbia have a legal obligation to implement environmental protection measures. Larger companies, such as Zijin Mining Group and the EPS, have taken steps to reduce pollution, including the construction of wastewater treatment plants and the modernization of thermal power plants. On the other hand, smaller companies often face financial and technical challenges in implementing environmental standards. Although there are numerous examples of good practice, there are still challenges for some smaller companies in terms of tailings management, as well as mine water treatment.

Mining Waste Management by Mining Companies

Managing mining waste is an important aspect of responsible business practices for mining companies in the Republic of Serbia. The legal framework is aligned with European standards, and many companies are taking steps to improve practices in this area.

Companies like Zijin Mining Group and the EPS are investing in modern technologies for waste management, building safe landfills, wastewater treatment systems, and land reclamation. In Bor, a modern tailings dam with a protective layer and a seepage control system has been built, while in Kostolac, the remediation of old tailings dumps has been initiated.

To ensure consistent application of the Best Available Techniques (BAT), it is necessary to further support smaller mining operators in implementing sustainable solutions. The potential for applying the concept of circular economy is being explored, including the recycling of mining waste, which opens new perspectives for more efficient resource management.

The remediation of tailings and waste dumps and improving waste management remain priorities in strategic documents, and through continuous efforts to improve practices and support innovative solutions, the mining sector can further reduce its environmental impact and contribute to sustainable development.

The Republic of Serbia is actively initiating procedures aimed at the remediation of abandoned mines and waste damps, to reduce environmental impact and improve the safety of local communities. The priority is the remediation of the most critical locations, using the BAT.

Remediation processes include the stabilization of waste dumps, prevention of erosion, soil remediation, and the implementation of environmentally sustainable solutions for wastewater management.

In addition to the ecological benefits, the remediation of mining areas opens opportunities for their further reclamation and economic use, such as agriculture, forestry, or the development of tourism potential.

In line with sustainable development requirements, some companies in the Republic of Serbia are exploring the possibilities of recycling mining waste. Initial results show that the application of the circular economy is feasible, but additional support through incentives and favorable loans is needed.

Guidelines aimed at eliminating or minimizing the negative impacts of the exploitation of mineral deposits on the quality of the environment

To eliminate or minimize the negative impacts of mineral resource exploitation on environmental quality, certain guidelines are recommended. The application of sustainability principles is crucial as it allows for the integration of sustainable practices in all stages of mining activities, from exploration to mine closure. The use of the BAT can reduce pollution and increase efficiency. The process of strategic impact assessment and environmental impact assessment must be conducted before approving mining projects, with the involvement of the local community and relevant stakeholders in the decision-making process.

The implementation of a system for secure management of mining waste and pollution prevention must be a priority, along with the promotion of recycling and reuse of materials. Land reclamation and remediation after the completion of mining activities involve rehabilitating degraded areas. Continuous monitoring of air, water, and soil quality during and after mining activities, along with transparent reporting on environmental impacts and the measures taken to reduce them, are also important activities for reducing the negative impacts of mineral resource exploitation on environmental quality.

The implementation of environmental protection guidelines and sustainable mining requires the integration of various approaches and technologies, in line with the Best Available Techniques (BAT) and Best Available Reference Documents (BREF) standards and regulations of the European Union, along with the application of domestic regulations harmonized with EU directives. The following measures represent specific steps that mining companies and relevant institutions must take to ensure sustainable management of mineral resources with minimal negative impacts on the environment:

1. Conducting the Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and Issuance of the Integrated Permit and consideration of the acceptance assessment

1. In accordance with the Law on Strategic Environmental Assessment, before any mining activity is permitted, a Strategic Environmental Assessment must be conducted for all strategies, plans, and programs in the field of mining. In line with the Law on Environmental Impact Assessment, projects in the mining sector are required to undergo an Environmental Impact Assessment.
2. При изради Стратешке процене утицаја на животну средину и Процене утицаја на животну средину, у складу са наведеним законима, обавезно се спроводи учешће заинтересованих органа и организација и јавности и спровођење прекограничних консултација (пре давања Сагласности на Извештај о стратешкој процени утицаја и Решење о сагласности на Студију о процени утицаја).

2. Water resources management

1. ***Reduction of Water Consumption***: Mining companies should implement technologies and practices that reduce water consumption. This includes water recycling and using less water in extraction and processing operations.
2. ***Water Pollution Control***: Implement strict measures to prevent the discharge of pollutants into water courses. This may include the construction of wastewater treatment facilities and continuous monitoring of water quality.

3. Waste management

1. ***Waste Minimization***: Implement technologies and procedures that reduce the amount of waste generated. This includes more efficient resource utilization and waste reduction at the source.
2. ***Safe Waste Disposal***: Ensure that mining waste is disposed of in a safe manner that minimizes the risk of soil and water contamination. This includes proper design and maintenance of waste disposal sites.
3. ***Recycling and Reuse***: Promote the recycling of mining waste and the reuse of secondary raw materials. This not only reduces the amount of waste generated but also decreases the need for new mining activities.

4. Air pollution control

1. ***Emission Reduction***: Implement technologies to reduce the emission of harmful gases and particulate matter into the atmosphere. This may include filtration systems, wet dust suppression, and technologies aimed at reducing greenhouse gas emissions.
2. ***Air Quality Monitoring***: Establish a continuous air quality monitoring system around mining facilities and in local communities to quickly identify and address potential pollution issues.

5. Protection of biodiversity

1. ***Habitat Conservation***: Plan mining activities to minimize the impact on natural habitats. This can include avoiding the exploitation of mineral deposits in environmentally sensitive areas and creating protected zones.
2. ***Ecosystem Restoration***: After the completion of mining activities, implement programs for ecosystem restoration. This includes returning the land to its original state and creating new habitats for endangered species.

6. Energy Efficiency and Use of Renewable Energy Sources

1. ***Increase Energy Efficiency***: Implement technologies that enhance the energy efficiency of mining facilities and processes. This includes the use of energy-efficient equipment and the optimization of operations.

2. ***Use of Renewable Energy Sources***: Promote the use of RES, such as solar and wind power, to reduce dependence on fossil fuels and decrease the carbon footprint.

7. Social responsibility and inclusivity

1. ***Involvement of Local Communities***: Actively involve local communities in the planning and implementation of mining projects. This includes employing local labor, investing in local infrastructure, and developing community initiatives.
2. ***Transparency and Accountability***: Ensure transparency at all stages of the mining process, including the availability of information on environmental impacts and social aspects. Companies should be accountable for their actions and regularly report on their progress in achieving sustainable goals.

8. Technological innovation

1. ***Implementation of Advanced Technologies***: Invest in the research and development of new technologies that can reduce the negative environmental impacts of mineral extraction. This includes automation, digitization, and the use of artificial intelligence to optimize mining operations.
2. ***Sharing Best Practices***: Encourage collaboration and the exchange of best practices between mining companies, research institutions, and government agencies to improve methods and approaches for sustainable mining.

2.10. Recommendations and Guidelines of the European Union Regarding the Policy for the Management of Mineral and Other Geological Resources

The EU guidelines for mineral policy and legislation define a framework that promotes entrepreneurship, innovation, and a sustainable value chain in the mining sector. Mineral policy generally defines the factors driving innovation throughout the entire mining value chain (i.e., exploration, opening, exploitation, processing, permits, cross-border exploitation, waste management, recycling, remediation, and mine closure), including recommendations for managing mineral resource policies and the recommended requirements for standardization and systematic reporting of mineral resource data in the EU.

The Good Practice Framework in EU countries has established a clear and informed approach to what can be considered good practice regarding: (1) innovation in mining in both the private and public sectors, and (2) mineral resource policy and management. This has resulted in a set of proposed good practice indicators, enabling access to sustainable development that encompasses all economic, social, and environmental dimensions. Also, the same framework includes criteria for: (*i*) resource security; (*ii*) economic sustainability; (*iii*) environmental sustainability; (*iv*) social responsibility; and (*v*) efficient management.

Geological exploration is the first step in the MRM acquisition chain, encompassing all processes related to the discovery and validation of mineral resources, i.e., commercially viable mineral concentrations for exploitation and preparation, and later processing of raw materials in the subsequent phase. Exploitation involves the opening of deposits for large-scale production with sustainable development throughout the mine's lifespan.

Exploitation, costs and productivity, the geology of the ore body (including inaccessible deposits, lower-quality raw materials, or morphologically and technologically complex ore bodies), legislation (e.g., environmental), and the health and safety of employees are key challenges for innovation in terms of requiring companies to follow innovations to remain competitive or meet changing societal expectations.

Proposals and recommendations for overcoming existing shortcomings in current national mineral resource policies in EU member states are:

- Develop a strategy for the management of non-energy solid mineral raw materials in each EU member state.
- Encourage and simplify the procedures for issuing permits for the exploration, exploitation, and processing of mineral resources and mineral reserves.
- Ensure the availability and secure supply of non-energy solid mineral raw materials.
- Improve social acceptance and public perception of mining.
- Better qualitative and quantitative characterization of mineral resources and ore reserves.
- Encourage and simplify the procedures for issuing permits for geological exploration and mining exploitation of solid mineral resources.
- Monitor and shape policies in other areas.

Decision-makers in mining must be aware of innovations in exploration and exploitation and their links with various other sectors of public (i.e., non-mining) policy, and they must have an active role in shaping them in such a way that the mining aspect is considered relevant. These policies should regulate data transparency, privacy and security, and educational and labor policies that potentially affect technological innovations in mining processes.

A holistic, comprehensive and well-performing approach to the mining sector requires a clear and consistent framework of mineral policy in the mining sector. The National Strategy for Mineral Resources can provide guidance to public institutions and stakeholders about the direction and expectations of the nation regarding the regulation of the mineral sector, while simultaneously addressing identified shortcomings in previous, more ad hoc, policy regimes. A key determinant of a strong mineral policy framework is the presence of a body with the responsibility and mandate to oversee and coordinate relevant ministries/departments/actors within the mineral policy. Thus, EU MIN-GUIDE data identified two key aspects for the strategic framework of mineral policy: a National Strategy for Mineral Resources and a Centralized Administration for Mineral Policy, with the presence of a body responsible for overseeing and coordinating relevant ministries/departments/stakeholders within the framework of mineral policy.

The characteristics of legal frameworks for various policies present a challenge to create a unified mineral policy. The prevailing challenges include: (1) the rationalization or integration of different policies to balance the weaknesses and strengths of various types of instruments; (2) the coordination of different public policy actors for their creation and implementation; and (3) the revision of policy instruments based on changing circumstances or new challenges that require more efficient arrangements in public administration.

The focus is on improving the framework conditions for mining. Generally, several factors hinder mineral resource exploration in the EU, including social and economic constraints and limited geological knowledge. The national policy framework and regulatory structure can either enable or hinder the development of mining operations. According to the European Innovation Partnership for Raw Materials, the key issues that determine the adequacy of mineral policy are related to:

- the level of implementation of existing mining policies;
- ecological regulation;
- duplication of regulations;
- uncertainty regarding the implementation of existing regulations.
- legal system;
- disputed land claims and socio-economic agreements;
- levels of taxation; and
- quality of infrastructure.

Very often, the legislative body and the implementing body are the same. Only in a few cases do the authorities responsible for policy creation and implementation differ. This aspect may point to the need for intersectoral coordination and cooperation regarding mineral policy.

The interconnected nature of the policies of the mineral sector and related sectors requires an integrated and holistic approach. It is necessary to achieve consistency between policies and cooperation among different parties and stakeholders.

Capital-intensive investments in the mining industry, the long initiation period, or the complex development of commodity markets require stable legal framework conditions and efficient public administration. In this regard, the procedures for issuing permits for licensing research and exploitation of mineral resources are of vital importance to the mining sector.

According to the conclusions from the Legal Framework for the Use of Mineral Resources and Permitting Procedures for Exploration and Exploitation in the EU (MINLEX) [32], there are several challenges faced by the permitting systems in EU member states.

The European Union has set high standards for environmental protection in the mineral production sector through a series of directives. In the context of the EU Green Deal, which aims to achieve climate neutrality by 2050, mining activities are particularly emphasized due to their role in securing raw materials needed for green technologies, such as energy storage batteries and renewable energy sources. However, it is essential to ensure that these activities are sustainable and that negative impacts on the environment and local communities are minimized.

Recommendations for improving existing policies and regulations include better implementation and monitoring of current regulations, promoting the use of renewable energy sources in mining operations, as well as introducing ecological compensation for biodiversity destruction. It is also important to increase local community participation in decision-making processes and ensure that their concerns are adequately addressed.

The United Nations (UN), the Economic and Social Council (ESC), and the Economic Commission for Europe (ECE) have published the United Nations Resource Management System (UNRMS) draft with principles and requirements for the management of mineral resources (Draft United Nations Resource Management System: Principles and Requirements /ENERGY/GE.3/2022/6) [33], which was adopted in 2022 and is based on the United Nations Framework Classification for Resources (UNFC) [34].

UNRMS is a comprehensive, sustainable resource management system that supports the achievement of the 2030 Agenda for Sustainable Development [35]. While resources are essential to support sustainable development, they must be produced and used sustainably and efficiently. UNRMS is a voluntary global standard for integrated resource management within partnerships between the public, public-private, and civil society sectors, which is uniformly applicable to all resources.

Sustainable resource management is defined as a synthesis of policies, strategies, regulations, investments, operations, and capabilities within partnerships between the public, public-private, and civil society sectors, based on ecological, socio-economic sustainability, and technical feasibility. That should determine what, when, and how resources are developed, produced, consumed, reused, and recycled by society.

Sustainable resource management using UNRMS is aimed at optimizing sustainable benefits for stakeholders in the triad of people-planet-prosperity. The approach emphasizes the interconnections between sectors and minimizes potential harmful impacts. For sustainable resource management to be holistic, i.e., aligned with the complexity of all resources, temporal and spatial dimensions, and life cycles, it should be based on principles that provide general guidelines on the direction of sustainable resource management.

The Initiative for Responsible Mining Assurance (IRMA) [36] is a response to the global demand for socially and environmentally responsible mineral extraction. IRMA offers an independent assessment according to the comprehensive IRMA standard for all produced materials, ensuring that a wide range of issues related to the impacts of mining are covered in one place. The standard provides the most extensive and stringent global definition of best practices for industrial-scale mineral extraction and, in the context of legal regulations, sets a higher benchmark than the laws of any country. Voluntary performance standards to which mining companies can commit serve as an important complement to existing laws and regulations. It represents a set of guidelines aimed at promoting the implementation of responsible practices in mining, or responsible mining [37]. These guidelines cover aspects such as environmental protection, human rights, and community engagement. Although the IRMA standard is not directly EU regulation, it aligns with broader EU objectives in the areas of ethical supply chains and environmental protection.

The IRMA standard aims to specify performance levels so that it can be expected that a mineral resource exploration project, mining development, or mineral processing operation that operates according to best practices will comply with the specified requirements of each chapter. The performance of a project that has not yet developed best practices can be measured against its current status.

2.11. Global Trends in the Management of Mineral and Other Geological Resources

The requirements of sustainable development depend on the optimal and responsible production and use of natural resources. However, the sustainable use of resources today faces countless challenges. These challenges include economic aspects such as market instability, the need for responsible investments, the avoidance of unexpected revenues, and ensuring that no one is left behind in development. Social impacts should be appropriately assessed and explained at a satisfactory level for society, following all objectives set by the commitments specified by the UN Climate Change Conference. This must be done in an environment of geopolitical conflicts and many uncertainties.

Decisions regarding resource management have historically been made on a project-by-project or sector-by-sector basis, typically by a single government entity and the companies involved in the respective sectors. This fragmented approach has been significantly limited, lacking a broader perspective and often involving a narrow range of knowledge and viewpoints to support informed decision-making. The limitations of isolated management practices are becoming increasingly evident, leading to conflicts, delays, and substantial losses of natural capital. The world needs to shift from fragmented processes to more integrated approaches in how it plans and manages resources.

Integrated resource management is key to overcoming the challenges mentioned above. UNRMS embraces the critical concept of integrated resource management, which takes into account complexity, multiple dimensions, and competing interests to support informed decision-making. Sustainable resource management begins with an understanding of the world’s natural capital and natural resources, including the efforts required to enhance and utilize them, and how these resources are connected to societal needs. Natural capital is the world's supply of natural resources. Includes various components such as water, geology, energy, biodiversity, land, the ozone layer, and attributes such as ecological resilience, ecosystem health, and integrity.

Many countries, in line with current trends and developments in the exploration and exploitation of mineral resources, particularly those related to CRMs, have adapted their legal frameworks and developed new strategies for MRM.

Mineral resources are non-renewable, exhaustible, and of essential importance for economic development, industry, addressing social issues, and other areas of society. A fundamental prerequisite for the exploitation and processing of mineral raw materials is compliance with all environmental standards. Through environmentally responsible operations and monitoring and oversight by competent authorities, the negative effects of mineral resource utilization can be minimized.

Mineral resource management strategies, exploration programs, as well as various data on mineral raw materials of interest, are relevant at both the national and global levels, as mineral raw materials are freely traded commodities. They are particularly important for communities at the regional and local levels, which are directly affected by mining activities or host mining companies operating in their area.

According to the document, ***Critical Minerals Market Review 2023*** from the International Energy Agency (IEA) [38], the global economy's demand for mineral raw materials is continuously increasing, necessitating appropriate changes in the development of mineral resource management strategies during the energy transition. In the period from 2017 to 2022, the energy sector's demand for lithium tripled, while the demand for cobalt increased by 70% and for nickel by 40%. The record deployment of clean energy technologies is driving a growing market demand for CRMs. Total investments in the development of critical minerals recorded a 30% increase in 2022, following a 20% increase in 2021.

The pace of energy transitions is directly linked to the availability of resources and reserves of CRMs. There is growing recognition of the need for political interventions to ensure adequate and sustainable supplies of CRMs, and the expansion of such initiatives includes the adoption of appropriate laws and strategies worldwide.

To adequately assess the approach to the development, definition of measures, and activities, a brief overview of several key national strategic documents is provided.

In 2017, the Council of Ministers of **Poland** adopted a new medium-term national development strategy - the *Strategy for Responsible Development for the period up to 2020 with a perspective until 2030* [39]. This is a binding and key document that defines the main directions of Poland's development in the area of medium and long-term economic policy, which includes, among other things, the management of mineral resources.

The National Raw Materials Policy [40] is directly linked to the *Energy Policy of Poland until 2040* [41], as well as the *National Environmental Policy 2030* – the development strategy in the area of the environment and water management [42]. The main objective of the measures planned within these policies is to ensure the current and future needs of the country and to continuously expand the mineral resource base for raw material production (including raw materials for energy security), as well as to intensify exploration, research, and management of geothermal systems and supportive measures related to the use of clean coal technologies. Achieving the intended goals can be ensured through appropriate legal and administrative changes that facilitate and support exploration and extraction activities. Effective and comprehensive protection of mineral deposits, which enables access to already documented deposits, and the direct involvement of the entity acting as the Polish Geological Survey in activities related to the development of new technologies for the exploration, documentation, and use of mineral deposit resources for raw material production, is also of great importance.

The implementation of the assumptions outlined in the National Raw Materials Policy is also influenced by the activities of geological and mining companies, whose operations in the field of exploration and exploitation of minerals directly contribute to achieving the main goal, namely the widely understood raw materials security of the state.

Finland is a global leader in the sustainable use of mineral resources, and the mineral sector is one of the key pillars of the Finnish national economy. Global changes in the mineral sector present significant opportunities for Finland, which has important known deposits of many critical metals and minerals and significant potential for discovering new resources. *Finland's Minerals Strategy* [43] states that effective management and sustainable use of mineral resources ensures long-term raw material supply at the national level, creating conditions for stable regional development far into the future. The mineral sector also includes companies that produce machinery, equipment, technology, and services necessary for extraction and other mining needs.

Three strategic objectives and 12 action proposals have been defined, relating to four different themes to facilitate the implementation of the strategic vision for minerals. The mineral sector is already well positioned to serve as a platform for a sustainable and diverse export-oriented industry based on the refinement and value-added processing of mineral products, along with related technologies and services. However, this is only possible by providing an optimal legislative framework and business environment for this sector. Therefore, this vision for the minerals strategy is based on promoting the enhancement of knowledge and skills, along with research and development of innovations, as the foundation for sustained and sustainable growth in the sector.

The **Swedish** Mineral Strategy was developed by the Government with the help of the Geological Survey of Sweden [44] and through extensive dialogue and cooperation with stakeholders at the local, regional, and national levels who contribute to and are affected by the activities of the mining and mineral industry. The approaches highlighted in the mineral strategy were identified based on the contributions of stakeholders and the government's overall assessments of which measures are important for achieving the objectives and vision of the strategy.

It is anticipated that this mineral strategy will increase the competitiveness of Sweden's mining and mineral industry so that Sweden retains and strengthens its position as a leading mining country in the EU. Sweden's mineral resources should be exploited in a long-term sustainable manner, respecting ecological, social, and cultural dimensions, so that the natural and cultural environment is preserved and developed. The mineral strategy addresses non-energy minerals for industrial purposes. The term 'mining and mineral industry' refers to companies that produce ores for metal extraction, aggregates, industrial minerals, and natural stone.

The strategy aims to highlight opportunities and challenges, create prerequisites, clarify roles, and identify synergies that can be achieved through cooperation. The vision is permanent, but the strategy can be updated according to changing circumstances. In the mineral strategy, the government identifies five strategic goals that are considered of particular importance for achieving the vision of the strategy. Within these five strategic goals, there are eleven areas of action with a set of objectives and measures.

2.12. Management of Mineral Resources, Groundwater, and Geothermal Resources in the Republic of Serbia in Existing Conditions

The Strategy for the Management of Mineral and Other Geological Resources of the Republic of Serbia (hereinafter referred to as the Strategy) defines in more detail the instruments, measures, and activities needed to achieve the long-term sustainable development goals in the mining sector and attract investments, apply global standards in environmental management and supervision, as well as strengthen the cooperation between mining companies and local communities. The Strategy aims to contribute to solving issues related to the definition of long-term development goals for mining and geological exploration of mineral and other geological resources, projections of needs for all types of mineral raw materials and other resources, the development of the mining and geological exploration sectors, as well as issues related to the

projection of imports and exports of all types of mineral raw materials in the Republic of Serbia. All the previously mentioned includes following economic, environmental, and social aspects. The Ministry of Mining and Energy is responsible for preparing, implementing, and monitoring the mineral policy and plans for the development of geological research in the Republic of Serbia, as well as the resources and exploitation of deposits, under the Strategy, adopted by the National Assembly upon the proposal of the Government. The strategy shall be adopted for at least 10 years.

In the Republic of Serbia, the previous version of the Strategy until 2030 was adopted by the Government in 2012. The National Assembly of the Republic of Serbia has not considered this strategy. In the area of geological research, a draft Long-Term Program for the Development of BGE has been prepared. In the field of surface coal mining, a new long-term exploitation plan for the Kostolac and Kolubara coal basins must be adopted, as well as a long-term copper exploitation program within the Bor and Majdanpek mining basins. In 2016, the Government of the Republic of Serbia adopted the Water Management Strategy for the territory of the Republic of Serbia until 2034. The implementation of mineral resource management today is carried out through the Mining and Geological Exploration Law and a series of subordinate regulations

Article 53 of the Mining and Geological Exploration Law, defines that the Geological Survey prepares the Balance of Resources and Reserves of Mineral Raw Materials, the Balance of Resources and Reserves of Underground Waters, and the Balance of Geothermal Resources in the Republic of Serbia, based on the obtained data - books on the status of resources and reserves of MRM, resources and reserves of underground waters, as well as geothermal resources held by exploration and exploitation entities, and holders of exploitation space approvals. The Ministry is responsible for issuing certificates of balance reserves of MRM, confirmed and verified by the competent commission or working group, as well as previously prepared balances and Reports on resources and reserves.

For more efficient collection, processing, archiving, searching, and distribution of geological data and information, and to simplify and improve access to geological data and information on reserves and resources in the Republic of Serbia, which are necessary for the implementation of mineral policies, monitoring, control, and recording of geological research and the exploitation of MRM, underground waters, and geothermal resources, the Ministry of Mining and Energy manages various information systems.

In the use of groundwater, the greatest attention is focused on solving problems related to the quantity and quality of groundwater.

PEST and SWOT analysis

For the analysis of different impacts on Strategy, PEST (Political, Economic, Social, and Technological) and SWOT (Strengths, Weaknesses, Opportunities, and Threats) methods were used. These methods are commonly employed for situational analysis when developing different strategic documents.

PEST Analysis

PEST analysis is a method for analyzing the business environment and serves as the foundation for strategic planning. The basis consists of the environment in the domain of the mentioned aspects of analysis, which can have an impact on the production of mineral resources. PEST analysis is compatible with SWOT analysis, and its results serve to identify threats and opportunities from the environment in the SWOT analysis. The average score of all aspects of the PEST analysis represents a quantified impact on strategic development.

Political factors

The policy of the state has a significant impact on the development of the mineral resources sector and relates primarily to the following aspects:

- **Strategic framework.** Overall, it is clear that the strategic framework is not fully established, particularly concerning strategic documents related to economic development and the management of mineral and other geological resources.
- **Legal framework**. The legal framework remains incomplete - the existing Law on Mining and Geological Exploration requires improvement and innovation in certain areas, primarily to better protect the interests of the Republic of Serbia and should be supplemented by the adoption of accompanying by-laws.
- **Strategic approach to non-renewable minerals and other resources**, whether in the context of geological exploration, exploitation, or the status of MRM abundant in the Republic of Serbia (such as lignite, copper, lithium, etc.), especially in comparison to other natural resources, with particular attention required for strategic and critical mineral raw materials.
- **The institutional framework** is relatively defined, with a service-oriented focus (procedures related to obtaining approvals and permits, responsibilities, and decision-making hierarchy within the mineral and other resource sectors).
- **Inefficient employment** practices in state-owned mines.
- **Insufficient application of the valorization of technogenic mineral raw materials and the principles of the circular economy**.
- **Strategic long-term exploration** aimed at increasing reserves of mineral and other geological resources.
- **Obligations arising from the EU accession negotiations.**
- **The relationship between some NGOs and political organizations** towards resource exploration and mineral raw material exploitation.
- **International political relations,** i.e., relations with other countries.
- **Security of raw material supply**.

Economic factors

A stable economy significantly influences the development potential of minerals and other geological resources. In this context, the major challenges considered were:

- **Stability of the domestic currency** (Serbian dinar) against the euro and the dollar.
- **Credit and interest rate policy.**
- **The investment potential** of the country is limited.
- **Incomplete restructuring and reorganization.**
- **Inadequate system for the valuation** of mineral and other geological resources that are not subject to the stock exchange.
- **Geostrategic issues and significant price fluctuations**, primarily of energy sources but also of mineral raw materials (it is positive that the prices of copper, lithium, cobalt, tungsten, and other critical mineral resources are projected to rise significantly).
- **The price of mineral raw materials on the global market** mostly fluctuates under the influence of various factors.

Sociological factors

For a long period, sociological impacts on the mining sector have been growing year by year. Based on a detailed analysis, the following can be especially emphasized:

- **Public awareness** of the importance of mineral and other resources for both energy stability and overall economic development of the country, alongside a noticeable lack of education.

- **Transparency** of Programs and Projects.
- **The economic crisis and the crisis of critical mineral resources**, in the context of the need for accelerated economic development, may lead to unsustainable pressure on mineral resources.
- **Demographic movements due to the exploitation of minerals and other resources.**
- **Disrupted balance between rural and urban areas**.
- **Lack of expertise** in the economic, ecological, and sociological valorization of mineral resources.
- **Organizing activities for training** to acquire new knowledge in related fields to mining.

Technological factors

The aspects of the technical and technological components are of particular importance for the further directions of research and exploitation. This aspect is currently crucial in the context of exploitation in mines that are state-owned, while the situation in large mining complexes where the Republic of Serbia has ownership stakes or where they are privately owned has significantly improved. The main challenges from this aspect are:

- **Investment in geological research and production capacities**, both in terms of equipment and deposits.
- **The implementation of modern technical solutions** in mining and ore processing.
- **The application of scientific knowledge and best practices**.
- **Control of pollution and exploitation of groundwater**.
- **Ensuring health and safety** during exploration and exploitation.
- **Employment of professional staff and implementation of modern technical solutions in private mines**, especially in open-pit mines of non-metals.
- **Application of modern technologies and equipment in geological research**.

SWOT Analysis

SWOT analysis is a widely accepted analytical tool used to define internal and external factors that may be important for the implementation of strategic plans. It is based on identifying factors of strengths (advantages), weaknesses (disadvantages), opportunities for progress, and threats (risks) in determining the framework and possible directions for strategic decision-making. The analysis process goes from the inside, analyzing strengths and weaknesses, to the outside, analyzing opportunities and threats. A well-defined SWOT analysis determines the current situation and provides clear guidelines for the future position. The average rating of all aspects of the SWOT analysis represents the quantified impact on strategic development.

Strength

The identified aspects of this component of the SWOT analysis are:

- **Significant geological potential** of mineral and other geological resources (coal, copper, lithium, nickel, lead, zinc, molybdenum, antimony, magnesite, phosphates, fluorite, and non-metallic minerals for the construction industry, groundwater, etc.);
- **Favorable geostrategic position** of the country.
- **Improved institutional and legislative framework.**
- **A strong foundation of highly skilled professionals.**
- **Receptiveness to investment opportunities and capital inflows**, coupled with strong interest from potential investors.
- **New investments** - development of related industries, creation of new jobs, and improvement in living standards.

- **Government commitment to improving the state** of mineral and other resource exploration and exploitation
- **Comparative advantages of domestic energy mineral resources** related to other energy sources, both imported and renewable.

Weaknesses

The identified aspects of this component of the SWOT analysis are:

- **Planning documents**.
- **Mechanisms for resolving conflicts** of public interest and property rights.
- **Financial investments.**
- **Public awareness** of the importance of mineral resources for economic development, both at the local and national levels.
- **Environmental protection processes, reclamation, and occupational health and safety.**
- **Adverse relationship between NGOs and environmental associations** towards mining.

Opportunities

The identified aspects of this component of the SWOT analysis are:

- **Potential for obtaining high-value processed products from metallic mineral resources**.
- **Potential for substituting the total import** of mineral products, as well as significant opportunities for the export of final products derived from certain mineral resources.
- **Potential for reliable supply of thermal power generation capacities** with coal.
- **Secure and cost-effective source of energy**.
- **Independence of the state in energy supply, as well as in securing certain highly important mineral resources** in the future (lithium, copper, nickel, antimony, molybdenum, certain rare metals, etc.).
- **Attraction of foreign capital** from the mining and energy sectors for investment purposes, including investment funds.
- **Economic development of the state**.
- **Positioning the state as a significant producer of electricity and certain mineral resources**, in the regional and EU markets.
- **Strengthening the local economy and promoting more balanced economic development**, considering the geographical distribution of mineral resources and raw materials.
- **Development and implementation of modern technologies** in the field of sustainable mining.
- **Increase the economic potential of mineral resources and raw materials**.
- **Improvement of energy efficiency** in the mining sector.
- **Enhancement of cooperation with local communities**.
- **Implementation of environmental protection measures**.
- **Implementation of occupational health and safety measures**.
- **Execution of programs related to secondary mineral resources and the circular economy**.

Threats

The identified aspects of this component of the SWOT analysis are:

- **Risk of increased pressure on mineral resources** driven by the need for accelerated economic development.
- **Risk related to restructuring and privatization** approaches for certain state-owned and public mining companies.

- **Risk related to the approach and method of granting concessions** for certain mineral resources, both at the level of geological exploration and exploitation.
- **Presence of activities leading to environmental degradation**.
- **Excessive expectations** regarding the efficiency of public administration.
- I**ncompatibility between legal regulations** in the fields of mining and geological exploration, environmental protection, water, and land management.
- **Decreased investments in geological exploration and the mining sector** due to global economic crises;
- **Decline in mineral raw material production.**

The summary of the SWOT analysis, as the average impact assessment of all aspects for each component, is presented in Table 2.12.

Table 2.12. Average score of SWOT analysis

SWOT Component	Average Score
Strength	7,6
Weaknesses	- 6,2
Opportunities	7,2
Threats	-6,5

The results of the SWOT components range from 6.2 to 7.6, which, according to the evaluation scale, correspond to a 'good' rating for strengths and opportunities which indicates a stimulating influence on future development. Conversely, weaknesses and threats fall within the 'insufficient' rating category and may have a discouraging effect on corporate development.

Defining Strategic Frameworks

The **Strengths (S)** component received a score of **7.6**, which falls within the "good" rating domain, indicating that its overall impact is considered stimulative for future development. It is important to emphasize that special attention needs to be given to strengthening professional skills, which have the lowest score of 5. The remaining two aspects, which are rated at 7, also have room for improvement, particularly concerning enhancing the institutional framework.

The **Weaknesses (W)** component received a score of **6.2**, which falls within the "insufficient" rating domain, indicating that its overall impact is considered inadequate for future development. This suggests that the identified weaknesses may have a demotivating effect on growth, while simultaneously representing potential that could be transformed into strengths. Therefore, efforts should be made in the upcoming period to address and improve the aspects rated above 6, particularly focusing on public awareness, environmental protection processes, reclamation, and workplace safety and health, with special emphasis on the relationship between NGOs, environmental movements, and the mining industry.

The **Opportunities (O)** component received a score of **7.2**, which falls within the "good" rating domain, indicating that its overall impact is considered stimulatory for future development. It is important to leverage the stimulatory influence of these growth opportunities, monitor trends in the surrounding environment, and utilize the organization's influence on the environment to improve opportunities or, at the very least, maintain them at the existing level. Special attention should be given to the aspects rated below 6, as their potential can be significantly utilized through appropriate strategic actions.

The **Threats (T)** component received a score of **6.5**, which falls within the "insufficient" rating domain, indicating that its overall impact is considered insufficient for future development. This means that the identified threats could have a de-stimulatory effect on development. It is essential to continuously and maximally utilize influence to reduce these threats.

3. Vision

The Strategy for the Management of Mineral and Other Geological Resources is a strategic document based on which the Government of the Republic of Serbia defines the policy for geological exploration and exploitation of minerals and other geological resources. The establishment of the Strategy provides a foundation for further action and is implemented across relevant policy areas to achieve the set objectives. The Strategy should highlight opportunities and challenges, create preconditions, clarify roles, and identify synergies that can be achieved through cooperation. The vision is long-term, yet continuously innovated through a transparent resource management process and updated to reflect changing circumstances.

The global increase in the consumption of raw materials and other resources, along with growing environmental challenges, offers significant potential for business activities promoting the sustainable use of mineral raw materials and other resources. The sustainable growth of the mining industry in Serbia creates a favorable environment for achieving technological leadership across the entire industrial sector. In this context, the defined national policy for the development of sustainable mining, through the rationalization of existing production and the opening of new mines, should be aligned with other national policies.

The Republic of Serbia should take a proactive role in implementing the principles of sustainable development in the mining and processing sectors. Mining and processing activities should be aligned with established EU guidelines and best practices, conducted responsibly toward society, and according to the state's right to responsibly and inclusively manage its mineral and other natural resources.

Sustainable growth in the production of MRM in the Republic of Serbia represents a significant step toward achieving these goals, while also gaining practical experience in implementing a sustainable mining strategy.

The long-term objective of the Strategy for the Management of Mineral and Other Geological Resources is to develop an active, globally competitive geological and mining sector that ensures a stable supply of raw materials, supports regional development, promotes the responsible use of natural resources, and continuously enhances the key competencies and capacities of its workforce. The mining sector exerts a significant direct and indirect impact on the national economy, employment, and society.

A well-structured mining sector can serve as a platform for a sustainable and diversified export-oriented industry, based on increasing the value of mineral products and related technologies and services. Among others, ***the vision for mining in the Republic of Serbia includes achieving the highest possible level of final processing of products derived from its mineral resources***. However, this is only feasible by ensuring an optimal, service-oriented legislative framework for mineral resource management and a favorable business environment for the mining sector. ***This vision of the Strategy is grounded in the enhancement of knowledge and skills, combined with research, innovation development, and the adoption of international best practices, underpinned by a societal consensus as the foundation for sustainable growth in the mining sector.***

The development of the mining sector requires proactive support and commitment from the government and other relevant public authorities to create a business environment conducive to long-term investment. A positive attitude and approach are essential for the environmentally and socially sustainable use of natural resources, as well as appropriate support for the educational system, and for regulatory and administrative reforms. The mining sector in the Republic of Serbia is expanding and rapidly diversifying, playing an important role in supplying raw materials both for the country and for the EU.

The key challenge in modern mining and industry is the integration of the mineral resource management strategy and the environmental protection strategy. These strategies are typically aligned to achieve sustainable development, which involves the efficient utilization of mineral resources with minimal environmental impact and maximum protection of the environment. A holistic approach encompasses the ***integration of goals***, ***application of best practices***, ***social responsibility***, ***innovation and technological advancement***, and ***legal regulation and oversight***.

Mining activities have a direct impact on regional economies by generating income through employment, demand for local subcontractors, and various business services. Additionally, all levels of revenue increase, including corporate income taxes, municipal taxes paid by new residents, taxes related to increased consumption, value-added tax (VAT), etc. According to various estimates, for every job directly created by mining activity, three to four additional jobs are generated indirectly. Mining generally leads to the diversification of regional business activities and can positively affect other sectors through improved services, transportation links, and broader infrastructure development. In the long term, growth and diversification in the mining sector can only be sustained by discovering new deposits of raw materials. This requires continuous commitment to exploration, as it typically takes 15 to 20 years from the start of exploration to the opening of a new mine.

The Republic of Serbia has traditionally offered a favorable business environment for exploration and mining activities. In addition to its diverse mineral potential, Serbia possesses a well-developed infrastructure and a stable working environment. Therefore, the executive government of the Republic of Serbia should actively promote mining activities and their strategic importance for national development, especially for the development of local communities. However, increasing concerns in the mining sector include growing land use restrictions, more complex legislation, and lengthier permitting processes. Efforts must continue to ensure, through laws and other legal instruments, a competitive operating environment for exploration and to enable sustained investment in the mining sector.

The mining industry in the Republic of Serbia is one of the few industrial sectors currently attracting significant foreign investment. Exploration is inherently a high-risk activity, and the opening of a mine requires substantial capital investment. To maintain long-term growth, it is necessary to further improve financing mechanisms that support the development of the mining sector. Contributions to high-risk investments by institutional investors and the government, either through direct ownership or as creditors, are important, as they can effectively accelerate mining and exploration projects. An additional goal should also be the gradual increase of state ownership in the mining sector. In recent years, the government has begun to provide support for infrastructure investments in mining projects, and such support should continue in the future.

Competition for land use and related conflicts of interest, as well as access restrictions, are becoming an increasing challenge for all forms of mining activity. Mines in certain areas need to adapt to competing interests related to environmental protection and tourism. However, the land area required for mining operations is typically relatively small, and the release of potentially harmful emissions from modern mines has been significantly reduced. Mining and tourism, for instance, can also offer mutual benefits, such as improved services and transportation links. It should also be emphasized that jobs in the mining industry are permanent and long-term in nature.

Although mining operations can continue for decades, legislation should require investors to include a fully funded strategy for environmentally adequate mine closure and post-closure monitoring as part of the mine development process. It is important to consult and involve the local population during the key stages of the mining project’s development to establish appropriate procedures for compensation and preparation for any issues that may arise in local communities due to mine closure.

Vision - ***By 2040, and with a long-term outlook to 2050, the Republic of Serbia will be an institutionally and economically developed country committed to the sustainable use of mineral resources. The mineral resource complex of the Republic of Serbia is one of the pillars of the national economy, aligned with EU standards, with a knowledge-based mineral sector that ensures the efficient use of resources while minimizing environmental impacts. The goal is for the majority of extracted raw materials to be processed within Serbia, including the final stages of production.***

This vision stems from the strategic objectives of sustainable development, based on a thorough analysis of the geological potential of the Republic of Serbia, as well as the conditions and constraints under which development goals are pursued. The realization of this vision is possible through the consistent implementation of fundamental, strategic, and coherent objectives that are based on the needs of the citizens of the Republic of Serbia to achieve a higher quality of life and better living standards while respecting all environmental standards. Social consensus implies that all levels of government recognize and take their role in the realization of this vision and that all stakeholders influence state institutions to implement the main strategic development goals through the exploitation of mineral resources with maximum environmental protection and the safeguarding of human health and safety.

Aligned with this vision, the Strategy determines the priorities and sustainable development goals of the mineral sector. To achieve these, the Strategy proposes development tools and activity programs. The strategic goals and proposed measures, along with their respective programs, are presented in the following chapters.

4. Required Development of the Mining and Geology Sector for the Period up to 2040, with Projections until 2050

Coal - The development of the solid energy mineral resources sector by 2040, with projections to 2050, will largely depend on geopolitical conditions and the implementation of two potential energy development scenarios for the Republic of Serbia. According to the Energy Development Strategy of the Republic of Serbia until 2040, with projections to 2050, two possible energy development scenarios for the Republic of Serbia have been thoroughly analyzed, focusing on the coal sector. The implementation of Scenario S, which is being carried out by the Government of the Republic of Serbia, represents changes in the intensity and structure of energy production and consumption. All measures and activities proposed by this scenario aim to transform the energy sector. A gradual reduction in production is planned in line with the closure of old blocks and the reduction of coal's share in total energy production, according to decarbonization policy. By 2040, coal production is expected to decrease to about 25 million tons, and coal's share in electricity production will be phased out by 2050. The implementation of this scenario will lead the Republic of Serbia into an energy-dependent state with high import reliance. Considering that the energy transition process involves some uncertainty, as well as the intermittency and stochastic availability of certain renewable energy sources, the remaining coal reserves should be treated with strategic importance. It is necessary to secure funds for the preventive excavation of overburden, for slope stabilization, and for coal exploration. The discovered coal could serve as a strategic reserve that would allow for the rapid resumption of production in crises.

Oil and Gas - The Republic of Serbia is an energy-import-dependent country in the oil sector, with a relatively low share of domestic oil and gas production in the total demand. In the coming period, the main activities in the oil exploration and production subsector will focus on mitigating the decline in crude oil production. Domestic crude oil production reached its peak level in 2013, after which it has been experiencing a constant natural decline. So far, there have been no significant discoveries of larger new reserves. Production is maintained by increasing

the number of development wells in existing fields and through supplementary methods on existing wells. It is planned to partially offset the production decline through discoveries in new reserves. In this regard, the implementation of new exploration projects will continue, while the reconstruction and modernization of production systems will increase their energy efficiency.

One of the potential solutions for reducing import dependency is the use of oil shale for oil production. To fully assess this potential, it is essential to undertake all necessary activities to comprehensively evaluate the geological, mining, processing, and economic aspects of their exploitation and processing, with particular attention to analyzing the environmental impacts.

The Republic of Serbia is an energy-import-dependent country in the natural gas sector. In recent years, there have been no significant discoveries of new natural gas fields, and most gas fields are in the final stages of exploitation, with domestic natural gas production declining.

Metallic raw materials - The production of metallic raw materials in the Republic of Serbia by 2050 will largely depend on the production levels of companies within the Zijin Mining Group. Within the Zijin Mining Group, copper ore exploitation is carried out at five open-pit mines and two underground mines.

From the active producers of lead and zinc ores, Grot and Veliki Majdan mines are nearing the depletion of their reserves (with reserves available for a limited production lifespan), while other mines have limited reserves for a slightly longer exploitation period (e.g., Rudnik). At this point, the Karamanica is the only new mine that is planned. This mine is in a stage of the design and environmental impact study phase, with an expected annual production of 240,000 tons of lead, zinc, and copper. The established balance of ore reserves is approximately 3.3 million tons.

The Jadar deposit (the mineral jadarite) contains high-quality mineralization of boron and lithium. A report on reserves has been accepted, and a certificate of balance reserves and lithium resources in the Jadar deposit near Loznica (lower Jadarite horizont) has been issued, totaling 158 million tons. If exploitation proceeds (pending the fulfillment of all conditions set in the Environmental Impact Assessment), the Feasibility Study suggests the possibility of producing 58,000 tons of lithium carbonate, 160,000 tons of boric acid, and 255,000 tons of sodium sulfate annually.

Gold ore exploration is ongoing in the Zagubica and Rogozna regions. There is potential for exploitation if all environmental protection requirements are met.

Strategic mineral resources – Strategically important metallic raw materials of Serbia include copper, gold, lead, zinc, silver, and lithium. Their development in the period up to 2040, with projections until 2050, involves a series of activities aimed at increasing the total quantities of these strategically important mineral resources, reliably assessing their current quantities, quality, and opportunities for economic valorization.

Other metallic raw materials - Other metallic mineral resources in the territory of the Republic of Serbia include molybdenum, iron, manganese, tin, mercury, and chromium. The development of their sector until 2040, with projections until 2050, depends on the mineral potential of Serbia's terrain regarding their established and inferred presence.

Molybdenum. In the territory of the Republic of Serbia, several molybdenum ore occurrences are known, as well as one established mineral deposit – Mackatica near Surdulica. There is potential for discovering new molybdenum ore concentrations around Mackatica, in the contact aureole of the Boranja granitic complex, in the contact-metamorphic aureole of the central Kopaonik granitoids, as well as in porphyry copper deposits.

Iron. In the Republic of Serbia, there are no known iron ore deposits capable of ensuring long-term, economically viable exploitation and meeting the country’s total needs over an extended period, both in terms of ore quantity and quality. However, from several deposits, smaller

quantities of ore may be extracted, although the quality is inferior to imported ore. There are also large iron deposits (such as Mokra Gora) that could potentially meet national demand, but their quality is low, and there are associated environmental issues. Exploration of other deposits is justified if they are considered raw materials that could meet the needs of the country's metallurgical capacities under emergency conditions and for shorter periods.

Manganese. In the Republic of Serbia, there are several small manganese deposits of various ore types. Some of these were thoroughly explored in the past and partially exploited. The most significant work has been carried out in the mining areas of Draca, Draznja, Dreznik, Svrackovo, Laznica, and Novo Brdo. Potential areas for discovering new mineral deposits include the area between Priboj and Tutin, the Rzav region, Sumadija, and others. Defining the mineral potential of manganese requires systematic geological exploration and technological testing.

Tin. Despite local ore occurrences of cassiterite and smaller mineral deposits of various types, tin has not yet been exploited in the Republic of Serbia. Overall, based on the current level of exploration, the mineral resources of tin are limited and insufficient to meet the needs of the domestic economy over an extended period.

Mercury. The mineral resources of mercury are not economically significant due to environmental restrictions, small quantities, and relatively low concentrations.

Chromium. The mineral resources of chromium are limited. New chromium deposits could potentially be found in deeper parts of the massifs, primarily those relatively enriched in chromium and where larger bodies of chromite ore have already been identified.

The development of other metallic mineral raw materials in the period up to 2040, with projections until 2050, entails a series of activities aimed at increasing their total quantities, reliably assessing existing quantities, quality, and possibilities for economic valorisation. In areas where mineral deposits with preliminarily established quantities of mineral resources exist, it is necessary to undertake prospecting and preliminary geological exploration to evaluate the quantitative and qualitative characteristics of the inferred and indicated mineral resources and to convert the indicated resources into probable mineral reserves.

Critical mineral raw materials defined by the EU - This group of mineral raw materials includes: antimony, arsenic, bauxite, bismuth, gallium, germanium, hafnium, heavy rare earth elements, light rare earth elements, platinum group elements, scandium, strontium, tantalum, elemental titanium, tungsten, and vanadium, as well as copper, nickel, cobalt, and lithium. The mineral resources of copper, nickel, cobalt, and lithium have already been discussed above.

Antimony. The terrains of Western Serbia, despite the predominant exhaustion of known ore deposits, remain the most interesting regions for antimony mineralization. Significant quantities of antimony are also known in the Kopaonik region (Rajiceva Gora). The potential of antimony mineral resources of the jasperoide type is significant, though insufficiently studied. The conversion of mineral resources into ore reserves through the consideration and analysis of modifying factors is conditioned by significant investments in exploration.

Arsenic. There are no arsenic deposits in Serbia. It is found in the mineral deposits of other mineral raw materials, in economically insignificant concentrations.

Bauxite. The mineral potential of bauxite has not been fully studied and requires further research. The possibilities of finding economically significant mineral deposits are low to moderately high.

Bismuth. Potentially ore-bearing environments for finding bismuth include the granitic complex of Cer Mountain, the skarn zones of Reskovica, Kopaonik, Boranja, Golija, and Rudnik, as well as environments with hydrothermal-vein types of mineralization (Golija, Sijarinska Banja, Zaglavak, Rudnik, etc.). Further research is needed.

Gallium. The mineral gallium is not found in large quantities or high concentrations in explored deposits of base metals, as well as in certain coal and bauxite deposits. The prospects for its economic exploitation in larger quantities are small.

Germanium. High concentrations of germanium in the deposits that have been explored to date have not been found. It is possible to obtain it as an impurity during the exploitation and processing of deposits of base metals, and less frequently from certain coal deposits.

Hafnium is not found in high concentrations or quantities in the geological environments, rock complexes, and deposits of other mineral raw materials that have been analysed so far. The prospects for its economic exploitation in significant quantities are low.

Rare Earth Elements (REE) are known to be associated with uranium and in alluvial monazite deposits. Further research is required to more fully define the mineral potential.

Tantalum and Niobium have been identified in several locations in Serbia, but they have not been thoroughly explored. A more complete assessment of their mineral and raw material potential requires additional geological studies.

Titanium. The observed titanium ore occurrences to date are small. A potentially significant deposit is located at Zukovacka Reka near Knjazevac. Further exploration and a geological-economic evaluation are needed.

Tungsten. Potential areas for finding higher concentrations of tungsten are located near known ore occurrences and mineral deposits around Blagojev Kamen, on Golija Mountain, in Bresnica, and on Kopaonik Mountain. It is assumed that the quantities and contents of tungsten are not significant enough to ensure economic exploitation for an extended period.

Vanadium. The possibilities for finding significant quantities of vanadium in the terrains of the Republic of Serbia are low.

The development of the sector of critical mineral raw materials, which the EU has defined as deficient, until 2040 with projections until 2050, involves a series of strategic scientific-technical activities and investments in exploration. It is necessary to carry out prospecting and preliminary geological exploration to assess the quantitative and qualitative characteristics of the assumed and indicated mineral resources and to convert indicated resources into probable ore reserves.

Non-metallic raw materials – The construction industry is experiencing significant expansion in the Republic of Serbia, reflected in the construction of highways, high-speed railways, buildings, sports facilities, shopping centers, and even entire settlements. The development of industrial non-metallic raw materials in the period until 2040, with projections until 2050, involves a series of strategic activities aimed at increasing their total quantities, reliably assessing existing quantities, quality, and the potential for economic valorization.

Carbonate raw materials. Calcitic carbonate raw materials in the Republic of Serbia are relatively well- explored. Further explorations will be conducted as needed to verify quality and expand the raw material base. The valorization of dolomite as a chemical raw material requires quality checks, which poses a significant challenge for future research.

Sand and sandstone. The degree of exploration is high. Further explorations depend on the needs of the industry, the location of potential buyers, and processing plants.

Magnesite. The economic and political crisis has led to the suspension of exploration for new magnesite reserves, technological obsolescence of mining equipment, and the outflow of qualified staff due to poor material conditions. Considering the potential for increased production, adequate funds need to be allocated for geological exploration, as well as for new mining equipment and modernization of the mines.

Bentonites. The status of the bentonite raw material base is unsatisfactory. To fully valorize bentonite (excluding bentonite clays), it needs to be enriched and offered as a complete product assortment. A comprehensive assessment of the raw material base is necessary, with an emphasis on the quality of bentonite, considering the requirements and capacities of the market.

Refractory and ceramic clays. The Republic of Serbia has a significant raw material base of Kaolin and Kaolinitic clays. Based on the analysis of the existing raw material base of Kaolinitic clays, many deposits can be classified as prospective.

Zeolites. Several deposits of Zeolites (Zeolitic Tuffs) are known on the territory of the Republic of Serbia, as well as numerous occurrences. To expand the raw material base, it is necessary to explore prospective areas.

Groundwater resources – According to the Water Management Foundation of Serbia, the gross potential of groundwater resources in the territory of the Republic of Serbia is approximately 67 m^3/s and it is estimated that with the implementation of artificial recharge, this value could increase to 100 m^3/s. Compared to the current consumption, this amount significantly exceeds the water needs of the population and the economy in all areas of water usage. To develop exploration, exploitation, and protection of groundwater resources, it is necessary to:

- Conduct basic hydrogeological exploration to complete the coverage of the territory of the Republic of Serbia with the Basic Hydrogeological Map at a scale of 1:100,000.
- Expand the monitoring network to assess the quantitative and qualitative status of groundwater resources for all water bodies and carry out regular groundwater monitoring.
- Conduct research and analyses to assess possible hazards to the qualitative and quantitative status of groundwater.
- Protect groundwater resources from over-exploitation.
- Introduce a system for the "return" of used and treated water (both municipal and technological) into water bodies.
- Improve the quality and competence of the professional staff engaged in the exploitation and protection of groundwater, and in the protection from groundwater – recruiting Master's-level geology engineers specialized in hydrogeology for state institutions, local governments, public utility companies for water supply, mining operations, industries using groundwater in technological processes.
- Innovate laws and by-laws that create conditions for the sustainable use and protection of groundwater in compliance with EU regulations, etc.

Geothermal energy – The development of the geothermal energy sector involves investments in resource exploration and exploitation technology, alongside the simultaneous development of financial support mechanisms and affirmative legislation. In line with the priorities defined in the Green Agenda and the Energy Development Strategy of the Republic of Serbia until 2040, with projections up to 2050, it is necessary to increase the share of geothermal energy in the energy mix in a way that supports the sustainable use of resources with high efficiency and reliability. The foundation of such an approach entails a prior assessment of the geothermal potential of the territory of Serbia and the creation of the Geothermal Atlas of Serbia. In this way, the total geothermal potential would be valorized and a unique database would be formed, enabling planned and sustainable resource exploitation according to the growing energy needs, particularly in the building sector. Development should be directed towards the use of geothermal energy in district heating systems, both in existing heating plants and through the construction of new geothermal heating plants, as well as the development of new technologies for district cooling using underground waters. At the same time, development should focus on individual systems – geothermal heat pumps for heating and cooling buildings, which would not only increase energy efficiency but also reduce harmful gas emissions. One way to develop geothermal energy, especially in the context of producing heating and cooling energy in the

building sector, is to introduce a legal obligation to assess the geothermal potential of the location before issuing location permits for construction and to examine the possibility of utilizing renewable energy sources. It is essential to activate mechanisms for resource protection by improving legislation, specifically through the legal obligation to implement geothermal doublets, i.e., returning thermally used geothermal waters into the geological environment, ensuring stability and sustainability in exploitation. There is a need for synchronization between institutions and greater visibility - accessibility to existing geothermal research and achieved results, as well as the application of these results in the urban planning and energy sectors, both through legislative and planning documents and in specific projects of significance for the development of the Republic of Serbia. To achieve the full capacity of geothermal resource utilization, the development should also focus on building geothermal power plants and co-generation energy production. Following development trends in geothermal energy exploitation, investments should be directed towards research and development of innovative geothermal energy utilization systems, such as converting abandoned (used) oil wells into geothermal sources, extracting critical mineral raw materials from high-temperature geothermal waters, combining geothermal energy systems with hydrogen production, and integrating systems for carbon dioxide storage and geothermal energy production. These measures will contribute to both the sustainable exploitation of geothermal resources and their integration into Serbia's broader energy strategy, with an emphasis on innovation and environmental sustainability.

Finally, the exceptional relevance of research and exploitation of geothermal energy has led to a situation where these resources (as well as all hydrogeological resources in general) are addressed across a series of laws and legal acts, often in mutual conflict, each following the spirit of the respective act. Therefore, in the upcoming period, it is necessary to synchronize all the laws addressing this field, with a clear priority given to the primary Mining and Geological Exploration Act, which also pertains to the exploration and exploitation of hydrogeological and geothermal resources.

Necessary activities for implementation by 2040:

- Promotion of the use of geothermal resources in district heating systems and the development of at least 30 geothermal plants with a total capacity of up to 300 MWt.
- Development of at least 10 geothermal power plants with a total capacity of up to 200 MWe.
- Continuation of the use of geothermal resources in the building sector, aiming to reach 10,000 facilities utilizing geothermal energy, with a total capacity exceeding 1,000 MWt.
- Development of remote cooling technology using underground water.
- Introduction of a legal requirement that, before issuing location conditions for construction, a geothermal potential assessment of the relevant location be conducted, and the possibility of utilizing renewable energy sources be considered.
- Development of technology for converting abandoned (depleted) oil wells into geothermal sources.
- Analysis and application of technology for extracting critical mineral raw materials from high-temperature geothermal waters.

Analysis of Development Options of the Mineral Resources Sector

For all analyzed sectors, three development options were considered: slow, realistic, and accelerated development of the mineral raw materials sector. In defining the development options, assumptions were provided, as a prerequisite for the fulfillment of the projected option.

Option for the slow development of the mineral raw materials sector – for this development option, the following assumptions have been adopted:

- Coal production from surface mines decreases following the S scenario of the energy strategy, with the import of high-quality coal. The level of coal production in underground mining significantly declines, leading to the closure of a substantial number of mines.
- Oil and gas are exploited at a level lower than the current one.
- Copper production does not follow existing plans but remains at the level of current production, with market prices being lower than they are now.
- Lead and zinc mines are closed, additional mines are not opened, and no lithium or gold mines are developed.
- Production of non-metallic raw materials decreases by 50% and is primarily limited to production for the cement industry.

The total value of production for the slow development option of the sector is approximately **3,273,000,000 USD**.

Option for realistic development of the mineral raw materials sector – for this development option, the following assumptions have been adopted:

- Coal production does not decrease under the S scenario but is somewhat higher than the previous level, amounting to 35,000,000 tonnes, with partial import of high-quality coal continuing. Underground mining produces 400,000 tonnes.
- Oil and gas are exploited at the current level.
- Copper production follows the existing plans of the companies.
- Lead and zinc mines operate at the current level.
- A lithium mine is open, as well as gold mines.
- Production of non-metallic raw materials remains at the current level.

The total value of production for the realistic development option of the sector is approximately **6,810,000,000 USD**.

Option for accelerated development of the mineral raw materials sector – for this development option, the following assumptions have been adopted:

- Coal production does not decrease under the BAU scenario, amounting to 40,000,000 tonnes, with partial import of high-quality coal. Underground mining produces 1,000,000 tonnes.
- Oil and gas are exploited at the current level.
- Copper production concentrates, and cathode copper as a final product of metallurgical processing increased compared to plans, with deposits and prices on the market rising to 12,000 USD per tonnes.
- Gold production increases with the opening of new deposits, and the price on the market is 80,000 USD per kg.
- Lead and zinc production remains the same.
- A lithium mine is opened with a production of 58,000 tonnes, the price on the market is 15,000 USD per tonnes, borates as well as gold mines produce 20 tonnes, and silver mines produce 10 tonnes. Nickel and Cobalt production are launched (20,000 tonnes).
- Production of non-metallic raw materials remains at the current level.

The total value of production for the accelerated development option of the sector is approximately **8,624,000.000 USD**.

Previous analysis indicates that there are various development options for the mining sector in the Republic of Serbia. These depend on numerous factors, ranging from strategic plans related to energy, the realization of plans for copper and gold production, the potential opening of new mines, environmental and sociological conditions, market prices, and more. In any case, mining can significantly impact the gross domestic product, and by introducing higher levels of mineral raw material processing (such as the possibility of obtaining final products from lithium), this value can be substantially increased.

In 2022, mining contributed 2.7% to the Gross Domestic Production (GDP) of the Republic of Serbia. If the realistic development option for the mining sector were achieved, the share of mining in GDP could increase to around 5%, or approximately 8% in the accelerated development option. In any case, mining can significantly impact the GDP, and by introducing higher levels of raw material processing, this value can be substantially increased. Therefore, the goal is to introduce higher levels of ore processing in the Republic of Serbia. If indirect benefits were also considered, the share would be significantly higher. This primarily pertains to direct foreign green-field investments, increased employment, growth in service sectors, transportation, construction, tax revenues, and more.

The intention should be the realization of the accelerated development option; however, the implementation of these projects will depend on numerous factors, ranging from economic ones (such as raw material prices on the global market) and demand for specific raw materials, to the feasibility of environmentally sustainable production.

Human Resource Development

Contemporary trends in the field of geological exploration of mineral resources differ significantly from those in previous periods. Changes in geological exploration and mineral resource assessment worldwide have been accompanied by changes in the education and training of students.

Secondary education is ideal for the introduction of dual education, as those schools are located near major mining areas. However, the misinterpretation of the Regulation on Defining Hazardous Work for Children has affected the ability to conduct internships in mines. As a result, it is not possible to directly provide conditions for dual education. One possible solution is to establish training centers outside the mines or to procure specialized software for simulating the operation of mining equipment.

As previously mentioned, although over 30,000 workers are employed in the field of mining and geology in the Republic of Serbia, there is a noticeable downward trend in the number of students enrolling in secondary mining and geological schools, as well as in faculties specializing in mining and geology. This raises the question of how the necessary human resources will be secured if the negative public narrative surrounding mining and geology continues. Given the importance and necessity of mining and geology, as well as their impact on industrial development and the advancement of humanity as a whole, within the framework of sustainable development and environmental protection, students must be introduced to basic information on these topics already in primary school. Unfortunately, public media is largely dominated by the image of mining as an industry that devastates the environment, portraying mining professionals as the main culprits for climate change and environmental pollution. This is in stark contrast to the current global demand for significant expansion of mining production.

The number of machine operators required solely for EPS, assuming operations are conducted in three shifts throughout the year on a four-crew rotation schedule, exceeds 2,500. This means that a minimum of approximately 50 to 70 new operators is needed annually, while currently fewer than 40 are being trained. Due to the shortage of qualified labor, companies often resort to internal qualification programs within the mining system or training through the Serbian Publicly Recognized Organizers of Activities (PROA). However, it has been shown that this form of training falls significantly short compared to the official education system.

5. Objectives

5.1. General Objective

The Strategy for the Management of Mineral and Other Geological Resources of the Republic of Serbia defines its general objective as ***the sustainable management of exploration and exploitation activities, aimed at meeting the current and future needs of the country for mineral raw materials and expanding the mineral resource base by intensifying activities related to the prospecting, exploration, and verification of mineral and other geological resources***. Achieving this objective can be ensured through appropriate legal and administrative solutions that improve the processes of obtaining various permits, conducting mineral exploration, and protecting and utilizing mineral resources. Of particular importance is the efficient and comprehensive protection of mineral deposits, which ensures access to already documented reserves. Greater involvement of the Geological Survey of Serbia is necessary in developing new methods for prospecting, exploration, and documentation of geological data related to known mineral deposits and potentially mineral-bearing environments. Access to raw materials is based on the Constitution of the Republic of Serbia, which recognizes the state's right and obligation to manage mineral and other resources responsibly and by its duty to humanity. This access must ensure the country’s long-term economic needs, stemming from the adopted priorities for economic development, thereby contributing to a high standard of living for its citizens.

Global changes in the mining sector are creating numerous opportunities for the Republic of Serbia. Known mineral deposits in Serbia contain significant elements of many critical and strategic metals and minerals and hold substantial potential for the discovery of new resources. The current strengthening of the mining and mineral industry presents new export opportunities for the sector. Improvements in existing production processes, the circular economy, and continued innovation within the sector provide a strong foundation for future success. Some of the key challenges facing the mining sector include increased material recycling, more efficient resource utilization, the search for alternative and new materials, and the mitigation of negative environmental impacts. Progress is also expected in the efficient use of mineral resources and the implementation of intelligent systems, along with recycling initiatives promoted by sustainable mining best practices, which will define key future growth areas within the mining sector.

The European Raw Materials Initiative places a strong emphasis on the efficient use of resources and the development of new technologies. Alignment between EU objectives and national strategic goals ensures further opportunities for strengthening the mining sector in the Republic of Serbia, through various forms of support from the EU.

The Republic of Serbia has an active mineral industry, an extensive metallurgical sector, and significant potential for further production of critical and strategic minerals. The exploitation of ores and the production of metals are not only important for achieving green value chains in both Serbia and the EU but also for Serbia’s role as a strategic ally and partner. The Government of the Republic of Serbia should aim to be a stable, long-term supplier of minerals essential for the green transition.

Ensuring a long-term stable supply of mineral raw materials for the Republic of Serbia should actively overcome and eliminate barriers in international trade, while simultaneously promoting good governance and transparency in the country's mineral development policy. At the same time, this could create export opportunities for Serbian industry and increase the international influence and support for the Republic of Serbia in raising awareness about the impacts and associated responsibilities of mineral raw material production and consumption.

5.2. Specific Objectives

The achievement of the general objective should result from the implementation of individual measures defined within the specific objectives related to geological research, mining, environmental issues, the economy, the intensification of the use of so-called technogenic raw materials, and other areas. These objectives are based on an analysis of the current situation and the projection of basic and applied geological research of mineral raw materials and other geological resources. They are generally categorized into the following groups:

- **Specific Objective 1:** Integrated sustainable management of mineral and other resources with continuous process innovation and the enhancement of state and corporate control in geological exploration and mining processes, including health and safety.
- **Specific Objective 2:** Ensuring access to mineral raw materials and other geological resources, and enhancing international cooperation in this field.
- **Specific Objective 3:** Prospecting, exploration, and geological documentation of resources and mineral deposits and other geological resources.
- **Specific Objective 4:** Ensuring favorable legal conditions for the development, modernization, and investment in geological exploration and sustainable mining with a service-oriented approach.
- **Specific Objective 5:** Strategic spatial protection of mineral deposits and other geological resources.
- **Specific Objective 6:** Ensuring access to and exploitation of technogenic raw materials and supporting the development of the circular economy.
- **Specific Objective 7:** Expanding knowledge and continuously strengthening the key competencies and capabilities of the professional staff, along with broad public education.
- **Specific Objective 8:** Sustainable mining industry with incentives for joint infrastructure investments, research, innovation, and control of environmental degradation.

5.3. Problems and Risks That May Lead to the Failure of Achieving the Objectives

The problems and risks that may lead to the non-achievement of the objectives are outlined in Section 2, where the analysis was conducted by applying the PEST and SWOT methods. Within the analysis, strengths and opportunities were defined, as well as weaknesses and threats to achieving the goals of the Strategy.

The biggest problems can be highlighted as follows:

- Insufficiently developed regulatory framework.
- Incomplete capacity in the field of inspection supervision.
- Insufficient public awareness about the importance of mineral resources for economic development at both the local and national levels.
- Disagreement between NGOs and environmental movements regarding mining.
- Presence of activities that lead to environmental threats.

Multiple problems are generally related to the lack of clear strategies, incomplete and insufficiently transparent statistics on the production and consumption of different raw materials, and inadequate education regarding the sector's importance for broader socio-economic development. The lack of professional spatial planning bases and exploitation plans indicates that raw materials and the mining sector are given relatively low priority compared to other economic sectors. Therefore, it is necessary to integrate mineral resources into spatial planning on an equal footing with other interests and activities. The above-mentioned problems can be overcome by ensuring access to new resources or mineral deposits, as they are a key

prerequisite for the successful and sustainable development of mineral exploitation activities. It is also necessary to adopt a national mineral resource management policy, as mineral resources, as a natural asset, are not currently given sufficient importance. The fact is that many other traditionally better-articulated interests, including environmental protection (soil, water, air, etc.), are usually given high priority. In contrast, mining issues are often addressed at the local level, without sufficient strategic perspective and without considering the long-term time frame required for implementing strategic mining projects (20-50 years).

Mineral resources must be considered in spatial plans in such a way that certain areas are designated for their exploitation. It is necessary to strategically define the production of raw materials at a higher, national level, taking into account their spatial distribution, domestic demand, and subsequently, the demand of regional markets. At lower levels of planning, the details are then elaborated such as exploitation sites, the planned volume of production, and so on.

The regulatory framework entails simplifying administrative procedures for issuing permits for geological exploration and the exploitation of mineral deposits, as administrative barriers are one of the key factors limiting investments in geological exploration and mining. It is necessary to take measures related to the effective protection of mineral deposits and to introduce appropriate amendments and additions to the Law on Mining and Geological Exploration, as well as to other legal acts regulating spatial planning issues. The current legal provisions do not fully protect mineral deposits, and in many planning documents, they are either undocumented or improperly recorded. Geological authorities lack effective legal tools to participate jointly with planners in making decisions about the development of areas where these deposits are located. For this reason, it is essential to amend legislation and introduce the category of strategically important mineral deposits, which, due to their importance for the economy and/or national security, should be subject to special legal protection. The recognition of mineral deposits as strategically important should be made through an appropriate administrative decision, based on which such deposits would receive special protection in planning documents.

The state should establish mechanisms and a legal framework that, in addition to the standard procedures for obtaining geological and mining permits, will also allow for certain forms of contracting with the state concerning strategic and critical raw materials. Furthermore, the state should consider the possibility of restricting the export of certain raw materials to protect vital national interests and ensure higher value chain retention within the country.

It is essential to simplify and shorten the procedures for defining strategic projects and for incorporating strategically important mineral deposits into planning documents while taking into account changes in land use conditions and local spatial development plans.

A clearer and more efficient regulatory framework is needed. The goal is to ensure that permits for new or modified existing mining operations are issued through transparent, efficient, and legally secure processes, without compromising compliance with environmental requirements.

Strategic documents defining the future direction of development for the Republic of Serbia and its mining sector (currently lacking) are in the process of being updated and adopted, and their absence represents a significant challenge.

The legislative framework remains incomplete. While the Law on Mining and Geological Exploration has been adopted, certain sections require revision and innovation. Several by-laws must also be updated, as they are outdated and pose obstacles to the implementation of modern technical solutions. In addition, some by-laws have not yet been adopted and are currently missing.

It is necessary to expand human resources and intensify inspection oversight, with zero tolerance for violations related to environmental protection, land reclamation, and occupational safety. In the initial phase, the required number of inspectors should be determined based on the workload,

specifically concerning the number of companies registered in the fields of mining and geology. Additionally, efforts should be made to improve the transparency of their work.

The perception of certain NGOs and political parties that the exploration and exploitation of mineral resources are the primary causes of pollution and environmental degradation, along with the general public's lack of awareness about the importance of mineral resources for economic development, both locally and nationally, can represent a significant obstacle to achieving the goals set out in the new Strategy. An important objective of the Strategy is to establish the foundations for broad and transparent public communication regarding the environmental impacts of geological and mining activities, based solely on scientific knowledge, while also highlighting the mining sector's contributions to economic growth, employment, and other areas.

One of the activities that could negatively impact the implementation of the Strategy is the presence of actions that pose a threat to the environment. It is necessary to minimize potential hazards, adequately prepare Environmental Impact Assessments, rigorously evaluate them, and ensure consistent monitoring throughout the exploitation process.

6. Measures to Achieve General and Specific Objectives

To achieve the general objective, individual measures related to key issues in the areas of geological exploration, mining, the environment, the economy, intensifying the use of technogenic raw materials, and other areas have been defined within the specific objectives. Based on the analysis of the current situation and expected predictions of BGE and AGE of mineral and other geological resources, the defined measures should more clearly determine the direction in which efforts are being made to fulfill the set goals. For each of the defined specific objectives, the measures are listed, and their descriptions are provided.

Specific Objective 1 - Integrated sustainable management of mineral and other resources with continuous process innovation and the enhancement of state and corporate control in geological exploration and mining processes, including health and safety, implies:

- **Measure 1:** Implementation of the integrated system for managing mineral and other geological resources for the sustainable development of the mining sector, with optimization of locally and globally changing sustainability components related to stakeholders.
- **Measure 2:** Efficient implementation of sustainable long-term mining projects.
- **Measure 3:** Establishment and alignment of common measures between different Ministries and industries regarding the implementation of the management system and strategic projects.

Measure 1 involves monitoring the implementation of the jointly adopted standard for the sustainable management system of mineral and other geological resources, with necessary corrections, as a framework for public, public-private, and civil society partnerships, uniformly applicable to all types of resources. In this process, each stakeholder participates in the implementation of the joint system with specifically defined objectives within the standard. It forms the basis for setting and timely monitoring the processes of exploration and exploitation, as well as the sustainable development of the mining industry. Based on the strategic system of sustainable resource management, according to global practices, it is possible to timely assess the impacts of predictable and unpredictable, ongoing ecological, social, and economic changes, and establish measures for appropriate management of the development process of the mining sector aligned with the country's economy. In the decision-making process according to this system, with its changing characteristics over time and space, it is essential to continuously and optimally monitor the impacts of sustainability components under the needs of all stakeholders (government, industry, investors, and civil society), to eliminate conflicts as it is defined in the UNRMS standard.

Strategic projects through **Measure 2** should have a changing priority status of the highest possible national importance and public interest in the national permitting process (max 27 months according to EU standards). The project is implemented sustainably, particularly concerning monitoring, prevention, and minimizing environmental impacts, minimizing socially harmful effects through the use of socially responsible practices, including respect for human rights and labor rights, especially in the case of necessary displacement. To facilitate the rapid implementation of new projects, especially those involving CRMs, it is important to generate support and avoid conflicts. There are many reasons to believe that mining projects that involve good and transparent cooperation with local communities and environmental organizations, give high priority to sustainability, apply circular business models, and minimize the need for waste disposal to an absolute minimum, could be implemented significantly faster and with fewer complications than other projects. A special state Commission evaluates whether a given mining project meets the conditions to be considered strategic according to predefined criteria.

Measure 3 implies that, for the application of tasks related to the execution of the management system and strategic projects, synchronization of measures and cooperation between the mining sector and relevant Ministries is essential. This refers to the coordinated implementation of actions during exploitation (Ministry of Environmental Protection, Ministry of Agriculture, Forestry and Water Management, Ministry of Finance, and others). Each time, cooperation on the aforementioned scale requires the establishment of a framework for collaboration in the preparation and implementation of management studies and strategic projects.

Specific Objective 2 - Ensuring access to mineral raw materials and other geological resources, and enhancing international cooperation in this field, implies:

- **Measure 1:** Increase the types, quantities, and quality of resources and reserves of mineral raw materials in the Republic of Serbia.
- **Measure 2:** Assessment of the Republic of Serbia's needs for mineral raw materials and other geological resources, based on analyses of existing and potentially deficient mineral raw materials in ore-bearing areas.
- **Measure 3:** Monitoring the extent to which resources, reserves, and the exploitation of mineral raw materials are integrated into spatial plans for various purposes.

Measure 1 involves the assessment of growth in the types, quantities, and quality of all mineral resources and reserves of raw materials relevant to the economic development of the Republic of Serbia, with particular emphasis on strategically important raw materials. The expected outcome of this measure is a high level of knowledge regarding Serbia's mineral resource potential. Implementation of the measure is binding for all institutions and economic entities involved in the planning and direction of geological exploration activities. The Geological Survey of Serbia is the main implementing body.

Measure 2 involves the assessment of the Republic of Serbia's needs for mineral raw materials and other geological resources, as well as the potential to meet the demand for the most important raw materials based on the country's mineral potential and projected demand up to the years 2030, 2040, and 2050. This assessment should take into account active and well-explored deposits, abandoned deposits, ore-prospective and potentially mineral-bearing areas, and technogenic deposits. The objective is to realistically evaluate the domestic economy's demand for various types of raw materials, determine the possibilities for meeting that demand from national sources, and identify which raw materials must be imported. The Geological Survey of Serbia is the lead institution responsible for this measure. Their tasks include monitoring the global raw materials market and tracking and analyzing new geological exploration and mining projects. Collected data should be periodically updated through analyses of developments that directly affect domestic demand for raw materials, as well as their classification into groups of strategic and critical raw materials. These activities are carried out at defined intervals based on a pre-

established methodology. The results of these analyses should serve as a reliable source of information for all government authorities responsible for tasks related to the use of raw materials, economic development, and the planning and direction of all types of geological research.

Measure 3 entails ensuring the conditions necessary for providing timely, accurate, and reliable information on: areas where mining activities are currently taking place; areas without active mining production, but where identified raw materials could be subject to future exploitation; areas with geological potential for discovering new mineral raw materials; areas where geological exploration of significant scale is either ongoing or planned; etc. The implementation of this measure should enable the inclusion of mineral areas in spatial plans for various purposes, i.e., to reserve areas for geological exploration and the exploitation of raw materials important to the Serbian economy. It is necessary to strategically define mineral raw material production at a higher, national level, taking into account their spatial distribution, and then assess regional market demand. At lower planning levels, details such as specific exploitation sites and projected production volumes should be developed. The implementation of this measure will impact all stakeholders involved in spatial planning, geological research, and raw material exploitation. The responsible institution for implementing the measure is the Geological Survey of Serbia.

Specific Objective 3 - Prospecting, exploration, and geological documentation of resources and mineral deposits and other geological resources, implies:

- **Measure 1:** Documentation and geological-economic evaluation of the results of exploration of mineral deposits and occurrences in the Republic of Serbia, along with establishing cooperation between the competent administrative authority, the Geological Survey of Serbia, and economic entities, to support investment in exploration activities.
- **Measure 2:** Identification and exploration of new geothermal energy resources and making them available for use.

Measure 1 involves documenting and evaluating the progress of geological exploration results of mineral raw materials in the territory of the Republic of Serbia, with an emphasis on ore-prospective areas. These activities should enable the continuous integration of data on mineral deposits into planning documentation, which will lay the groundwork for their further development and encourage the mining sector to expand the scope of geological exploration and exploitation of mineral raw materials. The implementation of this measure provides new geological information, identifies directions for geological, geochemical, and geophysical prospecting and exploration of mineral resources, and requires periodic updating and verification. The Geological Survey of Serbia is the lead institution for these activities. It is necessary to establish cooperation between the Geological Survey of Serbia and economic entities that possess valid geological documentation on currently active mineral deposits and those whose exploitation has been suspended but are assessed to have adequate mineral potential for redevelopment using modern exploitation and processing technologies. In addition, measures should be provided for geological mapping and research of Serbia's terrain during the construction of linear infrastructure projects (e.g., roads), which not only provides new geological data and insights into ore-bearing geological structures but also reduces the cost of purpose-specific geological works. Efforts should also increase in identifying and evaluating areas with realistic potential for discovering critical and unconventional mineral raw materials, ensuring their documentation, and in the identification, exploration, and documentation of thermal water deposits to make them available for use.

Measure 2 emphasizes that, due to the growing importance of developing geothermal resources in the Republic of Serbia, it is of key importance to formulate a comprehensive development strategy that will define the main directions for the exploration and exploitation of these resources. This strategy will focus on the sustainable use of geothermal energy, through activities such as the development of studies on the geothermal potential of the Republic of Serbia: the creation of a

Geothermal Atlas providing an overview of available resources; the promotion of geothermal resources use in district heating systems; the development of technologies for district cooling using groundwater as a sustainable energy source; the development of technologies to convert abandoned oil wells into geothermal energy sources; and research and implementation of technologies for extracting critical mineral raw materials from high-temperature geothermal waters.

Specific Objective 4 - Ensuring favorable legal conditions for the development, modernization, and investment in geological exploration and sustainable mining with a service-oriented approach, implies the following main measures:

- **Measure 1**: Activities aimed at addressing institutional issues and improving the work of the Geological Survey of Serbia.
- **Measure 2**: Improvement of the legislative framework in the area of classification of mineral resources and reserves, methodology for preparing preliminary feasibility studies, and feasibility studies according to international standards (PERC, CRIRSCO standards, and in line with UNFC).
- **Measure 3:** Allocation of responsibilities and improvement of information flow among stakeholders in the mining industry.
- **Measure 4**: Digitalization of geological plans and documentation, introduction of e-government in the field of geological research and mining activities.
- **Measure 5:** Concession for geological exploration and exploitation of mineral raw materials.

Measure 1 involves monitoring and improving the work of state institutions responsible for mineral resources, mining, and related fields, as well as enhancing the work of the Geological Survey of Serbia. The goal is for relevant state authorities to align their activities and plans with the status and prospects of mineral resource development, expressed through: identified reserves and their quality, lifespan with existing and planned production capacities, the depletion and non-renewability of mineral resources, the impact of their exploration, exploitation, and use on the environment, and the associated risks and uncertainties.

The measure aims to improve the operations of the Geological Survey of Serbia, which must meet the tasks set within the domain of BGE and AGE of mineral resources, particularly in the areas of: conducting metallogenic analyses and creating forecast maps, geological-economic modeling of deposits, developing criteria for the prospecting and exploration of new types of deposits, performing geological-economic evaluations of research results, and producing geological-economic and other maps. The expected outcomes of this measure, in addition to the development of human resources, should provide the necessary conditions for modern laboratory testing and logistical support for geochemical prospecting and exploration. It is also essential to intensify the work of the Geological Survey of Serbia in the following areas: Coordinating activities related to the development of strategies and policies for the development of BGE mineral resources, their implementation, assessment of research and exploitation results of mineral resources in Serbia, and management of mineral resources; Preparing short, medium, and long-term plans and programs for BGE and other activities of national interest; Participating in the preparation of regional and local development plans and sustainable use of geological resources for spatial planning, maintaining a registry of geological planning documents for the territory of Serbia, and cooperating with other state organizations in preparing the Mineral Resources and Reserves Balance of Serbia and related materials; Updating the Geological Information System of Serbia; Promoting international cooperation in the planning of BGE and study of mineral resources, promoting investments in geological research and mineral resource exploitation, and reserves; Performing other tasks under legal and regulatory acts.

The responsible institutions for implementing this measure are the Geological Survey of Serbia and the relevant authorities of the Republic of Serbia in the field of geological exploration and mining.

Measure 2 involves monitoring changes in legal regulations to facilitate easier access to permits for exploration and exploitation in one place and to increase investment in the modernization of geological exploration and the exploitation of mineral raw materials. It is also necessary to control the alignment of the categorization and classification methods for solid, liquid, and gaseous mineral raw materials in the Republic of Serbia with those of countries with developed mining industries, as well as the reporting standards for mineral resources and reserves. This includes the methodology for preparing the preliminary study and feasibility study according to international standards (PERC, CRIRSCO, and UNFC standards). The measure aims to simplify and accelerate the permitting processes in the domain of geological research and planning for the exploitation of mineral resources. It encourages the development of Long-term geological exploration programs for mineral resources, Long-term exploitation programs for mineral and other geological resources, and other planning documents.

The responsible institutions for implementing this measure are primarily the Geological Survey of Serbia, in cooperation with the relevant authorities of the Republic of Serbia.

Measure 3 involves monitoring the clarity of responsibility distribution and improving the flow of information among stakeholders in the mining industry. The goal is to promote dialogue among the parties influenced by and contributing to the operations of the mining industry to improve information exchange, enable proactive planning, and reduce the potential for conflict situations. The parties in the dialogue forum should coordinate their business information and analytical activities to create a holistic view of development, thus avoiding surprises. The measure also aims to ensure that permits for new or modified existing mining operations are issued through transparent, efficient, and legally secure processes, without compromising the fulfillment of environmental requirements. It is crucial to provide landowners with more reliable and complete information about what will happen on their land as early as possible.

The responsible institutions for the implementation of this measure are primarily the Geological Survey of Serbia, along with the relevant authorities of the Republic of Serbia in the field of geological research and mining, and companies engaged in the same areas.

Measure 4 involves the assessment of activities related to the application of modern information technologies with the goal of more efficient implementation of state administrative functions related to geological exploration and mining. The aim is to reduce the number of documents submitted in the process of issuing various permits, shorten the time for information flow between government authorities and parties involved in the procedure, and ensure the cybersecurity of the IT systems used for carrying out public tasks related to geological exploration and mining. It is expected that the digitization process, in addition to accelerating administrative procedures, will improve the rational management of mineral deposits and create conditions for verifying whether economic operators holding permits for managing mineral deposits are doing so in an optimal way, ensuring maximum extraction of the mineral substance under existing technical-technological conditions. In case of cessation of exploitation, it will be possible to verify whether the maximum possible quantities of the mineral substance were extracted from the deposit. Data on the quantities of extracted mineral raw materials from deposits are submitted annually to the Geological Survey of Serbia according to the law, enabling the assessment of the scope of exploitation and remaining quantities of mineral resources in the deposit. This will also help prevent potential negative changes in the exploitation process.

The responsible institutions for implementing this measure are the Geological Survey of Serbia and the relevant authorities of the Republic of Serbia in the field of geological exploration and mining.

Measure 5 refers to the periodic monitoring of the established concession system for geological exploration and the exploitation of mineral resources, with clearly defined conditions and a specified duration. The competent institutions responsible for implementing this measure are the relevant authorities of the Republic of Serbia in the field of geological exploration and mining.

Specific Objective 5 - Strategic spatial protection of mineral deposits and other geological resources, contains the following measures:

- **Measure 1:** Monitoring the effectiveness of the adopted criteria for selecting strategically important mineral deposits and their classification into the group of deposits under special protection.
- **Measure 2:** Incorporation of representations of mineral deposits into planning documents, with a special focus on deposits of strategic importance, aligning the processes of geological exploration, environmental protection, and sustainable development.

Measure 1 involves monitoring the documented application of the developed methodology for classifying mineral deposits as strategically important and selecting deposits that meet the adopted criteria to place them under special protection. Additionally, the measure aims to improve conditions for securing access to areas where mineral deposits and other geological resources are located, for the needs of renewable energy, agriculture, forestry, water management, tourism, sports, and recreation.

It is necessary to ensure the proper documentation and protection of mineral deposits that are of strategic importance to the economy and/or national land security. Additionally, spatial planning issues must be addressed, as geological authorities currently lack effective legal instruments to collaborate with urban planners in making decisions regarding the development of areas where such deposits are located.

The methodology also includes recognizing the category of strategically important deposits through an appropriate administrative decision, so they can be granted special protection in planning documents. Adequate financial resources, which are currently lacking in the budgets of local self-governments, must also be secured for these activities. The measure should aim to simplify the procedures for integrating strategically important mineral deposits into planning documents as much as possible, taking into account changes in land use conditions and local spatial development plans.

The criteria for defining strategically important mineral deposits must be periodically reviewed, supplemented, and modified according to changes in the factors upon which they were initially determined. The data obtained serves as a coherent source of information for all administrative bodies involved in tasks related to raw materials within the scope of their responsibilities. The activities are directed towards the general protection of documented mineral deposits from activities associated with the construction of residential, infrastructural, and other structures. To achieve this goal, it is necessary to amend the legal regulations governing the efficient operation of all administrative bodies responsible for spatial planning and geological governance. Additionally, it is essential to develop forms and methods of protection for mineral deposits, which will enable the development of local communities, as well as the development of areas above the mineral deposits for non-residential purposes, thereby preventing harmful effects related to potential mining activities.

Mineral deposits whose exploitation is not planned for economic, social, or other reasons should be treated as a resource base, providing the possibility of their use in emergencies. Ensuring direct access to these deposits, especially energy resources, guarantees the security of the state, offering full independence in times of crisis.

The responsible institutions for the implementation of this measure are the Geological Survey of Serbia (primarily) and the relevant authorities of the Republic of Serbia for geological research and mining.

Within **Measure 2**, it is necessary to monitor the consistency of the implementation of the adopted scheme of activities by administrative authorities, ensuring continuous monitoring of the obligation to include mineral deposits in planning documents, along with an analysis of the actual development of immovable property. The administration involved in the process of

negotiating and adopting official decisions related to land use and providing opinions on planning documents must create a platform for cooperation and fast, efficient exchange of information to eliminate shortcomings in the acts issued by local government bodies.

This measure intensifies activities aimed at improving the current state of the mining industry and mineral resource research by determining research priorities, including resources of non-ferrous metals (Cu, Pb, Zn) with accompanying associations of rare elements; resources of precious metals (Au, Ag) as associated minerals of non-ferrous metals; gold as the main ore component in deposits; and resources of alloying metals (Sb, Mo, Ni, Co). Attention should also be directed towards other resources of Serbia: nuclear raw materials, elements from the rare earth group, and partially black metals (Fe, Mn, Ti, Cr, etc.). The BGE of mineral resources should focus on areas where metallogenic assumptions for discovering new deposits have been established. Furthermore, efforts are intensified to ensure full cooperation between the state authorities, mining organizations, employees in these organizations, NGOs, and local communities where metallic mineral resources are explored, exploited, and processed. This entails the promotion of geological research on mineral resources, demonstrating that modern society cannot exist without the exploitation of mineral raw materials, reporting on the benefits of research and exploitation of mineral resources for the Republic of Serbia, and emphasizing the possible achievement of a balanced and sustainable relationship between natural resources, economic, ecological, and social factors.

The responsible institutions for the implementation of this measure are the Geological Survey of Serbia (primarily) and the relevant authorities of the Republic of Serbia for geological exploration and mining.

Specific Objective 6 - Ensuring access to and exploitation of technogenic raw materials and supporting the development of the circular economy, implies:

- **Measure 1:** Inventory of mining waste dumps and assessment of their potential for utilization.
- **Measure 2:** Raising awareness about the importance of recycling Secondary Raw Materials (SRM) and sustainable resource management.
- **Measure 3:** Development of raw material recovery from waste (especially strategic and critical raw materials), including the development of technology for processing such waste. In addition to using ash from thermal power plants for the cement industry and road construction, exploring the possibility of processing into new products such as humic acids, graphene, filters for water and exhaust gases, etc.
- **Measure 4:** Improvement and harmonization of legislative regulations with EU legislation regulating the principles of SRM management.

Measure 1 promotes the exploration and exploitation of critical and strategic raw materials that have a high recycling potential from SRM, in line with sustainable development. Since the Republic of Serbia is a country with a long mining tradition, large quantities of mining waste have been deposited over decades in dumps across the country. According to the Mining Waste Registry, 250 inactive mining waste dumps have been identified, which, along with active dumps of mining and other industrial waste, could be a source of SRM. Mapping primary and secondary potential mineral resource deposits and creating a registry containing all necessary information provides the opportunity to increase the capacity for managing mineral resources. Additionally, such a registry ensures a sufficient flow of information about mineral raw materials for the European industry, aiming to expand its business and investments.

Within **Measure 2**, it is necessary to monitor efforts to raise awareness among citizens and mining companies about the possibilities and importance of proper disposal and reuse of these potential raw materials.

Through **Measure 3**, it is important to track and support the development of new technologies and the introduction of existing technologies from the EU related to these areas. It is also essential to develop and implement new technologies for processing all types of mineral raw materials and increase the degree of utilization of ore substances, CO2 disposal, hydrogen, etc.

Measure 4 relates to monitoring the improvement and harmonization of legal regulations with EU legislation governing the principles of SRM management. This measure pertains to the circular economy and the definition of technogenic mineral resources, or the need to classify mineral substances that have emerged as part of ongoing mining and processing activities and stored in mining waste disposal facilities, which, in terms of properties, are similar to mineral raw materials, into legal regulations. Previously, this will impose an obligation for their exploitation and processing as additional secondary sources of mineral raw materials, as they may represent a source of many valuable raw materials, whose potential has not been fully explored and utilized. The main sources of so-called waste are mining and ore processing, waste generated as a result of industrial processing, production, and energy supply.

Specific Objective 7 - Expanding knowledge and continuously strengthening the key competencies and capabilities of the professional staff, along with broad public education, contains:

- **Measure 1:** Expanding and promoting knowledge related to geology and mining to raise public awareness about the measures that will be implemented.
- **Measure 2:** Introducing dual education at the secondary school level in the fields of mining and geology.
- **Measure 3:** Optimization and modernization of higher education in the fields of mining and geology.
- **Measure 4:** Expanding the knowledge of employees in the mining and geology sector.

Within **Measure 1**, an important goal is to ensure that special attention is given to social education, including a broad informational campaign related to sustainable measures, in the process of implementing the Strategy. It is of great importance to build public understanding through social dialogue regarding the decisions made by mining-geological authorities related to the protection of mineral resources. Local government representatives must be aware of the opportunities and potential benefits of projects related to the use of water resources (of different temperatures) for heating and energy purposes. Furthermore, it is important to present complementary knowledge about, among other things, the storage of substances in rock formations, underground CO_2 storage, waste storage in rock formations, and hydrogen, as well as professionally countering the frequent misinformation about the impact of these projects.

Measure 2 relates to secondary education in the fields of mining and geology, as well as related occupations in mining (mechanical and electrical engineering), to create conditions for the introduction of dual education, as such schools are typically located near large mining regions.

Measure 3 refers to the need for the rationalization, optimization, and modernization of study programs offered at the Universities related to mining and geology. Currently, the study programs are oversized, narrowly specialized, and do not meet the needs of modern mining and geology. It is necessary to improve and align them with the study programs of countries that are leaders in mining production in the EU and worldwide.

Measure 4 relates to employees in the mining and geology sector. Employees in the mining and geology sector, as well as other supervisory (responsible) bodies, must be well-trained and qualified for mining, geological, and administrative procedures and tasks. It is essential to regularly assess the necessary improvement of skills and capacity building for employees in this sector. Therefore, it is necessary to implement licenses with a requirement for their renewal

and continuous knowledge upgrading. The mining inspection should have sufficient capacity and play a central role in monitoring compliance with mining and exploration laws, providing information about legislation and ongoing research, and overseeing the exploitation and processing of ores for companies, stakeholders, authorities, the media, and the public.

Specific Objective 8 - Sustainable mining industry with incentives for joint infrastructure investments, research, innovation, and control of environmental degradation, contains the following measures:

- **Measure 1:** Coordinated joint investments in infrastructure for the growth of the mining industry and stimulating research and innovation.
- **Measure 2:** Transparency and implementation of sustainability in mining industry projects and control of environmental impacts, mine closure processes, and waste management.
- **Measure 3:** Implementation of standards that define sustainable and responsible mining.

Measure 1 should assess the value of joint investments in infrastructure to support the growth of the mining industry. The goal is to create a robust and reliable infrastructure that meets the needs of the mining sector. The growing mining industry is exposing deficiencies in the country's transport infrastructure in terms of load capacity, functionality, maintenance, and more.

Measure 2 should promote the consistent implementation of sustainable, legally regulated, and transparent projects, as well as the control of environmental protection, mine closure processes, and waste management as obligations throughout the entire, generally long, life cycle of a mine. It should also require and ensure that, within the project, already at the opening of the mine, financial planning includes funds for environmentally sustainable mine closure, as well as for post-closure monitoring. This is a dynamic process that should be adjusted as new technologies advance or new exploitation solutions are developed. Proper planning facilitates innovation in waste management within the mining industry and in the mine closure process. The mine closure plan should include future uses and objectives for the site after closure, the existing infrastructure, and measures for the protection of workers, property, and the environment.

Measure 3 supports the application of standards that define responsible mining, thereby implementing the principles of the highest standards such as IRMA, UNRMS, ISO 31000, and ISO 14000. Competent authorities should support collaboration with NGOs, the academic community, and other experts to ensure that the implementation of these standards is as effective and transparent as possible. The application of available standards also includes the engagement of experts to assess the impact of mining operations on the environment and local communities, as well as support for research and development projects focused on new technologies for sustainable mining.

7. Key Performance Indicators

Competent organizations and regulatory authorities are obligated to assess the effects of the defined policies and measures. The implementation of specific measures should be monitored by the relevant institution, which must report to the Ministry of Mining and Energy on time. The implementation of the measures will be monitored based on a database and production reports, along with a set of performance indicators (Figure 7.1).

According to Article 43 of the Law on the Planning System of the Republic of Serbia, the Ministry of Mining and Energy shall report to the Government on the results of the implementation of the Strategy no later than 120 days after the end of every third calendar year from its adoption, and through a final report submitted no later than six months after its expiration. Performance indicators and risks at the level of the general and specific objectives of the Strategy are presented in Tables 7.1 and 7.2.

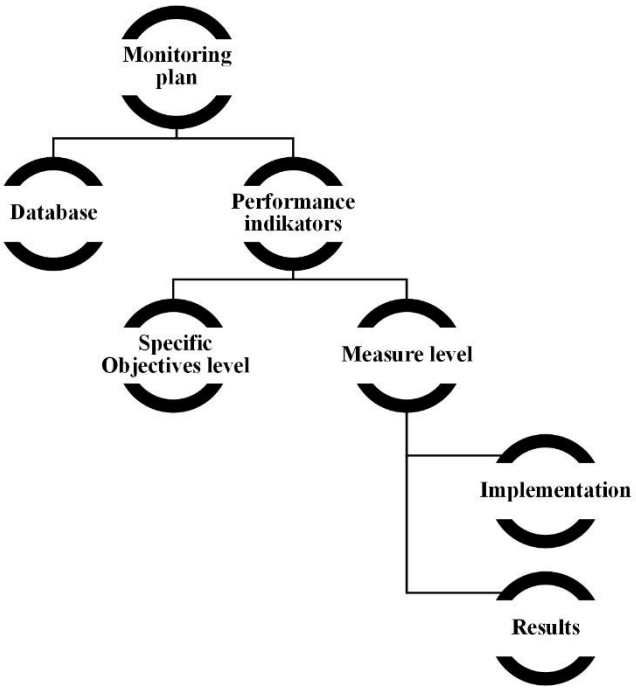

Figure 7.1. *Monitoring Framework*

Table 7.1. Performance indicators at the level of general objectives

General Objective	Indicator	Implementation Risk	Jurisdiction
By 2040 (2050), the Republic of Serbia will be secured with mineral raw materials and other geological resources.	Achieved/planned production of mineral raw materials and other geological resources	• Requirements for reducing the share of coal in electricity generation. • Demand for mineral raw materials. • Lack of reserves of certain mineral raw materials. • Environmental impact.	- Ministry of Mining and Energy - Geological Survey of Serbia
	Achieved/planned investments in the mineral raw materials and other geological resources sector	• Lack of investment funds. • Fluctuation of prices on the stock exchange. • Implementation of investment projects. • Inconsistent legislation.	- Ministry of Mining and Energy - Geological Survey of Serbia
Expansion of the mineral resources base	New/current reserves of mineral raw materials and other geological resources (growth).	• Inaccessibility of information on mineral raw material reserves by categories and classes. • Insufficient number of qualified professionals engaged in the implementation of the measure. • Inconsistent relationship between NGOs, environmental movements, and geology and mining.	- Ministry of Mining and Energy - Geological Survey of Serbia

The following table will present performance indicators and risks at the level of specific objectives and the measures of those specific objectives. Additionally, the table will include the responsibilities of the institutions in implementing the measures. The Action Plan will define, in addition to the indicators and risks, the sources of verification, baseline values for the reference year, and target values for the year in which the achievement or realization of objectives is expected. The Action Plan will define the responsible institutions, an assessment of the required financial resources for the implementation of each measure, and the source of funding.

Table 7.2. Performance indicators at the level of specific objectives and measures

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
1. Integrated sustainable management of mineral and other resources with continuous process innovation and the enhancement of state and corporate control in geological exploration and mining processes, including health and safety	• Degree of implementation of the Strategy according to set objectives / planned degree of implementation of the Strategy. • Changes in the number of social conflicts – total and related to subjects. • Changes in business-economic parameters – total and by subjects. • Change in the number of environmental parameter deviations compared to permissible values – total and by subjects.	**Measure 1:** Implementation of the integrated system for managing mineral and other geological resources for the sustainable development of the mining sector, with optimization of locally and globally changing sustainability components related to stakeholders		
		• Degree of implementation of the planned measures by the objectives of this Strategy – implemented measures/planned measures.	• Economic impacts. • Environmental impacts. • Social impacts. • Geopolitical impacts.	- Ministry of Mining and Energy - Geological Survey of Serbia - Ministry of Environmental Protection
		Measure 2: Efficient implementation of sustainable long-term mining projects		
		• Number of new strategic mining projects / total number of strategic mining projects (growth); • Deadline for issuing permits / current deadline for issuing permits (effective and functional reduction of the deadline) – reduction of the deadline compared to the current state.	• Inconsistent legislative regulation. • Inconsistent relationship between NGOs, environmental movements, and mining. • Insufficient awareness of the importance of mineral and other geological resources at the local community level. • Insufficient number of qualified professionals engaged in the implementation of the measure. • Delay in administration and responsible institutions in implementing the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 3: Establishment and alignment of common measures between different Ministries and industries regarding the implementation of the management system and strategic projects		
		• Number of unresolved projects / total number of projects (effective and functional improvement of the alignment process).	• Inconsistent legislative regulation. • Inconsistent approach of different ministries toward mineral raw materials and other geological resources.	- Ministry of Mining and Energy - Geological Survey of Serbia - Ministry of Environmental Protection - Ministry of Economy - Ministry of Agriculture, Forestry, and Water Management - Ministry of Finance - Ministry of Construction, Transport, and Infrastructure

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
2. Ensuring access to mineral raw materials and other geological resources, and enhancing international cooperation in this field	• Ratio: number of newly discovered deposits/number of known deposits (by mineral raw materials). • Ratio: number of deposits with verified resources and reserves/total number of explored deposits (by mineral raw materials). • Ratio: amount of verified mineral resources and reserves/forecasted demand for 10 years (by mineral raw materials).	**Measure 1:** Increase the types, quantities, and quality of resources and reserves of mineral raw materials in the Republic of Serbia		
		• Total geological reserves/balance reserves (growth in favor of balance reserves). • Balance reserves/non-balance reserves (growth in favor of balance reserves). • Total geological reserves/exploitable reserves (growth in favor of exploitable reserves). • Balance reserves/forecast reserves (growth in favor of balance reserves). • Raw material demand/balance reserves (imbalance between balance reserves and their demand). • Raw material demand/forecast reserves (imbalance between raw material demand and forecast reserves).	• Inaccessibility of information about mineral reserves by categories and classes. • Outdated and inaccurate data in the Mineral Resources Balance of the Republic of Serbia. • Insufficient number of people engaged in the implementation of the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 2: Assessment of the Republic of Serbia's needs for mineral raw materials and other geological resources, based on analyses of existing and potentially deficient mineral raw materials in ore-bearing areas		
		• Quantity of established mineral resources by types (t, m^3) / the needs of the Republic of Serbia for those resources (establishing a balance between the quantity of established mineral resources and the needs of the Republic of Serbia for them).	• Inaccessibility of information on mineral reserves by categories and classes. • Insufficient exploration of certain mineral resources. • Insufficient number of qualified personnel engaged in the implementation of the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 3: Monitoring the extent to which resources, reserves, and the exploitation of mineral raw materials are integrated into spatial plans for various purposes		
		• Ratio of areas where mining activities are taking place / total number of mineral-rich areas, with a 5-year status update (balanced and harmonized ratio); • Ratio of areas where there is no active mining production but where exploitable minerals have been identified / total number of mineral-rich areas, with a 5-year status update (harmonized ratio); • Ratio of areas with geological assumptions of the possibility of discovering new mineral resources / total number of mineral-rich areas, with a 5-year status update (balanced and harmonized ratio); • Areas where geological exploration work of significant scope is being conducted or planned / total number of mineral-rich areas, with a 5-year status update (balanced and harmonized ratio).	• Insufficient number of professionally qualified individuals engaged in the implementation of the measure. • Unharmonized legal regulations defining the field of geological research and mining to the Spatial Planning Law. • Insufficient consideration of geological foundations during the preparation of spatial and urban planning documents.	- Ministry of Mining and Energy - Geological Survey of Serbia

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
3. Prospecting, exploration, and geological documentation of resources and mineral deposits and other geological resources	• Ratio: Number of documented and assessed anomalies and occurrences of mineral resources / total number of anomalies and occurrences of mineral resources (by types of anomalies and types of mineral resources). • Ratio: Number of documented and assessed mineral resource deposits (by mineral resources / total number of mineral resource deposits (by mineral resources). • Ratio: Number of newly discovered and explored geothermal energy resources / total number of known geothermal energy resources.	**Measure 1:** Documentation and geological-economic evaluation of the results of exploration of mineral deposits and occurrences in the Republic of Serbia, along with establishing cooperation between the competent administrative authority, the Geological Survey of Serbia, and economic entities, to support investment in exploration activities		
		• The ratio of new data / total data (growth of information).	• Insufficient number of professionally qualified personnel engaged in the implementation of the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 2: Identification and exploration of new geothermal energy resources and making them available for use		
		• Total installed capacity based on geothermal resources (geothermal plants, geothermal power plants, building applications) / total installed capacity in the base year (growth).	• Low investment in research and development. • Lack of awareness about the importance of geothermal energy. • Lack of resource protection mechanisms (e.g., development of geothermal doubles, etc.). • Collaboration between different ministries.	- Ministry of Mining and Energy - Geological Survey of Serbia - Ministry of Construction, Transport, and Infrastructure
4. Ensuring favorable legal conditions for the development, modernization, and investment in geological exploration and sustainable mining with a service-oriented approach	• Ratio: Number of new legal documents (laws, regulations, decrees, etc.) implemented / Number of planned documents. • Ratio: Number of dialogues with stakeholders and provide information / Number of required dialogues and information.	**Measure 1**: Activities aimed at addressing institutional issues and improving the work of the Geological Survey of Serbia		
		• The ratio of total achieved results (number of implemented projects) / number of existing results (number of planned projects - growth). • The ratio of the total number of geological maps produced / number of geological maps planned for production (growth)	• Insufficient number of professionally qualified staff in the implementation of the measure. • Delay in administration and decisions of competent institutions in the implementation of the measure. • Lack of accredited laboratories.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 2: Improvement of the legislative framework in the area of classification of mineral resources and reserves, methodology for preparing preliminary feasibility studies, and feasibility studies according to international standards (PERC, CRIRSCO standards, and in line with UNFC)		
		• The ratio of the number of new, amended, and supplemented legal acts/the existing scope of legal acts (qualitative and quantitative improvement of legal acts); • Adopted classification of resources and reserves under the proposed standard (yes/no); • Adopted methodology for the preparation of feasibility studies (yes/no).	• The insufficient number of professionally qualified staff engaged in the implementation of the measure. • Delay in administration and decisions of the competent institutions in the implementation of the measure. • Lack of understanding of the importance of standardizing reporting.	- Ministry of Mining and Energy - Geological Survey of Serbia - Local Government

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
		Measure 3: Allocation of responsibilities and improvement of information flow among stakeholders in the mining industry		
		• The ratio of the total number of dialogues with stakeholders with a positive outcome / total number of dialogues held; • The number of provided information / the number of requested information.	• An insufficient number of professionally qualified staff engaged in the implementation of the measure. • Delays in administration and decisions by competent institutions in the implementation of the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 4: Digitalization of geological plans and documentation, introduction of e-government in the field of geological research and mining activities		
		• Ratio: number of achieved results/number of planned results (by types of documents); • Ratio of the total number of achieved results/number of planned results for the introduction of e-government; • Adopted classification of resources and reserves under the proposed standard (yes/no); • Adopted methodology for the preparation of feasibility studies (yes/no).	• An Insufficient number of qualified staff engaged in the implementation of the measure. • Delays in administration and decisions of the competent institutions in the implementation of the measure. • Lack of financial and material resources for the implementation of the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia
		Measure 5: Concession for geological exploration and exploitation of mineral raw materials.		
		• The ratio of the number of amended and supplemented legislative acts to the existing scope of legislative acts (qualitative and quantitative improvement of legislative acts). • Financial performance after the introduction of new legislative regulations compared to the financial performance of the old legislative regulations (growth).	• Insufficient number of professionally qualified staff involved in the implementation of the measure. • Delays by competent state authorities in adopting legislative acts and monitoring the achieved effects.	- Ministry of Mining and Energy - Ministry of Economy - Ministry of Finance - Geological Survey of Serbia
5. Strategic spatial protection of mineral deposits and other geological resources	• Number of precisely defined criteria for selecting strategically important mineral raw material deposits and areas according to the proposed classification methodology/total number of identified criteria.	**Measure 1:** Monitoring the effectiveness of the adopted criteria for selecting strategically important mineral deposits and their classification into the group of deposits under special protection.		
		• The ratio of the number of strategically important raw materials/total number of identified raw materials (documented and justified increase); • Ratio of the number of strategically important mineral deposits/total number of mineral deposits (documented and justified increase).	• Insufficient number of professionally qualified staff involved in the implementation of the measure. • Delays by competent state authorities in adopting legislative acts and monitoring the achieved effects. • Inconsistent legal regulations.	- Ministry of Mining and Energy - Geological Survey of Serbia - Ministry of Construction, Transport, and Infrastructure - Spatial Planning Agency. - Local Government

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
	• Number of harmonized planning documents that include strategically important mineral resources and areas / total number of planning documents (by type of document and type of mineral resource).	**Measure 2:** Incorporation of representations of mineral deposits into planning documents, with a special focus on deposits of strategic importance, aligning the processes of geological exploration, environmental protection, and sustainable development.		
		• The ratio of the number of completed documents (by type) / total number of planned documents (by type) (growth); • Number of completed activities promoting geological exploration and mineral resource exploitation/number of planned activities.	• Insufficient number of professionally qualified staff involved in the implementation of the measure. • Delays by competent state authorities in adopting legislative acts and monitoring the achieved effects. • Inconsistent legal regulations.	- Ministry of Mining and Energy - Geological Survey of Serbia - Ministry of Construction, Transport, and Infrastructure - Spatial Planning Agency. - Local Government
6. Ensuring access to and exploitation of technogenic raw materials and supporting the development of the circular economy	• The ratio of production from technogenic materials compared to the previous year (growth). • The ratio of defined technogenic resources compared to the previous year (growth).	**Measure 1:** Inventory of mining waste dumps and assessment of their potential for utilization		
		• Number of active landfills and tailings (technogenic sources) / total number of landfills and tailings (growth); • Number of old unremediated landfills and tailings (potential technogenic sources) / total number of old unremediated landfills and tailings (growth).	• Partially inaccessible information on active and abandoned landfills and tailings (deposits) of SRM materials by categories and classes (UNFC categorization). • Insufficient number of professionally qualified staff involved in the implementation of the measure. • Misalignment with spatial planning documents in mining regions and legal regulations for exploitation, and slow reform and codification of regulations.	- Geological Survey of Serbia - Ministry of Mining and Energy - Local Government
		Measure 2: Raising awareness about the importance of recycling Secondary Raw Materials (SRM) and sustainable resource management		
		• The number of held meetings, printed publications, workshops, etc., in years when the importance of SRM is promoted, and the number of activities held in the previous year (growth).	• Low social acceptance of mining and processing activities by local communities and NGOs. • Land use conflicts and implementation of Natura 2000. • Insufficient number of professionally qualified staff involved in the implementation of the measure. • Gaps in covering the entire REE value chain in higher education institutions and their programs.	- Ministry of Mining and Energy - Geological Survey of Serbia - Local Government

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
		Measure 3: Development of raw material recovery from waste (especially strategic and critical raw materials), including the development of technology for processing such waste. In addition to using ash from thermal power plants for the cement industry and road construction, exploring the possibility of processing into new products such as humic acids, graphene, filters for water and exhaust gases, etc.		
		• The ratio of the number of newly adopted technologies to the existing number of technologies in use (growth).	• Energy and environmentally demanding extraction processes. • Low interest from companies in exploitation due to high processing costs. • Low investment in research and development of new technologies compared to the EU average. • Gaps in covering the entire REE value chain in higher education institutions and their programs. • Patent protection that limits the spread of technology. • Insufficient number of professionally qualified staff involved in the implementation of the measure.	- Ministry of Mining and Energy - Geological Survey of Serbia - Ministry of Science, Technological Development, and Innovation
		Measure 4: Improvement and harmonization of legislative regulations with EU legislation regulating the principles of SRM management.		
		• The ratio of harmonized and amended legislative acts / total number of acts in the EU (growth).	• Delay of relevant state authorities in harmonizing legislative acts and monitoring achieved effects. • A small number of trained and certified professionals for harmonizing current methods for resource assessment with the UNFC.	- Ministry of Mining and Energy
7. Expanding knowledge and continuously strengthening the key competencies and capabilities of the professional staff, along with broad public education	• The ratio of enrolled students in the fields of mining and geology compared to the base year (growth). • The number of licensed mining and geology engineers / total number of mining and geology engineers (growth).	**Measure 1:** Expanding and promoting knowledge related to geology and mining to raise public awareness about the measures that will be implemented		
		• The number of conferences, printed publications, workshops, etc., held in years promoting mining and highlighting implemented and planned protective measures / the number of activities held in the previous year (growth). • The introduction of geology as a subject in secondary education.	• The poor reputation of mining in society. • Prejudices about mining held by the local population regarding its environment impact. • Negative attitude of some non-governmental organizations in the field of environmental protection, which spread misinformation to the public and exaggerate the dangers and impact of mining operations and geological surveys.	- Ministry of Mining and Energy - Association of Engineers and Technicians of Mining and Geology - Ministry of Education - Universities - Geological Survey of Serbia
		Measure 2: Introducing dual education at the secondary school level in the fields of mining and geology		
		• Number of occupations within dual education in the field of mining and geology/total number of occupations in the field of mining and geology (growth).	• Legal regulations in the field of occupational safety (mining practice is not allowed for minors), which has been incorrectly interpreted as applying to surface mines as well. • The interest of large mining companies in opening	- Ministry of Education - Ministry of Mining and Energy - Agency for Qualifications

Specific Objective	Performance Indicator of a Specific Objective	Performance Indicator of Measures	Implementation Risk	Jurisdiction
		Measure 3: Optimization and modernization of higher education in the fields of mining and geology		
		• Number of rationalized study programs / total number of study programs in the field of mining and geology (justified and functional rationalization).	• Lack of interest from universities in changing curricula. • Incompatibility of universities in the Republic of Serbia with other universities in the EU.	- Ministry of Science, Technological Development, and Innovation - Ministry of Education - Universities
		Measure 4: Expanding the knowledge of employees in the mining and geology sector		
		• Number of training sessions, workshops, courses held in the year/number of activities held in the previous year (growth); • Number of issued licenses / total number of licenses (growth).	• Lack of interest among employees for continuous improvement. • Lack of interest from mining and geological companies for employee development. • Lack of financial resources. • Inactivity of professional associations. • The lack of licenses in this field leads to the need for license renewal and knowledge upgrades. • Lack of financial resources.	- Ministry of Science, Technological Development, and Innovation - Ministry of Mining and Energy
8. Sustainable mining industry with incentives for joint infrastructure investments, research, innovation, and control of environmental degradation	• Number of companies that have integrated standards / total number of mining companies. • Number of annual conflicts by causes/number of conflicts by causes in the baseline year (decline).	**Measure 1:** Coordinated joint investments in infrastructure for the growth of the mining industry and stimulating research and innovation.		
		• Number of completed projects / total number of projects (growth).	• Lack of projects and financial resources. • Long implementation period. • Insufficient interest and awareness for implementation.	- Ministry of Economy - Ministry of Mining and Energy - Ministry of Construction, Transport, and Infrastructure
		Measure 2: Transparency and implementation of sustainability in mining industry projects and control of environmental impacts, mine closure processes, and waste management.		
		• Number of incident situations in the current year/number of incident situations in the previous year (decline); • Alignment of legal regulations in the Republic of Serbia / legal regulations in the EU (growth).	• Inertia in adopting legal regulations. • Insufficient interest and awareness for implementation. • Lack of financial resources.	- Ministry of Mining and Energy - Ministry of Environmental Protection. - Local Government
		Measure 3: Implementation of standards that define sustainable and responsible mining.		
		• Number of companies using IRMA (or a similar standard) / total number of companies (growth).	• Insufficient interest in mining companies in implementing such standards. • Insufficient awareness of the importance of applying these standards. • Lack of legal obligation	- Ministry of Mining and Energy - Ministry of Environmental Protection - Chamber of Commerce - NGOs - Institute for Standardization - Local Government

8. Mechanism for the Implementation of the Strategy

The Ministry responsible for geological exploration and mining will oversee the implementation of the Strategy through monitoring, coordination, reporting, and evaluating its performance. Its role includes supervising the achievement of strategic goals, periodic reporting on results, as well as analyzing success indicators within established deadlines.

Deadlines for data submission and reporting will be defined according to the needs of regular monitoring and evaluation. This will ensure the timely collection and analysis of relevant information, allowing for adjustments in the implementation of planned measures.

An Action Plan for the Strategy will be developed to manage the implementation of public policy measures. This plan will represent the most detailed public policy document. It will be aligned with Articles 18-22 of the Planning System Law of the Republic of Serbia (“Official Gazette of RS”, No. 30/18).

Adoption and updating of action plans

- The first Action Plan will be adopted within 90 days from the date of adoption of the Strategy, with a validity of three years.
- New Action Plans will be adopted in line with the objectives of the Strategy and current needs, with regular updates to adapt to changes in the sector and new challenges.
- Action plans will be prepared according to Article 22, Paragraph 5 of the Regulation on the Methodology for the Preparation of Public Policy Documents ("Official Gazette of RS", No. 20/25) and will include clearly defined steps, deadlines, and responsible institutions for each measure.

Financing and Sustainability

The financing of the Strategy's implementation relies on state budget funds, European Union and international organization funds, as well as private sector investments and strategic partnership models.

Budget funds are intended for strengthening institutional capacities, improving oversight of geological exploration and exploitation, and developing basic and detailed geological exploration for the assessment of mineral resources and the definition of strategic deposits.

Funds from the European Union and international organizations are directed toward the sustainable development of the mining sector, environmental protection, improvement of technological innovations and digitalization, as well as education and professional training of staff. They also promote energy efficiency and the exploration of critical minerals necessary for the energy transition.

Given the predominant private financing of projects in this sector, cost estimation depends on various factors, including the state of the mineral resources market, global economic trends, investment availability, regulatory frameworks, environmental standards, as well as technological and infrastructural conditions for project implementation.

9. Final Considerations

A sustainable Strategy for the Management of Mineral and Other Geological Resources represents systematic planning of all aspects of the field of mineral resources, based on the broadest consensus and a shared vision of the country, business entities, regional and local governments, and the scientific and professional public. It is also a socially, economically, and environmentally justified and generally required activity aimed at realistically achievable goals in the regulation, organization, management, and protection of the mineral and other geological resources of the Republic of Serbia. Such a conceptually developed Strategy should be promoted as one of the most complex and significant mechanisms of modern management of non-renewable mineral resources, as well as of the overall area where these mineral raw materials are located. In addition to defining the position, role, and optimal ways of developing the exploitation of non-renewable mineral resources, the Strategy also addresses the analysis of water potential and the use of surface and underground waters, geothermal energy, various aspects of geotechnical and other activities, assessment of the current state, and proposals for its improvement.

The goal of developing the Strategy is based on the need to reduce contradictions, i.e., to reassess existing and identify new models of managing the mineral raw materials sector and other geological resources. In the mineral raw materials sector, one of the key sectors for the country's economic development, unclear management models currently prevail, resulting in a modest valorization of the sector's overall potential and an inadequate contribution of the sector to the economic and social development of the country.

The development of the Strategy reflects the desire of the state, business entities, and the professional public to define a coherent, valid, and practically applicable platform for the mineral raw materials sector. This platform should ensure the sustainable management of mineral resources based on solutions acceptable to all stakeholders. Through the Strategy, mineral resources, as well as mining and geological activities, are placed within the broader context of the country's overall socio-economic sustainable development.

The Strategy is a document intended to comprehensively analyze the state of all mineral resources available to the Republic of Serbia, as well as to assess the current and define the future position of the state in terms of the development and use of its mineral raw material potential. The Strategy should demonstrate how to best manage mineral resources in a way that maximizes economic growth while minimizing harmful impacts on the environment.

Strategic planning in the development of mineral resources and the mining sector of the Republic of Serbia, as presented in the Strategy, ensures that future management is conducted based on broad consensus and a shared vision among all stakeholders, to create a more prosperous and, above all, sustainable common future. These activities involve identifying key parameters and reaching agreement on the most important goals in the mining sector, as it is far better to manage development processes in a systematically pre-agreed manner than to leave them to chance. In other words, the development of the Strategy is the essential opposite to lack of organization and the reactive mitigation of the consequences of mining activities in the absence of such a framework. In this way, the Strategy can be characterized as a socially, environmentally, and sociologically justified, and generally necessary, activity aimed at realistically achievable goals in the regulation, organization, management, and protection of the territory and mineral resources of the Republic of Serbia. These conceptually defined goals establish the Strategy as one of the most complex and important mechanisms of modern spatial management and its long-term and purposeful development prospects. The alternative to rejecting the proposed concept and goals of the Strategy is the continuation of the already advanced economic, resource-based,

environmental, and other degradation of the mining sector, and thus the narrowing of the overall development prospects of the Republic of Serbia.

The proposed approach to mineral resources and mining should result in significantly improved, or maximally possible, valorization of the sector's overall potential and its appropriate contribution to the economic and social development of the country while ensuring maximum environmental protection. The strategic document should reflect the shared intent of the state, business entities, and the professional public to define a coherent, transparent, valid, and realistically applicable platform for the mineral resources and mining sector. This platform should ensure sustainable management of resource potential based on solutions acceptable to all stakeholders.

The proposed concept and methodology for developing the Strategy have made it possible to comprehensively define both general and specific objectives, as well as the corresponding measures and activities for their implementation, based on the completed foundational studies. In line with good practice, the Strategy should be periodically updated by adjusting the implementation of strategic programs according to unpredictable changes in resources, geopolitics, the economy, and society.

The proposed framework of goals and the proposed measures for their implementation are not and should not be final. However, at this point, given the comprehensiveness, they provide a solid foundation on which a high-quality, realistic, and comprehensive Action Plan can be built for achieving both short-term and long-term objectives related to the management of mineral resources and the development of the mining sector in the Republic of Serbia. What is crucial for success is the dynamics of implementing the individual strategic directions and programs. Due to the current position of the mining and mineral resources sector, it is particularly important to immediately and simultaneously begin implementing all the objectives. Considering the different scopes of each, and respecting the proposed timeline, synchronized completion of all planned activities can be achieved, and in just a few years, the mineral resources and mining sector can be fully regulated in terms of legislation, institutions, and strategy. Finally, since circumstances relevant to determining optimal management policies change over time, the Strategy will fully achieve its goal if it serves as a foundation for establishing a system of sustainable management of mineral resources and the development of the mining sector over time. Only by establishing an effective system that recognizes, respects, and includes all relevant actors and stakeholders will mineral raw materials transition from what they often are today a source of unnecessary and unjustifiably artificially induced problems, conflicts, and frustrations into what they objectively can be: a significant element of the overall, harmonious, and sustainable development of the country.

With knowledge of the geological potential of the Republic of Serbia, as well as the need to improve the mining industry, and considering the turbulent events in the global mineral raw materials and capital markets, the realization of a viable development option is highly likely. This option envisions the necessary development of the energy mineral raw materials sector to maintain the country's energy stability and independence, as well as the essential development of the sector for metallic and non-metallic industrial and other mineral raw materials - primarily critical minerals for the Republic of Serbia and the EU, within the scope of already initiated projects by foreign companies, and future planned infrastructure development in the country. It is particularly important to highlight that for all these mineral raw materials, production capacities based on exploitation can already be planned, designed, and constructed today, which only increases the reliability of this development option.

Through the previous Sections, all answers to the fundamental questions have been provided, either in brief or in more detail:

- **What kind of mining does the Republic of Serbia need?**

The Republic of Serbia needs modern, productive, and environmentally acceptable mining that will ensure a secure and reliable supply of raw materials to the energy and industrial sectors. Serbia should take a proactive role in applying the principles of sustainable development in the mining and processing sectors, ensuring that mining and processing are in line with established EU guidelines and best practices. A sustainable increase in the production of mineral raw materials in the Republic of Serbia represents a significant step towards achieving these goals, while simultaneously gaining practical experience in implementing a sustainable mining strategy. Incentives for the use of environmentally suitable mineral raw materials, quality certification of processes and products, and the enforcement of penalties through environmental taxes should be the main mechanisms for driving reforms in the mining sector.

- **What is the long-term goal of the Strategy?**

The long-term goal of the Strategy for Mineral Resources is to develop an active mining sector that is globally competitive, ensures a supply of raw materials, supports regional development, and promotes responsible use of natural resources. The mining sector has a significant direct and indirect impact on the national economy, employment, and society as a whole. The mining sector is already well positioned to serve as a platform for a sustainable and diversified export-oriented industry based on the value addition of mineral products, related technologies, and services. Additionally, the vision for mining includes achieving maximum product finalization from mineral resources extracted in Serbia, which is only possible through the establishment of an optimal legislative framework and a favorable business environment for the mining sector. As a specific long-term goal, the strategy emphasizes the use of underground water as the highest quality method for supplying the population with water, and the utilization of geothermal resources as one of the most important renewable energy resources in the Republic of Serbia. Therefore, the vision of this strategy is based on enhancing knowledge and skills combined with research and development of innovations, as a foundation for sustainable growth in the mining sector.

- **What type of mining exists in EU countries and the region?**

In recent decades, there has been a significant decline in mining activities in the EU, especially in coal extraction. However, due to global geopolitical events at the world level and the EU's need for a secure supply of critical mineral raw materials, an expansion in the production of critical minerals is expected within the EU. To secure its economy with the necessary raw materials, the EU is also relying on countries that are currently not its members, which will open the door for faster integration and full membership for the Republic of Serbia.

- **What are the modern principles of mining development?**

Today, global and European mining practices undoubtedly prioritize the sustainable development of mining activities and the management of mineral resources, which implies a balanced relationship between the economic, ecological, and sociological components. The ethically and environmentally based Mineral Policy, grounded in the principles of sustainable development, relies on three pillars: economic, ecological, and sociological. The standard response of the mining sector to the demands of sustainable development is the rational management of mineral raw materials as the only non-renewable resource, the location of which cannot be changed in the context of sustainable management of the entire space with all its components. The main goal of sustainable management is to meet the growing demand for raw materials while continually striving to ensure that naturally and geologically conditioned mining activities are simultaneously a positive factor, given their overall impact on the environment, population, and other elements within the space.

- **What types of mineral raw materials exist in the Republic of Serbia?**

The Republic of Serbia owns numerous and very diverse mineral raw materials. Generally, they can be divided into three groups: metallic, non-metallic, and energy. The dominant economic significance within the metallic mineral resources group lies in the base metals (copper, lead, and zinc) and precious metals (gold and silver), followed by lithium, alloying metal resources (nickel, cobalt, molybdenum, tin, tungsten, antimony), ferrous metal resources (iron, manganese, chromium, titanium), nuclear mineral resources (radioactive metals – uranium), and light metal resources (aluminum). Other metallic mineral resources are of subordinate importance (rare metals and rare earths, such as niobium-tantalum, rhenium, etc.). In the group of non-metallic mineral raw materials, those that stand out in terms of mineral resources and reserves include: raw materials for technical and construction materials, architectural and construction stone, carbonate raw materials, brick-making raw materials, construction materials, borates, magnesite, quartz raw materials, cement raw materials, zeolite, ceramic raw materials, loess, sand, marlstone, pozzolanic tuff, asbestos, and others. The group of energy mineral raw materials includes coal, oil, natural gas, oil shale, geothermal waters, and other renewable energy sources (petrogeothermal, etc.). Groundwater is one of the most significant geological resources available to the Republic of Serbia. This resource includes groundwater used for water supply, waters of special value (for bottling), mineral waters, and thermal and geothermal waters as natural sources of heat and electricity.

- **What types of mineral raw materials are needed for the development of modern society in the Republic of Serbia?**

The European Raw Materials Initiative places a strong emphasis on the efficient use of resources and the development of new technologies. Alignment between EU goals and national strategic objectives ensures further opportunities to strengthen the mining sector in the Republic of Serbia by applying for EU assistance in developing new mining equipment and processing technologies.

The Republic of Serbia has an active mineral industry, an extensive metallurgy industry, and significant potential for further production of critical minerals. The exploitation of ores and the production of metals is important not only for achieving green Serbian and European value chains but also for the role of the Republic of Serbia as a strategic partner. Serbia should become a stable long-term producer of raw materials necessary for the green transition.

Ensuring a long-term stable supply of mineral raw materials, Serbia should actively participate in overcoming and eliminating barriers to international trade, while simultaneously promoting good governance and transparency in the country's mineral development policy. At the same time, this could increase the export potential of Serbia's industry and enhance Serbia's international influence and support in raising awareness about the impacts and related responsibilities of mineral raw material consumption. A special goal is to process the majority of raw materials into higher value-added levels (up to finalization) and to enable part of the mineral raw materials currently exported as concentrates to be prioritized and returned (sold) to Serbia, such as gold, platinum, etc.

- **What are the proven reserves of mineral raw materials in the Republic of Serbia?**

The established mineral reserves in the Republic of Serbia, presented in Section 2, are significant, with large mineral potential and opportunities for their increase. Metallic mineral raw materials are defined through their economic importance, recognizing primary, secondary, and tertiary significance. Based on the total balance reserves ($A+B+C_1$ categories), as of the end of 2023, the primary economic significance reserves for metals are: Cu 8.079 Mt, Au 311.06 t, Pb 185.15 kt, Zn 413.69 kt, Ag 13,277.5 t. Reserves in the C_2 category of primary economic significance are: Cu 5.51 Mt, Au 638.77 t, Pb 221.5 kt, Zn 368.5 kt.

Outside the territory of Vojvodina, the largest quantities of non-metallic mineral raw materials in the Republic of Serbia, as of the end of 2023, are: technical-construction stone 923,141,457 tonnes, cement raw materials 266,777,782 tonnes, carbonate raw materials 227,540,622 tonnes, quartz raw materials 103,795,714 tonnes, brick raw materials 88,358,976 tonnes, construction materials 21,554,149 tonnes, architectural-construction stone 10,725,250 tonnes, and others. In addition to these, significant reserves of borates, magnesite, zeolite, and ceramic raw materials are also present. According to reserves of non-metallic mineral raw materials in the territory of AP Vojvodina, as of the end of 2023, the largest reserves are of marl 204,943,416 tonnes, brick raw materials 60,640,844 tonnes, limestone 78,604,413 tonnes, and sand 15,612,343 tonnes. Economically significant quantities of ceramic raw materials, loess, sand, gravel, and pozzolanic tuff have also been recorded.

From an economic significance perspective, the primary balance reserves of coal include lignite in quantities of 2,786,622,693 tonnes, secondary brown coal and lignite in quantities of 473,297,825 tonnes, and tertiary hard coal and anthracite in quantities of 3,649,220 tonnes. The total balance reserves of all types of coal in the Republic of Serbia are 3,263,569,738 tonnes.

Balance reserves of oil, condensate, and natural gas in the Republic of Serbia are: oil 10,004.19 $\times 10^3$ tonnes; dissolved gas 1,156.61 $\times 10^6$ m³; gas - gas caps 1,234.78 $\times 10^6$ m³; condensate 812,020.66 tonnes; free gas 6,808.87 $\times 10^6$ m³; gas - CO2 2,272.64 $\times 10^6$ m³.

The total balance reserves of oil shales in Serbia amount to 352,759,195 tonnes with a total moisture content of 1.32-1.42%, ash content of 72.75%, total sulfur content of 2.20-3.40%, lower calorific value of 5.86-7.22 MJ/kg, organic substance content of 16.45-18.83%, and oil yield of 9.9-12.5%.

- **What is the importance of groundwater in the Republic of Serbia?**

Underground waters represent an extremely important resource for various purposes because they are renewable and, to some extent or completely, protected from external factors, including pollution. Due to their "better" quality compared to surface waters, underground waters are given priority in use for any purpose. For the needs of water supply to settlements and cities in the Republic of Serbia with quality drinking water, underground waters contribute 75% of the total water quantities. The total yield from underground water sources in Serbia is about 23 m³/s, which is only about 30% of the renewable reserves from the total estimated underground water reserves. With the application of artificial replenishment, an additional 40 m³/s could be secured.

In addition to supplying drinking water to the population, underground waters account for 100% of the participation in bottled waters ("carbonated" mineral waters and low-mineralized drinking waters), spa centers for balneological and sports-recreational purposes, as well as in the food industry and the production of alcoholic and non-alcoholic beverages. The use of thermo-mineral waters in spa centers in the Republic of Serbia is a key factor for the development of tourism, as Serbia possesses over 200 occurrences and facilities with thermo-mineral waters, making it one of the richest countries in Europe in this regard.

In order to properly and sustainably manage underground water resources, it is necessary to adhere to a strategy that, in addition to analyzing and assessing the current state of the resource, includes long-term objectives and measures that need to be implemented to achieve these goals.

- **What is the importance of geothermal energy resources in the Republic of Serbia?**

The Republic of Serbia possesses one of the largest geothermal potentials in Europe. The development of the geothermal energy sector involves investments in resource exploration and exploitation technologies, along with the simultaneous development of financial support mechanisms and affirmative legislation.

In the coming decades, significant growth in the development of geothermal resources in Serbia is expected. Therefore, it is of crucial importance to create a comprehensive development strategy that will define the main directions for the exploration and exploitation of these resources. This strategy will be focused on the sustainable use of geothermal energy through activities such as the creation of studies on the geothermal potential of the Republic of Serbia, the development of a geothermal atlas that will provide an overview of available resources, promoting the use of geothermal resources in district heating systems, developing technologies for district cooling using underground waters as a sustainable energy source, developing technologies for converting abandoned oil wells into geothermal energy sources and researching and applying technologies to obtain critical mineral raw materials from high-temperature geothermal waters.

- **What are the determined reserves of groundwater in the Republic of Serbia?**

The total reserves of groundwater established for the year 2022 are as follows: Category A reserves amount to 2,514.3 l/s, Category B reserves to 12,290.91 l/s, and Category C reserves to 8,735.58 l/s. In the territory of the Republic of Serbia, including the water sources of public urban and rural water supply systems and the water sources of economic entities, the total is 25,613.04 l/s. The exploitation reserves amount to 807,543,613.4 m³ annually. In 2022, the produced amount was 251,577,457.5 m³.

The estimated reserves of groundwater in the Republic of Serbia without an artificial recharge, as presented in Section 2, include alluvial deposits, MAS of Vojvodina, neogene deposits, karst environments, and fissured environments. The total quantities for Bačka, Banat, Srem, Mačva, central, eastern, southwestern, and western Serbia amount to 67.13 m³/s.

- **What are the determined reserves of geothermal resources in the Republic of Serbia?**

The temperature of geothermal waters ranges from 20°C to 72°C. The balance reserves of geothermal waters for the area of AP Vojvodina are presented in Section 2. The total reserves, as the sum of reserves from categories A, B, and C, amount to 349.5 l/s. The exploitation reserves are 11,021,832 m³ annually. The total balance reserves of mineral, thermal, and thermo-mineral waters for the area of AP Kosovo and Metohija amount to 396.56 l/s, with annual exploitation reserves of 12,505,916 m³.

- **What is the potential of geothermal resources in the Republic of Serbia?**

The estimated current capacity of geothermal resources for the production of heating and cooling energy in buildings is 150 to 200 MWt, while the planned capacities for the period from 2040 to 2050 are 2,500 MWt. There are currently no capacities for electricity generation and cogeneration of energy, but for the same period, a capacity of 50 MWe for electricity generation and 200 MWe for cogeneration of energy is planned. A detailed overview of the geothermal resource potential is provided in Section 2.

- **What is the production and consumption of mineral raw materials in the Republic of Serbia?**

The production of mineral raw materials in Serbia in 2022 amounted to around 110 million tons, with lignite having a dominant share. In the last six years, there has been a significant increase in the production of copper (360%) and gold (766%). However, due to problems in coal production for the supply of thermal power plants, coal imports have drastically increased in recent years.

- **How is mining activity regulated under the current legal framework of the Republic of Serbia?**

In the Republic of Serbia, unfortunately, there is currently no Strategy for the management of mineral and other geological resources, and the management of mineral resources is carried out sporadically, without a clear development direction and strategic decisions being made. In the field of geological research, a draft of the Long-Term Program for the Development of Basic Geological Research has been created but has not been adopted. In the field of surface coal exploitation, it is necessary to adopt a new long-term exploitation plan within EPS, as well as a long-term copper exploitation program within the company ZiJin. In 2016, the Government of the Republic of Serbia adopted the Water Management Strategy for the territory of the Republic of Serbia until 2034 and the Water Management Action Plan for the territory of the Republic of Serbia for the period 2024 to 2026.

- **What are the institutional frameworks for resolving issues within the mining sector?**

Similar to most other countries around the world, the Geological Survey of Serbia is a state-owned organization, predominantly financed by funds from the budget of the Republic of Serbia. The Geological Survey of Serbia is an institution engaged in conducting basic and entrusted applied geological exploration of mineral resources. The responsibilities of the Geological Survey of Serbia include implementing tasks defined by the Long-Term Program for the Development of Basic Geological Exploration in the Republic of Serbia and the Annual Program for Conducting Basic Geological Exploration, as well as other strategic tasks of national importance.

The Mineral Resources Exploration Sector of the Geological Survey of Serbia is understaffed, as it lacks sufficient geological expertise to carry out the research process across all domains of basic geological exploration of mineral resources. It is necessary to reorganize the Geological Survey and innovate its strategic status, as well as strengthen its human resources and laboratory potential. Additionally, there is a need to enhance the scientific potential of laboratories and research centers in institutions that are the key drivers of scientific development in the fields of mining and geology.

- **Can the current legal framework ensure a quality balance between mining and environmental protection?**

The existing legal framework must be changed and adjusted to the recommendations of the EU and the UN, as well as to the standards related to responsible and sustainable mining.

- **What are the obligations of the Republic of Serbia towards the harmonization of legislation with the EU legislation?**

The Stabilization and Association Agreement with the European Union, the acquisition of candidate status for EU membership, and the opening of accession negotiations have accepted that the Republic of Serbia's final goal is full alignment with the system, values, and legislation of the European Union, which should lead to its full membership in the EU. The Strategy for the Management of Mineral and Other Geological Resources of the Republic of Serbia is connected to negotiation chapters 15 (Energy), 27 (Environment, subgroups: waste and climate), and 20 (Entrepreneurship and industrial policy, subchapter: industrial policy).

Mineral resource management particularly encompasses environmental protection, which is a key component of sustainable development. The European Union and the international community have set various legal and political frameworks to ensure that the exploitation of mineral resources is in line with the principles of sustainability and environmental protection. This chapter reviews EU public policies, international initiatives, and obligations, as well as best practices in this area.

- **What should be the relationship between mining activity locations and spatial planning documents?**

One of the key strategic commitments of the Spatial Plan of the Republic of Serbia (SPRS) relates to the conservation, rational use, and protection of natural resources, especially those that are scarce and strategically important for the development and quality of life in the Republic of Serbia. The overall balance of water resources, as well as their spatial and temporal distribution, requires extremely careful use and regulation of water, along with a fully secured system for protection against pollution, floods, and unplanned use of water and water-related land. In addition, to ensure timely reservation and protection of space for the rational construction and use of facilities/areas of public interest of national importance, the protection of areas for the development of mineral raw materials and energy resources is established. Sustainable use, protection, and management of mineral raw materials and the development of mining in the Republic of Serbia are planned, based on planning solutions, measures, and policies aimed at the full integration of mineral resources as a non-renewable natural good, mining as an economic activity, and the planned use of land, environmental protection, and sustainable development of local communities.

- **Is the Republic of Serbia professionally equipped to carry out tasks in the field of mining and geology?**

The Republic of Serbia has a long-standing tradition and experienced personnel in the geology and mining sectors. However, over the past fifteen years, there has been a significant decline in interest in the fields of mining and geology, both at the secondary school and university levels. This has already led to a major shortage of qualified professionals, which will become even more pronounced in the coming years. Additionally, the transition to new technologies and the introduction of digitalization, robotics, remote management, and corporate governance, with a focus on higher productivity, efficiency, cost reduction, increased workplace safety, and environmental protection, has created the need for new skills and knowledge. Therefore, a comprehensive reform of education in these fields is necessary. Secondary education is ideal for the introduction of dual education, while at the university level, curricula need to be updated in line with the new demands of the mining and geological professions.

- **What measures and activities are needed for the implementation of the Mineral Resource Management Strategy of the Republic of Serbia?**

The implementation of the stated goals and measures will enable an increase in the physical volume of exploration and sustainable exploitation of all types of mineral resources, as well as the initiation of the use of certain mineral resources that are currently not being exploited. Most importantly, it will lead to the achievement of the long-term strategic goal, which is ***to ensure the present and future needs of the country for mineral resources (especially energy-related and critical mineral resources, as well as water), expand the mineral resource base, and intensify activities related to the prospecting and exploration of mineral resources.***

The implementation of these activities will create the preconditions for realizing the vision: ***By 2040, and looking ahead to 2050, the Republic of Serbia will be an institutionally and economically developed country committed to the sustainable use of mineral resources. Serbia's mineral resource sector will be one of the pillars of the national economy, aligned with EU standards, based on knowledge and efficient resource use while minimizing environmental impacts. The goal is for the majority of extracted raw materials to be processed within the Republic of Serbia, including final-stage processing.***

References

[1] World Mining Data 2023 & 2024. Available at: https://www.world-mining-data.info/?World_Mining_Data___PDF-Files

[2] Statista. Population of the world's continents from 1800 to 2022. Available at: https://www.statista.com/statistics/997040/world-population-by-continent-1950-2020/

[3] Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition. (2020). World Bank Group.
Available at: https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

[4] Material Consumption. OECD Data Explorer
Available at: https://data-explorer.oecd.org/?lc=en

[5] United Nations Economic Commission for Europe: United Nations Resource Management System. Available at: https://unece.org/sites/default/files/2022-04/ECE_ENERGY_GE.3_2022_6.pdf

[6] The Canadian Critical Minerals Strategy. (2022). Government of Canada. Available at: https://www.canada.ca/en/campaign/critical-minerals-in-canada/canadian-critical-minerals-strategy.html

[7] Resilience for the Future: United Kingdom's Critical Minerals Strategy. (2022). Department for Business and Trade and Department for Business, Energy & Industrial Strategy. HM Government. Available at: https://www.gov.uk/government/publications/uk-critical-mineral-strategy

[8] Australia's Critical Minerals Strategy 2023-2030. (2023). Available at: https://www.allens.com.au/insights-news/insights/2023/06/Australias-Critical-Minerals-Strategy-2023-2030/

[9] Critical Mineral Resources: National Policy and Critical Minerals List. (2024). Congressional Research Service, USA. Available at: https://crsreports.congress.gov/search/#/?termsToSearch=Critical%20Mineral%20Resources:&orderBy=Relevance

[10] Critical Raw Material Act. (2024). European Commission. Available at: https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en

[11] Study on the Critical Raw Materials for the EU. (2023). European Commission. Available at: https://op.europa.eu/en/publication-detail/-/publication/57318397-fdd4-11ed-a05c-01aa75ed71a1

[12] Agreement between the Government of the United States of America and the Government of Japan on Strengthening Critical Minerals Supply Chain. (2023). Available at: https://ustr.gov/about-us/policy-offices/press-office/press-releases/2023/march/united-states-and-japan-sign-critical-minerals-agreement

[13] PERC Standard – The PERC Standard for Reporting of Exploration Results, Mineral Resources and Mineral Reserves. Available at: https://percstandard.org/perc-standard/

[14] Lund, J. W. & Toth, A. N. (2021). Direct utilization of geothermal energy 2020 worldwide review. *Geothermics*, (90), 101915. doi: https://doi.org/10.1016/j.geothermics.2020.101915

[15] Миладиновић Б., Петровић Пантић Т., Томић, М. (2023): Биланс ресурса и резерви подземних вода и геотермалних ресурса Републике Србије на дан 31.12.2022. године. Геолошки завод Србије. Београд.

[16] Споразум о стабилизацији и придруживању (ССП), Република Србија, Влада, Канцеларија за придруживање Европској унији (2005). Available at: http://www.parlament.gov.rs/upload/documents/seio/ssp.pdf.

[17] The raw materials initiative — meeting our critical needs for growth and jobs in Europe {SEC(2008) 2741}. Commission of the European Communities, Brussels 4.11.2008. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0699:FIN:en:PDF

[18] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). European Union, EUR-Lex. Available at: https://eur-lex.europa.eu/eli/dir/2010/75/oj/eng

[19] Mining waste. European Commission. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/mining-waste_en

[20] EUR-lex. European Union. Available at: https://eur-lex.europa.eu

[21] A new Circular Economy Action Plan For a cleaner and more competitive Europe. European Union, EUR-Lex, Document 52020DC0098. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0098

[22] Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024. Critical Raw Materials Act. European Commission. Available at: https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en

[23] Paris Agreement. United Nations, 2015. Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[24] Guidelines for the Implementation of the Green Agenda for the Western Balkans, European Union, EUR-LEX, Document 52020SC0223, Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0223

[25] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, European Union, EUR-LEX, Document 02000L0060-20141120. Available at: https://eur-lex.europa.eu/eli/dir/2000/60/2014-11-20

[26] Поломчић, Д., Васић, Љ., Милановић, С., Ристић Вакањац, В., Петровић, Б., Мариновић, В., Бајић, Д., Хајдин, Б., Чокорило Илић, М., Ратковић, Ј. (2021). Водоснабдевање - подземне воде и одрживо управљање ресурсима, 50 година Департмана за Хидрогеологију, Универзитет у Београду, Рударско-геолошки факултет, п. 67-108, Београд.

[27] Миливојевић, М., и др. (1995). *Геотермални ресурси Србије: потенцијалност, стање истраживања, коришћења и могући планови за будућност*. Водни и минерални ресурси литосфере Србије, с. 133-151, Рударско-геолошки факултет, Београд

[28] Martinović, M. & Milivojević, M. (2000). *The Hydrogeothermal model of Mačva*. Proceedings World Geothermal Congress

[29] Stevanović, Z., Milenić, D., Vasiljević, I. & Vraneš, A. (2017). *Study of geothermal resources of Serbia* (potential, exploration and prospects of utilization), GOSPEL Project (GeOthermal Serbian Pilot projects for hEat and eLectricity), University of Belgrade, Faculty of Mining and Geology, Belgrade

[30] Геолошки завод Србије. Нацрт дугорочног програма геолошких истраживања до 2030.

[31] Статистички годишњак, Републички завод за статистику, Република Србија, Београд 2021. ISSN 0354-4206. Available at: https://publikacije.stat.gov.rs/G2021/pdf/G20212054.pdf

[32] Legal framework for mineral extraction and permitting procedures for exploration and exploitation in the EU – Final report, European Union, Publication Office of the European Union. Available at: https://op.europa.eu/en/publication-detail/-/publication/18c19395-6dbf-11e7-b2f2-01aa75ed71a1/language-en

[33] United Nations Resource Management System: Principles and Requirements, Draft for Public Comment. UNECE, September 2022. Available at: https://unece.org/draft-united-nations-resource-management-system-principles-and-requirements

[34] United Nations Framework Classification for Resources. United Nations, UNECE, Update 2019. Available at: https://www.un-ilibrary.org/content/books/9789210046862#:~:text=The%20United%20Nations%20Framework%20Classification,injection%20projects%20for%20geological%20storage

[35] Transforming our world: the 2030 Agenda for Sustainable Development. United Nation, Department of Economics and Social Affairs. Available at: https://sdgs.un.org/2030agenda

[36] Initiative for Responsible Mining Assurance, IRMA. Available at: https://responsiblemining.net/

[37] EU recognizes IRMA as best standard for responsible mining. National Committee of the Netherlands. Available at: https://www.iucn.nl/en/news/eu-recognizes-irma-as-best-standard-for-responsible-mining/

[38] Critical Minerals Market Review 2023. International Energy Agency (IEA). Available at: https://www.iea.org/reports/critical-minerals-market-review-2023

[39] Responsible Development Plan. (2018). Ministerstwo Roywoju Poland. Available at: https://www.gov.pl/web/fundusze-regiony/plan-na-rzecz-odpowiedzialnego-rozwoju

[40] National Raw Material Policy. (2022). Ministry of Climate and Environment. Available at: https://www.gov.pl/web/climate/national-raw-materials-policy

[41] Energy Policy of Poland until 2040. (2021). Ministry of Climate and Environment. Available at: https://www.gov.pl/web/climate/energy-policy-of-poland-until-2040-epp2040

[42] The 2030 National Environmental Policy - the Development Strategy in the Area of the Environment and Water Management. (2019). Monitor Polski. Available at: https://climate-laws.org/documents/the-2030-national-environmental-policy-the-development-strategy-in-the-area-of-the-environment-and-water-management_65da?q=Danish&id=the-2030-national-environmental-policy-resolution-no-67-of-the-council-of-ministers_a5d8

[43] Finland's Minerals Strategy. Available at: http://projects.gtk.fi/minerals_strategy/index.html

[44] Sweden's Minerals Strategy For sustainable use of Sweden's mineral resources that creates growth throughout the country. (2015). Government Offices of Sweden. Available at: https://www.government.se/reports/2013/06/swedens-minerals-strategy-for-sustainable-use-of-swedens-mineral-resources-that-creates-growth-throughout-the-country/

[45] Стевановић, З., Хајдин, Б., Ристић Вакањац, В., Докмановић, П., Милановић, С., Петровић, Б. (2010). Биланс подземних вода у Србији (Оцена резерви подземних вода Србије и могућности регулације издани), Год. изв. за групу Стратешких нпројеката Мин. ЖСРПП и Дирекције за воде Србије реал. од РГФ, ИЈЧ и ГИС, Фонд стр. док. РГФ, Београд.