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The Sustainable Development Strategy of the German Hard Coal Mining Industry

By the end of the 1950s, the German coal mining industry produced 150 million tons of hard coal per year in 170 collieries with 600,000 employees. At that time, 70% of the primary energy demand of the Federal Republic of Germany was covered by domestic coal. Since the advance of oil, later of natural gas, in the world energy market and with the growth of world coal trade, domestic coal stood under a long-term restructuring pressure. In 2007, a political understanding was arranged to phase out German coal mining, meanwhile concentrated under the umbrella of RAG Aktiengesellschaft, until the end of 2018 in a socially acceptable manner.

This decision required a new strategy for the coal mining industry. Now German coal mining will be strictly finalized and will be prepared for the post-mining era. Within a sustainability strategy the long-term impacts of mining activities before and after the mine closures concerning the environmental, economic and social dimensions will be analyzed systematically and forward-looking. The regional and social responsibility of the coal industry during the closing process and for the post-mining era after 2018 will be emphasized. Additionally to the high technical standards the performance of German coal mining concerning occupational health and safety, environment protection, past mining and post-mining and the development of mine sites to create new jobs are significant from an international point of view and should attract worldwide attention. The traditionally constructive social partnership between employers, union and employees has enabled long-term stable change processes and avoided social frictions. The sustainability strategy of the German hard coal mining industry can be regarded as a role model for other mining countries and regions facing similar transition challenges.

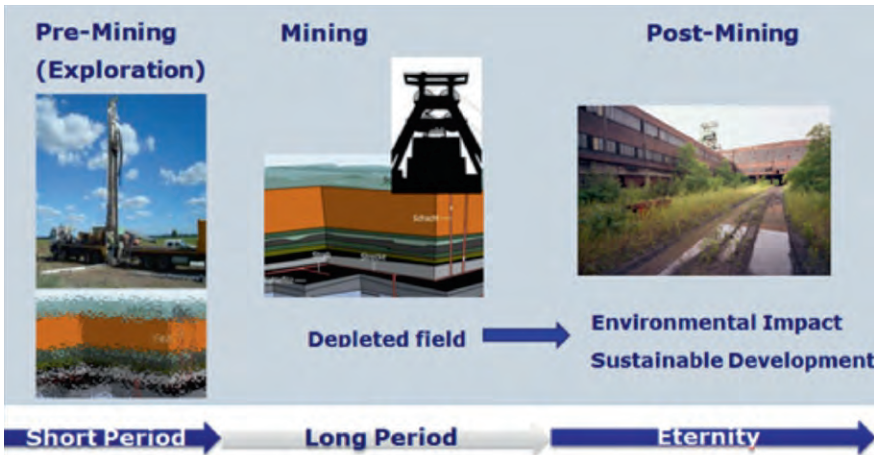


Figure 1 / The mining cycle.

1 Introduction

Principally, mining raw materials is a finite business that reaches its limits once the deposits mined are depleted or the resources can no longer be mined in an economically profitable way. However, the impact of winning raw materials by mining is potentially an infinite one – at least if you measure it at a human time scale because mining always means to interfere with geological and ecological structures that cannot be reversed to their original condition. If we look at the entire process of mining end-to-end, we have to consider the period after active mine works have finished as well.

Therefore, the mining cycle can be divided into three stages:

1. The exploration phase, in which the deposit is investigated to determine its technical and economic profitability. The period of these undertakings is relatively short and can lead to the launch of mining operations.
2. What follows is the actual mining period which usually lasts for a long time and ends latest when all deposits are fully depleted. The operational lifespans of German hard coal mines for example reached up to 120 years. This point of time, however, may be brought forward if the economic conditions (production cost or market price) deteriorate. Nevertheless, mining may be resumed even after a longer period of downtime if those conditions become favorable once more (examples are silver mining in Germany or rare earths mining in the USA).
3. The longest stage, however, is the post-mining stage as the human interference into geology and nature is usually intensive and irreversible. Mining can lead to consequences which have a permanently adverse impact on people and the environment; therefore, they have to be managed as best as we can. In Germany, what has to be

done at the post-mining stage is called “Ewigkeitslasten” or “Ewigkeitsaufgaben” – which translates as “perpetual obligations” or “perpetual tasks”. The literal translation for “Ewigkeit” is “eternity”, expressing that we will have to cope with post-mining endlessly. (Kretschmann and Hegemann 2012)

In the past, mining companies were mostly busy with the first two stages as those were the ones in which they could act profitably on the market. Moreover, most mining nations had not created a legal framework that would oblige companies to take care of the impact of active mining at the post-mining stage.

As a result, the medium and long term impacts the environment and the people living in the mining regions have to endure were often neglected – and even the economic impact was neglected. Mining damage that occurred years later such as the permanently necessary drainage of mine water and the restoration of land and water bodies are what the entire society has to cover the costs if the funding of such activities is not properly defined. In the end, such impacts can lead to a loss of acceptance that mining often faces in politics and among the population.

2 Sustainability and (Post-)Mining

Thus the aim has to be to strive for mining that is as sustainable as possible. In other words, all three stages of the entire process have to be integrated, and the requirements of post-mining stage have to be included in the strategic planning and the operations. Especially as mining cannot be done without impact, there is the need to minimize the negative consequences as much as possible.

The Brundlandt Report, published by the United Nations in 1987, defines the term sustainable development as follows: “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (United Nations 1987)

The origins of the idea of sustainability or rather, its German expression of Nachhaltigkeit, to provide for later, lie in the eighteenth century. The German pioneer of forestry, Hans Carl von Carlowitz, described in his “*Sylvicultura oeconomica*”, which was the first standard work of this scientific discipline, the “continuous and sustainable use” of wood as essential for economic, social and ecological development. (Carlowitz 1713) Wood was the major energy source for mining and metallurgy during this period. Because of the intensive use of wood the industry risked depleting this resource, creating an energy crisis that would threaten not only production but the fast growing population as well that also needed wood as fuel for heating. By establishing a sustainable forest economy, Carlowitz claimed, the cultivation and use of wood could be balanced, so that an enduring supply could be ensured as a foundation of general well-being.

Sustainability is sometimes shortened to ecological issues, especially in political debates. But it is by no means limited to ecology. Of equal importance are social and eco-

conomic aspects. Sustainability is about three basic aims: the share of wealth for as many people as possible (social sustainability), a durable positive economic development (economic sustainability), and the preservation of nature (environmental sustainability). (Kretschmann 2014)

This three-dimensional approach to sustainability can easily be transferred to mining and post-mining activities of today: sustainable management of the mining impact means that environmental damage caused by emissions, subsidence and such can be limited (environmental dimension); the cost of managing both mining damage and perpetual tasks can be kept as low as possible (economic dimension), and the population living in the mining regions can be offered future prospects to ensure their standard of living and their well-being after mining has come to an end (social dimension).

3 Risk Management in German (Post-)Mining

Sustainable mining also includes the need to manage the risks which may result from the mining processes and which involve the post-mining stage in particular. In Germany, there is a specific legal framework that regulates risk management in mining:

The mining of minerals such as hard coal, lignite, ores, and salt, is regulated by the Federal Mining Act, the Bundesberggesetz (BBergG). Supervisory authorities are the mining authorities of the federal states. They are in charge of taking care that mining is operated without threats to people or the environment during all stages of the mining process, i.e. from exploration to post-mining. As a rule, this mining charge ends after closing down production with the installation of a final operation schedule where long-lasting impact of mining is recognized and regulated as far as possible. The mining companies or their legal successors have to cover the costs. If danger emerges from old, desolate and unknown underground work, the mining authority is responsible. If the former owner is unknown, the federal state has to bear the costs.

With particular regard to post-mining, the mining authorities – in close collaboration with the mining companies – have developed a risk management system that facilitates recognition of all risks and definition of suitable mitigation measures.

The risk fields of abandoned mine sites can be divided into the following categories:

- Close-to-surface extractions
- Surface openings, shafts
- Subsidence, uplifts
- Discontinuous faults
- Mine gas emission at the ground surface
- Surface water
- Pumping of pit water
- Refuse dumps
- Operation areas.

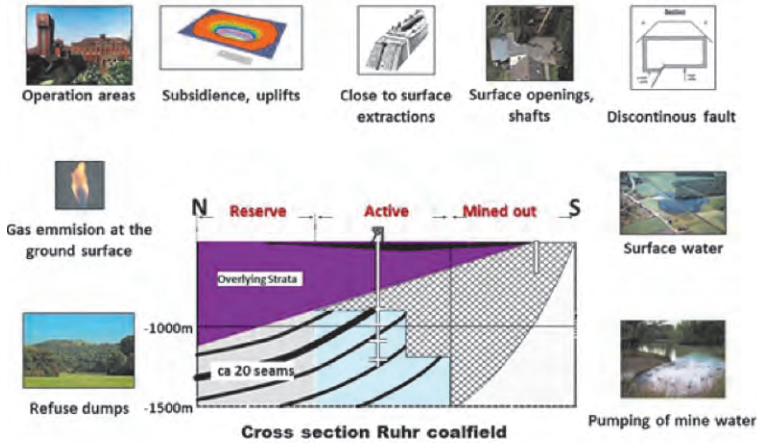


Figure 2 / Risk fields of a mining company.

In the risk context, sustainability requires a holistic view of the mining cycle, including the opportunities that arise from abandoned mining sites. Effective post-mining provides numerous opportunities for avoiding, mitigating or even utilizing the risks by reinventing brownfields to create new jobs. What principally matters is the successful control and management of post-mining risks and the effective use of the opportunities it provides. (Kretschmann and Hegemann 2012)

4 Hard-Coal Mining in Germany: From Industrialization to Post-Mining

In Germany, industrial underground mining of hard coal began in the early 19th century. In the roughly 200 years since there were times when several hundred mining companies of different sizes existed, mostly located in the Ruhr area and in the Saar region where Germany's largest hard coal deposits can be found.

For more than hundred years, hard coal from domestic production was the basis for industrial success in Germany, even after World War II, when Germany started its "economic miracle", becoming one of the leading economies in the world. But since the 1960s hard-coal mining in Germany has been in the state of continuous decline. Because of relatively high production costs hard-coal mining in Germany seemed not to be capable of competing in the world market any more.

In 1969 the remaining mining companies merged to form an umbrella company called Ruhrkohle AG. The hard-coal production received state subsidies to ensure the domestic power supply and the supply of coking coal and to maintain jobs in mining. In 1997 Ruhrkohle AG was restructured and received a new name, RAG. The operation of the mines was by and by separated from the other business units in order to optimize funding opportunities and to draw a line between profitable and subsidized business activities.

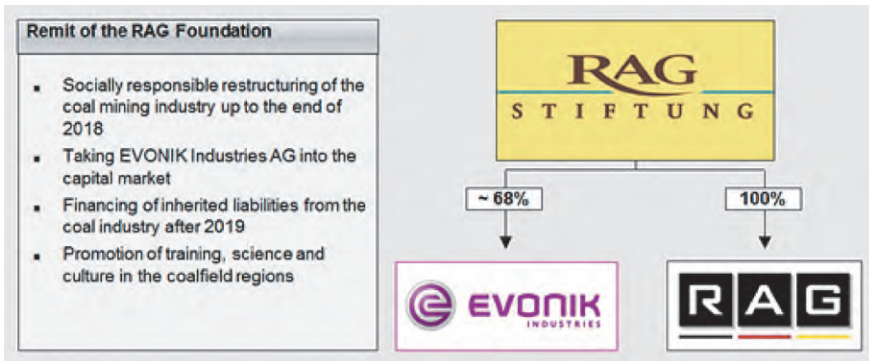


Figure 3 / Company structure of the RAG Stiftung/RAG.

In 2007, the German government decided to end financial support of the coal mining industry in 2018 because the European Union no longer allows such subsidies. This has led to a final mining closure program. The era of post-mining is about to begin.

Germany has experience with mine closure, as early in the 1960s, when the decline of German hard-coal mining began, the German government decided an adjustment process that would soften the social consequences. To do so, the mining companies worked in close collaboration with political institutions and trade unions. The objective has been, until today, to achieve the economically necessary downsizing of the staff without creating large numbers of unemployed in the mining regions. This objective could be achieved by means of a number of measures, such as the different ways collective bargaining offered (e.g. agreements of early retirement), by attracting new employers of the manufacturing industry, and by establishing universities. This structural change was accompanied by providing a new use to closed mining areas. The structures often became monuments of industrial heritage now open to the public, and the brownfield sites were restored for purposes of leisure and environment or even for new commercial use.

Since the end of mining has been definitely decided at the beginning of the 21st century, RAG is turning from an active hard-coal producer to a post-mining group. Its business activities today can be defined according to the three dimensions of sustainability. The structural change that has been going on in the last decades already aimed at achieving a balance of social and economic sustainability and included certain ecological aspects, too. In today's era of post-mining we need to master the organizational and technical challenges of mine closure in such a manner that any harm to people or damage to the environment can be avoided or offset: we need to strive for environmental and social sustainability. The question of how to master the perpetual tasks is inevitably linked with the question of the running cost, in particular that of permanent mine water drainage. In 2007, the German government passed a bill on funding the termination of hard-coal mining. Based on this act, the "old" RAG was split into three parts: a newly set up foundation,



Figure 4 / Burdens and perpetual obligations.

the RAG Stiftung (1), the subsidized coal mining unit plus coal trade, land management, site development, and a few other coal related service companies, still named ("new") RAG (3), and profitable business units mainly the subsidiary Evonik Industries, one of the world's leading specialty chemicals companies, beside other interests (3). The foundation has to ensure that the proceedings from the profitable business units will be used to provide sustainable funding for the eternity tasks so that German tax payers will not have to pay for them. In addition, the RAG foundation has the responsibility for promotion and support of education, science and culture in the mining regions. This corporate structure mainly aims at economic, ecological and social sustainability. (RAG-Stiftung 2015)

5 How to master Mining Impact Technically

According to the post-mining risk areas described above RAG has defined a number of technical core competencies which are divided into two parts: legacy and perpetual tasks. Legacy includes the old mine structures (former collieries, coking plants, slag and coal heaps etc.), the removal of mining damage caused by e.g. subsidence and the securing of abandoned shafts and former close-to-surface mining panels. Perpetual tasks include measures to handle permanent features that result from the end of underground hard-coal mining by the RAG, i.e. the pit water drainage, the landfill measures where mining subsidence occurs, and the cleaning of groundwater at former mining locations. The distinction of legacy and perpetual tasks is especially relevant for the funding. Whereas the mining company RAG has built provisions for the legacy cost, the perpetual tasks are to be paid for by the RAG foundation. In both cases, however, RAG will be in charge of the operating measures.

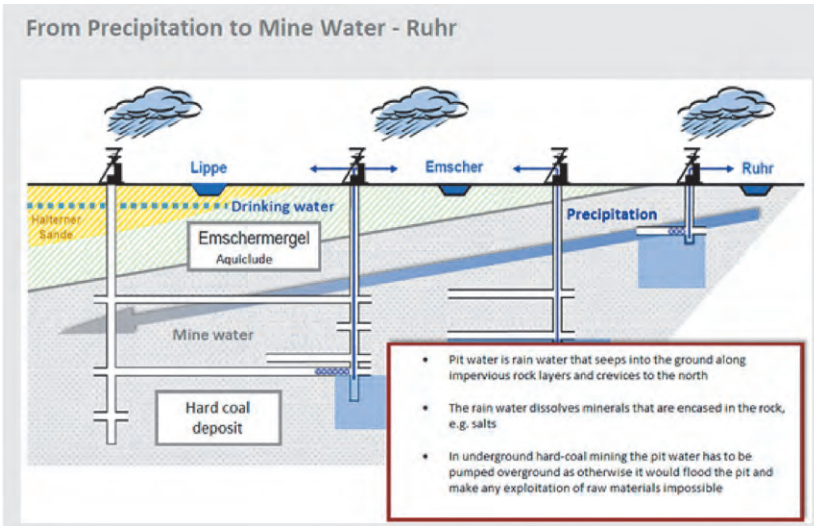


Figure 5 / Pit water handling at the Ruhr.

Regarding the pit water drainage, probably the biggest challenge among the perpetual tasks, the RAG has presented a concept in 2015 that is currently being reviewed by the state authorities. This concept intends to optimize the pumping out of the pit water in the coal fields. As the Chief Executive of the RAG, Bernd Tönjes, has explained:

“Our plans on how to optimize the underground water drainage intend to reduce the number of pit water sites successively and to discharge waterbodies from the pit water. Respective measures consider a sustainable protection of drinking water supply and, in addition, also another aim of protection concerned with how to avoid higher emissions of methane, heavy subsidence caused by ground heaving and hazards caused by caving to the surface.” (Tönjes 2015)

Mine water is rain water that seeps into the ground along impervious rock layers and crevices. The rain water dissolves minerals that are encased in the rock, e.g. salts. In underground hard-coal mining the mine water has to be pumped over the ground as otherwise it would flood the pit and make any exploitation of raw materials impossible. At the moment, RAG pumps 92 million cubic meters of mine water per year in its three coal fields. Where mining operations are closed, water drainage is particularly important to avoid groundwater contamination by pit water which would endanger the drinking water supply in the regions. At both its active and its abandoned collieries RAG is currently operating a total number of 16 drainage systems. The mine water concept intends to reduce this number to eight water handling systems by connecting adjacent pit works. On the one hand, this project would lead to a reduction in cost, and on the other hand, it would help to discharge some water bodies that still receive strongly mineralized mine water today. Moreover it is planned to raise the

pit water level in order to reduce the effort for the pumps. For example, in the Ruhr area the pumping level is to be reduced from 800 m to 600 m whereas a distance of minimum 150 m will be maintained to the drinking water levels above. So far, the drainage is conventionally done in the mine workings which need to be kept open for this purpose; in the future, this system is to be replaced by a well drainage where immersion pumps will be used. These pumps can be installed in the shaft, lowered from the surface, and can be operated and serviced without the need to guarantee continuous access to the mine workings. (Fischer 2015)

6 Risks and Opportunities from Post-Mining

Until recently, post-mining management has focused on the issue of defending and preventing risks. In the last years, however, the situation in the energy industry has undergone fundamental changes. Some keywords in this context are: the finite nature of fossil fuels, global warming, CO₂-emissions, and the risks of nuclear power. Therefore, German politics has made it its mission to achieve a change towards alternative energies: renewable forms of energy without CO₂-emissions such as solar energy, wind power and geothermal energy are to be the focus of public development and funding. This move towards alternative energy sources brought about a boost of creativity and innovation which also captured post-mining areas. Because if we take a closer look at the risk fields of historical mining, they may encompass large opportunities of generating renewable energies as well as new, future uses for former operating areas.

There are a number of applications already in use, research projects, prototypes, ideas and visions included in this:

- Energy-producing utilization of methane that is released from coal beds
- Wind wheels on refuse dumps
- Production of biomass on former mining areas
- Pump-storage power plants either on refuse dumps or underground in existing mine structures
- Photovoltaic plants on mining areas
- Heat from mine water or exhaust heat
- Geothermal energy. (Kretschmann and Hegemann 2012)

7 Post-Mining Education – The Basis for Post-Mining Excellence

Post-mining excellence requires a high motivation as well as a high level of abilities and skills. Without key elements like ideas and visions, research and development, integration of surface and underground, and risk management post-mining will be nothing but inefficient short-term thinking of muddling through, or lip service where no one practices what they preach.

A high motivation needs a change of mind: post-mining no longer means simply avoiding certain hazards, but has become an evolutionary process which is based on the man-

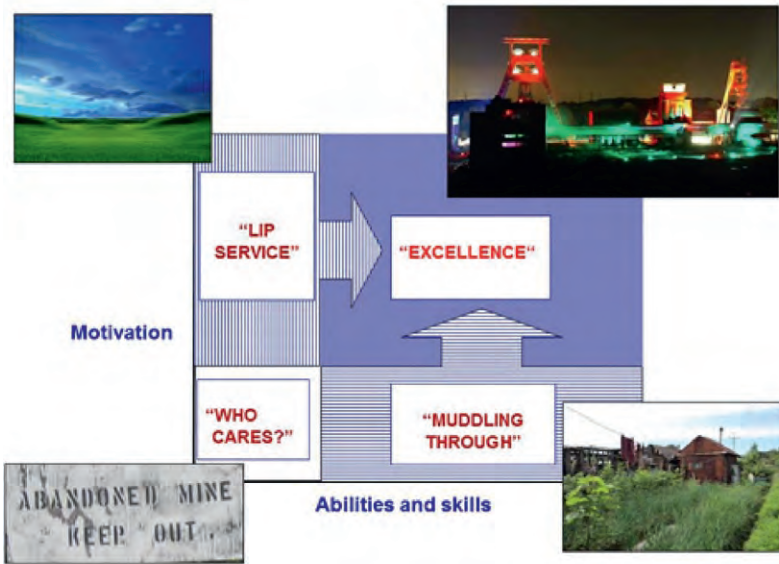


Figure 6 / Post-mining excellence.

agement of risks and the utilization of chances towards a sustainable development. This process should be encouraged by suitable governmental incentives and regulations to promote ideas, to support research and development, and to run lighthouse projects profitably. The implementation of such innovative lighthouse projects at old mine sites is often a milestone for mining communities on their long road into a brighter future. In order to improve abilities and skills, we need to establish a network of companies, universities, government institutions, mining authorities and research centers which will promote a transfer of both knowledge and technology.

In order to competently implement post-mining management, a sufficient number of experts and executives have to be trained in this field. As early as the 19th century the mining companies and the state authorities in Germany began their cooperation on education and research. In 1864, the Westphalian Mining Insurance Bochum (WBK) was founded jointly by the mining companies and supervised by the state. On the one hand, WBK was active in research and development in particular in the fields of surveying, exploration technology and occupational health and safety; on the other hand, WBK trained experts and engineers for the mining industry. The tradition of WBK is still honored today by DMT-Gesellschaft für Lehre und Bildung (DMT Company for Teaching and Education) which is the owner of the TH Georg Agricola. In other words, the scientific research into mining can look back at an excellent track record which will be continued in the post-mining era as well. For example, TH Georg Agricola offers a unique master program in geoenvironmental engineering and post-mining to train specialists who will then be able to deal with the

challenges provided by legacy and eternity tasks. (TH Georg Agricola 2015) This focal point in teaching and research also helps to preserve the know-how and intellectual heritage of underground hard-coal mining in Germany: a knowledge transfer which is also urgently required because, due to the closure of coal mine operations in Germany, many experts in post-mining have either retired or are nearing retirement and the company RAG will not undertake the training of any new specialists. As part of its geoengineering activities the TH Georg Agricola is also setting up a research-focused competence center for post-mining where new methods of geoengineering will be developed and tested for a sustainable management of the mining impact. Both the master program and the research center are supported by the RAG foundation which also provides funding for an endowment professorship for geo-engineering and post-mining.

8 Conclusion

Being established in 1968 RAG will stop producing hard coal after a 50 years long period in 2018. To avoid frictions during the transition period from the mining to the post-mining era RAG has realized a sustainable development strategy that includes numerous measures. The experiences RAG has made and the knowledge the company has gained can be used in many mining regions all around the world that have to face similar transition processes in the future. To develop and transfer the knowledge and the experiences in post-mining the TH Georg Agricola has established a specific master program and a research center.

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Chapter 2

Research projects