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SYNCHRO-MINING: THE NEW SIGHT

Mining is the act, process, or industry of extracting coal, ores, etc., from the earth

Collins English Dictionary

Mining: the process or business of working mines

The dictionary by Merriam-Webster

Mining is the activity intended to extract minerals from Earth's interior...

Mining Law of Ukraine

Mining interpreted by Collins English Dictionary as well as by Mining Law of Ukraine, is extraction of minerals, inclusive of coal, from Earth's interior.

In 2018, amounts of the world coal mining exceeded 8 billion tons [1]. More than 60 countries are engaged in the industrial process; 10 of them mine almost 9/10 of the volume.

Despite the fact that production capacity of any of the 50 national economies, being great in terms of coal mining, is not more than 100 mln tons a year, namely Mining is the key means to satisfy solid fuel and furnace feed demand for coking since coal product stream through international trading floors is not above 15-17% of total production [2].

Coal import is a refuge of predominantly the countries which scaled back their national coal mining. The above concerns especially thermal coal grades.

Japan and such European states as France, Belgium, the Netherlands, and Luxemburg, having eternal mining traditions, have done it relying upon economic reasons. The Great Britain also joined them as well as Germany. Kellingley, the last Britain mine, was closed in 2015. Prosper-Haniel, the last German mine, was closed in 2018. Next in turn is the last Spanish mine was closed in 2019. The same was expected for Ukrainian coal industry: the USSR authorities planned rapid and mass liquidation of Donbas mine stock [3]. In the 1980s, social and political difficulties prevented from doing in such a way as well as dissipation of the Soviet Union.

Processes of active restructuration of mining industries in many countries called into existence Post-Mining idea (i.e. physical closure of an enterprise with "correction" of ecological and social effects of its activities), and a great number of scientific papers, concerning the

issue. Thus, according to Google Scholar data, a paper by a group of Czech authors, concerning the problems of ground and biological restoration of territories after mining and processing were ceased [4], was referenced 262 times starting from the year of 2018; since 2012, a paper by another group of Czech scientists [5] has been referenced 95 times in the papers of their followers; since 2014, a paper by such American authors as J. Skousen, and C. E. Zipper [6] has been referenced 35 times etc. The diversified list also involves a paper concerning lung cancer morbidity within Appalachian coal field regions engaged in a Post-Mining stage [7]. Geography of those, processing the topic, comprises Europe, America (as it has already been mentioned), China [8], and Southern Africa [9].

The necessity to support coal mining under the complex Ukrainian mining and geological, and economic conditions motivated scientists and researchers of the National Mining University (National Technical University now) to develop original ideology for solving economic, ecological, and social problems of depressive mining regions entitled as Synchro-Mining [10, 11].

Started in 2010, the research has resulted by 2012 in the concept of strategic development of industrial regions and in the sustainable functioning of mining enterprises on the basis of their synchronous (along with mining diversification projects) implementation of following innovative techniques: chemical processing of coal; deep purification of mine water; methane extraction; underground gasification of non-commercial coal reserves, occurred in thin seams; processing of mine dumps; alternative power industry etc.

Synchro-Mining is notable for aiming to implement completely the key measures, involved traditionally in Post-Mining, at the active stage of a mine functioning rather than post factum (after the enterprise was closed temporary or closed down).

It looks like the idea was in the air: almost synchronously, experts, known in coal industry, published papers in the manner of Synchro-Mining as for the 3-D mine-based industrial parks [12, 13].

It also should be noticed that despite the fact that the Synchro-Mining concept is almost close ideologically to such Policy European Documents as Program Targets of European Network of Mining Regions, Strategy of Development of Mining European Industry, Concept to Form European Technological Platforms, Strategy to Use Natural Resources on the Basis of Sustainable Progress of European Commission, its expansion turned out to be less active as it has been seen and worth.

Since the moment of the declaration paper publication [10], hardly more than two dozen references by the national researches were recorded. As for the foreign authors (if one Russian issue is ignored [14]), scientific sources concerning Synchro-Mining have not been almost unnoted although the texts in English are available within the network [15, 16].

The above mentioned may be explained by poor scientific understanding of Synchro-Mining idea which prevents from consolidation of the national scientists and researchers engaged in the field of mining industry. As to the business structures, low coal mining profitability stipulates high investment risks making implementation of innovative technologies commercially senseless.

The above listed has specified the paper objective to clarify Synchro-Mining matter while bringing to light additional motivations of the new ideology for business structures.

Seeing into the matter has shown that discrepancies, concerning the ideology understanding, emerge from the Mining notion itself.

According to the definitions by the Mining Law of Ukraine and Collins English Dictionary, insisting on the primacy of a mineral mining from the Earth's interior, it is expedient to mention the three stages of a deposit development: Pre-Mining (i.e. exploration, and construction of a mining enterprise); proper Mining (i.e. activities by a mine, open pit, quarry, well etc.); and Post-Mining. Hence, if winning is available then there is Mining; if winning is not available then Post-Mining is meant.

If one proceeds from a mine primacy, predetermined by Merriam-Webster dictionary, then in case of the mine availability, we observe Mining; if a mine is not available, then Post-Mining is meant.

Affinity Mine in Western Virginia (Appalachians, the USA) being potential, shallow, and with great reserves of prime-grade coking coal, was abandoned for more than quarter of a century before Ukrainian Metinvest Company purchased it in 2009. Collins English Dictionary interprets the situation as Post-Mining and Merriam-Webster Dictionary interprets it as Mining: the mine is not liquidated and its reserves are not exhausted.

Hence, to solve the problem, it is expedient to use a Case Study, i.e. a technique analyzing specific and actual economic, social, and business situations.

Case 1. Power stations on the basis of mines

Power stations on the basis of mines are the alternatives to diversify core activities of a mining enterprise.

In Ukraine, the idea of fuel and energy complexes as thermal power objects started to be developed in the 1990s [17, 18]. Mine peak power stations (i.e. storages of power resources) are more actual currently. Germany develops actively a project to transform a closed Prosper-Hanielmine (i.e. a mine which terminated coal extraction) into 200 MW pumped storage plant [19]. The time has come when the expediency of such structures was explained in 2000 by M.M. Tabachenko, an employee of the National Mining University [20].

The point at issue is that when electric power is critical, it is necessary to bypass water from a surface cunette to underground space through a turbine generating electricity simultaneously; if electric power surplus

takes place, the water should be pumped out from a mine.

Classification nuances are available like in a case with Affinity Mine. Since coal is not mined, the project may be classified as that corresponding to Post-Mining ideology. However, the mine has not been closed; its shafts and mine workings are used for operational procedures. Thus, the above may be considered rationally Synchro-Mining.

Hannelore Kraft, the Minister President of North Rhine-Westphalia, considers it as preservation of the largest centre of national industry as a participant of power market [21].

The same is true for Estonian project in Muuga connected with bypassing of water from neighbouring gulf through hydraulic turbines to the mine workings of the mined out granite quarry [22].

The compressed air energy storages (CAESs) are also potential energy accumulators.

There are two operating gas-turbine power stations with underground pneumatic accumulators in the world. One of them is near German town of Huntorf; another one is in the neighbourhood of American town of McIntosh, Alabama. 290 MW and 110 MW electricity generating parts of the stations are surface-mounted, and high-speed compressed air storages (i.e. natural caverns) are at 600-800 depth.

It is characteristic that the power stations cannot be considered as those belonging to Synchro-Mining category due to the nonavailability of Mining as itself but also nonavailability of a traditional mine. This is not true for RICAS 2020 Project being implemented currently by a consortium of large European companies which budgetary financing is almost € 1.4 mln. The Project is transformation of non-operating Austrian mine into a compressed air storage for a surface power station [23].

Case 2. Coal extraction and preparation

Such two Donbas enterprises as *Pokrovkse* Colliery Group and *Shakhta imeni A.F. Zasiadka* mine metallurgical coal. Their activities differ in the fact that *Pokrovkse* Colliery Group, owned by *Donetskstal* Company, delivers rough coal as a commodity product to a *Sviato-Varvarynska* preparation plant through transport facilities i.e. to another legal entity belonging to *Donetskstal* Company as well. In turn, *Shakhta imeni A.F. Zasiadka* owns and uses the connected mine and *Kyivska* central preparation plant. Coal concentrate is a final product of the enterprise.

In the context of almost similar methods of coal extraction and conversion, mine one implements Mining schedule, and mine two is engaged in Synchro-Mining since coal mining and its preparation are synchronous processes.

Concerning the above, waste treatment aspect is indicative one.

If this is done using “mine and preparation plant” complex, then the development of a circular economy (i.e. decrease in the waste amount and its return to pro-

duction cycle) then it can be considered as Synchro-Mining. The disposal of high-ash coal materials accumulated in tailings separated from the ore mines [24] is classic Post-Mining, but not Synchro-Mining. Conversely, recycling of high-ash coal materials, accumulated in tailing dumps separated from the mines of preparation plants, [24] is the classic Post-Mining rather than Synchro-Mining.

Case 3. Methane production and utilization

Such leading coal mining countries as the USA, Canada, Australia, and China solve the problem of rock mass degasification by means of preliminary development using surface well drilling before mining starts within the mine field. During 5-8 years, the collieries decrease gas concentration drastically prior to the start of mining owing to the well drilled from the surface before mining; moreover, they have both commercial methane and significant impact. That is the classic methane Mining rather than Synchro-Mining.

However, it takes almost a decade to decrease methane saturation of rock mass by 50% but the available Ukrainian Companies have no time for that. Consequently, to degas effectively coal seams, *Pokrovskoye* Colliery Group combines mining both temporary and spatially with surface well construction. The mine functioning is Synchro-Mining.

Methane obtained either through traditional Mining or while combining drilling and mining operations, and utilized by a cogeneration plant, a mine boiler or a near-mine refueling plant, classifies the complex as Synchro-Mining.

The same is true for underground coal gasification. To adapt the complex to the Synchro-Mining architecture, utilization part is required, which can be either a surface power plant or a chemical plant for further transformation of the synthesis gas. It is the only case when it is possible to speak about synchronous operation of two cross-sectional operations rather than about the traditional Mining of synthesis gas by means of underground coal gasification.

Case 4. Synchro-Mining and Vertical Integration

Theoretically, mine-based fuel and energy technological complexes; syngaspower plants; mine methane cogeneration modules; small and medium-sized coal-fired power plants etc., concentrated in the hands of a single owner, are hierarchical structures on the principles of Synchro-Mining as well as vertically-integrated structures with positive and negative features which Bengt Karlof mentioned as “Advanced vertical integration is a problem that troubles Mikhail Gorbachev in Kremlin as much as Directors of General Motors in Detroit” [25, p. 163].

Under the conditions of low profitability of coal production or even under the conditions of its unprofitability, effectiveness of the technological complex as a whole may turn out to be an unmanageable problem making Synchro-Mining commercially senseless.

As for the propriety factor, the “mine and preparation plant” complexes, mentioned in case two, are vertically integrated structures in the both contexts; however, as it has been shown, only one of them belongs to Synchro-Mining models.

Case 5. Synchro-Mining and industrial parks

Eco-industrial park Red Hills EcoPlex (Choctaw County, Mississippi, USA), involving a mine and 440 MW thermal power plant, is neither an example of Synchro-Mining nor an example of a vertically-integrated structure since neither the company, which operates the TPP, as well as other members of the park, being a brick factory and various agricultural firms, do not synchronize their activities with solid fuel Mining commercially. It is a group of disparate economic agents using their membership right to apply steam, heat, ash, and mine waste [26].

Another matter is an industrial park involving the integrated coal mine and a power plant (using solid fuel or gas fuel stored in underground facilities etc.), belonging to different owners, who act as a technologically connected heterarchical structure.

Heterarchy differs fundamentally from a traditional hierarchical company in the fact that its functioning is managed by two or more equivalent nerve centres.

The advantage of such an industrial-park system is its opportunity to attract investment resources as well as potential synergism demonstrated in the possibility of using power plant ash to backfill mine workings; using mine water to cool down boiler units; using mine methane as an illuminating fuel etc. In this context, the mine itself is a supplier of fuel resources and materials as well as important consumer of electric power and thermal power.

Owing to the opportunities, being typical for network capitalism, heterarchical foundations of the formations, relying upon Synchro-Mining ideology, may generate interest in business structures (for instance, energy corporations) as for their participation in the activities of industrial parks, and essential increase in the potential of unprofitable public sector of the national coal industry [27, 28].

To implement such opportunities, in 2014 Dnipro Polytechnic proposed software product Synchro-Mining on the basis of the open technological platform. The product favours more active development of technoparks and industrial parks.

In 2015, UNO countries adopted the Agenda of the Sustainable Development up to the year of 2030 [29]. The program document involves seventeen goals intended to eliminate the poverty, to save the planet resources, and to ensure well-being for everyone. It is significant that the Synchro-Mining ideology is close to seven (of the seventeen ones) Sustainable Development Goals, namely:

7. Ensure access to affordable, reliable, sustainable and modern energy for all;

8. Promote inclusive and sustainable economic growth, employment, and decent work for all;

9. Build resilient infrastructure, promote sustainable industrialization and foster innovation;

11. Make cities inclusive, safe, resilient and sustainable;

12. Ensure sustainable consumption and production patterns;

15. Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss; and

17. Revitalize the global partnership for sustainable development.

The analysis of Synchro-Mining alternatives, performed by the paper, has shown the multidimensionality being typical for the ideology and even controversy stipulating complexity of its understanding both by experts and scientifically oriented people.

It has been substantiated that it is expedient to base the Synchro-Mining phenomenon on Mining interpretation by Merriam-Webster Dictionary version relying upon the existence primacy of a mining enterprise (i.e. a mine, quarry, open pit, well etc.): Mining exists irrespective of the mineral extraction until the enterprise is liquidated physically.

Hence, Synchro-Mining is diversification of the key activity of a mining enterprise performed in parallel with Mining whether it is coal or ore preparation, generation of electric energy and thermal energy, early Post-Mining measures, commercial extraction of methane, deep treatment of mine water, progress of circular economy etc. not only in the form of vertical integration of various businesses (i.e. hierarchical production method) but also in the form of heterarchies (i.e. network capitalism) or in the form of industrial parks.

Just Synchro-Mining, aimed at the achievement of power autarchy of coal mining enterprises, may become the most topical in the situation of coal extraction unprofitability and systemic payment defaults existing in the public sector of Ukrainian coal industry

The Synchro-Mining ideology in the form of 3-D industrial parks will favour the attraction of investment resources of business structures of the large corporations as participants.

To deepen and expand the Synchro-Mining theory, it is expedient to perform corresponding scientific and research activities in the context of official theme, namely: hold international forums (conferences, panel discussions etc.), publish monographs and complex of papers among them in English.

The obtained results will favour grouping of experts, scientists, and researchers from different countries, representing fields of sectoral, academic, and University science.

To activate attraction of investors (first of all, from among power companies having desire to equip and possess energy storages), it is expedient to support and popularize the software Synchro-Mining platform spread out in Dnipro Polytechnic.

To the effect of self-development of the new paradigm of functioning of mining enterprises, it is practical to establish international scientific-research Synchro-Mining International Institute under the aegis of MES and NAS of Ukraine and auspices of such large national corporations as DTEK, Metinvest, Donetskstal etc. Moreover, it is necessary to approach to the world leading mining corporations with a proposition to support Synchro-Mining movement within different basins on different continents.

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Амоша О. І., Череватський Д. Ю., Півняк Г. Г., Шашенко О. М., Бородай Л. В. Новий погляд на Synchro-Mining

Виконаний у роботі з використанням методу кейсів аналіз варіантів побудови Synchro-Mining показав властиву самій ідеології багатоаспектність, а то й суперечливість, що обумовлює складність її сприйняття не тільки практиками, а й навіть підготовленими вченими.

Обґрунтовано, що в основу феномена Synchro-Mining рціонально покласти тлумачення Mining (Гірництва) у версії словника Merriam-Webster, заснованого на приматі існування гірничодобувного підприємства (шахти, рудника, кар'єру, свердловини тощо): Mining існує незалежно від видобутку корисних копалин до тих пір, поки фізично не ліквідовано саме підприємство.

Таким чином, Synchro-Mining – це диверсифікація основної діяльності гірничодобувного підприємства, яка проводиться синхронно з Mining, будь-то в напрямку збагачення вугілля або руди, виробництва й акумуляції електричної та теплової енергії, заздалегідь проведених заходів Post-Mining, комерційного видобутку метану, глибокого очищення шахтних вод, розвитку циркулярної економіки та ін., як у формі вертикальної інтеграції різнопрофільних бізнесів (ієрархічний спосіб виробництва), так і у вигляді гетерархій (мережевого капіталізму), чи індустріальних парків.

Ключові слова: Synchro-Mining, Mining, диверсифікація, вертикальна інтеграція, гетерархія, індустріальний парк.

Amosha O., Cherevatskyi D., Pivnyak G., Shashenko O., Borodai L. Synchro-Mining: the New Sight

The analysis of Synchro-Mining alternatives, performed by the paper, has shown the multidimensionality being typical for the ideology and even controversy stipulating complexity of its understanding both by practices and by qualified scientists.

It has been substantiated that it is expedient to base the Synchro-Mining phenomenon on Mining interpretation by Merriam-Webster Dictionary version relying upon the existence primacy of a mining enterprise (i.e. a mine, quarry, open pit, well etc.): Mining exists irrespective of the mineral extraction until the enterprise is liquidated physically.

Thus, Synchro-Mining is diversification of the key activity of a mining enterprise performed in parallel with Mining whether it is coal or ore preparation, generation of electric energy and thermal energy, early Post-Mining measures, commercial extraction of methane, deep treatment of mine water, progress of circular economy etc. not only in the form of vertical integration of various businesses (i.e. hierarchical production method) but also in the form of heterarchies (i.e. network capitalism) or in the form of industrial parks.

Keywords: Synchro-Mining, Mining, diversification, vertical integration, heterarchies, industrial parks.

Амоша А. И., Череватский Д. Ю., Пивняк Г. Г., Шашенко А. Н., Бородай Л. В. Новый взгляд на Synchro-Mining

Выполненный в работе с использованием метода кейсов анализ вариантов построения Synchro-Mining показал свойственную самой идеологии многоаспектность, а то и противоречивость, что обуславливает сложность ее восприятия не только практиками, но даже подготовленными учеными.

Обосновано, что в основу феномена Synchro-Mining рационально положить толкование Mining (Горное дело) в версии словаря Merriam-Webster, основанного на примате существования горнодобывающего предприятия (шахты, рудника, карьера, скважины и т.д.): Mining существует независимо от добычи полезных ископаемых до тех пор, пока физически не ликвидировано само предприятие.

Таким образом, Synchro-Mining – это диверсификация основной деятельности горнодобывающего предприятия, которая проводится синхронно с Mining, будь то в направлении обогащения угля или руды, производства и аккумуляции электрической и тепловой энергии, заранее проведенных мероприятий Post-Mining, коммерческой добычи метана, глубокой очистки шахтных вод, развития циркулярной экономики и др., как в форме вертикальной интеграции разнопрофильных бизнесов (иерархический способ производства), так и в виде гетерархий (сетевой капитализма), или индустриальных парков.

Ключевые слова: Synchro-Mining, Mining, диверсификация, вертикальная интеграция, гетерархия, индустриальный парк.

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