POTENTIALS

RFCS AM PROJECT

Synergistic potentials of end-of-life coal mines and coal-fired power plants, along with closely related neighbouring industries: update and re-adoption of territorial just transition plans

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Deliverable 2.2

Matrix of Direct Influence

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Executive summary

The general objective of the POTENTIALS Accompanying Measure is to identify and assess the challenges, opportunities and impacts related to the synergistic potentials of end-of-life mine sites and coal-fired power plants (and related infrastructure), along with closely related neighbouring industries.

It will take advantage of their joint potential to stimulate new economic activities, developing jobs and economic value especially in relation to Coal Regions in Transition, and supporting the update and re-adoption of territorial just transition plans.

In Task 2.1 Defining relevant variables, the most important key variables were determined to address the synergistic potentials of end-of life coal mine sites and coal-fired power plants. These were defined against closely related neighbouring industries, the implementation of business models relying on renewable energy, circular economy and scaling energy storage. The outcome of this work was an unsorted list of 69 relevant variables that are important to understand the potential opportunities that end of life coal related infrastructure presents.

During this work, a 69 × 69 matrix that states these influences, based on the experts' knowledge and expertise, was provided.

With the information collected and after two-round Delphi-based study in order to correct inconsistencies within the first Delphi round, a Matrix of Direct Influence describing the relation of direct influences between the variables defining the system was then developed.

1 Introduction

The main objectives of this deliverable are:

- To state the influence that each variable has over the rest of variables of the system.
- To provide a Matrix of Direct Influence describing the relation of direct influences between the variables defining the system will be developed.

With the unsorted list of variables developed in Task 2.1 and presented in Deliverable 2.1, different groups of experts stated the influence that each variable has over the rest of variables of the system.

The group provided a 69 × 69 integer matrix that states these influences, based on the experts' knowledge and expertise. With this information, a Matrix of Direct Influence describing the relation of direct influences between the variables defining the system was developed.

In a systemic vision, a variable does not exist other than as part of the relational web with the other variables. In addition, structural analysis allows connecting the variables in a two-entry table (direct relations). This entry of the matrix is generally qualitative, adjusting the intensities of the relations among the variables.

This phase of entry helps to put for 69 variables 69 × 68 questions (4,692 questions), of which some would have escaped without such a systematic and comprehensive reflection. It was developed with a two-round Delphi-based study.

The Delphi method is a forecasting process framework based on the results of several rounds of questioners sent to a panel of experts. In this case and to correct inconsistencies within the first Delphi round, a second round of the Delphi method was implemented in the form of direct brainstorming sessions or panel sessions.

This procedure of questioning allows not only avoiding errors, but also to order and classify the ideas by creating a common language within the group; it also gives the opportunity to redefine the variables and thus refine the system's analysis.

GIG and CERTH discussed the relations between the variables with some local key stakeholders in their respective countries to help determining the influence of these variables.

2 Describing relationships between variables

Under a systemic prism, a variable only exists because of its relational fabric with the other variables. Structural analysis is also concerned with relating the variables in a double-entry table or matrix of direct relationships.

Relating the variables is carried out by a group of people who have previously participated in the list of variables identification and in their definition, who fill in the so-called structural analysis matrix.

Completion is qualitative. For each pair of variables, the following questions are posed:

Is there a direct relationship of influence between variable *i* and variable *j*?

If not, we score 0, otherwise we ask whether this direct influence relationship is low (1), medium (2), strong (3) or potential (P).

In this phase of filling in the matrix, questions are asked on n variables, n × n-1 questions (4,692 for 69 variables), some of which would have been forgotten without such a systematic and exhaustive reflection.

This questioning procedure that was undertaken with the Delphi methodology, allows not only to avoid mistakes, but also to order and classify ideas, which leads to the creation of a common language within the group. In the same way, it also makes it possible to redefine the variables and thus to refine the analysis.

It should be borne in mind that, for all intents and purposes, experience shows that a normal filling matrix, i.e., ratios other than 0, is around 20÷30%.

The final Matrix of Direct Influence is presented in Annex 3.

3 Experts involved in the description of relationships

3.1 Główny Instytut Górnictwa (GIG)

During the activities performed under Task 2.2 GIG was represented by the following experts:

- prof. Alicja Krzemień, Head of Department of Risk Assessment and Industrial Safety,
- prof. Eugeniusz Krause, Department of Mining Aerology,
- dr Stanisław Tokarski, Plenipotentiary of the Director for Energy,
- dr Aleksandra Koteras,
- dr Adam Duda, Deputy Head of Department of Risk Assessment and Industrial Safety,
- Aleksander Frejowski, Department of Risk Assessment and Industrial Safety,
- Angelika Więckol-Ryk, Department of Risk Assessment and Industrial Safety,
- dr Jan Szymała, Head of Laboratory of Underground Engineering Construction, Department of Extraction Technologies, Rockburst and Mining Support,
- Aleksander Wrana, Department of Extraction Technologies, Rockburst and Mining Support,
- dr Wojciech Masny, Department of Extraction Technologies, Rockburst and Mining Support,
- dr Jacek Myszkowski, Laboratory of Rockburst and Rock Mechanics, Department of Extraction Technologies, Rockburst and Mining Support,
- Ewelina Strzoda, Department of Energy Saving and Air Protection,
- Piotr Zawadzki, Department of Water Protection,
- dr Mariusz Kruczek, Deputy Head of Department of Water Protection,
- dr Ewa Janson, Department of Water Protection,
- Małgorzata Markowska, Department of Water Protection,
- Elżbieta Uszok, Department of Water Protection.

3.2 Centre for Research and Technology - Hellas (CERTH)

An on-line meeting of experts from CERTH took place on November 15, 2021 and was a brainstorming session. CERTH was represented by the following experts:

- Pavlos Tyrologou,
- Joanna Badouna,
- Christos Karkalis,
- Dimitris Karapanos.

3.3 VGB PowerTech e.V. (VGB)

A meeting of experts from VGB took place on November 16, 2021 and was a brainstorming session. VGB was represented by the following experts:

- Thomas Eck,
- Sven Göhring,
- Christian Stolzenberger,
- Sabine Polenz.

3.4 Universidad de Oviedo (UNIOVI) and Hulleras del Norte, S.A. (HUNOSA)

A joint meeting of experts from UNIOVI and HUNOSA took place on November 15, 2021 and was a brainstorming session. UNIOVI and HUNOSA was represented by the following experts:

- Ana Suárez Sánchez (Universidad de Oviedo),
- Agustín Menéndez Díaz (Universidad de Oviedo),
- Gregorio Fidalgo Valverde (Universidad de Oviedo),
- Pedro Riesgo Fernández (Universidad de Oviedo),
- Juan José Álvarez Fernández (Hulleras del Norte, S.A.).

3.5 Technische Hochschule Georg Agricola University (DMT-THGA)

A meeting of experts from DMT-THGA took place on November 16, 2021 and was a brainstorming session. During the meeting the DMT-THGA was represented by the following experts:

- Prof. Dr. Kai van de Loo,
- Julia Tiganj,
- Stephan Möllerherm.

3.6 GIG external experts: Economic Society Polish Power Plants (TGPE)

A meeting of experts from TGPE took place on November 18, 2021 and was a brainstorming session. During the meeting the TGPE was represented by two experts:

- Paweł Woszczyk,
- Waldemar Szulc.

3.7 Other GIG external experts

Jastrzębska Spółka Węglowa S.A. (two underground mining expert) and Polish Coal Group (retired mining expert).

3.8 CERTH external experts: Public Power Corporation (PPC)

Two experts in coal mining, energy production and power plant operation.

Expertise of experts involved in the study is presented in Annex 1.

4 Development of the study

The study was developed in two Delphi-based rounds. The first one took place between November 1, 2021, and November 19, 2021, when experts from GIG, CERTH, VGB, UNIOVI, HUNOSA and DMT-THGA were invited to fill-in the table of direct influences between the variables. Also, external experts were invited in order to support the study, i.e., Economic Society Polish Power Plants (TGPE) and Public Power Corporation from Greece.

It was decided that after the first round of study (first round of Delphi) in case of variables where unanimity was not reached a second round will be applied. The process was developed in the following order:

1. Variables where unanimity was not reached were identified. An example is shown in Figure 4-1.

POTENTIALS RFCS AM PROJECT			11 Depth of the shafts	12 Shaft diameter	13 Shaft technical condition	14 Function/status of shaft (liquidated, pumping station, ventilation working)	15 Water inflow	16 Pumped water temperature
12	SN	Shaft diameter	2		1	3	2	1
	AF		2		1	3	0	2
	JS		0		0	0	0	0
	JM		1		1	3	0	2
	AW		0		2	3	0	0
	WM		1		0	1	1	0
13	SN	Shaft technical condition	3	2		3	1	0
	AF		2	2		3	2	2
	JS		3	0		0	0	0
	JM		2	2		3	2	2
	AW		0	0		3	0	0
	WM		0	3		3	3	0

Figure 4-1. An example of a difference in the judgment of experts during the first round of Delphi study

2. Experts with different judgement were asked to revise they answers once again, they were also asked to give a short explanation on the judgement:

   ✓ Example of a value change from the first round with an explanation: 17/7 (17 is the raw and 7 is the column) value assigned in 1st round: **3**, value in 2nd round: **P**; The assessment of the inflow takes into consideration possible impact of the fact that mine is fully flooded (requires consideration of additional protection).

- ✓ Example of maintaining the values from the first round with an explanation: 59/60, value assigned in 1st round: **2**, value in 2nd round: **2**; The impact of proximity to industries on water treatment plant was assessed. Water consumption by industry for technological purposes and the impact of industry availability on the risk of pollution generation were taken as a factor.

The feedback from brainstorming sessions which took part as a second Delphi round is presented in Annex 2.

The final values, in the form of Matrix of Direct Influence, were reached during two workshop sessions that took place on November 29 and 30, 2021, and are presented in Annex 3.

4.1 First round of Delphi study

4.1.1 Główny Instytut Górnictwa GIG

On November 9, in GIG the Delphi's study first round meeting was held, attended by: Alicja Krzemień, Stanisław Tokarski, Aleksandra Koteras, Adam Duda, Aleksander Wrana, Ewelina Strzoda, Jacek Myszkowski and Aleksander Frejowski. An initial analysis of the mutual influences of variables was performed and variable areas were selected which will be transferred to the project's foreign partners and to external experts. Figure 4-2 presents the clean matrix ready for filling.

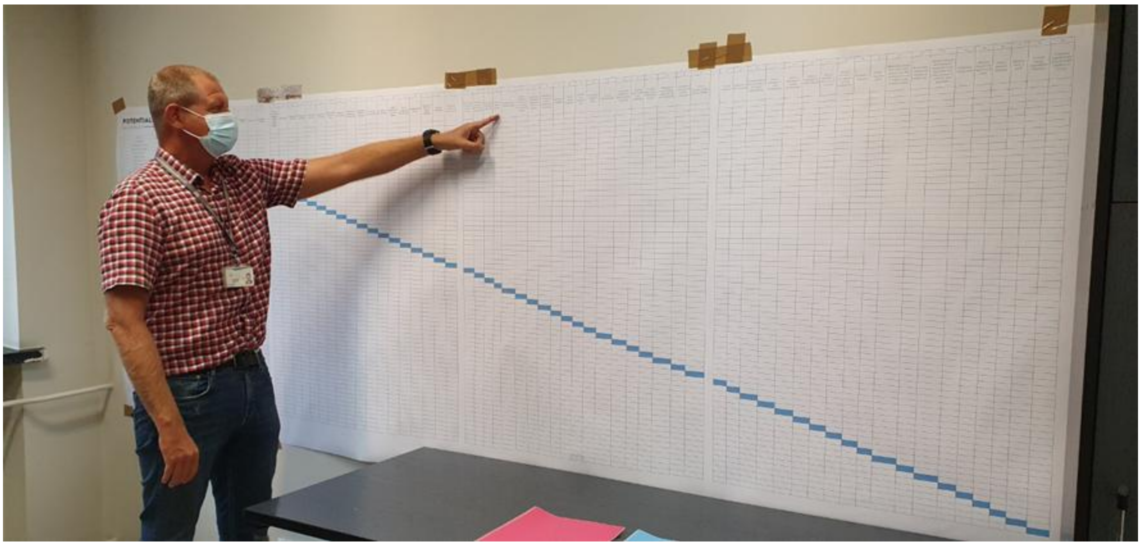

Figure 4-2. Clean matrix ready for filling

Aleksander Frejowski from Department of Risk Assessment and Industrial Safety filled in the matrix for the impacts of "mining" variables (from variable no. 1 to variable no. 31) on all “mining” variables (from variable no. 1 to variable no. 31).

Jacek Myszkowski from Laboratory of Rockburst and Rock Mechanics, Department of Extraction Technologies, Rockburst and Mining Support filled in the matrix for the impacts of "mining" variables (from variable no. 1 to variable no. 31) on all “mining” variables (from variable no. 1 to variable no. 31) .

Jan Szymała from Laboratory of Underground Engineering Construction, Department of Extraction Technologies, Rockburst and Mining Support filled in the matrix for the impacts of "mining" variables (from variable no. 1 to variable no. 31) on all “mining” variables (from variable no. 1 to variable no. 31) .

Aleksander Wrana from Department of Extraction Technologies, Rockburst and Mining Support filled in the matrix for the impacts of "mining" variables (from variable no. 1 to variable no. 31) on all variables (from variable no. 1 to variable no. 69).

Wojciech Masny from Department of Extraction Technologies, Rockburst and Mining Support filled in the matrix for the impacts of "mining" variables (from variable no. 1 to variable no. 31) on all variables (from variable no. 1 to variable no. 69).

Stanisław Tokarski, Plenipotentiary of the Director for Energy and Ewelina Strzoda, Department of Energy Saving and Air Protection filled in the matrix for the impacts of "energy" variables (from variable no. 32 to variable no. 69) on all “energy” variables (from variable no. 32 to variable no. 69).

Piotr Zawadzki, Mariusz Kruczek, Ewa Janson, Małgorzata Markowska and Elżbieta Uszok from Department of Water Protection filled in the matrix influence of the following variables:

- variable no. 8 (Volume of pumped water),
- variable no. 9 (Pumped water chemistry/quality),
- variable no. 10 (Hazardous substances in the pumped mine water),
- variable no. 11 (Depth of the shafts),
- variable no. 12 (Shaft diameter),
- variable no. 13 (Shaft technical condition),
- variable no. 14 (Function/status of shaft (liquidated, pumping station, ventilation working),
- variable no. 15 (Water inflow),
- variable no. 16 (Pumped water temperature),
- variable no. 17 (Flooding status of the mine),
- variable no. 28 (Neighbourhood density),
- variable no. 29 (Existence of historic or singular buildings),
- variable no. 30 (Land use restrictions),
- variable no. 34 (Power plant concession expiry date),
- variable no. 35 (Expected technical lifetime),
- variable no. 36 (Number of units decommissioned),

- variable no. 37 (Access / proximity to reservoirs and water courses. Water reservoir capacity),
- variable no. 41 (District heating connection),
- variable no. 42 (Cooling water installation type),
- variable no. 43 (Wastewater treatment plant),
- variable no. 44 (Fly ash characterisation),
- variable no. 45 (Power plant landfill area. Hazardous/non-hazardous),
- variable no. 51 (Land use restrictions),
- variable no. 52 (Character of the local area),
- variable no. 53 (Neighbourhood and proximity to the nearest urban/industry),
- variable no. 54 (Access / proximity to road infrastructure),
- variable no. 55 (Access / proximity to railway infrastructure),
- variable no. 56 (Access / proximity to water reservoir),
- variable no. 57 (Access / proximity to the river (for transport)),
- variable no. 58 (Access / proximity to gas pipeline network connections),
- variable no. 59 (Proximity to industries),
- and variable no. 60 (Water treatment plant)

on all variables (variables from number 1 to 69).

On November 18, 2021 Prof. Eugeniusz Krause from Department of Mining Aerology and prof. Alicja Krzemień, Head of Department of Risk Assessment and Industrial Safety assessed the impact of the variables no. 4 (Methane surface emissions - AMM) and no. 5 (Methane resources - CBM) on the "mining" variables (variables from no. 1 to no. 31) and the impact of all the "mining" variables (variables from no. 1 to no. 31) on the variables no. 4 (Methane surface emissions - AMM) and no. 5 (Methane resources - CBM).

4.1.2 Centre for Research and Technology - Hellas (CERTH)

For task 2.2, invitations were sent to internal and external experts related to the activities of the Potentials project. Two external experts provided anonymously their input by phone conversation in a questionnaire manner approach. Due to their limited time they provided partial but important input. The process was complemented by an internal experts brainstorming, that took place online and hosted by the zoom platform, lasted for 4,5 hours (Figure 4-3). For each variable, its description was elaborated and discussed, subsequently the degree of influence against the other variables was decided.

A general comment received the external experts was on potential overlapping of some of the variables although understandably they have to be structured that way to capture holistically the concept. In addition, there were some disagreements between them on the degree of influence that after the online discussion reached a consensus.

Figure 4-3. Brainstorming meeting between internal experts - CERTH

During the on-line brainstorming session four experts from CERTH analyzed the impacts of the following variables:

- variable no. 10 (Hazardous substances in the pumped mine water),
- variable no. 26 (Acidity potential of the waste heap material),
- variable no. 32 (Power plant connection capacity to the grid),
- variable no. 44 (Fly ash characterization),
- variable no. 45 (Power plant landfill area. Hazardous/non-hazardous.),
- variable no. 47 (Available space for new technologies/projects),
- variable no. 48 (Obligations of thermal energy supply after the decommissioning),
- variable no. 50 (Cost of decommissioning and remediation),
- variable no. 55 (Access / proximity to railway infrastructure),
- variable no. 56 (Access / proximity to water reservoir),
- variable no. 57 (Access / proximity to the river (for transport)),
- variable no. 58 (Access / proximity to gas pipeline network connections), and
- variable no. 63 (Special screening mechanisms for employees (early retirement, paid long-term leaves, voluntary leave programs),

on all variables (variables from no. 1 to no. 69). The results of the analyzes were placed in the Matrix of Direct Influences and sent by e-mail to the Central Mining Institute.

4.1.3 VGB PowerTech e.V. (VGB)

During the brainstorming session experts from VGB analyzed the impacts of the following variables:

- variable no. 42 (Cooling water installation type),
- variable no. 43 (Wastewater treatment plant),
- variable no. 46 (Coal ash waste landfill area availability),
- variable no. 47 (Available space for new technologies/projects),
- variable no. 48 (Obligations of thermal energy supply after the decommissioning),
- variable no. 49 (Availability of concession for power generation),
- variable no. 50 (Cost of decommissioning and remediation.),
- variable no. 51 (Land use restrictions), and
- variable no. 61 (Obligations arising from concessions, contracts and other regulations in case of a power plant decommissioned),

on all variables (variables from no. 1 to no. 69).

The results of the analyzes were placed in the Matrix of Direct Influences and sent by e-mail to the Central Mining Institute.

4.1.4 Universidad de Oviedo (UNIOVI) and Hulleras del Norte, S.A. (HUNOSA)

During the brainstorming session above mentioned experts analyzed the impacts of the following variables:

- variable no. 4 (Methane surface emissions AMM),
- variable no. 5 (Methane resources CBM),
- variable no. 18 (Area of the waste heap),
- variable no. 22 (Material type deposited on the waste heap),
- variable no. 23 (Geotechnical stability of waste heaps),
- variable no. 24 (Fire hazard at the waste heap),
- variable no. 25 (Gas hazard at the waste heap),
- variable no. 28 (Neighborhood density),
- variable no. 29 (Existence of historic or singular buildings),
- variable no. 30 (Land use restrictions),
- variable no. 31 (Connection capacity of mine to the grid),
- variable no. 33 (Electricity production efficiency of power plant),
- variable no. 34 (Power plant concession expiry date),
- variable no. 35 (Expected technical lifetime),
- variable no. 36 (Number of units decommissioned),
- variable no. 37 (Access / proximity to reservoirs and water courses. Water reservoir capacity),
- variable no. 38 (Repowering: possibility of adapting the boiler for biomass),
- variable no. 39 (Feasibility of reusing air cleaning installation for repowering),
- variable no. 59 (Proximity to industries),
- variable no. 62 (Power Plant employment - number of employees),

- variable no. 64 (Temporary storage areas), and
- variable no. 65 (Relevant resource for land lease & rental)

on all variables (variables from no. 1 to no. 69).

The results of the analyzes were placed in the Matrix of Direct Influences and sent by e-mail to the Central Mining Institute. Figure 4-4 shows the brainstorming session.

Figure 4-4. Brainstorming session – experts from HUNOSA and UNIOVI

4.1.5 Technische Hochschule Georg Agricola University (DMT-THGA)

During the brainstorming session experts from DMT-THGA analyzed the impacts of the following variables:

- variable no. 52 (Character of the local area),
- variable no. 53 (Neighborhood and proximity to the nearest urban/industry),
- variable no. 66 (Electro-intensive industries),
- variable no. 67 (Industries likely to use H_2),
- variable no. 68 (Constant energy consumption industries), and
- variable no. 69 (Companies manufacturers of goods and/or suppliers of services)

on all variables (variables from no. 1 to no. 69).

The results of the analyzes were placed in the Matrix of Direct Influences and sent by e-mail to the Central Mining Institute. Figure 4-5 presents the brainstorming session.

Figure 4-5. Brainstorming session – experts from DMT-THGA

4.1.6 GIG External experts: Economic Society Polish Power Plants (TGPE)

During the meeting external experts from TGPE analyzed the impacts of the following variables:

- variable no. 32 (Power plant connection capacity to the grid),
- variable no. 33 (Electricity production efficiency of power plant),
- variable no. 34 (Power plant concession expiry date),
- variable no. 35 (Expected technical lifetime),
- variable no. 36 (Number of units decommissioned),
- variable no. 37 (Access / proximity to reservoirs and water courses. Water reservoir capacity),
- variable no. 38 (Repowering: possibility of adapting the boiler for biomass),
- variable no. 39 (Feasibility of reusing air cleaning installation for repowering),
- variable no. 40 (CO_2 capture installation),
- variable no. 41 (District heating connection),
- variable no. 42 (Cooling water installation type), and
- variable no. 43 (Wastewater treatment plant)

on all "energy" variables (variables from no. 32 to no. 69).

The results of the analyzes were placed in the Matrix of Direct Influences and sent by e-mail to the Central Mining Institute.

4.2 Second round of Delphi study

On November 23, the second round of the Delphi study started regarding the discrepancies in the assessment of mutual influences of "mining" and "energy" variables. The first meeting was attended by: Alicja Krzemień, Stanisław Tokarski, Adam Duda, Jan Szymała, Ewelina Strzoda and Aleksander Frejowski.

Particular attention was paid to the discrepancies regarding the influence of variables related to the parameters and function of shafts, i.e., the variables: variable no. 11 (depth of the shaft), variable no. 12 (shaft diameter), variable no. 13 (shaft technical condition), and variable no. 17 (flooding status of the mine) on the “mining” variables (numbers from 1 to 31).

It was decided to modify the name of variable no 37 from “Access / proximity to reservoirs and water courses. Water reservoir capacity” to “Water reservoir capacity”.

The analysis also included the influence of the "energy" variables no. 37 (Water reservoir capacity), no. 54 (Access / proximity to road infrastructure), no. 55 (Access / proximity to railway infrastructure), no. 56 (Access / proximity to water reservoir), no. 57 (Access / proximity to the river for transport), no. 58 (Access / proximity to gas pipeline network connections), no. 59 (Proximity to industries), no. 60 (Water treatment plant), and no. 64 (Temporary storage areas) on the variables no. 66 (Electro-intensive industries), no. 67 (Industries likely to use H_2), no. 68 (Constant energy consumption industries), and no. 69 (Companies manufacturers of goods and/or suppliers of services). Figure 4-6 shows the second round of expert study at GIG.

Figure 4-6. Second round of expert study (Delphi) at GIG

On November 25, a second meeting was held as part of the second round of the Delphi survey - the participants were: Aleksander Wrana, Aleksander Frejowski and Jacek

Myszkowski. The following relationships between the "mining" variables were analyzed in the second round (Figure 4-7 and Figure 4-8):

- Influence of variable no. 1 (Depth of mine) on variables no. 8 (Volume of pumped water) and no. 15 (Water inflow)
- Influence of variable no. 2 (Ground movement) on variable no. 29 (Existence of historic or singular buildings).
- Influence of variable no. 3 (Geological singularities of the mine) on variables no. 9 (Pumped water chemistry/quality), no. 13 (Shaft technical condition), and no. 15 (Water inflow).
- Influence of variable no. 10 on variables no. 8 (Volume of pumped water), and no. 16 (Flooding status of the mine).
- Influence of variable no. 11 on variables no. 7 (Coal processing plant capacity), no. 8 (Volume of pumped water), no. 9 (Pumped water chemistry/quality), and no. 15 (Water inflow).
- Influence of variable no. 12 (Shaft diameter) on variable no. 17 (Flooding status of the mine).
- Influence of variable no. 22 (Material type deposited on the waste heap) on variable no. 18 (Area of the waste heap), and no. 30 (Land use restrictions).
- Influence of variable no. 24 (Fire hazard at the waste heap) on variable no. 30 (Land use restrictions).
- Influence of variable no. 27 (Status of reclamation of the waste heap) on variable no. 26 (Acidity potential of the waste heap material).

Figure 4-7. Second round of expert study at GIG

Figure 4-8. Another photograph of the second round of expert study at GIG

In the Department of Water Protection, a second round was carried out for variable influences, which differed from the indications of other experts. It concerned the impact of the following variables:

- impact of variable no. 8 (Volume of pumped water) on variables no. 7 (Coal processing plant capacity), no. 13 (Shaft technical condition), no. 15 (Water inflow), and no. 16 (Pumped water temperature),
- impact of variable no. 9 (Pumped water chemistry/quality) on variable no. 7 (Coal processing plant capacity),
- impact of variable no. 10 (Hazardous substances in the pumped mine water) on variable no. 50 (Cost of decommissioning and remediation),
- impact of variable no. 11 on variables no. 2 (Ground movement), and no. 3 (Geological singularities of the mine),
- impact of variable no. 16 (Pumped water temperature) on variable no. 7 (Coal processing plant capacity),
- impact of variable no. 17 (Flooding status of the mine) on variable no. 7 (Coal processing plant capacity),
- impact of variable no. 30 (Land use restrictions) on variables no. 2 (Ground movement), no. 4 (Methane surface emissions - AMM), no. 7 (Coal processing plant capacity), no. 8 (Volume of pumped water), no. 14 (Function/status of shaft (liquidated, pumping station, ventilation working)), no. 17 (Flooding status of the mine), no. 19 (Height of the waste heap), no. 20 (Angle of slopes of the waste heap), no. 21 (Geometry of the waste heap), no. 22 (Material type deposited on the waste heap), and no 23 (Geotechnical stability of waste heaps),
- impact of variable no. 34 (Power plant concession expiry date) on variables no. 35 (Expected technical lifetime), no. 36 (Number of units decommissioned), no. 40

(CO_2 capture installation), no. 44 (Fly ash characterization), and no. 66 (Electro-intensive industries),

- impact of variable no. 35 (Expected technical lifetime) on variables no. 36 (Number of units decommissioned), no. 44 (Fly ash characterization), no. 46 (Coal ash waste landfill area availability), no. 49 (Availability of concession for power generation), no. 52 (Character of the local area), no. 53 (Neighborhood and proximity to the nearest urban/industry), no. 59 (Proximity to industries), no. 60 (Water treatment plant), and no. 67 (Industries likely to use H_2),
- impact of variable no. 36 (Number of units decommissioned) on variables no. 44 (Fly ash characterization), no. 52 (Character of the local area), and no. 53. (Neighborhood and proximity to the nearest urban/industry),
- impact of variable no. 41 (District heating connection) on variable no. 32 (Power plant connection capacity to the grid),
- impact of variable no. 42 (Cooling water installation type) on variables no. 59 (Proximity to industries), and no. 66 (Electro-intensive industries),
- impact of variable no. 43 (Wastewater treatment plant) on variable no. 45 (Power plant landfill area. Hazardous/non-hazardous), no. 46 (Coal ash waste landfill area availability), no. 51 (Land use restrictions), no. 58 (Access / proximity to gas pipeline network connections), no. 59 (Proximity to industries), no. 60 (Water treatment plant), and no. 66 (Electro-intensive industries),
- impact of variable no. 44 (Fly ash characterization) on variables no. 33 (Electricity production efficiency of power plant), no .35 (Expected technical lifetime), no. 36 (Number of units decommissioned), no. 38 (Repowering: possibility of adapting the boiler for biomass), no. 45 (Power plant landfill area. Hazardous/non-hazardous), no. 46 (Coal ash waste landfill area availability), no. 47 (Available space for new technologies/projects), and no. 59 (Proximity to industries),
- impact of variable no. 45 (Power plant landfill area. Hazardous/non-hazardous) on variables no. 7 (Coal processing plant capacity), no. 8 (Volume of pumped water), no. 9 (Pumped water chemistry/quality), no. 10 (Hazardous substances in the pumped mine water), no. 11 (Depth of the shafts), no. 13 (Shaft technical condition), no. 37 (Access / proximity to reservoirs and water courses. Water reservoir capacity), no. 42 (Cooling water installation type), no. 43 (Wastewater treatment plant), no. 44 (Fly ash characterization), no. 56 (Access / proximity to water reservoir), no. 60 (Water treatment plant), no. 61 (Water treatment plant), and no. 66 (Electro-intensive industries),
- impact of variable no. 51 (Land use restrictions) on variables no. 37 (Access / proximity to reservoirs and water courses. Water reservoir capacity), no. 43 (Wastewater treatment plant), no. 59 (Proximity to industries), and no. 60 (Water treatment plant),
- impact of variable no. 52 (Character of the local area) on variables no. 1 (Depth of mine), no. 2 (Ground movement), no. 61 (Obligations arising from concessions, contracts and other regulations in case of a power plant decommissioned), no. 62

(Power Plant employment (number of employees)), no. 63 (Special screening mechanisms for employees (early retirement, paid long-term leaves, voluntary leave programs)), and no. 68 (Constant energy consumption industries),

- impact of variable no. 55 (Access / proximity to railway infrastructure) on variables no. 56 (Access / proximity to water reservoir), no. 57 (Access / proximity to the river (for transport)), no. 63 (Special screening mechanisms for employees (early retirement, paid long-term leaves, voluntary leave programs)), and no. 64 (Temporary storage areas),
- impact of variable no. 56 (Access / proximity to water reservoir) on variables no. 47 (Available space for new technologies/projects), no. 48 (Obligations of thermal energy supply after the decommissioning), and no. 49 (Availability of concession for power generation),
- impact of variable no. 58 (Access / proximity to gas pipeline network connections) on variable no. 32 (Power plant connection capacity to the grid),
- impact of variable no. 59 (Proximity to industries) on variables no. 2 (Ground movement), no. 5 (Methane resources - CBM), no. 32 (Power plant connection capacity to the grid), no. 33 (Electricity production efficiency of power plant), no. 34 (Power plant concession expiry date), no. 37 (Access / proximity to reservoirs and water courses. Water reservoir capacity), no. 38 (Repowering: possibility of adapting the boiler for biomass), no. 39 (Feasibility of reusing air cleaning installation for repowering), no. 40 (CO_2 capture installation), and no. 60 (Water treatment plant).

Also on November 25, 2021, another brainstorming session with two mining experts specialized in mine ventilation took place. Consensus on methane hazards related issues was reached especially with respect to variables no. 4 and no. 5.

On November 26, 2021, an online meeting was held, attended by: Alicja Krzemień, Mariusz Kruczek, Aleksander Frejowski and Adam Duda. It specifies the method of determining the values in the above variables impacts and the method of their transfer.

On November 29, 2021, a brainstorming session was held, attended by: Aleksander Wrana, Jacek Myszkowski, and Aleksander Frejowski. Consensus was reached on the influence of selected variables 1 to 31. The influence values of the variables were determined:

- influence of variable 1 (depth of mine) on variables 8 (volume of pumped water), and 15 (water inflow)
- influence of variable 2 (ground movement) on variable 29 (existence of historic or singular buildings)
- influence of variable 3 (geological singularities of the mine) on variables 9 (pumped water chemistry/quality), 13 (shaft technical condition), and 15 (water inflow),

- influence of variable 10 (hazardous substances in the pumped mine water) on variable 8 (volume of pumped water), and 17 (flooding status of the mine),
- influence of variable 11 (depth of the shafts) on influences 7 (coal processing plant capacity), 8 (volume of pumped water), 9 (pumped water chemistry/quality), and 15 (water inflow),
- influences of variable 12 (shaft diameter) on variable 17 (flooding status of the mine),
- influence of variable 22 (material type deposited on the waste heap) on variable 18 (area of the waste heap), and 30 (land use restrictions),
- influence of variable 24 (fire hazard at the waste heap) on variable 30 (land use restrictions),
- influence of variable 27 (status of reclamation of the waste heap) on variable no 26 (acidity potential of the waste heap material).

On November 30, 2021, a final brainstorming session was held, attended by: Alicja Krzemień, Stanislaw Tokarski, and Aleksander Frejowski.

The results of the second round of Delphi study for the above variables are presented in Annex 2.

External experts who participated in the second round of Delphi's study:

- External expert Marek Modrzik retiree from Polish Coal Company (27 years of experience in underground coal mining, mining transport, and management of the underground coal mine) filled in the matrix for the impacts of "mining" variables (from variable no. 1 to variable no. 31) on all “mining” variables (from variable no. 1 to variable no. 31).
- External expert from Jastrzębska Spólka Węglowa (15 years of experiences in underground mining and Rockburst hazard) assessed the impacts of the variables no. 1, 2, 3 and 5 on variables no. 1 to no. 31.
- External expert from Jastrzębska Spółka Węglowa SA (10 years of experiences in underground mining, mining extraction, mining hazards and ventilation) assessed the impact of the variables no. 4 (Methane surface emissions - AMM) and no. 5 (Methane resources - CBM) on the "mining" variables (variables from no. 1 to no. 31) and the impact of all the "mining" variables (variables from no. 1 to no. 31) on the variables no. 4 (Methane surface emissions - AMM) and no. 5 (Methane resources - CBM).

On November 29, a final consensus workshop was organized in order to define the final results of the study.

5 Conclusions and lessons learnt

The relationships between the variables were assigned to different group of experts according to their experience on coal mines and on coal-fired power plants.

40 experts representing GIG (sixteen experts), Universidad de Oviedo (five experts), Hulleras del Norte, S.A. (one expert), CERTH (four experts), VGB (4 experts), THGA-DMT (three expert) and seven external experts participated in the research. GIG experts completed 8 matrixes, Universidad de Oviedo and Hulleras del Norte, S.A. together, one matrix, CERTH experts and external CERTH experts together one matrix, VGB experts one matrix, THGA-DMT experts together one matrix and GIG external experts three matrixes.

The main problem encountered were the discrepancies between the responses in the matrix, which required a second round of Delphi study. The revision of the results showed that in some cases experts were able to evaluate the relation between two variables but without proper identification of the direction of influence, i.e.: Influence of variable no. 69 (Companies manufacturers of goods and/or suppliers of services) on variable no. 58 (Access / proximity to gas pipeline network connections) does not exist, but the opposite one was identified (access / proximity to gas pipeline network connections may affect companies manufacturers of goods and/or suppliers of services).

The second round of Delphi study benefited from the knowledge and experience of external experts, who positively influenced the final results. The Matrix of Direct Influence presented in Annex 3 will be transferred to MICMAC software in the next stage of the POTENTIALS project.

It should be emphasized that the matrix is not in its final version, as it is possible to use the opinion of additional experts when performing analyses and calculations in the MICMAC software.

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Annex 1: Expertise of experts who evaluated the relation between the variables in POTENTIALS project

List of experts who evaluated the relation between the variables in POTENTIALS project				
Number	Name and surname	Institution	Years of experience	Occupational specialization
1	Aleksander Frejowski	Central Mining Institute	18	mining geology, geomechanics, postmining
2	Jacek Myszkowski	Central Mining Institute	32	underground mining, geomechanics
3	Alicja Krzemień	Central Mining Institute	16	underground mining, postmining, risk assessment
4	Eugeniusz Krause	Central Mining Institute /previously coal mine	40	underground mining, postmining, gas hazard in mining, GHG emissions
5	Stanisław Tokarski	Central Mining Institute /previously Tauron Energry Production Company	35	energy production, energy management
6	Aleksandra Koteras	Central Mining Institute	18	underground mining, risk assessment
7	Adam Duda	Central Mining Institute	23	underground mining, postmining, risk assessment
8	Jan Szymała	Central Mining Institute	29	underground engineering construction, mining extraction, shaft stability
9	Aleksander Wrana	Central Mining Institute	15	underground mining, postmining, mining extraction
10	Wojciech Masny	Central Mining Institute	17	underground mining, mining extraction
11	Ewelina Strzoda	Central Mining Institute	6	professional power engineering, heat engineering, renewable energetics, energy audits of enterprises and buildings, preparation of building energy performance certificates, technical, economic and ecological analyzes, as well as preparation of application forms
12	Piotr Zawadzki	Central Mining Institute	4	water, wastewater and soil technology, risk assessment
13	Mariusz Kruczek	Central Mining Institute /previously Silesian University of Technology	24	strategic planning, environmental assessment, impact of mining on environment, transport and logistic, postmining
14	Ewa Janson	Central Mining Institute/ previously Polish Coal Mining Restructuring Company (Central Department of Mine Dewatering)/ previously Polish State Mining Authority – District Mining Office Katowice	19	mine dewatering, mine water use, mine flooding, drainage systems, pumping systems in underground coal mining, mine water chemistry, water management, water law regulations, water and wastewater technology, regional impact of mining in water environment
15	Małgorzata Markowska	Central Mining Institute	12	impact of mining on environment, including water environment; water management, hydrology and environmental protection.
16	Elżbieta Uszok	Central Mining Institute	19	revitalisation and integrated development, underground mining, postmining,
17	GIG external expert: Marek Modrzik	Polish Coal Group Company /retiree	27	underground mining, mining transport
18	GIG external expert	Underground coal mine worker: JSW S.A.	10	underground mining, mining extraction, mining hazards, ventilation
19	GIG external expert	Underground coal mine worker: JSW S.A.	15	underground mining, mining extraction, mining hazards, rockburst
20	GIG external expert: Waldemar Szulc	Towarzystwo Gospodarcze Polskie Elektrownie (Economic Society Polish Power Plants)	35	power engineer, power plant operation, investment processes
21	GIG external expert: Paweł Woszczyk	Towarzystwo Gospodarcze Polskie Elektrownie (Economic Society Polish Power Plants)	30	power engineer, experience in power plant operation, maintenance, power distribution
22	Ana Suárez Sánchez	Universidad de Oviedo	20	chemical plants, risk assessment, postmining
23	Agustín Menéndez Díaz	Universidad de Oviedo	30	technical installations, mining
24	Gregorio Fidalgo Valverde	Universidad de Oviedo	21	risk assessment, management
25	Francisco J. Iglesias Rodríguez	Universidad de Oviedo	20	risk assessment, postmining, management, quality control
26	Pedro Riesgo Fernández	Universidad de Oviedo	30	underground mining, postmining, risk assessment
27	Juan José Álvarez Fernández	Hulleras del Norte, S.A.	23	mining geology, underground mining, postmining, investments
28	Pavlos Tyrologou	CERTH	18	engineering geology, risk assessment, land contamination, energy geological storage
29	Joanna Badouna	CERTH	5	engineering geology, materials science, energy geological storage
30	Christos Karkalis	CERTH	4	mineralogy, geochemistry, energy geological storage
31	Dimitris Karapanos	CERTH	3	risk assessment, hazard management, energy geological storage, CCUS
32	CERTH external expert	Public Power Corporation S.A.	20	coal mining, energy production, power plant operation
33	CERTH external expert	Public Power Corporation S.A.	30	coal mining, energy production, power plant operation
34	Thomas Eck	VGB	15	power plant technologies/operation, dismantling, repurposing
35	Sven Göhring	VGB	10	power plant technologies/operation, maintenance, environmental issues
36	Christian Stolzenberger	VGB	30	power plant technologies/operation, fuel combustion, materials, quality control
37	Sabine Polenz	VGB	30	power plant technologies/operation, research, emerging technologies
38	Kai van de Loo	THGA-DMT	33	experience in an industry association, especially in energy economy, energy statistics and energy policy including 1 year work for the European Commission as chef de cabinet of the president of the Consultative Committee of the former European Coal an Steel Community; scientific work in research on industry and energy topics, in the last years with main point Post-Mining and structural change in coal regions
39	Julia Tiganj	THGA-DMT	4	post-mining, chinese raw materials industry, reactivation and transition of former mining areas, socio-economic aspects, economics, politics
40	Stefan Möllerherm	THGA-DMT	36	mining, underground mining, open pit mining, business administration, post-mining

Figure Annex 1-1. Expertise of experts that participate in the evaluation

Annex 2: Delphi round II results

Feedback from November, 25 first brainstorming session:

- Influence of variables no. 3 on variable no. 4. Geological singularities of the mine have influence on methane surface emissions (AMM), this applies in particular to the possibility of gas migration on the surface through geological disturbances, mainly faults. The final value of the influence of variable no. 3 on variable no. 4 was set as 2 (medium influence).
- Influence of variables no. 3 on variable no. 5. Geological singularities of the mine have influence on methane resources (CBM), this applies in particular to the possibility of gas migration during methane exploitation through geological disturbances, mainly faults. The final value of the influence of variable no. 3 on variable no. 5 was set as 3 (strong influence).
- Influence of variables no. 4 on variable no. 1. Methane surface emissions (AMM) have influence on depth of mine, surface emissions occur from methane coal seams, these are at deeper depths. The final value of the influence of variable no. 4 on variable no. 1 was set as 1 (low influence).
- Influence of variables no. 4 on variable no. 24. Methane surface emissions (AMM) may have influence on fire hazard at the waste heap, if the waste heap is located in a methane emission zone, for example in a fault zone. The final value of the influence of variable no. 4 on variable no. 24 was set as 1 (low influence).
- Influence of variables no. 4 on variable no. 25. Methane surface emissions (AMM) may have influence on gas hazard at the waste heap, if the waste heap is located in a methane emission zone, for example in a fault zone. The final value of the influence of variable no. 4 on variable 25 was set as 1 (low influence).
- Influence of variables no. 5 on variable no. 11. Methane resources (CBM) may have influence on depth of the shaft, which is related to the fact that the deeper the coal bed methane resides, the deeper the shaft must be. The final value of the influence of variable no. 5 on variable no. 11 was set as 2 (medium influence).
- Influence of variables no. 5 on variable no. 30. Methane resources (CBM) may have influence on land use restriction - refers to the plans for future coal bed methane exploitation and related legal conditions. The final value of the influence of variable no. 5 on variable no. 30 was set as P (potential influence).
- Influence of variables no. 6 on variable no. 4. Coal spontaneous ignition may have influence on methane surface emission (AMM) - refers to shallow mining. The final value of the influence of variable no. 6 on variable no. 4 was set as 1 (low influence).
- Influence of variables no. 8 on variable no. 5. Volume of pumped water may have influence on methane resources (CBM) - the less water is pumping the faster the water level rises and the faster the mine is flooded, water is a methane blocker in the deposit

- methane is trapped by the hydrostatic pressure of the water column. The final value of the influence of variable no. 8 on variable no. 5 was set as 2 (medium influence).

- Influence of variables no. 11 on variable no. 4. Depth of the shaft may have influence on methane surface emissions (AMM) – if the shaft is deeper, the ventilation capacity is higher, more air enters the mine (for an active mine). The final value of the influence of variable no. 11 on variable no. 4 was set as 2 (medium influence).

Feedback from November, 26 brainstorming session:

8/7 value assigned in 1st round: 3, value in 2nd round: 3

The assessment of the inflow takes into consideration possible use of water pumped from the mine in coal processing plant;

8/13 value assigned in 1st round: 3, value in 2nd round: 3;

The assessment of the inflow takes into consideration technical condition of shaft with installation of dewatering system;

8/15 value assigned in 1st round: 3, value in 2nd round: 3;

The assessment of the inflow takes into consideration hydraulic and hydrogeological conditions in the mine and direct interrelation between volume (intensity) of pumping and total mine water inflow increase/decrease (drainage capacity)

8/16 value assigned in 1st round: 2, value in 2nd round: 2;

The assessment of the inflow takes into consideration hydraulic and hydrogeological conditions in the mine as well as geothermal gradient which is influenced due to capacity of pumping devices

8/37 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering mostly volume of pumped water use of possible capacity of the reservoir (in the meaning the installation capacity)

8/42 value assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the use of water pumped for cooling purposes

8/43 assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the possible discharge of pumped water into the installation of wastewater treatment plant

8/56 value assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the possible discharge of pumped water into the water reservoir (in this meaning as part of installation)

8/57 value assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the capacity of the river and the flow as well as increase /decrease of it due to discharge of pumped water

8/60 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the possible discharge of pumped water and direct impact on water treatment plant capacity

9/7 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of the inflow takes into consideration possible use of water pumped with particular chemistry from the mine in coal processing plant

9/8 value assigned in 1st round: 3, value in 2nd round: 3;

this assessment takes into consideration geochemistry gradient and direct relation of total inflow of mine water to be pumped

9/37 value assigned in 1st round: 3, value in 2nd round: 3;

this assessment takes into consideration direct impact of the chemistry of pumped water to the water reservoir (and law obligations)

9/42 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the use of pumped water (with particular chemistry parameters) for cooling purposes

9/43 assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the possible discharge of pumped water into the installation of wastewater treatment plant and direct impact of chemistry parameters on treatment process

9/52 value assigned in 1st round: 1, value in 2nd round: 1;

the assessment of this variables is considering the possible discharge of pumped water and its impact on protected areas and other land use restrictions (according to urban planning, local restrictions, water directives etc)

9/52 value assigned in 1st round: 1, value in 2nd round: 1;

the assessment of this variables is considering the possible discharge of pumped water and impact of its chemistry on local area (ie. Protected areas etc)

9/53 value assigned in 1st round: 2, value in 2nd round: 1;

the assessment of this variables is considering the possible discharge of pumped water with particular chemistry on urban or industry activity (ie. Impact on other users of water resources etc)

9/60 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the possible discharge of pumped water and direct impact of its chemistry on water treatment process

9/66 value assigned in 1st round: 2, value in 2nd round: 1;

the assessment of this variables is considering the possible use of pumped water with particular chemistry for purposes of electro intensive industry

10/7 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of the inflow takes into consideration possible use of water pumped with particular chemistry and hazardous substances from the mine in coal processing plant

10/37 value assigned in 1st round: 3, value in 2nd round: 3;

this assessment takes into consideration direct impact of the hazardous substances in pumped water to the water reservoir (and law obligations)

10/42 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the use of pumped water (with particular hazardous parameters) for cooling purposes

10/43 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the possible discharge of pumped water into the installation of wastewater treatment plant and direct impact of chemistry parameters on treatment process, with particular attention of hazardous substances

10/47 value assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the possible implementation of new technologies, in terms of necessity and law obligations to remove and reduce of hazardous substances from water environment

10/50 value assigned in 1st round: 0, value in 2nd round: 0;

the assessment of this variables is taking into consider only obligations related to water environment (not decommissioning or remediation of particular installation or land)

10/53 value assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the possible discharge of pumped water with particular concentration of hazardous substances on urban or industry activity (ie. Impact on other users of water resources etc)

10/60 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the possible discharge of pumped water and direct impact of its hazardous parameters on water treatment process

10/66 value assigned in 1st round: 2, value in 2nd round: 2;

the assessment of this variables is considering the possible use of pumped water with particular chemistry (hazardous substances) for purposes of electro intensive industry

11/2 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the stability and the depths of the shaft and its possible impact on the ground

11/3 value assigned in 1st round: 3, value in 2nd round: 3;

the assessment of this variables is considering the depth of the shaft and its possible impact on geological conditions in the mine

16/ 7 value assigned in 1st round: 2, value in 2nd round: 2;

The assigned value takes into consideration the fact that pumped mine waters can be used for circulation (e.g. cooling) in coal preparation plants - thus reducing the production costs (by the price of purchasing water from outside / from the waterworks). Therefore, the water temperature matters.

17/7 value assigned in 1st round: 3, value in 2nd round: P;

The assessment of the inflow takes into consideration possible impact of the fact that mine is fully flooded (requires consideration of additional protection).

45/7 value assigned in 1st round: 3, value in 2nd round: 0;

Indirect impacts have been considered, which are related to the impact of contaminants on resource availability

45/8 value assigned in 1st round: 3, value in 2nd round: 0;

No direct link identified

45/9 value assigned in 1st round: 3, value in 2nd round: 1;

Infiltration of contaminants from the landfill may cause point changes in the chemistry of the pumped water,

45/10 value assigned in 1st round: 3, value in 2nd round: 1;

As for 45/9, leachate from landfill may affect the presence of hazardous substances in pumped mine water,

45/11 value assigned in 1st round: 0, value in 2nd round: 0;

No direct link identified

45/37 value assigned in 1st round: 3, value in 2nd round: 1;

In principle, it can be indicated that the area of the landfill of the power plant will affect the size (capacity) of the water bodies in the immediate vicinity through the occupation of the landfill area. This is a low impact phenomenon.

45/42 value assigned in 1st round: 3, value in 2nd round: 0;

No direct link identified

45/43 value assigned in 1st round: 3, value in 2nd round: 1.

Water from the landfill (leachate) may contain substances whose removal requires specialist technological and/or biological solutions for their removal. Considering the scale of the phenomenon.

45/44 value assigned in 1st round: 0, value in 2nd round: 3;

Differences in the types of landfill waste that will affect fly ash characteristics were not previously considered.

45/56 value assigned in 1st round: 3, value in 2nd round: 1;

The area of the landfill affects access to the water body - the size of the landfill may affect the need for alternative access routes, storage of hazardous waste may also result in the ability to use the water being restricted.

45/60 value assigned in 1st round: 3, value in 2nd round: 0;

The assessment took into account the location factor, which in the perspective of the study will not have a direct impact.

45/61 value assigned in 1st round: 0, value in 2nd round: 0;

No direct relationship, it is the regulations that may influence the way the site is developed and not the way the site is developed that determines decommissioning.

45/66 value assigned in 1st round: 2, value in 2nd round: 0;

The assessment took into account the location factor, which will not have a direct impact in the perspective of the study.

52/1 value assigned in 1st round: 3, value in 2nd round: 1;

The nature of the site e.g.: highly urbanised restricts the potential may affect restrictions on mining, due to safety and stability at the surface. Due to the localized nature of the undesirable phenomena

52/2 value assigned in 1st round: 3, value in 2nd round: 3;

Consideration has been given to the issue of landform, which in combination e.g.: with extreme phenomena may affect ground movements.

52/61 value assigned in 1st round: 0, value in 2nd round: 0;

The nature of the site does not condition the provisions of the decommissioning documents, it could be assumed that the regulations arise from special land use - conservation issues.

52/62 value assigned in 1st round: 0, value in 2nd round: 0;

It is difficult to identify a direct link.

52/63 value assigned in 1st round: 0, value in 2nd round: 0;

It is difficult to identify a direct link.

52/68 value assigned in 1st round: 0, value in 2nd round: 2;

The specificity of the area, especially the number of inhabitants, the presence of industry affects the continuous demand for energy, unless alternative power sources or prosumer energy are more strongly developed in the area.

55/56 value assigned in 1st round: 0, value in 2nd round: 0;

It is difficult to identify a direct link.

55/57 value assigned in 1st round: 0, value in 2nd round: 0;

It is difficult to identify a direct link.

55/63 value assigned in 1st round: 0, value in 2nd round: 0;

It is difficult to identify a direct link.

55/64 value assigned in 1st round: 3, value in 2nd round: 1;

Railway is used in process of transport of raw materials or waste to disposal sites, hence access to railway line was assessed as a factor determining, among others, location of disposal site, additionally implementation of railway investments will also depend on location of disposal sites.

56/47 value assigned in 1st round: 2, value in 2nd round: 2;

Water is an important ingredient in the implementation of many innovative projects in the mining and energy sectors, taking into account its availability is important.

56/48 value assigned in 1st round: 2, value in 2nd round: 1;

Heat carrier includes water, ensuring access to it is an important factor in maintaining supply.

56/49 value assigned in 1st round: 2, value in 2nd round: 0;

It is difficult to identify a direct link.

59/2 value assigned in 1st round: 2, value in 2nd round: 2;

The impact of ground movement on the proximity to industries was assessed. Ground movement affects the interest and access of industry, as the industry may not be interested in locating plants in these areas due to the ground movement.

59/5 value assigned in 1st round: 2, value in 2nd round: P;

The impact of methane resources (CBM) on the proximity to industries was assessed. Coal bed methane (CBM) is treated as obtaining gas from unconventional sources. Therefore, the possibility of the development of industries and industry around mining plants was taken into account (proximity to industries). Thus, it is reasonable to say that variable 5 affects variable 59. However, it should be considered whether this is a medium impact (grade: 2) in the short term or in the long term (grade: P). It can be allowed to change the grade to P due to the still continuous development and improvement of the mining and recovery technology of CBM.

30/2; value assigned in 1st round: 2, value in 2nd round: 2;

Restrictions on surrounding land use determine the extent of mining activities, especially a the type of land use determines the maximum predicted value of land deformation i connection and directly related ground movement

30/4; value assigned in 1st round: 3, value in 2nd round: 3;

Restrictions on surrounding land use determine the extent of mining activities and restrictions on land use are closely related to value and possibility methane surface emissions, in the case of thermally active coal waste storage sites and in justified cases on peatland.

30/7; value assigned in 1st round: 3, value in 2nd round: 2;

Environmental constraints related to land availability and related legal conditions, which determine the capacity of sorted solid waste disposal sites especially at the planning stage. The assessment was reviewed to reflect current practice.

30/8; value assigned in 1st round: 3, value in 2nd round: 1;

Environmental constraints directly affect the possibility of discharging water from the pits and constraints related to natural water inflow vs. rationalization of the handling of discharged water, taking into account the possibility of its use or re-rolling. Re-introduction of water or rational management has an impact on the amount of pumped water. The assessment was reviewed to reflect current practice.

30/14; value assigned in 1st round: 2, value in 2nd round: 2;

Shafts, pumping stations are a special type of infrastructure and their location is dictated by space constraints. Providing safety on the ground during decommissioning and development of this infrastructure also has an impact on its scale and manner.

30/17; value assigned in 1st round: 3, value in 2nd round: 3;

Direct relationship, especially at the stage of locating a mining company and dealing with areas affected by mining damage generating additional land use restrictions

30/18; value assigned in 1st round: 3, value in 2nd round: 3;

Environmental constraints related to land availability and related legal conditions, which determine the area at the planning stage

30/19; value assigned in 1st round: 3, value in 2nd round: 2;

Landscape issues affect how the landfill is formed and its height. The assessment was reviewed to reflect current practice.

30/20; value assigned in 1st round: 3, value in 2nd round: 2;

Landscape issues affect how the landfill is formed and potential future use of the site. The assessment was reviewed to reflect current practice.

30/21; value assigned in 1st round: 3, value in 2nd round: 2;

Landscape issues affect how the landfill is formed and potential future use of the site. The assessment was reviewed to reflect current practice.

30/22; value assigned in 1st round: 2, value in 2nd round: 1;

Environmental conditions and legal requirements determine the depositing of material types. The assessment was reviewed to reflect current practice.

30/23; value assigned in 1st round: 3, value in 2nd round: 2;

Future development and use of waste heaps areas affects geotechnical stability issues. The assessment was reviewed to reflect current practice.

34/35; value assigned in 1st round: 3, value in 2nd round: 3;

The concession period shall depend on the technical condition of the facility guaranteeing the proper performance of the activity

34/36; value assigned in 1st round: 2, value in 2nd round: 2;

Compliance with the provisions of the concession obliges entrepreneurs to ensure adequate generation capacities and well-considered actions regarding the closure of units.

34/40; value assigned in 1st round: 2, value in 2nd round: 1;

The expiry of the concession is linked to the possession of the required permits and decisions, in this case for CO_2 emissions. This is a special case for low carbon standards on the part of the entrepreneur. The assessment was reviewed and relates special circumstances

34/44; value assigned in 1st round: 2, value in 2nd round: 1;

The expiry of the concession is linked to the possession of the required permits and decisions, in this case for fly ash emission. This is a special case for low carbon standards on the part of the entrepreneur. The assessment was reviewed and relates special circumstances

35/36; value assigned in 1st round: 3, value in 2nd round: 3;

Expected technical lifetime → Number of units decommissioned

the technical lifetime of the infrastructure and the closely related factors of technical condition efficiency and compliance with legal standards are decisive in deciding on the scope of decommissioned units

35/44; value assigned in 1st round: 2, value in 2nd round: 2;

The technical life condition of the infrastructure in the case of solid fuel combustion has an impact on the fly ash characteristics. The more outdated the infrastructure, the less efficient and the worse the environmental effect.

35/46; value assigned in 1st round: 2, value in 2nd round: 2;

The technical life condition of the infrastructure in the case of solid fuel combustion has an impact on the fly ash characteristics. The more outdated the infrastructure, the less efficient and the worse the environmental effect and more demand for landfill availability

35/49; value assigned in 1st round: 3, value in 2nd round: 3;

Ensuring technical durability is a prerequisite for obtaining a license

35/52; value assigned in 1st round: 2, value in 2nd round: 2;

The use of land (in this case for energy purposes) directly influences the local character

35/53; value assigned in 1st round: 2, value in 2nd round: 2;

Ensuring adequate infrastructure lifetime is related to the aspect of neighborhood and minimizing the costs of its maintenance

35/59; value assigned in 1st round: 3, value in 2nd round: 3;

Ensuring adequate infrastructure lifetime is related to the aspect of neighborhood, energy market and minimizing the costs of its maintenance

35/60; value assigned in 1st round: 2, value in 2nd round: 2;

Ensuring an adequate lifetime of infrastructure is related to the need to ensure adequate water quality and environmental standards, including for industrial wastewater

36/44; value assigned in 1st round: 3, value in 2nd round: 3;

Reducing the number of emitters (furnaces), including those which are environmentally inefficient - directly influencing emissions, waste, dust in the atmosphere, i.e. the quantity and quality of dust

36/52; value assigned in 1st round: 2, value in 2nd round: 1;

Land use change and decommissioning of energy facilities changes the local character of the area. Analysis included total decommissioning. assessment was changed for cases where energy use remains.

36/53; value assigned in 1st round: 2, value in 2nd round: 2;

Decisions to decommission units are related to the issue of efficiency and minimization of energy losses, and the distance to final consumers is an important element in the distribution of energy and heat (for cogeneration)

41/32; value assigned in 1st round: 3, value in 2nd round: 3;

Cogeneration and associated heat production in power stations is related to the grid connection capacity

44/33; value assigned in 1st round: 2, value in 2nd round: 2;

Emission standards are important and influence technical and legal solutions related to energy production

44/35; value assigned in 1st round: 2, value in 2nd round: 2;

Emission standards are important and influence technical and legal solutions related to energy production

44/36; value assigned in 1st round: 2, value in 2nd round: 2;

Emission standards are important and influence technical and legal solutions related to energy production

44/38; value assigned in 1st round: 3, value in 2nd round: 3;

The characteristics of fly ash generation determine the technical solutions related to the adaptation of boilers for biomass combustion to ensure appropriate emission standards

44/45; value assigned in 1st round: 0, value in 2nd round: 0;

The characteristics of fly ash and the content of heavy metals and other hazardous components determine the handling and storage

44/46; value assigned in 1st round: 0, value in 2nd round: 3;

The characterization of ash in the context of facility availability and the possibility of depositing this type of waste can be analyzed in various ways. In the case of existing facilities, the available capacity for its deposition does not show any relation, but due to the decarburization of the energy industry (and so was adopted in the first round). In contrast, in the case of locating new facilities, it is crucial. The assessment has been modified with respect to the siting of new facilities.

44/47; value assigned in 1st round: 0, value in 2nd round: 0;

Due to the decarburization of energy as well as the implementation of the circular economy, combustion methods are being replaced by other alternative methods and in this case too. They are currently not the decisive factor in terms of providing available new space. Also the trend towards waste closure should influence the minimization of waste generation and the need for new landfills for this type of waste.

42/59, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of cooling water installation type on proximity to industries was assessed. Another understanding of the problem was adopted, namely the impact of cooling water installation type. The assessment included the availability of technology and costs that may affect the presence of industry.

42/66, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of cooling water installation type on electro-intensive industries was assessed. Another understanding of the problem was adopted, namely the impact of cooling water installation type. The assessment included the availability of technology and costs that may affect the presence of electro-intensive industries.

43/7, value assigned in 1st round: 2, value in 2nd round: 0;

The impact of wastewater treatment plant on coal processing plant capacity was assessed. The understanding of the problem might have been different from that of others (the impact of the efficiency of the treatment plant on the capacity of the coal processing plant).

43/8, value assigned in 1st round: 2, value in 2nd round: 0;

The impact of wastewater treatment plant on volume of pumped water was assessed. The understanding of the problem might have been different from that of others (pumps as an element of the water and wastewater management system of the plant-wastewater treatment plant), thus the assessment in 1st round was: 2. In the 2nd round is: 0.

43/9, value assigned in 1st round: 3, value in 2nd round: ;

The impact of wastewater treatment plant on pumped water chemistry/quality was assessed. Before pumping out, prior treatment installations was taken as a factor, thus in this assessment, probably a different understanding of the problem was considered.

43/10, value assigned in 1st round: 3, value in 2nd round: 1;

The impact of wastewater treatment plant on hazardous substances in the pumped mine water was assessed. Before pumping out, prior treatment installations was taken as a factor, thus in this assessment, probably a different understanding of the problem was considered.

43/46, value assigned in 1st round: 2, value in 2nd round: 1

The impact of wastewater treatment plant on coal ash waste landfill area availability was assessed. In this assessment, probably a different understanding of the problem was considered. Coal ash waste landfill area may be a source of leachate containing pollutants that require the treatment methods. First, the existence of a wastewater treatment plant can affect the coal ash waste landfill area availability (e.g. treatment technology on-site). Second, in the absence of a treatment plant, the coal ash waste landfill should include methods for treating potential leachate.

43/51, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of wastewater treatment plant on land use restrictions was assessed. The assessment included the limitations resulting from the Water Framework Directive concerning the necessity to protect the water bodies designated in order to avoid their quality deterioration, to reduce the level of treatment required in the production of drinking water. The location of the wastewater treatment plant may affect local restrictions on land use or the establishment of safeguard zones if the treatment plant had a significant impact on the environment.

43/58, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of wastewater treatment plant on access / proximity to gas pipeline network connections was assessed. One of the factors adopted for the assessment was the production of biogas from sewage sludge and possible transport to the gas pipeline. However, the transport of all biogas has been taken into account, and possibly its use on site could be considered.

43/59, value assigned in 1st round: 3, value in 2nd round: 2;

The impact of wastewater treatment plant on proximity to industries was assessed. Industry must have a place to discharge wastewater to comply with the Water Framework Directive. Lack of access to the treatment plant or necessitates the necessity to build a new one or construct devices for pre-treatment of industrial wastewater. Which may affect the availability of industries due to investment and operating costs.

43/60, value assigned in 1st round: 3, value in 2nd round: 3

The impact of wastewater treatment plant on water treatment plant was assessed. The location of the wastewater treatment plant in relation to the water treatment plant was assumed as an important factor. The proximity of the wastewater treatment plant implies the need to use technically efficient and effective water treatment processes and special attention and monitoring of water intake. A wastewater treatment plant can contaminate the water source.

43/66, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of wastewater treatment plant on electro intensive industries was assessed. The types of electro-intensive industries and their impact on the operation of wastewater treatment plants were adopted for the assessment. Electro intensive industries must have a place to discharge wastewater to comply with the Water Framework Directive. Lack of access to the treatment plant or necessitates the necessity to build a new one or construct devices for pre-treatment of industrial wastewater. Which may affect the availability of electro intensive industries due to investment and operating costs.

45/43, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of wastewater treatment plant on “Power plant landfill area. Hazardous/non-hazardous” was assessed. In this assessment, probably a different understanding of the problem was considered. Power plant landfill area (hazardous/non-hazardous) may be a source of leachate containing pollutants that require the treatment methods. First, the existence of a wastewater treatment plant can affect the power plant landfill area (e.g. treatment technology on-site). Second, in the absence of a treatment plant, the landfill of the power plant should include methods for treating potential leachate. The assessment in 1st round was: 2. In the 2nd round is: 1.

51/37, value assigned in 1st round: 2, value in 2nd round: 0;

In the 1st round, the impact of land use restrictions on “access / proximity to reservoirs and water courses. Water reservoir capacity” was assessed. The assessment took into account both access to reservoirs (in the physical sense) and legal (e.g. the possibility of water intake from these reservoirs). Certain restrictions and obligations in the field of water intake result from the regulations. Due to removal of second part of variable 37, the impact of variable 51 on 37 was re-assessed.

51/43, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of land use restrictions on wastewater treatment plant was assessed. The influence of the wastewater treatment plant on social preferences for land uses in wastewater treatment plant buffer zones have been taken into account. The location of the wastewater treatment plant may influence on creating buffer zones defined as the land between the boundary of a wastewater treatment plant or pumping station and the boundary of the area where there could be a negative impact from odour emissions. To avoid the risk of incompatible land uses being approved in buffer zones, water utilities/industries often seek planning restrictions, such as land use controls, on uses of land owned by others within a buffer zone.

51/59, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of land use restrictions on proximity to industries was assessed. The assessment was based on the local spatial development plans and their impact on the industries (e.g. transformation of the right of perpetual usufruct). In the 2nd round, assessment is maintained.

51/60, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of land use restrictions on water treatment plant was assessed. The assessment included the limitations resulting from the Water Framework Directive concerning the necessity to protect the water bodies designated in order to avoid their quality deterioration, to reduce the level of treatment required in the production of drinking water.

58/32, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of access / proximity to gas pipeline network connections on power plant connection capacity to the grid was assessed. The availability of the gas network was taken as a factor, which may have an impact on the efficiency of the power plant (the high availability of the gas network may mean that it will not be necessary to produce large amounts of energy), but it should not have a significant impact on the overall efficiency, rather on the daily production.

59/2, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of proximity to industries on ground movement was assessed. Another understanding of the problem was adopted, namely the positive impact of adapting land and areas affecting the proximity of industries, thus, the understanding of the problem might have been different from that of others.

59/5, value assigned in 1st round: 2, value in 2nd round: 0;

The impact of proximity to industries on methane resources (CBM) was assessed. One of the criteria was to increase the interest of industries in relation to CBM sources. thus in this assessment, probably a different understanding of the problem was considered.

59/32, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of proximity to industries on the power plant connection capacity was assessed. The impact of connecting the industries to the grid, and therefore the grid capacity has been taken into account, that may affect the operating parameters on power plant connection capacity to the grid. Thus, the understanding of the problem might have been different from that of others.

59/33, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of proximity to industries on electricity production efficiency was assessed. Another understanding of the problem was adopted, namely the necessity of development of the power plant resulting from the high availability and demand of industry, which may have an impact (although not large) on the production of electricity.

59/34, value assigned in 1st round: 3, value in 2nd round: 1;

The impact of proximity to industries on power plant concession expiry was assessed. A different understanding of the problem was adopted (the need to extend the license in order to ensure the security and stability of energy supplies). Thus, the understanding of the problem might have been different from that of others.

59/37, value assigned in 1st round: 2, value in 2nd round: 1;

In the 1st round, the impact of “access / proximity to reservoirs and water courses. Water reservoir capacity” on land use restrictions was assessed. The assessment took into account both access to reservoirs (in the physical sense) and legal (e.g. the possibility of water intake from these reservoirs). Certain restrictions and obligations in the field of water intake result from the regulations. Due to removal of second part of variable 37, the impact of variable 59 on 37 was re-assessed. Industries can draw water from reservoirs and have a relatively small impact on the possible necessity of their expansion or construction of new ones with greater capacity.

59/38, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of proximity to industries on repowering: possibility of adapting the boiler for biomass was assessed. The factor assumed was the influence and interest of industries in repowering technologies. Directive 2018/2001 of The European Parliament and of The Council on the promotion of the use of energy from renewable sources provides a common framework for the promotion of energy from renewable sources, including sustainability criteria for biomass fuels. The directive also lays down rules on financial support for electricity from renewable sources. Therefore, it can be concluded that the repowering technologies and the adaptation of biomass boilers will increase in interest.

59/39, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of proximity to industries on feasibility of reusing air cleaning installation for repowering was assessed. Influence and industry interest in reusing air cleaning installation for repowering was taken as a factor. Repowering results, i.e. from the Directive of the European Parliament and of the Council (EU) 2018/2001 on the promotion of the use of energy from renewable sources. Member States shall facilitate the repowering of existing renewable energy plants by ensuring a simplified and swift permit-granting process. Therefore, the analysis took into account the provisions of the above-mentioned Directive and its significant impact on the new technologies.

59/40, value assigned in 1st round: 2, value in 2nd round: 1;

The impact of proximity to industries on CO2 capture installation was assessed. In this assessment, probably a different understanding of the problem was considered. The influence and interest of industries in CO2 capture technologies were taken as a factor.

The provisions of the 2018/2001 Directive of The European Parliament and of The Council on the promotion of the use of energy from renewable sources were adopted for the analysis. The emission reduction due to CO2 capture and replacement is directly linked to the biofuel or bioliquid production to which it is attributed and relates only to emissions avoided through CO2 capture, where carbon is derived from biomass and is used to replace CO2 of origin fossil in the production of commercial goods and services. However, the potential costs of using this solution should also be taken into account, not just formal requirements.

59/60, value assigned in 1st round: 2, value in 2nd round: 2;

The impact of proximity to industries on water treatment plant was assessed. Water consumption by industry for technological purposes and the impact of industry availability on the risk of pollution generation were taken as a factor.

Feedback from November, 29 brainstorming session:

1. Influence of variables no. 1 on variable no. 8. Depth of mine has influence on volume of pumped water. The final value of the influence of variable no. 1 on variable 8 was set as 3 (strong influence).

2. Influence of variables no. 1 on variable no. 15. Depth of mine has influence on water inflow, except in rare cases, water inflow rises with increasing mining depth. The final value of the influence of variable no. 1 on variable 15 was set as 3 (strong influence).

3. Influence of variables no. 3 on variable no. 9. Geological singularities of the mine has influence on pumped water chemistry/quality, this especially relates to water flow through permeable layers and/or faults. The final value of the influence of variable no. 3 on variable 13 was set as 2 (medium influence).

4. Influence of variables no. 3 on variable no. 13. Geological singularities of the mine has influence on shaft technically condition, it is related to the occurrence of tectonic disturbances. The final value of the influence of variable no. 3 on variable 13 was set as 2 (medium influence).

5. Influence of variables no. 3 on variable no. 15. Geological singularities of the mine has influence on water inflow, it is related to the occurrence of tectonic disturbances in permeable layers. The final value of the influence of variable no. 3 on variable 15 was set as 2 (medium influence).

6. Influence of variables no. 10 on variable no. 8. Hazardous substances in the pumped mine water may have influence on volume of pumped water, this is due to the

necessity to purify the pumped water. The final value of the influence of variable no. 10 on variable 8 was set as 2 (medium influence).

7. Influence of variables no. 10 on variable no. 17. Hazardous substances in the pumped mine water may have influence on flooding status of the mine, this is due to the need to protect the environment. The final value of the influence of variable no. 10 on variable 17 was set as 3 (strong influence).

8. Influence of variables no. 11 on variable no. 7. Depth of the shaft do not have influence on coal processing plant capacity, this is influenced by the volume of extraction. The final value of the influence of variable no. 11 on variable 7 was set as 0 (no influence).

9. Influence of variables no. 11 on variable no. 8. Depth of the shaft may have influence on volume of pumped water, however it will not be a strong influence. The final value of the influence of variable no. 11 on variable 8 was set as 2 (medium influence).

10. Influence of variables no. 11 on variable no. 9. Depth of the shaft may have low influence on pumped water chemistry/quality, however it will not be a strong influence. The final value of the influence of variable no. 11 on variable 9 was set as 1 (low influence).

11. Influence of variables no. 11 on variable no. 15. Depth of the shaft may have low influence on water inflow, however it will not be a strong influence. The final value of the influence of variable no. 11 on variable 15 was set as 1 (low influence).

12. Influence of variables no. 12 on variable no. 17. Shaft diameter may have low influence on flooding status of mine, however it will not be a strong influence. The final value of the influence of variable no. 12 on variable 17 was set as 1 (low influence).

13. Influence of variables no. 22 on variable no. 18. Material type deposited on the waste heap do not have influence on area of waste heap, these variables are not related. The final value of the influence of variable no. 22 on variable 18 was set as 0 (no influence).

14. Influence of variables no. 22 on variable no. 30. Material type deposited on the waste heap may have potential influence in the future on land use restriction, this relates to the plans for future development of the waste heaps . The final value of the influence of variable no. 22 on variable 30 was set as P (potential influence).

15. Influence of variables no. 24 on variable no. 30. Fire hazard at the waste heap may have influence on land use restriction, this relates to the plans for future

development of the waste heaps and possible fire hazard. The final value of the influence of variable no. 22 on variable 30 was set as 3 (strong influence).

16. Influence of variables no. 27 on variable no. 26. Status of reclamation of the waste heap may have influence on acidity potential of the waste heap material, this is related to environmental protection. The final value of the influence of variable no. 27 on variable 26 was set as 2 (medium influence).

Feedback from November, 30 brainstorming session:

1. Influence of variables no. 36 on variable 44. There is no influence of variable no 36 (number of units decommissioned) on variable No 44 (fly ash characterization). The final value of the influence of variable no. 36 on variable 44 was set as 0 (no influence).

2. Influence of variables no. 41 on variable 32. There is no influence of variable no 41 on variable no 32 (power plant connection capacity to the grid). The final value of the influence of variable no. 41 on variable 32 was set as 0 (no influence).

3. Influence of variables no. 44 on variable 33. Fly ash characterisation (variable no. 44) does not affect the electricity production (variable no. 33), as the fly ash is residue from different types of fuel used in power plant. The final value of the influence of variable no. 44 on variable 33 was set as 0 (no influence).

4. Influence of variables no. 44 on variable 35. There is no impact of variable no 44 (fly ash characterisation) on variable no 35 (expected technical lifetime). The final value of the influence of variable no. 44 on variable 35 was set as 0 (no influence).

5. Influence of variables no. 44 on variable 38. There is no influence of variable no 44 (fly ash characterisation) on variable no 38 (repowering: possibility of adapting the boiler for biomass) .The final value of the influence of variable no. 44 on variable 38 was set as 0 (no influence). However, dust from biomass combustion has different characteristics from dust from coal combustion and therefore value of the influence of variable no. 38 on variable no. 44 was set as 2 (medium influence).

6. Influence of variables no. 59 (proximity to industries) on variable 38 (repowering: possibility of adapting the boiler for biomass). The demand for electricity from energy-intensive customers may affect the need for repowering. The final value of the influence of variable no. 59 on variable 38 was set as 2 (medium influence). In contrast, the potential impact on the establishment of industrial plants is the construction of energy plants - the value of the influence of variable no. 38 on variable no. 59 was set as P (potential influence).

7. Influence of variables no. 59 on variable 39. The new desulphurisation plants can be used for other industrial processes. The final value of the influence of variable no. 59 on variable 39 was set as P (potential influence).

8. Influence of variables no. 60 (water treatment plant) on variable 43 (wastewater treatment plant). There is no influence of variable no. 60 on variable no. 43 .The final value of the influence of variable no. 60 on variable 43 was set as 0 (no influence). On the other hand the possible influence of water purification on water availability - the value of the influence of variable no. 43 on variable no. 60 was set as P (potential influence).

9. Influence of variables no. 60 (water treatment plant) on variable 45 (power plant landfill area. Hazardous/non-hazardous). There is no correlation between these variables. The final value of the influence of variable no. 60 on variable 45 was set as 0 (no influence).

10. Influence of variables no. 60 (water treatment plant) on variable 46 (coal ash waste landfill area availability). There is no influence of variable no 60 on variable no 46. The final value of the influence of variable no. 60 on variable 46 was set as 0 (no influence).

11. Influence of variables no. 61 (obligations arising from concessions, contracts and other regulations in case of a power plant decommissioned) on variable 49 (availability of concession for power generation). There is no influence of variable no 61 on variable no 49. On the other hand is influence of availability of concession for power generation on obligations arising from concessions, contracts and other regulations in case of a power plant decommissioned. The final value of the influence of variable no. 61 on variable 49 was set as 0 (no influence). On the other hand the value of the influence of variable no. 49 on variable no. 61 was set as 2 (medium influence).

12. Influence of variables no. 61 (obligations arising from concessions, contracts and other regulations in case of a power plant decommissioned) on variable 51 (land use restrictions). The final value of the influence of variable no. 61 on variable 51 was set as P (potential influence) - this may be due to future legal conditions. On the other hand the reclamation method resulting from the concession may restrict the use of the land - the value of the influence of variable no. 51 on variable no. 61 was set as 3 (strong influence).

13. Influence of variables no. 69 (companies manufacturers of goods and/or suppliers of services) on variable 58 (access / proximity to gas pipeline network connections). There is no influence of variable no 69 on variable no 58. The final value of the influence of variable no. 69 on variable 59 was set as 0 (no influence). On the other hand access to the pipeline may affect the development of new companies - the

value of the influence of variable no. 59 on variable no. 69 was set as 2 (medium influence).

14. Influence of variables no. 69 (companies manufacturers of goods and/or suppliers of services) on variable 65 (relevant resource for land lease & rental). There is no influence of variable no 69 on variable no 65. The final value of the influence of variable no. 69 on variable 65 was set as 0 (no influence On the other hand, relevant resource for land lease & rental have a significant impact on new business possibility for companies manufacturers of goods and/or suppliers of services - the value of the influence of variable no. 65 on variable no. 69 was set as 3 (strong influence).

Annex 3: Matrix of Direct Influence

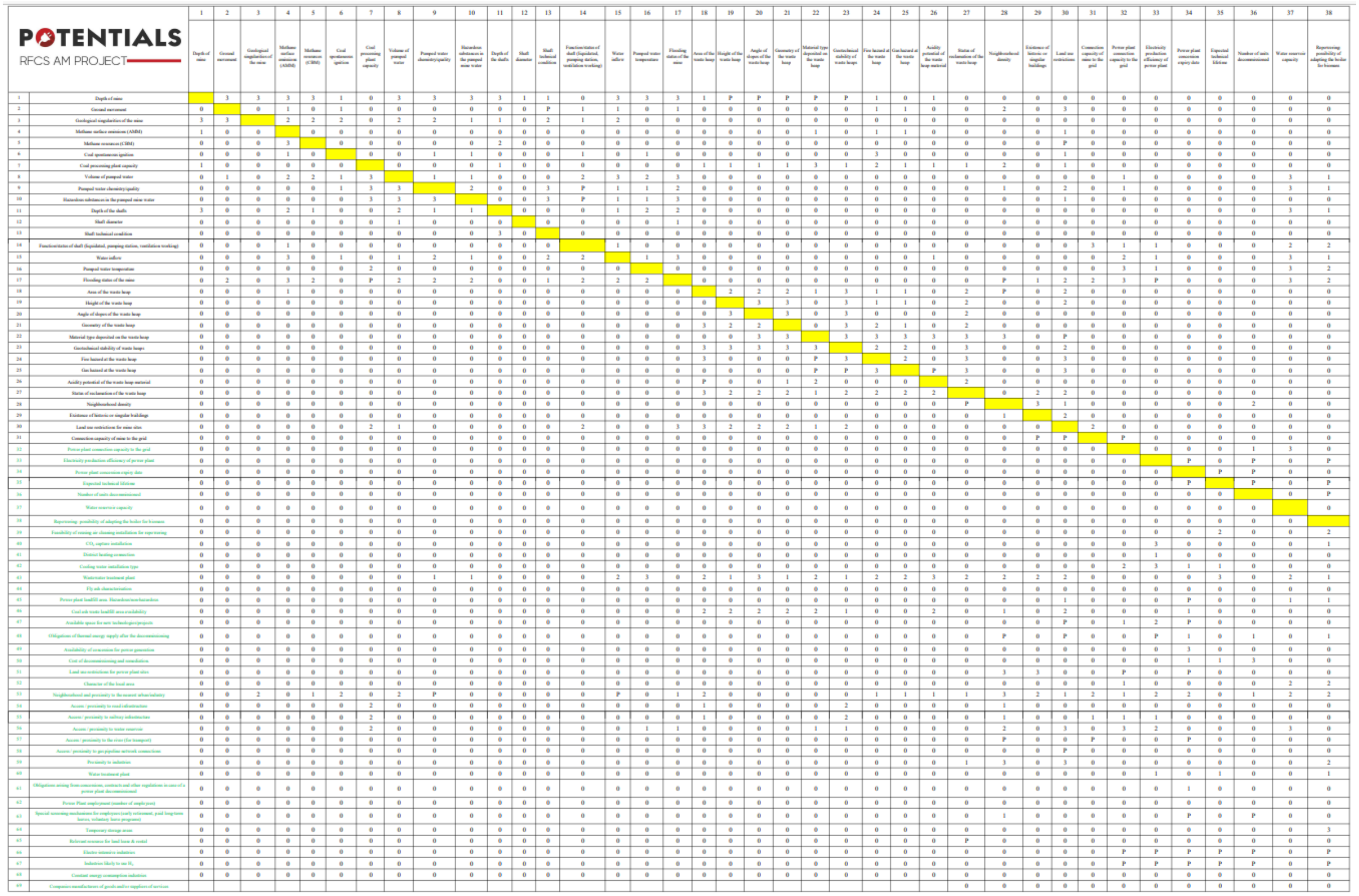

Figure Annex 3-1. First part of the Matrix of Direct Influence

39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
Feasibility of reusing air cleaning installation for repowering	CO_2 capture installation	District heating connection	Cooling water installation type	Wastewater treatment plant	Fly ash characterisation	Power plant landfill area. Hazardous/non hazardous	Coal ash/waste landfill area availability	Available space for new technologies/projects	Obligations of thermal energy supply after the decommissioning	Availability of connection for power generation	Cost of decommissioning and remediation	Land use restrictions	Character of the local area	Neighbourhood and proximity to the nearest urban/industry	Access / proximity to road infrastructure	Access / proximity to railway infrastructure	Access / proximity to water reservoir	Access / proximity to the river (for transport)	Access / proximity to gas pipeline network connections	Proximity to industries	Water treatment plant	Obligations arising from concessions, contracts and other regulations in case of a power plant decommissioned	Power Plant employment (number of employees)	Special screening mechanisms for employees (early retirement, paid long-term leaves, voluntary leave programs)	Temporary storage areas	Relevant resources for land lease & rental	Electro intensive industries	Industries likely to use H_2	Constant energy consumption industries	Companies manufacturers of goods and/or suppliers of services
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	2	2	0	0	0	1	1	0	0	0	1	1	0	0	3	2	0	1	3	0	0	0	0	0	1	1	1	1
0	0	0	3	3	0	0	0	1	1	0	0	1	1	1	0	0	3	1	0	1	3	0	0	0	0	0	1	1	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	3	3	0	0	0	2	1	0	0	1	1	2	0	0	3	1	0	1	3	0	0	0	0	0	2	0	0	0
0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	1	1	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	P	0	3	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	3	0	2	0	0	0	3	0	0	1	1	3	3	2	2	0	0	2	1	2	0	1	0	0	2	1	0	2	2
0	0	2	0	2	0	0	0	3	0	0	2	2	2	3	2	2	0	0	2	2	2	0	1	0	0	1	0	0	2	1
0	0	0	0	0	0	1	3	3	0	0	0	0	0	3	2	2	0	2	3	0	1	2	0	0	3	2	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	P	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0
0	0	0	P	0	P	P	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	2	0	0	1	1	3	P	0	0	0	0	0	0	0	0	0	0	P	2	2	0	P	0	0	0	0
0	0	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	3	3	0	0	2	2	1	2	1	1	0	0	2	0	0	3	3	2	3	1	1	0	0	0
0	0	0	3	2	0	0	0	0	0	0	0	1	2	2	1	1	3	3	0	1	1	0	0	0	0	1	2	2	2	2
0	0	0	0	0	2	0	1	1	1	2	2	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	3	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0	0		0	0	0	0	0	1	2	2	0	1	1	3	0	0	0	0	1	2	0	3	0	0	0	0	3	2	1	0
0	0	0		2	0	0	0	1	0	1	2	1	1	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	1
0	0	0	0		0	2	1	2	0	0	0	2	P	2	0	0	1	0	2	P	P	0	0	0	0	1	2	1	0	1
0	0	0	0	0		3	3	1	0	0	0	2	0	0	1	1	0	0	0	0	0	2	0	0	P	0	0	0	0	1
0	0	0	0	1	3		2	2	0	0	2	3	0	1	1	1	0	0	0	0	0	0	0	0	0	P	0	0	0	0
0	0	0	0	0	0	1		1	0	1	2	1	1	1	1	1	0	0	0	0	0	1	0	0	0	P	0	0	0	0
0	P	1	P	P	0	1	2		0	0	2	0	P	P	P	P	0	0	1	P	P	P	P	P	0	3	P	P	P	3
0	0	P	0	0	0	0	0	P		0	2	0	1	0	0	0	0	0	0	0	0	3	1	0	0	0	0	1	1	1
0	0	0	0	0	0	0	0	3	0		2	1	1	1	1	1	1	1	1	1	0	2	0	0	0	1	0	0	0	0
0	0	P	0	0	0	0	0	0	P	P		0	0	0	0	0	0	0	0	0	0	2	2	1	0	P	0	0	0	0
0	P	0	0	0	0	1	2	2	0	1	3		2	1	0	2	1	0	0	2	2	3	0	0	2	1	1	2	0	1
1	1	1	0	2	0	3	2	1	0	3	0	3		3	3	3	2	3	2	2	3	0	0	0	2	1	3	2	2	2
0	0	2	0	3	0	1	1	1	2	3	2	1	2		2	2	2	2	2	3	2	2	2	0	0	1	1	3	2	2
0	0	0	0	0	0	1	0	2	2	1	1	0	0	2		0	2	2	1	3	1	0	0	3	3	1	3	2	3	3
0	0	0	0	0	0	1	0	2	2	1	1	0	0	2	0		2	2	1	3	1	0	0	0	1	1	3	2	3	3
0	0	0	3	3	0	0	0	2	1	0	0	1	0	1	0	0		3	1	2	3	0	0	0	0	1	2	2	2	2
0	0	0	0	0	0	0	0	P	2	0	P	0	1	1	0	0	2		0	1	0	0	0	0	0	1	1	0	0	2
0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	0		1	0	0	0	0	0	2	2	2	2	2
P	0	1	0	0	0	0	0	0	1	0	P	2	3	3	3	2	0	P	2		0	2	0	0	0	0	P	P	2	3
0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		0	1	0	0	0	0	2	1	1
0	0	0	0	0	0	0	0	0	2	0	3	P	0	0	0	0	0	0	0	0	0		0	0	0	P	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0		3	0	0	0	0	0	0
0	0	P	0	0	0	0	0	0	0	P	P	0	1	0	0	0	0	0	0	0	0	1	3		0	P	0	0	0	1
0	0	0	0	0	0	0	0	3	0	0	P	1	0	1	1	1	0	0	0	0	0	P	0	0		3	2	2	2	2
0	0	0	0	0	0	0	0	3	0	0	P	0	0	1	1	1	0	0	0	1	0	0	0	0	3		1	1	1	3
P	P	P	0	0	0	0	0	0	0	0	1	1	2	2	2	2	0	0	0	2	0	1	0	0	0	0		P	2	2
P	P	P	0	0	0	0	0	0	0	0	1	0	P	P	P	1	0	0	0	2	P	P	P	0	0	0	P		P	2
0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	2	2	0	0	0	2	0	1	0	0	0	0	3	0		0
0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	2	2	0	0	0	3	0	0	1	0	0	0	1	2	0	

Figure Annex 3-2. Second part of the Matrix of Direct Influence

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