Coal mine closure in Albania and Serbia

How can the infrastructure/resources of active mines in Serbia and closed mines in Albania be better utilised?

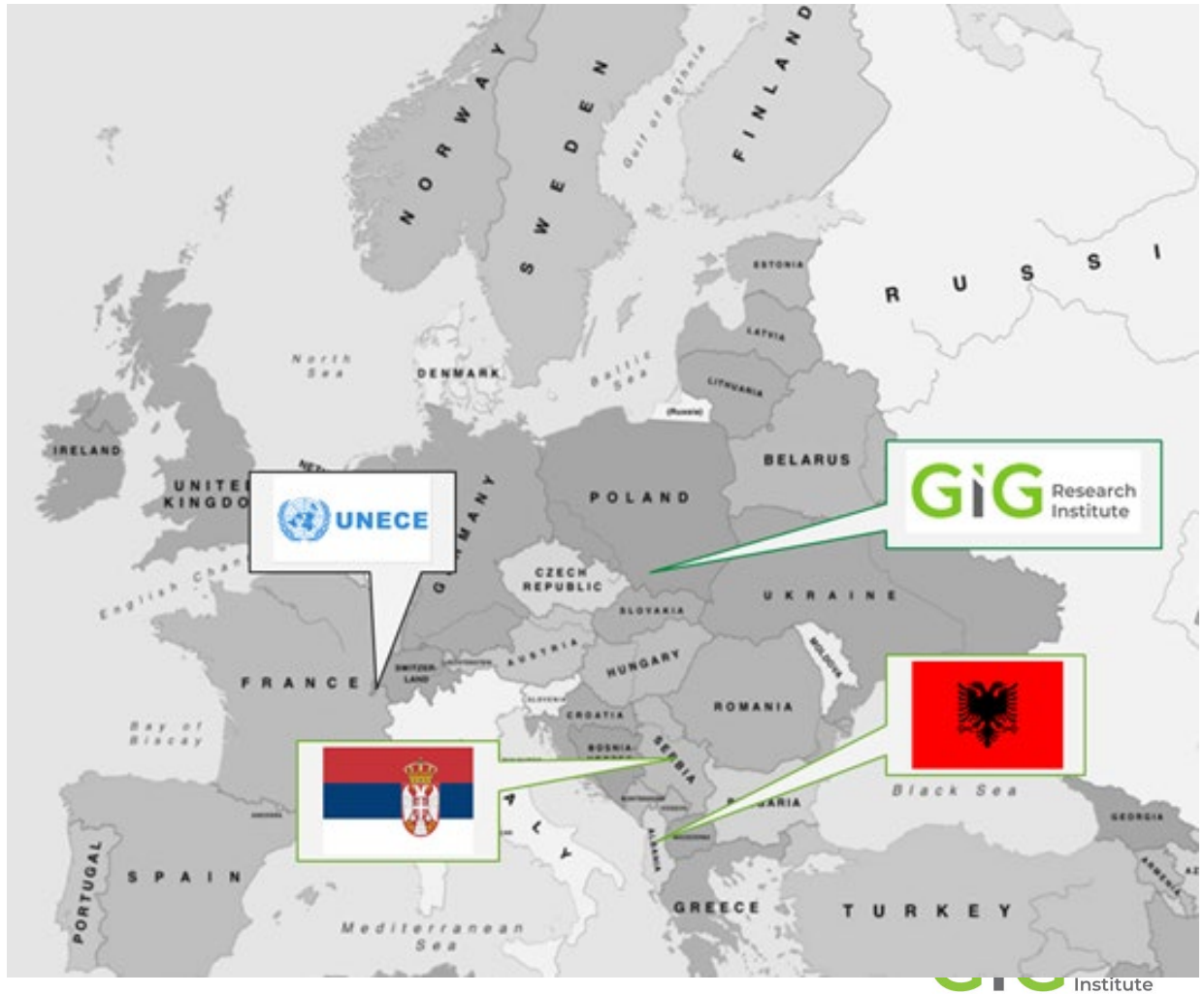
Alicja Krzemień

18th session of the Group of Experts on Coal Mine Methane and Just Transition
Geneva, Switzerland, 21-22 March 2023

HR EXCELLENCE IN RESEARCH

Preparation of a study of the local geological and mining conditions and development of technical, principle-based guidelines for designing and implementing a programme for efficient, safe and environmentally conscious mine closure in Albania and Serbia

The goal of the study is to provide a theoretical background for actions allowing to reclaim the coal mined land and mitigate mining and post-mining hazards in Albania and Serbia



Current situation of underground coal mining in Albania

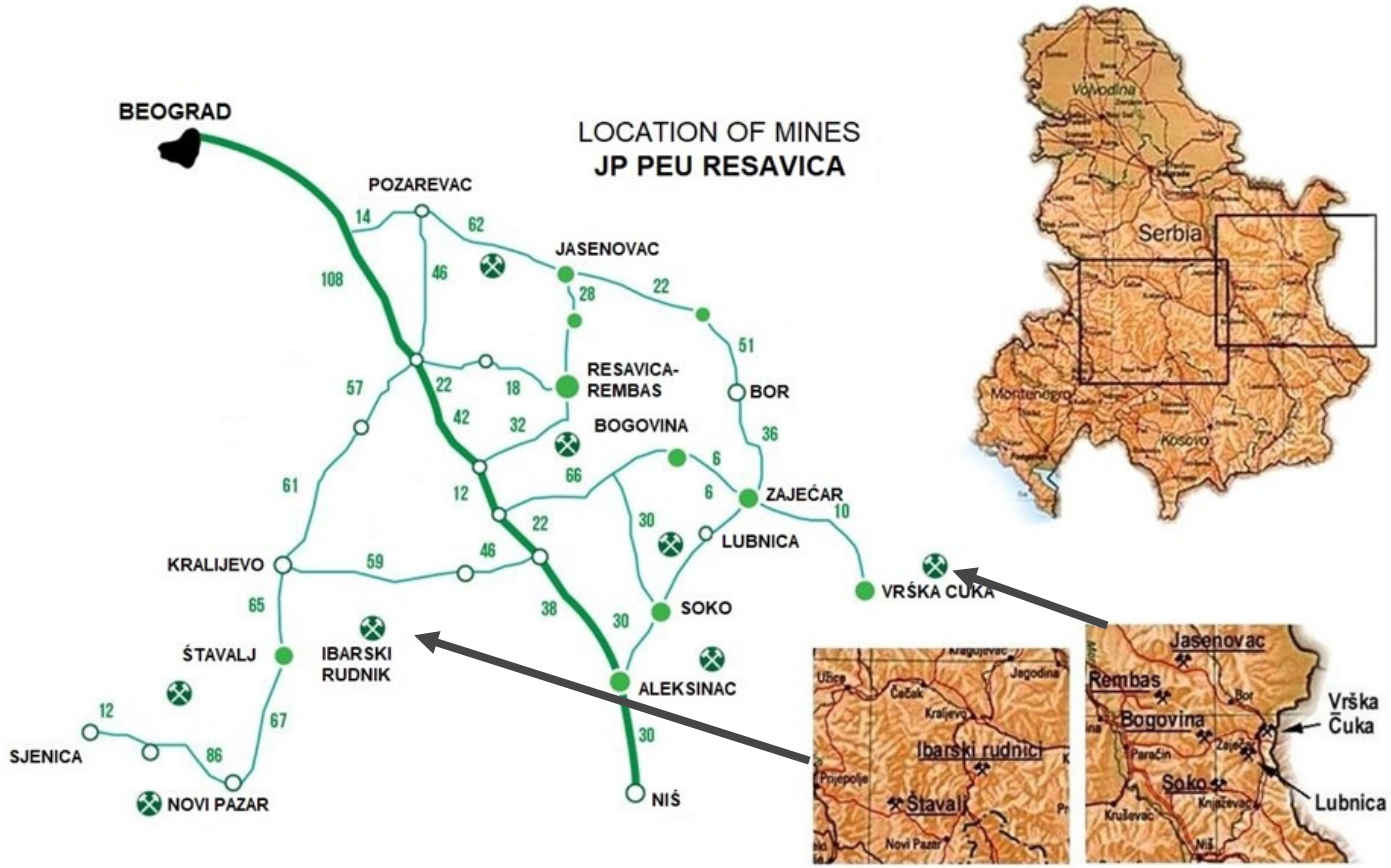
There are currently no active state-owned underground coal mines in Albania

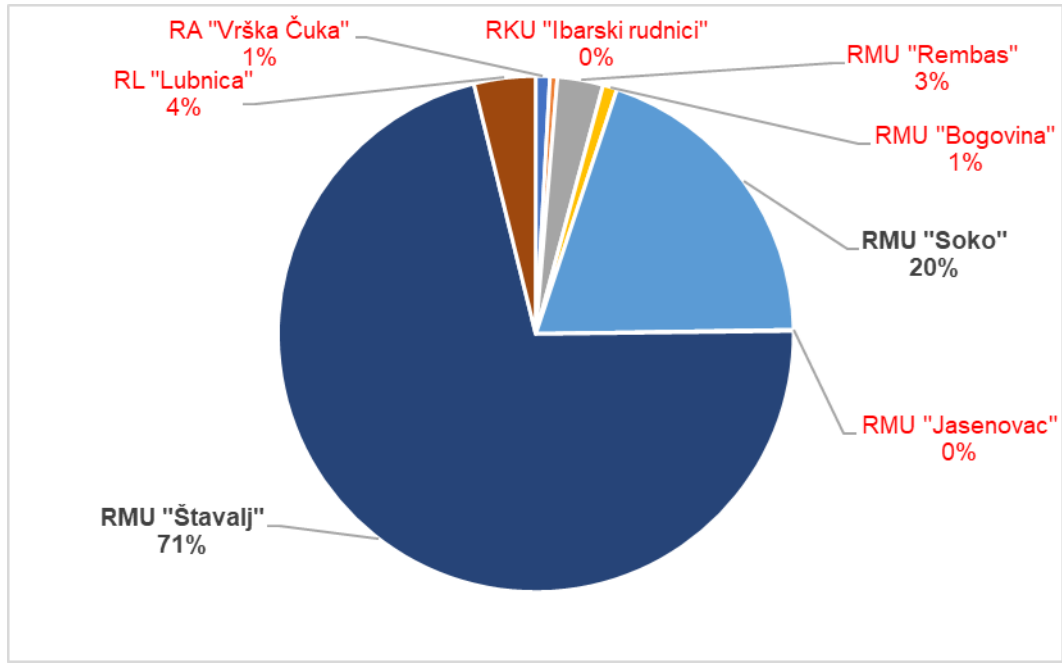
Nr	Name of Deposit	Start exploitation	Government Order for closing coal mines	No. of project (AKBN technical archive)	Production (Ton)	Geological reserves remained (Ton)
1	Valias	1978	Nr.139 dt.20.03.1995	Nr.2978 / 2001	3,515,178	49,186,000
2	Mëzez	1968	Nr.824 dt.04.12.1996	Nr.2978 / 2001	1,435,320	1,426,000
3	Mushqeta	1968	Nr.550 dt.26.08.1996	Nr.2978 / 2001	2,300,000	5,365,000
4	Kërrabë	1938	Nr.101 dt.02.03.2001	Nr.2748 / 2000	1,658,270	8,100,000
5	Priska 2	1980	Nr.550 dt.26.08.1996	Nr.2978 / 2001	374,057	2,682,000
6	Priskë	1980	Nr.101 dt.02.03.2001	Nr.2978 / 2001		2,460,000
7	Gërdec	1978	Nr.550 dt.26.08.1996	Nr.2978 / 2001	293,200	297,000
8	Manëz	1967	Nr.232 dt.15.05.1995	Nr.2978 / 2001	1,317,000	1,281,000
9	Mborje-Drenovë	1930	Nr.349 dt.07.07.2000	Nr.2978 / 2001	1,100,000	3,698,000
10	Selcë	1984	Nr.233 dt.15.05.1995	Nr.2978 / 2001	253,563	125,000
11	Babjen	1984	Nr.233 dt.15.05.1995	Nr.2871 / 2003	75,236	478,562
12	Krosnisht	1978	Nr.500 dt.13.08.1998	Nr.2682 / 1999	1,342,174	496,000
13	Qenckë	1978	Nr.349 dt.07.07.2000	Nr.2682 / 1999	23,000	69,750
14	Bezhan	1972	Nr.233 dt.15.05.1995	Nr.2978 / 2001	1,068,519	7,714,000
15	Alarup	1959	Nr.500 dt.13.08.1998	Nr.2978 / 2001		1,600,000
16	Pretushë	1968	Nr.233 dt.15.05.1995	Nr.2809 / 2002	909,300	2,885,500
17	Dardhas	1972	Nr.349 dt.07.07.2000	Nr.2978 / 2001	1,076,100	6,087,000
18	Vërdovë	1978	Nr.349 dt.07.07.2000	Nr.2978 / 2001	900,000	2,300,000
19	Potgozhan	1985	Nr.233 dt.15.05.1995	Nr.2978 / 2001	105,000	10,869,700
20	Homezh	1986	Nr.233 dt.15.05.1995	Nr.2978 / 2001	1,377,951	8,174,500
21	Memaliaj 1 dhe 2	1916	Nr.268 dt.08.06.1999	Nr.2978 / 2001	10,126,170	820,0000
22	Memaliaj 3	1980	Nr.29 dt.15.01.1996	Nr.2978 / 2001		6,500,000
Sum					**29,250,038**	**129,995,012**

GIG Research Institute

Current situation of underground coal mining in Serbia

There are currently 8 active state-owned underground coal mines in Serbia (JP PEU Resavica).





Balance coal reserves per highest categories A and B in JP PEU Resavica active coal mines, %

Current situation of underground coal mining in Serbia

Mine		Technology of exploitation	Access to the mine by shafts (deep, m/diameter, m),		Access to the mine by drifts (cross-section area, m^2)		Coal / Depth of exploitation
RMU "Bogovina"		Blasting-drilling works	Ventilation shaft No. 11 (180/3.5)		Main haulage drift GTN (14)		Brown coal / 240 m
RA "Vrška Čuka"		Drilling and blasting and manual loading	Ventilation shaft VO2 (138/5)		Horizontal Avramica drift (16)	Inclined N4 drift (10)	Anthracite / up to 270 m
RKU "Ibarski rudnici"	**Jarando**	Blasting-drilling works	None		Horizontal Baljevac drift (12)	Inclined GIN haulage drift (12)	Hard coal / 150 – 470 m
	Tadenje		None		Horizontal Tadenje drift 360 m (12)	Inclined GIN haulage drift 66 m (12)	Hard coal / up to 100 m
RMU "Jasenovac"			None		Horizontal GIP drift (12)	Inclined GVN drift (12)	Brown coal - lignite / 220 m
RMU "Rembas"	**Strmosten**		None		Three drifts - industrial estate (10, 12, 12)	Ventilation drift - dislocated (10)	Brown coal / 480 m
	Jelovac		None		Entrance to Jelovac drift (15)	Entrance to Bučar drift (12)	Brown coal / 160 – 200 m
	Senjski rudnik		Hoisting shaft (230/6)	Ventilation shaft (220/5)	South drift - connection to Resavica		Brown coal / 350 m
RMU "Soko"			Hoisting shaft (246/6)	Ventilation shaft (156/5.5)	Drift GTN-1 (17)		Brown coal / 450 m
RL "Lubnica"			None		Osojno-South - two capital drifts - main haulage (17) and main ventilation drift (17)	Stara jama N-2 haulage drift (10) and N-3 roadway (connection between pits)	Lignite / 200 m
RMU "Štavalj"			None		Main haulage drift GIN-1 (13)	Main ventilation drift GVN-2 (13)	Brown coal - lignite / 280 m

GIG Research Institute

Current situation of underground coal mining in Serbia

Water hazard

Mine	RMU "Bogovina"	RA "Vrška Čuka"	RKU "Ibarski rudnici"		RMU "Jasenovac"	RMU "Rembas"			RMU "Soko"	RL "Lubnica"	RMU "Štavalj"
			Jarando	Tadenje		Strmosten	Jelovac	Senjski rudnik			
Water inflow, m^3/min	0,04	1,5 l/s	1	0,5	3	2,5	0,6-1,0	3	3,67	0,5	6,0-8,0

Ivkovic et al., 2012

Gas hazard

Mine	RMU "Bogovina"	RA "Vrška Čuka"	RKU "Ibarski rudnici"		RMU "Jasenovac"	RMU "Rembas"			RMU "Soko"	RL "Lubnica"	RMU "Štavalj"
			Jarando	Tadenje		Strmosten	Jelovac	Senjski rudnik			
Relative methane-bearing capacity, m^3 CH_4/t	registered appearance	8,93	0,025-0,245	non-methane	non-methane	registered appearance	registered appearance	registered appearance	11,74	registered appearance	non-methane
Absolute methane-bearing capacity, m^3 CH_4/min	registered appearance	0,147	0,008-0,079	non-methane	non-methane	registered appearance	registered appearance	registered appearance	2,71	registered appearance	non-methane

Dust hazard

Mine	RMU "Bogovina"	RA "Vrška Čuka"	RKU "Ibarski rudnici"		RMU "Jasenovac"	RMU "Rembas"			RMU "Soko"	RL "Lubnica"	RMU "Štavalj"
			Jarando	Tadenje		Strmosten	Jelovac	Senjski rudnik			
Dust explosives (g/m^3)	225	non-explosive	70-100	270	225	180	230	200	230	110	-
Dust self-ignition (°C)	250	not self-ignition	630-700	no data	260	280-290	300	260-290	250-350	215-235	220-280

Fire hazard

Mine	RMU "Bogovina"	RA "Vrška Čuka"	RKU "Ibarski rudnici"		RMU "Jasenovac"	RMU "Rembas"			RMU "Soko"	RL "Lubnica"	RMU "Štavalj"
			Jarando	Tadenje		Strmosten	Jelovac	Senjski rudnik			
Coal self-ignition, °C/min	80-120	not self-ignition	69-98	no tendency	80-100	110-120	70-110	118-140	115-188	80	103-111

Ivkovic et al. 2012; Savic, 2015; Todorovic et al., 2020

GIG Research Institute

Is it possible to open a new underground coal mine in Albania?

The size of the coal reserves and their quality, as well as their environmental impact, make it impossible to open a new mine. Instead, attention should be directed towards using areas of closed mines for purposes other than coal mining.

What can be done to improve underground coal mining in Serbia?

To improve underground coal mining in Serbia it would be necessary :

- to introduce new modern equipment in the selected mines (especially in RMU "Soko", RMU "Štavalj", RMU "Rembas" (Strmosten), and RL "Lubnica"), and conduct technical and organizational changes (change of structure, and reduce the number of employed non-production workers in the company to the optimal number)

It seems that the optimal actions will be:

- **to start a program of planned closure of mines with the use of their resources and infrastructure for other economic purposes**.

GIG Research Institute

HOW CAN THE INFRASTRUCTURE/RESOURCES OF THE ACTIVE MINES IN SERBIA AND THE CLOSED MINES IN ALBANIA BE BETTER UTILISED?

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.

EU Research Fund for Coal and Steel (RFCS)

Grant Agreement No 101034042

www.potentialsproject.eu

Green JOBS
RFCS RESEARCH PROJECT

Leveraging the competitive advantages of end-of-life underground coal mines to maximise the creation of green and quality jobs.

EU Research Fund for Coal and Steel (RFCS)
Grant Agreement No 101057789

www.greenjobsproject.eu

GIG Research Institute

POTENTIALS Project

POTENTIALS
RFCS AM PROJECT

It focuses on taking advantage of the joint potential of end-of-life coal mines and coal-fired power plants to stimulate new economic activities and develop jobs in Coal Regions in Transition.

It identifies and assess opportunities by means of a prospective analysis, enabling to develop business models that rely on renewable energy, on the circular economy or scale energy storage, guaranteeing a sustainable and combined use of assets and resources.

ACTIONS

N°	Short label	Long label
1	Virtual	Virtual power plant
2	Hydrogen	Green hydrogen plant
3	Ecopark	Eco-industrial park
4	Tourist	Cultural heritage and sports/recreation areas
5	FloatingPV	Floating PV panels at flooded open-pit coal mines
6	Pumping	Pumped hydroelectric storage at former open-pit coal mines
7	Fisheries	Fisheries in flooded open-pit coal mines
8	CCGT	Combined-cycle gas turbine (CCGT) power plant powered by natural gas
9	Minegas	Mine gas utilization for gas-powered CHP power units
10	Nuclear	Small modular reactors (SMRs)
11	Biofuels	Biofuels combustion energy plant
12	Moltensalt	Molten salt plant
13	Agrophotovoltaics	Agrophotovoltaics at former open-pit coal mine areas

MICRO-ACTIONS

N°	Short label	Long label
1	Batteries	Ancillary services provided by batteries
2	Wasteheaps	Recovery of resources from coal mining waste heaps
3	Methane	Usage of methane from degasification units in closed coal mines
4	Water	Circular mining technologies for pumped water material recovery
5	Forest	Forest restoration at former open-pit coal mines
6	Information	Large-scale IT infrastructure - power plant
7	Geothermal	Geothermal energy
8	Gravitricity	Storage of energy in the form of potential energy using weights
9	Dense fluids	Storage of energy using dense fluids.
10	Hydropumping	storage energy in the closed coal mine shafts

POTENTIALS Project

CRITERIA

CRITERIA	DEFINITION
C1 EnerSec	Energy security
C2 Greenin	Renewable resources (greening)
C3 Cost	Low investment barriers
C4 Benef	Benefits
C5 RegDev	Regional development
C6 Envirom	Environment
C7 Job	Job creation

EUROPEAN GREEN DEAL POLICIES

POLICY	DEFINITION
Climate	No net emissions of greenhouse gases by 2050
Growth	Economic growth decoupled from resource use
People	No person and no place left behind

POTENTIALS Project

Evaluation of actions and micro-actions related to policies.

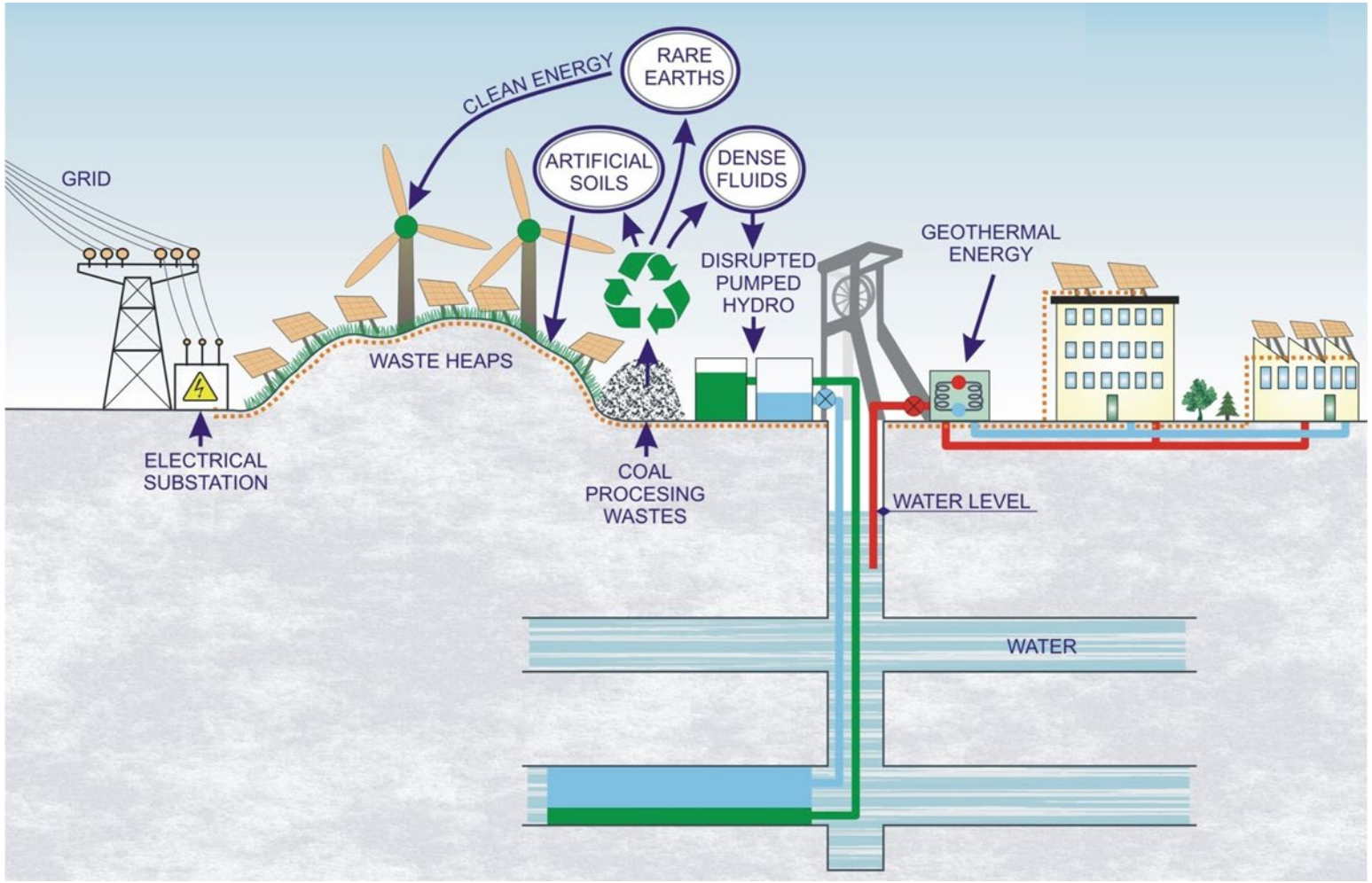
ACTIONS	POLICIES			Mean	Standard deviation
	P1: Climate	P2: Growth	P3: People		
1 : A1_VIRTUAL	13,3	9,4	7,4	10	2,5
2 : A2_H2	16,4	10,5	10,9	12,6	2,7
3 : A3_ECOPARK	12,5	12,9	15,9	13,8	1,5
4 : A4_TOURIST	10	8	9,2	9,1	0,8
5 : A5_PANELS	12,5	9,6	8,5	10,2	1,7
6 : A6_PHS	17,2	11,5	9,6	12,8	3,2
7 : A7_FISHES	5,6	7,8	8,1	7,2	1,1
8 : A8_C/O_CGT	10,8	11	9,7	10,5	0,6
9 : A9_MINEGAS	6,4	6,4	5,3	6	0,5
10 : A10_SMR	14,2	11,7	15,1	13,7	1,4
11 : A11_BIOFUE	15	13,2	12,4	13,5	1,1
12 : A12_SALT	18,1	13,8	10,9	14,2	3
13 : A13_APV	15,3	11,4	10,1	12,3	2,2

MICRO-ACTIONS	POLICIES			Mean	Standard deviation
	P1: Climate	P2: Growth	P3: People		
1 : AM1_BATT	13,8	10,8	5,8	10,1	3,3
2 : AM2_HEAPS	5,8	6,3	7,1	6,4	0,5
3 : AM3_C2H4	8,5	7,8	7,8	8	0,3
4 : AM4_WATER	7,5	6,2	6,4	6,7	0,6
5 : AM5_FOREST	7,5	7,2	7,2	7,3	0,1
6 : AM6_IT	4	6	2,8	4,2	1,3
7 : AM7_THERMA	19,6	14,5	12,4	15,5	3
8 : AM8_GRAVIT	12,2	8	7,6	9,2	2,1
9 : AM9_FLUIDS	18,5	10,8	8,8	12,7	4,2
10 : AM10_HPUMP	18,2	10,5	9,3	12,7	3,9

GiG Research Institute

GreenJOBS Project

Business model 1: Virtual Power Plant where energy is sold to the grid.



Photovoltaic deployment parameters

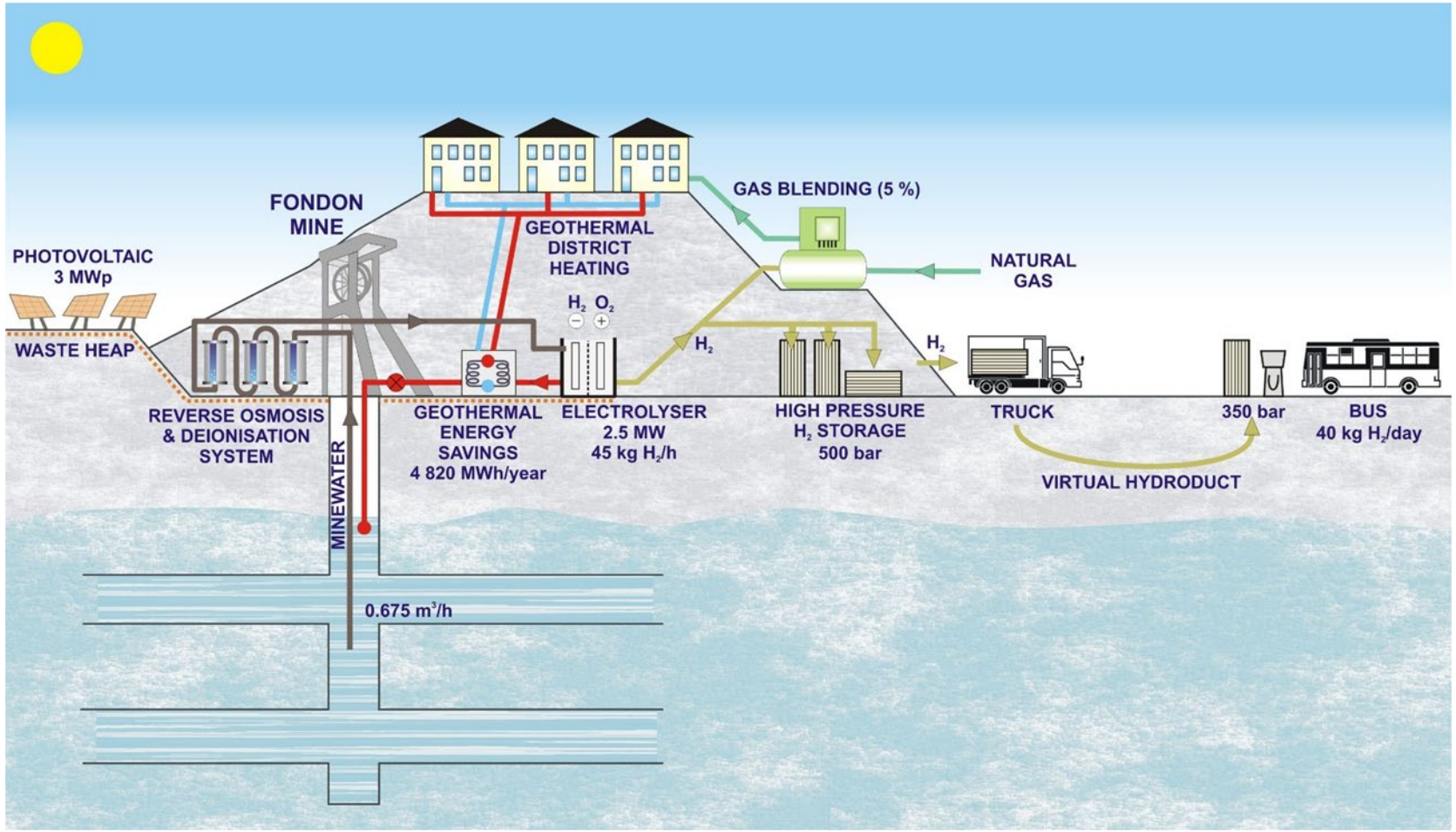
Business model 1: Virtual Power Plant where energy is sold to the grid.

Parameter	Value
Installed capacity	50 MW
Estimated investment (plant life: 25 years)	20 M€
Capacity factor (% time of use of the installation per year)	30%
Daily production (50 MW x 30% x 24 hours)	360 MWh
Fraction of energy to be sold, the rest to be stored	50%
Daytime energy sold (360 MWh x 50%)	180 MWh
Daytime energy price	40 €/MWh
Daytime revenue (180 MWh x 40 €/MWh)	7,200 €
Photovoltaic annual revenues (7,200 € x 365)	2.63 M€
Annual expenditure (staff, maintenance and overheads)	0.50 M€

Photovoltaic parameters for a 50 ha waste heap area with an installed capacity of 1 MW/ha, a capacity factor of 30% and 50% of energy to be stored.

GreenJOBS Project

Business model 2: Green hydrogen plant.



Technical and economic parameters

Business model 2: Green hydrogen plant.

Description	Value
Functioning hours of the installation for one year	6,000 h
Annual hydrogen production (45 kg/h)	270,000 kg/year
Photovoltaic energy production (1,200 h/year)	3,600 MWh/year
Tolls and charges for electricity supply	15 €/MWh
Operating expenses (personnel, maintenance, repairs)	250,000 €
Electrical consumption of the plant	3 MWh
Hydrogen sale price	8 €/kg
Power purchasing agreement (PPA) price	55 €/MWh
Green hydrogen plant depreciation period	15 years
Photovoltaic installation depreciation period	25 years

CONCLUSIONS AND RECOMMENDATIONS

1. Albania's economic development makes post-mining areas attractive to entrepreneurs. Therefore, having a large potential for being repurposed, they should be continuously and carefully monitored, especially in terms of water quality and land deformation in the areas around the shafts.
2. Analysis of Albania's coal reserves, estimated at 130 million tonnes, shows that, in theory, there is a possibility to restart coal extraction. However, the complexity of geological and mining conditions and the history of the local underground coal mining indicate that the economic viability of such undertaking is questionable, leaving aside the environmental aspects.
3. The most promising directions for **repurposing former mining land in Albania are to utilize them for development of green energy generation infrastructure**, in particular photovoltaic farms, as the climate and weather conditions in the country are favourable for such projects.

CONCLUSIONS AND RECOMMENDATIONS

4. The complicated tectonic conditions pose serious problems for any potential mining efficiency improvements in Serbia.

5. GIG's analyses of coal reserves indicates that only three out of eight active coal mines in Serbia: RMU "Soko", RMU "Štavalj" and RL "Lubnica", have sufficient coal reserves to justify potential planning for longer-term exploitation. However, all these mines are characterized by natural hazards, including those related to methane, water, and fire, which make any such plans questionable. In addition, the assessment is based solely on the magnitude of the reserves and does not take into account other considerations such as environmental impact assessments, the public health costs associated with the continued operation of the mines, and/or the country's international environmental commitments.

6. In RMU "Soko" and RMU "Štavalj", **the first step should be to recover and economically utilize coal mine methane (CMM)**. That would improve the safety of the current production and provide a basis for a new business case after the mine is closed.

THANK YOU FOR ATTENTION

Alicja Krzemień

Head of Laboratory of Risk Assessment and Industrial Safety

Department of Extraction Technologies, Rockburst and Risk Assessment

Plac Gwarków 1
40-166 Katowice
Poland
phone: +48 32 259 2556
akrzemien@gig.eu

GIG Research Institute