Safe Operations and Closure of Coal Mines Taskforce

Alicja Krzemień

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

ALICJA KRZEMIEŃ

Who am I? Where do I work?

Professor, Central Mining Institute (GIG), Katowice, Poland

Department of Extraction Technologies, Rockburst and Risk Assessment at GIG

A specialist in risk assessment and Occupational Health and Safety in mines. The EURACOAL's Technical Research Committee Chair and a member of the European Commission's advisory group for coal (CAG). A lecturer in Risk Management at the University of Oviedo (Spain).

What do I do?

European R&D projects related to:

- leveraging the competitive advantages of end-of-life underground coal mines;

- management of environmental risks during and after mine closure;

- recovery of degraded and transformed ecosystems in coal mining-affected areas.

GIG Research Institute

TWO IDEAS ON POTENTIAL SCOPE AND ACTIVITIES OF THE SAFE OPERATIONS AND CLOSURE OF COAL MINES TASKFORCE

POTENTIALS
RFCS AM PROJECT

Green JOBS
RFCS RESEARCH 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

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

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 - ACTIONS

First, using MULTIPOL program (Multicriteria and policy), the scoring of actions with respect to criteria from 0 to 20 is made.
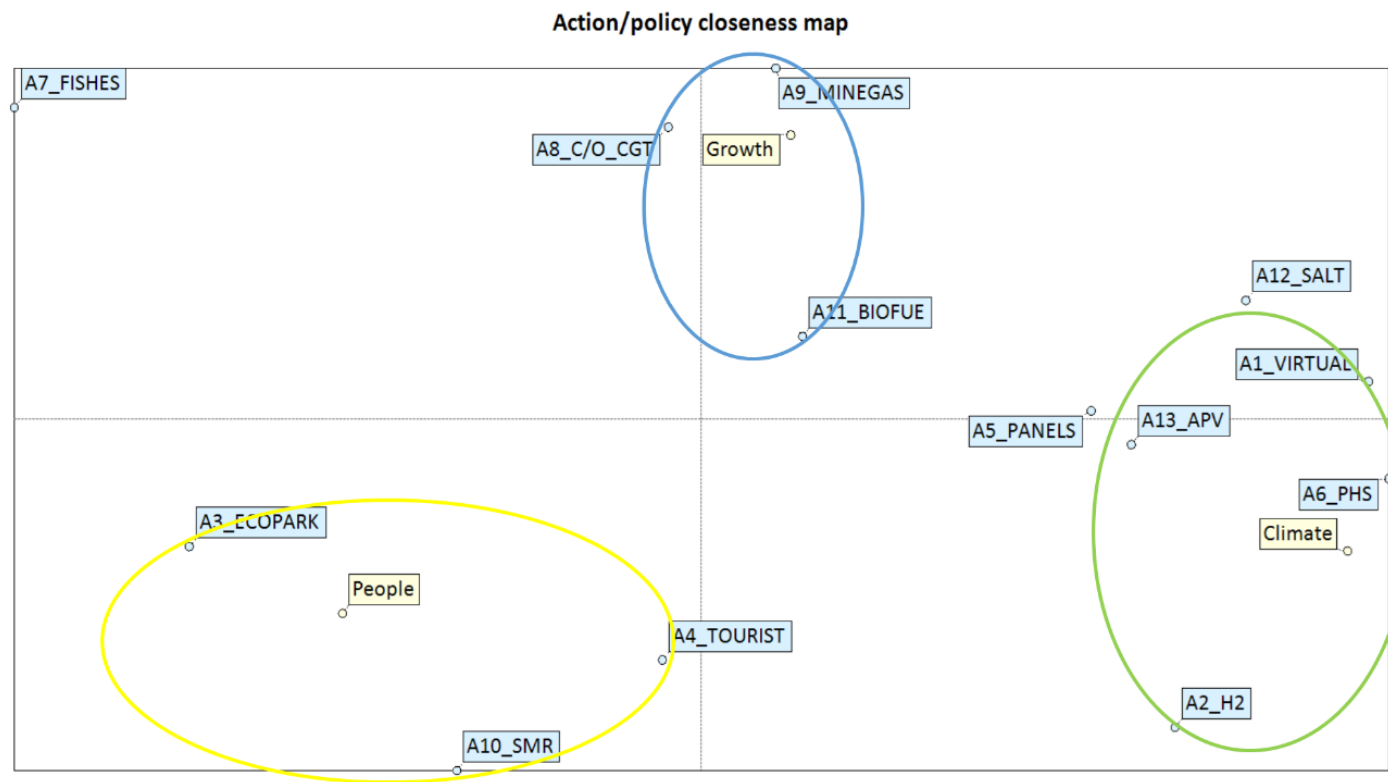
Actions / MULTIPOL Criteria	Actions short label	Consensus values						
		CM1 Energy security	CM2 Renewable resources (greening)	CM3 Low investment barriers	CM4 Benefits	CM5 Regional development	CM6 Environment	CM7 Job creation
A1 Virtual power plant	A1_VIRTUAL	10	20	8	10	10	15	3
A2 Green hydrogen plant	A2_H2	15	20	4	5	20	20	5
A3 Eco-industrial park	A3_ECOPARK	10	15	10	5	17	15	20
A4 Cultural heritage and sports/recreation areas using green energy	A4_TOURIST	5	5	10	5	15	20	5
A5 Floating PV panels at flooded open-pit coal mines.	A5_PANELS	10	15	10	8	10	15	5
A6 Pumped hydroelectric storage (PHS) at former open-pit coal mines	A6_PHS	20	20	7	10	10	15	5
A7 Fisheries in flooded open-pit coal mines	A7_FISHES	1	5	12	10	10	10	8
A8 Combined Cycle Gas Turbines (CCGT) plant. Open Cycle Gas Turbines (OCGT)	A8_C/O_CGT	15	10	13	10	5	5	10
A9 Mine gas utilization for gas-powered CHP power units	A9_MINEGAS	1	0	15	10	3	15	2
A10 Small modular reactors (SMRs)	A10_SMR	20	3	2	10	20	18	15
A11 Biofuels processing energy plant	A11_BIOFUE	15	15	15	10	12	15	10
A12 Molten salt plant	A12_SALT	20	20	16	10	10	15	5
A13 Agrophotovoltaics (APV) at former open-pit coal mine areas	A13_APV	15	20	8	10	10	15	8

Second, matrix values corresponding to policy evaluation with respect to the criteria are assigned. As this concerns the set of criteria weights, the row sum must always equal 100.

Policies / Criteria	CM1 Energy security	CM2 Renewable resources (greening)	CM3 Investment cost	CM4 Benefits	CM5 Regional development	CM6 Environment	CM7 Job creation	SUM
P1 Climate (No net emissions of greenhouse gases by 2050)	40	20	10	0	0	30	0	100
P2 Growth (Economic growth decoulped from fossils resources use)	20	10	25	10	10	5	20	100
P3 People (No person and no place left behind)	15	0	15	0	20	10	40	100

POTENTIALS Project - ACTIONS

Evaluation of actions related to policies and actions/policies closeness map.

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

Action/policy closeness map

POTENTIALS Project – micro-ACTIONS

First, using MULTIPOL program (Multicriteria and policy), the scoring of micro-actions with respect to criteria from 0 to 20 is made.

| Micro-actions / Criteria		Micro-actions short label	Consensus values						
			CM1	CM2	CM3	CM4	CM5	CM6	CM7
			Energy security	Renewable resources (greening)	Low investment barriers	Benefits	Regional development	Environment	Job creation
1	Ancillary services provided by batteries	AM1_BATT	20	20	15	8	2	1	0
2	Circular mining technologies based on waste heap materials recovery	AM2_HEAPS	0	0	10	10	10	16	5
3	Usage of methane from degasification units on closed coal mines	AM3_C2H4	5	5	10	10	10	15	5
4	Circular mining technologies for pumped water material recovery	AM4_WATER	0	10	10	3	7	15	5
5	Forest restoration at former open-pit coal mines	AM5_FOREST	0	0	15	10	5	20	5
6	Large scale IT infrastructure - power plant	AM6_IT	0	5	15	15	0	5	0
7	Geothermal energy	AM7_THERMA	20	20	16	10	15	20	5
8	Gravitricity	AM8_GRAVIT	15	15	2	5	10	10	5
9	Dense fluids	AM9_FLUIDS	20	20	5	10	5	20	5
10	Underground hydropumping	AM10_HPUMP	20	20	2	10	10	20	5

Second, matrix values corresponding to policy evaluation with respect to the criteria are assigned. As this concerns the set of criteria weights, the row sum must always equal 100.

Policies / Criteria		CM1	CM2	CM3	CM4	CM5	CM6	CM7	SUM
		Energy security	Renewable resources (greening)	Investment cost	Benefits	Regional development	Environment	Job creation	
P1	Climate (No net emissions of greenhouse gases by 2050)	40	20	10	0	0	30	0	100
P2	Growth (Economic growth decoulped from fossils resources use)	20	10	25	10	10	5	20	100
P3	People (No person and no place left behind)	15	0	15	0	20	10	40	100

POTENTIALS Project – micro-ACTIONS

Evaluation of actions related to policies and micro-actions/policies closeness map.

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

Action/policy closeness map

POTENTIALS Project
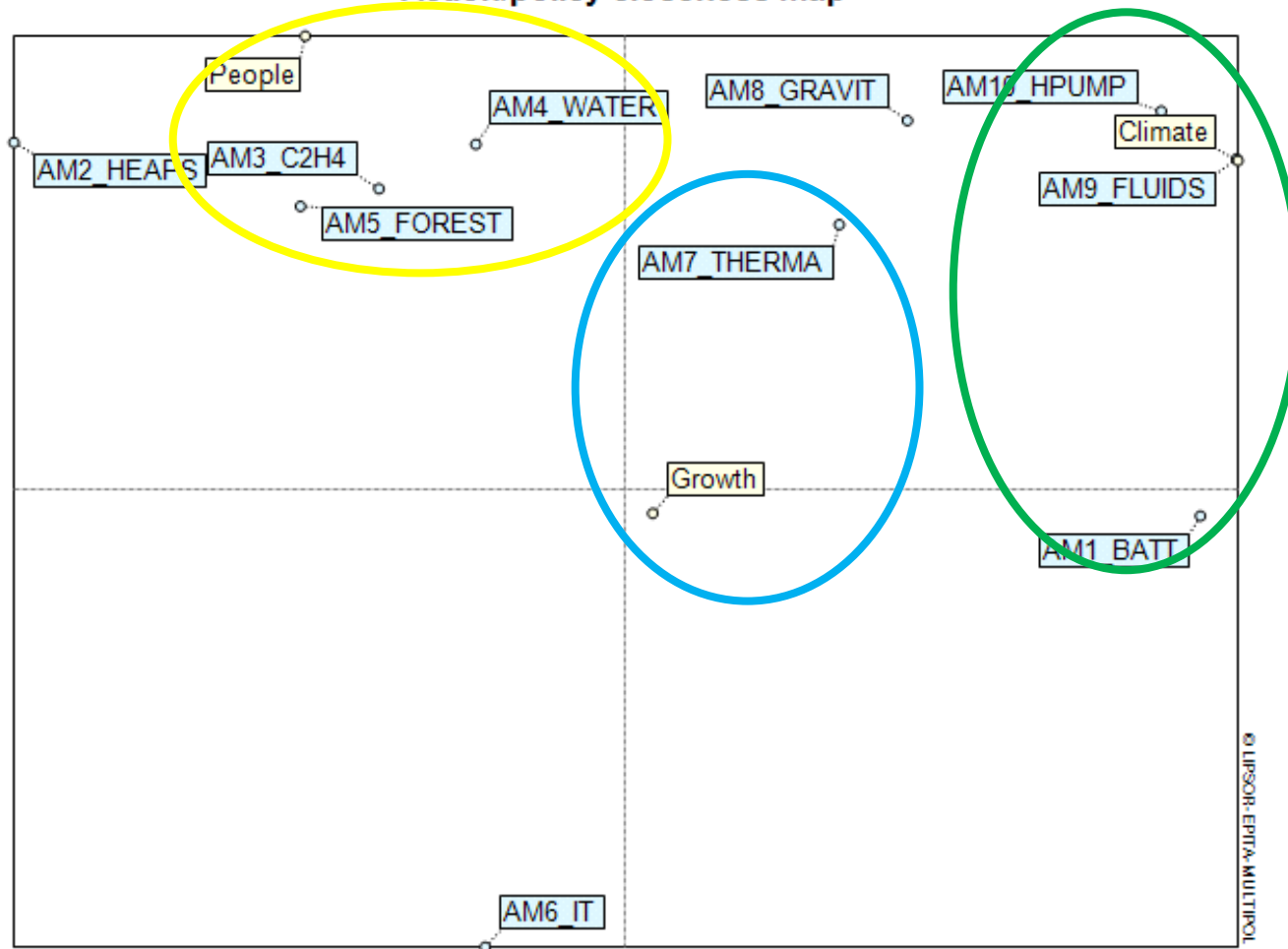
Evaluation of actions and micro-actions related to policies.

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

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POTENTIALS Project - business model choice (actions)

Evaluation of actions

Technical criteria

TRL

European taxonomy

Synergistic potential

Circular economy

Sector coupling

ECO-INDUSTRIAL PARK

HYDROGEN

Chart categories: Moltensalt, Ecopark, Biofuels, Nuclear, Pumping, Hydrogen

Legend: Evaluation of actions, Technical criteria, TRL, European taxonomy, Synergistic potential, Circular economy, Sector coupling

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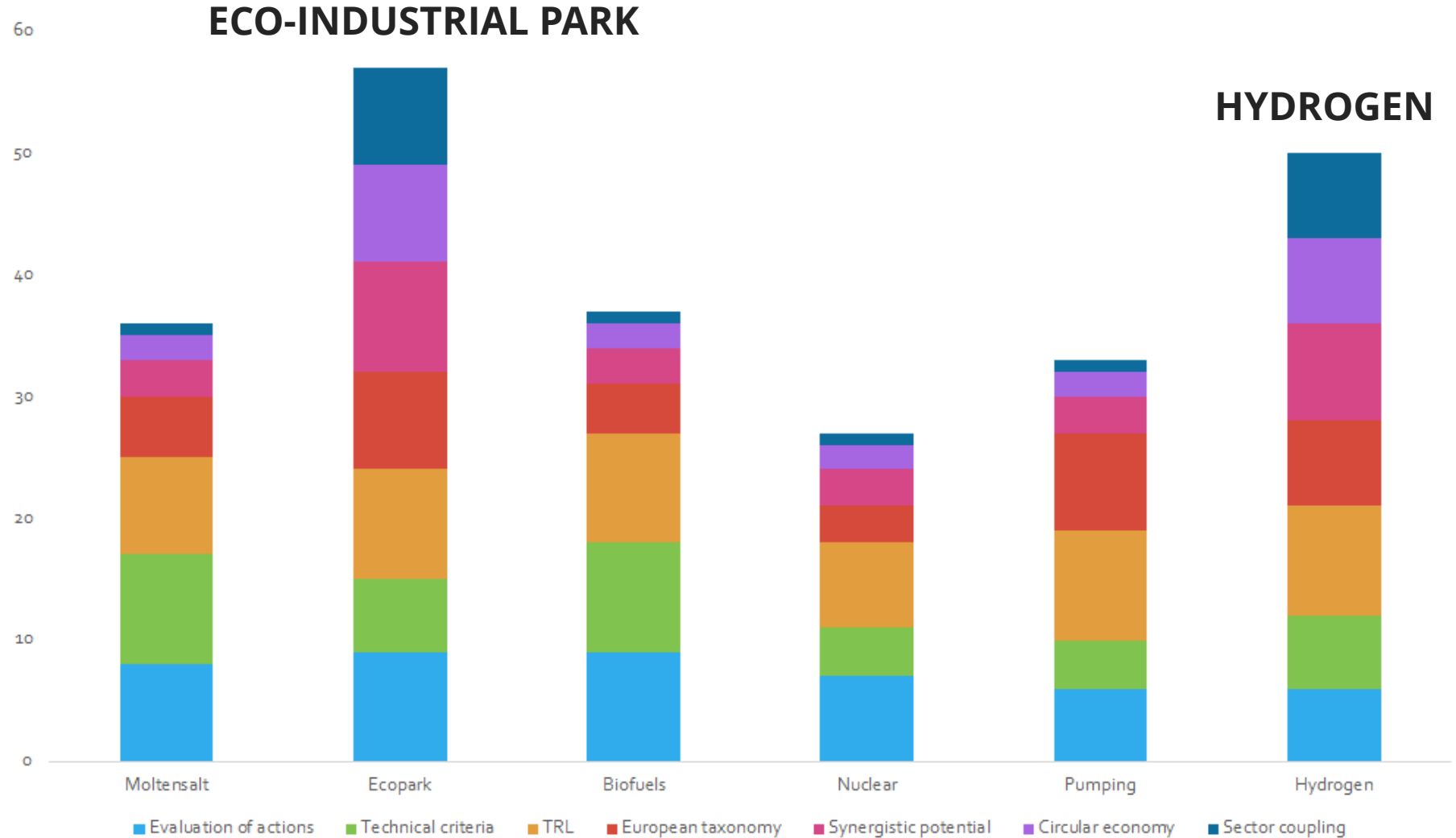
ECO-INDUSTRIAL PARK SCENARIO

Eco-industrial parks (with virtual power plant) as an integrated alternative to be developed within coupled end-of-life coal mine sites and coal-fired power plants along with surrounding residential/industrial areas for sustainable renewable energy generation (geothermal and photovoltaic/wind), storage technologies, circular economy contributions and synergies for reducing waste and pollution by promoting short distance transport and optimising the park's material, resource, and energy flows, producing the goods needed for the industrial transition in Europe and cooperating to its achievement.

Eco-industrial parks should be based on district networks that allow multiple energy sources to be connected to various energy consumption points, helping to increase photovoltaic deployment by transforming heat and power energy customers into prosumers or customers with excess electricity from solar panels on their roofs. Eco-industrial parks should be supported by pursuing financial privileges and other benefits to boost and diversify the area's economy, attracting external investment: tax exemptions for industries, access to preferential credits from National authorities, European Investment Bank, and others.

POTENTIALS Project - business model choice (micro-actions)
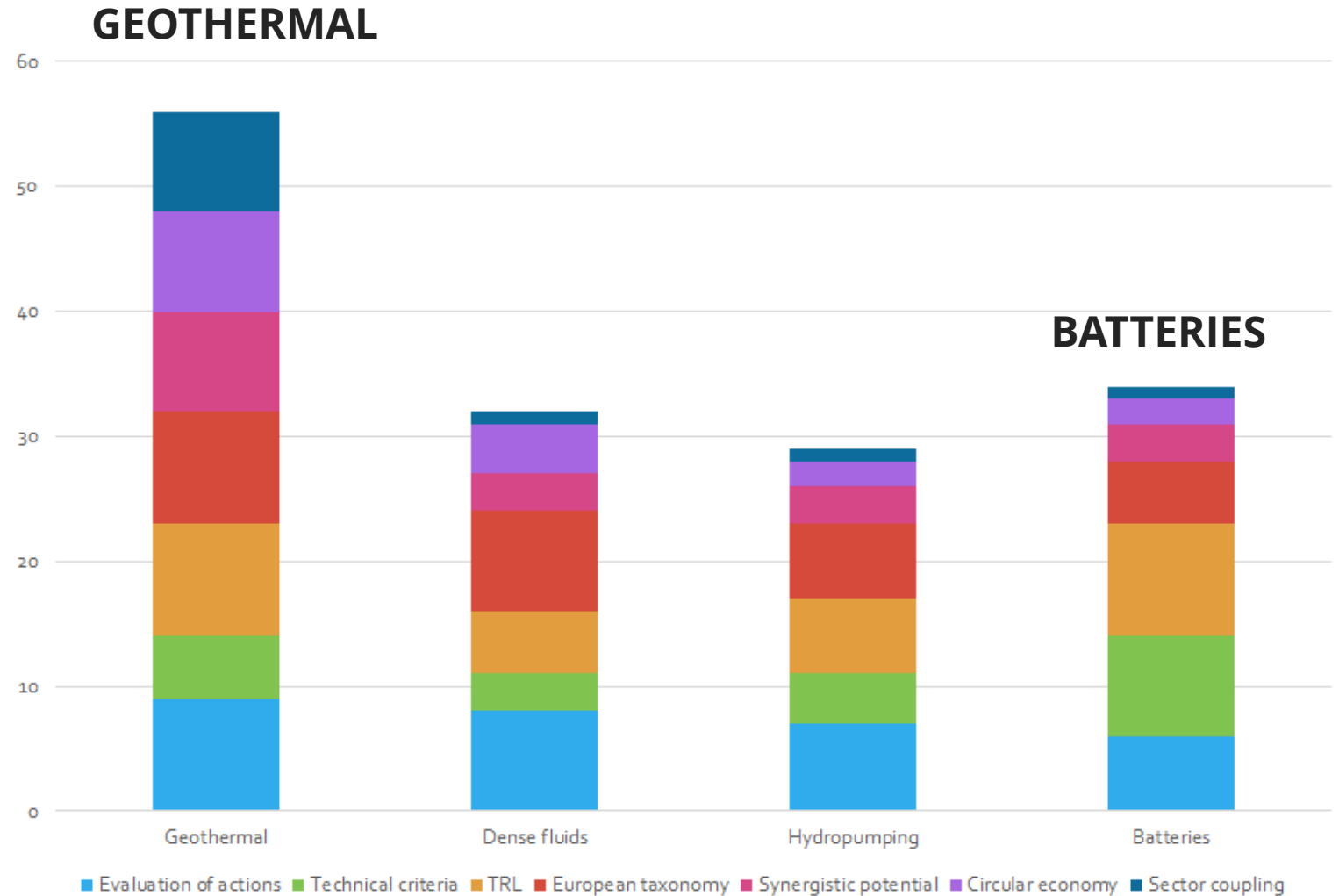

Evaluation of actions

Technical criteria

TRL

European taxonomy

Synergistic potential

Circular economy

Sector coupling

GEOTHERMAL

BATTERIES

Legend: Evaluation of actions · Technical criteria · TRL · European taxonomy · Synergistic potential · Circular economy · Sector coupling

Categories: Geothermal, Dense fluids, Hydropumping, Batteries

POTENTIALS Project

SCENARIO (MULTI-ACTION)

Eco-industrial park (with virtual power plant)

+

Green H$_2$ plant

Molten salt plant

Batteries

Biofuels production

Biofuels combustion

Nº	Direct result indicators	Eco-industrial park (with virtual power plant) +				
		Green H$_2$ plant	Molten salt plant	Batteries	Biofuels (production)	Biofuels (combustion)
1	Full-Time Employment creation	3,8	3,2	1,6	4,4	3,6
2	Full-Time new researchers	3	1,8	1,4	3	2
3	Companies introducing process/product innovations	4,2	2	2,5	3,4	2,4
4	Patent applications submitted to EPO	3	2,4	2,4	3	1,8
5	Energy users connected **to smart grids**	3,6	3,8	3,8	1,6	2,4
6	The capacity of renewable energy production installed and connected to the network	3,6	4,2	3,6	2,2	3,4
7	Energy efficiency (support for the smart grid)	1,8	3,6	4	1,8	3,4
8	Estimated **low** GHG emissions (tons of CO_2 equivalent) during the lifetime of the technology	4,6	4,2	3,6	2,2	1,6
9	"Tons" of recycled waste (more waste produced, lower value)	4	3	1	2,6	1,2
10	Space required to develop the option (more space, lower value)	2,4	3,125	4,2	2,2	2,2
11	Improvement of quality of offered services within the eco-industrial park	4	3	2,8	3,4	3,8
12	Benefits/**return on investments** (CAPEX and OPEX are considered)	3,2	2,8	3	3,2	3,7
13	Potential to stimulate other business activities	4,7	2,3	2,8	4	3
14	Energy security degree (independence)	4	3,6	4	4,4	4,6
15	Reduction of environmental impact - LCA (higher impact produced, lower value)	4,75	4,25	3,25	2,5	2
16	Environmental impact at the place of operation (higher impact, lower value)	4,2	3,8	4	2,4	1,4
17	Increased competitiveness of the region	4,4	2,8	2,4	4,4	4
	SUM	63,25	53,875	50,35	50,7	46,5

GreenJOBS Project

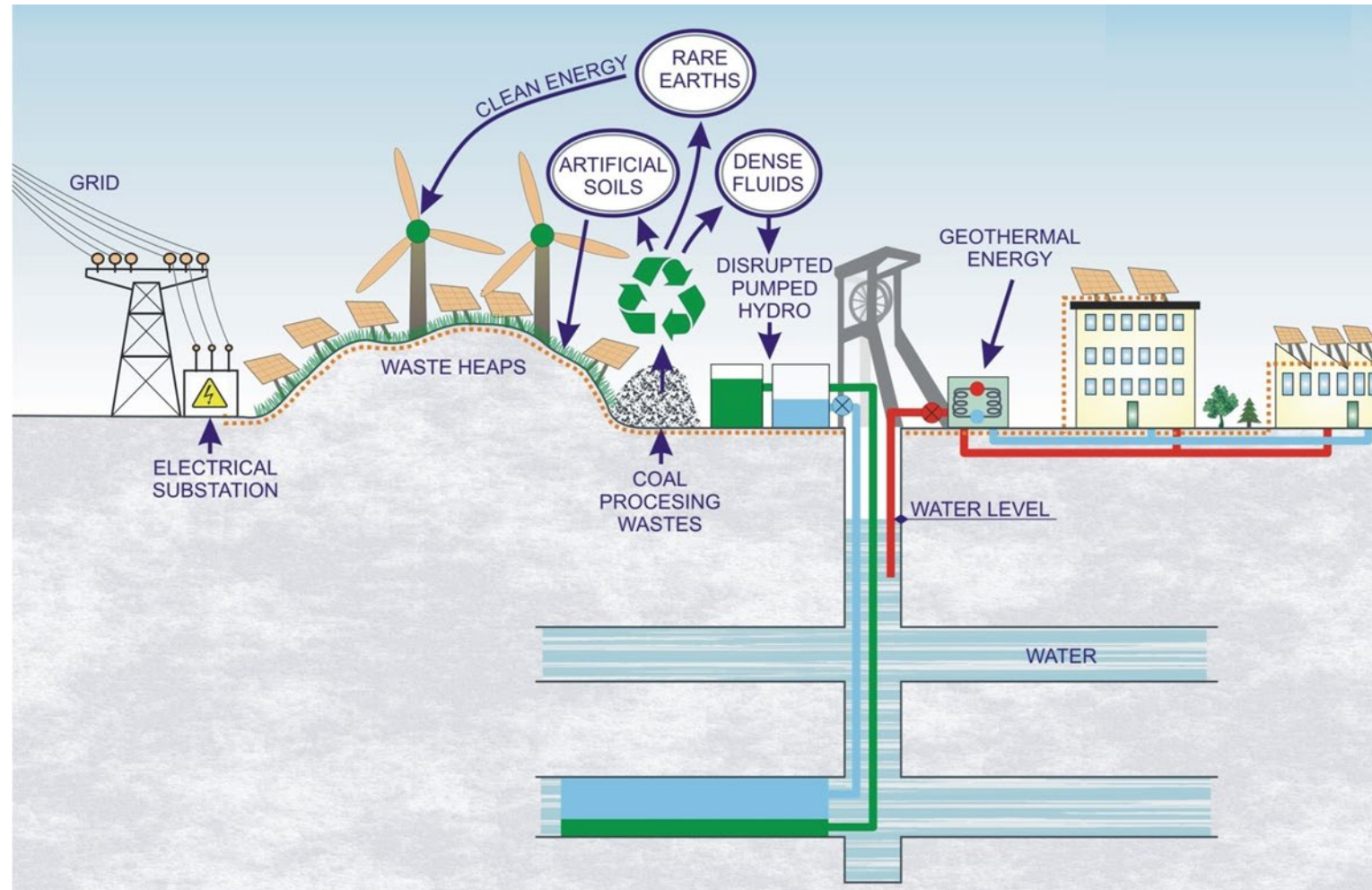## Bobrek-Piekary Coal Mine, POLAND

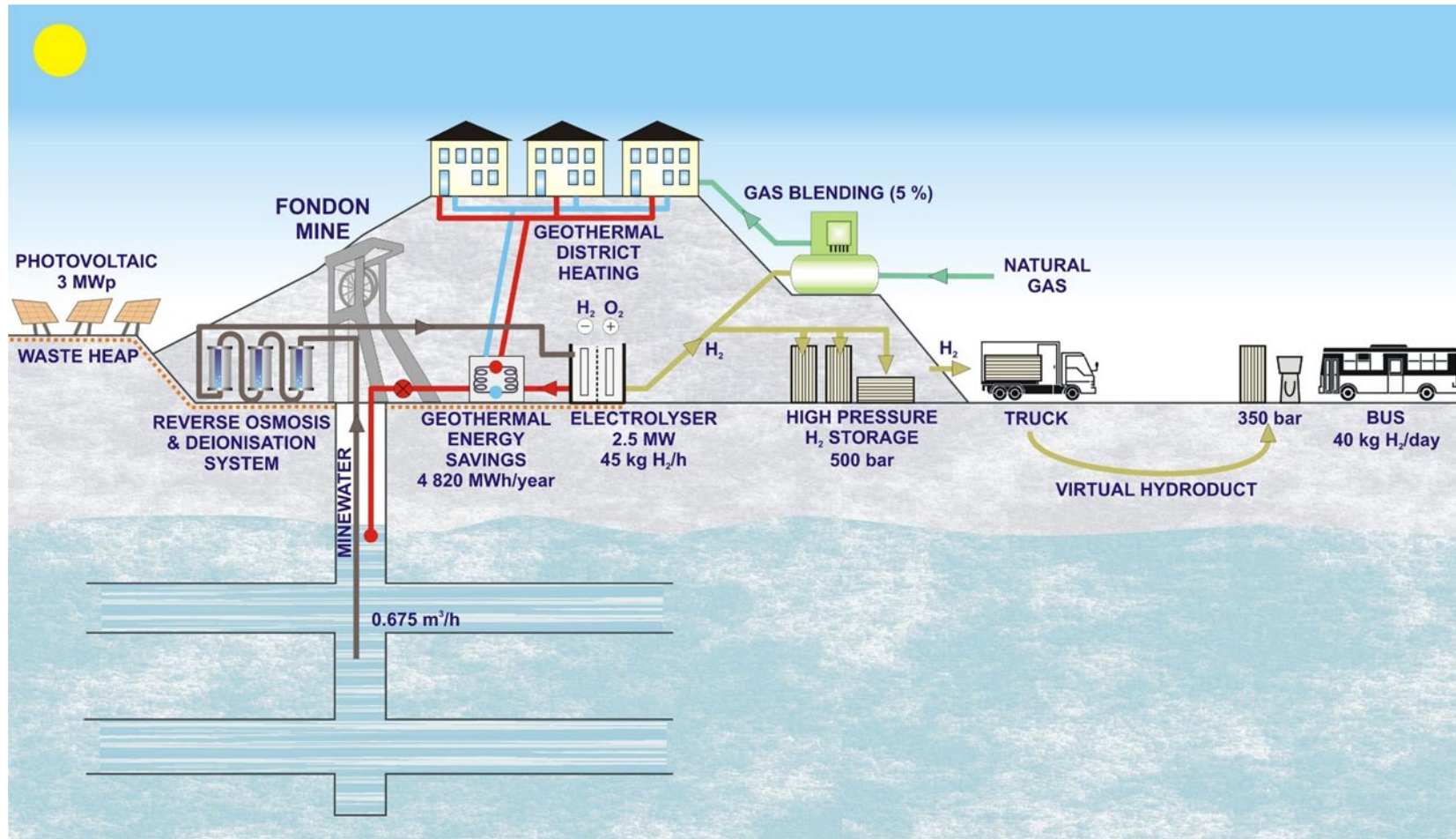## Aller-Barredo-Figaredo, SPAIN

Premogovnik Velenje, SLOVENIA

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

Business model 2: Green hydrogen plant.

POTENTIAL SCOPE AND ACTIVITIES OF TASK FORCE ON SAFE OPERATIONS AND CLOSURE OF COAL MINES

1. How could the results change when applying specific criteria and policies corresponding to different non-European countries?

2. How to adapt the business models based on renewable energy to different non-European countries?

3. Are there any alternative opportunities to develop business models that rely on renewable energy, on the circular economy or scale energy storage?

4. Which direct result indicators might be representative in other non-European countries?

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THANK YOU FOR ATTENTION

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