31st Session of the UNECE Committee on Sustainable Energy

Business models to stimulate new economic activities and jobs in coal regions in transition

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Mitigation of Methane Emissions from the Extractive Industries in Transition: Concrete Actions, Goals, and the Costs of the Process

Geneva - 22.09.2022

RFCS PROJECTS: POTENTIALS & GeenJOBS

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

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	DEFINITION
A1_VIRTUAL	Virtual power plant
A2_H2	Green hydrogen plant
A3_ECOPARK	Eco-industrial park
A4_TOURIST	Cultural heritage and sports/recreations areas using green energy
A5_PANELS	Floating PV panels at flooded open-pit coal mine
A6_PHS	Pumped hydroelectric storage (PHS) at former open-pit coal mines
A7_FISHES	Fisheries in flooded open-pit coal mines
A8_C/O_CGT	Combined-cycle gas turbine (CCGT) power plant powered by natural gas
A9_MINEGAS	Mine gas utilization for gas-powered CHP power units
A10_SMR	Small modular reactors (SMRs)
A11_BIOFUE	Biofuels combustion energy plant
A12_SALT	Molten salt plant
A13_PUMP	Hydropumping open-pit
A14_APV	Agrophotovoltaics (APV) at former open-pit coal mine areas

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

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

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Using MULTIPOL program (Multicriteria and policy), first, the scoring of actions with respect to criteria from 0 to 20 is made. 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.

	C1 EnerSec	C2 Greenin	C3 Cost	C4 Benef	C5 RegDev	C6 Environ	C7 Job
A1_VIRTUAL	10	20	8	10	10	15	3
A2_H2	15	20	0	5	20	20	5
A3_ECOPARK	10	15	10	5	15	15	20
A4_TOURIST	5	5	10	5	20	20	5
A5_PANELS	15	20	10	15	10	15	10
A6_PHS	10	20	7	15	15	15	10
A7_FISHES	5	5	12	10	10	10	15
A8_C/O_CGT	20	10	13	10	5	5	10
A9_MINEGAS	1	0	15	15	3	15	2
A10_SMR	20	3	5	10	15	18	10
A11_BIOFUE	20	15	15	10	10	15	10
A12_SALT	18	20	16	10	13	15	5
A13_PUMP	20	10	0	20	10	20	10
A14_APV	15	20	0	15	10	15	8

	Sum	C1 EnerSec	C2 Greenin	C3 Cost	C4 Benef	C5 RegDev	C6 Environ	C7 Job
Climate	100	40	20	30	0	0	10	0
Growth	100	20	10	25	10	10	5	20
People	100	15	0	15	0	20	10	40

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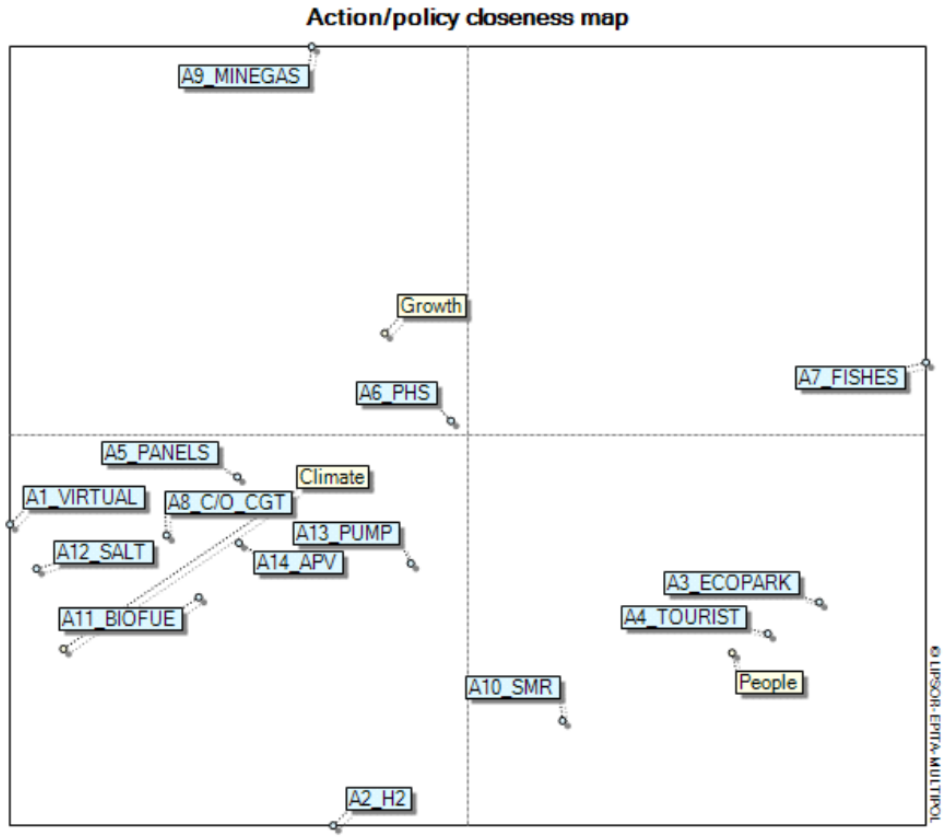
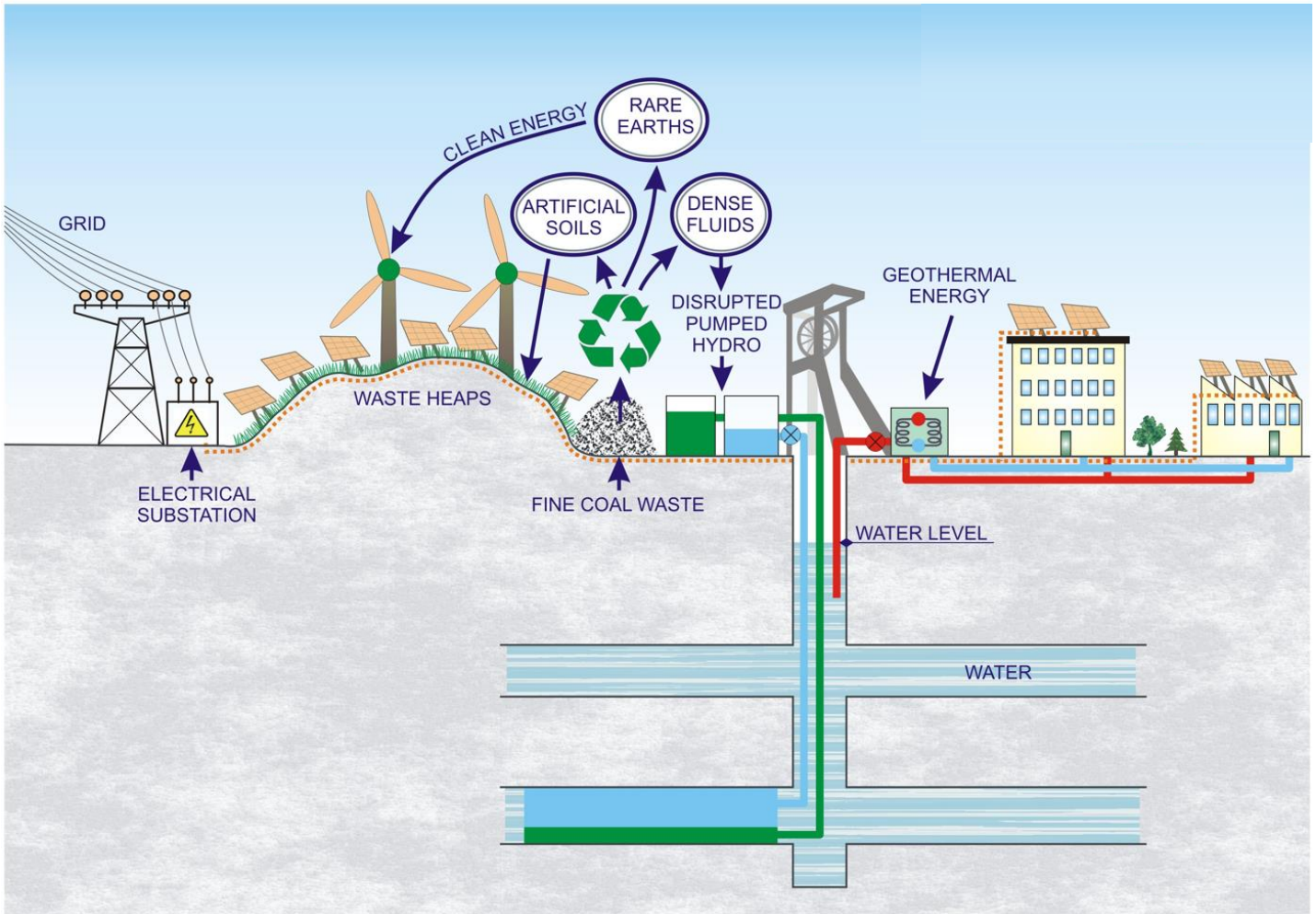
Management decisions should be based on a prospective analysis of business models.

	Climate	Growth	People	Moy.	Ec. Ty	Number
A1_VIRTUAL	11,9	9,4	7,4	9,6	1,8	3
A2_H2	12	9,5	10,2	10,6	1	6
A3_ECOPARK	11,5	12,8	15,5	13,2	1,7	12
A4_TOURIST	8	8,5	10,2	8,9	1	2
A5_PANELS	14,5	12,8	11,2	12,8	1,3	11
A6_PHS	11,6	11,5	11,1	11,4	0,2	8
A7_FISHES	7,6	10	11,6	9,7	1,6	4
A8_C/O_CGT	14,4	12	10,4	12,3	1,6	10
A9_MINEGAS	6,4	6,9	5,3	6,2	0,7	1
A10_SMR	11,9	10,9	12,6	11,8	0,7	9
A11_BIOFUE	17	14	12,8	14,6	1,8	14
A12_SALT	17,5	13,6	11,2	14,1	2,6	13
A13_PUMP	12	11	11	11,3	0,5	7
A14_APV	11,5	9,9	8,9	10,1	1,1	5



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



Photovoltaic deployment parameters

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.

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€

Disrupted pumped hydro storage deployment parameters

Parameters of the disrupted pumped hydro storage calculated to cover daytime energy storage plus a 10% safety margin, with around half of the daytime hourly energy production in twice the time (around 16 hours), resulting in an installed capacity of 200 MWh-10 MW.

Parameter	Value
Installed capacity	200 MWh-10 MW
Estimated investment (plant life: 50 years)	5 M€
Roundtrip efficiency	80%
Daytime energy storage (360 MWh x 50%)	180 MWh
Night-time energy production (180 MWh x 80%)	144 MWh
Night-time energy price	70 €/MWh
Night-time revenues (144 MWh x 70 €/MWh)	10,080 €
Annual revenue for Disrupted pumped hydro (10,080 € x 365)	3.68 M€
Annual expenditure (staff, maintenance and overheads)	0.15 M€

Cash flow calculations (k€)

Using high-power batteries for very short periods, with an estimated investment of 1.5 M€ for an installed capacity of 200 MWh-2 MW and an annual expenditure of about 0.05 M€, cash flows for the three first years, using constant 2021 euros, annual depreciation of 5% and working capital of about 9% of operating revenues, are presented.

Item	2021	2022	2023
Capital expenditure	(26,500)		
Working capital	(565)		
Operating revenues		6,310	6,310
Operating expenses		(700)	(700)
Depreciation (20 years)		(1,325)	(1,325)
EARNINGS BEFORE INTEREST AND TAXES		4,285	4,285
Taxes (25%)		(1,072)	(1,072)
NET INCOME		3,213	3,213
CASH FLOW (Net income + Depreciation)	(27,065)	4,538	4,538

Expected financial outcomes

Considering an 8% capital cost, the expected financial outcomes for 25 years will be:

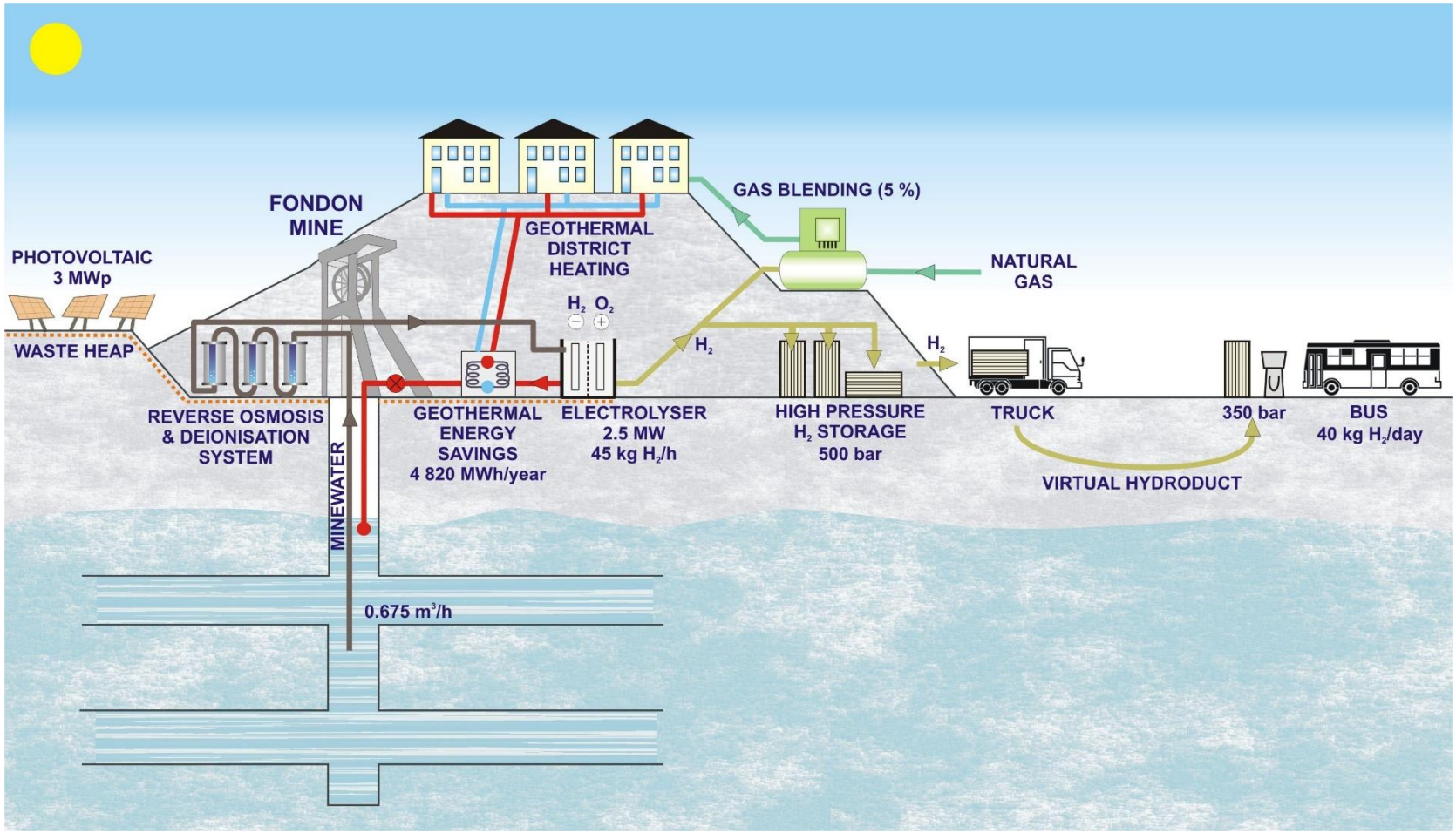
$$NPV = -27{,}065 + \frac{4{,}538}{(1+0{,}08)} + \frac{4{,}538}{(1+0{,}08)^2} + \ldots + \frac{4{,}538}{(1+0{,}08)^{25}} = 21{,}991\ k€$$

$$Internal\ rate\ of\ return\ (IRR) = 16\%$$

$$Payback\ Period\ (PP) = 9\ years$$

These figures confirm the project's commercial viability, showing an economic added value of almost 22 M€, for an investment of 27 M€.

Business model 2: Green hydrogen plant.



Capital expense (CAPEX)

Capital expense for a 3MWp photovoltaic plant, a 2.5 MW Green Hydrogen Plant, a hydrogen refuelling station at 350 bar built for intercity buses, and a blending installation into the existing natural grid (5%).

Description	Estimated cost (€)
3MWp Photovoltaic plant	4,040,000
Electrolyser system	3,200,000
Mine water feeding and treatment systems	220,000
Blending installation	901,202
Hydrogen storage and refuelling systems	3,559,675
Electrical system connections	324,000
Mechanical balance of plants (BOP)	390,000
Electrical balance of plants (BOP)	190,000
TOTAL	**12,824,877**

Technical and economic parameters

Parameters for a 69% of green hydrogen plant functioning and a 14% of photovoltaic plant functioning.

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

Cash flow calculations (€)

Cash flows for the first three years, using constant 2021 euros and working capital of about 9% of operating revenues, are presented. To simplify calculations, no inflation was considered.

Item	2021	2022	2023
Capital investment	(12,824,877)		
Working capital	(170,100)		
Operating revenues		2,160,000	2,160,000
Operating expenses		(846,000)	(846,000)
Depreciation of green hydrogen plant		(543,212)	(543,212)
Depreciation of photovoltaic installation		(48,480)	(48,480)
EARNINGS BEFORE INTEREST AND TAXES		722,308	722,308
Taxes (25%)		(180,577)	(180,577)
NET INCOME		541,731	541,731
CASH FLOW (Net income + Depreciation)	(12,994,977)	1,133,423	1,133,423

Expected financial outcomes

Considering an 8% capital cost and a residual value of the photovoltaic plant of 1,616 k€ (10/25 of the initial investment), the expected financial outcomes for 15 years, will be:

$$NPV = -12{,}995 + \frac{1{,}133}{(1+0{,}08)} + \frac{1{,}133}{(1+0{,}08)^2} + \ldots + \frac{2{,}749}{(1+0{,}08)^{25}} = -2{,}784\ k€$$

$$Internal\ rate\ of\ return\ (IRR) = 4.511\%$$

$$Payback\ Period\ (PP) = N.A.$$

These figures confirm that even with a hydrogen sale price of 8 €/kg (currently is about 6 €/kg), the project's commercial viability is not achieved.

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Thank you for your attention!

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Research Fund for Coal & Steel