



RÉPUBLIQUE
FRANÇAISE

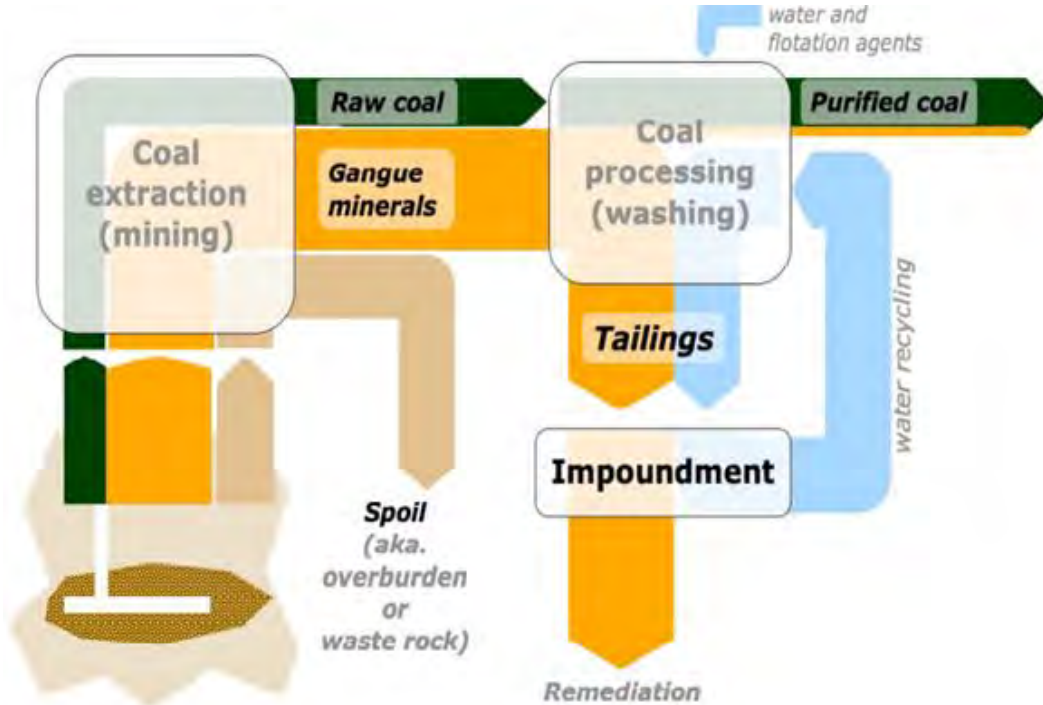
*Liberté
Égalité
Fraternité*



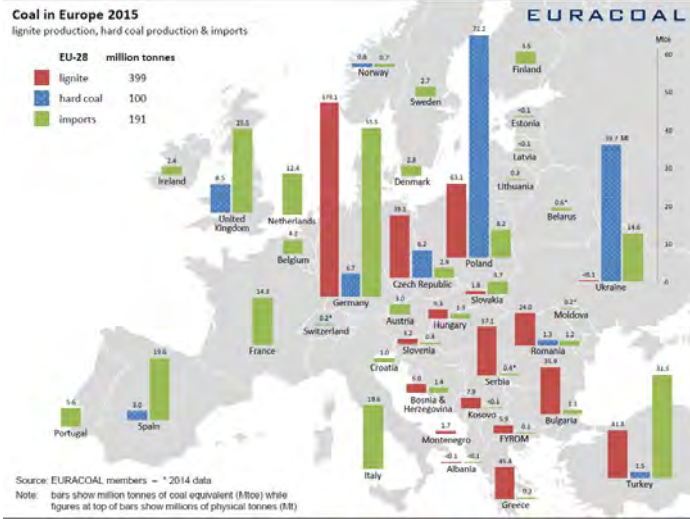
*maîtriser le risque
pour un développement durable*

Advantages and limitations of installing photovoltaic panels on dumps European feedback

Schematic of the origins of spoil and tailings waste in coal mining



Significant potential in Europe and France



Stopping the Coal production

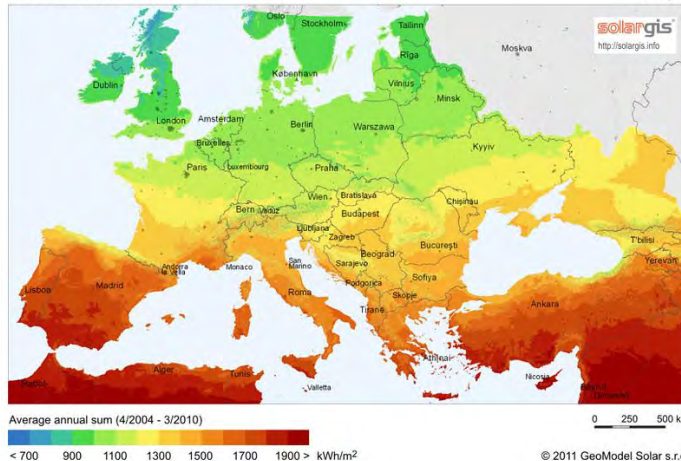


Increasing the
Renewable Energy

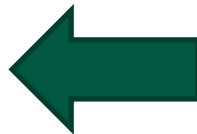
Improving the coal
regions in transition

Global horizontal irradiation

Europe



Reuse of mining land
(Dumps)



Context and objective

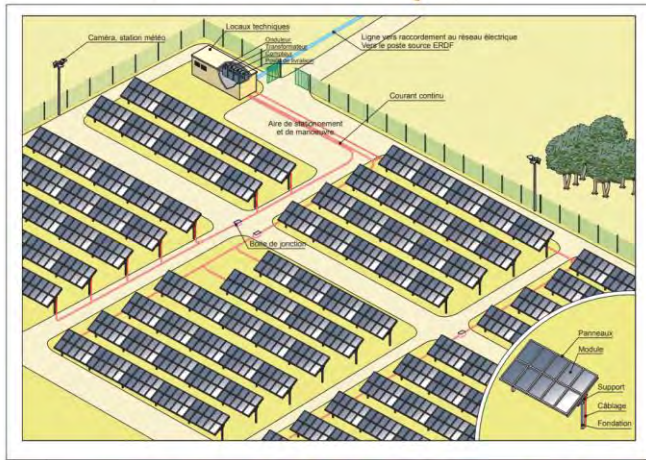
- The ratio of the volume of the waste material to coal or lignite ranges between **1<:1 and >10:1**.
- Mining and quarrying activities in Europe generate approximately **55% of total industrial wastes**,
- In China, coal mining waste, accounts for **40%** of all solid wastes.
- Approximately 50 mtpa of colliery discard was being stored above ground in dump heaps.
- Ruhr district of Germany has **104 dump tips** where the large majority are from coal mining activity. **1,300 coal tailings** were identified in France.
- The identification of **sustainable reuse** opportunities of dumps is certainly a **modern and attractive business €€€€**.
- The coal mine waste may be used for different types of economic activities.
- These new economic activities represent a potential for job creation, increased revenues, revitalization, economic development, stability for local and regional energy grids.



Fig.1.7. The cheapest sources of electricity generation in the first half of 2020

PV and energy production

Photovoltaic (PV) systems convert sunlight directly to electricity by means of **PV cells** made of semiconductor materials. Concentrating **solar power (CSP)** systems concentrate the sun's **energy** using reflective devices such as troughs or mirror **panels** to produce heat that is then used to generate electricity.



Concept of reuse of dumps

Costs
Hazards



Revitalization of dumps

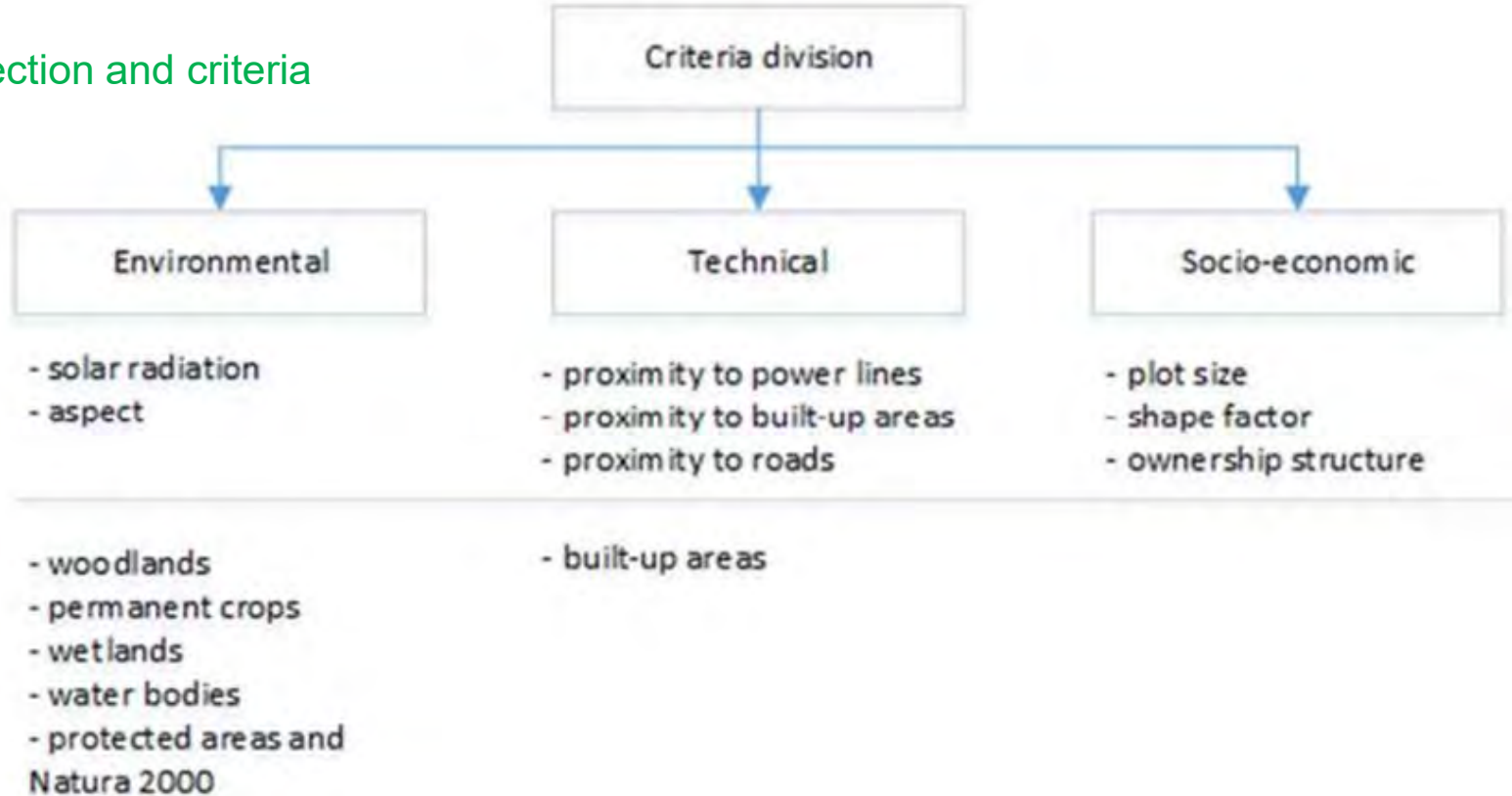


Benefits



- Research common interests: economy, social,
- Efficient agreement for sustainable development,
- Developed the cooperation between mining industry and society.

Site selection and criteria



Selection criteria for the installation of PV farms

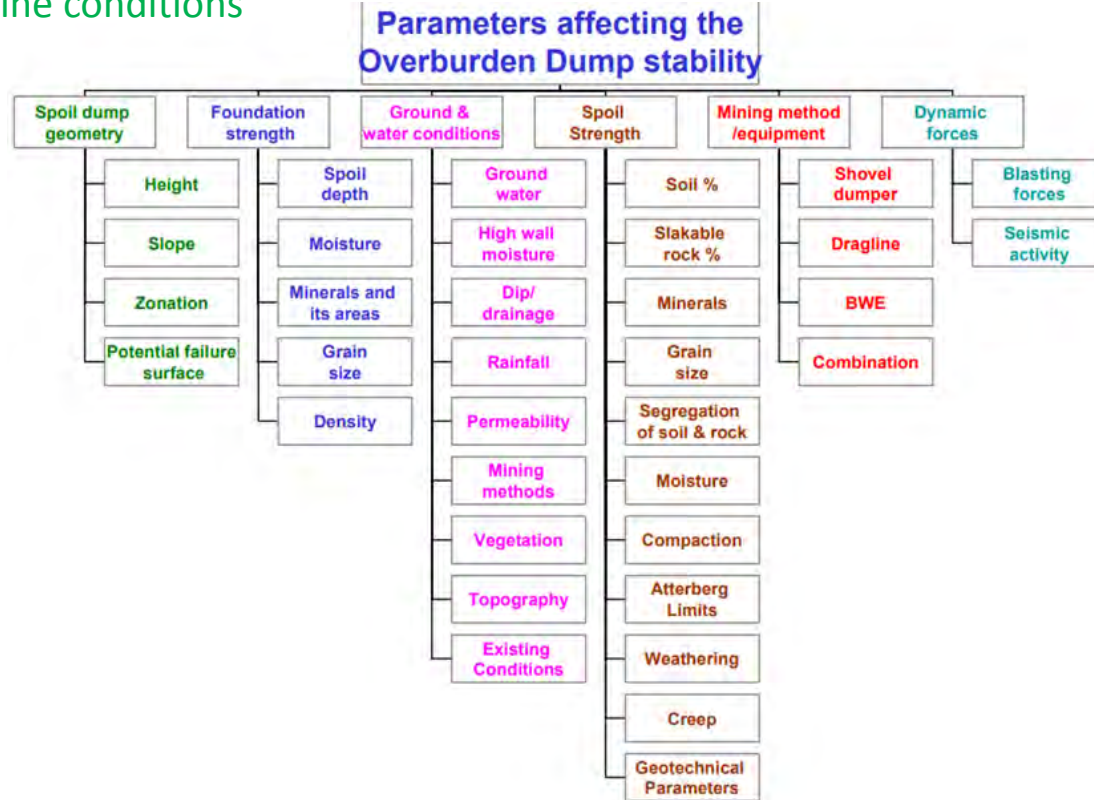
No	Authors	Palmer et al. 2019	Mierzwik and Clark, 2017	Kereush and Perovych 2017	Noorollahi et al. 2016	Paneru, 2016
Country		UK	Poland	Ukraine	Iran	Nepal
Evaluation criteria						
1	Abundant solar irradiation	1050 kWh.m ² /year		1100 kWh.m ² /year	1300 kWh.m ² /year	>1500 kWh.m ² /year
2	Slope and Orientation	< 11 %	Southeast, south, partly southwest	< 5-15° Southeast, south, partly southwest	< 11%	See table (xx) South, south Est and south oust
3	Transmission lines	<2500 m	<1500 m	More than 35 kv, 600 m nearby	X, < 50 km	
4	Proximity to populated area			<2500m		
5	Proximity to populated area			<3500m	> 2000 for cities and 500 for villages	
6	Proximity to road network		<1500 m		< 50 km	< 2000 M
7	Average air temperature in July			15-40°	X, number of cloudy days, number of dusty days	
8	Proximity to multi-storey houses (>16m)			>100m		>200 m
9	Proximity to residential areas		<3000m	>500m	<45 km	> 200 m
Exclusion criteria						
10	Land cover		Wetland, built-up area	Free of mountains, forest, water bodies, buildings, wetlands, floodplains; Preferably low and medium grassy vegetation, shrubland, barren land, closed landfills, abandoned mine lands	Urban lands, cultural heritage, watercourses, wildlife, conservation areas, national parks, etc. Land-use such as forest, agricultural lands.	Forest, water and built-up areas with < 200 m Water bodies, built-up areas, forest,
11	Protected areas		Natura 2000	Nation and regional parks, areas of cultural heritage, paleontological and archaeological sites	Regions with a distance less than 1000 m from rivers, lakes, wetlands, and dams	

Criteria related to mine conditions

- Slope stability
- Settlement and differential settlement
- Fire and internal combustion
- Dust and small soil particles
- Pollution due to new drainage system and the chemical composition of the dumps;
- Preservation of new biodiversity and natural habitats installed on the spoil and dumps during the construction and abandoned mines;



Criteria related to mine conditions



Slope angle and PV installation

	Degree of the slope	Suitability ranking
1	0-5	Highly suitable
2	5-10	Moderately suitable
3	10-15	Latest suitable
4	>15	Not suitable

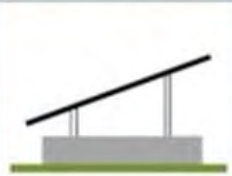


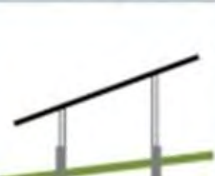










Structures can be established on land with slopes up to 15% at 20%.

SUMAD suggestion for installing PV on DUMPS:

- **Low suitable: >25%, heavy earthworks and slope reinforcement, the land should be remodelled, and special deep foundations are recommended or thin-film technology,**
- **Moderate: <25 and < 15 %, the land should be remodelled, and special deep foundations are recommended,**
- **Suitable: <15 and < 5 % special shallow foundation**
- **Best suitable <5, ideal conditions, corresponding to the upper and the foot of the dumps.**

Types of foundation function of the ground (tech.nikkeibp.co.jp)

Type A	Type B	Type C	Type D
Flat-1	Slope	Side slope	Flat-2
			
Precast	Precast + anchors	Rock anchors	Piles
			
			



Fire PV and mitigation



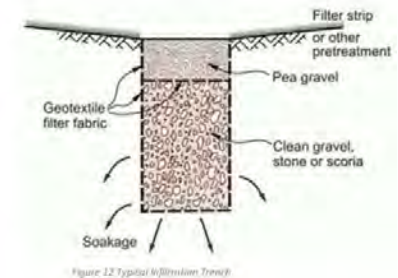
Assessing Fire Risks in Photovoltaic Systems and Developing Safety Concepts for Risk Minimization



Hazard and risk management

- Improvement measures relative to ground movement hazards
- Improvement measures relative of water hazards and flooding
- Improvement measures relative to fire and combustion hazards
- Improvement measures relative to environmental and health hazards and risks

Flooding hazards



PV installation on dump – Hungary – Vistona park (Orosz, 2018)

The solar park Visonta (Hungary) is one of the most important installations in terms of energy production capacity (16 MW). In 2015, the Hungarian power plant company Matrai Eromu opened a solar power plant, which is situated on top of a lignite mine dump site and generates 16 MW of solar power (Solar Power Europe, Weston, 2015). An additional 60 MW could be built as an extension of the actual site on the overburden deposit of the mine.

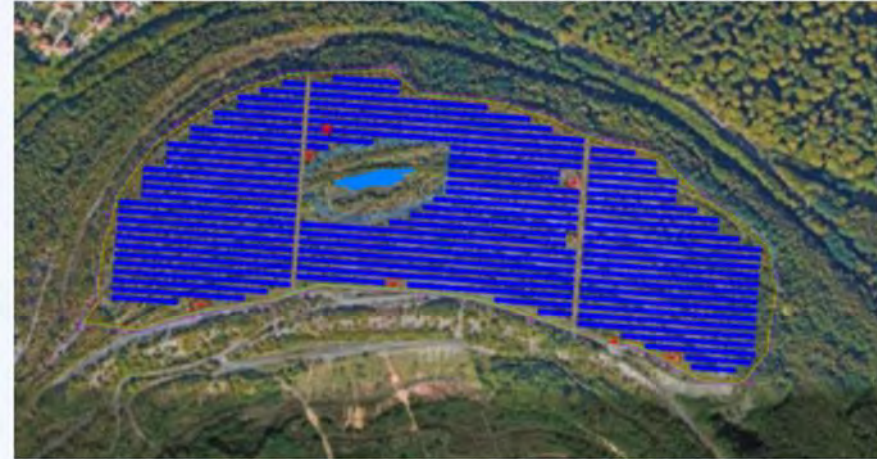


In Belgium, the abandoned coal mine grounds of Zolder (closed in 1992) were converted into a modern industrial project. The decontaminated land into a solar power plant – and so an ostensibly lost site acquired a new use (Figure 11). The project was finished in the end of 2009.

Peak output	4,7 MWp
Number of PV modules	23,500 modules
Expected annual output	300,000 kWh
Annual savings CO2 emissions	1,800 tonnes
Utilised ground surface	17 ha
Project developer	NV Zonnecentrale
Start of execution	Nov. 2008
Completion of the works (expected)	end 2009



France – Lorraine – Coal mine



Conclusion (1/2)

- Spoil/dump are profitable for the communities and corresponding of the main objective for coal regions in transition
- The installing PV on the spoils/dumps helps to support fragile areas impacted by the coal mining industry
- The installation of PV on dumps and spoils reduces the environmental and social-economic negative impacts
- They could be repurposed for investments into new low-carbon industries and the installation of the PV on dumps land.

Conclusion (2/2)

- The spoils/dumps, of coal mine is overburden waste material, heterogenic and unconsolidated comparing to natural lands.
- The spoil geometry is generally built as conical or irregular in shape with a high profile in relation to the local topography. The typical height of spoil piles ranges from 30m–100m and the slope of the spoil pile varies between 20° to 40°.
- The slope stability and the PV security should be assessed to predict and mitigate any potential hazard and risk. The specific characterisations of spoil/dumps present a challenge for investments. The current situation shown few PV installation projects and installations in Europe and in the world.



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THANK YOU FOR YOUR ATTENTION