# REPURPOSING COAL ASSETS

In many countries the energy transition programme leads to the closure of coal mines and power stations, which can have an important role in the transition. The EU seeks to accelerate the change to renewable generation, and the USA is also promoting a switch from fossil fuels. Asia leads the introduction of renewable energy, but there is increased reliance on coal as a strategic fuel, meaning the switch from coal will be delayed, especially in China.

Scrapping and clearance of former coal sites is one option, followed by conventional redevelopment of industrial sites, especially if located near urban centres. There is also a substantial programme of land restoration to create new forests or parkland. However, variable renewable energy (VRE) generation requires considerable energy storage to ensure electricity grid stability and former coal stations and mines offer advantaged sites. This study explores beneficial options for both coal mines and power plants that seek to turn disused sites into attractive projects that support the energy transition; distinct from opportunities that adopt refuelling or carbon capture technology.

Energy storage is a sector set to grow at 30% per year, attracting massive investment that reflects real urgency and poses a major opportunity. More than 20 coal facilities are switching to energy storage plants or transforming into multigeneration energy hubs. Repurposing covers simply reusing existing substations and transmission lines to complex mixed-generation energy hubs that can incorporate much of a coal station.

## ENERGY STORAGE IN DISUSED COAL MINES

Energy storage in hydro facilities is the dominant method. Reservoirs at two levels with pump/turbine systems gather potential energy during low demand and deliver energy at peak demand. These systems may be reproduced in a former mine at a lower cost by using the mine infrastructure. Similar concepts use compressed air built into a coal mine that avoid the need for large pressure vessels. The storage of hydrogen could also be 'in shaft' and for enhanced safety, underground storage uses larger volume and pressure, potentially enabling hydrogen fuelling infrastructure.

At depth, water in mines is warmer, making it a geothermal energy source of increasing interest for district heating schemes previously supplied by coal stations; heat pumps can provide a hot water supply, and additionally offer a cooling system for summer.

Deep mine shafts hundreds of metres deep are suitable for a rapid response gravitational energy system. Raising and lowering 500-tonne weights can generate power during shortfalls and store power when in excess, using a system of pulleys that also act as turbines. This is a novel technology with the first commercial plant in progress.

## MIXED GENERATION POWER STATIONS, BATTERIES, HYDROGEN, AND SALT STORAGE

Renewable generation combined with storage and a fuelled power plant can supply dispatchable power more reliably than solar and wind alone. In Europe, a generating hub would consist of hydrogen electrolysis and battery storage with a former coal power plant possibly refuelled with biomass or natural gas.

In China, a mixed-generation site is based on a high-efficiency coal station, with energy storage from batteries and hydrogen intended to permit optimum operation of the total system. The net renewables capacity is designed to be similar to that of the coal station.

Many battery energy storage systems are being installed. Locating these large battery plants at a former coal station allows the use of transformers and connectivity to the grid. The preferred technology is high-energy density lithium. One issue for batteries is a short generating time of hours, inadequate to cover prolonged periods of low generation from VRE. New flow battery plants aim to supply lower power levels but for periods of weeks.

A high-capacity system that uses most of an existing coal station is thermal salt energy storage. A hot salt reservoir provides high thermal capacity, with the heat applied to drive a steam system and turbine, providing energy equivalent to a power plant. A hot salt-steam system can outperform a battery plant in terms of maximum power supply and duration. This would be suitable for newer installations where expensive units can be reassigned for this technology.

## NUCLEAR

Conventional nuclear stations provide critical dispatchable power, but costs are high, and the scale may not match regional demand complementing renewables. Small compact modular reactors (SMRs)could match the scale of older coal plants their mass production could lower the cost. An economic benefit of locating SMRs at coal plant sites is the incorporation of existing facilities including cooling systems and grid connectivity.

## PROSPECTS

Former coal sites have attractive attributes to support the energy transition, including their location, connectivity and support facilities. Renewable generation has been supported by flexing fossil power plants, but as these are withdrawn an urgent issue arises of how to support electricity grids. This need for energy storage has led to a complete revaluation of former coal sites and mines which could offer technical solutions using potential energy from air water and gravity, and geothermal energy pumped water systems.

Coal stations have valuable grid connections, which can be a key barrier to new VRE development. The sites can house large battery installations or be developed into energy hubs that even retain the coal boiler, possibly refuelled with natural gas or biomass. Battery installations pose significant demand for critical elements that are in short supply, and technical alternatives based upon potential energy storage reduce this economic risk. Previously, the fate of coal plants was simply to scrap them and for mines to commence restoration, but the realisation that there is an urgent need for energy storage and base power generation is changing perceptions.

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Each executive summary is based on a detailed study which is available separately from: www.sustainable-carbon.org. This is a summary of the report: Repurposing coal assets by Dr Ian, ICSC/328, ISBN 978-92-9029-651-5, 85 pp, October 2023.

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