





The South Wales coalfield
The potential of extracting ground heat from
mine water in abandoned deep coal mines –
A case study from Caerau, Upper Lynfi Valley,
South Wales

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FLEXIS
SMART ENERGY FOR OUR FUTURE
YNNI CALL AR GYFER EIN DYFODOL




What is FLEXIS?

- Welsh European Funding Office ERDF Programme.
- Total budget of £24.5 million over 6 years.
- Pan-Wales ENERGY research over 18 work packages.
- EARTH ENERGY SYSTEMS (Prof Hywel Thomas / Dr Manju / Dr Peter Brabham/ G. Farr (BGS) et al.).

Today's talk

- Heat from minewater – an untapped HEAT resource of future green energy for coalfield communities and industries?



We are committed to supporting, developing and promoting equality and diversity in all our practices and activities.

FLEXIS is part funded by the European Regional Development Fund through the Welsh Government.

Cwmparc Rhondda 2018

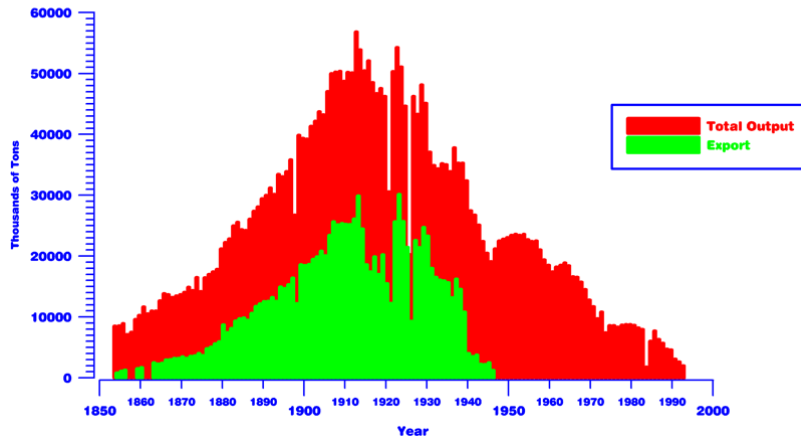


Cwmparc Rhondda 1960



At peak production in 1913 over 50% of South Wales' coal was exported all over the World through the ports Cardiff, Swansea, Barry & Newport

Total coal production versus export of the South Wales Coalfield



At least 3 BILLION Tons of coal has been mined out from over 1200 major South Wales coal mines since 1850 when output records began.

That's an awful lot of mineworkings and 100s of miles of tunnels that may still be extant underground and full of warm water!



When deep mines were in operation they constantly pumped water to stop flooding. So after abandonment they gradually fill up with groundwater



In South Wales many deep mines operated over 80 years mining as many as 8 to 12 seams at different levels. The typical Upper Carboniferous geological sequence can be seen here at Fros Y Fran land reclamation scheme.

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Heat from minewater

What are the research QUESTIONS ?

- QUESTION 1 – FLEXIS - Can we utilise the geothermal potential of minewater in the abandoned coal mines of Wales ?
- QUESTION 2 - Bridgend CC – Can we tap into the minewater below Caerau village, Upper Llynfi valley for community heating ?

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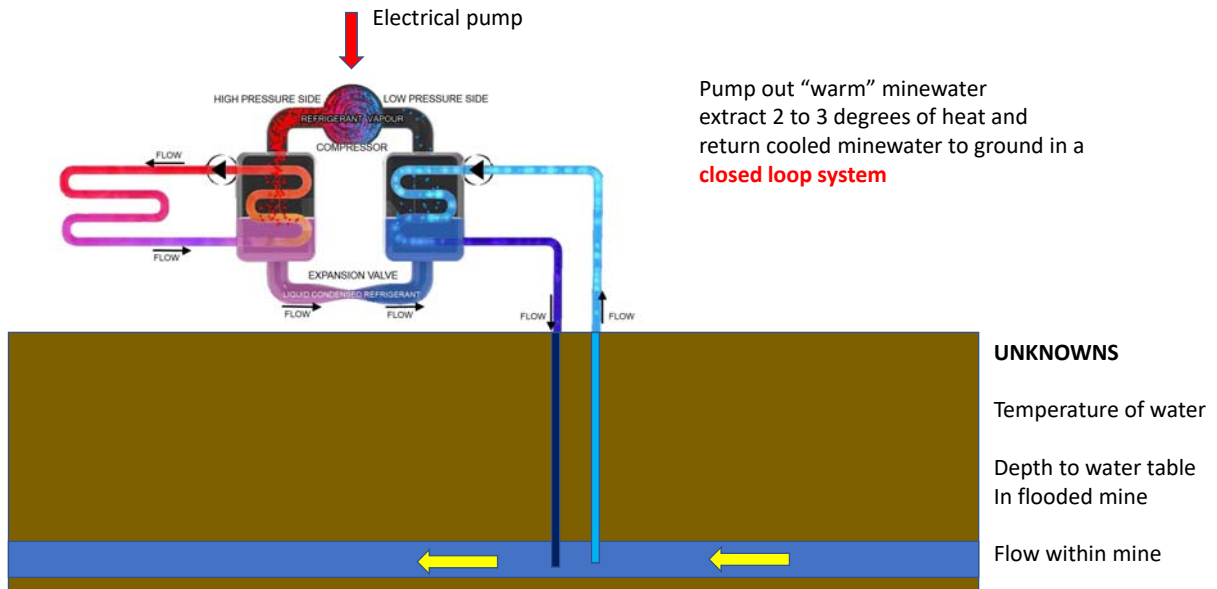
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Minewater Heat Pumps – for community heating projects



EU working example – Heerlen Netherlands

Underground water reservoir

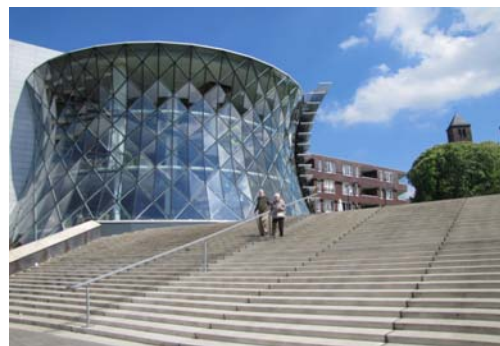
There were three active mines in Heerlen. After the closure of the coal mines over the period 1965-1974 the tunnels gradually filled with groundwater

Renewable energy production

In 2003 the municipality of Heerlen conceived the plan to do some exploratory drilling for the appraisal of potential renewable energy production.

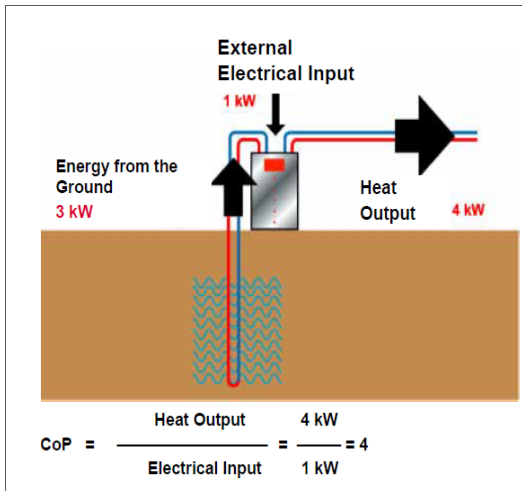
First mine water geothermal plant

In 2005, with support from the EU five wells were drilled and an underground piping system stretching approximately 8 kilometres was built to circulate water. In 2008 the first mine water geothermal plant in the world, Gen Coel in Heerlerheide, was put into operation and the first connection serving approximately 30,000 m² of indoor space was established.



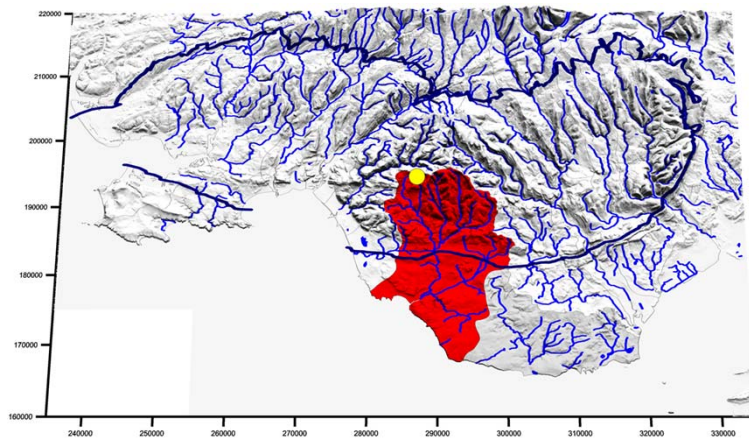
Can we utilise the thermal potential of minewater trapped in our abandoned coal mines ? **YES**

- **CRYNANT test site project 2015**
- Mine water at Crynant is stable at 11.5°C
- Some water temperature gain from ground (1° to 2°C)
- Borehole water levels constant at 25m below gl, mine workings are a single drainage adit at 65m depth.



Data loggers and meters show running costs are < 50% of oil system

QUESTION 2 from Bridgend C.C. – Can we tap into the minewater under Caerau village - Upper Llynfi valley for community heating ?



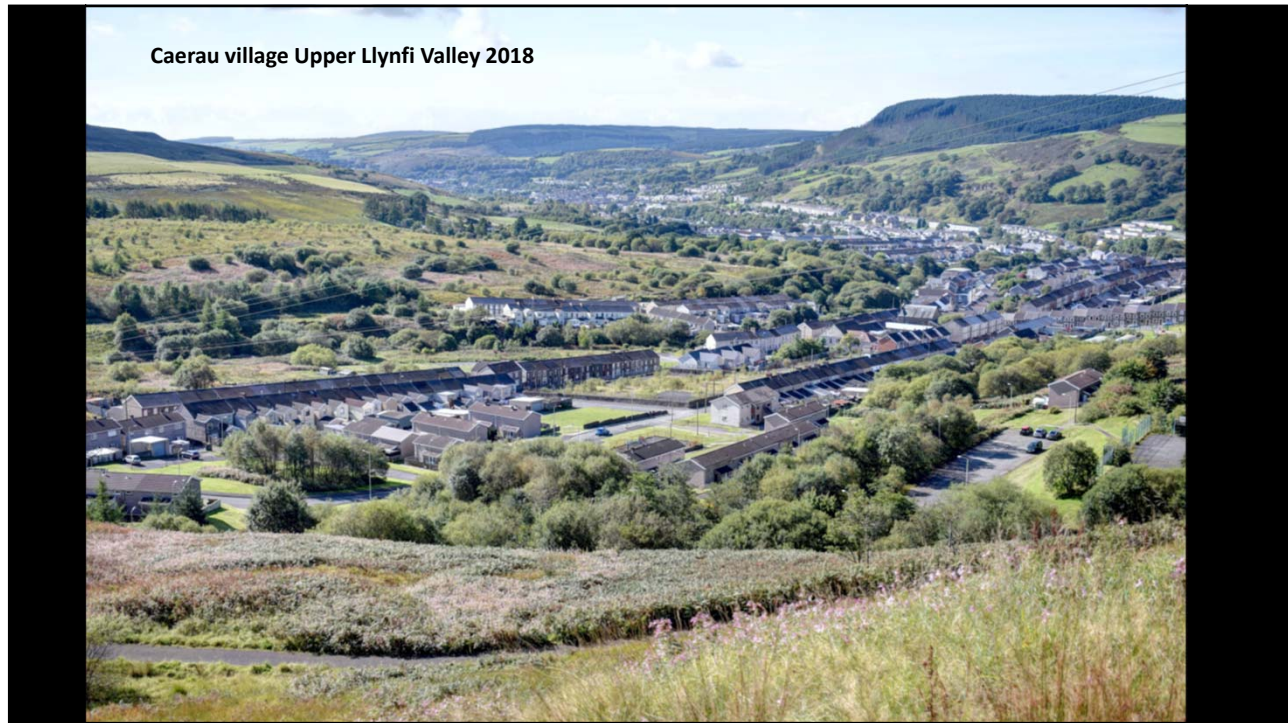
River Ogwr catchment

Garw
Ogwr Fawr
Ogwr Fach
Llynfi
Ewenny

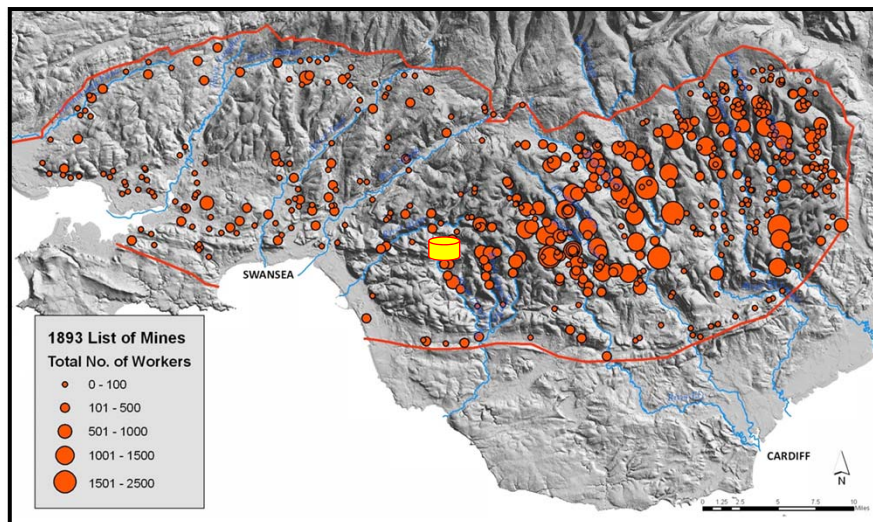
Local town

MAESTEG

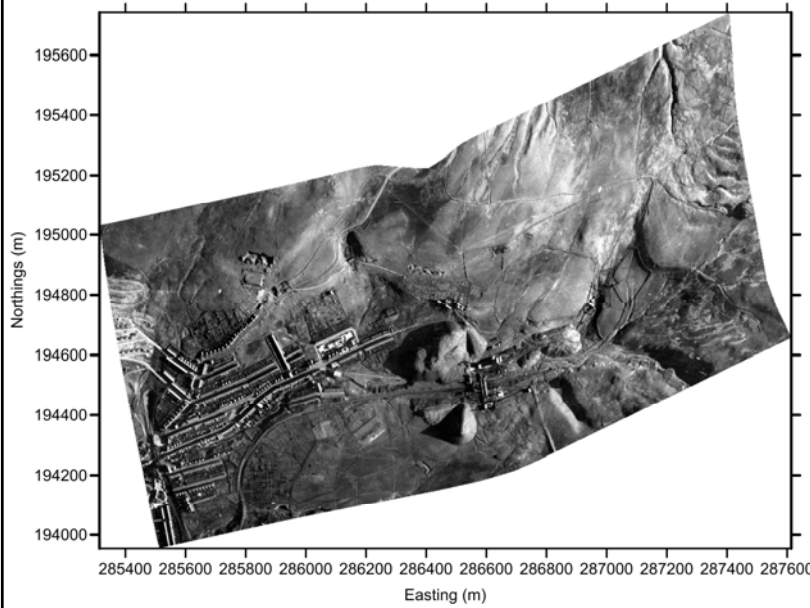
● Caerau village was selected on socio-economic grounds



QUESTION from Bridgend C.C. – Can we tap into the minewater at Caerau Upper Llynfi for community heating ?



Historical desk study RAF 1947 - Caerau colliery working



Caerau Colliery Brief History



- Exploration by North's Navigation (1889) Ltd.
- Two shafts sunk in 1897 to 293m (320 yards) depth.
- Extended underground in 1920s to exploit deeper seams
- At least NINE seam horizons known to be mined.
- 80 years of mining operation.
- Mine closed by NCB in 1977.

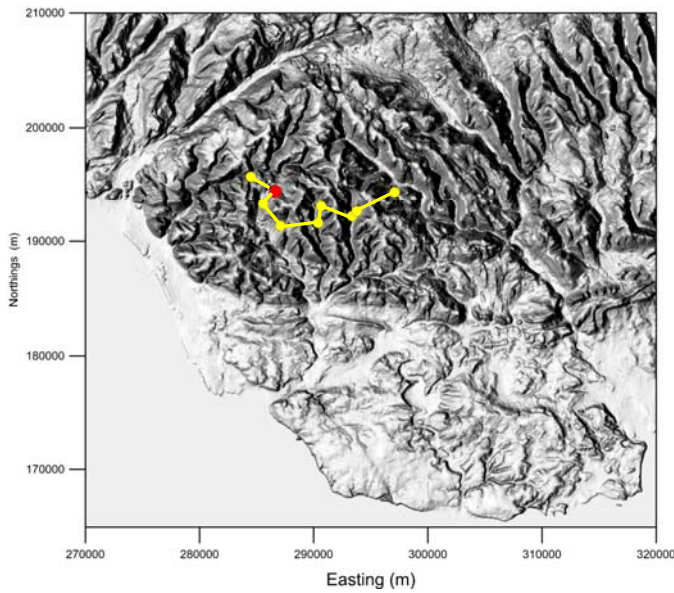
Historical desk study – modern air imagery 2018



- 1977 mine closed
- Shafts filled 1978
- Shafts capped 1994
- site landscaped 2001 by Coal Authority

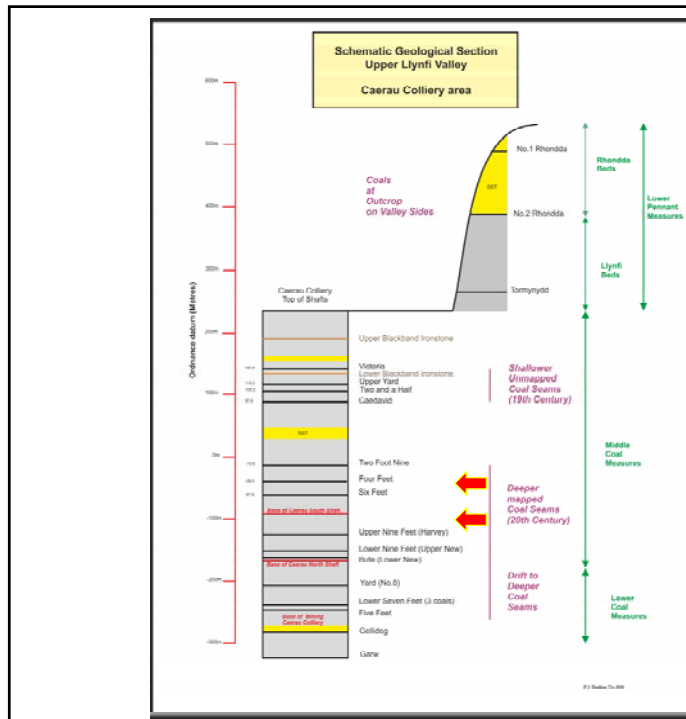
● Shaft Locations

Desk study - Known underground coal working interconnections by NCB era.



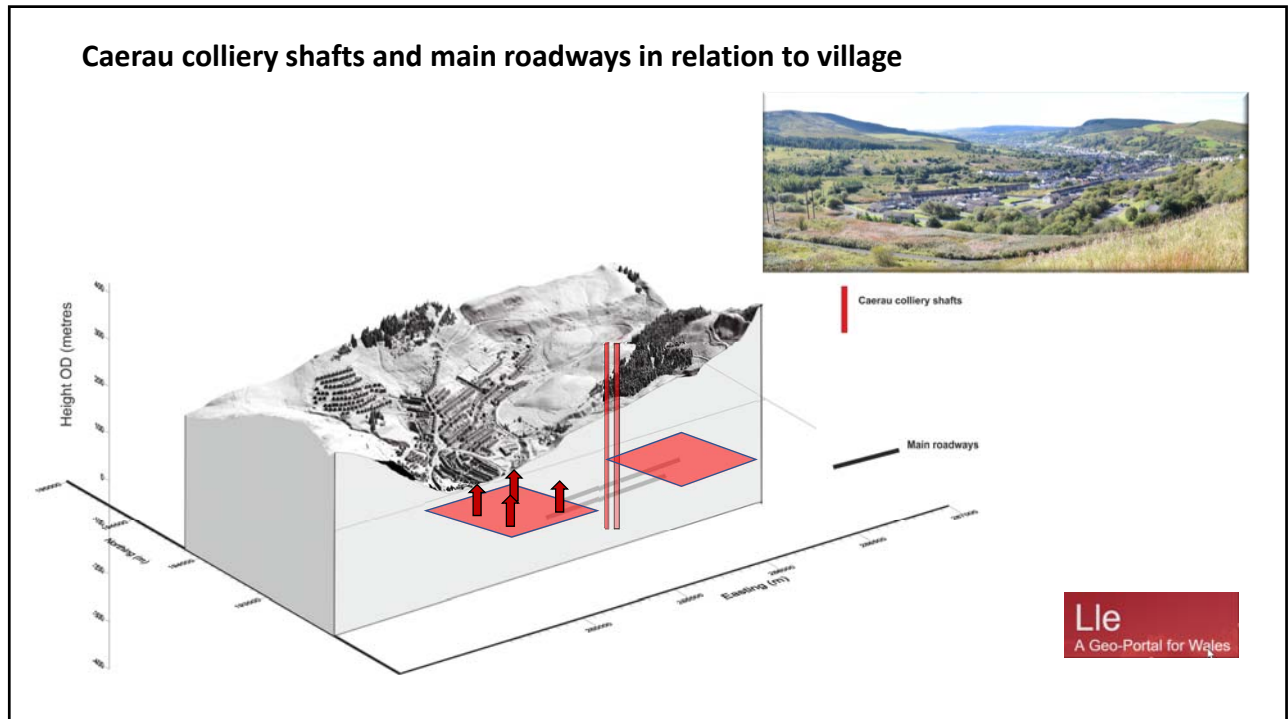
- | | |
|-----------------|------------------|
| Dyffryn Rhondda | (Afan valley) |
| CAERAU | (LLynfi valley) |
| Coegnant | |
| St Johns | |
| Ffaldau | (Garw valley) |
| Ocean Garw | |
| Wyndam | (Ogmore Vale) |
| Western | |
| Eastern | (Rhondda valley) |

64 Square miles of interconnected mineworkings
12.5 mile walk in 1947

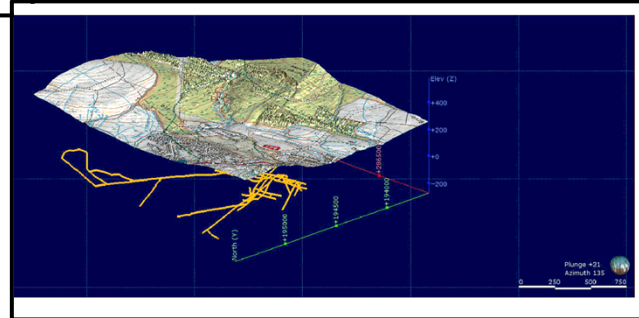
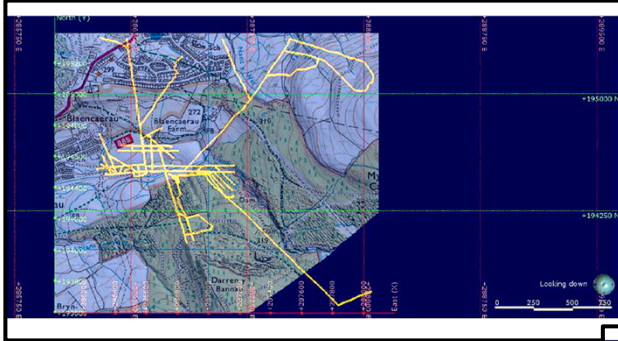


- Pentre Rider (*Victoria*, 39")
- Lower blackband ironstone (potential ironstone mining horizon)
- Upper Yard Seam (*No.8*, 74")
- Lower Pentre (*Two and a Half seam*, 30")
- Caedfaid seam (3ft)
- Two feet nine seam
- FOUR feet seam
- **SIX feet seam**
- Caerau seam (*Seven feet seam*, 2ft 6")
- Red Vein (49")
- **NINE feet seam (Harvey, 60")**
- **Bute Seam (Lower new, 45")**.
- **FIVE feet seam**

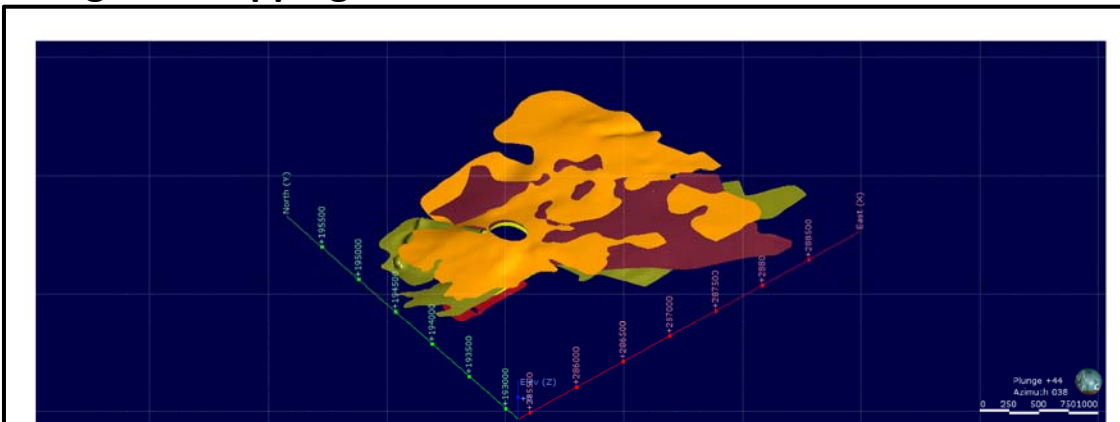
Red indicates known mine plans under village



Stage I - GIS Mapping main Roadways in 2D and 3D

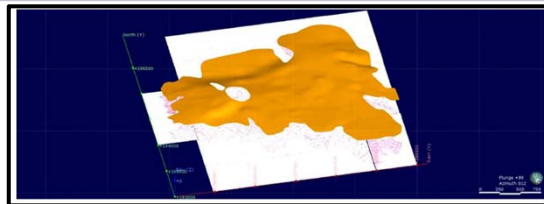


Stage II - Mapping known seam extraction areas in 3D

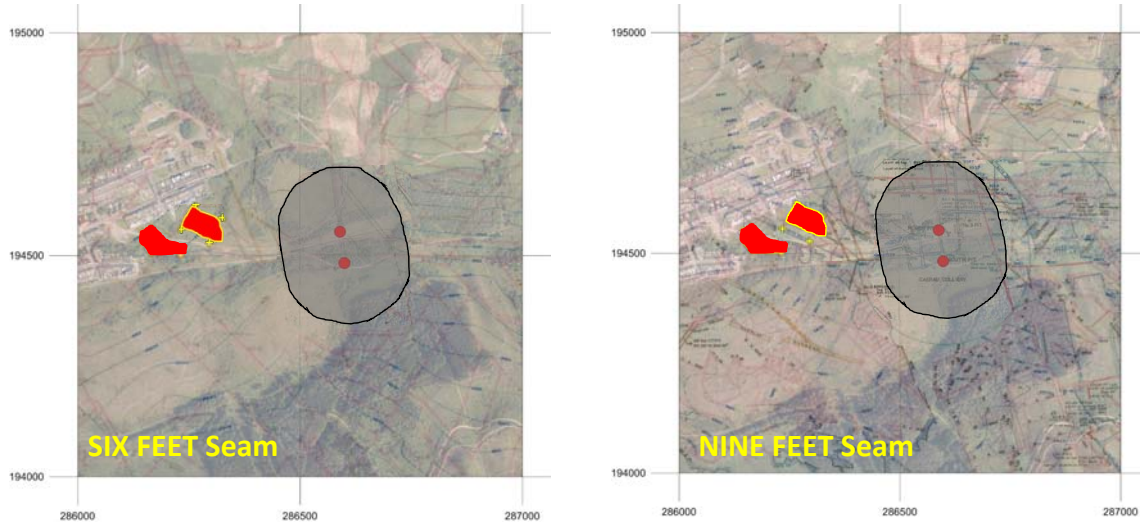


Legend

- 6 Feet Seam
- 5 Feet Seam
- Caerau Seam
- Bute Seam
- 9 Feet Seam



Stage III - Drill site location into known workings SIX and NINE feet seams under village



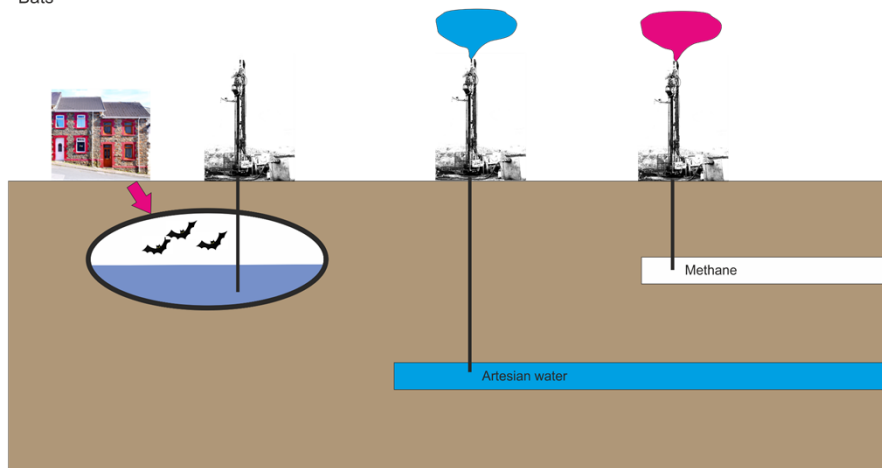
Other criteria – Drill on Bridgend CC land ownership, GIS mapping and risk register to identify potential drilling sites.

Community Engagement activities for months before drilling commenced

Residents concerns

Subsidence
Bats

Technical concerns



Planning for an exploration drill hole – community sensitivity PARAMOUNT

- **Many permissions & permits to drill are required – risk register:**
 - **License from Coal Authority**
 - Mine water heat recovery access agreement
 - No drilling within 50m of houses
 - Keep off landscaped tips (CA land)
 - **Permits from NRW (EA Wales):**
 - Permission to pump test; to investigate a groundwater source i.e. S32 consent
 - permit or exemption to discharge (no discharge to river).
 - Drill site not close to the river banks
 - **Planning permission for temporary borehole exploration site.**
 - for site investigation works – Site on Bridgend CC land
 - 9am to 5pm working no drilling on weekends.
 - 1 Month on site temporary drilling licence.
 - **Satisfy Health & Safety Executive**
 - **Agreement with PEDL licence owners about Methane ownership.**

Drilling in progress October 2017



Drilling on Site - Washington Control Valve (HSE requirement)



Top of the valve with a drilling rod going through

Seals the drill rods within the first casing whilst still allowing rotation.

The flush medium (and hence any gases) are diverted to a safe distance from the drill crew via the exhaust.



Shut off valve underneath the drilling rods

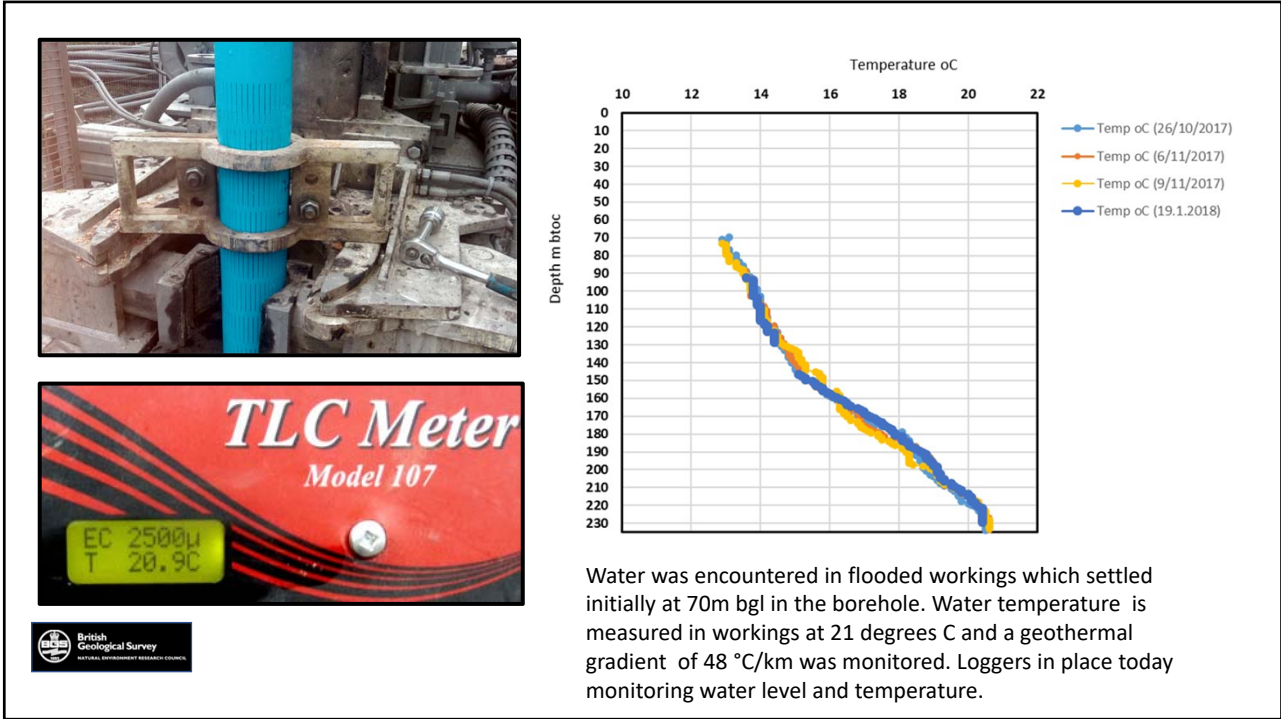


Drilling results

Drilling started on 29/9/2018 and on 16/10/2017 the drilling encountered a void space at a depth of 224- 225m bgl (766ft). The borehole collar is at 207m (676ft) . This within the mapping survey error for the predicted 6 Feet seam depth.

The drill rig carried on drilling on to 234m bgl, by which time it was certain it had passed through the workings back into solid geology.





Borehole is now completed and under long term monitoring by Cardiff University and BGS.



CONCLUSIONS – Keeping lessons alive (coal mining legacy)

- Engineering geologists have traditionally seen mineworkings as hazards and minewater AMD as a pollutant, but do they contain an as yet untapped future geothermal resource ?
- In the South Wales coalfield even for a single colliery do not ever underestimate the extent of abandoned mineworkings over large areas in multiple stacked seam horizons.
- Adjacent collieries were often interconnected by the NCB over many square miles extent between valleys.
- Every coal mine layout is unique and requires an extensive desk study using primary mine plans to produce an accurate 3D ground model on which to plan a drilling programme.
- When operational, deep mines continually pumped water to stop flooding, after closure flooding takes place.
- Water was encountered by drilling in flooded workings at 21 degrees C and the measured geothermal gradient of 48 °C/km which is higher than the average UK geothermal gradient of 28 °C/km (Busby et al., 2011).
- The extent of collapse of workings and tunnels over a century is a challenge to predict and design a hydrogeological model. - Desk study, drill accurately, hit open and flooded workings and pump test.

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£6.5m for Caerau coal mine water central heating plan

19 January 2018

A public exhibition will go on show in the spring to people can find out about the project

A £6.5m grant has been awarded to pump naturally-heated water from an old coal mine and use it to heat 150 homes.

Bridgend council said the £3.4m scheme would extract water from the former Caerau colliery.

The cash is to develop and implement technology to pump water from a depth of 230m (750ft) which has been heated by the earth to about 20.8C (70F).

"It's a very prestigious project and I am proud it's happening in Bridgend," said cabinet member Richard Young.

A feasibility study is ongoing until the end of February and the British Geological Survey has tested the temperature, chemistry and volume of water available.

The scheme could eventually heat 1,000 homes and help cut energy bills in Wales' 10th most deprived ward.

It is hoped it will save people up to £100 a year as it does not require gas to heat the water.

Construction work is expected to start in 2020 with the first 150 homes being heated by winter 2021.

January 2018

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ITV REPORT 19 January 2018 at 11:35am

Water from disused Caerau Colliery to be used to heat homes

Water from a disused mine that has been warmed by the earth is to be used to heat homes in a valleys village, the Welsh Government has said.

The scheme described as "trailblazing" would use underground mine water from the workings of the old Caerau colliery, which closed in the late 1970s, to heat houses, a school and a church in Caerau in the Llynfi Valley South Wales.

On Friday, cabinet secretary for energy, planning and rural affairs Lesley Griffiths said the Welsh Government had awarded the project £6.5 million in EU funds.

“Our ambition is for our nation to be a world leader in pioneering low carbon energy. This is a cutting-edge model of generating a clean source of renewable energy, drawing on the legacy of our coal mining heritage.”

— LESLEY GRIFFITHS AM, CABINET SECRETARY FOR ENERGY, PLANNING AND RURAL AFFAIRS