Heating and Cooling with Minewater
A Guidebook for Decision Makers
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From fossil to renewable energy - Former mining areas as sustainable communities

Complex geological conditions and strict social insurance rules - mining history over the past decades has been marked by large-scale mine closures, Europe-wide. Ecological and social problems have followed: mineral-rich mine water threatens the ecological balance in mining areas and people’s health; increasingly high levels of unemployment and a lack of regular income lead to the desertion of mining communities, a decrease in the quality of people’s lives, and isolation from their country’s economic and social life.

Remining-Lowex – An opportunity for change

For communities that make use of the Remining-Lowex approach, abandoned mines are valuable: with their large volumes of water, these constitute a source of low valued geothermal energy and provide space for the storage of hot and cold water - water that Remining-Lowex uses for the heating and cooling of buildings.

Remining-Lowex presents an opportunity for former mining communities to use post-mining structures in a rational and sustainable way. By using mine water as a geothermal energy carrier and equipping buildings to cope with mine water temperatures for heating and cooling, the Remining-Lowex approach offers (former) mining communities numerous benefits. It can create jobs, have a multiplier effect on the local economy, provide a safe energy supply, and make communities less dependent on other energy sources. Reusing the mines can inspire social cohesion in former mining areas. By optimising buildings for low-temperature heating and cooling, the Remining-Lowex concept provides benefits such as a healthy indoor climate for occupants and lower energy costs for end users. A vital surplus: heating and cooling with mine water conserves the earth’s low running conventional energy resources and serves climate protection.

The positive economic, social and environmental effects of the Remining-Lowex approach are similar to those from other renewable energy sources such as solar or wind energy - but specifically for communities in European areas with mining activity (in the past). By implementing the Remining-Lowex concept, (former) mining areas can become sustainable communities, meeting the needs of present and future generations.

From black to green

The decisive factor for a nation’s economy and political strength is energy. Today, more than 80% of global energy production comes from fossil fuels, having turned the EU among other regions into a centre of power. At the same time, the increased combustion of fossil fuels since the beginning of industrialisation has led to a verifiable increase in global temperatures, endangering our climatic system.

Alternative, sustainable sources of energy need to be found. Besides other renewables such as solar, wind, hydroelectric power and modern biomass, mine water as a source of geothermal energy can reduce the dependency on fossil fuels and help combat climate change. The Remining-Lowex concept supports (former) mining communities in the reuse of mines and mine water thereby speeding the transition from black to green energy.
LowExergy - What it means

“Energy, which is entirely convertible into other types of energy, is exergy (high valued energy such as electricity and mechanical workload). Energy, which has a very limited convertibility potential, such as heat close to room air temperature, is low valued energy. LowExergy heating and cooling systems use low valued energy, which could also easily be delivered by sustainable energy sources (e.g. by using heat pumps, solar collectors or others).” (LowExergy Systems for Heating and Cooling of Buildings, Dietrich Schmidt and Mia Ala-Juusela, 2004)

Mine water & buildings - The workings behind Remining-Lowex

From the mineshaft to the building - How Remining-Lowex works

Abandoned underground mines are filled with large volumes of groundwater. With increasing depth, the temperature of rock and therefore of mine water rises: a typical heat gradient is 30°C/km depth. Common values are that about 16°C to 18°C can be found at 250 m and around 30°C at 700 m underground. Heated up by the surrounding rock, mine water can function as a source of low valued energy for the heating and cooling of buildings. Shallow water up to 15°C in temperature can be used to cool LowEx buildings, while deep water of at least 40°C can be used to heat LowEx buildings. Between these limits, additional processing is necessary to attain the required supply temperatures for cooling and heating. Common solutions for this post-processing are heat pumps and solar systems.

A site-specific concept must be developed to make use of mine water. This can range from a pumping station already operating, which delivers mine water...
to nearby building(s), to the drilling of wells to deliver the mine water to multiple buildings via a city-wide grid. The main components of a mine water system are: source - transport - energy user(s). The aim of Remining-Lowex is to balance these components.

Local experts such as geologists and engineers are involved in examining the local circumstances and providing a system set-up, containing an evaluation of:

- the mine water reservoir characteristics (temperature, volume, interference);
- the grid design, so the insulation of pipes, equipping against scaling, leakage and corrosion;
- the transfer points, such as an energy station with heat exchangers and heat pumps;
- the building measures to make the LowEx.

In parallel to this, financial and legal experts establish the conditions for exploitation.

To cover higher or lower temperatures e.g. for hot water or dehumidification of supply air, or to meet the needs of electricity use or generation, additional sustainable solutions need to be taken into account. One possibility is biomass combined heat and power stations, which can also deliver higher temperatures for domestic hot water.

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**Local Energy Systems**

Mine water is a local energy source which requires local application and therefore local energy systems. Mine water energy can be delivered to nearby buildings or production processes via a grid or district heating system.

A clear distinction should be made between direct heating and cooling buildings by mine water on the one hand, and mine water as a thermal half fabricate requiring post-processing on the other. Direct heating and cooling is highly preferable because of the high energy savings, the clear cost structure, low investments and reduced dependency on fossil fuel prices. To balance potential fluctuations in mine water temperature, post-processing by heat pumps is an option.

The layout of a mine water system requires a customised approach, especially with regard to how to bring together the producer of mine water energy and use of this.
(+ and -) features of common situations are:

<table>
<thead>
<tr>
<th>Supply side (mine water)</th>
<th>Open shaft for mine water extraction</th>
<th>New access necessary (wells to panels)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General characteristics</strong></td>
<td><strong>Demand side:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>supply side</strong></td>
<td>Example A (+) water properties and volume rate well known (+) extra benefits from pumping necessity (-) location, temperature, and volume of mine water supply is fixed (-) constant pumping 24/7 available?</td>
<td>(+) water properties known or easy to determine (+) often large volumes available (-) mix-up of cold and warm mine water (-) location and temperature of mine water supply fixed (-) additional pumping equipment and costs</td>
</tr>
</tbody>
</table>

| Single building, suitable for LowEx heating and cooling | (+) simple alignment of supply and demand (+) few parties involved (-) transport grid to fixed locations | (+) simple alignment of supply and demand (-) transport grid to fixed locations (-) scale of project in relation to earnings | (+) perfect alignment of supply and demand (+) compact, optimised transport grid (-) scale of project in relation to earnings |

| Multiple buildings with same energy profile, Suitable for LowEx heating and cooling | (-) transport grid to fixed locations | (-) transport grid to fixed locations | Example B (+) perfect alignment of supply and demand (+) optimised transport grid (+) large scale and spread of risks (-) many parties involved |

| Multiple buildings, with different energy profiles. Suitable for LowEx heating and cooling | (+) possibility of heat and cold exchange between users (+) large scale and spread of risks (-) complicated alignment of supply and demand (-) transport grid to fixed locations (-) many parties involved | (+) possibility of heat and cold exchange between users (+) large scale and spread of risks (-) complicated alignment of supply and demand (-) transport grid to fixed locations (-) many parties involved | (+) possibility of heat and cold exchange between users (+) large scale and spread of risks (-) complicated alignment of supply and demand (-) many parties involved (-) transport grid to fixed locations |

| Decision parties involved | mine water dehydrating company building owner(s) landowner(s) and governmental organisations for grid route | owner of the shaft and the mine water building owner(s) landowner(s) and governmental organisations for grid route | owner of the former mines and mine water building owner(s) landowner(s) and governmental organisations for grid route |

A typical Example A in the table above (single building connected to existing nearby pumping station) is the SRK’s project in Poland. The Example B is in fact the most complicated system, but is realised in Heerlen in the Netherlands.
“Mine water-proof” buildings - An integrated design approach

Integrated building design
A traditional design approach is often based on partial optimisation of the different disciplines. An integrated approach as in Remining-Lowex achieves total optimisation. It takes into account all disciplines and their interaction – mechanical, electrical, architectural and control designs.

Very low valued energy e.g. from mine water can generally be used for the heating and cooling of buildings. To cope with temperatures close to the required room temperature, buildings need to fulfil a number of boundary conditions:

<table>
<thead>
<tr>
<th>Boundary condition</th>
<th>Realisation</th>
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<tbody>
<tr>
<td>Limitation of heat loss</td>
<td>High thermal insulation</td>
</tr>
<tr>
<td>Limitation of ventilation losses and peaks</td>
<td>Airtight building with highly efficient mechanical ventilation or advanced natural ventilation</td>
</tr>
<tr>
<td>Limitation of solar and internal gains to limit cooling loads</td>
<td>External shading devices and extensive use of daylight</td>
</tr>
<tr>
<td>Suitable emission systems for low temperature heating and high temperature cooling</td>
<td>Emission systems like thermally-activated building components, floor and wall heating, concrete core activation</td>
</tr>
</tbody>
</table>

The aim: to construct energy-efficient buildings that can provide occupants with a comfortable, clean and healthy environment.

LowExergy systems can be applied to a wide range of buildings - new building stock and retrofits alike, including dwellings and offices, churches, concert halls and shopping centres. To gain full efficiency and flexibility, the LowEx principle should be integrated into preliminary drafts of the building design.

Today the total energy use in buildings accounts for more than one third of the world’s primary energy demand. Designing buildings in a ‘mine water-proof’ manner therefore contributes to climate protection.
Remining-Lowex & Trias Energetica

The Remining-Lowex approach is an example for Europe of how to apply an integrated design approach strategy by simply following the steps of “Trias Energetica”:

Step 1: Limiting the demand for energy - “What you do not need, you do not use”
Step 2: Maximizing the share of renewables - ”What is left to use, do it with renewables”
Step 3: Maximizing the efficiency of using fossil fuels for remaining energy demand - “What you cannot cover with renewables, do it with fossil fuels in the most efficient way”, limiting the temperature levels of heat and cold supply

The Trias Energetica concept - the most sustainable energy is saved energy

LowEx Approach

Looking at the energy efficiency of buildings, the current discussion is focused on quantitative aspects. Today, the primary energy demand is widely accepted and used to indicate the environmental impact of domestic energy consumption. This approach leads to a saving policy that can help reduce consumption of fossil fuels and help draw attention to renewable energy sources.

The neglected aspect within this discussion is the question of energy qualities. This quality aspect of energy based on the second law of thermodynamics is implied in the common experience of “energy loss” by using energy for heating and cooling purposes. Contrary to the first law of thermodynamics, energy resources are being consumed, and have to be replaced and paid for. Energy in the form of indoor air warmth transmitted through exterior walls and windows is irretrievably lost for our heating purposes.

The exergy balance puts these losses into figures and allows for the minimization of losses, which occur over the energy transformation chain. By taking into account the quality aspects of energy sources, it becomes possible to not only match energy quantities (which must be done in any case to ensure thermal comfort), but also to provide comfort using energy sources with similar qualities.
Financial and Economic Aspects - Recommendations

The economic feasibility of a mine water energy concept depends on many preconditions such as the:
- type of mine water application (e.g. use of heat pumps);
- effectiveness of pumping and distribution of the mine water;
- type of ownership of the wells and the buildings;
- cost of capital for the investments;
- cost of fossil energy and their future price development.

Considering the type of mine water application, different situations are possible:
- mine water is already available, for example through pumping;
- mine water should be extracted from galleries, in which case the drilling of wells is necessary;
- mine water can be extracted from shafts (that remain open).

The main cost aspects are the capital costs of the wells (if necessary), infrastructure and LowEx building services on the one hand, and the running costs for pumping, distribution and control on the other.

Depending on the kind of mine water reservoir and the location of the buildings, more or less investments have to be made in the:
- drilling and development of the wells;
- pumps and pipelines for transportation of the mine water;
- heat exchangers and filters to supply the building services with the energy;
- heat pumps and/or gas-fired boilers;
- management and control of the system.

Energy price trends - A favourable scenario for mine water

Probably the most important economic parameter is the cost of capital itself. The interest rate and additional costs of the investments can vary between 4% and 15%, and can therefore make or break a financial forecast. Since these kinds of energy systems have a long-term horizon, it cannot be combined with a short pay-back time. It is therefore highly recommended that a life cycle costing approach be used. From an economic point of view, the fuel mix of mine water, fossil energy and electricity gives some freedom in purchasing on the energy market. The electricity required can be generated by wind turbines, solar panels, etc. The price of gas in the Netherlands increased by 7% a year in the period between 2000 and 2009 in comparison to 4% each year for electricity for example. From an economic point of view, the common expectation is that the electricity price will stabilize because of larger (renewable) production facilities, and that the gas price will continue to increase (rapidly). This is a favourable scenario for mine water energy exploitation, which depends more on electricity and less on fossil fuels.

Business model - Recommendations

The business model and financial forecast for mine water as a commercial energy source is of particular importance. Ideally, all activities for the use of mine water for climate control in buildings should be controlled centrally. In practice, the pumping and distribution can be carried out by a different entity than the energy consumer. This requires clear assignments of tasks between the supply and demand side of mine water. Furthermore, the allocation of costs for optional extra investments such as back-up systems and low exergy systems requires negotiation between the supply and demand sides of mine water energy.

General recommendations are:
- an as small as possible distance between the mine water source and energy demander(-s);
- matching temperatures for mine water and building services (in general, only the latter can be influenced by LowEx emission systems);
- a clear business model and financial forecast appoints the economic and energetic return of the system.

Mine water - Reductions in costs and CO₂ emissions

Studies conducted within the scope of the Remining-Lowex project indicate a reduction in energy costs and CO₂ emissions of 20% to 40% in comparison to conventional, fossil-based heat and/or cold generation. The difference between the reference energy costs and the scenarios with mine water is in fact the available financial space for the mine water production costs and any extra investments needed for LowEx buildings.
Benefiting from Remining-Lowex

Remining-Lowex saves money - economic benefits

- Lower exergy consumption in buildings means a lower share of energy costs for the end user. The Remining-Lowex concept therefore supports the development and selection of new technologies: air tight buildings for the limitation of ventilation losses and peaks and mechanical ventilation with high-efficiency heat recovery ease the end users’ purses. The buildings’ integrated design complements this effect.

- Low-temperature heating systems are flexible and therefore sustainable and cost effective. Not bound to one particular energy source, they can utilise a variety of heat sources including district heat, biofuel, solar energy, gas, oil or electricity. In low-temperature heating systems, fuel switching entails only moderate costs and allows end users to choose - even after the planning phase.

- Low-temperature heating and high-temperature cooling can be combined in one emission system, i.e. no separate emission systems are necessary for heating and cooling. This can be a major cost benefit.

- The Remining-Lowex concept is economically feasible. Despite a rather high level of investments for energy installations and building measures, the system’s life cycle costs make the utilisation of mine water realisable. Private energy exploitation adds to this effect: the main investors will also conduct energy exploitation in a separate, privately-owned energy exploitation construction. Possibilities for economically-sound energy exploitation can occur through lower internal interest rates, profits from selling energy not as core business, or the raising of connection fees for heating and cooling.

Quality of life and pride - Local benefits

- Large-scale closures of mines lead to high levels of unemployment and a wide range of social problems in former mining areas. Sustainable redevelopment through the Remining-Lowex approach offers an opportunity to improve the quality of life in affected areas. The use of mine water as an energy carrier can stimulate the creation of new products and innovation in the region as well as cross-border collaboration with enterprises and knowledge centres. Young people can be motivated to get involved in the field, and can become dedicated and well-qualified personnel to continue and represent this new form of energy.

- Due to the large-scale closures of mines, people tend to feel a loss of their mining history and heritage, and a lack of respect from others. By using mine water to supply and store the energy of the future - in an environmentally-friendly and economical manner - the Remining-Lowex approach can enhance mining communities’ social cohesion and pride in their heritage and in achieving a sustainable future. Remining-Lowex supports regions linked to energy from mining industry in the reclaiming of their role as energy suppliers, including the possibility of creating new jobs.

- The Remining-Lowex approach gives the opportunity to draw upon local miners’ knowledge of the land, mines and water in the mines. Since mine water is highly site-specific, local people can provide much needed information and experience. The importance of this experience gives the local population stability and provides them with an income.

Sustainable communities

Sustainable development is development that meets the needs of the present generation without compromising those of future generations. Sustainable communities are communities planned, built, or modified to promote sustainable living. They are more environmentally-sound, economically prosperous, and socially equitable.
Health & Comfort

- Due to higher radiant temperatures, low-temperature heating systems allow for a decrease in room temperature by a few degrees, which is more energy efficient and healthier for occupants. They provide a high level of ambient indoor air quality, a reduction in draughts and dust, and fresher air.

- Due to climate change, poorly insulated buildings in Europe are expected to overheat more often, with negative effects on people’s health. Integrating heating and cooling into one emission system in combination with low valued heat sources and the heat pump concept can be profitable - both economically and in terms of health.

Sustainable and flexible - Environmental benefits

- In many cases, abandoned mines have problems with flooding and rising water levels, meaning mine water has to be pumped out to avoid flooding of nearby areas. The need to drain water from abandoned mines is turned into an opportunity when the thermal energy of mine water is used as a source for heating and cooling.

- The Remining-Lowex approach is in accordance with the Kyoto Protocol and the Renewable Energy White Paper. By exploiting geothermal energy from mine water for heating and cooling, Remining-Lowex fundamentally supports the transition from fossil fuels to sustainable clean and non-exhaustive energy. It can spur former mining areas to become sustainable communities.

- Mining areas are ideal locations to combine energy from mine water with other renewables and residual heat. The almost infinite volumes of mine water can be used for heat and cold storage. By storing and regaining a surplus of heat or cold limitlessly and at any time, mine water can balance energy supply and demand throughout the year, providing ultimate efficiency for every sustainable energy concept.

- More than one third of the world’s primary energy demand is used in buildings. With buildings optimised for low-temperature heating and high-temperature cooling, environmentally friendly LowExergy heating can be used - a significant contribution to climate change mitigation.

Remining-Lowex contributes to European climate protection targets:
20 + 20 + 20 by 2020

Remining-Lowex contributes to the comprehensive EU climate and renewable energy package. It is designed to reduce carbon dioxide emissions by 20%, increase the share of renewable energy in the energy mix by 20%, and improve energy efficiency by 20% by 2020. Remining-Lowex can help communities go well beyond the agreed 20 / 20 / 20 targets.
Forerunners in Remining-Lowex - Heerlen, the Netherlands

Heerlen is a municipality in the former mining region of South-East Limburg known as Parkstad Limburg. Due to coal mining activities, Heerlen expanded quickly in the early 20th century, with 90,000 inhabitants living in the municipality today. Heerlen’s mines were closed in 1976, since which time the former mineshafts have filled with geothermally-heated ground water that can be used for both the heating and cooling of buildings.

Following technical and economic feasibility studies concerning the use of mine water in 2003, two projects were implemented in Heerlen: the Mine water Project and Remining-Lowex. Both are important elements in the city’s overall policy for reducing energy consumption and consequent carbon emissions by integrating new and more sustainable types of energy.

The Heerlen demonstration site includes a large number of new buildings such as apartments, offices, public buildings, schools and health facilities as well as existing non-residential buildings.

Geothermal mine water for heating and cooling - 3 locations in Heerlen

Heerlerheide Centre
The Heerlerheide Centre is situated on the concession of the Oranje Nassau III pit in a relatively deep-mined area with warm wells of almost 30°C. The plans include 330 dwellings, commercial buildings, public and cultural buildings, health care and educational buildings. The first new building and construction activities in Heerlerheide Centre started in 2006. The total plan is to be realised between 2006 and 2011. All planned buildings are connected to the heating and cooling energy supply from mine water.

Water from the energy station runs through an embedded hydraulic piping system under the floor of the Heerlerheide Centre, a new functional complex for residential use. The Centre also contains a library, supermarket, conference room and café. To provide warmth, the water’s energy activates the thermal mass of the floor. Even the heat produced by the supermarket’s chilled cabinets is delivered back to the energy station. To gain additional energy, solar cells are to be integrated in the buildings’ window shades, moving in accordance with the position of the sun.

All buildings are positioned in a very compact area - ideal for energy distribution - and are situated between two warm wells. The planned building functions require heating as well as cooling. The energy supply includes the construction of an energy station and a small-scale distribution grid from this station to the buildings. In the energy station, mine water is brought to the necessary heating and cooling levels by heat pumps. An important fact: with minor modifications, the energy supply can also be functional and operational without the application of mine water.
Stadspark Oranje Nassau (SON)

The development of Stadspark Oranje Nassau is of a strategic significance to the social and economic rehabilitation of Heerlen. This plan is realised in combination with sustainable mobility and accessibility. The total programme contains the Central Bureau of Statistics' (CBS) new office building (21,000 m²), a new office at Zeswegen (17,500 m²) and a computer data centre, which has a high demand for cooling. The new CBS office was completed in 2009 and is connected to the mine water grid. Measurements confirm good indoor air quality and, in spite of large windows, good thermal comfort.

Educational campus

This location contains four schools. Arcus College’s new building will be connected to the mine water grid, hence the grid will be extended. A biomass plant will provide electricity and high-temperature heating for the older buildings (1980s and 1990s). Renovated buildings will be cascaded in a mini district heating grid and use the moderate return temperature of the old buildings for heating. The mine water will heat and cool the new LowEx building.

APG Dutch Pension Fund head office

This location concerns the retrofitting of the APG head office of 41,000 m². The entire building envelope is retrofitted to a level better than the current Dutch Building Decree values for new buildings. Mine water can be used for low-temperature heating and high-temperature cooling in all offices. The emission systems in the offices are climate ceilings. Special glazing is used to limit solar radiation in summer, making it possible to use high-temperature cooling.
Zagorje ob Savi

Zagorje is a town and a municipality near Ljubljana in central Slovenia. It is located in the valley of the Medija Creek in the centre of Slovenia. The town is home to 7,000 people; the total population of the municipality is 17,000. In 1755 coal deposits were discovered in the area, which heralded the start the town’s economic development. Coal mining was one of the area’s main activities until 1995 when the last mines were closed. To balance the process of mine closure, the town tries hard to improve financial conditions and consequences from mining, as well as to replace the community’s lost income. At the same time, Zagorje was one of the most severely polluted towns in Slovenia. Pollution is caused by prolonged usage of fossil fuels for industry and local heating systems, reinforced by Zagorje’s natural characteristics - a particularly narrow valley.

In the Remining-Lowex project, the community studied the possibility of exploiting locally-available energy sources in detail and has already developed an energy plan. The potential of renewable energy sources in the community and energy efficiency measures in public buildings were investigated, first retrofitting of buildings was implemented on the basis of this investigation (Kisovec kindergarten, cultural centre and municipality headquarters) and public building managers were given training. At the same time, the existing biomass plant’s grid was extended to the health service, and part of the biomass district heating grid under the new roundabout was refurbished. The first solar power plant in the city was built and is now in operation.

The activities, presumably implemented by Spekter, will demonstrate low-energy construction, state-of-the-art solutions as well as the refurbishment of some older multi-family buildings in the Polje district. In the first phase, live energy monitoring of 3 public buildings will be undertaken, and energy accounting of all public buildings in the municipality introduced. Warm mine water from the well will be used for demonstration mobile living units, where LowEx technologies and RES utilisation will be shown in real scale. In the coming years, mine water will be used for the Toplice swimming pool, which is to be built in connection with a new gym and Tone Okrogar building.
Associated locations in the Remining-Lowex project

In Remining-Lowex, Bulgarian and Polish cities and entities are involved as associated, non-investment partners. The partners’ aim is to work on the potential utilisation of mine water and to demonstrate the feasibility of using mine water for the heating and cooling of buildings. The result will be a business case of the pilot locations.

Bulgaria

Cherno More mine is located in the south-eastern part of Bulgaria to the north-west of Burgas city. The mine consists of three coalfields - “Brigadir”, “D.Blagoev” and “9.IX.” which were abandoned after more than 50 years of exploitation between 1972 and 1988. The main objectives for Cherno More mine within Remining-Lowex are:

- to demonstrate the potential of coalmining areas to develop into a sustainable community based on local renewable resources;
- to assess and demonstrate the economy of sustainable systems and to show that it is possible to ensure the integration of a renewables and urban planning approach into the revival of post mining areas;
- to accomplish a sustainable urban plan and energy vision for the area.

Potential consumers for low-temperature heating are a private furniture factory located near the “9.IX.” vertical shaft, as well as several public buildings (school, kindergarten, municipality, post office and cultural centre) located in Cherno More village to the north of the “9.IX.” mine. Due to favourable climate conditions, Cherno More mine provides good conditions for a complex use of renewable sources - geothermal, solar and biomass.

Poland

The city of Czeladź as well as two Polish entities, namely the University of Silesia and the coal mine restructuring company, are associate partners in Remining-Lowex. Czeladź is one of the oldest towns in the Upper Silesian Coal Basin as well as in Poland. The town is located in the centre of the region, in the Silesian conurbation near its capital Katowice. The conurbation is home to a population of 2,770,000.

The town covers an area of over 16.4 km² with a population of about 34,000 and is one of the most densely-populated towns in the whole country. Until the early 1990s, the town’s economy was based on heavy industry and coal mining. Czeladź was the first town in the Upper Silesian Coal Basin to close all coal mines. During the first few years, the closure dramatically affected the local economy and labour market. Following the major economic shift, the town is still undergoing a transition process. The economy is currently based on trade and the service sector.

There are two possible sites where mine water can be used: the new housing estate planned for the south-eastern part of Czeladź as well as modernisation of the dehydration company’s central plant office. Both these locations are situated close to the Pawel shaft, where mine water is still pumped out of the mine.
Remining-Lowex in Spain - Coal mining company conducts first follow-up project

Hunosa is a public coal mining company located in Asturias in the north of Spain. The company runs six large underground mines, a washing plant and a power station. The company’s research department attempts to obtain some added value from different sources related to the mining activities. One of the new resources was low valued energy from mine water. The company planned to take advantage of the mine water to supply heating and cooling to the local population and industrial districts by using heat pump technology. The use of mine water was envisaged to make the pumping necessary to avoid the flooding of buildings sustainable in economic and environmental terms.

In a large coal field with 70 shafts and 300 mountain mines, detailed studies showed favourable technical and geological circumstances for a first pilot project: two new buildings in their early stages of construction located just 250 metres from a mineshaft. Following installation of a pumping system in the shaft, a water distribution system to the buildings, and heating and cooling generation systems, a research centre and university hall of residence can now use mine water for both heating and cooling. Energy savings through the geothermal system are estimated to amount to around 71% compared to traditional energy systems, CO₂ savings to around 49%, and annual cost savings of a minimum of 15%.

In a next step the “Alvarez Buylla” public hospital was provided with geothermal services. Resulting energy savings are estimated to amount to around 73% for heating and to around 51% for cooling.
Implementing Remining-Lowex - 9 steps to proceed

Remining-Lowex saves money, benefits health and the environment and boosts the quality of life in former mining areas. The following schedule represents a roadmap for the implementation of Remining-Lowex.

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<tr>
<th>Step</th>
<th>Details</th>
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<td>1</td>
<td>Engage the whole community, many of whom are former miners</td>
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<tr>
<td>2</td>
<td>Examine local geology and former mines</td>
</tr>
<tr>
<td>3</td>
<td>Develop building energy systems for optimal use of the resource</td>
</tr>
<tr>
<td>4</td>
<td>Balance supply and demand</td>
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<tr>
<td>5</td>
<td>Assess exploitation parameters</td>
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<td>6</td>
<td>Assess feasibility</td>
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<td>7</td>
<td>Assess financial parameters</td>
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<td>8</td>
<td>Found legal entities for mine water operation</td>
</tr>
<tr>
<td>9</td>
<td>Contract</td>
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</tbody>
</table>

- **Step 1:** Engagement of the whole community, many of whom are former miners
  - Awareness of mining heritage for future energy supply
- **Step 2:** Examination of local geology and former mines
  - Simulations and reservoir models in combination with old mine maps to determine drilling locations
- **Step 3:** Development of building energy systems for optimal use of the resource
  - Distribution: low-temperature heating and cooling distribution system
  - Close location of wells and end users located to avoid necessary permits (archaeological, flora and fauna, civil infrastructure) and minimise costs for pipe infrastructure.
  - Water/LowEx proof buildings: extra thermal insulation, airtight building, energy efficient ventilation systems, low-temperature heating, high-temperature cooling systems, limitation of internal and solar heat gains in summer
- **Step 4:** Balancing supply and demand
  - Temperature levels of supply (mine water)
  - Energy profiles of buildings and other users
  - Energy quantities (heating and cooling)
- **Step 5:** Exploitation parameters assessment
  - Definition of energy plant and building services
  - Demarcation of boundaries of the system (transfer point production and consumer)
  - Volumes of investment
  - Return of investment
  - Economic life span
- **Step 6:** Feasibility assessment
  - Calculations with exploitation models: business plan
  - Sensitivity analyses: investments, energy prices, pumping costs
- **Step 7:** Financial parameter assessment
  - Settlement of reference energy costs
  - Settlement of GJ prices for heat and cold
  - Settlement of connection fees for heat and cold
  - Settlement of standing fees
- **Step 8:** Founding of the necessary legal entities for the operation of the mine water system
  - Investigation of legal structures
  - Inventory of possible participants
  - Formation of legal entities, this can be for example a mine water production company and exploitation company(s)
  - Billing and customer care
  - Possibilities for (up)scaling
- **Step 9:** Contracting
  - Negotiations with possible customers
  - Settlement of final delivery contracts
Involving stakeholders - Remining-Lowex communication plan

Technical and financial aspects aside, the success of Remining-Lowex depends on the motivation, collaboration and commitment of local stakeholders, citizens, and the occupants of mine water buildings. To raise awareness and ensure participation of all relevant parties including end users, Remining-Lowex recommends creation of a communication plan.

Target groups can be local, regional and national authorities, investors in buildings and residences, organised interest groups such as environmental or science groups, tenants and users of buildings with mine water heating and/or cooling, or the general public.

Suggested content for a Remining-Lowex communication plan:

- In-depth information for all stakeholders and citizens about the project including its European dimension and contribution to EU policies on energy and climate change, as well as the planned activities in the respective community;
- Additional specified information with implications and opportunities for individual groups (landlords, tenants, local businesses), in particular on the plans regarding energetic upgrading of buildings/demand measures;
- Involvement of local citizens groups or initiatives, and joint development of the participation process based on pre-existing communication structures among the occupants and/or by setting up new working or focal groups, offering specific participation opportunities for urban development;
- Realisation of the participation process, providing stakeholders and citizens with the opportunity to comment on the planned activities and to develop their own initiatives in addition to these, the aim being to not only consider specific needs of individual groups, but also to create a new identity among the occupants.

Various means of communication can be used: info guides, information on websites, mobile presentation systems, free publicity, gadgets, a logo, personal information and consulting/advice for (potential) tenants and users, instruction brochures, a guided tour of the power station, or meetings.

To support key actors involved in the building process on their way to energy transition, an advanced training course can be offered in Remining-Lowex communities.
Remining-Lowex project profile

Four ambitious local communities, Heerlen (the Netherlands), Zagorje (Slovenia), Czeladz (Poland) and Bourgas (Bulgaria) demonstrate the use of locally-available low valued renewable energy sources, specifically from water in abandoned mines for the heating and cooling of buildings. The system is based on LowExergy principles, facilitated by an integrated design of buildings and energy concepts. They have developed two sustainable mining communities (Heerlen and Zagorje) with a 50% to 100% reduction in CO₂ and 60% renewable energy systems (RES) compared to standard national practices.

Expert contacts

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Remining Lowex presents an opportunity for former mining communities to use post mining structure in a rational and sustainable way: The use of minewater as energy carrier may bring positive results for society and economy, rehabilitate social life and improve health for communities living in European areas with (former) mining activity.

www.remining-lowex.org