Contents

Landscape Design 2
Visions and Plans
Developing the Forest 8
Reforestation
Establishing Agricultural Land 14
Agricultural Land Recultivation
Protecting the Environment 22
Land Restoration and Wildlife Conservation
Reforming with Water 28
Water Resources Management
Using the Resources 36
Renewable Raw Materials
Experiencing the Landscape 42
Lignite, Art and Culture

Recultivated Land

Mine Recultivation in the Lusatian Lignite Mining Region
This is the dichotomy the people here have been living with for centuries and continue to live with. The resource provides warm homes, employment and a living, yet digging for lignite interferes with the natural cycle of both man and the environment, it changes the habitats and transforms cultural landscapes.

In the Lusatian mining region, Vattenfall is responsible for both the mining and refining of this domestic resource as well as for land recultivation after mining.

The result is a new landscape.

Mining also always provides us with an opportunity to redesign landscapes.
Every year, some 500 hectares of land are claimed by mining with the same amount simultaneously being recultivated.
Landscape Design
Visions and Plans

The Lusatian Mining Region

Summer in Lusatia: a golden landscape with fields of rye and wheat, paths meandering across the countryside, a group of cyclists enjoying the panoramic view from one of the numerous vantage points. The green of the densely forested region pleases the eye, as does the blue of the chain of Lusatian artificial lakes.

Forests, fields, meadow, orchards, heath lands, gardens, nature trails, habitats for hoopoes, wolves and partridges, biotopes that are a refuge to endangered species such as spring cinquefoil, veronica and the sticky catchfly, memorials commemorating relocated villages, adventure playgrounds for children, cycle paths and sandy beaches extending for kilometres on the shore of the future Cottbuser Ostsee lake: All this can be experienced in the Lusatian post-mining landscape. This list is by no means complete, as many projects are still awaiting completion.

Projects such as the revitalisation of the “Hühnerwasser” stream and the nature reserve “Hermansdorfer See” near the town of Weißwasser are likewise evidence that land recultivation carried out is more than just the restoration of post-mining landscapes according to set requirements.

The “Energiewald Welzow” short rotation forestry producing biomass for the neighbouring cogeneration power plant and the “Wolkenberg” hill with its vineyards yielding the grapes for the Brandenburg regional wine, are an obvious reality.

Close to 30 million trees and shrubs were planted on Lusatian post mining sites over the course of the past years. Many of these trees were cultivated out of acorns collected from century old oaks.

Recultivation is more than simply “adding grass” and that is exactly why land recultivation requires time.
The first forested mining dumps in the region originated – initially without human hand – from the end of the 19th century. Seeds carried by the wind, birch trees, pines, aspens and robinias settled on the abandoned areas and pit heaps. Nature helped itself. It was only around 1900 that so-called works gardeners, later succeeded by foresters, endeavoured to rehabilitate the areas where the coal was no longer extracted.

These days, the demands on post-mining landscapes are higher than ever before: They have to provide a living environment, in particular, one that can be used in a sustainable manner, that is of ecological value, typical of Lusatia as a region and one that is versatile.

Even so, the regional landscape is changing considerably. Where once farmers ploughed their fields, today tourists swim. The pine forests were substituted by species-rich mixed forests. Specific mining technology and special land reclamation technologies now render it possible to convert plains into flat-topped hills, to create catchment areas for water bodies or leisure parks for recreational sports. The manner in which land is utilised has changed, not only dictated by the new site conditions on a mine dump but also increasingly on grounds of societal demands being placed on the new land.

Transforming Landscapes

Without receiving any subsidies Vattenfall extracts some 60 million tonnes of lignite annually from opencast mines.

At the same time, the expanses claimed by mining are being recultivated.
Not a single tonne of coal is mined without prior fixed plan of how to compensate for the impact caused by mining in the existing landscape. In Germany, it is mandatory to have an operating plan for all mine operators. This plan is only granted approval with proof of the fixed plan and the manner in which the land will be rehabilitated after mining.

### Statutory Basis for Mining and Land Recultivation

This is stipulated by the German Federal Mining Act (Bundesberggesetz). It constitutes the most important basis for any kind of mining activity and defines rehabilitation as the structuring in proper form of expanses claimed by mining under due consideration of the public interest.

This is reflected in the state planning lignite plans. These are part of overall regional planning and are binding declarations at governmental level. The mining regulations framework operation plans, which are based on these regional plans, already make stipulations regarding the design of the future post-mining landscape in addition to practical specifications as regards the avoidance, minimisation or compensating for environmental impact.

The complete set of approval papers also includes environmental sustainability studies. These provide the basis for environmental impact assessments within an approval procedure. All documents required for this purpose are compiled in cooperation with independent assessors, scientific institutions and expert planning offices. During this process, the pre-mining condition of the landscape is compared with the planned post-mining landscape.

Both the compilation of lignite mining plans and the approval of overall operation plans are linked to environmental assessments.

Areas under ecological field research of approved opencast mines in the Lusatia mining region.
Approximately 30 million trees have been planted since 1994.
Developing the Forest

Approximately 30 million trees have been planted since 1994.
A forest does not grow from one day to the next. It is usually tended to by many generations of foresters. The establishment of a new forest, the planting of the one- or two-year old trees, is a special moment for every forester. In contrast to a natural assemblage of forest trees and plants, the young growth on post mining areas has to cope with extreme conditions. The challenges include a lack of water, absence of soil organisms and the extremely exposed position, to name only a few.

The relatively young forests in the Cottbus, Spremberg and Weißwasser area are evidence that species-rich forests featuring a large percentage of deciduous trees are able to grow on post mining areas. Well-designed forest margins, special biotopes or the adoption of old fruit tree cultivars dispel the preconception of pine monocultures being typical of the Lusatia region.

“In keeping with the natural appearance of a forest the indigenous species should be given preference when selecting trees and shrubs. As long as the conditions on site and the forest management and ecological development objectives allow for this, approximately fifty percent should be deciduous trees.”

Guideline issued by the Mining Authority of the Federal State of Brandenburg (Landesberamt) regarding the rehabilitation of land affected by mining activities, June 2001.

The chart shows the natural forest structure in Lusatia (according to Prof. Hoffmann 1987) and the targeted tree species distribution for Vatterfall.

- Pine 29%
- Pine/pedunculate oak 30%
- Pine/sessile oak 25%
- Ash 8%
- Alder 4%
- Pedunculate oak 2%
- Wetlands 2%

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<td>Robinia</td>
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Recultivation by planting forests aims at a species-rich mixed forest.
The Mark Brandenburg Pine in Good Company

Recultivation offers the unique opportunity to recreate large scale forests. Approximately 30 million trees have been planted on Lusatian post mining area so far. These have been grown mostly in regional forest nurseries.

In accordance with several programmes for the maintenance and utilisation of forest genetic resources for forest management in Lusatia, sprigs from old oaks are taken prior to commencement of opencast mining and the acorns from centuries-old trees are collected to provide a basis for new crops. In addition to pines, the local mixed forest landscape features sessile and pedunculate oaks, birches, small-leaved limes, hornbeams and shrubs.

Rare types of cypresses can be admired in the post-mining landscape of the opencast mine Welzow-Süd: Giant sequoias grow near the vantage point on Stradower Berg hill, symbolising as “living fossils” the origins of lignite. These giant redwoods constituted much of the forest during the Tertiary geological period. A species of sequoias from China was very common in Lusatia some 17 million years ago. Geologists continue to find traces of redwood in the Lusatian coal seams. The three solitary trees near Spremberg were planned as a landmark for generations to come when lignite is no longer mined.
Forest History: A Small Excursus

Brandenburg more than 10,000 years ago:
The last glaciations spell in the late Pleistocene period is over and it is getting warmer again.

Very slowly forests grow, first with birches and pines establish themselves. As yet, forests are still open. Masses of hazel bushes are spreading. Slowly in this time more demanding deciduous trees establish themselves. Some 2,000 years later, an oak forest interspersed with elms, limes and ashes covers the Brandenburg landscape. This period coincides with the so-called Holocene climatic optimum, during which the average annual temperatures were significantly higher than today.

The ground water level rises as well. Forests of alders settle in depressed areas and river valleys. They will characterise the lower regions of Brandenburg well into the time of mediaeval forest clearances. This was also the time when the first European beeches and hornbeams appeared in the area.

The transition from the hunter and gatherer civilisations of the Mesolithic era to those developing farming and stock breeding during the Neolithic period has long since taken place. For a while both ways of life existed parallel.

Now, about 1700 BCE, the climate is growing colder again. This coincides with the Bronze Age. The forests of European beeches and hornbeams grow larger.

As late as in the early Slav Middle Ages, the clearing of forests was limited to the immediate area around settlements. Only from the 12th century onward are the forests transformed to become cultivated landscapes. During the High Middle Ages, the landscape is rendered almost free of forest due to large-scale, unregulated forest clearing until the time of a planned forest management is introduced in the modern era.

Susanne Jahns, Brandenburg Federal State Office for the Preservation of Monuments and Archaeological State Museum
About 1,600 hectares of agricultural land have been created on former mining dumps so far.
About 1,600 hectares of agricultural land have been created on former mining dumps so far.
Establishing Agricultural Land

Establishing New Land for Lusatian Farmers

Approximately a tenth of the total post-mining landscape will provide a livelihood for farmers in the future. The objective of agricultural land recultivation is to promote soil genesis processes in order to establish sustainably fertile production areas.

An industrial region with a rural appeal: A fitting description for Lusatia. Besides the tradition of lignite mining there is also a tradition of agriculture and stock breeding. The best example in recent history is the Spreewald, with its vegetable farming, which is evolving to become the larder of Berlin.

Agriculture is to continue to feature in the region in the future as well. In the past year alone, 120 hectares of agricultural land was created in the Lusatian mining region. This is a dimension that even surpasses the size of the Branitzer Park by 20 hectares.

The post-mining landscape of the open-cast mines Welzow-Süd and Jänischwalde offers particularly favourable conditions for agricultural areas. The declarations of intent, which already regulate the transfer of almost 2,000 hectares of post-mining land are evidence of how highly desired these areas are by regional agricultural cooperatives.

After land recultivation has been completed, farmers will be offered the land as leaseholds, with an option to purchase.
The Soil
A foundation to create a new, usable land

Land is the foundation for life.
Man live both on the land and off it.

Compared to natural soil structures, the raw soil from mine dumps is free of humus. Soil biological processes have to develop first and there is no influence of ground water. Soil substrates favouring plant growth are a rare feature of mine dumps. For the most part, they consist of tertiary sands often containing iron sulphides. With weathering of sulphides there is an acidification of the substrates. So as a result it is difficult to grow anything on this soil.

Fertile layers are added to improve the properties of the soil. Soil geological site investigations determine where and how to ameliorate. The objective is to develop sustainable humus. The agricultural area should be of at least the same quality as was the agricultural land of the old sites. A seven-year crop rotation system developed by the Research Institute of Mining Landscapes Finsterwalde registered association (FiB) has proven itself successful.

The Creation of Agricultural Land

1. Dump substrates suitable for agriculture are deposited, forming a two metres thick fertile layer.

2. The terrain is levelled and shaped taking the slope necessary for drainage and land plot sizes appropriate for the future farming activities into consideration.

3. The substrate is ameliorated by applying additives such as lime, mineral and organic fertilisers during the optimal vegetation periods.

4. Soil genesis is activated by sowing an initial crop of a seven year crop rotation system.

5. Small structures, such as windbreaks, dead hedges and erratic boulder fields are integrated predominantly with the purpose of providing protection from erosion, yet which at the same time fulfill the environmental protection demands and provide the landscape with aesthetic features.
The establishment of agricultural land on mine dumps is an important for retaining the rural areas in the region. Soil quality is the core issue here.

Searching for alternatives to conventional soil enhancers and fertilisers, the scientists from the Research Institute of Mining Landscapes Finsterwalde registered association (FIB) have introduced the mining professionals to “terra preta”, a type of black soil from the Amazon Basin. This, originally more than 2,000-year old, fertile mixture of organic materials, charcoal and potsherds has for a long time already been praised by experts in the field as a “miracle soil” and saviour of critical soils.

A research project under the expert guidance of the FIB will establish, whether this also applies to sites in Lusatia and in how far such substrates influence soil performance and plant growth in the process of agricultural land recultivation post-mining areas. The trial area is located in the post-mining landscape of the opencast mine Welzow-Süd.

The project “Application of terra preta in plant cultivation on low yield sites in Lusatia as an integral component of innovative, sustainable land and material management” is funded by the German Federal Ministry of Education and Research. It is scheduled for a period of four years and is thus embedded in the joint research project LATERRA until autumn 2014.

Terra preta (Portuguese for “black earth”) is the term for an anthropogenic (from Greek ánthropos “human”, denoting anything developed, made, caused or influenced by humans) soil from Amazonia.

Terra Preta:
Research for Practical Application

The establishment of agricultural land on recultivated post-mining areas with modern, soil-care machinery.

Left: The farmers cultivate their future leaseholds on recultivated post-mining areas with modern, soil-care machinery.

Right: The approx 160 hectare agricultural land on the Stradower Höhe is now ten years old. It is cultivated by a local agricultural holding.

Terra preta (Portuguese for “black earth”) is the term for an anthropogenic (from Greek ánthropos “human”, denoting anything developed, made, caused or influenced by humans) soil from Amazonia.
New Prospects

**Brandenburg Wine from Wolkenberg Hill**

The example of Welzow-Süd proves that the new land also offers prospects for modern viticulture. Here landscape designers looked for historical elements to symbolise the history of the region in the post-mining landscape.

Historical records, map material and the Geisendorf vineyard wall quickly pointed to the local tradition of winegrowing. Combined with the efforts on the part of various stakeholders in revitalising viticulture in Brandenburg, the concept of establishing vineyards in the post-mining landscape was born.

The first vines were planted on a test area of only 0.25 hectare in the spring of 2005. Both the plants’ resistance against frost and the water available on the dumps had to be examined. Two years later, the first grapes were harvested in August. The harvested grape varieties were Merzling, Ortega and Rondo. The quality of the grape juice was in order, proving that the trials were successful. The path to planning a vineyard on a large scale was open.

In addition to legal considerations, the type of soil, relief of the terrain and its exposure to the elements was relevant in planning an economically viable plantation of sufficient operational size. To develop the area on the long term, the choice of grape variety and soil needed to be coordinated with the climatic conditions and the cultivation strategy.

In the interim Wolkenberg GmbH manages the vineyard consisting of some 26,000 vines growing on the southern slope of the hill of the same name. The maiden vintage in 2011 yielded a total of 360 kilogram of grapes. A full yield is only expected in the coming years. In future, the vineyard could yield up to 9,000 litres of regional wine per hectare.
Red Wines
• Cabernet Dorsa
• Rondo

White Wines
• Pinot gris
• Red Riesling
• Pinot blanc
• Schönburger
More than 50 animal species have been provided with a new habitat in the renaturalized Spree flood plains.
Protecting the Environment

More than 50 animal species have been provided with a new habitat in the renaturalized Spree flood plains.
Land Renaturation and Wildlife Conservation

Man Made Home

Thousands of species make up the flora and fauna of Lusatia. Many of these have found their habitats in the post-mining landscape. Whereas in previous years activities concentrated on the development and integration of individual biotopes, now large interconnected areas are being created that will, in future, be reserved exclusively for nature conservation.

New nature conservation habitats intended for specific species are being established on about 15 per cent of the total post-mining area. Even animals, which do not feel comfortable in the cultural landscape influenced by Man, find a home here.

The restored post-mining areas attract not only the European hare, but also kingfishers, partridges and quail. Immigrants such as wolves find a refugium in the landscape still under development. The skylark will find what has become scarce elsewhere: wide open land with little agricultural activity.

Other birds favouring open habitats, such as the Tawny Pipit and the Northern Wheatear, "migrate" along with the opencast mines, as do insects and migrating amphibians favouring raw soil and warmth. Tiger beetles, red-winged grasshoppers (Oedipoda germanica) and the European green toad are quick to populate the young post-mining landscape.

Birds of prey, such as white-tailed eagles, red kites and members of the crow family (corvids), use the landscape as resting sites. Pioneering plants, such as grey hair-grass, dwarf everlasting, rare algae and mosses, rapidly grow on any site, no matter how extreme.

Left: The Whinchat, a severely endangered species in Brandenburg, is frequently seen resting in the post-mining landscape, in particular during the late summer.
Nature has many colonization strategies. Yet not every species can apply these without help. So-called stepping stone biotopes assist colonization on post-mining land. They create a spanning bridge between the original breeding grounds or sites on the margins of the opencast mines and the new habitats. Depending on the respective species’ radius of action, small biotopes are established, which are then interconnected by way of designed fringing areas. These can consist of deposited dead wood, a stone heap or a band of dead hedges. Sometimes, it cannot be avoided that specific species from the land designated for opencast mining require targeted transfer to compensation areas. The expert term for this is “rescue and relief relocation”. Forest ants migrated from the forest clearance areas preceding mining activity and the Great Crested Newt and sand lizards likewise find a new home on post-mining land.

In order to protect the habitats of flora and fauna in the area around the opencast mines, Vattenfall employs an additional special satellite aided monitoring system. More than 43,000 hectares are captured by the Geographical Information System (GIS). Together with the terrestrial images taken in the context of environmental protection monitoring activities, the impact both within and outside the mining excavation areas can be carefully assessed.

Land Restoration for Diversity

With the partial depositing of heath land soil and trimmings rich in seeds on former mine dumps local indigenous endangered species, such as Cheddar Pink (Dianthus gratianopolitanus) and Spiked Speedwell were successfully established on raw soils. Monitoring activities will now assess the sustainability of these measures. Renaturilized areas of land such as “Nagola” on the dumps of the opencast mine Jänschwalde are important landscape elements in the post-mining landscape. The lignite mining plan Jänschwalde assigned an area totalling 1,200 hectares for this purpose. Accordingly, some 15 per cent of the previous area of the opencast mine will be kept free of intensive utilisation during land recultivation. Open land embedded in near-natural forests is to develop here. Such areas are primarily designed for wildlife conservation. They are not only potential propagation areas and stepping stone biotopes for endangered species and other wildlife, but they also provide opportunities for interaction with the surrounding areas.
Environmental Protection on “Lake Hermannsdorf”

A mosaic of landscape structures that are distinctive - not only from an environmental protection point of view - is being created on the inner dumps of the opencast mine Nochten south of the town of Weißwasser. The newly designed habitats for rare animal and plant species are linked together with a stretch of original Muskauer Heide heathland and a lake.

The entire terrain stretches over almost 15,000 hectares. Inlets, islands, shallow and deep water areas, dry grassland, sandy heathland, juniper, pines and mixed deciduous forests: Almost all of this will be here in the future post-mining landscape of the opencast mine Nochten. The “Hermansdorfer See” lake is a large body of water in the Lusatia mining region, which will be reserved exclusively for nature conservation purposes. With a surface area of 256 hectares, it will be larger than the Berlin Tiergarten park.

In contrast to the opencast mine lakes of the Lausitzer Seenland (Lusatian Lake-land), the “Hermansdorfer See” lake is an environmentally protected lake that is being created parallel to the active opencast mining.

Work on the lake began in 2005 by sealing the northern and eastern shores. Then the southern bank was created, featuring a promontory and two islands as special refuge areas for birds. The creation of the initial moorland “Neue Jeseritzen” with its catchment area to the south of the lake was quite spectacular. A total of 5,000 cubic metres of peat were deposited here to create a new habitat for rare plants from the former original moors. This pioneering moorland is almost two hectares in size and its water catchment area encompasses more than seven times that area. The peat came from the “Großer Jeseritzen” moor.

In the interim, the western shore of the lake is likewise beginning to take shape, structured by woods and small copses of trees. The bordering open land is intended as a habitat for the Black Grouse. The lake will be flooded in the coming year. Then the European main watershed between North Sea and Baltic Sea that formerly passed through the opencast mining area Nochten will have been restored.
Each year, the rivers Neisse, Spree and Schwarze Elster receive some 300 million cubic metres of water from the opencast mines.
Reviving with Water
Water and coal are an ambivalent combination: Water signifies danger in the pit and at the same time it is indispensable for designing the post-mining landscape. For safety reasons the lignite reserves must be free of ground water.

Consequently the excavation area is dewatered by the miner. A funnel shaped area of lowered water level is created, extending beyond the boundaries of the actual opencast mine. About six to seven cubic metres of water have to be pumped out in order to obtain one tonne of coal. Almost unnoticeably, this water is purified again at another site and then fed into the rivers Spree, Schwarze Elster and Neisse.

The pit water by then has become ecological compensatory water. With an iron content of two milligrams per litre it definitely complies with the high requirements for a flowing body of water in good water status. Thus the water that was lost due to mining is returned to streams, rivers and wetlands.

With this support of the local and regional hydrological balance periods of low water levels in the Spreewald are compensated for and the agricultural land benefits. Mining even provides parks and natural conservation areas with this principle element of life.

Ponds, pools or Cottbuser Ostsee Lake: The principle element of life, i.e. water, has returned to the post-mining areas. By the time mining ceases the proportion of aquatic usages in the post-mining landscape will rise from one to 25 per cent, with the lakes created from flooded former opencast pits. Even on post-mining land it is already apparent that the region lives up to its name. Lusatia, Sorbian Łužica, originally referred to low-lying land, swamp-land or simply wet meadow.
If one were to trace back the path of water in the post-mining landscape, it begins with a targeted depositing of soil.

Spreaders shape the dump’s relief: Gentle hills and valleys extend across vast expanses, transition areas to the natural surroundings are created and slopes are shaped. The targeted inclusion of layers of clay and soils, rich in loam, creates artificial water catchment areas and keeps moisture on the dumps.

Aquatic systems are constructed from top to bottom. Initial sites for moors are established like this even without man’s intervention. Water from precipitation collects in the depressions. It all starts with one or two puddles, an enticing resting place for little ringed plovers and species of water striders, and suddenly there is a small body of water.

The dump geometry determines not only the general durability and future direction in which the water flows as well as the susceptibility to erosion, but significantly influences also the economic usability of the natural environment and hence the diversity of biotopes and species on the recultivated land.
Some years ago, the “Hühnerwasser” stream was created in the post-mining landscape Welzow-Süd. It was named after an old stream in the vicinity of Spremberg.

The site is made up of two layers with the help of opencast mining equipment: A clay layer in the substratum which retains seepage water and a 3.5 metres thick sand layer above, in which the ground water body is held.

Scientific interest focuses in particular on the shaping of the surface and its colonization by plants and animals.

“Zero Hour” at the “Hühnerwasser”

Due to the fact that the area is left to natural succession from the beginning, it provides scientists with diverse opportunities to research the initial phase of ecosystem development as of a clearly defined “zero hour”. The artificial water catchment area is used as a model and is continuously and intensively monitored.

To date, more than 130 species of plants have been counted in the “Hühnerwasser” stream. Moreover, investigations are concentrated on soil development changes and the origin of symbioses in a small pond within the area.

Up to now, interdisciplinary ecological research work has only been possible on a small scale in a laboratory. The six hectare large research area now provides worldwide unique conditions for such environmental research.

The “Hühnerwasser” project is a joint undertaking of the BTU Cottbus, the Technical University Munich and the ETH Zürich technical university in cooperation with Vattenfall.

The six hectare large, artificially created “Hühnerwasser” stream was transferred for research purposes to the BTU Brandenburg University of Technology Cottbus in summer 2008.

Since then, scientists from various countries have been investigating how a new ecosystem develops on the sandy soils. A comprehensive measuring programme has already compiled valuable scientific information.
Towards the late 1980s a roughly six kilometre long stretch of the river Malxe, East of Cottbus between Bohrau and Heinersbrück, was dried up for coal mining purposes. Now, once again, water will flow in the Malxe, based on its original course. The construction site for re-establishing the river was opened in November 2011.

However, important safety and securing operations must first be completed before the reconstruction process for the flood plain displays visible contours. Over the course of the next few years, the river bed substratum will be stabilised by vibro-compaction section by section, as it is close to the ground water.

Following that starting points for nature will be fixed. Predominantly indigenous flora and fauna should find conducive conditions to establish themselves and flourish. In the future, the Malxe valley will be embedded in a 1,200 hectare large land rehabilitated area.

The “Neue Lugteich” pond: compensation and substitute site for endangered plant and animal species. This is where the miners acquired their first experience in creating artificial water catchment areas.
Recultivated Land

Building sealing walls to protect the environment. Original biotopes can thus be conserved although coal is being mined in the immediate vicinity.

The Spree River near Cottbus: formerly a straightened, regulated waterway, soon to be once again a near-natural river with flood plains. Vattenfall is restoring an 11 kilometre long section of the Spree flood plain by way of a compensation measure.

Document for the planning application “Post-mining landscape Jänschwalde”, project reconnection of the Malxe river.

Building sealing walls to protect the environment. Original biotopes can thus be conserved although coal is being mined in the immediate vicinity.
Each year, approximately 3 tonnes of biomass per hectare are harvested on the trial field of the “Energiewald Welzow”.
Using Resources

Each year, approximately 3 tonnes of biomass per hectare are harvested on the trial field of the "Energiewald Welzow".
Renewable Raw Materials

Energy Forests on Post-mining Areas

Since the mid1990s research has been carried out in cooperation with partners from scientific institutions to investigate alternative forms of land use of former mining dumps that do justice to both ecological demands and economic aspects. What began as a field trial has now established itself as an economic pillar of support for local farmers: Biomass on dumping sites creates impulses for regional added value and is an attractive alternative to traditional soil mediums.

There is no energy supply more natural than wood. As traditional forests alone cannot satisfy the demand for wood for energy applications, so-called short rotation coppices producing biomass in a sustained manner have been established. Trees of the kind being planted in such energy forests are only grown for about three to six years before they are harvested. Experts call this the rotation period. By contrast, the forester in a standard forest determines the rotation period for a relatively fast growing spruce to be 80 to 120 years, whereas a sessile oak can survive several generations of human life spans.

Two research areas on Lusatian post-mining land demonstrate that renewable raw materials offer not only economic advantages, but also the opportunity to improve the ecological value of a given site. On the site of the opencast mine Jänschwalde, scientists and farmers developed and evaluated the increment of growth of fast growing types of trees in combination with arable crops, whereas a traditional short rotation forest in the opencast mine Welzow-Süd yielded very promising results.

Trees such as robinia and poplar, which are cultivated both in pure short rotation coppices and in combination with arable crops, have stood the test of time in land recultivation practice.
The “Energiewald Welzow” situated in the post-mining landscape of Welzow-Süd is about as large as the island of Helgoland. The 170 hectare area was established in 2005. Each year, about 10 to 20 hectares are harvested, with the proportion rising. The first harvest in February 2009 yielded about 20 tonnes of biomass per hectare. This corresponds to about three tonnes of dry matter per year for this portion of land.

One of the customers is the biomass co-generation power station close-by at the resettlement site Sellessen near Spremberg, which in addition to providing district heat for all public buildings as well as for numerous private homes and rented accommodations produces electricity from renewable energy sources.

A joint project of the BTU Cottbus, Chair of Soil Protection and Recultivation, the Mitteldeutsche Bergbau-Verwaltungsgesellschaft LMBV (Central German Mining Administration Association), Vattenfall and regional farmers, the “Energiewald Welzow” is an example of a successful cooperation between science, research and practical application. Some of topics focus on including research on characterising the conditions on site, investigations into plant nutrition and fertilisation as well as growth and yield. Moreover, the scientists work together with experts from the agricultural machinery construction industry to optimise harvesting techniques. The re-conversion of an area planted with short rotational tree types for conventional agricultural utilisation is likewise part of this research project.

**Energy Wood Harvesting**

Converted field choppers cut robinias and chop up the wood into pieces of three centimetres. The tree stumps sprout new growth in spring, which can be harvested again after four years. Such a coppice forest can be maintained over a period of three decades.

**Robinia (Robinia pseudoacacia)**

In Brandenburg, robinias populate an area of more than 8,000 hectares. This is more than half of those to be found in the whole of the Federal Republic of Germany. It is an energy plant with an extremely high calorific value. Its straight trunks can grow up to 20 metres in height. The stress-resistant robinia is particularly well suited for dry sites.
Alley cropping, a form of agro-forestry, is a method of using land to produce biomass. Its main characteristic is the joint cultivation of trees or shrubs and arable crops on the same field.

Agriculture and forestry alternate strip by strip: Agricultural crops (cropping) grow between swathes of fast growing tree types (alleys). These cultures mutually benefit each other.

Already in 1996 a trial field of about 10 hectares was established in the opencast mine Jänschwalde. Here, the experts from the BTU Cottbus and the agricultural co-operative Heinersbrück researched which fast growing types of trees would prove particularly productive under the given climatic conditions in Lusatia. The experiments included rye, robinias and poplar clones. The combination of poplar with rye proved to be the most promising.

On all investigated alley cropping fields results were achieved corresponding to those of a short rotation plantation.
Several 100,000 guests visit the Lusatian mining district each year.

Experiencing the Wonderful Landscape
Lignite, Art and Culture

Old New Lusatia

Every second recultivated hectare of the lignite industry in Germany is located in Lusatia. Over the course of the past two decades some 12,000 hectares of land have been recultivated here by miners and remediation experts. The total combined area of all parks, gardens, animal enclosures, green spaces and playgrounds in Brandenburg is only a fraction larger.

Upon cessation of activities, the mining industry will leave behind a landscape clearly emulating the state prior to industrialisation. Even so, the recultivated landscapes will not be merely a copy of past cultural landscapes.

The leisure grounds around Cottbus, Spremberg and Weißwasser, already now give a first impression of what is to come. An active guest would require weeks or even months to explore and do everything that is on offer.

On land, waterways or from the air: Lusatia provides a highly diversified experience. Some marvel at the giants of technological engineering, others enjoy the well developed network of cycle paths and opportunities for water sports. Cross country runners compete on the Bärenbrücker Höhe. Ornithologists offer guided walks to see the bird life in the post-mining landscape.

Even romantics are rewarded in the mining district. They enjoy the evening of readings at Gut Geisendorf, the Lusatian lignite cultural forum, or the Shakespeare performance at the amphitheatre against the backdrop of the Senftenberger Lake. No lengthy explanation is required: It quickly becomes apparent that all which represents Lusatia – the language, culture, landscape – is characterised by lignite.
Glück auf to Visitors!

Each year, some 80,000 interested people visit the area to learn about the technical processes of lignite mining, coal refining and power generation. About a third of these visitors are experts, 25 per cent are classes of school children. Some even travel across continents, such is their interest and curiosity.

The technical dimensions and extent of changes to the landscape can be seen from the freely accessible vantage points on the edges of the opencast mines. Those wishing to find out more will be well rewarded by visiting the numerous information centres, public exhibitions or the Knappenrode Energiefabrik museum. This aforementioned facility provides a vivid impression of the history of mining in the region and the miners’ everyday life as well as getting to the root of the legendary “Kumpeltod” spirits. It houses also the largest exhibition of fireplaces and ovens in Germany.

By contrast, those daring to walk across the open grating decks of the exhibition mining equipment F60 in Lichterfeld move across the largest mobile technical facility in the world. The Bergbautourismusverein Welzow (mining tourism association) promises surprise discoveries, for instance, by inviting grown-up and young adventurers to join a small picnic in the pit by the coal face.

The excavation of lignite has also uncovered erratic boulders, witnesses of the last ice age.

In the Saxon town of Nochten, near the Boxberg power plant, about 6,000 of these erratic boulders scattered across an area of nearly 20 hectares can be admired. Embedded in natural gardens, this creates a changing tableau of rocks and flowers throughout the years. The fascinating winter heath is succeeded by the exotic blossoms of succulents, carnations and rhododendron bushes, making visitors forget that they are walking on the recultivated mining land of the opencast mine Nochten.

This terrain is seamlessly connected to a mountain bike trail, a sledge slope and an adventure playground. Those who are looking for more sports activities are invited to cycle along the network of cycle paths from the Erratic Boulder Park Nochten via the Upper Lusatian Heath and Lakelands and the Erlichthof in Rietzchen to the Neisse river. A detour along the Hermannsdorfer cycle path leads directly to the vantage point - Turm am Schweren Berg. Vattenfall’s communication and nature conservation centre.
From Mining District to Lakeland

“Blue eyes of Lusatia”: This is the name given to the post-mining lakes. About 30 lakes with a total water surface of 14,000 hectares will shape the face of the future Lusatian Lakeland. Some of these will be interconnected via navigable canals. More than a dozen lakes from the future “Lusatian Lakeland Chain” will join the list of the 50 largest lakes in Germany.

The Knappensee, a lake near Hoyerswerda and the Senftenberger See in the vicinity of the district town of the same name, are considered pioneers of the opencast mine lakes. They welcomed their first bathers already 40 years ago. Yet the tourism-related use of a large number of current land reclamation projects began only approximately one decade ago. Since then, water sports activities are on offer at many of the sites. Bituminised paths around the lakes attract cyclists and skaters. One of the first floating houses of the Federal State of Brandenburg provides a base for dives into the underwater world of the former pits.

Currently the youngest lake still under construction is the Cottbuser See situated in the post-mining landscape of the opencast mine Cottbus-Nord. Its lake bed will continue to grow until excavation ultimately ceases here. Since 2009, the miners have simultaneously been creating sections of shore, sandy beaches and paths. As of 2018, the first water will be fed into the future 1,900 hectare large lake. By 2028/2030 it is expected to be finally opened as a bathing paradise.

Remediators and Lake Builders

In the mid-90s, on behalf of the federal government and the federal states the Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft (Lusatian and Central German Mining Administration Association), LMBV for short, took over the land remediation and rehabilitation of discontinued opencast mines and refineries in the Lusatian and Central German lignite mining district. Since then, some 100,000 hectares of mining land have been transformed into nearly 50,000 hectares of near-natural areas and forest and into 27,000 hectares of water bodies. 60 per cent of this area is located in Lusatia alone. The remediation and flooding of lakes in opencast mine pits, as well as the building of navigable connections between the water bodies combine to create the largest artificial water landscape in Europe with an area totalling 7,000 hectares.
Glossary

**Overburden** | Layers of soil, such as gravel, sand, clay, which has to be moved to expose the seams of lignite in an opencast mine. Also called “spoil above the coal”.

**Overburden conveyor bridge (short: OCB)** | High-performance assembly of opencast mining machines for removing the overburden - predominantly used in the Lusatian mining district. OCBs can remove, transport and dump soil layers of up to 60 metres in one process step. This exposes the coal seam. Overburden conveyor bridges of the F60 type are more than 600 metres in length and are considered to be the largest movable technical industrial machines in the world.

**Spreader** | Opencast mining machine for the dumping of overburden; deposits fertile soil layers on dumping sites and shapes the area relief for the post-mining landscape.

**Accompanying growth** | Total ground vegetation accompanying a forest plantation. It can consist of natural accompanying vegetation and/or the artificially disseminated protective plant cover. It protects the ground from erosion by wind and water, counteracts the leaching of nutrients and augments the soil with organic matter.

**Biotope** | The uniform habitat or site of a community of organisms (biocoenosis) that is clearly differentiated from neighbouring biotopes, with a regularly returning community of species (plants and animals) comprising all abiotic environmental factors affecting the community of organisms. On recultivated land, a site fulfilling the above criteria, which is suitable for the settlement of such communities of organisms.

**Soil** | Biologically active uppermost weathered layer of the lithosphere; the climate-induced conversion product of mantle rock and bedrock.

**Erosion** | Leaching, degradation of the earth’s surface by the destructive influence of water, ice and wind.

**Compensation** | If the impact suffered by nature and the landscape cannot be compensated for but is allowed, the causal party has to re-establish the destroyed values and functions of the ecosystem in similar manner elsewhere in the region affected by the interference (compensatory measures). The manner and scope of compensatory measures are to take into account the stipulations of landscape planning.

**Monitoring** | Continuous observation of abiotic and/or biotic factors and compartments to control the state of the environment.

**Landscape** | A section of the Earth’s surface that is characterised by structure (landscape appearance) and function (landscape ecosystem) and is perceived as a unity.

**Ecosystems** | Structural, functional and production units in which biotic and abiotic factors interact; an ecosystem is the unity of organisms within a biocoenosis and of the environmental factors affecting the corresponding biotope including the interactions within.

**Land renaturation areas** | A term introduced by the current lignite mining plans of the Federal State of Brandenburg denoting areas in the post-mining landscape where biotope and species protection is given precedence over other land uses.

**Protective vegetation** | Diverse functional plantings (e.g. hedges) using indigenous plants suitable for the site, which protect the soil and the vegetation on it (e.g. agricultural crops) or residential areas from extreme influences, in particular from wind, and which at the same time prevent negative biocoenotic effects and promote soil fertility and the natural potential of the landscape to flourish.

**Succession** | The succession of plant communities as a consequence of the close interaction between the plant community and site factors.

**Rehabilitated areas** | Areas which have been restored in a proper way for the intended use as stipulated in the operating plan. A distinction is made between rehabilitation for agricultural, forestry, or hydrological uses.

**Target species** | Species or groups of species that are representative of a landscape and the preservation of which is a designated target of nature conservation measures. The development of a landscape can be evaluated on the basis of their demands on the living environment.
Mining Cultural Landscape

Points of interest between forest, fields and lakes

- Restored Spreeau flood plain
- Bärenbrücker Höhe
- Milleniumshain
- Hain der Feuerwehrleute
- Cottbuser Seerunde (cycle way)
- Cottbuser Ostsee
- Buckwitzberg - ornithologists’ meeting point
- Vineyards
- Energy forest
- Hühnerwasser stream on Wolkenberg
- Stradower Höhe with a protective dyke system
- Neuer Lugteich - nature conservation area
- Steinitz Cultural park
- Gut Geisendorf
- “Excursio” visitors’ centre
- Forest railway
- Ancient oaks’ gene conservation project
- Turm am Schweren Berg (vantage point)
- “Green classroom”
- Restored Malxe flood plain
- Look out area on depot
- The Nagola renaturation project
- Historico-cultural orchard
- Wildlife species diversity conservation projects
- Spreyer Höhe
- Nochten Boulder Park
- Quad bike tours