Coal & Coke Catalogue
New World Resources Plc (‘NWR’ or the ‘Company’) is one of Central Europe's leading hard coal and coke producers.

The Company produces quality coking and thermal coal for the steel and energy sectors in Central Europe through its subsidiary OKD, a.s. (‘OKD’), the largest hard coal mining company in the Czech Republic. NWR’s coke subsidiary, OKK Koksovny, a.s. (‘OKK’) is Europe’s largest producer of foundry coke.
OKD, a.s.

OKD is the only producer of hard coal (bituminous coal) in the Czech Republic. Its coal is mined in the southern part of the Upper Silesian coal basin, in the Ostrava-Karviná district. Mining is carried at four mines – Karviná, Darkov, ČSM and Paskov. OKD is engaged in coal prospecting, mining, processing and refining. The company sells hard coal with a low content of sulphur and other materials. The hard coal sold by OKD can be used for coking as well as in the chemical industry and other sectors.

OKK Koksovny, a.s.

OKK Koksovny, a.s., is the leading European producer of coke and the largest producer of foundry coke in Europe. The company performs its business activity in the Svoboda Coking Plant in Ostrava, which enables the company to effectively supply coke to significant industrial entities in the Czech Republic and neighbouring countries. More than 65% of its production is designated for export. The company produces a wide range of coke types used in the foundry industry, special and other metallurgy, chemical industry and heating sector.
The cokeability of a coal is determined from demonstrable plasticity within a certain temperature interval, during which its structure and chemical composition change (while releasing some of the coal constituents). The end product of these changes is a fuel with a whole new quality – coke. The cokeability is the given degree of coalification and the petrographic composition of the coal.

Degree of coalification – this quality is usually expressed as the content of volatile matter ($V_{daf}$), or as the light reflectivity of the vitrinite content (a hard coal constituent visible under the microscope). The greater the volatile matter content, the lower the degree of coalification. In the case of vitrinite light reflectivity, the lower the reflectivity, the lower the degree of coalification.

Petrographic composition is determined by the given composition and qualities of the original plant material and by the conditions that influenced the formation of the coal stratum and the process of its coalification.

The above properties determine whether a coal is suitable for coking or for use in the energy sector.

Coke production

The following “coking parameters” are monitored for coal suitable for coking:

- Swelling index (SI)
- Dilation (dil$^b$)
- Volatile matter content ($V_{daf}$)

Coal can be further classified according to the particular values of the above parameters.

Coking coal – typical for its low volatile matter content with a high swelling index. It is indispensable in the manufacturing of blast-furnace coke and foundry coke.

Fat coal – typical for its high degree of dilation and plasticity. It is in high demand for coking charges.

Gas coal – this type of coal has a high volatile matter content and negative degree of dilation.

The Czech part of the Upper Silesian Coal Basin (more than 75% of the basin’s area is in Poland) contains coal reserves that are of good quality in terms of both coking characteristics and sulphur content. The actual manner of utilisation of the extracted raw material is determined by its specific qualities, according to which it is used as either coking coal or thermal coal.
Coal for the energy sector

A coal's suitability for use in the energy sector is primarily determined by the following parameters:

- Calorific value \( (Q_i) \)
- Sulphur content \( (S^d) \)

Preparation stages for thermal coal

**Washed thermal coal mix** – This a product of coal washing used in large energy facilities, cement mills, blast furnace and PCI (pulverised coal for injection) facilities.

**Washed and sorted thermal coal** - This a washed coal sorted by grain size (10-30 mm, 30-50 mm, 30-80 mm, 50-200 mm) for use in the civil sector, for household use and in sugar refineries.

**Coal dust** - The product of the separation of 0-20 mm coal grains before the process of coal washing. It is used by large power generation plants and in large energy-consuming operations.

**Middlings** - A product of coal washing, with a higher ash content.

**Coal from Karviná strata** - Coal of a medium coalification. The Karviná strata contain both coking and thermal coals.

**Coal from Ostrava strata** - Coal of a medium to high coalification, mostly suitable for coking purposes.

**Coal preparation**

The market value of coal depends not only on its innate properties but also on the degree of preparation. At OKD, coal is prepared for the market in preparation plants. The main task of the preparation plants is to approximate the ash and moisture contents of the supplied coal to the requirements of individual customers.

**Coal suitable for coking** - A washing preparation removes any tailing residues and lowers the ash content to below 10%, a prominent factor for the quality of the final product – coke.

**Thermal coal** - Prepared and mixed in accordance with the needs of the end users, and particularly in accordance with the characteristics of their combustion facilities.

OKD mines coal from the Karviná and Ostrava strata. They differ in terms of the height of seams and the degree of coalification.
## Qualitative parameters of produced coal

### Thermal coal

<table>
<thead>
<tr>
<th>Type</th>
<th>Grain size</th>
<th>W&lt;sub&gt;t&lt;/sub&gt;</th>
<th>A&lt;sub&gt;d&lt;/sub&gt;</th>
<th>V&lt;sub&gt;daf&lt;/sub&gt;</th>
<th>Q&lt;sub&gt;i&lt;/sub&gt;</th>
<th>S&lt;sub&gt;t&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mm)</td>
<td>%</td>
<td>(MJ/kg)</td>
<td>(%)</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Washed thermal coal mix</td>
<td>0-30(60)</td>
<td>8.0-10.0</td>
<td>7.5-8.5</td>
<td>27.0-30.0</td>
<td>28.0-29.0</td>
<td>0.50-0.60</td>
</tr>
<tr>
<td>Washed and sorted thermal coal</td>
<td>10-30</td>
<td>4.0-6.0</td>
<td>5.0-6.5</td>
<td>28.0-32.0</td>
<td>31.00-32.0</td>
<td>0.60-0.70</td>
</tr>
<tr>
<td></td>
<td>30-50</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>50-200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal dust</td>
<td>0-20</td>
<td>8.0-10.0</td>
<td>20.0-26.0</td>
<td>25.0-32.0</td>
<td>23.00-25.0</td>
<td>0.60-0.70</td>
</tr>
<tr>
<td>Middlings</td>
<td>0-30</td>
<td>10.0-14.0</td>
<td>38.0-45.0</td>
<td>29.0-30.0</td>
<td>15.00-18.0</td>
<td>0.60-0.80</td>
</tr>
</tbody>
</table>

### Coal suitable for coking

<table>
<thead>
<tr>
<th>Grain size</th>
<th>W&lt;sub&gt;t&lt;/sub&gt;</th>
<th>A&lt;sub&gt;d&lt;/sub&gt;</th>
<th>FSI</th>
<th>dil.b</th>
<th>S&lt;sub&gt;t&lt;/sub&gt;</th>
<th>P&lt;sub&gt;d&lt;/sub&gt;</th>
<th>Fmax</th>
<th>CSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mm)</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>0-50(80)</td>
<td>9.5-11.5</td>
<td>7.5-9.0</td>
<td>4.5-7.5</td>
<td>25-70</td>
<td>0.60-0.70</td>
<td>0.010-0.090</td>
<td>50-500</td>
<td>45-69</td>
</tr>
</tbody>
</table>
Explanation of symbols used

Designation of analytic indicators

The analytic indicators are comprised of the following:

- a symbol describing the basic indicator of the fuel
- lower index, supplementing the description of the basic indicator
- upper index, specifying the condition of the fuel in relation to the indicator
- original condition of the fuel – upper index “r” (from the term “received”)
- analytic condition of the fuel – upper index “a”
- moisture-free condition of the fuel – upper index “d” (“dry”)
- combustible content of the fuel – upper index “daf” (“dry ash free” – for fuel free of ballast materials, i.e. ash and water)

Explanation of symbols:

$W_{t}^{r}$ – total water content in the original sample (as received) – lower index “t” = “total”

$A^{d}$ - ash content in moisture-free condition

$V_{daf}$ – volatile matter content (content of volatile substances in the combustible component)

Dilation $b$ - the degree of change in volume during the heating of the coal under specific conditions until it reaches plasticity

$F_{\text{max}}$ - maximum fluidity (maximum RPM speed of the rheometer plate)

$SI$ - swelling index – the capacity of coal to increase its volume in its plastic state

$Q_{r}^{t}$ – calorific value (combustion heat minus the heat of water evaporation)

$S_{t}^{d}\text{max}$ - maximum content of sulphur in any form

$P^{d}$ - phosphorus content
Quality control in the production of solid hard coal fuels is applied in all four of OKD’s mines, and takes place from the moment that the preparation of the coal blocks is commenced underground, through the mining and extraction from the mine, to the processing in the preparation plants and the distribution to customers.

These activities are performed by employees of the Quality and Control Departments situated at each of the mines. In order to ensure the best possible execution of the process, each of the departments is equipped with a modern laboratory.

Quality control comprises two main processes - fuel analysis and gas analysis.

The first analysis focuses on analysing the fuel-related properties, i.e. determining the contents of moisture, ash, volatile matter, sulphur, carbon, hydrogen and nitrogen, and determining the caloric value, swelling index (SI) and the swelling index as determined by a dilatometric test. Other analysed parameters include ash fusion temperatures and grain size analyses.
The second process, gas analysis, concentrates on examining gases present in the atmosphere down in the mine, and in the degasified product of atmosphere extracted from the mine - determining the ratios of O\textsubscript{2}, CO, CO\textsubscript{2}, CH\textsubscript{4}, H\textsubscript{2}, plus dust content ratios as part of dustiness authorisation. All OKD laboratories operate in accordance with the relevant Czech ČSN standards, with their practice regularly checked for correctness by international inter-laboratory analyses. Moreover, the laboratory at the Karviná Mine is accredited for conducting fuel analyses.

The collecting of samples from underground ensures the verification of the basic qualities of the extracted coal in terms of chemical and calorific properties for the purposes of coke production and energy generation, in accordance with the relevant standards. The samples collected are subsequently processed and analysed in laboratories. The results obtained then determine whether the extracted commodity will be refined at a preparation plant and used as coking coal or as thermal coal.

The production processes and quality are continuously checked throughout the preparation facilities by controlling systems, which monitor the conditions of the operating technologies in real time and feed information on performance and quality from commercial-grade rail and road weigh bridges, ash gauges, conveyor scales, and online analysers used to determine the content of ash, moisture, sulphur and calorific value, as well as other from other measuring instruments. Measuring devices and analysers are subject to regular checks and reviews in accordance with the relevant metrology codes of operation. The complete information system provides a comprehensive overview of the condition of processes and ensures consistency in maintaining qualitative parameters of coking coal, as well as a complete range of thermal coal types.

When loading fuel deliveries for individual customers, sampling takes place in accordance with the relevant standards. This process is performed by automatic or mechanical samplers. The samples collected are verified mainly by online analysers and are subsequently analysed in fuel laboratories. The laboratory results are used as a basis for the evaluation of the quality of the deliveries. The loaded fuel deliveries are weighed using road or rail weigh bridges. In the case of a complaint by a customer, this system enables the searching of the archive for the day, shift, time and place of loading, including the employee responsible for the loading.
Coke

Informative data on coke

OKK Koksovny, a. s., is a supplier of the complete range of coke types and of other products generated by processing virtually all types of coal suitable for coking. The coal is obtained from both OKD and foreign suppliers, e.g. from Poland or overseas. Coke from OKK is suitable for special metallurgy, heating and other purposes.

Metallurgical coke

| Blast furnace coke | Grain size 25 - 90 mm |
| Blast furnace coke | Grain size 40 - 90 mm |
| Blast furnace coke | Grain size +80 mm |

Blast furnace coke

Blast furnace coke is used mainly as a reducing agent and a heat source in blast furnaces. It also acts as a carrier and filling material in which gas circulates through the blast furnace charge column.

| Foundry coke I | Grain size +100 mm |
| Foundry coke II | Grain size 70 - 130 mm |
| Foundry coke III | Grain size 60 - 90 mm |

Foundry coke

In terms of its qualities, foundry coke is similar to the blast furnace variant. Foundry coke is currently not only used for cast iron production; it is also a highly sought-after fuel in the production of basalt-based insulation materials. Compared to blast furnace coke, foundry coke differs primarily in its higher rigidity and higher lumpiness. The comparably higher quality of foundry coke makes it suitable for the production of pig iron. On the other hand, blast furnace coke is not suitable for the smelting of cast metals without prior adjustments in the full range to the smelting technology.
Heating coke

A cheap and environmentally friendly fuel with a broad range of applications. Heating coke is an excellent fuel for the economical production of heat and the heating of utility water for households, businesses and thermal heating plants, especially in locations lacking the possibility of long-distance heat or gas distribution. The heating power of 28 MJ/kg of heating coke exceeds the heating power of all other conventional solid fuel sources. With respect to the low pollutant content, heating coke is an environmentally friendly fuel, meeting stringent environmental limits.

Chemical products of the coking process

The coking process yields a number of by-products that are important input materials in the chemical industry. Coal gas is captured during the coking process, with individual chemicals subsequently separated from the gas.

OKK Koksovny, a.s. offers its customers:

- Coke-oven gas
- Tar
- Benzol
- Ammonium sulphate
- Solid sulphur

In 2011, OKK Koksovny a. s., produced:

- 295,8 mil. m³ of coke-oven gas
- 22,500 tonnes of anhydrous tar
- 7,400 tonnes of raw benzol
- 1,900 tonnes of ammonium sulphate
- 600 tonnes of sulphur

Technological coke

Partially-nut sizes O1, O2 - see also heating coke.
The OKK laboratory and quality control

The OKK laboratory is divided into four sections (entry and output checks, laboratory and special analyses). All four sections are mutually interconnected, with processes seamlessly passing from one to the next, forming a comprehensive environment for laboratory and verification activities required for faultless control of technological processes in the production of coke and related chemical products. The whole laboratory operation must provide real-time information on the quality of both entry-level, intermediate and output processes, utilised by technology specialists at individual production centres and by other employees at various levels of control and management, ensuring conditions necessary for smooth production.

The entry checks focus on determining the quality of coal supplies. Samples are collected, processed and prepared for various assays to determine qualitative parameters of received types of coal, suitable for coking. Automatic samplers are used to collect samples of individual coal types as well as of the final mix to be charged in the coking ovens. Sample collection is performed for each shift in accordance with the coal unloading schedule and the coke production programme.

The entry checks include sampling of the entry material upon unloading, as well as of individual constituents used in the preparation and mixing of the coal charge. The ready coal charge is sampled again when leaving the coal-side service. These activities and analyses must be performed in real time, since quality protocols and goods samples arrive at the laboratory with a delay of as many as five days.
Analyses of entry raw materials (coal, chemical substances) are important in terms of ensuring quality production at a plant, and the results of such analyses are required before the analysed materials enter into the production process.

**Intermediate analyses** in the laboratory aim to obtain necessary data on raw material flows in individual technology units and extend to the quality monitoring of wastewater and coal gas used as a heat source, as well as analyses of tar, benzole, ammonium sulphate and sulphur. Chemical analyses also include monitoring for the safe technological operation of the coking plant, safeguarding the employees’ health and protecting the environment.

The **output checks** focus on monitoring the quality of manufactured products and they take place during each shift as a part of product dispatching to customers. Extra analyses are performed at regular intervals (daily averages, ten-day analyses, aggregate samples, etc.). The most important analyses in the production of coke include the determination of the CRI\(^1\) and CSR\(^2\) parameters, which alongside other qualitative parameters provide the customer with a comprehensive picture of the coke quality.

All the above-mentioned laboratory activities are rigorously governed by valid standards applicable to individual analytic methods, from the sampling of input raw materials, through their processing to the final determination of the quality parameters of the products desired by customers.

The laboratory participates at regular intervals in interlaboratory calibration (also known as ring tests) to verify the accuracy of its laboratory methods. Testing protocols issued by the ring test organisers (e.g. ICHPW Zabrze, Technical Standardisation Centre TEKO-Prague) that certify participation in the tests document the laboratory’s place among reliable and accurate facilities in the determination of the CRI and CSR parameters, and the contents of moisture, ash, sulphur, and volatile matter, as well as the heating value and dilation.

The laboratory is equipped with high-quality apparatuses for the individual assays, which ensure accuracy and the reproducibility of the assays.

The laboratory is also equipped with a new x-ray fluorescence spectrometer, SPECTRO XEPOS, used for analysing coal and coke ash, and a gas chromatograph, MASTER GC, used for analysing coal gas and benzole. These new devices enable the laboratory to maintain its competitive advantage by providing analyses demanded by the coke and chemical markets, something which has become a standard service offered by sophisticated independent laboratories.

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1 Coke Reactivity Index – It specifies the weight loss of coke after the heating of coke grains between 19 and 22.4 mm in size in a stream of CO\(_2\) for two hours.

2 Coke Strength after Reaction – Following a reaction with CO\(_2\), the coke is subjected to mechanical stress in a revolving drum for 30 minutes. All grains exceeding 10 mm in size are then weighed.
Sales of coal, coke and chemical products – contact information

Sales of coal and coke to wholesale customers and industrial enterprises:
Marta Šebková
Sales manager and CCO Deputy for Coal and Coke
OKD, a.s.
TOKOVO Building, Jankovcova 2/1518
170 00 Praha 7 - Holešovice
Tel: +420 225 282 461
Fax: +420 225 282 415
E-mail: sebkova@okd.cz

Sales of chemical products
Mr Jiří Vojník, MSc
Head of the Quality Management and Sales Department
E-mail: jiri.vojnik@koksovny.cz

General contact information:
OKD, a.s.
Prokešovo náměstí 6/2020
728 30 Ostrava
Czech Republic
Tel: +420 596 261 111
Fax: +420 596 118 844
E-mail: info@okd.cz
Website: www.okd.cz

OKK Koksovny, a.s.
Koksární ulice 1112
702 24 Ostrava - Přívoz
Czech Republic
Tel: +420 596 133 428
Fax: +420 596 133 472
E-mail: okk@koksovny.cz
Website: www.koksovny.cz