Coal, Peat and Derived Fuels

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Overview

1. The role of coal
2. Coal classification
3. Coal transformation processes
4. Compiling/Reporting coal data
5. Concluding remarks
The role of coal

- World TES
- 2nd largest source of world’s energy supply in 2015
- Largest source of electricity generation (39.3%)

Source: IEA KWES 2017

1. World includes international aviation and international marine bunkers.
2. In these graphs, peat and oil shale are aggregated with coal.
3. Includes geothermal, solar, wind, tide/wave/ocean, heat and other.
Importance of Coal

- Abundant, cheap with low technology barriers
- Used for power generation, iron and steel production and cement manufacture
- Energy security can be enhanced with coal-to-liquids, gas or chemicals

But:
- Environmental concerns: largest CO2 emission per unit of energy among conventional energy sources
  - Potential for development and deployment of clean coal technologies such as carbon capture and storage
<table>
<thead>
<tr>
<th>Section / Division / Group</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Coal</td>
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<tr>
<td>01</td>
<td>Hard coal</td>
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<td>011</td>
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<td>02</td>
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<td>Sub-bituminous coal</td>
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<td>0220</td>
<td>Lignite</td>
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<td>03</td>
<td>Coal products</td>
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<td>0311</td>
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<td>0312</td>
<td>Gas coke</td>
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<td>0313</td>
<td>Coke breeze</td>
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<td>0314</td>
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<td>0340</td>
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<td>0350</td>
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<tr>
<td>0360</td>
<td>Gas works gas</td>
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<tr>
<td>0371</td>
<td>Recovered gases</td>
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<tr>
<td>0372</td>
<td>Basic oxygen steel furnace gas</td>
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### Coal classification

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Type</th>
<th>Reporting unit</th>
<th>Expected calorific value (kJ/kg, MJ/ton)</th>
<th>GCV estimation</th>
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</thead>
<tbody>
<tr>
<td>Coking coal</td>
<td>Fossil fuels</td>
<td>kt</td>
<td>25000 - 33000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Anthracite</td>
<td></td>
<td>kt</td>
<td>22000 - 29000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Other bituminous coal</td>
<td></td>
<td>kt</td>
<td>22000 - 29000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Sub-bituminous coal</td>
<td></td>
<td>kt</td>
<td>16000 - 24000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Lignite</td>
<td></td>
<td>kt</td>
<td>5000 - 18000</td>
<td>≈ NCV + 5%</td>
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<tr>
<td>Peat</td>
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<td>kt</td>
<td>7000 - 13000</td>
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<tr>
<td>Oil Shale</td>
<td></td>
<td>kt</td>
<td>2500 - 12000</td>
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<tr>
<td>Coal tar</td>
<td></td>
<td>kt</td>
<td>30000 - 44000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Patent fuel</td>
<td></td>
<td>kt</td>
<td>25000 - 32000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Coke oven coke</td>
<td>Derived solid products</td>
<td>kt</td>
<td>24000 - 32000</td>
<td>≈ NCV</td>
</tr>
<tr>
<td>Gas coke</td>
<td></td>
<td>kt</td>
<td>24000 - 32000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>BKB</td>
<td></td>
<td>kt</td>
<td>15000 - 21000</td>
<td>≈ NCV + 5%</td>
</tr>
<tr>
<td>Peat products</td>
<td></td>
<td>kt</td>
<td>8000 - 14000</td>
<td>≈ NCV + 5%</td>
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<tr>
<td>Gas works gas</td>
<td>Manufactured gases</td>
<td>TJ</td>
<td>15000 - 22000</td>
<td>≈ NCV + 10%</td>
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<tr>
<td>Coke oven gas</td>
<td></td>
<td>TJ</td>
<td>15000 - 22000</td>
<td>≈ NCV + 10%</td>
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<td>Blast furnace gas</td>
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<td>TJ</td>
<td>2000 - 4000</td>
<td>≈ NCV</td>
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<tr>
<td>Other recovered gases</td>
<td></td>
<td>TJ</td>
<td>2000 - 20000</td>
<td>≈ NCV</td>
</tr>
</tbody>
</table>
## Coal classification

- Primary coal classification by physical and chemical characteristics (e.g., Calorific Value and Vitrinite mean Random Reflectance)

<table>
<thead>
<tr>
<th>Coking coal</th>
<th>Hard Coal</th>
<th>Metallurgical Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracite</td>
<td></td>
<td>Steam Coal</td>
</tr>
<tr>
<td>Other bituminous coal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-bituminous coal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lignite</td>
<td>Brown Coal</td>
<td></td>
</tr>
<tr>
<td>Peat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil shale and oil sands</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Coal classification

- **Peat**
  - Solid fossil fuel, often a precursor to coal, particularly lignite

- **Oil shale and oil sands**
  - Sedimentary rock which contains organic matter in the form of kerogen, a precursor of petroleum
  - *Oil shale* may be burned directly or processed by heating to extract shale oil*
  - *Shale oil* should be reported as non-conventional oil

*Note that this term is also used for oil extracted from reservoirs in shale formations*
Coal transformation processes

• Transformation: includes fuels used for conversion of energy (e.g., coal to electricity) or for the transformation to derived energy products (e.g., coke ovens, blast furnaces)
  - Reporting what should be transformation in final consumption affects indicators based on final consumption (such as SDG indicator 7.2.1)

• The largest consumption of coal is in electricity and heat generation

• There are several transformation processes unique to the coal sector
Coal transformation processes

- Coke ovens
  - Coking coal
  - Coke oven coke
  - Coke oven gas
  - Coal tar

- Blast furnace
  - Coke oven coke
  - Blast furnace gas

- Gas works and coal gasification plants
  - Coal and Coal Products
  - Gas works gas
  - Gas coke
Coal transformation processes

- Typical mass yields from coke ovens

- Coke 71.8%
- Gas 16.9%
- Tars 4.8%
- Light Oils 1.2%
- Water 4.2%
- NH₃ 0.2%
- Other 0.7%
Vale Royal Furnace

- iron ore/limestone
- charging hole
- water channel
- coke
- charging ramp
- blast furnace
- water channel (leat)
- bellows
- pig iron
- tuyere
- waterwheel
- cams
- slag layer
- molten iron
- slag
- crucible
- pig bed

1200-1300°C
Coal transformation processes

• Patent fuel: manufactured from hard coal fines with binding agent

• BKB or Brown coal briquettes: composite fuel manufactured from brown coal without binding agent

• Coal liquefaction (coal-to-liquid) plants utilize coal to create liquid fuels (diesel, naphtha, etc.).
  - The liquid fuels production must be reported as “Other hydrocarbons” (SIEC 45) together with Oil.

• Peat products: products such as peat briquettes derived directly or indirectly from peat
Note: Some transformation outputs will be reported in other questionnaires such as electricity, oil, and natural gas.
Compiling/Reporting coal data

• Coal washing
  - Removes ash & impurities
  - Improves quality and price
  - Reduces emissions
  - Coal washing can significantly affect both the physical amount of coal available and its calorific value
  - It is therefore very important to know when the quantity of coal and its NCV are measured
  - Measuring these values just before a quantity of coal enters a transformation process is essential as only then the efficiency of the transformation process can be accurately calculated!
Compiling/Reporting coal data

- **Colliery gas**: although a type of natural gas, it is produced from coal mines, and as such should have production quantities inquired from coal mines.

Colliery gas as a source for generating electricity at the Appin and Tower coal mines in New South Wales, Australia.
Compiling/Reporting coal data

Input:
coking coal

Output #1:
Coke oven coke

Output #2:
coke oven gas + coal tar

Fuels transformed into another energy form

Transformation

Fuels consumed to support operations

Energy industry
Own-use
Compiling/Reporting coal data

- Data quality checks:
  - Numbers (sums, signs, etc.)
  - Statistical differences
  - Time series consistency
  - Calorific values
  - Transformation efficiency
  - Comparison between tables
  - Physical vs. energy content balance
  - Comparison with other questionnaires
  - Data are complete and tell the correct story
  - Comparison with secondary and partner sources
Quality check: transformation efficiency

Example: Coke oven

- **Input**: coking coal
  - 10 kt, 26 000 kJ/kg

- **Output #1**: Coke oven coke
  - 6 kt, 28 000 kJ/kg

- **Output #2**: coke oven gas + coal tar
  - 15 TJ (gross) + 1 kt, 35 000 kJ/kg

Efficiency = \[ \frac{15 \times 0.9 + 1 \times 35 + 6 \times 28}{10 \times 26} \] = 83%
Expected values

- Electricity plants: 10 – 50% depending on the fuel and main activity / autoproducer
  - Anthracite 30 - 40%
- CHP Plants: 30 – 80%
- Heat Plants: 40 – 100%
- Blast Furnaces: 35 – 45%
- Coke Ovens: 67 – 100% (Coke Oven Coke + Coke Oven Gas)
- Patent Fuel plants: 90 – 100%
- BKB: 85 – 100%
- Gas Works: 67 – 100% (Gas works Gas + Gas Coke)
Compiling/reporting coal data

- Calorific values of coal products may differ for different flows such as:
  - Production
  - Imports
  - Exports
  - Used in Coke Ovens
  - Used in Blast Furnaces
  - Used in main Activity Plants
  - Used in Industry
  - For Other Uses

Domestic supply

Statistical difference on an energy basis

Total demand
Compiling/reporting coal data

• For products classified in SIEC under Section 0 (Coal) and Section 1 (Peat), the following list of additional data items applies.

<table>
<thead>
<tr>
<th>Item number</th>
<th>Data item</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Production</td>
</tr>
<tr>
<td>2.1.1</td>
<td>Of which: Underground</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Of which: Surface</td>
</tr>
<tr>
<td>2.2</td>
<td>Production from other sources</td>
</tr>
</tbody>
</table>

• **Underground production**: from underground mines where coal is produced by tunnelling into the earth to the coal bed.

• **Surface production** refers to production from surface mines.
Compiling/reporting coal data

- **Production from other sources** consists of two components:
  - (a) recovered slurries, middlings and other low-grade coal products, including coal recovered from waste piles and other waste receptacles; and
  - (b) fuels whose production is covered in other sections of SIEC, for example, from oil products (e.g. petroleum coke addition to coking coal for coke ovens), natural gas (e.g., natural gas addition to gas works gas for direct final consumption), biofuel and waste (e.g., industrial waste as binding agent in the manufacturing of patent fuel).
Concluding remarks

• Distinction between transformation and final use (by industry – mainly metallurgical) is important:
  - Recovered gases can be used to generate electricity, for example
  - Indicators based on final energy consumption (SDG 7.2.1)

• Distinction between transformation and own use (by industry – mainly metallurgical) is important:
  - To access efficiency of the process, which in turn can be used as a data quality check

• Assessing country-specific (and flow-specific) Calorific Values important (rather than using default CVs):
  - For the construction of accurate balances and indicators
  - For the accurate assessment of efficiencies
Thank you.

http://unstats.un.org/unsd/energy