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# MANAGING THE REDUCTION OF ENVIRONMENTAL IMPACT OF COAL USE TOWARDS SUSTAINABILITY

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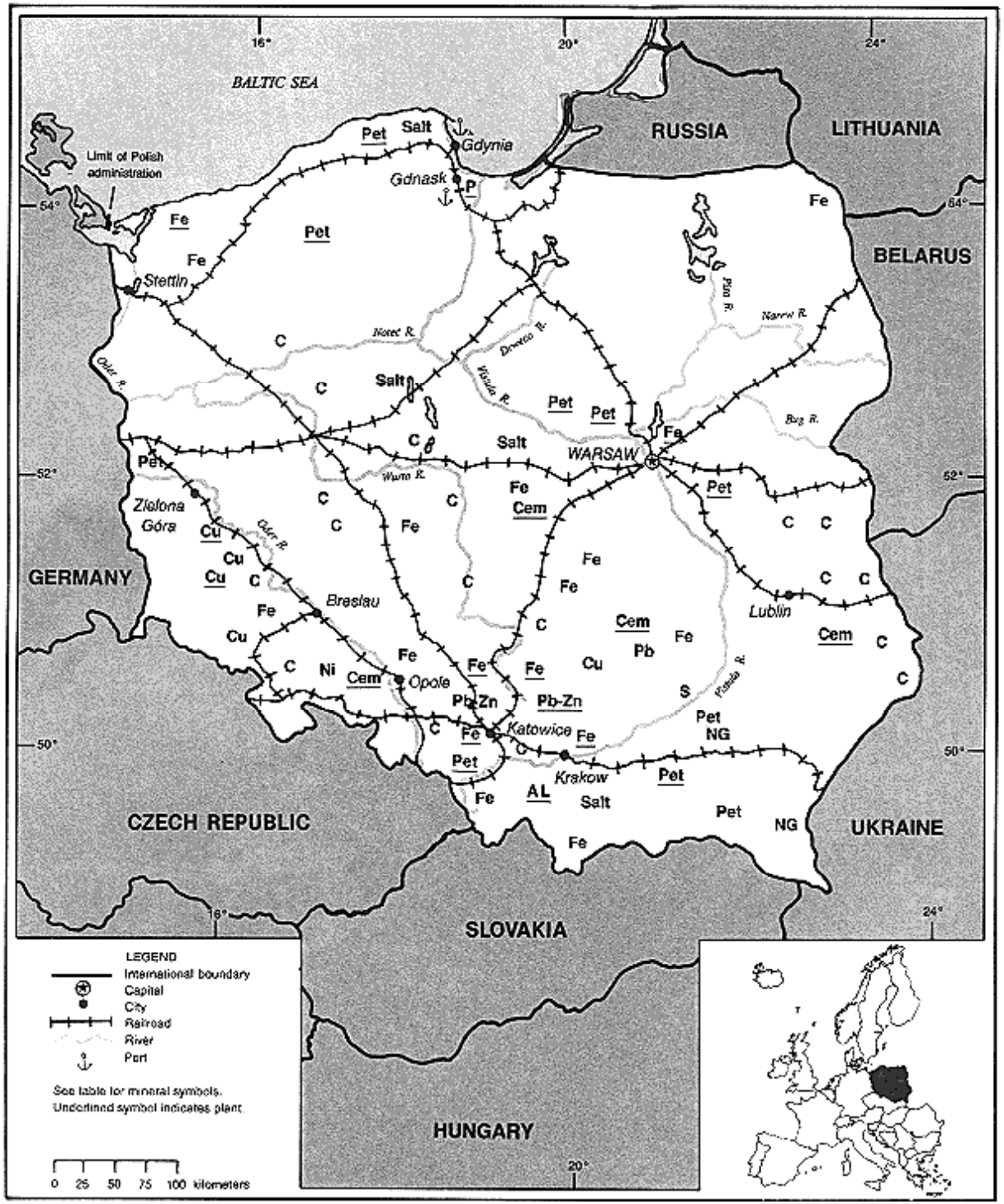
***Assessing and Managing Cumulative Effects***

**Calgary, Alberta, Canada • 6-9 November 2008**

# World's largest countries with diversified non-renewable mineral resources:

1. USA
2. China PR
3. Russia
4. Canada
5. Australia
6. South Africa
7. Poland
8. Mexico
9. India
10. Chile

# POLAND


BALTIC SEA
RUSSIA
LITHUANIA
BELARUS
GERMANY
CZECH REPUBLIC
SLOVAKIA
HUNGARY
UKRAINE
Limit of Polish administration
Gdynia
Gdnask
Stettin
WARSAW
Zielona Góra
Breslau
Opole
Katowice
Krakow
Lublin
Odra R.
Notec R.
Drwęca R.
Wisła R.
Pisa R.
Narew R.
Bug R.
Warta R.
Pet
Salt
Fe
Cu
C
Cem
Pb
Ni
Pb-Zn
S
NG
AL
LEGEND
International boundary
Capital
City
Railroad
River
Port
See table for mineral symbols.
Underlined symbol indicates plant
0 25 50 75 100 kilometers
16°
20°
24°
54°
52°
50°

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# The sustainable development strategy for coal global sector, based particularly on clean coal technologies could be the best solution for environmental challenges.

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The issues discussed in this paper concern 1980-2006, a period that has been influenced by two factors:

1. the idea of sustainable development was evolving and was finally crystallized by improvement of its definition, concept, rules, methods and instruments;

2. access to objective and comprehensive data on the global coal sector, collected mainly by such institutions as the Committee for Cleaner Fuels World Energy Council, the UN Economic Commission for Europe, the European Association for Coal and Lignite (EURACOAL), the International Energy Agency, the EU Directorate-General for Transport and Energy, the World Coal Institute, and British Petroleum.

# Proved coal reserves in selected countries and its R/P ratio, 2006 and 2007

| TOTAL WORLD | mill. tons | years |
|---|---|---|
| 2006 | 909064 | 147 |
| 2007 | 847488 | 133 |

The R/P ratio for coal is calculated for 147 years, taking into account the production level in 2006. It should be noted that predictions made in 1999 indicated that the R/P ratio of coal global reserves was for about 200 years.

This situation requires saving the coal reserves.

In 2005, the structure of global **sources of secondary energy** generation **in all forms** was as follows [%]:

| | |
|---|---|
| crude oil | - 34.3 |
| coal | - 25.1 |
| natural gas | - 20.9 |
| combustible renewables and waste | - 10.6 |
| nuclear | - 6.5 |
| hydro | - 2.2 |
| other sources | - 0.4 |

Relatively, the coal share in **electric energy** generation was very high in 2005.

The global structure of **primary energy sources** usage was as follows [%]:

| | |
|---|---|
| coal | - 39.8 |
| natural gas | - 19.6 |
| hydro | - 16.1 |
| nuclear | - 15.7 |
| crude oil | - 6.7 |
| renewable sources | - 2.1 |

International trade in hard coal is a key factor in the international segment of the global coal sector, which includes international co-operation in the following areas:

- standardization of parameters of coal reserves, and use of this instrument for the deposits' balance criteria;
- prospecting exploration and documentation for coal reserves;
- saving the financial capital from various sources to finance mining activities with long-term return periods and a high level of risk;
- realization of investment projects including objects of technical infrastructure, mines and coal-enriched mining companies;
- exploitation of coal mineral deposits;
- coal transportation from mining regions via exporting harbours to the customers;
- logistics of harmonized huge flows of coal, usually between continents;
- classification and standardization of the coal as a trade product;
- creation of optimal coal mixtures for energy plants and the metallurgical industry;
- creation of new technologies for coal use, characterized by economic efficiency and environmental safety.

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# The development of international co-operation during all economic stages of coal reserves, including coal trading, in 1991 created a situation where hard coal attained the position of the main mass product in international sea transport.

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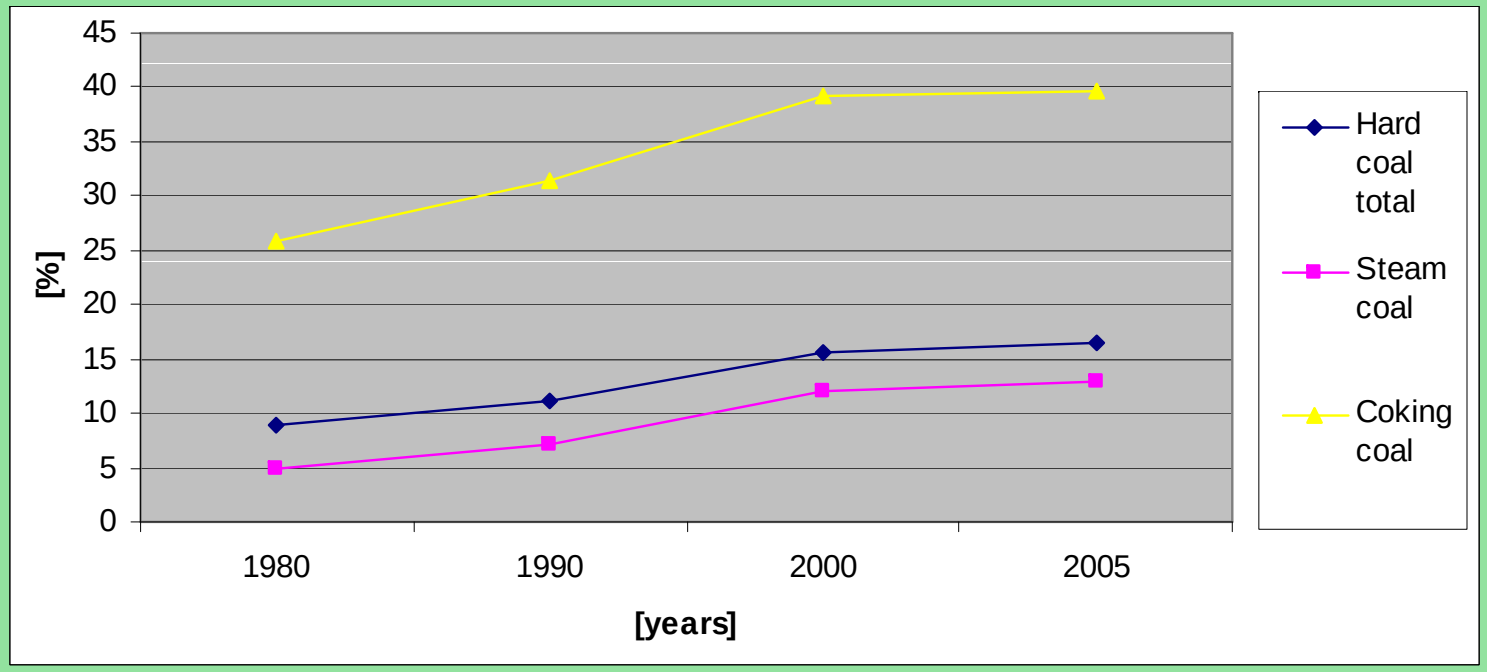


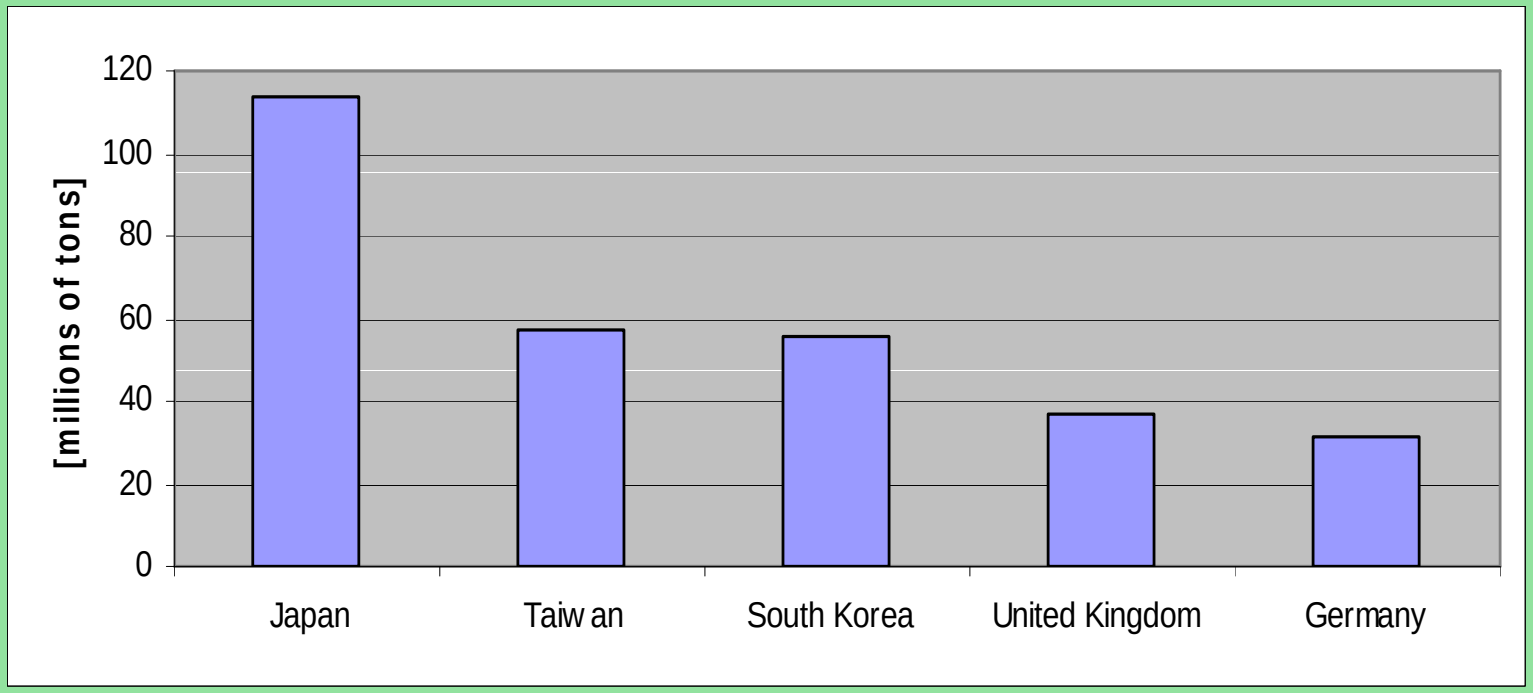

The average rate of export increase for the whole hard coal sector is influenced by the very high dynamics of international trade in steam coal, starting from a low level and significantly lower dynamics of hard coal sales, but it should be stressed that, since 1980 coking coal international markets constituted a very important segment on the global sale.

The statistical data presented below indicates stabilized export production of coal in Canada, Columbia, Venezuela, Australia, Indonesia, and … Poland.

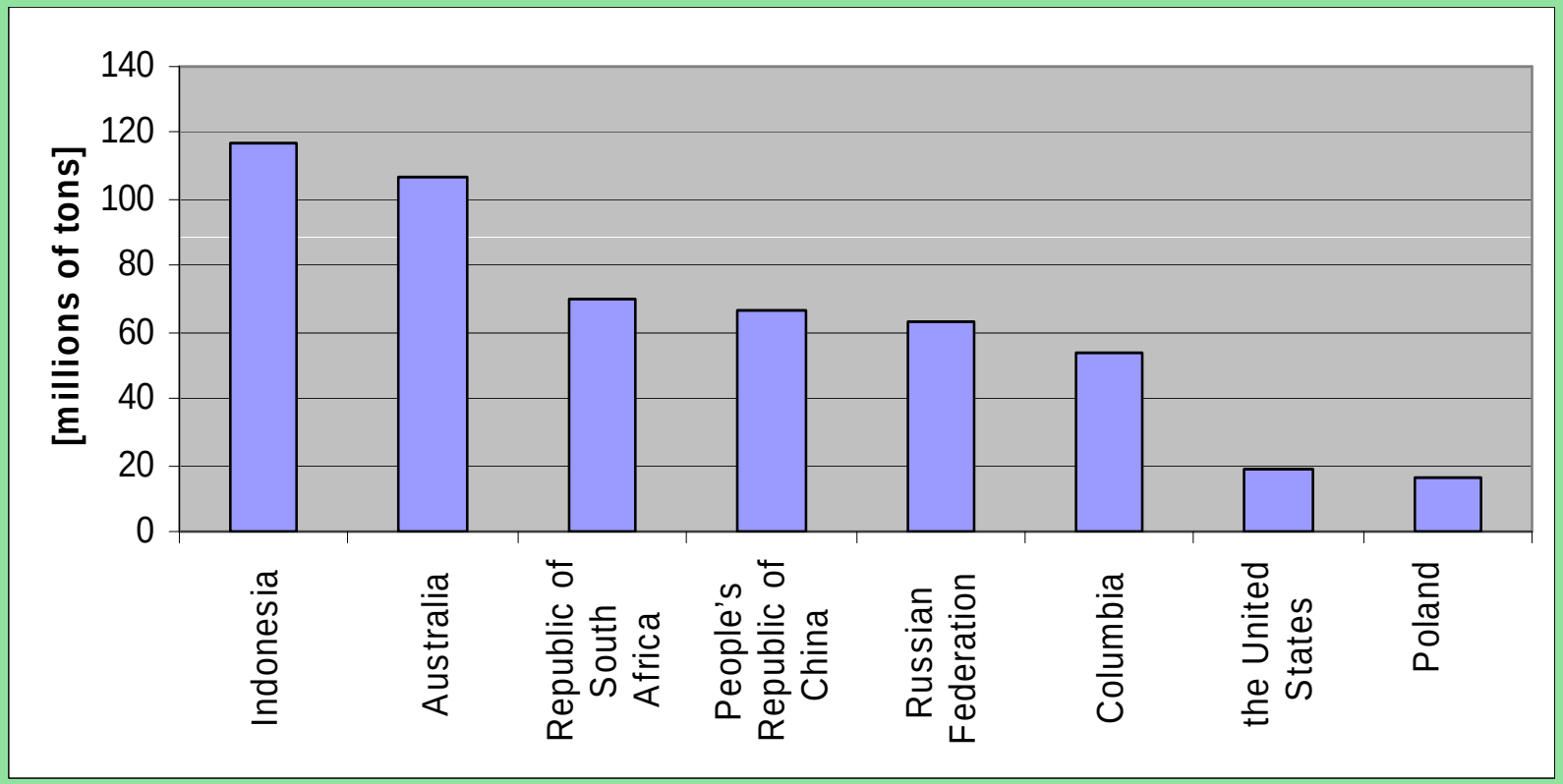
Share of exports in hard coal production in selected countries, 1980, 1990, 2000 and 2005 [%]

| Country | 1980 | 1990 | 2000 | 2005 |
|---|---|---|---|---|
| Canada | 75.7 | 82.2 | 94.1 | 94.4 |
| Columbia | - | 68.2 | 93.0 | 94.2 |
| Venezuela | - | 81.8 | 88.7 | 89.9 |
| Australia | 58.4 | 65.1 | 78.4 | 79.6 |
| Indonesia | - | 40.0 | 72.2 | 73.1 |
| Poland | 16.5 | 19.2 | 22.5 | 20.7 |

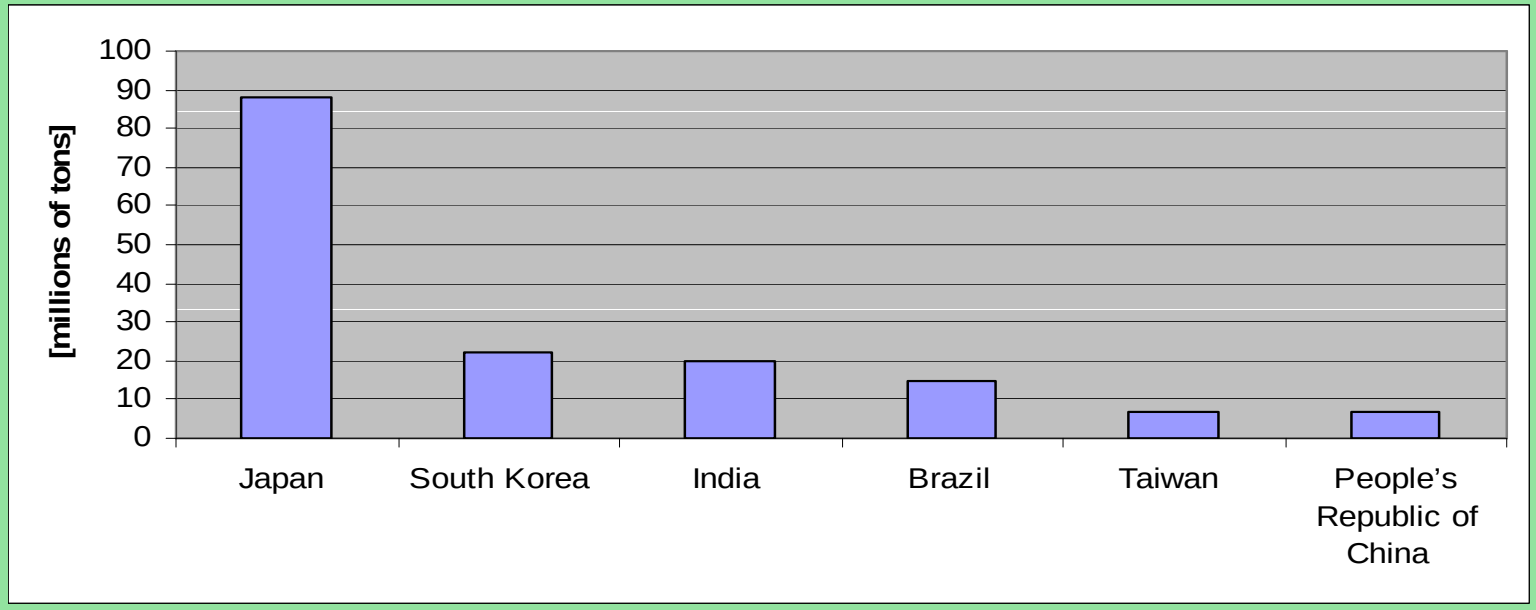
In 2005, the demand for steam coal imports exceeded the level of 568 mill. tons, which means an import rate of 12.9%.



In 2005, the global ranking of steam coal exporters [mill. tons] was the following:

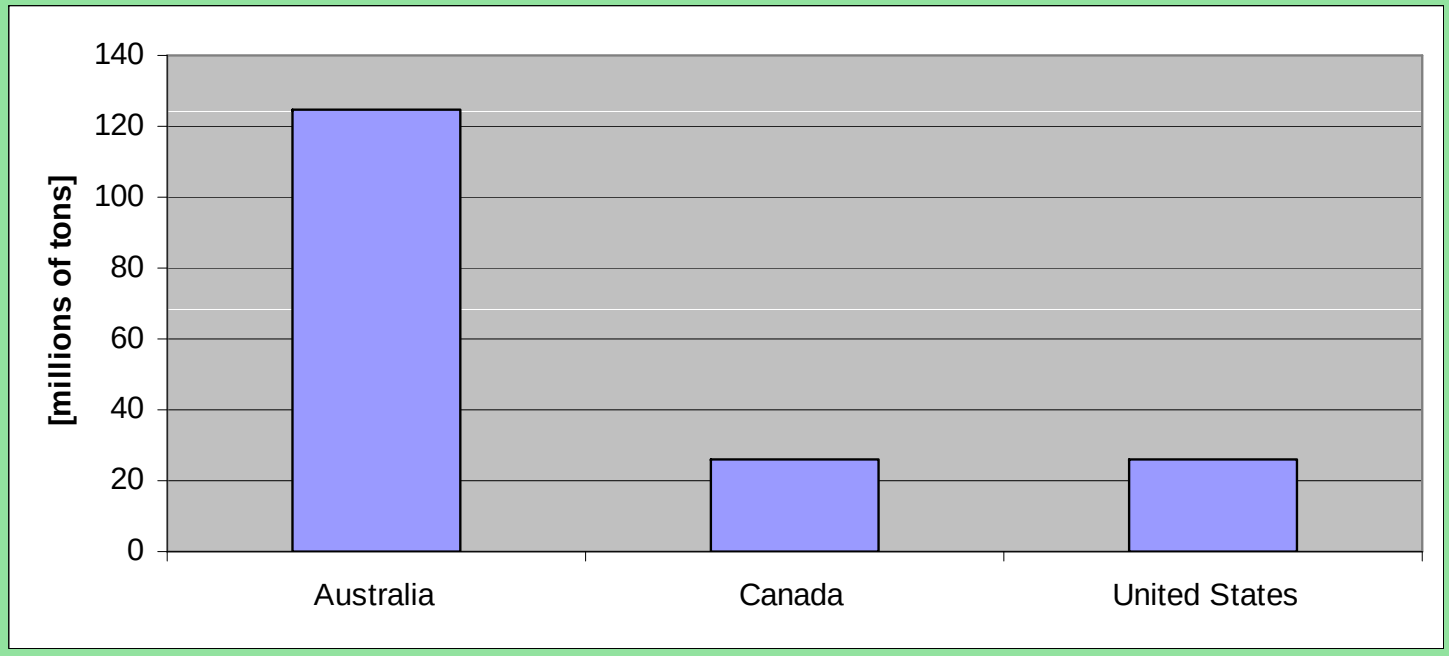


The highest level of imports [mill. tons] has been presented on figure below:




From the point of view of evaluating the trends seen in coking coal international markets, most important is the progression of increased coal imports to the People's Republic of China, noticed since 2003, and resulting in the huge dynamics of demand for coke by the metallurgical industry in continental China. At this point, it should be underlined that, since 2002, the People's Republic of China was a net exporter of coking coal.

In 2005, among the main suppliers of coking coal [mill. tons] in international markets there are presented on figure below:




This very high indication of coking coal export concentration, exceeding the level of 77% – due to the share of the three main exporting countries listed above – is still characteristic in the international trade of coking coal.

As many experiments have showed – the heat received from a high-temperature reactor can be used for mass production of hydrogen in the way of water thermolysis, without carbon dioxide emission.

Hydrogen is an energy carrier and will also be a basis for energy production as well as even a basis for hydrogen economy in the future, because it can be used for very many chemical processes, including coal gasification.

Industrial production of hydrogen using other methods requires an energy supply, which comes from coal and the burning of other fuels. This means that fossil fuels will be used, and consequently carbon dioxide and other greenhouse gas emission will also be produced.

The rapid growth in prices of crude oil and natural gas in recent years has meant that liquid fuels produced from coal (Coal to Liquid – CTL) has received new attention. A particular growth of interest in this respect appears in countries that posses large coal mineral resources, but have no sufficient crude oil reserves.

The European Commission, within the Fifth, Sixth and Seventh Framework Programmes as well as EUROATOM, also financed and still is financing a programme for development of gas technologies for high-temperature nuclear reactors, which focus on several projects grouped within the High–Temperature Reactor – Technology Network (HTR – TN).

It should be emphasized that the process of coal conversion into synthetic crude oil is endo-energetics. To produce one litre of fuel it is necessary to use 3-6 kg of coal. This also raises the problem of significant carbon oxide emission. An optimal solution appears to be a process based on coal use – of clean coal technologies – only as a resource material for processing, but not as an energy source.
A nuclear reactor could be such an energy source.

The synergy process of coal use and high-temperature nuclear reactors could be particularly important for countries like Poland.

This could allow for rational economic coal reserves use in Poland, and at the same time facilitate successfully meeting the required changes of the primary energy sources structure.

The problems analyzed in this paper allow formulation of many conclusions which also take into account the circumstances and criteria of sustainable development.
The most important conclusions are presented below:

1. analysis of the volume of proved coal reserves and conditions for coal exploitation qualify the statement that coal supply could be stable even over a very long time period;
2. the geographical location of coal mineral resources reduces the risk of supply monopolization;
3. re-orientation of prospecting exploration and documentation of coal mineral resources help to significantly increase the coal reserves base characterized by environmentally-friendly parameters;
4. selective investments undertaken for use in coal deposits characterized by low contents of sulphur and ash, results in significantly enlarged assortment of commercial products offered in the domestic and international coal markets;

5. the dynamics of coal trade observed in international markets since the beginning of the 1970s is still higher than world coal sales;

6. international coal markets generated slight and flexible information about changes in coal demand structure at two levels: qualitative and geographical;

7. a stabilized share of coal as a primary energy source in the processes of total secondary energy generation as well as electric energy qualifies the statement that adjustment processes in the world coal sector are adequate to changes of demand, mainly resulting from implementation of sustainable development principles;

8. the synergy of coal use and nuclear techniques will result in reaching two important goals: more economical use of coal reserves,
and reduction of environmental threats, mainly a reduction in greenhouse gas emissions.