

To Phase Out Coal

The structure of the coal industry,
its environmental effects,
and the possibilities of
phasing out the use of coal.

By
Fredrik Lundberg



THE SWEDISH
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AIR POLLUTION AND CLIMATE SERIES

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By Fredrik Lundberg.

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Executive summary

Coal is a major contributor to greenhouse gases and to other pollutants. About 37 per cent of the world's emissions of carbon dioxide come from coal.

The global CO₂ emission total has been relatively constant since about 1985, but there has been dramatic cuts of production and consumption in some countries, such as the UK, the former Soviet bloc and more recently in China (1996-2000), while consumption has increased steadily in the United States and Japan and some other countries.

About two thirds of the coal is used for electricity. That share is increasing and represents the only potential growth market for coal. Some fifteen per cent is used in the steel industry. Other uses have ended in some nations and is decreasing in the others.

Coal is also a major source to acidification and eutrofication, and in many countries, of hazardous particles.

Unlike oil, coal is fairly easy to substitute. There are several other methods to produce electricity and to use it more efficiently.

The costs for phasing out coal power stations are often very low, as many plants are old, inefficient and in need of large reinvestments to comply with modern environmental demands. There are also subsidies to coal in many countries.

The coal industry is strong lobbying force, and was a strong factor behind the US withdrawal from the Kyoto Protocol in 2001.

In western Europe, coal contributes about 25 per cent to the total CO₂ emissions, but differences in coal use between European nations vary by a very large factor. A substantial part of Europe's coal is lignite and peat, both of which emit even more CO₂ per unit of useful energy than hard coal.

The coal lobby is strong also in Europe, especially in Germany. Special consideration for the coal industry is visible in almost every piece of EU environmental legislation.

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1. The global perspective

Coal is “Environmental enemy No 1” said the Economist on its cover July 6, 2002. This seems to be an accurate assessment.

Global carbon emissions from coal¹ in 2000 were 2387 Mt out of a 6443 Mt total² for fossil fuels use, or 37 per cent. Coal is also of great importance for global emissions of other greenhouse emissions, of methane and nitrous oxide (N₂O), though these are harder to quantify, especially for N₂O. Coal is an important emitter of nitrogen oxides (NO_x), which are precursors of ozone, a very potent greenhouse gas (though not regulated by the Kyoto protocol). Coal is also a major contributor to eutrophication of soil and water, and to acidification. Coal is a dominating source of SO₂ emissions and a major source of heavy metal emissions.

Locally, coal mining and combustion can damage biodiversity, groundwater and landscape values. Dust from coal combustion is a major public health hazard in many countries.

Coal mining is a truly earth-moving activity. It is by far the biggest product of all mining activities, and that is not all. In a World Resources Institute study, *Weight of the Nations* (2000)³, the total material flows have been estimated for the United States. About 5 billion tons of coal mining overburden is produced every year, almost all of it from surface mining. A study for Europe⁴ has found that for every ton of hard coal extracted, one ton of other material is also extracted. For lignite, 9 tons of other material is dug up.

Associated with the life cycle of coal is also huge use of and pollution of water, huge use of limestone and dolomite for desulphurisation and land for mining, coal transport infrastructure and then other infrastructure for the electricity output. The waste streams are dominated by emissions to air (especially of CO₂) but there are also enormous amounts of ashes, and desulphurization products, some of which is reused, but much of which is not.

Political heavyweight

The indirect, political, impact might be of even greater importance. Coal is a strong political force, locally, regionally, nationally and internationally. The difference between the United States and the European Union in the Climate Convention and the Kyoto Protocol can largely be explained by the differences between their coal industries.

In Europe, where the coal industry has been declining since the 1960's, real reductions of CO₂ emissions is perceived as a real, economically feasible option. Ratification of the Kyoto protocol has been decided by virtual unanimity in most national parliaments. In the United States where the coal output and use have increased practically every year since the 1980's, the opposition against any real action has

¹ US Department of Energy, Energy Information Agency, www.eia.doe.gov/emeu/iea/tableh4.html

² US Department of Energy, Energy Information Agency, www.eia.doe.gov/emeu/iea/tableh1.html

³ See www.wri.org

⁴ *Total material requirement of the European Union* by Stefan Bringezu and Helmut Schütz (Wuppertal Institute) for the European Environment Agency 2001.

been fierce, culminating in the 2001 US withdrawal from the Kyoto Protocol. Before that, the US was the leader of the “Umbrella group”, which acted within the Kyoto Protocol in order to water it down (to say the least).

Other members of the Umbrella were Australia, the world’s biggest coal exporter with also a large and increasing use of coal at home; Canada, another leading coal exporter and user; and Japan, the top coal importer. Japan and Canada did finally ratify the Kyoto Protocol, but only after a long internal debates. Australia will not ratify, at least not under the present government.

In a sense it is logical for the coal industry to be dead against Kyoto. A rapid phase out of coal is possible, and it will not be the end of the world as we know it. The UK cut its coal use by half from 1989 to 1999. Germany has cut its coal use by more than a third since 1990. China cut its coal use by 17 per cent in just the four years from 1996 to 2000, although it increased again 2001-02. All of them achieved this change just by a combination of stricter environmental laws and reduction of subsidies.

Most coal is used in power plants, and there are several alternatives to coal for that purpose. Many coal power stations are either directly subsidized or face a near-term threat from environmental legislation with respect to SO₂, NO_x and dust, which would make them unprofitable. Any kind of serious CO₂ policy would kill a very large number of coal power stations in short time, with immediate repercussions for the mining industry.

The coal industry is expendable and vulnerable. The coal producers can’t produce anything else than coal, and if they cannot sell to the power industry, there is no alternative market.

Coal vs. oil

The contrast to oil is striking. For the time being there is no credible large-scale alternative to oil as a vehicle fuel. The biofuels are of little consequence for the oil companies, and if it should grow very much, they are in a good place to conquer that market too; they have the right expertise in chemical technology, they can handle the complicated distribution market. If hydrogen should become an alternative, the oil companies could adapt to that, too. Increased fuel efficiency and changed transport policy could diminish the market for oil, but that takes a long time. Even if all new cars, trucks, busses, airplanes, and ships would double their efficiency overnight, many of the gas-guzzlers will still be around for another 15-20 years.

At least half the market for oil is essentially guaranteed for some 15 years, probably more, even if the oil companies do nothing to adapt. Options are however abundant for hi-tech companies with lots of cash and lots of time for adaptation. The oil companies also dominate the natural gas market, which safely can be predicted to grow for the next few decades, especially if the use of coal is restricted. They also have good niche markets such as lubricants and plastics, which are almost invulnerable and where they can shift towards higher quality and higher prices.

That is why some oil companies think they can cope with a rigorous anti-pollution policy and even some climate policy. Shell and BP endorse the Kyoto Protocol, and also invest some money (though a very small share of their investment budget) in renewable energy. On the other hand Exxon has lobbied heavily against Kyoto, while ChevronTexaco is somewhere in between. They can chose between making money from quantity oil sales or making money from knowledge.

Bound for decline

Theoretically, coal combustion can cut all pollutants except CO₂ to near zero. The technology is demonstrated. But this so-called Clean Coal Technology is not competitive. Many existing plants cannot profitably retrofit any kind of pollution con-

trol, not to mention an upgrade to modern environmental standards.

Faced with the forces of de-subsidization, global competition, and environmental standards, coal is set for a sharp decline.

When CO₂ enters the equation, that spells death for coal. CO₂ emissions from the best coal power plants are much lower than from the worst ones, but still much higher than from standard new natural gas power plants. CO₂ emissions per energy unit can also be cut by co-producing power and heat, but the market for that is limited – and is open to competition for less carbon-intensive fuels.

Lastly and very theoretically, CO₂ could be separated and stored. If this can be done safely on a very large scale, which is extremely doubtful, it would add heavily to the costs of coal power.

This leads to the inescapable conclusion: the world has to choose between coal and the environment. For the environmentalist the only question that remains is how to get rid of the coal as fast as possible.

Much worse than gas

The argument, sometimes advanced by coal supporters, is that it makes no sense substituting one fossil fuel for another. This simply does not hold.

In the EU Commission study of external effects for Germany, ExternE⁵, the most important emissions for a new coal, lignite and natural gas power plant are summed up in Table 1. Some data from a Greek reference lignite plant is added for comparison. "Life cycle" includes all the way from mine to power station.

Table 1. Lifecycle emissions in milligrams per kWh from different fuel cycles.

	SO ₂	NOx	particles	CO ₂	CH ₄	N ₂ O
Coal	326	560	182	815	3313	43
Lignite	425	790	511	1047	26	46
Greek lignite	860-1518	1000	max 253	1370	no data	no data
Gas	3	277	18	362	1700	2

SO₂= sulphur dioxide, NOx=nitrogen oxides, CH₄=methane, N₂O=nitrous oxide.

The reference plants represent neither the best natural gas cycle (which can emit much less NOx, and improve considerably on methane, and cut CO₂ emissions to just over 300), and by no means the worst coal and lignite plants. Still, the differences are huge. Gas wins on every score against coal, even more against lignite with the exception of methane. (On that score, one can strongly suspect that the leaks in the natural gas system are mainly in the distribution system, not in the big pipelines that lead to the power stations, and should not be attributed to power production.)

The differences are still larger if existing coal and lignite plants are compared to a mix of conservation, wind, biomass and natural gas.

⁵ <http://externe.jrc.es/>

2. Coal in Europe

According to a report from PriceWaterhouseCoopers,⁶ in 2001, the five largest CO₂ emitters among the European power industry were:

RWE (Germany)	126 Mton CO ₂
ENEL (Italy)	99 Mton CO ₂
E.ON (Germany)	76 Mton CO ₂
Endesa (Spain)	73 Mton CO ₂
Vattenfall (mainly Germany)	71 Mton CO ₂

The emissions are not specified by fuel, but it is well-known that the emissions from these companies originate mainly from coal, say 400 Mtons for just these five companies. For comparison, the EU total emissions of CO₂ were 3326 Mtons in 2000, so just the coal CO₂ emissions from these five companies were about 12 per cent of all EU CO₂.

As for carbon factors, the PWC study says that on average in Europe lignite emits 1100 kg CO₂/MWh, (hard) coal 900, and gas 400; hydro and nuclear of course none at all.

The specific emissions vary much between companies, and interestingly, also between the US and Europe.

RWE has the highest carbon factor of the big European companies: 700 kg CO₂/MWh. ENEL and ENDESA have 500-600 kg, and Vattenfall, Electrabel and E.ON have carbon factors 380-450 kg CO₂/MWh. Electricité de France has only 69 kg CO₂/MWh, and Norwegian Statkraft none at all.

It is also interesting to note that the average in Europe is 353 kg CO₂/MWh, compared to 720 kg CO₂/MWh in the United States. These two simple figures may explain a lot of the different roles of the EU and the US in the climate negotiations.

But it should also be noted that RWE is in the same position as the US power industry (and indeed also is an important player in the US as well) and that it stands to lose a lot if serious climate policy action will take place. This is also to a large extent true of Vattenfall, E.ON, ENDESA and many smaller power companies.

Reserves

The physical resources of coal are huge. According to the BP statistical review of world energy 2001, the European reserves were 41,664 million tons of hard coal, and 80,368 million tons of brown coal (i.e. lignite and sub-bituminous coal) at end-2000, together 12.4 per cent of world total.

Europe is here defined as except the former Soviet Union. Though some parts of the former Soviet Union are clearly a part of Europe, this can easily be defended.

⁶ **Climate Change and the Power Industry, European Carbon Factors: A Benchmarking of CO₂ Emissions by the Largest European Power Producers.** Available at www.pricewaterhousecoopers.co.uk/fr/pwc_pdf/pwc_europe_carbon_factor_2002-10_en.pdf

Russia is so big in energy, emission and population terms that for policy analysis should be kept distinct from Europe, which roughly equals the European Union with satellites in the EEA and applicant countries, including Turkey.

The coal reserves of Europe would suffice for 165 years of present consumption.

The coal reserves translates to 29 billion tons of oil equivalent (Gtoe) for hard coal alone and something similar for brown coal, say 60 Gtoe together.

The actual oil reserves are only 2,5 Gtoe, and if Europe used only its own oil, and at present pace, it would only last 7.7 years.

The gas reserves of Europe are not much more reassuring. They would last 17.5 years.

The notion that coal is of strategic importance is thus not far-fetched.

On the other hand, the CO₂ content of the European coal reserves is about 31.5 Gt of carbon from hard coal alone, certainly more than that from brown coal, say altogether 80 Gt. For comparison, all the carbon emissions from fossil fuels in the world are about 6 Gt a year. These 6 Gt are far above the carrying capacity of the earth, which is shown by the increasing CO₂ content in the atmosphere.

According to the calculations of the climate scientist Bill Hare⁷ for Greenpeace a maximum fossil carbon budget for the 21st century can set at 225 GtC. This is not a safe level, but everything more is very dangerous. That would leave us with an annual budget of 2.25 Gt, which however is being decreased by every year, and will soon be down to 2 Gt.

The coal in Europe, if used up, corresponds to 40 annual budgets for the whole earth, and that for a part of the earth that has less than 8 per cent of the world population.

If even a tenth of the reserves should be used during the present century, that would amount to four annual global budgets.

If the global budget is divided on a per capita basis, Europe's share is less than 0.16 GtC/year, which should also cover oil and fossil gas – both much harder to replace – and imported coal. If Europe plans to emit more than its share, it either accepts a certain disaster of unprecedented magnitude in human history, or plans to steal shares from other parts of the world. The present emissions from Europe are about 1.2 GtC, or 7-8 times more than what is sustainable.

An interesting aspect of Europe's reserves is that so much of it is brown coal, which is the worst for the environment in every aspect, including carbon emissions.

Production

While the European coal **production** has declined from 380 Mtoe in 1990 to 230 in year 2001, a 40-per-cent decrease, it is still a huge amount.

In Table 2 (next page) are figures. For comparison, major non-European producers are inserted.

⁷ **Fossil Fuels and Climate Protection: The Carbon Logic.** By Bill Hare, Greenpeace, September 1997. Can be downloaded from www.greenpeace.org

Table 2. Global coal production. Source: BP statistical review of world energy y, June 2002. Own trend calculations added.

Million tons oil equivalent	1990	2001	Change 1990-2001	2001 share of total
USA	561.4	590.7	5.2%	26.3%
Canada	37.9	37.6	-0.8%	1.7%
Bulgaria	5.4	4.7	-13.0%	0.2%
Czech Republic	36.7	25.8	-29.7%	1.1%
France	7.8	1.5	-80.8%	0.1%
Germany	117.3	54.2	-53.8%	2.4%
Greece	7.1	9.0	26.8%	0.4%
Hungary	4.0	2.8	-30.0%	0.1%
Poland	94.5	72.5	-23.3%	3.2%
Romania	8.7	7.3	-16.1%	0.3%
Spain	11.9	8.0	-32.8%	0.4%
Turkey	12.1	12.9	6.6%	0.6%
United Kingdom	54.7	19.6	-64.2%	0.9%
Other Europe	20.3	12.1	-40.4%	0.5%
Total Europe	380.5	230.4	-39.4%	10.2%
Kazakstan	67.7	40.6	-40.0%	1.8%
Russian Feder.	176.2	120.8	-31.4%	5.4%
Ukraine	83.9	43.6	-48.0%	1.9%
Other Former Soviet Union	4.2	1.0	-76.2%	--
Total Former Soviet Union	332.0	206.0	-38.0%	9.2%
South Africa	100.1	126.7	26.6%	5.6%
Australia	108.6	168.1	54.8%	7.5%
China	542.3	548.5	1.1%	24.4%
India	104.9	161.1	53.6%	7.2%
Indonesia	6.6	56.9	762.1%	2.5%
TOTAL WORLD	2277.8	2248.3	-1.3%	100.0%
Of which OECD	1074.6	1016.8	-5.4%	45.2%

Comments: The major producers in Europe are Poland, Germany, the Czech Republic and the UK in the EU sphere of influence, and Russia, Ukraine and Turkey outside it. All except Turkey have decreased their production.

In the surrounding world, coal production has increased in the US, Canada, Australia and South Africa, which are the also the major exporters, in the last few years joined by China, Indonesia and Colombia.

Consumption

The coal **consumption** in Europe has decreased less than the production during the 1990's, from 478 to 344 Mtoe, or 28 per cent. The difference is accounted for by increased imports.

From environmental perspective, the consumption is the important thing. It can be argued that producers and consumer share the moral responsibility for the consequences, but international environmental agreements place that responsibility only at the point of emission, including CO₂ and N₂O emissions in the Kyoto protocol.

From Table 3 it can be seen that whereas the general trend is falling, much of this decrease is in the ex-Communist countries, and that some of the EU countries have increased their consumption: Finland, Greece, Portugal, Spain, and the EEA member Norway. Outside the EU, Turkey's consumption is also growing.

Table 3. Global coal consumption. Source: BP statistical review of world energy, June 2002. Own trend calculations added.

Million tons oil equivalent	1990	2001	Change 1990-2001	2001 share of total
USA	485.2	555.7	14.5%	24.6%
Canada	24.4	28.9	18.4%	1.3%
Austria	3.6	2.7	-25.0%	0.1%
Belgium & Luxem	10.4	7.1	-31.7%	0.3%
Bulgaria	8.9	6.1	-31.5%	0.3%
Czech Republic	33.5	21.3	-36.4%	0.9%
Denmark	6.0	4.2	-30.0%	0.2%
Finland	3.3	3.9	18.2%	0.2%
France	19.1	10.9	-42.9%	0.5%
Germany	129.6	84.4	-34.9%	3.7%
Greece	8.0	9.5	18.8%	0.4%
Hungary	5.6	3.1	-44.6%	0.1%
Iceland	0.1	0.1	0.0%	
Ireland	2.2	2.1	-4.5%	0.1%
Italy	14.1	13.9	-1.4%	0.6%
Netherlands	9.5	8.4	-11.6%	0.4%
Norway	0.5	0.6	20.0%	
Poland	80.2	57.5	-28.3%	2.5%
Portugal	2.8	3.6	28.6%	0.2%
Romania	11.7	7.7	-34.2%	0.3%
Slovakia	6.9	4.1	-40.6%	0.2%
Spain	19.0	19.5	2.6%	0.9%
Sweden	2.2	2.0	-9.1%	0.1%
Switzerland	0.3	0.1	-66.7%	
Turkey	16.8	20.4	21.4%	0.9%
United Kingdom	64.9	40.3	-37.9%	1.8%
Other Europe	19.2	10.6	-44.8%	0.5%
Total Europe	478.4	344.1	-28.1%	15.3%
Azerbaijan	0.1	-	-100.0%	
Belarus	1.2	0.3	-75.0%	
Kazakstan	40.2	24.7	-38.6%	1.1%
Lithuania	0.6	0.1	-83.3%	
Russian Federat.	180.6	114.6	-36.5%	5.1%
Turkmenistan	0.4	-	-100.0%	
Ukraine	74.8	39.0	-47.9%	1.7%
Uzbekistan	4.1	1.1	-73.2%	
Other f. Soviet U.	6.0	0.6	-90.0%	
Total f. Soviet Union	308.0	180.4	-41.4%	8.0%
South Africa	71.3	80.6	13.0%	3.6%
Australia	39.5	47.6	20.5%	2.1%
China	533.6	520.6	-2.4%	23.1%
India	107.8	173.5	60.9%	7.7%
Indonesia	4.0	16.7	317.5%	0.7%
Japan	76.0	103.0	35.5%	4.6%
Malaysia	1.3	2.4	84.6%	0.1%
New Zealand	1.3	1.3	0.0%	0.1%
South Korea	24.4	45.7	87.3%	2.0%
Taiwan, China	11.2	30.9	175.9%	1.4%
Thailand	3.7	8.8	137.8%	0.4%
Other Asia Pacific	54.9	58.7	6.9%	2.6%
Total Asia Pacific	866.6	1020.7	17.8%	45.3%
TOTAL WORLD	2266.0	2255.1	-0.5%	100.0%
Of which EU 15	294.7	212.5	-27.9%	9.4%
Of which OECD	1092.8	1108.2	1.4%	49.1%
Of which f. Soviet U.	308.0	180.4	-41.4%	8.0%

So while Europe on the whole is moving towards less use of coal, there is a wide range.

Trends are interesting, but still more interesting is the absolute level of coal use.

Germany is the top coal user, but it is also has the biggest population, so that does not tell very much. The per capita figures are much more interesting. Here they are, expressed as ton carbon emitted per capita from coal combustion, which is practically the same thing as energy from coal per capita.

Table 4. Carbon emissions from coal combustion metric ton per capita 2000.

Source: data from US DOE EIA.

	Em. per capita	Comment
Czech Republic	1.73	big coal producer
Poland	1.54	big coal producer
Bulgaria	1.09	big coal producer
Russia	1.01	big coal producer
Germany	1.00	big coal producer, subsidized, large share brown coal
Ukraine	0.98	big coal producer
Greece	0.93	big coal producer
Macedonia, FYR	0.90	big coal producer
Slovakia	0.87	big coal producer
Belgium	0.84	was a big producer, ceased 1992
Netherlands	0.84	no coal production for decades
Slovenia	0.76	small coal production
Denmark	0.75	no coal production
Yugoslavia	0.75	coal producer
Finland	0.70	no coal production (but peat)
United Kingdom	0.63	rapidly shrinking coal production
Malta	0.52	no coal production
Spain	0.47	big coal producer
Ireland	0.46	no coal, but peat*
Austria	0.43	small production
Portugal	0.40	no coal production
Iceland	0.39	no coal production
Hungary	0.38	coal production
Turkey	0.37	increasing coal production
Romania	0.36	coal production
Luxembourg	0.28	no coal production
Estonia	0.26	no coal production, but oil shale*
France	0.25	insignificant coal production, being phased out
Sweden	0.25	no coal, but some peat
Norway	0.24	insignificant coal production
Italy	0.23	no coal production
Croatia	0.14	no coal production
Bosnia and Herzeg.	0.09	insignificant coal production
Belarus	0.05	no coal production
Lithuania	0.03	no coal production
Latvia	0.03	no coal production
Switzerland	0.03	no coal production
Moldova	0.02	no coal production
Cyprus	0.02	no coal production
Albania	0.00	no coal production

*Peat and shale are sometimes accounted for as "coal", but not included in the EIA statistics.

Table 4 shows that the use of coal varies by a very large factor between nations. For example Germany has four times as big coal use as France, and 33 times as

much as Switzerland, both neighboring countries with similar standard of living and not very different industrial profile. This shows that coal use is a matter of choice. (For oil and gas, the differences between nations are much smaller.)

The table also gives a good hint as to why some nations use a lot of coal, and others much less: most big users are also producers, or have recently been. Most of the nations with small coal consumption are not producers.

From a static perspective (one single year), it seems that it is difficult to decrease coal production. The obvious reason is that a complete coal lobby with both a mining industry, coal users (power and steel), and the accompanying trade unions, local and regional politicians can mobilize an effective resistance.

Conversely, it is easy to show that the circle *can* indeed be broken. In western Europe, coal production was cut by about 50 per cent from 1990-2000,⁸ and in the former USSR and ex-Communist Europe, the reduction was almost as radical. The UK, one of the two leading coal countries in Europe since the industrial revolution started, cut its production by two thirds from 1990-2000.

It can be done, and it can be done fast. Belgium, another once coal-based economy closed its last mine in the early 1990s.

Case: United Kingdom

The UK also illustrates the relation between production and consumption. When production was cut, the consumption followed suit. Some of the indigenous coal supply was replaced by imports, but most was not. It should also be mentioned that that the rapid decline of coal took place while nuclear power has been cut. Since 1988, 12 reactors have been closed down, while only one reactor has been added (in 1995). Though the one new reactor has a much larger capacity than any of the decommissioned reactors, the net effect is a real decrease in nuclear capacity. More closings are foreseen before 2010, and still more before 2020.⁹

Table 5. Coal balance, the UK.¹⁰

(Mtce)	1980	2000	2005 forecast
production	105.7	27.5	12.8
import-export	2.0	21.4	23.4
supply	98.3	53.3	36.2

There is of course some specific British history behind these figures, such as the miners' extremely long and bitter strike against closures in 1984-85 and the Thatcher government's crushing victory over them. But the structural causes were stronger. The industry was loss-making and had a low productivity. The cure for this according the unions and the government in the "Plan for coal" 1974 was more investment in technology. But more productivity is per definition less employment at a constant production level. The investments had to be unevenly spread, and most pits closed, and most miners got out of work. The alternative, to keep going without investments in new technology would have saved enormous amount of money and initially also employment, but then killed the entire industry.

The traditional role for coal, in the UK as in most of the world, was to be produced near the user. An old marginally profitable or slightly subsidized mine could be kept alive by selling slightly overpriced coal to a nearby old marginally profitable

⁸ US Department Of Energy, Energy Information Agency <http://www.eia.doe.gov/pub/international/iealf/tablef5.xls>

⁹ See e.g. IEA: Electricity information 2001, p II.681.

¹⁰ IEA Coal Information 2001, p II.380. The figures do not match exactly due to stock changes.

or slightly subsidized steel or power plant. But if the mine goes, the plant needs new harbors or railways to import coal. If the plant goes, the mine needs such infrastructure to export it. Neither of them can afford such investments.

An added factor was the environment. A steel plant or a power station can retrofit pollution control devices, and drastically cut emissions of SO₂, NO_x, and dust. But at a high cost. Many steel plants were closed, and many coal power stations were closed or downgraded from base load to reserve or peak load.

New coal power stations, with much stricter environmental demands were too expensive to build. It was cheaper to build new gas-fired power stations.

So it was not only a question of being competitive with imported coal, but also with other ways of producing electricity, and to some extent with more efficient use of electricity. True, electricity use has kept going up, but not at all as fast as was predicted in the 1970s, and which resulted in overcapacity and low electricity prices on a deregulated market.

The factors behind the rapid decline of the British coal industry were, as seen, rather general. In fact, much the same story was repeated in other West European countries, in the ex-Soviet bloc, and from 1996 on in China.

This is not to say that the demise of coal in Europe is inevitable. Coal is a very cheap fuel for the plants that already have the infrastructure to import it and the licensing to use it without much further investments. It is also obvious that economically and ecologically unsustainable subsidies can actually be sustained for a very long time, as in Germany.

The future of coal in the European Union is not only of interest for the Union itself, nor is European coal an internal European affair. Europe is an export market for Australian and Canadian coal, which has strengthened the anti-Kyoto lobby in Australia and Canada. Europe-based coal companies operate all over the world. Technology to use coal can also be used to reinforce coal-based industrial structure in other nations, as well as development of alternatives such as wind power can spread to other nations. Obviously the coal policy in the EU influences the surrounding nations, especially the applicant countries.

Export and imports

Europe is a net importer¹¹ of coal, which means that it encourages coal mining and reinforces the coal lobby in other parts of the world. It also means that it uses coal from parts of the world where environmental regulation can be less strict, and with less worker protection.

OECD member countries in Europe imported 136 Mtons of steam coal in year 2000,¹² of which 42 Mtons from South Africa, 22 from Colombia, 18 from Poland, and 16 from Russia.

Germany¹³ imported 23 Mt hard coal, of which 18 steam coal in 2000. (The rest is coking coal or coke.) Poland was the biggest steam coal supplier with 6.7 Mt, followed by South Africa 4.6 Mt, Colombia 2.7 Mt, Czech Republic 1.1 and Russia 0.9 Mt.

The UK imported 23.4 Mt hard coal, of which 15 Mt steam coal, most from Colombia (5.6), South Africa (4.8), Australia (1.2) and Poland (1.1).

France imported 19 Mt hard coal, of which 12.5 steam coal, mainly from South Africa (4.6), Colombia (1.5) and Australia (1.5).

¹¹ See e.g. www.europa.eu.int/comm/energy/coal/annual_report/2001_en.pdf

¹² IEA Coal Information 2001, p II.63. Most data preliminary.

¹³ IEA Coal Information 2001, various pages.

Italy imported 19 Mt, of which 11.8 steam coal, mainly from South Africa (3.5), Indonesia (1.9), Colombia 1.8, Venezuela (1.1), and Russia (1.0).

Spain imported 21.6 Mt hard coal of which 17.2 steam coal, mainly from South Africa (9.2), Indonesia (2.8), Russia (1.5), China (1.1), and Australia (1.0).

The Netherlands imported 22.3 Mt of hard coal, of which 17.4 steam coal, mainly from South Africa (5.3), Indonesia (2.7), Colombia (4.8), Australia (1.1), and the United States (1.6). Much of the coal imported to the Netherlands was however reexported to Germany.

The only major exporter in the EU+ area is Poland which exported 18 Mt of steam coal in 2000, mainly to other European countries. Russia exported 34.3 Mt, while Ukraine was a net importer.

Lignite in Europe

One specific feature for Europe is the high use of lignite or brown coal.

Of the world total production 915,000 short tons in 2000, no less than 389,000 were mined in western Europe, and 248,000 in eastern Europe and the former Soviet Union, according to the geographical definitions of the US Department of Energy. Lignite is the most CO₂-emitting kind of coal. Since it is almost only strip-mined, it is extremely destructive for the landscape, groundwater etc. It also, on average, emits more SO₂ per unit of energy.

Germany alone mines a fifth of the world's lignite, and is the world leader of lignite technology, which it has exported to eastern Europe and to the United States, where Rheinbraun is a leading coal company.

Unlike coal, lignite is not directly subsidized in Germany, though obviously the production and use of lignite do not carry their own environmental costs. This means that there can be considerable economic interests to keep and expand lignite. The Vattenfall company, 100 per cent owned by the Swedish government, has now through its German acquisitions a strong stake in keeping lignite. Now that Vattenfall is a major carbon emitter, it has suddenly found that "Carbon dioxide separation and storage could play a significant role in limiting greenhouse-gas emissions from the use of fossil fuels." (Annual report 2001).

Germany's lignite production has decreased over the 1990s, but not very fast since 1995, and is projected stable through 2005 at about 49 mtce (34 Mtoe).¹⁴ Lignite contributed a fifth¹⁵ of the German CO₂ emissions in year 2000, or about 173 Mt, or 5 per cent of the total EU CO₂ emissions.

Greece's 23 per cent growth of CO₂ emissions from 1990-2000 can largely be explained by its growing use of lignite, 12 Mtce in year 2000, or some 42 Mt CO₂, or about a third of its CO₂ emissions. Spain's consistent anti-environmental stance, and "special-case pleading" in EU negotiations has also a background in its use of lignite with up to 7 per cent sulphur.

Lignite is almost only used for power production, where it is an important fuel in many countries, but also fairly simple to replace, either by other power sources, conservation, or fuel switch in existing plants. Table 6 (next page) should therefore call for policy attention.

¹⁴ IEA Coal Information 2001, p II.196.

¹⁵ <http://www.diw.de/deutsch/publikationen/wochenberichte/docs/01-06-1.html>

Table 6. Lignite's share of power production year 2000 (per cent).¹⁶

Macedonia	78
Greece	69
Czech Republic	69
FR Yugoslavia	66
Bosnia-Herzegovina	56
Bulgaria	40
Poland	34
Slovenia	34
Romania	30
Turkey	28
Germany	26
Hungary	26
Slovakia	7
Spain	6

Peat in Europe

Peat is another fuel with high carbon emissions, which is also very destructive for landscape, and with varying but often high sulphur and heavy metals content, and high VOC emissions. Peat resources are huge all over the world, but not much used outside Europe. Its now small use may be increased, spreading from the main producers and users in Finland, Ireland and Sweden, unless checked.

In Sweden, peat is exempt from CO₂ tax, which is the only reason why it is used, and to an increasing degree even imported (from the Baltic republics). In Finland, peat is no longer directly subsidized, but still not levied full CO₂ tax.

The peat lobby in the EU has with some success claimed that peat is almost a renewable fuel, arguing that more peat is formed (all over the place) every year than is consumed (at some points)!

Though presently of small consequence for the total EU emissions, peat is significant in relation to the national CO₂ targets for Finland, Ireland and Sweden. In Finland, the total amount of peat-based emissions was 13.5 million tons CO₂-equivalents or almost one-fifth of all greenhouse gas emissions in Finland in 1999, according to the third national communication. In 1995, 11 per cent of the total energy came from peat.

In the EU system, such "national circumstances" can be of considerable importance, even when it concerns smaller nations, and create new problems for the second Kyoto commitment period.

Both Estonia and Latvia project increased peat production and use in the future in their third national communications to the Climate Convention. This may partly be the result of influence from Sweden and Finland, and may reinforce the peat lobby in the EU when Estonia and Latvia enter as members.

Like lignite, peat is easy to substitute.

¹⁶ Ballisoy and Schiffer: Lignite in Europe. September 2001. From RWE Rheinbraun's website www.rwe.com

3. Coal and the environment

The environmental impact of coal has been and still is enormous. While it is technically possible to virtually eliminate these impacts, with the exception of CO₂ emissions, real world coal is on average very dirty, and is likely to remain so.

Emissions of SO₂ and NOx

In the EU in 1999, 6803 ktons of SO₂ was emitted, out of which 4306, or almost two thirds, came from energy industries. Since hydro, gas and nuclear does not emit SO₂, it can be safely concluded that most of this comes from coal, with most of the remainder from heavy fuel oil.

Another large tranche came from “manufacturing industries and construction”, which contributed 1150 ktons, where a considerable part must come from coal.

In the non-EU parts of Europe, clearly SO₂ emissions are still more dominated by coal.

A more detailed analysis is not needed to conclude that acidification caused by SO₂ emissions is mainly linked to coal. (It is also difficult to find data for an up-to-date analysis, and things change fast.)

There are of course many ways to reduce SO₂ emissions from coal combustion, such as flue-gas desulphurisation (FGD) and use of low-sulphur coal. This is fine for the mining industry to state. But at the point of use, the relevant parameter by which to judge is real performance and not future options.

While emissions of SO₂ from coal on the whole is a manageable problem, it is important in quantitative terms. It does matter a lot to the forests and to Europe's historic monuments *when* emissions are cut, and how much. The SO₂ reduction targets are regulated by the CLRTAP Gothenburg protocol and by different sets of EU and national legislation.

If SO₂ is seen as an isolated issue, low-sulphur coal and FGD may often be the least-cost option and the quickest solution.

If a more integrated approach is chosen, where the costs for reducing SO₂, NOx, methane, dust, VOC and N₂O (nitrous oxide) and methane and ammonia, the added costs for each step often precludes the continued use of coal. If CO₂ is costed (by tax, permit trading or by the regulatory process or a combination) or if such costing is predicted, the disincentives against coal become very strong.

NOx emissions from coal are generally higher than from other fuels, due both to the combustion process per se, to the age of the plants, and to the low thermal efficiency. Just like as for SO₂, the technological solutions are well-developed since many years, but much of the coal combustion is still very high in NOx.

The NOx control equipment can reduce emissions 90 per cent, but some power stations have no control, and some of the real-world de-NOx systems are much less efficient and some actually add extra N₂O or ammonia emissions.

To give an overall figure is hard, as statistics are not produced in terms of fuel. However an externality study, based on the EU “50-% gap closure” for acidification/eutrophication found that the effects are five times higher for coal, and 20

times higher for lignite than for natural-gas combined cycle plants. This study gives the following figures for full fuel cycles for Germany:¹⁷

	SO ₂	NOx	Particulates
Coal	326	560	182
Lignite	425	790	511
Oil	1611	985	67
Gas	3	277	18

The oil figure is not very important, since oil is not much used for power generation. But a comparison between gas and lignite/coal is indeed striking. Particulates is predominantly a coal/lignite problem, and NOx emissions are 2-3 times higher than for natural gas. It should be kept in mind that Germany has a very strict regulation on power plants since 20 years, and that in other countries, the differences may be much bigger.

Methane

Methane is the second most important antropogenic greenhouse gas, and methane concentrations are now higher than any time for at least 420,000 years.

Methane emissions are another consequence of coal mining. It is a well-known work hazard since coal mining began, and has caused the death of many thousand miners through either suffocation or explosions. (Canaries are more sensitive to methane, and have been used to warn miners since very long.)

Methane is ventilated out of all gassy mines. Some of it is recovered and burned, but most is emitted to the atmosphere, where it is a potent greenhouse gas. The recovery rate is small, and will probably remain so. In an IEA study¹⁸ it was calculated that in 1990 25 Mt of methane was emitted from mines, preparation, transport, storage of coal, of which 1 Mt was recovered, and the rest discharged to the atmosphere.

Some of the methane is emitted from preparation, transport and storage of coal. This is less dangerous, and therefore usually not even calculated, and anyway not recorded.

The methane emissions vary by a large factor between mines and coals. As a rule there is more methane in deeper mines, and hardly any at all near the surface.

Coal mining represents a relatively small part of the total antropogenic methane emissions, about 12 per cent (1994).¹⁹ But two of the other major sources, rice paddies and ruminants (belching cows) look very hard to form a policy about, or at least to implement efficiently. Of the methane emissions that can be influenced by policy, coal represents about 30 per cent of the annual methane emissions.

Heavy metals

According to a position paper²⁰ for the mercury part of the EU air quality directive, 52 per cent of the antropogenic mercury came from coal combustion in 1995.

Coal is also a dominating source of antropogenic arsenic. Stationary combustion contributes 87 per cent according to another position paper for the same direc-

¹⁷ <http://externe.jrc.es/Germany+Coal.htm>

¹⁸ Global methane and the coal industry OECD/IEA 1994.

¹⁹ Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US. See cdiac.esd.ornl.gov/trends/meth/ch4.htm

²⁰ <http://www.europa.eu.int/comm/environment/air/background.htm#transport>, see *Ambient air pollution by mercury (Hg). Position Paper*. European Commission 2001.

tive.²¹ Of the 1990 emissions, 60 per cent came from hard and brown coal, most of it from hard coal. Though there has been substantial cuts in emissions since 1990, the proportions should not have changed drastically.

Coal also contains significant amounts of radioactive elements, especially thorium and uranium. According to an issue brief from the World Nuclear Association:²²

“The amounts of radionuclides involved are noteworthy. In Victoria, 65 million tons of brown coal is burned annually for electricity production. This contains about 1.6 ppm uranium and 3.0-3.5 ppm thorium, hence about 100 tons of uranium and 200 tons of thorium is buried in landfill each year in the Latrobe Valley. Australia exports 88 Mt/yr of steaming coal averaging 1.1 ppm U and 3.5 ppm Th in it, hence 100 tons of uranium and 300 tons of thorium could conceivably be added to published export figures; maybe double this if the 87 Mt/yr of exported coking coal is similar.

Other coals are quoted as ranging up to 25 ppm U and 80 ppm Th.”

Other externalities

Coal mining has killed and maimed millions of workers. This situation has rapidly improved, both due to better technology, better worker protection and to the workforce reduction. The increasing strip-mining is also less dangerous than deep mining.

On the other hand, as deep mining is reduced in western Europe, and replaced by imports from Russia, China, South Africa, Columbia and Indonesia, one should keep in mind that the working conditions there can be much worse. In year 2000, 5736 deaths in mining were recorded in China,²³ though some sources would put the total nearer 20,000. To be fair, it should be noted that most of these accidents occur in village mines, and that the big coalfields from which coal is exported are much less dangerous. Still, even in the big state-owned mines the fatalities about 2 per Mtce, much higher than for example Russia, which saw 137 deaths, South Africa 30, Poland 28.

In China, over 10 million people have dental and skeletal fluorosis and at least 3000 people are reportedly suffering from severe arsenic poisoning as a result of coal burning.

Practices such as mountaintop removal for strip-mining are very damaging for landscape and local biodiversity. As the best seams are already mined, the overburden proportion tends to get bigger.

As for the waste products from coal, much of it reused, and in 1999, 50 per cent of the fly ash and bottom ash were reused in the EU – which can also be expressed as that 50 per cent was landfilled.²⁴ For the rest of the world that part is certainly much higher.

²¹ <http://www.europa.eu.int/comm/environment/air/background.htm#transport>, see *Ambient air pollution by As, Cd and Ni compounds. Position Paper*. European Commission 2001.

²² *Naturally-Occurring Radioactive Materials (NORM)* July 2000 a t www.world-nuclear.org

²³ This and following figures for fatalities and health comes from a World Coal Institute report to UNEP and the World Summit on Sustainable Development at http://www.uneptie.org/outreach/wssd/contributions/sector_reports/sectors/coal/coal.htm, London 2002.

²⁴ Above-mentioned world coal insitute report.

4. Winding down the coal industry

From figures above, it can be seen that a rapid phase-out of coal production and consumption is indeed possible. It has been done in the UK, in China, in France and in other countries.

Theoretically, there are two ways to cut down the coal industry. If coal isn't produced, it won't be used. Or: If the coal cannot be sold, it won't be mined.

The latter approach has several advantages. Most coal is used for power production, and that share is also increasing. Some 70 per cent of all coal (globally) is used for power. Of brown coal, more than 90 per cent goes to power stations.

There are many alternatives to coal, on short, medium and long term. Power is an increasingly competitive business, and the power producers always look for the least cost option (though it is a simplistic view that they only look for cost-reduction), so they are quite responsive when the rules of the game change, for example when subsidies are lowered or taxes are increased.

Power companies can adapt ..

Power producers are very resourceful in money, propaganda and politics, but they can collectively survive a fast decrease of coal use and still make money, at least if they are allowed to recover their losses by a moderate increase in electricity prices. The power companies also have different shares of coal of their total generation, so there are winners and losers among them. They are also moderately vulnerable to consumer pressure. A "greener" power company may be able to increase its market share, or attract more money from the stock market, due to the regulatory risks associated with operating many old coal power stations.

The users of electricity, especially electricity-intensive industry, are however also very interested in low prices, and if the power industry is able to align with them they are a formidable opposition.

In sum, the power industry can compromise with the environmental demands. They generally do not deny the problems, but want to move slowly. Cuts in coal production in one place do not necessarily lead to cuts in power production, because the power companies might switch over to imported coal. But if the use of coal is getting more expensive through taxes and/or regulation and licensing on SO₂, NO_x, N₂O and other pollutants, as is the case in many countries, imported coal is not an attractive option. Also, switching from indigenous to imported coal may demand investments in infrastructure, which are expensive, takes long time and are subject to regulatory risk. This risk can be substantially increased by NGOs fighting against many such projects, in an early stage.

If it has to, the power industry can adapt.

.. but not the coal mining industry

This is in stark contrast to the coal mining industry, which does not have any other option than to fight for its life. Though some energy companies have divested their

coal assets, this only means that they change hands, not that the pits are actually closed. There is no room for discussion or compromise with the coal mining industry.

The discussions (and compromises) should be taken with politicians on all levels on how to find replacement industries and jobs, retraining schemes etc, so as to ensure that an unfair burden is not placed on people who now are now dependent on coal. The coal industry has too often been able to muster public sympathy, by keeping these communities and workers as hostage.

Within the European NGO community, a discussion is needed on how to handle this issue. It may only be mentioned that the German BUND²⁵ “demanded” in 2001 that brown coal operations are closed down within 30 or 35 years (for different locations) – a timeframe that other NGOs might find rather long.

The third possible target for action against coal is of course national governments and the EU. The governments have, in theory, everything in their hands to enforce electricity conservation, de-subsidization of coal, subsidies to cleaner energy, environmental legislation and taxation. But they will not use the power they have, unless under pressure to do so. (Clearly in the environmental issues, scientists and NGOs exert *some* pressure, but opposing pressures are also strong.)

Arguments for retaining coal

The arguments for retaining coal can easily be predicted, and countered.

Employment and local economy

Effects on employment and local/regional economy ought not to be a big issue, since relatively few people are employed in coal mining, and there is no way to stop employment from falling substantially even if production is kept at present level. There are many more cost-effective methods to increase employment than to keep mining coal. Nevertheless the dying industry’s fight often can muster a lot of public sympathy and political support, and campaigning for pit closures can look heartless. One way to counter this is to campaign along the line “save the people, save the communities, not the coal”. The problem is a small one in economic terms, and government action for establishing new industries and retraining schemes could pave the way for early closures.

More imported coal instead

The risk that indigenous coal is replaced by imported coal should not be great, if a minimum of environmental policy is introduced by the same time as coal production is de-subsidized. This need not be a high carbon tax or carbon trading at high prices. A more stringent legislation and/or taxation for SO₂ and NO_x etc. would discourage use of all coal, indigenous as well as imported.

Natural gas instead

The risk that the moribund coal industry is replaced by more long-term dependence on other fossil fuels can in some cases be real. Investments in new pipelines, LNG facilities and in natural gas production all mean a very large CO₂ emission commitment. This is, to a lesser degree, also true for new natural gas power stations. Though a fuel shift from coal to gas can cut all emissions drastically, it can create a long-term obstacle to sustainability.

The NGOs in Sweden have fought against major extensions of the natural-gas pipeline for many years, so far with success, as they see it as a threat to the growing biomass alternative. Biomass, mainly from wood residues, is used for district heating and private home heating, and for process heat in the paper and pulp industry. A

²⁵ www.bund.net, see Energipolitik, Braunkohle: “Sozialvertaglich aus der Braunkohle aussteigen.

small part of the biomass is also used for power in CHP. As renewables are already replacing coal and oil, NGOs see no reason for introducing another fossil fuel.

The gas lobby claims that gas could be a “bridge” to biogas or hydrogen, but this is hardly credible, technically or economically, considering the enormous amounts of energy concerned.

Norwegian NGOs have opposed building pipelines and gas power stations in Norway, also so far with success. Norway has the highest per-capita electricity consumption in the world, all of it hydropower.

Though Sweden and Norway are different from the rest of Europe in many ways, with low population density, abundant hydropower and huge forests, there are very large untapped renewable resources in every nation. Still, the NGOs have to pick their fights.

A CO₂ tax or trading scheme that includes power production can be designed so as to give an edge to gas against coal but favour biomass even more.

Shift to nuclear power

Most NGOs are against nuclear power and do not want coal replaced by it. But in spite of all propaganda from the nuclear lobby, there has not been any new orders in Europe since 1993 (Civaux-2 in France), and very few during the last 20 years. Sizewell B in Great Britain was the last order for nuclear power in western Europe, and that was a result of an election promise from the Conservatives in the 1979 election; actually Margaret Thatcher promised to build ten reactors in ten years time, but only one materialized.

Under increasingly market-like conditions, a nuclear renaissance looks unlikely. A more realistic prospect is that the existing nuclear power plants are kept running longer than foreseen, that some of them are uprated to more megawatts and that they could be used more hours per year. This, however, demands huge reinvestments and a good bit of luck to achieve, and for political, and economical reasons, some plants will have to close down within too long, so that nuclear power production will fall. The Finnish parliament’s decision to give permission for a fifth reactor in May 2002 can not change that, and it is not even sure that a reactor will be ordered.

The need for more efficient use of electricity must always be stressed, since such potential conflicts are easier to handle if consumption is lower. In the rich countries, there is an enormous potential to cut energy use without reducing the energy services, such as comfortable temperatures indoor, convenient transport, cold milk and clean clothes.

The issue of how much electricity is really needed is a critical one for the prospects of a nuclear revival. A recent study from the OECD Nuclear Energy Agency²⁶ assumes that electricity demand will grow about eight-fold from year 2000 to 2100, which will produce an 18-fold increase in nuclear power in the most pro-nuclear of their two scenarios. Though this is a blatant example of wishful thinking, it illustrates the importance of energy demand. A just as crude scenario might be that the world uses the same amount in year 2100 as it did in year 2000 and that the growing needs of the third world countries is compensated for by more efficiency in the rich countries and a dematerialization of the economy; more education instead of 8 ton cars.

Security of supply

Coal is abundant and spread over all parts of the world, unlike oil and gas. But energy efficiency and renewables share the same features.

²⁶ **Nuclear Energy and the Kyoto Protocol**, August 2002, see www.nea.fr/html/ndd/reports/2002/nea3808-kyoto.pdf

In theory, everybody would agree that, technically, renewables can replace all present and future energy needs, though opinions on cost differ (see below).

There is much less agreement on the potential for efficiency, as demand side management is extremely complex. It is easier to order a 1000 megawatt coal power plant than to design a program for more efficient lighting or ventilation, saving 1000 megawatts. It takes one decision to increase supply, but millions of decisions to cut demand, many of which include psychological and sociological expertise. Nevertheless efficiency is, physically and economically, a real alternative to more supply.

“Clean coal”

“Clean coal technology” is a rather loose concept, but always includes a far-reaching pollution control for NO_x, SO₂ and particles. In most existing top performing plants this is achieved with electrostatic filters, flue-gas desulphurization and catalytic or non-catalytic NO_x reduction. More advanced technologies are based on fluidized bed combustion, gasification and combined cycle (gas turbine+ steam turbine), which increases the fuel-to-power efficiency, which means less CO₂ per kWh. Some of them result in increased N₂O emissions. Even the most advanced coal power plants are in every respect inferior to natural gas power plants.

CHP, i.e. to produce district heat and power, or industrial steam (for drying, distillation etc.) can cut specific emissions substantially for one plant, but is not credible as a way to improve the efficiency of coal-based electricity. It takes a lot of time and money to build district heating systems, and that time and money could usually be spent better. If CHP is an option, biomass is much preferable to coal.

One of the most modern coal power plants is the lignite-fired Lippendorf outside Leipzig in Germany. The 2x933 MWe plant has a fuel-to-electricity efficiency of 42 per cent, with some heat use even 46 per cent. This is quite good for a coal, but not much compared with a contemporary gas power station such as Baglan Bay in Wales, which has 60-per-cent efficiency, and less than half the specific CO₂ emissions. The investment cost per kW for Lippendorf is about \$1300, with about \$500 for natural gas combined cycle.

Carbon sequestration and storage

Even more futuristic concepts involve carbon sequestration and storage. Some researchers claim that this is achievable technically and economically. The big issue, however, is if the CO₂ stays put. If it re-enters the atmosphere at any time while there is life on earth, it will cause just as much climate change. The more CO₂ stored, the bigger the risk. If sequestration and storage is going to mitigate climate change and really make a difference, it means that a lot of it would have to be stored – in the order of 100 billion tons. It is a next to impossible task to design a leak-proof storage and to prove the case.

Hydrogen from coal may be clean at the point of use, but burning coal without CO₂ emissions remains impossible.

Economic considerations

Coal is extremely cheap to dig up in many locations, but burning coal under anything near environmentally acceptable conditions gives a kWh price roughly the same as wind power. Energy conservation often costs less. It costs at least 1 billion euros to build a new 1000 MWe coal power plant. That sum could buy at least 500 million 11 watt CFL lamps at Ikea, which replace 60 watt incandescent lamps, so the plant would not be needed. But since the \$2 lamp is already a good investment for the customer – saving \$3 for 6 incandescent lamp replacements and reducing electricity bill – there is no need for the government or a utility to invest a cent. All that is needed is an information campaign, and some inducement to lamp designers to design more lamps suited to CFLs.

Biomass for heating and solar heating can often produce cheaper heat than electric heating from coal electricity. The claim for superior economy usually either represents vested interests or expresses a specific strategic political vision, which more or less is the antithesis of environmentalism; a belief that ever-increasing use of natural resources is a prerequisite for wealth. An example of both is the present US administration, but it was also prominent in the whole history of the Soviet Union, and is still alive in many predecessor states.

That ideology is much less explicit in western Europe now than in the past. But much of the energy industry was formed when expansion-for-ever was the prevailing paradigm, and has left its imprint on planning legislation, environmental legislation, in energy forecasting practices and in corporate culture. There is thus still a strong slant towards supply rather than demand measures. For example in Germany, there is an enormous push for wind power through subsidies, but hardly any pull factor for energy conservation and renewable through internalization of external costs for nuclear and fossil power. The German citizen thus has to pay for both coal and wind subsidies, with very little value for the money: the employment is rapidly decreasing in the coal industry, while CO₂ emissions are still high.

Increasing competition

Increasing competition on the electricity market could, in principle, lead to a better balance between supply and demand.

But electricity and energy are riddled with market imperfections. Huge state-owned companies like Electricité de France, Vattenfall, Statkraft and Fortum behave very differently from market conditions according to economy textbooks. The former (or present) state or private monopolies now buy each other at breakneck speed all over Europe and sometimes all over the world, creating or retaining a very oligopolistic situation.

The transport and distribution of electricity, gas and district heating is, inevitably, monopolistic. The government watchdogs try to keep the monopolies clear from cross-subsidies and to keep prices down to reasonable levels, and also to take measures to avoid blackouts, but they do not see it as their job to avoid overcapacity. Neither the power producer nor the customer will focus on the money that could be saved by not transporting, transforming and distributing the extra watt or kilowatt-hour. Both tend to see the huge infrastructure cost as fixed and nothing to do about, though this is by no means the case.

Market barriers for increased efficiency

There are also several other market barriers for conservation of energy compared to supply. People do not ask for products that do not exist or for products they do not know exist. In a tenement or office building, the landlord has a strong interest in keeping the *capital* costs down for lighting, heating, refrigeration and ventilation, but there is little incentive to the end customer who pays the energy and maintenance has an interest in keeping those low, but cannot influence the choice of equipment. And so on. The market does not work very well, and the incentives usually point in the wrong direction if we are heading for a sustainable energy use.

I ask the reader to pardon this long digression, but the point is that traditional cost comparisons tend to underestimate the economical potential for change. It all depends on the rules of the game, and much of it on the fine details. For example: if electricity bills have a substantial fixed component, the incentive to conserve electricity is much smaller. And unless electronic equipment manufacturers are forced to supply transformers that use minimum power for stand-by mode, they will produce cheaper but energy-wasting goods.

Strategic issues for Europe

The biggest coal user in the world is the United States, but Europe is not that far behind. Many people believe that the destiny of the climate will be determined in the third world, where China, India and Indonesia are already big producers and consumers.

But the third world countries tend to copy the technology of the rich countries. The “do as we say, not as we do” message will never get across.

The choice of how to develop energy systems in the third world is therefore much influenced by what Europe, Japan, Australia and North America do.

Japan has ratified the Kyoto Protocol. That means that they will have to start reversing the increasing use of coal power. Europe has already started along that path.

As for the United States the situation for coal is not so good as it might seem. Many of the coal power plants are very old and very dirty, and this is true also for much of the other heavy industry, which also uses a lot of coal and, more importantly, the electricity from coal. Many coal power plants exceed their pollution limit values, but are presently not brought to court, and the steel industry survives by huge subsidies. This cannot go on forever. The arrogant position of the United States in climate negotiations cannot hold for a very long time against international pressure, science and indigenous opinion.

The worldwide market for clean technology could be expected to boom for a long time, starting soon. If this development starts in Europe, European industry would be in a very good position to take a large part of that market. This is already happening for windpower, where Danish manufacturers have kept 50 per cent of the booming world market (3.5 of 7 GW, with an annual growth rate of 37 per cent over the past years).²⁷ Denmark, with 5 million people has changed the world, and prospered in the process.

So far, however, much of this growth is accomplished by the push of subsidies. This is vulnerable to a change of government, as has been shown in Denmark, though the slower growth in Denmark was over and over compensated by exports. If a more aggressive environmental policy is pursued in Europe, a much stronger, and sustainable, “pull” market can be formed – not only for wind but also for biomass power and heat, for solar heating, for energy-efficient equipment, for small-scale natural gas and biomass CHP. (Photovoltaics will not enter the equation for the next few years; it is profitable in a large number of off-grid applications, but it is no alternative to coal and nuclear.)

Another angle is that the fastest and cheapest way for the whole economy to achieve the decided cuts in CO₂, NO_x, SO₂, methane, mercury etc. in the energy and transformation sector and the heavy industry is to phase out coal. (The transport and agricultural sector are almost unconnected). The best way to do it is by internalization of costs, either through taxes or through permit trading, or a combination.

Germany holds the key

The key country is Germany, which is the world leader in brown coal technology, which has subsidized hard coal and which is the by far dominant coal producer and user in the EU, and the biggest and most influential nation in the EU. 44 per cent of the EU coal use is in Germany. The schizophrenic climate and coal policy of Germany is the greatest obstacle for a coherent European coal policy, and a source of inspiration to the coal lobby in other nations.

German coal companies are active all over the world. The German tax-subsidized company RAG is an international coal giant and a member of the Washington-

²⁷ See www.windpower.dk

based Climate Council,²⁸ which has tried to sabotage most climate negotiations^{29 30} from 1990 on, under the leadership of Don Pearlman, who mainly works for the US oil industry but who has also advised Saudi Arabia and Kuwait. This is not only an internal German issue.

But every country has unwarranted use of coal. Much of this use is a result of lax environmental legislation and to lack of publicity and public discussion about big point sources. Deficient environmental reporting can also be a reason why the public and the elected politicians put up with it.

EU coal policies

When the Commission prepared a directive for a CO₂ tax in the early 1990s, they argued that the tax should be revenue-neutral, and result in cut for other taxes, such as income tax or payroll tax, as this would cut unemployment. They were against earmarking of the revenues; a small tax can be earmarked (for renewables, conservation etc.) but a big tax cannot. This seems to hold well today.

The Commission has tried ever since the failure of the energy and CO₂ tax to amend the mineral oil directive to include minimum taxes on other fuels including coal, and finally succeeded in March 2003. One absurd, but not surprising, aspect of the proposal is that the tax is based on energy content (same for coal and natural gas) rather than on carbon content. Also the tax is far too low.

Also a trading system is on its way. The agreed directive is very far from the so-called Polluters Pay Principle: the permits are given away for free. Again, coal is favoured. There are several methods for distributing emission permits, but in practical terms they are variations on the "grandfathering" principle that those who emit most (coal) shall also inherit most permits. If benchmarking or Best Available Technology is used as a criterion, there is no level field for all power; instead natural gas power stations are judged by one standard, coal power stations by another etc.

This follows a long-standing tradition from the Large Combustion Plant Directive of 1988, where coal power plants are allowed to emit much more SO₂ and NO_x per amount of useful energy than gas power plants. Perhaps it could even be traced back to the origin of the EU, which was the Coal and Steel Treaty in the early 1950's.

Strong coal lobby, shy opposition

The lobby for coal (and peat) is often strong on the national level, and governments are unwilling to challenge it. So are many NGOs. Like in the US, the oil industry is a legitimate target, but the coal industry enjoys almost immunity to criticism. Even if NGOs have taken critical positions, they do not actually campaign on the issue. It is not high on the priority list.

Perhaps it would work better to campaign on the European level, with a coordinated effort, where the loss of national fossil employment etc. is balanced by similar losses in other nations. The usual give-and-take negotiations on the European council meetings result in compromises of the type: if you accept my overfishing, we will accept your dragging the feet about the water treatment plant upgrades.

²⁸ Hans-Jochen Luhmann, Wuppertal Institut: Eine weitere Form „partizipato-rischer“ TA: Die Unternehmensstrategie Privater als Gegenstand eines Technology Assessment seitens öffentlicher Wissenschaft.

²⁹ TA-Datenbank-Nachrichten, Nr. 1 / 10. Jahrgang - März 2001, S. 145-152 Forschungszentrum Karlsruhe, Institut für Technikfolgenabschätzung und Systemanalyse (ITAS) www.itas.fzk.de/deu/tadn/tadn011/luhm01a.htm

³⁰ Jeremy Leggett (Greenpeace scientist) A catalogue of carbon club manipulation, distortion, sabotage or lying at the climate negotiations. www.carbonwar.com/ccchrono.html

This process could be turned around to something like: if you phase out your coal subsidies, we will impose strict pollution limits on our power stations. If such compromises can be reached each government can take credit for the environmental effects, save money and blame all negative effects on "Brussels".

Also, the power industry say that they want a level playing ground for competition with common rules. Why not take them at their word? Common environmental taxes are more efficient, economically and ecologically.

A concerted campaign against coal from the environmental NGOs would also leave each national NGO less exposed nationally. But it still takes a minimum of political courage. It is necessary to say right out that nobody has a right to stay in his present job for decades.

The old obsession with national independence and security of supply must also be attacked in clear terms. We import and export everything else, what is so special about energy?

Of course we should not put our whole existence at the mercy of OPEC, but that is exactly what we are doing in the transport sector; this cannot be compensated for by use of coal in the power sector.

A phase-out campaign for coal should focus on taxes and subsidies, and on pointing out the dirty industry and its dirty lobbying tactics. The main alternative should be efficiency, but also renewables.

The important thing is to make it clear that there is a choice – the choice between coal on one hand and the future for man and nature on the other. Once that message gets through, there is a whole catalogue of methods to phase out coal fast, meaning a 50 per cent cut in 10 years or so. That corresponds to a less than 7 per cent decrease per year, hardly a drastic change for other businesses.

Annex 1.

Corporate coal – international perspective

Figures about production and consumption of coal (and accompanying emissions) are often hard to find. The data below are compiled in March 2002, with the exception of Vattenfall which is updated after its sustainability report July 2002.

Table A1. Top 10 largest commercial coal producing companies, 2000. Source: IEA Coal Information 2001.

Companies	Prod. Mt	Exports Mt	Share exp/prod %
Peabody (USA)	176.1	10.5	6.0
Rio Tinto (UK)	132.0	25.4	5.3
Arch Coal (USA)	106.3	4.0	3.8
RAG (Germany)	97.0	7.0	7.2
Billiton (UK)*	68.6	34.0	49.6
Anglo Coal (UK)	64.8	23.1	35.6
Consol(USA)	63.1	9.0	14.2
BHP (AUS)*	54.1	35.0	64.7
Sasol Mining (SA)	50.9	3.5	6.9
Glencore (CH)**	39.1	31.0	79.3
Total	852.0	182.5	21.4

* merged to BHP Billiton in 2001.

**acquired by xtrata February 2002.

Notes about commercial coal producing companies

The top ten producers in year 2000 produced around 852 Mtons or 23.4 per cent of the global hard coal production. Adding the production of the large state-owned companies in India and China raises this percentage to around 60 per cent.¹

As for exports, the concentration is even more striking: “The top four export coal producers, Rio Tinto, BHP Billiton, Glencore and Anglo American now supply 37% of the total traded coal market.”²

The top coal companies sometimes co-own mines. The Baalbone mine in Australia is owned by Glencore subsidiary Enx resources and Sumitomo Corp., the Cerrejon mines in Colombia are owned by BHP Billiton, Glencore, Anglo-American and Exxon. Douglas in South Africa is owned by Glencore and BHP Billiton, Glencore, Anglo American, Mitsui & Co Ltd and Mitsui.

Kestrel in Australia in owned by Rio Tinto and Mitsui & Co Ltd. Etc etc. Several mines are partly owned by Japanese

companies, notably by Mitsui and Mitsubishi.

One strategic aspect of the mining industry, which is not covered here, but should be noted, is that coal is by far the most important mining activity, which means that the equipment industry has also a strong interest in continued coal mining. Other minerals are mined in thousands up to tens of million tons; coal is the only billion ton industry (except oil, gas, and possibly water, which are by convention not classified as mining companies.) Some of the mining companies also market mining equipment. The lobbying capacity of the coal industry may or not be reinforced by the mining equipment industry.

The relation to the power industry is sometimes mentioned in the corporate information, for example as long term contracts, 10 years or more.

Peabody

<http://www.peabodyenergy.com/>

Headquarters in St Louis, MO, USA.

Majority owner: Investment bank Lehman Brothers

The world’s biggest commercial coal company, and very expansive. Opened its first coal mine in 1895.

“Peabody shipped more than 190 million tons of coal to 325 customers in 18 countries last year. /i.e. year 2000/ It fueled 9 percent of the U.S. power plant demand and 2.5 percent of the world’s electric demand.”³

Controls reserves of 9.5 billion (short) tons, corresponding to about 6.5 GtC, more than the annual global fossil emissions.

The company mines much of its coal in the American West, with operations in Arizona, Colorado, Montana, New Mexico and Wyoming.⁴ Has sold its Australian operations to Rio Tinto.

Environmental policy and performance. Quotes from website:

“**The Kyoto Treaty.** America’s economy has grown by leaps and bounds since 1990, fueled by relatively inexpensive energy that averages 73 per cent below Japan’s average industrial rate and 49 per cent below the German average. This wave of economic prosperity is expected to continue into the next century. But in endorsing the Kyoto Treaty – a 1997 agreement negotiated to reduce global carbon dioxide emissions – the Clinton administration may have put much of the

¹ IEA Coal Information 2001 part I, p.238.

² AME Research, <http://www.ame.com.au/guest/Co/strategic.htm>

³ http://voiceofmining.com/cover_stories/jan2001.html, story about Peabody being awarded FT Global Energy Award as “best coal company”.

⁴ *ibid*

nation's future prosperity at risk. The treaty offers no assurance of environmental benefits and fails to create binding targets for 136 developing countries such as Brazil, China, Mexico, Indonesia and South Korea. It only affects 38 developing nations and is legally binding on those countries while placing no requirements on the more than 100 countries whose emissions are expected to increase most dramatically.

For the United States to achieve the promises the treaty tentatively agrees to, Americans would have to reduce energy consumption by about 30 percent in little more than one decade. According to the National Mining Association, the Kyoto accord will take away 2 million American jobs in the first 10 years, drive up energy costs and consumer prices and drain at least \$150 billion a year from the U.S. economy. You can support a fair treaty by writing to:

The President
The White House
Washington D.C. 20500"

“Greenhouse Effect. The greenhouse effect occurs naturally, keeping temperatures constant to support life on the planet. The phenomenon occurs when the earth's atmosphere traps solar radiation caused by gases such as water vapor, carbon dioxide and methane. These gases allow incoming sunlight to pass through and absorb heat from the earth's surface. There is a lack of concrete scientific evidence to prove or disprove the concept of global warming. While computer-based projections suggest that atmospheric CO₂ may double over the next century and cause average temperatures to rise up to 6 degrees Fahrenheit, scientists cannot definitively determine whether they will increase at all. Satellite temperature data, which is believed to be an accurate measure of global climate change, indicate no warming trend in the past two decades. Records also show that average temperatures have increased only one – half degree Fahrenheit since the late 1800s. Scientists are not sure if this change is due to normal variability or if it is linked to increased greenhouse gas levels in the atmosphere.”

One of Peabody's executive vice presidents, Fred Palmer, was one of the most aggressive anti-climate campaigners in the world in his former capacity (up to early 2001) as CEO for Western Fuels Associations and its campaign “Greening earth society”. On Peabody's homepage there is a link to Greening Earth Society, which simultaneously claims that there is no climate change, that warming depends on solar cycles, that warming is beneficial, that CO₂ increase is good for plants etc.

FOR IMMEDIATE RELEASE March 3, 2000

Clipping from⁵ Minnesotans for an energy-efficient economy. press release (Note that formatting may not be exact.) For more information: Michael Noble (651) 225-1133, pager (651) 649-7262.

Environmentalists Preparing to Launch “Jihad”

Coal-Industry Spokesman Tells Electric Utilities

St. Paul — Representatives at the Minnesota Rural Electric Association conference in St. Paul on February 23rd were told “the Clinton Administration and the environmental com-

munity want to put coal plants down, they want to put us out of business, there is no doubt about that.”

Fred Palmer, executive director of the Western Fuels Association and its Greening Earth Society campaign, told Minnesota's electric coops, “you have to protect yourself, your family, your way of life, your community, and your cooperative,” against those who want to take action to slow global warming.

Palmer's remarks were made during a debate with Minnesotans for an Energy-Efficient Economy (ME3) executive director Michael Noble. Palmer assured the audience, “There is no reason to do anything,” he said, “because fossil fuels provide positive good for us and there is not a risk of catastrophic global warming.”

ME3's Noble presented the scientific consensus of the Intergovernmental Panel on Climate Change (IPCC), made up of about 2500 world scientists, that global warming threatens extreme changes in agriculture, forests and habitat. Noble said Minnesota scientists are very concerned that Climate change could substantially deforest the state of Minnesota by the year 2100.

“There is no global warming,” rebutted Palmer. “The science of climate change isn't uncertain – it's wrong.” furthermore, he said “It's just a big coincidence the fact you are burning fossil fuels and CO₂ is going up.”

Palmer said IPCC data referred to by Noble came from scientists “who are not only wrong, they're cooking the books.”

He characterized Earth Day 2000, whose international theme is Clean Energy, as “the ‘Jihad’ (holy war) against industrial activity by the human community.”

Michael Noble documented that industrial leaders such as Dow, Ford, DuPont, GM, Chrysler-Daimler, 3M, Toyota, BP Amoco, Shell and Xerox have all acknowledged global warming as a legitimate concern and are taking unilateral action to curb greenhouse gas emissions.

Palmer said action by other industry was self serving and told the electric utility representatives, “Putting CO₂ into the air, fertilizing plants, is making the world a better place to live. It's our duty as people to create conditions on earth for more people to live better and, by God, burning coal in a power plant does that.” He said, “Maybe by turning the wick up a little bit, by putting CO₂ in the air, we won't have another ice age.”

“It's preposterous to say people putting CO₂ in the air and making it warmer is a bad thing,” said Palmer.

Noble showed slides of ads for the Greening Earth Society placed by Western Fuels Association in publications such as Harper's Magazine. The ads feature graphics of chimps with their hands over their eyes, ears, and mouth. “The Western Fuels Association position on climate change is “see no evidence, hear no argument, speak no truth about climate change,” he said.

Noble urged members of the audience to look at what Western Fuels Association is doing in the name of consumer and taxpayer owned utilities. “You are paying for this. If you truly believe the statements by Mr. Palmer I think you should let

⁵ <http://www.me3.org/>

your customers know this is their utility's position.. But if you agree that this Greening Earth Society is using the equivalent of 'tobacco science', then you should make sure your customers know that you are not using their money to buy these ads."

Noble then congratulated one of Minnesota's electric coop's for dropping its membership in Western Fuels Association because of the Greening Earth Campaign. He quoted a spokesperson for Great River Energy as saying, "When it comes to global warming, we believe it's best to err on the side of doing what's best for the environment, not wasting effort on debating whether something exists. Minnesotans are environmentally minded, and so are we. We would not take as radical a view on global warming as the Greening Earth Society."

More information on climate change and Minnesota is available on ME3's Sustainable Minnesota web site at <http://www.me3.org/issues/climate/>

Arch coal

www.archcoal.com

Headquarters St Louis, Missouri (like Peabody). Formed 1997 through a merger between Ashland Coal and Arch Mineral Corporation.

Only US, only coal. "Second largest U.S. coal producer," roughly 115 million tons of sales annually." Produces 10% of U.S. coal supply. Fuel source for 6% of domestic electricity. Reserves total 3.4 billion tons. Production is 100% low sulphur"⁶

Environmental policy and performance: climate change is not mentioned on website. Takes pride in reclamation activities: "In fact, a recent university study of reclaimed lands in West Virginia determined that reclaimed lands have substantially higher habitat value for wildlife than surrounding, unmined lands."

The slogan "Essential, affordable, Increasingly clean" is used by Arch as well as by Peabody.

Another slogan is "fuelling the new economy", claiming that electronics etc. consumes huge and increasing amounts of electricity. (This is a recurring theme from many US Coal and power companies.)

Links on the web site include Greening earth Society, Global Climate Coalition.

RAG

<http://www.rag.de/indexe.htm>

Headquarters: Essen, Germany.

Total production 2000: 98 Mt. Produced 33.3 Mt in Germany (Deutsche Steinkohle), down 6 from 1999. Target for 2005: 26 Mt. Production according to subsidies and plan for reduction of subsidies demanded by the European Union.

RAG Coal International produced 65 Mt, of which 58 in the United States, remainder in Australia and Venezuela.

Complicated structure including RAG Coal International AG, power generators STEAG and IPP International. Also into rubber, plastics, environment etc.

In its supervisory board are RWE and E.ON members, and also a vice chairman for the federal German parliament.

The declining German market is compensated for by international acquisitions and by other means.

In year 2000 "STEAG broke ground for what is to be the largest investment project in its history – the 1210 MW coal-burning power plant at Iskenderun, Turkey, which in 2003 will begin supplying the state-owned utility company TEAS with electrical power."

Rio Tinto

www.riotinto.com

Production of coal 2001: 148.9 Mt (2000: 131.5). ⁷

Has coal operations (fully or partly owned) in the US (Kennecott), Australia, and Indonesia. Also has operations in copper, iron ore, industrial minerals (titanium diamonds, mineral sand, talc), aluminum, and gold. Energy, including uranium, represented some 18 per cent of total turnover in year 2000, and a similar percentage of the earnings.

The company could survive without coal or with a shrinking coal market, but other operations are also carbon intensive.

Environmental attitude and performance. ISO 14001 implementation ongoing. Supports the UN Global Compact. Has environmental targets, including for greenhouse gases. "Greenhouse gas emissions per unit of production fell by 5.7 per cent on the 1998 level, meeting Rio Tinto's target." ⁸

This way of formulating environmental targets is open to criticism on several points. A goal expressed as per unit of production in an aggregate company is hard to understand, and could be achieved by methods that are largely irrelevant to the environment. Even if the goal were not aggregate, but applied for coal operations alone, increasing emissions divided by even more increasing production is hardly for the benefit of the planet. Also, improved energy efficiency and reduced methane emissions from the mines are of very little importance compared to the impact of the coal when consumed.

Rio Tinto emitted some 23 Mtons of CO₂-eq. in 2000 – to be compared with the emissions from the 132 Mtons of coal, which should be about 400 Mtons. This increased considerably during 2001, at least the first half year.

Rio Tinto is the first mining and metals company to join the Business Environmental Leadership Council, a project of the Pew Center on Global Climate Change in Washington DC.

The obviously pro-active attitude is sometimes open for alternative interpretations:

"We will identify opportunities to minimize threats to our business units and seek to maximize opportunities that may arise as the pressure to reduce carbon emissions increases in

⁶ Analyst's presentation, website http://www.archcoal.com/i_set_news.html

⁷ <http://www.riotinto.com/investors/presentations/download/handouts.doc>

⁸ Annual report 2000.

the countries where we do business. We will continue to participate in national and international climate change policy formulation.”⁹

BHP Billiton

www.bhpbilliton.com

Production¹⁰ 2001: energy coal 92.9 Mt, metallurgical coal 31.1, together 124 Mt.

BHP Billiton is the world's largest producer and marketer of export¹¹ steaming coal and the world's largest exporter of hard coking coal for the steel industry, according to its own web information.

BHP and Billiton are both mining companies with a long history from 1860 and 1885, respectively. Coal mines is only a minor part of their operations. They have coalmines in Australia, Colombia and South Africa.

“Our spectrum of operations produces a variety of coal (e.g. low-sulphur, high-volatile South African coal and bituminous and sub-bituminous Indonesian coal), which allows us to provide product solutions for most applications.

Operations: BHP Billiton has interests in the following operations that produce steaming coal:

Ingwe, South Africa (100% ownership)

New Mexico Coal, North America (100% ownership)

COAL, Australia (100% ownership)

BMA Coal, Australia (50% ownership)

Carbones del Cerrejon, South America (33.3% ownership)

Cerrejon Zona Norte, South America (33.3% ownership)

Exclusive agents for 75% of PT Arutmin, Indonesia”¹²

The coal share of the earnings is relatively minor, surpassed by petroleum, aluminum and base metals and roughly equal to the importance of the steel sector. The company could thus, theoretically, survive without coal. But the other parts, such as aluminum smelters in South Africa and Mozambique, base metals, steelworks, ferroalloys etc are also very energy intensive and GHG intensive. The company is very unlikely to fundamentally change.

Coal production, especially steam coal, has lately been declining, due to divestments and closures.

Anglo-American, (division name: Anglo Coal)

<http://www.angloamerican.co.uk/>

Headquarters: London, UK.

Produced 64.8 Mt coal in 2000, in South Africa, Australia, Colombia and Venezuela. The South African operations were by far the largest 55.2 Mt (total South African production about 180 Mt). The South African coal was divided between deliveries to ESCOM (36.1 Mt) and trade (19.1).

Other businesses: gold, nickel, platinum, sand, concrete lime etc and paper pulp and board.

Expanding: “During April, Heads of Agreement were concluded between Anglo Coal and Sasol Mining for the joint development of the Kriel South coal reserves. Detailed feasi-

bility studies should be completed during 2001 and, subject to viability, first production of coal should be in 2004. Coal production resulting from this co-operation could reach 9-10 million tons per annum, destined for consumption at the Sasol synthetic fuels plant at Secunda in South Africa. Anglo Coal's attributable production from this project will amount to at least 4.5 million tons per annum over 20 year period.” (From Interim report 2000)

Expands also in Colombia: “In Colombia, the Carbones del Cerrejón (CdelC) mine is expected to produce 3 million tons in 2000. The initial expansion of the rail and port capacity from 17 to 21 million tons per annum is complete. The feasibility study for a further expansion of the mine to 9 million tons and the rail and port capacity to 30 million tons per annum is close to being finalised. Following the purchase of Rio Tinto's one-third interest in CdelC, the remaining shareholders, Anglo Coal and Glencore, on-sold a one-third share to Billiton.

Has acquired Shell Coal in Australia and Venezuela during 2000.”

“We emitted 9 million tons of CO₂ from processes and fossil fuels consumed, of which 5 million tons were from our mining and smelting operations. Approximately 1 million tons of CO₂ were sequestered by our forestry operations.”

This does of course not include the emissions from the coal itself when burned.

The reserves as defined in the Annual Report, are well over 2 bn tons, additional resources about 6 bn tons. Has acquired Exxon's part of the Colombian operations together with BHPBilliton and Glencore in February 2002.

CONSOL

<http://www.consolenergy.com/>

Headquarters Pittsburgh, Pa, USA. Controlled (more than 90 per cent owned) by RWE Rheinbraun. Biggest US coal exporter. Produced 73.7 Mt hard coal in 2001, mainly underground and high-sulphur. Also producer of natural gas.

Reserves: 4.5 billion short tons June 2001.

Consol has no information on environmental policy or records on its website, but links to anti-environmental lobbying organizations such as National Mining Association and Edison Electric Institute.

Glencore

Has no website as of March 8, 2002, only “under construction.”

Headquarters Baar Switzerland.

Operates coal mines in South Africa, Australia and Colombia. Otherwise active in trading of metals and other commodities. Is probably more important in the coal business than is shown by its production figures, as it trades coal for no-owned mines, at least in South Africa.

Proposed acquisition of its coal operation by **xstrata**, another Swiss company where Glencore already had a major share. Can be found at www.xstrata.com

AEI Resources

www.aeiresources.com

Headquarters: Ashland, Kentucky.

Produced 46.7 Mtons 2000. Only US. Much long term contracts with electric utilities. Filed bankruptcy early 2002; information scarce.

Massey Energy

www.masseycoal.com

Headquarters Richmond, Virginia, USA.

Produced just over 36 Mt coal fiscal 2000 and is a close runner-up to the top 10 list.

Some other companies:**Western Fuels Association**

“Western Fuels Association is a not-for-profit fuel supply cooperative for consumer-owned electric utilities in the Great Plains, Rocky Mountain, and Southwest states, and Louisiana. We are a cooperative. Our 19 members/owner are rural electricity generating & transmission cooperatives, municipal utilities and other public power bodies.”

“Much of the 20 million tons of coal we supply each year is purchased from coal companies operating mines in the Powder River Basin. The Powder River Basin has the largest reserves of low-sulphur coal in the nation. In our view, the PRB is the single most important energy resource on earth because it is the most important energy resource for the world’s most important economy – that of the United States.”

Unsuccessfully sued a New York Times advertisement from environmental organizations Turning Point Project, Friends of the Earth, Earth Island Institute, Ozone Action, Rainforest Action Network, and the International Center for Technology Assessment “commercial defamation” in April 2000.

Uses innovative methods for financing lobbying:

“We settled litigation with the Burlington Northern Santa Fe /railway company/ involving a trackage rights petition filed with the Surface Transportation Board by Western Fuels Service Corporation. As a part of the settlement package, rate relief was secured for the Holcomb Station.

We also agreed to support the BNSF merger with the Canadian National Railroad. BNSF has agreed to support our advocacy activities at Greening Earth Society. This is a package that is in the best interests of all concerned and we are extremely pleased that we reached this compromise.”

(From annual report 2000)

While Western Fuels does not exactly claim paternity for Greening Earth Society, the latter states:

“Greening Earth Society is a not-for-profit membership organization comprised of rural electric cooperatives and municipal electric utilities, their fuel suppliers, and thousands of individuals.”

UK Coal

www.ukcoal.com

The biggest mining company in the UK with 22 Mt annually.¹³

⁹ http://www.riotinto.com/community/mining/Climate_Commitment.asp

¹⁰ 2001 BHP Billiton Plc Annual Report - Part B.

¹¹ www.bhpbilliton.com/bb/customerCentre/productGroups/energyCoal.jsp

¹² www.bhpbilliton.com/bb/customerCentre/productGroups/energyCoal.jsp

¹³ Website information.

Annex 2.

Corporate CO₂ emissions from coal burning

This Part contains data on the emissions by company for the companies emitting the most CO₂ from coal burning, subdivided into Tables setting out those data:

Table A2.1 Top emitter power companies, preliminary data.

Sources: various data on the companies web pages, some as stated, others converted from coal or estimated from capacity and coal share.

Company	MtC/yr	Country
American Electric Power Company Inc	46.3	USA
Southern Company	31.3	USA
RWE Power	31	Germany
Tennessee Valley Authority	30	USA
Cinenergy	29.3	USA
Korea Electric Power Corp	25	South Korea
Edison International	25	USA
Mirant	19	USA
Vattenfall	18.7	Germany, Sweden
Scottish Power/PacifiCorp	16.7	USA
Taiwan Power Company TAIPOWER	15.6	Taiwan, China
Electricité de France	15	France
TXU	12.5	USA
Duke Power	12	USA
Powergen	12	UK
E.on Energie	12	Germany
Electricidad SA (ENDESA)	12	Spain
Detroit Edison Company	11	USA
Ontario Power Generation Inc	10.3	Canada
Electric Power Development Company Ltd EPDC	9.9	Japan
CEZ as	9.8	Czech Republic
ENEL Spa	7	Italy
Delta Electricity	5.1	Australia

American Electric Power

<http://www.aep.com/>

Headquarters: Columbus Ohio.

Annual emissions from coal power 46.3 MtC.

Worldwide generating capacity: 38,404 megawatts (After

divestiture of assets required by state and federal settlements). U.S. electricity sales: Almost 200 million megawatt hours. Foreign presence: Australia, Brazil, China, Mexico, United Kingdom.¹

Subsidiaries are mainly electricity distribution companies, intrastate natural gas pipeline and storage companies, communication and services, of little interest for this purpose, but also includes a Chinese generation company AEP Pushan Power LDC, Henan Province.

Merged in June 15, 2000 with Central and South West Corp.

66.2 per cent of its capacity in 2000 was coal/lignite, 23.2 per cent natural gas, the remainder mainly nuclear and hydro.

Emitted 187.2 Mtons² of CO₂ in year 2000 or 169.8 Mt metric or 46.3 MtC, which is like a medium-sized European country (Belgium with 10 million people emits some 38 MtC.)

Burns some 75 Mtons (short) of coal each year.

Acquired 4000 MW of coal capacity in the UK in December 2001.

Environmental profile: Plants trees, relocates beavers, invests in wind power, claims to work for renewables and efficiency etc. Member of Pew. Driving force behind the Bolivia Noel Kempff project, in which a national park by not being logged is supposed to sequester carbon. "The NKMCA is projected to avoid emissions of 7-10 millions tons of carbon or 25-36 million tons of carbon dioxide during its 30-year life." "It is the largest project of its kind in the world and serves as a showcase for an innovative and cost-effective approach to abating greenhouse gas emissions."³

Also strives to reduce SF₆ (from transformers).

Southern Company

www.southernco.com

Headquarters: Atlanta, Georgia, USA.

Annual CO₂ emission from coal power, only in the US: 31.3 MtC (1999).⁴

The company's stake in Mirant (formerly Southern Energy), which markets and trades energy throughout North America and has stakes in power plants and utilities abroad, has been

¹ "Facts at a glance" <http://www.aep.com/29/01/02>

² **1999 CERES Report Electric and Gas Industries Form** (Coalition for Environmentally Responsible Economies) from AEP:s web

³ <http://www.noelkempff.com/English/ProjectSummary.htm>

⁴ 140 million short tons total, from all power, of which only 6 per cent was other fossil (gas&oil) multiplied by a factor 0.95 (as gas and oil emits less CO₂ than coal).

spun off to shareholders. Southern Company has formed a new subsidiary, Southern Power, to develop merchant plants in the southeastern US.

“74 generating stations 32,000 megawatts of generating capacity Sources of energy: 72.3% coal; 15.1% nuclear; 1.5% hydro; 4.0% oil and gas; and 7.1 % purchased power.”⁵

That means that of their own power 77.8 per cent was from coal.

Parent firm of the following power companies: Alabama Power, Georgia Power, Gulf Power, Mississippi Power. Savannah Electric.

Emissions: 121 Mt (metric) of CO₂.⁶

Interestingly, absolute CO₂ emissions have increased from 1993 on and are projected to increase through 2020 as generation is increased from about 176 TWh in 2001 to 250 TWh.⁷

Big coal power interests in the UK, China, the Philippines.

Mirant

www.mirant.com

Formerly southern energy, spun off from Southern Company.

Mirant owns 13,600 megawatts of generating capacity in the United States and ranks among the top three owners of unregulated generation. Mirant is one of the top 15 power producers in the country, including traditional regulated utilities. Mirant also has 2000 MW in the Caribbean, more than 3,100 megawatts of generation in the Philippines and China, and has some power activity in Europe, including a very controversial planned natural gas power station in Norway. (The opposition of this project from climate policy objectives actually led to a change of government a few years ago.)

Has sold its shares of German Bewag to Swedish Vattenfall.

Owns or controls 21,500 megawatts. Of the electric energy produced 2000, 54.4 per cent was coal. Plans to have 50,000 megawatts by 2005. The “vast majority” of new power plants will be gas fired.

No figures for emissions in 2000 in environmental report, but if 6000 hours of full capacity operation is assumed, the carbon emissions should be 19 MtC.

RWE AG

<http://www.rwe.com/en/>

Headquarters, Essen, Germany.

RWE Power main electricity producer, parent company RWE AG. Biggest German power company. Produced 255 TWh in 2000/2001.

Of the 33,016 MW of own and contracted power June 2001, the proportions were 29 per cent hard coal, 28 per cent lignite, 17 per cent nuclear, 11 per cent natural gas and 4 per cent oil.⁸

No emission figures published, but on assumption of 6000 average hours full-power operation, the total would be 198 TWh, of which 57 hard coal and 55 lignite, resulting in some 31 MtC from total coal.

Subsidiary Rheinsbraun:

“RWE Rheinbraun is the leading lignite company worldwide.”⁹

“The most important field of operations of RWE Rheinbraun is power generation from lignite mined in the Rhineland region. With their installed total capacity of approx. 10,000 megawatt, the power plants of the company secure approx. 15 percent of German power supply using about 85 per cent of close to 100 million tons of lignite mined per year. The remaining portion of lignite production is refined to solid products, especially fuels for private households and industry.”

“Since the 80s, RWE Rheinbraun AG has been involved in American hard-coal mining. It has taken control of CONSOL Energy Inc., one of the largest and most profitable companies of the industry. The commitment to hard coal as an energy source, whose international importance will grow even more due to growing world energy demand, is broadening the raw material base of the RWE Group and strengthens its international position. Against this backdrop, the hard-coal activities are being expanded further with determination and a clear focus.”¹⁰

Lignite (brown coal) contributed 165 Mt CO₂ from Germany in 1999, from a consumption of 163 Mt brown coal.¹¹

In year 2000, according to RWE¹², Germany produced 172.8 Mt of which RWE Rheinbraun AG 93.1 Mt, which should according to above have produced 94.2 Mt CO₂ or 25.7 MtC.

Internationally active:

“In Visonta, approx. 100 km northeast of Budapest, the mining and power plant company MÁTRA operates a lignite-fired power plant with a capacity of 699 MW as well as two lignite opencast mines. The Hungarian interconnected electricity utility MVM is the only consumer of the generated electricity; with these power purchases, the utility meets approx. 12 % of Hungary’s electricity demand. At the inter-

⁵ <http://www.southerncompany.com/aboutus/figures.asp> 30/01/02

⁶ www.southerncompany.com/planetpower/operation/emissions_data.asp?mnuOpc=soco&mnuType=ppb&mnuItem=0

⁷ Environmental Progress Report 2001: **Our Environmental Commitment**, p.6-10.

⁸ RWE Power Annual Report 200/2001.

⁹ http://www.rwe.com/en/one_group/group_structure/group_structure.jsp, click Rheinbraun click market position

¹⁰ http://www.rwe.com/en/one_group/group_structure/group_structure.jsp, click Rheinbraun click strategy

¹¹ **Energiedaten 2000** Bundesministerium für Wirtschaft... downloadable from www.bmwi.de/Homepage/Politikfelder/Energiepolitik/Service/Publikationen/Publikation.jsp#energiedaten

connected level, MÁTRA has put its sales and marketing partnership with MVM on a secure long-term basis by concluding a new electricity supply contract running until 2015.

RWE Power owns 25.86 % of the shares, another 28.28 % are held by RWE Rheinbraun which is also part of the German consortium.

In autumn 2000, a wide-ranging backfitting program was completed as scheduled to increase the capacity and extend the plant lifetime and to build a flue-gas desulphurisation system. The opencast mines are being upgraded at the moment. These activities are due to be completed in 2002. This will put fuel supplies to the lignite-fired units and the local jobs on a secure long-term basis.”

AIJ project in outsourced Skoda CHP plant in the Czech Republic, with fuel shift from lignite to hard coal, credited 5.44 Mton CO₂eq over 20 years.¹³

Lignite mining company Rheinbraun is a subsidiary, whose fuel emits very large amounts of CO₂ and has several conflicts with the German environmental movement.

EPDC

www.epdc.co.jp/english/

Tokyo Japan. Government majority-owned utility (power companies have minority shares), to be privatized 2002.

“As of March 31, 2000, we operated six coal-fired power stations with a combined output of 5,642 megawatts. We are the largest coal-fired thermal power station operator in Japan, with a 25% share of nationwide output.

We entered the coal-fired power field in the late 1960s to assist the domestic coal industry. Even prior to the oil crises of the 1970s, EPDC began planning power stations fueled by imported coal to diversify source of energy, and was the first in Japan to operate such power stations.

To secure stable supply and economy of overseas coal, we have diversified procurement channels from Australia, China, South Africa, Indonesia and the United States. Imports are based on both long-term and spot contracts. We have invested in overseas coal mine developments to secure long-term stability in coal supply, notably the Blair Athol and Ensham projects in Australia.”

Produced 41.8 TWh from coal 2001. According to a diagram,¹⁴ emissions are about 870 g/kWh, which should mean 9.9 MtC emissions. Better information should be forthcoming, as the company is ISO 14001-certified.

Puts much emphasis on clean coal power development, and plans for more coal power plants.

Other Japanese companies

Tokyo Electric Power Company TEPCO emitted 92.4 Mt CO₂ FY 2000 and is Japan’s biggest power company. Small share of coal, but plans for two new coal power stations.

Kansai Electric Power Company KEPCO did not use coal at all.

Chubu Electric Power Company, another heavyweight in thermal generation had only 7% of its generation from coal (4.87 Mt coal). Tohoku used 7.75 Mt coal,¹⁵ Kyushu used 3.93 Mt.¹⁶

The 60.6 Mtce used for power and heat (IEA 1999) are, as can be seen, spread out over many companies.

KEPCO

<http://www.kepco.co.kr/en/about.html>

Seoul, South Korea.

Annual coal CO₂ emission: 25 MtC.

The South Korean Korea Electric Power Corporation was vertical monopoly with a majority government ownership until April 2001, when its generation part was transferred to six newly-established power generating subsidiaries.

Up till then KEPCO was one of the most aggressively growing generating companies in the world, with both an internationally outstanding investment in nuclear power and a very ambitious coal power program. Coal use for electricity in Korea grew from 1 Mtce in 1980 to 34.3 in 1999,¹⁷ equivalent to 25-26 MtC emissions. Of this was 25.3 Mtce or about 19 MtC emissions from public utilities, i.e. KEPCO.

The accumulated emissions from KEPCO coal use should be possible to calculate, since the company was formed in 1961 and did not use any coal by 1973, i.e. before the first oil crisis.

Tennessee Valley Authority

www.tva.com/

Headquarters Knoxville, Tennessee, USA

Annual coal CO₂ emissions: 30 MtC.

TVA is owned by the federal government.

“TVA began its fossil-plant construction program in the 1940s, and today it has 59 operating units at 11 fossil-plant sites in the Tennessee Valley.

In 2001 TVA’s fossil plants produced 100.1 billion kilowatt-hours of electricity, accounting for 64 per cent of TVA’s power generation.

TVA is the largest single utility buyer of coal in the U.S., purchasing almost 45 million tons in 2001. TVA’s costs for coal are about \$1.3 billion annually.”

TVA accumulated emissions should in principle be possible to calculate from EIA data or by direct questions to TVA. As a federal agency TVA is required by the Freedom of Information Act to disclose records requested in writing.

No details on emissions are available on the website. The so-called environmental report 2000 mentions only avoided CO₂ emissions (through energy saving). But the 45 million (short

¹² www.rwe.com/microsites/en/environmental_reports/environmental_report2000/popup_input_output_bilanz.html

¹³ <http://unfccc.int/program/aij/aijproj.html>

¹⁴ Annual report www.epdc.co.jp/english/annual_rep/annual2001/annual_p06.html

tons of coal should correspond to at least 30 MtC emissions.

TVA has entered a 30 year contract to purchase all the electric output of a lignite-fired plant, commissioned 2001. Whether that is included in the 45 million tons is unclear.

“TVA anticipates that its CO₂ emissions will continue to rise in coming years as demand for power increases.” (Environmental Report 2000)

TVA was No. 1 coal consumer in the US year 2000, according to US DOE EIA.

VEAG (Now Vattenfall)

Total annual coal CO₂ emissions: at least 18.7 MtC, of which 14.9 Mt from lignite in Germany + about 1 MtC from hard coal in Germany, at least 2.8 MtC from hard coal in Poland¹⁸ plus minor use of peat and coal in Sweden, Finland and Estonia.

Vereingde Energiewerke AG Berlin. 100% owned by Swedish government.

Vattenfall has recently acquired VEAG and another German company which will form Vattenfall Europe. As this company, set to be the third biggest in Germany, is still being formed in February 2002 after a long and complicated series of transactions, no comprehensive information is available.

VEAG consumed 54 Mt lignite year 2000, which means 54.7 Mt CO₂ (14.9 MtC), or more than 6 per cent of Germany's total CO₂ emissions, for less than 50 TWh.

Vattenfall has a relatively environmental profile, at least in Sweden. (Though it also has a long history of long and bitter fights with environmental NGOs over hydropower and nuclear power.) The lignite mining operations are very controversial in Germany and also in Sweden, and Vattenfall should at some point also be vulnerable to questions as why their German acquisitions emit about the same amount of CO₂ as Sweden does.

Very uninformative and late environmental report (for 1998-99, emissions only given as per cents of 1989 values). Vattenfall has promised that they will publish the CO₂ emissions for all their power & heat production, but not exactly when.

Vattenfall now has about 8000 MW power (including some heat) lignite power stations in Germany, and about 1000 MW hard coal. (Some stations also use other fuels, so more exact figures would be more exactly misleading.)

It has also about 1000 megawatt power stations and 1000 megawatt district heating in Poland, all hard coal. (All the power stations are nominally CHP, but much of the year they must be used as extra inefficient only-power plants, as the

demand for district heat is insufficient from at least May to October.)

With the acquisition of Uppsala Energi, late year 2000, Vattenfall also became a major user and producer of peat. In international energy terms the ensuing CO₂ emissions are not big, but still big enough to be of importance for if Sweden can meet its unilateral target of a -4 per cent GHG emission 2010/1990. Vattenfall is also present in Finland, where peat is much greater importance.

Vattenfall, E.ON-owned Sydkraft and Finnish Fortum have now a very dominant position in the Nordic Power market.

PowerGen

www.pgen.com

Headquarters: Coventry, England.

Total annual coal CO₂ emissions, rough estimate, 12 MtC.

PowerGen UK emitted about 18 Mt CO₂ (4.9 MtC) year 2000 from coal power stations, though the figure includes some unspecified use of heavy fuel oil in the same plants¹⁹. Has decreased its CO₂ emissions considerably since the split up of the government-owned CEBG in 1990, by shift coal-to-gas, combined heat and power and renewables.

As for foreign plants the situation is pretty complicated. Shareowner of coal-powered plants in Indonesia, Australia and Germany. The half-owned lignite Yalloum plant in Australia dominates the non UK/US holdings emits 13.1 Mt CO₂²⁰ (3.6 MtC), of which Powergen's share should be 1.78 MtC.

The US LG&E Energy is a subsidiary, which was acquired in late 2000, so no figures in environmental report, used about 6.2 Mton (short) coal, which should result in emissions of about 4.3 MtC.

One of the bigger owners is Lehman Brothers, New York (majority owners of Peabody Energy). Another is Deutsche Bank.

Complicated picture of acquisitions, among them LG&E Energy Corp. in the US, with more electricity generation than PowerGen in the UK, and divestments (among others coal power stations in England to Edison Mission Energy).

Very informative environment report. On the way to be acquired by German E.ON.

E.ON

www.eon-energie.com

Headquarters Munich, Germany.

Annual coal CO₂ emissions: about 12 MtC. Second German power producer, sold 211 TWh in 2000.²¹

¹⁵ <http://www.tohoku-epco.co.jp/enviro/tea2001e/01e/e06.htm>

¹⁶ http://www.kyuden.co.jp/english/action/english/action-report01/e_10.pdf

¹⁷ IEA Coal Information 2001 p II.258.

¹⁸ Calculated as 5677 MW of output heat + power, divided by 0.85 for efficiency losses (very conservatively), 4500 hours/year full operation (conservative) and emission factor 25.8 from IPCC for “other bituminous coal”

¹⁹ Powergen Environment Report: 2000 (pdf) p.21.

²⁰ Powergen Environment Report: 2000 (pdf) p.32.

²¹ <http://www.strom.de/wyssstr/stromwys.nsf/WYSFrameset1?Readform&JScrip=1&>

E.ON was recently formed by a merger between Preussen-Elektra and Bayernwerk Parent company E.ON also has “non-core business” in aluminum, logistics, and chemistry. In the core business is also water and natural gas. Of the electricity part, nuclear power is very important.

“To date, the E.ON Energie Group operates in 15 European countries. It has shareholdings and cooperative agreements in Scandinavia, Russia, the Baltic States, Poland, the Czech Republic, Austria, Hungary, Italy, Switzerland and The Netherlands. We expect our sales to double within the next five years. Around 40% will be generated outside of Germany.

E.ON Energie owns both conventional and nuclear power plants as well as power plants which are based on renewable energy sources – both in Germany and abroad. Their combined capacity is approx. 34,000 MW. In Germany, three independent subsidiaries are engaged in conventional power generation (about 15,000 MW), nuclear power generation (around 7,500 MW) and hydropower generation (roughly 2,800 MW). Our Swedish subsidiary, Sydkraft, operates power stations with a total capacity of approx. 6,200 MW. Our Dutch subsidiary, E.ON Benelux Generation, operates power stations with a total capacity of approx. 1,800 MW.”

Produced almost 60 TWh from fossil power in year 2000, of 43 from hard coal, 12 from lignite; should correspond to about 15 MtC. Also purchased power from VEAG (now owned by Vattenfall) and others, so the total coal CO₂ emissions are probably much larger. No figures on coal consumption or CO₂ emissions on web site.

No environment report as yet, but one should be expected during spring 2002.

Comment: E.ON could well survive harder restrictions on coal/carbon at least in Germany and Sweden, due to non-core business, water and in the power sector much nuclear and some hydro. More committed to nuclear than coal.

Edison International

www.edison.com

Headquarters Rosemead, California, USA.

Annual coal power CO₂ emissions: 25 MtC.²²

Operates in nine countries and four regions of the United States. The Edison group has 28 000 MW of generating capacity, shared between:

Southern California Edison. Owns 48% of Four Corners Generating Station Fruitland, New Mexico, 2040 MW coal, 56% of Mohave Generating Station 1,580 Megawatts, Nevada, and

Edison Mission Energy, 8162 MW coal in the Midwest, 3984

MW coal in the UK, 1000 MW coal in Traralgon, Victoria Australia, 40 per cent of Paiton East Java, Indonesia 1,230 MW Edison Share: 492 MW; sum 15.5 GW.

Other US companies with Edison in its name are unrelated, among them **Edison Commonwealth**, which used to be a big coal power producer but has divested most and is now in the mainly nuclear power Exelon group.

Detroit Edison

www.dteenergy.com

Annual CO₂ emissions from coal power some 11 MtC.

Generates 85 per cent of its electricity from coal, and emitted 46 million tons²³ of CO₂ in 1998. No. 6 top coal consumer in year 2000, according USDOE EIA (only rank given.)²⁴

Pacificorp/Scottish Power

Subsidiary of Scottish Power, www.scottishpower.com

Annual CO₂ emissions from coal power: 16.7 MtC (from Pacificorp).

Pacificorp has headquarters Portland, Oregon, USA, and contributes almost all the CO₂ from the Scottish Power group. In 2000/2001 year (up to March 31, 2001) their power stations in the US emitted 61.4 Mt CO₂.²⁵

Ranked 4 of coal consumers for electricity year 2000 by US DOE EIA.²⁶

Operates 6666 MW of thermal power plant of which more than 90 per cent is coal-fired. Has also hydro and minor wind power and, biomass and geothermal plants. Produced 47.5 TWh of coal power in year 2000. In Scotland: 15.7 TWh.

Scottish power has a high environmental profile, with much wind power and CHP projects, and sees conservation as a key element to achieve the UK's Kyoto targets, and has a specific target of 2.4 TWh saved electricity for domestic customers. But still has a much higher coal proportion than the national average in both the US and the UK operations, and has – as yet unspecified – plans for new coal power stations. The US operations includes mines and holdings in a 1600 MWe brown coal power station, Hazelwood, Australia.²⁷

Duke Power

www.dukepower.com

North and South Carolina, USA. Parent company Duke Energy (www.duke-energy.com) which is mainly in natural gas, also all over the US and internationally.

Annual coal CO₂ emissions: 12 MtC.²⁸

²² At 6000 hours operation of the 15.5 GWe coal and 1Mt CO₂ per TWh.

²³ <http://www.dteenergy.com/community/environmental/greenhouseGases.html>

²⁴ EIA Coal Industry Annual 2000 p.195 (downloadable).

²⁵ <http://www.scottishpower.com/library/rep2001/env01/>

²⁶ EIA Coal Industry Annual 2000 p.195.

²⁷ <http://www.sec.gov/Archives/edgar/data/75594/000007559400000018/0000075594-00-000018-0001.htm>

²⁸ Calculated from the 53.4 million short tons of “greenhouse gases”, below: if all of this were CO₂ it would give 13.2. Discounting for methane and N₂O is arbitrarily 1.2.

Emitted 53.4 million short tons²⁹ of CO₂-eq greenhouse gases in year 2000 from power plants, all of which comes from coal. (Fuel mix³⁰ end-2000: 51% Coal 48% Nuclear 1% Hydro) emissions substantially up from previous year, due to more electricity production.

Ranked 11 of top US coal consumers among power companies 2000 by USDOE EIA.³¹

Coal Power's present stations³² should account for most of accumulated carbon emissions:

Allen (Belmont, North Carolina 1140 MW from 1957

Belews Creek, North Carolina 2240 MW from 1974

Buck, North Carolina 329 MW from 1926

Cliffside, North Carolina 760 MW from 1940

Dan River, Eden, North Carolina 276 MW from 1940

Lee, Pelzer, North Carolina 370 MW from 1951

Marshal, Terrell North Carolina 2090 MW from 1965

Riverbend, Mt Holly, North Carolina 454 MW from 1940

Electricité de France

www.edf.com

Headquarters Paris, France.

Total coal CO₂ emissions: rough guess 15 MtC in France, Germany, China, UK.

EDF is the biggest electricity company in Europe, with 470 TWh generation, 103 GW capacity in France and 34 GW outside France, and 7 GWth (district heating). EDF is owned by the French government. Though best known for its large nuclear capacity, it also operates a large capacity of old coal and oil power stations, run to balance the nuclear power. This capacity is used or unused due to availability of nuclear and hydropower and for peak capacity.

EDF France produces 25 TWh "thermal", i.e. mainly coal. If all were coal, that would mean about 7 MtC. (Does not correspond well to the IEA figure 18.9 Mtce coal for heat and power 2000, or 14.3 MtC emissions.)

As for the non-French power stations, the information is very scarce. Some of it is coal power. EDF's environmental reports are very uninformative.

The new **EDF Trading** imported 10 Mt coal year 2000.³³

EDF recently acquired EnBW (Energie Baden-Württemberg AG), which used 2.7 Mtce of hard coal and 0.9 Mtce of

lignite in year 2000.³⁴ (EnBW publishes good environment reports)

Also has a 2000 MW coal power plant in the UK, and some in Poland.

EDF has financed and built a 2x350 MW coal power station in China together with Alstom (coal & other power plant engineering company), on a build-operate-transfer basis, meaning that the French companies get paid by the first 15 years sales of electricity, while they operate the plant.

EDF is committed to "clean coal", and is developing clean coal combustion at Carling and Gardanne in France and Puertollano in Spain.

It should also be noted, however, that some important projects internationally (e.g. in Egypt and China) focus on combined-cycle natural gas, and that there is some effort on wind power.

Delta Electricity

www.de.com.au

Headquarters: Sydney, Australia.

Produced 21.2 TWh 2000³⁵, all of it from coal power stations. The 1996 emissions was 15 Mtons with an emission rate of 890, which (to judge from diagrams) is essentially unchanged and should mean 5.1 MtC.

Has vague ambitions to move away from coal to gas and renewables.

Ontario Power

www.opg.com

Headquarters Canada.

Emissions from coal power year 2000: 37.64 Mt³⁶ i.e. 10.3 MtC. Trend since 1998: strong increase.

Big company: total generation 150 TWh/year about 30 per cent of Canada consumption, most nuclear, then hydro and coal.

TXU

ex. Texas Utilities Electric Company, ex. Eastern Generation, UK.

www.txu.com

Headquarters; Dallas, Texas, USA.

Annual CO₂ emissions from coal: at least 12.5 Mtce.

²⁹ Duke Energy environment health & safety in action. 2000 progress review

³⁰ <http://www.dukepower.com/content/default2.asp?wpm=DP02a3>

³¹ EIA Coal Industry Annual 2000 p.195 (downloadable).

³² <http://www.dukepower.com/content/default2.asp?wpm=DP02d2>

³³ EDF trading limited, 1st year of activity (from edf web).

³⁴ EnBW Environment report 2000.

³⁵

³⁶ Sum of emissions from individual plants in **Towards Sustainable Development 2000 Progress Report**, available from web in full pdf and text pdf.

TXU Energy is the third-largest generator of electricity in the US. TXU Energy owns more than 21,000 megawatts of coal, natural gas and nuclear generation capacity through 70 electric generating units at 23 plant sites.

No. 2 top coal consumer among US utilities in DOE EIA ranking 2000.

Recovers lignite coal at three Texas locations for use in the company's Texas generating plants; mined 26 million tons in 2000. That is 12.5 Mtce³⁷ or 10.1 MtC³⁸ CO₂.

The total lignite mined in the US was about 84 Mt in year 2000, so TXU mined, and used 30 per cent of it.

To judge from a map on TXU's website, it has several lignite power stations, but no other coal.

UK: "coal powered stations: High Marnham five 189 MW units Unit four to be mothballed from 31 March 02, Drakelow three 333MW units Unit C12 to be mothballed from 31 March 02, Ironbridge two 485 MW units"

Estimated emission from UK operations: 2.5-3 MtC.

Owns half of 350 MW in Kiel, Germany, the other half is owned by E.ON. Coal?

Comment: The core business of TXU is electricity and gas retailing and trading, rather than generation and it has also a large nuclear gas power capacity and a commitment to renewables.

Taipower

<http://www.taipower.com.tw/>

Headquarters Taipei, Taiwan, China.

Annual CO₂ emissions from coal power: 15.6 MtC (1999)
Trend: strongly increasing since 1980.

Government owned near-monopoly.

Produced 110.7 TWh thermal power 2000. According to IEA, public electricity and heat generation, i.e. Taipower, consumed 20.6 Mtce in 1999.

ENEL

www.enel.it

Former government owned, now undergoing privatization and restructuring.

Produced 25.7 TWh from coal year 2000.

Spun off Elettrogen to Spanish ENDESA, of which 321 MW coal power (not a lot), Eurogen is next to go.

ENDESA

www.endesa.es

Headquarters Madrid, Spain.

Annual coal power CO₂ emissions: at least 10 MtC + ca 2 from Hiberdrola and Elettrogen.

Dominant Spanish power generating company (more than half market), also in electricity distribution, telecom etc. A lot of activity abroad, especially Latin America and Italy, but little coal so far.

In Spain, Endesa has 2.2 GW imported coal power stations and 4 GW domestic coal, with a mix of lignite, anthracite and other hard coal in some of that. A simple calculation gives a conservative figure of 10 MtC.³⁹

Merging with Hiberdrola, which produced 7.6 TWh coal power in 1999.

Endesa is in an ISO 14000 implementation process and should be able to produce better information soon.

"In 1999, mining production /lignite and coal/ in Endesa was 8.5 million tons, which is equivalent to 19,901 billion therms." That would correspond to some 5 MtC+.

Cinenergy

www.cinergy.com

Annual coal power CO₂ emissions: 29.3 MtC.⁴⁰

Burned 28.1 million tons of coal⁴¹ 2000 in a large number of coal power stations in the Midwest.

Committed to clean coal technology and carbon sequestration.

CEZ

<http://www.cez.cz/eng/>

Headquarters, Prague, Czech Republic. Majority owner National Property Fund; full privatization planned for 2002.

Annual coal power CO₂ emissions⁴²: 9.8 MtC. (2000)

CO₂ emissions from CEZ power stations (mainly lignite) fell through 1993, but have since increased.

³⁷ A conversion factor for US lignite is produced by dividing the total lignite production in actual metric megatons with the US 1996 the total lignite in Mtce. This gives 0.481 tce/tonne. Input figures from IEA Coal Information 2001 p II.308.

³⁸ Emission factor assumed 27.6 kg carbon per GJ, after IPCC manual. Real figure could be somewhat higher or lower.

³⁹ 6000 hours operation (can be slightly more or less), at t Mt CO₂/TWh (should be more for older and/or lignite fired stations).

⁴⁰ If the 28.1 Mtons are equal to tce, IPCC standard emission factor 25.8 tonne/TJ.

⁴¹ www.cinergy.com/environment/decade_of_progress/coal_energy_and_the_environment.asp

⁴² <http://www.cez.cz/eng/environment/article.asp?id=54084&cat=1826&ts=8ec16>

Annex 3. Other big coal users

The world's top **steel** producer; Nippon Steel, year 2000 used 20.98 Mt coal, which should produce 15-16 MtC, which would put them about 10th on the corporate list. Many other big steel companies have no information on coal consumption or CO₂ emissions readily available.

Table A3.1. The biggest steel producers, according worldsteel.org.

Rank	Mt steel	Company
1	28.4	Nippon Steel
2	27.7	POSCO
3	24.1	Arbed
4	22.4	Ispat International
5	21.0	Usinor
6	20.0	Corus
7	17.7	Thyssen Krupp
8	17.7	Shanghai Baosteel
9	16.0	NKK
10	15.6	Riva
11	13.0	Kawasaki
12	11.6	Sumitomo
13	10.9	SAIL
14	10.7	USX
15	10.0	Magnitogorsk
16	10.0	Nucor
17	10.0	China Steel
18	9.6	Severstal
19	9.1	Bethlehem Steel
20	8.8	Anshan

Major coal carbon emitters are likely to be found among these, even if carbon intensity for crude steel production varies. Arbed (Luxemburg) and Usinor (France) have announced plans to merge to the by far biggest steel company in the world, in what the companies refer to as a “strategic alliance” with Nippon Steel.

The **cement industries** emit CO₂, both because it is an inherent feature of the process, partly because of energy use, which is often coal.

Annex 4. Top coal electricity generators 2000

Table A4.1 The world's top 30 coal-fired electricity generators year 2000, by capacity. From IEA Coal Information 2001.

	GWe	country
Ministry of ElectricPower*	124.7	China
ESCOM	33.9	South Africa
American Electric Power Company Inc	26.1	USA
RWE Power	18.9	Germany
Tennessee Valley Authority	17.4	USA
National Thermal Power Corporation	17.3	India
Korea Electric Power Corporation	14.2	(South) Korea
Georgia Power Company	14.0	USA
Vereinigte Energiewerke AG Berlin VEAG	12.2	Germany
E.on Energie	8.8	Germany
Electricité de France	8.8	France
Alabama Power Company	8.7	USA
RENEL Romanian Electricity Authority	8.7	Romania
ENEL Spa	8.6	Italy
Donbassenergo	8.5	Ukraine
Electric Power Development Company Ltd EPDC	8.5	Japan
Edison Mission Energy	8.1	USA
Taiwan Power Company TAIPOWER	8.1	Taiwan, China
Detroit Edson Company	8.0	USA
Ontario Power Generation Inc	7.8	Canada
CEZ as	7.3	Czech Republic
Delta Electricity	6.9	Australia
Electricidad SA (ENDESA)	6.8	Spain
Sverdlovennergo	6.4	Russia
PSI Energy	6.3	USA
Huaneng Power International Inc	6.3	China
PacifiCorp	6.3	USA
Texas Utilities Electric Company	6.1	USA
Dneprenergo	6.0	Ukraine
Eastern Generation Ltd	6.0	UK

*Incl Huaneng Power (also on the list)

The Swedish NGO Secretariat on Acid Rain

The essential aim of the Swedish NGO Secretariat on Acid Rain is to promote awareness of the problems associated with air pollution, and thus, in part as a result of public pressure, to bring about the required reduction of the emissions of air pollutants. The eventual aim is to have those emissions brought down to levels – the so-called critical loads – that the environment can tolerate without suffering damage.

In furtherance of these aims, the secretariat operates as follows, by

- Keeping under observation political trends and scientific developments.
- Acting as an information centre, primarily for European environmentalist organizations, but also for the media, authorities, and researchers.
- Publishing a magazine, Acid News, which is issued four to five times a year and is distributed free of charge.
- Producing and distributing information material.
- Supporting environmentalist bodies in other countries by various means, both financial and other, in their work towards common ends.

- Acting as coordinator of the international activities, including lobbying, of European environmentalist organizations, as for instance in connection with the meetings of the bodies responsible for international conventions, such as the Convention on Long-range Transboundary Air Pollution.

- Acting as an observer at the proceedings involving international agreements for reducing the emissions of greenhouse gases.

The work of the secretariat is largely directed on the one hand towards eastern Europe, especially Poland, the Baltic States, Russia, and the Czech Republic, and on the other towards the European Union and its member countries. By emitting large amounts of sulphur and nitrogen compounds, all these countries add significantly to acid depositions over Sweden.

As regards the eastern European countries, activity mostly takes the form of supporting and cooperating with the local environmentalist movements. Since 1988, for instance, financial support has been given towards maintaining information centres on energy, transport, and air pollution. All are run by local environmentalist organizations.