The Future Role of Coal in Europe

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The future role of coal in Europe is the object of a comprehensive study that EURACOAL, together with many enterprises and associations of the coal and electricity sectors in the EU, commissioned from Prognos AG, Berlin/Basel. The final report describes different developments in the framework of various scenarios to the horizon 2030. The analysis provides both an overview of EU 27 and also detailed country reports.

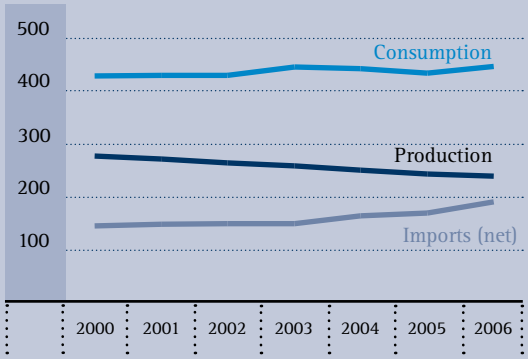
The importance of coal for Europe

Coal (hard coal and lignite) is a source of energy that is vital for Europe. Over the last five years, consumption in the EU 15 increased by about 1 % a year, now reaching approximately 314 million tonnes coal equivalent (Mtce). In the New Member States (EU 12), consumption amounts to approximately 145 Mtce. In other European neighbour countries, demand represents about 60 Mtce. Demand in Russia and the other countries of the former Soviet Union is around 250 Mtce. With approximately 750 Mtce in total, Europe (including Russia) is the third consumer in the world, behind North America and China. Europe thereby represents a share of about 15 % of world coal consumption. In EU 27, coal will progressively cover up to a fifth of primary energy demand.

The major coal consumer in the EU is Germany, followed by Poland. Europe can cover a significant share of its coal demand with its own resources. With an annual production of 315 Mtce, Europe (without the former Soviet Union) represents 8 % of world production. Other neighbour countries produce the same amount as Europe. Concerning production as well, Poland and Germany are the leaders in the EU. Together, they represent a share of two thirds of total EU coal production. The Czech Republic, Greece, Spain and the United-Kingdom also belong to the major coal producers in the EU. Important coal producers in the South-East of the EU are Hungary, Romania and Bulgaria. Coal is, however, also mined in other EU Member States as well as in Associated and Accession Countries. The Prognos Study focuses on the EU 27. With a share of just under 5 % of world coal reserves, Europe disposes of sufficient reserves. Hard coal, lignite and bituminous coal are available.

The vital importance of coal for EU energy supply is also mirrored by the development of imports. Around 200 Mtce are imported each year to cover

Production, Imports and Consumption of Coal in EU 27 - in Mtce



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demand,mainly from South Africa, Australia, Colombia as well as Russia and the Ukraine.

Coal plays a vital role above all for secure and competitive power generation in the EU. More than a quarter of EU electricity production is based on coal. Against the background of a dynamic increase in demand of approximately 2 % each year, secure, competitive and environmentally-friendly power production has great significance for EU energy policy.

Demand for electricity is increasing at above average rates, mainly in the southern Member States, with annual rates of up to 5 %. The technical and economic integration of the EU electricity market requires a global strategy to secure a sufficient supply of electricity on the basis of reliable and affordable sources of energy. The use of coal for power generation therefore remains a key factor for the EU into the future.

On the other hand, European power plants require major modernisation. Power generating capacities in the range of 400 000 MW must be replaced by new installations. With an average life span of 40 years, at least 2,5 % of the existing power plant portfolio should be replaced each year by new installations. As in practice life spans are often longer, the estimate is to be considered as an upper limit. However, in many EU Member States, a technological revolution is about to take place, that can basically include innovative technology for installations, improved use of fuel and also flue-gas cleaning technologies.

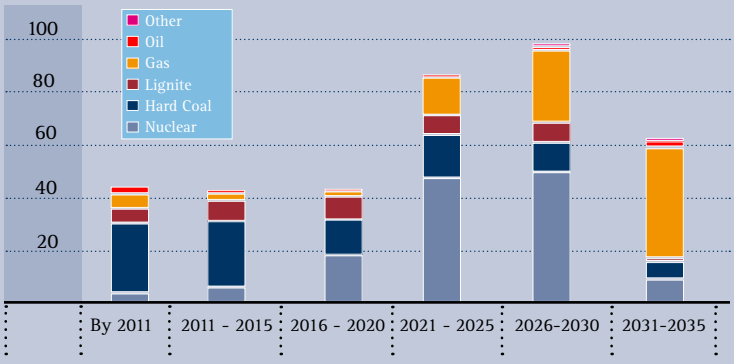
A shift of existing investments, in the hope of even better technologies, does not appear meaningful. There would be a detrimental slow-down of investment, which would later have to be compensated, over-burdening both power plant operators and constructors.

New framework conditions

The investments to be made in modern power plants are determined by future developments on international energy markets, by the climate debate and the continuous liberalisation of the EU energy market, with its many new instruments and obligations.

The forward-looking decisions of European energy policy play a central role for the future structure of European energy production. EU dependence on increasing oil and gas imports requires a response. A technology policy to promote emission-free energy technology has already been implemented. The EU and many Member States support an accelerated development of the use of renewable energies not related to hydro by 2020. This is an ambitious objective, leading to major changes in the energy mix for the supply of electricity in Europe and requiring new responses concerning the security of electricity supply and the networks. With the European Trading Scheme for CO_2 emission certificates, efforts to reduce CO_2 emissions have clearly shifted towards the energy economy.

Power Plant Capacity to be Replaced by 2035 and Fuel provided in EU 25 - in GW



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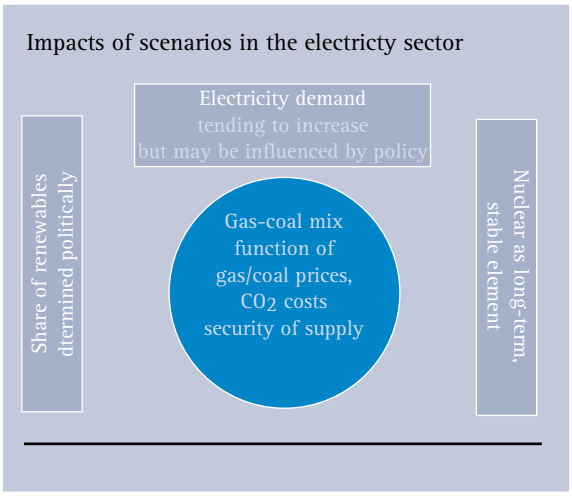
Above all, power plants carry the main burden of reducing emissions. There will be less market-driven construction up to 2020 than actually expected. A combination of coal and gas fills the gap that nuclear and renewable energies cannot fill, with the main determinant of the choice being prices of coal, gas and CO_2.

The European coal industry therefore requested a comprehensive survey of the future role of coal in Europe. The customer is EURACOAL. The association of the European coal industry represents producers, generators and traders from 15 countries. Furthermore, power producers from Germany, as well as enterprises and associations from Greece, Hungary, the Czech Republic, Poland and Germany took part in the project. The analysis thereby counts among the most wide ranging studies on the use of coal in Europe.

Wide spectrum of scenarios

The Study on the future role of coal in Europe commissioned by EURACOAL and many European enterprises and associations does not establish target values or repeat known opinions of the sector. A wide spectrum of various scenarios was chosen as the method for the analysis. It was therefore possible to take into account a wide spectrum of various factors and their respective impacts on the energy market, and especially on coal, thereby making those impacts transparent. The gain in knowledge resulting from the analysis therefore goes far beyond current coal-related issues. Multi-factor impacts are explained and also the effects of energy policy decisions or changes on the international energy markets. EURACOAL assumes that the analysis will in future form the basis for many debates and consultations. The analysis is also outstanding in the depth of its analysis. All the scenarios are undertaken and documented separately for each individual EU Member State.



Scenarios analysed

The Base Scenario: Characterised by high prices for energy as well as low CO_2 costs resulting from an internationally decided and coordinated climate policy. The basic economic data such as assumptions concerning price trends and energy consumption are based on the forecast “Trends to 2030” (up-date 2005) of the European Commission, Directorate-General Energy and Transport.

The Policy 15, 30, 45 Scenario: Based on assumptions of various climate policies, resulting in different CO_2 costs of € 15, 30 or 45 per tonne of carbon dioxide. Furthermore, high energy prices are assumed.

The Low Price Policy 15, 30, 45 Scenario: This scenario analyses two different climate policies with moderate energy prices.

The Tech 30 Scenario: This scenario analyses an accelerated technological development of new power plant technologies including Carbon Capture and Storage (CCS) and relatively high CO_2 costs.

The Tech 45 Scenario: This scenario is based on the

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assumption of an ambitious technology strategy for particularly efficient and emission-free power plants and a development of nuclear energy with high prices for CO_2.

To evaluate future power plant technologies, state-of-the-art technology and also future developments have been thoroughly and comprehensively documented.

The analysis of the assumptions concerning future energy price developments is essentially based on the "Trends to 2030" (up-date 2005) of the EU. Today's expectations concerning future price developments reach the higher range of the forecast.

Outcome

All the scenarios analysed come to the conclusion that European power generation will still rely mainly on the use of fossil fuels in the year 2030 and that because of price and security of supply, all sources of energy will be necessary. The development of the difference in price between gas and coal will be determining for the future role within European power generation. The binding reduction objectives of climate protection change also have a high impact resulting, in economic terms, in different CO_2 costs.

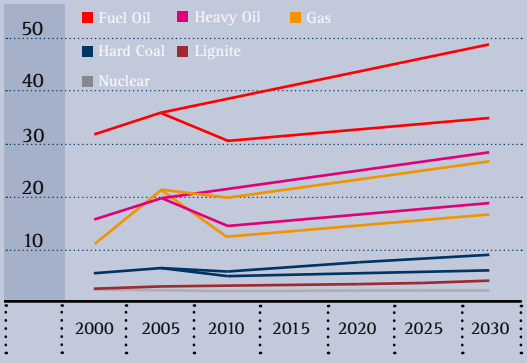
Coal remains competitive

The relatively high energy prices assumed in the Base Scenario in conjunction with low CO_2 prices lead to increasing shares of coal used for power generation and to a corresponding increase of CO_2 emissions. With prices for gas remaining high, the use of this fuel on a liberalised European electricity market is only competitive with prices for CO_2 at more than € 30 per tonne. For a clear drop in carbon dioxide output, in this case CO_2 prices of at least € 45 per tonne are necessary. With moderate gas prices, coal remains competitive as long as CO_2 prices remain at € 15 per tonne. With increasing CO_2 prices, coal loses shares to gas. With prices above € 30, the use of fuel shifts clearly in favour of gas. The resulting doubling of the demand for gas for power generation would however result in sharp price increases and would level out the competitive advantage.

Protecting climate by means of modern Technology

In comparison with the output of carbon dioxide of European power plants in the year 2005, amounting to 1.275 billion tonnes, reductions by 2030 can only be expected with high prices for CO_2 and moderate prices for gas. A significant reduction of the output of CO_2 by about 774 Mt would for example be possible when combining the simultaneous intensive use of CCS technologies with the use of nuclear energy. After 2020, CCS power plants will presumably be successful on the market when prices for electricity and CO_2 are high. If climate-related costs drop, the competitive position compared with conventional coal-fired power plants tightens with CO_2 prices at just under € 30.

Fuel Prices at Power Plant in EU
in Euro/MWh - Source: „Trends to 2030 (update 2005)" of the EU (upper line) and EWI/Prognos (basic line)



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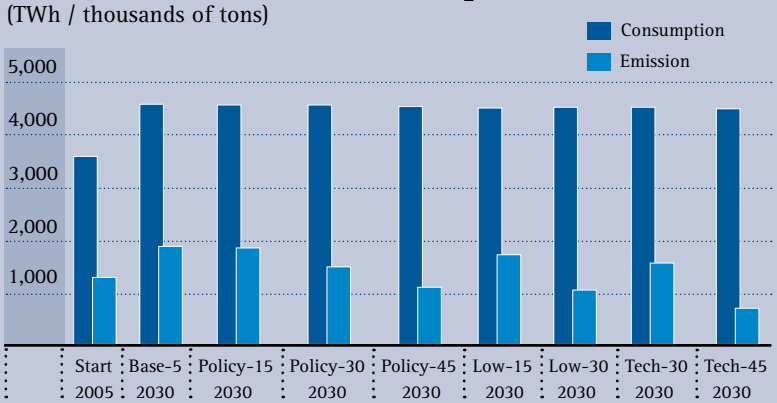
In the coal industry's opinion, in accordance with Europe's energy policy, the market-led use of CCS power plants should have priority over the policy-led fuel switch to gas. In the latter case, not only the spiral of prices for gas, but also the cost of power generation would increase, but above all dependence on imports and thereby the risks concerning the supply of power to EU would increase. The demanding CCS technology also leads to a clearly higher reduction of CO_2 output than a simple switch to lower-carbon fuels. The analysis does not take further CO_2 reduction potential into account that may result from an even stronger use of renewable energies than foreseen in the Base Scenario of the EU. Furthermore, the consequences of a climate policy that has not been agreed internationally on the competitiveness of energy-intensive industries and the resulting drop in energy consumption and in CO_2 released have not been considered.

Power plant portfolio undergoing renewal

In order to provide sustainable solutions to climate issues and also reduce the increasing dependence on imported sources of energy at volatile prices, an option is to use all available alternatives for power generation in Europe. These include the rational use of energy, improved power plant efficiency, nuclear as well as Carbon Capture and Storage (CCS technology). This requires intensive Research & Development in all areas concerned, therefore also including Clean Coal Technologies.

Already with prices for CO_2 at just under € 30 per tonne, efficient coal-fired power plants with CCS technologies are competitive on a liberalised electricity market. Incentives to implement CCS will probably be necessary. If CCS is widely applied in all fossil-fuelled power plants after 2020, hard coal and lignite-fuelled power plants will make a major contribution to EU power generation. In spite of efficiency losses due to CCS lignite-fired installations with this technology are particulary cost-effective because with low fuel costs they save much CO_2.

Consumption of Electricity and Emissions CO_2 to 2030
(TWh / thousands of tons)



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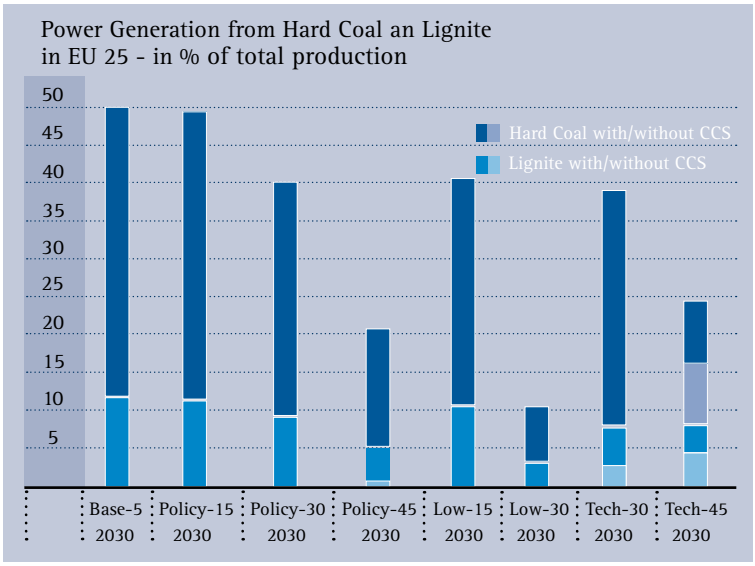
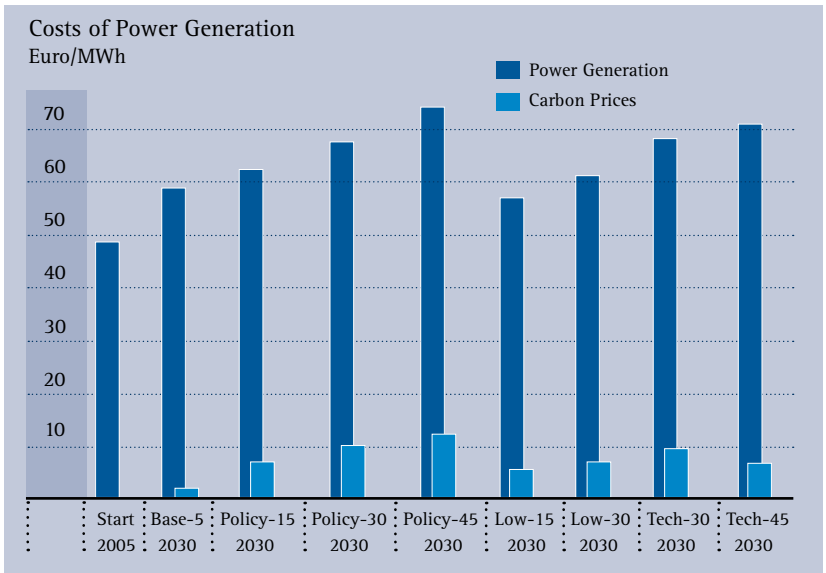
Trends in power generation costs

Electricity prices in the EU will increase during the period forecast till 2030 because of increasing demand, higher fuel prices and capital-intensive technologies. The rise will amount to between 0.4 and 1 % per year according to the developments of individual factors. For the year 2030, real power generation costs of between €/MWh 58 and 73 can be expected, of which € 2 to just under € 12 is accounted for by CO_2 permit prices. It is very important to note that the implementation of CCS technologies does not at all result in the highest electricity prices. This proves that in the EU, reducing emissions with relatively moderate electricity prices is possible, without the need to give up security of supply and the potential of coal.





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Results to 2030 (EU 27)

	Base-5	Policy-15	Policy-30	Policy-45	Low-Price-15	Low-Price-30	Tech-30	Tech-45
Generation Capacities in MW	991,364	991,539	1,003,289	1,008,790	999,164	1,001,261	1,002,618	1,016,898
Nuclear	38,277	38,277	57,477	67,077	38,277	46,277	55,877	165,477
Lignite	69,181	68,431	54,381	32,531	66,731	29,681	46,306	27,781
Lignite (CCS)	-	-	-	1,901	-	-	14,229	24,754
Hard Coal	320,810	319,635	243,735	94,285	231,760	64,907	237,910	65,152
Hard Coal (CCS)	-	-	-	-	-	-	-	56,153
Gas	90,267	92,367	174,867	340,167	189,567	387,567	175,467	204,152
Gas (CHP)	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800
Gas (CCS)	-	-	-	-	-	-	-	600
Oil	6,415	6,415	6,415	6,415	6,415	6,415	6,415	6,415
Conv, Other	-	-	-	-	-	-	-	-
Wind	184,502	184,502	184,502	184,502	184,502	184,502	184,502	184,502
Hydro	120,787	120,787	120,787	120,787	120,787	120,787	120,787	120,787
Res, Other	12,079	12,079	12,079	12,079	12,079	12,079	12,079	12,079
Biomass	80,246	80,246	80,246	80,246	80,246	80,246	80,246	80,246
Import	6,112	6,112	6,112	6,112	6,112	6,112	6,112	6,112
Power Generation in GWh	4,641,543	4,641,653	4,640,590	4,641,062	4,641,771	4,641,187	4,638,716	4,640,493
Nuclear	261,771	266,324	433,172	510,093	266,390	355,826	425,069	1,104,430
Lignite	499,748	493,452	389,767	231,235	503,872	120,120	327,927	151,589
Lignite (CCS)	-	-	-	28,306	-	-	115,577	193,621
Hard Coal	1,811,226	1,791,019	1,469,158	715,815	1,403,023	378,602	1,424,744	425,347
Hard Coal (CCS)	-	-	-	-	-	-	-	442,766
Gas	18,007	18,904	223,714	1,005,623	373,460	1,651,689	223,121	231,283
Gas (CHP)	630,418	630,420	630,424	630,452	630,424	630,502	630,424	630,436
Gas (CCS)	-	-	-	-	-	-	-	239
Oil	35,023	35,023	35,023	35,023	35,023	35,023	35,023	35,023
Conv, Others	-	-	-	-	-	-	-	-
Wind	210,434	228,886	269,981	292,388	245,509	278,869	267,354	238,545
Hydro	531,959	531,959	531,959	531,959	531,959	531,959	531,959	531,959
Res, Others	10,658	10,658	10,658	10,658	10,658	10,658	10,658	10,658
Biomasse	600,885	600,885	600,885	600,885	600,885	600,885	600,885	600,885
Import	31,416	34,124	45,850	48,626	40,569	47,055	45,977	43,714
Primary Energy Input in ktce	1,091,584	1,088,871	1,085,046	1,052,902	1,070,191	1,003,954	1,086,836	1,163,413
Nuclear	88,833	90,369	145,133	170,414	90,391	119,724	141,539	366,301
Lignite	132,301	129,992	102,681	62,776	132,508	32,382	87,398	41,466
Lignite (CCS)	-	-	-	7,518	-	-	31,491	52,974
Hard Coal	42,387	437,668	359,576	179,697	344,730	95,292	349,067	108,467
Hard Coal (CCS)	-	-	-	-	-	-	-	118,588
Gas	3,579	3,759	44,082	195,824	72,643	321,727	44,074	46,111
Gas (CHP)	124,867	124,868	124,869	124,874	124,868	124,884	124,868	124,871
Gas (CCS)	-	-	-	-	-	-	-	55
Oil	10,268	10,268	10,268	10,268	10,268	10,268	10,268	10,268
Conv, Others	-	-	-	-	-	-	-	-
Wind	25,852	28,119	33,167	35,920	30,161	34,259	32,844	29,305
Hydro	65,351	65,351	65,351	65,351	65,351	65,351	65,351	65,351
Res, Others	1,291	1,291	1,291	1,291	1,291	1,291	1,291	1,291
Biomasse	192,994	192,994	192,994	192,994	192,994	192,994	192,994	192,994
Import	3,859	4,192	5,633	5,974	4,984	5,781	5,648	5,370
Carbon Output in kt CO2	1,848,703	1,828,836	1,595,730	1,230,662	1,698,126	1,106,846	1,528,274	774,135
Nuclear	-	-	-	-	-	-	-	-
Lignite	426,465	419,020	330,988	202,356	427,133	104,403	281,722	133,662
Lignite (CCS)	-	-	-	2,423	-	-	10,151	17,076
Hard Coal	1,191,941	1,179,227	968,819	484,164	928,821	256,762	940,505	292,246
Hard Coal (CCS)	-	-	-	-	-	-	-	31,952
Gas	5,798	6,088	71,422	317,207	117,671	521,153	71,394	74,694
Gas (CHP)	202,267	202,268	202,270	202,279	202,269	202,295	202,269	202,274
Gas (CCS)	-	-	-	-	-	-	-	-
Oil	22,232	22,232	22,232	22,232	22,232	22,232	22,232	22,232
Con, Others	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-
Hydro	-	-	-	-	-	-	-	-
Res, Others	-	-	-	-	-	-	-	-
Biomass	-	-	-	-	-	-	-	-
Cost of Power Generation in Mio EUR	270,870	288,450	314,511	338,623	266,304	284,107	313,218	328,008
Nuclear	13,892	13,967	23,251	27,595	13,968	18,966	22,757	63,533
Lignite	16,438	20,484	21,350	15,908	20,065	8,264	18,140	10,895
Lignite (CCS)	-	-	-	1,369	-	-	4,758	9,739
Hard Coal	83,045	94,006	88,188	48,046	65,394	21,795	85,837	29,414
Hard Coal (CCS)	-	-	-	-	-	-	-	26,089
Gas	7,223	7,478	25,838	86,453	26,340	91,172	25,843	29,027
Gas (CHP)	32,170	34,193	37,227	40,263	23,800	26,836	37,227	40,142
Gas (CCS)	-	-	-	-	-	-	-	89
Oil	3,607	3,829	4,163	4,496	2,245	2,579	4,163	4,497
Conv, Others	-	-	-	-	-	-	-	-
Wind	23,762	23,762	23,762	23,762	23,762	23,762	23,762	23,763
Hydro	55,867	55,867	55,867	55,867	55,867	55,867	55,867	55,919
Res, Others	4,054	4,054	4,054	4,054	4,054	4,054	4,054	4,054
Biomass	30,811	30,811	30,811	30,811	30,811	30,811	30,811	30,847

1 Mtce is equivalent to 29.308 PJ and 0.7 Mtoe
Source: Prognos, Future Role of Coal, 2007

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Key Messages

- Throughout the world, coal cannot be replaced during the next decades. Facilitating further coal use, acceptable to the market and the environment, is an important political task for Europe.

- The EU must fight with determination against its increasing dependence on imported oil and gas with a strategy balanced between security of supply and sustainability. In addition to the rational use of energy and the increased use of renewable energies, coal makes a major contribution above all to stable prices and security of supply.

- Coal has outstanding long-term perspectives and a good competitive position for power generation in Europe. The moderate development of electricity prices in the long–term is the result of the use of coal and nuclear energy. Till 2020, the focus is on construction and modernisation of existing power plants, and thereby improved efficiency.

- The use of coal for power generation will mainly be determined by the level of prices for gas and by CO_2 costs. Above all with rising prices for gas, the market position of coal for power generation continues to improve. The implementation of Emissions Trading can greatly change the structure of power generation in Europe and especially burden countries that use a lot of coal.

- The future of coal in Europe will also be determined by technological responses to climate issues. With CCS (Carbon Capture and Storage), technology is available that, if developed systematically within an appropriate framework, makes a wide-ranging avoidance of CO_2 output at acceptable costs become a reality in the future, i.e. after 2020.

- CCS technology makes possible ambitious objectives to reduce CO_2 with electricity prices remaining at a reasonable level. In this context, coal remains a competitive source of energy for power generation. In order to avoid major competition distortions, Europe should play the leading role together with other major industrialized nations, first in matters of efficiency, later for CCS technology but also for Emissions Trading.

The Study “The Future Role of Coal in Europe (2007)” has been compiled by Prognos AG. The final report was accepted by EURACOAL in June 2007 and is available for download on EURACOAL’s Web page (www.euracoal.org).