Dirty Thirty

Ranking of the most polluting power stations in Europe

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1. Dirty Thirty – Europe's worst climate polluting power stations

Rank	Power Plant	Country	Fuel	Start of operation	Operator	Relative Emissions[1]	Absolute Emissions[2]
1	Agios Dimitrios	Greece	Lignite	1984-1986, 1997	DEH	1.350	12.4
2	Kardia	Greece	Lignite	1975, 1980-1981	DEH	1.250	8.8
3	Niederaußem	Germany	Lignite	1963-1974, 2002	RWE	1.200	27.4
4	Jänschwalde	Germany	Lignite	1976-1989	Vattenfall	1.200	23.7
5	Frimmersdorf	Germany	Lignite	1957-1970	RWE	1.187	19.3
6	Weisweiler	Germany	Lignite	1955-1975	RWE	1.180	18.8
7	Neurath	Germany	Lignite	1972-1976	RWE	1.150	17.9
8	Turow	Poland	Lignite	1965-1971, 1998-2004	BOT GiE S.A.	1.150	13.0
9	As Pontes	Spain	Lignite	1976-1979	ENDESA	1.150	9.1
10	Boxberg	Germany	Lignite	1979-1980, 2000	Vattenfall	1.100	15.5
11	Belchatow	Poland	Lignite	1982-1988	BOT GiE S.A.	1.090	30.1
12	Prunerov	Czech Republik	Lignite	1967 & 1968	CEZ	1.070	8.9
13	Sines	Portugal	Hard coal	1985-1989	EDP	1.050	8.7
14	Schwarze Pumpe	Germany	Lignite	1997 & 1998	Vattenfall	1.000	12.2
15	Longannet	UK	Hard coal	1972-1973	Scottish Power	970	10.1
16	Lippendorf	Germany	Lignite	1999	Vattenfall	950	12.4
17	Cottam	UK	Hard coal	1969-1970	EDF	940	10.0
18	Rybnik	Poland	Hard coal	1972-1978	EDF	930	8.6
19	Kozienice	Poland	Hard coal	1972-1975, 1978-1979	state owned	915	10.8
20	Scholven	Germany	Hard coal	1968-1979	E.ON	900	10.7
21	West Burton	UK	Hard coal	1967-1968	EDF	900	8.9
22	Fiddlers Ferry	UK	Hard coal & oil	1969-1973	Scottish & Southern	900	8.4
23	Ratcliffe	UK	Hard coal	1968-1970	E.ON	895	7.8
24	Kingsnorth	UK	Hard coal & heavy fuel oil	1970-1973	E.ON	892	8.9
25	Brindisi Sud	Italy	Coal	1991-1993	ENEL	890	14.4
26	Drax	UK	Hard coal	1974-1976, 1984-1986	AES	850	22.8
27	Ferrybridge	UK	Hard coal	1966-1968	Scottish & Southern	840	8.9
28	Großkraftwerk Mannheim	Germany	Hard Coal	1966-1975, 1982 & 1993	RWE, EnBW, MVV	840	7.7
29	Eggborough	UK	Hard coal	1968-1969	British Energy	840	7.6
30	Didcot A & B	UK	Hard coal & gas	1968-1975, 1996-1997	RWE	624	9.5

Table 1.1.: These 30 power plants are the biggest CO_2 emitting power plants in EU25 countries in absolute terms (million tonnes of CO_2 per year). WWF has ranked the 30 biggest emitters according to their relative emissions.

[1] Grams of CO_2 per Kilowatt hour (g CO_2/kWh). Where two plants have the same relative emissions, the plant with the higher absolute emissions (million tonnes CO_2 per year) ranks dirtier.
[2] Annual emissions for the year 2006 in million tonnes of CO_2 ($mtCO_2$)

Focus 1) Germany's worst climate polluting power stations

Rank	Power Plant	Country	Fuel	Start of operation	Operator	Relative Emissions[1]	Absolute Emissions[2]
3	Niederaußem	Germany	Lignite	1963-1974, 2002	RWE	1.200	27.4
4	Jänschwalde	Germany	Lignite	1976-1989	Vattenfall	1.200	23.7
5	Frimmersdorf	Germany	Lignite	1957-1970	RWE	1.187	19.3
6	Weisweiler	Germany	Lignite	1955-1975	RWE	1.180	18.8
7	Neurath	Germany	Lignite	1972-1976	RWE	1.150	17.9
10	Boxberg	Germany	Lignite	1979-1980, 2000	Vattenfall	1.100	15.5
14	Schwarze Pumpe	Germany	Lignite	1997 & 1998	Vattenfall	1.000	12.2
16	Lippendorf	Germany	Lignite	1999	Vattenfall	950	12.4
20	Scholven	Germany	Hard coal	1968-1979	E.ON	900	10.7
28	Großkraftwerk Mannheim	Germany	Hard coal	1966-1975, 1982 & 1993	RWE, EnBW, MVV	840	7.7

Table 1.2.: Ranking of Germany's biggest emitting power plants according to their level of efficiency

[1] Grams of CO_2 per Kilowatt hour (g CO_2/kWh). Where two plants have the same relative emissions, the plant with the higher absolute emissions (million tonnes CO_2 per year) ranks dirtier.
[2] Annual emissions for the year 2006 in million tonnes of CO_2 ($mtCO_2$)

Focus 2) The UK's worst climate polluting power stations

Rank	Power Plant	Country	Fuel	Start of operation	Parent Company	Relative Emissions[1]	Absolute Emissions[2]
15	Longannet	UK	Hard coal	1972-1973	Scottish Power	970	10.1
17	Cottam	UK	Hard coal	1969-1970	EDF	940	10.0
21	West Burton	UK	Hard coal	1967-1968	EDF	900	8.9
22	Fiddlers Ferry	UK	Hard coal & oil	1969-1973	Scottish & Southern	900	8.4
23	Ratcliffe	UK	Hard coal	1968-1970	E.ON	895	7.8
24	Kingsnorth	UK	Hard coal & heavy fuel oil	1970-1973	E.ON	892	8.9
26	Drax	UK	Hard coal	1974-1976, 1984-1986	AES	850	22.8
27	Ferrybridge	UK	Hard coal	1966-1968	Scottish & Southern	840	8.9
29	Eggborough	UK	Hard coal	1968-1969	British Energy	840	7.6
30	Didcot A & B	UK	Hard coal & gas	1968-1975, 1996-1997	RWE	624	9.5

Table 1.3.: Ranking of the UK's biggest emitting power plants according to their level of efficiency

[1] Grams of CO_2 per Kilowatt hour (g CO_2/kWh). Where two plants have the same relative emissions, the plant with the higher absolute emissions (million tonnes CO_2 per year) ranks dirtier.
[2] Annual emissions for the year 2006 in million tonnes of CO_2 ($mtCO_2$)

Focus 3) Poland's worst climate polluting power stations

Rank	Power Plant	Country	Fuel	Start of operation	Parent Company	Relative Emissions[1]	Absolute Emissions[2]
8	Turow	Poland	Lignite	1965-1971, 1998-2004	BOT GiE S.A.	1.150	13.0
11	Belchatow	Poland	Lignite	1982-1988	BOT GiE S.A.	1.090	30.1
18	Rybnik	Poland	Hard coal	1972-1978	EDF	930	8.6
19	Kozienice	Poland	Hard coal	1972-1975, 1978-1979	state owned	915	10.8

Table 1.4.: Ranking of Poland's biggest emitting power plants according to their level of efficiency

[1] Grams of CO_2 per Kilowatt hour (g CO_2/kWh). Where two plants have the same relative emissions, the plant with the higher absolute emissions (million tonnes CO_2 per year) ranks dirtier.
[2] Annual emissions for the year 2006 in million tonnes of CO_2 ($mtCO_2$)

2. Dirty Thirty - Emissions vs allocation

Comparing the verified emission of 2006 with the amount of emission allowances allocated to Dirty Thirty plants in 2006 reveals which plants got more allowances than needed and which got less. In total, the Dirty Thirty were short of allowances and got 39.5 $MtCO_2$ less than they emitted. 21 plants were short of emission allowances, while 9 were long and 1 plant emitted exactly as much as it was allocated. Most plants are in Germany and the UK (10 each). While half of the German plants were long, all plants in the UK were short.

No.	Power Plant	Country	Operator	Allocation 2006	Verified Emissions 2006	Short	Long
				mln EUAs	mln t CO2	mln t CO2	mln t CO2
1	Agios Dimitrios	Greece	DEH	12,9	12,4	-	0.5
2	Kardia	Greece	DEH	9,8	8,8	-	1.0
3	Niederaußem	Germany	RWE	28,7	27,4	-	1.3
4	Jänschwalde	Germany	Vattenfall	25,8	23,7	-	2.1
5	Frimmersdorf	Germany	RWE	20,3	19,3	-	1.0
6	Weisweiler	Germany	RWE	19,0	18,8	-	0.2
7	Neurath	Germany	RWE	16,9	17,9	1.0	-
8	Turow	Poland	BOT GiE S.A.	13,0	13,0	-	-
9	As Pontes	Spain	ENDESA	7,2	9,1	1.9	-
10	Boxberg	Germany	Vattenfall	15,1	15,5	0.4	-
11	Belchatow	Poland	BOT GiE S.A.	30,8	30,1	-	0.7
12	Prunerov	Czech R.	CEZ	8,6	8,9	0.3	-
13	Sines	Portugal	EDP	7,8	8,7	0.9	-
14	Schw. Pumpe	Germany	Vattenfall	13,1	12,2	-	0.9
15	Longannet	UK	Scottish Power	7,4	10,1	2.7	-
16	Lippendorf	Germany	Vattenfall	12,2	12,4	0.2	-
17	Cottam	UK	EDF	5,1	10,0	4.9	-
18	Rybnik	Poland	EDF	8,5	8,6	0.1	-
19	Kozienice	Poland	state owned	10,5	10,8	0.3	-
20	Scholven	Germany	E.ON	8,7	10,7	2.0	-
21	West Burton	UK	EDF	5,5	8,9	3.4	-
22	Fiddlers Ferry	UK	Scottish & Southern	4,5	8,4	3.9	-
23	Ratcliffe	UK	E.ON	5,9	7,8	1.9	-
24	Kingsnorth	UK	E.ON	6,0	8,9	2.9	-
25	Brindisi Sud	Italy	ENEL	13,4	14,4	1.0	-
26	Drax	UK	AES	14,6	22,8	8.2	-
27	Ferrybridge	UK	Scottish & Southern	4,8	8,9	4.1	-
28	Großkraftwerk Mannheim	Germany	RWE, EnBW, MVV	6,6	7,7	1.1	-
29	Eggborough	UK	British Energy	4,5	7,6	3.1	-
30	Didcot A+B	UK	RWE	6,6	9,5	2.9	-
			Total:	**353,9**	**393,4**	**39.5 short**	

3. Methodological Background: The European Dirty Thirty

WWF commissioned the Institute for Applied Ecology (Öko-Institute) to acquire and analyse data across EU countries regarding absolute and relative carbon dioxide (CO_2) emissions from Europe's power stations. Using this data, WWF put together a ranking table to define the European Dirty Thirty, the dirtiest (i.e. most inefficient) of the thirty biggest climate polluting power stations in EU25 countries.

1) Data sources

The calculations of emissions and of the various emission scenarios (see below) are based on data from the following sources:

Starting point for all analyses is the data set provided by the European Pollutant Emission Register (EPER) (http://eper.ec.europa.eu/) and the Community Independent Transition Log (CITL) of the European Union Emission Trading Scheme (http://ec.europa.eu/environment/ets/). These sources contain information about CO_2 emissions from EU Member States for the years 2004, 2005 and 2006. Only those power plants serving the public power supply are covered.

The CO_2 emission data were combined with data on the net electric capacity and the annual average efficiency of the power plants or the respective generating units. These additional data come from various sources, in particular from company information and national and international statistics.

A third data set contains information on the dates of commissioning and the last retrofit measures differentiated by power plant units. These data are available from Platts (www.platts.com) and from the CoalPower5 database of the International Energy Agency (IEA) and from the operating companies.

2) Ranking Methodology

A two-step approach was used to define the Dirty Thirty. In short, the final ranking is based on the efficiency of the thirty biggest CO_2 emitting plants in EU25 countries.

2a) Absolute emissions

First, the Öko-Institut identified the absolute amount of CO_2 emissions from European power plants in 2006, using the above-mentioned databases.

WWF then ranked the European power plants according to the amount of CO_2 they are emitting, which gave us a ranking of the thirty biggest CO_2 emitting plants.

2b) Relative emissions

In a second step, the Öko-Institut used data about the efficiency of the power plants to calculate the relative emissions (grams CO_2 per Kilowatt hour) of the thirty biggest emitting power plants.

WWF then used this data to rank the power plants, with the highest (i.e. Number 1) in the final ranking table being the least efficient of the thirty biggest emitting power plants in EU25 countries.

3) Replacement Scenarios

The dates of commissioning and retrofitting of the various generating units were used to derive a projection for the end of their technical lifetime.

Given that the power production for a typical year doesn't change over the next 30 years, and given that replacement of outdated generating units does not include a change in location, illustrative scenarios were developed for different replacement strategies.

Öko-Institut calculated the absolute CO_2 emissions of a power plant for different time horizons (2010, 2020, 2030) by estimating the mix of old and new generating units, taking into account the emission levels of the current generating units and the emission levels of new generating units after replacement.

Base year CO_2 emissions were identified, against which the three replacement scenarios can be compared. The base year emissions represent the absolute CO_2 emissions from a power plant in 2005 and 2006.

3a) Replacing coal with coal

For the scenarios *Coal 2010/20/30* Öko-Institut assumed that every power plant unit which reaches the end of its technical lifetime is replaced by a modern plant with the same fuel. For new hard coal fired power plants an average efficiency of 45 per cent and for new lignite fired power plants an average efficiency of 43 per cent were assumed. For oil fired power plants new plants with an efficiency of 47 per cent were assumed. It was assumed that the current oil fired plants would be replaced by coal fired plants if such a fuel switch was announced by the operators.

3b) Replacing coal with gas

For the scenarios *Gas 2010/20/30* Öko-Institut assumed that every power plant unit after its technical lifetime is replaced by a new, highly efficient gas fired combined cycle power plant with an emission level of 365 grams CO_2 per Kilowatt hour.

3c) Replacing coal with clean

For the scenarios *Renewables 2010/20/30* Öko-Institut assumed that every unit reaching its technical lifetime is replaced by CO_2 emission free power generation capacities from renewable energies.

4. From coal to clean – Replacement Scenarios

The next 20 years will offer a historic window of opportunity for Europe to dramatically reduce the level of power sector emissions. Over that period, most of Europe's dirtiest coal power stations will have to be decommissioned. If they are replaced with new coal-fired power stations, the continent will be locked into high levels of CO_2 pollution for decades to come. However, if current coal-fired plants are replaced by cleaner alternatives like the less CO_2-intense natural gas or CO_2-free renewable energies, Europe would lead the world towards a low-carbon economy and the Earth could avoid the dangerous impacts of abrupt climate change. Europe's *Dirty Thirty* contains three scenarios about future power generation, showing the potential for emission reductions as a result of fuel switching.

Replacement Scenario 1 - Replacing coal with coal: The scenarios *Coal 2010/20/30* assume that every power plant unit which reaches the end of its technical lifetime is replaced by a modern plant with the same fuel. For new hard coal fired power plants an average efficiency of 45 per cent and for new lignite fired power plants an average efficiency of 43 per cent were assumed.

Total verified emissions of *Dirty Thirty* plants in 2006	**Annual emissions by 2010 under Scenario 1**	**Annual emissions by 2020 under Scenario 1**	**Annual emissions by 2030 under Scenario 1**
Million tonnes CO_2			
393.4	355.2	325.5	309.8
Compared to 2006			
	-9.7%	-17.3%	-21.3%

Replacement Scenario 2 - Replacing coal with gas: The scenarios *Gas 2010/20/30* assume that every power plant unit after its technical lifetime is replaced by a new, highly efficient gas fired combined cycle power plant with an emission level of 365 grams CO_2 per Kilowatt hour. The following emissions savings would be made:

Total verified emissions of *Dirty Thirty* plants in 2006	**Annual emissions by 2010 under Scenario 2**	**Annual emissions by 2020 under Scenario 2**	**Annual emissions by 2030 under Scenario 2**
Million tonnes CO_2			
393.4	340.4	233.9	179.2
Compared to 2006			
	-13.5%	-40.5%	-54.4%

Replacement Scenario 3 - Replacing coal with renewables: The scenarios *Renewables 2010/20/30* assume that every unit reaching the end of its technical lifetime is replaced by CO_2-free power generation capacities from renewable energies. This would lead to the following emissions savings:

Total verified emissions of *Dirty Thirty* plants in 2006	**Annual emissions by 2010 under Scenario 3**	**Annual emissions by 2020 under Scenario 3**	**Annual emissions by 2030 under Scenario 3**
Million tonnes CO_2			
393.4	330.7	167.3	82.4
Compared to 2006			
	-15.9%	-57.5%	-79.1%

For WWF, the coal-replacement scenario is fully inadequate, the gas-replacement scenario is insufficient and the renewable-replacement scenario is probably unrealistic. However, in order to render the European power sector carbon-free before mid century in order to help stay below 2 degree global warming, the magnitude of emissions reductions of about 80% of those *Dirty Thirty* needs to be maintained. With an EU focussing on increased renewable energy of 20% by 2020 and enhanced energy efficiency as well as new technologies of carbon capture and storage (CCS), a mixture of various technologies may help to reduce emissions by around

80% and more assuming no forced early retirement. Those technologies and policies include:

- a strong focus on energy savings at the demand side rendering new power supply unnecessary
- a better integration of heat and power demand, therefore incentivising highly efficient Combined Heat and Power Plants as a replacement for traditional electricity plants
- both, CCS-retrofitted and CCS-new build power stations
- and all in combination with a large expansion of new renewables baseload power probably from a new grid structure supplying offshore wind and imported concentrated solar power from Southern Europe and North Africa.

5. Dirty Thirty Replacement scenarios plant by plant

No.	Power Plant	Scenario "Fuel by Fuel"			Scenario "Natural Gas"			Scenario "Renewables"		
		by 2010	by 2020	by 2030	by 2010	by 2020	by 2030	by 2010	by 2020	by 2030
		million tonnes CO2			million tonnes CO2			million tonnes CO2		
1	Agios Dimitrios	14,0	14,0	11,6	14,0	14,0	6,2	14,0	14,0	3,3
2	Kardia	10,1	8,8	8,4	10,1	4,8	2,9	10,1	2,6	-
3	Niederaußem	21,7	20,6	18,6	18,8	15,9	10,2	17,1	13,0	4,9
4	Jänschwalde	25,2	20,0	20,0	25,2	7,7	7,7	25,2	-	-
5	Frimmersdorf	16,8	14,4	14,4	14,1	5,5	5,5	12,3	-	-
6	Weisweiler	16,0	13,6	13,6	13,5	5,2	5,2	12,0	-	-
7	Neurath	15,5	13,9	13,9	11,8	5,3	5,3	9,5	-	-
8	Turow	13,4	12,9	12,9	12,1	10,2	10,2	11,2	8,5	8,5
9	As Pontes	10,5	8,9	8,9	10,5	3,3	3,3	10,5	-	-
10	Boxberg	14,6	12,7	12,7	14,6	8,6	8,6	14,6	6,0	6,0
11	Belchatow	29,0	29,0	26,9	29,0	29,0	19,4	29,0	29,0	14,5
12	Prunerov	8,0	7,5	6,3	8,0	6,4	2,7	8,0	5,6	-
13	Sines	8,6	8,6	6,0	8,6	8,6	3,0	8,6	8,6	-
14	Schwarze Pumpe	11,2	11,2	11,2	11,2	11,2	11,2	11,2	11,2	11,2
15	Longannet	10,8	8,4	8,4	10,8	4,1	4,1	10,8	-	-
16	Lippendorf	11,9	11,9	11,9	11,9	11,9	11,9	11,9	11,9	11,9
17	Cottam	5,9	5,4	5,4	5,9	4,1	4,1	5,9	3,0	3,0
18	Rybnik	8,0	6,5	6,5	8,0	3,1	3,1	8,0	-	-
19	Kozienice	10,2	10,2	8,5	10,2	10,2	4,1	10,2	10,2	-
20	Scholven	10,2	8,5	8,5	10,2	4,4	4,1	10,2	0,4	-
21	West Burton	7,7	7,7	6,5	7,7	7,7	3,1	7,7	7,7	-
22	Fiddlers Ferry	8,4	7,1	7,1	8,2	3,4	3,4	8,0	-	-
23	Ratcliffe	6,3	5,3	5,3	6,3	2,6	2,6	6,3	-	-
24	Kingsnorth	5,5	5,0	4,6	5,5	3,8	2,2	5,5	2,7	-
25	Brindisi Sud	15,3	15,3	15,3	15,3	15,3	15,3	15,3	15,3	15,3
26	Drax	16,5	15,6	14,7	16,5	11,8	7,1	16,5	8,2	-
27	Ferrybridge	4,9	4,4	4,4	4,9	2,1	2,1	4,9	-	-
28	Großkraftwerk Mannheim	7,4	7,1	6,9	7,4	6,1	4,7	7,4	5,1	2,5
29	Eggborough	5,6	5,6	5,3	4,2	4,2	2,6	2,9	2,9	-
30	Didcot A+B	6,0	5,3	5,3	5,9	3,3	3,3	5,9	1,3	1,3
Total		**355,2**	**325,5**	**309,8**	**340,4**	**233,9**	**179,2**	**330,7**	**167,3**	**82,4**

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption

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