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# EUROPE'S DARK CLOUD

HOW COAL-BURNING  
COUNTRIES ARE MAKING THEIR  
NEIGHBOURS SICK

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sandbag





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NEIGHBOURS SICK

The content of this report was researched and written by Dave Jones from Sandbag, Julia Huscher from Health and Environment Alliance (HEAL), Lauri Myllyvirta and Rosa Gierens from Greenpeace, Joanna Flisowska and Kathrin Gutmann from Climate Action Network (CAN) Europe, Darek Urbaniak and Sarah Azau from WWF European Policy Office.

The health impact methodology used in this report was drawn up by HEAL and Greenpeace. It is guided by recommendations from the World Health Organization Europe's 'Health risks of air pollution in Europe' (HRAPIE) project on health impact assessments for air pollution. It includes atmospheric modelling with the European Monitoring and Evaluation Programme Meteorological Synthesizing Centre - West (EMEP MSC-W) computer model, which is also used by the European Environment Agency for assessments of health impacts from air pollution in Europe. The methodology and calculations have been peer reviewed by Dr Mike Holland, Ecometrics Research and Consulting. They are based on publicly available, relevant data known of by the authors; this data may not be exhaustive and there may exist further or updated information they were not aware of at the time of writing.

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**“COAL IS THE SINGLE GREATEST  
THREAT TO CIVILISATION AND  
ALL LIFE ON OUR PLANET”**

Climate scientist **James Hansen**

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# PREFACE



Concerns about the impacts of Europe's dependence on coal power generation on health, the environment and climate change have grown steadily in recent years.

An ever larger alliance of health and medical professionals, climate experts and environmental groups are demanding a full phase-out of coal in Europe, which will improve air quality and public health and mitigate climate change.

On top of the commitment European countries made at the climate summit in Paris, which will need Europe to plan the phase out of fossil fuel use, this report provides new evidence on why a phase-out of coal power generation is also urgent from a public health perspective.

The 'Dark Cloud' report quantifies for the first time the cross-border health impacts of air pollution from coal use in electricity generation in the European Union. It also provides an in-depth assessment of the 30 plants with the highest negative health and climate impacts.

Already, a series of reports have accumulated evidence on the vital role that a phase-out of coal in Europe could play. The Health and Environment Alliance (HEAL) report: 'The Unpaid Health Bill: How coal power plants make us sick' (2013) provided the first economic assessment of the health costs associated with air pollution from coal power plants in Europe.

Subsequent reports on 'The Unpaid Health Bill' for Germany, Poland, Romania, UK, Turkey, and the Western Balkans include recommendations for policy-makers and the health community on how to address the unpaid health bill and ensure that it is taken into account in future energy decisions.

The 2013 Greenpeace 'Silent Killers' reports also assessed the health impacts from coal power generation. Total mortality impact of coal power plants in the EU was estimated at 240,000 life years lost, equivalent to about 22,000 premature deaths<sup>1</sup>. And finally, CAN Europe and WWF's 'Europe's Dirty 30 - how the EU's coal-fired power plants are undermining its climate efforts' (2014) highlighted the 30 most CO<sub>2</sub> polluting coal-fired power plants in the EU.

The current report provides yet another strong argument for a rapid coal phase-out, showing that the health and climate impacts of coal power plants are immense, harmful and extremely costly to European countries, with the overall economic costs of health impacts from coal combustion in the EU estimated at up to 62.3 billion Euros. The fact that coal pollution travels means there is no 'safe spot' while any coal plant is running.

Putting an end to coal-burning power generation across Europe will bring huge benefits for citizens, environment and the economy both at home and abroad.

Protecting public health and averting dangerous climate change are two important challenges of our time, which our policy-makers need to tackle head on. Phasing out the use of coal will contribute to both and on top will also have benefits for economic development and the creation of new jobs.

We hope that his report will initiate new public debate on the rapid phase out of coal power generation and prompt healthier energy and climate action at national and EU level.

**Geneviève Pons**, Director, WWF European Policy Office

**Wendel Trio**, Director, Climate Action Network Europe

**Genon K. Jensen**, Executive Director, Health and Environment Alliance (HEAL)

<sup>1</sup> Figures have been rounded.

# EXECUTIVE SUMMARY

Coal is a polluting and harmful power source. Emissions from coal plants damage our health, contribute to climate change and cost society a great deal of money. Despite this, as of the end of 2015 there were 280 coal-fired power plants operating in the European Union, providing around 24% of our electricity.<sup>2</sup> Air pollutant emissions data is available for 257 of these coal plants for 2013, the most recent year recorded.<sup>3</sup>

## COAL'S COST TO HEALTH

The report finds that:

- EU's currently operational coal-fired power plants were responsible for about 22,900 premature deaths in 2013: this can be compared to 26,000 deaths in road traffic accidents in the EU the same year.<sup>4</sup>
- The coal plants were responsible for 11,800 new cases of chronic bronchitis and 21,000 hospital admissions in 2013.
- The health impacts of EU coal created an overall bill of 32.4 to 62.3 billion Euros.<sup>5</sup>

The atmosphere does not care where CO<sub>2</sub> is emitted - it ends up distributed fairly evenly, causing global climate change. Air pollutants emitted by coal-fired power plants do not travel globally, but they do travel hundreds of kilometres. Burning coal creates toxic particles of fine dust, which can be carried a long way away from the power plant, beyond the borders of the countries where the plants are situated. People living nowhere near a coal plant can inhale these particles and suffer the health consequences.

This report assesses the cross-border health impacts of coal-burning for power generation for the first time.

It finds that:

- Coal plants in Germany and Poland alone cause over 7,000 premature deaths abroad - 4,700 from Poland and 2,500 from Germany.
- Coal plants in the Netherlands cause over 200 premature deaths abroad.
- Coal plants in Romania cause 1,600 deaths abroad.
- Coal plants in the UK cause 1,300 premature deaths abroad.
- Coal plants in the Czech Republic cause 1,300 premature deaths abroad.
- The biggest health impacts from coal abroad are seen in France with 1,200 premature deaths caused by coal pollution from Germany, the UK, Poland, Spain and the Czech Republic alone.

<sup>2</sup> Calculation based on 2014 Eurostat data, updated with 2015 ENTSOE data.

<sup>3</sup> Croatia - which became an EU member state in 2013 - has not yet reported emissions from its coal power plant Plomin to the E-PRTR database.

<sup>4</sup> [http://ec.europa.eu/transport/road\\_safety/pdf/observatory/trends\\_figures.pdf](http://ec.europa.eu/transport/road_safety/pdf/observatory/trends_figures.pdf)

<sup>5</sup> Depending on the monetary valuation of mortality outcomes applied. See Holland (2014), Cost-benefit Analysis of Final Policy Scenarios for the EU Clean Air Package. <http://ec.europa.eu/environment/air/pdf/TSAP%20CBA.pdf>



The cross-border impact of coal pollution means that each plant closed provides a major boost for the health not only of those living nearby but also for citizens in neighbouring countries, as well as practically everyone across the continent.

The UK's planned phase-out of coal by 2025 could save up to 2,900 lives at home and abroad each year and from 4 to 7.7 billion Euros per year in health costs. **Closing all of the EU's coal-fired power plants could prolong 22,900 lives annually.**

Over half of the EU's premature deaths from coal can be attributed to just 30 plants - the 'Toxic 30'. The same goes for the top 30 most climate damaging coal power plants, which contribute almost half of all of the CO<sub>2</sub> emissions from the EU coal fleet - the 'Dirty 30'. These plants should be closed as a priority.

**A full coal phase-out should be one of the EU's stated goals, as a key step in the transition to a 100% renewables based energy system.** Phasing out coal-fired power stations, alongside dedicated support for mining regions affected by the transition from coal power to renewable energy, will relieve EU countries of a massive health burden and is the only chance of avoiding the worst impacts of climate change.

In the aftermath of the Paris UN Climate Summit last year and the countries agreement to keep global temperature rise to well below 2°C and to pursue efforts to keep it to 1.5 °C above pre-industrial levels, the EU has an even greater responsibility to ensure that it phases out all coal-fired power plants as quickly as possible<sup>7</sup>. While the UK and Finland have committed to a coal phase-out, many others - such as Poland, Germany, Czech Republic and Spain - are still holding the coal line with financial support for mining and power production.<sup>8</sup>

To speed up the process of transitioning out of coal, specific EU policies will need strengthening, alongside national coal phase-out efforts: The EU Emissions Trading System needs a rapid and ambitious structural reform in order to put a meaningful price on carbon emissions. This should be accompanied by an Emissions Performance Standard (EPS) for CO<sub>2</sub> from power plants to provide a clear investment signal for the decarbonisation of the power sector. The Industrial Emissions Directive and National Emissions Ceilings Directive must introduce stricter pollution limits for the emissions they cover. EU funding instruments need to be reformed so that they aid the transition away from coal and other fossil fuels and support regions and communities with mining region transformation.

The cross-border impact of coal pollution, be it health or climate, shows why all citizens in Europe and beyond have a shared interest in putting an end to its use, irrespective of where the plant operates. Chapter 6 gives some examples of communities already taking action against a local plant. This is a true Europe-wide cause that unites us all.

7 Studies show that no coal power technology, however "efficient", is compatible with the 2°C temperature rise limit as agreed in Paris, see: [http://www.wwf.eu/what\\_we\\_do/climate/publications\\_climate/?265630/Incompatibility-of-HELE-coal-with-2C-scenarios](http://www.wwf.eu/what_we_do/climate/publications_climate/?265630/Incompatibility-of-HELE-coal-with-2C-scenarios) See also p.46.

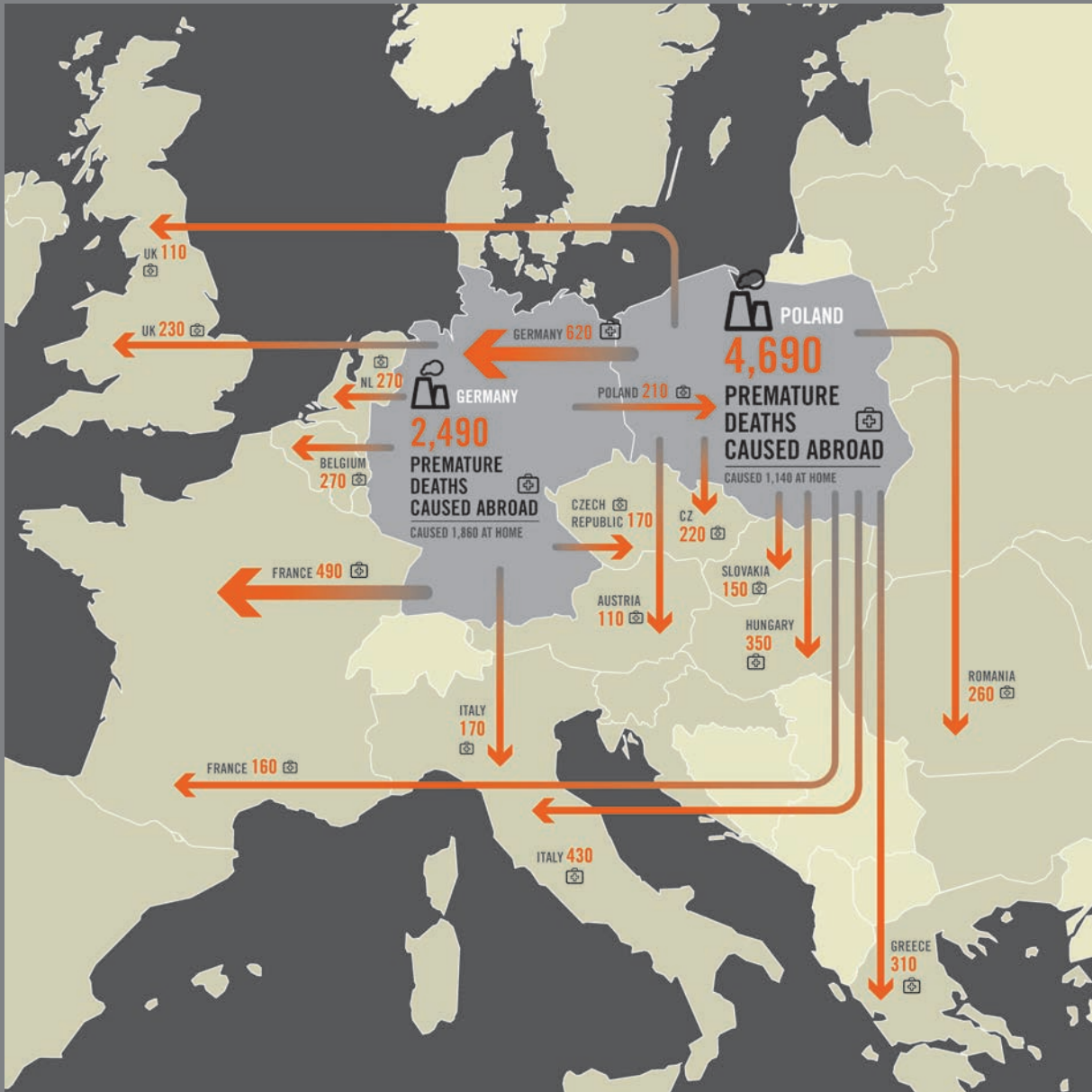
8 21 countries in the EU still burn coal for electricity production. In March 2016 Belgium joined the list of coal power free EU countries of Cyprus, Estonia, Latvia, Lithuania, Luxembourg and Malta. Coal power capacity is slowly decreasing across Europe and

political debates on coal phase out are happening in the Netherlands, Germany, Italy etc. However, to date it is only clear for a very few countries that they will indeed become coal power free based on either current government policies or market developments: In the UK the government announced to become coal power free by 2025. In Austria, the companies which own the coal plants announced last year that they would take them off-line by 2025. The Finnish government intends for Finland to become coal free in the 2020s. Portugal's coal plants will close before 2025.

# WHO MAKES THE DARK CLOUD



## POLAND & GERMANY



POLISH AND GERMAN COAL PLANTS CAUSE THE MOST HEALTH DAMAGE ABROAD IN THE EU.



# ... & WHO BREATHES IT IN?



FRANCE



**FRANCE** HAS LITTLE COAL IN ITS POWER MIX, BUT IS HEAVILY IMPACTED BY ITS NEIGHBOURS' COAL PLANTS.

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## CHAPTER 1.

# HOLDING BACK

## HOW COAL IS HOLDING BACK THE EU'S CLEAN AIR AND CLIMATE AMBITIONS

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# 1

### THE EU COAL FLEET

The EU's electricity generation mix is changing. The amount of EU electricity generated from renewables rose from 20% in 2010 to 29% in 2015.<sup>9</sup> In addition, the EU's electricity consumption fell by 4% from 2010 to 2015. While hard coal-based generation is steadily declining, lignite-based electricity generation in 2015 was unchanged from 2010.<sup>10</sup> Coal as a whole still makes up 24% of the EU's electricity mix in 2015.<sup>11</sup> Instead, it was generation from gas-fired power stations - which produce less than half the emissions of lignite per unit of electricity - that fell due to the gas price being higher than that of coal.

By end of 2015, there were 280 operational coal-fired power stations in the EU.<sup>12</sup> When comparing closures with additions of coal capacity between 2000 and 2015, the wind energy association EWEA found that net available coal power capacity in the EU shrank by 32.58 GW.<sup>13</sup> The EU's remaining operational fleet is old; 66% are already 30 years and older. As electricity prices fell, operators cut costs by shrinking workforces, reducing maintenance costs and slashing investment. Indeed, the only sizeable investments in existing coal power plants over the last five years have been in Poland and the Czech Republic.

Nevertheless, the EU's remaining 280 operational coal-fired power stations alone were still responsible for 18% of EU's greenhouse gas (GHG) emissions in 2014.<sup>14</sup>

The Paris Agreement on climate change recognises the need to limit global temperature rise to 1.5°C to avoid dangerous climate change. This increases the need for the EU to phase out all fossil fuels as soon as possible and means that a full phase-out of coal is inevitable. The question is whether this is happening quickly enough. Comparing the International Energy Agency (IEA) scenarios to keep global warming to 2°C degrees to past trends, we found that the EU's coal power-based CO<sub>2</sub> emissions must fall three times faster (by 8% per year to 2040) than they have to date (2.3% per year from 2005 to 2014).<sup>15</sup> Limiting warming to well below 2°C or 1.5°C will require steeper reductions.

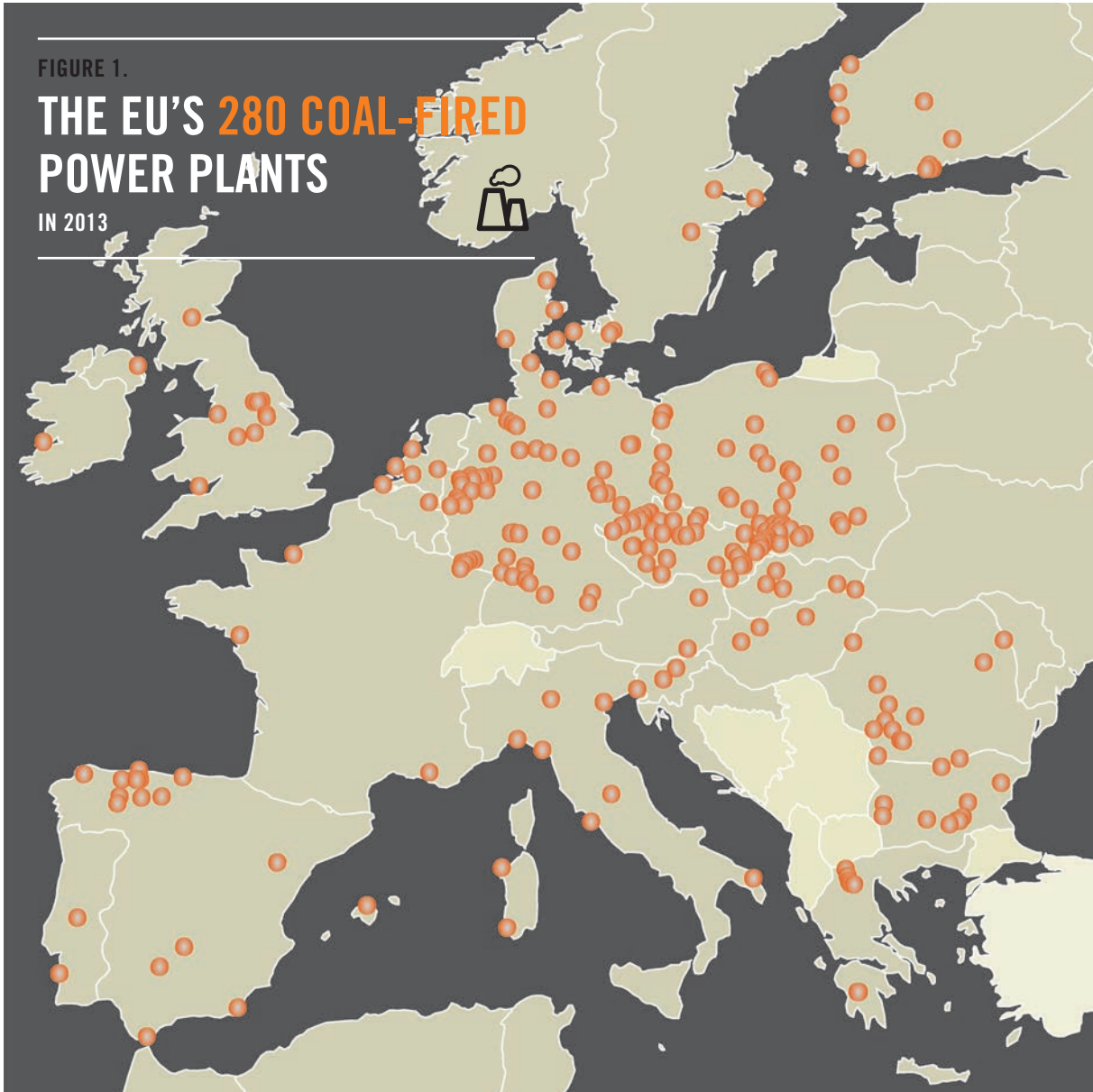
To date, 16% of the current operational plants have announced they will close between 2016 and 2020.<sup>16</sup> This means that most of Europe's coal-fired power plants are not yet committing to closing. They are instead using quick-fix solutions to stay open from one year to the next to avoid overly costly modernisations required to meet, for example, stricter emissions standards and postponing the decision to extend plant life or close plants altogether. For example, in order to meet the lower NO<sub>x</sub> limits on 1 January 2016, only a few coal-fired power plants have installed the more effective, but expensive, selective catalytic reduction (SCR) technology. Instead, most have used a chemical process called selective noncatalytic reduction (SNCR), which is cheaper but much less effective.

In the meantime, Europe's 280 coal power plants continue to impact the health of European citizens.

FIGURE 1.

# THE EU'S 280 COAL-FIRED POWER PLANTS

IN 2013



- 9 Sandbag, 2015 European Power Sector Review. The figures for renewables include hydropower. <https://sandbag.org.uk/reports/2015-european-power-sector-review/>
- 10 Ibid.
- 11 Calculation by the authors, based on Eurostat data.
- 12 The Climate Action Network (CAN Europe) tracks all EU coal-fired power plants, and this dataset was first used in "End of an Era" report published in December 2015. The cut-off date used is October 2015. <http://www.caneurope.org/attachments/article/930/End%20of%20an%20Era%20report%20single%20pages%20final.pdf>
- 13 EWEA (2016): Wind in Power. 2015 European Statistics. <http://www.ewea.org/fileadmin/files/library/publications/statistics/EWEA-Annual-Statistics-2015.pdf>
- 14 2015 data to calculate coal's share of EU's greenhouse gas emissions is not yet available.
- 15 The CAN Europe "End of an Era" report published in December 2015. <http://www.caneurope.org/attachments/article/930/End%20of%20an%20Era%20report%20single%20pages%20final.pdf>. This report, used scenarios from the International Energy Agency (IEA).204.pdf
- 16 A few of the closures announced for 2016 have taken place, including in UK, Czech Republic, the Netherlands and Belgium. Source: CAN Europe database, based on government or utility announcements.

## CHAPTER 2.

# THE IMPACTS

## HOW BURNING COAL IMPACTS OUR HEALTH

# 2.

## EUROPE-WIDE IMPACT

**For the first time, this report has analysed the health impact of all coal-fired power stations in the European Union for which data was available - 257 of the 280 plants.<sup>17</sup>**

We found that the emissions from the 257 power plants were associated with 22,900 premature deaths in 2013.<sup>18</sup> These premature deaths resulted from the impacts of three main pollutants - particulate matter (by far the most harmful), ground-level ozone and nitrogen dioxide - on the cardiovascular or respiratory system. Most common causes of death connected to particulate matter exposure are strokes, heart disease, chronic lung disease or lung cancer.

Around 83% of the premature deaths - approximately 19,000 in total - were caused by fine particulate matter, known as PM<sub>2.5</sub>. The PM<sub>2.5</sub> particles are formed in the atmosphere from the coal plants' sulphur dioxide and nitrogen dioxide emissions.

The way that these PM<sub>2.5</sub> particles are formed means that they are transported hundreds of kilometres and across national borders, impacting the health of people both within the country of production and further afield.

This means that Europeans have a shared interest in phasing out all coal-fired power plants, wherever they are situated.

17 257 coal plants reported their 2013 pollution emissions to the European Pollutant Release and Transfer Register (E-PRTR). There are 23 other plants we do not have official data from the E-PRTR. This is for most of them either because they have come online since 2013 or because their emissions were below the reporting threshold.

18 Numbers are rounded up/down to the nearest 100 (text) or 10 (figures).

19 WHO Europe (2013), Health risks of air pollution in Europe, HRAPIE project recommendations. <http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/health-risks-of-air-pollution-in-europe-hrapie-project-recommendations-for-concentration-response-functions-for-cost-benefit-analysis-of-particulate-matter,-ozone-and-nitrogen-dioxide>

20 Depending on the monetary valuation applied for mortality, the total costs amount to either 32.4 billion Euros (median value of 1.26 million Euros as Value of a Statistical Life, VSL) or 62.3 billion Euros (high value of 2.56 million Euros as Value of a Statistical Life, 2013 prices). See annex 1 for documentation of all monetary values applied.

21 A 'confidence interval' means that if the same population is sampled on numerous occasions and interval estimates are made on each occasion, the resulting intervals would bracket the true population parameter in approximately 95% of the cases. In this case, epidemiological studies which have observed changes in mortality in large population groups in association with an increased level of air pollution have given a range of lower and higher mortality increases for the same level of air pollution increase. The range that corresponds to the 95% confidence intervals of the relative risk for mortality is 14,400 to 33,900 premature deaths.

## EXPLAINER: COAL & HEALTH METHODOLOGY

For our analysis, we first took the most up to date pollution data (from 2013) on SO<sub>2</sub>, NO<sub>x</sub> and primary particulate matter submitted by Member States for each coal power station. We then ran the emissions through an atmospheric dispersion model, using weather data from 2013. Taking into account variables such as wind speed and direction, temperature, humidity and precipitation, land use, topographical and other relevant geophysical data, we simulated the way pollution would spread across Europe. By introducing information on population density and different consequences for health of different levels of pollution, we were able to estimate the health impacts. 5,600 premature deaths were attributed to exposure with nitrogen dioxide (NO<sub>2</sub>). However, some of these will be the result of joint exposure to particulates and nitrogen dioxide, so one third of these deaths were not added to the total.<sup>19</sup>

We carried out a separate assessment for the impact of mercury released by the European coal fleet and excluded health impacts from CO<sub>2</sub> from the assessment (see Annex 1 for a complete description of the methodology).

Our assessment put total health costs at up to 62.3 billion Euros per year.<sup>20</sup> In fact, the actual figure is likely to be higher because our estimate does not include the morbidity costs of all health conditions related to exposure to air pollution. It does not take into account adverse outcomes including stroke, coronary ('ischaemic') heart disease, lung cancer, impaired lung function, low birth weight, pre-term delivery and impaired cognitive development in children. The estimate also excludes any health costs arising from the full life cycle of coal, such as mining and waste disposal or indirect health costs resulting from CO<sub>2</sub> emissions that fuel climate change.

## WHAT IS A 'PREMATURE DEATH'?

'Premature death' is used in this report to highlight deaths that are attributed to exposure to a risk factor, namely air pollution. These early deaths are preventable in the sense that they would occur later in life if air quality was improved.

Premature death is a statistical measure based on large-scale epidemiological studies which found associations between the number of deaths (from all natural causes, and especially from stroke, ischaemic heart disease, COPD, and lung cancer) and air pollution. It is a calculation that gives special weight to deaths taking place before old age.

In our assessment, the 95% confidence interval for the relative risk of death, which signifies the lower range and the higher range of the response function from the scientific literature applied, is approximately 14,400 to 31,900 premature deaths.<sup>21</sup> Some recent studies focus instead on the concept of 'equivalent attributable deaths' as an alternative to 'premature deaths'.<sup>22</sup>

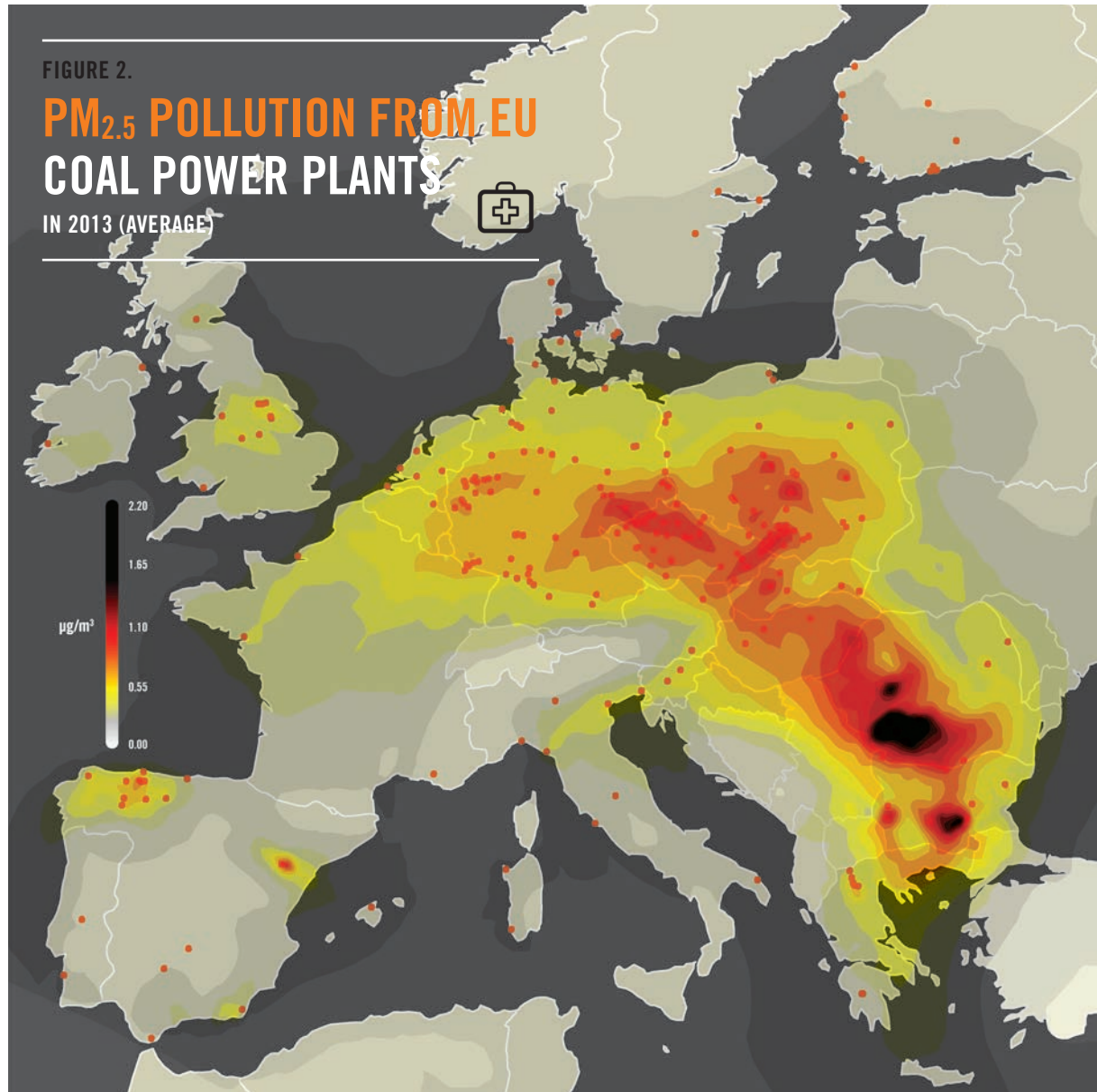
In addition to premature deaths, the pollutants also caused many cases of ill-health, including around 11,800 new cases of chronic bronchitis as well as over 538,000 asthma attacks in children. In addition, approximately 21,000 hospital admissions and 6.6 million lost working days were linked to emissions from coal-fired power plants in the EU.

The health impacts of coal, along with the reduced productivity caused by absence from work, create substantial costs. These costs are valued at 32.4 to 62.3 billion Euros for 2013.<sup>23</sup> These costs are not covered by the coal sector. Rather, they are paid by society, including direct healthcare costs accruing to national healthcare budgets, individual treatment costs borne by the people affected and economic losses caused by reduced productivity.<sup>24</sup>

22 For example, the Committee on the Medical Effects of Air Pollutants proposes 'equivalent attributable deaths' to describe that air pollution might be implicated as a risk factor in an even larger number of deaths than expressed by the number of premature deaths, but due to other important risk factors working at the same time, a fraction of deaths equivalent to the importance of the risk factor is attributed to air pollution. COMEAP (2010), Mortality effects of long-term exposure to particulate air pollution in the UK. <https://www.gov.uk/government/publications/comeap-mortality-effects-of-long-term-exposure-to-particulate-air-pollution-in-the-uk>

23 Depending on the monetary valuation of mortality outcomes applied. See annex 1 for documentation of monetary values.

24 The costs of a premature death are derived from the willingness to pay for avoiding premature death, which in turn is based on observed risk behaviour and economic surveys.



- 25 VSL stands for Value of a Statistical Life, an economic expression. It puts a monetary value for one statistical human life lost.
- 26 Restricted activity days (RADs) are days on which a person's health is impaired so that the person has to stay in bed, or cannot go to work or to school. Work days lost are a

part of RADs but are deducted from the total number and listed separately. Also deducted from the total RADs are days with asthma symptoms in children and hospitalizations (applying an average stay length in hospital).

## Health impacts from emissions of EU coal powered plants

Associated health costs in million Euros (VSL, median/ high value, 2013 prices)<sup>25</sup>

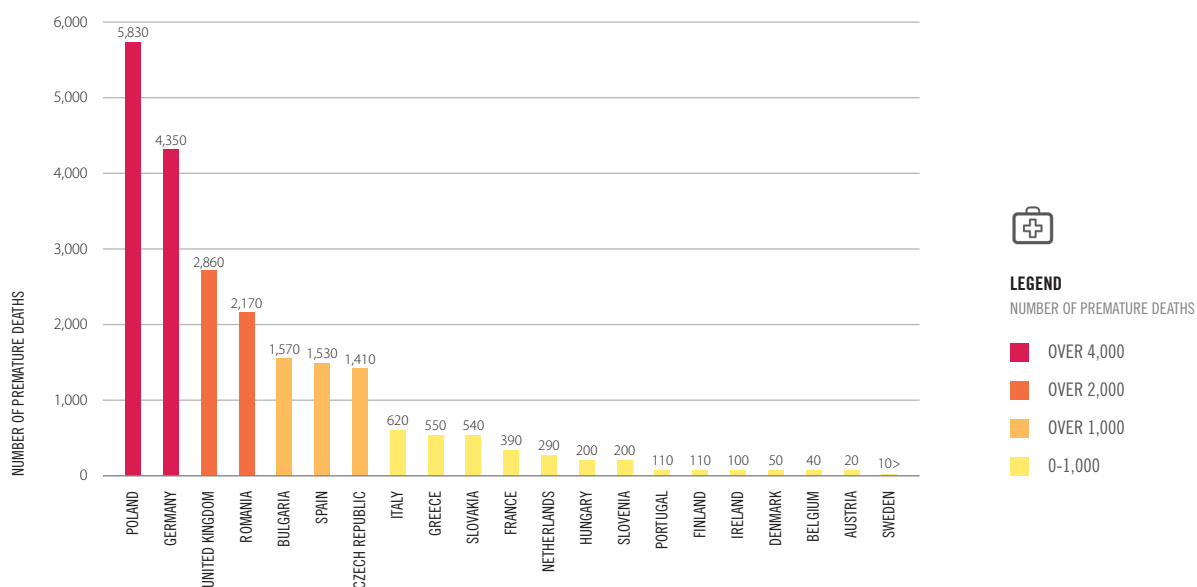
Premature deaths from PM <sub>2.5</sub>	19,000	23,900 / 48,500
Premature deaths from ground-level ozone	200	200 / 500
Premature deaths from NO <sub>2</sub> (scaled to 2/3rd's of model results to avoid double-counting with PM <sub>2.5</sub> )	3,800	4,700 / 9,600
Infant mortality	40	70 / 100
Hospital admissions (respiratory or cardiovascular)	21,000	50
Cases of chronic bronchitis (adults)	11,800	700
Work days lost	6,575,800	1000
Additional restricted activity days <sup>26</sup>	23,502,800	2,500
Minor restricted activity days	1,166,700	60
Asthma symptom days in children	538,300	30
Bronchitis in children	51,700	40
<b>Total health costs</b>		<b>32,400 / 62,300</b>

## COAL COUNTRIES CAUSING THE MOST NEGATIVE HEALTH IMPACTS

The countries with coal plants making the largest contribution to premature deaths and the burden of disease in 2013 were Poland, Germany, the United Kingdom, Romania, Bulgaria, Spain and the Czech Republic.

FIGURE 3.

## PREMATURE DEATHS FROM COAL-FIRED POWER PLANTS ACCORDING TO COUNTRY IN WHICH THE COAL PLANTS RESPONSIBLE ARE SITUATED (2013)



## COAL POLLUTION RESPECTS NO BORDERS

Gases and soot particles emitted by the coal plant via the smokestack rise and are dispersed into the atmosphere. These can be transported over hundreds of kilometres, depending on weather conditions such as wind speed and direction, sun radiation and humidity, but also on the topography and the height of the smokestack. All of these factors can influence concentrations of air pollutants.

This means that emissions from coal power plants may impact the health not only of citizens in the originating country but also in neighbouring countries.

The citizens experiencing the greatest health impact from coal pollution in the EU in 2013 were those in Germany, the United Kingdom, Poland, Italy, France, Romania and Spain. Those in Greece, the Netherlands, Hungary, the Czech Republic, Bulgaria and Belgium also suffered considerable health damage from coal.

The countries producing the highest levels of coal emissions were - perhaps unsurprisingly - the same countries that exported most pollution; Poland, Germany, Romania, the United Kingdom, Bulgaria and the Czech Republic.

For example, coal power stations in Poland - the country with coal plants causing the greatest damage - caused 5,800 premature deaths across the EU. Of these, only 20% - 1,100 - occurred in Poland. The remaining 4,700 occurred outside the country with Slovakia, the Czech Republic and Hungary, and even far-distant countries such as Italy, Greece and France experiencing more lives lost due to Polish coal pollution than from their domestic coal fleets. In the same period, Poland itself also suffered an additional 700 premature deaths due to coal plant emissions from outside the country.

Other examples include Bulgarian coal-fired power plants causing more premature deaths in Romania and Greece than in Bulgaria, while the Czech coal fleet is responsible for a higher number of premature deaths in both Germany and Poland than at home. The largest cross-border effects occurred from Poland into Germany and from Germany into France. While exporting pollution associated with 2,500 premature deaths, Germany is at the same time the biggest recipient of coal pollution from abroad, linked to 1,700 early deaths. The country with the second highest impact from coal pollution originating externally, while causing little of its own, is France: This makes France the largest net importer of coal pollution in Europe. In addition, non-EU countries received a proportion of the coal pollution from EU power plants, which was associated with 4,300 premature deaths.<sup>27</sup>

27 Non-EU countries which experienced more than 50 premature deaths each from EU coal pollution are (in ascending order): Israel, Ukraine, Bosnia and Herzegovina, Republic of Moldova, Lebanon, Kosovo, Tunisia, (and over 100 premature deaths) Switzerland, Algeria, Albania, Belarus (and over 400 premature deaths) Serbia, Russia, Egypt and Turkey.

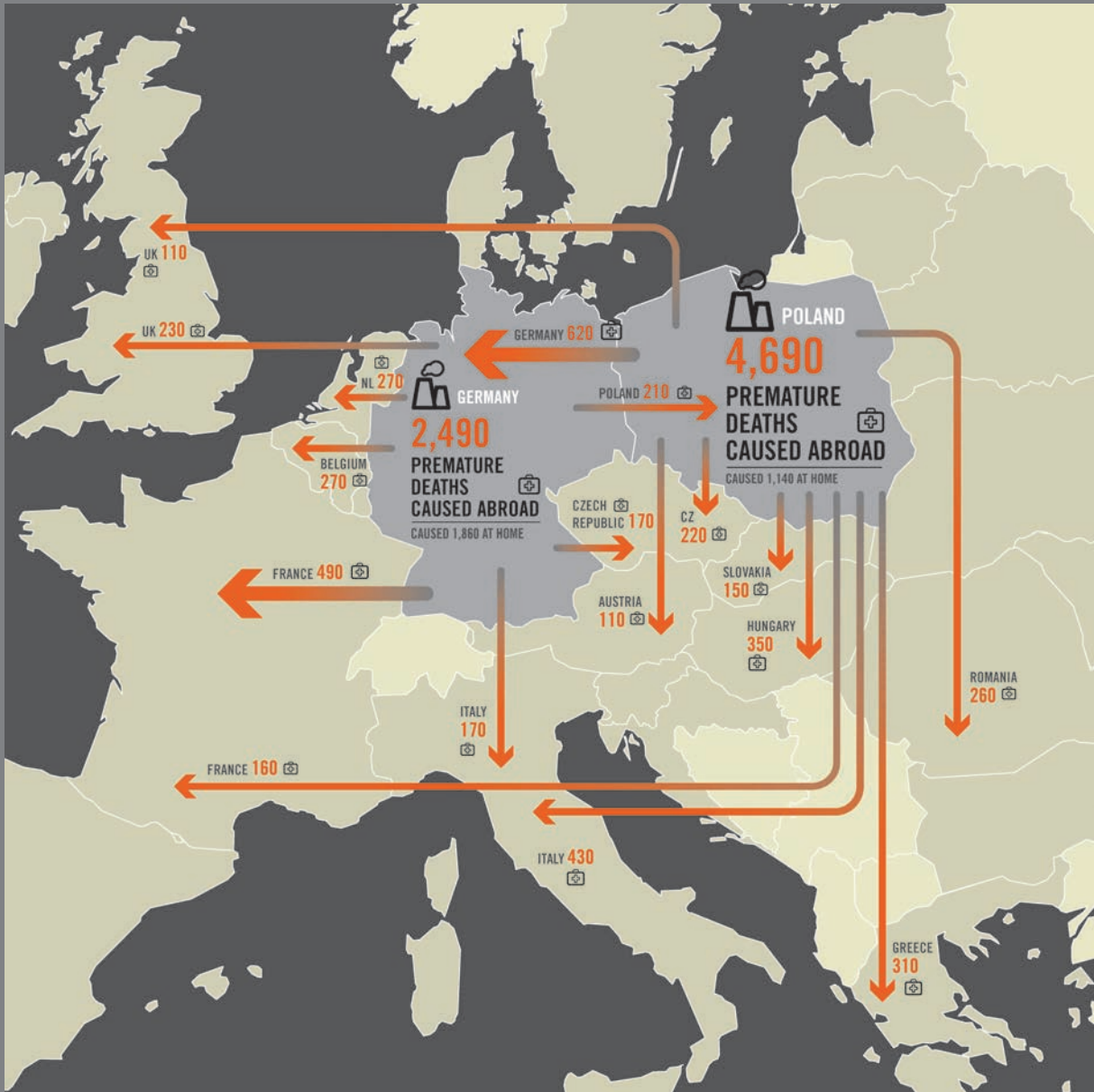


FIGURE 4.

# WHO MAKES THE DARK CLOUD



POLAND & GERMANY



## POLAND 5,830

PREMATURE DEATHS CAUSED, INCLUDING:

- POLAND: 1,140
- GERMANY: 620
- ITALY: 430
- HUNGARY: 350
- GREECE: 310
- ROMANIA: 260

- CZECH REPUBLIC: 220
- FRANCE: 160
- SLOVAKIA: 150
- AUSTRIA: 110
- UNITED KINGDOM: 110

## GERMANY 4,350

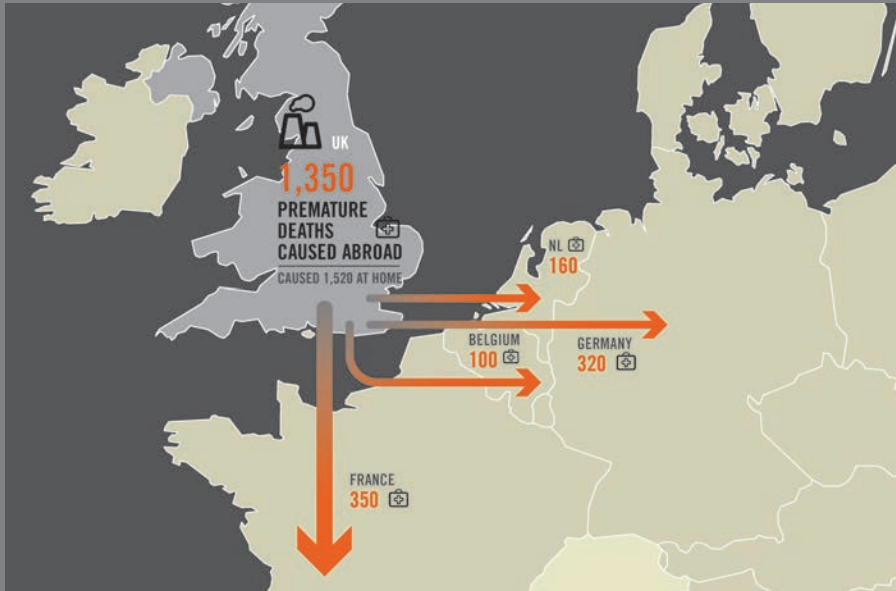
PREMATURE DEATHS CAUSED, INCLUDING:

- GERMANY: 1,860
- FRANCE: 490
- BELGIUM: 270
- NETHERLANDS: 270
- UNITED KINGDOM: 230

- POLAND: 210
- CZECH REPUBLIC: 170
- ITALY: 170

FIGURE 4. CONTINUED

# WHO MAKES THE DARK CLOUD



## UNITED KINGDOM 2,870

PREMATURE DEATHS CAUSED, INCLUDING:

UNITED KINGDOM: 1,520

FRANCE: 350

GERMANY: 320

NETHERLANDS: 160

BELGIUM: 100



## ROMANIA 2,170

PREMATURE DEATHS CAUSED, INCLUDING:

ROMANIA: 510

GREECE: 270

BULGARIA: 260

HUNGARY: 90



**BULGARIA 1,570**

PREMATURE DEATHS CAUSED, INCLUDING:

- BULGARIA:** 190
- ROMANIA:** 370
- GREECE:** 200
- HUNGARY:** 70



**CZECH REPUBLIC 1,410**

PREMATURE DEATHS CAUSED, INCLUDING:

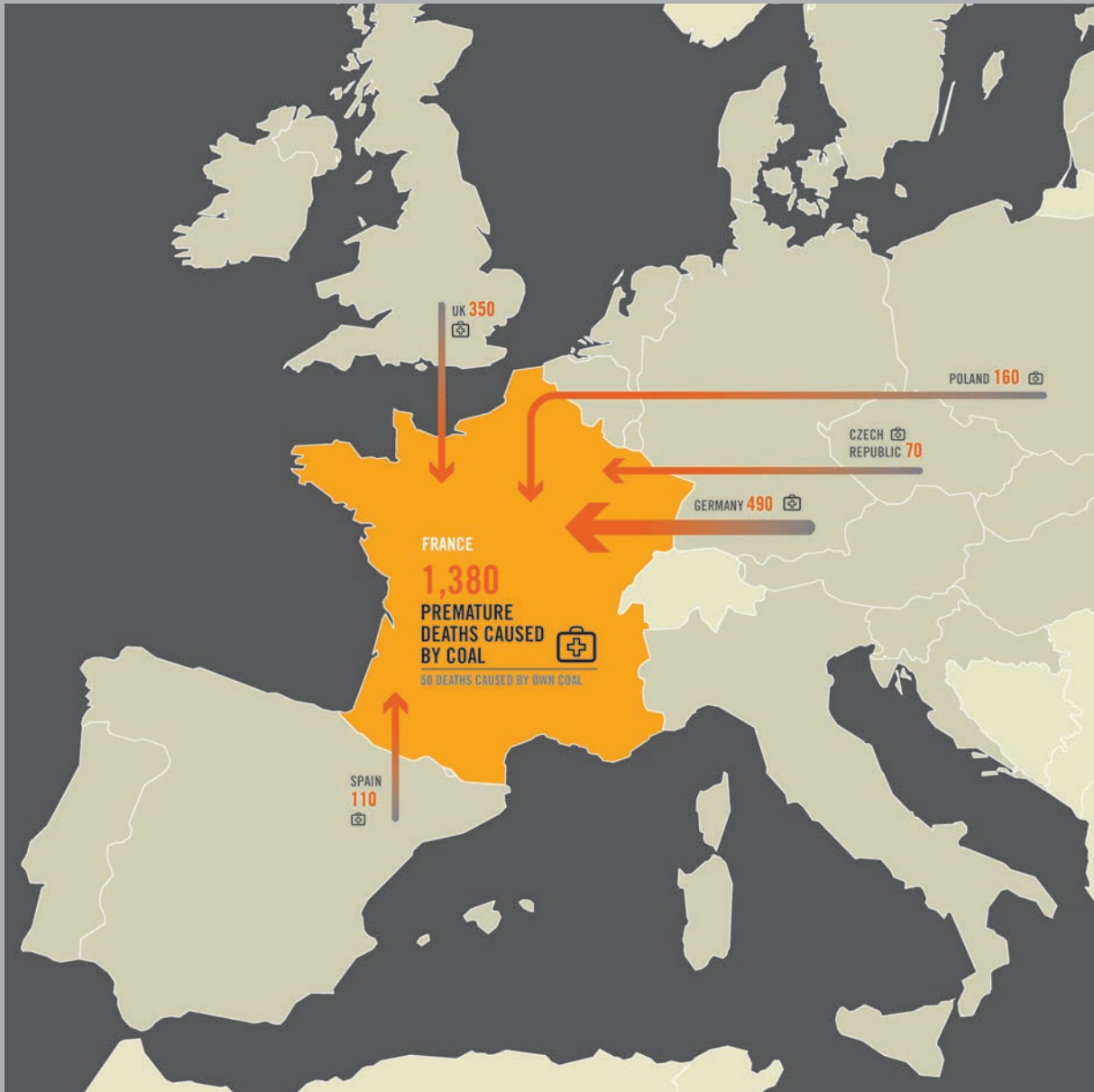
- CZECH REPUBLIC:** 110
- GERMANY:** 390
- POLAND:** 180
- ITALY:** 110

FIGURE 4. CONTINUED

# ... & WHO BREATHES IT IN?



## FRANCE

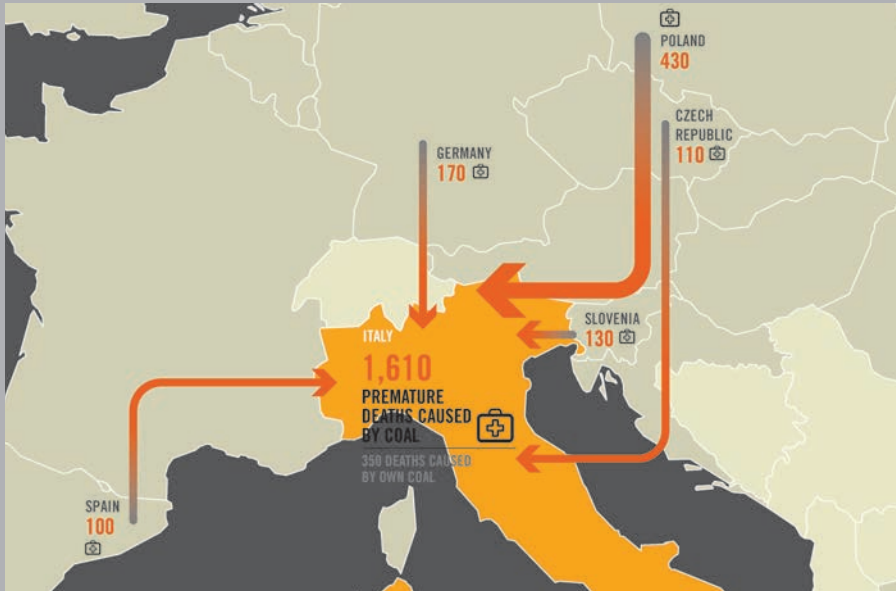


### FRANCE 1,380

PREMATURE DEATHS CAUSED BY COAL, INCLUDING FROM:

- |                     |                           |
|---------------------|---------------------------|
| <b>FRANCE:</b> 50   | <b>SPAIN:</b> 110         |
| <b>GERMANY:</b> 490 | <b>CZECH REPUBLIC:</b> 70 |
| <b>UK:</b> 350      |                           |
| <b>POLAND:</b> 160  |                           |

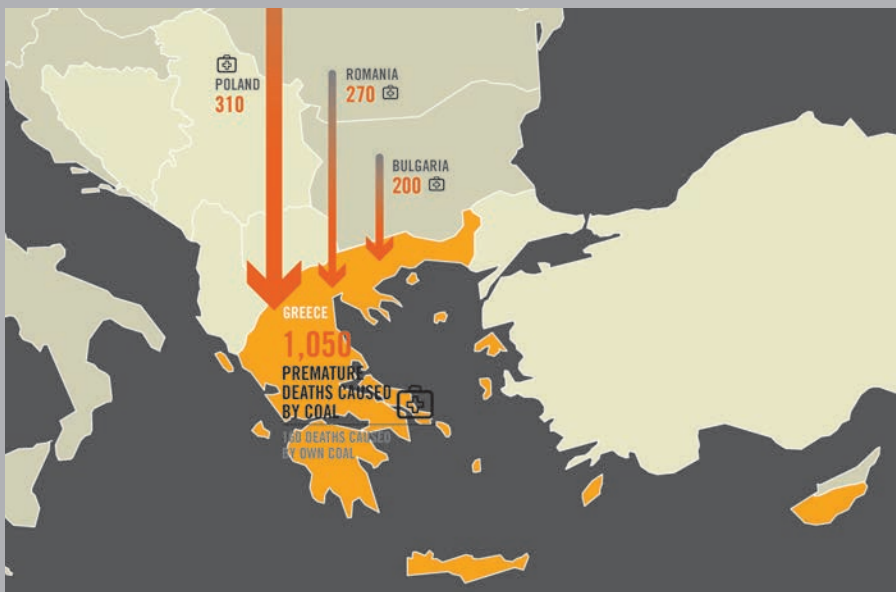
While Germany is a major producer of coal pollution, which caused 1,860 deaths within the country in 2013, it also suffered 1,770 additional premature deaths from its neighbours' coal.



## ITALY 1,610

PREMATURE DEATHS  
CAUSED BY COAL,  
INCLUDING FROM:

ITALY: 350  
POLAND: 430  
GERMANY: 170  
SLOVENIA: 130  
CZECH REPUBLIC: 110  
SPAIN: 100



## GREECE 1,050

PREMATURE DEATHS  
CAUSED BY COAL,  
INCLUDING FROM:

GREECE: 160  
POLAND: 310  
ROMANIA: 270  
BULGARIA: 200

FIGURE 4. CONTINUED

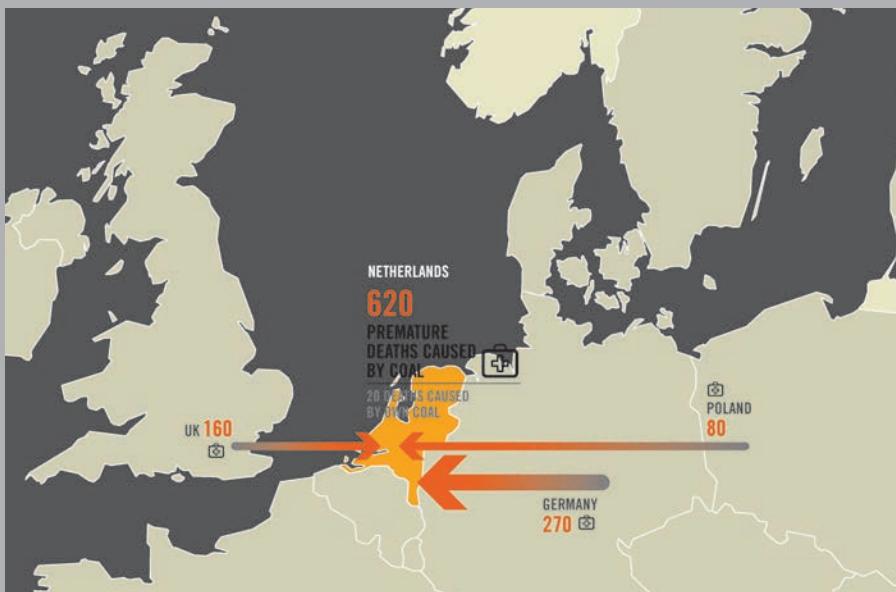
## ... & WHO BREATHES IT IN?



### HUNGARY 700

PREMATURE DEATHS CAUSED BY COAL, INCLUDING FROM:

- HUNGARY: 10
- POLAND: 350
- ROMANIA: 90
- BULGARIA: 70
- GERMANY: 60



### NETHERLANDS 620

PREMATURE DEATHS CAUSED BY COAL, INCLUDING FROM:

- NETHERLANDS: 20
- GERMANY: 270
- UK: 160
- POLAND: 80



FIGURE 5.

# OVERVIEW OF PREMATURE DEATHS\*

LINKED TO COAL PLANTS ACROSS EUROPE IN 2013

LEGEND

- OVER 50 PREMATURE DEATHS
- EUROPEAN TOTAL
- PREMATURE DEATHS CAUSED IN ONE COUNTRY BY THAT SAME COUNTRY'S COAL PLANTS

IMPACTED COUNTRY 	EMITTING COUNTRY 																				TOTAL
	Austria	Belgium	Bulgaria	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Netherlands	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	United Kingdom	
Austria	0	0	10	30	0	0	0	50	0	0	0	10	0	110	0	10	10	0	0	0	250
Belgium	0	0	0	20	0	0	20	270	0	0	0	0	20	50	0	0	0	0	10	100	510
Bulgaria	0	0	190	10	0	0	0	10	20	0	0	0	90	0	260	10	0	0	0	0	590
Czech Republic	0	0	10	110	0	0	0	170	0	10	0	0	220	0	10	20	0	0	10	570	
Denmark	0	0	0	10	0	0	0	40	0	0	0	0	30	0	0	0	0	0	40	140	
Finland	0	0	0	0	0	10	0	0	0	0	0	0	10	0	0	0	0	0	0	30	
France	0	10	0	70	0	0	50	490	0	0	10	40	40	160	10	0	10	10	110	350	1,380
Germany	0	20	10	390	20	10	90	1,860	0	20	10	10	130	620	0	10	50	0	40	320	3,630
Greece	0	0	200	30	0	0	0	10	160	10	0	20	0	310	0	270	20	0	10	0	1,050
Hungary	0	0	70	50	0	0	0	60	10	10	0	10	0	350	0	90	40	0	0	10	700
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	50
Italy	10	0	40	110	0	0	60	170	40	10	0	350	10	430	10	60	40	130	100	30	1,610
Netherlands	0	0	0	30	0	0	20	270	0	0	10	0	20	80	0	0	10	0	10	160	620
Poland	0	0	30	180	0	10	10	210	0	40	0	10	10	1,140	0	40	120	0	10	40	1,860
Portugal	0	0	0	0	0	0	0	10	0	0	0	0	0	0	10	0	0	0	150	10	190
Romania	0	0	370	30	0	0	0	30	20	10	0	10	0	260	0	510	30	0	0	10	1,280
Slovakia	0	0	10	20	0	0	0	20	0	10	0	0	0	150	0	20	20	0	0	0	250
Slovenia	0	0	0	10	0	0	0	10	0	0	0	10	0	30	0	0	0	10	0	0	80
Spain	0	0	0	20	0	0	10	70	0	0	0	30	10	40	60	0	0	10	840	60	1,170
United Kingdom	0	0	0	40	0	10	80	230	0	0	50	0	20	110	0	0	10	0	20	1,520	2,100
Other EU countries	0	0	20	40	0	10	10	80	20	10	0	20	0	210	0	30	20	10	20	50	570
Non-EU countries	0	0	610	200	0	30	20	270	270	50	0	80	10	1,420	10	850	130	20	200	110	4,310
<b>TOTAL</b>	<b>20</b>	<b>40</b>	<b>1,570</b>	<b>1,410</b>	<b>50</b>	<b>100</b>	<b>390</b>	<b>4,350</b>	<b>550</b>	<b>200</b>	<b>110</b>	<b>620</b>	<b>290</b>	<b>5,830</b>	<b>110</b>	<b>2,170</b>	<b>540</b>	<b>200</b>	<b>1,530</b>	<b>2,870</b>	<b>22,940</b>

\* All numbers are rounded to the nearest 10; therefore in some cases the sum of these appears slightly different from the sub-totals.

## THE UK: A COAL PHASE-OUT WITH CONTINENTAL BENEFITS

### The UK's coal phase-out in a nutshell

Deadline for phase-out:	2025
Amount of coal to be phased out as of 2015:	19,000 MW
Percentage of electricity from coal in 2012:	40%
Premature deaths from these plants in 2013:	2,900

The industrial growth of Great Britain may have been powered by coal, but coal's dominance is over: the UK has announced it will end coal by 2025.

This will bring major benefits to the health both of UK residents and of those in nearby countries, such as France.

In 2014, coal generation made up 36% of the UK's electricity and was responsible for 18% of the UK's CO<sub>2</sub> emissions. But the independent Committee on Climate Change has advised that the UK's power sector will need to be largely decarbonised by 2030<sup>28</sup> in order to reduce emissions in the most cost effective manner.

The tide began to turn against coal in February 2015, when, prior to a general election, future Prime Minister David Cameron pledged to "accelerate the transition to a competitive, energy efficient low carbon economy and to end the use of unabated coal for power generation."<sup>29</sup>

Between March 2015 and March 2016, the permanent closure of five of the UK's eleven coal plants was announced. This equates to roughly half of the UK's total coal capacity.

In the autumn of 2015 and following a concerted campaigning push from a coalition of NGOs, the UK Secretary of State for Energy and Climate Change announced that the Government intends to consult on "proposals to close coal by 2025 - and restrict its use from 2023."<sup>30</sup>

However, this commitment came with the caveat that the closure would only be implemented if enough gas were brought online to cover capacity. A managed phase-out over a decade will give time for this replacement capacity to be built. With the future of coal now clear, greater investment should be available for other energy projects.

The UK carbon floor price has been essential for this transition. It was fundamental in moving generating capacity away from coal. At the time of writing, the consultation is yet to be published.

The closures announced to date represent a major step forward in the decarbonisation of the UK economy and in the improvement of air quality in the UK. These five coal power stations were responsible for emitting around 6% of UK greenhouse gas emissions, 18% of total UK SO<sub>2</sub> and 7% of UK NO<sub>x</sub> in 2014. In May 2016, UK electricity generated from coal fell to zero on more than one occasion - for the first time since the first coal plants opened there in 1882.

However, there are still six unabated coal-fired power plants emitting vast quantities of CO<sub>2</sub> and pollutants into the atmosphere. The emissions from these alone represented 10% of the UK's total GHG emissions in 2014.



The UK government must follow through on their promise to phase out coal from the UK energy mix by bringing forward the legislation that will force them to close by 2025. Closing down the UK's coal plants will prevent approximately 2,900 early deaths every year - more than 1,300 of them in continental Europe.<sup>31</sup>

As this report shows, every coal-fired power station switched off will have benefits for human health, as well as for the climate.



**EGGBOROUGH POWER PLANT.**  
© John Mabbitt

28 To 50-100gCO<sub>2</sub>/kWh, <https://www.theccc.org.uk/2015/10/22/new-low-carbon-electricity-generation-is-cost-effective-option-for-uk-power-sector-investment-in-2020s-and-beyond/>  
29 [http://www.green-alliance.org.uk/leaders\\_joint\\_climate\\_change\\_agreement.php](http://www.green-alliance.org.uk/leaders_joint_climate_change_agreement.php)

30 <https://www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy>  
31 [https://www.e3g.org/docs/UK\\_country\\_profile\\_-\\_G7\\_coal\\_scorecard.pdf](https://www.e3g.org/docs/UK_country_profile_-_G7_coal_scorecard.pdf)

# THE SCIENCE

## BEHIND HEALTH IMPACTS FROM AIR POLLUTANTS

# 3.

**It is estimated that, in 2012, about 3.7 million people died prematurely from the effects of outdoor air pollution around the world. Most of these fatalities will be due to the effects of polluted air on the circulatory system (40% from coronary heart disease and 40% from strokes).<sup>32</sup> The International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) has classified both outdoor air pollution and particulate matter as carcinogenic to humans, further describing these as “a leading environmental cause of cancer deaths”.**

Recognising the important role that air pollution plays in many chronic diseases, the EU set a goal of achieving levels of air quality that do not “give rise to significant impacts on, or risks to, human health”<sup>33</sup> in its Sixth Environmental Action Programme in 2001.

Despite major improvements in air quality, levels of outdoor air pollution in Europe remain high. More than 80% of the urban population in Europe is exposed to levels of particulate matter above the levels recommended by the WHO. The European Environment Agency estimated that, in 2012, about 403,000 premature deaths in the EU were caused by long-term exposure to PM<sub>2.5</sub>. Lowering PM<sub>2.5</sub> levels would bring the greatest reductions in mortality and ill-health. Were WHO guideline values to be met, around 144,000 early deaths could be avoided in the EU every year.<sup>34</sup>

The scientific consensus<sup>35</sup> is that even low levels of exposure to particulate matter lead to physiological changes within the body and can damage health. In fact, no official safe threshold for this material could be established. Therefore, **every reduction in current levels of particulate matter will bring gains for human health.**

‘Particulate matter’ describes a mixture of liquid and solid particles dispersed in the air, which differ in size and many other properties. Important size categories are PM<sub>10</sub>, with a diameter of less than 10 micrometres; PM<sub>2.5</sub> with a diameter less than 2.5 micrometres; and ultrafine particles less than 0.1 micrometre in diameter. While the coarse particles are mostly filtered from the inhaled air in the larger airways, PM<sub>2.5</sub> are small enough to enter the small airways and alveoli. These fine particles have a high likelihood of passing from the alveoli into the blood and can thus reach different organs of the body. Physiological changes induced by PM include tissue damage from free radicals (oxidative stress) and inflammation, plaque formation in arteries (atherogenesis) as well as narrowing of blood vessels (vasoconstriction) and even permanent damage to cell DNA. These changes have strong knock-on effects, eventually leading to serious chronic diseases such as heart attacks, strokes and cancer (see Figure 6).

Even short-term exposure to particulate matter - short-term meaning as little as several hours, and up to several days - can have negative effects, including increased mortality rates. The short-term and long-term effects (commonly referred to as acute effects and chronic effects) for which strong scientific evidence exists are shown in Figure 6. In assessments of mortality, short-

term and long-term mortality from PM, however, must not be added up to avoid double counting. Not all the recognised effects of particulate matter have been quantified in this report. In some cases, the causal mechanisms are still not well understood or epidemiological data are not sufficient or consistent

enough to allow for quantification. Therefore, this report follows WHO recommendations for the set of health impacts to be included. The impacts are thus dominated by the effects of long-term particulate matter and nitrogen dioxide exposure on mortality.

FIGURE 6.

## COAL'S IMPACTS ON THE HUMAN BODY

HEALTH IMPACT OF PARTICULATE MATTER EMISSIONS FROM COAL-FIRED POWER PLANTS<sup>36</sup> 

### Short-term (hours to days):

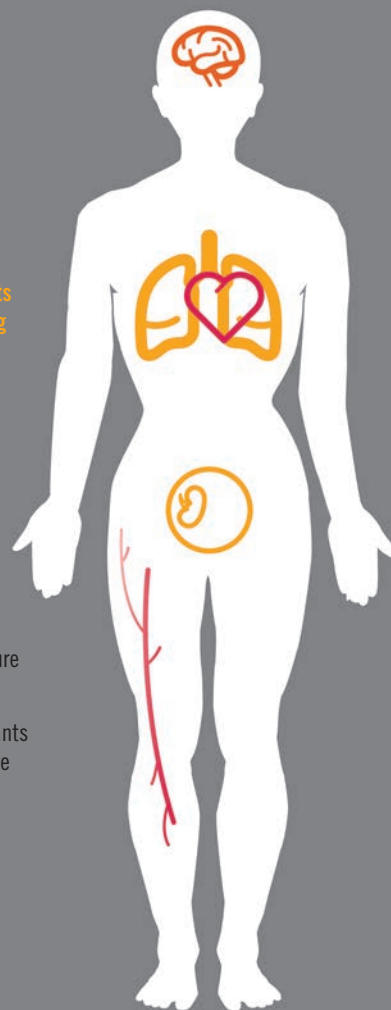
- Cardiovascular & respiratory hospital admissions
- Restricted activity days
- Work days lost
- Incidence of asthma symptoms in asthmatic children & adults
- Higher death rates
- Reduced lung function

### Long-term (years):

- Reduced life expectancy
- Mortality from cerebrovascular or coronary heart disease, COPD & cancer of the lungs, bronchi & trachea
- Infant mortality
- Prevalence of bronchitis in children
- Incidence of chronic bronchitis in adults
- Incidence of lung cancer & bladder cancer
- Incidence of ischemic heart disease including heart attacks
- Heart arrhythmia
- Incidence & prevalence of COPD (chronic obstructive pulmonary disease)

### Further health effects with some supporting scientific evidence:

- Pre-term birth
- Low birth weight
- Impaired sperm quality
- Increased risk of type 2 diabetes
- Atherosclerosis & high blood pressure
- Impaired cognitive development in infants & impaired cognitive function in adults



32 WHO 2014: Burden of disease from Ambient Air Pollution for 2012. [http://www.who.int/phe/health\\_topics/outdoorair/databases/FINAL\\_HAP\\_AAP\\_BoD\\_24March2014.pdf?ua=1](http://www.who.int/phe/health_topics/outdoorair/databases/FINAL_HAP_AAP_BoD_24March2014.pdf?ua=1)

33 <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=URISERV:l28027&from=EN>

34 EEA 2015: Air quality in Europe - 2015 report, <http://www.eea.europa.eu/publications/air-quality-in-europe-2015#tab-data-references>

35 WHO REVIHAAP Final technical report, page 1: "There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur."

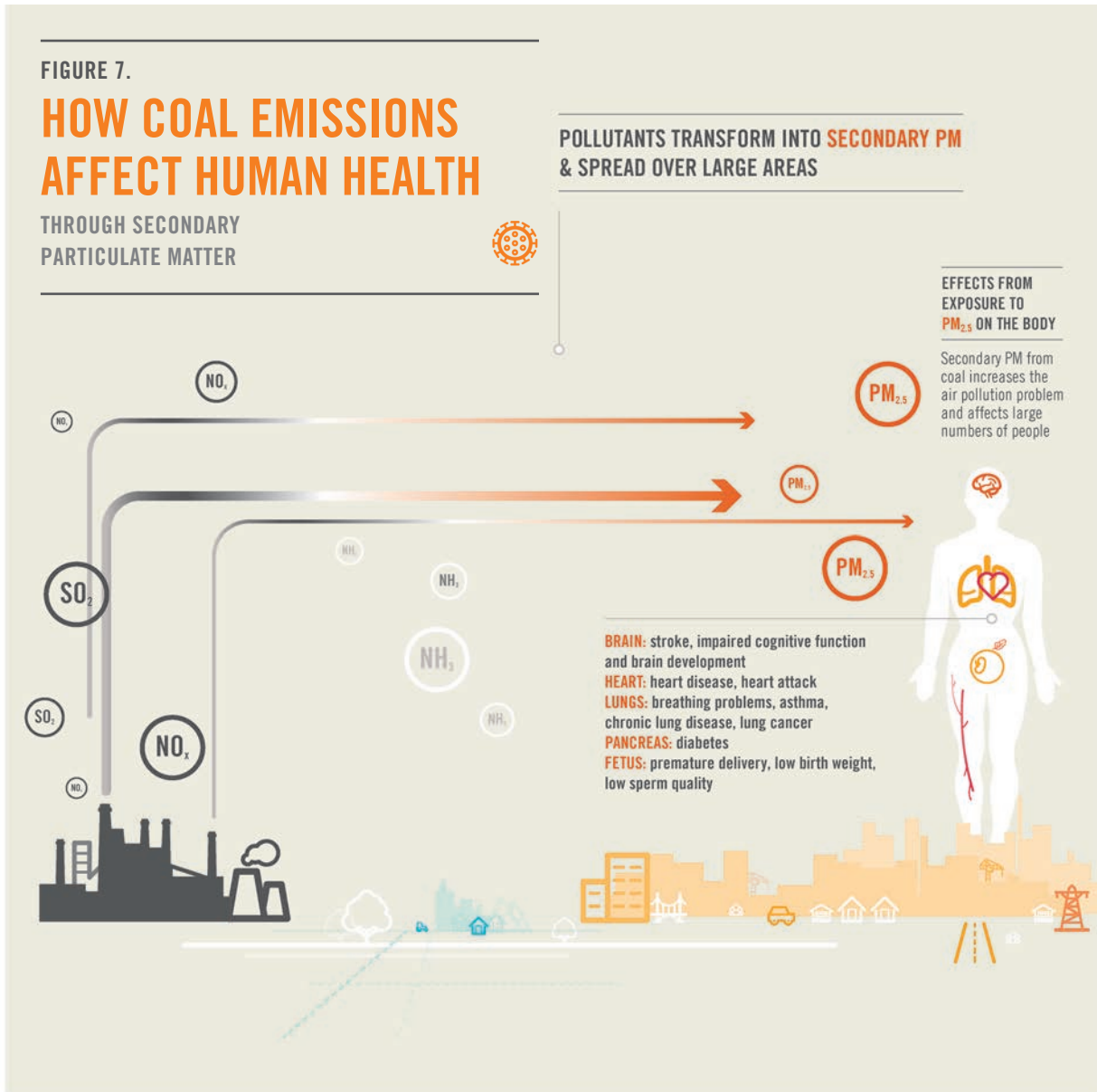
[http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf](http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf) as well as WHO HRAPIE project report.

36 Sources: European Respiratory Society (2012), Air Quality and Health. <http://www.ersnet.org/publications/air-quality-and-health.html>, WHO REVIHAAP Final technical report, 2013; and Ruckerl et al. Inhalation Toxicology 2011 Aug;23(10):555-92

**THE MOST TOXIC INGREDIENT OF COAL POLLUTION:  
SECONDARY PARTICULATE MATTER**

Around 83% of the approximately 22,900 premature deaths associated with the emissions of coal-fired power plants in Europe - around 19,000 - were caused by exposure to PM<sub>2.5</sub>.<sup>37</sup> There are two types of particulate matter, primary particulate matter (primary PM) and secondary particulate matter (secondary PM).

Although coal-fired power plants contribute only a small fraction of the emissions of primary PM compared to other sources, they contribute substantially to the formation of secondary PM via emissions of sulphur dioxide and nitrous oxides. These emissions react with ammonia in the atmosphere to form ammonium sulphate and ammonium nitrate.



These secondary inorganic aerosols or secondary PM are an important component of PM<sub>2.5</sub>, and can enter deep into the lungs. When inhaled, PM<sub>2.5</sub> causes various health problems, particularly on the circulatory system, the lungs and the reproductive system, including on unborn children. Only some of these impacts have been quantified in this report.

37 See ref 35.

There has been considerable debate as to whether all types of particles in the varying mixtures of PM are equally toxic. The most recent meta-analysis of scientific literature carried out by the WHO in its 'Review of evidence on health aspects of air pollution' concluded that the same toxicity should be applied for all components of particulate matter.<sup>38</sup>

The WHO report also stressed that there was strong evidence for the adverse health effects of sulphate-contaminated particles resulting from coal combustion and that power generation was one of the key contributors to air pollution.<sup>39</sup> In a follow-up study on the American Cancer Society's Cancer Prevention Study II cohort data, coal pollution was strongly associated with mortality from heart disease (IHD)<sup>40</sup> as well as lung cancer.<sup>41</sup>

### SHEDDING LIGHT ON OTHER HARMFUL POLLUTANTS

While particulate matter is the chief driver behind premature deaths, other pollutants released into the air also lead to adverse health and environmental impacts. The flue gases from coal power plants contain acids, heavy metals and organic pollutants among other contaminants.<sup>42</sup> Coal power plants are a leading producer of the acid gases sulphur dioxide and nitrogen oxides. Moreover, coal power plants release a greater level of mercury than any other source.

**Sulphur dioxide, acid rain and asthma.** Sulphur dioxide (SO<sub>2</sub>) is a colourless, water-soluble gas. It is a precursor to sulphates and is washed out as acid rain, leading to the acidification of lakes and streams and the accelerated corrosion of buildings and monuments. Long-term acidification can alter the natural variety of plants and animals in an ecosystem.

The major health concerns associated with exposure to high concentrations of SO<sub>2</sub> include effects on breathing, respiratory illness, alterations in pulmonary defences and aggravation of existing cardiovascular disease. Children, the elderly and people with asthma, cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) are most susceptible to the adverse health effects associated with exposure to SO<sub>2</sub>. It produces its irritant effects by stimulating nerves in the lining of the nose and throat and the airways to the lungs. This causes a reflex cough, irritation and a narrowing of the airways, which is experienced as a tightening of the chest. This latter effect is particularly likely to occur in people suffering from asthma or chronic lung disease, whose airways are often inflamed and easily irritated.

People with asthma are generally considered one of the groups most susceptible to the effects of SO<sub>2</sub> at lower concentrations. Another high-risk group are those who exercise regularly outdoors. With nasal breathing at low to moderate volumes, penetration of SO<sub>2</sub> into the lungs is negligible. However, with oral inhalation and larger volumes, common during physical exercise, significant doses may reach the bronchi or lungs. About half the urban population in Europe is still exposed to SO<sub>2</sub> levels above the mean daily concentration recommended by WHO to protect highly vulnerable groups.

### Nitrogen oxides, crop losses and summer smog.

Nitrogen dioxide (NO<sub>2</sub>) and nitric oxide (NO) are air pollutants resulting from combustion processes such as the burning of coal for electricity production, and are known collectively as nitrous oxides (NO<sub>x</sub>). Nitrogen dioxide has direct effects on human health; short-term exposure can reduce the oxygen saturation of the blood and lead to dizziness, while long-term exposure can cause damage to the respiratory system and lead to increased risk of premature death.

In addition to the direct health effects of NO<sub>2</sub>, there are also important indirect health effects associated with nitrogen oxides. They are an important precursor of ozone, leading to the formation of ground-level or so-called tropospheric ozone. This process is accelerated by high temperatures and sunlight radiation (summer smog phenomenon). Ozone is a highly reactive gas that causes respiratory irritation and cardiopulmonary symptoms, and it has long-term effects on mortality rates. In addition to its adverse effects on human health, ozone also damages crops and leads to substantial losses in agricultural production.

Thirdly, nitrous oxides emitted from coal power plants are an important contributor to ecosystem eutrophication (excess nitrogen deposition) as well as acid deposition, negatively affecting both soils and water bodies. In many regions of Europe, the critical loads for eutrophication and acid deposition have already been exceeded.

38 See ref 35.

39 WHO Regional Office for Europe (2013). Review of evidence on health aspects of air pollution – REVIHAAP Project. Technical Report. WHO, Copenhagen. [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf](http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf)

40 IHD stands for ischemic heart disease.

41 Thurston, G. D. et al. in Lippmann, M. et al.(eds ) 127–166 (Health Effects Institute Research Report 177, Boston, 2013), <http://pubs.healtheffects.org/getfile.php?u=934>

42 For a detailed list of pollutants released and their associated health hazard, see annex 2 of HEAL (2013), The Unpaid Health Bill. How coal power plants make us sick. [http://www.env-health.org/IMG/pdf/heal\\_report\\_the\\_unpaid\\_health\\_bill\\_-\\_how\\_coal\\_power\\_plants\\_make\\_us\\_sick\\_finalpdf.pdf](http://www.env-health.org/IMG/pdf/heal_report_the_unpaid_health_bill_-_how_coal_power_plants_make_us_sick_finalpdf.pdf)

**Mercury: heart disease and impaired cognitive development in children.** Coal-fired power plants are the largest source of mercury emissions in Europe, mostly in the form of elemental mercury.<sup>43</sup> Out of 280 operating coal power plants in the EU, only 156 reported on their mercury emissions in 2013.<sup>44</sup> These plants alone emitted about 12.3 tonnes of mercury that year.

Once mercury has been released into the environment, it contaminates water and soils. It is transformed by bacteria into an organic compound, methylmercury, which has a particularly high neurotoxicity. Methylmercury mostly affects the cognitive development of young children, especially in the case of prenatal exposure of a foetus in the womb. Even low levels of exposure to methylmercury can lead to the impairment of cognition, memory, motor and language skills<sup>45</sup> and can affect school performance.

Each year, more than 1.8 million children in the EU are born with mercury levels above the safe threshold of 0.58 microgram per gram of hair sample (the concentration of mercury in the mother's hair is used as a marker for maternal exposure during pregnancy).<sup>46</sup> Some 200,000 babies have been exposed to even higher levels before birth, exceeding the tolerance limit set by the WHO.

Mercury released by EU coal power plants in 2013 is associated with developmental damage and lower learning potential in European children. In addition, exposure to methylmercury is also associated with effects on the cardiovascular system, including heart attacks and hypertension, and is increasingly acknowledged as a contributing factor to cardiovascular mortality. Recent recommendations for monetary valuation of the combined effect of methylmercury on children's neurological development and cardiovascular mortality concluded the values of 22,937 Euro to 52,129 Euro per kilo of mercury emitted.<sup>47</sup> This leads to a cost estimate of 281 to 639 million Euro for mercury emitted by EU coal power plants.

## HEALTH ADVOCATES DEMANDING A PHASE-OUT OF COAL

Climate change is widely recognized as posing severe risks to human health within the course of the next decades. The WHO calls climate change the biggest public health challenge of this century<sup>48</sup> and estimates that **by 2030, approximately 250,000 additional deaths worldwide will be caused by climate impacts.**<sup>49</sup> Many health advocates are thus calling for a rapid energy transition to phase-out fossil fuels, especially coal. Among them are the 2015 Lancet Commission on Health and Climate Change,<sup>50</sup> the World Medical Association,<sup>51</sup> the British Medical Association,<sup>52</sup> the Canadian Medical Association,<sup>53</sup> the Royal Australasian College of Physicians<sup>54</sup> and the World Federation of Public Health Associations.<sup>55</sup> A global coal phase-out led by the G7 has been demanded in a statement by 82 health organizations from 30 countries, representing more than 300,000 health professionals.<sup>56</sup> Another group of 44 health organizations from around the globe demonstrated their support for a phase-out of all fossil fuels through endorsing the Paris Platform For Healthy Energy.<sup>57</sup> Five Turkish medical groups have called on the Turkish government to stop the building of any new coal power station.<sup>58</sup>

43 Elemental mercury is released as a vapour from the smokestack. At room temperature it is liquid.

44 This is chiefly so because either they came into operation after 2013 or because emissions were below reporting thresholds.

45 Karagas et al. *Environ Health Perspect.* (2012);120(6):799-806, [https://findresearcher.sdu.dk:8443/ws/files/62525686/A230\\_Karagas\\_MeHg.pdf](https://findresearcher.sdu.dk:8443/ws/files/62525686/A230_Karagas_MeHg.pdf)

46 Bellanger M. et al. (2013), Economic benefits of methylmercury exposure control in Europe: Monetary value of neurotoxicity prevention. *Environmental Health* 2013, 12:3

47 Nedellec, V. and Rabl, A. (2016), Costs of Health Damage from Atmospheric Emissions of Toxic Metals: Part 2-Analysis for Mercury and Lead. *Risk Analysis* 2016 Mar 14. doi: 10.1111/risa.12598 E-publication ahead of print. <http://onlinelibrary.wiley.com/doi/10.1111/risa.12598/abstract>

48 WHO Director General Margaret Chan during World Health Day 2008. [http://www.who.int/world-health-day/dg\\_message/en/](http://www.who.int/world-health-day/dg_message/en/)

49 As compared to a future without climate change. Out of these, 38,000 deaths are attributed to additional heat exposure in elderly people, 48,000 to diarrhoea, 60,000 to malaria and 95,000 to childhood malnutrition. See WHO 2014: Qualitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. <http://www.who.int/globalchange/publications/quantitative-risk-assessment/en/>

50 Watts et al. (2015): Health and climate change: policy responses to protect public health. <http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736%2815%2960854-6.pdf>

51 WMA 2015: Health must be given higher priority in climate summit say physician leaders. [http://www.wma.net/en/40news/20archives/2015/2015\\_22/](http://www.wma.net/en/40news/20archives/2015/2015_22/)

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# THE 'TOXIC 30'

## - THE EU COAL POWER PLANTS THAT DO THE GREATEST HEALTH DAMAGE

# 4.

**The 257 coal power stations that report SO<sub>2</sub>, NO<sub>x</sub> and particulate matter emissions to the European Pollutant Release and Transfer Register<sup>59</sup> and for which 2013 data is available, were linked to a total of 22,900 premature deaths<sup>60</sup> and health costs of up to 62.3 billion Euros per year.**

However, the 30 most toxic coal power plants alone were responsible for 51% of these premature deaths and 51% of the health costs. The list of the top 30 coal power plants is shown in Figure 8.

### WHAT MAKES THESE 30 COAL PLANTS SO POLLUTING?

Firstly, there are coal plants that produce disproportionately high rates of SO<sub>2</sub> and NO<sub>x</sub> for each tonne of coal burnt. These are most commonly found in Romania and Bulgaria, home to seven of the 30 most polluting coal power plants - the 'Toxic 30'. Romania and Bulgaria are temporarily exempt from complying with EU emission limit values for industrial pollutants, so many do not even have so-called flue gas desulphurisation (FGD) equipment installed, the most basic filters for sulphur dioxide. The resulting high emissions of sulphur dioxide, which contribute substantially to the formation of particulate matter, mean that Romanian and Bulgarian coal-fired power plants account for 17% of all premature deaths caused by coal pollution in Europe, despite accounting for only 6% of the total amount of coal burnt in power plants.

Secondly, there are coal plants that burn a great deal of coal. German plants may be equipped with better filters, but this is outweighed by the sheer volume of coal they burn. This places six German plants in the Toxic 30. For example, number 11 is Germany's Neurath plant, which has one of the lowest SO<sub>2</sub> and NO<sub>x</sub> emissions rates of Europe's coal-fired power plants. However, in 2013 it burnt a staggering 12 million tonnes of lignite- against an average of 1 million tonnes. This made its emissions of SO<sub>2</sub> and NO<sub>x</sub> highly significant; according to our modelling it was associated with approximately 400 premature deaths.<sup>61</sup>

Clearly, there are also a number of coal-fired power plants that have both a high emissions rate and burn a great deal of coal. At number one in the Toxic 30 is Poland's Bełchatów. Although Bełchatów burned only 12% more coal than Germany's Neurath plant in 2013, it contributed to over twice as many premature deaths - a total of almost 1,300. This is because its abatement equipment for NO<sub>x</sub>, and particularly for SO<sub>2</sub>, was less effective. Altogether, five of the Toxic 30 plants are in Poland and all of them have fairly high emissions rates and burn large amounts of coal.

<sup>59</sup> That reported on their SO<sub>2</sub> and NO<sub>x</sub> emission from 2013 and were by the end of 2015 still in operation, <http://prtr.ec.europa.eu/#/home>

<sup>60</sup> The 95% confidence interval being 14,400 to 33,900 premature deaths.

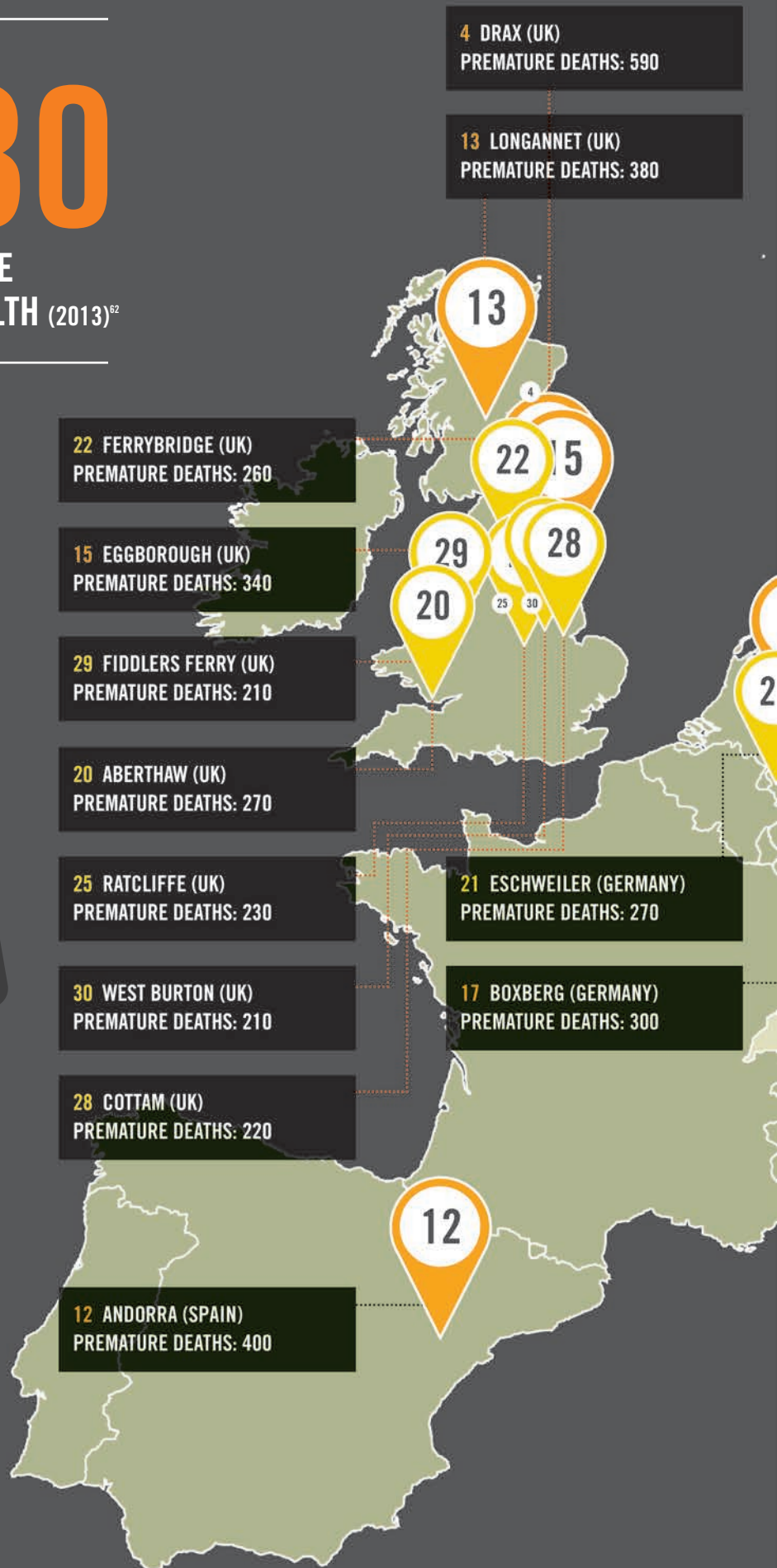
<sup>61</sup> Each operational power plant adds to the overall amount of particulate matter, ozone and nitrogen dioxide in the air, which in turn adds to the health impacts of that

polluted air on Europeans. Each coal power plant which comes offline will therefore improve overall air quality and people's health. The figures concerning the health impacts of individual power stations in this report should be treated as a signifier of the extent of the health damage caused by that plant and therefore the benefits of closing it down, rather than a precise measurement of its exact impact.

FIGURE 8.

# EUROPE'S TOXIC 30

THE COAL PLANTS WITH THE BIGGEST IMPACTS ON HEALTH (2013)<sup>62</sup>

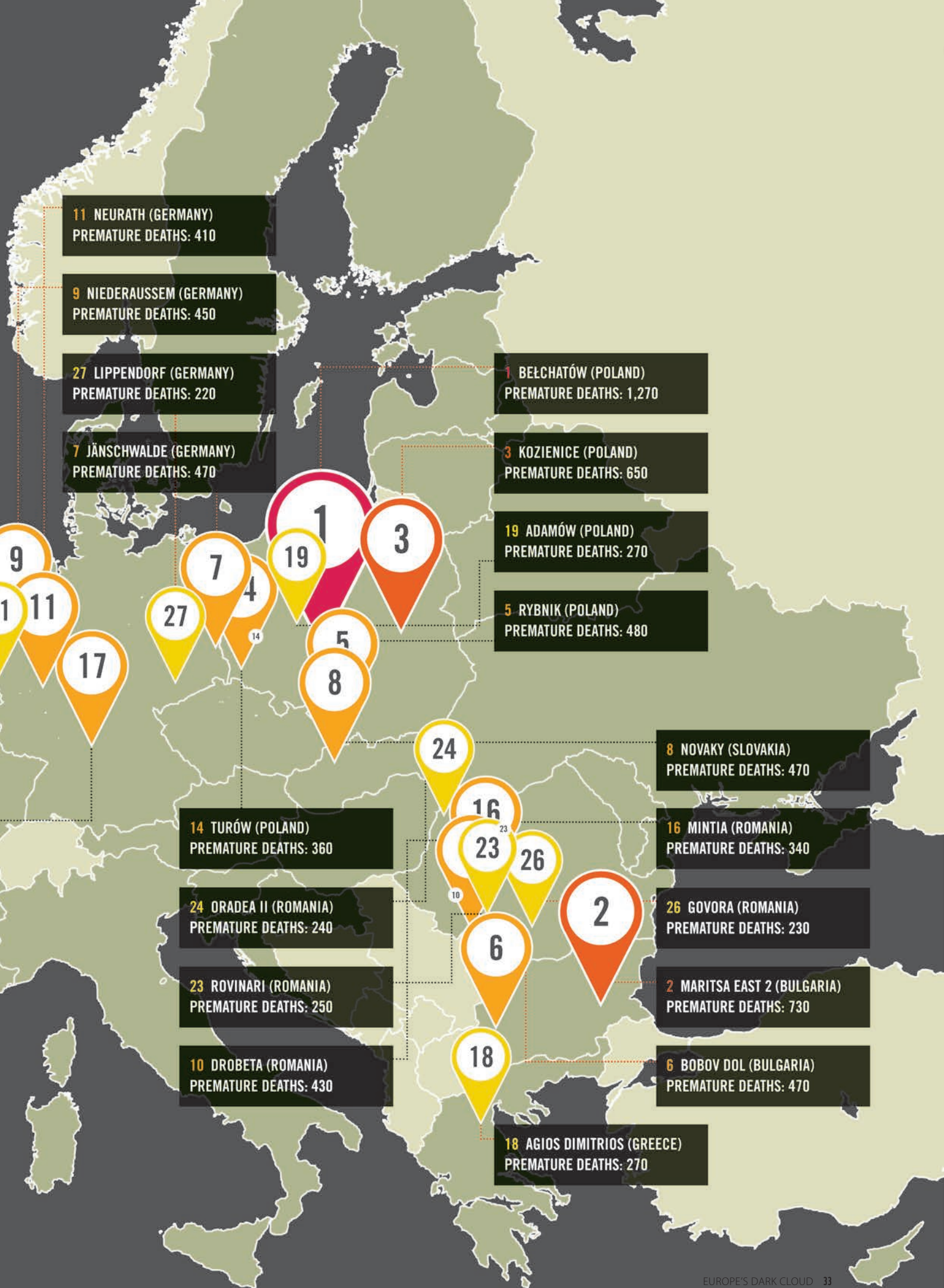


PREMATURE DEATHS



<sup>62</sup> For the methodology used, please see Annex 1.





**11 NEURATH (GERMANY)**  
PREMATURE DEATHS: 410

**9 NIEDERUSSEM (GERMANY)**  
PREMATURE DEATHS: 450

**27 LIPPENDORF (GERMANY)**  
PREMATURE DEATHS: 220

**7 JÄNSCHWALDE (GERMANY)**  
PREMATURE DEATHS: 470

**1 BELCHATÓW (POLAND)**  
PREMATURE DEATHS: 1,270

**3 KOZIENICE (POLAND)**  
PREMATURE DEATHS: 650

**19 ADAMÓW (POLAND)**  
PREMATURE DEATHS: 270

**5 RYBNIK (POLAND)**  
PREMATURE DEATHS: 480

**8 NOVAKY (SLOVAKIA)**  
PREMATURE DEATHS: 470

**16 MINTIA (ROMANIA)**  
PREMATURE DEATHS: 340

**26 GOVORA (ROMANIA)**  
PREMATURE DEATHS: 230

**2 MARITSA EAST 2 (BULGARIA)**  
PREMATURE DEATHS: 730

**6 BOBOV DOL (BULGARIA)**  
PREMATURE DEATHS: 470

**14 TURÓW (POLAND)**  
PREMATURE DEATHS: 360

**24 ORADEA II (ROMANIA)**  
PREMATURE DEATHS: 240

**23 ROVINARI (ROMANIA)**  
PREMATURE DEATHS: 250

**10 DROBETA (ROMANIA)**  
PREMATURE DEATHS: 430

**18 AGIOS DIMITRIOS (GREECE)**  
PREMATURE DEATHS: 270

FULL TABLE FOR FIGURE 8. THE COAL PLANTS WITH THE BIGGEST IMPACTS ON HEALTH (2013)

Rank	Power plant	Country	Premature Deaths	Chronic bronchitis	Hospital admissions	Lost working days	Asthma attacks in children	€m Health costs median	€m Health costs high
1	Bełchatów	PL	1,270	630	1,310	359,200	27,830	1,790	3,450
2	Maritsa East 2	BG	730	370	640	192,820	18,150	1,050	2,000
3	Kozienice	PL	650	320	660	186,500	14,140	920	1,770
4	Drax	UK	590	300	480	142,590	14,630	820	1,590
5	Rybnik	PL	480	240	490	134,660	10,380	670	1,290
6	Bobov Dol	BG	470	240	390	123,280	11,680	680	1,290
7	Jänschwalde	DE	470	240	420	157,000	10,080	660	1,270
8	Novaky	SK	470	230	450	138,320	9,700	640	1,240
9	Niederaussem	DE	450	190	340	125,320	8,500	630	1,210
10	Drobeta	RO	430	220	350	118,170	10,840	620	1,180
11	Grevenbroich-Neurath	DE	410	160	320	98,180	7,110	560	1,100
12	Andorra	ES	400	260	360	150,370	11,970	580	1,100
13	Longannet	UK	380	210	290	105,240	10,100	540	1,040
14	Turów	PL	360	190	300	129,510	7,940	510	970
15	Eggborough	UK	340	180	260	87,080	8,620	480	920
16	Mintia	RO	340	170	310	80,970	8,260	470	910
17	Boxberg	DE	300	150	270	97,720	6,340	420	800
18	Agios Dimitrios	EL	270	160	280	84,390	9,500	400	750
19	Adamów	PL	270	140	280	76,740	5,960	390	740
20	Aberthaw	UK	270	120	240	41,490	5,540	360	710
21	Eschweiler-Weisweiler	DE	270	110	200	71,070	4,930	360	710
22	Ferrybridge	UK	260	130	200	64,600	6,490	360	690
23	Rovinari	RO	250	120	240	58,510	6,000	350	680
24	Oradea II	RO	240	120	200	61,250	5,990	350	660
25	Ratcliffe	UK	230	110	190	51,580	5,510	330	640
26	Govora	RO	230	120	200	59,980	5,820	320	630
27	Lippendorf	DE	220	120	190	77,680	4,860	310	600
28	Cottam	UK	220	100	190	40,580	4,850	300	580
29	Fiddler's Ferry	UK	210	110	170	52,440	5,330	290	570
30	West Burton	UK	210	100	180	42,380	4,760	280	550
	<b>TOP 30</b>		<b>11,680</b>	<b>5,870</b>	<b>10,380</b>	<b>3,209,610</b>	<b>271,780</b>	<b>€ 16,440</b>	<b>€ 31,660</b>
	All 257		23,900	11,800	21,000	6,575,800	538,300	32,400	62,300
	TOP 30 as % of all		51%	50%	50%	49%	50%	51%	51%

\* Of these 30 coal power plants operating in 2015, all are still operating today with some exceptions: Longannet and Ferrybridge were retired in 2016.



BEŁCHATÓW POWER PLANT.  
© scyther5

# EUROPE'S 'DIRTY 30'

- THE EU COAL POWER PLANTS THAT DO  
THE GREATEST DAMAGE TO THE CLIMATE

# 5.

In 2014, the EU's 280 coal plants released 755 million tonnes of CO<sub>2</sub> - representing around 18% of the EU's total greenhouse gases.<sup>63</sup> Based on the CO<sub>2</sub> emissions data available for 2015, **almost half of the EU's total CO<sub>2</sub> emissions from coal - 367 million tonnes - were released by the 30 most polluting plants, the 'Dirty 30'**.<sup>64</sup> Closing the plants on that list should therefore be a priority.

Three countries are home to 19 of the 'Dirty 30' plants: Germany (eight), Poland (six) and the UK (five).

Bełchatów in Poland topped the list in 2015, as it has every year since the EU ETS first reported emissions in 2005.

However, places two to six, nine and 14 are all occupied by Germany's lignite plants. These seven German megapolluters alone emitted 19% of all the CO<sub>2</sub> from Europe's coal plants.

In the United Kingdom, there have been some major changes due to a surge in wind power, which has changed the way the electricity market operates. This caused two coal plants to be pushed out of the 2014 Dirty 30, leaving five behind. The combined emissions of the five British coal plants still in the Dirty 30 fell by 23% from 2014 to 2015.































In contrast to Germany and the UK, consecutive Polish governments have opposed any attempts to reduce the country's reliance on coal, even actively undermining

relevant EU policies. Poland continues to officially advance its plans for more coal power development citing energy security reasons. Compared to the 2013 analysis, Poland now has one more plant in the top 30 list, while the UK and Germany have respectively two fewer and one fewer.

However, Germany, the UK and Poland are not the only countries with responsibility for closing the EU's most climate damaging coal plants. Italy (two plants), Greece (two plants), Spain (three), Bulgaria (one), Hungary (one), Portugal (one) and the Netherlands (one) all harbour top polluters. Only one of these nine plants - the Netherlands' Amer plant - had committed to a closure date, and closed at the beginning of 2016. The Hungarian Matra lignite plant is also planned to close gradually by 2027, but the operator wants to replace it with a new lignite facility.

In 2015, the CO<sub>2</sub> emissions from the Dirty 30 fell by just 1% on 2014 levels. Although UK emissions decreased dramatically, Germany's emissions remained similar and there were increases in both Spain and the Netherlands. Carbon emissions from coal need to fall more than three times faster than the recent average in order to avoid the most dangerous impacts of climate change.<sup>65</sup> Ultimately, all coal and other fossil fuel-based power plants will need to be phased out in order to meet the commitment the EU made to pursue efforts to limit temperature rise to 1.5°C in the 2015 Paris Agreement.

FULL TABLE FOR FIGURE 9. THE 30 EU COAL POWER PLANTS EMITTING THE MOST CO<sub>2</sub>

Rank	Power plant	Country	Main fuel	MW	2015 CO <sub>2</sub> emissions, Mt
1	Bełchatów	Poland	Lignite	5,400	 37.1
2	Neurath	Germany	Lignite	4,168	 32.1
3	Niederaussem	Germany	Lignite	3,430	 27.3
4	Jänschwalde	Germany	Lignite	2,790	 23.3
5	Boxberg	Germany	Lignite	2,427	 19.4
6	Weisweiler	Germany	Lignite	1,800	 18.1
7	Drax	United Kingdom	Hard coal	2,580	 13.2
8	Brindisi Sud	Italy	Hard coal	2,428	 13.1
9	Schwarze Pumpe	Germany	Lignite	1,500	 12.2
10	Kozienice	Poland	Hard coal	2,919	 11.4
11	Maritsa East 2	Bulgaria	Lignite	1,473	 11.3
12	Torrevaldaliga	Italy	Hard coal	1,821	 10.7
13	Agios Dimitrios	Greece	Lignite	1,456	 10.6
14	Lippendorf	Germany	Lignite	1,750	 10.3
15	Kardia	Greece	Lignite	1,110	 8.9
16	Sines	Portugal	Hard coal	1,192	 8.7
17	West Burton	United Kingdom	Hard coal	2,012	 7.7
18	Turów	Poland	Lignite	1,488	 7.6
19	Aboño	Spain	Hard coal	843	 7.5
20	As Pontes	Spain	Lignite	1,403	 7.5
21	Longannet	United Kingdom	Hard coal	2,260	 7.5
22	Mannheim	Germany	Hard coal	1,953**	 7.3
23	Cottam	United Kingdom	Hard coal	2,008	 6.8
24	Aberthaw	United Kingdom	Hard coal	1,586	 6.7
25	Rybnik	Poland	Hard coal	1,775	 6.5
26	Litoral	Spain	Hard coal	1,066	 6.4
27	Mátra Eromu	Hungary	Lignite	812	 6.4
28	Połaniec	Poland	Hard coal	1,657	 6.3
29	Centrale Maasvlakte	Netherlands	Hard coal	1,040	 5.9
30	Opole	Poland	Hard coal	1,532	 5.8

63 2015 data is not yet available to calculate a EU GHG from coal percentage. However, we expect it will be around 18% as well. Source: CAN E report: 'End of an Era - Why Every European Country Needs A Coal Phase-out Plan' <http://www.caneurope.org/attachments/article/930/End%20of%20an%20Era%20report%20single%20pages%20final.pdf>

64 The 'Dirty 30' report published by WWF, CAN Europe, HEAL, EEB, Klima-Allianz in 2014 was based on 2013 CO<sub>2</sub> data, [http://awsassets.panda.org/downloads/dirty\\_30\\_report\\_finale.pdf](http://awsassets.panda.org/downloads/dirty_30_report_finale.pdf)

65 The CAN Europe "End of an Era" report published in December 2015: <http://www.caneurope.org/attachments/article/930/End%20of%20an%20Era%20report%20single%20pages%20final.pdf>

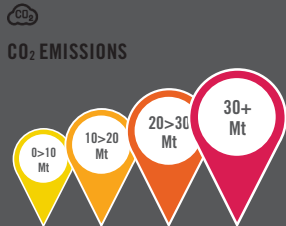
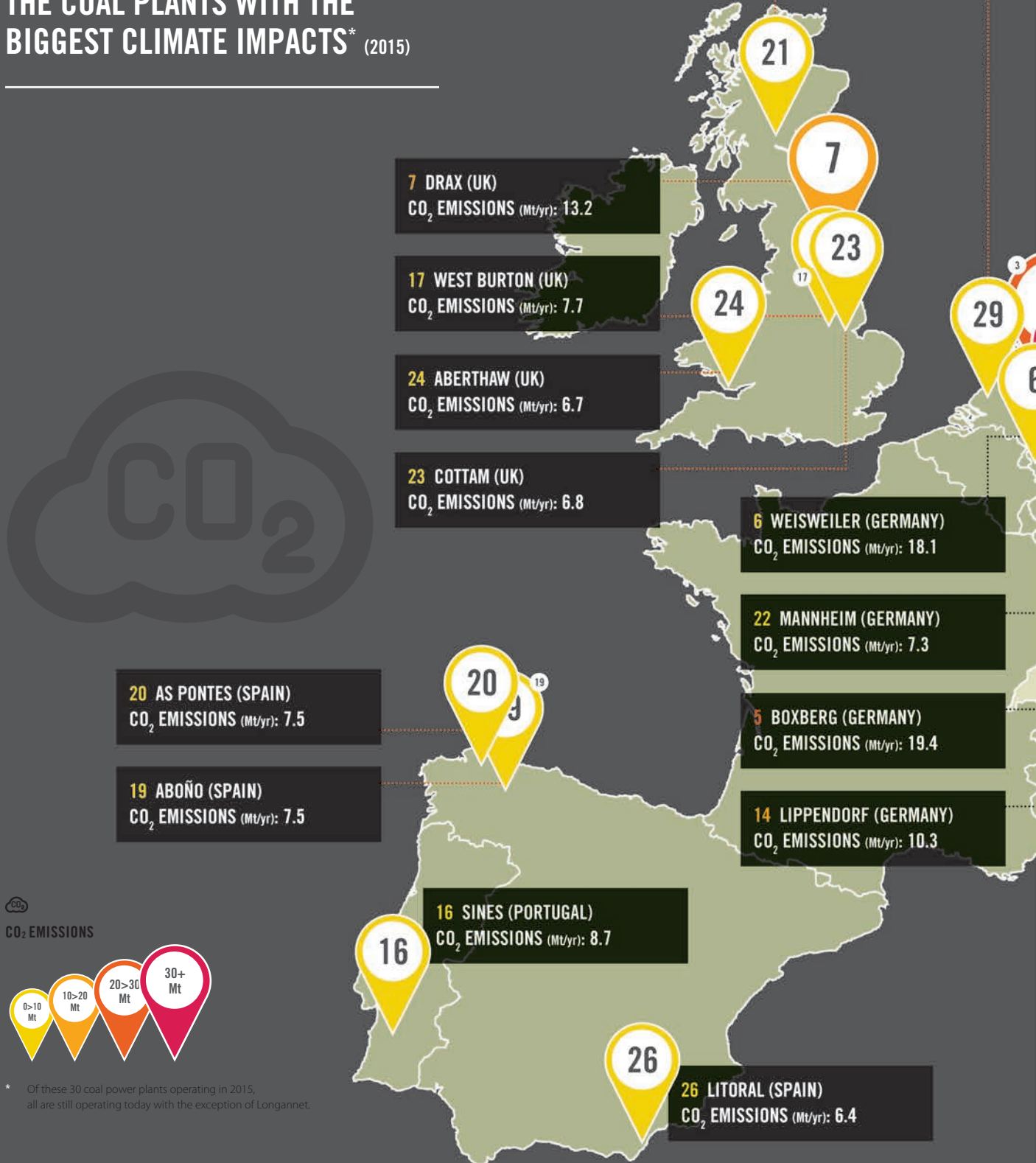
n.b. Of these 30 coal power plants operating in 2015, all are still operating today with some exceptions: Longannet was retired in 2016.

\*\* Mannheim's power station unit 9 switched online in 2015 from the test phase, increasing power station capacity from 1115 MW to 1953 MW.

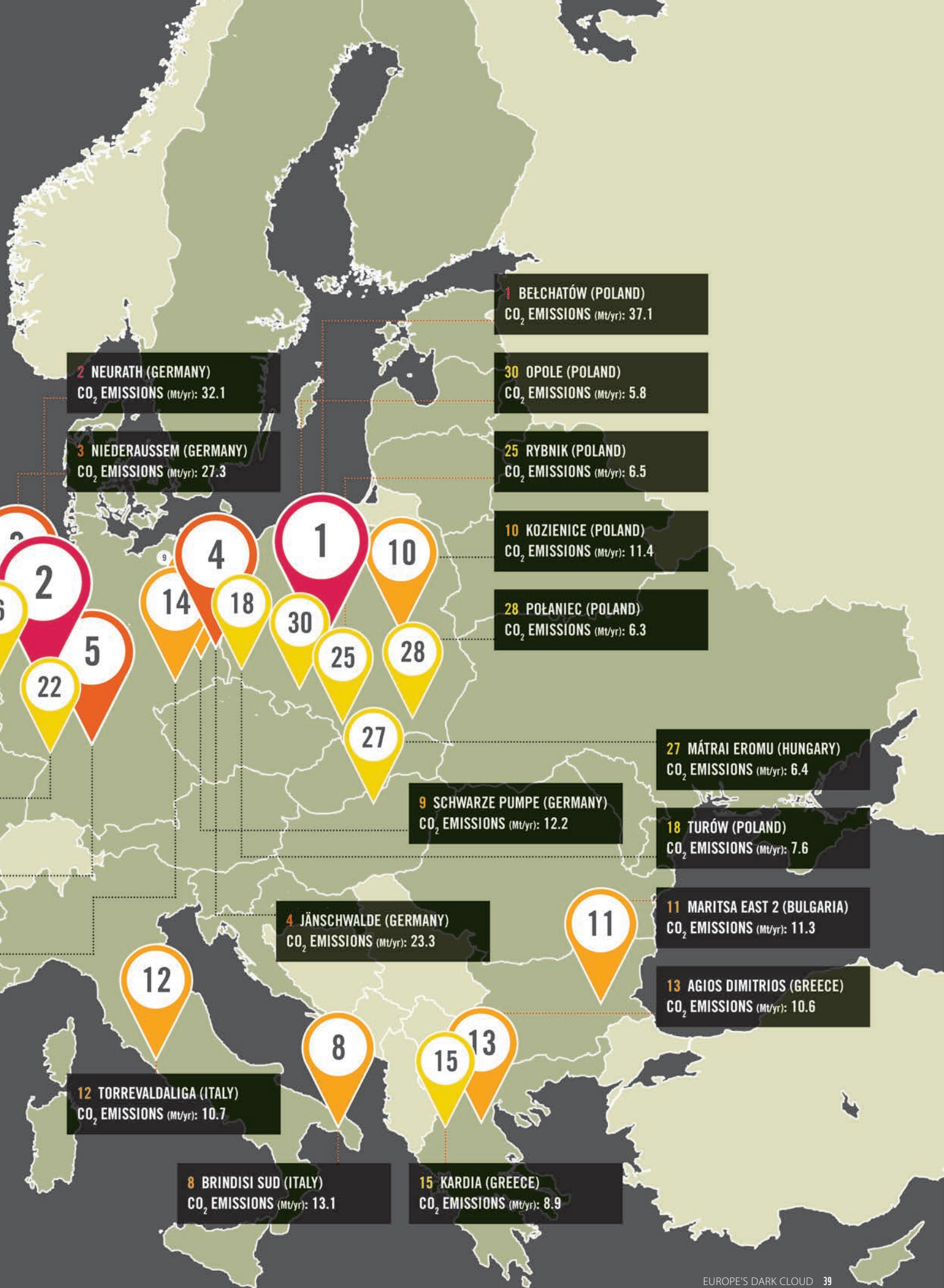
FIGURE 9.

# EUROPE'S DIRTY 30

THE COAL PLANTS WITH THE BIGGEST CLIMATE IMPACTS\* (2015)



\* Of these 30 coal power plants operating in 2015, all are still operating today with the exception of Longannet.



CHAPTER 6.

# THE COAL CLOUD & LOCAL COMMUNITIES

- CASE STUDIES  
FROM ACROSS EUROPE

# 6.

<b>BULGARIA: THE LOST VILLAGE</b>	41
<b>GREECE: BREAKING RECORDS, BATTERING HEALTH</b>	42
<b>POLAND: EVICTED TO MAKE WAY FOR KING COAL</b>	43
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# BULGARIA: THE LOST VILLAGE

- FROM HEALTHY DESTINATION TO HEALTH DISASTER



**BOBOV DOL COAL PLANT NEAR GOLEMO SELO.**  
© Teodora Stoyanova

Several decades ago, the village of Golemo Selo in Bulgaria was home to a health sanatorium. The beneficial mountain air helped people recover from respiratory diseases and health problems. Today the sanatorium is long gone, and the number of people suffering from respiratory problems in the region is increasing.

The 579 MW net capacity “Bobov Dol” coal plant was built in the 1970s beside Golemo Selo, and is still running today. It burns lignite coal, which produces particularly high amounts of sulphur. It is impossible not to see the coal plant when you arrive in Golemo Selo; it almost appears to be part of the village.

Although the plant is the main source of employment for the villagers, providing work for about 40 of them - 10% - no-one living locally can avoid the toxic dust that covers their cars, outdoor tables and anything that is left outside overnight.

The open-air coal storage and coal dust disposal landings, which are both in close proximity to the village, exacerbate the problem.

The coal power plant is in violation of the EU regulations for emissions of dust and sulphur dioxide emissions, however it continues to operate despite fines and warnings from the local authorities.

There has been a long history of using political leverage to keep the power plant operating, regardless of its damaging impact on health and the environment. Recently, the operator submitted a proposal to start burning waste in addition to coal, which would create even more pollution.

NGOs such as Greenpeace Bulgaria, together with the environmental organisation “Za Zemiata” have been fighting against coal power plants in Bulgaria for several years. “The residents of Golemo Selo are falling victim to an outdated energy system. These people deserve to breathe clean air. There are solutions that are available and affordable – renewable energy can offer both jobs for the people and protection to the environment”, said Teodora Stoyanova, climate and energy campaigner for Greenpeace Bulgaria.

## GREECE: BREAKING RECORDS, BATTERING HEALTH



**AGRIOS DIMITRIOS POWER PLANT.**  
© Ioannis Tokaris

The citizens of Ellispontos in Greece's Western Macedonia region have an unwelcome claim to fame; they live near the country's largest coal-fired power plant, Agios Dimitrios, which has a capacity of 1,456 MW net.

Agios Dimitrios is not only Greece's largest power plant, it is also its thirstiest, guzzling around 24 million m<sup>3</sup> of water

per year.<sup>66</sup> It also holds Europe's record for CO<sub>2</sub> emitted per unit of energy produced, at around 1.35 t CO<sub>2</sub>/MWh.<sup>67</sup>

The people of Ellispontos have tried to take legal action against Agios Dimitrios' dismal environmental performance. However, their complaint was dismissed by the European Parliament (Committee on Petitions), which cannot take action against a single plant.<sup>68</sup>

There was a similar outcome when 11 environmental groups filed a complaint against all state-owned energy company PPC's lignite plants in 2010.<sup>69</sup>

The power plant is in dire need of extensive retrofits in order to comply with existing limit values, which will reduce the damage it is causing to the quality of air and human health. However, the large economic investment needed for the retrofit could create pressure to prolong the lifetime of the plant.

According to a report by the European Environmental Agency (EEA), were Greek lignite plants to apply the best available techniques just for SO<sub>2</sub> and NO<sub>x</sub> emissions reduction, Greece would gain up to 2.3 billion Euros per year in health and environmental costs.<sup>70</sup>

PPC, the owner and operator of Agios Dimitrios, is obliged to upgrade the plant, as it is included in Greece's Transitional National Plan (TNP) approved by the European Commission in 2014. Yet PPC is currently behind schedule and out of funds.

Air pollution from Agios Dimitrios has a huge cost for crisis-stricken Greece. According to the recent EEA report, the combined air pollution costs to health and environment for which Agios Dimitrios was responsible during the period 2008-2012 are estimated at between 1.5-3.1 billion Euros (300-600 million Euros per year).<sup>71</sup>

"The outlook for Greek lignite has become very bleak because of its poor quality and the recent changes in the relevant EU legislation such as the IED (LCP BREF) and the EU ETS reform. Their combined effect will be a dramatic increase in electricity production costs from lignite in coming years. Agios Dimitrios is particularly vulnerable, due to its abysmal environmental performance and its need for extensive and expensive retrofits. Citizens and environmental groups will eventually win the battle. Hopefully it will be sooner rather than later" said Nikos Mantzaris, Climate and Energy Officer for WWF Greece.

66 According to the last environmental permit Agios Dimitrios requires 3500 m<sup>3</sup> of water per hour. On average the power plant operates ~6800 hrs/year.

67 <http://assets.panda.org/downloads/dirty30rankingfinal260905.pdf>

68 Petition to the European Parliament (0401/2004)

69 <http://www.europarl.europa.eu/sides/getDoc.do?type=COMPARL&reference=PE-460.714&format=PDF&language=EN&secondRef=04>

70 <http://www.eea.europa.eu/publications/costs-of-air-pollution-2008-2012>

71 Ibid

# POLAND: EVICTED TO MAKE WAY FOR KING COAL



**PĄTNÓW POWER PLANT.**  
© Tomasz Krzykała

Piotr Krygier lives on the edge of an open lignite mine.

He used to have a pond where swans swam and farm animals drank. Today, it is a dry hole. The water has been sucked up by the coal plant.

"There was always plenty of water; in the spring meadows were always flooded. Now it's like the Sahara", says Krygier.

The mine in question fuels the Pątnów power plant, part of a complex of four thermal power plants burning lignite near Konin city and providing about 8.5% of Poland's national power.

A lignite open pit mine resembles a surreal lunar landscape. The gigantic hole extends beyond the horizon. At the bottom of this hole are massive machines and trucks that look as small as toys. The area is surrounded by a system of pipes, constantly pumping out the water which is being sucked in through a giant opencast funnel.

Under Polish law, an opencast lignite mine is for the public good. And to create such a mine, many hectares of forests, fields and villages must be destroyed. Therefore losing a home to make way for a lignite mine and power station is not a rare event in Poland.

Things are not much better for those who do get to retain their homes. Their properties lose value and they have to cope with the noise, pollution and damage from the mines. There is the roar of machinery day and night, and toxic dust everywhere.

## ITALY: FARMERS FIGHT FOR THEIR RIGHT TO GROW UNPOLLUTED CROPS



BRINDISI POWER PLANT.  
© Ida Santoro

Farmers in part of southern Italy are locked in a court battle with the operators of a coal power plant over the plant's contamination of surrounding land.

The plant in question is situated near Brindisi in Puglia and is run by Enel. It has been producing power since 1991 and is the largest fully coal-powered plant in Italy, with a capacity of 2,428 MW. It is split into four units.

The toxic coal dust released into the air by the plant has contaminated vast areas of land, rendering it no longer cultivable. This is causing serious damage to the local economy as well as to the environment.

When the Mayor of Brindisi banned farmers from planting crops near the plant in 2007, Enel challenged the Mayor's decision in court. Its legal team contested the analyses used by the public prosecutor, the public administration and the civil parties (the farmers). Enel argued that the contamination was nothing to do with the coal plant.

The ongoing court battle follows past requests by the region of Puglia to Enel to reduce the emissions of the power plant. It seems that Enel has begun to do so only very recently, and with only partial success.

Green campaigners are also concerned over the huge amounts of waste that the plant produces, some of which - according to a police investigation - was disposed of illegally. Enel employees were incriminated in police findings and the case remains open.

In July 2015, researchers published a report on the health impacts of the Brindisi plant. This found that health impacts are likely to be much more severe than previously believed. In February 2016, for the first time, a report demonstrated a clear link between the high use of coal in the Puglia region and increased rates of mortality and health problems linked to coal-burning, such as cancers and respiratory and cardiovascular diseases.

# CONCLUSIONS

# 7

## EACH COAL-FIRED POWER PLANT CLOSED PROLONGS LIVES AT HOME AND ABROAD

Continuing to burn coal for power puts our health, well-being and our climate at risk.

The pollution from each coal-fired power plant is carried far and wide, with major health consequences both on the people living near the plant and those a considerable distance away.

Particulate matter is the leading environmental cause of chronic disease in Europe, and emissions from coal power plants play an important part in it. Mercury – produced by burning coal – damages the nervous system of thousands of unborn children in Europe every year.

The cross-border nature of coal pollution means that no-one – even in those countries, like France, with little coal themselves – can escape from the impact on mortality, health and health costs.

However, this means that each coal plant closed brings dramatic benefits for citizens in the country of origin and further afield.

## COAL: THE CLIMATE CHANGE CATALYST

But the health impact of coal-fired power plants extends beyond air pollution: due to the greenhouse gases it produces, coal is also a major contributor to what health professionals call the ‘number one risk to public health’ worldwide, climate change.<sup>72</sup>

Climate change is a terrifying public health risk and more: it threatens the very survival of the world’s communities and ecosystems. A warming planet alters weather patterns and water supplies, seasonal growth for plants and ways of life for people and wildlife. Its impacts can already be seen all over the world, from devastating floods, heat waves, forest fires, to prolonged droughts.

The devastation coal wreaks on the climate and human health mean that European governments therefore have a shared interest in working together to phase it out as rapidly as possible.

<sup>72</sup> Watts, N. et al., Health and climate change: policy responses to protect public health, *The Lancet* (2015), 386:10006;1861-1914, 7 November 2015. <http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2815%2960854-6/fulltext>

## THE “CLEAN COAL” CONUNDRUM

There is no such thing as “clean coal”: no coal is clean either in terms of air pollution nor for climate change.

Even the most modern coal-fired power plants are inefficient, losing 56% of their energy.<sup>73</sup> In almost all EU countries, building new coal-fired power plants is therefore a thing of the past; the few that still intend to do so like Poland and Greece will undoubtedly regret making major investments into a non-competitive, outdated technology which comes with immense costs to society.

Even if the costs of so-called “clean coal” technology were to come down sharply so it became financially more viable, it would not be sufficient to make coal “clean”. A recent study showed even the “cleanest coal” - so-called “High Efficiency Low Emissions” coal technology - is completely incompatible with the global warming limit of well below 2°C agreed by governments.<sup>74</sup> Carbon capture and storage (CCS) technology remains far from commercial implementation, with not a single large scale CCS project yet operational in the EU.<sup>75</sup>

Modern technology can remove a portion of the toxic substances produced by coal: particulate matter and mercury. However, such technology is not only inefficient, it is also extremely expensive.<sup>76</sup> This is particularly the case when compared to renewables, which are becoming increasingly competitive.<sup>77</sup> At first glance, expensive retrofits of existing coal power plants can be seen to be cost-effective given the reduction in health costs and avoided climate impacts.

However, the need to write off such investments could create pressure to continue operating the plant for longer than without the retrofit. Thus, the cumulative effect on human health and the climate need to be taken into account. Which means that also these relatively less polluting coal power stations will have to be closed down soon in order to limit cumulative carbon emissions and end their still considerable negative impact on human health and the environment.

Burning coal aside, hard coal and lignite mining result in massive air and water pollution, destroy land and cause significant environmental and social damage to communities, including health impacts. The disposal of hard coal and lignite wastes, including coal ash, also pollutes water and soils. Lignite mines are also located next to lignite power plants, multiplying their negative impacts.

## “BLACK GOLD” IS NOW AN EXPENSIVE BET

Coal is a long-term risk. Investors are pulling out of coal amid fears of stranded assets and warnings<sup>78</sup> that the value of coal stocks will continue to decline.<sup>79</sup> Companies are declaring bankruptcy or being taken to court over their climate policies. The case of Peabody, the world’s biggest private sector coal company can serve as a warning sign to others in the sector.<sup>80, 81</sup>

Historically, cost was often cited as a reason for burning coal rather than moving to zero emission renewable energy sources. However, the falling costs of renewable energy technologies are making the transition less expensive than the alternative. Moving to renewable energy makes sense for the environment, for health, and for the economy.

73 New unabated coal is not compatible with keeping global warming below 2°C, <http://www.europeanclimate.org/documents/nocoal2c.pdf>

74 Ecofys (2016): The Incompatibility of HELE coal with 2C scenarios, <http://www.ecofys.com/files/files/ecofys-2016-incompatibility-of-hele-coal-w-2c-scenarios.pdf>

75 <http://www.globalccsinstitute.com/projects/large-scale-ccs-projects>

76 James E. Staudt, Control Technologies to Reduce Conventional and Hazardous Air Pollutants from Coal-Fired Power Plants, Andover Technology Partners, (2011), <http://www.nescaum.org/documents/coal-control-technology-nescaum-report-20110330.pdf/>

77 Bloomberg New Energy Finance (2015): Wind and solar boost cost competitiveness versus fossil fuels <http://about.bnef.com/press-releases/wind-solar-boost-cost-competitiveness-versus-fossil-fuels/>

78 ‘Coal Stocks Will Only Get Worse – Don’t Bargain’, <http://investorplace.com/2015/07/coal-stocks-btu-cnx-arlp-aci-anr/>

79 IEA Coal Medium – Term Report Market Report (2015) [http://www.iea.org/bookshop/712-Medium-Term\\_Coal\\_Market\\_Report\\_2015](http://www.iea.org/bookshop/712-Medium-Term_Coal_Market_Report_2015)

80 <http://www.bloomberg.com/news/articles/2016-04-13/peabody-majority-of-its-u-s-entities-file-for-chapter-11>

81 [http://www.nytimes.com/2015/11/09/business/energy-environment/peabody-energy-agrees-to-greater-disclosures-of-financial-risks.html?\\_r=0](http://www.nytimes.com/2015/11/09/business/energy-environment/peabody-energy-agrees-to-greater-disclosures-of-financial-risks.html?_r=0)

## WHAT SHOULD THE EU DO?

The Paris Agreement adopted last year sent a clear signal that there is no viable future for coal anywhere.<sup>82</sup> Governments agreed to not only stay “well below” 2°C but also to pursue efforts to limit temperature rise to 1.5°C. Either of these targets would mean eliminating coal completely, and this is what the EU must commit to doing.

Coal-fired generation is the quick win: 18% of Europe’s greenhouse gases came from the chimneys of just 280 coal power plants.

However, speed is of the essence. EU coal power carbon emissions need to be cut at least three times faster than currently planned, in order to limit warming to 1.5°C and avoid the worst impacts of climate change.<sup>83</sup>

Unfortunately, many governments have been reluctant to take action against coal projects. EU governments continue to subsidise the coal industry to the tune of almost €10 billion per year.<sup>84</sup> The real cost of coal, in terms of health and environmental damage, is much higher than even the huge taxpayer-funded subsidies the industry currently receives.<sup>85</sup> These costs, known as “externalities”, would double or triple the price of electricity from coal if they were included, according to a Harvard University study.<sup>86</sup>

Coal is exerting a heavy toll on the health of present and future generations and must be phased out of the EU energy mix as soon as possible. The EU institutions and Member State governments need to **strengthen the suite of policies that regulate industrial emissions and CO<sub>2</sub> emissions and which shape the energy transition toward a 100% renewables future.** In addition, they need to ensure these measures are properly implemented. This will help curb emissions and send the right signals to market players.

However, the only way of permanently dispelling the black cloud over Europe is by shutting coal plants down and ensuring no more are developed. **A full coal phase-out should be one of the EU’s stated goals. This phase-out effort needs to be accompanied by dedicated support for mining regions affected by the transition from coal power to clean energy.** For example, phasing out fossil fuel subsidies would free up funds to support the transformation and help alleviate social impacts. A ‘Just Transition Fund’ at EU level could catalyse transition of local economies in coal regions across Europe through the use of revenue from auctioning of CO<sub>2</sub> allowances or other EU financial mechanisms. The resulting improvements in health, climate and economies will be immeasurable.



<sup>82</sup> <http://www.bbc.com/news/science-environment-34977265>

<sup>83</sup> End of an Era - Why Every European Country Needs A Coal Phase-out Plan,' <http://www.caneurope.org/attachments/article/930/End%20of%20an%20Era%20report%20single%20pages%20final.pdf>

<sup>84</sup> ECOFYS, Subsidies and costs of EU energy, 2014, Annex, p.32, <http://bit.ly/1R997Jj> or <https://ec.europa.eu/energy/sites/ener/files/documents/DESNL14583%20Final%20report%20annexes%201-3%2011%20Nov.pdf>

<sup>85</sup> Coal Atlas: Facts and figures on a fossil fuel,' <https://www.boell.de/en/2015/11/05/coal-atlas-facts-and-figures-fossil-fuel>

<sup>86</sup> Full Cost Accounting for the Life Cycle of Coal, <http://www.chgeharvard.org/resource/full-cost-accounting-life-cycle-coal>

# ANNEX 1.

## METHODOLOGY & SOURCES

This report focuses on power plants predominantly fuelled by lignite and hard coal. We use data for the pollutants that are most damaging to health, based on their SO<sub>2</sub>, NO<sub>x</sub>, dust and mercury emissions, as well as to the climate, based on their CO<sub>2</sub> emissions. Authors were able to estimate the number of premature deaths, cases of ill health such as chronic bronchitis and associated health costs thanks to atmospheric modelling that allowed us to estimate air pollution exposure caused by SO<sub>2</sub>, NO<sub>x</sub> and dust emissions from the studied plants. The modelling used the MSC-W meteorological model and the associated input datasets developed by European meteorological institutes under the Convention on Transboundary Air Pollution.

Underpinning this report are the results of a year-long exercise to map all the coal-fired power stations in Europe. A comprehensive database of Europe's coal power stations was built, coordinated by the Climate Action Network (CAN) Europe. This database links power stations to official EU registries to gain up-to-date CO<sub>2</sub> emissions for 2014 as well as 2013 data on all non-CO<sub>2</sub> pollutants. All analyses are based on verified data reported to the European Environmental Agency and to the EU Commission. These are reported via the European Union Transaction Log (EUTL) and European Pollutant Release and Transfer Register (E-PRTR).<sup>87</sup> Following feedback from national experts, the E-PRTR reported emissions were corrected in a few cases. Missing reports for one or more pollutants from individual power plants point to gaps in the PRTR dataset.

The methodology of estimating mortality and morbidity caused by emissions of coal-fired power plants in this report follows the recommendations of WHO experts for health impact assessment of air pollution in Europe in terms of the health endpoints included (see HRAPIE<sup>88</sup> recommendations). It applies the same monetary valuations as those used in impact assessments for the EU Clean Air Policy Package in 2014, but updated to reflect 2013 prices.<sup>89</sup>

Exposure with primary and secondary particulate matter, ozone and nitrogen dioxide caused by emissions from the studied plants was estimated using the MSC-W meteorological model and the associated input datasets developed by European meteorological institutes under the Convention on Transboundary Air Pollution (CLRTAP).<sup>90</sup> The MSC-W is an advanced chemical-transport model that simulates air quality across Europe using spatial data on emissions from different sectors and sources, along with three-dimensional time series data on meteorological variables, such as wind speed and direction, temperature, humidity and precipitation as well as land use, topographical and other relevant geophysical data. The model is continuously developed and validated yearly by comparing predicted total pollution levels and pollution composition with measurements at dozens of ground stations. All datasets used and meteorological data are for the year 2013.

The total air quality and health impacts from all the studied power plants were estimated using a simulation that singled out SO<sub>2</sub> and NO<sub>x</sub> emissions as well as fine (PM<sub>2.5</sub>) and coarse (PM<sub>2.5-10</sub>) particle emissions from all facilities.

For the purpose of further simulations, the power plants were grouped into 10 geographical clusters and a simulation was carried out separately for the SO<sub>2</sub> and NO<sub>2</sub> emissions from each cluster. This provided a total of 22 simulations, including two baseline simulations with all clusters and without all clusters. The pollution exposure and health impacts resulting from one unit of emissions of SO<sub>2</sub> and one unit of NO<sub>x</sub> from each cluster were then calculated and applied to the emissions from each facility in the cluster. This assigned estimated health impacts to each facility. This approach is similar to that used in the European Commission's 'Clean Air For Europe (CAFE) Cost Benefit Analysis' methodology<sup>91</sup> as well as the EEA's 'Revealing the costs of air pollution from industrial facilities in Europe' report, improving upon it in some respects:

- Atmospheric modelling is carried out specifically for the studied coal-fired power plants. Earlier approaches to plant-level health impact estimates relied on modelling results, including emissions from all sectors, using sectoral adjustment factors to make the estimates more appropriate for power plants.



- PM<sub>10</sub> concentrations were simulated directly, rather than being calculated from PM<sub>2.5</sub> using a fixed ratio.
- The influence of coal-fired power plants on ambient NO<sub>2</sub> levels is included. Earlier work only looked at the impacts on PM<sub>2.5</sub> and ozone, but the new WHO recommendations recognise that NO<sub>2</sub> exposure also has long-term health impacts. Accordingly, only grid cells for which background concentrations of NO<sub>2</sub> above 20 µg per m<sup>3</sup> had been reported in the AirBase dataset<sup>92</sup> from European monitoring stations, as well as grid cells for which the MSC-W simulations yielded concentrations above 20 µg per m<sup>3</sup> were included to calculate NO<sub>2</sub> mortality.

## CLUSTERING OF THE STUDIED POWER PLANTS

It is important to note that the MSC-W model is a regional-scale model with a 50x50km resolution. The local pollutant concentrations at most affected locations would be much higher than indicated by the value for the whole grid cell, but most of the health impacts are associated with long-range transport of pollution which exposes millions of people to small additional concentrations, leading to an additional burden of disease and mortality.

## HEALTH IMPACTS

The health impacts resulting from modelled pollutant concentrations were evaluated by assessing the resulting population exposure, based on high-resolution gridded population data for 2015 from NASA SEDAC Gridded Population of the World v.4,<sup>93</sup> then applying the WHO HRAPIE recommendations for health endpoints and for concentration-response functions for health impact assessment.<sup>94</sup> The extended set of pollutant-outcome pairs recommended for inclusion in total effect (HRAPIE groups A\* and B\*) was used.<sup>95</sup> Affected fractions of the population were applied evenly to all grid cells. Required baseline health data were obtained from WHO databases<sup>96</sup> as well as from a technical guidance paper on implementing HRAPIE recommendations.<sup>97</sup>

The health impacts in each grid cell are calculated as:

*[number of cases] = [population in grid cell] \* [affected population fraction] \* [baseline incidence] \* [change in pollutant concentration] \* [concentration-response factor],*

**Baseline incidence** refers to the incidence or prevalence of the studied impact in the population; e.g. new cases of chronic bronchitis per 100,000 people.

**Affected population fraction** refers to the percent of the total population that the impact estimate is applied to e.g. population at or above 30 years of age for chronic mortality. The fractions were calculated for the total population and applied to all grid cells.

**Change in pollutant concentration** refers to the change in predicted concentrations between the baseline and the simulations.

**Concentration-response factor** refers to the percentage increase in cases per increase in pollutant concentration derived from scientific studies, e.g. 6.2% increase in mortality when PM<sub>2.5</sub> concentrations increase by 10µg/m<sup>3</sup> over a long period. These results for each grid cell are then summed over the geographic area for which impacts are being calculated.

87 Dataset used for modelling of SO<sub>2</sub>, NO<sub>x</sub>, dust, mercury was EPTR v7 for 2013 data: <http://prtr.ec.europa.eu/#/home>. A few corrections were made to v7 on the basis for EPTR v8.

88 See ref 35.

89 [http://ec.europa.eu/environment/air/pdf/TSAP\\_CBA\\_corresponding\\_to\\_IJASA7\\_v1-02%5B1%5D.pdf](http://ec.europa.eu/environment/air/pdf/TSAP_CBA_corresponding_to_IJASA7_v1-02%5B1%5D.pdf)

90 Norwegian Meteorological Institute (2015), EMEP/MSC-W model performance for acidifying and eutrophying components, photo-oxidants and particulate matter in 2013. [http://emep.int/publ/reports/2015/sup\\_Status\\_Report\\_1\\_2015.pdf](http://emep.int/publ/reports/2015/sup_Status_Report_1_2015.pdf)

91 AEA Technology Environment (2005), Methodology for the cost-benefit-analysis for CAFE. Volume 2: Health Impact Assessment. [http://ec.europa.eu/environment/archives/cape/pdf/cba\\_methodology\\_vol2.pdf](http://ec.europa.eu/environment/archives/cape/pdf/cba_methodology_vol2.pdf)

92 European Environment Agency, AirBase. The European air quality database. <http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-6>

93 <http://beta.sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density>

94 [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0006/238956/Health-risks-of-air-pollution-in-Europe-HRAPIE-project-Recommendations-for-concentrationresponse-functions-for-costbenefit-analysis-of-particulate-matter-ozone-and-nitrogen-dioxide.pdf?ua=1](http://www.euro.who.int/__data/assets/pdf_file/0006/238956/Health-risks-of-air-pollution-in-Europe-HRAPIE-project-Recommendations-for-concentrationresponse-functions-for-costbenefit-analysis-of-particulate-matter-ozone-and-nitrogen-dioxide.pdf?ua=1)

95 Groups A\* and B\* are recommended by HRAPIE for estimating the total effect as one option for impact analyses, representing the extended set of effects. Groups B\* and B come with higher uncertainty than groups A\* and A.

96 WHO Global Health Estimates, 2012, [http://www.who.int/healthinfo/global\\_burden\\_disease/estimates/en/index1.html](http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html)

97 Holland, M. (2014), Implementation of the HRAPIE Recommendations for European Air Pollution CBA work, <http://ec.europa.eu/environment/air/pdf/CBA%20HRAPIE%20implement.pdf>

**TABLE 1. CONCENTRATION-RESPONSE FUNCTIONS FOR MORTALITY**

– INCREASE IN RISK FOR A 10µg/m<sup>3</sup> INCREASE IN CONCENTRATION. CORE MORTALITY FUNCTIONS WITHOUT INFANT MORTALITY TO BE ADDED FOR TOTAL IMPACT WITH LIKELY OVERLAP OF 33% BETWEEN PM<sub>2.5</sub> AND NO<sub>2</sub> EFFECT. OZONE CONCENTRATION REFERS TO SUMMER PERIOD (APRIL TO SEPTEMBER) AVERAGE.

Impact	Subgroup	Pollutant	Central	Low	High
All cause natural mortality from chronic exposure	Over 30 years	PM <sub>2.5</sub>	6.20%	4%	8.30%
All cause natural mortality from acute exposure	All ages	O <sub>3</sub>	0.29%	0.14%	0.43%
All cause natural mortality from chronic exposure	Over 30 years	NO <sub>2</sub>	5.5%	3.1%	8.0%
Infant mortality (HRAPIE group B*)	1 month to 12 months	PM <sub>2.5</sub>	4.0%	2.0%	7.0%

**TABLE 2. CONCENTRATION-RESPONSE FUNCTIONS AND POPULATION AND MORBIDITY DATA FOR NON-FATAL HEALTH IMPACTS**

Pollutant	Effect	Affected population fraction	Incidence rate	Response function	Concentration increase (µg/m <sup>3</sup> )	HRAPIE group
PM <sub>10</sub>	Incidence of chronic bronchitis, population aged over 27 years	67.6%	0.39%	11.70%	10	B*
PM <sub>10</sub>	Bronchitis in children, ages 6-12 years	7%	18.6%	8%	10	B*
PM <sub>10</sub>	Incidence of asthma symptoms in asthmatic children, ages 5-19 years	0.6%	62	2.8%	10	B*
PM <sub>2.5</sub>	Respiratory hospital admissions, all ages	100%	1.165%	1.9%	10	A*
PM <sub>2.5</sub>	Cardiac hospital admissions, all ages	100%	2.256%	0.91%	10	A*
PM <sub>2.5</sub>	Restricted activity days (RADs)	100%	19	4.7%	10	B*
PM <sub>2.5</sub>	Work days lost, working age population	42.5%	9.4	4.6%	10	B*
Ozone (SOMO35)	Minor restricted activity days, all ages	100%	7.8	1.54%	10	B*
Ozone (SOMO35)	Respiratory hospital admissions, ages over 64 years	16.4%	2.2%	0.44%	10	A*
Ozone (SOMO35)	Cardiovascular hospital admissions, ages over 64 years	16.4%	5%	0.89%	10	A*
NO <sub>2</sub>	Bronchitis in asthmatic children, ages 5 to 14 years	0.5%	1.52%	2.1%	1	B*
NO <sub>2</sub>	Respiratory hospital admissions, all ages	100%	1.165%	1.8%	10	A*

The mortality estimates include the effect of direct NO<sub>2</sub> exposure, in line with new WHO recommendations. The central and low estimates of mortality in this report (low range of 95% confidence interval) only include 67% of the NO<sub>2</sub> mortality effect based on a single-pollutant risk model because of possible overlap with PM<sub>2.5</sub> health impacts identified by the WHO (HRAPIE project report).

## HEALTH COSTS

The economic valuation of human health impacts is a tool to estimate what would be an acceptable cost for avoiding those impacts. The approach used by the European Commission<sup>98</sup> as well as the World Health Organization<sup>99</sup> and adopted in this paper includes both direct costs, such as health care costs and lost economic output due to absence from work, as well as a measure of people's willingness to pay to avoid the risk of death or disease. The premise is that since health risks from air pollution affect all European citizens and individual people do not have the choice of spending money to significantly reduce toxic power plant emissions, the government's willingness to direct resources to reducing health impacts from air pollution should be the same as the willingness of the people it governs.

The costs associated with the health impacts of EU coal-fired power plants are estimated based on the cost values used in 2014 impact assessments for the EU Clean Policy Air Package.<sup>100</sup> They were updated from 2005 prices to 2013 prices to reflect the substantial changes in prices.<sup>101</sup> Similar to the work for the EU Clean Policy Air Package, in this assessment EU averages were applied for all monetary valuations of the impacts, as the health impacts are transboundary in nature.

**TABLE 2A. MONETARY VALUES APPLIED TO MORTALITY AND MORBIDITY ENDPOINTS**

Impact	Median monetary value, EU-28 average, Euro 2013 prices	High monetary value, EU-28 average, Euro 2013 prices
Mortality from chronic or acute exposure, Value of a Statistical Life (VSL)	1,260,000	2,560,000
Infant mortality (1-12 months)	1,850,000	3,810,000
Hospital admission due to respiratory or cardiovascular symptoms	2,560	-
Chronic bronchitis in adults	61,870	-
Work days lost, working age population	150	-
Restricted activity days	106	-
Minor restricted activity days	48	-
Bronchitis in children	672	-
Asthma symptom days in asthmatic children	48	-

<sup>98</sup> AEA Technology Environment 2005: Damages per tonne emission of PM<sub>2.5</sub>, NH<sub>3</sub>, SO<sub>2</sub>, NO, and VOCs from each EU25 Member State (excluding Cyprus) and surrounding seas. Tables 4 and 5.

[http://ec.europa.eu/environment/archives/cafe/activities/pdf/cafe\\_cba\\_externalities.pdf](http://ec.europa.eu/environment/archives/cafe/activities/pdf/cafe_cba_externalities.pdf)

<sup>99</sup> WHO European Region (2015), Economic cost of the health impact of air pollution in Europe: Clean air, health and wealth. <http://www.euro.who.int/en/media-centre/events/events/2015/04/ehp-mid-term-review/publications/economic-cost-of-the-health-impact-of-air-pollution-in-europe>

<sup>100</sup> Amann, M. (ed.) (2014), The Final Policy Scenarios of the EU Clean Air Policy Package. International Institute for Applied Systems Analysis.

<http://ec.europa.eu/environment/air/pdf/TSAP.pdf> as well as Holland, M. (2014), Cost-benefit Analysis of Final Policy Scenarios for the EU Clean Air Package.

<http://ec.europa.eu/environment/air/pdf/TSAP%20CBA.pdf>

<sup>101</sup> Price development as reflected in Eurostat indicator "Purchasing power parities (PPPs), price level indices and real expenditures for ESA2010 aggregates [prc\_ppp\_ind]" for Actual Individual Consumption, real expenditure per capita (EU-28). <http://ec.europa.eu/eurostat/data/database>

# ANNEX 2. TOP TEN COAL PLANTS IN TERMS OF INDIVIDUAL POLLUTANTS

TABLE 3. THE 10 EU COAL POWER PLANTS EMITTING THE MOST SO<sub>2</sub>\*

Rank	Country	Power plant	Main fuel	Current capacity (MWe net)	SO <sub>2</sub> total emissions in tonnes in 2013
1	Poland	Bełchatów	lignite	5,400	61,000
2	Bulgaria	Maritsa East 2	lignite	1,473	54,100
3	Bulgaria	Bobov Dol	lignite	579	36,600
4	Romania	Drobeta	lignite	170	35,900
5	Poland	Kozienice	hard coal	2,919	33,400
6	United Kingdom	Drax	hard coal	2,580	32,300
7	Slovakia	Novaky	lignite	476	31,000
8	Greece	Agios Dimitrios	lignite	1,456	28,200
9	United Kingdom	Longannet	hard coal	2,260	25,800
10	Spain	Andorra	lignite	1,015	25,500

\* The Longannet coal power plant closed in March 2015.

TABLE 4. THE 10 EU COAL POWER PLANTS EMITTING THE MOST NO<sub>x</sub>

Rank	Country	Power plant	Main fuel	Current capacity (MWe net)	NO <sub>x</sub> total emissions in tonnes in 2013
1	Poland	Bełchatów	lignite	5,400	40,300
2	United Kingdom	Drax	hard coal	2,580	39,300
3	United Kingdom	Aberthaw	hard coal	1,586	31,500
4	Germany	Neurath	lignite	4,168	22,800
5	Germany	Jänschwalde	lignite	2,790	20,500
6	United Kingdom	Cottam	hard coal	2,008	20,100
7	Germany	Niederaussem	lignite	3,430	19,300
8	United Kingdom	West Burton	hard coal	2,012	18,300
9	Poland	Kozienice	hard coal	2,919	18,100
10	United Kingdom	Ratcliffe	hard coal	2,000	18,100

**TABLE 5. THE 10 EU COAL POWER PLANTS EMITTING THE MOST MERCURY**

Rank	Country	Power plant	Main fuel	Current capacity (MWe net)	Mercury total emissions in tonnes in 2013	External costs in million Euro, assuming an effect threshold	External costs in million Euro, assuming no effect threshold
1	Germany	Neurath	lignite	4,168	0.67	15	35
2	Germany	Niederaussem	lignite	3,430	0.53	12	27
3	Poland	Adamów	lignite	600	0.44	10	23
4	Germany	Schkopau	lignite	900	0.43	10	22
5	Germany	Lippendorf	lignite	1,750	0.41	9	21
6	Greece	Agios Dimitrios	lignite	1,456	0.41	9	21
7	Poland	Patnow II	lignite	1,200	0.38	9	20
8	Germany	Boxberg	lignite	2,427	0.37	8	19
9	Germany	Jänschwalde	lignite	2,790	0.33	8	17
10	United Kingdom	Drax	hard coal	2,580	0.31	7	16



POČERADY POWER PLANT,  
CZECH REPUBLIC.  
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**“THE DANGEROUS IMPACTS OF COAL ON HEALTH  
FROM EXPOSURE TO AIR POLLUTION  
... AND THE MAJOR CONTRIBUTION THAT BURNING  
COAL AND THE RELEASE OF GREENHOUSE GASES HAS  
IN CHANGING THE LONG-TERM CLIMATE ALMOST  
CERTAINLY UNDERMINES THE USE OF  
COAL AS A LONG-TERM FUEL.”**

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**CLIMATE ACTION NETWORK  
(CAN) EUROPE**

The Climate Action Network Europe is Europe's largest coalition working on climate and energy issues. With over 120 member organisations in more than 30 European countries – representing over 44 million citizens – CAN Europe works to prevent dangerous climate change and promote sustainable climate and energy policy in Europe. CAN Europe is a regional node of the Climate Action Network International, a worldwide network of over 900 Non-Governmental Organisations.



**HEALTH AND ENVIRONMENT  
ALLIANCE (HEAL)**

The Health and Environment Alliance is a leading European not-for-profit organisation addressing how the environment affects health in the European Union. We demonstrate how policy changes can help protect health and enhance people's quality of life. Our broad alliance of more than 70 member organisations represents health professionals, not-for-profit health insurers, cancer and asthma groups, citizens, women's groups, youth groups, environmental NGOs, scientists and public health research institutes. Members include international and Europe wide organisations, as well as national and local groups.



**SANDBAG**

Sandbag is an evidence-based non-profit organisation to help European decarbonisation. We focus on phasing out coal generation across Europe, getting a higher carbon price through EUETS reform, and working on long term ways to decarbonise energy intensive industries.