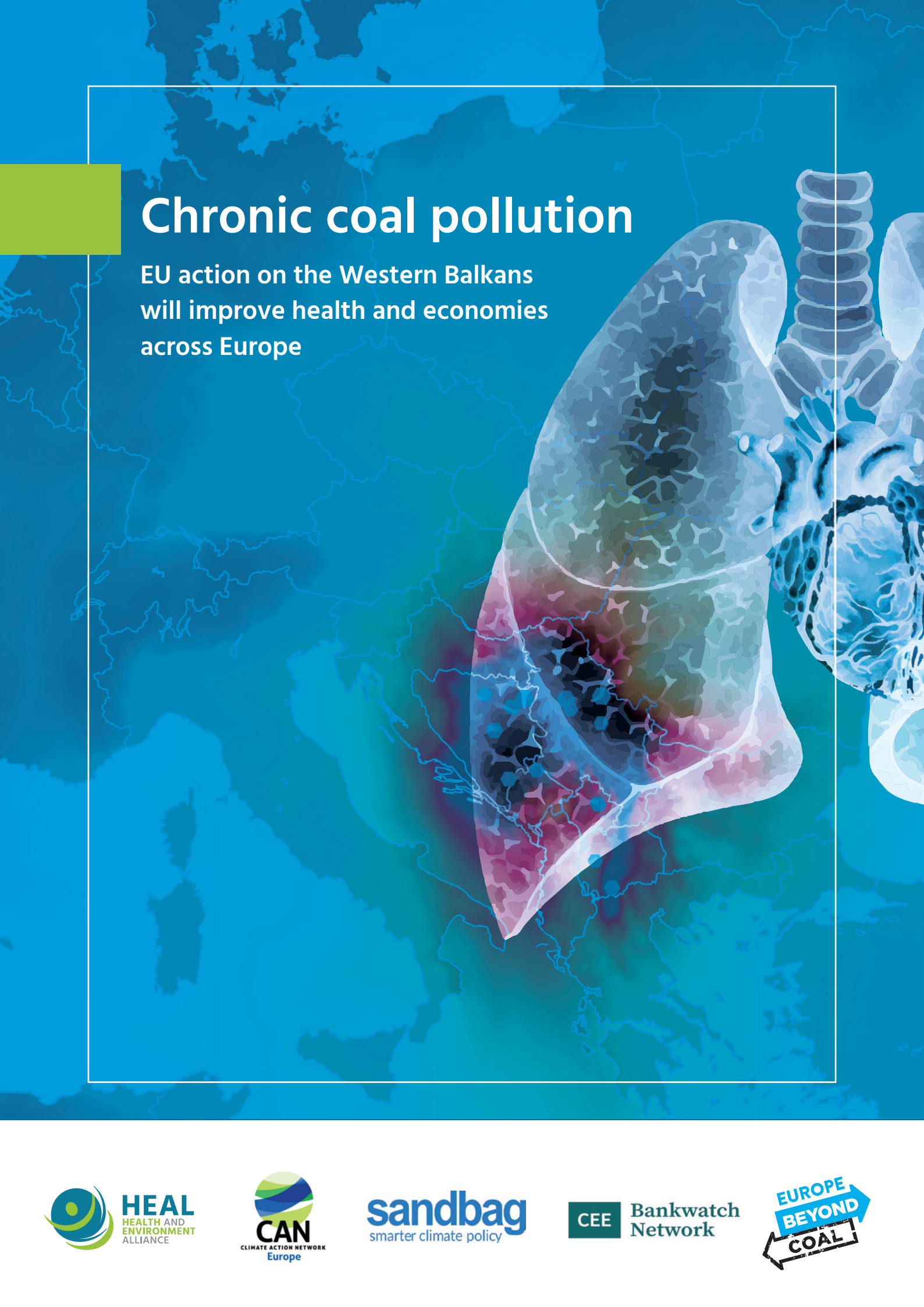
Chronic coal pollution

EU action on the Western Balkans will improve health and economies across Europe



HEAL HEALTH AND ENVIRONMENT ALLIANCE

CAN CLIMATE ACTION NETWORK Europe

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EUROPE BEYOND COAL

ABOUT

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The health impact methodology used in this report is guided by recommendations from the World Health Organization (WHO) '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 European Commission assessments of health impacts from air pollution in Europe. 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. This report does not attempt to quantify actual health occurrences nor their actual costs.

The methodology and calculations have been peer reviewed by Dr Mike Holland, Ecometrics Research and Consulting.

LIST OF ABBREVIATIONS

BiH	Bosnia and Herzegovina
de-SOx	technologies designed to remove sulphur oxides
ECJ	EU Court of Justice
ECT	Energy Community Treaty
EU	European Union countries
EUR	euro currency
GW	gigawatts
GWh	gigawatt-hour
MW	megawatt
NOx	nitrogen oxides
PM	particulate matter
PM2.5	particulate matter size 2.5 micrometers or less
PM10	particulate matter size 10 micrometers or less
RES	renewable energy sources
SEERMAP	South East Europe Electricity Roadmap
SO2	sulphur dioxide
TWh	terrawatt-hour
USD	US dollar
WB	Western Balkans
WHO	World Health Organization

CONTENTS

Executive summary

In the Western Balkans there are 16 outdated coal power plants that threaten public health by producing enormous amounts of air pollution, impacting people in the region, the EU and beyond. Every year they cause 3,000 premature deaths, 8,000 cases of bronchitis in children, and other chronic illnesses costing both health systems and economies a total of EUR 6.1-11.5 billion. The EU bears the majority of the health costs amounting to EUR 3.1-5.8 billion, while the economic burden on the Western Balkan countries is estimated to be EUR 1.9-3.6 billion every year.

Air pollution, from fossil fuelled power plants or other emitters, knows no borders. Coal power plants in the Western Balkan countries - Bosnia and Herzegovina, Macedonia, Montenegro, Kosovo and Serbia - whilst not members of the European Union, add to its air pollution by emitting alarmingly high levels of pollutants that travel long distances. The biggest impacts are found in neighbouring Romania, Italy, Hungary, Bulgaria, Greece and Croatia, but also in countries further afield such as Poland, Germany, Czech Republic and Austria.

This is due to the fact that Western Balkan coal power plants are old, inefficient and substandard. In 2016, the region's coal fleet (16 plants totalling 8 GW) emitted more sulphur dioxide pollution than the entire fleet of European coal power plants (250 equal to 156 GW), combined with equally worrying levels of particulate matter and nitrogen oxides.

As early as 2005 Western Balkan countries signed up to the Energy Community Treaty which aims to integrate the European Union energy market with those of its neighbours. The Treaty set a deadline requiring Western Balkan countries to comply with EU pollution control legislation by 2018. However, compulsory moves towards healthy energy sources, investments and retrofits in energy production across the Western Balkans have largely been delayed.

One crucial reason for the lack of progress is the determination of policy makers in the region to replace the old coal fleet with new coal plants. It is in the interest of people across Europe - citizens of the EU and the Western Balkan countries - to engage on this public health threat. Policy-makers in both the EU and in Western Balkan countries must prioritise healthy energy and climate ambition. This implies an unavoidable and just coal phase out. The Energy Community has to be strengthened to promptly enforce existing pollution control measures and propose additional legislation in the Treaty. The European Commission needs to prioritise pollution control and air quality within the EU accession process in particular by excluding companies planning new coal power capacity from EU financing.

The expertise of medical professionals about the health impacts and costs of coal energy must be recognised in public debates and decisions, as well as ensuring that the health argument is included in clean air plans and energy policy overall.

1.

Western Balkan coal harms public health in Europe

Air pollution caused by energy production, transport and households is a persistent and harmful public health concern in the EU countries and the number one environmental threat to health across Europe. In fact, the problem of poor air quality is so severe, with most EU member states failing to keep air quality standards, that the European Commission has taken legal action on excesses of particulate matter (PM) against 16 countries[1] to protect its citizens from air pollution.

In 2017, the EU Court of Justice (ECJ) ordered Bulgaria to take action to improve the quality of its air. The Court ruling states that Bulgaria not only failed to meet the binding EU air quality standards, but also remained inactive in improving it. Bulgaria now faces severe financial penalties should it not improve the country's air quality[2]. In 2018, Poland became the second country to be found in breach of EU air quality legislation by the ECJ[3].

In 2018 the European Commission referred six countries to the ECJ: Hungary, Italy, and Romania - for persistently high levels of particulate matter (PM10), and France, Germany, and the United Kingdom - for breaching nitrogen oxides (NOx) limits[4].

While governments in the EU struggle to reduce air emissions to keep air quality standards, additional and harmful pollution travels into the EU from five neighbouring Western Balkan countries: Bosnia and Herzegovina, Macedonia, Montenegro, Kosovo and Serbia, a fact that is often overlooked. This pollution comes mainly from the region's fleet of old and hugely polluting lignite coal power plants. As this report's modelling shows, the EU countries most impacted by Western Balkan coal pollution are those directly adjoining them. Often these are the same EU countries already failing to meet clean air standards, making it much more difficult to design local actions to clean up the air. But EU countries further away are impacted too.

The map below shows the pollution cloud created by 16 coal plants in five Balkan countries that covers Europe.

1. http://ec.europa.eu/environment/air/pdf/clean_air_for_all.pdf
2. http://curia.europa.eu/juris/document/document.jsf?text=&docid=189624&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=7926814
3. https://curia.europa.eu/jcms/upload/docs/application/pdf/2018-02/cp180019en.pdf
4. http://europa.eu/rapid/press-release_IP-18-3450_en.htm

Fig. 1 Modelled pollutant exposure to particulate matter (PM2.5) caused by the 16 coal power plants in the Western Balkans in 2016, annual mean

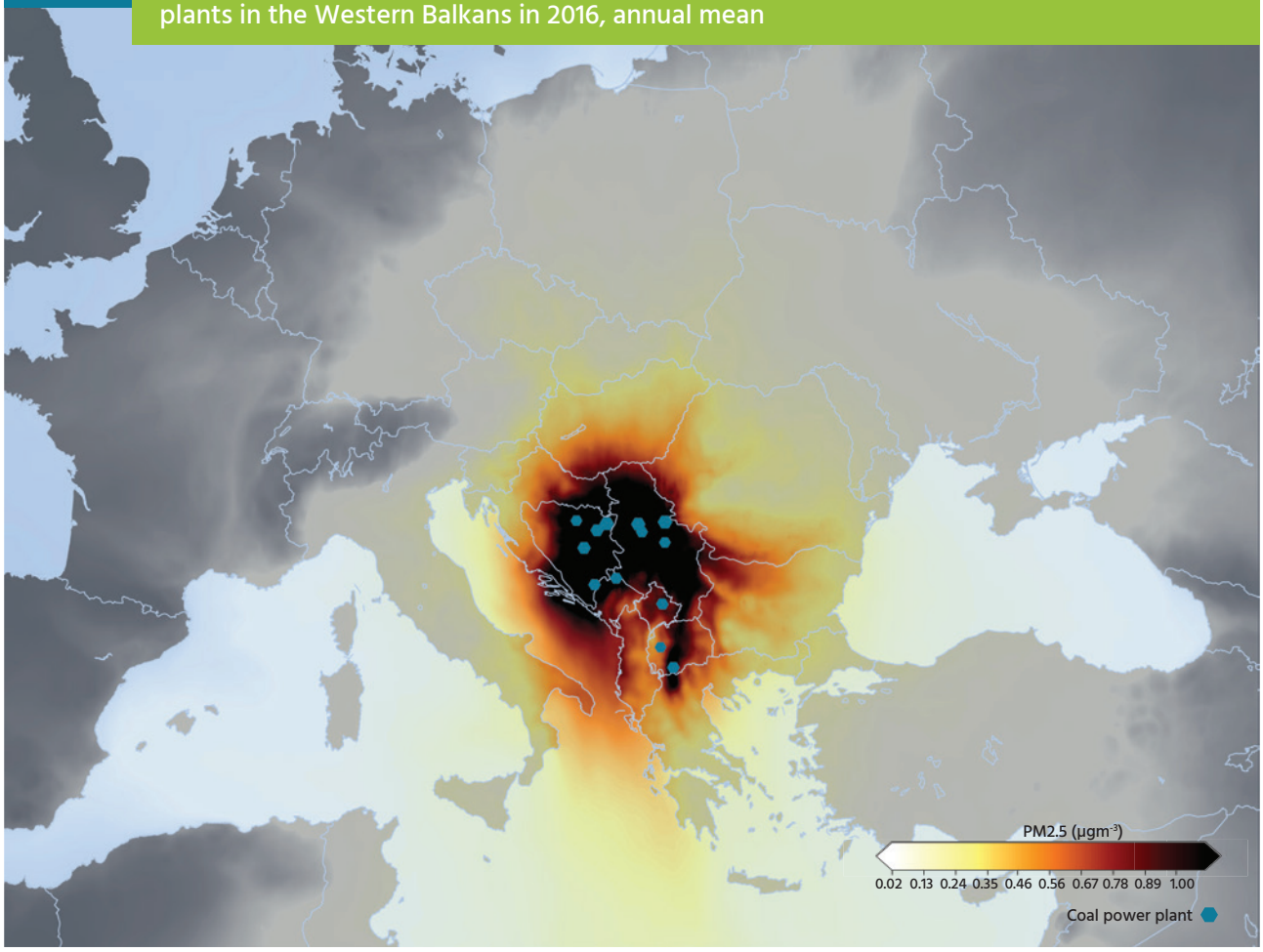
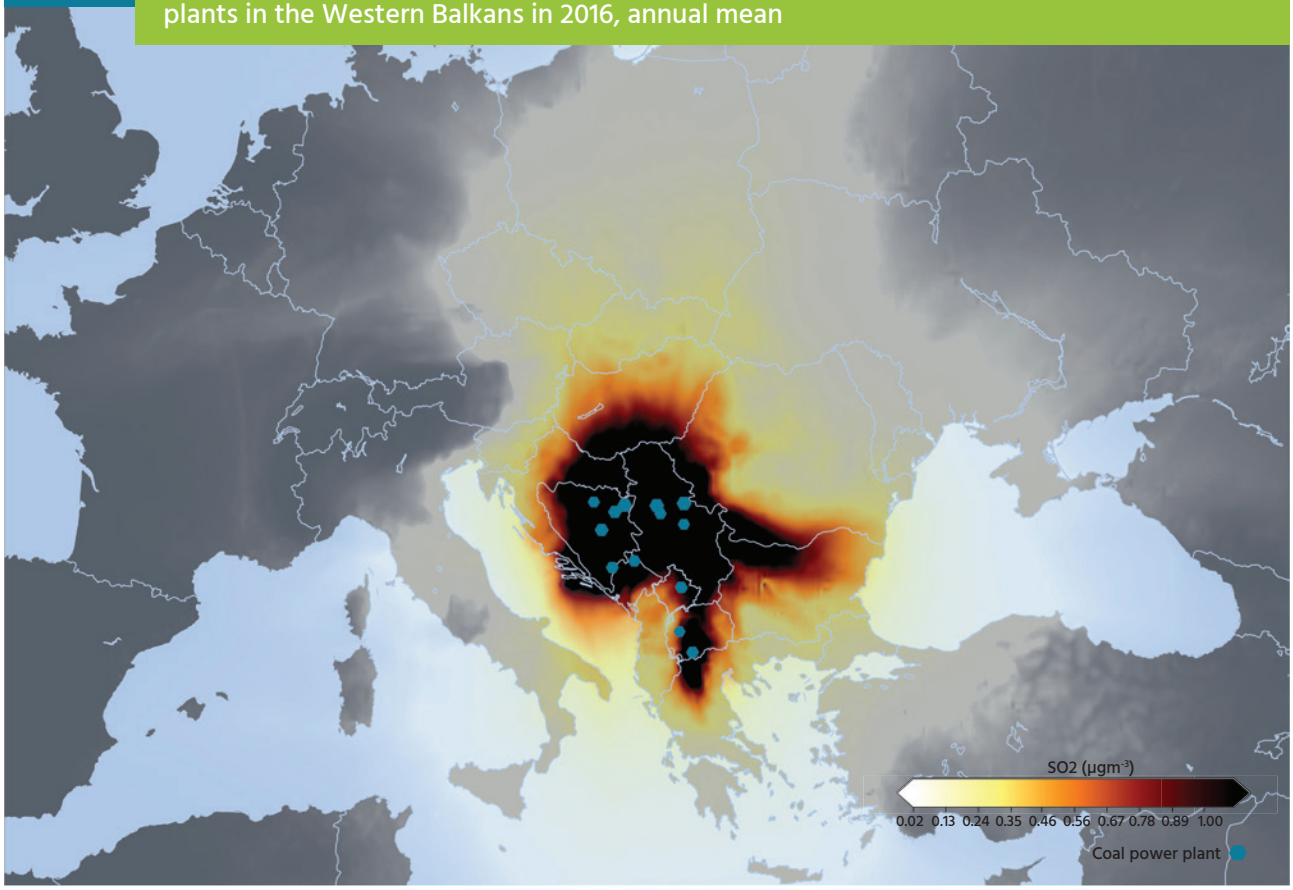


Fig. 2 Modelled pollutant exposure to sulphur dioxide (SO2) caused by the 16 coal power plants in the Western Balkans in 2016, annual mean



EU citizens bear the brunt of health impacts

The modelling shows that more than half of the number of premature deaths in 2016 caused by emissions from Western Balkan coal power plants occurred in the EU: 2,013 of the total 3,906 premature deaths afflicted the EU population, while 1,239 deaths occurred within the Western Balkans and 654 elsewhere.

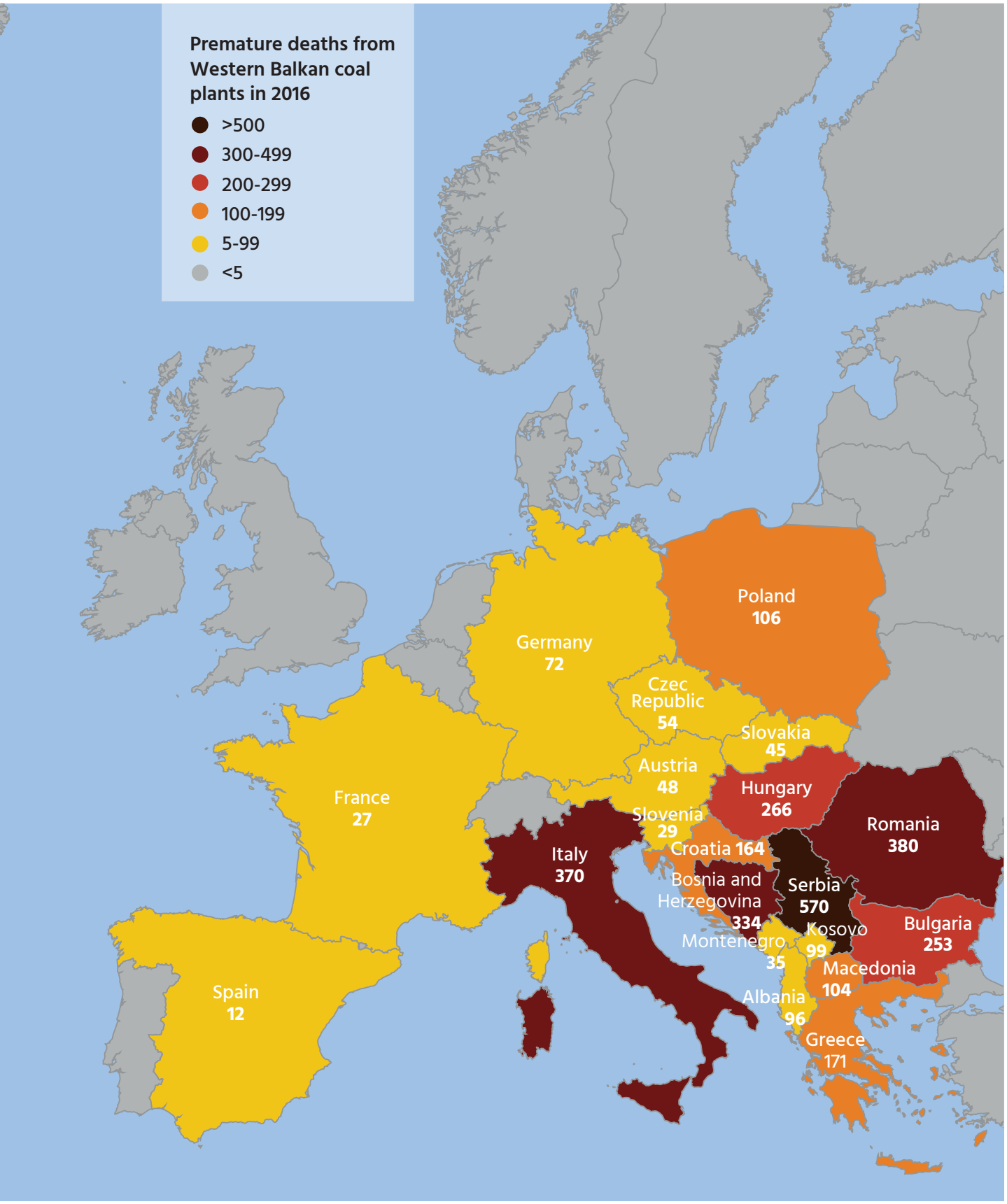
In the Western Balkans, Serbia suffered the biggest health impacts from the region's coal pollution: 570 premature deaths. In Romania, an EU country, 380 people died early in 2016, closely followed by Italy with 370 premature deaths.

Coal plants in the five Balkan countries also contributed to disease and ill health: their emissions caused a total of 8,516 cases of bronchitis in children and 2,023 cases of bronchitis in adults. Of those, 38% of cases of bronchitis in children (3,272) and 50% of cases (1,007) in adults occurred in the EU.

Asthmatic children living in the EU suffered from asthma symptoms for a combined total of over 36,400 days in 2016, (the total number of days was 86,200) caused by polluting Balkan coal plants.

Chronic coal pollution in the Western Balkans also harmed European productivity with an estimated total of 3,047 hospital admissions and over 1.16 million lost working days in the EU and Western Balkan countries during 2016. In the EU alone, the total was 1,418 hospital admissions and over 600,000 lost working days.

Fig. 3 Modelled number of premature deaths caused by Western Balkan coal power pollution in the EU, the Western Balkans and beyond in 2016



Note: Numbers of premature deaths for all countries see in Annex 2, Table 1 and 2.

Table 1 Health impacts from Western Balkan coal power plants based on emissions data for 2016

Health impacts	EU	Western Balkans	Other countries	Total
Restricted activity days	2,782,743	1,845,297	1,422,020	6,050,060
Work days lost in working age population	612,241	355,064	198,852	1,166,157
Asthma symptom days in asthmatic children	36,467	24,197	25,628	86,292
Bronchitis in children	3,272	2,419	2,825	8,516
Hospital admissions due to respiratory or cardiovascular symptoms	1,418	947	682	3,047
Chronic bronchitis in adults	1,007	634	383	2,024
Infant mortality (1-12 months)	2	2	3	7

Unnecessary and preventable health costs

The health impacts occurring in the EU due to the Western Balkan coal emissions are a huge burden on health systems, not to mention the strain they put on those affected and those caring for them.

Results modelled on emissions from the Western Balkans coal plants in 2016 show that the total damage to health is estimated to be in the range of EUR 6.1 to EUR 11.5 billion. More than half of these health costs relate to people and countries in the EU (EUR 3.1 to 5.8 billion), a third (32%) to Western Balkan countries (EUR 1.9 to 3.6 billion) and around 17% of the total health damage cost appears in other countries such as Ukraine, Turkey, Egypt and Russia.

These huge costs are paid for by citizens and countries in the form of increased national healthcare budgets and personal costs for individual treatment. They also create economic losses through reduced productivity.

Table 2 Modelled annual health damage costs from Western Balkan coal plants pollution, 2016

	Total cost median case (EUR million)	Total cost high case (EUR million)
EU	3,105	5,899
Western Balkans	1,928	3,648
Other countries	1,076	1,988
Total	**6,109**	**11,535**

EU countries bordering the Western Balkan countries, such as Italy, Romania, Hungary and Bulgaria, bear the biggest health cost burden. They include some of the least well-off EU countries with lower total health budgets and reduced ability to pay the costs of transboundary air pollution from coal. This exacerbates health, social and economic inequalities.

Bulgaria and Croatia's health budgets are the most heavily impacted. Costs needed to cover the health impacts of Western Balkan coal pollution amount to EUR 0.3-0.7 billion. For Bulgaria this is the same as 10%-18% of the country's total health expenditure in 2016[5]. For Croatia (costs of EUR 0.2-0.4 billion), it amounts to 8%-14% of total health expenditure in 2016. In Romania additional health costs caused by Western Balkan coal pollution reach EUR 0.5 to 1.1 billion per year. That equals 7%-13% of total health expenditure in 2016.

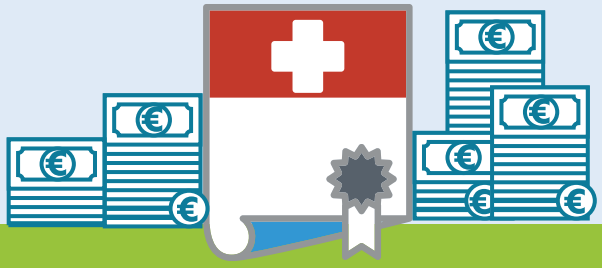


Fig. 4

Health costs

caused by Western Balkan coal pollution and share of total national health expenditure

	Croatia	Bulgaria	Romania
	0.2-0.4 billion (€)	0.3-0.7 billion (€)	0.5-1.1 billion (€)
% of total health expenditure in 2016	8%-14%	10%-18%	7%-17%

5. Calculation based on health care expenditure data from Eurostat, 2016

Fig. 5

Top 10 countries

where most health costs occur (EU and Western Balkans),
modelled from 2016 emissions of Western Balkan coal plants

		Total cost median case	Total cost high case
1	Serbia	€ 1,682,648,627	€ 890,007,062
2	Italy	€ 1,095,395,710	€ 582,341,360
3	Romania	€ 1,107,492,473	€ 579,444,102
4	Bosnia and Herzegovina	€ 985,388,752	€ 522,794,194
5	Hungary	€ 770,417,823	€ 401,580,843
6	Bulgaria	€ 728,856,412	€ 377,489,289
7	Greece	€ 504,415,742	€ 267,553,433
8	Croatia	€ 478,974,523	€ 251,299,359
9	Poland	€ 313,639,231	€ 166,804,994
10	Macedonia	€ 302,709,554	€ 158,402,008

Note: Numbers of premature deaths for all countries see in Annex 2, Table 1 and 2.

How air pollution from coal-fired power plants damages health

The World Health Organization (WHO) says that no level of air pollution can be considered 'safe[6]' and the link between air pollution and respiratory and cardiovascular diseases is well established[7,8,9]. Breathing in particulate matter, even at low levels, can lead to physiological changes in the body that damage health. Poor air quality is also linked to chronic and acute respiratory diseases, which significantly degrades quality of life, such as bronchitis and the aggravation of asthma.

Scientists continue to identify new ways that air pollution can harm our health, for example, there is increasing evidence linking air pollution to dementia[10] and new evidence has shown that particles of air pollution travel through the lungs of pregnant women and lodge in their placentas, harming babies before they are born .

When burning coal to generate electricity, three main health-harming pollutants are released into the air:

Particulate matter (PM): Small particles in the air. The number next to the abbreviation PM indicates the size of the particle: PM10 is 10 micrometers or less, while PM2.5 is 2.5 micrometers or less. When inhaled, particles travel into the bloodstream and cause harm to our lungs and heart. They can cause stroke and lead to premature death. New studies also link particulate matter with harm to the healthy development of children, and diseases such as obesity and Alzheimer's.

Sulphur dioxide (SO2) is classified as very toxic for humans when inhaled. It can cause severe irritation of the nose and throat. High concentrations can cause a life-threatening accumulation of fluid in the lungs (pulmonary edema). Symptoms may include coughing, shortness of breath, difficult breathing and tightness in the chest. Even a single exposure to a high concentration can cause a long-lasting condition like asthma. It can react in the atmosphere to form PM, called 'secondary PM'.

Nitrogen oxides (NOx**)** are gases that cause inflammation of the airways. They are oxidisers which means they cause oxidative stress which can disrupt normal cell mechanisms and cause damage to tissues, reducing the immune abilities of the body. They can react in the atmosphere to form PM, called 'secondary PM'.

6. http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-versio?n.pdf
7. WHO/Europe. Review of evidence on health aspects of air pollution – REVIHAAP Project. http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report
8. Royal College of Physicians - Every breath we take: the lifelong impact of air pollution. https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution
9. The European Respiratory Society/The European Lung Foundation. The European Lung White Book. https://www.erswhitebook.org/chapters/outdoor-environment/
10. https://blogs.bmj.com/bmjopen/2018/09/18/air-pollution-may-be-linked-to-heightened-dementia-risk/
11. https://www.theguardian.com/environment/2018/sep/16/air-pollution-particles-found-in-mothers-placentas

How air pollution from coal-fired power plants damages health

Brain

- Increased cerebrovascular ischemia
- Dementia

Blood

- Altered rheology
- Increased coagulability
- Translocated particles
- Peripheral thrombosis
- Reduced oxygen saturation

Cells

- Bladder cancer
- Skin cancer
- Obesity
- Diabetes

Lungs

- Inflammation
- Oxidative stress
- Accelerated progression and exacerbation of COPD
- Increased respiratory symptoms
- Effected pulmonary reflexes
- Reduced lung function
- Higher lung cancer risk

Heart

- Altered cardiac autonomic function
- Oxidative stress
- Increased dysrhythmic susceptibility
- Altered cardiac repolarisaion
- Increased myocardial ischemia

Children

- Pre-eclampsia of the pregnant mother
- Pre-term birth
- Reduced birth weight
- Pollutants can reach the placenta
- Increased asthma risk, and increased frequency of attacks for already asthmatic children
- ADHD

Vasculature

- Atherosclerosis, accelerated progression and destabilisation of plaques
- Endothelial dysfunction
- Vasoconstriction and hypertension

Health impacts result from both short and long-term, repeated exposure to air pollution. A recent review by the World Health Organisation (WHO) found that impacts can already occur at concentrations even lower than previously considered, and that the range of health impacts is larger than previously thought. For particulate matter there is no safe threshold.

Source: Adapted from APHEKOM project 2012; and Pope&Dockery 2006, as well as REVIHAAP 2013.

2.

Europe's top polluters

Eight of the top ten most polluting coal power plants in the EU plus Western Balkans can be found in the latter.

In 2016, the Serbian power plant Kostolac B surpassed Bosnia and Herzegovina's Ugljevik becoming the most notorious sulphur dioxide polluter. Kostolac B and Ugljevik account for half of all the SO2 pollution from coal plants in the Western Balkan region. These two plants alone are responsible for around 25% of all coal SO2 emissions in the EU and the Balkans combined.

Fig. 6 Top 10 polluting plants in Europe by SO2 emissions in 2016

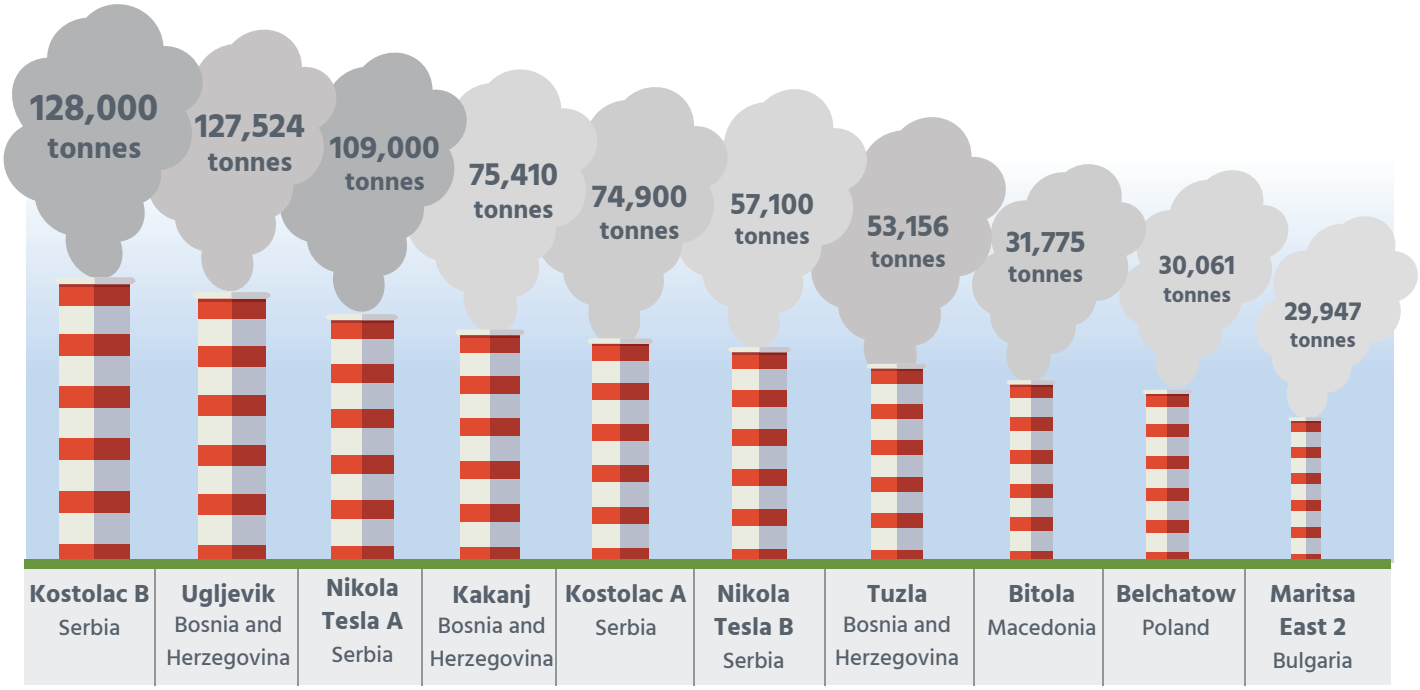
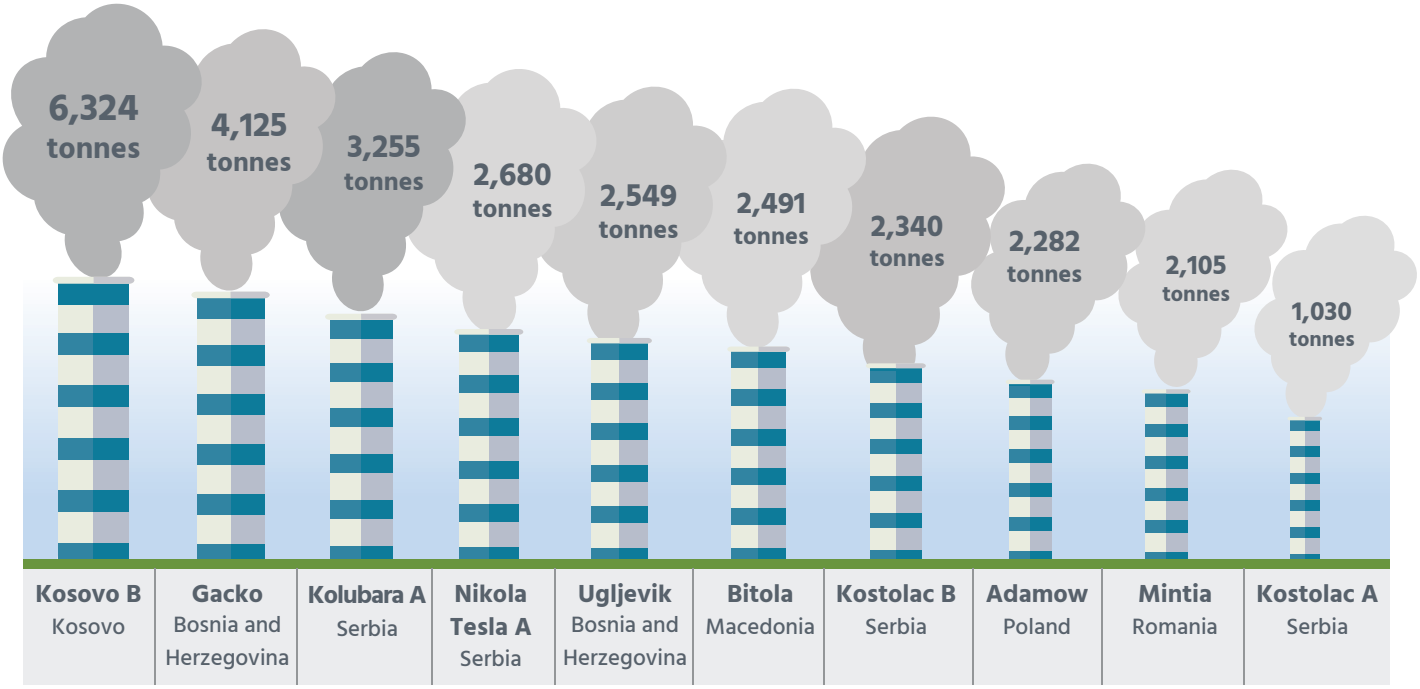


Fig. 7 Top 10 polluting plants in Europe by emissions of particulate matter (PM10) in 2016



Western Balkan coal power plants emit 20 times more SO2 and PM pollution than EU plants

The average coal power plant in the Western Balkans emits 20 times more sulphur dioxide (SO2) and 16 times more particulate matter (PM) than the average European plant.

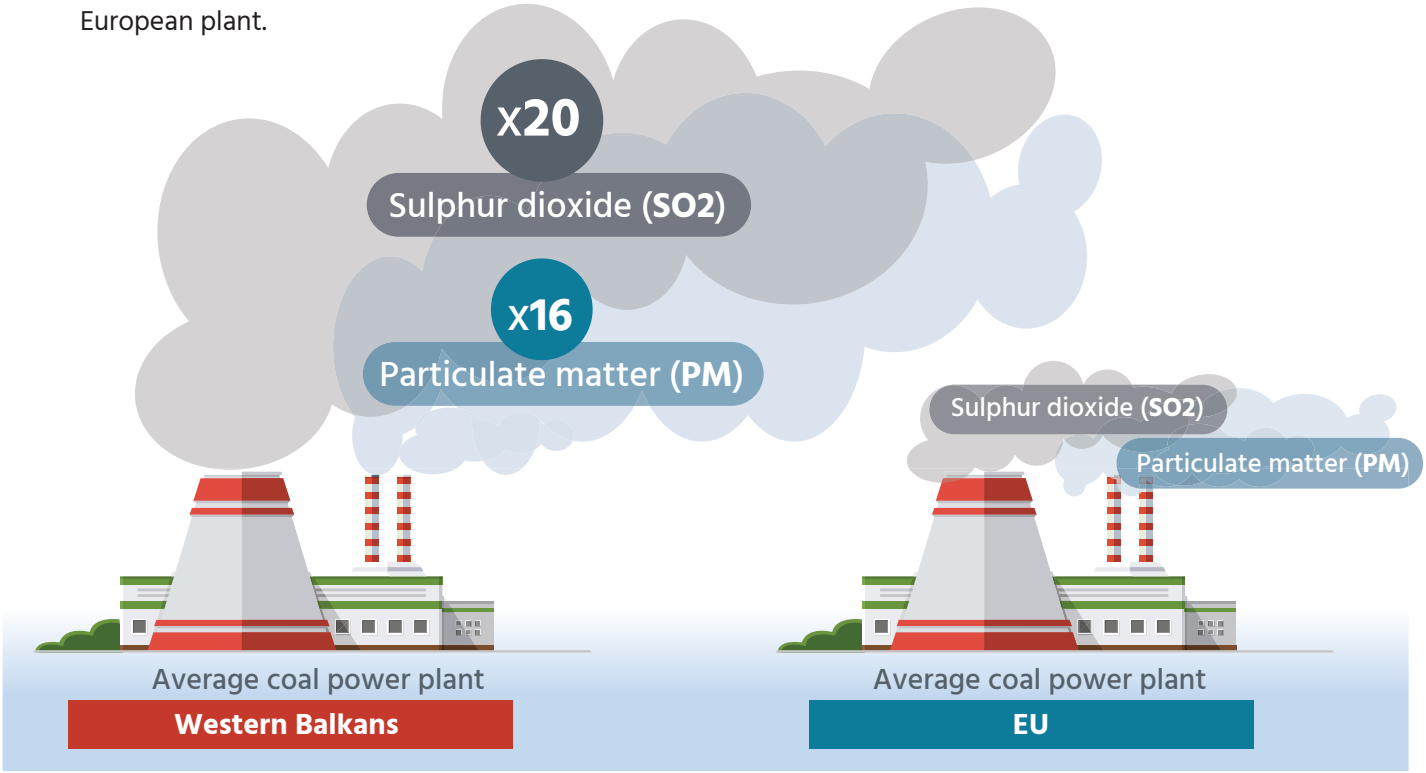


Table 3 Comparison of average emissions per MW from coal plants in the EU vs. the Western Balkans[12]

Air pollutant	EU average emissions per coal plant (tonnes/MW)	WB average emissions per coal plant (tonnes/MW)
Sulphur dioxide (SO2)	4	82
Particulate matter (PM)	0.2	3.3
Nitrogen oxide (NOx)	3.9	9.5

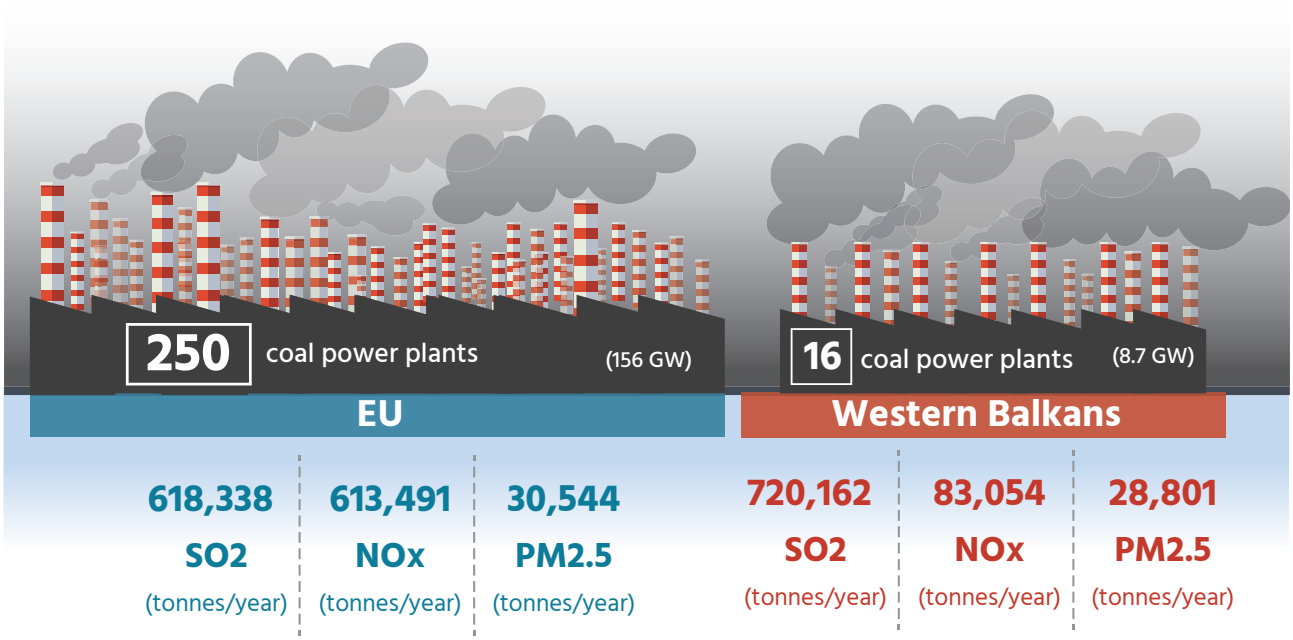
16 Western Balkan plants pollute as much as 250 EU plants

In 2016, total SO2 and PM 2.5 emissions from the 16 coal power plants (8.7 GW) in the Western Balkans were almost as high as from the 250 existing coal plants (156 GW) in the EU.

Sulphur dioxide (SO2) emissions from coal plants in the Western Balkans are a significant public health challenge. Most of the health impacts and economic health burden come from this single pollutant, accounting for 88% of total health costs from those plants. In contrast, in the EU, where plants are often equipped with technologies to remove SO2 from the fumes coming out of the coal plant stacks, SO2 emissions contribute to less than half (46%) of the total damage from the plants.

Desulphurisation technology in Western Balkan plants has either not been fitted at all or, in the case of Kostolac B in Serbia, it has been fitted but is largely non-functional, leading to enormous pollution (see case study below).

Fig. 8 Total emissions of the main pollutants from coal power plants in the Western Balkans and the EU in 2016



12. See Annex 1 for the sources of the emissions data for each plant.

Kostolac B - SO2 pollution control largely unused

Kostolac B, Serbia, is one of the few coal plants in the region equipped with pollution control technology.

In 2016 - before the equipment was fitted - the plant's two units consumed nearly 6 million tonnes[13] of lignite, generating a total of 5,216 GWh[14] of electricity without SO2 pollution control.

In July 2017, work to retrofit units B1 and B2 with de-SOx equipment was allegedly completed.[15] Since then, however, the power plant has rarely emitted through the de-SOx stack[16] which essentially means the retrofit failed to bring any results.

Responding to an enquiry by the Environment Inspectorate of the Serbian NGO CEKOR about de-SOx non-functionality in December 2017, the operator explained it was decided not to run the desulphurisation during winter, without stating why. The reply also mentioned that continuous emissions measurement equipment had not yet been set up, making accurate measurement impossible. It finally stated that the landfill site for gypsum - a by-product of de-SOx - had not been completed.

Energy Community contracting parties, including Serbia, have been obliged to continuously monitor emissions at the stack since 1 January 2018. However, observations by local people indicate that the de-SOx equipment is still predominantly unused.

Additionally, independent measurements[17] of PM10 and PM2.5 emissions recorded by Bankwatch between 17 November and 16 December 2016, in Drmno, the village nearest to the Kostolac B power plant, showed that the legal daily average limit for PM10 was breached on 16 days in the observed period. The PM2.5 daily average values were above the 25 µg/m^3 limit recommended by the World Health Organisation on 26 out of 30 days of measurements.

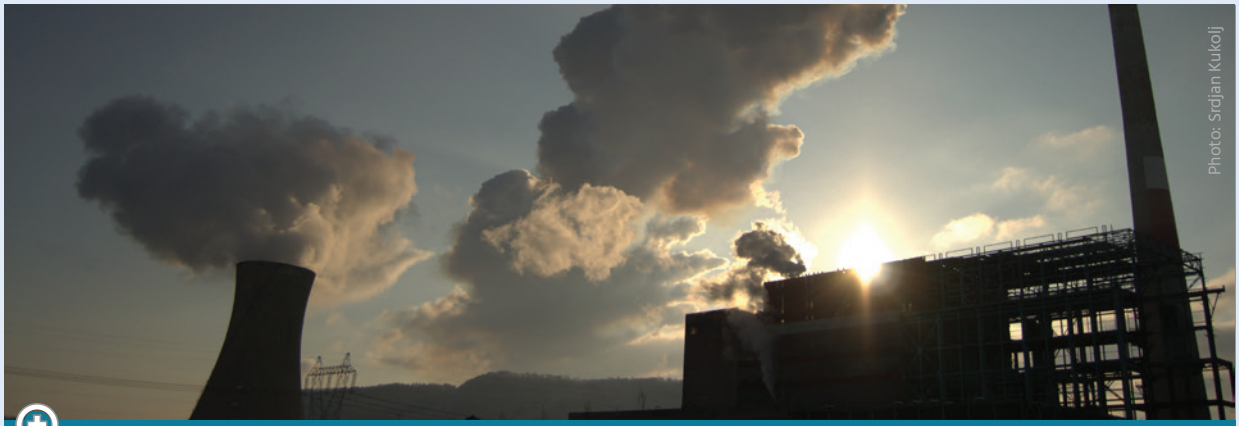
Expansion of Kostolac B and coal mining planned

Both the power plant operator and the environmental authorities have shown their inability to reduce the emissions of the Kostolac power plant and yet Serbia's state-owned utility Elektroprivreda Srbije is planning a new 350 MW lignite plant at Kostolac - B3. It would be constructed by the China Machinery Engineering Corporation (CMEC) and financed by the China EximBank through a USD 608 million loan that was signed between the Serbian government and the China EximBank in December 2014.

In addition to the construction of the new unit, the loan also covers the expansion of the Drmno open cast lignite mine, raising annual production from 9 to 12 million tonnes. The mine expansion is already underway without an environmental impact assessment, while work on the new unit also seems to have begun[18], even though a construction permit has not yet been issued. Increasing coal production and adding another coal unit at Kostolac B will worsen the air quality of the surrounding region, by adding pollution from mining operations and coal ash disposal.

13. 5,997,272 tonnes. http://195.250.121.20/SiteAssets/Lists/Sitemap/EditForm/Izve%C5%A1taj%20o%20stanju%20%C5%BEivotne%20sredine%20u%20JP%20EPS%20za%202016.%20godinu.pdf, page 13
14. http://195.250.121.20/SiteAssets/Lists/Sitemap/EditForm/Izve%C5%A1taj%20o%20stanju%20%C5%BEivotne%20sredine%20u%20JP%20EPS%20za%202016.%20godinu.pdf, page 12
15. https://www.energetskiportal.rs/blokovi-b1-i-b2-u-kostolcu-dobili-postrojenja-za-odsumporavanje/
16. Both units use one, common stack
17. https://bankwatch.org/blog/call-the-chimney-sweepers-independent-monitoring-shows-for-first-time-true-level-of-air-pollution-near-coal-plant-in-serbia
18. https://vimeo.com/302397223

Ugljevik emits more SO2 than all German coal power plants



Ugljevik's toxic emissions caused

635
premature deaths

1,689
cases of bronchitis in children and adults

494
hospital admissions

192,236
lost working days in 2016

The 300 MW Ugljevik power plant in Bosnia and Herzegovina is a one-of-a-kind polluter. For a relatively small plant (300 MW) it emits unimaginable amounts of dangerous sulphur dioxide - 127,524 tonnes in 2016. That's more than all of Germany's plants combined - they emitted a total of 110,255 tonnes in 2016. Ugljevik's dubious record was unmatched in Europe until 2016 when the Serbian plant Kostolac B (with a capacity of 700 MW, twice that of Ugljevik) emitted 128,000 tonnes of SO2.

Ugljevik is located in the east of Bosnia and Herzegovina, near the Serbian and Croatian borders. The plant started to operate 33 years ago, making it one of the newer ones of Bosnia and Herzegovina's coal plants with an average age of 38 years.

According to Bosnia and Herzegovina's National Emissions Reduction Plan, Ugljevik's SO2 emissions should have been cut down to 9,100 tonnes in 2018 continuing to fall until 2027 when each Bosnian coal power plant must comply with Annex V part 1 of the EU Industrial Emissions Directive.

A contract for the installation of flue-gas desulphurisation equipment was signed[19] in July 2016, and is expected to be finalised in 2019. It remains to be seen how effective this will be.

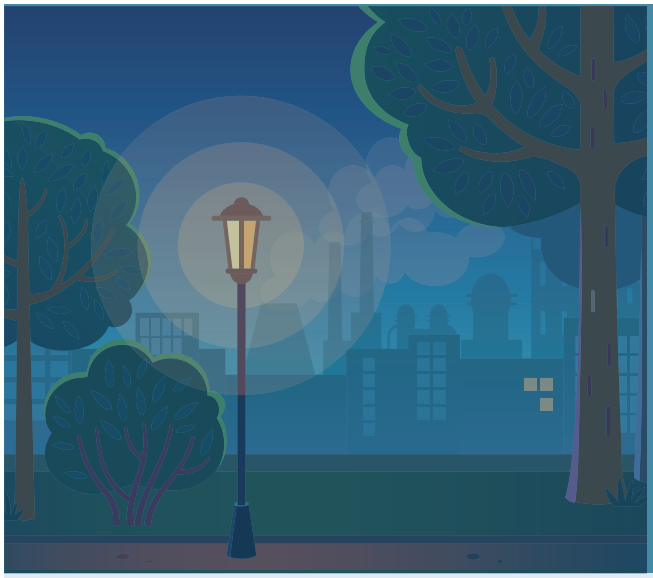
Ugljevik's toxic emissions caused 635 deaths, 1,689 cases of bronchitis in children and adults, 494 hospital admissions and 192,236 lost working days in 2016 alone.

Should Ugljevik keep running until January 2028, it would need to bring its SO2 emissions down each year to around 2,100 tonnes per year[20] - a 99% reduction from 2016 values. Desulphurisation technologies that would support this kind of reduction have been implemented in most of the EU's coal power plants. Such a huge reduction in air pollution would also mean a huge reduction in health impacts and savings: EUR 0.9 to 1.8 billion a year of health costs.

19. https://www.mhps.com/news/20160721.html

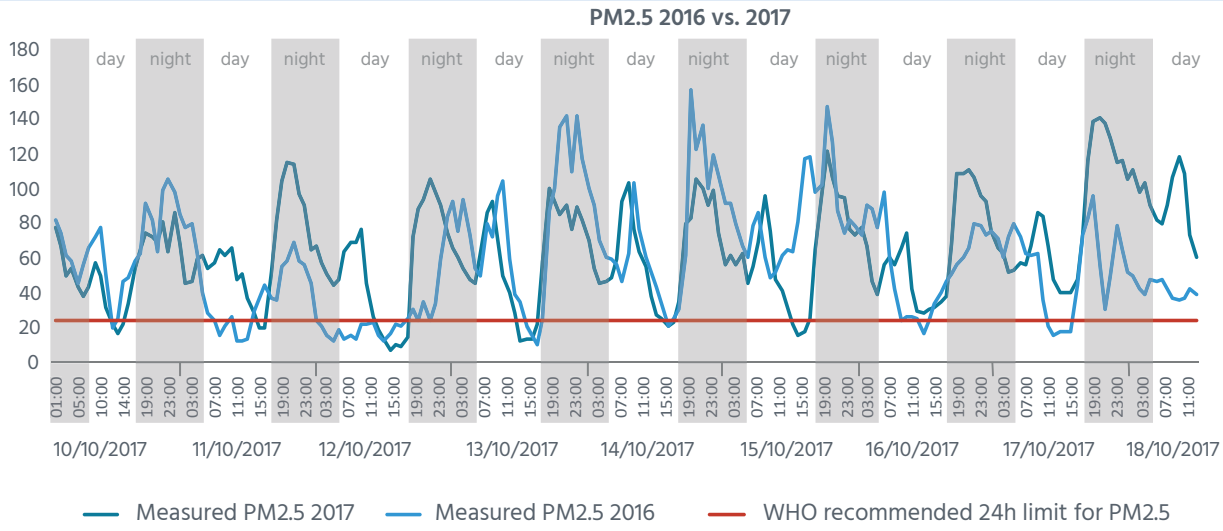
20. Limits for SO2 emissions should follow: by 2024 SO2 emissions should be in the range of 2,000 to 400 mg/Nm^3 (linear decrease) and by 2028 linear decrease to 200 mg/Nm^3.

Dark and darker: Tuzla spewing emissions at night



Independent measurements[21] of particulate matter pollution in Tuzla revealed worsening levels of emissions in 2017 compared to the same period in 2016. These findings have been used by locals to argue that the source of pollution is the town's power plant, which burns approximately 3.8 million tonnes of brown coal and lignite a year. A striking observation during both 2016 and 2017 independent monitoring periods is the pattern of emissions skyrocketing as soon as it gets dark, after 7:00 in the evening, suggesting that the dust filters at the Tuzla power plant are turned off at night.

Fig. 9 Hourly mean PM2.5 values recorded in Tuzla for 8 days, 2016-2017 comparison



In spite of excessive emissions, a new unit is planned by the state owned energy company, Elektroprivreda BiH, which signed a financing agreement with China Exim Bank in November 2017. The 450 MW proposed Tuzla 7 project would constitute additional coal capacity as only the smaller existing units are planned to close before 2030.

'Poor air quality causes heart and lung disease and brings immense suffering, especially for vulnerable citizens. The doctors, nurses, and health professionals across the region should put an emphasis on the preventive potential of cleaner air. Reducing the air pollution could have great impacts on saving lives and improving public health.'

Maida Mulić
PhD MD, director of Public Health Institute Tuzla

21. https://bankwatch.org/blog/race-to-the-bottom-dire-air-quality-worsens-as-bih-government-mulls-new-coal-plant-at-tuzla

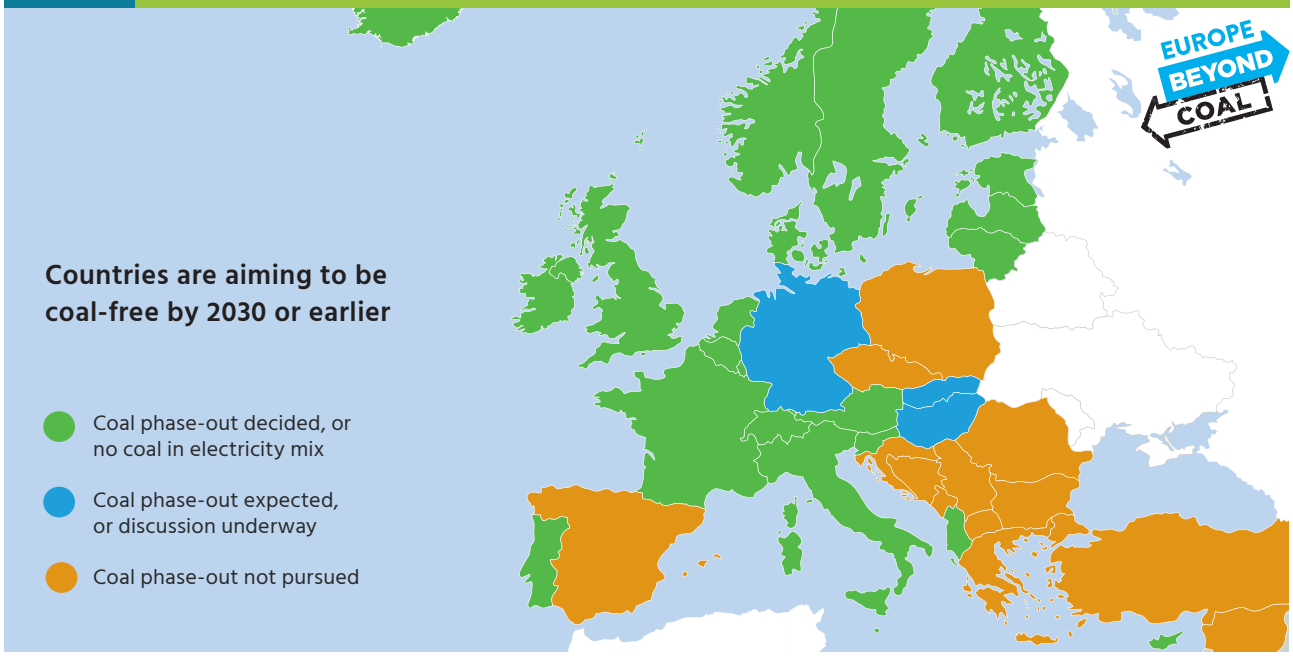
3.

Decarbonisation for a healthy energy system

With seven EU member states now coal-free, and 10 more planning to end electricity generation from coal by 2030, the coal phase out in the EU is well underway. 2018 saw additional plant closures and announcements[22] while, in its recent long-term climate strategy draft, the European Commission called for net-zero emissions by 2050[23] - meaning a coal-free Europe.

Western Balkan countries should equally strive to achieve full decarbonisation of the power sector by 2050 to ensure adequate climate action, less air pollution, improved health of their citizens, decreased healthcare costs and increased productivity. However, today they suffer from rampant energy poverty and heavily centralised energy systems that rely on old, energy intensive and polluting lignite power plants.

Fig. 10 Coal phase out status by country, February 2019



22. https://twitter.com/EurBeyondCoal/status/1075007131668176898

23. https://ec.europa.eu/clima/news/commission-calls-climate-neutral-europe-2050_en

Renewable energy is a readily-deployable solution. With the steady decrease in costs of renewable energy sources (RES), they are now, in many places, cheaper to develop than new coal capacity.

To introduce renewable energy into an energy system, certain preconditions or changes in regulatory frameworks are needed. Moreover, since renewables have higher upfront investment costs than conventional units such as coal or lignite, smart financing is needed to reduce costs.

Western Balkan governments have expressed their political commitment to implement the Paris Agreement on climate change. According to Agora Energiewende, an energy think tank: "The EU is pushing for an integrative, economy-wide approach to climate and energy policy-making consistent with the EU acquis, particularly as four Western Balkan countries are candidates for EU accession and two are potential candidates. Also, the Western Balkan countries have close geographical and political ties with Central and East European and with South-East European member states of the EU and engaging the WB countries on the clean energy transition will narrow the EU/non-EU divide"[24]. This will further alleviate the alarming impact of the region's energy systems on air quality and public health across Europe.

Enough is enough: Balkan grassroots anti-smog movements speak up

In February 2018, as air pollution experienced its usual winter spike, the Clean Air Movement – a group of over ten thousand citizens living in Tuzla, Bosnia and Herzegovina, concerned about their worsening health condition as a result of exposure to air pollution – took to the streets to demand that authorities find long-term solutions to this persistent problem.

Tuzla is not the only air pollution hotspot in the region where residents have taken to the streets. Citizens in Pljevlja in Montenegro, Bitola, Skopje and Tetovo in Macedonia, and Pristina in Kosovo have voiced their concerns in public rallies[25] about the impacts of air pollution, including from coal burning, on their health.

Photos: Clean Air Movement

24. Internal Impulse Paper of Agora Energiewende, Clean energy transition in the Western Balkans: Challenges, options and policy priorities

25. http://stories.bankwatch.org/up-in-smoke

Serbian doctors call to end coal

In June 2015, Serbian health experts in public and clinical medicine called for better air quality to reduce respiratory, cardiovascular and other diseases related to air pollution, as well as associated long-term economic costs to the health system.

In a position paper, the medical professionals pointed out that air quality in Serbia is a serious problem and concentrations of PM2.5 and PM10 are significantly higher than those in the EU and higher than the thresholds recommended by the WHO. They identified coal combustion in thermal power plants as a key contributor to air pollution, causing negative effects on the cardiovascular and respiratory system, potentially severely harming the brain and the developing nervous system of children, hampering foetal development and causing cancer.

They stressed that for every TWh (Terawatt-hour) of electricity produced from coal, there are an average of 24.5 air pollution-related deaths, 225 cases of serious cardiovascular, respiratory, and cerebrovascular disease as well as 13,288 cases of minor illness in Europe[26]. Those numbers are even higher for lignite, the most polluting form of coal, which produces about 70% of Serbia's electricity[27].

They suggested including the health sector in energy policy development and regulation, adopting legislation on indoor air quality, raising awareness on the damaging effects of air pollution on health, improving data quality and data sharing including transparency and indication of health risks of environmental pollution to the public.

The call was signed by the the Department for Hygiene, School of Medicine, University of Novi Sad, the Institute of Public Health Valjevo and the Institute of Public health "Timok" Zaječar, as well as more than 10 individual health experts.

Air quality in Serbia is a serious problem. Concentrations of PM2.5 and PM10 are significantly higher than in EU countries and those recommended by the WHO. Poor air quality affects human health and it has also been linked to premature mortality and reduced life expectancy. We must act now to protect public health and prevent unnecessary suffering.'

Marija Jevtic

Full professor, University of Novi Sad, Faculty of Medicine,
Institute of Public Health of Vojvodina, Serbia

'Air pollution is becoming more extreme and intense as the climate changes. Poor air quality is expected to continue or worsen, and burning coal to make electricity is a major source of this.'

Branislava Matić

MD, PhD, Head of the Department of Environmental Health
and School Hygiene, Institute of Public Health of Serbia

26. The Lancet 2007. Markandya A. Electricity generation and health.

27. IEA: Electricity and heat for 2016: https://www.iea.org/statistics/?country=SERBIA&year=2016&category=Electricity&indicator=ElecGenByFuel&mode=table&dataTable=ELECTRICITYANDHEAT

Pollution control measures under Energy Community Treaty long overdue

The Energy Community Treaty (ECT), an international treaty designed to create an integrated and sustainable pan-European energy market, entered into force in 2006. It aims to extend the EU energy market into Southeast Europe. Its Contracting Parties are the European Union, the six Western Balkan countries, Moldova, Ukraine and Georgia.

The Treaty's goals are to integrate energy markets, facilitate investments, enhance security of supply and improve environmental conditions in the region through the adoption and implementation of EU energy and energy-related legislation including competition and the environment.

One of the original pieces of environmental legislation included in the Treaty was the Large Combustion Plants Directive, which came into force at the beginning of 2018. However between 2006 and 2018 very little action was taken by governments to implement this legislation on time.

One of the mechanisms for its implementation is the National Emissions Reduction Plan. This allows countries to comply during 2018-2027 by totalling up air emissions from the plants included in the plan and meeting an overall ceiling for the whole sector rather than each plant complying separately. This is supposed to lead to flexibility and cost-effectiveness in emissions reductions but so far has been interpreted by plant operators and governments as just another loophole to further delay action: the plants look set to massively exceed the 2018 ceilings.[28]

The Energy Community Treaty is often cited as one of the most successful tools of EU external energy policy[29]. However, it lacks strong enforcement mechanisms, hindering its achievements. Energy Community countries in the Western Balkans have avoided meeting some of their obligations since there are neither direct penalties nor court to sanction them.

Regrettably, energy policy makers in the region continue to perceive the inevitable energy transition away from fossil fuels towards renewables as a threat to the existing patterns of rights and privileges largely driven by considerations of short term political gain, as opposed to medium- to long term economic, health and environmental sustainability.

Nevertheless, since the ECT draws its power from the EU, the Contracting Parties have been declared non-compliant with the Treaty several times through its dispute settlement mechanism. Given the negative impact this has on their EU accession prospects and financing from international donors, it often spurs them into action, with the exception of some heavily politicised cases.

28. HEAL: Boosting Health by improving air quality in the Balkans, December 2017, https://www.env-health.org/wp-content/uploads/2018/06/Boosting-health-by-improving-air-quality-in-the-Balkans.pdf

29. Energy Community, (June 2014) Report of the High Level reflection group https://www.ceas-serbia.org/images/2015-i-pre/Energy_Community_HLRG_Report.pdf

Decarbonising the energy sector in Bosnia and Herzegovina

Is decarbonisation something that Bosnia and Herzegovina (BiH) can achieve without enormous costs and risk to security of supply? Factnote: achieving a very high share of renewables in the electricity mix by 2050 is both technically possible and financially viable.[30]

In Bosnia and Herzegovina, more than 35% of current fossil fuel generation capacity is expected to be decommissioned by 2030 and nearly 85% by 2050, according to national plans and the age of the power plants[31]. The country has remarkable renewable energy potential. The South East Europe Electricity Roadmap (SEERMAP) models show that BiH will experience a significant shift away from fossil fuel-based electricity generation towards renewables, driven primarily by the EU emissions trading system (EU ETS) carbon price. This is not yet levied in the Western Balkans, but once it is in place it will inevitably make coal and lignite electricity production financially unviable.

In SEERMAP's 'decarbonisation'[32] scenario, the share of renewable energy as a percentage of gross domestic consumption will reach 107% by 2050. Hydropower and wind electricity production will play a prominent role, contributing around 60% and 30% respectively, while solar will contribute 8%. The share of biomass in the generation mix will increase but remain negligible.

Concerning potential conflicts due to competing water uses, nature protection and environmental concerns, the feasibility of achieving a shift towards RES was also analysed in a scenario where the large-scale hydropower and onshore wind power potential was assumed to be 25% lower than in the core scenarios, albeit at a higher cost. Political issues on the expansion of production from hydropower plants in Bosnia and Herzegovina must however be taken into account. Growing social resistance should be a signal to the institutions that any decision-making on the location of new hydropower plants has to be a subject to a careful, transparent and participatory process.[33]

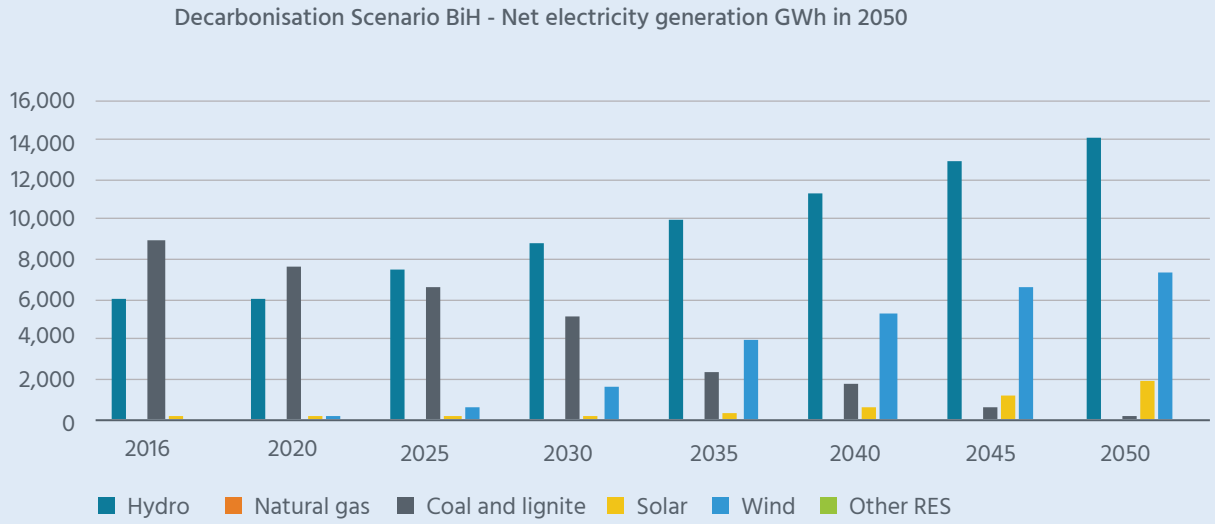
30. Based on information from: Myths and facts about deploying renewables in the power systems of Southeast Europe, Fanni Sáfián, Gabriella Dóci, Dóra Csernus, Ágnes Kelemen, Xuenan Mao, Klimapolitika, Budapest, December 2018. https://www.agora-energiewende.de/en/publications/myths-and-facts-about-deploying-renewables-in-the-power-systems-of-southeast-europe/

31. South East Europe Electricity Roadmap – SEERMAP https://rekk.hu/analysis-details/238/south_east_europe_electricity_roadmap_-_seermap

32. The 'decarbonisation' scenario reflects a long-term strategy to significantly reduce CO_2 emissions according to indicative EU emission reduction goals for the electricity sector as a whole by 2050, driven by the CO_2 price and strong, continuous RES support

33. SEERMAP does not cover energy governance. Information on the risks surrounding new hydro power capacities in Bosnia and Herzegovina can be found here: riverwatch.eu

Fig. 11 Scenario for coal phase out and increase in renewable energy electricity generation Bosnia and Herzegovina by 2050, Source SEERMAP

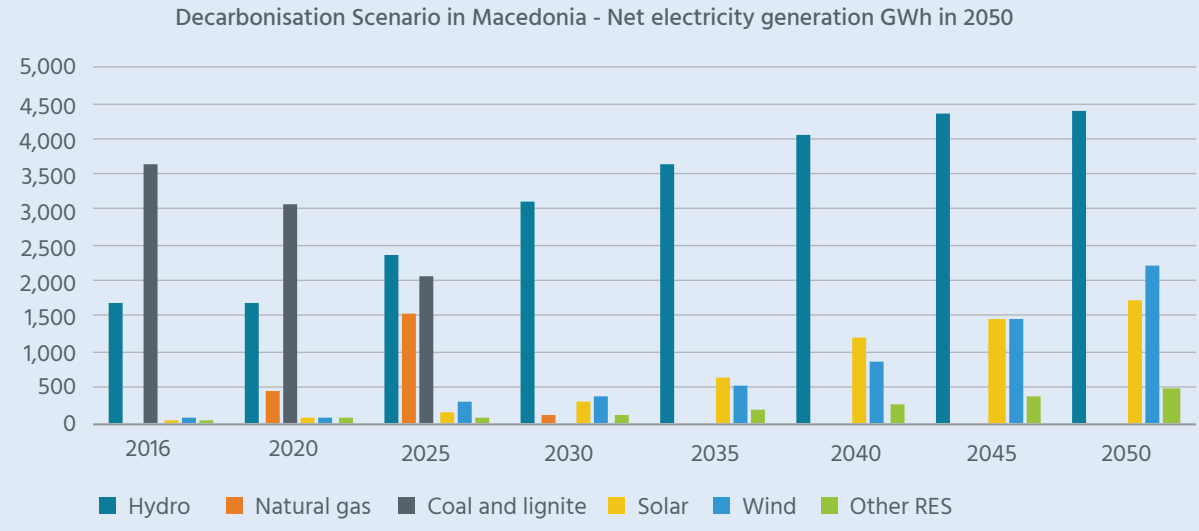


In Bosnia and Herzegovina, SEERMAP modelling showed that a high share of renewables in electricity production can satisfy electricity demand, with only 300 MW of existing coal power plants still running by 2050. The coal plant will be operated intermittently, generating less than 1% of Bosnia's total net electricity production.

Renewable energy sources in Macedonia[34]

Macedonia can significantly increase its current share of RES generation in all scenarios by 2050, with an 85% share in the 'decarbonisation' scenario. At the same time, the share of fossil fuels will drop to zero by 2050.

Fig. 12 Scenario for coal phase out and increase in renewable energy electricity generation in Macedonia by 2030, source: SEERMAP



34. Based on information and data from: Myths and facts about deploying renewables in the power systems of Southeast Europe, Fanni Sáfián, Gabriella Dóci, Dóra Csernus, Ágnes Kelemen, Xuenan Mao, Klimapolitika, Budapest, December 2018. Link to the document: https://www.agora-energiewende.de/en/publications/myths-and-facts-about-deploying-renewables-in-the-power-systems-of-southeast-europe/

Hydropower emerges as the dominant RES technology, reaching 40-50% of total generation by 2050.[35] Consequently, energy efficiency and demand side management measures (initiatives and technologies that encourage consumers to optimise their energy use) are of utmost importance, since the development of hydropower always raises concerns about nature protection and biodiversity.[36]

Moreover, climate change can impact Macedonia's water resources, and new stricter rules under the Nature and Habitats Directives and Water Framework Directive will come into force. Just as in BiH and elsewhere in the Western Balkans, any decision-making on new hydropower plants has to be a subject to a careful, transparent and participatory process. The focus should be on upscaling wind and solar to 25% of total generation for wind and 20% for solar by 2050, according to the 'decarbonisation' scenario of the SEERMAP model. Compared to current levels, this is a 30-fold increase in wind generation and more than 50-fold increase in solar generation. Biomass remains insignificant (below 6%) in all scenarios.

Decarbonisation policies do not drive up wholesale electricity prices compared to a scenario with no emissions reduction target. This is an important finding for one of the least developed regions in Europe: RES will not be an added burden to consumers. In SEERMAP, the price of electricity follows a similar trajectory in all scenarios, only diverging after 2045 when prices are lower as a result of the low marginal cost of RES electricity production.

In order to benefit from RES and the phasing out of lignite, decision-makers in Macedonia should focus on market reforms and regional power market integration. System adequacy at a regional rather than purely national level, lowers the costs of achieving a reliable power system. As market size increases, the quantity of required resources will on the one hand decrease, saving time and money for all parties concerned, while on the other hand, the options for balancing the system will expand, guaranteeing security of supply. Moreover, regulatory, administrative, financial and political barriers to renewables must be removed to allow the capital costs of wind and solar to fall. All this should be brought about by holistic and sound energy and climate planning in order to foresee and proactively address challenges.

35. The SEERMAP modelling shows hydro capacity increasing to 1754 MW by 2050, and in the restricted potential scenario to 1388 MW. It is approximately the same amount as in the 2011 UNDP study on Assessing the Economic Impact of Climate Change for Macedonia proposing three optimal generation capacity mixes (scenarios) expecting 1279 MW hydro by 2030. However, defining sustainable hydro capacities needs careful planning concerning nature protection areas and negotiations with the inclusion of local population (Myths and Facts document).

36. SEERMAP was more restrictive about demand side management. However energy efficiency as the first fuel is one of the pillars of the Energy Union and hence an important measure for achieving decarbonisation. For more on the importance of energy efficiency in the Western Balkans: https://www.wbif.eu/content/stream//Sites/website/library/EE-Brochure.pdf

4.

Recommendations

The dire consequences of carbon-intensive Western Balkan energy systems and their chronic coal pollution can be treated. Recommendations to policy-makers both in the European Union and in Western Balkan countries seeking EU membership include aligning climate and energy policies with the common need to safeguard public health.

To the European Union:

- Show leadership and prioritise healthy energy and climate ambition in the Western Balkans. Demand the same level of climate ambition for all candidate countries. The EU's climate and energy agenda should set an example as a fast track to a climate-neutral society.
- Support the Energy Community in promptly enforcing existing pollution control rules: the Large Combustion Plants Directive and Chapter III and Annex V of the Industrial Emissions Directive for new plants.
- Strengthen the Energy Community's mandate to tackle air pollution by promptly proposing additional legislation in the Treaty and strengthening its dispute settlement mechanism. Such legislation includes: the Industrial Emissions Directive Chapter II, the Air Quality Directive and/or National Emissions Ceiling Directive and the Clean Energy Package.
- Prioritise the implementation of pollution control and air quality legislation within the EU accession process, including by applying Chapter II of the Industrial Emissions Directive to existing plants as well as new ones. Countries which have failed to take action since 2006 to implement the Large Combustion Plants Directive now have a chance to leapfrog to higher standards and should be pressed by the EU to do so, otherwise they will have to make additional investments within a few years.

- Given the danger of high carbon lock-in and stranded assets, no EU-related financial support should be given to companies planning new coal power capacity at all, irrespective of the type of project they are applying for. With fossil fuels being a financial and environmental liability, supporting companies planning new coal power plants is not in line with an EU-wide decarbonisation agenda.
- Support innovative financial mechanisms for increasing investments in renewables and energy efficiency.
- Continue strong enforcement of EU air quality and industrial emissions legislation within the EU in order to lead the Energy Community by example.

To the Western Balkan countries:

- Urgently enforce the Large Combustion Plants Directive for existing plants. Ensure any pollution abatement investments in coal plants are in line with the 2017 Best available techniques reference document (BREF) for large combustion plants to better protect public health and avoid the need for additional investments in a few years.
- Close all existing and ageing coal-fired plants as soon as possible and do not build new ones.
- Make informed energy choices based on health and environment impact assessments, and economic cost-benefit analyses that include short and long term cost-benefits, local and transboundary impacts.
- Make energy sector planning more streamlined by connecting strategies and legislation from economic, energy and environmental sectors and increase transparency by allowing experts and the general public to participate. Demonstrate this in the next two years by adopting ambitious 2030 greenhouse gas reductions, renewable energy and energy efficiency targets and national energy and climate plans.
- Opt for sustainable forms of renewable energy and energy savings. Take advantage of the falling costs of solar and wind. Lift the tariff and non-tariff barriers (regulatory, administrative etc.) to increase RES deployment.
- Fully implement standards agreed in the 2015 Paris Agreement. Strengthen Nationally Determined Contributions and develop ambitious long term low greenhouse gas emissions development strategies by 2020 to ensure real reductions of greenhouse gas emissions, which will also lead to cuts in air pollutants. This will lead to public health benefits as well as cost savings.
- Regional cooperation is essential to decarbonisation in the Balkans as it is a low-cost and simple way of achieving the desired security of electricity supply. Countries should strive to improve their cooperation and work towards power market integration.

To the medical and health community in Europe

Doctors, nurses, asthma patients and health affected groups have a unique role to play and can add a long neglected perspective to the debate about Europe's energy future.

- Increase health and medical organisational and individual capacity to engage in debates on the health impacts and costs of coal and energy production, through communication and providing evidence, e.g. in public consultations
- Highlight the evidence and materials of the World Health Organization (WHO), including the ground-breaking roadmap on Health, environment and climate change[37] and resolution on Addressing the health impact of air pollution[38], as well as the *WHO Ostrava Ministerial Declaration on Environment and Health*[39], to enable better air quality and climate action for greater public health gains and a quicker energy transition
- Share the *Lancet Countdown 2018 Briefing for EU policymakers*[40], developed in conjunction with the Standing Committee of European Doctors (CPME); the briefing recommends a coal phase out. CPME strongly encourages their national member associations and individual physicians to bring the recommendations of the briefing to national authorities
- Highlight the true costs of coal power generation in economic and public health deliberations and decisions, and work towards increasing the public understanding of how public health will benefit in reducing coal's unpaid health bill
- As health ministries, participate and provide input in the development and implementation of clean air activities and plans, as well as energy and climate policies, supporting measures to reduce coal pollution and ambitious phase out plans and mitigation measures

37. http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_10Add1-en.pdf
38. http://apps.who.int/gb/ebwha/pdf_files/WHA68/A68_ACONF2Rev1-en.pdf
39. http://www.euro.who.int/__data/assets/pdf_file/0007/341944/OstravaDeclaration_SIGNED.pdf?ua=1
40. http://www.lancetcountdown.org/media/1420/2018-lancet-countdown-policy-brief-eu.pdf

5.
Annexes

Annex 1

Methodology and sources for health impact modelling

This methodology details how we calculated the health impact caused by air pollution from Western Balkans coal power plants in 2016.

There are a series of discrete steps:

1. Identify coal power plants operating in the Western Balkans in 2016.
2. Source 2016 coal power plant emissions data.
3. Model the pollutant exposure resulting from the emissions from all Western Balkan coal power plants.
4. Calculate the health impacts associated with modelled pollutant exposure.
5. Attribute the health impacts to individual coal power plants.
6. Calculate the cost of the health impacts.

1

Identify coal power plants operating in the Western Balkans in 2016.

Europe Beyond Coal maintains a database of information on coal power plants.[41] From this, we identified the 16 coal plants operational in the Western Balkans in 2016 and the utility or utilities that owned these plants.

2

Source 2016 coal power plant emissions data.

In the modelling, SO2 and NOx emissions as well as fine (PM2.5) and coarse (PM2.5-10) particle emissions from all facilities are accounted for. Data on emissions for each plant was obtained via the following sources:

Bosnia: for the Gacko, Ugljevik and Stanari plants, data on emissions were obtained from the Republic Hydrometeorological Institute, and the Ministry of Agriculture, Forestry and Water Management. For the Kakanj and Tuzla plants data comes from the Elektroprivreda Bosne i Hercegovine Annual Report on Environmental Protection for 2016.

Kosovo: plant data came from energy operator KEK's annual environmental report "Raport i gjendjes mjedisore në kek për vitin 2016".

Montenegro: data was provided by coal plant operator 'Elektroprivreda Crne Gore' Operations Department.

Macedonia: data was obtained from the national operator ELEM.

Serbia: coal plants report their emissions in the European Pollutant Release and Transfer Register (E-PRTR).[42] For our modelling, we used the E-PRTR emissions for 2016.

41. https://beyond-coal.eu/data/

42. Dataset used for modelling of SO2, NOx & dust was EPRTR v13 for 2016 data https://www.eea.europa.eu/data-and-maps/data/member-states-reporting-art-7-under-the-european-pollutant-release-and-transfer-register-e-prtr-regulation-21

3

Model the pollutant exposure resulting from the emissions from all Western Balkan coal power plants.

The modelling used the Open Source EMEP/MSC-W chemical transport model[43] and the associated input datasets developed by European meteorological institutes under the Convention on Transboundary Air Pollution (CLRTAP). Specifically, for this report we relied on input data provided by EMEP/MSC-W, ECMWF and the Norwegian Meteorological Institute.

The EMEP/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.[44] All datasets and meteorological data we used cover 2016.

For the first time in this report series, the total air quality and health impacts from all the studied power plants were estimated using the new, high-resolution EMEP grid.[45] We used two simulations[46] that singled out SO2 and NOx emissions as well as fine (PM2.5) and coarse (PM10) particle emissions from all facilities.

The MSC-W model is a regional-scale model. The local pollutant concentrations at the 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 the long-range transport of pollution. Long-range pollution exposes millions of people to small additional concentrations, causing disease and mortality.

43. Version 4.17a

44. EMEP MSC-W model performance for acidifying and eutrophying components, photo-oxidants and particulate matter in 2016: http://emep.int/publ/reports/2018/sup_Status_Report_1_2018.pdf

45. A 0.1 x 0.1 degree regular longitude-latitude grid (as opposed to the lower resolution 50 x 50 km polar stereographic grid used in previous years) - this represents an approximately 26 fold increase in model resolution.

46. A simulation with all emissions from all sectors - known as the baseline - and a simulation with the emissions from the coal power stations removed (with all other emissions left unchanged). The difference between the two simulations identifies the impact of coal power stations on air quality.

4

Calculate the health impacts associated with modelled pollutant exposure.

The methodology for estimating mortality and morbidity caused by emissions of coal-fired power plants in this report followed the recommendations of experts from Europe and North America, convened by WHO Europe to assess the health impact of air pollution in Europe. (see HRAPIE[47] recommendations).

Exposure to primary and secondary particulate matter, ozone and nitrogen dioxide caused by emissions from the studied plants was estimated using the modelling process described earlier.

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's SEDAC Gridded Population of the World v.4.[48] We then applied the WHO HRAPIE recommendations for health endpoints and for concentration-response functions to assess the health impact.[49] The extended set of pollutant-outcome pairs recommended for inclusion in the total effect (HRAPIE groups A* and B*) was used.[50] Affected fractions of the population were applied evenly to all grid cells. Required baseline health data were obtained from WHO databases[51] as well as from a technical guidance paper on implementing HRAPIE recommendations.[52]

47. 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-concentrationresponse-functions-for-costbenefit-analysis-of-particulate-matter,-ozone-and-nitrogen-dioxide

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

49. 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: 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-concentrationresponse-functions-for-costbenefit-analysis-of-particulate-matter,-ozone-and-nitrogen-dioxide

50. 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.

51. WHO Global Health Estimates, 2012, http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html

52. 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

The health impacts in each grid cell were 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 - excluding the impact of the modelled coal emissions; e.g. new cases of chronic bronchitis per 100,000 people.

Affected population fraction refers to the percentage 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 PM2.5 concentrations increase by 10µg/m^3 over a long period. These results for each grid cell are then summed over the geographic area for which impacts are being calculated.[53]

Table 1 Concentration response functions for mortality

Increase in risk for a 10µg/m^3 increase concentration core mortality functions without infant mortality to be added for total impact with likely overlap of 33% between PM2.5 and NO2 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	PM2.5	6.20 %	4 %	8.30 %
All cause natural mortality from acute exposure	All ages	O_3	0.29 %	0.14 %	0.43 %
All cause natural mortality from chronic exposure	Over 30 years	NO2	5.5 %	3.1 %	8.0 %
Infant mortality (HRAPIE group B*)	1 month to 12 months	PM2.5	4.0 %	2.0 %	7.0 %

53. Natural mortality in the over 30s, eliminating deaths under that age, and any death from accidental and intentional causes (suicides, murders etc.).

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 ($10\mu g/m^3$)	HRAPIE group
PM10	Incidence of chronic bronchitis, population aged over 27 years	67.6 %	0.39 %	11.70 %	10	B*
PM10	Bronchitis in children, ages 6-12 years	7 %	18.6 %	8 %	10	B*
PM10	Incidence of asthma symptoms in asthmatic children, ages 5-19 years	0.6 %	62 %	2.8 %	10	B*
PM2.5	Respiratory hospital admissions, all ages	100 %	1.165 %	1.9 %	10	A*
PM2.5	Cardiac hospital admissions, all ages	100 %	2.256 %	0.91 %	10	A*
PM2.5	Restricted activity days (RADs)	100 %	19 %	4.7 %	10	B*
PM2.5	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*
NO2	Bronchitis in children, ages 5-14 years	0.5 %	1.52 %	2.1 %	1	B*
NO2	Respiratory hospital admissions, all ages	100 %	1.165 %	1.8 %	10	A*

The mortality estimates include the effect of direct NO2 exposure, in line with WHO recommendations. The central and low estimates of mortality in this report (low range with a 95% confidence interval) only include 67% of the NO2 mortality effect based on a single pollutant risk model. This is because of possible overlap with PM2.5 health impacts identified by the WHO (HRAPIE project report).

Only grid cells with background concentrations of NO2 above 20 µg per m^3 were reported in the AQ e-Reporting dataset[54] from European monitoring stations, as well as grid cells for which the MSC-W simulations yielded concentrations above 20 µg per m^3 were included to calculate NO2 mortality.

Our analysis, based on WHO Europe's latest recommendations from 2013, suggests that ~ 1% of the damage caused by power coal power stations in the Western Balkans is linked to exposure to NO2. There is comparatively more research on the effects of fine particles than NO2 exposure, so our NO2 results carry a higher level of uncertainty. A more recent review has been provided by COMEAP (2018)[55] on behalf of the UK's Department for Health and Social Care. It gives a detailed account of the uncertainties involved in NO2 assessments.

5

Attribute the health impacts to individual coal power plants.

For the purpose of further simulations, the power plants were grouped into two geographical clusters and a simulation was carried out separately for SO2 and NO2 emissions from each cluster. Due to limitations on computational availability, these additional simulations were carried on the lower resolution 50 x 50 km polar stereographic grid. This provided a total of six 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 SO2 and one unit of NO2 from each cluster were then calculated and applied to the emissions from each facility in the cluster. This assigned the estimated health impacts caused by SO2 and NO2 to each facility.

54. European Environment Agency, Air Quality e-Reporting (AQ e-Reporting). The European air quality database. https://www.eea.europa.eu/data-and-maps/data/aqereporting-8

55. https://www.gov.uk/government/publications/nitrogen-dioxide-effects-on-mortality

To assign the primary PM2.5 and PM10 emissions impact, we used the existing country-by-country emissions-to-exposure values from the CAFE CBA methodology. Primary PM emissions are responsible for a small share of the total health impacts, therefore we did not do an additional set of cluster runs for them – we believe the added value would have been negligible.

This approach is similar to that used in the European Commission's 'Clean Air For Europe (CAFE) Cost Benefit Analysis' methodology[56] as well as the European Environment Agency'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.
- PM10 concentrations were simulated directly, rather than being calculated from PM2.5 using a fixed ratio.
- The influence of coal-fired power plants on ambient NO2 levels is included. Earlier work only looked at the impacts on PM2.5 and ozone, but the WHO recommendations now recognise that NO2 exposure also has long-term health impacts.

6

Calculate the cost of the health impacts.

The economic valuation of human health impacts is a tool to estimate an acceptable cost for avoiding those impacts. The approach used by the European Commission and the European Environment Agency[57] as well as the World Health Organization[58] 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

56. AEA Technology Environment (2005), Methodology for the cost-benefit-analysis for CAFE. Volume 2: Health Impact Assessment. http://ec.europa.eu/environment/archives/cafe/pdf/cba_methodology_vol2.pdf

57. AEA Technology Environment 2005: Damages per tonne emission of PM2.5, NH3, SO2, NOx 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

58. 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/health-topics/environment-and-health/air-quality/publications/2015/economic-cost-of-the-health-impact-of-air-pollution-in-europe

from air pollution affect all citizens, and individual people do not have the choice of spending money to significantly reduce toxic power plant emissions, a government's willingness to direct resources to reduce 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 Western Balkan coal-fired power plants are estimated based on the cost values used in 2014 impact assessments for the EU Clean Air Policy Package.[59] They were updated from 2005 prices (the reference year for the values in the report) to 2016 prices using the following methodology:

- For health impacts that occurred within the EU, the 2005 prices were adjusted according to Actual Individual Consumption, real expenditure per capita (EU).[60]
- For health impacts that occurred within the six Western Balkan countries, 2005 prices were adjusted by the ratio of the 2016 population-weighted Western Balkan GDP per capita (power purchasing parity - PPP) to the 2005 EU GDP per capita (PPP)[61]. An elasticity of 0.8 was applied to account for the variation in willingness to pay as incomes change.
- For health impacts that occurred outside the EU and Western Balkan countries, 2005 prices were adjusted by the ratio of the 2016 population-weighted GDP per capita (PPP) value for Turkey, Ukraine and Egypt[62] to the 2005 EU GDP per capita (PPP). An elasticity of 0.8 was applied to account for the variation in willingness to pay as incomes change.

59. Amann, M. (ed.) (2014), The Final Policy Scenarios of the EU Clean Air Policy Package. International Institute for Applied Systems Analysis IIASA. 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

60. Price development as reflected in Eurostat indicator "Purchasing power parities (PPPs), price level indices and real expenditures for ESA 2010 aggregates [prc_ppp_ind]" for Actual Individual Consumption, real expenditure per capita (EU-28). http://ec.europa.eu/eurostat/data/database

61. Population and GDP per capita (PPP) figures from the world bank. https://data.worldbank.org/indicator/ny.gdp.pcap.pp.cd & https://data.worldbank.org/indicator/SP.POP.TOTL

62. These three countries account for the large majority of the health impacts that occur outside of the EU and the Western Balkans.

Table 3 Monetary values applied to mortality and morbidity endpoints for EU, the Western Balkans and for other countries

	EU		Western Balkans		Other countries	
Health impact	Median monetary value, EU average Euro 2016 prices	High monetary value average, EU Euro 2016 prices	Median monetary value, WB PPP adjusted average Euro 2016 prices	High monetary value, WB PPP adjusted average Euro 2016 prices	Median monetary value, Other countries PPP adjusted average Euro 2016 prices	High monetary value, Other countries PPP adjusted average Euro 2016 prices
Mortality from chronic or acute exposure, VSL	1,335,915	2,720,854	657,826	1,339,792	774,967	1,578,374
Infant mortality (1-12 months)	1,960,976	4,044,512	965,616	1,991,583	1,137,567	2,346,231
Hospital admissions due to respiratory or cardiovascular symptoms	2,721		1,340		1,578	
Chronic bron-chitis in adults	65,693		32,348		38,108	
Work days lost, working age population	159		78		92	
Restricted activity days	113		56		65	
Minor restricted activity days	51		25		30	
Bronchitis in children	721		355		418	
Asthma symptom days in asthmatic children	51		25		30	

Health impacts and associated health costs

Table 1 Modelled annual health impacts and health costs occurring in each EU country due to air pollution emissions from Western Balkan coal plants, emissions in 2016

Country	Premature deaths	Infant mortality (1-12 months)	Bronchitis in children	Asthma symptom days in asthmatic children	Chronic bronchitis in adults	Hospital admissions due to respiratory or cardiovascular symptoms	Restricted activity days	Work days lost, working age population	Total cost high case (€)	Total cost median case (€)
Austria	48	0	94	1,286	28	57	77,978	20,676	141,860,738	75,596,771
Belgium	3	0	5	67	1	1	4,100	844	7,644,144	4,056,802
Bulgaria	253	0	275	2,697	96	129	261,580	53,856	728,856,412	377,489,289
Croatia	164	0	263	2,621	76	99	213,809	50,665	478,974,523	251,299,359
Cyprus	4	0	7	72	2	3	5,891	1,213	10,993,301	5,834,017
Czech Republic	54	0	87	843	29	45	81,191	30,474	158,866,136	84,409,709
Denmark	0	0	1	9	0	0	648	133	1,237,098	656,295
Estonia	0	0	0	5	0	0	341	70	906,674	471,706
Finland	0	0	1	12	0	0	575	118	1,043,984	560,109
France	27	0	76	949	17	20	48,623	10,011	81,060,921	43,415,055
Germany	72	0	117	1,510	39	59	105,091	38,527	212,178,903	112,459,955
Greece	171	0	309	3,855	97	128	265,543	54,672	504,415,742	267,553,433
Hungary	266	0	362	3,818	110	222	310,082	67,454	770,417,823	401,580,843
Ireland	0	0	0	4	0	0	171	35	197,116	109,379
Italy	370	0	661	8,517	223	228	592,223	121,932	1,095,395,710	582,341,360
Latvia	1	0	1	14	0	1	1,228	253	3,248,970	1,687,869
Lithuania	3	0	5	49	1	3	3,890	739	8,743,114	4,581,861
Luxembourg	0	0	1	10	0	0	531	102	717,231	391,554
Malta	2	0	6	87	2	2	4,594	500	6,296,051	3,421,513
Netherlands	3	0	8	100	2	2	5,574	1,539	9,011,987	4,844,175
Poland	106	0	201	2,118	59	101	167,492	48,827	313,639,231	166,804,994
Portugal	0	0	1	13	0	0	769	158	1,340,935	715,437
Romania	380	1	620	6,013	171	239	486,190	75,909	1,107,492,473	579,444,102
Slovakia	45	0	91	933	26	44	74,945	16,302	134,724,572	71,737,734
Slovenia	24	0	44	417	15	21	40,931	11,649	71,868,875	38,427,086
Spain	12	0	24	306	8	8	21,051	4,334	34,407,949	18,461,939
Sweden	0	0	1	12	0	0	153	1,388,386	739,214	738,472
United Kingdom	4	0	10	131	2	2	1,095	11,635,426	6,217,825	5,961,398

Note: numbers are rounded, omitting the decimal places. Thus, sum of numbers might not add up.

Table 2 Modelled annual health impacts and health costs occurring in each Western Balkan country due to air pollution emissions from its own coal plants, emissions in 2016

Country name	Premature deaths	Infant mortality (1-12 months)	Bronchitis in children	Asthma symptom days in asthmatic children	Chronic bronchitis in adults	Hospital admissions due to respiratory or cardiovascular symptoms	Restricted activity days	Work days lost, working age population	Total cost high case (€)	Total cost median case (€)
Serbia	570	1	1,042	10,682	303	439	853,836	175,795	1,682,648,627	890,007,062
Bosnia and Herzegovina	334	0	616	6,410	181	276	521,436	107,358	985,388,752	522,794,194
Macedonia	104	0	216	2,060	46	70	140,355	4,036	302,709,554	158,402,008
Kosovo	99	0	180	1,540	42	61	124,144	25,560	288,102,961	150,691,157
Albania	96	0	300	2,958	46	79	161,035	33,155	286,481,092	152,333,167
Montenegro	35	0	64	548	15	23	44,491	9,160	102,789,489	53,784,642

Note: numbers are rounded, omitting the decimal places. Thus, sum of numbers might not add up.

Table 3 Modelled total annual health impacts and total health costs for each Western Balkan coal plant, emissions in 2016 total damage for all regions

Plant name	Premature deaths	Infant mortality (1-12 months)	Bronchitis in children	Asthma symptom days in asthmatic children	Chronic bronchitis in adults	Hospital admissions due to respiratory or cardiovascular symptoms	Restricted activity days	Work days lost, working age population	Total cost high case (€)	Total cost median case (€)
Gacko	158	0.3	331	3371	83	115	235,666	46,306	359,334,036	189,997,369
Kakanj	390	0.7	835	8,494	201	309	602,006	116,864	890,667,791	471,599,963
Stanari	11	0.0	23	233	6	9	15,285	2,998	24,728,867	13,038,542
Tuzla	274	0.5	586	5,961	141	215	423,758	82,285	625,294,558	331,131,952
Ugljevik	635	1.2	1,362	13,845	328	494	990,727	192,236	1,450,692,632	768,524,979
Kosovo A	22	0.1	67	651	13	18	36,076	6,066	46,865,741	24,917,302
Kosovo B	63	0.2	142	1,421	35	32	93,839	18,185	131,983,308	69,830,265
Pljevlja	133	0.2	285	2,894	68	106	20,4449	39,686	303,087,731	160,455,296
Bitola	181	0.5	534	5,160	95	154	317,677	52,709	386,325,572	206,016,066
Oslomej	2	0.0	5	48	1	1	2,936	493	3,614,401	1,926,171
Kolubara A	57	0.1	117	1,194	31	35	8,4161	16,761	129,433,698	68,412,190
Kostolac A	381	0.7	816	8,295	196	299	590,581	114,625	868,613,242	460,032,698
Kostolac B	657	1.2	1406	14,301	339	514	1,017,706	197,612	1,498,451,744	793,565,162
Morava	21	0.0	43	440	11	14	30,753	6,081	47,197,468	24,947,484
Nikola Tesla A	600	1.1	1,278	13,003	310	473	915,677	178,138	1,366,077,086	722,995,776
Nikola Tesla B	322	0.6	686	6,983	166	257	488,766	95,114	733,916,837	388,301,602

Note: numbers are rounded, omitting the decimal places. Thus, sum of numbers might not add up.

Table 4 Impact Matrix table from total annual health impacts and total health costs for each Western Balkan coal plant, emissions for year for all modelled regions

	EU	Western Balkans	Other countries
Gacko	53%	32%	16%
Kakanj	53%	32%	16%
Stanari	53%	32%	16%
Tuzla	53%	32%	16%
Ugljevik	53%	32%	16%
Kosovo A	38%	32%	30%
Kosovo B	38%	32%	30%
Pljevlja	52%	32%	15%
Bitola	38%	28%	34%
Oslomej	38%	28%	34%
Kolubara A	52%	32%	15%
Kostolac A	52%	32%	15%
Kostolac B	52%	32%	15%
Morava	52%	32%	15%
Nikola Tesla A	52%	32%	15%
Nikola Tesla B	52%	32%	15%

Annex 3

Directives relating to air pollution emissions for the Energy Community contracting parties

Acquis in the Energy Community	Implementation deadline for Western Balkan countries	Notes
Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (SO_2, NOx, PM10)	31 December 2017	Contracting Parties may use, until 31 December 2027, the option of national emission reduction plans (NERPs). NERPs stand for an implementation alternative to the emission limit values foreseen in the Directive, where compliance is not verified at individual, plant-by-plant level. Instead, the Party can choose to set an overall emission ceiling at national level. The countries also have an "opt-out" (limited lifetime derogation) possibility. This is applicable between 1 January 2018 and 31 December 2023, for a total number of 20,000 operational hours.
Chapter III, Annex V and Article 72(3)-(4) of Directive 2010/75/EU on industrial emissions (integrated pollution prevention control)	1 January 2018	The implementation deadline applies to: • completely new plants, built after 1 January 2018 • plants permitted before 31 December 2017 and entering into operation before 1 January 2019 • existing plants where a complete retrofit is carried out between 2018 and 2028. All other existing plants need to comply with Annex V part 1 by 1 January 2028 at the latest.
Directive (EU) 2016/802 relating to a reduction in the sulphur content of certain liquid fuels	30 June 2018	The Directive covers two types of fuel oil, i.e. refined oil used for combustion with the purpose of generating heat or power. It sets the maximum sulphur content for heavy fuel oil and gas oil.

Energy efficiency and renewables

In addition to the adoption of new and stricter air pollution directives, another crucial development is the energy transformation of the region towards investments in energy efficiency (EE) and renewable energy sources (RES).

In November 2018 the Energy Community's Ministerial Council agreed to adopt the Energy Efficiency Directive, the Renewable Energy Directive and the Governance Regulation with targets for 2030 in November 2019.[63]

This will inevitably have a positive effect on air quality in the region and beyond, and has the potential to drive the energy development of the region halting the planned coal development. Reducing energy demand by improving energy efficiency and increasing energy savings would tackle the rampant energy poverty and increase energy access for the 5 million households in the Western Balkans.

This process is being run by the Energy Community Secretariat and supported by the EU Commission, and is bringing the Energy Community countries closer to the EU's Energy Union project[64], in line with previous EU announcements of spreading the Energy Union beyond EU borders.

63. General Policy Guidelines on the 2030 Targets for the Contracting Parties of the Energy Community, 29 November 2018, https://www.energy-community.org/events/2018/11/MC.html

64. The Energy Union is based on three key objectives of the EU energy policy: security of supply, sustainability and competitiveness. To reach these objectives, the Energy Union framework is based on five mutually supportive dimensions: energy security, solidarity and trust; the internal energy market; energy efficiency as a contribution to the moderation of energy demand; decarbonisation of the economy; and research, innovation and competitiveness. Only by working on these dimensions jointly, can the EU and the Western Balkans move towards a joint market.

The Health and Environment Alliance (HEAL) is the leading not-for-profit organisation addressing how the environment affects human health in the European Union (EU) and beyond. HEAL works to shape laws and policies that promote planetary and human health and protect those most affected by pollution, and raise awareness on the benefits of environmental action for health.

HEAL's over 70 member organisations include international, European, national and local groups of health professionals, not-for-profit health insurers, patients, citizens, women, youth, and environmental experts representing over 200 million people across the 53 countries of the WHO European Region.

As an alliance, HEAL brings independent and expert evidence from the health community to EU and global decision-making processes to inspire disease prevention and to promote a toxic-free, low-carbon, fair and healthy future.

HEAL's EU Transparency Register Number: 00723343929-96