HEALTH

CO-BENEFITS KNOWLEDGE COMMONS

Edition 2022

Renewable energy for air quality and people's health

Socio-economic assessment tools, key findings and expert contacts

CREA Centre for Research on Energy and Clean Air

IASS POTSDAM

UfU Independent Institute for Environmental Issues

COBENEFITS

Imprint

"Co-Benefits Knowledge Commons: Renewable energy for air quality and people's health" is published by the COBENEFITS project in collaboration with the Climate and Clean Air Coalition (CCAC).

The **COBENEFITS** project is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag. The COBENEFITS project is coordinated by the Institute for Advanced Sustainability Studies (IASS, Lead) in partnership with the Renewables Academy (RENAC), Independent Institute for Environmental Issues (UfU) and International Energy Transition GmbH (IET).

The **Centre for Research on Energy and Clean Air (CREA)** is an independent research organisation focused on revealing the trends, causes, and health impacts, as well as the solutions to air pollution.

Editors: Franziska Sperfeld, Sarah Kovac, Sophie Dolinga, Laura Nagel, Héctor Rodríguez – UfU and IASS

September 2022

Supported by:

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

based on a decision of the German Bundestag

INTERNATIONAL CLIMATE INITIATIVE

CREA & COBENEFITS Air Quality and Health Factsheet, 2022 Edition:

Connecting policymakers with expert organisations to assess and unlock air quality co-benefits

Air pollution, primarily from coal-fired power plants, is one of the main impacts that the energy sector has on the environment and human health.[1] The health impacts of greatest concern include heart disease, lung cancer, stroke and chronic obstructive pulmonary disease.[2] The consequences of such diseases include increased levels of morbidity, which further result in elevated health costs, as well as loss of productivity.

The impacts of emissions from coal-fired power plants are not restricted to areas and inhabitants in close vicinity to thermal power plants. Rather, atmospheric pollutants are often transported long distances, becoming dispersed across regions and countries and impacting the health of millions:

According to the World Health Organization, around 4.2 million premature deaths are caused globally by ambient air pollution per year,[3] while worldwide 93% of all children aged under 15 breathe toxic air every day.[4]

The good news is that the burden of diseases associated with ambient air pollution can be significantly reduced by decarbonising the power sector.

Constantly evolving renewable energy technologies and decreasing power generation costs offer opportunities to rapidly increase the share of renewables in power generation. The related shift towards a less carbon-intensive power sector in turn significantly reduces the burden of diseases associated with ambient air pollution..

With this factsheet series, we seek to present the state of the art in assessing air-quality co-benefits, interconnecting climate friendly power planning, air quality and public health.

This joint factsheet edition, by CREA and the COBENEFITS project, connects policymakers in local and national government agencies with expert organisations and contact persons, to quantify specific air quality co-benefits, assess policy options and unlock potentials for people and communities.

We hope that this latest edition of Co-Benefits Knowledge Commons factsheets inspires scientists to carry out further work on the multiple social and economic co-benefits of renewable energy, and policymakers to raise ambition in climate mitigation efforts by working towards a rapid transition to low-carbon power sectors.

Nandikesh Sivalingam
Director Centre for Research on Energy and Clean Air
(CREA)

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(IASS)

[1] https://www.cobenefits.info/wp-content/uploads/2019/10/COBENEFITS-Study-South-Africa-Health.pdf

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About this edition

A first edition of the Knowledge Commons was launched in 2019 at the Climate Opportunity conference, hosted by the COBENEFITS project in Berlin. It presented latest assessment results, tools and policy measures to unlock the social and economic co-benefits of ambitious climate action with renewable energy.

With the 2022 edition we present an update with a series of Co-Benefits Knowledge Commons factsheets, each compiling latest research and assessment tools on the co-benefits of decarbonizing the power sector:

1. Renewable energy, employment opportunities and skill requirements – in partnership with the Sustainable Energy Jobs Working Group under IRENA's Coalition for Action

2. **Air quality and health – in partnership with the Centre for Research on Energy and Clean Air (CREA)**

The 2022 Air quality and people's health edition, published in partnership with the the Centre for Research on Energy and Clean Air (CREA), presents the state of the art in socio-economic assessment tools and recent research findings on the air quality and health benefits of decarbonizing the power sectors in countries around the globe. The factsheets are accompanied by expert contacts to reach out to.

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CLIMATE AND AIR-QUALITY BENEFITS OF WIND AND SOLAR POWER IN THE UNITED STATES

Berkeley Lab

- Country: USA
- Co-Benefit: Air Quality and Health
- Method: AVERT tool
- Assessment by: Berkeley Lab
- Published by: Berkeley Lab
- Year: 2017

RE deployment in the US

In 2007, around 10 GW of wind and solar power capacities were installed in the USA. They increased tenfold until 2015, while electricity generation based on these sources grew from 35,000 GWh yr^{-1} in 2007 to 227,000 GWh yr^{-1} in 2015. In 2015, solar power was still heavily concentrated in California and the west, while wind power was concentrated in the Upper and Lower Midwest regions and Texas.

The replacement of conventional power sources by a higher share of renewable energies like wind and solar can be accompanied by co-benefits of avoided air pollutant emissions. In this study, the authors assessed the **monetary and physical magnitude of climate co-benefits and air-quality related health benefits**, the two most prominent benefits from avoided emissions. Therefore, they used models that cover slightly different impact pathways.

Unlike climate benefits, health benefits related to avoided emissions tend to vary among regions. Another aspect of the study was thus to assess the **quantity of health benefits across different regions in the United States**.

Methodology

In the study, the overall capacities and locations from wind and solar power generation in the US have been retraced for the period from 2007 to 2015. US EPA's AVERT tool was used to assess air pollutant emissions (SO_2, $PM_{2.5}$ and CO_2) most likely avoided by the generation of solar- and wind–based power.

Then a set of reduced-form air quality models was adopted to estimate public health benefits of reduced air pollutant emissions and their dispersion among regions. To address the uncertainty related to air pollution, a wide range of models was applied.

A comparison of the results gave insights into the range of underlying uncertainties and their simple average.

Indicators assessed

- Annual marginal and absolute benefits (air quality and climate) of wind or solar power from 2007 to 2015 in ¢ kWh^{-1} (marginal) and US$ billion (absolute)
- Avoided climate change damages (2007 – 2015) in billion USD
- Avoided air pollution damages (2007 – 2015) in billion USD

Contact

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Dev Millstein, Ryan Wiser, Mark Bolinger, Galen Barbose, 2017. The climate and air-quality benefits of wind and solar power in the United States. Nature Energy 2, 17134.

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Technical implementation:

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Avoided air pollution damages

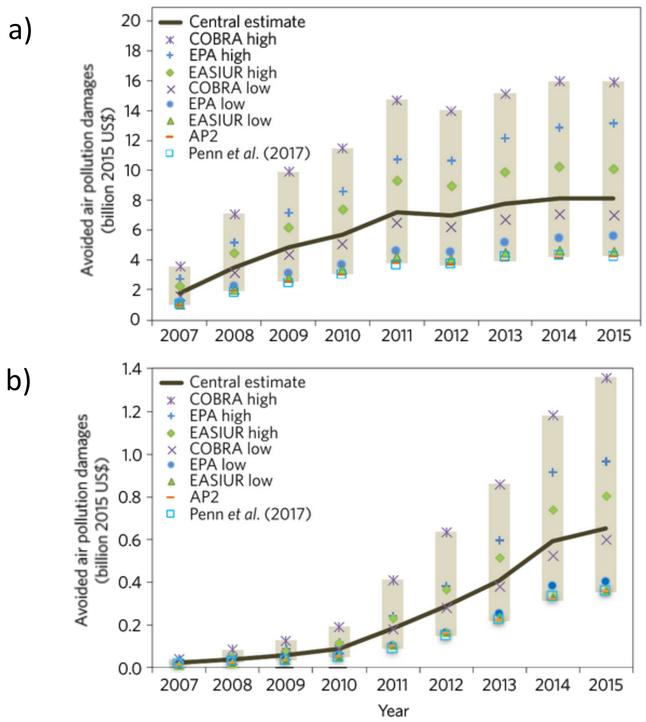

Figure:

Annual avoided damages from air pollution due to wind power (a) and solar power (b) between 2007 and 2015, in billion 2015 USD

Source:

Millstein et al. (2017)

Health benefits across US regions

- During the study period, emissions avoided due to wind generation produced **US$28.4–107.9 billion** (central value of US$54.0 billion, equivalent to 5.1 ¢ kWh^{-1}) **in air-quality and public health benefits** and **US$4.9–98.5 billion** (central value of US$29.0 billion, equivalent to 2.8 ¢ kWh^{-1}) **in climate benefits.**
- From 2007 to 2015, wind generation led to the **avoidance of 2,900 to 12,200 premature mortalities**. Solar generation added another **100 to 500 avoided premature mortalities** to these totals.
- The highest marginal benefits from the expansion of wind and solar generation took place in the Upper Midwest and Mid Atlantic regions of the United States

Conclusions and recommendations

The study showed that the already-realized quantified air-quality and climate co-benefits of power generation from wind and solar across the USA were similar in size to public and private support for these renewable energies in the US.

Policies targeting unpriced externalities or directing the wind and solar deployment to those regions offering the greatest benefits at the least cost have the potential to increase the gains from the co-benefits assessed.

BERKELEY LAB

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CO-BENEFITS OF METHANE REDUCTION

ASSESSING ENVIRONMENTAL AND SOCIAL BENEFITS OF METHANE MITIGATION

CCAC

- **Country:** Global
- **Co-Benefit:** Air Quality and Health
- **Method:** Assessment tool of methane reduction
- **Assessment by:** CCAC
- **Published by:** CCAC
- **Year:** 2021

Assessment tool of methane mitigation

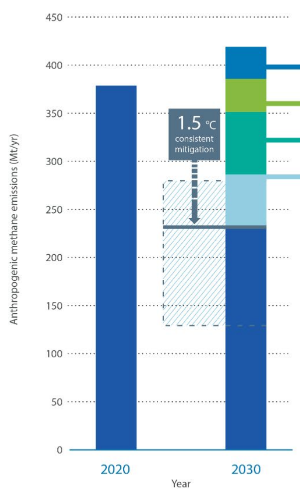
Methane, a short-lived climate pollutant (SLCP) with an atmospheric lifetime of roughly a decade, is a potent greenhouse gas tens of times more powerful than carbon dioxide at warming the atmosphere. Reducing human-caused methane emissions is one of the most cost-effective strategies to rapidly reduce the rate of warming and contribute significantly to global efforts to limit temperature rise to 1.5°C.

Available targeted methane measures, together with additional measures that contribute to priority development goals, can simultaneously reduce human-caused methane emissions by as much as 45 per cent. This would **prevent 775 000 asthma-related hospital visits, 255 000 premature deaths and 73 billion hours of lost labour due to extreme heat every year.**

More than half of global methane emissions stem from human activities related to fossil fuels, waste and agriculture. The majority come from agriculture (~40%), fossil fuels (~35%) and waste (~20%). Within the fossil fuel sector, oil and gas extraction, processing and distribution account for 23 per cent, and coal mining accounts for 12 per cent.

The assessment tool of environmental and social benefits of methane reduction **provides an in-depth analysis of opportunities to mitigate methane emissions from different sectors across all regions**. Users of the tool can either explore the mitigation potential in specific socioeconomic sectors or enter the potential methane emission reductions (or increases) associated with specific actions, from individual projects to national or international action plans. The tool then provides quantitative values for several effects of these emission reductions.

Infographic



	Avoided warming (C) 2040-2070	Avoided deaths ozone (per year)	Avoided asthma-related ER visits (per year)	Avoided crop losses (Mt/yr)	Lost work hours avoided (billion hrs/yr)
AGRICULTURE	0.04	40 000	120 000	4	11
WASTE	0.05	45 000	135 000	5	13
FOSSIL FUELS	0.09	80 000	250 000	8	24
ADDITIONAL	0.10	90 000	270 000	9	25
TOTAL	0.28	255 000	775 000	26	73

Remaining global anthropogenic methane emissions

Range of methane mitigation consistent with the IPCC 1.5°C pathways

Figure 1

Current and projected anthropogenic methane emissions and sectoral mitigation potential in 2030 along with several benefits associated with sectoral-level methane emissions mitigation.

Source: CCAC and UNEP, 2021

Contact

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Technical implementation:

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Methodology

The tool is based on the results of modelling that uses five state-of-the art global composition-climate models to evaluate changes in the Earth's climate system and surface ozone concentrations from reductions in methane emissions, which was published in the 2021 CCAC and UNEP Global Methane Assessment.

The tool allows users to rapidly evaluate the multiple benefits from methane mitigation strategies for the climate and ground-level ozone formation and, air quality, public health, agricultural, labor productivity and other development benefits. The impacts analyzed include the effects on climate change and ground-level ozone concentrations, and then via those environmental changes the resulting impacts on human health, agricultural crops and the economy.

Human health impacts are taken into account for the same year as emissions change. Premature deaths are calculated based upon the relationship between ozone exposure and health impacts determined from the American Cancer Society Cancer Prevention Study II (which showed ozone effects on heart disease, cerebrovascular disease, pneumonia and influenza, chronic obstructive pulmonary disease and lung cancer). Those **increased risks are combined with data on public health conditions and population distributions to evaluate worldwide health burdens**.

Exemplary simulations

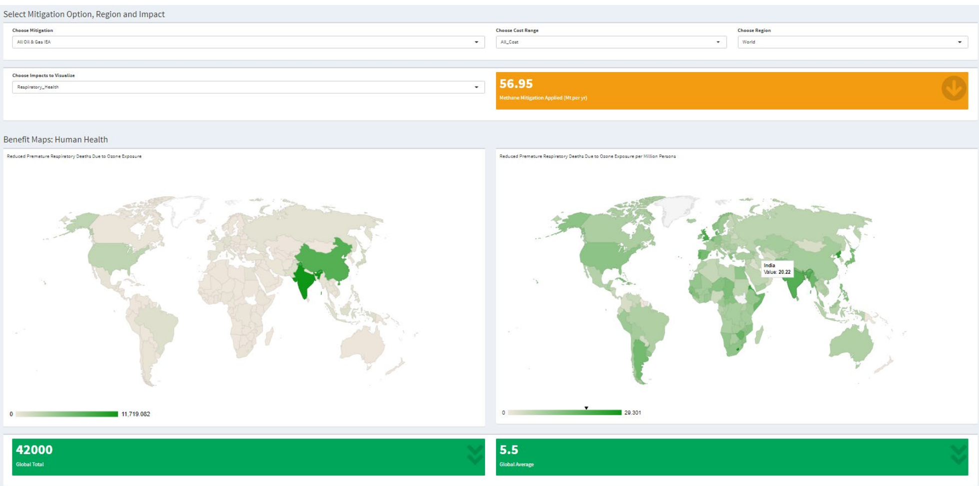

Figure 2: Example from assessment tool of human health benefits of methane reduction.

Source: CCAC and UNEP 2021

The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations Environment Programme

Conclusions

The impacts analyzed include the effects of methane emissions on climate change and ground-level ozone concentrations, and the resulting impacts on human health, agricultural crops, labor productivity and the economy.

CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

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AIR QUALITY BENEFITS OF AN ACCELERATED ENERGY TRANSITION IN GERMANY

SCIENCE BASED COAL PHASE-OUT PATHWAY FOR GERMANY IN LINE WITH THE PARIS AGREEMENT 1.5°C WARMING LIMIT

Climate Analytics

- **Country:** Germany
- **Co-Benefit:** Air Quality and Health
- **Method:** SIAMESE model
- **Assessment by:** Climate Analytics
- **Published by:** Climate Analytics
- **Year:** 2019

Coal phase out in Germany

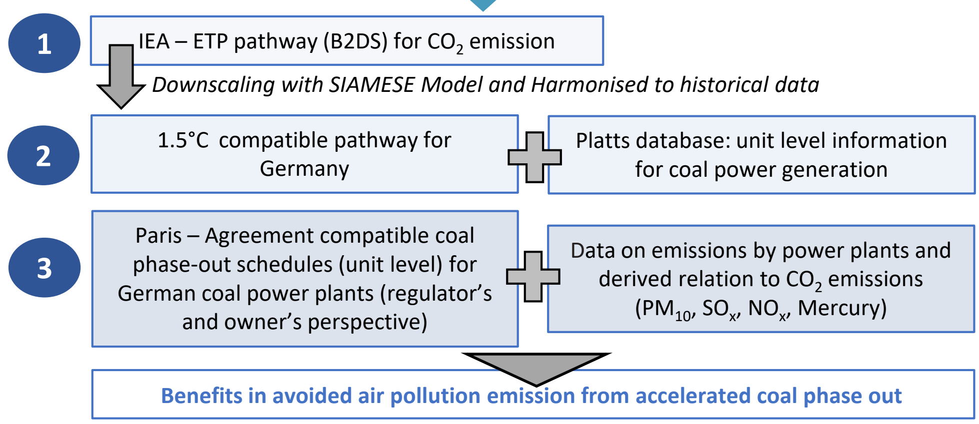
Germany is the EU's largest greenhouse gas emitter with coal accounting for 37% of its gross power production in 2018 (EIA, 2020). In June 2018, the German government had established the Commission on Growth, Structural Change and Employment with the task to develop a coal phase-out plan to meet short-, medium- and long-term climate goals, combined with forward-looking structural development in the coal-mining regions.

To provide information for the commission's decision making, the underlying report:

- **Examined what the Paris Agreement 1.5°C target means for coal phase out in Germany's electricity generation (closing the gap of lacking 1.5°C compatible coal phase out pathways).**
- **Assessed the benefits in terms of reduced emissions of harmful air pollutants and health implications that could be achieved**

For this aim, the research team modelled two perspectives of the coal phase out: A Regulator's perspective in which plants with the highest emissions intensity are phased out first and an Owner's perspective prioritising economic value over emissions intensity in the phase out.

Methodology



Indicators assessed

- (Reduced) emissions of PM_{10}, mercury, NO_x, SO_x in tons/year
- Number of (avoided) asthma attacks of children, premature deaths, hospital admissions and lost working days per year
- Damage costs saved in billion Euro following VOLY and VSL approaches

CLIMATE ANALYTICS

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Link

Paola Yanguas Parra et al., 2018. Science based coal phase-out pathway for Germany in line with the Paris Agreement 1.5°C Warming limit. Opportunities and benefits of an accelerated energy transition.

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Advantages of 1.5°C pathways

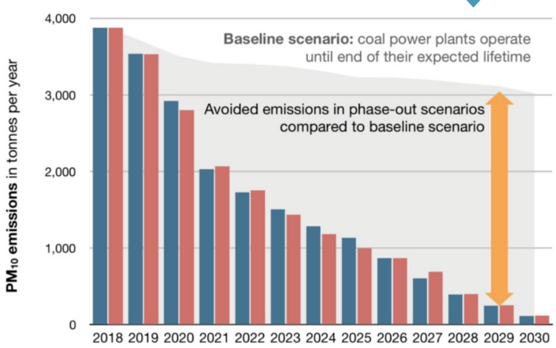

Figure 1:
Particulate matter (PM10) emission estimates comparing the Paris Agreement compatible phase out scenarios to the baseline scenario.

Source: Climate Analytics

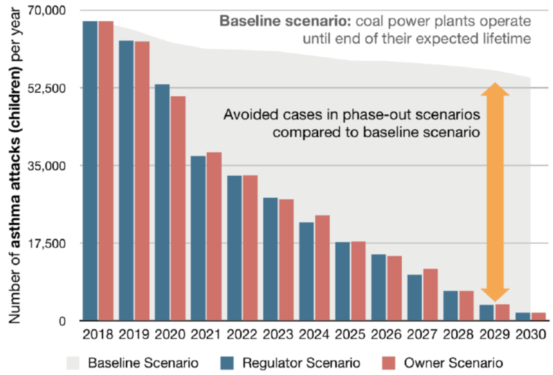

Figure 2:
Estimates of coal-power related asthma attacks (children) comparing the Paris Agreement compatible phase out scenarios to the baseline scenario.

Source: Calculation by Climate Analytics based on data from Europe Beyond Coal.

Co-benefits of the 1.5°C target

Substantial co-benefits of avoiding air pollution could result from the proposed accelerated coal phase out schedules:

- **Air pollution co-benefits:** More than half of the air pollutant emissions of nitrogen oxides (NO_X), sulphur oxides (SO_X) and primary particulate matter (PM_{10}) as well as mercury emitted by coal power plants between 2018 and 2030 and related health impacts would be avoided.
- **Health implications:** more than 20,000 premature deaths, 9,400 hospital admissions, and 420,000 asthma attacks in children as well as around 6.7 million lost working days could be avoided.
- **Health costs:** Through the reduction of NO_X, SO_X, and PM_{10} emissions, between 18 and 53 billion Euro of damage costs between 2018 and 2030 can be potentially saved following the Regulator scenario (18 – 53 billion Euro following the Owner's scenario.)

Action towards the 1.5°C target

Coal use for electricity generation will need to be phased out by 2030 in Germany in order to achieve a rapid decarbonisation consistent with the Paris Agreement. This pathway is accompanied with a number of health-related co-benefits. A defined strategy for an accelerated coal phase-out **increases planning security** for affected regions and industries and can help to cushion negative impacts by active planning and supporting measures. An accelerated coal phase out plan can help to avoid that investments continue to flow into unsustainable assets and new coal-related infrastructure.

CLIMATE ANALYTICS

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CAUSES AND EFFECTS OF AIR POLLUTION IN JAKARTA

TRANSBOUNDARY AIR POLLUTION IN THE JAKARTA, BANTEN, AND WEST JAVA PROVINCES

CREA

- **Country:** Indonesia
- **Co-Benefit:** Air Quality and Health
- **Method:** Pollutant dispersion modelling, risk functions and cost-benefit calculations
- **Assessment by:** CREA
- **Published by:** CREA

Year: 2020

Jabodetabek: Air quality and power generation

Most coal-fired power plants (CFPPs) in Southeast Asia are located in Indonesia. Partially due to the lack of ambitious renewable energy targets, **electricity generation from CFPPs in the country has more than doubled since 2010**. Indonesia also plans an additional 31,200 MW of coal generation capacity, 20% of which will be located within a 100 km radius of Jakarta.

As a result, the country's capital is suffering from increasingly dangerous air quality. **In 2019, more than 172 days were recorded as "unhealthy"**, which is more than half of the year. The study identifies main sources of air pollution affecting Jakarta, Tangerang, Bogor, Depok, Bekasi, Puncak and Cianjur (Jabodetabek), assesses how pollutants from these sources are spread and calculates the type and quantity of health impacts and economic costs associated with CFPPs surrounding Jakarta.

Infographic

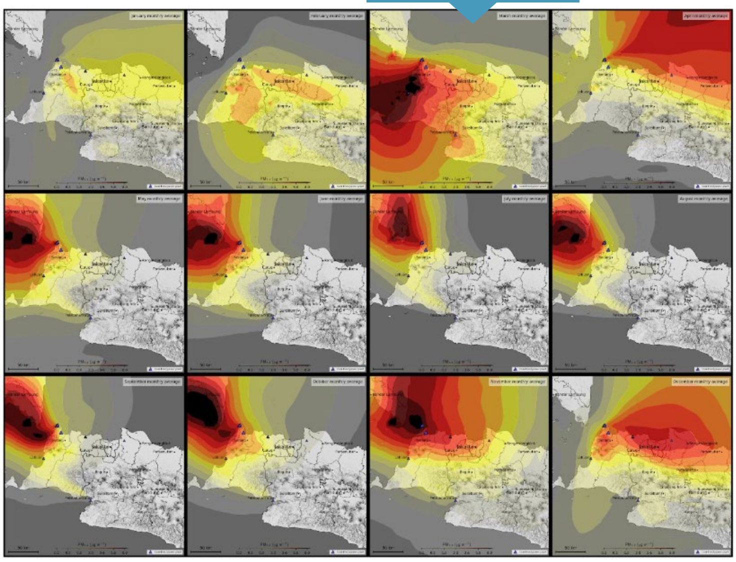

Figure 1: Monthly Average of PM2.5 concentrations from coal-fired power plants in Banten, Jakarta and West Java.

Source: CREA, 2020

Key findings

- **Air pollutant emissions both in Jakarta and in surrounding provinces**, where major industrial centers and coal-fired power plants are located, **have been worsening Jakarta's air quality and hampering clean air efforts**
- With COVID-19, reductions of local traffic and urban activity occurred but with the Suralaya CFPPs operating as usual, the city's air quality did not improve significantly
- **Coal-fired power plants within 100 km of the city are responsible for an estimated 2.500 premature deaths in the Jabodetabek area annually**
- **The annual cost of transboundary pollution from CFPPs is estimated at IDR 5.1 trillion per year** in Jabodetabek

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Lauri Myllyvirta, Isabella Suarez, Erika Uusivuori, Hubert Thieriot, 2020. Transboundary Air Pollution in the Jakarta, Banten, and West Java provinces. Centre for Research on Energy and Clean Air.

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Technical implementation:

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Methodology

U.S. NOAA's HYSPLIT model was used to generate distinct patterns of air flow and wind trajectories. Individual wind trajectories were modeled on some days with worst air pollution. This was followed by a detailed atmospheric modeling of pollutant dispersion from CFPPs surrounding the city, using the TAPM meteorological model developed by CSIRO. Then the CALPUFF dispersion model was used to simulate pollution from CFPPs.

Health impacts of coal power plants surrounding Jakarta were calculated following the methodology of Koplitz et al. 2017, updated to the current situation of operating coal-fired power plants. The air quality modeling was done with the CALMET-CALPUFF modeling system that allows higher local resolution.

Economic costs of health impacts were assessed following the methodology of the CREA report "Quantifying the Economic Costs of Air Pollution from Fossil Fuels".

Indicators assessed

- Monthly average concentrations of $PM_{2.5}$, NOx and SO_2 from coal-fired power plants in Jakarta and West Java
- Number of cases of diseases and number of sick leave days associated with air pollution per year and disease
- Number of years lived with disabilities and years of life lost due to disabilities associated with air pollution
- Economic costs due to disabilities associated with air pollution

Infographic

Outcome	Number of cases	Cost (IDR billion)
asthma emergency room visits	1,772 (1,180 - 2,427)	1.6 (1 - 2.1)
new cases of asthma in children	3,180 (1,485 - 4,013)	51 (24 - 65)
preterm births	718 (416 - 746)	264 (153 - 275)
work absence (sick leave days, million)	0.65 (0.56 - 0.73)	191 (166 - 215)
years lived with disability	9,616 (7,678 - 11,275)	1,040 (830 - 1219)
years of life lost	24,953 (18,432 - 34,855)	3,528 (2,606 - 4,927)
total economic cost		**5,076 (3,781 - 6,703)**

Figure 2: Major impacts and estimated economic cost of transboundary air pollution from operating coal-fired power plants on Jabodetabek (excluding PLTU Jawa-7), using 2019 emissions standards

Source: CREA, 2020

Recommendations

- **Revise the National Ambient Air Quality Standard** to meet the WHO guidelines
- **Improve monitoring networks both within Jakarta and in all major cities.** Monitoring stations should measure in real-time. Data should be readily available to the public and reported electronically across different government levels
- **Enforce the updated 2019 emissions standards on all planned thermal power plants including ones currently under construction.**
- Make facilities responsible for **installing continuous emission monitoring systems (CEMS) for all major pollutants**

CREA
Centre for Research on Energy and Clean Air

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COAL-FREE CITIES

THE HEALTH AND ECONOMIC CASE FOR A CLEAN ENERGY REVOLUTION

CREA

- **Country:** Global
- **Co-Benefit:** Air Quality and Health
- **Method:** CALPUFF atmospheric model combined with concentration response functions
- **Assessment by:** CREA
- **Published by:** CREA, Vivid Economics
- **Year:** 2021

Emissions causing health risks in Ukraine

Cities are at the centre of the global energy transition. They account for two-thirds of global energy use – influence and are influenced by the shift from coal to clean energy, and the impact of this on climate, health and prosperity.

Describing **air pollution, health, jobs and energy cost impacts of (future) pollution caused by coal-fired power plants (CFPPs) on 61 C40 megacities** across 27 countries between 2020 and 2030, this report presents a **clear urban case for the rapid phase-out of coal and a transition to clean energy**. It also developed a 1.5°C plant-by-plant phase-out trajectory how a coal phase-out could be structured to minimise economic losses while significantly reducing air pollution.

Infographic

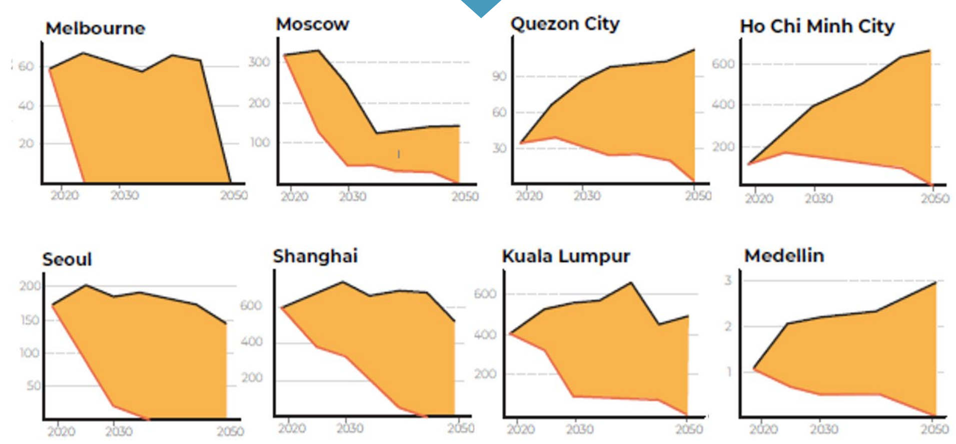

Figure 1: Avoided premature deaths due to CFPP retirement in line with a 1.5°C scenario for exemplary C40 cities **Source**: CREA,2021

Key findings

- With **C40 cities following a 1.5°C scenario, a high number of premature deaths, preterm births and asthma emergencies could be avoided**
- Due to a high exposure to pollution and relatively high population densities, **C40 cities located in South Africa, India, Indonesia, China, the US and Vietnam are expected to experience the biggest health burden today**
- Economic costs of the health burden are significant, including estimated **costs of USD 10 billion of around 124 million sick days due to air pollution exposure** from CFPPs from 2020 to 2030
- The modelling showed that contributions from ultra-supercritical coal units or units with emission control devices to GHG emissions and air pollution – and resulting health impacts – remain high due to the significant capacity installed.

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Myllyvirta et al., 2021. Coal-free cities: the health and economics for a clean energy revolution.

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Methodology

The modelling is based on a **"current coal plans" scenario**, considering CPFFs currently operating, new plants in the pipeline and scheduled retirements up to 2050; and a **"1.5°C scenario"**, based on GHG emissions reductions in line with the Paris Agreement.

The current coal plans scenario is based on CFPPs within the Global Energy Monitor's Global Coal Plant Tracker. The 1.5°C scenario was modelled following the near-term goals to retire 100% of their existing coal fleet by 2030 for C40 cities in OECD countries, and a phase-out trajectory with significant retirements during the 2030s, only a few ultralow emissions plants by 2040 and a complete phase-out by 2050 for C40 cities in non-OECD countries. The 1.5°C scenario is based on IRENA and IEA data.

CALPUFF model was run to model NO_X, SO_2 and $PM_{2.5}$ emissions, and related air pollution in all C40 cities located within 500 km of these plants. Health and economic impacts of air pollution were calculated using concentration response functions.

Indicators assessed

- NO_X, SO_2 and $PM_{2.5}$ emissions for CFPPs 2020 – 2030
- N° of preterm births, new asthma cases among children, asthma emergency visits, years of life with disabilities, premature death's and costs attributed to air pollution from CPFFs, 2020 - 2050

Infographic

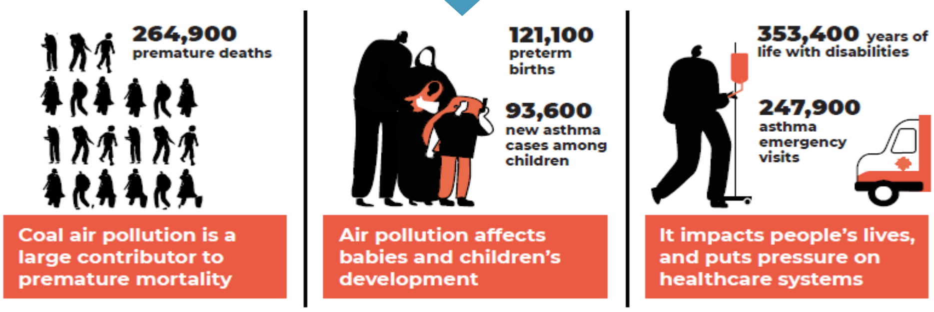

Figure 2: Health impact of coal-power plants in 61 C40 cities, 2020-2030. **Source**: C40 modelling

Recommendations

- **Cities can deliver a green, just and prosperous future by rapidly phasing out coal and replacing it with renewable, zero-carbon technologies**.
- **Local actions to accelerate a rapidly phasing out coal shall be combined with action rapidly increasing the share of RE's in cities**, including the establishment of "green" contracts with energy providers and a green transition of the municipal energy procurement
- Where urban air pollution levels exceed national standards, **cities can participate in regional and national air quality planning to address large sources of emissions** (such as coal-fired power plants) that lie outside the city's boundary

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DEGRADED AIR QUALITY BY UKRAINE'S COAL-FIRED POWER PLANTS

ASSESSING THE IMPACTS OF UKRAINE'S COAL-FIRED POWER GENERATION ON AIR QUALITY AND HEALTH

CREA

- **Country:** Ukraine
- **Co-Benefit:** Air Quality and Health
- **Method:** EMEP atmospheric chemical transport model, application of WHO risk ratios for Europe
- **Assessment by:** CREA
- **Published by:** CREA & Ecoaction
- **Year:** 2021

Emissions causing health risks in Ukraine

Some of the highest emitting power plants in Europe and the world are located in Ukraine. Although pre-war Ukraine sought to align its regulation with the Industrial Emissions Directive including Best Available Techniques (BAT), there are barely any emission controls in Ukrainian coal-fired power plants (CFPPs). **CFPPs thus account for 80 % of total sulphur dioxide emissions and 25 % of nitrogen oxides in Ukraine.**

Fly ash emissions are also particularly high, exceeding emission limits by a factor of 40. 72% of the total volume of fly ash emitted by coal plants in the EU, Energy Community member states and Turkey combined comes from Ukrainian thermal power plants, while **18 out of the top 30 ranking of large combustion plants with highest fly ash emissions are located in Ukraine**.

The associated study assessed air quality and health impacts of Ukraine's coal-fired power generation. Furthermore, health implications are examined in detail; e.g. avoided health impacts and associated costs if emission limits had been respected.

Infographic

Cause	Pollutant	Number of cases avoided, in 2019	95% Confidence interval	Cost, EUR mln	95% Confidence interval
Asthma symptom days in asthmatic children	PM_{10}	32,196	6,974–57,993	0.6	0.13–1.09
Bronchitis in children	PM_{10}	3,207	0–7,248	0.84	0–1.90
Cardiovascular hospital admissions	$PM_{2.5}$	623	117–1,132	0.63	0.12–1.14
Low birth weight births	$PM_{2.5}$	184	57–319	-	-
Mortality, all causes	all	2,252	1,459–2,999	3,699	2,398–4,923
Respiratory hospital admissions	all	710	0–1,449	0.70	0–1.43
Restricted activity days	$PM_{2.5}$	2,475,801	2,217,758–2,783,831	82	73.4–92.1
Work days lost	$PM_{2.5}$	383,239	326,020–440,076	23	19.6–26.5

Figure:
Avoided health impacts and costs in 2019 if ceilings had been respected, total in all regions

Source:
CREA, 2021

CREA
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Lauri Myllyvirta, Rosa Gierens, 2021. Health Impacts of Coal Power Plant Emissions in Ukraine. Centre for Research on Energy and Clean Air.

Co-Benefits Knowledge Commons is a factsheet series published by:

COBENEFITS

Technical implementation:

IASS POTSDAM

UfU

Methodology

The report examines the air quality and health impacts of coal-fired power generation in Ukraine by applying the **atmospheric chemical transport model developed under the European Monitoring Programme (EMEP)** of the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the **WHO recommendations for assessing health impacts in Europe**.

Officially reported plant-by-plant emissions data from the Ministry of Energy and Coal Production of Ukraine for 2018 and 2019 (Ministry of Energy 2019, 2021) were used to assess emissions.

Indicators assessed

- $PM_{2.5}$, PM_{10}, NOx and SO_2 emissions of coal-fired power plants in Ukraine for 2018 and 2019
- Restricted activity days and work days lost associated with Health and air quality impacts of emissions in Ukraine for 2018 and 2019
- Deaths associated with emissions of Ukrainian CFPPs by region and country in 2019
- Costs associated with emissions of Ukrainian CFPPs by region and country in 2019

Key findings

- Emissions from Ukrainian coal-fired power plants were associated with an estimated **3,300 deaths** in **2018** and **5,000 deaths** in **2019**. The most affected regions in Ukraine were Donetsk, Kyiv, Dnipropetrovsk and Lviv, with estimated annual deaths of 430, 410, 280 and 230, respectively.
- Around 2,700 of the associated deaths occurred in Ukraine, around 1,300 in the EU (mostly Romania, and Poland) and 1,000 in other countries (Russia, Moldova, other). **Air pollutants emitted by CFPPs in Ukraine are thus a transboundary issue**.
- **8 of the 20 power plants exceeded emission limits in 2019**. Had the limits been met, an estimated 2,300 deaths could have been avoided.
- Ukranian thermal power plants are exposing approximately **8.7 million people** to exceedances of the World Health Organisation's air quality guidelines.

Recommendations

- A structural change in power generation, namely the **optimisation, modernisation and gradual decommissioning of coal-fired power plants can provide cost-effective emission reductions for all major pollutants**.
- National energy regulatory authority, transmission system operator and the Ministry of Energy shall **create the conditions to support clean energy sources and their grid access. This includes building an enabling framework for the development of flexibility options for balancing intermittent renewables**.
- The **installation of a continuous emission monitoring systems (CEMS)** automatically submitting data to the central repository shall be a requirement from the permitting authority to all operators applying for permits and their continuation

CREA
Centre for Research on Energy and Clean Air

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HEALTH IMPACTS OF WEST BALKAN COAL POWER PLANTS

HOW WESTERN BALKAN COAL PLANTS BREACH AIR POLLUTION LAWS AND CAUSE DEATHS AND WHAT GOVERNMENTS MUST DO ABOUT IT

CREA

- **Countries:** West Balkan states
- **Co-Benefit:** Air Quality and Health
- **Method:** EMEP atmospheric chemical transport model, concentration-response functions
- **Assessment by:** CREA
- **Published by:** CREA & Bankwatch Network
- **Year:** 2021

Power generation in the Western Balkans

Largely based on coal, **power generation in the Western Balkans emits around 300 times more SO_2 per unit of electricity produced than power generation in the EU.**

The EU is a net importer of electricity, including from the Western Balkans. From 2018 to 2020 the Western Balkans exported 25 TWh of electricity into the EU, amounting to 8 per cent of the total coal-fired power generation in this region. Hence, the EU plays a significant role in sustaining coal-based electricity in Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia and Serbia.

The EU's imports of electricity from the Western Balkans make up only 0.3% of the EU's total electricity consumption, but **SO_2 emissions associated with these imports equal 50% of the entire SO_2 emissions from all power plants in the EU in 2020.**

The **Large Combustion Plants Directive (LCPD),** part of the Energy Community Treaty with the EU, obliges countries to implement National Emissions Reduction Plans (NERPs) to comply with an overall ceiling for SO_2, NO_X and dust emissions of their power plants.

The study projected health impacts linked to exceedances of emissions ceilings and to power exports to the EU. Also a detailed atmospheric simulations of pollutant dispersion and of air quality and public health impacts of CFPP emissions were carried out.

Infographic

Cause	EU	Western Balkans	Others	Total for all regions
Restricted activity days	3,494,000	2,013,000	547,000	**6,054,000**
Work days lost	779,000	382,000	50,000	**1,211,000**
Asthma symptom days in asthmatic children	45,000	26,000	8,100	**80,000**
Bronchitis in children	4,000	2,600	890	**7,500**
Cardiovascular and respiratory hospital admissions	1,800	1,000	270	**3,100**
Chronic bronchitis in adults	1,200	670	170	**2,100**
Low birth weight	270	320	70	**660**

Figure:
Health impacts from Western Balkan power plant emissions exceedances in 2020

Source:
CREA, 2021

CREA
Centre for Research on Energy and Clean Air

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Lauri Myllyvirta, Erika Uusivuori, 2021. Comply or Close – How Western Balkan coal plants breach air pollution laws and cause deaths and what governments must do about it. Centre for Research on Energy and Clean Air.

Co-Benefits Knowledge Commons is a factsheet series published by:

COBENEFITS

Technical implementation:

IASS POTSDAM

UfU

Methodology

The dispersion, chemical transformation and deposition of pollutants in the atmosphere was simulated using an **atmospheric model developed under the European Monitoring Programme (EMEP) of the Convention on Transboundary Pollution (CLRTAP)**. The model uses a full year of meteorological data. Predictions derived from this model were validated against air quality measurements by EMEP in its annual reports.

The assessment of health impacts associated with the coal plants' emissions follows the **WHO recommendations for concentration-response functions and health impact assessment in Europe**, as implemented in Huscher et al.

Indicators assessed

- Emissions of coal-fired power plants per year, pollutant and country
- Deaths associated with air pollution due to emission exceedances, or due to electricity export from WB to the EU, per country
- Restricted activity days, asthma symptom days in asthmatic children and work days lost associated with air pollution due to emission exceedances per region
- Cases of air pollution-related disabilities due to emission exceedances per country

Key findings

- In 2020, coal plants included in the NERPs emitted around 6.4 times as much SO_2 and 1.6 times more dust as allowed. Total **SO_2 emissions from CFPPs in the Western Balkans were 2.5 times as high as those from all coal plants in the EU**.
- From 2018 – 2020, **nearly 19,000 deaths occurred due to total emissions of coal-fired power plants in the Western Balkans**. Of these, more than 50% were in EU countries, almost 30% in the Western Balkans.
- Total emissions of thermal power plants from 2018 to 2020 resulted in **health-related costs between EUR 25.3 billion and 51.8 billion**.
- EU countries bordering the Western Balkans bear the biggest health cost burden of transboundary air pollution from coal – all estimated at over EUR 1 billion in 2020.

Recommendations

- To reduce the number of deaths and other negative health impacts, **governments and utilities shall consider to close the oldest coal-fired power plants earlier than planned, as well as those that require the highest investments to become LCPD-compliant.** In the meantime, their operating hours shall be reduced.
- Closing of thermal power plants shall be accompanied by measures to reduce distribution losses, to increase energy efficiency and the share of renewable energies, and by **participatory planning and implementation processes for a just transition of the coal mining regions**
- In order to achieve efficiency of investments and maximise their benefits for human health, **new pollution control equipment should ensure that plants reach the latest EU standards**

CREA
Centre for Research on Energy and Clean Air

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IMPROVING HEALTH AND REDUCING COSTS THROUGH RENEWABLE ENERGY IN SOUTH AFRICA

ASSESSING THE CO-BENEFITS OF DECARBONISING THE POWER SECTOR

IASS and IET

- **Country:** South Africa
- **Co-Benefit:** Air Quality and Health
- **Method:** Integrated health cost model
- **Assessment by:** Prime Africa Consultants
- **Published by:** IASS and IET
- **Year:** 2019

Health impacts of energy production

Air pollution, primarily from coal-fired power plants, is one of the main impacts that the energy sector has on the environment and human health. **South Africa's heavy reliance on coal energy is a major contributor to air pollution.**

Air pollution has many negative impacts, of which those of greatest concern include heart disease, lung cancer, stroke and chronic obstructive pulmonary disease (WHO, 2016). The consequence of the increased levels of morbidity, result in elevated health costs and productivity losses.

This study quantifies the impacts of South Africa's power sector on human health, and how a shift to a less carbon-intensive power sector can help to reduce negative impacts and contribute to reducing costs in South Africa's health system.

Projection of health costs

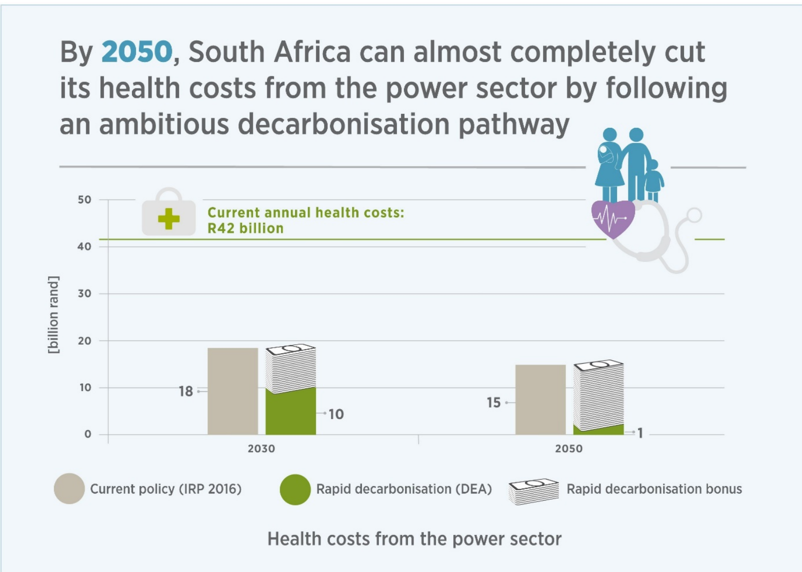

Figure:

Estimated health costs associated with the power sector in 2030 and 2050.
The *Current policy* bar indicates health costs in case of the implementation of the current South African Integrated Resource Plan 2016 (IRP 2016), which amount to R18 billion (USD 1 billion) in 2030 and R15 billion (USD 833 million) in 2050.
The *Rapid decarbonisation* bar indicates health costs in case of the implementation of the Department of Environmental Affairs (DEA) rapid decarbonisation plan, amounting to R10 billion in 2030 (USD 556 million) and R1 billion (USD 56 million) in 2050.
Thus, a rapid decarbonisation permits savings of R8 billion (USD 444 million) in 2030 and R14 billion (USD 778 million) in 2050 as indicated by the *rapid decarbonisation bonus*.

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Ayodeji Okunlola, David Jacobs, Ntombifuthi Ntuli, Ruan Fourie, Laura Nagel, Sebastian Helgenberger – IASS Potsdam, CSIR and IET, 2019. Improving health and reducing costs through renewable energy in South Africa. Assessing the co-benefits of decarbonising the power sector. COBENEFITS Study.

Co-Benefits Knowledge Commons is a factsheet series published by:

COBENEFITS

Technical implementation:

IASS POTSDAM UfU

Methodology

Air pollution emissions for four energy-generation scenarios with different intensities of decarbonization were evaluated (1) and the dispersion of air pollutants in the atmosphere were modelled (2). The exposure of the population to air pollutants was calculated (3) and the changes in disease incidence could be estimated (4). Attributing monetary costs to different diseases (5), allowed the estimation of the total financial cost of health impacts in each scenario.

Indicators assessed

- Excess particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and oxides of nitrogen (NO_X) ambient exposure (ųg/m^3) per municipality
- Premature mortality per annum
- Restricted activity days per annum
- Health cost externality of coal power (Rands/kWH and USD/kWh)

Health benefits from decarbonization

Up to 44 million people are exposed to air pollution from coal power plants in South Africa. As many as 2080 premature deaths annually can be attributed to air pollution from power plants in South Africa.

Estimated health costs of coal power generation in 2018 range from **R11-30 billion** (USD 0.73-2 billion) and will continue to rise until 2022 with around 27 % associated with a decline in workforce productivity.

By increasing renewable energy, these health costs associated can be cut from **45% in 2030 up to 93% by the year 2050** amounting to as much as **R76-269 billion (USD 5-18 billion)** in absolute savings.

Health costs could be further reduced by phasing out coal power before 2050.

Creating an enabling environment

We propose to direct the debate in three areas where policy and regulations could be put in place or enforced in order to reduce air pollution from coal-fired power plants within the shift to a less carbon-intensive power sector:

- **Integrate health externalities of coal into power sector planning**
- **Enforcement of Air Quality Act (emission standards)** and potential retro-fitting of existing coal-powered plants that do not comply with existing regulations
- **Ensure better data availability** for health cost assessments and public information

PRIME AFRICA CONSULTANTS

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HEALTH BENEFITS RELATED TO RENEWABLE ENERGY DEPLOYMENT IN INDIA

ASSESSING THE CO-BENEFITS OF DECARBONISING THE POWER SECTOR

TERI

- **Country:** India
- **Co-Benefit:** Air Quality and Health
- **Method:** Emission dispersion model with dose-response coefficients and health expenditure survey
- **Assessment by:** TERI
- **Published by:** TERI
- **Year:** 2019

The energy-air quality-health nexus

India has experienced a remarkable transition in reducing absolute poverty, improving standards of living and creating livelihood opportunities for the impoverished, and enhancing access to cleaner and affordable energy. However, ambient air pollution has emerged as the second leading health risk factor in India.

Since electricity generation in India is still largely coal-based, the power sector is an important contributor to ambient air pollution.

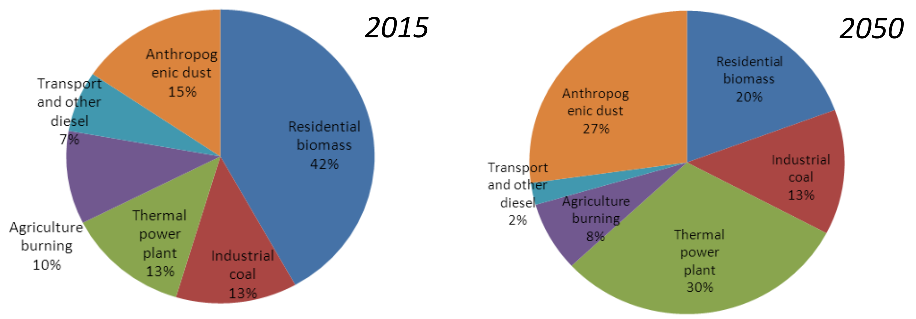

Figure 1: Ambient $PM_{2.5}$ related deaths attributable to different sectors in India under BAU scenario.
Source: HEI, 2018

This study assesses the economic and health effects of the Indian power sector until 2050 under three different energy scenarios.

Methodology

This study assesses the impact of ambient air pollution on human health in India by quantifying health effects and economic costs associated with $PM_{2.5}$/PM_{10} exposure.

Besides the quantification of impacts of ambient air-pollution from all sectors of the Indian economy, the specific impact of the Indian power sector is evaluated.

The study is based on three different energy scenarios: A BAU scenario, an INDC scenario and an INDC+ scenario, taking up strategies for higher decarbonisation compared to the INDC scenario. The analysis covers the years 2020, 2030, 2040, 2050.

Indicators assessed

- N° of premature deaths due to exposure to PM_{10} (2020 - 2050 following different scenarios
- N° of disability-adjusted life years (DALYs) attributable to ambient $PM_{2.5}$/PM_{10}, between 2020 and 2050 following different scenarios
- Total economic loss between 2020 and 2050 due to mortality and morbidity caused by $PM_{2.5}$/PM_{10} in INR trillion/ USD billion

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David Jacobs, Ayodeji Okunlola, Laura Nagel, Sebastian Helgenberger, Arunima Hakhu, 2019. Improving health and reducing costs through renewable energy in India. Assessing the co-benefits of decarbonising the power sector. COBENEFITS Study.

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Technical implementation:

IASS POTSDAM

UfU

Changing ambient air quality

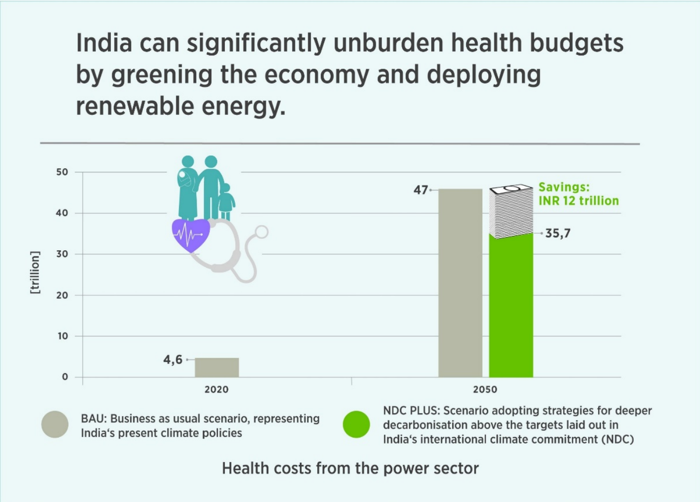

Figure 2: By reaching a higher share of renewable energies in the power sector (as indicated in the NDC PLUS scenario), than originally planned in its NDCs, India can save health costs of around INR 12 trillion (170 billion US Dollar) until 2050.

Renewables and (future) health

- With current $PM_{2.5}$ concentrations five times higher than the values recommended by the WHO, air pollution accounts for 4–5% of total mortality in India.
- In the BAU scenario, all-cause mortality due to exposure to PM_{10} during 2020 will be around 500,000 people. This number would rise to 830,000 by 2050.
- By moving from the BAU to the INDC+ pathway, more than 200,000 premature deaths can be avoided.

Year	BAU	INDC	INDC+
2020	36174	34919	32602
2030	30115	28832	28334
2040	41094	38048	37385
2050	52135	45404	45741

Table 1: All cause mortality attributable to air pollutants emissions from power plants in India

Enable future health opportunities

The following policies and activities can seize and broaden positive health impacts for the population of India by following an ambitious decarbonisation pathway in the power sector:

- Develop innovative business models and incentive mechanisms for promoting RE technologies particularly in rural and remote locations
- Improve independent emission monitoring and law enforcement through third-party assessments and extended mandates for state run agencies like the CPCB and SPCBs
- Foster interdisciplinary exchange between researchers and ensure methodological standards and joint monitoring.

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HEALTH-SMART POWER SECTOR PLANNING IN VIETNAM

UNLOCKING HEALTH AND AIR QUALITY BENEFITS OF CLIMATE CHANGE MITIGATION IN VIETNAM'S POWER SECTOR

IASS and UfU e.V.

- **Country:** Vietnam
- **Co-Benefit:** Air Quality and Health
- **Method:** Participatory Policy Roundtables
- **Assessment by:** UfU e.V. and GreenID
- **Published by:** IASS and UfU e.V.
- **Year:** 2019

Air quality and power generation in Vietnam

Air pollution is one of the main adverse effects of the energy sector on the environment and human health, contributing to more than 7.6% of all deaths worldwide in 2016. There is a strong association between exposure to high concentrations of PM_{10} and $PM_{2.5}$ and increased mortality and morbidity due to diseases such as stroke, lung cancer, heart disease, and chronic and acute respiratory diseases. **In 2018, the annual mean $PM_{2.5}$ concentration in Vietnam's largest cities, Ho Chi Minh City and Hanoi, exceeded WHO international guidelines by more than three to four times**. In other Northern provinces of Vietnam, WHO guidelines are also widely exceeded.

As part of the COBENEFITS project, a review of recent studies has shown that **power sector planning can have a significant impact on air quality in Vietnam's largest urban cities and surrounding provinces**. The findings of the COBENEFITS project in India and South Africa show that ambitious deployment of renewable energy can substantially reduce health impacts compared to scenarios that assume a higher share of conventional energy over the next 20-30 years.

Infographic

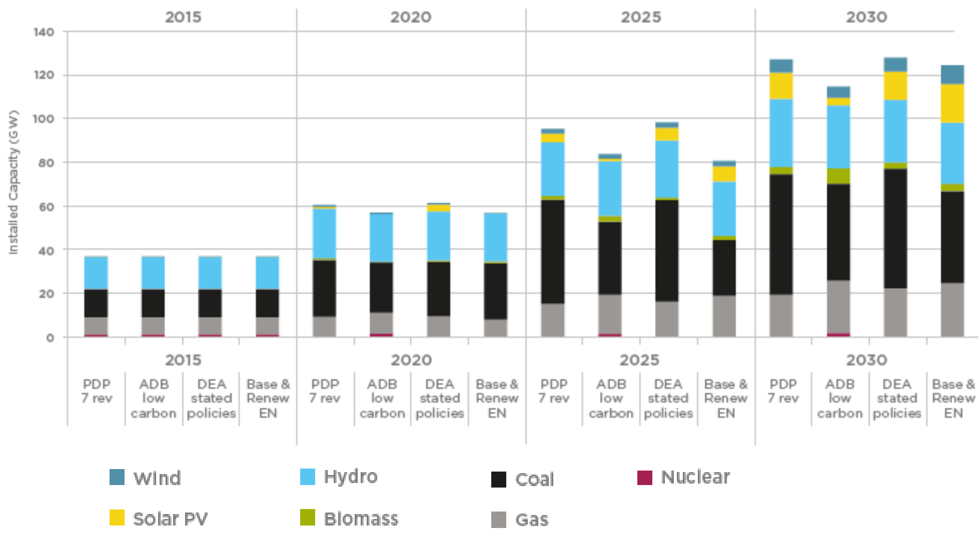

Figure 1:
COBENEFITS Vietnam Power System Reference Scenarios Installed Capacities (GW) by sources.

Source: IASS/UfU/GreenID, 2020

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Co-Benefits Knowledge Commons is a factsheet series published by:

COBENEFITS

Technical implementation:

IASS POTSDAM
UfU

Methodology

The COBENEFITS project includes a **systematic review of existing literature on air quality and health in Vietnam** to identify possible power generation development pathways and to gain an overview about their impacts on air quality and health.

These outlooks and linkages were discussed in **participatory roundtables assembling stakeholders from politics, economy, administration and the non-governmental sector**. The discussions were followed by a joint brainstorming to identify challenges in the creation of an enabling environment for health- and air quality-related co-benefits. Stakeholders then identified **high impact actions** to overcome the identified barriers, which were elaborated further by focus groups moderated with researchers.

Key findings

- The COBENEFITS study stresses that **power sector planning can have a significant impact on air quality in Vietnam's main cities and surrounding provinces**.
- The number of premature deaths associated with coal power plants is expected to increase under current policy scenarios. Kopitz et al. (2017) calculated **4,250 premature deaths in 2011 caused by coal power plants operating in Vietnam, which can rise to 19,220 by 2030**.
- The **largest increase in $PM_{2.5}$ concentrations in Northern Vietnam in 2015-2030 will be caused by emissions from the power sector** (Amann et al., 2019).
- An **ambitious extension of renewable energies will reduce health risks substantially** compared with scenarios assuming a higher share of conventional energy sources in the next 20-30 years.
- There are only **few available and consistent long-term data series on air quality and health impacts in Vietnam**, although they are necessary to inform the development of national power planning considering air quality and health scenarios.

High Impact Actions

- A key opportunity to unlock health cobenefits in the power sector is to **implement health-smart energy planning tools** into power generation planning, thus implementing a progressive air quality legislation which **embeds emission management in the power sector.** Smart energy planning combines the deployment of **measures to boost renewable energies and energy efficiency in the power sector**, combined with a **constant review of planned power plants by considering future impacts on air quality** in the decision making process.
- The support of **structured and integrated research and data** collection is needed to build a solid database on emissions, air quality and related health data for Vietnam. The **creation of a joint air quality–health–energy nexus research programme** by the Ministry of Health, the Ministry of Environment and Natural Resources and the Ministry of Science and Technology and/or its inclusion in existing research programmes is the right approach to strengthen cooperation and data exchange.
- It is crucial that researchers and the public have access to data from the GHG inventory system and smokestack tele-monitoring systems, for example through a **digital platform**.

GreenID

UfU Independent Institute for Environmental Issues

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AIR POLLUTION IMPACT MODEL FOR ELECTRICITY SUPPLY: AIRPOLIM-ES

A TOOL TO ESTIMATE AIR POLLUTION HEALTH IMPACTS OF COAL- AND GAS-FIRED POWER PLANTS

NewClimate Institute

- **Country:** several
- **Co-Benefit:** Air Quality and Health
- **Method:** AIRPOLIM-ES
- **Assessment by:** NewClimate Institute
- **Published by:** Ambition to Action
- **Year:** Updated regularly

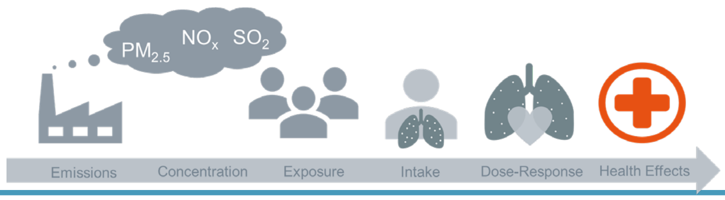
Background

NewClimate Institute has developed an accessible spreadsheet-based model to estimate the health impacts of air pollution from different sources of electricity generation and other fuel combustion that can be applied in multiple countries.

The first version of the model focuses on air pollution caused by electricity generation from **coal- and gas-fired power plants**. It calculates the **impacts on mortality from four adulthood diseases: lung cancer, chronic obstructive pulmonary disease, ischemic heart disease and stroke**, all of whose prevalence is increased with the intake of pollution.

The tool can be used to compare the magnitude of health impacts under different scenarios across both existing and planned plants.

A **version for the transport sector** is currently under development.



Input requirements and outputs

INPUTS

Plant data
- Lifetime
- Installed capacity
- Capacity factor
- Heat rate (efficiency)
- Emissions control
- Location
- Emission factors

Population mapping
- Gridded population data
- GIS mapping

Population statistics
- Country- and age-specific mortality rates
- Share of population per age category
- Population growth rate
- Life expectancy at age x

OUTPUTS

Emissions

Annual and lifetime emissions for:
- *$PM_{2.5}$*
- *NO_x*
- *SO_2*
- *CO_2*

Health Impacts

Annual and lifetime premature deaths and years of life lost for:
- *Lung cancer*
- *Chronic obstructive pulmonary disease*
- *Ischemic heart disease*
- *Stroke*

Available on **plant**, **country** or **scenario** level

restricted to **country population** or **all affected population**

Ambition to Action

NEW CLIMATE INSTITUTE

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AIRPOLIM–ES Tool (Air Pollution Impact Model for Electricity Supply)

Co-Benefits Knowledge Commons is a factsheet series published by:

COBENEFITS

Technical implementation:

IASS POTSDAM

UfU

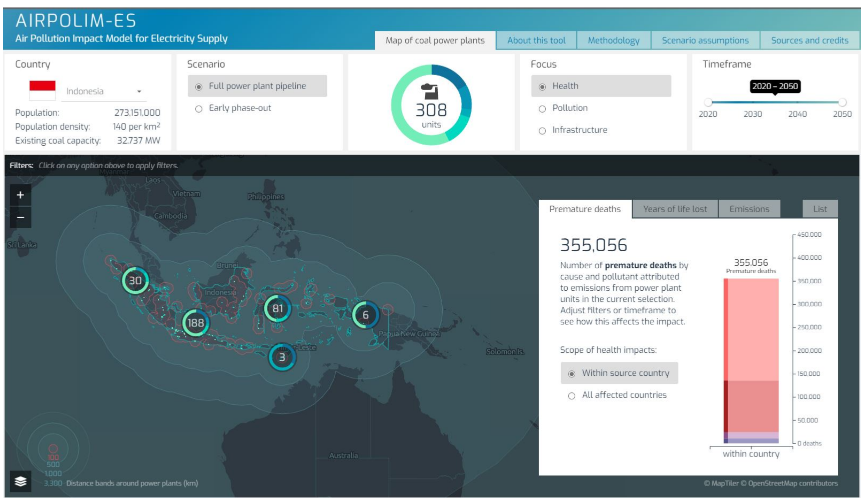
Methodology

- The model estimates the **annual and lifetime electricity generation** (GWh) for each plant as well as the corresponding **emissions of air pollutants (CO_2, $PM_{2.5}$, SO_2 & NO_x)** using plant-specific data and emission factors. Depending on the type of emission control equipment installed, the model multiplies the estimated fuel consumption with the country-specific emission factor (GAINS). Plant-specific emission factors can be entered into the model to improve accuracy.
- **Exposed population** living within four distance bands (0–100 km, 100–500 km, 500–1,000 km, and 1,000–3,300 km) from each power plant is estimated using an open-source geographical information system software (QGIS) and population growth estimates.
- The model uses the intake fraction concept to estimate the **change in $PM_{2.5}$ concentration** in the air dependent on the calculated pollutant emissions. To estimate the intake the model applies coefficients from a study by Zhou et al. (2006) to avoid resource-intensive dispersion modelling.
- **Increased mortality** risk per additional ton of pollutant emissions is determined by multiplying the estimated change in $PM_{2.5}$ concentration with the respective concentration-response function (increase in cause-specific mortalities per 10 µg/m³ increase in $PM_{2.5}$).
- The risk estimates, **age-weighted mortality rates** and exposed population are combined to calculate the **number of premature deaths and years of life lost (YLL)** per ton of pollutant. These numbers are multiplied with the estimated pollutant emissions to obtain the total number of premature deaths and YLL for each power plant.

Interactive web tool

The interactive web tool **provides policy makers, planners, analysts and civil society with accessible insights** into the magnitude of health impacts under different scenarios, allowing users to configure the set up by changing the country, filtering the timeframe or operational status of plants; and to drill-down to examine the impacts of individual units.

The web-based version currently includes power plants and results for **Argentina, Indonesia, Kenya, Mongolia and Thailand**, under a "Full power plant pipeline" and "Early phase-out" scenario.



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HEALTH IMPACT ANALYSIS OF KENYA'S ELECTRICITY SECTOR

ASSESSING THE SUSTAINABLE DEVELOPMENT IMPLICATIONS OF THE ROLE OF GEOTHERMAL AND COAL IN KENYA'S ELECTRICITY SYSTEM

Ambition to Action

- **Country:** Kenya
- **Co-Benefit:** Air Quality and Health
- **Method:** AIRPOLIM-ES
- **Assessment by:** NewClimate Institute
- **Published by:** Ambition to Action
- **Year:** 2019

Power planning for Kenya

Kenya is one of the fastest growing economies in Sub-Saharan Africa with high anticipated economic growth rates and ambitious infrastructure flagship projects. However, recent electricity demand forecasts were considerably decreased. Both, in a possible scenario of subdued growth and one of future electricity demand growth, it is key that capacity planning for electricity generation is carried out in a way that electricity supply matches demand. At the same time, sustainable development goals and environmental targets need to be achieved. This includes Kenya's target to reduce greenhouse gas (GHG) emissions by 30% below business as usual by 2030, as announced in the country's Nationally Determined Contribution (NDC) to the Paris Agreement.

A major challenge for planners and policymakers in the electricity sector is the identification of the optimal composition of electricity generation technologies within different load-factor categories. This study aims at supporting decision making in the electricity sector by **comparing the two main power generation technologies** that are considered as baseload electricity supply options in Kenya, namely **geothermal and coal**, and their **impact on air quality and related human health.**

Methodology

The analysis of co-benefits under different scenarios is based on quantitatively analysing the impacts of geothermal and coal-based power generation on national development objectives.

The socio-economic assessment was focused on employment and health, applying the **Economic Impact Model for Electricity Supply (EIM-ES)** and the **Air Pollution Impact Model for Electricity Supply (AIRPOLIM-ES)** to better inform policy makers of relevant wider impacts beyond economic cost and the climate.

Health benefits from a no coal path

- **Negative effects on human health can be avoided if no coal-fired power plant is built:** Up to 2065, roughly an additional 1,650 Kenyans would die prematurely if both coal plants in Lamu and Kitui were built and operated, including almost 44,000 years of life lost (based on AIRPOLIM-ES, see graphic illustration). Impacts of geothermal-based electricity generation are not considered since its emissions do not include significant amounts of air pollutants.
- **Using geothermal instead of coal to generate electricity leads to more domestic job creation**
- Building the Lamu coal-fired power plant puts Kenya's **climate change target at risk and may result in increased public spending** to address the adverse effects of climate change.

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Marie-Jeanne Kurdziel, Thomas Day, Lukas Kahlen, Tessa Schiefer, 2019. Climate change and sustainable development in the Kenyan electricity sector. Impacts of electricity sector development on Kenya's NDC. Ambition to Action.

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COBENEFITS

Technical implementation:

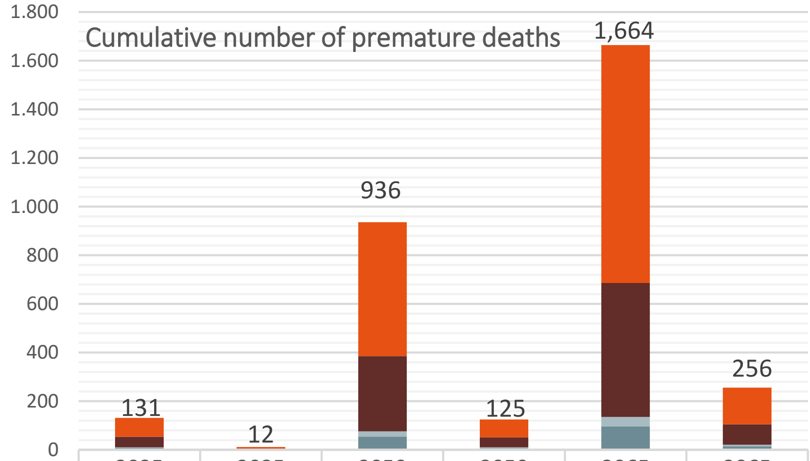
IASS POTSDAM

UfU

Indicators assessed

- GHG emissions of electricity per year and power source in $MtCO_2e$
- Years of life lost per 60 year lifetime
- N° of cumulated premature deaths over modelling horizon

Health costs for Kenya



	2035 Reference case	2035 Alternative case	2050 Reference case	2050 Alternative case	2065 Reference case	2065 Alternative case
Stroke	77	7	550	73	978	151
Ischemic heart disease	43	4	309	41	550	85
Lung cancer	3	0	22	3	39	6
COPD	8	1	54	7	97	15

Figure:
Results of the Health impacts assessment in the cumulated number of premature deaths in 2035 and 2050.

* Reference case: Lamu power station: 981 MW (start: 2024), Kitui power station: 960 MW (start: 2034); Alternative case: * Lamu power station: 450 MW (start: 2034); assumed lifetime of all coal-fired power plants is 30 years

Conclusions and recommendations

Building and operating coal-fired power plants in Kenya, starting with the Lamu power plant, would considerably slow the development of readily available, clean and increasingly low-cost geothermal and other renewable energy sources such as wind and solar.

The analysis of the employment and health co-benefits of geothermal energy use supports this line of argumentation by showing the **negative sustainable development impacts that can be avoided in terms of health as well as the positive impacts on domestic job creation and the wider economy**.

NEW CLIMATE INSTITUTE

Ambition to Action

References

AIRPOLIM-ES:
https://newclimate.org/2018/11/30/airpolim-es-air-pollution-impact-model-for-electricity-supply/

EFFECTS OF EU CARBON MITIGATION ON CO-POLLUTANTS

IMPROVING LOCAL AIR QUALITY BY REDUCING EMISSIONS OF HAZARDOUS CO-POLLUTANTS

PERI

- **Country:** European Countries
- **Co-Benefit:** Air Quality and Health
- **Method:** Two-way fixed effects (FE) model combined with an instrumental variables approach
- **Assessment by:** PERI
- **Published by:** IAEE
- **Year:** 2020

Integrating air quality co-benefits into CO_2 mitigation policies

Fossil fuel combustion releases not only carbon dioxide (CO_2) but also air pollutants such as sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulate matter (PM_{10}). More stringent and comprehensive climate policies can therefore provide co-benefits for air quality that increase the overall benefits of carbon mitigation. This means that carbon mitigation not only contributes to meet international climate goals and address global climate change, but also **improves local air quality and public health by reducing emissions of hazardous co-pollutants**.

To estimate the full social cost of carbon, air quality co-benefits must be included in addition to climate benefits. To date, little empirical research has been conducted on the relationship between CO_2 emissions and co-pollutants at the individual pollutant source level, despite the importance of air quality side effects from economic, health and environmental perspectives.

Infographic

Source: E-PRTR, authors' calculations.

Figure:
Releases of CO_2 are accompanied by releases of hazardous air pollutants. Average emissions per facility (in mio t).

POLITICAL ECONOMY RESEARCH INSTITUTE
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Klara Zwickl, Simon Sturn, James K. Boyce, 2020. Effects of Carbon Mitigation on Co-pollutants at Industrial Facilities in Europe. The Energy Journal 42 (5).

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COBENEFITS

Technical implementation:

IASS POTSDAM UfU

POLITICAL ECONOMY RESEARCH INSTITUTE
PERI
University of Massachusetts Amherst

Indicators assessed

- CO_2 Emissions and co-pollutants SO_X, NO_X, and PM_{10} of industrial facilities in all European Union member states plus Iceland, Liechtenstein, Norway, Serbia, and Switzerland
- Climate policy stringency based on the OECD's Environmental Policy Stringency Index

Methodology

- Based on European data on large industrial point sources from the European Pollutant Release and Transfer Register (E-PRTR), an empirical estimate of how changes in carbon dioxide emissions affect emissions of the three co-pollutants SO_X, NO_X, and PM_{10} is generated.
- The sample includes between 630 and 2,400 facilities for the years 2007 to 2015.
- Changes in climate policy are assessed by using the OECD's Environmental Policy Stringency Index.

Key findings

- For industrial point sources as a whole, the study shows a 1% reduction in CO_2 emissions in 2007-2015 resulted in about a **1% reduction in SO_X and NO_X emissions**, and a **0.7% reduction in PM_{10} emissions**. These elasticities vary by sector.
- In the electricity sector, climate policy-induced CO_2 emission reductions have an even stronger impact: a 1% reduction in CO_2 emissions is associated with a **1.2-1.8% reduction in SO_X**, **1.1-1.5% reduction in NO_X**, and a **0.8% reduction in PM_{10} emissions**.
- The monetized air quality co-benefits from a ton of CO_2 reduction in the energy sector range from **33 to 98 EUR/t CO_2 for SO_X**, **9 to 24 EUR/t CO_2 for NO_X**, and **4 to 10 EUR/t CO_2 for PM_{10}** (in 2005 Euros).
- These calculated co-benefits for air quality are considerably higher than the European Environment Agency's estimated climate damage costs of 10 to 38 EUR/t CO_2.

Conclusion

- **More stringent climate policies also bring air quality and public health benefits.** Ignoring these co-benefits will lead to a significant underestimation of the advantages of carbon mitigation.
- The study suggests that conventional European Environmental Agency estimates of carbon damages **substantially underestimate the benefits of carbon mitigation**.
- These results can justify significantly **higher carbon prices** based on the co-benefits of carbon mitigation alone, independent of their climate benefits.

ENERGIZING MEXICO'S DEVELOPMENT WITH CLEAN SOURCES

CRUNCHING NUMBERS - QUANTIFYING THE SUSTAINABLE DEVELOPMENT CO-BENEFITS OF MEXICO'S CLIMATE COMMITMENTS

GIZ Mexico

- **Country:** Mexico
- **Co-Benefit:** Air Quality and Health
- **Method:** CMM national electricity system model with established social cost estimates
- **Assessment by:** SD Strategies
- **Published by:** GIZ Mexico
- **Year:** 2020

Linking global agendas

The **Paris Agreement and the Sustainable Development Goals (SDGs)** are profoundly interconnected. While main objectives of climate policies are emissions mitigation and climate change adaptation, their implementation can generate cross-sectoral development benefits. Also in Mexico, an ambitious social and economic development agenda is put in the center of domestic political discussions, while the Mexican government reaffirmed its international commitment to combat global warming with determined national climate action.

In 2018, the Mexican Government, together with the Office of the Presidency, SEMARNAT, INECC and GIZ Mexico, commissioned a **study on the co-benefits of implementation of Mexico's Nationally Determined Contributions (NDCs) for the achievement of the SDGs**. Power generation has been identified as one climate action whose co-co-benefits shall be assessed. To calculate co-benefits of different clean electricity targets, four scenarios have been considered:

A business-as-usual scenario based on Mexican BAU projections for the NDC from 2015, a PRODESEN scenario from the Ministry of Energy, a scenario oriented on Mexico's current NDCs and an ambitious SD+ (REP 100) scenario.

From the three types of co-benefits of clean power generation calculated in the study, the findings regarding public health in Mexico are shown at this page.

Health benefits for Mexico

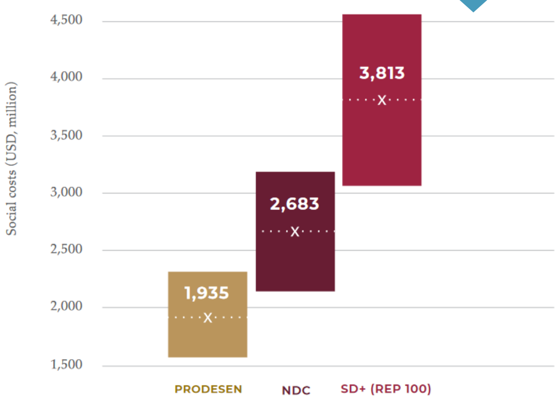

Figure 1:
Total social/health costs avoided from reduced $PM_{2.5}$–related mortality, relative to the business-as-usual (2019-2030).

Indicators assessed

- Share of electricity generation from clean sources in % per year
- $PM_{2.5}$ emissions from electricity generation in tons/year
- Reduction of total $PM_{2.5}$ emissions from electricity generation between 2019 and 2030 per scenario, in tons and in % of BAU scenario results

SD STRATEGIES

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SD Strategies, 2020. Crunching Numbers. Quantifying the sustainable development co-benefits of Mexico's climate commitments. GIZ Mexico.

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COBENEFITS

Technical implementation:

IASS POTSDAM

UfU

Calculating health-related cobenefits

The calculation of health-related co-benefits from cleaner power generation in Mexico was based on four scenarios representing various levels of penetration of clean sources into Mexico's electricity mix.

After the share of installed capacities and the amount of electricity generation from each technology were determined, the latter was multiplied by $PM_{2.5}$ emission factors and summed.

The resulting total amount of $PM_{2.5}$ emissions from power generation was then multiplied by established estimates of the total social costs of $PM_{2.5}$-related mortality to calculate the avoided health/social costs from $PM_{2.5}$ emissions reductions.

Health benefits for Mexico

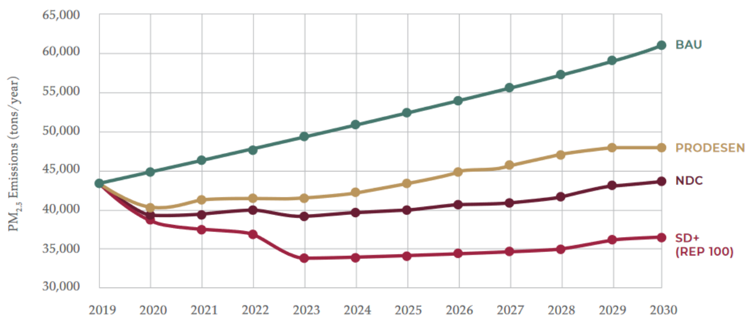

Figure 2: $PM_{2.5}$ emissions from electricity generation in tons per year from 2019 to 2030, using different scenarios

Key findings

- Implementing NDC targets in the Mexican power sector results in approx. **USD 2.68 Billion of avoided costs** relative to BAU by 2030. This value represents around 41% of the budget allocated to the Mexican Ministry of Health for 2019.
- Increasing ambition to the SD+ (REP 100) scenario would even lead to around **USD 3.81 billion of avoided costs**, although even this ambitious zero-carbon scenario only reaches a share of 53% of clean power sources in 2030, with $PM_{2.5}$ emissions from power generation amounting 434,000 tons by 2030.
- Increasing the share of electricity generated from clean sources can thus make significant contributions towards the achievement of SDG 3 Good Health and Wellbeing.

Conclusion

- A cleaner electricity sector can produce significant **social and health benefits** and can so create the broad support needed for the transformation of energy systems.
- It is now crucial to design and implement climate and sustainable development strategies as an integrated approach. Correlating and, ideally, quantifying NDC-SDG correlations is a prerequisite for effective and efficient action. Action can be triggered by the definition of short-, mid- and long-term targets, cross-sectoral mainstreaming as well as federal and sub-federal integration.

SD STRATEGIES

References

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EXPLORING MITIGATION BENEFITS

THE LOW EMISSIONS ANALYSIS PLATFORM (LEAP) – INTEGRATED BENEFITS CALCULATOR (IBC)

SEI and CCAC

- **Country:** Global
- **Co-Benefit:** Air Quality and Health
- **Method:** LEAP-IBC
- **Assessment by:** SEI
- **Published by:** SEI and CCAC
- **Year:** 2017

LEAP-IBC and its use

The **Low Emissions Analysis Platform (LEAP)** and the **Integrated Benefits Calculator (IBC)** form together a comprehensive planning tool for energy and non-energy policy analysis and climate change mitigation assessment. It assesses greenhouse gas, short-lived climate pollutants (SLCPs), and other air pollutant emissions and can be used to create mitigation scenarios to understand how emissions can be reduced and have strong positive effects on climate, health, and crops and thus enable important co-benefits.

LEAP is a widely deployed tool with users in over 190 countries. Users include government agencies, nongovernmental organizations, academics, consulting firms, and energy utilities. The tool is used by twelve countries to support national action planning for action on short-lived climate pollutants (SLCPs) as part of the Climate and Clean Air Coalition's SNAP initiative. LEAP can be deployed at a variety of levels, including city, state, national, regional, and global.

The Integrated Benefits Calculator (IBC) is a module of the LEAP system developed by SEI in collaboration with US EPA and Daven Henze at the University of Colorado and with the support of the Climate and Clean Air Coalition (CCAC).

Infographic

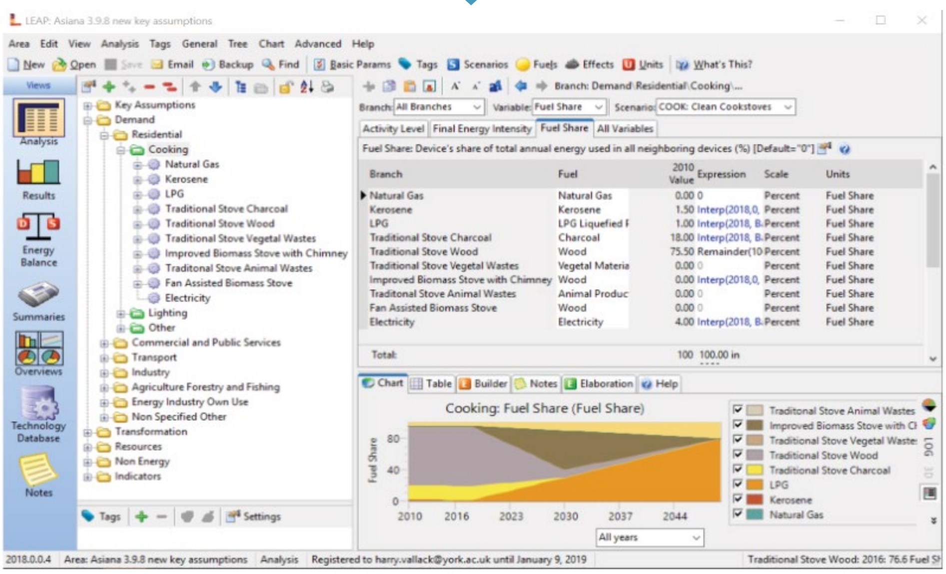

Figure 1:
An example use of the LEAP-IBC tool showing the structure of sectors for energy-related and non-energy-related greenhouse gas and air pollution emissions.
Source: SEI, 2020

Contact

Stockholm Environment Institute

Link

Stockholm Environment Institute, 2017. The Long-range Energy Alternatives Planning – Integrated Benefits Calculator (LEAP-IBC).

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COBENEFITS

Technical implementation:

IASS POTSDAM UfU

Methodology

LEAP is **an integrated, scenario-based modeling tool** originally developed to track energy use, production, and resource extraction across all economic sectors. It can **account for sources and sinks of greenhouse gas emissions from both the energy and non-energy sectors**.

In addition, LEAP can also **analyze emission patterns of local and regional air pollutants** and **assess short-lived climate pollutant (SLCP) mitigation strategies**, making it well-suited for studies on the climate co-benefits of reducing local air pollutant emissions.

The LEAP-IBC-tool **combines emissions scenarios from LEAP with output from a global atmospheric chemistry transport model and with various exposure-response functions**. It produces national-scale estimates of avoided premature deaths from red. In addition to that, the tool assesses the climate benefits of addressing short-lived climate pollutants (SLCPs), adopting air pollution reduction strategies and implementing greenhouse gas mitigation.

LEAP-IBC assessment

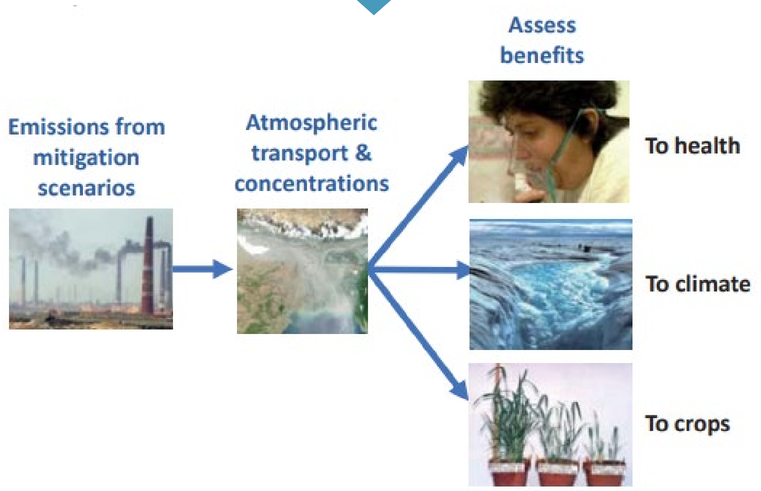

Figure 2:
Assessment methodology of the LEAP-IBC tool
Source: SEI, 2020

LEAP-IBC enables to

- characterize national emissions of greenhouse gases, short-lived climate pollutants and other air pollutants
- understand possible future trends in emissions
- explore alternative emission reduction scenarios
- calculate health, agricultural, and global impacts at the country level
- compare the results of the alternative scenarios
- inform appropriate national actions on climate, air quality, and SLCPs

References

Stockholm Environment Institute, 2017. The Long-range Energy Alternatives Planning – Integrated Benefits Calculator (LEAP-IBC). Factsheet.

HEALTH

RAISING CLIMATE AMBITIONS AND IMPROVING AIR QUALITY IN MONGOLIA

OPPORTUNITIES FROM TAKING INTEGRATED ACTIONS ON AIR POLLUTION AND CLIMATE CHANGE IN MONGOLIA

SEI and CCAC

- **Country:** Mongolia
- **Co-Benefit:** Air Quality and Health
- **Method:** Emission Mitigation Assessment
- **Assessment by:** CCAC SNAP initiative
- **Published by:** SEI and CCAC
- **Year:** 2020

Air pollution in Mongolia

Mongolia faces many challenges related to the adverse impacts of climate change and air pollution. Due to a substantial rise in coal burning in the energy sector combined with increasing urbanization, air pollution reaches in the cold season dangerous levels in Mongolian cities. In the capital Ulaanbaatar, home to 45% of Mongolia's population, the **air pollution level is almost six times higher than WHO air quality standards**.

Besides agriculture, transport and coal use for household heating and cooking, electricity and heat generation are main sources of short-lived climate pollutants (SLCPs), greenhouse gases (GHGs) and air pollutants in Mongolia.

In its revised NDCs, Mongolia states, among others, mitigation measures to reduce GHG emissions in the energy sector. This includes an **increase in the share of renewable energy in total energy production from around 7% in 2018 to 20 and 30 percent by 2020 and 2030** respectively. Simultaneously, actions have been identified and implemented to improve air pollution in Ulaanbaatar specifically.

As part of the Climate and Clean Air Coalition SNAP initiative, an **integrated assessment of air pollutant emissions, SLCPs, and GHGs** was undertaken to **evaluate the potential of mitigation options to simultaneously improve air quality and mitigate climate change.**

Infographic

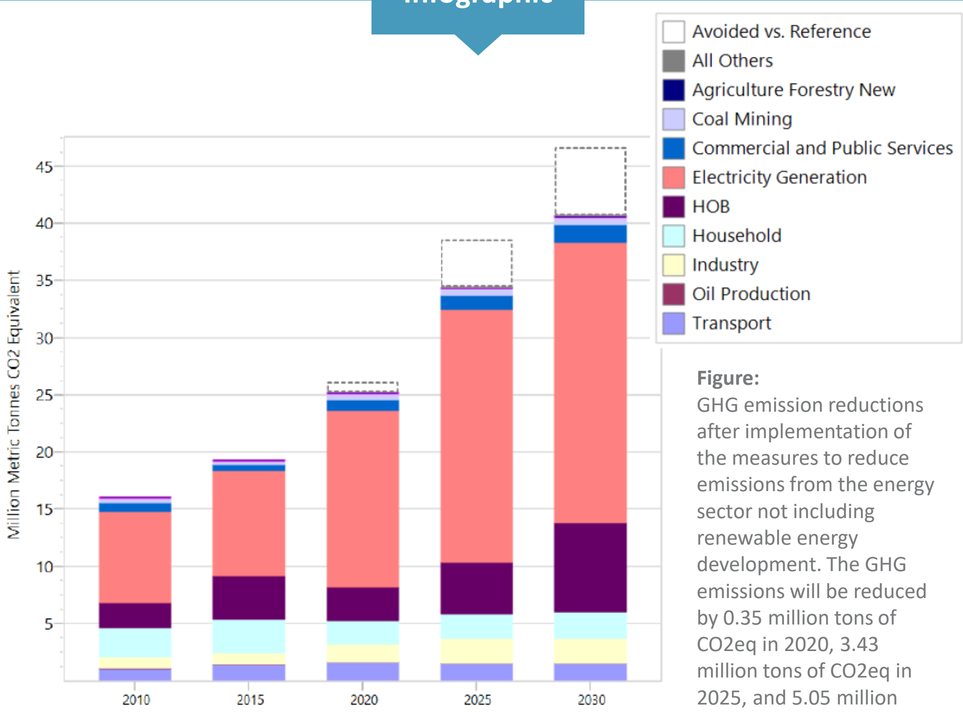

Figure:
GHG emission reductions after implementation of the measures to reduce emissions from the energy sector not including renewable energy development. The GHG emissions will be reduced by 0.35 million tons of CO_2eq in 2020, 3.43 million tons of CO_2eq in 2025, and 5.05 million tons of CO_2 in 2030.

Source:
SEI, 2020

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SEI, CCAC, Mongolia, 2020. Opportunities from taking integrated actions on air pollution and climate change in Mongolia.

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Technical implementation:

IASS POTSDAM
UfU

Methodology

To quantify emissions of air pollutants, to generate mitigation scenarios and to estimate benefits of actions, **the LEAP-IBC (Low Emissions Analysis Platform (LEAP) Integrated Benefits Calculator (IBC) tool was applied**. Deployed as part of the SNAP project by CCAC/SEI, LEAP-IPC enables the development of policy scenarios and facilitates their comparison and selection based on a socio-economic co-benefit analysis.

For Mongolia, data from the energy and non-energy sectors as well as environmental data in a variety of areas were analysed. Having already been used in Mongolia, the LEAP tool could be applied for an integrated assessment of greenhouse gases, short-lived climate pollutants and air pollutants based on the latest available national data.

Indicators assessed

- Emission of SLCPs, GHGs and air pollutants by source
- Projections of SLCPs, air pollutant and GHG emissions for 2030 following different scenarios

Key findings

- In Mongolia, GHG, SLCP and air pollutant emissions are in many cases are emitted from the same sources, e.g. from coal use for heating and for power generation
- **Electricity and Combined Heat and Power Plants contributed over 70% of emissions from the electricity and heat generation sectors**, while heat-only boilers (HOBs) contributed approximately 28% of total emissions.
- **Full implementation of Mongolia's revised NDC will result in a 22.7% reduction in GHG emissions**. The implementation of Mongolia's climate change commitment and additional air pollution measures can reduce emissions of black carbon by 26%, $PM_{2.5}$ by 17% and NO_x by 22% in 2030 compared to a business-as-usual scenario.
- Most effective GHG emission reduction measures are efficiency improvements of coal fired power plants and HOBs, together with the use improved briquette fuel. Most of effective measures to reduce air pollution is the modernization of housing, the use of electric heaters and the ending of raw coal use in Ulaanbaatar.

Recommendations

- To ensure an improvement in ambient air quality and climate change mitigation alike, **emission reduction measures outlined in the revised NDCs needs to be implemented** in combination with air pollution reduction measures for Ulaanbaatar.
- An **increase in technical capacity for integrated air pollution, climate change and SLCP planning** is essential to be able to track progress on air pollution and climate change mitigation, and to revise priorities as national circumstances change.
- **Capacity-building at local government level** is necessary to develop air quality management strategies in municipalities outside of Ulaanbaatar. Collaborations with local academic institutions can be effective in building capacity for air pollution and climate change assessments, and may support generating improved or additional data to increase the accuracy and precision of emission estimates.

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HEALTH

RAISING NDC AMBITION TO IMPROVE AIR QUALITY IN THE DOMINICAN REPUBLIC

RECOMMENDATIONS FOR COMBINED CLIMATE CHANGE AND AIR POLLUTION MITIGATION MEASURES

SEI and CCAC

- **Country:** Dominican Republic
- **Co-Benefit:** Air Quality and Health
- **Method:** LEAP-IBC
- **Assessment by:** Dominican Republic National Climate Change Council, Dominican Republic Ministry of Environment, SEI
- **Published by:** SEI and CCAC
- **Year:** 2020

NDC measures in the Dominican Republic

The Nationally Determined Contribution of the Dominican Republic lists climate change mitigation policies that will achieve its climate change commitment. Some of these actions can simultaneously improve outdoor air quality by reducing emissions of short-lived climate pollutants (SLCPs) and other air pollutants. Considering these synergies in climate mitigation planning offers opportunities to improve public health.

This study assesses for the first time the magnitude of emissions of SLCPs and air pollutants in the Dominican Republic, and strategies for mitigation. Based on an emission inventory of SLCPs in the Dominican Republic, the potential of different climate change mitigation policies and measures was evaluated regarding their impacts on reducing SLCP emissions and thus ambient air pollution. Furthermore, the emission reduction potential until 2030 is quantified for six high-impact measures mitigating climate change impacts while reducing ambient air pollution in the Dominican Republic.

Infographic

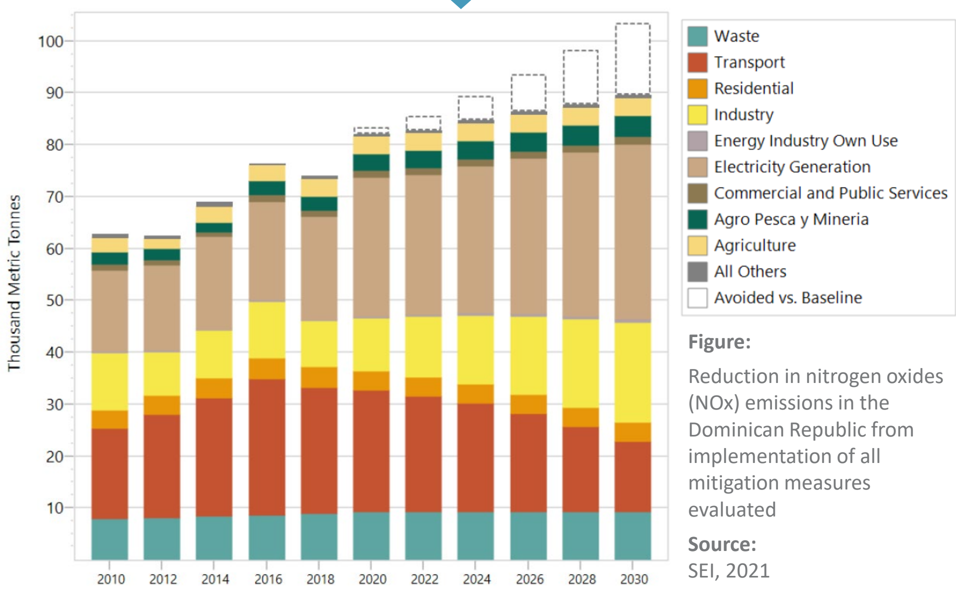

Figure:

Reduction in nitrogen oxides (NOx) emissions in the Dominican Republic from implementation of all mitigation measures evaluated

Source:

SEI, 2021

Indicators assessed

- Emission of short-lived climate pollutants (SLCPs), greenhouse gases (GHGs) and air pollutants by source
- Projections of SLCPs, air pollutants and greenhouse gases to 2030 (baseline scenario and mitigation activities added)

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Dominican Republic, Stockholm Environment Institute (SEI), 2021. Assessment of Short-Lived Climate Pollutant mitigation in the Dominican Republic. Recommendations for NDC enhancement.

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Technical implementation:

Methodology

Using data on energy consumption, electricity generation, agricultural production and waste management systems in Dominican Republic, the authors developed an integrated short-lived climate pollutant (SLCP), greenhouse gas (GHG) and air pollutant emission **inventory** to characterize the emissions of various pollutants.

These emissions were then projected for a **baseline** scenario to 2030. **Additional policies and measures were then identified** that are not included in existing plans and strategies. They were extracted from global and regional assessments where they are listed as key mitigation measures.

The **LEAP-IBC tool** was then applied to carry out an integrated assessment of greenhouse gases, short-lived climate pollutants and air pollutants based on the latest available national data.

Key findings

- Major sources of black carbon emissions are residential combustion, industry, transport and waste burning. Industrial use of biomass fuels cannot be quantified due to a lack of emission control technologies but may be large black carbon emission source.
- Raising the ambition of the NDCs of the Dominican Republic through the full implementation of the six proposed measures reduces emissions of black carbon by an estimated 6% in 2030. Mitigation measures would also be effective in reducing other GHGs emissions such as CO_2 (23% in 2030 compared to a baseline scenario).
- Added mitigation measures that target an increase in the fraction of power generated from renewables and a decrease in the age of the vehicle fleet result in a combined 20% reduction of NO_x emissions in 2030 compared to a baseline scenario.
- As individual mitigation measure, an increase of the proportion of electricity generated from renewable sources is a highly effective measure to reduce carbon dioxide emissions and other air pollutant emissions in the Dominican Republic.

Recommendations

- GHG, air pollutant and SLCP emissions shall be monitored, evaluated and reported simultaneously to make use of existing synergies. Thus, integrated climate change and air pollution mitigation analyses needs to be maintained and updated, while air pollutant and SLCP emissions shall be included in the official GHG inventory, the National Communications and Biennial Reports.
- In the Dominican Republic, pollutants contributing to air pollution, and climate change are often emitted from the same sources. Integrating air pollution and climate change planning by identifying strategies having the potential to simultaneously achieve both thus offer great synergies.
- Mitigation actions maximizing SLCP and air pollutant emission reductions shall be included into the NDC revision, together with estimations quantifying their individual emission reduction potentials.
- The establishment of an inter-sectoral or inter-ministerial task force can support climate change and air pollutant mitigation actions alike by serving as a forum to discuss and engage relevant stakeholders relevant to tackle both challenges

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THREE INDONESIAN SOLAR-POWERED FUTURES

Solar PV and ambitious climate policy

TNO and NewClimate Institute

- **Country:** Indonesia
- **Co-Benefit:** Health
- **Method:** AIRPOLIM-ES
- **Assessment by:** TNO & NewClimate Institute
- **Published by:** TNO & NewClimate Institute
- **Year:** 2019

Pathway to a decarbonised future

Indonesia's current long-term energy policy focuses on diversifying the energy mix and keeping up with fast economic development while maximising domestic value added. With **two-thirds of the growth to be coal- and gas-powered, Indonesia's development pathway needs serious reconsideration**. On the upside, clean technologies prove to have many development benefits and recently cost reductions have been spectacular (e.g. LED lights, solar power, and electric vehicles).

This report takes a closer look at **solar photovoltaic as a clean alternative to coal-powered grid-connected electricity supply for Indonesia**. A sense of direction and scale of the impacts of solar deployment on air pollution is established, among others. Based on the example of the planned 1.9GW coal-fired Central Java Power project in the middle of Java, the study aims to show the **impacts on air quality and the related reduction of health issues and deaths if solar deployment replaces new or existing coal-fired electricity generation**. The plant is expected to be commissioned in 2020 with a lifetime of at least 40 years.

Infographic

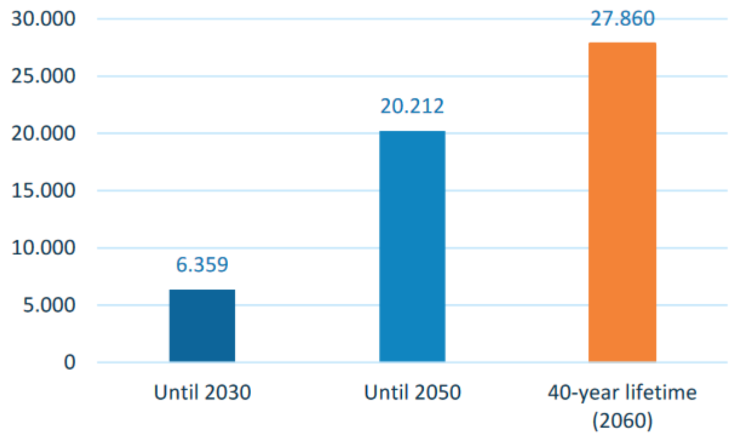

Figure 1: Cumulative number of premature deaths caused by Central Java Power Project

Indicators assessed

- Cumulative number of premature deaths per year (average), until 2030, 2050 and 2060
- Number of premature deaths until 2060 caused by lung cancer, chronic obstructive pulmonary disease, ischemic heart disease, and strokes
- Years of life lost per year (average), until 2030, 2050 and 2060

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Jasper Donker, Xander van Tilburg, 2019. Three Indonesian solar-powered futures. ECN. TNO Report Ambition to Action.

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COBENEFITS

Technical implementation:

IASS POTSDAM

UfU

Methodology

The air pollution tool **AIRPOLIM-ES** has been applied in this study. AIRPOLIM-ES is a transparent, Excel-based tool to provide a first avenue into quantifying the health impacts of air pollution from electricity generation based on fossil fuels.

It provides an indication on the **impacts on mortality from four diseases**: lung cancer, chronic obstructive pulmonary disease, ischemic heart disease, and strokes, whose prevalence is increased through exposure to air pollution. It is assumed that some emission control technologies will be installed in the Central Java Power project. Impacts are based on the average emissions factors for Indonesia from the GAINS model on air quality.

Infographic

Premature deaths by cause/lifetime				
COPD	Lung Cancer	Ischemic Heart Disease	Stroke	Total
869	1,036	8,733	17,221	**27,860**

Figure 2: Number of premature deaths caused in a 40-year lifetime by Central Java Power Project clustered by causes of lung cancer, chronic obstructive pulmonary disease, ischemic heart disease, and strokes.

Key findings

The Central Java Power project is expected to result, on average, in the **premature death of 696 persons every year**, resulting in more than six thousand premature deaths until 2030. These results are in line with earlier research done by Greenpeace Indonesia on this specific power plant (Greenpeace, 2015). The '10 GW: bright but cautious' solar PV future could prevent the construction of about 2,400 MW of new coal-fired plants and thereby the premature death of hundreds of people every year through air pollution, based on a NewClimate Institute case study.

Conclusion

The study showed the positive impacts regarding air quality and health if coal-fired power plants are replaced by solar PV. Short term interventions like more attractive net-metering and feed-in tariff arrangements, enabling and encouraging PLN to connect (variable) renewables, and a realistic alignment of local content ratio to wider support are long-hanging fruits that could help the nascent solar PV market in Indonesia. This way, the potential of solar PV to significantly reduce health problems, the number of premature deaths and to support the implementation of Indonesia's international commitments to climate change mitigation can be activated.

References

AIRPOLIM-ES: https://newclimate.org/2018/11/30/airpolim-es-air-pollution-impact-model-for-electricity-supply/

Greenpeace, 2015. Human Cost of Coal Power: How Coal-Fired Power Plants Threaten the Health of Indonesians.

This joint factsheet edition by the Centre for Research on Energy and Clean Air (CREA) and COBENEFITS connects policymakers in local and national government agencies with expert organisations and contact persons to quantify specific air quality co-benefits, assess policy options and unlock potentials for people and communities.

COBENEFITS works with national authorities and expert organisations in countries across the globe to quantify and unlock the social and economic co-benefits of early climate action with renewable energy. The project facilitates capacity building and cross-country learning among policymakers, expert organisations, CSOs and the private sector.

The **Centre for Research on Energy and Clean Air (CREA)** is an independent research organisation focused on revealing the trends, causes, and health impacts, as well as the solutions to air pollution.

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September 2022

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DOI: 10.48481/iass.2021.029

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Supported by:
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
based on a decision of the German Bundestag

Centre for Research on Energy and Clean Air