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BRIEFING: Health impacts of coal-fired power projects with HSBC equity stakes

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Key findings

- Through its equity holdings, HSBC has a stake in at least 137 coal-fired power plant units under development, in 11 different countries. We assessed the likely health impacts of the air pollutant emissions from these projects, assuming they are all completed and brought into operation.
- The new coal units would emit more deadly air pollutants (sulfur dioxide, nitrogen oxides and particulate matter) than all coal-fired power plants in the EU and the UK combined in 2019, assuming they all follow national emissions standards in the countries where they are built.
- The air pollutant emissions would be responsible for an estimated 18,700 deaths from air pollution per year (95% confidence interval: 13,000–25,600), as well as 29,000 emergency room visits due to asthma, 25,000 preterm births and 14 million days of work absence per year.
- The economic costs of the health impacts amount to 6.2 billion USD per year (95% confidence interval: 4.2–8.6) due to lost economic productivity, health care costs and welfare losses.
- The projected health impacts are largest in India (8,300 deaths per year), followed by China (4,200), Bangladesh (1,200), Indonesia (1,100), Vietnam (580) and Pakistan (450).

Introduction

An April 2021 investigation by Market Forces (2021) demonstrated that HSBC, via its asset management arm, has stakes in coal companies that together plan at least 137 coal-fired power plant units (73 new coal plants in total). The total capacity of these units, if built, will equal 99 gigawatts, emitting 15 billion tonnes of CO2 over their conventionally assumed lifetimes.

This study builds on that research, projecting the health impacts of these coal units, if they are all built.

HSBC has announced its intention to draw up a new coal policy by the end of 2021, and has committed to coal financing exit dates for the first time. However, HSBC's proposed new policy will exclude its asset management arm, allowing continued investments in companies building new coal plants. This study shows the human and economic impact of those new coal plants.

Results

Emissions

The central input to health impact assessment of coal-fired power plants are the annual emissions volumes. We built a unit-level emissions inventory for all coal power projects with HSBC equity stakes, assuming that all plants follow national emissions standards, at the minimum; when information on more stringent plant-specific emission limit values was available, these values were assumed to be complied with. The inventory includes all units identified in Market Forces (2021) except for the Imaloto coal power station in Madagascar for which we didn't have emissions data.

The total emissions of the three major air pollutants from the units are projected at 420kt/yr sulfur dioxide (SO2), 450kt/yr nitrogen oxides (NOx), and 60kt/yr fly ash (particulate matter, PM). This exceeds the emissions of all coal-fired power plants in the European Union and the United Kingdom combined (based on emissions data compiled in EBC 2021).

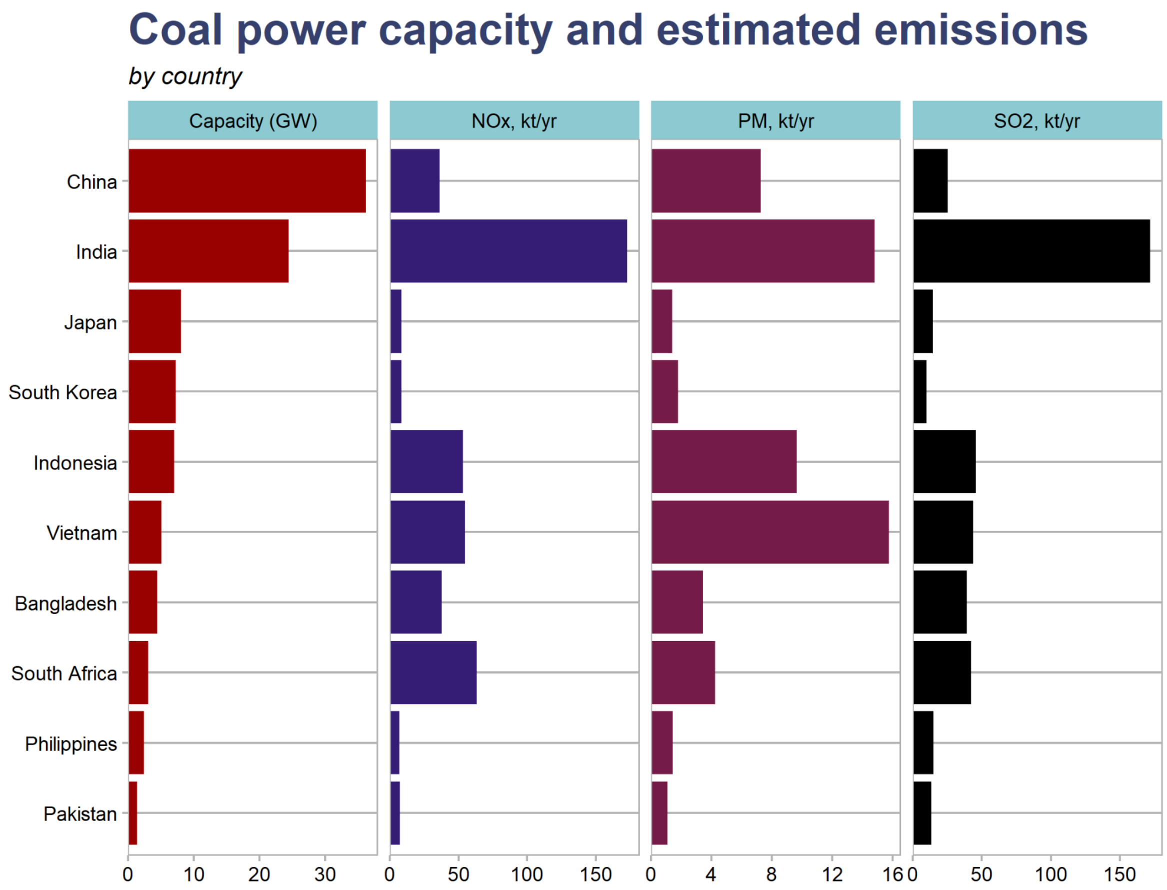

Figure 1. *Emissions by country.*

Health impacts

The air pollutant emissions would be responsible for an estimated 18,700 deaths from air pollution per year (95% confidence interval: 13,000–25,600), as well as 29,000 emergency room visits due to asthma, 25,000 preterm births and 14 million days of work absence per year. The projected health impacts are largest in India (8,300 deaths per year), followed by China (4,200), Bangladesh (1,200), Indonesia (1,100), Vietnam (580) and Pakistan (450).

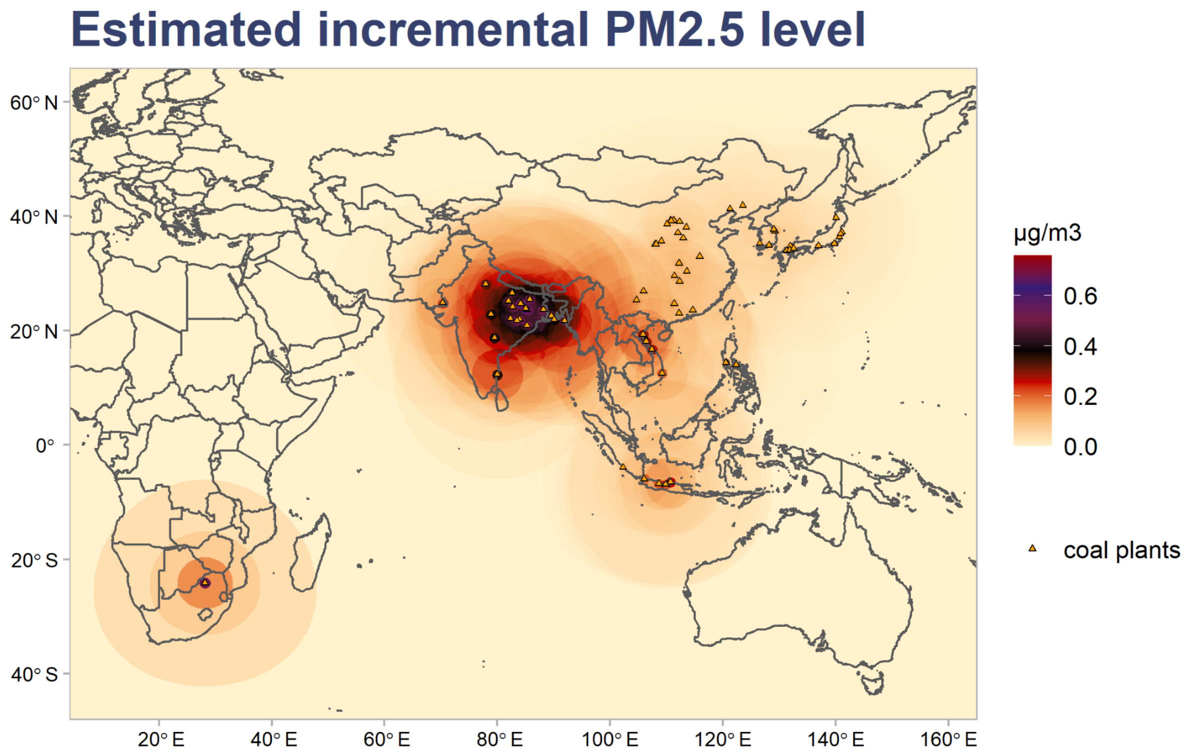

Figure 2. *Projected increase in annual mean PM2.5 level from the studied plants.*

Table 1. *Projected annual health impacts in 2025*

Outcome	Cases, central estimate	Cases, 95% confidence interval	Unit
deaths	18,662	(12,983 - 25,561)	cases
of which due to			
chronic obstructive pulmonary disease	*2,948*	*(1,042 - 5,645)*	
diabetes	*310*	*(67 - 566)*	
ischaemic heart disease	*6,819*	*(5,098 - 8,813)*	
lower respiratory infections	*2,079*	*(770 - 3,897)*	
lower respiratory infections in children	*327*	*(196 - 505)*	
lung cancer	*1,144*	*(531 - 2,001)*	
stroke	*4,082*	*(1,577 - 7,404)*	
asthma emergency room visits, adults	16,263	(10,649 - 21,832)	cases
asthma emergency room visits, children	13,108	(6,857 - 19,283)	cases
preterm births	25,169	(12,196 - 26,725)	cases
work absence	14,419,287	(12,267,409 - 16,556,478)	days of sick leave
disabilities: chronic obstructive pulmonary disease	15,188	(5,649 - 27,674)	years lived with disability
disabilities: diabetes	5,465	(1,022 - 11,335)	
disabilities: stroke	10,963	(3,589 - 22,291)	

Table 2. *Projected deaths from pollution from the studied coal power plants, per year*

Country	central	low	high
India	8,347	5,848	11,360
China	4,188	2,970	5,655
Bangladesh	1,225	811	1,751
Indonesia	1,094	753	1,474
Vietnam	583	401	803
Pakistan	450	307	641
Myanmar (Burma)	435	308	600
Japan	329	257	408
Thailand	304	186	460
Philippines	284	190	401
Nepal	234	154	325
South Africa	198	146	258
Sri Lanka	156	98	236
South Korea	94	71	118
Malaysia	88	56	128

Economic costs

The economic costs of the health impacts amount to 6.2 billion USD per year (95% confidence interval: 4.2–8.6) due to lost economic productivity, health care costs and welfare losses.

Table 3. *Annual economic costs by cause, mln USD*

Outcome	**Central estimate**	**95% confidence interval**
Absences	345	(294 - 397)
Emergency room visits for asthma	1	(1 - 2)
Preterm births	454	(220 - 482)
Disabilities	344	(109 - 683)
Deaths	5,119	(3,566 - 7,031)
Total	6,264	(4,189 - 8,595)

Table 4. *Total annual economic costs by economy (mln USD and local currency)*

Economy	cost, mln USD	cost, mln LCU	Currency name
China Mainland	2,568	17,741	Yuan Renminbi
India	1,571	111,388	Indian Rupee
Japan	481	52,394	Yen
Indonesia	354	5,014,481	Rupiah
Bangladesh	216	18,130	Taka
Thailand	155	4,827	Baht
South Korea	150	175,011	Won
Vietnam	115	2,647,979	Dong
South Africa	94	1,359	Rand
Philippines	82	4,222	Philippine Peso
Malaysia	67	277	Malaysian Ringgit
Pakistan	64	8,719	Pakistan Rupee
Myanmar	51	78,669	Kyat
Sri Lanka	43	7,609	Sri Lanka Rupee
Macao	33	267	Pataca
Singapore	27	36	Singapore Dollar
Nepal	21	2424	Nepalese Rupee
Cambodia	11	45,493	Riel
Laos	10	86,270	Kip
Zimbabwe	8	8	Zimbabwe Dollar

Materials and Methods

Emissions

We built a unit-level emissions inventory for all coal power projects with HSBC equity stakes, assuming that all plants follow national emissions standards, at the minimum; when information on more stringent plant-specific emission limit values was available, these values were assumed to be complied with. In Japan and the Philippines, as emissions limits adopted by new projects are generally more stringent than the national standards, the median of the limit values for projects with data was applied to projects lacking project-specific data. In Bangladesh and Pakistan, when project-specific data wasn't available, we assumed that new projects comply with International Finance Corporation guidelines (which are more stringent than national regulation). In India, we took into account the planned weakening of NOx emissions standards, assuming a limit value of 350mg/Nm3. New plant standards were assumed to apply to plants commissioned in 2022 or later. More detailed information on the sources of emissions data is given in Table 5.

Emissions are estimated as:

$CAP / EFF \times CF \times SFGV \times ELV$,

where power capacity CAP and thermal efficiency EFF were taken from the Global Coal Plant Tracker database (GEM 2021); capacity factor (CF) is the national average CF for operating plants calculated from BP Statistical Review of World's Energy data; ELV is the emissions limit value that the plant is assumed to comply with, and SFGV is the specific flue gas volume, calculated using empirical formula ISO EN-12952-15 and data on representative coal samples in USGS (2011) World Coal Quality Inventory.

Table 5. *Air pollutant emissions by country*

Country	Capacity (MW)	SO2, t/yr	NOx, t/yr	PM, t/yr
Bangladesh	4,420	39,102	37,849	3,433
China	36,140	25,379	36,255	7,251
India	24,410	172,024	172,754	14,808
Indonesia	7,024	45,646	53,155	9,650
Japan	8,018	14,729	8,627	1,405
Pakistan	1,320	13,514	7,566	1,082
Philippines	2,400	15,147	7,185	1,435
South Africa	3,000	42,247	63,371	4,225
South Korea	7,260	9,971	8,357	1,762
Vietnam	5,040	43,634	54,812	15,739

Table 6. *Sources of emission data by country*

Country	**Reference**
India	New plants assumed to comply with SO2 standard from 2022 and NOx standard assumed to be diluted to 350mg/Nm3. For plants commissioned before 2022, average flue gas concentrations calculated from Guttikunda & Jawahar 2014.
South Africa	South Africa New Plant MES.
Japan	Kiko Network 2020: compilation of emission limit values from Environmental Impact Assessments.
South Korea	CREA 2020.
China	Ultralow emissions standards.
Indonesia	National emissions standards. Existing plant limits applied to "construction" and "permitted" projects, new plant limits applied to "pre-permit" and "announced" projects, per personal communication from MoEF. (Myllyvirta et al. 2020a.)
Pakistan	Myllyvirta 2020b ; projects with no data assumed to follow IFC (2017) Guidelines for "non-degraded airsheds"
Bangladesh	Myllyvirta 2020 c & d.
Vietnam	Myllyvirta & Suarez 2021.
Philippines	Myllyvirta & Suarez 2020.

Population exposure

To project the population exposure to PM2.5 resulting from the air pollutant emissions, we applied a regression model developed by Zhou et al. (2006), based on dispersion modeling results for 29 plant sites in China, and earlier applied for India by Cropper et al. (2012). The model predicts population exposure based on the total amount of population within different distances of the power plant, taking into account the contribution of SO2 and NOx emissions to the formation of secondary PM2.5. However, the health impacts of direct exposure to SO2 and NO2 are not taken into account, owing to the limitations of the methodology, which makes the results conservative.

The spatial distribution of population was based on Gridded Population of the World v4 (CIESIN 2018). Precipitation data required by the model was taken from WorldClim 2.1 (Fick & Hijmans 2017).

The Zhou et al. (2006) model used entire mainland China as the domain for which population exposure was assessed. To make the model globally applicable, we limited the domain to a distance of 2000km from each power plant.

The results were derived separately for exposure in each country, so that differences in population age structure, baseline incidence of different health outcomes, and differences in income levels could be taken into account in subsequent analysis.

Health impacts and economic costs

The health impact assessment methodology is adapted from CREA's "Quantifying the Economic Costs of Air Pollution from Fossil Fuels" (Myllyvirta 2020e).

The calculation of health impacts follows a standard epidemiological calculation:

$$\Delta cases = POP \times \sum_{age}\left[Frac_{age} \times Incidence_{age} \times \left(1 - \frac{RR(c_{base} + \Delta c_{coal}, age)}{RR(c_{base}, age)}\right)\right],$$

where *POP* is the total population in the grid location, *age* is the analysed age group (in the case of age-dependent concentration-response functions, a 5-year age segment; in other cases, the total age range to which the function is applicable), $Frac_{age}$ is the fraction of the population belonging to the analysed age group, *Incidence* is the baseline incidence of the analysed health condition, c is pollutant concentration, with c_{base} referring to the baseline concentration and Δc_{coal} is the concentration attributed to coal-fired power plants, with the contribution from existing plants having a negative sign (subtracted from the baseline concentration) and projected future incremental concentration from new plants a positive sign (added on top of the baseline concentration). *RR(c, age)* is the function giving the risk ratio of the analysed health outcome at the given concentration, for the given age group, compared with clean air.

In the case of a log-linear, non-age specific concentration-response function, the RR function becomes:

$$RR(c) = RR_0^{\frac{c - c_0}{\Delta c_0}} \text{ when } c > c_0, \ 1 \text{ otherwise},$$

where RR_0 is the risk ratio found in epidemiological research, Δc_0 is the concentration change that RR_0 refers to, and c_0 is the assumed no-harm concentration (generally, the lowest concentration found in the study data).

Data on total population and population age structure in each country was taken from Global Burden of Disease (GBD) results for 2019 (IHME 2020), which collects and aggregates data from health departments of national governments.

Adult deaths and years of life lost from $PM_{2.5}$ exposure were estimated using the risk functions developed by Burnett et al. (2018), as applied by Lelieveld et al. (2019). Deaths of small children from lower respiratory infections linked to $PM_{2.5}$ pollution were assessed using the GBD risk function for lower respiratory diseases (IHME 2020).

For all mortality results, the baseline death rates and years of life lost by country were taken from the GBD project 2019 (IHME 2020); sources of incidence data for other health outcomes are given in Table 7. As the non-linear concentration-response functions require information on baseline concentrations of $PM_{2.5}$, these were taken from van Donkelaar et al. (2016).

Future health impacts projects account for projected population growth on the national level, and for mortality impacts, using projected changes in age-specific death rates based on the UNDP (2019) medium variant. Use of age-specific death rates captures the impact of expected improvements in population health status and health services, which results in lower mortality for children, while increasing the susceptibility of the adult population to non-communicable diseases associated with air pollution.

Table 7*. Input parameters and data used in estimating physical health impacts*

Age group	Effect	Pollutant	Concentration response function*	Concentration change	No-risk threshold	Reference	Incidence data
0-17	Asthma emergency room visits	PM2.5	1.03 (1.01–1.04)	10 ug/m3	6 ug/m^3	Zheng et al. 2015	Anenberg et al. 2018
18-99	Asthma emergency room visits	PM2.5	1.02 (1.02–1.03)	10 ug/m3	6 ug/m^3	Zheng et al. 2015	Anenberg et al. 2018
Newborn	Preterm birth	PM2.5	1.15 (1.07, 1.16)	10 ug/m3	8.8 ug/m^3	Trasande et al. 2016	Chawanpaiboon et al. 2019
0-4	Deaths from lower respiratory infections	PM2.5	GBD 2019		5.8 ug/m^3	GBD 2019	GBD 2019
25-99	Premature deaths from non-communicable diseases	PM2.5	Burnett et al. 2018		2.4 ug/m^3	Burnett et al. 2018	GBD 2019
25-99	Disability caused by diabetes, stroke and chronic respiratory disease	PM2.5	GBD 2019		2.4 ug/m3	Burnett et al. 2018	GBD 2019

**Numeric values in the "Concentration-response function" refer to relative risk corresponding to the increase in concentrations given in the "concentration change" column. Literature references indicate the use of a non-linear concentration-response function. No-harm threshold refers to a concentration below which health impact is not quantified, generally due to lack of evidence in the studies from which the function is based on.*

Economic Valuation

The economic losses from air pollution-related deaths were assessed based on the resulting reduction in life expectancy, with one year of life lost valued at EUR 56,000 (US$ 69,400 at 2005 exchange rate) in the European Union, following the EEA (2014) cost-benefit methodology. This was adjusted by purchasing power adjusted Gross National Income (GNI PPP) in each country, with an elasticity of 0.9 as recommended by the OECD (2012). The estimates for economic costs per case of each health outcome in each country were calculated using 2019 GDP per capita, GNI per capita, purchasing power and exchange rate data from the World Bank (undated):

$C_c = C_0 \times \left(\frac{I_c}{I_0}\right)^{\eta}$, where C_c is cost per case in country c. C_0 is cost at reference income level, I is income level in country c, I_0 is the reference income level and η is the elasticity.

Table 8. *Economic cost of different health outcomes*

Effect	Valuation	Currency	Unit	Year	Source	Adjustment	Reference income level	Elasticity
New asthma cases	496,000	GBP	case	2018	Birchby 2019	GNI PPP	UK	1
Emergency room visits for asthma	844	USD	visit	2010	Brandt et al. 2012	GDP PPP	California	1
Preterm birth	321,989	USD	birth	2010	Trasande et al. 2016	GDP PPP	U.S.	1
Disability	62,800	GBP	year lived with disability	2018	Birchby 2019	GNI PPP	UK	1
Premature deaths	56,000	EUR	lost life year	2005	EEA 2014	GNI PPP	EU	0.9
Work absence	130	EUR	work day	2005	EEA 2014	GDP PPP	EU	1

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