USERGUIDE

Air Pollution Impact Model for Electricity Supply

AIRPOLIM-ES

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Ambition to Action

Model overview

Purpose and features of the main sections of the model

INPUTS > >	Setup scenarios, define power plant characteristics (capacity, lifetime, pollution control etc.) and input population exposure data
CALC > >	Calculation of population exposure, emissions, concentration change, health impacts and corresponding costs
RESULTS > >	Results can be set-up and presented on plant-, country- or scenario-level.
APPENDIX > >	Fixed inputs (including concentration-response functions, intake fraction coefficients)

IMPORTANT NOTE: Yellow cells throughout the file are input cells where the user needs to include either text or data. Non-yellow shaded cells typically denote where formulas are used to perform calculations or link to other cells.

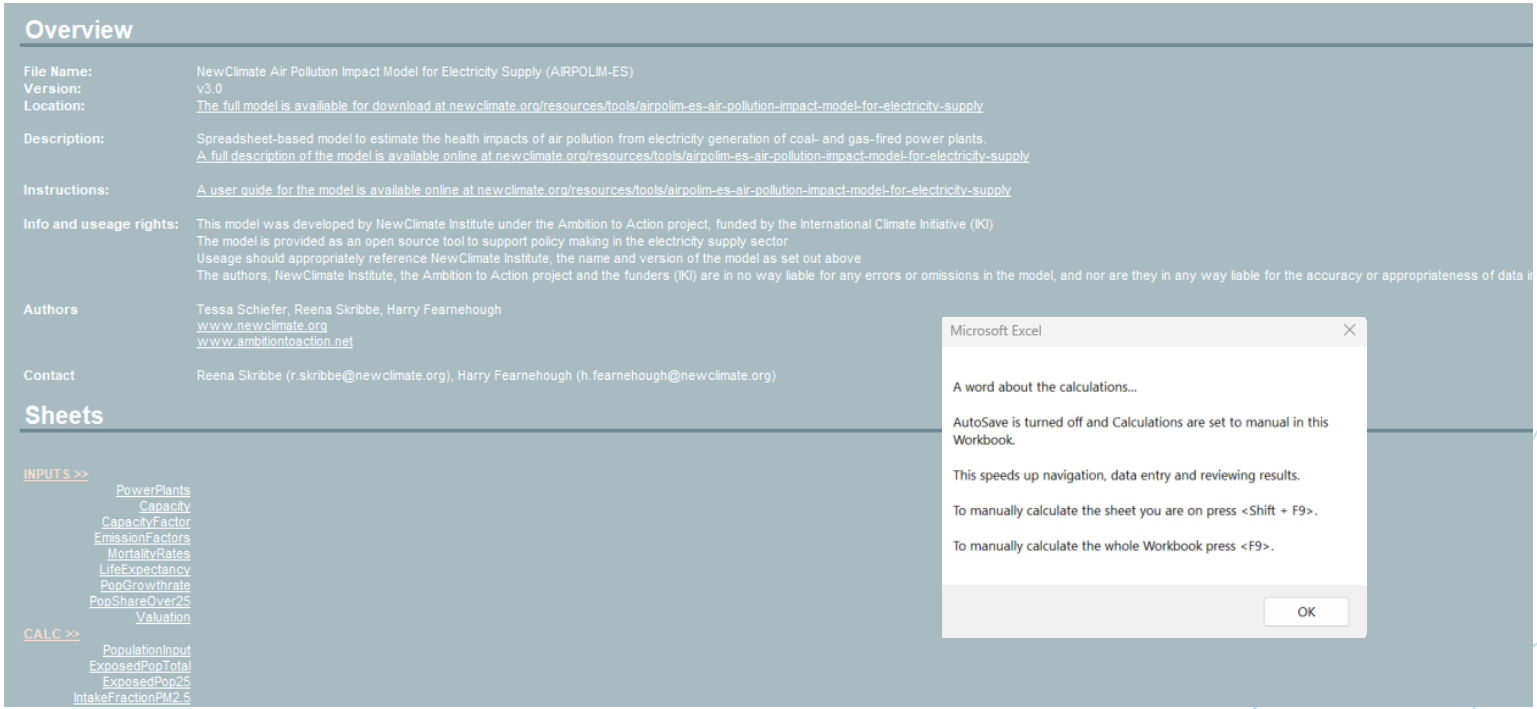
Opening the Excel file

The file opens on the cover sheet with a notice about calculations: read, click OK and start set up

INPUTS > >

CALC > >

RESULTS > >



Setting up the tool

Ambition to Action

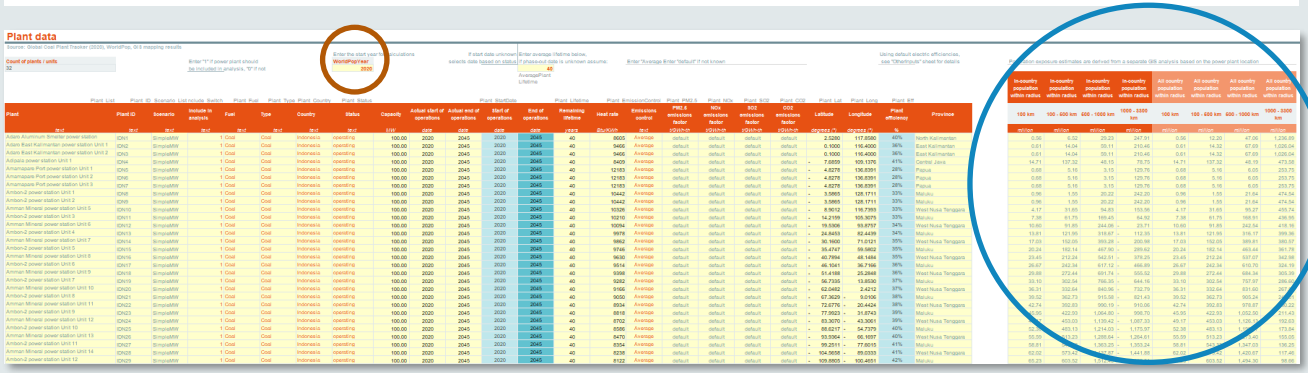
INPUTS > >

CALC > >

RESULTS > >

- PowerPlants
- Capacity
- CapacityFactor
- EmissionFactors
- MortalityRates
- LifeExpectancy
- PopGrowthrate
- PopShareOver25

- List all **power plants** and add their **specific characteristics**
- Corresponding information required includes start date, end date or lifetime, capacity, heat rate, type of emissions control (insert “Average” if unknown), and emission factor (enter “default” if unknown)
- Set the year of population data in the **“WorldPopYear” field**, changing the number will adjust all years throughout the tool and we recommend defining (if different from 2020) at the start of the analysis and entering as a multiple of 5. Please note that population data needs to be downloaded starting in the same year as the year of population
- **Population exposure estimates** have to be estimated in a separate geographic information system (GIS) analysis (*open source population data sets and GIS software is available*)
- The **start date** has to be equal or later than the year of population data set
- **Press F9 (calculate model) once complete** to update changes across all sheets



Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

RESULTS > >

PowerPlants

Capacity

CapacityFactor

EmissionFactors

MortalityRates

LifeExpectancy

PopGrowthrate

PopShareOver25

- **The "Capacity" sheet does not require manual user input!**
- Capacities are automatically calculated using information on capacity, start date, and end date from the "PowerPlants" sheet

Plant capacity

Source: Global Coal Plant Tracker (2020)

Plant	Plant ID	Country	Capacity Overall	Capacity 2020	Capacity 2021	Capacity 2022	Capacity 2023	Capacity 2024	Capacity 2025	Capacity 2026	Capacity 2027	Capacity 2028
text	*text*	*text*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*	*MW*
Adaro Aluminum Smelter power station	IDN1	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Adaro East Kalimantan power station Unit 1	IDN2	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Adaro East Kalimantan power station Unit 2	IDN3	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Adipala power station Unit 1	IDN4	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Amamapare Port power station Unit 1	IDN5	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Amamapare Port power station Unit 2	IDN6	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Amamapare Port power station Unit 3	IDN7	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ambon-2 power station Unit 1	IDN8	Indonesia	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

- In the "CapacityFactor" sheet input the annual capacity factor for each unit over time (only the yellow cells require input)
- **Press F9 (calculate model) once complete** to update changes across all sheets

Plant capacity factor

Source: Global Coal Plant Tracker (2020)

Plant	Plant ID	Country	Status	Capacity factor 2020	Capacity factor 2021	Capacity factor 2022	Capacity factor 2023	Capacity factor 2024	Capacity factor 2025	Capacity factor 2026	Capacity factor 2027	Capacity factor 2028	Ca fa 2
text	*text*	*text*	*text*	*text*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	*%*	
Adaro Aluminum Smelter power station	IDN1	Indonesia	operating	51%	51%	51%	51%	51%	51%	51%	51%	51%	
Adaro East Kalimantan power station Unit 1	IDN2	Indonesia	operating	51%	51%	51%	51%	51%	51%	51%	51%	51%	
Adaro East Kalimantan power station Unit 2	IDN3	Indonesia	operating	51%	51%	51%	51%	51%	51%	51%	51%	51%	
Adipala power station Unit 1	IDN4	Indonesia	operating	51%	51%	51%	51%	51%	51%	51%	51%	51%	
Amamapare Port power station Unit 1	IDN5	Indonesia	operating	51%	51%	51%	51%	51%	51%	51%	51%	51%	
Amamapare Port power station Unit 2	IDN6	Indonesia	operating	51%	51%	51%	51%	51%	51%	51%	51%	51%	

Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

RESULTS > >

- PowerPlants
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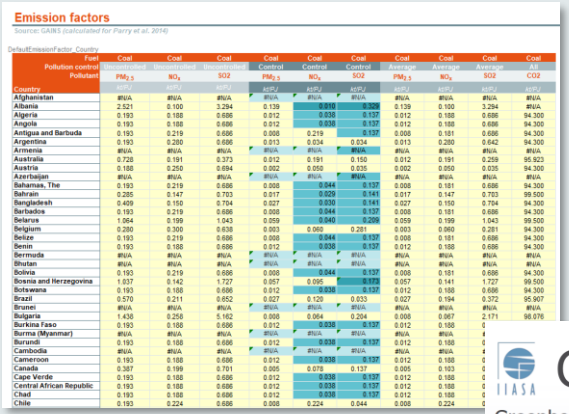
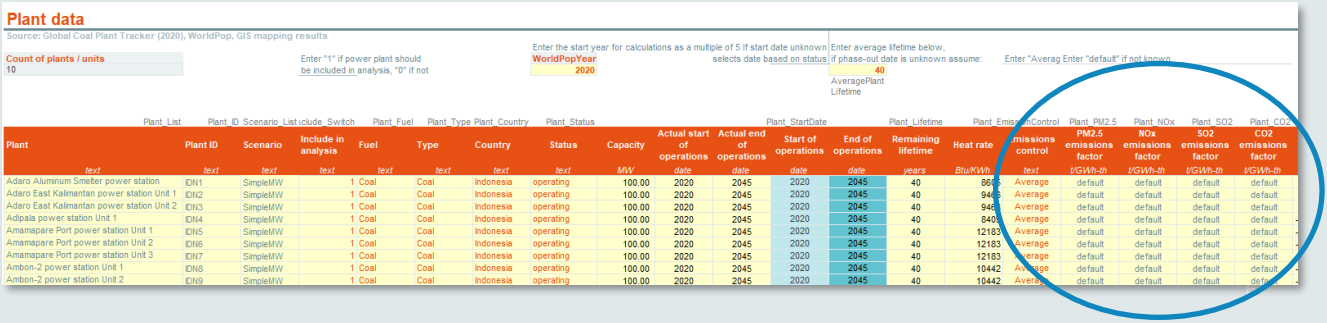


- If emission factors are unknown, **approximate emission factors** for each country and type of control technology calculated by the **GAINS model** can be used
- Entering plant-specific emission factors improves the accuracy of the estimates

GAINS Online

Greenhouse Gas - Air Pollution Interactions and Synergies



Setting up the tool

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IHME Global Health Data Exchange | GHDx | Institute for Health Metrics and Evaluation

WDI DataFinder

- Enter age-specific **mortality rates** for COPD, lung cancer, ischemic heart disease and stroke from the Global Health Data Exchange for each country that is included in the analysis
- To obtain the age-weighted mortality rates add **the percentage share per age group,** e.g. using data from the World Development Indicators

Age-weighted mortality rates

Source: IHME (2019), World Development Indicators (2019)

MortalityRate_25 pShare_25 lityRate_30 pShare_30 lityRate_35 pShare_35 lityRate_40 pShare_40 lityRate_45 pShare_45 lityRate_50 pShare_50 lityRate_55 pShare_55 lityRate_60 pShare_60 lityRate_65 pShare_65 lityRate_70 pShare_70 lityRate_75 pShare_75 lityRate_80 pShare_80 ality Rate_Tbl

	Analysis countries	Health impact type	Age category 25- 29		Age category 25- 29		Age category 30 - 34		Age category 30 - 34		Age category 35 - 39		Age category 35 - 39		Age category 40 - 44		Age category 40 - 44		Age category 45- 49		Age category 45- 49		Age category 50 - 54		Age category 50 - 54		Age category 55 - 59		Age category 55 - 59		Age category 60 - 64		Age category 60 - 64		Age category 65- 69		Age category 65- 69		Age category 70 - 74		Age category 70 - 74		Age category 75 - 79		Age category 75 - 79		Age category over 80		Age category over 80		Age-weighted mortality rate
			Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	Mortality rate	population	%
1	Indonesia	COPD	0.01%	13.36%	0.01%	12.75%	0.01%	13.53%	0.01%	12.57%	0.02%	11.60%	0.02%	10.19%	0.03%	8.43%	0.04%	6.64%	0.05%	4.56%	0.06%	2.95%	0.06%	1.89%	0.06%	1.54%																									0.022%
1	Indonesia	LC	0.01%	13.36%	0.01%	12.75%	0.01%	13.53%	0.02%	12.57%	0.03%	11.60%	0.04%	10.19%	0.04%	8.43%	0.05%	6.64%	0.05%	4.56%	0.04%	2.95%	0.03%	1.89%	0.02%	1.54%																									0.025%
1	Indonesia	IHD	0.07%	13.36%	0.10%	12.75%	0.12%	13.53%	0.15%	12.57%	0.16%	11.60%	0.17%	10.19%	0.17%	8.43%	0.16%	6.64%	0.16%	4.56%	0.16%	2.95%	0.16%	1.89%	0.16%	1.54%																									0.134%
1	Indonesia	ST	0.05%	13.36%	0.07%	12.75%	0.10%	13.53%	0.12%	12.57%	0.15%	11.60%	0.18%	10.19%	0.20%	8.43%	0.21%	6.64%	0.23%	4.56%	0.24%	2.95%	0.25%	1.89%	0.25%	1.54%																									0.136%
2	Kenya	COPD	0.07%	13.36%	0.11%	12.75%	0.15%	13.53%	0.19%	12.57%	0.23%	11.60%	0.25%	10.19%	0.27%	8.43%	0.27%	6.64%	0.29%	4.56%	0.29%	2.95%	0.30%	1.89%	0.30%	1.54%																									0.193%
2	Kenya	LC	0.09%	13.36%	0.13%	12.75%	0.19%	13.53%	0.24%	12.57%	0.28%	11.60%	0.31%	10.19%	0.33%	8.43%	0.34%	6.64%	0.35%	4.56%	0.36%	2.95%	0.37%	1.89%	0.37%	1.54%																									0.236%
2	Kenya	IHD	0.11%	13.36%	0.16%	12.75%	0.22%	13.53%	0.28%	12.57%	0.33%	11.60%	0.37%	10.19%	0.39%	8.43%	0.40%	6.64%	0.42%	4.56%	0.42%	2.95%	0.44%	1.89%	0.44%	1.54%																									0.283%
2	Kenya	ST	0.12%	13.36%	0.18%	12.75%	0.26%	13.53%	0.33%	12.57%	0.39%	11.60%	0.43%	10.19%	0.46%	8.43%	0.46%	6.64%	0.48%	4.56%	0.49%	2.95%	0.51%	1.89%	0.51%	1.54%																									0.329%
3	0	COPD																																														0.000%
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Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

RESULTS > >

PowerPlants

Capacity

CapacityFactor

EmissionFactors

MortalityRates

LifeExpectancy

PopGrowthrate

PopShareOver25

UNITED NATIONS
DESA / POPULATION DIVISION
World Population Prospects

- Enter the **remaining life expectancy (years) at exact age and time** for each country that is included in the analysis
- Data can be derived from the UN World Population Prospects

Remaining life expectancy at exact age and time

Source: UN World Population Prospects (2019)

LifeExpectancy_Tbl

	Analysis countries	Age category	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	CountryAgeLifeExp
		years	years	years	years	years	years	years	years	years	years	years	years	years	
1	Indonesia	25	49.10	49.66	50.29	50.93	51.57	52.23	52.87	53.53	54.20	54.88	55.56	56.24	Indonesia25
1	Indonesia	30	44.40	44.95	45.56	46.19	46.82	47.47	48.11	48.75	49.41	50.08	50.75	51.42	Indonesia30
1	Indonesia	35	39.73	40.25	40.85	41.47	42.09	42.73	43.36	44.00	44.64	45.30	45.96	46.62	Indonesia35
1	Indonesia	40	35.12	35.62	36.20	36.81	37.42	38.05	38.66	39.28	39.92	40.56	41.20	41.85	Indonesia40
1	Indonesia	45	30.62	31.09	31.65	32.24	32.83	33.44	34.04	34.64	35.26	35.88	36.51	37.14	Indonesia45
1	Indonesia	50	26.27	26.72	27.25	27.81	28.38	28.97	29.54	30.12	30.71	31.31	31.91	32.52	Indonesia50
1	Indonesia	55	22.14	22.55	23.05	23.57	24.11	24.67	25.21	25.76	26.32	26.88	27.45	28.03	Indonesia55
1	Indonesia	60	18.28	18.65	19.09	19.57	20.06	20.57	21.07	21.58	22.10	22.62	23.15	23.69	Indonesia60
1	Indonesia	65	14.74	15.05	15.44	15.86	16.29	16.75	17.19	17.65	18.12	18.59	19.06	19.55	Indonesia65
1	Indonesia	70	11.53	11.79	12.11	12.47	12.84	13.23	13.61	14.01	14.42	14.83	15.25	15.67	Indonesia70
1	Indonesia	75	8.72	8.94	9.20	9.48	9.78	10.10	10.42	10.74	11.08	11.43	11.78	12.14	Indonesia75
1	Indonesia	80	3.76	3.86	3.96	4.07	4.18	4.31	4.44	4.57	4.71	4.86	5.00	5.16	Indonesia80
2	Kenya	25	49.10	49.66	50.29	50.93	51.57	52.23	52.87	53.53	54.20	54.88	55.56	56.24	Kenya25
2	Kenya	30	44.40	44.95	45.56	46.19	46.82	47.47	48.11	48.75	49.41	50.08	50.75	51.42	Kenya30
2	Kenya	35	39.73	40.25	40.85	41.47	42.09	42.73	43.36	44.00	44.64	45.30	45.96	46.62	Kenya35

Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

RESULTS > >

- PowerPlants
- Capacity
- CapacityFactor
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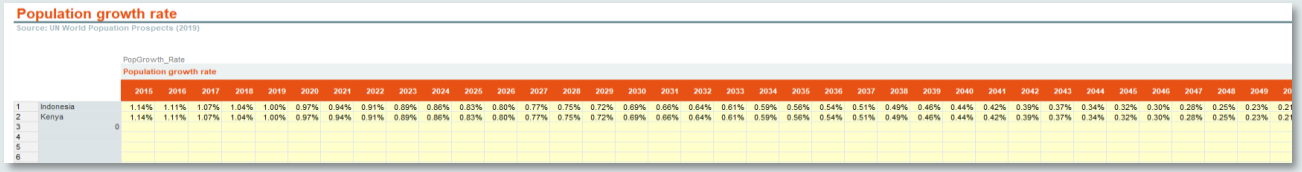
- PopShareOver25

UNITED NATIONS
DESA / POPULATION DIVISION
World Population Prospects

- Enter the **population growth rate** and **percentage share of population over 25 years of age** for each year and country that is included in the analysis
- Data can be derived from the UN World Population Prospects
- **Press F9 (calculate model) once complete**



Population growth rate

Source: UN World Population Prospects (2019)

PopGrowth_Rate

Population growth rate

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
1	Indonesia	1.14%	1.11%	1.07%	1.04%	1.00%	0.97%	0.94%	0.91%	0.89%	0.86%	0.83%	0.80%	0.77%	0.75%	0.72%	0.69%	0.66%	0.64%	0.61%	0.59%	0.56%	0.54%	0.51%	0.49%	0.46%	0.44%	0.42%	0.39%	0.37%	0.34%	0.32%	0.30%	0.28%	0.25%	0.23%
2	Kenya	1.14%	1.11%	1.07%	1.04%	1.00%	0.97%	0.94%	0.91%	0.89%	0.86%	0.83%	0.80%	0.77%	0.75%	0.72%	0.69%	0.66%	0.64%	0.61%	0.59%	0.56%	0.54%	0.51%	0.49%	0.46%	0.44%	0.42%	0.39%	0.37%	0.34%	0.32%	0.30%	0.28%	0.25%	0.23%
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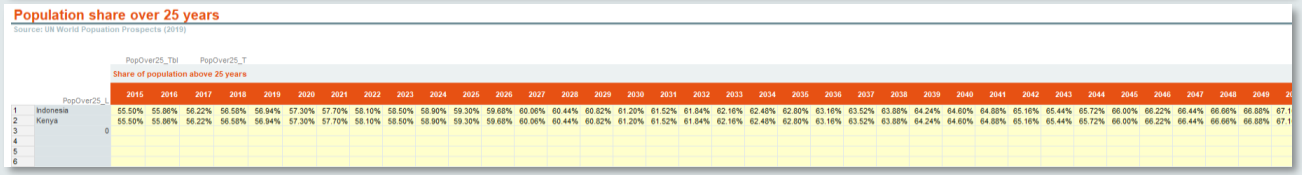

Population share over 25 years

Source: UN World Population Prospects (2019)

PopOver25_Tbl PopOver25_T

Share of population above 25 years

	PopOver25_L	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
1	Indonesia	55.50%	55.86%	56.22%	56.58%	56.94%	57.30%	57.70%	58.10%	58.50%	58.90%	59.30%	59.68%	60.06%	60.44%	60.82%	61.20%	61.52%	61.84%	62.16%	62.48%	62.80%	63.16%	63.52%	63.88%	64.24%	64.60%	64.88%	65.16%	65.44%	65.72%	66.00%	66.22%	66.44%	66.66%	66.88%
2	Kenya	55.50%	55.86%	56.22%	56.58%	56.94%	57.30%	57.70%	58.10%	58.50%	58.90%	59.30%	59.68%	60.06%	60.44%	60.82%	61.20%	61.52%	61.84%	62.16%	62.48%	62.80%	63.16%	63.52%	63.88%	64.24%	64.60%	64.88%	65.16%	65.44%	65.72%	66.00%	66.22%	66.44%	66.66%	66.88%
3	0																																			
4																																				
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Setting up the tool

INPUTS > >

...

CALC > >

Valuation (optional)

RESULTS > >

- This is an optional input used to monetise the corresponding health costs of air pollution
- Enter the **value of statistical life in USD** and **the corresponding source** for each country that is included in the analysis
- **Press F9 (calculate model) once complete**

The metric "value of statistical life" does not place a monetary value on individual life, rather it reflects an average value of what people are willing to pay to marginally reduce their risk of mortality from environmental pollution (for more information on how the value is calculated see OECD, 2008)

Valuation (premature deaths)

AnalysedCountries VSL

	Analysis Country	Value of a statistical life USD	Source
1	Indonesia	$ 100,000.00	Test value
2	Kenya	$ 100,000.00	Test value
3	0	$ -	
4		$ -	
5		$ -	
6		$ -	
7		$ -	
8		$ -	
9		$ -	
10		$ -	
11		$ -	
12		$ -	
13		$ -	
14		$ -	
15		$ -	
16		$ -	
17		$ -	
18		$ -	
19		$ -	
20		$ -	

Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

RESULTS > >

- PopulationInput
- IntakeFraction (…)
- RelativeRisk (…)
- BaseCases (…)
- PrematureDeaths (…)
- YLL (…)
- ValuationPDs

- In order to limit calculations to the number of units inserted for the particular analysis, after populating the PowerPlants sheet:
  - **Step 1:** Click on the button "Clear rows" to reset all calculation sheets (note this does not reset, or delete any inputs, but just means that the tool will only calculate results for the power plant unit included in the first row)
  - **Step 2:** Click on the button "Extend rows" to set up all of the calculation sheets to align with the number of power plant units inserted in the PowerPlants input sheet
- The model allows the user to insert up to 9,990 units in the PowerPlants sheet
- **After steps 1 and 2, press F9 and go to the RESULTS** >> section to review results of the analysis

- The calculation sheets are hidden and can be unhidden by pressing the button “unhide calculation sheets”. These sheets do not require any user input.

Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

RESULTS > >

- Scenario
- Country
- PowerPlant

- In the result set-up **choose the scenario and population coverage**
- "In-country" calculates the results only for the population in the country where the power plant is located, "All countries" for all populations affected by the emissions of the power plant
- **Press F9 (calculate model)** when making changes to the result set-up
- Graphs and result tables will automatically update

Setting up the tool

Ambition to Action

INPUTS > >

CALC > >

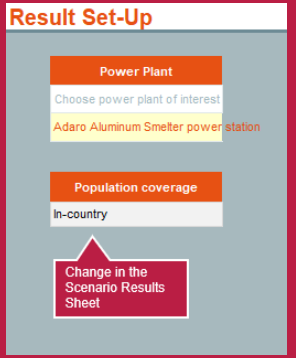
RESULTS > >

Scenario

Country

PowerPlant

- In the result set-up **choose the country or power plant** of interest
- Population coverage can only be changed in the Scenario results sheet
- **Press F9 (calculate model)** when making changes to the result set-up
- Graphs and result tables will automatically update



QUESTIONS / COMMENTS / FEEDBACK

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NEW CLIMATE INSTITUTE

Ambition to Action