The Co-benefits from Heat Only Boilers in Mongolia

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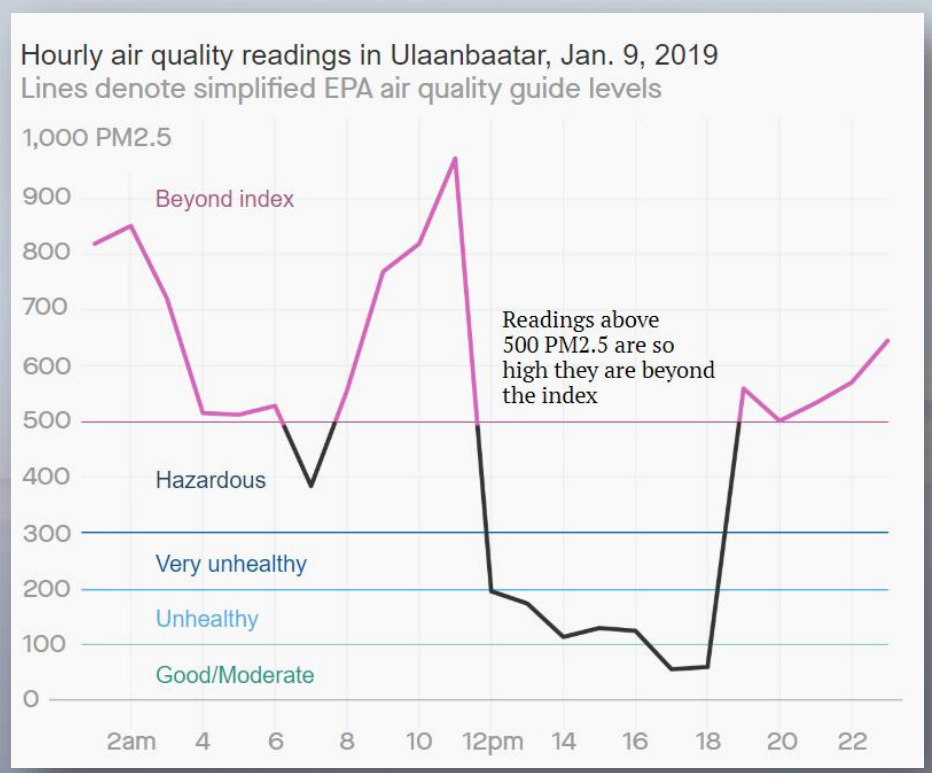
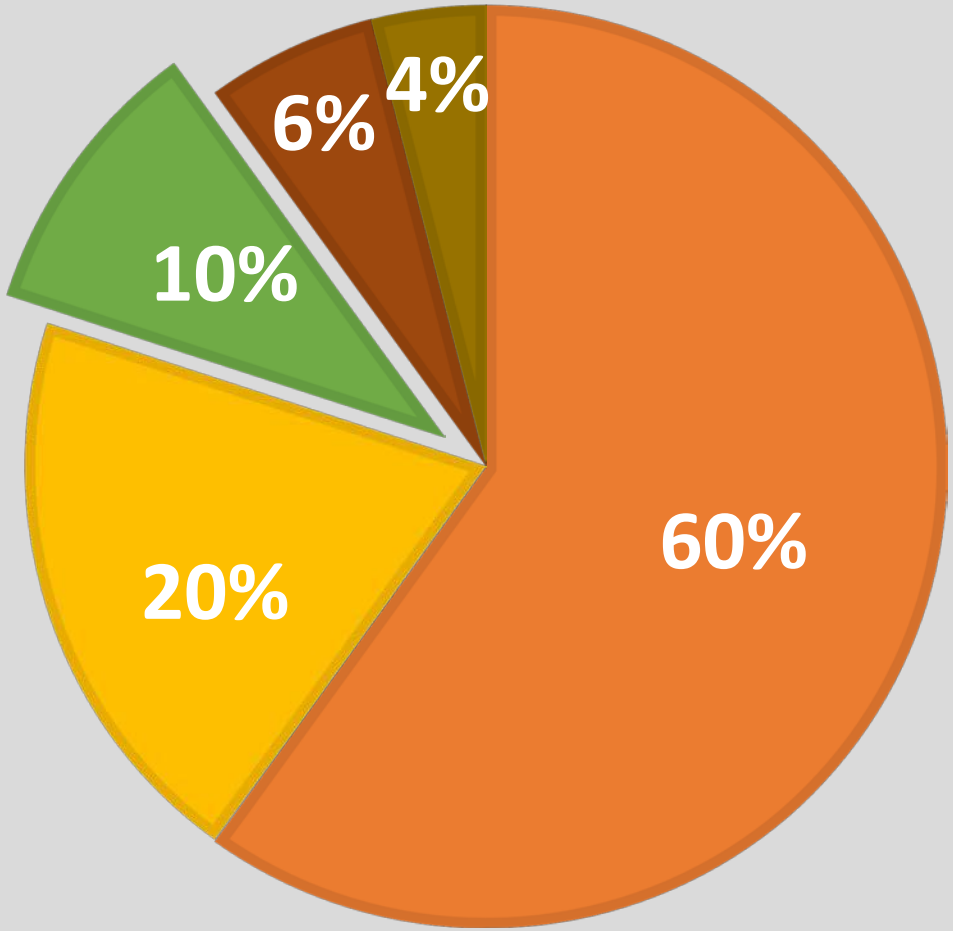
GOVERNMENT OF MONGOLIA
MINISTRY OF ENVIRONMENT AND TOURISM

Institute for Global Environmental Strategies (IGES)
7 November 2019

MONGOLIA


Hourly air quality readings in Ulaanbaatar, Jan. 9, 2019
Lines denote simplified EPA air quality guide levels
1,000 PM2.5
900
800
700
600
500
400
300
200
100
0
Beyond index
Readings above 500 PM2.5 are so high they are beyond the index
Hazardous
Very unhealthy
Unhealthy
Good/Moderate
2am
4
6
8
10
12pm
14
16
18
20
22

Sources of air pollution

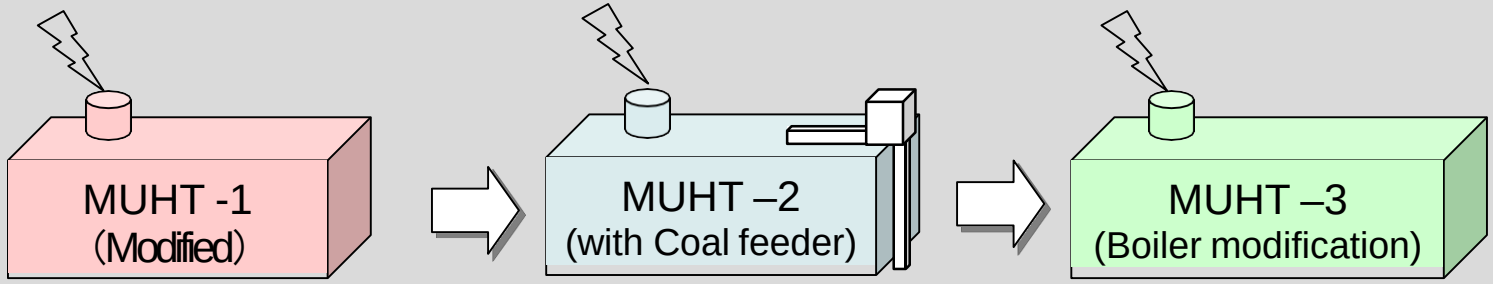


- Г Ger district
- А Transport means
- У Heating boilers
- Д CHPs
- Б Other

Heat Only Boiler /MUHT 1-3/

Study on Co-benefits Type Pollution Control for Heat OnlyBoiler (HOB) (Co-benefits Project) 2014 -2017

- During 2014 - 2015
  Production of auxiliary unit (Fan, Cyclone Control unit) modified HOB (MUHT-1)
- During 2015 – 2016
  Attachment of coal feed unit on the modified HOB (MUHT-2)
- During 2016-2017 (MUHT-3)

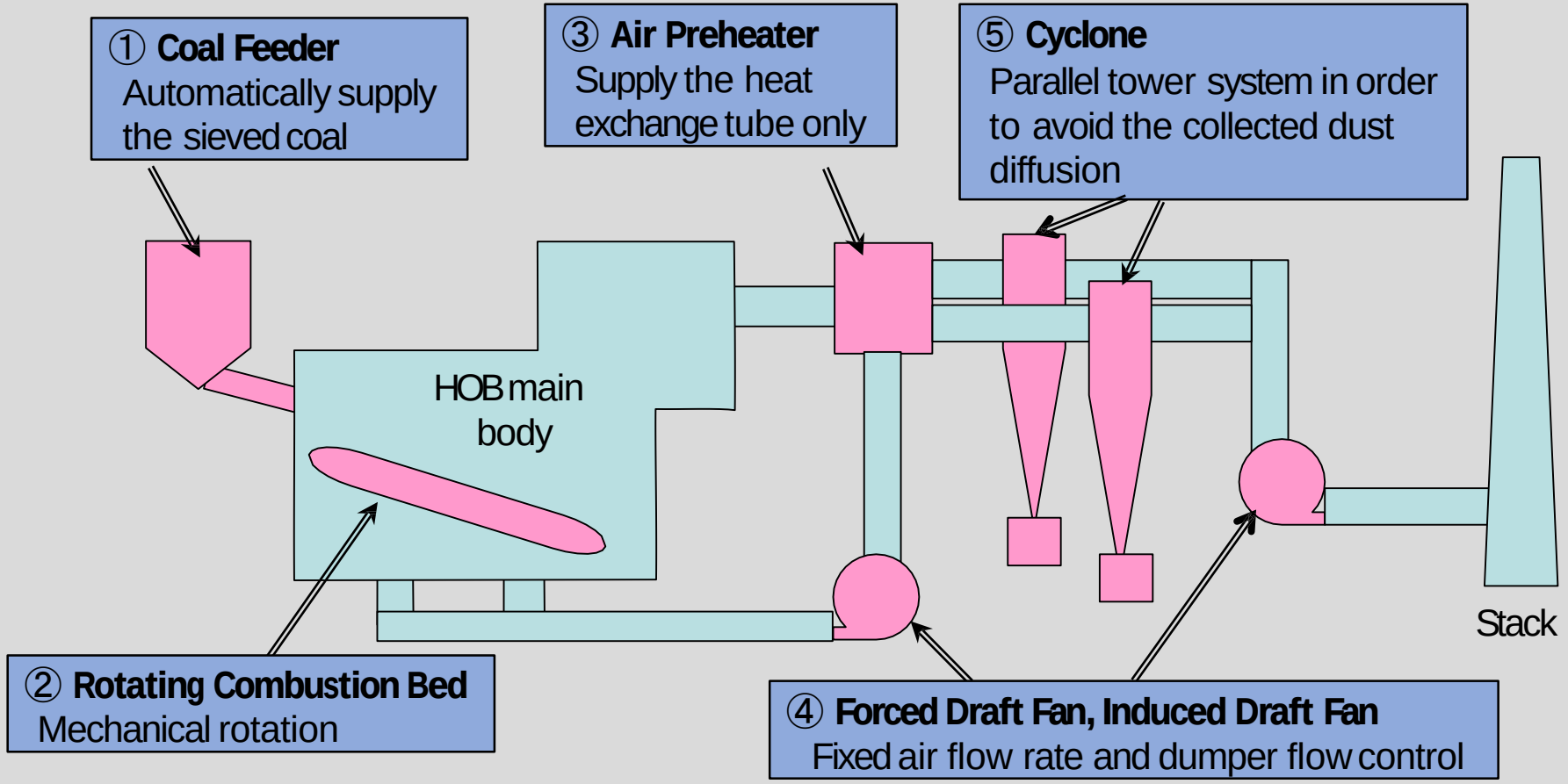


- Stable Combustion
- Reduction of Coal Moisture
- Upgrading the Thermal Efficiency
- Reduction of HOB Dust

- Stable Combustion
- Reduction of Coal Dispose Work
- Upgrading the Thermal Efficiency
- Reduction of HOB Dust

Modified HOB（MUHT-3）

- Main body is manufactured in Mongolia（MUHT design basis）
- Auxiliary is made in Japan ⇒ made in Mongolia in near future
- HOB structure and control system are simplified in order to be manufactured in Mongolia



Source: MOEJ

Co-benefits

Unit: ton/year*

	Emissions from reference HOB*	Emissions from modified HOB*	Co-benefits effect* (Reduced emission)	Co-benefits effect (i)	Co-benefits effect (ii)	Co-benefits effect (iii)
CO_2	728	455	273	51,000	382,000	820,000
SO_2	3.69	3.33	0.36	67	500	1,100
NOx	1.34	0.32	1.02	190	1,500	3,100
CO	50.36	5.38	44.98	8,400	63,000	135,000
Dust	6.02	2.44	3.58	670	5,000	11,000

* Assuming that operating days are 240 days per year (8 months from October to May)

(i) Case of replacing registered HOB in Ulaanbaatar City (about 200) with modified HOB

(ii) Case of replacing all HOB in Ulaanbaatar City (about 1,400) with modified HOB

(iii) Case of replacing all HOB in Mongolia (about 3,000) with modified HOB

Source: MOEJ

Policy support

Climate Change

- **National Action Programme on Climate Change 2011;**
- **INDC 2015;**
- **Green development policy 2016**
- **Sustainable development vision 2030**
- **NDC 2019**

Measures:

Bilateral & Multilateral mechanisms

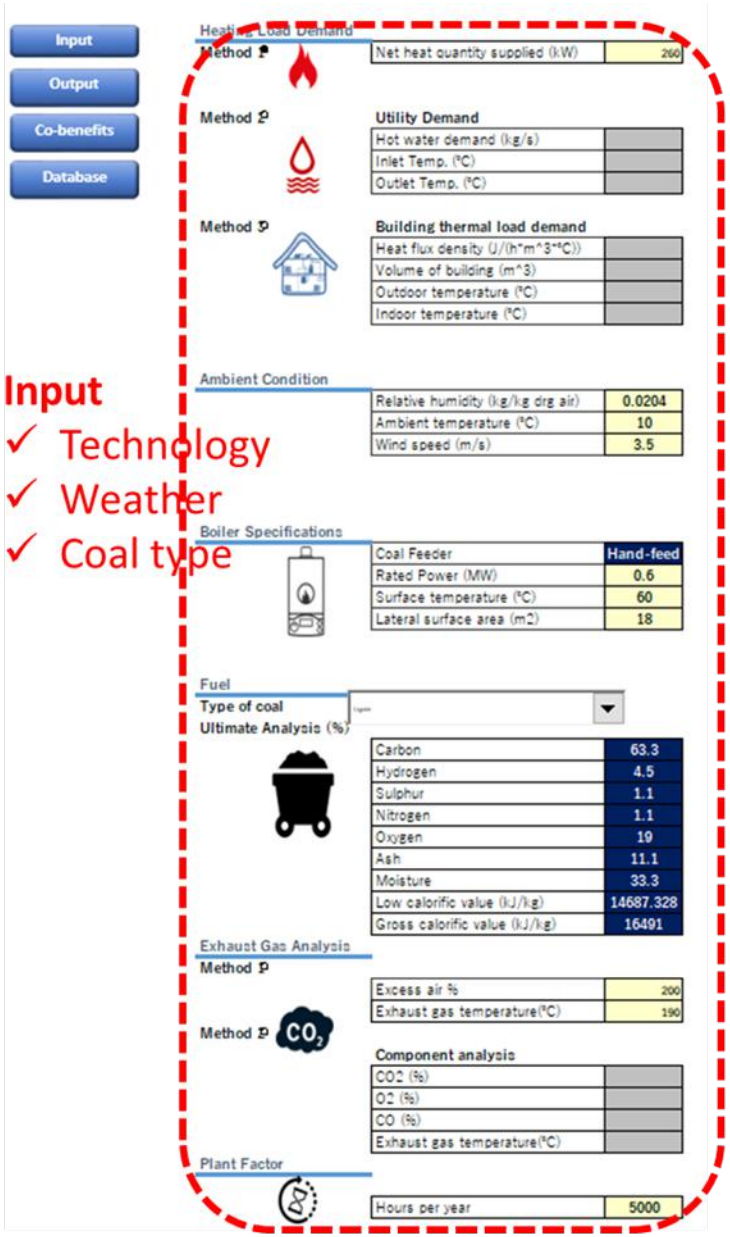
Air pollution

- **National Programme on Reducing Air and Environment Pollution 2017;**
- **Decision to ban the raw coal in the capital**

Measures:

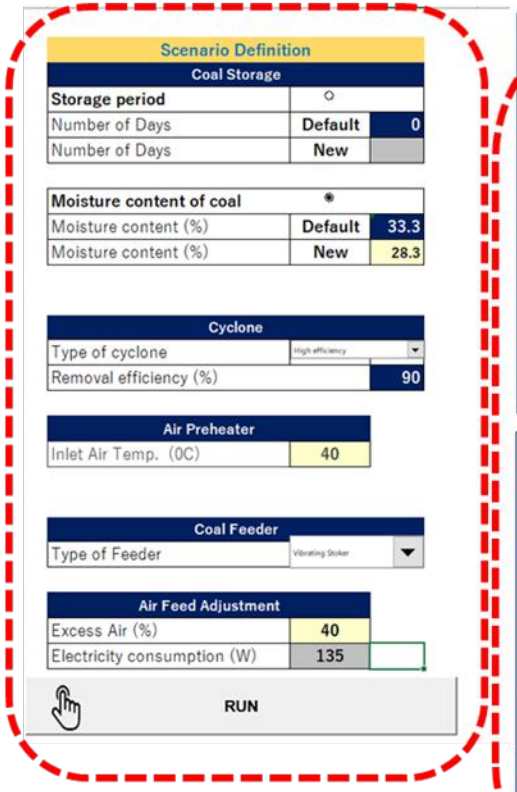
- Night time electricity incentive;
- 2019.05.15 the raw coals was banned in the capital city, instead utilizing fuel-efficient briquettes;
- Utilization of efficient stove
- Installment of filters in old heating boilers
- Restructuring of ger district, decentralization-banned internatl migration until 2020

Co-benefit Assessment Tool Ver. 1 (Organization)



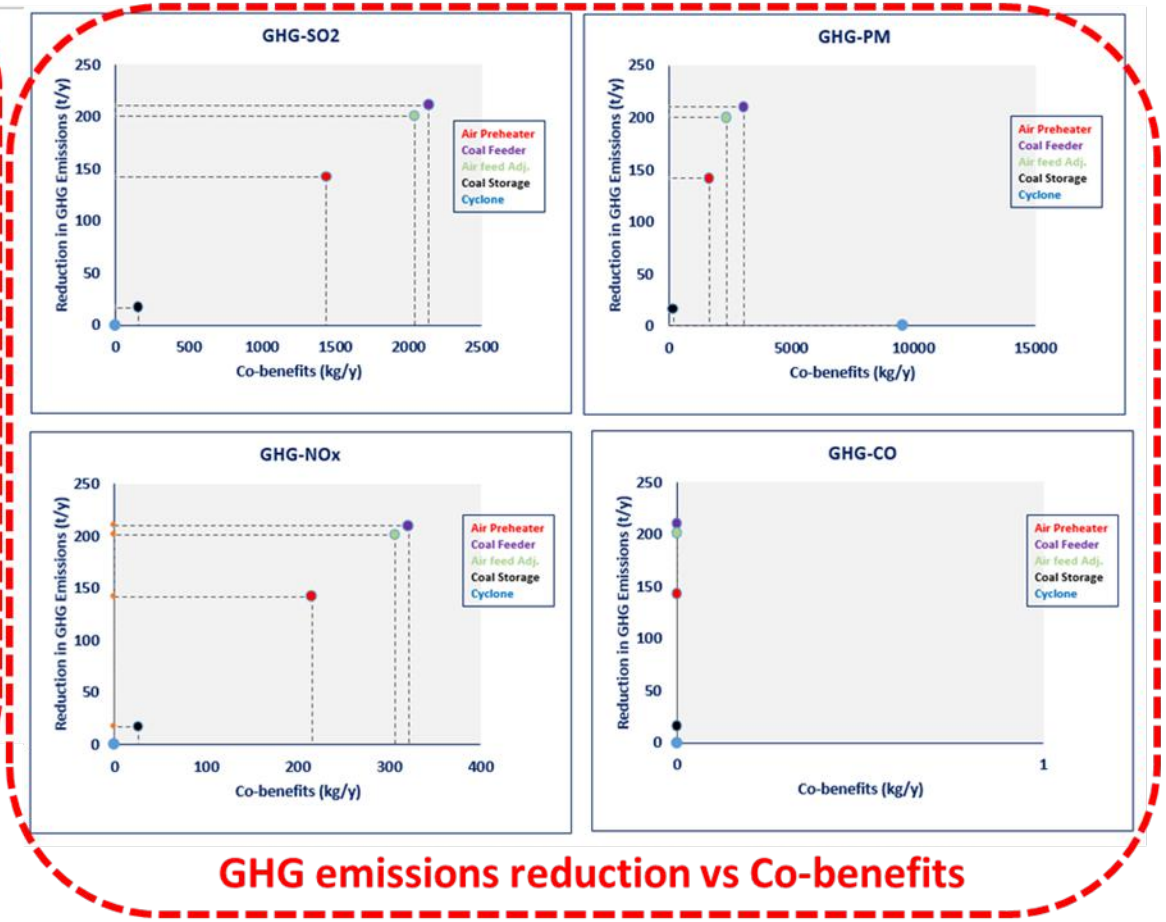
Input

- ✓ Technology
- ✓ Weather
- ✓ Coal type



Scenario Definition

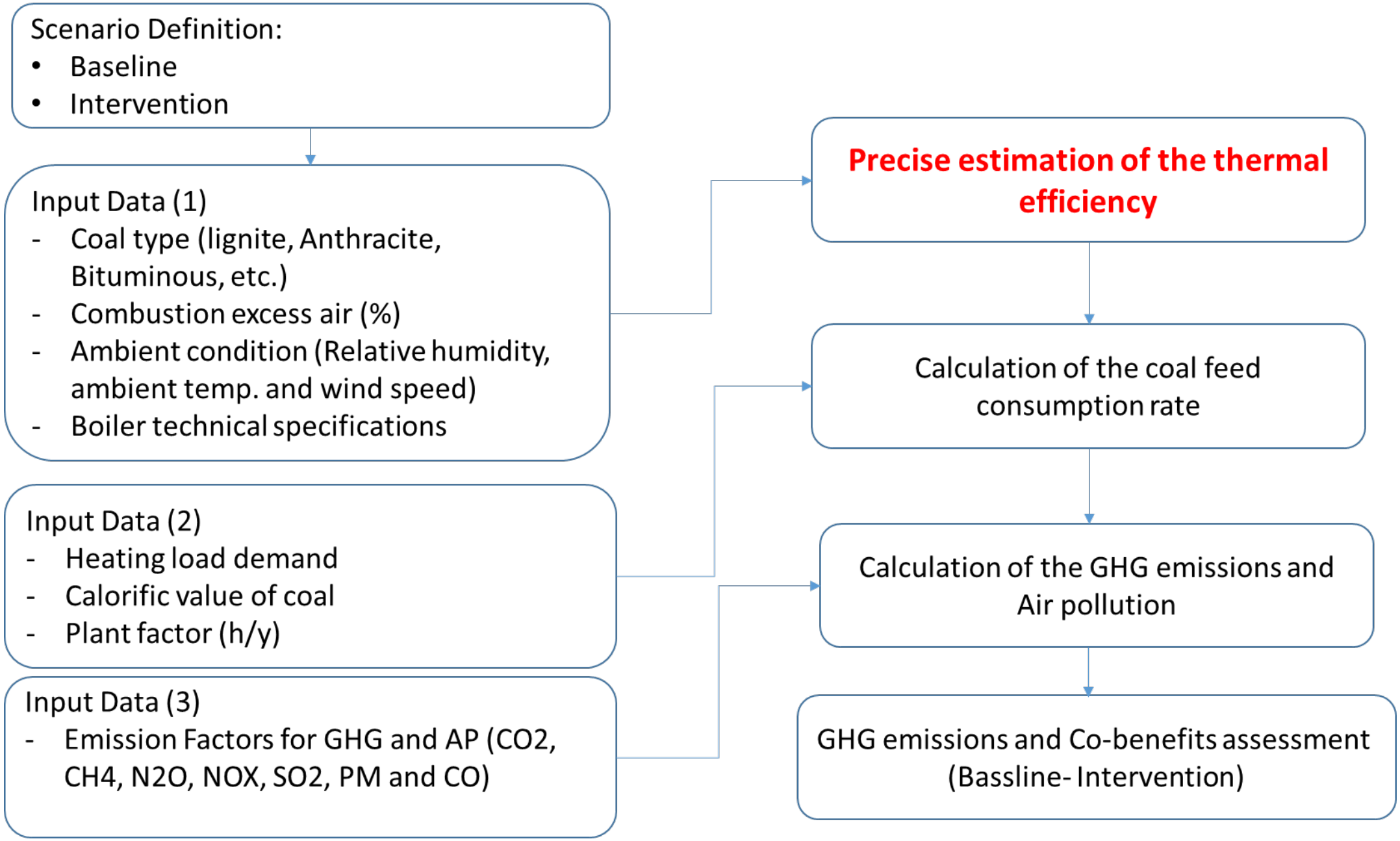
- ✓ Coal Feeder
- ✓ Air Preheater
- ✓ Cyclone dust removal
- ✓ Air Feed Adjustment
- ✓ Moisture Control



GHG emissions reduction vs Co-benefits

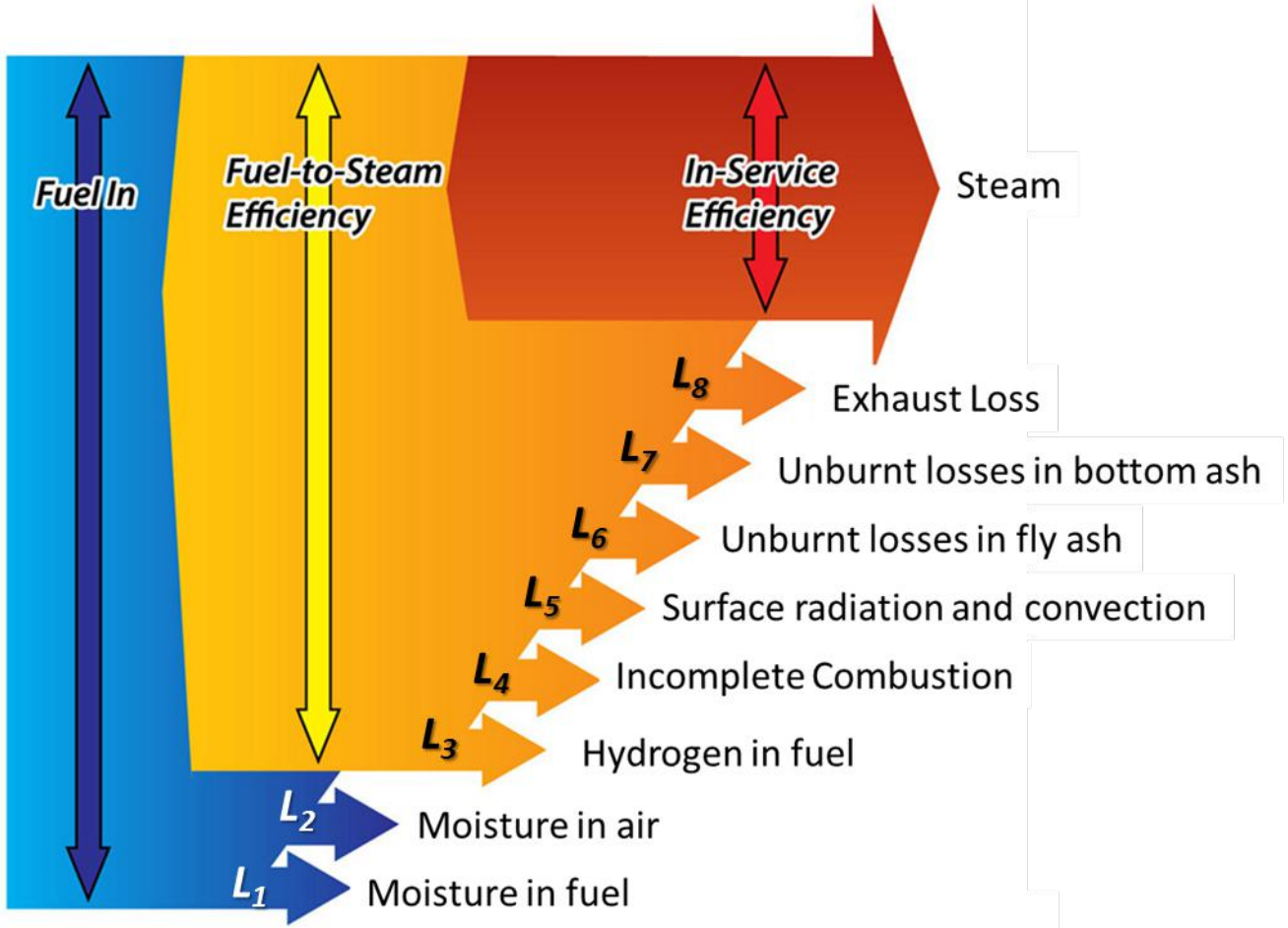
Bottom-up technology assessment spreadsheet tool to evaluate co-benefits of technical improvements in HOB

Co-benefit Assessment Tool Ver. 1 (Calculation Flow)



Co-benefit Assessment Tool Ver. 1 (Methodology)

$$\eta_{HOB} = 1 - (L_1 + L_2 + L_3 + L_4 + L_5 + L_6 + L_7 + L_8)$$



American Society of Mechanical Engineers (ASME)
Power Test Code 4.1

$$m_c = \frac{PH_p}{\eta_{HOB} GCV_c}$$

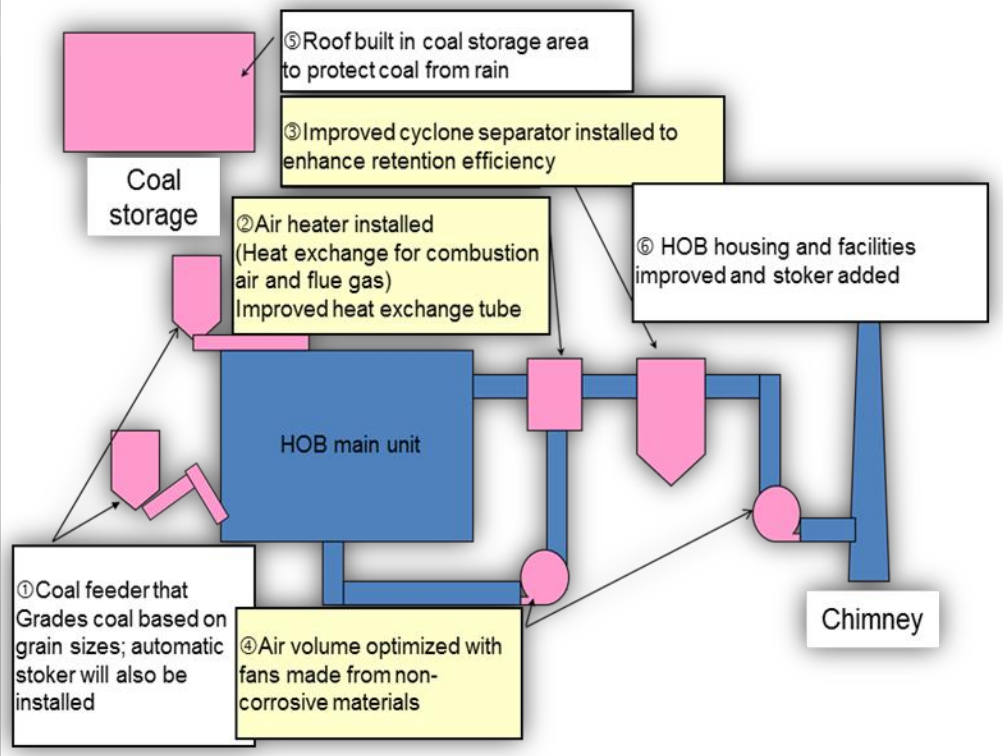
GCV_c: Calorific value of coal
PH_p: Net quantity of heat supplied by the HOB

$$E_p = (m_c \times EF_p) + (EC \times EF_{p,Grid})$$

- E_p: Pollutant Emission (t_p)
- m_c: Coal consumption (t_{coal})
- EF_p: Emission factor of pollutant (t_p/t_{coal})
- EC: Electricity consumption(kWh)
- $EF_{p,Grid}$: Emission factor of the grid (t_p/kWh)

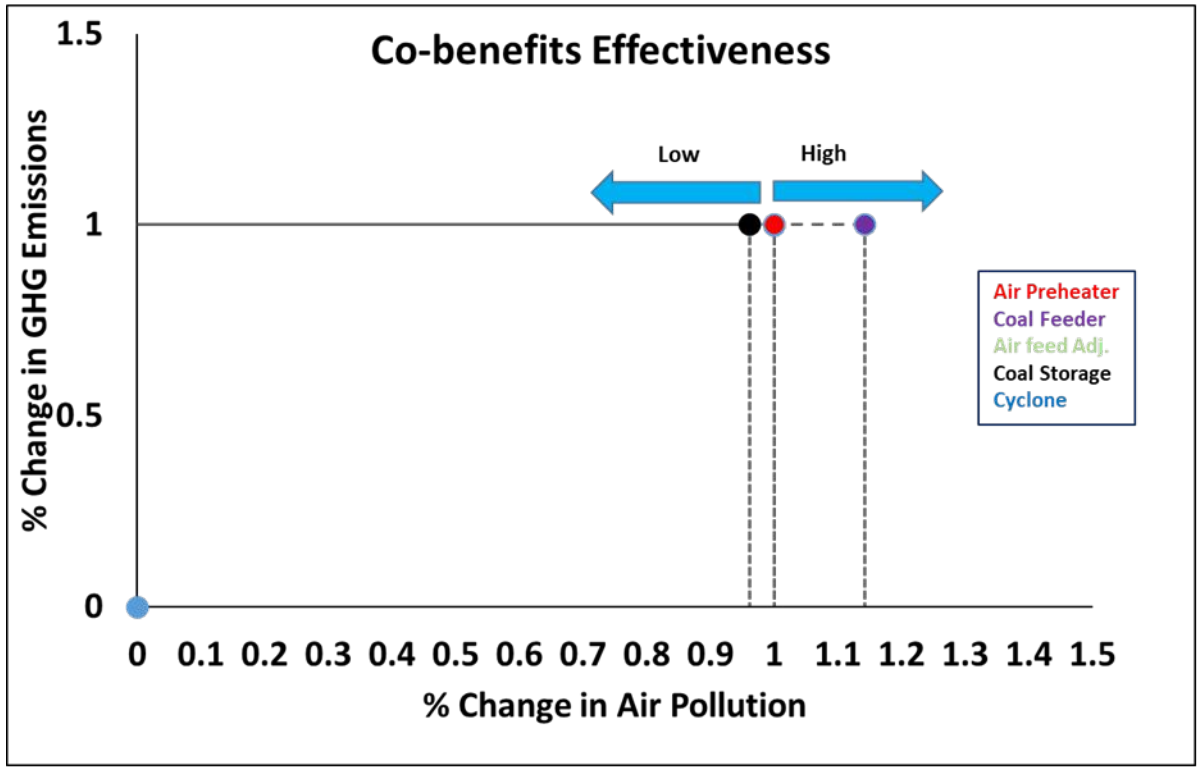
Co-benefit Assessment Tool Ver. 1 (Scenarios and Results)

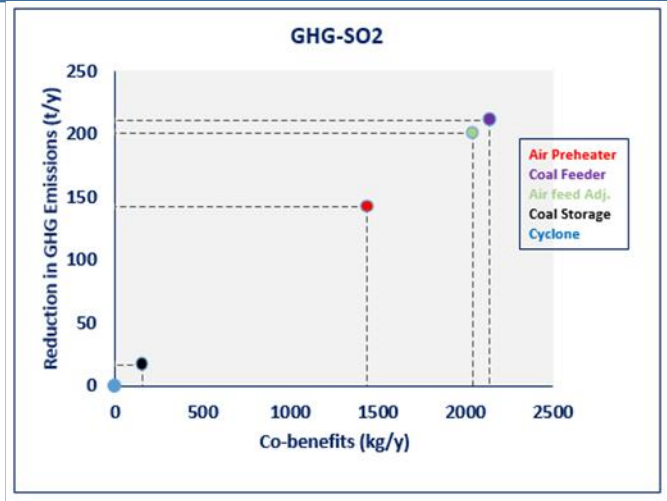
	Baseline scenario	Intervention scenario
Ambient Condition		
Ambient Temp. (C)	10	10
Relative humidity (kg/kg drg air)	0.0204	0.0204
Wind speed (m/s)	3.5	3.5
Boiler information		
Boiler Type	E-BIO 600	E-BIO 600
Rated Power (kW)	600	600
Heat duty (kW)	260	260
Coal Feeder	Hand feed	Vibrating stoker
Lateral surface area (m2)	18	18
Surface temp. (C)	60	60
Exhaust gas Temp. (C)	190	190
Coal Type	Lignite	Lignite
Interventions		
1. Cyclone Dust Collector	-	High efficient, $\eta_{cy} = 90\%$
2. Air Preheater	-	Air temp. after Preheater =40 C Flue gas outlet temp. after Preheater= 162 C
3. Coal Storage	-	5% reduction in the moisture content of coal
4. Air feed adjustment	- Excess air= 200%	Using damper, controller and FD fan Excess air= 40% Electric power = 135 kW

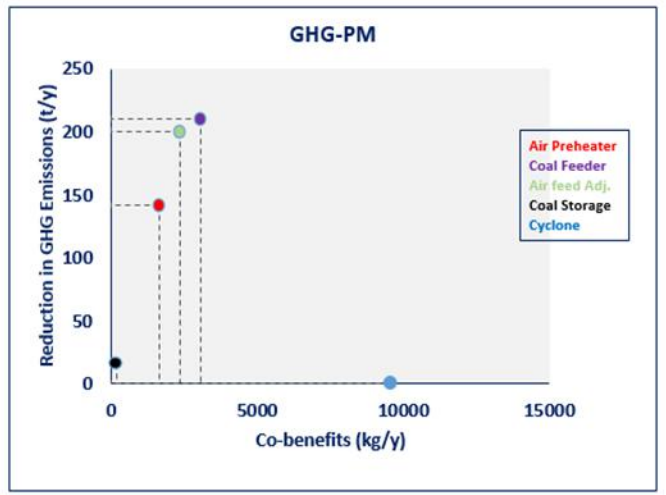


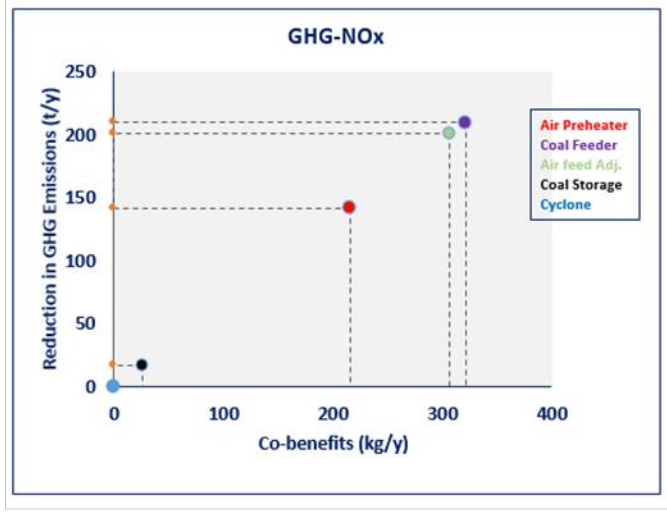
Unit: t/h	Coal Storage	Cyclone dust collector	Air preheater	Coal Feeder	Air Feed Adjustment	Combined Scenario
GHG	-16.72	0.00	-141.56	**-210.45**	-200.65	**-368.74**
SO_2	-0.155	0.00	-1.44	**-2.14**	-2.04	**-3.73**
PM	-0.195	**-9.56**	-1.65	-3.07	-2.34	**-14.48**
CO	0.00	0.00	0.00	0.00	0.00	**0.00**
NOx	-0.025	0.00	-0.216	**-0.322**	-0.306	**-0.563**

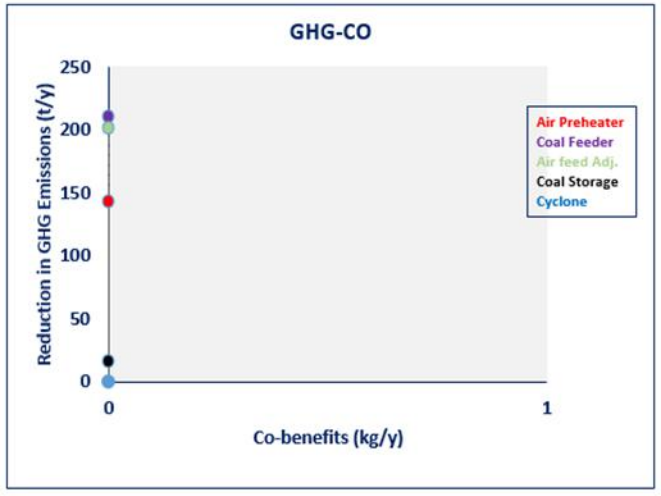
Co-benefit Assessment Tool Ver. 1 (Scenarios and Results)











Midpoint method

$$\text{Co-benefit Project Effectivity} = \frac{\text{Percent change in Air pollution}}{\text{Percent change in GHG}} = \frac{(AP_B - AP_I)/(AP_B + AP_I/2)}{(GHG_B - GHG_I)/(GHG_B + GHG_I/2)}$$

AP: Air Pollution
B: Baseline scenario
I: Intervention Scenario

Co-benefit Assessment Tool Ver. 2 (Organization)

New Feature added to Ver. 1: Health Benefit Assessment

Input | Output | Co-benefits | Health Impact | Database

Input

Exposure Level

Adult	1,616,477
Child (0-5)	167,099

Deaths and DALYs

Background Mortality Rate	(per 100000)
Chronic Obstructive pulmonary Disease (COD)	23
Ischemic Heart Disease!(IHD)	150.9
Cerebrovascular disease (Stroke)	109.7
Lung Cancer (LC)	18.14
Acute Lower Respiratory Infections (ALRI)	276.82
Tuberculosis and Bronchus (TB)	15.7

DALYs	
Chronic Obstructive pulmonary Disease (COD)	1614
Ischemic Heart Disease!(IHD)	11922
Cerebrovascular disease (Stroke)	9686
Lung Cancer (LC)	1490
Acute Lower Respiratory Infections (ALRI)	10804
Tuberculosis and Bronchus (TB)	2484

PM Emissions

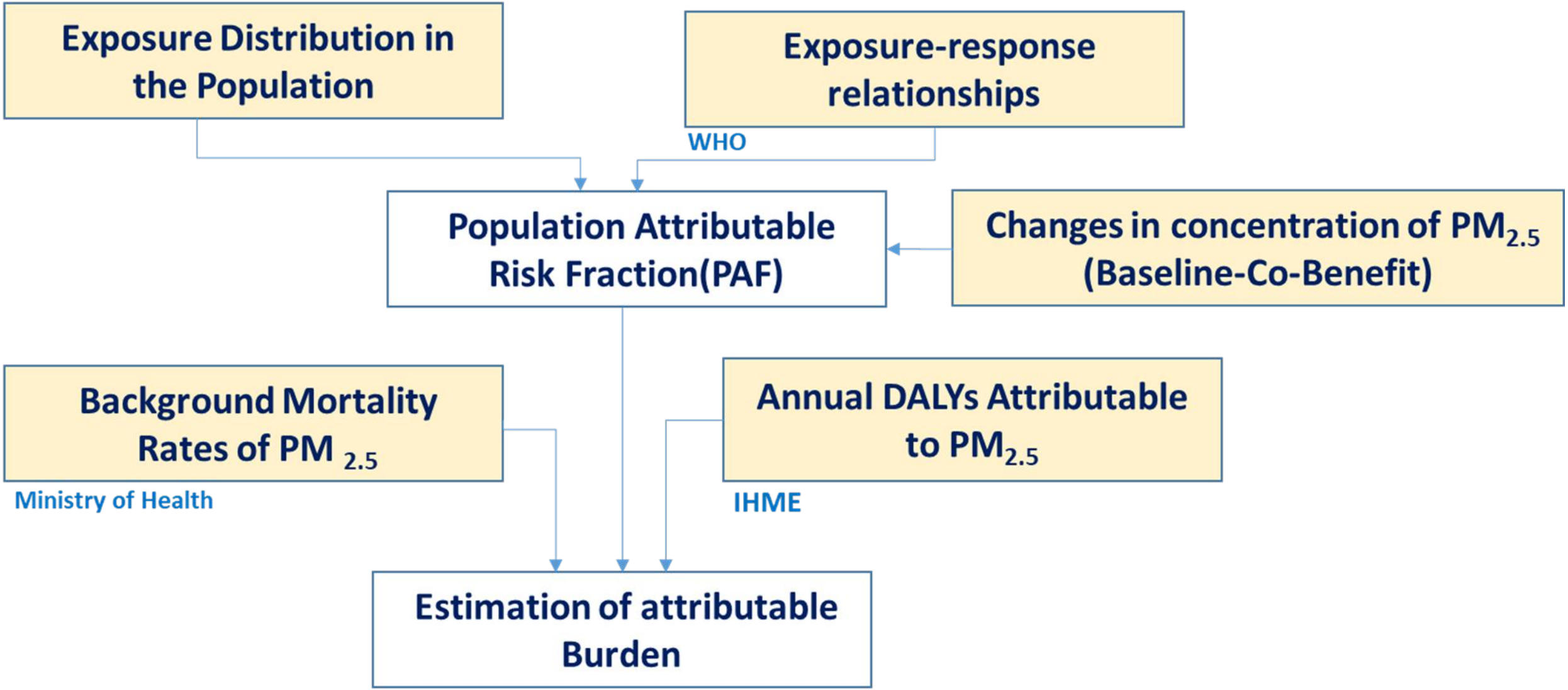
Baseline Scenario	
PM emissions (t/y)	1300.00
Population weighted Concentration of PM (ug/m3)	57.00
Co-Benefits Scenario	
Number of HOBs	1
Reduction in PM from the Co-benefits Scenario (t/y)	14.49
Reduction in PM from the Co-benefits Scenario (ug/m3)	0.64
Co-benefits Scenario Concentration of PM (ug/m3)	56.36

Results

	COPD	IHD	Stroke	LC	ALRI	TB	Total
Baseline Scenario							
Relative Risk (Lower Limit)	1.100	1.239	1.169	1.088	1.306	2.125	
Relative Risk (Upper Limit)	1.311	1.842	1.768	1.520	1.437	2.338	
PAF (Lower Limit)	0.091	0.193	0.145	0.081	0.234	0.529	
PAF (Upper Limit)	0.237	0.457	0.434	0.342	0.304	0.572	
Health Burden (Lower Limit)	34	470	256	24	108	134	1027
Health Burden(Upper Limit)	88	1115	770	100	141	145	2359
DALYs (Lower Limit)	147	2299	1401	120	2533	1315	7815
DALYs Upper Limit)	383	5448	4207	510	3285	1421	15254
Co-benefits Scenario							
Relative Risk (Lower Limit)	1.099	1.238	1.168	1.086	1.303	2.111	
Relative Risk (Upper Limit)	1.308	1.837	1.763	1.515	1.433	2.322	
PAF (Lower Limit)	0.090	0.192	0.144	0.080	0.232	0.526	
PAF (Upper Limit)	0.235	0.456	0.433	0.340	0.302	0.569	
Health Burden (Lower Limit)	34	469	255	23	108	134	1022
Health Burden(Upper Limit)	88	1111	768	100	140	144	2350
Deaths Prevented (Lower Limit)	0	2	1	0	1	1	5
Deaths Prevented Upper Limit)	1	4	3	1	1	1	9
Averted DALYs (Lower Limit)	1.3	8.5	7.7	1.4	21.6	7.9	48
Averted DALYs Upper Limit)	2.6	17.9	14.0	3.0	19.6	7.2	64

- Chronic Obstructive pulmonary Disease (COD)
- Ischemic Heart Disease (IHD)
- Cerebrovascular disease (Stroke)
- Lung Cancer (LC)
- Tuberculosis and Bronchus (TB)
- Acute Lower Respiratory Infections (ALRI)

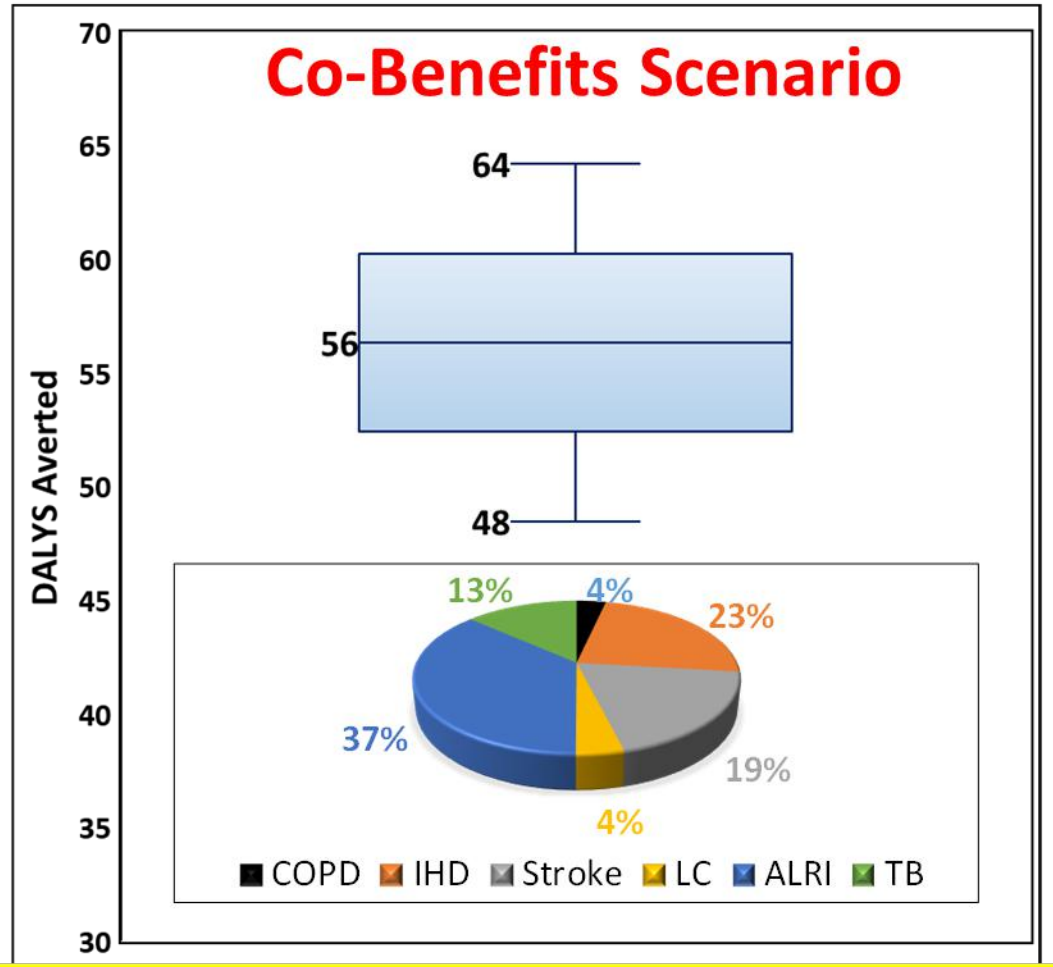
Co-benefit Assessment Tool Ver. 2 (Calculation Flow)

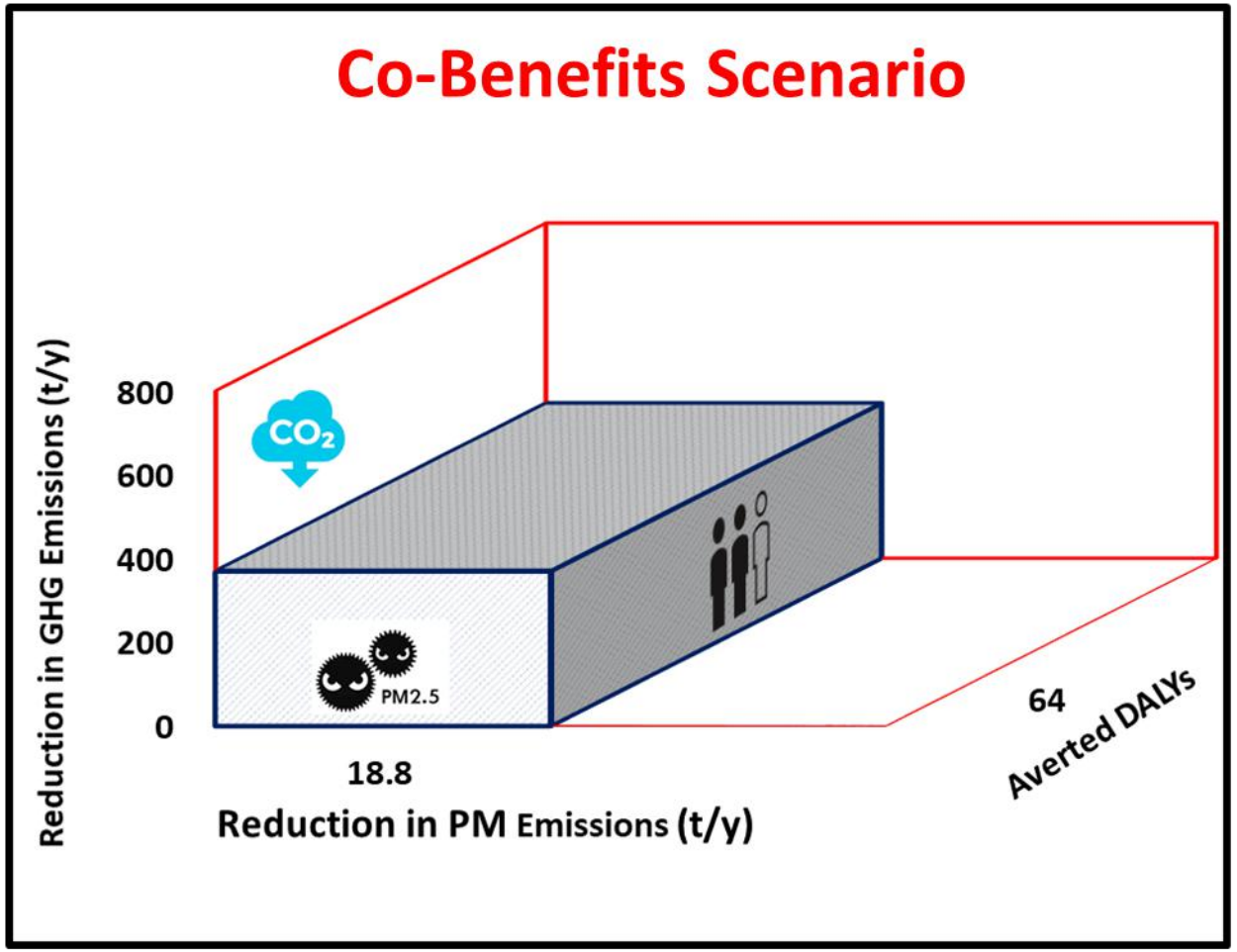


IHME: Institute for Health Metrics and Evaluation
WHO : World Health Organization

Co-benefit Assessment Tool Ver. 2 (Results)

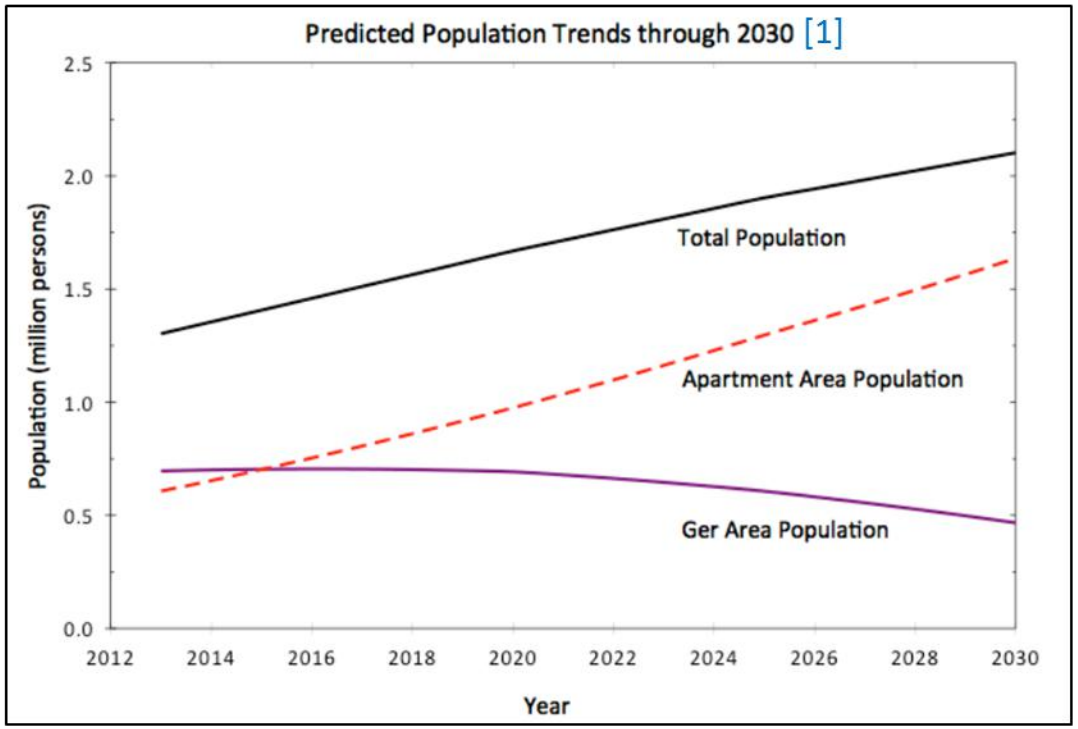
Integrated Environment-Health Assessment





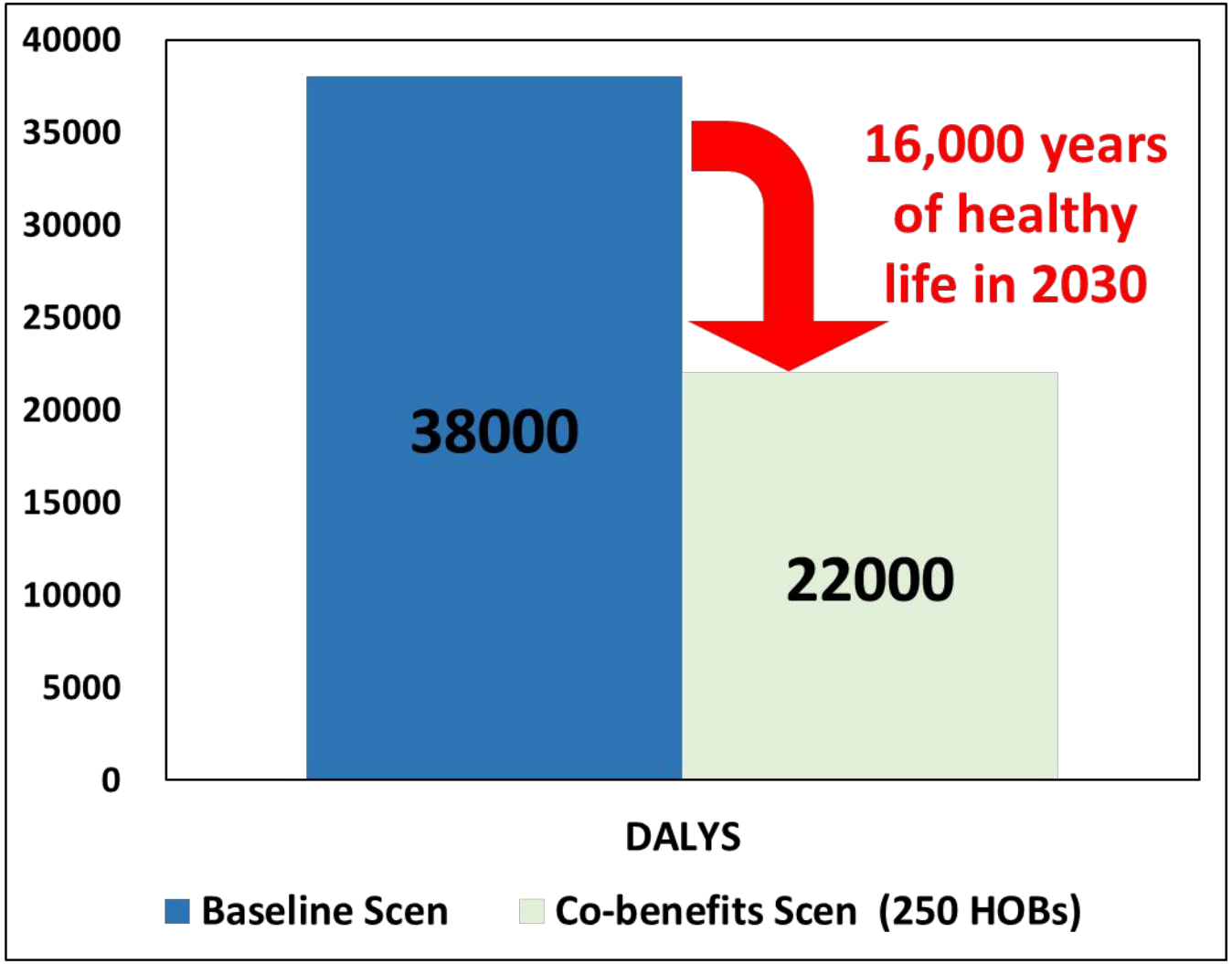
Deployment of <u>one</u> high-efficiency HOB will result in nearly <u>64 years</u> of healthy life in Ulaanbaatar

Co-benefit Assessment Tool Ver. 2 (Results)



- Total apartment households in 2030[1]= **400,000**
- Share of HOB in total heating (%)[1]= **14**

- Estimated number of HOBs in 2030[2] =**250**
- HOBs emission (tons $PM_{2.5}$/year)[3]= **4500**



1] Air Pollution and Health in Ulaanbaatar, Ministry of the Environment and Green Development, Mongolia
2] Sustainable Development Series: Discussion Paper Sustainable Development Department East Asia and Pacific Region, The World Bank
3] EES Co-benefits Assessment Tool

Thank you very much for your attention

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