

Assessing GHG and SLCP emissions from urban city services in Indonesia: a co-benefits analysis and case study on wastewater



















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Highly Potent Short-Lived Climate Pollutants—Sources and Impacts

POLLUTANT	SOURCES	MAJOR IMPACTS
BLACK CARBON	 black coal  diesel exhaust  biomass for cookstoves	 local regional
METHANE	 natural gas  livestock  landfills	 global
TROPOSPHERIC OZONE	 methane  carbon monoxide  nitrogen oxide  volatile organic compounds	 local regional
HYDROFLUORO-CARBONS	 air conditioning  refrigeration	 global

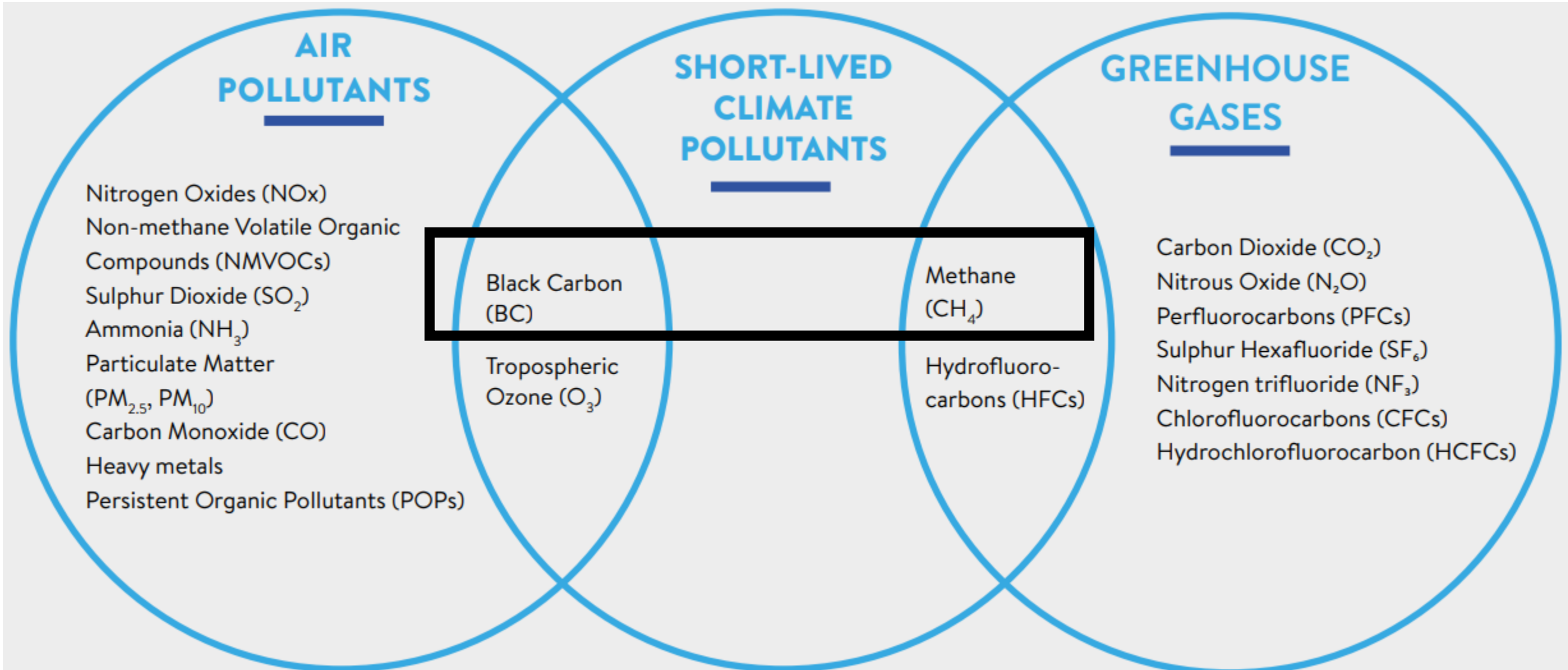
Source: The Climate and Clean Air Coalition.

Notes: Black carbon and tropospheric ozone also have a small global impact; methane also has small local and regional impacts.



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Air Pollution and Climate Change Linkages



Air pollution is increasingly being compared to smoking



The health impacts of pollution globally are about the same as smoking

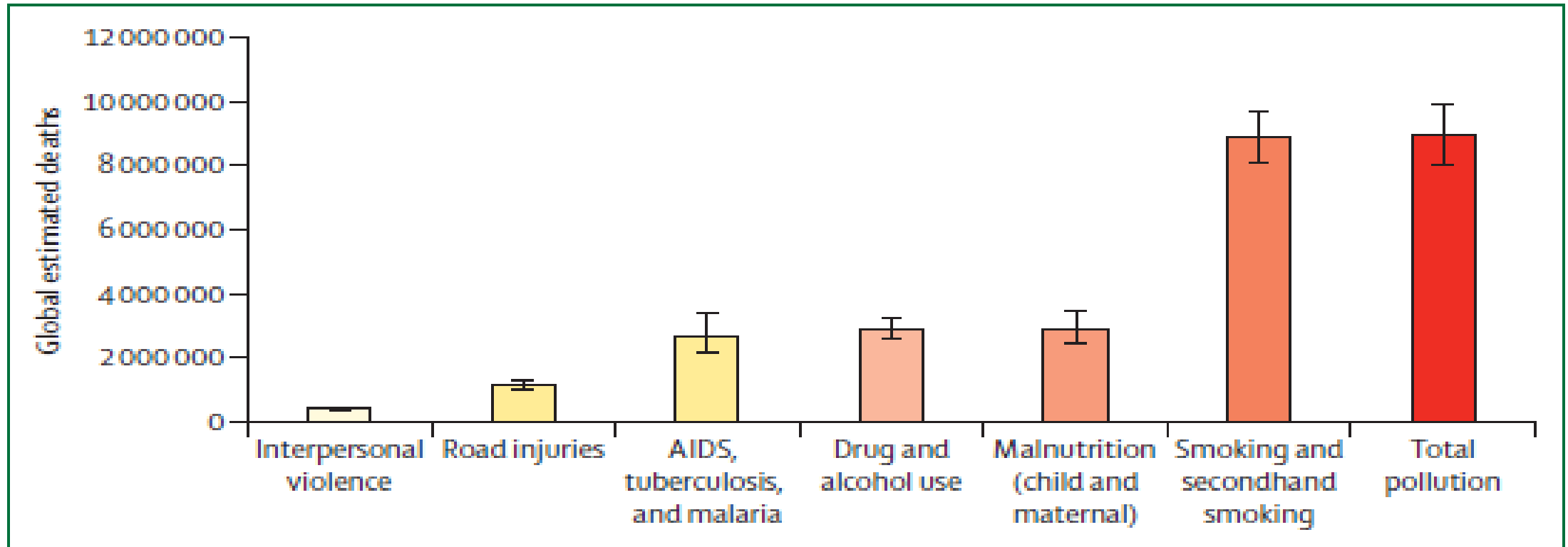


Figure 1: Global estimated deaths by major risk factor or cause

Data from Institute for Health Metrics and Evaluation and Global Burden of Diseases, Injuries, and Risk Factors Study 2019.⁶ Error bars are 95% CI.

SLCP Impacts

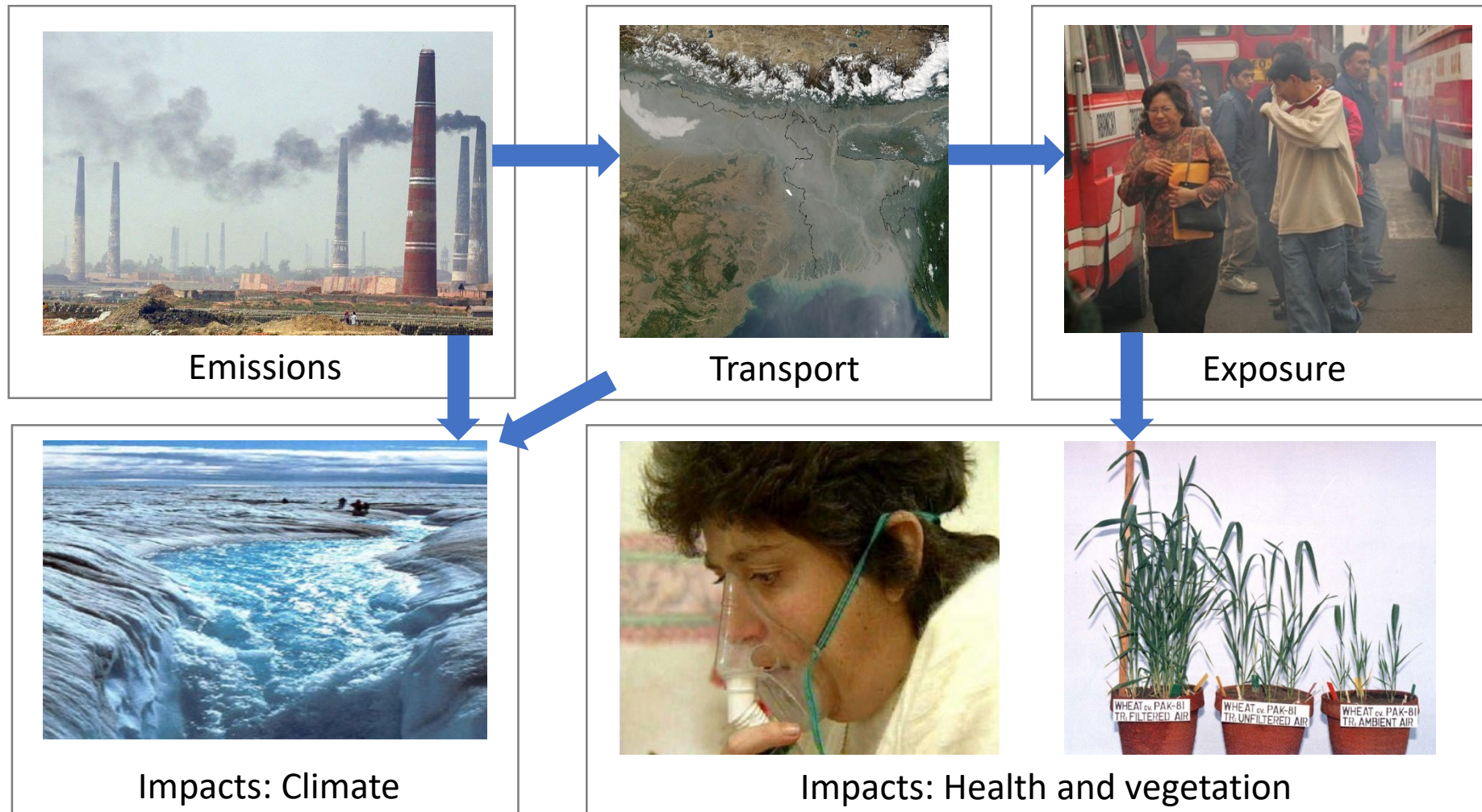


There are several tools that can help understand these impacts

- Cross-sectoral
 - SEI-LEAP-IBC
 - IIASA-GAINS
 - NIES-AIM
- Sector Specific
 - Kyushu Univ (with training with IGES)-Wastewater, Solar Energy, Heat Only Boiler
 - IGES (EQT)-Waste Management
 - Clean Air Asia-Transport

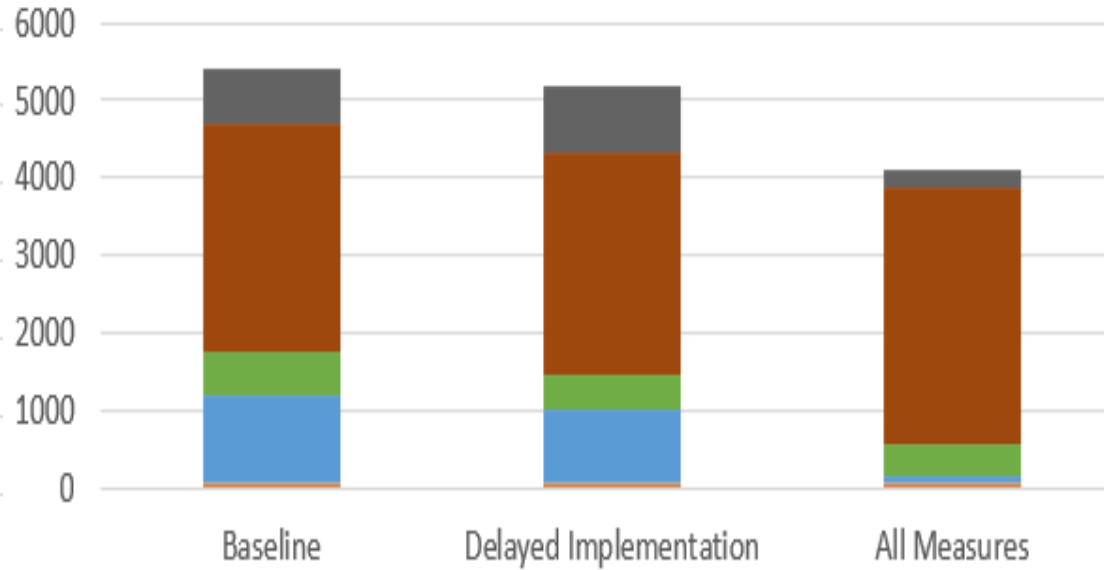
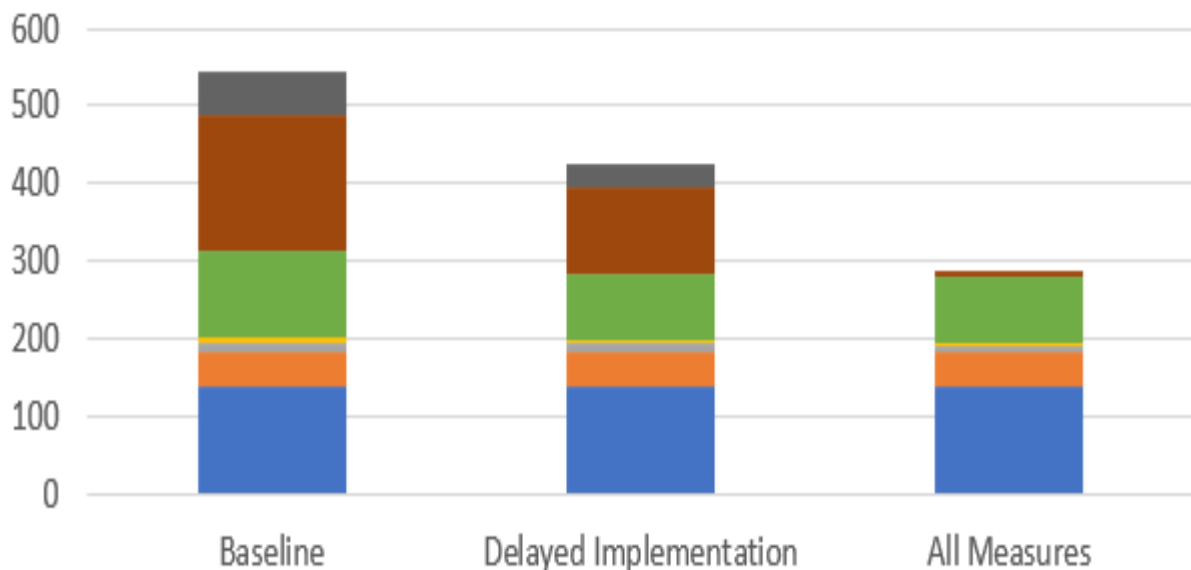
Cross-Sectoral— LEAP IBC and GAINS

LEAP-IBC: Tool for integrated air pollution and climate change mitigation assessment



LEAP in Thailand

Source: SEI and IGES, 2022
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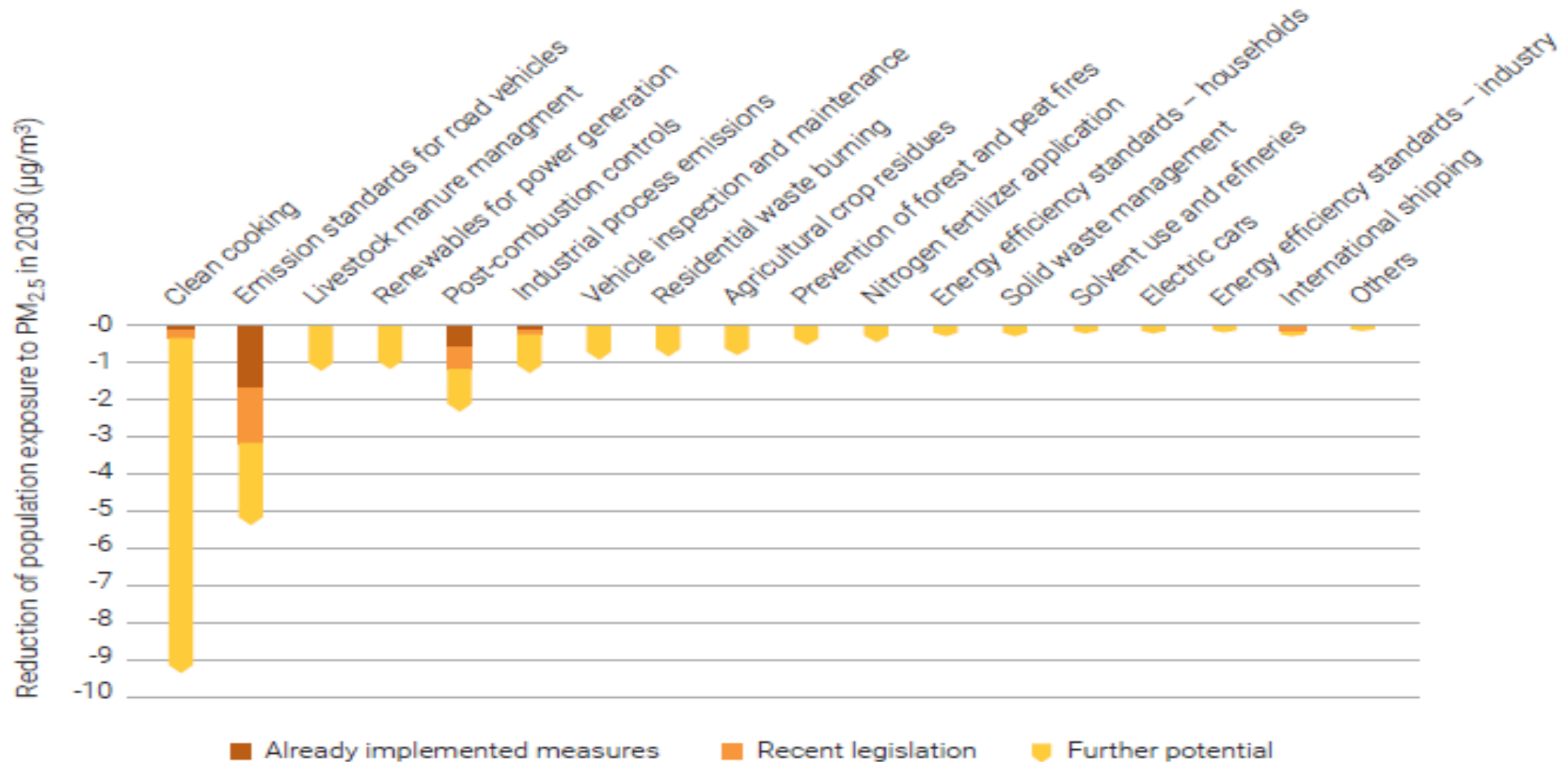
- Industry
- Residential
- Transport
- Electricity
- Fossil Fuel Production
- Charcoal Production
- Industrial Processes and Product Use
- Agriculture, Forestry and Fishing
- Waste

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PM_{2.5} emission in 2030 for the baseline, delayed implementation and all measures scenarios

CH₄ emission in 2030 for the baseline, delayed implementation and all measures scenarios

Outputs from GAINs for all of Asia



Source: UNEP and APCAP, 2019

**Sectoral—
Wastewater and Solar Energy**

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Anaerobic lagoon

Anaerobic Aerated Lagoon + Swimbed UASB UASB+Swimbed Comparison Co-benefits

Input	Unit	Value
Amount of the Wastewater	m3/d	35965
COD Concentration in Wastewater	g/m3	1507
Total Nitrogen in Wastewater	g/m3	120.56
COD removal efficiency at first step	%	50
COD degradation rate at up to discharge point	%	50
COD degradation rate at discharge point	%	10
Maximum methane formation potential	kgCH4/kgCOD	0.21
Methane emission/kg generated sludge	kgCH4/kg Sludge	0.15
Amount of generated sludge	kg/d	5306
Electricity Use	kWh/d	42561

Output	Unit	Value
COD Concentration at the different stages		
After the wastewater treatment	g/m3	753.5
At up to discharge point	g/m3	376.8
At discharge point	g/m3	339.1
GHG Emissions at the different stages		
Wastewater treatment	kg CO2e/d	159417.0
At up to discharge point	kg CO2e/d	56169.4
At discharge point	kg CO2e/d	5616.9
From sludge	kg CO2e/d	16713.9
From electricity used	kg CO2e/d	32091.0
Total GHG emission, including N2O	kg CO2e/d	270008.3

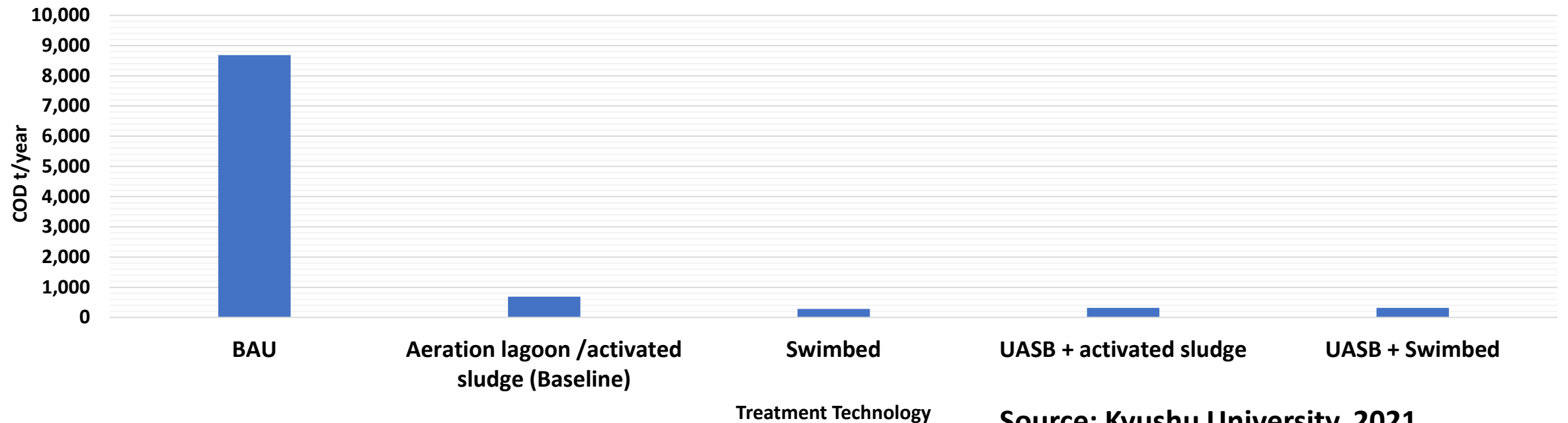
Wastewater Management Tool

Can be used to look at industrial wastewater management in Indonesia

Source: Kyushu University, 2021

Reduction in COD

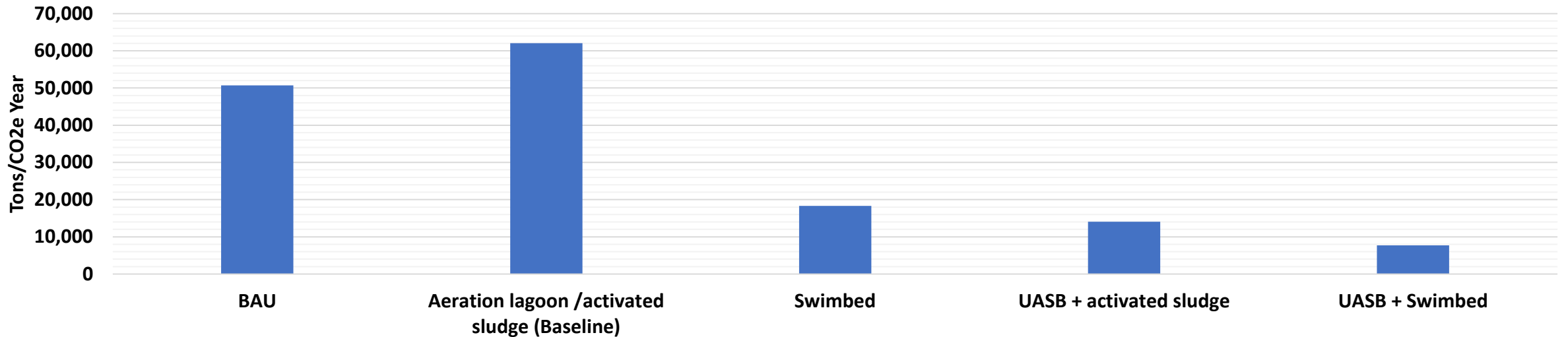
Scenarios	BAU	Aeration lagoon /activated sludge (Baseline)	Swimbed	UASB + activated sludge	UASB + Swimbed
COD t/year	8,685	686	285	317	317
Percentage reduction in COD	--	92.1	96.7	96.4	96.4



Source: Kyushu University, 2021

Amount of GHGs (t-CO₂e/year)

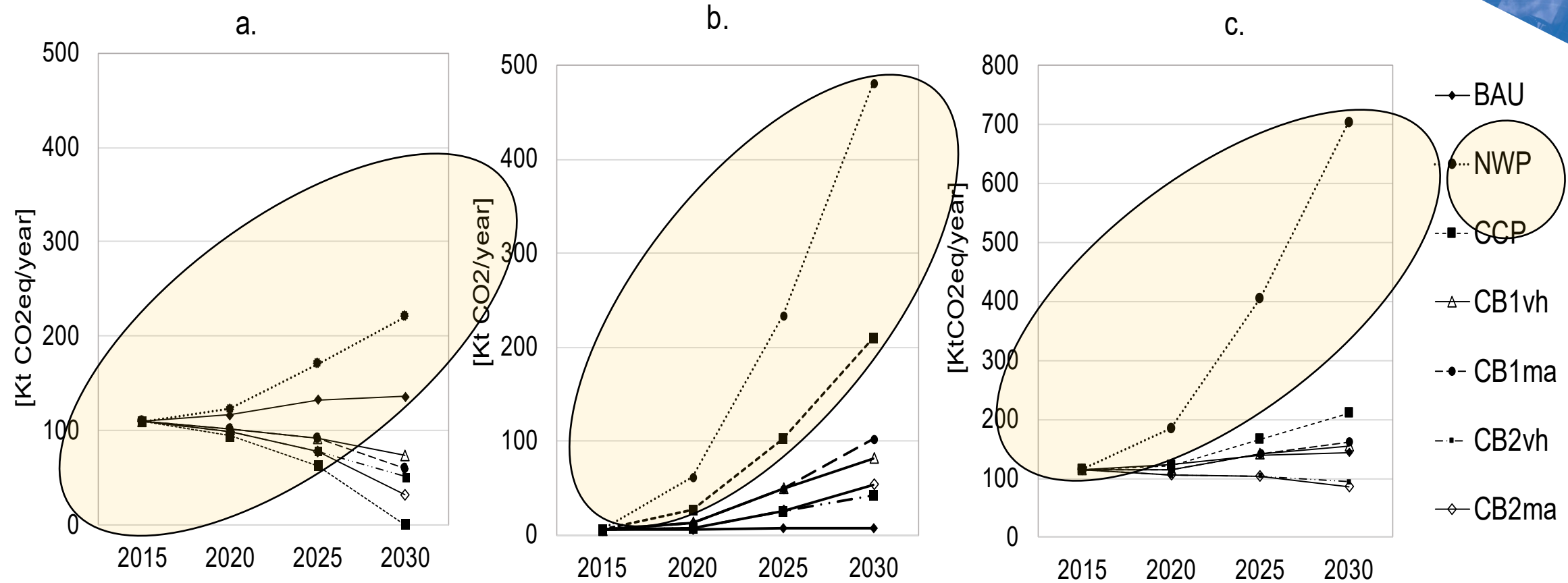
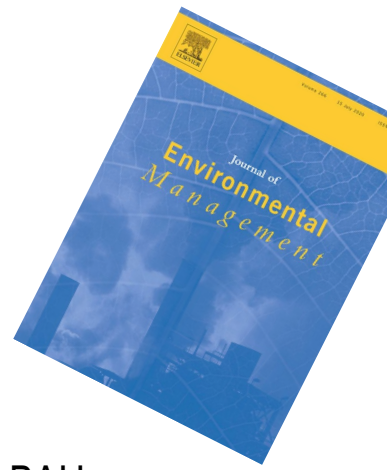
Scenarios	BAU	Aeration lagoon /activated sludge (Baseline)	Swimbed	UASB + activated sludge	UASB + Swimbed
GHGs	50,715	62,059	18,294	14,047	7,686
Percentage reduction in GHGs	--	-22.4	63.9	72.3	84.8



Wastewater Treatment Technologies

Source: Kyushu University, 2021

Indonesia: Multi-level Governance Required to Achieve Climate Benefits in Fish Processing




Gómez-Sanabria A, Zusman E, Höglund-Isaksson L, Klimont Z, Lee S-Y, Akahoshi K, Farzaneh H, & Chairunnisa (2019). Sustainable wastewater management in Indonesia's fish processing industry: bringing governance into scenario analysis. *Journal of Environmental Management*.

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Input Data

Local Geographical Data

Longitude	138.4
Time zone	3.0
azimuth Angle	0.0
Latitude	33.5



Local Meteorological Data


Solar Radiation	
Ambient Temperature (OC)	



Photovoltaic Cell Specifications

Single crystal


Nominal operation cell temperature [°C]	44.00
Nominal operation ambient temperature [°C]	25.00
Incident radiation under nominal condition [W/m²]	1.00
Incident radiation under real condition [W/m²]	1.00
Surface Area [m²]	1.67
Rated power [kW]	0.55
Maximum efficiency [%]	0.204
Standard Temperature [°C]	25.00
Temperature coefficient [%/deg]	-0.26
Solar Irradiance	0.30
Operating Factor	0.30
Surface Slope [Degree]	35.00



Solar Water Heater Specifications



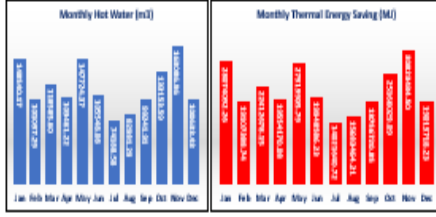
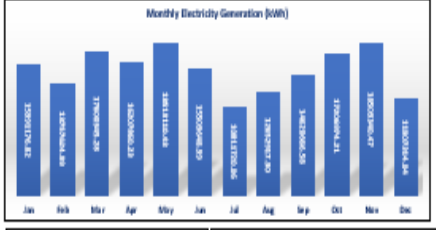
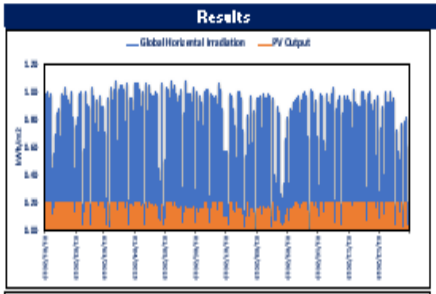
Flat Plates (Direct active)

Surface Area [m²]	2.24
Solar Fraction	0.50



Utilization

Photovoltaic	
Installed Capacity [kW]	100,000
Water Heater	
Quantity	20,000
Water Inlet Temperature [°C]	15
Water Outlet Temperature [°C]	50

Solar Power	
Total Electricity Generation [MWh/y]	100,230,433.30
Expected Reduction in GHG emissions and air pollution	
GHG [t/y]	170,588.05
PM2.5 [kg/y]	32,626.06
CO [kg/y]	25,664.26
SO2 [kg/y]	2,193,536.33
NOx [kg/y]	733,464.03
Solar Heat	
Total Thermal Energy [MJ/y]	260,002,020.07
Total Hot Water [m³/y]	1,370,242.40
Expected Reduction in GHG emissions and air pollution	
GHG [t/y]	50,235.27
PM2.5 [kg/y]	10,146.37
CO [kg/y]	0.00
SO2 [kg/y]	510,532.10
NOx [kg/y]	77,262.32
Total Reductions in GHG emissions and air pollution	
GHG [t/y]	220,743.02
PM2.5 [kg/y]	62,672.43
CO [kg/y]	25,664.26
SO2 [kg/y]	2,714,128.52
NOx [kg/y]	876,627.04

Solar Energy Tool

Can be used to look at co-benefits of solar energy installations

Source: Kyushu University, 2021

Regional Action Plan for West Java Greenhouse Gas Emission Reduction 2010 - 2030



Forestry

- Rehabilitation of critical land and mangroves
- Forest protection and security

Agriculture

- Application of the fertilization system
- Cultivation Technology

Energy

- Renewable energy development
- Fossil Fuel Substitution
- Energy efficiency

Transportation

- ITS/ATCS development
- Bus Rapid Transit (BRT) Development
- Rejuvenation of general transportation
- Car Free Day
- Smart Driving Training
- Parking Management

Waste and Domestic Waste

- Rehabilitation of open dumping landfill
- Development and operation of regional TPPAS
- Construction and operation of TPS3R
- Construction and operation of Waste Bank
- Sludge Treatment Plant Construction
- Construction and Operation of Sanimas (MCK++ or WWTP)

13,5 Million tonnes CO₂eq
Emission Reduction



9,94% of BAU
Baseline Projection in
2030

There is significant potential for solar PV in Bandung

Figure 6. Hourly solar PV with hillshade analysis.

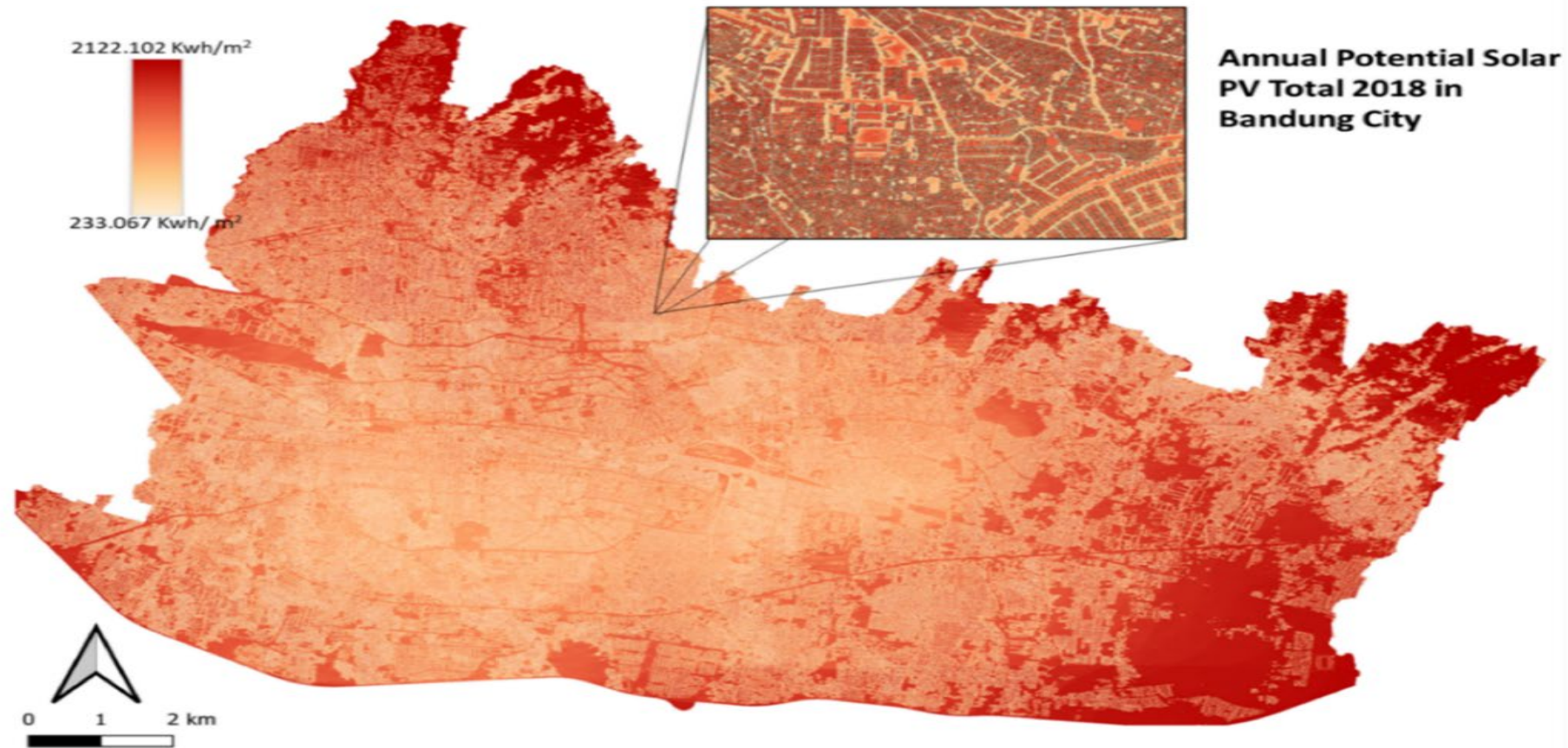


Figure 7. The annual potential of solar PV energy in Bandung.

Solar Energy Rooftop



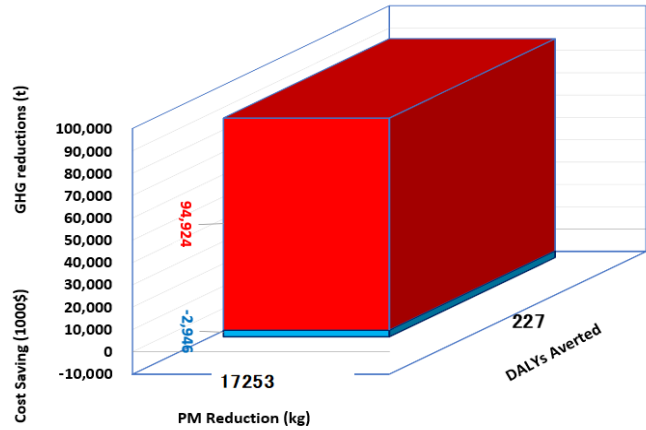
Source : West Java Energy and Mineral Resources Agency (2020)

Solar Panel Rooftop is developed as a new renewable energy which is planned to be installed in government buildings, schools, sports buildings and health facilities.

- Bandung has 849,421 state electricity company (PLN) customers
- Energy consumption in 2018: 1,585,382 MWh
- High-end residential developments are required to cover at least 25% of their rooftop with solar PV

Source: Anjar Dimara Sakti, 2022

Estimated co-benefits of installation of solar pv in residences in Bandung (2022-2032)

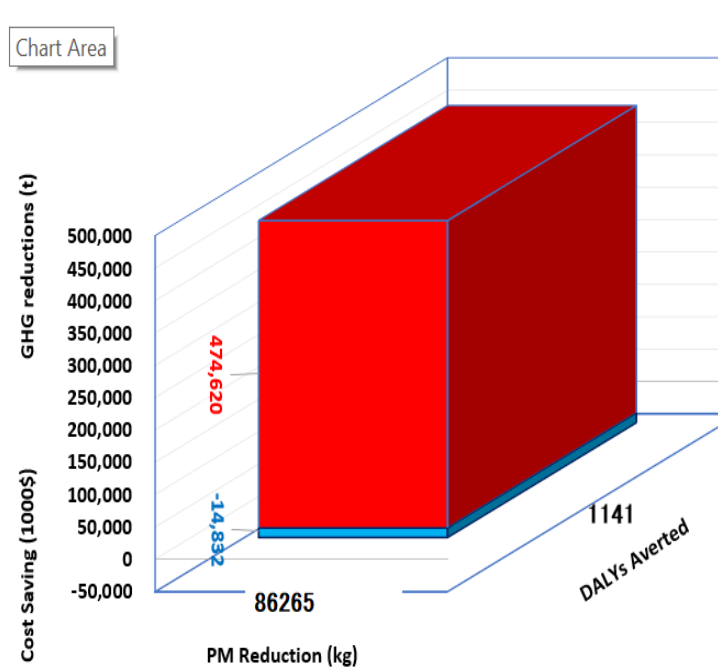


Avoided Emissions	Solar
GHG (t/y)	9,492.4
PM2.5 (kg/y)	1,725.3
CO (kg/y)	1,357.0
SO2 (kg/y)	116,311.7
NOx (kg/y)	42,259.9

2022

Total Energy: 60,000 kW/year

Units: 85,000

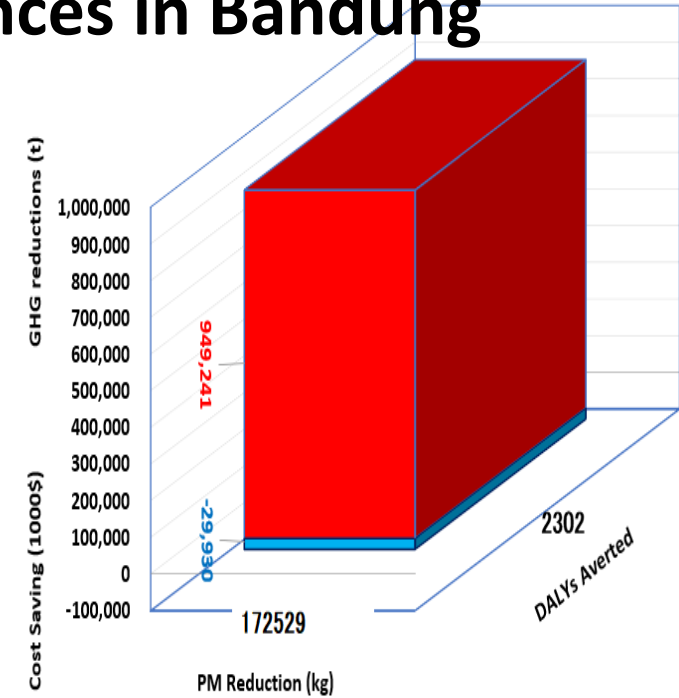


Avoided Emissions	Solar
GHG (t/y)	474,620.4
PM2.5 (kg/y)	86,264.5
CO (kg/y)	67,848.5
SO2 (kg/y)	5,815,587.4
NOx (kg/y)	2,112,996.7

2026

Total Energy: 300,000 kW/year

Units: 425,000



Avoided Emissions	Solar
GHG (t/y)	949,240.7
PM2.5 (kg/y)	172,529.1
CO (kg/y)	135,697.0
SO2 (kg/y)	11,631,174.7
NOx (kg/y)	4,225,993.5

2032

Total Energy: 600,000 KW/year

Units: 850,000