Application of Emissions Quantification Tool(EQT) for Estimation the impact of development of Anaerobic Digester (AD) on the overall GHGs/SLCPs from MSWM sector in Balikpapan

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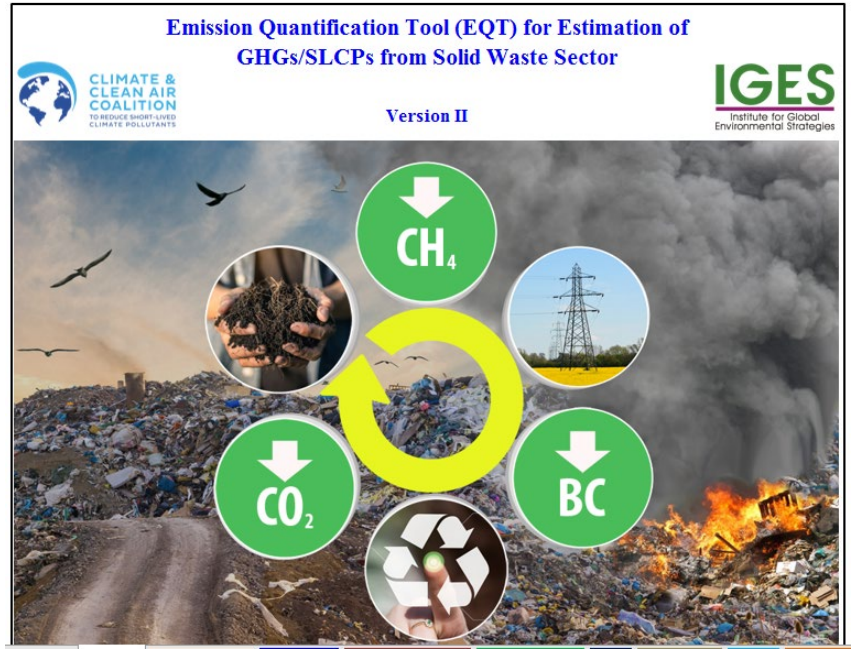
IGES
Institute for Global Environmental Strategies

IGES/CCAC's Emission Quantification Tool (EQT):
Calculation of SLCP Emissions based on Life Cycle and IWM Approach



Available here, please download!

https://www.ccet.jp/publications/emission-quantification-tool-eqt-estimation-ghgsslcps-solid-waste-sector

Emissions Quantification Tool

Emission quantification tool (EQT)

Decision making tool

User Manual

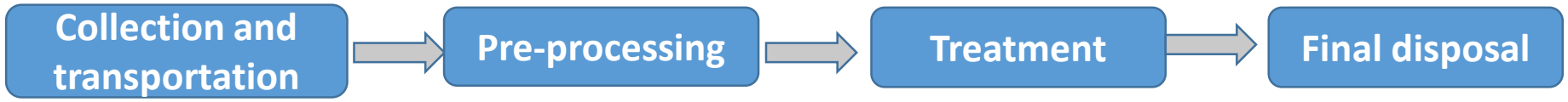
Monitoring tool

- Undertake a rapid assessment of GHGs and SLCPs from BAU with alternative solutions and find the most suitable options for the city.

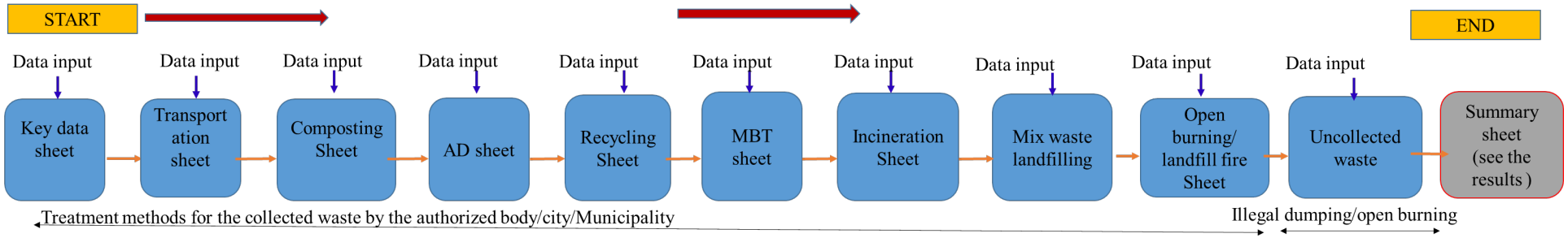
- Keep records and monitor the progress made on mitigating GHGs and SLCPs emissions from chosen waste management options

Features of the Emission Quantification tool

- This tool is simple and step by step guidance has been provided to users in all the sheets on how to enter the data and obtain the results
- Special skill is not required and ability to work with excel would be sufficient
- Each and every sheet has designed a way that users can easily move among the sheets , enter the data and obtain the results on their preferred waste treatment options
- The tool accounts both SLCPs and other GHGs from waste management considering the entire life cycle



- Both emissions and savings potentials is accounted across the life cycle



The case study in Balikpapan City

Current Situation (Business as Usual)	Scenario 1 (With Anaerobic Digester / AD)
Total Waste Generation: 521.86 ton/day a. Collected by city or private sector: 440.68 ton/day b. Collected by Informal Sector: 54 ton/day c. Uncollected waste: 27.18 ton/day d. Uncollected waste (openly dumped and openly burned) : 1.02%	Total Waste Generation: 521.86 ton/day a. Collected by city or private sector: 440.68 ton/day b. Collected by Informal Sector: 54 ton/day c. Uncollected waste: 27.18 ton/day d. Uncollected waste (openly dumped and openly burned) : 1.02%
Final Treatment (at the final disposal) a. Total amount of collected waste in disposal site: 400 ton/day (2022), annual growth: 2.26% b. Recycling by City: 84.45 ton/day c. Composting : 8.3 ton/day	Final treatment (at disposal site) a. Total amount of collected waste in disposal site: 400 ton/day (2022) (Annual growth 2.26%) **b. Anaerobic digester: 400 ton/day (344 food waste & 56 garden waste, based on OBC study)** c. Recycling: 84.45 ton/day d. Composting: 8.3 ton/day
Final Disposal (landfill) with gas recovery a. Start & end of year of disposal: 2002 & 2026 b. Efficiency gas collection: 60% (start in 2012) c. Closing year of gas recovery: as long as possible	Final Disposal (landfill) with gas recovery a. Start & end of year of disposal: 2002 & 2026 b. Efficiency gas collection: 60% (start in 2012) c. Closing year of gas recovery: as long as possible

Step by step applying EQT – Key Data Sheet

Key Data | Go to Transportation | Go to Composting | Go to Anaerobic digestion | Go to Recycling | Go to MBT | Go to Incineration | Go to Landfilling | Open burning and landfill fire | Go to uncollected | Go to Summary

Print sheet

Version II- March 2018
Excel 2013 has been used

Note to user: In order to access user 'Help' options in the tool, users must enable macros.

Basic data		**User input required in green cells ***	
Select your country from the list of CCAC member countries		Indonesia	
Select the global region where your country is located		Southeast Asia	
Write the name of the city or country		Balikpapan	
Select the climatic zone of your country		Moist and Wet Tropical	Notes & references (if any)
Reference year of the data		2021	Notes & references (if any)
Enter the population of the city/country in the reference year		710,293	Notes & references (if any)
Select the economic level of the country		Upper middle income	Notes & references (if any)
Select the source for waste generation data		Country/location specific	Notes & references (if any)
Total waste generation (tonnes/day) in the city at present	Theoretical (default generation rate)		
	Type Actual Amount	521.86	Notes & references (if any)

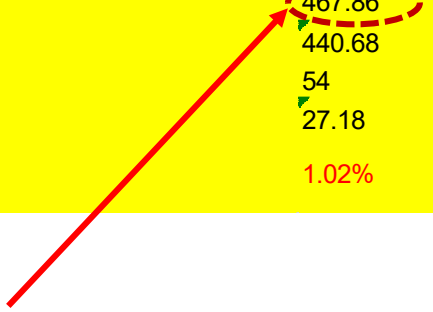
Legend
- Required User Input
- Default values
- Emission results

Collected and uncollected amount of waste	**User input required in green cells***

Part of generated waste is collected by the city (e.g. Municipality or contracted private/authorized companies) and informal collectors (e.g. waste pickers, households, voluntary organizations) with the rest being uncollected waste.
Specify the collection and non-collection rates in your city **as accurate as possible** with respect to the number of scenarios that you would like to compare.

Help		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Notes & references (if any)
(1) Collected amount by the city or private/authorized companies	Tonnes/day	440.68	440.68				
(2) Collected amount by informal collectors (e.g. recyclables)	Tonnes/day	54	54				
(3) Uncollected amount	Tonnes/day	27.18	27.18				
Total generated waste	**Tonnes/day**	521.86	521.86	0	0	0	

Input ID	Questions	Required answers	Note
E1	**General Information**		
E1.1	City/Country name	Balikpapan/ Indonesia	
E1.2	Total Population / year	710293/2021	
E1.3	Total waste generation (Tonnes (T)/day (d))	467.86	**It should be: 440.68 + 27.18 + 54**
E1.4	Total waste collection (T/d)	440.68	Collection amount by City or Private sector
E1.5	Total waste collection by informal sector (T/d)	54	Collection amount by informal sector wihout any contact with the city
E1.6	Uncollected waste (T/d)	27.18	Amount of generated waste openly burned/scatted dump
E1.8	Percenatage of uncollected waste openly dumped (%)	1.02%	--->berapa persen sampah tidak terangkut
E1.7	Percentage of uncollected waste openly burned (%)		---> berapa persen sampah yang dibakar masyarakat



It is not correct input!

It should be: 440.68+ 54 + 27.18= 521.86 !

Step by step applying EQT – Key Data Sheet

Composition of generated and collected waste | **User input required in green cells***

Please select the source for waste composition data. If location specific data is available, specific generated and collected waste composition data (as a percentage %) should be entered in the green cells. If the city does not have such data, IPCC recommended composition data for the region will be used. For more information, click "Help" Button.

Select the source for waste composition data

Help | Country/location specific

Adjust composition | Derive composition

Enter generated and collected waste compostion in green cells

Components	IPCC Default waste composition (%) for Southeast Asia	County/location specific **generated waste** composition (%)	County/location specific **collected waste** composition (%)
Food waste		42.30	42.30
Garden waste		6.36	6.36
Plastics		7.20	7.20
Paper		10.26	10.26
Textile		2.94	2.94
Leather/rubber		0.98	0.98
Glass		6.56	6.56
Metal (aluminium + steel)		3.87	3.87
Nappies/diapers (disposable)			
Wood			
Hazardous waste			
Others		19.53	19.53
Total	**0.00**	**100.00**	**100.00**

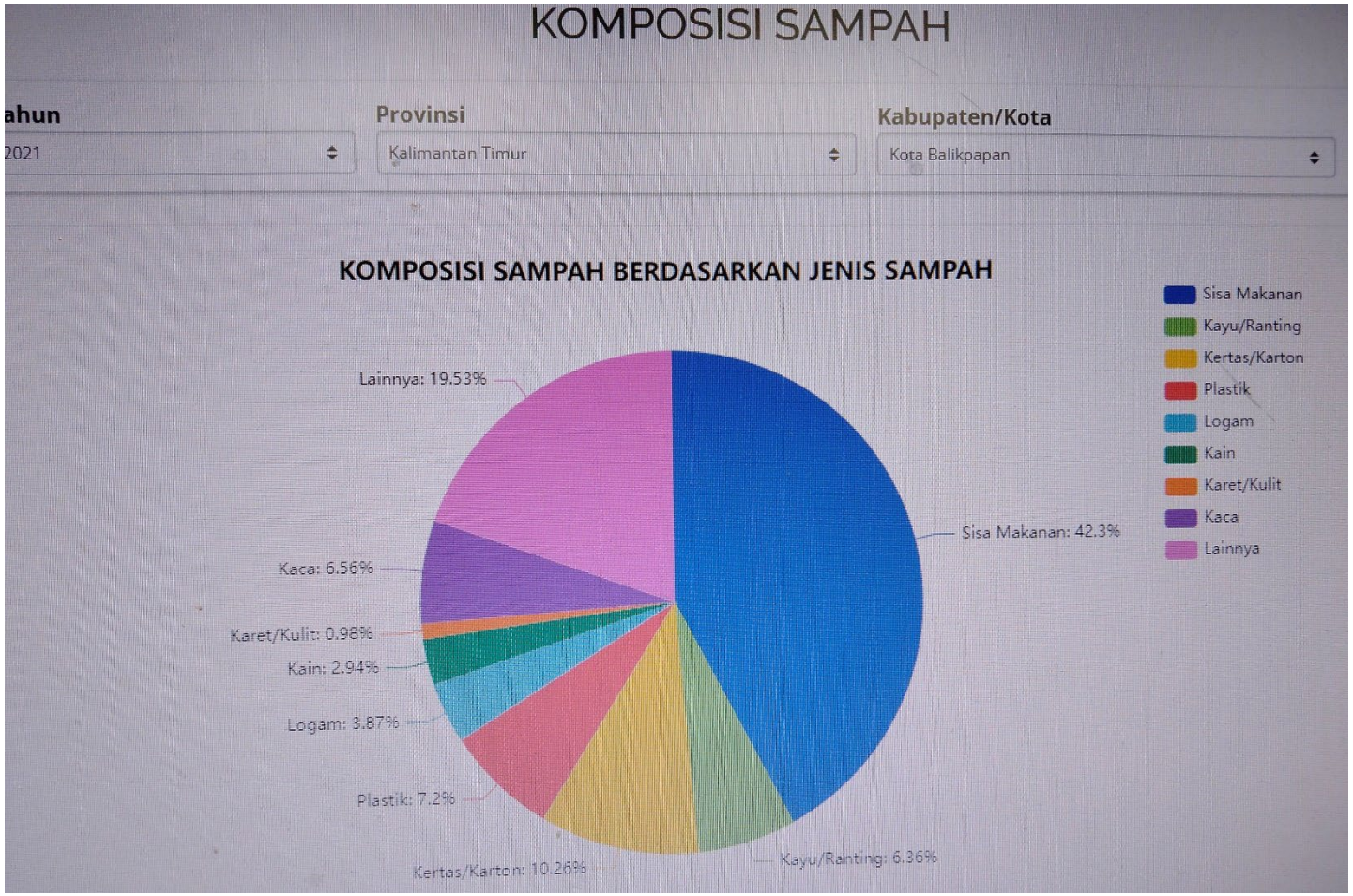
Notes & references : https://sipsn.menlhk.go.id/sipsn/public/data/komposisi for Balikpapan city (if any)

Utilisation of waste (collected by city or private/authorized companies) for different treatment options | User input required in green cells*

Step by step applying EQT – Key Data Sheet

Composition of Generated and Collected Waste

City waste composition refer to National Data available here: https://sipsn.menlhk.go.id/sipsn/public/data/komposisi for Balikpapan city.



Step by step applying EQT – Key Data Sheet

Data of Food Waste and Garden Waste:

a. **Food Waste: 42.30%**

   → **Total food waste: 42.30% x 440.68 = 186.54 ton/day**

b. **Garden Waste: 6.36%**

   → **Total Garden Waste: 6.36%x440.68= 28.05 ton/day**

Total Available Organic Waste : 214.59 ton/day!

Only 214.59 ton/day for composting & Anaerobic digestion !

Step by step applying EQT – Key Data Sheet

Help

Show example

Utilization of MSW	Units	Note to User	BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total collected waste by the formal collectors	Tonnes/day	Total collected waste by the city and formal collectors (private/authorized companies)	441	441	0	0	0
Step I: Type the amount of separated waste used for the below treatment options prior to disposal		Help				Check available	
Composting	Tonnes/day	Total amount of organic waste (food waste and garden waste) used for composting	8	8			
Anaerobic digestion	Tonnes/day	Total amount of organic waste (food waste and garden waste) used for anaerobic digestion	0	400			
Recycling	Tonnes/day	Total amount of seperated recyclable collected by formal sector. (municipality/contracted private/ authorized companies only)	33	33			
				Error : Amount entered should be lower than the available amount			
Total amount of remained mixed waste for final disposal	Tonnes/day	The remaining mix waste which can be treated using one or more disposal options shown below	400	0	0	0	0
Step 2: Type the amount of remaining mix waste utilised among below disposal methods		Help				Check suitability of incineration for	
MBT	Tonnes/day	Mix waste use for MBT	0				
Incineration	Tonnes/day	Mix waste use for incineration	0				
Landfilling/Open dumping	Tonnes/day	Total mix waste dispose at landfills or open dumps	400				
Total treated waste collected by the city			**441**	**441**	**0**	**0**	**0**

OBC Study

Total should be 441 tonnes

Adjusted Scenario for Balikpapan City - EQT

Current Situation (Business as Usual)	Scenario 1 (With Anaerobic Digester / AD)
Total waste collected by city: 440.68 ton/day Total waste in final disposal : 400 ton/day (2022)	Total waste collected by city: 440.68 ton/day Total waste in final disposal : 400 ton/day (2022)
Recycling: 30825.25 (ton/year) = 84.45 ton/day	Recycling: 30825.25 (ton/year) = 84.45 ton/day
Composting: 8.3 ton/day a. Food waste: 7.05 ton/day b. Garden waste: 1.25 ton/day	**Composting: 8.3 ton/day** a. Food waste: 7.05 ton/day b. Garden waste: 1.25 ton/day
Anaerobic Digester : No	**Anaerobic Digester** a. Food waste : 186.54 – 7.05 = 179.49 ton/day b. Garden waste : 28.05 -1.25 = 26.8 ton/day **c. Total organic waste: *179.49 + 26.80 = 206.29* ton/day**
Landfill (mixed waste): 440.68-84.45-8.3=**347.93**	**Landfill** (mixed waste): 440.68-84.45-8.3-206.29=**141.64**
Landfill with gas recovery a. Start & end of year of disposal: 2002 & 2026 b. Efficiency gas collection: 60% (start in 2012) c. Closing year of gas recovery: as long as possible	**Landfill with gas recovery** a. Start & end of year of disposal: 2002 & 2026 b. Efficiency gas collection: 60% (start in 2012) c. Closing year of gas recovery: as long as possible

Utilisation of waste (collected by city or private/authorized companies) for different treatment options | User input required in green cells*

Note to User: Using this tool, Business as Usual (BAU) practice (BAU is the current situation) can be compared against possible 4 intended (future) scenarios. Decide the number of scenarios to compare against BAU. If only one intended scenario is to be compared against BAU, enter the data under BAU and Scenario 1, leaving other scenarios empty.

Amount of MSW collected will be shown based on the waste collection rate of the city or private/authorized companies . For the comparison purposes, the same amount of collected waste in each scenario can be used with different technological options in order to determine the best climate friendly technology. Decide the type of treatment method available in BAU and intended scenarios (e.g. type of treatment option chosen for intended scenarios may depend on the technical and financial capacity of the city). Enter the amount of waste that the city plans to use for each treatment type. The waste amount entered here under different treatment options will be displayed on the individual treatment sheet.

Help | Show example

Utilization of MSW	Units	Note to User	BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total collected waste by the formal collectors	Tonnes/day	Total collected waste by the city and formal collectors (private/authorized companies)	441	441	0	0	0
Step I: Type the amount of separated waste used for the below treatment options prior to disposal		Help					Check available
Composting	Tonnes/day	Total amount of organic waste (food waste and garden waste) used for composting	8	8			
Anaerobic digestion	Tonnes/day	Total amount of organic waste (food waste and garden waste) used for anaerobic digestion	0	206			
Recycling	Tonnes/day	Total amount of seperated recyclable collected by formal sector. (municipality/contracted private/ authorized companies only)	84	84			
Total amount of remained mixed waste for final disposal	Tonnes/day	The remaining mix waste which can be treated using one or more disposal options shown below	348	142	0	0	0
Step 2: Type the amount of remaining mix waste utilised among below disposal methods		Help					Check suitability of incineration for
MBT	Tonnes/day	Mix waste use for MBT	0				
Incineration	Tonnes/day	Mix waste use for incineration	0				
Landfilling/Open dumping	Tonnes/day	Total mix waste dispose at landfills or open dumps	348	142			
Total treated waste collected by the city			**441**	**441**	**0**	**0**	**0**

Total should be 441 tonnes

Total should be 441 tonnes

Final Key data for EQT

Energy consumption data | **User input required in green cells***

Fossil fuel and grid electricity is utilized in various stages of waste management. If you know the country/location specific default values please enter in green cell. If you do not know, default emission factor will be utilized throughout the calculation.

(1) Emission factors for grid electricity production

Default GHG emission factor from grid electricity production in Indonesia: 0.757 kg CO_2-eq/kWh

Type country specific/location specific GHG emission factor for grid electricity production (if available): kg CO_2-eq/kWh

(2) Calorific values of fossil fuel

Select the data source for heating values/calorific values of fossil fuel

Type of fuel	IPCC default	Country specific
	Net calorific value (MJ/L)	Net calorific value (MJ/L)
LPG	25.07	
Gasoline	35.44	
Kerosene	35.28	
Diesel	36.372	
Natural Gas	0.0333	

Transportation Worksheet – Input data

GHG and SLCP emissions from waste collection and transportation

User input is required in green cells *

Data Input	Unit		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Amount of collected waste by the city	Tonnes /day		441	441	0	0	0
(I) Fossil fuel consumption for collection and transportation							
Type of trucks used for waste collection and transportation	Type	Help	Both modern and older trucks	Both modern and older trucks			
Type of fuel (type I) used for collection and transportation	Type I	Help	Gasoline	Gasoline			
Total amount of fossil fuel (type 1) used	L/day		171	171			
Type of fuel (type II - if city uses more than one fuel type) used for collection and transportation	Type II		Diesel	Diesel			
Total amount of fossil fuel (type II) used	L/day		1602	1602			
(II) Energy consumption at transfer station (only if available)		Help					
Amount of waste handled at the transfer station	Tonnes/day		12	12			
Type of fossil fuel used at the transfer station	Type		Diesel	Diesel			
Amount of fossil fuel used for operation at transfer station	L/day		6	6			
Amount of electricity used for operation at transfer station	kWh/day		87	87			

Clear

Composting Worksheet – Input data

Key Data | Go to Transportation | Composting | Go to Anaerobic digestion | Go to Recycling | Go to MBT | Go to Incineration | Go to Mix waste Landfilling | Go to open burning and landfill fire | Go to uncollected | Go to Summary

GHG and SLCP emissions from Composting

User input is required in green cells *

Data Input	Unit		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total amount of organic waste use for composting	Tonnes/day		8.3	8.3	0	0	0
					Check available amount		
Amount of food waste use for composting	Tonnes /day	Help	7.05	7.05			
Amount of garden waste use for composting	Tonnes /day		1.25	1.25			
Type of fossil fuel use for operation activities	Type		Diesel	Diesel			
Total amount of fossil-fuel use for operational activities	L/day	Help	4	4			
Total amount of grid electricity use for operational activities	kWh/day		1	1			
Compost production potential from waste	kg /tonne	Help	175	175			
% of compost use for the agricultural and gardening purposes	%	Help	18	18			
Choose the option for emission factors of chemical fertilizer production in your country	Source	Help	Country/location specific	Users should enter the input data in N46:P50 cells			Clear cells

Results: Summary of the emissions Show Graph Print Sheet

AD Worksheet – Input data

Key Data | Go to Transportation | Go to Composting | Anaerobic digestion | Go to Recycling | Go to MBT | Go to Incineration | Go to Mix waste landfilling | Go to open burning and landfill fire | Go to uncollected | Go to Summary

GHG and SLCP emissions from Anaerobic Digestion (AD)

User input is required in green cells *

Data Input	Unit		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total amount of organic waste used for anaerobic digestion	Tonnes /day		0.00	206.29	0.00	0.00	0.00
				Food waste + Garden waste should be 206.29	Check available amount		
Amount of food waste used for AD	Tonnes/day	Help	0.00	179.49			
Amount of garden waste used for AD (if any)	Tonnes/day		0.00	26.79			
Type of fossil fuel used for operation activities	Type			Diesel			
Total amount of fossil fuel used for operational activities	L/day	Help					
Total amount of grid electricity used for operational activities	kWh/day						
Select the data source for energy production potentials from AD	Data Source			Default values			
The product of energy from AD	Product	Help		Biogas as a direct energy source			
If the recovered product is heat or biogas, select the type of fossil fuel which would be replaced by the recovered heat or biogas	Type	Help		Kerosene			
Recovery of compost (solid digestate) from AD	Yes or NO			Yes			
% of recovered compost (solid digestate) use for agricultural and gardening purposes	%	Help		18			

Clear

Output: Products from anaerobic digestion

Electricity	kWh/tonne	0.00	0.00	0.00	0.00	0.00
Heat recovered	MJ/tonne	0.00	0.00	0.00	0.00	0.00
Biogas (as thermal energy source)	m^3/tonne	0.00	137.51	0.00	0.00	0.00
Compost (solid digestate) use for agriculture	kg/tonne	0.00	36.00	0.00	0.00	0.00

Recycling Worksheet – Input data

GHG and SLCP emissions from Recycling

Data Input **User input is required in green cells ***

(1) Recyclables collected by the city (e.g. Municipality or contracted/authorized private companies)

Help

		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total amount of recyclables collected by the city	Tonnes/day	84.45	84.45	0	0	0

Composition (percentage %) of recyclables collected by the city

Check available amount

Paper and cardboard	Percentage (%)					
Plastic						
Aluminium						
Metal/Steel						
Glass						
Total		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

2) Recyclables collected by the informal sector (e.g. waste pickers, households, any voluntary organizations)

Help

		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total amount of recyclables collected by the informal collectors	Tonnes/day	54	54	0	0	0

Composition (percentage %) of recyclables collected by the informal sector

Paper and cardboard	Percentage (%)					
Plastic						
Aluminium						
Metal/Steel						
Glass						
Total		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3) Energy consumption data

Clear

(i) Energy consumption for transportation: Energy consumption for transportation of recyclables for further processing/ manufacturing is considered as equivalent to the corresponding fuel consumption for transportation of the virgin materials and therefore emissions from long distance transportation of recyclables are ignored.

(ii) Energy consumption for processing activities (cleaning, sorting, baling, processing)

Data source for energy consumption data for recycling Help

Landfill (mixed waste) Worksheet – Input data

Key Data | Go to | Go to Composting | Go to Anaerobic digestion | Go to | Go to | Go to Incineration | Mix waste Landfilling | Go to open burning and landfill fire | Go to uncollected | Go to Summary

GHG and SLCP emissions from the MSW landfilling technologies

User input is required in green cells *

Data Input	**Unit**	BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total amount of waste dispose at landfills/open dumps	Tonnes/day	347.93	141.69	0.00	0.00	0.00

Composition of waste disposed at the landfill — Help

Food waste	(Percentage) %	41.48	0.00			
Garden waste		6.19	0.00			
Plastics		7.34	14.02			
Paper		10.46	19.98			
Textile		3.00	5.73			
Leather/rubber		1.00	1.91			
Glass		6.69	12.78			
Metal (aluminium + steel)		3.94	7.54			
Nappies (disposable diapers)		0.00	0.00			
Wood		0.00	0.00			
Hazardous waste		0.00	0.00			
Others		19.90	38.04			
Total		**100.00**	**100.00**	**0.00**	**0.00**	**0.00**

Allocation of amount of disposal of waste among different landfill options — Help

Disposal site I	Amount of collected waste dispose in site I	Tonnes/day	348	142			
	% of disposed waste ultimately fired/open-burned in site I	%	0.00	0.00			
Disposal site II	Amount of collected waste dispose in site II	Tonnes/day					
	% of disposed waste ultimetely fired/open-burned in site II	%					
Disposal site III	Amount of collected waste dispose in site III	Tonnes/day					
	% of disposed waste ultimetely fired/open-burned in site III	%					
Total collected waste dispose at landfill/ open dump sites		Tonnes/day	**347.93**	**141.69**	**0.00**	**0.00**	**0.00**

Landfill (mixed waste) Worksheet – Input data

(1) Specifications of disposal site I

Check landfill classification

Amount of waste dispose at site I	Tonnes/day		348	142			
Select the type of landfill/open dump	Type of the landfill	Help	Sanitary landfill with gas recovery	Sanitary landfill with gas recovery			
Starting year of waste disposal (e.g. 2010)	Year		2002	2002			
End year of waste disposal (e.g. 2020)	Year		2026	2026			
Current year of disposal (e.g.2018)	Year		2022	2022			
Estimated growth of annual disposal at the landfill	%		2.26	2.26			
Type of fossil fuel used for operation activities	Type	Help	Diesel	Diesel			
Enter the amount of fossil fuel used for operation activities	L/day		512.45	512.45			
Grid electricity used for operation activities	kWh/day		12.83	12.83			

Specifications of Landfill-gas recovery project (If any)

Efficiency of gas collection	%	Help	60	60			
Treatment method of collected landfill gas			Direct use of LFG to replace conventional fuel	Direct use of LFG to replace conventional fuel			
LFG utilization efficiency (e.g. electricity production efficiency, flare effifiency)	%	Help	70	70			
Starting year of gas recovery after commencing the landfill			2012	2012			
Closing year of gas recovery project after commencing the landfill			2030	2030			
Select the type of fossil fuel which is replaced by the recovered LFG (if LFG use for heating or cooking)	type		LPG	LPG			

Clear

Uncollected waste worksheet – Input Data

Key Data | Go to Transportation | Go to Composting | Go to Anaerobic digestion | Go to Recycling | Go to MBT | Go to Incineration | Go to Mix wasste landfilling | Go to Open burning/landfill fire | Uncollected waste | Go to Summary

GHG and SLCP emissions from uncollected waste: Open burning and Scattered dumping

User input is required in green cells *

Data Input

		BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total amount of uncollected waste	Tonnes/day	27	27	0	0	0

Composition of uncollected waste. If the user enter the uncollected waste composition in 'user guide page', such composition data will appear here. If not, uncollected waste composition considered be similar to the composition of collected waste. Composition of uncollected waste is same for all scenarios

Food waste	(Percentage) %	42.30
Garden waste		6.36
Plastics		7.20
Paper		10.26
Textile		2.94
Leather/rubber		0.98
Glass		6.56
Metal (aluminium + steel)		3.87
Nappies (disposable diapers)		0.00
Wood		0.00
Hazardous waste		0.00
Others		19.53
Total		**100.00**

% uncollected waste openly burned	0.5				
% of uncollected waste openly dumped	0.52				

Total should be 100%

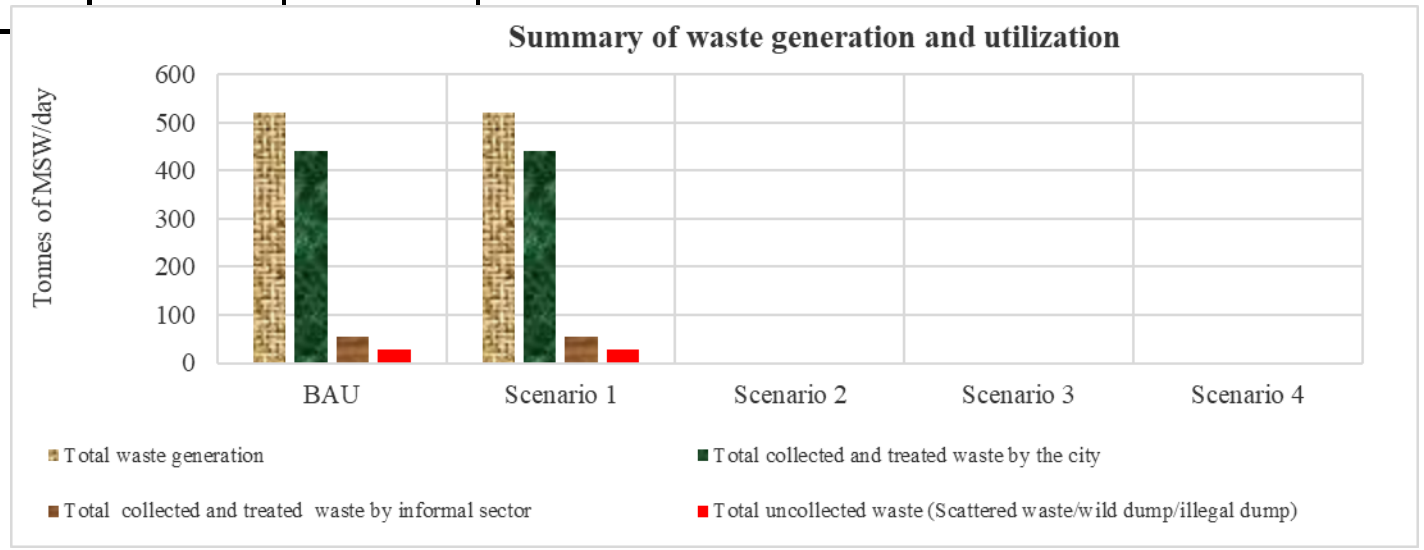
Clear

Summary EQT – Waste generation and utilization

Summary of GHG and SLCP emissions from waste management in Balikpapan

Summary of waste generation, collection and utilization for different treatment options

Conditions	Tonnes/day				
	BAU	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total waste generation	522	522			
Total collected and treated waste by the city	441	441			
Total collected and treated waste by informal sector	54	54			
Total uncollected waste (Scattered waste/wild dump/illegal dump)	27	27			



Summary EQT – Calculation emissions per ton of generated waste

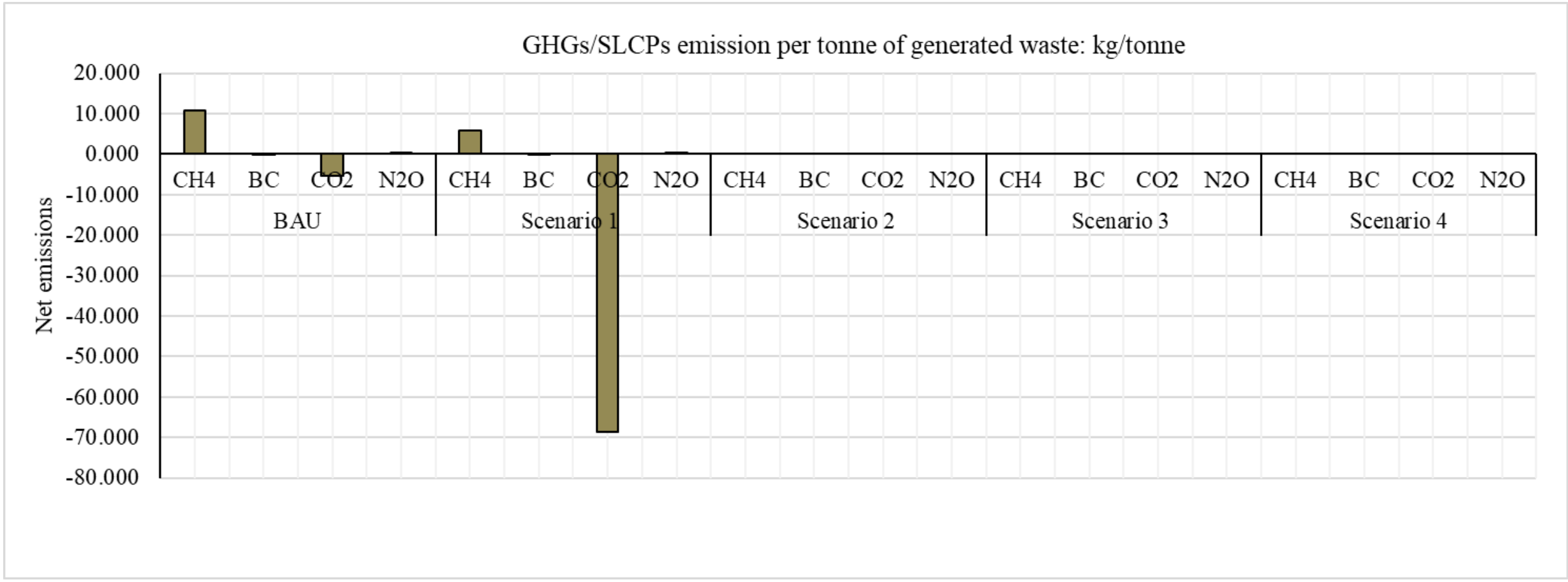
Please choose the prefered 'Unit' for emissions estimation

Calculate emissions per tonne of generate waste

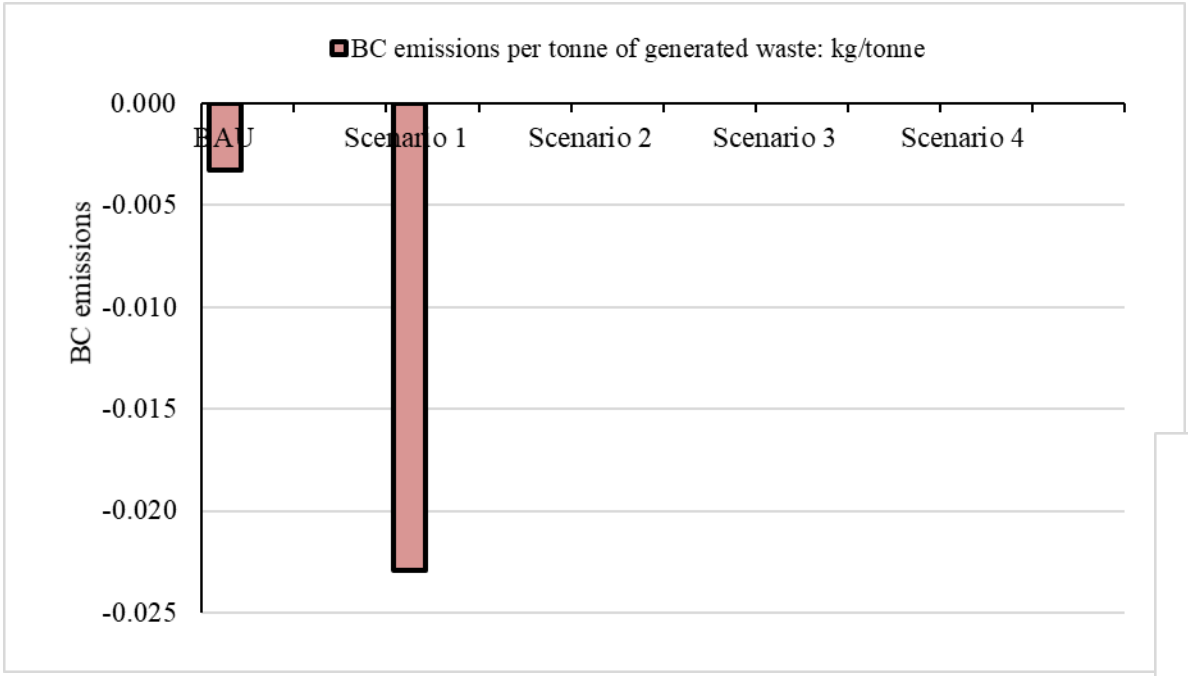
Summary of net GHG/SLCP emissions from waste management

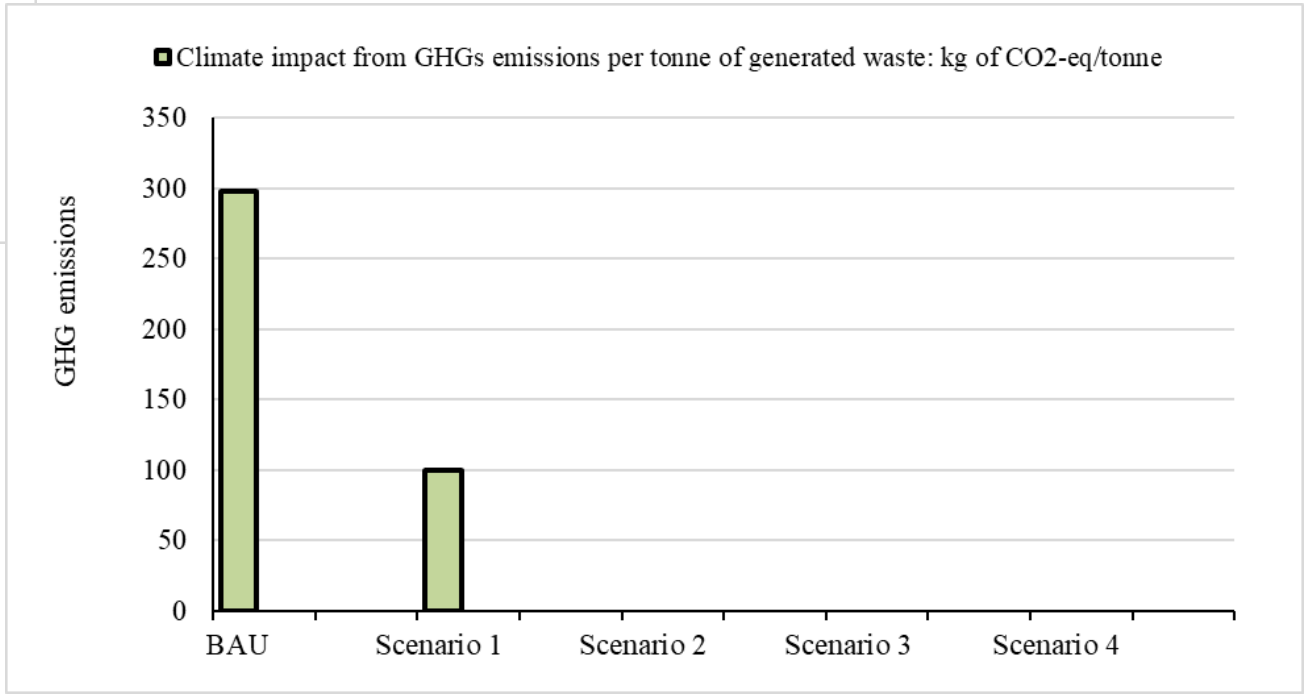
Description	Technology	Unit	BAU				Scenario 1			
			CH_4	BC	CO_2	N_2O	CH_4	BC	CO_2	N_2O
Waste collection and transportation by the city	Transportation	**kg /tonne** (unit ' kg ' used here to show the magnitude of small amount of emissions)	0.001	0.005	17.577	0.001	0.001	0.005	17.577	0.001
Treatment for separated waste	Composting		4.000	0.000	1.390	0.300	4.000	0.000	1.390	0.300
	Anaerobic digestion						0.991	-0.071	-218.579	-0.002
	Recycling		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment for mixed waste	MBT									
	Incineration									
	Landfilling		16.075	-0.013	-34.378	0.000	20.263	0.000	0.440	0.000
	Open burning/landfill fire									
Uncollected waste	Open burning/scattered dumping		0.105	0.003	0.615		0.086	0.003	0.615	
GHGs/SLCPs emission per tonne of generated waste:		**kg/tonne**	**10.787**	**-0.003**	**-5.288**	**0.005**	**5.963**	**-0.023**	**-68.653**	**0.005**
BC emissions per tonne of generated waste:		**kg/tonne**	**-0.003**				**-0.023**			
Climate impact from GHGs emissions per tonne of generated waste:		**kg of CO2-eq/tonne**	**298.134**				**99.557**			

Summary EQT – Calculation emissions per ton of generated waste



Summary EQT – Calculation emissions per ton of generated waste





Summary EQT – Calculation emissions total yearly collected waste

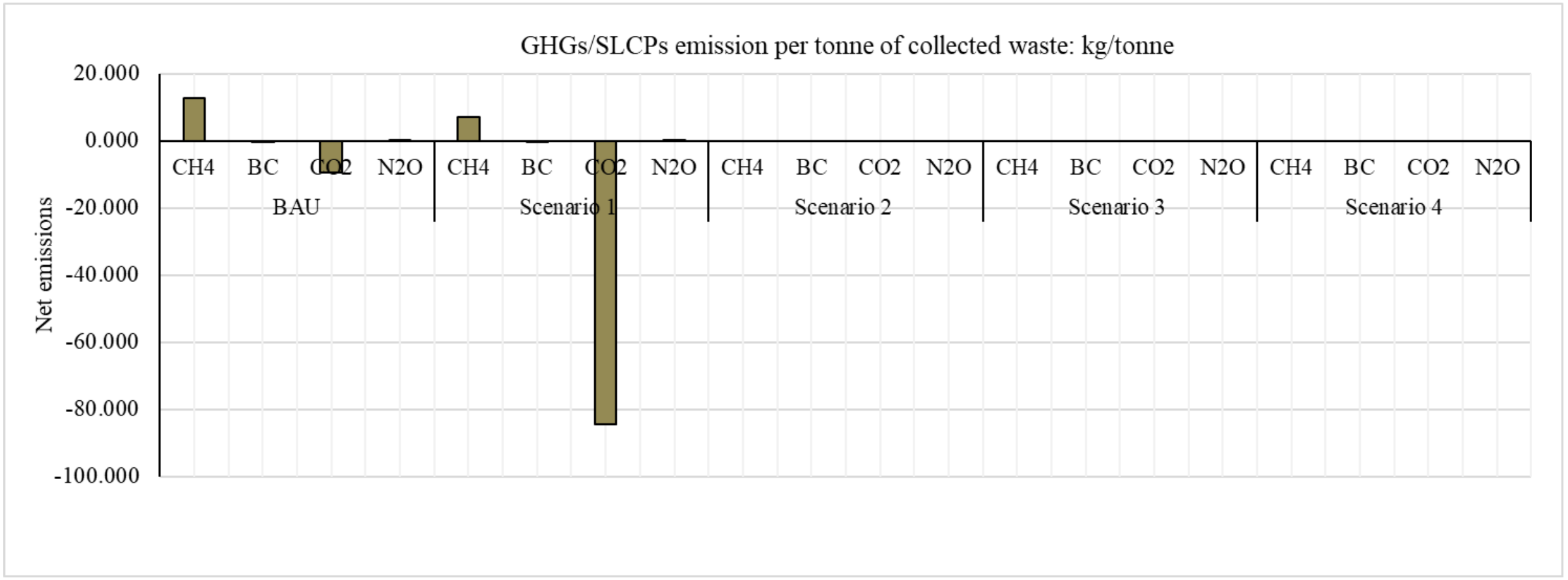
Please choose the prefered 'Unit' for emissions estimation

Calculate emissions from yealy collected waste

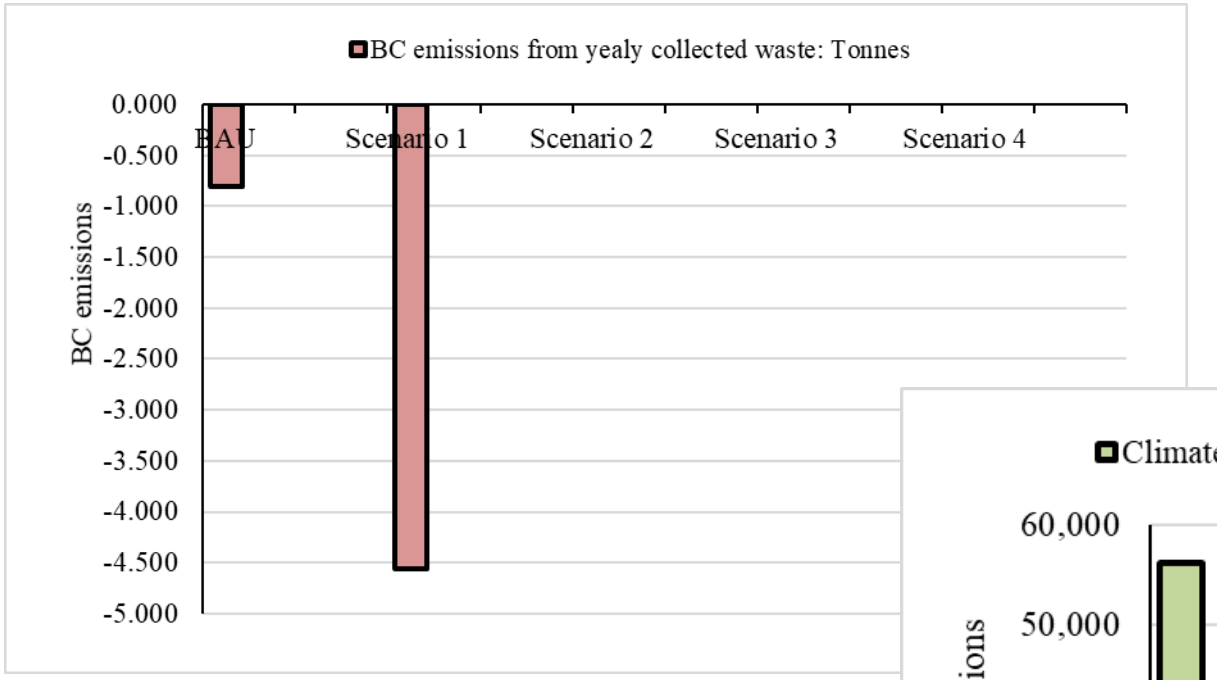
Summary of net GHG/SLCP emissions from waste management

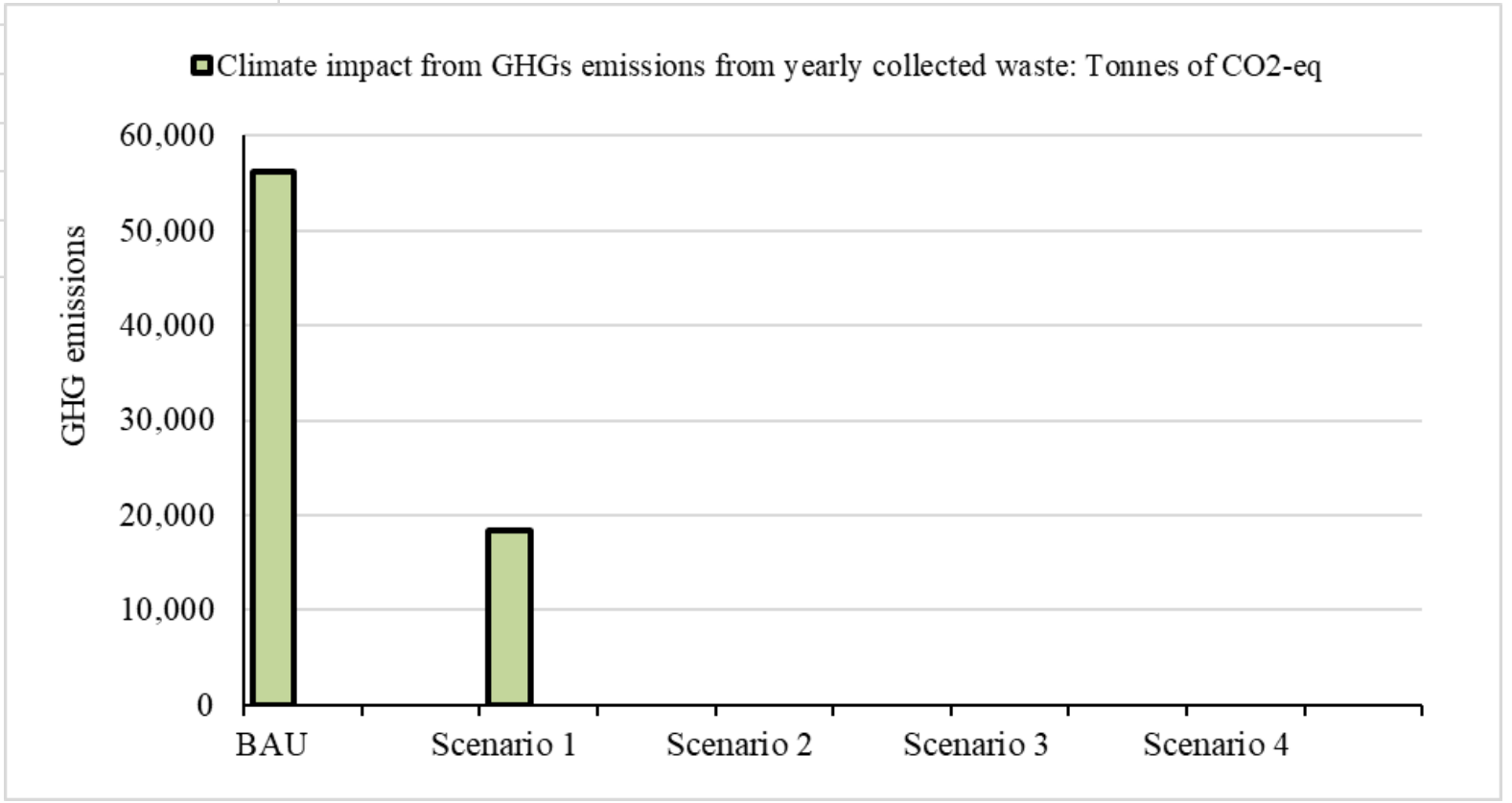
Description	Technology	Unit	BAU				Scenario 1			
			CH_4	BC	CO_2	N_2O	CH_4	BC	CO_2	N_2O
Waste collection and transportation by the city	Transportation	**kg /tonne** (unit ' kg ' used here to show the magnitude of small amount of emissions)	0.001	0.005	17.577	0.001	0.001	0.005	17.577	0.001
Treatment for separated waste	Composting		4.000	0.000	1.390	0.300	4.000	0.000	1.390	0.300
	Anaerobic digestion						0.991	-0.071	-218.579	-0.002
	Recycling		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment for mixed waste	MBT									
	Incineration									
	Landfilling		16.075	-0.013	-34.378	0.000	20.263	0.000	0.440	0.000
	Open burning/landfill fire									
Uncollected waste	Open burning/scattered dumping		0.105	0.003	0.615		0.086	0.003	0.615	
GHGs/SLCPs emission per tonne of collected waste:		**kg/tonne**	**12.759**	**-0.005**	**-9.519**	**0.006**	**7.050**	**-0.028**	**-84.501**	**0.005**
BC emissions from yealy collected waste:		**Tonnes**	**-0.805**				**-4.556**			
Climate impact from GHGs emissions from yearly collected waste:		**Tonnes of CO2-eq**	**56,228.406**				**18,403.712**			

Summary EQT –Calculation emissions total yearly collected waste

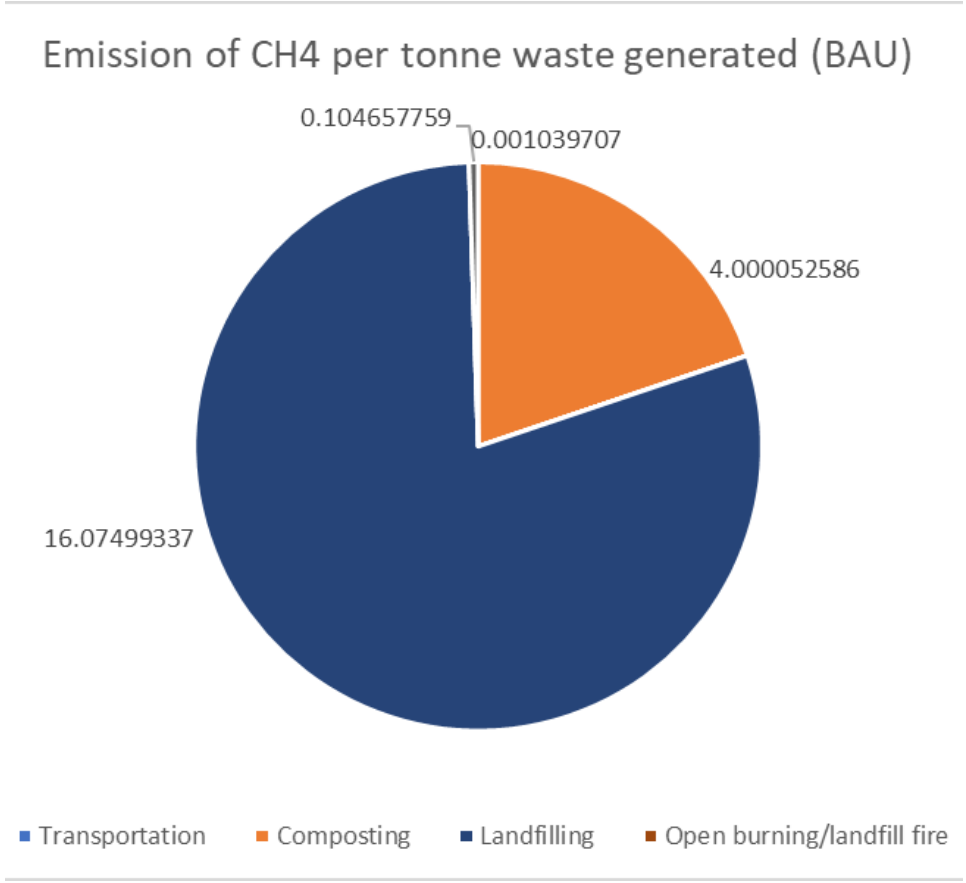


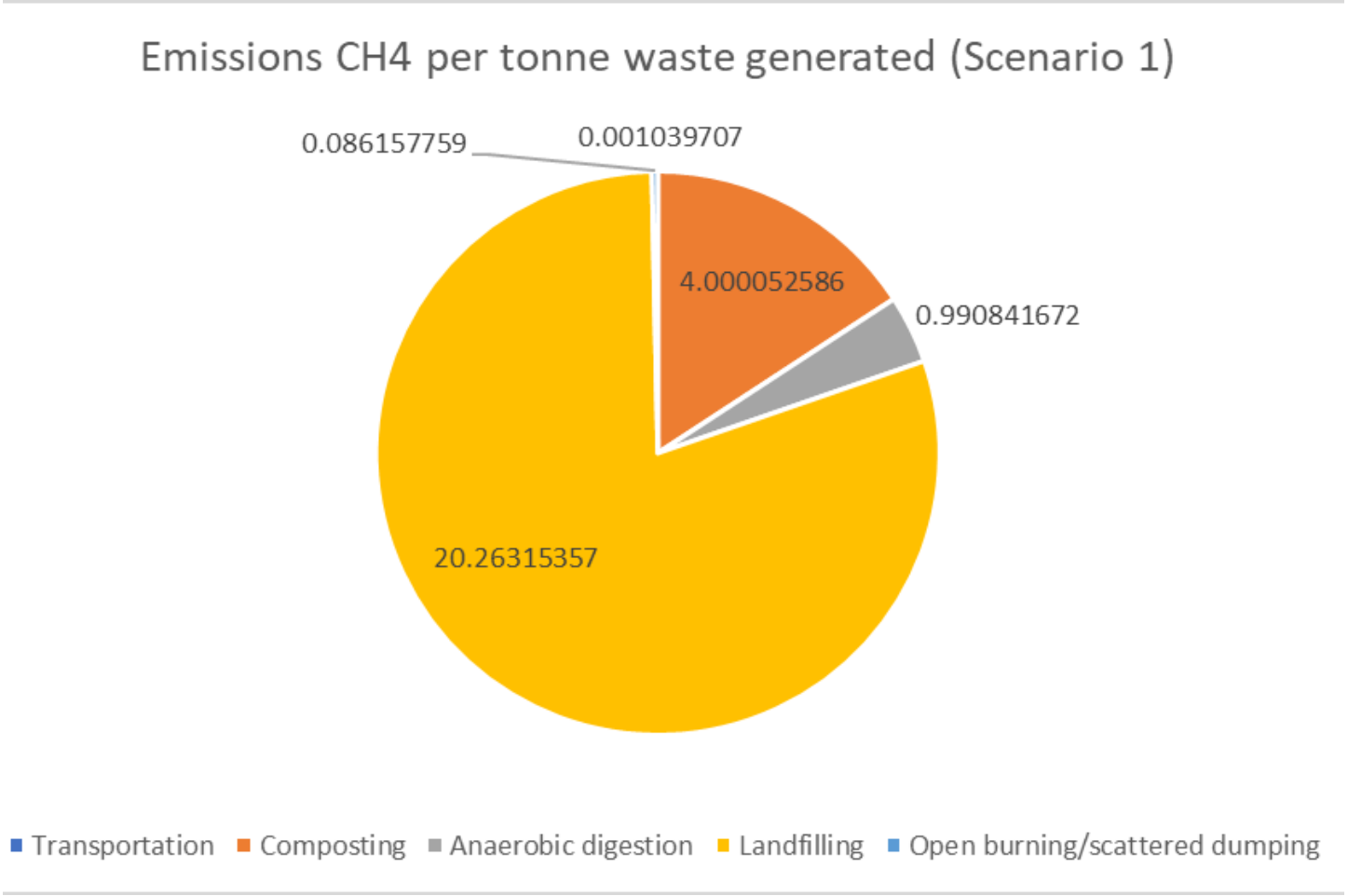
Summary EQT – Calculation emissions total yearly collected waste



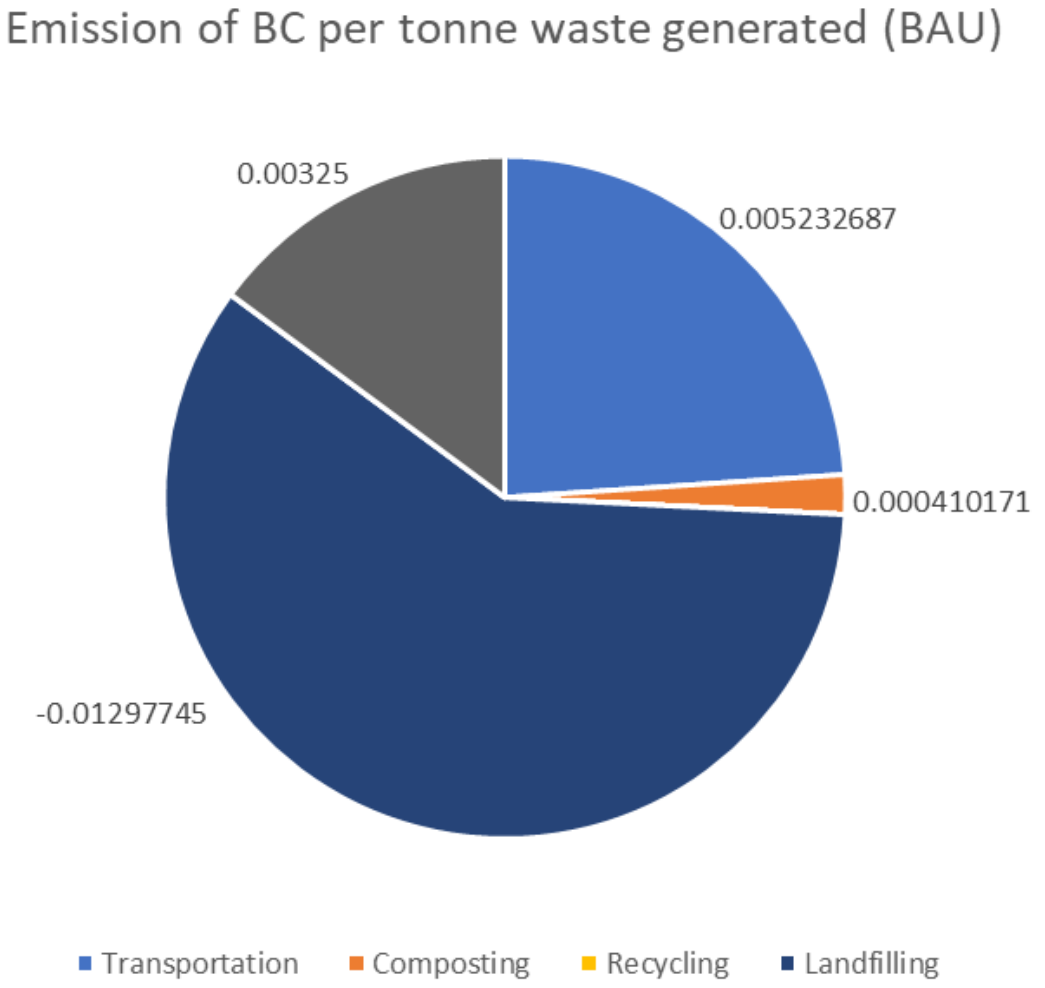


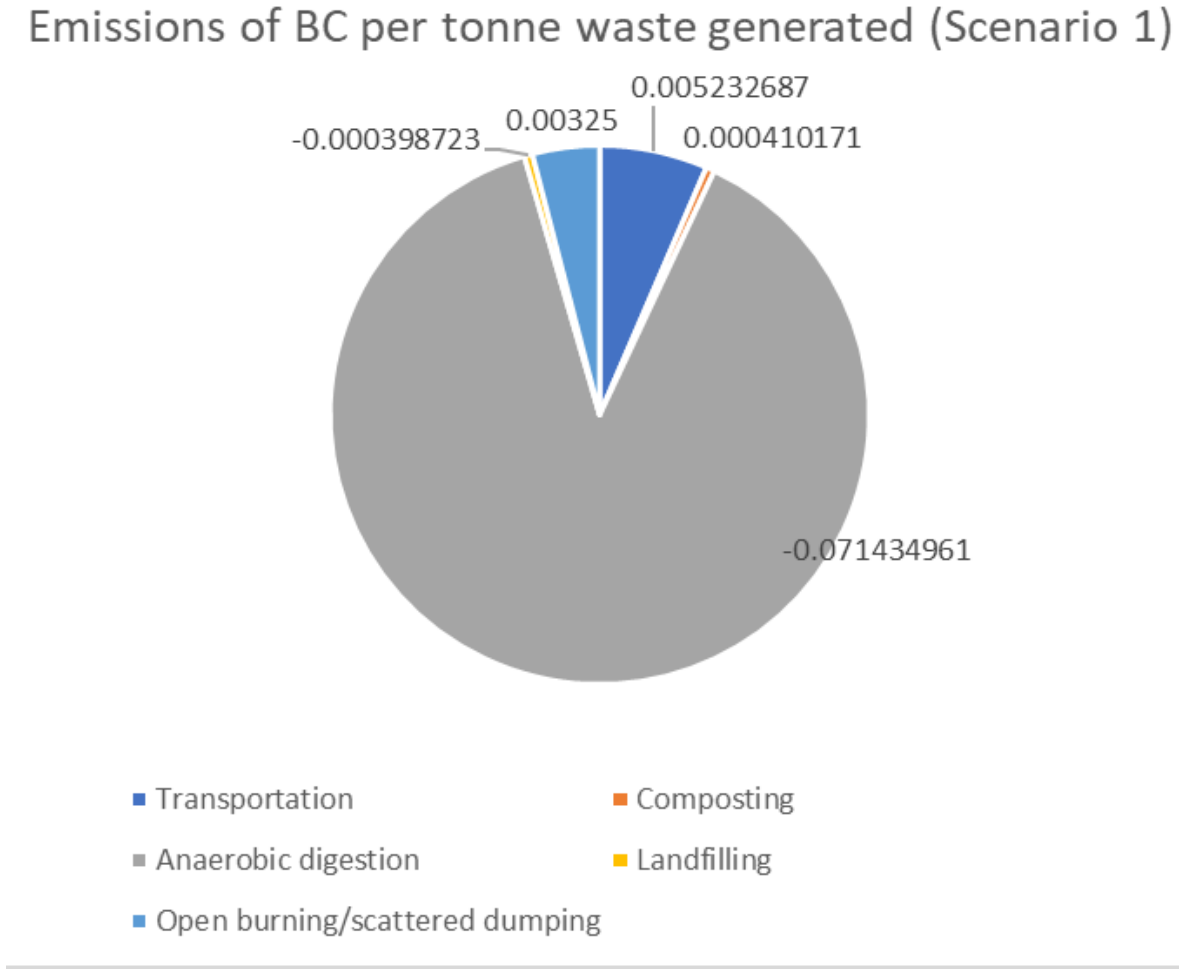
Emissions CH4 (BAU vs Scenario 1 (AD))



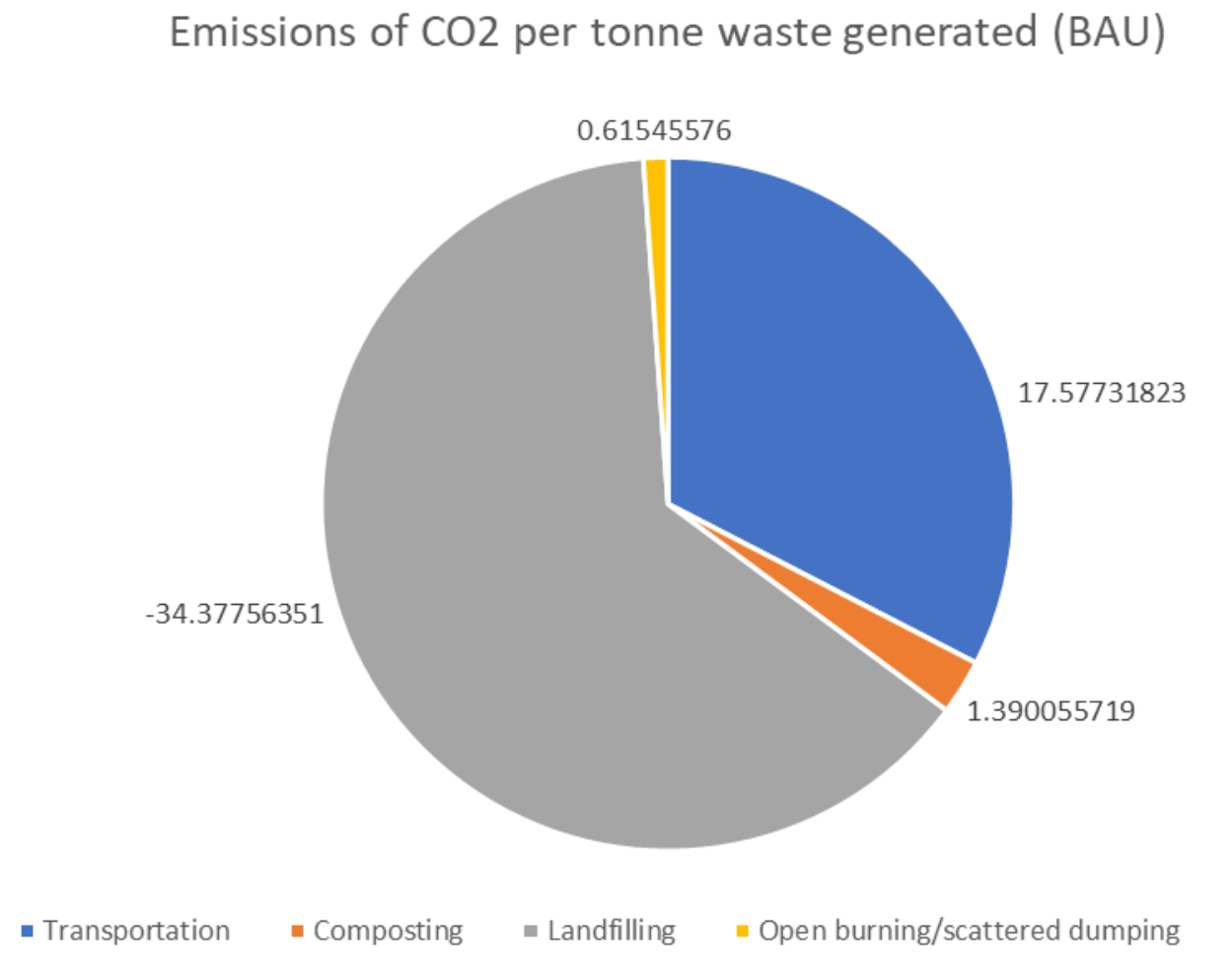


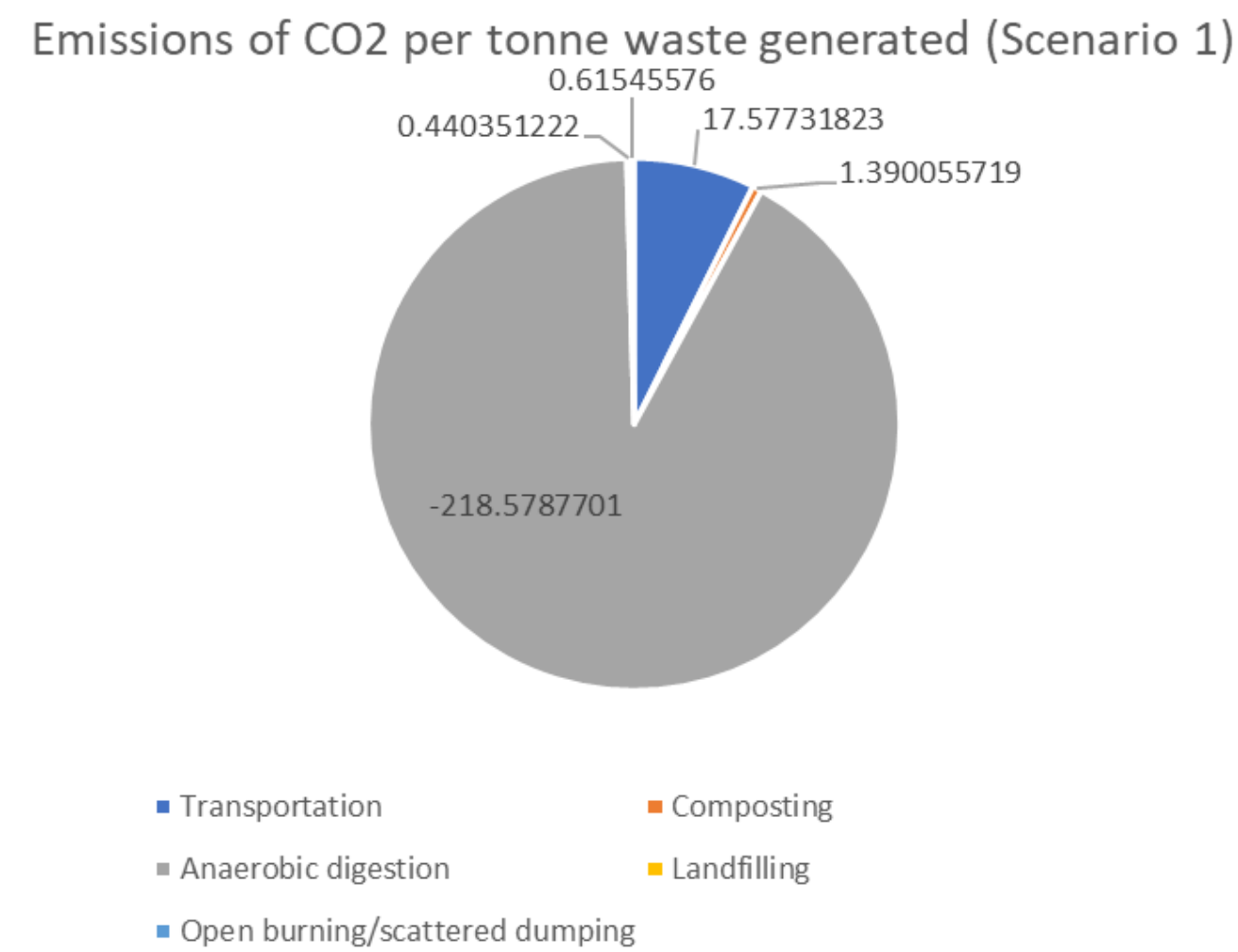
Emissions BC (BAU vs Scenario 1 (AD))





Emissions CO2 (BAU vs Scenario 1 (AD))





Developing Scenario for future (2030)

Basic Assumption

- Annual growth rate of waste generated from the city: 2.26%
  Total waste generated in 2022: 521.86 ton/day
  Total future waste generated in 2030: 624.02 ton/day
- Collection rate by city government:
  Total collected by city: 440.68/521.86 = 84.44%
  Assumed will be 90% in 2030 total waste collected by city= 561.62 ton/day
- Food waste remain same 42.3% and Garden waste 6.36%
  Food waste : 42.3% x 561.62 = 237.56 ton/day
  Garden waste: 6.36% x 561.62 = 35.72 ton/day
  Total organic waste = 273.28 ton/day

Developing Scenario for future (2030) – Organic waste treatment

Organic Waste

- Total organic waste: 273.28 ton/day
  Food waste: 237.56 ton/day & Garden waste: 35.72 ton/day
- Composting (remain same): Capacity: 8.3 ton/day
  Food waste: 7.05 ton/day & Garden Waste: 1.25 ton/day
- **Anaerobic Digester (AD)**
  Remaining organic waste: 273.28 – 8.3 = ***264.98 ton/day***
  Food waste = 230.51 ton/day
  Garden waste: 34.47 ton/day

Recycling

84.45 ton/day (2022) → remain same in 2030: 84.45 ton/day

Remaining Landfill (mixed) = 561.62 – 84.45 – 8.3 – 264.98 = ***203.89 ton/day***

Future Scenario 2030 (BAU vs Scenario 2)

Current Situation (BAU 2030)	Scenario 2 (With Anaerobic Digester / AD)
Total waste collected by city: 561.62 ton/day	Total waste collected by city: 561.62 ton/day
Recycling: 30825.25 (ton/year) = 84.45 ton/day	Recycling: 30825.25 (ton/year) = 84.45 ton/day
Composting: 8.3 ton/day a. Food waste: 7.05 ton/day b. Garden waste: 1.25 ton/day	**Composting: 8.3 ton/day** a. Food waste: 7.05 ton/day b. Garden waste: 1.25 ton/day
Anaerobic Digester : No	**Anaerobic Digester** **Total organic waste: 264.98 ton/day (FW: 230.51; GW:34.47)**
Landfill (mixed waste): 561.62-84.45-8.3=**468.84**	**Landfill** (mixed waste): 561.68284.45-8.3-264.98=**203.89**
Landfill with gas recovery a. Start & end of year of disposal: 2002 & 2026 b. Efficiency gas collection: 60% (start in 2012) c. Closing year of gas recovery: 2035	**Landfill with gas recovery** a. Start & end of year of disposal: 2002 & 2026 b. Efficiency gas collection: 60% (start in 2012) c. Closing year of gas recovery: 2035

Summary EQT – Calculation emissions per ton of generated waste in 2030

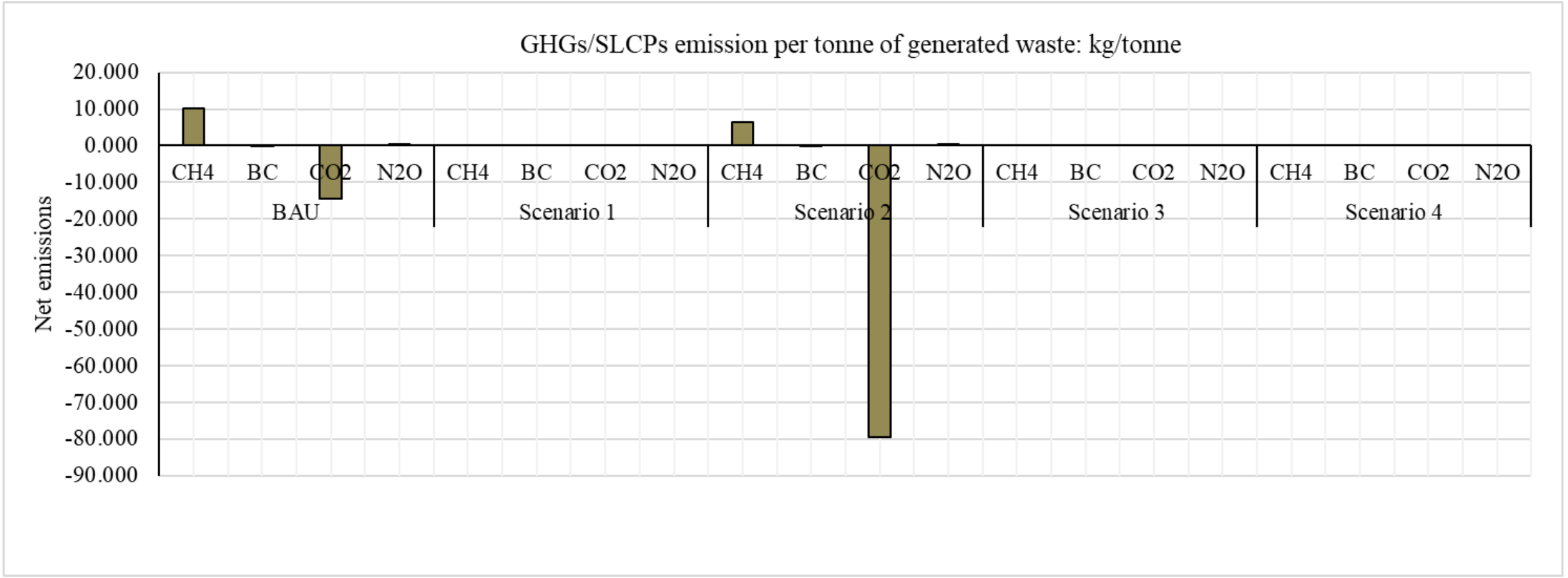
Please choose the prefered 'Unit' for emissions estimation

Calculate emissions per tonne of generate waste

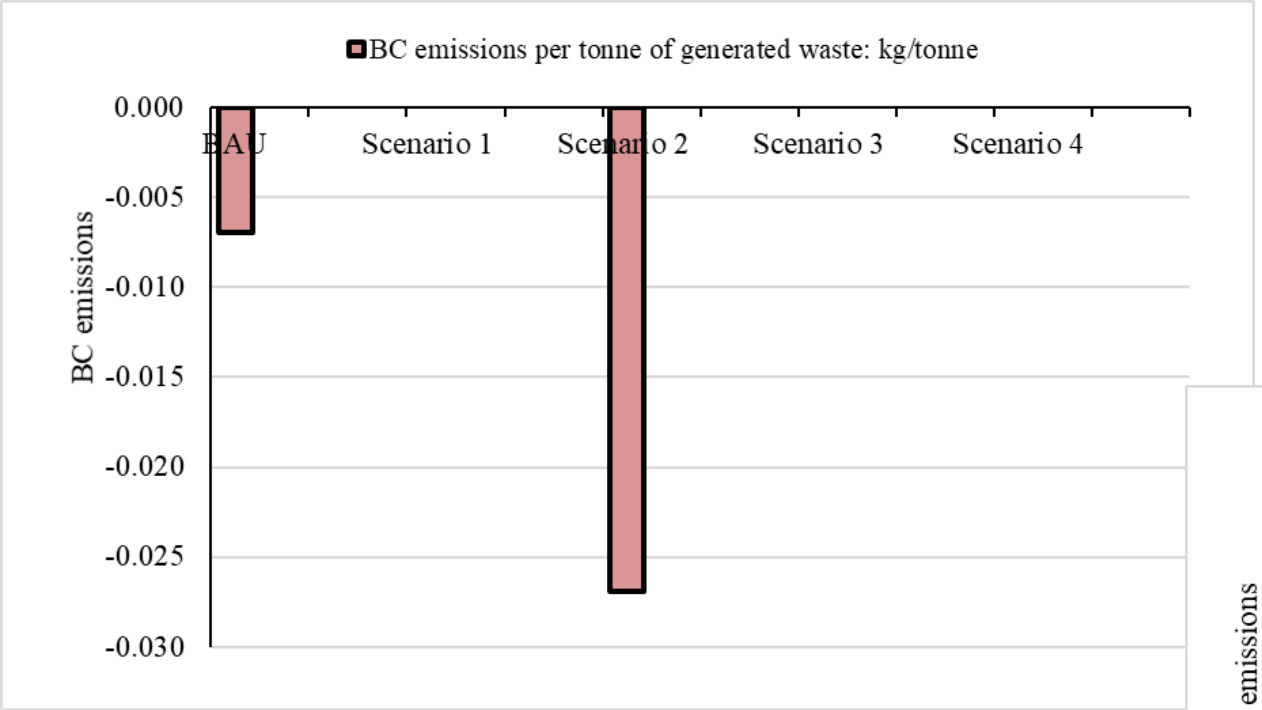
Summary of net GHG/SLCP emissions from waste management

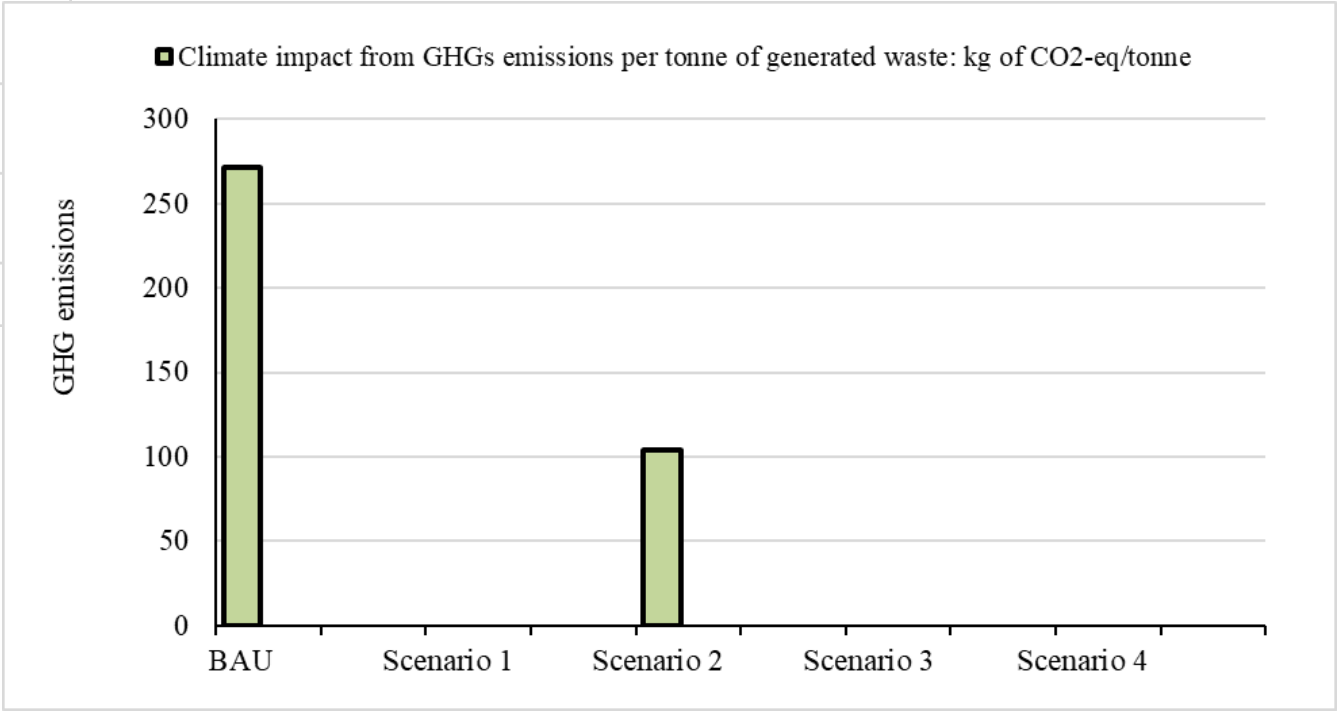
Description	Technology	Unit	BAU				Scenario 2			
			CH_4	BC	CO_2	N_2O	CH_4	BC	CO_2	N_2O
Waste collection and transportation by the city	Transportation	**kg /tonne** (unit ' kg ' used here to show the magnitude of small amount of emissions)	0.001	0.004	15.264	0.001	0.001	0.004	15.264	0.001
Treatment for separated waste	Composting		4.000	0.000	1.390	0.300	4.000	0.000	1.390	0.300
	Anaerobic digestion						0.991	-0.071	-218.579	-0.002
	Recycling		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Treatment for mixed waste	MBT									
	Incineration									
	Landfilling		13.469	-0.015	-39.705	0.000	18.450	-0.003	-5.719	0.000
	Open burning/landfill fire									
Uncollected waste	Open burning/scattered dumping		0.105	0.003	0.615		0.086	0.003	0.615	
GHGs/SLCPs emission per tonne of generated waste:		**kg/tonne**	**10.175**	**-0.007**	**-14.542**	**0.004**	**6.505**	**-0.027**	**-79.398**	**0.004**
BC emissions per tonne of generated waste:		**kg/tonne**	**-0.007**				**-0.027**			
Climate impact from GHGs emissions per tonne of generated waste:		**kg of CO2-eq/tonne**	**271.485**				**103.707**			

Summary EQT – Calculation emissions per ton of generated waste

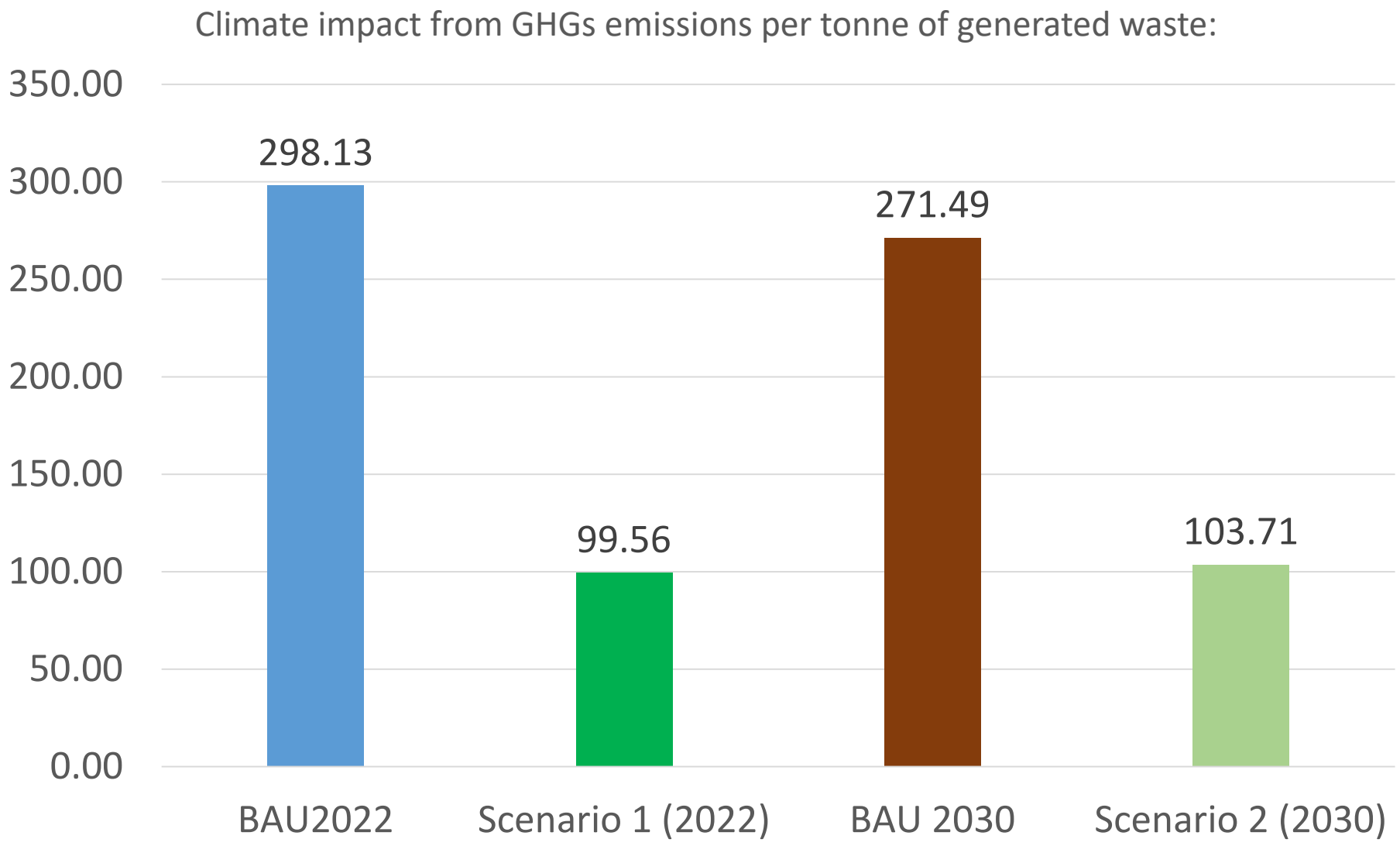


Summary EQT – Calculation emissions per ton of generated waste

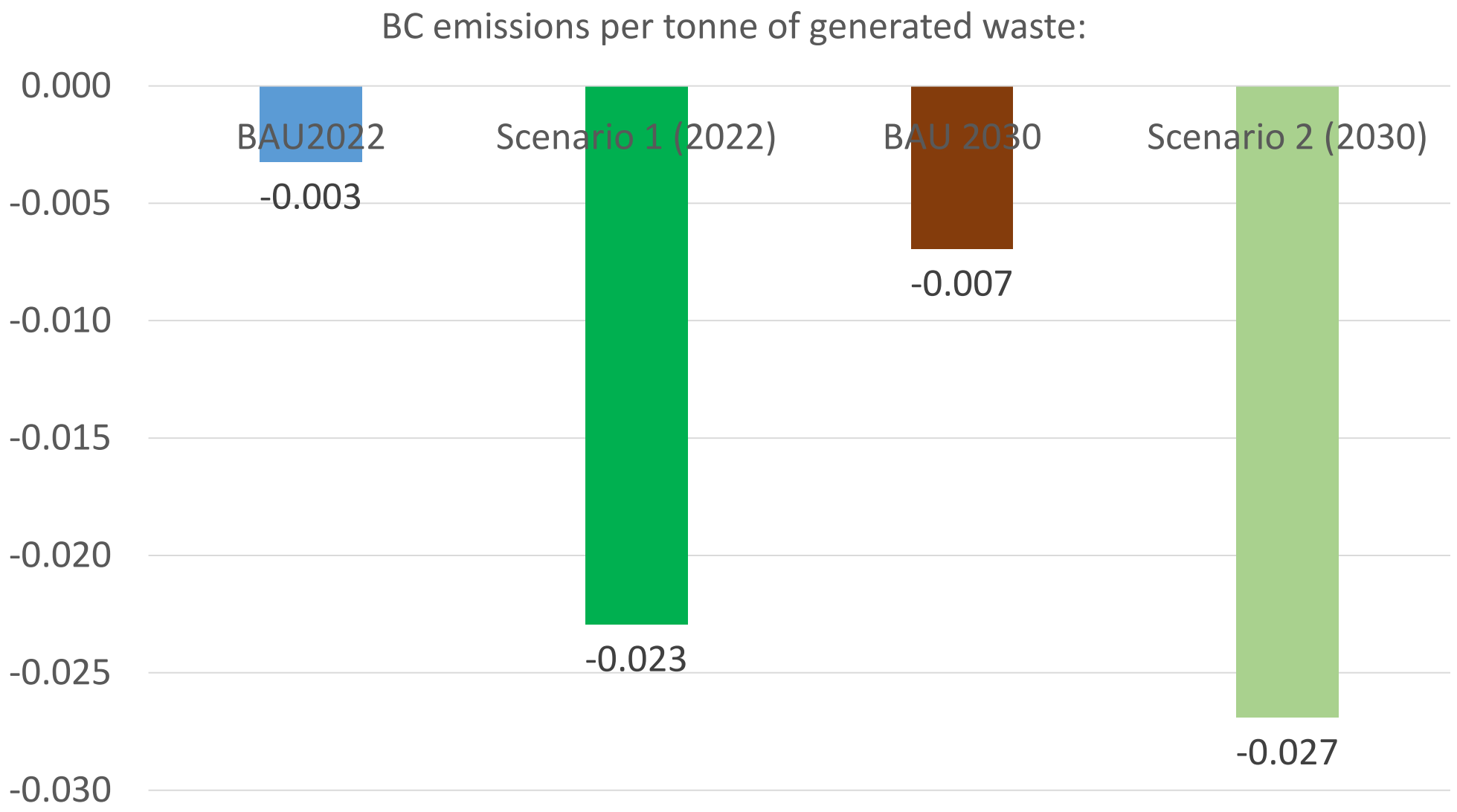




Climate Impact from GHGs emissions per ton of generated waste



Black Carbon emissions per ton of generated waste



Discussion Points – Using EQT Tool

- Application of EQT Tools is simple, BUT it requires ***Robust and Reliable Data***! It is just a tool to help to quantify the Data. So Data is Key!
- Example missing (existing) data in Balikpapan:

a. Total waste generated from city = waste collected by City + waste collected by informal sector + uncollected waste
b. Waste composition of generated waste in city level

- Example of missing (existing) data of Recycling

a. Waste composition (%)
b. Energy/fuel consumption for Recycling process

- Detailed uncollected waste (% dumped and % burned)
- Example of missing (planning/design) data in Balikpapan → Anaerobic Digestion:

a. Fossil fuel used for operation of AD
b. Grid electricity used for operation of AD

Discussion Points – Impact of Infrastructures on Emissions

- *As far as Black Carbon is concerned, scenario 1 (development of AD) has the lowest emission and which seems to be the best option for Balikpapan*
- *As far as other GHGs emissions is concerned, Scenario 1 has lowest net GHG emissions. Technological option used in this scenario seems to be the most appropriate choice for Balikpapan city*
- *Sanitary landfill with gas recovery in the long-run has potential to reduce GHG emissions from the case in Balikpapan.*

a. Although the waste generated will increase in 2030, however Climate Impact from GHGs emissions per ton of generated waste decrease from 298.13 kg/ton in 2022 to 271.49 kg/ton in 2030

b. Black carbon also decrease from -0.003 to -0.007 kg/ton waste generated in Balikpapan

- Developing an Anaerobic Digester (AD) will further decrease both climate impact from GHGs emissions and Black Carbon Emissions per ton generated waste
- ***Food waste & garden waste available in 2022 about 206 ton/day and it will be about 264.98 ton/day in 2030. So, the design capacity of AD 400 ton/day need to be feed in by other organic sludge from wastewater treatment plant and others!***

Way Forward

- EQT Tools is useful and simple to help to quantify analysis. So it can be applied for other types of Low Carbon Infrastructures on waste management such as: TPS3R, MBT, Composting, Incinerator/Waste to Energy/RDF facilities

- It can be applied for other cities at any level, for example 16 cities of the member of Integrated Solid Waste Management Program of MPWH & World Bank

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