



ISO Greenhouse Gas & Carbon Audit ISO/IEC 14064-1-2-3 Carbon Auditor & GHG Verifier

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Different kinds of GHG professional

- **GHG Carbon auditor** – Carbon Auditing Firm or Freelance
- **GHG Carbon verifier** – GHG Validation & Verification Body
- **GHG Carbon validator** - GHG Validation & Verification Body
- **GHG Carbon assessor** – HKAS, ANAB & IAS
- **GHG Carbon evaluator** – Peer evaluator to an economy

2

Different kinds of GHG Accounting Methodology

- GHG Carbon auditor to **HK EMSD Guideline**
- **CIC HKGBC** to **ISO 14067** – Carbon footprint labelling for Steel, Cement & RMC
- GHG verification & validation to **ISO 14064-1, -2 & -3** – **GHG VVB** - SGS, Pricewater House.
- GHG accreditation assessment to **ISO 14065 & ISO 17029** – HKAS, ANAB & IAS
- GHG evaluator – **IAF MD Requirements**

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CIC - Hong Kong Green Building Council Certified Carbon Auditor

**“Cement” & “Ready Mixed Concrete”
“Reinforced Bar & Structural Steel”**



**Energy Institute UK
Certified Carbon
Auditor**



Scope of accreditation
Reference No. ANAB-23-100
Page 1 of 2
Date of issue: 14/09/2023
Date of expiry: 14/09/2025

Item No.	Description
1	Design, development, production, installation, maintenance and repair of fire alarm systems
2	Design, development, production, installation, maintenance and repair of fire extinguishers
3	Design, development, production, installation, maintenance and repair of fire extinguishers

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Carbon Offsetting & Neutrality

Definition of Carbon Offsetting and Neutrality

Carbon Offsets

- CO₂e savings equivalent to your footprint have been achieved by others

Carbon Neutrality
the organisation does not emit any CO₂e or has offset all emissions

Figure 1: Carbon neutrality

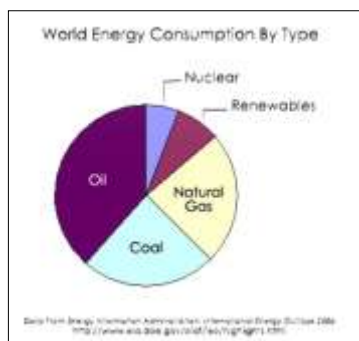
Consumption of Fossil Fuels

Fossil Fuel

- Burial of vegetation under successive layers of sedimentary sands & rocks; fossilized vegetation - physical compression & chemical decomposition lead to formation of coal.
- Decomposed marine life buried under ocean floor forms oil & natural gas
- Chemical reaction: carbohydrate -> hydrocarbon

$$C_6H_{12}O_6 \xrightarrow[\text{absence of } O_2]{\text{pressure + heat}} C_6H_{12}$$

World Energy Consumptions




Consumption of Hydrocarbon

Hydrocarbon (C_nH_m)

- Natural gas - mostly methane (CH₄)
- Liquefied petroleum gas (LPG) - propane (C₃H₈) and butane (C₄H₁₀)
- Gasoline - octane (C₈H₁₈)
- Diesel - cetane (C₁₆H₃₄)
- Coal - very long-chain hydrocarbon

C: ●
H: ●

Combustion of C_nH_m - Gasoline


Combustion of C_nH_m 

Chemical reaction for complete combustion of gasoline:

$$\text{C}_8\text{H}_{18} + 12.5\text{O}_2 + 12.5(3.76)\text{N}_2 \rightarrow 8\text{CO}_2 + 9\text{H}_2\text{O} + 47\text{N}_2$$

The exothermic reaction releases heat.

Carbon & Carbon Dioxide

Carbon & carbon dioxide 

Carbon dioxide is made up of 1 atom of carbon and 2 of oxygen (CO₂).
The relative atomic mass of Oxygen (the bottom number on the periodic table) is 16 and Carbon 12.
This means one molecule of CO₂ has a relative atomic mass of 16+16+12 (44).

Carbon + Oxygen = Carbon Dioxide


C	+	O ₂	=	CO ₂
12	+	16 x 2	=	44

Carbon is 12/44 of CO₂.

44 tonnes of CO₂ contains only 12 tonnes of Carbon!

So how many tonnes of carbon is there in 88 tonnes of CO₂?

Emissions of GHGs

Emissions 

Combustion of fossil fuels emits airborne pollutants.

Carbon dioxide (CO₂): major greenhouse gas (GHG) that causes climate change and global warming


Sulfur dioxide (SO₂): may cause infant mortality, cardiovascular disease, viral diseases, respiratory tract, chronic bronchitis, asthma, lower respiratory, emphysema, kidney damage, anemia fatigue, bone changes, cancer

Nitrogen oxides (NO_x): may cause cardiovascular disease, viral diseases, respiratory tract, chronic bronchitis, asthma, lower respiratory, emphysema, hypertension, visual disorders


Carbon monoxide (CO): extremely toxic, cardiovascular disease and symptoms such as fatigue, rapid breathing, chest tightness, etc.

Volatile organic compounds (VOC): headache, depression of central nerves, irritation of eyes, nose, & throat, carcinogenic


Particulate matters: PM₁₀ (dia. ≤ 10 µm) and PM_{2.5} (dia. ≤ 2.5 µm) can be deposited in lungs and cause harm to our health.



Consequence of Global Warming – Climate Change

Consequences of Global Warming – Climate Change 

- Sea level rise
 - 15 – 100 cm in next century.
 - Potential coastal flooding.
- Intensification of hydrologic cycle
 - increasing evaporation will result in drier soil.
 - impact on regional water sources.
- Dramatic effects on ecosystems
 - forest, deserts, mountain regions, lakes, streams, wetlands etc.
- Health effect
 - disease such as malaria.
 - adverse heat strain.



Kyoto and Beyond – Paris COP 26 – Glasgow Nov 2021

Actions 

KYOTO AND BEYOND

- 1990 UN Intergovernmental Panel on Climate Change (IPCC) First Assessment Report concludes and triggers UNFCCC process
 - Second World Climate Conference
 - UN General Assembly sets up group to negotiate United Nations Framework Convention on Climate Change (UNFCCC).
- 1992 UNFCCC concluded with weak targets
- 1994 Alliance of Small Island States (AOSIS) submits Protocol proposal for 25% reduction by 2005 for CO₂
- 1995 Conference of the Parties COP1, Berlin agrees to negotiate protocol urgently
 - IPCC Second Assessment Report concluded under extreme pressure from industry and COP1.
- 1996 COP2 US surprises EU, Rattengasts Japan and calls for legally binding tradeable targets
- 1997 COP3 Adopts Kyoto Protocol with reduction targets
 - More than 180 nations have ratified the Kyoto Protocol.
- 2009 G8 pledged to support a global target to cut emissions by 50% by 2050 compared with 1990.

UNFCCC = United Nations Framework Convention on Climate Change
COP = Conference of the Parties

Kyoto and Beyond – Paris COP 26 – Glasgow Nov 2021 Climate Summit

Actions 

KYOTO AND BEYOND

- 2008 G8 pledged to support a global target to cut emissions by 50% by 2050 compared with 1990.
- 2009 Copenhagen Accord - addressed climate change as one of the greatest modern challenges. Agreed that actions should be taken to keep the average temperature increase to below 2°C, but no legally binding commitments.
- 2010 New proposed 60% minimum reduction by 2050
- 2010 Kyoto extended (2nd commitment period) until 2020
- 2011 Durban COP laid the framework for post 2020. All member nations committed to a "comprehensive plan that would come closer over time to delivering the ultimate objective of the Climate Change Convention" to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous interference with the climate system and at the same time will preserve the right to sustainable development
- 2013 IPCC 5th assessment report states that warming of the climate system is unequivocal and asserts that "human influence on the climate system is clear".
- 2015 COP21 Warsaw: The goal was to develop a new legally binding international treaty to curbing global emissions in order to limit the global average temperature increase to 2°C by the end of the century. This future agreement, to be signed in 2015, is enter into force in 2020, would replace the Kyoto Protocol (expires in 2020). Negotiations ended with a directive for all nations to establish and submit their emissions reduction contributions by early 2015. Consensus was for nations to submit "contributions" rather than "commitments".

Kyoto and Beyond – Paris COP 26 – Glasgow Nov 2021 Climate Summit

Kyoto Protocol

- Commit to meet target for greenhouse gas (GHG) emission reduction.
- Implement emission trading.

APEC Sydney Declaration on Climate Change

- Ensure energy supply for the needs.
- Address environmental issues and reduce GHG emission.

ISO 14064: GHG Emissions Inventories and Verification

- Quantify, report and verify GHG emissions.

Copenhagen Conference

- Not too successful as no concrete agreement on the reduction

Paris United National Climate Change Conference 2015

- Agreement signed off among 170+ jurisdiction states for the reduction of GHG including developing countries
- In particular USA and China committed to mitigating the GHG and reduce the temperature rise to 1.5 degree C in the upcoming decade.

Carbon Management

CARBON

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- Auditing
- Trading
- Offsetting
- Credits
- Accounting
- Foot printing



Carbon Audit

Carbon Audit

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A carbon audit measures an organisation's or process's greenhouse gas emissions, including direct emissions generated on-site and indirect emissions associated with energy use.

e.g.

- direct emissions include CO₂ from diesel combustion and refrigerants, leaking from air-conditioning systems,
- indirect emissions include those attributed to electricity consumption and the use of other products including water, paper, etc..

Carbon Audit References

Useful References

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- Intergovernmental Panel on Climate Change (IPCC)
- U.S. Environmental Protection Agency (U.S. EPA - AP42)
- European Environment Agency (EMEP/EEA air pollutant emission inventory guidebook)
- Census and Statistics Department (C&SD - Hong Kong Energy Statistics Annual Report)
- Electrical and Mechanical Services Department (EMSD - Hong Kong Energy End-use Data)

Carbon Emission Trading

What is Carbon Trading?

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Carbon Emissions trading (also known as the **carbon cap and trade**) is an administrative approach used to control emissions by providing economic incentives for achieving reductions in emissions of pollutants from energy consumption.

Carbon Emission Trading

energy INSTITUTE

CONSULTATION PAPER
ON
A
CARBON EMISSIONS TRADING SCHEME
FOR
HONG KONG

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Carbon Emission Trading - Problems

Problems



- Market price for Carbon (HK\$ 4 -150+)
- Supply and Demand
- Complex reporting methodologies
- Verification of emissions
- Voluntary v Compulsory

Carbon Dioxide Sequestration

Environmental



Dioxide (CO₂) or Carbon Sequestration

Carbon dioxide sequestration is the term given for locking up CO₂ somewhere other than the atmosphere.

Also be called **carbon** sequestration because the carbon dioxide may be broken down into its component parts and the carbon stored away while the oxygen is released to the atmosphere.

There are two kinds of sequestration:

- **Biological:** carbon is naturally sequestered in plants, soils, and in ocean life.
- **Geological:** is the storage of carbon dioxide directly in rocks or underwater.

Kyoto Protocol - GHGs

Kyoto Protocol Greenhouse Gases



Greenhouse Gases (GHGs): A group of gases that absorb and re-radiate infrared radiation. These gases result from both natural and human-influenced processes.

Carbon Footprint

What is a Carbon Footprint



The total greenhouse gas emissions caused directly and indirectly by an individual, organisation, event or product.

Expressed in units of carbon dioxide equivalent (CO_{2e}).

- Carbon Dioxide Equivalent (CO_{2e}): A measure used to compare and sum the impact from various greenhouse gases based upon their global warming potentials (GWP).
- The CO₂-equivalent for a gas is derived by multiplying the tonnes of the gas by the gas's associated Global Warming Potential (GWP).



Carbon Dioxide – its Size & Scale

Carbon Dioxide



1 tonne of Carbon Dioxide is equivalent to a balloon **10 metres** in Diameter!



Kyoto Protocol – 6 Kinds of GHGs

Kyoto Protocol Greenhouse Gases (GHG)



Carbon Dioxide
Fuels for Energy and Transport, Manufacturing Processes



Methane
Waste (Landfills, natural activity)

Nitrous Oxide

Chemical manufacture and agriculture

HFCs

(hydrofluorocarbons)

Refrigerants, chemical manufacture, foams & aerosols

PFCs

Aluminium manufacture, electronics manufacture

Sulphur hexafluoride

Magnesium smelting, high voltage switchgear, electronics manufacturing

GHG – Global Warming Potential

GHG	Global Warming Potential (GWP)
CO ₂	1
CH ₄	21
N ₂ O	310
HFCs	140 – 11,700
PFCs	6,500 – 9,200
SF ₆	23,900

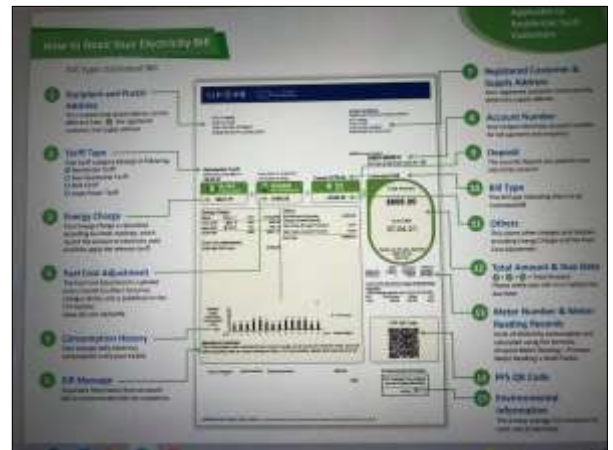
Note: Taking into account the amount of worldwide emissions, CO₂ contributes about 50% to the total global warming effect.

Top Ten CO₂ Emitter

CO ₂ Emissions from the Consumption of Energy 2010 data (Miles Metric Tons)			
Country	Rank	Miles Metric Tons	Tonnes per person
China	1	6,321	8
United States	2	5,810	18
India	3	1,806	1
Russia	4	1,624	12
Japan	5	1,168	9
Germany	6	744	18
Korea, South	7	579	12
Iran	8	566	7
Canada	9	549	16
United Kingdom	10	532	9
Australia	10	405	19

Global average is ~ 4/tonnes/person

Electricity Bill – China Light Power



Electricity Bill – HK Electric Co.

Gas Supply Bill – Towngas Co Ltd





Water Bill –
Hong Kong WSD

The Carbon Auditing Process



Carbon Footprint Audit

GHG inventory / carbon footprint

■ The Fundamental Formula:

■ Emissions in terms of tons CO₂e =

$$AD_i \times EF_i \times GWP_i$$

■ The Footprint:

$$\text{Footprint} = \sum_i^n (AD_i \times EF_i \times GWP_i)$$

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Information gathering

- Types
- Sources
- Accuracy

Site Tour

- Preparation
- Responsibilities
- Equipment
- Time
- How far?

Information Analysis

- Observations
- Data collected
- History
- Benchmarks
- Future plans
- Capabilities

Reporting & Action Plans

- Reports
- Action Plans
- Implementation
- Closing the loop

Carbon Audit Process

Simple Auditing

First Principles

OTHERS

- Motors
- Water Heaters
- Office equipment
- Plant
- Process equipment
- Fugitive emissions
- Waste
- Transport

Audit steps

- Preliminary Contact
- Preparation
- Start up meeting
- Collecting Data
- Site Tour
- Visit closing meeting
- Analysis
- Report
- Post Survey briefing
- Implementation?

Detailed Carbon Audit

- Short period metering data
- Sub metering information
- Descriptions of operation
- Staffing levels, working hours and patterns
- Building and refurbishment history
- Information on building materials
- Future projects being planned
- Issues of current concern
- Discussions with relevant staff
- Waste Management
- Fleet management

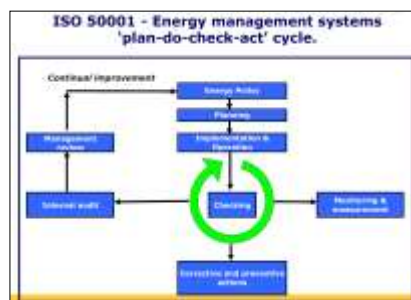
REPORTING

- Text
- Tabular
- Graphical or PowerPoint
- Action points and Recommendations

Remember the reader

- Is it a report or a resource to prompt decision and actions?
- Will it still make sense in 12 / 24 months time?
- Does it offer sufficient options?
- Does it recognise the needs and the ability of the organisation / individuals?
 - Can they afford it?
 - Are they motivated?
 - Are the main objectives met?

ISO 50001:2018 EnMS



Post ISO 50001 - EnMS

Suite of Standards

- **ISO 50002** - Energy Audits
- **ISO 50003** - Energy Management System Audits & Auditor competency
- **ISO 50004** - Guidance for Implementing, Maintaining and Improving an EnMS
- **ISO 50006** - Energy Performance Indicators and baselines
- **ISO 50015** - Measurement & Verification of Organisational Energy Performance
- **ISO 17741** - General technical rules for Measurement, Calculation & Verification of energy savings of Projects
- **ISO 17742** - General calculation methods on energy efficiency and savings for Countries, regions and Cities
- **ISO 17743** - Definition of methodological framework applicable to the calculation and reporting of energy savings
- **PAS 2030** - Improving the energy efficiency of existing buildings. Specification for installation process, process management and service provision

ISO 14001:2015 EMS

• Environmental "aspects"

- emissions to air
- releases to water
- releases to land
- use of raw materials and natural resources
- use of energy
- energy emitted, e.g. heat, radiation, vibration
- waste & by-products, and
- physical attributes, e.g. size, shape, colour, appearance

The range of renewable energy

- Wind
- Wave
- Hydroelectric
- Energy from waste
- Landfill gas
- Energy crops
- Agricultural and forestry residues
- Active solar (hot water panels & PV)
- Passive solar design
- Geothermal
- Ground, Air and water source cooling / (GSHP)

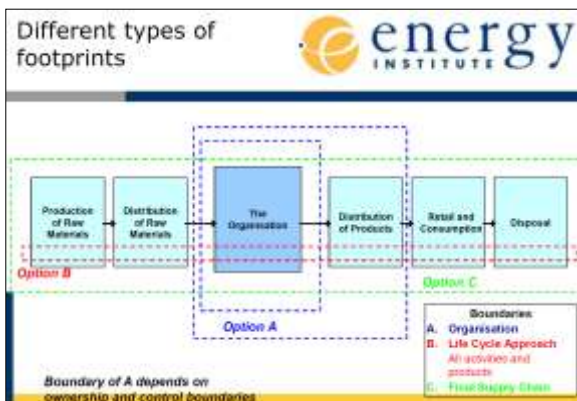
Recap of the CO2 Equivalent

The total greenhouse gas emissions caused directly and indirectly by an individual, organisation, event or product.

Expressed in units of carbon dioxide equivalent (CO₂e).

- Carbon Dioxide Equivalent (CO₂e): A measure used to compare and sum the impact from various greenhouse gases based upon their global warming potentials (GWP).
- The CO₂-equivalent for a gas is derived by multiplying the tonnes of the gas by the gas's associated Global Warming Potential (GWP).





Principles: accounting for and reporting GHG emissions



- **Relevance:** Boundaries, data, assumptions & methodologies must reflect the emission status of the building.
- **Completeness:** The reporting entity should account and report all GHG emissions & removals. Specific exclusions should be disclosed and justified.
- **Consistency:** The reporting entity should use consistent methodologies to allow meaningful comparisons in the GHG-related information including trends over time.
- **Accuracy:** The reporting entity should ensure that any bias & uncertainties in quantifying GHG emissions and removals are minimised, as far as practicable.
- **Transparency:** The reporting entity should disclose sufficient & appropriate information, assumptions and references to allow the users of the report to arrive at conclusions with a reasonable confidence.



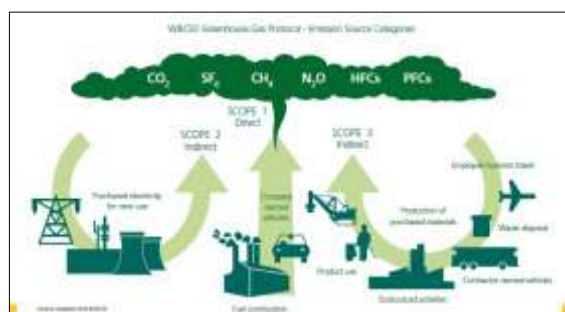
Relevance of the Guide

Applicable to buildings used for residential or commercial purposes:

- Offices
- Retail
- Restaurants
- Hotels
- Also most institutional buildings such as:
- Schools
- Colleges
- Universities
- Community centres
- Sports complexes

• **but not** industrial buildings because of other emitting processes

Emissions Scope

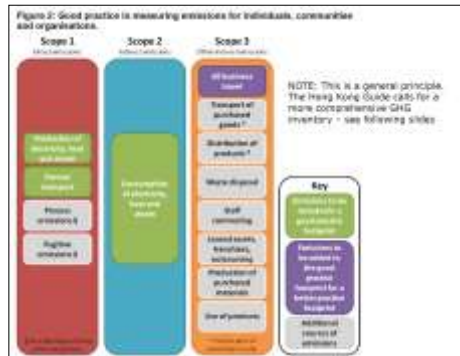


Reporting Scopes

- **Scope 1 operations** are on-site electricity generators, boilers, gas stoves, dedicated motor vehicle fleets, leakage from refrigeration systems, and additional trees planted on site.
- **Scope 2 operations** include production and transportation of electricity and Towngas consumed (purchased) by the buildings.
- **Examples of Scope 3 operations** are commuting and business travel by employees; transportation of products, materials, people or waste by third parties; outsourced activities;
 - GHG emissions arising from the production and distribution of energy products, other than those covered under Scope 2;
 - GHG emissions from production of purchased materials and products.

Scopes of Audit

Establish the Operational Boundary that is identify the operational activities which will result in a GHG emission or removal



Reporting Scopes

Scope 1 – Direct emissions from sources and removals by sinks

1. Combustion of fuels in stationary sources (excluding electrical equipment) to generate electricity, heat, or steam. For example: electricity generators, boilers, gas cooking stoves, etc..
2. Combustion of fuels in mobile sources (e.g. motor vehicles and ships) controlled by the reporting entity and dedicated to the building concerned to transport materials, products, waste and employees to and / or from the building concerned or used within the physical boundary of the building, for example, the commuter shuttle bus services operated for the building.
3. Intentional or unintentional GHG releases from equipment and systems. For example: HFCs and PFCs emissions during the use of refrigeration and air conditioning equipment and other fugitive emissions.
4. Assimilation of CO₂ into biomass through e.g. planting of trees in addition to those already in existence before the operation of the concerned building.
5. Any other physical and chemical processing in the physical boundary which will emit or remove GHG. For example, on-site waste or sewage processing facilities in the building.

Reporting Scopes

Stationary combustion devices

- Boilers
- Burners
- Turbines
- Heaters
- Furnaces
- Ovens
- Dryers
- Internal Combustion Engines (e.g. Emergency Electricity Generator)
- Any other equipment or machinery that combusts carbon bearing fuels or waste streams.

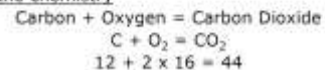
Calculation of Emissions

Carbon Dioxide

$$\text{Emissions} = \text{Fuel quantity} \times \text{relevant emissions factor for CO}_2$$

$$\text{Emissions factor} = \text{NCV} \times \text{Carbon Factor} \times \text{fraction of carbon oxidised}$$

Reminder of the chemistry



Calculation of Emissions

CH₄ and N₂O

$$\text{Emissions} = \text{Fuel consumed} \times \text{relative emissions factor}$$

Check relative Global Warming Potential of CH₄ and N₂O so that values are in CO₂ equivalent values

Calculation of Emissions

Emission category (e.g. CH ₄ , N ₂ O, HFC, PFC, SF ₆)	Step 1		Step 2		Step 3		Step 4		Step 5		Step 6		
	Activity	Fuel type	Fuel type	CO ₂ emissions factor (kg CO ₂ /kg fuel)	CO ₂ emissions (kg CO ₂)	CH ₄ emissions factor (kg CH ₄ /kg fuel)	CH ₄ emissions (kg CH ₄)	N ₂ O emissions factor (kg N ₂ O/kg fuel)	N ₂ O emissions (kg N ₂ O)	HFC emissions factor (kg HFC/kg fuel)	HFC emissions (kg HFC)	PFC emissions factor (kg PFC/kg fuel)	PFC emissions (kg PFC)
Stationary combustion (e.g. Boilers, Burners, Turbines, Heaters, Furnaces, Ovens, Dryers, Internal Combustion Engines (e.g. Emergency Electricity Generator))	Stationary combustion	Fuel type	Fuel type	CO ₂ emissions factor (kg CO ₂ /kg fuel)	CO ₂ emissions (kg CO ₂)	CH ₄ emissions factor (kg CH ₄ /kg fuel)	CH ₄ emissions (kg CH ₄)	N ₂ O emissions factor (kg N ₂ O/kg fuel)	N ₂ O emissions (kg N ₂ O)	HFC emissions factor (kg HFC/kg fuel)	HFC emissions (kg HFC)	PFC emissions factor (kg PFC/kg fuel)	PFC emissions (kg PFC)
Mobile combustion (e.g. Motor vehicles, Ships)	Mobile combustion	Fuel type	Fuel type	CO ₂ emissions factor (kg CO ₂ /kg fuel)	CO ₂ emissions (kg CO ₂)	CH ₄ emissions factor (kg CH ₄ /kg fuel)	CH ₄ emissions (kg CH ₄)	N ₂ O emissions factor (kg N ₂ O/kg fuel)	N ₂ O emissions (kg N ₂ O)	HFC emissions factor (kg HFC/kg fuel)	HFC emissions (kg HFC)	PFC emissions factor (kg PFC/kg fuel)	PFC emissions (kg PFC)
Fugitive emissions (e.g. HFCs, PFCs, SF ₆)	Fugitive emissions	Fuel type	Fuel type	CO ₂ emissions factor (kg CO ₂ /kg fuel)	CO ₂ emissions (kg CO ₂)	CH ₄ emissions factor (kg CH ₄ /kg fuel)	CH ₄ emissions (kg CH ₄)	N ₂ O emissions factor (kg N ₂ O/kg fuel)	N ₂ O emissions (kg N ₂ O)	HFC emissions factor (kg HFC/kg fuel)	HFC emissions (kg HFC)	PFC emissions factor (kg PFC/kg fuel)	PFC emissions (kg PFC)
Other indirect emissions (e.g. Purchased goods, Waste disposal, Travel, Leased assets, Other indirect emissions)	Other indirect emissions	Fuel type	Fuel type	CO ₂ emissions factor (kg CO ₂ /kg fuel)	CO ₂ emissions (kg CO ₂)	CH ₄ emissions factor (kg CH ₄ /kg fuel)	CH ₄ emissions (kg CH ₄)	N ₂ O emissions factor (kg N ₂ O/kg fuel)	N ₂ O emissions (kg N ₂ O)	HFC emissions factor (kg HFC/kg fuel)	HFC emissions (kg HFC)	PFC emissions factor (kg PFC/kg fuel)	PFC emissions (kg PFC)
Total													

Please refer to Annex 1 for details

EXPLANATION: Emissions of fluorinated gases (HFC, PFC, SF₆) should also be reported in Table 3, under the category of 'Other indirect emissions'. Emissions of greenhouse gases should be calculated in Table 4.

Notes:

1. Select the appropriate fuel type.
2. Select the appropriate fuel type and the corresponding emissions factor (Table 1) for the calculation.
3. Refer to Table 1 for the calculation of CO₂ emissions and Table 1 for the calculation of CH₄ and N₂O emissions.
4. Select the appropriate fuel type and the corresponding emissions factor (Table 1) for the calculation.

Emission factors
For stationary
sources

Emission Factors for Stationary Combustion Sources

Table 1-1 CO₂ Emission factor by fuel type (for stationary combustion sources)

Fuel Type	Emission Factor	Unit
Steam Coal	1.81	kg/GJ
LPG	1.81	kg/GJ
Gasoline	1.82	kg/GJ
Charcoal	1.82	kg/GJ
Travertine	1.82	kg/GJ

Table 1-2 CH₄ Emission factor by fuel type (for stationary combustion sources)

Fuel Type	Emission Factor	Unit
Steam Coal	0.0230	g/GJ
LPG	0.0230	g/GJ
Gasoline	0.0241	g/GJ
Charcoal	0.0250	g/GJ
Travertine	0.0240	g/GJ

Table 1-3 NO_x Emission factor by fuel type (for stationary combustion sources)

Fuel Type	Emission Factor	Unit
Steam Coal	0.0074	g/GJ
LPG	0.0080	g/GJ
Gasoline	0.0076	g/GJ
Charcoal	0.0076	g/GJ
Travertine	0.0080	g/GJ

Mobile combustion sources

- Road transport
 - Air Transport
 - Water Transport
- Emissions from all mobile sources which serve within the physical building boundary, and mobile sources dedicated to provide transportation services for the concerned building (e.g. shuttle bus services provided by the building) should be included

Mobile combustion sources

Table 1-4 CO₂ Emission factor by mobile source

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Vehicle Type	Fuel Type	CO ₂ Emission Factor (kg/GJ)	CO ₂ Emission Factor (kg/GJ)	CO ₂ Emission Factor (kg/GJ)	CO ₂ Emission Factor (kg/GJ)	CO ₂ Emission Factor (kg/GJ)	CO ₂ Emission Factor (kg/GJ)
Road Transport							
Tramways							
Aircraft							
Ship							

Notes for CO₂ Emission factor by mobile source

Step 1: Refer to Table 1-1 for CO₂ emission factor for different vehicle and fuel type.

Step 2: Refer to Table 1-2 for CO₂ emission factor for different vehicle and fuel type.

Step 3: Refer to Table 1-3 for CO₂ emission factor for different vehicle and fuel type.

Step 4: Initial Emission Factor (kg/GJ) of CO₂ is 1.81 kg/GJ for all fuel types.

Emission factors
For mobile
combustion
sources

Emission Factors for Mobile Combustion Sources

Table 1-1 CO₂ Emission factor (for mobile combustion sources)

Fuel Type	Emission Factor	Unit
Steam Coal (GJ)	1.81	kg/GJ
Gasoline (GJ)	1.82	kg/GJ
Charcoal (GJ)	1.82	kg/GJ
Travertine (GJ)	1.82	kg/GJ
Gasoline (GJ)	1.82	kg/GJ

Table 1-2 CH₄ Emission factor (for mobile combustion sources)

Fuel Type	Emission Factor	Unit
Motorcycle	0.0230	g/GJ
Passenger Car	0.0230	g/GJ
Private Van	0.0230	g/GJ
Public Light Bus	0.0230	g/GJ
Heavy Goods Vehicle	0.0230	g/GJ
Medium Goods Vehicle	0.0230	g/GJ
Light Goods Vehicle	0.0230	g/GJ
Ship	0.0230	g/GJ
Aircraft	0.0230	g/GJ
Other Mobile Machinery	0.0230	g/GJ
Gasoline	0.0230	g/GJ

Emission factors
For mobile
combustion
sources

Table 1-5 NO_x Emission factor (for mobile combustion sources)

Vehicle Type	Fuel Type	Emission Factor	Unit
Motorcycle	LPG	0.0040	g/GJ
Passenger Car	LPG	0.0040	g/GJ
Private Van	LPG	0.0040	g/GJ
Public Light Bus	LPG	0.0040	g/GJ
Heavy Goods Vehicle	LPG	0.0040	g/GJ
Medium Goods Vehicle	LPG	0.0040	g/GJ
Light Goods Vehicle	LPG	0.0040	g/GJ
Ship	LPG	0.0040	g/GJ
Aircraft	LPG	0.0040	g/GJ
Other Mobile Machinery	LPG	0.0040	g/GJ
Gasoline	LPG	0.0040	g/GJ

Fugitive Emissions

HFC and PFC Emissions for Refrigeration / Air-conditioning

Emissions = Refrigerant inventory (added and disposed) x GWP

See next slide for the calculation

Fugitive Emissions

Table 3: HFC and PFC Emissions from Refrigeration / Air-conditioning Equipment (Operation Process)

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
A	B	C	D	E	F	G
Type of refrigerant (New)	Amount of HFC / PFC at the beginning of the reporting period (kg)	Amount of HFC / PFC purchased during the reporting period (kg)	Amount of HFC / PFC disposed (through environmentally responsible means) during the reporting period (kg)	Amount of HFC / PFC at the end of the reporting period (kg)	GNP of refrigerant (New)	HFC / PFC conversions in terms of CO ₂ equivalent $(H + C - D - E) \times F / 1000$
Total						

Table 14. Listed Vascular Plants (VPP) of Common Redigermes and Redigermes (2007)

Site or Date	1982	Interference (mm)
1982-1	1.00	0
1982-2	1.00	0
1982-3	1.00	0
1982-4	1.00	0
1982-5	1.00	0
1982-6	1.00	0
1982-7	1.00	0
1982-8	1.00	0
1982-9	1.00	0
1982-10	1.00	0
1982-11	1.00	0
1982-12	1.00	0
1983-1	1.00	0
1983-2	1.00	0
1983-3	1.00	0
1983-4	1.00	0
1983-5	1.00	0
1983-6	1.00	0
1983-7	1.00	0
1983-8	1.00	0
1983-9	1.00	0
1983-10	1.00	0
1983-11	1.00	0
1983-12	1.00	0
1984-1	1.00	0
1984-2	1.00	0
1984-3	1.00	0
1984-4	1.00	0
1984-5	1.00	0
1984-6	1.00	0
1984-7	1.00	0
1984-8	1.00	0
1984-9	1.00	0
1984-10	1.00	0
1984-11	1.00	0
1984-12	1.00	0

Global Warming Potential of Common Refrigerants

Source: Bond	1990	1990-1995 (mean)
0-10%	30	6
10-20%	150	9
20-30%	10	2
30-40%	1,000	3
40-50%	1,400	3
50-60%	10	0
60-70%	0	0
70-80%	0	0
80-90%	1,000	0
90-100%	10	0
100% or more	1,000	0
0-10%	10,000	0
10-20%	10,000	0
20-30%	10,000	0
30-40%	10,000	0
40-50%	10,000	0
50-60%	10,000	0
60-70%	10,000	0
70-80%	10,000	0
80-90%	10,000	0
90-100%	10,000	0
100% or more	10,000	0

Carbon Removal – New Trees

- Only NEW trees capable of reaching 5m in height
- Within the physical site boundary after beginning of construction of building

Table 4: Direct GHG Removals from Newly Planted Trees

Step 1 A	Step 2 B	Step 3 C	Step 4 D	Step 5 E
Source description (Location of the trees planted)	Nr. of trees planted (a22)	Nr. of trees received (a23)	CO ₂ removal factor α_{CO_2} (kg / unit / year)	CO ₂ removals in terms of CO ₂ equivalent ($(B-C) \times D / 1000 \times$ length of reporting period (in years))
			23	
Total				

Scope 2 - Indirect

- **Scope 2 – Energy indirect emissions**
 - GHG emissions from the generation of purchased electricity and / or Towngas that is consumed by the reporting entity's controlled equipment or its operations within the physical building boundary.
- **Scope 2 emissions include**
 - Electricity purchased from power companies.
 - Towngas purchased from The Hong Kong and China Gas Company (Towngas).

Scope 2 - Indirect

Electricity and Towngas

- Produced off site but the reporting entity's operational activity results in the consumption

Emissions = Quantity purchased x emission factor

Electricity Unit = kWh
Towngas Unit = 48 Megajoules

Scope 2 – Indirect GHG from Electricity from Power Companies

Report electricity using two factors

- Territory wide default value: 0.7 kg CO₂ per kWh
- Power Company specific value
 - obtain from the supplier for the relevant reporting period but past years values are shown for reference in the guide
- Towngas: The factor relates to the production and transmission of the fuel.
 - Variable from year to year – request factor for reporting period

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Group 1 (A)	Group 2 (B)	Group 3 (C) ^a	Group 4 (D)
Facility name (Occupant (i.e. firm) Location (the plant or bill is generating)	Amount of electricity generated (in kWh)	Electricity from the (1991)	Adjusted CO ₂ emissions in terms of CO ₂ equivalent (20 x C) (1991)
		From consumption specific	From consumption specific
		Capacity-wide default value	Capacity-wide default value

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Year category	2011	2012	2013	2014	2015	2017
Q1	0.8	0.9	1.1	1.2	1.0	1.1
Q2	1.0	1.0	1.0	1.1	1.0	1.0

Table 6: GHG Emissions from Towngas Purchased from the Hong Kong and China Gas Company (Towngas)

Step 1 A	Step 2 B	Step 3 C	Step 4 D
Facility / source description (i.e. data facilities the Towngas bill is reporting)	Amount of Towngas purchased (GJ or Nm^3)	Emission factor (kg / GJ or Nm^3)	Indirect GHG emissions in tonnes of CO ₂ equivalent (B x C / 1,000)
Total			

GHG Emission Factor (in kg CO₂e / Unit of Towngas purchased)

Year	2005	2006	2007
Emission Factor	0.752	0.683	0.582

Scope 2 – Indirect GHG from Towngas Company

Scope 3 – Other direct emissions

Scope 3 – Other indirect emissions (Optional for reporting purposes)

The reporting entity **may choose** to report other indirect GHG emissions that are relevant to their activities and goals.

- If the quantification methodologies and necessary activity data (input data) are well-defined and easily available.

While reporting such indirect emissions is optional, the reporting entity is encouraged to collect information relevant to the following emission sources (where simple quantification methodologies have been developed for Hong Kong) and to quantify and report a Scope 3 emissions:

- Methane gas generation at landfill in Hong Kong due to disposal of paper waste.
- Mobile sources controlled by users of the concerned building dedicated for particular employees/groups of employees working in the buildings are not included under Scope 1. However, the reporting entity may choose to report these under Scope 3 as transport for employees.
- GHG emissions due to electricity used for fresh water processing by Water Services Department.
- GHG emissions due to electricity used for sewage processing by Drainage Services Department (if the sewage collected within physical boundary is treated by the Drainage Services Department).

Scope 3 – Other direct emissions

- Emission due to methane gas generation at landfill in Hong Kong caused by the disposal of paper waste.
- GHG emissions due to electricity used for fresh water processing by Water Supplies Department.
- GHG emissions due to electricity used for sewage processing by Drainage Services Department (if the sewage collected within physical boundary is treated by Government department).

Scope 3 – Other direct emissions Methane from Landfill – Disposal of Waste paper

Table 7: Methane Generation at Landfill in Hong Kong due to Disposal of Paper Waste

Step 1 A	Step 2 B	Step 3 C	Step 4 D	Step 5 E	Step 6 F	Step 7 G
Source description (i.e. Area / Dept)	Amount of paper in storage at the beginning of the reporting period (kg)	Amount of paper purchased during the reporting period (kg)	Amount of paper collected for recycling during the reporting period (kg)	Amount of paper in storage at the end of the reporting period (kg)	Emission factor (kg CO ₂ e / kg of waste) ¹⁰⁰	Indirect emissions in tonnes of CO ₂ equivalent ((B + C - D - E) x F / 1000)
					4.8	
Total						

Scope 3 – Other direct emissions Due to electricity for Fresh Water Processing by WSD

Table 8: GHG Emissions due to Electricity Used for Fresh Water Processing by Water Supplies Department

Step 1 A	Step 2 B	Step 3 C	Step 4 D
Source description (i.e. Area / facilities the water service bill is reporting)	Amount of water consumed as listed on the water service bill (m ³)	Emission factor (kg / m ³) ¹⁰⁰	Emissions in tonnes of CO ₂ equivalent (B x C / 1000)
Total			

Scope 3 – Other direct emissions Due to electricity for Sewage Processing by DSD

Table 9: GHG Emissions due to Electricity Used for Sewage Processing by Drainage Services Department

Step 1 A	Step 2 B	Step 3 C	Step 4 D
Source description (i.e. Area / facilities the water service bill is reporting)	Fresh sewage consumption (m ³)	Emission Factor (kg / m ³) ¹⁰⁰	Emissions in tonnes of CO ₂ equivalent (B x C / 1000)
Total			

100: (1.3 x Emission Factor) x (100% of the fresh water consumed will enter the sewage system)

GHG Emission Factor (in kg CO₂e / m³)

Year	2005	2006	2007
Emission Factor	0.752	0.683	0.582

Other Scope 3 Sources

- Extraction and production of purchased materials and fuels for sources covered in Scope 1 or for generation of electricity / Towngas gas covered in Scope 2.
- Transportation of purchased materials or goods, fuels, products, waste, employees, occupants and guests, to and from the concerned buildings (other than those covered under Scope 1).
- Business travel by employees.
- Emissions from outsourced activities or other contractual arrangements.
- Use of sold products and services.
- Waste disposal other than those covered in the above list.

International Standardization

Links with International Emissions Reporting Framework

- Scopes of emissions (direct and indirect) and removals mentioned in the Guidelines are defined in accordance with the international reporting framework published by the World Resources Institute (WRI) / World Business Council for Sustainable Development (WBCSD), as reported in *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard and International Organization for Standardization (ISO), as reported in ISO14064-1*.

Reporting methodology

- 1. Determine the Organisational Boundary – the physical boundary for accounting & reporting**
 - Usually matches the boundary of the building concerned
 - But can choose to account for emissions for adjoining buildings or those sharing centrally provided services
- 2. Determine the Operation Boundary**
 - emissions for which the organisation is responsible
 - emissions removals from site
- 3. Determine the reporting period**
 - Usually 12 months to match other accounting cycle
- 4. Collect necessary data and quantify the GHG performance**
- 5. Prepare the report**

Initially for Scopes 1 and 2 and then optional Scope 3 sources

Content of report

- Approaches to data collection and quantification
- Conversion factors
- Emissions factors
- Working procedures
- Worksheets

- Total emissions for Scope 1 and Scope 2 activities (in tonnes of CO₂ equivalent);
- Emissions data for each separate scope and for each type of GHGs (in tonnes of CO₂ equivalent);
- Total GHG removals from Scope 1 operations, in tonnes of CO₂ equivalent;
- Methodologies used to quantify emissions and removals of GHG, including any methodologies changes since the last report of emissions and removals;
- Changes in GHG emissions and removals since the last report over time, including any recalculations to previously reported emissions and removals

Check and Balance

- Collect consistent volumetric or mass data on fuels
 - Fuel receipts
 - Invoices
 - Metering
 - Tank dips
- Consistent time periods for all data
- All sources included or exclusions justified
- Correct emission factors
- Calculations

Reporting Format (1)

- 1. Name of the reporting entity;**
- 2. Description of the reporting entity**
 - Some possible descriptions are:
 - (a) Building management with a single responsible occupier;
 - (b) Building management with all end-users;
 - (c) Building management with some of the end-users (with details of the end-users participated);
 - (d) Building management only of a building of multiple responsible occupiers; and
 - (e) Others (with full details).
- 3. Reporting period (with start and end dates)**
- 4. Scope of physical boundary chosen**
 - (a) Location of the building(s);
 - (b) Description of the purpose of the building(s) or physical boundary chosen. Some possible descriptions are: (i) Dwelling; (ii) Retail; (iii) Restaurant; (iv) Hotel / hostel; (v) Residential; (vi) School; (vii) University; (viii) Sports complex; and (ix) Community centre
 - (c) Description of physical boundary with detailed information (including the respective construction floor areas) on the areas covered in the exercise by (i) Commonist areas (including common facilities); and (ii) Tenant areas.
 - (d) Description of areas excluded in the exercise.

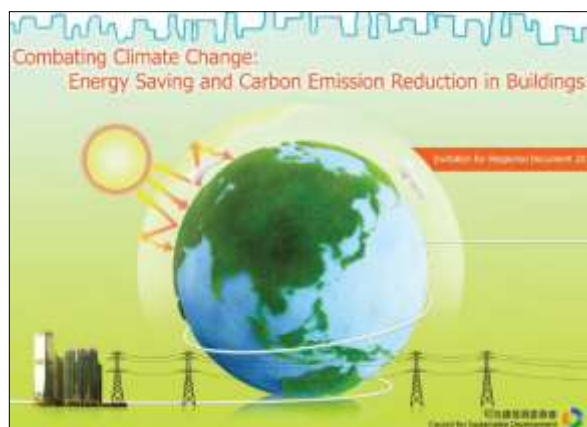
Reporting Format (2)

5. Scope of operations/boundary chosen
 - (a) Description of Scope 1 activities included and excluded
 - (b) Description of Scope 2 activities included and excluded
 - (c) Description of Scope 3 activities included
6. Methodologies for quantifying emissions and removals
 - (a) List of activities for which simplified methodologies and conversion factors in the Guidelines are used for quantification
 - (b) Details (including necessary reference) of other methodologies and conversion factors used for quantification
 - (c) Details of any changes to methodologies and conversion factors since the last report
 - (d) Details on any re-calculation of previously reported emissions and removals because of changes in methodologies and conversion factors
7. Information on GHG emissions and removals
8. Information on GHG emissions and removals over time
 - (a) Summary of the quantities and changes of GHG emissions and removals since the first report
 - (b) Details of any changes to annually-reported emissions and removals
9. Information on GHG offsets and programmes
 - (a) Description of GHG performance against internal and / or external benchmarks (if any) including any reductions used
 - (b) Goals and actions identified to improve GHG performance
 - (c) Description of activities / programmes to improve GHG performance including provision of in-situ renewable energy sources and/or carbon sequestering activities. For example, if the reporting entity has only quantified the amount of paper waste recycled, the amount of GHG avoided due to recycling of paper waste can be reported here.
10. Other optional information
11. Contact person of the reporting entity
12. List of data sources, references, etc.,

[illegible]

Summary of Results

Summary of Results	
Total Scope 1 Emissions:	_____ Tonnes of CO ₂ Equivalent
Total Scope 1 Removals:	_____ Tonnes of CO ₂ Equivalent
Total Scope 2 Emissions:	_____ Tonnes of CO ₂ Equivalent
Total Scope 3 Emissions:	_____ Tonnes of CO ₂ Equivalent
Total other GHG Offsets / Removals:	_____ Tonnes of CO ₂ Equivalent
GHG Performance in Ratio Indicator:	



The End



Thank You