ISO Greenhouse Gas Audit
Carbon Auditor Training
On ISO 14064, 14065, 14066 & 14067

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Environmental Pollution

ISO 14001:2015 EMS

EMS - Environmental Aspects

- 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

Emissions to Atmosphere

Emissions

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Combustion of fossil fuels emits airborne pollutants:

Carbon dioxide (CO_2): major greenhouse gas (GHG) that causes climate change and global warming

Sulfur dioxide (SO_2): 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, irritations of eyes, nose, & throat, carcinogenic.

Particulate matters: PM_{10} (dia. ≤ 10 μm) and PM_{25} (dia. ≤ 2.5 μm) can be deposited in lungs and cause harm to our health.

環境(E)、社會(S)和公司治理(G)的相關認證標準

1.環境面(ENVIRONMENTAL)
2. 社會面(SOCIAL ACCOUNTABILITY)
3.治理面(GOVERNANCE)

環境、社會和公司治理(ESG) 是對公司對社會和環境因素的集體責任感的評估。它通常是根據圍繞與企業內無形資產相關的特定指標收集的數據編制的分數。它可以被認為是企業社會信用評分的一種形式。

CSR(corporate social responsibility）的概念，乃 1999 年由聯合國（UN，United Nations）祕書長科菲．安南（Kofi Anan）倡議，要求公司落實 CSR。2008 年金融風暴之後，再次推升企業社會責任的浪潮至今。

ESG則分別是環境保護（E，environment）、社會責任（S，social）和公司治理（G，governance）三者，此為聯合國全球契約（UN Global Compact）於 2004 年提出的概念，被視為評估一間企業經營的指標。

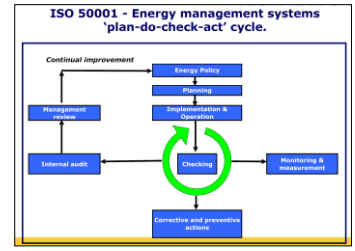
SDG則是聯合國大會於 2015 年通過的永續發展目標（SDGs，sustainable development goals），同樣屬於永續原則與目標可落實的具體方針。

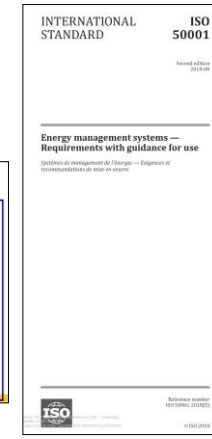
ESG對我們的啟示

ESG給我們的機會

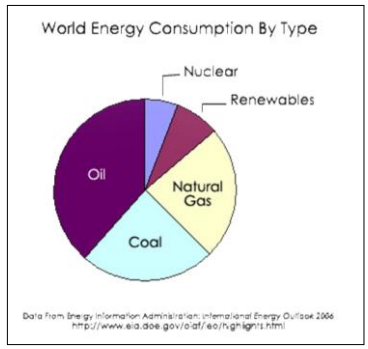
如何利用這個機會

ISO 50001:2018 EnMS





World Energy Consumptions



Humans are the Primary Cause of Global Warming

The science indicates humans are the primary cause of global warming at the >95% probability (In science that is a virtual certainty)

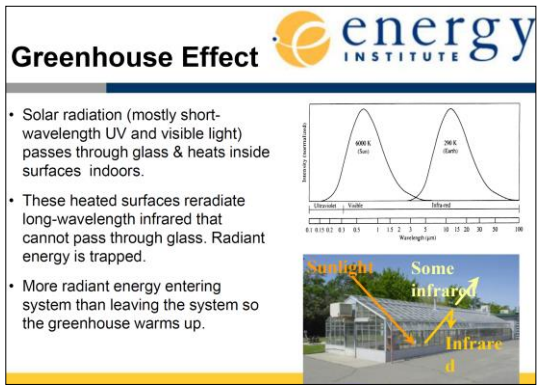
Deforestation

Desertification

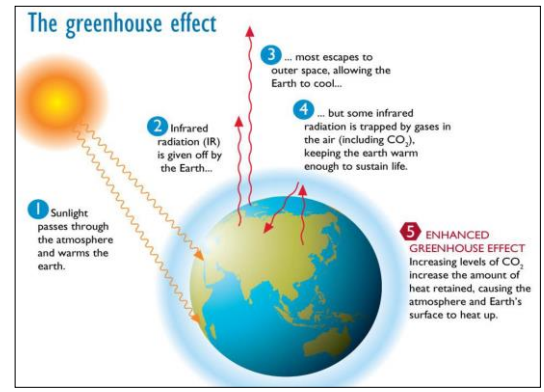
Flash Floods

EXTINCTION OF SPECIES

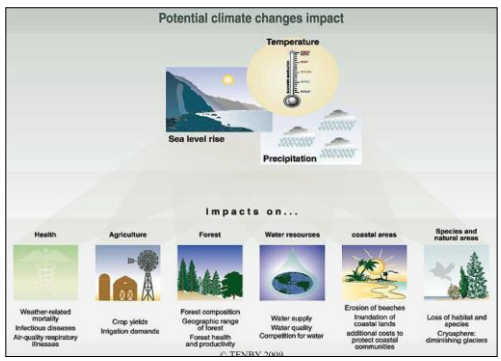
Greenhouse Effect



The Greenhouse Effect



Potential Climate Changes Impact



Hong Kong Context - Climate Change

Climate change is recognised as one of the most important challenges facing mankind.

Hong Kong is starting measures to reduce greenhouse gas (GHG) emissions:
- promoting use of cleaner energy & renewable energy
- improving energy efficiency & energy conservation
- encouraging greening & raising public awareness.

Your target is to reduce energy intensity by 25% by 2030 (with 2005 as the base year).

Breakdown of Kong Kong's GHG emissions:
- electricity 60%
- transport 16%
- waste 12%

Buildings account for 89% of electricity consumed.

For building owners and managers to reduce emissions:
- first step is to find out the amount of GHG released
- then to take appropriate actions to reduce emissions.

Carbon Offsetting & Neutrality

Definition of Carbon Offsetting and Neutrality

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- Carbon Offsets
  - CO_{2e} savings equivalent to your footprint have been achieved by others

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

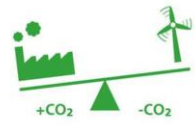

Figure 1: Carbon neutrality

Kyoto Protocol – 6 Kinds of GHGs

Kyoto Protocol
Greenhouse Gases (GHG)

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Carbon Dioxide

Fuels for Energy and Transport, Manufacturing Processes

Nitrous Oxide

Chemical manufacture and agriculture

HFCs (hydrofluorocarbons)

Refrigerants, chemical manufacture, foams & aerosols

PFCs

Aluminium manufacture, electronics manufacture

Methane

Waste (Landfills, natural activity)

Sulphur hexafluoride

Magnesium smelting, high voltage switchgear, electronics manufacturing

Six Different Kinds of GHGs

There are six defined GHG as mentioned in the Kyoto Protocol to the UNFCC that including:

CO_2	Carbon dioxide	二氧化碳
CH_4	Methane	甲烷
N_2O	Nitrous oxide	氧化二氮
PFCs	Perfluorocarbons	全氟化碳
HFCs	Hydrofluorocarbons	氫氟碳化合物
SF_6	Sulphur hexafluoride	六氟化硫

以上是六種由UNFCC在京都議定書中提及的六類溫室氣體。

Global Warming Potential

GHG are released to the atmosphere by fuel combustion, generated from waste, or discharged from machineries over time. Different GHGs are rated based on their global warming potential (GWP).

溫室氣體會在燃料燃燒時被排放到大氣中，溫室氣體也會從廢物中產生，或者從機器中泄漏出來。各種溫室氣體都以全球暖化潛勢(GWP)來評量。

Green House Gas 溫室氣體	Global Warming Potential (GWP) 全球暖化潛勢	
	20 years GWP	10 years GWP
Carbon Dioxide 二氧化碳 (CO_2)	1	1
Methane 甲烷 (CH_4)	72	25
Nitrous Oxide 氧化二氮 (N_2O)	289	298
Perfluorocarbons 全氟化碳 (PFCs)	8630	9200
Hydrofluorocarbons 氫氟碳化合物 (HFCs)	12000	11700
Sulphur hexafluoride 六氟化硫 (SF6)	16300	23900

Global Warming Potential of others GHGs

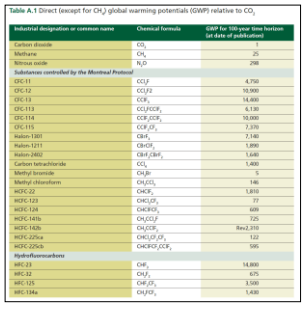
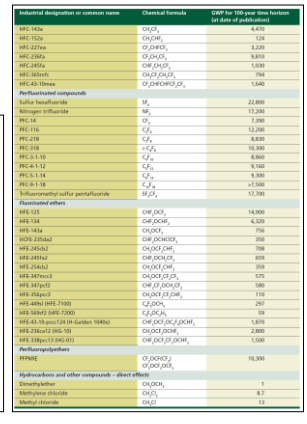


Table A.1 Direct (except for CH_4) global warming potentials (GWP) relative to CO_2

Industrial designation or common name	Chemical formula	GWP for 100-year time horizon (at date of publication)
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
Substances controlled by the Montreal Protocol		
CFC-11	CCl_3F	4,750
CFC-12	CCl_2F2	10,900
CFC-13	$CClF_3$	14,400
CFC-113	CCl_2FCClF_2	6,130
CFC-114	$CClF_2CClF_2$	10,000
CFC-115	$CClF_2CF_3$	7,370
Halon-1301	$CBrF_3$	7,140
Halon-1211	$CBrClF_2$	1,890
Halon-2402	$CBrF_2CBrF_2$	1,640
Carbon tetrachloride	CCl_4	1,400
Methyl bromide	CH_3Br	5
Methyl chloroform	CH_3CCl_3	146
HCFC-22	$CHCF_2$	1,810
HCFC-123	$CHCl_2CF_3$	77
HCFC-124	$CHClFCF_3$	609
HCFC-141b	CH_3CCl_2F	725
HCFC-142b	CH_3CClF_2	Rev2,310
HCFC-225ca	$CHCl_2CF_2CF_3$	122
HCFC-225cb	$CHClFCF_2CClF_2$	595
Hydrofluoroethers		
HFC-23	CHF_3	14,800
HFC-32	CH_2F_2	675
HFC-125	CHF_2CF_3	3,500
HFC-134a	CH_2FCF_3	1,430



Industrial designation or common name	Chemical formula	GWP for 100-year time horizon (at date of publication)
HFC-143a	CH_3CF_3	4,470
HFC-152a	CH_3CHF_2	124
HFC-227ea	CF_3CHFCF_3	3,220
HFC-236fa	$CF_3CH_2CF_3$	9,810
HFC-245fa	$CHF_2CH_2CF_3$	1,030
HFC-365mfc	$CH_3CF_2CH_2CF_3$	794
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	1,640
Perfluorinated compounds		
Sulfur hexafluoride	SF_6	22,800
Nitrogen trifluoride	NF_3	17,200
PFC-14	CF_4	7,390
PFC-116	C_2F_6	12,200
PFC-218	C_3F_8	8,830
PFC-318	$c\text{-}C_4F_8$	10,300
PFC-3-1-10	C_4F_{10}	8,860
PFC-4-1-12	C_5F_{12}	9,160
PFC-5-1-14	C_6F_{14}	9,300
PFC-9-1-18	$C_{10}F_{18}$	>7,500
Trifluoromethyl sulfur pentafluoride	SF_5CF_3	17,700
Fluorinated ethers		
HFE-125	CHF_2OCF_3	14,900
HFE-134	CHF_2OCHF_2	6,320
HFE-143a	CH_3OCF_3	756
HCFE-235da2	$CHF_2OCHClCF_3$	350
HFE-245cb2	$CH_3OCF_2CHF_2$	708
HFE-245fa2	$CHF_2OCH_2CF_3$	659
HFE-254cb2	$CH_3OCF_2CHF_2$	359
HFE-347mcc3	$CH_3OCF_2CF_2CF_3$	575
HFE-347pc2	$CHF_2CF_2OCH_2CF_3$	580
HFE-356pcc3	$CH_2OCF_2CF_2CHF_2$	110
HFE-449sl (HFE-7100)	$C_4F_9OCH_3$	297
HFE-569sf2 (HFE-7200)	$C_4F_9OC_2H_5$	59
HFE-43-10-pccc124 (H-Galden 1040x)	$CHF_2OCF_2OC_2F_4OCHF_2$	1,870
HFE-236ea12 (HG-10)	$CH_2OCF_2OCHF_2$	2,800
HFE-338pcc13 (HG-01)	$CHF_2OCF_2CF_2OCHF_2$	1,500
Perfluoropolyethers		
PFPMIE	$CF_3OCF(CF_3)$ $CF_2OCF_2CF_3$	10,300
Hydrocarbons and other compounds – direct effects		
Dimethylether	CH_3OCH_3	1
Methylene chloride	CH_2Cl_2	8.7
Methyl chloride	CH_3Cl	13

Sources of Emissions A

Combustion 燃燒

Vehicles consume fossil fuels. Many machines that generate heat also require fuel to operate. Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are released to the atmosphere during combustion.

車輛需要消耗化石燃料，很多產生熱能的機器都需要燃料來運行。在燃燒過程中，二氧化碳(CO_2)、甲烷(CH_4)和氧化二氮(N_2O)會被排放出來。

Electricity 電力

Electricity consumption would cause indirect emission from fuel combustion in power plants operated by power companies. Different power companies will have different emission levels depending on their power plant design and fuel use.

電力消耗會因電力公司的發電廠中的燃料燃燒而造成間接排放，不同的電力公司會因爲不同的發電廠設計和燃料而造成不同程度的排放。

Sewage Methane 污水沼氣

Organic waste in sewage decomposes in anaerobic condition would generate methane. Methane is released to the atmosphere when not collected.

污水中的有機廢物在缺氧情況下會被分解並產生沼氣，如果沒有把沼氣收集，甲烷便會被排放到大氣中。

Sources of Emissions B

Refrigerants 製冷劑

Refrigerants such as HFCs are present in air conditioners and refrigerators. They are discharged to the atmosphere in small amount over time, but their special inert characteristics cause them to have a high impact on greenhouse effect.

空調和冷藏系統中有HFCs之類的製冷劑，當中的製冷劑會隨時間少量流失到大氣中，而它們的特殊惰性特質會造成非常高的溫室效應。

Dielectric medium 電介質

Sulfur hexafluoride (SF_6) is a dielectric medium used in industry. It is very inert and has ten thousand times more greenhouse effect than carbon dioxide.

六氟化硫是一種工業用途的電介質，它有非常高的惰性，並會造成比二氧化碳高超過萬倍的溫室效應。

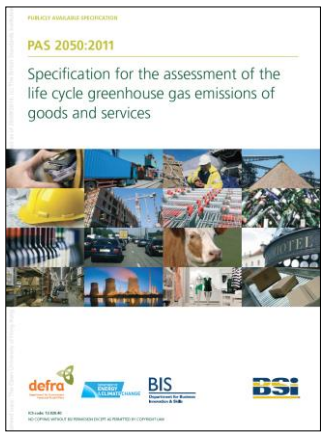
Worldwide accepted measuring protocols included：
世界公認的測量協議有：

The Greenhouse Gas Protocol 溫室氣體盤查議定書	A Corporate Accounting and Reporting Standard published by the World Resources Institute (WRI) / World Business Council for Sustainable Development (WBCSD) 一個由世界資源協會 (WRI) / 世界企業永續發展委員會 (WBCSD) 公佈的公司會計和報告準則
ISO 14064-1	ISO 14064-1 Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals, published by is the copyright of International Standard Organization (ISO) 溫室氣體-第1部：組織層級溫室氣體排放與移除量化及報告附指引之規範，由國際標準化組織 (ISO) 出版及持有版權

There is also a newly developed standard used for quantifying product emission:
現有一種新開發、用於量化產品排放的標準：

PAS 2050	PAS 2050: Specification for the assessment of the life cycle greenhouse gas emissions of goods and services published by BSI Group. 產品和服務生命週期溫室氣體排放評估規範，由英國標準協會出版

The ISO 14064-1 and the PAS 2050 will be used in the case studies to be further described in section 5 in details
ISO 14064-1和PAS 2050將被用於案例研究，應用細節會在第五章進一步說明。



PAS 2050 Specification for Life Cycle GHG Emissions of Goods & Services

Direct Emission A

Direct Emission from Stationary Combustion Sources:

GWP (100yrs)	1	25	298		
Fuel Type 燃料類別	CO_2 Emission Factor 排放系數	CH_4 Emission Factor 排放系數	N_2O Emission Factor 排放系數	Overall Emission Factor 整體排放系數	Unit 單位
Diesel Oil 柴油	2.614	0.0005975	0.0022052	2.617	kg CO_2e / litre
LPG 液化石油氣	3.017	0.0000500	0.0000000	3.017	kg CO_2e / kg
Kerosene 煤油	2.429	0.0006025	0.0022648	2.432	kg CO_2e / litre
Charcoal 木炭	2.970	0.1382250	0.0082248	3.116	kg CO_2e / kg
Towngas 煤氣	2.549	0.0011150	0.0029502	2.553	kg CO_2e / Unit

Reference 參考資料
Michael Gillenwater, Environmental Resources Trust (2005),
Calculation Tool for Direct Emission from Stationary Combustion,
世界資源研究所及世界可持續發展工商理事會 (WRI / WBCSD).

Direct Emission B

GWP (100yrs)		1	25	298		
Vehicle Type 車輛類別	Fuel Type 燃料類別	CO_2 Emission Factor 排放系數	CH_4 Emission Factor 排放系數	N_2O Emission Factor 排放系數	Overall Emission Factor 整體排放系數	Unit 單位
Motorcycle 電單車	Petrol	2.360	0.0356	0.0137	2.409	kg CO_2e / litre
Automobile 私家車	Petrol	2.360	0.0063	0.3293	2.696	kg CO_2e / litre
	Diesel	2.614	0.0018	0.0328	2.649	
LGV 輕型貨車	Petrol	2.360	0.0051	0.3293	2.694	kg CO_2e / litre
	Diesel	2.614	0.0018	0.1508	2.767	
HGV 重型貨車	Diesel	2.614	0.0036	0.0215	2.639	kg CO_2e / litre
Ship 船舶	Gas Oil	2.645	0.0037	0.3263	2.975	kg CO_2e / litre

Reference 參考資料
世界資源研究所及世界可持續發展工商理事會 (WRI / WBCSD)
Calculating CO2 Emissions from Mobile Sources – Guidance to calculation worksheets,
WRI / WBCSD

Global Treaties & Policies for Carbon Reduction

Kyoto and Beyond – Paris COP 26 – Glasgow Nov 2021

Actions

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 20% reduction by 2005 for CO_2
1995	Conferences of the Parties COP1, Berlin agrees to negotiate protocol urgently - IPCC Second Assessment Report concluded under extreme pressure from industry and OPECs
1996	COP2 US surprises EU, flabbergasts Japan and calls for legally binding tradeable targets
1997	COP3 Adopts Kyoto Protocol with reduction targets
2008	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

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. Asserted that actions should be taken to keep the average temperature increase to below 2°C, but no legally binding commitments.
2010	Now proposed 80% minimum reduction by 2050 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 stabilise 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".
2013	COP19 Warsaw. The goal was to develop a new legally binding international treaty to curb rising 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 & 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.

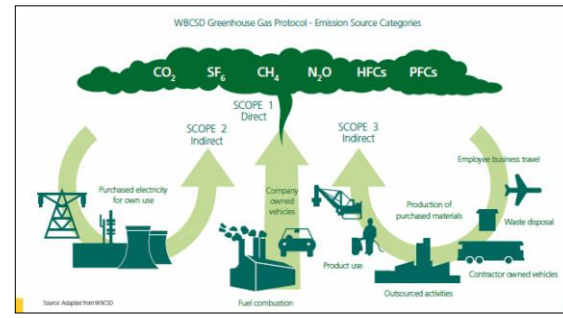
APEC Sydney Declaration on Climate Change
- Ensure energy supply for the needs.
- Address environmental issues and reduce GHG emission.

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.

Emissions Scope



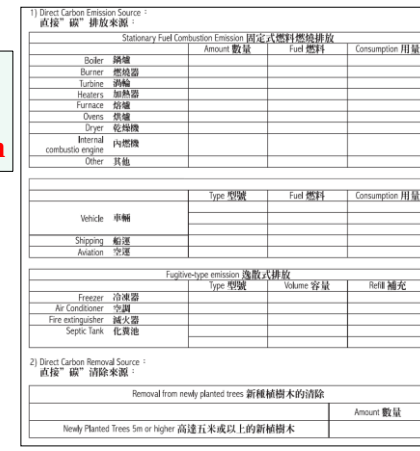
GHG Emission = CO2 Equivalent

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

Expressed in units of carbon dioxide equivalent (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 CO_2-equivalent for a gas is derived by multiplying the tonnes of the gas by the gas's associated Global Warming Potential (GWP).

Carbon Emission Information



1) Direct Carbon Emission Source：
直接"碳"排放來源：

Stationary Fuel Combustion Emission 固定式燃料燃燒排放			
	Amount 數量	Fuel 燃料	Consumption 用量
Boiler 鍋爐			
Burner 燃燒器			
Turbine 渦輪			
Heaters 加熱器			
Furnace 熔爐			
Ovens 烘爐			
Dryer 乾燥機			
Internal combustio engine 內燃機			
Other 其他			

	Type 型號	Fuel 燃料	Consumption 用量
Vehicle 車輛			
Shipping 船運			
Aviation 空運			

Fugitive-type emission 逸散式排放			
	Type 型號	Volume 容量	Refill 補充
Freezer 冷凍器			
Air Conditioner 空調			
Fire extinguisher 滅火器			
Septic Tank 化糞池			

2) Direct Carbon Removal Source：
直接"碳"清除來源：

Removal from newly planted trees 新種植樹木的清除	
	Amount 數量
Newly Planted Trees 5m or higher 高達五米或以上的新植樹木	

Boiler

Burner

Turbine

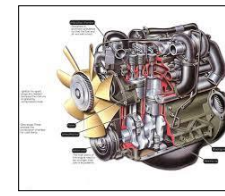
Heater (Steam, water, gas, oil)

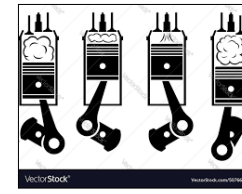
Furnace

Oven

Dryer

Internal Combustion Engine



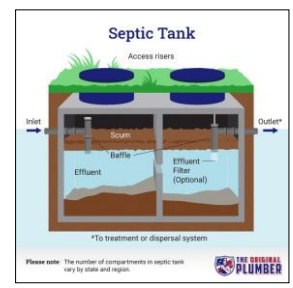


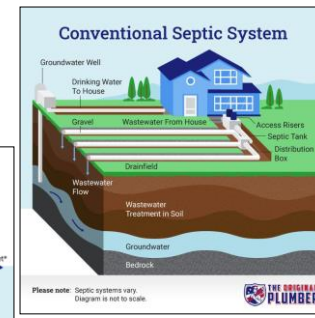
Freezer

Fire Extinguisher

Air Conditioner

Septic Tank





Carbon Emission Information

1) Direct Carbon Emission Source :
直接"碳"排放來源 :

Stationary Fuel Combustion Emission 固定式燃料燃燒排放		Amount 數量	Fuel 燃料	Consumption 用量
Boiler	鍋爐			
Burner	燃燒器			
Turbine	渦輪			
Heaters	加熱器			
Furnace	熔爐			
Ovens	烘爐			
Dryer	乾燥機			
Internal combustio engine	內燃機			
Other	其他			

		Type 型號	Fuel 燃料	Consumption 用量
Vehicle	車輛			
Shipping	船運			
Aviation	空運			

Fugitive-type emission 逸散式排放		Type 型號	Volume 容量	Refill 補充
Freezer	冷凍器			
Air Conditioner	空調			
Fire extinguisher	滅火器			
Septic Tank	化糞池			

2) Direct Carbon Removal Source :
直接"碳"清除來源 :

Removal from newly planted trees 新種植樹木的清除	
	Amount 數量
Newly Planted Trees 5m or higher 高達五米或以上的新植樹木	

Carbon Emission Information

3) Energy Indirect Carbon Emission Source :
能源間接"碳"排放來源 :

Purchased energy emission 外購能源排放		Source 來源	Amount 數量
Purchased Electricity	購入電力		
Purchased Town Gas	購入煤氣		
Purchased Heat	購入熱力		
Purchased Natural Gas	購入天然氣		
Other Purchased Energy	其他購入能源		

4) Other Indirect Carbon Emission Source :
其他間接"碳"排放來源 :

	Description 描述
Business Trip Record 商務旅行紀錄	
Water Usage Record 水用量紀錄	
Water Discharge Record 水排出紀錄	
Paper Purchase Record 紙張購入紀錄	
Paper Recycling Record 廢紙回收紀錄	
Waste Recycling Record 廢物回收紀錄	
Other Indirect Emission 其他間接排放	

Section 4 Emission Reduction Information
第四節 減排資料

1) Emission Reduction Machineries Installed / Measures :
已經安裝的減排設備 / 措施 :

	Description 描述
Energy Efficiency 能源效益	
Renewable Energy 再生能源	
Recycling facility 回收設施	
Waste Treatment 污染處理	

2) Other Greenhouse Gas Related Information :
其他溫室氣體相關資料 :

Different Kinds of Energy

- Energy
  - Primary
    - Gas (F)
    - Oil (D & S)
    - LPG (D & S)
    - Coal (D & S)
    - Biomass (D & S)
  - Secondary
    - Electricity (F)
    - Hot water (S)
    - Steam (S)
    - Thermal Fluid (depends on heat source) (S)
  - Tertiary
    - Compressed Air (S)
    - Hydraulic (S)
    - Coolant (S)

(F= Fiscal, D = Deliveries, S = Sub meters)

CLP 中電

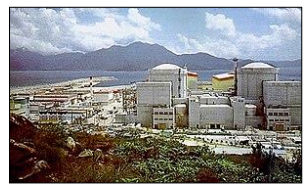
Penny's Bay Power Station
竹篙灣燃氣輪機發電廠

Black Point Power Station
龍鼓灘發電廠

CLP 中電

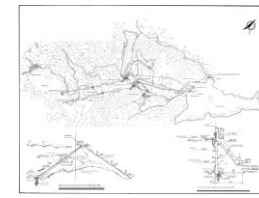
Castle Peak Power Station
青山發電廠

Daya Nuclear Power Plant
大亞灣核電站



CLP 中電

Guangdong Pumped Storage Power Station广州抽水蓄能电站



港燈 HK Electric

Lamma Power Station
南丫發電廠

Lamma Winds
南丫風采發電站

煤氣 Towngas

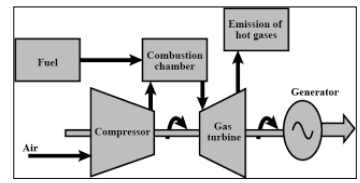
Towngas Tai Po Plant

The Towngas Plant Ma Tau Kok

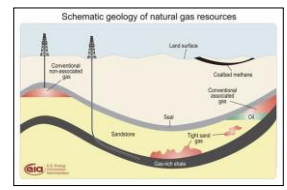
Towngas Production

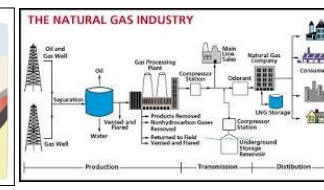
- In Hong Kong, town gas is produced at two production plants: 95 per cent comes from the newer Tai Po Plant, and the rest comes from the Ma Tau Kok Plant.
- The Tai Po Plant can supply a maximum of 8.4 million standard cubic metres of gas per day.
- Source fuel is Naptha

Chemical Composition	
Carbon Dioxide	19.5 %
Carbon Monoxide	3 %
Methane	28.5 %
Hydrogen	49 %
Physical Properties	
Calorific Value	17.27 MJ/m³
Specific Gravity	0.52
Wobbe Index	24
Weaver Flame Speed	35



Natural Gas Power Plant





Water Supplies Department
The Government of the Hong Kong Special Administrative Region

Water Treatment Plant

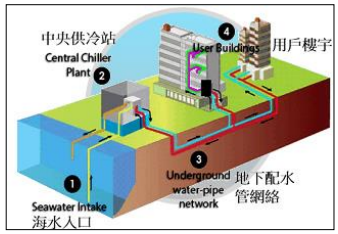
Water Pumping Station

渠務署

Shatin Sewage Treatment Plant

機電工程署 EMSD
Electrical and Mechanical Services Department
The Government of the Hong Kong Special Administrative Region

District Cooling System at Kai Tak Development



Recycling of Solid Waste in HK

EMSD Energy Labelling

US EPA EnergyStar

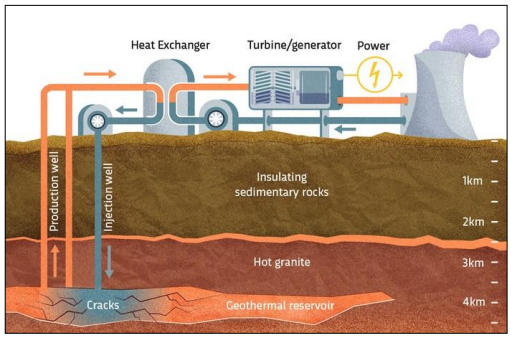
The range of renewable energy

- 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)

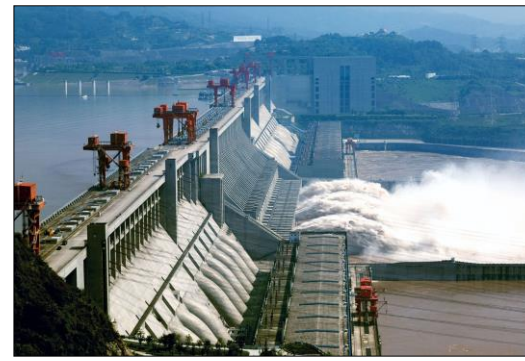
Alternative Energy

1. **Solar energy system**
2. **Wind turbine system**
3. **Geothermal energy storage system**

Geothermal energy storage system

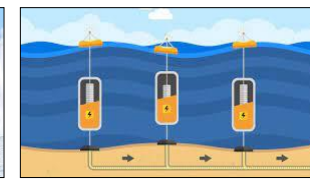


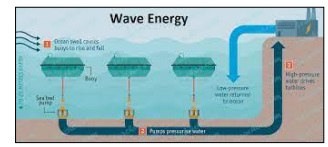
Hydro Power plant – Three-Gorge Dam

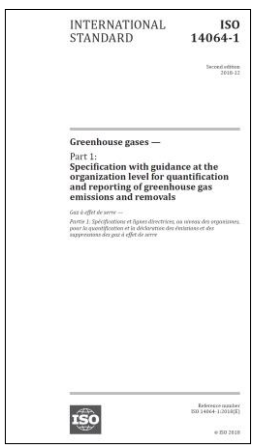


Nuclear Power plant

Sea Wave Power plant

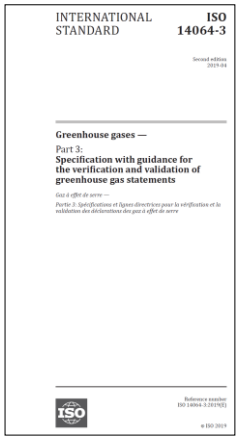






ISO 14064-1:2018 GHG Spec at Organization Level for Quantification & Reporting of GHG Emission & Removal

ISO 14064-1:2019 GHG Spec at Project Level for Quantification, Monitoring & Reporting of GHG Emission, Reduction & Removal Enhancements



ISO 14064-3:2019 GHG Spec for Validation & Validation of GHG Statement

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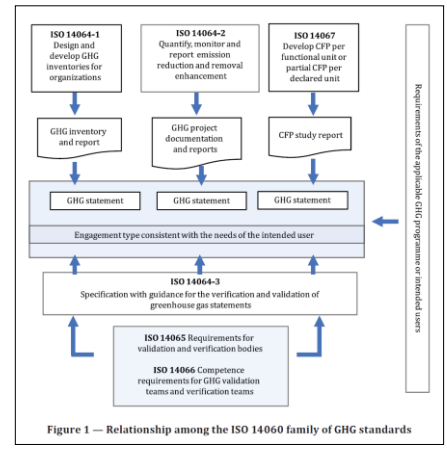

Figure 1 — Relationship among the ISO 14060 family of GHG standards

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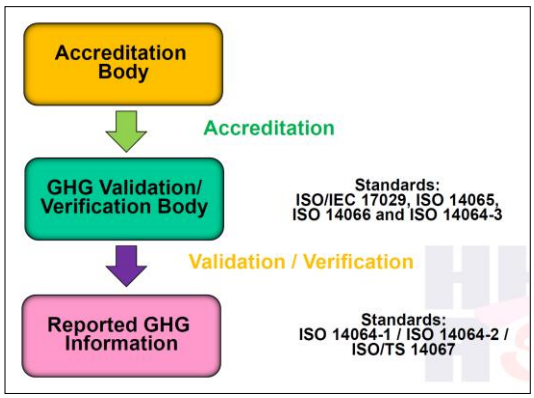
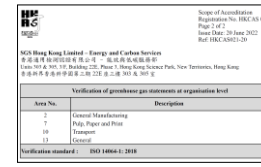
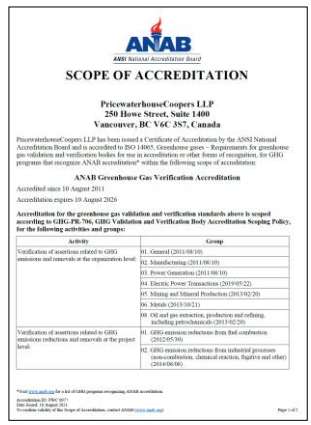
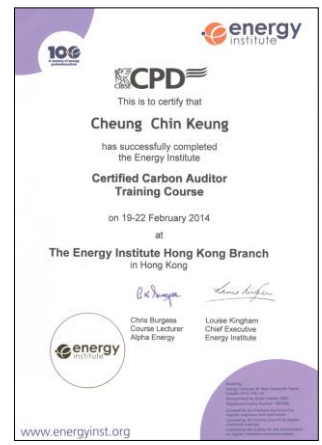
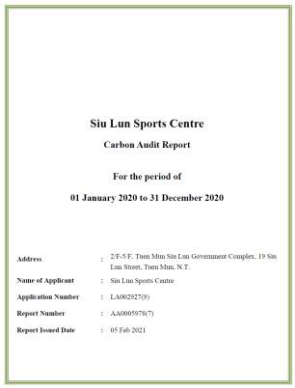








Energy Institute UK Certified Carbon Auditor



Siu Lun Sports Centre

Carbon Audit Report

For the period of

01 January 2020 to 31 December 2020

Address	:	2/F-5/F, Tsen Mun Sin Lun Government Complex, 19 Sin Lun Street, Tsen Mun, N.T.
Name of Applicant	:	Siu Lun Sports Centre
Application Number	:	LA002927(8)
Report Number	:	AA0005978(7)
Report Issued Date	:	05 Feb 2021

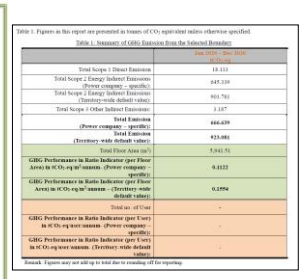


Table 1: Figures in this report are presented in tonnes of CO_2 equivalent unless otherwise specified.

Table 1: Summary of GHG Emission from the Selected Boundary

	Jan 2020 – Dec 2020 (CO_2-e)
Total Scope 1 Direct Emission	18.111
Total Scope 2 Energy Indirect Emissions (Power company – specific):	645.339
Total Scope 2 Energy Indirect Emissions (Territory-wide default value):	801.781
Total Scope 3 Other Indirect Emissions:	3.187
Total Emission (Power company – specific):	**666.639**
Total Emission (Territory-wide default value):	**923.081**
Total Floor Area (m²):	5,841.51
GHG Performance in Ratio Indicator (per Floor Area) in tCO_2-eq/m²/annum – (Power company – specific):	**0.1222**
GHG Performance in Ratio Indicator (per Floor Area) in tCO_2-eq/m²/annum – (Territory-wide default value):	**0.2554**
Total no. of User	-
GHG Performance in Ratio Indicator (per User) in tCO_2-eq/user/annum (Power company – specific):	-
GHG Performance in Ratio Indicator (per User) in tCO_2-eq/user/annum (Territory-wide default value):	-

Remark: Figures may not add up to total due to rounding off for reporting

Table 3: Summary of Scope 1 Activities Included and Excluded

GHG Emissions/ Removal	Activities/ Operation	Location/ Equipment Sources	Remark
Emissions	Towngas	Used for water heating	-
Fugitive Emissions	CO_2 extinguisher/Refrigerant consumed	Fire system and air conditioning system	Excluded since no consumption, only do the yearly inspection and replacement

Table 4: Summary of Scope 2 Activities Included and Excluded

GHG Emissions/ Removal	Activities/ Operation	Location/ Equipment Sources
Emissions	Consumption of electricity purchased from China Light and Power (CLP)	i) Lightings ii) Air conditioning iii) Lift and escalator service iv) Other equipment
Emissions	Consumption of towngas purchased from Hong Kong and China Gas (HKCG)	Water heating

Table 5: Summary of Scope 3 Activities Included and Excluded

GHG Emissions/ Removal	Activities/Operation	Location/ Equipment Sources
Emissions	Fresh water processing by Water Services Department (WSD)	Fresh Water supply
Emissions	Sewage processing by Drainage Services Department (DSD)	Waste Water drainage
Emissions	Disposal of paper waste	Paper consumption and recycling

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Scope 1: Direct Emission from Sources and Removals

i) GHG Emission from Stationary Sources

Table 9: GHG Emissions from Stationary Sources

Step 1	Step 2		Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
A	B	C	D	E	F	G	H	I
Facility/ Sources description	Fuel Information: Amount of fuel used	Fuel type	CO_2 emission factor	CO_2 emissions in tonnes of CO_2 equivalent ((B×D)/1000)	CH_4 emission factor	CH_4 emissions in tonnes of CO_2 equivalent ((B×F)/(1000×1000)×GWP)	N_2O emission factor	N_2O emissions in tonnes of CO_2 equivalent ((B×H)/(1000×1000)×GWP)
Water heating	7,095 (Unit)	Towngas	2.549	18.085	0.0446	0.009	0.0099	0.019
Total				**18.085**		**0.009**		**0.019**

Scope 2: Energy Indirect emission

i) GHG Emission from Electricity Purchased from China Light & Power (CLP)

Table 10: GHG Emissions from Electricity Purchased from CLP

Step1	Step 2	Step 3		Step 4	
A	B	C		D	
Facility/ Sources description	Amount of electricity purchased (in kWh)	Emission Factor (kg/kWh): Power Company Specific	Territory-wide default value	Indirect GHG emissions in tonnes of CO_2 equivalent (B×C/1000): Power Company Specific	Territory-wide default value
Electricity Consumption on air-conditioning (A/C no. 82850-24150-2, 82850-24191-1)	339,539	0.50	0.70	169.770	237.678
Electricity Consumption on general (A/C no. 82850-24192-4, 82850-24190-3,82850-24193-0,82851-20056-1)	942,667	0.50	0.70	471.333	659.867
Total	**1,282,206**			**641.103**	**897.545**

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ii) GHG Emission from Towngas Purchased from Hong Kong and China Gas (HKCG)

Table 11: GHG Emissions from Towngas Purchased

Step1	Step 2	Step 3	Step 4
A	B	C	D
Facility/ Sources description	Amount of Towngas purchased (Unit)	Emission Factor (kg/Unit)	Indirect GHG emissions in tonnes of CO_2 equivalent (B×C/1000)
Towngas Consumption	7,095	0.597	4.236
Total	**7,095**		**4.236**

Scope 3: Other Indirect Emission

i) Fresh water processing by Water Supplies Department (WSD)

Table 12: GHG Emissions due to Electricity Used for Fresh Water Processing by WSD

Step 1	Step 2	Step 3	Step 4
A	B	C	D
Facility/ Source description	Amount of water consumed as listed on water service bill (m^3)	Emission factor (kg/m^3)	Emission in tonnes of CO_2 equivalent (B×C/1000)
Water Consumption (Meter no. M17-300607, M15-236654)	1,160	0.424	0.492
Total	**1,160**		**0.492**

ii) Sewage processing by Drainage Services Department (DSD)

Table 13: GHG Emissions due to Electricity Used for Sewage Processing by DSD

Step 1	Step 2	Step 3		Step 4
A	B	C		D
Facility/ Source description	Amount of water consumed as listed on water service bill (m^3)	Emission factor (kg/m^3)	Default Emission factor	Emission in tonnes of CO_2 equivalent (B×C/1000)
Water Consumption (Meter no. M17-300607, M15-236654)	1,160	0.20	100%	0.232
Total	**1,160**			**0.232**

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Table 14: Methane Generation at Landfill in Hong Kong due to Disposal of Paper Waste

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
A	B	C	D	E	F	G
Facility/ Source description	Amount of paper in storage at the beginning of the reporting period (kg)	Amount of paper purchased during the reporting period	Amount of paper collected for recycling during the reporting period (kg)	Amount of paper in storage at the end of the reporting period	Emission factor (kg CO_2-e/kg of waste)	Indirect emissions in tonnes of CO_2 equivalent ((B + C - D - E) × F / 1000)
Disposal of Paper Waste	0.00	513.07	0.00	0.00	4.8	2.463
Total	**0.00**	**513.07**	**0.00**	**0.00**	**4.8**	**2.463**

Remark: Figures may not add up to total due to rounding off for reporting for the above tables of calculation of emission.

Table 15: Information of GWP and Emission Factor in the GHG Emissions/Removals Calculation

Scope	Emission / removal source	Emission/ removal factor			GWP values for 100-year time horizon	Reference
		CO_2	CH_4	N_2O		
1	Stationary combustion (Towngas)	2.549kg/unit	0.0446g/unit	0.0099g/unit	GWP of CH_4: 28 GWP of N_2O: 265	1&2
2	Electricity Purchased from CLP (2019)	0.50kgCO_2-eq/kWh	N/A	N/A	N/A	3
2.	Towngas Purchased from HKCG (2019)	0.597kgCO_2-eq/unit	N/A	N/A	N/A	4
3	Fresh Water Processing by WSD (FY2018/2019)	0.424kgCO_2-eq/m^3	N/A	N/A	N/A	5
3	Sewage Processing by DSD (FY2019/2020)	0.20kgCO_2-eq/m^3	N/A	N/A	N/A	6
3	Paper Waste Disposed	4.8kgCO_2-e/kg	N/A	N/A	N/A	1

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Worldwide Carbon Labels

Labeling Schemes


INTERNATIONAL STANDARD

ISO 14067

Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

Equivalent to ISO/IEC 17067 Quality Product Certification

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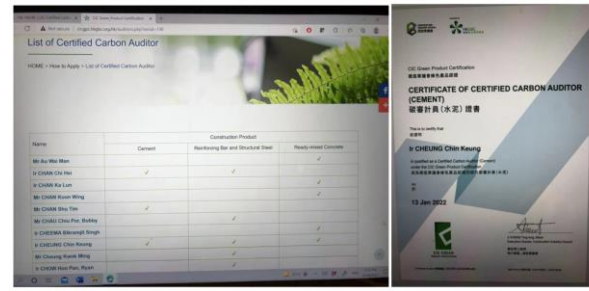
CIC - Hong Kong Green Building Council

Certified Carbon Auditor

"Cement" & "Ready Mixed Concrete"

"Reinforced Bar & Structural Steel"



Carbon Footprint

What is a Carbon Footprint

energy INSTITUTE

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 CO_2-equivalent for a gas is derived by multiplying the tonnes of the gas by the gas's associated Global Warming Potential (GWP).

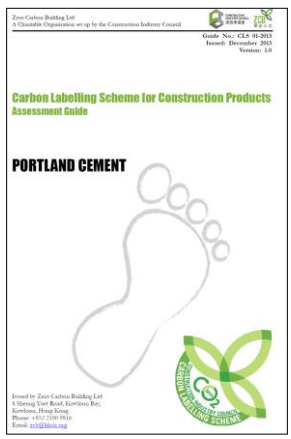


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Table 1. System Boundary for Quantifying Carbon Footprint of Portland Cement

System Boundaries		Processes
I.	Upstream Processes	▪ Extraction and production of raw material and energy wares used in the production and packaging of the finished product ▪ Transportation of raw materials and recycled materials to the plant ▪ If relevant, recycling process of recycled materials used in the product
II.	Core Processes	▪ Production of raw meal ▪ Production of clinker (calcinations) ▪ Grinding of cement ▪ Storage and packaging for dispatch
III.	Downstream Process	▪ Transportation from manufacturing to site

Source: EPD (2010)

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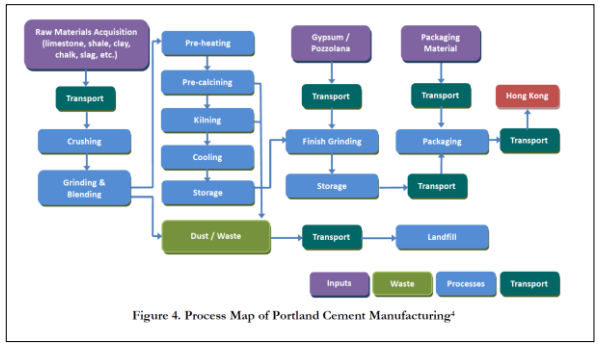

Figure 4. Process Map of Portland Cement Manufacturing[4]

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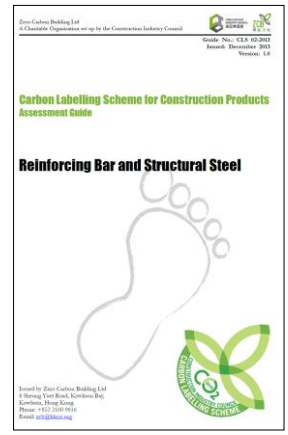

Figure 3. CIC Carbon Label with Product Details

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Table 2. System Boundary for Quantifying Carbon Footprint of Reinforcing Bar and Structural Steel

System Boundaries	Processes	
I. Upstream Processes	▪ Extraction and production of raw material and energy wares used in the production and packaging of the finished product ▪ Recycling process of recycled materials used in the product ▪ Transportation of raw materials and recycled materials to the plant	
II. Core Processes	▪ Production of steel including processes in: ▪ Coking plant ▪ Sintering plant ▪ Pelletising plant ▪ Blast furnace ▪ Basic oxygen furnace ▪ Electric arc furnace ▪ Ladle furnace ▪ Reheating furnace of rolling mill	▪ Finishing of steel ▪ Casting ▪ Hot rolling ▪ Cold rolling ▪ Storage and packaging for dispatch
III. Downstream Process	▪ Transportation from manufacturing to the border of HK	

Source: EPD (2011)

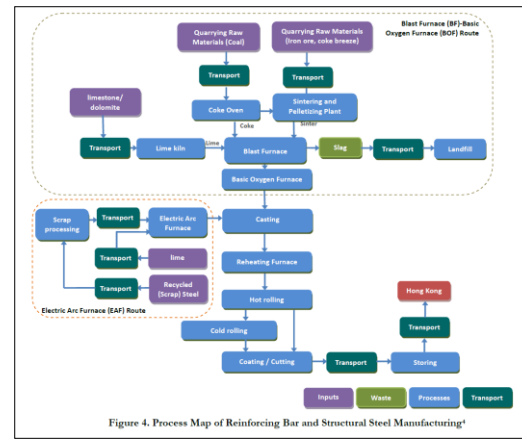
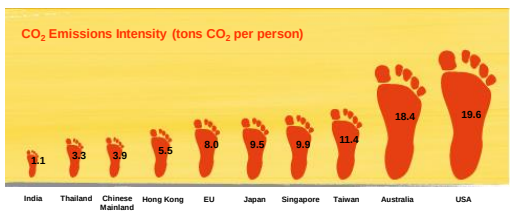


Figure 4. Process Map of Reinforcing Bar and Structural Steel Manufacturing[4]

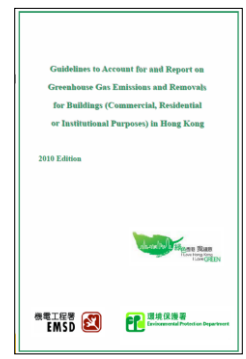
Carbon Footprint by Country

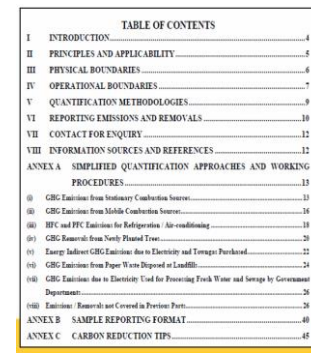
- Concerted efforts are needed to combat the Climate Change



Source: Key World Energy Statistics 2007, International Energy Agency, and Environmental Protection Department, the Hong Kong SAR Government

Hong Kong Guideline for GHG Accounting





Carbon Management

CARBON

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

Carbon Audit

Carbon Audit

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 CO_2 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

- 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?

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

HKEX

CONSULTATION PAPER
CERTIFIED EMISSION REDUCTION FUTURES

June 2009

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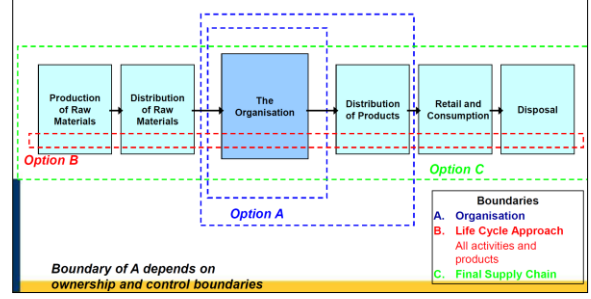
Different types of footprints



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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Relevant 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

Carbon Emission Information

1) Direct Carbon Emission Source :
直接"碳"排放来源 :

Stationary Fuel Combustion Emission 固定式燃料燃烧排放

	Amount 数量	Fuel 燃料	Consumption 用量
Boiler 锅炉			
Burner 燃烧器			
Turbine 涡轮			
Heaters 加热器			
Furnace 炉子			
Ovens 烘箱			
Dryer 烘干机			
Internal combustio engine 内燃机			
Other 其他			

	Type 型号	Fuel 燃料	Consumption 用量
Vehicle 车辆			
Shipping 船运			
Aviation 空运			

Fugitive-type emission 逸散式排放

	Type 型号	Volume 容量	Refill 补充
Freezer 冷冻器			
Air Conditioner 空调			
Fire extinguisher 灭火器			
Septic Tank 化粪池			

2) Direct Carbon Removal Source :
直接"碳"消除来源 :

Removal from newly planted trees 新种植树木的消除	
	Amount 数量
Newly Planted Trees 5m or higher 高达五米或以上的新植树木	

3) Energy Indirect Carbon Emission Source :
能源间接"碳"排放来源 :

Purchased energy emission 外购能源排放

	Source 来源	Amount 数量
Purchased Electricity 购入电力		
Purchased Town Gas 购入煤气		
Purchased Heat 购入热力		
Purchased Natural Gas 购入天然气		
Other Purchased Energy 其他购入能源		

4) Other Indirect Carbon Emission Source :
其他间接"碳"排放来源 :

	Description 描述
Business Trip Record 商务旅行纪录	
Water Usage Record 水用量纪录	
Water Discharge Record 水排放纪录	
Paper Purchase Record 纸张购入纪录	
Paper Recycling Record 废纸回收纪录	
Waste Recycling Record 废物回收纪录	
Other Indirect Emission 其他间接排放	

Section 4 Emission Reduction Information
第四部 减排资料

1) Emission Reduction Machineries Installed / Measures :
已经安装的减排设备 / 措施 :

	Description 描述
Energy Efficiency 能源效益	
Renewable Energy 再生能源	
Recycling facility 回收设施	
Waste Treatment 污染处理	

2) Other Greenhouse Gas Related Information :
其他温室气体相关资料 :

The End

Thank You