2. UNDERSTANDING YOUR COMPANY

Before establishing reduction targets or developing an implementation programme, it is important to understand your company's air emissions and energy consumption. This section provides guidance and references on how to evaluate your company's air emissions and energy consumption and how to conduct an initial audit of operations.

Identifying Emissions Sources

Energy Consumption

Saving energy reduces air emissions. Electricity and fuel consumption can be used to quantify energy consumption. This information can be gathered from your utility and fuels bills. If this information is not routinely kept, establishing a system to do so is an important first step in quantifying your energy consumption.

1 unit of electricity consumed is equal to 1 kilowatt hour (kWh) and 1 unit of gas consumed is equal to 48 megajoules (MJ) for Towngas or 46 MJ for liquefied petroleum gas (LPG). These conversion factors are useful for quantifying energy consumption on a common basis across different sectors and estimating corresponding direct and indirect air emissions.

Air Emissions

Industrial operations, vehicles and power plants are the main "direct" air pollution sources in the PRD region. Offices are also an "indirect" air pollution source as the electricity consumed by these operations results in air emissions from power plants.

Sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM) and volatile organic compounds (VOCs) are key air pollutants in the PRD region. The Hong Kong Special Administrative Region Government (HKSAR Government) and the Guangdong Provincial Government reached a consensus in April 2002 to reduce emissions of SO_2, NO_x, PM and VOCs by 40%, 20%, 55% and 55%, respectively, by 2010, using the emissions levels at 1997 as a base. Therefore, this section focuses on quantifying SO_2, NO_x, PM and VOCs emissions.

Selective key air pollutant emissions sources are summarised below.

Emissions Sources	Air Pollutants			
	Sulphur Dioxide (SO_2)	Nitrogen Oxides (NO_x)	Particulate Matter (PM)	Volatile Organic Compounds (VOCs)
Fuel Consumption				
Coal and oil-fired power plants	✓	✓	✓	
Diesel oil-fired generators, boilers and furnaces	✓	✓	✓	
Vehicles				
Motor vehicles	✓[(a)]	✓	✓	✓
Marine vessels	✓	✓	✓	
Petrol filling stations				✓
Typical Manufacturing Industries (emissions from processes) [(b)]				
Cement	✓	✓	✓	
Chemical				✓
Construction	✓	✓	✓	
Electronics				✓
Plastics			✓	✓
Printing				✓
Textiles	✓	✓	✓	✓
Toys			✓	✓
Indirect Source				
Office	✓[(c)]	✓[(c)]	✓[(c)(d)]	✓[(e)]

Notes:
(a) Motor vehicle fuel sold in Hong Kong has a low sulphur content. Much of the diesel sold on the Mainland does not.
(b) Many different industries operate in Hong Kong and the Pearl River Delta region. These are just some of the more common industry sectors.
(c) SO_2 and NO_x emissions are generated from energy consumed in offices.
(d) PM emissions in offices also include dusts from ventilation systems, paper, photocopiers, printers, etc.
(e) VOCs in offices come from cleaning agents, chemical usage, paints, furnishing, etc.

Quantifying Air Emissions

Energy Consumption

Electricity, Towngas or liquefied petroleum gas (LPG) are the common sources of energy used in Hong Kong. "Indirect" air emissions from offices can be estimated by considering the quantity of electricity consumed, as identified from monthly electricity bills, and using typical emissions factors.

Electricity

Nitrogen oxides (NO_x), sulphur dioxide (SO_2) and particulate matter (PM) are the major air pollutants generated from power stations. A reduction in electricity used will reduce air emissions from power stations. To estimate indirect emissions from electricity usage in Hong Kong, the following equations can be used.

EMISSIONS ESTIMATION FROM USE OF HONG KONG ELECTRICITY

NO_x = electricity used (no. of units**) x 1.3 (g/kWh)
SO_2 = electricity used (no. of units**) x 2.1 (g/kWh)
PM = electricity used (no. of units**) x 0.1 (g/kWh)

EXAMPLE OF EMISSIONS ESTIMATION

Emissions estimation from the electricity bill from the office of "ABC" in Hong Kong.

Meter Number	Present Reading	Previous Reading
1020188	360345	358746

Multi Factor	Units Consumed
10	15990
Total	15990

NO_x = 15,990 x 1.3 (g/kWh) = 21 kg
SO_2 = 15,990 x 2.1 (g/kWh) = 34 kg
PM = 15,990 x 0.1 (g/kWh) = 1.6 kg

*** 1 unit (in the electricity bill) = 1 kWh*
Reference to CLP Social and Environmental Report 2005 and HEC Environment, Quality, Health and Safety Report 2005

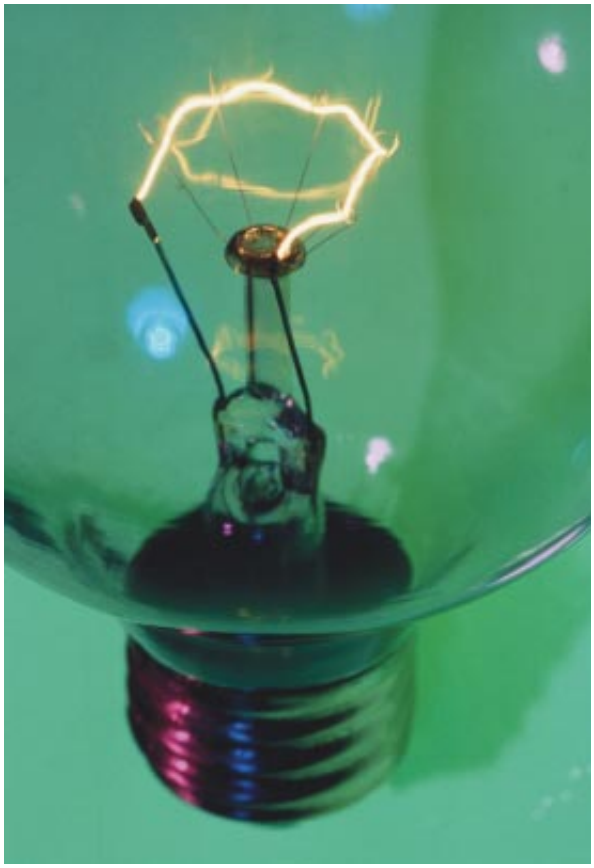
Towngas/Liquefied Petroleum Gas (LPG)

Apart from electricity consumption, gaseous fuel is also another common energy source in Hong Kong. NO_x is the main air pollutant resulting from gaseous combustion. NO_x emissions can be estimated using the following equation.

EMISSIONS ESTIMATION FROM GASEOUS FUEL CONSUMPTION

[Towngas]
NOx = no. of unit x 48 (MJ) x 8.92 (kg/106 MJ of gas)
[LPG]
NOx = no. of unit x 46 (MJ) x 8.92 (kg/106 MJ of gas)

Reference to Towngas Environment, Quality, Health and Safety Report 2005



Vehicle Movement / Idling

NO_x and PM are the main air pollutants generated from vehicle movements on roads and idling. Different sizes and types of vehicle engines produce different levels of air pollutants. Estimating air emissions from vehicle fleets is complex and would require more detailed information on the vehicle type, engine condition, fuel used, and running pattern, etc. To provide a simple way, total distance travelled and idling time can be used to conduct rough estimations of vehicle emissions.

The HKSAR Environmental Protection Department (EPD) has developed a comprehensive EMFAC model to estimate vehicle emissions. Further information on the EMFAC model can be found at EPD's Website: *www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/emfac.html*.

EMISSIONS ESTIMATION FROM VEHICLE MOVEMENT / IDLING

While Travelling

Air Emissions = [kilometres travelled] x [average emissions factor for different vehicle type (g/km)]

Air Pollutant	NO_x	PM
Average Fleet Vehicle Emissions (g/km travelled)		
Passenger Car	0.9	Negligible
Light Goods Vehicle	1.6	0.3
Heavy Goods Vehicle	8.2	0.6

Example:
A light goods vehicle running 20 km a day,
NO_x emissions = 20 x 1.6 = 32 g ; PM emissions = 20 x 0.3 = 6 g

While Idling

Air Emissions = [Idling time (min)] x [average emissions factor for different vehicle type (g/min)]

Air Pollutant	NO_x	PM
Average Emissions Factor (g/min of idling)		
Passenger Car	0.2	Negligible
Public Light Bus / Passenger Van /Light Goods Vehicle	0.5	0.05
Heavy Goods Vehicle / Non-franchised / Franchised Bus	2.0	0.05

Example:
A heavy goods vehicle idling to unload goods for 10 minutes,
NO_x emissions = 10 min x 2.0 g/min = 20 g ; PM emissions = 10 min x 0.05 g/min = 0.5 g

Reference to Energy Consumption Indicators (HKSAR Electrical and Mechanical Services Department), Traffic Census 2005 (HKSAR Transport Department), and Emissions Inventory Guidebook 2005 (European Environment Agency)

Industrial Operations

Power plants and industrial operations contribute to the local air pollution problem in Hong Kong and the Pearl River Delta (PRD). Industrial processes and back-up diesel generators produce a variety of different air pollutants.

Power Plants in PRD Region

Emissions from power plant operating in Hong Kong have been discussed in the above section. In the PRD region, there are a large number of government and privately owned power plants operating. As noted above, NO_x, SO_2 and PM are the main air pollutants from these power plants.

In China, power plants are mostly coal-fired. The emissions levels of SO_2 from power plants depend in part on the sulphur content of the coal used as well as the nature and type of emissions controls installed, which can vary significantly between power plants. The following equations can be used to estimate pollutant emissions from electricity consumed in the PRD.

EMISSIONS ESTIMATION FROM ELECTRICITY IN MAINLAND CHINA

NO_x = electricity used (kWh) x 1.4 (g/kWh)
SO_2 = electricity used (kWh) x 2.1 (g/kWh)
PM = electricity used (kWh) x 0.2 (g/kWh)

Reference to Study of Air Quality in the Pearl River Delta Region, Environmental Protection Department, HKSAR

Diesel Backup Generators

Diesel generators are usually used as backup for power generation in manufacturing industries. Air pollutants will be generated from the combustion of diesel oil and NO_x is the main air pollutant. The emissions of NO_x can be estimated based on the installed capacity of the generator and an emissions factor. The following simplified formula could be useful for estimating NO_x emissions.

EMISSIONS ESTIMATION FROM A DIESEL BACKUP GENERATOR

NO_x = installed generator capacity (hp) x 0.014 (kg/hp-hr) x operating hour (hr)

Source : Compilation of Air Pollutant Emissions Factors, AP-42, 5th Edition, U.S. Environmental Protection Agency

Diesel Boiler

Diesel boilers are usually used to provide heat and steam for the manufacturing processes such as dyeing. NO_x and SO_2 are the main air pollutants generated from the combustion of diesel oil. Such emissions can be estimated based on the diesel oil consumption, sulphur content in diesel oil and the well-established emissions factors. The following simplified formula could be useful for estimating NO_x and SO_2 emissions.

EMISSIONS ESTIMATION FROM A DIESEL BOILER

If power rating < 293 kW
NO_x = diesel oil consumption (litre) x 2.2 g/litre
SO_2 = diesel oil consumption (litre) x 17 g/litre x sulphur content in diesel oil (%)

Source : Compilation of Air Pollutant Emissions Factors, AP-42, 5th Edition, U.S. Environmental Protection Agency

Industrial Process

Different types of industrial processes will produce different types of air emissions. The U.S. Environmental Protection Agency (EPA) developed a *Compilation of Air Pollutant Emissions Factors, AP-42, 5th Edition (AP-42)* in 1995, which is a comprehensive guidebook to assist facility operators to understand:

- The types of air pollutants generated by specific activities;
- Methodologies for estimating emissions factors; and
- Suitable air pollution control measures and associated removal efficiencies.

The AP-42 covers a number of industrial activities including:

- External combustion sources such as boilers;
- Solid waste disposal such as landfills;
- Stationary internal combustion sources such as gas turbine engines;
- Evaporation loss sources;
- Petroleum industries;
- Organic chemical process industries;
- Liquid storage tanks;
- Inorganic chemical industries;
- Food and agricultural industries;
- Wood products industries;
- Mineral products industries such as concrete batching and stone crushing;
- Metallurgical industries such as aluminium manufacturing.

For further details: *www.epa.gov/ttn/chief/ap42*

Volatile Organic Compounds (VOCs)

VOCs are a family of chemical compounds that possess high vapour pressure and low water solubility. Many VOCs are human-made and are used in the manufacturing of paints, inks, adhesives, pharmaceuticals and refrigerants.

A "Joint Study on Pearl River Delta Region Air Quality" completed in 2002 identified paints, the printing industry, VOC-containing consumer products and motor vehicles to be the major VOC emissions sources in the PRD. VOCs are mainly emitted from the solvent evaporation and the level of VOC emissions depends on the composition of the products and solvent. For example, VOC emissions will be higher from solvent-based paint or printing inks than their water-based equivalents.

The HKSAR Government proposed in late 2004 a scheme to require mandatory registration and labelling of the VOCs in paints, printing inks and selected consumer products for sale in Hong Kong. However after extensive consultation, the Government has amended the initial proposal to be a more direct and effective control scheme.

In the 2006 Policy Address on 11 October 2006 the HKSAR Chief Executive, Mr Donald Tsang, announced that legislation to restrict the VOC content of printing materials, paints and consumer products will be introduced, based on stringent U.S. and California standards. The new regulation will impose maximum limits on the VOC content of selected products in phases from 1 April 2007. This will enhance significant reduction of VOC emissions. During the transitional periods, paints not complying with the future VOC limits will be required to carry a bilingual advisory label.

Conducting An Initial Audit

Before defining the EEM objective and establishing the reduction target, you should know the current position of your company, i.e., how much energy is consumed and how many emissions are produced by your operation. Carrying out an initial energy and emissions audit is essential to gather the background data of the company.

The types of data to be gathered should include:

General Information	• No. of staff • Working hours • Floor area
Information related to air emissions	• Number of operating stacks • Types of fuel used (i.e., diesel, natural gas, LPG, etc.) • Monthly fuel consumption rate (litre/month or m^3/month) • Operating hours of each stack • Any air control measures (i.e., air filter, wet scrubber, cyclone, activated carbon, etc.)
Information related to energy consumption	• Number and types of office equipment (i.e., printers, computers, photocopiers, fax machines, etc.) • Power rating of industrial equipment (kilowatts, horsepower, etc.) • Operating hours of each equipment • Type and number of fluorescent tubes / light bulbs • Electricity bills for the past twelve months • Gas bills for the past twelve months • Number of air conditioning units • What type of air conditioning system (i.e., window-mounted type, split type, water-cooling tower, etc.)
Information related to vehicular emissions	• Total number of company cars and trucks by type and size of vehicle • Total kilometres travelled by cars and trucks by type and size of vehicle

The gathered data can be used to estimate the energy consumption and air emissions based on the equations and references presented above. In addition, the benchmarking system of the HKSAR Electrical and Mechanical Services Department (EMSD), as described in the next section, also provides guidance on how to estimate energy consumption.

The initial audit should be carried out by the EEM Team. The gathered data should be recorded and kept on file to enable tracking of performance. A sample template for undertaking an initial audit can be found in *Appendix A*.

Energy Audit – An Effective Energy Management Tool

"To many SMEs, energy audit sounds like a technical term, but it is simply an examination of existing energy consuming systems and housekeeping practices to ensure that energy is being used efficiently," Mr Eddie Wu, Energy Services Manager of CLP Power Hong Kong Limited (CLP Power) said. "You can always find room for improving energy efficiency by just walking around your offices or premises and conducting a site survey according to the Energy Audit Guidelines, which is available from various sources such as the Government's website."

Since 1999, CLP Power has dedicated an Energy Services Team to conduct energy audits for more than 500 large commercial and industrial customers, helping them increase energy efficiency and achieve tangible energy savings. Amongst them is a large property management company which manages many office towers, hotels, service apartments and shopping arcades, a case illustrated by Mr Wu.

"On lighting and hot water supplies, the property management company installed over 20,000 electronic ballasts, phased out several aging gas or diesel boilers and switched to the highly energy efficient and emission-free heat pump water heating systems. On power supply, capacitor banks have been installed to improve the power factor. On air-conditioning, the customer was advised to use fresh water cooling towers for chiller heat rejection. Total energy savings from all these initiatives are as high as 5 million kWh a year."

Energy audit is similar to financial accounting. It is a quick way to assess and analyse energy performance, identify obvious energy wastage and opportunities for energy savings that help reduce emissions.

"Through auditing, customers are made aware of their potential areas of energy inefficiency," Mr Wu continued to explain. "During the visits to customers' premises, we gave various advice to clients, ranging from housekeeping management to installation of energy-efficient equipment. Our experience shows that through energy audit, most users can identify the potential to save 5-10% on overall energy costs."

Many energy saving practices are just simple steps. For example, replacing T12 or T10 fluorescent tubes with T8 or T5 energy efficient fluorescent tubes can improve 10% to 30% energy efficiency; using LCD monitor can save more than 50% of the electricity than that of the CRT monitor; regular cleaning of condenser tubes, cooling coils and air filters can help maintain cooling efficiency; using energy efficient equipment (e.g. equipment affixed with Energy Label) can reduce energy consumption.

Other than energy audits, CLP Power has actively contributed to raising energy saving and environmental awareness through various programmes such as community-based education activities and regular seminars or conferences to share international and local energy practices with SMEs.